Atlantic States Marine Fisheries Commission

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

Douglas E. Grout (NH), Chair *James J. Gilmore, Jr., (NY), Vice-Chair* *Robert E. Beal, Executive Director*

Vision: Sustainably Managing Atlantic Coastal Fisheries

MEMORANDUM

July 18, 2017

TO: Commissioners; Proxies; American Eel Management Board; American Lobster Management Board; Atlantic Coastal Cooperative Statistics Program Coordinating Council; Atlantic Menhaden Management Board; Executive Committee; Interstate Fisheries Management Program Policy Board; South Atlantic State/Federal Fisheries Management Board; Shad and River Herring Management Board; Summer Flounder, Scup, and Black Sea Bass Management Board; Tautog Management Board

FROM: Robert E. Beal *REB*
Executive Director

RE: ASMFC Summer Meeting: August 1 – 3, 2017 (TA # 17-106)

The Atlantic States Marine Fisheries Commission's Summer Meeting will be held August 1-3, 2017 at **The Westin Alexandria** (Telephone: 703.253.8600) located at 400 Courthouse Square, Alexandria, Virginia. Meeting materials are available on the Commission website at http://www.asmfc.org/home/2017-summer-meeting. Supplemental materials will be posted to the website on Wednesday, July 26, 2017.

Board meeting proceedings will be broadcast daily via webinar beginning August 1st at 9:45 a.m. and continuing daily until the conclusion of the meeting (expected to be 4:30 p.m.) on Thursday, August 3rd. The webinar will allow registrants to listen to board/section deliberations and view presentations and motions as they occur. No comments or questions will be accepted via the webinar. Should technical difficulties arise while streaming the broadcast the boards/sections will continue their deliberations without interruption. We will attempt to resume the broadcast as soon as possible. Please go to https://attendee.gotowebinar.com/register/3016985523909460737 to register.

I look forward to seeing you at the Summer Meeting. If the staff or I can provide any further assistance to you, please call us at 703.842.0740.

Enclosures: Final Agenda, Hotel Directions, TA # 17-106, and Travel Reimbursement Guidelines

Atlantic States Marine Fisheries Commission

Summer Meeting

August 1 – 3, 2017

The Westin Alexandria

Alexandria, Virginia

Public Comment Guidelines

With the intent of developing policies in the Commission's procedures for public participation that result in a fair opportunity for public input, the ISFMP Policy Board has approved the following guidelines for use at management board meetings:

<u>For issues that are not on the agenda</u>, management boards will continue to provide opportunity to the public to bring matters of concern to the board's attention at the start of each board meeting. Board chairs will use a speaker sign-up list in deciding how to allocate the available time on the agenda (typically 10 minutes) to the number of people who want to speak.

<u>For topics that are on the agenda</u>, but have not gone out for public comment, board chairs will provide limited opportunity for comment, taking into account the time allotted on the agenda for the topic. Chairs will have flexibility in deciding how to allocate comment opportunities; this could include hearing one comment in favor and one in opposition until the chair is satisfied further comment will not provide additional insight to the board.

<u>For agenda action items that have already gone out for public comment</u>, it is the Policy Board's intent to end the occasional practice of allowing extensive and lengthy public comments. Currently, board chairs have the discretion to decide what public comment to allow in these circumstances.

In addition, the following timeline has been established for the **<u>submission of written comment for issues for which the Commission has *NOT* established a specific public comment period</u>** (i.e., in response to proposed management action).

1. Comments received 3 weeks prior to the start of a meeting week will be included in the briefing materials.
2. Comments received by 5:00 PM on the Tuesday immediately preceding the scheduled ASMFC Meeting (in this case, the Tuesday deadline will be ***July 25, 2017***) will be distributed electronically to Commissioners/Board members prior to the meeting and a limited number of copies will be provided at the meeting.
3. Following the Tuesday, ***July 25, 2017 5:00 PM deadline***, the commenter will be responsible for distributing the information to the management board prior to the board meeting or providing enough copies for the management board consideration at the meeting (a minimum of 50 copies).

The submitted comments must clearly indicate the commenter's expectation from the ASMFC staff regarding distribution. As with other public comment, it will be accepted via mail, fax, and email.

Final Agenda

The agenda is subject to change. The agenda reflects the current estimate of time required for scheduled Board meetings. The Commission may adjust this agenda in accordance with the actual duration of Board meetings. Interested parties should anticipate Boards starting earlier or later than indicated herein.

Tuesday August 1, 2017

8:00 – 9:30 a.m. **Executive Committee**
Breakfast will be served when you arrive; you may arrive as early as 7:30 a.m.
(A portion of this meeting will be a closed session for Committee members and Commissioners only)
Members: Abbott, Allen, Blazer, Boyles, Jr., Bull, Clark, Davis, Estes, Gilmore, Grout, Keliher, McNamee, Miller, Miner, Pierce, Shiels, Woodward
Chair: Grout
Staff: Leach

1. Welcome/Call to Order *(D. Grout*)
2. Committee Consent
    - Approval of Agenda
    - Approval of Meeting Summary from May 2017
3. Public Comment
4. Discuss Council/Commission Line in NOAA Budget
5. Discuss the Secretary of Commerce Decision Regarding New Jersey Summer Flounder Recreational Measures
6. Discuss Executive Director's Contract Renewal **(Closed Session)**
7. Other Business/Adjourn

9:45 a.m. – 12:15 p.m. **South Atlantic State/Federal Fisheries Management Board**
Member States: New Jersey, Delaware, Maryland, Virginia, North Carolina, South Carolina, Georgia, Florida
Other Members: DC, PRFC, NMFS, SAFMC, USFWS
Other Participants: Jiorle, Lynn, Lee, McDonough, Powers, Rickabaugh
Chair: Estes
Staff: Schmidtke, Daniel

1. Welcome/Call to Order *(J. Estes)*
2. Board Consent
    - Approval of Agenda
    - Approval of Proceedings from May 2017
3. Public Comment
4. Review and Consider Cobia Draft Fishery Management Plan for Public Comment *(L. Daniel)* **Action**

5. 2017 Spot Benchmark Stock Assessment **Final Action**
   - Presentation of Benchmark Assessment Report (*C. McDonough*)
   - Presentation of Peer Review Panel Report *(P. Campfield*)
   - Consider Acceptance of Benchmark Stock Assessment and Peer Review Report for Management Use
   - Consider Management Response to Benchmark Stock Assessment and Peer Review Report (*J. Estes*)
6. Recess

12:15 – 12:45 p.m. **Lunch Provided for Commissioners, Proxies and Board Members**

12:45 – 1:30 p.m. **South Atlantic State/Federal Fisheries Management Board (continued)**

7. Consider 2017 Traffic Light Analyses for Atlantic Croaker and Spot (*C. McDonough*)
   - Review 2017 Traffic Light Analyses
   - Progress Update on Exploratory Analyses for Incorporation of Additional Indices and Adjustments to the Atlantic Croaker Traffic Light Analysis
8. Consider 2017 Atlantic Croaker FMP Review and State Compliance (*M. Schmidtke*) **Action**
9. Other Business/Adjourn

1:45 – 2:45 p.m. **Atlantic Coastal Cooperative Statistics Program Coordinating Council**
Members: Alexander, Baum, Beal, Blazer, Boyles, Jr., Carmichael, Cimino, Clifford, Coit, Cyr, Detlor, Fegley, Gary, Geer, Gilmore, Grout, Keliher, King, McCawley, Michels, Moore, Nies, Perkins, Pierce, Ponwith, Risenhoover, Shiels, Stephen, White
Chair: Boyles, Jr.
Staff: Cahall

1. Welcome/Introductions *(R. Boyles, Jr.)*
2. Public Comment*
3. Council Consent
   - Approval of Agenda
   - Approval of Proceedings from May 2017
4. ACCSP Status Report *(M. Cahall)*
   - Program Updates
   - Committee Updates
5. Review and Consider Approval of the Marine Recreational Information Program Atlantic Regional Implementation Plan *(G. White)* **Action**
6. Recreational Data Collection: Changes on the Horizon *(G. White)*
7. Other Business/Adjourn

See Public Comment Guidelines:
http://www.accsp.org/sites/all/themes/aqua/File/ACCSP_PublicCommentPolicyOct2013.pdf

3:00 – 6:00 p.m. **American Lobster Management Board**
Member States: Maine, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Delaware, Maryland, Virginia
Other Members: NEFMC, NMFS
Chair: Borden
Other Participants: Cloutier, Reardon, Gwin, Mansi, Moore
Staff: Ware

1. Welcome/Call to Order *(D. Borden)*
2. Board Consent
   - Approval of Agenda
   - Approval of Proceedings from May 2017
3. Public Comment
4. Consider American Lobster Addendum XXV for Final Approval **Final Action**
   - Presentation of Proposals from Lobster Conservation Management Teams (LCMT) 2, 3, 4, 5, and 6
   - Technical Committee Report on LCMT Proposals *(K. Reardon)*
   - Consider Final Approval of Addendum XXV
5. State and Federal Inconsistencies in Lobster Conservation Management Area 4 Season Closure *(M. Ware)* **Possible Action**
6. American Lobster Gulf of Maine/Georges Bank Subcommittee Report *(M. Ware)* **Possible Action**
7. Update on Development of American Lobster Draft Addendum XXVI *(M. Ware)*
8. Law Enforcement Committee Report on American Lobster Chain of Custody *(M. Robson)*
9. NOAA Office of Law Enforcement Draft Enforcement Priorities 2018-2022 *(M. Ware)* **Possible Action**
10. Other Business/Adjourn

Wednesday August 2, 2017

8:00 – 10:00 a.m. **Shad and River Herring Management Board**
Member States: Maine, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Delaware, Maryland, Virginia, North Carolina, South Carolina, Georgia, Florida
Other Members: DC, PRFC, USFWS, NMFS
Other Participants: Chase, Furlong
Chair: Clark
Staff: Rootes-Murdy

1. Welcome/Call to Order *(J. Clark)*
2. Board Consent
   - Approval of Agenda
   - Approval of Proceedings from February 2017
3. Public Comment
4. Review Update for River Herring Stock Assessment *(B. Chase)*
5. Review Update for Shad Stock Assessment Timeline *(J. Kipp)*

6. Consider Approval of Shad and River Herring Sustainability Fishery Management Plans (SFMPs) **Final Action**
   - Review SFMPs and Technical Committee Memo *(B. Chase)*
     - South Carolina: Updated River Herring SFMP
     - Florida: Updated Shad SFMP
7. Consider Approval of 2016 FMP Review and State Compliance Reports *(K. Rootes-Murdy)* **Action**
8. Other Business/Adjourn

10:15 – 11:15 a.m. **American Eel Management Board**
Member States: Maine, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, Pennsylvania, New Jersey, Delaware, Maryland, Virginia, North Carolina, South Carolina, Georgia, Florida
Other Members: DC, NMFS, PRFC, USFWS
Chair: Clark
Other Participants: Cloutier, Delucia, Wildman
Staff: Rootes-Murdy

1. Welcome/Call to Order *(J. Clark)*
2. Board Consent
   - Approval of Agenda
   - Approval of Proceedings from January 2017
3. Public Comment
4. Consider North Carolina Glass Eel Aquaculture Plan for 2018 *(K. Rootes-Murdy)* **Action**
   - Technical Committee Report
   - Law Enforcement Committee Report *(M. Robson)*
5. Consider 2016 Yellow Eel Landings Overage and Coastwide Cap *(K. Rootes-Murdy)* **Possible Action**
6. Consider 2016 American Eel FMP Review and State Compliance *(K. Rootes-Murdy)* **Action**
7. Other Business/Adjourn

11:30 a.m. – 12:30 p.m. **Atlantic Menhaden Management Board**
Member States: Maine, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Delaware, Maryland, Virginia, North Carolina, South Carolina, Georgia, Florida
Other Members: NMFS, PRFC, USFWS
Other Participants: McNamee, Kaelin, Kersey
Chair: Ballou
Staff: Ware

1. Welcome/Call to Order *(R. Ballou)*
2. Board Consent
   - Approval of Agenda
   - Approval of Proceedings from May 2017
3. Public Comment
4. Review 2017 Atlantic Menhaden Stock Assessment Update *(J. McNamee)*
5. Recess

12:30 – 1:30 p.m. **Lunch Break (not provided)**

1:30 – 5:45 p.m. **Atlantic Menhaden Management Board (continued)**

6. Biological Ecological Reference Point Work Group Report *(S. Madsen)*
   - Review of Hilborn, et al (2017) Paper
7. Consider Draft Amendment 3 for Public Comment **Action**
   - Biological Ecological Reference Point Workgroup Report on Interim Reference Points (*K. Drew*)
   - Review of Management Issues and Alternatives (*M. Ware*)
   - Plan Development Team Report on New York Proposal to Recalibrate Landings (*M. Ware*)
   - Advisory Panel Report (*J. Kaelin*)
8. Set 2018 Atlantic Menhaden Fishery Specifications **Final Action**
   - Overview of Specification Process (*M. Ware*)
   - Technical Committee Report (*J. McNamee*)
   - Advisory Panel Report *(J. Kaelin*)
9. Update on 2017 Episodic Events Set Aside *(M. Ware)*
10. Other Business/Adjourn

Thursday, August 3, 2017

8:00 – 11:15 a.m. **Interstate Fisheries Management Program Policy Board**

Member States: Maine, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Delaware, Maryland, Virginia, North Carolina, South Carolina, Georgia, Florida
Other Members: DC, NMFS, PRFC, USFWS
Chair: Grout
Staff: Kerns

1. Welcome/Call to Order *(D. Grout)*
2. Board Consent
   - Approval of Agenda
   - Approval of Proceedings from May 2017
3. Public Comment
4. Update from the State Director's Meeting and Executive Committee (*D. Grout*)
5. Review and Consider New Jersey Appeal of Addendum XXVIII to the Summer Flounder Fishery Management Plan **Final Action**
   - Postponed Motion: *Move to postpone the New Jersey Appeal of the Summer Flounders, Scup, and Black Sea Bass Addendum XXVIII until the Summer/August ISFMP Policy Board Meeting. Motion by Mr. Nowalsky; Second by Mr. Keliher.*
6. Discuss the Secretary of Commerce Decision Regarding New Jersey Summer Flounder Recreational Measures
7. Review of the Annual Performance of the Stocks (*T. Kerns*)
8. Discuss New England Fishery Management Council Participation on the Atlantic Herring Section (*T. Kerns*) **Possible Action**

9. Review and Consider Approval of Standard Meeting Practices (*T. Kerns*) **Action**
10. Progress Update on the 2017 Atlantic Sturgeon Benchmark Stock Assessment (*K. Drew*)
11. Review and Consider Approval of the Assessment Schedule (*S. Madsen*) **Action**
12. Standing Committee Reports
    - Habitat and Artificial Reefs *(L. Havel)* **Action**
    - Atlantic Coastal Fish Habitat Partnership *(L. Havel)*
13. Review Non-compliance Findings (if necessary) **Action**
14. Other Business/Adjourn

11:15-11:30 a.m. **Business Session**
Member States: Maine, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Delaware, Maryland, Virginia, North Carolina, South Carolina, Georgia, Florida
Chair: Grout
Staff: Beal

1. Welcome/Introductions *(D. Grout)*
2. Board Consent
    - Approval of Agenda
    - Approval of Proceedings from May 2017
3. Public Comment
4. Review Non-compliance Findings (if necessary) **Final Action**
5. Other Business/Adjourn

11:45 a.m. – 12:15 p.m. **Summer Flounder, Scup, and Black Sea Bass Management Board**
Member States: Maine, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Delaware, Maryland, Virginia, North Carolina
Other Members: NMFS, PRFC, USFWS
Other Participants: Wojcik, Snellbaker
Chair: Luisi
Staff: Rootes-Murdy

1. Welcome/Call to Order *(M. Luisi)*
2. Board Consent
    - Approval of Agenda
    - Approval of Proceedings from May 2017
3. Public Comment
4. Summer Flounder Recreational Working Group Report *(K. Rootes-Murdy)* **Possible Action**
5. Recess

12:30 – 12:55 p.m. **Lunch Provided for Commissioners, Proxies and Board Members**

12:55 – 1:45 p.m. **Summer Flounder, Scup, and Black Sea Bass Management Board (continued)**

6. Review of 2017 Black Sea Bass Recreational Measures *(K. Rootes-Murdy)* **Possible Action**
7. Black Sea Bass Recreational Working Group Report *(K. Rootes-Murdy)*
8. Other Business/Adjourn

2:00 – 4:30 p.m. **Tautog Management Board**
Member States: Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Delaware, Maryland, Virginia
Other Members: NMFS, USFWS
Other Participants: McNamee, Snellbaker
Chair: Nowalsky
Staff: Kerns

1. Welcome/Call to Order *(A. Nowalsky)*
2. Board Consent
   - Approval of Agenda
   - Approval of Proceedings from May 2017
3. Public Comment
4. Consider Amendment 1 for Final Approval **Final Action**
   - Review Public Comment and Review Management Options *(T. Kerns)*
   - Advisory Panel Report
   - Law Enforcement Report *(J. Snellbaker)*
   - Consider Final Approval of Amendment 1
5. Elect Vice-Chair **Action**
6. Other Business/Adjourn

Atlantic States Marine Fisheries Commission

Executive Committee

August 1, 2017
8:00 – 9:30 a.m.
Alexandria, Virginia

Draft Agenda

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

A portion of this meeting may be a closed session for Committee members and Commissioners only

1. Welcome/Call to Order (*D. Grout)*

2. Committee Consent
   - Approval of Agenda
   - Approval of Meeting Summary from May 2017

3. Public Comment

4. Discuss Council/Commission Line in NOAA Budget

5. Discuss the Secretary of Commerce Decision Regarding New Jersey Summer Flounder Recreational Measures

6. Discuss Executive Director's Contract Renewal **(Closed Session)**

7. Other Business/Adjourn

Please Note: Breakfast will be served when you arrive; you may arrive as early as 7:30 a.m.

The meeting will be held at the Westin Alexandria; 400 Courthouse Square; Alexandria, VA; 703.253.8600

Vision: Sustainably Managing Atlantic Coastal Fisheries

MEETING SUMMARY OF THE

ATLANTIC STATES MARINE FISHERIES COMMISSION

EXECUTIVE COMMITTEE

Westin Alexandria
Alexandria, VA
May 10, 2017

INDEX OF MOTIONS

1. **Approval of Agenda by Consent. (Page 2)**

2. **Approval of Meeting Summary from February 1, 2017 by Consent. (Page 2)**

3. **Motion to "Approve the FY18 Budget as presented." Mr. Abbott/Mr. Blazer. The motion passed unanimously. (Page 2)**

4. **Move adoption of option 2 "Once an AP member is assigned as an <u>ongoing or</u> board-specific proxy to a species board for which (s)he serves as an advisor (e.g. American Eel Board/American Eel AP), the new proxy must step down from the AP and the state appoint a new AP member."** *The underlined words are added to the original Option #2*. **Mr. Abbott/Dr. Pierce (14-1) (Page 2)**

5. **Adjournment by Consent (Page 3)**

ATTENDANCE

Committee Members

Doug Grout, NH
Dennis Abbott, NH (LA Chair)
David Pierce, MA
Mark Alexander, CT (proxy for Craig Miner)
Jason McNamee, RI
Jim Gilmore, NY
Russ Allen, NJ
Andy Shiels, PA
John Clark, DE
Roy Miller, DE (GA Chair)
David Blazer, MD
John Bull, VA
Michelle Duval, NC (proxy for Braxton Davis)
Robert Boyles, SC
Spud Woodward, GA
Jim Estes, FL

Other Commissioners

David Borden, RI (GA)
Emerson Hasbrouck, NY (GA)
Raymond Kane, MA (GA)
Ed O'Brien, MD (LA proxy)

Staff

Bob Beal
Laura Leach

Others

Lindsay Fullenkamp, NOAA Fisheries
Wilson Laney, USFWS
Chip Lynch, NOAA
Derek Orner, NOAA Fisheries

CALL TO ORDER

The Executive Committee of the Atlantic States Marine Fisheries Commission convened in the Bell Room of the Westin Alexandria in Alexandria, Virginia May 10, 2017. The meeting was called to order at 8:00 a.m. by Chair Doug Grout.

APPROVAL OF AGENDA

The agenda was approved with the addition of: 1) Federal budget update, time permitting.

APPROVAL OF PROCEEDINGS

The summary minutes from the February 1, 2017 meeting were approved as presented.

PUBLIC COMMENT

There was no public comment.

FY18 BUDGET

On behalf of the Administrative Oversight Committee, staff presented the Proposed FY18 Budget. After a brief discussion, Mr. Abbott moved "Approval of the FY18 Budget as presented." Mr. Blazer seconded and the motion passed unanimously.

BOARD PROXY/AP MEMBER SITUATION

Executive Director Beal presented an options paper on how to handle Advisory Panel members who become Commissioner proxies to management boards. He noted that there is no guidance in the ISFMP Charter or the Rules and Regulations. The options paper provided four options to handle this situation. After lengthy discussion, Mr. Abbott moved adoption of option 2: Once an AP member is assigned as an <u>ongoing or</u> board-specific proxy to a species board for which (s)he serves as an advisor (e.g. American Eel Board/American Eel AP), the new proxy must step down from the AP and the state appoint a new AP member." The underlined words are added to the original Option #2. Dr. Pierce seconded the motion and it passed 14-1.

There was a discussion on term limits for Advisory Panel Chairs and it was decided to take no action at this time.

TECHNICAL MEETING WEEKS

Executive Director Beal provided background information on the origin of Technical Committee (TC) Meeting Weeks, noting that with the advances in technology the TCs have been having more webinars, and posed the question "have technical committee meeting weeks become an artifact of the past, and should they be discontinued?"

After a lengthy discussion, it was decided that staff should poll the TC members to see if TC meeting weeks are still valuable to them. It was noted that face to face meetings are very important, and TCs should meet in person at least annually. It was also suggested that staff should develop a two or three meeting outlook for what the boards are projected to be working on and what tasks the TCs (and other committees) might be assigned so perhaps a combined meeting could be planned in advance.

FUTURE ANNUAL MEETINGS

The Commission's 76th annual meeting will be held October 15 - 19, 2017 in Norfolk, Virginia; in 2018 we'll meet October 21 -25 in New York City and in 2019 we'll meet October 27 - 31 in New Castle, New

Hampshire. Mr. Abbott promises larger lobster than the state of Maine.

OTHER BUSINESS

Executive Director Beal asked the Committee members what feedback do we want to provide with regard to emerging budget issues, especially regarding the allocation of any SK money we might receive and the Council/Commission line in the NOAA budget.

Mr. Grout said he is hoping to get the Commission back up to the 26% share of the Council/Commission line that ACFCMA used to get, perhaps recommending for the next several years any increase would be a 50-50 split until the Commission gets back to 26%. The Committee members agreed with this approach.

Executive Director Beal noted that the Commission is receiving significantly reduced peer review support from the Science Centers recently. Based on the current schedule, it will be five years without a solely managed species on the SAW/SARC peer review schedule.

Mr. McNamee asked how do we get the lines separated so we don't have an adversarial relationship with the councils. He sees the logic in getting back to 26% but feels we might need to justify why we need the return to 26%, especially since our species are not part of federal plans.

Mr. Grout suggested that the Committee have a discussion on Mr. McNamee's suggestion at the summer meeting.

CLOSED SESSION

The Committee went into closed session at 9:30 a.m. to discuss the Executive Director's Performance Review.

ADJOURN

CHAIR DOUG GROUT adjourned the Executive Committee meeting at 9:50 a.m.

June 8, 2017

The Honorable Wilbur Ross
Secretary of Commerce
Herbert C. Hoover Building
United States Department of Commerce
1401 Constitution Avenue, Northwest
Washington, DC 20230

Dear Mr. Secretary:

This letter is to notify you that the Atlantic States Marine Fisheries Commission (Commission) has determined the State of New Jersey is out of compliance with the Commission's Interstate Fisheries Management Plan (FMP) for Summer Flounder, Scup, and Black Sea Bass.

The Commission adopted the following motion on June 1, 2017, upon the recommendation of the Summer Flounder, Scup, and Black Sea Bass Management Board and the Interstate Fishery Management Program Policy Board:

On Behalf of the ISFMP Policy Board, move the full Commission find the state of New Jersey be found out of compliance for not fully and effectively implementing and enforcing Addendum XXVIII to the Summer Flounder, Scup, and Black Sea Bass Fishery Management Plan if the State does not implement the following measures by May 25, 2017:

- *Shore mode for Island Beach State Park only: 17-inch minimum size limit; 2-fish possession limit and 128-day open season.*
- *Delaware Bay only (west of the COLREGs line): 18-inch minimum size limit; 3-fish possession limit and 128-day open season.*
- *All other marine waters (east of the COLREGs line): 19-inch minimum size limit; 3-fish possession limit and 128-day open season*

The implementation of these regulations is necessary to achieve the conservation goals and objectives of the FMP to end overfishing of the summer flounder stock. In order to come back into compliance, the state of New Jersey must implement all of the measures listed above as contained in Addendum XXVIII to the Summer Flounder FMP.

The motion passed with all member states voting in favor except New Jersey, which voted against the motion, and Florida which was absent from the meeting. By this action, the Commission has found the State of New Jersey out of compliance with the FMP and has outlined what the state must do to come back into compliance.

The Summer Flounder, Scup, and Black Sea Bass Management Board approved Addendum XXVIII with the goal of providing anglers fair and equitable access to summer flounder throughout the range while staying within the 2017 recreational harvest limit (RHL) as required by the FMP and the Magnuson-Stevens Act. 2017 catch limits were reduced by approximately 30% in response to the stock assessment result that overfishing was occurring, the fishing mortality threshold had been exceeded by 26% and spawning stock biomass has been declining since 2010 and is nearing the threshold as indicated by the 2016 Stock Assessment Update. The Update, based on data through 2015, shows 14 out of 15 fishery independent survey indices along the US Atlantic coast showed declining numbers of summer flounder from their most recent peak abundance, with the largest decline at 97%. The failure of New Jersey to implement and enforce a management program consistent with the FMP will result in summer flounder harvest levels that will negatively impact state and federal efforts to end overfishing and conserve the resource by increasing its abundance. The increase in the minimum size limit from 18 to 19-inches and the bag limit reduction from 4 to 3 fish will decrease the number of summer flounder harvested in order to not exceed the RHL and work towards ending overfishing.

The Atlantic Coastal Fisheries Cooperative Management Act (16 U.S.C. 5101) requires all Atlantic coastal states to implement and enforce fishery management plans adopted by the Commission. If the Commission determines a state is out of compliance with one of its FMPs, the Act requires the Commission to report this determination to you. I have also communicated a similar letter to the Secretary of the Interior.

Sincerely,

Robert E. Beal

cc: New Jersey ASMFC Commissioners and Proxies
Doug Grout, ASMFC Chair
James Gilmore, ASMFC Vice-Chair
Summer Flounder, Scup, and Black Sea Bass Management Board
Summer Flounder, Scup, and Black Sea Bass Technical Committee
Summer Flounder, Scup, and Black Sea Bass Advisory Panel
Interstate Fisheries Management Program Policy Board

L17-70

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
1315 East-West Highway
Silver Spring, Maryland 20910
THE DIRECTOR

JUL 12 2017

Mr. Robert E. Beal, Executive Director
Atlantic States Marine Fisheries Commission
1050 N. Highland Street
Suite 200A-N
Arlington, VA 22201

Dear Mr. Beal:

On June 8, 2017, you notified Commerce Secretary Wilbur Ross of the Atlantic States Marine Fisheries Commission's determination that the State of New Jersey was out of compliance with Addendum XXVIII to the Summer Flounder, Scup, and Black Sea Bass Interstate Fishery Management Plan. The measures in question regarding noncompliance are designed to constrain recreational catch to established catch limits and end overfishing of the summer flounder stock.

The Atlantic Coastal Act's noncompliance process (16 U.S.C. § 5106) involves two criteria. The Secretary must determine: 1) whether the State in question has failed to carry out its responsibility under the Commission's ISFMP; and 2) if so, whether the measures that the State failed to implement and enforce are necessary for the conservation of the fishery in question. If the Secretary determines a State is noncompliant with both of these criteria, the Atlantic Coastal Act mandates that the Secretary impose a moratorium on fishing in State waters in the fishery in question.

New Jersey makes a compelling argument that the measures it implemented this year, despite increasing catch above the harvest target, will likely reduce total summer flounder mortality in New Jersey waters to a level consistent with the overall conservation objective for the recreational fishery. While there is some uncertainty about how effective the New Jersey measures will be, considering the information provided by the State, the Secretary has found that the measures are likely to be equivalent in total conservation as those required under Addendum XXVIII. Therefore, the second criterion of the noncompliance finding is not met and it is unnecessary to implement a fishery moratorium in New Jersey waters for 2017.

Please contact Alan Risenhoover, Director of the Office of Sustainable Fisheries, if you need additional information. He can be reached at 301-427-8500, 1315 East-West Highway, Silver Spring, Maryland 20910, or alan.risenhoover@noaa.gov.

Sincerely,

Chris Oliver

cc: Mr. Douglas Grout, Chairman, Atlantic States Marine Fisheries Commission
Mr. Michael Luisi, Chairman, Atlantic States Marine Fisheries Commission Summer Flounder Management Board

THE ASSISTANT ADMINISTRATOR
FOR FISHERIES

Atlantic States Marine Fisheries Commission

South Atlantic State/Federal Fisheries Management Board

August 1, 2017
9:45 a.m. – 1:30 p.m.
Alexandria, Virginia

Draft Agenda

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

1. Welcome/Call to Order *(J. Estes)* — 9:45 a.m.
2. Board Consent — 9:45 a.m.
   - Approval of Agenda
   - Approval of Proceedings from May 2017
3. Public Comment — 9:50 a.m.
4. Review and Consider Cobia Draft Fishery Management Plan for Public Comment (*L. Daniel*) **Action** — 10:00 a.m.
5. 2017 Spot Benchmark Stock Assessment **Final Action** — 11:25 a.m.
   - Presentation of Benchmark Assessment Report (*C. McDonough*)
   - Presentation of Peer Review Panel Report (*P. Campfield*)
   - Consider Acceptance of Benchmark Stock Assessment and Peer Review Report for Management Use
   - Consider Management Response to Benchmark Stock Assessment and Peer Review Report (*J. Estes*)
6. Lunch (provided for Commissioners, proxies and Board members) — 12:15 p.m.
7. Consider 2017 Traffic Light Analyses for Atlantic Croaker and Spot (C. *McDonough*) — 12:45 p.m.
   - Review 2017 Traffic Light Analyses
   - Progress Update on Exploratory Analyses for Incorporation of Additional Indices and Adjustments to the Atlantic Croaker Traffic Light Analysis
8. Consider 2017 Atlantic Croaker FMP Review and State Compliance *(M. Schmidtke*) **Action** — 1:20 p.m.
9. Other Business/Adjourn — 1:30 p.m.

The meeting will be held at the Westin Alexandria, 400 Courthouse Square, Alexandria, Virginia 22314; 703.253.8600

MEETING OVERVIEW

South Atlantic State/Federal Fisheries Management Board Meeting
Tuesday, August 1, 2017
9:45 a.m. – 1:30 p.m.
Alexandria, Virginia

Chair: Jim Estes (FL) Assumed Chairmanship: 02/16	Technical Committee Chairs: Red Drum: Ryan Jiorle (VA) Atlantic Croaker: Chris McDonough (SC)	Law Enforcement Committee Representative: Capt. Bob Lynn (GA)
Vice Chair: Pat Geer	Advisory Panel Chair: Tom Powers (VA)	Previous Board Meeting: May 11, 2017
Voting Members: NJ, DE, MD, PRFC, VA, NC, SC, GA, FL, NMFS, USFWS, SAFMC (12 votes)		

2. Board Consent

- Approval of Agenda
- Approval of Proceedings from May 11, 2017

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

4. Cobia Draft Fishery Management Plan (FMP) (10:00 – 11:25 a.m.) Action

Background

- In February, 2017, the Plan Development Team (PDT) was directed to construct a Draft FMP for cobia to complement the federal FMP.
- The Board initiated a Working Group in February, 2017, to investigate potential options for allocation. Options were provided to the PDT and included in the Draft FMP.
- The PDT completed the Draft Cobia FMP in July, 2017.

Presentations

- L. Daniel will present the Draft Cobia FMP (**Supplemental Materials**).

Board actions for consideration at this meeting

- Approve the Draft Cobia FMP for Public Comment

5. Spot Stock Assessment (11:25 a.m. – 12:15 p.m.) Final Action

Background

- The 2017 benchmark stock assessment was completed in February, 2017.
- A peer review was held April 18-21, 2017.

Presentations

- C. McDonough will present the Stock Assessment Report (**Supplemental Materials**).

• P. Campfield will present the Peer Review Panel Report (**Supplemental Materials**).
Board actions for consideration at this meeting • Consider acceptance of the Stock Assessment and Peer Review Report for management use

6. Lunch

7. 2017 Traffic Light Analyses (TLA) for Atlantic Croaker and Spot (12:45 – 1:20 p.m.)
Background • Addendum II (2014) of the Atlantic Croaker FMP and Addendum II (2014) of the Spot FMP establish TLA as the new management framework for these species in non-assessment years. • In May, 2017, the Board directed the Technical Committee (TC) to conduct exploratory analyses to potentially incorporate additional indices and adjustments into the TLAs; the TC has begun working on this task and has preliminary results and recommendations for the Atlantic croaker TLA.
Presentations • C. McDonough will present the 2017 Traffic Light Analysis Reports for Atlantic croaker and spot (**Supplemental Materials**) and an update of the TC's progress on analyses exploring incorporation of additional indices and adjustments into the TLAs**.**

8. 2017 Atlantic Croaker FMP Review (1:20 – 1:30 p.m.) Action
Background • Atlantic Croaker State Compliance Reports are due on July 1. The Plan Review Team reviewed each state report and compiled the annual FMP Review. Delaware (commercial), South Carolina (commercial and recreational), Georgia (commercial and recreational), and Florida (commercial) have applied for *de minimis.*
Presentations • M. Schmidtke will present an overview of the Atlantic Croaker FMP Review Report (**Supplemental Materials**).
Board actions for consideration at this meeting • Accept 2017 FMP Review and State Compliance Reports • Approve *de minimis* requests

9. Other Business/Adjourn

DRAFT PROCEEDINGS OF THE

ATLANTIC STATES MARINE FISHERIES COMMISSION

SOUTH ATLANTIC STATE/FEDERAL FISHERIES MANAGEMENT BOARD

The Westin Alexandria
Alexandria, Virginia
May 11, 2017

TABLE OF CONTENTS

INDEX OF MOTIONS

1. **Approval of Agenda** by Consent (Page 1).

2. **Approval of Proceedings of February 2017** by consent (Page 1).

3. **Motion to request that the South Atlantic Fishery Management Council and the Gulf of Mexico Fishery Management Council consider transferring management authority of the Atlantic migratory cobia stock to the Atlantic States Marine Fisheries Commission** (Page 12). Motion by David Bush; second by Joe Cimino. Motion carried (Page 15).

4. **Motion to adjourn by Consent** (Page 36).

ATTENDANCE

BOARD MEMBERS

Roy Miller, DE (GA)
Rachel Dean, MD (GA)
Craig Pugh, MD, proxy for Rep. Carson (LA)
Ed O'Brien, MD, proxy for D. Stein (LA)
Russ Allen, NJ, proxy for l. Herrighty (AA)
Adam Nowalsky, NJ, proxy for Asm. Andrzejczak (LA)
Lynn Fegley, MD, proxy for D. Blazer (AA)
David Bush, NC, proxy for Rep. Steinburg (LA)
Michelle Duval, NC, proxy for B. Davis (AA)
Robert Boyles, SC (AA)
Malcolm Rhodes, SC (GA)
Patrick Geer, GA, proxy for Rep. Nimmer (LA)
Spud Woodward, GA (AA)
Rep. Thad Altman, FL (LA)
Jim Estes, FL, proxy for J. McCawley (AA)
Martin Gary, PRFC
Wilson Laney, USFWS
John Carmichael, SAFMC

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

Ex-Officio Members

Staff

Toni Kerns
Robert Beal
Katie Drew
Kristen Anstead
Mike Schmidtke
Louis Daniel
Lisa Havel
Jeff Kipp

Guests

John Clark, DE DFW
Joe Cimino, VMRC
Roy Crabtree, NMFS
Lynn Fegley, MD DNR
Laura Lee, NC DNR
Chris McDonough, SC DNR

The South Atlantic State/Federal Fisheries Management Board of the Atlantic States Marine Fisheries Commission convened in the Edison Ballroom of the Westin Hotel, Alexandria, Virginia, May 11, 2017, and was called to order at 11:45 o'clock a.m. by Chairman Jim Estes.

CALL TO ORDER

CHAIRMAN JIM ESTES: I would like to call the South Atlantic State/Federal Fisheries Management Board to order please.

APPROVAL OF AGENDA

CHAIRMAN ESTES: You all should have received an agenda; and I'm going to suggest some fiddling with the agenda. I suggest that we move cobia to the top of the agenda. I also would like to add a short discussion about Spanish mackerel at the end of the agenda. Are there any other suggested changes for the agenda? Yes.

DR. MICHELLE DUVAL: Not a change, just for the record to let the Board know that I will be sitting at the table for our discussion on items with regard to cobia; and Chris Batsavage, my counterpart, will be at the table for the spot and croaker items.

CHAIRMAN ESTES: Are there any other suggestions to the agenda? If not, is there any objection to taking the agenda as it is? Seeing none; the agenda is approved.

APPROVAL OF PROCEEDINGS

CHAIRMAN ESTES: We all have proceedings from our February, 2017 meeting. Are there any suggested changes to those proceedings? Seeing none; we'll take those as approved.

PROGRESS REPORT ON COBIA DRAFT FMP

CHAIRMAN ESTES: Our first item is going to be about cobia and we're going to get an update about where we're at. Louis is going to give us an update.

DR. LOUIS B. DANIEL: Good morning, still. I am Louis Daniel, staff with the commission working on the cobia issue. I would like to go over a summary of the work that has been done by the working group; and get your advice and direction on next steps for the Atlantic migratory group cobia FMP. First there is some new information that John Carmichael has on the stock assessment for cobia, and I was going to get him to give us a quick briefing on that; and then I'll proceed.

MR. JOHN CARMICHAEL: I heard the emphasis on quick, so I'll do that. The Steering Committee, which oversees the SEDAR schedule and balances the workload met last Friday. One of the things they discussed was the research track process, which we have discussed, and the effects of that on the cobia assessment and the timing of cobia.

The Steering Committee has come to the conclusion that the research track has not been fully fleshed out to the extent that it's ready to be implemented here in 2018. There are still a number of logistical and procedural details that are yet to be worked out within the principal players of the Southeast Center.

They've agreed to continue to work on that but as a result the Steering Committee has put off a bit, implementing the research track approach for stock assessments. Our scamp will start probably in 2019 instead of 2018; and then cobia, the recommendation is to not do this as a research track, but to do it as a regular SEDAR benchmark. This came from the folks themselves within the Center, and the SEDAR staff working on trying to define the research track process.

There were some concerns about that being a new approach, and uncertainty into how it would proceed; particularly with resolving this critical stock identification question. That group felt that really this needed to be a benchmark with resolution of stock ID occurring, before it gets started.

The Steering Committee supported that and the recommendation now is that we would start cobia in 2018 with a stock ID resolution during the first half of the year. That will include a workshop with participants from all the different entities involved, so the South Atlantic, the Mid-Atlantic, the ASMFC folks, the state folks, and probably also some folks from the Gulf; because some initial genetics research suggests the potential for at least one overall stock.

That would include everybody, and then we'll have a recommendation from that group on stock ID, which will be reviewed by the technical groups, SSCs and technical committees; and then have an independent peer review. If there are any remaining issues, then the management leadership will have to figure out how to resolve it.

We're hoping that will take place during the first half of 2018, with the specific timing of the workshop really scheduled with an eye toward much of the research that is currently underway, and being able to bring that into the process and have it considered; because we would like to be able to get this stock ID question addressed in a way that is acceptable to everyone who is involved.

Then that would put us into a mid-late 2018 data workshop as a target, which would include 2017 data. There is a little bit of a wrinkle there, because the South Atlantic had asked that cobia have 2019 data; to allow some of the management changes which were pending to be considered. That was made at a time when we had the spike in recreational landings in 2015. It really was a thought at that time that perhaps that was just a spike. We didn't want to go into an assessment with a spike in a terminal year, potentially having a real driving effect.

Since that time we've learned that it really is more of an ongoing issue. We had higher landings in 2016 as well, which then of course raises the concerns about getting this assessment done sooner, and what may happen if it is pushed back until say a 2019 terminal year as the council asked for. The Steering Committee happened last week. The council will meet in June and get all of this, and at that time we'll have to inform them about the Steering Committee's recommendation relative to the South Atlantic's request on terminal years.

But I think they are well aware of the issues with cobia, and they've certainly been kept up-to-date on what's happened around this board with cobia; and the work on proceeding with the Atlantic State's FMP on cobia. I think that they will be in support of the recommendation to get this assessment going sooner; even using the 2017 terminal year.

CHAIRMAN ESTES: Dr. Carmichael, I have one curiosity question. I know that there is an assessment due about the same time in the Gulf. Is there coordination between the two assessments, beings that we're going to have some stock issues?

MR. CARMICHAEL: The Gulf hadn't prioritized their cobia, but they did mention it at the Steering Committee meeting that they were interested in getting cobia. What the Science Center told them was due to the analyst assignments and what they're already working on that they wouldn't be able to do cobia in the Gulf in 2018.

That would be something that would have to be pushed back a little bit farther. Of course if it comes out that the one genetic study suggesting one overall stock of the Atlantic in the Gulf were the case, then certainly the Center would have to consider what that means to their folks and that resource, and who does the actual models. They'll be involved at the stock ID phase, and depending on how that goes, they may have to have some involvement in this assessment; depending on where the lines end up being drawn.

CHAIRMAN ESTES: Any other questions; yes, Roy?

DR. ROY CRABTREE: Just a comment. We are hearing some concerns coming out of the northern Gulf of Mexico that they're not seeing fish at the numbers they feel they should be. I suspect this will come up at the Gulf Council meeting, which is the second week in June. I think there will be renewed interest in looking at cobia in the Gulf; and we're still going to have to work the timing out on that.

DR. WILSON LANEY: John, the last time, at least I thought the last time we had a genetics discussion about cobia at the South Atlantic Council, there was some discussion of the fact there might be as many as three different stocks with that coastal South Carolina/Port Royal Sound stock being one, possibly Chesapeake Bay being another, and the Atlantic pelagic stock being a third. What changed? I guess obviously there is a new study. Did they use a different technique? Are they looking at more genetic markers? What is going on there?

MR. CARMICHAEL: There is a lot going on, on the genetics front. There could be multiple stocks. It certainly seems like there are multiple spawning units within the Atlantic population that go to different river areas and spawn; and then they're all mixed up out in the ocean itself. Then there is really some uncertainty as to how far around through the Keys and into the Gulf those fish extend.

There is always some wandering fish that can throw off a genetic study, and I expect a lot of the discussion at the workshop about the connectivity between the Gulf and South Atlantic and Atlantic components, will be just how much of that is going on versus how much are they functioning; contributing to each other types of populations?

There is genetic study underway now, there are some genetic studies that were completed between the last assessment and today, and we're hoping to get as much of that as we can in a workshop; in front of enough genetics experts that we can tease out what the real answer is, or at least an answer that is acceptable to all of the management and scientist entities that have to weigh in.

CHAIRMAN ESTES: Let's listen to Dr. Daniel's work that they've done with the document. What I would like to do is, first of all he has some very specific questions for us to answer; and so we can't get out of here until we answer those questions. I promised him that we wouldn't. Also, I would like to try to be more inclusive and exclusive, and so I would like to try to work for a consensus if we're going to add things; rather than have to go through motions, and go through that lengthy process if it's possible. Go ahead.

DR. DANIEL: Thank you, John, for that update. It's good news. The working group meetings that you established at the last meeting consisted of Lynn Fegley, Joe Cimino, Michelle Duval, Robert Boyles and Kathy Knowlton, from Georgia. We had three conference calls to discuss various management options for Board review.

They had an opportunity to look over white papers that were put together by me, with help from my partner next to me; Mike Schmidtke. We were able to review those and discuss some of the options and some of the concerns that the Board had. All the data and discussion summaries were also provided to the Plan Development Team to make sure that everyone was in the loop; as best I could.

Going back, just as a refresher on the primary board objectives for the development of the plan, were to complement the South Atlantic's coastal migratory pelagics FMP for cobia; to constrain the coastwide harvest to the allowable catch limits established by the South Atlantic Council, and to provide the states with maximum flexibility to manage their specific cobia fisheries.

The issues that we discussed at the working group comprised of a series of issues; size limits, bag limits, vessel limits, state allocations, seasons. There were some other issues that I'll bring up and the commercial fishery, which we did not discuss at the working group; but I did want to add that in for clarity.

The first issue revolved around size limits. The South Atlantic Council's Framework 4 established a 36 inch fork length size limit in federal waters. The working group generally recommended a consistent coastwide 36 size limit for the FMP. Concerns raised were that different size limits can create enforcement and assessment concerns, if there are varying size limits up and down the beach.

But also recognizing one of the primary intents is to try to extend the season for as long as possible. Lower minimum size limits could result in higher catch rates and shorter seasons, and a larger minimum size limit while it could result in longer seasons, it could increase discards and potential safety concerns.

The primary issue here is making sure that there is consensus amongst the Board to limit the size limit options to the 36 inch fish consistent with the federal council plan. Assuming there are no comments or questions that would be the consensus of the Board. The next issue is bag limits. Again Framework 4 established a one fish recreational individual bag limit in federal waters.

The working group also recommended consistency with the one fish limit in the plan. Again, higher bag limits result in higher catch rates and shorter seasons; and we can't go lower than one without a season; which we'll talk about here in just a moment. Any discussion or comment on bag limits? If not, we will recommend maintaining a one fish bag limit. Vessel limits, here is where you've got some flexibility potentially as you move forward. The South Atlantic framework allows up to six fish per vessel in federal waters. The working group really had no specific recommendation regarding vessel limits, but the vessel limits could vary based on specific state objectives. What we know is based on current actions by the various states is that they have selected variable vessel limits from 1 to 3 in Virginia, I believe; and 4 in North Carolina.

That is what is going to adjust the landings to a large degree is the amount of fish allowed and the vessel limits. Whether or not you want to have specific vessel limit options in the plan, or whether you would like for that to be an option that you consider when developing your state-specific plan to move forward, is a question for the Board. Right now if you agree to leave it the way it is it would be at your discretion, to determine at the state level the vessel limits that you would want to implement in your state-specific plan.

CHAIRMAN ESTES: Yes sir, Robert.

MR. ROBERT H. BOYLES, JR.: I'll just bring it up for discussion purposes. I can imagine how this might go. Six fish per vessel to me seems very generous; given what we are trying to do, in terms of constraining the catch. I recognize that there are new fisheries that have grown and developed, and maybe that's a "bridge to far" right now. If the objective here is to find ways to constrain the catch of this popular and growing fishery, six just seems to send a message that we're not so concerned. I'll just state that Mr. Chairman.

CHAIRMAN ESTES: Yes, Michelle.

DR. DUVAL: I think in consideration of Robert's comments, my recommendation would certainly be that in regards to any state-specific seasonal measures, because as Dr. Daniel stated, you know that is one of the areas where states do have flexibility; that six would be the limit. That would be the cap. I would not recommend going above that.

There might be states that were interested in individual approaches that included perhaps a one fish, or two fish per vessel limit for this chunk of time; and maybe a four-fish vessel limit for this chunk of time. But I would certainly recommend no more than six per vessel; recognizing Robert's concerns about what we're doing here.

MR. JOE CIMINO: There is one other element to it I think. I agree with Robert, it does seem generous, and I think from the many public comments we heard in Virginia, they were fully understanding of it is an important way to constrain the catch. But one of the interesting things that we see is it is very likely that a for-hire fleet charter boat can manage that six fish vessel limit.

However, they're extremely underrepresented in Virginia's catch. We see very few charter intercepts. What we see is a large, private recreational catch that doesn't even achieve that six or even four-fish vessel limit anyway. It is a challenge. I think as we institute this mandatory reporting we'll find out more about what the for-hire fleet does. I think I am leaning towards Michelle's suggestion. Since it is one of the few places we're going to have some flexibility of a six-fish cap.

CHAIRMAN ESTES: Okay, did you get enough direction there?

DR. DANIEL: I did. My intent there was to simply mirror the federal plan of up to six fish, and I think that is what I'm hearing is that is a reasonable limit. Just let me point out too that these are not management. I will go back and develop these management options, and they will be included in the FMP for your review in August.

You are not making any final decisions here, just to make sure everybody is clear on that. But I am clear on vessel limits. If there is no further discussion on vessel limits; next are the state allocations. There are several different opinions and issues that need to be resolved here. This is probably one of the big meatier items.

I am going to go through this as briefly as I possibly can, and if there are any questions please don't hesitate to ask. Much of the data tables were very large and cumbersome to put up on the screen. You wouldn't have been able to see them. I'm hoping that you've got those tables in front of you from the white paper that was in the supplemental materials.

What we did was looked at the landings time series, and we considered a three, five, and ten year period. It was also suggested by the working group that we include an option that looks at 50 percent of the five-year average to account for more recent timeframe, and 50 percent of the ten-year average to look more at the historical timeframe.

All of the tables represent those timeframes, three, five, ten and the 50/50 option is what I'll call it from here on. One of the big questions also was in the terminal year. Working group reviewed 2014 and 2015 as terminal years, to develop allocations based on landings. There was a PDT member that proposed 2013, and that was a period prior to some state-specific cobia management changes.

I believe the specific one mentioned was the South Carolina spawning season closure in May. The working group had no final opinion on terminal year, but appeared to agree; and I'm not trying to speak for them, but appeared to agree that 2015 provided the most recent information and did not include a year with a closure.

It did not include, there was some confusion and some misstatements that were made that 2015 had a closure, and that some states elected to continue fishing. That was not the case. That occurred in 2016. At present we've got essentially three options to develop the allocations; either looking at '13, '14, '15. I think it would be very helpful if we selected one terminal year to analyze for the public comments. Unless a working group member has a different opinion, I believe '15 was the proposed year to use.

CHAIRMAN ESTES: Are there any problems with that?

DR. DANIEL: All right, great. The next issue and this one is probably the one that generated the most discussion and comment, is looking at the landings and the weights. The working group first reviewed a bunch of different tables with a bunch of different allocation options; that were looking at the MRIP landings data in weight, and the Southeast Fisheries Science Center landings data in weight, and those differ due solely to the different methods for estimating average weight. The MRIP uses the annual length weight data regardless of sample size. If you go back and look at the 2012 landings in New Jersey, those have been estimated based on one fish that was measured and weighed. But that was the average weight of the fish that was used, and that number was multiplied by the number of fish harvested; to generate the annual landings. The Southeast Fisheries Science Center requires a minimum sample size.

They may combine states or years depending on the sample size. Landings and allocations based on weights, whether it was the Southeast Fisheries Science Center method or the MRIP method, and the numbers of fish, are in the working group memo; and I'll have those up here in just a second.

Every time when we looked at there were very big differences between using the MRIP data, using the Southeast Fisheries Science Center data; and I'll give you a brief review of what we found. Based on the number of samples in the southern states, South Carolina and Georgia were actually combined; and their average weights were the same, between South Carolina and Georgia.

North Carolina arguably had more samples, and they had individual, annual average weights through the Southeast Fisheries Science Center process. Virginia had fewer lengths, and weren't able to get the SEFC required sample size, so all their samples were combined for an average weight that was used over a ten-year time series; 33.9 pounds.

There were all different variability's in how the different weights were calculated; and most of that was due to sample sizes, and the difficulty of going out and getting samples on a fishery like cobia that is considered somewhat of a rare event in a pulse fishery. In discussions with some of the PDT members, and in working with a student I've got at N.C. State, we started looking at the possibility of using numbers of fish; to remove those inconsistencies in average weight estimates throughout the management unit and amongst the different methods.

If we look at the next slide, you can get an idea of what this actually means using just one of the examples. This is the allocation using the five and ten year 50/50 average landings for the 2005 to 2014 time series; so that would be adjusted for the 2015 time series, based on our previous discussions.

You can see how the numbers change, albeit slightly they do change. If you look at Georgia as an example, using the five and ten year pounds from the Southeast Fisheries Science Center, which is what the Board directed us to use at the very beginning; is about 9.5 percent of the coastwide ACL allocation recreationally to Georgia.

If you use numbers, it jumps up to 10.2 percent. You can see we've also included the actual ACL that would be allocated to the individual state, were either one of those options chosen. You can go through and look at your individual state. We only were able to look at Georgia, South Carolina, North Carolina, and Virginia; because those were the data that we had.

But it kind of breaks it down to where it is about a 40/40 Virginia/North Carolina and about 10 percent for Georgia and South Carolina. Those numbers, if you look at those tables that were produced, those numbers really don't vary a whole lot. But depending upon which time; until you get into the three-year time series, it really doesn't make a huge impact, and it doesn't have a huge difference in those allocation schemes. We believe, and from discussions and what I heard, I don't think there was a consensus at the working group meeting. But what I've heard is primarily support; at least for cobia, not dissing on the Southeast Fisheries Science Center, because they recognize the numbers are not there to really do the complete analysis that they may otherwise do, but for cobia and for allocation analysis, looking only at the numbers of fish. The proposal would be to use numbers as opposed to weights when we develop the various scenarios for allocation.

CHAIRMAN ESTES: Yes, Robert.

MR. BOYLES: Just perspective from a working group member. One of my motivations, I think you all know this, but our General Assembly made cobia a gamefish several years ago in South Carolina; so there is no commercial take. The message we've heard consistently from our anglers is, they are interested in the experience, and experience is measured in numbers of fish not in pounds of fish. I just offer that perspective for the Board.

CHAIRMAN ESTES: Pat.

MR. PATRICK GEER: Louis, I had a real quick question about if we went with the numbers, how would that play out with the development of a stock assessment?

DR. DANIEL: Well, if I'm not mistaken the stock, I'm sorry, John. If you want to answer that question you would be more appropriate.

MR. CARMICHAEL: It actually really wouldn't at all; because the stock assessment, fish die is a number anyway, and the stock assessment includes catch in numbers for many of the data series. Certainly all the recreational discards are numbers, and the recreational harvest is numbers. The only thing that comes into the system in weight is the commercial; and the commercial has the much better weight sampling than any of the recreational fishery.

It is actually much more logical from reducing uncertainties to do this as numbers, because you would be using your commercial average weights; which are quite good, to convert that into the numbers. It won't have any impact on the assessment and will reduce uncertainties really, I think in terms of setting your allocations.

DR. DUVAL: I mean the one thing I will say though is that any weights that are collected by MRIP are certainly available to the assessment scientist, for use in any way that they would see fit. Because I would just note that the commercial minimum size limit on the federal side is still 33 inches at this point. There would certainly likely to be greater variability in the average weights of the fish, I would think a little bit, based on that. But certainly, Pat, any weights collected by MRIP would be available for use in analysis during the assessment process; if needed.

CHAIRMAN ESTES: Louis made a suggestion, is there any opposition to the use of numbers instead of weights? Do we need to discuss this further? Okay, thank you.

DR. DANIEL: The next issue, Issue 5 is Seasons. The South Atlantic Council's Framework 4 provides analysis to examine coastwide seasons based on a suite of bag size and vessel limits. You've all seen that where it is presented for you. The working group spent a lot of time looking at the various Framework 4 analyses. We also received a detailed analysis from Mr. Chris Wilson with the North Carolina Division of Marine Fisheries. He was able to do a very detailed analysis for all the states from Virginia to Georgia.

What was requested of the working group was to look at issues such as variable start dates. The South Atlantic had thought about looking at changing the fishing year, but could not do that in a framework action. They had begun to put together some information on the impacts of say a May 1 start date to the fishery, and a June 1 start date to the fishery.

Obviously that has extreme variable impacts, depending upon where you are on the coast. A June 1 start date may eliminate the Georgia fishery, whereas it may not have such an impact on the Virginia fishery. Trying to do that on a coastwide basis is unlikely to result in parity amongst the various states.

We provided that information to the working group, so that they could look at the state-specific information that was available; to look at the various reductions that could be achieved by having variable season restrictions. This is where it gets a little bit difficult. If you look at Framework 4 and you consider the options that are available in there; that is for a coastwide, seasonal option.

Those unlikely would satisfy the needs of the individual states of the Commission. Several questions that are important for moving forward with the development of the management options are whether or not we want to include state or regional-specific season options in the FMP at all. There are seasonal decisions best left to the states to develop and have approved by the Technical Committee and the Board.

If state or regional-specific seasons are desired for the FMP, should they be based on state-specific allocations? If not, are there other options to ensure equity and accountability? The issue here really is, if you've got as we've discussed so far, if you've got a one-fish bag limit, a 36 inch minimum size limit, variable vessel limits, and a state-specific allocation based on the '15 terminal year and numbers; will provide the 3, 5, 10 and 50/50 options to take out in the management options.

If you've got a specific allocation at that point, do you want to leave it to the states to make the decision based on the analyses that have been done, to tailor make your own specific season; or do you want to somehow develop specific seasons in the FMP that are specified for each individual state? I know that is a lot, and I will be happy to answer any questions related to that and direct you to any information that I can. That is probably the biggest decision we need to clarify today.

MR. BOYLES: I think Louis, to that question. I can't imagine a lot of other states around the table finding acceptable South Carolina's May closure that we've done for just a portion of our state waters. I'm not sure that there is a lot of fruit in mandating seasons as part of the interstate plan.

I would like, quite frankly, that was a management tool that we employed that got a lot of support for our anglers, a lot of support in our General Assembly. I would like to have that in my tool kit, but I don't know that it is necessary for us to include those kinds of things as a requirement for the fishery management plan.

MR. A.G. "SPUD" WOODWARD: I just want to echo what Robert said. I think we've got enough other things to work with. We don't need to put parameters around season in this plan. I know from our perspective, we certainly want to be able to extend the opportunity to harvest over as wide a period of time as we can; and I'm thinking we've got the tools to do that.

DR. DUVAL: I will add my echoing to Robert's comments about not having any mandated type of coastwide season that is clearly not going to work. I think looking at the questions that Dr. Daniel has on the board, are season decisions best left to the states to develop and have approved by the TC and the Board. I think my response to that would be yes.

CHAIRMAN ESTES: Okay, anything else with that? I think we got what we need, unless there is somebody that has something else to say. Yes, Michelle.

DR. DUVAL: I would probably be remiss if I didn't once again state for the record what we've heard from stakeholders in North Carolina at least, with regard to having hard and fast state-by-state allocations. They are not interested in that at this point. They are more interested in the flexibility that would be provided with state-by-state seasonal approaches.

I think having sat around the Commission and watch some of the struggles with trying to implement recreational state-by-state allocations on other boards. Having something hard and fast like that I think really trends us in much more supportive of seasonal decisions left to the states that come forward through a technical committee review; and then are reviewed and approved by the Board. I just wanted to add that.

CHAIRMAN ESTES: Joe.

MR. CIMINO: I'll be brief. Just to that end. In Virginia we did go with a May closure, and of course it doesn't have the meaning that it might have in South Carolina or Georgia. But we know with these MRIP estimates which is putting us in this difficult situation that as you drill down, the estimates are even more questionable.

When we're talking about a wave estimate, we may not have that much confidence in that. But we did make a biological argument as staff at VMRC to our commission that any removals that are prevented in May, are going to allow more fish to spawn. I think that really drove that closure, so to have that type of flexibility at the state level and not forced by an FMP is why I would support that.

DR. DANIEL: I think it's important. I hear some disconnects, and so I just need to make sure that I am moving forward in the appropriate direction in developing the management options. I heard concerns over a state-specific allocation; and developing a season based on a state-specific allocation.

The way it is moving right now and my understanding thus far, is that we actually would be developing options for state-specific allocations; based on the number of fish with the 2015 terminal year. The states would be assigned a specific allocation under the current options. There would be no alternative, at least at this particular minute; there would be no alternative seasonal option that was not anchored by a specific state allocation. I'm not exactly sure how to develop seasons without a specific target harvest amount. But if there is that interest by the Board, I mean I certainly heard from North Carolina that there is an interest in not having a specific state allocation.

I'm not sure how to develop those seasonal options for the plan. My understanding is the individual state would go back home with a specific quota, and develop the season that they believed would constrain their harvest to within that specific allocation. If there is more that needs to be included in the document, I need that direction; and an explanation as to how you would like to see that developed.

DR. DUVAL: Yes, you know when we had this discussion at the working group there were several of us who indicated that we were not interested in state-specific allocations. I think we've seen the difficulty in trying to manage a recreational fishery by a state-specific allocation. We spent probably eight hours on that yesterday. That is why I bring forward or in support of the more flexible approach of the states developing state-specific seasonal options. Certainly for inclusion in the draft fishery management plan that would go out to public comment.

I think looking at how each state's proportion of the overall harvest changes, based on the scenarios that you've illustrated here; and you know, the three year, the five year, the weighted options so that the public can have something to look at to see how those have varied. But I think stakeholders have been pretty loud and clear that they are not interested in state-specific allocations until after there is a new assessment. That is where I'm coming from.

CHAIRMAN ESTES: Lynn.

MS. LYNN FEGLEY: Just to echo that point. I think as one of the states to the north of the epicenter, if we were to go to state-by-state allocation, which I agree with Michelle. I think we had a slightly different direction on the work group calls. I am not clear what happens to Maryland, Delaware, and New Jersey. Does that mean we get 0 percent?

Does that mean we have no fishery? What does that actually mean? I would have a very difficult time going home and saying, well gee folks, you know we've got 0 percent because we have no history; so just toss back that cobia. I think we can work within the confines of the size limits and the vessel limits that we discussed. But if we go to state-by-state allocation I think things are going to get a little more dicey, at least in our more northern waters.

DR. DANIEL: In terms of the episodic landings north of Virginia, I think that's going to have to be worked out in the de minimis criteria and how we develop that. I don't think there is any intent of sending anybody home with a zero quota when they have a historical landing. That does occur in New Jersey. There was one year with landings in Delaware and Maryland. I think that was one of the concerns that we had discussed, especially when you go north of Virginia and there seems to be these smaller fish.

We really haven't discussed how to deal with those fish that are being caught that are in the 20, 22, 24 inch range. But the idea so far has been, if we have this one fish, 36 inch size limit there may be, as somebody brought up the point that there could be some misidentification problems up there in the northern sub unit that they may have been remoras of some kind as opposed to cobia. It is kind of hard to imagine a 24 inch cobia in New Jersey that is a two-year-old fish. That would be an interesting situation. It is hard to determine that. I guess going back; I mean I understand the working group discussions on the seasonality. But what we've got in our tool box right now as I understand it is there are options out there to begin the season later; to implement some type of a spawning season closure, which we'll talk about here in a minute. We probably don't even need to at this point.

But there is some interest at the Plan Development Team at least, of having some type of spawning season closure; if that is something that the Board would want to consider and individual states would want to consider. But essentially, when do you start your season and when do you end your season?

In order to make that determination the only way I can come up with doing it is to have some type of target, some kind of an allocation that assures at the South Atlantic that we're maintaining our harvest within that 620,000 pound ACL. If that assurance is not provided in the Commission plan, I don't know how that is going to impact the decision making at the federal level to get the EEZ open, which tends to be one of the big issues, is one of the major issues for the more southern states.

That issue tends to vary and be more important as you go from north to south; very little harvest in the EEZ off of Virginia, more off North Carolina, even more off South Carolina, and the majority off of Georgia. That is an issue that Bob and I want to discuss with the South Atlantic in June at their meeting in Florida.

But trying to get from the National Marine Fisheries Service what type of plan do they want to see, and I think the allocation issue is the only way that I've been able to come up with to meet the first requirement that the Board directed me to do, was to stay within the ACL. I don't know any other way to do it, and I don't know how to construct the seasons without there being some kind of a target to shoot for. That is my problem. If there are other issues and if there are other ways to do that I just don't know how to do it.

CHAIRMAN ESTES: Dr. Crabtree.

DR. CRABTREE: It is not entirely clear to me how you would do it and still fit it under a management construct that is built around annual catch limits. There will still have to be an overall annual catch limit in the Council plan. Now I guess it might be possible if you did some sort of more F-based, mortality-based approach to set seasons that you think are going to constrain the fishing mortality appropriately; and not focus so much on how many pounds of fish that are caught.

But that is problematic with the annual catch limit approach that is required under the Magnuson-Stevens Act. I think one thing you ought to think about, because I know your objective is maximize flexibility I've heard a number of times. The alternative way to go with this would be to remove cobia from the federal fishery management plan, the Atlantic stock; and then let the Commission manage the fisheries through your Commission plan.

At that point you wouldn't have to base your management around an annual catch limit type of strategy, and you may be able to implement some of these types of management schemes like Michelle has brought up. That is probably something that you ought to give some consideration of. I think that could potentially get us to a less cumbersome, more efficient way of managing the fishery. I think the Service's interest in this is just finding a management paradigm that can work in this fishery efficiently.

I don't think just federal management. Clearly that is not a successful way to go now. There may be a way to get to what Michelle is describing under an annual catch limit management paradigm, but it's not entirely clear to me how we could get there. But the alternative might be to rethink how we approach the whole problem.

DR. DUVAL: Roy, I'm really sorry that you weren't here for the seven and a-half hours worth of debate that we had yesterday around the summer flounder, scup, and black sea bass board, because that board is constrained by the federal annual catch limit for those species recreationally; and that was the bulk of the conversation yesterday, was how to craft state-specific measures to maintain harvest within an overall annual catch limit.

I feel like we've answered the question that is on the board, our season decisions best left to the states to develop and have approved by the TC and the Board, and we said yes. What are the tools that we have to do that with? We've agreed on a one-fish-per-person bag limit, a 36 inch size limit. Where the flexibility lies is in when you start and end your season, and the vessel limits that you apply.

It wouldn't matter if we had an annual catch limit or not. When you calculate what type of harvest you are likely to end up with, based on once again past performance of the fishery, which as we know is uncertain with the numbers that we have to deal with through MRIP. But that's what you do.

You base any projection of how much you might harvest, based on the past performance of the fishery, by applying those variable season and vessel limits. I mean that's how you would project it. It doesn't matter if you have a state-specific allocation or not. What I've heard from other folks is that they don't have a desire to try to manage a state-specific allocation, and indeed don't necessarily have the tools to manage a state-specific allocation.

We're always going to be in a situation with a pulse fishery like cobia, where we develop a suite of management measures based on past performance of the fishery. We're going to evaluate that the next year. It's clear to me that there is not really an effective way of in-season management with this fishery right now, and it is so subject to environmental variability as well that it is going to be very difficult to do that.

Now Dr. Crabtree has brought up the option of transitioning from a complementary state/federal fishery management plan to solely a Commission plan, which would certainly provide I think flexibility to manage under an F-based approach; which is what we used for striped bass. Maybe that's a separate conversation.

But I really wanted to get to the question that I thought we'd answered with regard to season decisions best left to the states and developed and approved by the TC and the Board, which I think is not much different than how we do things under some other boards; and that is how we would evaluate what projected harvest is. It's not relevant whether or not there is a specific allocation to one state.

CHAIRMAN ESTES: Dr. Carmichael.

MR. CARMICHAEL: It seems to me what Louis is getting at is there needs to be some way of anchoring how you determine this flexibility. If we know that the combination of the bag limit and the size limit won't constrain the fishery to the ACL, then there is going to have to be some type of season.

If you were to say set an overall base season coastwide, then you may have a way of giving states some flexibility to deviate how they take that length of season and apply it to their respective fisheries. That won't be easy, because you're going to have to come to grips with, you know what periods do you use to establish that base; because we've had a number of regulations changing and we've got a lot of data changes that are underway.

It will certainly be a challenge. Then you know that the catch rates are probably not consistent across time. When a state shifts its season may affect that state's respective catch rates. You will have to have some way of deciding what is equitable across the different states, if they chose times with different catch rates.

But I think you will have to anchor this in some way, if not by the state-by-state shares of some sort then by some base season that you allow states to deviate some; which I think an example there is what happens with waterfowl seasons where the Fish and Wildlife Service sets X number of days.

Then states regionally have the ability to decide when to apply those numbers of days over the particular window. You may have to do something like that. You may pick a six-month window and have a four-month season that states can deviate the start and end dates within their perhaps. But I think that one or the other is going to have to be anchored.

CHAIRMAN ESTES: David, I see your hand up.

MR. DAVID E. BUSH, JR.: The state quotas that I've heard from as well, going back to the conversation previous here, would be interested in having it removed from federal fisheries management. That would apply the flexibility needed too, especially the southern states that have no access otherwise. I'm not sure what needs to be done to bring that further into conversation or even a motion, but I would be interested in hearing some other perspectives.

CHAIRMAN ESTES: Why don't we break? Lunch is being served out there right now, I guess. Can we break for lunch, think about all this, come back; because I think we're kind of in a spot we're a little stuck.

(Whereupon a recess was taken.)

CHAIRMAN ESTES: If I could have your attention. I think we had a suggestion or a question that was asked right at the end, before we broke for lunch, about whether we want to have a complementary plan, and whether we might want to request management through the Atlantic States Marine Fisheries

Commission. I would like to go ahead and have a discussion about that if we could, please.

DR. CRABTREE: Let me say, Jim that from the Service's perspective, we're just looking towards an effective management paradigm. We're not looking to withdraw the level of support and particularly scientific support that we've provided in recent years. Our intent would be to continue to provide all of the types of support we have.

CHAIRMAN ESTES: Do we have anybody that would like to start the discussion? Spud.

MR. WOODWARD: Let me swallow my biscuit down here. I'll speak in support of that. Being on the southern end of this, our fishery is almost episodic. We know generally when the fish might move through, but when they are there and how long they are there is dictated by a lot of environmental factors.

If we are unsuccessful through whatever we do at the interstate level to show the Service that we are constraining the harvest; in order to be able to stay within the ACL. We are going to end up with the federal waters closed like they're closed this year. Since our fishery is almost exclusively federal waters, then the longer we're bound to an ACL the more risky things are from our state's perspective. I can certainly speak to I think it needs reconsideration, especially after the necessity of closing it this year.

CHAIRMAN ESTES: Anybody else not have a biscuit that can talk to this issue? Michelle.

DR. DUVAL: I think this was a conversation that we had early on when the South Atlantic came forward. The question was would the Commission consider complementary, joint, or sole management. I think if the Board is reconsidering the decision of complementary management, and would like to move forward with the request for sole management.

I think my recommendation would be to probably make a motion, and to request the South Atlantic Council that they consider turning over management of Atlantic cobia to the ASMFC. I would look to others around the Board, but I think having a motion to do so would probably be useful.

Then the Commission could send a letter to the South Atlantic Council. Clearly there would need to be some conversations there about how we would move forward doing that logistically; given that there are a few balls in the air with regard to stock delineation and what that might mean.

MR. BUSH: I don't know that I have all of that memorized, but I would like to make a motion to that; if I could get some assistance putting it together.

CHAIRMAN ESTES: While we're doing that do we have a second? I guess while we're getting that. Well, we already have it up on the board. How about some discussion about this, David, I think you first, please.

MR. BUSH: Certainly, thank you, Mr. Chairman. I probably can't give as much of the technical justification. I just understand that the way that it has been managed so far, the stakeholders are obviously not happy with it. The flexibility for the states to do what is particularly tailored to them has been discussion of the past couple of days. Without that ability all we're doing is trying to make a one-size-fits-all for everyone. It is obviously not working at this point. I think that we'll have hurdles that we'll need to address, and that is the case with any other fisheries. I am willing to put in the time that I can to help address those hurdles, but I know I'm speaking more so for the others doing the work. That is about it, thank you.

MR. CIMINO: When Dr. Crabtree brought this up today, it really was no surprise; because to some extent it was an elephant in the room, I think. We know that if this moved forward we would at least likely be managing towards an F target instead of an ACL. We know many of the folks on this Board know there are still challenges to that.

Overall I support it. I know managing to F targets means you need updated assessments, and you need assessments that are speaking to whether or not your management actions are working. I know moving forward that maybe one of our biggest challenges is where cobia falls on assessment updates, and who ends up handling that responsibility?

MR. BOYLES: My thinking on this continues to evolve. As the Board knows, we've been very aggressive in managing cobia in South Carolina. A lot of concerns I've mentioned already, and just to remind folks. We have a spawning season closure in an area where these fish are very accessible.

I've talked about cobia fishing in a canoe, which is literally obtainable in the Port Royal Sound area. It is a game fish, so there is no commercial take of cobia in South Carolina waters. I remind the Board that last count 80 some odd percent of our cobia were taken from federal waters. Our fishery has transformed the last several years as that inshore fishery has been fished down.

But having said that I think I could support this, with the understanding that what Dr. Crabtree indicated that the Agency intends to continue to provide scientific support for assessments. I would also be looking at ways to extend our management measures into federal waters, recognizing that at least off South Carolina 80 some odd percent of our fishery is located there.

CHAIRMAN ESTES: This is a pretty bold step. I want to make sure that we don't have discomfort that's not said out loud. Spud.

MR. WOODWARD: The one thing I guess I just want to make sure I get on the record. I certainly don't want to slow down what we're doing, while this potential change in direction is debated; because if we don't do something we could find ourselves in the same situation next year, where the Service is compelled to close the EEZ.

I don't know how we're going to balance that out. I think the commercial fishing management part of this is something that is going to have to be considered and contemplated. If the Board supports this motion, and we decide to engage in a renewed discussion with the Council and the Service about this, is it going to stop everything we're doing?

In terms of promulgating an interstate plan, or can we move forward with promulgating an interstate plan with its own specific measures and requirements; and you'll have the option to go complementary or sole at some point down the road, when some of the legal discussions and other matters that have to take place are concluded.

CHAIRMAN ESTES: Can somebody talk about the process here? Toni.

MS. TONI KERNS: I was focused on my biscuit just now, so sorry. Can you repeat the question for the process? I heard process.

CHAIRMAN ESTES: Spud was concerned that by us doing this that we might slow the process down, and he might be in the same shape next year that he's in this year.

CHAIRMAN ROBERT E. BEAL: I don't want Toni to choke on her biscuit, so I'll give it a shot. I think Spud's concerns are valid in that this Board should probably keep moving down some path to serve as at a minimum an interim transitional period. I don't remember the exact timeline, but when red drum management authority was transferred to solely ASMFC management that took quite a while.

Maybe that was because the federal waters were closed and there was no urgency to do that. But as you said, this is a bold step. It's a big change, and we don't know what the council's response to this would be. I think time can elapse pretty quickly here before something like this gets sorted out. Some interim step through a Commission FMP that allows more flexibility later on, should this occur, is probably a reasonable thing to do.

CHAIRMAN ESTES: Any comments on that? Roy.

DR. CRABTREE: From the Council side of things, we're going to need to do probably some type of amendment in either circumstance. It is a little different than red drum, because in red drum we were withdrawing an entire fishery management plan. In this case we would just be removing a stock from the fishery management plan, and we've done that on a number of occasions in the last few years.

I think Bob's advice is good that we continue to explore both options here, and so we have a better read on what the Council's likely view of this would be. Also I think it would be wise to sit down and spend us some time with the Council and with the Regional Office attorneys; talking about all the pieces of this, and get a better appreciation of how quickly either avenue can move.

CHAIRMAN ESTES: Okay Wilson and then Robert.

DR. LANEY: One change that would occur if cobia is transferred to ASMFC is the same thing that happened with red drum; which is you would lose essential fish habitat. I can't remember whether any HAPC has been designated for cobia or not, but you would also lose that. You could potentially, depending on what happens with the Gulf Council or Gulf Commission, I suppose.

Roy and I had a little bit of conversation about that. But you could also wind up in a situation where you have essential fish habitat and HAPC in place in the Gulf of Mexico, like is the case for red drum, but not in place on the Atlantic coast. That is just one thing to think about, and I am saying that from the perspective of a member of your Habitat Committee.

MR. BOYLES: Just a perfecting comment. I believe were we to go and approve this, I would suggest that the request should be made to both the South Atlantic and the Gulf Council's. I think they share jurisdictions for the plan itself.

CHAIRMAN ESTES: Yes, so we're not really clear. In my mind we're not really clear about what it is that we're doing. Are we removing the one existing stock? Are we going to request removal of both stocks? I'm not really clear on what we're requesting here.

MR. BOYLES: To that point, Mr. Chairman, either way if the Feds were to turn loose of this, I believe it would require action on both councils. I'll look to Dr. Crabtree to clarify that.

DR. CRABTREE: Yes, I think it would be fine to send the request to the South Atlantic Council. But Robert is right that it is a joint FMP, coastal migratory pelagics, so the Gulf would have to approve it. I'm reading that we're talking about the Atlantic cobia stock. That is what the interstate management plan has been focused on, and that is where the problems that we're talking about have been. My assumption has been that that is what the motion applied to.

CHAIRMAN ESTES: Okay. Michelle.

DR. DUVAL: Given the comments that have been made around the table, it sounds like there is a little bit of uncertainty. People want to continue moving forward on the path that we're on; which I completely agree with. I'm wondering if there might need to be some additional perfecting that you know the requests would be that the Council's consider transferring management authority. Because that might allow for that discussion and not seem like a cow grab, or whatever you want to call it. That softening might help.

CHAIRMAN ESTES: Is the maker and seconder comfortable with that? Joe.

MR. CIMINO: To that end. I think we do need to continue moving forward with something. I assume that this may be a process that takes some time, and I would actually kind of hope that the Council wouldn't make that decision until perhaps after the assessment is done and decisions on stock ID.

DR. CRABTREE: Well it will be a process, and so I think what you're really asking the South Atlantic is to consider this and advise you. But they would have to go through an amendment, so there will have to be public hearings and development of amendment and analysis; and particularly a rationale for why federal management is not necessary and state management would be more efficient.

My hope would be we could get through that process along the timeline that's similar to the one we are here. But under any circumstance the Council will have to come in and make modifications to the plan to reflect the interstate management plan, whether it is complementary or the sole plan. We're going to have to go through that process under any circumstance.

CHAIRMAN ESTES: I get the sense we kind of have our minds made up about this, so with no objections. I'm sorry.

DR. DANIEL: Just a couple of comments, and just to make sure that we're all on the same page here, is that this would not impact the SEDAR 2018 proposal. We don't want to lose that opportunity, not only to address the genetic stock boundary issues, but also the stock assessment.

CHAIRMAN ESTES: I'll read the motion. Move to request that the South Atlantic Fishery Management Council and the Gulf of Mexico Fishery Management Council consider transferring management authority of the Atlantic migratory cobia stock to the Atlantic States Marine Fisheries Commission. Motion by Mr. Bush and seconded by Mr. Cimino. Robert.

MR. BOYLES: Mr. Chairman, I presume that this is going to come in the form of a letter that would have to go to the Policy Board?

CHAIRMAN ESTES: I was going to suggest the same thing. Is that correct, Robert?

EXECUTIVE DIRECTOR BEAL: Just a quick comment. Looking back at the motions from the Policy Board, when the Policy Board granted this Board the authority to initiate a cobia FMP, it actually said for this Board to explore management options; either complementary, joint, or sole management of cobia.

Given the timing of this it is a little bit awkward, because the Policy Board has already met. We can send around an e-mail to the Policy Board, let them know that this group would like to do that and some rationale. We'll get an approval that way. But I think they've already set the course essentially to allow this to happen; should this Board decide it's appropriate. But I'll follow up with an e-mail to the Policy Board after this meeting.

CHAIRMAN ESTES: Are you good, Robert? **Okay let me try it this way. Is there any opposition to this motion? I guess seeing none; the motion is approved.** I think now, based on the discussion that we can quickly maybe go back to what Louis was trying to put together, and we can finish that up; because it sounds like we still need to be thinking about management. This may need to be adjusted in the future, but I think we can just continue.

DR. DANIEL: Let me try to summarize where I think we are. The state-specific allocations were more intended to provide a framework on how seasonal options might be constructed to maintain the harvest within the ACL. There was not a consensus of the working group that specific statewide allocations be implemented at this time.

That may be something decided on in August, but at the present because the options would be developed that would provide that summary of how the state landings occur. If you go back and look at Framework 4, and you look at the different seasonality of when the fishery occurred, it has changed dramatically. A one fish, 36 inch size limit, with a two-fish vessel limit would extend the season out to October, if you only looked at data through 2012; whereas that season is constrained to around the middle of August if you look at the more current data.

I think it is important to continue moving forward with the various options that would provide the states with the authority to select their own seasonal options, reviewed by the Technical Committee and the Board. That seems to be the direction that the group is heading. One point of clarification that I think is important, and I'm glad Roy is here so he can correct me if I say anything wrong and Michelle too. We're not overfished and overfishing is not occurring. The terminal year of the stock assessment is 2012, and the stock status was declining in terms of biomass. Down from an F over Fmsy, in the 4 to 5 range down to about a 1 and a fraction, so we're close based on the stock assessment. Depending upon the level of confidence you have in that peer reviewed stock assessment, we're probably in a concerning state.

The fact that we've doubled the quota in the last two years might lead one to believe that an updated stock assessment using current methodologies probably wouldn't show any improvements. The concern is still though trying to maintain the catch levels within the Council's ACL, which we've been mostly unsuccessful doing to this point.

But if we go over, and I think this is an important point to make. If we go over the 620,000 pound recreational allocation, or the 50,000 pound commercial allocation, there is no payback provision at this particular point in time. What the Council plan does is drop you back to the allowable catch target, which would suggest that you're trying to harvest 500,000 pounds as opposed to 620, or 670.

But there is no requirement other than to shorten seasons in order to try to accommodate that. It is my understanding that as we proceed in this plan, and develop any kind of options that would develop seasons; that if we didn't hit the mark in the first year that our reaction would be to adjust those seasons the following year, in order to try to limit the harvest back down to the allowable catch limits.

For those of you that might believe that there is a payback provision or some kind of a penalty for going over; that doesn't exist at the present time. But I think it is something we need to be cognizant of, because in some level of likelihood the stock is probably not going to fare as well in the next stock assessment; maybe it will.

Maybe the new information, maybe additional information will tend to suggest that things are better than we anticipated. But if it doesn't then we kick ourselves into an overfished, overfishing situation; which kicks in a totally different scenario, and a whole different set of rules and requirements.

The one thing that I would ask is that we consider what is in the best interest of the resource moving forward. Is it to remove the ACLs, because they're a hassle, and because they may not allow us to manage it specifically the way we want to at the state level; or is having those constraints from an ACL an important component of the fishery?

I think it would be important to have our technical folks look at those questions to see, how can we best manage this fishery to maintain its important status on the coast? I hope that helps to explain part of the confusion was mine, in terms of the state specific allocations. But if everyone seemed to be satisfied with the decisions made to date, if we go back, well I can't go back for some reason.

My computer won't let me go back. The previous slide, no keep going, so it was the one we were on. There was general understanding at this point. Go with one fish, 36 inches up to six fish vessel limit; the allocation information and the potential for states to develop their own seasons. That is where we are right now. I believe that is consistent with what I've heard around the Board table today.

CHAIRMAN ESTES: Roy.

MR. ROY W. MILLER: Jim, just to pursue something I talked to you about over the break. Following up on Lynn's suggestion, could we reach an agreement that all states north of Virginia that are within the historical range of this species consider the one fish per person daily harvest limit and 36 inch minimum size limit, the six fish per vessel limit and no further restrictions; like no seasons to worry about for those states that could otherwise qualify for de minimis.

CHAIRMAN ESTES: Any issues with having that as an option in the document? Okay, seeing none.

DR. DANIEL: The next is Issue 6. These are some other board questions, decisions. I'm not so sure that we really need to get into this now, after the discussions that we've had, unless there is interest from the Board to discuss these. I brought up the point, because this has been a very important issue for the state of South Carolina that they have implemented a spawning season closure in their southern management area; the question of should the FMP include options for similar closures in other states.

There was some strong interest, maybe strong expressed by some of the PDT members about spawning season closures. But it appears to me that based on the previous discussion that would be left up to the states if they wanted to try to set up seasons that would impact spawning season times.

Try to get the best bang out of their spawning season as possible but that there not be anything specific. I am not sure we have the best data to analyze what the actual spawning seasonality is on a coastwide basis. Unless there is interest from the Board in pursuing this option, I would ask that we potentially remove it from the document.

MR. CIMINO: Dr. Daniel, if your predictions on a new assessment are right that may be Addendum I, but I agree to leave that out for now.

DR. LANEY: Well, given the interest of the PDT and given what Louis just said about whether or now we have adequate data to really make a determination as to when these fish spawn, I would be interested in at least seeing us look into the literature; and see what information is out there.

As you said that could still be left up to the states to determine, based on whatever data are available to them. I would guess that if we do have sufficient information, it is probably going to show some sort of latitudinal variation with fish further south spawning earlier; and so forth and so on.

DR. DANIEL: Next slide. Again current vessel limits vary by state up to four fish, and again as we've discussed vessel limits could impact the NMFS decision to open the EEZ. It does seem that everyone agrees that the FMP should include options to complement federal actions sufficient to allow the EEZ to open. One option is to include a request to extend state regulations into the adjacent EEZ. I'm not sure at this point where we are in the game, if we're requesting the transfer.

This is going to require action from the Council, and so I would wonder if we want to put our Council request eggs just in the transfer basket or ask for these various modifications. I'm not sure what the Board would prefer here. Otherwise, we would be relying on NMFS that if we were to implement a plan that constrained the harvest to the ACL; that there would be some agreement that we would be able to get the EEZ open at some level during the seasonality where the states are most involved in the EEZ fisheries.

DR. DUVAL: I agree with Dr. Daniel in terms of putting all the eggs in the transfer basket. I think you want to have that conversation first, so my recommendation would be to keep some component of this in here that could go out to public comment; because if the eventual decision ends up being complementary management or it is complementary management for some period of time.

I think this example here to include a request to extend those state regulations out into the adjacent EEZ provides some of that access and equity and parity for states like South Carolina and Georgia, where the major component of their fishery is in those EEZ waters. I guess it would be my recommendation to leave that in there as we have those exploratory conversations.

CHAIRMAN ESTES: Dr. Crabtree.

DR. CRABTREE: Yes, let me assure you that my goal in all of this is to get the EEZ open again, so we can have a season. We have a stock that is not overfished, not undergoing overfishing; and I certainly am not comfortable with having the EEZ closed under those circumstances.

There are a couple of ways to think about just mechanically how this would work. Currently we have an annual catch limit, and the fishery opens when the season starts, and then we close it in order to avoid going over the ACL. If we had the complementary plan in place, we could open when the first state decides their season is going to begin; and then the states would control the landings in their states by controlling when they allow landings to occur.

At least in theory the ACL should be caught when the last state closes their season down, because that would be what the full conservation equivalency would be based on. That would be one way to do it. The EEZ just opens. The states control their harvest by regulating landings in those states; and then the EEZ closes when all the states are closed.

I guess the other way to do it would be for the states to come in advance and tell us this is going to be our season, and then we could open and close the EEZ according to what each individual state does. I guess we would have to have some lines out as to what's open and closed. That is more bureaucratically cumbersome I think. But I think we could really do it either way.

But I think it is a good topic to discuss at the Council level, because it might require changes to the accountability mechanisms. But that is sort of my thinking on how mechanically two ways I could see this working in a complementary plan. Then the commercial fishery, which we haven't talked about very much, we would have to figure out how that would go as well. But I think that's a lot more straightforward.

DR. DANIEL: Next slide. This has been an issue that has been brought up in multiple boards over many years, in terms of tracking the recreational ACL on an annual basis. Effort data are unavailable until after a wave is complete, and could result in significant overages; despite best efforts, as we've seen in the cobia fishery. The question would be should the FMP try to develop or discuss alternative ACL monitoring methods to track the ACL on a scale finer than waves?

I'm not exactly sure how to do that. That was a request from various folks, but I can tell you from the work that Mr. Wilson did in North Carolina, he was not very comfortable in looking at the data at any finer a scale than I believe it was monthly; for the majority of the data. I know there have been discussions around the building about ACCSP and other avenues, but I'm not precisely sure how we might go about making those changes specifically for cobia. But I bring it up for your thoughts.

DR. DUVAL: I think as Dr. Daniel indicated there are a number of balls in the air with regard to alternative means of at least reporting harvest recreationally. The Council has a pilot project that has been funded by the Fisheries Service that is looking at working with the Snook and Game Fish Foundation to modify their reporting Ap. It was specifically for red snapper, I believe, and discards of red snapper.

But we've had some discussions about possibly expanding that to include cobia on a pilot basis, you know to determine if anglers are amendable to that, what type of response we get; that sort of thing. Our chairman is probably familiar with multiple programs that are going on in the Gulf of Mexico, similarly looking at almost census type of reporting I think; in some of the smaller states like probably Alabama and Mississippi with regard to red snapper.

I think all those things are good, and we can probably learn from those experiences, in regards to recreational reporting for cobia. The state of Virginia has required reporting they're doing this year. North Carolina, our Commission voted to request anglers to bring fish to our citation weigh stations; which we're sort of piloting that this year.

There are some alternative methods out there. I think there is a certification process that would probably have to be undertaken to be able to use those numbers, rather than MRIP to track harvest. I think the other thing that we are interested in pursuing, and I've brought this up a couple other times at the Board, are some of these alternative estimation techniques that the MRIP staff have developed for rarely intercepted species that they have applied to several of the South Atlantic Council rarely intercepted species.

Cobia does not happen to be one of them, but some of our deepwater species and that has been a presentation made to the SSC. We've had some back and forth on again, who is the decider, in terms of when those methods can be applied and how you would apply them. But given that at least at the federal level right now, our accountability measures are not in-season accountability measures they are post-season accountability measures.

It doesn't seem to me that there is a great need to track harvest on a wave-by-wave basis in season, because we can't track it quickly enough or accurately enough to actually take any action. Some of these alternative techniques that use annual or multi-year levels of catch estimates and effort estimates that result in greater precision in harvest estimates might be more appropriate. The Council is pursuing that. Dr. Van Voorhees referenced a workshop that the South Atlantic, Mid-Atlantic, Gulf are working on to evaluate those. Personally I would like to see cobia move along a little bit faster on that; but that is just my opinion, so thank you for letting me talk on a little bit. I'll shut up.

DR. DANIEL: All right, I think that is a long way of saying no. Yes, okay. I didn't mean it disrespectfully. I think I agree with Dr. Duval, and I don't know that we would get much traction if we just tried to do it for cobia. But there is the need, and I think everybody is aware of that.

Just before I move on away from the recreational side, I will let you know that we have been working on putting together the document. We're very close to an FMP. I'm glad to at least see some light of day before any transfer of authority. All the states have submitted their information, and I'm hopeful that we can move forward.

We probably will not need another working group call, but if we do I will contact the Chairman, if we run into any problems. I will work up some language, because there was clear interest in the de minimis section, and get that out as well; so that folks can take a look at that and make sure that they're comfortable with that approach, especially for those states north of Virginia. Make sure they know they were not left out.

The final issue is commercial management options. The working group really didn't discuss commercial issues. The Framework 4 essentially maintains status quo, which is the current essentially bycatch allowance; which is a coastwide two fish at 33 inches fork length and six fish per vessel.

We've received very few public comments on the commercial fishery. In fact, I think all of the comments were maintain it as a bycatch fishery and essentially maintain it as it currently is, it's working. The quotas have not been exceeded to much degree, and just to maintain what we currently have.

The only suggestion that was put forward and it was by a commercial fisherman, I believe in Virginia, was to require that commercial landings be reported in whole weight. I don't know if that is something we want to consider or not, how that might conflict with the federal plan. But at the present time I would move forward on the commercial options; maintaining the Framework 4 options, which is status quo coastwide.

They have about a 50,000 pound ACL, and there was not the intent at least at this point, to try to look at allocations amongst the various states on that fishery. We could do that if you would like, but if we're not going to make any changes I didn't see the need to do that unless you request it. The information will be in the document so that you can look and see what the various states land; in terms of commercial landings.

MR. BOYLES: I think we need to think carefully about this. Before he left, Spud had suggested you know one of the issues with completely eliminating federal management is how do you manage the commercial fishery? At least in my experience cobia has been a bycatch fishery on the commercial side. The 33 inch fork length might be a problem and a problem in the following way. Are you fishing as a commercial fisherman, you can take a smaller fish. It is my understanding there is no permit in federal waters, and so right now we're dealing with some issues back home where folks are buying a state commercial fishing license to go out and access that commercial ACL. I think this is something that is going to require us to think about consistency, and I'm going to refute what I said last meeting. Quoting Oscar Wilde, "Consistency is the last refuge of the unimaginative." But the first refuge of the fisheries manager.

DR. DUVAL: Just a couple things, in terms of tracking landings and pounds whole weight. Right now coastal migratory pelagic species landings are tracked. They are tracked as landed, so it is a mix of whole weight and gutted weight. This was something that we had a discussion on at the previous Council meeting in March, and that we've asked.

I believe it's going to come up again on the mackerel/cobia agenda for this meeting; because we wanted to get some input from the Gulf Council with regard to, would you want it tracked all in whole weight or gutted weight. But the pitch I made was that really for the data providers, it would be good to have a consistent metric, because right now that causes some confusion when they are pulling data down from ACCSP; you know which cell you're pulling data from to compile it. I just wanted to let folks know that.

Then in terms of the commercial fishery, at the Mackerel/Cobia Advisory Panel meeting just a few weeks ago, I believe there was a motion made to implement a commercial cobia permit. Now the council had considered this previously, and I think maybe in Amendment 20A, when we were looking at splitting things into northern zone and southern zone, and at that time none of the states were interested in moving forward with any federal permit at that time; given that it was more of a bycatch fishery.

But I think the motion from the Advisory Panel was to ask for a limited access cobia federal commercial permit, with requirements to have a history of commercial sales to qualify; or any other federal permit. This is something similar to what the Council has considered in the past, where I think if you had any other federal commercial permit you could land cobia. That is just an FYI for the Board that that topic, in terms of the commercial fishery has come up in sort of this loophole that has been created by not having a federal permit.

DR. DANIEL: Just to the earlier point, Michelle, the issue of whole versus gutted weight. It would be interesting to hear some discussion from folks as to which one provides more biological information. It would seem to me for cobia, with a pulse fishery during the spawning season that perhaps whole weight versus gutted weight might be more informative.

I'm not sure. But in the discussions on that if it's based on the ease of doing it or the quality of information received, you might want to err on the side of the quality of information received; since we do know so little about the reproductive ecology that could help there. Then my final comment would be, and I'm sorry Spud's gone, but it's to thank Kathy Knowlton put together a lot of good information.

She's been very helpful on the working group and the Plan Development Team, and there is a lot of information that she's provided that will be very helpful in developing the plan. I'm sorry she's not here, but I do want to shout out to her for the work that she's done for the state of Georgia; thank you.

CHAIRMAN ESTES: Thank you, Louis. I expect we'll see a nice, nifty document in August that will have all this information in it? Okay if we can move on then to a couple of stock assessments. Atlantic croaker, Chris is going to give a report on the Atlantic croaker stock assessment. Yes, sir.

DR. MALCOLM RHODES: Before we leave cobia, and I don't know if this is the right venue for it, but I didn't know where to ask. Last year the ACL was reached and federal waters were closed. After that point essentially another ACL was prosecuted, closing this season, which closed Georgia with 100 percent and South Carolina, since we follow the federal mandates.

Both of our states have no seasons for cobia fishing at all. What measures have North Carolina and Virginia put in place this year to try and prevent a recurrence of over catching the coastwide ACL, and possibly us looking at 2018 with a closed season also? I mean I don't know if this is the appropriate time to ask; but while we have the whole venue together.

CHAIRMAN ESTES: Michelle or Joe.

DR. DUVAL: Malcolm, are you asking what state specific measures our respective commissions have put in place?

DR. RHODES: Correct, because we're under the same.

DR. DUVAL: Our Commission established measures effective May 1st through August 31st of one fish per person up to four per vessel for both charter vessels and private vessels; and then you know we have a shore-based fishery that is probably the chunkiest on the coast, and that would be one fish per person as well.

It is different than what we had last year, which was a Monday, Wednesday, Saturday two fish per vessel, private boat season that ran from like May 23rd through September 30th. Then for charter vessels it was fishing seven days of the week, one per person, four per vessel; shorter on the back end by a month this year, but far more generous on the private boat fishery.

I will just say that was not an option. Staff provided analyses to the Commission that looked at different start dates of measures, different vessel limits, one fish per person limits; and that was what the Commission chose. That was not an option, it was advocated by staff.

MR. CIMINO: It was a difficult challenge for us as well. Michelle talked about the analyses, and I think that we've all been pretty much on the same page on how to do that. We did something very similar to what the Science Center was doing to predict harvest. We were concerned with what happened in 2015.

We put measures in place in 2016 that we projected would have a harvest estimate of about 330,000 pounds. That estimate came in at over 900,000 pounds; so it was a very difficult challenge to go to the public and to go to our Commission and give them projections. They went with something that they felt would be restrictive.

There is a three-fish vessel possession limit. We've been at one fish for a long time on the possession limit. We have a 40 inch total length, which we feel is a good conversion for the max fork length that is used in the South Atlantic; and they went with a season of June 1st to September 15th. Again, we didn't spend a lot of time on what those projections are, because they haven't been all too meaningful to us lately. But hopefully it will provide some reasonable harvest level.

CHAIRMAN ESTES: You good, go ahead.

ATLANTIC CROAKER BENCHMARK STOCK ASSESSMENT 2017

BENCHMARK STOCK ASSESSMENT REPORT

MR. CHRIS McDONOUGH: All right, are we all set? Just before we start, we're going to actually split this up. I'm going to do the data portion and then Laura Lee is going to cover the modeling section; since she did that. Okay next slide. I don't have the clicker, so Megan you are going to have to click it.

Okay so what we're going to cover is a little bit of basic life history; different datasets we looked at, commercial discards, recreational as well as the fishery independent index data. Then we'll cover the assessment model, the reference points and the stock status that their model estimated; and then research recommendations.

Okay spot are, oh spot, sorry. I apologize for doing that but going back and forth between those two species gets a little confusing. Croaker are demersal sciaenid and they're generally found nearshore waters from the Gulf of Maine all the way down to Argentina, and most abundant from Florida to New Jersey.

Relatively fast growing, they reach about 80 percent of their maximum growth within two years. Maximum age is 17 years. They typically mature between ages 1 and 2, and 100 percent maturity is reached by Age 3. One thing that confounds a little bit with croaker is the fact that they have this extended spawning season; depending on the area of the coast it can range anywhere from September to April, and there are arguments that could be made to stretch a little bit outside of that.

But that could sometimes throw some issues in the aging and some other things that we've dealt with in the past. Okay for the datasets, actually you can go two slides ahead. Start off with the commercial landings. The majority of commercial landings over the years have come from Virginia and North Carolina.

You've got periods of high landings that occurred in the fifties, the seventies, and then into the two thousands. In recent years you've seen essentially a steady decline from the peak that happened in about 2004 or 5. Landings by gear, early years you see the majority of the landings coming from haul seines as well as trawls.

The assessment time period shows a shift to gillnets and trawls in recent years, and then the fixed gear that's in there is primarily pound net, is the pound net fishery in the Chesapeake. Okay the commercial scrap bait fishery, these landings come primarily from North Carolina and Virginia. North Carolina is actually the only state that samples by species that gives us estimates for the species composition within the scrap and bait fishery.

We use the angle ratios of croaker to the total landings in North Carolina to estimate scrap landings; for landings of croaker in Virginia, and actually this was the same method that was used in the 2010 assessment for these scrap and bait landings. For the discard estimates, and this is one of the big sticking points that has happened, particularly with croaker for every assessment it's had; and that is the South Atlantic shrimp trawl fishery. We used a general linear model approach, which is the same basic approach that was used in the king mackerel assessment, which did pass.

Then we also looked at the Mid-Atlantic gillnet and trawl fisheries bycatch for discard estimates as well. One note, for some of the material we're covering here in croaker, some of the detail that I'm going to go into a little bit here for the shrimp fishery, I'm not going to cover in spot; because spot we basically did the same exact thing. To save time and just what we're covering, just so you're aware of that.

Okay the shrimp trawl observer program data was only available from 2001 onward. What we did was we used the SEAMAP survey, which essentially covers the same geographic range. It was used to estimate the discard rates for years prior to 2001. The way this was done was that the GOM used that fishery survey catch rate to estimate a trend of relative abundance.

Then the shrimp trawl observer data catch rates was used to estimate the magnitude and the trend of the discarding rates in the fishery. The assumption is that as abundance changes the discard rates would change proportionately. As you can see on that graph, the discard rate and the SEAMAP survey, actually those two correlated fairly well.

Okay for the actual discards. Discards were relatively high in the beginning of the time series, but decreased through the early 1990s before bycatch reduction devices were required. There were particularly high discards in 1991; this was due to high effort and catch-per-unit effort that occurred in that year.

Discards were pretty stable through most of the 2000s, and then despite the declining or stable trends in effort during the 2010s, there actually was a slightly increasing trend in discards in the last couple years; and that is mostly driven by an increasing catch-per-unit effort over those particular years.

But the discard estimates generally followed the same trends as landings by the shrimp trawlers, your positive trend between the shrimp landings and the bycatch landings. The discard estimates from this assessment using this technique were actually greater than the discard estimates that were developed in the 2010 benchmark assessment; average is a little over 7.5 times greater. The 2010 assessment used a ratio estimator.

The gill net and trawl discards, this one we did use a ratio estimator expanded by reported landings. High discards occurred in the gillnet fishery in the late nineties, and the trawl fishery discards were variable; but there was really no consistent pattern there. We did see if there was a correlation between the gillnet and trawl net discards with the National Marine Fisheries Service Fall Groundfish Survey, which occurred in the same geographic area as the gill and trawl net fisheries.

But there really was no consistent relationship there. One thing to point out, the fishery discards for the gill net and trawl net were included in the model for removals. However, there was relatively low number of discards, particularly compared to the shrimp fishery; on the order of less than 250 metric tons annually. This was significantly less than the removals from the shrimp trawl fishery, so it plays a part but a very small one. For the recreational removals to the harvest, and this is total harvest as well as the estimated mortality from the recreationally released fish. Total recreational removals used in the model were the sum of the harvest, as well as the estimated discard mortality by number. Estimated discard mortality for the recreational fishery was fixed at 15 percent. We'll talk a little bit more about that. That was decided by the Stock Assessment Committee, and we'll address that a little bit more in a bit.

Commercial landings are included on this plot to show how well they track with the recreational harvest and mortality. For the recreational removals, total harvest and release mortality were done in number. Then recreational harvest in numbers and estimated annual discard mortalities was used as one of the annual removal factors in the stock synthesis model. Just to give you a big picture of the total removals that orange or yellow there that is the shrimp fishery discards.

You can note the difference in the scale, it's a huge, about a 24 fold difference in scale from some of the other; when you pile them all together and include them with the shrimp fishery. The shrimp fishery accounts for greater than or equal to 90 percent of total removals in all those years.

Then afterwards there is commercial and recreational essentially account for the next highest levels, but they're pretty much drowned out by those shrimp fishery removals. For the fishery independent data, the criteria we use to evaluate the surveys, the time series had to be – we were looking for something that was at least 17 years long or one generation time for croaker.

No changes in methodology or the gear. The survey had to operate in a place and a time where croaker were present and typically available, and then have a relatively high proportion of positive tows. We reviewed 43 fishery independent surveys, and then we narrowed the ones we were considering down to six. These included the National Marine Fisheries Service Trawl Survey, the SEAMAP Survey, the VIMS Trawl Survey, and then the North Carolina DMF Program 195 Survey; all of which were used in the 2010 assessment.

Two additional surveys, ChesMMAP and NEAMAP were considered for sensitivity runs in the stock synthesis model, but they represented shorter time periods of 2002 to 2014 for ChesMMAP, and 2007 to 2014 for NEAMAP. The indices, the timeframe used in the indices was 1989 to 2014, 1989 was the start year; primarily due to the availability of that was the first year we had complete-removal data.

Just to cover the trends in the various surveys. For the NMFS Trawl Survey, the first 20 years for the croaker abundance was relatively stable, and then you start to see this beginning increasing trend in the early '90s, peaked at 2009 and has declined after that point. The SEAMAP survey, it has more annual variability compared to the NMFS survey, but has also shown a general increasing trend that began at about 2001 and into recent years; although the last two years in SEAMAP have also shown a decline.

The North Carolina DMF, the Program 195 Survey showed a high degree of inter annual variability, but given that this survey catch is primarily young-of-the-year fish that is not uncommon in a young-of-the-year survey. Then the VIMS index, similar to the North Carolina Survey, the VIMS Survey catches a high number of juvenile fish; so it also showed a high degree of inter annual variability. Both the North Carolina and the VIMS surveys actually correlated fairly well with each other. The ChesMMAP Survey had peak biomass, actually wait, yes it is biomass. Making sure I got the right graph. Peak biomass occurred in 2002 and then in 2005 and 6, but otherwise it has essentially been a long term declining trend of croaker. Then NEAMAP, which was the shortest dataset we had, other than peak years at the beginning of the survey in 2007 and 2012 has been relatively stable with no clear trends.

In conclusion for those fishery independent surveys, what we used in the base run were NMFS and SEAMAP indices, as well as biomass; and then the VIMS and North Carolina Program 195 indices for young-of-the-year relative abundance. ChesMMAP was negatively correlated with the other indices.

It was basically a big conflicting signal, and so it was used in the sensitivity analysis but was not used in the base model. Then NEAMAP it was decided that the dataset or the time period was just still too short to be of much use in the model; but certainly will continue to be considered in future efforts for assessment. All right, and with that I am going to hand it off to Laura.

STOCK ASSESSMENT MODELING

MS. LAURA M. LEE: Okay so we used the stock synthesis model, program rather, to assess Atlantic croaker. This is considered a state-of-the-art model, it is forward projecting. It is very flexible in that it can use all types of data, including length and age data, multiple indices, multiple fisheries.

We implemented a two-sex model and we use it to estimate stock size, fishing mortality, and our reference points. As far as our configuration, we modeled 1989 through 2014, and our unit stock was New Jersey to the east coast of Florida. We had four fleets, which included the commercial, the recreational, commercial scrap landings and the shrimp trawl fishery, which was modeled as a bycatch only fleet.

Then we had the five surveys that Chris described. I also want to mention that we did a Bayesian prior on steepness of 0.76. This value comes from two sources. One, it was the value we assumed in the last assessment, and that value for that assessment came from a meta-analysis. Joseph Munyandarero on our committee, he also did a life history approach to estimate steepness, and it just happened to come out as that same value of 0.76. We included that in the model as a prior.

This is a summary. I apologize, this is difficult to read. Of all the data that was used in the model, including catch data, abundance indices, length compositions, age-at-length, mean-length-at-age, and discards. The width of the line gives an indication of the length of the time series for each different input from each different source.

Getting into the results, the trend in annual recruitment deviations showed the expected patterns; it was very variable over the time series, but it is decreasing in the very most recent years, and the variance is increasing over time; and that is typical of these models, where the most recent years are the most uncertain.

Spawning stock biomass started at a very low value, and just steadily increased over the time series again, just like recruitment the variability is greatly increasing with time. Those estimates in the terminal year are the most uncertain. Estimates for fishing mortality were variable with a general decreasing trend over the time series. The smallest fishing mortality was observed in 2005 at a value of 0.11. As I said before, we had that prior 0.76 of steepness for the stock recruit relationship, but despite that the estimated steepness value was 0.99 essentially, and you can see that the model is giving a very poor fit to the stock recruit relationship; so the data we have is just not informing that.

We did a number of sensitivity analyses. We looked at recreational discard mortality and the base run. We assumed a value of 15 percent mortality, and we varied that over a range in the sensitivity analyses. We removed one survey at a time in another set of sensitivity analyses. We looked at different values of steepness. We looked at different assumptions relative to the shrimp trawl bycatch, and we also did the traditional retrospective analysis.

Now for each of these sensitivities I'm going to show you the spawning stock biomass and fishing mortality estimates. This first slide you can see that we varied the level of recreational discard mortality from 8 percent to 18 percent. For SSB fishing mortality and recruitment, which isn't shown here, varying that level had little impact on the model results.

Our next set of sensitivity analyses was to remove one index at a time and not just the index but all the data associated with it, so the biological data associated with it. You can see that there is just a small impact on SSB and fishing mortality. Removing the NMFS and the SEAMAP Survey probably had the biggest impact on recent recruitment, which isn't shown.

But recruitment and SSB in recent years appeared to be most sensitive to which survey data were removed. We looked at a range of steepness values from, I think 0.61 and I just want to note that we did implement this reweighting procedure, and the models wouldn't converge without doing that reweighting procedure when we varied the steepness value.

There is definitely an impact on recruitment and female spawning stock biomass. Assuming the smaller levels of steepness resulted in higher estimates of recruitment, especially in the recent years. Similarly assuming smaller levels of steepness resulted in higher predicted estimates of female spawning stock biomass, especially in the final years of the models; as you can see here.

Predicted fishing mortality tended to be smaller at smaller assumed values of steepness. For shrimp trawl bycatch we had the base levels and then we reduced that level by 10, 20, 30, 40 and 50 percent; to see what the impacts were on the models. Thirty percent is in the ledger, but the estimates aren't shown because the model couldn't find a solution when we made that assumption.

But you can see there wasn't much impact on the model estimates of SSB and fishing mortality. When we showed the data that 1991 value from trawl bycatch was estimated to be really high, because I think effort and CPUE were really high in that year. We changed that value in two ways, one is we basically took that value out of the model, and that's the new 1991 run.

Then the dent in 1991 run is where we set the 1991 value equal to the median of the other values prior to the implementation of the BRDs. You can see there is not much impact on spawning stock biomass. There is a little bit of impact on fishing mortality in the initial years of the assessment. Finally the retrospective analysis shown here suggested there is no consistent over or under estimation of terminal year values for recruitment; which isn't showing female spawning stock biomass or fishing mortality. Reference for Atlantic croaker is defined in Addendum I to Amendment 1 of the fishery management plan, and they are shown here. The stock synthesis model was used to estimate the reference point values; which are also given here, the threshold and targets for spawning stock biomass in fishing mortality.

The overfished and overfishing definitions are based on the ratio of current F and spawning stock biomass to the respective thresholds. If F in the terminal year over F threshold is greater than 1 then overfishing is occurring. Likewise, if spawning stock biomass in the terminal year over spawning stock biomass threshold is less than 1, then the stock is considered overfished.

This graph shows the relative status over time, and you can see for relative spawning stock biomass we start out very low, below the threshold and increasing very optimistically in the terminal years. As far as the fishing mortality threshold, there were maybe three years where the stock was considered overfishing occurring; but throughout most of the time series and including the terminal year, overfishing is not occurring.

You can see that below with the actual values of terminal year SSB and F to their respective thresholds. We developed a series of short term and long term research recommendations and ranked them according to priority. Start with the short term recommendations; high priority, increase observer coverage for commercial discards, particularly the shrimp trawl fishery.

Developing a standardized protocol for biological samples from this fishery, this is needed just to characterize what those discards look like; and better inform the model. The next high priority is to describe the coastwide distribution, behavior and movement of croaker by age, length and season, with emphasis on collecting larger, older fish; which is what is currently lacking in the available data.

For short term medium priority, the way I conduct studies of discard mortality for recreational and commercial fisheries. I don't think I mentioned for commercial fisheries any discards we had there we assumed 100 percent mortality, and for recreational those estimates came from meta-analyses. I don't think they were specific to croaker; the estimates that we came up with.

We recommend conducting these studies. In recreational fishery, we really don't have samples of discarded fish, so if we can get ages and lengths from that that would be good for characterizing those recreational discards in the model. Encourage fishery dependent biological sampling with proportional landings representative of the distribution of the fishery, so more samples from states with higher landings; and of course develop associated prototypes.

For the long term high priority, we're suggesting to continue state and multistate fisheries independent surveys throughout the range, and to continue to subsample for lengths and ages. Another thing, this might be written twice, is looking at factors affecting catchability and long term fishery independent surveys, so that if there are significant factors affecting catchability then we would consider standardizing our indices, using something like a GLM approach based on those significant factors.

Next would be to quantify the effect of BRDs and TEDs implementation in the shrimp trawl fishery, by examining their relative catch reduction rates on Atlantic croaker. Continue to develop estimates of length at maturity and year round reproductive dynamics throughout the species range. Look at historical ichthyoplankton studies for the magnitude of estuarine and coastal spawning. Then we have out medium priority for the long term. One was investigating environmental covariates in stock assessment models, including climate cycles and recruitment of year class strengths, spawning stock biomass, stock distribution, maturity schedules and habitat degradation.

Utilize NMFS ecosystem indicators biannual reports to consider folding indicators into the assessment, and identifying mechanisms for how environmental indicators affect the stock. Encouraging efforts to recover historical landings data, this would be important for us to take that to a start year back in time; and maybe get a better estimate of initial equilibrium catch.

Collect data to develop gear specific fishing effort estimates. Investigate methods to develop historical estimates of effort. Investigate the relation between estuarine nursery areas and their proportional contribution to the biomass. This could eventually end up being used in weighting of the indices in the stock assessment model.

This is the last one. Continuing with the medium priority, develop gear selectivity studies. There is not a lot out there, but it will be great if we could get a better handle on the actual shapes of the selectivity curves for the different gears; and maybe get external parameter estimates to inform our models better.

Conduct studies to measure female reproductive output at size and age and impact on the assessment models and biomass reference points. Developing sampling programs for state-specific commercial scrap and bait fisheries; in order to monitor the relative importance of croaker in those fisheries.

Currently North Carolina is the only one that does biological sampling of those fisheries, and we're not sure of the importance in other states. That's why we're recommending this. As far as the timing of the next assessment, the Subcommittee and the Technical Committee recommend that the next assessment be completed five years from the completion of this assessment, so 2022.

We also recommend that we not do them at the same time, because it was kind of a burden on the Subcommittee to have to try and complete two assessments at the same time. If you could recommend staggering them next time that would be great, and with that we would be happy to take any questions.

CHAIRMAN ESTES: Thank you, Laura and Chris. I think before we'll do questions maybe, I would like to have Pat talk about the peer review; and then we can get questions all together.

PEER REVIEW PANEL REPORT

MR. PATRICK A. CAMPFIELD: I am going to provide a summary of the highlights from the peer review of both assessments; starting with croaker. Just real quick on the process, the Stock Assessment Subcommittee and TC developed a new coastwide assessment. Our review panel consists of three reviewers; the Chair and then two technical reviewers.

In combination they had expertise in general population dynamics, stock assessment modeling, statistics, and croaker biology. Their charge or their task was to provide a scientific review, focusing on data inputs, model results, and sensitivities and the overall quality of the assessment. The review workshop was held down in Raleigh, and the Review Panel consisted of Ken Able from Rutgers, Dr. Shannon Cass-Calay from NMFS Southeast Science Center, and Dr. Mike Wilberg from the University of Maryland. To start with the overall peer review findings, the Panel really reached two conclusions or looked at this at two different levels. They were in full support that the stock assessment provides the best available science; that the stock assessment team turned over every rock in looking for data that the suite of analyses and models that they attempted were very rigorous, in terms of comparisons to other assessments.

However, they found that the stock status determinations were uncertain. Although the biomass is increasing in most of the model runs, they didn't see sort of commensurate increases in the population age and length structure that you often see with a population that's increasing in biomass.

Under the modeling context, they noted that the stock status results were sensitive to some key assumptions; most notably the gear selectivity options for the commercial fishery, as well as the Northeast Science Center trawl survey. While the Panel does not recommend using the absolute estimates of population size, they were fairly comfortable saying that the trends in landings and surveys suggest that the current removals are sustainable.

Then I'll go quickly by each review term of reference and try to hit the highlights. The first term was essentially to evaluate the data that were collected and how they were treated in the assessment. The Panel concluded that all major sources of removals were accounted for and Chris described those in more detail.

The criteria and the process that was used for selecting abundance indices were adequate and correctly applied; leading to selection of a subset of five indices. Data source variances and uncertainties were well described; they were very thorough about that and that the procedures for data weighting meet typical stock assessment standards.

However, the Panel did note that model stability was highly sensitive to how the data sources were weighted; and you might get different model results depending on those weighting factors. The Panel recommendations related to the data, the assessment as Chris and Laura described started in 1989 through 2014.

But the Panel noted that there were of course significant removals of croaker prior to 1989, and they suggested trying to develop historic estimates and evaluate the sensitivities of the initial depletion in the assessment; by going back and looking to see if a longer time series might inform the trends and the overall model results in a different fashion. They are not guaranteeing that that would improve things, but they suggested at least looking at it.

Their second recommendation was to develop CPUE indices from the fishery dependent data. But of the overall concerns this was that the biomass seemed to be increasing from the model results. Landings have been coming down, and the Panel thought that using these fishery dependent CPUE indices may tease apart those contrasting trends.

Their third recommendation was to consider standardizing all of the survey indices. Again, not suggesting that is going to fix things; but it is worth looking at. The fourth recommendation was to develop criteria to better evaluate the reliability of each data source; again for model data weighting purposes. The second term of reference was to evaluate the methods used to develop discard and bycatch estimates. The Panel concluded that the bycatch estimation methods from the shrimp trawl fishery were innovative, and similar and consistent with what the most recent SEDAR assessments have used. They were completely onboard with that and noted it was a major improvement from the last croaker stock assessment.

As I think Chris described the methods, essentially taking observer data from the shrimp trawl fishery and combining that with trends in SEAMAP survey information, as well as sort of calculating for the change of when bycatch reduction devices went in, again was innovative and a smart way to go about bycatch estimation.

Similarly, the Panel agreed with the approach for estimating discards from the Mid-Atlantic gillnet and trawl fisheries. Term of Reference 3, was to evaluate the methods and models used to estimate population parameters and reference points. The Panel concluded that the stock synthesis catch-at-age model configuration and parameterization were reasonable.

However, they noted alternative configurations that were requested and provided by the assessment team at the review workshop could result in different stock status determinations. The Panel's recommendations again were to look into starting the model prior to 1989, although the time period selected by the assessment promoted model stability, again it reduced the Panel's confidence in the initial depletion starting point.

One of the other recommendations or sort of a set of recommendations within the models was to look at the different selectivity options. I mentioned that in the earlier slide, but essentially compare results between dome shaped selectivity, which was used I think for all but one of the inputs in the assessment; and also to try asymptotic selectivity.

There are other recommendations there more technical that we'll spare for today. The fourth term of reference was to evaluate sensitivity in retrospective analyses performed in the assessment; to look at model stability and consequences of model assumptions. The Panel concluded that the range of sensitivity analyses that was conducted was reasonable; that they took a strong look at sensitivities.

It showed the model was insensitive to recreational discard mortality and index selection, but they did have a recommendation, again for additional sensitivity analyses around commercial fleet selectivity as well as effective sample sizes. You guys covered the retrospective analyses, but in summary the Panel was not concerned about retrospective patterns.

Term of Reference 5 was to evaluate the methods used to characterize uncertainty in the stock assessment. The assessment team used asymptotic standard errors to characterize uncertainty. A minor recommendation from the Panel was to try likelihood profiles to better understand parameter uncertainties.

Term of Reference 6 was to recommend best estimates of stock biomass abundance and exploitation. The Panel does not recommend using the assessment estimates of absolute biomass abundance and exploitation, due to the model sensitivities that we mentioned; again on selectivity. However, they thought there were several important take homes that could be gleaned from the stock assessment; one that abundance indices are increasing across most of the stock range, and they were confident in that conclusion. That second catch appears to be stable and declining over time. That catch and indices patterns together indicate declining fishing mortality rates. It looks like the croaker stock in recent years is in better shape than the late ’80s and early 1990s. Finally that shrimp fishery effort and croaker bycatch appears to be declining. Related to this the Panel recommended reviewing the shrimp bycatch estimates on an annual basis, given their substantial contribution to overall mortality; and to consider adding this to the annual-traffic-light analyses.

Term of Reference 7 was to evaluate the choice of reference points and the methods used to estimate them, and recommend the stock status. Again the Review Panel does not recommend specific absolute values for reference points, due to uncertainty in the scale of biomass and fishing mortality; although stock status cannot be determined reliably, because models with alternative plausible selectivity assumptions resulted in different stock status determinations.

Although we’ve used MSY based reference points to date for croaker, given some of the uncertainties the Panel recommended making a switch to spawning potential ratio reference points. Finally, the last two terms were to review the research recommendations that the stock assessment team developed; and help them prioritize them.

Both the Review Panel Chair and Chris, as the Assessment Team Chair, we spent a lot of time at the review developing top priorities. I won’t repeat all those, but the take-home was that the most important research recommendations were to increase shrimp trawl fishery observer coverage and to increase collection of croaker lengths and ages from the shrimp trawl fishery.

It is fairly obvious, but definitely supported continuing the fishery independent surveys; and again to subsample to take lengths and ages from those surveys. The last term was to recommend timing for the next benchmark assessment, and the Panel agreed with the stock assessment team that the next benchmark should be in five years; continue the traffic-light-analyses, and again consider adding shrimp bycatch estimation to those analyses. Thank you, Mr. Chairman that is all from the Review Panel.

CHAIRMAN ESTES: Do we have questions about the assessment or about the review; Marty?

MR. MARTIN GARY: Well thanks, Chris and Laura and Pat for the update. It was really appreciated. From our little jurisdiction, PRFC, and then a little bit north and south of there where our constituents fish in the lower part of Maryland’s Bay and the upper part of Virginia’s Bay, croaker have been really, really important.

I have two questions, the first one, and I would like to follow it up if I could. I know it was stated up front that range of the stock is New Jersey south, and it may not have been an emphasis. But is there any indication in any of the data that this species is expanding northward like we see some? I was curious about that.

MR. McDONOUGH: Yes there was some data that showed that you see increasing, particularly in recent years in New York, Massachusetts, Rhode Island, a little bit here and there. It is not a consistent pattern. The most consistent pattern in terms of increase in about the last five years has been seen in New Jersey; but then that's pretty variable. One year they won't get a whole lot, the next year they'll triple to quadruple what they're seeing. But there does seem to be. It's not so much; I wouldn't call it a range expansion or anything like that. But it seems like the core of the distribution has broadened or at least gone north. I shouldn't say broaden, because the distribution in the south has stayed about the same.

MR. GARY: Mr. Chairman, could I have a follow up?

CHAIRMAN ESTES: Yes, sir.

MR. GARY: Then for this next question, it's a two-parter, and I'll put myself in the shoes of one of my for-hire constituents, just to throw it out to you. If anybody was around for the Striped Bass Advisory Board and you heard, like you have on several occasions, the frustration from our for-hire fleet. Part of it is driven by the lack of diversity of what they can fish for.

They're really restricted as you go from the mouth of the Potomac to Potomac and then north to almost striped bass and maybe bluefish and white perch, et cetera. But croaker, weakfish and some other species were available, spot, throughout the '90s a prodigious fishery for the for-hire fleet; really important to them, and your data showed all that as I was watching it.

By the time we got to like '03, '04, '05 that fishery was waning. They are catching some now, but it is a shadow of what it was. I think the first question, to put myself in their shoes, and I can go back and talk to them about what this revealed, is what caused that? It wasn't clear to me, was it environmentally driven? Did the shrimp bycatch lead to some of that as a combination of factors?

One question is why did we go from that abundance and down? Again, I'm putting myself sort of in my constituent's shoes. Then the other part is I see some of the information suggesting that spawning stock biomass is increasing. Is there room for optimism for these folks to get back close to maybe what we had before? That is somewhat hypothetical, but I thought I would put it out to you.

MR. McDONOUGH: Well I'll start. I think we really don't have a clear picture as to that. The model was showing that biomass increase. We've seen increases in some of the fishery independent surveys. But those commercial and recreational rates have been going down. There are some differences in terms of the age structure between the fishery independent surveys; they tend to such a smaller, younger fish versus what the commercial and recreational fishery gets.

Recruitment has been pretty poor for croaker, and there is a lot we don't know about the recruitment processes along the coast. We know they spawn along the coast, but we don't know how those recruits distribute out and whether or not you're getting high recruit mortalities in some of those northern estuaries.

The Chesapeake has had the dissolved oxygen issues, although I think for the PMRC that is more concern with the center of the bay than back in the rivers, maybe not as much of an issue. But some of the work we did with the traffic-light-analysis, there was some differential between those commercial and recreational and the independent surveys. It pointed more to the difference in the age, you know the relative age structure of what the fishery was targeting versus what some of the surveys were finding. But there really isn't a good direct answer for that.

MR. CAMPFIELD: I would just add to that that we did see corroboration of that in the ChesMMAP index. You see a completely different trend from that index. I think we do recognize that there does appear to be something different going on in the Chesapeake Bay than from what we've seen elsewhere along the coast, and even in the NMFS bottom trawl survey that covers the mouth of the bay.

We do see that and we certainly don't know the mechanisms to explain those differences in trends. But the model is a coastwide model trying to give us a picture of what the coastwide stock unit is doing. The indices that we did use within the modeling framework are different than that and are showing what we hope is more so a picture of the coastwide stock. Until we can get to a more spatially explicit model that is kind of what we're held to and limited to, as far as trying to determine, as far as stock status from the coastwide population or stock unit.

MR. CIMINO: I would just like to add to the discussion. First, thank all of you for the work that you've done. I am a little concerned as well. If you look at the removals without shrimp trawls that is a pretty considerable downward trend in recent years. I put in a plug for NEAMAP and all the other surveys that are still tracking this, because that may be our only answer.

One of the interesting things that I've heard from quite a few fishermen now over the past couple of years, is that they really feel that the overwintering migration, where we used to have croaker and weakfish sitting just offshore, have moved into considerably deeper water. Now it seems that there are some fisheries that are fishing in 400, 500 feet of water for croaker and weakfish in the winter. I find that pretty interesting.

CHAIRMAN ESTES: Chris.

MR. CHRIS BATSAVAGE: Thank you for all the work that the group did on this assessment, as you know it is no small task. From seeing the results and the peer review, it of course showed that biomass has increased quite a bit here in recent years. However, just some of the comments it doesn't really bear out as far as what people are seeing. If you consider like black sea bass being two times over the target, you know they're hard to get away from in certain areas; not really the case with croaker.

My question is, you know with I guess the uncertainty in the gear selectivities chosen for the model, specifically the commercial fishery where you kind of have a mix of dome shaped selectivity type fishery like the gillnet fishery versus more asymptotic selectivity fisheries such as the ocean trawl, long haul seines, and probably even pound nets to a certain extent. Is there I guess a future direction to maybe split the commercial fleets out by the gear selectivity, you know to maybe get a better idea of what the stock status is?

MS. LEE: Thanks, Chris, I've been thinking about that; because we talked about that a little bit. I think that that would be a good approach moving forward, because of the issues that we had with the selectivity modeling. I didn't completely agree with going to totally logistic for the commercial fishery, but he convinced me that maybe dome shape wasn't appropriate either, so I think that would be the best way to go.

MR. DAVID BUSH: The first question I had originally for Laura was answered when the Peer Review went over it, because I couldn't quite see some of the scales up there. But it looks like in general we can't use the numbers but the trends are there, and the trends are pretty substantial. They are increasing, spawning stock biomass is going up, and one of the biggest impacts could be the shrimp trawl bycatch side of it.

Looking at it for the past few years there, you know that trend has dramatically increased and it's probably the wrong place to do it, but I'm going to try anyway. My division here has worked very well with our fishermen in our state to get to the source of some of this discard issue, and over the past few years have really had huge impacts.

Hopefully that bears out in this. But I do have one question that was brought up by the comments earlier. I know that we check for where these fish traditionally were, and that is where we do our surveys, but have we ever made any efforts to try to see what the extent of their ranges are; because if they are moving out past our surveys, then we're going to get a very skewed perception of what the biomass of the stock really looks like?

MR. McDONOUGH: We have, as far as looking at those broader areas, we have on occasion looked at the NMFS survey; we look primarily from about New York Harbor down to Hatteras. That is what the index is generated from, because that is where 60 to 70 percent plus the positive tows for croaker occur. However, they sample all the way up to the Gulf of Maine in that survey. We have looked at croaker catches outside of the regular strata on occasion.

Those numbers still kind of bear out. You really don't see much. There is variability. Some years they might go up, but then you'll have a couple of down years where you might see them off of Rhode Island and Massachusetts. Then I think Joe's point about the depth distribution is a good one.

The NMFS survey does sample fairly deeply, however they don't sample the really deep strata on a regular basis, like they do, I call it the mid-shore strata, because NEAMAP took over their inshore strata from starting in 2008 and '09. Croaker weren't consistently caught at those deeper stations over the years, and that's another reason why that data hasn't been paid as much attention to. But that is probably something that warrants going back and looking at it, because certainly it is all available.

CHAIRMAN ESTES: Yes, John.

MR. CARMICHAEL: Laura, when I went through it I read the assessment report first, and I didn't get the same sense of it as I got once I read the review. I didn't get the sense of doubt that the reviewers cast upon it from the assessment report, and I was wondering if the reviewer's opinions took the Technical Committee somewhat by surprise; or were they anticipating some of that?

MS. LEE: That's a good question. I think we were taken more by surprise than not. I think we were probably going in most worried about the shrimp trawl discards, just because that was such a concern at the last assessment; and we spent so much time trying to come up with really good estimates. The issues that they came up with were a little unexpected, but they weren't wrong in what they brought up.

MR. CARMICHAEL: Follow up if I could. I noticed one thing and I think it is important to the SSB trend, because in the introduction of the overview executive summary from the reviewers, they talk about the selectivity issue that Chris raised and the problems with, I think we're all well aware when you have a lot of dome shaped selectivities, you're older age fish can kind of do whatever they wish to do.

They mentioned the chance or the possibility that the increased SSB could be cryptic, and just be driven by the dome shape selectivity so the fish can get out past those selectivities and just continue to grow. I thought that raised some concern, because then they say later, well it seems like the trends are good, and fishing mortality is low, and spawning stock biomass is increasing.

But I have to go back and say well, if you tell me spawning stock biomass is increasing in the base runs, but you told me earlier that maybe the increase in the older fish was cryptic; then that might shed a little bit of uncertainty onto whether or not spawning stock biomass is really increasing that much.

But especially because they also in there mention that the length-in-age comps didn't really support the increasing population, they supported more of a static or potentially declining population. I kind of was disappointed that they didn't delve into that more in the other terms of reference.

Because this chance that there is some cryptic population out there is really pretty critical, in terms of interpreting these results and what you might do, and how you view what is maybe increasing or is it the landings aren't there and the landings aren't increasing as much? Maybe there is something else at work here.

CHAIRMAN ESTES: What is the pleasure of the Board? It seems that we have an assessment that has quite a bit of data, folks worked really hard on it; yet the review says we really can't use it for management purposes. What is the pleasure of the Board?

MR. BOYLES: First of all before we answer the question. You know for Jeff, Kristen, Megan, Michael, Pat, all the staff, Chris, Laura, and everybody who has worked on this, thank you. I know it is disappointing when we find ourselves kind of scratching our head to try to answer Jim's question, Chairman Estes' question of where do we go from here? But I would like to say on behalf of the Board thank you. I know it was a long slog. We've got data limitations. I'm grateful, and I think I'll go out on a limb and say I think the Board is grateful for your effort.

Job well done, and we've got challenges before us and we'll make things better next time, but thank you. Mr. Chairman, at the risk of sounding really, really parochial, a number of us, I included, have a flight to catch and there is a lot to think about here; not only with this one, but with the spot assessment as well. I would like a little bit of time to think about this. If you want a motion to accept this, accept the assessment and the peer review and give us a little bit of time to chew on it. I think this probably warrants for some further discussion, maybe at our next meeting.

CHAIRMAN ESTES: Agreed, so how do we procedurally do that?

EXECUTIVE DIRECTOR BEAL: Well usually the peer reviews are accepted for management, and since the assessment wasn't upheld by the peer review, I don't think there is any necessary motion by the Board that has to accept the peer review results; or anything along those lines for management use, since that won't be the plan. I think if there is comfort around the table of waiting until the August meeting, allow folks to sleep on this for a few months and think about the next steps forward. That is the Board's prerogative for sure.

CHAIRMAN ESTES: Yes, Joe.

MR. CIMINO: Very quickly, Mr. Chair. I don't want Laura to have to leave without some sort of promise that we can decouple these two assessments. I think we'll hear a lot more about the challenges with spot. I would be happy to do this at the next meeting, but I probably think it's logical that spot could be a more delayed; and maybe give croaker another shot in the near future.

MR. CARMICHAEL: Laura, I think to that I would say, given the issues that they raised with the data and such, I don't think a year prediction for when you do this next; in five years or what have you. But when do you guys think you can actually make some progress on the real issues? You're not going to resolve the past shrimp trawl bycatch.

The numbers we have are the numbers we have, and they said that you used the accepted methods and appropriate methods, so the issue is with the data. Well you can't go back in time to fix the data, so I think it would be a better use of the Technical Committee's time to think about how you deal with that limitation within the tools we have to deal with making good predictions for croaker.

Maybe in the near term you guys could look at something like F max or some yield per recruit type approach for this, since there is not stock recruitment relationship that is at all discernible. I think dig into the selectivity issues, as was mentioned, and maybe try to do some research to really determine what the selectivity is; and not have to estimate so many selectivities in this model.

Then maybe you can come up with a croaker model that will be informative and acceptable to those guys. It is a lot of work to go down this path, and I hate to see folks go do that when you can't resolve the issues that are standing in the way of its acceptance now.

CHAIRMAN ESTES: Okay, following Robert's suggestion. Oops, hang on a minute.

MS. KERNS: I think that's helpful, John, at least for the TC to look into some information on the path forward. I think one of the things that might be helpful for the Board, and if you guys disagree with me that is perfectly acceptable, but it is to update the traffic-light-approach with the last two years of data; because the assessment only went through 2014.

Have the TC work on that between now and the August meeting, and present the updated traffic light at the August meeting. Especially I think that there may be some hesitation with spot, and I think it would be good for the Board to see the information with the new years for spot on that; because we had seen some declining trends earlier. They can at least review that. We can think long term or even medium term for some of those suggestions of which John just brought up as well. There are also suggestions from the Peer Review Panel, I think from both assessments or just for the croaker assessment that we may want to consider adding the shrimp trawl discard information into the traffic-light-approach. I don't think we necessarily need to do that for the August meeting, but that is something that the TC could think about if there is some sort of possible way to do that or not. Those are some things that could happen between now and August, and then some things could happen between now and question mark end date.

CHAIRMAN ESTES: In the meantime I think we will postpone the spot assessment until our August meeting, as I think was suggested. If that is all right with everybody, does anybody have a problem with that? Okay it doesn't look like anybody has a problem with that.

SPANISH MACKEREL ADDENDUM I

CHAIRMAN ESTES: I think we will go to what is our last agenda item, it is Spanish mackerel Addendum I, I believe that Michelle would like to talk to us about.

DR. DUVAL: I will be very brief. If you all recall, Addendum I to the Spanish mackerel fishery management plan for the Commission allowed for seasonal exemption from the 12 inch minimum size limit, specifically for pound nets and only for the months of July through September.

The past couple years, so North Carolina is the only state that has utilized this particular exemption, and the past several years we've provided the Board with a report; generally at this meeting, with regards to the previous year's performance of the fishery. I had spoken to the Chairman previously about this.

We had a little bit of trouble trying to get that report together within that timeframe. This year we do have it together now. It should be finalized tomorrow, and so Mr. Chairman, I was simply going to ask and I believe we have done this in the past, if perhaps the Board will be amendable to reviewing that via an e-mail type of review.

I will put forward that North Carolina is indeed interested in continuing that exemption for this upcoming 2017 fishing year, so if I can provide that report to staff first thing Monday, and then they can get it out to the Board; that would be my recommendation.

CHAIRMAN ESTES: Is that acceptable to the Board that we should get it sometime in the next week or so? Okay, thank you, Michelle.

ADJOURNMENT

CHAIRMAN ESTES: Is there any other business to come before the Board today? Seeing nobody rushing up front here, I think that we are adjourned.

(Whereupon the meeting was adjourned at 2:53 o'clock p.m. on May 11, 2017.)

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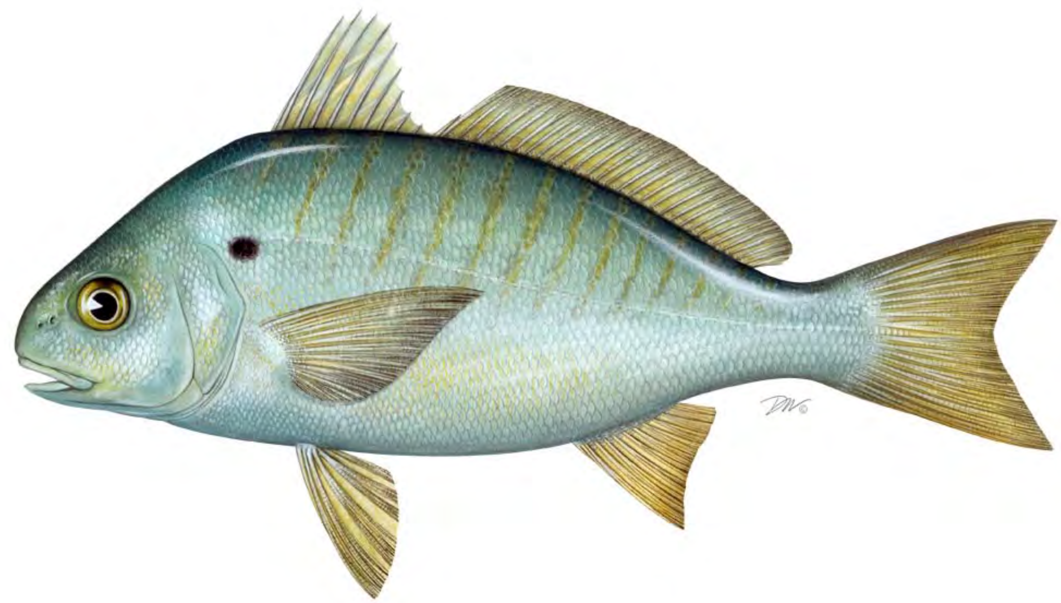
Atlantic States Marine Fisheries Commission

2017 Spot Stock Assessment Peer Review



May 2017

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Atlantic States Marine Fisheries Commission

2017 Spot Stock Assessment Peer Review

Conducted on
April 18-21, 2017
Raleigh, North Carolina

Prepared by the
ASMFC Atlantic Croaker and Spot Stock Assessment Review Panel

Dr. Ken Able, Rutgers University, Institute for Marine and Coastal Science
Dr. Shannon Cass-Calay, NMFS Southeast Fisheries Science Center
Dr. Michael Wilberg, University of Maryland Center for Environmental Science

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Executive Summary

Spot are caught in commercial and recreational fisheries, primarily in the Chesapeake Bay and Mid-Atlantic (New York-Virginia) and South Atlantic (North Carolina-Florida) coastal waters. The majority of annual fishery removals of spot were discards in South Atlantic shrimp trawl fisheries, followed by commercial landings and recreational harvest. Data to estimate discards in South Atlantic shrimp trawl fisheries were available starting in 1989 and the terminal year of data for this assessment was 2014. From 1989-2014, total annual removals of spot from all fishery sources (landings and discards) have ranged from between 4,637 and 57,287 metric tons, or 41 and 1,324 million fish. Removals were relatively large, but variable in the 1990s. Removals since 1997 have been relatively stable, coinciding with the requirement of bycatch reduction devices (BRDs) across shrimp trawl fisheries. The long term mean removals were 12,785 metric tons, or 254 million fish. However, total removals after the peak year that occurred in 1991 averaged 9,399 metric tons, or 158 million fish.

Indices of relative abundance from the NMFS Trawl Survey and the NCDMF Pamlico Sound Trawl Survey were used in the preferred stock assessment model (modified-CSA model). The indices generally suggested a period of low abundance through the 1990s and early 2000s, followed by increasing abundance in the late 2000s and 2010s. There was a decline across indices in the assessment terminal year (2014).

Although the current stock status could not be inferred with confidence, the Panel noted that the models generally suggested spawning biomass was increasing. Therefore, the Panel agreed no immediate management actions are required. However, monitoring of abundance indices, removals, and age/length composition should continue (Traffic Light Analysis). If new information suggests the stock could be declining, a new assessment should be expedited.

The Panel noted the uncertainty of the stock assessment outcome was due to inherent data uncertainties, and to conflicting information regarding population trends contained in the various data components. The Panel agreed the assessment used the best available information, all significant removals were incorporated, the data analyses conducted were based on current best practices, the structure and application of the assessment model appeared reasonable, and that important uncertainties were identified and explored.

Terms of Reference

1. **Evaluate the thoroughness of data collection and the presentation and treatment of fishery-dependent and fishery-independent data in the assessment, including the following but not limited to:**
    a. **Presentation of data source variance (e.g., standard errors).**
    b. **Justification for inclusion or elimination of available data sources,**
    c. **Consideration of data strengths and weaknesses (e.g., temporal and spatial scale, gear selectivities, aging accuracy, sample size),**
    d. **Calculation and/or standardization of abundance indices.**

The Review Panel commended the analytical team for their concise and comprehensive presentation of data inputs used in the stock assessment. The Panelists agreed the written report and summary presentations were unusually complete which greatly facilitated evaluation.

All major sources of removals of Spot were thoroughly described including: discards in the shrimp trawl fisheries, commercial landings, and recreational harvest. Discards from the shrimp trawl fisheries accounted for 31-70% of annual removals, commercial landings for 10-40% most years, while recreational harvest typically accounted for approximately 10% each year. The remaining sources of fishery removals were typically 5% or less of total annual removals over the last 20+ years (e.g., scrap fishery). The assessment period was 1989-2014. This timeframe was used because fishery dependent and independent data sets were more widely available. The Panelists noted that important removals began much earlier than 1989. Therefore, it may be useful to attempt to recover or estimate historical removals to improve initial estimates of depletion in the stock assessment.

Data strengths and weaknesses – temporal and spatial scale, sample sizes, coefficients of variation (CV) – were described in the stock assessment report, and input directly in assessment models when possible with an adjustment applied for the CVs of the indices. The justification for inclusion or elimination of available data sources was evaluated, particularly criteria for inclusion of abundance indices. A total of 35 fishery-independent surveys that encountered Spot were reviewed during the assessment. Of these, five met most of the criteria for inclusion. The criteria included the length and continuity of the time series, the spatial scale (population-wide/regional/local) and the constancy of survey methodologies. The Panelists agreed index selection criteria were adequate and suitably applied. The base model application (Catch-Survey Analysis or CSA Model) used indices of abundance for Age 0 and Age 1+ Spot from two sources, the NMFS NEFSC Groundfish Trawl Survey and the NCDMF Pamlico Sound Trawl Survey. The effect of index selection was explored through sensitivity runs.

Some potential data sources were not considered during the assessment, including fishery-dependent catch rate indices and annual effort estimates from the commercial and recreational fleets. It was not mandatory to include these inputs in the assessment, and some reviewers would not recommend including fishery-dependent indices in assessment models if high quality fishery independent indices are available. However, the availability of fishery-dependent catch-per-unit-effort (CPUE) inputs may have facilitated better interpretation of the commercial and recreational catch series in the context of increasing stock biomass predicted by the assessment model. I.e. catch in some fisheries has declined while the indices of abundance have increased. Typically, catches are expected to increase with increasing population abundance.

All but one of the indices of relative abundance were developed using a statistical standardization (e.g., delta-logormal, negative-binomial). The exception was the NMFS/Northeast Fisheries Science Center fall groundfish trawl survey which was a non-standardized, nominal index developed from design-based estimates. The Panelists noted many expert reviewers recommend a non-standardized approach, but also suggested that a standardized index be developed for future assessments, and that the sensitivity of the model results to these alternative approaches be considered.

Spot are an important component of Atlantic coast scrap (bait) landings. Quantifying the amount of spot landed as scrap fish along the coast is problematic due to the limited availability of sampling data. The Panel agreed the methods used during the assessment appear reasonable, but noted the resulting estimates from the scrap fishery are quite uncertain due to the number of required assumptions. However, as the magnitude of scrap landings is very small relative to total removals, the Panel agreed the assessment is not likely to be sensitive to these assumptions.

2. Evaluate methods used to develop discard and bycatch estimates.

Estimates of spot discard rates in South Atlantic shrimp trawl fisheries were developed using discard rate data from the Shrimp Trawl Observer Program to estimate the magnitude of discard rates and the SEAMAP Trawl Survey to estimate the trend of discards prior to (1989-2000) and during the observer program (2001-2014). Discard rate estimates were then applied to effort data from state trip ticket programs and the South Atlantic Shrimp System (SASS) to estimate total discards in these fisheries from 1989-2014 (Walter and Isley, 2014). Discard rates were applied to effort estimates summarized by “strata” (combinations of factors included in the model). Because there were no observer data before Bycatch Reduction Devices (BRDs) were required in the penaeid shrimp fishery, discard estimates prior to 1997 were adjusted for the reduction in catch due to the required use of certified BRDs on observed tows. Adjustments were based on a weighted average of Atlantic croaker catch reductions in the Gulf of Mexico shrimp trawl fishery estimated depending on the distance of fisheye BRDs from tie-off rings (Helies et al. 2009).

Discards from the Mid-Atlantic gill net and trawl fisheries were estimated using observer data from the Northeast Fisheries Science Center’s Northeast Fisheries Observer Program (NEFOP) and At-Sea Monitoring Program (ASM). Annual ratios of observed discarded spot to observed landings of all species by gillnets and bottom trawls were calculated, then applied to reported gillnet and bottom trawl landings of all species to estimate total discards of spot.

The Panelists recognized discard/bycatch estimates are unusually uncertain due to data insufficiencies, but agreed the method used to develop estimates of spot bycatch from the southern shrimp trawl fishery was current, supported, and similar (or identical) to methods used in SEDAR assessments of South Atlantic king mackerel, and Gulf of Mexico red snapper, king mackerel, gray triggerfish and domestic sharks. The Panel also agreed the method used to estimate spot discards from the commercial and recreational fisheries were acceptable given the available data, and noted the relatively small contribution of these discards to total removals.

3. **Evaluate the methods and models used to estimate population parameters (e.g., F, biomass, abundance) and biological reference points, including but not limited to:**

    a. **Evaluate the choice and justification of the preferred model(s). Was the most appropriate model (or model averaging approach) chosen given available data and life history of the species?**

The Assessment Team chose a catch-survey analysis (CSA) model as their preferred base model. The Review Panel agreed with the choice of the CSA model over the surplus production model because the CSA model uses more of the available information. However, the Review Panel also noted that the CSA (and production model) results did not follow the same pattern as catch-curve estimates of the total mortality rates; catch curves indicated relatively stable total mortality, while the CSA model indicated declining total mortality. Additionally, the CSA model had some difficulties reconciling differences in trends between the two primary indices, which was why the models that allowed catchability to change over time improved the model fits. The NMFS trawl survey index of Age 1+ biomass indicated about a 6.4X increase between 1990-1993 and 2011-2014, while the SEAMAP index of Age 1+ biomass indicated about a 10% increase. Given the inherent conflicts in the data (among the indices) and the conflicts between the catch curve and CSA estimates of Z, a more complicated model that can make fuller use of the available data may allow future progress in spot stock assessments. In future efforts the Assessment Team may want to consider simple age-length structured models (e.g., SCALE) that can use all of the available data or a simple Stock Synthesis model.

    b. **If multiple models were considered, evaluate the analysts' explanation of any differences in results.**

The Assessment Team applied CSA and surplus production models. The base CSA model and the base surplus production model generally agreed on the trend and stock status determinations. The approach of fitting multiple models is considered best practices.

c. **Evaluate model parameterization and specification (e.g., choice of CVs, effective sample sizes, likelihood weighting schemes, calculation/specification of M, stock-recruitment relationship, choice of time-varying parameters, plus group treatment).**

In general, the Review Panel agreed the approaches used by the Assessment Team for specifying the assessment models were appropriate and followed best practices. The Assessment Team used the approach of adding a constant to the CV of the index for each year to represent the process error in the indices of abundance. CSA models separate the population into pre-recruits (Age 0) and fully recruited (Age 1+) age classes, which seems reasonable for a short-lived species like spot. The Assessment Team used a maximum age approach combined with a Lorenzen size-based adjustment to calculate natural mortality, M. The CSA model included a Beverton-Holt stock-recruitment relationship. The base CSA model did not include time-varying parameters, but allowing catchability to change was explored in sensitivity analyses. These choices by the Assessment Team appear to be well founded and follow standard practices used in the region. One of the assumptions that caused fairly large changes in the results was whether catchability changes were allowed in the indices. See TOR 8 below for research recommendations from the Review Panel that would support research to better understand the need for time-varying catchability.

4. **Evaluate the diagnostic analyses performed, including but not limited to:**
   a. **Sensitivity analyses to determine model stability and potential consequences of major model assumptions**

Sensitivity analyses were conducted for both assessment models including evaluations of sensitivity described in the Stock Assessment Report Table 95 for the CSA and sensitivity analyses around the assumed initial level of biomass relative to carrying capacity (i.e., initial depletion) for the surplus production model. During the Review Workshop, the Panel requested additional sensitivity runs for the penalty on total instantaneous mortality (Z) that was calculated outside the CSA, and alternative initial depletion levels. The CSA was sensitive to the time trend in Z because the catch curves indicated a relatively stable Z, but the model without the time series of Z values estimated declining Z. The model that used the time series of Z values resulted in the stock being overfished in the last year, while the CSA that only used mean Z during the period resulted in no concerns about stock status. The surplus production model was sensitive to the assumed initial depletion level and values of initial depletion below about 0.16 of carrying capacity resulted in the stock being overfished in the most recent year. However, the overfishing determination was less sensitive to these alternative assumptions.

b. Retrospective analysis

The Assessment Team conducted retrospective analyses for the base CSA model. The results of the retrospective analyses indicated no concerning patterns in estimates of static Spawning Potential Ratio (sSPR), fishing mortality, recruitment, or spawning stock biomass. The calculated Mohn's Rho statistics and visual inspection of plotted patterns are standard best practices used by the Assessment Team.

5. Evaluate the methods used to characterize uncertainty in estimated parameters. Ensure that the implications of uncertainty in technical conclusions are clearly stated.

The Assessment Team used asymptotic standard errors and Markov Chain Monte Carlo (MCMC) to estimate uncertainty for the CSA. The Review Panel thought the asymptotic standard errors were a reasonable approach for quantifying uncertainty for this model. Although MCMC is a justifiable approach, there were some issues with its diagnostics for select parameters (particularly the parameters of the stock-recruitment relationship). Specifically, the chains for these parameters showed very high autocorrelation that indicates the distribution derived from the MCMC chain likely does not fully describe the distributions for those parameters.

6. Recommend best estimates of stock biomass, abundance, and exploitation from the assessment for use in management, if possible, or specify alternative estimation methods.

The Review Panel recommends against using specific estimates of stock biomass, abundance, and exploitation for management purposes because of the sensitivity of the models to several key assumptions. Specifically, the differences in estimates were quite large between CSA models that used the time series for Z from models that only used the average Z value and indicated the estimates of abundance and fishing mortality rates were very sensitive to a range of reasonable assumptions. The surplus production model showed similar issues, but the key assumption appeared to be the initial level of depletion in 1989.

Despite the inability to arrive at a new base model, several patterns seem clear from the data:

1) The indices of abundance for spot appear to be stable or increasing across most of the stock's range.
2) Catch appears to be stable or declining over time.
3) The combination of these two patterns indicates it is likely that fishing mortality rates have also declined over time such that the relative status of the stock in the most recent years is likely better than it was in the late 1980s – early 1990s.
4) Shrimp fishery effort and spot bycatch magnitude appear to be declining. The Stock Assessment Subcommittee should consider adding shrimp bycatch estimates to annual Traffic Light analyses. The new estimates of shrimp bycatch are a notable improvement from previous spot assessments and should be reviewed annually given their substantial contribution to overall spot removals and mortality.

7. Evaluate the choice of reference points and the methods used to estimate them. Recommend stock status determination from the assessment, or, if appropriate, specify alternative methods/measures.

The Spawning Potential Ratio (SPR) reference points appeared to be appropriate for the species (30% threshold, 40% target) and are consistent with reference points used for similar species in the region. However, given uncertainties in fishing mortality and biomass estimates exhibited by the sensitivity analyses, stock status cannot be reliably determined. In particular, models with different sets of plausible assumptions resulted in estimates of biomass above and below the limit reference point. The result of whether the stock was overfished in the most recent year depended on how low stock size was at the beginning of the time series. In contrast, all of the models indicated that overfishing is unlikely in the most recent years and that stock size appears to be increasing over the time series.

8. Review the research, data collection, and assessment methodology recommendations provided by the TC and make any additional recommendations warranted. Clearly prioritize the activities needed to inform and maintain the current assessment, and provide recommendations to improve the reliability of future assessments.

The Panel thoroughly reviewed the research recommendations identified by the Technical Committee, and noted additional research and data collection priorities. Following discussions with the SASC at the Review Workshop, the Panel worked closely with the SASC chair to refine and prioritize a final set of research recommendations, adapted from the stock assessment report and provided here as High or Medium Priorities, within Short-term vs. Long-term research categories.

Short-term

HIGH PRIORITY

- Expand collection of life history data for examination of lengths and age, especially fishery-dependent data sources.
- Organize an otolith exchange and develop an ageing protocol between ageing labs.
- Increase observer coverage for commercial discards, particularly the shrimp trawl fishery. Develop a standardized, representative sampling protocol and pursue collection of individual lengths and ages of discarded finfish.

MEDIUM PRIORITY

- Develop and implement sampling programs for state-specific commercial scrap and bait fisheries in order to monitor the relative importance of Spot. Incorporate biological data collection into program.

- Conduct studies of discard mortality for commercial fisheries. Ask commercial fishermen about catch processing behavior for Sp/Cr when trawl/gillnets brought over the rail to determine if the discard mortality rate used in the assessment is reasonable.
- Conduct studies of discard mortality for recreational fisheries.
- Collect data to develop gear-specific fishing effort estimates and investigate methods to develop historical estimates of effort.

Long-term

HIGH PRIORITY

- Continue state and multi-state fisheries-independent surveys throughout the species range and subsample for individual lengths and ages. Ensure NEFSC trawl survey continues to take lengths and ages. Examine potential factors affecting catchability in long-term fishery independent surveys.
- Continue to develop estimates of length-at-maturity and year-round reproductive dynamics throughout the species range. Assess whether temporal and/or density-dependent shifts in reproductive dynamics have occurred.
- Re-examine historical ichthyoplankton studies for an indication of the magnitude of estuarine and coastal spawning, as well as for potential inclusion as indices of spawning stock biomass in future assessments. Pursue specific estuarine data sets from the states (NJ, VA, NC, SC, DE, ME) and coastal data sets (MARMAP, EcoMon).

MEDIUM PRIORITY

- Identify stocks and determine coastal movements and the extent of stock mixing, via genetic and tagging studies.
- Investigate environmental and recruitment/ natural mortality covariates and develop a time series of potential covariates to be used in stock assessment models.
- Investigate environmental covariates in stock assessment models, including climate cycles (e.g., Atlantic Multi-decadal Oscillation, AMO, and El Nino Southern Oscillation, El Nino) and recruitment and/or year class strength, spawning stock biomass, stock distribution, maturity schedules, and habitat degradation.
- Investigate the effects of environmental changes (especially climate change) on maturity schedules for spot, particularly because this is an early-maturing species, and because the sSPR estimates are sensitive to changes in the proportion mature.
- Investigate environmental and oceanic processes in order to develop better understanding of larval migration patterns into nursery grounds.
- Investigate the relationship between estuarine nursery areas and their proportional contribution to adult biomass. I.e., are select nursery areas along Atlantic coast contributing more to SSB than others, reflecting better juvenile habitat quality?
- Develop estimates of gear-specific selectivity.

9. Recommend timing of the next benchmark assessment and updates, if necessary, relative to the life history and current management of the species.

A benchmark stock assessment is recommended in five years. No assessment updates are called for given challenges with the current model, and the existing annual use of Traffic Light analyses. Despite uncertainty in the assessment model results and an inability to confidently determine stock status, trends in landings and indices do not indicate immediate cause for concern, and therefore do not call for a subsequent new stock assessment in the short-term.

Literature Cited

Helies, F., and J. Jamison. 2009. Reduction rates, species composition, and effort: assessing bycatch within the Gulf of Mexico shrimp trawl fishery. Gulf & South Atlantic Fisheries Foundation, Inc., Tampa, FL, 182 pp.

Walter, J.F., and J. Isley. 2014. South Atlantic shrimp fishery bycatch of king mackerel. SEDAR38 RW-01. SEDAR, North Charleston, SC. 18 p.

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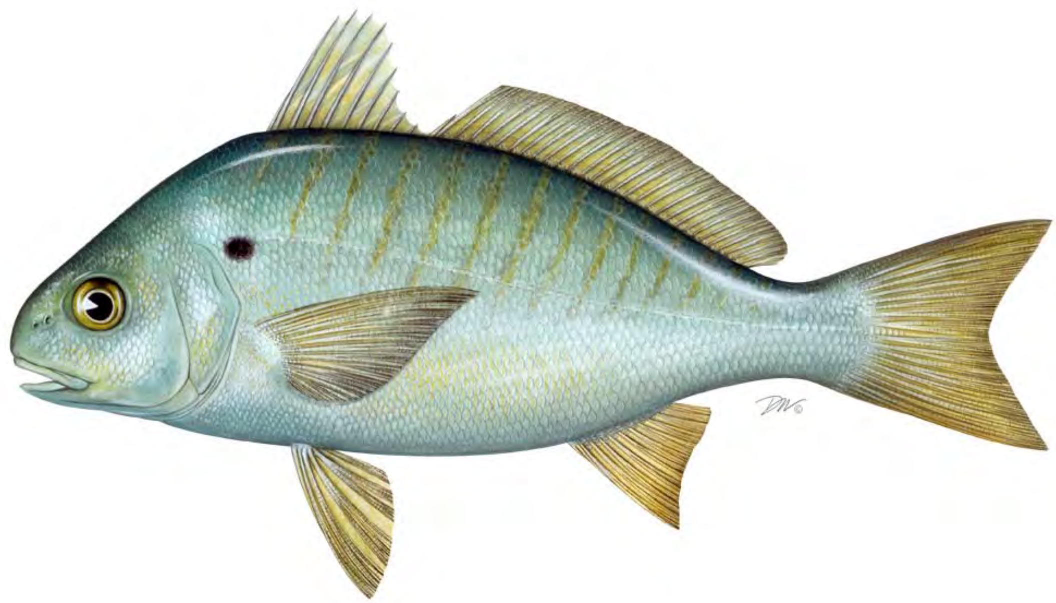
Atlantic States Marine Fisheries Commission

2017 Spot Benchmark Stock Assessment



May 2017

Vision: Sustainably Managing Atlantic Coastal Fisheries

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Atlantic States Marine Fisheries Commission

2017 Spot Benchmark Stock Assessment

May 2017

Prepared by the
ASMFC Atlantic Croaker and Spot Stock Assessment Subcommittee:

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EXECUTIVE SUMMARY

This is the first stock assessment of spot on the Atlantic coast. The management area of spot is the distribution of the resource from New Jersey through Florida (Monroe County). Spot are considered one coastwide stock.

Spot are caught in commercial and recreational fisheries, primarily in the Chesapeake Bay and Mid-Atlantic (New York - Virginia) and South Atlantic (North Carolina - Florida) coastal waters. The majority of annual fishery removals of spot were discards in South Atlantic shrimp trawl fisheries, followed by commercial landings and recreational harvest. Data to estimate discards in South Atlantic shrimp trawl fisheries were available starting in 1989 and the terminal year of data for this assessment was 2014. From 1989-2014, total annual removals of spot from all fishery sources (landings and discards) have ranged from between 4,637 and 57,287 metric tons, or 41 and 1,324 million fish. Removals were relatively large, but variable in the 1990s. Removals since 1997 have been relatively stable, coinciding with the requirement of bycatch reduction devices (BRDs) across shrimp trawl fisheries. The long term mean removals was 12,785 metric tons, or 254 million fish. However, total removals after the peak year that occurred in 1991 averaged 9,399 metric tons, or 158 million fish.

Thirty five fishery-independent surveys that encountered spot were reviewed during the assessment. Biological data from all surveys were used to estimate life history parameters (e.g., growth, maturity). Indices of relative abundance from the NMFS Trawl Survey and the NCDMF Trawl Survey were used in the preferred modified-CSA model. These indices generally show a period of low abundance through the 1990s and early 2000s, followed by increasing abundance in the late 2000s and 2010s. There was a decline across indices in the assessment terminal year (2014).

Both age-0 abundance (914 million fish) and age-1+ abundance (654 million fish) were estimated to be relatively high in 1989. Age-0 abundance remained high through 1991 as age-1+ abundance steadily declined. Total abundance was highly variable through the mid-1990s as age-0 abundance fluctuated drastically. Age-0 abundance (99 million fish) and total abundance (166 million fish) hit a time series lows in 1997. Abundance then fluctuated around an increasing trend through 2013, with the exception of several subsequent poor recruitments from 2006-2009. The 2014 recruitment was relatively poor (205 million fish) resulting in a decline in total abundance, despite increasing age-1+ abundance. Age-1+ abundance in the end of the time series increased close to levels at the beginning of the time series, while age-0 abundance in recent years (excluding the terminal year) increased to about half the magnitude of peak age-0 abundance at the beginning of the time series. Spawning stock biomass followed a similar trajectory as total abundance, generally increasing since 1996 with the exception of the lowest spawning stock biomass of the time series in 2001 (208 metric tons). There was a slight down turn of spawning stock biomass in 2014 (19,032 metric tons), but the estimate was still the second highest of the time series.

Initial fishing mortality was estimated at 1.06 and increased steeply in the next two years. Full fishing mortality then generally fluctuated around a declining trend throughout the time series. Full fishing mortality has remained below 0.50 since 2005. Very low static spawning potential ratios (< 0.2) occurred in the beginning of the time series, when shrimp trawl discards were highest, and during years with large peaks in fishing mortality. Static spawning potential ratios fluctuated around a mean over the last five model years (0.48, 2010-2014) about seven times greater than the mean static spawning potential ratios during years when BRDs were not required (0.07; 1989-1995).

The assessment recommends an overfishing threshold associated with a 30% static spawning potential ratio (F 30%) and a fishing target associated with a 40% static spawning potential ratio (F 40%). The assessment also recommends the equilibrium spawning stock biomass resulting from fishing at F 30% and the recruitment levels estimated from 1996-2014 as a spawning stock biomass threshold and the equilibrium spawning stock biomass resulting from fishing at F 40% and the recruitment levels estimated from 2003-2014 as a spawning stock biomass target. Based on the recommended reference points, overfishing of the Atlantic coast spot stock did not occur in 2014 and the stock was not overfished. The 2014 full fishing mortality was estimated at 0.249, below the threshold (0.5) and target (0.36). The 2014 beginning year spawning stock biomass (2013 end year spawning stock biomass) was estimated at 19,032 metric tons, above the recommended threshold (4,730 metric tons) and target (7,854 metric tons). This stock status determination is reasonable, given the significant decline of discards in South Atlantic shrimp trawl fisheries and the recent increases in relative abundance observed across indices of abundance.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

TERMS OF REFERENCE

For the Spot Benchmark Stock Assessment

Board Approved August 2015

1. Characterize uncertainty of fishery-dependent and fishery-independent data used in the assessment, including the following but not limited to:
    a. Provide descriptions of each data source (e.g., geographic location, sampling methodology, potential explanation for outlying or anomalous data)
    b. Describe calculation and potential standardization of abundance indices.
    c. Discuss trends and associated estimates of uncertainty (e.g., standard errors)
    d. Justify inclusion or elimination of available data sources.
    e. Discuss the effects of data strengths and weaknesses (e.g., temporal and spatial scale, gear selectivity, ageing accuracy, sample size) on model inputs and outputs.
2. Review estimates and PSEs of MRIP recreational fishing estimates. Request participation of MRIP staff in the data workshop process to compare historical and current data collection and estimation procedures and to describe data caveats that may affect the assessment.
3. Develop estimates of spot discards in the South Atlantic shrimp trawl fishery. Develop estimates of bycatch and discards in other fisheries where possible. Characterize uncertainty of all discard and bycatch estimates.
4. Develop models used to estimate population parameters (e.g., F, biomass, abundance) and biological reference points, and analyze model performance.
    a. Describe stability of model (e.g., ability to find a stable solution, invert Hessian)
    b. Justify choice of CVs, effective sample sizes, or likelihood weighting schemes.
    c. Perform sensitivity analyses for starting parameter values, priors, etc. and conduct other model diagnostics as necessary.
    d. Clearly and thoroughly explain model strengths and limitations.
    e. Briefly describe history of model usage, its theory and framework, and document associated peer-reviewed literature. If using a new model, test using simulated data.
    f. If multiple models were considered, justify the choice of preferred model and the explanation of any differences in results among models.
5. State assumptions made for all models and explain the likely effects of assumption violations on synthesis of input data and model outputs. Examples of assumptions may include (but are not limited to):
    a. Choice of stock-recruitment function.
    b. Calculation of M. Choice to use (or estimate) constant or time-varying M and catchability.
    c. Choice of equilibrium reference points or proxies for MSY-based reference points.

    d. Choice of a plus group for age-structured species.
    e. Constant ecosystem (abiotic and trophic) conditions.
6. Characterize uncertainty of model estimates and biological or empirical reference points.
7. Perform retrospective analyses, assess magnitude and direction of retrospective patterns detected, and discuss implications of any observed retrospective pattern for uncertainty in population parameters (e.g., F, SSB), reference points, and/or management measures.
8. Recommend stock status as related to reference points (if available). For example:
    a. Is the stock below the biomass threshold?
    b. Is F above the threshold?
9. Other potential scientific issues:
    a. Compare trends in population parameters and reference points with recent results of the Traffic Light Approach. If outcomes differ, discuss potential causes of observed discrepancies.
    b. Compare reference points derived in this assessment with what is known about the general life history of the exploited stock. Explain any inconsistencies.
10. If a minority report has been filed, explain majority reasoning against adopting approach suggested in that report. The minority report should explain reasoning against adopting approach suggested by the majority.
11. Develop detailed short and long-term prioritized lists of recommendations for future research, data collection, and assessment methodology. Highlight improvements to be made by next benchmark review.
12. Recommend timing of next benchmark assessment and intermediate updates, if necessary relative to biology and current management of the species.

1. Introduction

1.1 Brief Overview and History of Fisheries

Spot (*Leiostomus xanthurus*) are caught in commercial and recreational fisheries, primarily in the Chesapeake Bay and Mid-Atlantic (New York - Virginia) and South Atlantic (North Carolina - Florida) coastal waters. Spot along the Mid-Atlantic coast are generally available to commercial and recreational fisheries from April through October, the bulk being taken from August through October when spot are moving out of estuaries (Pacheco 1962a). In the South Atlantic, spot are caught year round but are most abundant during the fall months (Johnson 2013). Commercially, spot are caught in mixed species or opportunistic fisheries and as bycatch. Historically, haul seines have been used to land the majority of spot, but gillnets have become the dominant gear for spot landings in recent years. During winter, spot are taken in the winter trawl fishery operating off Cape Hatteras, North Carolina (Pearson 1932). Spot bycatch is often discarded at sea or landed as scrap. The North Carolina Division of Marine Fisheries (NCDMF) defines scrap fish as those fish not marketed for human consumption and instead sold for bait, industrial use, or discarded. Spot are a major component of Atlantic coast scrap landings Spot are also one of the most frequent species caught in shrimp trawl fisheries in the South Atlantic (Scott-Denton 2007 and Scott-Denton 2012). Most of these fish are discarded at sea. Generally, a majority of annual recreational catches of spot from hook and line fisheries are harvested. Spot are often kept by recreational anglers to be used as bait, as it is a popular bait species for striped bass recreational fisheries.

1.2 Management Unit Definition

The management area of spot is the Atlantic coast distribution of the resource from New Jersey through Florida (Monroe County).

1.3 Stock Definitions

Spot on the Atlantic coast are considered one coastwide stock due to their migratory behavior (Section 2.1) and the lack of any solid evidence to manage the species on a regional basis (McBride 2014).

1.4 Regulatory History

Historically, any management regulations for spot were left up to the individual states. There have been few regulatory measures enacted by the states for spot (Table 1). States have issued regulations for other species or fisheries that have likely affected spot harvest (Table 2). For example, in North Carolina waters, the elimination of fly-net fishing south of Cape Hatteras (1994), the introduction of bycatch reduction devices (BRDs) in shrimp trawls (1994, by proclamation authority), limits on the incidental catch of finfish by shrimp and crab trawls in inside waters (since 1970s), and culling panels in long haul seines (1999) all likely affected the catch of spot.

The Atlantic States Marine Fisheries Commission's (ASMFC) Fishery Management Plan (FMP) for Spot was adopted in 1987 and includes the states from Delaware through Florida (ASMFC 1987). In reviewing the early plans created under the Interstate Fisheries Management Plan process, the ASMFC found the FMP for Spot to be in need of evaluation and possible revision. Specifically, the ASMFC South Atlantic State/Federal Management Board (Board) found recommendations in the plan to be vague and perhaps no longer valid, and recommended that an amendment be prepared to the FMP for Spot to define the management measures necessary to achieve the goals of the FMP. In August 2009, the Board expanded the initiated amendment to the FMP for Spanish Mackerel to include spot and spotted seatrout, creating the Omnibus Amendment for Spot, Spotted Seatrout and Spanish Mackerel. The goal of the Omnibus Amendment was to update all three plans with requirements specified under the Atlantic Coastal Fisheries Cooperative Management Act (1993) and the Interstate Fishery Management Program Charter (1995). In August 2011, the Board approved the Omnibus Amendment for Spot, Spotted Seatrout, and Spanish Mackerel.

The Omnibus Amendment objectives are to: (1.) Increase the level of research and monitoring on spot bycatch in other fisheries, in order to complete a coastwide stock assessment (2.) Manage the spot population to maintain the spawning stock biomass above the target biomass level. (3.) Develop research priorities that will further refine the spot management program to maximize the biological, social, and economic benefits derived from the spot population. The Omnibus Amendment does not require specific fishery management measures in either the recreational or commercial fisheries for states within the management unit range. However, for years between benchmark stock assessments, the Omnibus Amendment does task the Spot Plan Review Team (PRT) with conducting annual monitoring analysis. This annual analysis has been known as the trigger exercises, where annual statistics were compared to the 10th percentile of the data sets' time series.

In August of 2014, the Board approved Addendum I to the Omnibus Amendment for Spot, Spotted Seatrout, and Spanish Mackerel which altered the method by which the trigger exercises were carried out by the Spot PRT. This Addendum establishes the use of the Traffic Light Approach (Caddy and Mahon 1995, Caddy 1998, Caddy 1999; TLA) within a precautionary management framework for the management of spot. The management framework using the TLA replaces the management triggers as stipulated in the Omnibus Amendment. The Board initiated this addendum at its February 2014 meeting following the development of the TLA report and management memo by the Atlantic Croaker Technical Committee (TC) and Spot PRT. The Spot PRT recommended spot for a benchmark stock assessment with the proposed TLA providing guidance in the interim period. The TLA methodology was extended to develop some additional metrics for comparison to the results of this assessment (Appendix 1, Section 8.3).

The TLA was originally developed as a precautionary management framework for data poor fisheries whereby reference points could be developed that would allow for a reasonable level of resource management. The name comes from assigning a color (red, yellow, or green) to categorize relative levels of different indicators for either a fish population or a fishery. These indicators can be combined to form composite characteristics within similar categories and can include biological indicators, such as growth and reproduction; population level indicators, such as abundance and stock biomass estimates; or fishery indicators, such as harvest/landings and fishing mortality. However, each indicator must be evaluated separately to determine its appropriateness for use in management. In general practice when applying the TLA, the green/yellow boundary is typically set at the long-term mean of the data series reference period (Halliday et al. 2001) of the indicator and the yellow/red boundary is set at 60% of the long-term mean, which would indicate a 40% decline from the series mean. Index values in the intermediate zone can be represented by a mixture of either yellow/green or yellow/red depending on where they fall in the transition zone. Since increasing proportions of red reflect decreasing trends away from the time series mean, the relative proportion of red of the indicator may offer one way of determining if any management response is necessary.

1.5 Assessment History

A formal coastwide stock assessment of spot has not been conducted prior to this assessment. The 1987 FMP recognized the lack of biological and fisheries data necessary for stock assessment and effective management of the resource. A review of available biological data and survey data was conducted through a life history workshop in 2010 to evaluate availability of data for a stock assessment (ASMFC 2010b). It was determined during this workshop that the available data do not support a complex stock assessment model, such as a statistical catch-at-age model, but may support a simpler assessment approach. Commercial and recreational catch and effort data have only been analyzed since 2010 to determine the relationship between landings and abundance via the annual trigger exercises using the TLA.

2. Life History

A review of literature and analyses of available data were conducted to characterize spot life history. For life history analyses, biological samples include paired length-length, length-weight, length-age, and age-maturity data, and sex data. Four commercial, three recreational, and six fishery-independent sources provided these data (Table 3). Descriptions of these sources' sampling and processing methods are provided in the Sections 4 and 5.

2.1 Migration Patterns

Spot larvae have been collected from within estuaries to the edge of the continental shelf (Hildebrand and Cable 1930, Berrien et al. 1978, Lewis and Judy 1983, Warlen and Chester 1985, Hare et al. 1999) from October through May. Larvae were smaller and more numerous offshore (34–128 meters) than inshore (17–26 meters; Berrien et al. 1978, Lewis and Judy 1983, Warlen and Chester 1985). Warlen and Chester (1985) reported that spot larvae may be present at any depth but occurred more frequently near the bottom. However, Lewis and Wilkens (1971) found this to be true only at night. Hare et al. (1999) found spot eggs and yolk sac stage spot at mean depths of 17 meters while older larvae (first and second stage) were typically found at greater mean depths of 20-28 meters.

Direct across-shelf transport has been suggested as the major transport mechanism for larvae of sciaenids and other species along the Mid-Atlantic coast (Nelson et al. 1976, Norcross and Austin 1981, Miller et al. 1984). Spot larvae exhibit this type of cross-shelf transport from the offshore spawning area to nursery habitat in winter and early spring (Govoni and Spach, 1999, Hare et al. 1999). Larval transport from the continental shelf is driven primarily by strong wind events as well as location where larvae were spawned (Hare et al. 1999). However, vertical distribution within the water column has also played a role in the success of larval recruitment, with spot occurring north of Cape Hatteras being transported farther along the Gulf Stream compared to spot transported cross shelf south of Cape Hatteras (Hare et al., 1999). Actual recruitment into estuarine nursery areas from offshore was subject to both vertical movement within tidal cycles as well as fine scale depth patterns within the given estuary (Forward et al. 1999). Spot larvae entered a North Carolina estuary at an average age of 59 days (range 40–74 days) and an average size of 13.6 millimeters (mm; range 11.4 to 15.6 mm; Warlen and Chester 1985). Larvae entered the estuary segregated by age. Recruitment of the new year-class into the Chesapeake Bay occurs in March through May (Norcross 1989). Postlarval spot have been collected in estuarine nursery areas chiefly in April in Delaware Bay (DeSylva et al. 1962), in January and February in the Chesapeake Bay (Welsh and Breder 1923) and North Carolina (Hildebrand and Cable 1930, Tagatz and Dudley 1961, Williams and Deubler 1968, Turner and Johnson 1973, Weinstein 1979, Weinstein and Walters 1981, Lewis and Judy 1983, Warlen and Chester 1985), and from February through May in South Carolina (Shenker and Dean 1979, Bozeman and Dean 1980, Beckman and Dean 1984), Georgia (Music 1974, Music and Pafford 1984), and Florida (Welsh and Breder 1923).

Young-of-year (YOY) spot are largely resident in nursery habitat for the duration of warm weather, but as temperature drops in the fall, they emigrate to deeper estuarine waters and offshore waters (Weinstein and O'Neil 1986). Hildebrand and Schroeder (1928) reported that some YOY overwinter in the deeper waters of the Chesapeake Bay although studies only collected spot from April or May through December in the York River and Chesapeake Bay, respectively (Pacheco 1962b; Markle 1976). YOY spot are found year round in South Carolina in low salinity and brackish waters, but were most abundant during the spring (South Carolina Department of Natural Resources (SCDNR), Unpublished Data).

Adult spot migrate seasonally between estuarine and coastal waters. They enter bays and sounds during spring, but seldom occur as far up-estuary as do the young. They remain in these areas until late summer or fall before moving offshore to spawn or escape low water temperatures (Hildebrand and Schroeder 1928, Roelofs 1951, Dawson 1958, Hoese 1973). A tagging study in Georgia estuaries indicated offshore movement of spot; the longest distance traveled was 118 km (Music and Pafford 1984).

2.2 Diet

The following is a brief summary from the 1987 FMP for Spot (ASMFC 1987), and is included to provide a general description of spot diet. For a more extensive description and references, please refer to the FMP.

Spot are opportunistic bottom feeders that mainly eat polychaetes, small crustaceans and mollusks, and detritus. Spot larvae primarily feed upon copepodid and adult copepods, pteropods, and pelecypods. Juvenile spot, 40–99 mm, fed on micro-bottom surface animals such as ostracods, harpacticoid copepods, ispods, amphipods, minute gastropods, and foraminifera. Isopods, amphipods, and mollusks predominate in the diet of larger spot (>100 mm). Small spot tend to be selective; larger spot are more opportunistic.

2.3 Age

2.3.1 Ageing Methods

Spot have been aged using scales, otoliths, and length frequency analysis. Barger and Johnson (1980) evaluated marks on scales, otoliths, and vertebrae and found that the otoliths possessed the highest potential as age determination structures. Marginal increment analysis indicated that spot annuli on scales were formed in October and November in the Chesapeake Bay (Pacheco 1957), from March through May in North Carolina (DeVries 1982), from April through June in South Carolina (Dawson 1958), and from late February through early April in Georgia (Music and Pafford 1984).

To date, there has not been a formal hard part exchange to evaluate precision or bias of age determinations among agencies ageing spot. There has also not been a formal workshop or efforts to establish a standardized ageing protocol among agencies. Ageing workshops have been held for other species of sciaenids (Atlantic croaker and red drum) and those species have been found to be relatively straightforward to age (ASMFC 2008). Similar protocols have been found to work well with spot.

2.3.1.1 Maryland Department of Natural Resources

The left otolith (the right one is substituted when necessary) is mounted to a glass slide using Crystalbond™ 509, and sectioned using a Buehler IsoMet® Low Speed Saw using two blades separated by a 0.4 mm spacer. The Buehler 15 HC diamond wafering blades are 101.6 mm in diameter and 0.3048 mm thick. The 0.4 mm sections were then mounted on microscope slides and viewed under a microscope to determine the number of annuli. All age structures were read by two readers. If readers did not agree, both readers reviewed the structures together, and if agreement still could not be reached the sample was not assigned an age.

2.3.1.2 Old Dominion University

The otoliths collected through the Virginia Marine Resources Commission’s (VMRC) Biological Sampling Program (BSP) are processed and read by the Old Dominion University’s (ODU) Center for Quantitative Fisheries Ecology (CQFE). Otoliths are processed following the methods described in Barbieri et al. (1994) with a few modifications. Briefly, the left or right sagittal otolith is randomly selected and attached to a glass slide with Aremco's clear Crystalbond™ 509 adhesive. At least two serial transverse sections are cut through the core of each otolith with a Buehler Isomet low-speed saw equipped with a three-inch, fine-grit Norton diamond-wafering blade. Otolith sections are placed on labeled glass slides and covered with a thin layer of Flo-texx mounting medium.

All fish are aged in chronological order based on collection date, without knowledge of the specimen lengths. Two readers must age each otolith independently. When the readers' ages agree, that age is to be assigned to the fish. When the two readers disagree, both readers must reage the fish together, again without any knowledge of previously estimated ages or specimen lengths and assign a final age to the fish. When the readers are unable to agree on a final age, the fish is excluded from further analysis.

The process for ageing spot otoliths at ODU involves two steps: (1) read the otolith—count the number of annuli in the otolith transverse cross-section; and (2) determine the age of the fish in terms of sacrifice date and annulus formation period.

2.3.1.3 Virginia Institute of Marine Science

The Multispecies Research Group (MRG) at the Virginia Institute of Marine Science (VIMS) has been ageing spot collected by the group's Chesapeake Bay Multispecies Monitoring and Assessment (ChesMMAP) Trawl Survey and Northeast Area Monitoring and Assessment Program (NEAMAP) Trawl Survey since 2002 and 2007, respectively. Whole otoliths are taken from a subsample of each size class of each species from each tow; these ageing structures are labeled and stored dry at sea.

Upon completion of all field sampling in a given year, each set of whole otoliths of a given species collected by a given survey is assigned a random number, such that location and time of collection are not known during the subsequent processing and assignment of age. Processing protocols for spot follow the methods developed during the ASMFC Atlantic Croaker and Red Drum Ageing Workshop (ASMFC 2008), as they are also similar members of the drum family, Sciaenidae. Specifically, the right whole otolith is selected for each specimen, and a thin (0.3-0.4mm) transverse section is taken through the nucleus of the structure and perpendicular to the sulcal groove. The section is mounted on a glass slide using Crystal-bond™ adhesive.

Each transverse section is viewed under a dissecting microscope (12x magnification), and the number of annuli on the structure is recorded. Each is read independently by three different readers, where one individual is assigned as the "senior" reader. This individual is typically the most experienced in the ageing of the species under consideration. Following the reading of the structures, ages are assigned to each fish (for each of the three reads) based on the number of annuli on the structure and the time of capture. Since mark formation (annuli deposition) typically occurs during the early to mid-summer period, the age of specimens collected prior to June is given by the number of annuli present plus one, while those collected in June or later are assigned an age equal to the number of annuli present.

After ages are assigned to each read, a final age is determined for each fish by taking the mode of the three independent assigned ages for that specimen. If no mode exists (i.e., all three reads generated different ages), the otolith section for that specimen is re-read by each of the three original readers. If this procedure fails again to produce a mode, the sample is discarded. Upon completion of final age assignments, age data are then incorporated into the appropriate survey database.

2.3.1.4 North Carolina Division of Marine Fisheries

Sagittal otoliths are removed, cleaned, and stored dry in plastic vials. Whole otoliths are read from an image on a high resolution monitor coupled with a video camera mounted in a stereo microscope. Ages are assigned based on the number of otolith annuli viewed. The ageing lab biologist conducts a first read of the whole otolith. The samples are then independently read by the species lead biologist. If any differences are not resolved, the data are omitted.

2.3.1.5 South Carolina Department of Natural Resources

In the laboratory, the left sagittae are viewed under low magnification with a binocular microscope (10X) and marked with a soft lead pencil on the core. These are then embedded in epoxide resin in silicon molds. After the resin has polymerized, the embedded otoliths are glued to a card held in a jig attached to the arm of a low speed saw. The otolith is positioned so that a transverse section ~0.5-mm thick can be taken through the core. The Isomet Saw is equipped with a pair of diamond-wafering blades, separated by a plastic washer so that the section can be taken with a single cut. The resulting section is mounted on a labeled microscope slide with Cytoseal-XLY. After polymerization of the mounting medium, slides are stored in boxes until viewing. These are examined with a Nikon SMZU microscope equipped with a Supercircuits model PC - 23C high resolution camera with transmitted light. The video image is captured by a frame grabber board in a personal computer and is subsequently analyzed with the Image-Pro image analysis software. The following measurements are taken on each otolith section:

1) radius—distance in mm from the center of the core to the edge of the section as measured along the sulcus acousticus
2) a_1—distance in mm from the center of the core to the distal edge of the first annulus
3) a_2—distance in mm from the center of the core to the distal edge of the second annulus
4) a_3 to a_n—distance from the center of the core to the distal edge of the third annulus and from the core to the distal edge of the nth annulus
5) marginal increment—distance from the distal edge of the last annulus to the edge of the otolith section

Some spot otoliths vary with respect to diffuse, undefined marking near the core of the otolith. These diffuse areas are not interpreted as being a ring. The first annulus is considered the first well-defined, opaque band that can be traced around the entire section.

2.3.2 Age Characteristics

Spot is a short-lived species, rarely attaining a maximum age of six years (NCDMF 2005). The maximum lifespan of spot appears to be greater along the Mid-Atlantic coast. Maximum ages reported in the literature include: age 4.5 (290 mm TL) in New Jersey (Welsh and Breder 1923), age 5 (237.5 mm FL) in the Chesapeake Bay (Pacheco 1962b), age 6 (355–369 mm FL) in North Carolina, although fish greater than age 3 were rare (DeVries 1981b), age 3 (210–283 mm TL) in Georgia (Music and Pafford 1984), and age 3 in South Carolina (Johnson 2013). Age 0–2 spot were predominate in populations throughout the range (Pacheco 1962b, Joseph 1972, DeVries 1981a, DeVries 1982, Music and Pafford 1984, NCDMF 2005). A summary of available age data by data source is in Table 3**.**

2.4 Growth

Growth of spot is very rapid. Daily growth rates for juvenile spot range from 0.02–0.04 g/day (Peters et al. 1978, Warlen at al. 1979, Weinstein 1983, Currin et al. 1984). An average of 84% of the cumulative growth of spot occurs within the first year, and 99% occurs by the end of the second year (Piner and Jones 2004). The reported range of lengths were similar throughout the Atlantic coast for most previous studies, though spot reach a greater maximum size in the northern part of the range (i.e., north of South Carolina; 0). Maximum sizes reported in the literature were 33 centimeter (cm) in New Jersey (Welsh and Breder 1923), 34.5 cm in Chesapeake Bay (Hildebrand and Schroeder 1928), and 34.6 cm in Core Sound, NC (DeVries 1982). Estimated relative growth is lower in the south and increases with latitude, with the higher growth rates found in the northern latitudes of the Northeast Atlantic (Johnson 1999).

Identifying an appropriate model describing change in length with age is useful given that many stock assessment models rely on an age-length relationship. Estimates of natural mortality for this assessment were also derived from growth model parameters (see Section 2.7). Several growth models were evaluated during the ASMFC Spot Life History Workshop, but no one model consistently outperformed the other. The broad overlap in length ranges observed from adjacent age classes indicate that there is not a well-defined relationship between these characteristics (ASMFC 2010b). A similar analysis was completed during this assessment with additional data collected during recent years. There were ten data sets with paired length and age data (Table 5). Ages ranged from 0-6 with sizes ranging from 4-36 cm total length (TL). All age data derived from scales or lengths were dropped from the analysis. Models compared were the von Bertalanffy, Richard's, Gompertz, and logistic models using the FSA package in R (Ogle 2016, Table 6). The models were fit to all age-length data combined (regardless of presence or absence of sex data), all age-length data with sex data (males and females combined), and all age-length data with sex data by sex. According to Akaike information criterion (AIC), the von Bertalanffy model fit the data best for the entire and reduced data sets (Table 7-Table 10). Analysis of residual sum of squares (ARSS) was used to compare growth between males and females (Chen et al. 1992). The ARSS method provides a procedure for testing whether two or more nonlinear curves are statistically different. There was a significant difference in growth between males and females ($F_{(3, 20105)} = 113.3$, $p < 0.0001$). Model predictions, by sex, are in Figure 1 and Figure 2. Residual plots for the von Bertalanffy fit to the data, by sex, are in Figure 3 and Figure 4. Asymptotic average length (L_{inf}) ranged from 34.4-38.5 cm TL depending on the data set (Table 7). Males had the highest L_{inf} value, while the other groups had a narrower range (34.4-35.4 cm). Growth coefficients (k) ranged from 0.220-0.324. These values are a narrower range than estimates for the von Bertalanffy growth parameters from the Spot Life History Workshop which listed L_{inf} values of 30-46 cm and k values of 0.156-0.648 year $^{-1}$ (ASMFC 2010b).

2.5 Meristics and Conversion Factors

2.5.1 Length-Length Relationship

Measurements of spot length are reported in standard length (SL), fork length (FL), and TL, the definitions of which can be found in Table 11**.** Length conversion factors from the literature and those developed for this assessment from available data sources are reported in Table 12**.** All length data compiled for this report were converted to TL (if TL was not available) using the conversion developed from coastwide aggregated data in this assessment prior to use in any life history analyses.

2.5.2 Length-Weight Relationship

Previously estimated length-weight relationships for spot were available for North Carolina (Hester and Copeland 1975), South Carolina (Dawson 1958), and Georgia (Music and Pafford 1984) (Table 13). For this assessment, parameters of the length-weight relationship were modeled using a non-linear power regression with length in mm and weight in grams (g). There were eleven data sets with available length-weight data (Table 3). A subset of the data sets demonstrated typical allometric growth patterns with a highly significant relationship between length and weight (Table 14). There was no significant difference between male and female spot length-weight relationships estimated from these data sets as tested with ARSS (Table 15). All length-weight data were combined for a coastwide conversion (Table 13) to be applied for conversions in this assessment.

2.6 Reproduction

2.6.1 Spawning Seasonality

Spot is a late fall to early spring spawner. Time of spawning for spot has been estimated from gonadal development and the appearance of larval and post-larval fish. Spawning off the Chesapeake Bay, North Carolina, and South Carolina occurs from October to March (Welsh and Breder 1923, Hildebrand and Schroeder 1928, Lippson and Moran 1974, Colton et al. 1979, Hildebrand and Cable 1930, Dawson 1958, Berrien et al. 1978, Lewis and Judy 1983, Warlen and Chester 1985, Flores-Coto and Warlen 1993, Johnson 2013). DeVries (1982) reported that back-calculated lengths at the first annulus for North Carolina spot with one annulus were bimodally distributed with modes at 94-134 mm TL and 172–206 mm TL. This bimodality may represent two peaks in spawning as length frequencies of trawled age-0 spot from North Carolina estuaries showed a bimodal distribution from June to September (Ross 1980, Ross and Carpenter 1983, Ross and Epperly 1985). Peak spawning in North Carolina and South Carolina occurs in December and January (Warlen and Chester 1985) with the bulk of larval and juvenile fish moving into estuarine nursery habitat from January to April (Johnson 2013). In Georgia, spot spawn from October to April (Dahlberg 1972, Mahood et al. 1974, Music 1974; Setzler 1977). There are no references that estimate individual spawning frequency.

2.6.2 Sexual Maturity

Early studies using gross visual assessment of gonads estimated that spot mature at the end of their second year or early in their third year of life (Hildebrand and Cable 1930, Dawson 1958). Other studies have supported spot maturity occurring at an age of two years for most fish

(Hales and Van Den Avyle 1989, Phillips et al. 1989). Recent histological data indicate that spot can begin to mature before reaching one year in age, with 50% maturity for both males and females occurring between age one and two (Johnson 2013). Both males and females reached 100% maturity by age-2 (Johnson 2013). Reported sizes at maturity have ranged from 14.6-21.4 cm TL on the Atlantic coast (Hildebrand and Cable 1930, Dawson 1958, Hales and Van Den Avyle 1989, Phillips et al. 1989, Waggy et al. 2006, Johnson, 2013).

Of the different data sets available for the assessment, seven of the data sets had information on maturity (Table 3). Only SCDNR and VMRC provided paired age-maturity data for maturity estimates. VMRC uses a maturity schedule (Feigenbaum et al. 1985) that does not differentiate between mature and immature fish and, therefore, only SCDNR data were used for maturity-at-age estimates with a logistic regression model. SCDNR uses the Brown-Peterson et al. (2011) maturity schedule. These data were subset to female samples collected from August-December and assessed with histological methods as opposed to macroscopic methods.

Observed and predicted maturity ogives are in Table 16 and Figure 5. Female spot maturity-at-age-1 (January 1 after their first full year) is estimated to be 0.215. Some spot younger than age-1 are estimated to be mature and 50% maturity was estimated to occur at approximately the beginning of September (age-1.75), consistent with the estimates by Johnson (2013). The estimate of 100% maturity occurs when spot are age-4 and is different from the previous studies, including Johnson (2013), that indicate 100% maturity around age-2. This estimate may be a result of low sample size for fish age-2 and older. The average sample size for fish younger than two years is 36.8 and decreases to 5.9 for fish two years and older.

2.6.3 Sex Ratio

Only one study reporting sex ratio for spot was identified. Hata (1985) reported a 1:1 ratio of females to males for spot occurring in the northwestern Gulf of Mexico.

Combined (Table 17) and age-specific (Table 18) sex ratios of spot were calculated by data set. The chi-square (X^2) goodness-of-fit test with Yate's correction for continuity was applied to test whether the observed sex ratios departed from a 1:1 ratio (Zar 1999). The heterogeneity chi-square analysis was also applied to determine if performing a goodness-of-fit test on pooled data (i.e., all commercial and all fisheries-independent data) would be justified. The null hypothesis of the heterogeneity chi-square analysis is that the individual datasets have the same sex ratios.

The sex ratio (female:male) for spot ranged from 1.014 (50.4% female) to 2.729 (73.2% female) among the individual data sets (Table 17). The highest percentages of females were observed in North Carolina's fishery-independent surveys (73.2%) and Virginia's commercial fisheries data (70.5%). The chi-square goodness-of-fit indicated that the sex ratios derived from all datasets significantly deviated from a 1:1 ratio, except for the Southeast Area Monitoring and Assessment Program (SEAMAP) Coastal Trawl Survey data (X^2 = 0.063, p=0.801). The results of the heterogeneity chi-square analysis suggest that there are significant differences in the sex ratios among the individual commercial fisheries datasets (X^2 = 81.2; df = 2; P < 0.001) and that these data sets should not be pooled. The sex ratios of the fisheries-independent datasets were also found to be heterogeneous (X^2 = 672.6; df = 5; $P < 0.001$). These results suggest pooling of all data would not be justified.

The sex ratios-at-age indicated a predominance of females at most ages from commercial fisheries data (Table 18). The age-specific sex ratios tended to be higher for the commercial data than the fisheries-independent data. The majority of the age-specific sex ratios and corresponding X^2 values were found to be significantly different from a 1:1 ratio ($P < 0.01$; Table 18).

It should be noted that the months sampled and the available years of data varies among the individual datasets, so the proportion of females by month was also examined across data sets to determine if sex ratios were relatively consistent across months where data was available (Table 19). The proportion female by month was often around 50% across fishery-independent data sets. The proportion of females was greater than 50% in the majority of months across commercial fishery data sets.

2.6.4 Fecundity

Spot, like all of the sciaenids, are batch spawners and there is very limited information on fecundity of this species. Dawson (1958) calculated fecundity gravimetrically for two spot (15.8 and 18.7 cm SL) caught off South Carolina. The estimated the number of eggs >200 micrometers (µm) in diameter to be 77,730 and 83,900, respectively, but it was not known whether these were representative of fully ripe fish. The average size of oocytes undergoing full oocyte maturation (FOM) stage in other sciaenid species typically range from 700–900 µm (Roumillat and Brouwer 2004, Overstreet 1983), so the Dawson fecundity levels may be an overestimation due to the inclusion of oocytes that would not have developed enough to be spawned during that spawning event. Sheridan et al. (1984) listed batch fecundity in spot from the Gulf of Mexico as ranging from 20,900–514,400 oocytes per ovary, with relative fecundity relating poorly to both length and weight.

2.7 Natural Mortality

A variety of indirect methods were applied to available data to derive estimates of natural mortality (M). Approaches for estimating both an age-constant M and age-specific M were considered.

2.7.1 Age-Constant M Approaches

There have been numerous methods developed to estimate age-constant M based on the relationship of M to various life history characteristics. Some commonly used methods are based on maximum age (T_{max}) of a population (Hoenig 1983, Alagaraja 1984, Hewitt and Hoenig, 2005). Other approaches use von Bertalanffy growth model parameter estimates (L_{inf} and K), as well as $T_{\max}$ to determine M (Alverson and Carney 1975, Pauly 1980, Ralston 1987, Jensen 1996). Recent work by Then et al. (2015) evaluated different estimators of M using various combinations of $T_{\max}$, growth model parameters, and water temperature for greater than 200 independent, direct estimates of M in order to determine how well the estimators worked in terms of prediction error. They determined that a T_{max} based estimator performed best among all of the estimators evaluated such that $M = 4.889 * T_{max}^{-0.916}$. If T_{max} was not available, the next best estimator was growth based ($M = 4.118 * K^{0.73} * L_{inf}^{-0.33}$). *M* estimates were made using both T_{max} and growth parameter methods for comparison purposes. Since there was a significant difference in growth between males and females, *M* estimates were made using T_{max} and parameter estimates from the von Bertalanffy growth model for all age data combined, all age data with sex data, and age data by sex (Table 20). The Then et al. (2015) T_{max} method produced the same *M* (0.613 year $^{-1}$) for each data set since T_{max} (six) was the same across all data sets. The *M* estimates using growth parameter estimates were markedly lower than the T_{max} estimates, ranging from 0.336– 0.427 year^{-1} depending on the data set (Table 20).

2.7.2 Age-Specific M Approaches

Lorenzen's (2005) method was used to estimate age-specific *M* of spot. This approach requires estimates of the von Bertalanffy growth model parameters (to translate length to age) and the range of ages over which *M* will be estimated. The age-specific estimates of *M* are scaled such that the cumulative *M* across the selected age range is equal to a "target" *M*. This "target" *M* for spot was set equal to the age-constant *M* estimate from the T_{max} method recommended by Then et al. (2015). Since there was a significant difference in growth between males and females, *M* estimates were made using the parameter estimates from the von Bertalanffy growth model for all age data combined, all age data with sex data, and age data by sex (Table 21).

Estimated *M* rates decrease with increasing age as would be expected. The different data sets had very similar mean *M* for ages 1+ (range of 0.306 – 0.396 year $^{-1}$), with the combined data set having the highest *M* (0.396 year $^{-1}$) and males having the lowest *M* (0.306 year $^{-1}$) which was likely due to the lower von Bertalanffy K parameter estimate for males. Age-specific estimates of *M* based on all available data ranged from 0.356 to 0.542 year^{-1} with a mean of 0.396 year^{-1} and a median value of 0.489 year $^{-1}$.

2.8 Discard Mortality

No studies on spot discard mortality rate were identified. A review of recreational angler discard mortality studies found a median discard mortality of 0.11 and a mean of 0.18 across studies (Bartholomew and Bohnsack 2005). The SAS believes a value approximately in the middle of the range between the median and mean (0.15) is an appropriate approximation of the discard mortality rate for spot in recreational fisheries.

A study on Atlantic croaker, a species similar to spot, by Johnson (2003) determined the immediate (15–30 minutes) survival of discards onboard estuarine commercial shrimp trawlers. His results showed that the survival of Atlantic croaker decreased as time on deck increased—from 40% survival for Atlantic croaker that were on deck less than 20 minutes to 8% survival for Atlantic croaker that were on deck longer than 20 minutes. This study does not take into account mortality due to tow time or increased vulnerability to predation and mortality post discarding. Duration of observed tows from the Southeast Shrimp Trawl Observer Program

(Section 4.1.2.4) ranged from twelve minutes to just under nine hours with a median of three hours. Because there is no information from the observer program on the time discards spent on deck and unknown additional mortality from other causes (e.g., stress during long tow durations, increased vulnerability to predation), 100% discard mortality is assumed for spot discarded in commercial fisheries.

3. Habitat Description

3.1 Overview

Spot are found in estuaries and coastal areas from the Gulf of Maine to the Bay of Campeche, Mexico to depths of at least 205 meters, but are most commonly found from the Chesapeake Bay to South Carolina (Smith and Goffin 1973, Bigelow and Schroeder 1953, Dawson 1958, Springer and Bullis 1958, Phillips et al. 1989, Chesapeake Bay Program 1991, Murdy et al. 1997, Mercer 1987). Larval spot are spawned on the continental shelf off the Atlantic coast and use this habitat as they are transported toward the coast and juvenile nursery habitat. Juveniles use estuarine habitat. As they mature, spot are found on the continental shelf during spawning and inshore, estuarine habitat during warm summer and fall months.

3.1.1 Spawning, egg, and larval habitat

Fall migrations of mature spot to offshore waters were reported from Chesapeake Bay (Hildebrand and Schroeder 1928), North Carolina (Roelofs 1951), and South Carolina estuaries (Dawson 1958). During the migration to offshore habitats, some adults may spawn in estuaries and nearshore on the inner continental shelf during the late fall, if water temperatures remain warm enough (Dawson 1958; Lewis and Judy 1983). Smith (1907) stated that, in North Carolina, spot spawn in the sounds and inlets and Hidebrand and Cable (1930) suggested that spawning occurred in close proximity to inlet passes off North Carolina. However, larval distributions of spot indicate that spawning occurs more heavily in offshore waters of the outer continental shelf (26-128 meters) where temperatures are suitable for spawning and egg development (17.5 to 25ºC; Hettler and Powell 1981) than inshore (14.6-20.1 m; Berrien et al. 1978, Lewis and Judy 1983, Warlen and Chester 1985). Govoni and Spach (1999) found that larval spot occurred on both sides of the frontal zone along the Gulf Stream edge indicating spawning on the outer continental shelf in or along the Gulf Stream frontal boundary, with cross-shelf transport of larvae occurring towards the coast and inshore nursery waters. Ripe spot were collected in depths up to 82 meters off South Carolina (Dawson 1958) and 8-10 miles off the Georgia coast (Hoese 1973). Data indicate that spot spawn further offshore and in deeper waters than other sciaenids (Barbieri et al. 1994).

Newly hatched larvae are likely still close to offshore spawning locations, which have been suggested to be up to or beyond 90 kilometers offshore (Flores-Coto and Warlen 1993). Larvae depend on wind and currents (e.g., warm water eddies) for transportation and do much of their developing in the continental shelf waters during the winter (Able and Fahay 2010). In the winter and through early spring, larval spot ingress into estuarine habitats, often into upper regions of an estuary.

3.1.2 Juvenile and adult habitats

Tidal salt marshes and larger estuaries are recognized primary nurseries for spot (Weinstein 1979, Currin et al. 1984), although juvenile spot have been frequently collected on the inner continental shelf (Woodland et al. 2012). Juvenile spot prefer shallow water areas, less than 8 meters, over fine sediment and in tidal marshes (Phillips et al. 1989, Stickney and Cuenco 1982, Chesapeake Bay Program 1991). Juvenile spot are found from polyhaline to tidal fresh water in nursery areas. Although densities of spot were twice as high in polyhaline marshes versus oligohaline marshes in the York River (O'Neil and Weinstein 1987), patterns in other systems suggest that the production of spot may be highest in lower salinity, upper estuarine habitats (Brackin 2002, Ross 2003). The preferred temperature range of juvenile spot is 6–20°C, with a tolerable temperature range extending from 1.2–35.5°C (Parker 1971; Stickney and Cuenco 1982; Phillips et al. 1989, ASMFC 1987). Juvenile spot can tolerate dissolved oxygen (DO) levels as low as 1.3 milligrams/liter (mg/L), but prefer concentration of 5.0 mg/L or higher (ASMFC 1987; Phillips et al. 1989).

Adult spot are bottom-oriented, and require substrates to forage on epifauna and benthic infauna (Chao and Musick 1977). Adults likely prefer muddy substrates to sand or vegetated substrate, which has been reported for juveniles, although offshore adults will likely utilize sand substrates, which are more common outside of estuaries. Adults are likely tolerant of a wide range of DO, but prefer normoxic conditions (> 4.0 mg/L; Chao and Musick 1977). Adult spot are tolerant of salinities up to 60 parts per thousand (ppt, ASMFC 1987; Phillips et al. 1989) and are more abundant in coastal waters and lower estuaries and less abundant in lower salinity areas, compared to juveniles. Survival in adults dropped to 5% when DO was lowered to 0.6 mg/L, which suggests a strong (lethal) effect of DO below 0.8 mg/L (Burton et al., 1980). Recent work has begun to show that spot actively avoid hypoxic areas and even inhabit the margins of these areas (Campbell and Rice 2014). Hypoxic conditions (< 2.0mg/L) are less common offshore, and thus DO is probably less of a concern for adults than for juveniles.

4. Fishery-Dependent Data Sources

4.1 Commercial Data

4.1.1 Commercial Landings

4.1.1.1 Data Collection and Treatment

Commercial landings data are collected by the National Oceanic and Atmospheric Administration's (NOAA) National Marine Fisheries Service (NMFS; aka NOAA Fisheries) and individual state agencies, depending on year and granter of permit(s) (i.e., state and/or federal). Federally permitted dealers and fishermen must report landings to the NMFS using the appropriate reporting process. Individual states may also have reporting requirements for dealers and fishermen landing in-state and some state agencies conduct biological sampling. The types of information and level of detail collected varies among and within the NMFS and various state agencies. Frequency of reporting also has varied over time. The Atlantic Coastal

Cooperative Statistics Program (ACCSP) provides a summary of reporting frequency by state and year on their website (http://www.accsp.org/data-warehouse).

Commercial landings are also maintained at the ACCSP Data Warehouse. The ACCSP provides quality assurance and quality control measures to ensure data are comparable and accurate. For this assessment, commercial landings data were obtained from the ACCSP Data Warehouse and vetted with state agencies (J. Myers, personal communication, January 7, 2016). Commercial landings by gear are available for all states from 1950-present. Though there have been some landings in states north of New Jersey (New York-Massachusetts), they make up such a small proportion of total commercial landings that details of data collection programs in these states are not provided.

4.1.1.1.1 Survey Methods

4.1.1.1.1.1 New Jersey

Commercial landings for spot are obtained from the NMFS reporting. There is no mandatory state reporting of spot in New Jersey.

4.1.1.1.1.2 Delaware

Delaware Division of Fish and Wildlife monitors the commercial fishery through mandatory monthly logbook reporting. Trip-based data collected from these reports include pounds landed by species, area fished, and gear type.

4.1.1.1.1.3 Maryland

The Maryland Department of Natural Resources (MD DNR) has a mandatory reporting system for commercial fishermen that began in 1980. Catch in pounds, days fished, area fished and amount and type of gear used were reported by month prior to 2006. A daily trip log was phased in from 2002 to 2005 with all fishermen using the daily log for the entire year beginning in 2006. Effort data is only available for 1980-1984, 1990 and 1992 – 2014. Maryland relied on the NMFS for collecting commercial landing data prior to 1980.

4.1.1.1.1.4 Virginia Marine Resources Commission

The VMRC's commercial fisheries records include information on both commercial harvest (fish caught and kept from an area) and landings (fish offloaded at a dock) in Virginia. Records of fish harvested from federal waters and landed in Virginia have been provided by the NMFS. The VMRC began collecting voluntary reports of commercial landings from seafood buyers in 1973. A mandatory harvester reporting system was initiated in 1993 and collects trip-level data on harvest and landings within Virginia waters. Data collected from the mandatory reporting program are considered reliable starting in 1994, the year after the pilot year of the program. The Potomac River Fisheries Commission (PRFC) has provided information on fish caught in their jurisdiction and landed in Virginia since 1973.

4.1.1.1.1.5 North Carolina

Prior to 1978, the NMFS collected commercial landings data for North Carolina. In 1978, the NCDMF entered into a cooperative program with the NMFS to maintain the monthly surveys of

North Carolina's major commercial seafood dealers and to obtain data from more dealers. North Carolina initiated a Trip Ticket Program (NCTTP) in January 1994 in response to a decrease in the NCDMF/NMFS cooperative reporting and due to an increase in demand for complete and accurate trip-level commercial landings statistics by fisheries managers. A trip ticket is a form used by state-licensed fish dealers to document all transfers of fish from the fishermen to the dealer. These forms collect information such as transaction date, area fished, gear used, and the quantity of each species landed from non-scrap landings. Scrap landings are recorded as bait landings on trip tickets but species is not identified. The data obtained through the NCTTP allow for the calculation of fishery-specific effort (i.e., trips, licenses, participants, vessels) and provide a more detailed record of North Carolina's seafood landings.

4.1.1.1.1.6 South Carolina

Landings of spot in South Carolina were collected by the NMFS through the early 1980s. In 2003, SCDNR instituted a wholesale dealer reporting system that provides monthly summaries from wholesale dealers with weight (and value) of fish purchased per species per month. Spot landed as bycatch and sold from the shrimp trawl fishery are also reported through the wholesale dealer reporting system.

4.1.1.1.1.7 Georgia

Commercial landings of all finfish, including spot, from 1950 through 1988 were collected by the NMFS. In 1989, the Georgia Department of Natural Resources (GADNR) instituted mandatory trip-level reporting for commercial fisheries dealers and fishermen.

4.1.1.1.1.8 Florida

During 1950 through 1984, Florida's commercial landings data were collected from seafood dealers on a monthly basis by the NMFS. In late 1984, Florida agencies involved in the management of natural resources, including fisheries (Florida Fish and Wildlife Conservation Commission, FL FWC), established a trip-ticket (TTK) reporting system, known as the Marine Fisheries Information System, designed to monitor the fisheries productions. When the program first started, data were collected by both the NMFS and through the TTK system to enable a comparison of the new data collection system. In 1986, the TTK system became the official commercial fisheries landings data collection system in Florida after it was determined that the monthly dealer summaries and the detailed TTK information were comparable. The TTK program requires all wholesale and retail seafood dealers to report their purchase of saltwater products from commercial fishermen on a trip-level basis. Dealers report the Saltwater Product License number, the wholesale dealer license number, the date of the sale, the gear used (since 1991), trip duration (time away from the dock), area fished (since 1986, but was mandatory from 1994), depth fished, number of traps or number of sets (where applicable), species landed, quantity landed, and price paid per pound for each trip.

4.1.1.1.2 Biological Sampling Methods

4.1.1.1.2.1 New Jersey

No biological sampling of spot from commercial landings has been conducted.

4.1.1.1.2.2 Delaware

No biological sampling of spot from commercial landings has been conducted.

4.1.1.1.2.3 Maryland

Commercial pound nets were sampled by the MD DNR in Maryland's portion of the Chesapeake Bay, and in the mouths of its major tributaries, from the Patuxent River south to the Potomac River. Sampling locations varied each year depending on where the cooperating fishermen's nets were set. The survey has been conducted every year from 1993 to 2014 from late May to early September. Each site was generally sampled once every two weeks, weather, and fisherman's schedule permitting. The commercial fishermen set all nets sampled as part of their regular fishing routine. Net soak time and manner in which they were fished were consistent with the fishermen's day-to-day operations. All spot were measured from each net when possible. In instances when it was not practical to measure all fish, a random sample was measured and the remaining individuals enumerated if possible. From 2008 through 2010 additional samples were obtained at fish dealers. All spot sampled at fish houses were from the pound net fishery, and were measured for length and weighed to the nearest g. All measurements were to the nearest mm TL. The aggregate length frequency is in Figure 6 and annual length sample sizes are in 0. Otoliths, weight to the nearest g, TL in mm and sex were taken during onboard pound net sampling from a subsample of spot beginning in 2007, and during all three years of the fish house survey. The otoliths were processed and aged by MD DNR from 2011 to 2014. The archived 2007 through 2010 otoliths were aged in 2011. Spot sample for age ranged from age-0 to age-2, with the majority being age-1 (Table 23).

4.1.1.1.2.4 Virginia

The VMRC's BSP has been collecting finfish biological data (length, weight, sex, and age) since 1988. The early sampling techniques included manual weighing and measuring of commercially harvested fish and removal of scales.

Several changes in the program have occurred since its inception. These include a switch from mechanical to electronic weighing scales and from manual to electronic fish measuring boards. The switch from mechanical to electronic equipment has increased precision of measurements and allowed a greater rate of sampling. In 1998 the BSP's sampling protocol initiated the removal of otoliths from thirteen important finfish species, including spot. ODU's CQFE Laboratory processes and reads otoliths and provides the VMRC age data for these finfish species.

Biological data sample sizes are in Table 24. Annual and aggregate length frequencies of spot sampled by the BSP are in Figure 7 and Figure 8, respectively. Spot have ranged from 11 to 39 cm TL. Spot sampled for age have ranged from age-0 to age-6, with the majority being age-1 to age-2 (Figure 9).

4.1.1.1.2.5 North Carolina

The NCDMF has sampled marketable landings from major commercial fisheries since 1982. Spot are sampled by gear, market category (in culled catches only), and area fished at local fish houses. Information on area fished and gear type is provided by the vessels captain or crew. As many random samples (usually 50 pound (lb) cartons) as possible were obtained from each market category with more samples being collected from cartons of larger grades since they contained fewer fish. Each sample was weighed to the nearest 0.1 kilogram (kg), individual fish were measured to the nearest mm FL and the total number of individuals was recorded. Annual length frequencies of spot sampled from all non-scrap landings (gears combined) are in Table 25. If the number of individuals in a carton were too numerous to measure, at least 30 were measured and the remainder counted. Subsamples of spot are purchased from the major commercial fisheries to excise otoliths for age determination. Sagittal otoliths have been collected since 1997. Each month, samples (n=10) are distributed across the length range in 20-mm length classes starting at 100 mm FL.

The NCDMF initiated sampling of scrap fish in 1986. Staff samples at least one-half basket (≈12 kg) of the scrap fish from each catch. The sample is sorted by species and weighed (kg). All individuals in the sample are measured for FL or TL to the nearest mm. Annual length frequencies of spot sampled from scrap landings (gears combined) are in Table 26. If the catch of a particular species is exceptionally large, a random subsample of at least 30 individuals is taken for measurement, and the remaining fish are counted.

4.1.1.1.2.6 South Carolina

No biological sampling of spot from commercial landings has been conducted.

4.1.1.1.2.7 Georgia

No biological sampling of spot from commercial landings has been conducted.

4.1.1.1.2.8 Florida

In Florida, biological samples from the commercial fisheries were limited to sample lengths (and, occasionally, to sample weights) of individual spot intercepted through a Trip Interview Program (TIP) at fish houses. While spot is included on the list of species to be sampled, they are only sampled “as available” due to its low priority and the small amounts that are generally landed. Commercial length data of spot were collected since 1992. Annual length sample sizes range from 2 (2005, 2010) to 3,620 (1993; 0). The length frequency from combined gears and years is in Figure 10.

4.1.1.1.3 Catch Estimation Methodology

Reporting of commercial landings in weight is treated as a census, so final reported values are assumed to equal total commercial landings in weight. State-specific commercial landings in weight were converted to numbers with biological sampling data from commercial landings or, if there was no biological sampling of commercial landings, biological sampling of recreational harvest from the Marine Recreational Fisheries Statistics Survey (MRFSS) and/or Marine Recreational Information Program (MRIP; Section 4.2.1). Individual weights or length frequencies and length-weight relationships were used for conversions, depending on the biological data available. Conversion were done at the level of detail permitted by the data to account for differences in size composition and/or mean weight (e.g., by year and gear). Conversions were done for landings from 1981-2014, as there was no fishery-dependent biological sampling prior to these years (recreational sampling began in 1981, see Section 4.2.1).

4.1.1.1.3.1 New Jersey

4.1.1.1.3.1.1 Commercial Landing Numbers

Landings in weight were converted to numbers by applying the wave specific annual average weights estimated for New Jersey from the MRIP and MRFSS, where possible. Average weights by wave from the Mid-Atlantic were used for waves and years when there was no average weight estimated by the MRFSS and MRIP for New Jersey alone. For waves when there is minimal recreational or commercial catches (wave 2 and wave 6, March-April and November-December, respectively) the Mid-Atlantic average weight over all years was used. For waves with no recreational sampling (wave 1; January-February), the Mid-Atlantic average weight over all years from waves 2 and 6 combined was used.

4.1.1.1.3.2 Delaware

4.1.1.1.3.2.1 Commercial Landing Numbers

Landings in weight were converted to numbers using the MRFSS and MRIP mean weight estimates by wave, where possible. If mean weight estimates were not available by wave, the annual estimate was used.

4.1.1.1.3.3 Maryland

4.1.1.1.3.3.1 Commercial Landing Numbers

Maryland spot landings in pounds were converted to numbers using three gear categories, fixed gear, haul seines, and mobile gear (excluding haul seine). Maryland pound net survey data lengths are randomly selected, but weights are not (only take from aged specimens). Spot pound net data was available for 1993-2014, and was used for conversion of weight to numbers for fixed gear for 1993-2008 and 2010- 2014. Maryland fish house sampling data is randomly selected, since fish are weighed and measured on site. Spot were only sampled in 2009 from the fish house survey (all fish were from pound nets), and these data were used to convert the 2009 fixed gear landings.

Virginia length and weight data were available for 1989 through 2014 for several gears and were used to convert Maryland fixed gear landings from 1989-1992 and all Maryland mobile and haul seine landings from 1989 to 2014. All 1981-1989 landing were converted using MRFSS annual mean weights. The ACCSP landings for those years did not include month, so conversions by wave was not possible. Virginia sampling and Maryland landings did not always match up by month. Since Virginia data was used for most conversions, annual landings were used to reduce the complication of matching sampling and landings data by month. ACCSP had several years with landings with gear reported as “NOT CODED”, the Maryland landings (that did not exactly match in total landings) had all gear coded. Some of the NOT CODED category accounted for the majority of landings, therefore, the Maryland proportion of landings by gear was used to place the NOT CODED landings into gear categories prior to conversion to numbers.

4.1.1.1.3.4 Virginia

4.1.1.1.3.4.1 Commercial Landings Numbers

Since 1989, Virginia has had sufficient biological data for spot to predict number of fish landed by size, separated by year, month, and gear. This was done by taking the number of measured and weighed spot in each length bin and using these relative proportions to divide up the total landings in pounds. If there were small sample sizes for any length bins during this time period, the samples were aggregated across all gears. From 1981-1988, when sufficient data were not available, MRFSS values were used to establish the catch frequencies.

4.1.1.1.3.4.2 Total Scrap Landings

Virginia does not subsample their scrap landings. In order to estimate the amount of scrap landings attributed to spot after 1993, data from North Carolina's scrap landings subsampling program were applied. Specifically, the proportion of spot occurring in North Carolina's scrap landings by month and gear were applied to Virginia's total scrap landings by month and gear to estimate scrap landings of spot. For a few years, certain gear-specific samples were not available. In these cases, the proportions were averaged over other gears within each specific month and applied to the landings.

Because VMRC did not begin collecting any information on scrap landings until 1994, it was necessary to hindcast estimates of scrap landings back to 1981. Annual ratios of spot scrap landings to total unclassified finfish landings from 1994–2014 were calculated for Virginia. The median ratio over 1994–2014 was then computed and used to generate hindcast estimates of scrap landings for 1981–1993 by applying this ratio to total unclassified finfish landings during this time period.

4.1.1.1.3.5 North Carolina

4.1.1.1.3.5.1 Commercial Landings Numbers

Numbers of spot landed were determined by calculating the mean number of individuals per sample by market grade and then expanding that number (by market grade and then summed for all market grades) to the total annual landings recorded for all trip tickets.

4.1.1.1.3.5.2 Scrap Landings

Scrap landings have been subsampled since 1994 to determine the species composition of the scrap landings. The total weight of each species in the scrap fish sampled from a trip is calculated by determining the proportion of that species in the subsample and expanding to the respective species' proportional weight of the total scrap fish for the trip. The number of individuals per species in the scrap fish component is calculated by expanding the number of individuals in the sample to represent the total weight of the species for the scrap fish in the samples. Estimates of total scrap fish landings for individual species are determined by applying the tri-annual ratio of marketable fish to scrap fish in the fish house samples to the reported tri-annual marketable landings. The quantity (weight or numbers) and percentage of scrap fish (total or by species) landed by the fishery was determined by applying the seasonal (six-month periods) weight ratio of marketable fish to scrap fish in the fish house samples to the reported seasonal marketable landings from the NCTTP. The estimated scrap fish quantity is for landed fish and does not account for discards at sea. The reported commercial landings of scrap fish (unclassified for scrap or industrial purposes) from the NCTTP were not used because of inconsistencies in dealer reporting. This ratio method of estimating scrap fish assumes marketable fish are accurately reported to the NCTTP. The percent scrap fish reported was computed on a per sampled trip basis, i.e., the percent scrap fish for each sampled trip was determined and the mean was taken across all trips, thereby accounting for sampled trips with no scrap fish. Each sampled catch was viewed as an independent estimate of scrap fish.

Because NCDMF did not begin collecting any information on scrap landings until 1994, it was necessary to hindcast estimates of scrap landings back to 1981. Annual ratios of spot scrap landings to total unclassified finfish landings from 1994–2014 were calculated for North Carolina. The average ratio over 1994–2014 was then computed and used to generate hindcast estimates of scrap landings for 1981–1993 by applying this ratio to total unclassified finfish landings during this time period.

4.1.1.1.3.6 South Carolina

4.1.1.1.3.6.1 Commercial Landing Numbers

There were no surveys that specifically sampled biological data for spot landed by the commercial fishery. While spot were reported commercially, they were generally only reported as total weight of landings by dealer through the Wholesale Dealer reports. There was some fishery dependent biological data available through the MRFSS and MRIP surveys as well as limited data from the South Carolina State Finfish Survey (SC-SFS). The SC-SFS was discontinued in 2012, as the state took over the MRIP survey and the two surveys overlapped.

In order to estimate the number of fish in the commercial landings, annual number of spot were estimated using the length frequency distribution from the recreational harvest, estimated weight at size from the TL to weight relationship from this assessment, and the total annual weight of landings reported in the commercial landings. The protocol required the length frequency be converted to proportion at length into one cm length bins and then the average weight was estimated at each length bin using the length-weight relationship. The total annual landings in weight was then proportioned across the range of TL frequencies and the estimated weight in that bin was then multiplied by the mean weight of that length bin to get the estimated number of spot in that particular length bin. This was done using the annual length frequencies for each year (1981-2014) and matched with the total commercial landings in weight for that year. One major assumption of this method was that the size frequency distribution in the recreational and commercial harvest were similar.

4.1.1.1.3.7 Georgia

4.1.1.1.3.7.1 Commercial Landing Numbers

There are no surveys that collect size, weight or number of spot landed by the commercial fishery. The available data for spot harvested through the commercial fishery include monthly total number of trips, gear used, and total weight landed. This information was not sufficient to estimate numbers of spot landed each year. The only fishery-dependent surveys that collected weights and numbers of spot harvested in Georgia are the MRFSS and MRIP. Therefore, the mean weight of spot harvested recreationally in Georgia was used to determine the total number of spot harvested by the commercial fishery. This was accomplished by dividing the monthly landings in pounds by the mean weight of spot harvested through MRFSS and MRIP in that same month. There were a number of concerns about using recreational information to determine number of harvested spot through the commercial fishery. First concern was that the gears used for each fishery were either different or gear type was not specified for the commercial landings. Another concern was that there were temporal gaps in the MRFSS and MRIP data, not every wave had recorded weights. To compensate for this concern, if there were no observed weights for spot in a month, the number of fish for the commercial landings was not calculated. Most importantly, since there is not a single data point collected on number, size, or weight of spot harvested through Georgia commercial fisheries, there is no way to determine if these estimates generated using this method have any accuracy. The uncertainty surrounding these estimates are very high. For this reason, it was requested that the SAS consider not using these estimates. Since the amount of landings was so low for the state in years for which landings were being converted (1981-2014; Table 29), removing them altogether should have negligible effects on the stock assessment.

4.1.1.1.3.8 Florida

4.1.1.1.3.8.1 Commercial Landings Numbers

The number of spot landed on the east coast of Florida were converted from landings in weight using annual length frequencies obtained from MRFSS recreational samples (1982–1991) and TIP commercial samples from landings made by gillnets (1992–1995) and various gears during 1996–2001 and 2002–2014, as well as a coastwide length-weight relationship. For each length bin during the sampled periods, the conversion was performed as follows:
(1) Estimation of mean weight by applying a weight-length relationship.
(2) Estimation of (i) the sampled weight by multiplying the number of fish sampled with mean weight and (ii) the proportion of sampled weight frequencies.
(3) Estimation of annual landings in weight by multiplying the proportion of sampled weight with total landings weight.
(4) Estimation of annual landings in number by dividing annual landings weight by mean weight.

4.1.1.2 Trends

4.1.1.2.1 Commercial Landings

4.1.1.2.1.1 Catch Rates

Catch rates were not developed from commercial data for modelling due to the availability of several regional fishery-independent surveys.

4.1.1.2.1.2 Total Commercial Landings

Because spot are short-lived and the majority of annual landings often consists of 1-2 year classes, commercial landings from 1950 to present have fluctuated from 638 to 6,586 metric tons (Table 28, Figure 11**)**. Number of spot landed between 1981 and 2014 has ranged between 3.6 and 26.7 million fish (Table 31, Figure 12). Most spot landings occurring in the Chesapeake Bay and South Atlantic states (Table 29). In 2014, 74% of spot were landed in Virginia, 15% in North Carolina, 8% in Maryland, 1% in Delaware, and less than 1% in New Jersey, South Carolina, and Florida. Landings have been negligible from states north of New Jersey. However, landings in these states have increased in recent years. Spot are harvested by a variety of gears including haul seines, pound nets, gillnets, and trawls (Table 30, Figure 11). From the 1950s to the early 1980s, commercial landings were predominately caught in haul seines. In the 1980s, gillnets became the dominant gear contributing to spot landings and has remained so since. In 2014, 77% of commercial landings were caught by gillnets, 8% by haul seines, 8% by fixed nets, 6% by other gears, and less than 1% by trawls.

4.1.1.2.2 Scrap Landings

4.1.1.2.2.1 Catch Rates

Catch rates were not developed from commercial data for modelling due to the availability of several regional fishery-independent surveys.

4.1.1.2.2.2 Total Scrap Landings

Total scrap landings of spot were stable through the 1980s and early 1990s, increased to the highest values of the time series in the late 1990s, and fluctuated around a declining trend through the 2000s and 2010s (Figure 13). Scrap landings were at the lowest levels of the time series in the final two years. North Carolina made the majority of scrap landings through the 1980s and mid-1990s, both states had similar landings through the late 1990s and 2000s, and Virginia made the majority of scrap landings in the most recent years (Table 32).

4.1.1.3 Potential Biases, Uncertainty, and Measures of Precision

4.1.1.3.1 Commercial Landings

Commercial landing reporting is designed to be a census, so there are no measures of precision for these data.

In Georgia, spot landed by trawls may be sold as unsorted mixed fish along with Atlantic croaker, whiting, and small flounder. In these cases, landings are not identified to species level and Georgia's estimates of spot landings may be underestimated.

Prior to 1986 in Florida, the NMFS collections of landings were most effective for fisheries where the majority of landings were made at the large-volume wholesale dealer outlets. Spot were a low-value species that were landed in small amounts at smaller fish houses so there may have been negative bias (underreporting) in the early commercial landings of spot.

4.1.1.3.2 Scrap Landings

The scrap landings combined from North Carolina and Virginia are likely the minimal estimate from the coastwide scrap fishery. There is currently no scrap landing sampling by other states, but it is believed that North Carolina and Virginia account for the vast majority of Atlantic coast spot scrap landings.

4.1.2 Discards

4.1.2.1 Northeast Fisheries Observer Program

4.1.2.1.1 Survey Methods

The Northeast Fisheries Observer Program (NEFOP) is conducted by the NMFS' Northeast Fisheries Science Center (NEFSC) in order to collect data on catch (harvested and discarded), gear, effort, and biological data during commercial fishing trips from North Carolina to Maine by trained fishery observers. The total catch and a subsample of the total catch from each observation (e.g., towed trawl net) are weighed. The observer program is mandatory for federally-permitted vessels which are selected at random for observation during fishing trips. The program began in 1989. Spot is a third tier priority species for both major gears that encounter spot, Mid-Atlantic gillnets and Mid-Atlantic inshore trawls (NEFSC 2016). See the NEFOP website for additional details (http://nefsc.noaa.gov/fsb/program.html).

4.1.2.1.2 Biological Sampling

Each fish from the catch subsample is counted and measured to the nearest cm. Length sampling of discarded spot has been relatively limited, with no spot measured from trawls and gill nets 14 and 18 years out of 26 years of sampling, respectively (Table 33). Spot discarded from gillnets were slightly larger than spot discarded from trawls (Figure 14 and Figure 15). No spot age samples have been collected.

4.1.2.2 North Carolina Shrimp Trawl Observer Study

4.1.2.2.1 Survey Methods

This study is statewide in all state waters (inshore estuarine and nearshore ocean 0-3 miles) and the primary gear is shrimp otter trawls. The sampling concept is a random design and trip ticket data from previous years is used to estimate coverage by area. Data are available from 2007-2014.

Observers contact and obtain weekly observer trips aboard commercial vessels operating in the commercial shrimp trawl fishery. Participating commercial fishermen are selected randomly from a list of active fishermen derived from license and NCDMF Trip Ticket data. Data collected include overall vessel length, net dimensions and mesh sizes, turtle excluder device (TED) type, tow time, latitude, longitude, depth, and sea surface temperature.

When possible the total catch weight is obtained for all tows, otherwise the total catch weight is estimated. All weights are recorded to the nearest kg or g, depending on the size of the sample categories being weighed. Shrimp are separated from each net and a total weight is obtained. Every tow is sampled. This sampling goal is adjusted according to the practicality of obtaining quality subsamples. Latitude and longitude are taken on each tow when the net is hauled back.

4.1.2.2.2 Biological Sampling

For large catches, a one-basket subsample (approximately 32 kg) is taken from each net. Finfish in each subsample is examined as follows: weigh total sample, separate to species, enumerate and weigh total of individual species, for commercially important species measure TL or FL of 30-60 individuals of each species and weigh this smaller subsample. The aggregate length frequency of spot observed is in Figure 16. Beginning in August 2012, the at-net mortality of select species (spot, croaker, and weakfish) was obtained. Observers randomly select 30 individuals from each of the species and record the status (dead or alive) and lengths. This is the first data obtained from the sample to offer a baseline for the at-net mortality of these species.

4.1.2.3 Georgia Large Shrimp Trawl Bycatch Observer Study

4.1.2.3.1 Survey Methods

The Georgia Large Shrimp Trawl Bycatch Observer Study was conducted over an eight year period from 1995 to 1998 and 2001 to 2005. The purpose of the study was to gather bycatch information associated with the shrimp trawl fishery. All NMFS protocols for observer bycatch studies were observed (NMFS 1992). A total of 185 tows were sampled aboard 129 individual trips. Field sampling was conducted on-board commercial shrimp trawling trips in the offshore state waters and in the Exclusive Economic Zone (EEZ) off Georgia (beaches extending to 7 miles offshore), targeting selected species to characterize size, age, and genetic structuring, as well as providing estimates of catch rates by season. After gaining permission from the captains of these vessels, two on-board observers accompanied the captain and crew on a trip. The observers recorded information on each vessel including the vessel code, tow number, date, vessel name, length, identification number, year model, construction, weight, horsepower, and crew size. In addition, records of the economic costs of the trip, such as fuel, oil, ice, food and wages were documented. The type of net used in each application was noted and the specifications on each TED and BRD were recorded. Just prior to deploying the net, the observers recorded the latitude and longitude and the time of day. After completing the tow, the observers again recorded the latitude and longitude as well as the exact time the net was removed from the water. The shrimp, crabs, and fish were then sorted into different groups for examination. The shrimp were weighed and their numbers were estimated when necessary. The fish and crabs were counted and weighed by species.

4.1.2.3.2 Biological Sampling

For the core target species, which includes weakfish, Atlantic croaker, and spot, lengths were recorded for every specimen, while age and genetic samples were collected from a predetermined number of the samples. Sizes of spot ranged from 5.3 to 24.3 cm TL with an average size of 12.8 cm TL. The aggregate length frequency of spot sampled from 1995-2005 is in Figure 17. Otoliths and fin clippings obtained from core target species were sent to the South Carolina Department of Natural Resources for analysis (Ottley et al., 1998).

4.1.2.4 Southeast Shrimp Trawl Observer Program

4.1.2.4.1 Survey Methods

The South Atlantic component of the Southeast Shrimp Trawl Observer Program (SESTOP) began as a voluntary shrimp trawl bycatch observer program implemented from North Carolina to Florida through a cooperative agreement between NMFS, the Gulf and South Atlantic Fishery Management Councils, and the Gulf and South Atlantic Fisheries Foundation, Inc. to characterize catch, as well as evaluate BRDs. Total discards, total shrimp catch, and a subsample (one basket per net, or approximately 32 kg) for species composition and biological sampling is taken from each observed net. Beginning in 2008, the program became mandatory in the South Atlantic and NMFS-approved observers were placed on randomly selected shrimp vessels. The voluntary component of the observer program also continued. Penaeid shrimp (primarily inshore) and rock shrimp (primarily offshore) fisheries in the South Atlantic are covered by the observer program. Observed coverage is allocated by previous effort, or shrimp landings when effort data are not available. Based on nominal industry sea days, observer coverage of South Atlantic shrimp trawl fisheries ranged from 0.2-1.4% and totaled 0.9% from 2007-2010 (see Scott-Denton (2012) Table 1). Number of observed tows are in Table 34. See Scott-Denton (2007) for more details on the voluntary component of the SESTOP and Scott-Denton et al. (2012) for more details on the mandatory SESTOP.

4.1.2.4.2 Biological Sampling

Biological information, such as length and weight of bycatch species, is collected from the subsample of total catch in observed nets. Very limited biological sampling has been conducted for spot. Only 698 spot have been measured for length, caught from just twenty three tows on three trips occurring from October to November in 2003. Lengths ranged from 13 to 23 cm FL (Figure 18). No spot age samples have been collected.

4.1.2.4.3 Trends

Spot is typically one of the most prevalent bycatch species, often outweighing and/or outnumbering individual species of shrimp (see Scott-Denton (2007) Figure 9, Figure 11, Table A2 and Scott-Denton (2012) Table 9, Table 11, Table 12, Figure 6). Discard rates have been variable, but have generally increased over the time series (Figure 22).

4.1.2.5 South Atlantic Shrimp System

4.1.2.5.1 Survey Methods

Detailed catch and effort statistics from commercial shrimp fishing trips were collected and processed by a cooperative effort between the South Atlantic states and, beginning in 1982, the NMFS' Southeast Fisheries Science Center (SEFSC). Data collection began in 1978 in North Carolina and Georgia, 1979 in South Carolina, and 1981 in Florida. Data are available by year, month, state, and port. Florida and North Carolina quit collecting data for the South Atlantic

Shrimp System (SASS) after 1992. The data are maintained by the NMFS. See Gloeckner (2014) for more details on the SASS.

4.1.2.6 Discard Estimation Methods

4.1.2.6.1 Mid Atlantic Trawl and Gillnet Discards

Observer data from the NEFOP were used to develop annual ratios of observed discarded spot to observed landings of all species by gillnets and bottom trawls. Ratios were then applied to reported gillnet and bottom trawl landings of all species to estimate total discards of spot from 1989-2014. The SAS investigated effort data from Vessel Trip Reports (VTRs), but deemed these data unreliable for discard estimates due to data caveats. For example, it was unclear how fishers interpreted certain data fields such as hours fished for trawl nets and whether or not these data fields are interpreted consistently among fishers through time. Orphanides and Palka (2007) also note issues with inconsistent and incomplete gillnet effort from VTRs. VTRs are only required for federally-regulated species.

Commercial landings are reported to the state where they are landed and initial review of the NEFOP data indicated that observed spot discards did not occur on trips landing in ports north of New York. Therefore, all NEFOP observations from trips that landed in ports from North Carolina to New York were used to estimate ratios and ratios were applied to all landings reported from North Carolina to New York. NEFOP data used in this analysis are summarized by year and gear in Table 35 and Table 36. The number of observations by NMFS statistical area (Figure 19) are in Table 37. Spatial distribution of observations are in Figure 20 and Figure 21.

Annual geometric mean ratios of discarded Atlantic croaker to landed Atlantic croaker were used in the 2010 Atlantic Croaker Stock Assessment. These ratios require excluding any trips where the species of interest was not discarded and landed and were deemed unreliable for Atlantic croaker by the Peer Review Panel (ASMFC 2010a). This methodology has the potential to bias ratios high by excluding zero discard trips and bias ratios low by excluding trips where the species was not landed, but was discarded. This method also decreases sample size. For this assessment, annual ratios by major gear type (gillnets and bottom trawls; Table 38) were calculated as the ratio of the mean discards of spot per observation (i.e., tow or net set), in pounds, to the mean landings of aggregated species per observation, also in pounds (Equation 1).

$$Equation\ 1: R = \frac{\bar{D}}{\bar{L}} = \frac{\sum_1^n D_i}{\sum_1^n L_i}$$

This ratio estimator includes all observations with observed landings of any species, including those where no spot were discarded. The variance of the ratio estimator was calculated with Equation 2 (Pollock et al. 1994).

$$Equation\ 2{:}\ Var(R) = \frac{1}{n(n-1)\bar{L}^2}\left(\sum_{1}^{n} D_i^2 + R^2\sum_{1}^{n} L_i^2 - 2R\sum_{1}^{n} D_i L_i\right)$$

It is assumed that discarding rates during observed trips are representative of overall discarding rates in these fisheries. Small sample sizes of positive observations precluded developing ratios at finer resolution (e.g., by state or season).

Annual mean weights were calculated as the total number counted from subsamples divided by the total subsample weight and were applied to the discard estimates in weight to derive discard estimates in numbers. In years with no observer data, averages of adjacent year observations were pooled to estimate ratios. In years with no preceding observer data, averages of the closest two year period were used. Spot discard subsamples from gillnets were particularly sparse, so data were pooled over all years to estimate discards in numbers.

Landings of all species combined by gillnet and bottom trawl gears (Table 39) were provided by ACCSP by year and state landed from North Carolina through New York. Some landings are not available at the gear level ("NOT CODED"). These landings were partitioned into trawl and gillnet landings by calculating the annual proportion of landings by these gear categories and then apply these proportions to the "NOT CODED" landings. Total landings by year and gear are in Table 35 and Table 36.We are assuming that vessels landing north of New York and South of North Carolina discard no spot.

Ratios estimates and variances are in Table 40 and Table 41. A discard mortality rate of 100% is assumed for both gillnet and trawl discards of spot (Section 2.8).

4.1.2.6.2 Shrimp Trawl Discards

Estimates of spot discard rates in South Atlantic shrimp trawl fisheries were developed using discard rate data from the SESTOP to estimate the magnitude of discard rates and the SEAMAP Trawl Survey (Section 5.2) to estimate the trend of discards prior to (1989-2000) and during the observer program. Discard rate estimates were then applied to effort data from state trip ticket programs and the SASS to estimate total discards in these fisheries from 1989-2014 following the methods used by Walter and Isley (2014). The SAS also evaluated the NCDMF observer study data, but the addition of these data resulted in negligible changes to shrimp trawl discard estimates. Only weight data from NCDMF were considered reliable and the SAS was cautioned against using the count data. Due to the negligible impact and lack of count data, the SAS agreed that NCDMF observed data should not be used for South Atlantic shrimp trawl discard estimates.

Only discarded spot are recorded by shrimp trawl observers, so no adjustments are needed to account for fish landed. Observer data were subset to exclude operation codes X, M, H, and J (Appendix 2) because these observations were not considered reliable (e.g., net was dumped overboard without recording catch data). Observations with all other operation codes were included under the assumption that these observations are representative of effort in the shrimp trawl fisheries. Observed nets with disabled BRDs after the requirement of BRDs were also dropped from the analysis. BRDs were required in federal penaeid shrimp fisheries in 1997 under Amendment 2 to the Shrimp Fishery Management Plan for the South Atlantic Region (SAFMC 1996) and federal rock shrimp fisheries in 2005 under Amendment 6 to the Shrimp FMP (SAFMC 2004). State BRD regulations generally fit these time frames.

Trends in catch rates (number of fish/hour fished) of the SEAMAP Trawl Survey and the SESTOP are in Figure 22 and generally track well during overlapping years. Spatial coverage of both surveys overlap throughout most of the sampled ranges (Figure 23). Catch rates by tow from the combined data sets are in Figure 24 and Figure 25.

Discard rates in weight were modelled with the delta-lognormal method (Lo et al. 1992) and discards in numbers were modelled with a negative binomial generalized linear model (GLM). The delta lognormal method combines a lognormal GLM used to predict discard rates of positive observations and a binomial GLM to predict the probability of a positive observation, with effort as an offset variable. The final discard rate is the product of the response variables from these two models. The negative binomial GLM predicts the number of fish caught per observation with effort as an offset variable. Distributions of the response variables for each model are in Figure 26 and Figure 27. Factors considered in the models were year, data set, depth zone, state, and season. Data sets included observer data from the rock shrimp (observer project types W, X, Y) and penaeid shrimp (observer project types A, C) commercial fisheries and fishery-independent data from SEAMAP Trawl Survey tows. Depth zones were less than or equal to 10 meters (=<10m), greater than 10 meters to 30 meters (10-30m), and greater than 30 meters (>30m). All SEAMAP tows were conducted in the shallowest depth zone, while the majority of observer tows were in the shallowest depth zone. State borders were defined by the latitudes used by Scott-Denton et al. (2012). Seasons were December through March (offseason) and April through November (peak season). There are decreases in catch rates during June due to a reduced number of SEAMAP tows (Figure 28), but the seasons were defined to align with shrimp fishing relative to operation in nearshore waters throughout the time series. Shrimp fishing in nearshore waters where catch rates are expected to increase has generally started as early as April and lasted through November. Discard rate data by factor are summarized in Table 42 and Table 43.

Model structure was evaluated with stepwise deletion of factors and the model with the lowest AIC was selected as the final model. Final model summaries are in Table 44-Table 46. All factors were retained for both models (Table 47 and Table 48).

Effort data are available from trip ticket systems from Florida (1986-present), Georgia (2001-present), South Carolina (2004-present), and North Carolina (1994-present) and the SASS from 1978 to the year trip ticket programs were implemented in each state, with the exception of North Carolina. There was a gap from 1992-1993 in North Carolina when data were not available from either a trip ticket program or the SASS. Trip counts were provided by state, year, month, and gear following the methods described in Gloeckner (2014) with a slight modification to eliminate some duplicate reporting issues in Florida (D. Gloeckner, personal communication, April 18, 2016). Code for this "standardized" data query is in Appendix 3. The monthly number of trips in North Carolina in 1993 are estimated as the average of the two adjacent years (1992, 1994). Average hours fished per trip and average number of nets fished per tow by state and year were used from NMFS Sustainable Fisheries Branch (2012) and are originally from trip ticket data. Averages were used before trip ticket data were collected and also for 2011-2014. Fishing hours were calculated as the product of total number of trips, average hours fished per trip, and average number of nets fished per tow. Effort is summarized by state and year in Table 49 and by month in Figure 29. As effort was only available by state, year, and month, some assumptions were made to partition the effort among depth zones and fisheries. The proportions of observations from the observer data by depth zone were applied to overall effort, assuming that the observer data is representative of fishing effort at depth and that fishing effort at depth is static over time. A similar assumption was then made to partition the effort data into fisheries. The proportions of observations in each depth zone allocated to each fishery were applied to the effort data in the respective depth zone. Proportions used to partition effort are in Table 50.

Discard rates were applied to effort estimates summarized by "strata" (i.e., combination of factors included in the model). Standard errors (SEs) of discard estimates made with negative binomial GLMs were estimated with the predict.glm function in the R package stats (R Core Team 2015).

Because there were no observer data before BRDs were required in the penaeid shrimp fishery, discard estimates for penaeid shrimp trawl effort prior to 1997 were adjusted for the reduction in catch due to the required use of certified BRDs on observed tows. Adjustments were based on a weighted average of Atlantic croaker catch reductions in the Gulf of Mexico shrimp trawl fishery estimated depending on the distance of fisheye BRDs from tie-off rings (Helies et al. 2009). The adjustments of spot discard estimates were based on the Atlantic croaker adjustment, as the SAS was unaware of any BRD estimates for spot. 99.6% of observer trips used fisheye BRDs. BRDs in the observed trips ranged from 6 to 21 feet from tie-off rings. Catch reduction estimates were available for BRDs <9 feet (69.7% reduction), 9-10 feet (0% reduction), and 10-11 feet (17.2% reduction) from the tie off rings. There was no estimated reduction for fisheye BRDs greater than 11 feet from the tie-off rings, so the estimate for the 10-11 foot category was used for the proportion of nets greater than 11 feet from the tie-off rings. The proportion of observed trips that fell into the categories of <9 feet, 9-10 feet, 10-11 feet, and >11 feet were 0.22, 0.28, 0.31, and 0.20, respectively. The weighted average adjustment was 0.23 (i.e., discards = unadjusted discards*1/(1-adjustment)). We assumed that observed trips were representative of BRDs used in the fisheries.

All discarded spot were assumed to be dead or to have died post-release (Section 2.8).

4.1.2.7 Discard Trends

4.1.2.7.1 Mid Atlantic Trawl and Gillnet Discards

4.1.2.7.1.1 Total Mid-Atlantic Trawl and Gillnet Discards

Discard estimates are in Table 51 and Table 52 and Figure 30 and Figure 31. Discards from trawls generally make up a larger proportion of the discards than gillnets in Mid-Atlantic fisheries. Discards in numbers of fish for gillnets range between 0 and 59,271 with a median of 2,769, while discards for trawls range between 0 and 25,326,383 with a median of 58,682. Discards in numbers for gillnets range between 0 and 50,021 pounds with a median of 2,336 pounds, while discards for trawls range between 0 and 5,740,647 pounds, with a median of 10,831 pounds. Estimates for both gears are highly variable, with an increasing trend for gillnets and no discernable trend for trawls. The trawl estimates in the first two years are significantly higher than any other year in the time series. There were several very large discard:landings ratios in tows observed these years (one in 1989, five in 1990), inflating the estimates (Table 53). The relative magnitude of the trawl discard estimate for 1989 is similar to the relative magnitude of the NMFS Trawl Survey (Section 5.1) catch rate in 1989 indicating very high relative abundance that was available to these fisheries, though these two sources do not agree on the relative magnitude in the 1990 estimates. The observer data were checked for errors and none could be confirmed, so the SAS agreed that these estimates should not be adjusted.

4.1.2.7.2 Shrimp Trawl Discards

4.1.2.7.2.1 Total Shrimp Trawl Discards

Final discard estimates are in Table 54 and Table 55 and Figure 32 and Figure 33. Mean weights of spot derived from discard number and weight estimates are in Table 56. Discards were relatively high, but decreasing in the early 1990s before BRDs were required. There were particularly high discards of spot in 1991 due to high effort and CPUE (Figure 34). Discards then became relatively stable throughout the 2000s. Despite slightly declining or stable trends in effort during the 2010s, there was an increasing trend in discards. This increase is driven by increasing CPUE over these years. Discard estimates generally follow the same trends as landings by shrimp trawlers (Figure 35).

4.1.2.8 Potential Biases, Uncertainty, and Measures of Precision

4.1.2.8.1 Mid-Atlantic Trawl and Gillnet Discards

Variances of annual ratio estimators were relatively large, resulting in CVs that averaged 0.63 and 0.47 for gillnets and trawls, respectively (Table 40 and Table 41). The relatively large variances were not unexpected given the low sample size of observations and high variances of landings and discards in many years (Table 35 and Table 36). Although variances of these estimates were often large, the estimates make up a small proportion (<3%) of total annual fishery removals (Section 4.3, Figure 59).

4.1.2.8.2 Shrimp Trawl Discards

Shrimp trawl discard estimate 95% confidence intervals are in Table 54 (millions of fish) and Table 55 (metric tons).

4.2 Recreational

Statistics for recreational total catch, catch size composition, and effort were provided by the MRFSS from 1981-2006, MRIP from 2007-2014, and the Southeast Region Headboat Survey (SERHS) from 1981-2014. Additional, though limited, recreational fishery biological sampling has been conducted by several state monitoring programs.

4.2.1 Marine Recreational Fisheries Statistics Survey and Marine Recreational Information Program

Estimates of Atlantic coastal recreational fishing effort (angler hours, number of trips), harvest in numbers and weight, numbers of fish released alive, and catch size composition from 1981-2003 are from the MRFSS and estimates from 2007-2014 are from the MRIP which replaced the MRFSS in 2007.

4.2.1.1 Data Collection and Treatment

4.2.1.1.1 Survey Methods

Data are collected in independent, complementary surveys. The Access Point Angler Intercept Survey (APAIS) and at-sea sampling are designed to collect catch rate data and biological samples. The Coastal Household Telephone Survey (CHTS) and For-Hire Survey (FHS) are designed to collect effort data. Data from the surveys are combined to generate estimates. Angler participation in the MRIP surveys is voluntary. An overview of these surveys from the MRIP website (http://www.st.nmfs.noaa.gov/recreational-fisheries/index) is provided below. See the website and data user handbook at (http://www.st.nmfs.noaa.gov/recreational-fisheries/MRIP-Handbook/MRIP_handbook.pdf) for additional details.

Catch Rate Surveys

APAIS conducts interviews of intercepted anglers at public fishing access sites (e.g., marinas, piers) that collect information on area(s) fished, catch, and angler participation during recreational fishing trips (example questionnaires are available on the MRIP website). Stratified random sampling is used to select access sites in a site registry. Sampling is stratified by state (Florida-Maine), fishing mode, and wave (i.e., bimonthly period). The four fishing modes for stratifying sampling are private boats (including rentals), shoreline (e.g., pier, jetty, etc.), charter boats, and headboats (i.e., party boats). The charter boat and headboat modes were combined as one mode from 1981-1985 and 1981-2003 in the South Atlantic and north of North Carolina, respectively, before being split into separate modes. Headboat anglers in the South Atlantic have not been sampled through APAIS since 1985; data from these anglers are collected by the SERHS (Section 4.2.2). Headboat anglers north of North Carolina have not been sampled by the APAIS since 2004. Catch has been sampled from this mode since 2005 during ride-along, at-sea sampling. Sampling is conducted in six waves, each wave being two consecutive calendar months starting with wave 1 (January and February) and ending with wave 6 (November and December). Sample allocation by wave has varied over time but generally covers all six waves in Florida, with the exception of wave 1 in 1981, all six waves in North Carolina since 1989, waves 2-6 from Georgia-Massachusetts, and waves 2-5 from New Hampshire-Maine. Sampling before 2013 was primarily done during peak daylight hours. In

2013, sampling was allocated to cover non-peak hours. Sampling is post-stratified into marine water areas based on the primary area fished during trips, as reported by anglers. Areas include inshore coastal waters (e.g., bays and tidal rivers), state territorial seas (0-3 miles from the coast), and the EEZ (>3-200 miles from the coast).

The number of spot caught during a trip is recorded as harvested fish observed by the interviewer in whole form (type A catch), fish reported as harvested by the angler but not observed by the interviewer (i.e., bait, filleted, discarded dead on headboats; type B1 catch), and fish reported as released alive (type B2 catch).

Effort Surveys

The CHTS is a stratified random digit dialing telephone survey that includes only households in coastal counties (generally counties within 25-50 miles of coastline, depending on state). The CHTS is stratified by county and wave. Sampling is conducted over a two week period at the end of each wave (last week of the wave and first week of the next wave) and is allocated proportional to county population. The number of telephone interviews conducted during each wave varies based on the amount of fishing activity expected for the season (NMFS, pers. comm.). Information is collected on the number of trips in the previous wave and details about those trips (example questionnaires are available on the MRIP website).

Evaluation of the CHTS found that for-hire modes (headboat and charter boat) were being underrepresented due to the nature of these fisheries (e.g., out of state clients). Beginning in 2005, angler effort on charter boats and headboats from ports north of North Carolina has been sampled through the FHS and several overlapping sampling programs, replacing the CHTS for for-hire modes. The FHS is also a random digit dial telephone survey that uses a vessel directory as a sampling frame. Other overlapping programs include VTRs for New Jersey through Virginia (census logbook) and various state logbook programs.

4.2.1.1.2 Biological Sampling Methods

Length and weight measurements are obtained from type A catch encountered during APAIS intercepts to develop harvest size composition (numbers-at-length) and harvest estimates in weight. Length measurements are FL to the nearest mm and weight measurements are to the nearest tenth of a kg. Information on sample sizes was retrieved from the MRIP and MRFSS raw intercept files. Table 57 include spot length and weight sample sizes obtained during sampling by year.

Beginning in 2004, length measurements have been obtained from type B2 catch encountered during at-sea sampling of headboats (type 9 samples). Sample sizes by year and state are in Table 58.

No age samples (e.g., otoliths) are collected during APAIS sampling or at-sea sampling of headboats.

4.2.1.1.3 Catch Estimation Methods

Effort data from the CHTS and FHS are combined with U.S. Bureau of Census data on population size to estimate the total number of trips in a stratum. The estimated number of trips in a stratum are applied to the spot catch-per-trip for each catch type from APAIS intercepts and at-sea sampling in a stratum to obtain stratum catch estimates. Estimates are summed across strata for total number of spot harvested (A+B1), released alive (B2), or caught (A+B1+B2).

Mean weight of spot weighed during APAIS intercepts for a stratum are applied to the number of harvested spot in the stratum to obtain estimates of harvest in weight. The mean weight of type B1 catch in each stratum is assumed to be the same as type A catch in the stratum. Some strata prior to 2004 have zero harvest estimates in weight and positive harvest estimates in numbers, biasing the weight estimates low. This occurred if all intercepted, harvested fish for the stratum were type B1 catch or if interviewers were unable to obtain weight measurements for type A catch. MRIP methods of imputation using length-weight relationships have been used for addressing missing harvest estimates in weight and there are no strata with missing estimates after 2003. Thirty two strata had zero weight estimates with positive number estimates. To estimate harvest in weight for these strata, individual weight observations for APAIS intercepts were pooled from surrounding strata until a threshold sample size was obtained (n=20). Pooling collapsed over areas, followed by modes, states within sub-region (Mid-Atlantic or South Atlantic), and finally waves until the threshold sample size was reached. Mean weights were calculated and applied to the stratum harvest number estimate to estimate harvest weight. Numbers of harvest weight estimates by pooling level are in Table 59. The original estimate of harvest in numbers, the mean weight from pooling, and the new estimate of harvest in weight are in Table 60.

The proportions of spot measured for length in 1 cm length bins in each stratum are applied to the total number of spot harvested in the stratum to obtain size composition estimates of the harvest in numbers. A custom request was made through MRIP to provide annual size compositions of fish released alive estimated from type 9 length samples collected on headboats. SAS code using the MRIP weighted estimation methodology was provided and annual estimates were generated for years when data were available (2004-2014).

Catch estimate provided by MRFSS and MRIP through the MRIP online data query (NMFS, Fisheries Statistics Division, Silver Spring, MD, pers. comm.) were adjusted for survey design changes through time, according to recommendation by Carmichael and Van Voorhees (2014) and the SEDAR Best Practice Workshop (SEDAR 2016). Adjustments were made by (1) calibrating estimates generated from APAIS intercepts during peak daylight hours only and the MRIP estimation methodology (2004-2012) to 2013 estimates generated from APAIS data collected during peak and non-peak hours and the MRIP estimation methodology, (2) calibrating for-hire estimates generated from CHTS effort data to fire-hire estimates generated from FHS effort data (years are state-specific), and, subsequently, (3) calibrating estimates generated from the MRFSS estimation methodology (1981-2003) to estimates generated from the MRIP estimation methodology (2004-2014). MRFSS estimates from 2004-2007 are already re-estimated with the new estimation methodology when estimates are provided. The combination of for-hire modes from 1981-1985 in the South Atlantic requires splitting the MRFSS estimates into headboat estimates and charter boat estimates so headboat estimates are not double counted when using the preferred SERHS estimates in these years. However, due to the negligible catch estimates from the SERHS (Section 4.2.2), MRFSS for-hire catch estimates in the South Atlantic during 1981-1985 are assumed to be all from charter boats.

Recommendations of Carmichael and Van Voorhees (2014) were followed to calibrate catch estimates for the change in APAIS intercept timing. A ratio of 2013 catch estimated with intercept data from peak hours sampled prior to 2013 to 2013 catch estimated with intercept data from all hours sampled in 2013 was applied to catch estimates from 2004-2012. Ratios were developed at the mode and state level. If a threshold number of intercepts (n=30) were not available at this level, pooling was done until the threshold was reached. Pooling was done by collapsing over states within a sub-region, followed by collapsing over species within a state, followed by collapsing over species and states within a sub-region. If the threshold was still not reached, no adjustments were made to original estimates. Headboat estimates provided by MRIP (i.e., north of NC) were not adjusted because catch rates are developed from at-sea sampling and that sampling design did not change in 2013 (J. Foster, personal communication, March 29, 2016). Catch estimates by pooling levels are in Table 61 and Table 62. The range of ratios for harvest number estimates was 1-4.85 with a mean of 1.53. The range of ratios for harvest weight estimates was 1-8.65 with a mean of 1.60. The range of ratios for released alive estimates was 1-2.60 with a mean of 1.48. For-hire catch estimates from the South Atlantic during 1981-1985 were calibrated using conversion factors (i.e., ratios of effort estimates) developed by Matter et al. (2012), estimates from the South Atlantic during 1986-2002 were calibrated using conversion factors developed by SEDAR (2011), and estimates from the Mid-Atlantic during 1981-2003 were calibrated using conversion factors developed by SEDAR (2008). Estimates were calibrated for the change in estimation methodology according to recommendations of Salz et al. (2012). A ratio of mean catch estimates generated from the two estimation methodologies (i.e., MRIP:MRFSS) during overlapping years (2004-2014) was applied to the MRFSS estimates from 1981-2003. Estimates using the MRFSS estimation methodology were queried from the ACCSP Data Warehouse. Ratios were developed at the broadest scale appropriate for the stock unit (i.e., coastwide), to avoid a deterioration in precision (Salz et al. 2012).

There is a pending change in effort surveys, with the CHTS to be replaced by a mail-based effort survey, but data were not available for this assessment to calibrate estimates generated from CHTS effort data to estimates generated from the new mail effort survey. These data are anticipated sometime in 2018 and should be considered for future updates of this assessment.

To convert recreational releases from numbers to weight, conversion factors were developed from headboat biological sampling (type 9 sampling) from 2004-2014 and annual length-weight relationships developed from the fishery independent biological sampling programs. Numbers of spot released were converted first into lengths using length distributions from the headboat sampling and then converted to weight using year-specific length-weight conversions. For years prior to headboat sampling, a ratio of the average weight of released fish (as calculated from the length frequencies observed on headboats from 2004-2014) to the average weight of harvested fish over that same period was used to estimate the average weight of released fish in years prior to 2004. A ratio of 0.40 was applied to the average weight of harvested fish to calculate the average weight of released fish for the years 1981-2003. The average weight was then applied to coastwide released alive estimates in numbers. This method was also used in the Atlantic Croaker Benchmark Stock Assessment (ASMFC 2010a).

4.2.1.2 Trends

4.2.1.2.1 Recreational Catch Rates (CPUE)

Catch rates were not developed from MRFSS and MRIP data for modelling due to the availability of several regional fishery-independent surveys.

4.2.1.2.2 Recreational Harvest

4.2.1.2.2.1 Total Harvest

Harvest is generally the primary component of MRFSS and MRIP coastwide recreational catch (Figure 36), averaging 65% of annual catch from 1981-2014. Along the Atlantic coast from 1981-2014, annual recreational harvest (type A+B1) of spot has ranged from a low of 4.489 million fish in 1999 to a high of 24.695 million fish in 1983 (Table 63, Figure 36). The harvest has generally declined over the time series. In terms of weight, recreational harvest has ranged between 905 metric tons in 2012 and 3,857 metric tons in 1981 (Table 64, Figure 37). Recreational harvest in 2014 was 8.723 million fish, or 1,328 metric tons. The final, adjusted estimates follow the same trend as the original estimates but are scaled up, on average, by about 2.4 million fish or 405 metric tons (Figure 38 and Figure 39).

The majority of the spot recreational harvest was taken in Virginia and North Carolina (Table 63, Figure 40 and Figure 41), followed by Maryland, South Carolina, Georgia, and Florida. States north of Maryland harvest relatively few spot.

The majority of spot recreational harvest is taken during waves four and five (July-October; Figure 42 and Figure 43) by shore-based anglers and anglers fishing from private or rental boats (Figure 44 and Figure 45). Early in the time series, the majority of spot were harvest from coastal waters, but the majority of harvest since 1986 has generally been from inshore waters (Figure 46 and Figure 47).

4.2.1.2.2.2 Harvest Size Composition

Annual size frequency estimates of coastwide spot harvest are in Figure 48. The figures are subset to a size range between 10 and 31 cm FL, as lengths within this range accounted for at least 1% of the annual harvest for at least one year. The average length of harvested fish generally increased through the 1980s and 1990s (Figure 49). Mean length hit a time series high of 23.2 cm FL in 2004, but has declined since. The mean length of harvested fish in 2014 was 20.4 cm.

4.2.1.2.3 Recreational Releases

4.2.1.2.3.1 Total Releases

Live releases are generally less than recreational harvest in numbers (Figure 36). The estimated number of spot released alive by recreational anglers along the Atlantic coast has been variable, ranging from a low of 2.593 million fish in 2002 to a high of 15.603 million fish in 1981 with a mean of 6.264 million fish (Table 65, Figure 36). Recreational releases in 2014 were estimated at 3.754 million fish. The final, adjusted estimates follow the same trend as the original estimates but are scaled up, on average, by about 1.8 million fish (Figure 50). In terms of weight, recreational releases have ranged from 26 metric tons in 2010 to 156 metric tons in 1981 (Table 66, Figure 51).

Released alive estimates break down similarly to harvest estimates. The majority of fish released alive were captured from North Carolina-Maryland (Figure 52), during waves 3-5 (Figure 53), by shore-based or private or rental boat anglers (Figure 54). The majority of fish released alive throughout the time series were caught in inshore waters (Figure 55).

Fifteen percent of fish released alive were assumed to die post-release as result of factors such as hooking mortality and improper handling (Section 2.8; Table 67).

4.2.1.2.3.2 Release Size Composition

Annual length frequencies of spot released alive by headboat anglers estimated from type 9 biological sampling are in Figure 56. The distributions vary across years with the peak usually occurring between 10 and 20 cm FL.

4.2.1.3 Potential Biases, Uncertainty, and Measures of Precision

The MRIP estimates are based on a stratified random sampling design and so are designed to be unbiased. The proportional standard error (PSE) is provided with MRFSS and MRIP estimates as a measure of precision (Table 68-Table 70). The PSE is the percentage of the SE relative to the catch estimate. PSEs of MRFSS estimates are calibrated similar to catch estimates to address the change in estimation methodology, but the PSE calibration accounts for the additional uncertainty from the estimate of the calibration factor (Salz et al. 2012). A workshop was conducted in 2014 to evaluate acceptable levels of precision for MRFSS and MRIP catch estimates through simulation (ACCSP 2016). PSEs for coastwide catch estimates all fall in or below the general rule of thumb range (40-60%) proposed at this workshop for acceptable levels of precision, with the exception of the released alive estimate in 1981 (72.5%).

4.2.2 Southeast Region Headboat Survey

4.2.2.1 Data Collection and Treatment

4.2.2.1.1 Survey Methods

The SERHS estimates catch (harvest and releases) and effort and provides biological samples of harvested fish from trips on headboats in the South Atlantic (home ports from North Carolina-Florida). The SERHS began in the 1970s, but only data from 1981-2014 were provided. This matches the time series of the catch estimates from other modes of fishing provided by the MRFSS and MRIP. Estimates of released fish from the SERHS are only available since 2004.

There are two, complementary components of the design for this survey. The first was designed as a census logbook program for captain self-reporting of total harvest in numbers and weight, total releases in numbers by disposition (alive, dead, or unknown), and effort on all headboat trips. The logbook program was originally voluntary, but became mandatory. Despite the mandatory nature of the program, there has been known non-reporting that has varied through time. The second component of the survey is intercepts of headboat anglers upon arrival at port following the trip to obtain biological samples from harvested fish. See Brennan (2010) for more details on the SERHS.

4.2.2.1.2 Biological Sampling Methods

Biological sampling is described as a systematic opportunistic sampling of harvest by vessels assigned to port agents. Port agents are instructed to focus on uncommon catches in attempts to collect sufficient sample sizes from all catch. Port agents attempt to sample all vessels they are assigned to proportionally and in a systematic rotation. Fish are measured, weighed and otoliths are collected for ageing.

Only five spot have been sampled for biological data from 1981-2014 and no age structures have been collected from spot.

4.2.2.1.3 Catch Estimation Methods

Catch is summed across headboat logbooks to provide total catch estimates. If necessary, port agents develop correction factors based on records of vessel activity and effort to adjust for non-reporting by applying correction factors to reported catch.

4.2.2.2 Trends

4.2.2.2.1 Recreational Catch Rates (CPUE)

Catch rates were not developed from SERHS data for modelling due to the availability of several regional fishery-independent surveys.

4.2.2.2.2 Recreational Harvest

4.2.2.2.2.1 Total Harvest

Spot are infrequently harvested on South Atlantic headboats and harvest estimates from this survey make a negligible contribution to total fishery removals (Table 71). Only 829 spot were harvested from 1981-2014.

4.2.2.2.3 Recreational Releases

4.2.2.2.3.1 Total Releases

Spot are infrequently caught on South Atlantic headboats and dead release estimates from this survey make a negligible contribution to total fishery removals (Table 72). Only fifteen spot were caught and released from 2004-2014, all with unknown disposition. All of these fish were assumed to die post-release. Due to these negligible numbers during the available time series, releases from 1981-2014 were assumed to be zero.

4.2.2.3 Potential Biases, Uncertainty, and Measures of Precision

No measures of precision were provided with catch estimates.

4.2.3 Maryland Headboat Creel Survey

4.2.3.1 Survey Methods

An onboard headboat creel survey was conducted from 1997-2000 from June through September. The survey focused on Atlantic croaker, spot and weakfish. Anglers were queried as to whether or not they would like to participate in the survey. Each creel clerk surveyed a maximum of six anglers. Total fishing time was determined from the time fishing began until the lines were removed at the last fishing location.

4.2.3.2 Biological Sampling

All spot caught by participating anglers were measured to the nearest mm TL and whether it was harvested or released was recorded.

The time series mean TL of harvested spot was 23.1 cm (n=7,606; Figure 57). Annual mean lengths of harvested spot ranged from 22.0 to 24.3 cm, with sample sizes ranging from 510 to 2,966 fish per year.

The time series mean TL of spot released alive was 15.8 cm (n=480; Figure 57). Annual mean lengths of released spot ranged from 15.3 to 17.2 cm, with sample sizes ranging from 20 to 328 fish per year.

4.2.4 Virginia Marine Resources Commission Marine Sportfish Collection Project

The VMRC's Marine Sportfish Collection Project began in 2007. Chest freezers, bags, and information cards were placed at high activity fishing facilities so that fishermen could donate freshly filleted carcasses with head and tail intact. Bags are collected by the VMRC staff and processed for biological information. Participating anglers receive a shirt, hat, or tape measure as incentive to donate carcasses. When the project began in 2007, freezers where placed at three bait and tackle shops and by 2010 freezers were at seven locations across Capeville, Hampton, Poquoson, Norfolk, and Virginia Beach. Only four spot have been collected through this sampling program (Table 5).

4.2.5 South Carolina Freezer Program

The SCDNR Inshore Fisheries group has run a fish wrack collection program where carcasses of spot were obtained from voluntary contributions of fish "wracks" (the remains of fish after filleting). The samples were collected using freezers for anglers to place the fish wracks in with corresponding catch information at their convenience. A minimum of four freezers were maintained at locations convenient for anglers throughout the Charleston area where fish wracks could be dropped off. Anglers recorded the date and location of where the fish were caught and included this information with the fish wracks. Only length measurements (TL and

SL) were taken for freezer fish since total weight could not be obtained. Sex and maturity were determined through gross morphological examination and otoliths were removed for ageing. Histological samples were not taken since the specimens had been frozen and cellular integrity of the gonad tissue was compromised. Specimens were collected from 2010-2011 (Table 3).

4.3 Total Removals

Total annual removals of spot from all fishery sources (landings and discards) have ranged from between 4,637 and 57,287 metric tons, or 41 and 1,324 million fish (Table 73 and Figure 58). Removals were relatively large, but variable in the 1990s. Removals since 1997 have been relatively stable, coinciding with the requirement of BRDs across shrimp trawl fisheries. The long term mean removals was 12,785 metric tons, or 254 million fish. However, total removals after the peak year that occurred in 1991 averaged 9,399 metric tons, or 158 million fish.

The majority of annual removals were discards in the shrimp trawl fisheries, followed by commercial landings and recreational harvest (Figure 59). Discards from the shrimp trawl fisheries accounted for 31-70% of annual removals depending on year. Commercial landings accounted for 10-40% most years, while recreational harvest typically accounted for approximately 10% each year. The remaining sources of fishery removals were typically 5% or less of total annual removals over the last 20+ years.

5. Fishery-Independent Data

The SAS reviewed 35 fishery-independent surveys that encountered spot (Table 74). Surveys collect biological data used in spot life history analyses (Table 3), as well as catch rate data used to develop indices of relative abundance/biomass. There are several surveys that cover broad geographical areas relative to the stock range and these are believed to be more representative of coastwide relative abundance/biomass than the localized surveys reviewed. These are generally the same surveys that have previously been determined as having utility for assessment of the coastwide Atlantic croaker stock (ASMFC 2010a), as the two species have similar life histories and are often encountered together. These surveys were further narrowed to five surveys that encounter the full age structure of spot which made them candidate surveys for indices of abundance/biomass for the assessment modelling approaches discussed as the SAS reviewed data limitations for spot during the data workshop (e.g., limited size composition information for fishery removals). In anticipation of the potential modelling approaches discussed and review of the first year of complete removal data (i.e., 1989), the SAS requested indices from 1989-2014 in numbers and biomass, as well as surveys split into age-specific (age-0 and age-1+) indices in numbers, when possible. The five selected surveys and indices evaluated and used in this assessment are described in this section.

Additionally, criteria were developed by the SAS for evaluating each survey to determine which should be included in this assessment. The following criteria was used by the SAS to evaluate the surveys:

1. Time series is at least six years long, the age of the oldest spot in the data for this assessment.

2. Time series is continuous and there have been no changes in methodology or gear.
3. Survey operates within the spot geographic range at a time when the fish are typically available.
4. There are a high proportion of positive tows.

These criteria were used as a guide and, when surveys were used to develop indices, the SAS also considered if the index was correlated with other indices, it provided a conflicting signal to other indices or the catch history, or the index was not representative of the stock unit.

5.1 NMFS Trawl Survey

5.1.1 Survey Design & Methods

In 1963, the NMFS NEFSC implemented a multispecies bottom trawl program, which surveys over a large portion of the Atlantic shelf (hereafter referred to as the NMFS Trawl Survey; Avarovitz 1981, Grosslein 1969). The objective of the program is to monitor trends in abundance and distribution, characterize age/length structure, and better understand the biology and ecology of a wide array of finfish and invertebrate species. The survey uses a stratified random design, with strata based on depth (0.0–9.0 m; 9.0–18 m; 18– 27 m; 27–55 m; 55–110 m; 110–188 m; 188–366 m). Both inshore and offshore strata are sampled. The fall survey is an inshore survey that samples sites from Cape Hatteras to Cape Cod. The area within each stratum is subdivided into one-nautical mile blocks that are selected randomly prior to the sampling trip. The sampling gear is a #36 Yankee otter trawl rigged with rollers, 5-fathom legs, and 1,000- pound polyvalent door. A small-mesh cod-end liner (0.5-inch mesh) is used to retain YOY fish.

5.1.2 Sampling Intensity

The fall component has been conducted consistently since 1972. The number of tows per strata and year are in 0. Tow duration is 30 minutes.

5.1.3 Biological and Environmental Sampling

The catch of each tow is identified, counted, weighed, and measured. When the catch of a particular species is large, a subsample of individuals is measured. Data on sex, maturity, stomach contents, and disease are recorded. Latitude, longitude, gear information, salinity, temperature, weather, and hydrographic parameters are recorded.

5.1.4 Evaluation of Survey Data

Data collected from 1972 onward were evaluated. Prior to 1972, the survey protocol changed several times and not all strata were sampled in all years. The survey protocol was standardized beginning in 1972, and with the exception of some vessel changes, has adhered to that protocol since. An evaluation of the proportion of zero catches indicated that the occurrence of spot has been consistent throughout the duration of the survey (Table 76). Zero tows accounted for 50% of the total tows across these years. When the survey was limited to the fall months, when it predominantly encounters spot, and limited to the years 1989-2014, zero tows accounted for 29% of the total tows. Because this survey encounters spot often in a representative geographic range and has a random statistical design, the SAS supported the use of this survey for developing indices of abundance/biomass.

5.1.5 Development of Estimates

Data from the fall months (September–November) and offshore strata were used to develop an index of relative abundance (number per tow) which was split into age-0 (Table 77) and age-1+ (Table 78) indices (Figure 60). The index was split using the age-length key (ALK; 0) from the NEAMAP Trawl Survey to estimate the relative proportions of the two age groups (0 and 1+) annually from the length frequency distributions. The final annual index value for each age group was estimated as the proportion of the total index attributed to that age group. Since there was no age data collected for spot in the NMFS Trawl Survey, the NEAMAP Trawl Survey ALK was used because both were offshore surveys and the geographic range (New York to Cape Hatteras, NC) matched that of the NMFS Trawl Survey. An aggregate index of relative biomass (kg per tow) for all ages was also developed (Figure 61; Table 80). Sampling frequency varied among years and NMFS strata, making it necessary to pool data across strata in order to generate comparable, non-biased metrics of abundance across years. In 2009 there was a change in the sampling protocol for both gear and vessel for the fall survey with the decommissioning of the RV Albatross and the transition to the RV Bigelow for all future surveys. The RV Bigelow is not able to sample the nearshore strata due to the increased draft of this vessel and the mid-shore strata were not sampled as frequently. For continuity of sampling in the nearshore and mid-shore strata, these areas were taken over in 2008 by the NEAMAP Trawl Survey based out of VIMS. Annual estimates of the survey index for spot were reformatted using only the outer offshore strata in order to maintain continuity and effective use of the time series from 1989-2014. Additionally, stratified mean CPUE for the RV Bigelow for 2009-2014 were converted to RV Albatross equivalent units using reported conversion factors from conversion experiments performed between the two vessels doing side by side tows in 2008 (Miller et al. 2010). Pooling of the offshore strata resulted in five pooled strata arranged into five latitudinally separated regions (Region 1 = most northerly, Region 5 = most southerly).

5.1.6 Trends

5.1.6.1 Size Composition

Annual size compositions before splitting the index varied throughout the time series (Figure 62), although on average from 1972-2014 catch was dominated by 16-17 cm TL spot. The length-frequency distributions suggest the survey has primarily encountered spot ages 0+. Young-of-the-year spot (≤ 9 cm TL) and late (mode at 12–13 cm TL) age-0 spot accounted for 0.24-43.4 % of spot annually depending on the year. Prior to 1991, the proportion of YOY fish was higher (9.9%) versus later years (1991-2014, 5.97%). In 2014, the highest proportion of fish was above average at 19 cm TL.

5.1.6.2 Stage-Specific Indices

Abundance was high in the beginning of the time series and remained relatively low in comparison throughout the 1990s and early 2000s for both stages (Figure 60). Abundance for age-0 and age-1+ increased since the mid-2000s to the highest points in the time series in 2012, only to be followed by a decrease in abundance in 2013-2014.

5.1.6.3 Biomass Index

Relative biomass was at its highest in 1989, followed by a low relative biomass through the early 1990s (Figure 61). Biomass was variable through the 2000s, reaching its highest point in 20 years in 2012 followed by another decline and low point in 2014.

5.1.7 Potential biases, Uncertainty, and Measures of Precision

Measures of precision for the index of abundance (CVs) and biomass (SEs) are in Table 77 and Table 80, respectively. An index of total abundance was calculated and then split into age-0 and age-1+ indices, so the CVs reported for these indices are the CVs for the index of total abundance. The CVs for the index of abundance are relatively small, ranging from 0.026 to 0.311 and averaging 0.089.

5.2 SEAMAP Trawl Survey

5.2.1 Survey Design & Methods

The SEAMAP - South Atlantic (SEAMAP-SA) Coastal Survey (previously known as the Shallow Water Trawl Survey; hereafter referred to as the SEAMAP Trawl Survey) began in 1986 and is conducted by the SCDNR Marine Resources Division (MRD). This survey has provided long-term, fisheries-independent data characterizing the seasonal abundance and biomass of all finfish, elasmobranchs, decapod and stomatopod crustaceans, sea turtles, horseshoe crabs, and cephalopods that are accessible by high-rise trawls. The sampling area extends from the coastal zone of the South Atlantic Bight (SAB) between Cape Hatteras, North Carolina, and Cape Canaveral, Florida. The survey uses a stratified random design, where strata are delineated by the 4-m depth contour inshore and the 10-m depth contour offshore. A total of 102 stations are sampled each season within 24 shallow water strata. In previous years (1989–2000), stations in deeper strata—at depths ranging from 10 to 19 m—were also sampled in order to gather data on the reproductive condition of commercially important penaeid shrimp. Those strata were abandoned in 2001 in order to intensify sampling in the shallower depth zone. The R/V Lady Lisa, a 23-m wooden-hulled, double-rigged, St. Augustine shrimp trawler owned and operated by the SCDNR, is used to tow paired 22.9-m mongoose-type Falcon trawl nets, without TEDs. The body of the trawl is constructed of #15 twine with 47.6-mm stretch mesh. The cod end of the net is constructed of #30 twine with 41.3-mm stretch mesh and is protected by chafing gear of #84 twine with 10-cm stretch “scallop” mesh. A 91.4-m three-lead bridle is attached to each of a pair of wooden chain doors, which measure 3.0 m × 1.0 m and to a tongue centered on the headrope. The 26.3-m headrope, excluding the tongue, has one large (60 cm) Norwegian “polyball” float attached top center of the net between the end of the tongue and the tongue bridle cable and two 22.3-cm PVC foam floats located one-quarter of the distance from each end of the net webbing. A 1-ft chain drop-back is used to attach the 89-ft footrope to the trawl door. A 0.6-cm tickler chain, which is 0.9 m shorter than the combined length of the footrope and drop-back, is connected to the door alongside the footrope. Each net is processed separately and assigned a unique collection number.

5.2.2 Sampling Intensity

Multi-legged cruises are conducted in the spring (April–May), summer (July), and fall (October). Trawls are towed for twenty minutes, excluding wire-out and haul-back time, exclusively during daylight hours (1 hour after sunrise to 1 hour before sunset).

5.2.3 Biological and Environmental Sampling

After each tow, the contents of each net are sorted to species or genus, and the total biomass and number of individuals are recorded for all species of finfish, elasmobranchs, decapod and stomatopod crustaceans, cephalopods, sea turtles, xiphosurans, and cannonball jellies. Only total biomass is recorded for all other miscellaneous invertebrates and algae, which are treated as two separate taxonomic groups. Where a large number of individuals of a species occur in a tow, the entire catch is sorted and all individuals of that species are weighed; a random subsample is processed and the total number is estimated. For large trawl catches, the contents of each net are weighed prior to sorting and a randomly chosen subsample of the total catch is then sorted and processed. In every collection, each of the majority of priority species is weighed collectively and individuals are measured to the nearest cm. When a large number of individuals of any of the priority species are collected in a tow, a random subsample consisting of 30 to 50 individuals is weighed and measured.

Spot otoliths were only collected in 2001 from 745 specimens.

5.2.4 Evaluation of Survey Data

The fall component of the SEAMAP Trawl Survey has been conducted consistently since 1989. An evaluation of the proportion of zero tows (37% of all tows) indicates that the SEAMAP Trawl Survey has regularly encountered spot in the spring, summer, and fall components of the survey. Zero tows were more prevalent during the spring component of the survey (41% of all tows). The length-frequency distributions suggest that the majority of spot captured in the spring, summer, and fall components of the survey are age 0+(Figure 65). YOY fish (< 10 cm) were encountered during the fall survey in most years, but not in very high numbers.

5.2.5 Development of Estimates

An index of relative abundance (numbers per tow) was developed and split into age-0 and age-1+ components (Table 77 and Table 78; Figure 63). The index was split using the ALK (0) from age samples taken in 2003. The ALK was then used to estimate the relative proportions of the two age groups (0 and 1+) annually from the length frequency distributions. The final annual index value for each age group was estimated as the proportion of the total index attributed to that age group. An index of relative biomass (kg per tow) was calculated using data from the fall component (September-November) of the SEAMAP Trawl Survey (Figure 64).

5.2.6 Trends

5.2.6.1 Size Composition

Annual size compositions of spot before splitting the index varied throughout the time series (Figure 65), although on average from 1989-2014 ranged from 12-16 cm TL. The length frequency plots indicate that mostly age 0+ spot are caught in this survey, with some YOY (<10 cm) caught during some portions of the year.

5.2.6.2 Stage-Specific Indices

Abundance was low in the beginning of the time series, with a notable peak in the age-1+ index in 1991. Both stage-specific indices remained relatively low throughout the 1990s and early 2000s for both stages (Figure 63). Abundance for age-0 and age-1+ was high in 2005, only to be followed by a decrease in abundance in 2006-2009. The age-0 index had another large peak in 2010 but decreased the following year and remained low until 2014.

5.2.6.3 Biomass Index

The index of relative biomass for spot indicates that abundance was low in 1989 but increased in the early 1990s (Figure 64). From the mid-1990s to the early 2000s abundance remained low. There was a large increase in 2005 followed by almost a decade of ups and downs in abundance.

5.2.7 Potential biases, Uncertainty, and Measures of Precision

Measures of precision for the index of abundance (CVs) and biomass (SEs) are in Table 77 and Table 80, respectively. An index of total abundance was calculated and then split into age-0 and age-1+ indices, so the CVs reported for these indices are the CVs for the index of total abundance. The CVs for the index of abundance range from 0.126 to 0.538 and averaging 0.289.

5.3 NCDMF Trawl Survey

5.3.1 Survey Design and Methods

The Pamlico Sound Survey (hereafter referred to as the NCDMF Trawl Survey), also known as Program 195 (P195), was initiated by the NCDMF in 1987 to provide a long-term, fisheries-independent database for the waters of the Pamlico Sound, eastern Albemarle Sound, and the lower Neuse and Pamlico rivers. The survey samples fifty-two randomly selected stations based on a grid system (one-minute by one-minute grid system equivalent to one square nautical mile). Sampling is stratified by depth and geographic area. Shallow water is considered water between 6 to 12 feet in depth and deep water is considered water greater than 12 feet in depth. The seven designated strata are: Neuse River; Pamlico River; Pungo River; Pamlico Sound east of Bluff Shoal, shallow and deep; and Pamlico Sound west of Bluff Shoal, shallow and deep. As of March 1989, the randomly selected stations have been optimally allocated among the strata based upon all the previous sampling in order to provide the most accurate abundance estimates (PSE < 20) for selected species. A minimum of three stations (replicates) are maintained in each strata. A minimum of 104 stations are sampled each year to ensure maximum areal coverage. Tow duration is 20 minutes at 2.5 knots using the R/V Carolina Coast, which is equipped with double-rigged demersal mongoose trawls. The R/V Carolina Coast is a 44-ft fiberglass hulled double-rigged trawler owned and operated by the NCDMF. The body of the trawl is constructed of #9 twine with 47.6-mm stretch mesh. The cod end of the net is constructed of #30 twine with 38.1-mm stretch mesh. The tailbag is 80 meshes around and 80 meshes long (approximately 3.1 m). A 36.6-m three-lead bridle is attached to each of a pair of wooden chain doors that measure 1.22 m × 0.0610 m and to a tongue centered on the headrope. A 60-cm "polyball" is attached between the end of the tongue and the tongue bridle cable. A 4.76-mm tickler chain that is 0.90 Section B, Page 38 m shorter than the 10.4-m footrope is connected to the door next to the footrope. Trawl door coverage area is 9.51 sq m. The sampling coverage area is 8,152 sq m and the sampling coverage volume is 13,042 cu m. Environmental data are recorded, including temperature, salinity, dissolved oxygen, wind speed, and direction.

5.3.2 Sampling Intensity

The sampling season has undergone some changes since the survey's inception. Beginning in 1991, sampling has been performed over a two-week period, usually the second and third weeks of both June and September. Sampling now occurs only in the Pamlico Sound and associated rivers and bays.

5.3.3 Biological and Environmental Sampling

All species are sorted, and a total number and aggregate weight is recorded for each species. For target species, thirty to sixty individuals are measured, and total aggregate weights are taken. The catches from each of the two towed nets are combined to form a single sample in an effort to reduce variability.

5.3.4 Evaluation of Survey Data

An evaluation of the proportion of zero catches (10% of all tows) indicated that spot have been regularly encountered during the June component of the survey. Because this survey often catches spot, is statistically designed, and represents a portion of the spot geographic range, the SAS supported its use to develop indices of abundance/biomass.

5.3.5 Development of Estimates

An index of relative abundance (numbers per tow) was developed from the June portion of the NCDMF Trawl Survey and split into age-0 and age-1+ components (Figure 66). Due to fast growth of age-0 spot, length separation of these two age groups was most distinct during June. Spot less than 12 cm were considered age-0 fish and those greater than or equal to 12 cm were considered age-1+.

5.3.6 Trends

5.3.6.1 Stage-Specific Indices

Both age-0 and age-1+ abundance indices for spot from the NCDMF Trawl Survey varied throughout the time series. Both were somewhat lower in the 1990s with larger peaks in the mid-2000s. The highest age-0 abundance was in 2008 and the highest age-1+ abundance was in 2006.

5.3.7 Potential biases, Uncertainty, and Measures of Precision

CVs for the age-specific indices of abundance are in Table 77 and Table 78. The CVs for the indices of abundance are similar, averaging 0.177 and 0.183 for the age-0 and age-1+ indices, respectively.

5.4 ChesMMAP Trawl Survey

5.4.1 Survey Design and Methods

The ChesMMAP Trawl Survey has been sampling the mainstem of the Chesapeake Bay, from Poole’s Island, Maryland to the Virginian Capes at the mouth of the bay since 2002. This survey is designed to sample the late juvenile and adult stages of the living marine resources in Chesapeake Bay, and as such the timing of sampling is meant to coincide with the seasonal residency of these life stages in the estuary.

The ChesMMAP Trawl Survey area is stratified into five latitudinal regions, and each region is comprised of three depth strata. Depth strata bounds are consistent across regions, and correspond to shallow (3.0m to 9.1m), middle (9.1m to 15.2m), and deep (>15.2m) waters in the bay. Sampling sites are selected for each cruise using a stratified random design; site allocation for a given stratum is proportional to the surface area of that stratum. A four-seam, two-bridle, semi-balloon bottom trawl is towed for 20 minutes at each sampling site with a target speed-over-ground of 3.5kts. The trawl has a 13.7m headline length, and is made of 15.2cm stretch mesh webbing in the body of the net and 7.6cm stretch mesh in the codend. The codend is not outfitted with a liner which enables the net to be towed effectively at relatively high speeds, facilitating the capture of the target late juvenile and adult stages. Trawl wingspread and headline height are measured during each tow.

5.4.2 Sampling Intensity

ChesMMAP conducts 5 cruises annually, during the months of March, May, July, September, and November. A total of 80 sites are sampled per cruise.

5.4.3 Biological and Environmental Sampling

A number of hydrographic variables (profiles of water temperature, salinity, dissolved oxygen, and photosynthetically active radiation [PAR]), atmospheric data, and station identification information are recorded at each sampling site.

Following each tow, the catch is sorted by species and, if appropriate, by size group within a species. Size groups are not predetermined for each species, but rather are defined relative to the size composition of that species for that tow. As such, size designations and ranges of small, medium, and large for a species may vary somewhat among tows. Such an approach facilitates representative subsampling, and therefore proper catch characterization, for each tow.

A subsample of five spot is selected from each size group from each tow for full processing. Specifically, individual TL (mm), whole and eviscerated weight (kg), sex, and maturity stage are recorded. Stomachs are removed for diet analysis and otoliths are removed for age determination. For specimens not taken for full processing, aggregate weight and individual TL measurements (mm) are recorded by size group.

5.4.4 Evaluation of Survey Data

The ChesMMAP survey encounters spot throughout the year except for March, although the amount of tows with zero spot is higher than some of the other surveys considered at 62%. When limited to May-September cruises, the amount of zero tows decreased to 51% and when limited to only stratum occurring in Regions 4 and 5, the amount of zero tows decreased to 37%. The SAS supported the development of indices using ChesMMAP data in May-September and only in regions 4 and 5 for consideration in the modeling approaches.

5.4.5 Development of Estimates

An index of relative abundance (numbers per tow) and an index of biomass (kg per tow) were developed from the May-September portion of the survey from Regions 4 and 5 (Table 80, Figure 68). The index of relative abundance for a given year was split into age-0 and age-1+ components using ALKs generated by the survey's age data on spot for that year. Specifically, the proportion of age-0 and age-1+ spot in the catch was determined using the associated ALK data for that year (Table 82), and these proportions were applied to the overall index to generate indices for age-0 and age-1+ fish, respectively (Table 77 and Table 78, Figure 69).

5.4.6 Trends

5.4.6.1 Size Composition

Most spot captured in the ChesMMAP survey throughout the year range from 14-20 cm TL (Figure 70) and ages 0 and 1 (Figure 71).

5.4.6.2 Stage-Specific Indices

From 2002-2014, age-0 and age-1+ indices indicate that the highest abundance of both age-classes was in 2006 and has been decreasing since then (Figure 69). The terminal year of 2014 experienced very low abundance of both age-0 and age-1+ indices.

5.4.6.3 Biomass Index

The index of relative biomass for spot developed from the May-September component of the ChesMMAP Trawl Survey in regions 4-5 only indicated that the highest biomass occurred in 2005 and has been on a decline since then (Figure 68). Biomass has been consistently low since 2010 and was at its lowest in the whole time series in the terminal year of 2014.

5.4.7 Potential biases, Uncertainty, and Measures of Precision

Measures of precision for the index of abundance (CVs) and biomass (SEs) are in Table 77 and Table 80, respectively. An index of total abundance was calculated and then split into age-0 and age-1+ indices, so the CVs reported for these indices are the CVs for the index of total abundance. The CVs for the index of abundance range from 0.208 to 0.348 and averaging 0.280.

5.5 NEAMAP Trawl Survey

5.5.1 Survey Design and Methods

The NEAMAP Mid-Atlantic/Southern New England Nearshore Trawl Survey (hereafter referred to as the NEAMAP Trawl Survey) has been sampling the coastal ocean from Martha's Vineyard, MA to Cape Hatteras, NC since the fall of 2007.

The survey area is stratified by both latitudinal/longitudinal region and depth. Depth strata between Montauk, NY and Cape Hatteras are 6.1m-12.2m and 12.2m-18.3m, while those in Block Island Sound and Rhode Island Sound are 18.3m-27.4m and 27.4m-36.6m. It is worth noting that, between Montauk and Hatteras, the outer boundary of the NEAMAP Trawl Survey and the inner boundary of the NMFS Trawl Survey align. Both programs sample in Block Island Sound and Rhode Island Sound.

A four-seam, three-bridle, 400x12cm bottom trawl is towed for 20 minutes at each sampling site with a target speed-over-ground of 3.0kts. The gear is of the same size as and nearly identical in design to that used by the NMFS Trawl Survey, only sweep configuration and trawl door type differ between the two programs. Tow times and tow speeds are consistent between the two programs. The net is outfitted with a 2.54cm knotless nylon liner to retain the early life stages of the various fishes and invertebrates sampled by the trawl. Trawl wingspread, doorspread, headline height, and bottom contact are measured during each tow, and those in which net performance falls outside of defined acceptable ranges are either re-towed or excluded from analyses in an effort to maintain sampling consistency.

5.5.2 Sampling Intensity

NEAMAP conducts two cruises per year, one in the spring and one in the fall, mirroring the efforts of the NMFS Trawl Surveys offshore. Spring cruises begin during the third week in April and conclude around the end of May, while the fall surveys span from the third week in September until the beginning of November. Sampling progresses from south to north in the spring and in the opposite direction in the fall, so as to follow the general migratory pattern of the living marine resources of these regions.

Sampling sites are selected for each cruise using a stratified random design; site allocation for a given stratum is proportional to the surface area of that stratum. A total of 150 sites are sampled per cruise, except 160 sites were sampled in the spring and fall of 2009 as part of an investigation into the adequacy of the program's stratification approach.

5.5.3 Biological and Environmental Sampling

A number of hydrographic variables (profiles of water temperature, salinity, dissolved oxygen, and photosynthetically active radiation [PAR]), atmospheric data, and station identification information are recorded at each sampling site.

Following each tow, the catch is sorted by species and, if appropriate, by size group within a species. Size groups are not predetermined for each species, but rather are defined relative to the size composition of that species for that tow. As such, size designations and ranges of small, medium, and large for a species may vary somewhat among tows. Such an approach facilitates representative subsampling, and therefore proper catch characterization, for each tow.

A subsample of five spot is selected from each size group from each tow for full processing. Specifically, individual TL (mm), whole and eviscerated weight (kg), sex, and maturity stage are recorded. Stomachs are removed for diet analysis and otoliths are removed for age determination. For specimens not taken for full processing, aggregate weight and individual TL measurements (mm) are recorded by size group.

5.5.4 Evaluation of Survey Data

NEAMAP has a statistical, randomly stratified design and does encounter spot throughout the year (65% of all tows were zero), specifically during the fall months (55% zeros). While the SAS was concerned about the length of the time series, indices of abundance and biomass were developed for consideration in modeling approaches.

5.5.5 Development of Estimates

An annual index of relative abundance was developed using data from the NEAMAP Trawl Survey by calculating the geometric mean number of spot caught per standard area swept (i.e., 25,000 m^2) for each year. Calculations were restricted to using catch data from the fall cruises and from tows conducted in Regions 06 to 15 (New York Harbor to Cape Hatteras), which represent the season and locations of consistent spot collections. The index of relative abundance for a given year was split into age-0 and age-1+ components using ALKs generated by the survey's age data on spot for that year. Specifically, the proportion of age-0 and age-1+ spot in the catch was determined using the associated ALK data for that year (Table 83), and these proportions were applied to the overall index to generate indices for age-0 and age-1+ fish, respectively (Table 77 and Table 78, Figure 72). Additionally, an index of relative biomass (kg per tow) was developed from the fall months of the survey (September-November) (Table 80, Figure 73).

5.5.6 Trends

5.5.6.1 Size Composition

Most spot captured in the NEAMAP survey throughout the year range from 14-20 cm TL (Figure 74). Data from the fall portion indicates that most spot caught in this survey are ages 0 and 1 (Figure 75).

5.5.6.2 Stage-Specific Indices

Both the age-0 and age-1+ indices for spot caught in the NEAMAP Trawl Survey show little variability throughout the time series with the exception of 2012 (Figure 72). In 2012, the age-1+ index declines to almost zero and the age-0 index shows high abundance in that year.

5.5.6.3 Biomass Index

The index of relative abundance for spot from the NEAMAP Trawl Survey shows some variability with the highest biomass in 2012 and the lowest in the terminal year of 2014 (Figure 73).

5.5.7 Potential biases, Uncertainty, and Measures of Precision

Measures of precision for the index of abundance (CVs) and biomass (SEs) are in Table 77 and Table 80, respectively. An index of total abundance was calculated and then split into age-0 and age-1+ indices, so the CVs reported for these indices are the CVs for the index of total abundance. The CVs for the index of abundance range from 0.113 to 0.278 and averaging 0.214.

5.6 Index Selection

Association of candidate indices was evaluated with Spearman's rank correlation coefficient, or Spearman's rho (ρ). This is a nonparametric test to evaluate association of two ranked variables over time (i.e., indices of abundance). Associations were evaluated between indices within stages as well as within indices between stages, with the age-0 indices being forward lagged by one year to match the year when these year classes would be indexed by the age-1+ index. It was assumed that age 1 fish are the primary age class in the age-1+ indices when evaluating these associations. There are positive associations within the NCDMF Trawl Survey, NMFS Trawl Survey, NEAMAP Trawl Survey, and ChesMMAP Trawl Survey split indices (Table 84). The SEAMAP Trawl Survey split indices were not associated with each other, but the lagged SEAMAP Trawl Survey age-0 index was positively associated with the NMFS and NCDMF Trawl Survey age-1+ indices. Further visual examination of the split SEAMAP Trawl survey indices suggested that this index was not tracking cohorts when split. For example, there are very large peaks of both age-0 and age-1+ fish in 2005. There does not appear to be any support for such a large increase in relative abundance of age-1+ fish from the preceding year age-0 relative abundance. It is suspected that the splitting method does not reliably partition the catch rates of these two age groups. Visual examination of the trend in the ChesMMAP Trawl Survey indices generally suggested a different trend than the other indices being considered and the SAS suspects that this survey is more reflective of localized relative abundance within the Chesapeake Bay. The

SAS also decided not to include the NEAMAP Trawl Survey in base models because of its short time series relative to the NMFS Trawl Survey that operates parallel to this survey and the potential to confound the modelling approaches and overweight the signal of abundance from the Mid-Atlantic region. Instead, the SAS recommended using the NEAMAP Trawl Survey indices in model sensitivity analysis. The NMFS Trawl and NCDMF Trawl Survey indices were selected as split indices for assessment modelling. These surveys are not positively associated with each other, but the SAS believes the signals are collectively representative of coastwide relative abundance.

The NMFS Trawl and SEAMAP Trawl biomass indices were selected as aggregate indices for assessment modelling because they have previously been used in the TLA and are believed to be representative of the coastwide relative biomass.

6. Methods

Available data guided the choice of modelling approaches for this assessment. Biological sampling from the fishery removals, particularly the dead discards, is a major limitation for spot precluding the development of a reliable time series of catch-at-age data. However, there are estimates of fishery removals in biomass and numbers and several regional surveys indexing the abundance of the entire population age structure that can be partitioned into two distinct groups, or stages, with similar life history characteristics. Single-species models in this assessment include a surplus production model performed in ASPIC (Prager 1994) and Excel and a two-stage, forward projecting model (hereafter referred to as the modified-CSA) with similarities to catch survey analysis (CSA; Collie and Sissenwine 1983) and fully age-structured statistical catch-at-age models.

Neither model is spatially explicit and estimate parameters describing the dynamics and condition of the coastwide stock from aggregated coastwide data. The population dynamics were modelled from 1989-2014. The start year was a pragmatic choice, given data used to generate commercial fishery discard estimates, the vast majority of spot fishery removals early in the time series, are available starting in 1989.

6.1 Surplus Production Model

6.1.1 Model Description

The surplus production model was developed as a secondary, supporting model for spot because of its relatively simple modeling approach. Surplus production models combine the effects of recruitment, growth, and mortality into a single function and assume no size or age structure in the population. It requires a time-series of fishery removals and one or more time-series of catch-per-unit effort from a survey. The non-equilibrium Graham-Schaefer, or logistic, form was used to assess spot (ASPIC; Prager 1994). The model assumes that the population is closed, the environment is constant, abundance indices are proportional to the true population abundance, total catch is known without error, the stock responds instantaneously to changes, and that the intrinsic rate of increase (r) and carrying capacity (K) remain constant.

6.1.2 Reference Point Model Description

The surplus production model estimates maximum sustainable yield (MSY) and the associated MSY-based references points of B_{MSY}, the stock biomass associated with MSY, and F_{MSY}, the fishing mortality that maximizes the yield from the population. These absolute values are usually imprecise (Prager 1994) since they require good estimates of catchability (q). Relative biomass (B_{2014}/B_{MSY}) and relative fishing mortality (F_{2014}/F_{MSY}) can be used to determine overfishing and overfished status.

6.1.3 Configuration

A complete description of inputs for the surplus production model can be found in Table 87, but briefly, this analysis used two fishery-independent surveys, the fall portions of the NMFS Trawl and the SEAMAP Trawl Surveys, as well as the complete fishery removals data.

Coastwide fishery removals from 1989-2014 (Table 73, Figure 58, Figure 59) were calculated in weight (metric tons) and were comprised of commercial and recreational landings, recreational dead discards, commercial dead discards from mid-Atlantic gillnet and trawl fisheries, landings from the scrap fishery, and dead discards from the shrimp trawl fishery (see Section 4).

6.1.3.1 Selection and Treatment of Indices

The surplus production model used the fall portions of the relative biomass indices (kg/tow) developed from NMFS Trawl and SEAMAP Trawl Surveys (Table 80, Figure 61, Figure 64). Indices were weighted equally in the model and were found to be positively correlated (r=0.38) but not significantly (P=0.09).

6.1.3.2 Sensitivity Analyses

The SAS conducted sensitivity runs by including the NEAMAP Trawl Survey as an additional relative biomass index, beginning the model in 1992 after the large peaks in the removal time-series, using alternative formulations of the Pella-Tomlinson model, and including the relative biomass index from the NMFS Trawl Survey only. The base run analysis was also performed in Excel to examine differences from and sensitivities to ASPIC.

6.1.3.3 Projections

The population was projected forward 10 years at a harvest level equal to the 2014 harvest.

6.2 Modified-CSA Model

6.2.1 Assessment Model Description

The modified-CSA was originally developed and subsequently modified for several blue crab stock assessments (Miller et al. 2011, VanderKooy 2013). The version used by VanderKooy (2013) was further modified for this assessment. The two stages for spot are recruits (age-0) and post-recruits (age-1+), according to calendar year ages (January 1-December 31). Unlike the original CSA, the modified-CSA model generates estimates that are not conditioned on catch (i.e., catch is not assumed known without error), can fit to multiple indices of abundance for each stage, does not relate the catchability coefficients of the two stages within a survey, allows for fishing to occur on recruits before the survey, and the population dynamics explicitly involves a stock–recruit relationship. The two-stage population structure and an assumed selectivity-at-stage preclude the need for catch-at-age data. Spot are short-lived and the age data that are available indicate that life history characteristics (i.e., growth, maturity) do not vary much between the majority of fish grouped into post-recruits (ages-1 and 2). The model is implemented in AD Model Builder (ADMB) version 11.2 (Fournier et al. 2012). Model code and data input files are in Appendix 4 and Appendix 5, respectively.

General model definitions and model inputs, population and observation model equations, and likelihood components of the model objective function (negative log-likelihood) are in Table 88, Table 89, and Table 90, respectively. Abundance of both stages is predicted in the initial year (1989) and projected forwarded as a function of total mortality (fishing mortality and natural mortality) and annual recruitment. Prior information on the average total mortality of post-recruits over a range of years can be included in the model to provide guidance on the scale of fishing mortality, and, therefore, the scale of abundance. Recruitment each subsequent year is predicted as a function of the previous year, end-year (December 31) spawning stock biomass through a stock-recruit relationship, parameterized in terms of steepness, and lognormally distributed deviations from the expected relationship. Lognormal recruitment deviations on the log scale have a mean of zero and standard deviation that can be estimated or fixed. Lognormally distributed recruitment deviations are bias corrected for transformation from the log space. Beverton-Holt (1957) and Ricker (1954) forms are options for the stock-recruit relationship. A beta prior distribution on steepness of the stock-recruit relationship and spawning stock biomass estimates are new options included for this assessment. Female spawning stock biomass, as opposed to female spawning stock abundance in the blue crab assessments, is assumed to be a proxy for spot reproductive capacity. Recruits that survive their first year (y) join the post-recruits the following year (y+1) and survive as part of subsequent post-recruit abundances (y+1+n) according to the annual total mortality. Initial full, or apical, fishing mortality is an estimated parameter and fishing mortality each subsequent year is estimated as a freely varying deviation from the initial fishing mortality (i.e., deviation vector not restricted to a mean of zero) to allow for freely trending fishing mortality over time (VanderKooy 2013), particularly due to the declining trend in shrimp trawl discards through the first part of the time series. There are no index of abundance data after the terminal year to tune the terminal year fishing mortality estimate, so the terminal year fishing mortality is equal to the geometric mean of the previous two years fishing mortality estimates.

Predicted indices of abundance are calculated as a function of model estimated abundances during the annual timing of the surveys and derived catchability coefficients and compared to observed indices of abundance as a lognormal likelihood component of the objective function. Predicted catch-at-stage is calculated with the Baranov catch equation (i.e., continuous catch throughout the year; Baranov 1918) as a function of the model estimated fishing mortality, then summed across stages, and compared to the observed total fishery removals as a lognormal likelihood component of the objective function. Other components of the objective function include recruitment deviations from the expected stock-recruit relationship, and prior distributions for steepness and average total mortality. Likelihoods components can be either directly weighted by adjusting the weighting "lambdas" or by adjusting input error for data observations (i.e., CVs).

6.2.2 Reference Point Model Description

Static spawning potential ratios (sSPR), fishing mortality rates and spawning stock biomasses at reference sSPRs (e.g., F40% and SSB40%), and MSY-based reference points are calculated from population model estimates (Table 91). sSPR is calculated as the ratio of spawning stock biomass per recruit experiencing annual fishing mortality to the unfished spawning stock biomass per recruit. Fishing mortality rates at sSPRs ranging from 20-40% were calculated, as these are common sSPR reference levels to approximate MSY (Appendix 6). Being a function of annual fishing mortality, the terminal year sSPR is calculated from the geometric mean fishing mortality from the two years prior to the terminal year. Spawning stock biomass reference points associated with reference sSPRs are calculated by projecting the population dynamics to equilibrium under the reference fishing mortality rate and annual recruitment randomly sampled from the model estimated recruitments. These biomass reference points are calculated under the assumption that recruitment estimates being sampled are representative of equilibrium recruitment levels of a stock fished at the reference fishing mortality rate over time. If recruitment estimates are biased low, biomass reference points would be biased low and vice versa. MSY-based reference points include MSY, F_{MSY}, the exploitation rate at MSY (U_{MSY}), and female spawning stock biomass at MSY (SSB_{MSY}). MSY-based reference points are estimated by calculating reference points at a range of F values (0.00-6.00 at increments of 0.01) and finding the fishing mortality rate that maximizes catch in equilibrium conditions, given the model estimated stock-recruitment relationship and yield per recruit calculations.

6.2.3 Configuration and Data

Fishery removals in numbers were aggregated across recreational fisheries (harvest and dead releases from Florida-Connecticut) and commercial fisheries (marketable landings from Florida and South Carolina-New Jersey, scrap landings from North Carolina and Virginia, shrimp trawl dead discards from Florida-North Carolina, and Mid-Atlantic gillnet and trawl dead discards from North Carolina-New York) into one 'fleet'. Total removals are in Table 73 and Figure 58. Removal percentages by fishery are in Figure 59. CVs for removal data were assumed to be 0.05.

Indices of abundance from two surveys, the NCDMF Trawl and NMFS Trawl Surveys, were developed for both stages, resulting in four indices of abundance. Indices were developed from catch in numbers and standardized to means. Indices from the NCDMF Trawl Survey were developed using a length cutoff and indices from the NMFS Trawl Survey were developed by applying an ALK borrowed from the NEAMAP Trawl Survey. These surveys parallel each other along the Atlantic coast, sampling fish as they move from inshore areas (NEAMAP) to offshore areas (NMFS). The NCDMF Trawl Survey indices were developed from June observations only and were compared to model estimated abundance at the middle of June (46% of the year past). The NMFS Trawl Survey indices were developed from fall observations (Sep-Oct) and were compared to model estimated abundance at the end of September (75% of the year past). Both surveys occurred throughout the model time series. Index CVs were derived from design-based estimation of catch rate means and variances. Indices of abundance and CVs are in Table 77, Table 78, Figure 60 and Figure 66. See Section 5 for more details on surveys and development and selection of indices.

Natural mortality-at-stage was fixed at estimates generated from weight-based methods of Lorenzen (2005) and was assumed time-invariant. The natural mortality of post-recruits is an average from ages 2-6 (Section 2.7.2). Post-recruits are assumed fully selected. Partial selectivity of recruits (relative to post-recruits) was fixed at 0.43 and assumed time-invariant. This value was developed by comparing length frequencies of fishery-independent surveys and fishery-dependent sampling from the various fisheries. The effects of each fishery on the overall selectivity (i.e., weighting) were determined by the relative magnitude of the respective fishery's removals to total removals (Appendix 7). Prior information on the average total mortality of post-recruits from 1996-2013 estimated from catch curve analysis (Appendix 8) was updated through the likelihood framework according to data informing fishing mortality estimates in the model. The CV on this prior information was assumed to be 0.05 to anchor the model estimates near the observed total mortality while allowing some flexibility (VanderKooy 2013). Maturity of recruits was estimated from a logistic regression and maturity of post-recruits was assumed to be one (Section 2.6.2). There is variability in information on the maturity of age-1 fish, but most supports age-1 spot maturing by the end of the year (time of spawning in the model). There is also variability in information on sex ratios. The only literature estimate of population sex ratio (female:male) is from the Gulf of Mexico and is 1. Estimates from fishery-independent data from the Atlantic coast range between 1 and 2.79 (Section 2.6.3). Ratios also vary by age and month. Fishery-dependent data are more indicative of a skewed sex ratio in the commercial landings, though there are no sex data from the shrimp trawl observer data. Given the variability of the estimates and the lack of sex data from the shrimp trawl fishery, sex ratios of the population and removals are assumed to be 1. Peak spawning is assumed to occur at the end of the calendar year and recruitment is assumed related to spawning stock biomass from the subsequent year through a Beverton-Holt stock-recruit relationship. The CV of the lognormal error around the expected recruitment was fixed at 0.66 (sd on log scale=0.6) based on a meta-analysis by Beddington and Cooke (1983). Prior information on the steepness of the stock-recruit relationship for spot from a meta-analysis (Appendix 9) was updated through the likelihood framework according to data informing estimation of this parameter in the model. The steepness prior was a beta distribution with parameters p=3.05 and q =1.73 (mean=0.64, CV=0.32). Mean weight-at-stage for spawning stock biomass calculations was developed from the NEAMAP Trawl Survey (Table 92), the only broad regional survey with multiple years of age data, and is assumed time-invariant. No significant differences ($p<0.05$) among annual mean weight within each stage were detected with analysis of variance (ANOVA) for these data (Table 93). Assumed inputs are summarized in Table 88.

There are five leading parameters and forty nine deviations estimated (denoted by ^ in Table 89) from 130 data points, not including CVs, and two priors. All parameters and deviations are estimated in the log space.

6.2.4 Weighting of likelihoods

The methods of Francis (2011) were originally implemented until it was discovered that data conflicts required extreme down weighting of index data, to the point of being uninformative, to achieve standard deviations of standardized residuals (SDSRs) near one. To acknowledge process error, the methods of Francis (2003) were ultimately adopted by adding 0.2 to index CVs representing measurement error (Table 94). This weighting was chosen as the preferred weighting, as the model fit to data with this weighting was deemed a better fit than the model fit to data with weighting that did not acknowledge process error (see next section).

6.2.5 Evaluation of Model Fit

The objective function is minimized to find best fit parameter estimates. Goodness of fit was evaluated by inspecting residuals from model predictions of observed data. Evaluation included visual inspection of residual plots, comparing means of standardized residuals to zero with a t-test, comparing sum of squared residuals (SSR), testing for normality of standardized residuals with a Shapiro-Wilk test, and testing for trends in residual signs (positive or negative) with respect to time with a runs test. Ideal results of evaluation were minimized SSR and normally distributed standardized residuals with no trends or means significantly different than zero. Focus was on fits to index of abundance data as Francis (2011) recommends that these data should have primacy in model fitting.

6.2.6 Characterizing Uncertainty

6.2.6.1 Asymptotic standard errors

The delta method within ADMB was used to generate asymptotic standard errors and CVs of key model parameters and derived values.

6.2.6.2 Sensitivity analysis

Sensitivity of the base model to key assumptions and data choices was evaluated by comparing results of alternative model configurations to the base model. Changes for sensitivity configurations relative to the base model are described below and summarized in Table 95. Each sensitivity configuration will be referred to by the name of the configuration in bold below. Four sensitivities focused on shrimp trawl discard estimates because these made up such a large component of the total removals; the model time series was changed to start in 1992 to exclude the relatively large discard estimates in 1990 and 1991 (**1992 start year**), the relatively large discard estimates were changed to equal the median shrimp trawl discard estimate during years when BRDs were not uniformly required (*259 million fish*; **adjust shrimp discards**), and all shrimp trawl discard estimates were scaled down to 10% (**10% shrimp discards**) and 50% (**50% shrimp discards**) of the base model estimates. The adjusted time series of removals for the sensitivity configurations, where applicable, and the base model time series of removals are in Figure 77. Two sensitivity configurations focused on the assumption about the recruit selectivity relative to post-recruit selectivity; the selectivity was estimated in the model which resulted in an estimate lower than the value assumed for the base model (*0.306*; **low selectivity**) and the selectivity was fixed at the value assuming recruits are vulnerable to fishing mortality for three quarters of the year which was higher than the value assumed for the base model (*0.645*; **high selectivity**). The analysis in Appendix 7 indicates that recruits are not even partially vulnerable to fishing mortality for at least the first few months of the calendar year, so this high value is regarded as the extreme upper bound on selectivity. Though the model estimated a reasonable selectivity for recruits, it was not estimated in the base model because the estimate fluctuated drastically across sensitivity runs and retrospective runs, often being estimated at a bound. Four sensitivity configurations focused on assumptions about mortality; natural mortality was developed using the upper and lower 95% confidence intervals on growth model parameters resulting in a lower natural mortality (*0.537 for recruits and 0.389 for post-recruits*; **low M**) and higher natural mortality (*0.550 for recruits and 0.405 for post-recruits*; **high M**), a prior on total mortality using fishery-dependent data only in catch curve analysis was used for a lower prior scenario (*1.157*; **FD Z prior**), and a prior on total mortality using a weighted catch curve with combined fishery-independent and fishery-dependent data was used for a higher prior scenario (*1.613*; **wt comb Z prior**). Six sensitivity configurations focused on choices and treatment of index data; no adjustments were made to original index CVs to incorporate process error (**no reweight**), the NMFS Trawl Survey indices for both stages were excluded from the model (**no NMFS trawl**), the NCDMF Trawl Survey indices for both stages were excluded from the model (**no NC DMF trawl**), the NEAMAP Trawl Survey indices for both stages were included in the model (**add NEAMAP trawl**), and catchability coefficient of the recruit NMFS Trawl Survey index was allowed to vary after 2004 (**change in NMFS recruit q in 2005**) and after 2008 (**change in NMFS recruit q in 2009**). Catchability was allowed to vary in 2005 based on visual inspection of the trend in residuals for the fit to this index in the base model and in 2009 due to the change of vessel conducting the survey. The final four sensitivity configurations focused on assumptions or treatment of aspects relating to the stock-recruit relationship; the steepness was fixed at 0.99 to specify an uninformative stock-recruit relationship (**h = 0.99**), the steepness was fixed at the mode value estimated in the steepness prior analysis (**h = 0.79**), the mean weight-at-stage used to calculate spawning stock biomass was developed from biological sampling of North Carolina commercial landings (**NCDMF comm mean wts**), and the population sex ratio was changed to 1.62, the value from combined fishery-independent data (**sex ratio**). The sex ratio only affects the stock-recruit parameters and spawning stock biomass estimates, so results from the configuration are only included for the spawning stock biomass estimate comparison. The reweighting methods of Francis (2003) were used for all sensitivity configurations to adjust the input CVs for indices of abundance, with the exception of the **no reweight** sensitivity configuration.

6.2.6.3 Retrospective analysis

A retrospective analysis was completed by comparing base model estimates to model estimates with up to five years of data removed from the end of the time series. A modified (i.e., averaged differences as opposed to summed differences among estimates) Mohn's Rho (Mohn 1999) was calculated for sSPR, fishing mortality, recruitment, and spawning stock biomass estimates. Retrospective plots were visually inspected and modified Mohn's Rhos were compared to general rule of thumb values for modelling short-lived species proposed by Hurtado-Ferro et al. (2015) to identify a retrospective bias.

6.2.6.4 Markov Chain Monte Carlo Simulation

Markov chain Monte Carlo (MCMC) sampling algorithms implemented in ADMB were used to sample from the posterior distribution of bounded model parameters.

6.2.6.5 Likelihood profiles

Likelihood profiling capabilities within ADMB were used to develop likelihood profiles for key unbounded derived values.

7. Results

7.1 Assessment Models

7.1.1 Surplus Production Model

7.1.1.1 Goodness of Fit

The surplus production model fit the NMFS Trawl and SEAMAP Trawl relative biomass indices reasonably well (Figure 78 and Figure 79), although there were concerns about how the model was not capturing the dynamics of the terminal year when abundance indices declined but the estimates in the model did not.

7.1.1.2 Parameter Estimates (include precision of estimates)

The surplus production model estimated that relative biomass (B/B_{MSY}) has been increasing steadily since 1999, the lowest point in the time series. B/B_{MSY} has been above 1.0 since 2006 and the largest relative biomass was in 2011 (Table 96, Figure 80). Relative fishing mortality (F/F_{MSY}) fluctuated in the early part of the time series but has been on decline since the late 1990s. F/F_{MSY} has been below 1.0 since 2002 and the lowest relative fishing mortality was in 2010.

7.1.1.2.1 Exploitation Rates

The surplus production model estimated total fishing mortality throughout the time series (Table 96, Figure 80). Fishing mortality was high and variable from the late 1980s through early 1990s, with the highest fishing mortality occurring in 1991. Since the late 1990s, fishing mortality has steadily declined.

7.1.1.2.2 Abundance or Biomass Estimates

The surplus production model estimated the average biomass (Figure 81). The results showed that the biomass decreased in the middle of the time series but began increasing in the late 1990s to high levels from 2009-2014.

7.1.1.3 Sensitivity Analyses

For sensitivity analyses, adding the NEAMAP Trawl Survey as an additional relative biomass index, abbreviating the time series to 1992-2014, omitting the SEAMAP Trawl Survey index, and performing the analysis in Excel resulted in reference point estimates that were on the same scale as the base run (Table 97**)**. Additionally, ASPIC includes a feature where the exponent can be estimated by the model directly to explore the utility of the Fox or Pella-Tomlinson formulations. The model estimated the parameter to be n=2.35 which was not significantly different from the logistic model (*P*=0.42). Overall, the SAS found the surplus production model to be stable based on these sensitivity runs. Additionally, no sensitivity run found $B2014/B_{MSY}$ to be less than one or $F2014/F_{MSY}$ to be greater than one.

7.1.1.4 Projection Estimates

The population was projected forward for 10 years (2015-2025) at a harvest level equal to 2014 landings of 9,492 metric tons. In the projections, relative biomass and fishing mortality remained stable under current conditions (Figure 82 and Figure 83).

7.1.1.5 Reference Point Model(s)

The estimates of the reference points for the base run of the surplus production model can be found in Table 97 along with the results from the sensitivity runs. In 2014, fishing mortality was 0.0884 and average biomass was 107,300 metric tons. Relative fishing mortality ($F2014/F_{MSY}$) was 0.1824 and has been less than one since 2002. Relative biomass ($B2014/B_{MSY}$) was 1.8610 and has been greater than 1 since 2006.

7.1.2 Modified-CSA Model

7.1.2.1 Goodness of Fit

The model converged on a solution (i.e., positive definite Hessian matrix) with a maximum final gradient of 1.6059e-004. Measures of model fit are in Table 98. The removals are fit well (Figure 84). Residuals for indices generally exhibited the desired properties, though there were some trends in residuals with respect to time for fits to the post-recruit NCDMF Trawl Survey and recruit NMFS Trawl Survey indices, as well as non-normality of the standardized residuals for the fit to the post-recruit NMFS Trawl Survey index (Table 98, Figure 85-Figure 88). Trends in residuals for the fit to the post-recruit NCDMF Trawl Survey index appear to be driven by conflicting signals and the model’s tendency to fit closer to the post-recruit NMFS Trawl Survey index due to smaller CVs for the latter. This was thought to be the cause of the trend in residuals in the recruit NMFS Trawl Survey index, as the SDSRs of other indices tended to decrease as the recruit NMFS Trawl Survey index was downweighted. However, late in the assessment process, it was determined that the trend is removed by allowing time-varying catchability for this survey.

7.1.2.2 Parameter estimates

7.1.2.2.1 Leading Parameters and Deviations

Model parameter estimates are in Table 99.

Steepness of the stock-recruit relationship was estimated close to the upper bound (0.98), despite the prior information on this parameter. Unfished spawning stock biomass was estimated at 36,086 metric tons. Given the model’s tendency to estimate steepness of the stock-recruit relationship close to the upper bound, the SAS recommends using SPR-based reference points and MSY-based reference points are not reported here. The SAS does believe there is an underlying relationship between recruitment and spawning stock biomass. However, the data do not support reliable estimation of this relationship.

7.1.2.2.2 Abundance and Spawning Stock Biomass

Both recruitment (914 million fish) and post-recruit abundance (654 million fish) are relatively high in 1989 (Table 100, Figure 89-Figure 91). Recruitment remains high through 1991 as post-recruit abundance steadily declines. Total abundance is highly variable through the mid-1990s as recruitment fluctuates drastically. Recruitment and total abundance hit a time series low in 1997. Recruitment and post-recruit abundance then fluctuate around an increasing trend through 2013, with the exception of several subsequent poor recruitments from 2006-2009. The 2014 recruitment was relatively poor resulting in a decline in total abundance, despite increasing post-recruit abundance. Post-recruit abundance in the end of the time series has increased close to levels at the beginning of the time series, while recruitment in recent years (excluding the terminal year) has increased to about half the magnitude of peak recruitments at the beginning of the time series.

Spawning stock biomass follows a similar trajectory as total abundance, generally increasing since 1996 with the exception of the lowest spawning stock biomass of the time series in 2001 (Table 100, Figure 92). There was a slight down turn of spawning stock biomass in 2014, but the estimate was still the second highest of the time series. Post-recruit abundance is a larger component of the total abundance in recent years, resulting in higher spawning stock biomass than during periods of high abundance early in the time series.

7.1.2.2.3 Fishing Mortality and Static Spawning Potential Ratio

Initial fishing mortality was estimated at 1.06 and increased steeply in the next two years (Table 101 and Figure 93). Full fishing mortality then generally fluctuates around a declining trend throughout the time series. There are some exceptionally large peaks in fishing mortality due to upticks in removals, notably in 1991, 1995, and 2001. Full fishing mortality has remained below 0.50 since 2005. The average total mortality from 1996-2013 (1.198) was estimated lower than the prior information (1.356). As an inverse function of fishing mortality, sSPR has fluctuated around an increasing trend throughout the time series (Table 101,Figure 94). Very low sSPR occurred in the beginning of the time series, when shrimp trawl discards were highest, and during years with large peaks in fishing mortality. sSPR has fluctuated around a mean over the last five years (0.48) about seven times greater than the mean sSPR during years when BRDs were not required (0.07; 1989-1995).

7.1.2.2.4 Reference Points

Fishing mortality rates associated with sSPR reference levels (20-40%) are in Table 102. Fishing mortality reference points range from 0.74 (F20%) to 0.36 (F40%).

7.1.2.3 Uncertainty

7.1.2.3.1 Asymptotic Standard Errors

Asymptotic standard errors of model parameters are in Table 99. CVs derived from asymptotic standard errors of model derived population estimates are in Table 100 and Table 101.

Confidence intervals of model derived population estimates are in Figure 90-Figure 94. Estimates of full fishing mortality, sSPR, recruitment, and post-recruit abundance are relatively precise, with mean CVs of 0.11, 0.12, 0.12, and 0.13, respectively. Precision of sSPR estimates tend to increase through time, while precision of recruitment and fishing mortality estimates tends to decrease (Figure 95, Figure 98, and Figure 99). Precision of post-recruit abundance remains relatively stable (Figure 96). CVs are slightly larger for spawning stock biomass estimates, averaging 0.16, though still indicative of relatively precise estimates. Precision of spawning stock biomass estimates is relatively stable with time (Figure 97).

7.1.2.3.2 Sensitivity Analysis

Estimates from sensitivity configurations generally follow the same trend (Figure 100-Figure 119). The **no reweight** configuration estimates a much lower sSPR in 2013 than other configurations due to the model fitting more closely to the NMFS Trawl Survey indices that indicate a sharp decline in abundance over the final two years. As expected, the sensitivities scaling down the shrimp trawl discards estimates (**10% shrimp discards** and **50% shrimp discards**) scaled down abundance. The trend in abundance and the trend and magnitude in fishing mortality and sSPR estimates are relatively insensitive to these changes. The **adjust shrimp discards** configuration results in much smaller recruitment estimates in the years of adjusted removals (1990 and 1991), as lower abundance is expected by the model to account for the reduced removals. Similarly, scaling the selectivity of recruits up (**high selectivity**), scales recruitment and spawning stock biomass down, scales the fishing mortality up, and scales the sSPR estimates down. The most variability in model estimates occurs due to treatment of the indices. This was not to be unexpected, given the somewhat contradictory trends between indices. Most estimates follow the same trend as the base run with some exceptions (i.e., 2013 estimates from the **no reweight** configuration and 1989 estimates from **no NMFS trawl** configuration). Model estimates are relatively insensitive to other configuration changes.

Being per-recruit reference points, the FSPR% reference points are only affected when an input of the per-recruit calculations is changed (e.g., natural mortality; see Table 91). Though a few sensitivity configurations estimate a terminal sSPR below the 95% confidence interval of the base model and the recommended target, all but one (**high selectivity** configuration) estimate the terminal sSPR to be above the threshold (see Section 8.1 for discussion on reference points and Table 103 for F30% threshold estimates). The **high selectivity** configuration is considered an unlikely scenario and represents the extreme upper bound on recruit selectivity.

7.1.2.3.3 Retrospective Analysis

Retrospective plots (Figure 120-Figure 123) show some patterning in estimates, though a consistent retrospective bias is disrupted by estimates from the configuration with 2011 as the terminal year (i.e., three year peel). These estimates reverse trend from the other peels (i.e., underestimates abundance, overestimates fishing mortality). The modified Mohn's Rhos are in Table 104. Modified Mohn's Rho for spawning stock biomass and fishing mortality fall near the bounds proposed by Hurtado-Ferro et al. (2015; -0.22-0.30) as a rule of thumb for values to be concerned about for short-lived species. The value for recruitment estimates exceeds the upper bound, but is driven by the large overestimate in the three year peel model. Dropping this run results in a modified Mohn's Rho (0.27) below the proposed upper bound. Steepness was consistently estimated near the base model estimate from each peel (Table 105).

7.1.2.3.4 MCMC

Two million MCMC samples were drawn from posterior distributions with a burn-in of one thousand samples and a thinning rate of one thousand samples. Samples showed low autocorrelation for the initial condition parameters, but high autocorrelation for parameters of the stock-recruit relationship (steepness, unfished spawning stock biomass; Figure 124-Figure 138). Trace plots indicate stable posterior distributions being sampled for the initial condition parameters, but the presence of a secondary stable region being sampled for the parameters of the stock-recruit relationship. These secondary regions are small relative to the primary stable region being sampled and do not result in bimodality of the density distributions, just more skewed distributions. A similar situation was observed in VanderKooy (2013) for the Western Gulf of Mexico stock.

Autocorrelation is not reduced by increasing the length of the chain (i.e., five million samples with a burn-in of one thousand samples and a thinning rate of one thousand samples; Figure 139 and Figure 140). Autocorrelation is reduced by increasing the thinning rate to ten thousand (Figure 141 and Figure 142), though it is debatable if this is an appropriate solution to approximate precision of the posterior distribution (Link and Eaton 2012). Autocorrelation in the unfished spawning stock biomass estimate is reduced to similar levels as those seen for the initial condition parameters (Figure 143) by fixing steepness and further supports the SAS's recommendation to use SPR-based reference points.

7.1.2.3.5 Likelihood Profile

Likelihood profiling of the terminal year sSPR shows a near identical distribution to the distribution from the asymptotic standard errors (Figure 144).

7.1.2.4 Discussion

The population dynamics predicted with the modified-CSA are heavily influenced by the relatively large magnitude of dead discard estimates from the South Atlantic shrimp trawl fisheries. The decline and stabilization of these discards paired with increasing trends in relative abundance in recent years suggest that the stock is responding favorably to increased regulations in the shrimp trawl fisheries (i.e., requirement of BRDs), which is supported by the model estimates. Though the modified-CSA does generally fit the data well, there are some areas that should serve as focal points for future assessments to improve fits and inconsistencies in the model estimates.

There was borderline indication of retrospective bias, according to general rules of thumb proposed by Hurtado-Ferro et al. (2015). These rules of thumb for short lived species were developed from Pacific sardine with a maximum age of fifteen and the authors note that as species longevity decreases and variability in species dynamics increase, Mohn's rho values and thresholds for concern are expected to increase. Spot have a maximum observed age of six, suggesting that appropriate threshold values for Mohn's rho may be larger than those for a species with a life history similar to Pacific sardine. Hurtado-Ferro et al. (2015) also point out that when biomass is high, the case here for spot, a retrospective pattern may be less problematic and the model results may be less risky for advising management than if biomass were low (i.e., near or below a management threshold). Nonetheless, the direction of the pattern in this assessment (i.e., systematic overestimation of biomass and underestimation of fishing mortality) is of higher concern, from a conservation perspective, and this retrospective pattern should be carefully evaluated in future assessments (Hurtado-Ferro et al. 2015).

Causes of this pattern, though often difficult to pinpoint, should be further explored. Much of this pattern could be due to conflicts in the index of abundance data and the potential change in catchability evaluated with sensitivity analysis. The SAS believes that the indices of abundance from multiple surveys used in the base model represent the coastwide signal of relative abundance better than indices from either survey individually. There were some preliminary attempts to combine the indices into a single index using the methods of Conn (2010), but little effect was observed and the method was not pursued further. The SAS also investigated changing catchability due to improvements in model fit, but believe it is most appropriate to retain time-invariant catchability, given the principal investigators of the survey have calibrated the indices based on side-by-side tow comparisons (Miller et al. 2010). If other causes of a changing catchability can be corroborated (i.e., climate change), modelling these changes would be more defensible.

There is also suspected influence form environmental conditions, particularly temperature, on spot mortality. No appropriate data were identified for this assessment, but identification and incorporation of environmental data time series in future assessment could improve the model's ability to differentiate environmental and density-dependent effects on year class strength. The model results are dependent and sensitive to the assumed selectivity of recruits, as seen with sensitivity analysis. The SAS used the best available estimates, but if additional information becomes available to update this estimate, it would serve future assessments well.

7.1.3 Comparison of Results and Model Selection

The general trends in population estimates from the base surplus production and base modified-CSA models are similar and verify the general dynamics of the stock over the modelled time series, given the input data. It is important to note that there are some major differences between the model estimates and comparison of the magnitude of estimates is not particularly informative. Rather, the objective of the comparison is to check trends in similar estimates provided by two models characterized by very different structures and assumptions. The fishing mortality estimates are in terms of different units (biomass for the surplus production model and numbers for the modified-CSA), but suggest very similar exploitation patterns (Figure 145). The biomass estimates are also in terms of different units (total exploitable biomass for the surplus production model and mature female biomass for the modified-CSA model), but also suggest similar patterns in the response of the reproductive capacity of the stock to exploitation over time (Figure 146). The surplus production model estimates a slower decline in fishing mortality through the 1990s and a slightly more pronounced decline in fishing mortality and increase in biomass in the late 2000s and 2010s.

The modified-CSA is able to incorporate some population structure, allowing more fine-scale changes to be estimated relative to the surplus production model (i.e., high interannual variability in the abundance estimates). The modified-CSA model appears to better capture the interannual variability in abundance and fishing mortality observed from the stock, as indicated by the input data. These different patterns may be due to the surplus production model being more rigid and restrictive, as a function of the constant intrinsic growth rate parameter, in allowing large swings in abundance that occur for stocks like spot that only consist of a few year classes. The terminal year spawning stock biomass estimate from the modified-CSA is more reflective of the decline in relative abundance observed in the indices. Given these points, the SAS recommends the modified-CSA as the preferred modelling approach to inform stock status.

8. Stock Status

8.1 Current Overfishing, Overfished/Depleted Definitions

There are currently no stock status definitions for the Atlantic coast spot stock. The SAS compiled a review of SPR-based reference points (Appendix 6) and recommends an overfishing threshold associated with a 30% sSPR (F 30%) and a fishing target associated with a 40% sSPR (F 40%). These reference point values tend toward precautionary values, acknowledging the potential for high interannual variability in recruitment with an unknown effect from environmental factors and the short life history of spot. Given that sSPR is a per-recruit reference point, a decline in recruitment and/or spawning stock biomass over even a short period could result in adverse impacts to stock condition even if the stock is maintained at relatively high sSPR levels (i.e., greater than the target). Therefore, the SAS also recommends the equilibrium spawning stock biomass resulting from fishing at F 30% and the recruitment levels estimated from 1996-2014 (Table 100) as a spawning stock biomass threshold and the equilibrium spawning stock biomass resulting from fishing at F 40% and the recruitment levels estimated from 2003-2014 (Table 100) as a spawning stock biomass target. The years 1996-2014 and 2003-2014 were chosen as they correspond with the stock fished, on average, at 30% sSPR and 40% sSPR, respectively (Table 101). These years also correspond with the period when BRD requirements were generally implemented and the shrimp trawl discards were at relatively stable levels. Randomly sampled recruitments for the spawning stock biomass threshold and target projections are in Table 106 and Table 107, respectively. Projected spawning stock biomasses and the median over the time series (reference point estimate) are in Figure 147 and Figure 148.

8.2 Stock Status Determination

Based on the recommended reference points, overfishing of the Atlantic coast spot stock did not occur in 2014 and the stock was not overfished. The 2014 full fishing mortality is estimated at 0.249, below the threshold (0.5) and target (0.36). The 2014 sSPR is estimated at 0.507, above the recommended threshold (0.30) and target (0.40). The 2014 beginning year spawning stock biomass (2013 end year SSB) is estimated at 19,032 metric tons, above the recommended threshold (4,730 metric tons) and target (7,854 metric tons). Based on MSY reference points and generic thresholds, the surplus production model status determination (B_{2014}>B_{MSY} and

$F_{2014}<F_{MSY}$) was the same as the modified-CSA determination. This stock status determination is reasonable, given the significant decline of discards in the shrimp trawl fishery and the recent increases in relative abundance observed across indices of abundance.

8.3 Comparison of Assessment Results to the Traffic Light Analysis

The TLA was compared to the assessment results to determine the utility and reliability of using the TLA to inform stock status. The TLA is currently used to inform stock status and the modified-CSA within this assessment is proposed to inform stock status moving forward on an intermittent basis according to future stock assessment schedules. However, the TLA has the potential to inform stock status in the future between stock assessments, so it is important to understand how the approaches compare and contrast. Some additional metrics were developed with the TLA framework (i.e., total fishery removals) to permit comparisons to the modified-CSA results (Appendix 1).

The pattern in the estimates of spawning stock biomass from the modified-CSA model are in agreement with the established abundance metric of the TLA (i.e., adult abundance from the regional SEAMAP Trawl and NMFS Trawl Surveys). Treating spawning stock biomass above the target (not overfished) the same as a TLA proportion red less than 30% (no concern), spawning stock biomass between the target and threshold (not overfished, but below the target) the same as a TLA proportion red between 30% and 60% (moderate concern), and spawning stock biomass below the threshold (overfished) the same as a TLA proportion red greater than 60% (significant concern), the two approaches agree 65% of the time (Table 108, Figure 149). The status from the two approaches is not the opposite (i.e., overfished vs. no concern or vice versa) for any years. The TLA is more conservative in the final two years, suggesting moderate concern, whereas the modified-CSA suggests no concern. There is no recruitment reference point estimated by the modified-CSA, but a qualitative comparison suggests the annual recruitment estimates match the TLA YOY abundance metric proportions well in many years (Figure 150). Specifically, the two approaches agree on relatively weak year classes in 1992, 1995-1996, 1998, 2001, 2003, 2006-2007, and the terminal year (2014). The approaches agree on relatively strong year classes in 1994 and 2010. Notable disagreements occurred for 1989-1991, 1997, 2005, 2011 and 2013. Some of these differences are not surprising given different indices are used in the two approaches and high interannual variability common in juvenile abundance indices.

The harvest metrics from the TLA are not in as close agreement with the modified-CSA sSPR estimates. The established harvest metric from the TLA, as the name suggests, does not include discard information, as there was not a time series of discard estimates established for the TLA. The modified-CSA estimates total fishing mortality across fisheries. Treating sSPR above the target (not overfishing) the same as a TLA proportion red less than 30% (no concern), sSPR between the target and threshold (not overfishing, but above the target) the same as a TLA proportion red between 30% and 60% (moderate concern), and sSPR below the threshold (overfishing) the same as a TLA proportion red greater than 60% (significant concern), the two approaches only agree 15% of the time (Table 109, Figure 151). This is not surprising considering the high proportion of fishery removals used in the modified-CSA attributed to shrimp trawl discards. This is improved slightly when all removals are added to the TLA metric, with agreement 26% of the time (Table 109).

This assessment supports the utility of these analyses as approaches for informing the condition of stock abundance, but highlights the need to further evaluate the incorporation of discards into a fishery removal metric to be used as a comprehensive indicator of fishing pressure between stock assessments with TLA. Given that abundance and fishing mortality are correlated, the abundance measures from both approaches generally agree, and that the abundance and fishing mortality are not independently estimated in the modified-CSA, the harvest metric from the TLA appears to be in disagreement with the other components of the comparison. A potential area of focus could be the appropriate weighting of discards relative to other fishery removals.

9. Research Recommendations and Future Assessments

9.1 Research Recommendations

Short-term

HIGH PRIORITY

- Expand collection of life history data for examination of lengths and age, especially fishery-dependent data sources.
- Organize an otolith exchange and develop an ageing protocol between ageing labs.
- Increased observer coverage for commercial discards, particularly the shrimp trawl fishery. Develop a standardized, representative sampling protocol and pursue collection of individual lengths and ages of discarded finfish.

MEDIUM PRIORITY

- Develop and implement sampling programs for state-specific commercial scrap and bait fisheries in order to monitor the relative importance of Spot. Incorporate biological data collection into program.
- Conduct studies of discard mortality for commercial fisheries. Ask commercial fishermen about catch processing behavior for Sp/Cr when trawl/gillnets brought over the rail.
- Conduct studies of discard mortality for recreational fisheries.
- Collect data to develop gear-specific fishing effort estimates and investigate methods to develop historical estimates of effort.

Long-term

HIGH PRIORITY

- Continue state and multi-state fisheries-independent surveys throughout the species range and subsample for individual lengths and ages. Ensure NEFSC trawl survey continues to take lengths and ages. Examine potential factors affecting catchability in long-term fishery independent surveys.

- Continue to develop estimates of length-at-maturity and year-round reproductive dynamics throughout the species range. Assess whether temporal and/or density-dependent shifts in reproductive dynamics have occurred.
- Re-examine historical ichthyoplankton studies for an indication of the magnitude of estuarine and coastal spawning. Pursue specific estuarine data sets from the states (NJ, VA, NC, SC, DE, ME) and coastal data sets (MARMAP, EcoMon).

MEDIUM PRIORITY

- Identify stocks and determine coastal movements and the extent of stock mixing, via genetic and tagging studies.
- Investigate environmental and recruitment/ natural mortality covariates and develop a time series of potential covariates to be used in stock assessment models.
- Investigate environmental covariates in stock assessment models, including climate cycles (e.g., Atlantic Multi-decadal Oscillation, AMO, and El Nino Southern Oscillation, El Nino) and recruitment and/or year class strength, spawning stock biomass, stock distribution, maturity schedules, and habitat degradation.
- Investigate the effects of environmental changes (especially climate change) on maturity schedules for spot, particularly because this is an early-maturing species, and because the sSPR estimates are sensitive to changes in the proportion mature.
- Investigate environmental and oceanic processes in order to develop better understanding of larval migration patterns into nursery grounds.
- Investigate the relationship between estuarine nursery areas and their proportional contribution to adult biomass. I.e., are select nursery areas along Atlantic coast ultimately contributing more to SSB than others, reflecting better quality juvenile habitat?
- Develop estimates of gear-specific selectivity.

9.2 Recommendation for Timing of Future Stock Assessments

The SAS and PRT recommend that the next assessment be completed five years from the completion of this assessment (i.e., 2022). Though the completion of the spot and Atlantic croaker assessments together was useful for this first assessment of spot, the SAS and PRT recommend a staggered schedule for future spot and Atlantic croaker assessments due to the overlap in personnel.

10. Minority Opinion

There was no minority opinion submitted by any member(s) of the SAS or PRT.

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12. Tables

Table 1. History of Atlantic state regulations specific to spot.

SC	Aggregate bag limit of 50 fish per person per day for small Sciaenidae species for com and rec hook and line gear	2014
FL	Default bag limit for unregulated species is 2 fish or 250 pounds per person per day-whichever is more.	1987
FL	Default bag limit for unregulated species is 2 fish or 100 pounds per person per day-whichever is more.	1989

Table 2. Additional Atlantic state regulations affecting the harvest and bycatch of spot.

State	Regulation	Date
NJ	Weakfish gill-net and pound-net seasonal closures established and trawl minimum mesh reduced (3” diamond)	1992
	Weakfish trawl seasonal closure established, gill-net seasonal closure lengthened, and trawl minimum mesh increased (3.25”)	1995
DE	Weakfish gill-net minimum mesh size (3.125”) and seasonal closures affect the harvest of Atlantic croaker	1995
MD	Weakfish trawl minimum mesh increased to 3.375” square or 3.75” diamond and gill-net and trawl seasonal closure lengthened	1995
	Trawling prohibited in Chesapeake Bay and coastal bays, and within 1 mile of coastal shore	1933
VA	Trawling prohibited in all state waters	1989
	Weakfish commercial gear minimum mesh sizes increased and seasonal closures established or increased	1995

Table 2 *Continued*. **Additional Atlantic state regulations affecting the harvest and bycatch of spot.**

State	Regulation	Date
NC	Minimum mesh size restrictions in shrimp trawl (1.5” tailbag) and crab trawls (3.0”) established	Pre-1975
	Finfish trawling prohibited in internal waters; shrimp and crab trawls limited to 1,000 lb of incidental finfish bycatch per trip	1983
	Shrimp and crab trawls in inside waters limited to 500 lb of incidental finfish from December 1–February 28 and 1,000 lb from March 1–November 30	1991
	Catch of unclassified bait limited to 5,000 lb/vessel/day	1991
	Minimum mesh size restriction in shrimp trawls (1.5” tailbag) and crab trawls (3.0”); shrimp trawls prohibited areas established and headrope length limited to 90 ft	1991
	Fly net minimum stretched mesh size of 3.0” square or 3.5” diamond; fly nets defined as nets having the first body (belly) section consisting of 35 or more continuous meshes of 8.0” or greater (stretched mesh) webbing behind the bottom and top line, with tailbags less than 15 feet in length; tailbags constructed of square mesh may have the terminal 3 feet of mesh hung on a diamond with a minimum stretched mesh length of 2.0”	1992
	Bycatch reduction devices required in all shrimp trawls.	1994
	Fly nets prohibited in ocean waters from Cape Hatteras to NC/SC state line	1994
	Fly net vessels limited to 150 lb weakfish unless all fly nets onboard meet definition; gill nets limited to 150 lb weakfish unless mesh length > 2.875” stretched	1996
	Shrimp and crab trawls in Atlantic Ocean prohibited from possessing incidental finfish December 1–March 31 unless weight of the combined shrimp and crab catch exceeds weight of finfish	1997
	Small mesh (<5.0”) estuarine gill-net attendance requirement, May 1–November 30 in select areas in inside waters	1998
	Mandatory use of long haul cull panels and swipe nets south/west of a line from Bluff Point in Pamlico Sound to Ocracoke Island	1999
	Authorized gear allowed and restrictions applied to the Recreational Commercial Gear License; modified in 2008 to allow mechanical retrieval of shrimp trawl	1999
	Crab trawl minimum mesh size increased to 4” in western Pamlico Sound	2005
	Headrope length internally limited to 90 feet and shrimp trawl prohibited areas established	2006

Table 2 ***Continued*****. Additional Atlantic state regulations affecting the harvest and bycatch of spot.**

State	Regulation	Date
SC	Net ban	1987
	Turtle excluder devices required in shrimp trawls in summer	1988
	Turtle excluder devices required in shrimp trawls year-round	1991
	Bycatch reduction devices required in shrimp trawls	1996
GA	Gill nets prohibited (except for shad and diamondback terrapin)	1957
	All sounds closed to large trawl shrimp fishery; TEDs mandated	1990
	Bycatch reduction devices mandatory in large trawl shrimp fishery.	1996
FL	Entangling nets (e.g., trammel and gill nets) prohibited in all state waters	1995
	Directed finfish trawl prohibited; bycatch reduction devices mandatory	1996

Table 3. Biological data available for life history analyses in the spot stock assessment.

Type	Area	Source	Gear	Length-Weight Data	Age - Length Data	Sex Data	Maturity Data	Length Measured
Commercial	Maryland Chesapeake Bay	MD DNR	Pound Net	2008-2014 (n=3,448)	2007-2014 (n=1,354, ages 0-2)	2007-2014 (n=831 F, n=532 M)		TL
Commercial	Virginia	VMRC	Multiple	1991-2014 (n=148,818)	1998-2014 (n=4,967 ,otolith ages 1-6)	1989-2014 (n=9,944 F, n=4,245 M)	1989-2014 (n=9,917 Maturity Stage 1-5)	TL, SL
Commercial	North Carolina	NCDMF	Multiple	1979-2014 (n=7,124)	1979-1997 (n=5,097, scale ages 0-5); 1997-2013 (n=1,631, otolith ages 0-4)	1996-2015 (n=1,086 F, n=646 M)		TL
Commercial	Florida	FWC	Multiple	2000-2014 (n=330)				FL
Recreational	Florida	NMFS (MRFSS)	Hook & Line	1982-2006 (n=1,653)				FL
Recreational	North Carolina	NCDMF	Hook & Line		1992-1996 (n=316 scale age 1-3); 1998-2013 (n=19, otolith ages 1-3)	2000-2013 (n=11 F, n=4 M)		TL
Recreational	South Carolina	SC	Hook & Line		2010-2011 (n=277, ages 0-3)	2010-2011 (n=102 F, n=46 M)	2010-2011 (n=150, Maturity Status I/M)	TL, SL
Fishery Independent	North Carolina	NCDMF	Multiple	1972-2014 (n=10,720)	1979-1997 (n=1,066, scale ages 0-4); 1997-2013 (n=5,610, otolith ages 0-6)	1995-2015 (n=5,155 F, n=1,887 M)		TL
Fishery Independent	Hudson River, NY to Cape Hatteras, NC	NMFS	Trawl	1992-2014 (n=1,008)		1992-2010 (n=455 F, n=257 M)	1992-2014 (n=782, Maturity Status I/M; n=798 Maturity Stage D/I/R/R/S)	FL
Fishery Independent	Hudson River, NY to Cape Hatteras, NC	NEAMAP	Trawl	2007-2014 (n=2,241)		2007-2015 (n=1,185 F, n=957 M)	2007-2015 (n=2,209 Maturity Stage A-D)	FL
Fishery Independent	Maryland and Virginia Chesapeake Bay	ChesMMAP	Trawl	2002-2014 (n=7,337)	2002-2014 (n=7,104, otolith ages 0-4)	2002-2015 (n=3,532 F, n=3,034 M)	2002-2015 (n=6,851 Maturity Stage, various codes)	FL
Fishery Independent	Cape Hatteras, NC to Cape Canaveral, FL	SEAMAP	Trawl	1998-99,2000-01,2009-10 (n=1,455)	2001 (n=731, otolith ages 0-3)	1998-2010 (n=643 F, n=633 M)	1998-2010 (n=873 Maturity Status I/M; n=585 Maturity Stage, various codes)	TL, FL, SL
Fishery Independent	South Carolia	SC	Multiple	Various from 1984-2014 (n=5,440)	1997, 2010-2011 (n=1,050, otolith ages 0-4)	1984-2014 (n=1,265 F, n=749 M)	1984-2014 (n=2,148, Maturity Status I/M)	TL, SL

Table 4. Reported size ranges of spot from previous studies along the Atlantic coast of the United States.

Reference	Region	Length Range (cm)
Welsh and Breder (1923)	NJ - FL	8-33 cm
Hildebrand and Schroeder (1928)	Chesapeake	10-34.5 cm
Hildebrand and Cable (1930)	NC	9-29 cm
Pacheco (1957)	Chesapeake	16-27 cm
Dawson (1958)	SC	8-22.5 cm
DeVries (1982)	NC	6-34.6 cm
Music and Pafford (1984)	GA	11-25 cm
Johnson (2013)	SC	4.5-27 cm

Table 5. Summary of spot paired age-length data by data source based on otolith ages and total length (cm), made available for the stock assessment.

Source		Total length in cm at age						
		0	1	2	3	4	5	6
MD DNR Summer Pound Net Survey (Commercial)	Size Range (cm)	14-25	14-16	18-26				
	Mean (cm)	16	20	23				
	n	217	856	25				
	Percent by age	19.76%	77.96%	2.28%				
MD DNR Fish House Survey (Commercial)	Size Range (cm)	16-23	13-27	21-25				
	Mean (cm)	18	21	23				
	n	14	236	6				
	Percent by age	5.79%	97.52%	2.48%				
NCDMF (Commercial)	Size Range (cm)	9-22	11-27	16-30	22-31	25-31		
	Mean (cm)	15	18	23	27	28		
	n	549	855	170	44	13		
	Percent by age	33.66%	52.42%	10.42%	2.70%	0.80%		
VMRC (Commercial)	Size Range (cm)		13-31	18-34	20-36	26-36	31-36	32-35
	Mean (cm)		23	25	29	30	33	33
	n		2,961	1,552	339	96	15	3
	Percent by age		59.63%	31.25%	6.83%	1.93%	0.30%	0.06%
ChesMMAP Survey (FI)	Size Range (cm)	4-24	7-28	14-30	24-33	23-33		
	Mean (cm)	16	19	23	28	29		
	n	3,837	3,088	155	20	4		
	Percent by age	54.01%	43.47%	2.18%	0.28%	0.06%		
NCDMF (FI)	Size Range (cm)	7-29	11-33	15-31	21-32	24-32	28-32	32-33
	Mean (cm)	16	21	24	27	28	30	32
	n	485	3,036	1,704	308	66	9	2
	Percent by age	8.65%	54.12%	30.37%	5.49%	1.18%	0.16%	0.04%
SEAMAP Survey (FI)	Size Range (cm)	11-22	12-27	16-25	21			
	Mean (cm)	16	18	22	21			
	n	294	415	21	1			
	Percent by age	40.22%	56.77%	2.87%	0.14%			
SCDNR (FI)	Size Range (cm)	4-22	12-27	16-26	23-25	23		
	Mean (cm)	12	21	22	24	23		
	n	693	284	69	3	1		
	Percent by age	66.00%	27.05%	6.57%	0.29%	0.10%		
SCDNR Freezer Survey (R)	Size Range (cm)	16-24	16-29	20-25	33			
	Mean (cm)	19	22	23	33			
	n	68	193	15	1			
	Percent by age	24.55%	69.68%	5.42%	0.36%			
VMRC (R)	Size Range (cm)		22-26	33				
	Mean (cm)		24	33				
	n		3	1				
	Percent by age		75.00%	25.00%				
All Data Combined	Size Range (cm)	3-24	6-31	13-24	19-35	21-36	28-35	32-34
	Mean (cm)	15	20	23	26	29	32	33
	n	6,637	15,041	6,026	997	195	26	5
	Percent by age	25.50%	50.81%	19.69%	3.25%	0.63%	0.08%	0.02%

Table 6. **Description of growth models used to estimate the age-length relationship of spot in the stock assessment. Parameters of the same name do not necessarily have the same interpretation across different models.**

Growth Model	Equation	Parameters
von Bertalanffy	$L_t = L_\infty \left[1 - e^{-K(t-t_0)}\right]$	*Lt* is length at age *t, L*∞ (or Linf) 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.
Gompertz	$L_t = L_\infty e^{-e^{-K(t-t_0)}}$	*L*∞ (or Linf) is the theoretical asymptotic average length (if *K* > 0) and *t*0 represents an inflection point on the curve.
Richard's	$L_t = L_\infty \left[1 + \frac{1}{p} e^{-K(t-t_0)}\right]^{-p}$	*L*∞ (or Linf) is the theoretical asymptotic average length (if *K* > 0) and *t*0 represents an inflection point on the curve.
Logistic	$L_t = L_\infty \left[1 + e^{-K(t-t_0)}\right]^{-1}$	*L*∞ (or Linf) is the theoretical asymptotic average length (if *K* > 0) and *t*0 represents an inflection point on the curve.

Table 7. **Sample size (n) and parameter estimates and AIC for the von Bertalanffy model fits to spot data sets. There was a significant difference in growth between males and females (ARSS: $F_{3,20105}$ = 113.31, p < 0.0001).**

Data Set	n	Linf (cm)		K		t0		AIC
		Estimate	SE	Estimate	SE	Estimate	SE	
All available ages	22,734	34.4	0.483	0.324	0.012	-1.84	0.036	116,146
Combined male and female ages	20,111	35.4	0.563	0.288	0.012	-2.12	0.045	99,637
Female ages	12,922	34.4	0.584	0.317	0.015	-2.04	0.054	63,766
Male ages	7,189	38.5	1.552	0.220	0.019	-2.42	0.093	35,541

Table 8. **Sample size (n) and parameter estimates and AIC for the Richard's growth model fits to spot data sets.**

Data Set	n	Lmin (cm)		Lmax (cm)		K		p		Amin	Amax	AIC
		Estimate	SE	Estimate	SE	Estimate	SE	Estimate	SE			
All available ages	22,734	15.7	0.084	36.9	0.270	0.369	0.003	1	0.010	0	6	116,352
Combined male and female ages	20,111	16.6	0.120	39.7	0.164	0.306	0.003	1	0.020	0	6	99,857
Female ages	12,922	16.4	0.181	37.8	0.844	0.317	0.010	1	0.035	0	6	64,343
Male ages	7,189	16.2	0.123	47.8	1.150	0.218	0.007	1	0.024	0	6	35,658

Table 9. Sample size (n) and parameter estimates and AIC for the Gompertz growth model fits to spot data sets.

Data Set	n	Linf (cm)		K		t0		AIC
		Estimate	SE	Estimate	SE	Estimate	SE	
All available ages	22,734	31.7	0.295	0.516	0.012	-0.65	0.013	116,177
Combined male and female ages	20,111	32.5	0.339	0.461	0.012	-0.79	0.016	99,664
Female ages	12,922	32.1	0.372	0.487	0.015	-0.83	0.017	63,794
Male ages	7,189	33.9	0.799	0.393	0.019	-0.72	0.045	35,542

Table 10. Sample size (n) and parameter estimates and AIC for the logistic growth model fits for to spot data sets.

Data Set	n	Linf (cm)		K		t0		AIC
		Estimate	SE	Estimate	SE	Estimate	SE	
All available ages	22,734	30.3	0.216	0.713	0.012	-0.07	0.019	116,221
Combined male and female ages	20,111	31.0	0.247	0.638	0.012	-0.15	0.022	99,700
Female ages	12,922	30.7	0.279	0.660	0.016	-0.22	0.024	63,829
Male ages	7,189	31.7	0.543	0.568	0.020	-0.02	0.057	35,545

Table 11. Description of length measurements used for spot.

Measurement	Description
Total Length (max)	Measured from the most anterior point of the fish to the farthest tip of the tail with the tail compressed or squeezed together.
Fork Length (midline)	Measured from the most anterior point of the fish to the rear center edge of the tail.
Standard Length	Measured from the most anterior point of the fish to the end of the vertebral column (caudal peduncle).

Table 12. Length relationships for spot, as reported in the literature and estimated during this assessment.

Reference	Location	Range (mm TL)	N	Relationship	R^2
Dawson (1958)	South Carolina		5,162	SL = 2.000 + 1.2333 TL	0.996
			446	FL = 8.90 + 1.09 SL	0.991
			546	FL = 6.170 + 0.893 TL	0.997
Jorgenson and Miller (1968)	Georgia	14-11	71	TL = -0.606 + 1.2888 SL	0.91
			87	SL = 0.760 + 0.771 TL	0.893
Life History Workshop (2010)	Virginia-Florida	106-370	65,534 (VA)	TL = -0.554 + 1.268 SL	0.949
			65,534	SL = 9.780 + 0.7749 TL	0.949
			745 (SEAMAP)	TL = 6.411 + 0.904 FL	0.984
			745	FL = -4.370 + 1.089 TL	0.984
			745	SL = -7.254 + 0.868 FL	0.97
			745	FL = 12.967 + 1.117 SL	0.97
Stock Assessment (2017)	Coastwide	21-370	43,053	TL = 1.079 FL - 0.843	0.981
			66,494	TL = 1.255 SL + 1.840	0.967

Table 13. **The length-weight relationships for Atlantic coast spot (L= total length in mm; W= total weight in grams), as reported in the literature and estimated during this assessment.**

Author	Area	N	Size Range	Equation
Hester and Copeland (1975)	North Carolina	356	25-195 (mm TL)	log W = -5.230 + 3.221 log L
Dawson (1985)	South Carolina	4,297	45-205 (mm SL)	log W = -4.54396 + 2.95831 log L
Music and Pafford (1984)	Georgia	325	120-283 (mm TL)	log W = -5.096 + 3.121 log L
Stock Assessment (2017)	Coastwide	22,835	Females: 72-375 (mm TL)	log W = -5.401 + 3.248 log L
		12,320	Males: 67-355 (mm TL)	log W = -5.440 + 3.260 log L
		35,155	Combined sexes: 67-375 (mm TL)	log W = -5.433 + 3.260 log L
		189,460	All available L-W data (mm TL)	log W = -4.636 + 2.916 log L

Table 14. **Length-weight relationships for Atlantic coast spot from different data sets using a non-linear power regression in the form: $W=a(L_T)^b$ where L_T = total length (mm); W = weight (g); a = y-intercept; b = slope (regression coefficient).**

Data Source	N	Size Range (TL mm)	a	b	r^2
NMFS (FI)	1,008	96-290	4.601×10^{-6}	3.204	0.935
NEAMAP (FI)	2,241	102-290	1.871×10^{-6}	3.377	0.849
ChesMMAP (FI)	7,337	42-335	4.710×10^{-6}	3.200	0.952
SEAMAP (FI)	1,454	87-271	8.533×10^{-6}	3.073	0.956
MD/VA/NC commercial (FD)	159,697	13-390	2.821 x 10-5	2.879	0.830

Table 15. **Tests of significance using ARSS between male and female spot length-weight relationship by data set.**

Type	Area	Gear	Source	degrees of freedom		*F*-statistic	*P*-value
				numerator	denominator		
Fishery-Independent	NE Atlantic	Trawl	NMFS	2	709	1.022	0.312
Fishery-Independent	NE Atlantic	Trawl	NEAMAP	2	2,139	0.384	0.535
Fishery-Independent	Ches. Bay	Trawl	ChesMMAP	2	6,558	0.019	0.889
Fishery-Independent	SE Atlantic	Trawl	SEAMAP	2	1,272	0.172	0.678
Commercial	Maryland	Pound Net	MDDNR	2	1,360	3.622	0.057
Commercial	Virginia	All	VMRC	2	12,377	1.817	0.178
Commercial	North Carolina	All	NCDMF	2	1,712	1.746	0.187
Commercial	All combined	All	All	2	15,455	2.542	0.111

Table 16. SCDNR histological maturity-at-age data from August-December and predictions and residuals from a logistic regression model (slope = -1.761, inflection = 1.7).

Age	All Observed	Observed Mature	Proportion Mature Observed	Proportion Mature Predicted	Residual
0.67	18	1	0.056	0.132	-4.4
0.75	33	0	0.000	0.150	-5.4
0.83	37	5	0.135	0.170	-14.8
0.92	46	14	0.304	0.191	-29.9
1.00	42	3	0.071	0.215	-14.1
1.67	19	5	0.263	0.470	-12.7
1.75	37	15	0.405	0.507	-25.7
1.83	74	61	0.824	0.543	-47.4
1.92	25	20	0.800	0.580	-15.2
2.00	6	2	0.333	0.615	-4.8
2.67	5	2	0.400	0.838	-5.8
2.75	12	7	0.583	0.857	-10.8
2.83	14	10	0.714	0.874	-9.6
2.92	2	2	1.000	0.889	-0.2
3.83	1	1	1.000	0.976	0.0
4.75	1	0	0.000	0.995	-5.3

Table 17. Calculated sex ratios (female:male), sample sizes (n), chi-squared (χ_2) values, and probabilities (*P*) that the spot sex ratio is 1:1 (female:male) by dataset, pooled over ages and available years. Sex ratios were also analyzed using a binomial test with similar results.

Type	Area	Gear	Source	Males n	Female n	Total n	Sex Ratio (F:M)	Chi-squared		Binomial	
								χ^2	*P*	Probability	*P*
Commercial	MD	Pound Net	MDDNR	532	831	1,363	1.56	65.6	<0.01	0.39	<0.01
Commercial	VA	All	VMRC	3,655	8,725	12,380	2.39	2,076.30	<0.01	0.295	<0.01
Commercial	NC	All	NCDMR	633	1,082	1,715	1.71	117.5	<0.01	0.369	<0.01
Fishery-Independent	North Atlantic	Trawl	NMFS	257	455	712	1.77	55.1	<0.01	0.361	<0.01
Fishery-Independent	North Atlantic	Trawl	NEAMAP	957	1,185	2,142	1.24	24.3	<0.01	0.447	<0.01
Fishery-Independent	Chesapeake Bay	Trawl	ChesMMAP	3,029	3,532	6,561	1.17	38.6	<0.01	0.462	<0.01
Fishery-Independent	NC	Trawl	NCDMF	1,879	5,128	77,007	2.79	1506.5	<0.01	0.291	<0.01
Fishery-Independent	South Atlantic	Trawl	SEAMAP	633	642	1,275	1.01	0.1	0.8	0.496	0.82
Fishery-Independent	Coastwide	All		7,500	12,195	19,695	1.62	1119.2	<0.01	0.385	<0.01
Commercial	MD, VA, NC	All		4,820	10,638	15,458	2.21	2,189.70	<0.01	0.312	<0.01
All	Coastwide	All		12,320	22,833	35,153	1.83	3,144.20	<0.01	0.381	<0.01

Table 18. **Sex ratio (female:male)-at-age by data set for spot on the Atlantic coast. Computed chi-squared (χ_2) values for age-specific sex ratios were pooled over years and were calculated using Yate's correction for continuity. An asterisk (*) indicates a sex ratio significantly (p-value < 0.05) different than 1.**

	Age 0		Age 1		Age 2		Age 3		Age 4		Age 5	
Data Set	Ratio	X^2	Ratio	X^2	Ratio	X^2	Ratio	X^2	Ratio	X^2	Ratio	X^2
MD Commercial	1.037	0.072	1.698	71.6*	1.500	1.2	-	-	-	-	-	-
VA Commercial	-	-	2.620	526.2*	3.098	382.4*	3.671	106.9*	1.879	8.85*	4.000	5.40*
ChesMMAP (FI)	1.108	8.021*	1.207	23.7*	0.943	0.117	0.667	0.60	2.000	-	-	-
SEAMAP (FI)	0.965	0.088	1.109	1.036	2.000	2.333	-	-	-	-	-	-
SCDNR (FI surveys)	1.280	6.627*	2.170	38.02*	2.722	14.3*	2.000	-	1.000	-	-	-
FD Combined	1.139	1.107	2.291	584.5*	3.057	384.8*	3.671	106.9*	1.879	8.85*	4.000	5.40*
FI Combined	1.115	11.18*	1.252	42.1*	1.358	5.16*	0.900	0.052	1.500	-	-	-
Total	1.117	20.3*	1.705	455.9*	2.709	335.2*	3.325	92.7*	1.857	9.33*	4.000	5.40

Table 19. **Percent female spot for available datasets, by month, pooled over years.**

				Collection		% Female											
Type	**Area**	**Gear**	**Source**	**Period**	**n**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
FI Survey	NE Atlantic	Trawl	NMFS	1992-2010	455				100.0	50.0	50.0	50.0		63.3	70.4		
FI Survey	NE Atlantic	Trawl	NEAMAP	2007-2015	1,185				49.3					58.1			
FI Survey	Ches. Bay	Trawl	ChesMMAP	2002-2015	3,532			72.4		56.6		52.1		53.2	85.9	53.2	
FI Survey	SE Atlantic	Trawl	SEAMAP	1998-2010	642				55.3	50.3		47.2	36.4		48.7	52.3	
Commercial	Maryland	Pound Net	MDDNR	2007-2014	689					69.1	62.2	63.1	63.0	53.1			
Commercial	Maryland	Fish House Survey	MDDNR	2009-2010	142						67.2	43.8	51.3				
Commercial	Virginia	All	VMRC	1989-2014	8,725			83.3	69.7	70.6	73.1	69.9	74.2	69.7	65.0	73.1	
Commercial	North Carolina	All	NCDMF	1996-2015	1,082	40.9	62.5	54.2	53.9	59.4	68.8	62.5	62.2	68.0	69.3	66.7	91.7

Table 20. Estimates of age-constant natural mortality (*M*) of spot using methods from Then et al. (2015) based on maximum age (T_{max}, where $M = 4.899 * T_{max}^{-0.916}$) and the von Bertalanffy growth parameters (VOB, where $M = 4.118 * K^{0.73} * L_{inf}^{-0.33}$). Growth model parameters are described in Table 6.

Data Set	n	L_{inf} (cm TL)	K	T_{max}	Then et al. 2015 T_{max}	Then et al. 2015 VOB
All Age Samples	22,734	34.4	0.324	6	0.613	0.427
Males & Females	20,111	35.4	0.288	6	0.613	0.400
Females	12,922	34.4	0.317	6	0.613	0.422
Males	7,189	38.5	0.220	6	0.613	0.336

Table 21. Estimates of spot age-specific natural mortality (*M*) based on the Lorenzen (2005) method using von Bertalanffy growth parameters (L_{inf}, K, t_o) and scaled to the Then et al. (2015) age-constant estimates.

Age	All Data (n=22,734)	Males and Females (n = 20,111)	Females: n = 12,922	Males: n=7,189
0	0.542	0.503	0..528	0.431
1	0.464	0.434	0.458	0.369
2	0.420	0.393	0.417	0.331
3	0.394	0.367	0.392	0.306
4	0.376	0.352	0.375	0.288
5	0.364	0.338	0.364	0.275
6	0.356	0.330	0.356	0.266
Age 1+ Mean	0.396	0.369	0.394	0.306

Table 22. Annual sample size of spot lengths collected during MD DNR commercial pound net sampling.

Year	n
1993	309
1994	451
1995	158
1996	276
1997	924
1998	60
1999	572
2000	510
2001	126
2002	681
2003	1,354
2004	883
2005	2,818
2006	2,195
2007	519
2008	1,204
2009	614
2010	300
2011	582
2012	1,508
2013	1,302
2014	420

Table 23. Annual sample size of spot age data collected during MD DNR commercial pound net sampling.

Year	Age		
	0	1	2
2007	27	68	3
2008	75	129	2
2009	24	205	3
2010	10	74	7
2011	2	171	0
2012	71	151	4
2013	12	155	0
2014	10	139	12

Table 24. Sample sizes of lengths, individual weights, sex, and age data collected by VMRC's BSP.

Year	Lengths Collected	Weights Colleted	Sex Determined	Structures Taken	Age Determined
1989	6,554	6,682	1,508	0	0
1990	11,497	8,414	2,747	0	0
1991	12,285	9,542	1,540	0	0
1992	15,552	10,662	362	0	0
1993	6,845	5,873	447	0	0
1994	10,213	8,842	384	0	0
1995	10,136	6,732	37	0	0
1996	13,234	9,845	1,028	0	0
1997	10,345	6,918	36	0	0
1998	8,438	4,851	222	173	173
1999	3,102	1,132	349	327	327
2000	3,143	860	400	342	341
2001	3,799	677	417	385	383
2002	8,208	4,566	758	406	405
2003	6,847	6,854	558	422	348
2004	10,068	9,252	464	459	458
2005	8,936	8,945	489	401	400
2006	10,762	10,560	377	384	263
2007	4,003	3,877	342	489	246
2008	2,650	2,587	203	248	197
2009	3,151	3,139	336	360	262
2010	1,667	1,667	334	371	277
2011	4,144	4,144	270	280	225
2012	3,169	3,169	243	297	248
2013	3,941	3,941	319	379	244
2014	5,215	5,215	282	337	276
Total	187,904	148,946	14,452	5,560	5,073

Table 25. Annual length frequency of spot sampled from commercial fishery landings (combined gears, non-scrap) by the NCDMF.

Fork Length (cm)	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
4	0	0	0	0	2	0	0	0	0	0	0	0	0
5	0	0	1	0	0	0	0	0	0	0	0	0	0
6	0	0	2	0	0	0	0	0	0	0	0	0	0
7	1	0	1	0	0	0	0	0	0	0	0	0	0
8	10	1	2	0	3	0	0	0	3	0	0	0	0
9	33	14	31	1	49	1	0	45	12	0	0	3	0
10	118	115	85	35	218	57	7	403	94	0	0	249	1
11	316	235	230	199	352	108	59	662	228	0	0	386	0
12	341	288	343	289	402	68	151	308	290	0	4	102	0
13	457	392	525	351	270	45	112	173	175	0	0	44	2
14	643	585	914	442	235	80	215	136	95	0	0	41	1
15	730	574	1293	669	382	153	478	71	55	1	3	44	2
16	922	709	1444	766	662	393	505	65	181	17	14	128	10
17	1348	1802	2338	1092	995	620	552	109	690	211	250	519	120
18	2182	3652	3839	2285	1975	760	695	398	1241	1069	778	893	589
19	2966	3839	3303	3078	2606	857	1007	1323	2252	2299	1141	1502	1688
20	2347	2086	2153	2902	2380	849	988	2521	2587	2341	1327	2237	2017
21	1211	794	1030	1482	1466	586	589	2516	1898	1396	999	2021	1893
22	502	197	306	545	543	186	290	1441	938	666	955	1855	2075
23	147	18	38	132	115	35	134	608	481	401	936	1590	2061
24	17	4	13	20	23	10	65	205	203	205	587	800	1465
25	3	1	7	1	1	2	16	55	90	40	186	327	799
26	2	1	0	1	1	1	4	1	27	3	46	105	366
27	0	0	1	1	0	0	1	1	6	1	7	67	301
28	2	1	1	0	0	0	2	2	3	1	6	24	163
29	2	0	1	1	0	0	4	4	0	0	2	8	33
30	0	0	0	0	0	1	8	0	0	0	0	4	10
31	0	0	1	0	0	0	9	0	0	0	0	0	4
32	0	0	0	0	3	0	8	0	0	0	0	0	0
33	0	0	0	0	0	0	11	0	3	0	0	0	0
34	0	0	0	0	0	0	7	0	0	0	0	0	0
35	0	0	0	0	0	0	5	0	0	0	0	0	0
36	0	0	0	0	0	0	1	0	0	0	0	0	0
37	0	0	0	0	0	0	1	0	0	0	0	0	0
38	0	0	0	0	0	0	1	0	0	0	0	0	0
39	0	0	0	0	0	0	2	0	0	0	0	0	0

Table 25 ***Continued*. Annual length frequency of spot sampled from commercial fishery landings (combined gears, non-scrap) by the NCDMF.**

Fork Length (cm)	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
4	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	3	0	0	0	0	0	0
11	0	0	0	0	0	0	1	2	0	2	0	1	0
12	0	0	0	0	0	0	1	0	0	0	0	0	0
13	1	0	0	0	1	0	3	1	1	0	0	0	0
14	0	0	2	0	3	0	4	0	6	2	0	0	0
15	2	0	6	1	11	15	21	1	6	7	0	0	0
16	14	4	58	30	37	132	56	17	28	68	5	5	3
17	113	70	142	175	317	602	188	168	141	311	51	33	36
18	608	591	370	648	805	1278	660	736	510	652	352	206	378
19	1403	1549	576	1155	1272	2012	1700	1545	1078	986	972	666	1437
20	2048	1646	817	1286	1889	2653	2258	2123	1788	1409	1156	1113	1949
21	2236	1586	1370	1599	2190	2688	2032	1881	1770	2010	1039	1046	1353
22	1710	1512	2069	1881	2195	2084	1552	1233	1110	1938	571	865	750
23	1264	1662	2418	1860	1555	769	680	629	444	899	114	500	353
24	998	1289	1937	1726	730	141	174	168	131	187	17	163	130
25	487	724	850	1484	369	38	40	40	39	27	5	25	35
26	232	351	315	984	255	15	8	8	8	1	0	4	3
27	124	188	166	634	142	10	1	0	3	2	0	0	2
28	76	136	70	286	64	11	0	1	1	0	0	1	0
29	42	71	29	99	31	7	2	1	1	1	1	1	2
30	24	36	20	34	8	1	2	0	0	0	1	0	0
31	6	12	14	8	0	0	2	0	0	2	0	0	0
32	2	1	19	2	0	0	0	0	0	0	0	0	0
33	0	0	37	1	2	0	1	0	0	1	0	1	1
34	0	0	33	0	0	0	0	0	0	0	0	0	0
35	1	1	13	0	0	0	0	0	0	0	0	0	0
36	1	0	4	0	0	0	0	0	0	0	0	0	0
37	0	0	2	0	0	0	0	0	0	0	0	0	0
38	0	0	1	0	0	0	0	0	0	0	0	0	0
39	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 26. Annual length frequency of spot sampled from scrap landings (combined gears) by the NCDMF.

Fork Length (cm)	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
5	0	1	0	0	0	0	0	0	0	0	0	0	0
6	2	4	0	0	0	0	0	0	0	0	0	0	1
7	5	2	0	0	0	0	0	0	0	0	0	0	0
8	66	15	3	20	2	0	1	8	5	14	6	4	0
9	117	24	6	44	6	0	25	24	26	66	28	15	5
10	147	48	10	65	2	36	103	144	108	120	79	67	21
11	167	173	20	52	4	109	190	275	132	181	130	110	49
12	210	406	31	82	25	140	195	277	155	278	174	148	133
13	348	501	52	96	73	107	123	179	160	188	211	142	138
14	429	675	173	246	176	143	115	206	213	215	222	123	107
15	493	768	431	520	237	185	139	231	368	191	261	126	94
16	504	840	526	662	239	202	216	305	480	188	296	159	121
17	410	620	565	607	152	241	197	485	558	210	345	213	209
18	226	305	490	211	92	226	156	672	573	156	307	278	252
19	62	89	206	87	62	153	112	392	276	146	284	196	229
20	5	32	36	67	22	96	51	103	42	43	183	160	176
21	1	6	6	8	7	74	16	18	6	10	86	131	70
22	0	0	1	0	0	15	1	5	1	4	58	85	20
23	0	0	1	0	0	1	2	0	1	3	15	21	8
24	0	0	0	0	0	0	0	0	0	0	3	15	4
25	0	0	0	0	0	0	0	0	0	2	5	5	2
26	0	0	0	0	0	0	0	0	0	0	2	4	1
27	0	2	0	0	0	0	0	0	1	0	1	0	0
28	0	0	0	0	0	0	0	0	0	0	0	1	1
29	0	0	0	0	0	1	0	0	0	0	0	0	1
30	0	0	0	0	0	0	0	0	0	0	0	0	0
31	0	0	0	0	0	0	0	0	1	0	0	0	0

Table 26. ***Continued*. Annual length frequency of spot sampled from scrap landings (combined gears) by the NCDMF.**

Fork Length (cm)	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
5	0	0	0	0	0	0	0	0	0	0	0	0
6	1	0	0	0	0	0	0	0	0	0	0	0
7	0	0	1	0	0	0	0	0	0	0	0	0
8	2	1	0	0	0	1	0	0	0	0	0	0
9	10	19	2	0	0	23	0	3	0	0	0	0
10	42	112	25	9	30	72	11	26	0	7	1	2
11	96	83	89	38	131	57	12	33	18	29	2	5
12	100	68	99	74	135	67	23	40	21	29	7	10
13	85	66	94	167	146	107	21	34	58	12	8	8
14	90	69	126	202	149	95	39	43	47	20	11	11
15	143	156	235	272	207	161	58	48	61	16	3	16
16	172	171	327	253	208	174	99	62	86	15	9	9
17	227	73	249	273	175	213	143	73	63	12	12	25
18	271	54	210	210	113	213	95	45	29	12	11	38
19	163	51	119	95	69	107	24	12	16	13	2	63
20	64	80	49	25	30	37	5	5	2	5	3	22
21	18	29	6	6	8	17	1	2	0	2	0	2
22	7	9	3	1	1	10	1	2	0	0	0	1
23	0	3	4	2	0	1	0	0	0	0	0	0
24	0	3	1	0	0	0	0	0	0	0	0	0
25	0	1	1	0	0	0	0	0	0	1	0	0
26	0	0	0	0	0	0	0	0	0	0	0	0
27	0	0	1	0	0	0	0	1	0	0	0	0
28	0	0	0	0	0	0	0	0	0	0	0	0
29	0	0	1	0	1	1	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0	0
31	0	0	0	0	0	0	0	0	0	0	0	0

Table 27. Spot length sample sizes by gear and year collected from commercial fisheries by the TIP in Florida. (Entangling gear) Net Ban began in 1995 and cast nets became the main commercial gear. For unknown reasons the TIP stopped recording the gears sampled beginning from 2004. So, since 2004, samples are assumed to come from cast nets landings. UNK stands for unknown gear.

				Gears						
Years	UNK	cast net	crab pot	gill net	lines	seine	trammel	traps	trawl	Grand Total
1992				2361						2361
1993				3620						3620
1994		8		1816						1824
1995		3		387			14		170	574
1996		25								25
1997		311		98	10	1			16	436
1998		97		73	8				4	182
1999		346							99	445
2000		241			1				98	340
2001		103		49				15	183	350
2002	67	385	4			14			25	495
2003		7								7
2004		10								10
2005		2								2
2006		118								118
2007		182								182
2008		91								91
2009		12								12
2010		2								2
2011		43								43
2012		66								66
2013		6								6
2014		78								78
Grand Total	67	2136	4	8404	19	15	14	15	595	11269

Table 28. Coastwide spot commercial landings (metric tons).

Year	Metric Tons	Year	Metric Tons	Year	Metric Tons
1950	4,611	1972	5,066	1994	3,990
1951	5,831	1973	4,726	1995	3,548
1952	6,586	1974	4,548	1996	2,600
1953	3,600	1975	5,778	1997	3,007
1954	3,784	1976	2,477	1998	3,368
1955	3,686	1977	3,201	1999	2,541
1956	5,007	1978	4,328	2000	3,142
1957	4,097	1979	5,065	2001	3,175
1958	4,383	1980	4,634	2002	2,480
1959	4,086	1981	3,403	2003	2,644
1960	4,893	1982	4,736	2004	2,642
1961	3,468	1983	3,246	2005	2,039
1962	3,374	1984	2,676	2006	1,555
1963	2,838	1985	3,255	2007	2,612
1964	3,902	1986	3,157	2008	1,381
1965	2,171	1987	3,675	2009	2,586
1966	2,533	1988	3,123	2010	1,068
1967	4,843	1989	3,213	2011	2,506
1968	2,674	1990	3,010	2012	638
1969	1,766	1991	3,255	2013	1,604
1970	4,422	1992	3,076	2014	2,402
1971	2,676	1993	3,272		

Table 29. Spot commercial landings (metric tons) by state. Red asterisks indicate confidential values.

Year	FL	GA	SC	NC	VA	MD	DE	NJ	NY	CT	MA	RI
1950	41.59		132.18	2,346.11	2,040.44	44.59	4.94	0.64	0.45			
1951	127.23	0.54	1,200.20	2,093.10	2,281.79	58.33	8.03	57.56				4.54
1952	169.05	5.81	825.99	2,516.53	2,683.36	190.46	54.66	140.61				
1953	156.31	3.99	199.58	1,276.73	1,774.59	128.55	20.28	39.01	0.95			
1954	212.60	6.08	226.16	1,084.04	2,010.50	117.12	46.90	79.92	1.00			
1955	163.93	46.72	512.70	860.92	1,791.14	184.88	103.46	22.32				
1956	221.04	18.78	1,897.06	1,167.91	1,454.99	136.30	89.49	20.91				0.05
1957	154.45	29.21	951.59	978.62	1,574.51	267.21	60.01	78.20	2.90			
1958	268.89	17.60	381.88	1,052.74	2,384.26	268.98	7.71	0.54				
1959	468.24	0.14	834.93	1,027.34	1,703.01	38.56	8.94	5.13				
1960	468.47	0.18	1,234.04	1,184.10	1,771.91	226.07	8.26	0.14				
1961	421.21	0.05	1,573.28	932.45	537.01	4.35						
1962	319.65	1.68	1,422.01	552.61	1,065.81	12.20		0.09				
1963	511.15	1.86	1,233.41	415.26	668.96	6.89	0.23					
1964	431.73	1.13	1,436.07	567.53	1,450.50	15.38		0.05				
1965	425.51	4.99	532.52	413.95	794.01	0.27						
1966	546.44	2.40	964.11	495.00	522.90	1.86						
1967	407.51	4.76	1,006.57	1,382.50	1,929.26	112.63		0.05				
1968	501.04	0.91	931.00	714.45	506.21	20.68						
1969	396.71	1.09	205.70	674.85	475.59	9.39		2.90				
1970	634.08	4.22	166.70	693.50	2,663.86	259.73		0.09				
1971	1,311.38	2.63	583.09	539.82	228.43	9.21		1.41				
1972	879.92	14.79	1,029.18	1,769.98	1,338.32	33.43		0.54				
1973	417.58	15.38	659.79	2,448.20	1,168.50	12.29		4.31				
1974	792.79	7.44	162.37	2,543.27	1,021.05	16.78		4.76				
1975	381.33	4.04	676.23	3,764.75	870.41	46.67	7.71	26.54				
1976	242.17	7.94	459.75	1,212.98	540.79	7.44	3.63	1.09	1.41			
1977	466.52	3.22	133.57	1,725.97	846.85	7.44	5.17	9.25	2.54			
1978	450.81	0.14	181.86	2,212.82	1,454.00	14.20	8.85	4.94	0.54			
1979	395.25	0.11	189.82	3,312.77	1,152.69	4.81	8.21	0.82	0.14			
1980	405.11	0.72	186.44	3,220.53	814.11	2.86	2.40	1.09	0.50			
1981	1,269.55	3.50	57.78	1,592.82	465.47	6.44	5.03	2.72				
1982	2,009.97	0.13	28.38	2,231.11	461.49	2.81	1.13	0.82				

Table 29. ***Continued*. Spot commercial landings (metric tons) by state. Red asterisks indicate confidential values.**

Year	FL	GA	SC	NC	VA	MD	DE	NJ	NY	CT	MA	RI
1983	1,027.97	*	108.91	1,339.14	711.27	58.69		0.36				
1984	684.27	*	59.09	1,579.37	333.42	19.60		0.05				
1985	634.95	*	64.75	1,834.25	708.46	3.49	7.80	1.09				
1986	416.79	0.06	297.27	1,521.43	831.84	47.36	39.19	2.99				
1987	428.17	0.69	100.04	1,272.80	1,687.88	114.21	63.55	7.21				
1988	609.75	0.29	170.65	1,397.18	900.53	26.31	17.55	0.73				
1989	519.25	0.16	14.28	1,476.20	1,133.32	52.53	13.15	3.72				
1990	578.66	0.02	17.17	1,567.37	773.33	58.01	11.29	4.10				
1991	476.93	*	14.42	1,382.23	1,151.82	97.99	107.14	24.69				
1992	342.79	0.12	78.00	1,281.91	1,132.90	150.52	43.09	46.36				
1993	374.61	0.58	113.95	1,212.07	1,472.85	82.64	9.98	4.94	0.03		0.01	
1994	454.69	*	130.74	1,332.34	1,936.57	75.41	45.54	14.25				
1995	253.80	0.11	94.86	1,363.88	1,643.21	150.31	28.12	13.68	0.01			
1996	25.59		27.48	1,038.73	1,354.01	116.44	36.71	0.52	0.14			
1997	103.01	*	39.54	1,192.01	1,598.26	54.58	16.19	2.80	0.09			
1998	73.07	*	28.99	1,087.25	1,999.42	102.48	63.67	12.51	*		*	
1999	33.12	*	4.26	1,026.10	1,349.32	101.36	23.38	3.55				
2000	26.30		3.86	1,283.59	1,726.36	80.26	14.65	6.28	0.43			
2001	14.99	*	5.87	1,403.36	1,577.46	128.59	35.50	9.09	0.07		*	
2002	9.35	*	10.26	990.66	1,397.31	62.89	6.25	0.60	2.60			
2003	4.23		7.74	926.86	1,584.14	83.66	34.94	2.72	0.02			
2004	5.87	*	1.20	1,051.05	1,536.25	19.84	26.54	0.75	0.04			
2005	9.59		4.75	777.68	1,122.60	52.16	71.47	0.35	0.20			
2006	10.21	*	2.58	619.04	876.09	15.91	28.55	1.65	1.34			
2007	6.50		2.88	398.74	1,966.46	176.68	58.15	2.03	0.49		*	
2008	4.16	*	0.68	334.06	969.59	56.11	14.81	0.88	0.49			
2009	10.00		10.23	456.54	1,820.98	239.78	32.41	15.45	0.14			
2010	6.10	*	1.79	259.60	501.07	268.53	27.40	2.74	0.62			
2011	15.37		5.52	425.00	1,706.89	283.32	41.79	24.90	3.70	*		
2012	16.67		0.25	222.11	279.35	46.40	8.21	4.51	57.87	0.53		2.59
2013	14.24		1.11	348.63	952.84	144.89	35.90	21.92	73.59	10.32		0.22
2014	7.58	*	2.68	346.86	1,814.05	161.55	54.26	13.50	1.02			*

Table 30. Spot commercial landings (metric tons) by gear.

Year	Haul Seines	Gill Nets	Trawls	Fixed Nets	Other Gears
1950	3,597	296	25	689	3
1951	4,933	354	22	496	26
1952	5,524	482	108	417	54
1953	2,931	272	41	313	43
1954	2,792	385	161	446	1
1955	2,740	412	141	388	4
1956	3,925	442	207	418	15
1957	2,886	506	192	466	47
1958	2,956	739	140	524	23
1959	2,663	642	141	601	40
1960	3,327	711	205	613	38
1961	2,489	515	193	260	11
1962	2,231	572	122	442	8
1963	1,921	638	95	178	6
1964	2,654	771	67	403	7
1965	1,223	590	58	292	8
1966	1,576	692	89	160	16
1967	2,640	924	391	877	12
1968	1,662	629	150	223	10
1969	871	540	179	141	36
1970	1,545	1,571	80	1,154	72
1971	1,134	1,295	126	101	20
1972	2,594	1,423	349	679	22
1973	2,616	910	592	591	17
1974	2,269	1,214	410	619	36
1975	3,918	886	584	374	16
1976	1,516	539	196	213	14
1977	1,539	909	370	357	25
1978	1,663	741	705	764	455
1979	2,610	978	634	444	399
1980	2,468	976	575	210	405
1981	1,323	399	175	236	1,270
1982	1,779	288	235	422	2,012

Table 30. ***Continued.*** **Spot commercial landings (metric tons) by gear.**

Year	Haul Seines	Gill Nets	Trawls	Fixed Nets	Other Gears
1983	1,192	482	159	385	1,028
1984	1,061	478	165	287	686
1985	1,341	852	259	165	638
1986	1,263	1,064	181	227	422
1987	947	1,837	134	303	455
1988	1,252	938	139	168	626
1989	1,040	1,262	161	213	536
1990	1,376	725	121	195	592
1991	1,153	1,505	98	167	332
1992	950	1,776	128	170	51
1993	998	2,060	52	132	29
1994	855	2,753	57	293	31
1995	755	2,304	55	272	161
1996	662	1,606	54	145	134
1997	919	1,797	59	165	68
1998	785	2,239	43	187	113
1999	553	1,792	45	125	26
2000	732	2,207	47	134	22
2001	673	2,163	91	219	29
2002	457	1,753	55	184	31
2003	512	1,806	42	265	19
2004	525	1,918	16	162	21
2005	438	1,433	6	142	21
2006	471	1,014	9	49	12
2007	561	1,819	22	147	64
2008	346	887	11	93	44
2009	293	2,048	30	127	87
2010	197	724	5	77	66
2011	197	1,937	6	140	227
2012	157	345	65	25	47
2013	189	1,099	90	62	164
2014	191	1,847	20	189	154

Table 31. Spot commercial landings (millions of fish). Conversions were not done for Georgia, North Carolina before 1989, or any states north of New Jersey.

Year	FL	SC	NC	VA	MD	DE	NJ	Total
1981	8.087	0.388		2.703	0.024	0.022	0.023	11.247
1982	12.803	0.190		3.263	0.031	0.013	0.008	16.308
1983	6.548	0.731		8.256	0.647	0.000	0.003	16.185
1984	4.359	0.018		2.739	0.108	0.000	0.000	7.224
1985	4.044	0.434		4.519	0.039	0.000	0.007	9.043
1986	2.655	1.995		6.540	0.348	0.288	0.027	11.853
1987	2.727	0.671		11.012	0.504	0.000	0.034	14.948
1988	3.884	1.145		5.269	0.193	0.035	0.005	10.531
1989	3.307	0.096	15.683	6.942	0.287	0.153	0.021	26.490
1990	3.686	0.115	16.821	4.261	0.352	0.086	0.041	25.362
1991	3.038	0.097	15.387	6.666	0.545	0.727	0.254	26.715
1992	2.184	0.523	12.685	6.758	0.872	0.272	0.261	23.555
1993	2.386	0.765	11.517	8.240	0.492	0.072	0.040	23.513
1994	2.896	0.877	5.448	10.060	0.407	0.244	0.223	20.156
1995	1.617	0.636	7.516	7.873	0.685	0.128	0.072	18.527
1996	0.143	0.184	5.451	6.440	0.530	0.101	0.002	12.852
1997	0.575	0.265	5.690	8.627	0.342	0.081	0.013	15.595
1998	0.408	0.195	5.392	10.002	0.492	0.338	0.070	16.897
1999	0.185	0.029	4.416	7.275	0.563	0.094	0.015	12.576
2000	0.147	0.026	6.513	8.202	0.395	0.076	0.099	15.457
2001	0.084	0.039	6.272	5.521	0.493	0.179	0.052	12.640
2002	0.052	0.069	4.367	6.087	0.385	0.038	0.003	11.002
2003	0.023	0.052	4.305	6.869	0.399	0.154	0.013	11.815
2004	0.032	0.008	4.664	6.248	0.111	0.141	0.004	11.208
2005	0.052	0.032	3.328	5.072	0.341	0.300	0.001	9.127
2006	0.055	0.017	3.097	4.586	0.095	0.209	0.010	8.070
2007	0.035	0.019	2.428	11.702	0.955	0.322	0.011	15.473
2008	0.023	0.005	1.929	5.454	0.212	0.109	0.011	7.743
2009	0.054	0.069	2.701	9.161	1.181	0.179	0.103	13.447
2010	0.033	0.012	1.496	2.671	1.422	0.197	0.017	5.847
2011	0.083	0.037	2.332	8.461	1.816	0.308	0.158	13.195
2012	0.090	0.002	1.430	1.610	0.329	0.049	0.057	3.568
2013	0.077	0.007	1.909	5.438	0.978	0.185	0.134	8.727
2014	0.041	0.018	1.999	9.520	1.051	0.201	0.056	12.886

Table 32. Scrap landings of spot by state.

Year	NC		VA	
	Millions	Metric Tons	Millions	Metric Tons
1981	3.894	197	0.479	24
1982	5.454	276	0.475	24
1983	3.274	166	0.733	37
1984	3.861	196	0.344	17
1985	4.484	227	0.730	37
1986	3.719	189	0.860	44
1987	3.111	158	1.739	88
1988	3.415	173	0.928	47
1989	3.608	183	1.153	58
1990	3.831	194	0.762	39
1991	3.379	171	1.187	60
1992	3.134	159	1.167	59
1993	2.963	150	1.565	79
1994	5.706	372	1.889	96
1995	1.644	169	3.572	181
1996	6.009	209	2.300	117
1997	5.839	321	1.105	56
1998	3.587	225	3.918	199
1999	2.194	139	2.917	148
2000	1.876	109	1.859	94
2001	1.576	133	1.519	77
2002	0.963	84	0.634	32
2003	1.784	131	1.622	82
2004	1.722	124	1.521	77
2005	0.635	48	0.860	44
2006	0.760	62	2.272	115
2007	2.442	129	2.661	135
2008	2.456	207	1.372	70
2009	1.005	37	0.262	13
2010	0.406	25	0.399	20
2011	1.121	83	0.714	36
2012	0.513	39	1.567	79
2013	0.153	6	0.335	17
2014	0.126	9	0.506	26

Table 33. Number of discarded spot measured for length (fork) by the NEFOP.

Year	Trawls	Gill Nets
1989	140	0
1990	300	0
1991	94	0
1992	0	0
1993	0	0
1994	0	0
1995	0	12
1996	0	1
1997	0	0
1998	0	0
1999	0	0
2000	0	32
2001	110	3
2002	240	0
2003	0	19
2004	0	1
2005	0	0
2006	0	2
2007	1	0
2008	9	0
2009	50	0
2010	78	0
2011	0	0
2012	1	0
2013	1	6
2014	5	0

Table 34. Number of tows observed by the SESTOP by South Atlantic fishery and year.

Year	Fishery	
	Penaeid Shrimp	Rock Shrimp
2001	30	16
2002	14	119
2003	0	177
2004	0	0
2005	158	0
2006	0	22
2007	135	0
2008	239	111
2009	458	19
2010	187	60
2011	320	0
2012	377	0
2013	308	96
2014	174	39

Table 35. NEFOP gillnet observer data from trips encountering spot and total aggregate landings of all species summarized by year. All landings and discard values are in pounds. Values highlighted in yellow are averages of adjacent years or the closest two year period with data.

Year	n Observed Trips	n Observed Sets	Total Observed Landings	Total Observed Discards	Mean Observed Landings	Mean Observed Discards	Observed Landings Variance	Observed Discards Variance	Total Reported Landings
1989	46	376	79,479	302	211	0.80	103,924	5	25,652,524
1990	46	376	79,479	302	211	0.80	103,924	5	24,002,907
1991	46	376	79,479	302	211	0.80	103,924	5	29,094,526
1992	46	376	79,479	302	211	0.80	103,924	5	35,577,345
1993	6	67	5,433	12	81	0.18	15,615	0	43,650,274
1994	40	309	74,046	290	240	0.94	118,692	6	44,036,266
1995	64	489	94,656	445	194	0.91	47,191	11	50,739,022
1996	32	282	64,431	15	228	0.05	72,069	0	69,291,360
1997	39	299	61,243	11	205	0.04	91,721	0	68,001,924
1998	10	43	6,047	25	141	0.58	14,222	3	71,081,469
1999	12	65	7,519	41	116	0.63	100,860	4	60,134,421
2000	12	73	17,000	46	233	0.63	76,590	7	53,612,915
2001	12	81	18,118	6	224	0.07	40,584	0	49,486,118
2002	13	62	13,125	190	212	3.06	84,019	69	44,679,363
2003	5	38	4,561	45	120	1.17	14,626	4	46,294,253
2004	3	19	1,303	35	69	1.82	2,439	61	43,035,622
2005	1	4	788	0	197	0.05	22,147	0	44,817,006
2006	1	7	1,603	1	229	0.20	7,730	0	36,334,649
2007	1	2	333	5	167	2.50	13,945	13	47,407,903
2008	3	30	6,279	5	209	0.16	71,611	0	44,172,162
2009	6	59	9,421	7	160	0.12	67,321	0	46,920,564
2010	3	29	3,142	2	108	0.07	59,914	0	45,500,133
2011	7	46	6,848	92	149	2.00	49,194	71	49,724,296
2012	7	46	6,848	92	149	2.00	49,194	71	43,074,272
2013	4	17	3,706	90	218	5.31	25,452	182	41,490,424
2014	10	83	6,420	85	77	1.02	17,228	25	50,323,940

Table 36. NEFOP trawl observer data from trips encountering spot and total aggregate landings of all species summarized by year. All landings and discard values are in pounds. Values highlighted in yellow are averages of adjacent years.

Year	n Observed Trips	n Observed Tows	Total Observed Landings	Total Observed Discards	Mean Observed Landings	Mean Observed Discards	Observed Landings Variance	Observed Discards Variance	Total Reported Landings
1989	7	67	15,859	3,163	237	47.21	33,506	8,762	102,266,145
1990	10	66	14,111	14,904	214	225.82	95,936	340,475	98,306,719
1991	10	96	75,505	896	787	9.33	2,841,320	561	124,235,440
1992	2	16	14,850	78	928	4.88	1,791,253	162	122,170,085
1993	5	36	11,221	228	312	6.33	64,487	141	122,523,204
1994	3	17	9,397	5	553	0.29	70,928	1	116,584,503
1995	22	179	122,610	416	685	2.32	1,521,473	38	111,100,026
1996	9	55	44,013	72	800	1.31	407,760	13	136,997,042
1997	2	24	79,208	445	3,300	18.54	21,426,228	927	113,737,816
1998	1	18	37,735	45	2,096	2.50	8,432,371	89	151,684,942
1999	3	52	39,878	93	767	1.79	3,055,011	49	124,402,919
2000	2	3	16,048	570	5,349	190.00	27,460,736	73,300	115,098,410
2001	14	67	84,106	46	1,255	0.69	911,833	1	90,445,547
2002	18	91	136,090	45	1,495	0.49	1,116,657	0	80,132,678
2003	22	106	145,557	102	1,373	0.96	1,073,754	4	74,051,714
2004	4	15	9,467	57	631	3.80	187,440	17	106,953,633
2005	5	46	167,852	384	3,649	8.35	37,363,223	1,222	55,072,880
2006	1	6	19,781	0	3,297	0.00	5,791,317	0	71,947,284
2007	16	131	220,367	565	1,682	4.31	12,106,105	519	48,895,736
2008	15	114	161,334	263	1,415	2.31	32,874,979	121	58,543,253
2009	25	164	218,409	350	1,332	2.13	8,222,888	79	71,184,696
2010	9	80	154,000	3,814	1,925	47.68	13,924,724	29,548	47,259,488
2011	12	92	110,180	437	1,198	4.75	2,647,643	690	77,198,373
2012	50	179	143,365	844	801	4.72	776,668	289	65,570,023
2013	75	306	254,069	9,412	830	30.76	3,711,261	44,531	51,079,933
2014	14	70	205,270	2,462	2,932	35.17	33,332,156	17,848	50,734,848

Table 37. Number of observations from NEFOP observer data for spot by NMFS statistical area and gear. A map of statistical areas is in Figure 19.

Stat Area	Gillnets	Trawls
611	0	52
612	2	140
613	0	107
614	92	46
615	0	10
616	0	19
621	92	916
622	0	27
623	0	2
625	1,437	142
626	0	37
631	125	168
632	0	14
635	251	283
636	0	27

Table 38. Gears observed by NEFOP on trips that were used to estimate spot discards.

GILL NET, ANCHORED-FLOATING, FISH
GILL NET, DRIFT-FLOATING, FISH
GILL NET, DRIFT-SINK, FISH
GILL NET, FIXED OR ANCHORED,SINK, OTHER/NK SPECIES
TRAWL,OTTER,BOTTOM,FISH
TRAWL,OTTER,BOTTOM,RUHLE
TRAWL,OTTER,BOTTOM,SCALLOP
TRAWL,OTTER,BOTTOM,TWIN

Table 39. Gears contributing to aggregate landings used to expand ratios to discard estimates. Additional landings recorded as "NOT CODED" were included in the total landings (GILL NETS NC, TRAWLS NC).

GILL NETS	OTHER TRAWLS
GILL NETS, FLOATING ANCHOR	OTTER TRAWL BOTTOM, CRAB
GILL NETS, FLOATING DRIFT	OTTER TRAWL BOTTOM, FISH
GILL NETS, OTHER	OTTER TRAWL BOTTOM, LOBSTER
GILL NETS, RUNAROUND	OTTER TRAWL BOTTOM, OTHER
GILL NETS, SINK ANCHOR	OTTER TRAWL BOTTOM, PAIRED
GILL NETS, SINK DRIFT	OTTER TRAWL BOTTOM, SCALLOP
GILL NETS, STAKE	OTTER TRAWL BOTTOM, SHRIMP
GILL NETS NC	OTTER TRAWL, PEELER
	OTTER TRAWL, RUHLE
	OTTER TRAWL, TWIN
	OTTER TRAWLS
	TRAWLS NC

Table 40. **Estimated ratios, variances, and CVs of discarded spot to total aggregate landings of all species from observed gillnets. Values highlighted in yellow are averages of adjacent years or the closest two year period with data.**

Year	Ratio	Ratio Variance	Ratio CV
1989	0.000119	2.64E-09	0.4304
1990	0.000119	2.64E-09	0.4304
1991	0.000119	2.64E-09	0.4304
1992	0.000000	0	NA
1993	0.000217	8.77E-09	0.4309
1994	0.000428	5.30E-09	0.1703
1995	0.000412	5.27E-09	0.1760
1996	0.000014	1.76E-11	0.3097
1997	0.000011	4.00E-11	0.5566
1998	0.000035	1.87E-10	0.3923
1999	0.000389	2.40E-08	0.3982
2000	0.000353	2.57E-08	0.4538
2001	0.001027	8.80E-07	0.9135
2002	0.000502	2.06E-07	0.9031
2003	0.000022	1.14E-10	0.4801
2004	0.000013	2.13E-10	1.0812
2005	0.000000	2.92E-14	1.0660
2006	0.000001	6.19E-13	1.0431
2007	0.000007	7.12E-11	1.1835
2008	0.000050	5.60E-10	0.4694
2009	0.000000	0	NA
2010	0.000002	6.63E-12	1.0513
2011	0.000000	0	NA
2012	0.000000	0	NA
2013	0.000252	3.58E-08	0.7515
2014	0.000117	7.62E-09	0.7491

Table 41. Estimated ratios, variances, and CVs of discarded spot to total aggregate landings of all species from observed trawls. Values highlighted in yellow are averages of adjacent years.

Year	Ratio	Ratio Variance	Ratio CV
1989	0.014079	1.83E-05	0.3040
1990	0.062590	4.83E-04	0.3512
1991	0.001233	1.51E-07	0.3155
1992	0.000153	1.12E-08	0.6916
1993	0.000852	1E-07	0.3713
1994	0.000016	1.3E-10	0.7223
1995	0.000638	1.85E-08	0.2131
1996	0.000044	3.25E-10	0.4077
1997	0.000406	2.60E-08	0.3968
1998	0.000067	3.69E-09	0.9046
1999	0.000122	5.41E-09	0.6048
2000	0.000227	4.15E-08	0.8968
2001	0.000013	1.16E-11	0.2547
2002	0.000049	3.10E-10	0.3621
2003	0.000000	0	NA
2004	0.000014	2.67E-11	0.3620
2005	0.000205	1.66E-08	0.6288
2006	0.000000	0.00E+00	NA
2007	0.000177	6.91E-09	0.4709
2008	0.000111	2.65E-09	0.4643
2009	0.000086	8.65E-10	0.3425
2010	0.000905	1.45E-07	0.4213
2011	0.000096	3.14E-09	0.5854
2012	0.000456	1.64E-08	0.2809
2013	0.002940	1.43E-06	0.4072
2014	0.000558	6.33E-08	0.4514

Table 42. **Number of observations, number of positive observations, proportion positive observations, and mean CPUE (kg per hour fished) of spot by factor level considered in the GLMs for shrimp trawl discard estimates using SEAMAP Trawl Survey and SESTOP data.**

season	N	N_pos	prop_pos	mean_CPUE
off	181	163	0.90	6.94
peak	17,107	11,583	0.68	19.93
depth_zone	**N**	**N_pos**	**prop_pos**	**mean_CPUE**
=<10m	16,007	10,927	0.68	21.08
10-30m	671	613	0.91	5.68
>30m	610	206	0.34	1.76
data_set	**N**	**N_pos**	**prop_pos**	**mean_CPUE**
penaeid_shrimp	2,386	2,139	0.90	4.79
rock_shrimp	658	249	0.38	1.69
SEAMAP	14,244	9,358	0.66	23.15
state	**N**	**N_pos**	**prop_pos**	**mean_CPUE**
FL	3,752	2,640	0.70	20.67
GA	3,708	1,996	0.54	7.54
SC	6,102	3,876	0.64	14.03
NC	3,726	3,234	0.87	40.57
year	**N**	**N_pos**	**prop_pos**	**mean_CPUE**
1989	318	201	0.63	28.75
1990	462	310	0.67	48.17
1991	466	343	0.74	60.43
1992	468	290	0.62	23.90
1993	468	300	0.64	15.80
1994	468	269	0.57	19.92
1995	468	309	0.66	29.87
1996	468	281	0.60	9.88
1997	468	227	0.49	20.53
1998	468	329	0.70	7.58
1999	468	259	0.55	5.61
2000	468	235	0.50	11.97
2001	657	476	0.72	11.75
2002	744	392	0.53	5.80
2003	789	532	0.67	18.58
2004	612	380	0.62	17.98
2005	770	556	0.72	31.84
2006	634	402	0.63	21.57
2007	742	472	0.64	5.61
2008	962	610	0.63	13.80
2009	1,148	896	0.78	11.63
2010	919	596	0.65	20.78
2011	992	828	0.83	25.82
2012	1,047	890	0.85	17.88
2013	990	733	0.74	19.31
2014	824	630	0.76	31.07

Table 43. **Number of observations, number of positive observations, proportion positive observations, and mean CPUE (numbers per hour fished) of spot by factor level considered in the GLM for shrimp trawl discard estimates using SEAMAP Trawl Survey and SESTOP data.**

season	N	N_pos	prop_pos	mean_CPUE
off	181	163	0.90	100.53
peak	16,815	11,291	0.67	350.86
depth_zone	**N**	**N_pos**	**prop_pos**	**mean_CPUE**
=<10m	15,715	10,635	0.68	371.34
10-30m	671	613	0.91	107.22
>30m	610	206	0.34	16.89
data_set	**N**	**N_pos**	**prop_pos**	**mean_CPUE**
penaeid_shrimp	2,379	2,132	0.90	150.07
rock_shrimp	658	249	0.38	16.77
SEAMAP	13,959	9,073	0.65	397.58
state	**N**	**N_pos**	**prop_pos**	**mean_CPUE**
FL	3,719	2,607	0.70	270.89
GA	3,662	1,950	0.53	129.73
SC	5,961	3,735	0.63	263.17
NC	3,654	3,162	0.87	784.52
year	**N**	**N_pos**	**prop_pos**	**mean_CPUE**
1989	318	201	0.63	487.60
1990	462	310	0.67	808.57
1991	466	343	0.74	899.24
1992	468	290	0.62	365.12
1993	468	300	0.64	194.54
1994	468	269	0.57	327.66
1995	468	309	0.66	547.13
1996	468	281	0.60	212.44
1997	253	12	0.05	10.90
1998	398	259	0.65	91.01
1999	468	259	0.55	119.66
2000	468	235	0.50	186.79
2001	657	476	0.72	252.98
2002	744	392	0.53	99.82
2003	789	532	0.67	405.51
2004	612	380	0.62	339.29
2005	770	556	0.72	557.24
2006	634	402	0.63	401.43
2007	742	472	0.64	100.43
2008	961	609	0.63	221.31
2009	1,147	895	0.78	242.47
2010	919	596	0.65	382.52
2011	992	828	0.83	539.31
2012	1,047	890	0.85	313.92
2013	986	729	0.74	320.47
2014	823	629	0.76	569.78

Table 44. Lognormal GLM summary of spot discard rate in weight (kg) from shrimp trawl fisheries.

```
Call:
glm(formula = lnCPUE ~ YEAR + data_set + depth_zone + state +
   season, family = gaussian, data = trips_pr_pos, na.action = na.exclude)
Deviance Residuals:
   Min      1Q  Median      3Q     Max
-5.6426  -1.1672  0.0818   1.1758   6.2999
Coefficients:
               Estimate Std. Error t value Pr(>|t|)
(Intercept)        0.616356   0.199370   3.092 0.001996 **
YEAR1990          -0.160520   0.155563  -1.032 0.302157
YEAR1991           0.607467   0.152647   3.980 6.95e-05 ***
YEAR1992          -0.040623   0.157693  -0.258 0.796715
YEAR1993          -0.839396   0.156619  -5.359 8.51e-08 ***
YEAR1994          -0.311419   0.160204  -1.944 0.051933 .
YEAR1995          -0.286344   0.155675  -1.839 0.065887 .
YEAR1996          -1.113360   0.158708  -7.015 2.42e-12 ***
YEAR1997          -0.616578   0.166371  -3.706 0.000212 ***
YEAR1998          -1.041126   0.153780  -6.770 1.35e-11 ***
YEAR1999          -1.565368   0.161498  -9.693  < 2e-16 ***
YEAR2000          -1.149601   0.165046  -6.965 3.45e-12 ***
YEAR2001          -0.763366   0.144870  -5.269 1.39e-07 ***
YEAR2002          -1.104388   0.150616  -7.332 2.41e-13 ***
YEAR2003          -0.480957   0.144169  -3.336 0.000852 ***
YEAR2004          -0.684820   0.150092  -4.563 5.10e-06 ***
YEAR2005          -0.707700   0.141981  -4.984 6.30e-07 ***
YEAR2006           0.005537   0.148637   0.037 0.970284
YEAR2007          -1.069100   0.145217  -7.362 1.93e-13 ***
YEAR2008          -0.733061   0.141184  -5.192 2.11e-07 ***
YEAR2009          -0.442210   0.136145  -3.248 0.001165 **
YEAR2010          -0.561131   0.141127  -3.976 7.05e-05 ***
YEAR2011           0.087099   0.136534   0.638 0.523532
YEAR2012           0.036136   0.135996   0.266 0.790466
YEAR2013          -0.303937   0.138043  -2.202 0.027702 *
YEAR2014           0.285651   0.140181   2.038 0.041599 *
data_setrock_shrimp -0.892799   0.250420  -3.565 0.000365 ***
data_setSEAMAP      1.499818   0.051907  28.895  < 2e-16 ***
depth_zone>30m      1.147655   0.273763   4.192 2.78e-05 ***
depth_zone10-30m    0.430202   0.091865   4.683 2.86e-06 ***
stateGA           -0.876792   0.053438 -16.408  < 2e-16 ***
stateNC            0.631736   0.048937  12.909  < 2e-16 ***
stateSC           -0.322651   0.047437  -6.802 1.08e-11 ***
seasonpeak         0.289818   0.148724   1.949 0.051355 .
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Dispersion parameter for gaussian family taken to be 2.950506)

   Null deviance: 43223  on 11745  degrees of freedom
Residual deviance: 34556  on 11712  degrees of freedom
AIC: 46079

Number of Fisher Scoring iterations: 2
```

Table 45. Binomial GLM summary for spot discard rate in weight (kg) from shrimp trawl fisheries.

```
Call:
glm(formula = success ~ YEAR + data_set + depth_zone + state +
   season, family = binomial(link = "logit"), data = trips_pr,
   na.action = na.exclude, offset = effort)
Deviance Residuals:
  Min     1Q  Median     3Q    Max
-3.738  -1.101   0.569   0.883   2.418
Coefficients:
                     Estimate Std. Error z value Pr(>|z|)
(Intercept)         -0.025634   0.339908  -0.075  0.93988
YEAR1990             0.156883   0.157416   0.997  0.31895
YEAR1991             0.483034   0.161206   2.996  0.00273 **
YEAR1992            -0.089449   0.155144  -0.577  0.56424
YEAR1993             0.007879   0.155814   0.051  0.95967
YEAR1994            -0.289501   0.154189  -1.878  0.06044 .
YEAR1995             0.097886   0.156548   0.625  0.53179
YEAR1996            -0.176228   0.154667  -1.139  0.25454
YEAR1997            -0.678486   0.153792  -4.412 1.03e-05 ***
YEAR1998             0.305887   0.158633   1.928  0.05382 .
YEAR1999            -0.386874   0.153880  -2.514  0.01193 *
YEAR2000            -0.618228   0.153714  -4.022 5.77e-05 ***
YEAR2001             0.342591   0.151703   2.258  0.02393 *
YEAR2002            -0.601331   0.144336  -4.166 3.10e-05 ***
YEAR2003             0.405722   0.148282   2.736  0.00622 **
YEAR2004            -0.188339   0.148523  -1.268  0.20477
YEAR2005             0.130572   0.147451   0.886  0.37587
YEAR2006            -0.069565   0.148226  -0.469  0.63884
YEAR2007            -0.257696   0.145175  -1.775  0.07589 .
YEAR2008            -0.143364   0.143052  -1.002  0.31626
YEAR2009             0.310370   0.143902   2.157  0.03102 *
YEAR2010            -0.123193   0.143296  -0.860  0.38995
YEAR2011             0.794631   0.150625   5.276 1.32e-07 ***
YEAR2012             0.737029   0.151319   4.871 1.11e-06 ***
YEAR2013             0.307538   0.145325   2.116  0.03433 *
YEAR2014             0.383633   0.149715   2.562  0.01039 *
data_setrock_shrimp -1.230365   0.445437  -2.762  0.00574 **
data_setSEAMAP       1.124871   0.088660  12.687  < 2e-16 ***
depth_zone>30m      -2.430597   0.454551  -5.347 8.93e-08 ***
depth_zone10-30m     0.172479   0.173383   0.995  0.31984
stateGA             -1.006508   0.056627 -17.774  < 2e-16 ***
stateNC              0.762613   0.066937  11.393  < 2e-16 ***
stateSC             -0.509512   0.053344  -9.551  < 2e-16 ***
seasonpeak          -0.488308   0.311995  -1.565  0.11756
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 23041  on 17287  degrees of freedom
Residual deviance: 19372  on 17254  degrees of freedom
AIC: 19440

Number of Fisher Scoring iterations: 5
```

Table 46. Negative binomial GLM summary for spot discard rate in numbers from shrimp trawl fisheries.

```
Call:
glm.nb(formula = catch ~ year + season + data_set + state + depth_zone +
   offset(log_eff), data = CPUE_data, init.theta = 0.1946308757,
   link = log)
Deviance Residuals:
   Min      1Q  Median      3Q     Max
-1.8621  -1.4007  -0.7148  -0.1309   5.2769
Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept)        5.659865   0.325906  17.367  < 2e-16 ***
year1990           0.799449   0.230525   3.468 0.000526 ***
year1991           0.880239   0.230123   3.825 0.000131 ***
year1992          -0.288392   0.230018  -1.254 0.209938
year1993          -0.622286   0.230071  -2.705 0.006842 **
year1994          -0.199967   0.230006  -0.869 0.384640
year1995           0.281341   0.229958   1.223 0.221179
year1996          -0.887417   0.230129  -3.856 0.000116 ***
year1997          -3.324336   0.271444 -12.247  < 2e-16 ***
year1998          -1.256965   0.238318  -5.274 1.35e-07 ***
year1999          -1.312748   0.230263  -5.701 1.21e-08 ***
year2000          -1.056787   0.230182  -4.591 4.44e-06 ***
year2001          -0.061423   0.216617  -0.284 0.776756
year2002          -1.019844   0.213662  -4.773 1.83e-06 ***
year2003           0.328165   0.213281   1.539 0.123909
year2004          -0.687410   0.219107  -3.137 0.001708 **
year2005           0.065884   0.211645   0.311 0.755581
year2006           0.099218   0.217791   0.456 0.648708
year2007          -1.209071   0.212861  -5.680 1.37e-08 ***
year2008          -0.735592   0.206845  -3.556 0.000377 ***
year2009          -0.243182   0.203655  -1.194 0.232462
year2010          -0.318099   0.207185  -1.535 0.124718
year2011           0.853106   0.205926   4.143 3.45e-05 ***
year2012          -0.187737   0.205454  -0.914 0.360851
year2013          -0.010730   0.206417  -0.052 0.958545
year2014           0.452699   0.210126   2.154 0.031222 *
seasonpeak        -0.904388   0.258977  -3.492 0.000480 ***
data_setrock_shrimp -1.183710   0.437108  -2.708 0.006775 **
data_setSEAMAP      1.141451   0.087538  13.039  < 2e-16 ***
stateGA           -1.083271   0.079646 -13.601  < 2e-16 ***
stateNC            1.124155   0.080906  13.895  < 2e-16 ***
stateSC           -0.170220   0.074022  -2.300 0.021484 *
depth_zone>30m     -0.663407   0.454311  -1.460 0.144240
depth_zone10-30m   -0.009523   0.159439  -0.060 0.952375
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for Negative Binomial(0.1946) family taken to be 1.944617)

   Null deviance: 22410  on 16995  degrees of freedom
Residual deviance: 18875  on 16962  degrees of freedom
AIC: 155001
Number of Fisher Scoring iterations: 1
```

Table 47. **Model selection summary for spot lognormal (left) and binomial (right) GLMS of discard rate in weight from shrimp trawl fisheries.**

Drop	Df	Deviance	AIC	scaled dev.	Pr(>Chi)	Drop	Df	Deviance	AIC	LRT	Pr(>Chi)
none	NA	34,556	46,079	NA	NA	none	NA	19,372	19,440	NA	NA
YEAR	25	37,123	46,870	842	1.92E-161	YEAR	25	19,839	19,857	468	3.97E-83
data_set	2	37,117	46,914	840	4.44E-183	data_set	2	19,517	19,581	146	2.42E-32
depth_zone	2	34,646	46,105	30	2.51E-07	depth_zone	2	19,416	19,480	44	2.18E-10
state	3	37,634	47,075	1,002	5.92E-217	state	3	20,460	20,522	1,089	1.11E-235
season	1	34,568	46,080	4	5.10E-02	season	1	19,374	19,440	3	1.06E-01

Table 48. **Model selection summary for spot negative binomial GLM of discard rate in numbers from shrimp trawl fisheries.**

drop	Df	Deviance	AIC	Pr(>Chisq)
none	NA	18,875.3	155,001	NA
year	25	18,934.1	156,266	7.27E-262
season	1	18,876.4	155,024	5.94E-07
data_set	2	18,886.0	155,280	4.88E-62
state	3	18,939.9	156,485	1.03753785626662e-322
depth_zone	2	18,875.6	155,004	3.24E-02

Table 49. Summary of shrimp trawl effort data by year and state. Averages are highlighted in yellow.

year	state	hours_fished	trips	avg_hours	avg_gear	year	state	hours_fished	trips	avg_hours	avg_gear
1989	FL	147,659	5,124	17.57	1.64	2002	FL	68,108	2,872	14.46	1.64
1989	GA	646,487	7,711	28.04	2.99	2002	GA	317,808	3,745	28.1	3.02
1989	NC	1,234,260	30,077	18.32	2.24	2002	NC	553,747	12,425	19.21	2.32
1989	SC	393,248	10,192	14.84	2.6	2002	SC	272,943	7,074	14.84	2.6
1990	FL	189,299	6,246	18.48	1.64	2003	FL	106,948	2,763	20.48	1.89
1990	GA	523,746	6,247	28.04	2.99	2003	GA	292,499	3,461	28.36	2.98
1990	NC	802,614	19,558	18.32	2.24	2003	NC	326,112	8,995	15.56	2.33
1990	SC	371,741	9,635	14.84	2.6	2003	SC	226,425	6,293	14.11	2.55
1991	FL	147,733	5,843	15.14	1.67	2004	FL	99,818	2,730	19.98	1.83
1991	GA	849,379	10,131	28.04	2.99	2004	GA	226,756	2,751	27.66	2.98
1991	NC	1,017,306	24,790	18.32	2.24	2004	NC	356,922	7,573	19.72	2.39
1991	SC	533,501	13,827	14.84	2.6	2004	SC	272,049	5,954	17.71	2.58
1992	FL	127,136	4,757	16.1	1.66	2005	FL	94,763	2,649	19.13	1.87
1992	GA	748,436	8,927	28.04	2.99	2005	GA	172,942	2,432	24.27	2.93
1992	NC	389,472	9,491	18.32	2.24	2005	NC	157,026	4,324	16.14	2.25
1992	SC	477,901	12,386	14.84	2.6	2005	SC	139,663	4,131	12.71	2.66
1993	FL	139,354	5,314	16.39	1.6	2006	FL	87,610	2,499	17.27	2.03
1993	GA	752,628	8,977	28.04	2.99	2006	GA	156,168	2,073	24.38	3.09
1993	NC	533,885	13,010	18.32	2.24	2006	NC	227,146	5,587	16.46	2.47
1993	SC	448,346	11,620	14.84	2.6	2006	SC	115,618	3,661	12.1	2.61
1994	FL	167,861	6,484	15.69	1.65	2007	FL	82,025	2,308	16.53	2.15
1994	GA	719,092	8,577	28.04	2.99	2007	GA	124,718	1,651	23.83	3.17
1994	NC	678,297	16,529	18.32	2.24	2007	NC	290,549	6,668	17.57	2.48
1994	SC	391,859	10,156	14.84	2.6	2007	SC	90,831	3,268	10.69	2.6
1995	FL	139,566	5,723	14.87	1.64	2008	FL	64,847	2,147	15.41	1.96
1995	GA	828,838	9,886	28.04	2.99	2008	GA	115,676	1,784	22.13	2.93
1995	NC	694,507	16,924	18.32	2.24	2008	NC	326,774	5,980	21.18	2.58
1995	SC	469,760	12,175	14.84	2.6	2008	SC	92,251	3,531	10.01	2.61
1996	FL	143,918	5,600	13.67	1.88	2009	FL	62,668	2,173	15.34	1.88
1996	GA	651,518	7,771	28.04	2.99	2009	GA	128,305	1,772	23.74	3.05
1996	NC	475,001	11,575	18.32	2.24	2009	NC	249,333	5,744	17.79	2.44
1996	SC	352,503	9,136	14.84	2.6	2009	SC	93,365	3,194	11.33	2.58
1997	FL	119,267	5,314	12.4	1.81	2010	FL	85,296	2,656	15.82	2.03
1997	GA	749,107	8,935	28.04	2.99	2010	GA	141,441	2,224	21.78	2.92
1997	NC	558,470	13,609	18.32	2.24	2010	NC	225,387	5,508	17.05	2.4
1997	SC	435,228	11,280	14.84	2.6	2010	SC	122,570	4,346	11.06	2.55
1998	FL	114,184	5,154	14.48	1.53	2011	FL	83,501	2,745	15.52	1.96
1998	GA	664,932	7,931	28.04	2.99	2011	GA	129,594	1,935	22.55	2.97
1998	NC	389,809	9,499	18.32	2.24	2011	NC	200,784	4,354	18.67	2.47
1998	SC	365,969	9,485	14.84	2.6	2011	SC	88,496	3,176	10.8	2.58
1999	FL	102,769	5,102	13.61	1.48	2012	FL	78,664	2,586	15.52	1.96
1999	GA	603,142	7,194	28.04	2.99	2012	GA	127,852	1,909	22.55	2.97
1999	NC	563,025	13,720	18.32	2.24	2012	NC	284,760	6,175	18.67	2.47
1999	SC	386,072	10,006	14.84	2.6	2012	SC	117,085	4,202	10.8	2.58
2000	FL	69,444	3,666	13.34	1.42	2013	FL	52,230	1,717	15.52	1.96
2000	GA	443,679	5,292	28.04	2.99	2013	GA	86,731	1,295	22.55	2.97
2000	NC	488,849	12,911	18.03	2.1	2013	NC	252,986	5,486	18.67	2.47
2000	SC	367,088	9,514	14.84	2.6	2013	SC	87,409	3,137	10.8	2.58
2001	FL	72,511	3,221	14.07	1.6	2014	FL	62,937	2,069	15.52	1.96
2001	GA	260,741	3,110	28.04	2.99	2014	GA	106,086	1,584	22.55	2.97
2001	NC	397,548	9,808	17.7	2.29	2014	NC	202,813	4,398	18.67	2.47
2001	SC	241,111	6,249	14.84	2.6	2014	SC	87,409	3,137	10.8	2.58

Table 50. **Proportions used to partition South Atlantic shrimp trawl effort data. Effort data are partitioned across depth zones first and then within each depth zone across fisheries.**

	Depth Zone		
	=<10m	10-30m	>30m
all effort at depth	0.58	0.22	0.20
penaeid effort within depth	1.00	0.93	0.01
rock effort wtihin depth	0.00	0.07	0.99

Table 51. **Estimated spot gillnet discards in weight (lbs) and numbers. Lower confidence intervals are truncated at zero due to large variances. Data used to estimate mean weight and discards in numbers were pooled over all years due to small sample size.**

Year	Discards (lbs)	Discards LCI (lbs)	Discards UCI (lbs)	n Fish Counted	Total Subsample Weight (lbs)	n Subsamples	Mean Weight (lbs)	Discards (numbers)
1989	3,063	426	5,699	NA	NA	NA	NA	3,629
1990	2,866	399	5,333	NA	NA	NA	NA	3,396
1991	3,474	483	6,464	NA	NA	NA	NA	4,116
1992	0	0	0	NA	NA	NA	NA	0
1993	9,484	1,310	17,659	NA	NA	NA	NA	11,238
1994	18,796	12,395	25,197	NA	NA	NA	NA	22,272
1995	20,858	13,515	28,201	2	8	1	4.000	24,715
1996	931	355	1,508	1	1	1	1.000	1,104
1997	770	0	1,627	NA	NA	NA	NA	913
1998	2,450	528	4,372	NA	NA	NA	NA	2,903
1999	23,110	4,705	41,515	NA	NA	NA	NA	27,384
2000	18,715	1,730	35,701	32	33	4	1.031	22,176
2001	50,021	0	141,409	3	2	2	0.500	59,271
2002	22,175	0	62,226	NA	NA	NA	NA	26,276
2003	1,020	41	1,999	19	8	3	0.421	1,208
2004	573	0	1,812	1	1	1	0.500	679
2005	7	0	22	NA	NA	NA	NA	8
2006	27	0	84	2	1	1	0.700	32
2007	337	0	1,136	NA	NA	NA	NA	400
2008	2,223	136	4,310	NA	NA	NA	NA	2,634
2009	0	0	0	NA	NA	NA	NA	0
2010	111	0	345	NA	NA	NA	NA	132
2011	0	0	0	NA	NA	NA	NA	0
2012	0	0	0	NA	NA	NA	NA	0
2013	10,353	0	25,914	6	2	1	0.383	12,268
2014	5,838	0	14,584	NA	NA	NA	NA	6,917

Table 52. **Estimated spot trawl discards in weight (lbs) and numbers. Lower confidence intervals are truncated at zero due to large variances. Values highlighted in yellow are averages of adjacent years or the closest two year period with data.**

Year	Discards (lbs)	Discards LCI (lbs)	Discards UCI (lbs)	n Fish Counted	Total Subsample Weight (lbs)	n Subsamples	Mean Weight (lbs)	Discards (numbers)
1989	1,344,507	526,949	2,162,065	140	14	2	0.100	13,445,069
1990	5,740,647	1,708,309	9,772,985	300	68	2	0.227	25,326,383
1991	141,751	52,305	231,197	94	21	2	0.223	634,504
1992	17,379	0	41,417	204	62	30	0.304	57,183
1993	93,537	24,069	163,006	204	62	30	0.304	307,768
1994	1,542	0	3,770	204	62	30	0.304	5,074
1995	59,024	33,867	84,182	204	62	30	0.304	194,210
1996	4,706	869	8,544	204	62	30	0.304	15,484
1997	37,588	7,759	67,417	204	62	30	0.304	123,676
1998	8,751	0	24,583	204	62	30	0.304	28,794
1999	11,098	0	24,523	204	62	30	0.304	36,517
2000	18,678	0	52,179	204	62	30	0.304	61,457
2001	1,033	507	1,559	110	41	28	0.373	2,771
2002	3,333	919	5,747	240	42	37	0.175	19,045
2003	0	0	0	241	42	38	0.176	0
2004	916	253	1,579	241	42	38	0.176	5,220
2005	10,563	0	23,846	241	42	38	0.176	60,181
2006	0	0	0	241	42	38	0.176	0
2007	8,029	468	15,590	1	0	1	0.300	26,763
2008	7,353	525	14,181	9	2	2	0.178	41,361
2009	7,196	2,266	12,125	50	5	2	0.104	69,189
2010	51,590	8,115	95,065	78	13	2	0.160	321,923
2011	6,056	0	13,146	79	13	3	0.163	37,088
2012	24,801	10,868	38,735	1	0	1	0.400	62,003
2013	125,149	23,228	227,069	6	2	2	0.317	395,206
2014	24,348	2,366	46,329	5	2	1	0.300	81,159

Table 53. Comparison of spot discard estimates from trawls in Mid-Atlantic fisheries with and without large discard tows observed in 1989 (1 tow) and 1990 (5 tows). Ratios are the weight of discarded spot to the weight of all species landed.

Year	Ratio	Ratio Variance	Ratio CV	Discards (lbs)	Discards (numbers)
Estimates with all data					
1989	0.0141	1.83E-05	0.30	1,344,507	13,445,069
1990	0.0626	4.83E-04	0.35	5,740,647	25,326,383
Estimates excluding anomalous tows in 1989 and 1990					
1989	0.0045	1.41E-06	0.26	432,981	4,329,810
1990	0.0040	2.20E-06	0.37	365,926	1,614,379

Table 54. Spot discard estimates (millions of fish) from South Atlantic shrimp trawl fisheries with values corresponding to 95% confidence intervals. Unadjusted estimates are estimates before making adjustments due to catch reductions by BRDs.

Year	LCI	Discards	UCI	Unadjusted Discards
1989	423	583	807	454
1990	694	930	1,250	723
1991	953	1,272	1,705	990
1992	154	208	284	162
1993	132	177	240	138
1994	232	311	419	242
1995	399	538	731	419
1996	87	116	157	91
1997	6	9	13	NA
1998	41	56	77	NA
1999	51	69	95	NA
2000	54	73	98	NA
2001	117	152	198	NA
2002	60	78	101	NA
2003	154	199	258	NA
2004	59	77	102	NA
2005	66	85	111	NA
2006	82	107	140	NA
2007	26	34	45	NA
2008	47	59	76	NA
2009	62	77	96	NA
2010	55	69	88	NA
2011	157	197	249	NA
2012	75	94	118	NA
2013	76	96	121	NA
2014	100	127	163	NA

Table 55. Spot discard estimates (metric tons) from South Atlantic shrimp trawl fisheries with values corresponding to 95% confidence intervals. Unadjusted estimates are estimates before making adjustments due to catch reductions by BRDs.

Year	LCI	Discards	UCI	Unadjusted Discards
1989	20,280	27,545	37,543	21,372
1990	13,157	17,239	22,682	13,382
1991	39,320	50,976	66,366	39,634
1992	8,392	11,219	15,083	8,694
1993	4,823	6,387	8,501	4,953
1994	8,682	11,603	15,581	8,990
1995	10,549	13,911	18,435	10,793
1996	3,043	4,051	5,420	3,139
1997	3,556	4,876	6,719	0
1998	2,577	3,386	4,473	0
1999	1,514	2,044	2,776	0
2000	1,793	2,439	3,334	0
2001	3,044	3,861	4,922	0
2002	2,086	2,720	3,564	0
2003	3,660	4,641	5,911	0
2004	2,630	3,413	4,452	0
2005	1,486	1,874	2,378	0
2006	3,453	4,458	5,784	0
2007	1,316	1,677	2,149	0
2008	2,113	2,628	3,289	0
2009	2,623	3,191	3,906	0
2010	1,977	2,473	3,111	0
2011	4,287	5,243	6,450	0
2012	5,330	6,489	7,948	0
2013	2,904	3,569	4,410	0
2014	4,553	5,650	7,050	0

Table 56. Mean weight of spot discarded in South Atlantic shrimp trawl fisheries based on the discard estimates in weight and numbers.

Year	Discard Numbers	Discard Weight (kg)	Annual Mean Weight
1989	583,370,348	27,545,377	0.047
1990	929,664,646	17,238,964	0.019
1991	1,272,210,025	50,975,781	0.040
1992	208,192,851	11,219,290	0.054
1993	177,436,234	6,387,178	0.036
1994	310,993,951	11,603,132	0.037
1995	538,455,701	13,911,437	0.026
1996	116,476,304	4,051,409	0.035
1997	9,229,182	4,875,524	0.528
1998	55,725,316	3,386,127	0.061
1999	69,292,192	2,044,180	0.030
2000	72,777,842	2,439,134	0.034
2001	152,054,525	3,861,087	0.025
2002	77,579,021	2,720,041	0.035
2003	198,910,447	4,640,864	0.023
2004	77,409,152	3,413,310	0.044
2005	85,110,306	1,873,689	0.022
2006	106,681,825	4,457,674	0.042
2007	34,223,459	1,676,660	0.049
2008	59,337,373	2,627,907	0.044
2009	76,673,915	3,190,751	0.042
2010	69,181,376	2,473,140	0.036
2011	196,989,629	5,243,226	0.027
2012	93,779,860	6,488,747	0.069
2013	95,573,541	3,568,750	0.037
2014	127,347,986	5,650,194	0.044

Table 57. Spot length and weight sample sizes by year obtained during MRFSS and MRIP sampling.

Year	Length	Weight	Year	Length	Weight
1981	1,514	1,719	1998	2,957	2,930
1982	1,905	1,794	1999	1,964	2,011
1983	3,349	3,090	2000	1,850	1,863
1984	1,281	1,146	2001	2,764	2,800
1985	5,104	4,816	2002	1,656	1,689
1986	5,607	5,249	2003	2,921	2,859
1987	3,955	3,741	2004	4,447	4,475
1988	1,834	1,761	2005	3,422	3,260
1989	3,986	3,835	2006	3,947	3,982
1990	2,742	2,716	2007	3,990	3,973
1991	4,764	5,044	2008	3,611	3,632
1992	3,216	3,349	2009	4,856	4,864
1993	2,470	2,403	2010	2,033	1,990
1994	4,581	4,572	2011	3,312	3,344
1995	2,753	2,550	2012	1,172	932
1996	3,150	2,819	2013	1,731	1,151
1997	3,016	2,942	2014	1,289	857

Table 58. Spot length sample size from MRIP at-sea sampling of headboats by year and state.

Year	FL	GA	SC	NC	VA	MD	DE	NJ	Total
2004	0	0	0	9	25	86	0	0	120
2005	0	0	0	6	231	464	0	4	705
2006	0	0	0	31	14	183	0	0	228
2007	0	0	0	3	35	167	3	0	208
2008	0	0	0	57	24	53	16	0	150
2009	0	0	1	13	11	58	1	0	84
2010	0	0	0	2	109	102	3	1	217
2011	0	0	0	7	64	49	5	0	125
2012	0	0	1	3	9	228	6	1	248
2013	0	0	0	7	18	357	0	4	386
2014	0	0	2	40	5	18	1	0	66

Table 59. Number of recreational harvest weight estimates by pooling level for MRFSS strata with zero harvest weight estimates and positive harvest number estimates.

Factor Collapsed for Pooling			
Area	Mode	State	Wave
0	1	16	15

Table 60. Total harvest number estimates without weight, imputed harvest weight estimates, and mean weights for MRFSS strata with zero harvest weight estimates and positive number estimates.

Year	Numbers	Weight (lbs.)	Mean Weight
1981	0	NA	NA
1982	0	NA	NA
1983	8,975	2,754	0.31
1984	21,046	5,084	0.24
1985	1,807	551	0.30
1986	0	NA	NA
1987	3,343	843	0.25
1988	10,657	3,885	0.36
1989	1,076	310	0.29
1990	2,881	915	0.32
1991	4,769	1,340	0.28
1992	0	NA	NA
1993	50,385	19,864	0.39
1994	35,127	13,869	0.39
1995	1,962	816	0.42
1996	0	NA	NA
1997	0	NA	NA
1998	8,797	4,058	0.46
1999	0	NA	NA
2000	2,597	943	0.36
2001	0	NA	NA
2002	3,953	1,594	0.40
2003	25,408	11,451	0.45

Table 61. MRIP harvest estimates (numbers and weight) by pooling level for APAIS design change calibration. Headboat estimates were not adjusted (No Ratio) because the design for this mode (at-sea sampling) did not change in 2013.

Ratio Pooling Level				
No Pooling	Collapse State	Collapse Species	Collapse State and Species	No Ratio
81	43	64	0	28

Table 62. MRIP released alive (number) estimates by pooling level for APAIS design change calibration. Headboat estimates were not adjusted (No Ratio) because the design for this mode (at-sea sampling) did not change in 2013.

Ratio Pooling Level				
No Pooling	Collapse State	Collapse Species	Collapse State and Species	No Ratio
81	94	13	0	28

Table 63. MRFSS and MRIP recreational harvest of spot (millions of fish) by state and coastwide.

Year	FL	GA	SC	NC	VA	MD	DE	NJ	NY	CT	Coastwide
1981	0.983	0.153	0.692	4.948	14.095	1.167	0.022	0.034	0.054	0.000	22.147
1982	0.904	0.103	1.513	5.072	5.444	3.523	0.101	0.477	0.000	0.000	17.136
1983	0.600	0.138	1.194	6.021	14.748	1.976	0.018	0.000	0.000	0.000	24.695
1984	0.487	0.447	0.891	3.392	1.729	1.079	0.019	0.010	0.000	0.000	8.056
1985	1.060	0.077	2.896	10.828	6.259	1.254	0.000	0.015	0.019	0.000	22.408
1986	0.119	0.170	2.468	3.254	5.019	5.223	0.015	0.012	0.005	0.000	16.285
1987	0.091	0.098	0.738	2.618	4.496	4.196	0.000	0.000	0.000	0.000	12.236
1988	0.816	0.071	2.399	3.146	2.451	0.342	0.003	0.429	0.000	0.000	9.656
1989	0.083	0.043	1.326	3.596	4.522	1.805	0.056	0.001	0.001	0.000	11.433
1990	0.009	0.022	0.175	2.443	6.497	3.352	0.055	0.032	0.000	0.000	12.585
1991	0.332	0.013	0.736	2.849	10.803	2.762	0.186	0.109	0.000	0.000	17.788
1992	0.440	0.032	1.464	1.564	7.680	2.428	0.110	0.025	0.000	0.000	13.743
1993	1.164	0.282	1.775	2.530	3.472	2.829	0.004	0.010	0.001	0.000	12.067
1994	0.169	0.012	1.635	7.292	4.027	2.473	0.114	0.178	0.024	0.000	15.922
1995	0.172	0.035	1.076	4.110	3.280	1.822	0.064	0.004	0.000	0.000	10.563
1996	0.079	0.017	1.750	2.470	1.345	0.748	0.001	0.029	0.000	0.000	6.440
1997	0.039	0.007	0.837	1.772	4.060	1.016	0.155	0.025	0.000	0.000	7.910
1998	0.148	0.008	0.601	3.528	2.437	1.648	0.119	0.000	0.000	0.000	8.489
1999	0.325	0.007	0.986	1.609	0.696	0.842	0.024	0.000	0.000	0.000	4.489
2000	0.050	0.004	0.303	2.367	0.638	1.898	0.082	0.346	0.613	0.000	6.302
2001	0.803	0.005	0.905	4.490	1.253	1.483	0.063	0.000	0.000	0.000	9.001
2002	0.032	0.009	0.484	3.182	1.966	0.851	0.027	0.000	0.000	0.000	6.550
2003	0.104	0.014	0.645	4.669	1.769	4.595	0.037	0.000	0.000	0.000	11.833
2004	0.010	0.002	0.948	5.362	1.560	0.996	0.023	0.000	0.000	0.000	8.902
2005	0.037	0.005	0.486	4.200	4.280	2.093	0.181	0.082	0.000	0.000	11.363
2006	0.013	0.002	1.310	4.551	2.895	3.716	0.279	0.016	0.000	0.000	12.782
2007	0.051	0.004	0.663	4.832	7.357	4.291	0.290	0.000	0.002	0.000	17.491
2008	0.094	0.011	3.197	2.557	6.169	2.293	0.224	0.172	0.000	0.000	14.717
2009	0.048	0.033	0.730	1.728	2.765	2.521	0.347	0.014	0.000	0.000	8.184
2010	0.188	0.002	0.252	1.312	2.042	1.366	0.164	1.134	0.000	0.000	6.460
2011	0.306	0.001	0.764	1.609	3.661	0.907	0.374	0.001	0.000	0.000	7.624
2012	0.125	0.000	1.115	1.255	2.336	0.876	0.147	0.878	0.059	0.000	6.791
2013	0.132	0.007	0.732	1.465	4.288	0.936	0.248	0.329	0.013	0.000	8.150
2014	0.609	0.016	0.466	2.112	3.909	1.254	0.345	0.013	0.000	0.000	8.723

Table 64. MRFSS and MRIP recreational harvest of spot (metric tons) by state and coastwide.

Year	FL	GA	SC	NC	VA	MD	DE	NJ	NY	CT	Coastwide
1981	176	29	82	673	2,566	313	5	3	11	0	3,857
1982	133	11	177	616	853	370	11	48	0	0	2,219
1983	96	16	165	921	1,413	201	2	0	0	0	2,814
1984	69	48	95	367	214	194	3	2	0	0	993
1985	120	7	249	1,762	1,014	109	0	2	2	0	3,266
1986	14	13	257	302	657	710	2	1	1	0	1,958
1987	19	8	128	389	716	932	0	0	0	0	2,193
1988	104	8	344	452	400	45	1	48	0	0	1,403
1989	13	4	163	524	781	438	6	0	0	0	1,930
1990	1	4	28	346	1,167	616	7	3	0	0	2,173
1991	61	2	139	410	1,534	442	30	11	0	0	2,629
1992	95	4	224	228	1,271	481	21	5	0	0	2,329
1993	234	62	261	458	534	456	0	1	0	0	2,008
1994	34	2	265	1,039	657	433	20	18	4	0	2,470
1995	25	4	137	707	589	376	13	1	0	0	1,852
1996	15	3	279	401	274	171	0	6	0	0	1,150
1997	8	1	144	408	706	259	29	5	0	0	1,559
1998	27	1	129	705	480	359	21	0	0	0	1,722
1999	48	1	221	365	137	159	6	0	0	0	937
2000	8	1	73	504	141	379	19	26	74	0	1,224
2001	161	1	196	1,000	285	387	11	0	0	0	2,041
2002	5	2	79	556	467	190	6	0	0	0	1,305
2003	20	3	128	967	493	1,042	8	0	0	0	2,661
2004	1	0	154	1,102	449	252	4	0	0	0	1,962
2005	6	1	79	709	943	404	40	19	0	0	2,201
2006	2	0	231	763	647	584	41	2	0	0	2,271
2007	11	1	86	704	1,305	730	59	0	0	0	2,895
2008	14	2	421	428	1,183	350	29	10	0	0	2,437
2009	8	5	126	264	493	471	59	2	0	0	1,428
2010	34	0	34	188	301	245	25	174	0	0	1,000
2011	50	0	125	248	556	153	59	0	0	0	1,192
2012	17	0	137	160	321	153	22	67	28	0	905
2013	19	1	137	209	602	126	49	54	3	0	1,199
2014	75	2	71	320	579	183	95	3	0	0	1,328

Table 65. MRFSS and MRIP recreational live releases of spot (millions of fish) by state and coastwide.

Year	FL	GA	SC	NC	VA	MD	DE	NJ	NY	CT	Coastwide
1981	0.090	0.008	0.115	1.028	12.428	1.896	0.002	0.036	0.000	0.000	15.603
1982	0.287	0.062	0.512	1.128	2.256	2.344	0.007	1.362	0.000	0.000	7.959
1983	0.261	0.056	0.269	0.911	3.790	1.564	0.000	0.080	0.000	0.000	6.931
1984	0.182	0.025	0.484	1.332	3.629	1.603	0.019	0.000	0.000	0.000	7.273
1985	0.238	0.024	0.720	0.642	2.750	1.026	0.000	0.004	0.031	0.000	5.435
1986	0.014	0.029	0.463	1.141	3.102	4.121	0.000	0.111	0.000	0.000	8.982
1987	0.080	0.040	0.425	0.830	2.399	0.375	0.002	0.000	0.000	0.000	4.150
1988	0.154	0.024	0.154	1.392	1.065	1.001	0.008	0.155	0.000	0.000	3.952
1989	0.031	0.002	0.194	0.734	3.494	1.056	0.056	0.006	0.000	0.000	5.574
1990	0.043	0.006	0.019	1.288	6.131	2.827	0.014	0.020	0.000	0.000	10.349
1991	0.235	0.021	0.141	1.323	9.818	3.060	0.095	0.129	0.000	0.000	14.821
1992	0.090	0.024	0.390	1.178	2.887	0.730	0.017	0.002	0.000	0.000	5.318
1993	0.259	0.067	0.193	0.739	1.914	2.386	0.051	0.000	0.000	0.000	5.609
1994	0.469	0.031	0.449	1.906	2.860	1.523	0.074	0.224	0.011	0.000	7.548
1995	0.376	0.014	0.464	1.447	1.602	0.365	0.020	0.031	0.000	0.000	4.318
1996	0.091	0.007	0.295	1.297	0.800	0.297	0.002	0.055	0.010	0.000	2.855
1997	0.025	0.002	0.343	0.630	1.885	1.920	0.124	0.030	0.000	0.000	4.960
1998	0.082	0.017	0.430	0.909	1.216	0.905	0.106	0.018	0.000	0.000	3.683
1999	0.742	0.015	0.121	0.885	0.472	0.867	0.022	0.000	0.000	0.000	3.124
2000	0.076	0.024	0.162	0.675	0.692	1.515	0.043	0.023	0.221	0.000	3.431
2001	0.104	0.016	0.215	1.598	1.329	0.835	0.018	0.003	0.000	0.000	4.119
2002	0.062	0.028	0.145	0.940	0.673	0.700	0.038	0.004	0.003	0.000	2.593
2003	0.149	0.043	0.324	1.583	1.304	0.957	0.019	0.055	0.000	0.000	4.434
2004	0.012	0.013	0.266	2.103	0.790	0.600	0.054	0.000	0.000	0.000	3.840
2005	0.052	0.031	0.222	2.350	2.231	3.200	0.189	0.010	0.000	0.000	8.284
2006	0.029	0.002	0.530	4.262	1.508	2.257	0.091	0.088	0.000	0.000	8.766
2007	0.034	0.011	0.122	2.199	1.893	2.730	0.036	0.200	0.001	0.000	7.226
2008	0.142	0.039	0.191	2.345	1.595	2.885	0.135	1.088	0.000	0.000	8.419
2009	0.043	0.011	0.414	2.090	1.418	1.076	0.188	0.012	0.000	0.000	5.253
2010	0.026	0.001	0.076	1.549	1.234	1.651	0.082	0.315	0.000	0.000	4.933
2011	0.169	0.015	0.267	1.792	2.574	0.508	0.087	0.001	0.000	0.000	5.413
2012	0.406	0.006	0.146	1.437	1.369	1.651	0.064	0.751	0.050	0.000	5.879
2013	0.111	0.009	0.958	1.314	2.218	2.622	0.214	0.748	0.000	0.001	8.194
2014	0.575	0.027	0.427	0.891	1.174	0.566	0.079	0.015	0.000	0.000	3.754

Table 66. MRFSS and MRIP recreational live releases of spot (metric tons) coastwide.

Year	Coastwide
1981	157
1982	60
1983	44
1984	56
1985	45
1986	73
1987	39
1988	35
1989	58
1990	104
1991	129
1992	50
1993	58
1994	67
1995	42
1996	28
1997	63
1998	42
1999	35
2000	40
2001	56
2002	31
2003	60
2004	29
2005	55
2006	98
2007	69
2008	70
2009	69
2010	27
2011	70
2012	50
2013	95
2014	64

Table 67. Total numbers (millions of fish) and weight (metric tons) of spot caught and released by recreational anglers assumed to die post-release (15%).

Year	Millions	Metric Tons
1981	2.340	157
1982	1.194	60
1983	1.040	44
1984	1.091	56
1985	0.815	45
1986	1.347	73
1987	0.623	39
1988	0.593	35
1989	0.836	58
1990	1.552	104
1991	2.223	129
1992	0.798	50
1993	0.841	58
1994	1.132	67
1995	0.648	42
1996	0.428	28
1997	0.744	63
1998	0.552	42
1999	0.469	35
2000	0.515	40
2001	0.618	56
2002	0.389	31
2003	0.665	60
2004	0.576	29
2005	1.243	55
2006	1.315	98
2007	1.084	69
2008	1.263	70
2009	0.788	69
2010	0.740	27
2011	0.812	70
2012	0.882	50
2013	1.229	95
2014	0.563	64

Table 68. MRFSS and MRIP coastwide recreational harvest of spot (millions of fish) and PSEs.

Year	Mean	PSE
1981	22.147	36.3
1982	17.136	25.4
1983	24.695	41.4
1984	8.056	27.5
1985	22.408	24.2
1986	16.285	25.5
1987	12.236	19.2
1988	9.656	24.8
1989	11.433	15.6
1990	12.585	20.1
1991	17.788	18.7
1992	13.743	23.6
1993	12.067	19.7
1994	15.922	15.3
1995	10.563	22.7
1996	6.440	29.3
1997	7.910	28.1
1998	8.489	21.0
1999	4.489	20.2
2000	6.302	22.2
2001	9.001	20.2
2002	6.550	20.4
2003	11.833	17.6
2004	8.902	12.6
2005	11.363	15.8
2006	12.782	18.3
2007	17.491	15.5
2008	14.717	24.3
2009	8.184	14.3
2010	6.460	18.1
2011	7.624	15.2
2012	6.791	19.5
2013	8.150	7.8
2014	8.723	17.3

Table 69. **MRFSS and MRIP coastwide recreational harvest of spot (metric tons) and PSEs.**

Year	Mean	PSE
1981	3,857	33.9
1982	2,219	30.2
1983	2,814	41.1
1984	993	29.6
1985	3,266	26.7
1986	1,958	25.9
1987	2,193	22.2
1988	1,403	28.5
1989	1,930	16.9
1990	2,173	22.2
1991	2,629	19.0
1992	2,329	25.4
1993	2,008	19.4
1994	2,470	15.2
1995	1,852	24.9
1996	1,150	30.0
1997	1,559	25.5
1998	1,722	22.8
1999	937	22.6
2000	1,224	25.3
2001	2,041	20.5
2002	1,305	22.2
2003	2,661	18.6
2004	1,962	12.7
2005	2,201	16.9
2006	2,271	19.2
2007	2,895	16.1
2008	2,437	28.2
2009	1,428	15.3
2010	1,000	18.4
2011	1,192	14.4
2012	905	19.6
2013	1,199	7.9
2014	1,328	14.9

Table 70. **MRFSS and MRIP coastwide recreational live releases of spot (millions of fish) and PSEs.**

Year	Mean	PSE
1981	15.603	72.5
1982	7.959	35.0
1983	6.931	57.8
1984	7.273	32.3
1985	5.435	22.1
1986	8.982	27.1
1987	4.150	20.3
1988	3.952	40.7
1989	5.574	16.4
1990	10.349	19.3
1991	14.821	18.1
1992	5.318	20.0
1993	5.609	20.9
1994	7.548	12.9
1995	4.318	17.5
1996	2.855	19.1
1997	4.960	20.4
1998	3.683	16.3
1999	3.124	20.5
2000	3.431	19.5
2001	4.119	13.9
2002	2.593	16.8
2003	4.434	20.0
2004	3.840	11.8
2005	8.284	14.0
2006	8.766	15.8
2007	7.226	13.9
2008	8.419	14.6
2009	5.253	12.7
2010	4.933	13.4
2011	5.413	12.8
2012	5.879	13.0
2013	8.194	8.1
2014	3.754	9.2

Table 71. Spot harvest estimates (number of fish) from the SERHS.

Year	Harvest	Year	Harvest
1981	363	1998	0
1982	0	1999	1
1983	0	2000	0
1984	0	2001	0
1985	7	2002	0
1986	0	2003	0
1987	35	2004	0
1988	0	2005	35
1989	0	2006	0
1990	57	2007	0
1991	58	2008	0
1992	227	2009	0
1993	28	2010	0
1994	0	2011	0
1995	0	2012	0
1996	0	2013	17
1997	0	2014	1

Table 72. Spot release estimates (number of fish) by disposition from the SERHS.

Year	Dead	Live	Disposition Unknown
2004	0	0	0
2005	0	0	0
2006	0	0	0
2007	0	0	0
2008	0	0	0
2009	0	0	0
2010	0	0	0
2011	0	0	0
2012	0	0	0
2013	0	0	3
2014	0	0	12

Table 73. Coastwide removals of spot combined across fisheries in metric tons and millions of fish. 1989 is the first year removal data from all fisheries are available.

Year	Metric Tons	Millions of Fish
1989	33,598	640
1990	25,364	999
1991	57,287	1,324
1992	16,900	251
1993	12,002	219
1994	18,607	356
1995	19,739	574
1996	8,157	145
1997	9,899	41
1998	8,947	89
1999	5,860	92
2000	7,066	99
2001	9,366	177
2002	6,663	97
2003	10,221	227
2004	8,248	101
2005	6,266	108
2006	8,559	132
2007	7,521	73
2008	6,797	87
2009	7,328	100
2010	4,637	83
2011	9,134	220
2012	8,212	107
2013	6,551	115
2014	9,492	150

Table 74. Surveys considered for developing abundance and biomass indices by the spot SAS for this assessment.

Survey Considered	Time Series Available	Used	Reason Not Used (if applicable)
NJ DFW Delaware River Seine Survey	1980-2014	N	Localized survey, too many zeros
NJ DFW Delaware Bay Trawl Survey	1991-2014	N	Localized survey, fixed design
NJ DFW Ocean Trawl Survey	1989-2014	N	Not representative of whole range
DE DFW 30ft Trawl Survey	1966-1971, 1979-1984, 1990-2014	N	Fixed design, localized survey
DE DFW 17ft Trawl Survey	1978-2014	N	Fixed design, localized survey
MD DNR Chesapeake Blue Crab Trawl Survey	1980, consistent from 1989-2014	N	Fixed design
MD DNR Striped Bass Seine Survey	1966-2014	N	Too many zeros
MD DNR Coastal Bays Trawl Survey	1972-2014, standardized 1989	N	YOY survey, others used instead
MD DNR Coastal Bay Seine Survey	1972-2014	N	Too many zeros
MD DNR Choptank River Gill Net Survey	2013-2014	N	Short time series
VIMS Juvenile Trawl Survey	1988-2014	N	YOY survey
NC P120 (estuarine trawl survey)	1970-2014	N	YOY survey, others used instead
NC P195 (NCDMF Trawl Survey)	1987-2014	Y	NA
NC P915	1987-2014	N	Not representative of stock
NC P135	1990-2014	N	Other survey in this region used
NC P123	1991-2014	N	Other survey in this region used
NC P100		N	Fixed design
NC P430 (pound net survey)	1986-2014	N	Other survey in this region used
NC P433	1979-2014	N	Other survey in this region used
NC P434 (gill net survey)	1982-2014	N	Other survey in this region used
NC P435 (beach seine)		N	Other survey in this region used
NC P537	1978-2014	N	Other survey in this region used
NC P441	1978-2014	N	Other survey in this region used
SC DNR Bears Bluff Shrimp Trawl	1952-1969	N	Localized survey, not representative
SC DNR Trammel Net Survey	1990-2014	N	Localized survey, not representative
SC DNR Electroshock Survey	2001-2014	N	Too many zeros, not representative of stock
SEAMAP Trawl Survey	1990-2014	Y	NA
GA DNR Ecological Monitoring Trawl Survey	1976-2014	N	YOY survey, others more representative

Table 74. ***Continued*****. Surveys considered for developing abundance and biomass indices by the spot SAS for this assessment.**

Survey Considered	Time Series Available	Used	Reason Not Used (if applicable)
GA DNR Gill Net Survey	2003-2014	N	Localized survey, not representative
FL FWC Fishery Independent Monitoring Bag Seine Survey	1996-2014	N	Localized survey, not representative
FL FWC Fishery Independent Monitoring Haul Seine Survey	1996-2014	N	Localized survey
FL FWC Fishery Independent Monitoring Trawl Survey	1996-2014	N	Localized survey
NMFS Trawl Survey	1972-2014	Y	NA
NEAMAP Trawl Survey	2007-2014	Y	NA
ChesMMAP Trawl Survey	2002-2014	Y	NA

Table 75. Annual number of trawl tows by strata for the NMFS Trawl Survey.

Year	1OFF	2OFF	3OFF	4OFF	5OFF	Total
1972	9	6	6	4	9	34
1973	17	6	4	4	11	42
1974	7	6	5	4	12	34
1975	6	4	4	4	7	25
1976	4	4	4	4	6	22
1977	4	4	4	4	6	22
1978	4	4	4	4	6	22
1979	4	4	4	4	6	22
1980	3	4	4	4	6	21
1981	4	4	4	4	6	22
1982	4	4	4	4	6	22
1983	4	5	4	4	6	23
1984	4	4	4	4	6	22
1985	4	4	4	4	6	22
1986	4	4	4	4	6	22
1987	4	4	4	4	6	22
1988	4	4	4	4	6	22
1989	4	4	4	4	6	22
1990	6	4	4	5	6	25
1991	4	4	4	4	6	22
1992	4	4	4	4	7	23
1993	4	4	4	4	6	22
1994	4	4	4	4	6	22
1995	4	4	4	4	6	22
1996	4	4	4	4	6	22
1997	4	4	4	4	6	22
1998	4	4	4	4	6	22
1999	4	4	4	4	6	22
2000	4	5	4	4	6	23
2001	4	4	4	4	6	22
2002	5	4	4	4	6	23
2003	4	4	4	4	6	22
2004	4	4	4	4	6	22
2005	4	4	4	4	6	22
2006	4	4	4	4	6	22
2007	4	4	4	4	6	22
2008	4	4	4	4	6	22
2009	5	8	6	4	12	35
2010	6	7	6	6	12	37
2011	13	6	6	11	12	48
2012	6	7	6	6	13	38
2013	9	7	6	6	13	41
2014	8	8	6	6	12	40
Total	220	199	187	188	312	1106

Table 76. **Annual proportion of positive tows by strata for spot from the NMFS Trawl Survey using pooled strata scheme.**

Year	1OFF	2OFF	3OFF	4OFF	5OFF
1972	0.00	0.00	0.17	0.75	0.33
1973	0.00	0.00	0.25	0.25	0.91
1974	0.00	0.00	0.20	1.00	0.92
1975	0.00	0.00	0.50	0.75	0.86
1976	0.00	0.25	0.25	0.75	0.83
1977	0.50	0.25	1.00	1.00	0.83
1978	0.00	0.00	0.75	0.75	1.00
1979	0.00	0.00	0.50	1.00	1.00
1980	0.00	0.00	0.25	0.50	0.83
1981	0.00	0.75	1.00	0.75	1.00
1982	0.25	0.25	1.00	1.00	0.67
1983	0.25	0.20	0.50	1.00	0.33
1984	0.00	0.25	1.00	1.00	0.83
1985	0.00	0.50	1.00	1.00	1.00
1986	0.00	0.25	1.00	1.00	1.00
1987	0.00	0.00	0.25	0.50	0.83
1988	0.00	0.25	0.25	0.75	0.67
1989	0.00	0.25	1.00	1.00	1.00
1990	0.00	0.25	0.75	0.80	1.00
1991	0.00	0.00	0.75	0.50	0.67
1992	0.00	0.00	0.50	0.25	0.14
1993	0.00	0.00	0.25	0.50	0.17
1994	0.00	0.00	0.50	1.00	0.33
1995	0.25	0.00	1.00	1.00	1.00
1996	0.00	0.00	0.25	1.00	0.67
1997	0.00	0.00	0.75	0.50	0.67
1998	0.00	0.00	0.75	0.75	0.50
1999	0.00	0.00	0.75	0.50	1.00
2000	0.00	0.00	0.00	0.75	0.67
2001	0.00	0.00	0.00	0.25	0.00
2002	0.00	0.25	1.00	0.50	0.50
2003	0.00	0.00	0.75	0.75	1.00
2004	0.00	0.00	0.50	0.50	0.83
2005	0.00	0.25	0.75	0.25	1.00
2006	0.00	0.50	0.75	1.00	1.00
2007	0.00	0.25	1.00	1.00	0.83
2008	0.25	0.50	1.00	1.00	1.00
2009	0.00	0.00	0.67	1.00	1.00
2010	0.50	0.71	1.00	0.83	0.50
2011	0.31	1.00	1.00	0.91	0.92
2012	0.00	0.71	0.67	1.00	1.00
2013	0.33	0.57	0.83	0.00	0.69
2014	0.13	0.13	0.83	0.83	0.58

Table 77. Age-0 indices of abundance and CVs developed for the spot assessment. All indices were in numbers per tow and have been standardized to their mean.

	NCDMF June Trawl		SEAMAP Fall Trawl		NMFS Fall Trawl		ChesMMAP Summer- Fall Trawl		NEAMAP Fall Trawl	
Year	Index	CV	Index	CV	Index	CV	Index	CV	Index	CV
1989	0.5050	0.1455	0.1918	0.3342	3.8526	0.0664				
1990	2.0224	0.1159	0.2627	0.1849	0.6861	0.0553				
1991	0.6570	0.1561	0.3704	0.1959	0.1380	0.2101				
1992	0.1765	0.2103	0.1281	0.2480	0.0444	0.1228				
1993	1.1139	0.1474	0.1500	0.4129	0.0256	0.1661				
1994	0.1948	0.1689	1.2351	0.2547	1.1866	0.1197				
1995	0.0960	0.2106	0.0719	0.1644	0.3425	0.0592				
1996	0.8724	0.1216	0.5658	0.1751	0.2936	0.1165				
1997	0.3996	0.1613	0.1010	0.2576	0.1236	0.1019				
1998	0.3140	0.2354	0.1505	0.2084	0.0718	0.1065				
1999	1.3754	0.2152	0.7167	0.3830	0.6050	0.0363				
2000	0.2787	0.1960	0.0847	0.4089	0.2985	0.0730				
2001	0.5169	0.2223	0.1527	0.2244	0.0005	0.3110				
2002	0.8841	0.1318	0.3398	0.2269	0.2194	0.1152	0.6630	0.3025		
2003	1.8855	0.1601	0.7943	0.4688	0.1398	0.0666	0.7769	0.2909		
2004	1.2624	0.2440	0.2174	0.2759	0.6557	0.0620	1.2951	0.2853		
2005	0.4614	0.1601	9.2655	0.3407	1.6146	0.0538	1.7277	0.2615		
2006	0.1921	0.1928	0.3094	0.1264	0.9300	0.0421	5.2776	0.2577		
2007	0.3853	0.2424	0.1511	0.2627	0.6343	0.1104	0.7931	0.2915	0.5228	0.2586
2008	3.1594	0.2301	0.5208	0.5379	1.1296	0.0487	1.0832	0.3175	1.3452	0.2783
2009	0.4469	0.1822	0.7962	0.2732	1.3712	0.0333	0.2582	0.2671	0.1634	0.1507
2010	1.6853	0.1895	6.8526	0.3420	2.9291	0.0368	0.6741	0.3483	0.5291	0.2697
2011	0.9423	0.1477	0.6487	0.2156	2.5109	0.0374	0.0215	0.2605	0.0938	0.1477
2012	2.4666	0.1047	0.7748	0.1819	4.4639	0.0263	0.2060	0.2800	5.0683	0.2556
2013	2.7690	0.1697	0.6494	0.4163	1.6031	0.0452	0.1876	0.2689	0.2195	0.2384
2014	0.9370	0.1437	0.4987	0.3872	0.1298	0.0697	0.0362	0.2081	0.0580	0.1125

Table 78. Age-1+ indices of abundance and CVs developed for the spot assessment. All indices were in numbers per tow and have been standardized to their mean.

Year	NCDMF June Trawl		SEAMAP Fall Trawl		NMFS Fall Trawl		ChesMMAP Summer-Fall Trawl		NEAMAP Fall Trawl	
	Index	CV	Index	CV	Index	CV	Index	CV	Index	CV
1989	0.8602	0.1757	0.2930	0.3342	3.5809	0.0664				
1990	0.4149	0.2220	0.4260	0.1849	0.6787	0.0553				
1991	0.8793	0.1032	2.9393	0.1959	0.1338	0.2101				
1992	0.4639	0.1408	0.6342	0.2480	0.1151	0.1228				
1993	0.8786	0.0978	1.1321	0.4129	0.0137	0.1661				
1994	0.9277	0.1227	0.8969	0.2547	1.2423	0.1197				
1995	1.5358	0.1334	0.2904	0.1644	0.6403	0.0592				
1996	0.3939	0.1673	0.6332	0.1751	0.2364	0.1165				
1997	0.6283	0.1433	0.0892	0.2576	0.0811	0.1019				
1998	0.4781	0.2664	0.1318	0.2084	0.0986	0.1065				
1999	0.7560	0.1639	0.3033	0.3830	0.7738	0.0363				
2000	1.7494	0.2053	0.5276	0.4089	0.4935	0.0730				
2001	0.6035	0.1573	0.1289	0.2244	0.0004	0.3110				
2002	0.5230	0.1953	0.3614	0.2269	0.2599	0.1152	0.5862	0.3025		
2003	1.2830	0.1671	0.5989	0.4688	0.4962	0.0666	0.6730	0.2909		
2004	0.9074	0.2671	0.5996	0.2759	0.6906	0.0620	0.8006	0.2853		
2005	1.3612	0.2895	4.2248	0.3407	1.1661	0.0538	1.8229	0.2615		
2006	4.2081	0.1248	0.5699	0.1264	1.6101	0.0421	3.9015	0.2577		
2007	0.9282	0.1939	0.3726	0.2627	0.5816	0.1104	1.3534	0.2915	1.0820	0.2586
2008	0.5587	0.3190	1.9167	0.5379	1.0389	0.0487	0.6614	0.3175	0.6773	0.2783
2009	0.6613	0.2073	1.1684	0.2732	1.6489	0.0333	1.4423	0.2671	1.0868	0.1507
2010	0.6246	0.1417	1.5220	0.3420	1.3827	0.0368	0.0976	0.3483	0.9530	0.2697
2011	1.0763	0.1432	0.6718	0.2156	2.7452	0.0374	1.1048	0.2605	1.9066	0.1477
2012	0.7906	0.2175	1.7912	0.1819	4.3593	0.0263	0.0105	0.2800	0.0121	0.2556
2013	1.3604	0.2086	2.6558	0.4163	1.4933	0.0452	0.4441	0.2689	2.2049	0.2384
2014	1.1479	0.1873	1.1214	0.3872	0.4386	0.0697	0.1017	0.2081	0.0772	0.1125

Table 79. Age length key proportions from the NEAMAP Trawl Survey used to estimate age group specific index of relative abundance for the NMFS Trawl Survey.

	Age	
TL_cm	0	1+
3	1	0
4	1	0
5	1	0
6	1	0
7	1	0
8	1	0
9	1	0
10	1	0
11	1	0
12	1	0
13	1	0
14	0.955	0.045
15	0.962	0.038
16	0.939	0.061
17	0.873	0.127
18	0.783	0.217
19	0.754	0.246
20	0.58	0.42
21	0.291	0.709
22	0.115	0.885
23	0.154	0.846
24	0	1
25	0	1
26	0	1
27	0	1
28	0	1
29	0	1

Table 80. Annual indices of biomass and standard errors for each of the surveys developed for the spot assessment.

Year	NMFS Fall (kg/tow)		SEAMAP Fall (kg/tow)		ChesMMAP Summer-Fall (kg/tow)		NEAMAP Fall (kg/tow)	
	Index	SE	Index	SE	Index	SE	Index	SE
1989	58.54	7.65	1.63	0.28				
1990	7.81	2.80	1.62	0.26				
1991	2.46	1.57	17.16	3.84				
1992	0.88	0.94	3.66	0.79				
1993	0.34	0.59	7.91	3.48				
1994	17.89	4.23	5.37	1.50				
1995	6.36	2.52	1.56	0.23				
1996	4.58	2.14	2.72	0.65				
1997	1.53	1.24	0.66	0.17				
1998	1.14	1.07	0.64	0.11				
1999	10.22	3.20	1.11	0.27				
2000	6.25	2.50	3.05	1.48				
2001	0.01	0.08	0.79	0.20				
2002	3.95	1.99	2.00	0.45	2.53	0.55		
2003	3.01	1.74	3.11	0.96	2.98	0.83		
2004	10.80	3.29	3.19	0.92	1.86	0.25		
2005	18.57	4.31	31.99	11.54	4.22	0.56		
2006	13.85	3.72	2.80	0.34	3.16	0.54		
2007	9.72	3.12	1.88	0.44	2.29	0.45	26.64	8.27
2008	14.21	3.77	11.55	7.03	1.22	0.17	25.99	5.38
2009	12.17	3.49	5.77	1.52	2.91	1.46	3.85	1.83
2010	19.53	4.42	17.98	5.97	1.08	0.15	33.96	11.45
2011	26.53	5.15	3.69	0.84	1.00	0.19	3.43	1.20
2012	32.65	5.71	9.29	1.74	0.56	0.19	100.65	19.11
2013	11.95	3.46	14.95	6.78	0.38	0.07	12.58	4.22
2014	2.93	6.06	6.06	2.58	0.34	0.13	0.82	0.32

Table 81. Age length key proportions from the SEAMAP Trawl Survey used to estimate age group specific index of relative abundance.

	Age	
TL_cm	0	1+
9	1	0
10	1	0
11	1	0
12	0.3706	0.6294
13	0.4503	0.5497
14	0.0899	0.9101
15	0.0185	0.9815
16	0	1
17	0	1
18	0	1
19	0	1
20	0	1
21	0	1
22	0	1
23	0	1
24	0	1
25	0	1
26	0	1
27	0	1

Table 82. Age length key proportions from the ChesMMAP Trawl Survey used to estimate age group specific index of relative abundance.

	2002		2003		2004		2005		2006		2007		2008	
LengthCM	Age0	Age1+	Age-0	Age-1+	Age-0	Age-1+	Age-0	Age1+	Age-0	Age-1+	Age-0	Age-1+	Age-0	Age-1+
0	1	0	1	0	1	0	1	0	1	0	1	0	1	0
1	1	0	1	0	1	0	1	0	1	0	1	0	1	0
2	1	0	1	0	1	0	1	0	1	0	1	0	1	0
3	1	0	1	0	1	0	1	0	1	0	1	0	1	0
4	1	0	1	0	1	0	1	0	1	0	1	0	1	0
5	1	0	1	0	1	0	1	0	1	0	1	0	1	0
6	1	0	1	0	1	0	1	0	1	0	1	0	1	0
7	1	0	1	0	1	0	1	0	1	0	1	0	1	0
8	1	0	1	0	1	0	1	0	1	0	1	0	1	0
9	1	0	1	0	1	0	1	0	1	0	1	0	1	0
10	1	0	1	0	1	0	1	0	1	0	1	0	1	0
11	1	0	1	0	1	0	1	0	1	0	1	0	1	0
12	1	0	1	0	1	0	1	0	1	0	1	0	1	0
13	1	0	1	0	1	0	0.983	0.017	1	0	1	0	0.925	0.075
14	1	0	1	0	0.949	0.051	1	0	0.971	0.029	1	0	0.871	0.129
15	1	0	1	0	0.977	0.023	0.957	0.043	0.905	0.095	1	0	1	0
16	0.923	0.077	0.909	0.091	0.967	0.033	0.927	0.073	0.792	0.208	0	1	0.722	0.278
17	0.833	0.167	0.85	0.15	0.88	0.12	0.893	0.107	0.561	0.439	0.071	0.929	0.359	0.641
18	0.684	0.316	0.755	0.245	0.462	0.538	0.5	0.5	0.431	0.569	0	1	0.341	0.659
19	0.661	0.339	0.725	0.275	0.607	0.393	0.111	0.889	0.244	0.756	0.065	0.935	0.343	0.657
20	0.635	0.365	0.556	0.444	0.103	0.897	0	1	0.037	0.963	0	1	0.04	0.96
21	0.171	0.829	0.2	0.8	0.05	0.95	0	1	0	1	0	1	0.133	0.867
22	0.2	0.8	0	1	0.059	0.941	0	1	0	1	0	1	0	1
23	0	1	0	1	0	1	0	1	0	1	0	1	0	1
24	0	1	0	1	0	1	0	1	0	1	0	1	0	1
25	0	1	0	1	0	1	0	1	0	1	0	1	0	1
26	0	1	0	1	0	1	0	1	0	1	0	1	0	1
27	0	1	0	1	0	1	0	1	0	1	0	1	0	1
28	0	1	0	1	0	1	0	1	0	1	0	1	0	1
29	0	1	0	1	0	1	0	1	0	1	0	1	0	1
30	0	1	0	1	0	1	0	1	0	1	0	1	0	1
31	0	1	0	1	0	1	0	1	0	1	0	1	0	1
32	0	1	0	1	0	1	0	1	0	1	0	1	0	1
33	0	1	0	1	0	1	0	1	0	1	0	1	0	1
34	0	1	0	1	0	1	0	1	0	1	0	1	0	1
35	0	1	0	1	0	1	0	1	0	1	0	1	0	1
36	0	1	0	1	0	1	0	1	0	1	0	1	0	1
37	0	1	0	1	0	1	0	1	0	1	0	1	0	1
38	0	1	0	1	0	1	0	1	0	1	0	1	0	1
39	0	1	0	1	0	1	0	1	0	1	0	1	0	1
40	0	1	0	1	0	1	0	1	0	1	0	1	0	1

Table 82. ***Continued.*** **Age length key proportions from the ChesMMAP Trawl Survey used to estimate age group specific index of relative abundance.**

	2009		2010		2011		2012		2013		2014	
LengthCM	Age-0	Age-1+	Age-0	Age-1+	Age-0	Age1+	Age-0	Age-1+	Age-0	Age-1+	Age-0	Age-1+
0	1	0	1	0	1	0	1	0	1	0	1	0
1	1	0	1	0	1	0	1	0	1	0	1	0
2	1	0	1	0	1	0	1	0	1	0	1	0
3	1	0	1	0	1	0	1	0	1	0	1	0
4	1	0	1	0	1	0	1	0	1	0	1	0
5	1	0	1	0	1	0	1	0	1	0	1	0
6	1	0	1	0	1	0	1	0	1	0	1	0
7	1	0	1	0	1	0	1	0	1	0	1	0
8	1	0	1	0	1	0	1	0	1	0	1	0
9	1	0	1	0	1	0	1	0	1	0	1	0
10	1	0	1	0	1	0	1	0	1	0	1	0
11	1	0	1	0	1	0	1	0	1	0	1	0
12	1	0	1	0	1	0	0.917	0.083	0.9	0.1	1	0
13	0.952	0.048	1	0	1	0	1	0	1	0	1	0
14	0.929	0.071	0.875	0.125	0.5	0.5	0.962	0.038	0.6	0.4	1	0
15	0.615	0.385	0.862	0.138	0	1	1	0	0.5	0.5	1	0
16	0.219	0.781	0.9	0.1	0	1	0.958	0.042	0.205	0.795	0.5	0.5
17	0.057	0.943	0.273	0.727	0	1	0.824	0.176	0.195	0.805	0.529	0.471
18	0.024	0.976	0.048	0.952	0	1	0.75	0.25	0.022	0.978	0.2	0.8
19	0	1	0.043	0.957	0	1	0.25	0.75	0.08	0.92	0.048	0.952
20	0	1	0.143	0.857	0	1	0	1	0	1	0	1
21	0	1	0.5	0.5	0	1	0	1	0.111	0.889	0	1
22	0.045	0.955	0.167	0.833	0	1	0	1	0	1	0	1
23	0	1	0	1	0	1	0	1	0	1	0	1
24	0	1	0	1	0	1	0	1	0	1	0	1
25	0	1	0	1	0	1	0	1	0	1	0	1
26	0	1	0	1	0	1	0	1	0	1	0	1
27	0	1	0	1	0	1	0	1	0	1	0	1
28	0	1	0	1	0	1	0	1	0	1	0	1
29	0	1	0	1	0	1	0	1	0	1	0	1
30	0	1	0	1	0	1	0	1	0	1	0	1
31	0	1	0	1	0	1	0	1	0	1	0	1
32	0	1	0	1	0	1	0	1	0	1	0	1
33	0	1	0	1	0	1	0	1	0	1	0	1
34	0	1	0	1	0	1	0	1	0	1	0	1
35	0	1	0	1	0	1	0	1	0	1	0	1
36	0	1	0	1	0	1	0	1	0	1	0	1
37	0	1	0	1	0	1	0	1	0	1	0	1
38	0	1	0	1	0	1	0	1	0	1	0	1
39	0	1	0	1	0	1	0	1	0	1	0	1
40	0	1	0	1	0	1	0	1	0	1	0	1

Table 83. Age length key proportions from the NEAMAP Trawl Survey used to estimate age group specific index of relative abundance.

	2007		2008		2009		2010		2011	
LengthCM	FallAge-0	FallAge-1+	FallAge-0	FallAge-1+	FallAge-0	FallAge-1+	FallAge-0	FallAge-1+	FallAge-0	FallAge-1+
0	1	0	1	0	1	0	1	0	1	0
1	1	0	1	0	1	0	1	0	1	0
2	1	0	1	0	1	0	1	0	1	0
3	1	0	1	0	1	0	1	0	1	0
4	1	0	1	0	1	0	1	0	1	0
5	1	0	1	0	1	0	1	0	1	0
6	1	0	1	0	1	0	1	0	1	0
7	1	0	1	0	1	0	1	0	1	0
8	1	0	1	0	1	0	1	0	1	0
9	1	0	1	0	1	0	1	0	1	0
10	1	0	1	0	1	0	1	0	1	0
11	1	0	1	0	1	0	1	0	1	0
12	1	0	1	0	1	0	1	0	1	0
13	1	0	1	0	1	0	1	0	1	0
14	1	0	0.95	0.05	1	0	0.933	0.067	0.75	0.25
15	1	0	1	0	1	0	0.86	0.14	0.818	0.182
16	0.952	0.048	0.981	0.019	0.917	0.083	0.907	0.093	0.7	0.3
17	0.947	0.053	1	0	0.5	0.5	0.742	0.258	0.2	0.8
18	0.879	0.121	0.96	0.04	0.308	0.692	0.941	0.059	0.347	0.653
19	0.88	0.12	1	0	0.125	0.875	1	0	0.417	0.583
20	0.5	0.5	0.667	0.333	0	1	0	1	0.267	0.733
21	1	0	0	1	0	1	1	0	0.125	0.875
22	0.5	0.5	0	1	0	1	0	1	0	1
23	0	1	0	1	0	1	0	1	0	1
24	0	1	0	1	0	1	0	1	0	1
25	0	1	0	1	0	1	0	1	0	1
26	0	1	0	1	0	1	0	1	0	1
27	0	1	0	1	0	1	0	1	0	1
28	0	1	0	1	0	1	0	1	0	1
29	0	1	0	1	0	1	0	1	0	1
30	0	1	0	1	0	1	0	1	0	1

Table 83. ***Continued.*** **Age length key proportions from the NEAMAP Trawl Survey used to estimate age group specific index of relative abundance.**

	2012		2013		2014		2015	
LengthCM	FallAge-0	FallAge-1+	FallAge-0	FallAge-1+	FallAge-0	FallAge-1+	FallAge-0	FallAge-1+
0	1	0	1	0	1	0	1	0
1	1	0	1	0	1	0	1	0
2	1	0	1	0	1	0	1	0
3	1	0	1	0	1	0	1	0
4	1	0	1	0	1	0	1	0
5	1	0	1	0	1	0	1	0
6	1	0	1	0	1	0	1	0
7	1	0	1	0	1	0	1	0
8	1	0	1	0	1	0	1	0
9	1	0	1	0	1	0	1	0
10	1	0	1	0	1	0	1	0
11	1	0	1	0	1	0	1	0
12	1	0	1	0	1	0	1	0
13	1	0	1	0	1	0	1	0
14	1	0	1	0	1	0	1	0
15	1	0	1	0	1	0	1	0
16	1	0	0.865	0.135	1	0	0.955	0.045
17	1	0	0.792	0.208	0.88	0.12	1	0
18	1	0	0.636	0.364	0.909	0.091	1	0
19	1	0	0.583	0.417	1	0	1	0
20	1	0	0.143	0.857	0.8	0.2	1	0
21	1	0	0.071	0.929	0.375	0.625	1	0
22	1	0	0.071	0.929	0	1	0	1
23	1	0	0.125	0.875	0	1	0	1
24	0	1	0	1	0	1	0	1
25	0	1	0	1	0	1	0	1
26	0	1	0	1	0	1	0	1
27	0	1	0	1	0	1	0	1
28	0	1	0	1	0	1	0	1
29	0	1	0	1	0	1	0	1
30	0	1	0	1	0	1	0	1

Table 84. **Associations evaluated with Spearman's rho (ρ) between age-0 and age-1+ indices where the age-0 indices have been adjusted forward by one year. Significant p-values (<0.05) are bolded and highlighted in yellow.**

Age 0 Indices Forward Lagged 1 Year	Age 1+ Indices: NCDMF June Trawl ρ	p-value	n	SEAMAP Fall Trawl ρ	p-value	n	NMFS Fall Trawl ρ	p-value	n	ChesMMAP Trawl ρ	p-value	n	NEAMAP Trawl ρ	p-value	n
NCDMF June Trawl	0.367	**0.04**	26	0.462	**0.01**	26	0.374	**0.03**	26	-0.016	0.53	13	0.238	0.29	8
SEAMAP Fall Trawl	0.595	**0.00**	26	0.141	0.25	26	0.521	**0.00**	26	0.011	0.49	13	0.357	0.19	8
NMFS Fall Trawl	0.314	0.06	26	0.342	0.05	26	0.564	**0.00**	26	-0.165	0.71	13	0.333	0.21	8
ChesMMAP Trawl	0.154	0.32	13	-0.357	0.88	13	-0.084	0.61	13	0.888	**0.00**	13	0.429	0.15	8
NEAMAP Trawl	0.357	0.22	8	0.107	0.42	8	0.000	0.52	8	0.786	**0.02**	8	0.857	**0.01**	8

Table 85. **Associations evaluated with Spearman's rho (ρ) between age-0 abundance indices for spot. Significant p-values (<0.05) are bolded and highlighted in yellow.**

Age 0 Indices	NCDMF June Trawl ρ	p-value	n	SEAMAP Fall Trawl ρ	p-value	n	NMFS Fall Trawl ρ	p-value	n	ChesMMAP Trawl ρ	p-value	n
SEAMAP Fall Trawl	0.466	**0.01**	26									
NMFS Fall Trawl	0.28	0.08	26	0.5904	**0.00**	26						
ChesMMAP Trawl	-0.291	0.84	13	-0.17	0.72	13	-0.154	0.70	13			
NEAMAP Trawl	0.5238	0.10	8	0.2619	0.27	8	0.4762	0.12	8	0.6667	**0.04**	8

Table 86. **Associations evaluated with Spearman's rho (ρ) between age-1+ abundance indices for spot. Significant p-values (<0.05) are bolded and highlighted in yellow.**

Age 1+ Indices	NCDMF June Trawl ρ	p-value	n	SEAMAP Fall Trawl ρ	p-value	n	NMFS Fall Trawl ρ	p-value	n	ChesMMAP Trawl ρ	p-value	n
SEAMAP Fall Trawl	0.1815	0.19	26									
NMFS Fall Trawl	0.3285	0.05	26	0.3716	0.03	26						
ChesMMAP Trawl	0.4341	0.07	13	-0.242	0.79	13	0.1044	0.37	13			
NEAMAP Trawl	0.381	0.18	8	-0.048	0.56	8	0.1905	0.33	8	0.5952	0.07	8

Table 87. Inputs for the spot base surplus production model calculated in ASPIC.

Parameter or Data Input	Value for Spot Base Model	Justification
Run mode	FIT & BOT	ASPIC fits the model and computes estimates of parameters, then runs bootstrapping program
Error type	LOGISTIC YLD SSE	Logistic (Schaefer) model, condition fitting on yield (recommended), sum of squared errors (recommended)
Verbosity	112	Recommended value
Number of bootstrap trials	700	Recommended value between 500-1000
Monte Carlo search enable	0 10000	Disabled as recommended by author
Convergence crit. for simplex	1.0d-8	Recommended value
Convergence crit. for restarts, N restarts	3.0d-8 6	Recommended value
Convergence crit. for estimating effort	1.0d-4	Recommended value
Maximum F allowed in estimating effort	8d0	Default value
Weighting for B1 > K as residual	0d0	0d0 for no penalty
Number of data series	2	NMFS (1), SEAMAP (1)
Statistical weights for data series	1d0 1d0	Equal weighting
B1/K (starting guess)	0.5	Reasonable default value
MSY (starting guess)	28644	1/2 the maximum catch of 57,287 metric tons
K (starting guess)	572870	10x the maximum catch of 57,287 metric tons
q (starting guess)	1.0d-4 5.4d-5	One for each index as the mean CPUE/(2*Max catch)
Estimate flags	1 1 1 1 1	One for each B/K, MSY, K, q1, q2
Bounds (min and max) on MSY	3.6d3 2.3d5	1/8x and 8x the starting guess of MSY (2.9d4)
Bounds (min and max) on K	7.2d4 4.6d6	1/8x and 8x the starting guess of K (5.7d5)
Random number seed	1952385	
Number of years of data	26	1989-2014; Availability of shrimp discards using SEAMAP (first year = 1989) and Mid-Atlantic discards using observer data (first year = 1989). Only one regional survey being considered that starts earlier than 1989 (NMFS).

Table 88. General definitions and inputs (assumed fixed values and data) of the modified-CSA model for spot.

General Definitions	Symbol	Description/Definition
Year index	y	1989-2014
Stage index	a	Stage 1 (recruits) = Age-0; Stage 2 (post-recruits) = Age-1+
Total years in model	k_m	26
Total years for each survey	$k_{I,a}$	NC DMF Trawl = 26, NMFS Trawl = 26
Total years of removal data	k_R	26
Inputs	**Symbol**	**Description/Definition**
Observed index of abundance	$I_{a,y}$	Based on catch rates of age-0 and age-1+ fish from the NC DMF Trawl and NMFS Trawl surveys
Observed fishery removals	R_y	Removals in numbers for each year
Observed average total mortality of post-recruits	Z_{prior}	Average catch curve estimates from 1996-2013 (1.356)
Stage-specific natural mortality	M_a	Fixed based on estimates from a Lorenzen curve ($M_{recruits}$=0.542, $M_{post-recruits}$=0.396)
Fishery selectivity	s_a	Fixed based on external analysis of length frequency data ($s_{recruits}$=0.43, $s_{post\text{-}recruits}$=1)
Probability of spawning	ρ_a	Fixed based on logistic regression for recruits and literature estimates for post-recruits ($\rho_{recruits}$=0.215, ρ_{adults}=1)
Stage-specific average weight (kg)	$\overline{wt}_a$	Fixed based on fall weight-at-age from the NEAMAP Trawl survey ($\overline{wt}_{recruits}$=0.0801, $\overline{wt}_{post-recruits}$=0.1324)
Spawn time	κ	Fixed at 1.0 to coincide with spawning at the end of the year (i.e., December 31)
Survey time	τ_a	Proportion of year passed when survey occurs, fixed based on middle of sampling period (NC DMF Trawl=0.46, NMFS Trawl=0.75)
Population proportion female	ω	Fixed at 0.5 (i.e., female:male sex ratio = 1)
Steepness prior	h_{prior}	Mean estimate from meta-analysis (0.64)
Standard deviation for *h*	σ_h	Estimate from meta-analysis (0.20)
Coefficient of variation for $I_{a,y}$	$cv_{I,a,y}$	Based on annual estimates from observations on the NC DMF Trawl and NMFS Trawl surveys plus any adjustments for process error
Coefficient of variation for R_y	$cv_{R,y}$	Fixed at 0.05
Coefficient of variation for r_y	cv_r	Fixed at 0.66
Coefficient of variation for *Z*	cv_Z	Fixed at 0.05

Table 89. Population model equations of the modified-CSA model for spot. Estimated parameters are denoted using hat (^) notation, and predicted values are denoted using breve (˘) notation.

Population Model	Symbol	Description/Definition
Fishing mortality	$F_{a,y}$	$\hat{F}_{1989}$ is estimated for the intial year $F_{a,1989} = s_a\hat{F}_{1989}$; $F_{a,y} = s_a\hat{F}_{1989}e^{\hat{\delta}_{F,y}}$; $\hat{\delta}_{F,y}$ are year specific deviations for all years after the initial year $F_{a,2014} = e^{\left(\left(log(F_{a,2012}) + log(F_{a,2013})\right)/2\right)}$ $F_{a,2014}$ equal to geometric mean of previous two years, as there are no index data from 2015 to tune the $F_{a,2014}$ estimates
Total mortality	$Z_{a,y}$	$Z_{a,y} = M_a + F_{a,y}$
Stage 1 abundance	$N_{0,y}$	$N_{0,1989} = \hat{N}_{0,1989}$ is estimated for the initial year Beverton-Holt SR relationship assumed for subsequent years; $N_{0,y+1} = \frac{SSB_y}{SSB_y\beta+\alpha}e^{\hat{\delta}_{r,y+1}-0.5\sigma_r^2}$; $\hat{\delta}_{r,y+1} \sim N(0,\sigma_r^2)$; $\alpha = \frac{\widehat{SSB}_0(1-\hat{h})}{4\hat{h}r_0}$; $\beta = \frac{5\hat{h}-1}{4\hat{h}r_0}$; $r_0 = \frac{\widehat{SSB}_0}{SSBr_0}$; $SSBr_0 = \omega\rho_0\overline{wt}_{0,0}e^{-\kappa M_0} + \omega\rho_1\frac{e^{-(M_0+\kappa M_1)}}{1-e^{-M_1}}$; $\sigma_r = \sqrt{\log(1+cv_r^2)}$; $\widehat{SSB}_0$ is the unfished SSB, r_0 is the unfished recruitment, σ_r is the standard deviation of lognormal recruitment deviations
Stage 2 abundance	$N_{1,y}$	$N_{1,1989} = \hat{N}_{1,1989}$ is estimated for the initial year $N_{1,y+1} = \sum_{a=0}^{1} N_{a,y}e^{-(M_a+F_{a,y})}$
Female spawning stock biomass	SSB_y	$SSB_y = \sum_{a=0}^{1}\omega\rho_a\overline{wt}_aN_{a,y}e^{-\kappa(M_a+F_{a,y})}$
Predicted catch-at-stage	$\breve{C}_{a,y}$	$\breve{C}_{a,y} = \frac{F_{a,y}}{Z_{a,y}}N_{a,y}[1-e^{-Z_{a,y}}]$
Predicted removals	$\breve{R}_y$	$\breve{R}_y = \sum_{a=0}^{1}\breve{C}_{a,y}$
Predicted stage 1 index of abundance	$\breve{I}_{0,y}$	$\breve{I}_{0,y} = q_0(N_{0,y}e^{-\tau_0(M_0+F_{0,y})})$; $\log(q_0) = \frac{\sum_y \log(\breve{I}_{0,y})-\log(N_{0,y})}{k_{I,0}}$; q_0 is the catchability coefficient for stage 1 fish

Predicted stage 2 index of abundance	$\check{\mathrm{I}}_{1,y}$	$\check{\mathrm{I}}_{1,y} = \mathrm{q}_1(N_{1,y}e^{-\tau_1(M_1+F_{1,y})})$; $\log(\mathrm{q}_1) = \frac{\sum_y \log(\check{\mathrm{I}}_{1,y}) - \log(N_{1,y})}{\mathrm{k}_{\mathrm{I},1}}$; q_1 is the catchability coefficient for stage 2 fish

Table 90. **Likelihood components of the modified-CSA model for spot. Predicted values are denoted using breve (˘) notation.**

Negative Log-Likelihood	Symbol	Description/Definition
Lognormal indices	$\Lambda_{I,a}$	$\Lambda_{I,a} = \lambda_{I,a} \sum_y [0.5\log(2pi) + 0.5\log(\sigma_{I,a,y}^2) + \log(\mathrm{I}_{a,y}) + \frac{[\log(\mathrm{I}_{a,y}+\chi) - \log(\check{\mathrm{I}}_{a,y}+\chi)]^2}{2\sigma_{I,a,y}^2}]$; $\sigma_{I,a,y} = \sqrt{\log(1+cv_{I,a,y}^2)}$; $\lambda_{I,a}$ is a preset weight factor set to 1.0 χ is fixed at a small value (0.000001) for numerical stability
Lognormal removals	Λ_R	$\Lambda_R = \lambda_R \sum_y [0.5\log(2pi) + 0.5\log(\sigma_{R,y}^2) + \log(\mathrm{R}_y) + \frac{[\log(\mathrm{R}_y+\chi) - \log(\check{\mathrm{R}}_y+\chi)]^2}{2\sigma_{R,y}^2}]$; $\sigma_{R,y} = \sqrt{\log(1+cv_{R,y}^2)}$; λ_L is a preset weight factor set to 1.0 χ is fixed at a small value (0.000001) for numerical stability
Lognormal recruitment deviations	Λ_r	$\Lambda_r = \lambda_r \sum_y [0.5\log(2pi) + 0.5\log(\sigma_r^2) + \log(\hat{\delta}_{r,y}) + \frac{\log(\hat{\delta}_{r,y})^2}{2\sigma_r^2}]$; $\sigma_r = \sqrt{\log(1+cv_r^2)}$; λ_r is a preset weight factor set to 1.0

Prior distribution for h	Λ_h	$\Lambda_h = \lambda_h[(1 - Bprior) * \log(\chi + h_{prior} - h\_lb) + (1 - Aprior) * \log(\chi + h\_ub - h_{prior}) - (1 - Bprior) * \log(\chi + \hat{h} - h\_lb) - (1 - Aprior) * \log(\chi + h\_ub - \hat{h})]$; $Bprior = \tau * \mu$; $Aprior = \tau * (1.0 - \mu)$; h_lb is the lower bound on the steepness parameter estimate (0.00001) h_ub is the upper bound on the steepness parameter estimate (0.99999) χ is fixed at a small value (0.0001) for numerical stability $\mu = \frac{\hat{h} - h\_lb}{h\_ub - h\_lb}$; $\tau = \frac{(\hat{h} - h\_lb) * (h\_ub - \hat{h})}{{\sigma_h}^2} - 1$; λ_h is a preset weight factor set to 1.0

Table 90 ***Continued.*** **Likelihood components of the modified-CSA model for spot. Predicted values are denoted using breve (˘) notation.**

Prior distribution for Z	Λ_Z	$\Lambda_Z = \lambda_Z \left[0.5 \log(2pi) + 0.5 \log(\sigma_Z^2) + \log(Z_{prior}) + \frac{[\log(Z_{prior}) - \log(\overline{Z_{1,1996-2013}})]^2}{2\sigma_Z^2} \right]$; $\sigma_Z = \sqrt{\log(1 + cv_Z^2)}$; $\overline{Z_{1,1996-2013}}$ is the mean post-recruit Z from 1996-2013 λ_Z is a preset weight factor set to 1.0

Table 91. Reference point calculations for the modified-CSA model for spot.

Reference Point Components	Symbol	Description/Definition
Fishing rate value: F={0, ….6}	F	F is incremented from 0.0 to 6.0 by 0.01, and the reference point calculations are performed at each F value. All final MSY-based reference points are set at the F that maximizes equilibrium removals (Req), while the spawning potential ratio F targets (F_{SPR}) are each set at the F that produces the SPR closest to an input set of targets (SPR={0.2,0.3,0.4})
Projection year for SSB_{SPR} calculations	py	1-100
Unfished female spawning stock biomass per recruit	$SSBr_0$	$SSBr_0 = \omega\rho_0\overline{wt}_0 e^{-\kappa M_0} + \omega\rho_1\overline{wt}_1 \frac{e^{-(M_0+\kappa M_1)}}{1-e^{-M_1}}$
Fished female spawning stock biomass per recruit	$SSBr$	$SSBr = \omega\rho_0\overline{wt}_0 e^{-\kappa(M_0+s_0\mathrm{F})} + \omega\rho_1\overline{wt}_1 \frac{e^{-(M_0+s_0\mathrm{F}+\kappa M_1+\kappa s_1\mathrm{F})}}{1-e^{-\kappa(M_1+s_1\mathrm{F})}}$
Number per recruit	Nr	$Nr = \frac{e^{-(M_0+s_0\mathrm{F})}}{1-e^{-\kappa(M_1+s_1\mathrm{F})}}$
Yield per recruit	Yr	$Yr = \frac{s_0\mathrm{F}}{M_0+s_0\mathrm{F}}\left[1-e^{-(M_0+s_0\mathrm{F})}\right]\overline{wt}_0 + \frac{s_1\mathrm{F}}{M_1+s_1\mathrm{F}}\left[1-e^{-(M_1+s_1\mathrm{F})}\right]\overline{wt}_1$
Equilibrium recruitment	req	$req = \frac{SSBr-\alpha}{\beta SSBr}$ Beverton-Holt SR relationship
Equilibrium number	Neq	$Neq = Nr * req$
Equilibrium female spawning stock biomass	SSB_{eq}	$SSB_{eq} = SSBr * req$
Equilibrium removals	Req	$Req = Yr * req$
Equilibrium exploitation rate	Ueq	$Ueq = \frac{Req}{Neq\overline{wt}_1 + req\overline{wt}_0 \frac{1-e^{-s_0\mathrm{F}}}{1-e^{-s_1\mathrm{F}}}}$
Maximum sustainable yield	MSY	$MSY = \max(Req)$ across all F values
Number at MSY	N_{MSY}	Neq at MSY
Female spawning stock biomass at MSY	SSB_{MSY}	$SSBeq$ at MSY
Fishing rate at MSY	F_{MSY}	F at MSY
Exploitation rate at MSY	u_{MSY}	Ueq at MSY
Static spawning potential ratio	$sSPR$	$sSPR = \frac{SSBr}{SSBr_0}$
Equilibrium female spawning stock biomass at reference SPR	SSB_{SPR}	$SSB_{py} = \omega\rho_0\overline{wt}_0 N_{0,py} e^{-\kappa(M_0+s_0F_{SPR})} + \omega\rho_1\overline{wt}_1 N_{1,py} e^{-\kappa(M_1+s_1F_{SPR})}$; $N_{0,py}$ is randomly selected from model $N_{0,y}$ estimates during a specified reference period $N_{1,py} = N_{0,py-1}e^{-(M_0+s_0F_{SPR})}$; $SSB_{SPR} = median(SSB_{py2}, \ldots SSB_{py100})$;

Table 92. Spot stage-specific mean weights by data source.

Data Source	Age Range	Age-0 n	Age-0 Ave wt (kg)	Age-0 sd	Age 1+ n	Ages 1+ Ave wt (kg)	Age 1+ sd
NEAMAP	0-3	1,122	0.0801	0.0298	264	0.1324	0.0524
ChesMMAP	0-4	3,129	0.0628	0.0331	1,025	0.1553	0.0701
SEAMAP	0-2	165	0.0580	0.0240	74	0.1191	0.0467
MD DNR Commercial	0-2	14	0.0598	0.0130	50	0.1804	0.0321
VMRC Commercial	1-4	0			1,344	0.2889	0.1062
NCDMF Commercial	0-4	292	0.0733	0.0311	1,011	0.1829	0.0948

Table 93. Test for significant differences (p<0.05) with analysis of variance (ANOVA) among annual spot mean weights within stage by data source.

Data Source	Age Group	Significant Difference between Years?
SEAMAP	0	Only one year of data
SEAMAP	1+	Only one year of data
ChesMMAP	0	Yes, p=0.016
ChesMMAP	1+	Yes, p=0.002
NEAMAP	0	No, p=0.994
NEAMAP	1+	No, p=0.374
NC DMF Commercial	0	No, p=0.862
NC DMF Commercial	1+	No, p=0.970
MD DNR Commercial	0	Yes, p=0.028
MD DNR Commercial	1+	No, p=0.119
VMRC Commercial	1+	No, p=0.544

Table 94. CVs for spot indices of abundance used in the modified-CSA model calculated from variance in catch rates (original; observation error) and adjusted according to the methods of Francis (2003) to acknowledge process error (adjusted).

Year	NC DMF Trawl Recruits		NMFS Trawl Recruits		NC DMF Trawl Post-Recruits		NMFS Trawl Post-Recruits	
	Original	Adjusted	Original	Adjusted	Original	Adjusted	Original	Adjusted
1989	0.1455	0.2473	0.0664	0.2107	0.1757	0.2662	0.0664	0.2107
1990	0.1159	0.2312	0.0553	0.2075	0.222	0.2988	0.0553	0.2075
1991	0.1561	0.2537	0.2101	0.2901	0.1032	0.2251	0.2101	0.2901
1992	0.2103	0.2902	0.1228	0.2347	0.1408	0.2446	0.1228	0.2347
1993	0.1474	0.2484	0.1661	0.26	0.0978	0.2226	0.1661	0.26
1994	0.1689	0.2618	0.1197	0.2331	0.1227	0.2346	0.1197	0.2331
1995	0.2106	0.2904	0.0592	0.2086	0.1334	0.2404	0.0592	0.2086
1996	0.1216	0.2341	0.1165	0.2315	0.1673	0.2607	0.1165	0.2315
1997	0.1613	0.2569	0.1019	0.2245	0.1433	0.246	0.1019	0.2245
1998	0.2354	0.3089	0.1065	0.2266	0.2664	0.3331	0.1065	0.2266
1999	0.2152	0.2938	0.0363	0.2033	0.1639	0.2586	0.0363	0.2033
2000	0.196	0.28	0.073	0.2129	0.2053	0.2866	0.073	0.2129
2001	0.2223	0.299	0.311	0.3698	0.1573	0.2544	0.311	0.3698
2002	0.1318	0.2395	0.1152	0.2308	0.1953	0.2795	0.1152	0.2308
2003	0.1601	0.2562	0.0666	0.2108	0.1671	0.2606	0.0666	0.2108
2004	0.244	0.3155	0.062	0.2094	0.2671	0.3337	0.062	0.2094
2005	0.1601	0.2562	0.0538	0.2071	0.2895	0.3519	0.0538	0.2071
2006	0.1928	0.2778	0.0421	0.2044	0.1248	0.2357	0.0421	0.2044
2007	0.2424	0.3143	0.1104	0.2284	0.1939	0.2786	0.1104	0.2284
2008	0.2301	0.3049	0.0487	0.2058	0.319	0.3765	0.0487	0.2058
2009	0.1822	0.2705	0.0333	0.2028	0.2073	0.2881	0.0333	0.2028
2010	0.1895	0.2755	0.0368	0.2034	0.1417	0.2451	0.0368	0.2034
2011	0.1477	0.2486	0.0374	0.2035	0.1432	0.246	0.0374	0.2035
2012	0.1047	0.2257	0.0263	0.2017	0.2175	0.2955	0.0263	0.2017
2013	0.1697	0.2623	0.0452	0.205	0.2086	0.289	0.0452	0.205
2014	0.1437	0.2463	0.0697	0.2118	0.1873	0.274	0.0697	0.2118

Table 95. Description of sensitivity configurations for the sensitivity analysis of the spot modified-CSA model.

Name	Description
1992 start year	Started the model time series in 1992 to remove relatively large shrimp trawl discard estimates prior to this year.
adjust shrimp discards	Changed the relatively large shrimp trawl discard estimates in 1990 and 1991 to the median value of surrounding, pre-BRD estimates (1989, 1992-1996; 259 million fish).
10% shrimp discards	Scaled the shrimp trawl discard estimates for the entire time series down to 10% of the base model estimates. This configuration can represent two scenarios; the base estimates are overestimated by an order of magnitude and the discard mortlaity rate is unchanged from the base model (100%) or the base model estimates are accurate and the discard mortality rate is 10%.
50% shrimp discards	Scaled the shrimp trawl discard estimates for the entire time series down to 50% of the base model estimates. This configuration can represent two scenarios; the base estimates are twice the true values and the discard mortlaity rate is unchanged from the base model (100%) or the base model estimates are accurate and the discard mortality rate is 50%.
low selectivity	The base model estimates recruit selectivity at 0.306. This is lower than the assumed value in the base model (0.43).
high selectivity	The high selectivity value (0.645) is between the value in the base model (0.43) and the value if we did not assume recruits are not vulnerable to capture for the first half of the year (0.86). The SAS does not consider selectivity values greater than 0.645 as plausible values.
low M	M-at-stage vector calculated from weight-at-age using the upper 95% confidence interval values of the growth parameters Linf, K, and t0. This results in M-at-stage (recruits=0.537, post-recruits=0.389) less than the base model M-at-stage (recruits=0.542, post-recruits=0.396).
high M	M-at-stage vector calculated from weight-at-age using the upper 95% confidence interval values of the growth parameters Linf, K, and t0. This results in M-at-stage (recruits=0.550, post-recruits=0.405) greater than the base model M-at-stage (recruits=0.542, post-recruits=0.396).
FD Z prior	Total mortality prior calculated from only FD data as opposed to FD and FI data (Appendix 8). This value (1.157) is lower than the base model prior value (1.356).
wt comb Z prior	Total mortality prior calculated from FD and FI data using a weighted catch curve (Appendix 8). This value (1.613) is greater than the base model prior value (1.356).
no reweight	Use the original CVs provided with indices. Do not allow for process error due to interannual variability in catchability.
no NMFS trawl	Exclude the NNMFS Trawl Survey indices for recruits and post-recruits.
no NCDMF trawl	Exclude the NCDMF Trawl Survey indices for recruits and post-recruits.
add NEAMAP trawl	Include the NEAMAP Trawl Survey indices for recruits and post-recruits. The reason for excluding these indices from the base model was the short time series realtive to the NMFS Trawl Survey indices.
change in NMFS recruit q 2005	Allowed for time-varying catchability (1989-2004=q1, 2005-2014=q2) in the NMFS Trawl Survey recruit index to address the residual trend after 2005. 2005 was selected based on visual evaluation of the resdiual trend.
change in NMFS recruit q in 2009	Allowed for time-varying catchability (1989-2008=q1, 2009-2014=q2) in the NMFS Trawl Survey recruit index to address the residual trend after 2005. 2009 was selected based on the change of vessel conducting the survey.
h = 0.99	Steepness fixed at 0.99 to specify an uninformative stock-recruit relationship (i.e., recruitment deviates around a time series mean).
h = 0.79	Steepness fixed at 0.79, the mode steepness value from the steepness prior analysis (Appendix 9).
NCDMF comm mean wts	Mean weight-at-stage developed from the fall NC DMF commercial catch sampling (recruits=0.0733 kg, post-recruits=0.1829 kg). There are no significant differences among annual mean weight-at-stage from these data and the SEAMAP Trawl Survey only collected one year of age data.
sex ratio	Proportion females = 0.62 (value from combined FI data). Sex ratio only affects stock-recruit parameters and spanwing stock biomass estimates, so results from this configuration are only included on the spawning stock biomass figure.

Table 96. Population parameter estimates from the base spot surplus production model.

Year	Estimated Total F	Estimated Starting Biomass	Estimated Average Biomass	Observed Total Yield	Model Total Yield	Estimated Surplus Production	Estimated F to F_{MSY}	Estimated B to B_{MSY}
1989	0.6180	57400	54370	33600	33600	28050	1.2740	0.9876
1990	0.4760	51850	53250	25360	25360	27980	0.9822	0.8921
1991	1.7290	54470	33130	57290	57290	22160	3.5650	0.9372
1992	0.9220	19340	18340	16900	16900	14980	1.9000	0.3328
1993	0.6260	17420	19170	12000	12000	15520	1.2910	0.2997
1994	0.9600	20940	19390	18610	18610	15670	1.9790	0.3602
1995	1.4830	18000	13310	19740	19740	11390	3.0570	0.3096
1996	0.8160	9644	9998	8157	8157	8863	1.6820	0.1659
1997	1.0220	10350	9682	9899	9899	8608	2.1080	0.1781
1998	1.0800	9059	8286	8947	8947	7463	2.2260	0.1559
1999	0.6970	7575	8408	5860	5860	7564	1.4370	0.1303
2000	0.6880	9279	10270	7066	7066	9075	1.4190	0.1596
2001	0.7990	11290	11720	9366	9366	10220	1.6480	0.1942
2002	0.4440	12140	14990	6663	6663	12640	0.9163	0.2089
2003	0.4780	18120	21380	10220	10220	16890	0.9856	0.3118
2004	0.2620	24800	31540	8248	8248	22160	0.5392	0.4266
2005	0.1280	38700	49130	6266	6266	27210	0.2629	0.6659
2006	0.1240	59640	69290	8559	8559	26910	0.2547	1.0260
2007	0.0880	78000	85720	7521	7521	21690	0.1809	1.3420
2008	0.0700	92160	97030	6797	6797	15500	0.1444	1.5860
2009	0.0710	100900	103100	7328	7328	11280	0.1465	1.7360
2010	0.0430	104800	106900	4637	4637	8308	0.0894	1.8040
2011	0.0850	108500	107700	9134	9134	7699	0.1749	1.8670
2012	0.0770	107100	107100	8212	8212	8205	0.1582	1.8420
2013	0.0610	107100	107700	6551	6551	7676	0.1254	1.8420
2014	0.0880	108200	107300	9492	9492	7991	0.1824	1.8610

Table 97. Parameter estimates from the base and sensitivity runs for the spot surplus production model. The base model included relative biomass indices from the SEAMAP Trawl and NMFS Trawl Surveys and the complete harvest data.

	Base Model 1989-2014	Abbreviated Model 1992-2014	Adding NEAMAP	Fox (n=1)	Pella-Tomlinson (n=2.35)	NMFS only	Excel
MSY	28,190	19,930	30,360	17,240	29,360	33,390	21,070
B_{MSY}	58,120	30,430	59,070	40,210	57,400	67,470	86,171
F_{MSY}	0.485	0.655	0.514	0.429	0.5115	0.495	0.445

Table 98. Measures of model fit from the base modified-CSA model for spot.

Likelihood Component	Negative Log-likelihood	Standardized Residual Mean	Standardized Residual sd	Sum of Squared Standardized Residuals	t-test p-value	Shapiro-Wilk p-value	Runs p-value
NC DMF Post-Recruits	161.83	0.165	3.75	352.78	0.412	0.075	0.005
NMFS Post Recruits	177.34	0.332	4.14	430.85	0.343	0.038	0.423
NC DMF Recruits	128.35	-0.003	3.45	298.01	0.498	0.107	1.000
NMFS Recruits	351.98	0.624	5.57	786.65	0.287	0.081	0.016
Removals	106.25	0.000	1.48	54.61	0.500	0.002	0.005
Total Mortality Prior	1.29	NA	NA	NA	NA	NA	NA
Steepness Prior	2.35	NA	NA	NA	NA	NA	NA
Recruitment Deviations	27.06	-0.301	1.18	35.86	0.108	0.331	0.545
Total	**956.46**	**NA**	**NA**	**1,958.77**	**NA**	**NA**	**NA**

Table 99. Parameter estimates from the base modified-CSA model for spot.

Parameter	Estimate	SE	Parameter	Estimate	SE
log(initial post-recruit N)	6.483	0.14	log(1990 R deviation)	1.313	0.11
log(initial recruit N)	6.818	0.12	log(1991 R deviation)	1.356	0.09
log(initial F)	0.064	0.11	log(1992 R deviation)	-0.583	0.15
log(1990 F deviation)	0.656	0.11	log(1993 R deviation)	0.394	0.15
log(1991 F deviation)	1.268	0.10	log(1994 R deviation)	1.274	0.09
log(1992 F deviation)	0.962	0.10	log(1995 R deviation)	-0.229	0.17
log(1993 F deviation)	0.521	0.12	log(1996 R deviation)	-0.537	0.09
log(1994 F deviation)	-0.210	0.11	log(1997 R deviation)	-1.164	0.14
log(1995 F deviation)	0.772	0.10	log(1998 R deviation)	-0.689	0.11
log(1996 F deviation)	0.454	0.11	log(1999 R deviation)	-0.010	0.09
log(1997 F deviation)	-0.615	0.13	log(2000 R deviation)	-1.071	0.12
log(1998 F deviation)	0.029	0.12	log(2001 R deviation)	-0.811	0.11
log(1999 F deviation)	-0.518	0.11	log(2002 R deviation)	0.793	0.39
log(2000 F deviation)	-0.321	0.12	log(2003 R deviation)	-0.109	0.11
log(2001 F deviation)	1.344	0.11	log(2004 R deviation)	0.103	0.11
log(2002 F deviation)	-0.467	0.12	log(2005 R deviation)	0.209	0.11
log(2003 F deviation)	0.212	0.11	log(2006 R deviation)	-0.598	0.13
log(2004 F deviation)	-0.756	0.12	log(2007 R deviation)	-0.616	0.14
log(2005 F deviation)	-1.058	0.11	log(2008 R deviation)	0.107	0.12
log(2006 F deviation)	-0.761	0.12	log(2009 R deviation)	-0.218	0.13
log(2007 F deviation)	-1.117	0.13	log(2010 R deviation)	0.538	0.11
log(2008 F deviation)	-1.159	0.12	log(2011 R deviation)	0.294	0.12
log(2009 F deviation)	-1.118	0.13	log(2012 R deviation)	0.412	0.12
log(2010 F deviation)	-1.627	0.12	log(2013 R deviation)	0.394	0.14
log(2011 F deviation)	-0.762	0.12	log(2014 R deviation)	-0.553	0.18
log(2012 F deviation)	-1.542	0.13	log(unfished SSB)	10.494	0.08
log(2013 F deviation)	-1.371	0.13	log(steepness)	-0.018	0.02

Table 100. Abundance and end-year spawning stock biomass estimates from the base modified-CSA model for spot. CVs are derived from asymptotic standard errors.

Year	Recruitment (millions of fish)		Post Recruitment (millions of fish)		Spawning Stock Biomass (metric tons)	
	Estimate	CV	Estimate	CV	Estimate	CV
1989	914	0.12	654	0.14	12,929	0.18
1990	1,317	0.09	488	0.13	5,510	0.18
1991	1,352	0.07	359	0.14	1,689	0.14
1992	182	0.14	160	0.12	712	0.20
1993	431	0.08	39	0.15	1,282	0.16
1994	1,135	0.07	120	0.15	6,175	0.10
1995	278	0.15	489	0.09	2,689	0.19
1996	197	0.09	93	0.12	1,253	0.18
1997	99	0.14	67	0.13	2,076	0.18
1998	167	0.11	70	0.15	1,568	0.18
1999	321	0.08	76	0.14	3,025	0.12
2000	117	0.12	169	0.09	3,898	0.15
2001	153	0.09	101	0.11	208	0.21
2002	439	0.09	17	0.16	2,026	0.11
2003	297	0.11	197	0.11	3,197	0.18
2004	378	0.12	134	0.14	5,137	0.15
2005	429	0.11	232	0.13	8,969	0.14
2006	194	0.14	321	0.11	9,463	0.16
2007	191	0.15	222	0.14	7,804	0.17
2008	391	0.12	201	0.14	8,102	0.16
2009	283	0.13	294	0.13	10,459	0.16
2010	605	0.12	281	0.14	12,932	0.14
2011	476	0.12	475	0.12	14,792	0.17
2012	536	0.13	418	0.14	17,251	0.16
2013	528	0.14	507	0.14	19,567	0.17
2014	205	0.17	533	0.15	19,032	0.18

Table 101. Full fishing mortality and static spawning potential ratio estimates from the base modified-CSA model for spot. Terminal year (2014) fishing mortality is the geometric mean of the previous two years (2012-2013) and terminal year static spawning potential ratio is calculated from the terminal year fishing mortality estimate. CVs are derived from asymptotic standard errors.

Year	Full Fishing Mortality		Static Spawning Potential Ratio	
	Estimate	CV	Estimate	CV
1989	1.07	0.11	0.12	0.16
1990	2.06	0.09	0.04	0.17
1991	3.79	0.06	0.01	0.12
1992	2.79	0.08	0.02	0.16
1993	1.80	0.11	0.05	0.19
1994	0.86	0.08	0.17	0.10
1995	2.31	0.08	0.03	0.15
1996	1.68	0.10	0.06	0.16
1997	0.58	0.13	0.26	0.14
1998	1.10	0.11	0.12	0.16
1999	0.64	0.09	0.24	0.10
2000	0.77	0.10	0.19	0.12
2001	4.09	0.08	0.01	0.16
2002	0.67	0.10	0.23	0.11
2003	1.32	0.10	0.09	0.16
2004	0.50	0.12	0.30	0.11
2005	0.37	0.11	0.39	0.09
2006	0.50	0.13	0.30	0.12
2007	0.35	0.14	0.41	0.10
2008	0.33	0.13	0.42	0.10
2009	0.35	0.14	0.41	0.10
2010	0.21	0.13	0.56	0.06
2011	0.50	0.13	0.30	0.12
2012	0.23	0.14	0.53	0.08
2013	0.27	0.15	0.48	0.09
2014	0.25	0.15	0.51	0.08

Table 102. Full fishing mortality reference point estimates for static spawning potential ratio reference levels (i.e., 20-40% SPR) from the base modified-CSA model for spot.

Fishing Mortality Reference Point	Estimate
F20%	0.74
F30%	0.5
F40%	0.36

Table 103. Full fishing mortality reference point estimates for static spawning potential ratio reference levels (i.e., 20-40%) from the base modified-CSA model for spot and all sensitivity configurations.

Model Configuration	F20%	F30%	F40%
base	0.74	0.5	0.36
1992 start year	0.74	0.5	0.36
adjust shrimp discards	0.74	0.5	0.36
10% shrimp discards	0.74	0.5	0.36
50% shrimp discards	0.74	0.5	0.36
low selectivity	0.81	0.54	0.38
high selectivity	0.65	0.45	0.32
low M	0.73	0.5	0.35
high M	0.75	0.51	0.36
FD Z prior	0.74	0.5	0.36
wt comb Z prior	0.74	0.5	0.36
no reweight	0.74	0.5	0.36
no NMFS trawl	0.74	0.5	0.36
no NCDMF trawl	0.74	0.5	0.36
add NEAMAP trawl	0.74	0.5	0.36
change in NMFS recruit q 2005	0.74	0.5	0.36
change in NMFS recruit q in 2009	0.74	0.5	0.36
h = 0.99	0.74	0.5	0.36
h = 0.79	0.74	0.5	0.36
NCDMF comm mean wts	0.71	0.49	0.35
sex ratio	0.74	0.5	0.36

Table 104. Modified Mohn's Rhos (Hurtado-Ferro et al. 2015) for retrospective analysis (5 year peel) of the modified-CSA model for spot. Full fishing mortality and static spawning potential ratio are estimated from the geometric mean full fishing mortality over the two years prior to the terminal year, so calculation are presented for final year estimate (2013) and terminal year derived estimate (2014) for these quantities.

Calculation Year	Recruitment	Spawning Stock Biomass	Full Fishing Mortality	Static Spawning Potential Ratio
Final Year Estimate	0.6029	0.2980	-0.2241	0.2489
Terminal Year Estimate	0.6029	0.2980	-0.0907	0.0964

Table 105. Steepness estimates from retrospective analysis of the base modified-CSA model for spot.

Model Terminal Year	2014	2013	2012	2011	2010	2009
Steepness	0.982	0.977	0.981	0.983	0.982	0.984

Table 106. Randomly sampled recruitment for threshold spawning stock biomass estimate. Recruitment was sampled from model estimated recruitments from 1996-2014.

Projection Year	Recruitment (millions of fish)	Projection Year	Recruitment (millions of fish)	Projection Year	Recruitment (millions of fish)	Projection Year	Recruitment (millions of fish)
1	153	26	378	51	476	76	205
2	99	27	99	52	528	77	297
3	378	28	528	53	476	78	528
4	283	29	536	54	429	79	194
5	191	30	429	55	117	80	191
6	528	31	605	56	321	81	99
7	321	32	429	57	528	82	605
8	321	33	153	58	99	83	429
9	536	34	197	59	476	84	283
10	153	35	297	60	321	85	153
11	476	36	117	61	167	86	194
12	117	37	99	62	99	87	283
13	194	38	439	63	99	88	378
14	191	39	297	64	167	89	297
15	117	40	297	65	476	90	191
16	391	41	283	66	205	91	605
17	429	42	283	67	205	92	153
18	117	43	476	68	476	93	205
19	99	44	283	69	605	94	197
20	197	45	99	70	391	95	194
21	205	46	197	71	283	96	528
22	391	47	153	72	429	97	117
23	191	48	167	73	439	98	536
24	283	49	536	74	391	99	605
25	117	50	117	75	391	100	194

Table 107. Randomly sampled recruitment for target spawning stock biomass estimate. Recruitment was sampled from model estimated recruitments from 2003-2014.

Projection Year	Recruitment (millions of fish)	Projection Year	Recruitment (millions of fish)	Projection Year	Recruitment (millions of fish)	Projection Year	Recruitment (millions of fish)
1	194	26	391	51	536	76	205
2	297	27	297	52	205	77	191
3	391	28	205	53	536	78	205
4	476	29	528	54	391	79	283
5	605	30	283	55	429	80	605
6	205	31	536	56	429	81	297
7	429	32	391	57	205	82	536
8	429	33	194	58	297	83	391
9	528	34	297	59	536	84	476
10	194	35	191	60	429	85	194
11	528	36	429	61	378	86	283
12	429	37	297	62	297	87	476
13	283	38	191	63	297	88	391
14	605	39	191	64	378	89	191
15	429	40	191	65	536	90	605
16	605	41	476	66	205	91	476
17	283	42	476	67	205	92	194
18	429	43	536	68	536	93	205
19	378	44	476	69	536	94	297
20	297	45	378	70	605	95	283
21	205	46	297	71	476	96	205
22	476	47	194	72	391	97	429
23	605	48	378	73	191	98	528
24	476	49	528	74	476	99	536
25	429	50	429	75	476	100	283

Table 108. Comparison of spot stock condition according to the modified-CSA end-year spawning stock biomass and reference point estimates and the TLA proportion of red from the adult abundance metric. Values highlighted in red indicate overfished (modified-CSA) or significant concern (TLA), values highlighted in yellow indicate not overfished, but below the target (modified-CSA) or moderate concern (TLA), and values highlighted in green indicate not overfished (modified-CSA) or no concern (TLA). Bolded values show agreement of condition between the analyses.

Year	Spawning Stock Biomass (metric tons)	Adult Abundance Metric Proportion Red
1989	**12,929**	**0.27**
1990	**5,510**	**0.48**
1991	1,689	0.37
1992	712	0.57
1993	**1,282**	**0.81**
1994	6,175	0.14
1995	2,689	0.55
1996	1,253	0.48
1997	**2,076**	**0.77**
1998	**1,568**	**0.78**
1999	3,025	0.54
2000	**3,898**	**0.70**
2001	**208**	**0.76**
2002	**2,026**	**0.69**
2003	3,197	0.38
2004	**5,137**	**0.52**
2005	**8,969**	**0.00**
2006	**9,463**	**0.27**
2007	**7,804**	**0.34**
2008	**8,102**	**0.00**
2009	**10,459**	**0.12**
2010	**12,932**	**0.29**
2011	**14,792**	**0.00**
2012	**17,251**	**0.00**
2013	19,567	0.31
2014	19,032	0.56

Table 109. Comparison of spot stock condition according to the modified-CSA static spawning potential ratio estimates and the TLA proportion of red from the harvest and total removal metrics. Values highlighted in red indicate overfishing (modified-CSA) or significant concern (TLA), values highlighted in yellow indicate not overfishing, but above the target (modified-CSA) or moderate concern (TLA), and values highlighted in green indicate not overfishing (modified-CSA) or no concern (TLA). Bolded values show agreement of condition between the analyses.

Year	Static Spawning Potential Ratio	Harvest Metric Proportion Red	Total Removals Metric Proportion Red
1989	0.12	0.00	0.26
1990	0.04	0.00	0.30
1991	0.01	0.00	0.25
1992	0.02	0.00	0.03
1993	0.05	0.00	0.00
1994	0.17	0.00	0.04
1995	0.03	0.00	0.05
1996	0.06	0.16	0.05
1997	0.26	0.07	0.03
1998	0.12	0.03	0.01
1999	0.24	0.20	0.07
2000	0.19	0.14	0.06
2001	0.01	0.00	0.01
2002	0.23	0.13	0.11
2003	0.09	0.00	0.01
2004	0.30	0.00	0.01
2005	0.39	0.03	0.09
2006	0.30	0.18	0.13
2007	**0.41**	**0.00**	**0.01**
2008	**0.42**	**0.20**	**0.08**
2009	**0.41**	**0.10**	**0.16**
2010	**0.56**	0.43	**0.26**
2011	0.30	0.17	0.13
2012	**0.53**	0.52	**0.24**
2013	**0.48**	0.30	**0.27**
2014	**0.51**	**0.15**	**0.18**

13. Figures

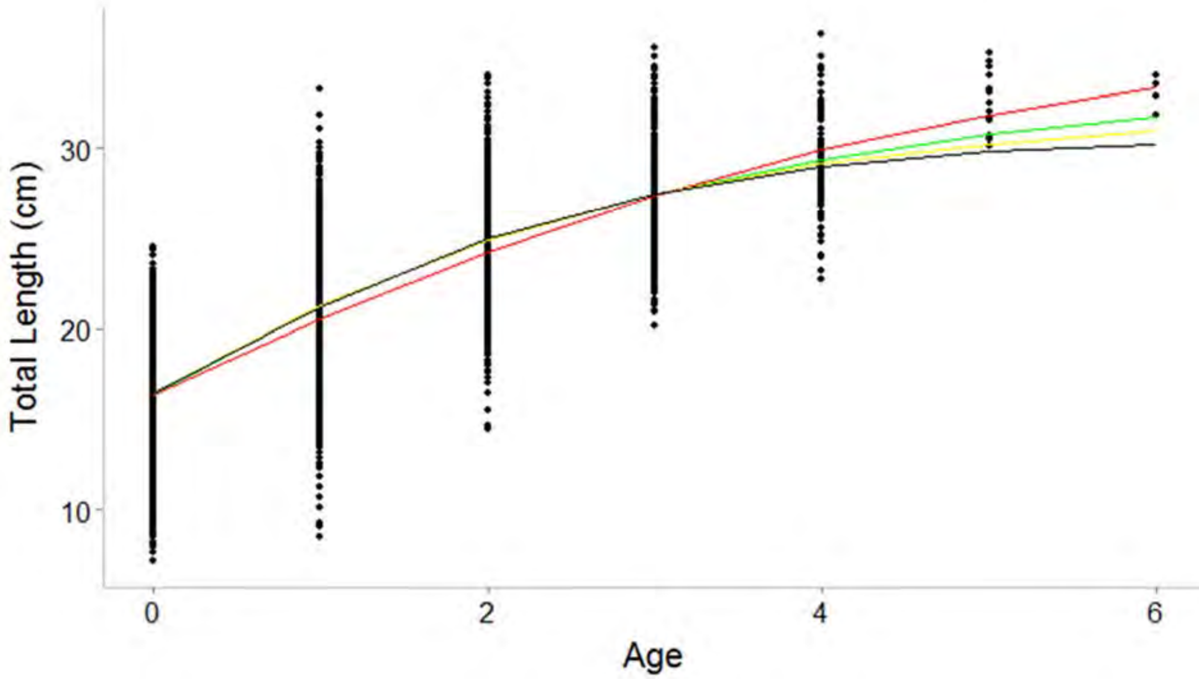

Figure 1. **Observed female spot age-at-total length (black circles) and predictions from the von Bertalanffy (green line), Richard's (red line), Gompertz (yellow line), and logistic (black line) growth models.**

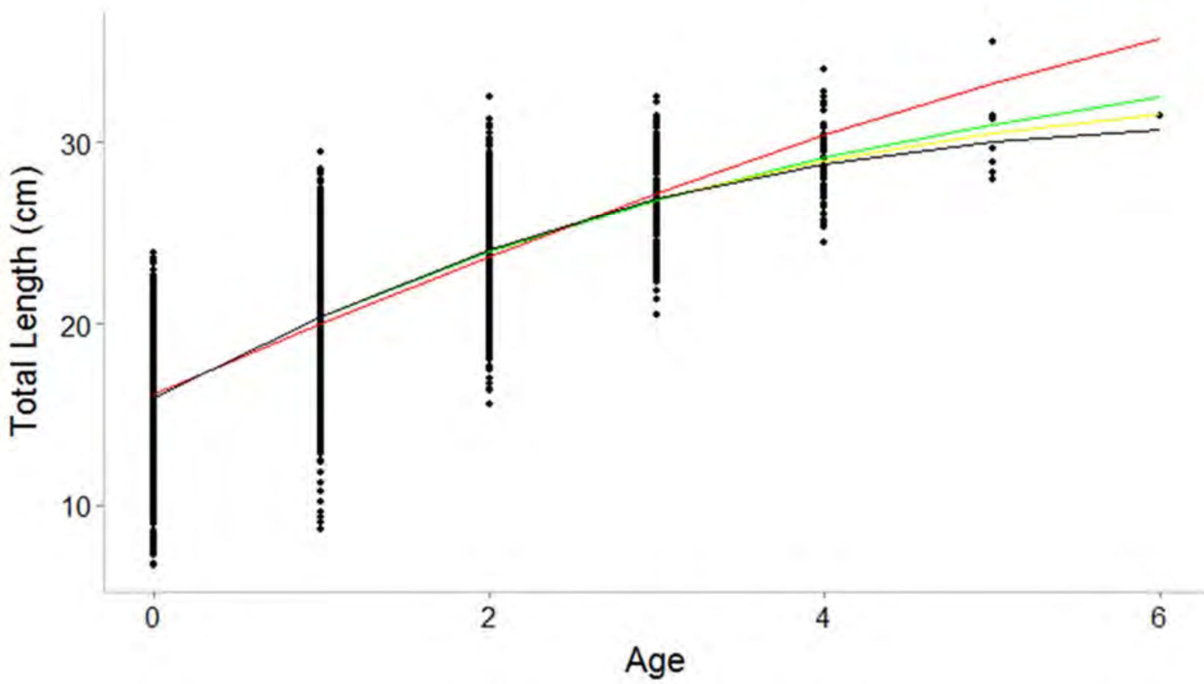

Figure 2. **Observed male spot age-at-length (black circles) and predictions from the von Bertalanffy (green line), Richard's (red line), Gompertz (yellow line), and logistic (black line) growth models.**

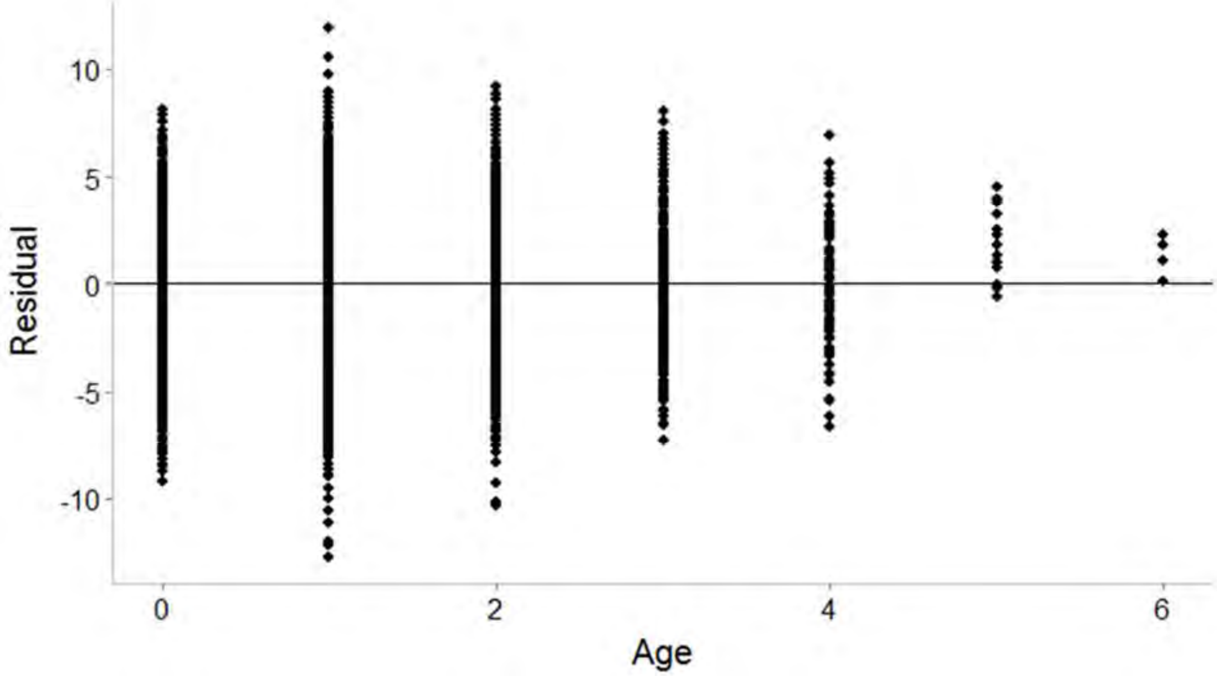

Figure 3. Residuals of von Bertalanffy growth model fit to observed female spot age-at-total length data.

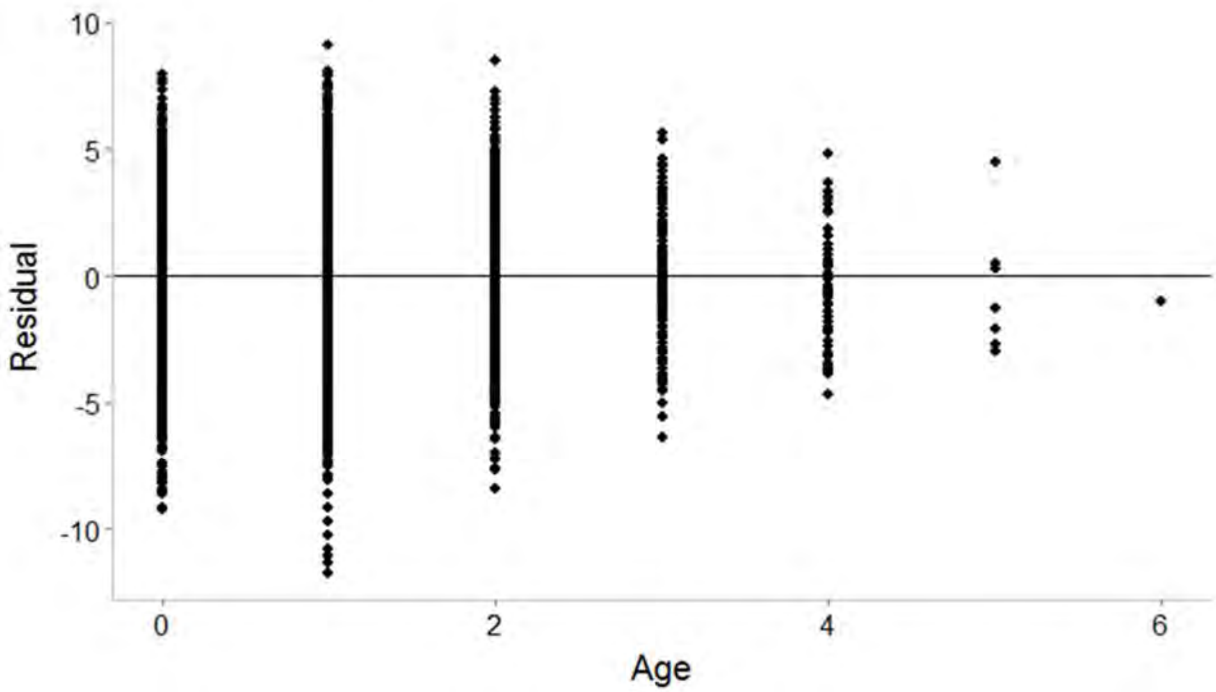

Figure 4. Residuals of von Bertalanffy growth model fit to observed male spot age-at-length data.

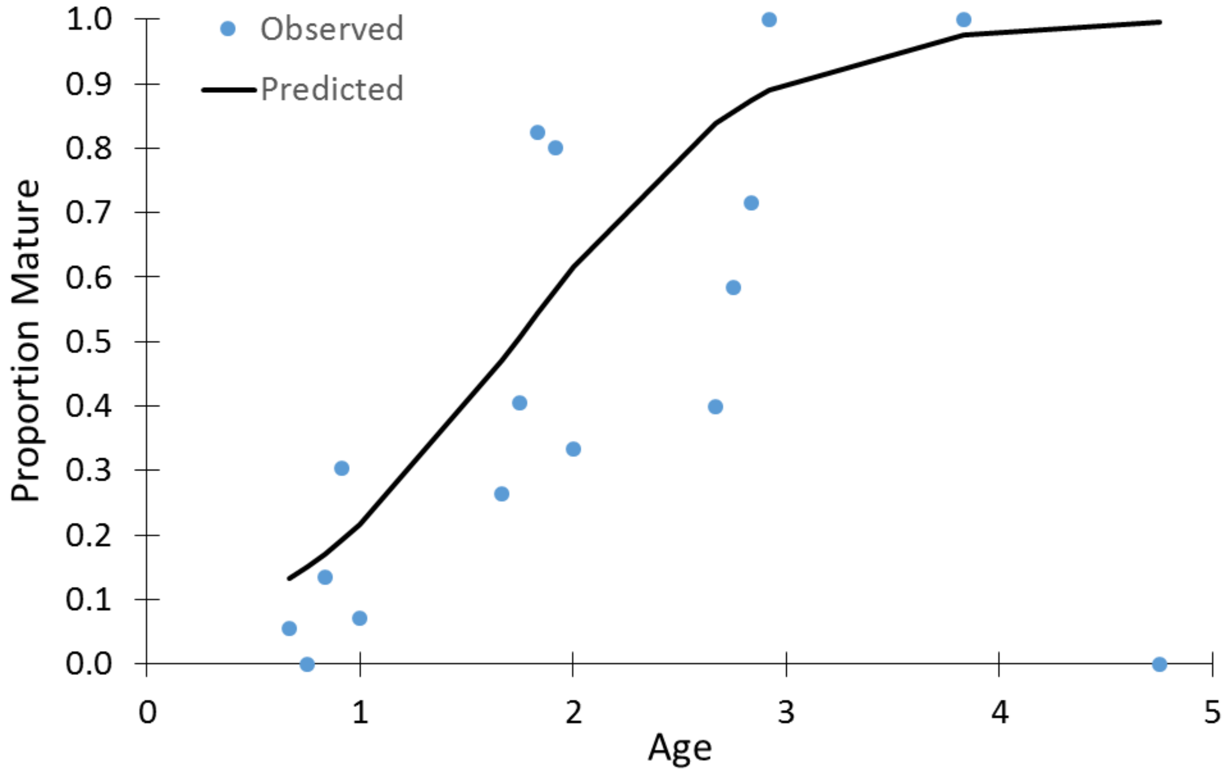

Figure 5. **Observed (blue circles) and predicted (black line) proportion female spot mature-at-age using SCDNR maturity data from August-December. Predicted values are from a logistic regression model (slope = -1.761, inflection = 1.7).**

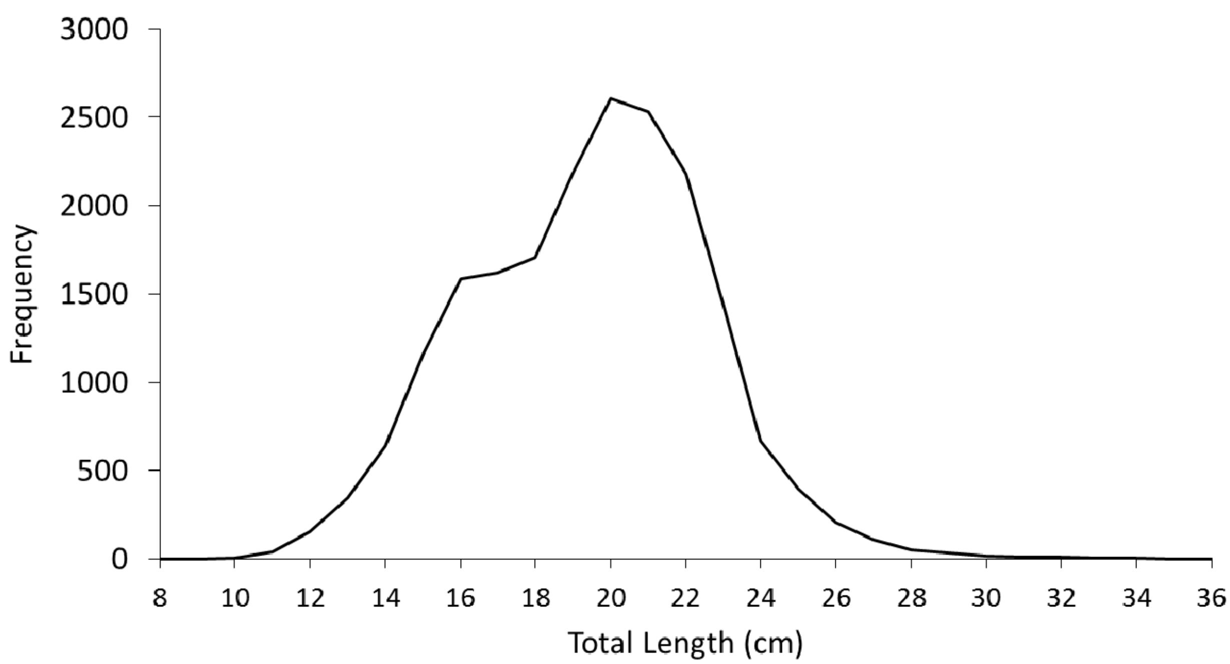

Figure 6. **Aggregate length frequency of spot (mm TL) sampled by the MD DNR from commercial pound nets from 1993-2014.**

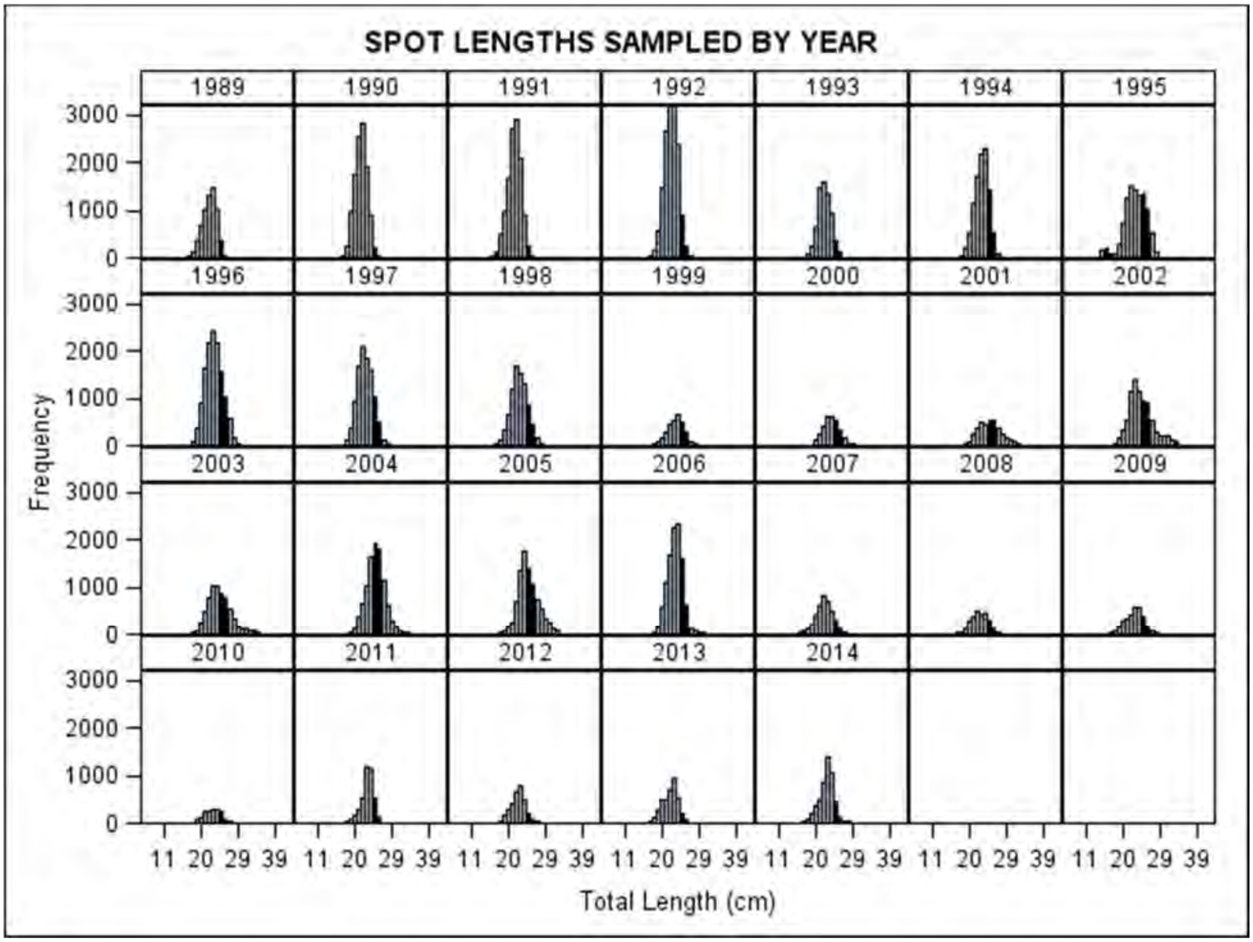

Figure 7. **Annual length frequency of spot sampled by the VMRC's BSP from commercial fisheries.**

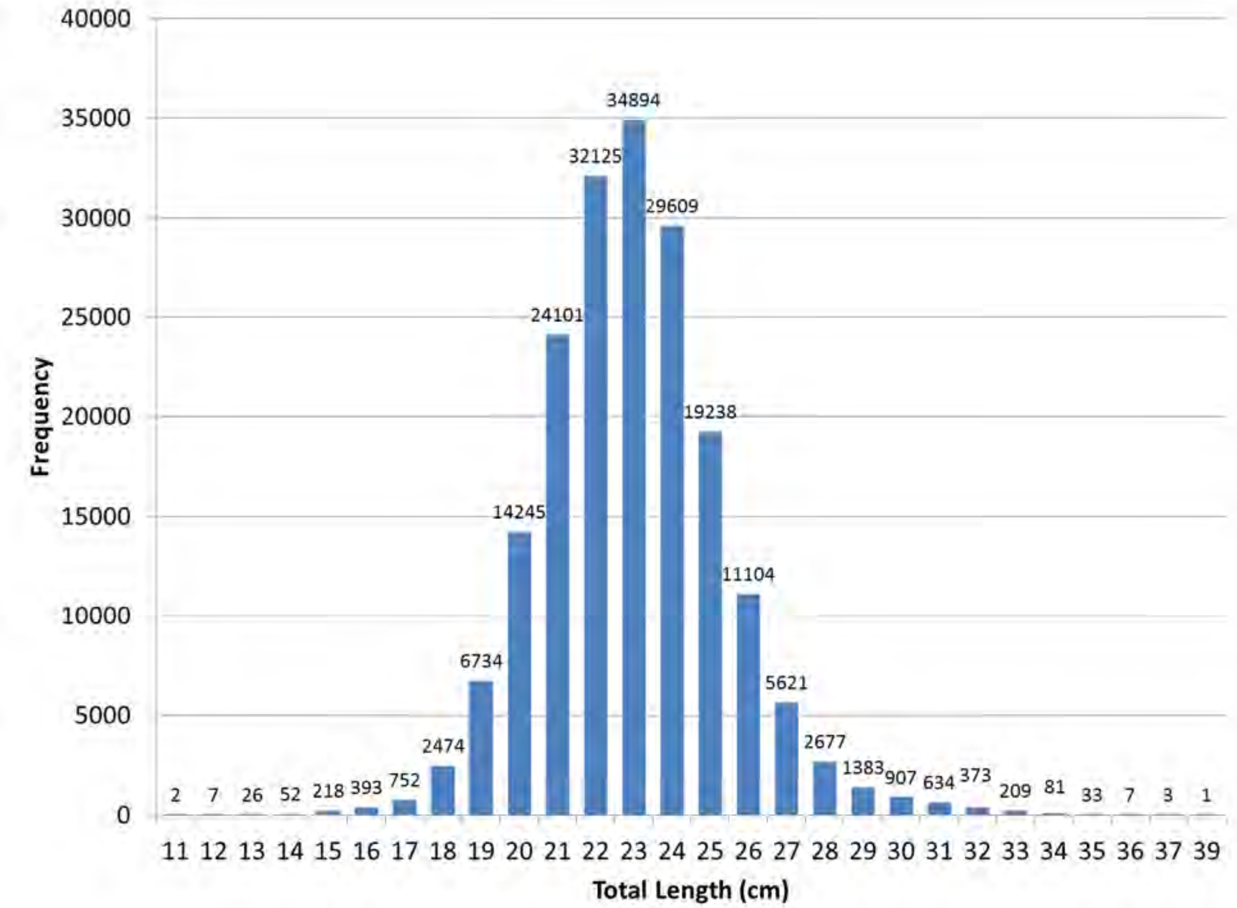

Figure 8. **Aggregate length frequency of spot sampled by the VMRC's BSP from commercial fisheries from 1989-2014.**

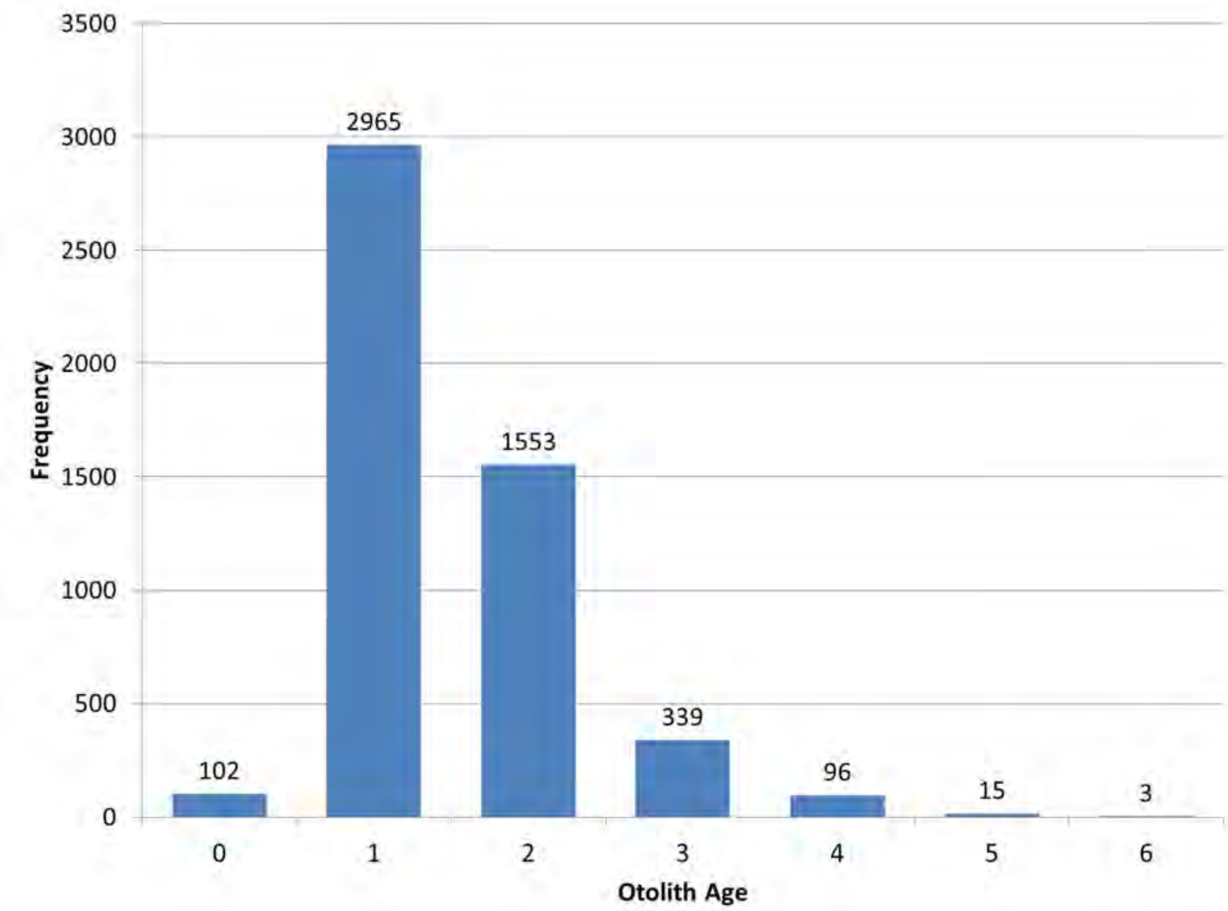

Figure 9. **Aggregate age frequency of spot sampled by the VMRC's BSP from commercial fisheries from 1998-2014.**

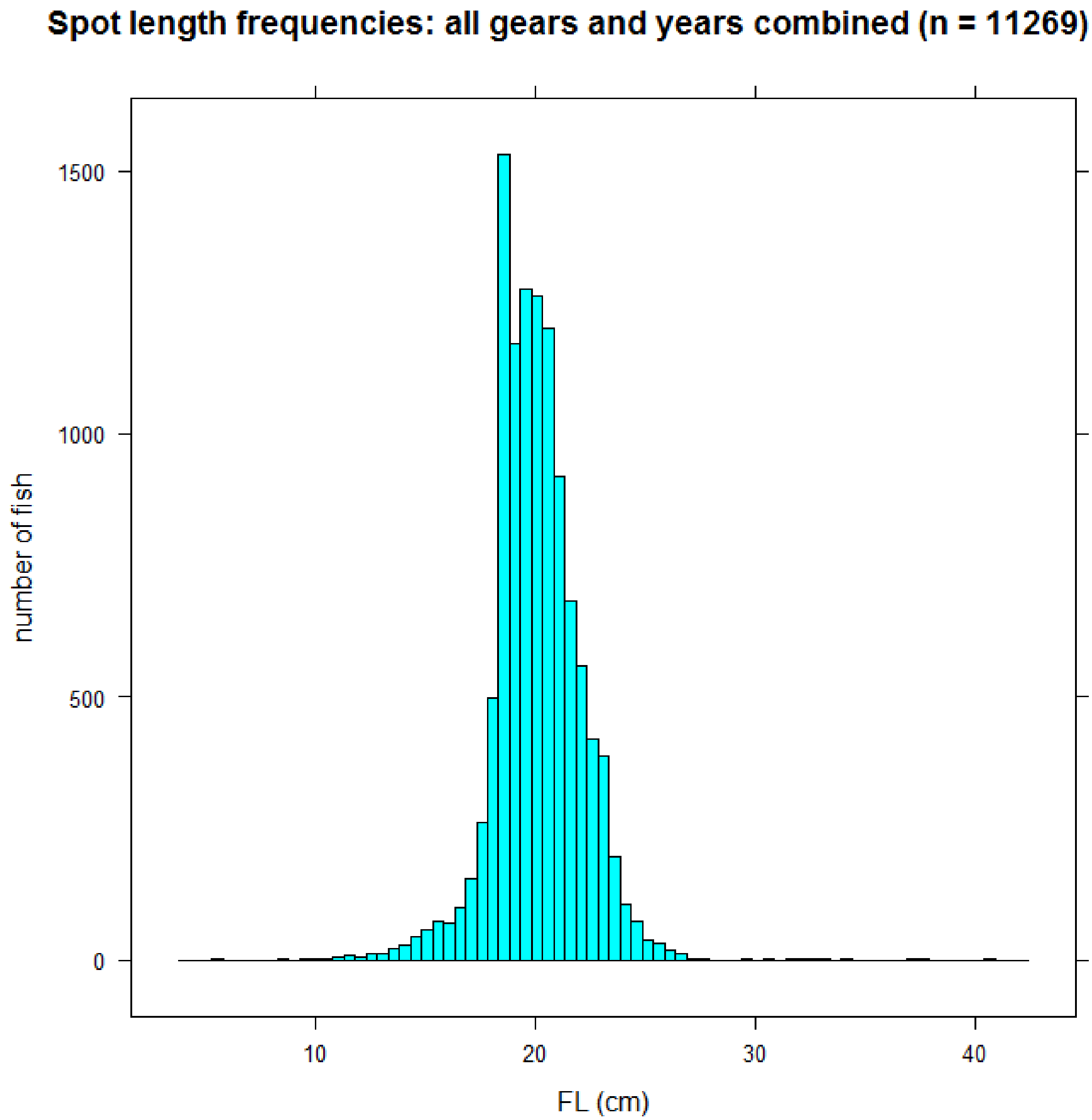

Figure 10. **Length frequency of spot collected by the TIP from commercial fisheries (all gears combined) in Florida from 1992-2014.**

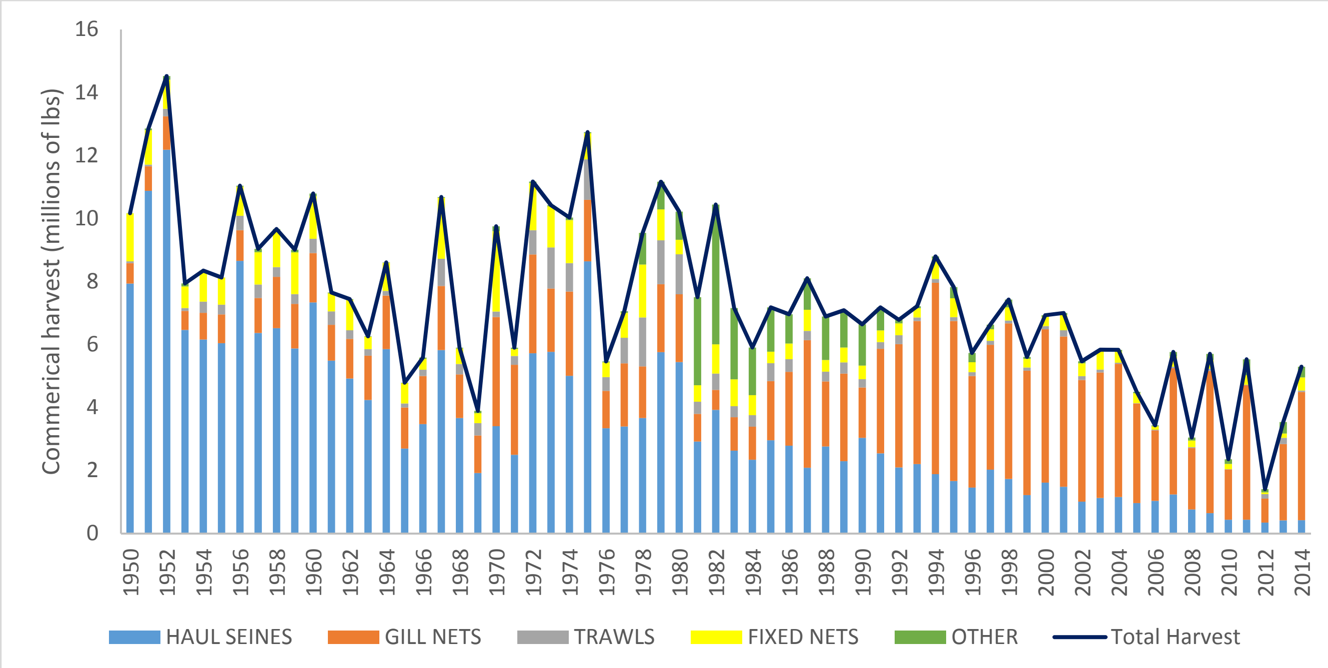

Figure 11. Coastwide spot commercial landings (millions of pounds) by gear.

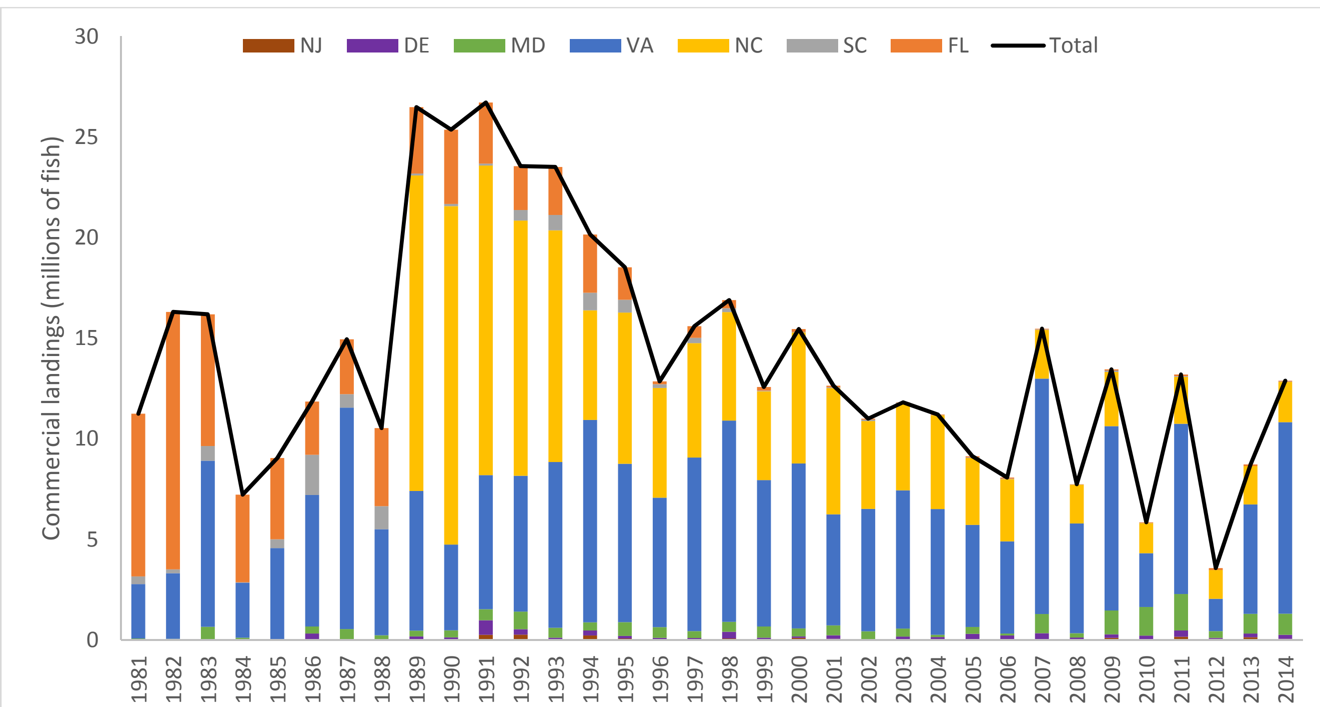

Figure 12. Spot commercial landings (millions of fish) by state.

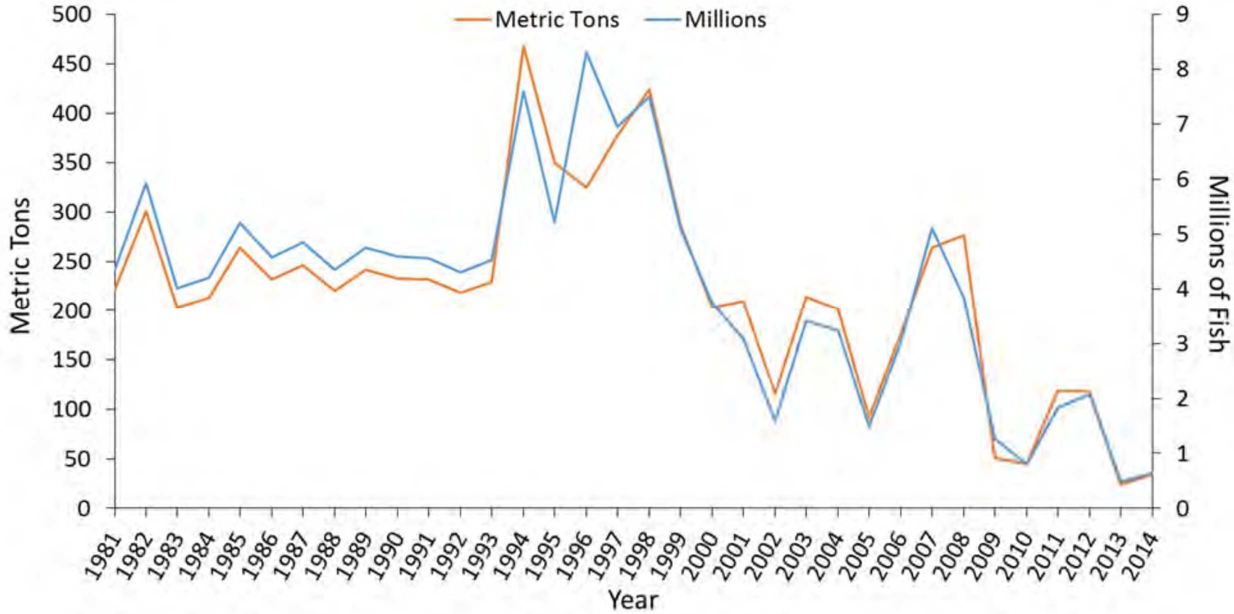

Figure 13. Annual spot scrap landing estimates in metric tons and millions of fish.

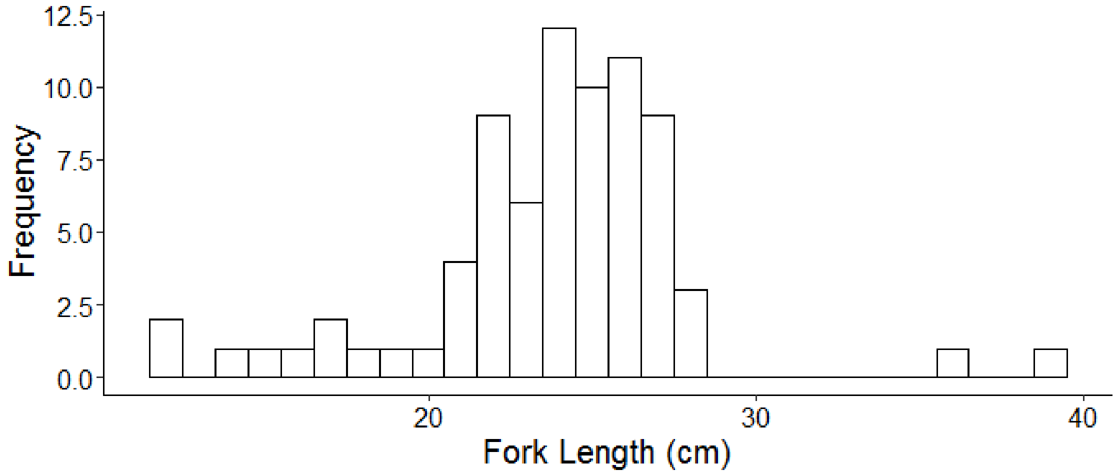

Figure 14. Length distribution of discarded spot observed in gillnets by the NEFOP.

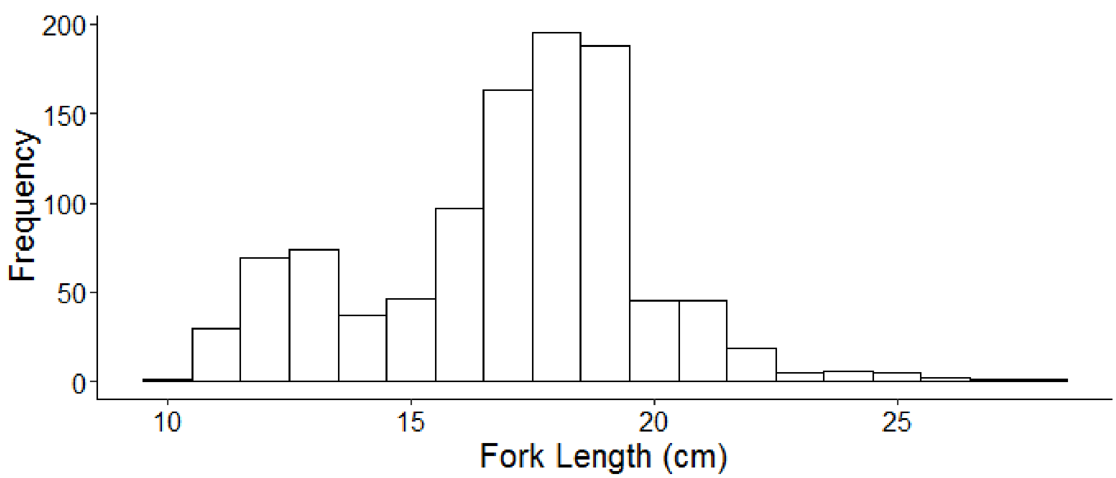

Figure 15. **Length distribution of discarded spot observed in trawls by the NEFOP.**

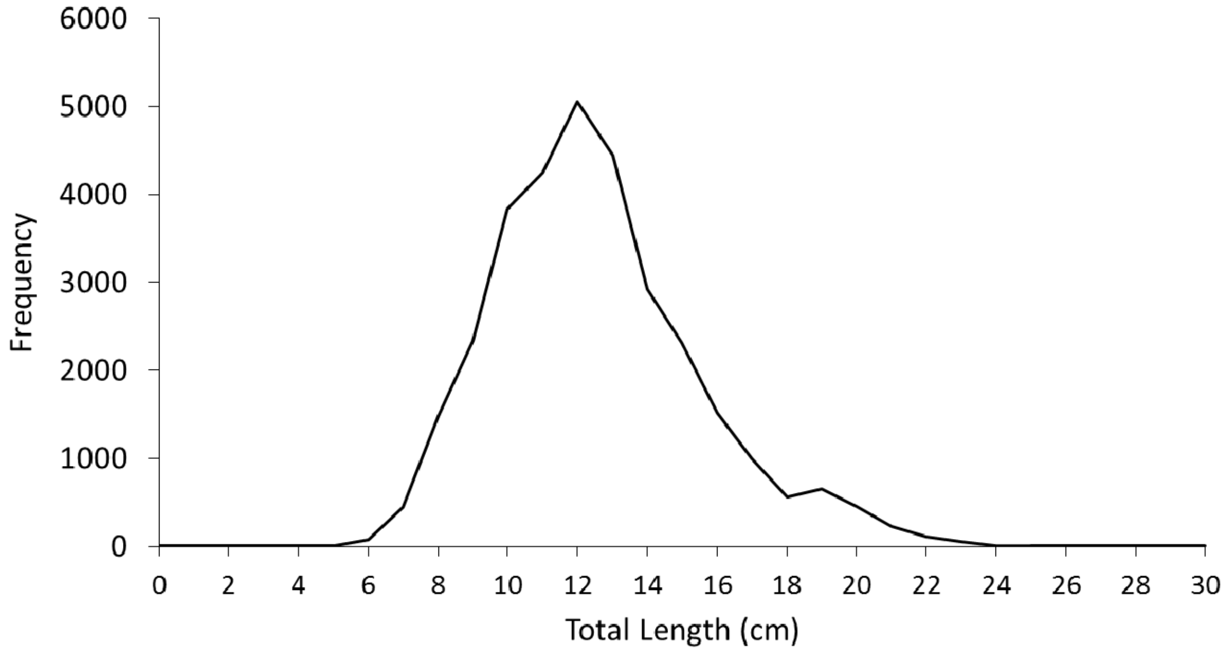

Figure 16. **Length frequency of spot observed during the North Carolina Shrimp Trawl Observer Study (2007-2014).**

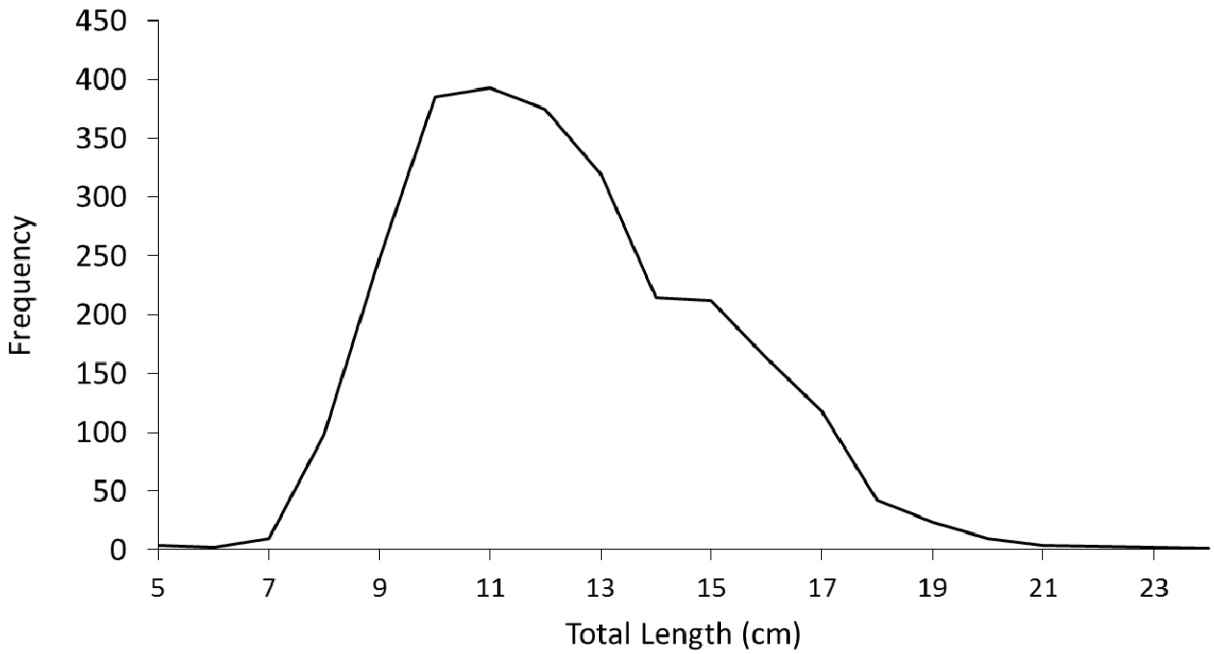

Figure 17. **Length frequency of spot observed during the Georgia Large Shrimp Trawl Bycatch Observer Study (1995-2005).**

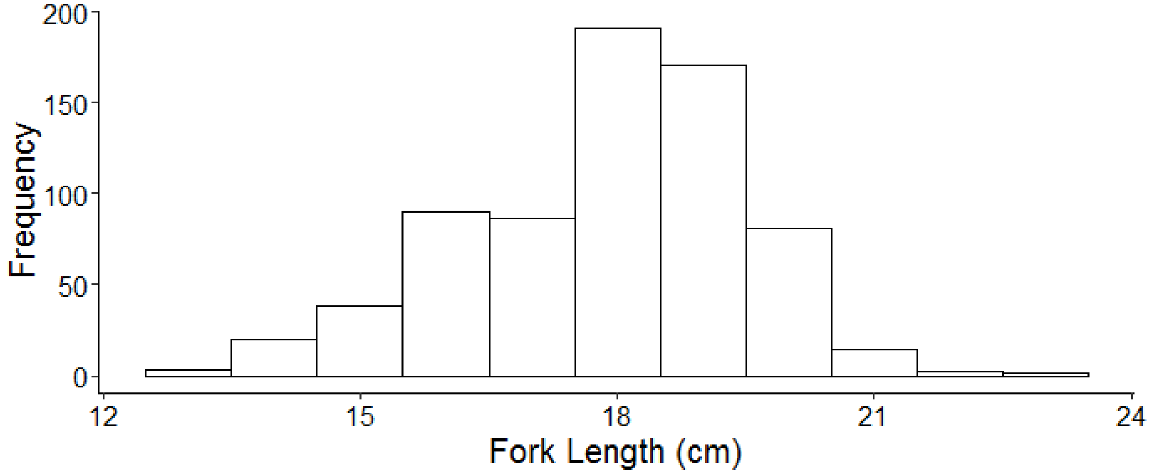

Figure 18. **Length distribution of spot measured by the SESTOP. All length samples were collected in 2003.**

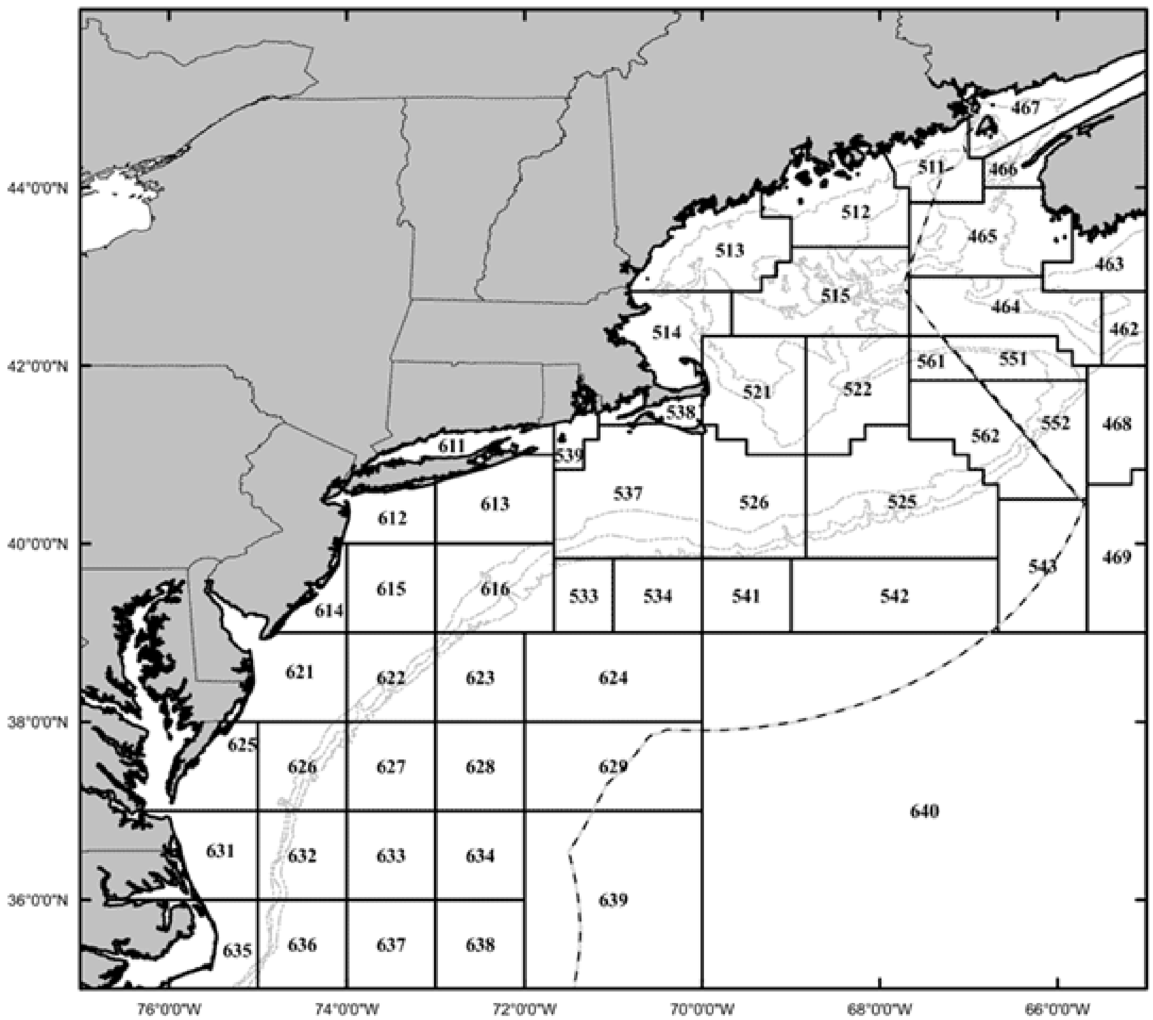

Figure 19. **Statistical area used for commercial fisheries data collection by the NMFS in the Northeast Region. The 50, 100 and 500 fa bathymetric lines are shown in**

light gray and the U.S. EEZ is indicated by the dashed black line (courtesy of NMFS NEFSC).

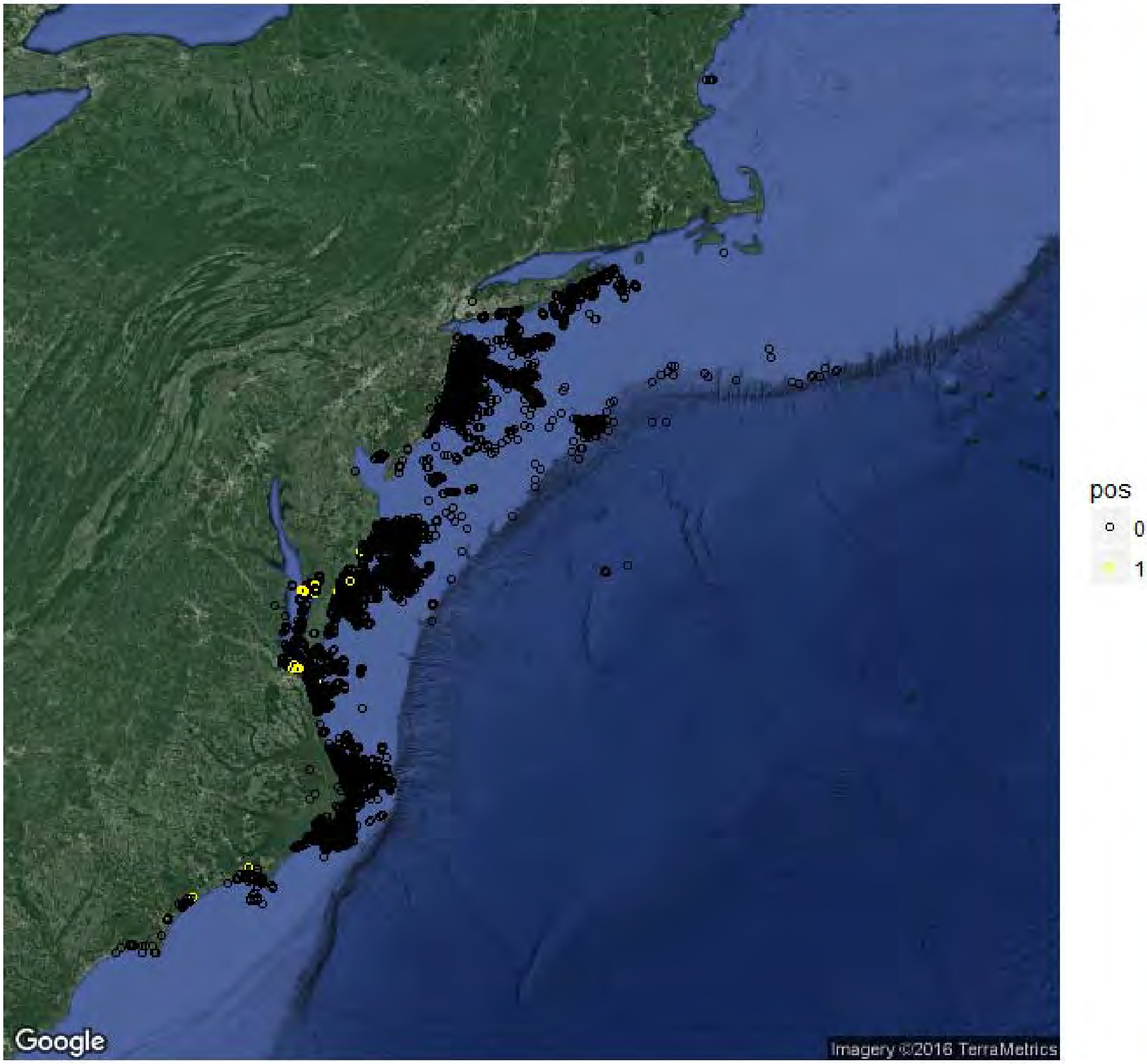

Figure 20. **Gillnet sets observed by the NEFOP. Yellow circles indicate sets where spot were discarded and black circles indicate sets where spot were not discarded.**

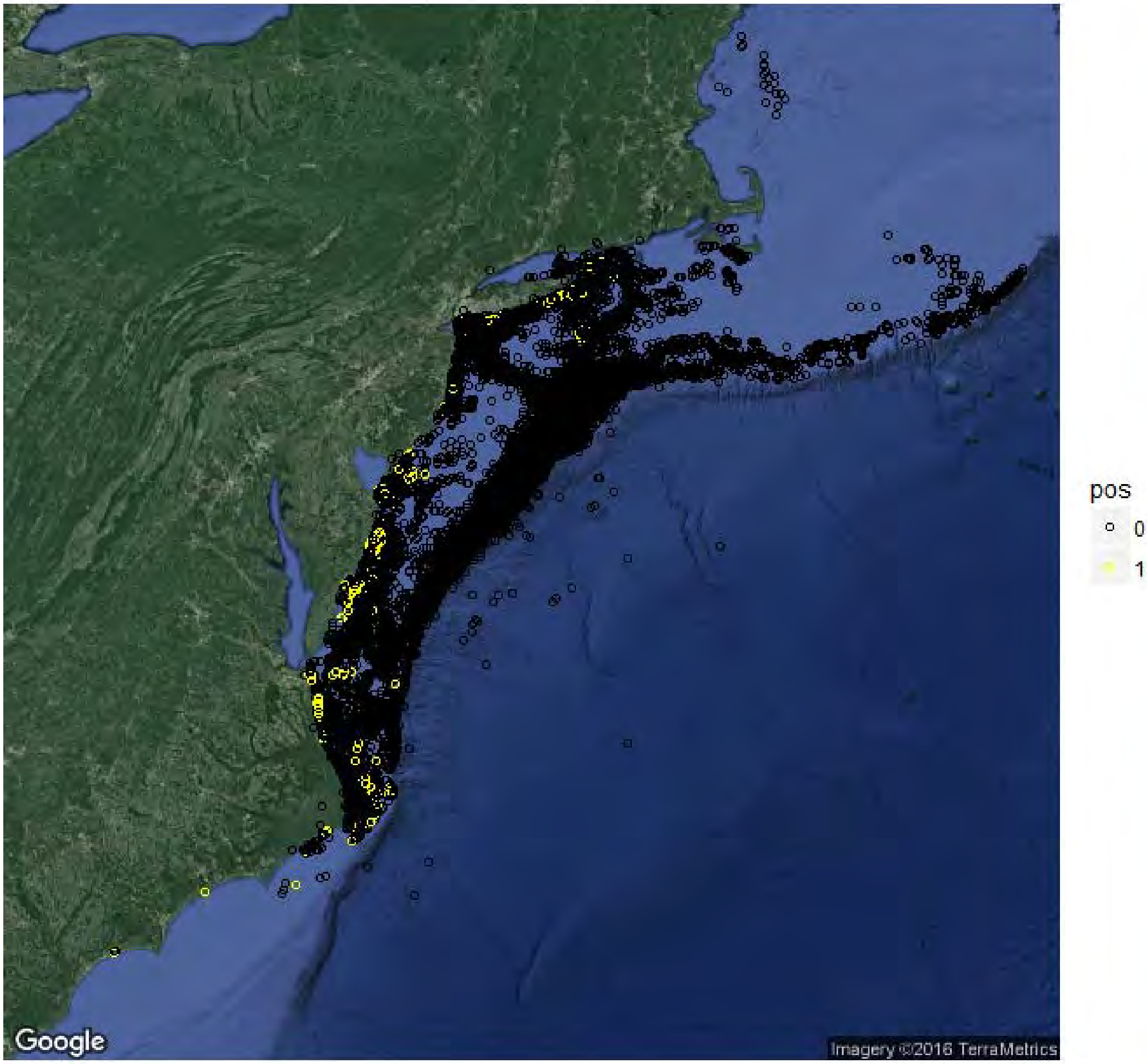

Figure 21. **Trawl tows observed by the NEFOP. Yellow circles indicate tows where spot were discarded and black circles indicate tows where spot were not discarded.**

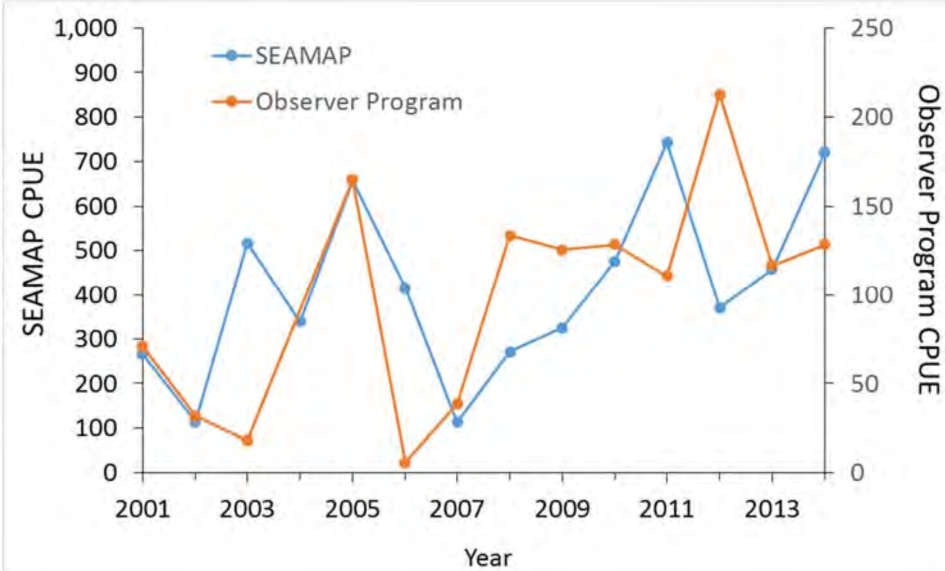

Figure 22. **Annual mean CPUE of spot (number of fish/hour fished) during SEAMAP Trawl Survey tows and observer program tows.**


data_set
SEAMAP
Google
Imagery ©2016 TerraMetrics

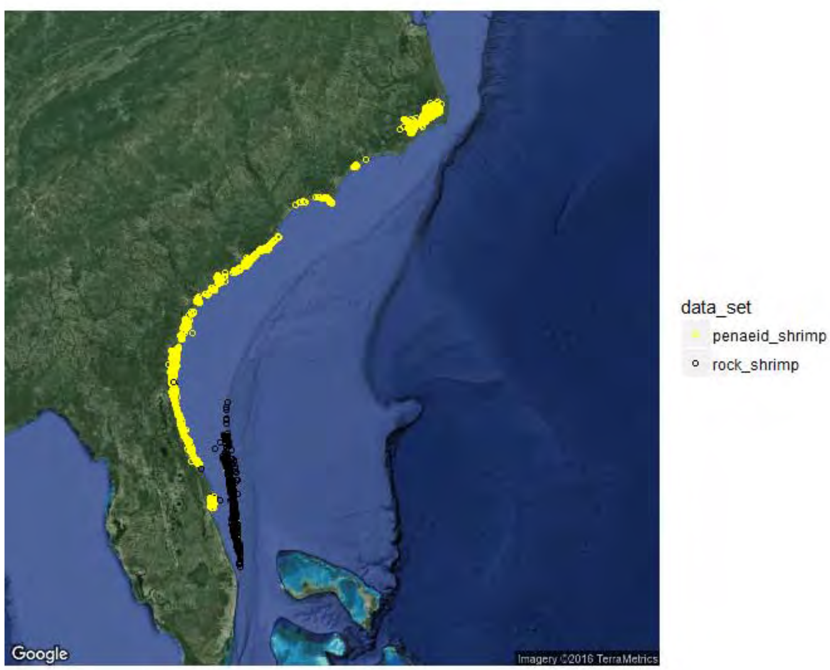
data_set
penaeid_shrimp
rock_shrimp
Google
Imagery ©2016 TerraMetrics

Figure 23. **Map of SEAMAP Trawl Survey tows (red circles) and SESTOP observer tows by fishery (yellow circles for the penaeid shrimp fishery and black circles for the rock shrimp fishery).**

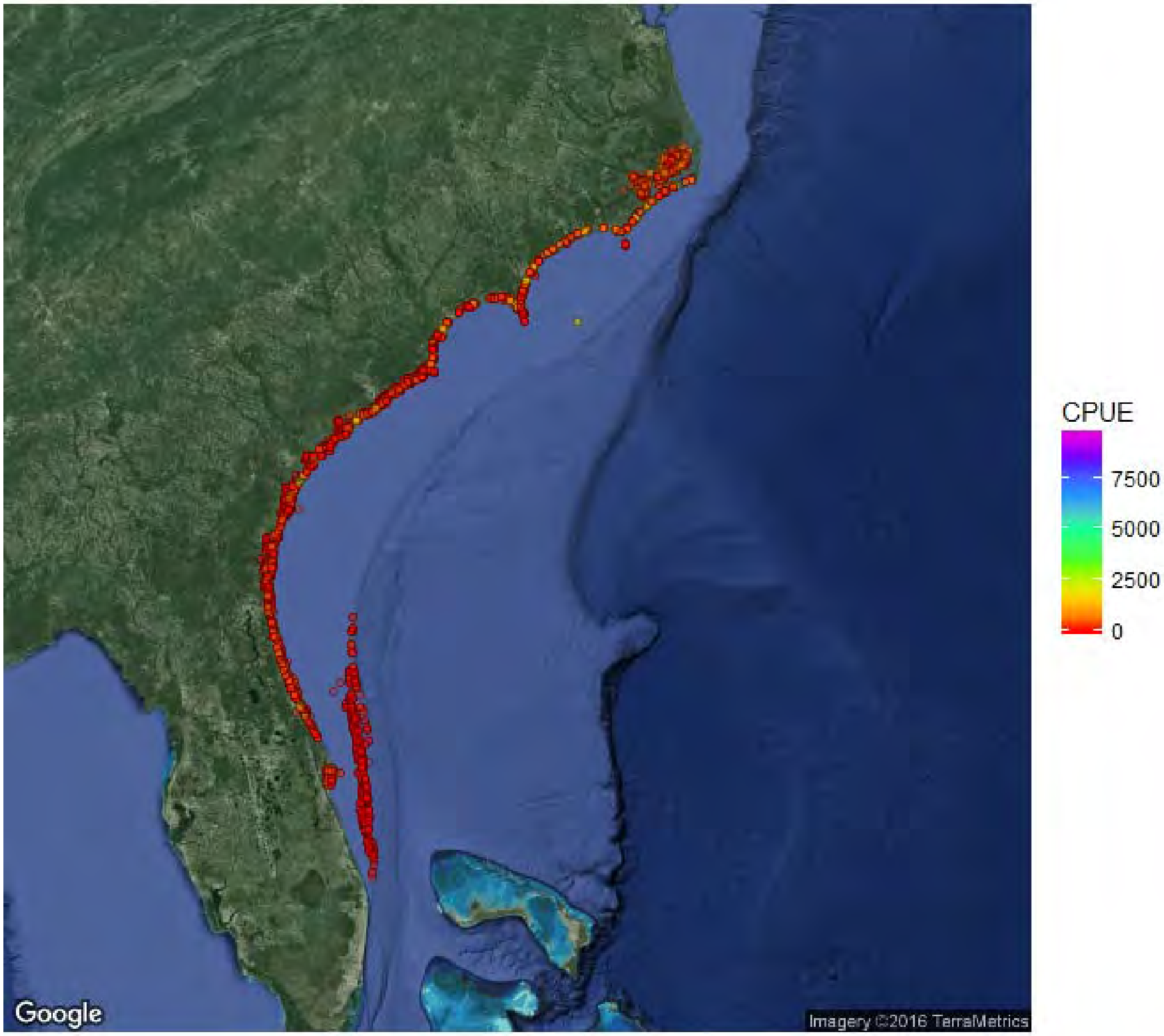

Figure 24. **Tows from SEAMAP Trawl Survey and SESTOP catch rate data set that encountered less than 10,000 spot per hour fished (CPUE).**

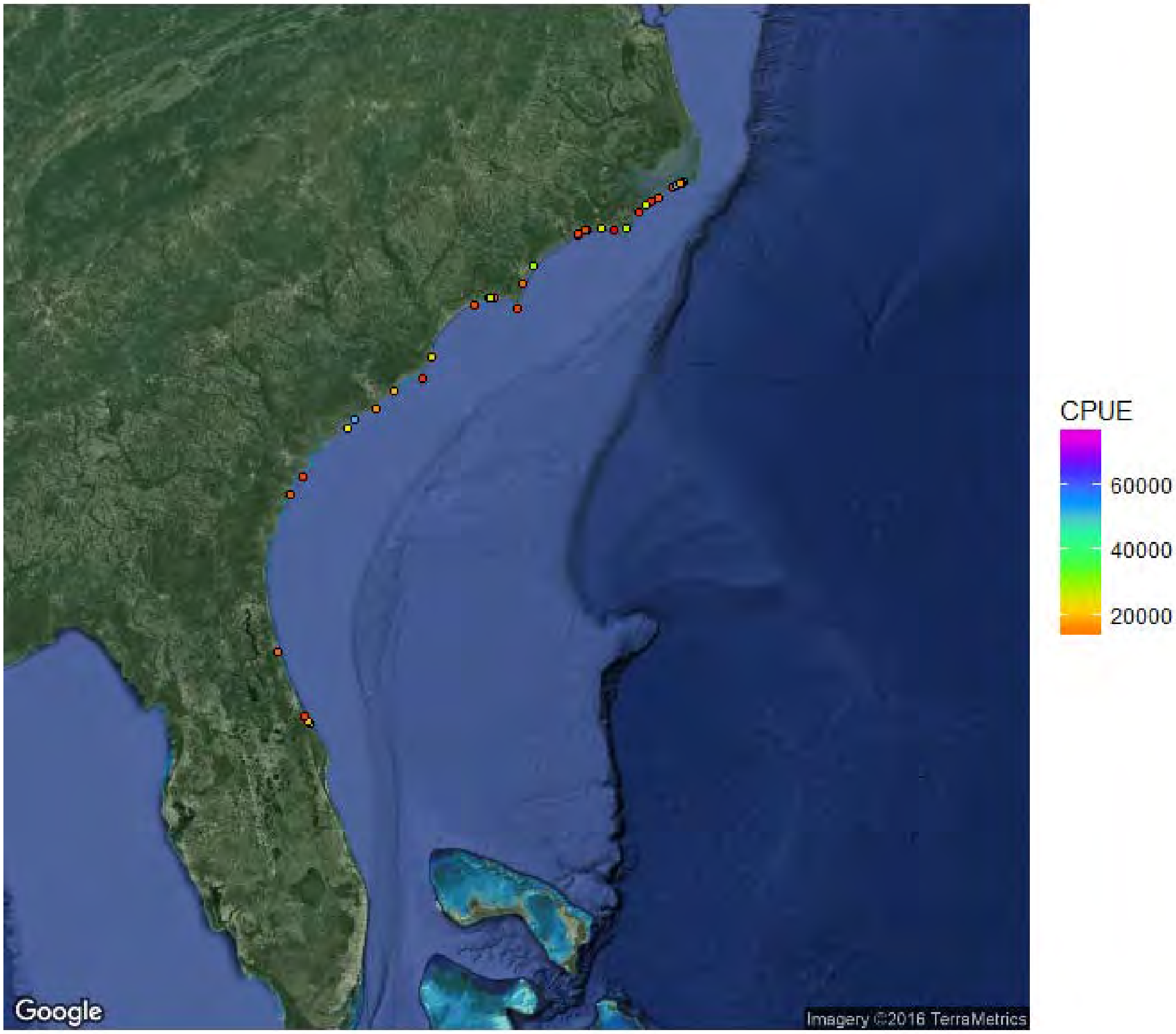

Figure 25. **Tows from SEAMAP Trawl Survey and SESTOP catch rate data set that encountered at least 10,000 spot per hour fished (CPUE).**

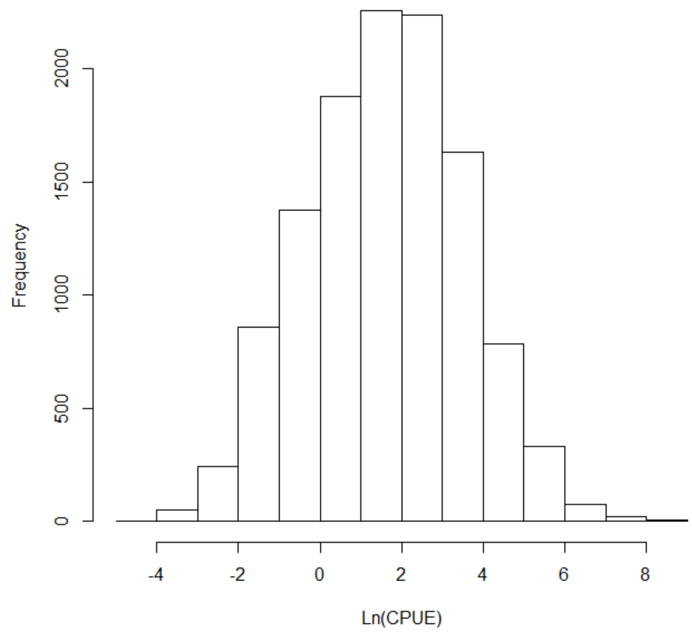

Figure 26. **Distribution of positive spot CPUE observations (weight in kg) from the SEAMAP Trawl Survey and SESTOP on the log scale.**

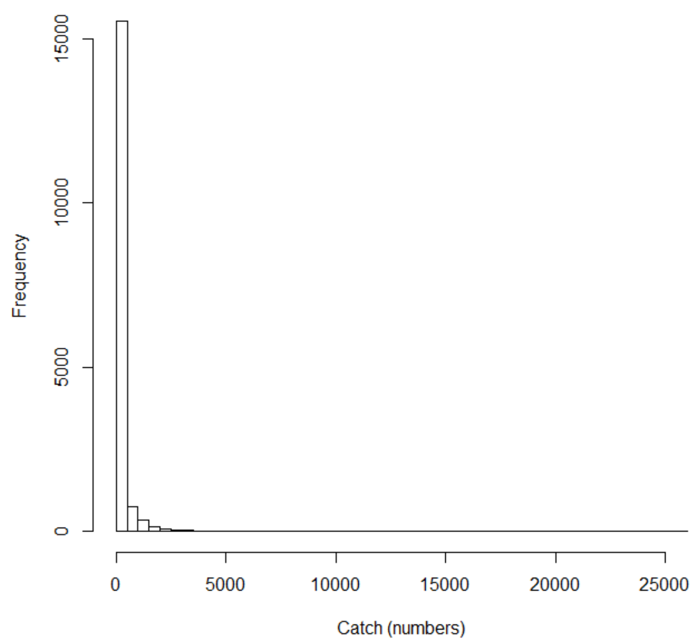

Figure 27. **Distribution of spot discards (numbers) during each observation from the SEAMAP Trawl Survey and SESTOP.**

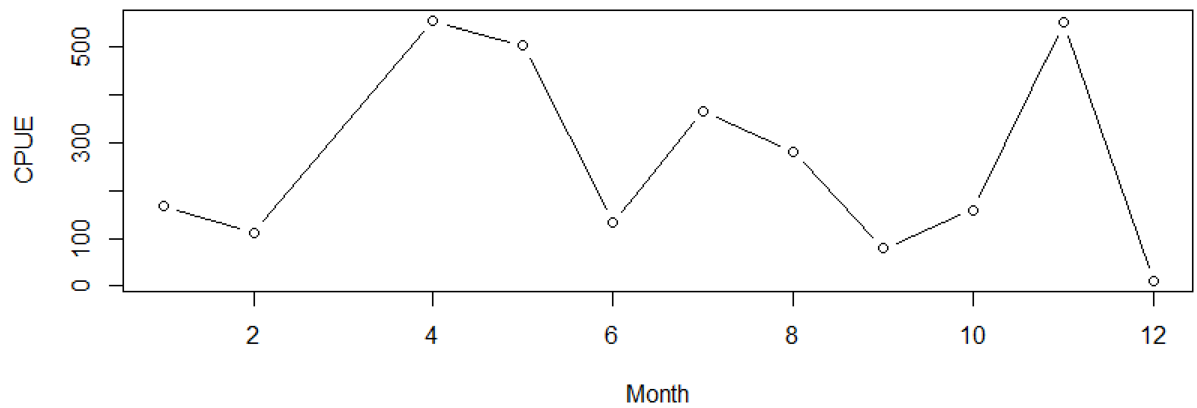

Figure 28. Spot CPUE (numbers) by month from all SEAMAP Trawl Survey and SESTOP catch rate data.

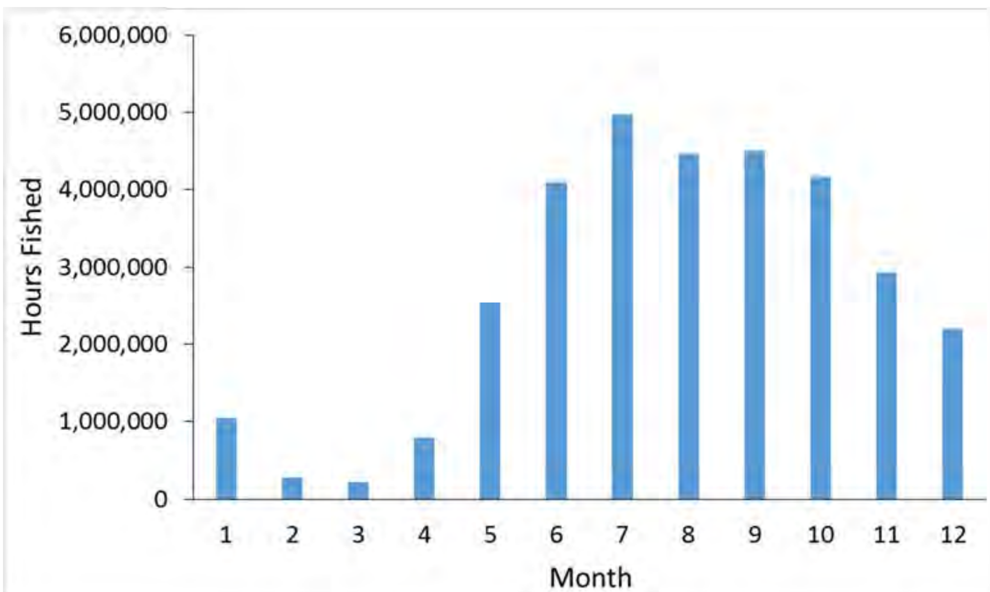

Figure 29. South Atlantic shrimp trawl effort by month.

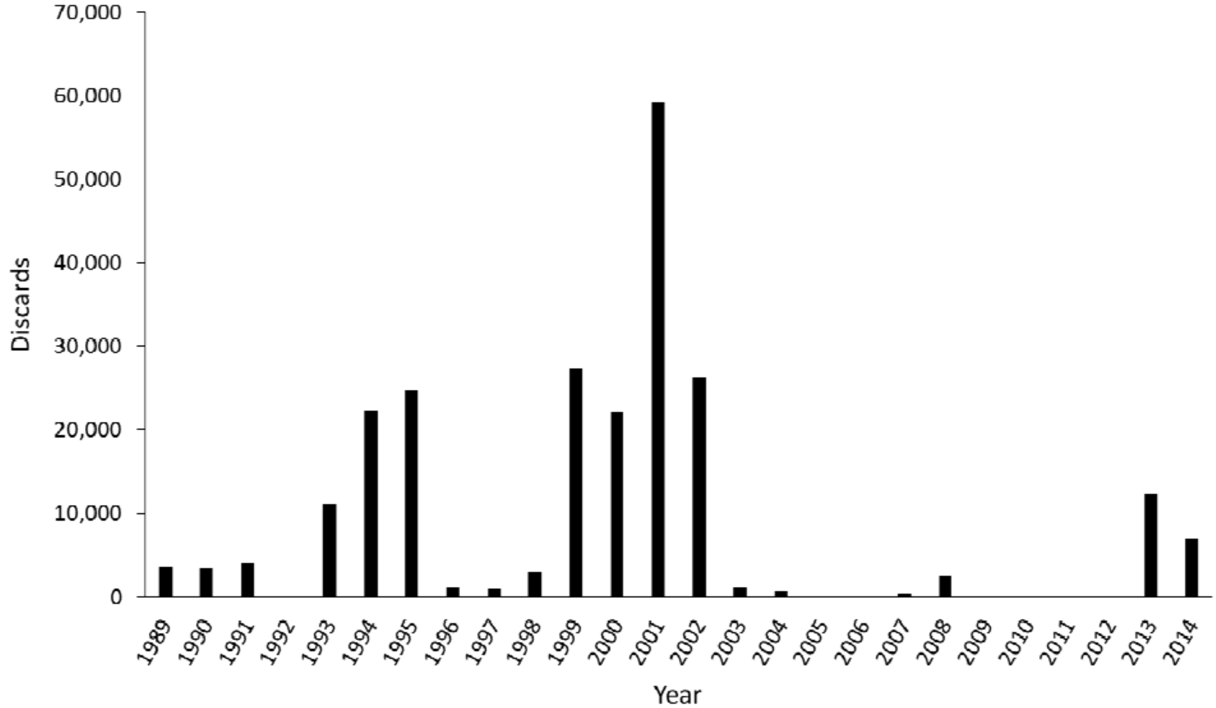

Figure 30. **Spot gillnet discards (number of fish) in Mid-Atlantic fisheries.**

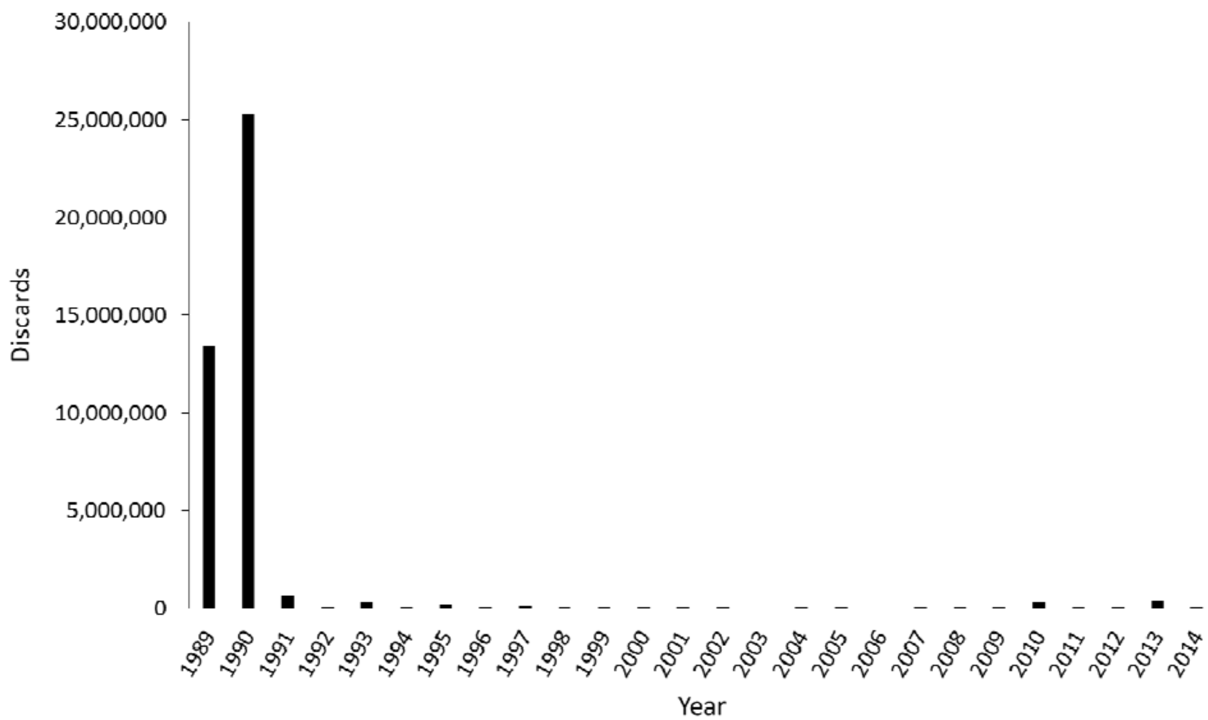

Figure 31. **Spot trawl discards (number of fish) in Mid-Atlantic fisheries.**

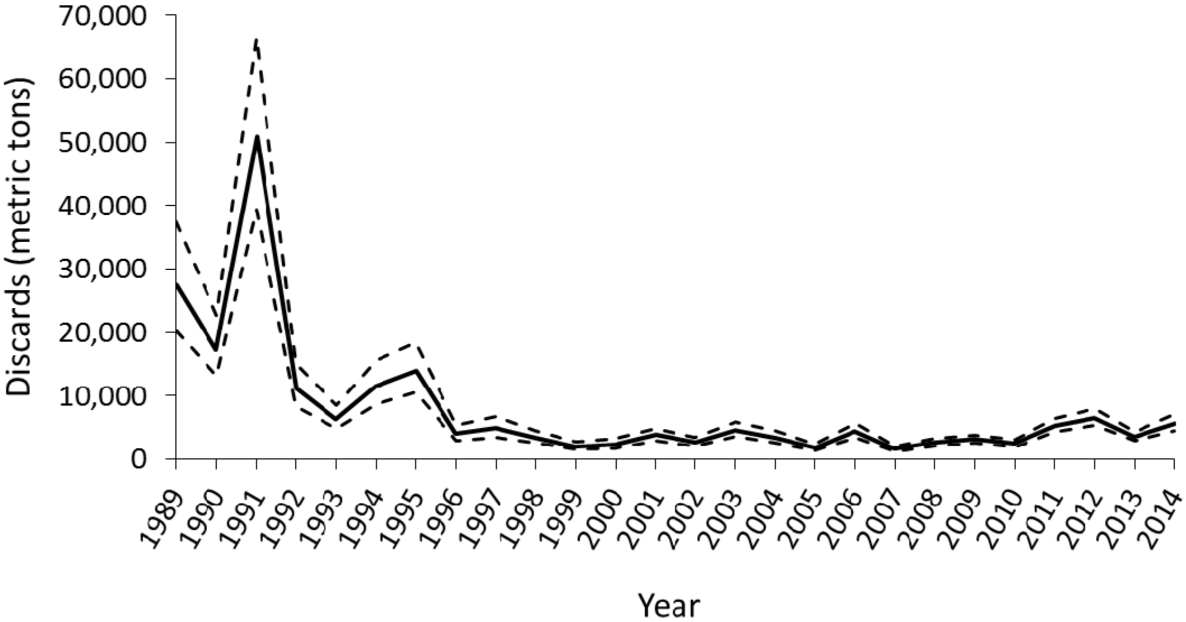

Figure 32. Spot discard estimates (metric tons, solid line) from South Atlantic shrimp trawl fisheries with 95% confidence intervals (dashed lines).

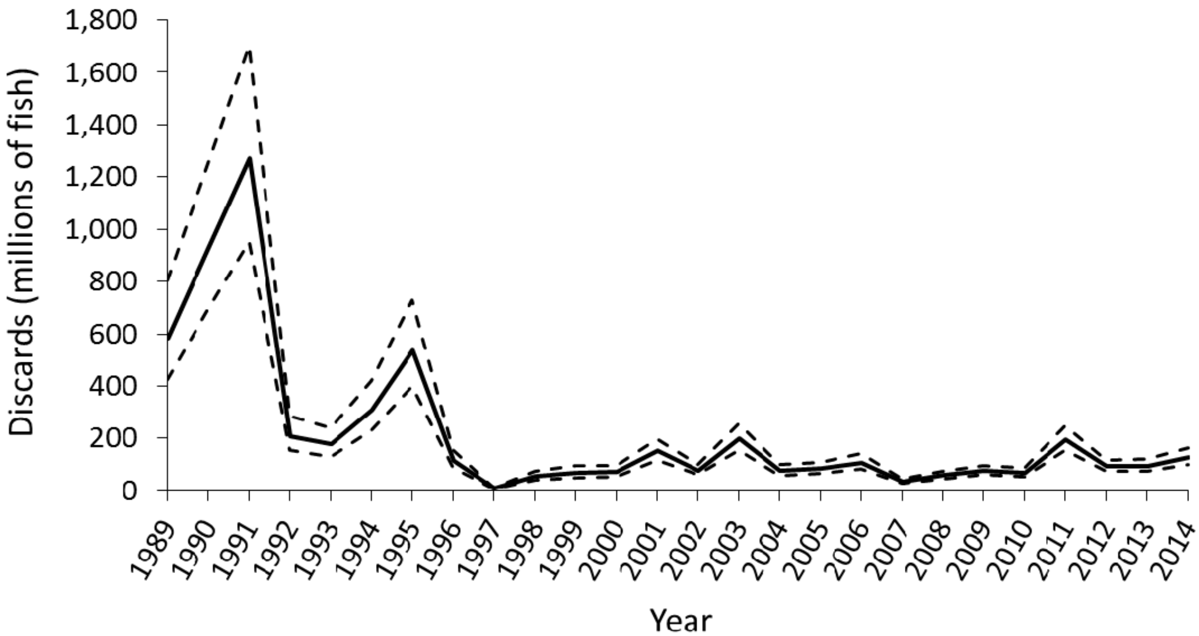

Figure 33. Spot discard estimates (millions of fish, solid line) from South Atlantic shrimp trawl fisheries with 95% confidence intervals (dashed lines).

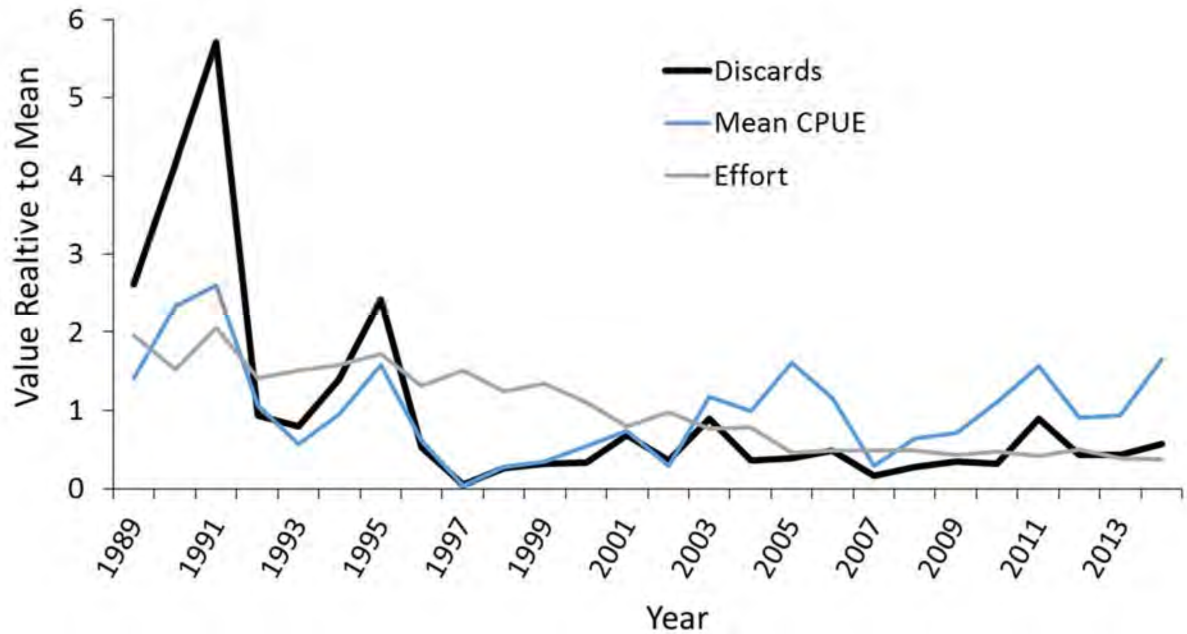

Figure 34. South Atlantic shrimp trawl effort, spot discard estimates (numbers), and mean spot CPUE (number of fish/hour fished) scaled to time series means.

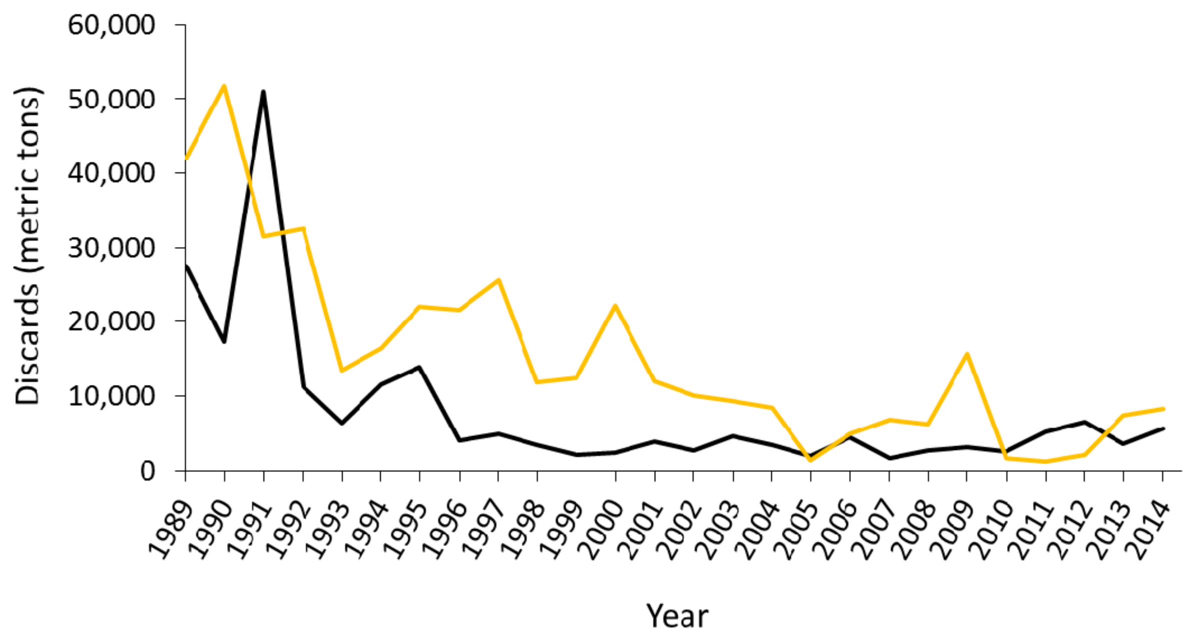

Figure 35. Comparison of spot discard estimates (black line) and spot landings by South Atlantic shrimp trawls (gold line). Landings scale is on secondary axis and values are not included due to confidentiality.

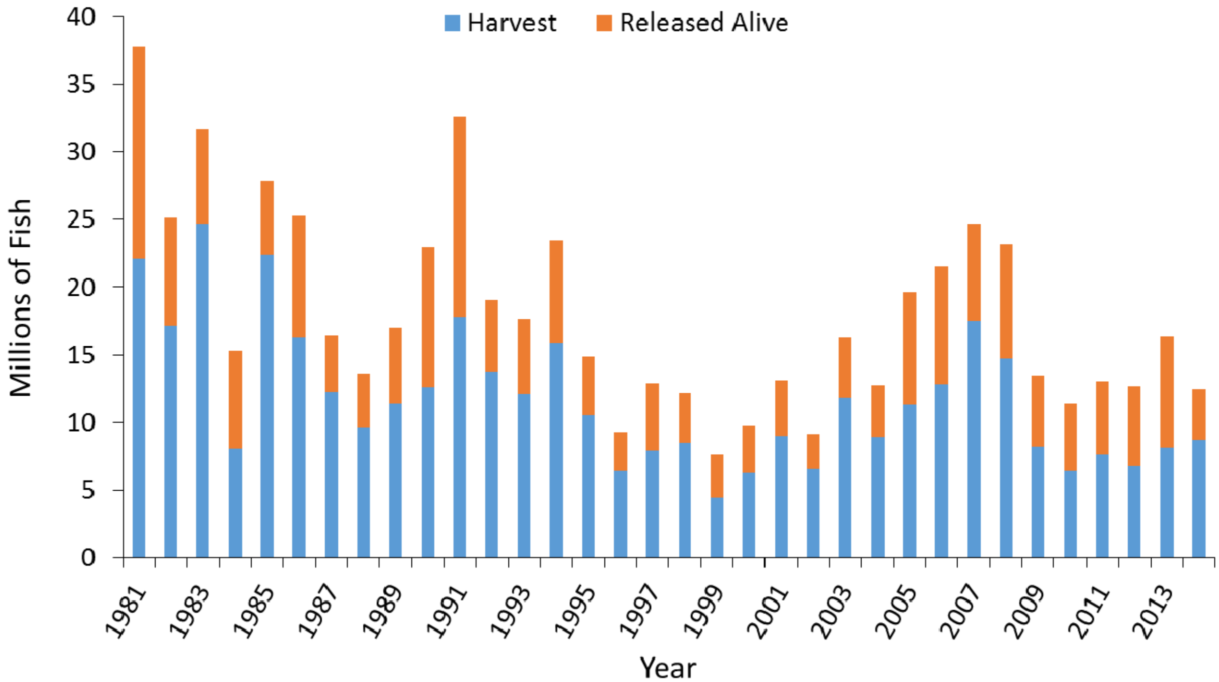

Figure 36. **MRFSS and MRIP coastwide recreational harvest and released alive estimates of spot in millions of fish.**

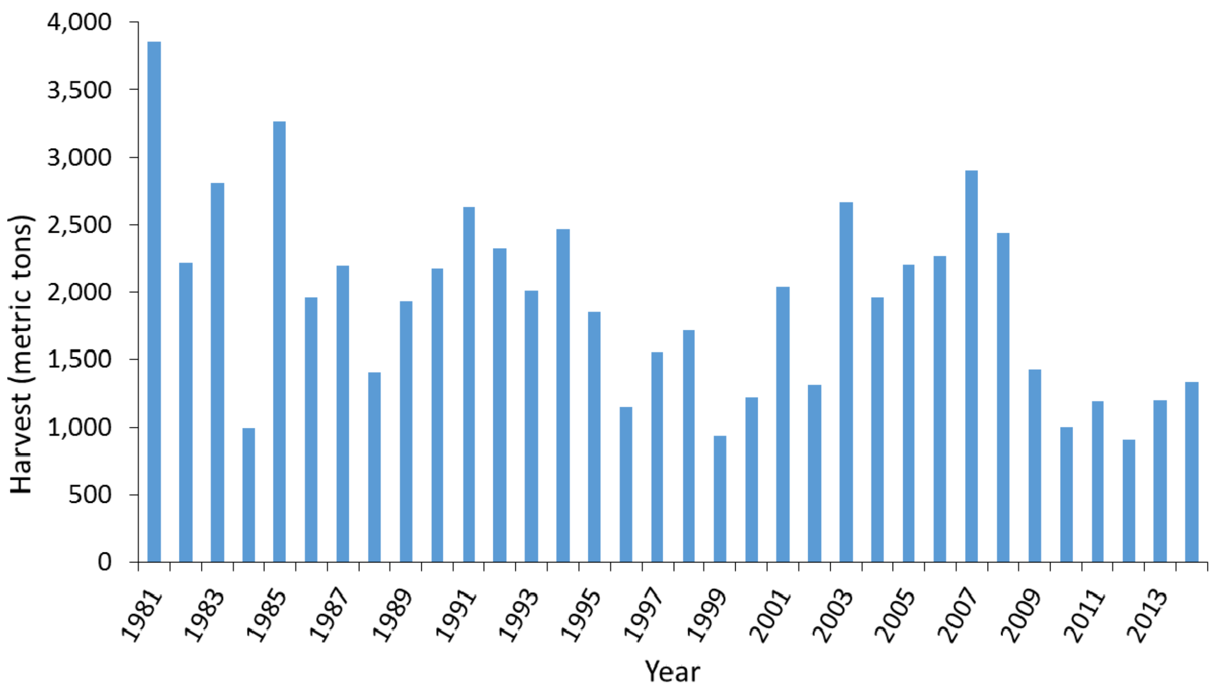

Figure 37. **MRFSS and MRIP coastiwde recreational harvest of spot (metric tons).**

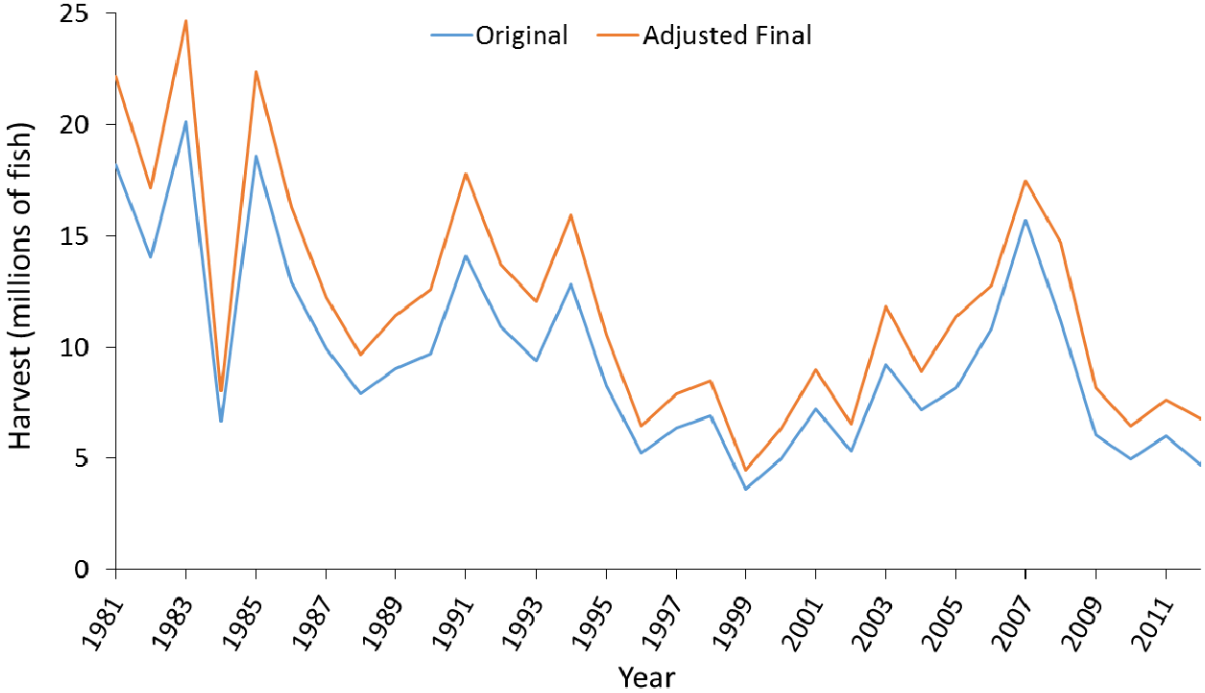

Figure 38. **Comparison of MRFSS and MRIP recreational harvest estimates of spot (millions of fish) before (blue line) and after (orange line) adjustments.**

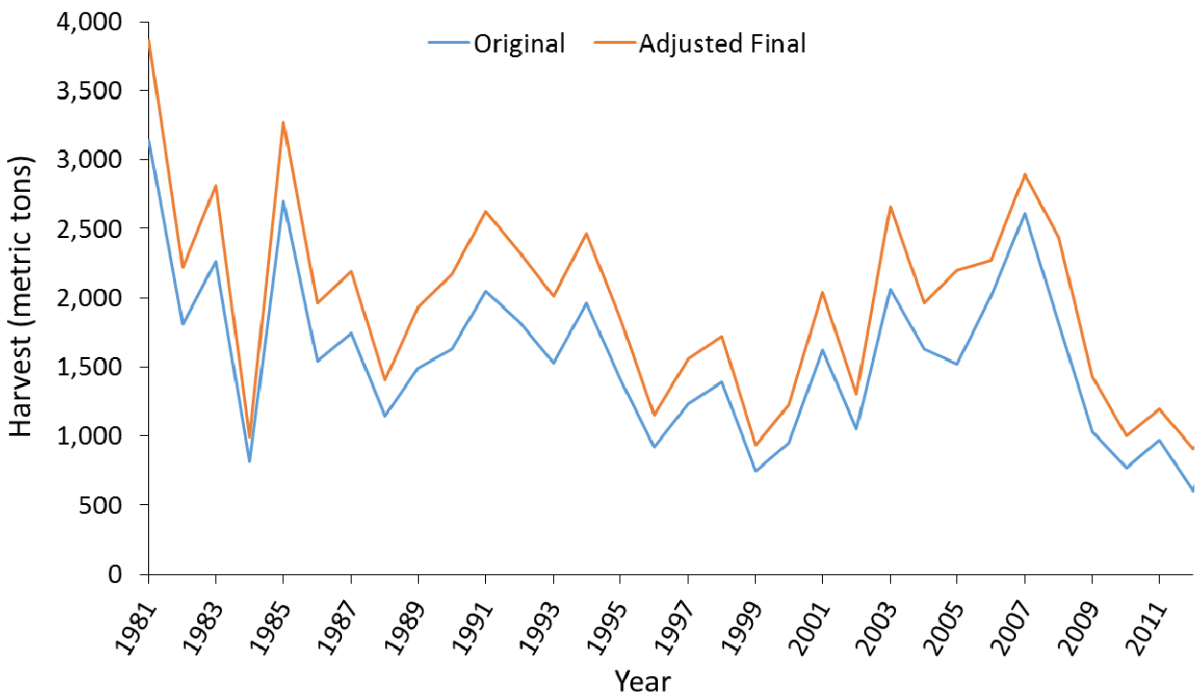

Figure 39. **Comparison of MRFSS and MRIP recreational harvest estimates of spot (metric tons) before (blue line) and after (orange line) adjustments.**

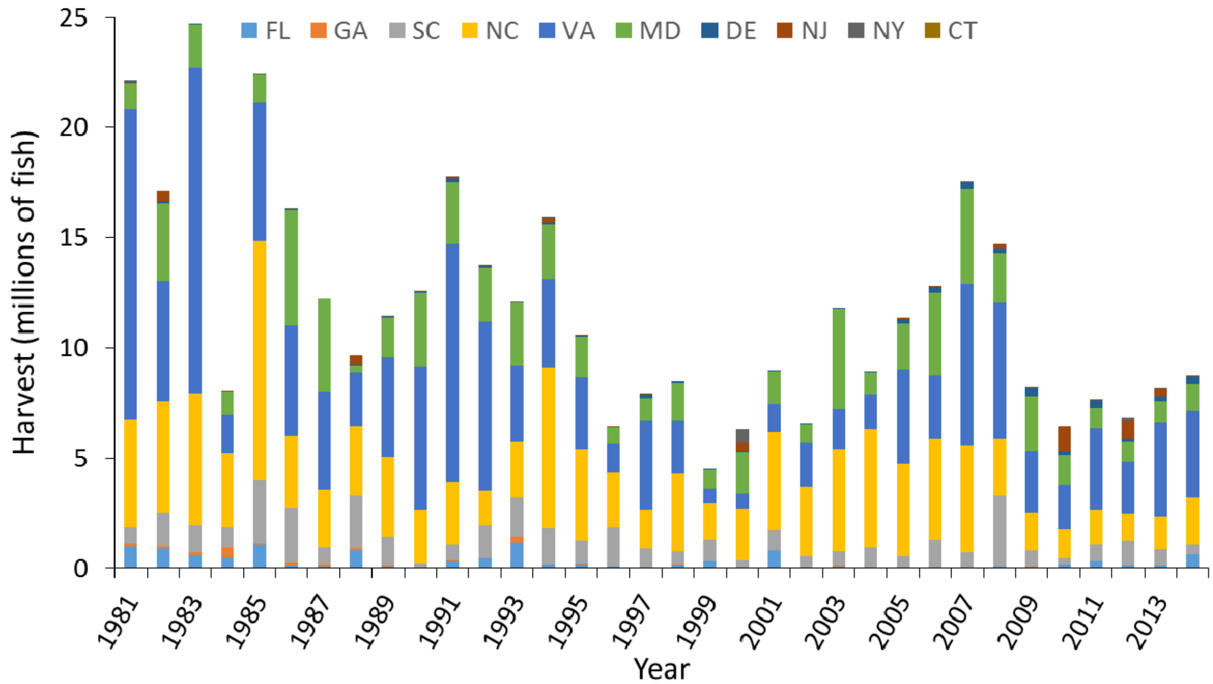

Figure 40. **MRFSS and MRIP recreational harvest estimates of spot (millions of fish) by state and year.**

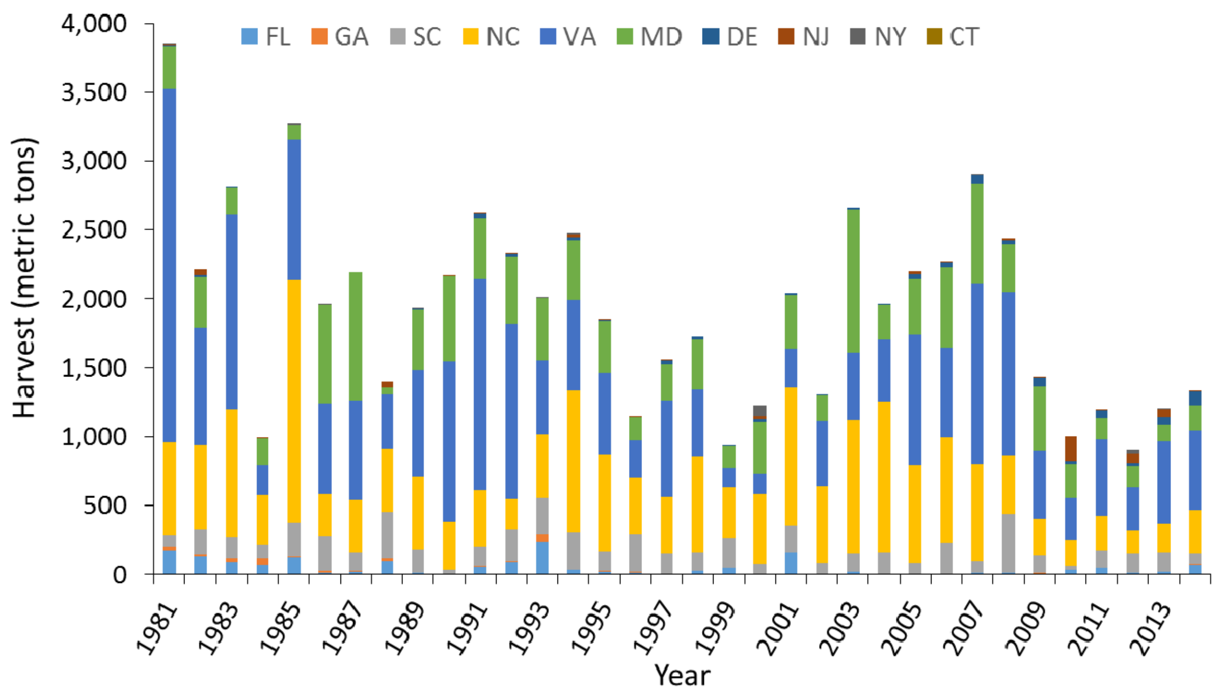

Figure 41. **MRFSS and MRIP recreational harvest estimates of spot (metric tons) by state and year.**

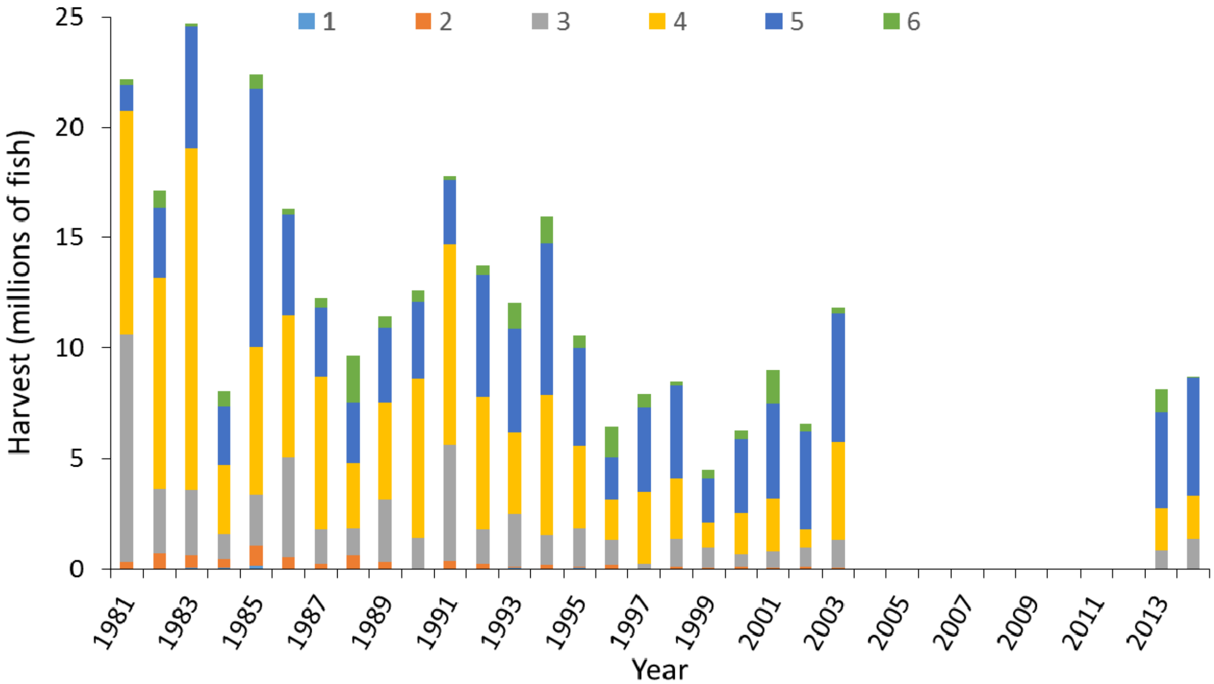

Figure 42. **MRFSS and MRIP recreational harvest estimates of spot (millions of fish) by wave and year. Estimates adjusted for the change in the APAIS design (2004-2012) are not provided by wave from the provided SAS code.**

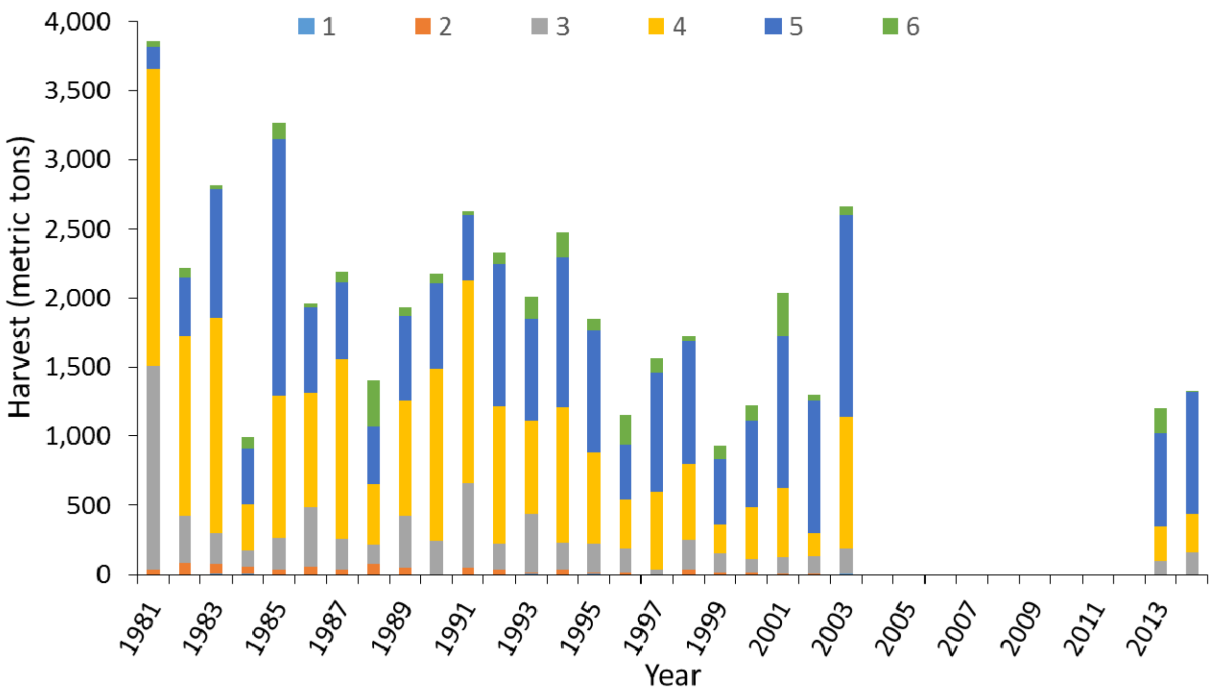

Figure 43. **MRFSS and MRIP recreational harvest estimates of spot (metric tons) by wave and year. Estimates adjusted for the change in the APAIS design (2004-2012) are not provided by wave from the provided SAS code.**

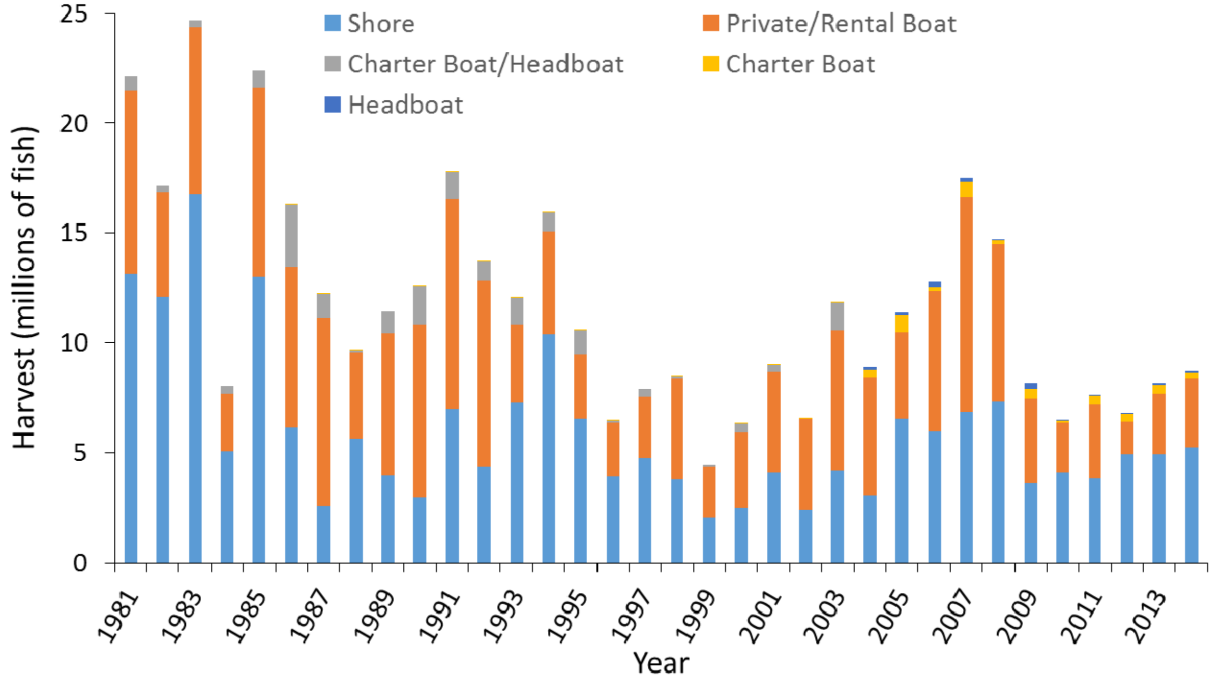

Figure 44. **MRFSS and MRIP recreational harvest estimates of spot (millions of fish) by mode and year.**

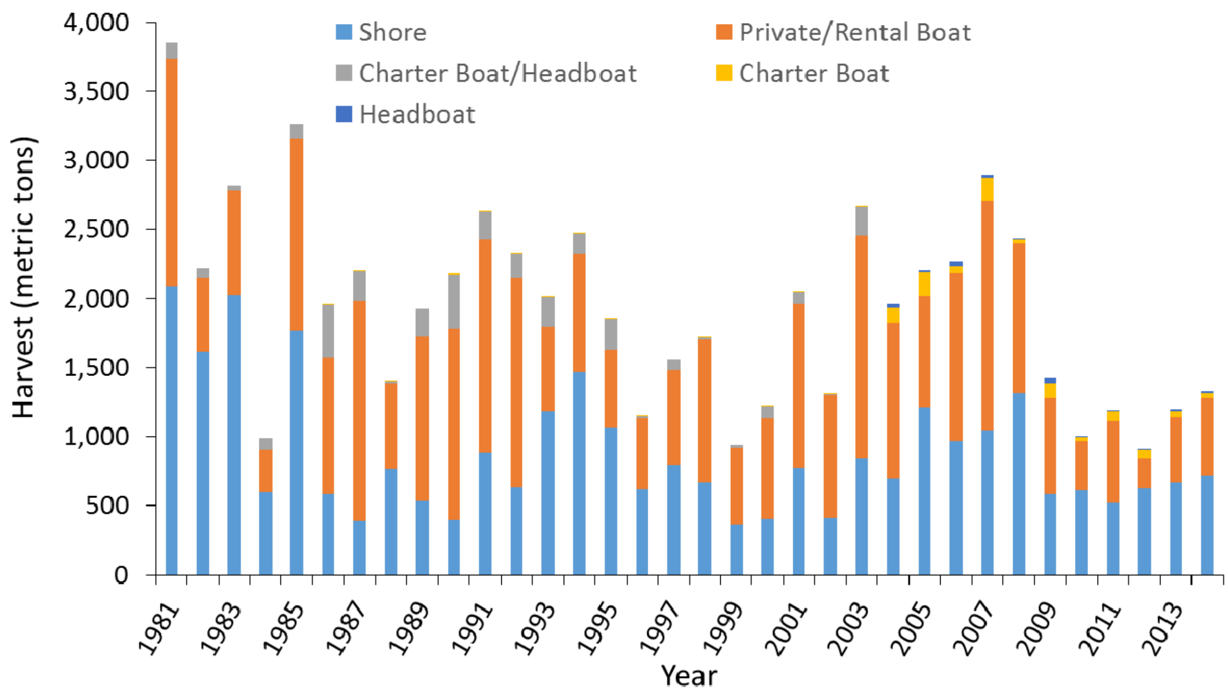

Figure 45. **MRFSS and MRIP recreational harvest estimates of spot (metric tons) by mode and year.**

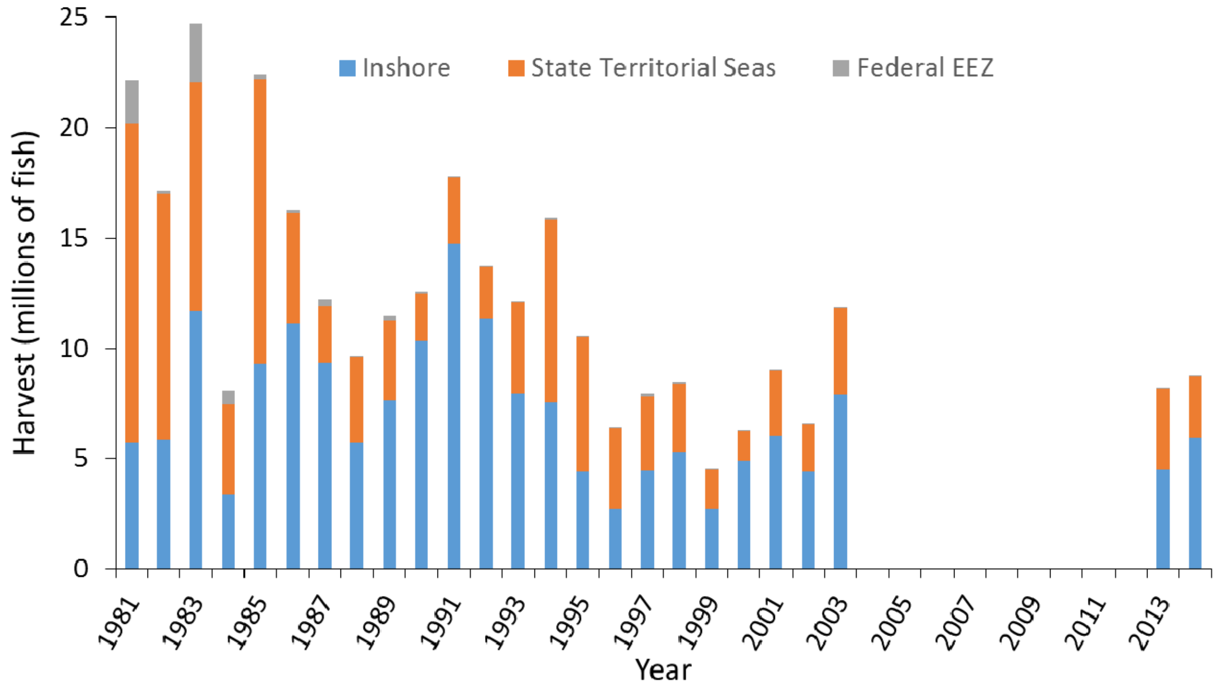

Figure 46. **MRFSS and MRIP recreational harvest estimates of spot (millions of fish) by area and year. Estimates adjusted for the change in the APAIS design (2004-2012) are not provided by area from the provided SAS code.**

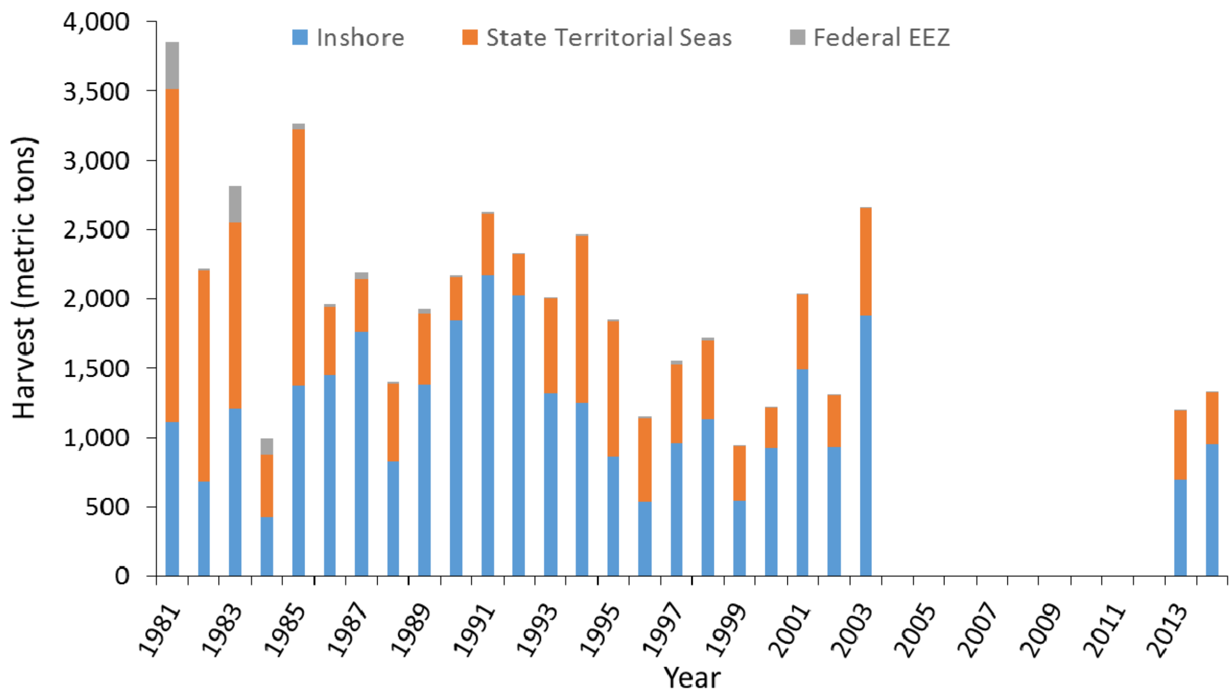

Figure 47. **MRFSS and MRIP recreational harvest estimates of spot (metric tons) by area and year. Estimates adjusted for the change in the APAIS design (2004-2012) are not provided by area from the provided SAS code.**

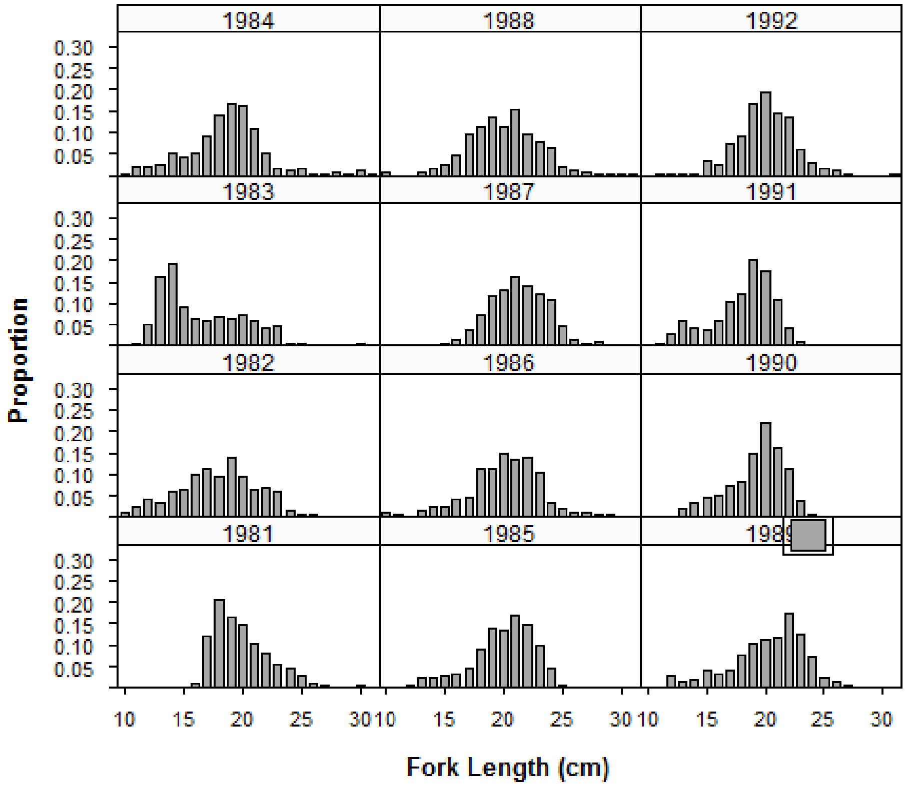

Figure 48. **MRFSS and MRIP recreational harvest length frequency estimates for spot. The x-axes have been subset to exclude lengths that did not account for more than 1% of the annual harvest in any year (<10cm and >31cm).**

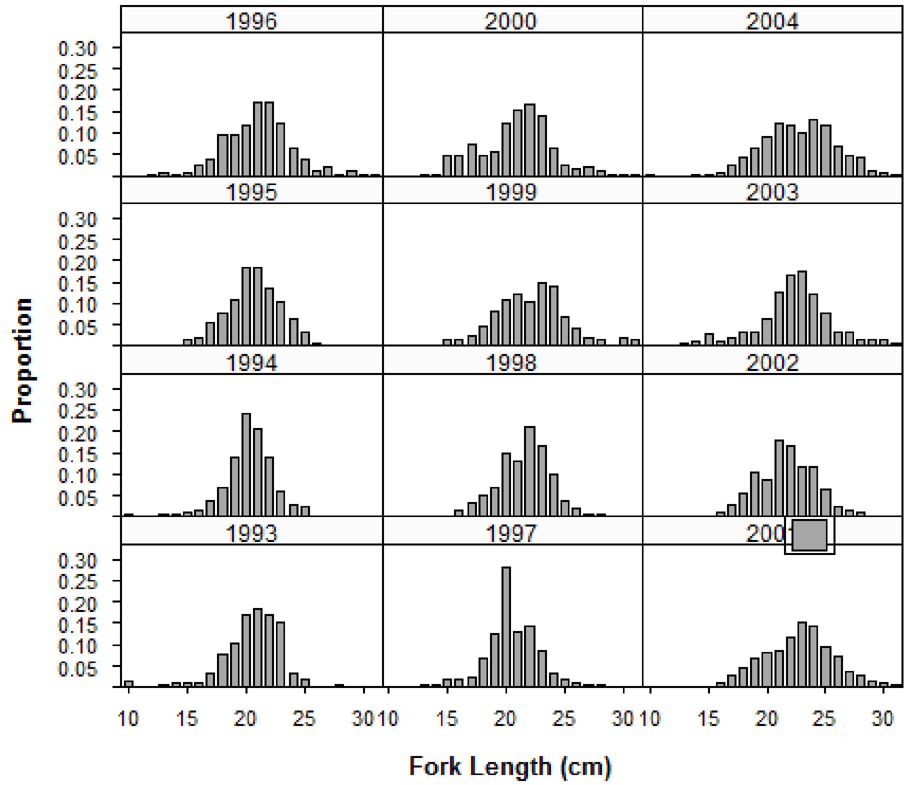

Figure 48. ***Continued.*** **MRFSS and MRIP recreational harvest length frequency estimates. The x-axes have been subset to exclude lengths that did not account for more than 1% of the annual harvest in any year (<10cm and >31cm).**

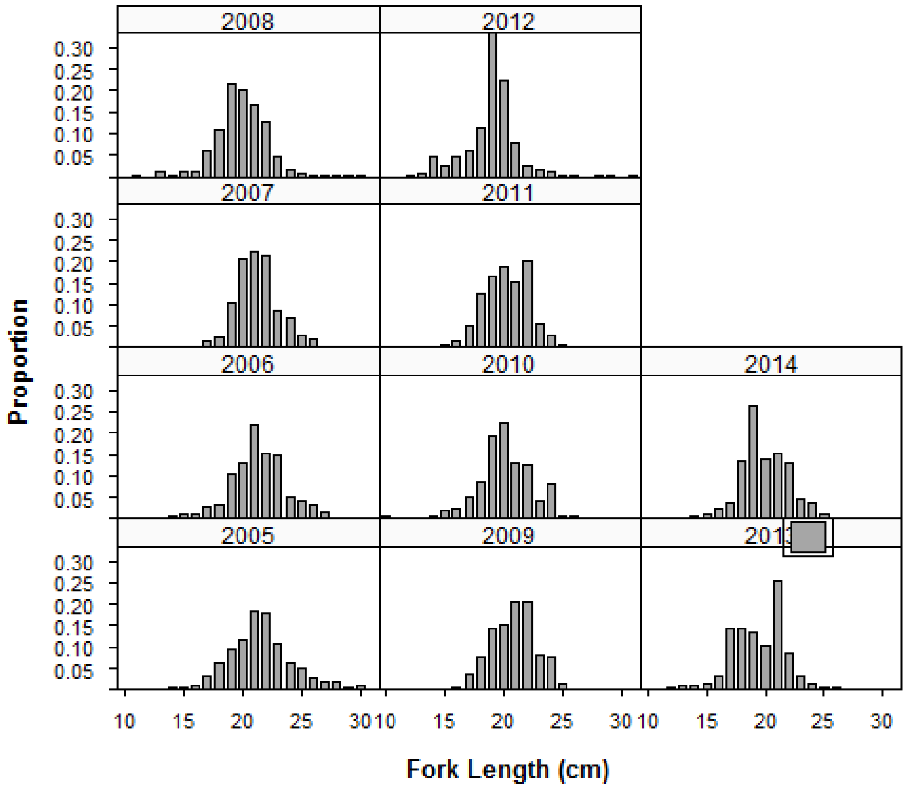

Figure 48. ***Continued.*** **MRFSS and MRIP recreational harvest length frequency estimates. The x-axes have been subset to exclude lengths that did not account for more than 1% of the annual harvest in any year (<10cm and >31cm).**

Figure 49. **Annual mean fork length (cm) of spot harvested by recreational anglers on the Atlantic coast.**

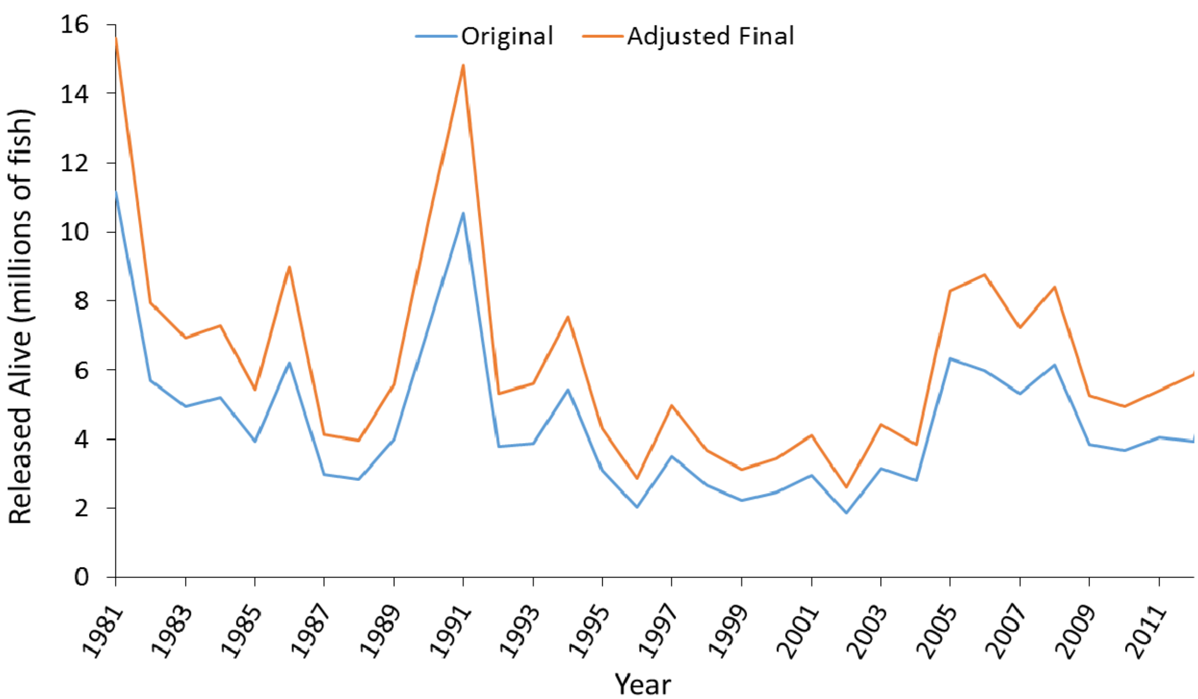

Figure 50. **Comparison of MRFSS and MRIP recreational released alive estimates of spot (millions of fish) before (blue line) and after (orange line) adjustments.**

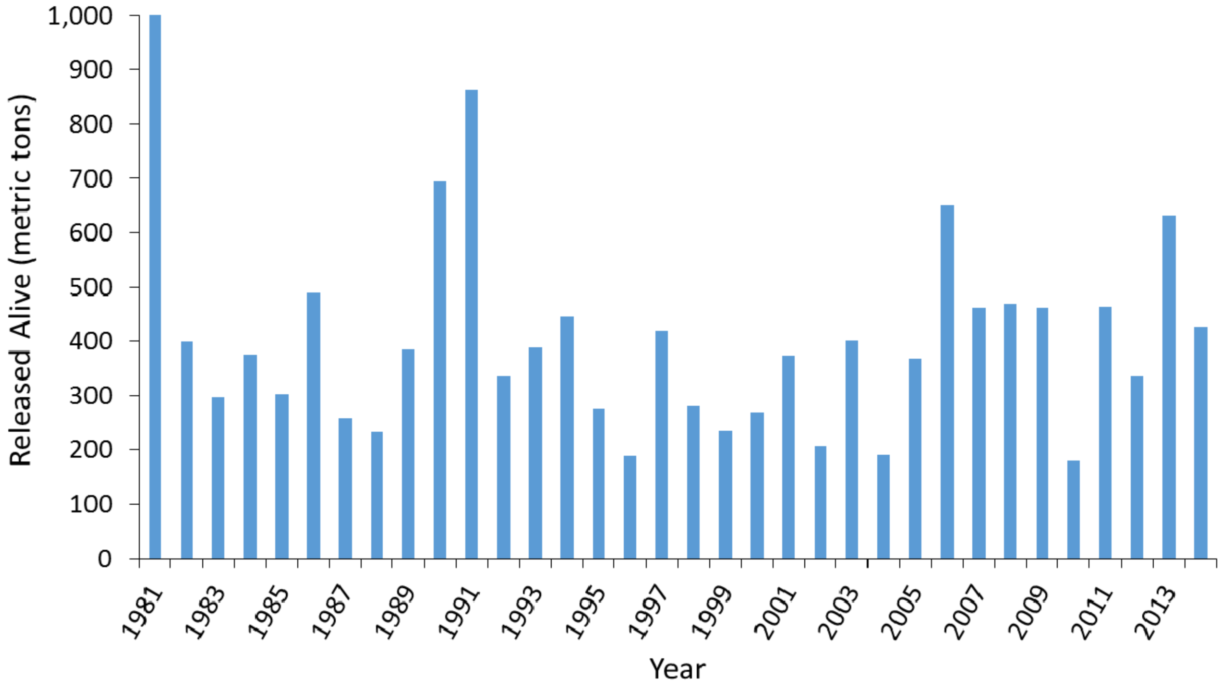

Figure 51. **MRFSS and MRIP coastwide recreational live releases of spot (metric tons).**

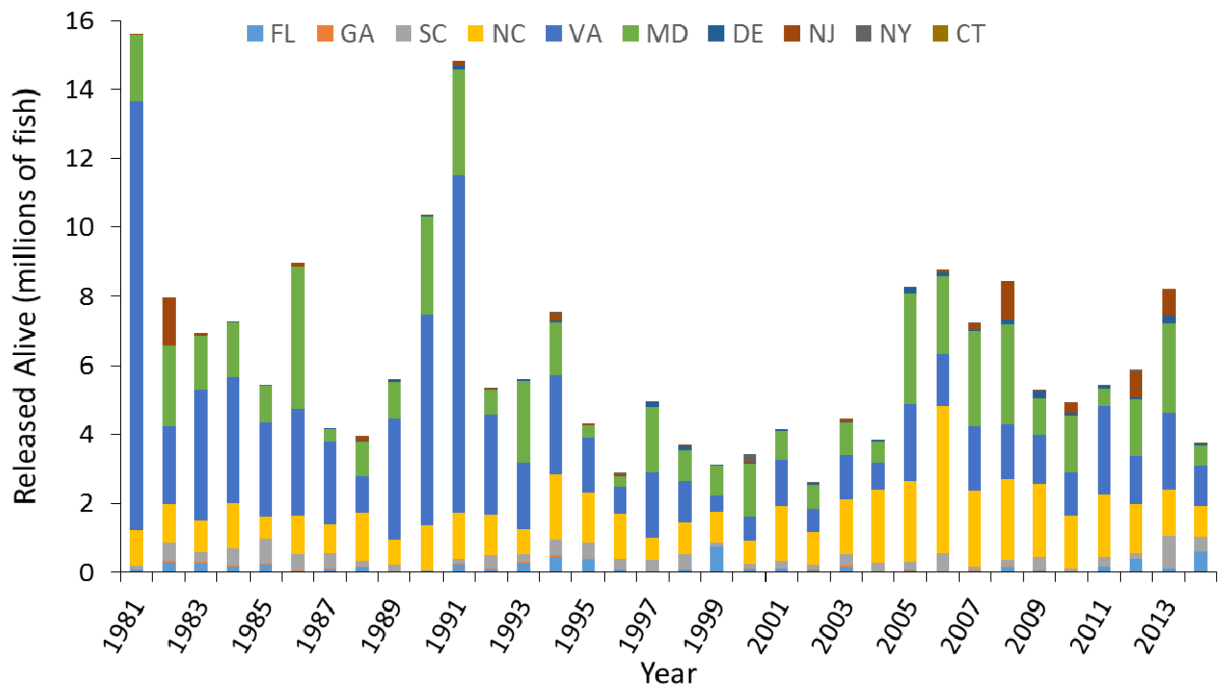

Figure 52. **MRFSS and MRIP recreational released alive estimates of spot (millions of fish) by state and year.**

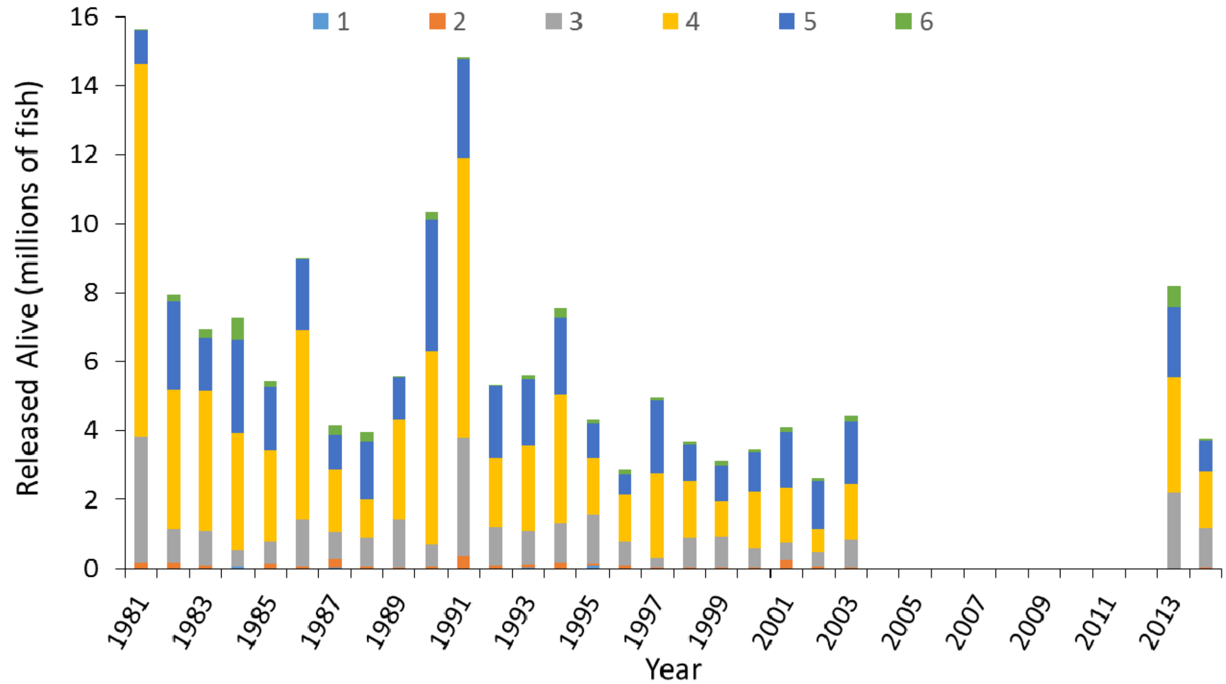

Figure 53. **MRFSS and MRIP recreational released alive estimates of spot (millions of fish) by wave and year. Estimates adjusted for the change in the APAIS design (2004-2012) are not provided by wave from the provided SAS code.**

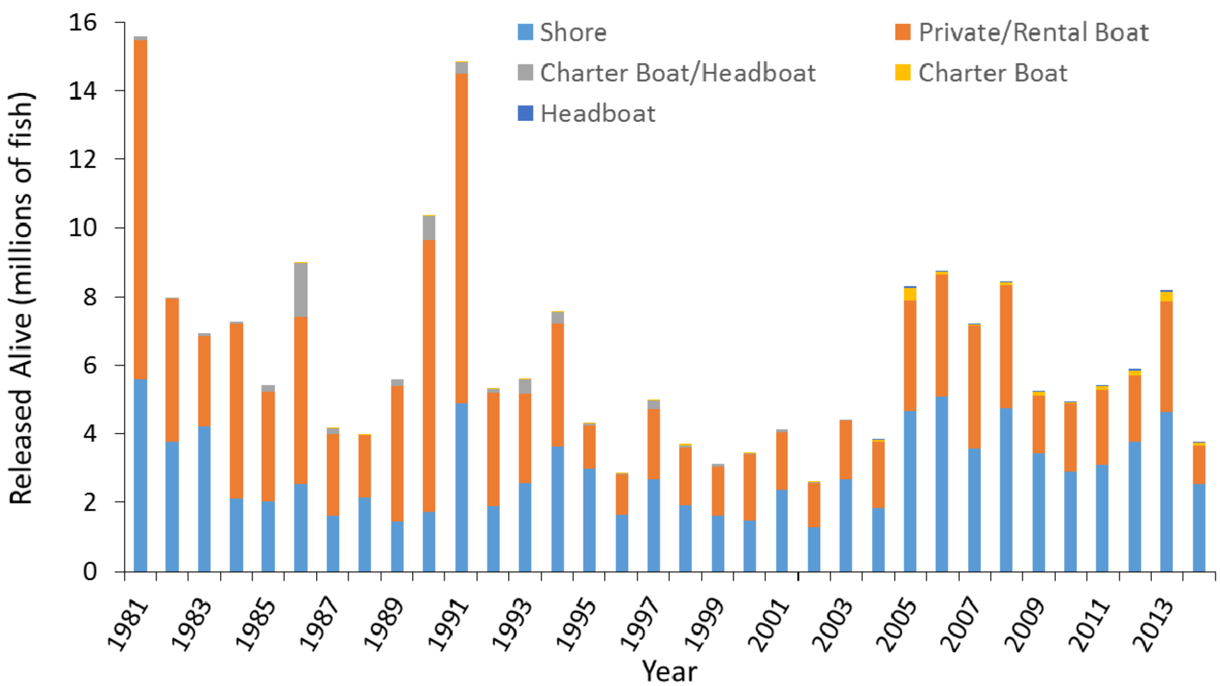

Figure 54. **MRFSS and MRIP recreational released alive estimates of spot (millions of fish) by mode and year.**

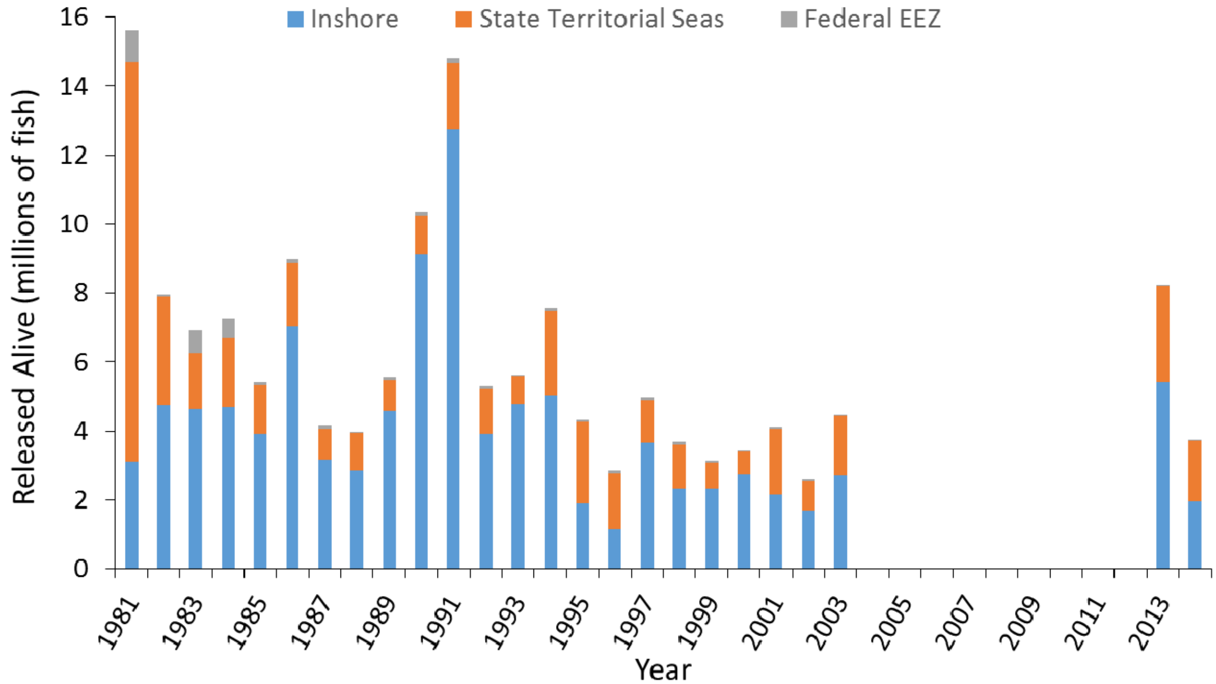

Figure 55. **MRFSS and MRIP recreational released alive estimates of spot (millions of fish) by area and year. Estimates adjusted for the change in the APAIS design (2004-2012) are not provided by area from the provided SAS code.**

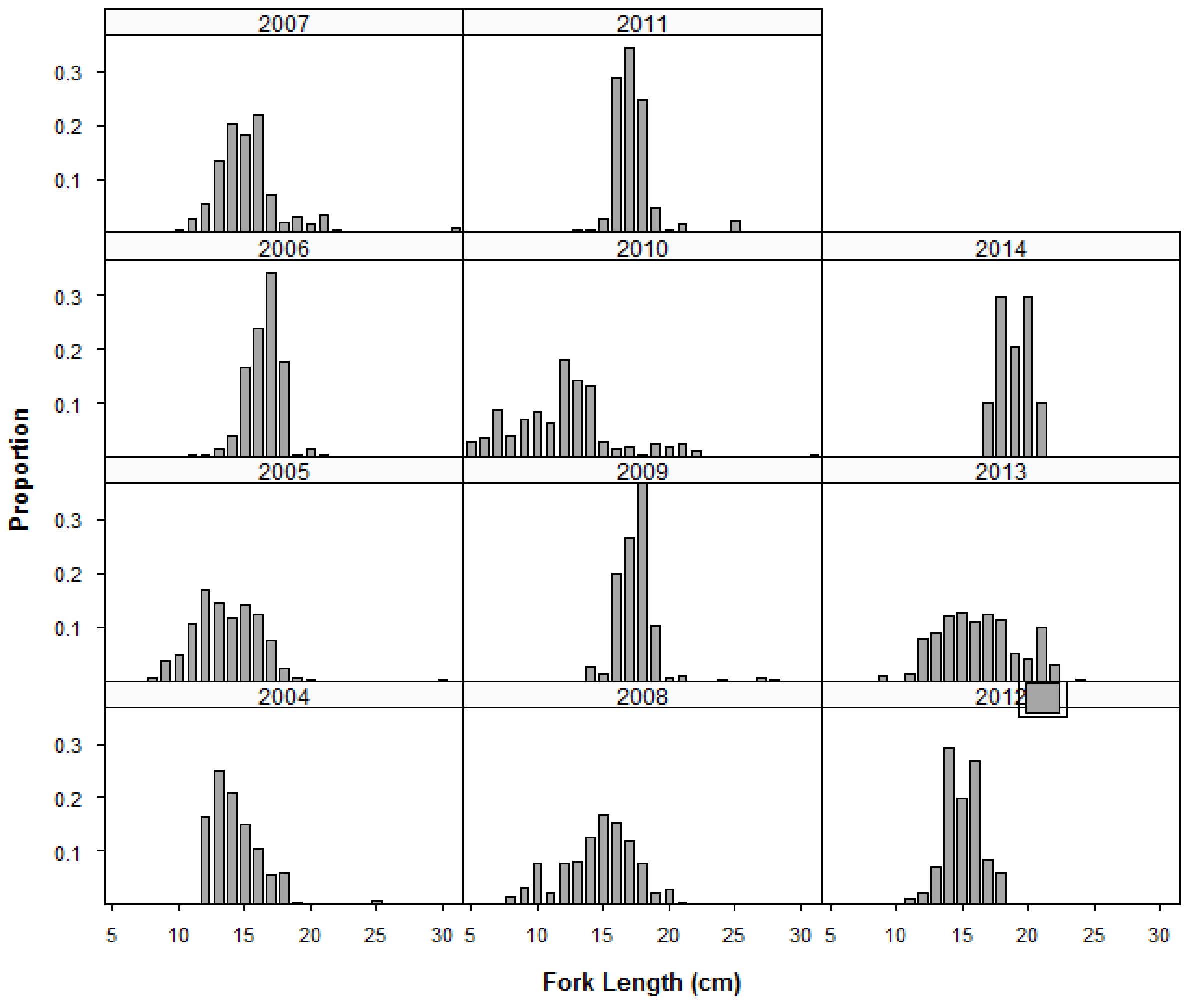

Figure 56. **Annual size compositions of spot caught and released on headboats estimated from MRIP type 9 sampling data.**

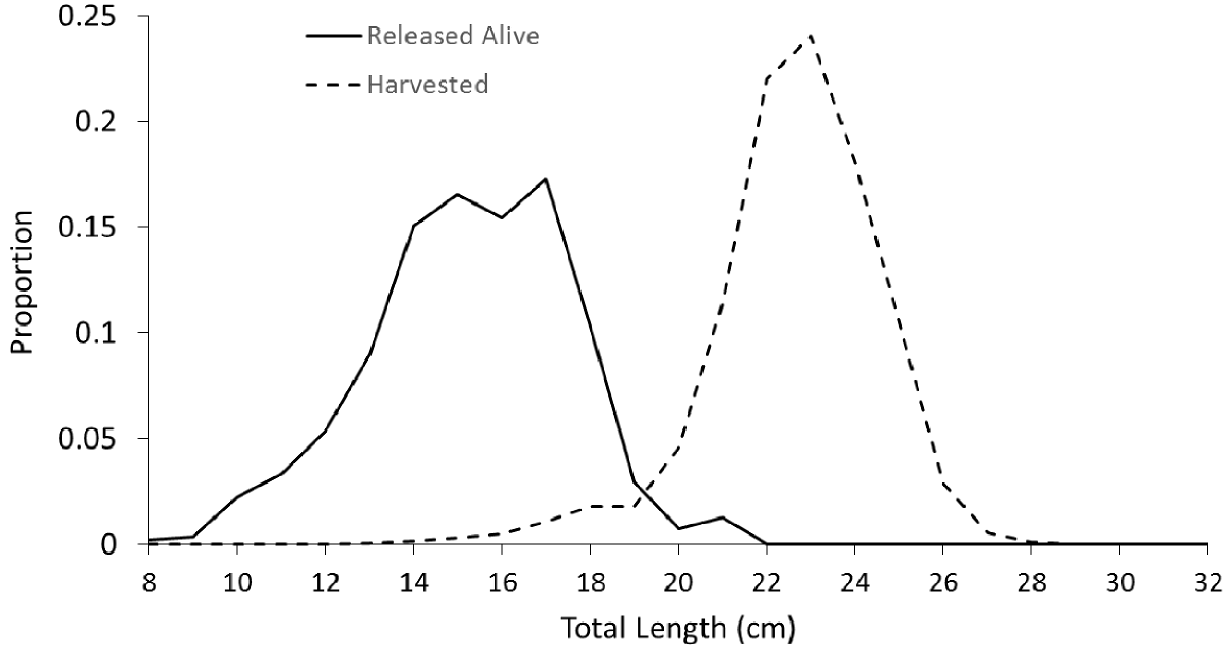

Figure 57. **Aggregate length frequency of spot sampled by the MD DNR Headboat Creel Survey during 1997-2000.**

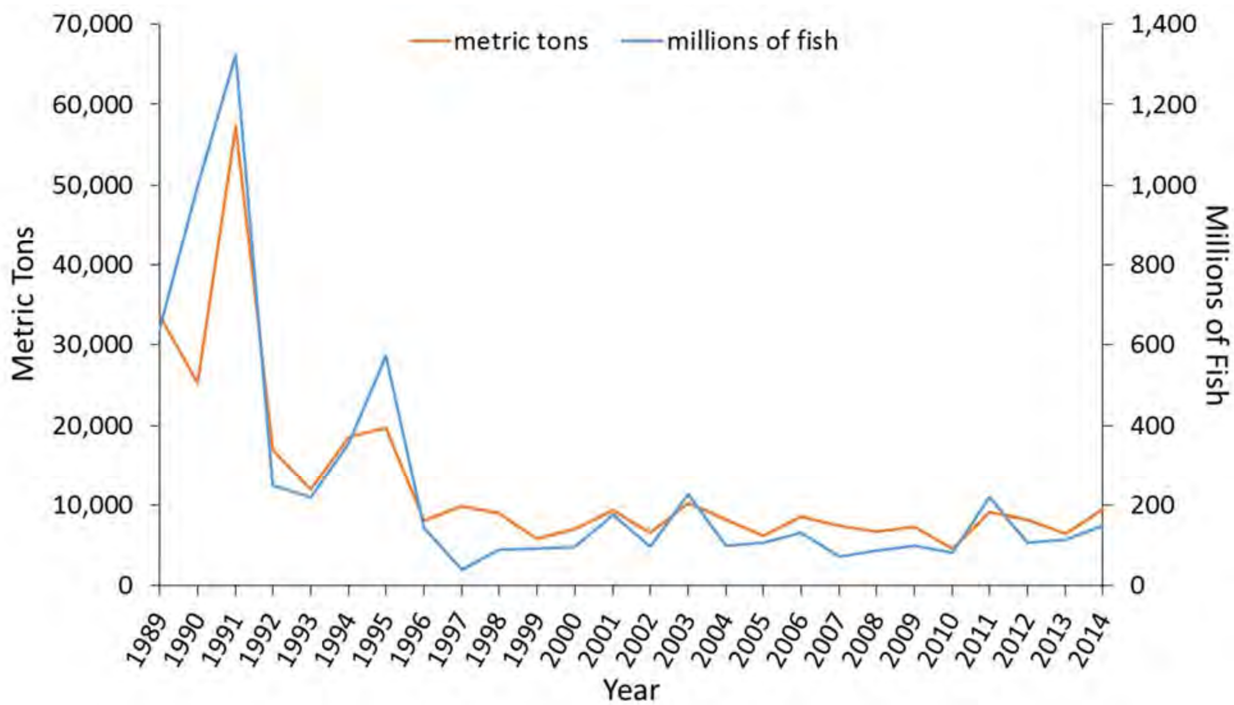

Figure 58. **Coastwide removals of spot combined across fisheries in metric tons (orange line) and millions of fish (blue line). 1989 is the first year removal data from all fisheries are available.**

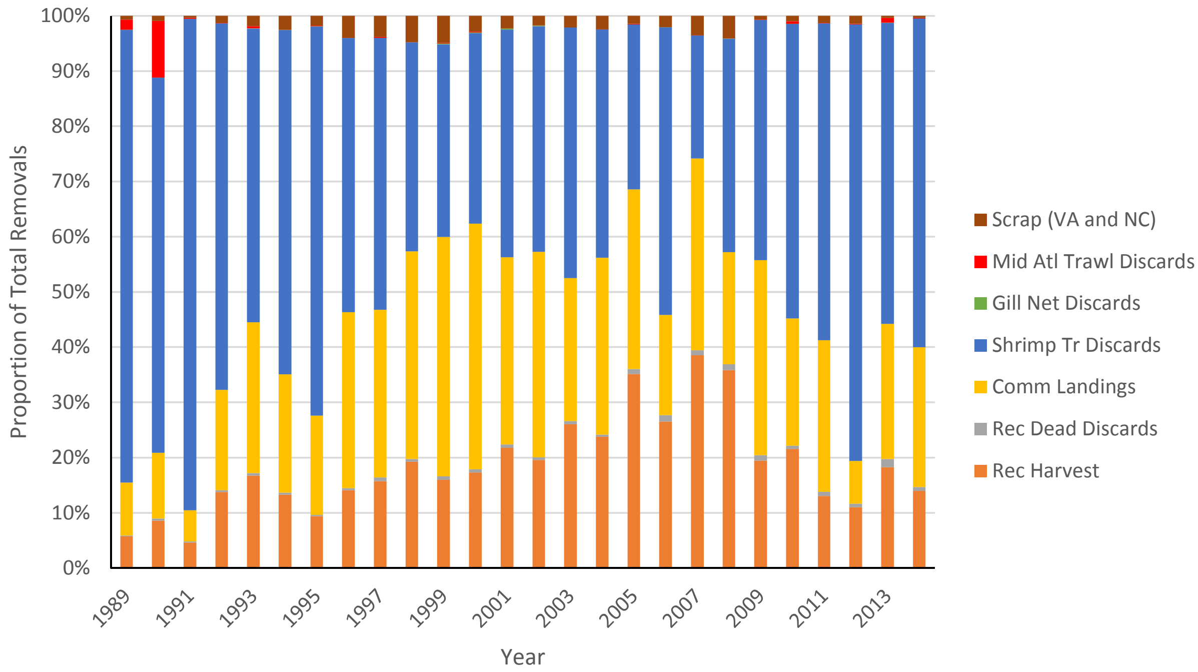

Figure 59. **Annual percentage of total spot removals by fishery source on the Atlantic coast.**

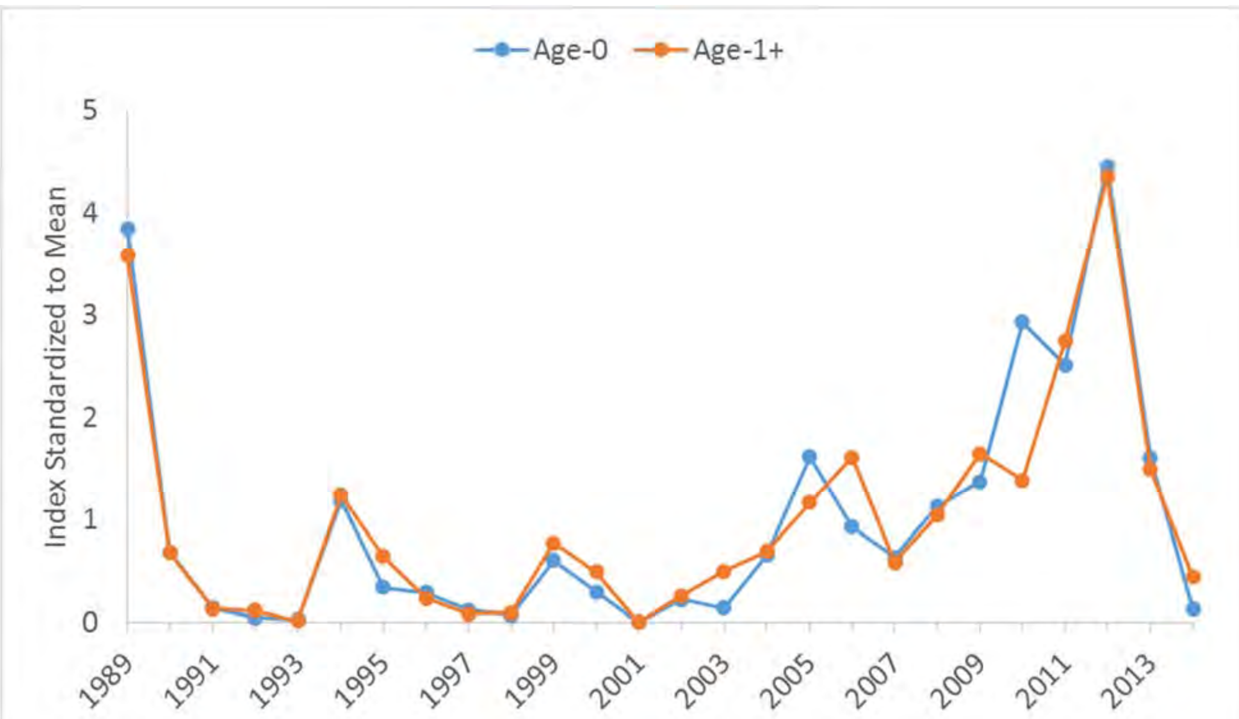

Figure 60. **Age-0 and Age-1+ relative abundance indices developed from the fall months and offshore strata of the NMFS Trawl Survey. Indices were developed in numbers per tow and then standardized to their mean.**

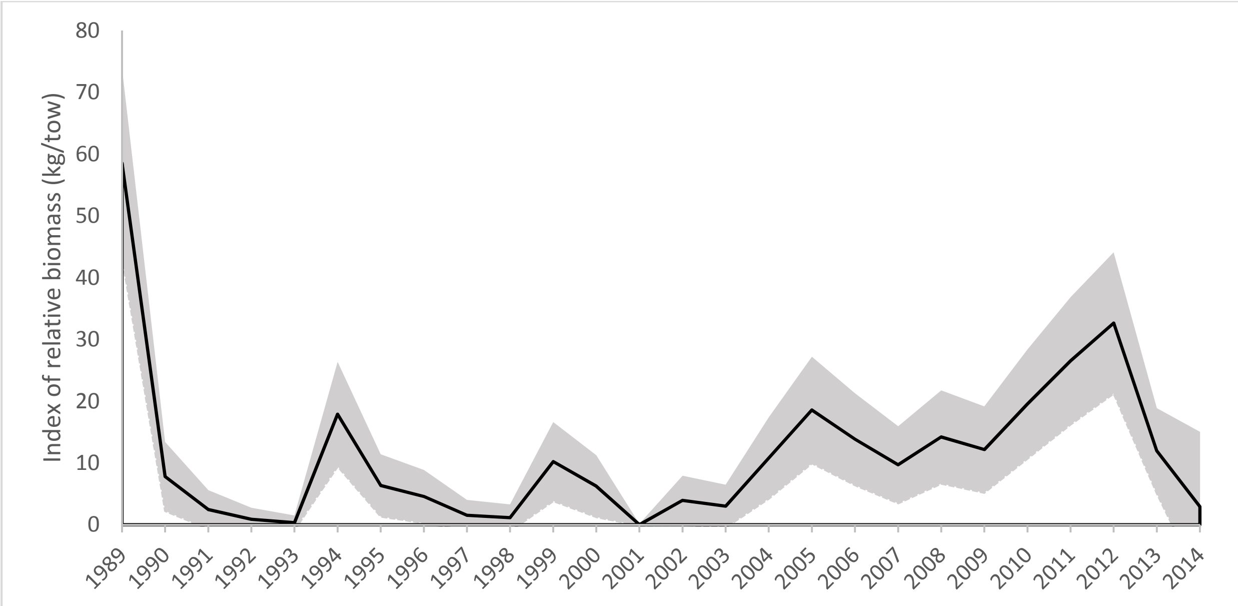

Figure 61. **Index of relative biomass developed from the fall months (September – November) and offshore strata of the NMFS Trawl Survey for 1989-2014 with 95% confidence intervals.**

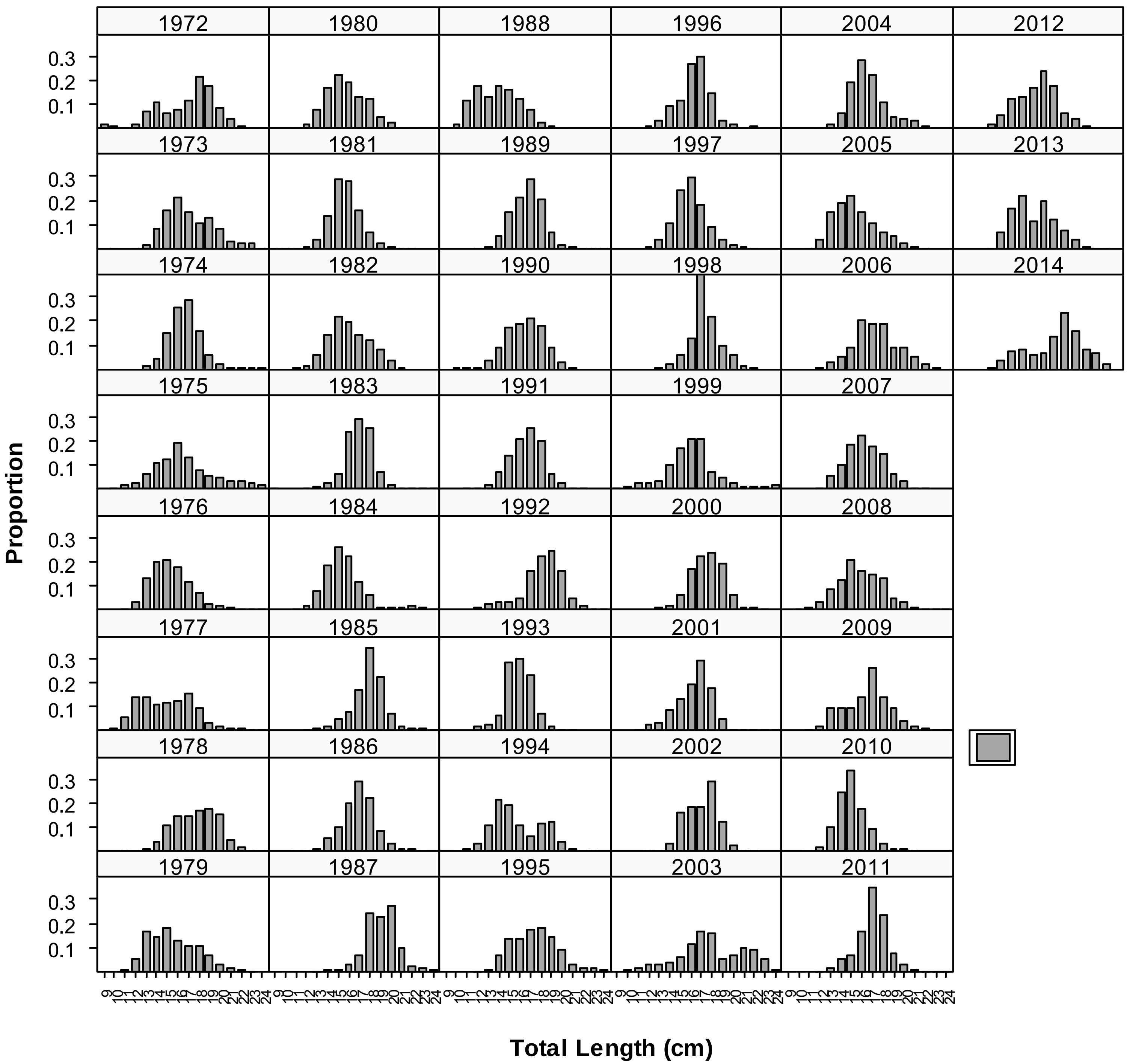

Figure 62. **Annual length frequency of spot caught in the NMFS Trawl Survey from 1972-2014.**

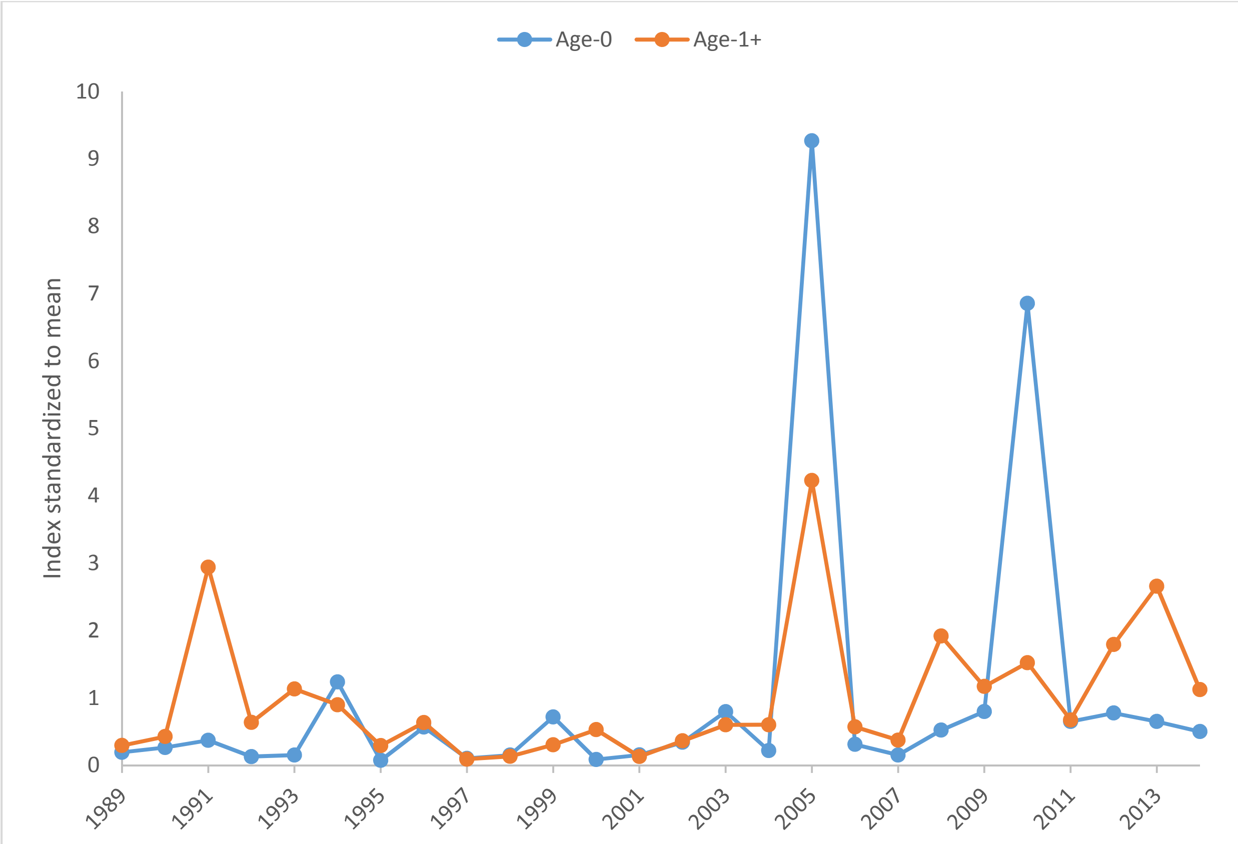

Figure 63. **Age-0 and Age-1+ relative abundance indices developed from the fall months of the SEAMAP Trawl Survey. Indices were developed in numbers per tow and then standardized to their mean.**

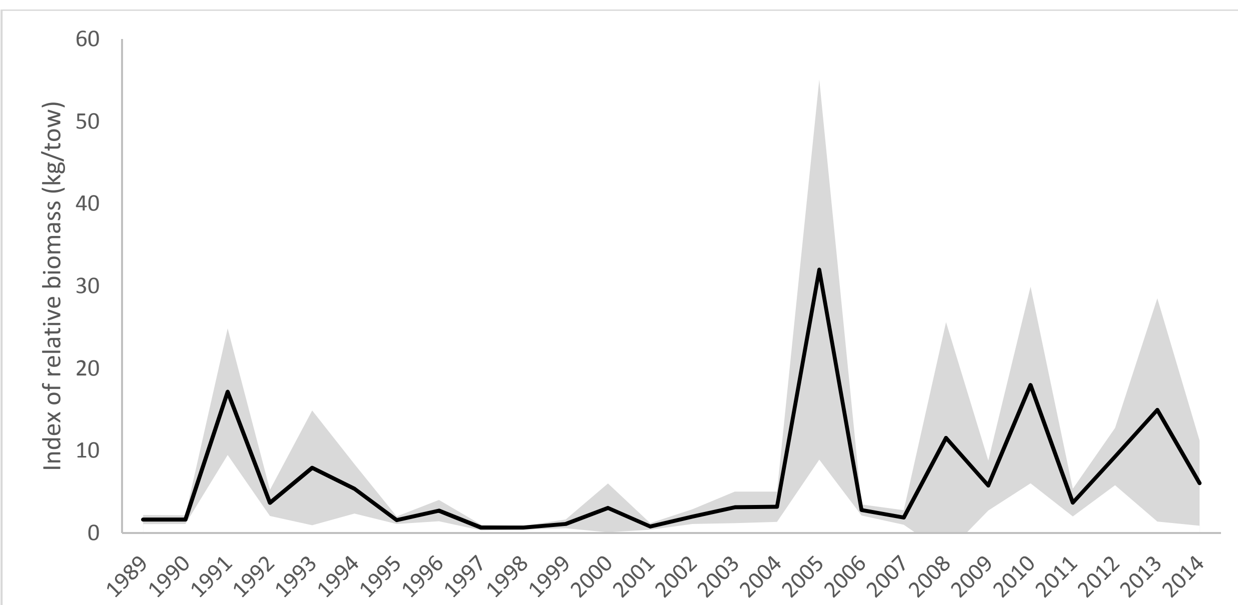

Figure 64. **Index of relative biomass of spot developed from the fall (September-November) months of the SEAMAP Trawl Survey (1989-2014).**

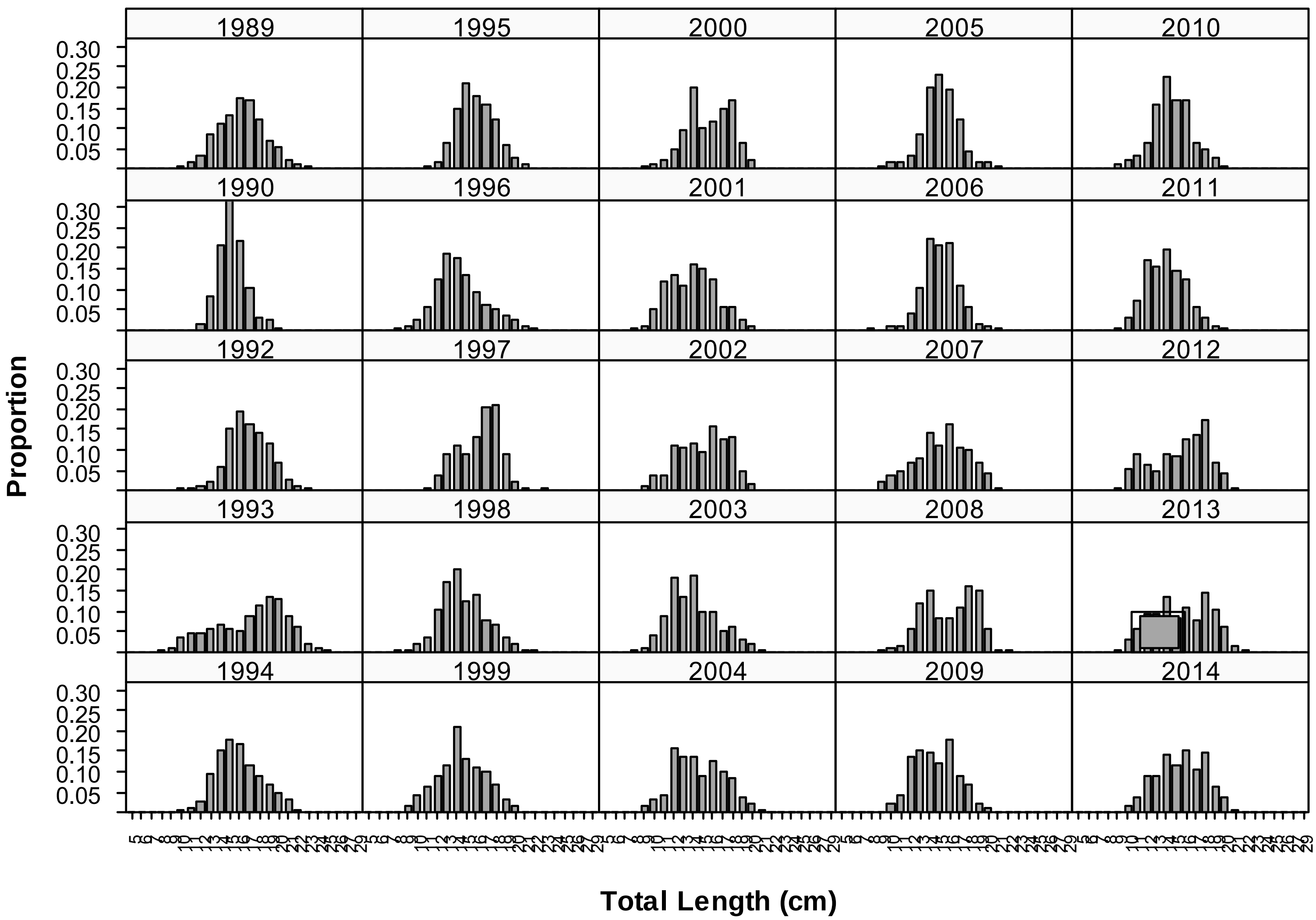

Figure 65. **Annual length frequency of spot caught in the SEAMAP Trawl Survey from 1989-2014. Data from 1991 were not available.**

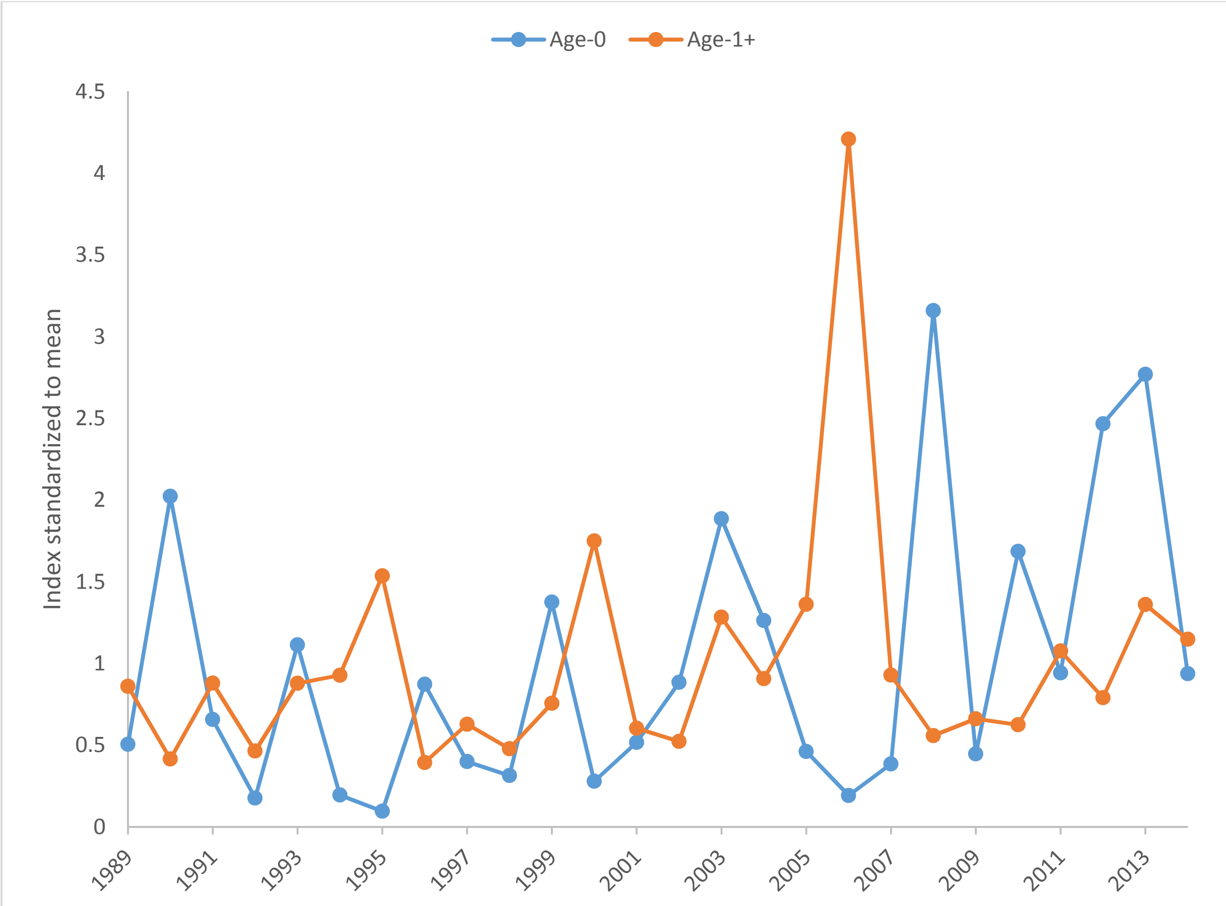

Figure 66. **Age-0 and Age-1+ relative abundance indices developed from the June component of the NCDMF Trawl Survey. Indices were developed in numbers per tow and then standardized to their mean.**

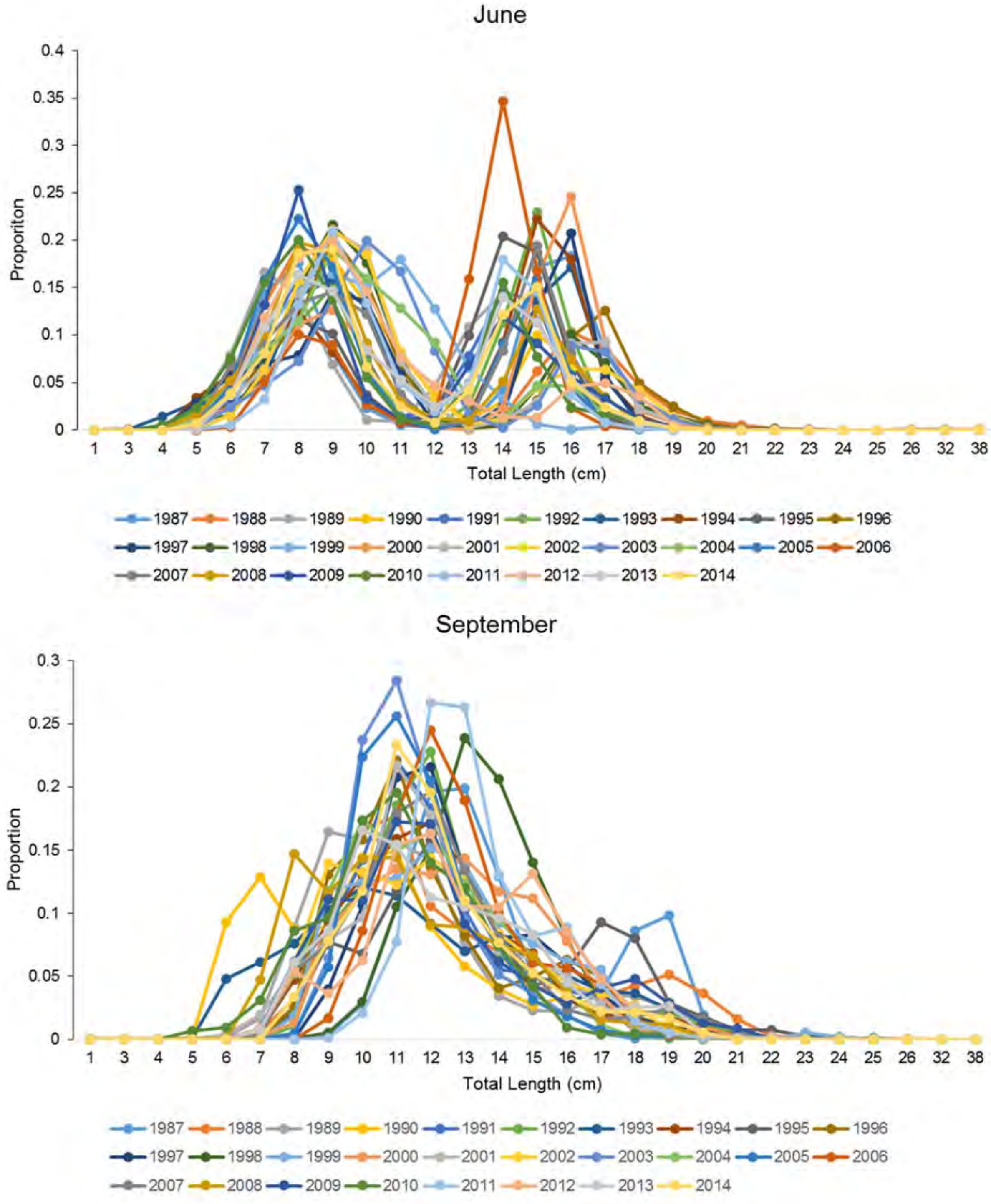

Figure 67. **Annual length frequencies of spot caught in the NC DMF Trawl Survey during June (top figure) and September (bottom figure).**

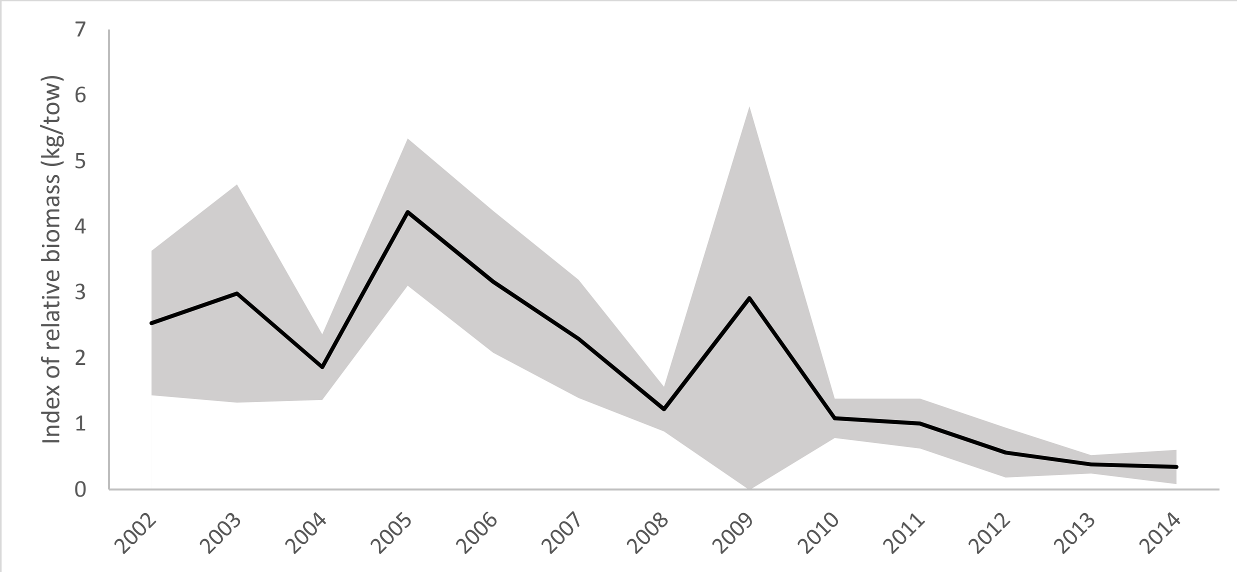

Figure 68. **Index of relative biomass for spot developed from the May-September component of the ChesMMAP Trawl Survey in Regions 4-5 only.**

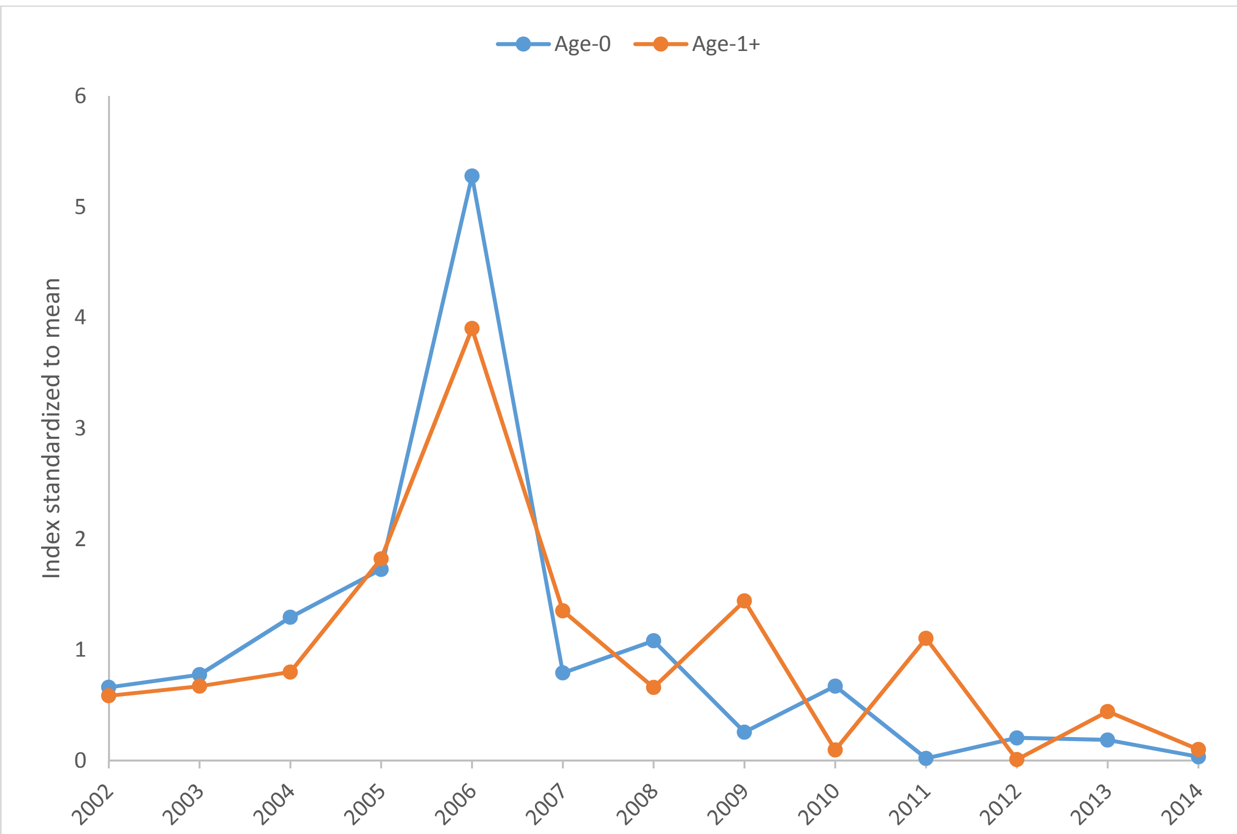

Figure 69. **Index of relative abundance for age-0 and age-1+ spot developed from the ChesMMAP Trawl Survey.**

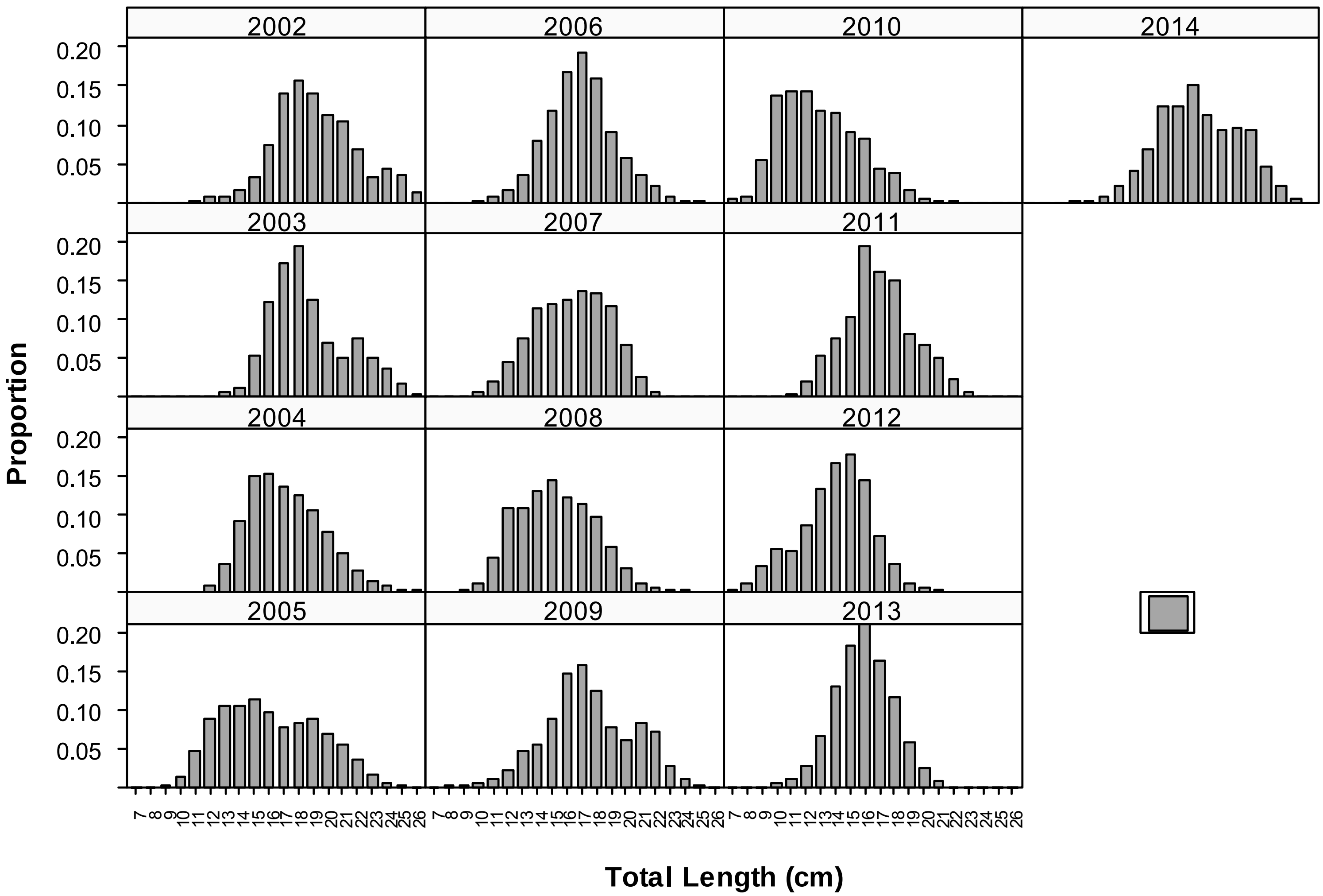

Figure 70. **Length frequency of spot captured in the ChesMMAP Trawl Survey.**

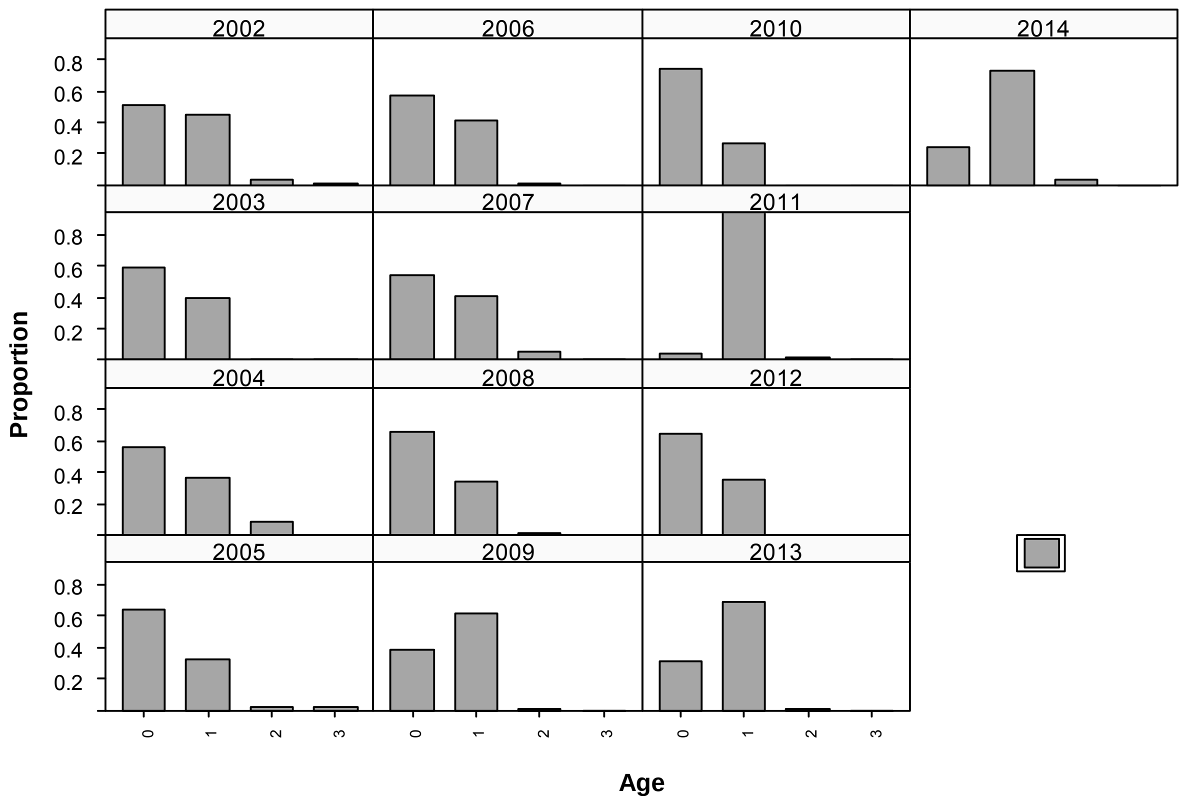

Figure 71. **Age frequency of spot captured in the ChesMMAP Trawl Survey for all months.**

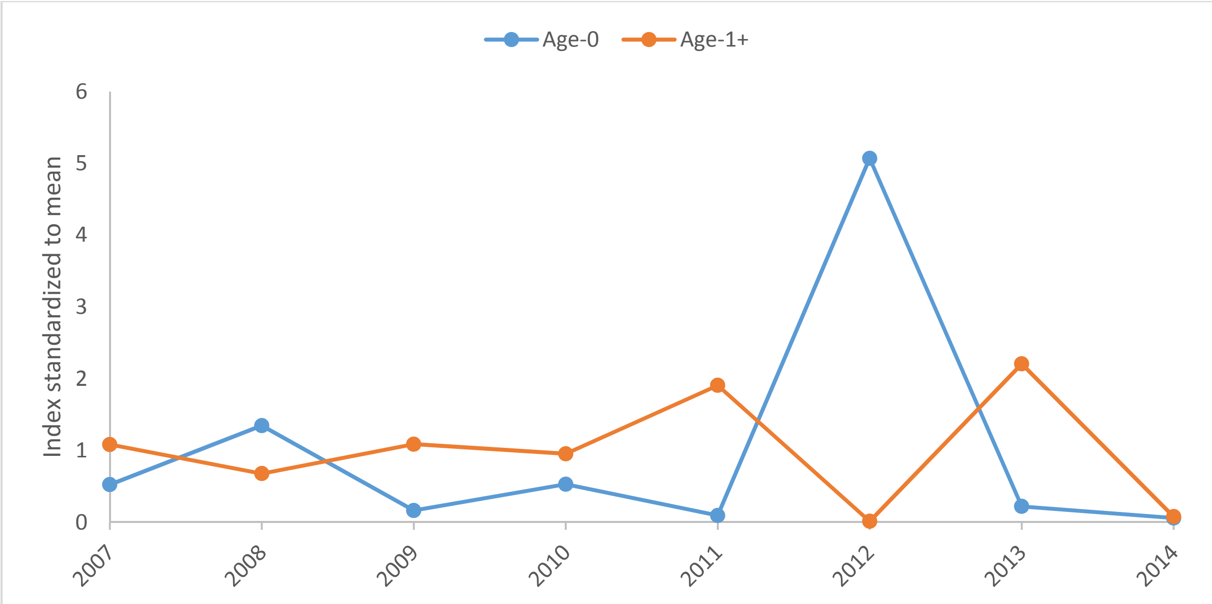

Figure 72. **Index of relative abundance for age-0 and age-1+ spot developed from the NEAMAP Trawl Survey.**

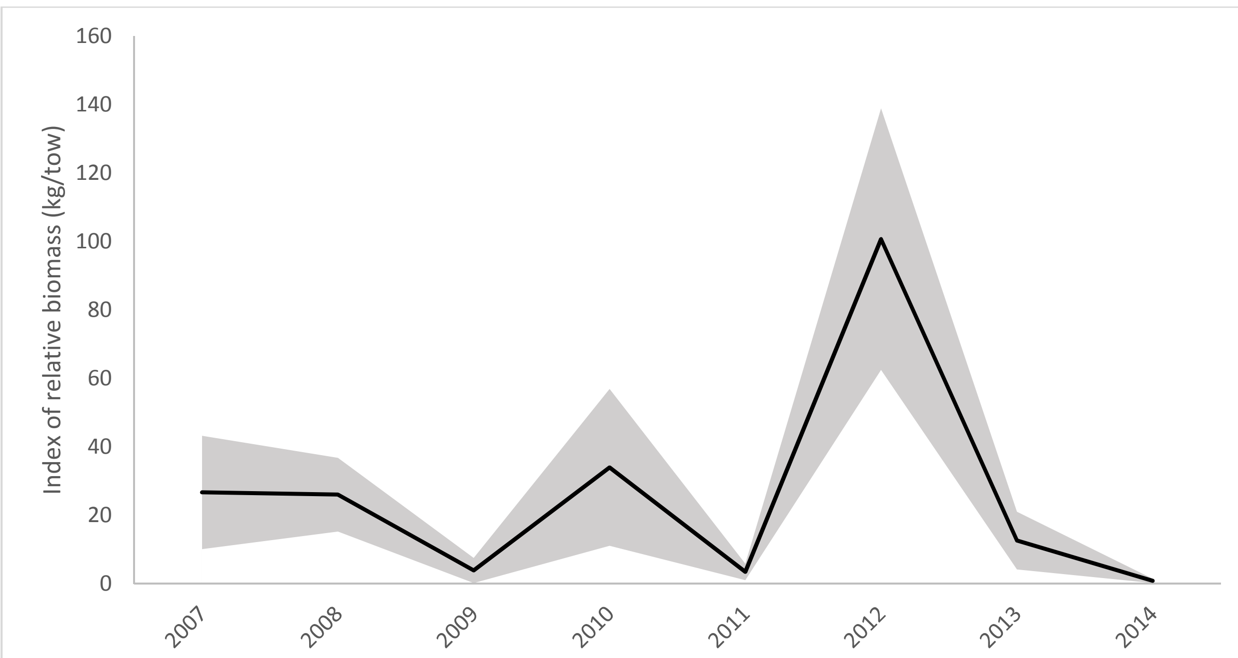

Figure 73. **Index of relative biomass developed from the fall component (September-November) of the NEAMAP Trawl Survey for spot.**

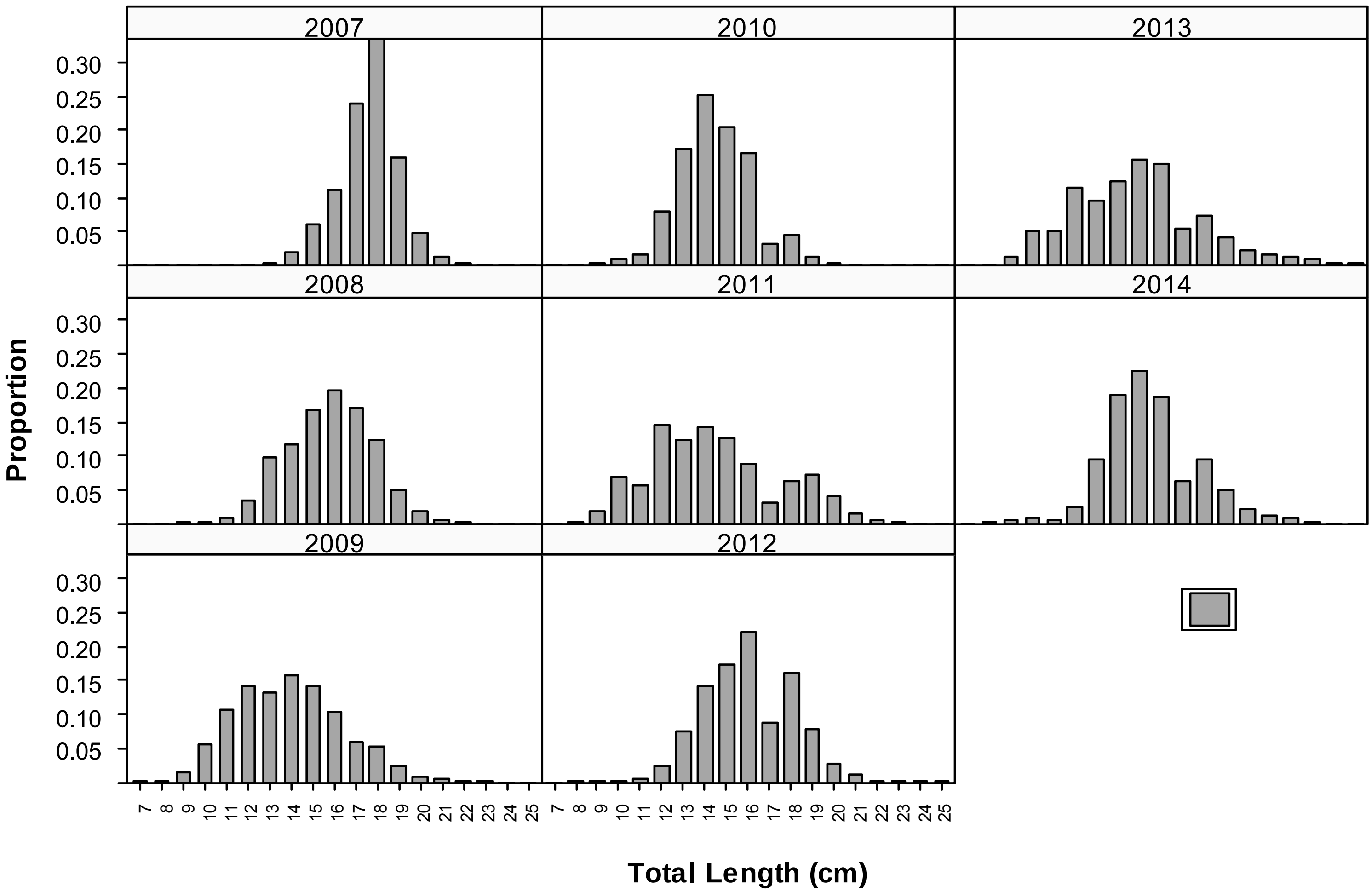

Figure 74. **Length frequency of spot caught in the NEAMAP Trawl Survey.**

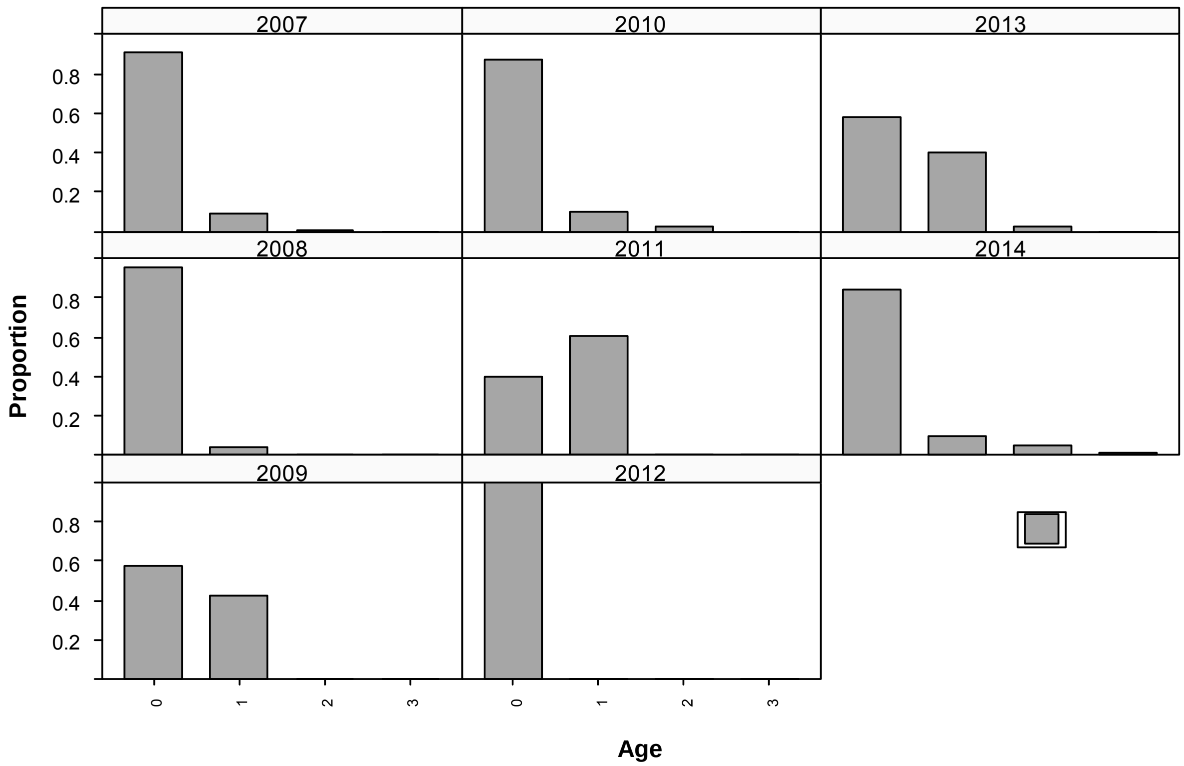

Figure 75. Age frequency of spot caught in the NEAMAP Trawl Survey during the fall component.

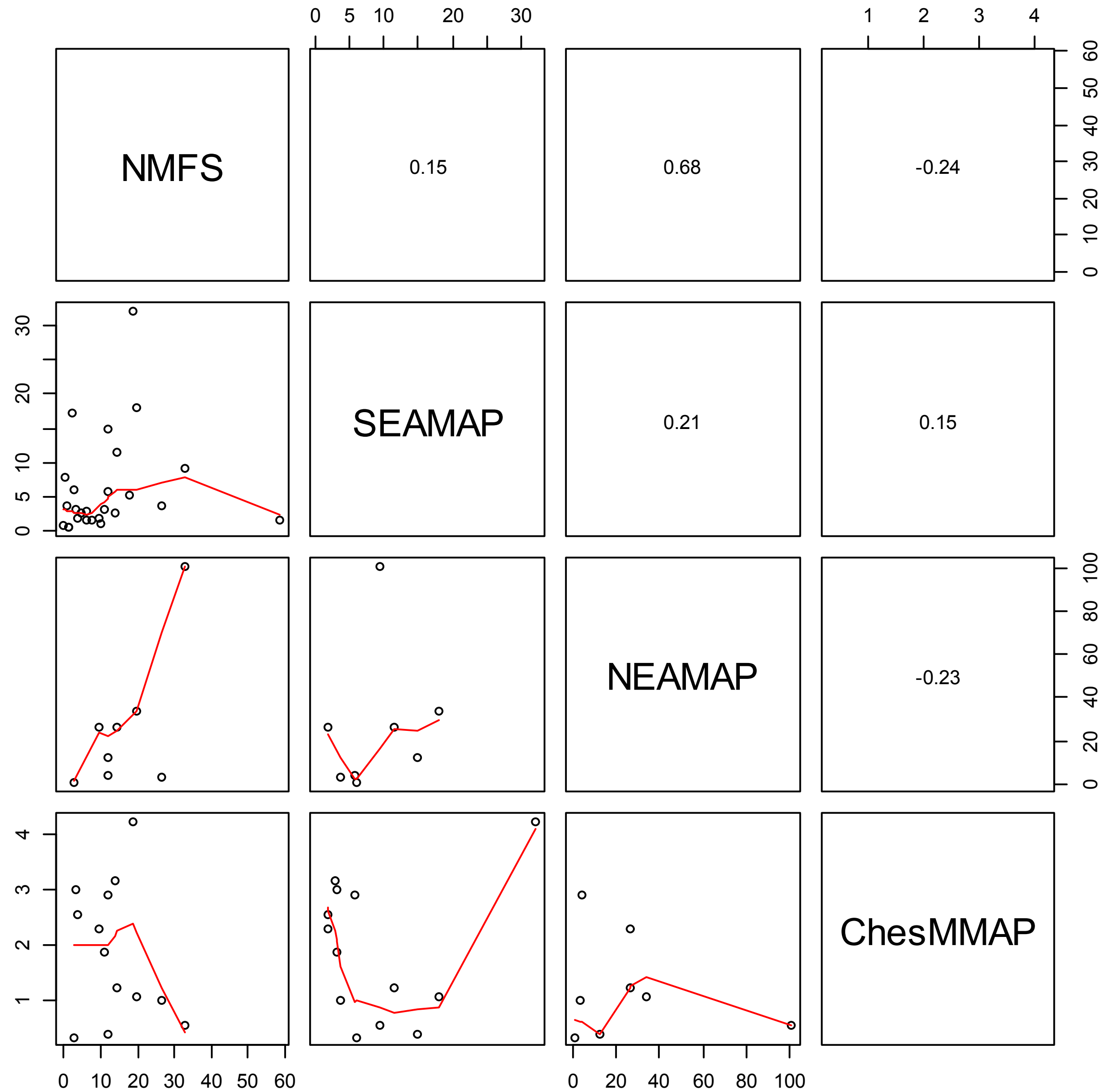

Figure 76. **Correlation coefficients and scatter plots for the aggregate indices considered for spot.**

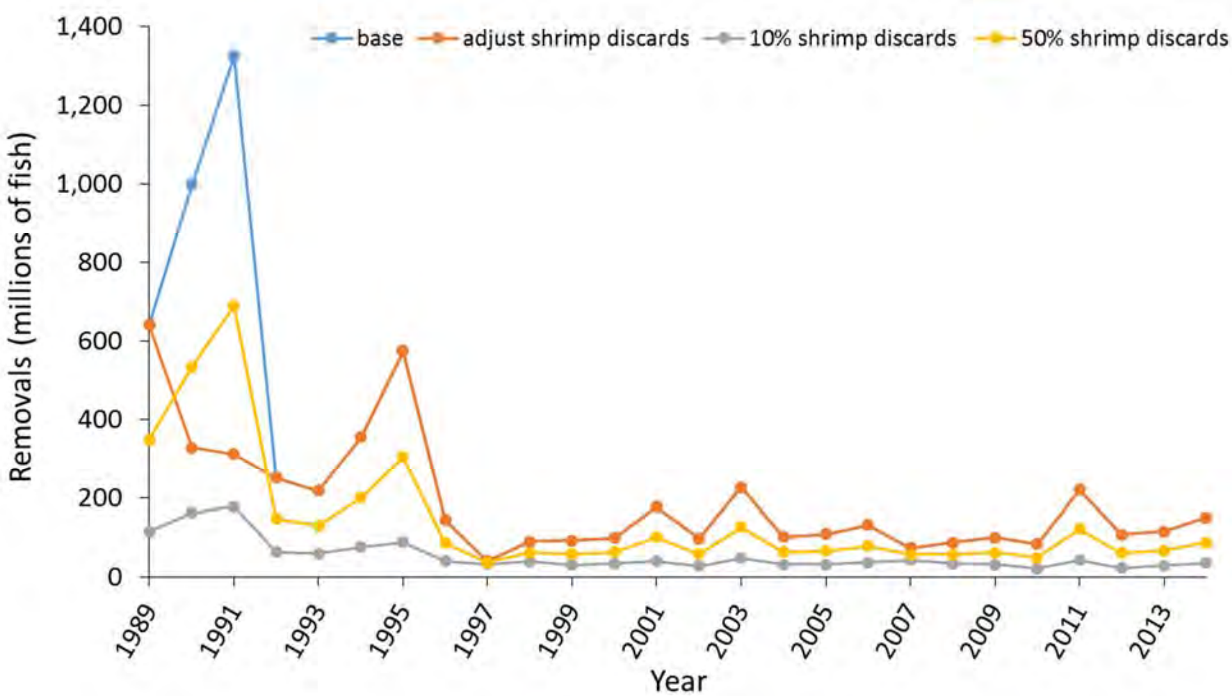

Figure 77. **Comparison of removal data time series in the modified-CSA base model and sensitivity configurations for spot with adjusted shrimp trawl discard estimates (see Table 95 for description of sensitivity configurations).**

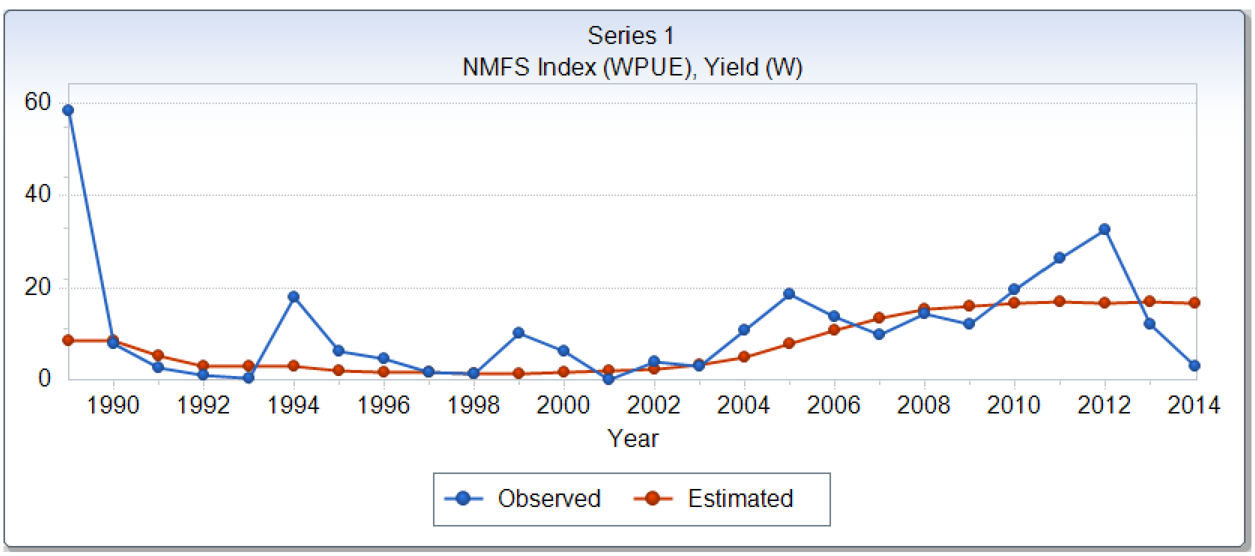

Figure 78. **The spot surplus production model fit of the relative biomass index from the NMFS Trawl Survey.**

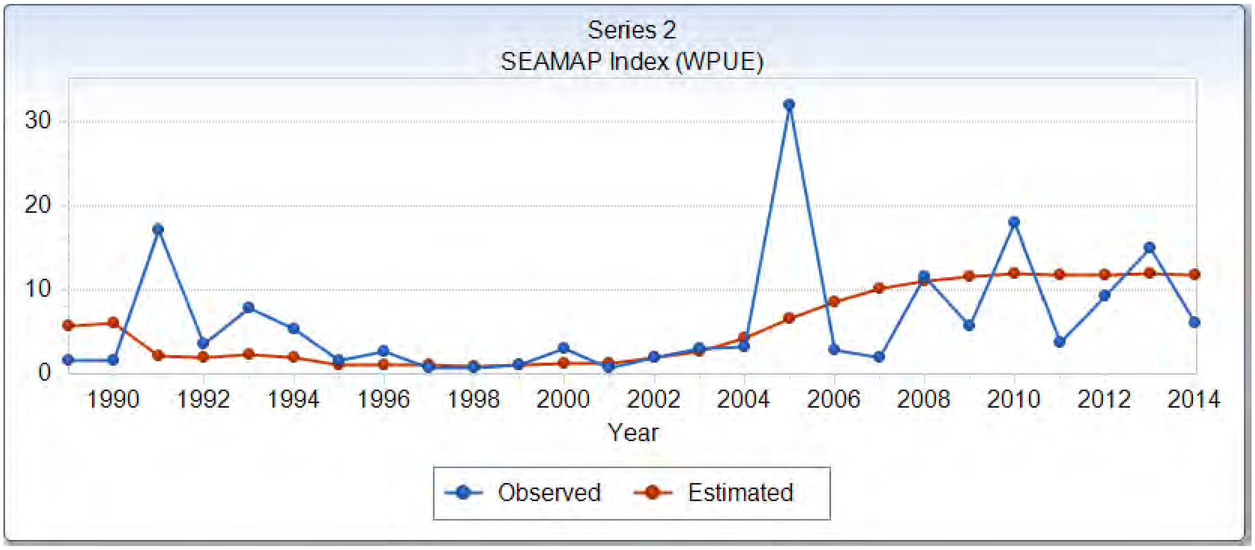

Figure 79. **The spot surplus production model fit of the relative biomass index from the SEAMAP Trawl Survey.**

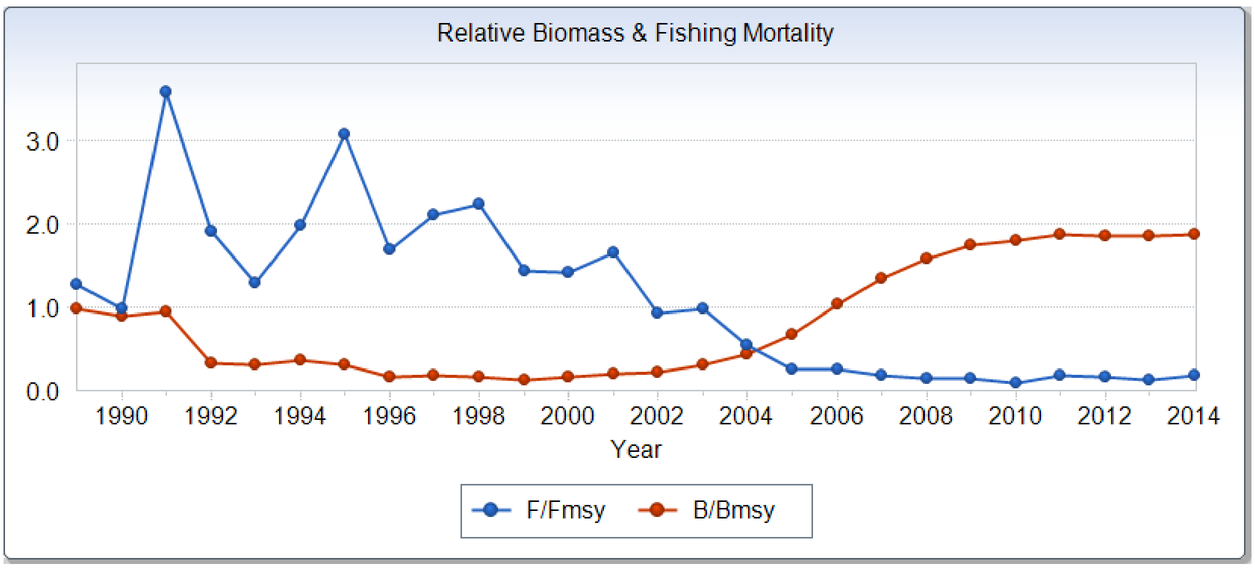

Figure 80. **Estimated relative biomass and fishing mortality of spot from the surplus production model.**

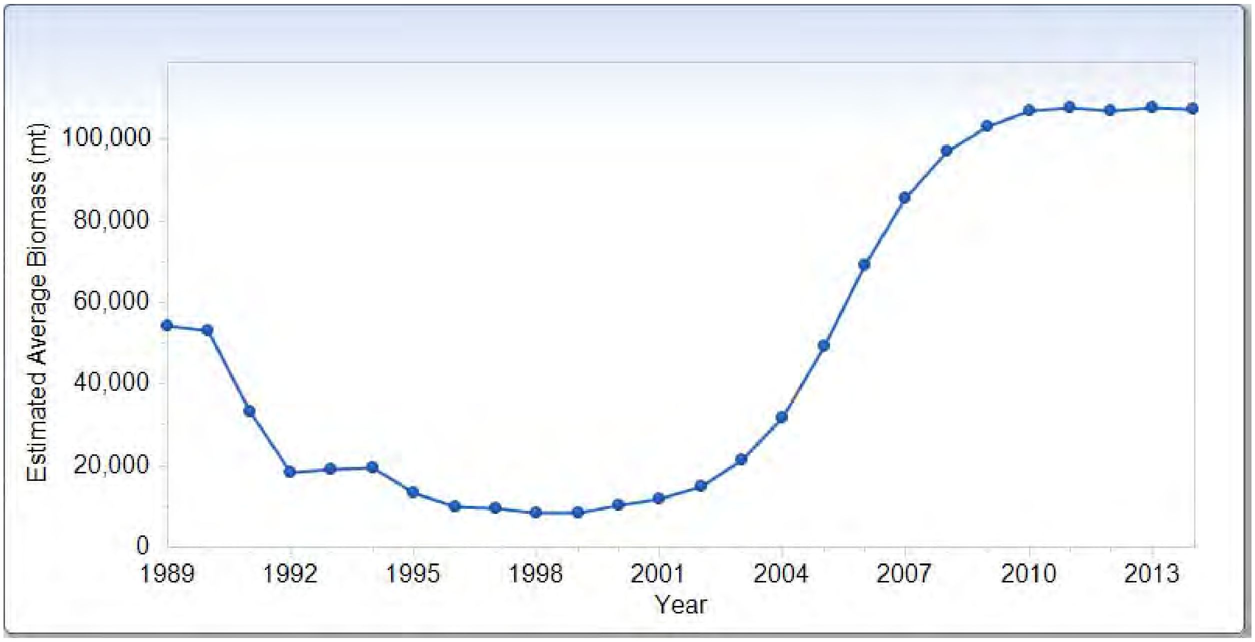

Figure 81. **Estimated average biomass (metric tons) of spot from the surplus production model.**

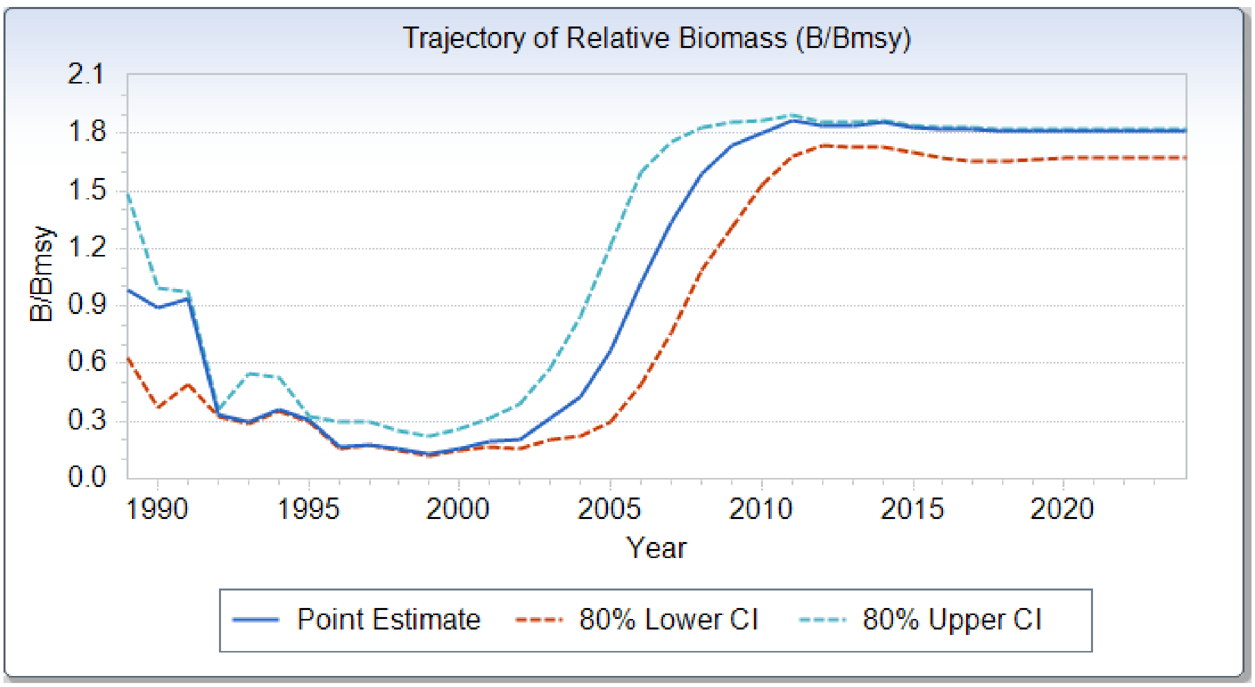

Figure 82. **Estimated relative biomass of spot from the surplus production model 10-year projections based on 2014 removal levels.**

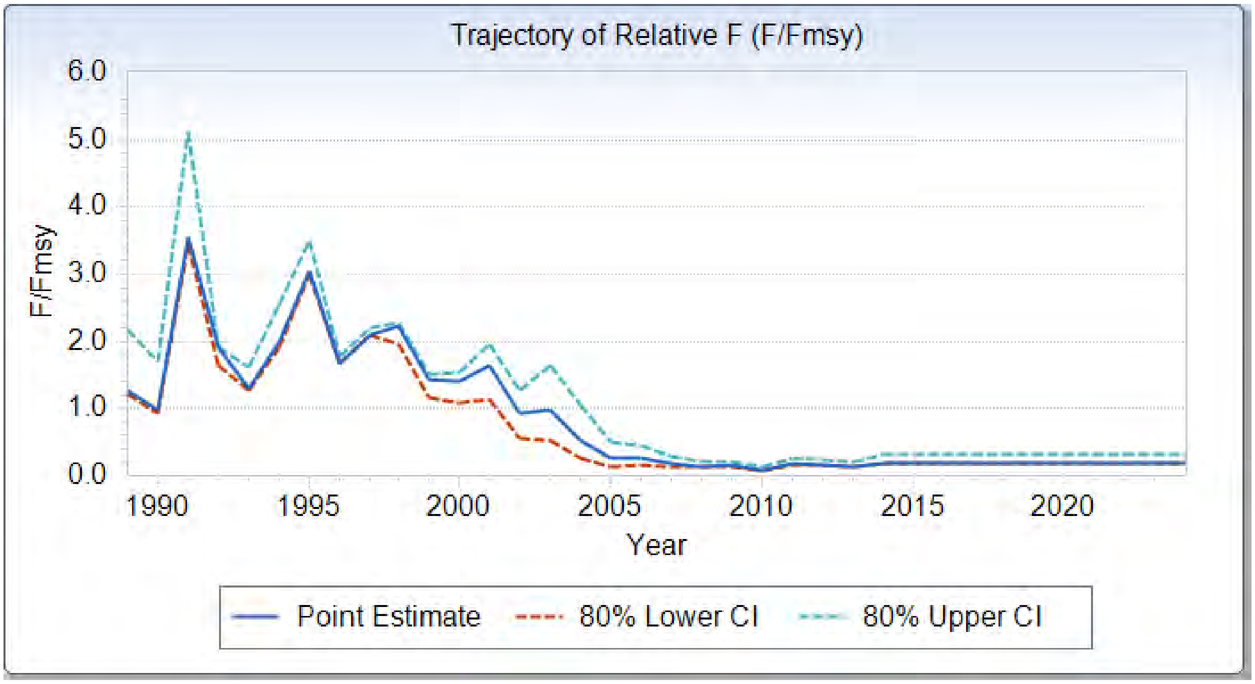

Figure 83. **Estimated relative fishing mortality of spot from the surplus production model 10-year projections based on 2014 removal levels.**

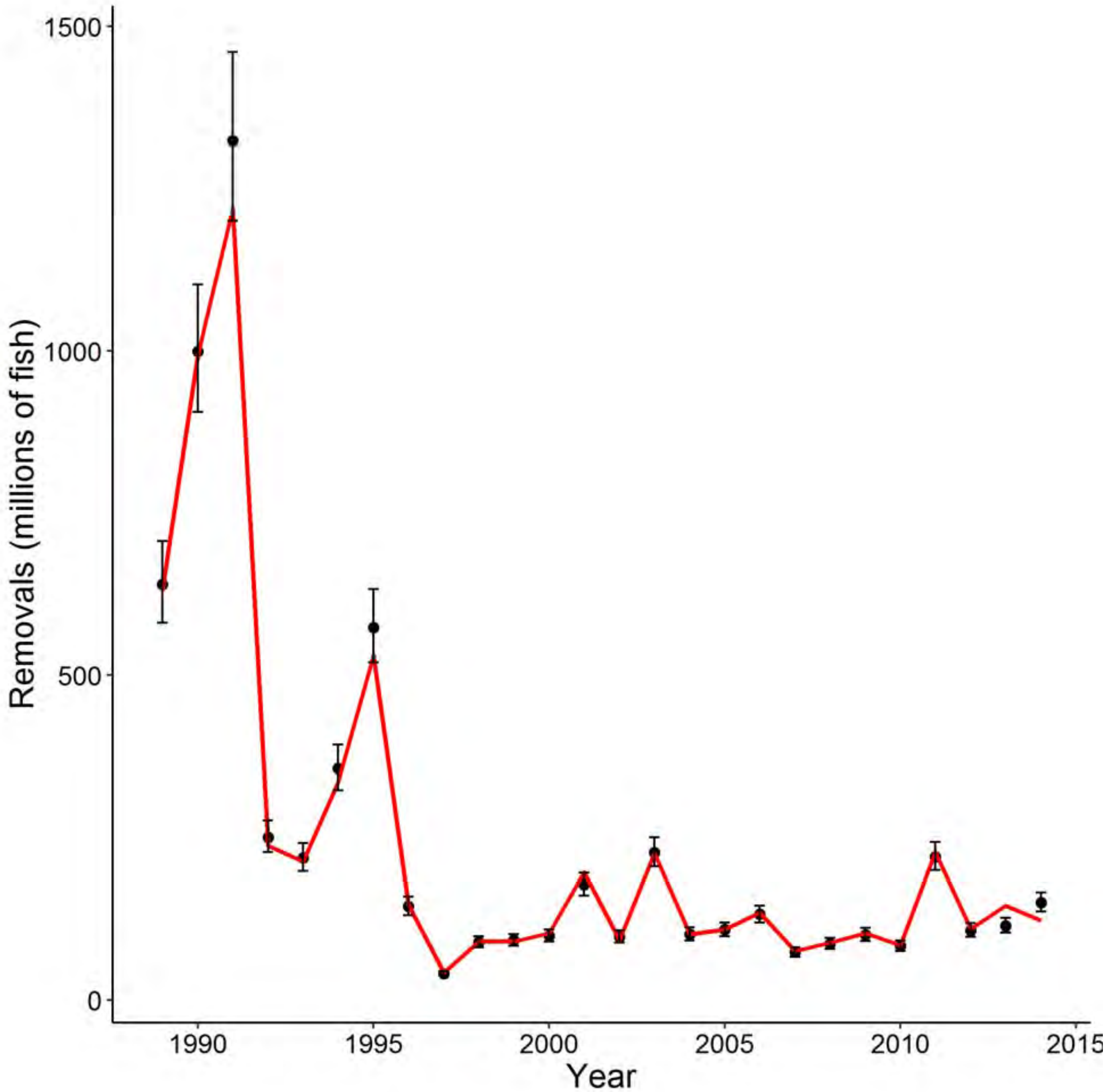

Figure 84. **Base modified-CSA model fit to total fishery removal data. The red line is model predicted removals, the black circles are observed removals, and error bars indicate 95% confidence intervals of observed removals based on assumed input CVs of 0.05.**

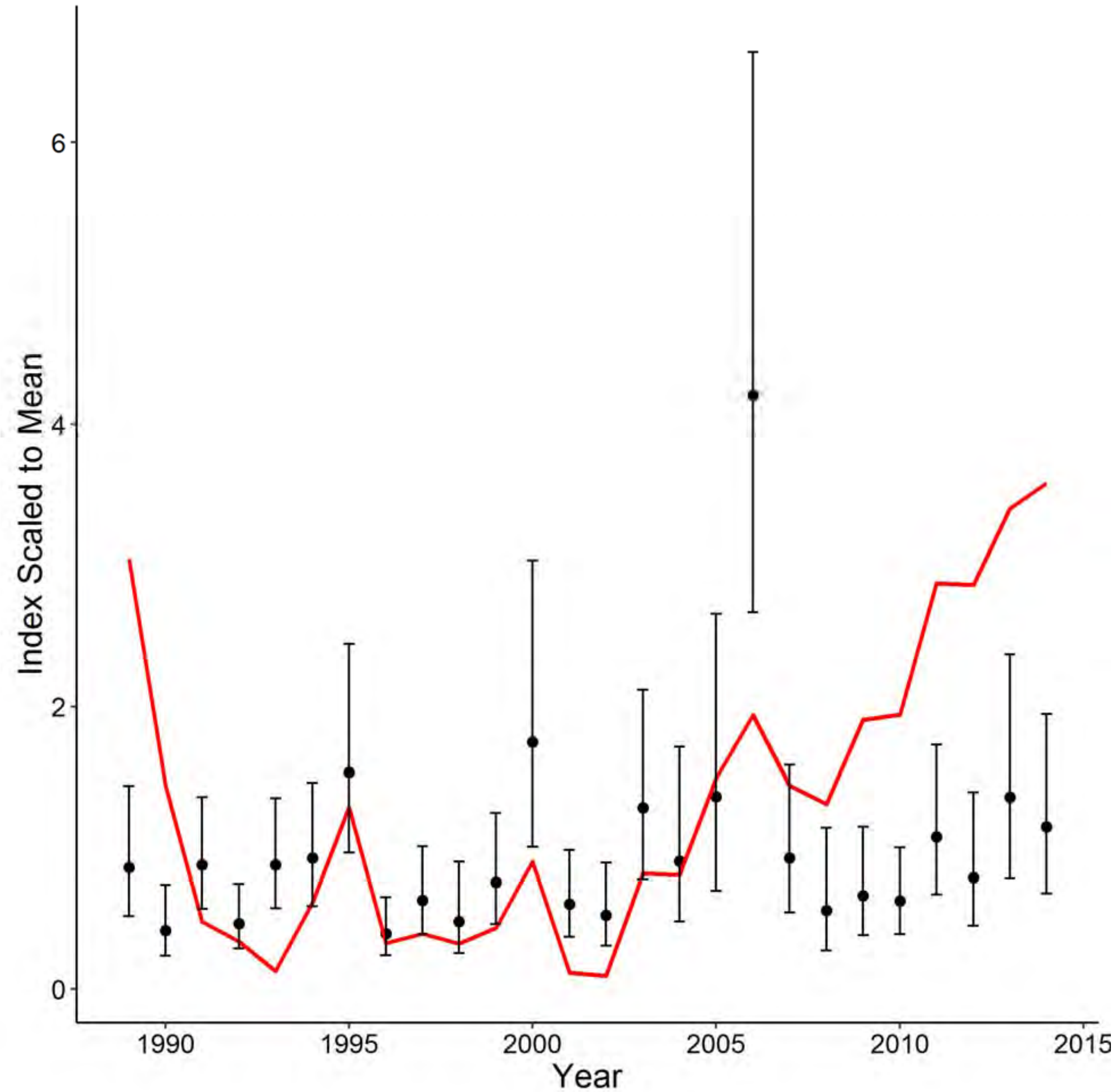

Figure 85. Base modified-CSA model fit to NCDMF Trawl Survey post-recruit index. The red line is the model predicted index, the black circles are observed index values, and error bars indicate 95% confidence intervals of the observed index values based on the input CVs.

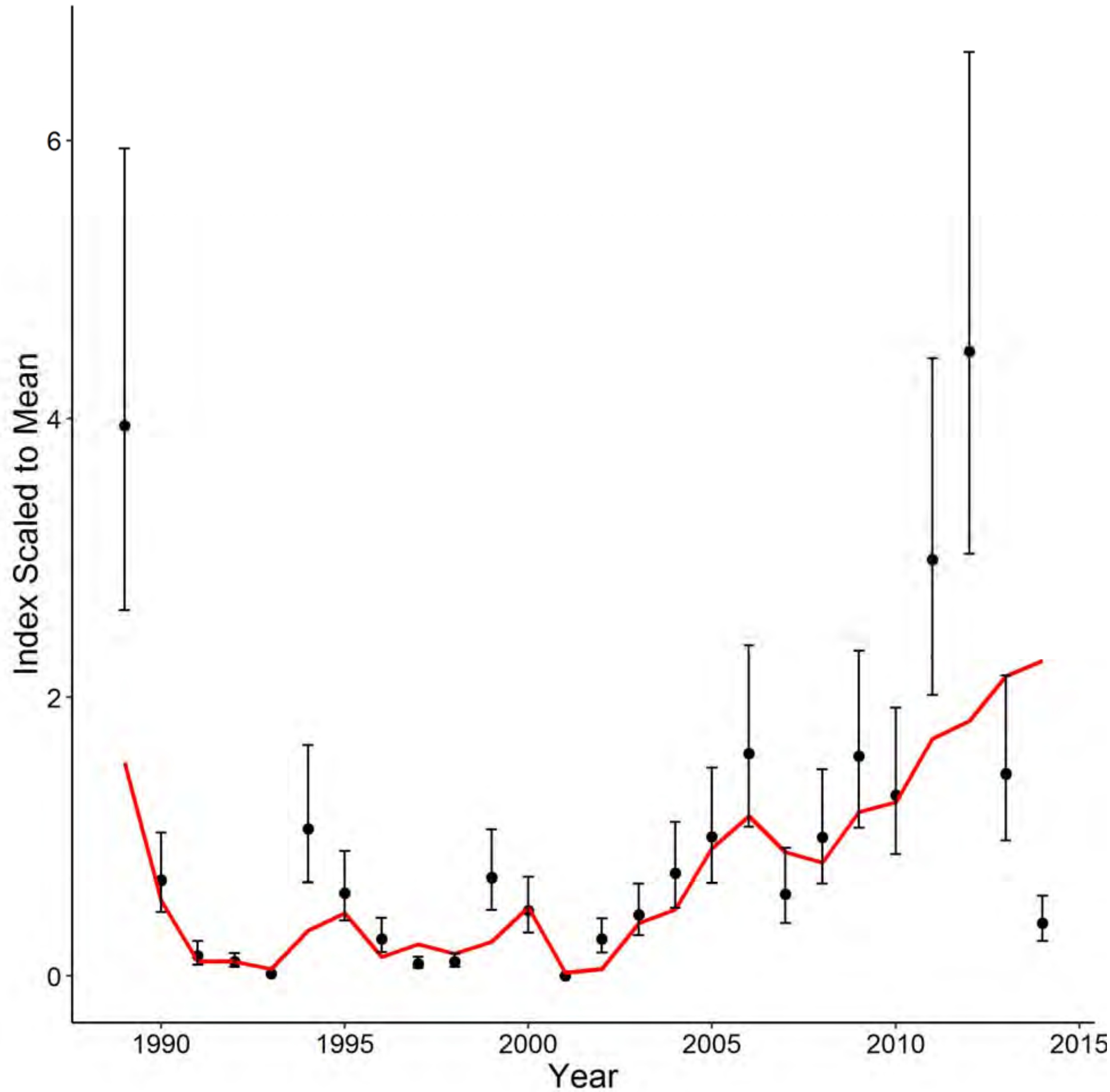

Figure 86. **Base modified-CSA model fit to NMFS Trawl Survey post-recruit index. The red line is the model predicted index, the black circles are observed index values, and error bars indicate 95% confidence intervals of the observed index values based on the input CVs.**

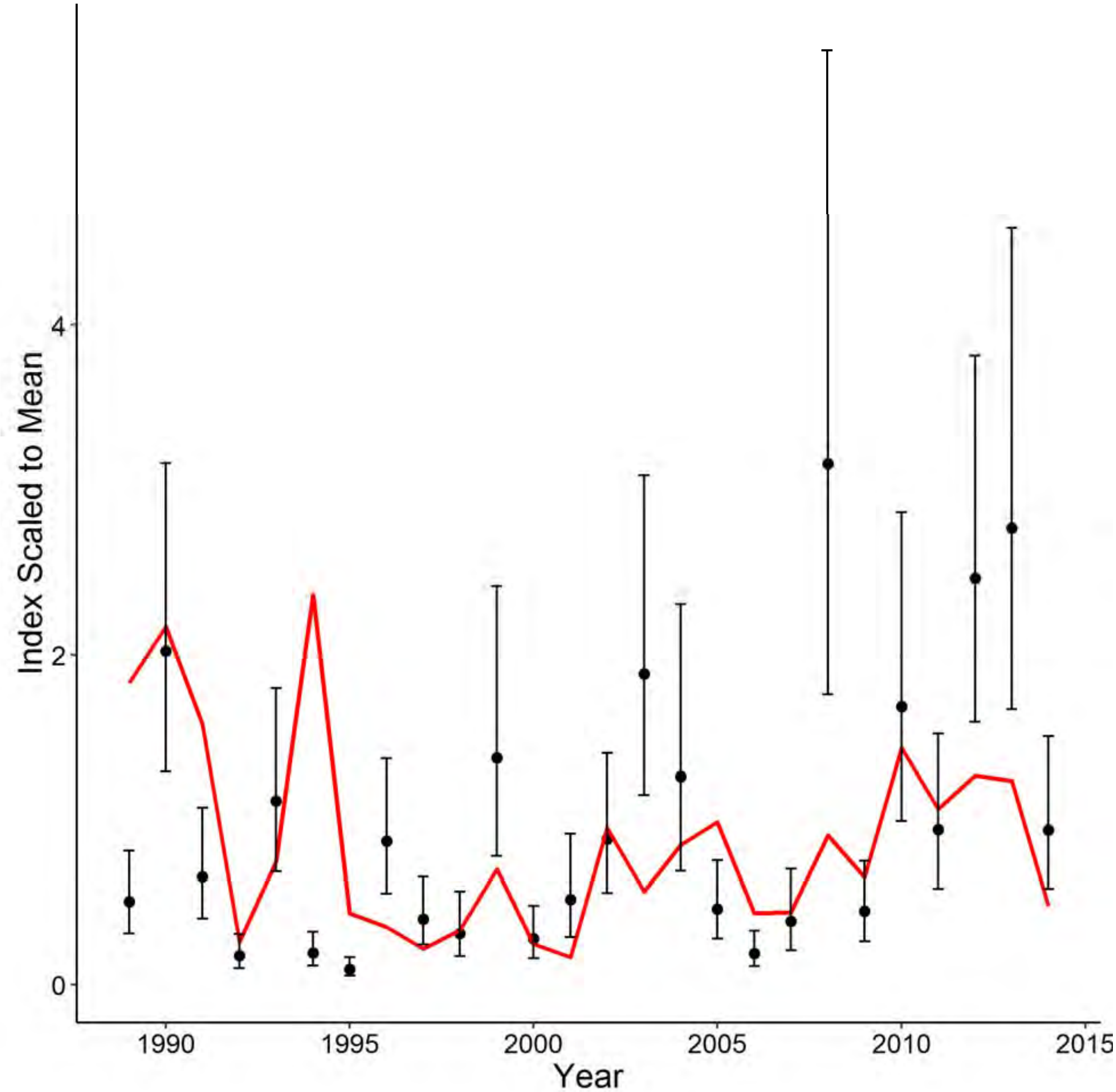

Figure 87. Base modified-CSA model fit to NCDMF Trawl Survey recruit index. The red line is the model predicted index, the black circles are observed index values, and error bars indicate 95% confidence intervals of the observed index values based on the input CVs.

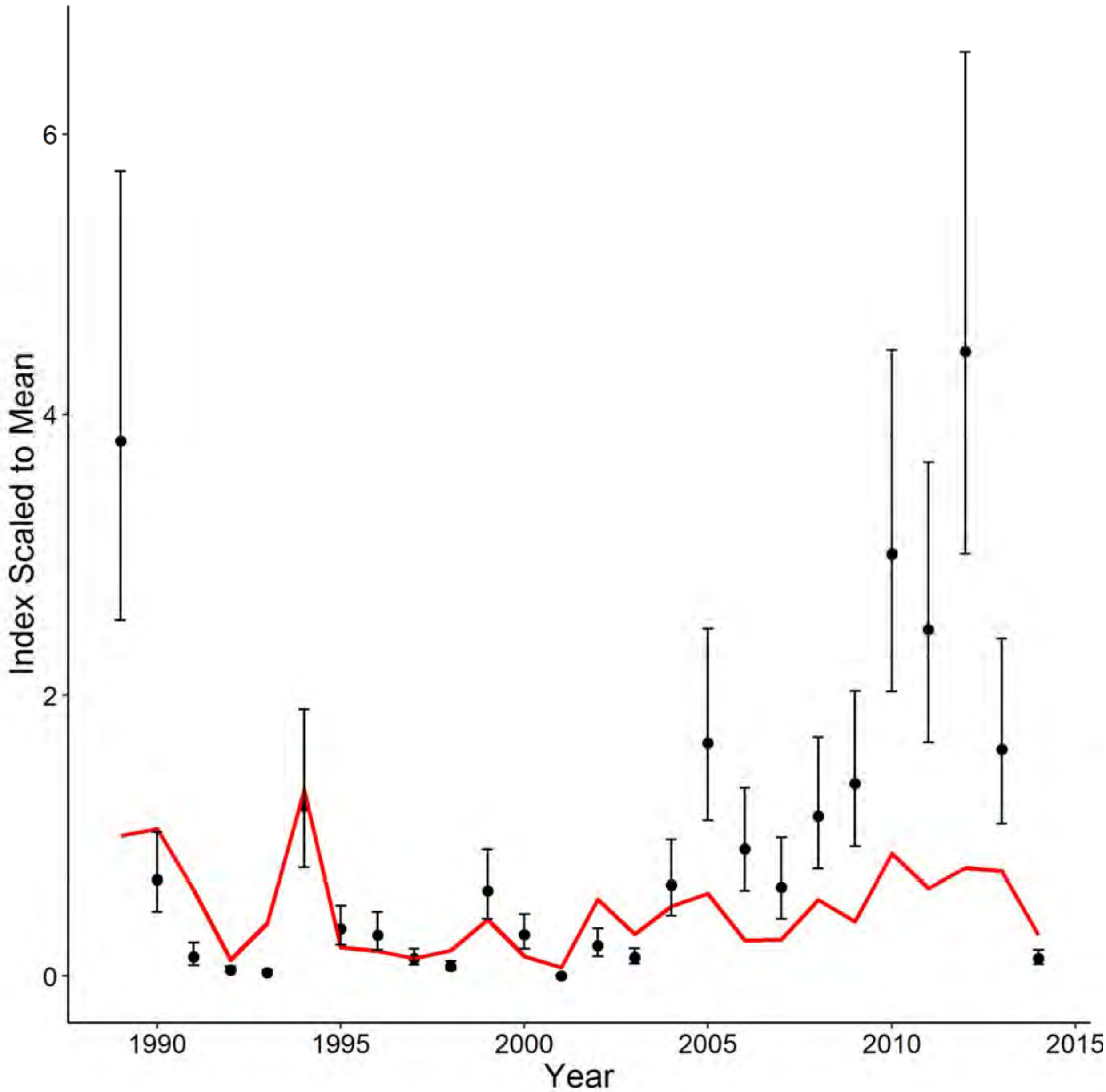

Figure 88. **Base modified-CSA model fit to NMFS Trawl Survey recruit index. The red line is the model predicted index, the black circles are observed index values, and error bars indicate 95% confidence intervals of the observed index values based on the input CVs.**

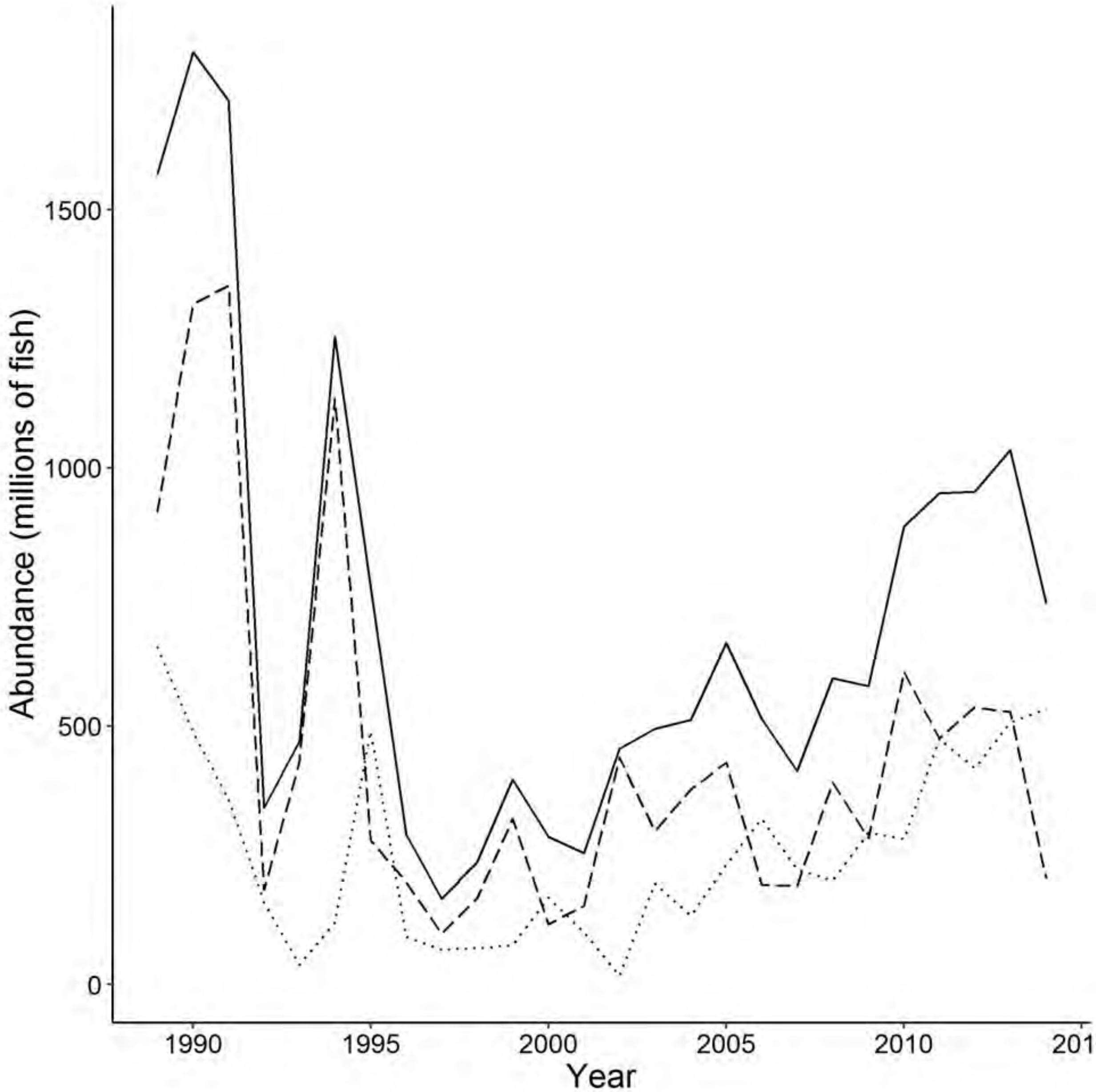

Figure 89. **Base modified-CSA model recruitment (dashed line), post-recruit (dotted line), and total abundance (solid line) estimates for spot (millions of fish).**

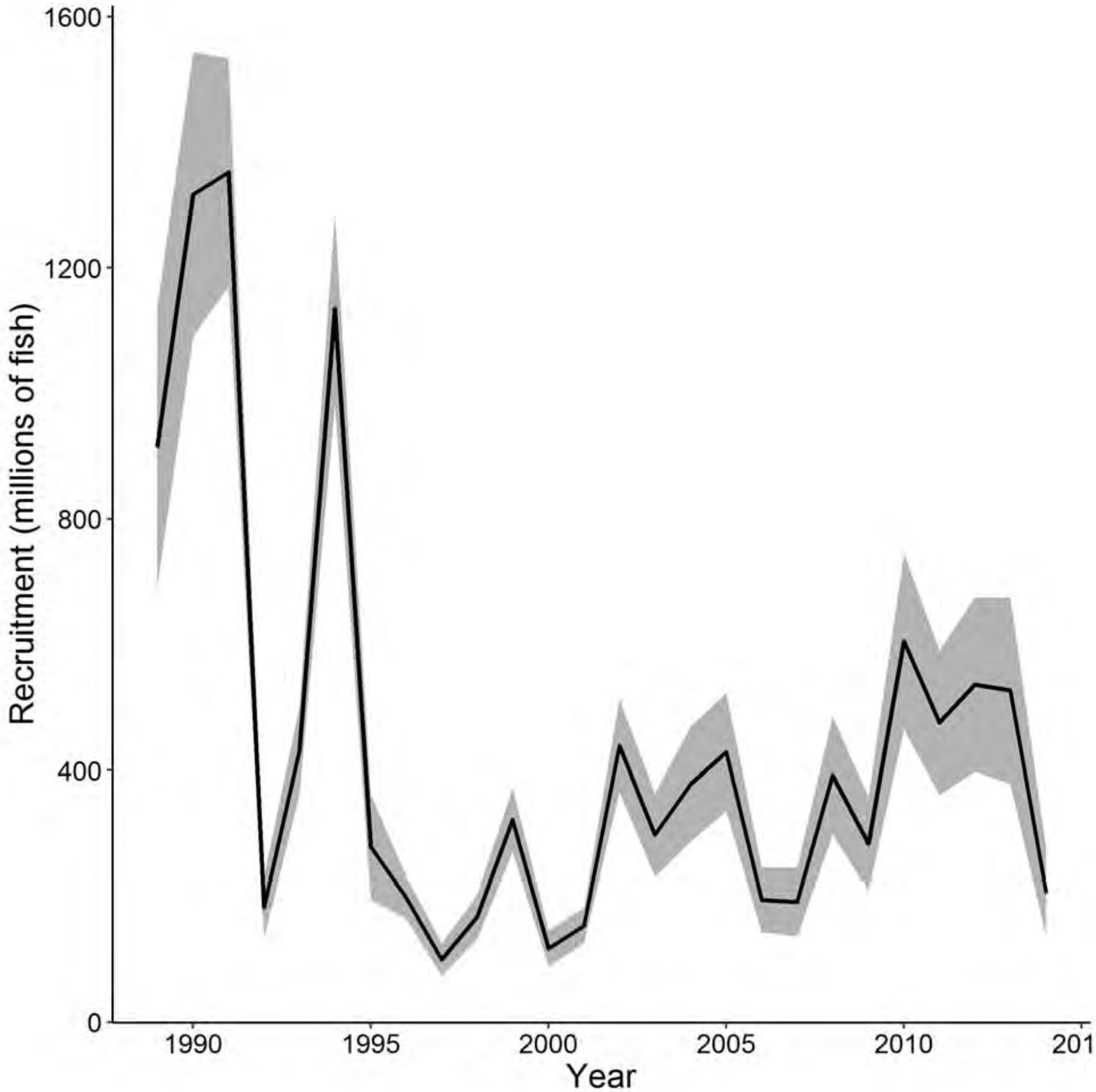

Figure 90. **Base modified-CSA model recruitment estimates for spot (millions of fish) with 95% confidence intervals derived from asymptotic standard errors.**

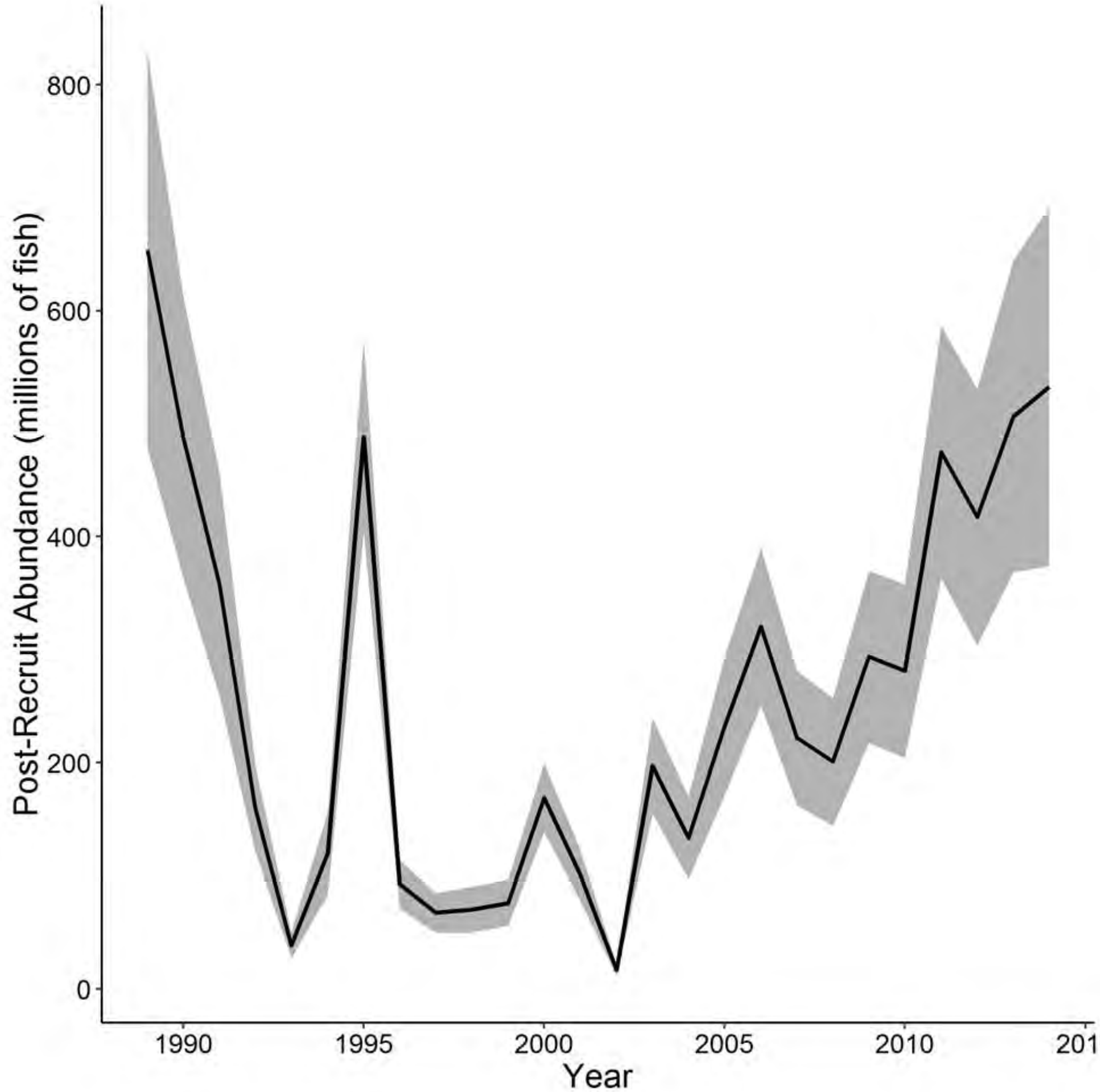

Figure 91. **Base modified-CSA model post-recruit abundance estimates for spot (millions of fish) with 95% confidence intervals derived from asymptotic standard errors.**

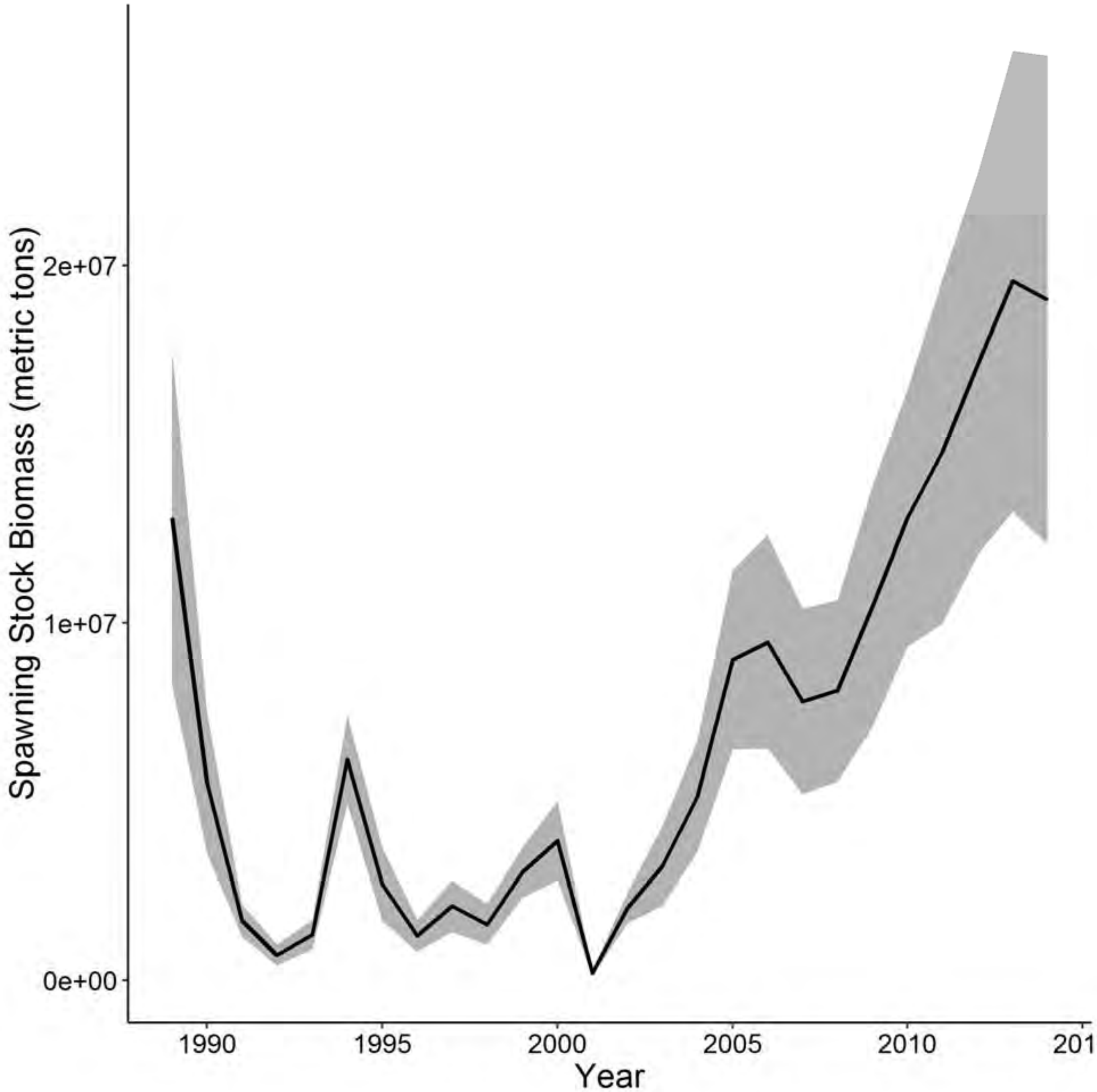

Figure 92. **Base modified-CSA model end-year spawning stock biomass estimates for spot (metric tons) with 95% confidence intervals derived from asymptotic standard errors.**

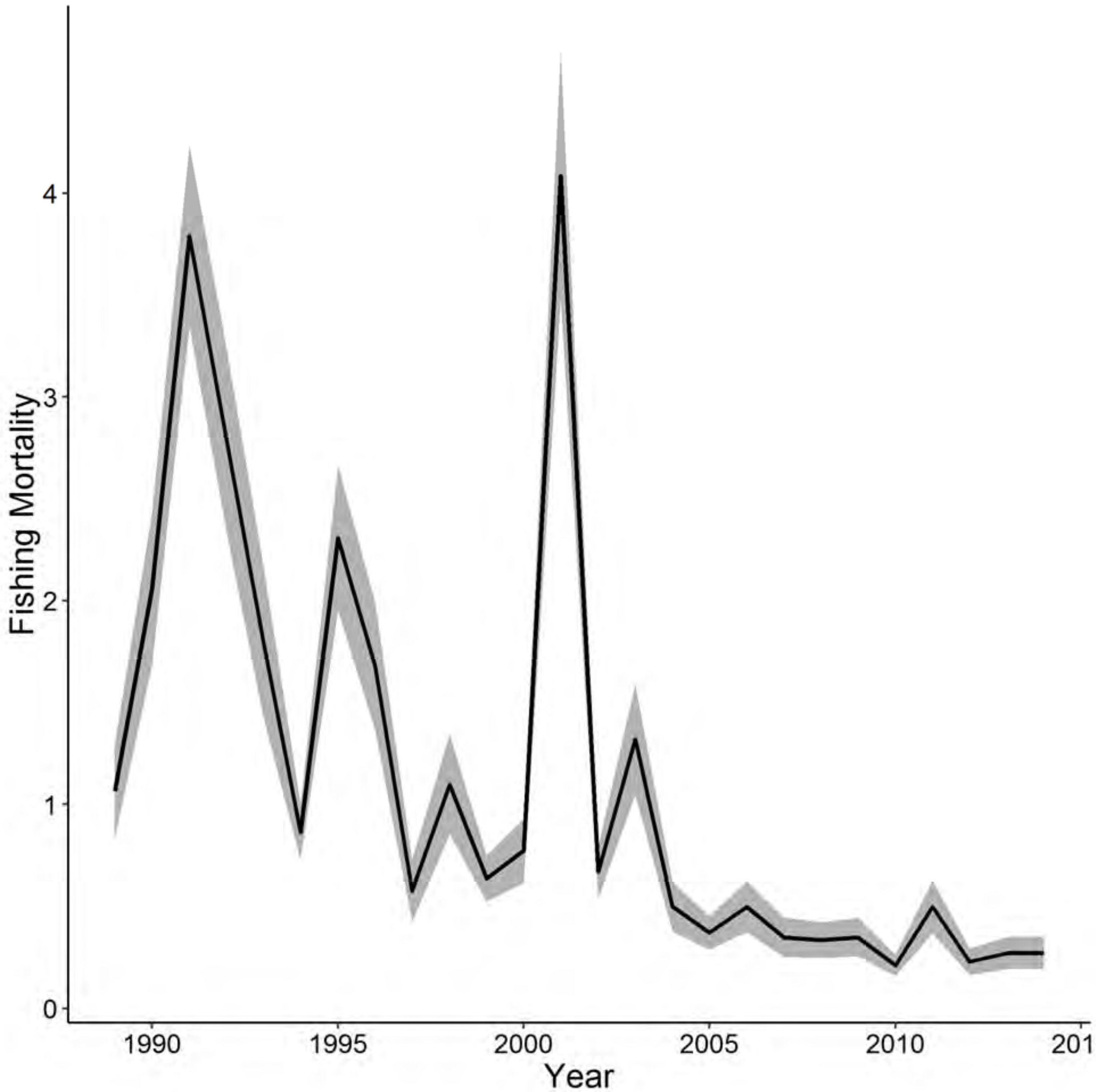

Figure 93. Base modified-CSA model full fishing mortality estimates for spot with 95% confidence intervals derived from asymptotic standard errors. Terminal year (2014) fishing mortality is the geometric mean of the previous two years (2012-2013).

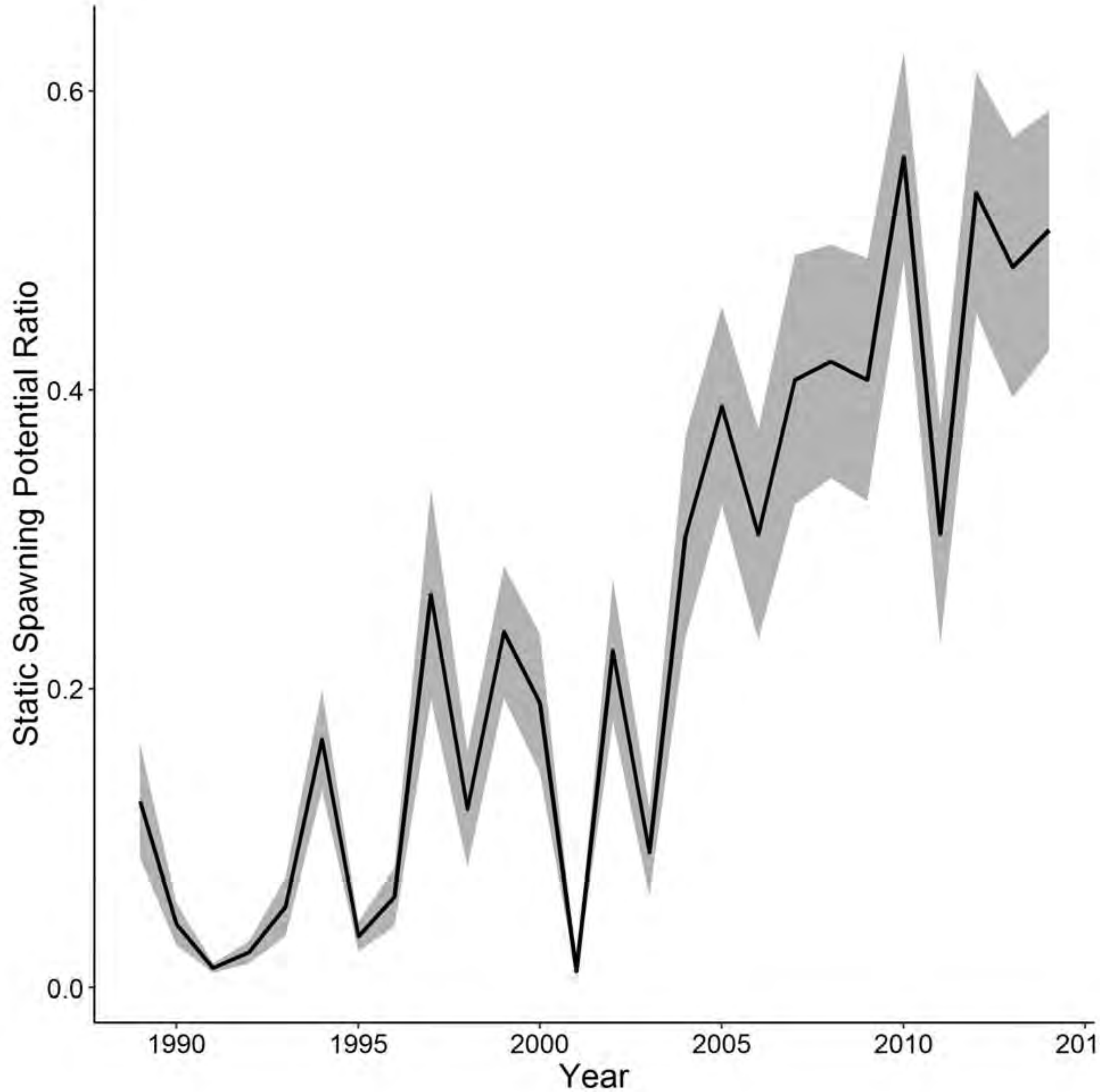

Figure 94. Base modified-CSA model static spawning potential ratio estimates for spot with 95% confidence intervals derived from asymptotic standard errors. Terminal year (2014) sSPR is estimated from the geometric mean of the previous two years (2012-2013) fishing mortality estimates.

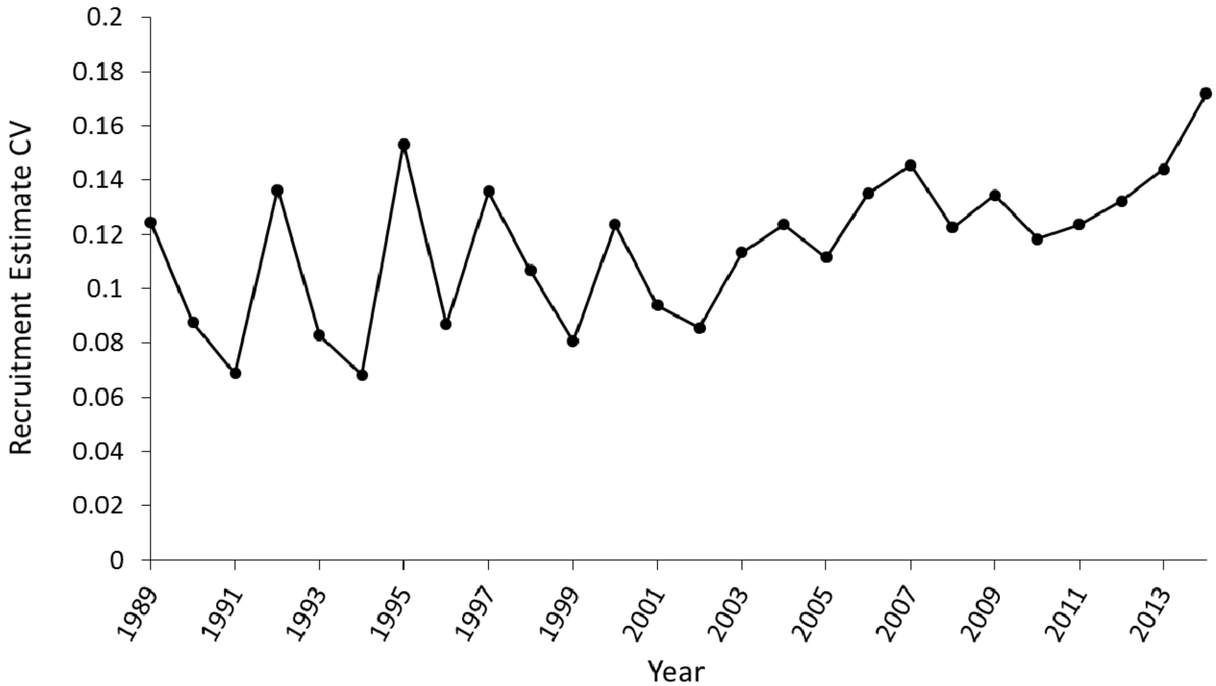

Figure 95. **Base modified-CSA model recruitment estimate CVs for spot derived from asymptotic standard errors.**

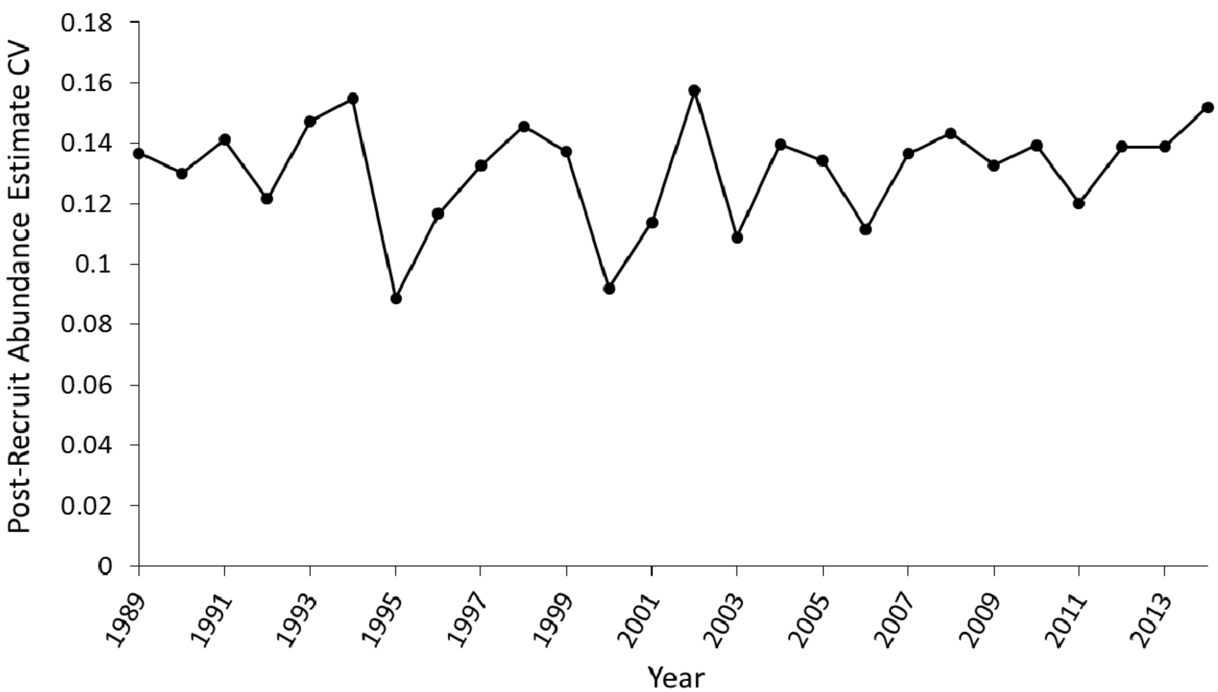

Figure 96. **Base modified-CSA model post-recruit abundance estimate CVs for spot derived from asymptotic standard errors.**

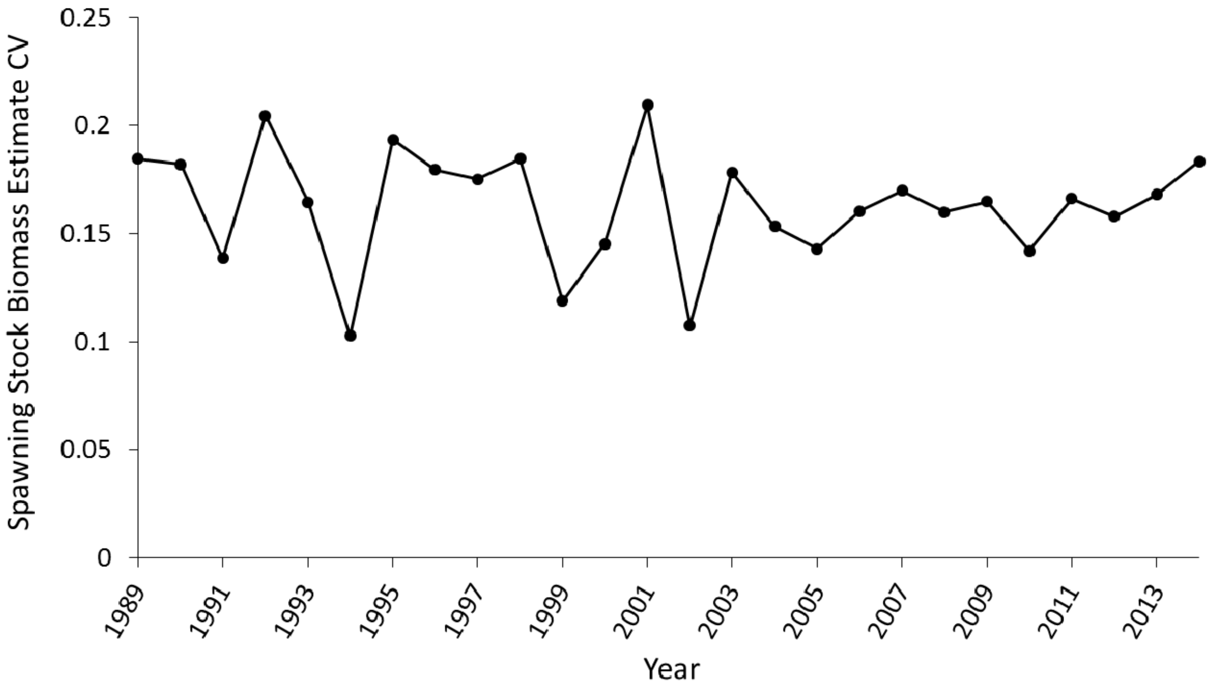

Figure 97. **Base modified-CSA model spawning stock biomass estimate CVs for spot derived from asymptotic standard errors.**

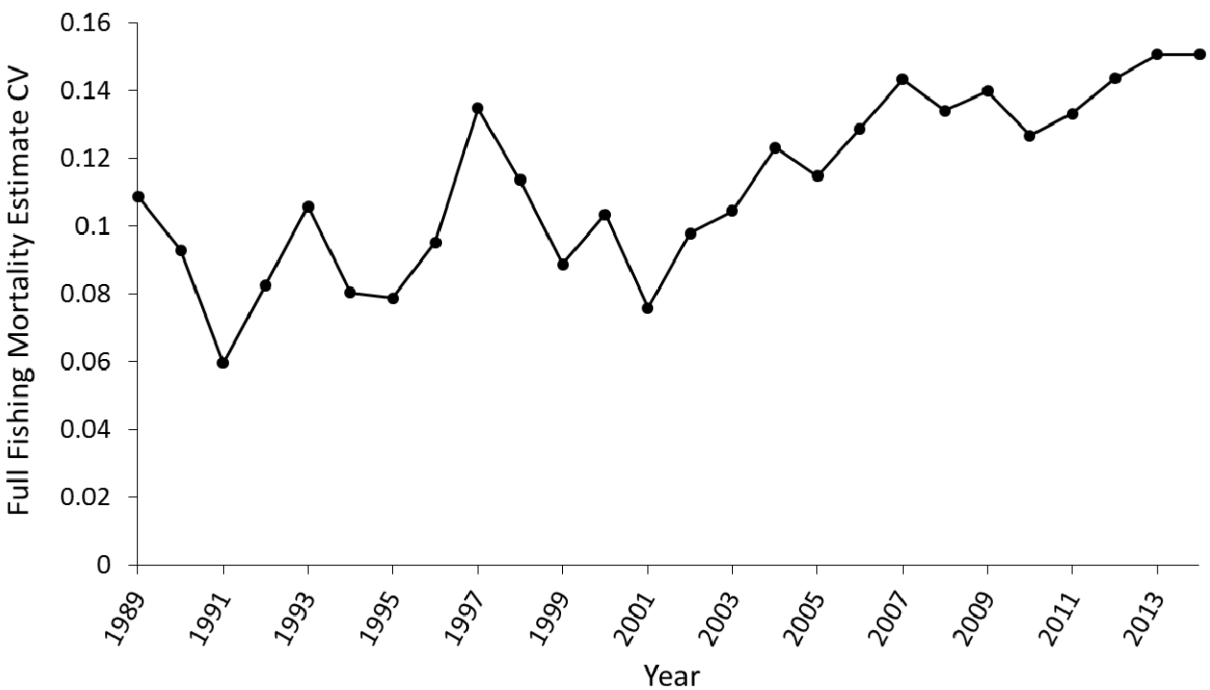

Figure 98. **Base modified-CSA model full fishing mortality estimate CVs for spot derived from asymptotic standard errors.**

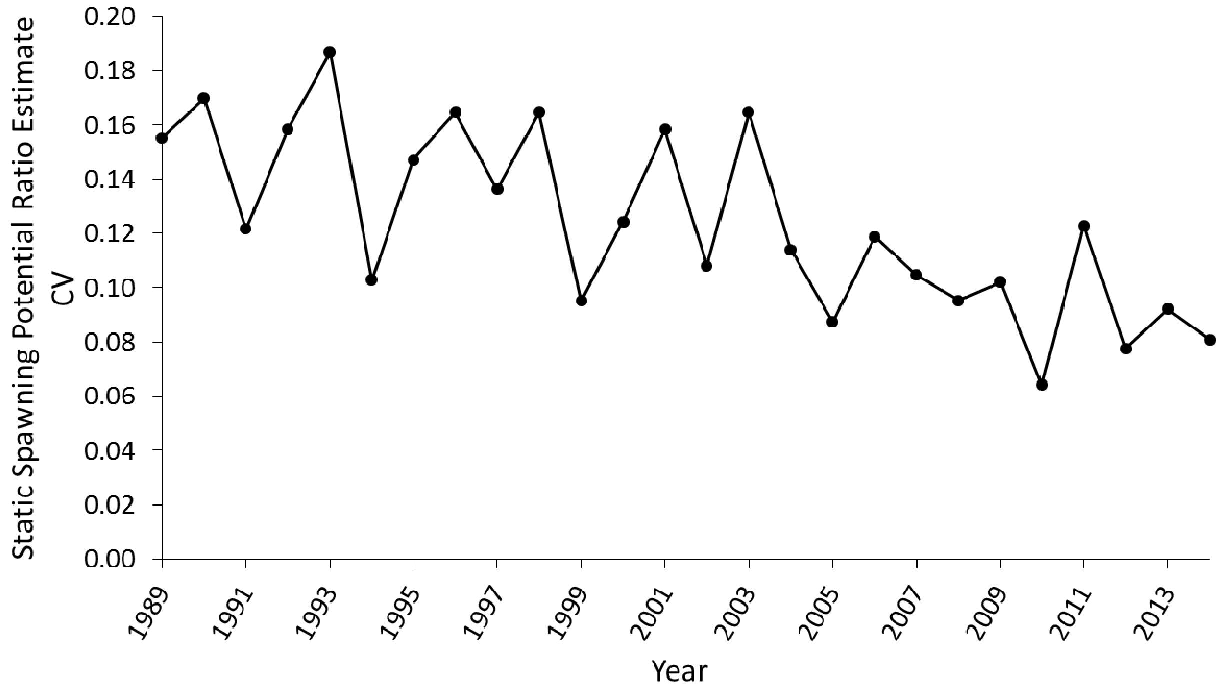

Figure 99. **Base modified-CSA model static spawning potential ratio estimate CVs for spot derived from asymptotic standard errors.**

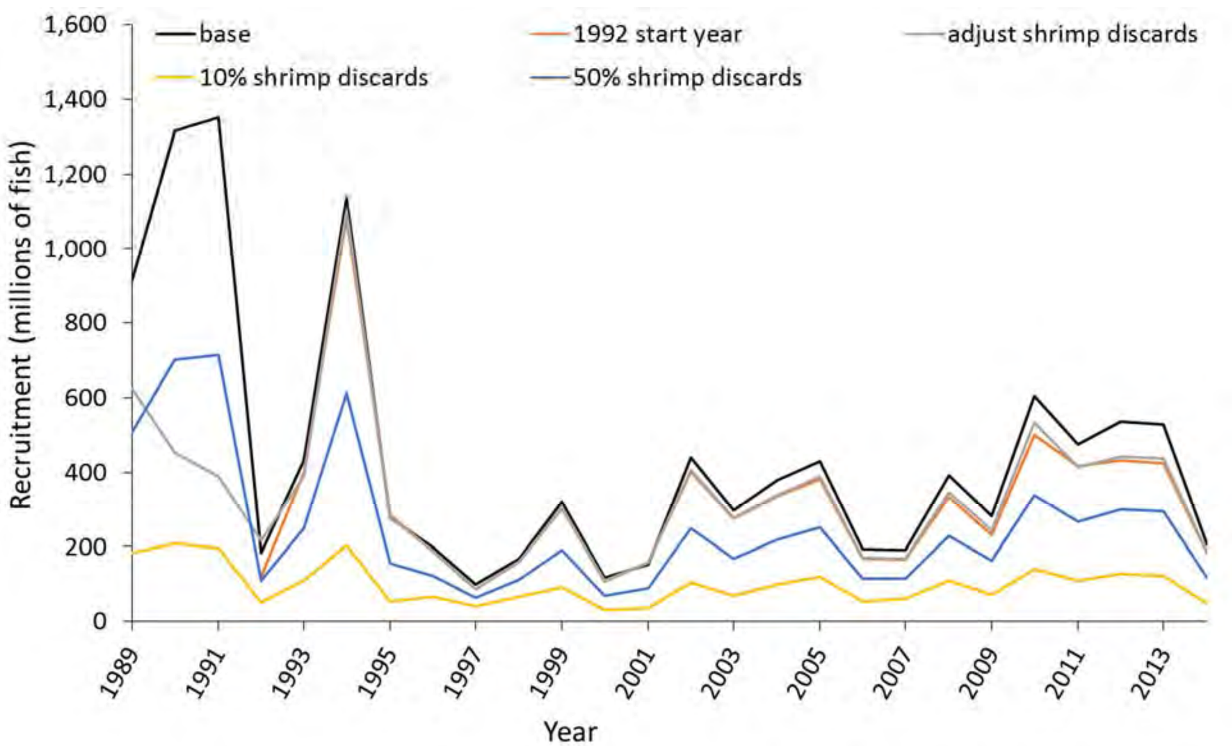

Figure 100. **Recruitment estimates for spot from the base modified-CSA model and sensitivity configurations focusing on shrimp trawl discard estimates (see Table 95 for description of sensitivity configurations).**

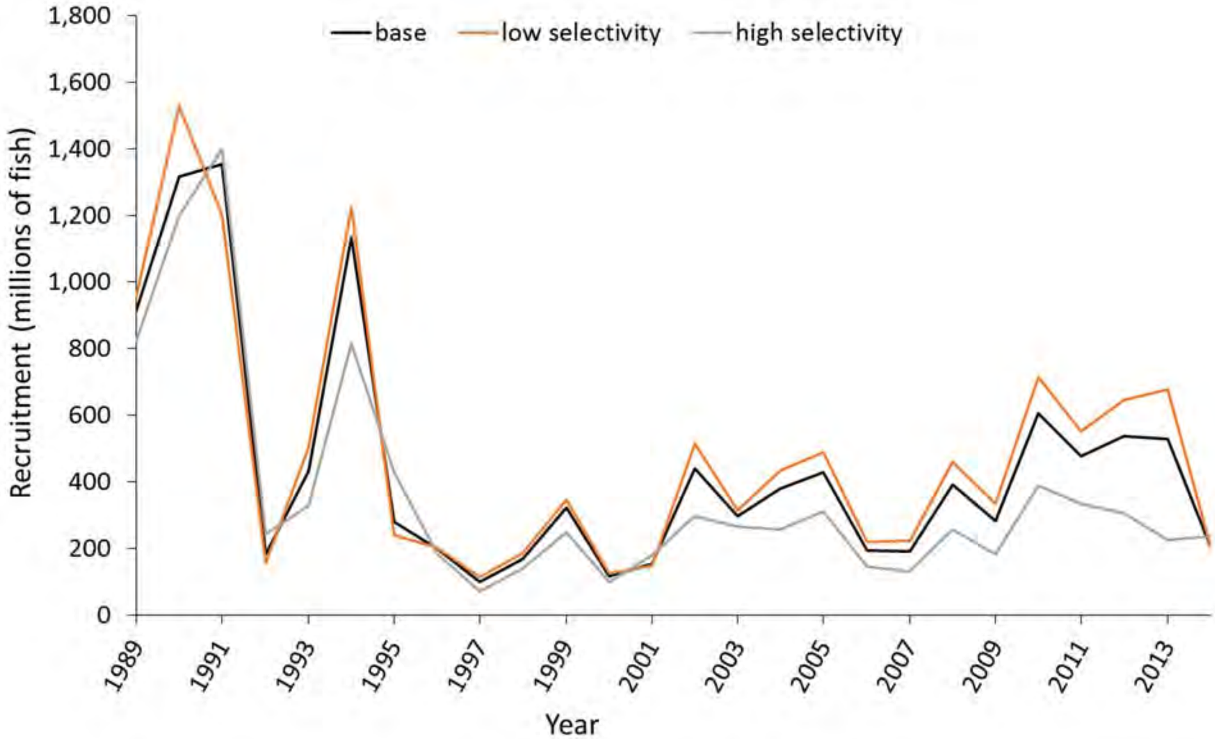

Figure 101. **Recruitment estimates for spot from the base modified-CSA model and sensitivity configurations focusing on recruit selectivity assumptions (see Table 95 for description of sensitivity configurations).**

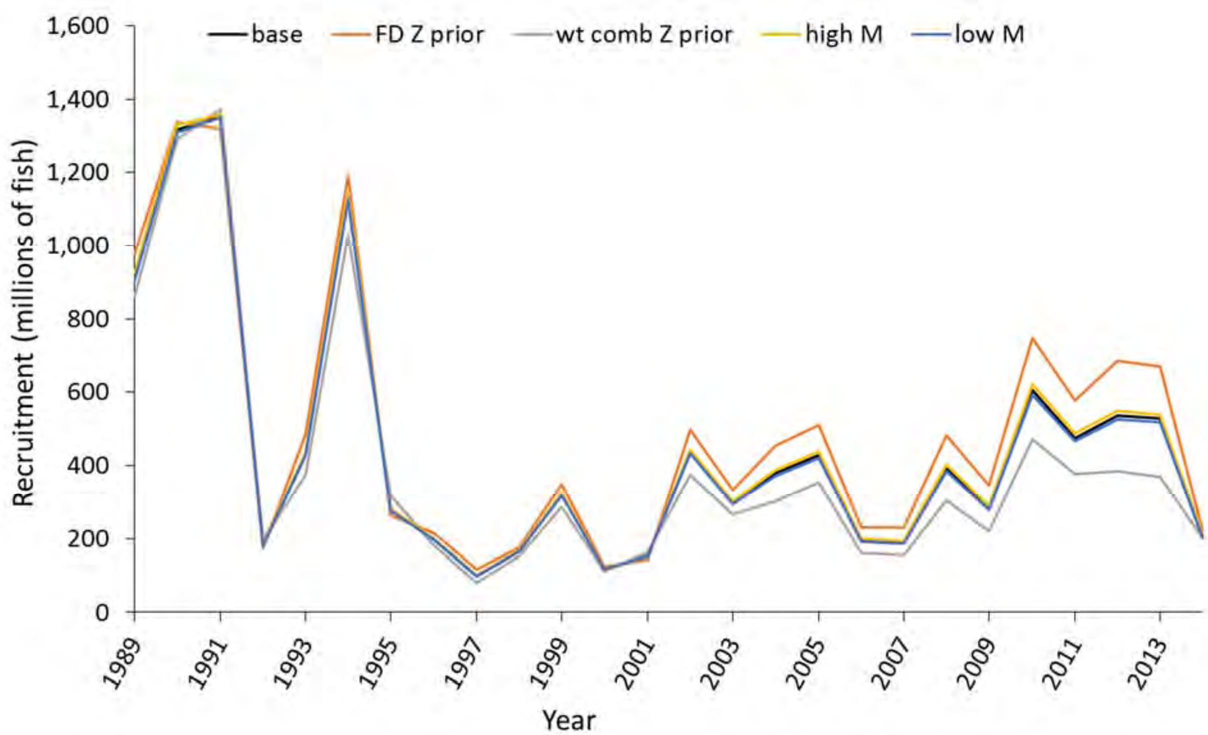

Figure 102. **Recruitment estimates for spot from the base modified-CSA model and sensitivity configurations focusing on assumptions about mortality (see Table 95 for description of sensitivity configurations).**

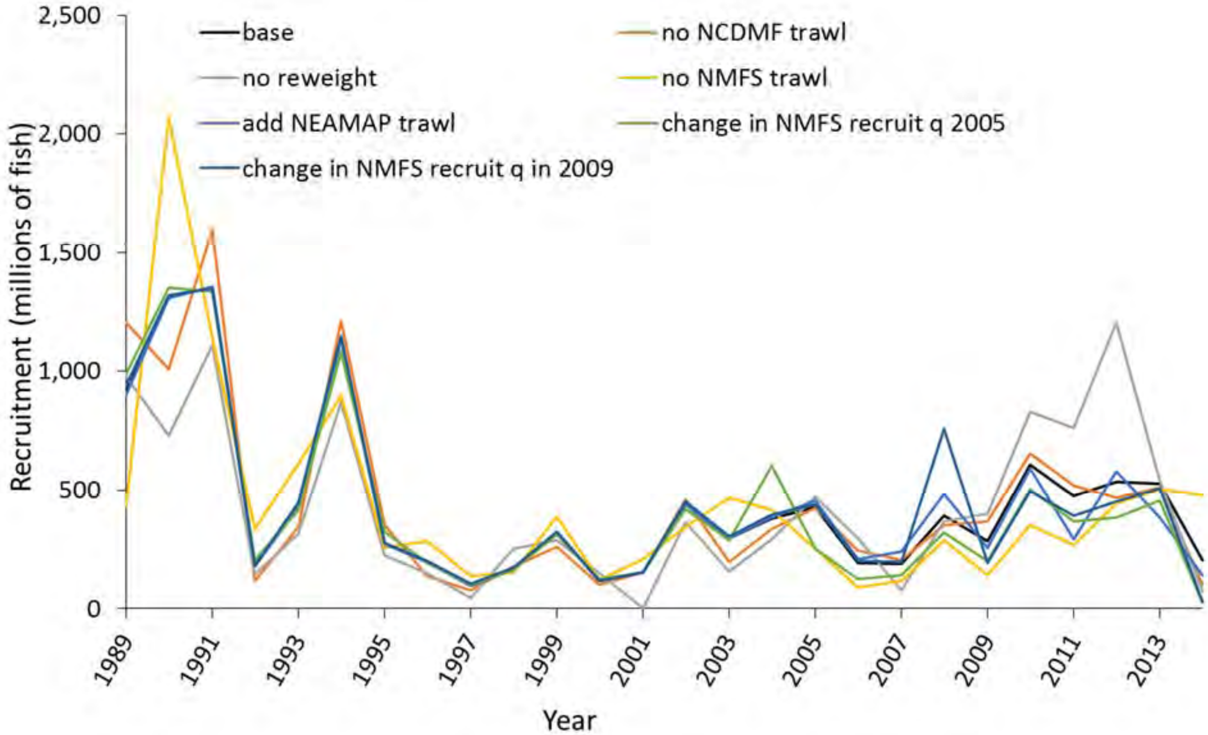

Figure 103. **Recruitment estimates for spot from the base modified-CSA model and sensitivity configurations focusing on choices and treatment of index data (see Table 95 for description of sensitivity configurations).**

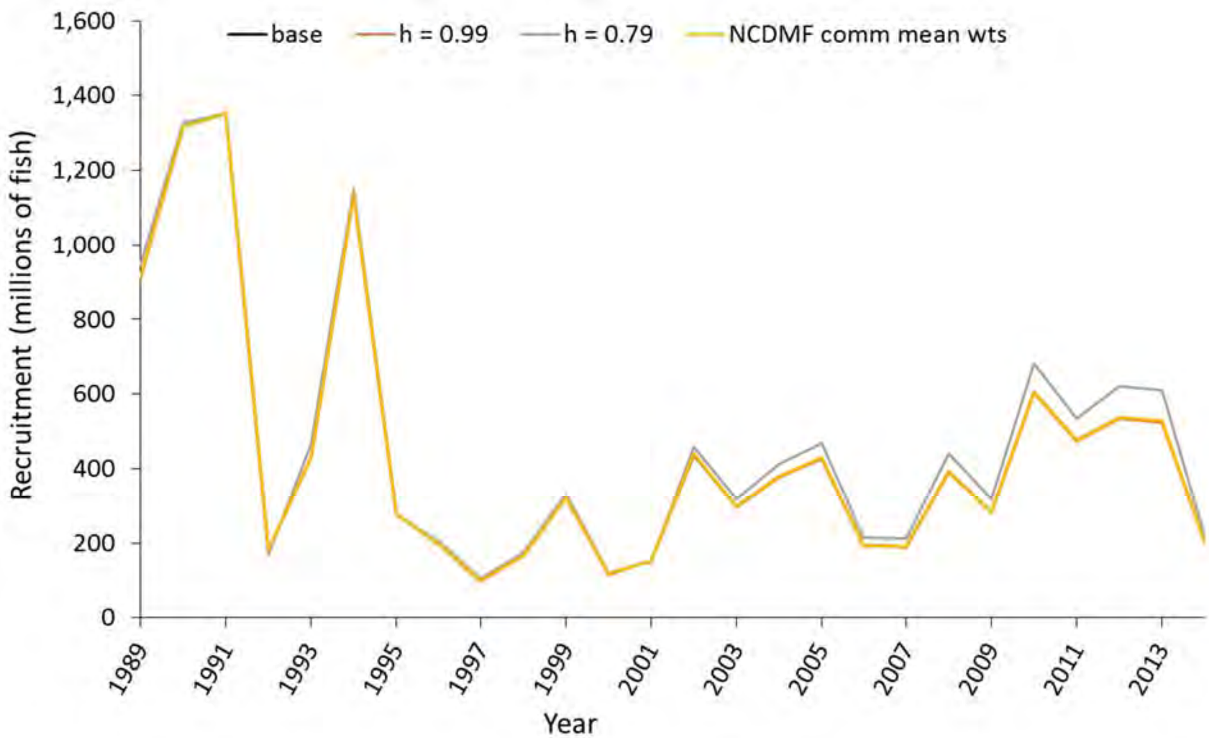

Figure 104. **Recruitment estimates for spot from the base modified-CSA model and sensitivity configurations focusing on aspects relating to the stock-recruit relationship (see Table 95 for description of sensitivity configurations).**

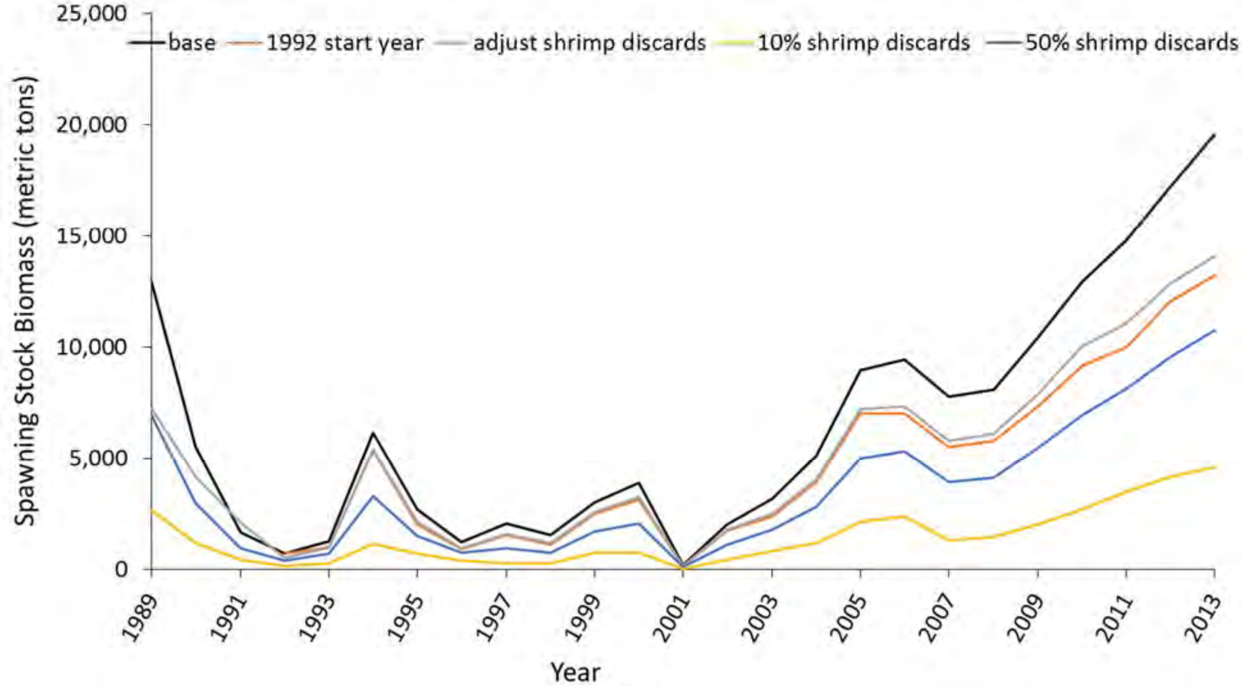

Figure 105. End-year spawning stock biomass estimates for spot from the base modified-CSA model and sensitivity configurations focusing on shrimp trawl discard estimates (see Table 95 for description of sensitivity configurations).

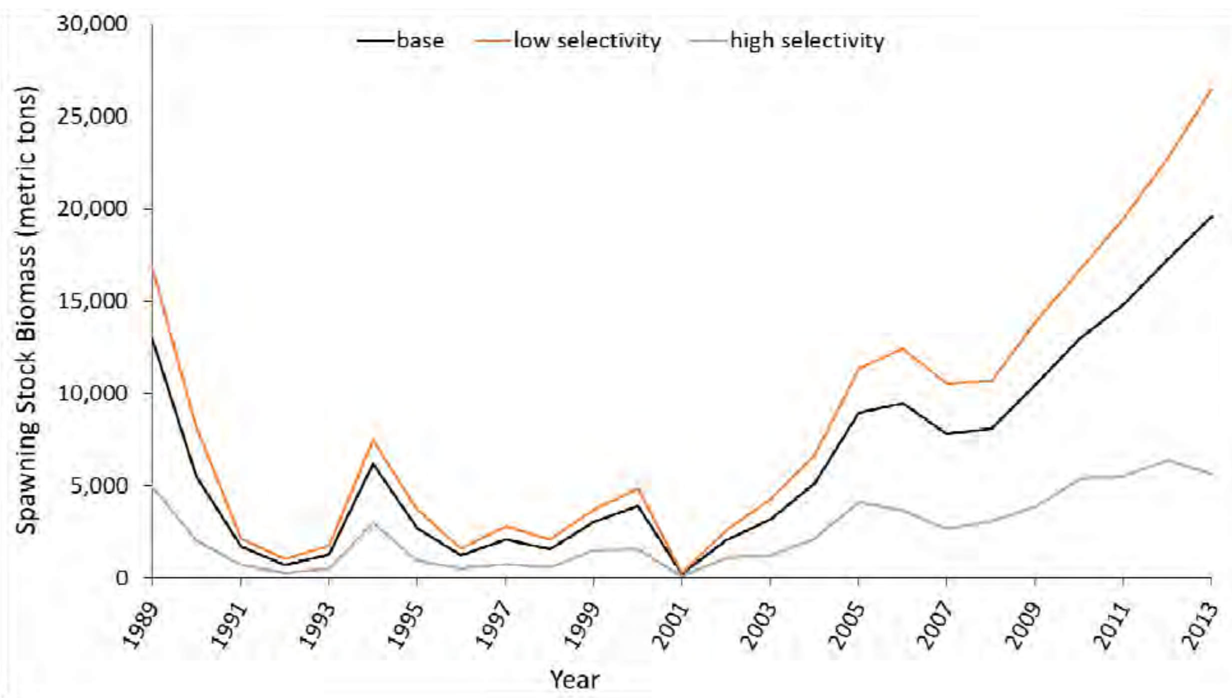

Figure 106. End-year spawning stock biomass estimates for spot from the base modified-CSA model and sensitivity configurations focusing on recruit selectivity assumptions (see Table 95 for description of sensitivity configurations).

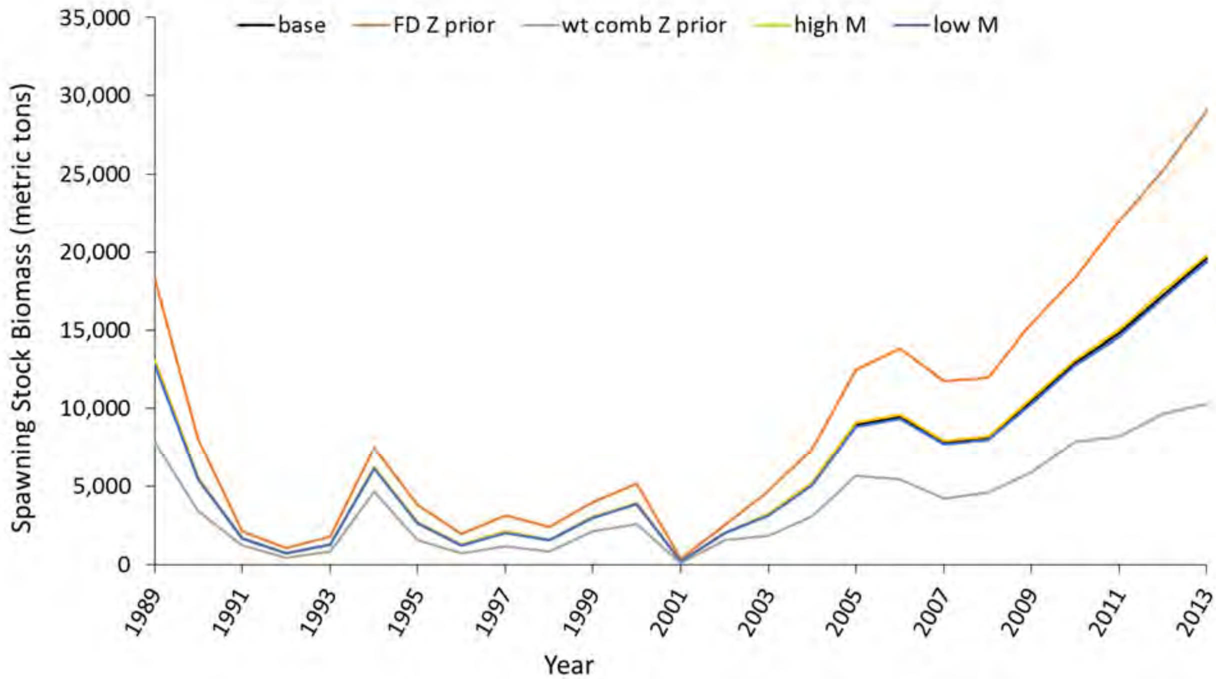

Figure 107. **End-year spawning stock biomass estimates for spot from the base modified-CSA model and sensitivity configurations focusing on assumptions about mortality (see Table 95 for description of sensitivity configurations).**

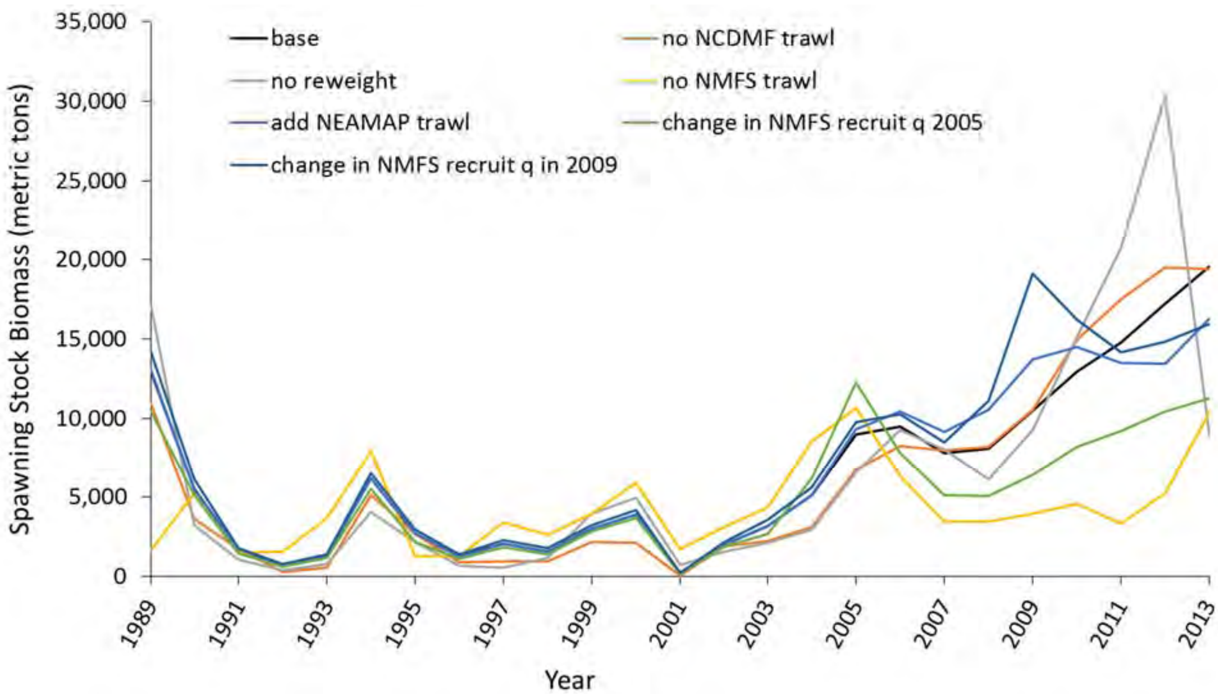

Figure 108. **End-year spawning stock biomass estimates for spot from the base modified-CSA model and sensitivity configurations focusing on choices and treatment of index data (see Table 95 for description of sensitivity configurations).**

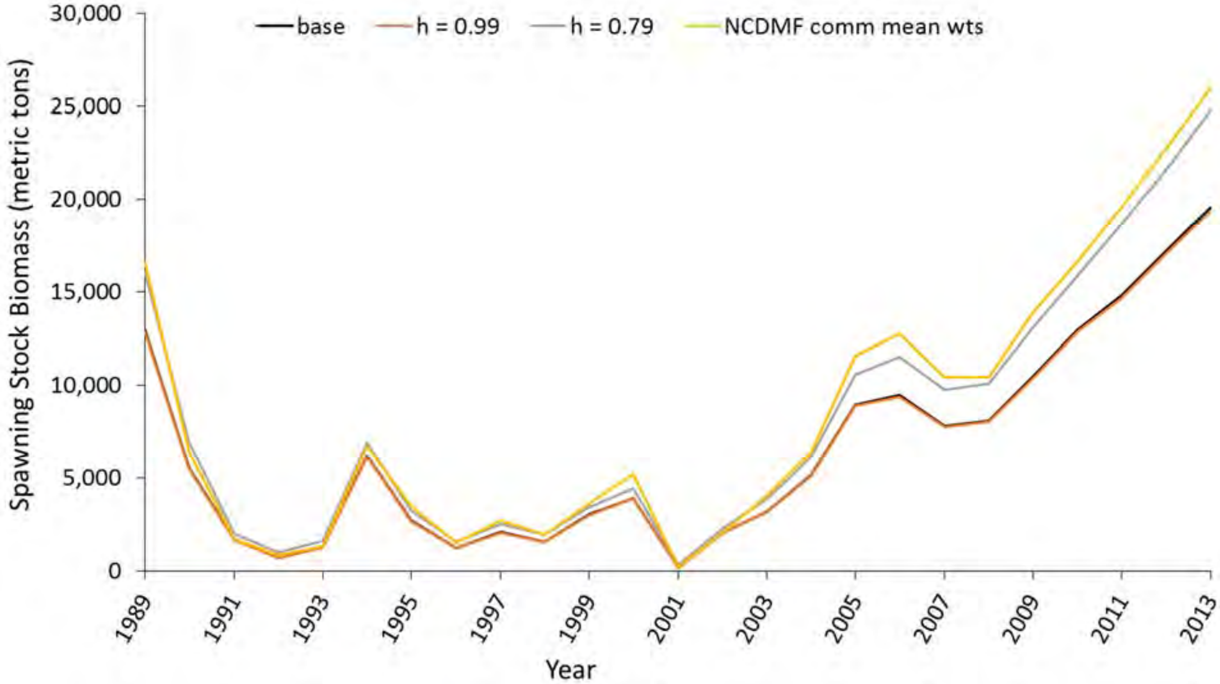

Figure 109. **End-year spawning stock biomass estimates for spot from the base modified-CSA model and sensitivity configurations focusing on aspects relating to the stock-recruit relationship (see Table 95 for description of sensitivity configurations).**

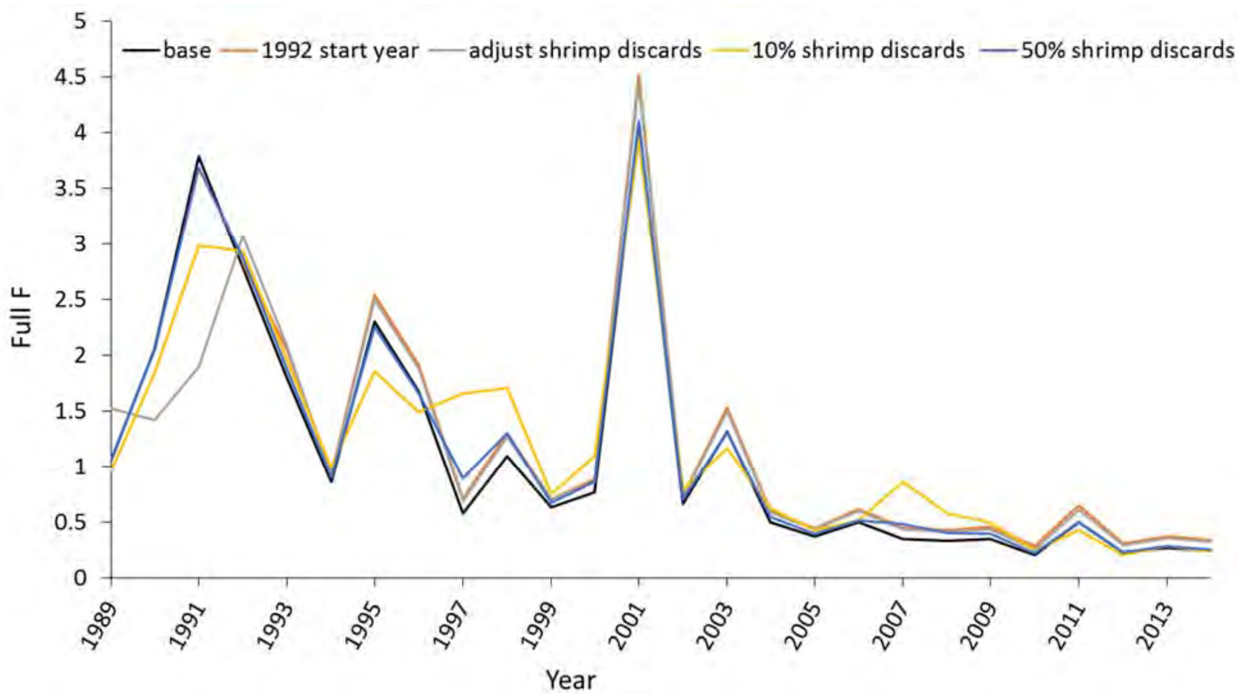

Figure 110. **Full fishing mortality estimates for spot from the base modified-CSA model and sensitivity configurations focusing on shrimp trawl discard estimates (see Table 95 for description of sensitivity configurations).**

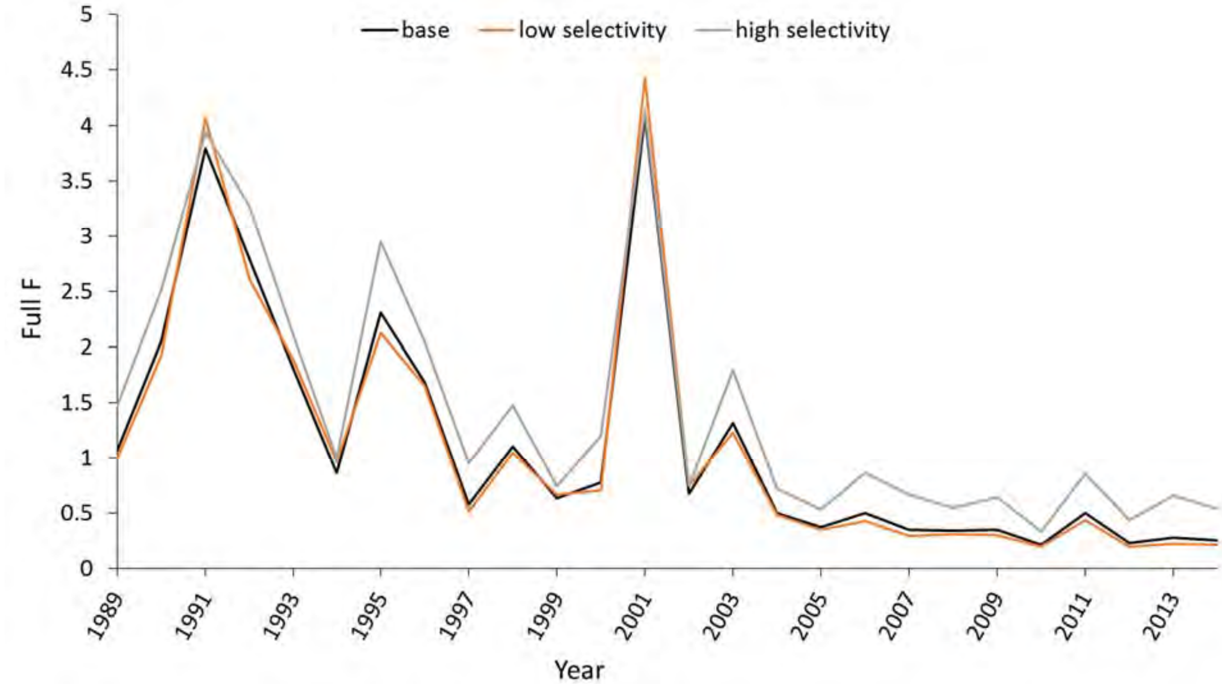

Figure 111. **Full fishing mortality estimates for spot from the base modified-CSA model and sensitivity configurations focusing on recruit selectivity assumptions (see Table 95 for description of sensitivity configurations).**

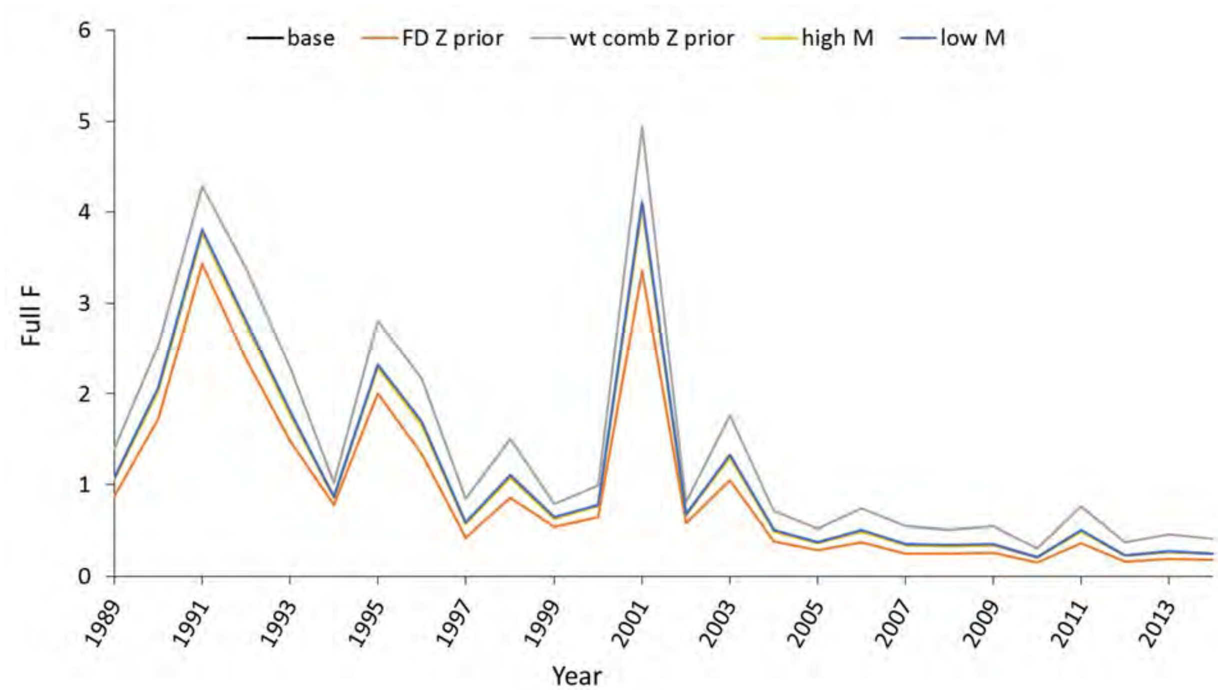

Figure 112. **Full fishing mortality estimates for spot from the base modified-CSA model and sensitivity configurations focusing on assumptions about mortality (see Table 95 for description of sensitivity configurations).**

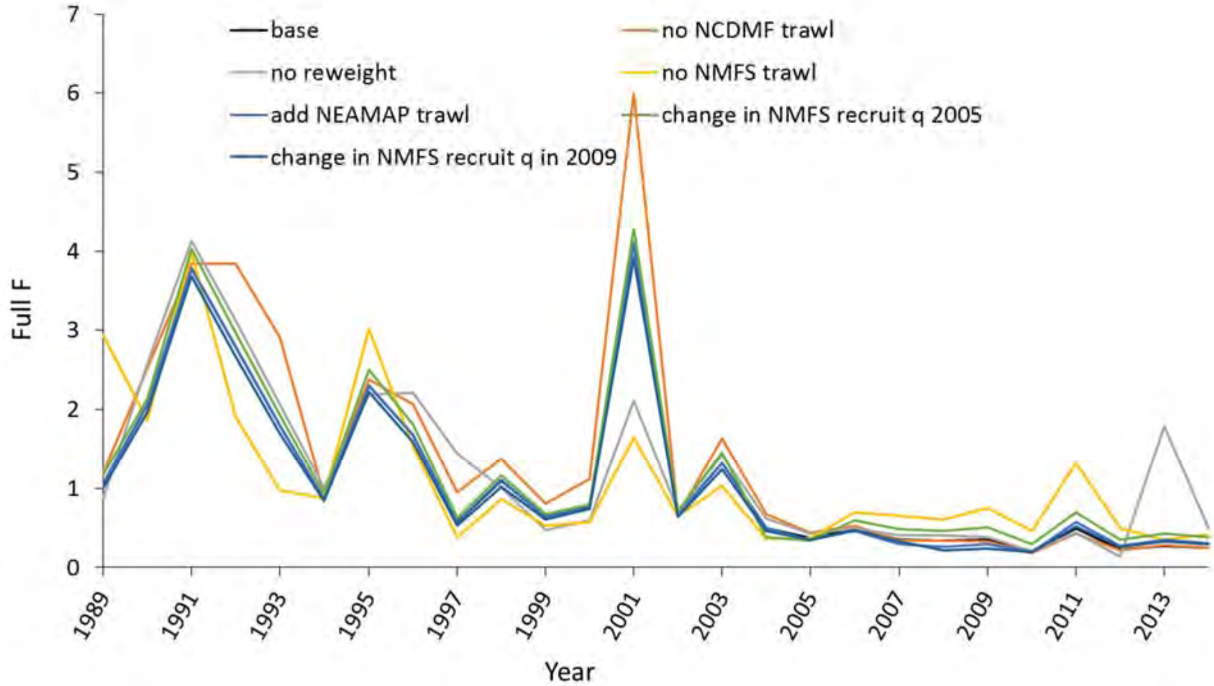

Figure 113. **Full fishing mortality estimates for spot from the base modified-CSA model and sensitivity configurations focusing on choices and treatment of index data (see Table 95 for description of sensitivity configurations).**

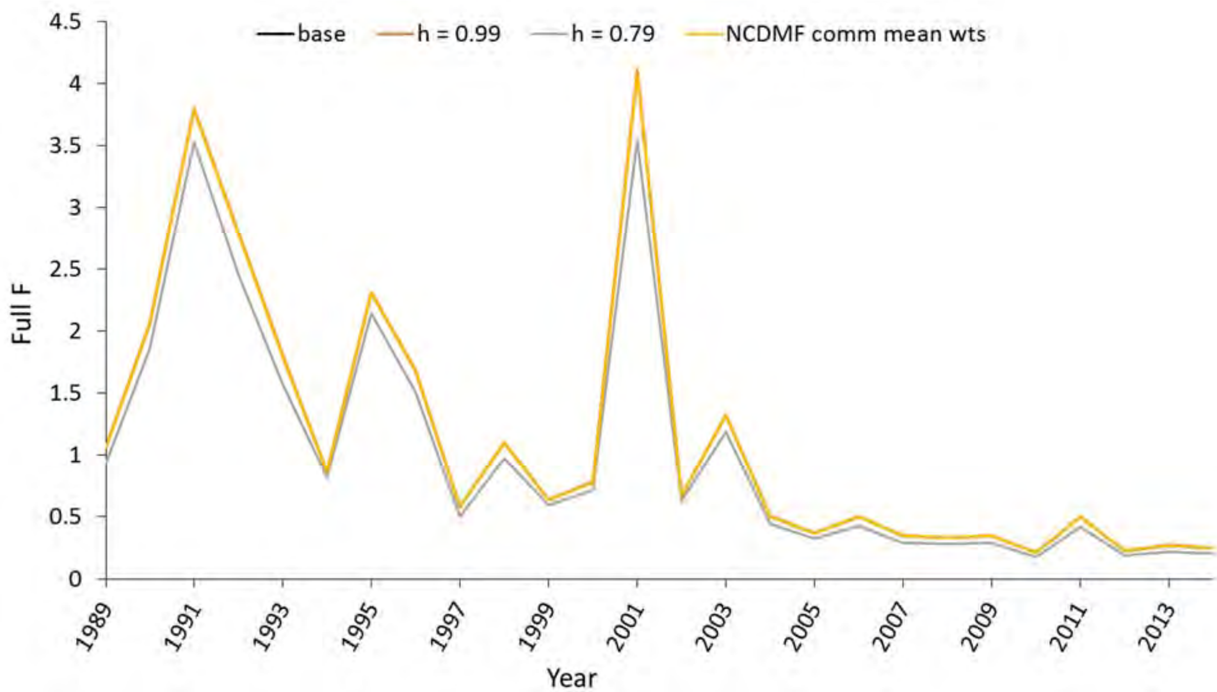

Figure 114. **Full fishing mortality estimates for spot from the base modified-CSA model and sensitivity configurations focusing on aspects relating to the stock-recruit relationship (see Table 95 for description of sensitivity configurations).**

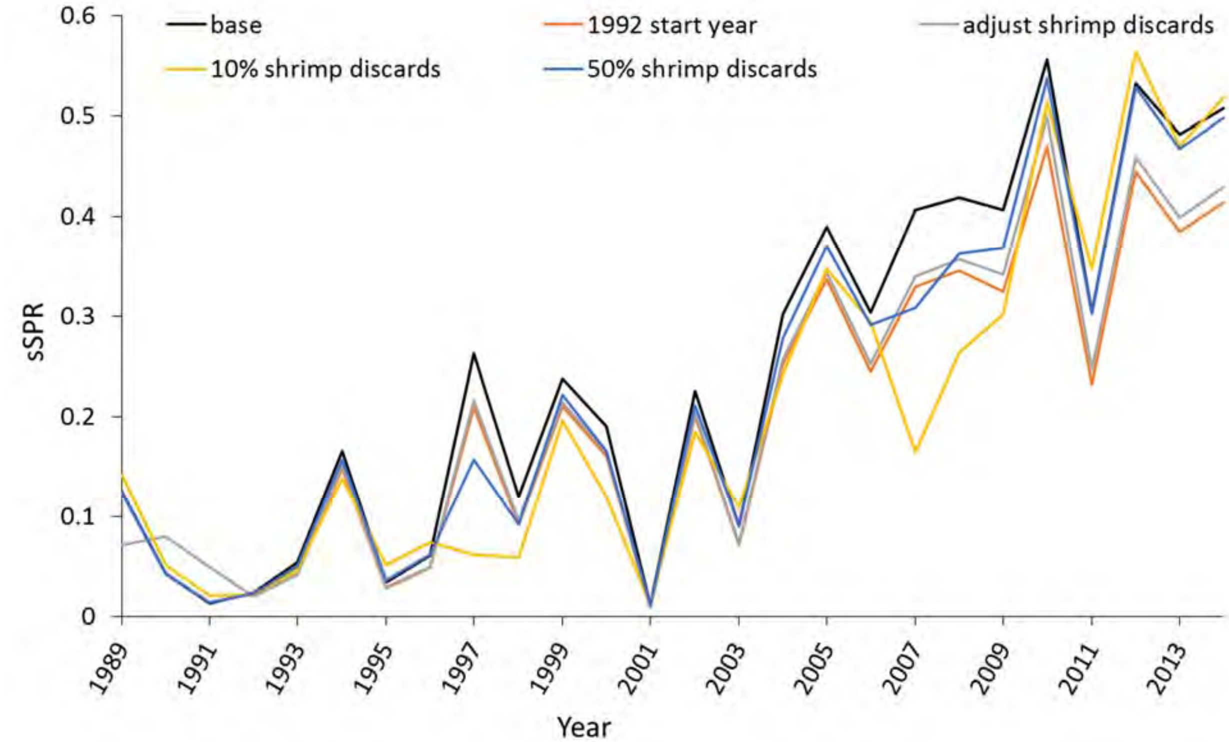

Figure 115. **Static spawning potential ratio estimates for spot from the base modified-CSA model and sensitivity configurations focusing on shrimp trawl discard estimates (see Table 95 for description of sensitivity configurations).**

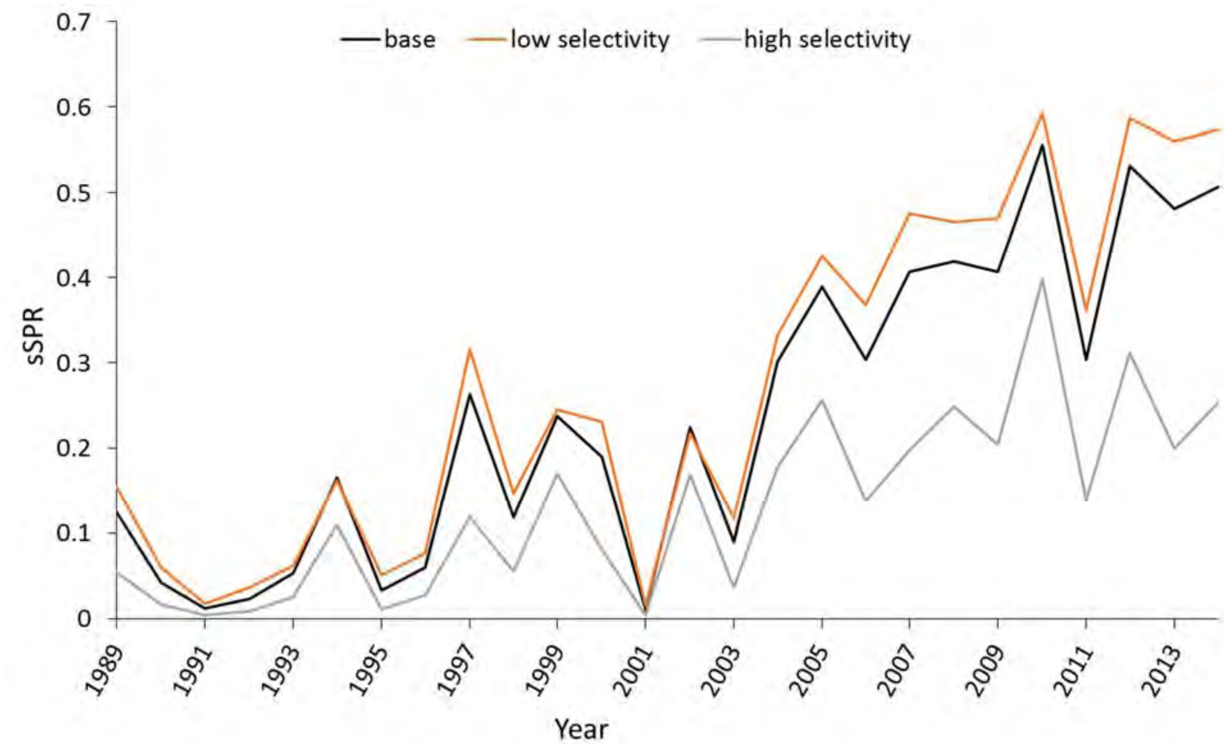

Figure 116. **Static spawning potential ratio estimates for spot from the base modified-CSA model and sensitivity configurations focusing on recruit selectivity assumptions (see Table 95 for description of sensitivity configurations).**

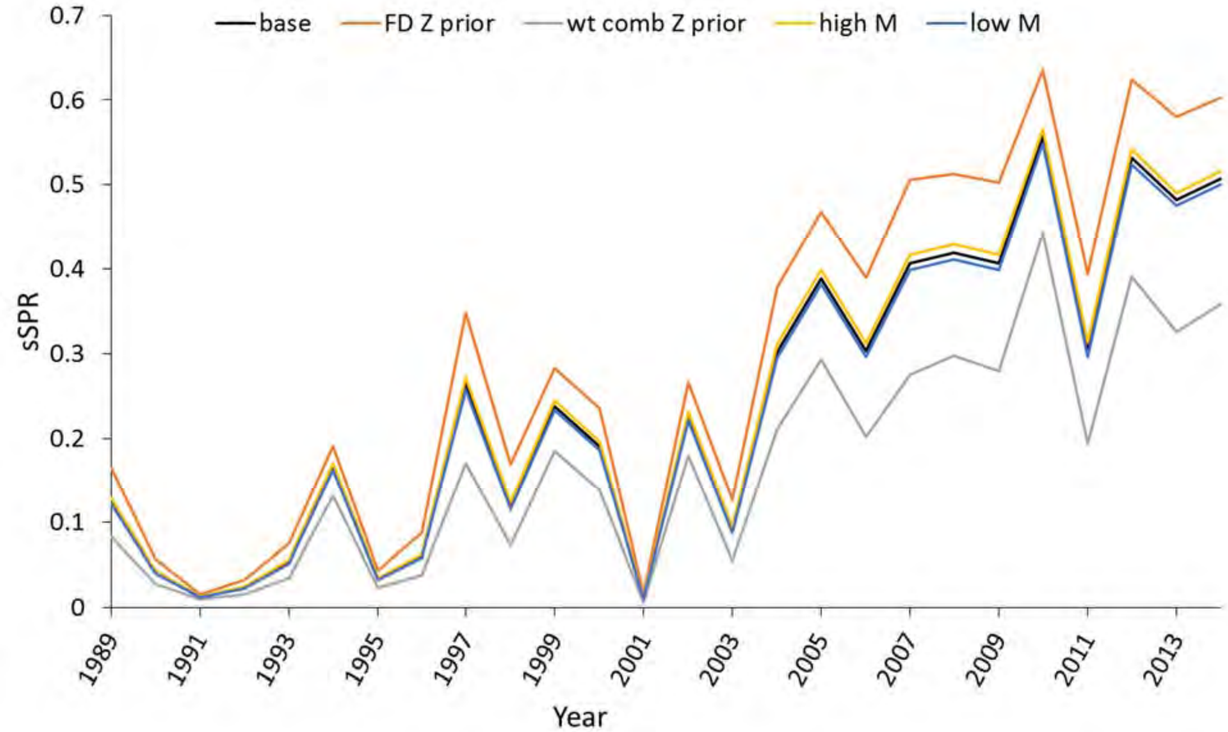

Figure 117. **Static spawning potential ratio estimates for spot from the base modified-CSA model and sensitivity configurations focusing on assumptions about mortality (see Table 95 for description of sensitivity configurations).**

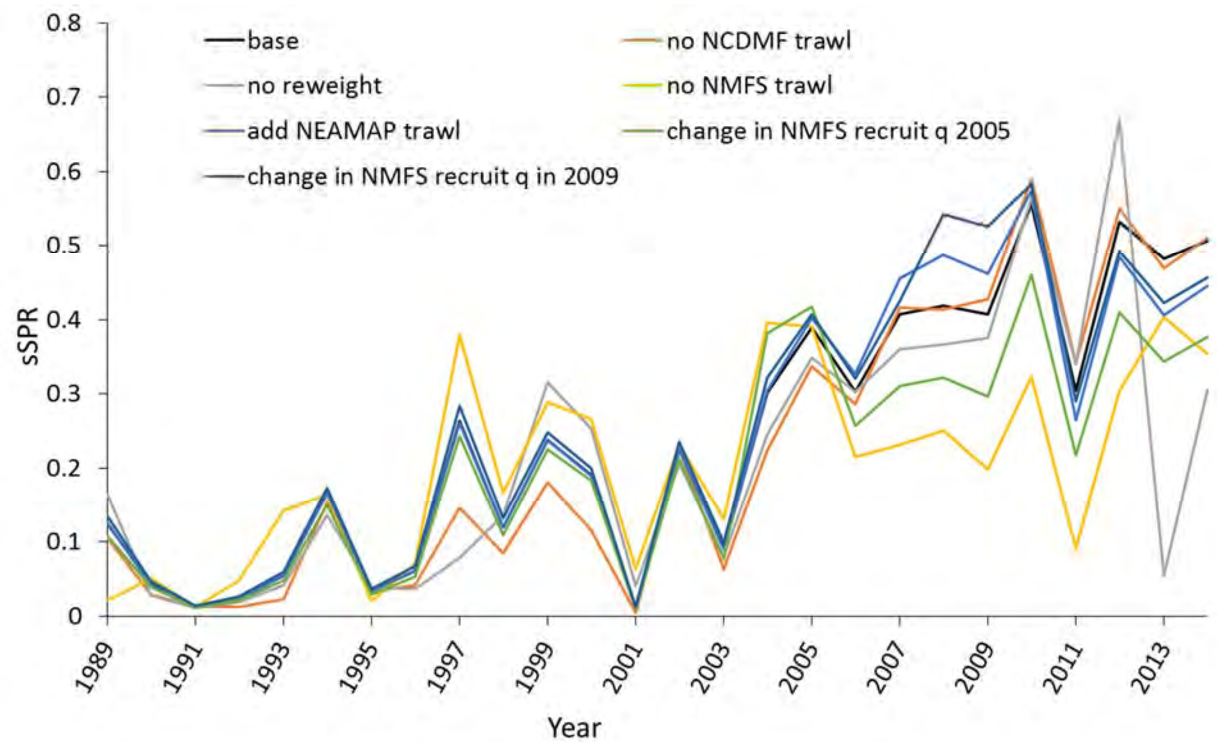

Figure 118. **Static spawning potential ratio estimates for spot from the base modified-CSA model and sensitivity configurations focusing on choices and treatment of index data (see Table 95 for description of sensitivity configurations).**

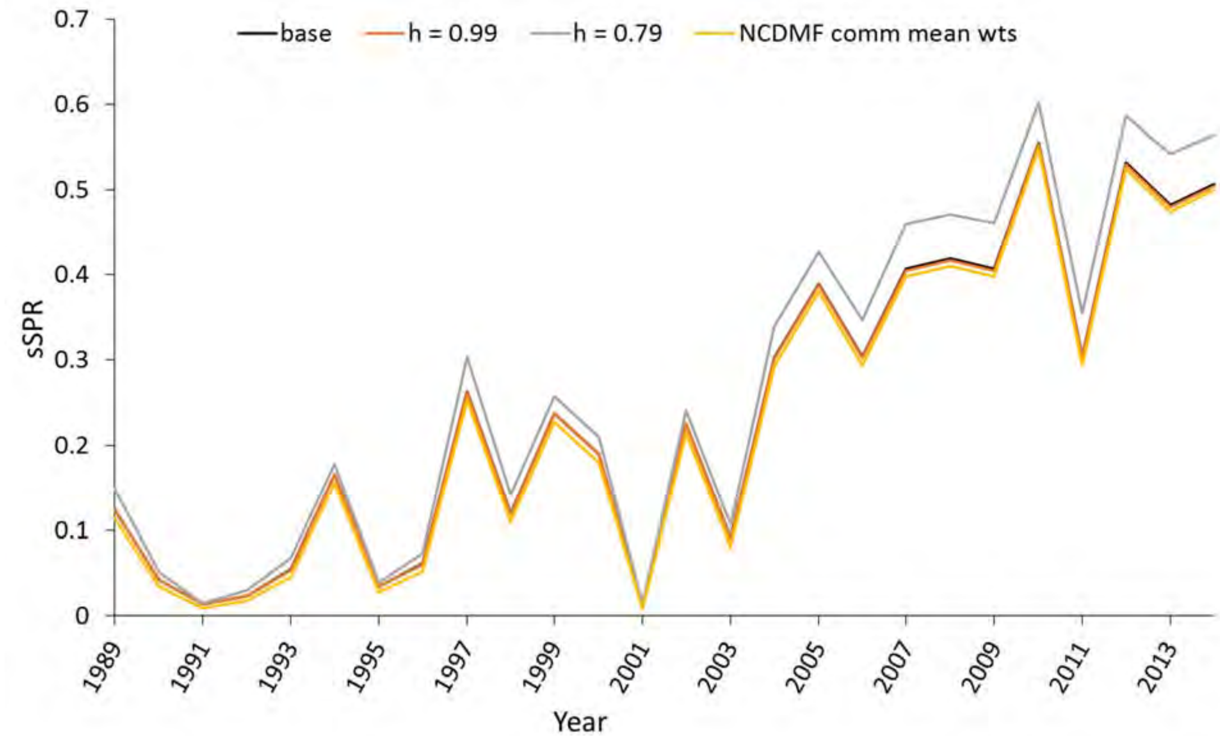

Figure 119. **Static spawning potential ratio estimates for spot from the base modified-CSA model and sensitivity configurations focusing on aspects relating to the stock-recruit relationship (see Table 95 for description of sensitivity configurations).**

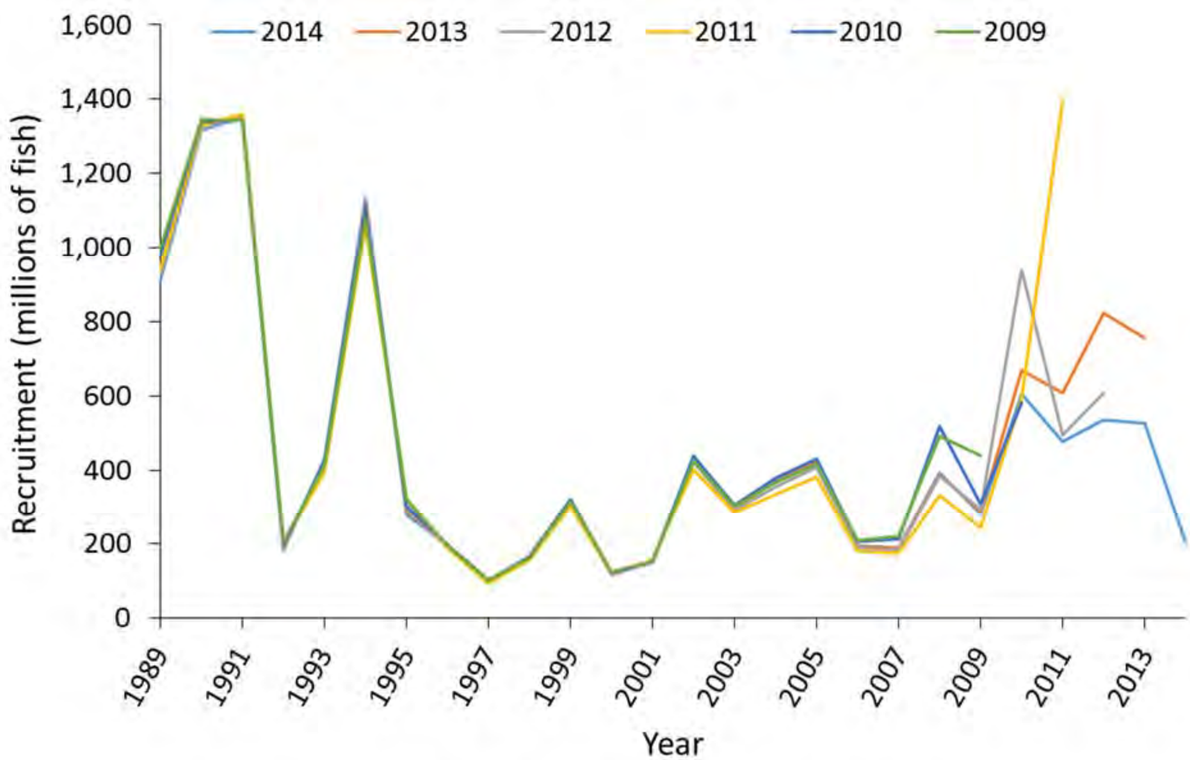

Figure 120. **Retrospective plot of recruitment estimates for spot from the base modified-CSA model (2014) and five year peel.**

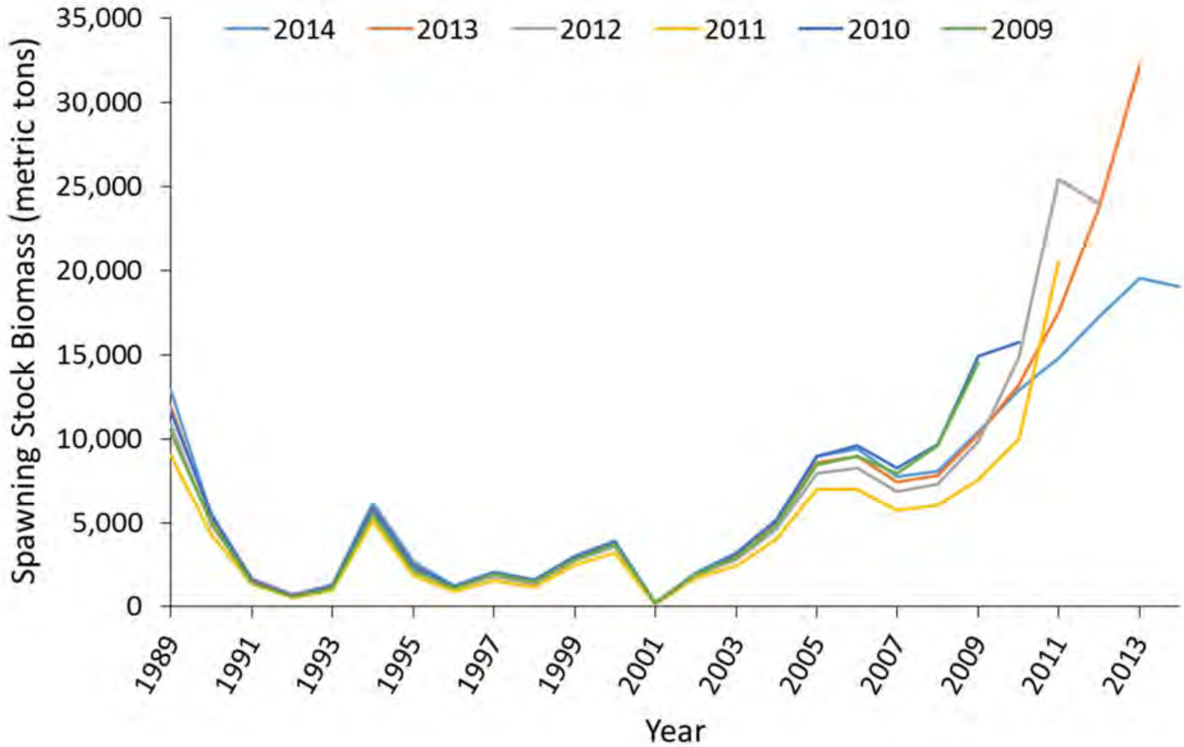

Figure 121. **Retrospective plot of end-year spawning stock biomass estimates for spot from the base modified-CSA model (2014) and five year peel.**

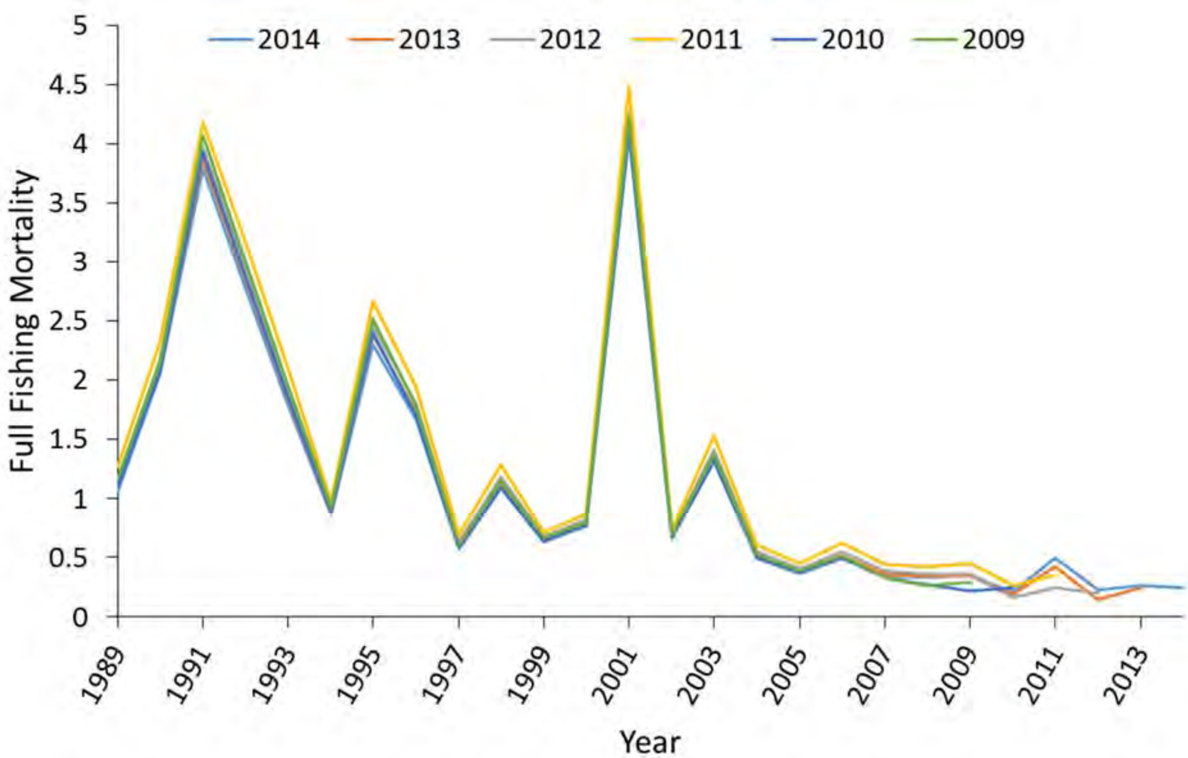

Figure 122. **Retrospective plot of full fishing mortality estimates for spot from the base modified-CSA model (2014) and five year peel.**

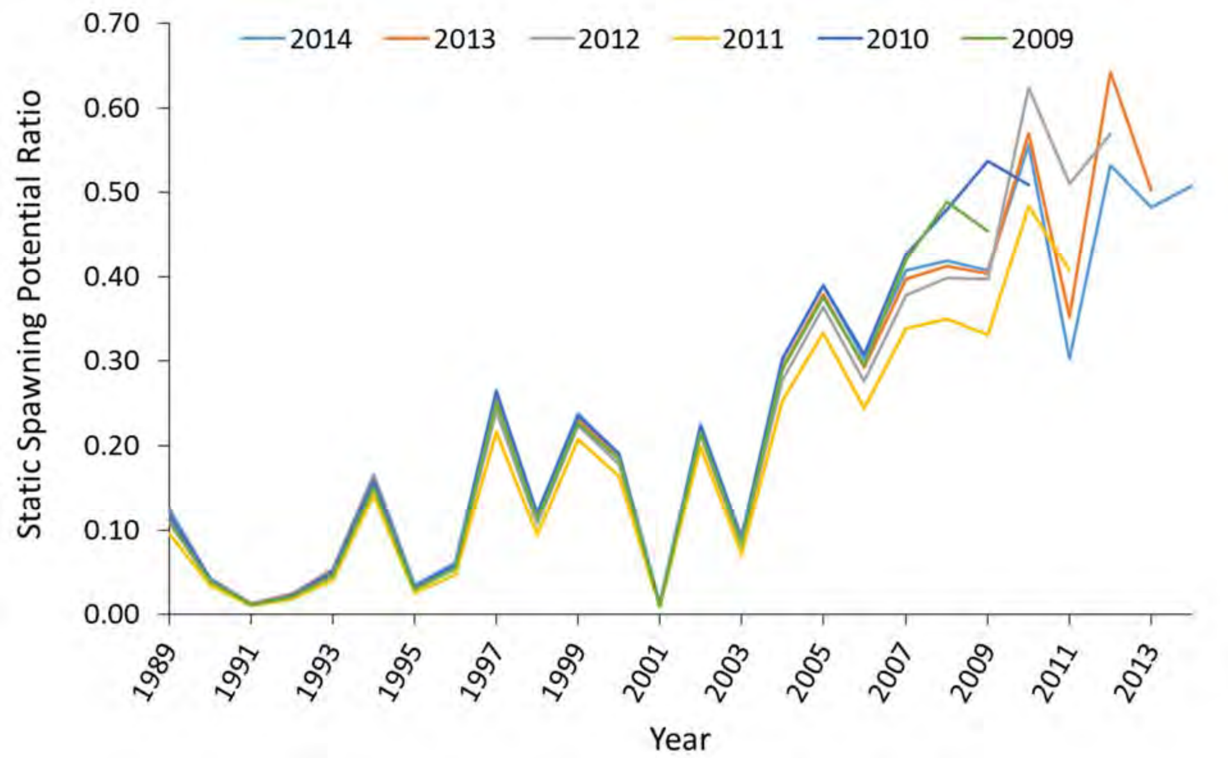

Figure 123. **Retrospective plot of static spawning potential ratio estimates for spot from the base modified-CSA model (2014) and five year peel.**

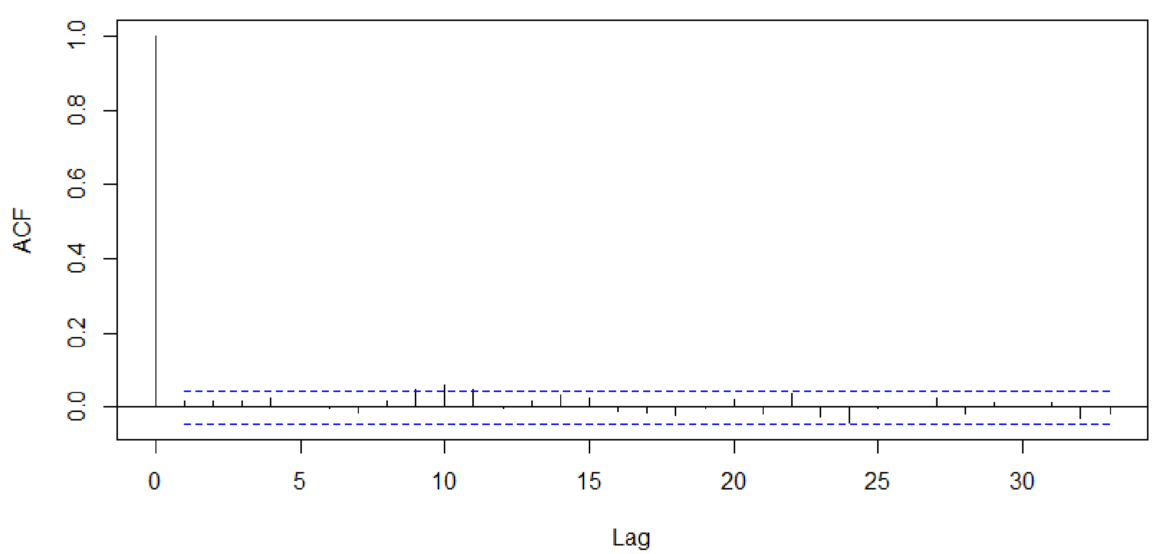

Figure 124. **Autocorrelation of MCMC samples for the initial recruitment parameter for spot from the base modified-CSA model. Two million MCMC samples were drawn with a burn-in of one thousand samples and a thinning rate of one thousand samples (final n = 2,000). Dashed blue lines are 95% confidence intervals with values exceeding these lines being statistically different than zero.**

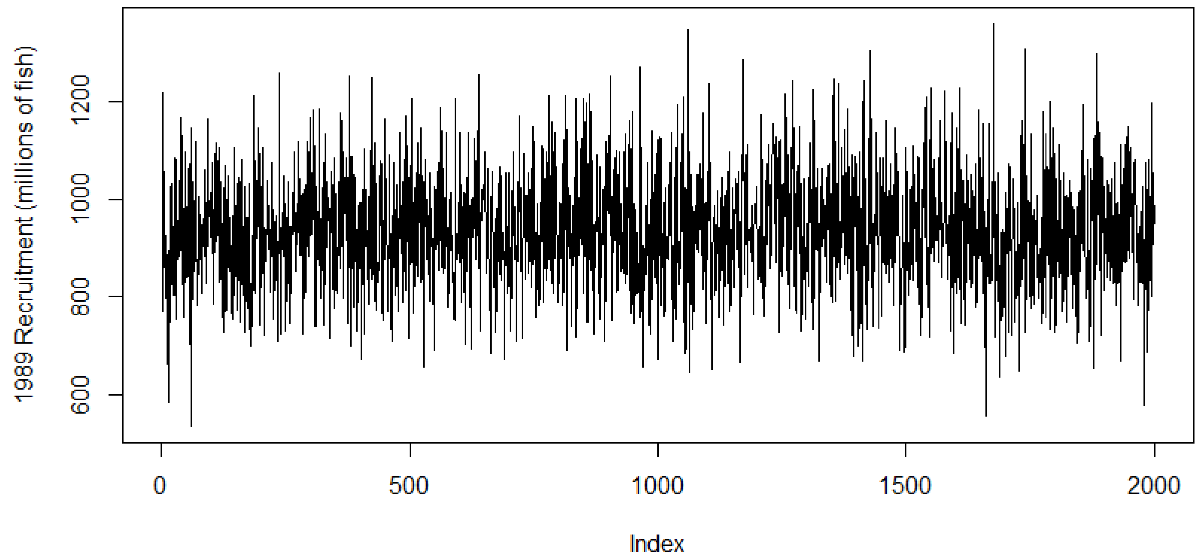

Figure 125. **Trace plot of MCMC samples for the initial recruitment parameter for spot from the base modified-CSA model. Two million MCMC samples were drawn with a burn-in of one thousand samples and a thinning rate of one thousand samples (final n = 2,000).**

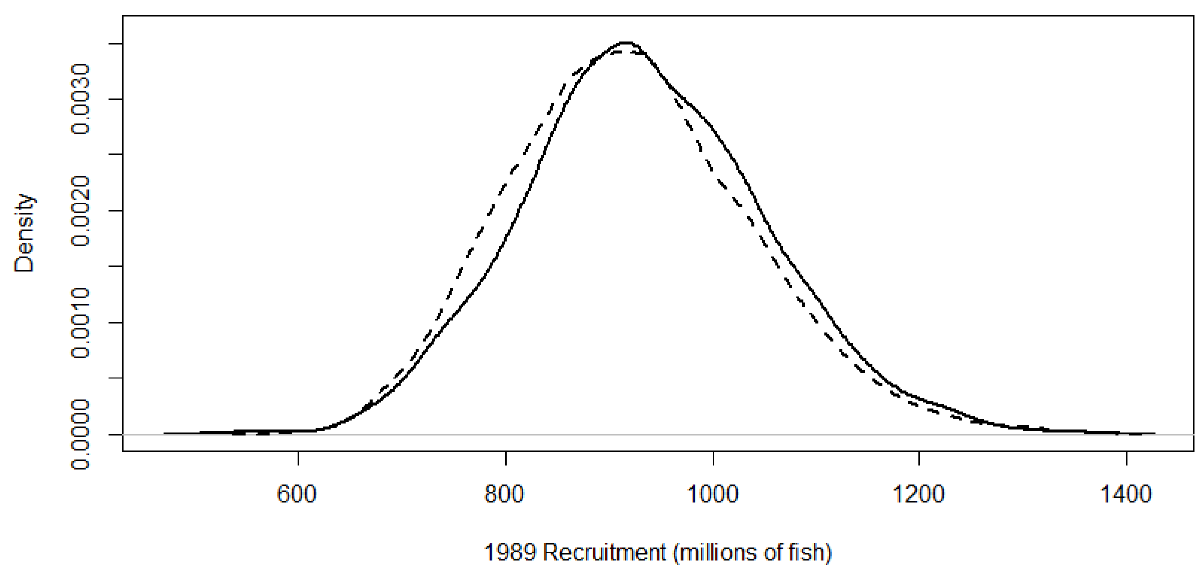

Figure 126. **Density of the base modified-CSA model initial recruitment parameter estimate for spot from MCMC draws (solid line) compared to the maximum likelihood estimate and asymptotic standard errors (dashed line). Two million MCMC samples were drawn with a burn-in of one thousand samples and a thinning rate of one thousand samples (final n = 2,000).**

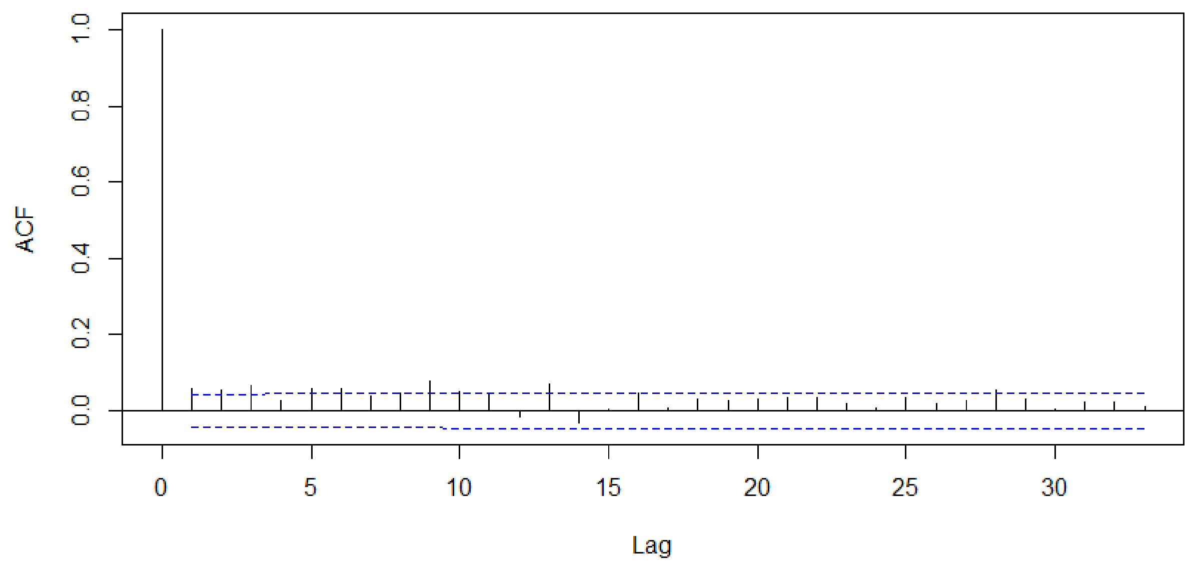

Figure 127. **Autocorrelation of MCMC samples for the initial post-recruit abundance parameter for spot from the base modified-CSA model. Two million MCMC samples were drawn with a burn-in of one thousand samples and a thinning rate of one thousand samples (final n = 2,000). Dashed blue lines are 95% confidence intervals with values exceeding these lines being statistically different than zero.**

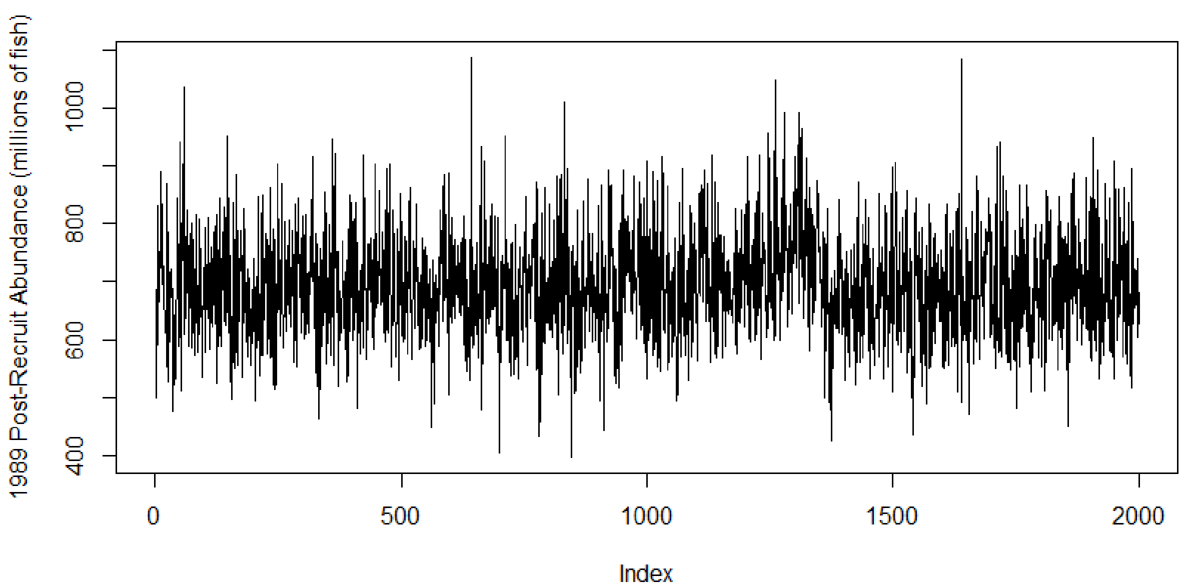

Figure 128. **Trace plot of MCMC samples for the initial post-recruit abundance parameter for spot from the base modified-CSA model. Two million MCMC samples were**

drawn with a burn-in of one thousand samples and a thinning rate of one thousand samples (final n = 2,000).

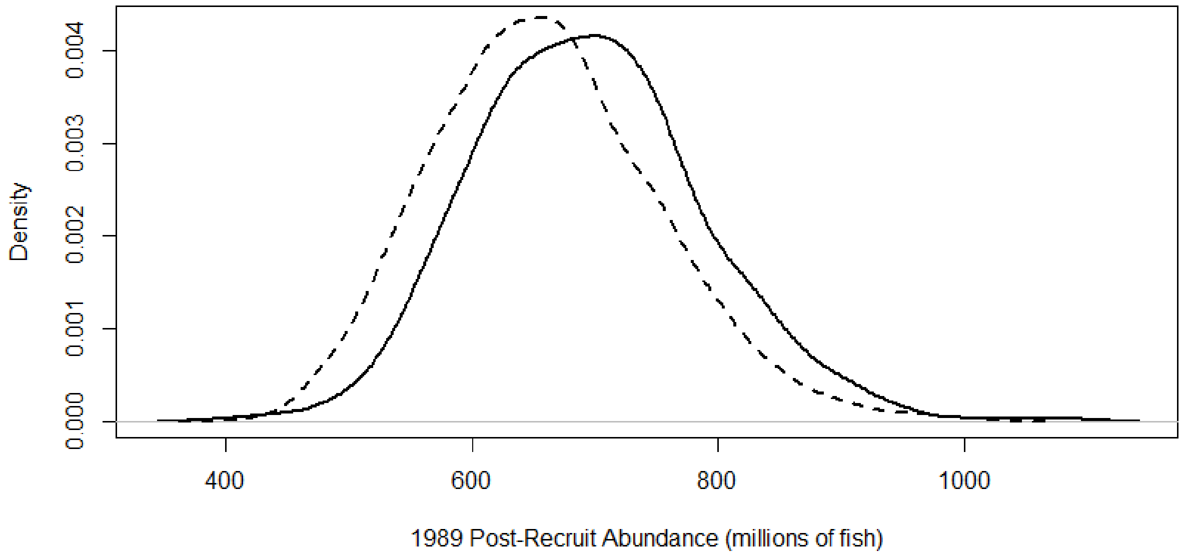

Figure 129. Density of the base modified-CSA model initial post-recruit abundance parameter estimate for spot from MCMC draws (solid line) compared to the maximum likelihood estimate and asymptotic standard errors (dashed line). Two million MCMC samples were drawn with a burn-in of one thousand samples and a thinning rate of one thousand samples (final n = 2,000).

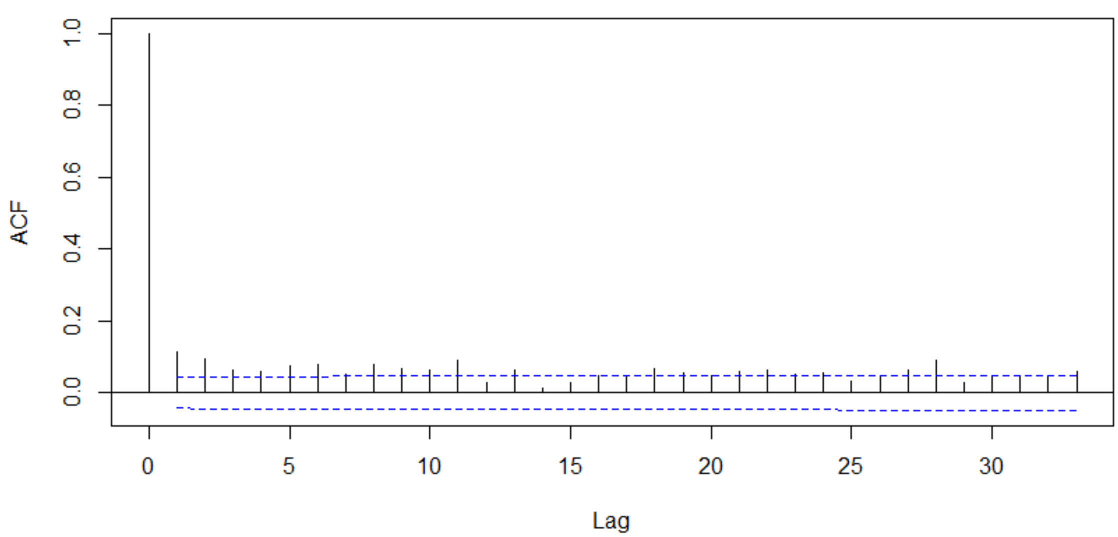

Figure 130. Autocorrelation of MCMC samples for the initial fishing mortality parameter for spot from the base modified-CSA model. Two million MCMC samples were drawn with a burn-in of one thousand samples and a thinning rate of one

thousand samples (final n = 2,000). Dashed blue lines are 95% confidence intervals with values exceeding these lines being statistically different than zero.

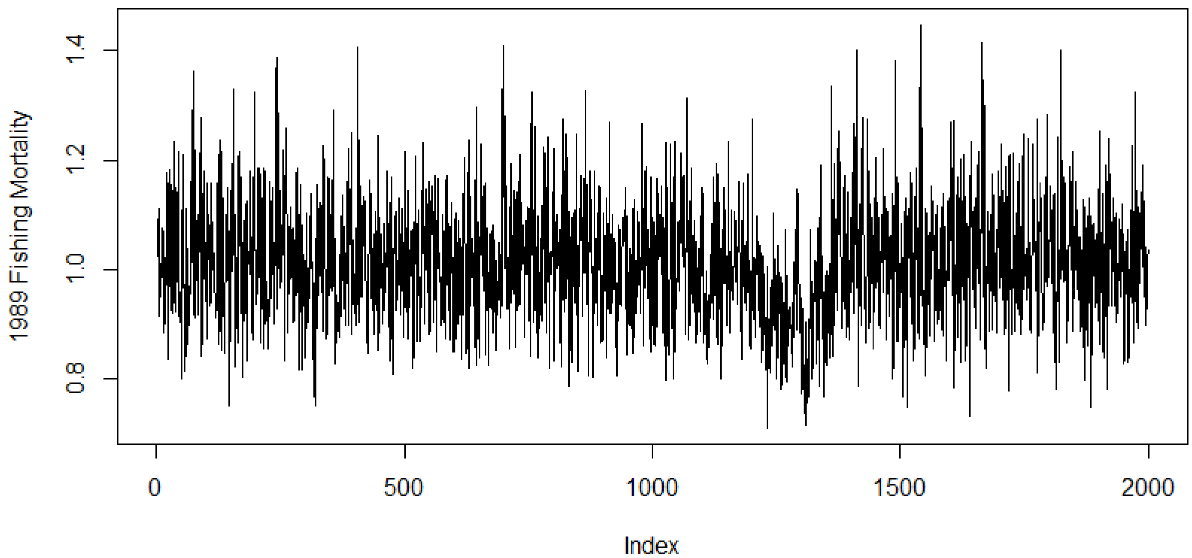

Figure 131. Trace plot of MCMC samples for the initial fishing mortality parameter for spot from the base modified-CSA model. Two million MCMC samples were drawn with a burn-in of one thousand samples and a thinning rate of one thousand samples (final n = 2,000).

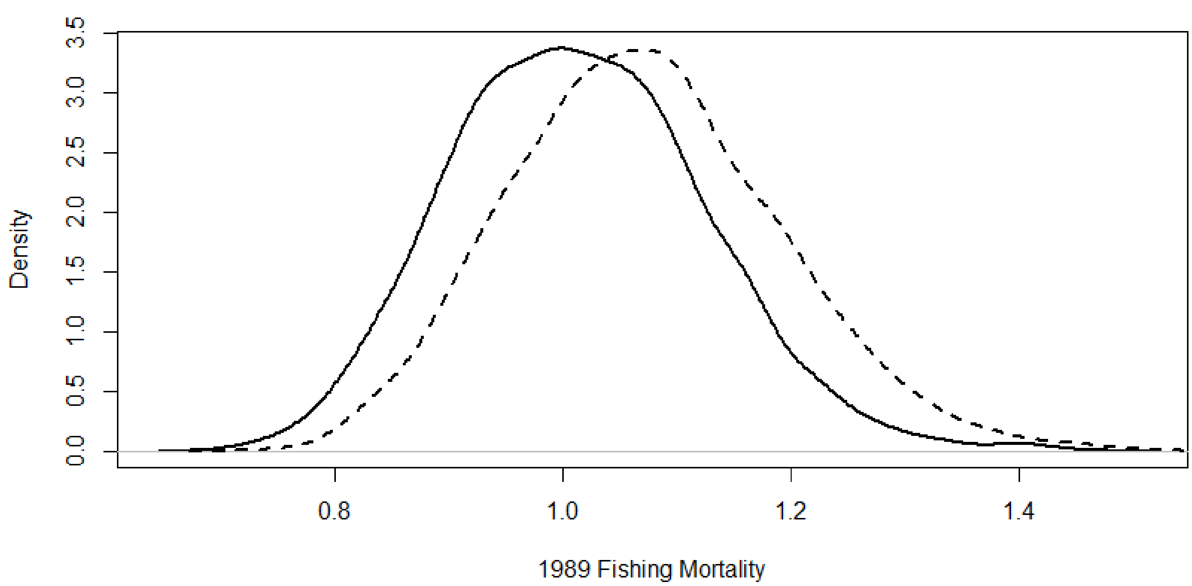

Figure 132. Density of the base modified-CSA model initial fishing mortality parameter estimate for spot from MCMC draws (solid line) compared to the maximum likelihood estimate and asymptotic standard errors (dashed line). Two million MCMC samples were drawn with a burn-in of one thousand samples and a thinning rate of one thousand samples (final n = 2,000).

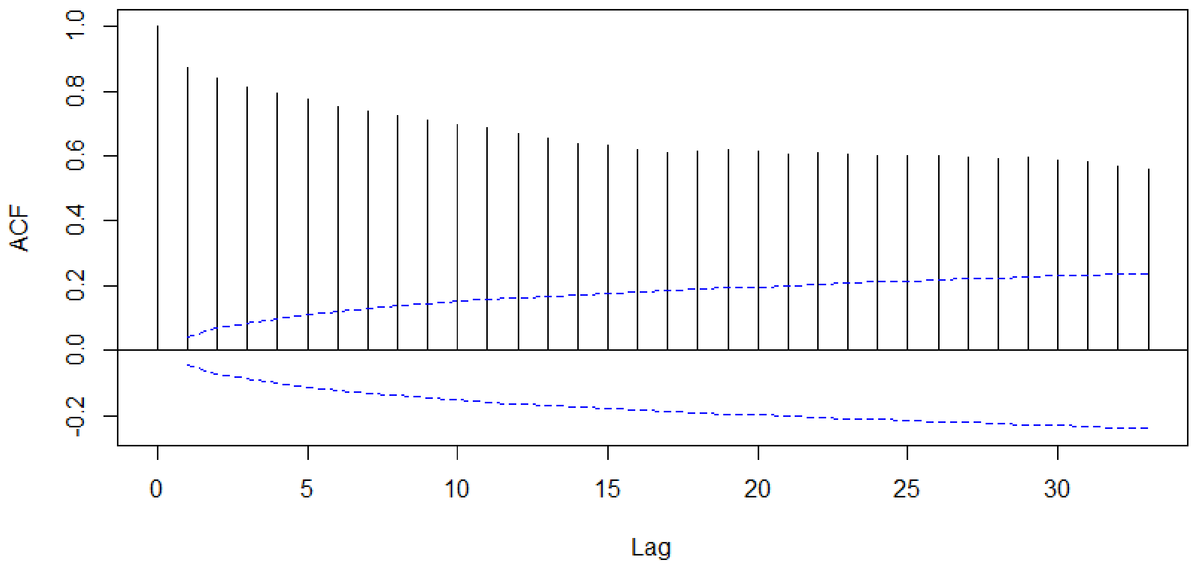

Figure 133. Autocorrelation of MCMC samples for the unfished spawning stock biomass parameter for spot from the base modified-CSA model. Two million MCMC samples were drawn with a burn-in of one thousand samples and a thinning rate of one thousand samples (final n = 2,000). Dashed blue lines are 95% confidence intervals with values exceeding these lines being statistically different than zero.

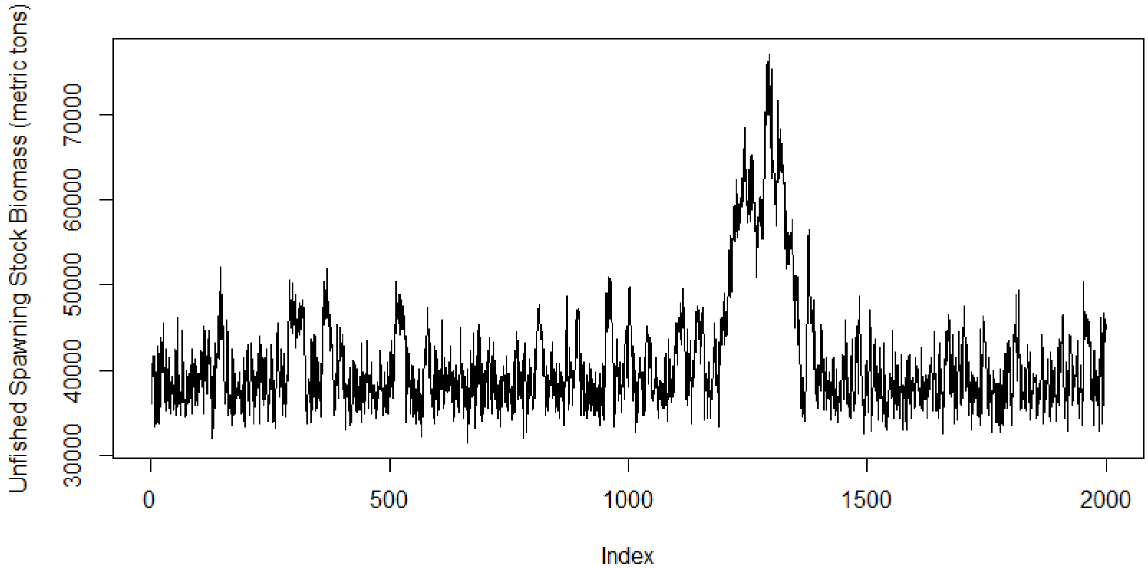

Figure 134. **Trace plot of MCMC samples for the unfished spawning stock biomass parameter for spot from the base modified-CSA model. Two million MCMC samples were drawn with a burn-in of one thousand samples and a thinning rate of one thousand samples (final n = 2,000).**

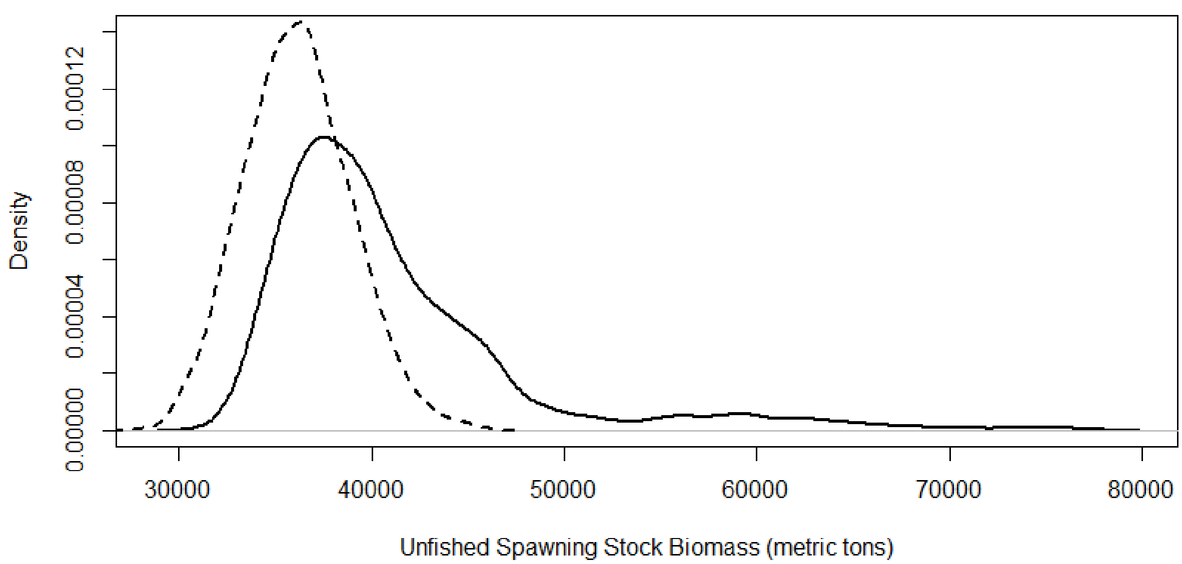

Figure 135. **Density of the base modified-CSA model unfished spawning stock biomass parameter estimate for spot from MCMC draws (solid line) compared to the maximum likelihood estimate and asymptotic standard errors (dashed line). Two million MCMC samples were drawn with a burn-in of one thousand samples and a thinning rate of one thousand samples (final n = 2,000).**

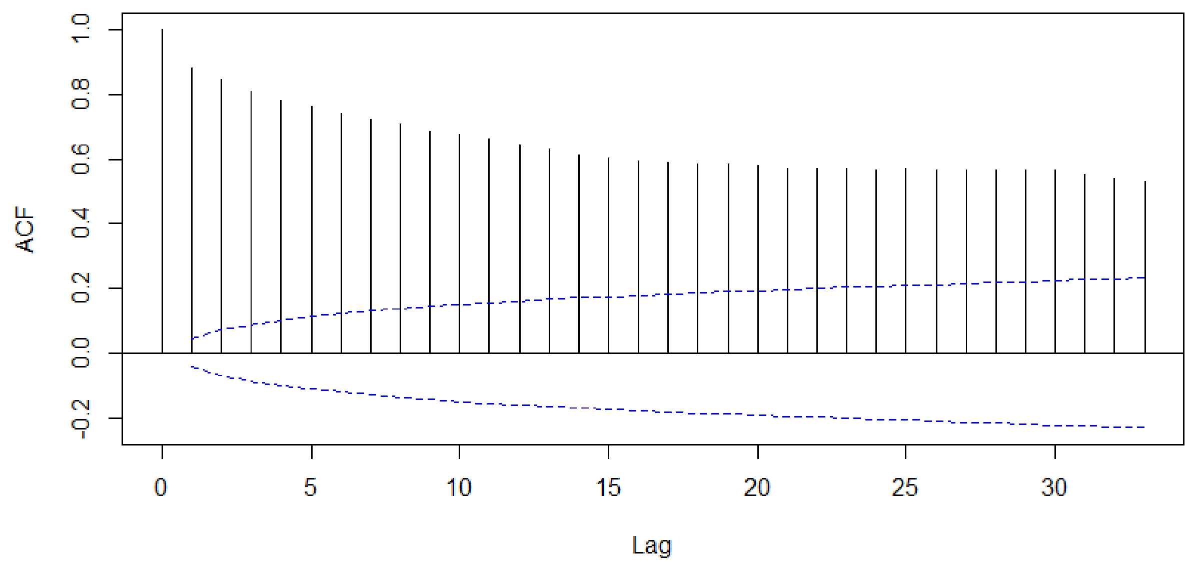

Figure 136. **Autocorrelation of MCMC samples for the steepness parameter for spot from the base modified-CSA model. Two million MCMC samples were drawn with a burn-in of one thousand samples and a thinning rate of one thousand samples (final n = 2,000). Dashed blue lines are 95% confidence intervals with values exceeding these lines being statistically different than zero.**

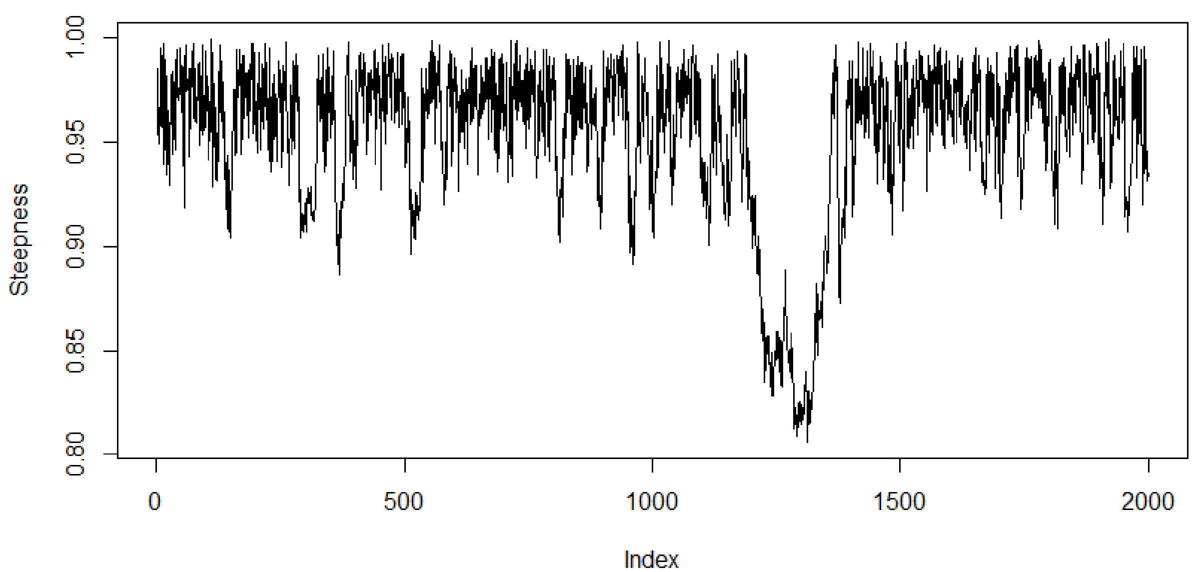

Figure 137. **Trace plot of MCMC samples for the steepness parameter for spot from the base modified-CSA model. Two million MCMC samples were drawn with a burn-in of one thousand samples and a thinning rate of one thousand samples (final n = 2,000).**

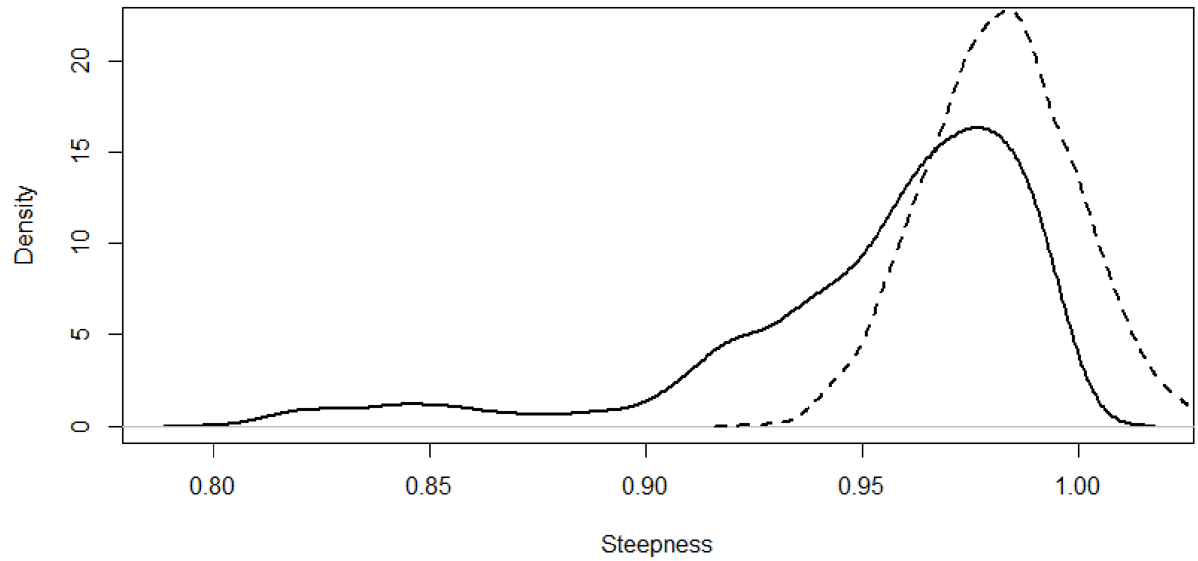

Figure 138. **Density of the base modified-CSA model steepness parameter estimate for spot from MCMC draws (solid line) compared to the maximum likelihood estimate and asymptotic standard errors (dashed line). Two million MCMC samples were drawn with a burn-in of one thousand samples and a thinning rate of one thousand samples (final n = 2,000).**

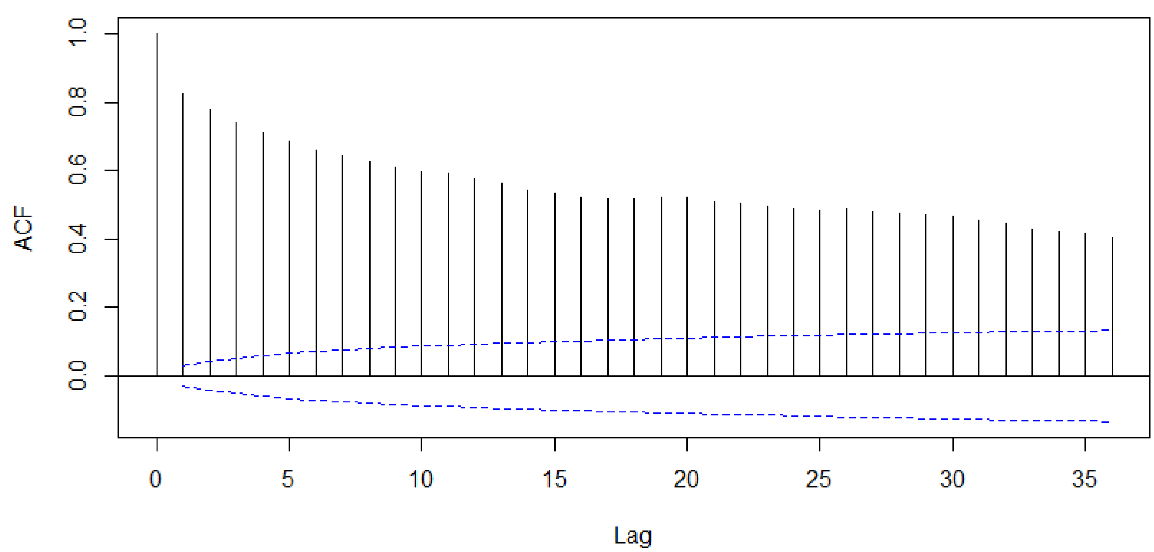

Figure 139. **Autocorrelation of MCMC samples for the unfished spawning stock biomass parameter for spot from the base modified-CSA model. Five million MCMC samples were drawn with a burn-in of one thousand samples and a thinning rate of one thousand samples (final n = 5,000). Dashed blue lines are 95%**

confidence intervals with values exceeding these lines being statistically different than zero.

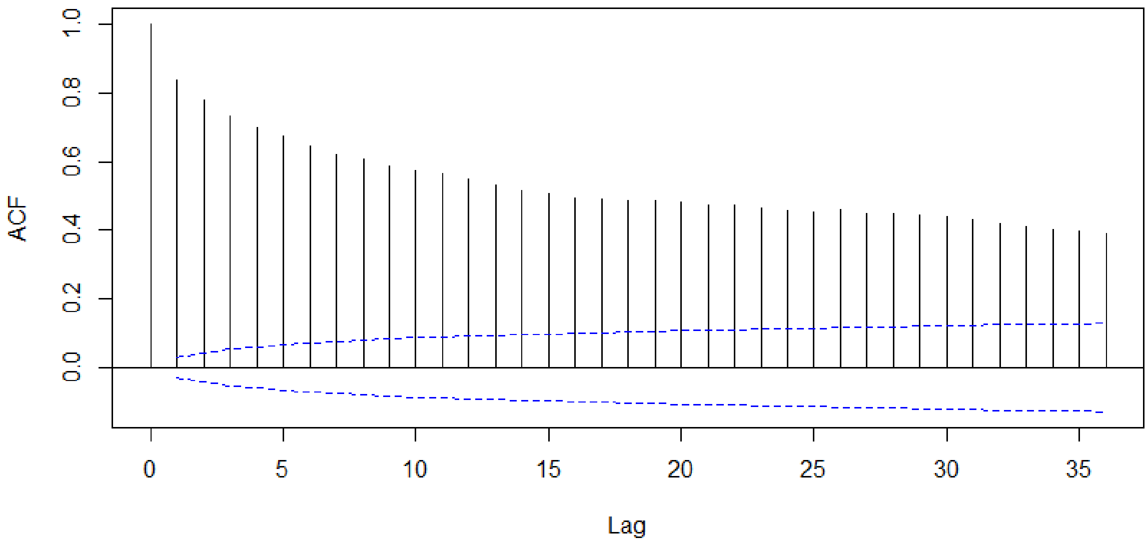

Figure 140. Autocorrelation of MCMC samples for the steepness parameter for spot from the base modified-CSA model. Five million MCMC samples were drawn with a burn-in of one thousand samples and a thinning rate of one thousand samples (final n = 5,000). Dashed blue lines are 95% confidence intervals with values exceeding these lines being statistically different than zero.

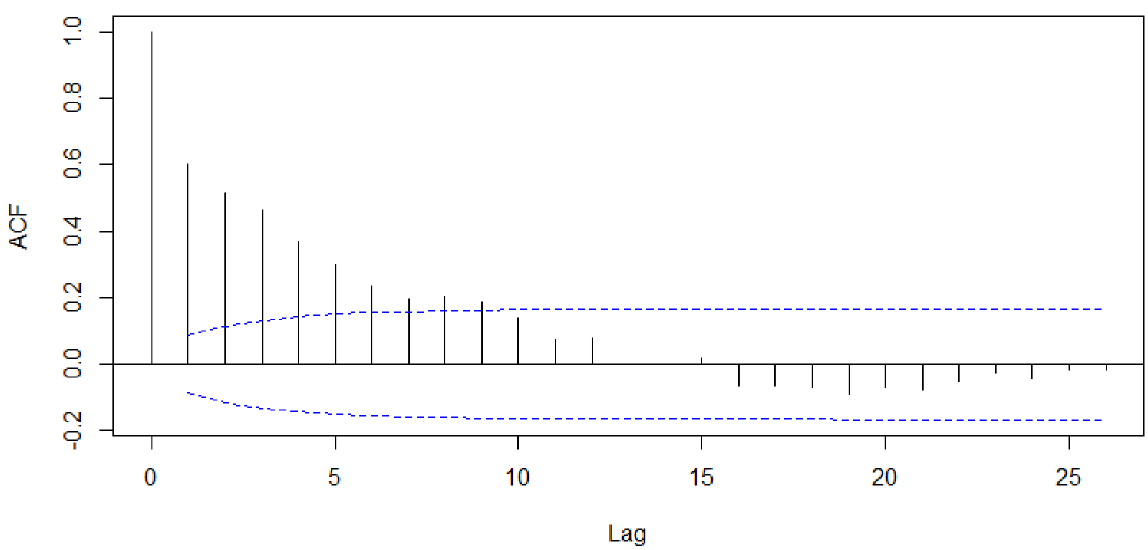

Figure 141. Autocorrelation of MCMC samples for the unfished spawning stock biomass parameter for spot from the base modified-CSA model. Five million MCMC samples were drawn with a burn-in of one thousand samples and a thinning

rate of ten thousand samples (final n = 500). Dashed blue lines are 95% confidence intervals with values exceeding these lines being statistically different than zero.

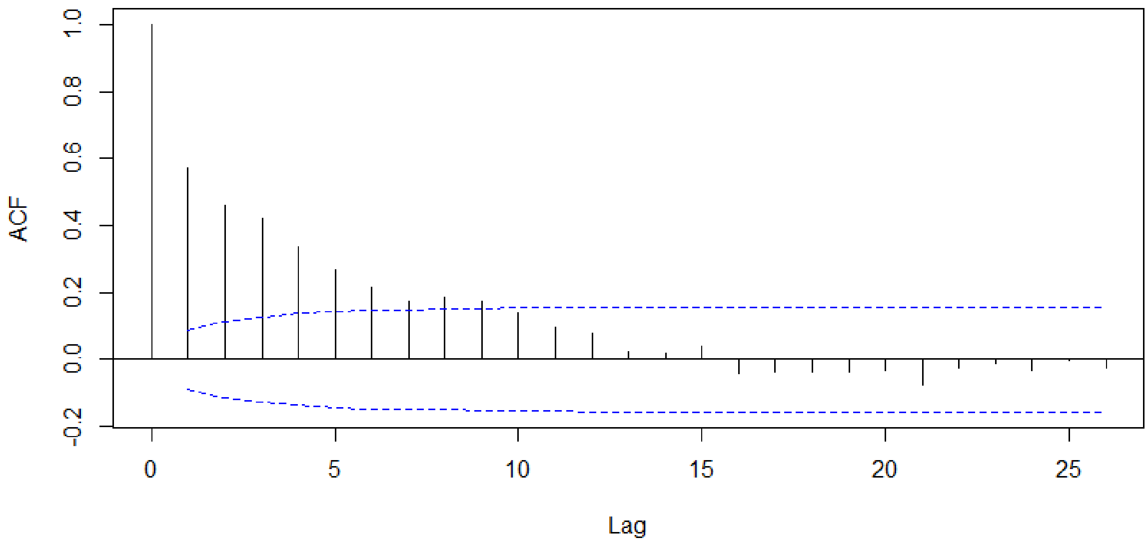

Figure 142. **Autocorrelation of MCMC samples for the steepness parameter for spot from the base modified-CSA model. Five million MCMC samples were drawn with a burn-in of one thousand samples and a thinning rate of ten thousand samples (final n = 500). Dashed blue lines are 95% confidence intervals with values exceeding these lines being statistically different than zero.**

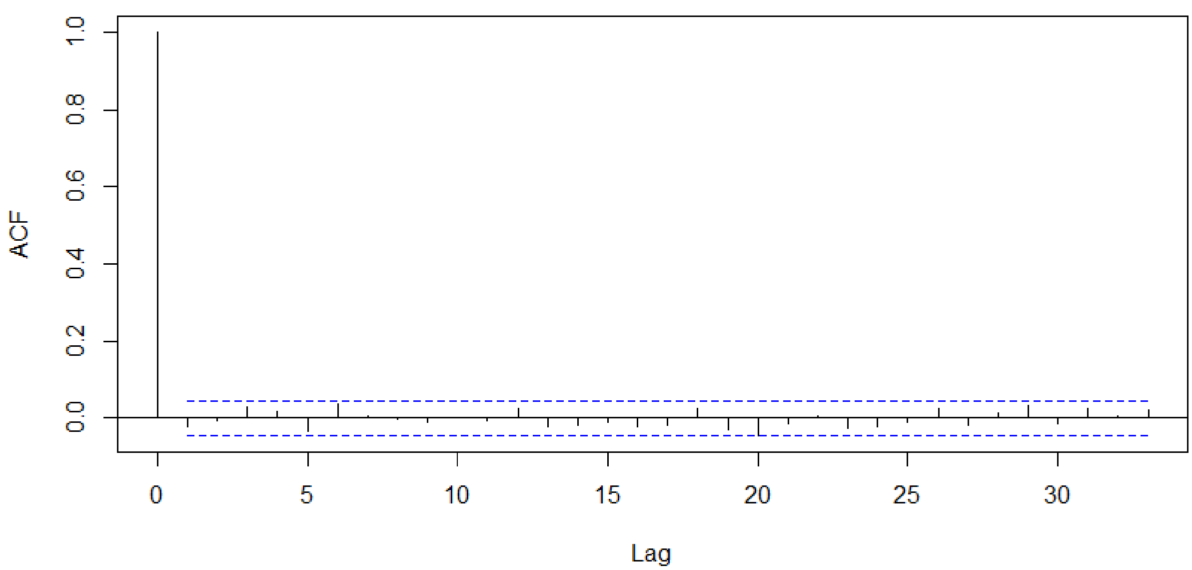

Figure 143. Autocorrelation of MCMC samples for the unfished spawning stock biomass parameter for spot from the modified-CSA model with the steepness parameter fixed at 0.99. Five million MCMC samples were drawn with a burn-in of one thousand samples and a thinning rate of ten thousand samples (final n = 500). Dashed blue lines are 95% confidence intervals with values exceeding these lines being statistically different than zero.

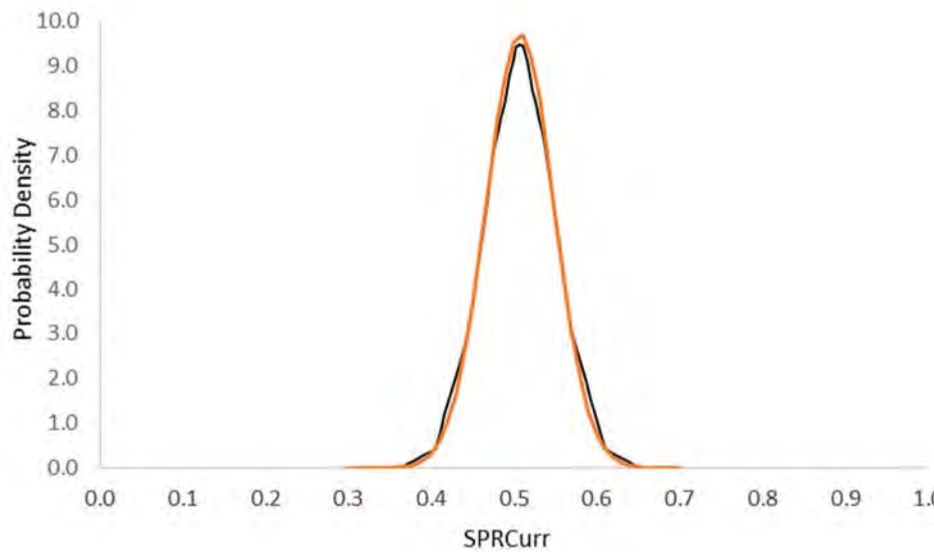

Figure 144. Likelihood profile of terminal year (2014) static spawning potential ratio estimate for spot from the base modified-CSA model.

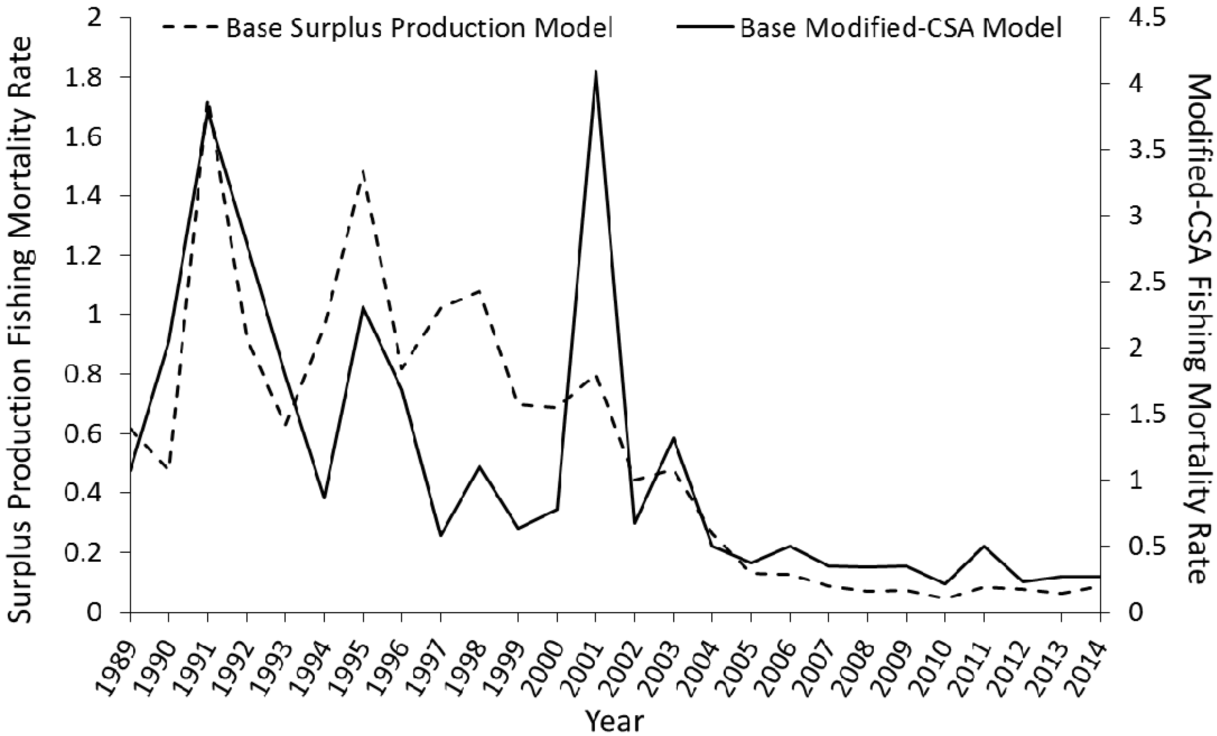

Figure 145. **Fishing mortality estimates for spot from the base surplus production model and modified-CSA model.**

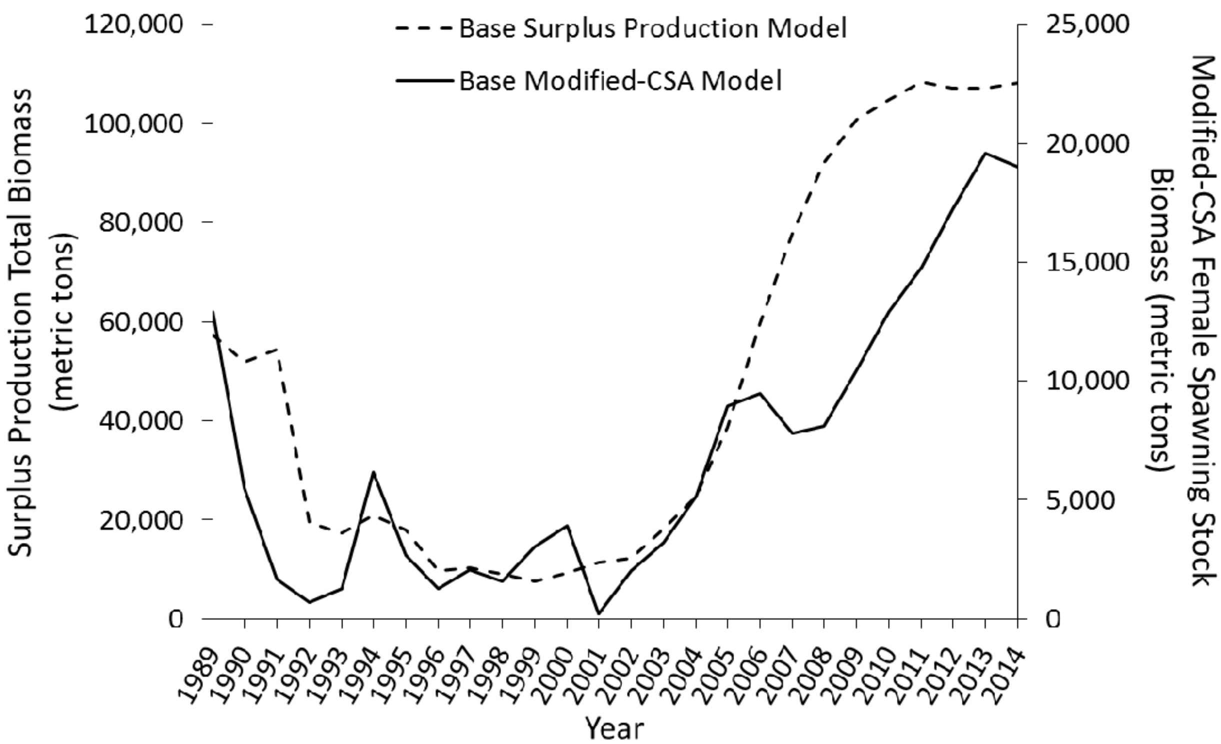

Figure 146. **Total biomass (metric tons) and end-year spawning stock biomass (metric tons) estimates for spot from the base surplus production model and base modified-CSA model, respectively.**

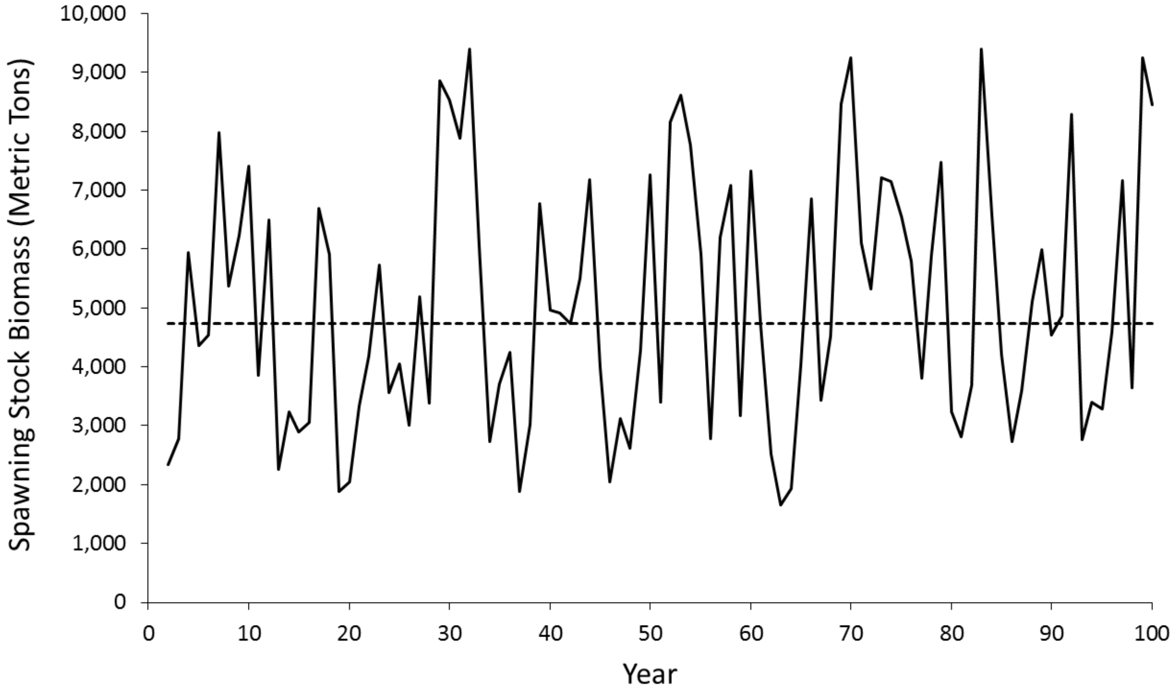

Figure 147. **Projected end-year spawning stock biomass estimates (solid black line) for threshold spawning stock biomass estimate. The median (dashed black line; 4,730 metric tons) estimate is the point estimate for the spawning stock biomass threshold.**

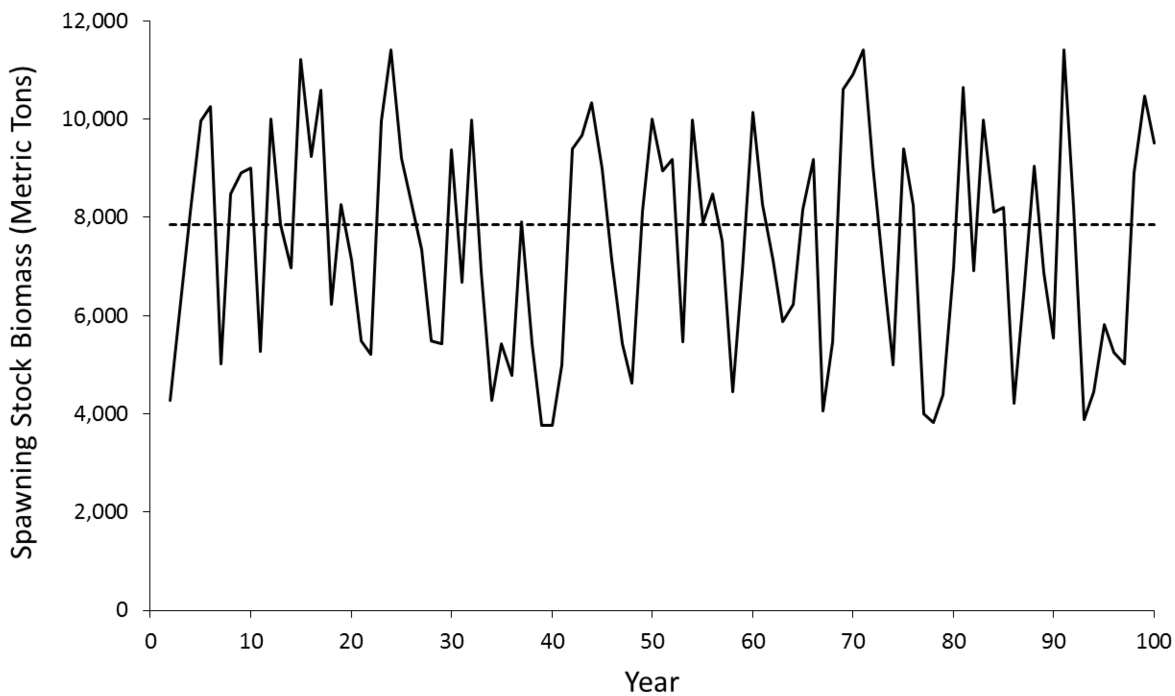

Figure 148. **Projected end-year spawning stock biomass estimates (solid black line) for target spawning stock biomass estimate. The median (dashed black line; 7,854**

metric tons) estimate is the point estimate for the spawning stock biomass target.

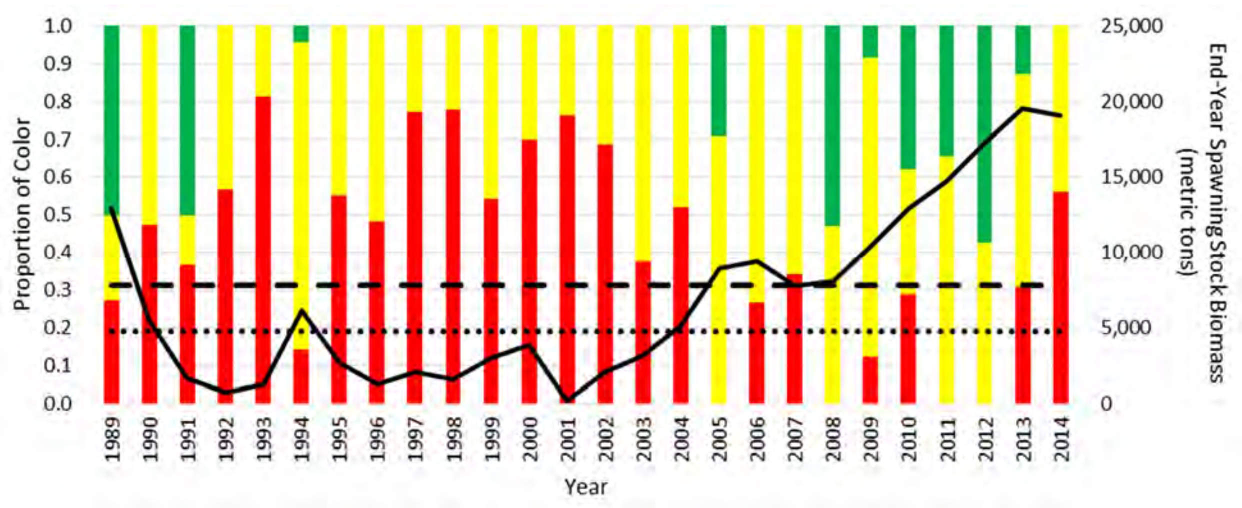

Figure 149. **Proportion colors from the spot TLA of the adult abundance metric and end-year spawning stock biomass (solid black line), spawning stock biomass threshold (dotted black line), and spawning stock biomass target (dashed black line) estimates from the base modified-CSA model.**

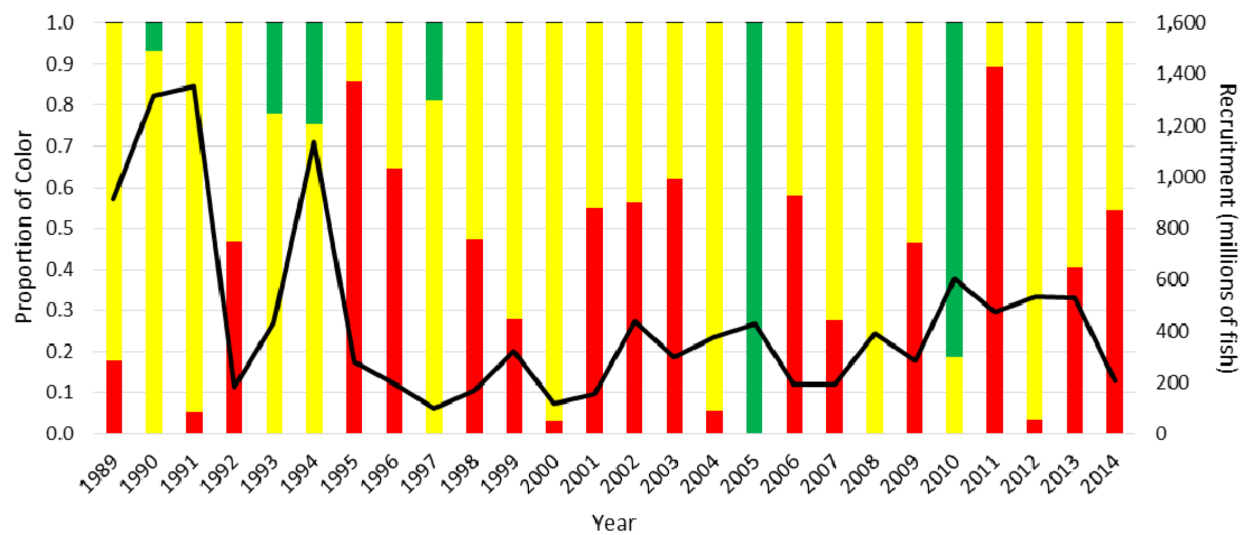

Figure 150. **Proportion colors from the spot TLA of the YOY metric and recruitment estimates (solid black line) from the base modified-CSA model.**

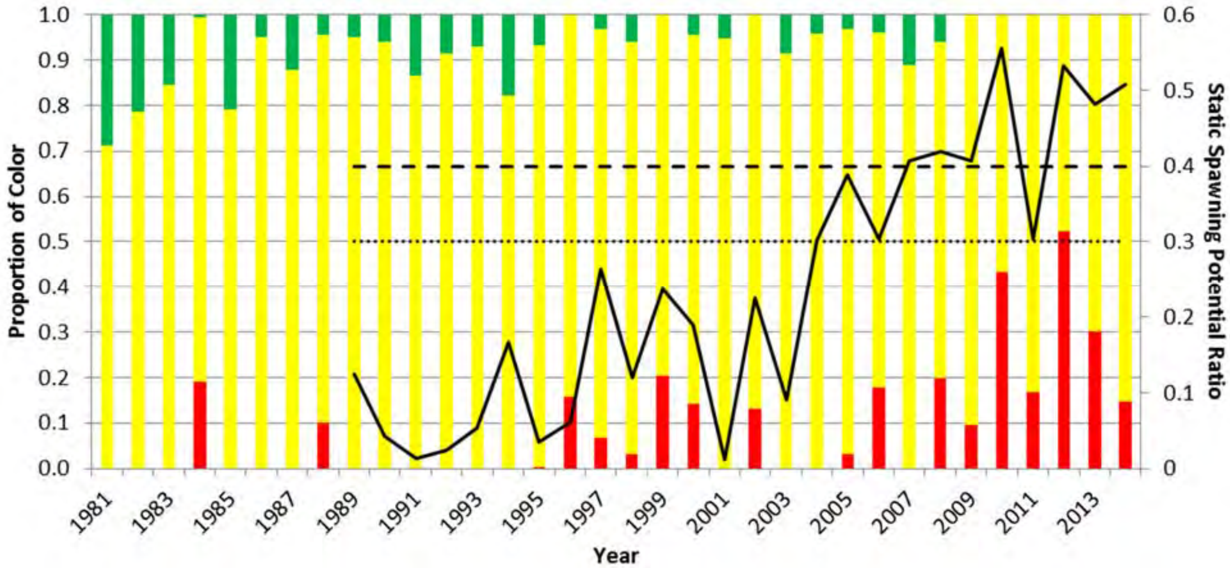

Figure 151. **Proportion colors from the spot TLA of the harvest metric, static spawning potential ratio estimates from the base modified-CSA model (solid black line), and the static spawning potential ratio threshold (dotted black line) and target (dashed black line) recommended in this assessment.**

14. Appendices

Appendix 1. Traffic Light Analysis of Spot: Alternate Model for 2017 ASMFC Stock Assessment

C. McDonough (SCDNR)

The Traffic Light method (TLA) was originally developed (Caddy and Mahon, 1995; Caddy, 1998, 1999) as a precautionary management framework for data poor fisheries whereby reference points could be developed that would allow for a reasonable level of resource management. The name comes from assigning a color (red, yellow, or green) to categorize relative levels of different indicators of the state of either a fish population or a fishery. These indicators can be combined to form composite characteristics within similar categories and can include biological indicators such as growth and reproduction, population level indicators such as abundance and stock biomass estimates, or fishery indicators such as harvest/landings and fishing mortality. However, each indicator must be evaluated separately in order to determine its appropriateness for use in a management scheme.

The purpose of developing the TLA for spot within the assessment was to allow for comparisons to be made to the assessment modelling results and determine how the two approaches would inform understanding of stock condition. It is important to note that while the TLA does provide a management guidance framework based on different index metrics, it does not provide population level parameters such as biomass (B_{msy}) spawning potential ratios (SPR) or fishing mortality (F_{msy}), so its utility for providing stock specific fishery parameters is limited. However, the ability to illustrate trends in different fishery or population parameters (abundance, landings, etc) is useful to compare to more rigorous population models such as the modified-CSA model used in the assessment.

The specific TLA model used is the fuzzy traffic light model. In the fuzzy traffic light model, we use boundary reference points to determine the relative proportion of each color that includes the buffer (yellow) zone based on the upper and lower 95% confidence intervals from the index values for either the entire data series or a pre-determined reference period (Halliday et al., 2001). In the case of this assessment we are using the 1989-2012 as the reference time period as this is the time frame of the data used for the annual management trigger exercises to determine stock status. The current assessment time period covered two more years, 1989-2014. The TLA color proportions were determined by setting the mean index value at 1.0 for yellow and 0.0 for both red and green as this is the exact center of the buffer zone. The 0.5 proportion value for all three colors is set at the mean index value minus the lower 95% confidence interval (CI) (red and left yellow leg) and the mean index value plus the upper CI (green and the right yellow leg). Finally, the value of 1.0 is set for red at the mean index value minus 2X the lower CI or zero, if the index mean minus 2X the lower CI is a negative number. For green the 1.0 value is set at 2X the upper 95% confidence limit. Once the known index values at the proportion values for each color are determined, the relative color proportions for each year can be estimated via linear regression using the annual values of the index. Any negative values are reset to zero and the proportion of yellow are set at 1 minus the color proportion for either red or green in that year. This allows a better illustration of the annual trends within a given color and whether or not values are approaching levels of concern about the reference boundaries.

Composite figures of combined indices can then be created using the color proportion tables from each individual index. These indexes are additive and the total index is re-scaled to 0-1. It is possible to add weighting factors to each index via the color proportion tables if necessary, although in practice indexes are commonly weighted prior to being run through the TLA. This type of composite index is what Halliday et al. (2001) referred to as a Characteristic, while the individual indices that make it up are the Indicators.

For the fishery dependent data there were two separate sets of indicator data. The first was harvest or landings data by weight (in metric tons) and the second was discard data, also by weight in metric tons. The landings data indicators included commercial landings, recreational harvest and scrap fishery landings (NC and VA only). In addition to the data sets used in the annual management trigger exercise, there were also discard indicator data sets that included the south Atlantic shrimp trawl fishery, commercial discards (mid-Atlantic gill net fishery and mid-Atlantic trawl fishery), and recreational discards that became available through the assessment process. These indicator data were included in this exercise to examine the effects on the TLA in relation to the modified-CSA model output. Mortality for the shrimp trawl, gill net and mid-Atlantic trawl fisheries was set at 100% as bycatch discard were typically released dead in these fisheries and there was no other available estimate of discard mortality. The recreational discard mortality was set at 15% as determined by the Stock Assessment Subcommittee at the Assessment workshop. The recreational discard index used was the estimated annual discards lost through mortality. All of the discard indices were treated as part of the total removals from the stock, along with the harvest landings.

The fishery independent indicator data included survey data from the MDDNR, NMFS, and SEAMAP. The modified-CSA model broke each of these indices into two separate components by age for age 0s and age 1+, however the TLA broke them down by adult (NMFS, SEAMAP) and juvenile (MDDNR) surveys. The reference time period (1989-2012) was the same as that used for the fishery dependent data sets. The data sets were split into the different age groups because while spot were considered fully recruited to the fishery at age 1, a certain proportion reach a large enough size each fall to enter into the fishery while still considered age 0 juveniles prior to spawning for the first time. Because of this, the TLA was run on each index for each age group as well as a combined model for all ages.

RESULTS

The majority of removals (95-99% annually) came from commercial landings, recreational harvest, and the southeast shrimp trawl discards (Fig. 1). Annual shrimp trawl discards varied widely, ranging from 22-89% of total removals with a long term mean of 52% annually for 1989-2014. Thus, trends in the TLA were largely driven by these three indices.

The harvest landings data characteristic (commercial and recreational harvest) showed a decline in landings since the mid 1990s, indicated by the increasing proportions of red through 2012 (Fig. 2). Recent years (since 2013) have shown a slight decline in red indicating an increase in harvest. Under the current management trigger guidelines for spot (ASMFC

Omnibus Amendment, 2012) the landings characteristic would not have triggered in 2014 with the three year average proportion of red being below the 30% threshold indicating moderate management concern.

The fishery discard annual total was dominated by the south Atlantic shrimp trawl fishery, accounting for ≤ 97% of all discards in any given year. Annual discards from the shrimp trawl and commercial fisheries have declined since the early 1990s, while recreational discards have been more variable annually. The discard composite characteristic reflected the decline in discards with high proportions of red in the early years and higher proportions of green in later years (indicating declining bycatch (Fig. 3). High discards in the first three years of the series (1989-1991) had red proportions in excess of the 30% threshold.

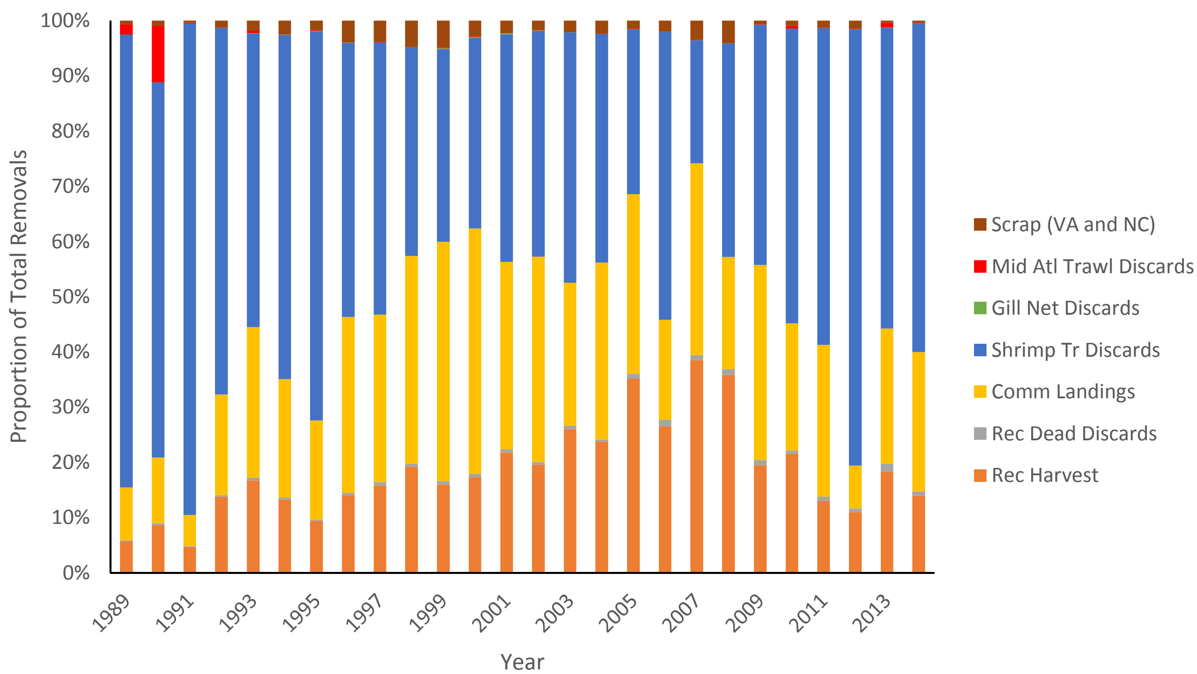

Figure 1. Proportion of annual removals by weight (metric tons) of spot for fishery dependent data by fishery type on the Atlantic coast of the USA from 1989-2014.

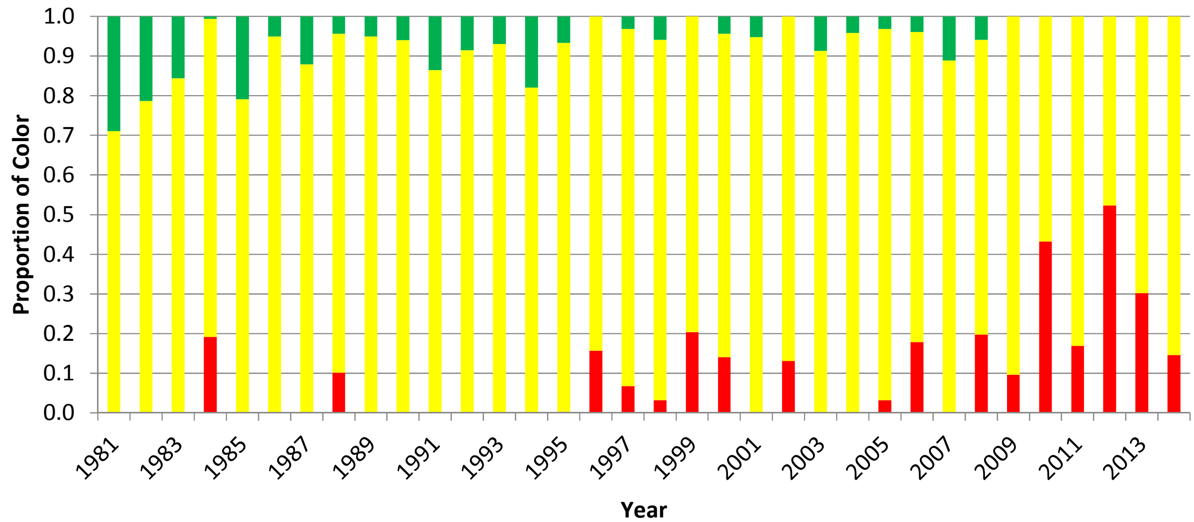

Figure 2. Annual fishery dependent TLA harvest characteristic (commercial, recreational, and scrap fishery landings) for spot on the Atlantic coast of the USA for 1989-2014.

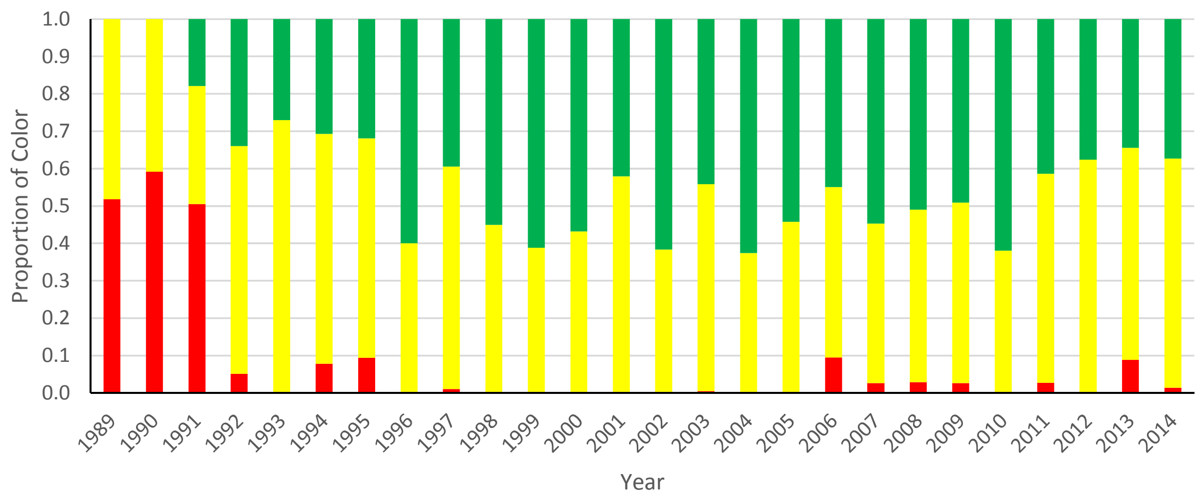

Figure 3. Annual fishery dependent TLA fishery discards characteristic (shrimp trawl fishery, commercial discards and recreational dead discards) for spot on the Atlantic coast of the USA for 1989-2014.

When the landings characteristic was combined with the discards characteristic to form a total removals characteristic, the resulting TLA (Fig. 4) indicated elevated red proportions in the early part of the time series (likely driven by high discards) and an increasing proportion of red since the late 2000s (likely driven by the increase in annual harvest). While this in and of itself was not direct indication of whether spot were being overfished or overfishing was occurring, it does show an increased impact of total removals on spot on the Atlantic coast.

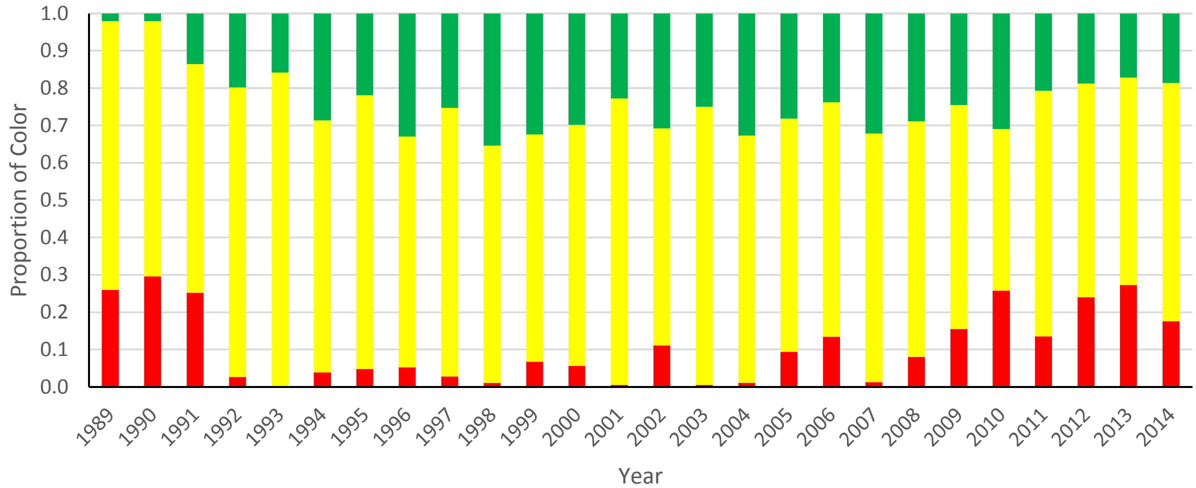

Figure 4. Combined composite TLA characteristic of total annual removals by harvest or fishery discards for spot on the Atlantic coast of the USA for 1989-2014.

The fishery independent survey (NMFS and SEAMAP) characteristic (Fig. 5) indicated high red proportions throughout the 1990s with an increase in green through the 2000s. The last two years showed an increase in red proportions with no triggering of the index since 2005, although it would have triggered in 2014.

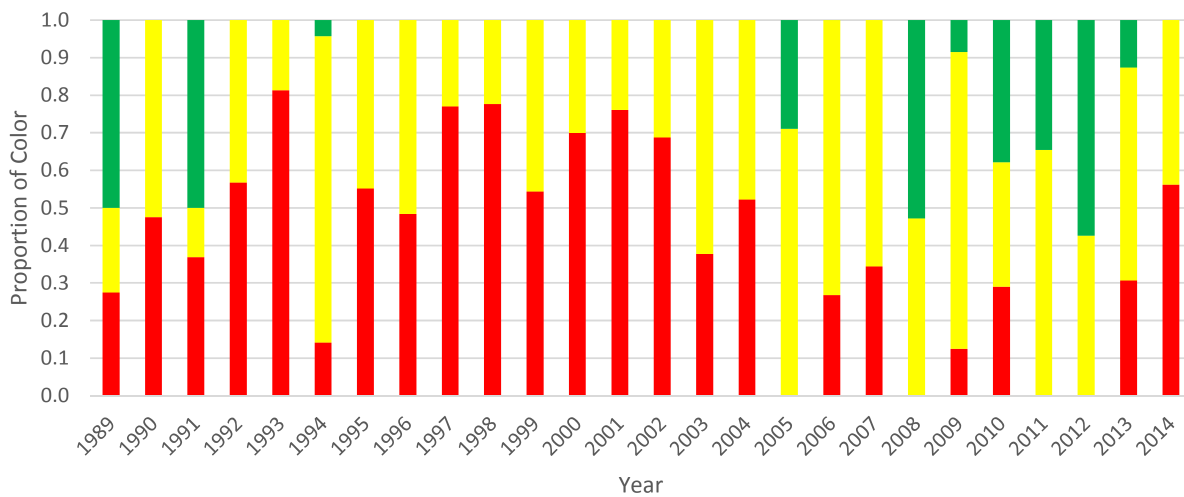

Figure 5. Annual fishery independent TLA composite characteristic for adult (age 1+) spot on the Atlantic coast of the USA using survey data from NMFS and SEAMAP.

The survey index characteristic young of the year spot (Fig.6) showed higher year to year variability in color proportions, likely due to recruitment variability. The higher degree of variability made it more likely that the red proportions would exceed the 30% threshold compared to the adult spot. The MDDNR survey used in the current trigger exercise was the only young of the year survey and increasing proportions of red in this survey reflect the longer term decline in juvenile abundance seen in that survey.

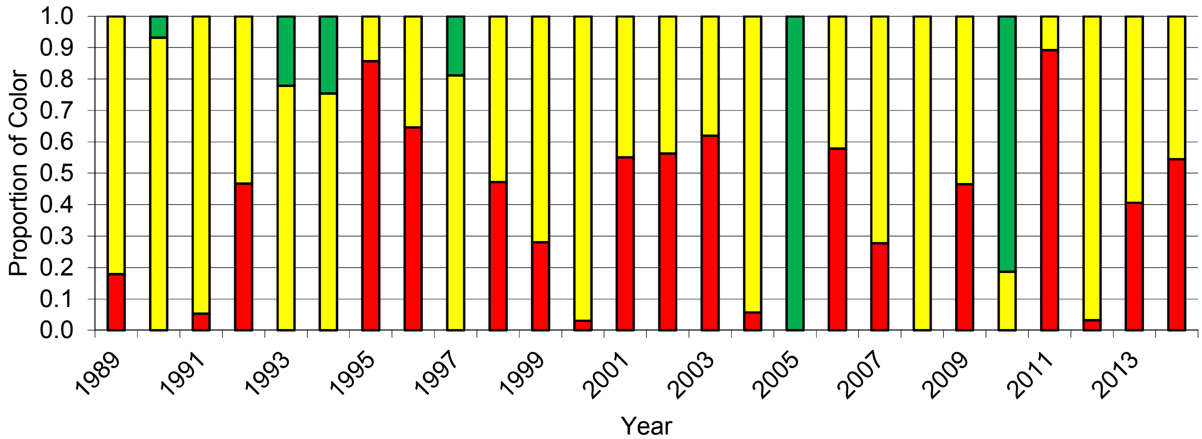

Figure 6. Annual fishery independent TLA composite characteristic for young of the year (age 0) spot on the Atlantic coast of the USA using survey data from MDDNR

FUTURE CONSIDERATIONS

After the current assessment has been completed, the traffic light analysis will have to be reexamined with regards to adjusting the reference period to the time frame of the current assessment and the consideration of adding additional indices to the TLA process. The additional metrics should possibly include the different by-catch estimates (shrimp trawl fishery, commercial discards and recreational discards) as well as possibly including the scrap fishery from Virginia and North Carolina. These indices, coupled with the harvest indicators would produce a characterization of total annual removals from fishery dependent sources. This would be particularly important for the shrimp trawl fishery given the magnitude of the bycatch compared to all other removal sources. For the fishery independent indices, consideration of including the VIMS juvenile trawl survey and NCDMF Program 195 survey might improve the young of the year recruitment characteristic which currently uses just the MDDNR juvenile fish survey. For the adult indices, ChesMMAP and NEAMAP should also be considered. Although, the time series for NEAMAP is still relatively short compared to all the other surveys. A full evaluation of modifying the TLA to improve its representation of both abundance and fishery trends should be considered after completion of the assessment and undertaken by a Spot Technical Committee.

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Appendix 2. Shrimp trawl observer database net performance operation codes.

A - Nets not spread; typically doors are flipped or doors hung together so net could not spread.
B - Gear bogged; the net has picked up a large quantity of sand, clay, mud, or debris in the tail bag possibly affecting trawl performance.
C - Bag obstructed; the catch in the net is prevented from getting into the bag by something (i.e. grass, sticks, turtle, tires, metal/plastic containers etc.) or constriction of net (i.e. twisting of the lazy-line around net).
D - Gear not digging; the net is fishing off the bottom due to insufficient weight or not enough cable let out (etc.).
E - Twisted warp or line; the cables composing the bridle get twisted (from passing over blocks which occasionally must be removed before continuing to fish). Use this code if catch was affected.
F - Gear fouled; the gear has become entangled in itself or with another net. Typically this involves the webbing and some object like a float or chains or lazy line (etc.).
G -Bag untied; bag of net not tied when dragging net.
H - Rough weather. Bags mixed due to rough seas (too dangerous to separate); if the weather is so bad fishing is stopped, then the previous tow should receive this code if the rough conditions affected the catch.
I - Torn, damaged, or lost net; usually results from hanging the net and tearing it loose. The net comes back with large tears etc. if at all. Do not use this code if there are only a few broken meshes. Continue using this code until net is repaired or replaced
J - Dumped catch; tow was made but catch was discarded, perhaps because of too mud. Give reason in comments.
SEDAR38RW01 18
K - Catch not emptied on deck; nets brought to surface, boat changes location, nets redeployed. (explain in comments)
L - Hung up; untimely termination of a tow by a hang. Specify trawl(s) which were hung and caused lost time in Comments.
M - Bags dumped together, catches could not be kept separate.
N - Net did not fish; no apparent cause. Describe reasoning in comments.
O - Gear fouled on submerged object but tow was not terminated. Performance of tow could be affected. Give specifics in Comments.
P - No measurement taken of shrimp and/or total catch.
Q - Main cable breaks and entire rigging lost. Describe in Comments.
R - Net caught in wheel.
S - Tickler chain heavily fouled, tangled, or broken.
T - Other problems. Describe in comments.
U - Turtle excluder gear intentionally disabled.
V – Unknown operation code.
W - Damaged (i.e., bent or broken) excluder gear.
X - BRD intentionally disabled or non-functional. (Damaged) Describe in comments.
Y - Net trailing behind try net.
Z - Successful tow.

Appendix 6. What Level of Spawning Potential Ratio (SPR) is a Good Proxy for Spot's MSY? A Report to the ASMFC Spot & Atlantic Croaker Stock Assessment Subcommittee.

Joseph Munyandorero: FWC/FWRI

Overview

When a stage-structured or an age-structured assessment model is completed, biological reference points (BRPs) such as the benchmarks based on the Maximum Sustainable Yield (MSY) should ideally be derived by combining the yield and spawner per-recruit and a spawner–recruit relationship (SRR; Shepherd 1982). Unfortunately, MSY-based prescriptions are seldom trustworthy, largely because they follow from unreliable and nonrobust SRRs. Therefore, BRPs based on age-, stage- or length-structured per-recruit models are often used as proxies of MSY-based BRPs, such F_{MSY}, for both data-rich stocks and data-limited stocks (NMFS 2011; Legault and Brooks 2013; Ault et al. 2008; Hordyk et al. 2015; Munyandorero 2015).

There is a large body of literature on BRPs that are purportedly suitable for precautionary management in terms of either Threshold or Limit Reference Points (LRPs) or Target Reference Points, TRPs (e.g., see Caddy and Mahon 1995; Caddy 1998; Gabriel and Mace 1999; McKown et al. 2008 for reviews). BRPs derived on a cohort or year-class basis typically employ yield per-recruit (YPR) criteria (F_{max}, a fishing mortality maximizing the YPR; and $F_{0.1}$, a fishing mortality at which the marginal increase in YPR is 10% of the marginal increase in YPR when $F = 0$) or spawner per-recruit considerations [typically $F_{x\%}$, a fishing mortality associated with x% (e.g., 40%) of the unfished spawner per-recruit]. The harvest control rules based on them vary according to fisheries jurisdictions (e.g., Caddy 1998). On the U.S. East Coast, Munyandorero (2015) noted that $F_{40\%}$ or $F_{35\%}$ in the US mid-Atlantic and Northeast Atlantic and $F_{15\%}$–$F_{30\%}$ or F_{max} in the US south Atlantic and Gulf of Mexico, have been preferred, respectively, as F_{MSY} proxies. Perhaps that McKown et al.' s (2008) report is the BRPs guideline for the ASMFC managed species.

Since the 1980's, the SRRs became the theoretical basis for BRP derivations in data-rich jurisdictions, but those SRRs are unfortunately unknown or poorly estimated (Fig. A2.1). This is the reason why research in the 1990's especially in the U.S.A focused on combining spawner per-recruit analyses and analyses of (assessment-generated or simulated) stock–recruit data to identify a spawning potential ratio, SPR (i.e., the ratio of the fished spawner per-recruit to the unfished spawner per-recruit), that could be associated with an F level approximating F_{MSY} (Clark 1991, 1993; Goodyear 1993; Mace and Sissenwine 1993; Mace 1994). According to Clark (2002), an ideal SPR target should be devised such that the spawning stock biomass is maintained at a sustainable level, while still providing a reasonable level of catch, perhaps in the form of MSY (Fig. A2.2). Based on these studies, it is generally accepted that:

- A SPR of 35–40% is sustainable for most species (Clark 1993, 2002; Mace and Sissenwine 1993; Mace 1994).
- A SPR of 35–40% may, however, be risk-adverse for species thought to be long-lived and less resilient to fishing (generally with low natural mortality rate M), so a SPR of 50–60% may be appropriate for them (Clark 2002).
- A SPR of 20% may be considered a recruitment-based LRP for average-to-high resilient species (usually short- and moderate-lived species, with moderate-to-high M) and, for little

known stocks, the LRP shout be set at 30% of the unfished spawner per-recruit (Caddy and Mahon 1995).

Case of Spot

Probably that spot is a short-lived species and, therefore, falls into the category of species for which an LRP should be a SPR of 20%. However, this SPR may be risk-adverse, because the corresponding $F_{20\%}$ may be high. For precautionary principle, an LPR between 30 and 40% may be a good option.

Another aspect to be considered relates to the type of "spawner" per-recruit analysis to be used for the LPR derivation. As indicated above, a spawner per-recruit analysis can be age-structured, stage-structured or length-structured and each approach may employ egg production or mass variables. For a given species, each of these analysis combinations may lead to different $F_{x\%}$ (say $F_{40\%}$). In any case, when a full assessment model is conducted, an LPR should be consistent with that model. This is the reason why a composite (i.e., stage-structured) spawning stock per-recruit analysis is recommended (see Munyandorero 2015). The CSA has that flexibility.

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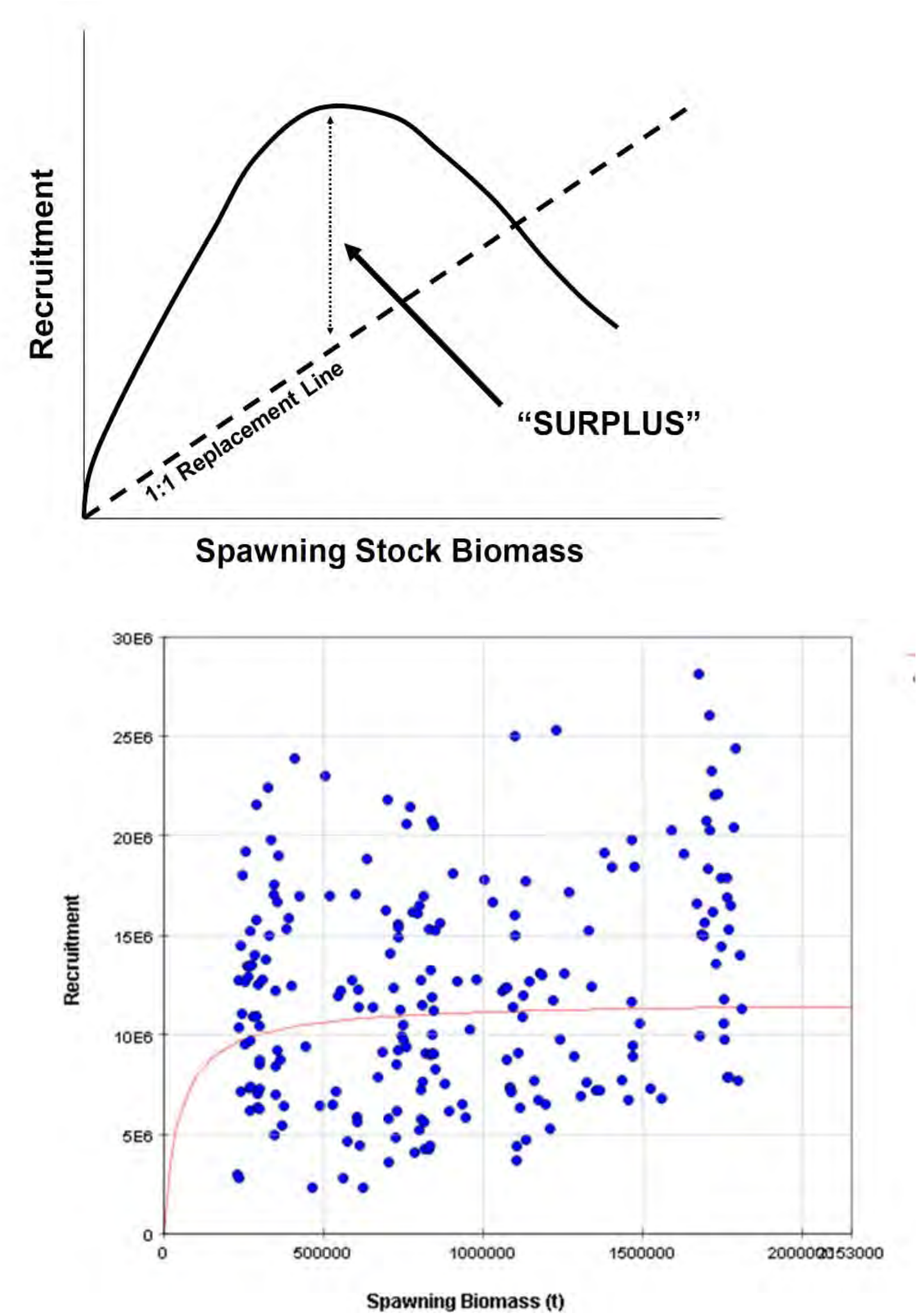

Fig. A2.1 – Theory (top) and reality (bottom) of stock – recruit relationships and stock productivity.

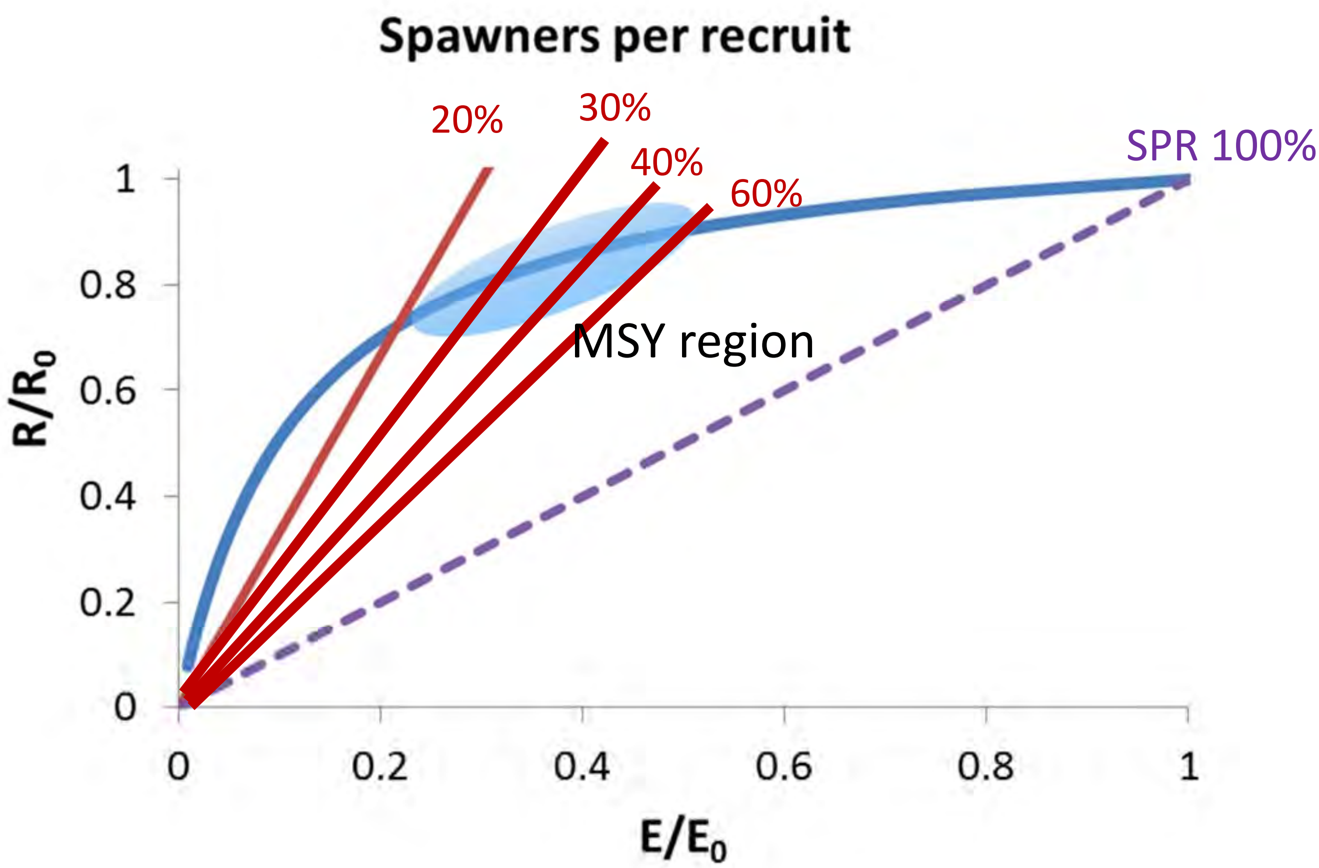

Fig. A2.2 – Theoretical representations of SPR levels for different life-history patterns.

Appendix 7. Selectivity of Age Zero Spot

The proportion of age zero spot available to removal sources was determined by comparing the length frequencies of spot from the removals to the length frequency of age zero spot from fishery independent samples. Only fishery independent lengths from specimens that were determined to be age zero using otolith ages were included in the analysis. All lengths were converted to total length in millimeters where necessary, and length frequencies were constructed using 5mm length bins. Removal types included commercial haul seines, commercial trawls, commercial gill nets, commercial fixed nets, commercial other gear, recreational harvest, recreational release discards, shrimp trawl discards, finfish trawl discards and finfish gill net discards. The length group at which the upper 95% of the removal length frequency remained was used as the cut off value for comparison to the fishery independent age zero length frequency. This was done to eliminate lengths at which incidental catch occurs, but the vast majority of spot at those lengths would not be selected by the gear.

In the first several months of the year, age zero spot are small enough to avoid capture in fishery independent gear, as indicated by 97% of age zero spot being sampled from July through December. The percentage of reported or estimated removals occurring July through December were 70% for the shrimp trawl discards, 91% for combined commercial landings and 90% for recreational harvest. These three removal categories represent 99.6% of total removals. The vast majority of shrimp trawl discards prior to July are likely age one, based on the monthly length frequency distribution.

The selectivity was calculated using length frequencies from July through December combined and dividing this value in half. This assumes age zero spot are not available in the first half of the year. The SAS acknowledges that a very small percentage of age zero spot are selected in the first half of the year. However, it is highly likely a small percentage of age zero spot are not recruited to the fishery independent gears during the July through December timeframe, leading to a slight over estimate of age zero selectivity. The assumption is that these two small errors are equal and offsetting, result in a reliable estimate of the proportion of age zero spot removed by the various fisheries.

Selectivity was calculated for each removal type, and weighted against the average landings from 1994-2014 by removal type. These years represented a timeframe in which removal estimates in numbers were available for all removal types by gear. The weighted portions by removal type were summed to generate a total selectivity from July through December of 0.86. This value was dived by two, yielding an annual age zero spot selectivity value of 0.43.

Cutoff length group in mm, number of lengths, average annual removals in numbers, percentage of total landings and proportion of age zero spot selected by removal type.

	July Through December				July Through December
Removal Type	95% Length Group Cutoff	Number of Lengths	Average Removals	Percentage of Total	Proportion of Age Zero Spot Selected
Commercial Haul Seines	180	20,338	4,012,154	2.70%	0.2528
Commercial Gill Nets	210	78,475	8,045,291	5.41%	0.0290
Commercial Trawls	135	934	518,254	0.35%	0.7303
Commercial Fixed Nets	185	24,005	801,017	0.54%	0.1891
Commercial Other	190	309	207,236	0.14%	0.5390
Shrimp Trawl Discards	90	26,705	124,942,995	84.08%	0.9767
Recreational Landings	170	83,101	9,461,346	6.37%	0.3753
Recreational Discards	110	2,246	528,692	0.36%	0.9226
Finfish Trawl Discards	125	64	75,577	0.05%	0.8258
Finfish Gill Net Discards	225	973	10,062	0.01%	0.0050

Appendix 8. Catch Curve Analysis of Spot for 2017 Stock Assessment

C. McDonough (SCDNR)

Catch curve analysis was used to estimate total annual mortality of spot for fishery dependent, fishery independent and the combined data sets where direct age and length data was available. In addition, separate catch curve analysis was also run on model index data from SEAMAP, NEFSC (NMFS) and MRIP using age length keys to convert available length data to age composition data. The catch curve analysis for the MRIP data was performed using the age length key from the fishery dependent data to convert annual length frequency distributions to annual age distributions. Catch curve analysis for SEAMAP and NEFSC were estimated using coastwide ALK'S within each year. The annual total mortality estimates for each data permutation can be seen in Table X. The time period used covered 1996 through 2014 as this represented years where age data was present in the most data sets.

Table A1.1 Estimated annual total mortality from catch curve analysis by data set or type for spot on the Atlantic coast of the United States. *Total number for SEAMAP, NEFSC, and MRIP were based on length frequency expansions of total number with age distributions estimated using age length key conversions.

Year	SEAMAP Z	NEFSC Z	MRIP Z	Fishery Independent	Fishery Dependent	All Data Combined
1996	2.715	2.030	2.133	1.179	1.204	1.379
1997	4.227	1.579	1.396	1.156	1.098	1.303
1998	2.912	1.698	1.305	1.048	1.088	1.237
1999	3.209	2.208	1.511	1.111	1.231	1.339
2000	3.353	2.130	1.754	1.248	1.209	1.401
2001	3.581	2.180	1.860	1.431	1.287	1.527
2002	3.087	2.179	2.065	1.318	1.158	1.370
2003	3.182	1.892	1.679	1.223	1.111	1.298
2004	3.992	2.284	1.806	1.100	0.911	1.071
2005	2.789	2.411	1.457	1.197	0.977	1.139
2006	3.101	2.435	1.820	1.211	1.114	1.303
2007	2.730	2.378	2.284	1.272	1.151	1.331
2008	4.321	2.409	2.678	1.319	1.214	1.445
2009	3.170	2.497	2.433	1.284	1.291	1.466
2010	3.285	2.471	2.342	1.315	1.284	1.464
2011	3.480	2.736	3.507	1.384	1.163	1.467
2012	2.722	2.913	1.482	1.162	1.258	1.385
2013	2.570	2.545	3.548	1.404	1.082	1.478
2014	2.823	2.150	2.244	0.954	1.259	1.328
Z-Range	2.57 - 4.32	1.57 - 2.91	1.31 – 3.55	0.95 -1.43	0.91 – 1.29	1.07 – 1.53
COV	0.305	0.190	0.282	0.098	0.122	0.146
Mean	3.224	2.271	2.069	1.227	1.163	1.354
Median	3.445	2.240	2.43	1.190	1.10	1.30
Age Range	0-4	0-6	0-6	0-6	0-6	0-6
Number	*817,871	*83,440	*138,548,315	9,870	12,460	22,593

In the fishery independent data sets, SEAMAP data had higher Z values than the NEFSC and MRIP data due to a smaller age range (0-4) found in this data set (Figure X.1). Annual Z values were significantly different between SEAMAP and MRIP (paired t-test, P_{MRIP} =0.339) but not with NEFSC (paired t-test, P_{NEFSC} < 0.001). The NEFSC and MRIP estimates had similar trends except for two large peaks in the MRIP data in 2011 and 2013 and were not significantly different (pair t-test, P = 0.143).. The peaks in the Z estimate for MRIP in 2011 and 2013 was likely due to the lack of ages 5 and 6 in the age range for those two years.

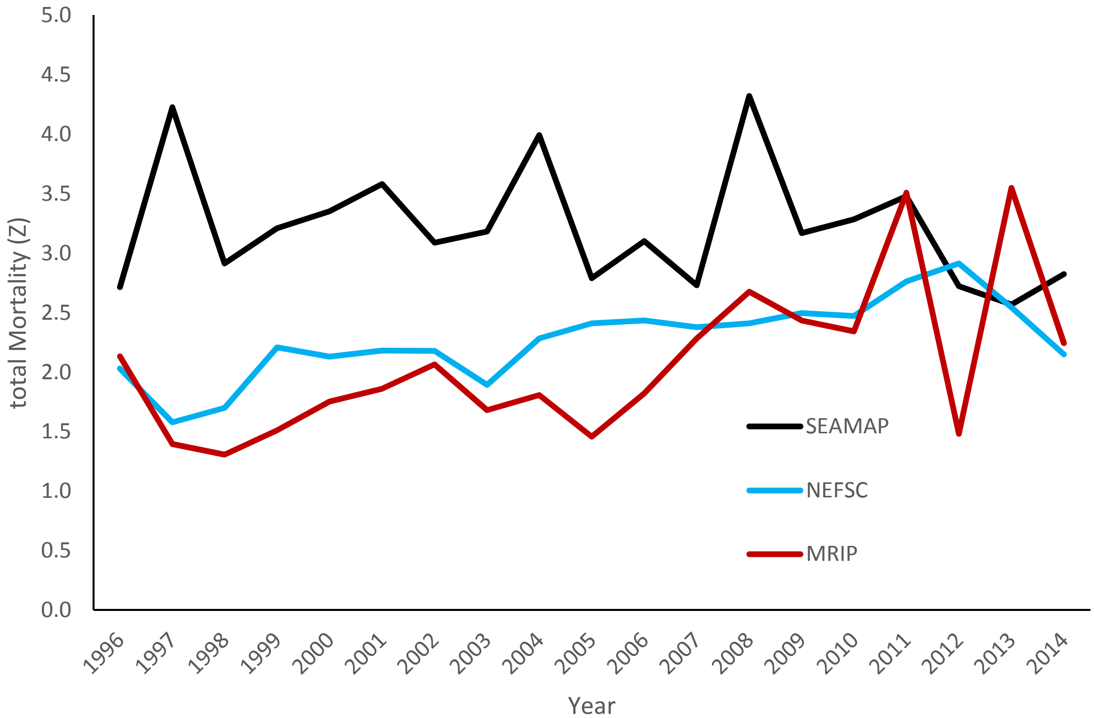

Figure A1.1 Estimated annual total mortality by data set (SEAMAP, NEFSC, MRIP) for spot on the Atlantic coast of the U.S. from assessment data.

The full fishery independent age data set (which also included age data from ChesMMAP, NEAMAP, FWC, and NCDMF) had lower range and mean value than the fishery dependent and full combined age data sets (Table A1.1). Annual trends were very similar across the FI, FD and combined data sets (Figure A1.2), with the mean values and range of Z for the combined data set higher than either the FI or FD data. The annual Z values for FI and FD were not significantly different (paired t-test, $P = 0.068$), so the combined data set was used to set the Z prior levels in the CSA model. However, because there was a significant difference in annual Z values between the combined data with both FI ($P < 0.001$) and FD ($P < 0.001$), separate sensitivity runs were made in the CSA model using the FI and FD values to determine if it effected the model.

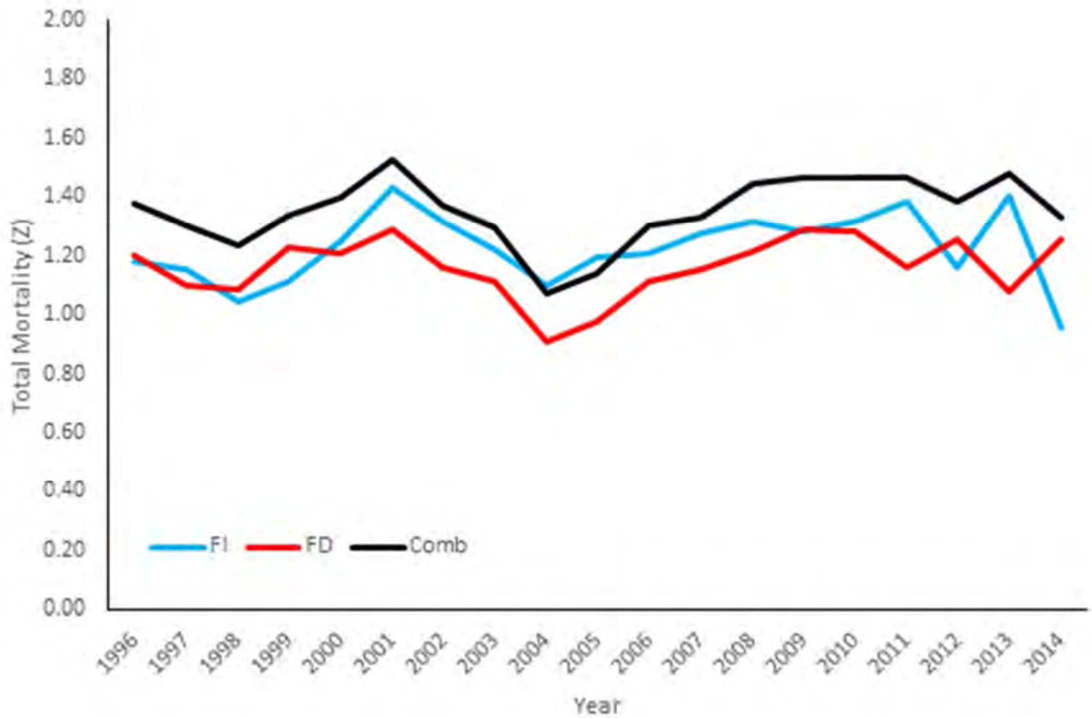

Figure A1.2 Estimated annual total mortality by data type (fishery independent, fishery dependent, combined) for spot on the Atlantic coast of the U.S. from available assessment age data.

Appendix 9. Prior distributions of stock–recruit steepness for the Atlantic croaker (*Micropogonias undulatus*) and Spot (*Leiostomus xanthurus*) populations in the U.S. Atlantic Ocean

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Abstract: The stock–recruit steepness is difficult to estimate. Estimation difficulties are often reduced upon fixing steepness at a "reasonable" value or assigning it a prior distribution. This contribution is devoted to the development of steepness prior distributions for Atlantic croaker and spot inhabiting the U.S. Atlantic coast. To this end, a relationship between slopes at the origin of stock–recruit curves (α) and asymptotic sizes is constructed to infer the plausible values of α, which in turn are combined with species-specific unfished spawning biomass per-recruit (Φ_0). Monte Carlo (MC) simulations are used to propagate uncertainty in growth parameters into natural mortality, Φ_0 and steepness. Under assumptions of Beverton–Holt stock–recruit dynamics, median steepness is 0.78 (80% probable range: 0.68–0.84, mean = 0.76 and mode = 0.79) for Atlantic croaker and 0.66 (80% probable range: 0.33–0.89, mean = 0.64 and mode = 0.79) for spot. If Ricker stock–recruit relationships were assumed, mean and median steepness are 1.68 (80% probable range: 1.1–2.25, mode = 1.78) for Atlantic croaker; for spot, median steepness is 1.58 (80% probable range: 0.35–3.28, mean = 1.03 and mode = 0.52). Two-parameter beta functions are fitted to empirical distributions of the Beverton–Holt stock–recruit steepness for both species. A normal function and a gamma function appear appropriate for fitting the Ricker stock–recruit steepness of Atlantic croaker and spot, respectively. The previous tendency statistics or probable ranges of steepness can guide its estimation. Alternatively, the fitted parameters can be used to select parametric prior for stock–recruit steepness of Atlantic croaker and spot.

Introduction

Contemporary assessments and management of data-rich stocks largely infer from stock–recruit relationships (SRRs). Inferences are made at two levels. First, assessment models include stock-recruit functions designed to govern the recruitment production. Second, nominally sustainable levels (i.e., maximum sustainable yield (MSY)-based benchmarks) and the determination of stock status in principle follow from the combination of (reliable) SRR and per-recruit models (Shepherd, 1982).

Since about the mid-1980s, data-rich stock assessments focused on recasting the stock–recruitment parameters (i.e., maximum recruits per spawner as spawner abundance approaches zero and the degree of compensation) in terms of "steepness" (h; i.e., the fraction of the unexploited recruitment produced by 20% of the unexploited parental stock). This move was adopted because the definition of h was considered biologically meaningful (Hilborn and Mangel, 1997; Haddon, 2001). The previous definition of steepness and related biological and management interpretations are, however, intelligible for and suited to the Bevertion–Holt SRR (BH–SRR). They are difficult to comprehend for other SRRs.

Steepness measures the degree of dependence of average recruitment on the parental stock. For the BH–SRR, it reflects the stock's productivity, whereby its higher values are thought to be associated with highly productive populations, especially at lower density (Beddington and Kirkwood, 2005; Lee et al., 2012; Maunder, 2012; Shertzer and Conn, 2012). In those cases, the stocks are considered to be resilient to harvest. In theory, therefore, intense exploitation and growth-overfishing associated with higher steepness would not affect recruitment or lead to recruitment-overfishing!

Unfortunately, steepness is difficult to estimate. Estimation difficulties arise from reasons such as changes of steepness over time, uninformative fishery data, large fluctuations in recruitment at low stock size, and lack of contrast (i.e., how well the possible range is covered) for the stock–recruit data (Walters and Martell, 2004; Conn et al., 2010; Shertzer and Conn, 2012). For example, in most assessments involving the BH–SRR where steepness is bounded between 0.2 and 1.0, the steepness estimates tend to hit the upper bound irrespective of whether the stock is or is not productive (e.g., Conn et al., 2010; Lee et al., 2012).

Strategies commonly adopted to reduce the estimation difficulties of steepness include: (i) fixing *h* to an assumed "reasonable" value in a base-model run and conduct sensitivity runs involving alternative values of *h*; (ii) constraining *h* between selected lower and upper bounds (e.g., Conn et al., 2010; Anonymous, 2011; Rademeyer et al., 2012); or (iii) developing a prior distribution (penalty function in a maximum likelihood context) for *h*. The first strategy, along with a fixed natural mortality rate (*M*), fixes biological reference points, BRPs (Mangel et al., 2013). The second strategy basically is a uniform distribution for *h*, a "reasonable" estimate of which depends on information contained in fishery data and on possible contrasts that the spawning stock may have exhibited. The third strategy relies on met-population analyses (Myers et al., 1999, 2002; Rose et al., 2001; Shertzer and Conn, 2012; Punt and Dorn, 2014), persistence principles (He et al., 2006), or uncertainty in reproductive and life history parameters (Mangel et al., 2010; Simon et al., 2012; Brodziak et al., 2015). This strategy is somewhat similar to the first strategy when *M* is fixed, but differ from it in that: (i) given a long and comprehensive time series of fishery data and variable spawning stock, the prior distribution of *h* can be updated, usually through Bayes' rule, into a posterior distribution; and (ii) the resulting BRPs have distributions.

For the current benchmark assessments of the Atlantic croaker (*Micropogonias undulatus*) and spot (*Leiostomus xanthurus*) stocks in the U.S. Atlantic coast, this note aims to construct plausible prior distributions for stock–recruit steepness of the stocks in question. Analyses combine: (i) the relationship between published stock productivity levels at low stock size and asymptotic lengths; (ii) species-specific parameters on growth and maturity/fecundity (the estimation of *M* follows from a nonlinear empirical equation in Then et al., 2015); and (iii) the unfished spawning biomass (or number of eggs) per-recruit (Φ_0).

Materials and methods

Basic parameters, relationships and assumptions

The construction of prior distributions of the stock–recruit steepness (*h*) for Atlantic croaker and spot relies on two main characteristics. First, the slopes at the origin of spawner-recruit curves (α, the maximum recruits per-spawner at lower spawner abundance) is negatively and significantly related to the parameters L_∞ and W_∞ of the von Bertlanffy growth (VBG) equation (Denney et al., 2002; Goodwin et al., 2006; Hall et al, 2006). Therefore, given species-specific values of L_∞ and longevity or W_∞ falling in the range of meta-analytic relationships $\alpha \sim L_\infty$ or $\alpha \sim W_\infty$, plausible species-specific values of α can be estimated. Second, the definition of *h* reduces to a nonlinear function *h* of α and the unfished spawning biomass (or number of eggs) per-recruit (Φ_0): $h = f(\alpha, \Phi_0)$ (Mangel et al., 2010, 2013 and references therein).

The previous aspects are accounted for by compiling estimates of α, L_∞, and Φ_0 that have preferably been estimated and published simultaneously. Otherwise, when only α is available, L_∞ values are compiled from various sources including FishBase (http://fishbase.org). Most α values were estimated employing the Ricker SRR (R–SRR)—Myers et al. (1999, 2002) argue that at the limit of small population size, the BH–SRR and R–SRR coincide, having the same α, although they produce different estimates of α once fitted to the same data (Michielsens and McAllister, 2004; Forrest et al., 2010; Galindo-Cortes et al., 2010). In this note, all compiled α values are used irrespective of the standard BH–SRR or standard R–SRR they were derived with, provided the BH–SRR was of the form similar to the equation used below for defining steepness. Furthermore, α estimates for the BH–SRR are preferred over those for R–SRR if they are available for the same stock. The relationship between α and L_∞ is (Fig. 1a, b; $r^2 = 0.67$, $P < 0.001$):

$$\alpha = 856213.7 L_\infty^{-2.9393} \quad (1)$$

The VBG parameters (L_∞, K year^{-1}, and age_0 (years)) and the length–growth scales (a) and exponents (b) for females of Atlantic croaker[1] include those in ASMFC (2010a) and those that have been updated during this assessment benchmark. The growth parameters for females of spot are available during this assessment benchmark only, so they also include those values that have been estimated for both sexes in ASMFC (2010b). Estimated growth parameters are treated as "observed data." Then, the variability in these parameters is considered reflective of scientific uncertainty, but note that the majority of them are linearly and significantly related (Fig. 1c–h). No unique combination made up of each point estimate from their respective sets is preferred *a priori* over other combinations in calculating composite life history metrics, such as M and Φ_0.

Characterizing uncertainty through random samples of growth parameters

Because at least two sets of the observed growth parameters are linearly and significantly related (Fig. 1c–h), the VBG parameters on the one hand, and the length-weight scales and exponents on the other, are jointly simulated as multivariate normal distributions given their empirical mean vectors and covariance matrices. Sampling is performed (number of iterations n = 10000) with the R package MASS (Venables and Ripley, 2002). (A different sampling scheme such as Monte Carlo (MC) simulations assuming uniform distributions would be appropriate if the previous pairs of growth parameters were not linearly related). Except for Atlantic croaker's parameter age_0 versus L_∞, stochastic realizations of various growth parameters are expectedly related linearly (Fig. 2a–h). In particular, isopleths have the highest probability density at about (L_∞, K) = (42 cm, 0.2 year^{-1}) and (a, b) = (0.015, 3.0) for Atlantic croaker and at bout (L_∞, K) = (370 mm, 0.35 year^{-1}) and (a, b) = (3.5×10^{-5}, 3.0) for spot.

During the sampling, some iterations can yield negative values for the parameter a and positive values for the parameter age_0. Such random draws are conducive, respectively, to negative mean weights and negative mean lengths at age-0, which are unfeasible. It is therefore necessary to subset the initial iterations, only keeping draws of L_∞, K, and b associated with positive values of a and negative values of age_0. The number of kept draws is denoted $n+$ and, for each of them, the following quantities are derived or calculated through MC simulations.

Natural mortality

Constant M (Figs. 3a, b) is estimated using the Pauly's nonlinear empirical equation (Then et al., 2015):

$$M = 4.118 K^{0.73} L_\infty^{-0.33} \quad (2a)$$

(Hoenig's updated nonlinear empirical equation can also be used, on the basis of maximum ages that individual studies have recorded). Natural mortality at age (M_{age}) follows from Lorenzen's

[1] The triplets (L_∞, K, age_0) equal to (85.4, 0.0638, −0.0016) and (64.5, 0.2, −3.06) are excluded because they appear to be outliers.

(2000, 2005) natural survival equation at age (S_{age}) for the VBG function (L_∞ is treated as reference length and M relates to L_∞):

$$S_{age} = \left[\frac{L_{age}}{L_{age}+L_\infty(e^K-1)}\right]^{\frac{M}{K}} \qquad (2b)$$

where L_{age} is mean length at age estimated with the VBG equation. It follows that $M_{age} = -\log(s_{age})$:

$$M_{age} = \frac{M}{K}\log\left[1+\frac{L_\infty}{L_{age}}(e^K-1)\right] \qquad (2c)$$

Figures 3c, d show levels (medians and empirical 95% confidence intervals) and trajectories of natural mortality at age.

Mean weights

The asymptotic weight (W_∞) is given by:

$$W_\infty = aL_\infty^{b} \qquad (3a)$$

Mean weight at age (W_{age}) is calculated as:

$$W_{age} = W_\infty\{1 - \exp[-K(age - age_0)]\}^{b} \qquad (3b)$$

The unfished spawning stock biomass per-recruit (SSBR)

The unfished SSBR at age (starting from age-0) for females ($\psi_{age.F=0}$) is calculated as:

$$\Psi_{ageF=0} = l_{age} sr_{age} W_{age} \mu_{age} \frac{\sum_{m=1}^{12}\pi_m exp(-\varphi_m M_{age})}{\sum_{m=1}^{12}\pi_m} \qquad (4)$$

where sr_{age} is the sex-ratio at age; μ_{age} is the probability mature at age; π_m is the monthly proportion of spawning-capable females; φ_m is the fraction of the year elapsed at the beginning of the spawning month m (calculated assuming that natural mortality by age is uniformly distributed over the year; by convention, φ_1 for the month of January is zero, φ_2 = 1/12 for the month of February consistent with the elapsed month of January, and so on); and l_{age} is the unfished survivorship to a given age (note: at age-0, l_{age} = 1): $l_{age} = l_{age-1}\,exp(-M_{age-1}) = exp(-\sum_0 M_{age-1})$. Figures 3e, f describe the estimated l_a levels and trajectories.

The sex-ratios and probability mature ate age (s_{age}, μ_{age}) as well as the vector φ_m used in Eq. (4) were developed during this assessment benchmarks. Together with the vector π_m, they are treated as deterministic.

The total unfished SBPR (Φ_0) is given by:

$$\Phi_0 = \sum_{age=0}^{T_{max}} \Psi_{ageF=0} \qquad (5)$$

where T_{max} is maximum observed age (17 years for Atlantic croaker, 6 years for spot).

Calculating the steepness parameter

The BH–SRR and R–SRR are commonly used in stock assessment models of population dynamics. Here, the steepness (h) is calculated on the ground that its definition relies on a BH–SRR of the form R = αS/(1 + βS), where R is recruitment, S is spawning stock biomass producing R, and α and β are parameters[2]:

$$h = a\Phi_0/(4 + a\Phi_0) \qquad (6a)$$

If there is evidence for mechanisms supporting the R–SRR, R = αS exp(−βS), then

$$h = 0.2(a\Phi_0)^{0.8} \qquad (6b)$$

[2] If the steepness were defined based on BH–SRRs of the forms R = αS/(β + S) and R = S/(α + βS), h would be expressed as $h = \alpha\Phi_0/(4\beta + \alpha\Phi_0)$ and $h = \Phi_0/(4\alpha + \Phi_0)$, respectively.

The quantity $\alpha\Phi_0$ is the maximum lifetime reproductive rate at low density (Myers et al., 1999, 2002), i.e., the number of recruits produced by a recruit over its lifespan in the absence of fishing (Brooks et al., 2010). It corresponds to the Goodyear (1977, 1980) compensation ratio and is related to steepness (Walters and Martell, 2004; Martell et al. 2008; Brooks et al., 2010; Fig. 4).

Some properties and estimation considerations of the steepness

The range of h is [0.2, 1) for the BH–SRR and [0.2, ∞) for the R–SRR; its domain (i.e., values of $\alpha\Phi_0$) is [1, ∞). The variation of h against $\alpha\Phi_0$ (Fig. 4) indicates that, for the BH–SRR for example, (i) $h = 0.5$ when $\alpha\Phi_0 = 4$; (ii) for $\alpha\Phi_0 > 4$, $h > 0.5$ (e.g., $h = 0.75$ if $\alpha\Phi_0 = 12$ and $h = 0.95$ if $\alpha\Phi_0 = 76$), but $h < 1$ because $\alpha\Phi_0 < 4 + \alpha\Phi_0$ (i.e., 1 should never upper-bound h); and (iii) for $\alpha\Phi_0 < 4$, $h < 0.5$ and $h = 0.2$ when $\alpha\Phi_0 = 1$.

Although the steepness is dimensionless and is considered a tool for comparison across species (e.g., Beddington and Kirkwood, 2005; Kell et al. 2013, Rossberg et al., 2013), the units chosen to calculate Φ_0 influence its magnitude. For example, given α in number of recruits per spawning biomass, values of h based on Φ_0 in g would be higher than those that would be based on Φ_0 in kg. For the BH–SRR in particular, it may be useful to develop Φ_0 with a unit in such a way that the order of magnitude for the $\alpha\Phi_0$ value is comparable with 4 on the denominator (typical values of $\alpha\Phi_0$ are single-digit and double-digit numbers; Figs. 4). For Φ_0 calculated as SSBR, as is here, use of kg is deemed appropriate and is recommended to facilitate comparisons among life histories. The previous remarks suggest that comparison of species of different life histories on the basis of the stock–recruit steepness make sense when their Φ_0 is in the same unit.

Estimating parameters of prior distributions for steepness

The R ExtDist package is used to estimate the parameters that provide the maximum likelihood fit to the empirical steepness distributions as obtained from MC simulations. Specifically, the fitted probability density functions (pdfs) are: (i) the two-parameter beta pdf for the BH–SRR steepness, and (ii) the normal or gamma pdf for the R–SRR steepness.

The forms of the fitted normal, gamma, and two-parameter beta pdfs are, respectively:

$$f(h) = \frac{e^{-\frac{(h-\mu_h)}{\sigma^2}}}{2\sqrt{2\pi}} \quad (7a)$$

$$f(h) = \frac{h^{p-1}e^{-\frac{h}{\theta}}}{\Gamma(p)\theta^p} \quad (7b)$$

$$f(h) = \frac{\Gamma(p+q)}{\Gamma p \Gamma q} h^{p-1}(1-h)^{q-1} \quad (7c)$$

The parameters are the mean μ_h and the standard deviation σ (> 0) for the normal pdf, the shape p (> 0) and the scale θ (> 0) for the gamma pdf, and the shape parameters p and q (> 0) for the two-parameter beta pdf. The mean and variance are given by $p\theta$ and $p\theta^2$ for the gamma pdf and, for the two-parameter beta pdf, by $p/(p + q)$ and $pq/[(p + q)^2(p + q + 1)]$, respectively.

Results

The distributions of the BH–SRR steepness are left skewed for both the Atlantic croaker and Spot (Fig. 5a, b) with MC sample medians of 0.78 (80% probable range: 0.68–0.84) and 0.66 (80% probable range: 0.33–0.89), respectively. The MC sample mean of the BH–SRR steepness is 0.76 (CV = 0.11) for Atlantic croaker and 0.64 (CV = 0.32) for spot.

The parameters of the fitted beta density (Fig. 5a, b) are p = 22.07 (standard error, SE = 0.324) and q = 6.93 (SE = 0.099) for Atlantic croak and p = 3.05 (SE = 0.05) and q = 1.73 (SE = 0.027) for spot.

The R–SRR steepness for Atlantic croaker is normally distributed (Fig. 5c) with an MC sample mean of 1.68 (CV = 0.28; 80% probable range: 1.1–2.25). For spot, the R–SRR steepness is right skewed (Fig. 5d), with an MC sample median of 1.03 and an MC sample mean of 1.58 (80% probable range: 0.35–3.28). The fitting of a gamma pdf to the MC sampled data for this distribution produces p = 1.42 and θ = 0.91 (mean = 0.61; standard deviation = 0.27).

Shertzer and Conn (2012) argue that, if data are informative, "a prior distribution (for steepness) informs the estimation process in that the best estimate occurs at the mode." If so, the modes of the BH–SRR steepness are 0.79 for both Atlantic croaker and spot. The modes of the R–SRR steepness for these species, respectively, are 1.78 and 0.52.

Discussion

This note builds upon a relationship that exits between the slopes at the origin of stock–recruit curves (α) and asymptotic lengths (L_∞). Empirical inferences of α for Atlantic croaker and spot are then made on the ground that their L_∞ values are in the range of the aforementioned relationship. Finally, the calculated α values are combined with the species-specific unexploited spawning biomass per-recruit (Φ_0) to develop the corresponding stock–recruit steepness. The construction of empirical distributions of steepness is made possible through: (i) Monte Carlo simulations of growth parameters, (ii) calculations of constant M using the realized L_∞ and K, and (iii) the propagation of uncertainty in L_∞, K, constant M and length-weight parameters into M-at-length and Φ_0. Therefore, contrary to fully meta-analytic approaches (Myers et al., 1999, 2002; Rose et al., 2001; Shertzer and Conn, 2012; Punt and Dorn, 2014) and methods exclusively based on reproductive and life history parameters (Mangel et al., 2010; Simon et al., 2012; Brodziak et al., 2015), the methodology used here combines results on α and L_∞ gained from other stocks and life history parameters of the species of interest. As such, the proposed approach is hybrid.

Apart from the relationship α ~ L_∞ (which may change depending on the selected pairs), a key step to estimating the steepness is the calculation of Φ_0 (Eq. (5)). Here, a calculation methodology is proposed to account for the protracted nature of the spawning activity for Atlantic croaker and Spot. However, because the incorporation of the reproductive dynamics into equilibrium per-recruit models is challenging, Eq. (4) attempts to address the protracted spawning season through a weighted average of monthly survival rates (i.e., $\frac{\sum_{m=1}^{12}\pi_m exp(-\varphi_m M_{age})}{\sum_{m=1}^{12}\pi_m}$) themselves based on φ_m values; the weights are monthly proportions of spawning-capable females. Such a procedure implies simplifying assumptions that all age-specific schedules are conserved each month and that females in a cohort can survive at the beginning of any month of a year but spawn only during a single month.

The previous weighting of monthly survival rates is flexible in that it can accommodate various configurations depending on species-specific reproductive dynamics in a year. For example, the proportion π_m should simply be set to zero in months during which a species is reproductively inactive. In that case, the resting months would weigh nothing. At another extreme, π_m would equal one if females reproducing in each month all were spawning-capable (the denominator = 12). It is of note that Gabriel et al.'s (1989) equation, applicable for a single month of peak spawning assuming (π_m = 1), is a special case of Eq. (4).

Parametric density functions (normal, gamma, and beta) for steepness are fitted to the empirical steepness distributions to the estimate their parameters. It is anticipated that the fitted parameters can be used to select parametric prior for stock–recruit steepness of Atlantic croaker and spot assuming either the BH–SRR or the R–SRR.

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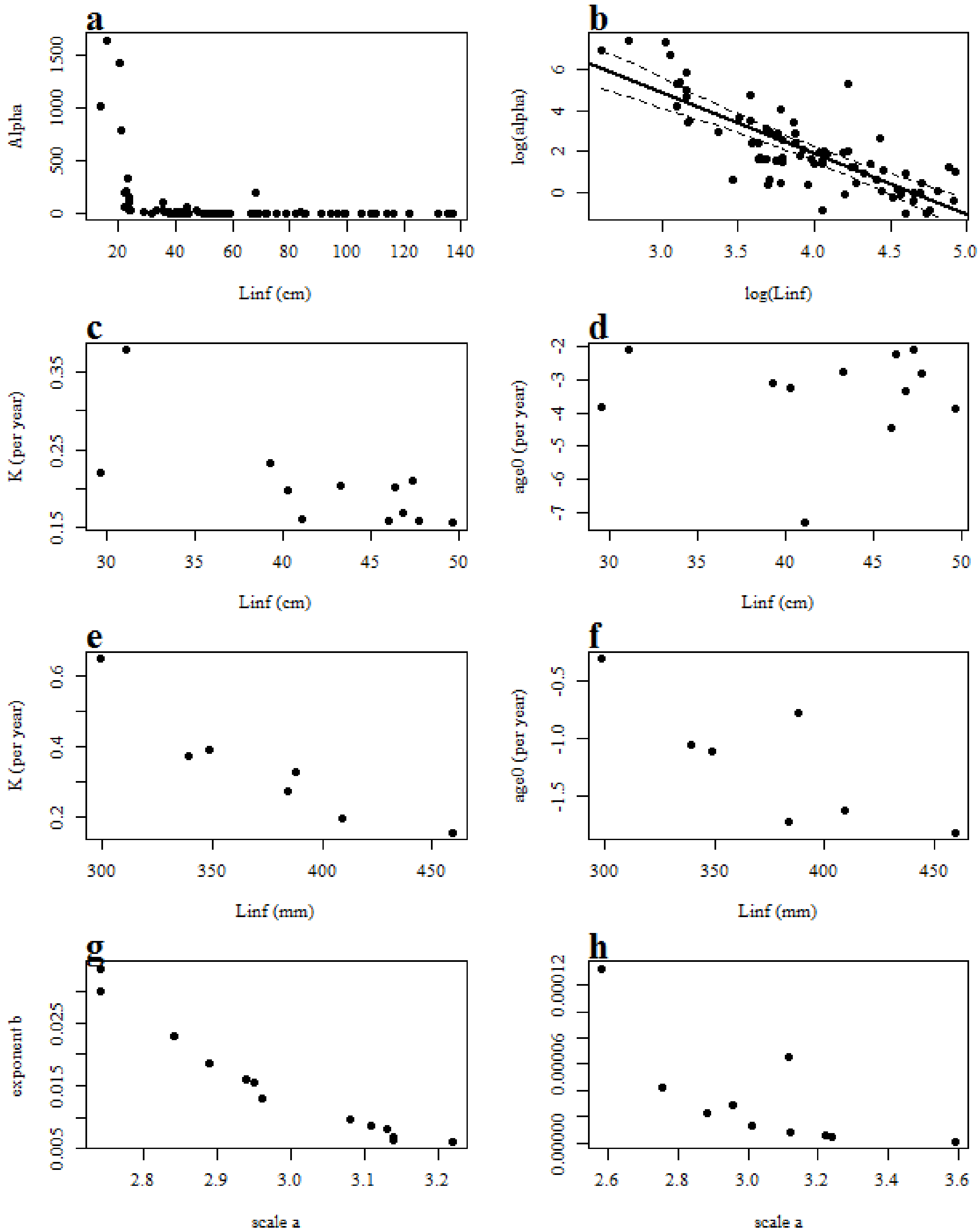

Fig. 1 Relationships between (a, b) "observed" values of alpha and L_∞, on arithmetic and log scale, respectively; (c, d) the VBG parameters K and age_0 for Atlantic croaker, (e, f) for spot; and (g, h) the exponent and the scale of length-weight for Atlantic croaker and spot, respectively.

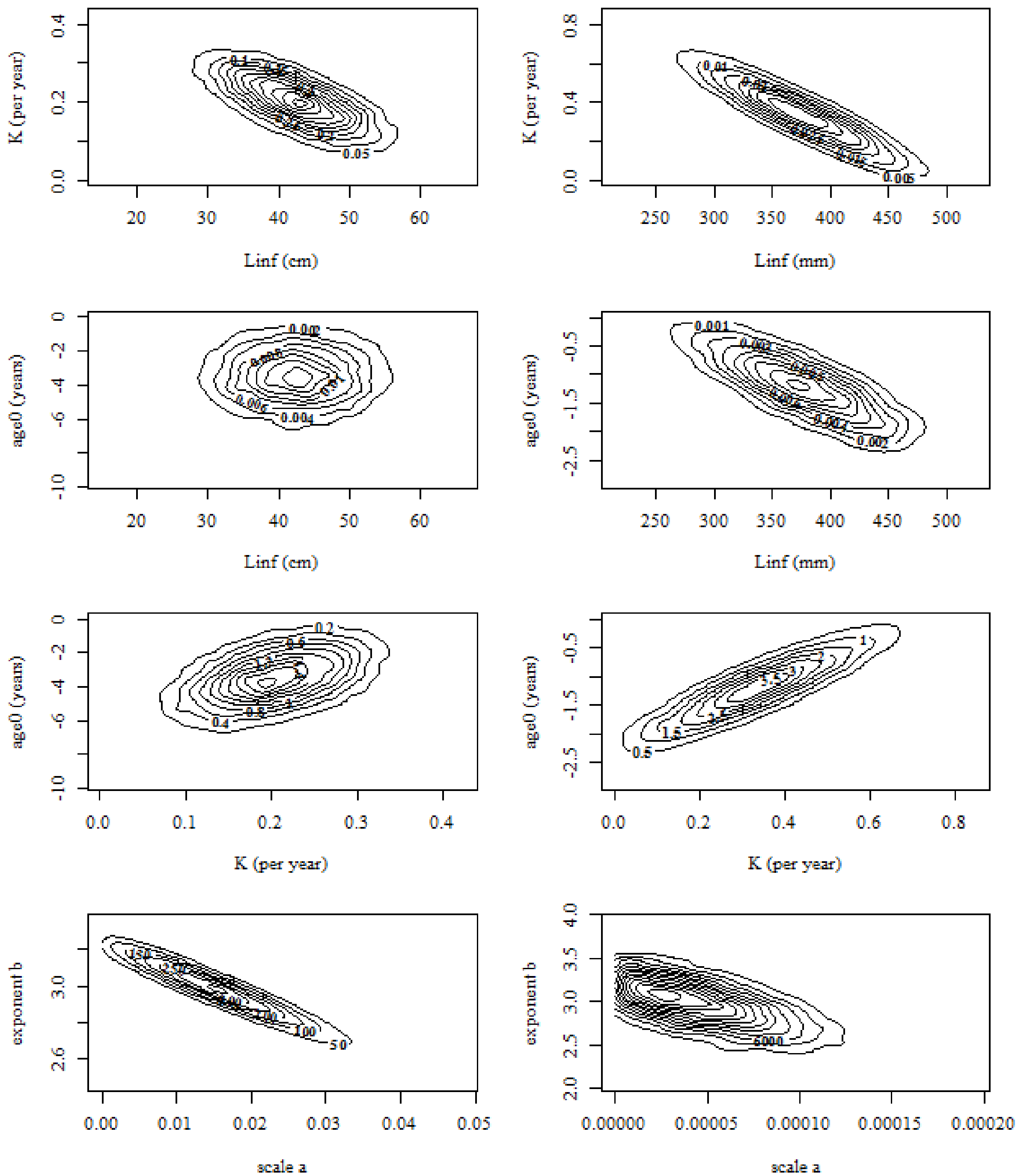

Fig. 2 Isopleth contours showing relationships between the growth parameters for Atlantic croaker (left panel; the number of draws producing the scale *a* > 0 and age-0 < 0, n+, is = 9394) and spot (right panel; n+ = 7632).

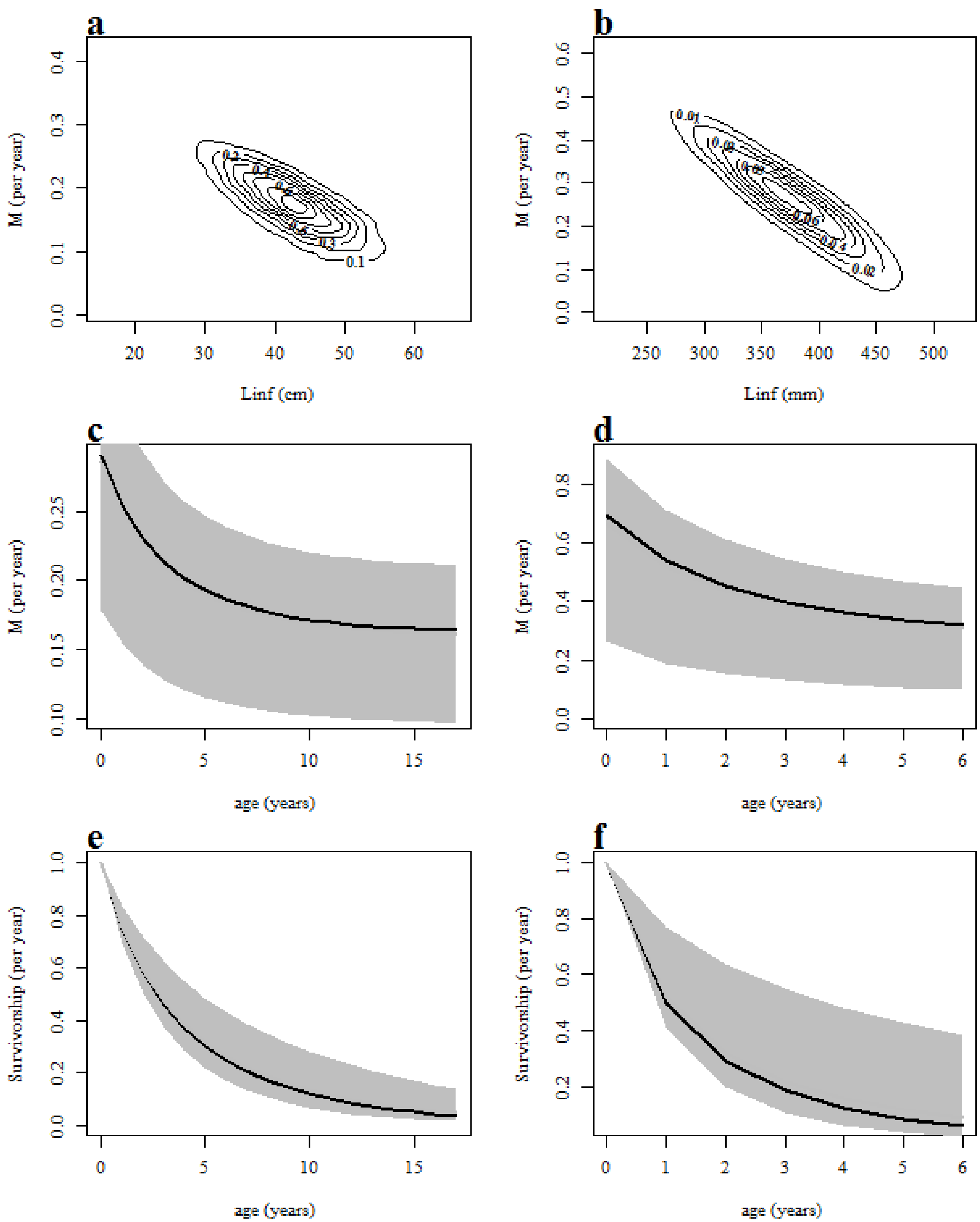

Fig. 3 Relationships between (a, b) the realized natural mortality (M) and L_∞; trajectories of median (black line) and 95% confidence intervals (gray color area) of (c, d) age-specific natural mortality and (e, f) survivorship for Atlantic croaker (left panel) and spot (right panel).

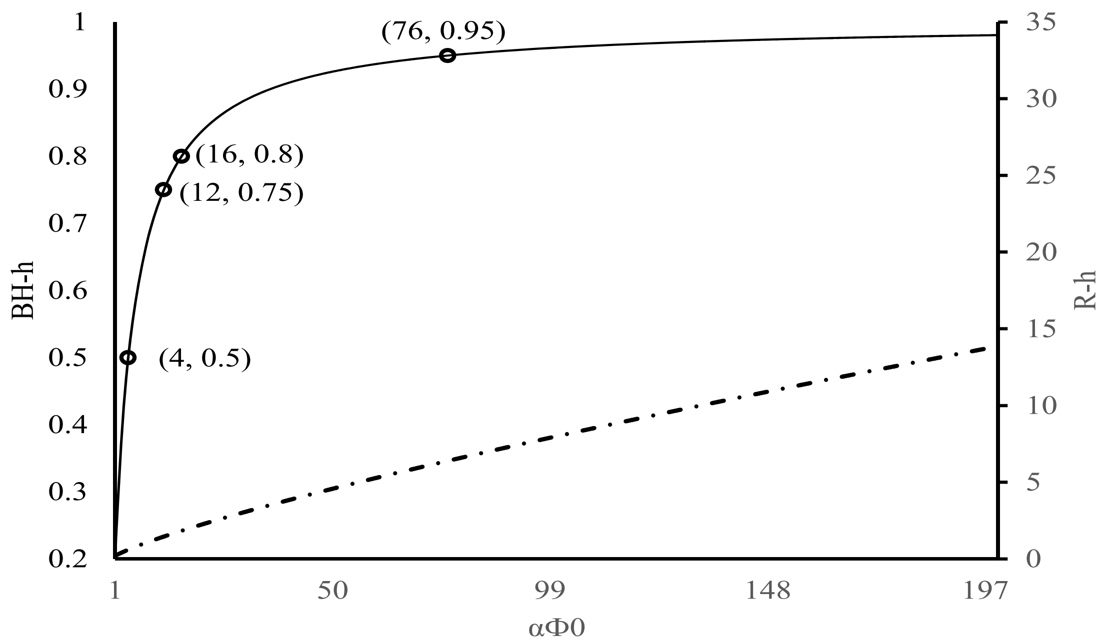

Fig 4 Curves for the BH–SRR steepness (BH–h) and R–SRR steepness (R–h) in relation with the maximum lifetime reproductive rate (a.k.a. Goodyear recruitment compensation ratio), $\alpha\Phi_0$. The selected coordinates for the BH–SRR relate to some commonly-assumed values of steepness.

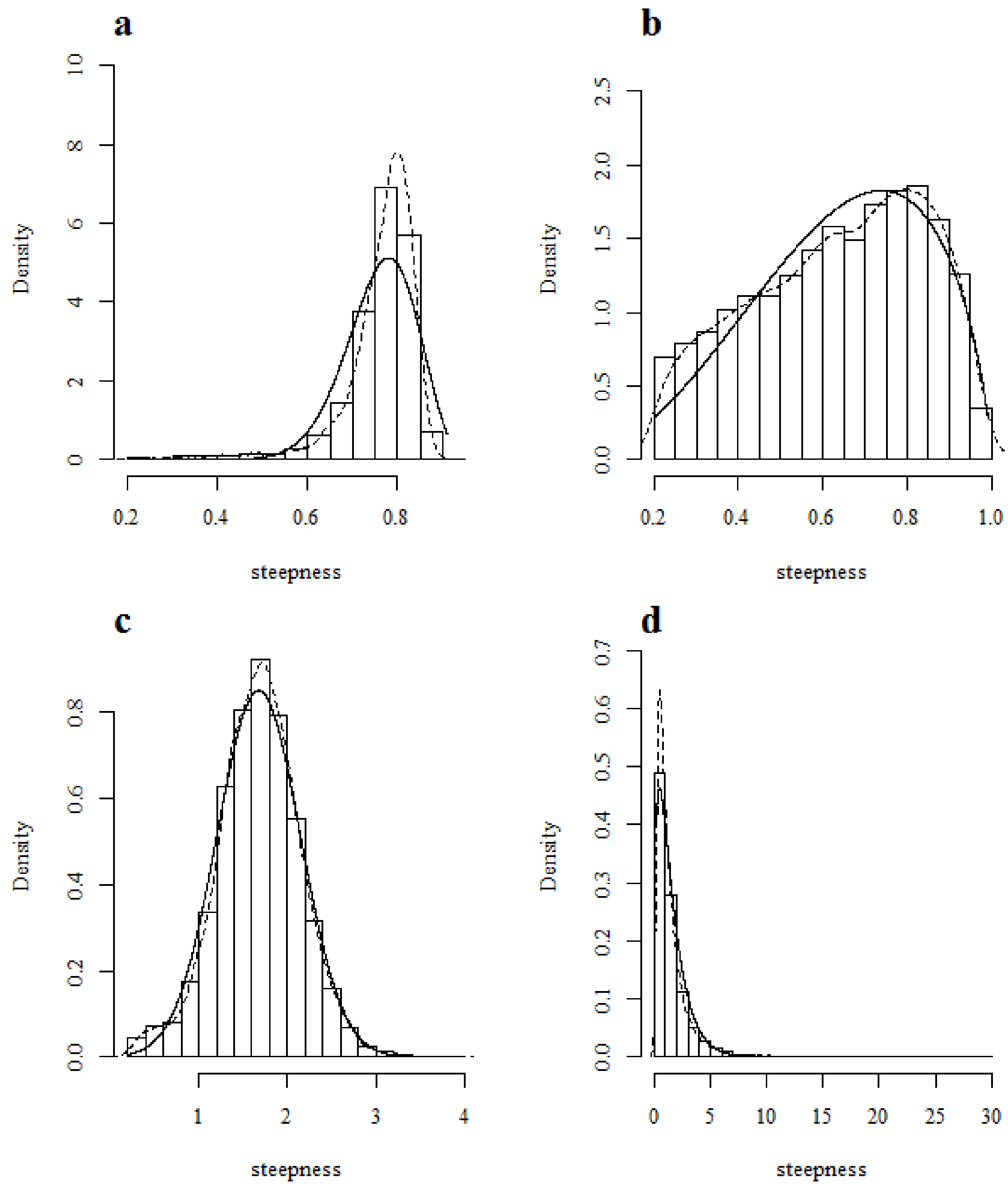

Fig 5 – Frequency histograms of steepness along with empirical (dashed lines) and parametric (solid lines) density functions fitted to those data for (a, b) the BH–SRR and (c, d) the R–SRR for Atlantic croaker (left panel) and spot (right panel) off the U.S. Atlantic coast.

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Atlantic Coastal Cooperative Statistics Program Coordinating Council Meeting
In-person Meeting
August 1, 2017 | 1:45 pm
Westin Alexandria, 400 Courthouse Square, Alexandria, VA
https://safis.accsp.org:8443/accsp_prod/f?p=550:15:1724908583617::NO:15:P15_CAL_ID_1:1899

1. Welcome and Introductions (Chair R. Boyles)

2. Review and Approve Agenda (R. Boyles) – Attachment I

3. Public Comment* (R. Boyles)

4. Review and Approve May Meeting Minutes (R. Boyles) – Attachment II

5. ACCSP Status Report (M. Cahall)
    a. Program Updates
    b. Committee Updates

6. Review and Consider Approval of the Marine Recreational Information Program Atlantic Regional Implementation Plan (G. White) – Attachment III

7. Recreational Data Collection: Changes on the Horizon (G. White)

8. Other Business

9. Adjourn (R. Boyles)

See Public Comment Guidelines:
http://www.accsp.org/sites/all/themes/aqua/File/ACCSP_PublicCommentPolicyOct2013.pdf

Our vision is to be the principal source of fisheries-dependent information on the Atlantic coast through the cooperation of all program partners.

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Atlantic Coastal Cooperative Statistics Program Coordinating Council Meeting
May 10th, 2017
Alexandria, VA
https://safis.accsp.org:8443/accsp_prod/f?p=552:15:::NO:15:P15_CAL_ID_1:1852

MEETING MINUTES

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Committee Members Not in Attendance: B. Clifford (GARFO/NEFSC), P. Keliher (ME DMR), B. King (DC FWD), T. Nies (NEFMC), B. Ponwith (SEFSC), J. Stephen (SERO)

Staff Members in Attendance: M. Cahall (Program Director), H. Konell (Data Coordinator), J. Myers (Senior Data Coordinator), A. Schwaab (Outreach Coordinator), J. Simpson (Data Team Leader) G. White (Recreational Program Manager), E. Wyatt (Program Coordinator)

Welcome/Introductions – Chair R. Boyles

The ACCSP Coordinating Council of the Atlantic States Marine Fisheries Commission convened in the Edison Ballroom of the Westin Hotel, Alexandria, Virginia, May 10, 2017, and was called to order at 11:05 o'clock a.m. by Chairman Robert H. Boyles, Jr.

CHAIRMAN ROBERET H. BOYLES, JR.: Good morning everybody, I would like to call to order the ACCSP Coordinating Council. My name is Robert Boyles; from South Carolina. It's my honor and privilege to serve as Chair of the Coordinating Council.

Public Comment

First item on the agenda is public comment, particularly for items that are not listed on the agenda.

I'm not aware that there has been any request for public comment; but I'll take an opportunity to scan the audience. I don't see anybody chomping at the bit to come speak, so we will move on and seek the Coordinating Council's consent and approval of the agenda, which was sent out in the briefing materials.

Committee Consent – R. Boyles

- **Approval of Agenda (Attachment I) – ACTION**

  Are there any additions to the agenda? I see none; we will consider the agenda adopted by consent.
- **Approval of Minutes from October 2016 (Attachment II) – ACTION**

  Also, looking for approval of our last meeting in October, 2016; also those minutes were sent out in the briefing materials. Any changes or edits to those minutes? Seeing none; those minutes will be adopted by consent.

ACCSP Status Report

- **Program Status – M. Cahall**

  We will move right into our status reports. Mike, I'll turn it over to you.

  MR. MIKE CAHALL: Good morning. We're going to go ahead and give you a little bit of a status update on what's going on with the program. From the programmatic side, we've been pretty busy. I think the single biggest areas where we've been putting a lot of our effort is in the expansions of the Standard Atlantic Fisheries Information System (SAFIS) system.

  We have been up and running again for the previous year with no significant issues that I'm aware of. We have a whole slew of pilots running. For reference, SAFIS is currently deployed in almost all of the federal dealers; probably in about half of the state dealers, and we're picking up right now about maybe 10 or 15 percent of vessel trips.

We have a number of pilots that are running that look to expand data collection; most notably in for-hire fisheries. We have one that's running in Massachusetts right now. It just started a few weeks ago; that looks at integrating biological sampling with the SAFIS electronic trip data that is collected.

We have another that's getting ready to roll for the South Atlantic Fisheries Council. That is a for-hire with validation project that also uses our eTrips Mobile tool. The South Carolina electronic trip report validation, which has some very interesting possibilities for automating some of the Access Point Angler Intercept Survey (APAIS) survey; we may have a little more on that in a few minutes. Then we're working also on the Georgia eDR. We're modifying the electronic dealer reporting system, to be used as a standard dealer reporting system. I'll speak to that in just a minute. Also, we've begun moving forward with the redesign.

I've been quite successful; my thanks to our friends at NOAA Fisheries, we've been well funded with Saltonstall-Kennedy (SK), and also with additional funding from Fisheries Information System (FIS). We now have, I think the funds that we're going to need to successfully redesign the SAFIS system. In addition, we have some help with our friends at GARFO, who have lent us part of the time of one of their contractors; who is helping us review our current design.

Then of course tomorrow we have an integrated reporting workshop. The goal of that is to come up with a programmatic standard on how business rules for integrated reporting might work. Obviously, we're going to move forward with that in much the same way the program always has. We recognize that initially it may not be adopted very much.

But we want to have a framework in place for the future; and we want to make sure that our technology is capable of performing those tasks. Right now, integrated reporting is one of those terms that is talked about a lot; but not generally very well understood, in the sense of exactly how would it work. That's the purpose of this workshop tomorrow.

We'll have hopefully a white paper from it, along with a program standard that we can push through our normal process; and in addition the concepts that are articulated by that workshop. My intention is to include those in the SAFIS redesign. In terms of the council initiatives, the councils have been very busy.

We have a Mid-Atlantic Council, which is working on a mandatory electronic for-hire reporting for all of their species. This will dramatically expand the number of trip reports that the SAFIS system collects. We have had a couple of workshops out in the field; A. Schwaab went to those. They were sponsored by the Council.

I don't know, they probably had what, 40 or 50 captains that attended total; something like that. Then although the council action doesn't require any specific tool to be used, the eTrips Mobile tool is the only one that is available to the captains at no cost; and has already been set up to send data into ACCSP, therefore/and by then extension to GARFO.

The data will come to us; we will format it and then push it into the GARFO Vessel Trip Report (VTR) system in near-real time. Those transactions occur almost instantaneously. Then in addition to that the Mid-Atlantic Council is looking at private angler reporting in the tilefish fishery. Because of the way tilefish are promulgated, we can adapt the trip reporting tool to work for that. Again, we're talking to them about exactly how that might be implemented. Some of these lessons learned will probably also be applicable to the work we're going to do for the South Atlantic Council.

Again, they're working on electronic mandatory reporting in the for-hire fisheries. Again, from a technical standpoint our eTrips Mobile tool can handle this requirement. The pilot is looking at a number of additional data elements and some changes. Our intention is at the end of the process to have a single unified tool that adapts itself, depending on what kind of permit you've logged in under, and what trip it expects to be reporting. Rather than be managing a specific version that might be in use in the South Atlantic or the North Atlantic or just for for-hire, we'll have a single version that reads your permit as you log in; and makes a decision about what kind of reports are going to be submitted. In addition, we're not quite done yet. In addition, the South Atlantic Council just kicked off last week a private angler pilot; targeted at the pulse fisheries or poorly understood fisheries, specifically our friend snapper grouper complex and cobia.

The goal there will be to recruit a group of private anglers to use an adapted version of the iSnapper tool, which has been around for a long time; and teach iSnapper how to send data into SAFIS. SAFIS will be able to collect that private angler data. Again, it looks a lot like a trip, and so we should be able to fit the data that comes in from the private angler reporting into our current trip structure, and then feed that data back in whatever format. I think I have to emphasize that at this point we don't know exactly how these data are going to be used.

From ACCSP standpoint, our job is to provide the facilities to collect the data; and be able to redistribute it back to the folks that need it. How this private angler data might be used in fisheries management, I think is very much a TBD, and also of course outside our ordinary purview. In terms of our Data Warehouse, we just completed a query overhaul, again thank you for SK and FIS for paying for that.

We've deployed our new non-confidential data queries to the public; and we are currently working on the last kind of tweaks that we're going to need for our confidential queries. At the same time we're also trying to work up a coastal confidentiality management policy, and as you can imagine we've run into some hurdles with how exactly we're going to put that data up, as we continue to have some disagreements on the finer points of what we mean my Rule of 3, and how that needs to be implemented.

I think we have some expectations that we're going to be able to actually get all of that finished shortly. I think we have consensus finally around a solution. The data structures that provide confidential data will be modified to handle those specific queries. We've got the preliminary 2016 data loaded; well in time for northeast stock assessments. We notified the Northeast Fisheries Science Center; it was about 10 days ago I think that the data became, maybe two weeks that we notified them of the data.

As some of you may recall there were some issues with timeliness last year, and it turned out that the data deadline we were given was the actual data deadline that they actually wanted data in their hands. There is a big difference between us populating our database and the Northeast Science Center processing that data and preparing it, so that it can be used for stock assessment; and Joan Palmer's staff needs a couple of weeks to do that.

We had to advance our timeline up a little bit, to make sure that those data were made available on time. In addition, we just bought a new server; which is part of our regular budgeted process. This system cost less than the last one, and has roughly five times the capacity of the current server.

We also deliberately bought it a good bit larger; because we are anticipating a transfer of substantial amounts of data from GARFO and the Northeast Science Center, as we move forward with our project to warehouse data with them. In terms of APAIS, I continue to report to you happily, this is going pretty smoothly. We've completed Wave 1, the data and we've delivered the report and data to the Marine Recreational Information Program (MRIP) program. We have completed the Wave 2 data, and we are working on processing. Those will be going out to the MRIP shortly; and Wave 3 is just started, and as far as we can tell is on track. Now we want to step back for just a minute and talk a little bit about some of the work we've been doing in APAIS.

Although the survey in and of itself hasn't changed, we've worked very hard with the staff out on the ground; most of you are probably aware of that. We've had multiple training sessions. We've been looking at the data and targeting the specific kinds of issues that we're seeing. This has been made possible by substantial automation.

The data now come into us and we read it directly into a database, where it can be reviewed and processed using a fairly powerful query system that we have; that we developed in house, and also with the help of a small amount of funding from MRIP. We're much better able to identify trends in data, and specific problems than we were previously.

We are also working on the (SEs), the social and economic data. I believe that is going also pretty well. We're getting a better response rate than we expected. Again, with a little additional funding from MRIP, we brought in a temporary person to help us process that data, so that we don't get bogged down.

Our goal is to stay ahead of the forms and keeping in mind that we're processing roughly 50,000 intercepts a year, and that the SEs adds a significant burden to that. Also the good news is as we are working, as you would expect, everybody is getting more familiar with what's going on. Folks better understand what is expected of them, we have a better understanding what the issues are out in the field; and are better able to work together.

I would say that we're watching things smooth out steadily, and the process gets better. It is very, very, very encouraging. We're also working directly with MRIP to work on the vessel registry. That continues to be a little bit of an issue, but we do have direct access to the site registry; and that kind of information, while we can provide now automated access to the assignments.

There are a lot of cool things that have been going on as a consequence of our ability to automate. In terms of for-hire, which of course has as you know caused some issues with some important species. We've been working again to make sure that everybody is clear on exactly what has to happen; and what the process and the procedures are, and how the differentiation between headboat and charterboat assignments is managed.

We've also been looking at an improved participation in the surveys. We have a roughly 25 percent improvement in response rate on those surveys; which is significant, and should improve the statistics. We're also working with MRIP to develop an improved outreach campaign; to make sure the captains understand that their data are important.

Although right now there is no mechanism for them to be able to access it that they are used; and we can certainly site examples where when their data are folded in, it does things to the statistics. We're also working directly with them to improve the vessel directory itself. There continues to be outreach to the captains to get better information on the vessels, on the kind of work that they're doing to make sure that we're accurately capturing the universal vessels, as well as their activity. We're also of course working on the council logbook initiatives. I think it's important to consider that right now there is no mechanism to integrate in any logbook data into the MRIP official figures; following the standard wave format.

Right now at the end of the year, the data are pulled from GARFO; who has VTR requirements for their for-hire fisheries, and integrated in to change the catch and effort estimates. What our goal would be would be to work with MRIP to find some mechanism to integrate these logbooks into the monthly waves. We believe that there are a couple of different options, and we've already had some preliminary discussions with MRIP.

We will continue to move forward and work with them; to try to work through a mechanism. Ideally, we would like to see the logbooks integrated in as an intercept. Then that would potentially exempt the captains from being called, and of course those data would be sent to where everything needed to go; depending on who needed them. We may look at a similar method for doing the private angler data.

But right now it is all very preliminary, and all we've had is like very superficial discussions with them. But we have a serious concern about making sure that these data get used. Now obviously any data that comes into us will be immediately available to the captains who submitted it. The issue with, I don't ever see my data can I get it back? We can resolve that by simply providing the captain's access to their own information.

How the information gets used, again I think remains to be determined. We continue to work with GARFO, actually quite closely. We have two GARFO contractors on site right now. We've been working carefully with their visioning process. Their visioning process essentially came to the same conclusion that ACCSP has; that we really need a single unified system that we need to have universal trip identifiers. I don't know, some of you have been with the program for a long time.

You might remember the concept of a single trip ID, unifying all of the different reports together; and that's essentially the direction that GARFO has decided that they want to go into. The planning for that continues, and in fact my hope is that some of the work that we do at the integration workshop will feed into their visioning process.

There are going to be a couple of folks from GARFO that will be there. I am now on the committee that is managing their visioning process, and we have a biweekly conference call; which I can tell you can be quite enlightening. Working again with the universal trip identifier, if you want to step back for just a minute, and I'll try hard not to glaze you over.

The goal here is to create a tool that any reporting tool can access; to get the universal trip identifier that will stamp that trip and propagate through any of the other transactions that might be associated with it. If I am a captain I'm haling out, I get a trip identifier. If I'm the observer I say I'm on that boat, I get that same trip identifier.

If I'm a dealer and I've bought from that boat, I get that trip identifier. If I am a bio-sampler, and I'm sampling catch from that boat, I get that trip identifier; so that the entire universe of data is pulled together. Now you can immediately trip over a whole slew of scenarios where that could get complicated. Again, that is part of what we're going to be talking about tomorrow. But the universal trip identifier is the core of the vision for GARFO, and is the core for our discussions around the SAFIS redesign. Our goal will be that no matter what tool is doing these reporting, it will access this universal trip identifier tool; that will automatically generate a number that can be referenced by other reporting activities.

We already have the contractor on our site that GARFO has hired. He's also been really helpful. He's done some analysis for us that we don't generally have time to do; and provided us with a lot of feedback about how our databases are laid out, and how they're designed. He's had some suggestions, and he'll be actively participating. He and the second contractor, who started just last week, will be actively participating in the workshop tomorrow as well, more as technical advisors.

But they've already been very helpful, because we don't just have the time to perform this kind of in-depth analysis; and it's been very helpful, as I keep saying. We have the Data Warehouse contractor. She is now tasked to us, until we get a little bit further down the road. What's she's doing is performing an up and down analysis of the Data Warehouse; much as we've already done for SAFIS, to look at our data structures, to understand the processes of how the data flows and moves in and out, so that it's all very thoroughly and clearly documented and understood.

Then the goal is to go over and look at what GARFO is doing, and what the requirements are in the Science Center, and look at the delta between these two things. What will we have to do, in order to be able to provide the services to GARFO and the Science Center? I suspect that we're going to be able to do that; it's relatively straightforward.

Even if it may sound like it's large, but the bottom line is that we're still looking at essentially the same kind of transactions. There are observer trips, there are biological samples, there are vessel trip reports, there are dealer reports, and then there are some ancillary datasets. They may be in different machines, they may be in different formats; but essentially the universe of data that we're talking about is stuff that I think we understand reasonably well already. Are there any questions for me? Mark.

MR. MARK ALEXANDER: Thank you for the presentation, Mike. It's always good to get a fresh look at what's going on. With regard to updating the vessel registry, I know that I've kind of looked over the shoulder of my staff; who was working on that. I was amazed to see that there were vessels for Connecticut in that registry that haven't had permits in years.

At the same time, we've been submitting for-hire vessel information, along with all our salt-water-angler registry data; every month for well over a year. I'm wondering, what's the impediment to getting that data to become the vessel registry; rather than have to suffer through this manual process?

MR. CAHALL: We've actually discussed this specific problem. I think I have a pretty good understanding, but I'm going to let Geoff give you the details.

MR. GEOFF WHITE: The vessel directory we're talking about here is primarily the for-hire survey vessel directory; that is also used by APAIS, and the parallel development of the angler registry and the charterboats, and the vessel information you've been sending was also part of the MRIP angler registry development. MRIP has been working on converging those two things in an online vessel directory; which will clean up a lot of the file passing, between the different components of the survey. We've been working with them on a lot of those details.

We certainly understand the extra effort that you and all the states have been putting into maintaining the more manual version of the vessel directory, as it stands today. We've been working and watching the progress of MRIP on their online vessel directory that should include all of the permit information and those types of things.

The short answer is that there were two parallel tracks that are now converging. We're getting really close. We've heard from MRIP that they've got some delays in contractor staff. They wanted to have the online directory posted, actually for the beginning of 2017, and it looks like it's going to be, we still hope later this year to get that out.

CHAIRMAN BOYLES: John.

MR. JOHN CLARK: Thank you for the photo update, Mike. I have a question about the APAIS Survey, and I'm sure you know where I'm going with this. We had a situation in Delaware, and I think it happened in some other states, where a headboat had mechanical problems. The headboat operator got a substitute boat that was pretty much the same size, same captain, and same crew; probably the same customers going to the same place, and yet the data was not used, because that boat wasn't the registered boat for the survey.

Is there anything you can do for that? I mean obviously you know how difficult it is to get a lot of this survey data. In this case it seemed common sense would seem to dictate that well, given the situation that we can just use that data. I'm just curious as to whether this problem will be addressed.

MR. WHITE: We have mostly already addressed it from a statistical standpoint. It was looking at, when we worked with MRIP staff all the way up, and had them help us determine. If a vessel is not in the directory, and there is no sampling probability for that vessel, while it makes complete common sense that the catch data from that vessel would be representative.

If there is no mathematical way to expand that with known sampling probabilities that were determined before the draw of that assignment, then it can't be used in the vessel frame and the expansion. That's what I understood the answer to you back. That is why we've had to clarify the headboat assignment instructions; to sample vessels that were part of the draw.

MR. CLARK: If I could just follow up a second, Geoff. They can't just accept that substitute boat as the boat that they already have the assignment for? I mean in this case where you have something that is so similar. I'm just having a hard time reconciling how the boat itself actually is going to make much of a difference here.

MR. WHITE: We can certainly continue to look at case-by-case situations. There were other situations where a boat listed in the directory is a charterboat was written as a headboat; or a boat listed in the directory as a charterboat, sorry the reverse as a headboat was sampled at the dock as a charterboat. When that happens you're switching protocols, you're switching methodologies, and those were some of the associated problems. There is some flexibility, and I'm working on giving all of the states some clear direction on it. If a vessel is of the same size and it's been drawn, and you can get it into the directory to get those things included. I realize in your particular case that was a little bit more unfortunate with that vessel change. But the instructions at that moment would be work off of the current months draw, actually wave, so two-month draw, and if there is a vessel that changes like that to provide those vessel changes to us; and make sure that they're in the next waves sampling frame, so we can make those changes within the year.

MR. CLARK: If I can just follow. Just to get you straight then, so in the case that happened this past summer. The instruction would still be not to go out on that boat. But if it happened in the following wave they could go out on that boat?

MR. WHITE: Correct. If it is not in the draw for this wave, don't ride it. But, adjust your vessel directory and your pressure files, which are the inputs to the draw; so that next wave that vessel can be included and then sampled.

CHAIRMAN BOYLES: Tom.

MR. TOM BAUM: Just to give another scenario, another headboat scenario; so it will probably be for you, Geoff. In the past, I guess the practice of getting to the dock, getting to your headboat assignment, and the captain decides well, I have five people here; I'm not going, and they have a captain's agreement at that dock. The headboat next to him is going out; his customers get on that boat for that day. As I understand this conversation that field interview can't do his assignment on that other boat, where they had that captain's agreement.

MR. WHITE: There is a procedure for riding an alternate vessel. It is the last option. The choices and the priorities are, if the vessel that you're planning to go on that day is not available, to reschedule. If you cannot reschedule and there is another vessel that was part of the draw for that month, you may ride that as an alternate vessel. Otherwise, unfortunately yes, go back home, reschedule it, and get back on a different vessel on a different day.

MR. BAUM: I'm just trying to imagine the field interviewer, if he's going to even know, they're going to even know that they'll be able to reschedule it? That's more of the coordinators job to know the entire schedule, as far as that boat goes and the rest of the month; not the field interviewer.

MR. WHITE: That would be up to the coordinator to make those phone calls and make those scheduling changes. As one of the things Mike pointed out, the application that we have that works on a cell phone, the field interviewers do know what vessels were in the draw that month. They do know which vessels they can do; and the protocols state, when that situation occurs, if something happens that is unusual. The field interviewer should call their state lead at that moment, before they board the vessel, and find out what they should do.

CHAIRMAN BOYLES: Further questions for Mike or Geoff? Next we'll move on into committee updates. Pat Campfield.

- **Committee Updates – P. Campfield**

MR. PATRICK A. CAMPFIELD: I'm going to summarize the activities of a number of the ACCSP committees over the past several weeks, and a lot of activity this spring that we should commend the staff and Mike on. They've been burning at a pretty high RPM rate. To start with, the Operations Committee met about a month ago for their, you could say their spring call; with the focus of the meeting being on reviewing some new Request for Proposals (RFP) Workgroup recommendations related to the annual funding process.

We'll cover that later this morning in a few additional slides. The other focus was the Operations Committee call was to review progress and the status of new proposals that were funded in the FY16 cycle. In summary, all those projects are underway. We also wanted to note there was a delay in the transfer of funds for a subset of those projects; and they will be applying for no cost extensions.

But that was related to money arriving to the program late, and therefore to the project partner recipients late. A week after the Operations Committee, the Advisory Committee met. I participated in that meeting, and the highlights of their call were to develop and improve materials for new advisors, so the welcome packets that A. Schwaab and others have developed to approve those materials, to get folks up to speed when they join the Advisory Committee.

I provided a summary to advisors of the RFP Workgroup recommendations. We also wanted to note that the advisors have added two new members from New Jersey, which is encouraging. But we also are looking to recruit additional members, notably from the four states listed on the board. If you have any ideas for potential advisors from North Carolina, New York, Mass or Maine, please communicate with A. Schwaab and M. Cahall.

Moving on to the Biological Review Panel, they have been very busy in the past six months; including their meeting in February to update the Biological Priority Matrix. That was completed, and will feed into this year's funding cycle and RFP project selection process. The biological group also elected a new Chair and Vice-Chair.

Since that time there have been some changes in those two people's professional tracks, and so the Vice-Chair will likely be moving into the Chair position. The Biological Review Panel also wanted to let you all know that the resilience factor project is proceeding. That's a new category or column within the Biological Matrix. They will also be working on a conversion factor project to build on what the Commercial Technical Committee will be completing in their report.

Conversion factors is something that it seems like the program is working on continually; but that's making great progress in getting all the conversion factors squared away among the states and different partners. The Biological Review Panel also provided a memo to the Operations Committee outlining guidelines for data collection proposals; to have them truly meet the biological module or category, and the related scoring criteria when we look at the proposals.

Finally, the Biological Sampling Program inventory application continues in its development, and we hope that will be available to the public on the website soon. The Bycatch Prioritization Committee met that same week in February. They also completed their prioritization matrix, and that feeds into the RFP process.

They also elected a new Chair and Vice-Chair, who are Mike Errigo from the South Atlantic Council, and Jacob Boyd from North Carolina; so good to have some new leadership there. Within the bycatch matrix itself, we've added a new metadata tab; which explains the current data sources that are contributing or feeding into the bycatch matrix. Bycatch also provided a memo to the Operations Committee, outlining some concerns with the matrix; and had some suggestions for additional fleets and how that relates to the ranking. Moving on to the Commercial Technical Committee, they had their meeting also about a month ago. One of the most notable new developments is the release of the Data Warehouse.

Mike touched on this, this went live about six months ago, which is a huge achievement for the program; and a really new and improved Warehouse. We've had a demo and a session within our office, and it's much better than the earlier version and easy to understand how to get in there and search for data.

The new version came out, but we are also looking for ways to enhance that and taking suggestions on refining the new version; including improving the display of non-confidential data for the public. Commercial Technical Committee has also been working on a swipe-card program. There were two pilot swipe-card programs in Massachusetts and Maine; which we've heard about in past council meetings.

We've now moved on to sort of a full implementation, where we're developing standards so that all partners can begin to adopt swipe-card technology; and use that to collect data and get everybody on the same page. I've also got a note there that Maine is expanding their program to the scallop fishery for the upcoming season.

Finally, for Commercial Technical Committee, Mike touched on this, but the SAFIS redesign and integrated reporting projects are continuing to progress very well; including former Operations Chair, Tom Hoopes, serving as a contractor to develop the requirements for the SAFIS redesign. There are a few other pieces listed there in terms of next steps for SAFIS redesign; including the integrated reporting workshop that will take place tomorrow across the hall.

Moving on to Recreational Technical Committee, they had a conference call last week. The primary project in front of them this spring is they drafted the Atlantic MRIP Implementation Plan. They'll be working on setting priorities within that plan; as well as getting input from MRIP leadership to the Recreational Technical Committee, as they make refinements to the Implementation Plan.

Then a few on the Council will see the draft before it is submitted and have an opportunity to comment on it before it's submitted to MRIP. The Recreational Technical Committee was also invited to provide comments on the newly forming MRIP Strategic Plan, and the other activities include setting the recreational priorities for the upcoming ACCSP funding process, which they do every year. G. White and company are also planning a meeting for this summer.

Lastly, the Standard Codes Committee has addressed a few detailed issues, including resolving some duplicate codes; ironing out some species or species group names within standard codes, as well as the addition of forage species or groups of forage species to the SAFIS species table, which I think was driven in part by the Mid-Atlantic Council's activities involving more forage species and their Forage Amendment.

A couple of pending items, the Standards Code group has established a Seized by Law Enforcement disposition category, which was a bit of a hang up in the past for any fish that were taken through law enforcement activity that didn't fall into the usual codes for disposition. They are also reviewing the gear attribute standards, which I believe are Appendix 1 in the ACCSP standards. That summarizes the committee updates, Mr. Chairman. I'll happily take any questions.

CHAIRMAN BOYLES: Questions for Pat. Lynn.

MS. LYNN FEGLEY: Thank you for that presentation. A question specifically for Maryland, we had a little bit of a furor in our state with the release of the preliminary estimates for black sea bass. The conversation that we started having was with MRIP. It seems as though estimates when they're released, the preliminary estimates tend to be significantly different from the final estimates.

The question that we were asking within our state was is there anything we can do to resolve, maybe not release the preliminary estimates, or something to sort of calm our constituents down? I know that our Recreational Technical Committee representative had sent a note, and asked to put that on to talk about it at the meeting. I just wondered if there was any discussion, and what the outcomes might have been.

MR. WHITE: Sure, no problem. It was raised near the end of the meeting, and a lot of the issue in including the for-hire information in the preliminary estimates has to do with the data timing. Whether it's the Maryland charter logbook information, or the federal VTRs, are those available within the timeline for MRIP to use those data within the preliminary wave base estimates?

It's different for how the headboats work and the charterboats work, and how those combine with the effort surveys to be able to include them and present them. They certainly discussed the idea of the timing of those reports coming in; and whether they were available to be included in the wave-based estimates. The issue was raised relative to not presenting some species versus not presenting all species; and that was certainly a concern that wasn't finalized, on choosing when to present some and not to present others. That would take some additional work.

MS. FEGLEY: As I understand it was the VTRs that I think were still in the pipe. Really I guess the overarching question here is what is the utility of presenting those preliminary estimates, when it's known that they're going to be very different from what's final? I don't need an answer to that now. But I think that's something just philosophically to consider as we go forward.

MR. WHITE: That's certainly up to MRIP to decide, and we can provide some advice on. But the VTRs are a mandatory program. This actually goes back to what the MRIP Communications Team and we have been working on in getting more APAIS intercepts on for-hire vessels.

The VTRs are mandatory, and have a different timeline associated with them. The APAIS Survey is voluntary and actually included in the for-hire telephone survey for the effort piece. The combination of which one does the captains answer to is another component in getting better compliance with the voluntary survey.

CHAIRMAN BOYLES: Further questions? Jay.

MR. JASON McNAMEE: A question for Pat. On your very last slide there, I saw there is a new disposition code for seized by enforcement or something like that. Is that code currently live? Is it something that can be used now, or is there still a process before it gets officially input?

MR. CAMPFIELD: I might turn to the staff to see if they can answer that in more detail than I can.

MS. JULIE SIMPSON: That is still being proposed to the Standard Codes Committee. The proposal is right now there is a single disposition for Seized by Law Enforcement, and so it loses the information of whether it is food or bait, or the other portion of the disposition that you would otherwise use the code for.

The idea is to take Seized by Law Enforcement and make it a disposition category, and then have, Seized by Law Enforcement, actual code bait. That is the proposal it's going to standard codes. Once they have proof of whatever they do with it, then it would be implemented.

MR. McNAMEE: Quick follow up. There is something there already, what is happening is it is being refined to better characterize what exactly was seized.

MS. SIMPSON: That's correct.

MR. BAUM: What happens with that seized law enforcement product, many times it's donated as food, just to keep that in mind.

CHAIRMAN BOYLES: Further questions, Tom? Wilson, excuse me.

DR. WILSON LANEY: A question for Pat or Geoff, I guess. Have you all noticed any uptick in use of the Data Warehouse since the redesign? I was just wondering.

MR. CAMPFIELD: I would say that's more for Julie and her crowd.

MS. SIMPSON: We're not directly monitoring it, but we are definitely seeing more use in that when folks come to us we're able to send them to the Data Warehouse and say, this is how you can get it. We get more, I got it, it was great as opposed to, I'm not getting it can you please do it for me. We're getting a lot more, and then we don't see that person come back to us again. Hopefully they're still continuing to use the Warehouse; but I don't have an actual metric for it.

DR. LANEY: That sounds great, Julie. That sounds like not only is the new interface more user friendly, but it's also making things more efficient; by not having folks come back to you for assistance as much.

MR. CAHALL: I would comment that we're also working on building utilities to be able track the statistics better. The way things are laid out right now, it's really hard to tell who is logging in and doing what. But it's certainly on our list of things to do.

CHAIRMAN BOYLES: Tom, did you have something?

MR. BAUM: Yes I did, thank you, Mr. Chair, not a question, just a moment to recognize. You mentioned that New Jersey had nominated two more members for the Advisory Committee, and I would just like to recognize Mr. Fred Akers, one of our Advisory Committee members; who is in attendance today. Thank you.

CHAIRMAN BOYLES: Welcome, and thank you for your volunteering. Further questions for Pat, all right seeing none; we will roll into Item 5, Mike, 2017 RFPs.

Review and Consider Approval of 2017 Request for Proposals – M. Cahall (Attachment III) – ACTION

MR. CAHALL: We requested per your direction, we requested that the Operations Committee consider making changes in the RFP processes with the eye towards providing better flexibility and reprioritizing the program priorities. The Operations Committee created a small workgroup that spent several weeks looking at various different scenarios, and made a series of recommendations; which were presented to the Operations Committee on a conference call a few weeks ago.

The Operations Committee does have a series of standard recommendations, and we'll go through those in just a second. Basically, we were looking at the module prioritization as the largest piece. We had a couple of different options on whether we might maintain status quo, which I think honestly is contrary to the directions that we had, all modules being equal; which is what the workgroup initially recommended and then whether or not we might want to rearrange the order of the modules.

We had, if you look at the decision on the model. The Operations Committee was unable in this conference call to come to consensus on the best way to reprioritize the modules; and they wanted to table that discussion until the upcoming year. That means that if that recommendation is adopted by the Council then we'll maintain status quo, in terms of how the scoring for each individual module occurs.

Just to refresh everybody's memory. Can you show the chart of how the scoring works? It's a little further down here. The way that we add weight in the proposal process, is by giving the highest priorities the best opportunity to get the most points. Catch effort projects have a maximum score of 10. Biological sampling projects have a maximum score of 6, and so on. It is those scores that drive the outcome of the process.

I think if you looked down even as a secondary module, I don't need to go into all the details, because it is actually a fairly complex scoring process. But essentially, if there is a secondary module in the proposal it too is scored, and again the commercial catch effort. If you have a biological project that has a large catch effort component; then it would receive additional scoring, because of the catch effort component.

Then finally there is one more spot. The point being that the easiest way to reprioritize the modules is to shuffle the scoring around. Can we just go back to this flow again? I'll try to be good. At that point, just to reiterate the Operations Committee were not able to come to consensus on the call, so that at this point their recommendation is essentially status quo.

They want to spend some more time to consider that. In terms of maintenance scoring, one of the big concerns that the Operations Committee raised was well, if we have a maintenance project it's essentially the same thing that was last years, it's going to get the same score. They wanted to simplify that process as much as possible. I think we want to keep in mind that the maintenance projects are going to start to fall off in 2020. The first cut, the 33 percent cut happens in March of 2020, whatever fiscal year that works out. I always get confused which one it's supposed to be. Some of these may become moot as we move forward.

In any event the maintenance projects tend to be dropping off anyway. Folks are picking up maintenance of these projects on their own, or some of it is transitioning to other places. Again, so what was recommended was to go ahead and use a condense scoring scheme for maintenance projects; which essentially is a scoring as proposed right there on bullet A, if it achieves the goals, was it properly prepared, et cetera, et cetera.

This also involves something that we haven't really taken into account too much before. We have had routine updates from the Principle Investigators (PIs) on these projects, but we've never actually scored their following year based on previous year's performances. This is new, and I think honestly a bit of an improvement over how we've been doing it before; and of course whether they're properly prepared, and you know spelling counts.

Whether they have a date of delivery plan, which of course is important to what we're doing. Then finally, they get higher scores if they ask for less money. They get a lower score if they ask for more. Then finally, we would only use that approach if funding was available that would exceed the maintenance total that was requested; which has been what's been happening in the recent years.

Typically we've had anywhere between 20 and 75K left over after the 75/25 split, and so it's been relatively easy to go ahead and take care of those maintenance projects. The Operations Committee came to consensus and is forwarding this recommendation to the Council. Then finally, they wanted to add a metadata into the scoring, so that improvement of data quality and timeliness becomes, essentially they're changing the name metadata to improve metadata quality and timeliness, which is kind of how it's been worked in the past.

The metadata is a very nebulous term. It's been difficult to quantify. But they wanted something that was a little more concrete that demonstrated; hey this is going to make a difference. They wanted to go ahead and include this. The metadata itself will be replaced by the Data Delivery Plan. Are we going to get the data from this project?

Because there are some projects that have not been routinely delivering data to us, which has been an ongoing issue. Then again, the Operations Committee considered that and forwarded this recommendation to this Council. Finally, one of the big issues is merit. This has come through where we have projects that are a little bit outside the normal, where folks felt that it was really a good idea, and in fact in the last round we asked you all to approve a project that fell outside of our normal funding criteria; which you did.

This will allow us to assign up to five points, based on the merit of the proposal; regardless of which of the modules it falls under. Five points will be enough to push a biological project up to have competitive scoring with catch effort; probably not a bycatch project as we currently stand right now. But it could make a significant difference, in terms of a well-prepared-biological project that was innovative. We've been getting a lot of kind of really cool ideas that often involve genetics, which is fun for me. Then again, the Operations Committee reviewed that recommendation and is forwarding it up to this Council. This is how the scoring would work. The blue section highlights the changes, so the Data Delivery Plan could be up to a plus two. The improvement in data quality and the timeliness could be a zero to four score, so that could make a significant difference. Then finally merit could push up a score by as much as five points.

This merit will give the Committee flexibility enough to push projects that otherwise might not make it into the top group are likely to be funded, if we felt they were really interesting, really innovative and would advance the science of data collection. Cheri.

MS. CHERI PATTERSON: Right now does that pretty much just pertain to new projects, or does that include maintenance projects with the merit?

MR. CAHALL: This is for new projects. No it's for both? I'm sorry, yes both. But again, I think just to step back. In the whole history that I've worked on the program, I think once we've been unable to provide funding for an ongoing maintenance project. Typically they get funded. Here's the ranking guide for the maintenance, the simplified guide.

Again, did the project achieve its goals? Did it have a data delivery plan? Are they asking for more or less money? I guess you know ten cents more is more, or exactly the amount of funding. Was it properly prepared? Again, we are beyond the era now where they come in where we really can't figure out what people are asking us for.

But occasionally they do come in and they're a little confusing, and it takes us some time to sort through them, and the Operations Committee also. We have a few members of the Operations Committee that are sticklers for making sure the formats right, and we can understand; because if you're looking at 10 or 15 of these things, it can get to be quite confusing. Then finally on the merit again, this is a zero to three as opposed to a zero to five score. This would be for the maintenance project. The merit does apply to both, but on a little bit of a different basis.

MR. CAMPFIELD: I just wanted to add. There was quite a bit of work that went into these recommendations from the Subcommittee of Operations and Advisors. I think we had four Operations members and two Advisors, so it was good to see participation from both groups. I want to recognize Nicole Lengyel from Rhode Island, who's here today, who did a lot of the rescoring analysis that was the meat and potatoes of laying out these options; as well as Elizabeth, who kept the project moving.

Although the Operations and Advisors were unable to reach a clear consensus, there was a fair amount of support for making a change to how the different modules are weighted. Ultimately we decided we didn't have consensus, and we might want to take more time into later this year and consider it for next year's cycle. But there was mixed support, so I just wanted to pass that on to the Council.

EXECUTIVE DIRECTOR ROBERT E. BEAL: Pat, were there kind of two camps, with the reason that the folks that didn't want to make the change, I guess. Was there a reason that they were resistant? Did they just run out of time or are there specific reasons where they were uneasy with flip flopping a couple of these priorities?

MR. CAMPFIELD: I think one example concern was that bycatch they see as important, but they didn't want to make it equal to catch and effort, which is core that we need that every year, it feeds into stock assessment and other management decisions. They were concerned about giving them a level playing field, and very concerned about making bycatch and bio higher than catch and effort.

Given that you can go in and get bycatch data less frequently, and still get an understanding of those dynamics. But they wanted to keep catch and effort as the high priority. That was one example. But they also mentioned they would like more time to think it through. Although we lay out, I think two or three options during the call. Operations came up with different variance, and so they asked for scoring of those additional options; and that would take more time.

MR. ALEXANDER: I just have a question about the properly prepared score there. That is interesting, and I can totally understand why that's there. Was the intent to ding a proposal on the initial review or only on the final review if they couldn't get it right?

MR. CAHALL: Always on the final review.

MS. FEGLEY: To follow up on Bob's question. It sounds like the Committee needs some more time to think about reshuffling these priorities. My question is can you tell us are there ramifications for staying status quo until the next funding cycle?

MR. CAHALL: Probably not. Even if let's just say we reshuffled the program priorities to make the biological equal with catch effort, which would potentially resolve some of the issues that folks have. The perception of the program right now is that we are focused primarily on catch effort. It will take us some time to get the word out to folks who might potentially be preparing biological proposals.

We sent out the RFP, and to be honest I'm not certain folks read it, beyond making sure that they're preparing things in the right format. I think without a significant outreach effort that says, hey we're looking for biological projects, or we want to start talking about bycatch. I don't think that the likely list of things that we're going to receive is going to change.

Even if we adjusted the priorities right now, and sent out the RFP with the adjusted priorities. I think that it would take a year or two for it to sink into folks that we're looking at adjusting; and we want to look at biological sampling projects, or maybe kick off another socio-econ research or something like that.

MS. PATTERSON: I would like to make a motion to approve the Operations Committee recommendations for this RFP process.

CHAIRMAN BOYLES: Okay motion by Cheri, is there a second; second by Tom, discussion. All those in favor of the motion signify by raising your hand, please. Any opposed to the motion; any abstentions, null votes. That motion carries unanimously.

Other Business

Is there any other business to come before the Coordinating Council? Michelle, is that a wrist raised or a hand raised? Yes that' a hand raised. Okay, Dr. Duval.

DR. MICHELLE DUVAL: Let me stand between you all and lunch. I guess just in reading the briefing materials, which included a long list of the RFP as modified. Also, we had some slides on the Biological Review Panel recommendations based on the matrix, and the bio-sampling priority matrix.

I just had a couple concerns about the scoring for some of those species. You know with regards to the greater than, I think 25 percent or significant changes in landings within 24 months. It seems like a couple of those scores were sort of mixed up a bit. Like cobia scored really low. I mean 24 months ago we had no problem with cobia.

Now there is like two and a half times the catch of cobia, so I was a little concerned to see just a one, in terms of significant change in landings; and then also looking at that sampling priority matrix, where you see in the bottom left hand quadrant, you know adequate sampling and low priority columns for red snapper and Atlantic menhaden. It notes that they're being sampled adequately and have low priority, so additional sampling is not needed.

Now if this is red snapper in the South Atlantic, I think we've got a lot of constituents who would probably argue otherwise. I feel like I would be remiss if I did not bring these things forward. I had a similar concern about snowy grouper, in terms of the bio-sampling matrix. Absolutely we need more sampling of snowy grouper, but again it was with that significant change in landings within 24 months.

I mean that scored a three and cobia scored a one and there hasn't been that significant a change in landings. Now we've had an increase in the ACL. I just want to lay those out there, because I understand that the Bio Sampling Committee met and reviewed this matrix. But I just wanted to get that out there.

CHAIRMAN BOYLES: Thanks, Dr. Duval. Cheri.

MS. PATTERSON: Considering that we will not be dealing with the priorities, rearranging the program priorities for this funding cycle. I would like to know in anticipation of this process being presented back to us next year, where the socioeconomic module lies in its progression, and how we can try and get that up on the scoring board for the somewhat near future. I guess I just want to know about the Committee and the module for the socioeconomic data.

MR. CAHALL: Certainly. First Dr. Duval, I think it would make a lot of sense for you to touch base with Julie, who can I'm certain explain exactly how those numbers were derived. If we find issues and errors in those numbers, we'll certainly be glad to correct them. Secondly, Cheri, in answer to your question, as you know we're dependent on the Commission's Committee on Economics and Social Sciences (CESS), which I understand is getting cranked back up again.

At this point, there has not been any forward motion on that nor have any funds been expended towards implementing that program. Honestly it was one of the kinds of drivers in thinking about; we need to consider readjusting our program priorities. Having said that, we have a lot of data that are being used by social economists that were unavailable in previous years simply because of the breadth of our registration tracking, we know how old the fishermen are. We know where they live. We know how busy they are, those kinds of things.

We are not asking specific social and economic questions. But we do have pretty good demographics, and we do have a fairly complete universe of commercial fishing folk, and are able to run different kinds of analyses on those. But we do need to get it going, I agree. It's just a matter now of getting it through the CESS.

MS. PATTERSON: Pat, did you want to mention something before I forward a recommendation?

MR. CAMPFIELD: Maybe it's one and the same, but I think offline discussions have led to we should identify a core group from the Socioeconomics Committee to work with the program and get the socio-econ standards moving; so that we can both ask for and better support those types of data's coming in if we fund a couple projects.

MS. PATTERSON: Follow up. **I would like to speak for the Council as a whole that we would recommend that that move forward in anticipation of program priorities reshuffling next year.** Then if there is a problem with interaction or engagement of the CESS Committee that there be a workgroup put together.

Where you're bringing in additional socioeconomic individuals that can help out and anybody who's on the CESS Committee that would like to participate in that work group would be helpful. But maybe not just rely on the CESS Committee, if they're having struggles getting this done. Maybe just put together a workgroup.

Adjourn

CHAIRMAN BOYLES: Without objection; so ordered. Any other business, seeing none; we will stand adjourned. Thank you all.

Action Items

1. The Coordinating Council recommends the CESS Committee to assess ACCSP's current Socio-economic standards in anticipation of the primary priorities reshuffling next year.

Atlantic States Marine Fisheries Commission

American Lobster Management Board

August 1, 2017
3:00 – 6:00 p.m.
Alexandria, Virginia

Draft Agenda

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

1. Welcome/Call to Order *(D. Borden)* 3:00 p.m.

2. Board Consent 3:00 p.m.
   - Approval of Agenda
   - Approval of Proceedings from May 2017

3. Public Comment 3:05 p.m.

4. American Lobster Draft Addendum XXV for Final Approval **Final Action** 3:15 p.m.
   - Presentation of Proposals from Lobster Conservation Management Teams (LCMT) 2, 3, 4, 5, and 6
   - Technical Committee Report on LCMT Proposals (*K. Reardon*)
   - Consider Final Approval of Addendum XXV

5. State and Federal Inconsistencies in Lobster Conservation Management Area 4 Season Closure (*M. Ware*) **Possible Action** 4:45 p.m.

6. American Lobster Gulf of Maine/Georges Bank Subcommittee Report (*M. Ware*) **Possible Action** 5:00 p.m.

7. Update on Development of Draft Addendum XXVI (*M. Ware*) 5:30 p.m.

8. Law Enforcement Committee Report on Lobster Chain of Custody (*M. Robson*) 5:50 p.m.

9. NOAA Office of Law Enforcement Draft Enforcement Priorities 2018-2022 *(M. Ware)* **Possible Action** 5:55 p.m.

10. Other Business/Adjourn 6:00 p.m.

The meeting will be held at the Westin Alexandria, 400 Courthouse Square, Alexandria, VA; 703.253.8600

MEETING OVERVIEW

American Lobster Management Board Meeting
Tuesday, August 1, 2017
3:00 – 6:00 p.m.
Alexandria, Virginia

Chair: David Borden (RI) Assumed Chairmanship: 02/16	Technical Committee Chair: Kathleen Reardon (ME)	Law Enforcement Committee Representative: John Cornish (ME)
Vice Chair: Stephen Train (ME)	Advisory Panel Chair: Grant Moore (MA)	Previous Board Meeting: May 8-9, 2017
Voting Members: ME, NH, MA, RI, CT, NY, NJ, DE, MD, VA, NMFS, NEFMC (12 votes)		

2. Board Consent

- Approval of Agenda
- Approval of Proceedings from May 2017

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

4. Draft Addendum XXV (3:15-4:45 p.m.) Final Action
Background • In May 2017, the Board selected a 5% increase in egg production for Addendum XXV. • LCMT's submitted proposals in June to achieve that 5% increase in egg production. • The TC met via conference call on June 28th to review the LCMT proposals.
Presentations • Review LCMT proposals to achieve a 5% Increase in egg production **(Briefing Materials)** • Technical Committee report on LCMT proposals by K. Reardon **(Briefing Materials)**
Board actions for consideration at this meeting • Select LCMA specific management measures and implementation deadline. • Approve final document.

5. State and Federal Inconsistencies in LCMA 4 Season Closure (4:45-5:00 p.m.) Possible Action
Background • In April 2017, NY and NJ sent a letter to the Board, highlighting inconsistencies between state and federal regulations for the LCMA 4 spring season closure. Specifically, in

federal waters traps must be removed from the water and the most restrictive rule does not apply, while the opposite is true in state waters. **(Briefing Materials)**

- In May 2017, the Board voted that, for any season closure implemented as a result of Addendum XXV, traps can remain in the water and the most restrictive rule does not apply.

Presentations

- Overview of season closure regulations by M. Ware

Board actions for consideration at this meeting

- Align state and federal regulations for season closures.

6. GOM/GBK Subcommittee Report (5:00-5:30 p.m.) Possible Action

Background

- At the May 2017 Board meeting, preliminary recommendations regarding future management of the GOM/GBK stock were presented to the Board. The intent of these recommendations is to improve resiliency of the stock.
- On July 13th, the Subcommittee met again to further develop these recommendations.

Presentations

- GOM/GBK Subcommittee report by M. Ware **(Supplemental Materials)**

Board actions for consideration at this meeting

- Consider future management of GOM/GBK stock

7. Draft Addendum XXVI (5:30 – 5:50 p.m.)

Background

- In February 2017, the Board initiated Draft Addendum XXVI to improve harvester reporting and biological data collection in state and federal waters.
- The PDT met via conference call on July 10th to continue work on Draft Addendum XXVI.
- The TC met via conference call on June 28th to continue work on identifying a statistically valid sample of harvester reporting and analyzing offshore biological sampling.

Presentations

- Update on development of Draft Addendum XXVI by M. Ware **(Supplemental Materials)**

8. Lobster Chain of Custody (5:50 – 5:55p.m.)

Background

- In May 2017, the Board requested the LEC review chain-of-custody regulations regarding minimum sized lobsters.
- The LEC met via conference call on June 29th to discuss the various minimum size regulations in place along the coast.

Presentations

- LEC report by M. Robson **(Briefing Materials)**

9. NOAA OLE Draft Enforcement Priorities FY2018-2022 (5:55 – 6:00p.m.)   Possible Action
Background • NOAA OLE has released 2018-2022 draft enforcement priorities for public comment. • The Board submitted a letter to NOAA OLE in April 2017 asking lobster be made a higher priority for enforcement in the Northeast division.
Presentations • Overview of NOAA OLE Draft Priorities by M. Ware **(Briefing Materials)**
Board actions for consideration at this meeting • Consider submission of public comment letter on draft priorities.

10. Other Business/Adjourn

DRAFT PROCEEDINGS OF THE

ATLANTIC STATES MARINE FISHERIES COMMISSION

AMERICAN LOBSTER MANAGEMENT BOARD

The Westin Alexandria
Alexandria, Virginia
May 8 and 9, 2017

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

TABLE OF CONTENTS

INDEX OF MOTIONS

1. **Approval of Agenda by Consent** (Page 1).

2. **Approval of Proceedings of January, 2017 by Consent** (Page 1).

3. **Move to recommend to the Policy Board supporting the preferred alternatives developed by the New England Fisheries Management Council in their Deep Sea Coral Amendment** (Page 9). Motion by Eric Reid; second by Pat Keliher. Motion. Motion carried (Page 10).

4. **Main Motion: Move to select Option B for Issue 3; the recreational fishery must abide by gauge size changes and seasonal closures** (Page 25). Motion by Dan McKiernan; second by Mark Gibson. Motion amended.

5. **Motion to Amend: Move to amend to remove the seasonal closures** (Page 26). Motion by Tom Fote; second by Roy Miller. Motion passes Motion amended.

6. **Main motion as amended: Move to select Option B for Issue 3; the recreational fishery must abide by gauge size changes (Amended to become Option C).** Motion carried (Page 27).

7. **Move to approve Option A to Issue 5; regulations not uniform across LCMAs** (Page 28). Motion by Mark Gibson; second by John Clark. Motion carried (Page 28).

8. **Move to approve Option A for Issue 6; Maintain LCMA 3 as a single area** (Page 29). Motion by Dan McKiernan; second by Eric Reid. Motion carried with a roll call vote (Page 32).

9. **Move to approve Option 1 to Issue 7; all *de minimis* states must implement management measures** (Page 35). Motion by John Clark; second by Mike Luisi. Motion carried without objection (Page 35).

10. **Move to implement 10 % increase in egg production for Issue 1 over a two-year period** (Page 45). Motion by Eric Reid; second by Mike Luisi. Motion amended.

11. **Motion to Amend: Move to amend to achieve a 10% increase in egg production, except in Area 6, which would be 5 %; both to be achieved over a two-year period** (Page 45). Motion by Mark Alexander; second by Emerson Hasbrouck.

12. **Motion to Substitute: Move to substitute 10% with 15%** (Page 48). Motion by Peter Burns; second by Doug Grout. Motion failed (Page 50).

13. **Main Motion: Move to implement 10% increase in egg production for Issue 1 over a two-year period** Motion by Mr. Reid, second by Mr. Luisi. Motion fails (5 in favor, 6 opposed) (Page 53).

14. **Main Motion: Move to approve Option A to Issue 1; 0 % increase in egg production** (Page 53). Motion by Rep. Sarah Peake; second by Emerson Hasbrouck. Motion substituted.

INDEX OF MOTIONS (continued)

15. **Motion to Substitute: Move to substitute 0 % with 5 %** (Page 53). Motion by Mike Luisi; second by Eric Reid. Motion carried (Page 54).

16. **Main Motion as Substituted: Move to implement a 5% increase in egg production for Issue 1**. Motion carried (Page 55).

17. **Move to approve Option A for Issue 2, Management Tools; management tools can be used independently** (Page 55). Motion by Mark Gibson; second by Rep. Peake. Motion carried (Page 56).

18. **Move to approve Option B, Sub-Option II, for Issue 4, Season Closures; No Possession of Lobsters While Fishing, Most Restrictive Rule Does Not Apply** (Page 58). Motion by Tom Baum; second by Mike Luisi. Motion carried (Page 60).

19. **Move to recommend to the ISFMP Policy Board to send a letter to NOAA recommending to fully adopt Addenda XXI and XXII** (Page 63). Motion by Dan McKiernan; second by Doug Grout. Motion carried (Page 64).

20. **Motion to adjourn** by Consent (Page 66).

ATTENDANCE

Board Members

Pat Keliher, ME (AA)
Terry Stockwell, ME, Administrative proxy
Stephen Train, ME (GA)
Sen. Joyce Maker, ME, proxy for Sen. Langley (LA)
Douglas Grout, NH (AA)
Sen. David Watters, NH (LA)
Dennis Abbott, NH, Legislative proxy
G. Ritchie White, NH (GA)
Raymond Kane, MA (GA)
Dan McKiernan, MA, proxy for D. Pierce (AA)
Rep. Sarah Peake, MA (LA)
Mark Gibson, RI, proxy for J. Coit (AA)
David Borden, RI (GA)
Eric Reid, RI, proxy for Sen. Sosnowski (LA)
Sen. Craig Miner, CT (LA)
Mark Alexander, CT (AA)
John McMurray, NY, proxy for Sen. Boyle (LA)
Jim Gilmore, NY (AA)
Steve Heins, NY, Administrative proxy
Emerson Hasbrouck, NY (GA)
Adam Nowalsky, NJ, proxy for Asm. Andrzejczak (LA)
Tom Baum, NJ, proxy for L. Herrighty (AA)
Tom Fote, NJ (GA)
Roy Miller, DE (GA)
Craig Pugh, DE, proxy for Rep. Carson (LA)
John Clark, DE, proxy for D. Saveikis (AA)
Ed O'Brien, MD, proxy for Del. Stein (LA)
Rachel Dean, MD (GA)
David Blazer, MD (AA)
Mike Luisi, MD, Administrative proxy
Joe Cimino, VA, proxy for J. Bull (AA)
Peter Burns, NMFS

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

Ex-Officio Members

Kathleen Reardon, Technical Committee Chair
Rene Cloutier, Law Enforcement Representative
Grant Moore, Advisory Panel Chair

Staff

Robert Beal
Toni Kerns
Jeff Kipp
Megan Ware
Shanna Madsen
Kirby Rootes-Murdy

Guests

Michelle Bachman, NEFMC
Bob Ballou, RI DEM
Beth Casoni, MA Lobstermen Assn
Kevin Chu, NMFS
Lanny Dellinger, RILA LCMT 2
Greg DiDomenico, GSSA
Jason Drake, MLA LCMT2
Michelle Duval, NC DMF
Al Eagles, RILA LCMT2
Michael Eastman, NH F&G
Lindsey Fullenkamp, NOAA
John German, LISLA
Colleen Giannini, CT DEEP
John Godwin, Point Lobster Co.
Earl Guinn, Ocean City, MD
Aaron Kornbluth, PEW
Arnold Leo, E. Hampton, NY
Charles Lynch, NOAA
Greg Magee, MLA LCMT2
Mike Ruccio, NMFS
Derek Orner, NOAA
Rene Zobel, NH F&G
Kyle Overturf, CT DEEP
Tom Tomkiewicz, MLA LCMT2
Brian Thibeault, RILA LCMT2
Greg Matarones, RI Lobstermens Assn
Jason McNamee, RI DEM
Cheri Patterson, NH F & G

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

The American Lobster Management Board of the Atlantic States Marine Fisheries Commission convened in the Edison Ballroom of the Westin Hotel, Alexandria, Virginia; May 8, 2017 and was called to order at 2:55 o'clock p.m. by Chairman Dave Borden.

CALL TO ORDER

CHAIRMAN DAVID V. D. BORDEN: My name is David Borden and I'm the Chairman of the Lobster Board; welcome!

APPROVAL OF AGENDA

CHAIRMAN BORDEN: We've got a considerable number of issues to go through on this agenda. The agenda has been circulated. Are there any additions, deletions or modifications to the agenda as circulated? No hands up, then we'll take the items in the order in which they appear.

APPROVAL OF PROCEEDINGS

CHAIRMAN BORDEN: Approval of the proceedings of January 17th, are there any comments on the proceedings, any modifications of the proceedings, any objection to adopting the proceedings by consensus? Proceedings stand approved.

PUBLIC COMMENT

CHAIRMAN BORDEN: Public comments, we had one individual sign up, John Godwin. John, do you want to come to the microphone, please?

While John is getting himself situated, let me just say that we have about 20 representatives from various associations up and down the coast here, lobster associations, LCMTs and so forth. Traditionally our practice, since we've already gone through the public comment period is to kind of curtail the public comments.

I intended a panel of input from the individuals in a slightly different manner today. I am going to take the public comment from Mr. Godwin. But then as different issues come up that involve different LCMTs, for instance. If we've got the president of the local LCMT or the president of a local association that is involved in the decision, then I may single them out and ask them to comment; provided we have the time. Is there any objection to me doing that? No objection then, so I'll handle it that way. Mr. Godwin, you have the floor for a few minutes.

MR. JOHN GODWIN: My name is John Godwin; I own Point Lobster Company in New Jersey. We import 80 percent of our lobsters from out of state; mostly Maine and Massachusetts lobsters. I feel ASMFC should consider adopting language that allows for southern New England dealers to buy and sell all legal sizes from LCMA-1.

The result would be an increase in demand for lobsters. Currently the limits on sizes are excluding a percentage of the Area-1 catch. New York and New Jersey are Area-1's closest neighbors. If the overall demand for lobsters is increased by allowing more of them to come in, as the demand goes up we're going to be able to sustain the prices paid in southern New England by limiting what's coming in. We're just simply losing customers.

Canada is already taking steps to promote their fishery; they've even made it a tariff. I feel like it's time that Atlantic States considers amending the general possession limits for sale amongst the other states. I realize the importance of having a management tool for the harvest of lobsters, but it has become burdensome on the rest of the industry. If we just use Price Chopper, for example, in New York they had 1,000 lobsters seized legally caught in Massachusetts. That's not the kind of market where the Massachusetts dealer was competing with the lobstermen.

The lobstermen in New York had no chance at making a sale to Price Chopper. Sometimes there is a misunderstanding that lobsters coming in from out of state are going to hurt the local fishery. I don't think that's true. What we need to do is increase the demand, sustain the boat price, and just keep the ball rolling here to do what we can to help the dealers and help the fishermen. That's all I've got; thank you for your time.

CHAIRMAN BORDEN: Thank you very much, John. Just a follow up on that; John submitted a letter and I received a number of other letters from different members of the public that are here. Mike, what I can do is I was going to circulate those to the staff. If there is anyone in the audience that has a letter that they want circulated to the Board, then please provide it to the young lady sitting on my right; Megan.

We'll copy it and pass out copies to the Board, so they have the benefits of the public comments.

NEW ENGLAND FISHERY MANAGEMENT COUNCIL DEEP-SEA CORAL AMENDMENT

GENERAL OVERVIEW

CHAIRMAN BORDEN: Okay so we're going to move on with the agenda; Discussion of Deep-Sea Coral Amendment, and this is a general overview. Michelle.

MS. MICHELLE BACHMAN: My name is Michelle Bachman; and I'm a staff member with the New England Fishery Management Council. I think I know a number of you, but some of you are new faces. It's nice to meet you. I'm happy to talk today about our ongoing Sea Coral Amendment.

Basically what I want to cover, just to make sure you're aware of what the alternatives are that the Council is considering; let you know which ones they have determined thus far are their preferred alternatives, and then kind of make sure that you're aware of the basics of how we're considering impacts in the amendment. I am happy to take more questions on that if you have them; and then also what the timeline is for the next few weeks and months, going forward.

This is basically the problem statement for the amendment. The Council adopted this a while back, I think. Some of you may have seen this already, certainly for those on the Council. The core of the problem statement to me is sort of articulating this trade on the amendment between the conservation of deep sea corals; which are vulnerable to the effects of fishing gear, and then balancing any negative impacts on fishing fleets and the communities that are supported by those fisheries.

I'll take a look sort of at what else is in the Problem Statement, but really I think that is kind of the core of what the Council is trying to do is figure out where that balance should be; and looking at a range of alternatives that have different levels of impacts, in terms of corals or impacts to fishing activities and try to figure out kind of where to put that. Just briefly, with our deep sea corals, there are a number of types of different corals in New England. We're learning more all the time about these animals; and we've learned a lot in the last, say five years, about their distribution and their diversity. What we were focusing on when we designed the alternatives in the amendment, sort of specific spatial management measures focused on different aggregations of corals.

We're really focused on species that are associated with hard bottom; which is a fairly rare habitat type in the Gulf of Maine, and also in the deep ocean. There are sort of soft bottoms associated with corals, but really in terms of the conservation focus, we are looking at corals on hard bottom areas.

As I mentioned there is a diversity of corals in New England. We have learned a lot recently. This is just an imagery of some of the different types of corals. Some of the black corals and even some of the stony corals in the canyons are in quite deep water. Others you do find in shallower areas.

In general in the shallow waters of the canyons you've got more soft corals, and in the Gulf of Maine the fauna we're interested in and focusing our conservation efforts on are generally soft corals; and I'll show you some pictures of the more common types on the next slide. If you're interested in what the science looks like, a good sort of one-stop read would be a paper by Petrini et al, and it is a Plos One paper from 2015.

It kind of goes through some of the recent data collection with remotely operated vehicles. It was done in 2013, I believe. You'll see kind of a good flavor for the types of exploratory surveys that have happened in recent years. This just gives you a sense of what some of the really common Gulf of Maine coral species are going to look like out of the water, if they were to come aboard a fishing vessel.

The two species in the upper right, Paragorgia and Primnoa are the really common species of soft corals that we see in all the management areas the Council is considering in the Gulf of Maine. Then there are a number of other different species that occur in deeper areas in the canyons, and also on the sea maps.

These are sort of cosmopolitan species, you know found in many different locations around the world. But these are the kind of main ones that you would see in the Gulf of Maine areas, which were generally between 150 and maybe 250 meters of depth. Big picture, why is the Council doing this? I think there are kind of two reasons, really.

The first is sort of the idea of conserving corals, kind of for their own sake, you know just for their existence value. These are very long-lived animals, have slow growth rates, have a limited reproduction potential, and then just kind of wanting to conserve their biodiversity. But also they're important habitat, as being structure forming organisms they provide habitat for fishes; those that are managed by the Commission and the Council and others that are not.

They have close associations with other invertebrate species. Corals are definitely an important plan or ecological. This is something that the Board may want to discuss and maybe you have in the past; but sort of the management authority that the Council is developing these measures under. The last time the Magnuson-Stevens Act was reauthorized there were actually provisions added to allow councils to take discretionary action to protect deep sea corals in particular. That has really kind of been the focus. That authority has been the focus of the Council's discussions. What it allows us to do is sort of decouple coral conservation from essential fish habitat. In many cases the corals occur in quite deep water, out to thousands of meters, including on the sea mounts; and that is really beyond the habitat of species that are managed by the Council.

It is less of a stretch to use its proper discretionary authority than to have to link coral conservation with our essential fish habitat designations; and that sort of program that the Council implements. There is some guidance that we got; I guess two pieces of guidance that we got, first from the Greater Atlantic Regional Fisheries Office back when they were MIRO. In 2010 we got a guidance letter from them about how to think about the discretionary provisions.

Subsequent to that in 2014, NMFS kind of at a national level published some guidance, basically explaining the obligations of the Council when using the discretionary authority, the things we need to consider, the consultation that we need to do; for example with the Commission, if considering regulation of gears managed by other management authorities such as the Commission or the Mid-Atlantic Council.

We've been doing a lot of consultation; we have membership on our committee. If you're interested in the specifics of that letter, it is on our website if you go under the habitat page and look for the coral amendment, you can see that guidance. Just a picture, other regions of the country are also working on deep sea coral management; and do have some areas in place that sort of serve this goal, or areas are under development.

This is just in terms of the Atlantic coast; basically North Carolina northward. Both the Mid-

Atlantic and the New England Fishery Management Council have been working on this for a while. The Mid-Atlantic measures did go into effect at the beginning of this year in January. Essentially what they held on to was kind of this broad coral zone that encompasses the whole slope region, within the Mid-Atlantic's jurisdictional footprint out to the EEZ boundary.

Their zone starts at around 450 meters, which was shallower in the heads of some of the canyons. We've heard a lot of discussion about how their process is similar to the New England process or how it's different. The lobster fishery being actively involved in our process, and being a fishery that the council is actively considering managing in these coral areas is the biggest difference between, I think the New England process and the process the Mid-Atlantic went through.

I think that has kind of influenced our discussions throughout, and sort of some of our public outreach and the focus of our analysis, and how we spend our time. I'm happy to tell more about the Mid-Atlantic Amendment if people have any questions. Since they are sort of the core alternatives in the amendment in a nutshell, essentially we're looking at a range of spatial management areas that could be designated for coral protection.

There are these broad water broad zones, which you saw in the previous slide; and I'll show you again on the next slide, with sort of depth limits as the shallow boundary. We're considering six different options there. Then we have these discreet zones. We have these canyon zones and sea mount zones that are sort of nested within that raw area. Then in the Gulf of Maine we have some other areas that we're considering; a couple inshore, Mt. Desert Rock, Outer Schoodic Ridge and then a couple further offshore with Area 3, Lindenkohl Knoll, and some areas within Georges Basin. Then in terms of the gear restrictions that could apply within those zones. We're looking at either prohibition on all bottom-tending gears, whether they made up a sphere, like a trap or a longline or gillnet or mobile gear like a trawl.

Dredges would also be considered a mobile gear, if they're not going to be used in the steps from the data that we looked at and the comments we've heard; or the council may consider just prohibitions on mobile bottom tending gears only. Under the fixed annual bottom-tending gear restriction, the council is considering a couple of different exemptions.

One would be to exempt the red-crab trap fishery. That is managed by our council. It is a relatively small fishery, I'm sure you're familiar with it, and any other option would exempt other trap fisheries; that would include folks fishing with lobster traps. It would also include for example, in Jordan Basin there is a hagfish pot fishery that would kind of follow under that as well.

Then there is some transiting language. What is up on the slide, it was adopted by the Mid-Atlantic Council and is in the regulations for their coral zone. It is a little relaxed relative to some of the language around transiting that is currently in the federal regulations. I struggled with a way to represent this visually that is any way clear, so I apologize.

Basically what you've got here, on the left hand panel is sort of the general location of these broad zones. They're quite large areas, but you know have these different depth based limits. On the right hand side you can see the kind of green shading is basically everything that is deeper than 600 meters.

The Council's preferred alternative is defining a zone. You know the entire slope region out to the EEZ that encompasses the sea mounts within, sort of the New England Council's footprint. Draw some simplified boundary lines to define that zone, so that there are specific coordinates that people could put in a plotter, I understand, and know if you were within the zone or outside it. But the criterion for that is that the zone be no shallower than 600 meters.

That green is sort of like what that footprint looks like. Then what we developed for that zone is basically a simplified line that kind of doesn't go any shallower than that green footprint. Then we've got a number of other options that we're considering as well. There is one that has sort of an average depth of 600 meters; but goes as shallow as 550.

There is another one that has an average depth of 5 and no shallower than 450. One of the targets is 400 meters and one of the targets is 300 meters. Then there is also an option, I think that really bounds the analysis nicely that it targets 900 meters, so it is much deeper; which has kind of solved the outside the footprint of any fishing, including the red crab fishery. Then we have these series of discreet zones. This first slide, just talks about the different canyon zones and the sea mount zones.

This is just a list of the different canyons that we're considering. There are some other smaller canyon features, but these are all the ones that have had coral sampling; so we know for certain from a couple to six or seven, either remotely operated vehicle or until the camera dies. But there are corals, sort of what the species composition is and that sort of thing, what the zonation is by depth. These are the areas where we have kind of detailed information. They're all the larger canyons in the New England region. The coloring, the yellow ones are those that are outside the northeast canyons and sea mounts from your national monument, and the red ones are inside. The Council had a sort of lengthy discussion about whether to continue developing management areas within the monument; and ultimately decided that they wanted to keep these measures as part of the amendment, just sort of see what impacts will be, and continue with their own management program in spite of the monument designation.

That just kind of breaks those apart visually for you, and we did kind of break out some of the analysis by canyons in the monument and not just sort of show the added potential impact of other zones that might be designated by the Council. Then the four blue areas are the New England sea mounts that are within the exclusive economic zone. That sea mount changes so much further to the east, but those are the four that are in the EEZ; and those are also being considered as discreet management zones.

The canyon zones and the sea mount zones; none of these are preferred alternatives at this time. They are in the document. The Council is looking to receive comments on them. But right now the preference is to just go with the broad zone approach with that 600 meter minimum, and not to designate these additional discrete zones that go into shallower water.

We had kind of framed it for the Council, if they could take a mix and match approach combining the two areas; maybe going shallower in the canyons. At this time they seem to prefer just a single, somewhat deeper effort. Moving into the Gulf of Maine, we have basically four different locations that we're looking at.

First will be Mount Desert Rock. Essentially we can see on here there are a couple different areas, the sort of larger red boundary; and within that there is a smaller blue outlined boundary. The Council is considering both of those options as boundaries for this management area. Right now they don't have a preference for which.

The smaller boundary was developed later in the process, so that is kind of a more recent refinement. Assuming that this area is designated, the Council's recommendation would be a mobile bottom tending gear closure only. Importantly, lobster traps could continue to be used in this area. That is really the only gear type that has any significant activity within the larger of the boundaries, and I expect within the smaller boundary, so unless it's a subset.

The next area is Outer Schoodic Ridge. This is within Lobster Management Area Zone-A, in Area 1, beyond 12 miles from shore. We only have the one boundary option for this area. This is a turn at this time as a closure to mobile bottom tending gear; and so again that wouldn't restrict on the lobster traps.

Jordan Basin, there is basically four different locations that we're looking at in Jordan Basin. From the general charts that show us the bottom topography in Jordan Basin aren't fantastic. We only have really detailed mapping for certain areas within the basin. But generally in sort of higher relief areas is where you tend to find these coral habitats.

Some of the locations that have been documented are on a couple of these bumps, and then more towards the center of the basin, along the Hague line. We've got 96 Fathom Bump, to 118 Fathom Bump and then the largest area is 114 Fathom Bump, and then the eastern area is that central Jordan Basin area. Within that the Committee and the Council in the last four months have discussed and refined these a little bit; more tightly around where the corals have been observed, where we think the high relief areas are. We really kind of focused down on smaller subsets of these original area boundaries to develop this second option. Right now the Council hasn't recommended designating zones in Jordan Basin as preferred.

They didn't really say it wasn't preferred either; they are sort of still deciding, I think. But if areas are designated in Jordan Basin, they are recommending that they be mobile bottom tending closures, not closures to fixed gears. Again that wouldn't affect the lobster fishery. We do know that there is groundfish and monkfish and some other species that would be caught but that gill nets or trawls are also caught in these areas. Then there is also a hagfish fishery in Jordan Basin as well, as I mentioned.

Then the next slide, just to show you quickly, is just an image of some of the types of features and corals that you can see in Jordan Basin; different soft corals and then other fishes and invertebrates associated with them. The final area that we're looking at in the Gulf of Maine is Lindenkohl Knoll. This is the western edge of Georges Basin, which is the deepest part in the Gulf of Maine.

We don't really have great data on its sea forage range in Lindenkohl Knoll, but we do have some RV dives in which corals have been observed. We have basically two options that we're considering here. This larger area Option 1 and Option 2 would be three sub-areas focused around the dive sites.

Similarly with Jordan Basin, the Council hasn't yet come down on whether they actually want it as a main management area for corals in Lindenkohl. But if they do, they did want to go with the no mobile bottom tending gear fishery. This just sums up where the lobster management areas are, and how those relate to the coral zones.

The different color shadings are the main management areas. The Schoodic Ridge is in Area A, the Mount Desert Rock, Area B, and then all the remaining areas are within Area 3. Then finally in addition to sort of a need of the amendment, these coral management areas and the measures for them. There are a couple other programs and options the Council is considering.

We talked early on in the process of developing this amendment about an idea of maybe developing some special access programs, so these areas could be broadly closed to allow any particular fisheries to continue operation under specific criteria or exploratory fishing; for example for currently un-harvested deepwater stocks.

The Council didn't develop any of those options more fully, as kind of specific programs. What they do want to do at this time, is under research activities just request that folks doing scientific research in these zones ask for a letter of acknowledgement from the Fisheries Service, just so we can kind of keep better track of what's happening; in terms of research in these areas, but that's a pretty limited alternative.

Then in terms of framework adjustments, I think many of you probably know the Council tends toward either on amendments, which are kind of larger initiatives or framework adjustments, the idea with those is they have them a little bit more quickly with fewer meetings. They are supposed to be more limited in scope and have fewer moving parts. In general the Council has kind of added to the list of things that we can consider doing within a framework. This would basically, just all these new types of measures that are part of this amendment; it would add that into that. You can specify that you could add new coral zones, change them, change their fishing restrictions, or develop these exploratory fishing or special access programs to frameworks.

REVIEW OF MANAGEMENT ALTERNATIVES

MS. BACHMAN: Just to recap the preferred alternatives again. The main one will give a 600 meter zone, close to all different types of fishing with an exemption for red crab; and then it would have its minimum depth of 600 meters. That is what the Council is recommending for the slope and the canyons and the sea mounts.

In terms of the Gulf of Maine the Council recommended all those zones be mobile bottom tending gear closures only. They did recommend designating coral management areas in Mount Desert Rock and Outer Schoodic Ridge, and still on the fence about those offshore sites; and then the other measures as indicated.

Just kind of quickly, in terms of how we're thinking about impacts analysis, basically we only have sampling for corals at select locations within these zones. In addition to using the information from those research cruises, we can also use suitability modeling results, as well as terrain data.

Figuring out where there are steeply sloping areas and things like that to get a sense for the total amount of coral habitat you link back to the different alternatives. Then combining that with what we know about different fishing activities that might be prohibited under a different option, we can kind of make an assessment of what the conservation benefits would be of corals of any given management zone.

We do know something about fishing gear impacts on corals. We've got some information about growth. Some of the major species in the Gulf of Maine that were on that earlier slide, really only grow a few centimeters a year. If they're disturbed or removed it takes them a while to repair the damage or re-colonize an area.

We certainly also acknowledge that the areas where the Council is considering management are currently fished, and these corals continue to persist there; when the dive indicates that they have some resilience to impact, or if really the corals are in parts that are more difficult to fish; on very steep habitats and that sort of thing.

We don't entirely know, and maybe some of these corals, in the Gulf of Maine or in shallow parts of the canyons are sort of the remains of a larger distribution of corals that was there previously; we're just really not sure. Basically, just to wrap up here. We're taking a look at a couple different sources of data.

I knew you guys have talked about this in the past, so don't need to go into a lot of detail. The focus has been the trip reports. The Commission also sent out a survey last spring about Area 3, and people's activity by depth, by area in Area 3; the results of that leads to kind of assess how much revenue was occurring at different depth intervals. We're using all that information from the Commission survey and from the Technical Committee's reporting and are folding that into our EA. In the inshore Gulf of Maine, we have sort of a different set of challenges; in terms of understanding the fishing activity that's occurring within these two zones. It is by and large the lobster fishery is what's going on here, and there is very little evidence of other types of fishing; in the data that we looked at, at least. We worked with DMR through the TC to get some information about these areas, sort of how many individuals are fishing, you know what months they're fishing, what proportion of their revenue might be coming from these areas.

Then coming up with some different estimates of how much revenue may be coming out of these two locations on an annual basis. I have all the information that we've grabbed through the TC and DMR and it's kind of folded into our documents. Finally, we're also looking at all those sorts of impacts to fisheries at the level of different fishing communities.

We've done that based on data from the dealer reports and the trip reports, as well as information through DMR about which ports are most important to the people fishing these areas. That is all discussed in our information; just finally to wrap up, the timeline for the amendment. Right now we're kind of in this public comment period that will end on June 5th.

In a couple weeks we'll be doing public hearings; and the schedule is on our next slide. You can get the notice with the specifics on our website as well. It should be in the Federal Register this week, if not already. On May 30, the Committee is going to meet in Wakefield, Massachusetts, and it will be either comments from the hearings and discuss if they want to make any revisions to their recommendations about preferred alternatives.

Then the Council is scheduled to take final action in June. We're figuring out which date of the meeting that might be. Then provided that schedule is met then we'll probably submit the amendment document towards the end of the summer, early fall for implementation early next year. The next slide just has a list of public hearing opportunities; again you can grab this off our website.

Our last hearing kind of leading into the Memorial Day weekend is a webinar, which you all can listen in on, or participate and comment. There are detailed instructions for registering in the hearing notice. That's all I've got. Just a nice picture of dogfish, this is at Outer Schoodic Ridge; happy to take questions and thanks for your attention.

CHAIRMAN BORDEN: Any questions? Dan. You look like you're waving your finger.

MR. DAN McKIERNAN: Well I was curious if there has been any thought given to compliance, and how would you know if a vessel in the future, if this was enacted had fish in that zone?

MS. BACHMAN: These areas will be enforced similar to other spatial management areas, through VMS for vessels that have VMS, through Coast Guard sort of direct observation in case there are vessels that don't have VMS. We talked a lot about, we had some workshops, and also at the Committee about whether, the intent was really to avoid having gear on the bottom within these zones; but really what is enforceable is the vessel being within the zones.

The Chairman will probably speak to this, but I think the idea behind that 600 meter minimum zone was that that was deep enough to accommodate giving space for people that are fishing a little bit shallower than that in reality. Kind of putting this buffer in, but especially given how far offshore some of these sites are enforcement I think is going to be difficult to be fully enforced.

CHAIRMAN BORDEN: Yes, I'll follow up on Dan's question also, since I represent the Commission on the Committee. There actually was a lot of discussion about the need to have buffers here. If the concept of this whole program is to freeze the existing footprint, then you want to do so in a manner that is enforceable.

But you don't want to have absolute lines on the boundary; you want to kind of move the line away from the boundary of the area that you want to protect. That is exactly the reason the Committee talked about this 600 meter line. They were actually talking about a line that was inside of that.

Then when we talked about the concept of buffers and how you would enforce it, and how the Coast Guard would enforce it. We decided to move the line out to 600 meters; other comments or questions on this? Okay, so since the Council is going to meet on June 20 to 22, and finalize a position on this. If we want to have input, I think what we should do is entertain a motion on the subject.

Does somebody want to make a motion? I would also note that we have a number of New England Council representatives here. I believe all of them and correct me if I misspeak, voted in favor of the preferred alternatives when it came up; with the possible exception of one. Eric, do you want to make a motion?

MR. ERIC REID: Somebody has it other than me. **I move to recommend to the Policy Board supporting the preferred alternatives developed by the New England Fisheries Management Council in their Deep Sea Coral Amendment.** If I get a second I have some rationale.

CHAIRMAN BORDEN: Seconded by Pat Keliher. Discussion, Eric.

MR. REID: Thank you, Michelle, it was a great presentation. My rationale goes with her comments. The Mid-Atlantic went first in their coral action, but they did not under current legal advice at the time they did not include lobster gear. New England received new advice; as Michelle referenced, so basically New England is more restrictive than the Mid-Atlantic in their action, as it will be regulating all bottom tending gear.

As the chairman referenced it is actually a true freeze the footprint approach and that came through many Habitat Committee meetings, two public workshops to identify from the industry where they actually fished; and Council discussion. That footprint has been decades in the making, decades. At least it's a discretionary action, but I think we should support the alternatives as the Council and its Committee and its workshops have developed.

CHAIRMAN BORDEN: Pat, do you want to offer a comment as the seconder, and then I'll go to Doug Grout.

MR. PATRICK C. KELIHER: I just want to echo Eric's statement, in particular the impact to the state of Maine's lobster fishery if it was included would have been multi millions of dollars, there would have been economic impacts to many fishermen in Zone A and Zone B, being very problematic. We certainly support the Council's preferred alternative in this process; and we certainly ask the Board to support the motion.

MR. DOUGLAS E. GROUT: Just a clarification of the motion. Is the intent that you would send a letter to support the preferred alternatives?

MR. REID: I'm assuming a letter would be better than a smoke signal.

MR. GROUT: Just for the record, so you know what we're voting on.

CHAIRMAN BORDEN: All right, any other comments? Pete Burns.

MR. PETER BURNS: I just want to point out that I'll abstain on the vote, because this amendment will likely come before NOAA Fisheries for implementation soon.

CHAIRMAN BORDEN: Anyone else at the table? Is there anyone in the audience that wants to make a comment on the motion? No hands up. Okay, so are you ready for the question? All those in favor, do you need a caucus, excuse me? No one needs a caucus. **Everyone in favor, signify by raising your right hand, 11 in favor,**

any opposed, no opposed, abstentions, 1 abstention, any null votes; motion carries.

Eric did you, and I should have mentioned this at the start of the meeting. Did you also want to talk about the notice from the Department of Interior, which I would point out for everyone's edification; the President has asked the Department of Interior to solicit input on the monuments. There has been a notice that's been circulated, and Eric will describe what it is. Then we'll take up the issue.

MR. REID: This is dated May 5, which is last Friday. It is from the Department of the Interior, the Office of the Secretary. It says the Department of Interior today announced the first ever formal public comment period, for members of the public to officially weigh in on monument designations under the Antiquities Act.

It is not a very long press release, and maybe staff could shoot it at the members if you want to look at it. If you remember, not that long ago the Commission developed a position letter; which was presented to the Office of CEQ by Chairman Grout, and several of the members. I think since this is a unique opportunity, the first of its kind that the Commission should reinforce our initial advice to the previous administration; and comment on this issue.

Hopefully you will all remember that the letter that we sent to the President; describing what we felt was an optimum solution to the use of the Antiquities Act. I don't remember the exact vote in front of the Policy Board, but it was 13 to 0 to 1. It was something to 0 to 1. I think since it is a unique opportunity, the first of its kind; that we should reinforce our initial position through our original position, and a cover letter or something that outlines the conditions of today.

CHAIRMAN BORDEN: I guess a question to the Board is that the comment period is over before our next meeting. What is a preference for the Board? Would you like to entertain a motion, make a recommendation to the Policy Board to submit a letter for the record? Eric is suggesting basically restating our position, so comments on that concept; anyone? Pat.

MR. KELIHER: I would recommend sending a request to the Policy Board that a letter be sent on this particular issue. It should be sent both to the Secretary of Interior and then the Secretary of Commerce. Governor LePage recently met with the Secretary of Interior; and actually brought this particular issue up. It is not included in the list that is being reviewed now, but a letter from this body, I think would be appropriate.

CHAIRMAN BORDEN: Comments to Pat's suggestion. Eric.

MR. REID: Obviously I support Commissioner Keliher's advice, but in this press release the Atlantic Monument is clearly outlined as one that is under consideration. If you please, Mr. Chairman, I have a motion.

CHAIRMAN BORDEN: All right, let me just see if anyone has another suggestion. Anyone here uncomfortable with us restating our position? I don't see any hands up. Yes, Sarah.

REPRESENTATIVE SARAH K. PEAKE: I was in support of the first letter that we sent. I had at that time objections to the fact that I felt there wasn't an adequate public comment period; that the New England Council had already taken some measures regarding fishing moratoriums. What my concern is now, is an outright lifting of the Monument status could open up this area around canyons and seamounts to activity that would have a great detrimental effect to the fishing industry, i.e. offshore drilling or other sorts of mining and resource-taking activities.

My issue isn't so much with the repeal of the Monument status, but that an outright appeal without some sort of replacement to ensure that the habitat remain a healthy one for fishing endeavors and fishing industry, without activity that would degrade that. That is where my level of discomfort is today; as we sit here in May.

CHAIRMAN BORDEN: Let me ask Doug and Bob Beal whether or not they have a preference for how we handle this. It seems to me, just looking at the reading the tea leaves around the table what people want to comment. It seems to me that we need to perfect a letter that people would be comfortable with.

I guess my question to the Chair and the Executive Director is should we pass a motion and then ask staff to draft a letter and circulate it; so that people get a chance to look at the letter and be a little bit more comfortable with it? Would that make more sense? Bob.

EXECUTIVE DIRECTOR ROBERT E. BEAL: What if we distributed the letter that we sent about a year ago, I guess it was; to the Full Commission, Policy Board, people will have 48 hours to look at it before Thursday, and see if that still is your position, if everyone is comfortable with that position still.

We can put a cover letter on that stating why we're sending it in; maybe in response to this comment opportunity. If that is not the position, we can sort out the position at the Policy Board in a couple days. But we'll send around that previously submitted letter, and folks can look at it and then come to the Policy Board ready to comment; whether it is or is not our position.

CHAIRMAN BORDEN: Does anyone object to that? Let's follow that process. We'll circulate the letter. I just point out from a personal perspective. I agree with Sarah's comments completely. But I also point out that it is a little bit concerning that we've got a position on the Coral Amendment, which is basically endorsing 600 meters; and the original position that we endorsed was 900 meters with the Monument. I think if we're going to circulate the letters, we should think about whether or not we want to standardize those two positions; which I think would be better if we linked one to a regulatory vision since it is trying to deal with this.

We'll circulate the letters and then we'll see what the reaction to it is, and maybe discuss it at the Policy Board. Are there any objections to doing that; anything else on corals? Before we move off corals, I would just like to take the opportunity to thank Michelle for all her work on this. She is a fabulous staffer.

The New England Council should be extraordinarily pleased with her performance. She has done a tremendous job working on this issue in the absence of a lot of information. She has really pushed people and she has pushed the whole envelope, and I think we should be thankful for all of her efforts; so thank you very much.

AMERICAN LOBSTER GULF OF MAINE/GEORGES BANK SUBCOMMITTEE REPORT

CHAIRMAN BORDEN: Next item here we're going to take on, the Georges Bank, Gulf of Maine Subcommittee; I'm going to turn it right over to Megan.

MS. MEGAN WARE: I am going to be reviewing the Gulf of Maine/Georges Bank Lobster Subcommittee report today. Just as a reminder, this Subcommittee was formed in January, in response to the Technical Committee's report on changing stock conditions in the Gulf of Maine and Georges Bank.

Just to take a step back and remind ourselves of why this subcommittee was formed, and why the TC has been looking into changing stock conditions. Looking at this slide here, and kind of taking Maine as a case study, we can see that over the past 30 to 40 years there has been really an incredible increase in the amount of landings that are coming from the Gulf of Maine; particularly in the last ten or so years there has been an exponential increase in those landings.
But at the same time, we kind of have a unique dichotomy here; because we are starting to see

declines in the settlement surveys. These are the Maine settlement surveys from the various statistical areas. What you can see is over the past five or so years, we've started to see noticeable declines in those settlement surveys.

This is concerning, because if this truly does reflect a decline in settlement, then this could foreshadow decreased recruitment and landings in the future. The Subcommittee met on April 13, in Durham, New Hampshire. We had participants from Maine through Rhode Island. This included Board members, TC members, industry association leaders, and lobstermen.

There were three purposes of this meeting. The first one to discuss current and future conditions in the Gulf of Maine/Georges Bank stock, to discuss ways to promote resiliency in the stock; given changing environmental conditions. Then also to provide recommendations to the Board as to how to best proceed.

There were three questions that started off the discussion from the Subcommittee. The first question is how are we currently protecting spawning stock biomass? The Subcommittee concluded that we're currently protecting spawning stock biomass through the V-notch program, the minimum gauge size and the maximum gauge size. Many noted that that minimum gauge size may be protecting an increasing portion of spawning stock biomass; given that we're seeing an earlier size at maturity. The next question was what does the Gulf of Maine lobster fishery look like with less catch? I think the concern here is that decreased lobster catch could have rippling economic effects; even if the stock is still biologically healthy. This could be even more concerning, given the fact that many lobstermen are not diversified in their catch.

Then the third question is; are there any deficiencies in the current management plan? Many pointed to the fact that currently under our reference point's management action is not triggered until abundance falls to the 25th percentile. Given that we're at record high landings now, this means that landings would likely have to fall by over 50 percent before any management action is triggered.

The second part of our Subcommittee discussion focused on lessons learned from southern New England. These lessons learned were provided by some of the Rhode Island and Massachusetts members of the Subcommittee. The first lesson learned was; be proactive. Many pointed to the fact that the decline in the southern New England stock happened over a relatively short period of time; particularly in Long Island Sound.

Waiting to see a couple years of decreased landings and then initiating management action may be too late. The second lesson learned was to address access in the system, so this includes things such as latent traps, unused permits, as well as a continued purchase of larger and faster boats. The third lesson learned was to standardize management measures. In southern New England many of the addenda have allowed the LCMAs to kind of tailor their own management proposal to meet a target.

While this provides flexibility, it also could create enforcement challenges and lessen the expected biological benefits of the management rules. The fourth lesson learned was 100 percent harvester reporting. Some noted that if management tools are considered which are based on historic participation in the stock, then it is going to be important to have your information as to when fishermen were harvesting.

We have preliminary recommendations from the Subcommittee. I do want to note these are preliminary; because the Subcommittee has asked for another meeting to better flush these out. But I did want to review these; in case there is any discussion on them. The first is to conduct additional research.

One of the things that kept popping up is the need for a coastwide study on growth and maturity. The TC members noted that the data that is currently being used is over 20 years old; and this should really be updated. The second recommendation is to continue to monitor the ventless trap survey and the trawl surveys.

The Subcommittee agreed with the TC that if that settlement survey is truly reflecting a decline in settlement, this will next be seen in the ventless trap surveys and the trawl surveys. The third recommendation is to improve enforcement offshore. Many noted that we are seeing an expansion of the lobster fishery offshore.

Also with the increase in the value in Gulf of Maine, there seems to be more issues with compliance. The fourth recommendation was to develop environmental indicators. This again was an original recommendation of the TC to include some sort of model for the indicator to look at environmental anomalies such as water temperature. The fifth was to develop an economic indicator and trigger. This really developed from the fact that some of these concerns are economic; and we may see economic effects before the stock is biologically unhealthy. This indicator could look at landings over a specified period of time, and if they decrease by a certain percentage that could trigger management action.

I think this is one of the things that the Subcommittee would like to further discuss. Then the sixth recommendation was to modify the current reference points. The Subcommittee agreed with the TC that management action should be triggered at the 50th percentile of abundance rather than the 25th. It comes down to takeaways and ways to move forward here.

I think one of the largest conclusions was that economic effects will likely be felt before biological triggers are met. Therefore, there may be deficiencies in the current management plan; which may need to be addressed, in order to build resiliency in the Gulf of Maine/Georges Bank stock.

That could include changes to the reference points as well as the development of an economic indicator. There are some things that the Board is already doing that we can continue to do. Through the FMP review we do monitor e-ventless trap surveys as well as the trawl surveys; and the LEC is continuing to have a discussion on offshore enforcement. Those are two of the things that the Board is already working on. With that I will take any questions.

CHAIRMAN BORDEN: Questions for Megan; yes, Ritchie.

G. RITCHIE WHITE: Was there any suggestions as to how to improve law enforcement offshore?

MS. WARE: I believe there is a recommendation for electronic tracking on vessels; but besides that there were no other specific recommendations.

CHAIRMAN BORDEN: Just a follow up on Ritchie's question. The Enforcement Committee, as I think many of you will recall, about six months ago or maybe nine months ago. The Lobster Board kind of engaged the Enforcement Committee, and pointed out that there were problems, a number of those, Pat Keliher and myself. I know Ritchie attended the Enforcement Committee meeting.

The Enforcement Committee has been trying to develop different systems to deal with nearshore, kind of the Mid-Shelf zone and offshore. Some of that that relates to technology, other aspects relate to modifying the Joint Enforcement Agreement and so forth. That is kind of a work in progress. But it definitely needs to take place in this particular case; and it is in progress. Ritchie, you want to follow up on that?

MR. WHITE: Yes, at that meeting there was a discussion that National Marie Fisheries Service that lobster was not a priority species in their list of priorities. There was discussion at that point about how do we move it up. I don't know if there was any decision on that; but there needs to be additional encouragement from this Board to have that happen.

MS. WARE: We did send a letter to NOAA OLE, asking that they move up the prioritization of lobster; and that was a motion that was passed at a previous Policy Board meeting. We heard that this was the appropriate time to send that. That has been sent.

MR. KELIHER: The timing here I think is good, with this Subcommittee elevating law enforcement; the Law Enforcement Committee meeting tomorrow, I think it would be really good to bring back a breakthrough of this conversation back to the Law Enforcement Committee, make sure they're prioritizing it.

Anything else that may be recognized from the Law Enforcement Committee is on a parallel track with the Subcommittee; and we can get some finalization of some really strong recommendations. Rene Cloutier; the representative here today, I would like to think he's well versed now on offshore lobster problems. It would be good if he could bring this message back to our Enforcement Committee.

CHAIRMAN BORDEN: Rene, I won't put you on the spot, but if you would like to comment please do, if not we'll move on. That's okay, no need to do it. Anyone else at the table, okay let me just add a couple of things. Oh, excuse me; Pat.

MR. KELIHER: Sorry, not to belabor this point. But because a 100 percent harvester reporting is on the table again and with the new Subcommittee, we all know how much the state of Maine loves this conversation. The fact that we have the budget being already packed, to the cost associated with this.

With the Reporting Subcommittee and the Law Enforcement component of this, I think we really need to stress the prioritization of a technical solution to reporting. If there is going to be additional reporting needed from a tracking side of this on boats, there is no reason that that tracking component does not have a reporting side of this to make it easier and less cost coming back to the state. I think it would help offset a lot of this cost.

CHAIRMAN BORDEN: To that point, I think Megan is going to get into that under the next agenda. That is about as fast an action as I can orchestrate. Okay so anything else? There is no action required at this point. The Subcommittee is going to meet again. I think the total cost of the meeting was four pizzas and Megan's travel, but four pizzas was a fairly modest sum to invest in this.

I just make a personal comment. Having attended the TRT meeting last week, I came away from that meeting. I am always amazed when I come away from those meetings, in terms of how that process works or doesn't work. But the one thing I think this Subcommittee has to deal with is that Megan put some polite language on the board about dealing with the excesses in the system.

I would put in that category dealing with some of the latency in the system, and the number of vertical lines. We're dangerously close, and there were a number of people around this table that attended the same meeting. We're dangerously close to having a few accidental, unintended takes trigger some type of legal action.

I think we would be well served by trying to address those excesses in the system before the courts do it. I would hope that the Subcommittee will have more discussion on that subject when it comes up. Dennis, no, anyone else at the table.

UPDATE ON THE DEVELOPMENT OF AMERICAN LOBSTER DRAFT ADDENDUM XXVI

CHAIRMAN BORDEN: Okay, so we're going to move on to the next agenda item; which is an

Update on the Development of Lobster Addendum XXVI.

MS. WARE: All right, Pat. You set me up pretty well for this here. In January the Board did initiate Addendum XXVI to improve harvester reporting and biological data collection in state and federal waters. I just wanted to provide an update on that. We have also been working on XXV, so XXVI is not ready for Board consideration today.

But my hope is to get a solid draft of that perhaps by August. The TC is continuing to work on determining a statistically valid sample of reporting; and they're also looking and evaluating the current biological sampling programs offshore, to identify areas where data is either missing or potential possibilities for collaboration.

I think some of the things that are going to determine the timing of this addendum are the TCs analysis, the workload of the PDT, and also any action that happens on Addendum XXV today. But one of the things that would be really helpful in moving this process along is to get members on the PDT; who are well versed in electronic reporting and electronic tracking.

That is not an expertise I claim to have, and it would be really helpful to get someone, or a couple people on the PDT who had that information and can help provide some guidance on where to go. My ask of the Board today is if it is okay to reshuffle the PDT a bit for this addendum; to get that expertise in the group.

If people have specific individuals in mind that fit that bill and are willing to help out with this amendment, please let me know. I am happy to talk with them to let them know what the time commitment would be, and hopefully convince them that this is a good use of their time. If there are any questions, I'm happy to answer that; or if there are any concerns.

CHAIRMAN BORDEN: Questions for Megan, anybody? No hands up. Any objection to, oh excuse me, Emerson.

MR. EMERSON C. HASBROUCK: Thank you, Megan for your update. What was it that you said you wanted expertise on, electronic reporting and what else, please?

MS. WARE: Tracking, so things like VMS or other beacons that track where ships are, vessels are at certain times.

CHAIRMAN BORDEN: Any other questions? This is another issue like the prior issue; which is going to be developed and it will come back to you with more specifics. I failed to note under the prior agenda item that after we get the next report from that Subcommittee, at that point I think we've got to decide whether or not we want to proceed with an addendum to the development of an addendum; and basically task the PDT.

Just so everyone is clear on the process on that prior issue. We'll get the report. If people like what they see in general, then we'll pass a motion to initiate Addendum XXVII to do that.

CONSIDER AMERICAN LOBSTER ADDENDUM XXV FOR FINAL APPROVAL

CHAIRMAN BORDEN: Any other business under this item, if not we're going to move on to Addendum XXV**,** which is the main order of business for the meeting. This addendum has been under development, I think as everybody knows here, for a considerable period of time. The Board has had numerous discussions about this. We developed objectives, and so that everybody understands the process that I intend to follow on this. We're going to listen to these reports. Then once the reports are over, it is my expectation, I'm being optimistic here; that we'll have at least a half hour where we can get into some of the substance of the addendum.

What I intend to do is to try to take some of the easier issues today. I would characterize those as the issue of how to handle the recreational fishery, the issue of standardizing the regulations, the issue of the line for Area 3, and the issue of de minimis. I think the other items in the addendum are fairly complex, and there is going to be a lot of discussion about it.

One of the things that I want to forewarn everyone that I'm going to do this before we break, I'm going to take about a two or three minute caucus; and allow all the states to caucus with your representatives. Then what I would like to do is to go around the table; and basically ask each of the jurisdictions to state what their initial position is, relative to the size of the cut and the management tools that can be used.

The reason I want to do that is that we have the benefit of a couple of dozen industry people here. I think once everyone hears everyone else's initial position, they can talk to their industry. You can talk amongst yourself tonight, and try to figure out if there is common ground on the positions; or whether or not we should consider other alternatives in the morning.

We'll do that prior to the point where we break. I would just point out; this does not obligate anybody to take that position in the morning. You have the ability to change your position between the time we recess and the time we come back. What I'm trying to do is promote a dialogue among the individuals at this table and in the audience; that's all. Let's start with a report; Megan, on the options.

OVERVIEW AND TIMELINE REVIEW

MS. WARE: The Board is scheduled to take action today. For an overview of this presentation, first I'm just going to review the timeline for this addendum, so the Board knows what to expect after today's meeting. I'll go into the public comment summary and also use that as an opportunity to review the management alternatives.

Then we have several committee reports from our Advisory Panel, our Law Enforcement Committee, and our Technical Committee. Then we'll move into Board discussion and action. In review of the timeline, the Board did initiate Addendum XXV in May of 2016. In January, 2017 the Board approved Draft Addendum XXV for public comment.

This meant our public comment period was from mid-February to early April. The Board is scheduled to select management measures today, including a potential increase in the target egg production. In June, pending the Board's decision, we would ask LCMTs to submit final proposals on how to achieve the target increase in egg production; and this will allow the Board to hopefully review and approve these proposals at the August Board meeting.

Just to take a step back here and remind ourselves how this all began. This was prompted by the results of the 2015 stock assessment; which found that that the southern New England stock is depleted, with record low abundance, spawning stock biomass and recruitment. The figure here is showing abundance in millions of lobsters. You can see in 2013, which was the terminal year of this estimate; it was well below the target and the threshold. In our tool box for this addendum, we are considering three management tools. The first is a gauge size change. I think overall there is probably the greatest confidence in this tool to produce increases in egg production; given that it is enforceable, and provides a direct benefit of keeping lobsters in the water longer. Analysis suggests that it can achieve up to a 60 percent increase in egg production.

The second tool is trap reductions, and analysis here suggests that a 25 percent active trap reduction may result in, at most a 13.1 percent increase in egg production. However, the Technical Committee has noted that the relationship between traps fished and fishing mortality is unclear.

They've noted several caveats with the analysis; notably that current trap reductions reduce total allocations not active traps, that fishermen may not maintain constant soak times, that it assumes all changes in exploitation are from trap reductions, and that there is currently a trap transferability program in Areas 2 and 3; which allows active fishermen to replace cut traps with purchased traps.

The third management tool is season closures, and the intent of this is to reduce pressure of the stock at vulnerable times. Analysis suggests that a quarterly season closure can achieve up to a 21.6 percent increase in egg production; however, this assumes that fishermen don't increase effort during the open season.

PUBLIC COMMENT SUMMARY

MS. WARE: Moving into our public comment summary, seven public hearings were held in six states. In total 235 individuals attended those hearings. We also received 145 written comments from organizations and individuals; 49 of these were from a recreational form letter. I wanted to go over the general themes at the public comments, because I think there were some clear themes that emerged when reviewing them.

I think maybe this will help provide an overview of what I heard, at least. The vast majority was in support of status quo, and many commented that the Board should wait for a current management program to work. They noted the ongoing trap reductions in Areas 2 and 3, as well as the recent changes in 2014.

Others pointed to a lack of data in the southern New England stock, and recommended that the Board rectify this problem before taking further action. Many noted that natural mortality has increased, and pointed to things such as predation and water quality as the primary factors; which are contributing to the stock decline.

Others noted the economic impacts of the proposed changes, noting that it will put fishermen out of business; and there were concerns about interstate commerce. Then at many of the public hearings I heard that there are separate areas in southern New England stock. The DelMarVa fishermen noted that that fishery is separate from southern New England, and Area 4, they said that they should be evaluated on their own.

I heard that Long Island Sound is its own area, and it is different from the ocean; and then I also had requests from Martha's Vineyard fishermen for them to be separated from the rest of Area 2. Our first issue is the target increase in egg production. The question here is what should our increase in egg production be? As previously noted, the vast majority were in favor of status quo; so that is a 0 percent increase in egg production. Many stated that predation from black sea bass, dogfish and seals, as well as shell disease and water quality issues are the source of the southern New England decline; and that the Board should address these issues before addressing fishing mortality.

Others highlighted the potential economic impacts of this draft addendum; including impacts to the commercial fishery, recreational fishery, dealers, restaurants, and dive shops. Several fishermen stated that there had already been significant reductions in effort in southern New England fishery, and further reductions are not needed. In Massachusetts and Rhode Island, many commented that their preferred management alternative is status quo.

However, if the Board feels it needs to take action, then the increase in egg production should be no more than 20 percent; and they asked that that 20 percent be implemented over two years. We did have a few individuals who supported a 20 percent increase in egg production; noting that the stock has declined, and limited action may be warranted, but no one supported a 30, 40, or 60 percent increase.

In terms of management tools, this is our second issue and it asks what tools in our toolbox can be used to achieve that target increase in egg production. The first option is that all three tools can be used. The second option is that gauge size changes and season closures can be used, and the third option is that gauge size changes can be used with limited use of trap reductions and season closures.

The majority of comments did not support a regulatory change in the lobster fishery. They did not support any of the management tools in Issue 2. However, those that did comment on this issue, the majority supported Option A, since it provides the greatest flexibility to industry. Many commented against a minimum gauge size change, stating it disadvantages the inshore fleet; as larger lobsters move offshore, and prevent southern New England fishermen from participating in markets which prefer smaller size lobsters.

Participants in New York, Delaware, and Maryland did not support the use of trap reductions; since they commented there are few active traps in their waters. Several, particularly in Long Island Sound, recommended a V-notch program be considered as a management tool in this addendum.

Issue 3 asks how the recreational fishery should be impacted by this addendum. Our three alternatives are that the recreational fishery must abide by all management changes. The recreational fishery must only abide by season closures and gauge size changes, and then that the recreational fishery only abide by gauge size changes.

The majority of the comments supported that the recreational fishery abide by all management changes. Those in favor of Option A frequently stated that all participants in a fishery should be subject to the regulatory changes in Addendum XXV. Overall the recreational fishery supported Option C, in which they only abide by gauge size changes.

They commented that a summer closure would devastate the dive fishery, and the businesses it supports. Our fourth question is how should season closures be implemented in this addendum? We have three options. The first is that traps must be removed from the water. The second is that traps can stay in the water, but there is no possession of lobster, and the third is that there is no possession of lobster, but the bycatch fishery can continue. The vast majority did not support the season closure. Many commented that season closures disrupt the lobster market; and decrease the efficiency of the fleet. Others commented that since the Jonah crab and lobster fisheries are now jointly managed, season closures hurt the Jonah crab fishery.

Of those that did comment on this issue, the majority stated that traps should stay in the water during a season closure. They stated that traps provide food and protection to lobsters, and they protect historic lobster grounds from mobile gear. Others commented on the safety hazard of the moving gear; particularly in the winter, and noted that there are limited places to store traps.

We also had sub-options here that asked if the most restricted rule is either applied or not applied to dual permit holders. We received few comments on this; but those who did comment did not support the application of the most restrictive rule to season closures. I did just want to kind of preview some of the questions that the Board is going to have to answer on season closures.

Some of these are, if traps can stay in the water is it just traps which are permitted for another species, or all lobster traps? Does Jonah crab count as another permitted species? Is there a way to tell the difference between those traps, which exclusively catch lobster and those which catch conch or black sea bass?

What about the of Atlantic Large Whale Take Reduction Team rule which prohibits wet storage gear for more than 30 days? Can there be a grace period during which fishermen can remove and set traps? Does the most restrictive rule apply? Just to preview these questions, when we get motions on season closures, we're going to have to be very specific in crafting those motions; to try and answer these questions.

Our fifth issue is standardized regulations. This asks whether management regulations have to be standardized between different LCMAs. Wave 3 options, the first is that they don't have to be standardized. The second is that Areas 4 and 5 have to be standardized, and the third option is that Areas 2, 4, 5, and 6 have to be standardized.

The majority of comments did not support the standardization of regulations. Many stated that LCMAs were created to reflect regional differences in the fishery, and that each LCMA should have the independence to make its own decision. We did have a couple that supported standardized regulations between Areas 4 and 5; and they generally noted that both of these areas span New Jersey.

Our sixth issue is in regards to the implementation of this addendum in Area 3. This question is prompted because Area 3 spans both the Gulf of Maine/Georges Bank stock as well as the southern New England stock. We had different options here. Option A was to keep Area 3 as a whole unit. Options B, C, and D were all variations on how to split Area 3.

The majority of comments did not support splitting Area 3. They cautioned the Board against unintended consequences, such as the migration of effort to the Gulf of Maine/Georges Bank stock and the devaluation of Area 3 permits. There were a couple who were in favor of splitting Area 3, and they generally stated that it is unfair to burden fishermen in the Gulf of Maine/Georges Bank stock. Then our final issue is Issue 7, which asks which management changes de minimis states have to abide by. Our first option is that de minimis states are not exempt from regulatory changes in this addendum, and Option B is that the de minimis states are exempt. Overall there was a slight majority in favor of de minimis states being exempt; and this primarily came from DelMarVa fishermen, who supported an exemption for de minimis states; but did express concern that the language in Addendum XXV could hinder future growth of the fishery.

Some also recommended that all of Area 5 be given de minimis status. Those who oppose an exemption for the de minimis states commented that the regulatory changes should be equally applied to everyone. Then finally, just to wrap up on some of the other comments we've received.

Several people commented that there should be an increase in quota for predator species such as black sea bass, that there should be a federal buy-out program or a reinstatement of hatchery programs. Many commented that coastwide lobster landings had a record high, and so there is no need to take management action.

Others stated that there is a need for more data offshore and in the southern range of lobsters. Several people disagreed with the statement that climate change is contributing to the stock decline; and others asked that credit be given for oversized vents. That is the public comment summary, and I'll take questions or move to the committee reports.

CHAIRMAN BORDEN: Questions for Megan. No hands up. Okay.

ADVISORY PANEL REPORT

Then we'll move on to the next report, which is the Enforcement Committee report, AP, Grant and then we'll deal with the Enforcement Committee report. Just by way of introductions, Grant is the Chair of the AP. He is also the Chair of the LCMT 3 group; and he is the President of the Atlantic Offshore Lobster.

MR. GRANT MOORE: You just stole my thunder; I was going to introduce myself to everybody. I'm in these positions, I guess because I've been an active fisherman for 42 years. I think I can speak to these issues. The AP met on April 11. The first issue that we discussed was the increase in egg production.

Unanimously we supported a 0 percent increase in egg production, Option A; which in reality is a 13 percent increase in egg production, if you take in the current trap reductions that are taking place. Members commented that the Board should give time to the recent regulatory changes to take effect; as fishermen saw more lobsters and eggers in 2016.

Two members commented that if the Board feels the need to take action there should be no more than a 20 percent increase. Another member noted there is nothing which prohibits the Board from considering an increase that is less than 20 percent; such as 10 percent, 11 percent or whatever the Board would choose.

This AP member also commented that the Board choosing an option other than status quo on current trap measures should cover the egg production increase in LCMA 2 and 3. Another member commented that with the continuation of the current trap reductions, status quo will result in a greater than a 0 percent increase, as I stated at the start here. Moving on to Issue 2, the management tools, the AP reiterated its desire for status quo. Four members supported Option A, which allows for the gauge size changes, seasonal closures, and trap reductions; to all be used independently or in conjunction with one another. Those who supported Option A stated that it provides the greatest flexibility to the industry. Two members commented that anything other than the currently schedule trap reductions in LCMA 2 will kill the industry.

They noted that an increase in the minimum size in Area 2 will shut down the fishery; because the larger lobsters migrate offshore. Another member commented that increasing the minimum gauge size in Area 3 will prevent the offshore fishery from participating in markets which require smaller grade lobsters.

One member commented that any of the management tools proposed in this addendum will permanently shut down the LCMA 6 lobster fishery. He noted the changes to the gauge size will only further exacerbate interstate commerce issues with Maine and LCMA 6. They already have a seasonal closure in September.

He supported a V-notch program, which is interesting; as the management tool to achieve increases in egg production. I'm sorry to be lengthy, but I want to make sure that I include everybody's comments here. One member commented that if climate change is truly the cause of the southern New England stock decline, why make any management changes given that scientists are predicting continued warming in the coming years; and the Board cannot control the ocean temperatures.

The Recreational Fishery; the Advisory Panel was not unanimous in its recommendation regarding the recreational fishery. Four members supported Option A, which requires the recreational fishery to abide by any management changes in the addendum. They commented that whatever changes are applied to one portion of the fishery should be equally applied to all sectors of the fishery.

One member supported Option B, which required the recreational fishery abide by gauge size changes and seasonal closures. He commented that this option is closest to status quo. One member supported Option C, in which the recreational fishery only abides by the gauge size change. He said the summer closure would be detrimental to the recreational fishery, since they are limited to the summer months when the weather is more amendable to the diving.

Seasonal Closures; we were unanimous in its recommendation that the most restrictive rule does not apply to seasonal closures; Sub-option 2. Two members supported Option A, which allows the traps to stay in the water but prohibits the possession of lobsters during a seasonal closure. One member supported Option C, which allows the traps to stay in the water and permits non-trap gears to continue to land lobsters under the bycatch limit.

He commented that the Option C allows Jonah crab fishery to continue while providing a small market for the bycatch of lobsters. Standardization of Regulations; five members supported the Option A, which does not require standardization of the management measures across all LCMAs. They commented that the purpose of the lobster LCMAs is to reflect regional differences in the fishery, and standardized regulations will negatively impact the industry.

One member commented that if the regulations are going to be standardized they need to be uniform along the entire coast; including Maine. One member supported Option B, which standardizes the regulations in LCMAs 4 and 5. His comment was given that New Jersey straddles two LCMAs, differences in the regulations between LCMAs 4 and 5, cause confusion in the recreational fishery. Issue 6, the Implementation of the Management Measures in LCMA 3; three members chose not to comment on this issue, stating that the LCMA 3 should be allowed to decide how to deal with this issue.

One member supported Option A, which maintains LCMA 3 is a single area. He commented that the industry is concerned about the migration of effort into the Gulf of Maine and Georges Bank stock, as well as a devaluation of an LCMA 3 permit if the area is split along the 70° West line.

Another member commented that there is no resource issue in LCMA 3 in the Gulf of Maine/Georges Bank, and there is no need to change the regulations in the offshore area. He also noted that the recent National Monument Deep Sea Coral Amendments are providing additional protection to lobster stocks in this area.

Issue 7, De Minimis; two members supported Option B, which exempts de minimis states from implementing the regulatory changes resulting from this addendum in state waters. One of these members requested that the exemption be extended into federal waters. Another member supported Option A, which requires de minimis states to implement the regulatory changes in this addendum. His comment was that any management changes should apply to all participants in the fishery.

We had some general comments. One member commented that the sport dive fishery is limited to the summer months, and asked the Board to avoid the summer season closure. He also commented that predation is the primary contributor to the lobster stock decline, and that the Board needs to pursue increases in quota for dogfish and black sea bass.

Another member stated that industry is united in its support for status quo; and the addendum should be stalled until new data is added to the addendum or the addendum is rewritten to address natural mortality. The comment was that increase in black sea bass population will hurt any progress made in this addendum; and also noted that there is no information regarding the cultural or tourism aspects of the lobster fishery nor the indirect economic consequences that could result from this addendum.

He disagreed with the natural mortality line in Figure 3 in Draft Addendum XXV; commenting that natural mortality has increased significantly in the last few years. Another member commented that the current approach to managing lobsters is just not working. He expressed concern about increase in back sea bass population in New England.

Another member reiterated his support for status quo, and commented that the industry is doing enough to protect the lobster stock. Another member commented that if the Board makes the wrong decision on Draft Addendum XXV it will finish the LCMA 2 inshore fishery;

which is the last remaining viable inshore fishery in southern New England.

Large reductions will result in the loss of the infrastructure and docks which once gone cannot be gained back due to the prevalence of coastal development; and also noted that it takes ten years to see the results of management measures that have already been put in place, due to the slow growth of lobsters. As a result he felt that the Board should give time for the benefits of the recent management changes to come to fruition. The last thing, one member commented that the Board's decision in this addendum could seriously hinder the future of the lobster fishery.

His comment was the lobster fishery is moving offshore, but commented that it is not up to ASMFC to dictate how this happens; or when fishing is no longer economically viable. He stated that industry has done a lot to protect the resource, and he questioned whether anything good will come out of this addendum.

CHAIRMAN BORDEN: Are there questions for Grant? Pete Burns.

MR. BURNS: Thank you, Grant for that report. That was really informative. I was just wondering if the AP had ever considered, they talked about the impacts of increasing the minimum size; but did they discuss the possibility of decreasing the maximum size as a conservation measure?

MR. MOORE: That was brought up, Peter. Basically with the information provided by the Technical Committee, to gain any significant percentage change in egg production we were looking at a 4.5inch maximum size in southern New England. By going to that the AP felt that we would be creating a slot fishery; which is not a viable option.
CHAIRMAN BORDEN: Any follow up, Peter?

MR. BURNS: No, thank you.

LAW ENFORCEMENT COMMITTEE REPORT

CHAIRMAN BORDEN: Any other questions? For the next report we have the Enforcement Committee report; Rene.

MR. RENE CLOUTIER: The Law Enforcement Committee of the Atlantic States Marine Fisheries Commission reviewed many different options contained in the American Lobster Draft Amendment XXV, during a teleconference meeting on March 17, 2017. North Carolina, Rhode Island, Florida, Maine, New Hampshire, Pennsylvania, New Jersey, New York, Virginia, Maryland, Georgia, Delaware, U.S. Coast Guard, and NOAA OLE participated in a teleconference. A copy of this memo has been provided to the Board.

Issue 1, Target Increase in Egg Production; the LEC has no comments or recommendations on this issue. Issue 2, Management Tools; the LEC did not make a recommendation specific to the three options presented in the draft addendum. It cautions however that trap reductions as a management tool is likely to be ineffective; because of enforceability problems with offshore fisheries, with the increasing effort in the fisheries occurring.

There can be no meaningful enforcement of trap limits without electronic tracking or the development of the significant offshore enforcement platform. Other recommendations regarding gauge size changes or seasonal closures are included later in this memorandum. Issue 3, Recreational Fishery; the LEC strongly supports consistency across the Board between recreational and commercial management measures, particularly with respect to gauge size.

The LEC recommends that if a commercial season closure is implemented, at the least a strict minimum recreational bag limit be applied and enforced; because states typically allow a smaller number of recreational traps per person. Consistency with commercial trap reductions seems less critical. Issue 4, Season Closures; the

LEC supports Option A, and recommends that lobster traps be removed from the water during closed season.

The LEC supports Sub-option A, requiring the most restrictive rule to apply to season closures if a fisherman is authorized to fish in more than one LCMA. The LEC recognized the potential impact this would have on Jonah crab and whelk harvest, but believes that leaving traps in the water will reduce the effectiveness of a seasonal closure to continue trapping and mortality of lobsters.

Economic incentives to retrieve inland lobsters illegally during the closed season, increased number of lost and derelict traps, and increased likelihood of whale entanglements, are some of the LECs concerns. Issue 5, Uniform Regulations; the LEC strongly reaffirms its longstanding recommendations for consistency, and uniform regulations.

Inconsistent regulations for the most restrictive requirement may be of some help, but once the product leaves the dock the least restrictive regulation becomes the enforceable standard. Regulatory inconsistencies decrease the likelihood of successful prosecutions. Issue 6, Management Measures in LCMA 3; the LEC recommends Option A, status quo, in light of the significant existing problems with offshore enforcement.

Until enforcement tools for monitoring and checking the offshore lobster trap fishery are enhanced, adopting a zone split in LCMA 3, with tending trap-tag-in-transit complications will depend most entirely on voluntary compliance. Issue 7, De Minimis States; the LEC did not comment on this issue. The LEC appreciates the opportunity to provide enforcement advice to the American Lobster Management Board during the time of drafting Addendum XXV.

TECHNICAL COMMITTEE REPORT

CHAIRMAN BORDEN: Can I have questions for Rene? No hands up. Now we're into the, excuse me. I missed a report; the TC report. Kathleen.

MS. KATHLEEN REARDON: We didn't necessarily meet on the addendum; but we did want to respond to comments from the January 4 meeting, and some of the public comments. We wrote a memo that is included in the materials; restating our previous analyses. First we wanted to confirm that the trap reduction analysis was based on the number of active traps; and that was estimated by the 2015 stock assessment.

Second, due to a number of uncertainties, we would like to reiterate that the analysis predicts the trap reduction. Analysis predicts at most a 13 percent increase in egg production in response to a 25 percent active trap reduction. With that said we have the greatest confidence in predicted egg production increases from a gauge size change.

We also wanted to note that the benefit of these management actions may be less if there are disparate regulations across management areas. The analyses were done on the stock level, not on the LCMA level. Different actions implemented to reach the target percentage may not be realistic; based on smaller spatial resolutions and different management types. Thank you.

CONSIDER FINAL APPROVAL OF ADDENDUM XXV

CHAIRMAN BORDEN: All right, questions for Kathleen, if not; Pete Burns.

MR. BURNS: Kathleen thanks a lot for the report. Just to touch on the trap reduction issue. It is clear then that the way that we're reducing traps now would apply to both latent and active effort, because it is being applied across every fisherman's allocation. In that case you wouldn't expect to get any reduction in fishing mortality; based on removing latent effort. Is that true?

MS. REARDON: Yes that is true.

CHAIRMAN BORDEN: Any other questions, no hands up, do we have any more reports that I've missed? Okay so we're through our reports. At this juncture I think we need to get into the actual addendum. What I indicated before, I think Bob Beal recommended that we break about five, is that correct, Bob; 5:15, so we've got 35 minutes or 40 minutes to get into some of these issues.

My suggestion is that we take up some of the issues that at least in my own case; I view as a low hanging fruit on the tree, the less difficult issues. What I would like to do is start off with the issue of the recreational fishery, and basically deal with the options. Megan, can you put the options up on the screen? Have we got time? Put the options up.

What I would like to do is open up for discussion after we have a little bit of discussion I would ask for a motion. Does anyone care to discuss recreational options? If you have your addendum, these are on Page 25; and you basically have three options in the addendum. Discussion, you heard the Enforcement Committee report that dealt with this issue directly. Does anyone want to make a comment? No comments, does anyone want to make a motion on this? Mark.

MR. MARK ALEXANDER: I just have a question. It says recreational fishery under Option A, must abide by the trap reduction stated in this Addendum XXV, but there are no trap reductions.

CHAIRMAN BORDEN: Megan, to that point.

MS. WARE: Yes, it would be any additional trap reductions that are implemented as a result of this. For example, if trap reductions are one of the tools that remain in the toolbox, and Area 6 wanted to pursue trap reductions, then your recreational fishermen would also have to abide by those. I don't think all states have trap numbers. I think some of them are lobster bag limits; another thing to think about.

CHAIRMAN BORDEN: That was going to be my question. Do all states have trap limits on the recreational fishery? I see a number of heads saying no. Dan.

MR. McKIERNAN: I believe we all do have trap limits among the states. Do you want to poll the states on that issue now?

CHAIRMAN BORDEN: Well, I think that is a good suggestion. How many states have trap limits, limits on the recreational fishery? Just raise your hand. If I understand it there are a number of Mid-Atlantic States that do not have trap limits, which raises an interesting question. If they don't have a trap limit, how do you reduce? This problem, I think is going to come up a couple of times during the discussions today and tomorrow. I think there are a couple of other instances where, depending upon the options that get selected, some aspects of the fishery essentially will be held harmless. This may be one of the cases. Dan.

MR. McKIERNAN: To me this is where the de minimis proposal really missed the mark; because I'm guessing that the states that don't have trap limits don't have fisheries in their state waters. I'm sure if the states, New Jersey or south or wherever the fishery doesn't exist anymore to any degree in state waters, and they ask for de minimis status for their recreational fishery. We would all give it to them; because what we all know about the lobster stock for the south is that it has moved offshore. I think it is kind of a nonissue.

CHAIRMAN BORDEN: Okay, which raised the question, how do we want to handle this? I mean we've only got three options in the document. Comments, Dan.

MR. McKIERNAN: I would say go with Option A, with a sub-option or an option for de minimis status that states could request de minimis status on aspects of this. If Delaware says I need de minimis status on my inshore lobster fishery; which doesn't exist for recreational fishermen, we could.

CHAIRMAN BORDEN: Okay you've heard that suggestion; comments to that suggestion.

MR. ERIC REID: You should have picked de minimis first, Mr. Chairman. I want to know what the legal advice is on de minimis. Has NOAA General Counsel looked at de minimis status?

CHAIRMAN BORDEN: De minimis in the case, to be blunt, there is no dialogue in the document about de minimis for recreational fisheries; although it is probably within the purview of the Board if there is no recreational fisheries, but de minimis was discussed in the document as it pertained to the Mid-Atlantic proposal. I mean Peter, if you want to comment on that. It is not necessary if you don't want to, but if you want to go ahead.

MR. BURNS: I can't speak for General Counsel, and I'm not an attorney certainly, but I think you're right. I think that within the context of this addendum it was really only talked about within a proposal that came up for Sections under what's in Addendum XXV, the regular fishery. I'm not quite sure how it would pertain here. I know that de minimis is a state issue really, not necessarily a federal one.

CHAIRMAN BORDEN: My suggestion here is we deal with the options on the table, and then depending upon which option gets approved, and then we can have some dialogue and discussion. I'll just follow Dan's suggestion. If the Mid-Atlantic states don't have a recreational fishery in their waters, there is no possibility for having them reduce a trap limit. That concept may have merit. Further discussion on it, it is always nice to have the wheels fall off the cart on the first issue. Doug.

MR. GROUT: Well I'm not southern New England, but I ask the states that would have to implement this, what are their recreational trap restrictions? Think about if they're anything similar to what's in New Hampshire, what are you really going to gain in egg production by having a reduction of the relatively small amount of traps? Maybe some states have recreational trap limits that are quite sizeable. But I would be surprised at that. From my perspective, if it was happening in New Hampshire I would say, stick with gauge size and season closures; because you're not going to gain anything from trap reductions in increasing your egg productions. Again, I offer that up to Rhode Island and Connecticut, Massachusetts and the states to the south of us that don't have traps set.

CHAIRMAN BORDEN: Just to follow up on that. I just remind everybody, as I said when we started to open a dialogue. When we met in Connecticut, we actually discussed certain aspects of this. The consensus was that all groups within the southern New England stock area should contribute something. I'm not saying that to disagree with the Chairman of the Commission. I think that was the context for putting these options in the document. If the commercial fishermen have to give up traps then maybe the recreational fishermen should give up some.

MR. McKIERNAN: Is it too early for a motion?

CHAIRMAN BORDEN: Yes, I'm ready for a motion.

MR. McKIERNAN: Move to adopt Option B; which is the recreational fishery must abide by gauge sizes and season closures.

CHAIRMAN BORDEN: All right is there a second; seconded by Mark Gibson, discussion on the motion. I've got Adam, then Pat, and Tom Fote.

MR. ADAM NOWALSKY: Our recreational lobster fishery, if you will, in New Jersey is essentially limited almost exclusively to our diving community. We do have a recreational trap limit of 10 pots per person. I could go every day that I fished and never see a recreational trap all year. It is very, very limited.

To have a seasonal closure during our prime diving seasons would be devastating to the diving community; quite frankly**. It is the one issue at our public hearing that the recreational interest came out and spoke out passionately to limit the changes to gauge size only. For that reason I would move to amend to remove the seasonal closures, Mr. Chairman**.

CHAIRMAN BORDEN: Is there a second to the motion to amend? **No second. The motion dies due to a lack of a second.** Tom Fote.

MR. FOTE: I was just going to say the same thing Adam said. Our fishery is July to August, and it is mostly a dive fishery. I didn't even know how many pots. For the first time I realized that we were able to have 10 recreational pots. But that is not really a big fishery. What we have is the dive fishery. It's something when they go out and dive the wreck and they want to grab a lobster in that. You have a season closure in July and August that puts all those people out of business. I'm not about to do that when it makes no difference to the stock.

CHAIRMAN BORDEN: I would like to go back to Adam's point and just make sure that everyone understands the issue. The intent of the motion, at least the intent of the option in the document, is not to pick other gauge sizes or season closures. That is yet to be decided, and it will probably be decided on an area-by-area basis. All this basically says is that if that option is selected then they have to abide by it, but for instance, if New Jersey chose a gauge size then there would be no season closure; other discussion on the motion on the floor? Yes, Roy.

MR. ROY MILLER: Mr. Chairman, I think I would offer a second to the motion proposed by New Jersey; just for voting purposes.

CHAIRMAN BORDEN: Too late. If somebody wants to make that motion again they can do that. But you're a little too late; further discussion. Tom Fote.

MR. FOTE: I'll make Adam's motion again.

CHAIRMAN BORDEN: Okay so we have a motion by Tom Fote, seconded by Roy Miller, and the motion specifically, Tom?

MR. FOTE: Is to remove the season closures, it's up there.

CHAIRMAN BORDEN: All right, does everybody understand the motion on the table? Discussion, any discussion? Yes, it's a second by Roy. Any discussion, Pete Burns.

MR. BURNS: I am just curious what the impact would be. How big is the recreational-dive fishery in New Jersey, and when does it operate?

CHAIRMAN BORDEN: Does someone want to comment on that? Tom.

MR. TOM BAUM: I don't know how large it is, but folks from Cape May, Point Pleasant, even up to Sandy Hook there is usually dive boats like a charter operation. I don't have the numbers in front of me. But it will affect them severely. The main seasons of business are during the summer months, June through September, probably. It is a popular sport. As evidenced by our public hearing, the New Jersey Dive Council was represented there. I'm not sure of their numbers, but it is quite significant.

MR. FOTE: Can I follow up?

CHAIRMAN BORDEN: Tom.

MR. BAUM: I'm going to finish up. One of the other issues we'll deal with later is the management tools. As I understand it, if there is a gauge size increase, could there also be a season closure? You can use them together. That would affect our recreational fishery.

CHAIRMAN BORDEN: That was the point that I was making. It may or may not be needed is the reality of it. Tom Fote.

MR. FOTE: Yes, and most dive boats are mainly going out to wrecks and just diving; and some of the guys like to get lobsters while they're down there. But I don't think that is really what the dive trips sell for. They are not sold for that harvest, but they are going to a particular wreck and observe and everything else. It's just a bycatch of the operation that they can come up with a lobster or so. I don't know what the triggers are and basically trying to figure that out. But it's difficult.

CHAIRMAN BORDEN: All right, anyone on the motion to amend; which basically removes the seasonal closure? Yes, Steve.

MR. STEPHEN TRAIN: If the divers are primarily diving in July and August and they don't want to lose that would they be open to a seasonal closure at the opposite times of the year? You know sometimes we have to balance these things out somewhat.

CHAIRMAN BORDEN: Anyone in the New Jersey delegation want to respond? Adam.

MR. NOWALSKY: Sure, it's great to go ahead and just look at the sea life on the bottom and then decompress, hang out for a while and swim back to the surface. But how can that opportunity to harvest a plug or two, take home that lobster, people want that opportunity. The dive boats need that opportunity. Sure, January, February, March is there less diving activity due to water temperature; absolutely. But it doesn't go completely to zero. I'm not sure those months could even provide much in the way of benefit at that time.

CHAIRMAN BORDEN: Anyone else at the table, does anyone want to caucus on that? A one minute caucus and then I can call the vote. Pete Burns.

MR. BURNS: I am thinking about how this would translate sort of north to south, because even though New Jersey's recreational fishery is mostly rooted in the dive fishery; how would it translate in some of the New England states that have those recreational fisheries? Then you would potentially be allowing fishermen to fish and have lobsters landed during the seasonal closure. I think those would be my concerns. I'm not sure if Rene on the Law Enforcement Committee wants to make a comment.

MR. MICHAEL LUISI: I was also thinking kind of the same way that Pete is, just as far as we're speaking of our recreational fishery down in DelMarVa, and ours is even smaller than what New Jersey has, a handful of boats that do a little diving, catch a few lobster. I'm going to support the motion to amend here; because we haven't made the decisions that we're going to be making tomorrow, to understand where we might be as far as is Area 4 going to be linked to go with Area 5?

Are we going to have management tools that are going to be linked together with mandatory seasonal closures? Without knowing all of that I think this is the least amount of impact to those very, very small fisheries in the southern extent of southern New England. I will support the motion to amend.

CHAIRMAN BORDEN: Anyone else? A one minute caucus and then I'll call the vote. I'm going to call the vote, is everybody ready? I don't want to rush this. **All those in favor signify by raising your right hand; and hold your hands up, please. Six in favor, opposed, 4 opposed, any abstentions, 2 abstentions, null votes, okay the motion passes. You have an amended motion on the floor;** any further discussion on the amended motion? Yes, Mark.

MR. ALEXANDER: Question, if Option B is selected that wouldn't preclude a state from considering trap reductions and the recreational fishery take the credit for it, would it?

CHAIRMAN BORDEN: I think the state could, and Megan, correct this if this is wrong, I think under conservation equivalency you could certainly propose that.

MR. WARE: I would say the state can always be more conservative than what the plan specifies. I would have to think that that could count towards your egg production target or not. I need to think about that. I don't want to give an answer right now.

CHAIRMAN BORDEN: Okay other questions, yes, John.

MR. JOHN CLARK: I'm just looking at the options. By taking out the season, isn't this now Option C, the motion?

CHAIRMAN BORDEN: Yes that is correct. Thank you for that observation. Not only did the wheels fall off. I won't go there. **All those in favor of the amended motion signify by raising your right hand, we've got 9 in favor, opposed, 1 opposed, abstentions, 2 abstentions, no null votes; motion passes.** Congratulations, first issue down.

You can take a deep breath; it will go a lot easier, until we get to the next item on the agenda, which is standardizing regulations. This is Item Number 5, on Page 26. Megan, if you've got the options. We have three different options here. I just remind everybody that the overwhelming public comment in the public hearing for Option A, the Advisory Committee recommended Option A. Discussion on this, any discussion, no discussion, does someone want to make a motion? Mark Gibson.

MR. MARK GIBSON: Yes, I would move the Issue 5 uniform regulations, the Board adopt Option A, regulations are not uniform across all LCMAs, status quo.

CHAIRMAN BORDEN: A second to the motion, John Clark. Discussion on the motion, any discussion, no hands up, do you need a caucus on this? Does anyone need a caucus, no caucus? **Okay, all those in favor of the motion on the board signify by raising your hand; 11 in favor, 0 no any abstentions, any null votes? Motion carries.** Just get right in the swing of things here.

MS. TONI KERNS: David, can we pause for one second? We had a technical difficulty. We just want to catch up with you on the screen. Two seconds.

CHAIRMAN BORDEN: All right the next issue we're going to deal with is the line in LCMA 3. This is the 70° line. Just probably a background, I was going to say this before, and I'm not trying to convince anybody to follow one path or another path. I just think it's useful to reflect on the history here.

When we got involved in this addendum, the industry some segments of the Area 3 industry basically came forward and said, this will be a disaster for the offshore boats that fish out on Georges and in the Gulf of Maine; if there isn't a line. They voiced their concern, they also voiced their concern that there was a substantial tendency among the offshore boats in Area 3 to fish both west of that line for Jonah crab fishing purposes; primarily I think in February and March, and then move to the east.

The impact, I want everybody to clearly understand this that the impact of no line, you have two stocks that are harvested in Area 3. You have the Georges Bank/Gulf of Maine stock, and the southern New England stock. The southern New England stock is west of 70°. The Georges Bank stock is east of 70°. If the line exists, everybody should be clear on this; if the line exists then you can propose restrictions on the southern New England portion of the stock; without negatively affecting the Georges Bank stock. If the line doesn't exist, then all Area 3 fishermen have to abide by whatever restrictions the Board adopts. The second issue that came up clearly in the public hearings was there was a lot of concern about the accumulation of gear in proximity to the line; and the potential impacts that this might have on whales, particularly south of like Martha's Vineyard, and what they've referred to as schooner lands.

I've heard a number of fishermen raise this, and voice that term. I want everybody to just understand. There are pros and cons of the line, and depending upon the decision that gets made on the line, either you end up extending the regulations just in one portion of Area 3, or you extend it to the other portion of Area 3.

Just so everyone is clear, advice from the public hearings was no line; was the advice. It is kind of a ticklish issue. Let me ask for any discussion. Are there any other points that people want to make on this? If they don't want to make points, does somebody want to make a motion? Jim.

MR. JAMES GILMORE, JR.: Just a question for the LEC again. What was their take on this, so I can add this to the report?

MR. CLOUTIER: The LEC said until enforcement tools for monitoring and checking the offshore lobster trap fishery are in hand, adopting the zone split in LCMA 3, would depend almost entirely on voluntary compliance.

CHAIRMAN BORDEN: Let me reiterate. The AP recommended against the line, and the Enforcement Committee basically is recommending against the line. Any advice we got at public hearings was against the line. Does someone care to make a motion on this issue? Dan.

MR. McKIERNAN: I move to adopt Option A; Maintain LCMA 3 as a single area.

CHAIRMAN BORDEN: Is there a second to that; seconded by Eric Reid. Discussion, Jim did you have your hand up, no? Does anyone here want to speak to this point? Since we have the benefit of Grant in the audience, Grant, are there any other considerations which the Board should know of that you can think of at this point? You don't have to speak, but if it is something you think the Board should know about this issue then I'll give you an opportunity to comment.

MR. MOORE: The only thing I would like to reiterate to the Board is that maintaining one area will put Georges Bank/Gulf of Maine stock under the same type of restrictions that would be imposed on the southern New England. If this Board decides to adopt any measures other than the status quo, it is going to affect a perfectly healthy stock; it is at record abundance at this time. I would advise that people keep that in mind.

MR. GROUT: I will oppose this motion for that very reason; that I think we would be implementing restrictions on a perfectly healthy stock, and I would support a motion to have, approve and land it. I'll be voting against this.

CHAIRMAN BORDEN: Back to Emerson and then John Clark, I think you raised your hand.

MR. HASBROUCK: I kind of missed it in your opening remarks here a couple minutes ago, my position. Did you say that establishing this line was brought by industry; and if so, then I'm wondering why either in the AP or in the public comments the issue wasn't supported right along?

CHAIRMAN BORDEN: I did say that. This issue was originally supported, because there were a few individuals in the Area 3 industry that basically submitted it. But clearly when we went to public hearing, I attended a number of the public hearings, the Area 3 industry is almost unanimously opposed to the line; for some of the reasons that I cited.

MR. CLARK: I just had the same question pretty much. I was just curious as to why at this point now they're against it; when it sounds like this would almost be a poison pill for this whole addendum; because as was just stated if this is approved, and then there is any type of reduction at all in this plan, it will apply to fishermen fishing Georges Bank/Gulf of Maine, correct?

CHAIRMAN BORDEN: The only other reason I heard at public hearings, John that came up repeatedly was there is this concern that if you establish a line at some point that line and whatever qualifying entry requirements are would be used to clear, basically break Area 3 into two areas. There is a lot of concern about that and the issue of devaluing permits.

The other related issue that came up was if you have a line, everyone knows the best fishing is east of the line, but generally the guys that are fishing west of the line don't take advantage of that; because they're also doing a lot of crabbing west of the line. The line will force a number of fishermen in southern New England to redirect into north of there. That was another issue that came up at the hearing. I agree. Having been involved in the early discussions on establishing a line, then I went to the public hearings and scratched my head a bit myself; someone else?

MR. TRAIN: This motion now, I do not see how I can support this. We're taking a very healthy stock in the Gulf of Maine and Georges Bank, and forcing management measures on the participants in that; maybe not Area 1, but Area 3. But it is the same stock as Area 1 that doesn't need to be there by not putting them on.

It makes absolutely no sense to me, and I wonder is this how we submarine the whole plan and do nothing? I can't see forcing time out of the fishery or a larger measure or anything else at this point, further trap reductions on the healthiest fishery we have in these LCMAs.

CHAIRMAN BORDEN: Any other comments; Peter Burns.

MR. BURNS: I was just wondering I'm trying to remember back on what the TC recommendation was on this; whether they recommended management by stock area or by the whole area.

CHAIRMAN BORDEN: Kathleen.

MS. REARDON: We were only looking at southern New England as a stock area; we were not looking at Georges Bank.

MR. LUISI: Would it be safe to say that in considering this issue that the Area 3 fishermen are willing to deal with what may end up being a small reduction; rather than the complications that come with the line? It kind of sounds like to me, I'm not quite clear on how the industry brought it up; but then once it was analyzed they've now decided that they don't want it anymore. But I wonder if they're just willing to accept the southern New England management, because that's less impactful than what they think might happen as a result of the line? Is that a fair?

CHAIRMAN BORDEN: That actually has been the way that a couple of individuals in Area 3 have characterized exactly. I think those individuals that support that position, basically they think that it would be better off, complications that come with the line are more damaging than just slight changes in the regulations.

To some extent, all these issues are linked. That is one of the reasons that I avoided not getting into Issue 1 and 2; because the way you decide on some of these issues now, will have major impact on the decisions that get made before. In other words, you don't really know what you're voting on with Issue 1 and 2; unless you flesh out some of these other details. Further discussion on this, Eric.

MR. REID: I'll paraphrase Mike Luisi. It would be safe to say that if I hadn't seconded this motion, I wouldn't have wasted the Board's time. It is my understanding that this motion was conditional on status quo being adopted; it is cart before the horse, and obviously we do a lot more damage than good to support it now. I'm going to oppose my second to the motion.

CHAIRMAN BORDEN: Okay, any other discussion? Do you need to caucus? This is probably an issue where we need to caucus; a couple of minutes. All right, are you ready or do you need more time? Mike asked for a little bit more time. Then I'll recognize Craig. Are you ready for the question here, and I'm going to take the extra step.

I want you to hold your hands up for a lengthy period of time here, so that we can write down who is voting which way. Given the way this dialogue has gone, I can envision after tonight's discussion somebody wanting to go back and reconsidering it. I think it's important to know who's voting what. Dennis.

MR. DENNIS ABBOT: I request a roll call.

CHAIRMAN BORDEN: Craig.

SENATOR CRAIG A. MINER: That was going to be my question. Depending on what happens, I guess today, and then what might happen tomorrow, would it be within our rules to reconsider this question; depending on the outcome?

CHAIRMAN BORDEN: Absolutely. While staff is getting this, after this I'm going to take a couple of minute break and then this will conclude our business for the day. But I want to do what I indicated before. I want to afford every jurisdiction here to provide us with an initial indication of what their position is on Item 1 and Item 2.

We'll take a short break, just a couple minutes after this motion gets dealt with. Then we're going to go right around the table and that will conclude the business of the day.

MS. WARE: For the reconsidering, if the Board would like to reconsider this vote tomorrow, someone from the prevailing side will have to bring forward that motion for reconsideration. I just wanted to let everyone know how that works.

CHAIRMAN BORDEN: All right Mike and then Roy.

MR. MILLER: First of all, if it is reconsidered tomorrow, wouldn't that require a two-thirds vote?

MS. WARE: I think we're saying it's the same meeting.

MR. MILLER: Would you also consider at this point a motion to table this until tomorrow?

CHAIRMAN BORDEN: That is certainly appropriate. That is certainly within the purview of the Committee. It might generate a stronger discussion tonight if we actually voted on it, and then let the record be the record. If somebody comes up with a very convincing argument overnight on why the position should change; or if in fact we do something tomorrow that dictates that the position should change. Then we would just follow the rules and reconsider.

MR. LUISI: I was going to ask the same question about postponing until the morning, but if you're not inclined to go down that path, we'll just go ahead and vote.

CHAIRMAN BORDEN: Are you ready for the question here? All those in favor, oh no we're doing a roll call, excuse me. Megan, would you call the roll please?

MS. WARE: Maine.

MR. KELIHER: No.

MS. WARE: New Hampshire.

MR. WHITE: No.

MS. WARE: Massachusetts.

MR. McKIERNAN: Yes.

MS. WARE: Rhode Island.

MR. GIBSON: Yes.

MS. WARE: Connecticut.

MR. ALEXANDER: Yes.

MS. WARE: New York.

MR. GILMORE: Yes.

MS. WARE: New Jersey.

MR. BAUM: Yes.

MS. WARE: Delaware.

MR. CLARK: Yes.

MS. WARE: Maryland.

MR. LUISI: Yes.

MS. WARE: Virginia.

MR. JOE CIMINO: Yes.

MS. WARE: NOAA Fisheries.

MR. BURNS: No.

MS. WARE: New England Council.

MR. TERRY STOCKWELL: Abstain.

CHAIRMAN BORDEN: All right, did we have any null votes? The vote on it is 8 to 3 with 1 abstention and 0 null votes. The motion passes. I urge members of the committee to continue to dialogue on this, because obviously there are different circumstances that would undoubtedly change the motion.

The next thing and this is a final action today. As I announced earlier, I would like to take a short caucus, a couple minutes, have each jurisdiction be able to basically talk to the fellow commissioners, and then go around the room and basically ask each jurisdiction to tell all of us which options you prefer on Issue 1, which is the egg production target.

The range of options here is basically status quo, all the way up to 60 percent increase. Then I would like when you have the floor, to also comment on which of the management tool options you prefer. As I indicted before, the reason I'm doing this is I'm trying to give individuals around the table some sense of how other jurisdictions are looking at this issue.

Nothing is binding, there is no commitment. If you want to change your position tomorrow you can. But by doing this, what I'm trying to do is promote a dialogue of the group here overnight. Tomorrow at breakfast, or whenever, if a majority all fall on one particular point I think this strategy will make the going easier tomorrow.

What I would like to do is to start north to south and have Megan call off each jurisdiction, and basically have them comment. Let's take a two minute or three minute caucus break, and then we'll go north to south. Then when we get into the actual vote we go south to north. As I indicated before, and I just want to make sure the record is absolutely clear on this. This is not a vote, number one. Number two, it does not bind any jurisdictions to what they say here; it is a preliminary indication of what you are thinking. If you want to change your position in the morning, you can change your position in the morning. This is nonbinding. If we have any members of the press in the room, do not publicize this; because it is a nonbinding activity. Megan, will you call the states and we'll go around? Given the time, we are not going to have any debate. Whatever you say is your position, and then we'll adjourn when we're finished.

MS. WARE: Maine.

MR. KELIHER: Status quo.

MS. WARE: New Hampshire.

CHAIRMAN BORDEN: Pat, can I just for clarification, do you have any position on the second item?

MR. KELIHER: No, I'm sorry, I was being inclusive. Status quo on Item 1, Item 2 would be, take no management action.

MS. WARE: New Hampshire.

MR. GROUT: Mr. Chairman, based on the last vote, we would support status quo. We came here prepared to support reductions of 20 to 40 percent using gauge size preferably. But given the fact that we're now going to, at least if the prior vote after the last vote where we implemented management measures that would bring it back to a fully rebuilt stock in the Gulf of Maine where the fishery takes place up there. We support 0.

MS. WARE: Massachusetts.

MR. McKIERNAN: Status quo.

MS. WARE: Rhode Island.

MR. REID: Status quo.

MS. WARE: Connecticut.

MR. ALEXANDER: Status quo.

MS. WARE: New York.

MR. GILMORE: Well let me split this with this new approach here with, you show your hand then to bed. For Area 6, status quo, because of its uniqueness, whatever, then for Area 4 it will likely need more discussion; maybe select discussion.

MS. WARE: New Jersey.

MR. BAUM: Status quo.

MS. WARE: Delaware.

MR. CLARK: Given that de minimis, which is something that our states from Delaware, Maryland, and Virginia were looking for, it won't really be effective for federal waters. We prefer status quo, but we will consider a reduction.

MS. WARE: Maryland.

MR. LUISI: We would support status quo, but we could consider a reduction up to Option B, but not any further than Option B; which is 20 percent. But we support status quo.

MS. WARE: Virginia.

MR. CIMINO: In this case last certainly is least.

CHAIRMAN BORDEN: Joe was it a contentious sub-caucus?

MR. CIMINO: I would like to go on record as other Board members from the Mid-Atlantic region have. It would be great to have more information on what's happening in the Mid-Atlantic, and I hope going forward that someday we do see that. But for right now I think status quo makes more sense for us.

MS. WARE: NOAA.

MR. BURNS: You spoke too soon, Joe. I guess last is least, right? I'll say that the one thing we won't support is status quo. What the Technical Committee has shown us, and what the stock assessment has shown is that even though a lot of the stock decline is due to climatic factors, and an inhospitable habitat.

We know that fishing mortality is still the largest source of mortality for this stock. We know in this document that some management measures could be useful, and could help if we do optimize our egg production and we get some cooperation from Mother Nature. We don't want to go with status quo.

We certainly can't support any types of trap reductions that have already taken place. We know that those trap reductions aren't targeted solely on active traps, and they don't permanently remove traps from the water. We know that over the last two years our trap transfer program has allowed the fleet to buy back 30 percent of the traps that we've cut, and activate them back into the fishery.

I think we're fooling ourselves if we think that we're getting all the reductions that we think we're getting for traps reductions. Because most of that is not from active and permanent effort being removed, we're not getting the egg production benefits that we think we're getting; so I'll leave it at that for now.

CHAIRMAN BORDEN: All right that concludes our business for today. We'll resume the fun tomorrow.

(Whereupon the meeting was adjourned at 5:15 o'clock p.m. on May 8, 2017.)

MAY 9, 2017

TUESDAY MORNING SESSION

The American Lobster Management Board of the Atlantic States Marine Fisheries Commission reconvened in the Edison Ballroom of the Westin Hotel, Alexandria, Virginia; May 9, 2017 and was called to order at 8:05 o'clock a.m. by Chairman Dave Borden.

CHAIRMAN BORDEN: In terms of process, let me just outline so everybody is clear what I intend to do. If anyone disagrees with it, I urge you to speak up. I've talked to a number of the states in the Mid-Atlantic states about dealing with the next issue; which is the issue of de minimis.

What I would like to do; the sequence of the discussion this morning, I would like to have a discussion of de minimis; resolve that issue, and then move to Item Issue 1, which is goals of the action, and then deal with Issue 2. Then following that if we can manage to get through that then I'm going to deal with Issue 4.

As I indicated yesterday, I want to package Issue 4 with the concerns that were voiced by, particularly Area 4 about the closed season. I think these are all the same issues in the discussion. Resolution on Issue 4 hopefully will resolve the issue that concerns the Area 4 and 5. Any concerns about that strategy? If not, Megan, I see no hands up so Megan could you outline the issue on Issue 7.

MS. WARE: Good morning everyone. Just a reminder for the de minimis issue, the question here is whether de minimis states, which are currently Virginia, Maryland, and Delaware, have to implement the management measures in this addendum. Option A, de minimis states must implement all management measures adopted under Addendum XXV.

Option B, the de minimis states are exempt from the Addendum XXV management measures if they meet certain criteria. The intent of this is to try and make sure that effort from non de minimis states doesn't move into these de minimis states.

CHAIRMAN BORDEN: Any questions on that? Yes, John.

MR. CLARK: Not so much a question as a comment. When our states proposed this, we expected that de minimis would apply to our lobstermen fishing in federal waters also; which is pretty much where all our landings come from. I had extensive e-mail question and answer with Peter Burns and Megan since the last meeting; and realized that that is not the case that these de minimis provisions would not apply to our fishermen fishing in federal waters. In that case de minimis really is not going to be much of a help in our state. I just wanted to clarify that for the Board.

CHAIRMAN BORDEN: John, are you saying you support Option 1?

MR. CLARK: Given the status right now, I would say that there is not really any difference, so Option 1 would probably work, Option A.

CHAIRMAN BORDEN: Mike, did you have your hand up and want to speak to that? No. Any other Mid-Atlantic states that want to speak to this? Mike.

MR. LUISI: Well I just agree with John. There was a lot of work that went into crafting this, but through the conversations we realized this really can't offset or help us in any way; given that we don't have state waters fisheries. John, I don't know, was that in the form of a motion? I would second it for you.

MR. CLARK: In that case, yes I would move that the Board accept Option A for de minimis.

CHAIRMAN BORDEN: Seconded by Mike. Let me suggest so the record is clear, the motion I think should be to approve Option 1 in Issue 7. Is that correct? That was your intent; Option 1 under Issue 7.

MR. CLARK: Option A.

CHAIRMAN BORDEN: It was the last issue.

MS. WARE: I'll just interject. This is my fault. It says Option A on the presentation and Option 1 in the document; they are the same thing, my apologies.

MR. CLARK: Yes 1A that one.

CHAIRMAN BORDEN: Now I understand why I'm confused. Okay so discussion on the motion. Is everyone clear on what the motion is? Does anyone at the table care to speak on the motion? No hands up, I think this is a pretty clear issue, fairly easy to resolve. Do the members need a caucus on this? No hands up.

Let me ask, since we had no one speak to it other than the proposers; are there any objections to approving this motion as it stands? No objections, motion stands approved as submitted. Next issue, which we're going to move back into the targeted increase in egg production, and what I would like to do is having served as Board Chair here for a while and I've agonized over this issue.

In particular I would say listen to people like Dennis Abbot and others, and Ritchie White on this issue. I would like to kind of frame, and this will take me about four or five minutes. I would like to frame what I think the issue is in terms of southern New England. What I'm about to say basically comes out of almost all of the technical documents. In other words, if I voice my own opinion I'll say so.

There is no question, if you look at all the technical documents; there is no question that the southern New England stock is overfished, according to our current definition. But I would note that the current fishing reference point is 35 percent below the threshold; and it is 27 percent below the target. To me this is really important, because older fish, in terms of the Plan, includes a timeframe when the Long Island stock was extraordinarily healthy. The Long Island stock, as Mark and Jim are painfully aware, used to contribute almost 9 million pounds of landings to the southern New England portion of the population. That portion of the population currently or that fishery in that area currently contributes, according to the most recent statistics, about 250,000 pounds.

In terms of dealing with overfished, to me, and this is where you'll get into some personal opinions. I think we're dealing with an obsolete reference here. In other words, I went out of my way to talk to the state directors; who I have great respect for, and asked them very pointedly. Do you think it is possible for us to rebuild the Long Island stock?

I got almost unanimously, no. Let me ask this as a question, so that the record is clear. Does anyone around the table think that we have the ability to rebuild the Long Island stock? If a hand goes up I'll recognize you, and ask you to say why. Does anyone believe that we can rebuild the population of Long Island Sound?

There are no hands up. Essentially we're dealing with a situation where we have a definition that is based on, I think a 20 year time period, where the environmental conditions have totally changed; and everyone is painfully aware of this. If we can't get back to – this is not a traditional type fishery management issue, normally you deal with these things where the population is overfished, it's formulaic.

You look at the current fishing mortality rates, you reduce the fishing mortality rates over a fixed period of time; and rebuild the population. That is the way we normally do that. But in this case, because you've had a complete decoupling; and that is what the technical people have indicated.

The stock recruitment relationship for the southern New England portion of the population has decoupled. I note that I was a bit alarmed when I went to the northern New England meeting, and some of the technical people started talking about the same thing manifesting itself in northern New England.

To me the technical advice has been clear on this. I think it's important so the record is clear. The stock has been in recruitment failure since 2011. We've had the SSB in recruitment, essentially decoupled. No one in this room I think has any control of that nor do we have a really good understanding of why that has taken place.

According to the technical people, the poor stock conditions are due to environmental conditions that have increased M, and specifically they reference water temperature, larval survival and predation all having major negative impacts on the stock. All of the technical projections indicate that if we were to handle this the way we normally handle all of our other fishery management issues, you would have to have a 75 to 90 percent reduction in fishing mortality; in order to stabilize the stock under current environmental conditions.

What we would be talking about with that; that is straight out of the technical report. What we would be talking about is for a complete fishery closure. We shouldn't try to sugar coat that and factor in that southern New England lobster is at the fringe of it's ideal habitat; and everybody knows that. The ideal habitat for lobsters now is in the Gulf of Maine. Who knows how long that condition will persist? Further complicating this whole situation we're in is that all of the projections that I've seen by the Center staff basically indicate that the environment that the southern New England lobster is in has been a change, and it's going to get worse. We have two papers by very distinguished NOAA scientists, Doctor's Hare and Saba. Both of those indicate the water temperatures are going to continue to increase.

The point in all of this is we're trying to manage a stock that really is at the fringe of its resource, and there is no assurance; no matter what strategy the commission follows on this, so we can rebuild the stock. I think personally, this is a personal opinion; I think it is important for us to simply recognize that and state that in the record, and essentially state that we don't have expectations that we can rebuild the stock.

Given the environmental changes that we're all confronting at this point, we just can't do this on a formulaic basis. Further complicating our life, we have major disconnects, not only in the system itself but in the science. I for one, and I've said this repeatedly. I started out as a lobster biologist. I for one think that the science, the work by our Technical Committee, the work by the NOAA Science Center, particularly the projections that individuals like Burton Shank and others has done.

The science as far as I'm concerned is the best science we've ever had on the lobsters; as long as I've been in the process. Unfortunately we have a situation where bad science is pretty much associated with the fringe of the lobster population. The lobster population historically, 87 percent of the lobsters were caught inshore; and that is straight out of the technical report.

Now we have a situation where about 65 or 70 percent of the fishery is taking place offshore. If you compare that to the actual science, the science is taking place, according to the technical memorandums, within 200 feet of water; from shore out to 200 feet. The fishery is taking place primarily in Area 3, according to the addendum, and I can point out the section; and from basically 300 feet of water out.

If you look at the science, the science extending from inshore, there is almost no sampling that is taking place in the deep areas. This isn't a criticism of NOAA, it's a fact. To quote the technical memos, the Technical Committee has repeatedly noted the deficiencies in the offshore sampling program. I think I found at least three or four references to it.

There are not larval surveys. There are no settlement surveys. There is limited benthos data. There is little current data on growth, movement, or survival. Each one of those parameters is absolutely a key if you want to do a lobster assessment or any other assessment. I mean where we sit with this is the science is really good, close to the coast, and it is not adequate off the coast.

The Technical Committee has repeatedly pointed out the need to do this. That is one of the reasons the Lobster Board agrees to Addendum XXVI, was to fill some of our holes in the science. I'm almost done. In terms of the federal sampling program and some of the federal employees here can correct me if I misspeak.

But when I served on the New England Council, I think it was somewhere between 15,000 and 17,000 observer days totally for Mid-Atlantic and New England. About 32 of those days are being spent on lobster in the offshore areas. We have a major disconnect, and I think we've got a disconnect in terms of the science and our FMP, in terms of the overfished definition. Personally, this is another personal opinion; I think that two years from now we're going to do another benchmark stock assessment. I have every confidence that our understanding of old fish will change; when the scientists look at that.

I mean there may be ways to petition the southern New England stock and assess it in different ways than we have historically done. That would shed some light on what the possibilities are. I would like to go back to one of the first points that I made. We're fishing this stock way below the reference target and threshold.

If we compared this it would be a really interesting analytical exercise, to compare this to how we are treating some of our other overfished stocks like winter flounder, and Gulf of Maine cod. I think Gulf of Maine cod is at 5 percent of the biomass; but lobster is about 45 to 50 percent of the biomass. I mean we have all these disconnects, so my conclusion is this is not formulaic. I think we should essentially acknowledge our situation that we can't rebuild the stock; and be right up front with members of the public, members of the industry.

The Board said when we set out the goals; we said we wanted to do something. Now we went around the table yesterday, and I know I probably offended some people when I did that. But I wanted everybody to have a sense of how everybody was kind of viewing this. The consensus that I heard was do nothing. I'll be candid. I don't think that is appropriate strategy.

I would also note that the Board has said we don't want to put the industry out of business. What this means to me is that we need to do something. We need to do something that isn't too radical; that is incremental that essentially moves the process forward in a short term basis, and doesn't put a lot of people out of business.

We're not going to rebuild this stock. I think that should be the driver.

You've heard my comments. I open the floor, before we actually get into a discussion of what is the target, and let anybody comment as you see fit. If you disagree with what I just said, please speak up. I'm not going to be the least bit offended. I've developed a really thick hide over the years for this type of stuff. Let me open it up. Does anybody want to comment? Doug Grout.

MR. GROUT: Yes this is a very challenging situation that we're in here. From my perspective it is too bad that this Board didn't recognize that they didn't think they were going to be able to rebuild this stock before they started down this road with this amendment. We've been trying to, in our Climate Change Working Group, come up with a variety of options how the Commission can adapt the management; in light of climate change that we see occurring, and that we have science that is backing this up that it is affecting the stocks.

One of the things that I think when we're talking management plans, if we have science that says that we're not going to be able to rebuild because of climate change, we need to change the goals and objective. We need to make a policy decision here to change the goals and objective. The goals and objective that we're working on right now is from Amendment III, and that was developed back in the nineties.

Right now the Goals and Objective Peer Management Plan is that the Atlantic states will have a healthy American lobster resource, and a management regime which provides for sustained harvest, maintain appropriate opportunities for participation, and provides for cooperative development of conservation measures by all stockholders. Then probably the most pertinent objective is to protect, increase, or maintain as appropriate for brood stock at levels that will minimize the risk of stock depletion and recruitment failure.

I think it's time that we changed the goals and objectives with this. I mean we can recognize and move forward with an action, and recognize that this is what we're thinking; that we can't rebuild it. But I think we need to put that in our plans in the future. I hope that this Board will take that measure forward, and start working on this and get a follow up amendment that will recognize that southern New England is not going to rebuild.

CHAIRMAN BORDEN: Other comments, Tom Fote and then Peter Burns.

MR. FOTE: I appreciate this understanding of we're not God; we can't do certain things. When we thought by restricting commercial and recreational catch and doing management, we could basically bring back any stock. My biggest disappointment after sitting around this table for 27 years is weakfish.

You think about it, weakfish was basically responsible for the Atlantic Coastal Conservation Act, because if it wasn't for Copper basically tackling weakfish, we wouldn't have this access. He talked him into doing the Atlantic Coastal Conservation Act. We did everything right. We put in strong commercial regulations for all the recreational regulations.

We went from 6 inch to a fish that was sexually mature by the time we harvested at least once, and the stocks collapsed. We did everything we could, and we couldn't stop them from doing that. The same thing with winter flounder, we've had moratoriums for years. These are both species that spawn the first year. It's not like they have to wait like sturgeon and the climate changes, where they have to wait 25 or 30 years.

These are fish that should be caught in a couple years and we put a moratorium; which we basically did on weakfish and winter flounder. I realized this a couple years ago with lobster. We keep spinning our wheels and saying we're going to do something to rebuild the stocks, and we can't do it. It is frustrating. It is hard to say you can't do something, because that is what we're not designed to do. But I think I am happy that the Board has finally realized that some things we just can't correct.

I'm looking at this; we have to do it the least painfully as possible to the people that depend on this for a living and basically do that. If we're not going to have any of the stocks and it ain't going to accomplish what we're doing, why are we doing it? The same thing could be said for summer flounder; but that's another day. Thank you for kind of considering us, and Dave, I appreciate your comments.

MR. BURNS: David, I appreciate you prefacing the issue with going through everything that you've done and what the science has done. I agree, I think the stock assessment information, the technical information we have now is better than it has probably ever been. I feel fortunate that we have that to be able to guide us. As far as rebuilding the stock, I think we all knew that we weren't going to be able to rebuild it when we started this addendum. We knew that we weren't even going to even try to stabilize it; because it was going to take an 80 to 85 percent reduction exploitation to get there. We knew that that was a nonstarter. That's why we went this route, and the purpose and need of this addendum really is still before us here. I think it is still attainable; and it is to improve egg production while maintaining some functional portion of the industry, and I think we can do that. I am very hopeful, despite all the disconnects and things like that that we've been talking about.

I think we're really poised as a Board to really move forward and take some action here that could really make a difference. We've got some disconnects in place, but you know we've got a good stock assessment. It is still going to be two years before we get to the next assessment. I think to wait would be kind of slaughtering an opportunity.

I had the opportunity to talk to, I don't know how many fishermen from southern New England last night, and I learned a lot. They are saying that there are good signs that there are egg bearing lobsters, there are small lobsters that are coming through some of these ventless trap surveys, and larval settlement is showing improvement; even in places like Buzzards Bay and Narragansett Bay, which have been virtual deserts in the last few years.

Those kinds of things don't make me think that we shouldn't do anything because it's getting better. Those are the kinds of things that make me think, great. Now we have an opportunity to take advantage of that; ride that wave. If we do something now to help increase egg production, then we'll be all better off probably if climatic conditions cooperate.

Then we have another stock assessment in two years that we can reassess this. We've got a lot of things that are happening here. We've got the Gulf of Maine issue looming over us right now, one of the things that we as a working group came forward with, one of the goals and objectives there listed; be proactive.

I think even though we've been dealing with recruitment failure in southern New England here since 2011, we still have the opportunity to try to do something. We can still stay within the purpose and need of this addendum and come out with some action that can meet that goal. I'll stop there.

CHAIRMAN BORDEN: Okay, Ritchie White then Emerson; anyone else?

MR. WHITE: I commend you for turning the ship, finally. This has been long in coming and overdue. We had started the process in northern shrimp. We've heard from the public in dealing with northern shrimp, how come northern shrimp gets a moratorium and southern New England lobster doesn't? We've been hearing that for some time.

We tasked the Technical Committee this year to develop new reference points to a level of biomass that is approximately what we now have, a mere fraction of what rebuilding would be; because we believe from a policy standpoint, not a technical standpoint that the shrimp will never recover due to the climate change.

I think that is the direction that this Board needs to do. I think we need to have new reference points so that when we take an action it is based on science from the Technical Committee. Not going to rebuild lobster to what it was. But there is a level of which you can have a harvest and probably maintain a much smaller population like what we have now. I think this clearly was an important moment. I applaud you for doing it. I hope we continue to go down this road.

CHAIRMAN BORDEN: Let me just follow up on one of the points that Ritchie made. I've got four people on the list, but I neglected to mention this, it's really an important point. Lobster fishery in southern New England is now a mixed crustacean fishery; and all you have to do is look at the values of it. At this point, lobster landings basically worth about $18 million, crab landings are worth even more than that. It is about a $36 million fishery that is operating.

But what you really need to look at is how the crab landings and the effort going into crabs. The effort is moving out of lobsters and it's moving into crabs, because the price of crabs, just since we adopted the FMP, for a whole variety of reasons related to the market. The price of crabs has basically gone from 0.75 up to a $1.00.

There was a boat in New Bedford in the past six months that landed 100,000 pounds of crabs. To be blunt, those people don't even want to bother trying to sell lobsters. They are making sufficient money fishing on crabs. The effort is moved already, just due to the economic forces that are in place. The effort is moving out of the lobster fishery.

One of the keys here is to not export the southern New England problem into the Gulf of Maine; which will be easy to do. If we impose really severe restrictions in southern New England, all those Area 3 boats have the permits already, they have landing licenses in most of the states. They simply shift their effort up in the Gulf of Maine, and you'll just accelerate the problems in the Gulf of Maine.

We need to do something reasonable here, and as Ritchie points out, develop some new reference points and a process to deal with this situation where it exists. We should be managing this as a mixed crustacean fishery and not as just a lobster fishery. But back, I've got Emerson, Sarah, Mark then Eric.

MR. HASBROUCK: Thank you for your overview and assessments of where we are and where we might go. I agree with what you had said, what your assessment is and your overview; particularly relative to Area 6, as you pointed out. When you asked the question, no one on this Board disagreed with your assessment of what's taking place in Area 6. To highlight what you said, landings in Area 6 have already been reduced by 97 percent. Active permits have been reduced by about 85 percent in Area 6.

Active traps fished have also been reduced by just over 90 percent. There has been a significant reduction in Area 6; no matter what metric you want to work out. Additionally, working with the few remaining lobster fishermen that are still working in Long Island Sound, we've removed 16,000 derelict and abandoned pots that continue to fish. I just wanted to highlight those metrics relative to Area 6.

CHAIRMAN BORDEN: Sarah and then Mark Alexander.

REPRESENTATIVE PEAKE: Thank you for your leadership and really setting the table this morning for us. As we move forward I think it is very helpful in getting through a very difficult topic. I just wanted to address the Board to say, join in the chorus of people who really feel, and I see this as a watershed moment. With all due respect to a previous speaker, doing that if climatic conditions cooperate within the next couple of years, maybe we can make different management decisions. It's taken us generations to get to where we are. This isn't a nimble day that we can turn quickly. It doesn't mean we should turn our back on addressing the underlying climatic conditions, but it may take a generation or more to turn those around.

I think what we're tasked with today is making appropriate management decisions; but as we are doing that to be as humane as possible to the human beings, the people, the men and women who are still in this fishery. I will certainly use that as my guiding principal as we move forward today.

MR. ALEXANDER: I appreciate your comments earlier, and your touching move to for Long Island Sound. As Emerson pointed out, the lobster population of Long Island Sound is a vestige of where it once was the fishing industry, is a vestige of what it once was. It was 18 years ago that we processed clipping from an open area of high productivity to the fringe of the range.

I don't think it's too farfetched to assume that in the not too different future we're going to pass beyond the range. Taking Doug's comments to heart, because I think we need to think about this precedented occurrence, and how do we manage a fishery that is eventually going to disappear? I think that conversation is important and I think we need to have it. That would help us figure out where we put our priorities in this situation.

CHAIRMAN BORDEN: I've got Eric and then Mark Gibson, and then Tom. Mark, if you want to go.

MR. GIBSON: Thank you, Mr. Chairman for framing the issue for us this morning. That was helpful. I agree with a bunch of what you said. I might differ a bit on the implications of Long Island Sound, a failure frankly that fishery independent data there isn't much different than it does for Narragansett Bay or Massachusetts out in the Cape and their larval surveys.

It doesn't look much different than our settlement surveys. I favor a broad inshore. They do look different than the federal survey offshore, which hasn't declined nearly as much as the inshore area. There is a disconnect between, as you pointed out, inshore science and management considerations and offshore.

It is clear to me that Option A is not a place we want to end up, I think that would be bad optics for the Commission to have an addendum that frankly doesn't do anything more than all the other addendums that are in place right now. I don't think that would be a good look. I could support a modest increase in egg production, reading some of the arguments that made me favor that.

I fear though that given the projection in the stock recruitment relationship, decoupling that you have pointed out, which is scientifically interesting, but it really hampers our management ability. I'm afraid that a modest increase in egg production is going to be for naught. I will support it, because Option A just doesn't look like to me a place the Commission wants to end up.

CHAIRMAN BORDEN: Eric, I was going to call on you next but I'm going to take Pat Keliher.

MR. KELIHER: Coming down this morning a few of us were wondering if this might be a ten minute meeting, based on the way the meeting ended yesterday afternoon with the poll vote. I do commend you for framing it the way you have done. This is obviously a serious issue. But I can't get over the issues related to the environmental factors associated with this for southern New England.

I think you're right. I think Ritchie White and Doug are also right regarding policy guidance when it comes to environmental changes related to these fisheries, southern New England lobster and shrimp being the two primaries. We need better policy guidance on how we're going to deal with fisheries that look like they will not recover.

We cannot engineer our way out of this problem in southern New England, it can't be done. That is why I have stated what I did yesterday; as far as status quo associated with the fisheries in southern New England. I completely agree with Representative Peake that we're in a situation that took a long time to get here.

The conversations that are now starting to happen related to the Gulf of Maine and Georges Bank are all about resiliency going forward. Could we put resiliency in place in what is nearly a collapsed or a collapsed fishery in southern New England? I don't know if we can. I think we have to take into account the industry, the industry members going forward; and we need to base decisions, whether it is a small, as Mark said, whether it is such a small increase in egg production or no increase in egg production.

I think going forward we need to make sure that is clear, why we are doing it that it is a policy call from this Board and from the Policy Committee; that we're not saying no, and giving up on the fishery or on the industry. We're recognizing the fact that again we can't engineer our way out of a problem that probably should have been dealt with 10 or 12 years ago, when there was a chance for resiliency. With that I'll end my comments.

CHAIRMAN BORDEN: All right does anyone else want to comment?

MR. BAUM: There is some quality discussion today, but I still go back and every week we get calls from our constituents. New Jersey has Areas 4 and 5 and some of 3; extended to a few permit holders for LCMA 3. I think the annual harvest in New Jersey is about 500,000 pounds. I believe there are 10 to 15 fulltime lobster harvesters from New Jersey, and they're all saying the same thing.

We have a 32 day season closure in Area 4, which really equates to a three month season closure; based on the restrictions of keep having to remove the traps from the water, you know hundreds of traps. It takes them weeks if not close to a month, to remove those traps; and then put them back in.

They can't fit 800, 1200 pots on one 40 foot boat in one trip, plus we have to deal with the weather. The other issue is the attrition. I say 10 to 15; I do know someone said 15. I don't even think it's that anymore and every year just one or two of the buoys fall out, so soon we'll be in single digits. Anymore reductions or restrictions that are placed on them as far as season closure goes. They are already taking a three month season closure, so anything additional to that season closure will put them out of business. As far as taking the traps out of the water, it's not only the efforts and the fine involved, it's they need to store them somewhere. New Jersey waterfront property is quite expensive; even to rent. They are finding it more and more difficult for that. I think I've suggested, lease a barge and anchor it somewhere with all the traps on it. I don't even know if that's legal, to tell you the truth. But I am standing firm to what I quoted yesterday, as far as status quo goes.

CHAIRMAN BORDEN: Okay, anyone that hasn't had the opportunity to comment here? Yes, Craig.

SENATOR MINER: I am struggling to find a place between zero and something. I attended the public hearings and listened to many conversations from not only fishermen but politicians, which is kind of a tough spot to be in. We've received plenty of correspondence; I think the Commission has as well, from our

Congressional delegation about the implications of doing almost anything.

Having said that my fear is that there is still a lot of effort. There is still the price of fuel with the amount of traps that are still out there that even if we view this as a moment where we're not going to rebuild the stock. What is the message of doing nothing? What does that send out to the public? What does that send the fishermen?

I was just saying to Mark. You know when we go back, what is the likelihood that we could develop a regulatory change of any kind to restrict effort? That is the part that I think I'm struggling with. I think 20 percent certainly creates such an economic hardship in the Sound that it would be impossible to imagine a fishery at that level.

But we had a good conversation last night based on that straw poll that I wasn't necessarily a fan of. To the extent that that did provide us an opportunity, maybe to communicate, I don't know where we go from here or how we go there; but I do think that there is some room for improvement, even if it's state-by-state voluntarily. I don't know how that would wash with Option A.

CHAIRMAN BORDEN: Let me just follow up on Craig's point; so that everyone's clear. Grant Moore made this point yesterday, so I'm just repeating it. Status quo is kind of a misnomer. The Commission has already promulgated regulations for two areas, Area 3 and Area 2. Those two areas contribute three-quarters of the landings of the stock.

Both of those areas have already promulgated regulations to cut traps down. You can get into a policy debate about how much credit should be given to that. But those, so the Technical Committee basically said that with a whole group of caveats, you may get as much as – let me rephrase this so somebody doesn't take offense.

You may get somewhere between 0 and 13 percent increase in egg production from the existing trap cuts. You can argue where you are on that continuum, but the fact of the matter is those have already been promulgated, they're going to be implemented in those two areas. There are going to be changes that reduce exploitation on them, on the stock.

We can get into the policy and say is it enough? Should we do more and those types of things? But there is some action now. I'm not suggesting, so everyone is clear that we just rely on that. I think we need to do something other than that to supplement that. But I also agree with this strategy of doing something that doesn't put a whole bunch of people out of business. The other point I would quickly make is that if you look at the offshore lobster landings, as the technical people have said and as the staff includes in the document. The landings offshore are stable. They are not going down. They haven't gone down to 80 percent.

They're fairly stable. This is what I struggle with. We have this disconnect between the inshore and offshore areas. They are sending us two entirely different signals, not that everything offshore is great; but it is a mixed crustacean fishery offshore now. Let me go back to my list, and I have Dan. Then what I would like to get into is a specific option to move forward. I'm probably going to look for a motion.

MR. McKIERNAN: You just said a lot of the things that I wanted to say that status quo is not the equivalent of doing nothing. In Massachusetts we have our Area 2 fishermen, and we are in the middle of this trap allocation reduction schedule. Based on the analysis that I've done, and I know I pledged at the last meeting that I would come forward with some data; but I wasn't able to get the data completed until last Friday, and we could comprised a little bit of an audit.

But I can tell you the first 25 percent cut did not necessarily cut active traps, but I believe the next 25 percent will. We're really in the middle of a major management scheme. What is interesting if you look at the guys behind us who have come up from Massachusetts; they're all pretty young.

It really isn't a dying fishery, but this is a fishery where young guys are diversifying into the crab fishery and the whelk fishery and the fish pot fishery, and the lobster fishery as well. I am not going to sit by, and even though we aren't going to be able to rebuild the stock to historic levels; we're not done managing this fishery.

As we cut these trap applications to fairly draconian levels, we're going to need compliance checks, and we're going to need enforcement to make those regulations real. I pledge to do that and work with the fishermen. We also have our V-notching requirement; we kind of forget that. All Area 2 lobstermen are supposed to V-notch all legal size eggers.

We need to sort of double up on our efforts to make sure there is compliance with that. Doing nothing to me is kind of a misnomer, because we're in the middle of a very massive administrative exercise of reducing trap allocations that are going to reduce traps in the water by the time we're done in five years.

The other thing I would like to mention is it's really difficult when you sit down and try to document the net effects of some of these rules; because there is so much leakage. I can't look at my Massachusetts only data, and show the effect that I hope to show; because I have some permits coming from the west jointing the Massachusetts fleet, which is perfectly legal.

A federal permit can be sold to Massachusetts fishermen fishing in Area 2 or Area 3. I have trouble teasing that out. I have Area 3 fishermen who can go back and forth. I have the effort attributable to the Jonah crab fishery, which is almost impossible to tease out; in terms of whether it's, as you pointed out, a lobster trap or a crab trap. I also have some Area 2 fishermen fishing east of Nantucket, which is a section of the Georges/Gulf of Maine stock. That's all legal. It's fairly difficult to actually nail down a net effect, but I think you've seen, not to be redundant, but the trends here are that it's a bunch of young guys that diversified that are ready to accept a lot of the ongoing trap cuts. They are ready to make a go of it. That is a very conservative point. Status quo is not doing nothing.

MR. LUISI: I know that you had asked for a motion on how we are going to move forward as a Board here. But I would like to just ask a question of you first for your guidance; as to whether or not we must select Option A, B, C, D or E here or is there an opportunity, based on the fact that we had a range of alternatives that went from 0 to 60. Is there a potential here for something in between 0 and 20, such as a 10 percent reduction?

The reason why I ask is you know I mentioned yesterday that we would support status quo, then the overwhelming majority of folks who offered public comment felt that way. But then there was a group of people who said in their testimony that while we agree with status quo, however we might be able to stretch and reach to something like 20 percent. But I do believe that 20 percent is a stretch. Maryland's fisherman, (with an a – that's man with an a) is here representing himself today.

You know he and I have spoken about how far of a stretch that he could make in order to have a viable business continue. While I do agree with other Board members that maybe 0, doing nothing, even though there is the trap reduction happening as we speak. Doing nothing might not be where this Board wants to be. But we can support a very modest increase, potentially at 10 percent. I'm not making that as a motion. I'm looking around the table to first of all ask if that's appropriate, and then I guess we can go from there.

CHAIRMAN BORDEN: I would defer to the staff, particularly the Executive Director, but from my perspective the Commission always has a right to do something between the options. Bob, if you disagree with that please speak up.

EXECUTIVE DIRECTOR BEAL: I will speak up to agree with you, not disagree with you. You're right, 10 percent or other numbers within the range as taken out to public comment is definitely in bounds for the Board to consider.

CHAIRMAN BORDEN: What that will mean is we'll have to recalculate the table, so that's not a difficult task. Eric Reid, I'm looking for a motion on that.

MR. REID: I am not going to waste any more time. I don't know whether or not it would be Option F or some other letter or number from everyone. But I move that we support a 10 percent increase in egg production over two years.

CHAIRMAN BORDEN: All right we have a motion; do we have a second for that motion? Mark, you can't get a second from the same state. Does somebody want to second the motion? Mike. Discussion on the motion. Peter Burns.

MR. BURNS: I am glad we're moving forward with getting down to business here about increasing egg production. I think that the one thing I do like about this is the opportunity to spread this out over two years. I think 10 percent is a start. I'm hopeful that there is a silver lining in there somewhere, where we can find a way to credit trap reductions that have already taken place or that are scheduled to take place. You know that we have the Area 3 trap caps that have yet to be implemented yet. I'm going to talk about that later today. I think there is some room to move here a little bit, and in consideration of stretching this out over two years; I think that's a good opportunity, and that gets us to our next stock assessment. **I'm going to make a motion to amend this to 20 percent increase over two years.**

CHAIRMAN BORDEN: Okay so we have a motion to amend. Is there a second on the motion to amend? Any second, any second? **Motion dies due to lack of a second**; further discussion on the original motion, Emerson?

MR. HASBROUCK: I would like to make a motion to amend that motion. My amendment would be move to implement a 10 percent increase in egg production, except in Area 6, which would remain at status quo.

CHAIRMAN BORDEN: Emerson, maybe my hearing is a mistake, 10 percent; they put 20 percent up there.

MR. HASBROUCK: Ten percent.

CHAIRMAN BORDEN: Is there a second?

MR. HASBROUCK: Move to implement a 10 percent increase in egg production, except for Area 6; which would remain at status quo.

CHAIRMAN BORDEN: Okay, do we have a second for that. No second, motion dies to lack of a second. Mark Alexander.

MR. ALEXANDER: I would like to offer the same motion, except that Area 6 be 5 percent.

CHAIRMAN BORDEN: All right, we're going to have to let the staff catch up here. That's a motion to amend, interest in increased egg production except in Area 6, which would achieve a 5 percent reduction. Is that correct, Mark.

MR. ALEXANDER: Yes, I would like to add one thing that it be over two years.

MS. WARE: For both Area 6 and everyone else would be two years?

CHAIRMAN BORDEN: We need to add the two-year provision for the motion. Okay, is everyone clear on this? Discussion on the motion to amend.

MR. HASBROUCK: Second, I'll second that motion.

CHAIRMAN BORDEN: Made and seconded discussion on the motion. Any discussion? Tom Fote.

MR. FOTE: Again I'm looking at what we're doing here, we're splitting hairs again. We're basically talking about 5 percent or 10 percent reduction; knowing that climate change is not going to turn around in a couple of years or as Sarah pointed out, it will be decades maybe before we basically see turn around and we actually admit there is a climate change. Just to say we're doing something, I don't see this. I mean the number of pots has been reduced in New Jersey, the number of fishermen that's been reduced in New Jersey, the lobstermen; the lack of effort that is going out there compared to what it was 15 years ago. We've done those types of reduction and we're just not seeing any increase because of that. I have a hard time supporting any of these motions.

CHAIRMAN BORDEN: Anyone else? Emerson, then Craig and then Mark Gibson.

MR. HASBOUCK: Relative to this motion to amend, I would just like to reiterate some of the metrics that I've pointed out before that in Area 6; we've already seen a 97 percent reduction in the landings. We've seen an 82 percent reduction in active permits, and we've seen a 91 percent reduction in active traps fished. That has already occurred in Long Island Sound, Area 6.

CHAIRMAN BORDEN: All right as I said, I'm going to go right up the table. Craig then Mark, and then I'm going to go over to Doug Grout.

MR. MINER: We're dealing with a couple of things in Connecticut, for those of you that get the newspaper out of Connecticut. We're still in the midst of a very significant deficit this year and forecasting another half a billion, next year; and somewhere around 200 million beyond the deficit that was paid back in January. It approaches $2 billion.

One of the concerns that I have about not having some number out there in terms of increased egg production is I have a heck of a time trying to advocate for money; staff, hard hiring freeze, doesn't really even allow us to put somebody on a boat. I think any number up there beyond zero is going to cause me a fair amount of ojida when I go back and talk to the fishermen, because they would have loved to, I think, have gotten out of this with zero.

It doesn't put me in a comfortable place, but I think it puts me in a place where I could continue with the conversation. I would hope that there would be a fair amount of support for this motion. It's not perfect. I think it gives us a platform to talk about a future, whatever size that might be.

We still have a lot of traps in Connecticut that we need to work on. We still need to work on licensing, and as I said we still need to work on trying to provide resources for an agency that absent resources will have no scientists and no enforcement, if some people have their way. This I think is a helpful thing.

CHAIRMAN BORDEN: Mark and then Doug Grout.

MR. GIBSON: I would just like to ask the maker of the motion what the biological rationale is for nuancing between Area 6 and the areas in southern New England. I previously stated that what they can see on Long Island Sound is not very different than what's happening in Narragansett Bay or Buzzards Bay or places like that. I would like to hear more about the rationale for nuancing this in this manner.

CHAIRMAN BORDEN: Mark, do you want to respond?

MR. ALEXANDER: Yes, Mr. Chairman. The decline in the Long Island Sound happened earlier, it probably has, I would say to a larger degree than it has anywhere else. We've been struggling with this for years. We've reached the point where our industry is on the verge of extinction. Trying to achieve 10 percent increase in egg production will pretty much kill the entire industry. I know maybe this comes down to a choice of what goes first, the fish or the fishermen. But we do want to do something, because we don't want to kill the industry either.

CHAIRMAN BORDEN: I've have Doug Grout, Dan and Jim Gilmore.

MR. GROUT: I do appreciate the efforts of this Board in trying to accomplish something here with this addendum. The vote that we took yesterday, which in retrospect I wish we had waited until after this. I still have concerns about having this apply throughout the range of Area 3. I still think that we need to add a line, despite the difficulties and the problems that that may cause; because you're implementing changes in management on a fishery at a resource that is at record levels out on the Georges Bank area.

If this does pass, I would appreciate it if we could get either some indication of how we might address this where it wouldn't apply to the actual Georges Bank area, either by reconsidering the motion or some other mechanism where there could be a line drawn where it would be implemented or restricted management measures on a resource that is fully developed.

CHAIRMAN BORDEN: Dan passed, we've got Jim Gilmore.

MR. GILMORE: Just in terms of the difference between maybe a little further north from us versus Long Island Sound. If you go to our public hearing, we had a packed room, and it was very different. If you look over at the New England side, you've got a lot of young guys coming up. No offense, John, but I've got John German here. He kind of represented the demographic in the room. A lot of guys that have watched this fishery die, and essentially are to the point where maybe it was more like a wake that meeting than anything else. Sort of in that respect, maybe give them a respectful death of this fishery as opposed to like trying to impose some limits that really don't mean much.

That is really why it almost had to be a separate issue on this, because it is very different. We don't have a bunch of young guys coming up in the fishery. We have a lot of historic folks that have a difficult time that they've had for many years now and watched this thing go away. For Long Island Sound, I really wish we could go with 0 percent, because I think we should let them hold onto this.

On the 10 percent, I'll just make one comment on that. As you saw before, David did a great job of bringing this all together is that 10 percent is, it's like a great New York philosopher said, you know déjà vu all over again. We went through this a few years ago and we got to 10 percent and then got another stock assessment and then we're right back to where we are again.

If we do go with the 10 percent, we clearly need to take what your leadership suggested, and come up with a new approach to this; because I really don't want to go through another few years and get the 10 percent again and just watch more and more wasted effort on something that we can't fix.

CHAIRMAN BORDEN: I've got a personal comment that the thing I much appreciate about the motion and the amended motion is that it gets us to the next stock assessment that I indicated before, I think things are going to change. Okay so are we ready for the motion to amend? Peter Burns.

MR. BURNS: I just wanted to address Doug Grout's comment about a line in Area 3. Well first of all, I'll start it off and say that I think you already know that NOAA Fisheries is very concerned about the condition of the stock, and concerned about making sure that we do something meaningful here within our charge here; the purpose and need of this addendum to improve egg production and preserve some level of the fishery.

I think we're moving in that direction, but keep in mind that this fishery is moving into federal waters. Most of it is in federal waters. I know Area 6; we don't really have a dog in the fight there. But most of the fishery in southern New England is in federal waters. We strive as an agency here to be cooperative partners with lobster management since 1998, and we transferred management authority from the Magnuson-Stevens Act over to the Atlantic Coastal Act.

I think we've done a good job of that being good partners, with the exception of a few disconnects we're going to talk about later on. But I think we're hopeful that there is still some room to be able to decrease fishing mortality here, and be able to get an upswing in egg production if we can. I think one thing we don't want to do is unnecessarily impact the Georges Bank portion of the Area 3 stock. We can certainly, I heard about yesterday there wasn't a lot of movement on the industry or the states to go forward with a line to split the stocks.

But that is something we could certainly consider as part of any kind of management strategy moving forward; to make sure that the Georges Bank stock doesn't get unnecessarily burdened by any management measures that go forward here. I think that is something to keep in mind. I think that with that I would like to try again to make a motion to change the 10 percent to 15 percent.

CHAIRMAN BORDEN: Peter, let's deal with the motion on the table. After we deal with that if you want to make another motion to amend, you are free to do that. But that way we won't have three motions on the table at the same time. Let me ask everyone to take a one minute caucus, and then we'll call the question on the motion to amend. All right we're going to come back into session.

I apologize, but a lot of questions were raised, and most of them relate to what might happen in a subsequent motion. I'll put on my Carnac the Magnificent hat to be able to tell the future. Okay so on a motion to amend. Are you ready for the question**? All those in favor of the motion to amend signify by raising your right hand, 4 in favor, opposed, 6 opposed. Let's do opposed one more time, because I had some of these. Six opposed any abstentions, any null votes? Motion fails, with two abstentions.**

Okay so you're back on the main motion. Are you ready for the question on the main motion? Okay Pete Burns, and just so everyone is clear here; Peter made a motion before which failed to request 20 percent. Now, I understand he wants to make a motion to do 15 percent, which is entirely appropriate.

MR. BURNS: That's right, Mr. Chairman. Thank you and I'm sorry that my lapse in judgment over the last motion there**. I forgot that there was a motion to amend on the table, so yes a motion to substitute 10 percent for 15 percent.**

CHAIRMAN BORDEN: **All right we have a motion to substitute, is there a second?** Second by Doug Grout, discussion. Mark Gibson.

MR. GIBSON: If it's just in the process we're following here, is it your intention to have a discussion about the Area 3 line matter, pending the outcome of these?

CHAIRMAN BORDEN: I'm a little reluctant to comment, and I totally understand the issues are intertwined. But I'm a little reluctant to combine those two, because we can't make a commitment to change the motion from yesterday without another motion, which could get complicated. To some extent I envision getting into that issue when we get into Issue Number 2.

In other words, when we get into the second aspect of the management tools, I mean the concern that was voiced around the break here is if a line exists, is that going to force individuals to relocate into the Gulf of Maine and drive effort into the Gulf of Maine. Actually, while I'm saying this, Grant Moore, the Chair of the AP asked to just make a brief comment on that. Grant, do you want to do that?

MR. MOORE: I just would like to reiterate what I spoke about yesterday, and this is from industry. If that line is instituted, depending upon what percentage is chosen by the Commission. If the percentage is so high, you will see a total shift in effort. That line, the fishermen are already going east of the line, but this underlying motion at the 10 percent.

Again I am going to say that zero is not a realistic number, 10 percent is, we're going to achieve over 10 percent with trap reductions that are already in place; and that's from the TC. This industry, Area 3 fishermen have already gone through the 32 percent reduction in effort in the early 2000s, with no credit there.

Gauge increases were up to 3 and 17/32. No credit there. Industry has been very proactive. This motion here, if there is a line drawn and we try to put separate regulations on part of Area 3, it is going to affect Gulf of Maine/Georges Bank slots. There will be a huge shift in effort. Thank you.

CHAIRMAN BORDEN: All right so the motion on the board is substitute. Actually, Peter what you said is 15 percent to 10 percent. We've got it reversed up here. Is that correct? Is the motion correct, Peter?

MR. BURNS: Yes, substitute 10 with 15 percent. As long as we end up with 15 at the end that is the intent.

CHAIRMAN BORDEN: Fifteen percent. Is there any discussion on the substitute motion? Eric Reid.

MR. REID: I hope that if this motion fails we don't have another motion of 14 percent or 13 percent or do that game all over again, which is a sad thing. It was the overwhelming consensus yesterday that status quo was acceptable. Of course smarter people than I spoke this morning, and Mr. Chairman, you framed the discussion very well. I don't think status quo is anywhere near what, the perception of status quo I should say, 10 percent is enough to keep these guys fishing, and 15 percent is too much. I hope this motion fails and we get back to business at 10 percent over two years.

MR. HASBROUCK: Yes, I cannot support this motion. A 15 percent increase in egg production, what that would precipitate, in terms of additional restrictions on the industry, is going to be devastating to Area 6.

CHAIRMAN BORDEN: Anyone other than the maker of the motion or the seconder want to speak in favor of this motion? Anyone? All right, Peter, you get the last bite of the apple; then I'm going to call the motion.

MR. BURNS: I appreciate the Board's indulgence as I try to find the sweet spot here as we move forward. But I think we're looking in the right direction. I think 15 is reasonable. We've even heard Grant from the Area 3 industry say that they've already think they've got 10 percent just with the trap reductions that are in place.

I'm confident that over a two year period we could certainly have something reasonable that could be implemented by the industry. Keep in mind that we started this as a range between 20 and 60 percent, and that we had status quo as a default. You know we've gotten guidance from our staff here that these lower percentages are okay; but I think that is something to keep in mind. We know that status quo is a nonstarter for us, and I think 15 makes sense.

CHAIRMAN BORDEN: All right, anyone want to offer something totally new here? If not I'm going to call the question. Does anyone need a caucus? Are you ready for the question? All in favor of the motion signify by raising your hand. **This is a motion to substitute. I've got 2 in favor, opposed same sign, 8 opposed, any abstentions, any null votes? Motion fails.** Okay, **you're back on the original motion**. Are you ready for the question? All in favor signify by raising your right hand.

MR. HASBROUCK: Point of order, Mr. Chairman.

CHAIRMAN BORDEN: Voting on the underlying motion, move to implement a 10 percent increase in egg production to Issue 1 over a two-year; is that worded correctly? Oh, in Issue 1 over two years. Does everyone understand the motion? Mark.

MR. ALEXANDER: I just want to clarify one thing. When I made my motion to amend and added a two-year period, a two-year period got added initially to the underlying motion before it got added to mine. I don't think the two-year period was in there when the original motion was made.

CHAIRMAN BORDEN: Eric Reid, was that what you intended?

MR. REID: It's what I intended, it is what I said.

CHAIRMAN BORDEN: All right, Emerson Hasbrouck.

MR. HASBROUCK: I am just wondering if we're going to take any other comments before we end up voting on what our increase in egg production is going to be.

CHAIRMAN BORDEN: Good thought. I'm willing to take a few comments from any of the leadership of the association. But I have to ask you, the industry reps, to be very brief at this point. Sarah.

REPRESENTATIVE PEAKE: If I could take a moment to speak to the underlying motion. I think there was a lot of discussion around the amended emotions, emotions right, motions; it is emotional. I am not in favor of the underlying motion. I'm not really sure why it's up there, when we have just heard from Mr. Grant that 10 percent is probably already going to happen with trap reductions.

Are we engaging in management or is this theatre that we're engaging in? Because we have a difficult time going home to say we supported status quo. If status quo is going to get us to the 10 percent increase in egg production, I would think that we should vote this down and vote for status quo, and an additional concern of mine is the uncertainty with Issue 2, what the management tools are going to be.

I know in a brief offline discussion with my colleagues here from Massachusetts, there is one of those options that we feel that we can live with, and the other two are somewhat draconian. I think given the uncertainty of Issue 2, plus the information we've received already that status quo will get us to the 10 percent increase in egg production; we should just defeat this and move forward with what is forthright and transparent and better the way it is.

CHAIRMAN BORDEN: All right let me take a couple of comments from the audience. Jarrett, you had your hand up, Greg Mataronas, yes, John.

MR. JARRETT DRAKE: All right, now I'm getting nervous. I thought through this before, I had a written speech. I don't want to be boring and just read something that I had written, but I can't remember this all so I'm going to read out part of it, because I really need to keep your attention. My name is Jarrett Drake. I am an Area 2 lobsterman for the past 33 years, currently the Vice-President of the Massachusetts Lobstermen's Association, an LCMT 2 member, and generally a guy who's a pretty decent guy.

I would like to thank you for this opportunity to speak, because it is important to me, and also the New England fishermen. Actually eight of us Area 2 lobstermen here today, forfeiting two days of fishing and $30.00 in our pockets and yesterday I spent my birthday here; it was status quo. We've been hearing that a lot today.

I would like to remind you, as has been said many times that status quo is not actually status quo, but in fact a 50 percent reduction in traps started in 2016 that is taking place entirely after the 2011-'13 stock assessment; which is why we're here. We are not greedy fishermen who don't want to do anything.

Actually, it is in our best interest to maintain a healthy population. A few of us lobstermen just want time to reflect these current actions; as a result the next stock assessment will be positive. As a lobsterman and ventless survey captain, I am personally seeing lobsters now in volumes and locations that have been quiet for years and am sure you will too. Anecdotally we are seeing it, now we'll just wait for the data to catch up. The current plan will have a dramatic impact on fishermen and their efforts. There is absolutely no need for gauge increases or seasonal closures in Area 2. A gauge increase will simply shift efforts further offshore in unsafe waters and designate the inshore areas as mere nurseries; without a fishery at all.

Lobster is also the only fishery you can do year round, and seasonal closures will have a severe impact on the fishermen's livelihoods. Right now there are only about 18 full-time in Mass for each new lobster pot, and very few of them have actually taken their trap licenses. Most of us have a lot less. I am not one of the lucky ones. You see, I have to buy a state license and a federal license to make one and fill it tonight.

The ability for me to build back up to a full 800 traps is extremely difficult today. There is just no TAC available; there is no latent effort to buy into. In closing, the most prudent thing to do would be to delay any further management actions until 2014-'16 stock assessment. There is a lot of optimism surrounding the data, and we're looking forward to positive results. A little more time won't hurt, especially since the fishermen aren't to blame here. Thank you very much.

CHAIRMAN BORDEN: Thanks, Jarrett, Greg Mataronas, and then I'm going to go to John German. Is there any other leadership in the industry that wants to speak to this Board? If not, we're going to go back to the motion after those two. Greg. Greg is the President of the Rhode Island Lobster Association.

MR. GREGORY MATARONAS: I would like to thank the Board for the opportunity to be here and speaking in front of you. As Dave mentioned, I am the President of the Rhode Island Lobstermen's Association. I have been lobstering for over 25 years, and involved in all aspects of research, involved in the management of this fishery as much as possible for almost two decades; which is hard to believe right now.

I think for the most part this motion for 10 percent is very reasonable to the industry, especially considering that we've got 50 percent trap cuts for Area 2. I've heard that the first 25 percent is only cutting into latent effort. As Jarrett just mentioned, it's actually cutting almost to the bone already, where trap tags, you can't find trap tags right now.

Another indication of the trap cuts was Area 2 and Area 3 traps got coupled together. Area 3 tags are worth much more, so those are being bought off of Area 2 boats, going out to Area 3 and will never be brought back into Area 2 again. That is something that is not captured in the database. It is something that has not been talked about.

In addition, there were coupled to Area 1 permits, so if there is someone qualified for 800 Area 1 traps, and they also have Area 2 or Area 3 allocations, as soon as they sell one trap off of that permit the Area 1 permit goes away. The incentive is there to not sell any traps off of that. Those tags are also tied up, and will not be reentering our fishery.

The bottom line is that first 25 percent did much more than get rid of latent effort; and with that in mind, I would also like to for the next issue. Industry really needs Option A to move forward on Issue 2, because we need the flexibility. The Board has been very gracious to this point in building flexibility into this addendum. If anything other than Option A is selected in Issue 2, I think the flexibility will be completely gone and as Representative Sarah just said, it will be quite draconian and will force our hand into something where we will be out of business. The Board has stated that we want a functional portion of the lobster fishery. At this point we are at the basis of a functional portion of the lobster fishery. After this big dealers go away, lobster shops go away, trap shops go away; any associated businesses go away, tourism, if we get any more cuts than what we have on the table right now. Thank you.

CHAIRMAN BORDEN: John, if you would like to come up. Why don't you use that microphone right next to Emerson? Then we're going to go back to the Board.

MR. JOHN GERMAN: My name is John German; I'm the President of Long Island Sound Lobstermen's Association. I would like to say I've been fishing all of my life, but really that's not true yet. I fished in Long Island Sound for 51 years. Right now I've got approximately 10 guys on the New York side fishing in Long Island Sound.

We have probably about the same amount, maybe less in Connecticut side. It comes to less than 20 guys. I notice in this room there are probably about 75 people in this room, so that is almost four times as many people sitting in this room that fish the entire Long Island Sound. I've been involved in this process, and sitting in front of this Board, since Amendment III.

I've seen, now we're up to Addendum XXV on Amendment III, which probably equates to about 50 or 60, 50 restrictions on lobsters through all those addendums. I find it hard to believe that somebody in this room thinks that by adding two or three more restrictions in this species is going to change something; after if you want to call it failure of 50 restrictions, two or three more are going to help something.

Right now we're just in survival mode. I agree with the Chairman that we're probably not going to change anything by these addendums. Maybe we should reassess the way the stock is assessed in Area 6, but so be it. I would like to see status quo, just so the rest of us can just live out our lives and die and catch lobsters, the little bit that we can; because as Jim stated, there is no young fishery in our addendum. We haven't had any new licenses given out since 1994.

We've reduced our harvest; our initial allocation was 360,000 in the New York side of Area 6. I think last year there was probably in Area 6 on the New York side, about 5,000 tags bought, not all were fished but they were bought. Like I said, I would like to see status quo, and I will leave you with the thought that if I may quote Sir Walter Scott, he said, "That's not fishery that's men's lives." It's the same thing with these laws. That's men's lives you're fooling with here right now. Thank you very much for the opportunity to speak.

CHAIRMAN BORDEN: Back to the Board. Does anyone have a new thought that they had not offered? Mike. It's always nice to have someone volunteer a new thought.

MR. LUISI: This isn't necessarily a new thought, and I'm sorry about that. But if Mr. Reid and my motion hadn't been on the board long enough for me to, well I wanted to just go on the record that I supported the motion for the discussion purposes; and that I'm not necessarily sold on the 10 percent. I feel for Long Island Sound and the issue that you guys have, and seeing 10 percent is maybe just too much. I'm hearing that anything more than the 10 percent is just too much for the guys I represent. I just wanted that to be on the record, and I'll leave it with that; if anyone else has any additional thoughts.

CHAIRMAN BORDEN: Anyone else? One minute caucus and then we'll vote. As I announced, we're going to vote on the motion on the board. Motion is to implement a 10 percent increase in egg production in Issue 1 over two years. **All those in favor of the motion, signify by raising a hand; 5 in favor, opposed 6, motion fails, any abstentions or null votes? Okay so the motion fails.** Where we are is essentially at status quo. Does anyone have another motion? Sarah.

REPRESENTATIVE PEAKE: I would move for Issue 1, Option A; 0 percent increase in egg production, status quo.

CHAIRMAN BORDEN: Is there a second; seconded by Emerson Hasbrouck, discussion on the motion. Peter.

MR. BURNS: I was really optimistic coming into this meeting after your initial comments that we were really going to stay away from status quo, knowing that it was really a nonstarter for all of us; that we're going to try to do what we can to try to help the stock to survive and help this fishery to survive too.

I certainly hear the comments of the fishermen, and I take those to heart, but I still think that there is some room here that we can do something; and to walk away from it right now, I think would really be a failure of this Board after the past year that we spent trying to get the best science available to make these decisions.

It is unfortunate, because as I said before our agency is looking at this very, very closely; and to walk away from this without doing anything is not going to be taken very lightly. As I said, we've been cooperative partners in state and federal lobster management now for two decades. This would be unfortunate if it had to go to the feds to have to take some kind of action, if the Board themselves decided not to do anything today.

CHAIRMAN BORDEN: Any other comments on the motion on the board? No comments, one minute caucus. Mike have you got a question?

MR. LUISI: I really appreciate all the discussion around the table. I very much listened to your comments, Mr. Chairman at the beginning of the meeting. If I had thought that we would find ourselves in a position to be taking some action. That action obviously is not going to be a significant action, but some action I thought was appropriate.

I know that we already caucused, and I guess you're planning to call the question. But I'm thinking here that this is like menhaden all over again, but perhaps we should consider 5 percent; that way we show signs of forward progress, yet we don't walk away from the table without doing anything**. If you're willing to accept it, Mr. Chairman, I would move to substitute for Option A, and replace it with 5 percent increase in egg production.**

CHAIRMAN BORDEN: It is certainly within your right to make a motion to substitute. Is there a second to that; seconded by Eric Reid, discussion on the motion to substitute? Actually, what I think I would like to do here is we have very limited time to get through the rest of this. But I would point out to you as the young lady to my right just pointed out to me that if we vote for 0 this entire addendum dies. I'm going to take a five minute break. What I would encourage people to do is talk among yourself, and then we'll come back and take up the substitute motion.

(Whereupon a recess was taken.)

CHAIRMAN BORDEN: Everybody have a seat please. Let me just say that there has been a lot of good discussion that's going on. I've heard kind of two views, one is to vote and approve the substitute motion; and then there is another body that's all around the table, maybe we might have to reconsider the 10 percent position. I'm just going to deal with these things mechanically. On the motion to substitute, any further discussion on that? Doug.

MR. GROUT: I have concern with this, because it accomplishes so little, yet there is going to be a lot of administrative work that would result. Essentially this is a form of status quo, but with this you would have to go to each of the LCMTs, each of the states would have to develop some rules. A status quo would accomplish just the same thing as 5 percent; from my perspective.

CHAIRMAN BORDEN: Doug, you fall in the camp, not trying to put words in your mouth, of want it going back to 10 percent. You were more comfortable with 10 percent.

MR. GROUT: We were more comfortable with 10 percent, yes.

CHAIRMAN BORDEN: Any other comments here? Pete Burns.

MR. BURNS: Well, I appreciate Mike Luisi's flexibility here to help us move the ball forward. I think this is a step in the right direction. Do I think 5 percent is enough? No. I think even 10 percent is not really hitting the mark. But I would vote in favor of this, just because it is moving in the right direction.

But I would expect that this isn't the last of the issue; and I think that we're going to have to look at this, reevaluate it when I get back and brief the folks back home about this, and see whether or not additional action needs to be made. Maybe make recommendations for the Board to reconsider additional motions, once the impacts of whatever happens with this are realized.

CHAIRMAN BORDEN: Anyone else around the table? All right, so does anyone need a caucus, we already had a caucus, a motion to substitute. Are you ready for the question? **All those in favor raise your right hand, wait, I had a couple of hands go up and down, raise your hands again, please, 6 in favor, opposed, 5 opposed, any abstentions, any null votes?** The motion carries. **We now have a main motion which is constituted by the substitute motion**; further discussion on this, any discussion, Emerson and then Sarah.

MR. HASBROUCK: If you recall yesterday, when you did a general canvas of all the states. We said in New York that we supported status quo for Area 6, and that we might consider an increase in egg production for other areas in Southern New England. Now, there was no support among the Board to exempt Area 6 from a couple of different actions that we took earlier, or proposed to take earlier. Now it is 5 percent reduction, and depending on what we do with management measures to get to that 5 percent, it is my understanding that for Areas 2 and 3, they may accomplish this 5 percent reduction without any additional action. In Area 6, where we've already reduced by 95 percent, landings and effort and so forth, we're going to go back and tell our Area 6 fishermen they're going to have to take a further reduction here to meet a 5 percent increase in egg production; and in Areas 2 and 3 they may not have to take any additional action. I can't support this.

CHAIRMAN BORDEN: Emerson, let me just comment on that and this is not a rebuttal by any way, shape or form; but that coin has two sides. What I heard when I went to the public hearings, particularly from the Area 3 fishermen and Area 2 fishermen. Area 3 fishermen have implemented restrictions that require, I think a 55 percent cut in traps.

The Area 2 fishermen have also instituted a cut of 50 percent. Area 6 did not institute any of those cuts; Area 4 did not institute any of those cuts. Area 5 did not institute any of those cuts. I agree with your statement, but I think this is the opposite of the circumstances just played out over the past few years. You had two areas instituting cuts, where three other areas did not institute cuts. This is just the opposite; further discussion on this. Are you ready? Sarah, excuse me.

REPRESENTATIVE PEAKE: I guess I feel like today what I'm focused on, sort of the big picture. What I hear us discussing here, whether we're at 0 percent, 5 percent, 10, what I sense in this Board is that we are struggling as managers to work in this new world of our acknowledgement of climate change and the impact that that has on this particular fishery.

I guess moving forward, what we have to think about is, are our goals and objectives in line with what the reality of the water is today? Are our reference points the appropriate reference points? I know that there is a Climate Change Working Group that is putting together a report, and looking at these various issues.

Maybe this is something that we could discuss further at the November annual meeting, maybe the Climate Change Working Group will have something for us to work over; and perhaps this is going to lead to a new addendum as we think about what the management practices are specifically, with the southern New England lobster stock.

But for me, one of the reasons I am supporting now the lowest increase in egg production that we've talked about, is because we're using old management tools inside of a new world. As I spoke about earlier, I think we have to act with the science that we have, but also as humanely as possible to protect the human beings who are still working inside of this fishery.

CHAIRMAN BORDEN: Are you ready for the question? **All those in favor of the motion; which is to move to implement a 5 percent increase in egg production for Issue 1, all those in favor signify by raising your hand, 7 in favor, opposed, 4 opposed, any null votes, motion carries.**

Okay so you've decided the Issue 1, we're going to move immediately because of timing issue into Issue 2; which is the management tools. There is already a lot of discussion on the management tools. A lot of discussion has taken place on this. Megan, could you just quickly outline this via options, and then what I will do is seek a motion on this.

MS. WARE: The question here is kind of what tools in the toolbox can be used to achieve that 5 percent increase in egg production. Under Option A, gauge size changes, season closures and trap reductions can all be used independently or in conjunction with one another to achieve that increase in egg production.

Under Option B, only gauge size changes and season closures can be used, so this means trap reductions cannot be used. Then under Option C, gauge size changes can be used; but trap reductions and season closures can only be used in a limited fashion and they must be used in conjunction with gauge size changes.

CHAIRMAN BORDEN: All right, so you heard Megan. You've basically got three options here, do I have a motion? Mark Gibson.

MR. GIBSON: I would move that under Issue 2, Management Tools, the Board adopt Option A; management tools can be used independently.

CHAIRMAN BORDEN: Is there a second; seconded by Sarah, discussion, any discussion? Pat.

MR. KELIHER: I would just caution the Board. I know this is a "tools in the toolbox," but gauge size increases and the continuation of expanding the gauge size differences between the Gulf of Maine and these areas continues to create additional market problems. I think we're starting this tread on issues with commerce laws.

CHAIRMAN BORDEN: Any other comments? Pete.

MR. BURNS: This wouldn't be my preferred option, but it does give some flexibility to the industry, and so I guess I would say that the backstop is that the Technical Committee is going to be looking at whatever the LCMTs come up with to attain the egg production goal. In the event that the trap reductions are used, we're not against giving credit for it.

But it is going to be up to the Technical Committee to tease out what the active effort is that is going to add up to this 5 percent; or whatever measures that they use for trap reductions. Keep that in mind. I think that I don't want us to be in the position as in the federal government, of getting a proposal from the LCMTs that we can't implement.

I think if these trap reductions aren't shown to be active and permanent then that might be a nonstarter for us. The other thing too is something that I haven't brought up yet today. With trap transferability, over the first two years of our trap cuts, due to the trap transfer program, 30 percent of those traps have been reactivated and put into the water. I want LCMTs to keep that in mind when they're going back, if they use trap reductions as a way to achieve these egg production goals.

CHAIRMAN BORDEN: Peter, one observation interesting thing about that statistic is 70 percent of them can't.

MR. McKIERNAN: Just a point of clarification relative to this and the previous motion that passed. What would be the deadline for implementation of the new rules?

MS WARE: It is kind of up to the Board. We need to set a date, hopefully sometime in June when LCMTs would send final proposals to the Commission, so that we can get those reviewed by the TC in time for the August Board meeting. At that August Board meeting the Board would review, and hopefully approve those LCMT proposals. In August we'll have to set an implementation deadline for the states, so that is where it is.

CHAIRMAN BORDEN: Further discussion on this, the motion is to adopt Option A. Tom Fote.

MR. FOTE: Following on Pat Keliher's question about basically importing lobsters. I would really like the Law Enforcement Committee to take a look at this, because we need lobsters in New Jersey. If the only place we can get them is Maine, we have to look at the gauge size, and there has been a lot of talk about that going on; so I wish we could run that by the Law Enforcement Committee. Years ago when he looked at it he says no, created all kinds of problems. But we need a vehicle to adapt to that situation.

CHAIRMAN BORDEN: Any other discussion? Are you ready for the question: **All those in favor of the motion raise your right hand, 10 in favor, opposed, no opposition, null votes, any abstentions; 1 abstention? The motion carries.** Okay, so we're through the bulk of the issues. Now we need to deal with closed seasons.

As I indicated before, the Option 4 is very analogous to the request by Area 4. I would like Megan to kind of flesh out both issues and I would afford an opportunity for Area 4 or 5, or 6 for that matter to offer any comments. Then I think we need to deal with this. But I also think we need to have consistent regulations in place. Megan.

MS. WARE: The question here is how should season closures be implemented? This is prompted by the fact that lobster is now jointly managed with Jonah crab. The answers to this question would pertain if an LCMT comes back with a proposal that includes a season closure. Under Option A, lobster traps must be removed from the water.

Under Option B lobster traps could stay in the water, but there would be no possession of lobsters while fishing. Then under Option C, traps again could stay in the water. There would be no possession of lobsters for lobster permit holders; but those who fish under the non-trap bycatch limit would be allowed to continue under that bycatch limit, which is 100 lobsters per day up to 500 lobsters per trip.

You also notice that there are sub-options under each of these; which asks whether the most restrictive rule applies. That would be for if a fisherman is permitted to fish in two areas, and if both of those areas implement a season closure, whether that fisherman would have to abide by both season closures or just one.

As the Chairman alluded to, Area 4 did submit a letter that was included in your meeting materials that highlighted some of the discrepancies between state and federal regulations in regard to their current LCMA 4 closure. That was a result of Addendum XVII. Some of those inconsistencies are with the application of the most restrictive rule, so that it is applied in state waters. That was not applied in federal waters for season closures. We also had inconsistency with regards to traps out of the water. In state waters if the trap is permitted to fish for another species, it can stay in the water. However, in federal waters all lobster traps have to be removed from the water. We can look at some of the motions that the Board made in 2012 to try and reconsider some of those. But I just wanted to kind of foreshadow those issues; so that we can hopefully come up with a consistent method for the implementation of season closures.

CHAIRMAN BORDEN: Any questions? Does someone in Area 4, 5, and 6 want to comment on this?

MR. BAUM: Yes we've had a lot of public comment on this, a lot of confusion with the federal regulations and with our state regulations. Our lobster harvesters, if they really want to be able to harvest Jonah crab during these closed lobster seasons, obviously that would be Option B, the no possessions of lobsters while fishing.

Also in New Jersey there are the two areas, Area 4 and Area 5; and their season closures are different. There are some lobster harvesters that do possess both those permits for those areas. Obviously we would favor that Sub-Option 2, the most restrictive rule does not apply. But again, as I mentioned earlier, removing these traps from the water is just putting them out of business.

CHAIRMAN BORDEN: Tom, just so I'm clear. Of the options in Issue 4, which of those would you prefer if you had a personal preference for an option to solve, to put in the addendum and also solve your problems. Which of those options would you prefer?

MR. BAUM: I would make a motion, and when that's appropriate. I would favor Option B, Sub-Option Roman Numeral two.

CHAIRMAN BORDEN: Okay that is very helpful, thank you; any other comments, Mike.

MR. LUISI: Yes, I'll just add to what was already said. I think we've heard Option A is just not reasonable to expect with the amount of effort that has to go into removing the traps. We heard from stakeholders earlier that that shouldn't be in consideration.

Also, looking at Option C, I think it would be tough for me going back home and telling your lobster permit holders that they can't have lobster; but somebody else that's dragging a bottom trawler using conch pots, or somebody else is able to harvest lobster. I would support where Tom is going with Option B; Sub-Option II.

CHAIRMAN BORDEN: All right, so I have Megan, Ritchie and then Mark.

MS. WARE: I just wanted to quickly provide some food for thought for the Board. There are a couple things that we need to think about, or these are some of the questions that the Board needs to answer in regards to this. Some of these things I want to point out. There is the Atlantic Large Whale Take Reduction Team rule that prohibits the wet storage of gear for more than 30 days; so I did want to point that out.

That is something the Board needs to consider here. Also the other thing I wanted to point out was that kind of note at the bottom that this is not from the Law Enforcement Committee, this is just from staff discussions. But there may be some enforcement challenges for dual permit holders, if traps can stay in the water and the most restrictive rule does not apply. It might be hard to tell which area those lobsters are coming from, if someone is permitted for two areas only one of them has a closure; just food for thought.

MR. WHITE: I was just thinking, and I am not knowledgeable on the fishery in that area, but I was assuming, which may be incorrect that there is a depth that these lobsters maintain, and would it be possible to have, if that's correct, would it be possible to have instead of taking them out of the water, bringing them into shallower water; if there are no lobsters there, so they're stored. You don't have the problem, not able to take them out of the water, take them where there are no lobsters if that would be an option.

MR. ALEXANDER: Long Island Sound already has a season, and Option B, Sub-Option B is the most consistent with the present rules that we have.

CHAIRMAN BORDEN: Other comments, suggestions. Pete Burns, and then I'm headed back to Tom for a motion.

MR. BURNS: Yes I am familiar with the Area 4 issue; I've spoken to quite a few Area 4 fishermen during the course of this closure and beforehand and also with Tom's staff in New Jersey about this. We implemented the closure based on what was in the addendum, to have the traps taken out of the water.

I think that a lot of that was based on, and I would have to go back to the minutes of the meeting, but I think that the Board decided to go that way because there was a Technical Committee document that said that leaving the traps in the water could still be catching lobsters, and it could cause mortality because of the handling pressure on that.

However we move forward, I would like to ensure that we work closely with the states so that everyone is clear on what the federal regulations say and what the state regulations say. I think that that is really important. But I think our preferred alternative here would be A-2, so that would be traps are removed but they can fish in other areas during the closure; and that's been another inconsistency with what has happened between ours and the state regulations.

If we went forward with something that allowed traps to stay in the water, I think it would be good to get it on some clarification from the Technical Committee about how much less conservation or what the difference in the conservation or other concerns that would be regarding that.

CHAIRMAN BORDEN: Tom, motion.

MR. BAUM: I move to approve Option B, Sub-Option Roman Numeral II for Issue 4.

CHAIRMAN BORDEN: All right is there a second? Mike. Tom, are you finished?

MR. BAUM: Does that capture, do you need me to put more wording there or did that capture it?

CHAIRMAN BORDEN: Is there a second on the motion. Anyone second? Mike. Discussion on the motion, we've already had some of the discussion. Tom.

MR. BAUM: Just another issue. We're basically keeping these pots in the water. At public hearings several lobster harvesters commented that as soon as they take these pots out of the water, the mobile fishing fleet will come in and just take advantage of the pots not being there. The pots over these years have been basically; I don't even want to use the term artificial reef.

But providing habitat and protecting the bottom. Even a comment was made by a lobster harvester that does have a mobile gear permit, and he says I can't wait for these pots to come out so I can go in and start dragging. There is a lot of concern that the mobile gear will cause more mortality, when they come in after those pots are removed, and more mortality there on the lobster population there.

MR. BURNS: I think it comes down to enforcement. I think I would ask Tom. I don't know what level of enforcement the states are doing down there. I know our NOAA Fisheries agents have been out there and trying to understand what the regulations are, and trying to enforce that.

But I think allowing these traps to stay in the water is going to require that we've got a strong enforcement presence to ensure that no lobsters are being harvested. When you've got closure, you've got closure with no traps in the water; it is a lot easier than when you have traps in the water. I just thought maybe Tom could address that.

CHAIRMAN BORDEN: Megan.

MS. WARE: Just to clarify the motion in the addendum is Sub-Option B, so Tom, if you're okay clarifying that.

CHAIRMAN BORDEN: Steve Train.

MR. TRAIN: As a fisherman I like this motion. I don't fish there of course, but I have one problem with it. I don't think there is any problem enforcing the no possession of lobsters. To say that that's hard to enforce would be saying it is hard to enforce oversize, undersize and v-tail, so all you've got to do is wander on the boat and see a lobster. I don't think that's a problem. But I think it is intended for people that are going to be fishing on Jonah crab or something else. I don't want to support this motion if it's intended for wet storage during the closed period.

MR. BAUM: Just I'll go one, two. I can't speak a lot for enforcement. I think that they're having their own committee meeting right now. I know the Division is under contract with the builder up in, I believe Maine for a larger ocean-going vessel, enforcement vessel. They are deputized by NOAA OLE.

They do some enforcement under where the enforcement, more in the fall for Large Whale Take Reduction issues, and trap or line and break points in the line. But that is as much as our law enforcement for Mr. Train. This is for to be able to harvest Jonah crab, to be able to fish for soft crabs.

CHAIRMAN BORDEN: I've got Dan and then Mark Alexander.

MR. McKIERNAN: That's good to hear and I want to reinforce Steve Train's comments that with the 30 day requirement to haul the gear, clearly this can't be an option for wet storage; it has to be because of the Jonah crab fishery.

MR. ALEXANDER: Yes I just want to point out Long Island Sound, when I said this is consistent with our present rules. The reason for that is not because of the Jonah crab fishery, but because of the whelk fishery. We made that accommodation years ago when the season was implemented. That rule has worked; it would be good to us, and certainly like to see it in our venue.

MR. BURNS: I have a question now. It seems like if this passed this would take effect for any future closures that are considered under Addendum XXV. But that leaves the question of what happens to the current closure that is happening in Area 4 and Area 5; and whether or not this would change that.

I guess I'm assuming that if this went forward and the LCMTs decided to look at seasonal closures as part of their 5 percent egg production goal; that they could use the existing closure, or somehow amend the current closures, and include something else to achieve the goals under Addendum XXV. Somehow there would still have to be a justification that they meet the 10 percent decrease in exploitation that was required when that closure initially went in place. Am I right in assuming that?

CHAIRAMN BORDEN: Megan, do you want to comment on that?

MS. WARE: Sure. Yes, it occurs that this motion only applies for future season closures that might be implemented as a result of this. To address the Area 4 issue that is our next item on the agenda. If either of you are looking for motions to reconsider previous motions to amend or change that issue; should the Board like to do that.

CHAIRMAN BORDEN: I guess my question I ask out of ignorance is let's for the question, assume that this motion passes. Do states have the right under conservation equivalency to submit alternative proposals to change the existing plans that have been implemented? If the answer is yes, then I would suggest they take advantage of that. Megan or Toni.

MS. KERNS: I think the Board would have to, you should make a decision of whether or not conservation equivalency can apply to the most restrictive rule or not. I need to do a quick check of the FMP. But I believe in the past, I'm not sure if the most restrictive rule is a coastwide measure than those do not apply to adapt to the conservation equivalency issues.

CHAIRMAN BORDEN: I guess my question may be the step off the edge of the world here. Let's deal with the motion on the table. If the motion passes, then I'll go back to the issue of how we revise the process we use to revise the existing regulations. My whole purpose in combining these two was to have consistent policies applied to Addendum XXV and any of the season closures.

We don't need two different policies on those. Let's deal with the motion. Are you ready for the vote on the motion? All right, I see no hands up**. All those in favor of the motion on the board, please signify by raising your hand, 11 in favor, any no votes? Zero no votes, any abstentions, and any null votes? Motion carries.** Let's go back to the point that was just raised, and maybe I'll get Toni. What is your preference for a process to modify the existing regulations? I think it's highly desirable to have all of these regulations be in place.

MS. KERNS: I want to clarify, when I was talking about whether or not conservation equivalency could apply. I think you can apply the conservation of equivalency to the number of days that the closure needs to be, or the time period. But I don't think that you can apply conservation equivalency to the traps in or out of the water part, or the most restrictive rule part. You would have to pick one and stick with that.

In terms of if this can apply to the previous actions of the Board, I guess that is the will of the Chairman; if he wanted to and no one disagrees, then that would work. But in order to change an action that we previously agreed to, we would need a two-thirds majority vote to make that change.

CHAIRMAN BORDEN: Okay, so with that guidance, and that's helpful. Let me suggest this that rather than dealing, if it's acceptable to the area's most affected, let me suggest that between now and the next meeting, the states that are negatively affected by this submit proposals, written proposals. I ask you to try to consolidate it into a single proposal on a way to handle this that is consistent with the motion that just passed; and we'll add it to the agenda for the next Board meeting.

If the consensus is that they want to accept that they won't have to go through the process that Toni just articulated, which is to reconsider the motion. Does that sound fair enough to the states most negatively affected by this? I'm not trying to postpone this. I'm just thinking we're already over our time limit.

We've got other issues we have to deal with, and unless this is a matter of urgency that needs to be resolved today that gives us a timeline and a process to do it, any objections to doing that? Okay, so the state's most negatively affected, please get together and craft a proposal and submit it for consideration at the next board meeting; any objections? No objections.

INCONSISTENCIES IN FEDERAL REGULATIONS

CHAIRMAN BORDEN: We're going to move on to the next agenda item, which is the Inconsistencies in Federal Regulations. Megan.

MS. WARE: We kind of just talked about one of them, but there is one other that we need to wrap up here; and that is in regards to Addenda XXI and XXII. Just to refresh the Board on what happened in those addenda, we had active trap cap, and that's the number of traps that can be fished.

Then we had an individual ownership cap that is the number of traps someone could own. You'll notice that that individual cap is higher than the active cap, and this allows for trap banking. The intent of these addenda was to modify the trap transfer program to address latent effort and scale the southern New England fishery to the diminished size of the resource.

In July 2016, NOAA suspended their rule making process for federal trap caps and banking. This was due to uncertainty surrounding the Board's response to the southern New England stock condition, as well as concern that trap caps and banking could encourage fishermen to invest in funds in a fishery, which could be severely restricted in the future. In October, the Board agreed to revisit the issue after action on Addendum XXV. We have now taken that action. The question before the Board is, would the Board like to provide a recommendation to NOAA regarding implementation of Addenda XXI and XXII.

CHAIRMAN BORDEN: I'm sorry, I was talking to Toni. We had industry recommendations on this. I'm probably repeating it to say, Megan my understanding is both the Area 2 Industry and the Area 3 Industry both recommended that the Board forward a recommendation to NOAA to implement these provisions.

MS. WARE: That's correct, yes.

CHAIRMAN BORDEN: Comments on that issue. Questions. The recommendation from the industry and having been part of some of those discussions, both at public hearings, one of the concerns came up at a couple of different meetings was the lack of federal action on this is allowing individuals, particularly in Area 3 to increase the number of traps they're fishing; which is I think counter to the whole strategy.

In other words, when the strategy was put in place, the assumption was that after X number of years we would be at 15,040 I think was the number. Yes, 15,048 and because of the delay I had Heidi, who works with me, go through the NOAA database. I think there are 27 vessels that have increased, or 17 maybe, one of the two numbers.

They have increased their trap cap above the cap that was proposed; actually more effort is coming into the fishery because of the lack of action on this. Well, my recommendation is for somebody to make a motion to reiterate our position that basically we recommend to NOAA that they institute the proposal as provided through our various addendum. Comments on that. Adam.

MR. NOWALSKY: Just procedurally, before I wasn't prepared to make a motion on that; but with this comment we need to revisit the issue after action. Do we want to have this discussion? Is it relevant before we take the roll call vote on final action on Addendum XXV, or should we have that final action first before we move into this issue?

CHAIRMAN BORDEN: I'm actually glad you asked that because Toni, the discussion I was having with Toni there was whether or not we actually need to take final action here. I mean there is kind of two ways forward with this addendum. The intent is to pass the LCMTs now and the states to basically put together plans consistent with the provisions that we've developed.

But we could take that final vote at the next meeting. In other words, there wouldn't be anything lost. I asked Toni to speak to this directly. I mean if the staff is recommending we take a final vote, I'll put it to a final vote. I'm not trying to avoid that. But if we can do that at the next meeting that is also fine with me. Toni, what's your guidance?

MS. KERNS: David, I suggest just guidance that you can go down two paths. If we wait to approve it in August, then what we're essentially doing is including the LCMT plans or proposals after you approve them, as part of the document itself; and so those will be solidified in to the document. If you approve the document today then the LCMT plans would not become part of the document, and they would just be side proposals down the line. It is up to the Board of how you, or the Chair.

CHAIRMAN BORDEN: This follows up on Adam's point. We want the LCMT proposals to be integrated into the addendum. What would happen there is the process would be they would prepare the plans, the plans would undergo a technical analysis; and then we would vote on those plans and finalize the addendum at the next meeting. In other words, we've set all the rules for the addendum, but we haven't allowed the LCMTs. Is there a preference around the table? Either path works. It is a question of what your preference is. Adam.

MR. NOWALSKY: Since you've asked for a preference, I'll state mine and that is to take final action today. Given the debate we had around the table, very contentious discussions. I think we need to walk out of here and say, we did what we did and it's done.

CHAIRMAN BORDEN: Dan.

MR. McKIERNAN: I respect Adam's view on that but for posterity and for transparency and long term documentation, it seems like we're better off having a document that captures the actions. But I can go either way.

CHAIRMAN BORDEN: Any other comments, Mike. I'm going to ask for a motion.

MR. LUISI: Just another thing to keep in mind regarding a reconsideration of any of the actions we took today. Because this is a continuation of yesterday's meeting, any actions that will be up for reconsideration would require two-thirds majority vote and the person making that motion would have been on the other side. If you get to August all those rules still apply. It's just another thing to keep in mind for the Board. I can go either way as well today.

EXECUTIVE DIRECTOR BEAL: Actually, since this is at the same meeting, if somebody from the prevailing side of the motion that is potentially reconsidered that only takes a simple majority during this current meeting if somebody from the prevailing side reintroduces that. But if you go to the next meeting that is when it takes a two-thirds vote to amend or rescind a previous final action.

CHAIRMAN BORDEN: Let me try this to try to accelerate this. I know that people hate doing this. Let me just see a show of hands from each delegation on whether or not they want to vote on final action today or put it off until the next meeting. All those in favor of voting on it today, please raise your hand, all those opposed, let me restate that. All those in favor of voting on it, finalizing it at the next meeting raise your hand. Okay, so we don't have a really convincing majority on either side. Does somebody want to make a motion here? Adam.

MR. NOWALSKY: I'll make the motion to approve Addendum XXV with the options included today.

CHAIRMAN BORDEN: Do I have a second? Is there a second? Motion dies due to lack of second. Does someone want to make a motion to approve final action at the next Board meeting? Dan.

MR. McKIERNAN: I move that we propose final action for the next Board meeting on Addendum XXV.

CHAIRMAN BORDEN: Is there a second? Seconded by Mark Gibson. Discussion. Megan, did you want to make a comment?

MS. WARE: I'm not sure we really need a motion for that. I think we can just say we'll take action, a roll call vote in August if people are comfortable with that.

MR. BURNS: Just a question. What happens if the LCMTs for some reason can't come back with proposals that meet the 5 percent goal after the Technical Committee has reviewed those? What happens at the August meeting?

CHAIRMAN BORDEN: Toni, do you want to take a shot at that? I think the head of the table is beginning to get worn out.

EXECUTIVE DIRECTOR BEAL: I'll save Toni from moving seats here. They all seem to use their Advisory Board, if they can't come up with an option then the Board has the authority and responsibility of coming up with those measures.

MS. WARE: In the addendum it does say that if we don't receive an LCMT proposal the states with fishermen in that LCMT decide the management actions. There is a bit of a backstop there.

CHAIRMAN BORDEN: Okay so we don't need a motion on this, according to the staff. Final approval will take place at the next meeting of the Board. Okay so what other issues at the meeting today?

MS. WARE: We still have the question before the Board whether someone would like to make a motion to provide a recommendation to NOAA regarding implementation of Addenda XXI and XXII.

CHAIRMAN BORDEN: Does anyone care to make that as a motion? Dan.

MR. McKIERNAN: I will make a motion to forward to NOAA a recommendation to adopt Addendums XXI and XXII.

CHAIRMAN BORDEN: Fully adopt.

MR. McKIERNAN: Fully adopt, thank you.

CHAIRMAN BORDEN: Is there a second? Seconded by Doug Grout. Bob Beal.

EXECUTIVE DIRECTOR BEAL: Just another technicality. I think is to recommend to the Policy Board to send a letter out to NOAA Fisheries.

CHAIRMAN BORDEN: Good point. Any objection to that perfection, Dan? Okay. It is a motion to recommend to the Policy Board to forward a recommendation to NOAA requesting full implementation of Addenda XXI and XXII. The second on the motion is Doug Grout. Okay, Pete Burns on the motion, please.

MR. BURNS: Of course I'm going to abstain on this, because it is a recommendation to the Service, but I would just recommend, you know a lot of things have changed now since those addenda were initially put in place. Now we have an idea where Addendum XXV is going to lead us with respect to how we're going to handle southern New England moving forward. But I think it would be helpful to us, rather than just forwarding those addenda as they were approved and sending them back to us.

I don't know then we'd have to sort of tease through a bunch of different issues. It might be a good idea to either have the LCMTs or the PDT, somebody maybe take a look at those options; see what makes sense now. See how the Board would want to recommend those be applied to the current state of the fishery in the management process that we have in place. I think that will help us to fully consider those in a more comprehensive way.

CHAIRMAN BORDEN: Okay so you have a motion on the board and a second; any other discussion on this? Are you ready for the question? **All in favor raise your right hand, 10 in favor, noes, 0, any abstentions? One abstention, any null votes, no null votes; motion passes.** Is there any other business to come before the Committee? If not, Tom, excuse me.

MR. BAUM: Yes this is really just a request for the Board to send to the Policy Board to request the Law Enforcement Committee to analyze the feasibility of legal size lobsters from LCMA 1 and 6, to be shipped and sold throughout the other states with conflicting possessions and size limits. That's just a request from this Board to the Policy Board.

CHAIRMAN BORDEN: Toni, did you want to comment on that?

MS. KERNS: Tom, are you just asking the Law Enforcement Committee to comment on the enforceability or to clarify where there would be enforcement loopholes? What are you asking the Law Enforcement Committee to specifically analyze?

MR. BAUM: First, if it's feasible, if it's doable; and then obviously if it is enforceable, yes.

MS. KERNS: Under the condition rules it is allowed. Possession laws are only for harvesters, it is not for what you bring from water to land is what we put in our FMP. For what the dealers have done our FMP regulations do not apply. Some states do apply it that way, because of loopholes in possession.

They do it to make it streamline. Now, not all states do that. There are other ways to look at that. Massachusetts is an example of a state that doesn't have that possession law apply all the way around the board. I just want to clarify what exactly it is that Law Enforcement is analyzing.

CHAIRMAN BORDEN: Tom or Adam.

MR. NOWALSKY: As Chairman of the next board, I'm probably even more sensitive to time right now than you are. But if I could ask Greg DiDomenico to come to a microphone just very briefly to specify what the issue is, so we can get direction on how we can get this addressed in our state.

CHAIRMAN BORDEN: Greg was last seen running, screaming from the meeting room. Greg, would you like to come up?

MR. GREG DiDOMENICO: I was trying to run and scream as quietly as possible, sorry you noticed. I'm going to make this short and sweet. I understand everybody is running out of patience and time is running. I'll try to do my best. The reason that we're bringing this issue up today, and asking the Board to take action, you asked the Law Enforcement Committee to analyze and weigh in this issue is pretty simple. Right now this is a New Jersey problem.

I understand not every state has the same situation we do. But I heard some testimony today that really compelled me to push on this issue, and that is the Board and the way that management of lobster has continued, is gauge increases. As gauge increases continue it exacerbates the problem of trade between states. Eventually it's going to have an impact on the fishermen and the price, and their ability to sell lobsters. That is certainly under your purview.

I think it would be extremely helpful if the Law Enforcement Committee took a look at this issue and made some finding, and compelled other states, including certainly ours, to address this issue and allow the shipping and sale of undersized lobsters or lobsters that have conflicting size and possession limits in other states. I know it's a complicated topic, but I see it very simple in the sense that we're making a legally caught product illegal in other states through different regulations.

That is a Commission issue. If the Law Enforcement folks weighed in heavily or weighed in in support of this, it would make it much easier for people in our state to continue this business within the state of New Jersey importing lobsters from areas like Maine and Massachusetts in and out of our state. I just see this as a very simple issue that is in the Commission's purview, and we would really appreciate moving this to the Law Enforcement Committee for their assistance. Thank you very much.

MR. KELIHER: So Toni, clearly lay this out from an FMP standpoint what we are putting in place is in regards to harvester and a possession limit from a harvester's standpoint. States then have different rules as they relate to the possession by a dealer or dealers. What the Law Enforcement Committee needs to look at is simply chain of custody.

Can the rules be put in place that allow chain of custody, so when it does transfer that product transfers from a harvester to a dealer; but it is now not an illegal product. We do it in Maine, Connecticut does it, I mean other states are doing it and it can be done. It needs to be resolved. Dealers in Maine clearly laid out to me that they are considering commerce clause law suits against states, because of the lack of ability to move millions of pounds of product. Some clarity on obtaining custody I think is very important.

CHAIRMAN BORDEN: Let me make this suggestion, and I know we've got a couple other people that want to speak to this. But we're really running out of time. Let me suggest between now and next meeting we get any input. Renee has heard the discussion; we'll get a record of this.

If you get any inputs that the Enforcement Committee would like to offer on this, any guidance that they would like to offer; and we formally schedule this discussion on the next agenda. That way we'll have enforcement input and any of the states can think about this and bring whatever recommendations back to us at that meeting; and allow enough time to actually delve into the details. It's a little bit more complicated than we have time for, Ritchie.

MR. WHITE: Add it to that the existing state regulations; so I understand what the lay of the land is now.

CHAIRMAN BORDEN: I just echo what Pat said. I mean Massachusetts and a number of the states have dealt with this, and so as part of that dialogue they can bring their regulations back and at least say, this is the way we handle the problem; and we'll have a more comprehensive discussion. Does anybody object to that? If not, the staff will schedule that and I guess we're under other business.

ADJOURNMENT

CHAIRMAN BORDEN: Is there any other business to come before the Committee? If not, thank you very much; meeting adjourned.

(Whereupon the meeting was adjourned at 10:58 o'clock a.m. on May 9, 2017.)

RHODE ISLAND
DEPARTMENT OF ENVIRONMENTAL MANAGEMENT
DIVISION OF FISH & WILDLIFE / MARINE FISHERIES
Three Fort Wetherill Road
Jamestown, Rhode Island 02835

Atlantic States Marine Fisheries Commission
Lobster Conservation Management Team Area 2

The LCMT 2 met on June 7, 2017 in Providence, Rhode Island. There were ten members of the fishing industry in attendance, as well as representatives from the State Marine Fisheries agencies of Rhode Island and Massachusetts.

At the May meeting of the Atlantic States Marine Fisheries Commission, the Lobster Management Board chose a 5% increase in egg production for the Southern New England Lobster Stock as part of Addendum XXV. At this time it is the responsibility of the LCMT's for each management area to submit proposals to the Commission on how the lobster conservation management area will achieve this increase in egg production.
The following is a summary of the LCMT for Area 2 on the above issue.

Issue 1. Egg Production Target
What should the target increase in egg production be for this addendum?
Option: 5% increase in egg production as proposed by the Lobster Management Board
Unanimous LCMT support

Issue 2. Management Tools
What management tools can be used to achieve the target increase in egg production?
Option A: Gauge size changes, season closures, and trap reductions used independently as proposed by the Lobster Management Board
Unanimous LCMT support

Issue 3. Recreational Fishery
What measures must the recreational fishery abide by this Addendum?
Option C: Recreational fishery must abide by gauge size changes as proposed by the Lobster Management Board
Unanimous LCMT support

Issue 4. Season Closures
How should season closures be implemented given lobster is jointly managed with Jonah crab?
Option B: No Possession of Lobsters While Fishing
Sub-Option II: Most Restrictive Rule Does Not Apply as proposed by the Lobster Management Board

Unanimous LCMT support

Issue 5. Standardized Regulations
Should regulations be standardized across LCMAs?
Option A: Regulations not uniform across LCMAs as proposed by the Lobster Management Board
Unanimous LCMT support

Issue 6. Implementation in LCMA 3
How should regulations be implemented in LCMA 3 given it spans both the SNE and GOM/GBK stock?
Abstention by LCMT 2 on this issue.
Reasoning: The LCMT for Area 2 does not wish to provide guidance on management action in any LCMA other than Area 2.

Issue 7. De Minimis
Do de minimis states have to implement the management measures in this Addendum?
Abstention by LCMT 2 on this issue.
Reasoning: The LCMT for Area 2 does not wish to provide guidance on management action in any LCMA other than Area 2.

Summary: The LCMT for Lobster Conservation Management Area 2 proposes to use the current trap reduction plan as the sole management tool to achieve the 5% increase in egg production.
Unanimous LCMT support

Attendance:
Jason McNamee, Chief RI Marine Fisheries
Scott Olszewski, RI Marine Fisheries
Conor McManus, RI Marine Fisheries
Dan McKiernan, Mass DMF, Associate Director
Jarrett Drake, LCMT 2 Mass
Grant Moore, LCMT 3 Mass
Greg Mataronas, LCMT 2 RI
Tom Tomkiewicz, LCMT2 Mass
Lanny Dellinger, LCMT 2 RI, Chair
Al Eagles, LCMT 2 RI
John Moniz, Area 2 Mass
Eric Moniz, Area 2 Mass
Richard Allen
Roy Campanale, LCMT 3 RI

June 15, 2017

Megan Ware
Fishery Management Plan Coordinator
1050 N. Highland St, Suite 200 A-N
Arlington, VA 22201

Dear Megan,

The Area 3 Lobster Conservation Management Team met on June 14, 2017 in person at the MADMF office in New Bedford, MA and via conference call.

The following LCMT members were in attendance: Grant Moore – Chair, Peter Brown, Marc Palombo, and Roy Campanale (phone). The following additional Area 3 lobstermen were in attendance: Dick Allen (representing Shafmaster Fishing). The following support staff were in attendance: David Borden – Atlantic Offshore Lobstermen's Assn. (AOLA) and ASMFC, Dan McKiernan – MA Division of Marine Fisheries (MADMF) and ASMFC, Tracy Pugh – MADMF and ASMFC's Lobster Technical Committee (phone), Heidi Henninger – AOLA (phone).

The Area 3 Lobster Conservation Management Team offers the following Addendum XXV management plan by consensus:

Area 3 will complete a 25% trap allocation reduction as approved in Addendum XVIII. Trap reductions of 5% per annum were taken in fishing years 2016 and 2017. As currently scheduled, there will be three more years (2018, 2019, 2020) of 5% annual reductions. The Technical Committee's analysis indicates that these trap reductions will exceed the 5% increased egg production target (Addendum XXV for Public Comment, page 17).

Related to the concern that this trap reduction plan, in combination with transferability, does not effectively remove active effort, we note that there are complexities with multi-area permits, the market for traps, and operational constraints that all serve to draw down the amount of potential fishing effort inherent in shelved permits and traps. The Rhode Island Lobstermen's Association's Addendum XXV comment letter provide a series of insightful examples.

Further, we strongly urge NOAA Fisheries to complete their Addendum XXI rulemaking, to align the federal trap cap with the ASMFC's plan. The federal cap is currently static, whereas the ASMFC's plan reduces the maximum permit and ownership trap caps annually. For further description, we have attached a letter that the Atlantic Offshore Lobstermen's Association submitted to NOAA NMFS GARFO on this issue.

The LCMT also discussed the provisions approved at the last Board meeting and resolved by consensus the following:

Issue 1 – Target Increase in Egg Production: The LCMT supports the Board's decision to pursue a 5% increase in egg production.

Issue 2 – Management Tools: As noted in our April comments, the LCMT continues to supports “Option A, Management Tools Can Be Used Independently”. This option allows for much needed management flexibility to craft area specific plans that will meet the goals of this Addendum.

Issue 3 – Recreational Fishery: The LCMT does not have a preference on this issue.

Issue 4 – Season Closures: The LCMT supports Option B with Sub-Option B, No Possession of Lobsters while fishing, most restrictive rule does not apply, with the addition of a bycatch allowance in the trap fisheries of 100 lobsters per day/500 lobsters per trip by count. This will create equitability between the trap and mobile gear fisheries.

Issue 5 – Uniform Regulations: As noted in our April comments, the LCMT continues to support “Option A, Regulations Are Not Uniform Across LCMAs”.

Issue 6 – Implementation of Management Measures in LCMA 3: As noted in our April comments, the LCMT continues to support “Option A: Maintain LCMA 3 as a Single Area (Status Quo).

Issue 7 - Management Action in De Minimis States: The LCMT does not have a preference on this issue.

Sincerely,

J. Grant Moore
LCMT Area 3 Chair

ATLANTIC OFFSHORE LOBSTERMEN'S ASSOCIATION
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exec@offshorelobster.org
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January 13, 2017

John Bullard
Regional Administrator
NOAA NMFS GARFO
55 Great Republic Drive
Gloucester, MA 01930

Dear John,

I'm writing as representative of the Atlantic Offshore Lobstermen's Association to urge NOAA NMFS GARFO to promulgate rules in response to the American lobster trap reduction provisions approved by the Atlantic States Marine Fisheries Commission in 2013 (ASMFC, Addenda XXI and XXII). In particular, the Agency's inaction on the LCMA 3 trap cap is resulting in traps being fished in Area 3 in excess of what the Commission intended. This is counter to the best interests of the lobster resource, especially in overfished Southern New England. It also harms protected species and marine mammals, as it results in more vertical lines being set in Area 3.

In terms of the history of this issue, the LCMA 3's trap transfer program and 5-year trap reduction strategy were approved by the Commission via a series of Addenda, the last being in 2013, and implemented in Fishing Year (FY) 2016. According to ASMFC's plan, the Area's trap cap should be reduced 5% each year in concert with allocation reductions. The Commission's plan proscribes the following annual active trap caps: 1900, 1805, 1715, 1629, 1548, for FYs 2016 to 2020, respectively. The federal cap is currently static at 1945 traps.

The Area 3 LCMT proposed the trap reduction plan outlined in Addenda XVIII, XXI and XXII specifically because it would remove all latent effort and afford those left in the industry an even playing field, with everyone fishing close to the same number of traps after consolidation. Business plans were made and permits and traps purchased with the 1548 ending trap cap in mind, however the higher federal cap allows those with means, to make additional trap purchases. There are not enough traps available under a higher trap cap scenario to realize the equity envisioned in the ASMFC plan and the traps still available are selling at rates 50-70% more than in years' past. The Agency's inaction on the trap cap provisions has undermined the equitability designed into the ASMFC Addenda, has caused confusion amongst many in the industry, and has allowed more traps in the water.

For example, multiplying the difference between federal and interstate trap caps by the number of Area 3 permit holders, there is the potential for ~6,000 extra traps in Area 3 this fishing year. Since the transfer process has already commenced for FY 2017, we can take this calculation one year further, which results in ~18,500 extra traps allowed because of the higher federal cap. Of course, only a portion of Area 3 permits are active, and not all permit holders have the means to purchase and transfer traps, but enough do to make this a real concern.

I also have concerns that the lack of federal action on this issue could be further delayed into 2018 or 2019, if combined into one rulemaking process with Addendum XXV. I note that the agenda for the ASMFC winter meeting includes discussion of initiation of a new data collection Addendum, which might also require changes in the federal program. These delays cause a major disconnect between State and Federal rules and are not in the best interest of the SNE lobster resource.

Not only does this delay in rulemaking cause conservation concerns with the SNE lobster stock, there are also logistical and economic concerns. How, for instance, will your Agency reconcile the disparate trap caps? I assume NOAA will not take traps in excess of the ASMFC cap away from permit holders. I suggest that GARFO set up a dialog with ASMFC and Area 3 permit holders on the development of a strategy to reconcile these differences and do so as soon as possible, in order to take advantage of the remaining years of scheduled trap cuts.

In conclusion, I implore you to correct the trap cap disparity before FY 2018 transfer applications are accepted. If not, your agency won't be able to address the active trap cap until FY 2019, at which point the federal cap will be 1945 and the ASMFC cap will be 1629. The Agency will also have the added complication of combining this rulemaking with Addendum XXV and, possibly, Addendum XXVI.

Thank you for consideration of the Association's concerns.

Sincerely,

J. Grant Moore
President

cc Robert Beal, ASMFC

NEW JERSEY DIVISION OF
Fish and Wildlife
P.O. Box 400
Trenton, NJ 08625-0400
David Chanda, Director

NEW YORK STATE OF OPPORTUNITY | Department of Environmental Conservation
Division of Marine Resources
205 N. Belle Mead Rd, Suite 1
East Setauket, NY 11733
James Gilmore, Director

To: American Lobster Technical Committee
From: Peter Clark (NJF&W) and Kim McKown (NYDEC)
Date: June 23, 2017
Subject: Lobster Conservation Management Team 4 Proposal for Addendum XXV

Addendum XXV of the ASMFC Lobster Fishery Management Plan was developed in response to record low abundance of the Southern New England (SNE) lobster stock and the concern that it is experiencing recruitment failure. The goal of the Addendum is to increase egg production of the SNE lobster stock by 5%. The increase in egg production can be achieves through one or more of the following management tools which must be implemented by January 2018.

1. **Gauge size change**: Increase the minimum size above 3 3/8 "and/or decrease the maximum size below 5 ¼ ".

2. **Trap reductions**: Decrease in the number of traps. Table 12 of the Addendum is based on the relationship of actively fished traps and egg production.

3. **Season closures**: During the season closure lobsters cannot be possessed on board or landed. Lobster traps may remain in the water and Jonah crab and whelk may be harvested. The most restrictive rule does not apply to season closures. Table 13 of the Addendum contains information on the increase in egg production resulting from quarterly season closures.

The options in the tables of Addendum XXV are based on increase in egg production ranging from 20% to 60%. At the spring 2017 the Lobster Board chose a target increase of 5%, which is considerably less than the options in the Addendum. Most of the management options developed for Addendum XXV are much large than 5%. This made it challenging to develop a proposal which didn't exceed the 5% increase in egg production goal of the Addendum.

The Lobster Conservation Management Team (LCMT) 4 met on May 18, 2017 in Belmar, New Jersey to determine management measures for compliance with Addendum XXV.

Trap Reduction

The LCMT 4 proposes to implement a 10% decrease in Lobster Conservation Management Area (LCMA) 4 trap allocation for New Jersey and New York permit holders. A proportional relationship was used to determine the proportion of traps that would need to be decreased to achieve a 5% increase in eggs based on the recent year's information included in Table 12 of the relationship between trap reductions and egg production (Table 1).

Table 1. Proportional determination of trap reduction which would achieve a 5% increase in egg production.

Years	Trap Reduction	Egg Production
recent (1999-2013)	25%	13.10%
Proportion	10%	5%

LCMA 4 lobstermen state that the active lobstermen are fishing their full trap allocations, so a 10% decrease in allocation should decrease actively fished pots by a similar amount. The number of NJ and NY lobstermen who have been actively fishing has been relatively stable since 2012 (13 – 21 for NJ and 9 – 13 for NY). Trap allocations and the number of traps fished have also been fairly stable over the same time period (Table 2). A 10% decrease in trap allocation will decrease traps in NJ to 32,861 and in NY to 34,034.

Table 2. Lobster Permits and LCMA 4 Trap Tags

NY

Year	All NY Lobster - Resident	All NY Lobster NonResident		# NY Permits w LCMA 4 trap allocation	NY LCMA 4 trap allocation		# LCMA active trap permit holder	# NY LCMA 4 traps fished	% Allocation Actively Fished
2012	27	334		94	39,700		13	10,783	27%
2013	23	326		91	38,525		8	7,890	20%
2014	20	309		90	38,515		9	11,221	29%
2015	18	293		87	38,165		12	9,966	26%
2016	18	280		83	37,815		9	8,842	23%
10% decrease					34,034				

CT

Year	All NJ Federal Lobster Permits			# NJ Boats w LCMA 4 trap allocation	NJ LCMA 4 trap allocation		# LCMA active boat permits	# NJ LCMA 4 traps fished	% Allocation Actively Fished
2012	199			42	47,326		21	17,905	38%
2013	184			38	41,636		14	13,540	33%
2014	188			35	40,236		16	15,518	39%
2015	188			33	37,596		13	13,158	35%
2016	48			32	36,512		15	13,773	38%
10% decrease					32,861				

Maryland-Delaware-Virginia
Lobster Conservation Management Team
LCMA5

Chair-Sonny Gwin Vice-Chair-Wes Townsend

June 15, 2017

Dear Ms. Megan Ware,

Thank you for providing the options for meeting Addendum XXV egg production requirements to the LCMT. Please ensure this letter is received by the ASMFC American Lobster Board.

We conducted the second official meeting of the Lobster Conservation Management Team (LCMT) for LCMA5 to address Addendum XXV on June 7, 2017. We are proposing to use the 88 mm -133 mm gauge change to meet the requirement in LCMA 5.

Thank you.

Sincerely,

Sonny Gwin

Sonny Gwin

Connecticut Department of
ENERGY &
ENVIRONMENTAL
PROTECTION

NEW YORK STATE OF OPPORTUNITY
Department of Environmental Conservation

To: American Lobster Technical Committee
From: Kim McKown, NY DEC
Colleen Giannini, CT DEEP
Date: June 16, 2017
RE: Lobster Conservation Management Area 6 Compliance Proposal for Addendum XXV

Addendum XXV to the Fishery Management Plan for American Lobster calls for a 5% increase in egg production for the Southern New England lobster stock to address continued stock decline while preserving a functional portion of the lobster fishery. The Addendum lists three compliance options that can be implemented by all LCMAs within the Southern New England (SNE) stock area, namely 2, 3, 4, 5, and 6. One or more of these options are to be implemented effective January 2018.

a. **Gauge Size Changes:** Increases in the minimum legal size (currently 3 3/8" in LCMA6) or decreases in the maximum legal size (currently 5 ¼" for LCMA6);

b. **Trap Reductions**: Decrease in the number of actively fished traps;

c. **Closed season:** Each LCMA could choose one of four quarterly closed seasons to achieve the 5% increase in egg production. For the purposes of meeting the criteria of this option, landings are directly equated to exploitation of non-egg bearing females and recoupment is not considered.

The option tables presented in Addendum XXV were developed in anticipation that the target increase in egg production would range from 20% to 60%. The target increase adopted by the Board was 5%, a value considerably lower than anticipated and outside the range of most of the egg production increases specified in tables 11, 12, and 13 in the main document and Tables 1 and 2 in Appendix 5. This presented a challenge in developing measures that did not grossly and unnecessarily exceed the 5% threshold.

LCMA 6 Compliance Proposal

Based on comments received at three public meetings (two in Connecticut and one in New York), and two meetings of the Area 6 Lobster Conservation Management Team (LCMT 6), two options are proposed below.

Option 1: Status Quo. The LCMT 6 had lengthy discussion surrounding the substantial decrease in effort and landings already observed in LCMA6. The team feels strongly that any additional restrictions would jeopardize the continued operation and the future of the commercial lobster fishery in Long Island Sound. The team feels the continued issue of latency in LCMA6 needs to be addressed and would like to develop and implement measures to further reduce the number of latent traps (Appendix 1).

Option 2: This option combines a decrease in the current maximum legal size from 5 ¾" (133mm) to 4 17/32" (115mm) (option A) in combination with an institution of nine Sunday closures in July and August (option C) and are being proposed to achieve a total 5.3% increase in egg production.

Reduction in the maximum legal length in LCMA 6.

The benefit of a decrease in the maximum size to 4 17/32" (115mm) was taken from Table 2 of Appendix 5 in Addendum XXV. Table 2 indicates the resultant increase in egg production at a given minimum legal length for a series of 10mm maximum length intervals. Selecting the current minimum legal size of 86mm (3 3/8") in LCMA 6 from the table, a decrease in the current maximum size from 133 (5 ¼") to 115m (4 17/32") achieved an increase of 1% in egg production. This reduction in the maximum size provides permanent protection from harvest.

Institution of Sunday closures in June and July in LCMA 6.

The institution of Sunday closures in July and August is in addition to the current season closure in place in LCMA 6 from September 8 through November 28.

Although there was some discussion of extending the current season closure on the front and/or back end, the strongest support emerged for closing harvest on Sundays in July and August. The team felt strongly that restricting any level of harvest during the summer months allows additional time for females to extrude eggs, protecting them from harvest. They also felt the additional soak time would allow lobsters to continue to exit traps through the escape vents, protecting them from harvest and the additional stress of being hauled to the surface.

The effect of Sunday closures was calculated using the monthly pattern for commercial (all gear types) landings reported for Connecticut and New York from LCMA 6 (Table 1) between 2013 and 2015. This time period was selected as the fishery has adjusted to the current fall closure (Sept 8 through November 28) which began in 2013. The monthly proportion of LCMA6 landings from 2013-2015 was used to determine the benefit to egg production (Table 2).

Table 1. Monthly and Total Area 6 Commercial) Landings (pounds) for New York and Connecticut, 2013-2015. *Commercial data taken from SAFIS.*

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
CT 2013 - 2015 sum	14,868	7,762	7,153	12,704	39,469	56,109	102,804	81,438	8,550	0	4,492	29,029	364,377
NY 2013 - 2015 sum	1,425	539	108	2,233	4,440	10,465	17,653	16,139	3,023	0	1,740	8,715	66,479
Totals	16,293	8,301	7,261	14,937	43,909	66,574	120,457	97,577	11,573	0	6,232	37,744	430,857

Table 2. Proportion of Total Landings for Area 6 by Month, 2013 - 2015.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
LMA6 2013 - 2015 prop	0.04	0.02	0.02	0.03	0.10	0.15	0.28	0.23	0.03	0.00	0.01	0.09	1.00

The quarterly proportion of legal sized (86mm – 133mm) non egg-bearing females observed from 2001-2016 was calculated using a combination of CT and NY sea sampling data, NY port and market sampling data and NMFS observer data from NY for LCMA6. Monthly sample sizes of marketable females were sparse in some years, therefore quarterly proportions were computed (Table 3).

Table 3. Quarterly proportion of legal non egg-bearing females for Area 6, 2001-2016.

	Quarter			
	1	2	3	4
01 - 16 prop	**0.40**	**0.44**	**0.58**	**0.35**

Daily landings percentages of females were computed by dividing the monthly landings proportion by the number of days in the month and multiplying that product by the corresponding quarterly proportion of fishery dependent observations of legal non egg-bearing females. Entering the number of days in the month that would be closed then yielded the percent decrease in the landings, reasoning that a reduction in the harvest of non-egg bearing females is suitable proxy for an increase in egg production. The institution of Sunday closures in July and August is proposed (Table 4) gaining a 4.3% increase in egg production.

Table 4. Sunday closure days in June and July that achieve a 4.3% increase in egg production, based on a reduction in the total commercial female landings for Area 6.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
days	31	28	31	30	31	30	31	31	30	31	30	31	365
%/day	0.000516	0.000286	0.000258	0.00044	0.001419	0.0022	0.005239	0.004303	0.00058	0	0.000117	0.001016	
days closed	0	0	0	0	0	0	5	4	0		0	0	**9**
% reduction	0	0	0	0	0	0	0.026194	0.017213	0	0	0	0	**0.043406**

The combination of the increase in egg production by the reduction of the maximum legal size to 4 17/32" (1%) and Sunday closures in July and August (4.3%) results in a calculated increase in egg production for LCMA 6 of 5.3%.

Overlap of Measures

Lobsters between 116 and 132 mm in size are being returned to the water throughout the year due to the implementation of the maximum size, so they need to be accounted for during the season closure to ensure they aren't double counted. To do this the percent increase from the change in the maximum size (1%) was multiplied by the percent increase from the season closure (4.341%) to estimate the percent overlap (0.043%). This value was subtracted from the sum of the maximum size and season closure percentages. The Final percentage increase in potential egg production is 5.297%.

Table 5. Accounting for overlap of management measures.

% Increase	
Max Size %	1.000%
Seasonal Closure %	4.341%
subtotal	5.341%
decrease due to overlap	0.043%
Final % increase	5.297%

The decrease in maximum gauge to 115 mm (4 17/32") will be implemented in both the commercial and recreational fisheries in LCMA 6. During the Sunday season closure in July and August, there will be no possession of lobsters by commercial permit holders while fishing. Lobster traps, as well as other gears which harvest lobster, may remain in the water during the season closure and Jonah crab and whelk may be harvested during the closure period. The most restrictive rule does not apply to the closed season. In addition, the closed season may only apply to the commercial lobster fishery.

Appendix 1. Connecticut and New York LCMA 6 Lobster Effort

NY

Year	All NY Lobster - Resident	All NY Lobster NonResident	# Res Permits w LCMA 6 trap allocation	Res LCMA 6 trap allocation	# LCMA6 who ordered trap tags	# of LCMA 6 trap tags ordered	# LCMA active trap permit holder	# LCMA 6 traps fished	% Allocation Actively Fished
2008	384	30	236	184,019	133	94,051	52	39,825	22%
2009	375	30	222	170,298	119	85,439	38	29,501	17%
2010	360	30	216	166,419	106	69,129	42	34,617	21%
2011	344	28	192	151,008	74	44,665	38	29,645	20%
2012	334	27	184	130,062	65	31,840	30	9,936	8%
2013	326	23	181	127,652	53	22,554	23	12,024	9%
2014	309	20	167	117,924	NA*	NA*	14	8,075	7%
2015	293	18	159	111,108	44	14,401	21	11,148	10%
2016	280	18	155	110,208	51	15,973	29	9,132	8%

CT

Year	All CT Lobster - Resident	All CT Lobster NonResident	# Res Permits w LCMA 6 trap allocation	Res LCMA 6 trap allocation	# LCMA6 who ordered trap tags	# of LCMA 6 trap tags ordered	# LCMA active permit holder	# LCMA 6 traps fished	% Allocation Actively Fished
2008	228	34	471	301,430	173	99,728	162	56,355	19%
2009	220	26	461	293,910	160	83,883	139	63,824	22%
2010	206	26	456	296,970	147	83,846	129	53,516	18%
2011	180	19	452	296,220	124	60,434	98	39,518	13%
2012	161	14	451	296,800	103	47,807	94	29,353	10%
2013	142	12	453	294,200	83	37,625	70	19,165	7%
2014	131	9	451	293,480	71	31,040	63	19,000	6%
2015	143	17	448	290,030	84	44,940	71	21,660	7%
2016	184	35	179	124,898	95	46,238	83	30,188	24%

NA* - not available

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MEMORANDUM

TO: American Lobster Management Board

FROM: American Lobster Technical Committee

DATE: July 12, 2017

SUBJECT: Review of LCMT Proposals for Addendum XXV

The American Lobster Technical Committee (TC) met via conference call on June 28th to review the Addendum XXV proposals submitted by LCMTs 2, 3, 4, 5, and 6 to achieve a 5% increase in egg production. Overall, the TC continues to assert that trap allocation reductions do not result in a meaningful increase in egg production given there is a large amount of latent effort in the Southern New England (SNE) fishery and fishermen can compensate by increasing their number of trap hauls (refer to the TC memo to the Board dated July 15, 2016 for a full description of caveats associated with trap reductions). This is supported by an analysis of the 25% trap allocation reduction in 2016 for Massachusetts LCMA 2 permit holders which shows that trap hauls and landings increased despite the trap allocation reduction. Additionally, the TC notes that it is difficult to determine the success or failure of Addendum XXV, given a 5% increase in egg production falls within the error bars of the previous analyses conducted by the TC.

Below is a summary of the TC's evaluation of each LCMT proposal, including a determination by the TC as to whether the proposal is sufficient to achieve a 5% increase in egg production.

Area 2 Proposal

LCMT 2 is proposing that the current trap reduction plan specified in Addendum XVIII (25% trap allocation reduction in year 1 followed by a series of 5% trap allocation reductions in years 2-6) be used to achieve the 5% increase in egg production.

The TC does not find the LCMT 2 proposal sufficient to achieve a 5% increase in egg production given uncertainty in the relationship between trap allocations, exploitation, and resulting egg production. As previously stated in their July 2016 memo to the Board, the relationship between traps fished and exploitation is highly uncertain, particularly given there is little data on what level of exploitation results from low trap allocations. As a result, the TC used a bootstrap analysis to estimate the relationship between actively fished traps in the SNE stock (MA, RI, CT, and NY) and exploitation. This analysis predicted, at most, a 13.1% increase in egg production from a 25% reduction in actively fished traps.

A key difference between the TC's analysis and the on-going trap reductions in LCMA 2 is that Addendum XVIII reduces total trap allocations rather than actively fished traps. Thus, these reductions are expected to primarily reduce latent effort. The efficacy of trap allocation reductions is further reduced given there is a trap transferability program in Areas 2 and 3 which allows active fishermen to replace cut traps with purchased traps.

In order to understand the potential impacts of the 25% trap allocation reduction which took place in LCMA 2 during 2016, Massachusetts reviewed its trap allocation and landings data for 2015 and 2016. While the total number of traps allocated to Massachusetts fishermen (including active and inactive traps) declined, the number of trap hauls and the pounds landed increased. The TC noted some caveats to this analysis, primarily that some LCMA 2 permits can be transferred between fishermen from different states and that the expansion of the Jonah crab fishery could be contributing to an increase in the number of trap hauls. To address these potential caveats, the TC looked solely at information from Massachusetts-only permit holders who fish in state waters and generally do not participate in the Jonah crab fishery (which primarily occurs in Federal waters). This analysis showed that while there was a 13% reduction in traps fished, trap hauls increased by 45% and pounds landed increased by 63%. This analysis illustrates that there is not a straight-forward relationship between trap allocation and traps fished, nor between traps fished and exploitation. Rhode Island Area 2, state-only information was also reviewed to assess how representative Massachusetts trends are of Area 2. These data indicated similar changes, with landings, pot-hauls, participants, and maximum traps fished all increased modestly from 2015 to 2016. Based on these results, the TC reiterates that trap allocation reductions alone should not be used to achieve the goal of Addendum XXV, especially if there is significant latent effort.

One TC member did note that the Board approved trap reductions as a management tool in Addendum XXV and the LCMTs have met the criteria specified by the Board. This individual recommended the TC review in the LCMT proposals based on the parameters set by the Board.

Area 3 Proposal
LCMT 3 is proposing that the current trap reduction plan specified in Addendum XVIII (5% trap allocation reduction for 5 years) be used to achieve the 5% increase in egg production.

The TC does not find the LCMT 3 proposal sufficient to achieve a 5% increase in egg production given uncertainty in the relationship between trap allocations, exploitation, and resulting egg production. Similar to the comments given in the review of the LCMT 2 proposal, the TC does not support the use of trap allocation reductions alone to achieve an increase in egg production. The TC does note that Area 3 may have lower levels of latent effort; however, it is still unclear if the on-going trap reductions will reduce active effort, or just latent effort. The expansion of the Jonah crab fishery offshore may complicate analyses of effort directed towards lobsters vs crabs; however, it is important to remember that effort currently directed towards the Jonah crab fishery can re-enter the lobster fishery given participation in both fisheries requires a single lobster permit.

Area 4 Proposal

LCMT 4 is proposing a 10% trap allocation reduction to achieve the 5% increase in egg production.

The TC does not find the LCMT 4 proposal sufficient to achieve a 5% increase in egg production given uncertainty in the relationship between trap allocations, exploitation, and resulting egg production. Similar to the comments given in the review of the LCMT 2 and 3 proposals, the TC does not support the use of trap allocation reductions alone to achieve an increase in egg production. While there is no trap transferability program in Area 4, trap allocation reductions still rely on the underlying assumption that the number of traps in the water correlates to the exploitation rate. Furthermore, LCMA 4 permit information for New York and New Jersey fishermen indicate a large percentage of latent effort in the fishery (roughly two-thirds of trap allocations are not fished). Therefore, this proposal assumes that latent effort does not re-enter the fishery at some future date.

Area 5 Proposal

LCMT 5 is proposing a minimum gauge size increase from 86mm to 88mm to achieve the 5% increase in egg production.

The TC finds the LCMT 5 proposal is sufficient to achieve a 5% increase in egg production. Table 2 in Appendix 5 of Draft Addendum XXV indicates that a 2mm increase in the minimum gauge size will result in a 6% increase in egg production. The TC does note that the gauge size analysis presented in Addendum XXV was conducted on a stock-wide scale and it would be ideal to have length information for lobsters harvested in LCMA 5 in order to validate this result. That said, the TC does support the use of a minimum gauge size change as this measure is enforceable, keeps lobsters in the water longer, and provides direct benefits in terms of fitness and egg production.

Area 6 Proposal

LCMT 6's preferred option is status quo. Their non-preferred option is a maximum gauge size decrease from 133mm to 115mm in combination with nine Sunday closures in July and August.

The TC does not find the LCMT 6 proposal sufficient to achieve a 5% increase in egg production given traps are still able to catch lobsters during a Sunday closure. The TC does support the use of a maximum gauge size decrease to achieve a 1% increase in egg production.

Table 2 in Appendix 5 of Draft Addendum XXV indicates that a maximum gauge size change from 133mm to 115mm results in a 1% increase in egg production. The TC supports the use of a gauge size change as this management tool is enforceable and provides permanent protection to larger lobsters. As noted above in the review of the Area 5 proposal, the gauge size analysis for Draft Addendum XXV was conducted on a stock-wide scale and it would be ideal to have length information for lobsters harvested in LCMA 6 in order to validate this result. Nonetheless, the TC supports the use of a maximum gauge size change.

The TC does not support the use of nine Sunday closures in July and August to achieve a 4% increase in egg production. The TC highlights that while the landing of lobsters may be prohibited on Sunday, traps still remain in the water and continue to fish for lobsters. As a result, unless the traps are disabled so they cannot catch lobster, a Sunday closure is more akin to a one day delay in harvest. The TC also notes that with such a short closure, it is easy for fishermen to recoup losses by harvesting on different days of the week. The TC does support the analytical methods used in the proposal to estimate LCMA-specific egg production increases from a season closure but notes that consecutive season closure days are more effective and traps must be disabled in order to prevent them from fishing.

The TC applauds LCMT 6 for noting the high level of latent effort in Long Island Sound and encourages the reduction of this latent effort through subsequent management action.

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Memorandum

April 3, 2017

TO: ASMFC American Lobster Management Board

FROM: Peter Clarke (NJDEP) and Kim McKown (NYDEC)

SUBJECT: LCMA 4 Proposal State and Federal Regulatory Consistency for Closed Seasons

This memo addresses two state – federal consistency concerns that have developed through the implementation of the 10% reduction requirement of Addendum XVII. These items relate to trap removal and implementation of the most restrictive rule during the closed season. These concerns are discussed below.

Trap Removal:

<u>Background</u>

In order to accomplish a required 10% reduction in harvest as outlined by ASMFC Addendum XVII, Lobster Conservation Management Area (LCMA) 4 implemented rules requiring v-notch all egg bearing females coupled with a seasonal closure from February 1 to March 31. During the Winter 2012 American Lobster Board (Board) meeting, the Board decided that all directed fishery lobster traps must be removed from the water. The Board also decided that if a closed season extended four weeks or longer, a two-week grace period for removal of lobster traps and a one-week grace period for setting un-baited lobster traps would be allowed. In accordance with these determinations, NJ Division of Fish and Wildlife (DFW) and NY Department of Environmental Conservation (DEC) developed closed regulations that required trap removal with the appropriate grace period, but also allowed for the traps to remain in the water if they were being legally fished for other species (non-lobster directed traps). NY DEC and CT Department of Environment and Energy (DEEP) adopted similar rules for LCMA 6 (see Appendix 1).

Upon evaluation in 2014, the ASMFC Lobster Management Board determined that LCMA 4 did not reach the required 10% reduction in landings for fishing year 2013. Due to the reduction not being met with the combined v-notching and seasonal closure a seasonal closure from April 30-May 31 was applied alone for the 2015 fishing year as approved by the Board. The NJ DFW and NY DEC closed season rules were revised to implement the new closure dates and new removal grace period, but the allowance for traps to remain in the water to allow fishermen to continue to legally fish for other species remained (see below).

In December 2014, the NJ DFW and NY DEC applied the seasonal closure with the following regulatory language:

For NJ; “A person fishing in ASMFC Lobster Management Area (LMA) 4 and/or 5 or that has designated LMA 4 and/or 5 for fishing on their Federal Fisheries or State Lobster Pot Permit shall not take or attempt to take, land, have in his or her possession, sell, or offer to sell any American lobster during the closed season of April 30 through May 31, inclusive. During the closed season, no dealer shall accept, have in his or her possession, buy or offer to buy, sell, or offer to sell any American lobster harvested from LMA 4 and/or 5. During the closed season, all lobster traps in LMA 4 and/or 5 must be removed from the water. However, a licensee shall have a two-week period from when the season closes to accomplish removal of all lobster traps. In addition, unbaited lobster traps may be set one week prior to the season reopening. *If the license holder is harvesting other species with lobster trap gear, the lobster trap gear does not need to be removed; however, it shall be tended at least every 30 days*.”

For NY; “The harvest and landing of lobsters from LMA 4 is prohibited from April 30th through May 31st. *During the April 30th through May 31st closure, lobster permit holders who use lobster traps or pots may set un-baited lobster traps or pots one week prior to the end of the closed season. No lobster trap or pot may be in the water from April 30th to May 24th, unless the lobster permit holder also holds appropriate license(s) to harvest other species from his or her traps or pots.*”

The key wording for both statutory regulations is the ability of lobster pot fishermen to continue harvesting other species, particularly Jonah crabs during the closed period.

<u>Current Issue</u>

In 2015, a Federal Registry Notice was released stating that all lobster gear needed to be removed from the water for extent of the closed period. This places an unfair burden on fishermen to remove gear for a 32 day closure. It takes a fisherman with a 1200 trap allocation in LCMA 4 approximately 12 days to remove all his gear. Coupled with poor weather during April, the removal of gear could take up to 4 weeks to accomplish effectively phasing in the seasonal closure over the course of a month instead of the required 32 days.

For the last 45 years, the Area 4 lobster grounds which are soft bottom have been protected from mobile gear (scallop dredge and otter trawl) creating an effective sanctuary for lobsters and other marine fish. With the opening of this ground, the mobile fleet will move in and fish heavily upon the resources there. Lobster mortality will increase by up to 15 percent and the mobile gear will cause significant damage to previously protected habitat.

Because of these reasons, we urge the ASMFC Lobster Management Board to adopt one of the following options for trap removal for Area 4 fishermen in both State and Federal waters

Option 1 (preferred):
Allow LCMA 4 fishermen the ability to continue fishing fixed lobster gear for other legal species (Jonah crab) during the closed period.

Option 2:
Allow LCMA 4 fishermen to keep traps in the water that have been disabled by removing the escape panel or permanently opening the top of the trap so that any animal that entered the trap could escape.

If approved, we ask the ASMFC to forward the Board findings to NMFS for an immediate retraction to the current Registry to allow these changes to take place for the 2017 fishing season.

Most Restrictive Rule:
Background:
LCMA's 4 and 6 both implemented closed seasons to accomplish the required 10% reduction in harvest of Addendum XVII, but during different times of the year. The LCMA 6 closed season is from September 8 through November 28, while the LCMA 4 closed season was originally from February 1 through March 31 and was revised to April 30 through May 31. Since there are NY lobstermen with joint LCMA 4 and 6 trap allocations, the question of whether the most restrictive rule applied to closed seasons was discussed at the Winter 2012 Board meeting. Due to concerns of potential shifting of effort, the Board determined that LCMT measures required the most restrictive rule apply to participants with multiple LCMA permits.

Due to the Board's determination, NY DEC adopted regulations that required permit holders with multiple area designations to abide by the most restrictive rule. The following is NY's most restrictive rule: "*Permittees who designate more than one LMA in their lobster permit application shall abide by the closed seasons rules in all designated LMAs, regardless of where they are fishing. Any person who possesses more than one commercial lobster permit shall abide by the closed season rules of the LMAs designated on all of their permits, regardless of where they are fishing. Any permittee who fails to designate an LMA on their application shall abide by all the closed season rules of the LMAs 1, 2, 3, 4, 5, 6, and Outer Cape Cod (OCC). The department shall provide license holders written notice of the current closed season rules of LMAs 1, 2, 3, 4, 5, 6 and OCC annually*.

<u>Current Issue:</u>
The 2015 Federal Registry Notice was silent about the most restrictive rule. NOAA Fisheries Lobster Information Sheet,
(https://www.greateratlantic.fisheries.noaa.gov/regs/infodocs/lobsterinfosheet.pdf*)*, has a section on the most restrictive rule, specifically mentioning trap allocations, lobster

size, v-notch rules, trap and vent size; but doesn't include season closures. Currently NOAA fisheries is not requiring lobster permit holder with joint LCMA 4 and 5 trap tag allocations to abide by the most restrictive rule as was required in NY.

NY's waters include 2 Lobster Management Areas (LCMA) 6 and 4. In addition, the south fork of Long Island is at the confluence of LCMA 6, 4, and 2. Many of NY's south shore lobster permit holders, in particular those on the south fork near Montauk, have traditionally fished in areas that now are part of multiple LMAs. These permit holders used to regularly move their pots throughout the year following the lobsters. Due to the implementation of the most restrictive rule, these lobstermen have had to remove one of the LCMA's that they historically fished in from their permit. This has caused significant financial hardship. Federal permit holders with joint LCMA 4 and 5 permits are not required to do this and are not impacted by this hardship.

Because of these reasons, we urge the ASMFC Lobster Management Board to adopt one of the following options for the most restrictive rule as it applies to closed seasons for permit holders with multi-area trap tag allocations in both State and Federal waters.

Option 1 (preferred):
Exempt closed seasons from the most restrictive rule (as currently done for federal permits).

Option 2:
Mandate that both federal and state multi-area permit holders abide by the most restrictive rule, which means they must abide by all season closures implemented in the areas listed on their permits.

If option 1 is approved, NY will remove the most restrictive language as it applies to closed seasons from NY state regulations. If option 2 is approved we ask the ASMFC to forward the Board findings to NMFS and request that they implement the most restrictive rule for closed seasons for federal permit holders.

Thank you for your consideration.

Appendix 1

LCMA 6 rules:

NY DEC:
"No lobster may be taken from Atlantic States Marine Fisheries Commission Area Six from September eighth through November twenty-eighth pursuant to the recommendations of the Area's Lobster Conservation Management Team as required by the Interstate Fishery Plan for Lobsters adopted by the Atlantic States Marine Fisheries Commission.

b. During the September eighth through November twenty-eighth closure, lobster permit holders who use lobster traps or pots shall remove lobster traps and pots from the water by September twenty-second.

c. No lobster trap or pot may be in the water from September twenty-second until November fourteenth unless the lobster permit holder also holds a permit or license that authorizes them to harvest other species from their lobster traps or pots.

d. Lobster permit holders may set unabated lobster traps or pots beginning November fourteenth.

e. Lobster permit holders may set baited lobster traps or pots beginning November twenty-first."

CT DEEP:
"**Season**

1. The closed season for Lobster Management Area (LMA) 6 (Long Island Sound and western Block Island Sound) is September 8 through November 28, inclusive, and applies to both recreational and commercial fisheries and all gears. Between those dates possession of lobsters taken from LMA 6 or from traps with LMA 6 trap tags is prohibited.
2. All lobster gear must be removed from the water during the closure, except that the ASMFC plan allows fishermen two weeks at the beginning of the closure period (September 8 through September 21) to remove gear and two weeks prior to the late fall reopening (November 15 through November 28) to redeploy the gear. Traps cannot be baited until one week prior to reopening (November 22).
3. An exception to the gear removal requirement is provided for fishermen who hold a conch (whelk) license for those lobster pots being actively fished for whelk. The take and landing of lobsters during these exception periods is prohibited."

Atlantic States Marine Fisheries Commission

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MEMORANDUM

July 11, 2017

To: American Lobster Management Board

From: Law Enforcement Committee

RE: Feedback on Management Issues Under Discussion

The Law Enforcement Committee (LEC) of the Atlantic States Marine Fisheries Commission (ASMFC) met via conference call on June 29, 2017. ASMFC staff asked members to provide input and advice regarding electronic tracking and reporting, and interstate movement and sale. The following members were in attendance:
LEC: Chairman, Lt. Mike Eastman (NH); Maj. Rene Cloutier (ME); Asst. Director Larry Furlong (PA); Lt. Tom Gadomski (NY); Sgt. Greg Garner (SC); Maj. Rob Kersey (MD); Capt. Bob Lynn (GA); Capt. Doug Messeck (DE); Katie Moore (USCG); Maj. Pat Moran (MA); Director Kyle Overturf (CT); Capt. Jason Snellbaker (NJ)
STAFF: Ashton Harp; Mark Robson; Megan Ware

Electronic Tracking and Reporting Systems
Megan Ware of ASMFC staff solicited information from the LEC members concerning possible ways to improve harvester reporting and tracking and the types of systems and data that would be useful for law enforcement purposes. In particular there is a desire to find systems that provide better spatial resolution on harvester activity, and better information on offshore fishing activity.

The Maine representative to the LEC reported on a system that they have installed for tracking harvest activity, sending a signal whenever a hauler is engaged. They have experimented with a number of tracker systems for their lobster fishery. The stumbling block to such systems is getting one that can provide frequent enough pinging to discern hauling activity, while remaining affordable. A separate system was tested using solar power for the energy source, and was cost-effective. But it was found lacking during the winter months. Maine and Connecticut are continuing to test tracking systems at this time.

LEC members agreed that a system useful for enforcement purposes needs to be able to accurately determine when and where vessels are working traps, especially in remote or offshore areas. It will also be important for the company providing the technology to have experts available and willing to certify equipment, and to testify in court as to the accuracy and reliability of the technology. Once tracking technologies are in place for some time, the need for expert witnesses and certification may lessen.

Lobster Chain of Custody and Retail Sale
Megan Ware briefed the LEC on questions from the Lobster Management Board concerning sale of lobster from other states with differing size or other harvest restrictions. The issue as understood is that states formerly relying on sale of lobsters from the Southern New England stock are being affected by declining harvest levels. This is leading to an interest in states receiving and allowing in-state sale of lobsters from Lobster Conservation Area 1, which has a smaller minimum size.

Rhode Island and Connecticut have regulations allowing dealers to purchase lobsters from out of state for through-shipment, in keeping with allowances under Interstate Commerce laws. Each state has specific regulations for permitting and documenting this activity. However, dealers are not allowed to sell undersized lobsters in their home state. The particular problem in Massachusetts is that multiple minimum size limits are in place depending on the area of harvest. Minimum sizes are enforced at the harvester level. Significant fines and penalties are in place to reduce illegal activity but it has been difficult to get maximum fines applied by the courts for "short" lobsters.

Other states have "strict possession" regulations which prohibit dealers from buying and possessing undersized lobsters from other states. Removing strict possession language specifically for American lobster would allow at a minimum the kind of regulations implemented by Connecticut and Rhode Island. However, New York and New Jersey representatives expressed concern that liberalizing minimum-size possession regulations could open the door to significant illegal harvest of undersized lobsters from off their respective coasts. Further discussion ensued regarding the differences and scale of the dealer markets among the states. Whereas Connecticut has not had problems distinguishing dealers engaged primarily in interstate commerce from smaller retailers, other states may have more difficulty sorting out dealers and where lobsters are being received and sent.

The broader question of when enforcement should cease to be concerned with minimum sizes in the marketplace was briefly discussed, but no consensus emerged. Several LEC members expressed general concern that states would consider allowing any retail sale of undersized lobsters in their states. This was seen as a possible pathway for undersized lobsters that are illegally harvested, to be passed along, essentially creating an open market for the smallest legal-sized lobsters available. The ability of enforcement staff in each state to monitor and control this potential new conduit would be dependent on the size of the fishery, the number of dealers, and the documentation requirements for receiving out-of-state lobsters. Several LEC representatives reiterated their concern that they would likely not have adequate resources to address such a change in regulations.

Office of Law Enforcement

Enforcement Priorities

FY 2018 – 2022

(DRAFT)

Comments on the document may be sent to the following email address: ole2017priorities@noaa.gov.

Contents

Introduction

NOAA's Office of Law Enforcement (OLE) protects living marine resources, sanctuaries and monuments, and critical habitat by enforcing domestic laws and supporting international treaty obligations designed to ensure these natural marine resources are available for future generations. OLE actively seeks to promote compliance with the nation's marine resource laws, and takes measured enforcement action when these laws are violated. OLE directly supports NOAA's stewardship mission and NOAA Fisheries' core mission mandates through its actions to enforce and promote compliance with the marine resource protection laws and implementing regulations under NOAA's jurisdiction.

The OLE Priority-Setting Process

OLE has established a 5-year priority-setting process to help accomplish our mission, guide our strategic planning, and focus the use of our enforcement assets where they are most needed. To guide this process, OLE uses NOAA strategic plans, historical enforcement data, emerging threat, and stakeholder input to identify areas in greatest need of enforcement effort – whether to maintain an existing level of compliance or to target areas where increased compliance may be required.

The goal of any priority-setting process is to make the best use of limited resources to maximize results. By design, the priority-setting process must make calculated choices about where to focus efforts, and how best to leverage existing capabilities to successfully address responsibilities. The OLE priority-setting process is no different, and seeks to ensure that we have the right people, in the right places, focusing on the right priorities.

Although OLE uses this priority-setting process to identify areas where we will concentrate our efforts, we will continue to enforce all the laws and implementing regulations under our jurisdiction.

FY2018-2022 National Priorities

The Office of Law Enforcement priorities are designed and conducted in a manner that supports three overarching NOAA Fisheries strategic goals:

- Ensure the sustainability of fisheries and fishing communities.
- Recover and conserve protected species.
- Improve organizational excellence.

As further defined and explained below, OLE supports these goals, as well as the related areas of combating illegal, unreported, and unregulated (IUU) fishing and supporting international fisheries; reducing seafood fraud; and interdicting wildlife trafficking as national priorities within every OLE office. Further, and as a cornerstone to OLE's enforcement approach, increasing outreach and education to foster voluntary compliance is also an integral national priority throughout OLE.

Sustainable Fisheries

NOAA Fisheries – in close coordination with the regional fishery management councils and state partners – is responsible for fostering healthy, productive, and sustainable living marine resources and their habitats. NOAA Fisheries achieves these outcomes through: effective, transparent management actions supported by strong science; habitat conservation and restoration programs; an ecosystem approach to fisheries management; partner and stakeholder coordination and communication; and effective enforcement.

Increasing compliance and enforcement of fishing regulations is an integral part of meeting NOAA's goal of ensuring the sustainability of fisheries and fishing communities. OLE will continue to emphasize investigations related to observer safety and actions that affect the integrity of observer data, such as assaults, interference or harassment of observers, and will also play an integral role in the development and implementation of the agency action plan in response to the Observer Program Safety Review. OLE will also continue to prioritize investigations involving gear and closed-area violations; by-catch and prohibited species violations; and reporting and landing data violations.

Protected Resources

NOAA Fisheries is responsible for the conservation and recovery of protected species and their habitats, as mandated by the Endangered Species Act (ESA) and the Marine Mammal Protection Act (MMPA). Through these acts, Congress provided us with an enduring mandate to recover species that are facing extinction and to conserve marine mammals.

NOAA Fisheries carries out the mandates of the MMPA and ESA through specific requirements focused on reducing negative effects of human activities, enforcing regulations against harming marine mammals and endangered species, and developing plans to guide the recovery and conservation of these protected species.

In addition, the conservation and protection of key marine and estuarine areas are critical to sustaining marine resources for future generations. The National Marine Sanctuaries Act (NMSA) plays a vital role in protecting these areas. Protected within these areas are important habitats like breeding and feeding grounds, coral reefs, kelp forests, and important artifacts of underwater cultural heritage.

To foster the protection of these protected species, places, and resources, OLE will prioritize its enforcement efforts on protecting marine mammals and endangered species. These efforts will focus on bycatch reduction regulations, gear and area restrictions, human interactions with protected species, and targeted enforcement presence in marine protected areas, including National Marine Sanctuaries (NMS) and Marine National Monuments (MNM).

IUU Fishing/International

The vast majority of the seafood consumed in the United States is imported. This demand for seafood makes the United States an attractive market for IUU fish and fish products, and also places pressure on wild stocks from all over the world. Like domestic fishery management councils, Regional Fisheries Management Organizations (RFMOs) work to ensure that seafood caught within their governing areas is taken in an authorized and sustainable manner. Those who circumvent RFMO conservation and management measures are engaged in IUU fishing. IUU fishing disadvantages legal fishers globally, including U.S. fishing fleets and coastal communities, and negatively impacts global fish stocks such as salmon and tuna.

OLE will continue to prioritize our efforts with RFMOs, foreign countries, federal partners and non-governmental organizations to detect and prevent IUU fish from entering U.S. markets and to bring to justice those who seek to profit from this activity. In support of this priority, OLE will implement the Port States Measures Agreement (PSMA) and will aggressively investigate interstate or foreign trafficking of illegally harvested fish or other marine resources. In addition, OLE will conduct technical assistance for international partners in fisheries law enforcement to enhance their abilities to detect IUU fish products before they enter the stream of commerce and investigate and prosecute IUU fishing violations.

Seafood Fraud

Seafood fraud, typically in the form of mislabeling or other forms of deceptive misidentification of seafood products with respect to quality, quantity, origin, or species undermines the economic viability of U.S. and global fisheries, and deceives consumers. Seafood fraud is generally driven by economic motives and can occur at multiple points along the supply chain.

OLE will prioritize monitoring and investigating major seafood fraud violations including increased efforts at Ports of Entry into the U.S. to detect illegal products and to implement the Seafood Import Monitoring Program (SIMP). We will work with international partners as well as state, local, and other federal agencies on strengthening seafood fraud detection throughout the supply chain through continued coordination via inter-agency task forces and information sharing mechanisms.

Wildlife Trafficking

Illegal wildlife trafficking is a multi-billion dollar-per-year enterprise that targets some of the most iconic and endangered species on the planet. As economic opportunists, wildlife traffickers are also frequently involved in other illegal activities such as human trafficking, illegal weapons sales and the illicit drug trade.

OLE will identify and investigate fish and other wildlife illegally shipped or transported through airports, ports, or borders. To support this priority, OLE will increase deployments of enforcement personnel to strategic ports of entry throughout the United States to better interdict these shipments. OLE will also continue its efforts to detect and investigate the illegal trafficking in marine mammal and endangered species parts or products.

Outreach and Education

A primary goal of OLE is voluntary compliance, by members of the public or regulated industries, with marine resource protection laws and implementing regulations. Engaging in outreach and education activities to foster voluntary compliance is the cornerstone of this goal. Outreach and education is a daily occurrence performed by OLE staff. While conducting patrol efforts, OLE enforcement officers have day-to-day interactions with industry members and the general public, and use these daily opportunities to answer questions and provide information. OLE, as part of its Vessel Monitoring System (VMS) program, employs Enforcement Technicians who, on a daily basis, answer calls from industry members concerning regulations and make proactive contact with owners of vessels at-sea when it appears that the vessel is entering or about to enter a protected area or have entered an incorrect fishing activity code.

OLE will, in addition to our day-to-day interactions, continue to conduct regular outreach and education initiatives regarding new and changing regulations to foster voluntary compliance. OLE will work with other NOAA and NOAA Fisheries offices as well as federal and state partners to encourage and promote voluntary compliance with marine resource laws and regulations. OLE will continue to use social media, outreach events, webstories, compliance liaisons, new articles as well as face-to-face contact with our stakeholders to share the information they need to understand and follow the law.

FY2018-2022 Enforcement Priorities by OLE Division

OLE is organized into five regional Divisions: Alaska, Northeast, Pacific Islands, Southeast, and West Coast. Division priorities support each national priority by providing greater detail for various geographic areas that considers specific resources, past enforcement activities, and emerging threats. The more specific priorities identified by each Division provides the strategic guidance for compliance and enforcement activities within each Division. OLE recognizes that priorities may change within a 5-year period. Subsequently, Divisions will regularly monitor priorities and identify possible changes by maintaining communication with internal and external stakeholders that help inform OLE priorities.

OLE seeks to improve compliance with and enforcement of all marine statutes and regulations under its jurisdiction. While priorities are being identified in this document to help guide planning efforts with each OLE Division, it is important to note that OLE will take appropriate enforcement action for all statutory or regulatory violations regardless of whether the impacted resource is, or is not, listed as a priority in this guidance document.

Alaska Division

Alaska supports a massive seafood industry and has the greatest number of domestic fish landings in the United States, with 59 percent of all U.S. seafood landings, measured by weight, occurring in the state. If it were a country, Alaska would be the ninth largest seafood producer in the world. Waters off Alaska account for more than half of all annual U.S. seafood harvests. Alaska also has five of the nation's top 10 fishing ports ranked by value of landings.

Alaska's coastal communities are uniquely dependent on living marine resources and healthy marine ecosystems. The seafood industry is Alaska's largest private sector employer, accounting for one in every seven local jobs. In addition to the roles of commercial and recreational fishing, subsistence fishing serves as an irreplaceable source of food and protein for much of rural Alaska and is interwoven into the cultural identity of Alaska Natives and coastal communities.

Sustainable Fisheries

- Patrol, outreach, and investigation to deter and detect:
    - Observer sexual assault, assault, harassment, observer safety, interference, and significant sample bias violations.
    - Violations involving prohibited species bycatch management measures.
    - Commercial vessel incursions into closed or protected marine areas.
    - Trafficking of illegally harvested and/or illegally commercialized marine resources including sale or commercial use of sport and subsistence caught halibut.
    - Violations that degrade agency data quality including electronic monitoring and reporting (flow scales, video, data loggers, electronic logs, etc.), recordkeeping and reporting, observer data, and observer coverage.

Protected Resources

- Patrol, outreach, and investigation to detect and deter:
    - Intentional illegal killing or injuring of Steller sea lions, Cook Inlet beluga, or other whales, dolphins, porpoises, or seals
    - Illegal takes of marine mammals (e.g. Level "A" Harassment, feeding, injuring, approaching, shooting, etc.).
    - Wasteful takes by authorized marine mammal harvesters.
    - Lacey Act investigations involving suspect marine mammal harvest products.
    - Commercial/recreational viewing of whales and harbor seals in glacial fjords.
    - Violations resulting in marine mammal stranding, entanglement, injury, and/or mortality incidents.
    - Vessel on whale collisions.
    - MMPA incidental take reporting violations
- Outreach and education to Alaska Native Village and Council governments regarding subsistence harvest of whales, with an emphasis on Bering Sea communities.

IUU/International

- Collaborate with law enforcement partners to enforce Port State Measures and to detect, deter, and investigate:
    - Foreign transshipment and fishing activity in violation of U.S. law or international treaty.

- Maritime Boundary Line incursions by foreign fishing, fishing support, and transshipment vessels.
- Illegal imports or undeclared product on foreign vessels.
- Transshipment and export of illegal product from U.S. fishing vessels.

Seafood Fraud

- Patrol, outreach, and investigation to detect and deter:
  - Seafood safety violations under the jurisdiction of NOAA where public health and safety is at risk.
  - Mislabeling or misbranding violations having a significant impact on national or international commerce.

Wildlife Trafficking

- Patrol, outreach and investigation to detect and deter:
  - Fish and Wildlife illegally shipped or transported through Alaskan airports, ports, or borders into domestic or foreign commerce.
  - Convention on International Trade in Endangered Species (CITES) listed fish and wildlife or parts entered illegally into interstate or foreign commerce.

Northeast Division

The Northeast Division (NED) is comprised of 20 states and covers more than 100,000 square nautical miles of the U.S. EEZ. Fish are landed in more than 500 ports along 1,000 miles of coastline. Four of the top 10 international landing ports, by weight and value, are found in the NED — New York, Portland (Maine), Boston, and Norfolk. Additionally, the NED has four of the top 10 states for domestic fish landings (measured by dollars) in the nation; this includes Massachusetts with the port of New Bedford, which has led the United States for 14 years as the top port in terms of value landed — a direct result of the scallop fishery. The NED touts an $8 billion seafood import industry with 2 billion pounds of seafood landings annually.

Working with Regional Partners NED has strong working relationships with the 10 coastal state fishery enforcement agencies under the Cooperative Enforcement Program (CEP). These relationships enable OLE to leverage resources and improve compliance with federal fishery regulations. In addition to state partners, NED works closely with two U.S. Coast Guard (USCG) districts. Recent partnerships have expanded with key federal agencies, including the Food and Drug Administration (FDA) and Customs and Border Protection (CBP), which are involved in ensuring consumer safety and integrity as it relates to seafood fraud.

Sustainable Fisheries

- Patrol, outreach, and investigation to detect and deter:
  - Observer assault, harassment, safety and interference complaints.
  - Vessel and Dealer reporting and permitting compliance.
  - Violations involving prohibited species bycatch management measures.
  - Commercial vessel incursions into closed or protected marine areas.
  - Monitoring and enforcement of illegal sales of fish by the recreational sector.
  - Gear compliance under the Magnuson-Stevens Fishery Management and Conservation Act (MSA).

Protected Resources

- Patrol, outreach, and investigation to detect and deter:
  - Illegal takes of marine mammals (harassment, feeding, injuring, approaching, shooting, etc.).
  - Violations resulting in marine mammal stranding, entanglement, injury, and/or mortality incidents.
  - Gear violations under ESA and MMPA.
  - Illegal human interactions with sea turtles.
- Patrol, outreach, and investigation within marine protected areas relating to:
  - Gear violations within NMS.
  - Moving, removing, injuring, or possessing, or attempting to move, remove, injure, or possess a Sanctuary historical resource.
  - Whale harassment/approach and vessel speed restrictions.
  - Enforcement of Marine National Monument regulations.
- Promote compliance with the Atlantic Large Whale Take Reduction Plan and Harbor Porpoise Take Reduction Plans.
- Provide presence and enforcement coordination during major stranding events.
- Provide enforcement support to the recovery of the wild populations of Atlantic salmon.

- Review and analysis of Automatic Identification System (AIS) data for enforcement of right whale ship strike reduction speed rule.

IUU/International

- Collaborate with law enforcement partners to enforce Port State Measures and to detect, deter, and investigate:
  - Foreign transshipment and fishing activity in violation of U.S. law or international treaty.
  - Maritime Boundary Line incursions by foreign fishing, fishing support, and transshipment vessels.
  - Illegal imports or undeclared product entering Ports of Entry in NED area of responsibility.
  - Transshipment and export of illegal product from U.S. fishing vessels.

Seafood Fraud

- Patrol, outreach, and investigation to detect and deter:
  - Seafood safety violations under the jurisdiction of NOAA where public health and safety is at risk.
  - False labeling, mislabeling and misbranding violations having a significant impact on state, national or international commerce.

Wildlife Trafficking

- Patrol, outreach, and investigation to detect and deter:
  - Fish and wildlife illegally harvested, shipper or transported through ports of entry into domestic or foreign commerce.
  - CITES listed fish and wildlife or parts entered illegally into interstate or foreign commerce.

Pacific Islands Division

The Pacific Islands Division (PID) was established in October 2004 and is geographically the largest division in OLE. Bound by the Hawaiian Islands in the north, American Samoa and U.S. Pacific remote island areas in the south, and the Mariana Archipelago, including Guam in the west, the Pacific Islands Division encompasses the largest geographical management area within both NOAA Fisheries and the regional fishery management council system. The total area of the U.S. EEZ waters included in the region is more than 1.5 million square nautical miles, which accounts for nearly half of the entire U.S. EEZ.

PID regularly conducts investigations related to the tuna fishery and other highly migratory species. The various longline and purse seine vessels within the U.S. permitted fleet operate extensively throughout established U.S. and foreign EEZs in the Pacific, and in international waters. The need to effectively monitor these U.S. vessels, along with foreign vessels that engage in IUU fishing in these vast waters, poses a unique enforcement challenge for PID. With the PSMA entering into force, PID has served as the center of activity for implementation of both domestic and international responsibilities.

The Hawaiian Islands Humpback Whale National Marine Sanctuary is adjacent to the main Hawaiian Islands, and during Humpback whale season this puts large numbers of ocean users close to these protected animals. In addition, several endangered species of sea turtles, Hawaiian monk seals, and spinner dolphins frequent the waters and beaches

Sustainable Fisheries

- Patrol, outreach, and investigation to deter and detect:
  - Observer assault, harassment, or interference violations.
  - Data consistency or integrity anomalies regarding collection and analysis of records.
  - Closed area/VMS violations and illegal tampering of NOAA VMS equipment and data.
  - Reported violations by U.S. and/or International Observers on the high seas regarding U.S. vessels.
  - Observer reported fishery management plan violations.

Protected Resources

- Patrol, outreach, and investigation to detect and deter:
  - Humpback Whale Sanctuary; take, vessel strikes and approach violations within the Sanctuary.
  - Spinner Dolphins, take and harassment, Level “A” Harassment and Level “B” Harassment.
  - Takes of Hawaiian Monk Seals.
  - Lethal takes, Level A Harassment; with the potential to injure marine mammals or ESA listed turtles.
  - Non- Lethal takes; Level B Harassment with the potential to disturb a marine mammal stock in the wild by causing a disruption of behavioral patterns including but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering.
- Patrol, outreach, and investigation within marine protected areas relating to:
  - Illegal or unpermitted discharges.
  - Vessel Groundings.
  - Unlawful removal or possession of historical artifacts as well as protected marine resources from within the sanctuary and/or monument boundaries.

- Illegal fishing and other designated non permitted activity within the sanctuary and/or monument boundaries.
- Noncompliance with conditions of any permits associated with sanctuary and/or monument.

IUU/International

- Collaborate with law enforcement partners to enforce Port State Measures and to detect, deter, and investigate violations of International Treaties and or agreements such as Western and Central Pacific Fisheries Commission (WCPFC), South Pacific Regional Fisheries Management Organization (SPRFMO), and Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR).
- Support and advise U.S. delegation at RFMO meetings.
- Enforce U.S. international commitments regarding fishing on the high seas.
- Provide support to monitoring, control, and surveillance (MCS) operations with the Federal Aviation Administration (FFA), U.S. Navy/Department of Defense, and USCG to prevent IUU fishing.
- Participate in capacity building with Pacific and Asian countries regarding their ability to execute Port State Measures inspections and enhance their abilities to detect, investigate and prosecute IUU violations.

Seafood Fraud

- Patrol, outreach, and investigation to detect and deter:
  - Mislabeled seafood.
  - Seafood commodities in interstate and/or international commerce under the jurisdiction of NOAA that may put the public's health and safety at risk.

Wildlife Trafficking

- Patrol and Outreach to deter, detect, and investigate:
  - Fish and Wildlife illegally shipped or transported through airports, seaports, or borders.
  - Illegal trafficking in marine mammal and endangered species parts or products.
  - Illegal trafficking in species associated with the aquarium trade.
  - CITES listed fish and wildlife or parts entered illegally into interstate or foreign commerce.

Southeast Division

The Southeast Division (SED) is comprised of eight coastal states, extending from Texas to North Carolina, and also includes Puerto Rico and the U.S. Virgin Islands. SED is responsible for enforcing regulations mandated by three regional fishery management councils, the conservation and protection of three national marine sanctuaries, and ensuring compliance with commercial and federal recreational laws and regulations throughout nearly 350,000 square miles of EEZ.

SED covers more than 3,160 miles of coastline, second only to AKD. However, the SED coastline has a much larger number of potential landing sites where commercial and recreational vessels have the ability to land economically important species, such as red snapper and grouper, IFQ managed fish stocks, swordfish, tuna, and other federally regulated species. In 2015, federally permitted vessels conducted more than 178,247 trips totaling $610,414,051 in revenue. SED also has the fifth (Louisiana), sixth (Florida), and seventh (Texas) ranked states for domestic fish landings in the United States. Four of the top 10 international landing ports, by weight and value, are found in this region – Miami, Savannah, Galveston, and Tampa – as well as the ports of entry on the U.S.-Mexico border.

SED also has the largest recreational fisheries sector in the continental United States. In 2015, SED accounted for nearly 60 percent of the more than 61 million recreational fishing trips taken by U.S. anglers.

Sustainable Fisheries

- Patrol, outreach, and investigation to deter and detect:
  - Observer assault, harassment, safety and interference complaints.
  - Red Snapper and Grouper Tilefish individual fishing quota (IFQ) under-reporting and illegal sales which undermine program integrity.
  - Recreational snapper/grouper closed season violations impacting annual catch allowances.
  - Commercial vessel incursions into Marine Protected Areas to protect spawning stocks and habitat.
  - Reporting requirements for commercial vessels and dealers, and highly migratory species (HMS) recreational fishers.
  - Illegal sales of fish harvested under a bag limit.

Protected Resources

- Patrol, outreach, and investigation to detect and deter:
  - Violations of Turtle Excluder Device (TED) requirements to protect ESA listed sea turtles.
  - Illegal takes of marine mammals and ESA listed species to include dolphin feeding, illegal possession of sea turtles and other ESA listed species.
  - Violations of the speed reduction rules to protect North Atlantic Right Whales.
- Patrol, outreach, and investigation within marine protected areas relating to:
  - Violations in the Florida Keys National Marine Sanctuary, including:
    - Vessel groundings.
    - Unauthorized anchoring.
    - Illegal discharges.
    - Illegal removal of Sanctuary resources.
  - Violations in Flower Garden Banks National Marine Sanctuary, including:
    - Illegal discharges.

    - Unauthorized fishing in designated areas.

IUU/International

- Collaborate with law enforcement partners to enforce Port State Measures and to detect, deter, and investigate:
  - Foreign transshipment and fishing activity in violation of U.S. law or international treaty.
  - Maritime Boundary Line incursions by foreign fishing, fishing support, and transshipment vessels.
  - Illegal imports or undeclared product entering Ports of Entry in the Southeast Division
  - Transshipment and export of illegal product from U.S. fishing vessels.

Seafood Fraud

- Patrol, outreach, and investigation to detect and deter:
  - Seafood safety violations under the jurisdiction of NOAA where public health and safety is at risk.
  - False labeling, mislabeling and misbranding violations having a significant impact on state, national or international commerce.

Wildlife Trafficking

- Patrol, outreach, and investigation to detect and deter:
  - Trafficking in marine mammal and endangered species.
  - Fish and Wildlife illegally shipped or transported through airports, ports, or borders into domestic or foreign commerce.

West Coast Division

The West Coast Division (WCD) encompasses the coastal states of Washington, Oregon, and California. The area of responsibility also extends inland to Idaho, North and South Dakota, and Montana. This unique division shares borders with Canada and Mexico, has five national marine sanctuaries along its coast, and includes 290 Marine Conservation Areas. The WCD is responsible for 1,293 miles of Pacific coastline and 7,863 miles of tidal shoreline, 222,471 nautical miles of EEZ, and 339,375 square miles of land encompassing numerous rivers and tributaries feeding into the Pacific Ocean. Two of the top 10 international landing ports, by weight and value, are found in the WCD—Seattle and Los Angeles. Additionally, there are 16 other international airports and 21 major international seaports monitored by the WCD.

Throughout the WCD are managed fisheries for salmon and steelhead, more than 90 species of groundfish, coastal pelagics such as anchovy and sardine, and highly migratory species such as billfish, sharks, and tunas. WCD also includes a number of ESA-listed species, including the Southern Resident Killer Whale population in the Puget Sound. Further, the Division is responsible for protecting ESA-listed species critical habitats from harm caused by stream alteration, water depletion, and drought conditions.

Sustainable Fisheries

- Patrol, outreach, and investigation to deter and detect:
    - Observer sexual assault, assault, harassment, observer safety, interference, and significant sample bias violations.
    - Violations that degrade agency data quality including electronic monitoring and reporting, recordkeeping and reporting, observer data, and observer coverage.
    - Violations involving federally managed commercial fisheries with focus on salmon, HMS, Coastal Pelagic Species, Halibut, and Open Access groundfish.
    - Violations involving federally managed recreational fisheries for overfished species and gear requirements.
    - Violations involving commercial vessel incursions into closed areas or other Marine Protected Areas.
    - Lacey Act investigations of suspect Tribal Treaty fisheries harvests:
        - Involving organized illegal fishing conspiracies with non-tribal commercial fish dealers.
        - Incidents involving ESA-listed salmonids.

Protected Resources

- Patrol, outreach, and investigation to detect and deter:
    - Illegal takes (e.g. Level A harassment, feeding, injuring, shooting, etc.) of ESA and MMPA listed species.
    - Wasteful takes by authorized marine mammal harvesters.
    - Lacey Act investigations involving suspect Tribal fisheries and marine mammal harvest products
    - Commercial/recreational violations relating to viewing of whales.
    - Vessel on whale collisions.
    - Destruction of listed salmon and steelhead critical habitat.
- Collaborate with the NOAA Fisheries West Coast Region to develop ESA section 4(d) protective regulations that identify take prohibitions.

- Patrol, outreach, and investigation within marine protected areas relating to:
  - Illegal marine mammal and seabird takes, and incidental take reporting violations.
  - Violations involving Federal/State Designated Special Closures, Marine Reserves, Marine Conservation Areas, and Marine Restoration Areas.
  - Unlawful discharge violations.
  - White Shark Approach and Attraction violations within the Greater Farallones NMS.
- Patrol, outreach, and investigation within marine protected areas relating to:
  - Vessel groundings and abandonment.
  - Overflight restrictions.
  - Fisheries within the sanctuary.
  - Protection of historic resources.
  - Motorized personal watercraft restrictions in the Monterey Bay and Greater Farallones NMS.

IUU/International

- Collaborate with law enforcement partners to enforce Port State Measures and to detect, deter, and investigate:
  - Foreign transshipment and fishing activity in violation of U.S. law or international treaty.
  - Maritime Boundary Line incursions by foreign fishing, fishing support, and transshipment vessels.
  - Illegal imports or undeclared product on foreign vessels.
  - Transshipment and export of illegal product from U.S. fishing vessels.

Seafood Fraud

- Patrol, outreach, and investigation to detect and deter:
  - Seafood safety violations under the jurisdiction of NOAA where public health and safety is at risk.
  - Mislabeling or misbranding violations having a significant impact on national or international commerce.

Wildlife Trafficking

- Patrol and Outreach to deter, detect, and investigate:
  - Fish and Wildlife illegally shipped or transported through airports, ports, or borders into domestic or foreign commerce.
  - CITES listed fish and wildlife or parts entered illegally into interstate or foreign commerce.

Congress of the United States

Washington, DC 20510

June 12, 2017

Atlantic States Marine Fisheries Commission
Attn: Megan Ware
1050 N. Highland Street
Suite 200A-N
Arlington, Virginia 22201

To Whom It May Concern,

We write to express our appreciation for the balanced approach the Commission has taken to address the declining lobster population in Long Island Sound and urge the Commission and the Lobster Conservation Management Team (LCMT) to continue to work with the lobster industry to adopt a management plan that carefully and prudently seeks to increase lobster egg production.

Any increase in lobster egg production through changes to the catch limits should use a well-recognized base of production with a measureable goal that, taking into consideration the increases in water temperature, can realistically be achieved while maintaining a viable lobster industry in Connecticut.

We are aware of the lobster industry's concerns about using a 2014 egg production base because it may not be verifiable. It is imperative that a starting point is established according to sound science so every interested party has assurance of its validity. Further, any management plan should seek to limit the impact on the lobster industry while treating the recreational industry in the same manner so as not to create an uneven playing field. Finally, if a clearly articulated, consensus-oriented production base cannot be achieved soon, we would urge the Commission and the LCMT to maintain the current status quo.

Thank you again for your thoughtful approach to this most difficult yet important issue.

Sincerely,

RICHARD BLUMENTHAL
United States Senate

CHRISTOPHER S. MURPHY
United States Senate

ROSA L. DELAURO
Member of Congress

JOE COURTNEY
Member of Congress

JIM HIMES
Member of Congress

ANDREW P. RAIA
Assemblyman 12[th] District

THE ASSEMBLY
STATE OF NEW YORK
ALBANY

MINORITY WHIP
RANKING MINORITY MEMBER
Committee on Health
COMMITTEES
Banks
Environmental Conservation
Housing
Rules
MINORITY REPRESENTATIVE
Legislative Council on
Health Care Financing

May 15, 2017

Atlantic States Marine Fisheries Management Commission
Attn: Megan Ware
1050 N. Highland Street Suite 200A-N
Arlington, VA 22201

To Whom it May Concern:

I am writing you in regards to the Draft Addendum XXV to Amendment 3 to the American Lobster Fishery Management Plan and the impact it will have on the lobster fishing industry throughout the Long Island Sound. Due to the significant impacts the final plan will have on these entities, I believe it is imperative that the Atlantic States Marine Fisheries Commission (ASMFC) review new, updated data and assess the economic impacts the proposed measures will have on Long Island's lobstermen.

Representing a legislative district that incorporates a large swath of the Long Island Sound, I understand the importance of maintaining a healthy, stable and sustainable ecosystem. As you know, this body of water has been used as a fishing ground for hundreds of years, providing residents with economic opportunities as well as fresh seafood. Throughout the past decade, stock assessments showed a decline in the lobster population in the Long Island Sound, leading to stricter management measures aimed at stabilizing and building up the lobster population. Indeed, in 2013, the states of New York and Connecticut, in conjunction with the ASMFC, enacted a fall harvest closure aimed at accomplishing these tasks by preventing overfishing.

However, in recent years, lobstermen working in the Long Island Sound have witnessed an increase in their stocks, particularly in 2016, resulting in higher economic benefits for both them and their communities. This trend seems to be continuing throughout the early half of 2017 as well, leading to new fishing and employment opportunities in the relevant industries. Unfortunately, due to the fact that the ASMFC does not have the current data regarding these updated figures and is basing its assessment on outdated numbers, I fear that the proposed management plan will inadvertently impact lobstermen in a negative way.

The new and updated data will be made available from the NOAA Fisheries Observer Program later in the year, and I urge the ASMFC to review this information before finalizing a new management plan. I would also implore the ASMFC to fully analyze and take into account the concerns of the lobstermen themselves before taking any further action. The Long Island Sound is a tremendously bountiful and delicate resource for thousands of nearby communities, and I

PLEASE REPLY TO: ☐ Room 635, Legislative Office Building, Albany, New York 12248 • 518-455-5952, FAX: 518-455-5804
☐ 75 Woodbine Avenue, Northport, New York 11768 • 631-261-4151, FAX: 631-261-2992
EMAIL: RAIAA@nyassembly.gov

believe that incorporating these factors into the final management plan will benefit not only the lobstermen themselves, but the millions of residents who live in immediate proximity to this body of water.

Thank you for your consideration, and if I can be of any further help, please do not hesitate to contact me directly.

Sincerely,

Andrew P. Raia

Andrew P. Raia
Member of Assembly
12th A.D.

From: bobwlang@aol.com
Sent: Monday, July 03, 2017 11:15 AM
To: Megan Ware
Subject: Lobster Addendum XXV

Follow Up Flag: Follow up
Flag Status: Completed

Ms. Ware,

It is nice to see that there was no closure of lobster fishing in New jersey for the summer months, as proposed. I am a sport diver. Summer is the only time that local divers can go Lobstering (due to water temperatures). As you & your initiative work to make waters healthy for the coastal waters, please keep in mind the sport diving community.

As you & your office sees fit to stop certain fishing, please consider off season for the local recreational sports-person.

Sincerely,
Robert Lang

1757 N. Olden Ave Ext
Ewing, NJ 08638
phone: 609-538-1970
fax: 609-538-8954

Atlantic States Marine Fisheries Commission

Shad and River Herring Management Board

August 2, 2017
8:00 – 10:00 a.m.
Alexandria, Virginia

Draft Agenda

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

1.	Welcome/Call to Order *(J. Clark)*	8:00 a.m.
2.	Board Consent • Approval of Agenda • Approval of Proceedings from February 2017	8:00 a.m.
3.	Public Comment	8:05 a.m.
4.	Review River Herring Stock Assessment Update (*B. Chase*)	8:15 a.m.
5.	Timeline for Shad Stock Assessment Update (*J. Kipp*)	9:15 a.m.

6.	Consider Approval of Shad and River Herring Sustainable Fishery Management Plans (SFMPs) **Final Action**
	• Review SFMPs and Technical Committee Memo *(B. Chase)*
	  • South Carolina – Updated River Herring SFMP
	  • Florida – Updated Shad SFMP
		9:25 a.m.

7.	Consider Approval of 2016 FMP Review and State Compliance Reports (*K. Rootes-Murdy*) **Action**	9:45 a.m.
8.	Other Business/Adjourn	10:00 a.m.

The meeting will be held at the Westin Alexandria; 400 Courthouse Square, Alexandria, VA; 703.253.8600

MEETING OVERVIEW

Shad and River Herring Management Board Meeting
August 2, 2017
8:00 – 10:00 a.m.
Alexandria, Virginia

Chair: John Clark (DE) Assumed Chairmanship: 2/17	Technical Committee Chair: Brad Chase (MA)	Law Enforcement Committee Representative: Furlong (PA)
Vice Chair: Mike Armstrong	Advisory Panel Chair: Pam Lyons Gromen	Previous Board Meeting: February 1, 2017
Voting Members: ME, NH, MA, RI, CT, NY, NJ, PA, DE, MD, DC, PRFC, VA, NC, SC, GA, FL, NMFS, USFWS (19 votes)		

2. Board Consent

- Approval of Agenda
- Approval of Proceedings from February 2017

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

4. Review River Herring Stock Assessment Update (8:15-9:15 a.m.)
Background • The 2012 Benchmark Stock Assessment was updated with new data from 2010-2015. The assessment includes trend analyses of abundance, mortality, and biological data from river-specific stocks and regional and coastwide mixed stocks. Results of trend analyses and recent trend determinations will be presented. • Coastwide Assessment **(Briefing Materials)** and State Chapters **(Supplemental Materials)**
Presentations • Overview of the River Herring Stock Assessment Update by B. Chase

5. Timeline for Shad Stock Assessment Update (9:15-9:25 a.m.)
Background • The 2007 Benchmark Stock Assessment will be updated in 2018. The update will follow a similar schedule as the River Herring Assessment Update and will provide similar information.
Presentations • Timeline for Shad Stock Assessment Update by J. Kipp

6. Consider Approval of Sustainable Fishery Management Plans (9:25-9:45 a.m.) Final Action
Background • The Florida Fish and Wildlife Conservation Commission (FWC) submitted an updated SFMP for recreational harvest of America shad in the St. Johns River. (**Briefing Materials**) The plan includes recent data and requests to maintain the existing recreational management measures from the 2011 SFMP. There are no commercial fisheries operating in state waters that take shad deliberately or that are likely to take shad as bycatch • The South Carolina Department of Natural Resources submitted an updated SFMP for commercial and recreational harvest of blueback herring (**Briefing Materials**). The plan includes recent data and requests to maintain the existing management measures from the 2010 SFMP. • The Technical Committee reviewed the documents and provided recommendations to the Board (**Briefing Materials**).
Presentations • Overview of the SFMPs and Technical Committee Recommendations by B. Chase
Board Actions for Consideration • Approval of the Sustainable Fishery Management Plans

7. Fishery Management Plan Review (9:45-10:00 a.m.) Action
Background • State compliance reports were due on July 1 • The PRT reviewed and complied the annual FMP Review. (**Briefing Materials**). • Florida, Maine, New Hampshire and Massachusetts have requested and meet the requirements for *de minimis* for American shad. • Florida and New Hampshire have requested and meet the requirements for *de minimis* for river herring
Presentations • Overview of the 2016 Fishery Management Plan Review by K. Rootes-Murdy
Board Actions for Consideration • Accept the 2016 FMP Review and approve *de minimis* requests

8. Other Business/Adjourn

DRAFT PROCEEDINGS OF THE

ATLANTIC STATES MARINE FISHERIES COMMISSION

SHAD AND RIVER HERRING MANAGEMENT BOARD

The Westin Alexandria
Alexandria, Virginia
February 1, 2017

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

TABLE OF CONTENTS

INDEX OF MOTIONS

1. **Approval of Agenda** by Consent (Page 1).

2. **Approval of Proceedings of October, 2016** by Consent (Page 1).

3. **Move to accept the New York Sustainable Fishery Management Plan (SFMP) for river herring, the Maine SFMP for river herring and the Delaware River Basin Cooperative SFMP for shad** (Page 8). Motion by Adam Nowalsky; second by Terry Stockwell. Motion passes unanimously (Page 8).

4. **Move to approve Florida's American Shad Habitat Plan** (Page 9). Motion by Michelle Duval; second by Malcolm Rhodes. Motion passes unanimously (Page 9).

5. **Move to elect Mike Armstrong as Vice-chair of the Shad and River Herring Management Board** (Page 9). Motion by Ritchie White; second by Robert Boyles. Motion passes unanimously (Page 9).

6. **Move to adjourn** by Consent (Page 9).

ATTENDANCE

Board Members

Terry Stockwell, ME, proxy for P. Keliher (AA)
Steve Train, ME, GA
Rep. Jeff Pierce, ME, proxy for Sen. Langley (LA)
Cheri Patterson, NH, proxy for D. Grout (AA)
Dennis Abbott, NH, proxy for Sen. Watters (LA)
Ritchie White, NH (GA)
Mike Armstrong, MA, proxy for D. Pierce (AA)
Raymond Kane, MA (GA)
Sarah Ferrara, MA, proxy for Rep. Peake (LA)
Mark Gibson, RI, proxy for J. Coit (AA)
Colleen Giannini, CT, proxy for M. Alexander (AA)
Lance Stewart, CT (GA)
John McMurray, NY, proxy for Sen. Boyle (LA)
Steve Heins, NY, proxy for J. Gilmore (AA)
Emerson Hasbrouck, NY (GA)
Russ Allen, NJ, proxy for D. Chanda (AA)
Chris Zeman, NJ, proxy for T. Fote (GA)
Adam Nowalsky, NJ, proxy for Asm. Andrzejczak (LA)
Andy Shiels, PA, proxy for J. Arway (AA)
Loren Lustig, PA (GA)
John Clark, DE, proxy for D. Saveikis (AA)
Craig Pugh, DE, proxy for Rep. Carson (LA)
Lynn Fegley, MD, proxy for D. Blazer (AA)
Rachel Dean, MD (GA)
Kyle Schick, VA, proxy for Sen. Stuart (LA)
Rob O’Reilly, VA, proxy for J. Bull (AA)
Michelle Duval, NC, proxy for B. Davis (AA)
David Bush, NC, proxy for Rep. Steinburg (LA)
Malcolm Rhodes, SC (GA)
Robert Boyles, SC (AA)
Pat Geer, GA, proxy for Rep. Nimmer (LA)
Kathy Knowlton, GA, proxy for S. Woodward (AA)
Jim Estes, FL, proxy for J. McCawley (AA)
Martin Gary, PRFC
Sherry White, USFWS
Derek Orner, NMFS

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

Ex-Officio Members

Brad Chase, Technical Committee Chair

Staff

Bob Beal
Toni Kerns
Ashton Harp
Jeff Kipp
Amy Hirrlinger

Guests

The Shad and River Herring Management Board of the Atlantic States Marine Fisheries Commission convened in the Edison Ballroom of the Westin Hotel, Alexandria, Virginia, February 1, 2017, and was called to order at 10:00 o'clock a.m. by Chairman John Clark.

CALL TO ORDER

CHAIRMAN JOHN CLARK: Good morning everybody, and welcome to the Shad and River Herring Board. Will Commissioners please be seated, and will everybody else please take conversations outside; thank you.

APPROVAL OF AGENDA

CHAIRMAN CLARK: All right are there any items to add to the agenda? Seeing none; are there any objections to the agenda as here? Seeing none; the agenda is approved.

APPROVAL OF PROCEEDINGS

CHAIRMAN CLARK: Do we have any changes or additions to the minutes from the last meeting? Seeing none; and with no objection then the minutes are approved.

CONSIDER APPROVAL OF SUSTAINABLE FISHERY MANAGEMENT PLANS (SFMP)

CHAIRMAN CLARK: We have no public comment, and so we'll move right on to Agenda Item 4, which is Consider Approval of Sustainable Fisheries Plans. Brad Chase, the head of the Technical Committee will be giving us a review of each of these plans; and we'll have times for questions after each plan.

NEW YORK SUSTAINABLE FISHERY MANAGEMENT PLAN FOR RIVER HERRING

MR. BRAD CHASE: Good morning. We're going to start with New York's plan to update their river herring sustainable fishery management plan. This plan is focused on the Hudson River and tributaries. There has been consistent spawning stock sampling since 2012; and the sampling has found that mean length and mean length at age are increasing, as well as the frequency of repeat spawning.

Mortality estimates from the sampling have been declining. The plan will adopt regulations changes that were implemented in 2013. During this period since the last plan, commercial landings have declined by about 50 percent. The two main data series used as benchmarks are the Seine Series for Blueback Herring and Alewife that are shown here.

There is a fair amount of variability in these series, but you can see that the benchmark is the 25th percentile, the data series that is the line running along the X axis, and the threshold is to stay above that line; and if it goes below for three years there will be a management response. You can see that they have stayed above it with a few exceptions in the time series.

The proposed plan for 2017 to 2021 is essentially the status quo, really no changes to the plan. The fishery just occurs in the Hudson River and tributaries. There is a moratorium otherwise in other state waters. There will be the continuation of the recreational possession limit of 10 fish per person, or 50 fish per boat; again status quo with no changes.

To repeat, the sustainability targets are the young-of-year indices and recruitment failure is considered three years in a row below the 25 percentile of the data series. The state is also pursuing additional sustainability measures; looking at mean length and age, as well as total mortality in the frequency of repeat spawning. These are not quite ready. The duration of the time series needs a little bit more length. They are also looking at catch-per-unit effort of commercial harvest. They hope to develop these additional measures for a future update. The TC recommended approval of the updated sustainable fishery management plan for New

York, and it will adopt the regulation changes in 2013 in this update; otherwise no changes to the plan.

CHAIRMAN CLARK: That was the New York SFP, are there any questions about that plan? Seeing none; Brad, do you want to take the next SFP?

DELAWARE RIVER BASIN COOPERATIVE SFMP FOR SHAD

MR. CHASE: Okay the next would be Maine. Oh, is Delaware cued up. The Delaware River Basin, it's their shad plan that was implemented five years ago. It is an update. It's prepared by the Delaware River Basin Fish and Wildlife Management Cooperative. This involves the entire Delaware River Basin; including the states of New York, New Jersey, Pennsylvania and Delaware.

The plan is based on four indices of abundance they use to track sustainability for the shad stocks. Pictured here are the four indices. The first one is the Smithfield Beach gillnet, it collects spawning adults for brood stock. It began in 1990. The second one is a title survey for juvenile shad, and then there is a non-title survey for juvenile shad; these are seine surveys.

The title began in 1987, the non-title in 1980. They also have an index developed from commercial reporting of total landings; and they could look at catch-per-unit effort as well. Here are those indices with a fifth added for the update. It also shows the benchmark levels. The first three are fishery independent, and they're using the 25th percentile of the data series.

The management trigger is to have a response if there are three years below that 25 percentile. Then for the two fishery dependent, they use the ratio of commercial harvest to the Smithfield Beach Survey, and they use the 85th percentile for that. Again, there is a management response if they are three years above the line.

The new proposals for the mixed stock landings, and they're going to use the 75th percentile with a management response if they go two years above that line. Since the last plan was approved there have been no necessary management responses due to these triggers. In terms of harvest restrictions for recreational New York, Pennsylvania, and New Jersey has a three shad per day with no size limit.

Delaware has a yearlong season also with up to ten shad per day no size limit. For commercial fisheries New Jersey has a directed fishery that has limited entry, and Delaware has a bycatch fishery in the striped bass gillnet fishery that has limited entry as well; but no specific shad restrictions. There is a series of management actions that will occur if the benchmark is exceeded. I won't go through them all.

There are different responses depending on which index is exceeded, and they can involve a closure of the fisheries or reductions of recreational fisheries to catch and release only; or different types of levels or responses, depending on what happens. There are also responses that occur if they have multiple exceedances of the different indices, and they're listed here. Again, the cooperative can decide if they want to have a full fishery closure or if they want to have some interim measure to reduce harvest. In terms of changes from the previous plan, first the nontitle juvenile abundance index will now be calculated as a result of a generalized linear model method, instead of a geometric mean. They are going to use data just for several specific sites, and continue to estimate the geometric mean; but they will use the GLM to produce that index. The next change from the previous plan is to have a new mixed stock benchmark.

The new management benchmark was added in response to concerns that our basin shad stocks are being harvested in lower Delaware Bay. The development of a benchmark required determining a limitation line for the upper and lower Delaware Bay in assigning stock percentages based on that line; and it also imposes limits in the amount of shad that can be harvested from the mixed stock fishery, and imposes gear restrictions in the lower Bay if management actions are warranted.

Further on a new mixed stock benchmark. The demarcation line had been from Leipsic River in Delaware over to Gandys Beach, New Jersey. This was a line where 100 percent of the stock above the line was considered to be Delaware River fish, and below that line was estimated to have 40 percent of Delaware River origin; an otherwise mixed origin.

What is being proposed by the Cooperative is to lower the line, keeping the Gandys Beach origin on the New Jersey side, but lowering it down to Bowers Beach in Delaware. The Cooperative selected Bowers Beach as delineation between the upper Bay and the lower Bay, and decided to assign a 40 percent of commercial landings to Delaware stock for any shad harvested in the lower Bay.

Here is a graph that shows the lines. You can see the original line running from Leipsic River over to Gandys Beach in New Jersey, and that's in blue. Then the orange line is the new proposed line. It's running from Gandys Beach down to Bowers Beach in Delaware. This is what is proposed by the Cooperative. The origin I think relates to past tagging studies, as well as an improvement in reporting for landings with a change in line. This item was discussed at length by the TC.

We did not come to consensus on the topic. There were some members that wished to support the proposal as stated, and other members felt that the line should not be moved south until there was more information that could be gathered. There is a proposed genetic study that's to be started this year, and there were members that expressed that concern that the line should remain where it is, or be lowered just two miles south down to Port Mahon instead of down to Bowers Beach.

That is where the TC ended. Let me go a little further on TC recreational concerns. The TC expressed concern that this could result in expanded effort in the mixed stock fishery, given some shad were previously in the mixed stock portion of the Bay would now be deemed 100 percent Delaware River stock if the proposed line is approved. They also expressed a concern that mixed stock landing benchmark is artificially high; because it is derived from landings that stretch back to the eighties, when the harvests were much higher and exceeded 100,000 pounds.

The plan says low market values have caused the decline in landings; but Figure 41 in the plan suggested the price of shad is increasing. If the price were to continue to increase, it could lead to unsustainable harvest. Questions were asked why Bowers Beach was selected as the new line as opposed to Port Mahon. There was discussion on ocean bycatch in federal waters; and concerns about the lack of information on mixed stocks in federal waters. Also again, they highlighted the fact that a new genetic study was going to begin in 2017, and some members expressed the interest in having that information before a decision was made. That sums up the TCs comments; otherwise there was support to approve the plan with all those changes; with just the lack of consensus on the line change.

CHAIRMAN CLARK: Any questions about the Delaware SFP? Yes, Mike.

MR. MIKE ARMSTRONG: It looks like the TC can go along with most of the plan, it's the line that we should be considering now; where the TC had a real problem with it. I guess I share a lot of those concerns. But my question and I couldn't find it. It wasn't in your presentation, and I didn't see it in anything. I apologize if I missed it.

Why the move to move itself? Is there a fishery going on along the west coast that needs to be accommodated? I know part of it was, I read that it doesn't match up currently with the reporting lines; and that's a big deal I guess. But that would bring it to Port Mahon, if that's the pronunciation. Why go to Bowers Beach? Is it a fishery issue? If someone could answer that it would be great.

CHAIRMAN CLARK: Yes Mike, I can take that. It is our reporting region, and really if you look at our shad landings they are mostly coming from Leipsic in the upper Bay, which is above Port Mahon and up into the river. We just felt that Bowers Beach was a much better dividing line between where we would expect to see the mixed stock being caught by the fishery.

Most of our effort, as was pointed out this used to actually be a shad fishery when striped bass fishery came back in. Striped bass was actually a bycatch fishery of our shad fishery; but now it's just the opposite, where most of our gillnetters in the spring are targeting striped bass.

They're using 7 to 7.5 inch mesh, because they want to get striped bass that are big enough to sell on the New York market; where they can get a premium price for it. We are not seeing really that much effort targeting shad in the first place and in the lower Bay where they would be most likely to have the interactions with the mixed stock, we figure this line actually is a much better demarcation point for Delaware.

MR. ARMSTRONG: But it does look like biologically that line will then encompass more mixed stock; which would be reported as Delaware River fish, is that correct, and does that present problems for the TC when you're trying to tease out mortality rates on different stocks?

CHAIRMAN CLARK: As you saw the map of the Bay there, we're still a good ways up the Bay. We're calling lower Bay all the way from Cape Henlopen up to Bowers Beach. It is a big chunk of Delaware Bay there, as you can see. Really the effort that would be catching shad is low in that point; even in the middle Bay it is pretty low.

I think it is pretty much a moot point. I don't think we're going to see a lot of shad landed in either the mid Bay or the lower Bay, more so in the upper part of the mid Bay. We think that this just captures it better if we do see a big increase in shad landings, let's say in the lower Bay that would be concerning. That could indicate that we were fishing more on mixed stock; any other questions? Lynn.

MS. LYNN FEGLEY: I just also had the same concerns that the TC voiced. How inconvenient, what would the impact be on the Delaware fisheries if the line was at Port Mahon and not down to Bowers Beach? What would be the difference for the fishery?

CHAIRMAN CLARK: I would have to look again at our landings to see. From what I recall though, based on the triggers we have in there, I don't think it will make a huge practical difference at this point. But we just wanted to make sure in the eventuality that shad landings did pick up again.

I don't see that happening, but if it did we think, and we've looked at it closely, we've had several of our scientists working on this of course. We just think that the Bowers Beach dividing line will protect the mixed stock well without causing unnecessary stoppages to our commercial fishery there. That was the impetus on our part to have that line moved. Cheri.

MS. CHERI PATTERSON: Yes, I'm going to have to echo my colleagues concerns. I'm looking at some of these percentages on the boxes in this map, indicating that there could be from the tagging studies I believe, kind of a higher percentage of stock that isn't necessarily specific Delaware River; if you go from Bowers Beach. It looks like you have more, unless I am not understanding this correctly, you have less of a mixed stock if you start from Port Mahon.

Those are Delaware River stock primarily. New York probably does have a concern if some of this mixed stock is Hudson River stock, and they're just barely above their line of maintaining their populations for their fisheries management plan. My thought is to err on caution, until we have a genetic study that the TC can look at; and have that compromise of starting from Port Mahon as opposed to Bowers Beach.

CHAIRMAN CLARK: Any other questions? Russ.

MR. RUSS ALLEN: Just a couple things. I'm the Chair of the Delaware River Basin Cooperative Policy Committee. We've had many discussions on this issue, and we've had many discussions on this issue back to the nineties. If you look at some of those tagging studies that were done in the sixties and then we started our tagging program in the nineties.

That information was available when we closed the mixed stock fishery back in 2000. We've known this for a long time that it's a mixed stock fishery. I think the flavor of the Board at that time was to not do anything to these fisheries at that time. At that point we put in limited entry; and I know Delaware has done a lot of work at that portion of their fishery, making sure that landings are down.

We now have three fishermen who landed last year, and I think Delaware was less than ten; so it's working. We really took a lot of time trying to figure this out. The good news is we have another study coming this year; with the help of the U.S. Fish and Wildlife Service, and we're going to do a lot of work.

The goal was to get a mixed stock benchmark in this plan, and we don't want to see it all of a sudden go by the wayside; because we're not happy with the line for New Jersey and Delaware, and we get some votes against that. We don't want that to happen. We put it in here to make sure we had one, because that was a major recommendation from five years ago. The one thing we want to do is use the new technology that's available; the new studies that we're going to do. This is a fluid document and we can change it at any time, as long as this Board agrees to that. We're hoping we can just get this benchmark in here at this time. We took into account the things that are happening, Delaware and their reporting. Maybe they can fix that in a year.

Maybe they can make that better and we can move the line again. But if it helps us get the benchmark right for now; that is the whole point behind this. We're looking forward to the help we can get from the other states, and U.S. Fish and Wildlife Service to make sure we get a good study done this year.

Hopefully that will continue for multiple years. I just wanted to get those points across that we're working hard to make sure this happens. The change in this line doesn't affect anything in New Jersey, this affects Delaware. It is not going to mix anything with our fishermen, but I want to make sure this benchmark is in there; so we can change it even next year if there is a new set of data, and take it to our Policy Committee at the Co-op, and then bring it back to the Board.

CHAIRMAN CLARK: Any further questions? Mike.

MR. ARMSTRONG: Not to belabor it, but it seems like we have a decision to either leave it the way it is or go ahead and move it, and then take a look at the genetics as they come in. A question for either Russ or Brad is the study definite and is the spatial resolution enough to resolve an issue involving 12 miles of coastline? I don't want to kick the can down the road, if in fact we're going to be looking at something that is not going to help us.

MR. CHASE: The TC did not receive a proposal in this study; we just had a brief summary that I think the U.S. Fish and Wildlife Service are going to initiate. I would ask if any of the other Board members have information on the nature of the study; because the TC was not briefed on it.

MR. ARMSTRONG: Okay and that's just level of comfort, knowing something is coming.

CHAIRMAN CLARK: Sherry, do you have information on the study?

MS. SHERRY WHITE: We don't have a study design yet, but we're working collaboratively with the TC on that.

CHAIRMAN CLARK: Thank you, I know that obviously the subject has come up in our states. In Delaware we're going to make all efforts to get samples from the entire extent of our fishery; any further questions? Oh, Lynn.

MS. FEGLEY: This is really I think for Russ. I'm trying to understand if the line was changed, if the line was moved up to Port Mahon, would that impact the mixed stock benchmark?

CHAIRMAN CLARK: Do you want to take that Russ?

MR. ALLEN: I'll try. We would have to go back and look at the landings and see. But I think the point that John is getting at is he can't differentiate between the two right now. He felt that it was better to put that line where it is, and the information would be more accurate than move the line and then not be sure if it was accurate. I think I hit that in a nutshell, but we're just trying to make sure we get the best numbers out there for people. But it is still not perfect.

CHAIRMAN CLARK: It was close, Russ. Cheri.

MS. PATTERSON: Yes, I have a question for New York, as this was also part of their concern and I'm not hearing anything. Are you guy's fine with moving the line down to Bowers, knowing that it could be affecting your stocks in Hudson?

CHAIRMAN CLARK: Do you want to take that Steve?

MR. STEVE HEINS: Not really, but I will. Well, obviously we have technical concerns about that. We don't have any, what we think is new information that would tell us that there is any reason to move that line that further south. But I'm not on the Policy Board, was not involved in those discussions.

I don't really know what happened at the Policy Board. I do know that New York and Pennsylvania had the same concerns, so there is no consensus on the Policy Board either on moving the line. But yes, I mean we have the concerns certainly. I would rather see it up at Port Mahon.

CHAIRMAN CLARK: It's Port Mahon. Andy.

MR. ANDY SHIELS: I have to weigh in because I'm the last state. I was on the call with Russ, John and some others, and Fish and Wildlife Service; and this issue went on for how many months, three, four, five months. We couldn't break the tie. The TC felt very strongly from the science side; that's why they put their comments in. There is a question as to whether or not their comments should show up in a, what was the name of the – something opinion – Dissenting Opinion or something like that. It went that far.

Pennsylvania agreed with New York, because we had the concerns biologically that they're trying to restore their stock in the Hudson, and these fish there is some evidence to prove that fish that mill around the lower part of the Bay also travel up the coast and get into the Hudson fishery. That is why we're supporting it for the conservation reasons. Pennsylvania doesn't have commercial fisheries, so we don't have the same pressures or concerns that New Jersey and Delaware have. That is kind of how it played out and we're kind of at this point today.

MAINE UPDATED SFMP FOR RIVER HERRING

CHAIRMAN CLARK: Are there any further questions on that one? Not seeing any; we'll move on to the final SFP, which is the Maine Updated River Herring SFP.

MR. CHASE: Next up is the Maine update for their sustainable fishery management plan for river herring. Maine has 40 municipalities that are approved to have river herring fisheries in which 24, I believe have viable fisheries currently. What they have typically for commercial fisheries, they have one fixed harvest location that's operated by one harvester.

The harvest can only occur in that one area. The commercial season is allowed to occur four days weekly or with conservation equivalence. Each commercial harvester collects biological data. The harvest is required to be reported by August 1st of each year. Recreational harvest can occur with 25 fish per day and the fishing can occur above in the watersheds where commercial harvest does occur. A brief update on how things are going in Maine, they have had some favorable results since the last update. They generally have seen improved survival in some of the large rivers of herring and reduced mortality.

They're seeing stability in some of the metrics such as maximum age, mean length at age. There have been some favorable responses, including run counts that have been going up in many of the rivers. A little more on that again, many of these runs are showing increases in the run size since the 1990s. The plan does propose to add an additional commercial harvest in the town of Franklin; and more on that in a minute.

Again, they've found stability in mortality estimates, in some cases declining mortality estimates; and they are seeing a trend of less harvest for resale and more harvest for personal use. The fishery they would like to add is in the town of Franklin, and it involves Card Mill Stream. It's a fishery that was closed in 2012, because they didn't have biological data.

In the eight years since then you can see the graph that shows the counts. Their sustainability target is 35 fish for a spawning acreage. You can see that line running across the X axis and where the counts have been in relation to the line. In the lower left you can see a graph for mortality estimates at this run, and you can see they're declining.

They've also documented increasing numbers of older fish in the run as well. They feel they have a justification based on the eight years of biological monitoring to open this fishery. In terms of their sustainability definition, what they have is a metric based on the number of spawning run fish brood stock needed per acre of spawning surface to sustain the populations.

What they've used as a threshold is 35 fish per surface acre of spawning habitat. Maine has used that for many years, and it's how they base their escapement numbers and also their sustainability measures. The Department of Marine Resources in Maine works with the commercial harvesters to collect biological data from 19 runs, and they also collected 14 noncommercial runs.

They look at repeat spawning rates, annual mortality estimates, and escapement estimates for each commercial fishery; and review these annually. They review age structure, length frequency data, they conduct run counts where possible, and they relate these run counts to environmental conditions. They also maintain total harvest levels as well.

A little bit more on their management actions and triggers. Again, they use the base of 35 fish per acre. They close the fisheries for three days a week to allow that escapement to occur, and then they review their biological data and they do this annually; and they have management actions in response to exceeding that metric.

It is a metric that goes well back to the seventies and eighties, and it was developed at a time when they had one closed day per week. Now they're at three closed days per week. It is a conservative approach compared to what was done previously. The TC looked at the changes in the update. They reviewed the request to open Card Mill Stream, and they supported this; and they recommended approval of the request to open the new fishery. Also, the TC was interested in seeing an additional sustainability measure. Right now there is the one metric used, and there is a lot of biological data that is being recorded by the state of Maine. The TC expressed interest in seeing an additional metric that could be used as a secondary measure. The one it zeroed in on was the repeat spawning ratio. That was discussed as being included as soon as possible or for the next sustainable fishery management plan as a sustainability measure. Otherwise the TC recommended approval by the Board.

CHAIRMAN CLARK: Are there any questions on the Maine updated river herring sustainable fisheries plan? Okay seeing none, I guess it's now time to move to action on these. Is there any further discussion of these plans before I ask for a motion; or do we want to get a motion up and then discuss the motion? All right, Adam.

MR. ADAM NOWALSKY: I move to accept the Sustainable Fishery Management Plans as presented here today.

CHAIRMAN CLARK: Do I have a second? Terry Stockwell. Is there any discussion on the motion? Toni.

MS. TONI KERNS: Can we get some specificity for which plans were presented and for which species? We can help you out, Adam with what's on the Board.

MR. NOWALSKY: I'll try this again. I'll move to accept the New York sustainable fishery management plan for river herring, the Maine sustainable fishery management plan for river herring and the Delaware River Basin Cooperative sustainable fishery management plan for shad. Would that address your concerns?

CHAIRMAN CLARK: Do we have any discussion of the motion? Seeing none; do we need any time to caucus? It doesn't look that way. **I guess I'll just ask are there any objections to passing the motion as presented here? Seeing none; the motion is passed**.

CONSIDER APPROVAL OF THE AMERICAN SHAD HABITAT PLAN FROM FLORIDA

CHAIRMAN CLARK: Our next item on the agenda is to consider approval of the American Shad Habitat Plan from Florida. I'll turn it back over to Brad.

MR. CHASE: The state of Florida submitted a Shad Habitat Plan for the TC to review. It's a new plan from the state of Florida, and it followed the format of all the other plans that have been approved previously. The TC approved the plan with no recommended changes.

CHAIRMAN CLARK: Are there any questions about the Florida habitat plan? Seeing none; can we get a motion? Michelle.

DR. MICHELLE DUVAL: I move that we approve Florida's Habitat Plan for American Shad.

CHAIRMAN CLARK: Do we have a second? Malcolm Rhodes. **Is there any objection to passing the motion as written? Seeing none; the motion is passed.**

ELECTION OF VICE-CHAIR

CHAIRMAN CLARK: That brings us on to our next agenda item and our final action item; and that is to elect a Vice-Chair. Ritchie White.

MR. G. RITCHIE WHITE: I would like to nominate the most distinguished and probably the most knowledgeable member of the Commonwealth of Massachusetts; team Mike Armstrong.

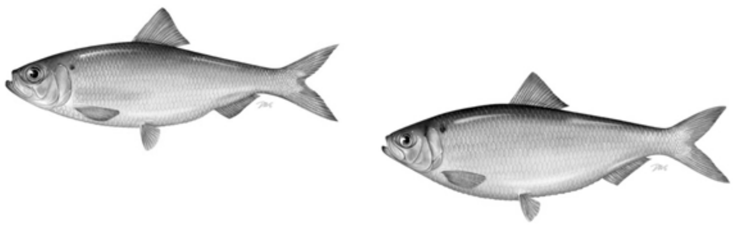
CHAIRMAN CLARK: Mighty high praise, and seconded by Robert Boyles**. I am guessing there is no objection to that so Mike, you're elected, great.**

ADJOURNMENT

CHAIRMAN CLARK: Is there any other business to come before the Board? Seeing none; we are adjourned.

(Whereupon the meeting was adjourned at 10:39 o'clock a.m. on February 1, 2017.)

River Herring Stock Assessment Update



Coastwide

Prepared by the
ASMFC River Herring Stock Assessment Subcommittee

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Michael Brown, Maine Department of Marine Resources
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Atlantic States Marine Fisheries Commission

Vision: Sustainably Managing Atlantic Coastal Fisheries

ACKNOWLEDGEMENTS

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Shad and River Herring Technical Committee: Brad Chase – Chair (MA Division of Marine Fisheries), Robert Adams (NY State Department of Environmental Conservation), Jacqueline Benway (CT Department of Environmental Protection), Michael Brown (ME Department of Marine Resources), Bryant Bowen (GA Department of Natural Resources), Ellen Cosby (Potomac River Fisheries Commission), Mike Dionne (NH Fish and Game), Phillip Edwards (RI Department of Environmental Management), Ruth Haas-Castro (NMFS), Ashton Harp (ASMFC), Dr. Eric Hilton (Virginia Institute of Marine Science), Reid Hyle (FL Fish and Wildlife Conservation Commission), Jeff Kipp (ASMFC), Dr. Wilson Laney (USFWS), Jeremy McCargo (NC Wildlife Resources Commission), Genine McClair (MD Department of Natural Resources), Larry Miller (USFWS), Johnny Moore (DE Department of Natural Resources and Environmental Control), Brian Neilan (NJ Division of Fish and Wildlife), Derek Orner (NMFS), Bill Post (SC Department of Natural Resources), Ray Rhodes (College of Charleston), Ken Sprankle (USFWS), Joseph Swann (D.C. Fisheries and Wildlife), Josh Tryninewski (PA Fish and Boat Commission), and Holly White (NC Division of Marine Fisheries).

The Stock Assessment Subcommittee would also like to acknowledge the following: Dr. Gary Nelson (MA Division of Marine Fisheries), Dr. John Sweka (USFWS), Laura Lee (NC Division of Marine Fisheries), Stephanie Iverson (VMRC), Chad Holbrook (SC Department of Natural Resources), Dave Ellis (CT Department of Environmental Protection), Wes Eakin (NY State Department of Environmental Conservation), Dr. Katie Drew (ASMFC), and Alan Weaver (VA Department of Game and Inland Fisheries) for their support during the assessment update.

EXECUTIVE SUMMARY

This document provides an update to the 2012 benchmark assessment of river herring (alewife, *Alosa pseudoharengus*, and blueback herring, *Alosa aestivalis*) stocks of the U.S. Atlantic Coast from Maine through Florida (ASMFC 2012). It was prepared by the River Herring Stock Assessment Subcommittee (SAS) of the Atlantic States Marine Fisheries Commission (ASMFC) Shad and River Herring Technical Committee (TC). The analyses and descriptions stem from data and summary reports provided by U.S. federal and state freshwater and marine resource management agencies, power generating companies, and universities to the ASMFC. The assessment update was a recommendation of the SAS following the benchmark stock assessment.

"We recommend an update of trend analyses in 5 years and the next benchmark assessment for river herring be conducted in 10 years (finalized in 2022). Due to the high variability of fisheries independent surveys, a benchmark assessment at a shorter timeframe (e.g. 5 years) will likely not show any significant changes in indices of abundance. Any population changes resulting from closures of fisheries in 2012; improved access to historic spawning grounds; and additional beneficial management measures, such as sustainable fishing plans and action by the federal councils, cannot be expected to result in any population change until at least one cohort of river herring has grown to maturity (assuming age at maturity is 3 – 6 years). A 10 year timeframe for the next benchmark assessment will also allow a longer time series of estimated total incidental catch in non-targeted ocean fisheries to be evaluated."

The recommendation for an update was supported by the TC in 2016 in preparation for this stock assessment. An update of a stock assessment includes updating the peer-reviewed, and Management Board-accepted benchmark assessment approaches with recent data since the benchmark data terminal year (2010). The data terminal year of this update is 2015.

The benchmark assessment included assessment of Atlantic coastal river herring stocks on an individual river basis for a few systems and also on a limited coastwide basis. As an anadromous species, ideally river herring should be assessed and managed by individual river systems. However, the majority of the life history of river herring is spent in the marine environment where factors influencing survival likely have impacts upon multiple river stocks when they mix during marine migrations. The complex life history of anadromous species complicates assessments on a coastwide scale as it is difficult to partition in-river factors from marine factors governing population dynamics. Also complicating the assessment of river herring is the variability in data quality among rivers along the coast.

Severe declines in landings began coastwide in the early 1970s and domestic landings are now a fraction of what they were at their peak having remained at persistently low levels since the mid-1990s. Moratoria were enacted in Massachusetts (commercial and recreational in 2005), Rhode Island (commercial and recreational in 2006), Connecticut (commercial and recreational in 2002), Virginia (for waters flowing into North Carolina in 2007), and North Carolina (commercial and recreational in 2007, with the exception of a four day open season in the Chowan River during the week of Easter). As of January 1, 2012 states or jurisdictions without an approved sustainable fisheries management plan, as required under ASMFC Amendment 2 to the Shad and River Herring FMP, were closed. As a result, prohibitions on harvest (commercial or recreational) were extended to the following states: New Jersey, Delaware, Pennsylvania, Maryland, D.C., Virginia (for all waters), Georgia and Florida.

Commercial CPUE

No CPUE data sets reflected declining trends over the last ten years of the update, with one of ten data sets showing an increasing trend and three showing no trend (Table 1). Six were not updated due to discontinuation or changes in methodology.

Run Counts

No run counts reflected declining trends over the last ten years of the updated data time series with eleven of twenty nine showing increasing trends, fourteen showing no trend, and four not being updated (two due to discontinuation and two due to agency recommendation; Table 1).

An updated cluster analysis using the most recent eight years (2008-2015) did not result in groupings of runs similar to the corresponding final eight year period (2003-2010) used in the benchmark analysis. It is difficult to discern any consistent trends as to why the two periods differ, but suggests that rivers along the Atlantic Coast that were previously grouped together for similar trends have not been experiencing similar population trends in the years since the benchmark.

Young-Of-The-Year Seine Surveys

Inclusion of datasets for the period after the benchmark up to 2015 did not show any changes in trends outlined in the benchmark assessment. One of sixteen YOY seine surveys indicated a declining trend over the last ten years, two indicated increasing trends, and thirteen indicated no trend (Table 1). Indices of alewife from young of year (YOY) seine surveys remained at relatively low levels similar to those seen for the period prior to 2011. Blueback herring also remained similar to levels observed in the terminal years of the benchmark assessment, although some surveys (Virginia, Maryland, and District of Columbia) have seen increases in 2014-2015.

Juvenile-Adult Fisheries-Independent Seine, Gillnet and Electrofishing Surveys

Seine CPUE for combined species in Narragansett Bay fluctuated without trend from 1988-1997, increased through 2000, declined and then remained stable from 2001-2004, increased again in 2005, and declined in 2009. The pond survey CPUE increased during 1993-1996, declined through 1998, increased in 1999, declined through 2002, peaked in 2012, and then declined and fluctuated without trend thereafter. Addition of data from 2011 to 2015 does not show a significant correlation ($p=0.413$) with the addition of more years of data, suggesting that the pond survey may not fully capture year-class strength.

The electrofishing CPUE indices for alewives and blueback herring in the Rappahannock River and James River were highly variable for the time series. The electrofishing CPUE indices for blueback herring in the St. John's River declined precipitously from 2001 to 2002 and has fluctuated without trends since 2003. The common trend among the Virginia and Florida electrofishing survey occurred in 2004 and 2015 when the Rappahannock River alewife index, James River blueback herring index, and St. John's River blueback herring index increased.

Juvenile and Adult Trawl Surveys

Trends in trawl survey indices varied greatly with one of twelve indicating a declining trend over the last ten years, four indicating increasing trends, and seven indicating no trend (Table 1). The probability of the final year of the survey being less than the 25^{th} percentile reference point [$P(<0.25)$], as estimated with ARIMA, ranged from 0 to 0.464 for alewives and 0 to 0.540 for blueback herring.

Mean Length

Updated trend analysis shows a continuation of the declining mean size of both species mentioned in the benchmark assessment. A significant decline in mean length of alewives was in 4 of the 9 river systems examined (Table 1). Similarly, blueback herring mean length is significantly declining in 6 of the 9 river systems examined (Table 1). Trends in mean lengths from the NEFSC bottom trawl survey were similar to those of the benchmark.

Maximum Age

Data provided in the update added little information to this visual analysis. In terms of maximum age no trends appear reversed and most runs had stable ages. Lamprey River (NH) alewife maximum age appears to be trending upward, while Nanticoke River (MD) alewife and blueback herring, and Chowan River (NC) blueback herring maximum ages appear to have dropped (Table 1).

Mean Length-at-Age

Of the 112 Rivers-Species-Age combinations updated (111 with data, as there was no data available for Gilbert-Stuart Alewife Male age 6), 26 have reversed in terms of their significance when compared to the analysis preformed in the benchmark assessment. Declines in mean length of at least one age were observed in most rivers examined. There is little indication of a general pattern of size changes along the Atlantic coast.

Repeat Spawner Frequency

There have been no increasing trends in the percent repeat spawners over the full data time series, with declining trends in three rivers assessed and no significant trends for all other data sets (Table 1).

Total Mortality (Z) Estimates

There have been no increasing trends in empirical total mortality estimates over the last ten years of the updated data time series. Three trends have declined and ten have shown no trend (Table 1). 2013-2015 average total mortality estimates for twelve rivers exceeded $Z_{40\%,M=0.7}$ benchmarks, while averages for two rivers were below these benchmarks (Table 2). All 2008-2010 average estimates from the benchmark assessment exceeded $Z_{40\%,M=0.7}$ benchmarks.

Exploitation Rates

In-river exploitation of river herring since the benchmark assessment appears to have declined or remained stable for the two Maine rivers where still observed. Coastwide relative exploitation since the benchmark stock assessment is the lowest of the time series, averaging 0.05.

Stock Status

Of the 54 in-river stocks of river herring for which data were available, 16 experienced increasing trends over the ten most recent years of the update assessment data time series, 2 experienced decreasing trends, 8 were stable, 10 experienced no discernible trend/high variability, and 18 did not have enough data to assess recent trends, including 1 that had no returning fish. The coastwide meta-complex of river herring stocks on the US Atlantic coast remains depleted to near historic lows. A depleted status indicates that there was evidence for declines in abundance due to a number of factors, but the relative importance of these factors in reducing river herring stocks could not be determined.

Table 1. Summary of river herring trends from select rivers along the Atlantic Coast.

State	River**	Commercial CPUE		Run Counts		YOY survey		Z		Trawl Survey†		Mean Length	Max Age	Percent Repeat Spawners	Updated Recent Trends*
		2006-2015	Full Time-series	2006-2015	Full Time-series	2006-2015	Full Time-series	2006-2015	Full Time-series	2006-2015	Full Time-series	Full Time-series	Full Time-series	Full Time-series	2006-2015
NE U.S. Continental Shelf (NMFS Bottom Trawl)^										↑[A,B]	↘↗[A], →↗[B]	↓[A], n.s.[B]			Increasing[A,B]
ME	Androscoggin			↑[A]	↑[A]			↔[A]	↔[A]			n.s.[A]	↔[A]	↓[A]	Increasing[A]
ME	Kennebeck			↑[RH]	↑[RH]										Increasing[RH]
ME	Sebasticook			↑[RH]	↑[RH]	↔[A,B]	↔[A], ↑[B]	↔[A]	↔[A]						Increasing[RH]
ME	Damariscotta			↑[A]	↘↗[A]										Increasing[A]
ME	Union			↔[A]	↔[A]										No Trend[A]
NH	Cocheco			↑[RH]	↑[RH]			↓[A]	↓[A,BF], ↔[BM]	↑[A], ↔[B]	↑[A], ↓[B]	n.s.[A,BF], ↓[BM]	↔[A,B]	n.s.[A,B]	Increasing[A,B]
NH	Exeter			↔[RH]	↔[RH]							↓[AM], n.s.[AF]	↔[A]	n.s.[A]	Stable[RH]
NH	Lamprey			↑[RH]	↑[RH]			↓[AM], ↔[AF]	↓[AM], ↔[AF]			n.s.[A]	↑[A]	n.s.[A]	Increasing[RH]
NH	Oyster			↔[RH]	↗↘[RH]			↔[B]	↔[B]			↓[B]	↔[B]	n.s.[B]	Decreasing[RH]
NH	Taylor			D (2015)	↓[RH]									D (2010)	No Returns[RH]
NH	Winnicut			D (2011)	↔[RH]			D (2011)	↔[A,B]			n.s.[A,B]	D (2011)	D (2010)	Unknown[A,B]
MA	Mattapoisett			↑[A]	↔[A]										Increasing[A]
MA	Monument			↑[A,B]	↗↘[A], ↓[B]			↔[A]	↑[AM,BF], ↔[AF,BM]			↓[A,B]	↔[A,B]	↓[A,B]	Increasing[A,B]
MA	Nemasket			↑[A]	↔[A]			↔[A]	↔[A]					n.s.[A]	Increasing[A]
MA	Parker			↔[A]	↓[A]				↔[A]						Stable[A]
MA	Stony Brook														Unknown[A]
RI	Buckeye			↔[A]	↔[A]										Increasing[A]
RI	Gilbert			↔[A]	↗↘[A]	↔[RH]	↔[RH]	↔[A]	↑[A]	↔[A], ↓[B]	↑[A], ↔[B]		↔[A]	↓[A]	Stable[A]
RI	Nonquit			↔[A]	↓[A]			↓[A]	↓[A]					n.s.[A]	Decrease[A]
CT	Bride Brook			↑[A]	↑[A]										Increasing[A]
CT	Connecticut			↔[B]	↗↘[B]	↔[B]	↓[B]								Stable[B]
CT	Farmington			X	X										Unknown[A,B]
CT	Mianus			↔[A,B]	↔[A,B]					↔[A,B]	↑[A], ↓[B]				No Trend[A],Increasing[B]
CT	Mill Brook			↔[A]	↔[A]										No Trend[A]
CT	Naugatuck			X	X										Unknown[A,B]
CT	Shetucket			↔[A,B]	↔[A,B]										No Trend[A], Stable[B]

Table 1. Continued

State	River**	Commercial CPUE		Run Counts		YOY survey		Z		Trawl Survey†		Mean Length	Max Age	Percent Repeat Spawners	Updated Recent Trends*
		2006-2015	Full Time-series	2006-2015	Full Time-series	2006-2015	Full Time-series	2006-2015	Full Time-series	2006-2015	Full Time-series	Full Time-series	Full Time-series	Full Time-series	2006-2015
NY	Hudson	↑^{RH}	↘↗^{RH}			↓^{A}, ↔^{B}	↔^{A,B}					↔^{A,B}			Increasing^{RH}
NJ, DE,PA	Delaware	D (2012)	↓^{RH}			↔^{A,B}	↔^{A}, ↓^{B}			↑^{A}, ↔^{B}	↔^{A}, ↑^{B}				No Trend^{A,B}
MD, DE	Nanticoke	D (2012)	↓^{RH}			↔^{A,B}	↔^{A,B}	↔^{A,B}	↔^{A,B}			↓^{A,B}	↓^{A,B}	↓^{AM,B}, n.s.^{AF}	Stable^{A},No Trend^{B}
VA, MD, DC	Potomac	D (2012)	↓^{RH}			↔^{A}, ↑^{B}	↓^{A}, ↑^{B}								Stable^{A},Unknown^{B}
VA	James	D (2013)	↔^{A}												Unknown^{A,B}
	Rappahannock	D (2013)	↗↘^{A}			↔^{A}, ↑^{B}	↔^{A,B}								No Trend^{A},Increasing^{B}
	York	D (2013)	→↗^{A}												Unknown^{A,B}
NC	Alligator								↔^{A,B}						Unknown^{A,B}
	Chowan	↔^{A,B}	↓^{A,B}	↔^{B}	↓^{A,B}	↔^{A,B}	↔^{A}, ↓^{B}	↔^{B}	↔^{A,B}	↔^{A,B}	↘↗↘^{A}, ↓^{B}	↓^{A,B}	↓^{A,B}	n.s.^{A,B}	No Trend^{A},Stable^{B}
	Scuppernog								↔^{A,B}						Unknown^{A,B}
SC	Santee-Cooper	↔^{B}	↘↗^{B}		↑^{B}				↓^{B}			n.s.^{B}			No Trend^{B}
FL	St. Johns River											↓^{BF}, n.s.^{BM}			Unknown^{B}

†: Adult or all age fish only; trawl surveys take place in bay or inshore state ocean waters

n.s. Trend was not statistically significant

Supersc Data available for

A Alewife only

B Blueback herring only

A,B Alewife and blueback herring by species

RH Alewife and blueback herring combined (river herring)

F Female. If sex is not noted, trends were either the same between sexes or the trend was evaluated for sexes combined.

M Male. If sex is not noted, trends were either the same between sexes or the trend was evaluated for sexes combined.

↔ No trend (flat or high inter-annual variability)

XXX Consensus not reached

No data. If data sets ended before the benchmark terminal year of 2010, the cell for recent trends is left blank.

*Updated recent trends reflects the most recent ten years (2006-2015). No trend indicates high inter-annual variability and stable indicates flat.

**Table reflects rivers that had data in addition to landings. Refer to the state chapter and/or coastwide summary for a complete list of rivers assessed and trends.

D Data collection discontinued since the terminal year of the benchmark assessment. Year data collection discontinued is in parenthesis.

X Data collection continuous, but recommended against use in the assessment update (see state chapter for details).

^NE shelf trends are from the spring, coastwide survey data which encounters river herring more frequently than the fall survey

Table 2. 2013-2015 average Z estimates by river with associated $Z_{20\%SPR}$ and $Z_{40\%SPR}$ benchmarks.

Z	3 year average of Z is above both the Z-20% and Z-40% benchmarks
XXXXXXX	No estimates of Z due to lack of returning fish
Z	3 year average of Z is between the Z-20% and Z-40% benchmarks
Z	3 year average of Z is below both the Z-20% and Z-40% benchmarks
	No current estimates of Z are available

State	River	Species	$Z_{40\%(M=0.7)}$	$Z_{20\%(M=0.7)}$	Benchmark $Z_{3yr\text{-}Avg}$	Update $Z_{3yr\text{-}Avg}$
ME	Androscoggin	Alewife	0.93	1.12	1.40*(1.35)	2.13
	Kennebeck	River herring				
	Sebasticook	Alewife	0.93	1.12	1.30*(1.67)	1.21
	Damariscotta	Alewife				
	Union	Alewife				
NH	Cocheco	Alewife	0.92	1.11	1.03	0.37
	Cocheco	Blueback	0.95	1.15	1.14	XXXXXXX
	Exeter	Alewife				
	Lamprey	Alewife	0.92	1.11	1.18	0.63
	Oyster	Blueback	0.95	1.15	1.02	1.60
	Taylor	Blueback				
	Winnicut	Alewife	0.92	1.11	1.12	XXXXXXX
	Winnicut	Blueback	0.95	1.15	1.80*(1.53)	XXXXXXX
MA	Mattapoisett	Alewife				
	Monument	Alewife	0.92	1.11	1.19	2.48
	Monument	Blueback				
	Mystic	Alewife	0.92	1.11	1.14	1.01
	Nemasket	Alewife	0.92	1.11	1.23	1.69
	Parker	Alewife				
	Stony Brook	Alewife				
	Town	Alewife	0.92	1.11	1.06	1.27
RI	Buckeye	Alewife				
	Gilbert	Alewife	0.94	1.14	1.80	1.66
	Nonquit	Alewife	0.94	1.14	1.81	1.68
CT	Bride Brook	Alewife				
	Connecticut	Blueback				
	Farmington	Alewife				
	Farmington	Blueback				
	Mianus	Alewife				
	Mianus	Blueback				
	Mill Brook	Alewife				
	Naugatuck	Alewife				
	Naugatuck	Blueback				
	Shetucket	Alewife				
	Shetucket	Blueback				
NY	Hudson	Alewife				
	Hudson	Blueback				
NJ, DE, PA	Delaware	Alewife				
	Delaware	Blueback				
MD	Nanticoke	Alewife	0.93	1.13	1.08	1.35
	Nanticoke	Blueback	0.92	1.11	1.34	1.05
VA-MD-DC	Potomac	Alewife				
	Potomac	Blueback				
VA	James	Alewife				
	James	Blueback				
	Rappahannock	Alewife				
	Rappahannock	Blueback				
	York	Alewife				
	York	Blueback				
NC	Alligator	Alewife				
	Alligator	Blueback				
	Chowan	Alewife	0.93	1.12	1.60	
	Chowan	Blueback	0.92	1.11	1.07	1.15
	Scuppernog	Alewife				
	Scuppernog	Blueback				
SC	Santee-Cooper	Blueback				

*Estimate changed due to new data discovered following the benchmark stock assessment. The original estimate from the benchmark stock assessment is in parentheses.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

TERMS

Stock Assessment: An evaluation of a stock, including age and size composition, reproductive capacity, mortality rates, stock size, and recruitment.

Benchmarks: A particular value of stock size, catch, fishing effort, and fishing mortality that may be used as a measurement of stock status or management plan effectiveness. Sometimes these may be referred to as biological reference points.

Bycatch: The total catch of river herring, regardless of final disposition, that is taken in fishery operations that target other species.

Catch Curve: An age-based analysis of the catch in a fishery that is used to estimate total mortality of a fish stock. Total mortality is calculated by taking the negative slope of the logarithm of the number of fish caught at successive ages (or with 0, 1, 2... annual spawning marks).

Catch-Per-Unit-Effort (CPUE): The number or weight of fish caught with a given amount of fishing effort.

Cohort: See "Year Class."

Discard: A portion of what is caught and returned to the sea unused. Discards may be either alive or dead.

Exploitation: The annual percentage of the stock removed by fishing either recreationally or commercially.

Fish Passage: The movement of fish above or below an river obstruction, usually by fish-lifts or fishways.

Fish Passage Efficiency: The percent of the fish stock captured or passed through the anthropogenic obstruction.

Fishing Mortality (F): The instantaneous rate at which fish in a stock die because of fishing.

Habitat: All of the living and non-living components in a localized area necessary for the survival and reproduction of a particular organism.

Historic Potential: Historic population size prior to habitat losses due to dam construction and reductions in habitat quality

Iteroparous: Life history strategy characterized by the ability to spawn in multiple seasons.

Incidental catch: See bycatch

Mortality: The rate at which fish die. It can be expressed as annual percentages or instantaneous rates (the fraction of the stock that dies within each small amount of time).

Natural Mortality (M): The instantaneous rate at which fish die from all causes other than harvest or other anthropogenic cause (i.e., turbine mortality). Some sources of natural mortality include predation, spawning mortality, and senescence.

Oxytetracycline (OTC): An antibiotic used to internally mark otoliths of hatchery produced fish.

Recovery: Describes the condition of when a once depleted fish stock reaches a self-sustaining or other stated target level of abundances.

Recruitment: A measure of the weight or number of fish that enter a defined portion of the stock, such as the fishable stock or spawning stock.

Relative Exploitation: An approach used when catch is known or estimated, but no estimates of abundance are available. For example, it may be calculated as the catch divided by a relative index of abundance. Long-term trends in relative exploitation are can be useful in evaluating the impact of fishing versus other sources of mortality.

Restoration: In this assessment, this describes the stocking of hatchery produced young-of-year to augment wild cohorts and the transfer of adults to rivers with depleted spawning stocks. Restoration also includes efforts to improve fish passage or remove barriers to migration.

River herring: Refers to both alewife and blueback herring.

Run Size: The magnitude of the upriver spawning migration of anadromous fish.

Semelparous: Life history strategy in which an organism only spawns once before dying.

Senescence: The process of ageing.

Spawning Stock Biomass: The total weight of mature fish (often females) in a stock.

Stock: A part of a fish population usually with a particular migration pattern, specific spawning grounds, and subject to a distinct fishery.

Stock Status: The agreed perspective of the SASC of the relative level of fish abundance

Sub-adult: Juvenile river herring which are part of the ocean migratory mixed-stock fish.

Total Mortality (Z): The instantaneous rate of removal of fish from a population from both fishing and natural causes.

Year Class: Fish of a particular species born during the same year.

Yield-per-Recruit: The expected lifetime yield per fish of a specific cohort.

1.0 INTRODUCTION

This document provides an update to the 2012 benchmark assessment of river herring (alewife, *Alosa pseudoharengus*, and blueback herring, *Alosa aestivalis*) stocks of the U.S. Atlantic Coast from Maine through Florida (ASMFC 2012). It was prepared by the River Herring Stock Assessment Subcommittee (SAS) of the Atlantic States Marine Fisheries Commission (ASMFC) Shad and River Herring Technical Committee (TC). The analyses and descriptions stem from data and summary reports provided by U.S. federal and state freshwater and marine resource management agencies, power generating companies, and universities to the ASMFC. The assessment update was a recommendation of the SAS following the benchmark stock assessment. For additional details on the results of the benchmark stock assessment, as well as other aspects of river herring such as biology, habitat, and historical fisheries, refer to the benchmark stock assessment report.

1.1 STATE REGULATIONS

Updated by: Ashton Harp, Atlantic States Marine Fisheries Commission; Benchmark Assessment Section by: Dr. Gary Nelson, Massachusetts Division of Marine Fisheries and Kate Taylor, Atlantic States Marine Fisheries Commission

States can harvest river herring if the specific regulations have been approved through a sustainable fisheries management plan (SFMP), as required under ASMFC Amendment 2 to the Shad and River Herring FMP. The SFMP must demonstrate a stock can support a commercial or recreational harvest that will not diminish potential future stock reproduction and recruitment. Data to substantiate these claims can include repeat spawning ratio, SSB, juvenile abundance levels, fish passage counts, bycatch rates, etc. Descriptions of state-specific regulations follow and are also summarized in Appendix 2.

Maine

In 2010, the Board approved the first SFMP to harvest river herring in Maine waters. In 2017, the Board approved an updated SFMP which included a request to open the Card Mill Stream in the town of Franklin for commercial harvest.

Maine has thirty-eight municipalities with the exclusive right to commercially harvest river herring. Currently, twenty-two municipalities actively harvest river herring. Directed commercial harvest of alewife or blueback herring does not occur in the main stem of nine of Maine's largest rivers (Penobscot, Kennebec, Androscoggin, Saco, St. Croix, Presumpscot, Machias, Salmon Falls, and East Machias). Commercial fisheries do exist on the tributaries of larger rivers.

Recreational fishermen are allowed to harvest four-days per week throughout the year. The limit is 25 fish per day and gear is restricted to dip net and hook-and-line. Recreational fishermen may not fish in waters, or in waters upstream, of a municipality that owns fishing rights. Recreational fishing for river herring in Maine is limited and landings are low.

The primary sustainability threshold is an escapement number equal to 35-fish per surface acre of spawning habitat. Escape numbers are measured through passage counts above commercial fisheries and managed by closed fishing days, season length, gear restrictions or continuous escapement. If the escapement threshold is not met than the commercial fishery will close for conservation.

New Hampshire

In 2011, the Board approved the first SFMP to harvest river herring in New Hampshire waters. In 2012, the Oyster River was closed to the taking of river herring by any methods from the head-of-tide dam at Mill Pond to the mouth of the river at Little Bay. In 2015, the Board approved an updated SFMP.

River herring in New Hampshire are currently managed as a statewide management unit with two sustainability targets (one fishery-dependent and one fishery-independent) were established in the SFMP using exploitation rates and numbers of returning river herring per surface acre of available spawning habitat in the Great Bay Estuary. This method was chosen because at least 95% of the river herring harvest in New Hampshire occurs in this estuary and there are currently fish ladders on four of the seven rivers in the Great Bay Estuary, each of which are monitored by the Department annually. Historical monitoring of river herring runs within New Hampshire have shown that the numbers of returning river herring to these four rivers have accounted for greater than 80% of the returning fish enumerated annually at fish passage structures on New Hampshire coastal rivers

The fishery-dependent target will be a harvest level that results in a harvest percentage (exploitation rate) that does not exceed 20% in the 'Great Bay Indicator Stock', providing an 80% escapement level. The fishery-independent sustainability threshold is an escapement number equal to 350-fish per surface acre of spawning habitat (72,450 fish). This target level is slightly above 50% of the mean annual river herring return to the Great Bay Estuary since 1990.

Massachusetts

In 2005, the Massachusetts Marine Fisheries Advisory Commission approved a three year moratorium regulation on the harvest, possession and sale of river herring in the Commonwealth in response to declines of many river herring spawning runs. The moratorium was extended through 2015.

In 2016, Massachusetts prepared a SFMP for the Nemasket River in response to a 2013 request to open the fishery from the Middleborough-Lakeville Herring Fishery Commission. The Board approved the SFMP in October 2016. The primary sustainability measure to monitor run status is the ongoing run count. Harvest will be capped at 10% of the time series mean (TSM), to be calculated each year. The plan also details a threshold that will trigger management action (exceeding cap or below the 25th percentile) and the resulting management action (harvest reduced from 10% to 5% of the TSM or three-year closure).

Connecticut

Since 2002, there has been a prohibition on the commercial or recreational taking of migratory alewives and blueback herring from all marine waters and most inland waters. This action was initially taken in 2002, and was still in place at publication (2017).

River herring were harvested primarily by haul seine, dip net, gill net and otter trawl. The gill net and haul seine fisheries were primarily directed toward collecting fish for bait. The fishermen involved were commercial as well as personal use lobstermen and recreational anglers. The drift gill net fishery operated in Long Island Sound and the Connecticut and the lower Thames River. Trawling is prohibited in Connecticut estuaries and is not allowed inland of a statutory line that is generally not more than ¼ mile from shore.

New York

In 2011, the Board approved New York's first SFMP to harvest river herring in the Hudson River and some of its tributaries. In 2013, the state implemented more restrictive management measures which include a closure of tributaries to nets, net size restrictions for scap nets (also known as lift and/or dip nets), mandatory monthly commercial reporting, and a recreational creel limit. In 2016, New York submitted an updated SFMP that includes recent data and the 2013 regulations. The sustainability benchmark was unchanged. The primary sustainability benchmark is based on young-of year-indices (YOY). Management action is triggered if the YOY indices indicate three consecutive years below the 25th percentile of the time series (1983-2015). Additional sustainability measures are collected annually to evaluate stock status and include: mean length at age, total mortality, frequency of repeat spawning and catch per unit effort (CPUE) of commercial harvest.

New Jersey/Delaware

As of January 1, 2012 commercial and recreational harvest of river herring was prohibited in New Jersey and Delaware, as required by ASMFC Amendment 2 to the Shad and River Herring FMP.

Maryland

As of January 1, 2012 commercial and recreational harvest of river herring was prohibited in Maryland, as required by ASMFC Amendment 2 to the Shad and River Herring FMP.

Potomac River Fisheries Commission / District of Columbia

The PRFC regulates only the mainstem of the river, while the tributaries on either side are under Maryland and Virginia jurisdiction. The District Department of the Environment (DDOE) has authority for the Potomac River to the Virginia shore and other waters within D.C. As of January 1, 2010 harvest of river herring was prohibited in the Potomac River, with a minimal bycatch provision of 50 pounds per licensee per day for pound nets.

Virginia

Virginia's Department of Game and Inland Fisheries (VDGIF) is responsible for the management of fishery resources in the state's inland waters. In 2008, possession of alewives and blueback herring was prohibited on rivers draining into North Carolina. As of January 1, 2012 commercial and recreational harvest of river herring was prohibited in all waters of Virginia, as required by ASMFC Amendment 2 to the Shad and River Herring FMP.

North Carolina

A no harvest provision for river herring, commercial and recreational, within North Carolina was approved in 2007, with one exception. A limited research set aside of 7,500 pounds was established to collect data necessary for stock analysis, and to provide availability of local product for local festivals.

In 2015, the limited research set aside was eliminated. The commercial and recreational harvest of river herring is now prohibited in all waters of North Carolina.

South Carolina

The South Carolina Department of Natural Resources (SCDNR) manages commercial herring fisheries using a combination of seasons, gear restrictions, and catch limits. In 2010, the Board approved a SFMP for the commercial and recreational harvest of blueback herring with the following restrictions. The commercial fishery for blueback herring has a 10 bushel daily limit (500 pounds) per boat in the Cooper and Santee Rivers and the Santee-Cooper Rediversion Canal and a 250 pounds per boat limit in the Santee-Cooper lakes. Seasons generally span the spawning season. All licensed fishermen have been required to report their daily catch and effort to the SCDNR since 1998. The recreational fishery has a 1 bushel (22.7 kg) fish aggregate daily creel for blueback herring in all rivers; however very few recreational anglers target blueback herring. In 2017, South Carolina submitted an updated SFMP with recent data and a request to maintain existing management measures. The Board will consider approval of the SFMP in August 2017.

Georgia

The take of blueback herring is illegal in freshwater. Historically, blueback herring could be taken for bait by using dip nets and cast nets. Harvest of blueback herring for any other purpose other than as bait was prohibited. As of January 1, 2012, harvest of river herring was prohibited in Georgia, as required by ASMFC Amendment 2 to the Shad and River Herring FMP.

Florida

The St. Johns River, Florida harbors the southernmost spawning run of blueback herring. Historically, regulations concerning river herring and shad prohibited the harvest or attempted harvest of any shad or river herring, by or with the use of any gear other than hook and line gear. As of January 1, 2012, harvest of river herring was prohibited, as required by ASMFC Amendment 2 to the Shad and River Herring FMP.

1.2 ASSESSMENT OVERVIEW

As an anadromous species, ideally river herring should be assessed and managed by individual river systems. However, the majority of the life history of river herring is spent in the marine environment where factors influencing survival likely have impacts upon multiple river stocks when they mix during marine migrations. The complex life history of anadromous species complicates assessments on a coastwide scale as it is difficult to partition in-river factors from marine factors governing population dynamics. Also complicating the assessment of river herring is the variability in data quality among rivers along the coast.

The SAS updated assessment approaches used in the benchmark stock assessment to assess Atlantic coastal river herring stocks on an individual river basis, where the data were available, and also on a limited coastwide basis. The following sections include (1) summary of available data and usefulness; (2) a trend analysis overview that provides summaries of the most meaningful data from state and major river systems; (3) a coastwide mixed stock population perspective exploring trend analyses and relative exploitation of mixed stock assemblage in ocean waters. During the benchmark assessment, the SAS also used depletion based stock reduction analysis to assess the coastwide mixed stock population. However, the peer review panel recommended against using this approach for assessment of river herring. Therefore, this assessment approach was not updated.

Coastwide approaches were used in the benchmark in addition to river specific approaches for several reasons. First- river herring stocks have been exploited in oceanic and estuarine mixed-stock fisheries as well as river-specific fisheries. Few of the mixed-stock fisheries are adequately monitored. There is no information about how to allocate the mixed-stock harvest among stocks. In-river data vary widely. Harvest is monitored for most in-river commercial fisheries but recreational harvest is monitored less often or non-existent. Little information is available on bycatch (discard and/or incidental catch) and so an updated analysis is provided.

The data gaps for river herring can be attributed mostly to the low priority the species receives in some agency monitoring efforts. This understandable prioritization results in there being few long-term fishery-independent indices, except on rivers with fish passage. Fishery-dependent indices provide some long time series but most data contain gaps and several have been discontinued since the benchmark stock assessment due to moratoria. Other concerns are on changes in effectiveness (catchability) of gear over time. Some efforts since the benchmark stock assessment have focused on identifying useful data collection for assessment purposes and the standardization of data collection along the coast (ASMFC 2016).

1.2.1 Summary of Available State / Jurisdiction Data

River specific data available for the benchmark assessment and updated for this assessment are summarized in Appendix 1. The quality and quantity of available data varied greatly among river systems. The data used represents a mix of fisheries dependent and independent data sources. Time series ranged in lengths up to as many as 72 years, but most time series were of shorter duration and often were not continuous. Some rivers had a full suite of data (e.g. harvest, age, length, weight, repeat spawner, and fisheries independent surveys) while others were limited in the types of data available or had data that was not reliable for assessment purposes. In addition to river specific data, several coastal trawl surveys were updated for this assessment. Again, the length of time series of these data varied from 8 to 41 years of data.

Throughout the update of the assessment, discrepancies between data provided during the benchmark assessment and data provided during the update for overlapping years (2010 and earlier) were observed. The SAS worked with TC members to identify the cause of these discrepancies and identify the correct data to use in the update, but often the discrepancies could not be explained and the updated data were used in the analyses. It is likely that QA/QC procedures and turnover of TC members since the benchmark assessment contributed to these discrepancies. All discrepancies are noted throughout the individual analysis sections.

The SAS noted during the benchmark assessment that some recent monitoring was not useful due to shortness of time series, but that “some of the current fishery-independent surveys should be of sufficient length to be useful in assessments five to 10 years from now if monitoring continues”. Therefore, the SAS identified all data sets explicitly noted in the benchmark as not being used due to shortness of time series and agree to include these data sets in the benchmark if they had reached ten years in length and could be analyzed with the same approaches used in the benchmark. The only new data set included in the updated trend analyses was the mean length data from the St. Johns River in Florida.

1.2.2 Assessment Approaches

Given the data gaps and issues described above, analyses requiring catch-at-age data were not used to assess most stocks in the benchmark stock assessment. The benchmark assessment was largely confined to analyses of trends, comparisons of trends among rivers or survey gears, and methods designed for data poor stocks, with the exception of the Monument River in Massachusetts, the Chowan River in North Carolina, and the Nanticoke River in Maryland, which had sufficient data to support statistical catch-at-age models. All analyses were updated with recent data (through 2015) except the depletion based stock reduction analysis and the statistical catch-at-age models for the Nanticoke River due to data limitations since the benchmark assessment (i.e., no harvest).

1.2.3 Trends in available state data

Data examined includes some fishery dependent (catch per unit effort) data, but primarily focuses on fishery-independent survey data (e.g. estimated run sizes, relative abundance indices, mean length or mean length at age, estimates of total instantaneous mortality, and in-river exploitation rates). Trends were updated with recent data to provide some perspective of current trends and to examine if patterns in trends were consistent across systems and regions. Analyses of trends included simple non-parametric Mann-Kendall tests for monotonic trends and correlation analyses to compare trends among rivers.

1.2.4 Trends in coastal composite data

Some data were only available as composite coastal populations stocks. There are currently no methods to allow for discrimination of individual stocks from coastal fisheries surveys. This includes several state trawl surveys conducted in near shore ocean waters (ME-NH survey, the Long Island trawl survey conducted by CT, the NJ coastal survey) and coastwide bottom trawl survey conducted by the Northeast Fishery Science Center (NEFSC). Autoregressive integrated moving average (ARIMA) models were used to evaluate trends in trawl surveys.

1.2.5 Total mortality estimates and benchmarks

Although there are issues identified with ageing techniques, total mortality benchmarks developed in the benchmark stock assessment and total mortality estimates were used to provide a perspective of the sustainability of and trends evident in current available mortality estimates. Mortality was also estimated from repeat spawner marks on scales, but the Peer Review Panel that reviewed the benchmark assessment preferred age-based mortality estimate (ASMFC 2012). Therefore, repeat spawner-based mortality estimates were updated, but age-based estimates were the focus of conclusions on mortality.

1.2.6 Relative exploitation

An index of relative exploitation was calculated from minimum swept area estimates of total biomass from the NEFSC bottom trawl survey and estimates of total catch (reported U.S. landings plus incidental catch). Although this approach did not yield absolute estimates of exploitation rates that could be compared to benchmarks, it did provide a means to observe relative trends in exploitation through time.

1.3 DATA UNCERTAINTIES

1.3.1 Age and mortality uncertainty

River herring have been aged historically using scales, using protocols first developed by Cating (1953) for American shad and Marcy (1969) for river herring. Although used extensively, these protocols have not been validated with known-age fish, and there had not been many efforts to standardize river herring ageing across states prior to the benchmark assessment. In recent years, several studies focused on American shad have concluded that Cating’s (1953) method for ageing shad scales should no longer be used (Duffy et al. 2012, Elzey et al. 2015). Additionally, some labs have switched to ageing river herring with otoliths since the benchmark assessment. Otolith protocols have not been validated with known-age fish either. As with any ageing method, there is the potential for bias both between labs and within labs over time as personnel change and methods are not consistently standardized. An age sample exchange and subsequent workshop were conducted stemming from recommendations in the benchmark assessment. A report details the varying degree of ageing error identified during this process between age structures and among labs providing age data for assessments (ASMFC 2014). Recommendations were made in efforts to standardize ageing practices across labs, but efforts should continue to assess ageing error and best practices.

Total mortality rates reflect the combined impact of intensive fisheries, spawning mortality, predation, and mortality associated with downstream passage at hydroelectric dams in some systems. Almost no stocks have sufficient information to separate mortality into these sources. Uncertainty about natural mortality is perhaps the biggest limiting factor in drawing strong conclusions about the status of river herring. There are no empirical estimates of natural mortality associated with spawning. Inferences about its magnitude are based almost entirely on total mortality rates and spawning marks on scales. Although interpretation of spawning marks on scales needs a validation study, spawning marks may help in establishing the magnitude of spawning mortality. Unfortunately, a lack of spawning marks may simply be a reflection of intensive fishing; for example, if a high percentage of migrants are harvested fewer will return to spawn. Considerable uncertainty also exists about the magnitude of predation. A brief description appears in the benchmark assessment. This predation could occur in rivers, estuaries, and in the ocean, and may be an important source of mortality for juvenile or adults. Recent concern has focused on predation by striped bass, whose population has increased coastwide. There is much diet information available for striped bass, but the magnitude of predation mortality is difficult to assess because of uncertainty about the proportion of the striped bass population within different bodies of water.

1.3.2 Total harvest uncertainty

Reporting requirements for anadromous fish have been strengthened across all states, and the reported landings from the directed in river commercial fisheries are considered fairly reliable in recent years. However, there are other directed and incidental fisheries that harvest river herring that are not well monitored.

River herring are caught by recreational anglers in-river, either as a target species or as bait for other gamefish. We explored, but did not use data from the National Marine Fisheries Service (NMFS) Marine Recreational Fisheries Statistics Survey (MRFSS) for several reasons. Recreational fishermen rarely catch river herring in marine waters, and MRFSS does not adequately sample the freshwater recreational fishery. As a result, MRFSS estimates of recreational catch, where they exist, have extremely high proportional standard errors (PSEs).

There is also considerable concern about potential species misidentification. Anecdotal evidence from state biologists indicates that hickory shad, which are growing in abundance, have been misidentified as river herring or young American shad, especially by anglers. Data are presented in the Fishery Dependent section, but not used due to the identified issues.

River herring are also caught incidentally at sea in fisheries targeting other species such as Atlantic herring, squid, and mackerel. The magnitude of this ocean catch is highly uncertain because of the short time series of bycatch data due to underreporting and a lack of observer coverage. In addition, there are no data on the stock composition of the incidentally caught fish and thus no way to partition estimates of bycatch among river systems. With no estimates of coastwide stock size, it is also difficult to assess the significance of these removals on the total population.

2.0 COASTWIDE TRENDS

2.1 FISHERY DESCRIPTIONS

2.1.1 Coastwide Commercial Landings

Updated by: Jeff Kipp, Atlantic States Marine Fisheries Commission; Benchmark Assessment Section by: Christine Jensen, North Carolina Division of Marine Fisheries and Katie Drew, Atlantic States Marine Fisheries Commission

Coastwide domestic commercial landings of river herring were presented from 1887 to 2015, where available, in Table 2.1 and Figure 2.1. Landings of alewife and blueback herring were collectively classified as “river herring” by most states. Only a few states had species-specific information recorded for a limited range of years. Commercial landings records were available for each state since 1887 except for Florida, which began in 1929, and the Potomac River Fisheries Commission (PRFC), which began in 1960. It is important to note that historic landings presented here do not include all landings for all states over the entire time period and are likely underestimated, particularly for the first third of the time series, since not all river landings were reported.

Total domestic coastwide landings averaged 18.5 million pounds from 1887 to 1928; however, landings information was sparse and only available intermittently during that time and ranged from a low of 22,000 pounds to a high of 85.5 million pounds. Coastwide landings increased sharply from lows in the early 1940s during World War II to more than 50 million pounds by 1951 and peaked at 74.9 million pounds in 1958. Severe declines in landings began coastwide in the early 1970s and domestic landings are now a fraction of what they were at their peak having remained at persistently low levels since the mid 1990s (Figure 2.1). Since the benchmark stock assessment, landings averaged just over 1.4 million pounds, which was almost identical to the average landings over the last five years of the benchmark stock assessment. Moratoria were enacted in Massachusetts (commercial and recreational in 2005), Rhode Island (commercial and recreational in 2006), Connecticut (commercial and recreational in 2002), Virginia (for waters flowing into North Carolina in 2007), and North Carolina (commercial and recreational in 2007, with the exception of a four day open season in the Chowan River during the week of Easter). As of January 1, 2012 river herring fisheries in states or jurisdictions without an approved sustainable fisheries management plan, as required under ASMFC Amendment 2 to the Shad and River Herring FMP, were closed. As a result, prohibitions on harvest (commercial or recreational) were extended to the following states: New Jersey, Delaware, Pennsylvania, Maryland, D.C., Virginia (for all waters), Georgia and Florida.

Foreign fleet landings of river herring (reported as alewife and blueback shad) are available through the Northwest Atlantic Fisheries Organization (NAFO) and are summarized in Table 2.2. Offshore exploitation of river herring and shad (generally $\leq$190 mm in length) by foreign fleets (NAFO areas 5 and 6; Figure 2.2) began in the late 1960s and landings peaked at about 80 million pounds in 1969. There have been no reported landings by foreign fleets since 1990.

2.1.2 Coastwide Commercial CPUE

Updated by: Dr. Mike Bailey, U.S. Fish and Wildlife Service; Benchmark Assessment Section by: Gary A. Nelson, Massachusetts Division of Marine Fisheries

All indices were normalized and graphed for comparative purposes. Linear and loess smoothers (Maindonald and Braun, 2003) were applied to all time series for a given state and species to elucidate trends in the annual estimates. Although offered as indices of relative abundance, the catch-per-unit-effort indices discussed below need to be validated in the future.

New York

Relative abundance of river herring is tracked through catch per unit effort (CPUE) statistics of fish taken from the targeted river herring commercial fishery in the lower Hudson River Estuary. All commercial fishers annually fill out mandatory reports. Data reported include catch, discards, gear, effort, and fishing location for each trip. Data within week is summarized as total catch divided by total effort, separately by gear type (fixed gill nets, drift gill nets, and scap nets). CPUE is calculated as the number of river herring caught per unit effort (square yards of net x hours fished). CPUE of the fixed gear fishery is used as an estimate of relative abundance as the fishery is located downriver of the spawning reach and it captures river herring moving through the reach to upriver spawning locations. Only data since 2000 was used as this is when mandatory reporting was enforced. CPUE for this gear declined slightly from 2000 to about 2006 then has slowly increased since (Figure 2.3). Since 2010, the CPUE for the Hudson is increasing.

New Jersey

New Jersey landing estimates for river herring were obtained from the NMFS for 1950 to 1999. These estimates are for the entire state and not solely from the Delaware Bay. River herring estimates for

2000 to 2010 were obtained from mandatory logbooks of the small mesh gill net fishery in Delaware Bay. The average reported landings for the time period is estimated at 8,263 pounds. There are no estimates of underreporting, however it is assumed that the current data for river herring are grossly underreported since the majority of landings are categorized as bait. New Jersey has voluntary effort data from reliable commercial fishermen in Delaware Bay. The fishery is directed towards white perch with river herring being a harvestable bycatch. The gear is not standardized and therefore the data should only be used for potential trends and not absolute numbers. CPUE has declined since 1997 (Figure 2.3). No additional data was entered for the update due to ongoing moratorium.

Maryland

River herring commercial landings and effort data from pound nets are available from the Nanticoke River. In general, CPUE has declined over time (Figure 2.3). No additional data was entered for the update due to ongoing moratorium.

Potomac River Fisheries Commission

River herring harvest in the Potomac River is almost exclusively taken by pound nets. In 1964, licenses were required to commercially harvest fish. After Maryland and Virginia established limited entry fisheries in the 1990's, the PRFC responded to industry's request and, in 1995, capped the Potomac River pound net fishery at 100 licenses. Catch-per-unit effort indices (kilograms of herring per pound net days- fished) are available from 1976-1980 and 1988-2010. CPUE indices from 1998-2008 for alewives are much lower than CPUE indices from 1976-1980 and values have declined since 1988 (Figure 2.3). No additional data was entered for the update due to ongoing moratorium.

Virginia

Annual commercial fishery harvest rates for alewives are available from 1994 to 2010 for selected Virginia waters. The harvest rates are computed as a ratio by dividing commercial harvest (kilograms) by the number of fishing trips for each area and gear. Only fishing trips with positive harvest of alewife were included in the calculations because only positive harvest is reported. Gill net harvest rates for alewife have been variable among Virginia water bodies from 1994 to 2007 (Figure 2.4). Harvest rates in the James River have been variable, but the data suggest a general decline through 2009 and an increase in 2010.

In the Rappahannock River, there was no obvious trend in harvest rates over time, though a small peak is evident in 2000. A three-year period of relatively higher rates occurred from 2002 to 2004 and an increase in 2010. Gill net harvest rates in the York River were highest after 2002 and showed an increasing trend through 2010. No additional data was entered for the update due to ongoing moratorium.

North Carolina

Harvest and effort data from the pound net fishery are available for alewife and blueback herring form the Chowan River from 1977 – 2015. CPUE (harvest divided by pound net weeks fished) for alewife declined from 1977 through the late 1990s, while CPUE for blueback herring declined from 1977 through the late 1980s (Figure 2.4). A slight increase in CPUE for alewife was observed through 2006. Blueback CPUE increased through the late 1990s but declined thereafter. The CPUE for blueback herring has continued to decline post 2010 assessment, while alewife numbers have been variable.

South Carolina

Annual estimates of CPUE (kg catch/man day) are available since 1969 from surveys of the Santee River and Cooper River blueback herring fisheries. Estimates of CPUE fluctuated widely over the time series. Estimates of CPUE were highest early in the time series in the Cooper River and declined dramatically soon after to a low that lasted through the late 1970s (Figure 2.4). Estimates increased again through the early 1980s and then declined as the Rediversion Canal was completed and flows shifted to the Rediversion Canal and the Santee River. CPUE increased in the Rediversion Canal and the Santee River but then began to decline in the late 1990s through 2006 and have since increased. Since 2010 the CPUE has been highly variable with no discernible trend.

Comparison of Trends in CPUE

Cluster analysis were not updated as there are now few systems that retain appropriate datasets for analysis.

2.1.3 Recreational Landings and Releases

Historically, there have been few reports of river herring being taken by recreational anglers for food. Most often, river herring were taken for bait. The Marine Recreational Statistics Survey (MRFSS) provides estimate of numbers of fish harvested and released by recreational fisheries along the Atlantic coast. MRFSS concentrates their sampling strata in coastal water areas and do not capture any data on recreational fisheries that occur in inland waters. Few states conduct creel surveys or other consistent survey instruments (diary or log books) in their inland waters to collect data on recreational catch of river herring. Some data are reported in the state chapters; but data are too sparse to conduct any systematic comparison of trends. These data were deemed not useful for management purposes during the benchmark assessment and were not updated.

2.1.4 Ocean Bycatch of River Herring

The Magnuson-Stevens Act defines bycatch as "fish which are harvested in a fishery but are not sold or kept for personal use […]" – i.e., discards. However, the term "bycatch" is often used to refer to both discarded fish and fish which are not targeted by a fishery but caught incidentally and landed. In this assessment, we do not use the stricter Magnuson-Stevens definition and instead use the terms "bycatch" and "incidental catch" interchangeably to refer to the total catch of river herring, regardless of final disposition, that is taken in fishery operations that target other species. We use the term "discards" to refer to the portion of the incidental catch that is discarded at sea.

2.1.4.1 River herring incidental catch estimates

Update and Benchmark Assessment Section by: Dr. Kiersten Curti, National Marine Fisheries Service

Methods

The total incidental catch of river herring was updated through 2015 following the methods described in the benchmark assessment, which were developed during Amendment 14 to the Atlantic Mackerel, Squid and Butterfish (MSB) Fishery Management Plan.

The total (retained + discarded) incidental catch of river herring (alewife and blueback herring) was quantified by fleet. Fleets included in the analyses were those sampled by the Northeast Fisheries Observer Program (NEFOP) and were stratified by region fished (Mid-Atlantic versus New England), time (year and quarter), gear group, and mesh size. Region fished was defined using statistical areas for reporting commercial fishery data; the Mid-Atlantic region included statistical areas greater than 600, and New England included statistical areas 464 through 599. Gear groups included in the analyses were: bottom trawls, paired midwater trawls, single midwater trawls, gillnets, dredges, handlines, haul seines, longlines, pots/traps, purse seines, scallop trawl/dredge, seines and shrimp trawls. Bottom trawls and gillnets were further stratified into three mesh-size categories:

Mesh category	Bottom Trawl	Gillnet
small	mesh ≤ 3.5	mesh < 5.5
medium	3.5 < mesh < 5.5	---
large	mesh ≥ 5.5	5.5 ≤ mesh < 8
x-large	---	mesh ≥ 8

In the benchmark assessment, trips with missing mesh information were dropped from the analysis. However, in analyses conducted since the benchmark, mesh was assumed based on gear or species caught. In this update assessment, mesh category for bottom trawl fleets was determined for trips with missing mesh information based on the primary species caught. For gillnets, trips with missing mesh information were assumed to come from the large mesh category.

The combined ratio method (Wigley et al. 2007) is the standard discard estimation method implemented in NEFSC stock assessments. We used this method to quantify and estimate the precision (CV) of river herring total incidental catch for 1989 – 2015 across all fleets. Incidental catch estimates for the midwater trawl (MWT) fleets are only provided for 2005-2015 because marked improvements to NEFOP sampling methodologies occurred in the high-volume MWT fisheries beginning in 2005, limiting the interpretability of estimates from these fleets in prior years.

For each trip, NEFOP data were used to calculate a total catch to kept (t/k) ratio, where t represents the total (retained + discarded) catch of an individual species (e.g., alewife) and k is the kept weight of all species. Annual estimates of total incidental catch were derived by quarter. Imputations were used for quarters with one or zero observed trips.

The t/k ratios were expanded using a raising factor to quantify total incidental catch. With the exception of the midwater trawl fleets, total landed weight of all species (from the dealer database) was used as the raising factor. Total landings from the dealer database are considered to be more accurate than those of the VTR database because VTR landings represent a captain's hail estimate. However, for the MWT fleets, we were unable to use the dealer data to estimate the kept weight of all species when stratifying by fishing area. When the area allocation (AA) tables were developed, MWT was not included in effort calculations because of difficulties determining effort for paired MWTs. Only those gears with effort information could be assigned to a statistical area. Consequently, VTR data were used as the expansion factor for the MWT fleets.

Results

Total incidental catch estimates by species are presented in Table 2.4.

From 2005-2015, the total annual incidental catch of alewife ranged from 36.5-531.7 metric tons (mt) in New England and 10.9-295.0 mt in the Mid-Atlantic. The dominant gear varied across years between paired midwater trawls and bottom trawls (Figure 2.5). Corresponding estimates of precision exhibited substantial interannual variation and ranged from 0-10.6 across gears and regions.

Total annual blueback herring incidental catch from 2005-2015 ranged from 8.2–186.6 mt in New England and 1.4-388.3 mt in the Mid-Atlantic. Across years paired and single midwater trawls exhibited the greatest blueback herring catches (Figure 2.6). Corresponding precision estimates ranged from 0-3.6.

The temporal distribution of incidental catches was summarized by quarter and fishing region for the most recent ten-year period (2005-2015) (Table 2.3). River herring catches occurred primarily in midwater trawls (62%, of which 48% were from paired midwater trawls and the rest from single midwater trawls), followed by small mesh bottom trawls (37%). Catches of river herring in gillnets were negligible. Across gear types, catches of river herring were greater in New England (59%) than in the Mid-Atlantic (41%). The percentages of midwater trawl catches of river herring were similar between New England (31.3%) and the Mid-Atlantic (30.5%). However, catches in New England small mesh bottom trawls were almost three times higher (27%) than those from the Mid-Atlantic (10%). Overall, the highest quarterly catches of river herring occurred in midwater trawls during Q1 in the Mid-Atlantic (28%), followed by catches in New England during Q4 (12%). Quarterly catches in small mesh bottom trawls were highest in New England during Q1 (9%) and totaled 5-7% during each of the other three quarters.

2.2 TRENDS IN FISHERIES-INDEPENDENT SURVEYS

Fisheries-independent data on alewives and blueback herring come from mostly historical reports and/or current work conducted by state, federal, and academic agencies as well as local citizen groups interested in protecting river herring resources. The data used in the summaries below were selected by state biologists during the benchmark assessment as reflecting trends in each state's alewife and blueback herring populations. Some data were not used because lack of statistical design, non-reflectance of natural abundance trends, and shortness of time series (see state reports for details).

2.2.1 Run Size Estimates

Updated by: Kevin Sullivan, New Hampshire Fish and Game; Benchmark Assessment Section by: Gary A. Nelson, Massachusetts Division of Marine Fisheries

Run sizes (total or escapement counts), proxies (number of fish lifted), or population sizes estimates of alewives and blueback herring (or both species combined) were available from six states, primarily from New England. Run sizes for Maine, New Hampshire, Massachusetts and Rhode Island were estimated using electronic counters or visual methods. Connecticut used the number of fish lifted at the Holyoke Dam and run counts made in 11 fishways using a variety of counting methods. North Carolina provided estimates of population sizes of blueback herring alewife in the Chowan River from stock assessments conducted in 2017 and 2005, respectively. South Carolina provided population abundance estimates from mark-recapture experiments for blueback herring in the Santee River. See state reports for full details. All time series were normalized (Z transformed) prior to analysis to eliminate scale and to make comparison of trends easier.

Maine

Run size estimates are available for the Androscoggin River (alewife) 1983-2015, Damariscotta River (alewife) 1977-2015, Kennebec River (combined species) 2006-2015, Sebasticook River (combined species) 2000-2015, and Union River (alewife) from 1982-2015 (Figure 2.7).

Androscoggin River - Since 1983 the DMR has operated the vertical slot fishway in the Brunswick dam located at the head-of-tide on the Androscoggin River. The construction of fish lifts at the next two up-stream dams, Pejepscot and Worumbo, allows passage of anadromous fish to Lewiston Falls. The majority of alewife habitat is located in the lakes and ponds in the Sabattus and Little Androscoggin rivers. These ponds are not currently accessible due to FERC licensed hydropower dams without upstream fish passage.

The DMR has transported alewives to ponds in these two drainages annually since 1983. The number stocked fluctuates widely over the years and relates to the amount and location of habitat stocked in previous years. The highest number of fish passed above the Brunswick fishway was 170,191 in 2012.

Damariscotta River - The Damariscotta fishery is one of the most studied fisheries in Maine. A 150-meter stone pool and chute fishway passes river herring into spawning habitat. The elevation of the 1,781-hectare lake is 16 meters above mean high tide. The efficiency of this fishway varies and its ability to pass larger female river herring was studied by Libby (1981). He concluded the male to female ratio of the commercial catch at the base of the fishway, compared to the ratio of alewives entering the lake favored males and directly relates to the efficiency of the fishway and its length. The ratios of males to females entering the lake were as high a 4:1 during the run. Unobstructed upstream passage is available to migrating fish throughout the run. Harvesters trap fish in a side channel that provides supplemental attraction water at the base of the fishway. The commercial fishery operates four days a week throughout the run. The number of fish entering the lake are counted during a ten minute period each hour and expanded to the hours of operation. The highest number of fish observed was 1,305,380 in 1977. The fishway was rebuilt after the last river herring assessment. Passage appears to have improved significantly as a result of the fishway modifications.

Kennebec and Sebasticook Rivers - The DMR implemented a restoration plan for alewives in the Kennebec River watershed above Augusta in 1986 as the result of an agreement with the majority of hydroelectric dam owners in the watershed. The plan called for the stocking of alewives in the program's initial years to rebuild the population, with fish passage provided later by the hydropower companies. This agreement was modified in 1998 and incorporated into the Kennebec River Settlement Accord, which resulted in the removal of the Edwards Dam in 1999, continued funding for the anadromous fish restoration program, and established new dates for fish passage. The alewife restoration program in the Kennebec River focuses on stocking lakes and ponds in the Sebasticook River watershed and Seven Mile Stream drainage. DMR has mainly stocked warm water lakes due to concerns of Maine Department of Inland Fisheries and Wildlife (IF&W) biologists that the restoration of alewives to cold water lakes might result in competition with smelt, an important forage species for landlocked salmon and brown trout. Results of a ten-year cooperative study in Lake George from 1987 through 1996, involving IF&W, DMR, and the Department of Environmental Protection (DEP),showed that the stocking of six alewives per surface acre of lake habitat had no negative impact on inland fisheries or water quality (Kircheis et al, 2002). Based on these findings, DMR and IF&W staff recommended the initiation of the restoration of alewives in additional lakes in the Sebasticook drainage. The highest numbers of stocked fish was 2,211,658 in 2009 in the Sebasticook River and 93,775 in 2008 in the Kennebec River.

Union River - The Town of Ellsworth maintains the Union River fishery by stocking adult alewives above the hydropower dam at head-of-tide. There is no free passage or upstream fish passage facility required at this hydropower station. The FERC license requires transporting river herring around the dam by Brookfield White Pine, the dam owners. Two lakes support this commercial fishery. The annual stocking rate (from 2015 forward) is 315,000 fish from the commercial run, during the harvest. The Union River is one of three commercially harvested resources with known escapement numbers. The highest number of stocked fish was 1,238,790 in 1986.

Common trends in run sizes were observed among rivers. Run sizes peaked during the 1980s in the Androscoggin River, Damariscotta River, and Union River. Run size declined in most rivers during the early 1990s, but it increased gradually and peaked again around 2004. In 2005, run counts dropped dramatically as a result of near-record high spring precipitation impeding upriver passage. Since 2005, increases and small declines in run size have been evident in all rivers (Figure 2.7). Fluctuations in run size for the Androscoggin, Kennebec, Sebasticook and Union rivers are likely influenced by DMR lifting and stocking activities.

New Hampshire

Run size estimates are available for the Cocheco River, Exeter River, Lamprey River, Oyster River, Taylor River and Winnicut River from 1972-2015 (Figure 2.8). Counts represent combined species totals or escapement numbers.

Cocheco River – The Cocheco River flows 48 km southeast through southern New Hampshire to Dover where it joins the Salmon Falls River to form the Piscataqua River. The lowermost dam (4.6 m high, built on a natural ledge for a total height of 8-10 m) on the Cocheco River is within the City of Dover at the head-of-tide, at rkm 6.1. A Denil fish ladder was constructed at the dam in 1969 to 1970 for anadromous fish by NHFGD, funded in part by the USFWS. The next barrier is a set of natural falls located at rkm 10.6. The City of Dover currently owns the dam and leases the attached hydroelectric facility to Southern New Hampshire Hydroelectric Development Corporation (SNHHDC). The FERC requires SNHHDC to provide downstream fish passage and utilize a grating system to prevent small fish from passing through the turbines. The downstream passage system is a PVC tube emptying in a plunge pool below the dam. This system successfully passes emigrating diadromous species when operating efficiently. Emigrating juvenile and adult river herring must either pass over the dam if flows allow, travel through the downstream migration tube, or move through the turbines at the hydroelectric facility if they can pass through the grating system. The highest number of river herring (combined species) passed upstream was 79,835 in 1995.

Exeter River - The Exeter River drains an area of 326 square km in southern New Hampshire. The River flows east and north from the Town of Chester to the Town of Exeter. It empties into Great Bay northeast of Exeter. The head-of-tide occurs at the Town of Exeter and the saltwater portion of the river is called the Squamscott River. The two lowermost dams on the main stem Exeter River are the Great Dam in Exeter at river kilometer (rkm) 13.5 and the Pickpocket Dam at rkm 26.9 (each 4.6 km high). The next barrier above Pickpocket Dam is a set of natural falls at rkm 38.1. NHFGD constructed upstream fish passage facilities (Denil fishways) on both dams from 1969 to 1971 for anadromous fish, funded in part by the USFWS. Fish ladder improvements occurred in 1994 and 1999 and a fish trap was constructed at the upriver end of the Great Dam fish ladder. There are no downstream fish passage facilities on either dam so emigrating adults and juveniles pass over the spillway when river flows allow. There are approximately one hundred meters of fresh water that occurs between head-of-tide and the Great Dam caused by an elevated ledge that prevents saltwater incursion. River herring have been observed below the Great Dam and have the ability to spawn in this area. Most spawning and rearing habitat occurs above the dam. Despite regulations introduced in 2005 to reduce harvest in the Exeter/Squamscott River it continues to account for between 53-88% of the total river herring harvested in New Hampshire between 2011 and 2015. Exeter/Squamscott River harvest in 2015 accounted for approximately 85% of all the river herring harvested in NH. However, the regulations introduced in 2005 implemented a daily limit of 1 tote per person and limited the fishery to only Saturdays and Mondays allowing for five days of escapement for migrating river herring. The highest number of river herring observed was 15,626 in 1981. The Great Dam and fish ladder were removed in the summer of 2016.

Lamprey River - The Lamprey River flows 97 km through southern New Hampshire to the Town of Newmarket where it becomes tidal and enters the Great Bay estuary just north of the mouth of the Squamscott River. The Macallen Dam, located at rkm 3.0 in Newmarket, is the lowermost head-of-tide dam (8.2 m high) on the Lamprey River. Fish passage on this river is a Denil fish ladder constructed from 1969 to 1970 for anadromous fish by NHFGD, funded in part by the USFWS. The Wiswall Dam is located 4.8 km above the Macallen Dam and passage Denil fish ladder was constructed in 2012. It has a 3.4 m spillway and is an effective barrier to upstream movement of river herring and other diadromous species. There are no downstream passage facilities at the Macallen Dam and emigrating juveniles and adults must pass over the spillway. Fish kills have not been observed below the first dam suggesting that adults and juveniles emigrate with limited mortality. The highest number of river herring observed was 86,862 in 2012.

Oyster River - The Oyster River drains a watershed of 27.5 km through southeast New Hampshire. It begins in Barrington and flows southeast to Lee, then flows east-southeast through Durham where it empties into Little Bay. The first dam exists at the head-of-tide just west of NH Route 108 at approximately rkm 5. The spillway length is 42.7 m and a height of 3 m. A Denil fish ladder was constructed at this dam around 1975. The next barrier to fish passage is a dam at about rkm 7.6. As with the other rivers, high flows in 2005, 2006, and 2007 might have contributed to lower juvenile production resulting in low returns for this and future years. Unpublished data acquired by the University of New Hampshire in the fall of 2005 showed hypoxic conditions in the impounded reaches of the Oyster River (Brian Smith, personal communication). The highest number of fish observed was 157,024 in 1992.

Taylor River - The Taylor River is located in southeastern New Hampshire and is about 17.1 km long. The river begins on the border between Hampton Falls and Kensington, New Hampshire. It flows north, east, then southeast through Hampton Falls where it meets tide water at Interstate 95. The lowermost 6.4 km of the river forms the boundary between Hampton and Hampton Falls. The first dam is located at rkm 3.2. There is a Denil fish ladder at this head-of-tide dam that was constructed in the late 1960s. The next dam is a barrier to further fish passage and is located at rkm 5.1. Since 2009 the fish ladder was operated only as a swim through due to staff constraints and low return numbers. Due to the lack of a trap for fish collection, no biological sampling has been conducted since 2010. The Taylor River has had very low return numbers for the past ten years. Eutrophication of the Taylor River impoundment compounded by high flow years in 2005, 2006, and 2007 are believed to be the main reasons for the decline. The highest number of river herring observed was 450,000 in 1976. Annual monitoring of the Taylor River for estimates of river herring returning was removed from the state management plan in 2015.

Winnicut River - The Winnicut River drains a watershed of 36.8 square km in southeast New Hampshire. It originates in the town of North Hampton and flows north through Greenland where it empties into Great Bay. The only barrier to fish passage was a dam at the head-of-tide at approximately 1.6 rkm. The dam was built in 1957 by NHFGD to create waterfowl habitat and is located in the Town of Greenland. It had a height of 4 m and a spillway length of 23.2 m and incorporated a Canadian Step Weir fishway. This type of fishway is not efficient for the passage of river herring; however with modifications, limited numbers of river herring do utilize this fishway. The Winnicut River head-of-tide dam and associated fish ladder were removed during the summer of 2009. A pool-and-weir fishway was constructed approximately 100 meters upstream from the former dam site in a river constriction under the NH Route 33 bridge because under certain flow conditions this constriction could be a possible velocity barrier to upstream migrating adult river herring. Improper design and construction of the fishway has prevented all river herring from passing the site since 2011. The highest number of river herring observed was 8,359 in 2008.

Common trends in run sizes were observed among rivers. Run sizes peaked either during the late 1970s-early 1980s (Lamprey River, Taylor River, and Exeter River) or the early 1990s (Cocheco River and Oyster River) (Figure 2.8). Declines in run size from peak abundance were observed through the mid-1990s in the Lamprey River and Taylor River, or briefly during the mid-1990s in the Cocheco River and Oyster River. Run sizes increased gradually and peaked around 2003-2004 in the Cocheco River, Exeter River, Lamprey River and Winnicut River but they continued to decline in the Oyster River and Taylor River. In 2005, run counts may have dropped as a result of near-record high spring precipitation impeding upriver passage. Run counts dropped dramatically in 2005-2006 in most rivers, but appear to have rebounded or increased during 2007 in the Cocheco River, Lamprey River, and Winnicut River. Run sizes in the Cocheco River and Lamprey River have reached time series highs, while those in the Exeter River, Oyster River and Taylor River remain low. In 2009 and 2010, run size in the Winnicut River declined before passage was halted by an improperly designed fishway.

Massachusetts

Run size estimates are available for the Mattapoisett River, Monument River, Nemasket River and Parker River from 1972-2015 (Figure 2.9).

Mattapoisett River – Since 1988, a local watershed group, Alewives Anonymous, has provided total and escapement abundance estimates of alewives by using an electronic fish counter at the fish ladder located at the outlet of Snipatuit Pond in Rochester (River mile: 11.1). This counter is used to estimate the number of alewives reaching the final and primary spawning impoundment (710 acres). The highest number of alewife observed was 132,500 in 2000.

Monument River - DMF has been scientifically monitoring the abundance, sex composition, length structure, age composition and removals of alewives and blueback herring populations in the Monument River, Bournedale, Massachusetts since the early 1980s. Prior to 1985, abundance was estimated by using visual counts following the statistical design of Rideout et al. (1979). Since 1985, run size has been estimated by using a Smith-Root electronic fish counter that is calibrated daily. The counter is situated just upstream of the river mouth at the top weir of the fish ladder at Benoit's Pond Dam in Bourne (River Mile: 0.2). The highest numbers of alewives and blueback herring observed were 597,937 in 2000 and 104,645 in1984, respectively.

Nemasket River - Since 1996, members of the Middleborough/Lakeville Herring Fishery Commission has provided abundance estimates of alewife escapement using visual counts and the Rideout et al. (1979) design. Counting takes place at the upstream exit of the Wareham Street Dam and fishway (River mile: 7.5). The highest number of alewives observed was 1,919,000 in 2002.

Parker River - The Parker River is a small stream arising in the town of Boxford and flowing 25.8 km north and east into Plum Island Sound. The freshwater portion drops 20 m during its 12.5 km length and flow is impeded by six low head dams. A pool-and-weir fish ladder was built at each dam. In 1974, the pool-and-weir fishway at dam 6 was replaced by a Denil type ladder. Since 1997, the Parker River Clean Water Association has been estimating run size at the first dam using visual counts and the statistical design of Rideout et al. (1979). Due to heavy rains in 2005, the weir at dam 1 was damaged and continues to run at lower efficiency. The highest number of alewives observed was 38,102 in 1973.

Total run sizes of alewives in the Mattapoisett River and Monument River increased from lows in the later 1980s and peaked in 2000 (Figure 2.9). After 2000, alewife run sizes declined precipitously in the Mattapoisett River, Monument River and Parker River. Run size in the Nemasket River peaked in 2002 and declined thereafter. For blueback herring, total run size was highest in the Monument River during 1980-1991, but it dropped to lower levels during 1992-2002. In 2005, run counts may have dropped dramatically as a result of near-record high spring precipitation impeding upriver passage. Since the run lows, river herring abundance has been increasing slowly.

Rhode Island

Run size estimates of alewives are available for Buckeye Brook, Gilbert-Stuart River and Nonquit River from 1980-2015 (Figure 2.10).

Buckeye Brook - The Buckeye Brook Coalition and RI DFW partnered in 2003 to initiate a direct count program utilizing volunteers. The highest number of fish observed was 90,625 in 2012.

Gilbert-Stuart River - Gilbert Stuart has an Alaskan steeppass fishway which provides access to 68 acres of nursery and spawning habitat. Gilbert Stuart Pond empties into the Narrow River and discharges into the Atlantic Ocean. RI DFW has estimated spawning stock size since 1981 by electronic fish counter or direct count methods. The highest number of alewife observed was 290,814 in 2000.

Nonquit River - Nonquit has a Denil fishway which provides access to 202 acres of nursery and spawning habitat. Nonquit Pond spills into Almy Brook which joins the Sakonnet River and empties into the Atlantic Ocean. The Division has estimated spawning stock size at Nonquit since 1999 by a solar powered electronic fish counter. The only known data prior to 1999 included run size estimates (80,000) from 1976. The highest number of alewife observed was 230,853 in 1999.

Total run size of alewife in the Gilbert-Stuart River increased from the early 1990s through 2000 (Figure 2.10). Dramatic drops in run size were observed after 1999-2000 in the Gilbert-Stuart River and Nonquit River, and after 2003 in Buckeye Brook. Run sizes in all rivers increased through 2010, but have declined since.

Connecticut

A proxy of blueback herring run size (number of fish lifted) was available for the Connecticut River from 1966 to 2015. Shorter time series (2002-2015) were available for alewives and blueback herring in Bride Brook, Mianus River, Mill Brook, Naugatuck River, Shetucket River, and Farmington River.

Bride Brook – The number of alewives passing has varied considerably over the short time series (Figure 2.11). The highest number observed in the time series (354,862) occurred in 2013.

Connecticut River – The number of blueback herring lifted at the Holyoke Dam increased dramatically from the late 1970s and peaked around 1985 (Figure 2.11). After 1985, the number of fish lifted began to decline and it dropped precipitously after 1991. The number of fish lifted has remained close to pre-1977 levels since 2002. The highest number of fish observed was 630,000 in 1985

Farmington River – Removed from analysis for the update upon request of the state (see CT section of state-specific report for details).

Mianus River - Trends in alewife and blueback counts were nearly identical (Figure 2.11). Counts of both species increased beginning in 2006, peaked in 2007-2008, and declined in 2009, increased again for a few years through 2012-2014 and then declined again. The highest numbers of alewives and blueback herring observed were 121,401 in 2012 and 29,424 in 2014, respectively.

Mill Brook - The number of alewives passing has varied considerably over the short time series (Figure 2.11). Numbers declined in 2008, increased from 2010 to 2012 and have declined. The highest number of fish observed was 15,361 in 2012.

Naugatuck River - Removed from analysis for the update upon request of the state (see CT section of state-specific report for details).

Shetucket River - The numbers of alewives and blueback herring passing have varied considerably without trend over the short time series (Figure 2.11). The highest numbers of alewife and blueback herring observed were 2,422 in 2007 and 394 in 2001, respectively.

North Carolina

Population size estimates of alewives and blueback herring from age-structured assessment models are available for the Chowan River from 1972-2003 and 1972-2015, respectively.

Chowan River - Alewife abundance in the Chowan River fluctuated widely without trend prior to 1985, declined dramatically through 1989, increased slightly in 1990, but it continued to decline through 2003 (Figure 2.12). Blueback herring abundance declined in the late 1970s, increased during the early 1980s and peaked in 1983, and has steadily declined since 1992. The highest numbers of alewife and blueback herring estimated in the model were 19,348,550 fish in 1984 and 133,738,077 fish in 1976, respectively.

South Carolina

Population abundance estimates of blueback herring are available for the Santee River from 1980-1990.

Santee River - Abundance increased from a low of 664,000 fish in 1982 to a high of 9,000,000 fish in 1986 (Figure 2.12). Blueback population size declined briefly in 1987 but then increased to the highest estimated level of 9,353,000 in 1990.

Comparison of Trends

Historical river counts were compared to identify common trends among rivers. It should be noted that trends may not reflect natural variation in some rivers due to events like anthropogenic changes to river access (see state reports for more detail). All data were normalized prior to analysis. Common trends were identified via hierarchical, agglomerative cluster analysis with the group average linking method using linear (Pearson) correlations among all rivers as the measures of similarity. Normalized river counts were then plotted together based on major grouping identified in the cluster dendrogram. Trends among rivers were examined for four time periods: 1984-2010, 1999-2010, 2003-2010, and 2008-2015. The first period was selected to include as many rivers as possible with long time series, and the latter periods were selected to examine recent changes in river counts from as many rivers as possible. Rivers in the analysis of years 1984-2010 included the Union River, Androscoggin River, and Damariscotta River in Maine, the Lamprey River, Taylor River, Cocheco River and Oyster River in New Hampshire, the Monument River in Massachusetts, the Gilbert-Stuart River in Rhode Island, and the Connecticut River in Connecticut. The 1999-2010 period included the aforementioned rivers plus the Winnicut River and Exeter River in New Hampshire, the Nonquit River in Rhode Island, and the Mattapoisett River, Nemasket River, and Parker River in Massachusetts. The 2003-2010 period included the aforementioned rivers plus the Sebasticook River in Maine, the Buckeye River in Rhode Island, and the Farmington River and Bride Brook in Connecticut.

1984-2010 - Cluster analysis grouped the similarities of trends in river counts into four main groups (Figure 2.13). Group 1 represents rivers (Monument River alewife, Gilbert-Stuart alewife, Oyster River Both, and Cocheco River Both) in which run sizes increased from 1984, peaked around 2000-2005 and remained low thereafter (Oyster River Both and Monument River alewife) or increased (Gilbert-Stuart alewife and Cocheco River Both; Figure 2.13). Group 2 represents rivers (Androscoggin River alewife, Damariscotta River alewife, and Lamprey River Both) in which run sizes increased from 1984, peaked before 1990, declined to lows in the mid 1990s. Group 3 represents rivers (Connecticut River blueback, Monument River blueback, Union River alewife, Chowan River blueback, and Taylor River Both) in which run sizes peaked in the mid 1980s, declined through 1990, before peaking again in the early 1990s. Runs declined after the early 1990s and remain at very low (Chowan, Taylor, and Connecticut) or relatively low (Monument blueback and Union River alewife) levels. River locations for each cluster group are shown in Figure 2.14 and show that the rivers in Group 1 are located in southeastern New England, those in Group 2 are located in New Hampshire, those in Group 3 are located from New Hampshire through northern New England, and those in Group 4 are scattered throughout New England.

1999-2010 - Cluster analysis grouped the similarities of trends in river counts into three main groups (Figure 2.15). Group 1 represents rivers (Gilbert-Stuart River, Mattapoisett River, Parker River, Taylor River, Oyster River, Connecticut River, Monument River, Nonquit River, Chowan River, and Exeter River) in which run sizes declined starting in the early 2000s (Figure 2.16). Since the decline, run sizes have remained low (Oyster River, Connecticut River, Exeter River, Chowan River, and Taylor River) or have increased over time (Gilbert-Stuart River, Monument River alewife, Mattapoisett River, Parker River, and Nonquit River) , albeit slowly in some cases. Group 2 represents rivers (Union River and Nemasket River) in which run sizes increased through 2002, declined through 2004 or 2005, and then increased. Group 3 represents rivers (Androscoggin River, Winnicut River, Lamprey River, Cocheco River, and Damariscotta River) in which run sizes increased from 1999, peaked in 2003-2004, dropped precipitously in 2004-2005, increased through 2007-2009. River locations for each cluster group are shown in Figure 2.17 and show that the rivers in Groups 1 and 3 are located from New Hampshire through north New England and from New Hampshire through southern New England, respectively.

2003-2010 - Cluster analysis grouped the similarities of trends in river counts into three main groups (Figure 2.18). Group 1 represents rivers (Exeter River, Bride Brook, Sebasticook River, Gilbert-Stuart River, Nemasket River, and Union River) in which run sizes increased from 2008 lows to time series or near time series highs between 2009 and 2010. Group 2 represents rivers (Chowan River, Parker River, Monument

River, Connecticut River, Mattapoisett River, Lamprey River, Oyster River, Cocheco River, Taylor River, and Damariscotta River) in which run sizes declined from 2000-2004 levels to lows between 2006 and 2007, and either increased or stabilized through 2010. Group 3 represents rivers (Androscoggin River, Winnciut River, Buckeye River and Nonquit River) in which run sizes either increased from 2005-2006 levels to peaks in 2008 and then steep declines after through 2010 (Figure 2.19). River locations for each cluster group are shown in Figure 2.20 and show that the rivers in Group 1 and 2 are scattered throughout New England, while those from Group 3 are primarily located from New Hampshire through southern New England.

2008-2015 - Cluster analysis grouped the similarities of trends in river counts into four main groups (Figure 2.21). Group 1 represents rivers (Nonquit River, Oyster River, and Taylor River) in which run sizes decreased through 2011-2012 and remained low thereafter (Figure 2.22). Group 2 represents rivers (Cocheco River and Exeter River) in which run sizes were relatively stable between 2008 and 2014 and then increased sharply in 2015. Group 3 represents rivers (Androscoggin River, Buckeye River, Gilbert-Stuart River, and Union River) in which run sizes peaked in 2012 and declined thereafter to near time series lows in 2015. Group 4 represents rivers (Chowan River, Mattapoisett River, Damariscotta River, Monument River, Nemasket River, Connecticut River, Bride Brook, Lamprey River, Parker River, and Sebasticook River) in which runs were relatively low early in the time series, increased to peaks between 2011 and 2014 and declined after. River locations for each cluster group are shown in Figure 2.23 and show that the rivers in Group 1 and 2 are scattered throughout New England, while those from Group 3 are primarily located from New Hampshire through southern New England.

Major declines in run sizes occurred in many rivers during 2001 to 2005. These declines were followed by increasing trends (2006 to 2010) in the Androscoggin River (ME), Damaraiscotta River (ME), Nemasket River (MA), Gilbert-Stuart River (RI), and Nonquit River (RI) for alewife and in the Sebasticook River (ME), Cocheco River (NH), Lamprey River (NH), and Winnicut River (NH) for both species combined. No trends in run sizes were evident following the recent major declines in the Union River (ME), Mattapoisett River (MA), and Monument River (MA) for alewife and in the Exeter River (NH) for both species combined. Run sizes have declined or are still declining following recent and historical major declines in the Oyster River (NH) and Taylor River (NH) for both species, in the Parker River (MA) for alewife, and in the Monument River (MA) and Connecticut River for blueback herring.

Cluster analysis was done for the assessment update using the same three periods used in the benchmark (1984-2010, 1999-2010, 2003-2010) with the addition of a fourth period to include the most recent years in the dataset (2008-2015). The grouping for 1984-2010 did not change with the exception of the fact that groups 1 and 2 from the benchmark were combined into a single grouping as there were no apparent differences in the trends of each group used in the benchmark assessment. Similarly, the groupings of the benchmark assessment cluster analysis for the period of 1999-2010 did not change. However, the Chowan River blueback herring dataset was included in the assessment update and was added to this group. For the final period examined in the benchmark assessment (2003-2010) there was a change in groupings as a result of changes in datasets from those previously submitted and the exclusion of the Farmington River. Most notable was the shift of groupings in the update compared to the benchmark assessment caused by the movement of the Exeter River, Damariscotta River, and Monument River alewife, Parker River, and Bride Brook. The new time period to look at trends in the most recent eight years (2008-2015) did not result in groupings similar to the corresponding final eight year period (2003-2010) used in the benchmark analysis. It is difficult to discern any consistent trends as to why the two periods differ, but suggests that rivers along the Atlantic Coast that were previously grouped together for similar trends have not been experiencing similar population trends in the years since the benchmark.

2.2.2 Young-of-the-Year Seine Surveys

Updated by: Kevin Sullivan, New Hampshire Fish and Game; Benchmark Assessment Section by: Gary A. Nelson, Massachusetts Division of Marine Fisheries and Katie Drew, Atlantic States Marine Fisheries Commission

States of Maine, Rhode Island, Connecticut, New York, New Jersey, Maryland, District of Columbia, Virginia, and North Carolina conduct fixed seine surveys that capture young-of-the-year alewives and blueback herring generally during summer and early fall. Detailed descriptions for each survey are found in state reports; a brief description and comparisons of trends are given below.

Maine – The State of Maine conducts an annual YOY alosine survey for six Maine rivers including Merrymeeting Bay. The survey began in 1979 and expanded to include 17 fixed stations and includes data from a separate juvenile striped bass survey designed to assess the numbers of juvenile striped bass in the lower Kennebec River. Geometric mean indices for blueback herring and alewives are used as relative indices of abundance. Indices for alewives fluctuated without trend over the time series, although large peaks in relative abundance occurred in 1979, 1983, 1995, 2000, and 2015 (Figure 2.24). For blueback herring, relative abundance was near zero from 1979 through 1991 but it increased gradually through 2004 before declining in recent years (Figure 2.25).

Rhode Island –The YOY survey is conducted weekly each fall at five stations in the Pawcatuck River estuary. It began in 1988 and the geometric mean index represents relative abundance for combined species. Relative abundance in the Pawcatuck River estuary fluctuated widely but generally increased through 2002 and it declined thereafter (Figure 2.24).

Connecticut – The YOY survey is conducted weekly during the months of July through October at stations located between Essex, CT (river km 10) and Holyoke, MA (river km 140). It began in 1978 and the geometric mean catch per seine haul is used as the relative index of blueback herring abundance. Relative abundance of YOY blueback herring fluctuated widely prior to 1989, but it declined gradually over time with a large increase in 2010 (Figure 2.25).

New York – The YOY survey was designed to index alosines and occurs in the upper half of the estuary (RM 60-140) which is generally fresh water and is the nursery reach for alosines. It began in 1980 and the geometric mean number of fish per haul is used as the relative abundance indices for alewives and blueback herring. Relative abundance of YOY alewives was low prior to 1999, but has increased since then, with large year-to-year fluctuations (Figure 2.24). For blueback herring, indices fluctuated widely throughout the time series, but appeared to decline during the late 1990s and then remained stable but variable through the present (Figure 2.25).

New Jersey – The YOY survey is conducted biweekly from August to October at fixed stations in the Delaware River. The survey began in 1980 and the geometric mean catch per haul is used as a relative index of abundance for alewives and blueback herring. The YOY index for alewives fluctuated without trend over the time series, although peaks in relative abundance occurred in 1988 and 1996 (Figure 2.24). Relative abundance of blueback herring fluctuated widely to high peaks through 2000, and then dropped to lower levels with less variability during 2001-2015 (Figure 2.25).

Maryland – The YOY survey is conducted monthly at fixed stations in the Maryland portion of Chesapeake Bay from summer through late fall. The survey began in 1959 and the geometric mean per haul is used as relative abundance indices for alewives and blueback herring. Relative abundance of alewives fluctuated widely without trend between 1959 and 1977 (peak abundance occurred in 1970) and it declined to lower levels and was less variable during the mid-1980s and early-1990s (Figure 2.24). A slight increase in average relative abundance occurred following 1992. Relative abundance indices for blueback herring also fluctuated without trend prior to 1970, it declined to low levels (except for increase in 1978) and was less variable during the mid-1980s and early-1990s (Figure 2.25). After 1992, the average magnitude and variation in relative abundance increased.

District of Columbia – The YOY survey is conducted annually in the Potomac River and Anacostia River. Sampling occurs monthly from May through August. The survey began in 1990 and the log of the mean number of fish per haul+1 is used as relative abundance indices for blueback herring and alewives. Relative abundance of alewives has declined since the series started in 1990 through 2003, and has remained low since then (Figure 2.24). Relative abundance of blueback herring increased from near zero levels during 1990-1994, and has shown large year-to-year variability and increasing trend since then (Figure 2.25).

Virginia – Indices of YOY relative abundance for alewife and blueback herring come from the VIMS Juvenile Striped Bass Seine Survey which tracks trends in the annual year-class strength of striped bass in the spawning and nursery areas of the lower Chesapeake Bay. The survey began in 1967 with a gap from 1974-1979, and the geometric average number of fish per seine set for all rivers combined (James, York, and Rappahannock rivers) was used as the relative abundance index in the benchmark assessment. VIMS provided data from 1990 onward, when the current sampling stratification was implemented. For the assessment update, only the Rappahannock River survey was included as geometric means of all rivers combined was not provided. Relative abundance of alewives and blueback herring fluctuated at low levels without trend, although increases occurred in 2010 for alewife and 2015 for blueback herring (Figure 2.24 and Figure 2.25).

North Carolina – The seine survey began nursery area sampling for YOY blueback herring and alewives in the Albemarle Sound area in 1972. Sampling occurs at 11 fixed stations during June-October and an additional 13 fixed stations are sampled in September of each year. The geometric mean number of fish per haul is used as the measure of the relative abundance. Relative abundance of alewives peaked during 1977-1980, it dropped to low levels during 1981-1994, and it increased slightly through 2004, but has dropped again in recent years (Figure 2.24). For blueback herring, relative abundance peaked in 1973 and declined through 2010 (Figure 2.25).

Comparison of Trends in YOY Seine Surveys - Indices of relative abundance were compared to identify common trends among river systems. Common trends were identified via hierarchical agglomerative cluster analysis with group average linking (Clarke, 1993) using linear (Pearson) correlations among all rivers as the measures of similarity. All data were normalized ((obs-mean)/sd) prior to analysis. Cluster groupings were identified based primarily on the largest distances shown in the cluster dendrogram; however, secondary groups were identified to aid in comparison of trends. Normalized indices were plotted together based on major grouping identified in the cluster dendrogram. Trends among systems were examined for two time periods: 1980-2015 and 1993-2015. The former period was selected to include as many surveys as possible with long time series, and the latter period was selected to examine recent changes in indices from as many systems as possible. The 1980-2007 period included surveys from Maine, Connecticut, New York, New Jersey, Maryland, and North Carolina. The 1993-2007 period included surveys from Maine, Rhode Island, Connecticut, New York, New Jersey, Maryland, District of Columbia, Virginia, and North Carolina.

1980-2007 - Cluster analysis grouped the similarities of trends in YOY indices into three main groups (Figure 2.26). Group 1 represents YOY indices for blueback herring from New Jersey and Connecticut and both species from North Carolina which shows peak levels in the early 1980s followed by declines, remaining at relatively low levels of abundance. Group 2 represents river systems in which YOY indices were highly variable with no apparent trends present (New Jersey alewife and both species in New York). Group 3 represents YOY indices of both species from Maryland and Maine, which showed similar fluctuations in relative abundance with peaks occurring around 1995 and 2005. With the exception of blueback herring in Maine, they have increased since 2013.

1993-2007 - Cluster analysis grouped the YOY indices into five main groups (Figure 2.27). Group 1 represents YOY indices from Connecticut River blueback herring and the District of Columbia alewife, which showed peaks in the early 1990s then declines to low levels, although the District of Columbian saw a single peak in 2002 and Connecticut River blueback herring had a peak in 2010 and variable thereafter. Group 2 represents YOY indices from Rhode Island and Maine that showed similar peaks in relative abundance in 1995, 2000, and 2004. Group 3 represents New York's Hudson River which showed similar peaks in relative abundance in 1999, 2001, 2004, and 2007. Alewives in the Hudson River remain relatively low and blueback herring show more variability but included a time series peak in 2014. Group 4 represents YOY indices for blueback herring in the District of Columbia and both species in Maryland and

Virginia, which showed similar peaks in relative abundance in 1996-1997 and 2011, with abundance at low levels between 2001 and 2005 (except Maryland Alewife) with all increasing in the most recent years. Group 5 represents YOY indices for alewives and blueback herring from New Jersey and North Carolina that showed similar peaks in relative abundance in 1996, 2000-2001, and 2003, but have remained low (New Jersey) or shown greater variability (North Carolina) since.

The young-of-the-year (YOY) seine surveys were quite variable and showed differing patterns of trends among rivers. Maine rivers showed similar trends in alewife and blueback herring YOY indices after 1991 with peaks occurring in 1995 and 2004. YOY indices from North Carolina, and Connecticut showed declines form the 1980s. New York's Hudson River showed peaks in YOY indices in 1999, 2001, 2005, 2007, and 2014. New Jersey and Maryland YOY indices showed peaks in 1994, 1996, and 2001. Virginia YOY surveys showed peaks in 1993, 1996, 2001, and 2003.

Inclusion of datasets for the period after the benchmark up to 2015 did not show any changes in trends outlined in the benchmark assessment. Indices of alewife from YOY seine surveys remained at relatively low levels similar to those seen for the period prior to 2011. Blueback herring also remained similar to levels observed in the terminal years of the benchmark assessment, although some surveys (Virginia, Maryland, and District of Columbia) have seen increases in 2014-2015. The clustering for 1980-2015, was similar to that of the benchmark assessment, although clustering changed as a result of New Jersey seine surveys previously grouped with Maryland is now grouped with New York for alewife and with Connecticut and North Carolina for blueback herring. The five groups from the benchmark assessment cluster analysis for this period have been reduced to three. Two clusters (Maine and Maryland) were combined to a single cluster in this update and the group containing only the Virginia seine survey in the benchmark is absent as no data was submitted for the period of 1980 to 1988. For the cluster analysis of the second time period (1993-2015) five groupings were again selected as was done in the benchmark assessment. Three of the groupings remained the same (Groups 1, 2, and 3 of this update), but two groups changed with the addition of data after 2010. It is difficult to discern a pattern of movement between groupings, but in the benchmark assessment North Carolina alewife and blueback herring were split between two groups and are now in a single group with both species for New Jersey. New Jersey was previously grouped with both species from Virginia and Maryland, which are still grouped together and now also include District of Columbia blueback herring.

2.2.3 Juvenile-Adult Seine, Gillnet and Electrofishing Surveys

Updated by: Dr. Mike Bailey, U.S. Fish and Wildlife Service; Assessment Benchmark Section by: Gary A. Nelson, Massachusetts Division of Marine Fisheries

Rhode Island has conducted large seine fixed station surveys for juvenile and adult river herring in coastal ponds and Narragansett Bay since 1988. Virginia has conducted a multi-panel gillnet surveys for adult river herring in the Rappahannock River since 1991. In addition, Virginia has conducted an electroshocking survey in the Rappahannock and James Rivers since 2000; however the data collection has ended. Similarly, Florida has conducted an electroshocking survey in the St. John's River since 2001 (see state reports for details). Fish biologists from respective states believe that the estimates of catch-per-unit-effort from each watershed reflect changes in river herring abundance.

Rhode Island

Seine CPUE for combined species in Narragansett Bay fluctuated without trend from 1988-1997, increased through 2000, declined and then remained stable from 2001-2004, increased again in 2005, and declined in 2009 (Figure 2.28). The pond survey CPUE increased during 1993-1996, declined through 1998, increased in 1999, declined through 2002, peaked in 2012, and then declined and fluctuated without trend thereafter. A significant correlation (rho=0.71, $p \leq 0.01$) between CPUEs from the pond survey (lagged forward two years) and the Narragansett Bay survey was found in the benchmark analysis. However, addition of data from 2011 to 2015 does not show a significant correlation (p=0.413) with the addition of more years of data, suggesting that the pond survey may not fully capture year-class strength.

Virginia

Gillnet CPUE for both species in the Rappahannock River ended in 2010 and, therefore, was not included in the update. The electrofishing CPUE indices for alewives and blueback herring in the Rappahannock River and James River were highly variable for the time series (Figure 2.29).

Florida

The electrofishing CPUE indices for blueback herring in the St. John's River declined precipitously from 2001 to 2002 and has fluctuated without trends since 2003 (Figure 2.29).

Comparison of Electrofishing CPUE Trends

Simple correlation analysis was used to compare trends in electrofishing CPUE from 2001-2015. The correlation coefficient between Rappahannock alewife and blueback herring indices indicated a significant ($p\leq0.05$), negative correlation between species in the original analysis; however the addition of 5 more years of data has not shown a continued relationship (p=0.561). The Rappahannock blueback herring indices were not significant for the entire time series for either the James River survey (p=0.01) or the Florida electrofishing survey (p=0.07). For the James River blueback and Florida blueback comparison, a significant ($p\leq0.01$), positive correlation between the two time series was evident in the original analysis but not significant for the expanded data set (p = 0.233). The common trend among the Virginia and Florida electrofishing survey occurred in 2004 and 2015 when the Rappahannock River alewife index, James River blueback herring index, and St. John's River blueback herring index increased (Figure 2.29).

2.2.4 Juvenile and Adult Trawl Surveys

Updated by: Dr. Edward A. Hale, DNREC, DFW; Benchmark Assessment Section by: Dr. John A. Sweka, US Fish and Wildlife Service, Northeast Fishery Center

The purpose of this analysis was to update the summarization of trends in river herring relative abundance data from fisheries independent trawl surveys through 2015. The trawl surveys used in this analysis are shown in Table 2.5 . Details of each survey are provided in individual state summaries. The majority of surveys grouped juvenile and adult fish together (Table 2.5) and no effort was made to develop separate juvenile and adult indices from combined data.

Trawl surveys for river herring can be quite variable, making inferences about population trends uncertain. Observed time series of relative abundance indices represent true changes in abundance, within survey sampling error, and varying catchability over time. One approach to minimize measurement error in the survey estimates is by using autoregressive integrated moving average models (ARIMA, Box and Jenkins 1976).

The ARIMA approach derives fitted estimates of abundance over the entire time series whose variance is less than the variance of the observed series (Pennington 1986). Helser and Hayes (1995) extended Pennington's (1986) application of ARIMA models to fisheries survey data to infer population status relative to an index-based reference point. This methodology yields a probability of the fitted index value of a particular year being less than the reference point [P(indext<reference)]. Helser et al. (2002) suggested using a two-tiered approach when evaluating reference points whereby not only is the probability of being below (or above) the reference point is estimated, the statistical level of confidence is also specified. The confidence level can be thought of as a one-tailed α-probability from typical statistical hypothesis testing. For example, if the P(indext<reference) = 0.90 at an 80% confidence level, there is strong evidence that the index of the year in question is less than the reference point. This methodology characterizes both the uncertainty in the index of abundance and in the chosen reference point. Helser

and Hayes (1995) suggested the lower quartile (25th percentile) of the fitted abundance index as the reference point in an analysis of Atlantic wolfish (*Anarhichas lupus*) data. The use of the lower quartile as a reference point is arbitrary, but does provide a reasonable reference point for comparison for data with relatively high and low abundance over a range of years.

Autoregressive integrated moving average models (ARIMA, Box and Jenkins 1976) were fit to log transformed trawl survey indices. In cases where a survey contained "0" values for one or more years, a small number (0.01) was added to the index prior to log transformation. In this analysis, the final year of a given trawl survey was compared to the 25th percentile of the fitted index values and a confidence level of 80% was used to assess the probability of the final year of the survey being less than the bootstrapped mean (n = 1000) of the 25th percentile reference point [P(<0.25)]. ARIMA models were fit in R version 3.3.2 and functions in the R package 'Fish Methods' (Nelson 2017) were used for the ARIMA model fit and comparison to reference points. Values of P(<0.25) were summarized by location of the trawl surveys – northern vs. southern surveys with a general separation occurring at Long Island. Trawl surveys with 10 or more years of data were included in 2010. Small differences in the survey indices were present in both alewife and blueback herring data sets for the DE adult trawl survey as well as the Maine-New Hampshire Inshore trawl survey in the updated data. To determine if those differences were significant, the updated data were analyzed through 2010, with similar results being found in terms of the probability of the index value in 2010 being greater than the bootstrapped mean reference point for the time series. Similarly, small difference in the annual indices of the NEFSC bottom trawl at the coast wide and northern regional level were present in the updated data. However, because of changes to the survey design, alewife were no longer present in the southern region in the fall survey. Other than the lack of an alewife index in the southern region during the fall, no substantial differences were present in the updated data when compared to previous analyses. Therefore, all surveys analyzed in 2010, were updated with data through 2015 and reanalyzed.

Trends in trawl survey indices varied greatly with some surveys showing an increase in recent years, some showing a decrease, and some remaining stable. Trawl surveys in northern areas tended to show either an increasing or stable trend in alewife indices (Figure 2.30 and Figure 2.32) whereas trawl surveys in southern areas tended to show stable or decreasing trends in alewife indices (Figure 2.31 and Figure 2.32). The NEFSC surveys showed a consistent increasing trend coastwide and in the northern regions for alewife. The probability of the final year of the survey being less than the 25th percentile reference point [P(<0.25)] ranged from 0 to 0.464 for alewives (Table 2.6) and 0 to 0.540 for blueback herring (Table 2.7). These probabilities tended to be less in northern regions compared to southern areas for alewife (Table 2.8). However, the differences in mean P(<0.25) were not as pronounced between northern and southern regions for blueback herring (Table 2.8) Overall, patterns in trends across surveys were less evident for blueback herring (Figure 2.33, Figure 2.34 and Figure 2.35).

Overall, the results of the 2015 ARIMA assessment update suggest similar spatial trends as were observed in 2010 for river herring. There appeared to be a greater likelihood of trawl surveys showing a decrease for those surveys in the southern areas, particularly for alewife. However, general spatial trends in blueback were less apparent compared to alewife by region, as well as when compared to values observed in 2010 despite the updated analyses showing a greater mean likelihood of surveys below the reference point than the northern region. Again when taken into context with the 2010 assessment, these observations are consistent with hypotheses concerning the effects of climate change on fish species distributions. Nye et al. (2009) showed the center of biomass for many stocks surveyed with the NEFSC bottom trawl survey has moved northward through time and changes in distribution were correlated with large-scale warming and climactic conditions such as the Atlantic Multidecadal Oscillation. In addition to the NMFS data used in this analysis, data from other sources also show similar patterns.

2.3 TRENDS IN MEAN LENGTH

Updated by: Kevin Sullivan, New Hampshire Fish and Game; Benchmark Assessment Section by: Dr. Gary A. Nelson, Massachusetts Division of Marine Fisheries

Length data come from Maine, New Hampshire, Massachusetts, New York, Maryland, North Carolina, South Carolina, and Florida. Fork length data were converted to total length when applicable. Mean length was calculated for each year by species and sex and the time series were examined to determine if changes have occurred over time. The Mann-Kendall test for trends in data was used to test if negative or positive trends occurred in the mean length data. A significance level of 0.05 ($p = 0.05$) was used to determine whether a statistically significant trend was present.

Maine

Plot of the mean total length for female and male alewife from the Androscoggin River versus year indicated that average sizes were slightly larger in the late 1980s than average sizes in the remaining years (Figure 2.36). However, the Mann-Kendall test did not detect a significant trend (Table 2.9).

New Hampshire

Plots of mean total lengths from fisheries-independent monitoring versus year for the Cocheco River, Exeter River, Lamprey River, Winnicut River, and Oyster River showed variable trends depending on river and species. For alewives, mean total lengths varied without trend in the Cocheco River, Lamprey River, and Winnicut River. The only significant trend for alewives detected by the Mann-Kendall test was a decline observed for males in the Exeter River (Figure 2.36; Table 2.9). For blueback herring, mean total lengths of female and males varied without trend in the Winnicut River, but notable declines were observed for males in the Cocheco River and for both sexes in the Oyster River (Figure 2.37). Significant trends in decreasing average size were detected for the Oyster River and Cocheco River blueback herring (Table 2. 9).

Massachusetts

Plots of the mean total length from fisheries-independent monitoring versus year for the Monument River show an apparent decline in the average sizes of male and female alewives (Figure 2.36) and blueback herring (Figure 2.37) from 1979 through the mid-1990s. Trend analyses of mean lengths indicated significant decreases in mean length for males and females of both species in the Monument River (Table 2.9).

New York

Mean lengths represent spawning stock lengths from the Hudson River Estuary. NY used only the least size-biased gears from the NYSDEC surveys: electro-fishing gear, the beach seine (61m) and the herring haul seine (91m). As sample size varied among years, all data were combined to characterize size. Mean total length are shown for adult alewives and blueback by sex ($\geq$170mm TL) in Figure 2.36 and Figure 2.37. Following the benchmark assessment, NYSDEC Staff implemented a new methodology for determining appropriate sample sizes for trend analysis. This new methodology changes the historical data used in the benchmark assessment to a subset of the data presented in Figure 2.36 and Figure 2.37 (see state report), including time series for females of both species that are shorter than 10 years. Trend analyses of mean lengths indicated no significant trend for males of both species (see state report for results).

Maryland

Alewives and blueback herring in the Nanticoke River were collected from commercial pound nets and fyke nets and a minimum of ten alewives and ten blueback herring were selected at random from unculled commercial catches. Samples were counted, sexed, length measured and scales removed for age analysis. Mean lengths of male and female alewives appeared to decline over the time series available (Figure 2.36). Blueback herring of both sexes showed a decline over the time series and are near their lowest values in the time series. Trend analyses of mean lengths indicated significant decreases in mean length for males and females of both species (Table 2.9).

North Carolina

The State of North Carolina conducts biological sampling of alewife and blueback herring from fishery-dependent pound net collections in the Chowan River. Length are available from 1972-2015. Declines in mean sizes of male and female alewife (Figure 2.36) and blueback herring (Figure 2.37) were apparent. Trend analyses of mean lengths indicated significant decreases in mean length for males and females of both species (Table 2.9).

South Carolina

Mean length of blueback herring taken in the commercial fisheries in the Santee Rediversion Canal varied widely among years (Figure 2.37). Mean length of males showed a slight declining trend over the time series through 2010 after which it began increasing. Mean length of females showed a slight increasing trend. Mean length of females has exceeded that of males since 2001. Blueback herring in the commercial catch tended to be smaller than those that survived the fishery and were lifted over the St. Stephen Dam (Figure 2.37). Trend analysis of mean lengths indicated no decline in mean lengths over time (Table 2.9).

Florida

An anadromous fish study in 1972 and 1973 used a commercial herring seine to capture blueback herring and other Alosines in the St. John's River. The seine was 306 m long, 131 meshes deep, 6.03 - 6.35 cm stretched mesh, bag with 5.08 cm stretched mesh. Modern length samples are collected by electrofishing. Mean lengths are lower in the 2001-2007sampling period than they were in the 1972 and 1973 samples (Figure 2.37). Trend analysis of mean lengths indicated a significant decline in mean length of female blueback herring over time (Table 2.9).

The general results of these analyses were that mean sizes for male and female alewife declined in 4 of 9 rivers, and mean sizes for female and male blueback herring declined in 6 of 9 rivers. The common trait among most rivers in which significant declines were detected is that length data were available prior to 1990. Mean lengths started to decline in the mid to late 1980s; therefore, it is likely that declines in other rivers were not detected because of the shortness of the time series.

National Marine Fisheries Service Trawl Survey

NEFSC bottom trawl survey data was analyzed by geographical region and season. Because of the large number of strata (376) and high variability in catches of river herring per tow, strata were aggregated into three regions for spring surveys (March – June): coastwide, north of Long Island and south of Long Island. Fall surveys (September – December) were only aggregated coastwide because of low catches in southern survey strata.

Mean lengths for combined sexes in trawl surveys were quite variable through time for both alewives and blueback herring (Figure 2.38). Despite this variability, alewife mean length tended to be lower in more recent surveys (Figure 2.38). This pattern was less apparent for blueback herring. Trend analysis of mean lengths indicated significant declines in mean lengths over time for alewives coastwide and in both regions in the spring, and for blueback coastwide and in the northern region in the fall (Table 2.10).

In this assessment update, one river systems previously included in the benchmark assessment was excluded due to a time series shorter than ten years (Stony Brook) and one new river system (St. John's River) was included. Updated trend analysis shows a continuation of the declining mean size of both species mentioned in the benchmark assessment. A significant decline in mean length of alewives was found in 5 of the 9 river systems examined. There were no reversals in significant trends of alewife mean length since the benchmark assessment, but two systems (Exeter River and Nanticoke River) previously exhibiting no significant trend now have significant declines in mean length of alewives. Similarly, blueback herring mean length is significantly declining in 7 of the 9 river systems examined. There was one reversal in trend since the benchmark, with the significant decline in mean length of female blueback herring in the Santee-Cooper fishlift no longer apparent. However, the Cocheco River and St. John's River (not included in benchmark) are two additional significant trends in decreasing mean length of blueback herring.

Trends in mean lengths from the NEFSC bottom trawl survey were similar to those of the benchmark, but previously significant declines for alewives in the fall are no longer significant, and the south region of the spring survey that was not significant in the benchmark is now significant in this update. Blueback herring trends in mean length are the same as they were in the benchmark, with the exception of the lack of the significant decline in blueback mean length during the spring survey in the south region that was observed in the benchmark assessment.

2.4 TRENDS IN AGE DATA

Updated by: Ben Gahagan, Massachusetts Division of Marine Fisheries; Benchmark Assessment Section by: Dr. Gary A. Nelson, Massachusetts Division of Marine Fisheries

Age data comes from commercial and fisheries-independent sampling programs, although lengths of the time series differ greatly (see state reports for more details). In general, female alewife and blueback herring are larger and heavier, and grow slightly faster than males of the same species and age, although blueback herring are smaller than alewife.

2.4.1 Trends in Maximum Age

Age data of fish from rivers in Maine, New Hampshire, Massachusetts, Rhode Island, Maryland, and North Carolina were included in the analysis.

Maine

The maximum age of both male and female alewife from the Androscoggin River was generally ≥age 6 during the 1990s, but it decreased by about one age during the late 1990s and early 2000s (Figure 2.39). Maximum age has since increased to early 1990s levels for female alewife, but male maximum age has fluctuated between 4 and 7 during the 2010's. Scale samples were not collected form Androscoggin River alewife in 2015. The maximum age of both sexes of alewife in the Sebasticook River has been stable in the range of 5 to 6 years, with an occasional max age of 7, throughout the time series.

New Hampshire

In 2010, New Hampshire Fish and Game switched from random sampling to bin sampling, which may have altered biases in the data over the time series. For alewife, the general trend in maximum age of females and males was river dependent. River restoration work on the Winnicut River has caused the time series for both species to be discontinued after 2010. In the Cocheco River and Lamprey maximum age increased from age 6 to ages 7 – 8 in the early 2000s and have remained in that range through 2015. (Figure 2.39). In the Exeter River, maximum age increased in the early 1990s, but it has been relatively stable at age 6 since that time except for a slight decline in 2010 (Figure 2.39). For blueback herring, the general trend in maximum age of females and males was river dependent. In the Cocheco River, maximum age has fluctuated widely, and a lack of blueback herring in recent years has led to insufficient sample sizes for analysis (Figure 2.40). In the Oyster River, maximum age increased by one age beginning in 2001 and has remained at this level for females. The maximum age for males has shifted between 5 and 6 since 2010.

Massachusetts

In 2013, Massachusetts Division of Marine Fisheries switched ageing structures form scales to otoliths. Analyses suggest that otoliths increased the precision of age estimates but did not alter accuracy biases. Maximum age of male and female alewife (Figure 2.39) and male and female blueback herring (Figure 2.40) in the Monument River declined from ages 7 – 8 in the mid-1980s to ages 5 – 6 during the early 1990s and has remained relatively stable since that time.

Rhode Island

Maximum age of male and female alewife (Figure 2.39) in the Gilbert-Stuart River declined from ages 6 – 7 in the mid-1980s to ages 5 – 6 during the 2000s and has remained stable since.

Maryland

Since the benchmark assessment, Maryland officially adopted the MA DMF ageing protocol (see state report). Maryland also introduced new agers in 2011 and 2014, which may have introduced error or bias into recent age estimates. Maximum age of male and female alewife from the Nanticoke River has decreased slightly over the past 25 years. Male alewife were predominately 7-8 until 2000 with a range of 6-7 since. Female alewife shifted from a range of 8-9 to a range of 7-8 in the late 2000's (Figure 2.39). Maximum age of male and female blueback herring from the Nanticoke River declined from ages >9 during the early 1990s to ages5 – 6 and 6 – 7, respectively, during 2005 – 2014 (Figure 2.40).

North Carolina

The maximum age observed for male and female alewife ranged from ages 5 to 9 (Figure 2.39). Due to ageing error identified during the assessment (see state report), updated alewife data were not included in the analysis and the trend determination from the benchmark assessment (declining) was not updated. Maximum age of male and female blueback herring from the Chowan River was generally ≥age 7 prior to 1984 but it declined thereafter to ages 6 – 7 through 2003 (Figure 2.40). After 2003, maximum age declined to ages 5 – 6 and the lowest maximum age was reported in 2014.

Data provided in the update added little information to this visual analysis. In terms of maximum age no trends appear reversed and most runs had stable ages. Lamprey River (NH) alewife maximum age appears to be trending upward, while Nanticoke River (MD) alewife and blueback herring, and Chowan River (NC) blueback herring maximum ages appear to have dropped. In future assessments, the value of examining the number of age classes present in a population should be examined as an alternate metric to maximum age.

2.5 TRENDS IN MEAN LENGTH-AT-AGE

Updated by: Kevin Sullivan, New Hampshire Fish and Game Department and Dr. Edward A. Hale, DNREC, DFW; Benchmark Assessment Section by: Dr. Gary A. Nelson, Massachusetts Division of Marine Fisheries

Mean lengths-at-age of alewife and blueback herring from state data were examined to determine if changes have occurred over time. The Mann-Kendall test for trends in data was used to test if negative or positive trends occurred in the mean length data for each age. A significance level of 0.05 ($p = 0.05$) was used to determine whether a statistically significant trend was present. Due to low sample sizes, only time series of ages 3-6 mean lengths were tested for trends. In order to determine if mean length-at-age for both alewife and blueback herring has changed since 2010, data were updated to 2015 and re-analyzed. Of the 112 Rivers-Species-Age combinations updated (111 with data, as there was no data available for Gilbert-Stuart Alewife Male age 6), 26 have reversed in terms of their significance when compared to the analysis preformed in 2010. Of those reversals, 11 have become non-significant, when they were categorized as significant in 2010 and 16 changed from non-significant to significant (Table 2.11). Updated data were verified by state specific TC representatives before being analyzed and included in the update to account for disagreements in all cases. In addition to analyzing the total time series for each time series, we separately analyzed a reference period from 2006-2015.

Maine

Maine DNR conducts biological sampling of alewives at fish ladders in the Androscoggin River. Length and age data are available from 1993-2010. For alewives, ages observed on the run ranged from 3 to 7 but most fish were ages 4-6. No updated data was submitted for the update so trend analysis was not possible.

New Hampshire

Length and age data for alewives and blueback herring from the Cocheco River, Exeter River, Lamprey River, Oyster River and Winnicut River have been collected by New Hampshire since 1990. For alewife, ages 3-9 fish were collected on the runs. Plots of mean lengths-at-age showed sizes varied among age, river and sex, but in some rivers, mean lengths-at-age showed some decrease in recent years (Figure 2.41). Trends analyses indicated significant declines in mean lengths-at-age for ages 4-5 female and 3-5 male alewife from the Cocheco River, for age 4 females and ages 3-4 males from the Exeter River, for ages 3-5 females and ages 3 and 4 males from the Lamprey River, and for age 4 females and age 3 males from the Winnicut River (Table 2.11). For blueback herring, ages 3-8 fish were collected on the runs. Plots of mean lengths-at-age showed sizes among age, river and sex, but in some rivers, mean lengths-at-age showed some declines over times (Figure 2.42). Trends analyses indicated significant declines in mean lengths-at-age for ages4-6 females and ages 3-6 male blueback herring from the Cocheco River, for ages 3-5 males and females from the Oyster River, and for age 4 females and age 3 males from the Winnicut River (Table 2.15). Trend analyses of the most recent ten years (2006-2015) detected significant increases in length-at-age for age-6 alewife of both sexes in the Cocheco River age-5 females and ages 5-6 males in the Exeter River (Table 2.11). Trend analyses of blueback herring for the same period detected significant increases in age-4 and age-6 females and age-4 and age-5 males in the Oyster River (Table 2.11).

Massachusetts

Length and age data for alewives and blueback herring from the Monument River have been collected since 1984, although age data were only intermittently collected prior to 1993. Mean lengths-at-age were plotted by sex and year to determine if changes in growth have occurred over time. Unfortunately, data from 1984-1987 were not available for historical comparison. For alewives, ages 3-8 fish were collected on the run. Although variable, mean length-at-age of alewives for ages 3-5 of both sexes appeared to decline in the mid-1990s and increased near the latter part of time series (Figure 2.43). There were no significant changes in size-at-age detected in the trend analyses (Table 2.11). For blueback herring, ages 3-7 fish were collected on the run. Mean lengths-at-age of both sexes varied without trend (Figure 2.42). There was only a significant decline of age 5 males detected in the trend analysis of the time series (Table 2.15). Trends analysis of the most recent ten years (2006-2015) detected a significant increase of age-3 female alewife and age-4 blueback herring of both sexes (Table 2.11).

Rhode Island

The State of Rhode Island conducts biological sampling of alewife at fish ladders in the Nonquit River and Gilbert Stuart River. Length and age data are available from 2000-2015 in the Nonquit River and from 1984-2015 in the Gilbert Stuart River; however no samples were collected during the mid-late 1990s (Figure 2.43). Ages 2-8 alewives were found in both rivers, although the runs were comprised mostly of ages 3-6. No significant changes in mean lengths-at-age for alewife in the Nonquit River were detected by trend analysis with data through 2010 and again with data through 2015. From 2006-2015, significant increases were detected for ages 5 and 6 female, as well as ages 4 and 5 male alewives. Significant decreases in mean length at-age were originally detected for age 4 females and males of the Gilbert Stuart. However, with the updated data, significant decreases in mean length at age were only detected in age 4 males through 2010, and no significant trends were detected using data through 2015 for either sex. From 2006-2015, significant increases in alewives were present in age 3 and age 4 males in the Gilbert-Stuart. No other significant trends were detected (Table 2.11).

Maryland

Maryland DNR collects biological samples of alewife and blueback herring from fishery-dependent pound nets in the Nanticoke River. Length and age data are available from 1989-2015. For blueback herring, individuals of ages 3-9 have occurred on the run, but most fish are ages 3-6 (Figure 2.42). Few fish of ages 7-8 have been observed in catches since the late 1990s. Mean lengths for most ages have shown little trend over time except for slight declines in the latter part of time series. A significant decline in mean length was detected only for age-5 male blueback herring when originally analyzed in 2010. However, updated data demonstrated that significant declines in mean length at age were detected for age-3, age-6 male blueback herring in addition to age-5 through 2010. When analyzed through 2015, significant declines in mean length at age were detected for age-3, age-4, age-5, and age-6 male blueback herring (Table 2.11). For alewife, individuals of ages 3-9 have occurred on the run, but most fish are ages 3-6 (Figure 2.43). Fish of age 9 have been rare in catches since the early 1990s. Mean lengths for most ages have shown little trend over time. Significant declines in mean length were detected only for age-5 female and male alewife when originally evaluated in 2010. However, updates to the data indicate that significant declines have occurred in mean length of age-6 female and age-3, age-4, age-5 male alewife through 2010. Similarly, the results of the updated analyses suggest mean length of age-6 female and age-3, age-4, and age-5 male alewife have declined through 2015. However, no significant trends were detected in mean length at age for either species from 2006-2015 (Table 2.11).

North Carolina

The North Carolina DMF collects biological samples of alewife and blueback herring from fishery-dependent pound nets in the Chowan River. Fork length and age data are available from 1972-2009 for alewife and 1972-2015 for blueback herring. Due to ageing error identified during the assessment (see state report), updated alewife data were not included in the analysis. For alewife, fish of age 2 (rare) through age 8 occur on the run but most fish are ages 3-6 (Figure 2.44). Plots of mean lengths-at-age for female and male alewife show that the sizes of most ages have declined over time (Figure 2.44). Trends analyses detected significant declines in sizes for all ages and sexes tested in 2010, again with updated data through 2010 and data through 2015 (Table 2.11). For blueback herring, fish of age 2 (rare) through age 9 occur on the run but most fish are ages 3-7 (Figure 2.44). Plots of mean lengths-at-age for female and male blueback herring show that the sizes of most ages have declined over time (Figure 2.44). Trends analyses detected significant declines in size for all ages and sexes tested in 2010, again with updated data through 2010 and data through 2015 (Table 2.11). However, significant increases were detected from 2006-2015 in male, age-5 blueback (Table 2.11).

Comparison of Trends

Declines in mean length of at least one age were observed in most rivers examined. The lack of significance in some systems is likely due to the absence of data prior to 1990 when the decline in sizes began, similar to the pattern observed in mean length (see Section 2.3). Declines in mean lengths-at-age for most ages were observed in the north (New Hampshire) and the south (North Carolina). There is little indication of a general pattern of size changes along the Atlantic coast.

2.6 TRENDS IN REPEAT SPAWNING FREQUENCY DATA

2.6.1 Trends in Coastwide Repeat Spawner Rates

Updated by: Ben Gahagan, Massachusetts Division of Marine Fisheries; Benchmark Assessment Section by: Laura M. Lee, North Carolina Division of Marine Fisheries and Katie Drew, Atlantic States Marine Fisheries Commission

Rates characterizing the percentage of repeat spawners were calculated and evaluated for alewife and blueback herring populations along the U.S. East Coast where data were available. Repeat spawner data for these species have been collected from various fisheries-independent (Table 2.12 Summary of fisheries-independent data sources that have collected repeat spawner data from river herring. Species indicates whether data were available for alewives (A), blueback herring (B), or both species combined (river herring, R).) and fisheries-dependent (Table 2.13 Summary of fisheries-dependent data sources that have collected repeat spawner data from river herring. Species indicates whether data were available for alewives (A), blueback herring (B), or both species combined (river herring, R). monitoring programs. Detailed information on the individual surveys of state water bodies can be found in the individual state summary reports. Repeat spawner rates were calculated by dividing the number of sampled fish with one or more spawning marks by the total number of fish sampled and multiplying the resulting quotient by 100. Rates were calculated by sex, year, water body, gear, and species (when possible) for each state.

Comparisons among the repeat spawner rates from different states were not made due to the large variability in sampling gears and time series available. For data series that had at least five continuous years of data and ten years of data overall, the Mann-Kendall test for trend in data collected over time. A significance level of 0.05 ($\alpha = 0.05$) was used to determine whether a statistically significant trend was present.

2.6.1.1 Fisheries Independent Repeat Spawner Rates

A summary of the available repeat spawner data for river herring collected by fisheries-independent surveys is presented in Table 2.12 Summary of fisheries-independent data sources that have collected repeat spawner data from river herring. Species indicates whether data were available for alewives (A), blueback herring (B), or both species combined (river herring, R). Annual estimates of repeat spawner rates based on data from these surveys are presented in Tables 2.14 – 2.23.

Maine

Androscoggin River: Repeat spawner data collected from the Brunswick Fishway on the Androscoggin River were available from 2005 through 2014. Scale samples were not collected in 2015. Species-specific data on repeat spawners were not available and so rates represent alewives and blueback herring combined, although very few bluebacks are sampled in the Androscoggin River. Also, detailed information on the number of spawning marks at age was not available. For the assessment update, Maine provided the entire time series as combined sexes rather than split. Repeat spawner rates ranged between 13.5% and 57.9% over the 10 year time series. The four most recent years were below the 10 year mean. (Table 2.14).

New Hampshire

New Hampshire has been collecting repeat spawning data from river herring sampled from fishways on the Cocheco, Exeter, Lamprey, Oyster, and Winnicut Rivers. Because of low sample size by species, the data were not analyzed by sex (Table 2.15 and Table 2.16 Estimated rates of repeat spawning for blueback herring (both sexes combined) observed in New Hampshire's fisheries-independent fishway surveys of the Cocheco and Oyster Rivers by year. [-- indicates inadequate sample size.]; Figure 2.45). Cocheco River: Alewife in the Cocheco River had up to four spawning marks; repeat spawners ranged from age 3 – 9. The proportion of repeat spawners ranged from 30.4 – 69.6% and showed no statistically significant trends (Table 2.15

Blueback herring in the Cocheco River had up to four spawning marks; repeat spawners ranged from age 3 – 8 (Table 2.16 Estimated rates of repeat spawning for blueback herring (both sexes combined) observed in New Hampshire's fisheries-independent fishway surveys of the Cocheco and Oyster Rivers by year. [-- indicates inadequate sample size.]). Sample sizes were inadequate in 2009-2012 and 2014-2015, and low in several years. The proportion of repeat spawners ranged from 12.5 – 44% and showed no statistically significant trends.

Exeter River: Alewife in the Exeter River had up to three spawning marks; repeat spawners ranged from age 4 – 8 (Table 2.15). The proportion of repeat spawners ranged from 9.0 – 48.6% and showed no statistically significant trends. Blueback herring sample sizes from the Exeter River were too small (0-12 fish in most years) to be analyzed.

Lamprey River: Alewife in the Lamprey River had up to four spawning marks; repeat spawners ranged from age 3 – 9 (Table 2.15). The proportion of repeat spawners ranged from 33 – 63% and showed no statistically significant trends. Blueback herring sample sizes from the Lamprey River were too small (0-12 fish in most years) to be analyzed.

Oyster River: Alewife sample sizes from the Oyster River were too small (0-16 fish in most years) to be analyzed. Blueback herring in the Cocheco River had up to four spawning marks; repeat spawners ranged from age 3 – 8 (Table 2.16 Estimated rates of repeat spawning for blueback herring (both sexes combined) observed in New Hampshire's fisheries-independent fishway surveys of the Cocheco and Oyster Rivers by year. [-- indicates inadequate sample size.]). The proportion of repeat spawners ranged from 20.0 – 68.8% and showed no statistically significant trends.

Winnicut River: Restoration work in 2010 prevented adequate collection of biological samples from 2011-2015. Alewife in the Winnicut River had up to four spawning marks; repeat spawners ranged from age 4 – 9 (Table 2.15). The proportion of repeat spawners ranged from 32.9 – 63.3% and showed no statistically significant trends. Blueback herring sample sizes from the Oyster River were too small (0-12 fish in most years) to be analyzed.

Massachusetts

Information on repeat spawner percentage of river herring species in Massachusetts was available from fisheries-independent dip net surveys of several rivers. Repeat spawner data from the Mattapoisett River, the Quashnet River, and Stoney Brook were limited and so not summarized here, but calculated repeat spawner rates can be found in Tables 2.17 and 2.18. In 2013, Massachusetts Division of Marine Fisheries discontinued processing scale samples from all site-species combinations with the exception of alewife in the Monument River.

Monument River: Repeat spawner data for alewives sampled during fisheries-independent surveys of the Monument River were available from 1986 through 1987, 1993, and from 1995 through 2015. Age-specific data were not available for 1986 and 1987. Of alewife that had spawned previously in recent years, most had only one spawning mark. Repeat spawner rates for male and female alewives were much higher in 1986 and 1987 (41–45%) compared to the most recent years available (1–15%;

Table 2.17 and Table 2.18). The Mann-Kendall test indicated both sexes had experienced a statistically significant decline in percentage of repeat spawners.

Repeat spawner data for blueback herring collected by dip net during fisheries-independent surveys of the Monument River were available from 1986 through, 1993, and from 1995 through 2013. As with alewives, age-specific data were not available for 1986 and 1987. None of the blueback herring sampled from 2004 to 2010 had more than one spawning mark. Repeat spawner rates for both male and female blueback herring were higher in 1986 and 1987 (20–38%) than in recent years (4–14%;Table 2.19 Estimated rates of repeat spawning for male blueback herring observed in Massachusetts, New York and South Carolina fisheries-independent surveys in select rivers by year and gear type. and Table 2.20 Estimated rates of repeat spawning for female blueback herring observed in Massachusetts, New York and South Carolina fisheries-independent surveys in select rivers by year and gear type.), similar to what was observed for alewives. As with alewives, the Mann-Kendall test indicated both sexes had experienced a statistically significant downward trend in percentage of repeat spawners.

Mystic River: Repeat spawner data for alewives were collected from 2004 to 2013 and for blueback herring from 2005 to 2013 as part of fishery independent surveys of the river. Alewife had up to four spawning marks on their scales and blueback had up to three. For alewives, the percentage of repeat spawners ranged from 0-33.9% for males and from 0-46.1% for females (

Table 2.17 and Table 2.18). For blueback herring, the percentage of repeat spawners ranged from 5.7-48.9% for males and from 2.7 – 51.8% for females (Table 2.19 Estimated rates of repeat spawning for male blueback herring observed in Massachusetts, New York and South Carolina fisheries-independent surveys in select rivers by year and gear type. and Table 2.20 Estimated rates of repeat spawning for female blueback herring observed in Massachusetts, New York and South Carolina fisheries-independent surveys in select rivers by year and gear type.). Nemasket River: Repeat spawner data for alewives collected from the Nemasket River were available from 2004 through 2013. Male alewife repeat spawners were between 3 and 7 years old, while females ranged in age from 3 to 7 years. Both male and female alewife repeat spawners had from one to three spawning marks. Repeat spawner rates for males and females were similarly variable from 2004 through 2013, ranging between 9% and 44% (

Table 2.17 and Table 2.18). There was no statistically significant trend for either sex over this time-period. No repeat spawner data were available for blueback herring from the Nemasket River.

Town Brook: Repeat spawner data for alewives collected by the fisheries-independent survey of Town Brook were available from 2004 through 2013. Male alewives that previously spawned ranged from 3 to 7 years in age, while females ranged in age from 3 to 7 years. Of alewives that had spawned previously, most had only one spawning mark. The percentage of male alewives that previously spawned ranged from 4.41% to 32.3% (

Table 2.17). Repeat spawner rates for female alewives ranged from 7.9% to 36.7% (Table 2.18). There was no statistically significant trend for male alewife over this time-period but female alewife experienced a statistically significant upward trend in percentage of repeat spawners. Blueback herring repeat spawner data were only available for 2005 for Town Brook (Table 2.19 Estimated rates of repeat spawning for male blueback herring observed in Massachusetts, New York and South Carolina fisheries-independent surveys in select rivers by year and gear type. and Table 2.20 Estimated rates of repeat spawning for female blueback herring observed in Massachusetts, New York and South Carolina fisheries-independent surveys in select rivers by year and gear type.). All of the blueback herring sampled were virgin spawners, although the sample size was very low.

Rhode Island

Rhode Island has been collecting repeat spawning data from river herring sampled from fishways in Gilbert Stuart Stream and Nonquit Pond. The data were not available by species, so calculated repeat spawner rates represent alewives and blueback herring combined.

Gilbert Stuart Stream: Repeat spawner data collected during sampling of the fishway at Gilbert Stuart Stream were available for intermittent years from 1984 through 1989 and were available for all years from 1991 – 2014. In 2015, returns to the Gilbert Stuart were too low to provide enough biological samples for a repeat spawning percentage calculation. Male repeat spawners ranged from 3 to 7 years in age while female repeat spawners ranged in age from 3 to 8 years. Male and female repeat spawners had from one to three spawning marks, and most had only one spawning mark. Repeat spawner rates have been variable for both male and female river herring through the time series (Table 2.21 Estimated rates of repeat spawning for male river herring observed in Rhode Island's fisheries-independent fishway surveys in select rivers by year. and Table 2.22 Estimated rates of repeat spawning for female river herring observed in Rhode Island's fisheries-independent fishway surveys in select rivers by year.; Figure 2.46). The percentage of males that had previously spawned ranged from a low of 4.44% in 2005 to a high of 81.4% in 1986. Rates of repeat spawner for females ranged from a low of 3.3% in 2009 to a high of 59.3% in 1992. The Mann-Kendall test indicated a statistically significant downward trend over time for both male and female repeat spawner rates.

Nonquit Pond: Repeat spawner data has been collected from river herring sampled at the Nonquit Pond fishway since 2000 and were available through 2015, with the exception of 2010. Male repeat spawners ranged in age from 3 to 7 years and most had only one spawning mark. Estimated repeat spawner rates for male river herring were variable, ranging from 0% to 25.7% over the time series. Female repeat spawners were between 3 and 7 years in age and, like the male repeat spawners, most had one spawning mark. Repeat spawner rates for females ranged from 0 to 34.1% and showed a general decrease from 2000 through 2007. The Mann-Kendall test indicated there was no statistically significant trend in repeat spawner rates for the Nonquit.

New York

River herring repeat spawner data collected from fisheries-independent surveys of the Hudson River Watershed in New York were combined over all gears and areas sampled.

Hudson River: Repeat spawner data for alewives sampled from the Hudson River were available from 1999 through 2001 and 2009 through 2015 (Table 2.23 Estimated rates of repeat spawning for male and female alewife observed in New York's fisheries-independent surveys in the Hudson River by year.). However, since the benchmark assessment, data from the earlier period have been determined to be unreliable and NYSDEC Staff recommended against their use (see state report). Therefore, the reliable data time series is less than 10 years and no trend analysis results are reported.

Repeat spawner data on blueback herring collected from the Hudson River were available from 1989 through 1990, 1999 through 2001, and 2009 through 2015 (Table 2.19 Estimated rates of repeat spawning for male blueback herring observed in Massachusetts, New York and South Carolina fisheries-independent surveys in select rivers by year and gear type. and Table 2.20 Estimated rates of repeat spawning for female blueback herring observed in Massachusetts, New York and South Carolina fisheries-independent surveys in select rivers by year and gear type.). However, since the benchmark assessment, data from 1999-2001 have been determined to be unreliable and NYSDEC Staff recommended against their use (see state report). Therefore, the reliable data time series is less than 10 years and no trend analysis results are reported here.

South Carolina

Santee River: Repeat spawner data for blueback herring sampled from the Santee River were available from 1978 through 1983 and 2014 through 2015. Repeat spawner data for alewives were not available from the Santee River. However, the gear used to collect the fish varied among those years. In 1978, a pound net was used. A haul seine was used in 1979. From 1980 through 1983, samples were collected with a gill net. In 2014 and 2015 samples were collected from a commercial cast net fishery in the lower Santee River. Repeat spawner rates based on data collected by the different gear types are not comparable due to differences in selectivity. As such, only data collected by gill net are summarized here since only one year of data was available from each of the other gears, though repeat spawner rates estimated for all gears are reported in the tables at the end of this report.

Male and female blueback herring that previously spawned ranged in age from 4 to 7 years and had marks indicating from one to three previous spawning events. Repeat spawner rates were variable between 1980 and 1983, ranging from 9.2% to 30.7% for males and from 17.1% to 33.7% for females. Current repeat spawner rates appear to be between 25 and 30%

2.6.1.2 Fisheries Dependent Repeat Spawner Rates

A summary of the available repeat spawner data for river herring collected by fisheries-dependent surveys is presented in Table 2.13 Summary of fisheries-dependent data sources that have collected repeat spawner data from river herring. Species indicates whether data were available for alewives (A), blueback herring (B), or both species combined (river herring, R).. Annual estimates of repeat spawner rates based on data from these surveys are presented in Tables 2.24 through 2.27.

Maryland

Nanticoke River (Pound & Fyke Net): Repeat spawner data for river herring collected during sampling of the pound net and fyke net fisheries on the Nanticoke River were available for most years from 1989 through 2014. During the period from 1989 to 2010, male alewives that previously spawned were between 4 and 8 years old and had from one to four spawning marks. Female alewife repeat spawners ranged from 4 to 9 years in age and had from one to five spawning marks. Repeat spawner rates for male and female alewives were variable over the time series, ranging from 25.0% to 72.0% for males and from 41.8% to 84.9% for females (Table 2.24 and Table 2.24 Continued.

	Maryland	**North Carolina**		
	Pound & Fyke Net	Pound Net		
Year	Nanticoke River	Alligator River	Chowan River	Scuppernong River
2001	50.0		48.1	
2002	70.4		57.4	
2003	64.6		20.0	

2004	41.2		39.7	
2005	34.3		59.5	
2006	72.0		13.0	
2007	25.0		29.6	
2008	59.1		20.3	
2009	31.0		35.7	
2010	32.0		X	
2011	57.1		X	
2012	26.2		X	
2013	27.9		X	
2014	23.9		X	
2015			X	

Table 2.25 Estimated rates of repeat spawning for female alewife observed in Maryland and North Carolina's fisheries-dependent surveys by river and year. ; Figure 2.47). Rates for female alewife repeat spawners were consistently higher than rates for males, and showed less of a decline over the time series. Both sexes showed a reduction in the abundance of fish that had more than one spawning mark. Application of the Mann-Kendall test indicated no statistically significant trend over time for female alewife repeat spawner rates but did indicate a statistically significant negative trend for male alewife rates.

During the period from 1989 to 2010, male blueback herring repeat spawners sampled from pound nets in the Nanticoke River ranged in age from 4 to 11 years. In 2001, an 11 year-old male blueback herring was observed with eight spawn marks. Female blueback herring that previously spawned ranged from 4 to 10 years in age and had from one to six spawn marks. The percentage of male blueback herring that previously spawned ranged from a low of 13.2% in 2007 to a high of 85.8% in 1997 ([-- indicates inadequate sample size and X indicates data excluded due to ageing error (see state report)]

Year	Maryland	North Carolina		
	Pound & Fyke Net	Pound Net		
	Nanticoke River	Alligator River	Chowan River	Scuppernong River
1972		46.7	51.3	58.3
1973		43.4	37.3	56.8
1974			12.1	0
1975		30.4	41.7	11.3
1976		22.6	68.2	14.3
1977		26.5	20.5	25.2
1978		45.3	39.2	0
1979		65.6	39.5	33.3
1980		78.8	57.3	52.0
1981		41.3	35.5	45.5
1982		19.7	31.3	37.8
1983		28.3	31.7	21.9
1984		27.0	32.0	12.5
1985		43.3	19.5	
1986		27.6	45.8	
1987		0	--	0
1988		53.7	20.8	28.6
1989	63.0	42.9	9.09	29.6
1990	73.9	50.9	--	63.2
1991	55.5	48.5	86.7	45.2
1992	57.7	39.6	51.7	58.7
1993	75.5	40.0	--	11.8
1994	66.7		--	
1995	55.4			
1996	58.7			

1997	61.2			
1998	57.6			
1999	74.2		--	
2000	41.8		25.5	
2001	67.7		34.5	
2002	84.9		42.3	
2003	83.5		36.7	
2004	66.1		52.3	
2005	58.6		57.1	
2006	84.8			

Table 2.25 Continued.

	Maryland	**North Carolina**		
	Pound & Fyke Net	Pound Net		
Year	Nanticoke River	Alligator River	Chowan River	Scuppernong River
2007	55.0		57.9	
2008	71.8		30.0	
2009	58.2		39.5	
2010	65.9		X	
2011	60.2		X	
2012	58.4		X	
2013	56.5		X	
2014	27.6		X	
2015			X	

Table 2.26 Estimated rates of repeat spawning for male blueback herring observed in Maryland and North Carolina's fisheries-dependent surveys by river and year.; Figure 2.48). Female blueback herring repeat spawner rates ranged from a low of 20.0% in 2005 to a high of 83.4% in 1990. Repeat spawner rates for male and female blueback herring showed similar variations over the time series. The Mann-Kendall test indicated both sexes had experienced a statistically significant decline in percentage of repeat spawners.

North Carolina

Alligator River (Pound Net): Repeat spawner data for alewives collected by pound nets from the Alligator River were available for all years from 1972 to 1993, except 1974. Male alewife repeat spawners were 3 to 8 years old and had one to four spawning marks. Female alewives that previously spawned ranged from 3 to 10 years in age and had one to five spawning marks. Repeat spawner rates for male and female alewives were similar in magnitude (0–79%) and exhibited similar fluctuations over time (Table 2.24 and Table 2.24 Continued.

	Maryland	**North Carolina**		
	Pound & Fyke Net	Pound Net		
Year	Nanticoke River	Alligator River	Chowan River	Scuppernong River
2001	50.0		48.1	
2002	70.4		57.4	
2003	64.6		20.0	
2004	41.2		39.7	
2005	34.3		59.5	
2006	72.0		13.0	
2007	25.0		29.6	
2008	59.1		20.3	
2009	31.0		35.7	
2010	32.0		X	
2011	57.1		X	
2012	26.2		X	
2013	27.9		X	
2014	23.9		X	
2015			X	

Table 2.25 Estimated rates of repeat spawning for female alewife observed in Maryland and North Carolina's fisheries-dependent surveys by river and year. ; Figure 2.49). Data collection was discontinued in 1994. Application of the Mann-Kendall test for trend found no statistically significant trend over time in either the male or female alewife repeat spawner rates.

Repeat spawner data for blueback herring sampled from pound nets during fisheries-dependent sampling of the Alligator River were available for intermittent years from 1972 to 1991. Both male and female blueback herring that previously spawned ranged in age from 4 to 8 years and had from one to three spawning marks ([-- indicates inadequate sample size and X indicates data excluded due to ageing error (see state report)]

Year	**Maryland**	**North Carolina**		
	Pound & Fyke Net	Pound Net		
	Nanticoke River	Alligator River	Chowan River	Scuppernong River
1972		46.7	51.3	58.3
1973		43.4	37.3	56.8
1974			12.1	0
1975		30.4	41.7	11.3
1976		22.6	68.2	14.3
1977		26.5	20.5	25.2
1978		45.3	39.2	0
1979		65.6	39.5	33.3
1980		78.8	57.3	52.0
1981		41.3	35.5	45.5
1982		19.7	31.3	37.8
1983		28.3	31.7	21.9
1984		27.0	32.0	12.5
1985		43.3	19.5	
1986		27.6	45.8	
1987		0	--	0
1988		53.7	20.8	28.6
1989	63.0	42.9	9.09	29.6
1990	73.9	50.9	--	63.2
1991	55.5	48.5	86.7	45.2
1992	57.7	39.6	51.7	58.7
1993	75.5	40.0	--	11.8
1994	66.7		--	
1995	55.4			
1996	58.7			
1997	61.2			
1998	57.6			
1999	74.2		--	
2000	41.8		25.5	

2001	67.7		34.5	
2002	84.9		42.3	
2003	83.5		36.7	
2004	66.1		52.3	
2005	58.6		57.1	
2006	84.8			

Table 2.25 Continued.

	Maryland	**North Carolina**		
	Pound & Fyke Net	Pound Net		
Year	Nanticoke River	Alligator River	Chowan River	Scuppernong River
2007	55.0		57.9	
2008	71.8		30.0	
2009	58.2		39.5	
2010	65.9		X	
2011	60.2		X	
2012	58.4		X	
2013	56.5		X	
2014	27.6		X	
2015			X	

Table 2.26 Estimated rates of repeat spawning for male blueback herring observed in Maryland and North Carolina's fisheries-dependent surveys by river and year. and Table 2.26 Continued.

1992	75.2		35.0	42.9
1993	82.7		63.3	23.1
1994	51.3		34.1	
1995	55.0		41.7	
1996	56.1		32.6	
1997	85.8		22.2	
1998	70.8		38.2	
1999	69.0		53.3	
2000	40.7		42.7	
2001	52.9		38.6	
2002	67.2		45.1	
2003	63.8		41.1	
2004	30.4		36.6	
2005	25.0		23.2	
2006	73.1		13.7	
2007	13.2		53.2	
2008	36.1		5.5	
2009	29.0		21.7	
2010	27.3		14.1	
2011	39.3		47.3	
2012	22.4		47.4	
2013	38.9		46.4	
2014	30.7		27.0	
2015			52.8	

Table 2.27 Estimated rates of repeat spawning for female blueback herring observed in Maryland and North Carolina's fisheries-dependent surveys by river and year.).

Chowan River (Pound Net): Fisheries-dependent repeat spawner data for alewives collected by pound nets from the Chowan River were available for 1972 through 1989, 1991 through 1994, and 1999 through 2009. Due to ageing error identified during the assessment (see state report), updated alewife data were not included in the analysis and the Mann-Kendall test from the benchmark assessment (no significant trend) was not updated. Male alewife that previously spawned ranged in age from 3 to 8 years and had from one to three spawning marks. Repeat spawner rates for male alewives were highly variable over the time series, ranging from 0% to 66.7% (Table 2.24 ; Figure 2.49). Female alewife repeat spawners ranged from 3 to 8 years in age and had from one to five spawning marks. The female alewife repeat spawner rates were also variable and as high as 86.7% in 1991, although sample size was very low that year (Table 2.24Continued.

	Maryland	**North Carolina**		
	Pound & Fyke Net	Pound Net		
Year	Nanticoke River	Alligator River	Chowan River	Scuppernong River
2001	50.0		48.1	
2002	70.4		57.4	
2003	64.6		20.0	
2004	41.2		39.7	
2005	34.3		59.5	
2006	72.0		13.0	
2007	25.0		29.6	
2008	59.1		20.3	
2009	31.0		35.7	
2010	32.0		X	
2011	57.1		X	
2012	26.2		X	
2013	27.9		X	
2014	23.9		X	
2015			X	

Table 2.25 Estimated rates of repeat spawning for female alewife observed in Maryland and North Carolina's fisheries-dependent surveys by river and year. ; Figure 2.49).

Repeat spawner data for blueback herring collected during fisheries-dependent pound net sampling of the Chowan River were available for all years from 1972 through 2015. Male blueback herring repeat spawners were 3 to 8 years in age and had from one to four spawning marks. Repeat spawner rates for male blueback herring ranged from a low of 5.5% in 2008 to a high of 64.0% in 1979 ([-- indicates inadequate sample size and X indicates data excluded due to ageing error (see state report)]

Year	**Maryland**	**North Carolina**		
	Pound & Fyke Net	Pound Net		
	Nanticoke River	Alligator River	Chowan River	Scuppernong River
1972		46.7	51.3	58.3
1973		43.4	37.3	56.8
1974			12.1	0
1975		30.4	41.7	11.3
1976		22.6	68.2	14.3
1977		26.5	20.5	25.2
1978		45.3	39.2	0
1979		65.6	39.5	33.3
1980		78.8	57.3	52.0
1981		41.3	35.5	45.5
1982		19.7	31.3	37.8
1983		28.3	31.7	21.9
1984		27.0	32.0	12.5
1985		43.3	19.5	
1986		27.6	45.8	
1987		0	--	0
1988		53.7	20.8	28.6
1989	63.0	42.9	9.09	29.6
1990	73.9	50.9	--	63.2
1991	55.5	48.5	86.7	45.2
1992	57.7	39.6	51.7	58.7
1993	75.5	40.0	--	11.8
1994	66.7		--	
1995	55.4			
1996	58.7			
1997	61.2			
1998	57.6			
1999	74.2		--	
2000	41.8		25.5	
2001	67.7		34.5	
2002	84.9		42.3	

2003	83.5		36.7	
2004	66.1		52.3	
2005	58.6		57.1	
2006	84.8			

Table 2.25 Continued.

	Maryland	**North Carolina**		
	Pound & Fyke Net	Pound Net		
Year	Nanticoke River	Alligator River	Chowan River	Scuppernong River
2007	55.0		57.9	
2008	71.8		30.0	
2009	58.2		39.5	
2010	65.9		X	
2011	60.2		X	
2012	58.4		X	
2013	56.5		X	
2014	27.6		X	
2015			X	

Table 2.26 Estimated rates of repeat spawning for male blueback herring observed in Maryland and North Carolina's fisheries-dependent surveys by river and year.; Figure 2.50). Female blueback herring that previously spawned ranged from 4 to 9 years in age and had from one to four spawning marks. Female blueback herring repeat spawner rates were similar in magnitude to the male rates, ranging from a low of 1.69% in 1987 to a high of 77.8% in 1979 (Table 2.26 Continued.

1992	75.2		35.0	42.9
1993	82.7		63.3	23.1
1994	51.3		34.1	
1995	55.0		41.7	
1996	56.1		32.6	
1997	85.8		22.2	
1998	70.8		38.2	
1999	69.0		53.3	
2000	40.7		42.7	
2001	52.9		38.6	
2002	67.2		45.1	
2003	63.8		41.1	
2004	30.4		36.6	
2005	25.0		23.2	
2006	73.1		13.7	
2007	13.2		53.2	
2008	36.1		5.5	
2009	29.0		21.7	
2010	27.3		14.1	
2011	39.3		47.3	
2012	22.4		47.4	
2013	38.9		46.4	
2014	30.7		27.0	
2015			52.8	

Table 2.27 Estimated rates of repeat spawning for female blueback herring observed in Maryland and North Carolina's fisheries-dependent surveys by river and year.; Figure 2.50). No statistically

significant trends over time were detected in the male or female repeat spawner rates when the Mann-Kendall test was applied.

Scuppernong River (Pound Net): The fisheries-dependent pound net survey of the Scuppernong River collected repeat spawner data from alewives from 1972 through 1984 and from 1987 through 1993. Male alewife repeat spawners ranged from 3 to 7 years in age, while female repeat spawners were between 3 and 8 years old. Males had from one to three spawning marks and females had one to four spawning marks. Repeat spawner rates for male and female alewives were similar in magnitude (0–69%) and showed similar variability over the time series (Table 2.24 and Table 2.24 Continued.

	Maryland	**North Carolina**		
	Pound & Fyke Net	Pound Net		
Year	Nanticoke River	Alligator River	Chowan River	Scuppernong River
2001	50.0		48.1	
2002	70.4		57.4	
2003	64.6		20.0	
2004	41.2		39.7	
2005	34.3		59.5	
2006	72.0		13.0	
2007	25.0		29.6	
2008	59.1		20.3	
2009	31.0		35.7	
2010	32.0		X	
2011	57.1		X	
2012	26.2		X	
2013	27.9		X	
2014	23.9		X	
2015			X	

Table 2.25 Estimated rates of repeat spawning for female alewife observed in Maryland and North Carolina's fisheries-dependent surveys by river and year. ; Figure 2.49). Data collection was discontinued in 1994. The Mann-Kendall test found no evidence for a statistically significant upward or downward trend over time for the either the male or female alewife repeat spawner rates.

Blueback herring repeat spawner data collected during the Scuppernong River pound net survey were available for all years from 1972 through 1993. Male blueback herring that previously spawned ranged from 3 to 8 years in age, while females were between 4 and 9 years old. Male blueback herring repeat spawners had from one to three spawning marks and females had from one to four spawning marks. Repeat spawner rates for male and female blueback herring demonstrated similar fluctuations over the time series, ranging from 0% to 45.8% for males and from 0% to 61.5% for females ([-- indicates inadequate sample size and X indicates data excluded due to ageing error (see state report)]

Year	Maryland	North Carolina		
	Pound & Fyke Net	Pound Net		
	Nanticoke River	Alligator River	Chowan River	Scuppernong River
1972		46.7	51.3	58.3
1973		43.4	37.3	56.8
1974			12.1	0
1975		30.4	41.7	11.3
1976		22.6	68.2	14.3
1977		26.5	20.5	25.2
1978		45.3	39.2	0
1979		65.6	39.5	33.3
1980		78.8	57.3	52.0
1981		41.3	35.5	45.5
1982		19.7	31.3	37.8
1983		28.3	31.7	21.9
1984		27.0	32.0	12.5
1985		43.3	19.5	
1986		27.6	45.8	
1987		0	--	0
1988		53.7	20.8	28.6
1989	63.0	42.9	9.09	29.6
1990	73.9	50.9	--	63.2
1991	55.5	48.5	86.7	45.2
1992	57.7	39.6	51.7	58.7
1993	75.5	40.0	--	11.8
1994	66.7		--	
1995	55.4			
1996	58.7			
1997	61.2			
1998	57.6			

1999	74.2		--	
2000	41.8		25.5	
2001	67.7		34.5	
2002	84.9		42.3	
2003	83.5		36.7	
2004	66.1		52.3	
2005	58.6		57.1	
2006	84.8			

Table 2.25 Continued.

	Maryland	**North Carolina**		
	Pound & Fyke Net	Pound Net		
Year	Nanticoke River	Alligator River	Chowan River	Scuppernong River
2007	55.0		57.9	
2008	71.8		30.0	
2009	58.2		39.5	
2010	65.9		X	
2011	60.2		X	
2012	58.4		X	
2013	56.5		X	
2014	27.6		X	
2015			X	

Table 2.26 Estimated rates of repeat spawning for male blueback herring observed in Maryland and North Carolina's fisheries-dependent surveys by river and year. and Table 2.26 Continued.

1992	75.2		35.0	42.9
1993	82.7		63.3	23.1
1994	51.3		34.1	
1995	55.0		41.7	
1996	56.1		32.6	
1997	85.8		22.2	
1998	70.8		38.2	
1999	69.0		53.3	
2000	40.7		42.7	
2001	52.9		38.6	
2002	67.2		45.1	
2003	63.8		41.1	
2004	30.4		36.6	
2005	25.0		23.2	
2006	73.1		13.7	
2007	13.2		53.2	
2008	36.1		5.5	
2009	29.0		21.7	
2010	27.3		14.1	
2011	39.3		47.3	
2012	22.4		47.4	
2013	38.9		46.4	
2014	30.7		27.0	
2015			52.8	

Table 2.27 Estimated rates of repeat spawning for female blueback herring observed in Maryland and North Carolina's fisheries-dependent surveys by river and year.; Figure 2.50). The Mann-Kendall test did not detect a significant trend over time for either the male or female blueback herring repeat spawner rates.

2.7 TRENDS IN TOTAL INSTANTANEOUS (Z) MORTALITY ESTIMATES

Updated by: Michael Brown, Maine Department of Marine Resources; Benchmark Assessment Section by: Dr. Gary A. Nelson, Massachusetts Division of Marine Fisheries

2.7.1 Age-based Total Instantaneous (Z) Estimates

The Chapman-Robson survival estimator (Chapman and Robson, 1960), the least biased estimator of survival compared to catch curve analysis (Murphy, 1997; Dunn et al., 2002), was applied to the annual age-frequency data to generate a single estimate of survival rate for each state, river, species, sex and year. Z was estimated by the natural-log transformation of S. The first age-at-full recruitment was the age with the highest frequency. Only Z estimates made from data with three or more age-classes (including first fully-recruited age) were deemed valid. Linear and loess smoothers (Maindonald and Braun, 2003) were applied to all river estimates for a given state, species, and sex to indicate trends in the annual estimates. Estimates of Z are given in state reports and are summarized below.

Maine – Estimates of Z were made for male and female alewife from the Androscoggin and Sebasticook rivers using fisheries-independent data. Z for female alewife in the Androscoggin River declined slightly from around 2.0/yr in the late 1980s to around 0.83 during 1995-1997 and then increased slightly to about 1.3/yr thereafter. During the period 2010-2014 Z values increased to 1.7. The time series average (1986-2015) is 1.4 with no indication of an increasing or decreasing trend (Figure 2.51). Z estimates for males showed little trend over time and averaged 1.6/yr over the time series though Z values averaged 2.0 for the period 2010-2014 (Figure 2.51). The time series of Zs for female and male alewife from the Sebasticook River showed little trend, and averaged 1.5/yr for both sexes for the series 2010-2015.

New Hampshire – Estimates of Z were made for male and female alewife and blueback herring from the Cocheco, Lamprey, Oyster and Winnicut rivers by using fisheries-independent data.

For alewife, declines in Z through 2015 were observed in the Cocheco and Lamprey rivers for both sexes (Figure 2.52). Since 2010, Z has decreased and has averaged 0.7/yr and 0.8/yr for females, and 0.3/yr and 0.8/yr for males in the Cocheco River and Lamprey River, respectively. Significant downward trends in Z for the time series (1992-2015) are noted for male and female alewife in the Cocheco and male alewife in the Lamprey River.

The time series of Zs for female and male alewife from the Winnicut River were short. No data beyond 2009 were provided for this river. Prior to 2010 Z showed little trend, and averaged about 0.9/yr for females and 1.2/yr for males (Figure 2.52). For blueback herring, declines in Z were observed in the Cocheco River for both sexes. A significant downward trend occurred for females for the period 1992-2008. Since 2000, Z has increased slightly for males with no significant trend in either direction (Figure

2.52). There were no data available for blueback herring after 2008 from the Cocheco. Little trend in Z was evident for females and males from the Oyster River; the average Z was 1.1/yr for both sexes prior to 2010. Since 2010 Z for males and female blueback averaged 1.5 and 1.2 respectively. For the time series 1992-2015 Z was 1.2 for males and 1.1 for females (Figure 2.52). The time series of Zs for female and male blueback herring from the Winnicut River were short, showed opposing trends, and averaged about 1.2/yr for females and 1.1/yr for males. No data beyond 2009 are available for this location (Figure 2.52).

Massachusetts – Estimates of Z were made for female and male alewife and blueback herring from the Agawam River, Back River, Charles River, Mattapoisett River, Monument River, Mystic River, Nemasket River, Parker River, Stony Brook, and Town River by using fisheries-independent data. For alewife, Z estimates averaged 1.1/yr and 1.2/yr for female and males, respectively, from the Parker River during the 1970s. There was a slight increase in Z on the Parker River for females and little variation in Z for the period 2010-2015 (Figure 2.53). In the Monument River, estimates of Z for females increased from 0.9/yr in the late 1980s to 1.22/yr in 1999, and then declined to an average of 1.1/yr in the late 2000s. The Z estimate for the years 2010-2015 average 1.8 but did not significantly influence the series trend of 1.3 for the period 1985-2015 (Figure 2.53). Z estimates for males increased from 0.9/yr to an average of 1.4/yr in the late 2000s but for the period 2010-2015 averaged 2.2 indicating a significant upward trend in Z over the time series 1985-2015 (Figure 2.53). In the remaining rivers, the time series of Zs were short and showed little trend except for a significant downward trend in Z estimates for female alewife in the Mystic River for the time series 2004 -2015 and a significant downward trend for females in Town Brook for the series 2004 - 2015 . The Nemasket River Z estimates for males averaged 1.4 for the period 2010-2015 and 1.3 for the time series starting in 2004. The average of Z for females during 2004-2010 was 1.4, similar to the value of 1.5 for the period 2010-2015. For blueback herring, estimates of Z for females and males from the Monument River showed increasing trends over time (Figure 2.54). The series average Z was 1.3/yr and 1.5/yr for females and males, respectively. Blueback herring Z estimates for males averaged 1.5 for the time series 1985-2015 while the Z estimates for female was slightly lower, 1.3 for the series 2005-2015 though it should be noted that several years data in the series are absent. Blueback herring in the Mystic River for both males and females is trending upward since the 2010 assessment. The data series is short for blueback herring in the Mystic, starting in 2007 for males and 2005 for females (Figure 2.54).

New York – Estimates of Z were made for female and male blueback herring from the Hudson River and tributaries collected during 1989 and 1990 (Figure 2.55). Recent Z estimates are available for alewife and blueback herring from 2012-2015 (see state report), but the data time series are less than 10 years and no trend analysis results are reported.

Maryland - Estimates of Z were made for female and male alewife and blueback herring from the Nanticoke River by using fisheries-independent data. Except for the sharp rise in 2003 and 2004, total mortality for female alewife showed little trend over time (

Figure 2.56). Estimates of Z for male alewife showed a very slight decrease in mortality for the period 2010-2014 compared to the time series 1991-2014 (

Figure 2.56). The average Z was 1.0/yr for females and 1.1/yr for males the period 2010-2014. For blueback herring, Z estimates for females showed little trend (except a slight rise in 1997-1999) over time (average = 1.1/yr), but mortality rose from an average 0.8/yr during the early 1990s to an average of 1.6/yr during 2006-2010 for males but then declined to an average of 1.1 for the period 2010-2014, only slightly higher than the time series trend of 1.0 for years 1989-2014 (

Figure 2.56).

North Carolina - Estimates of Z were made for alewife and blueback herring with sexes combined from the Chowan River, Alligator River, Meherrin River, Scuppernong River, and Albemarle Sound by using fisheries-dependent and fisheries-independent data. For alewife, estimates of Z from the Alligator River, Chowan River, Merherrin River and Suppernong River during the 1970s, 1980s, and 1990s averaged 1.3/yr, 1.0/yr, and 0.84/yr, respectively. During the 2000s, estimates of Z from the Chowan River and Albemarle Sound averaged 0.96/yr. For the longest river time series (Chowan), only slight increases in mortality were observed (Figure 2.57). Due to ageing error identified during the assessment (see state report), updated alewife data were not included in the analysis. For blueback herring, estimates of Z from the Chowan River, Merherrin River and Suppernong River during the 1970s, 1980s, and 1990s averaged 0.9/yr in each period. During the 2000s, estimates of Z from the Chowan River and Albemarle Sound averaged 1.1/yr. For the longest river time series (Chowan), slight increases in mortality were observed over the time series and continued to increase over the last 5 year period (Figure 2.57).

South Carolina – Estimates of Z were made for blueback herring with sexes combined from the Cooper River by using fisheries-independent data. A slight decline in Zs was indicated by the loess smooth for blueback herring (Figure 2.58). The average Z over the time series was 1.67/yr. No additional data are available after 2010.

2.7.2 Repeat Spawner Data-based Total Mortality (Z) Estimates

The Chapman-Robson survival estimator (Chapman and Robson, 1960), the least biased estimator of survival compared to catch curve analysis (Murphy, 1997; Dunn et al., 2002), was applied to the repeat-spawner frequency data of most states to generate a single estimate of survival rate (S) for each species, sex and year. The exception was data for New York to which standard catch curve analysis (linear regression) were applied. Z was estimated by the natural-log transformation of S. Only Z estimates made from data with three or more repeat spawner classes (including first fully-recruited class) were deemed valid.

Massachusetts – Estimates of Z were made for female and male alewife and blueback herring from the Back River, Charles River, Monument River, Mystic River, and Town River by using fisheries-independent data. For alewife, average Z estimates for male and female alewife from the Monument River were 0.9/yr and 1.1/yr, respectively, during 1986-1987 and increased to averages of 2.1/yr and 2.4/yr, respectively, during 2007-2010. For the period 2010-2014 Z estimates averaged 1.9 and 2.0 for males and females alewives respectively. There were no long term trends detected or the time series 1986-2015 for either sex (Figure 2.59). For the remaining rivers the time series were short and showed variable trends. The average Zs for females and males alewives from the Mystic River averaged 2.0/yr for males and 1.9 for females though the time series was short (2004-2015) with some year's data unavailable. The decrease in z estimates for Town Brook observed in the age data were not seen in the repeat spawner data. The series for repeat spawning data includes only eight years and runs from 2004-2013. For blueback herring on the Mystic River there were few Z estimates available for trend analysis (Figure 2.60). The average Zs for the time series for males is 1.8 and 2.0 for females. The time series runs from 2006 to 2015 for females and 2007 to 2014 for males.

Rhode Island – Estimates of Z were made for alewife (combined sexes) from the Gilbert-Stuart River and Nonquit River. For Gilbert-Stuart alewife, Z appeared to decline slightly from 1975 through the early 1990s (average Z=1.3/yr)(Figure 2.61). Starting in 2000, Z estimates increased and averaged 2.2/yr through 2010, suggesting increased mortality. A shorter time series was available for the Nonquit River, but it showed a slight increase in mortality since 2000. The average Z for this system from 2000-2010 was 2.6/yr (Figure 2.61).

New York – Estimates of Z were made for female and male alewife collected during 1999-2001 and blueback herring collected during 1989-1990 and 1999-2001 from the Hudson River and tributaries (Figure 2.62). However, since the benchmark assessment, data from 1999-2001 have been determined to be unreliable and NYSDEC Staff recommended against their use (see state report). Recent Z estimates are available for alewife and blueback herring from 2009-2015 (see state report), but the data time series are less than 10 years and no trend analysis results are reported.

Maryland - Estimates of Z were made for female and male alewife and blueback herring from the Nanticoke River using fisheries-independent data. For alewife, estimates of Z for females and males showed an increase from an average Z of 0.75/yr and 0.84/yr, respectively, in 1990-1993 to an average Z of 1.9yr and 1.7/yr, respectively, in 2000-2002 (Figure 2.63). Since 2003, the Z estimates declined to an average of 1.2/yr for each sex during 2007-2010. During the period 2010-2014 the average Z estimates for female and male alewife are 0.9 and 1.2 respectively. The average Z over each time series, 1991-2014 is 1.2/yr for females and 1.2/yr for males. For blueback herring, estimates of Z for females and males showed a slight decrease increase from an average Z of 0.8/yr and 0.8/yr, respectively in 1989-1993 to average Z of 1.1/yr and 1.5/yr, respectively, in 2000-2002 (Figure 2.63). Since 2003, the Z estimates have declined slightly to an average of 1.0/yr for females and 1.1 for males during 2007-2010 and has remained the same for males and decreased for females to 0.9 for the period 2010-2014. The average Z over the time series was 1.0/yr for females and 1.2/yr for males.

North Carolina - Estimates of Z were made for alewife and blueback herring from the Chowan River, Alligator River, Meherrin River, Scuppernong River, and Albemarle Sound using fisheries-dependent and fisheries-independent data. For alewife, estimates of Z from the Chowan River and Scuppernong River for females and males during the 1970s, 1980s, and 1990s averaged 1.2/yr and 1.6/yr, respectively, 1.4/yr and 1.5/yr, respectively, and 0.8/yr and 1.5/yr, respectively (Figure 2.64). During the 2000s, estimates of Z from the Chowan River and Albemarle Sound averaged 1.13/yr for both sexes. For the longest river time series (Chowan), mortality appeared to increase through 1990 and then decline to current averages of 1.2/yr for females and 1.4/yr for males. Due to ageing error identified during the assessment (see state report), updated alewife data were not included in the analysis. For blueback herring, estimates of Z from the Chowan River, Meherrin River and Scuppernong River during the 1970s, 1980s, and 1990s averaged 1.2/yr for females and 1.3/yr for males, 1.2/yr for female and 1.4/yr for males, 1.2/yr for females and 1.2/yr for males, respectively. During the 2000s, estimates of Z from the Chowan River and Albemarle Sound averaged 1.1/yr for females and 1.5/yr for males. For the longest river time series (Chowan), mortality showed little trend over time but during the last 5-year period estimates of Z have increased slightly above the time series average of 1.12 for females and 1.4 for males(Figure 2.64).

South Carolina – Estimates of Z were made for male and female blueback herring from the Santee River by using fisheries-dependent data. Although the Z estimates for female and male blueback herring showed opposing decreasing and increasing trends (Figure 2.65), the wide variation in the estimates and shortness of the time series suggests general trends may not be accurate. The average Z was 1.58/yr and 1.77/yr for female and male blueback herring, respectively.

2.8 TRENDS IN IN-RIVER EXPLOITATION RATES

Updated by: Jeff Kipp, Atlantic States Marine Fisheries Commission; Benchmark Assessment Section by: Dr. Gary A. Nelson, Massachusetts Division of Marine Fisheries

Trends of in-river exploitation rates of alewife spawning runs were updated for two Maine rivers, the Damariscotta River and the Union River. Trends were not updated for three Massachusetts rivers (Monument River river herring combined, Mattapoisett River alewife, and Nemasket River alewife) due to a moratorium on in-river harvest (i.e., exploitation rate of zero) implemented in 2006, but historical trends are provided in Figure 2.66. In-river exploitation rates were calculated by dividing in-river harvest by total run size (escapement plus harvest) for a given year. Exploitation rates generally varied around declining trends throughout the time series (Figure 2.66), with the exception of very low rates (<0.06) in the Damariscotta River from the mid-1990s to 2000. Damariscotta River estimates for the final three years in the benchmark assessment (2008-2010) increased by about 70% when updated. There are also some slight changes in the updated Union River estimates since 2000 (<± 0.1) and there is now an estimate for 2006, while there was no 2006 estimate in the benchmark assessment. This is likely due to updated harvest estimates from hydropower companies (M. Brown, personal communication, March 15, 2017) and the updated estimates are considered more accurate. Since the terminal year of the benchmark assessment, exploitation rates in the Damariscotta River declined from 0.37 in 2011 to 0.14 in 2012 and remained relatively stable since a SFMP was required, averaging 0.11 (

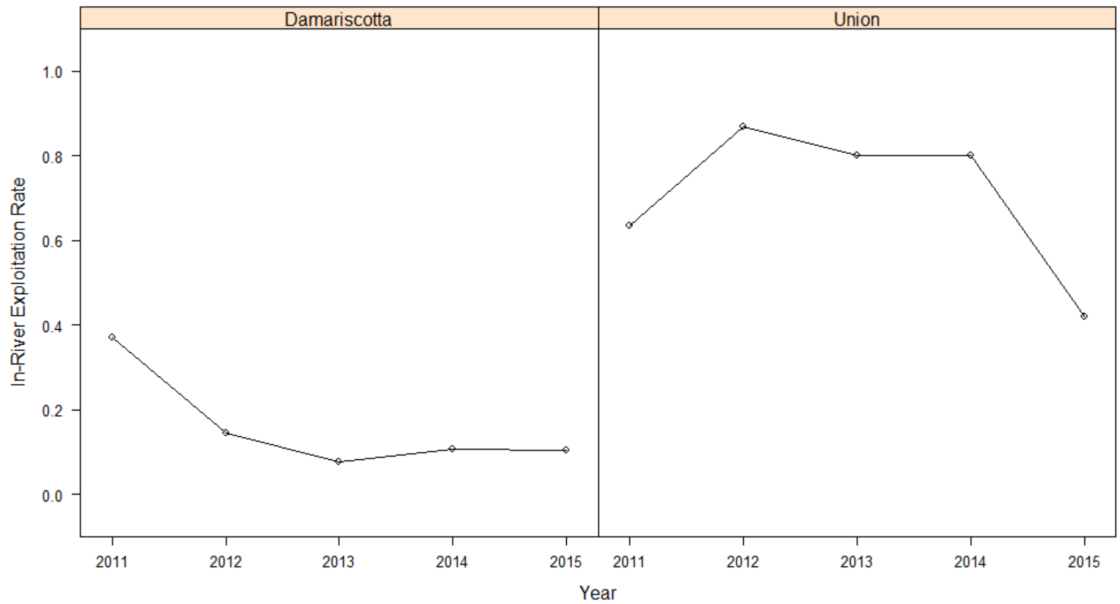

Figure 2.67). Rates since a SFMP was required are the lowest during the time series, with the exception of the very low rates from the mid-1990s to 2000. Exploitation rates in the Union River increased following the requirement of SFMPs from 0.63 in 2011 to 0.87 in 2012, were relatively stable from 2013 to 2014, averaging 0.80, and then decreased sharply to the lowest rate during the time series in 2015 (0.42;

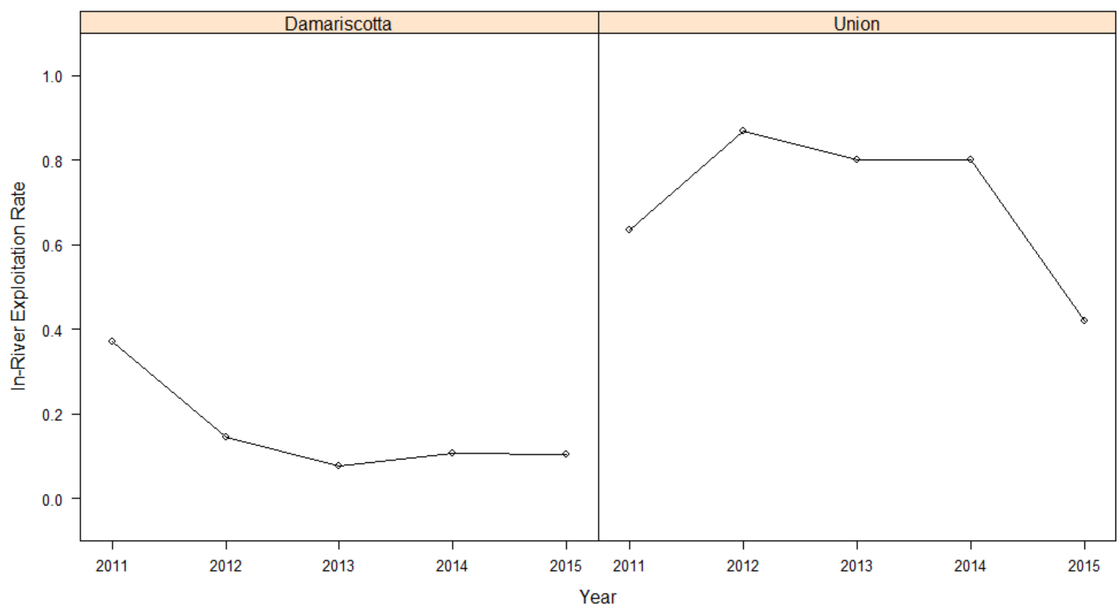

Figure 2.67).

2.9 INDEX OF RELATIVE RIVER HERRING EXPLOITATION

Updated by: Jeff Kipp, Atlantic States Marine Fisheries Commission; Benchmark Assessment Section by: Dr. John Sweka, US Fish and Wildlife Service

An index of relative exploitation was developed for the coastwide population of river herring. The NEFSC bottom trawl data were used to calculate a minimum swept area estimate of total biomass for spring surveys (1976 – 2015). Minimum swept area estimates are stratified total biomass estimates calculated by expanding the biomass caught within each NEFSC bottom trawl stratum to the area of the stratum and then summing over all strata. Spring surveys were used because river herring are more readily caught during the spring than during the fall surveys (see NEFSC trawl report section in River Herring Benchmark Stock Assessment Volume II). Estimated total catch was calculated from total reported landings (Section 2.1.2), NAFO landings reported from other countries (Section 2.1.1), plus total incidental catch derived via hindcasting methods using the survey-scaling method (NEFSC 2008, Palmer et al. 2008). Estimated total catch was divided by total swept area estimates of biomass to yield an index of relative exploitation. The relative exploitation index was developed for the coastwide population rather than regional populations because estimates of total incidental catch could not be partitioned among regions or discrete river stocks. It should be noted that there is potential for double-counting some of the incidental catch when it is added to the reported landings from the states and NAFO. The method of estimating total incidental catch (retained and discarded) from observer coverage uses total landings from ocean fisheries as the raising factor, and thus any reported river herring landings from federal ocean fisheries would theoretically be included in the incidental catch estimate.

Minimum swept area estimates of total biomass fluctuated greatly between 1976 and 1995 and were lowest between 1988 and 1990. Total biomass estimates remained fairly stable between 2000 and 2008, increased sharply in 2009, and then fluctuated around an increasing trend through 2015 (Figure 2.68 are biomass). Biomass estimates since the benchmark stock assessment are the highest of the time series, with the exception of the 1979 estimate (19,549 MT), and average about 2.2 times greater than the time series average. Total catch estimates showed a consistent decline from 1976 – 2015, decreasing from a high of 8,962 MT in 1976 to a low of 712 MT in 2011 (Figure 2.69). Catch following the benchmark stock assessment was at the lowest level during the time series, with the exception of a slight increase in 2012 (1,162 MT). Relative exploitation fluctuated greatly from 1976 – 1989, but decreased in 1992 and remained relatively stable until 2008. Another decrease occurred in 2009 followed by low and stable relative exploitation through 2015 (Figure 2.70). Relative exploitation since the benchmark stock assessment terminal year is the lowest of the time series, averaging 0.05.

Total catch estimates were often greater than minimum swept area estimates of total biomass in the 1970s and 1980s resulting in relative exploitation rates > 1.0. Catches of river herring from the NEFSC bottom trawl were not corrected by any assumed catchability coefficients, and as the survey stops at Cape Hatteras, NC, estimates do not include the southern range of the stock. Therefore total biomass estimates likely greatly underestimated the true total biomass of river herring. If we assume total biomass estimates are proportional to the true biomass, the calculated relative exploitation values provide an indication of recent trends in river herring exploitation.

2.10 TOTAL MORTALITY (Z) BENCHMARKS

Updated by: Jeff Kipp, Atlantic States Marine Fisheries Commission; Benchmark Assessment Section by: Dr. Gary Nelson, Massachusetts Division of Marine Fisheries and Dr. Katie Drew, Atlantic States Marine Fisheries Commission

River herring are subject to many different sources of mortality, some anthropogenic (e.g., directed and incidental fishing mortality, habitat loss, dam and passage mortality), and some natural (e.g., predation). We can estimate total mortality (Z) for alewives and blueback herring in a number of river systems from age structure and repeat spawner data; however, we often cannot partition this total mortality into its various fishing and non-fishing components.

Total mortality benchmarks were established during the benchmark assessment based on spawning stock biomass per recruit analyses in order to provide reference points for empirical measurements of Z (Table 2, Table 2.28). Reference points were calculated for two age-constant natural mortality estimates (0.3 and 0.7) to evaluate sensitivity of reference points to a range of potential natural mortality. The higher natural mortality results in higher reference points. Therefore, reference points calculated with the lower natural mortality can be considered more precautionary. The SAS and peer review panel favored reference points calculated with the higher natural mortality (ASMFC 2012). Additionally, the peer review panel recommended that a reference point in the range of $Z_{35\%}$-$Z_{40\%}$ is a more appropriate reference point for river herring and, therefore, results are focused on total mortality estimates relative to the $Z_{40\%}$ benchmarks calculated with a natural mortality of 0.7 ($Z_{40\%,M=0.7}$). $Z_{20\%}$ benchmarks and benchmarks calculated with a natural mortality of 0.3 are still included to be consistent with the benchmark and due to the uncertainty in total mortality estimates. In addition, the rates of fishing mortality (*F*), exploitation rate (*u*), and total mortality that cause run-specific river herring populations to collapse due to declining recruitment at low spawning stock biomass ($Z_{collapse}$) used in the benchmark were obtained from previously-derived estimates in Crecco and Gibson (1990), updates of their methods, literature values, or using stock assessment models (Table 2.29 and Table 2.30).

Though benchmark values are derived from assessment data in some cases, the values were not updated. Reference point adjustments should not be considered due to minor interannual variation in data over short time frames, as changing values create “moving targets” that are difficult to achieve through management (McKown et al. 2008). See the benchmark stock assessment for additional details on total mortality benchmarks.

2.10.1 Results

2.10.1.1 Spawning stock biomass per recruit

Empirical estimates of *Z* from several of the stock-sex combinations have been above $Z_{40\%,M=0.7}$ benchmarks since the benchmark assessment (Figure 2.71 - Figure 2.79). These include Sebasticook female alewives, Androscoggin male alewives, Monument female and male alewives, Nemasket female and male alewives, Gilbert-Stuart alewives (both sexes combined), and Nonquit alewives (both sexes combined). Additionally, all estimates for several other stock-sex combinations since the benchmark, with the exception of one year during that period, have been above $Z_{40\%,M=0.7}$ benchmarks. These include Sebasticook male alewives, Androscoggin female alewives, Mystic female and male alewives, Town male alewives, and Nanticoke female and male bluebacks.

Empirical estimates of Z for Cocheco male and female alewives were below $Z_{40\%,M=0.7}$ benchmarks in all years since the benchmark assessment. Additionally, estimates for Lamprey male and female alewives and Nanticoke female alewives were all below $Z_{40\%,M=0.7}$ benchmarks since the benchmark assessment, with the exception of one estimate during that period. Estimates for all other stock-sex combinations fluctuated around $Z_{40\%,M=0.7}$ benchmarks.

Terminal three year average Z estimates for ten of the eighteen stocks were above $Z_{40\%,M=0.7}$ benchmarks, while four were below (Table 2). Of the four stocks above the $Z_{40\%,M=0.7}$ benchmark, two exceeded the $Z_{20\%,M=0.7}$ benchmark. Four stocks did not have updated estimates during these years.

2.10.1.2 Z-collapse

Where applicable, the minimum, maximum and average $Z_{collapse}$ values were plotted for each river (Androscoggin values were used for the Sebasticook River) and compared to age-based *Z* estimates for alewife (Figure 2.80) and blueback herring (Figure 2.81). Total mortality estimates for female and male alewives exceed the maximum $Z_{collapse}$ benchmark in the Androscoggin River in 2013 and 2014, respectively. The male estimate also exceeds the average $Z_{collapse}$ benchmark in 2013. Empirical Z estimates for male and female alewives in the Monument River exceed the average $Z_{collapse}$ benchmark in 2014 and 2015 and all but the female estimate in 2014 exceeded the maximum $Z_{collapse}$ benchmark, while the total mortality estimates from the escapement model remain well below the minimum $Z_{collapse}$ benchmark. The empirical male estimates exceeded the minimum $Z_{collapse}$ every year since the benchmark terminal year except 2012. The total mortality estimate for female alewife in the Nemasket River exceeded the average $Z_{collapse}$ benchmark in 2014 and the male estimate exceeded the minimum $Z_{collapse}$ benchmark in 2015. The 2011 empirical estimate for bluebacks (combined sexes) in the Chowan River exceeded the minimum $Z_{collapse}$ benchmark, but declined to levels below this benchmark since. The SCA estimated total mortality similar to the empirical estimates, below the $Z_{collapse}$ benchmarks, since 2012 while the SCA 2011 estimate disagrees with the 2011 empirical estimate and is also well below the $Z_{collapse}$ benchmarks. Empirical total mortality estimates for all other rivers and years have been below the minimum $Z_{collapse}$ benchmark since the benchmark stock assessment.

2.10.1.3 Discussion

In recent years, the majority of the rivers examined were above the $Z_{40\%,M=0.7}$, with a few of those rivers above the $Z_{collpase}$ benchmarks as well. Conversely, Z estimates for a few rivers have declined to or near time series lows. However, there is uncertainty in our estimates of current *Z*, due to ageing error, the potential for violations in the assumptions of the Chapman-Robson method, such as constant recruitment, and the deterioration of the SCA model for the Chowan River.

The SPR benchmarks were sensitive to assumptions about *M*, which is difficult to estimate empirically for these species. However, results focused on here were from the higher natural mortality scenario. Therefore Z estimates that exceeded reference points calculated with the higher natural mortality would exceed the reference point calculated with the lower natural mortality by an even greater amount.

Additionally, these benchmarks are sensitive to the selectivity pattern assumed for the fishing mortality. A population can sustain a higher *F* if that *F* is applied to older, mature ages rather than juveniles. The *F* in these analyses represents a combination of fishing and other anthropogenic and non-anthropogenic sources of mortality, most of which we cannot quantify at the moment. Improving our understanding of the selectivity patterns of these different sources of mortality would improve our benchmark estimates as well as provide guidance on the best way to reduce excess mortality on these stocks.

3.0 CONCLUSIONS

Assessment of river herring along the U.S. Atlantic coast is difficult. River herring have a complex life history and life history characteristics vary spatially among different river systems (Munroe 2002). Also, factors that influence population dynamics differ among rivers, such as differences among agencies in harvest regulations, the degree of historic habitat alterations, and potential sources of mortality such as predation (Walter et al. 2003). The fate of river-specific stocks during marine migrations is still largely unknown as is the stock composition of river herring in bycatch of ocean fisheries. Among-system differences and uncertainty in the marine life stages of river herring combined with the great variation in the amount, types, and quality of data collected by different agencies limited the types of assessment methods used during the benchmark assessment and, subsequently, updated for this assessment.

Trend analyses and population models for a few rivers were evaluated to update generalizations about the status of the coastwide river herring meta-population. For the benchmark stock assessment, the SAS provided directions of recent abundance and total mortality trends by data set over the last five years of the benchmark assessment data time series (2006-2010) and collective abundance trends by stock over the last ten years. Directions of trends were determined with a consensus-based, expert opinion framework based on both qualitative, visual inspection and quantitative, statistical tests such as the Mann-Kendall test. For this update of the assessment, the SAS provided directions of recent trends with the same framework applied to the last ten years of the update assessment data time series (2006-2015) by abundance and total mortality data set and collectively by stock abundance. The SAS believes a decadal time period is more reflective of true trends in river herring population parameters due to the high interannual variability of data and the life span of the species. This period also encompasses the majority of management actions taken specifically for river herring (i.e., pre-benchmark period moratoria, ASMFC requirement of SFMPs in 2012). Recent trend designations include increasing, decreasing, stable, no trend, unknown, and no returns. Stable indicates a relatively flat time series over the time series evaluated. It does not indicate stock condition relative to other time periods. Stocks can be stable at historically low levels. No trend indicates relatively high interannual variability, impeding ability to differentiate between increasing, decreasing, or stable. Unknown indicates there was no river-specific abundance data to evaluate the trend specifically for the stock. No returns indicates a stock where fish stopped returning to the monitoring site(s). In addition to the recent trends evaluated during the benchmark assessment and summarized in Table 1 of that assessment, the SAS summarized recent trends of river herring on the northeast U.S. continental shelf based on data from the NEFSC bottom trawl survey and the St. Johns River in Florida during this update. Trends for the northeast U.S. continental shelf represent mixed stocks with unknown proportion contribution from river-specific stocks and should not be interpreted as reflecting the trends of any individual river-specific stock(s).

Several data sets have been discontinued since the benchmark stock assessment, primarily commercial CPUE and total harvest. Though fishery-independent data are typically preferred for assessment purposes, the discontinued CPUE time series are from several rivers that lack fishery-independent sampling. The SCA models for Nanticoke River river herring could not be updated due to moratoria on commercial harvest and the stability of the SCA model for the Chowan River bluebacks has deteriorated, partly due to reduced information coming from reduced harvest data. The SAS notes that, while management measures taken that have impacted data collection since the benchmark stock assessment were necessary, the reduced information has hindered the ability to draw conclusions from an assessment update.

Recent trends in abundance data sets were variable, but generally showed no trend or, to a lesser degree, increasing trends. No CPUE data sets reflected declining trends over the last ten years of the update, with one of ten data sets showing an increasing trend and three showing no trend. Six were not updated due to discontinuation or changes in methodology. No run counts reflected declining trends over the last ten years with eleven of twenty nine showing increasing trends, fourteen showing no trend, and four not being updated (two due to discontinuation and two due to agency recommendation). One of sixteen YOY seine surveys indicated a declining trend over the last ten years, two indicated increasing trends, and thirteen indicated no trend. One of twelve trawl surveys evaluated with ARIMA indicated a declining trend over the last ten years, four indicated increasing trends, and seven indicated no trend. The ranges of the probability of the final year of surveys being less than the 25th percentile reference points decreased relative to the ranges estimated during the benchmark for both species. Similarly to the benchmark, most of the fishery-independent indices indicate interannual variation at low stock sizes and more time is needed to reflect large scale changes in abundance. As noted in the benchmark assessment, the interannual variation observed may also be a factor of the high mortality the stocks have experienced historically. Fishing effort has been shown to increase variation in fish abundance through truncation of the age structure and recruitment becomes primarily governed by environmental variation (Hsieh et al. 2006; Anderson et al. 2008). When fish species are at very low abundances, as is believed for river herring, it is possible that the only population regulatory processes operating are stochastic fluctuations in the environment (Shepherd and Cushing 1990).

Biological indicators from river herring generally suggest total mortality may be stable or increasing. There have been no increasing trends in percent repeat spawners or mean length through the full data time series and declining trends were detected for several rivers. Declines in mean length-at-age were also observed in many rivers. Trends in maximum age have generally been stable. There have been no increasing trends in empirical total mortality estimates over the last ten years, three trends have declined, and ten have shown no trend. Only three trends have increased over the full time series. The lack of trends in age-based *Z* estimates could be due in part to relatively short time series of data or inconsistencies and uncertainties in aging methods through time. Also, age-based *Z* estimates were only performed on data sets that had three or more year classes which may have eliminated some data sets from these analyses that have experienced truncation of age distributions due to increasing mortality. These different indicators of mortality are often in conflict within stocks, with stable or decreasing empirical mortality estimates and decreasing mean length and/or percent repeat spawners.

River-specific three-year average total mortality estimates relative to $Z_{20\%}$ and $Z_{40\%}$ benchmarks were variable relative to these comparisons from the benchmark assessment. Average mortality estimates and benchmarks indicated deteriorating conditions (i.e., move from exceeding the $Z_{40\%}$ to exceeding the $Z_{20\%}$ reference points) for four rivers, improved conditions (i.e., fall from above to below $Z_{20\%}$ or fall from above to below $Z_{40\%}$) for four rivers, and no change for six rivers. Age-based total mortality estimates in recent years were not available for four stocks due to the lack of returning fish (Winnicut River alewife and blueback, Cocheco River blueback) or recent ageing error (Chowan River alewife). While all rivers assessed in the benchmark stock assessment were above the $Z_{40\%}$ benchmark, two rivers assessed during the update fell below the $Z_{40\%}$ benchmark. There is no apparent latitudinal pattern as stocks that appeared to deteriorate since the benchmark (Oyster blueback, Town alewife, Nanticoke alewife, Chowan blueback) were spread along the coast and stocks that appeared to improve (Cocheco alewife, Lamprey alewife, Mystic alewife, Nanticoke blueback) were also spread along the coast. Conditions even changed within rivers between species (Nanticoke). While most total mortality estimates were below

$Z_{collapse}$ reference points, a few estimates in recent years exceed at least the minimum $Z_{collapse}$ reference point.

Given the conflicting results from mortality indicators and uncertainty of total mortality estimates due to ageing error, uncertain natural mortality estimates, and estimator assumptions, conclusions about mortality remain uncertain. However, the comparison to reference points indicate that total mortality in recent years may be unsustainable in some rivers.

The benchmark assessment concluded that river herring abundance had declined significantly as evidenced by declines in commercial landings to less than 3% of the historical peaks in the late 1960s. Reported coastwide commercial landings have remained relatively stable since the benchmark stock assessment. Utility of these data for inferring about coastwide meta-population size have decreased due to the number of moratoria that have been implemented since the benchmark. However, the level of landings do not suggest any major changes since the benchmark stock assessment. Average incidental catch since the benchmark stock assessment (227 mt) was less than 50% of the 2005-2010 average (496 mt). Estimates starting in 2005 are considered the most certain estimates as this was the period of time when improvements in the NEFOP occurred in the high volume midwater trawl fisheries. Some unknown fraction of the total incidental catch is reported by NMFS and included in the U.S. landings, making direct comparisons uncertain. More specifically, the majority of river herring caught incidentally in the midwater trawl fleets is retained, but an unknown proportion of this retained catch is reported as river herring by the dealers. In a limited number of comparisons, some trips that listed river herring as landed on the VTR reports did not list river herring on the corresponding dealer reports. Therefore, it is unclear what proportion of reported landings is distinct from estimates of total incidental catch, making direct comparisons difficult. The impact of this incidental catch upon stock status remains largely unknown.

In-river exploitation of alewives has continued to decline in the Damariscotta River with the lowest levels occurring in the last five years, with the exception of very low values that occurred in the 1990s (due to lack of harvest). In-river exploitation of alewives has remained relatively stable in the Union River, but did decline to the lowest level of the time series in the terminal year of the update. Exploitation has essentially ceased on other rivers assessed during the benchmark due to moratoria (MA rivers). Coastwide relative exploitation has continued to decline since the benchmark to the lowest levels of the time series, as catches have continued to decline and biomass from the NEFSC bottom trawl survey has increased.

In summary, updated trend analyses generally indicate similar conditions as observed in recent years of the benchmark assessment and a more detectable response to restoration efforts will require more time. The SAS reiterates that multiple factors are likely responsible for river herring decline such as overfishing, inadequate fish passage at dams, predation, pollution, water withdrawals, acidification, changing ocean conditions, and climate change. It is difficult to partition mortality into these possible sources and evaluate importance in the decline of river herring. Thus, the recovery of river herring needs to address multiple factors including anthropogenic habitat alterations, predation by native and non-native predators, and exploitation by fisheries.

3.1 Stock Status

Though some positive signs were apparent through the update (e.g., few declining abundance trends by data set in recent years), the information updated indicates that the status of the coastwide river-herring meta-population being depleted to near historic lows remains unchanged since the benchmark stock assessment. A depleted status indicates that there was evidence for declines in abundance due to a number of factors, but the relative importance of these factors in reducing river herring stocks could not be determined. Combined factors such as intense historic fishing pressure, continued exploitation (both directed and incidental), ineffective fish passage resulting in the loss of riverine habitat, changing ocean conditions due to climate change, and increased abundance of native and non-native predator species are likely responsible for depleted river herring stocks and continue to hinder recovery of the stocks. More work is needed to evaluate the synergistic effects of the many factors that may be responsible for the decline in river herring.

Of the 54 in-river stocks of river herring for which data were available, 16 experienced increasing trends over the ten most recent years of the update assessment data time series, 2 experienced decreasing trends, 8 were stable, 10 experienced no discernible trend/high variability, and 18 did not have enough data to assess recent trends, including 1 that had no returning fish. A majority of the increasing trends occurred in the northeast which is also where there tends to be more data available. A majority of the unknown and no trend designations occurred in the Mid-Atlantic and southeast. The SAS notes that stocks included are due to data availability and don’t necessarily reflect stocks that are more important than stocks not included in the assessment.

Overfished and overfishing status could not be determined for the coastwide stock complex, as estimates of total biomass, fishing mortality rates and corresponding reference points could not be developed.

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TABLES

Table 2.1. Annual reported coastwide commercial landings (lb) of river herring, 1887-2015.

Year	Total	Year	Total	Year	Total	Year	Total
1887	21,952,075	1920	101,850	1953	46,535,253	1986	10,378,923
1888	22,641,527	1921	10,852	1954	48,153,600	1987	6,939,347
1889	18,297,800	1922	73,431	1955	41,952,500	1988	6,547,357
1890	16,480,263	1923	6,573,144	1956	48,394,404	1989	3,562,566
1891	0	1924	2,649,620	1957	53,767,400	1990	2,816,214
1892	3,651,000	1925	92,188	1958	70,334,100	1991	3,332,586
1893	0	1926	131,535	1959	45,326,300	1992	4,066,425
1894	0	1927	14,230,024	1960	50,204,218	1993	2,189,389
1895	0	1928	10,055,525	1961	54,610,885	1994	1,432,175
1896	5,356,000	1929	24,870,348	1962	56,521,722	1995	1,638,639
1897	20,420,770	1930	27,136,169	1963	59,713,801	1996	1,750,306
1898	2,900,000	1931	27,630,327	1964	49,652,734	1997	1,511,009
1899	0	1932	21,691,925	1965	69,431,946	1998	1,744,105
1900	0	1933	20,275,417	1966	65,075,187	1999	1,590,890
1901	0	1934	20,939,048	1967	62,510,234	2000	1,554,219
1902	15,550,475	1935	12,207,505	1968	57,966,781	2001	1,692,161
1903	0	1936	20,825,582	1969	58,237,135	2002	1,994,595
1904	501,438	1937	22,195,865	1970	40,166,957	2003	1,673,856
1905	5,138,225	1938	30,103,611	1971	32,655,990	2004	1,469,063
1906	0	1939	23,689,906	1972	32,618,493	2005	791,326
1907	0	1940	21,193,653	1973	23,093,126	2006	1,484,741
1908	15,211,711	1941	12,173,975	1974	26,837,288	2007	1,033,421
1909	111,334	1942	10,392,322	1975	28,748,865	2008	1,435,629
1910	0	1943	1,795,339	1976	15,714,244	2009	1,656,560
1911	0	1944	20,264,444	1977	14,496,457	2010	1,565,591
1912	0	1945	23,752,819	1978	14,321,259	2011	1,293,472
1913	92,175	1946	13,408,602	1979	11,074,915	2012	1,627,364
1914	0	1947	22,912,389	1980	11,656,881	2013	1,361,845
1915	0	1948	20,268,718	1981	6,304,996	2014	1,548,723
1916	21,762	1949	24,118,735	1982	13,432,844	2015	1,344,101
1917	49,935	1950	40,999,400	1983	11,524,000		
1918	14,562,044	1951	50,408,400	1984	10,574,011		
1919	3,064,000	1952	41,494,400	1985	14,321,083		

Table 2.2 Reported landings (pounds) of river herring in ICNAF/NAFO Areas 5 and 6 by country.

Year	Bulgaria	Germany	Poland	USSR	USA	Grand Total
1967	0	0	0	14,356,355	57,220,393	71,576,748
1968	0	0	0	49,184,626	55,141,455	104,326,081
1969	1,333,164	249,120	0	78,322,824	55,974,794	135,879,902
1970	1,481,491	418,874	0	42,083,609	36,047,415	80,031,389
1971	2,290,579	18,538,481	4,905,235	24,887,729	28,227,698	78,849,722
1972	1,128,755	7,674,213	4,162,285	14,755,388	2,707,249	30,427,890
1973	1,787,931	3,593,498	7,167,155	2,347,899	22,729,426	37,625,909
1974	1,704,156	5,862,031	2,398,605	1,042,776	24,490,901	35,498,469
1975	1,219,144	4,675,957	136,685	2,290,579	23,803,066	32,125,431
1976	564,378	2,777,796	30,864	537,922	14,290,217	18,201,177
1977	0	152,117	0	264,552	13,584,745	14,001,414
1978	0	0	0	46,297	12,632,358	12,678,655
1979	0	0	0	26,455	9,607,647	9,634,102
1980	0	0	2,205	0	10,498,305	10,500,510
1981	0	0	22,046	0	7,087,789	7,109,835
1982	0	0	178,573	0	12,784,475	12,963,048
1983	0	0	169,754	0	9,224,046	9,393,800
1984	0	17,637	436,511	0	9,003,586	9,457,734
1985	0	50,706	346,122	0	2,206,805	2,603,633
1986	0	37,478	103,616	0	8,988,154	9,129,248
1987	0	59,524	48,501	0	4,261,492	4,369,517
1988	0	63,933	66,138	0	5,251,357	5,381,428
1989	0	50,706	52,910	0	3,362,015	3,465,631
1990	0	30,864	0	0	2,892,435	2,923,299
1991	0	0	0	0	2,925,504	2,925,504
1992	0	0	0	0	3,209,898	3,209,898
1993	0	0	0	0	551,150	551,150
1994	0	0	0	0	0	0
1995	0	0	0	0	0	0
1996	0	0	0	0	0	0
1997	0	0	0	0	0	0
1998	0	0	0	0	0	0
1999	0	0	0	0	0	0
2000	0	0	0	0	0	0
2001	0	0	0	0	0	0
2002	0	0	0	0	284,393	284,393
2003	0	0	0	0	0	0
2004	0	0	0	0	0	0
2005	0	0	0	0	0	0
2006	0	0	0	0	0	0
2007	0	0	0	0	315,258	315,258
2008	0	0	0	0	286,598	286,598
2009	0	0	0	0	509,263	509,263
2010	0	0	0	0	0	0
2011	0	0	0	0	416,673	416,673
2012	0	0	0	0	105,822	105,822
2013	0	0	0	0	30,865	30,865
2014	0	0	0	0	2,205	2,205
2015	0	0	0	0	11,023	11,023

*: Italy, the Netherlands, Romania, and Spain also reported catch, but only in one or two years; they are included in the Grand Total.

Table 2.3 Proportion of 2005-2015 incidental catch of river herring by region, fleet and quarter for the dominant gears.

		BT			Gillnet			Paired MWT	Single MWT	Total MWT	Grand Total
Area fished	Quarter	sm	med	lg	sm	lg	xlg				
MA	1	0.027	0.001	0.001	0.000	0.000	0.000	0.229	0.051	0.280	0.309
MA	2	0.016	0.000	0.001	0.000	0.000	0.000	0.013	0.005	0.018	0.035
MA	3	0.038	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.040
MA	4	0.018	0.001	0.001	0.000	0.000	0.000	0.006	0.001	0.007	0.026
MA		**0.099**	**0.002**	**0.003**	**0.000**	**0.000**	**0.000**	**0.248**	**0.057**	**0.305**	**0.409**
NE	1	0.091	0.000	0.002	0.000	0.000	0.000	0.030	0.014	0.044	0.137
NE	2	0.049	0.000	0.002	0.000	0.000	0.000	0.045	0.040	0.085	0.136
NE	3	0.070	0.000	0.002	0.000	0.000	0.000	0.055	0.009	0.064	0.136
NE	4	0.059	0.000	0.002	0.000	0.000	0.000	0.099	0.022	0.120	0.181
NE		**0.268**	**0.000**	**0.009**	**0.000**	**0.000**	**0.000**	**0.229**	**0.085**	**0.313**	**0.591**
Total		**0.367**	**0.003**	**0.011**	**0.000**	**0.000**	**0.000**	**0.477**	**0.142**	**0.619**	**1.000**

Table 2.4 Species-specific total annual incidental catch (mt) and the associated coefficient of variation across all fleets and regions. Midwater trawl estimates were only included beginning in 2005.

	Alewife		American shad		Blueback herring		Herring NK		Hickory shad	
	Catch	CV	Catch	CV	Catch	CV	Catch	CV	Catch	CV
1989	44.16	0.49	229.10	0.98	37.65	0.42	17.53	1.13	0.00	
1990	101.63	0.85	45.20	0.34	170.01	0.45	681.30	0.59	0.00	
1991	148.56	0.44	176.09	0.25	285.07	0.40	265.61	0.51	39.35	0.00
1992	65.74	0.43	168.95	0.28	1190.98	0.42	786.21	0.39	0.00	
1993	381.05	2.42	211.34	1.00	745.60	0.28	135.86	4.83	0.00	
1994	5.56	0.30	109.93	0.64	240.17	0.87	58.34	0.47	0.95	0.82
1995	8.44	0.61	127.43	0.38	348.33	0.44	99.87	1.23	0.53	0.64
1996	704.10	1.14	64.52	0.39	2800.04	2.09	451.39	0.39	222.46	1.04
1997	49.42	1.36	65.95	0.61	1593.60	0.69	90.27	5.09	20.64	1.25
1998	145.64	1.47	161.03	0.23	76.81	1.52	228.12	2.08	479.82	0.72
1999	6.12	1.16	82.03	0.41	359.21	0.60	3457.27	0.74	208.75	0.94
2000	113.33	0.81	264.43	0.77	109.57	0.45	70.86	0.78	2.41	0.76
2001	189.63	0.84	67.82	0.39	309.86	0.32	2.51	0.44	330.44	0.27
2002	4.35	3.35	43.81	0.40	269.14	0.33	124.05	1.88	1.87	0.83
2003	388.04	1.43	60.20	0.54	526.83	0.56	26.21	1.17	18.80	0.85
2004	163.18	0.64	53.06	0.36	231.67	0.46	237.06	0.74	401.75	1.13
2005	404.42	0.40	94.50	0.28	254.68	0.34	29.46	0.58	27.42	0.34
2006	78.73	0.83	78.23	9.73	190.78	0.66	267.81	1.10	25.07	0.78
2007	543.58	0.71	79.08	0.56	187.99	1.42	357.43	0.91	16.72	0.90
2008	159.16	0.42	74.04	0.29	539.32	0.56	1669.08	0.50	5.56	0.80
2009	154.22	0.26	106.70	1.99	195.41	0.30	352.25	0.66	11.70	0.79
2010	134.60	0.19	60.61	0.16	132.42	0.20	106.67	0.32	1.26	0.59
2011	96.53	0.34	103.32	0.12	28.19	0.30	125.99	0.28	0.09	0.77
2012	173.85	0.24	76.53	0.16	249.35	0.31	91.72	0.30	0.51	0.55
2013	238.95	0.33	73.48	0.41	28.92	0.46	75.08	0.69	0.42	0.76
2014	83.61	0.14	63.46	0.19	29.55	0.25	76.68	0.44	0.68	0.39
2015	123.66	0.31	46.40	0.15	82.44	0.48	40.47	0.75	2.46	0.77

Table 2.5 Trawl surveys for river herring. Only those surveys used in the benchmark assessment were included in ARIMA model analysis.

Species	Age	Survey	Season	Duration	n	Index Units
Alewife	Adult	DE Deleware River and Bay Adult finfish survey	All	1966 - 2015	38	Arithmetic Mean Catch per Nautical Mile Towed
	Age1	DE Delaware River and Bay Juvenile finfish survey	All	1991 - 2015	24	Geometric Mean Count Per Tow
		Massachusetts DMF Inshore North Cape Cod	Spring	1978 - 2015	38	Mean Number per Tow
		Massachusetts DMF Inshore South Cape Cod	Spring	1978 - 2015	38	Mean Number per Tow
	All	Ches. Bay Multispecies Monitoring and Assessment Program	Spring	2002 - 2015	14	Number per square nautical mile
		CT DEEP Long Island Sound Trawl Survey	Fall	1984 - 2015	32	Geometric Mean Count Per Tow
		CT DEEP Long Island Sound Trawl Survey	Spring	1984 - 2015	32	Geometric Mean Count Per Tow
		ME-MH Fall Inshore Gulf of Maine	Fall	2000 - 2015	16	Stratified Mean Catch Per Tow
		ME-MH Fall Inshore Gulf of Maine	Spring	2001 - 2015	15	Stratified Mean Catch Per Tow
		New Jersey Ocean Trawl Survey	All	1989 - 20015	27	Geometric Mean CPUE
		NEFSC bottom trawl-Coast	Fall	1975 - 2015	41	Mean number per tow
		NEFSC bottom trawl-Coast	Spring	1976 - 2015	40	Mean number per tow
		NEFSC bottom trawl-North	Spring	1976 - 2015	40	Mean number per tow
		NEFSC bottom trawl-South	Spring	1976 - 2015	40	Mean number per tow
		Northeast Area Monitoring and Assessment Program	Fall	2007 - 2015	9	Number per 25K square miles
		Northeast Area Monitoring and Assessment Program	Spring	2008 - 2015	8	Number per 25K square miles
		Rhode Island Combined Coastal Trawl Survey	All	1979 - 2015	37	Arithmetic Mean Catch Per Tow
	YOY	DE Delaware River and Bay Juvenile finfish survey	All	1990 - 2015	26	Geometric Mean Count Per Tow
		North Carolina DMF Western Sound	Summer-Fall	1982 - 2015	34	Arithmetic Mean CPUE

Table 2.5 Continued.

Species	Age	Survey	Season	Duration	n	Index Units
Blueback	Adult	DE Deleware River and Bay Adult finfish survey	All	1966 - 2015	38	Arithmetic Mean Catch per Nautical Mile Towed
	Age1	DE Delaware River and Bay Juvenile finfish survey	All	1991 - 2015	24	Geometric Mean Count Per Tow
		Massachusetts DMF Inshore North Cape Cod	Spring	1978 - 2015	38	Mean Number per Tow
		Massachusetts DMF Inshore South Cape Cod	Spring	1978 - 2015	38	Mean Number per Tow
	All	Ches. Bay Multispecies Monitoring and Assessment Program	Spring	2002 - 2015	14	Number per square nautical mile
		CT DEEP Long Island Sound Trawl Survey	Fall	1984 - 2015	32	Geometric Mean Count Per Tow
		CT DEEP Long Island Sound Trawl Survey	Spring	1984 - 2015	32	Geometric Mean Count Per Tow
		ME-MH Fall Inshore Gulf of Maine	Fall	2002 - 2015	14	Stratified Mean Catch Per Tow
		ME-MH Fall Inshore Gulf of Maine	Spring	2001 - 2015	15	Stratified Mean Catch Per Tow
		New Jersey Ocean Trawl Survey	All	1989 - 2015	27	Geometric Mean CPUE
		NEFSC bottom trawl-Coast	Fall	1975 - 2015	41	Mean number per tow
		NEFSC bottom trawl-Coast	Spring	1976 - 2015	40	Mean number per tow
		NEFSC bottom trawl-North	Spring	1976 - 2015	40	Mean number per tow
		NEFSC bottom trawl-South	Spring	1976 - 2015	40	Mean number per tow
		Northeast Area Monitoring and Assessment Program	Fall	2007 - 20015	9	Number per 25K square miles
		Northeast Area Monitoring and Assessment Program	Spring	2008 - 2015	8	Number per 25K square miles
		Rhode Island Combined Coastal Trawl Survey	All	1979 - 2015	37	Arithmetic Mean Catch Per Tow
	YOY	DE Delaware River and Bay Juvenile finfish survey	All	1990 - 2015	26	Geometric Mean Count Per Tow
		North Carolina DMF Western Sound	Summer-Fall	1982 - 2015	34	Arithmetic Mean CPUE

Table 2.6 Summary statistics from ARIMA model fits to **alewife** trawl survey data. Q0.25 is the 25th percentile of the fitted values; P(<0.25) is the probability of the final year of the survey being below the bootstrapped mean Q0.25 with 80% confidence; r1 - r3 are the first three autocorrelations; θ is the moving average parameter; SE is the standard error of θ; and σ2c is the variance of the index.

Survey	Season	Age	FinalYear	n	P(<0.25)	Mean $Q_{0.25}$	r1	r2	r3	θ	SE	σ^2_c
CT DEP Long Island Sound Trawl Survey	Fall	All	2015	32	0.057	-1.53847	-0.6	0.13	-0.1	0.8	0.1	1
CT DEP Long Island Sound Trawl Survey	Spring	All	2015	32	0.043	-0.27407	-0.4	-0.2	0.28	0.6	0.1	0.3
DE Delaware River and Bay Adult finfish survey	All	Adult	2015	38	0.007	-0.59043	-0.3	-0.2	0.28	1	0.1	0.9
DE Delaware River and Bay Juvenile finfish survey	All	Age 1	2015	25	0.381	-3.41287	-0.8	0.55	-0.4	0.8	0.1	2.5
DE Delaware River and Bay Juvenile finfish survey	All	Age 0	2015	26	0.017	-1.80505	-0.5	0.02	-0.1	1	0.6	2.2
Massachusetts DMF Inshore North Cape Cod	Spring	Age 1	2015	38	0.009	2.20236	-0.3	-0.3	0.21	0.9	0.1	1.1
Massachusetts DMF Inshore South Cape Cod	Spring	Age 1	2015	38	0.148	-0.39794	-0.5	0.13	-0.1	1	0.1	2
ME-NH Inshore Gulf of Maine	Fall	All	2015	16	0.001	5.59119	-0.2	-0.2	-0.2	0.7	0.2	0.2
ME-NH Inshore Gulf of Maine	Spring	All	2015	15	0	5.05178	-0.5	0.38	-0.4	0.6	0.2	0.2
New Jersey Ocean Trawl Survey	All	All	2015	27	0.404	1.03283	-0.4	-0.1	0.01	0.8	0.2	0.6
NEFSC bottom trawl-Coast	Fall	All	2015	41	0	0.53968	-0.5	0.01	-0.2	0.7	0.1	0.6
NEFSC bottom trawl-Coast	Spring	All	2015	40	0	1.94602	-0.2	-0.2	0.03	0.4	0.2	0.2
NEFSC bottom trawl-North	Fall	All	2015	41	0	0.8866	-0.5	0.01	-0.2	0.6	0.1	0.6
NEFSC bottom trawl-North	Spring	All	2015	40	0	1.83144	-0.4	0.01	-0.2	0.5	0.2	0.3
NEFSC bottom trawl-South	Spring	All	2015	40	0.271	1.35078	-0.3	-0.2	0.04	0.9	0.1	1.2
North Carolina DMF Western Sound	Summer-Fall	Age 0	2015	34	0.056	-2.3188	-0.3	-0.1	-0.1	0.4	0.3	3.4
Rhode Island Coastal Trawl Survey	All	All	2015	37	0	0.14138	-0.5	0.11	-0.3	0.5	0.1	1.5

Table 2.7 Summary statistics from ARIMA model fits to **blueback herring** trawl survey data. Q0.25 is the 25th percentile of the fitted values; P(<0.25) is the probability of the final year of the survey being below the bootstrapped mean Q0.25 with 80% confidence; r1 - r3 are the first three autocorrelations; θ is the moving average parameter; SE is the standard error of θ; and σ2c is the variance of the index.

Survey	Season	Age	FinalYear	n	P(<0.25)	Mean $Q_{0.25}$	r1	r2	r3	θ	SE	σ^2_c
CT DEP Long Island Sound Trawl Survey	Fall	All	2015	32	0.03	-0.28326	-0.4	-0.2	0.28	0.6	0.1	0.3
CT DEP Long Island Sound Trawl Survey	Spring	All	2015	32	0.112	-2.12008	-0	0.03	0.02	0.4	0.2	1
DE Delaware River and Bay Adult finfish survey	All	Adult	2015	38	0	-2.82457	-0.4	0.13	-0.1	1	0.2	1.3
DE Delaware River and Bay Juvenile finfish survey	All	Age 1	2015	25	0.067	-3.44167	-0.5	-0	0.03	0.9	0.2	1.8
DE Delaware River and Bay Juvenile finfish survey	All	Age 0	2015	26	0.436	-3.80433	-0.7	0.48	-0.4	0.7	0.1	1.2
Massachusetts DMF Inshore North Cape Cod	Spring	Age 1	2015	38	0.006	0.45707	-0.4	-0.2	0.03	1	0.1	1.5
Massachusetts DMF Inshore South Cape Cod	Spring	Age1	2015	38	0.264	-2.74304	-0.5	0.01	0.12	0.9	0.1	3.1
ME-NH Inshore Gulf of Maine	Spring	All	2015	15	0.241	2.80829	-0.5	0.03	-0	1	0.3	0.7
New Jersey Ocean Trawl Survey	All	All	2015	27	0.058	1.30298	-0.2	-0.4	0.05	1	0.1	0.2
NEFSC bottom trawl-Coast	Fall	All	2015	41	0	-2.80216	-0.5	0.11	0.07	0.7	0.1	2
NEFSC bottom trawl-Coast	Spring	All	2015	40	0	0.59159	-0.3	-0.3	0.32	0.6	0.2	0.7
NEFSC bottom trawl-North	Fall	All	2015	41	0	-2.54985	-0.5	0.13	0.04	0.7	0.1	2.3
NEFSC bottom trawl-North	Spring	All	2015	40	0	-0.34661	-0.4	-0	-0.2	0.7	0.1	0.9
NEFSC bottom trawl-South	Fall	All	2015	41	0	-4.54659	-0.2	-0.3	0	0.9	0.1	0.1
NEFSC bottom trawl-South	Spring	All	2015	40	0.005	1.0361	-0.4	-0.1	0.18	0.7	0.1	1.6
North Carolina DMF Western Sound	Summer-Fall	Age 0	2015	34	0.393	-0.84596	-0.1	-0.6	0.23	0.8	0.1	8.8
Rhode Island Coastal Trawl Survey	All	All	2015	37	0.342	0.21024	-0.4	-0.1	-0.1	0.8	0.1	2

Table 2.8 Summary of P(<0.25) values from Tables 1 & 2 comparing northern to southern trawl surveys for river herring. Coastwide NMFS surveys were not included in this summary. N is the number of surveys included in each region.

Species	Region	n	Min.	Max.	Median	Average
Alewife	North	7	0.000	0.148	0.009	0.037
	South	5	0.007	0.464	0.056	0.173
Blueback	North	6	0.006	0.342	0.177	0.166
	South	5	0.000	0.540	0.067	0.191

Table 2.9 Results of the Mann-Kendall test for trends in mean length by river (state), species and sex. n = sample size, S is the Mann-Kendall test statistics, and p is the two-tailed probability. Significant results are bolded. The sign of the test statistic indicates the direction of the trend. *Hudson River (NY) results are provided in the updated NY state report due to changes in historical data between the benchmark and update assessments.

River (State)*	Species	Sex	n	S	p
Androscoggin River (ME)	Alewife	Male	25	-53	0.224
		Female	25	-57	0.191
Cocheco River (NH)	Alewife	Male	25	-46	0.293
		Female	25	-32	0.469
	Blueback	**Male**	**21**	**-94**	**0.005**
		Female	22	-63	0.080
Exeter River (NH)	Alewife	**Male**	**24**	**-94**	**0.021**
		Female	24	-66	0.107
Lamprey River (NH)	Alewife	Male	26	-11	0.826
		Female	26	13	0.791
Oyster River (NH)	Blueback	**Male**	**25**	**-150**	**0.001**
		Female	**25**	**-102**	**0.018**
Winnicut River (NH)	Alewife	Male	12	2	0.308
		Female	12	28	1.000
	Blueback	Male	12	-2	0.734
		Female	12	-12	0.734
Monument River (NH)	Alewife	**Male**	**30**	**-215**	**0.000**
		Female	**30**	**-197**	**0.000**
	Blueback	**Male**	**30**	**-211**	**0.000**
		Female	**30**	**-258**	**0.000**
Nanticoke River (MD)	Alewife	**Male**	**26**	**-105**	**0.022**
		Female	**26**	**-95**	**0.038**
	Blueback	**Male**	**26**	**-207**	**0.000**
		Female	**26**	**-225**	**0.000**
Chowan River (NC)	Alewife	**Male**	**39**	**-367**	**0.000**
		Female	**38**	**-329**	**0.000**
	Blueback	**Male**	**44**	**-648**	**0.000**
		Female	**44**	**-616**	**0.000**
Santee-Cooper River (SC)					
Commercial cast net	Blueback	Male	19	-14	0.649
		Female	19	48	0.099
Fishlift	Blueback	Male	24	-46	0.263
		Female	24	-68	0.095
St. John's River (FL)	Blueback	Male	18	-36	0.185
		Female	**18**	**-59**	**0.028**

Table 2.10 Results of the Mann-Kendall test for trends in mean lengths of alewife and blueback herring from the National Marine Fisheries bottom trawl survey by species and region. *n* = sample size, *S* is the Mann-Kendall test statistics, and *p* is the two-tailed probability. Significant results are bolded. The sign of the test statistic indicates the direction of the trend.

Species	Region	n	S	p
Alewife	Coastwide Spring	40	**-386**	0.0000
Alewife	North Spring	40	**-258**	0.0028
Alewife	South Spring	40	**-376**	0.0000
Alewife	Coastwide Fall	41	-162	0.0706
Alewife	North Fall	41	-162	0.0706
Alewife	South Fall			
Blueback	Coastwide Spring	40	-8	0.9350
Blueback	North Spring	40	-26	0.7708
Blueback	South Spring	40	112	0.1959
Blueback	Coastwide Fall	37	**-225**	0.0034
Blueback	North Fall	37	**-225**	0.0034
Blueback	South Fall	2	1	1.0000

Table 2.11 Results of the Mann-Kendall test for trends in mean length by river (state), species, sex and age. n = sample size, S is the Mann-Kendall test statistics, and p is the two-tailed probability. Significant results are bolded. The sign of the test statistic indicates the direction of the trend.

				Time Series			2006-2015		
River (State)	Species	Sex	Age	n	S	p	n	S	p
Cocheco River (NH)	Alewife	Female	3	13	-19	0.271	3	1	1.000
			4	**25**	**-112**	**0.010**	10	-9	0.474
			5	**25**	**-126**	**0.004**	10	3	0.858
			6	24	-42	0.309	**10**	**29**	**0.012**
		Male	**3**	**20**	**-82**	**0.009**	7	1	1.000
			4	**25**	**-122**	**0.005**	10	-7	0.592
			5	**25**	**-158**	**0.000**	10	1	1.000
			6	24	-60	0.143	**10**	**23**	**0.049**
	Blueback	Female	3	11	-3	0.876	0	0	1.000
			4	**19**	**-78**	**0.007**	5	-8	0.086
			5	**15**	**-53**	**0.010**	2	1	1.000
			6	**10**	**-31**	**0.007**	4	-2	0.734
		Male	**3**	**13**	**-38**	**0.024**	2	1	1.000
			4	**20**	**-98**	**0.002**	5	-6	0.221
			5	**15**	**-59**	**0.004**	3	-3	1.000
			6	**8**	**-18**	**0.035**	2	-1	1.000
Exeter River (NH)	Alewife	Female	3	13	-28	0.100	5	-4	0.462
			4	**23**	**-105**	**0.006**	9	6	0.602
			5	24	-58	0.157	**10**	**25**	**0.032**
			6	23	-34	0.383	10	13	0.283
		Male	**3**	**17**	**-82**	**0.001**	6	-5	0.452
			4	**24**	**-118**	**0.004**	10	-5	0.721
			5	24	-56	0.172	**10**	**25**	**0.032**
			6	21	-18	0.608	**9**	**32**	**0.001**
	Blueback	Female	3	6	-5	0.452	1	0	1.000
			4	**12**	**-33**	**0.028**	3	3	1.000
			5	13	-15	0.392	3	-1	1.000
			6	**10**	**-31**	**0.007**	3	-1	1.000
		Male	**3**	**13**	**-36**	**0.033**	4	2	0.734
			4	16	-39	0.087	5	0	1.000
			5	**15**	**-63**	**0.002**	4	0	1.000
			6	**10**	**-24**	**0.037**	3	2	1.000
Lamprey River (NH)	Alewife	Female	**3**	**15**	**-77**	**0.000**	4	-6	0.089
			4	**25**	**-173**	**0.000**	10	-1	1.000
			5	**26**	**-131**	**0.004**	10	5	0.721
			6	25	-14	0.761	10	13	0.283
		Male	**3**	**19**	**-88**	**0.002**	7	4	0.649
			4	**26**	**-185**	**0.000**	10	3	0.858
			5	26	-75	0.103	10	17	0.152
			6	24	-26	0.535	10	17	0.152
	Blueback	Female	3	3	-3	1.000	1	0	1.000
			4	5	0	1.000	2	1	1.000
			5	3	-1	1.000	1	0	1.000
			6	2	-1	1.000	1	0	1.000
		Male	3	5	0	1.000	4	2	0.734
			4	5	-6	0.221	2	-1	1.000
			5	7	-11	0.133	4	-4	0.308
			6	2	-1	1.000	2	-1	1.000
Oyster River (NH)	Alewife	Female	3	7	-6	0.448	5	0	1.000
			4	11	-7	0.640	7	7	0.368
			5	11	7	0.640	**8**	**20**	**0.019**
			6	8	0	1.000	6	9	0.133
		Male	3	9	-12	0.251	6	3	0.707
			4	11	-2	0.938	7	12	0.095
			5	12	0	1.000	8	16	0.063
			6	9	12	0.251	7	11	0.133
	Blueback	Female	**3**	**21**	**-120**	**0.000**	8	4	0.711
			4	**25**	**-95**	**0.028**	**10**	**32**	**0.005**
			5	**25**	**-144**	**0.001**	10	21	0.074
			6	25	-49	0.262	**10**	**31**	**0.007**
		Male	**3**	**24**	**-150**	**0.000**	9	6	0.602
			4	**25**	**-132**	**0.002**	**10**	**23**	**0.049**
			5	**25**	**-92**	**0.034**	**10**	**33**	**0.004**
			6	20	-52	0.098	8	0	1.000
Winnicut River (NH)	Alewife	Female	3	8	-6	0.536	2	-1	1.000
			4	**11**	**-35**	**0.008**	3	-3	1.000
			5	11	-21	0.119	4	2	0.734
			6	11	-6	0.696	4	-2	0.734
		Male	**3**	**12**	**-30**	**0.047**	4	2	0.734
			4	12	-24	0.115	4	4	0.308
			5	11	-23	0.087	4	6	0.089
			6	11	-15	0.276	4	-2	0.734
	Blueback	Female	3	9	-1	1.000	2	1	1.000
			4	**11**	**-27**	**0.043**	3	1	1.000
			5	10	-21	0.074	3	1	1.000
			6	9	-14	0.175	3	-1	1.000
		Male	3	11	-20	0.138	3	3	1.000
			4	12	-18	0.244	4	2	0.734
			5	**12**	**-30**	**0.047**	4	4	0.308
			6	9	-5	0.675	3	3	1.000

Table 2.11 Continued.

River (State)	Species	Sex	Age	Time Series n	Time Series S	Time Series p	2006-2015 n	2006-2015 S	2006-2015 p
Monument River (MA)	Alewife	Female	3	21	39	0.251	**10**	**27**	**0.020**
			4	23	27	0.492	10	17	0.152
			5	23	37	0.342	10	5	0.721
			6	21	24	0.487	9	-2	0.917
		Male	3	23	-9	0.833	10	21	0.074
			4	23	7	0.874	10	11	0.371
			5	23	37	0.342	10	-3	0.858
			6	20	14	0.673	7	-11	0.133
	Blueback	Female	3	18	15	0.596	10	19	0.107
			4	24	-32	0.442	**10**	**29**	**0.012**
			5	**24**	**-84**	**0.040**	10	15	0.210
			6	15	-15	0.488	6	5	0.452
		Male	3	24	24	0.568	10	19	0.107
			4	24	48	0.244	**10**	**23**	**0.049**
			5	24	54	0.189	10	9	0.474
			6	13	-7	0.714	6	-4	0.566
Gilbert-Stuart (RI)	Alewife	Female	3	10	-7	0.592	4	2	0.734
			4	15	-5	0.843	9	16	0.118
			5	15	8	0.729	9	9	0.402
			6	15	7	0.767	9	2	0.917
		Male	3	15	10	0.656	**9**	**21**	**0.036**
			4	15	-32	0.123	**9**	**21**	**0.033**
			5	15	-7	0.767	9	12	0.251
			6	*	*	*	*	*	*
Nonquit (RI)	Alewife	Female	3	11	-16	0.241	5	0	1.000
			4	15	-3	0.921	9	18	0.076
			5	15	20	0.346	**9**	**29**	**0.003**
			6	15	20	0.346	**9**	**23**	**0.021**
		Male	3	14	-13	0.511	8	14	0.108
			4	15	-1	1.000	**9**	**28**	**0.005**
			5	15	1	1.000	**9**	**20**	**0.048**
			6	8	5	0.618	7	12	0.095
Nanticoke (MD)	Alewife	Female	3	23	-5	0.916	8	7	0.454
			4	26	-13	0.791	9	-3	0.834
			5	26	-71	0.123	9	-12	0.251
			6	**26**	**-112**	**0.014**	9	-5	0.675
		Male	**3**	**26**	**-134**	**0.003**	9	-4	0.754
			4	**26**	**-163**	**0.000**	9	-14	0.175
			5	**26**	**-103**	**0.025**	9	0	1.000
			6	26	-80	0.081	9	-6	0.602
	Blueback	Female	3	22	-61	0.090	8	6	0.536
			4	26	-50	0.280	9	6	0.602
			5	26	-70	0.128	9	0	1.000
			6	26	-88	0.055	9	4	0.754
		Male	**3**	**26**	**-135**	**0.003**	9	4	0.754
			4	**25**	**-122**	**0.005**	8	-2	0.902
			5	**26**	**-151**	**0.001**	9	4	0.754
			6	**23**	**-143**	**0.000**	7	-1	1.000
Chowan (NC)*	Alewife	Female	**3**	**12**	**-51**	**0.001**	NA	NA	NA
			4	**29**	**-236**	**0.000**	NA	NA	NA
			5	**30**	**-279**	**0.000**	NA	NA	NA
			6	**29**	**-206**	**0.000**	NA	NA	NA
		Male	**3**	**25**	**-175**	**0.000**	NA	NA	NA
			4	**32**	**-331**	**0.000**	NA	NA	NA
			5	**30**	**-235**	**0.000**	NA	NA	NA
			6	**30**	**-237**	**0.000**	NA	NA	NA
	Blueback	Female	**3**	**29**	**-268**	**0.000**	7	-11	0.133
			4	**44**	**-592**	**0.000**	10	9	0.474
			5	**44**	**-501**	**0.000**	10	19	0.107
			6	**43**	**-484**	**0.000**	9	14	0.175
		Male	**3**	**43**	**-601**	**0.000**	10	5	0.721
			4	**44**	**-660**	**0.000**	10	7	0.592
			5	**44**	**-499**	**0.000**	**10**	**27**	**0.020**
			6	**41**	**-347**	**0.001**	9	16	0.118

*Chowan (NC) alewife results from the 2012 Benchmark Assessment.

Table 2.12 Summary of fisheries-independent data sources that have collected repeat spawner data from river herring. Species indicates whether data were available for alewives (A), blueback herring (B), or both species combined (river herring, R).

State	Water Body	Gear	Species	Years	
				From	To
Maine	Androscoggin River	Fishway	R	2005	20014
New Hampshire	Cocheco River	Fishway	A, B	2000	2015
New Hampshire	Exeter River	Fishway	A, B	2000	2015
New Hampshire	Lamprey River	Fishway	A	2000	2015
New Hampshire	Oyster River	Fishway	B	2000	215
New Hampshire	Taylor River	Fishway	B	2000	2005
New Hampshire	Winnicut River	Fishway	A	2000	2010
Massachusetts	Mattapoisett River	Dip Net	A	2006	2006
Massachusetts	Monument River	Dip Net	A, B	1986	1987
Massachusetts	Monument River	Dip Net	A, B	1993	1993
Massachusetts	Monument River	Dip Net	A, B	1995	2015
Massachusetts	Mystic River	Dip Net	A, B	2004	2010
Massachusetts	Nemasket River	Dip Net	A	2004	2013
Massachusetts	Quashnet River	Dip Net	A, B	2004	2004
Massachusetts	Stoney Brook	Dip Net	A	2004	2004
Massachusetts	Town Brook	Dip Net	A, B	2004	2013
Rhode Island	Gilbert Stuart Stream	Fishway	R	1984	2015
Rhode Island	Nonquit Pond	Fishway	R	2000	2015
New York	Hudson River	Various, Combined	B	1989	1990
New York	Hudson River	Various, Combined	A, B	1999	2001
New York	Hudson River	Various, Combined	A, B	2009	2015
South Carolina	Santee River	Pound Net	B	1978	1978
South Carolina	Santee River	Haul Seine	B	1979	1979
South Carolina	Santee River	Gill Net	B	1980	1983

Table 2.13 Summary of fisheries-dependent data sources that have collected repeat spawner data from river herring. Species indicates whether data were available for alewives (A), blueback herring (B), or both species combined (river herring, R).

State	Water Body	Gear	Species	Years	
				From	To
Maryland	Nanticoke River	Pound & Fyke Nets	A, B	1989	2014
North Carolina	Alligator River	Pound Net	A, B	1972	1993
North Carolina	Chowan River	Pound Net	A	1972	2009
North Carolina	Chowan River	Pound Net	B	1972	2015
North Carolina	Scuppernong River	Pound Net	A, B	1972	1993

Table 2.14 Estimated rates of repeat spawning for river herring (alewives and blueback herring combined) observed in Maine's fisheries-independent fishway survey of the Androscoggin River by year.

Year	Maine
	Fishway
	Androscoggin River
2005	47.3
2006	57.9
2007	56.5
2008	24.0
2009	41.5
2010	18.0
2011	20.0
2012	13.5
2013	27.2
2014	22.0

Table 2.15 Estimated rates of repeat spawning for male and female alewives observed in New Hampshire's fisheries-independent fishway survey of the Cocheco, Exeter, Lamprey and Winnicut Rivers by year.

	New Hampshire			
	Fishway			
Year	Cocheco River	Exeter River	Lamprey River	Winnicut River
2000	32.1	10.6	46.2	46.2
2001	43.6	37.5	58.6	58.6
2002	46.2	19.2	63.3	63.3
2003	30.6	38.9	51.4	51.4
2004	69.6	36.4	54.9	54.9
2005	54.2	21.9	51.6	51.6
2006	50.6	37.5	59.8	59.8
2007	31.2	17.5	57.1	57.1
2008	29.6	9.0	32.9	32.9
2009	30.4	11.7	50.8	50.8
2010	65.3	18.8	63.0	63.0
2011	42.7	11.1	47.6	
2012	58.7	33.9	45.6	
2013	48.8	28.6	53.7	
2014	56.6	48.6	57.4	
2015	37.5	27.0	57.8	

Table 2.16 Estimated rates of repeat spawning for blueback herring (both sexes combined) observed in New Hampshire's fisheries-independent fishway surveys of the Cocheco and Oyster Rivers by year. [-- indicates inadequate sample size.]

	New Hampshire	
	Fishway	
Year	Cocheco River	Oyster River
2000	44.00	34.97
2001	40.00	64.58
2002	20.75	36.17
2003	24.00	51.01
2004	41.18	69.53
2005	20.00	50.00
2006	12.50	42.55
2007	31.34	37.99
2008	37.50	27.59
2009	--	38.66
2010	--	52.56
2011		46.8
2012		56.5
2013	0.0	20.0

Table 2.17 Estimated rates of repeat spawning for male alewife observed in Massachusetts' fisheries-independent dipnet surveys in select rivers by year. Scale processing was discontinued at all sites other than the Monument River after 2013.

	Massachusetts						
	Dip Net						
Year	Mattapoisett River	Monument River	Mystic River	Nemasket River	Quashnet River	Stoney Brook	Town Brook
1986		38.6					
1987		41.1					
1988							
	⋮	⋮	⋮	⋮	⋮	⋮	⋮
1993		22.7					
1995		5.2					
1996		23.9					
1997		22.0					
1998		28.7					
1999		12.2					
2000		9.8					
2001		17.8					
2002		31.2					
2003		18.8					
2004		6.5	32.4	43.9	4.6	12.1	16.9
2005		3.7	30.0	33.8			9.7
2006	2.86	4.9	0.0	9.7			4.4
2007		6.2	6.7	11.9			22.8
2008		12.6	15.7	20.1			32.3
2009		10.2	20.7	17.5			32.0
2010		6.7	14.3	15.9			16.7
2011		9.0	22.4	26.4			24.6
2012		5.9	33.9	15.4			27.4
2013		4.1	16.0	20.9			30.9
2014		10.9					
2015		4.7					

Table 2.18 Estimated rates of repeat spawning for female alewife observed in Massachusetts' fisheries-independent dipnet surveys in select rivers by year. Alewife scale processing was discontinued at all sites other than the Monument River after 2013.

Year	Massachusetts						
	Dip Net						
	Mattapoisett River	Monument River	Mystic River	Nemasket River	Quashnet River	Stoney Brook	Town Brook
1986		45.3					
1987		43.6					
1988							
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
1993		19.6					
1995		7.9					
1996		18.2					
1997		28.6					
1998		41.3					
1999		10.8					
2000		7.6					
2001		13.8					
2002		28.7					
2003		12.1					
2004		1.4	35.7	43.1	7.06	20.6	13.8
2005		7.6	8.33	18.8			18.4
2006	4.17	15.8	0.0	9.7			7.9
2007		8.4	12.7	13.5			16.9
2008		14.9	24.5	21.6			29.5
2009		13.5	28.6	30.4			31.1
2010		13.3	15.4	22.8			20.7
2011		16.0	35.3	26.4			22.9
2012		11.8	46.1	19.5			36.7
2013		11.9	22.1	17.0			29.1
2014		12.8					
2015		6.2					

Table 2.19 Estimated rates of repeat spawning for male blueback herring observed in Massachusetts, New York and South Carolina fisheries-independent surveys in select rivers by year and gear type.

Year	Massachusetts				New York	South Carolina			
	Dip Net				Various, Combined	Pound Net	Haul Seine	Gill Net	Cast Net
	Monument River	Mystic River	Quashnet River	Town Brook	Hudson River	Santee River	Santee River	Santee River	Santee River
1978						31.6			
1979							0		
1980								10.0	
1981								30.7	
1982								25.3	
1983								9.18	
1984									
1985									
1986	21.6								
1987	20.0								
1988									
1989					35.1				
1990					21.4				
1991									
1992									
1993									
1994									
1995									
1996									
1997									
1998									
1999					21.4				
2000					6.33				
2001					11.7				
2002									
2003									
2004	6.25		100						
2005	8.00	5.71		0					
2006	13.80	20.91							
2007	6.17	17.72							
2008	5.56	27.39							
2009	3.53	12.96			40.6				
2010	1.25	12.85			20.3				
2011	7.0	19.7			16.5				
2012	15.1	48.9			10.6				
2013	4.0	10.0			7.8				
2014					19.7				26.9
2015					25.0				29.6

Table 2.20 Estimated rates of repeat spawning for female blueback herring observed in Massachusetts, New York and South Carolina fisheries-independent surveys in select rivers by year and gear type.

Year	**Massachusetts**				**New York**	**South Carolina**			
	Dip Net				Various, Combined	Pound Net	Haul Seine	Gill Net	Cast Net
	Monument River	Mystic River	Quashnet River	Town Brook	Hudson River	Santee River	Santee River	Santee River	Santee River
1978						27.8			
1979							30.0		
1980								17.1	
1981								19.5	
1982								33.7	
1983								27.2	
1984									
1985									
1986	38.5								
1987	38.7								
1988									
1989					24.6				
1990					21.3				
1991									
1992									
1993									
1994									
1995									
1996									
1997									
1998									
1999					22.9				
2000					13.6				
2001					12.9				
2002									
2003									
2004	4.17		100						
2005	5.00	2.70		0					
2006	14.29	16.13							
2007	1.47	15.49							
2008	5.97	35.71							
2009	5.41	11.76			25.4				
2010	1.49	15.25			30.3				
2011	6.1	21.2			28.6				
2012	11.5	51.8			21.3				
2013	6.5	17.8			21.9				
2014					35.1				30.4
2015					48.1				30.3

Table 2.21 Estimated rates of repeat spawning for male river herring observed in Rhode Island's fisheries-independent fishway surveys in select rivers by year.

	Rhode Island	
	Fishway	
Year	Gilbert Stuart Stream	Nonquit Pond
1984	24.7	
1985	26.8	
1986	81.4	
1987		
1988	16.4	
1989	27.3	
1990		
1991	17.0	
1992	16.5	
2000	20.9	11.5
2001	18.8	5.26
2002	13.0	6.76
2003	6.58	15.6
2004	5.41	3.77
2005	4.44	0
2006	10.0	3.09
2007	7.06	8.18
2008	17.02	14.12
2009	13.43	20.27
2010	6.25	
2011	12.3	13.3
2012	17.9	6.7
2013	17.2	10.2
2014	16.7	15.6
2015		25.7

Table 2.22 Estimated rates of repeat spawning for female river herring observed in Rhode Island's fisheries-independent fishway surveys in select rivers by year.

Year	Rhode Island	
	Fishway	
	Gilbert Stuart Stream	Nonquit Pond
1984	20.5	
1985	31.4	
1986	58.1	
1987		
1988	56.8	
1989	29.3	
1990		
1991	36.6	
1992	59.3	
2000	19.0	16.7
2001	23.4	15.2
2002	26.2	11.3
2003	10.3	15.2
2004	11.1	6.06
2005	5.71	12.0
2006	34.4	0
2007	3.6	5.13
2008	25.6	25.0
2009	3.3	13.1
2010	9.09	
2011	27.4	22.6
2012	11.8	10.5
2013	33.3	52
2014	11.5	13.4
2015		34.1

Table 2.23 Estimated rates of repeat spawning for male and female alewife observed in New York's fisheries-independent surveys in the Hudson River by year.

Year	**New York** Various Gear, Combined Hudson River Male	Female
1999	39.0	75.0
2000	4.08	15.4
2001	11.9	34.9
2009	25.2	42.2
2010	19.9	49.5
2011	17.9	31.7
2012	28.5	33.0
2013	20.2	40.8
2014	38.1	48.2
2015	49.1	64.0

Table 2.24 Estimated rates of repeat spawning for male alewife observed in Maryland and North Carolina's fisheries-dependent surveys by river and year. [-- indicates inadequate sample size and X indicates data excluded due to ageing error (see state report)]

Year	Maryland	North Carolina		
	Pound & Fyke Net	Pound Net		
	Nanticoke River	Alligator River	Chowan River	Scuppernong River
1972		77.8	36.5	47.0
1973		40.5	27.0	34.1
1974			13.5	4.55
1975		20.3	41.7	10.1
1976		20.2	40.4	14.9
1977		28.2	13.8	22.7
1978		37.9	13.8	0
1979		65.1	28.2	20.0
1980		38.6	42.4	36.7
1981		20.5	21.1	15.4
1982		28.7	28.4	51.0
1983		36.6	26.7	30.0
1984		18.8	32.5	21.7
1985		61.1	15.0	
1986		30.2	37.9	
1987		0	0	0
1988		38.5	27.5	35.7
1989	57.8	32.5	16.7	26.5
1990	67.1	36.7	--	68.4
1991	44.6	28.5	66.7	25.0
1992	52.7	14.9	26.3	10.3
1993	62.4	17.4	--	10.1
1994	50.8		--	
1995	45.5			
1996	35.1			
1997	52.3			
1998	51.5			
1999	63.6		40.0	
2000	31.4		20.3	

Table 2.24 Continued.

Year	Maryland	North Carolina		
	Pound & Fyke Net	Pound Net		
	Nanticoke River	Alligator River	Chowan River	Scuppernong River
2001	50.0		48.1	
2002	70.4		57.4	
2003	64.6		20.0	
2004	41.2		39.7	
2005	34.3		59.5	
2006	72.0		13.0	
2007	25.0		29.6	
2008	59.1		20.3	
2009	31.0		35.7	
2010	32.0		X	
2011	57.1		X	
2012	26.2		X	
2013	27.9		X	
2014	23.9		X	
2015			X	

Table 2.25 Estimated rates of repeat spawning for female alewife observed in Maryland and North Carolina's fisheries-dependent surveys by river and year. [-- indicates inadequate sample size and X indicates data excluded due to ageing error (see state report)]

Year	Maryland	North Carolina		
	Pound & Fyke Net	Pound Net		
	Nanticoke River	Alligator River	Chowan River	Scuppernong River
1972		46.7	51.3	58.3
1973		43.4	37.3	56.8
1974			12.1	0
1975		30.4	41.7	11.3
1976		22.6	68.2	14.3
1977		26.5	20.5	25.2
1978		45.3	39.2	0
1979		65.6	39.5	33.3
1980		78.8	57.3	52.0
1981		41.3	35.5	45.5
1982		19.7	31.3	37.8
1983		28.3	31.7	21.9
1984		27.0	32.0	12.5
1985		43.3	19.5	
1986		27.6	45.8	
1987		0	--	0
1988		53.7	20.8	28.6
1989	63.0	42.9	9.09	29.6
1990	73.9	50.9	--	63.2
1991	55.5	48.5	86.7	45.2
1992	57.7	39.6	51.7	58.7
1993	75.5	40.0	--	11.8
1994	66.7		--	
1995	55.4			
1996	58.7			
1997	61.2			
1998	57.6			
1999	74.2		--	
2000	41.8		25.5	
2001	67.7		34.5	
2002	84.9		42.3	
2003	83.5		36.7	
2004	66.1		52.3	
2005	58.6		57.1	
2006	84.8			

Table 2.25 Continued.

	Maryland	North Carolina		
	Pound & Fyke Net	Pound Net		
Year	Nanticoke River	Alligator River	Chowan River	Scuppernong River
2007	55.0		57.9	
2008	71.8		30.0	
2009	58.2		39.5	
2010	65.9		X	
2011	60.2		X	
2012	58.4		X	
2013	56.5		X	
2014	27.6		X	
2015			X	

Table 2.26 Estimated rates of repeat spawning for male blueback herring observed in Maryland and North Carolina's fisheries-dependent surveys by river and year.

	Maryland	North Carolina		
	Pound Net	Pound Net		
Year	Nanticoke River	Alligator River	Chowan River	Scuppernong River
1972		55.2	43.1	35.9
1973		41.2	43.7	13.8
1974			41.3	21.2
1975			15.2	6.99
1976		21.6	33.8	10.3
1977		41.8	18.4	21.4
1978			23.9	15.3
1979			64.0	20.6
1980		0	50.5	34.3
1981			37.4	14.3
1982			29.3	30.8
1983		66.7	33.9	21.8
1984		7.41	20.8	18.8
1985		28.6	42.7	45.6
1986			53.3	31.0
1987			11.0	0
1988		0	19.8	6.25
1989	66.5		22.6	18.4
1990	81.6		24.3	41.4
1991	66.0	9.09	18.6	45.8

Table 2.26 Continued.

1992	75.2		35.0	42.9
1993	82.7		63.3	23.1
1994	51.3		34.1	
1995	55.0		41.7	
1996	56.1		32.6	
1997	85.8		22.2	
1998	70.8		38.2	
1999	69.0		53.3	
2000	40.7		42.7	
2001	52.9		38.6	
2002	67.2		45.1	
2003	63.8		41.1	
2004	30.4		36.6	
2005	25.0		23.2	
2006	73.1		13.7	
2007	13.2		53.2	
2008	36.1		5.5	
2009	29.0		21.7	
2010	27.3		14.1	
2011	39.3		47.3	
2012	22.4		47.4	
2013	38.9		46.4	
2014	30.7		27.0	
2015			52.8	

Table 2.27 Estimated rates of repeat spawning for female blueback herring observed in Maryland and North Carolina's fisheries-dependent surveys by river and year.

	Maryland	**North Carolina**		
	Pound & Fyke Net	Pound Net		
Year	Nanticoke River	Alligator River	Chowan River	Scuppernong River
1972		61.9	44.0	32.1
1973		38.2	46.9	23.3
1974			48.1	20.6
1975			28.6	9.64
1976		39.7	42.4	23.3
1977		38.4	21.4	35.7
1978			19.3	17.5
1979			77.8	37.5
1980		20.0	57.9	34.1
1981			47.6	20.0
1982			36.2	25.0
1983		21.4	37.1	44.1
1984		13.0	37.5	19.4
1985		0	48.1	46.3
1986			52.6	42.6
1987			1.69	0
1988		25.0	36.0	36.8
1989	67.3		33.3	27.3
1990	83.4		27.0	44.4
1991	73.9	50.0	31.6	61.5
1992	74.7		31.3	14.3

Table 2.27 Continued.

1993	80.7		64.5	35.3
1994	56.2		23.3	
1995	40.0		41.9	
1996	61.0		46.2	
1997	77.8		47.9	
1998	67.1		43.3	
1999	81.5		59.7	
2000	41.2		66.4	
2001	41.8		37.4	
2002	65.9		27.4	
2003	48.6		36.8	
2004	44.4		35.6	
2005	20.0		25.8	
2006	54.8		22.9	
2007	35.0		65.7	
2008	43.8		26.8	
2009	28.6		37.6	
2010	40.0		31.0	
2011	50		51.3	
2012	38.2		54.7	
2013	33.3		51.0	
2014	39.7		23.6	
2015			48.4	

Table 2.28 Spawner-per-recruit Z benchmarks and terminal year estimates of Z by river system.

Year	State	River	Species	Sex	Z	Benchmark Z40% (M=0.3)	Z20% (M=0.3)	Z40% (M=0.7)	Z20% (M=0.7)
2014	ME	Androscoggin	Alewife	Male	2.56	0.47	0.62	0.93	1.12
2014		Androscoggin	Alewife	Female	0.92	0.47	0.62	0.93	1.12
2015		Sebasticook	Alewife	Male	1.73	0.47	0.62	0.93	1.12
2015	NH	Cocheco	Alewife	Male	0.185	0.46	0.6	0.92	1.11
2015		Cocheco	Alewife	Female	0.54	0.46	0.6	0.92	1.11
2015		Lamprey	Alewife	Male	0.71	0.46	0.6	0.92	1.11
2015		Oyster	Blueback	Male	2.83	0.48	0.64	0.95	1.15
2015		Oyster	Blueback	Female	0.8	0.48	0.64	0.95	1.15
NA		Winnicut	Alewife	Male	NA	0.46	0.6	0.92	1.11
NA		Winnicut	Alewife	Female	NA	0.46	0.6	0.92	1.11
NA		Winnicut	Blueback	Female	NA	0.48	0.64	0.95	1.15
2015	MA	Monument	Alewife	Male	3.52	0.46	0.61	0.92	1.11
2015		Mystic	Alewife	Male	1.14	0.46	0.61	0.92	1.11
2015		Nemasket	Alewife	Male	2.13	0.46	0.61	0.92	1.11
2015		Town	Alewife	Male	1.93	0.46	0.61	0.92	1.11
2015		Monument	Alewife	Female	2.87	0.46	0.61	0.92	1.11
2015		Mystic	Alewife	Female	0.93	0.46	0.61	0.92	1.11
2015		Nemasket	Alewife	Female	1.97	0.46	0.61	0.92	1.11
2015		Town	Alewife	Female	0.89	0.46	0.61	0.92	1.11
2014	RI	Gilbert-Stuart	Alewife	Both	1.78	0.48	0.64	0.94	1.14
2015		Nonquit	Alewife	Both	1.88	0.48	0.64	0.94	1.14
2014	MD	Nanticoke	Alewife	Male	1.74	0.46	0.61	0.93	1.13
2014		Nanticoke	Alewife	Female	1.55	0.46	0.61	0.93	1.13
2014		Nanticoke	Blueback	Male	1.2	0.47	0.61	0.92	1.11
2014		Nanticoke	Blueback	Female	1.61	0.47	0.61	0.92	1.11
NA	NC	Chowan	Alewife	Both	NA	0.48	0.62	0.93	1.12
NA		Albemarle FI	Alewife	Both	NA	0.48	0.62	0.93	1.12
2015		Chowan	Blueback	Both	1.28	0.47	0.62	0.92	1.11
NA		Albemarle FI	Blueback	Both	NA	0.47	0.62	0.92	1.11

Table 2.29 Estimates of Fcollapse, Ucollapse, and Zcollapse for alewife by river and method.

River	Method	Years	r_m	α (lbs)	F_{coll}	U_{coll}	Z_{coll}
Androscoggin	C & G M1		0.38	10.2	1.33	0.74	2.33
ME	M3			15.5	1.46	0.77	2.46
Damariscotta[1]	C& G S-R	1949-1989		19.7	2.00	0.86	3.00
ME	M1	1997-2004	0.23	5.6	1.06	0.65	2.06
	M3			15.5	1.46	0.77	2.46
	M4	1977-2010		10.8	0.94	0.61	1.64
Union	C & G M1		0.47	14.3	1.59	0.80	2.59
ME	M1	1993-2001	0.16	4.2	0.98	0.62	1.98
	M3			15.5	1.46	0.77	2.46
Cocheco	M1	1999-2003	0.36	9.4	1.29	0.72	2.29
NH	M3			15.5	1.46	0.77	2.46
	M5	1976-2004		29.8	1.83	0.84	2.53
Lamprey	C & G S-R			19.7	1.90	0.85	2.90
NH	C & G M1		0.48	15.2	1.63	0.80	2.63
	M1	1996-2004	0.25	6.0	1.09	0.66	2.09
	M3			15.5	1.46	0.77	2.46
	M5	1972-2004		60.9	2.48	0.92	3.18
Monument	C & G M2				1.61	0.80	2.61
MA	M1	1980-1996	0.10	3.2	0.93	0.60	1.93
	M1	2006-2010	0.20	4.9	1.02	0.64	1.79
	M3			15.5	1.46	0.77	2.46
	M4	1983-2006		16.5	1.29	0.72	1.99
Nemasket	M1	2005-2010	0.25	6.0	1.09	0.61	2.09
MA	M3			15.5	1.46	0.77	2.46
Wankinco	M1	2007-2010	0.38	10.2	1.33	0.74	2.33
MA	M3			15.5	1.46	0.77	2.46
Annaquatuc-	C & G S-R			8.8	1.10	0.67	2.10
ket RI	C & G M1		0.47	14.7	1.59	0.80	2.59
	M3			15.5	1.46	0.77	2.46
Gilbert-Stuart	M1	1985-1989	0.38	10.2	1.33	0.74	2.33
RI	M1	1993-2000	0.36	9.4	1.28	0.72	2.28
	M3			15.5	1.46	0.77	2.46

[1]Age and repeat spawner data from the Androscoggin River were used for the Damariscotta River to generate the recruitment and female spawning stock biomass data for 1977-2010 used in the M5 method.

Table 2.30 Estimates of Fcollapse, Ucollapse, and Zcollapse and required parameters for blueback herring by river and method.

River	Method	Years	r_m	α (lbs)	F_{coll}	U_{coll}	Z_{coll}
Connecticut	C & G S-R			28.2	2.20	0.89	3.20
CT	C & G M1		0.55	20.1	1.91	0.85	2.91
Chowan	C & G S-R			16.7	1.80	0.83	2.80
NC	M4			10.2	0.91	0.60	1.61

FIGURES

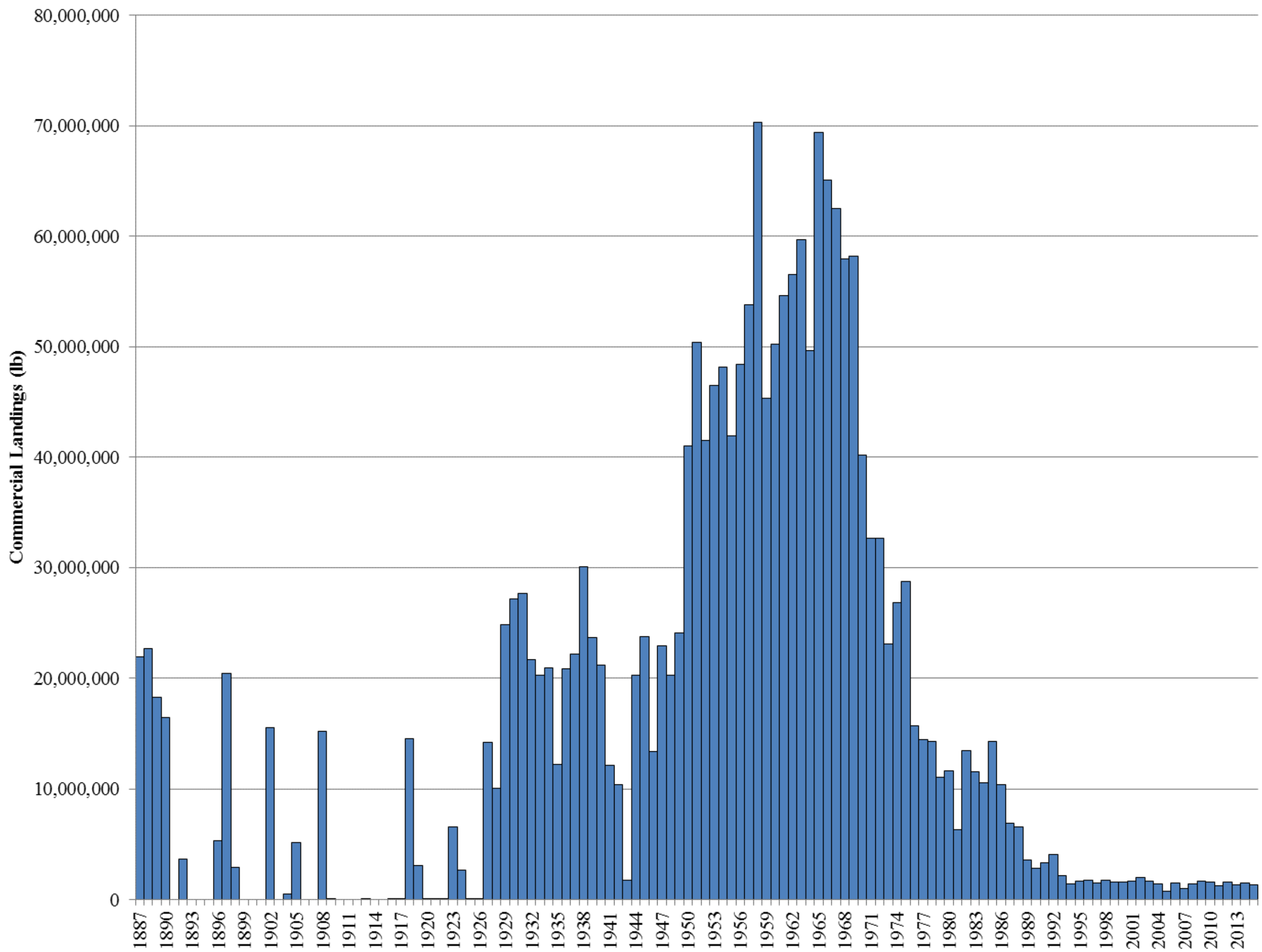


Figure 2.1 Domestic commercial landings of river herring from 1887 to 2015.

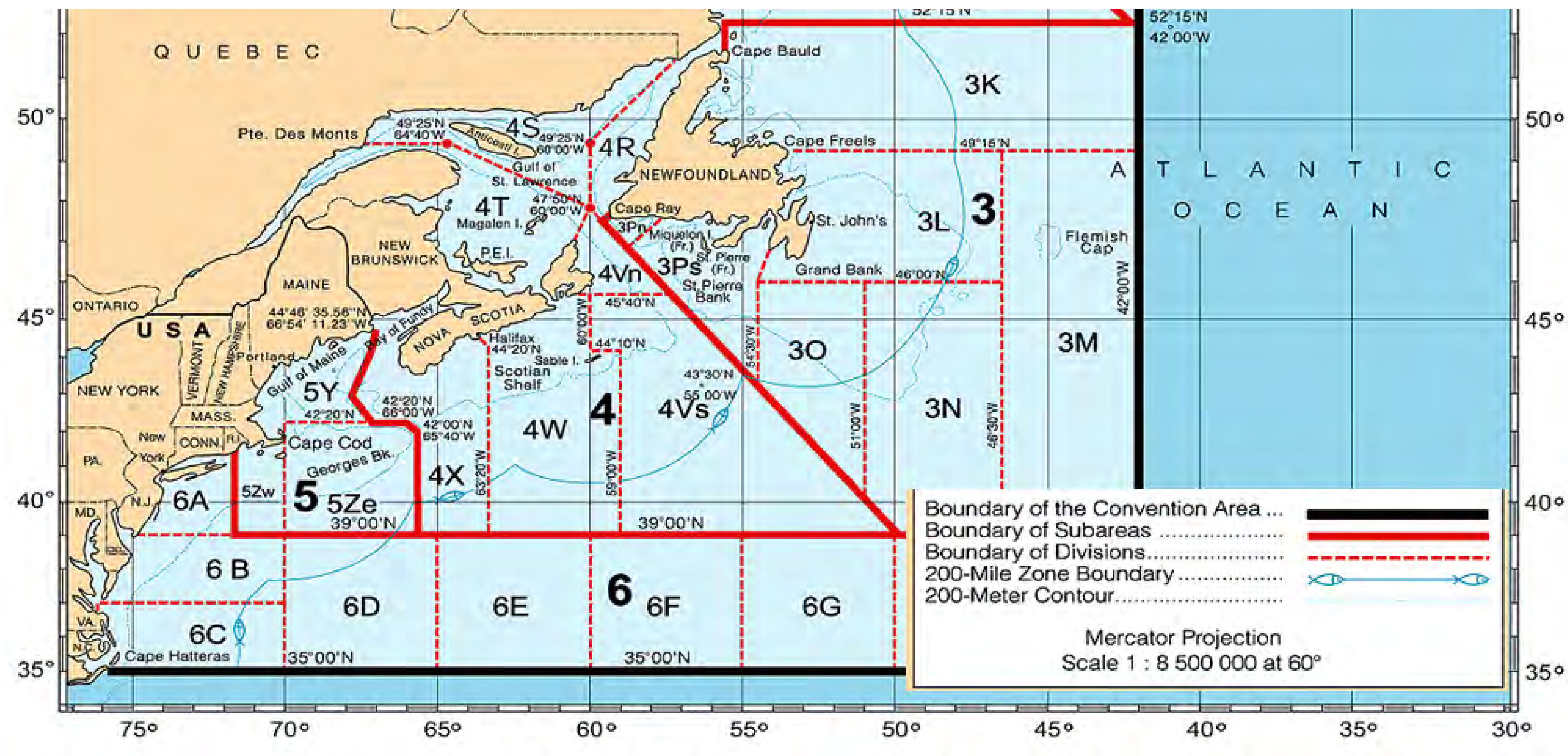


Figure 2.2 NAFO Convention areas off the coast of the US and Canada. The full convention area extends to the northern coast of Greenland.

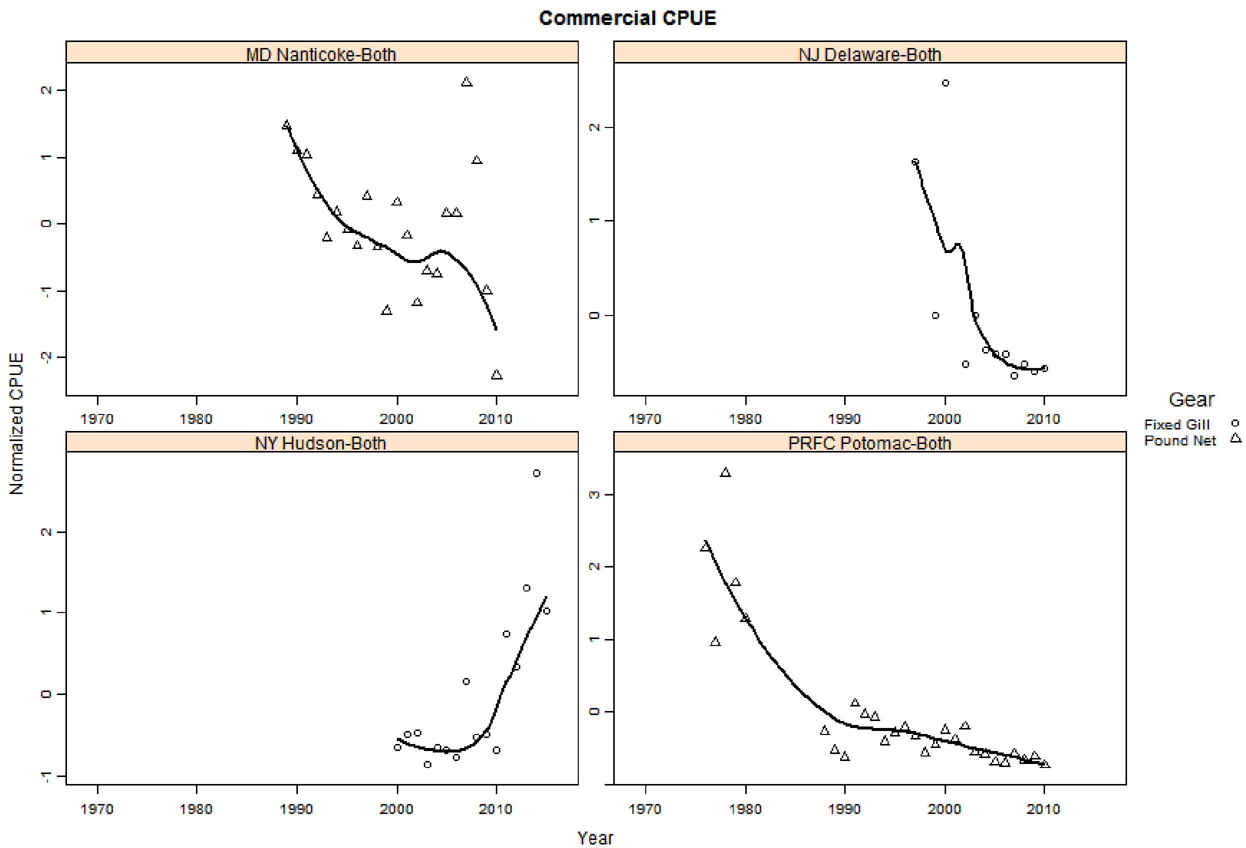


Figure 2.3 Normalized CPUE (catch-per-unit-effort) data for river herring in the Hudson River (NY), Delaware Bay (NJ), Nanticoke River (MD) and the Potomac River (PRFC) by year and gear type. Loess smooths are shown as indications of general trends.

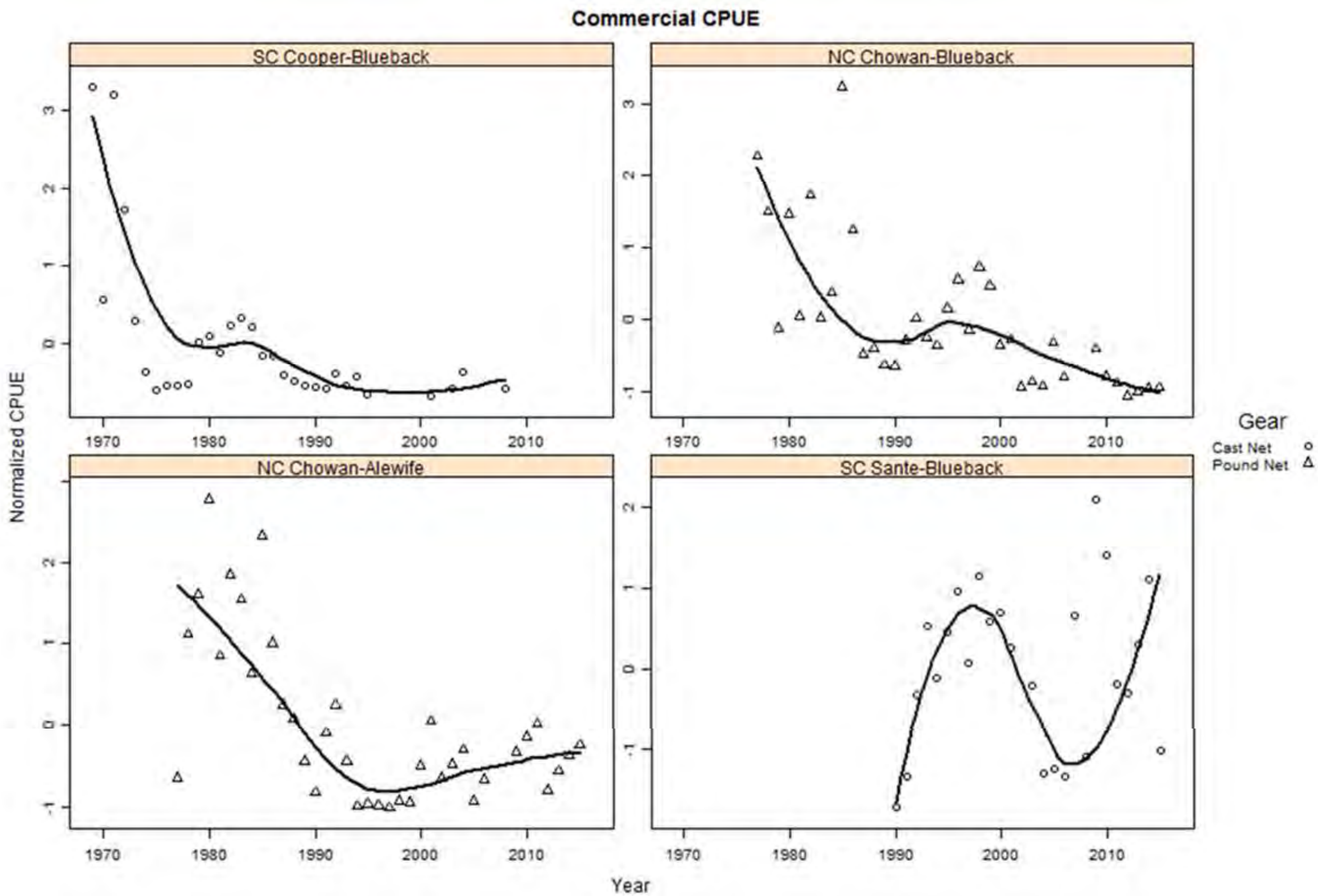
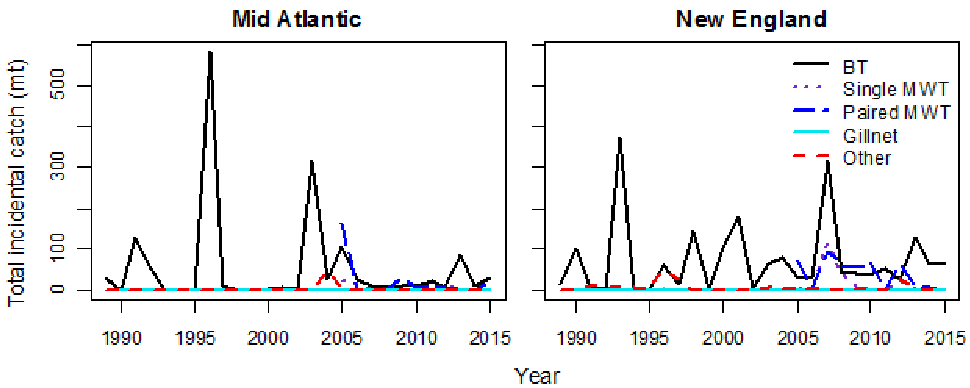
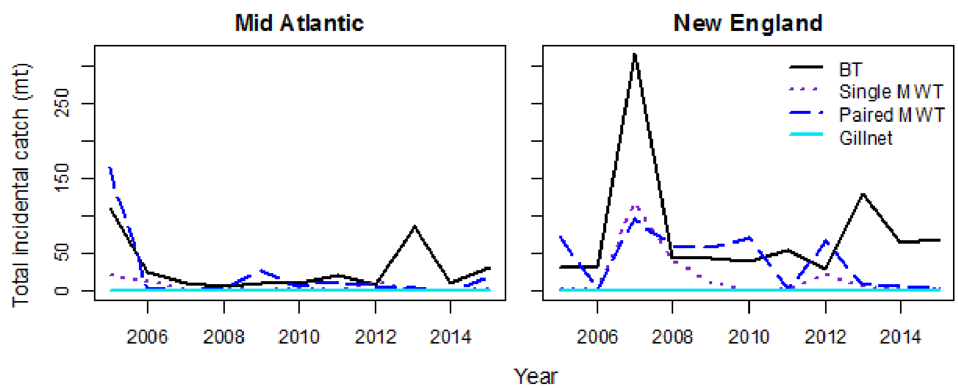


Figure 2.4 Normalized CPUE (catch-per-unit-effort) data for river herring in the Chowan River (NC), Cooper River (SC) and Santee River Diversion Canal (SC) by year and gear type. Loess smooths are shown as indications of general trends.

a)



b)



c)

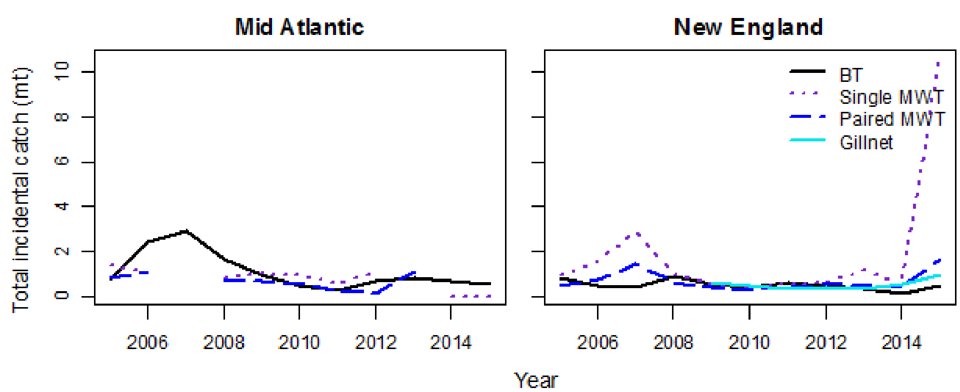
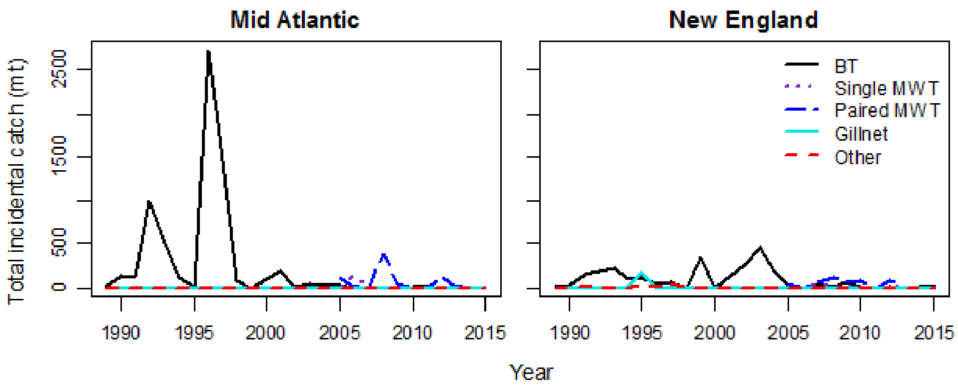
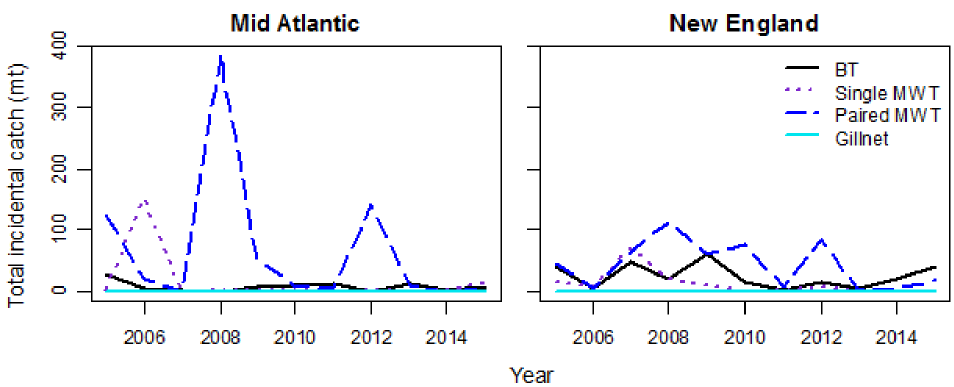


Figure 2.5 Alewife total annual incidental catch (mt) by region for the four gears with the largest catches from a) 1989 – 2015 and b) 2005 – 2015, and c) the corresponding estimates of precision. Midwater trawl estimates are only included beginning in 2005.

a)



b)



c)

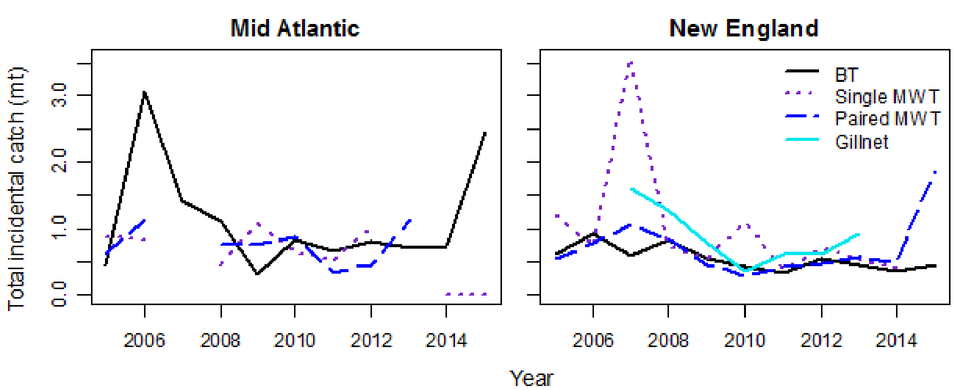


Figure 2.6 Blueback herring total annual incidental catch (mt) by region for the four gears with the largest catches from a) 1989 – 2015 and b) 2005 – 2015, and c) the corresponding estimates of precision. Midwater trawl estimates are only included beginning in 2005.

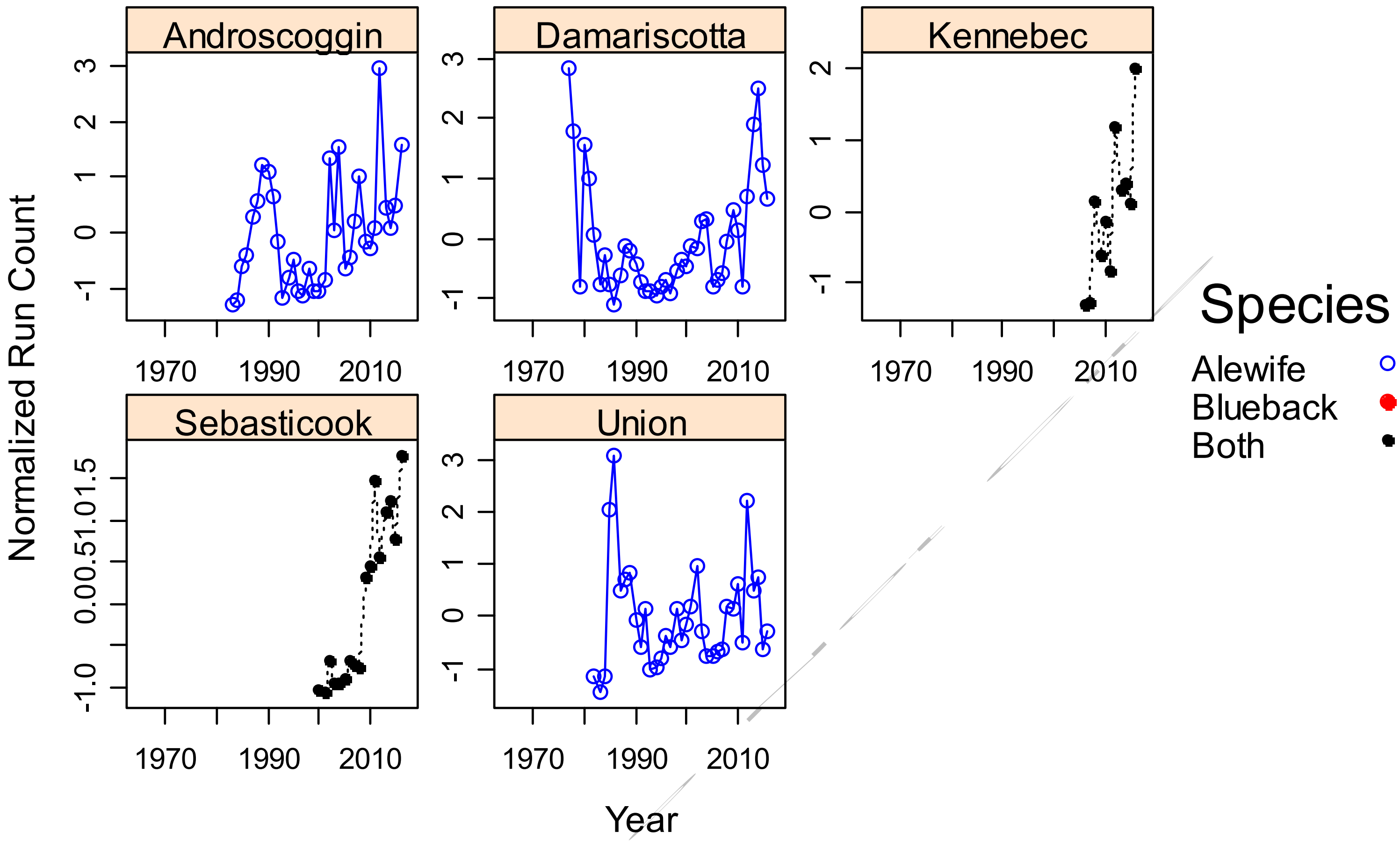


Figure 2.7 Plots of normalized run counts of alewife, blueback and combined species from Maine by river and year.

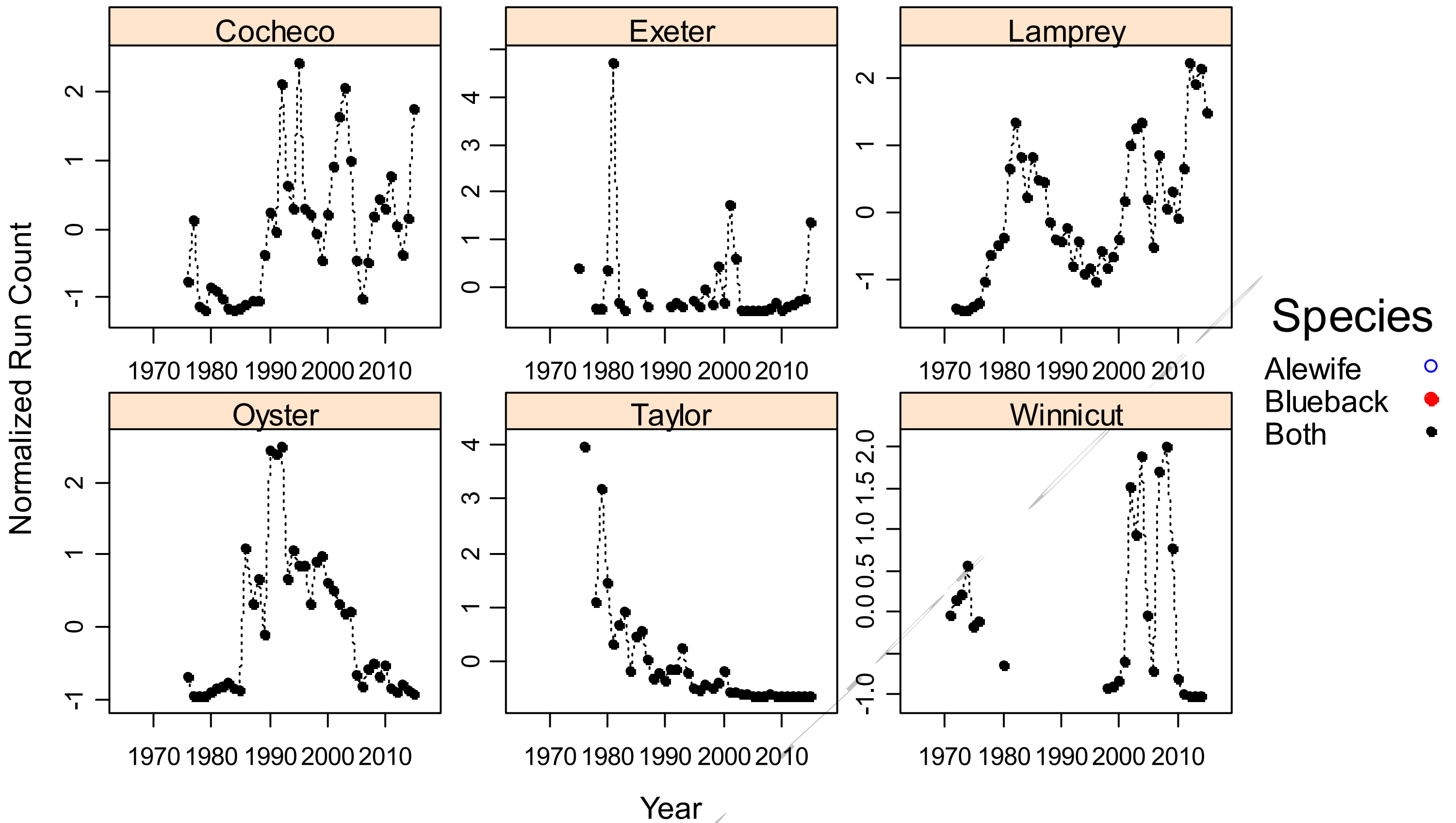


Figure 2.8 Plots of normalized run counts of alewife, blueback and combined species from New Hampshire by river and year.

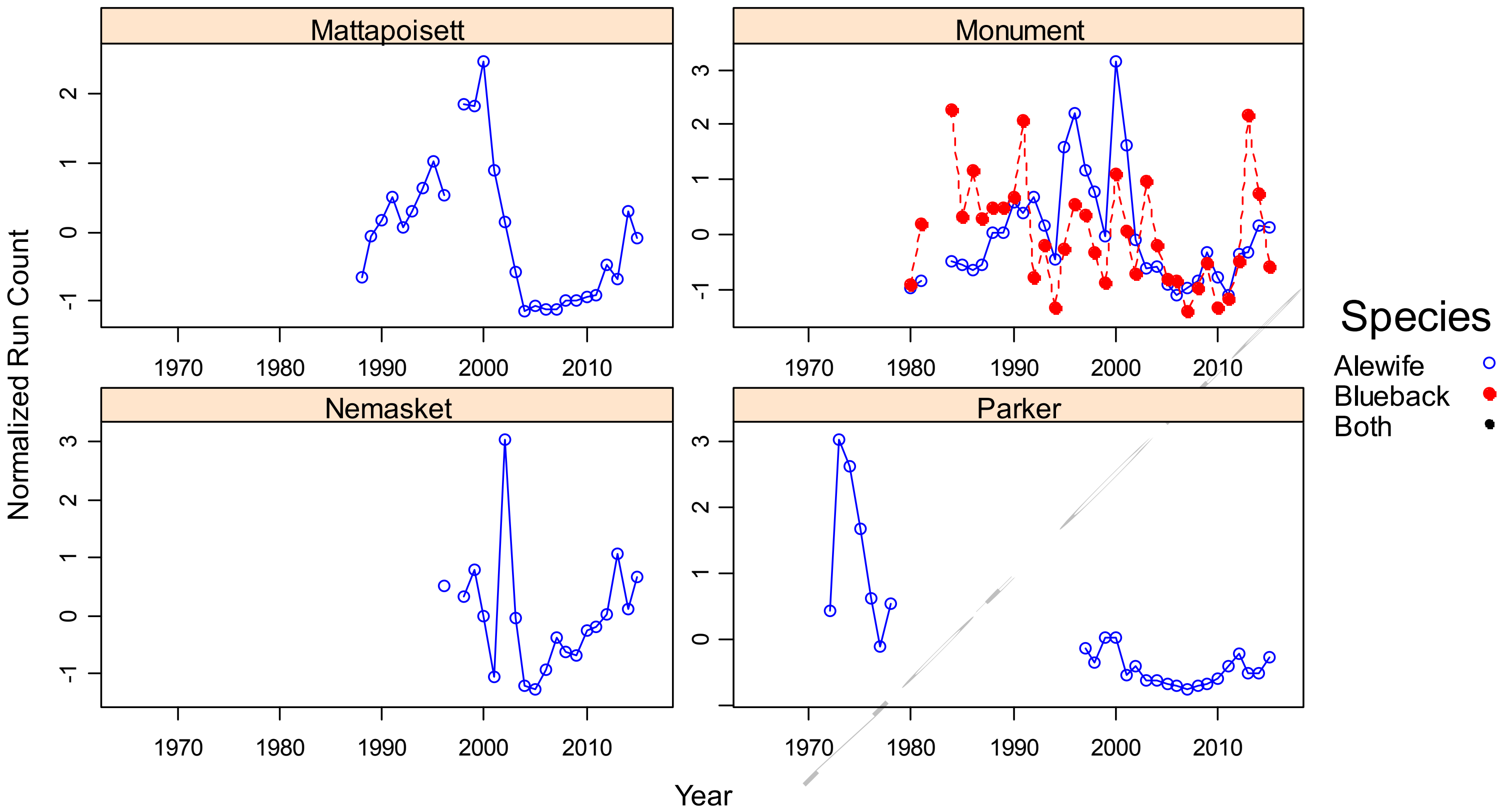


Figure 2.9 Plots of normalized run counts of alewife and blueback herring from Massachusetts by river and year.

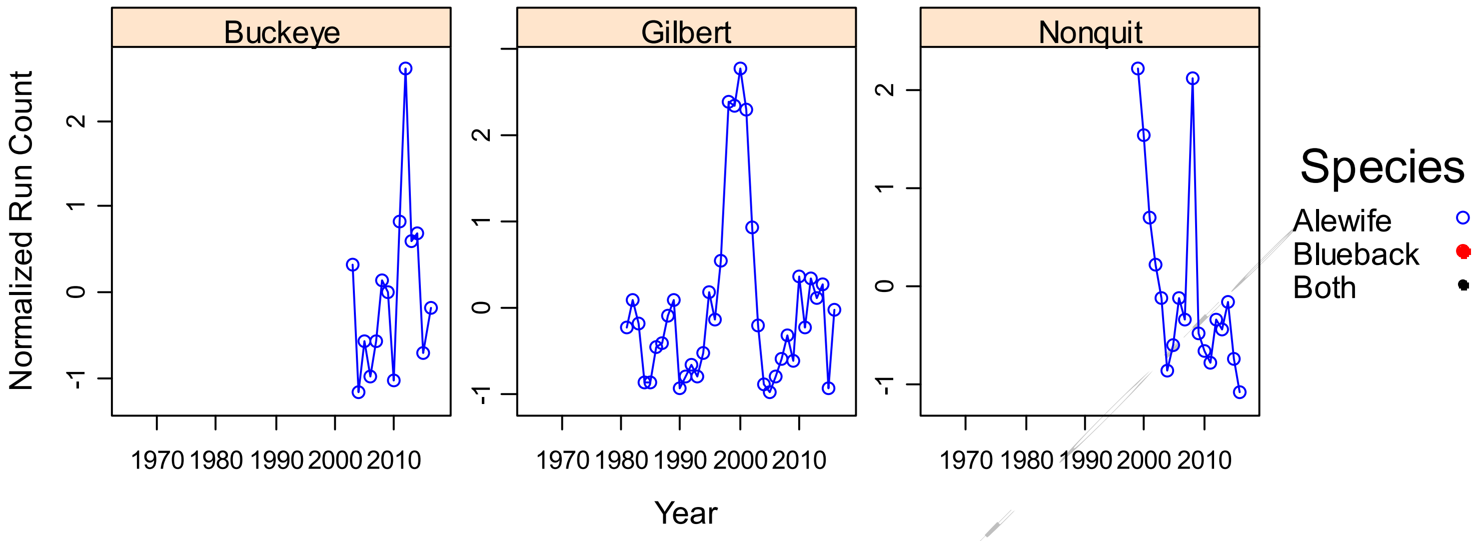


Figure 2.10 Plots of normalized run counts of alewife and blueback herring from Rhode Island by river and year.

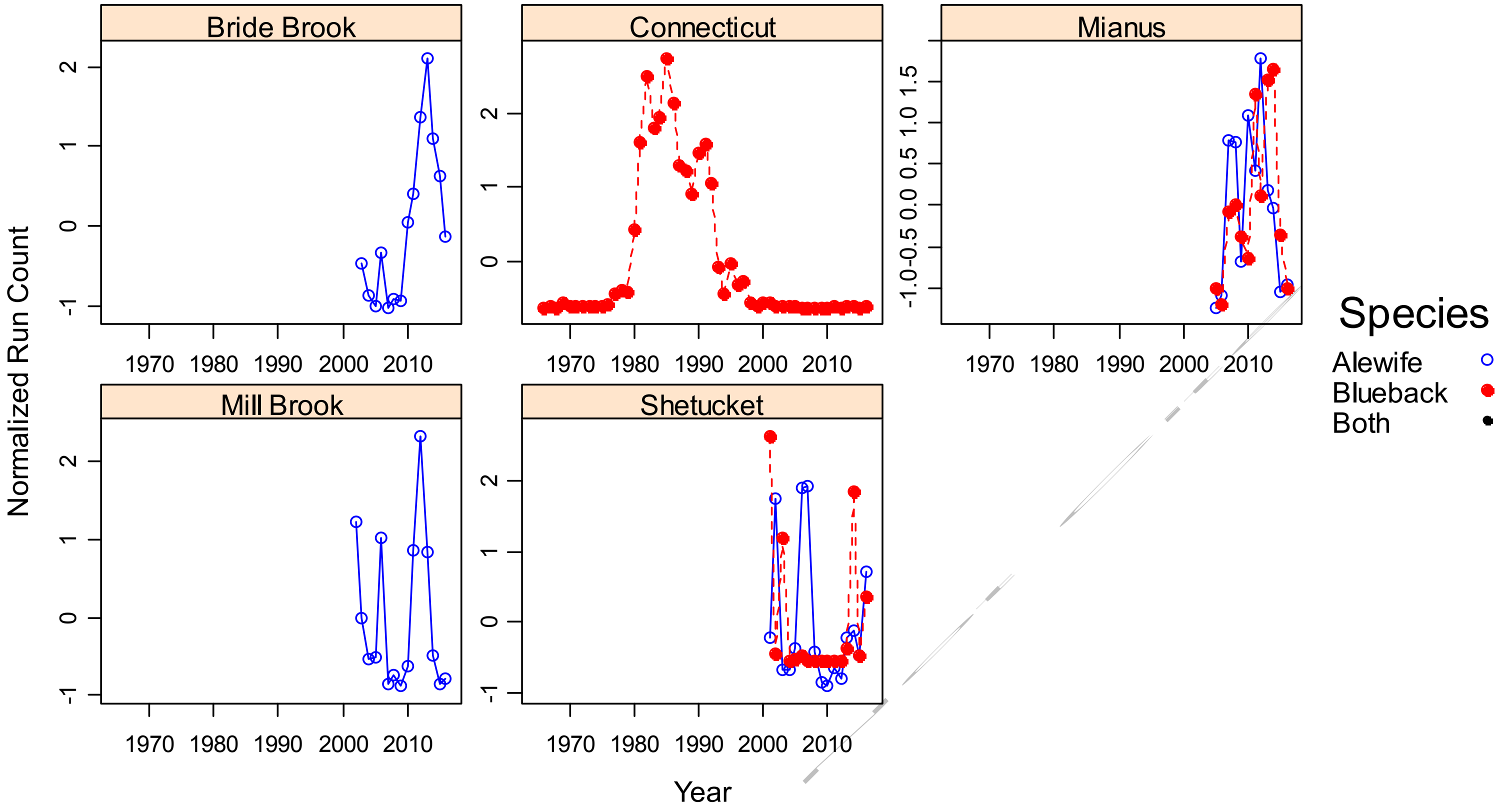


Figure 2.11 Plots of normalized run counts of alewife and blueback herring from Connecticut by river and year.

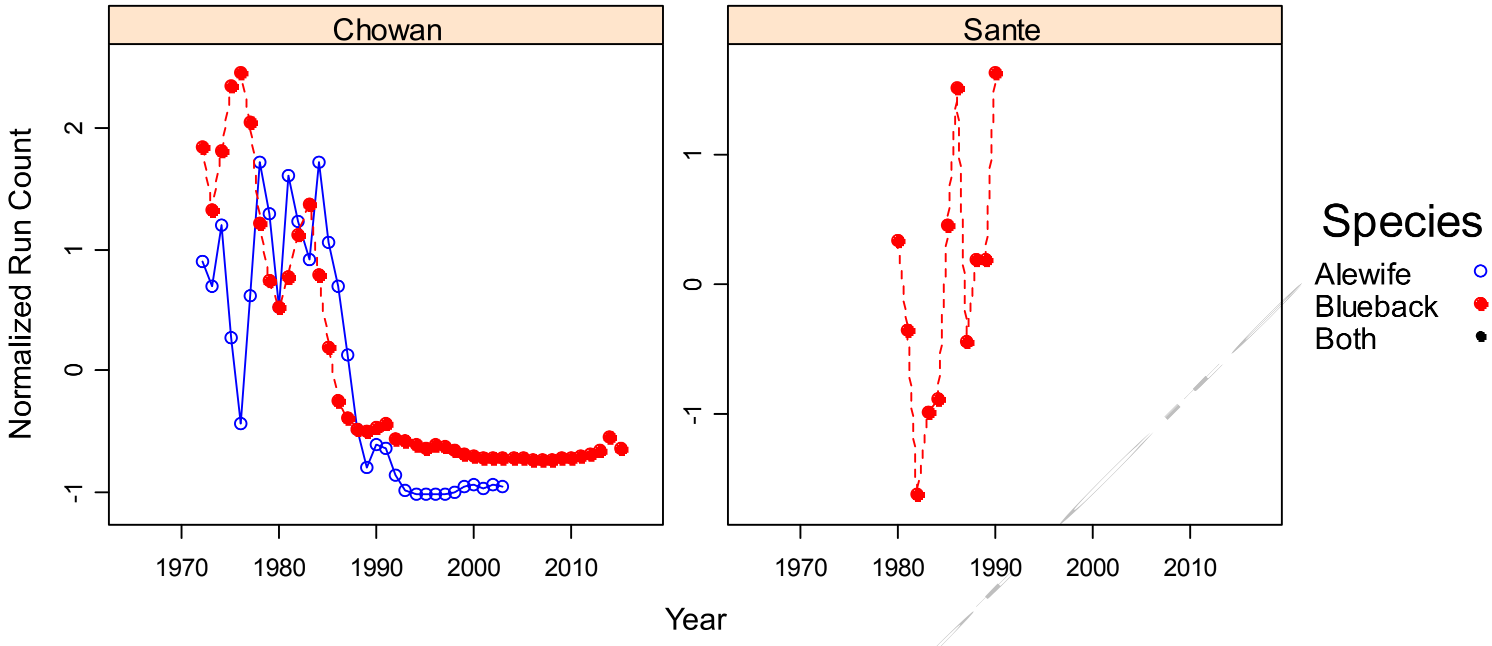


Figure 2.12 Plots of normalized run counts of alewife and blueback herring from North Carolina and South Carolina by river and year

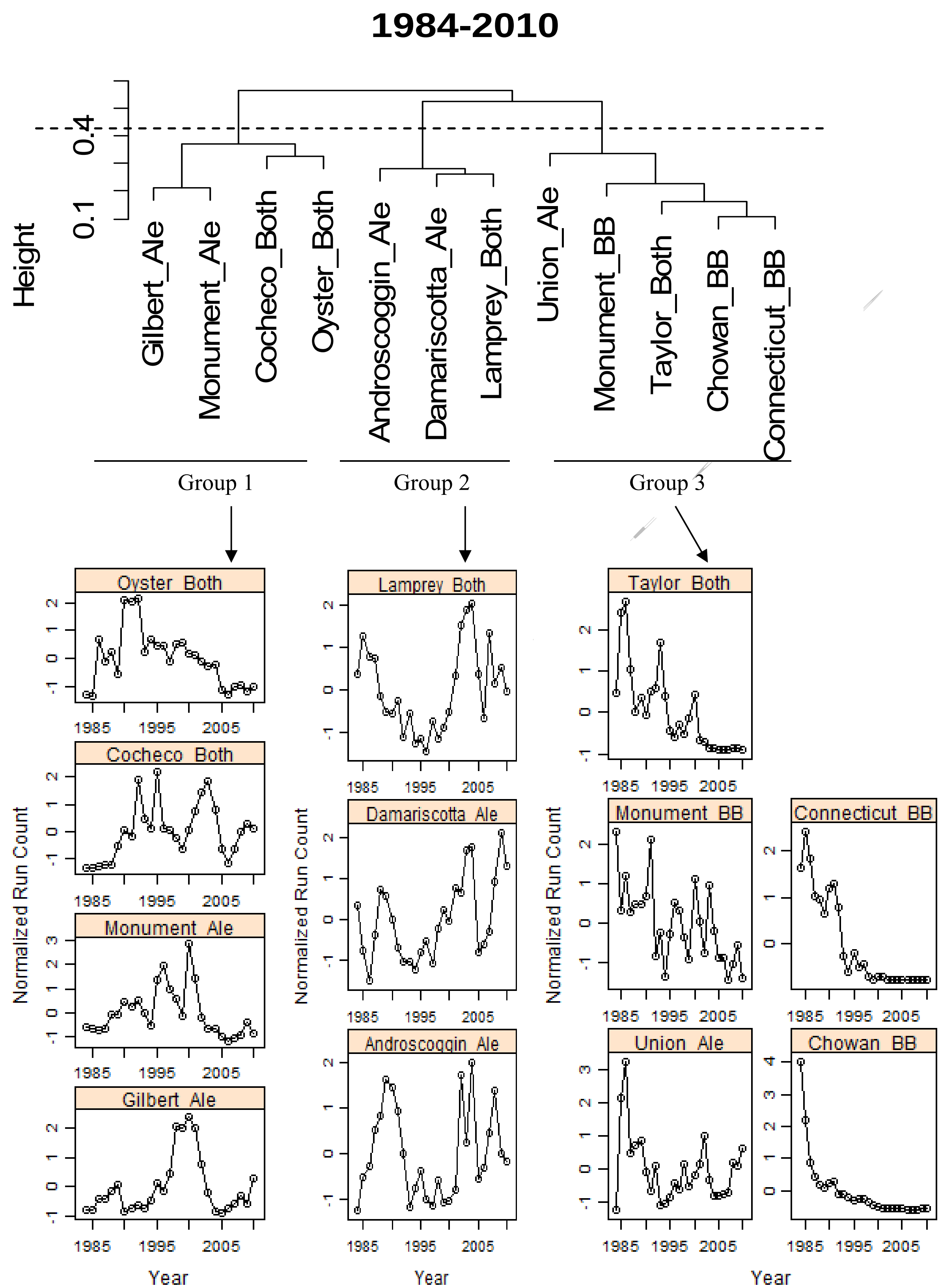


Figure 2.13 The resulting cluster dendrogram of river trends for 1984-2010 and plots of river counts for each grouping. The dotted line indicates the level of similarity selected to define groups.

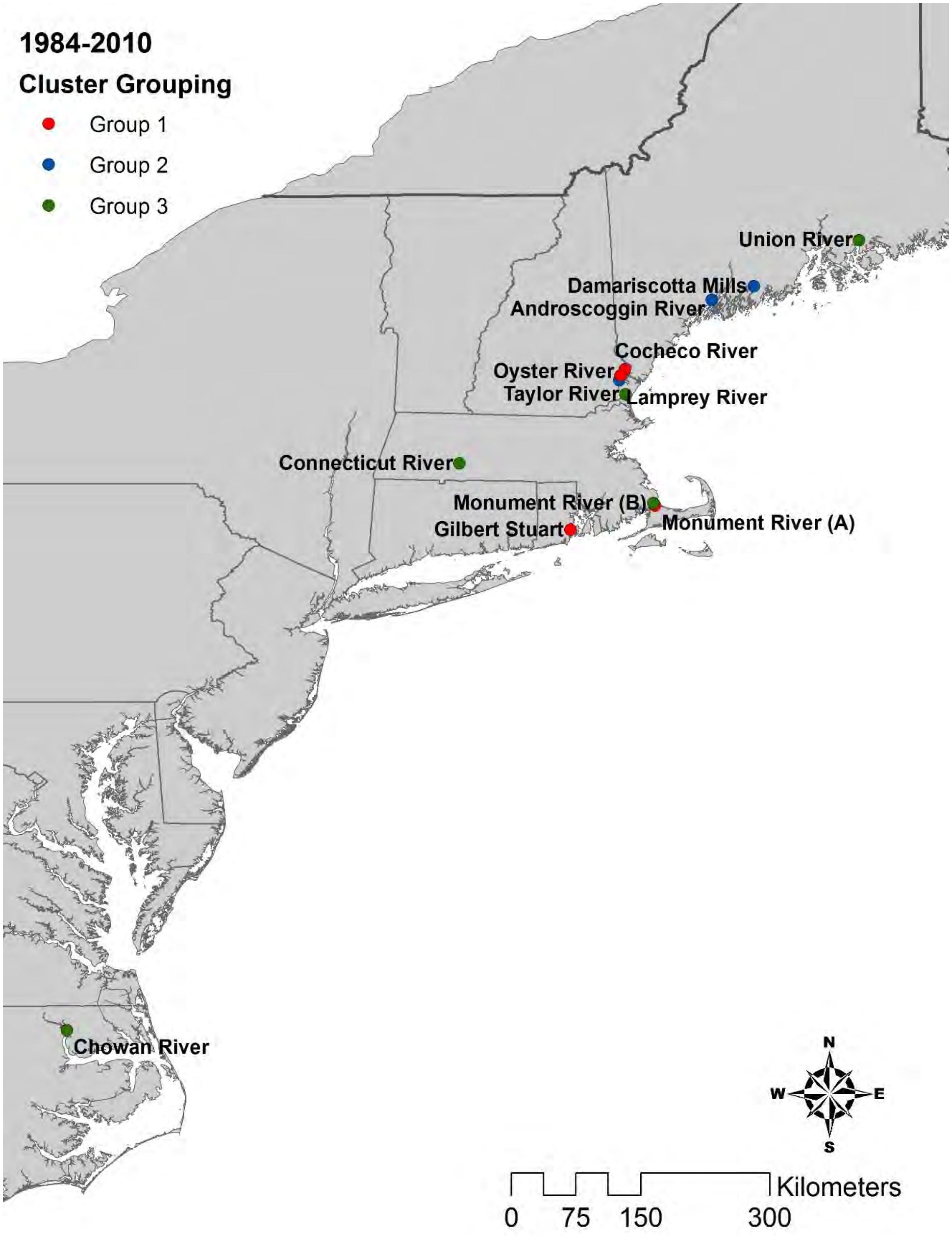


Figure 2.14 Locations of rivers used in the 1984-2010 cluster analysis. Both in the legend refers to sites where both species were counted separately and combined refers to sites where both species were counted together.

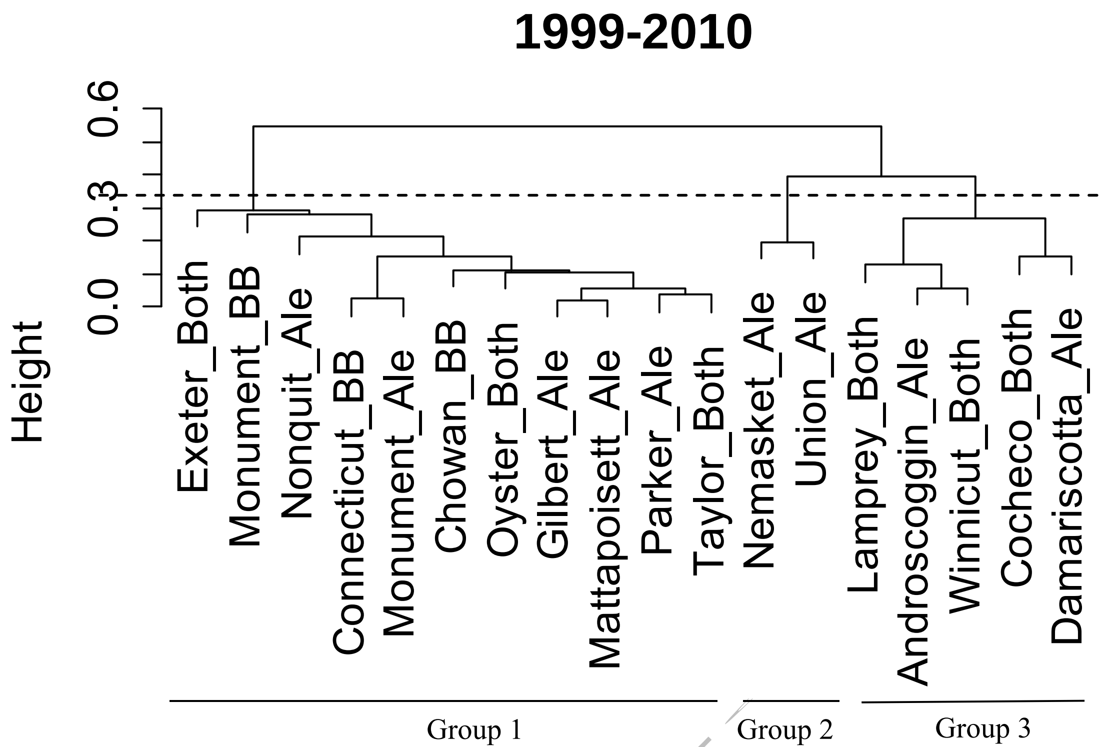


Figure 2.15 The resulting cluster dendrogram of river trends for 1999-2010. The dotted line indicates the level of similarity selected to define groups.

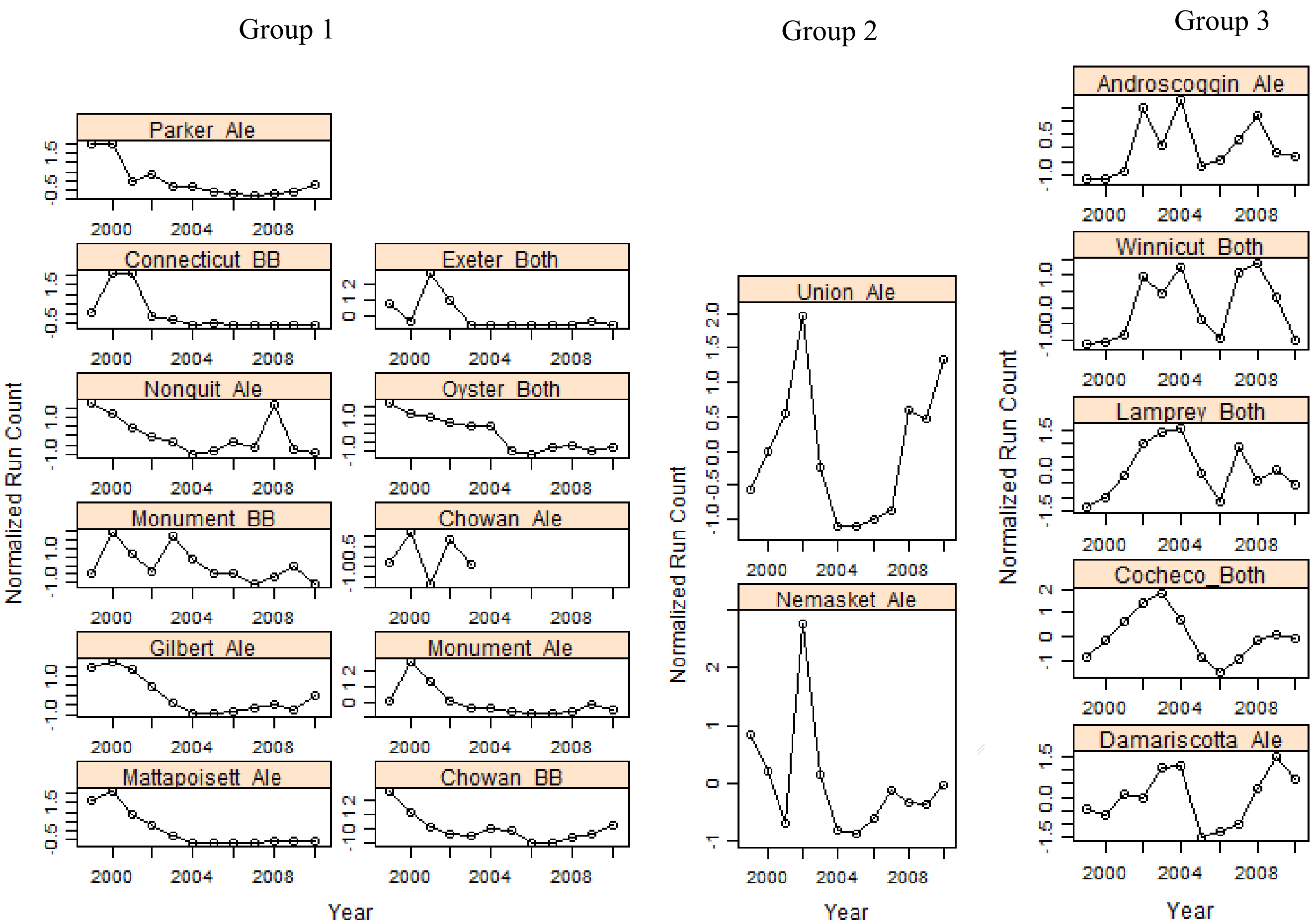


Figure 2.16 . Plots of river counts for each grouping associated with the cluster analysis of data from 1999-2010.

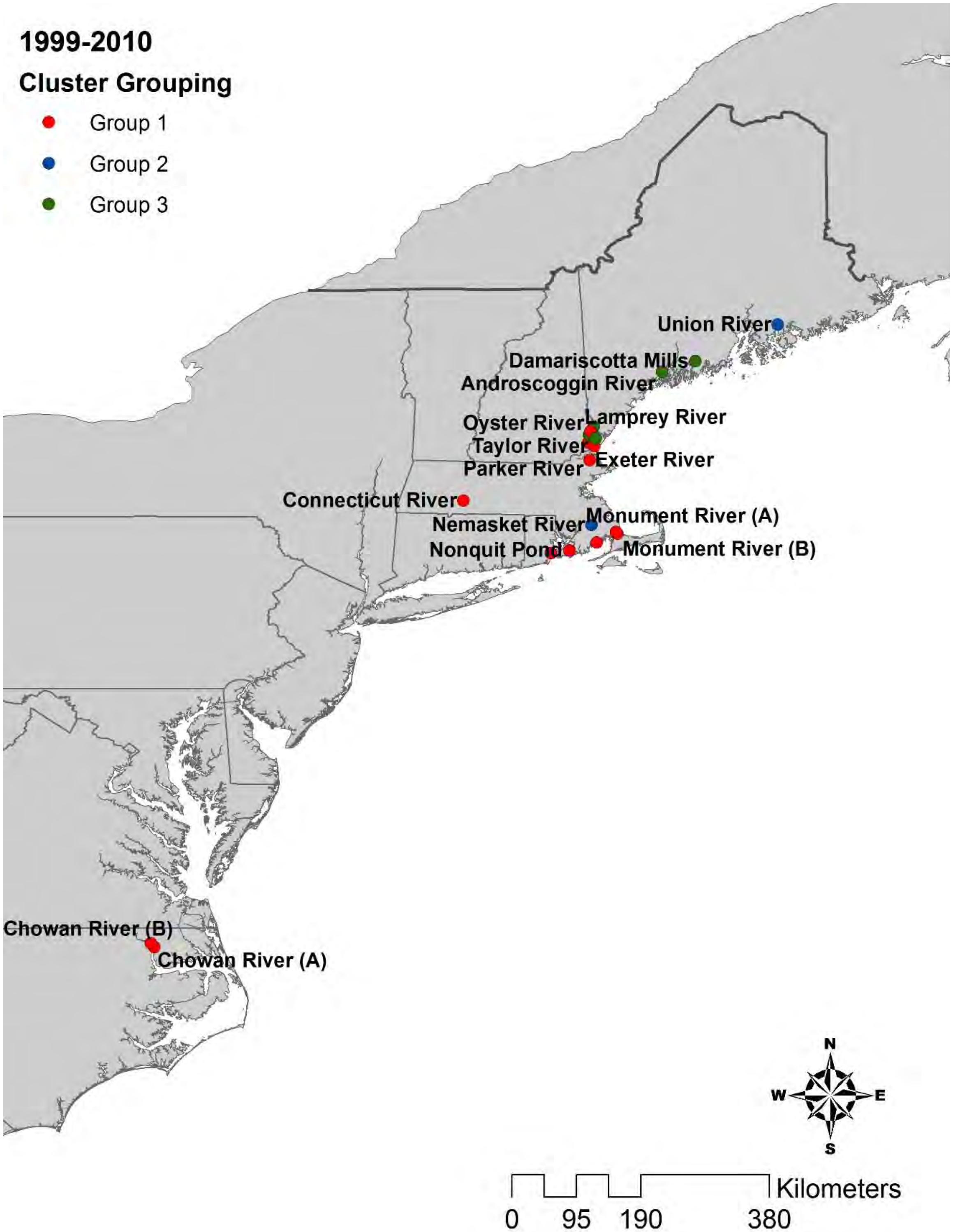


Figure 2.17 Locations of rivers used in the 1999-2010 cluster analysis. Both in the legend refers to sites where both species were counted separately and combined refers to sites where both species were counted together.

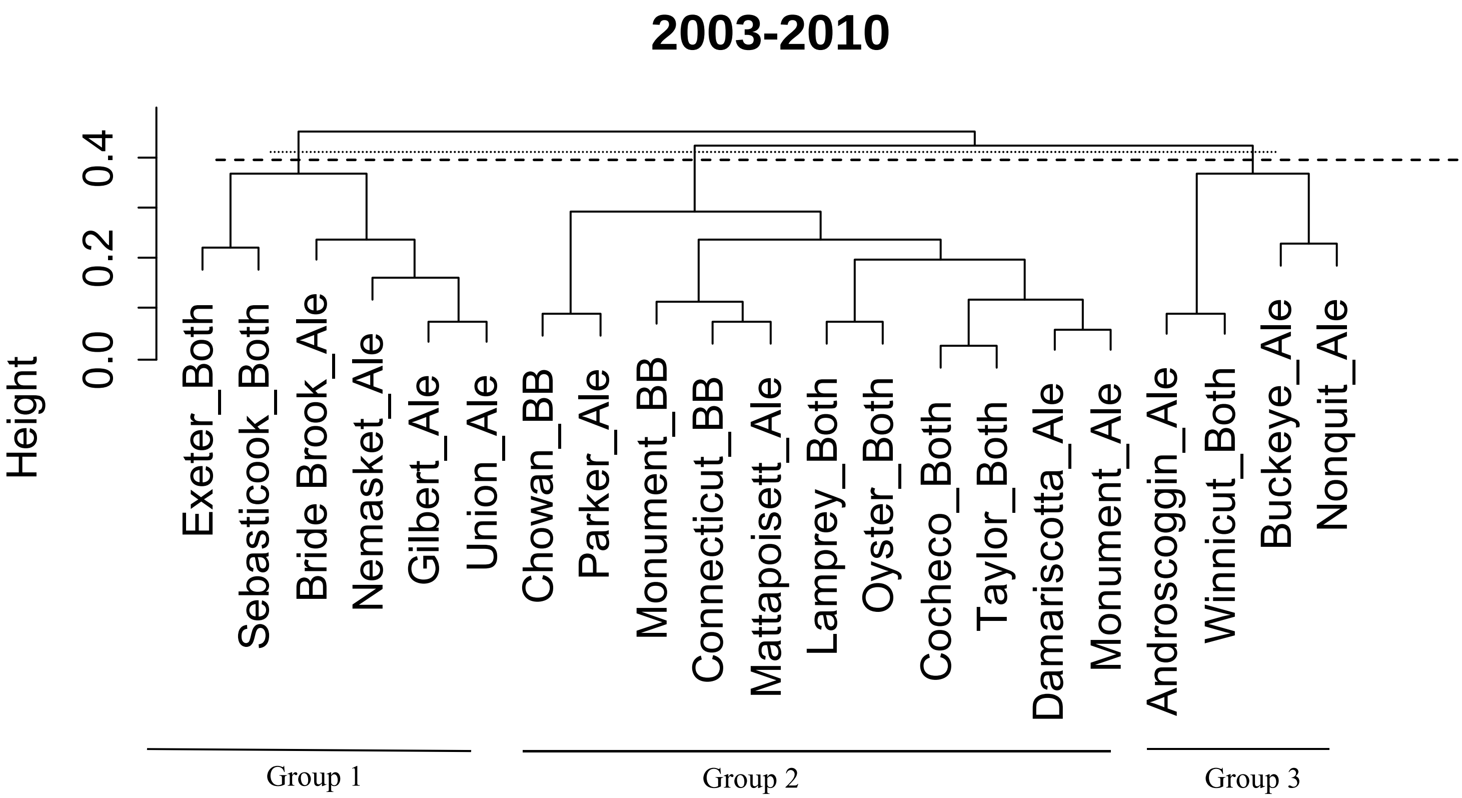


Figure 2.18 The resulting cluster dendrogram of river trends for 2003-2010. The dotted line indicates the level of similarity selected to define groups.

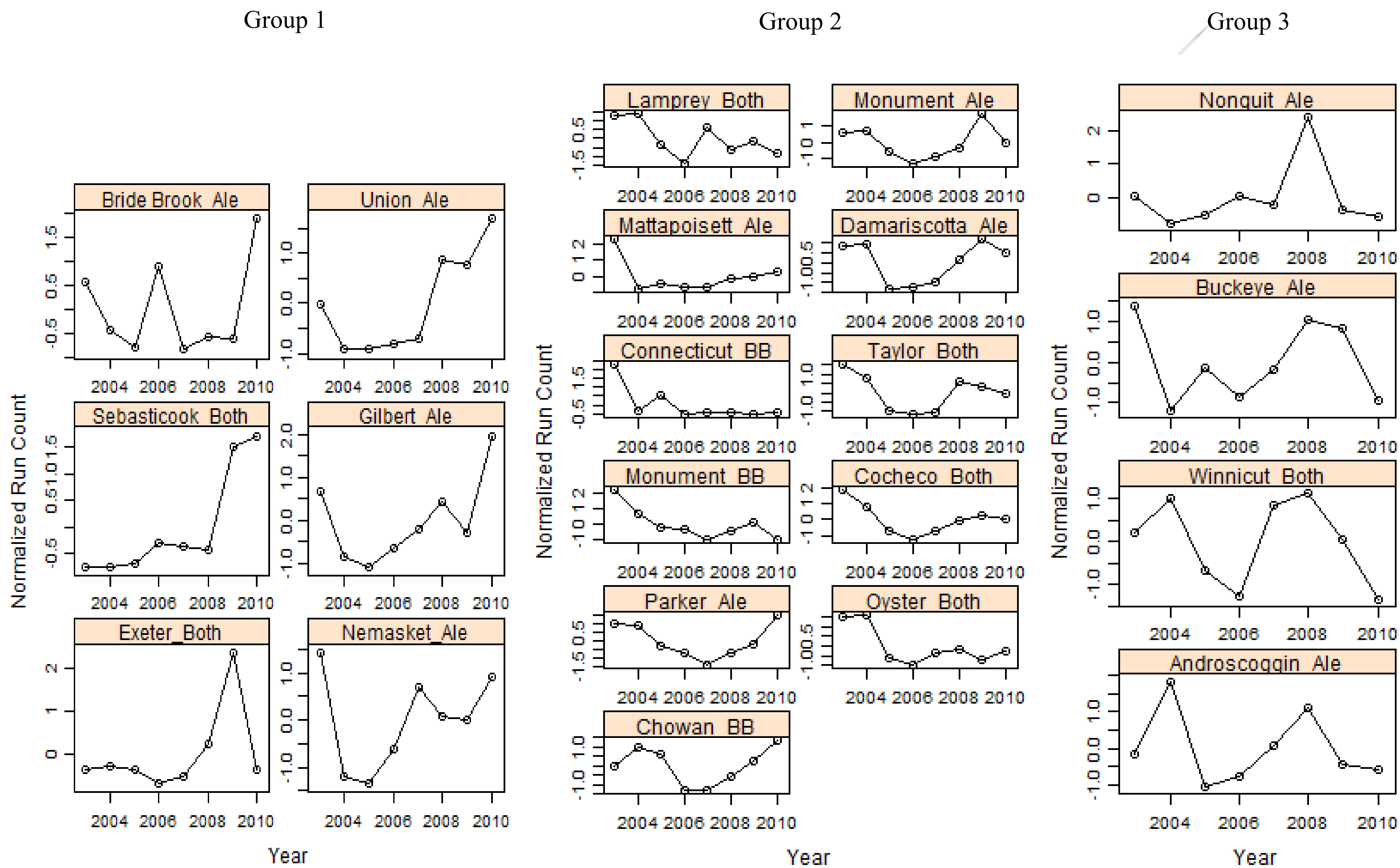


Figure 2.19 Plots of river counts for each grouping associated with the cluster analysis of data from 2003-2010.

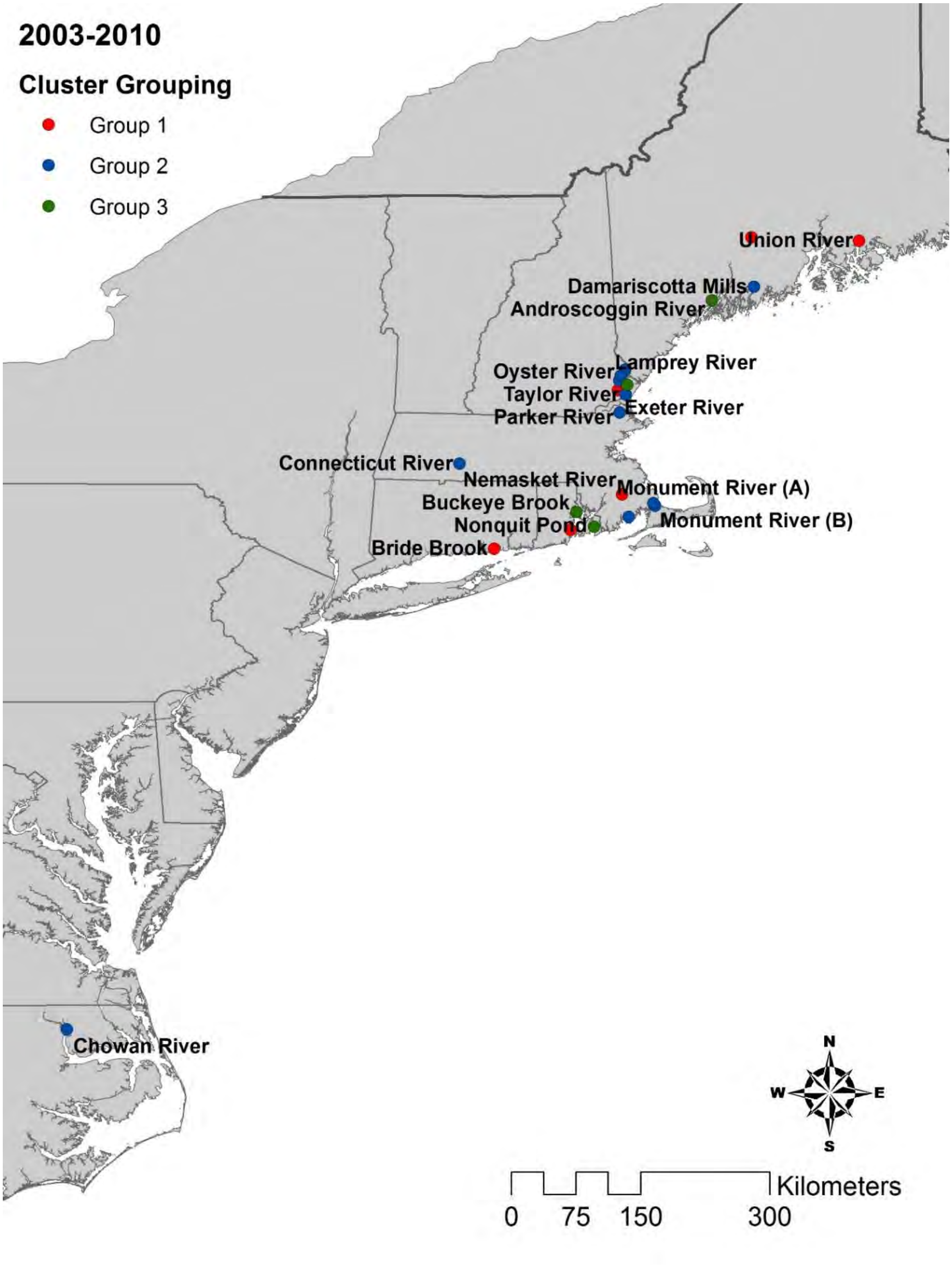


Figure 2.20 Locations of rivers used in the 2003-2010 cluster analysis. Both in the legend refers to sites where both species were counted separately and combined refers to sites where both species were counted together.

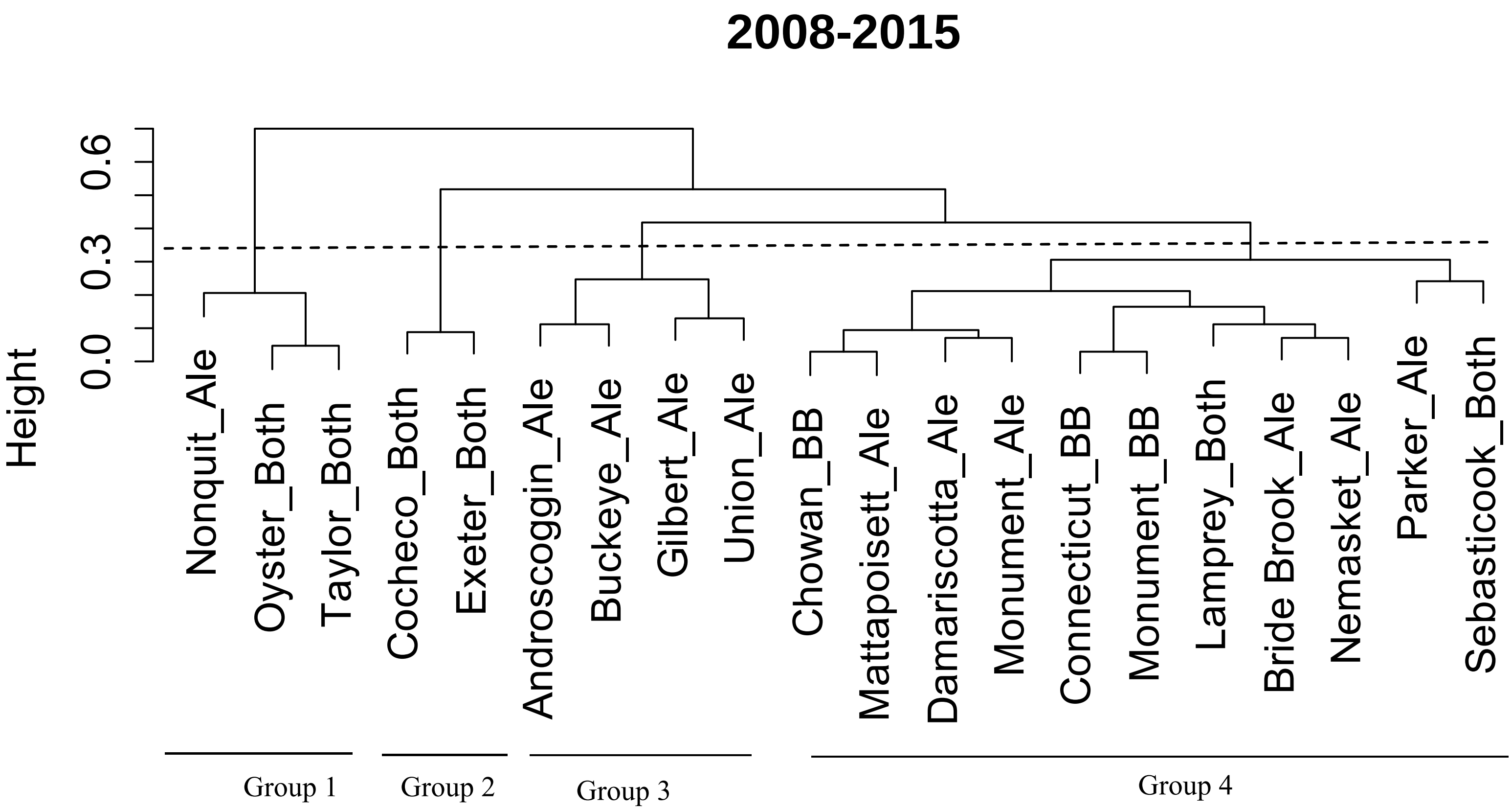


Figure 2.21 The resulting cluster dendrogram of river trends for 2008-2015. The dotted line indicates the level of similarity selected to define groups.

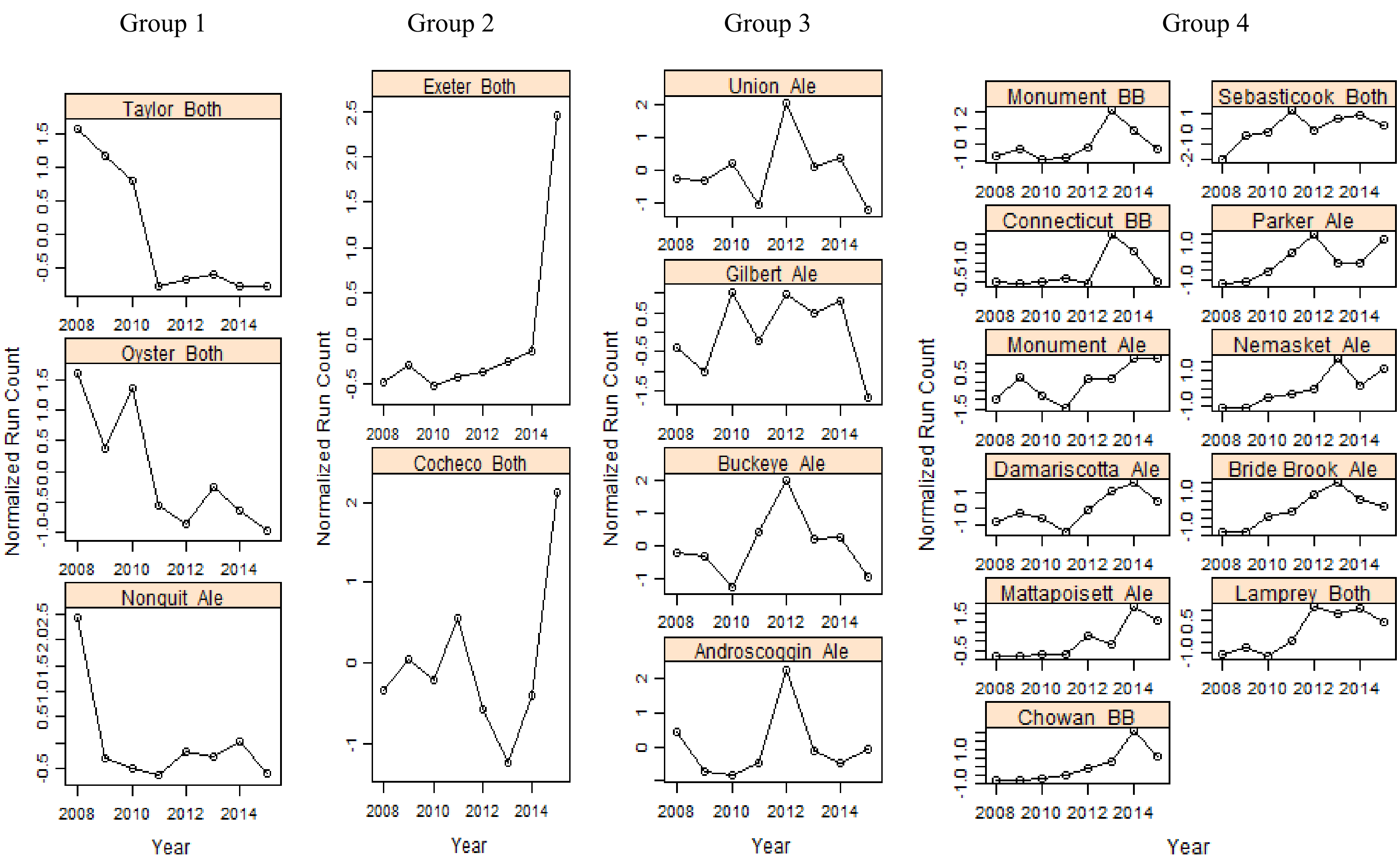


Figure 2.22 Plots of river counts for each grouping associated with the cluster analysis of data from 2008-2015.

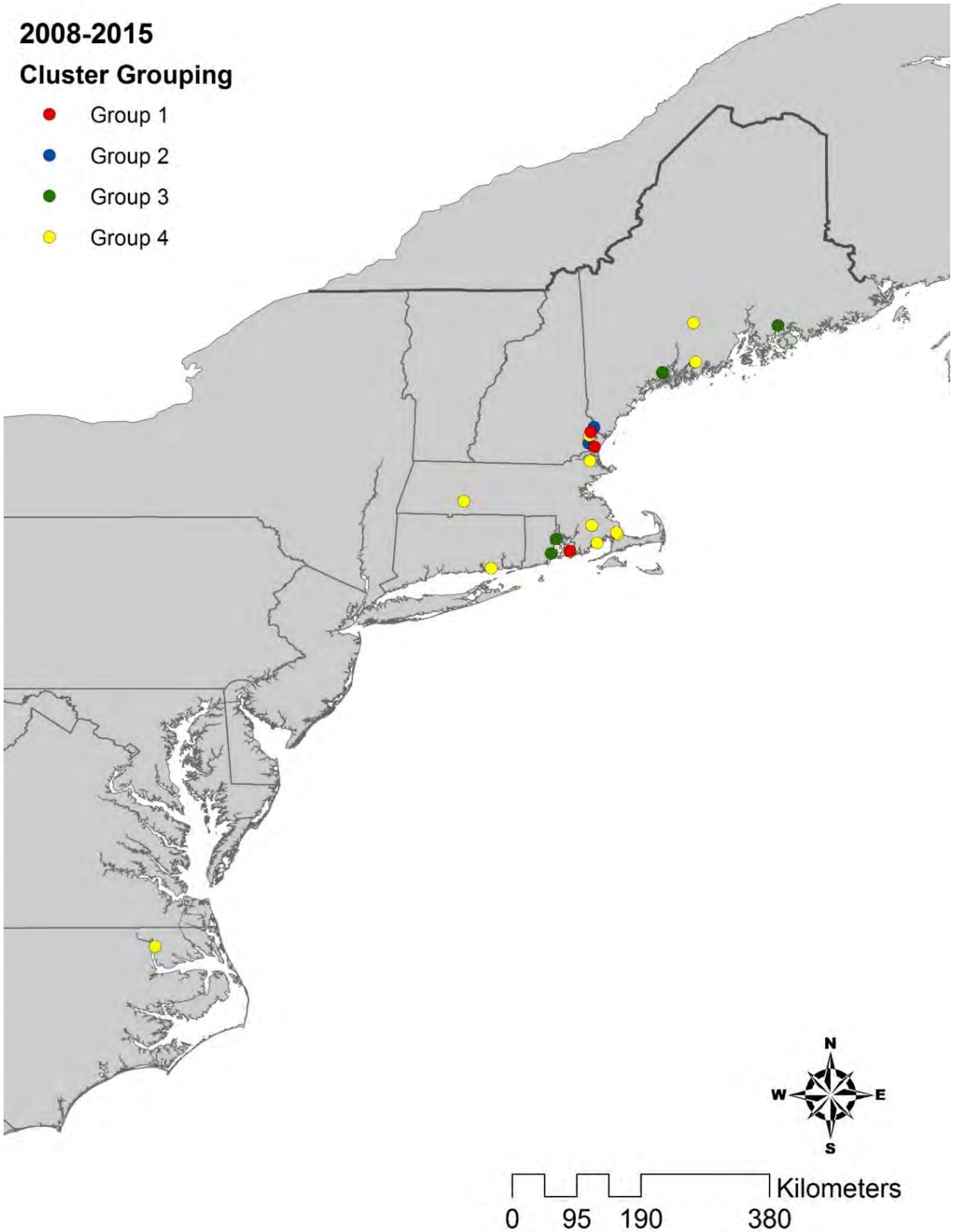


Figure 2.23 Locations of rivers used in the 2008-2015 cluster analysis. Both in the legend refers to sites where both species were counted separately and combined refers to sites where both species were counted together.

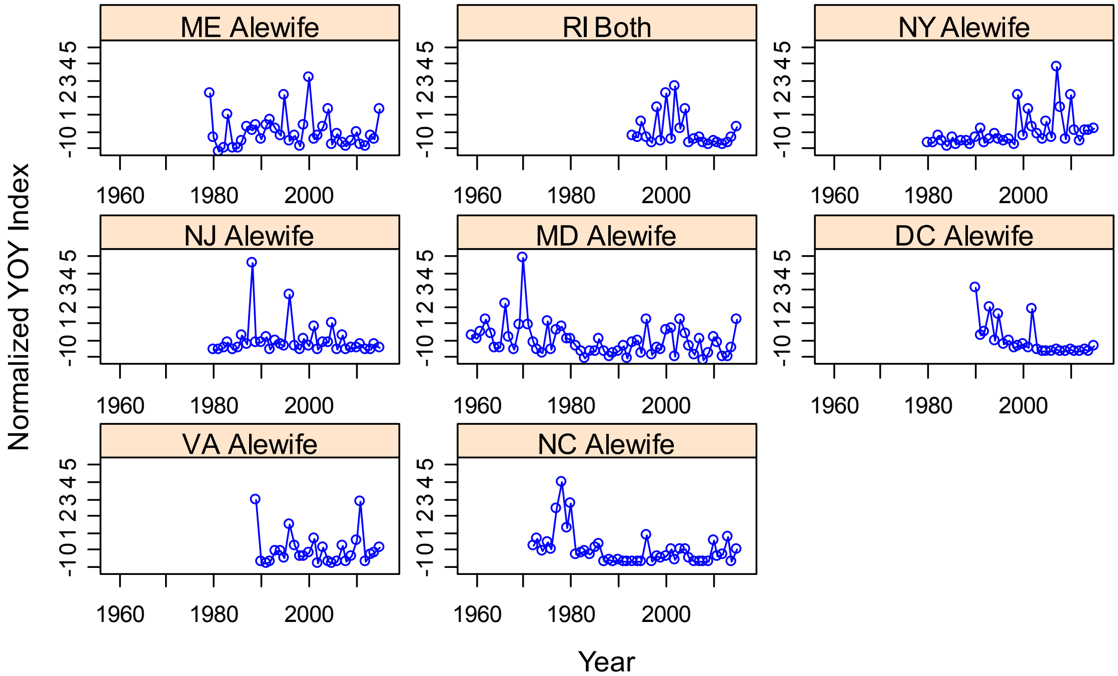


Figure 2.24 Normalized YOY indices of relative abundance for alewife from seine surveys.

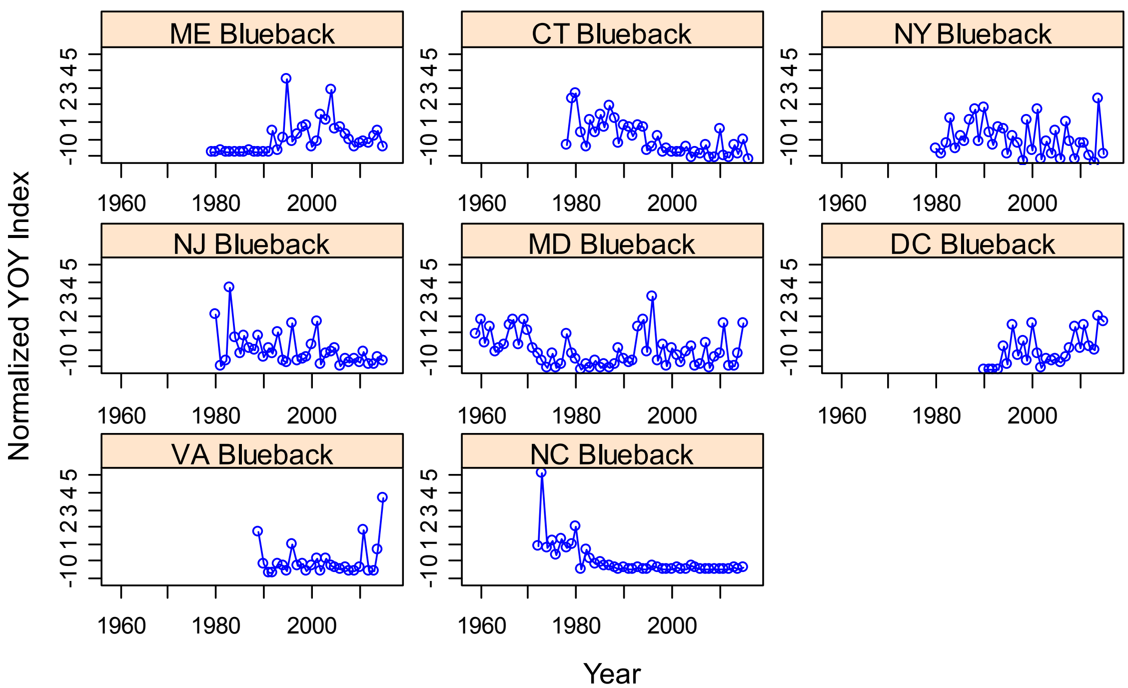


Figure 2.25 Normalized YOY indices of relative abundance for blueback herring from seine surveys.

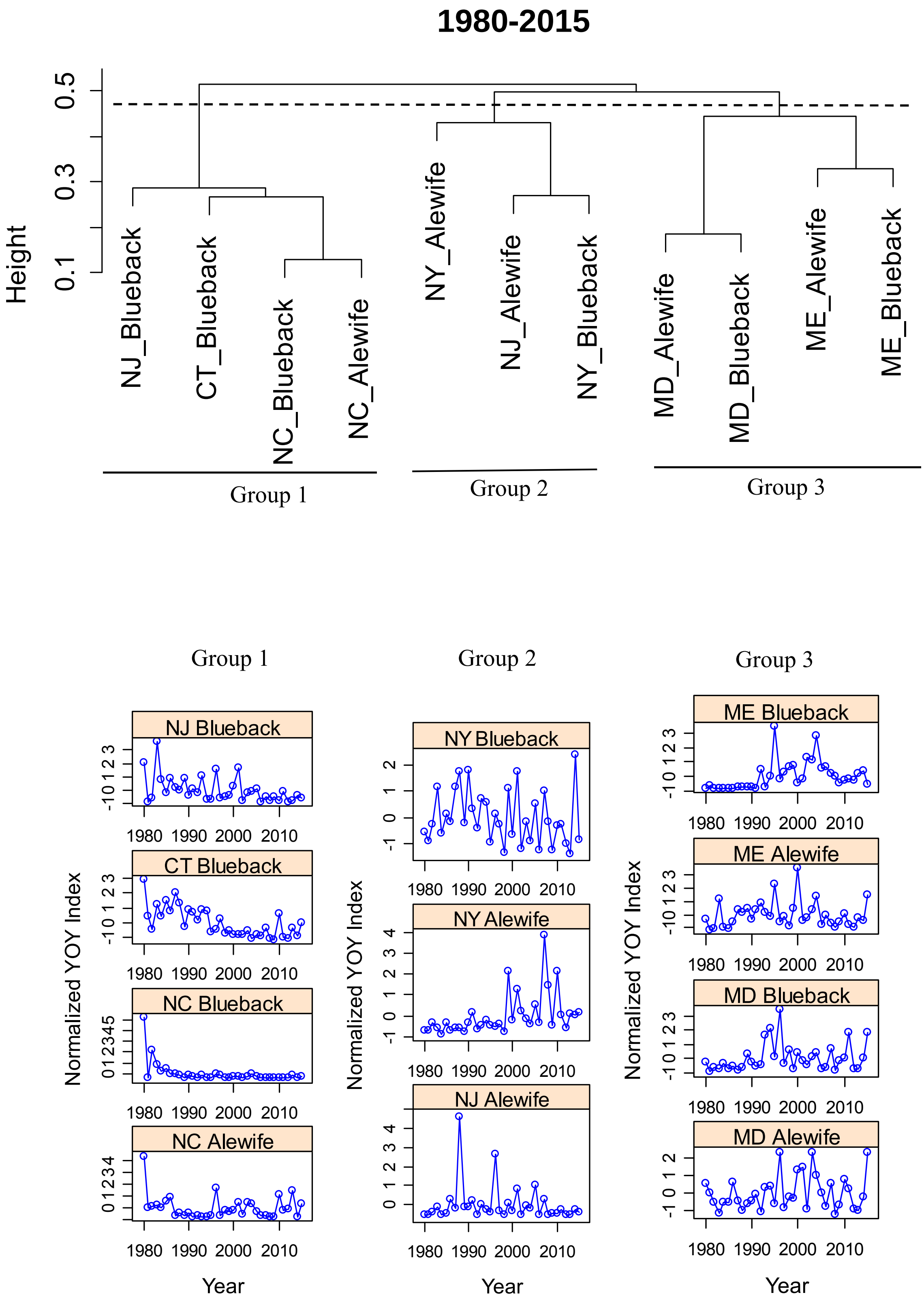


Figure 2.26 Results of cluster analysis of YOY seine indices of relative abundance, 1980-2015.

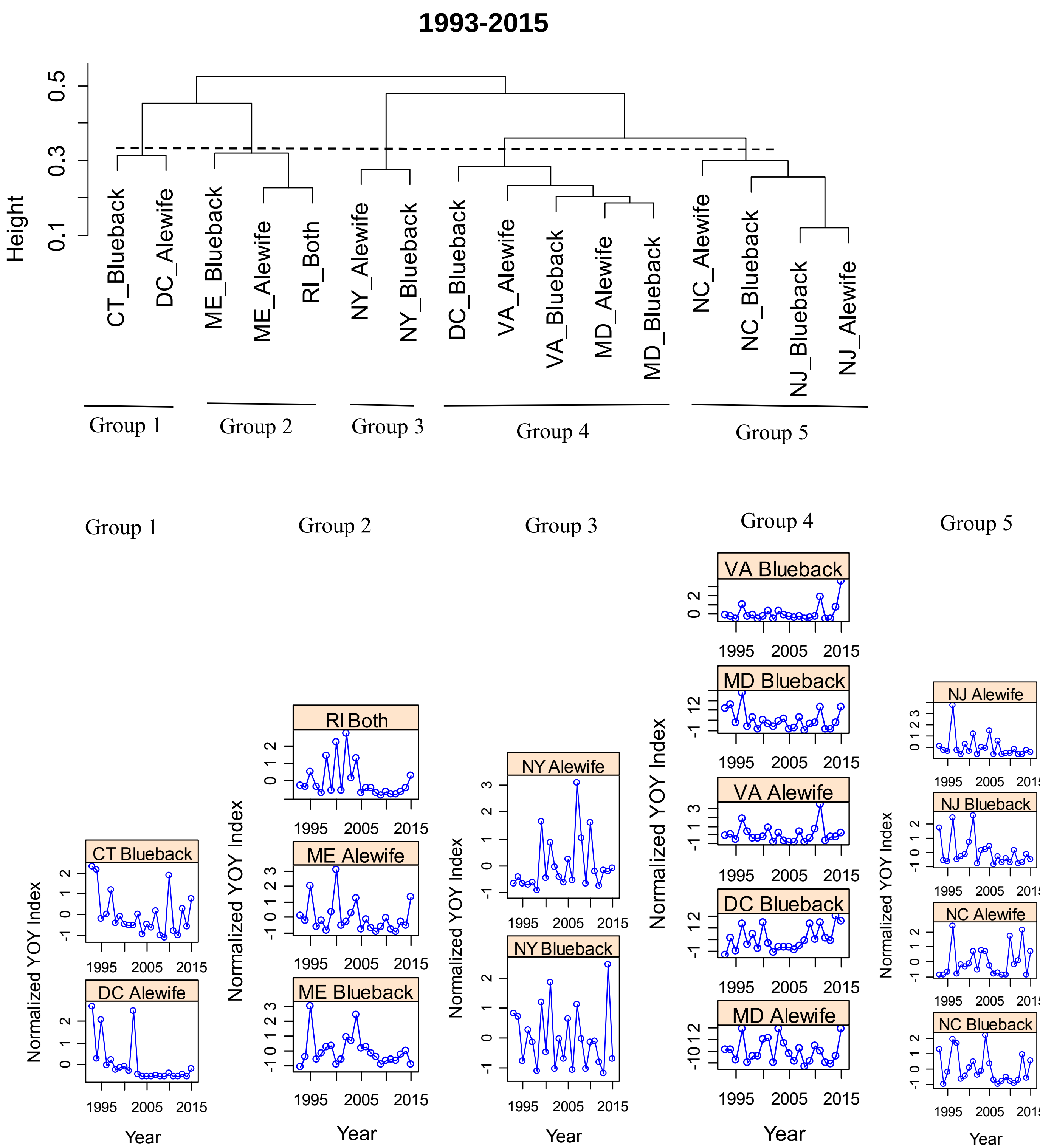


Figure 2.27 Results of cluster analysis of YOY seine survey trends for 1993-2015 showing the cluster dendrogram and plots of YOY indices for each grouping.

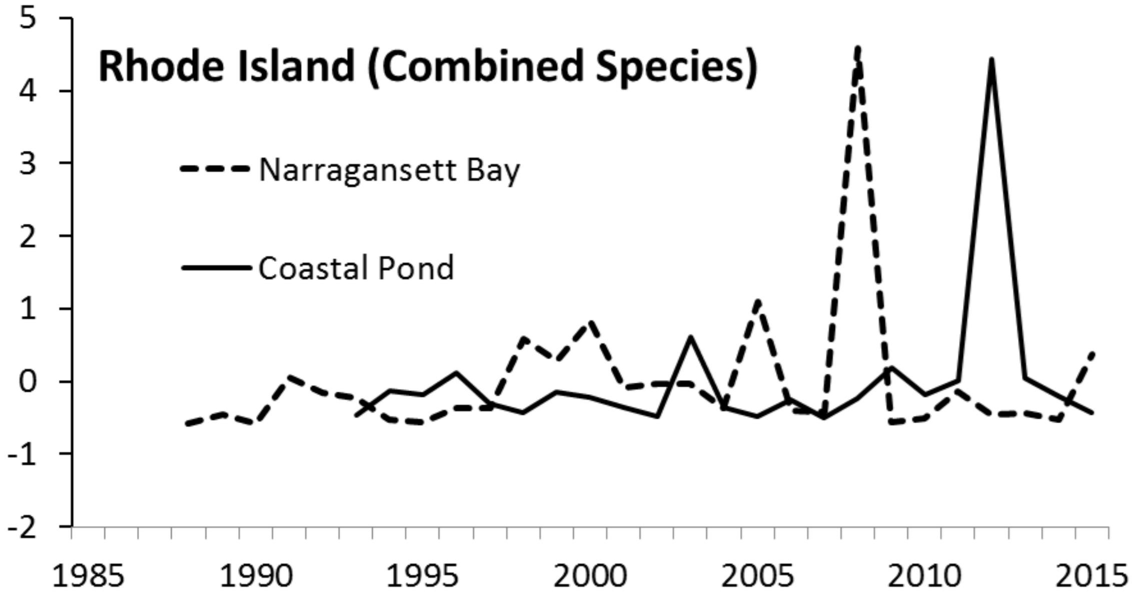


Figure 2.28 Normalized gillnet CPUE from Rhode Island, 1988-2015.

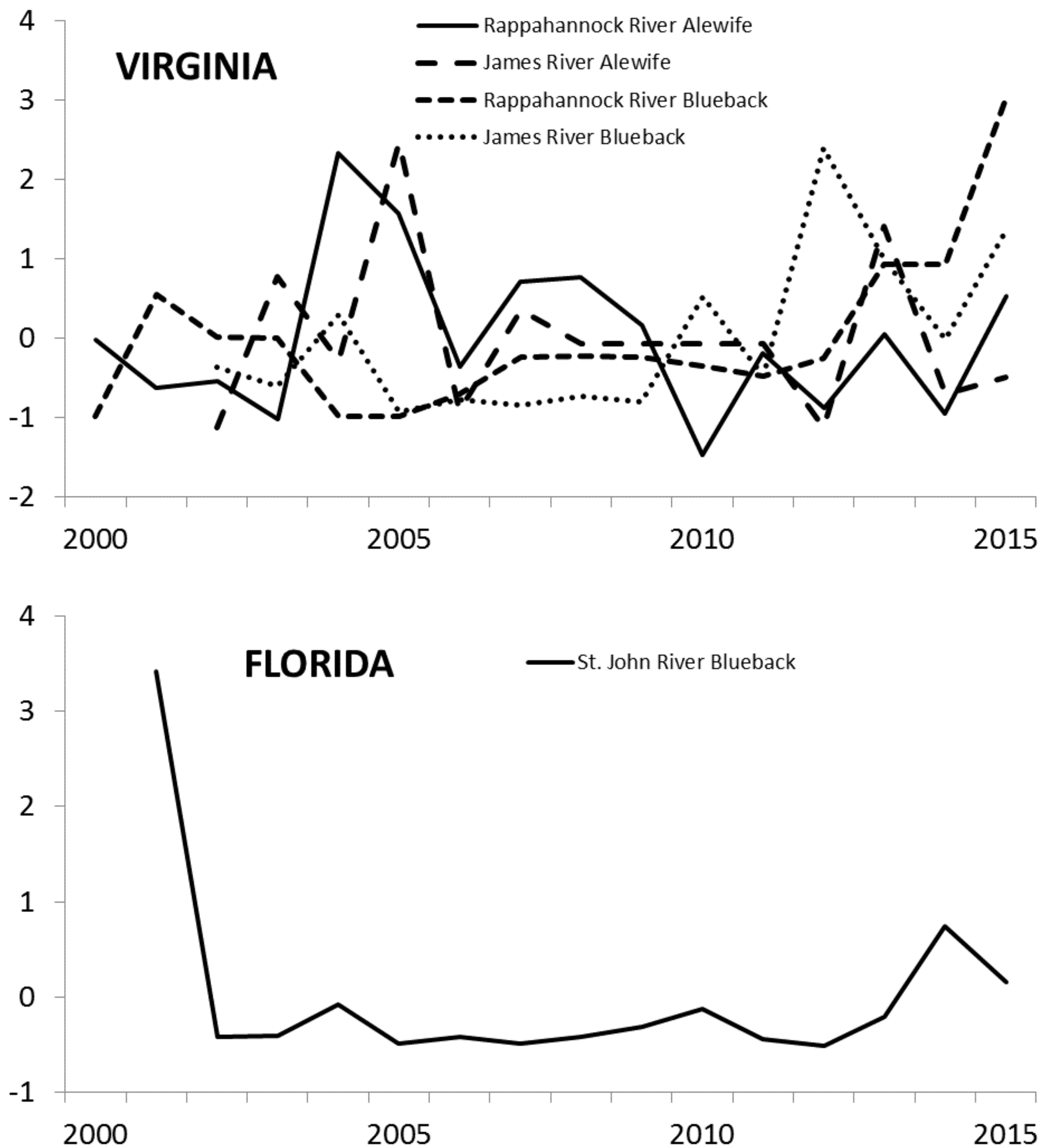


Figure 2.29 Comparison of normalized electrofishing surveys from Virginia and Florida, 2000-2016.

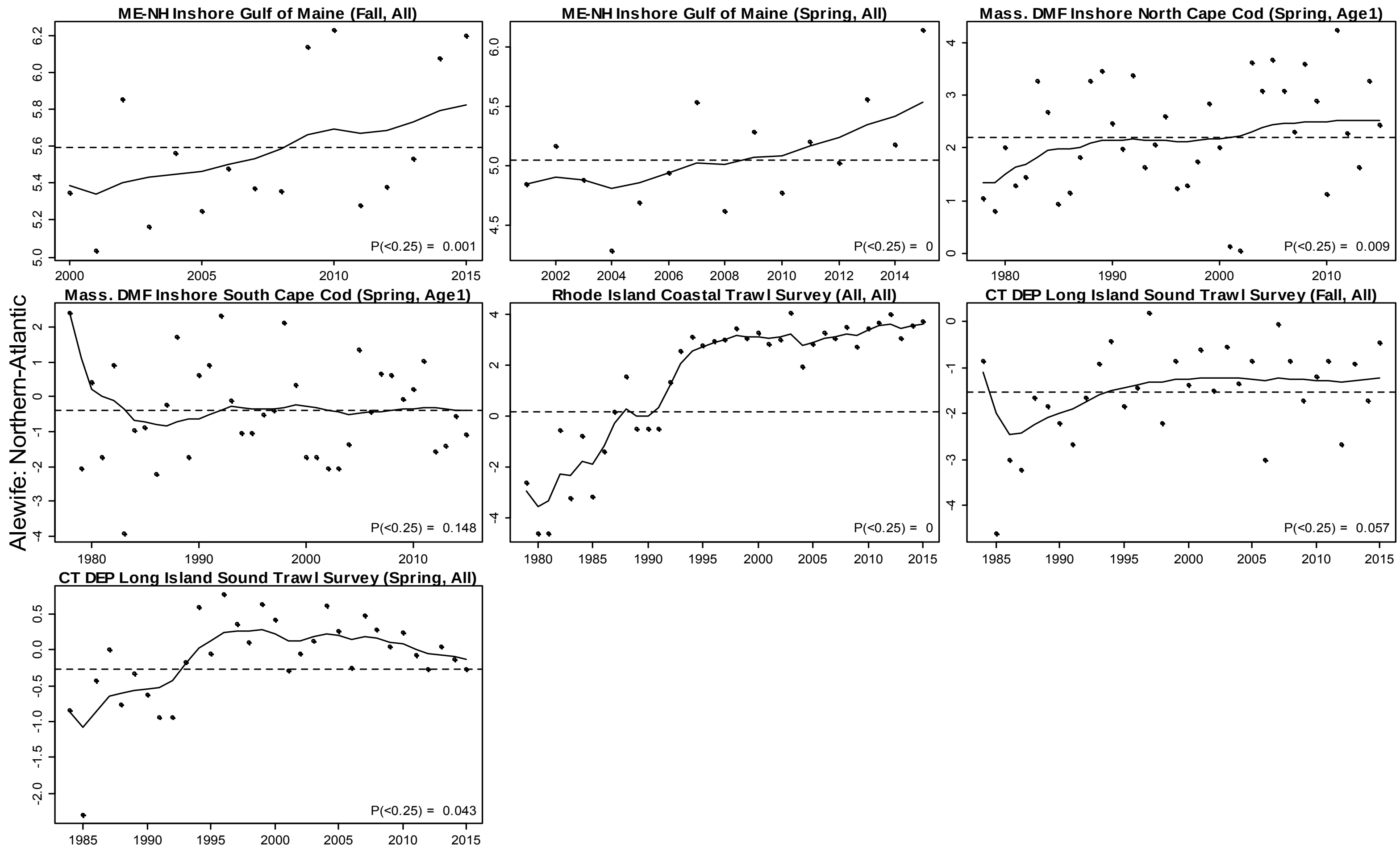


Figure 2.30 Autoregressive integrated moving average (ARIMA) model fits to log transformed **alewife** trawl survey indices from northern regions. The dotted horizontal lines correspond to the bootstrapped mean 25th percentile of the fitted values (Q0.25). Text on the graphs represents the probability of the last year of the survey being less than Q0.25 [P(<0.25)], the season of the trawl survey, and the ages of alewife in the trawl survey.

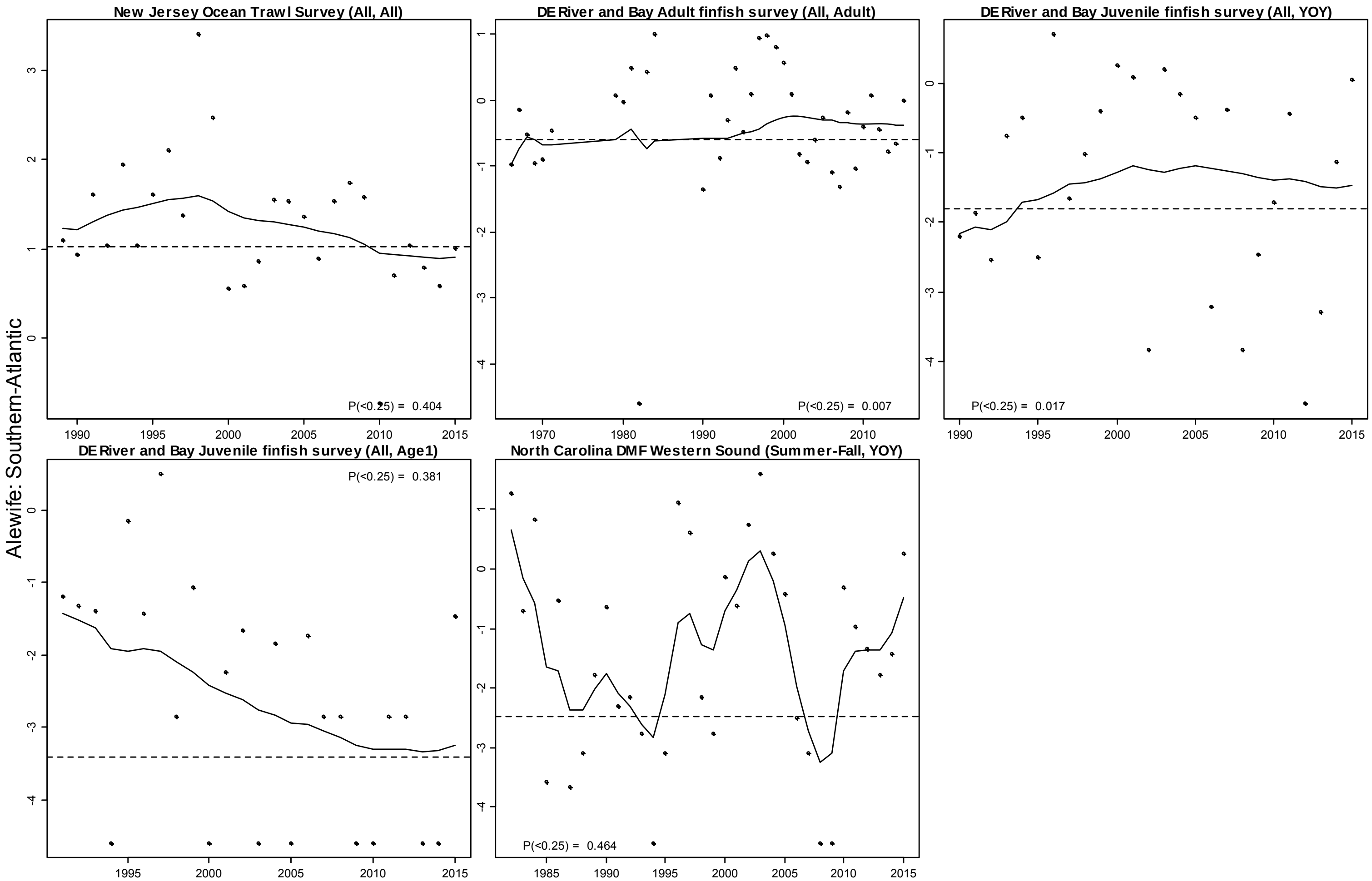


Figure 2.31 Autoregressive integrated moving average (ARIMA) model fits to log transformed **alewife** trawl survey indices from southern regions. The dotted horizontal lines correspond to the bootstrapped mean 25th percentile of the fitted values (Q0.25). Text on the graphs represents the probability of the last year of the survey being less than Q0.25 [P(<0.25)], the season of the trawl survey, and the ages of alewife in the trawl survey.

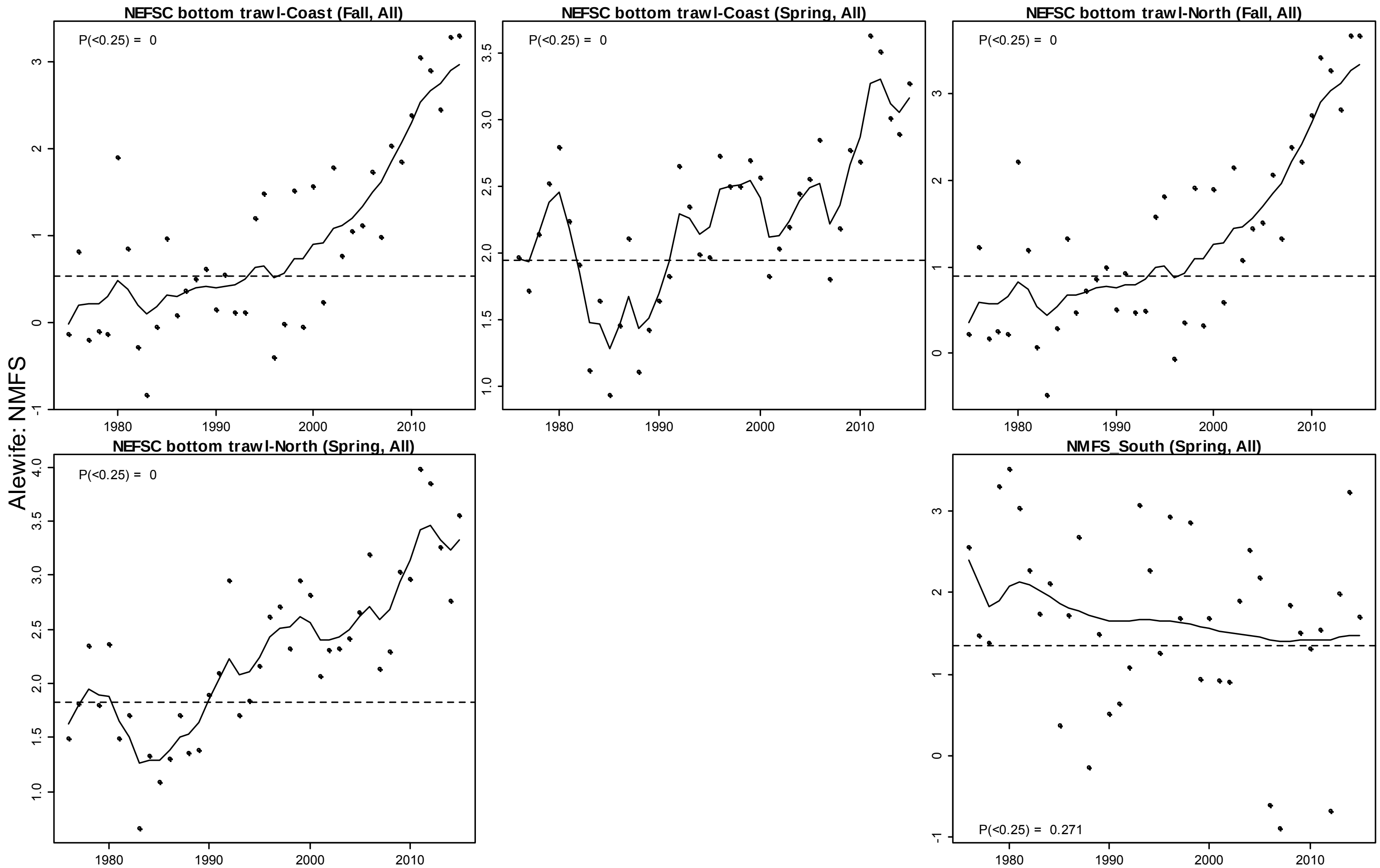


Figure 2.32 Autoregressive integrated moving average (ARIMA) model fits to log transformed **alewife** trawl survey indices from the NEFSC bottom trawl survey. The dotted horizontal lines correspond to the bootstrapped mean 25th percentile of the fitted values (Q0.25). Text on the graphs represents the probability of the last year of the survey being less than Q0.25 [P(<0.25)], the season of the trawl survey, and the ages of alewife in the trawl survey.

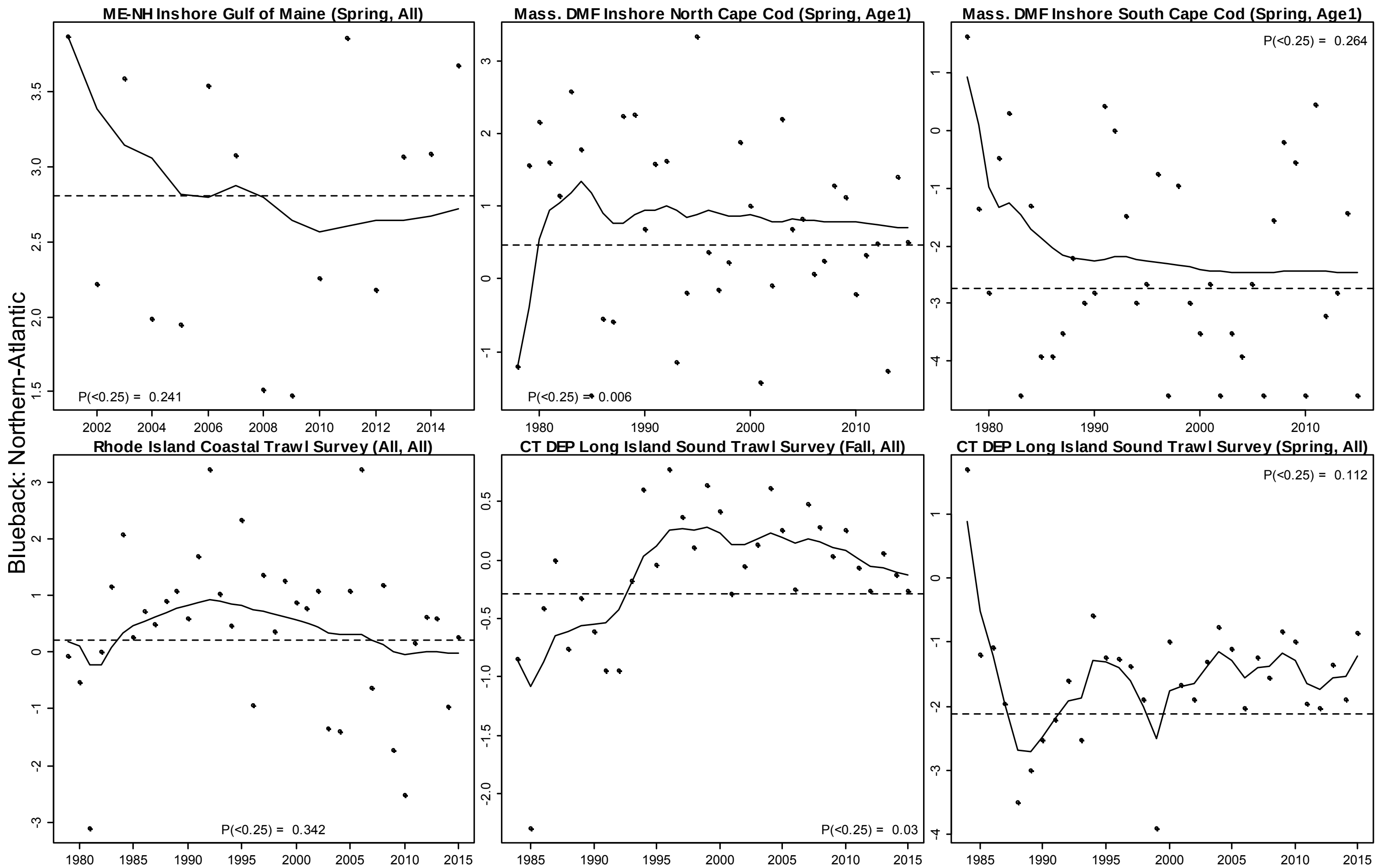


Figure 2.33 Autoregressive integrated moving average (ARIMA) model fits to log transformed **blueback herring** trawl survey indices from northern regions. The dotted horizontal lines correspond to the bootstrapped mean 25th percentile of the fitted values (Q0.25). Text on the graphs represents the probability of the last year of the survey being less than Q0.25 [P(<0.25)], the season of the trawl survey, and the ages of alewife in the trawl survey.

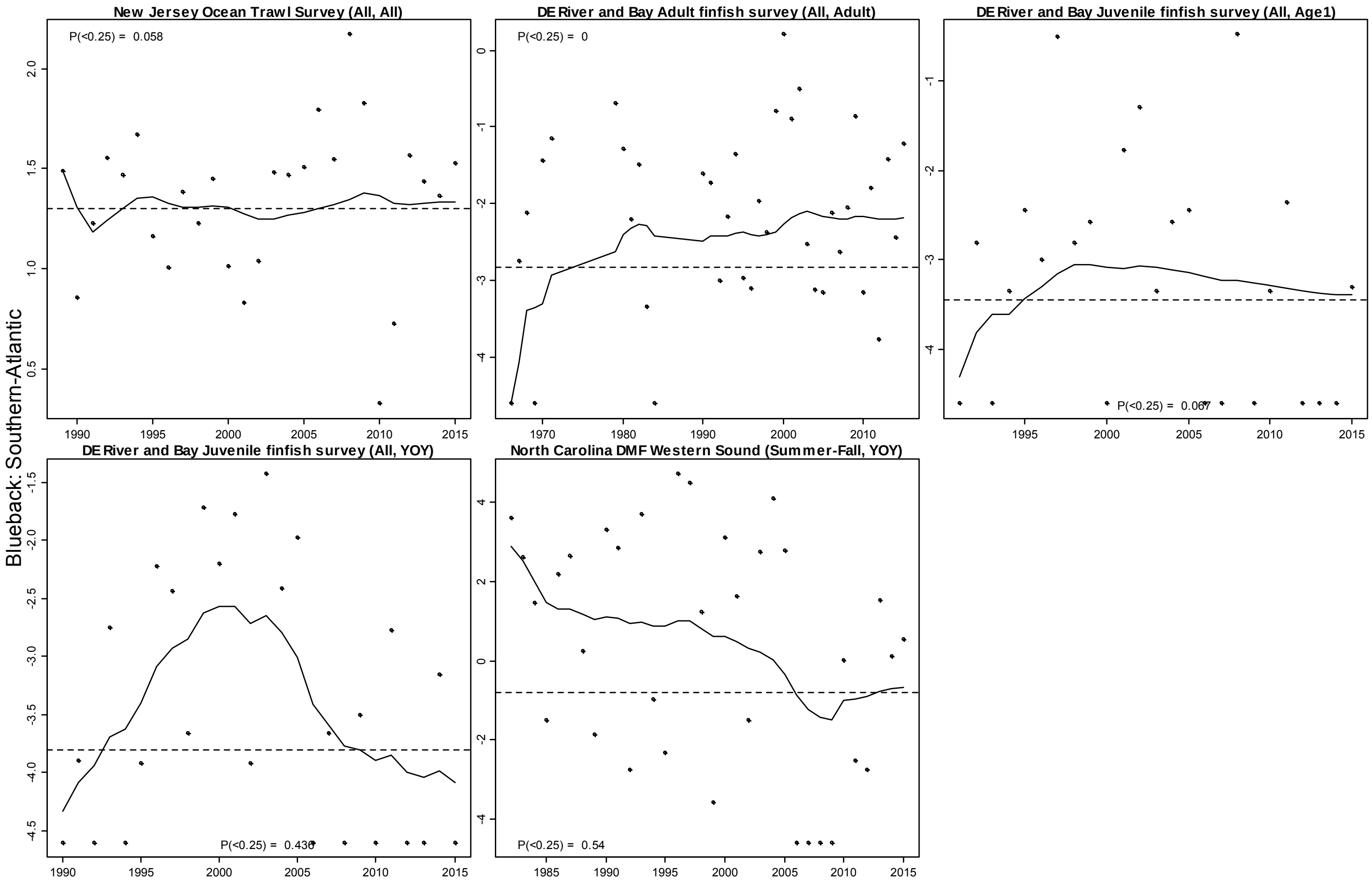


Figure 2.34 Autoregressive integrated moving average (ARIMA) model fits to log transformed **blueback herring** trawl survey indices from southern regions. The dotted horizontal lines correspond to the bootstrapped mean 25th percentile of the fitted values (Q0.25). Text on the graphs represents the probability of the last year of the survey being less than Q0.25 [P(<0.25)], the season of the trawl survey, and the ages of alewife in the trawl survey.

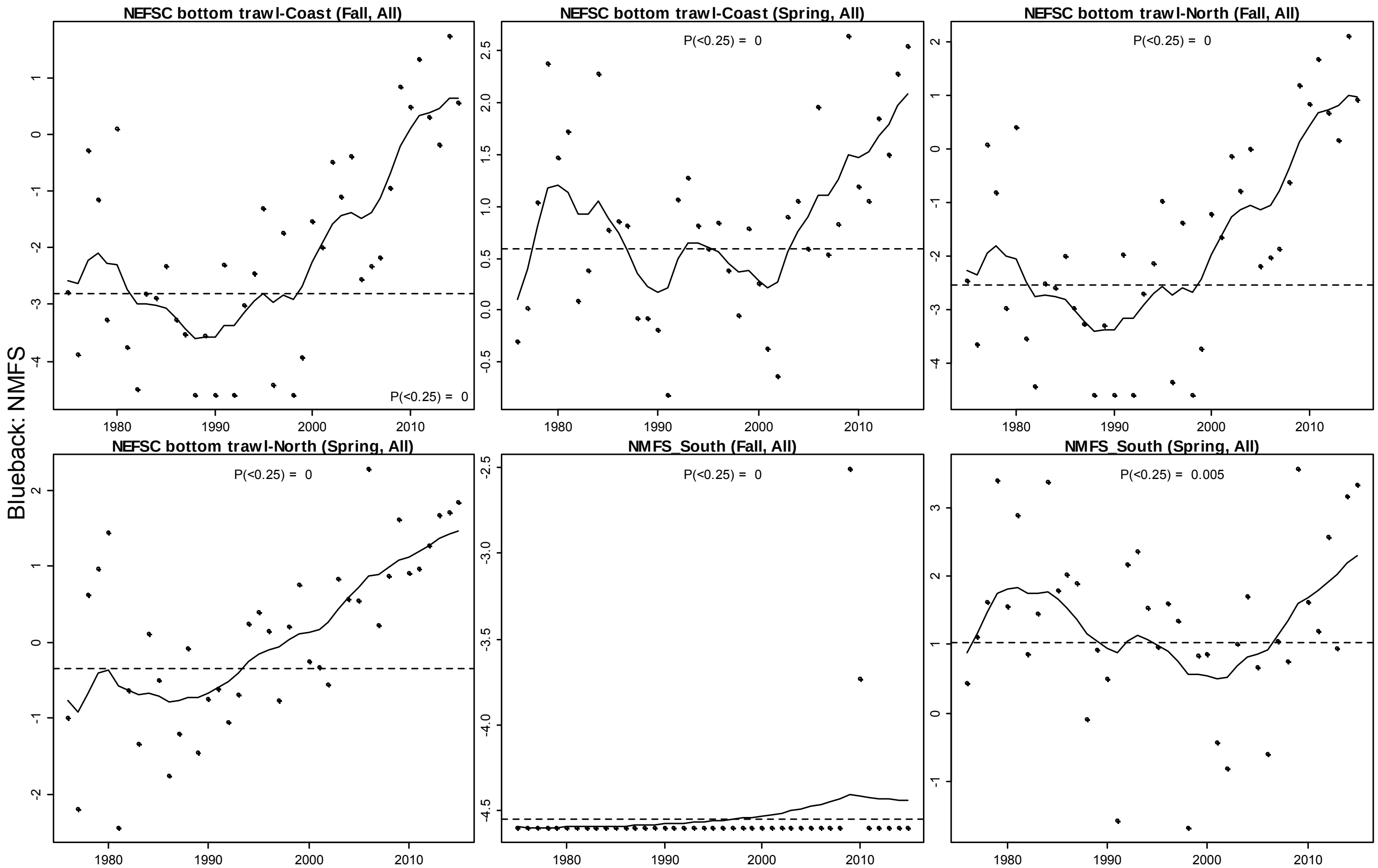


Figure 2.35 Autoregressive integrated moving average (ARIMA) model fits to log transformed **blueback herring** trawl survey indices from the NEFSC bottom trawl survey. The dotted horizontal lines correspond to the bootstrapped mean 25th percentile of the fitted values (Q0.25). Text on the graphs represents the probability of the last year of the survey being less than Q0.25 [P(<0.25)], the season of the trawl survey, and the ages of alewife in the trawl survey.

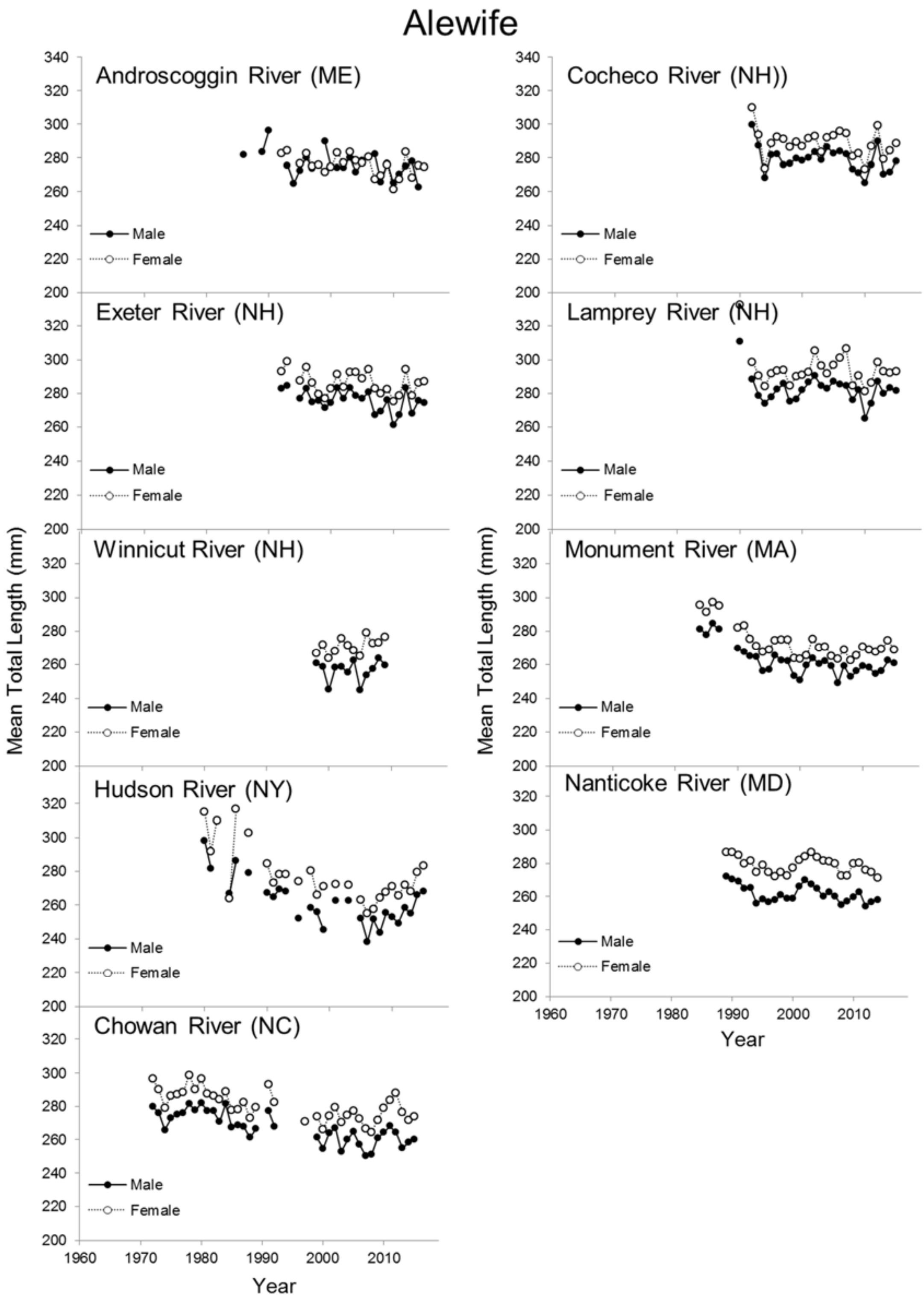


Figure 2.36 Mean lengths of male and female alewife by river and year.

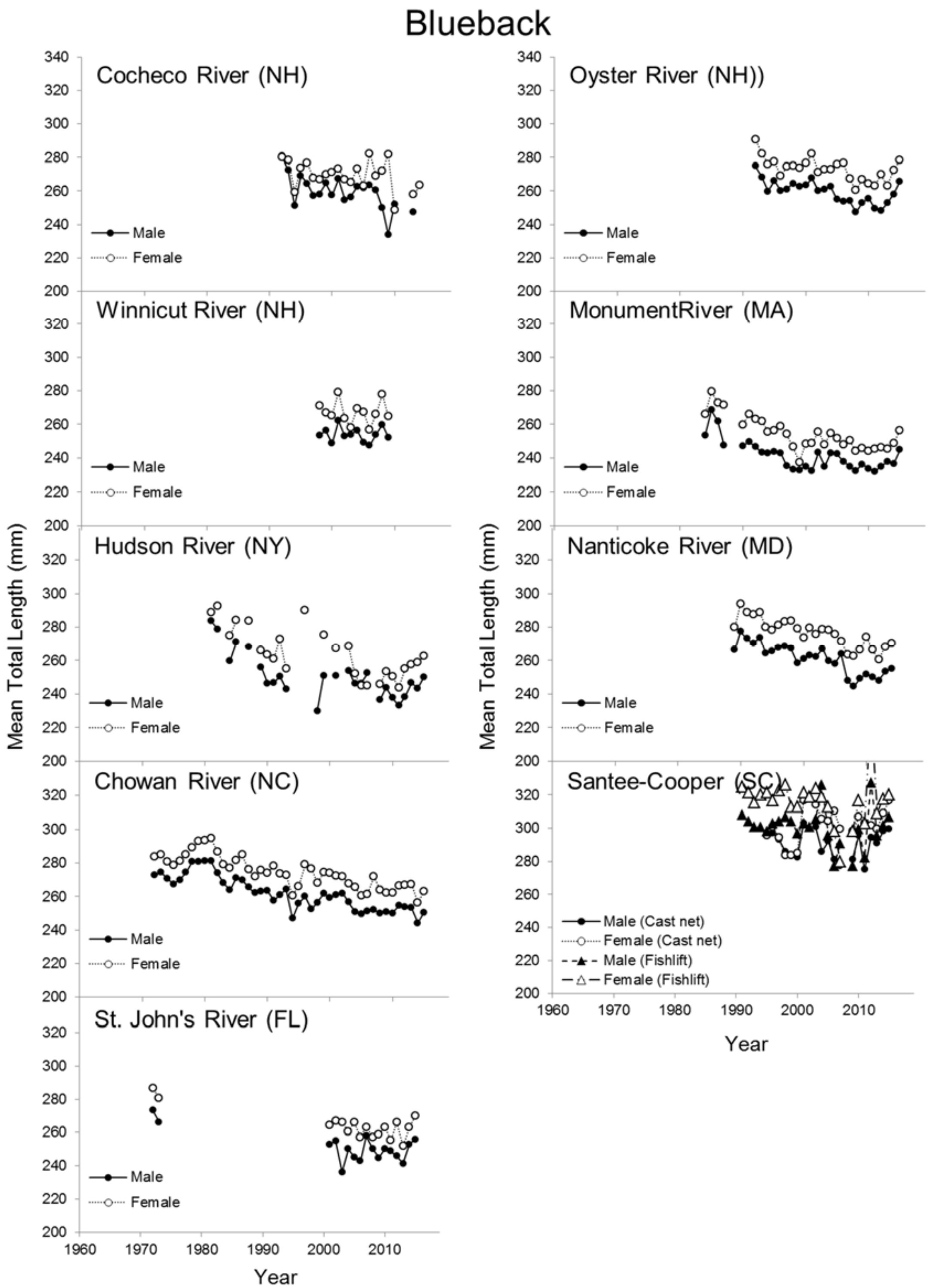


Figure 2.37 Mean lengths of male and female blueback herring by river and year.

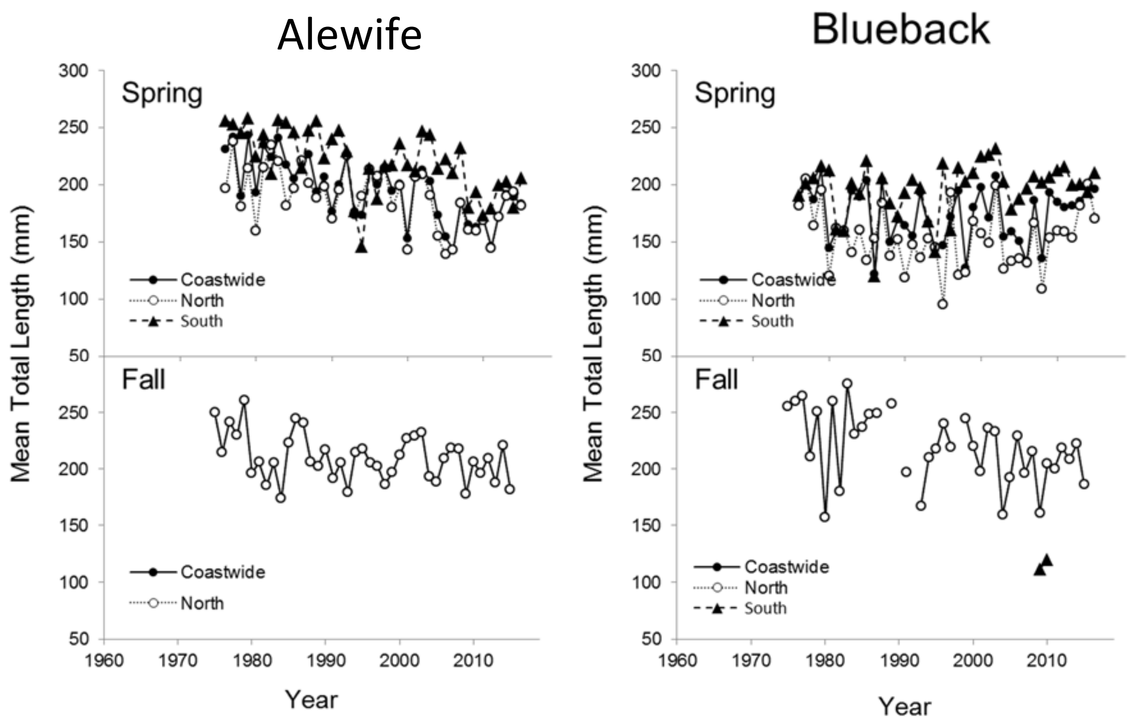


Figure 2.38 Mean lengths of alewife and blueback herring by region and year from the National Marine Fisheries Service bottom trawl survey.

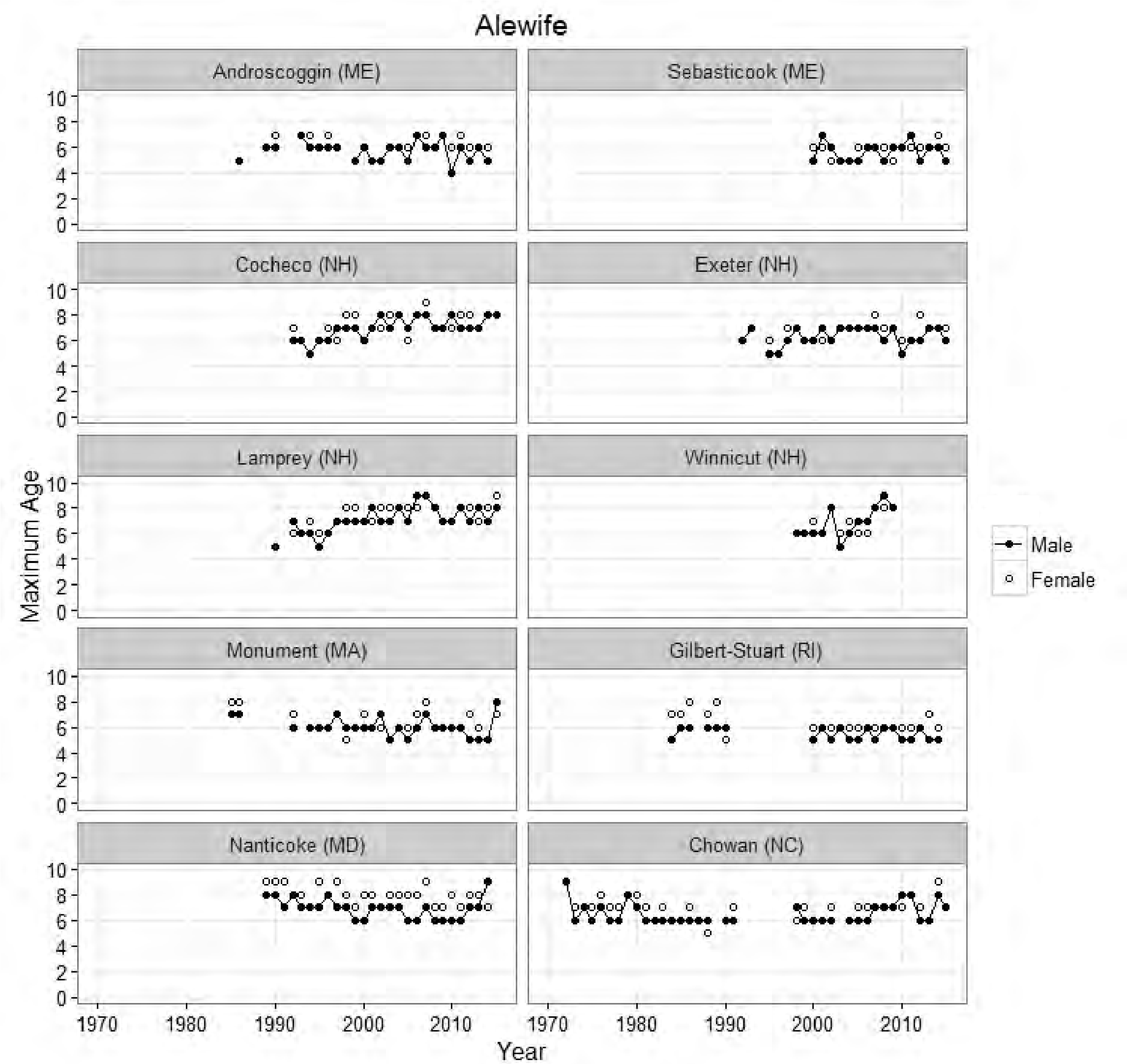


Figure 2.39 Maximum ages for male and female alewife by river. Updated data for the Chowan River (2010-2015) were determined to be unreliable due to ageing error (see state report) and were not used to update the trend in maximum age from the benchmark assessment.

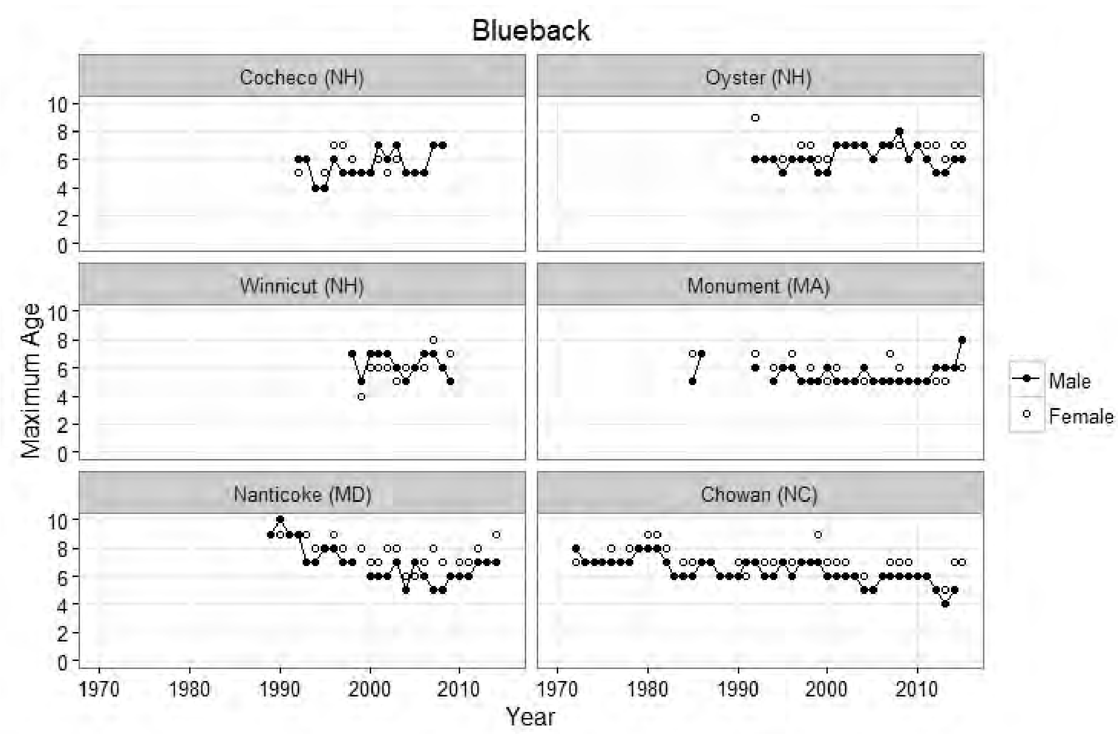


Figure 2.40 Maximum ages for male and female blueback by river.

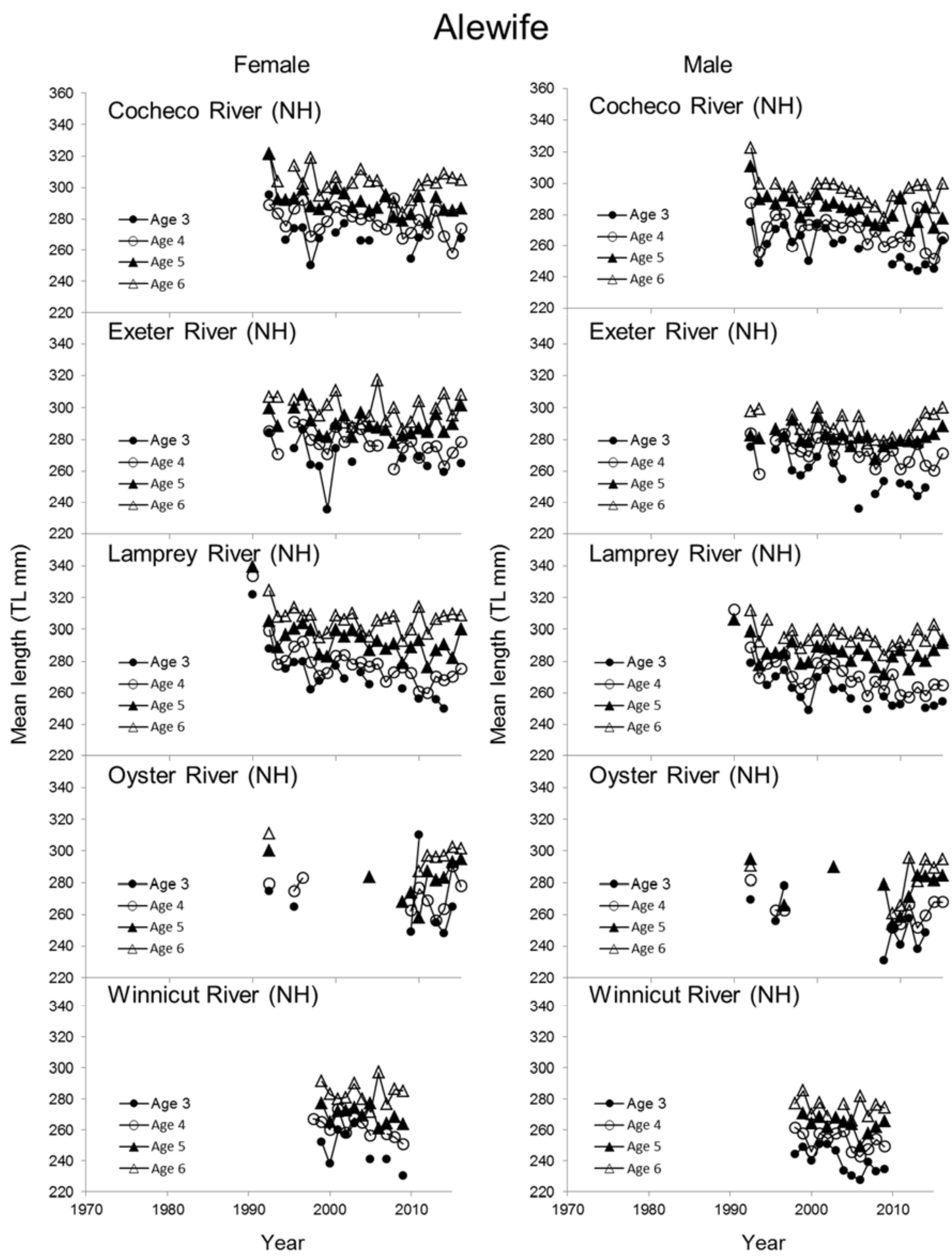


Figure 2.41 Mean lengths-at-age of male and female alewife from New Hampshire and Maine by sex, river, age and year.

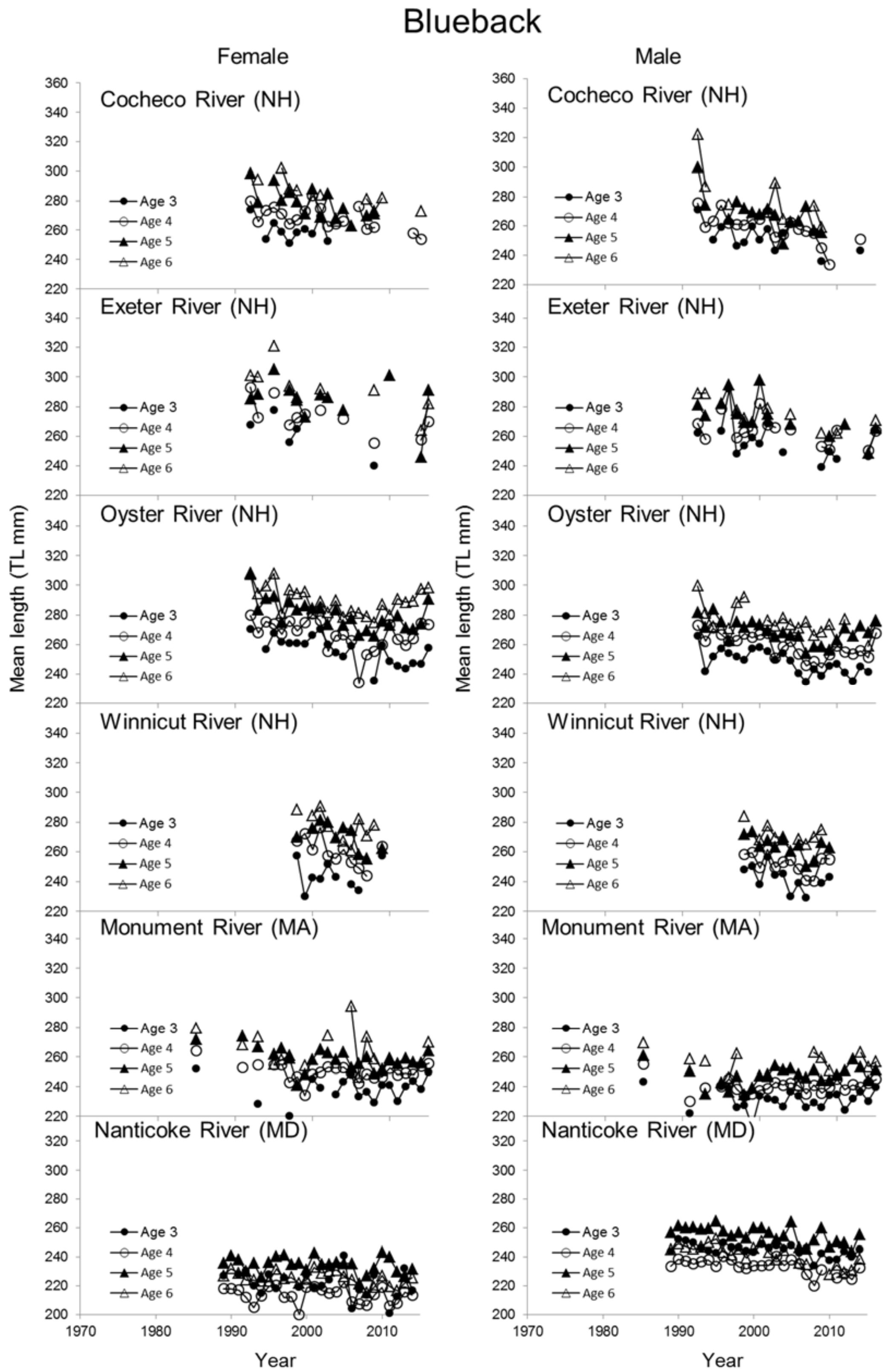


Figure 2.42 Mean lengths-at-age of male and female blueback herring from New Hampshire, Massachusetts, and Maryland by sex, river, age and year.

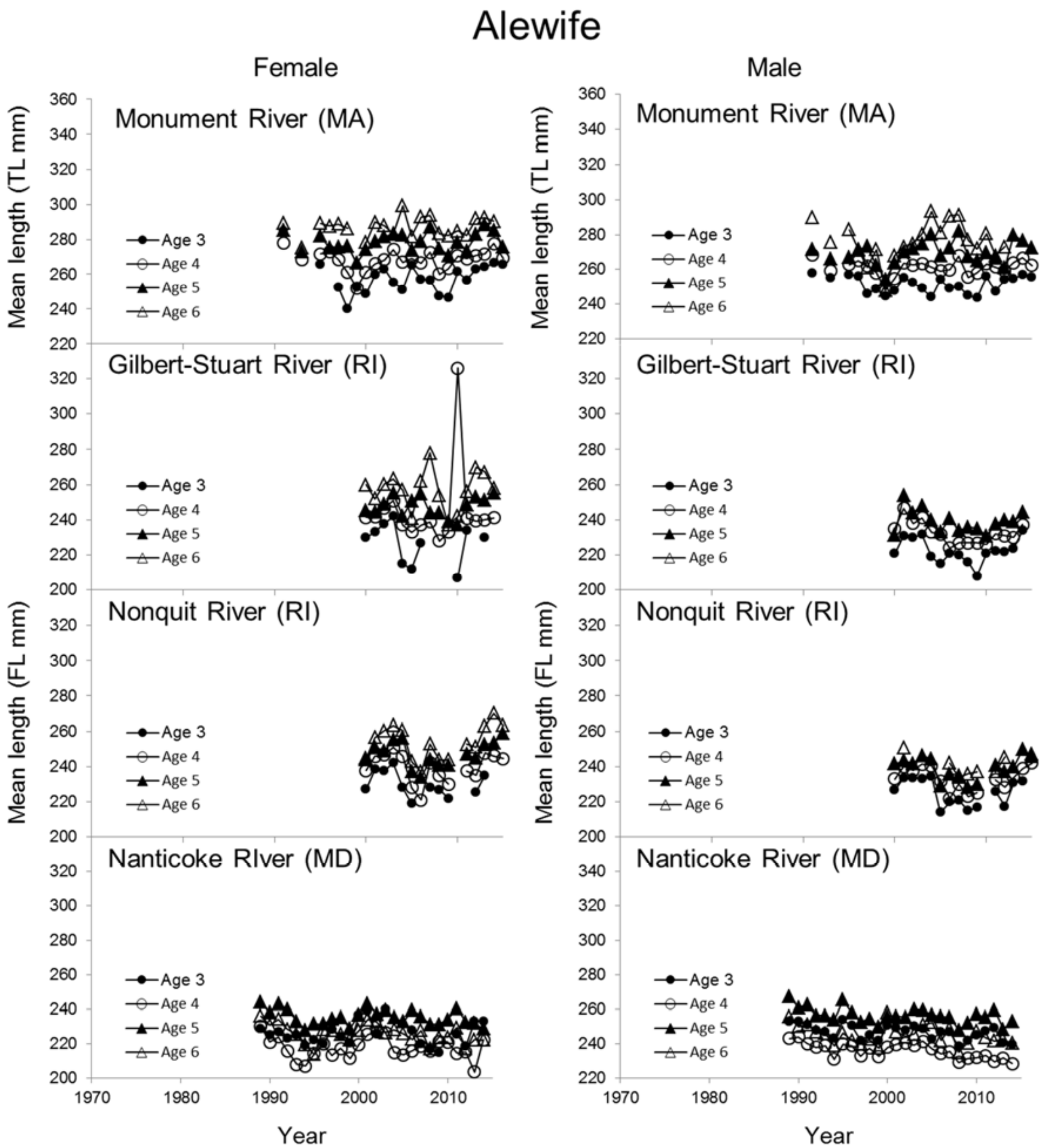


Figure 2.43 Mean lengths-at-age of male and female alewife from Massachusetts, Rhode Island and Maryland by sex, river, age and year.

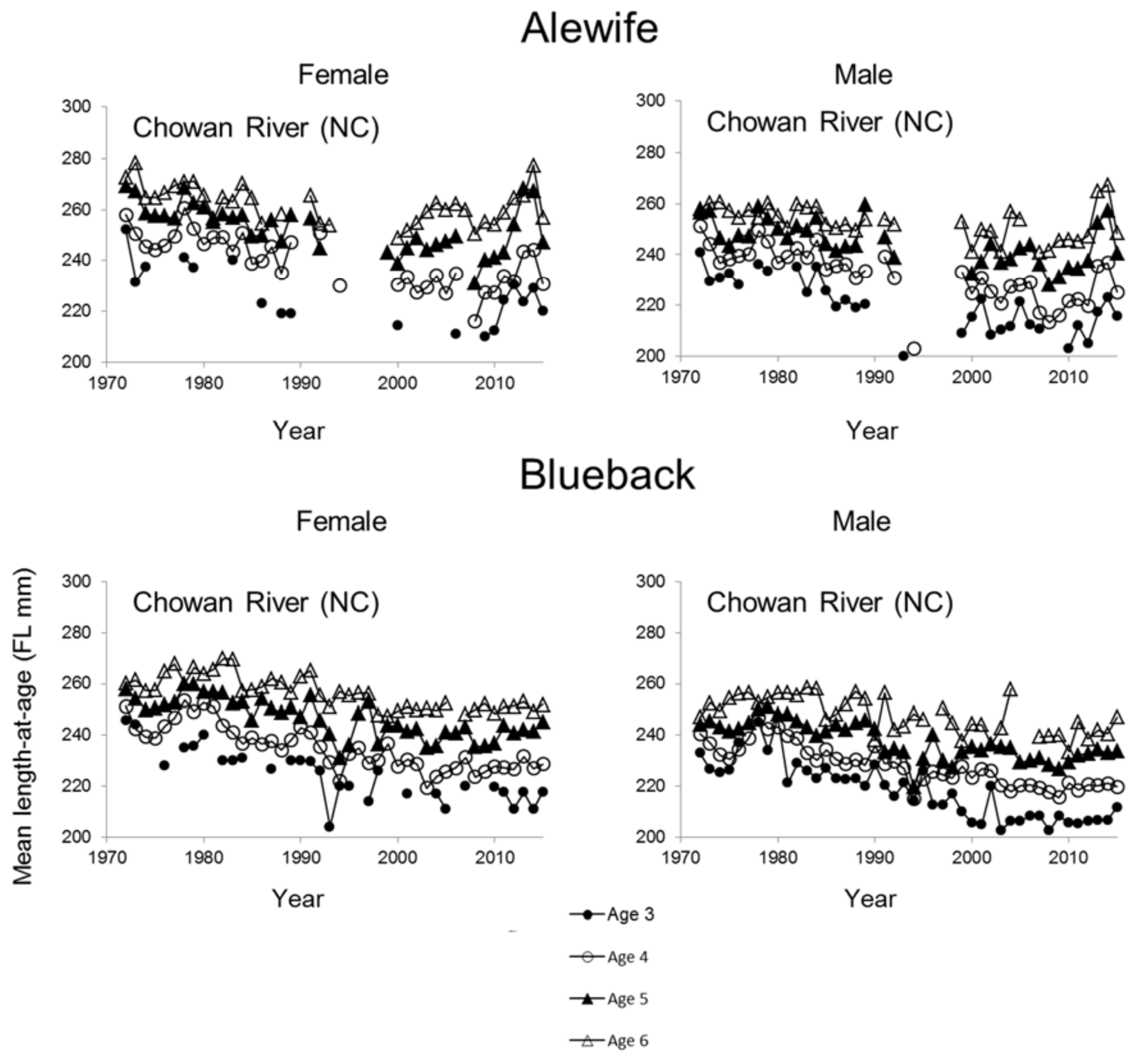


Figure 2.44 Mean lengths-at-age of male and female alewife and blueback herring from North Carolina by species, sex, age and year.

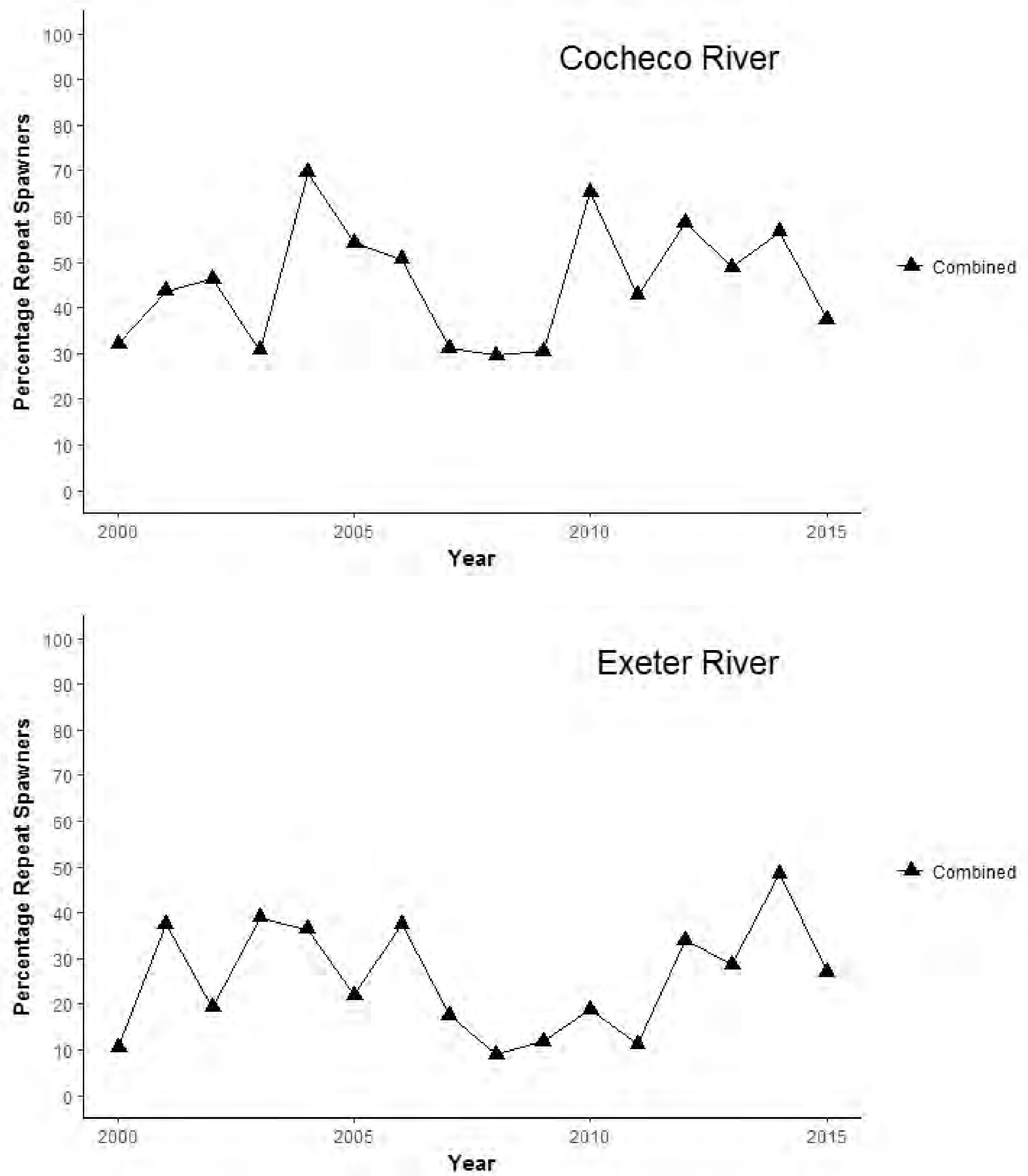


Figure 2.45. Annual repeat spawner rates for alewife observed in fisheries-independent surveys in New Hampshire by water body and year.

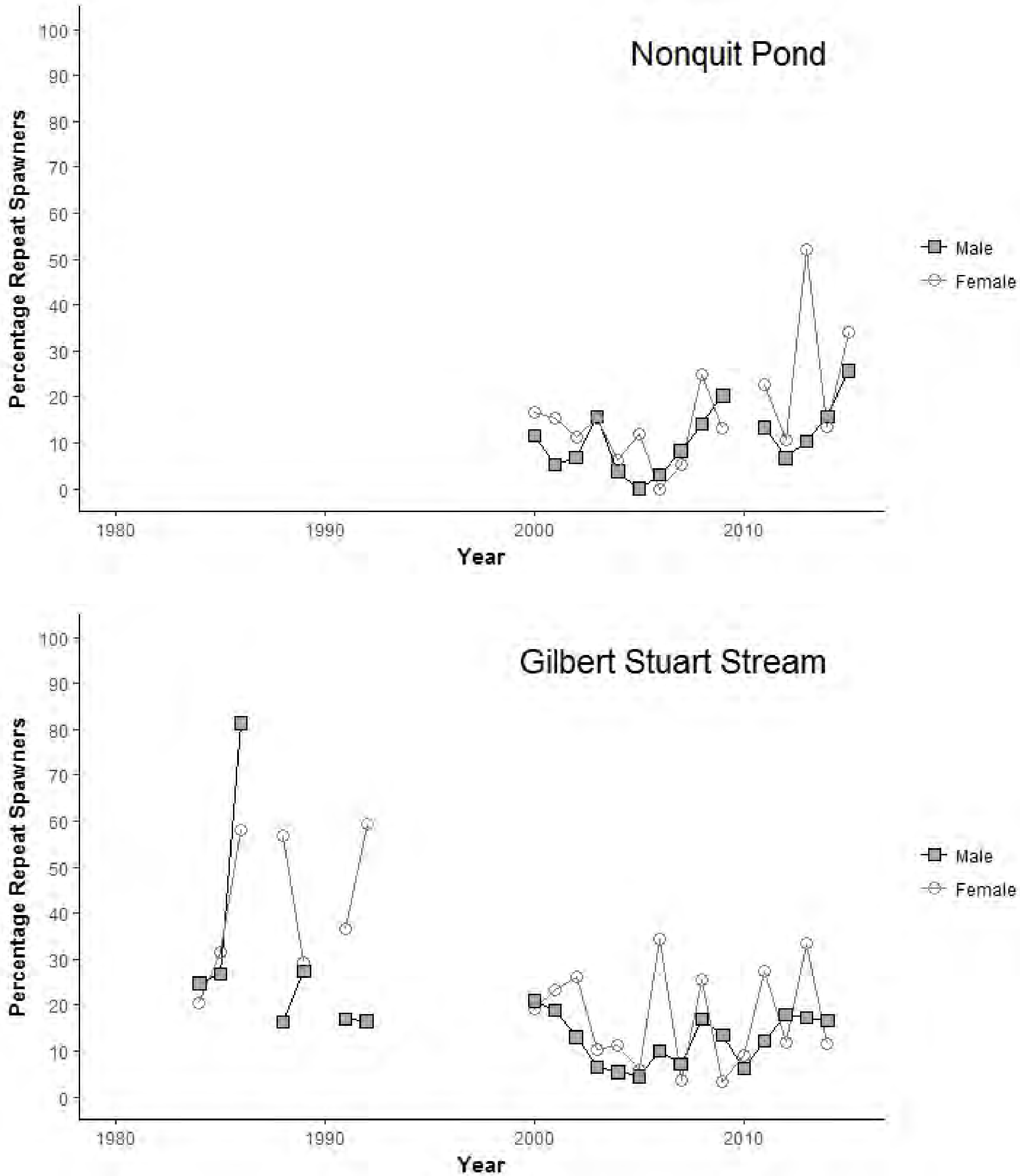


Figure 2.46. Annual repeat spawner rates for alewives observed in fisheries-independent surveys in Rhode Island by water body, sex, and year.

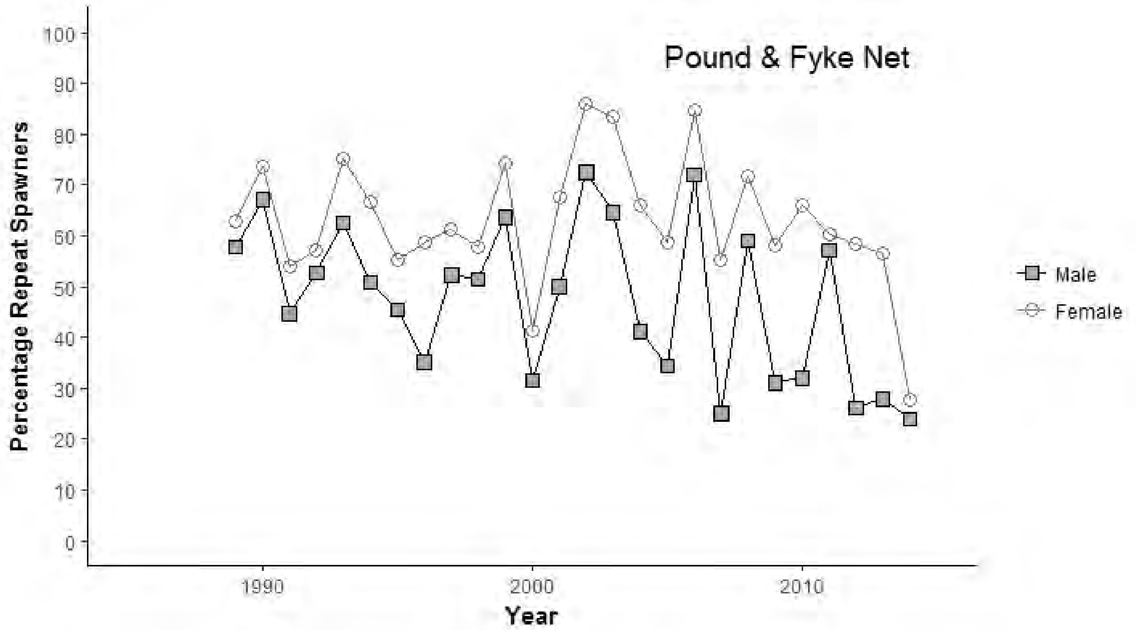


Figure 2.47. Annual repeat spawning rates for alewives observed in fisheries-dependent surveys of the Nanticoke River, MD by sex and year.

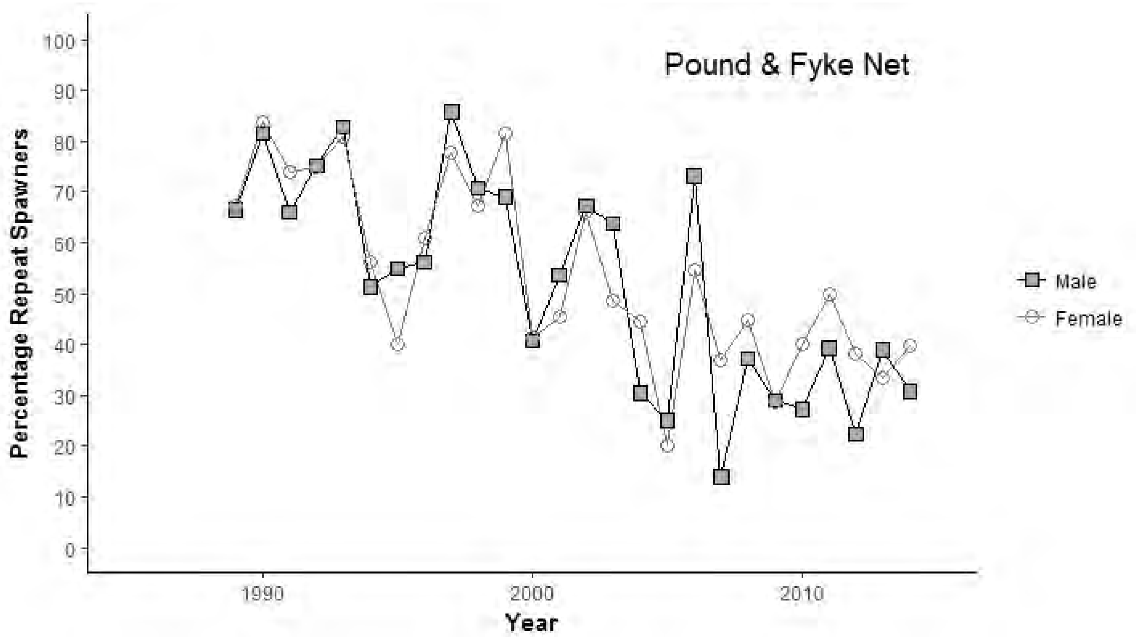


Figure 2.48. Annual repeat spawner rates for blueback herring observed in fisheries-dependent surveys of the Nanticoke River, MD by sex and year.

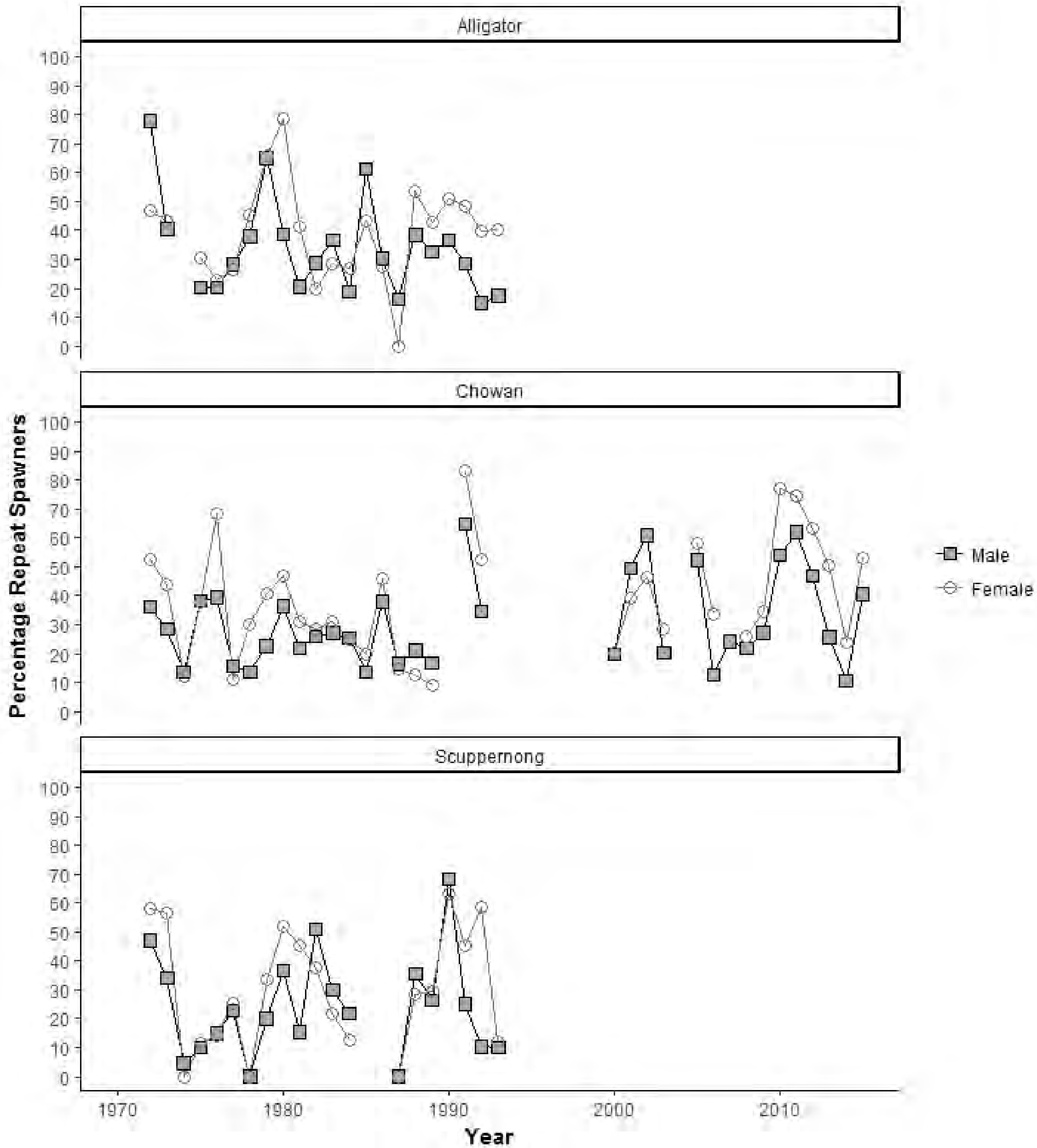


Figure 2.49. Annual repeat spawner rates for alewives observed in fisheries-dependent pound net surveys in North Carolina by water body, sex, and year. Updated data for the Chowan River (2010-2015) were determined to be unreliable due to ageing error (see state report) and were not included in the Mann-Kendall test.

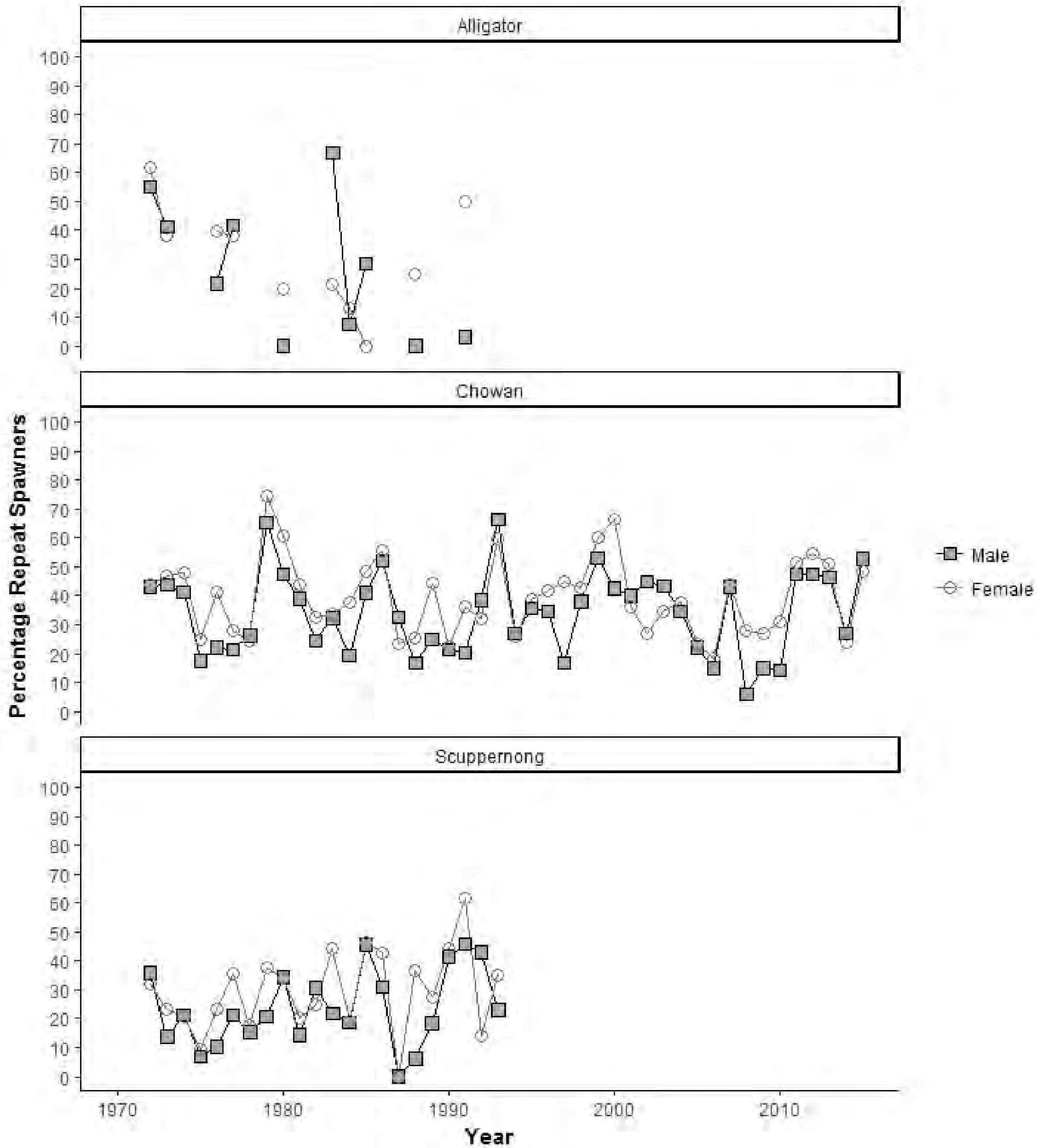


Figure 2.50. Annual repeat spawner rates for blueback herring observed in fisheries-dependent pound net surveys in North Carolina by water body, sex, and year.

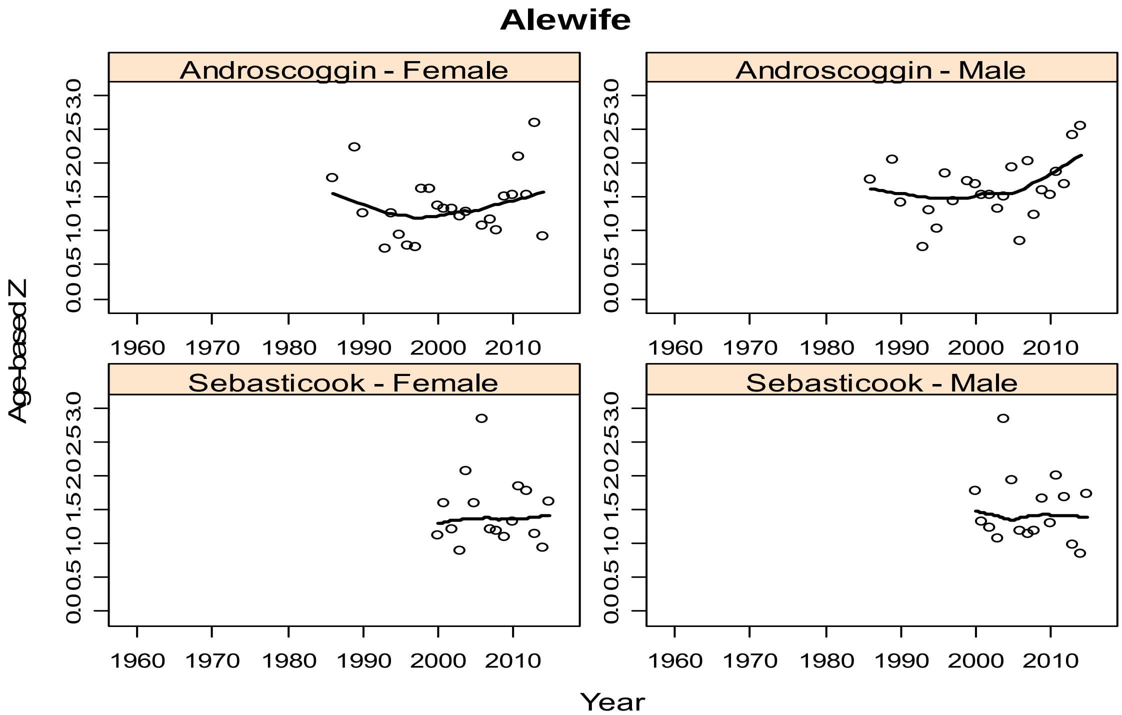


Figure 2.51 Age-based estimates of total instantaneous mortality (Z) for alewife from Maine by river, sex, and year. Linear or loess smooths are drawn to indicate trend.

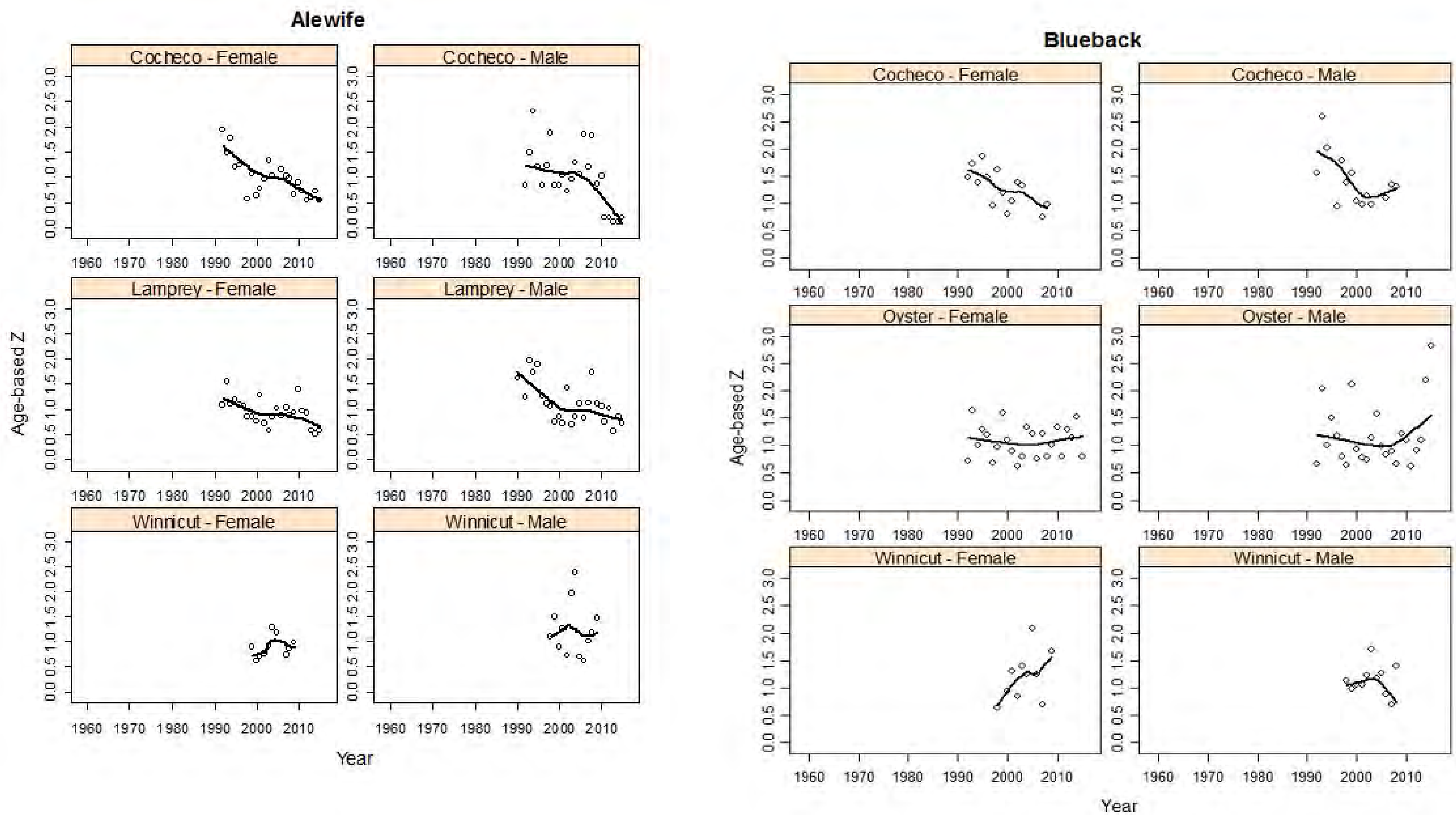


Figure 2.52 Age-based estimates of total instantaneous mortality (Z) for alewife and blueback herring from New Hampshire by river, sex, and year. Linear or loess smooths are drawn to indicate trend.

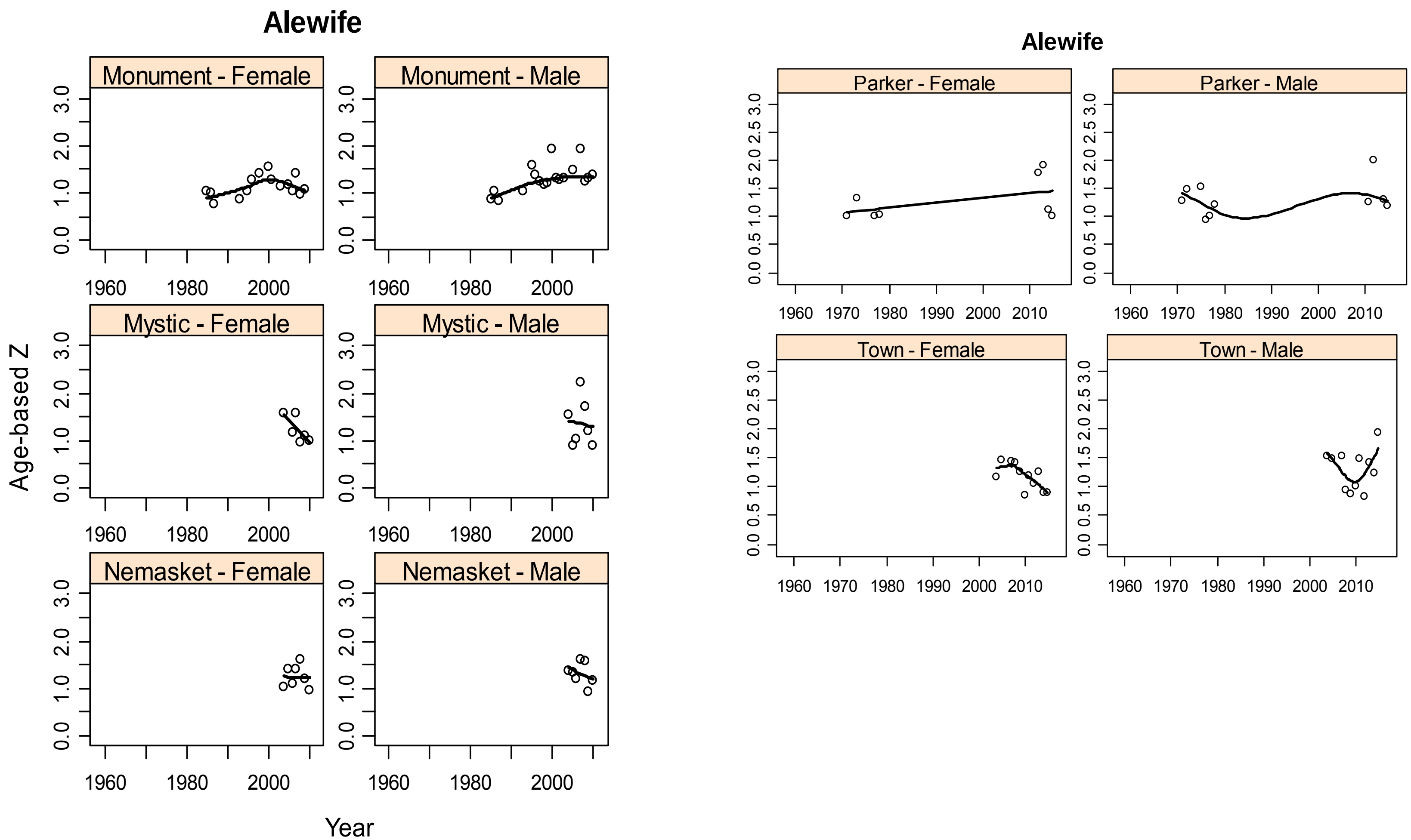


Figure 2.53. Age-based estimates of total instantaneous mortality (Z) for alewife from Massachusetts by river, sex, and year. Linear or loess smooths are drawn to indicate trend.

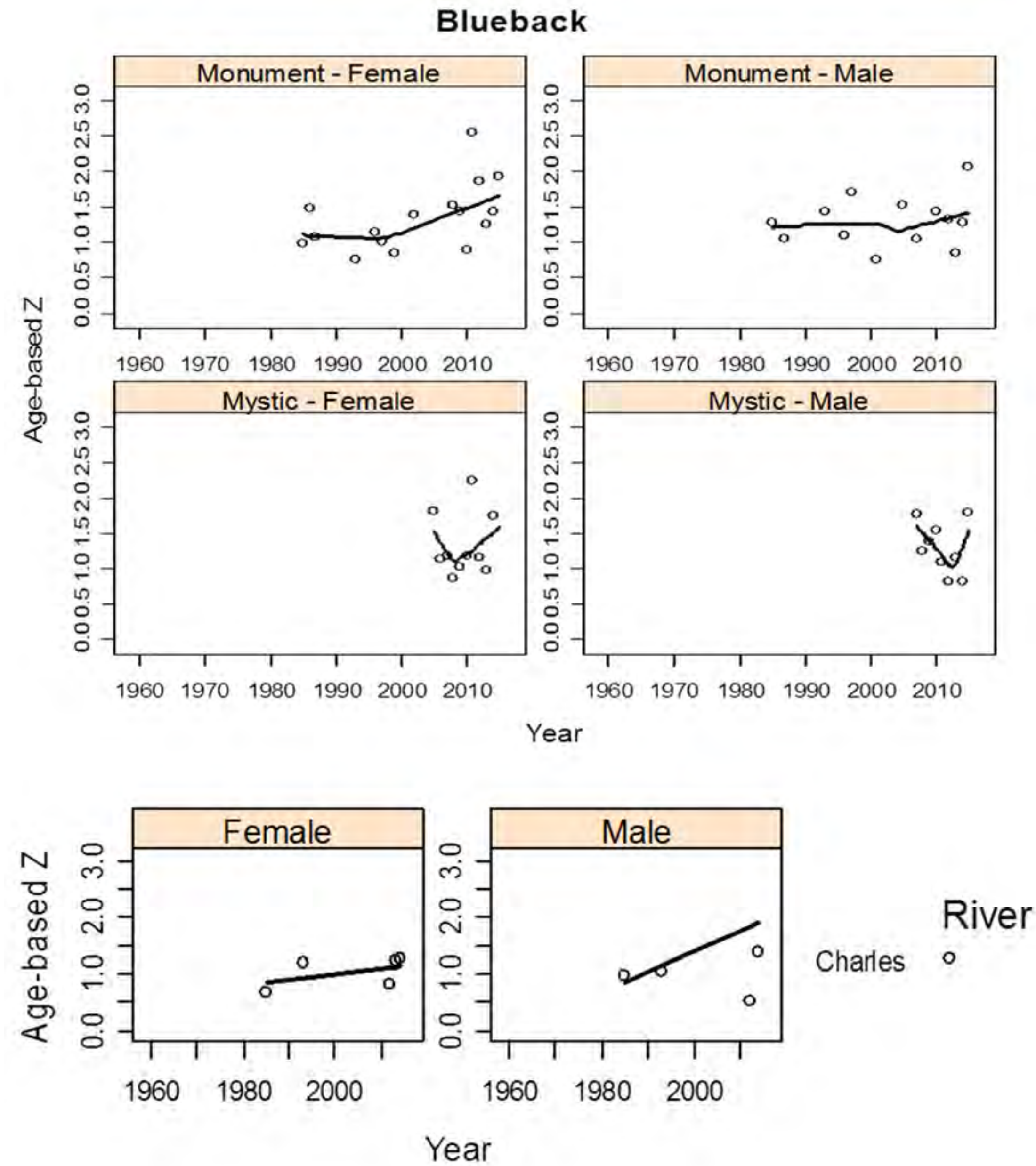


Figure 2.54. Age-based estimates of total instantaneous mortality (Z) for blueback herring from Massachusetts by river, sex, and year. Linear or loess smooths are drawn to indicate trend.

Figure 2.55. Age-based estimates of total instantaneous mortality (Z) for blueback herring from New York by river, sex, and year. Linear or loess smooths are drawn to indicate trend.

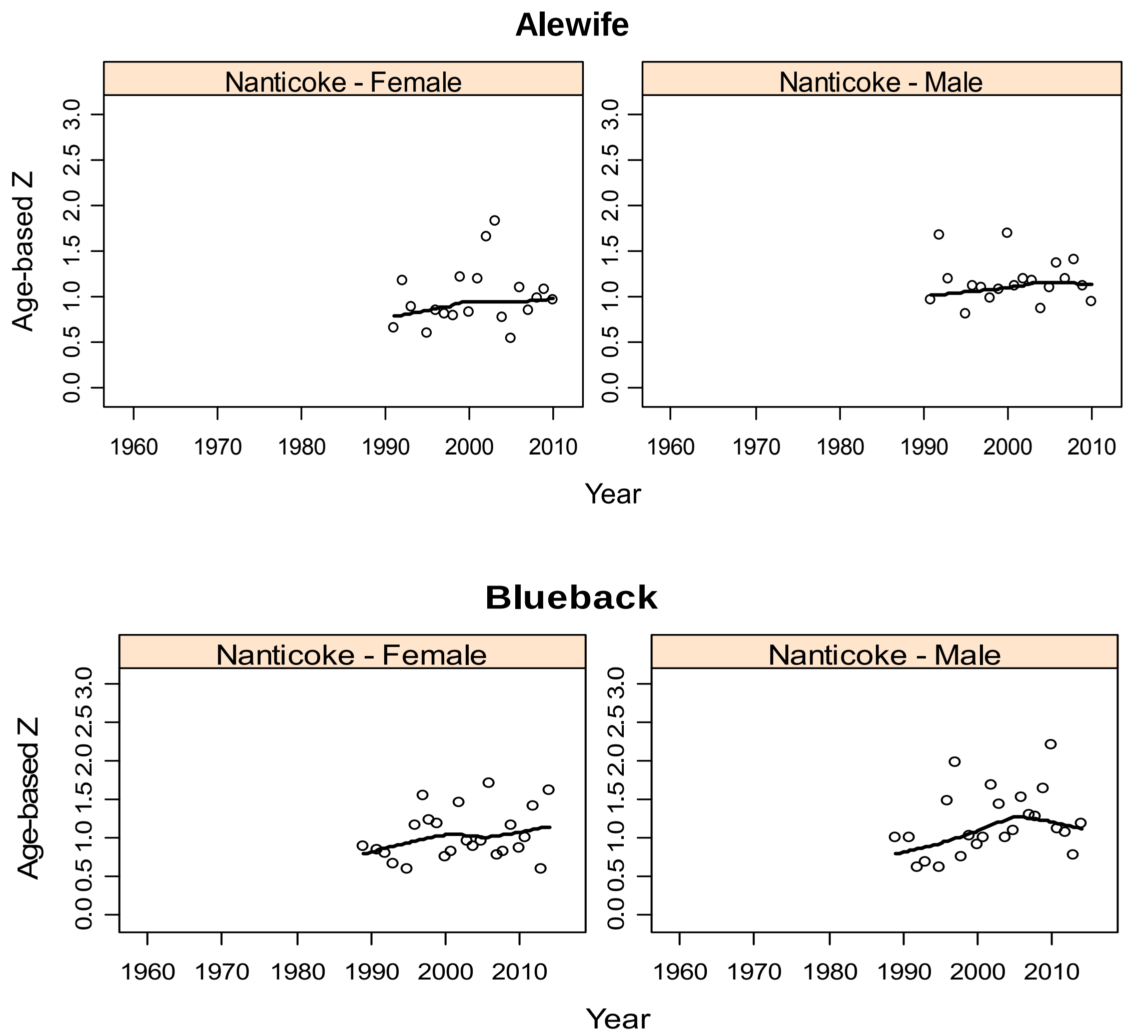


Figure 2.56. Age-based estimates of total instantaneous mortality (Z) for alewife and blueback herring from Maryland by river, sex, and year. Linear or loess smooths are drawn to indicate trend.

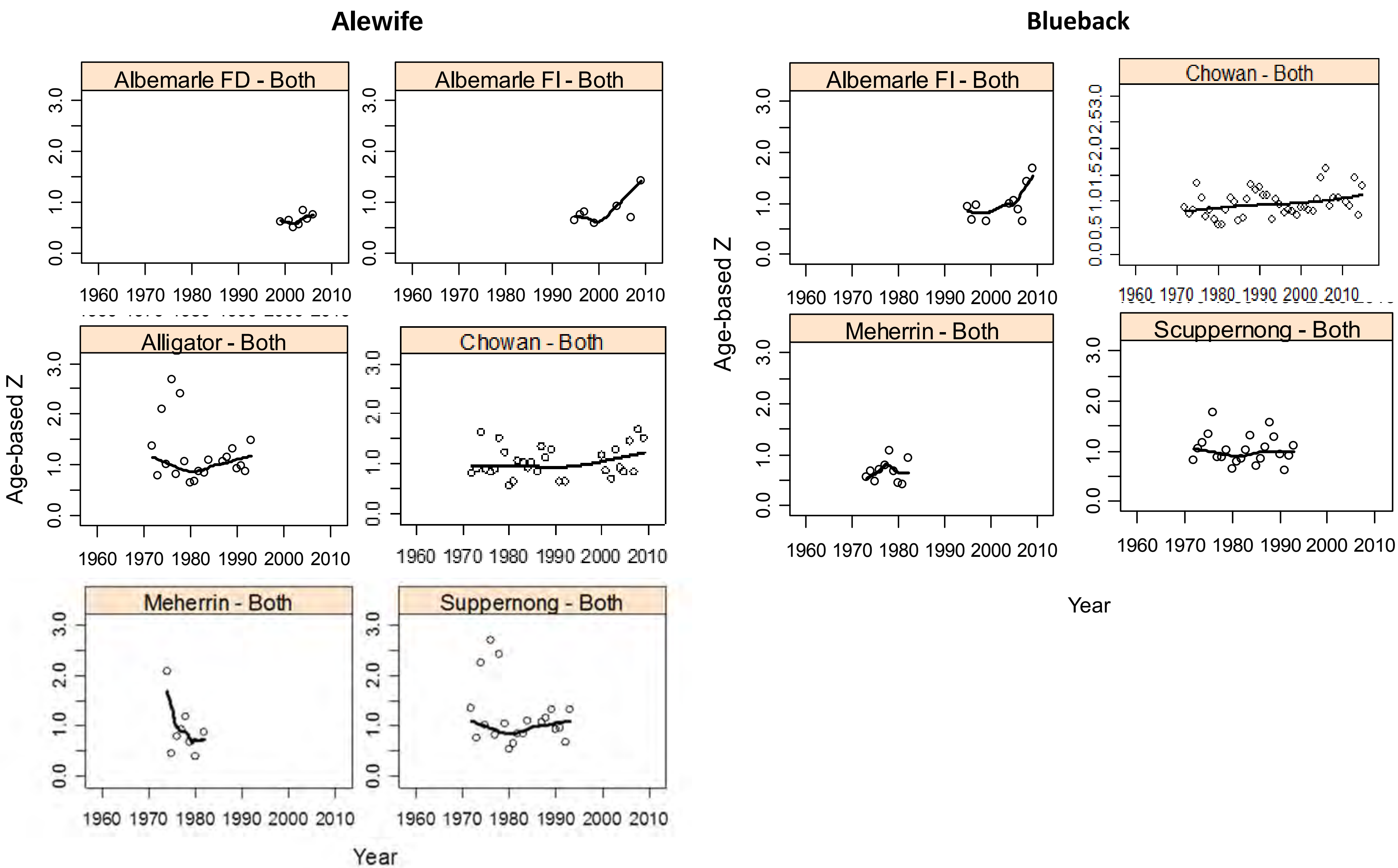


Figure 2.57. Age-based estimates of total instantaneous mortality (Z) for alewife and blueback herring (sexes combined) from North Carolina by river. Linear or loess smooths are drawn to indicate trend.

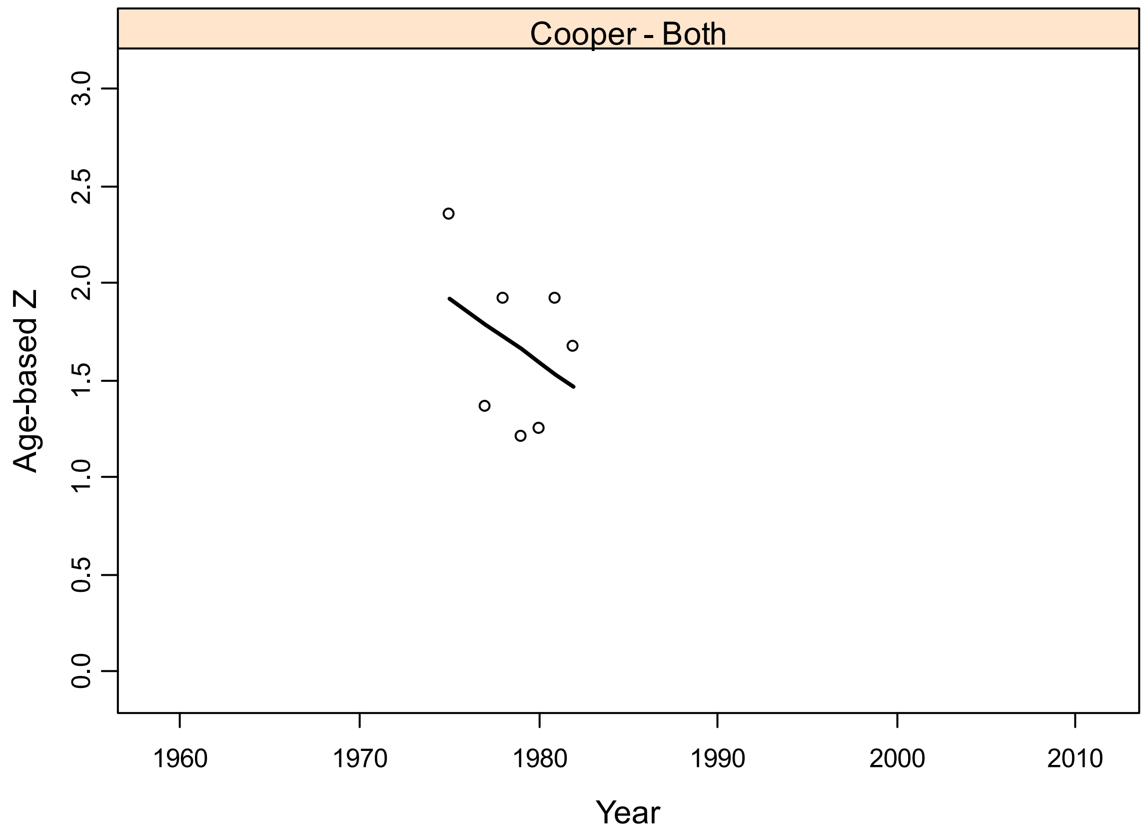
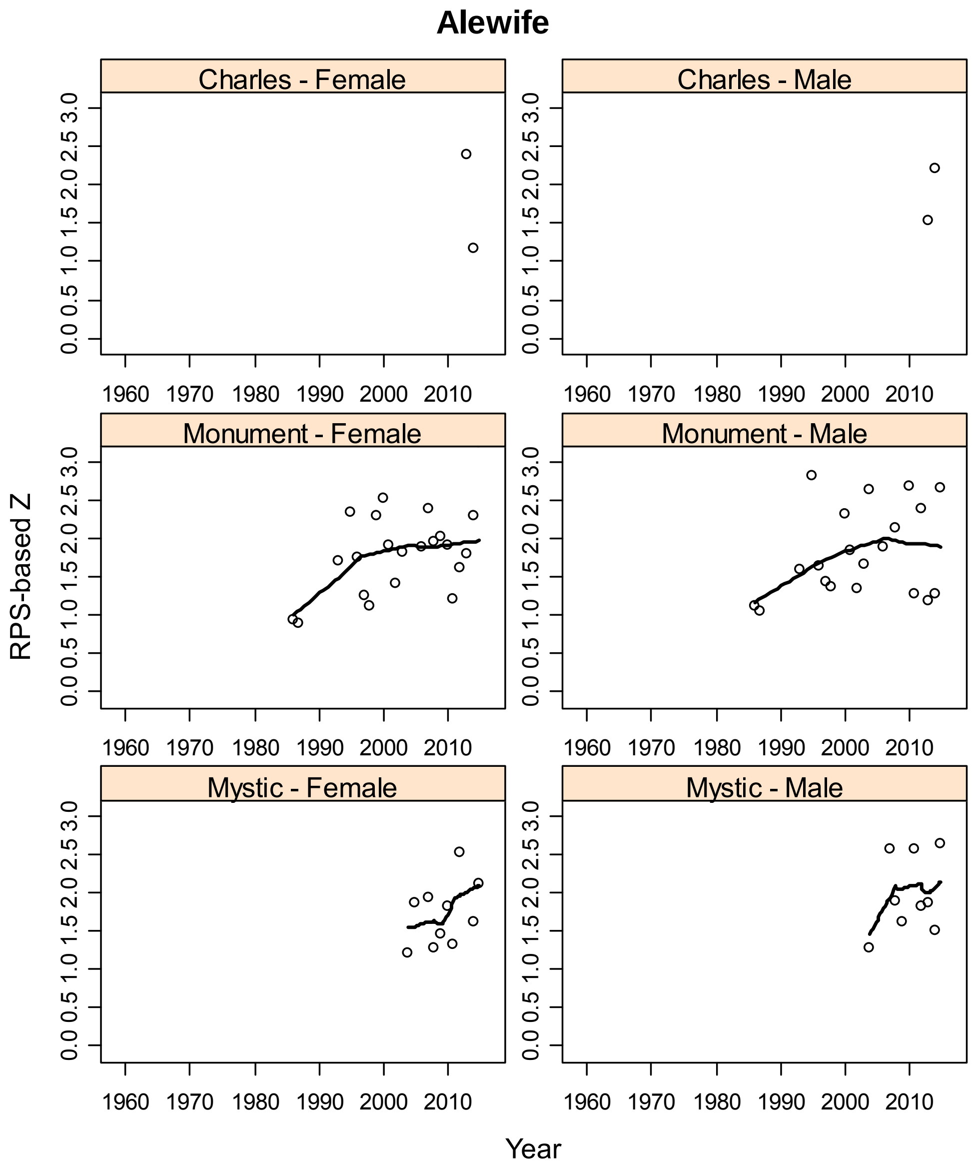


Figure 2.58. Age-based estimates of total instantaneous mortality (Z) for blueback herring (sexes combined) from South Carolina. Linear or loess smooths are drawn to indicate trend.



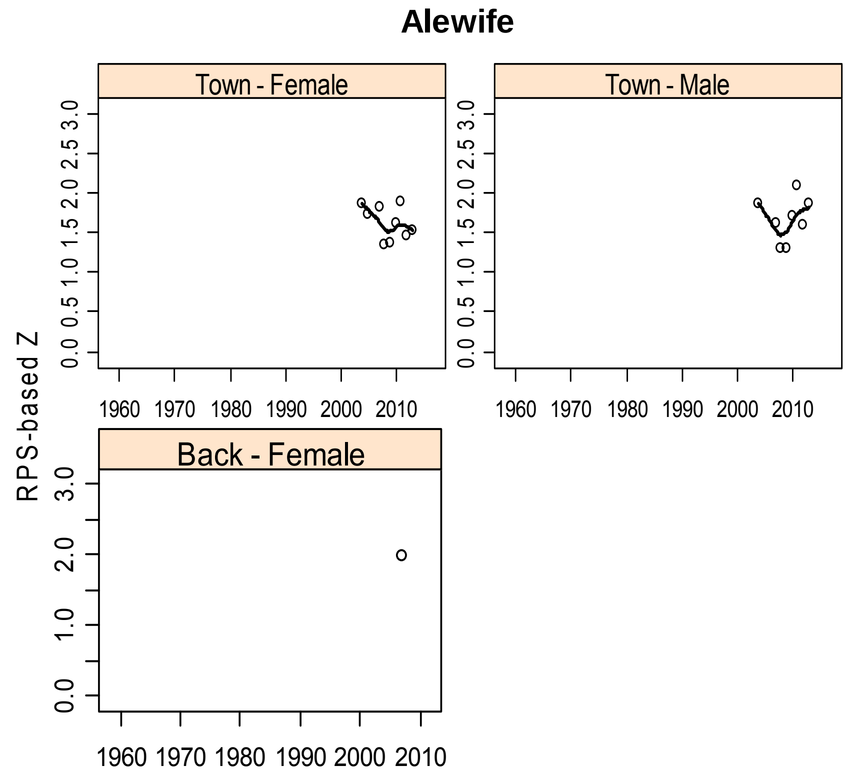


Figure 2.59 . Repeat spawner-based estimates of total instantaneous mortality (Z) for alewife from Massachusetts by year, sex and river from Massachusetts. Linear or loess smooths are drawn to indicate trend.

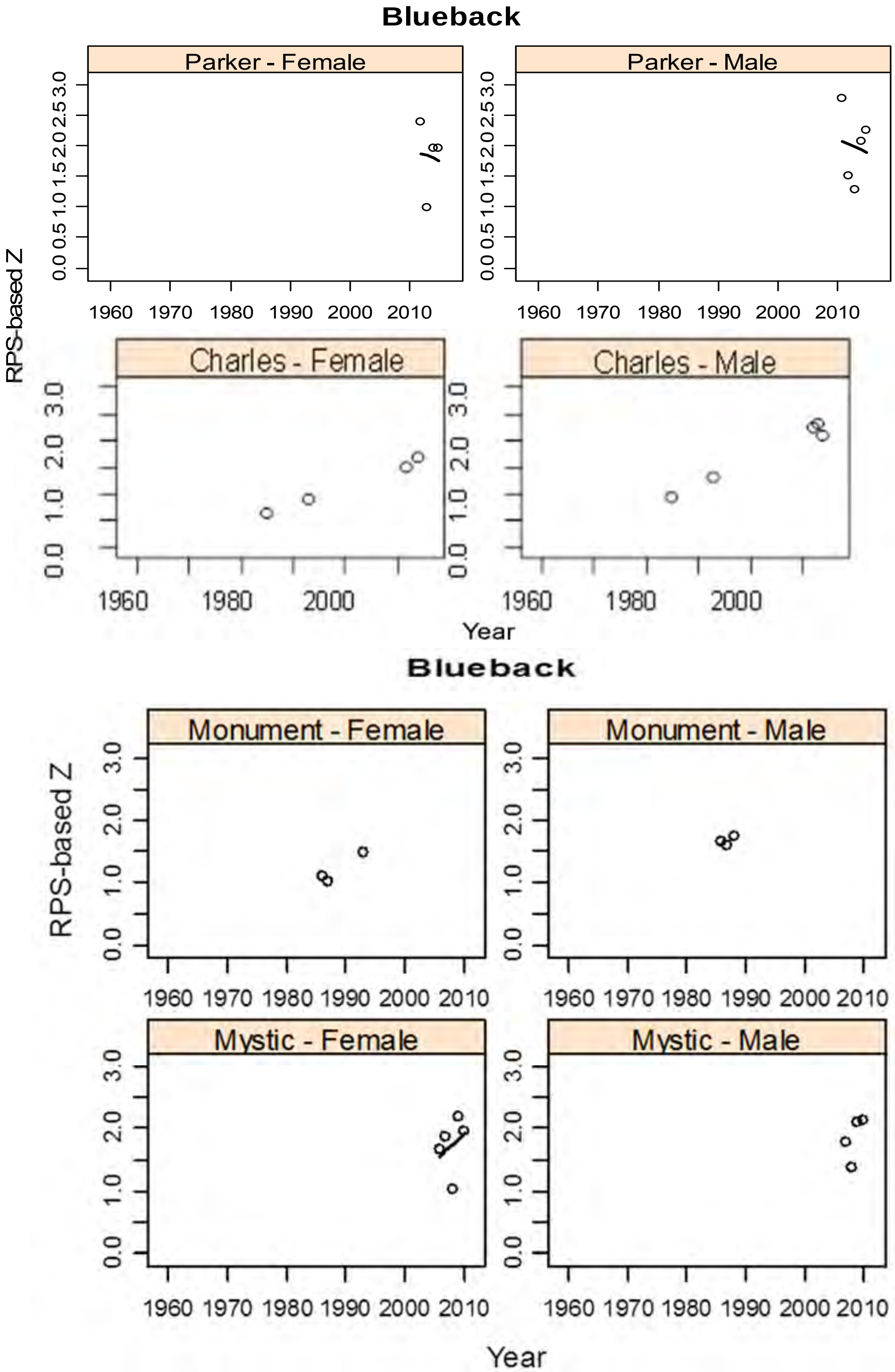


Figure 2.60. Repeat spawner-based estimates of total instantaneous mortality (Z) for blueback herring from Massachusetts by year, sex and river from Massachusetts. Linear or loess smooths are drawn to indicate trend.

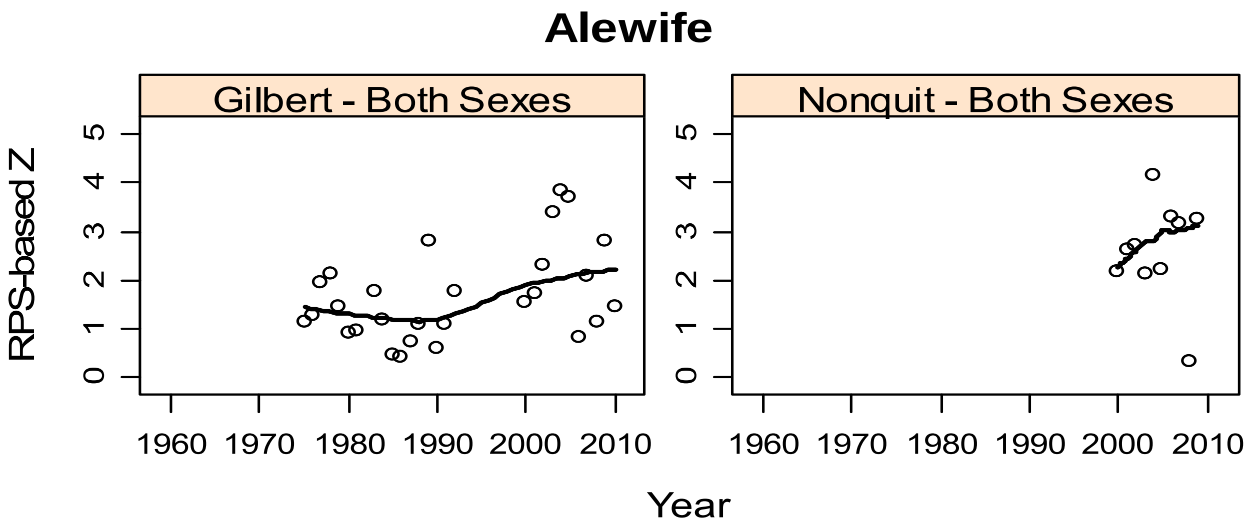


Figure 2.61. Repeat spawner-based estimates of total instantaneous mortality (Z) for alewife (sexes combined) from Rhode Island by river and year. Linear or loess smooths are drawn to indicate trend.

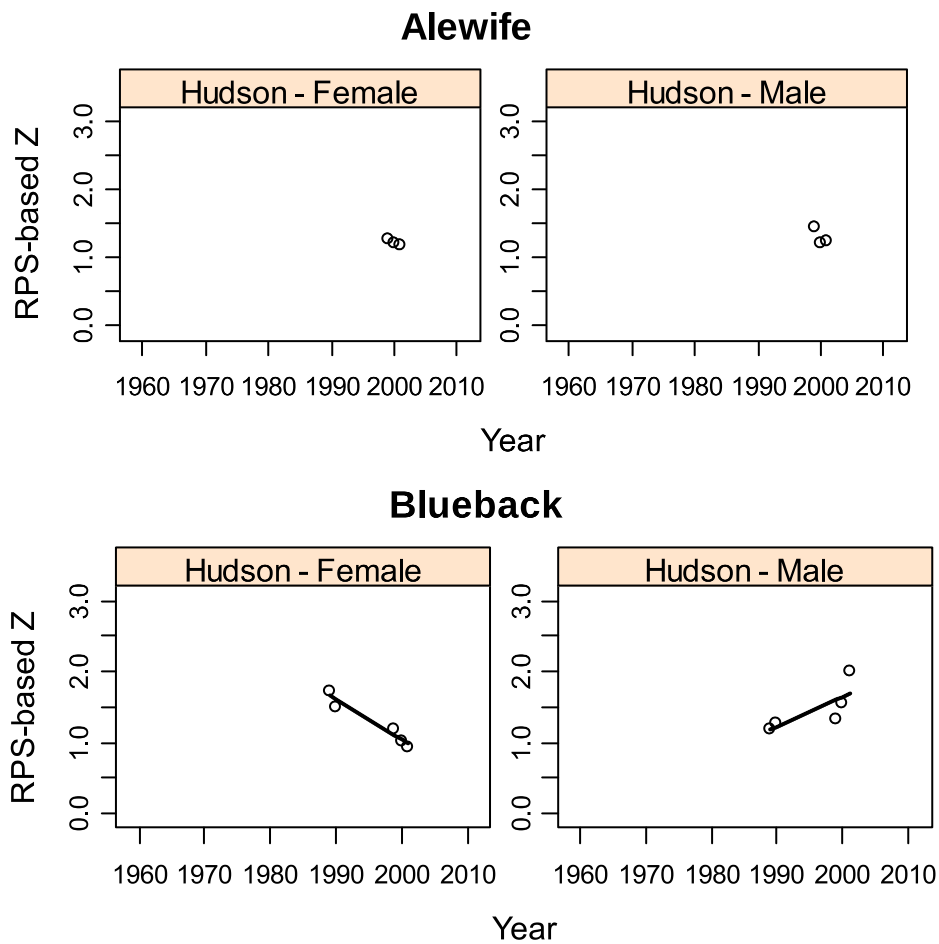


Figure 2.62. Repeat spawner-based estimates of total instantaneous mortality (Z) for male and female alewife and blueback herring by year, sex and river from New York. Linear or loess smooths are drawn to indicate trend.

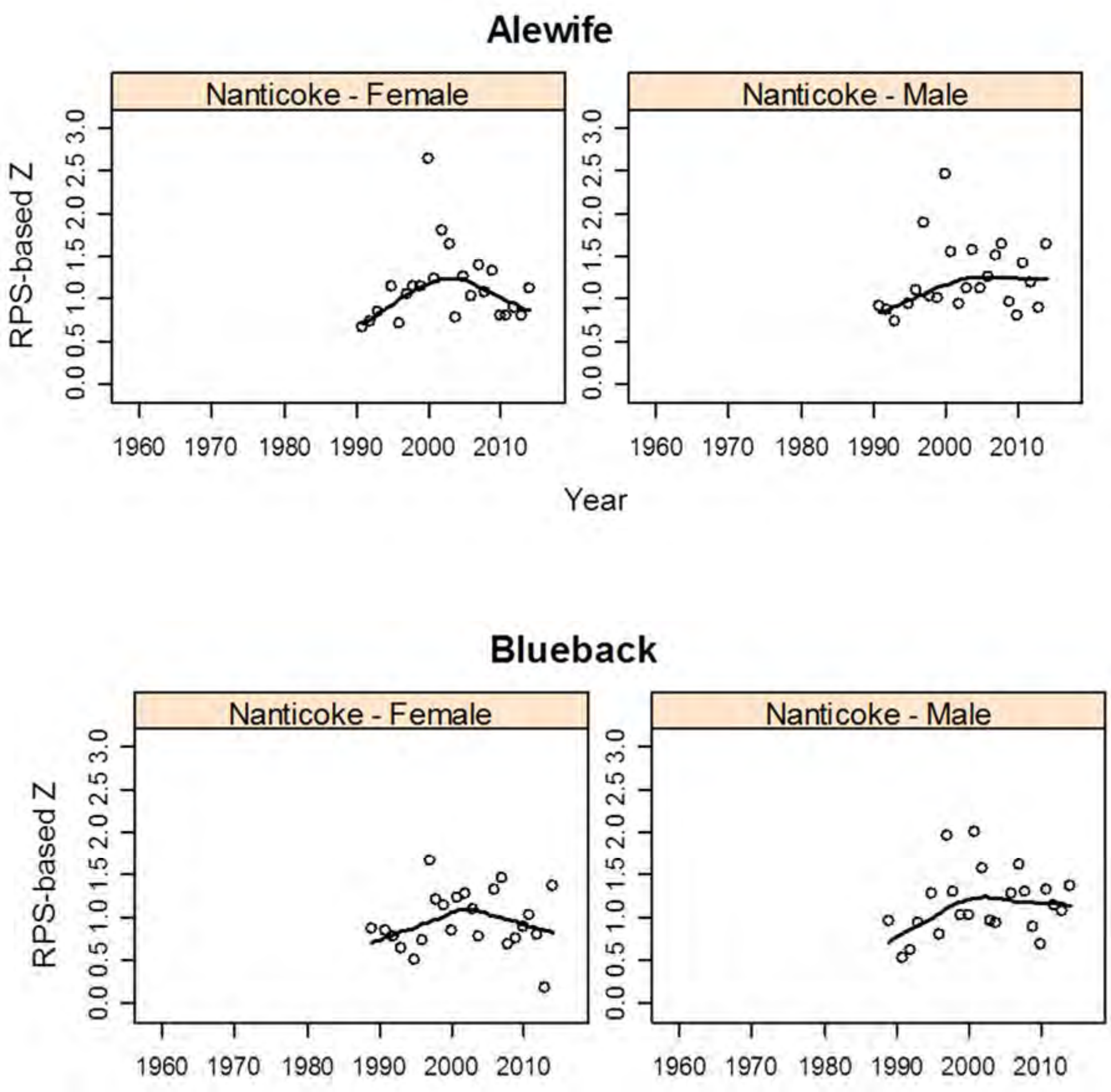


Figure 2.63 Repeat spawner-based estimates of total instantaneous mortality (Z) for alewife and blueback herring from Maryland by river, sex and year. Linear or loess smooths are drawn to indicate trend

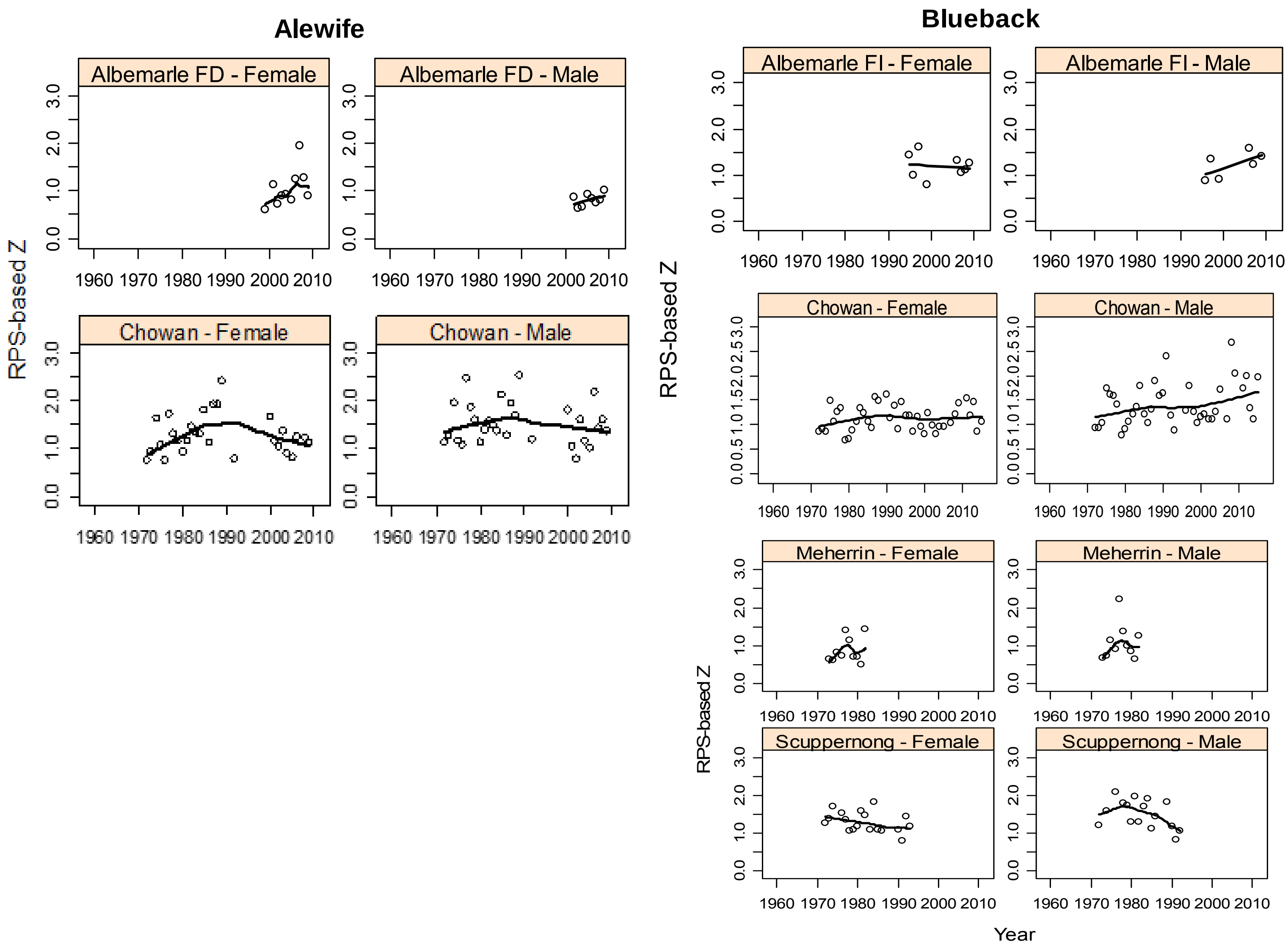


Figure 2.64. Repeat spawner-based estimates of total instantaneous mortality (Z) for alewife and blueback herring from North Carolina by river, sex and year. Linear or loess smooths are drawn to indicate trend.

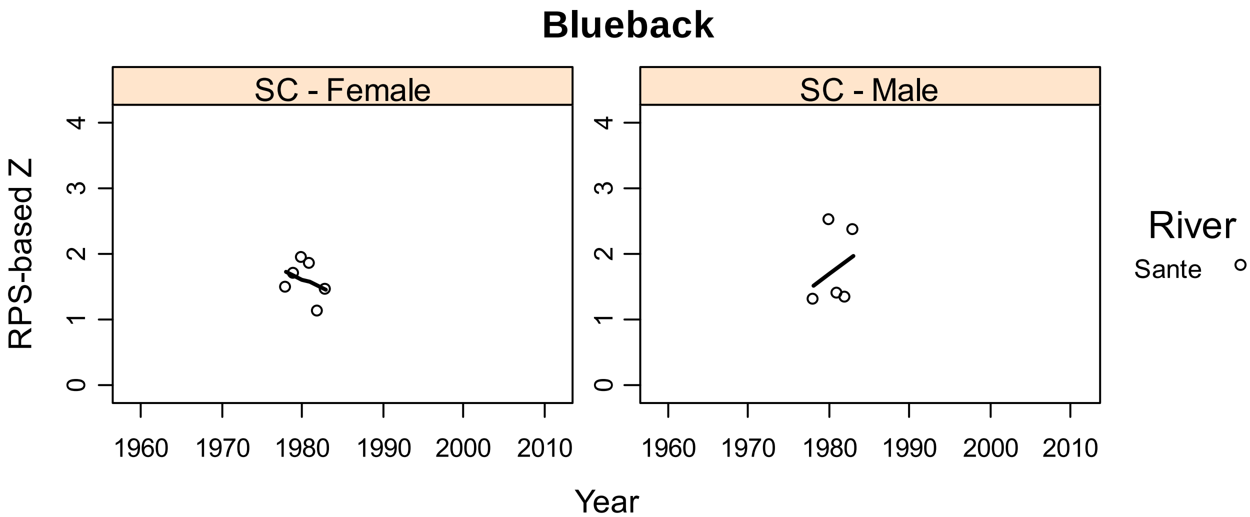


Figure 2.65 Repeat spawner-based estimates of total instantaneous mortality (Z) for blueback herring from South Carolina by river, sex and year. Linear or loess smooths are drawn to indicate trend

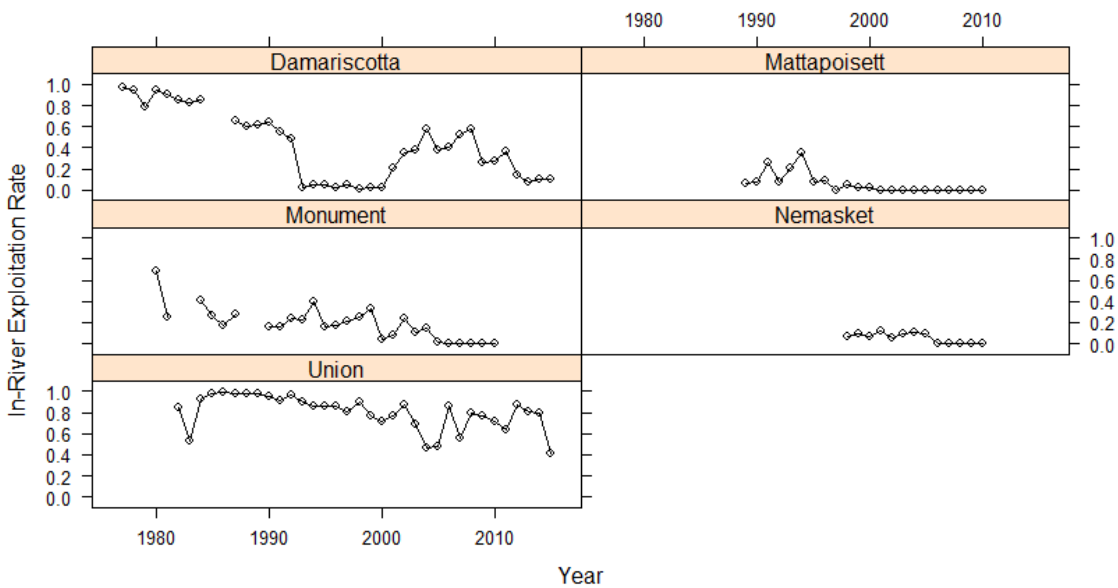


Figure 2.66 In-river exploitation rates for river herring from Massachusetts (Mattapoisett, Monument, and Nemasket) and Maine (Damariscotta and Union) rivers, 1977-2015. In-river exploitation rates are of both river herring species combined in the Monument River and only alewives in all other rivers.

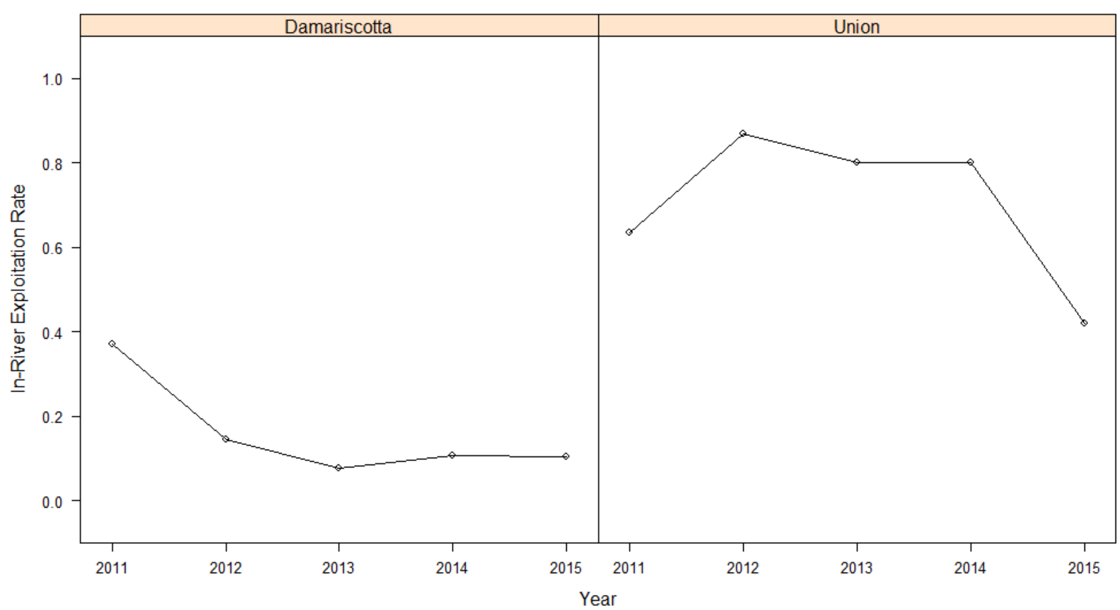


Figure 2.67 In-river exploitation rates for alewives from Maine rivers since the benchmark stock assessment terminal year. SFMPs were required starting in 2012.

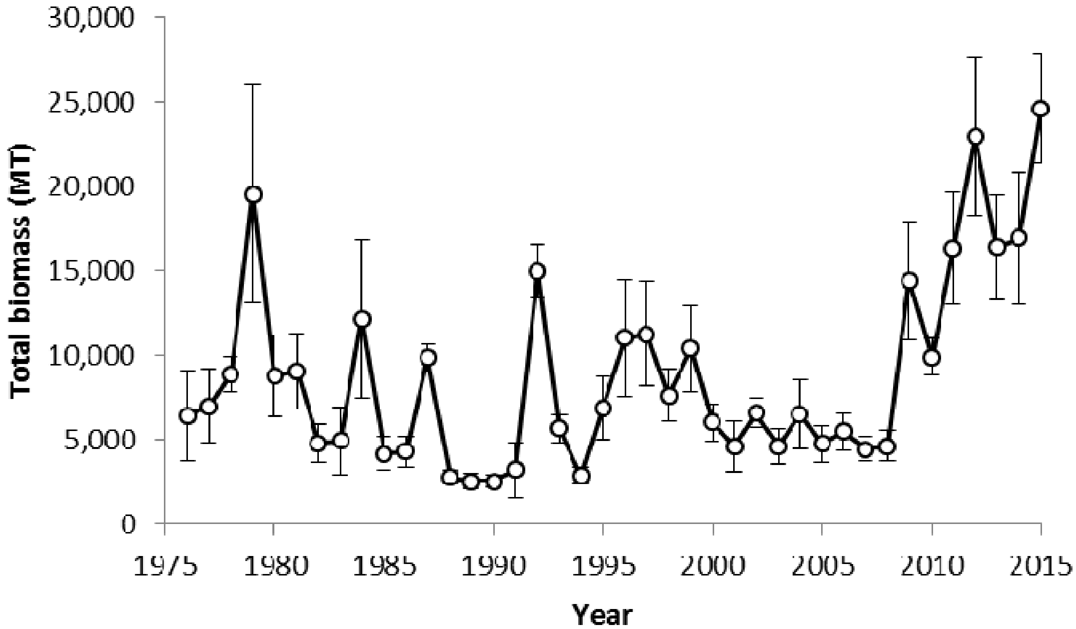


Figure 2.68 Minimum swept area estimates of total river herring biomass from NEFSC spring bottom trawl surveys (1976 – 2015).

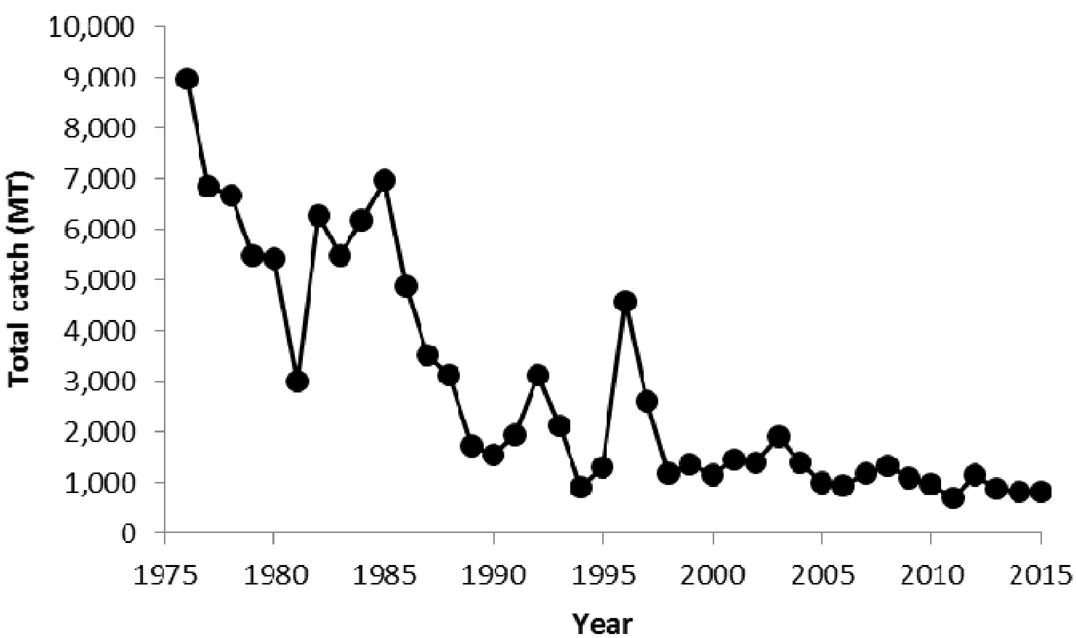


Figure 2.69 Total catch of river herring estimated from total reported landings plus total incidental catch using hindcasting methods.

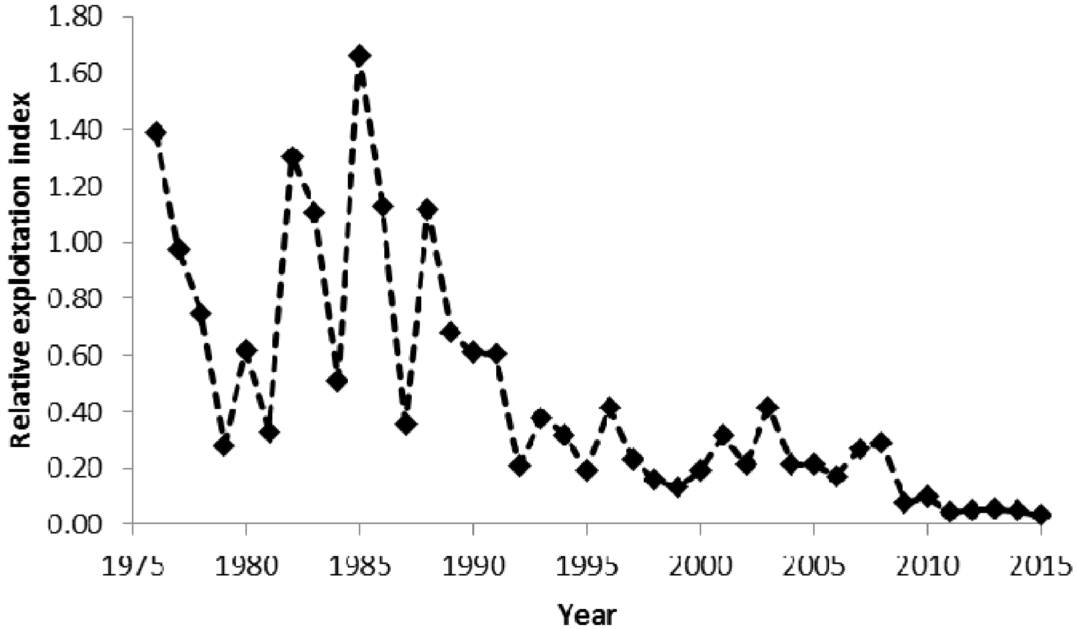


Figure 2.70 Relative exploitation of river herring (1976 – 2015)

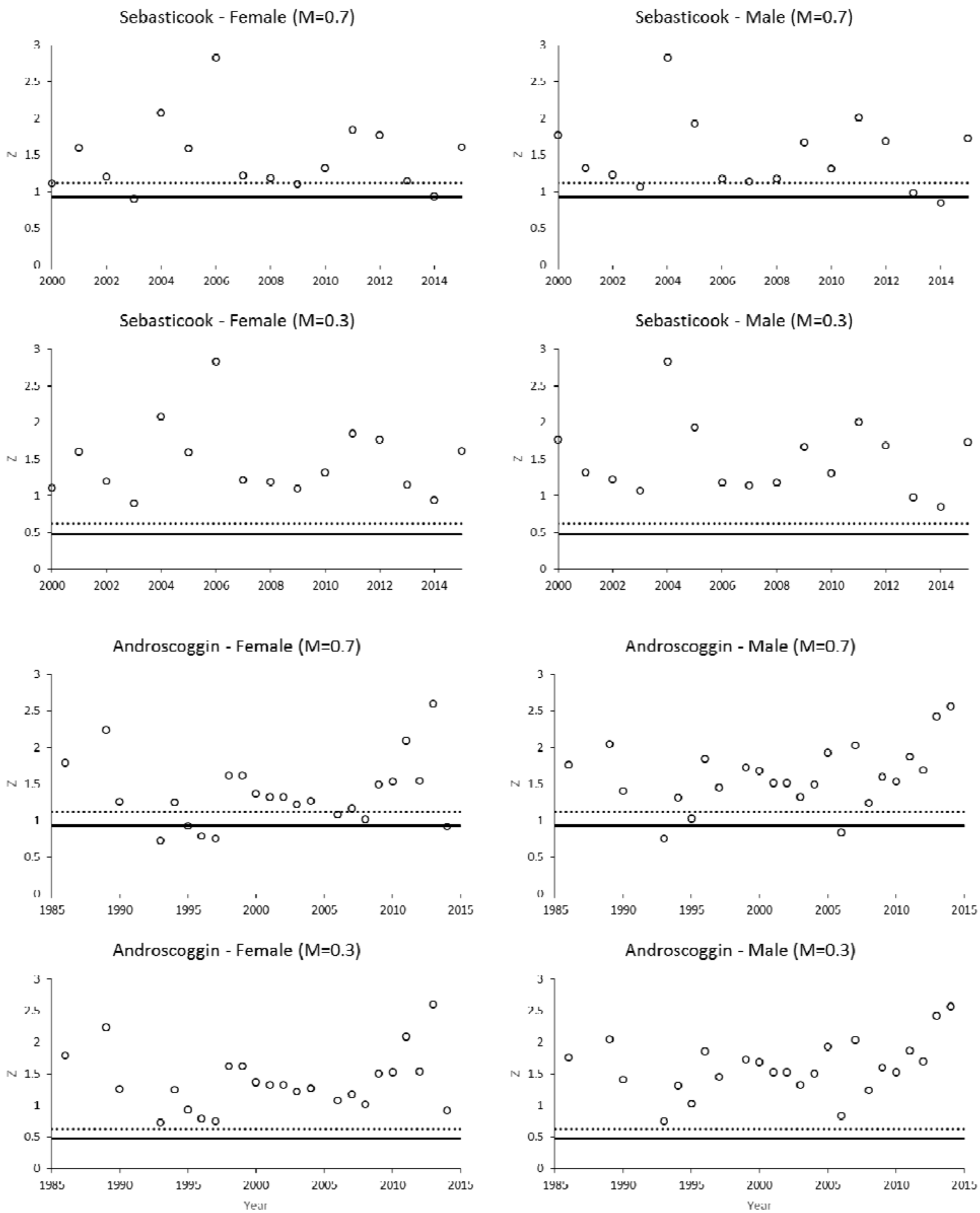


Figure 2.71 Empirical estimates of Z for ME alewife by river for different values of M. Dashed lines represent $Z_{20\%SPR}$ and $Z_{40\%SPR}$ benchmarks.

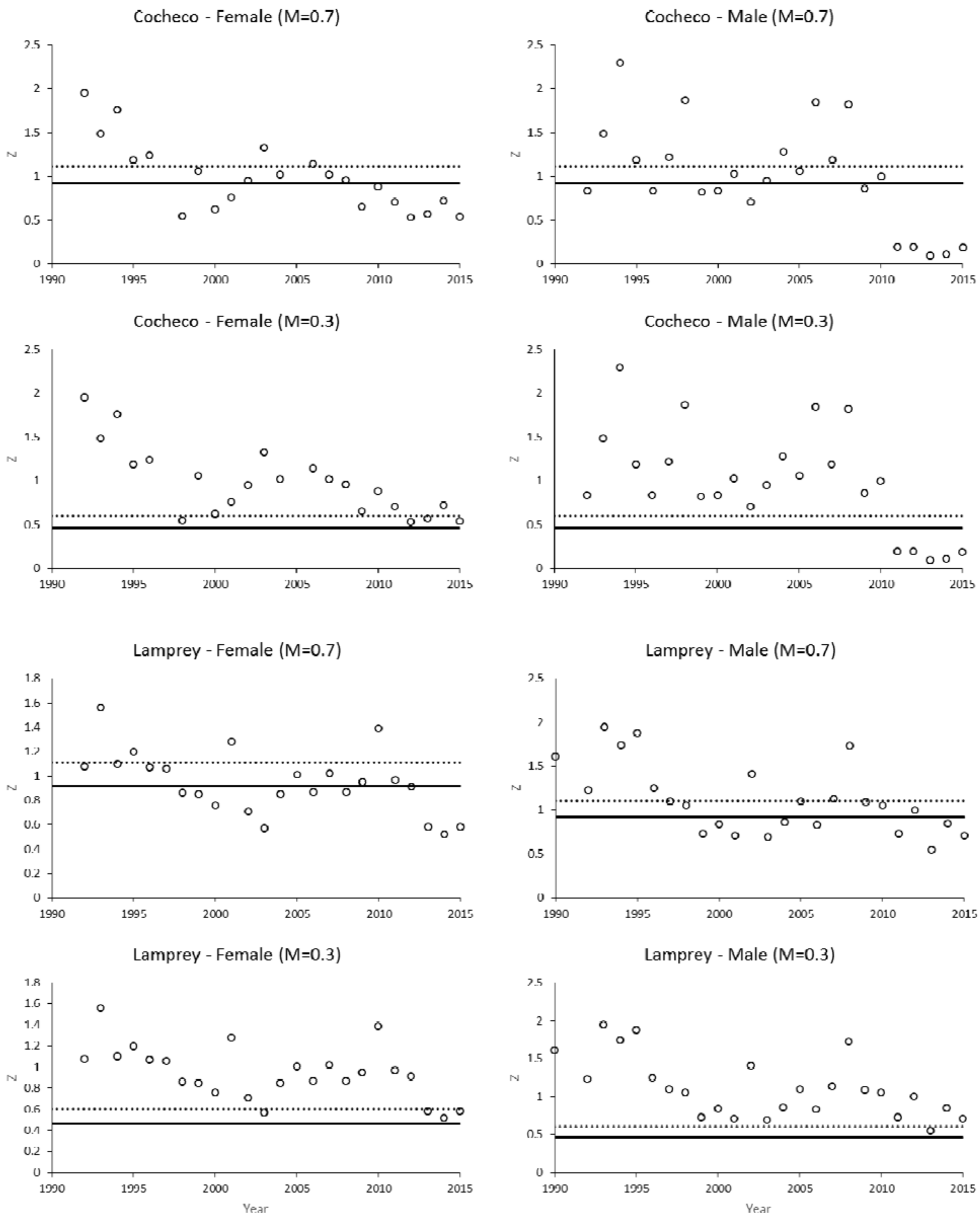


Figure 2.72 Empirical estimates of Z for NH alewife by river for different values of M. Dashed lines represent $Z_{20\%SPR}$ and $Z_{40\%SPR}$ benchmarks.

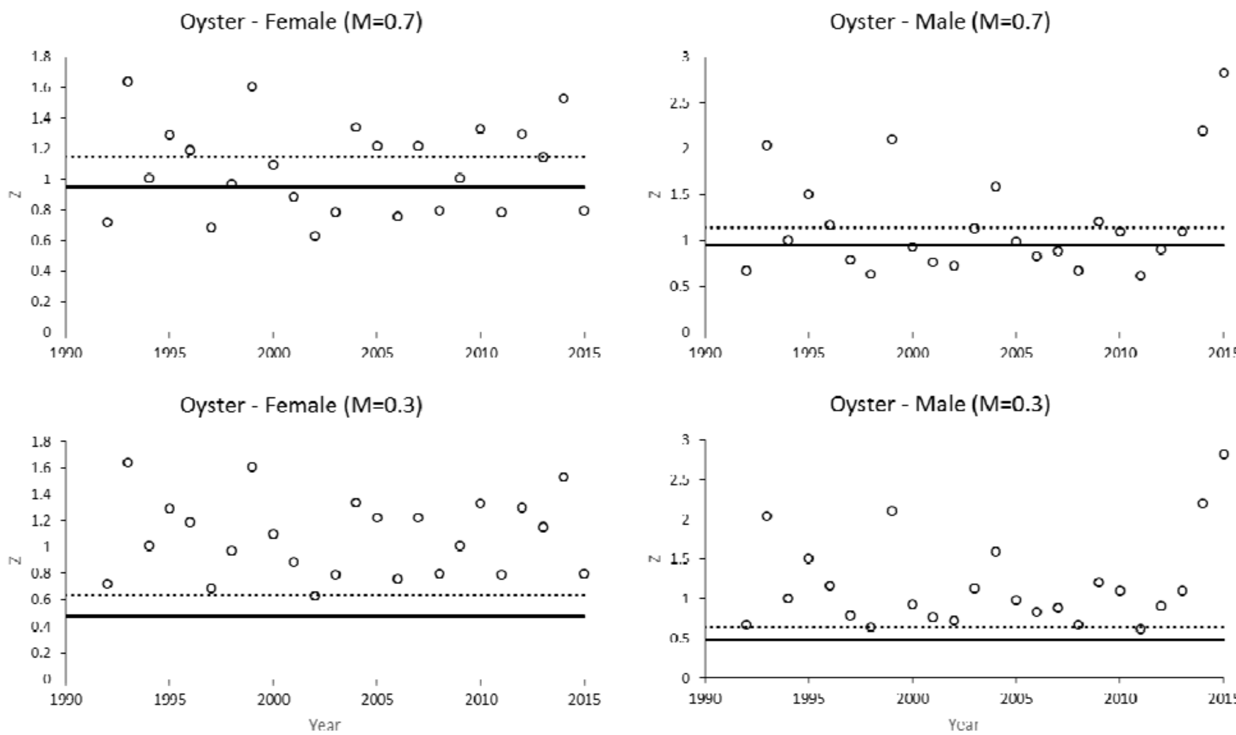


Figure 2.73 Empirical estimates of Z for NH blueback herring by river for different values of M. Dashed lines represent $Z_{20\%SPR}$ and $Z_{40\%SPR}$ benchmarks.

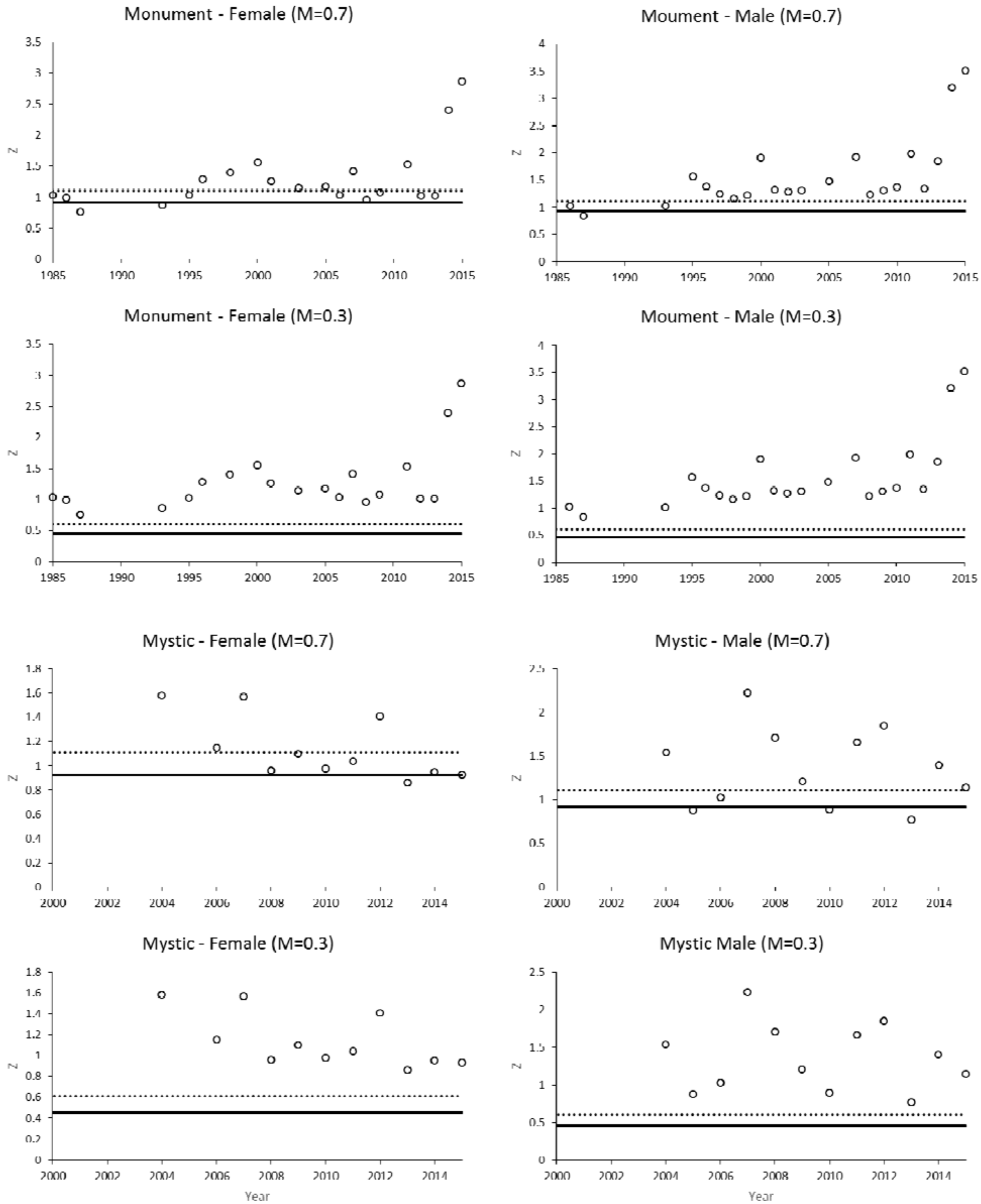


Figure 2.74 Empirical estimates of Z for MA alewife by river for different values of M. Dashed lines represent $Z_{20\%SPR}$ and $Z_{40\%SPR}$ benchmarks.

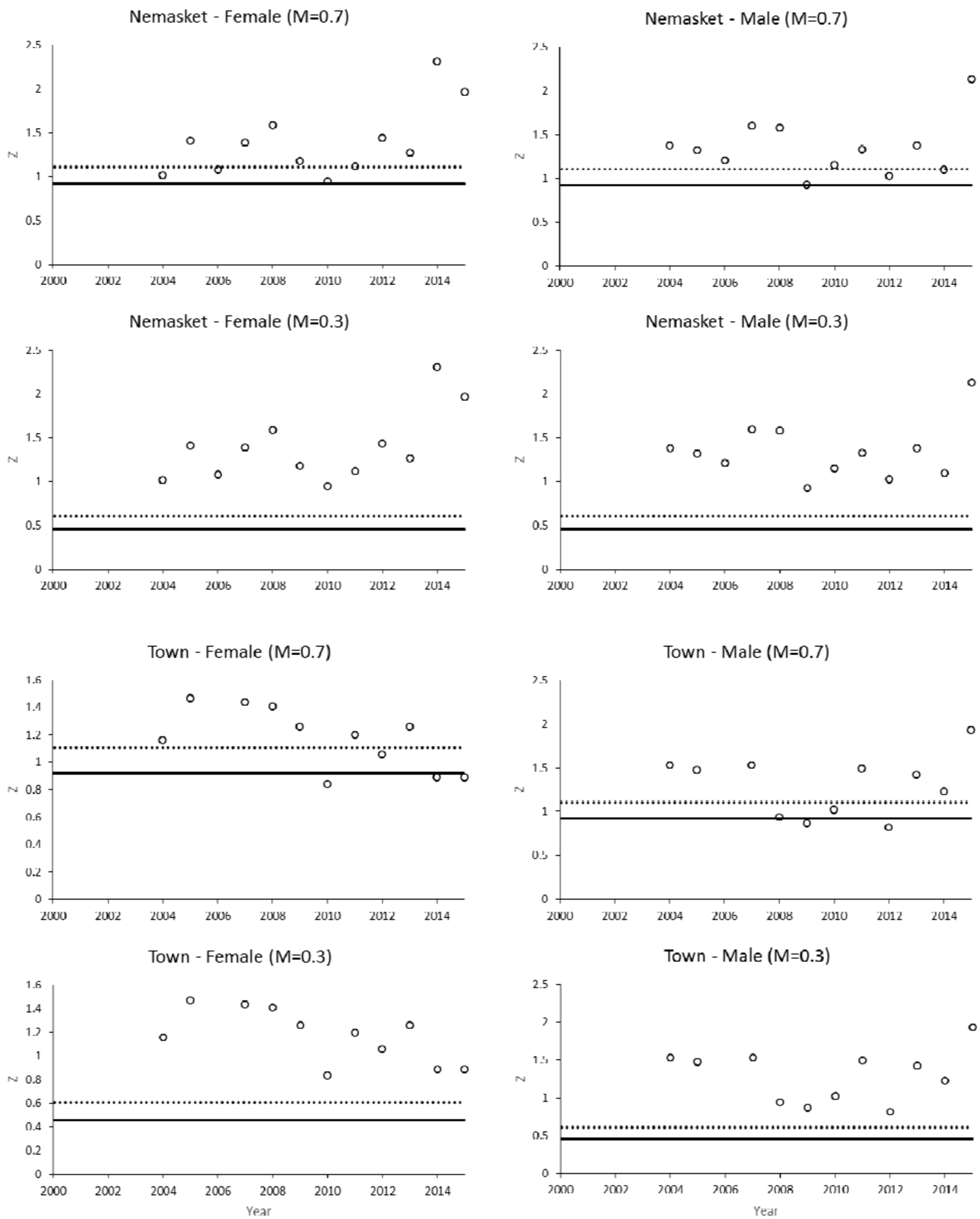


Figure 2.86 Continued.

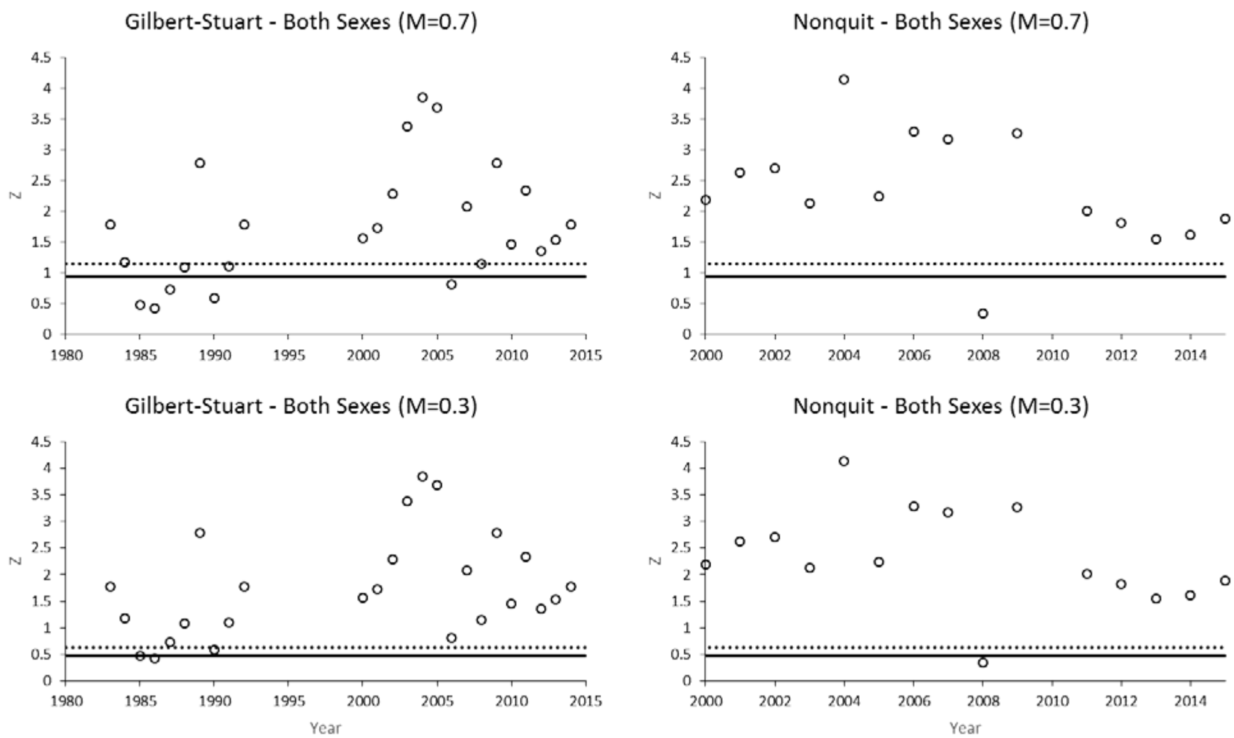


Figure 2.75 Empirical estimates of Z (repeat spawner-based) for RI alewife by river for different values of M. Dashed lines represent $Z_{20\%SPR}$ and $Z_{40\%SPR}$ benchmarks.

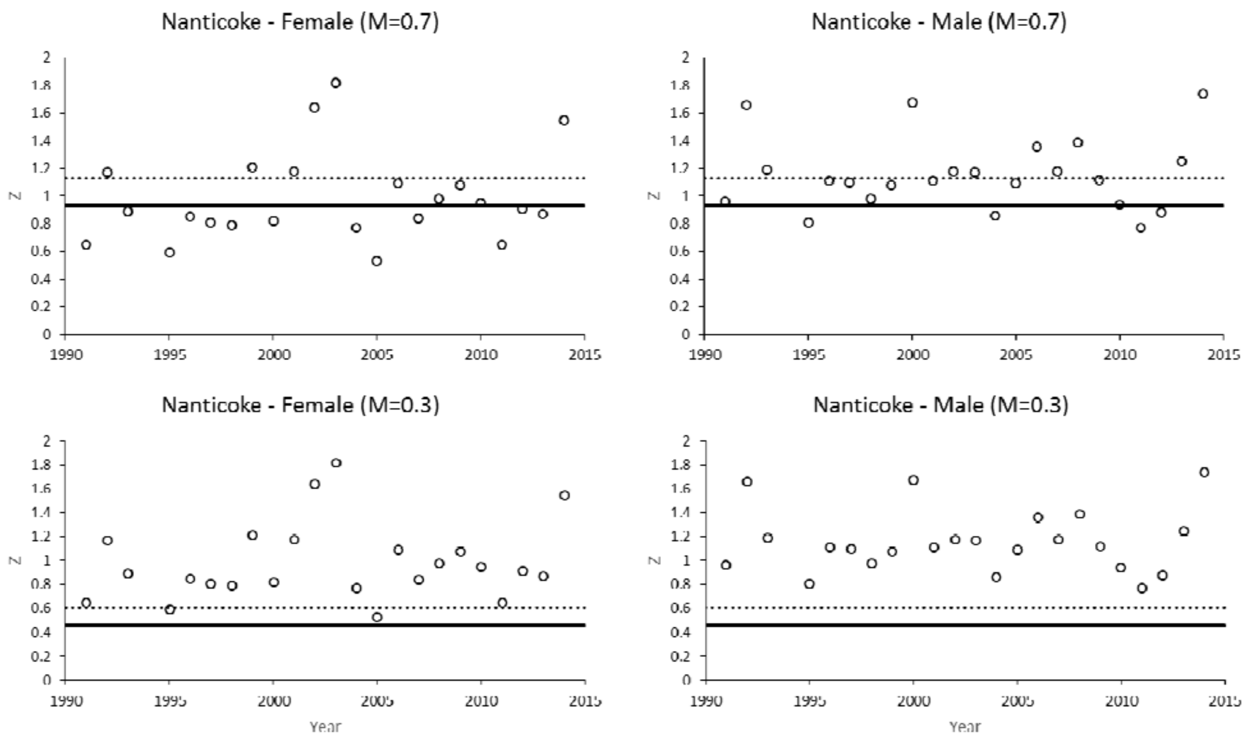


Figure 2.76. Empirical estimates of Z for MD alewife by river for different values of M. Dashed lines represent $Z_{20\%SPR}$ and $Z_{40\%SPR}$ benchmarks.

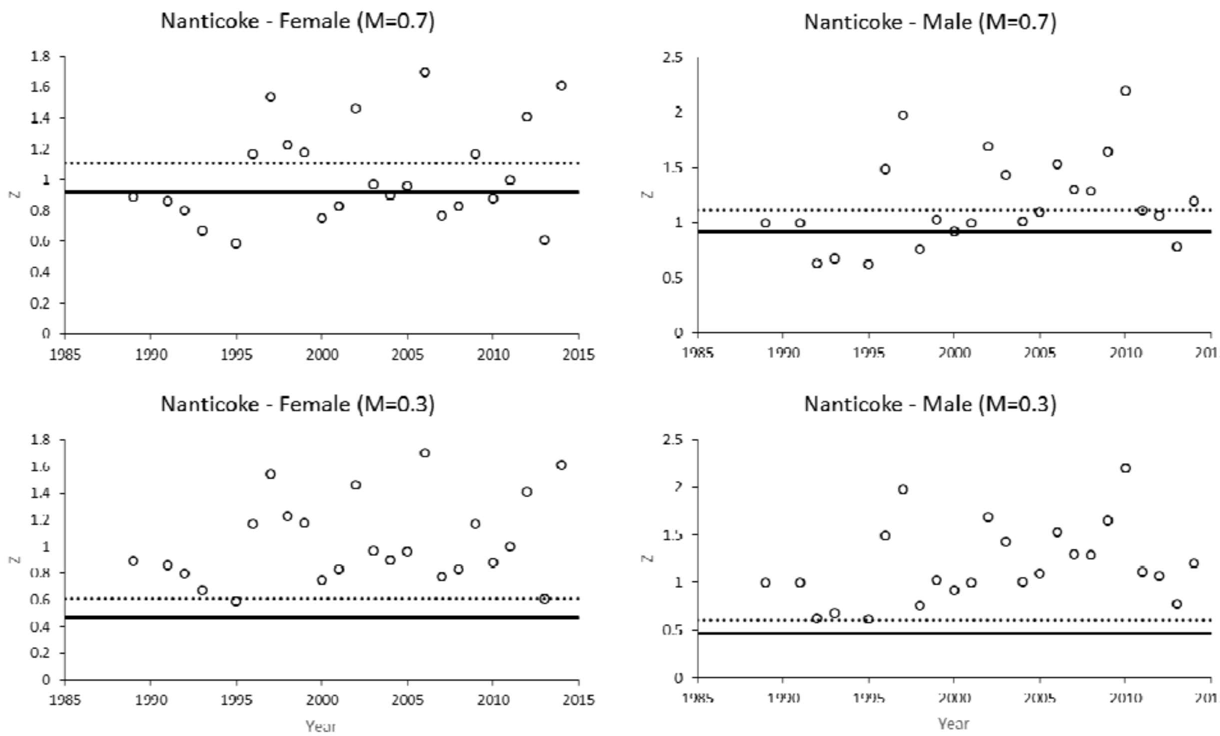


Figure 2.77 Empirical estimates of Z for MD blueback herring by river for different values of M. Dashed lines represent $Z_{20\%SPR}$ and $Z_{40\%SPR}$ benchmarks.

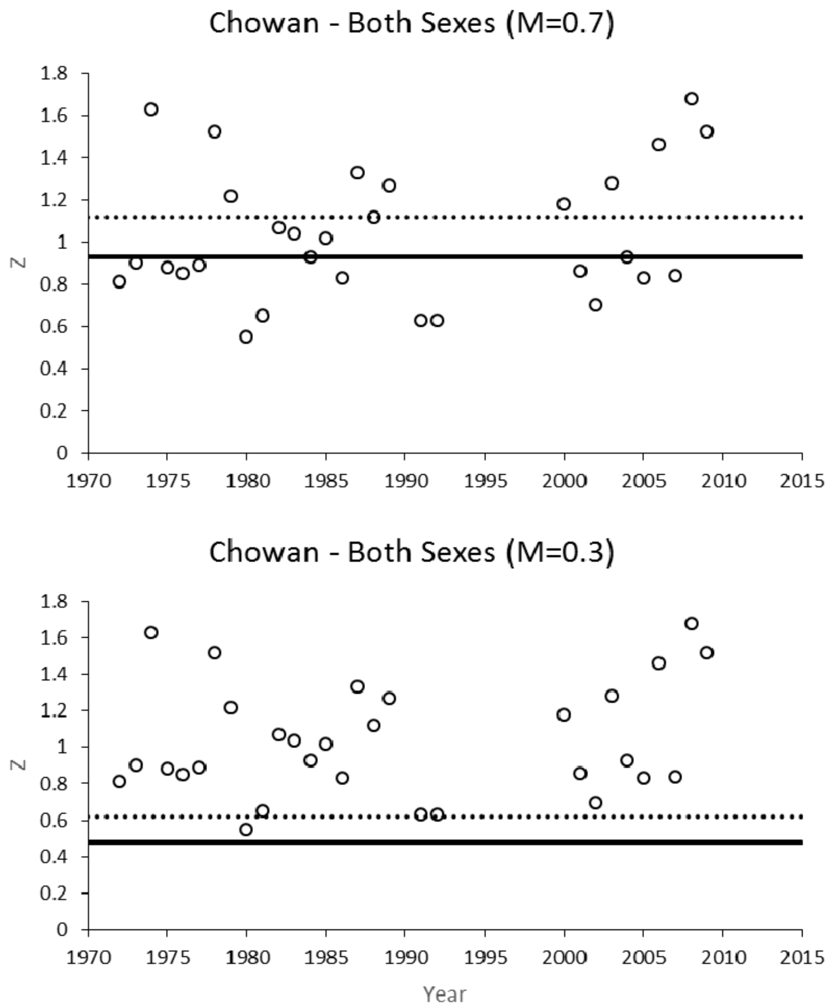


Figure 2.78 Empirical estimates of Z for NC alewife by river for different values of M. Dashed lines represent $Z_{20\%SPR}$ and $Z_{40\%SPR}$ benchmarks.

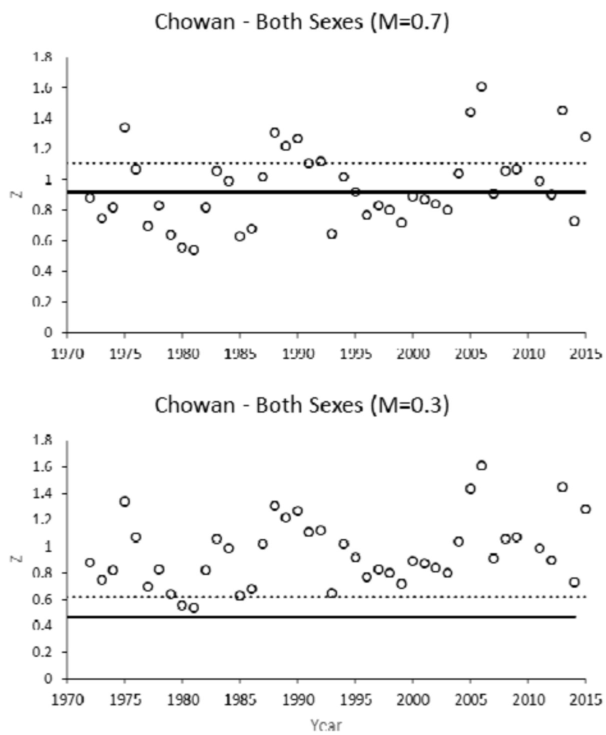


Figure 2.79 Empirical estimates of Z for NC blueback herring by river for different values of M. Dashed lines represent $Z_{20\%SPR}$ and $Z_{40\%SPR}$ benchmarks.

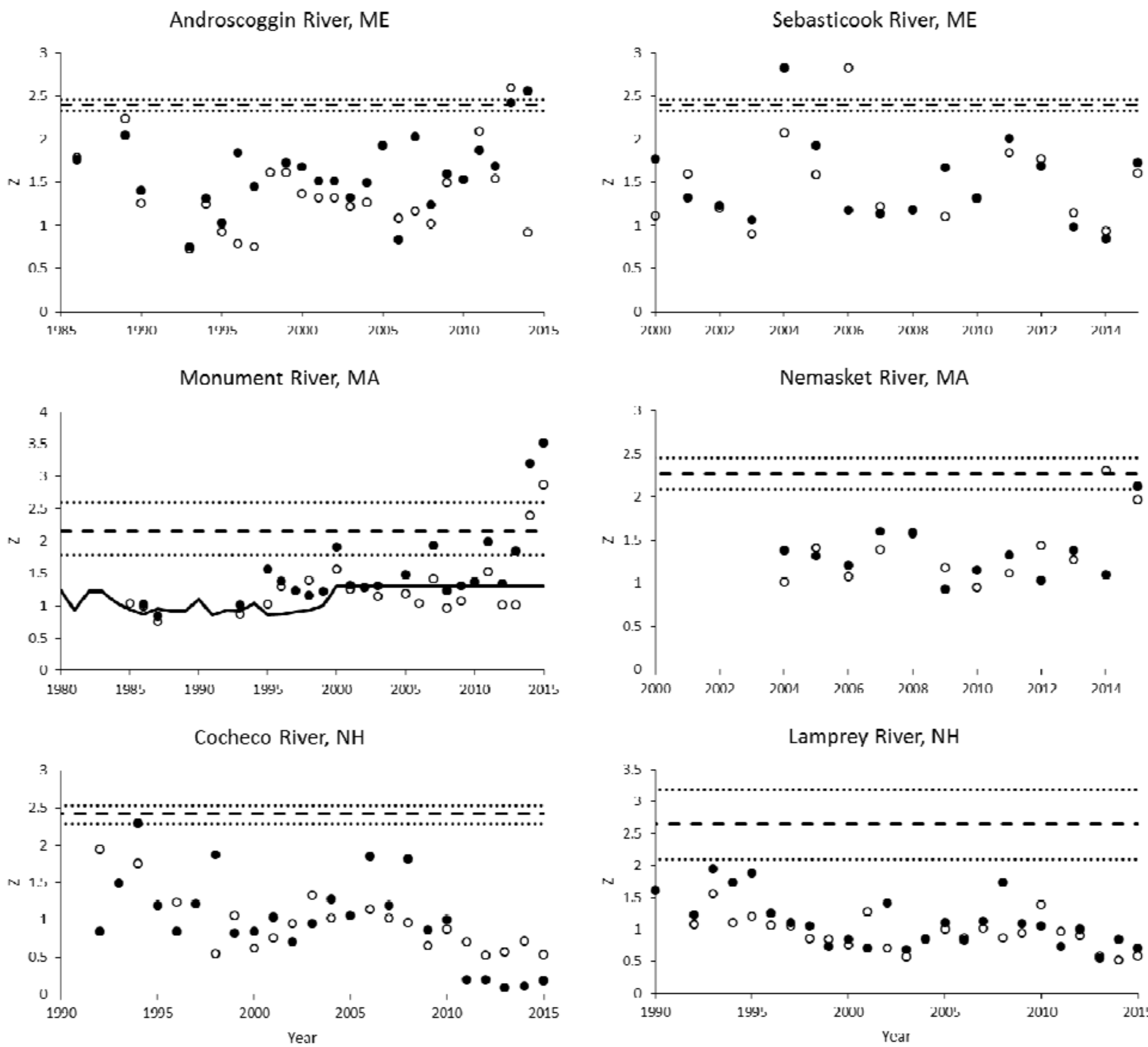


Figure 2.80 Plots of age-based Z estimates for male (closed circles) and female (open circles) alewife derived by using the Chapman-Robson (CR) survival estimator or derived in stock assessment models (solid line; SCAM) compared to the minimum/maximum (dotted lines) and average (dashed line) $Z_{collapse}$ values.

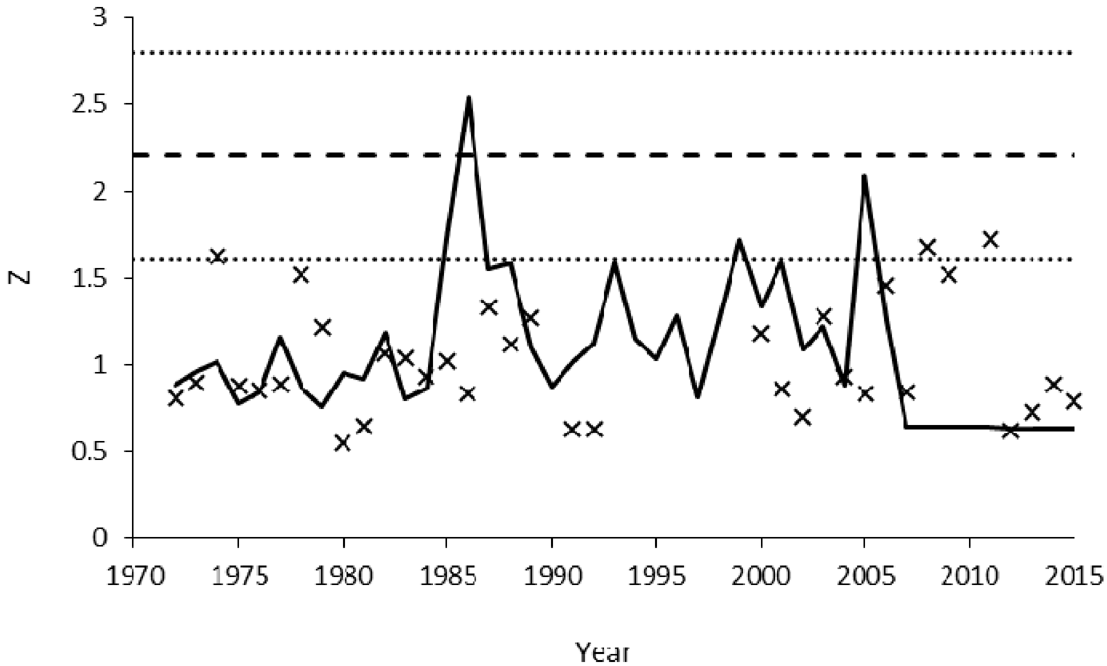


Figure 2.81 Plots of age-based Z estimates from the Chapman-Robson estimator (xs) and SCA model (solid line) for blueback herring in the Cowan River, NC compared to the minimum/maximum (dotted lines) and average (dashed line) $Z_{collapse}$ values.

APPENDIX 1. Summary of available river herring fisheries-independent and fisheries-dependent data.

State	River	Time series	By species	Harvest	Age	Length	Weight	Repeat Spawner	FI Adult	FI JAI	FD CPUE
ME	Damariscotta	1943-2015		●							
	St. George	1943-2015		●							
	Union	1975-2015		●							
	Orland	1943-2015		●							
	Androscoggin	1983-2015	●		●	●					
	Sebasticook	2000-2015	●		●	●					
	Merrymeeting Bay/Tribs	1979-2015	●			●				●	
	Gulf of Maine	2000-2015	●			●			●		
NH	Exeter/Squamscott	1991-2015	●	●	●	●		o	●		
	Lamprey	1991-2015	●	●	●	●		o	●		
	Winnicut	1991-2015	●	●	●	●		o	●		
	Oyster	1991-2015	●	●	●	●		o	●		
	Cocheco	1991-2015	●	●	●	●		o	●		
	Taylor	1991-2015	●	●	●	●		o	●		
	Great Bay Estuary	1997-2015	x			x				x	
MA	Mattapoisett	1988-2015	●	●	o	o	o		●		
	Monument	1980-2015	●	●	o	o		o	●		
	Nemasket	1996-2015	●	●	o	o	o				
	Parker	1971-1978, 2000-2015	●	●	o	o			●		
	Town	2000-2015		●					●		
	Agawam	2006-2015		●	o	o					
	Back	2007-2015	●	●	●	●			●		
	Charles	2008-2015		●	●	●	●	●	●		
	Mystic	2004-2015	●		●	●	●	●			
	Quashnet	2004	●		●	●	●	●			
	Stony Brook	1978-2004	●		o	o	o	o	o		
RI	Gilbert Stuart	1981-2015			●	●	●	●	●	o	
	Nonquit	1999-2015			●	●	●	●	●	o	
	Buckeye Brook	2003-2015							●		
	Pawcatuck	1988-2015			x	x	x	x	o	●	
	Ocean waters	1979-2015				●			●	●	
	Naragansett Bay	1988-2015				●			●	●	
	Coastal ponds	1992-2015				●			●	●	
CT	Bride Brook	1966-1967, 2003-2015	●			o			●		
	Connecticut River	1975-2015	●			o			●	o	
	Farmington River	1976-2015	●						●		
	Thames River	1996-2015	●						●		
NY	Hudson	1975-2015	●	o	o	o	o	o	o	o	o
DE, NJ, PA	Delaware River	1980-2015	o	o	o	o			o	o	o
	Delaware Bay	1966-2015	o	o	o	o			o	o	o
MD	Nanticoke	1959-2015	o		o	o		o		o	o
	Susquehanna	1972-2015	o						x		
	Chesapeake Bay	1959-2015			o						o
MD, VA, DC	Potomac River	1959-2015		●		o			o	o	o
VA	James	1966-2015	o	●	o	o	o	o	o	o	o
	Rappahannock	1966-2015	o	●	o	o	o	o	o	o	o
	York	1966-2015	o	●	o	o	o	o	o	o	o
NC	Albemarle Sound	1972-2015		o				o	o	●	
	Chowan River	1972-2015	●	●	●	●	●	o			●
SC	Wynah Bay									x	
	Santee-Cooper	1969-2015	o	●	o	o	o	o	o	x	●
	Savannah River									x	
	Ashley-Combahee-Edisto Basin									x	
GA	Altamaha River	2010								x	
	Ogeechee River	2010								x	
	Savannah River	2010								x	
FL	St. John's River	2001 -2015	●			●			●	o	

●	Data available for entire time-series
o	Data available for part of the time-series
x	Data available, but not reliable enough for assessment use
	Data not available

APPENDIX 2. Commercial and Recreational River Herring Regulations as of June 1, 2017.

State	River	Moratorium	Commercial Regs	Recreational Regs
ME	Long Pond		Harvest 4 days/week through 6/5; biological samples	25 fish/day, gear restrictons
	Winnegance Pond		Harvest 4 days/week through 6/5; biological samples	25 fish/day, gear restrictons
	Sebasticook River		Harvest 4 days/week through 6/5; biological samples	25 fish/day, gear restrictons
	Narraguagus River		Harvest 4 days/week through 6/5; biological samples	25 fish/day, gear restrictons
	Pleasant River		Harvest 4 days/week through 6/5; biological samples	25 fish/day, gear restrictons
	Mill Pond		Harvest 4 days/week through 6/5; biological samples	25 fish/day, gear restrictons
	Gardiner Lake		Harvest 4 days/week through 6/5; biological samples	25 fish/day, gear restrictons
	Ellsworth		Harvest 4 days/week through 6/5; biological samples	25 fish/day, gear restrictons
	Great Pond		Harvest 4 days/week through 6/5; biological samples	25 fish/day, gear restrictons
	Card Mill Stream		Harvest 4 days/week through 6/5; biological samples	25 fish/day, gear restrictons
	West Bay Pond		Harvest 4 days/week through 6/5; biological samples	25 fish/day, gear restrictons
	Nequasset Lake		Harvest 4 days/week through 6/5; biological samples	25 fish/day, gear restrictons
	Dyer-Long Pond		Harvest 4 days/week through 6/5; biological samples	25 fish/day, gear restrictons
	Damariscotta Lake		Harvest 4 days/week through 6/5; biological samples	25 fish/day, gear restrictons
	Orland River		Harvest 4 days/week through 6/5; biological samples	25 fish/day, gear restrictons
	Pennimaquan Lake		Harvest 4 days/week through 6/5; biological samples	25 fish/day, gear restrictons
	Peirce Pond		Harvest 4 days/week through 6/5; biological samples	25 fish/day, gear restrictons
	Boyden Lake		Harvest 4 days/week through 6/5; biological samples	25 fish/day, gear restrictons
	Flanders Pond		Harvest 4 days/week through 6/5; biological samples	25 fish/day, gear restrictons
	Tunk Lake		Harvest 4 days/week through 6/5; biological samples	25 fish/day, gear restrictons
	Webber Pond		Harvest 4 days/week through 6/5; biological samples	25 fish/day, gear restrictons
	St. George River		Harvest 4 days/week through 6/5; biological samples	25 fish/day, gear restrictons
NH	Exeter/Squamscott		Harvest 2 days/week, 1 tote/person/day	
	Lamprey		Harvest 6 days/week	
	Winnicut		Harvest 6 days/week	
	Oyster	2012		
	Cocheco		Harvest 6 days/week	
	Taylor		Harvest 6 days/week, closed area	
MA	Mattapoisett	2005		
	Monument	2005		
	Nemasket			Harvest 5 days/week; 20 fish/permit
	Parker	2005		
	Town	2005		
	Agawam	2005		
	Back	2005		
	Charles	2005		
	Mystic	2005		
	Quashnet	2005		
	Stony Brook	2005		

State	River	Moratorium	Commercial Regs	Recreational Regs
RI	Gilbert Stuart	2006		
	Nonquit	2006		
	Buckeye Brook	2006		
	Pawcatuck	2006		
	Ocean waters	2006		
	Naragansett Bay	2006		
	Coastal ponds	2006		
CT	Bride Brook	2002		
	Connecticut River	2002		
	Farmington River	2002		
	Thames River	2002		
NY	Hudson			10 fish/person or 50 fish/boat
DE, NJ, PA	Delaware River	2012		
	Delaware Bay	2012		
MD	Nanticoke	2012		
	Susquehanna	2012		
	Chesapeake Bay	2012		
MD, VA, DC	Potomac River	2010	50 lb bycatch allowance	
VA	James	2012		
	Rappahannock	2012		
	York	2012		
NC	Albemarle Sound	2007		
	Chowan River	2007		
SC	Winyah Bay	2012		
	Waccamaw	2012		
	Little Pee Dee	2012		
	Black	2012		
	Great Pee Dee		Gear Restrictions, lift period; annual harvest up to 1,000 kg	1 bushel/day
	Santee-Cooper		10 bushels/boat/day, gear restrictions	1 bushel/day
	Ashepoo-Combahee-Edisto	2012		
	Savannah	2012		
GA	Altamaha River	2012		
	Ogeechee River	2012		
	Savannah River	2012		
FL	St. Mary's River	2012		

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

Shad & River Herring Plan Review Team

Ashton Harp, Atlantic States Marine Fisheries Commission (Chair)

Mike Dionne, New Hampshire Fish and Game Department

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

I. Status of the Fishery Management Plan

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

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

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

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

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

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

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

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

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

II. Status of the Stocks

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

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

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

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

Estimates of coastwide abundance and fishing mortality could not be developed because of the lack of adequate data. The "depleted" determination was used instead of "overfished" because of the many factors that have contributed to the declining abundance of river herring, which include not just directed and incidental fishing, but likely also habitat issues (including dam passage, water quality, and water quantity), predation, and climate change. There are no coastwide reference points. A stock assessment update is scheduled for 2017 to analyze river herring stock status.

III. Status of the Fisheries

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

AMERICAN SHAD:

Total combined river and ocean commercial landings decreased from a high of 2,364,263 pounds in 1985 to a low of 1,390,512 pounds in 1999, but increased in 2000 to 1,816,979 pounds. The 2005 closure of the ocean-intercept fishery (phase out started in 2000) has substantially lowered the coastwide total landings of American shad. The total landings reported in compliance reports from individual states and jurisdictions in 2015 was 478,688 pounds, which is a 38% decrease from landings in 2014 (776,586 pounds) (Table 2)

Landings from North Carolina and South Carolina accounted for 20% and 54% of the commercial harvest, respectively, in 2015. The remainder of the harvest came from Maine, Connecticut, New York, New Jersey, Delaware, PRFC, Virginia, and Georgia. In 2015 New Hampshire, Massachusetts, Rhode Island, Maryland, District of Columbia and Florida reported no directed shad harvest in their state compliance reports.

Substantial shad recreational fisheries occur on the Connecticut (CT and MA), Delaware (NY, PA and NJ), Susquehanna (MD), Santee and Cooper (SC), Savannah (GA), and St. Johns (FL) Rivers. Shad recreational fisheries are also pursued on several other rivers in Massachusetts, District of Columbia, Virginia, North Carolina, South Carolina, and Georgia. Tens of thousands of shad are caught by hook and line from large east coast rivers each year, but detailed creel surveys are generally not available. Actual harvest (catch and removal) may amount to only about 20-40% of total catch, but hooking mortality could boost this "harvest" value substantially. Several comprehensive angler use and harvest surveys are planned or have been recently completed. In October 2006, the Management Board suspended the requirement to monitor the recreational fishery.

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

HICKORY SHAD:

In 2015, North Carolina, South Carolina, and Georgia reported hickory shad landings. North Carolina accounts for a vast majority of the landings with 97%. The coastwide commercial landings continue to increase, 153,263 pounds in 2015, a 29% increase from 2014 landings (119,118 pounds) (Table 2).

RIVER HERRING (BLUEBACK HERRING/ALEWIFE COMBINED):

Commercial landings of river herring declined 95% from over 13 million pounds in 1985 to about 700 thousand pounds in 2005. Recent commercial landings continue to increase, despite North Carolina restricting the commercial harvest of river herring in 2015. In 2015, river herring landings were reported from Maine, Massachusetts, New York, and South Carolina, totaling 2,005154 pounds, a 9% increase from 2014 landings of 1,844,821 pounds (Table 2).

Table 2. Shad and river herring in-river commercial and ocean bycatch landings (in pounds) provided by states, jurisdictions and NOAA Fisheries for 2015.

	American Shad	River Herring	Hickory Shad
Maine^		1,295,998	
New Hampshire			
Massachusetts		10,000	
Rhode Island			
Connecticut	51,004		
New York^		5,879	
New Jersey	9,418		
Pennsylvania			
Delaware	21,733		
Maryland			
D.C.			
PRFC	1,889		
Virginia	1,185		97
North Carolina	98,118		148,714
South Carolina	258,927	693,232	902
Georgia	36,414		3,551
Florida			
Total	**478,688**	**2,005,109**	**153,264**

^ Portions of Maine and New York landings are confidential and not shown

IV. Status of Research and Monitoring

Under Amendment 2 (2009) and Amendment 3 (2010), fishery-independent and fishery-dependent monitoring programs became mandatory for select rivers. Juvenile abundance index (JAI) surveys, annual spawning stock surveys (Table 3), and hatchery evaluations are required for select states and jurisdictions. States are required to calculate mortality and/or survival estimates, and monitor and report data relative to landings, catch, effort, and bycatch. States must submit annual reports including all monitoring and management program requirements, on or before July 1 of each year.

Table 3. American shad and river herring passage counts at select rivers along the Atlantic coast in 2015. This table includes the fish passage counts that are required by Amendments 2 and 3, it represents a sub-set the overall fish passage counts.

State/River	Shad	River Herring
Maine		
Androscoggin	58	71,887
Saco	6,171	53,891
Kennebec	26	91,850
Sebasticook	47	2,157,983
Penobscot		782,521
St. Croix		93,503
New Hampshire		
Cocheco		64,456
Exeter		5,562
Oyster		1,803
Lamprey		69,843
Taylor		
Winnicut		0
Massachusetts		
Merrimack	89,427	128,692
Rhode Island		
Gilbert Stuart		11,135
Nonquit		32,330
Buckeye Brook		15,333
Connecticut River		
Holyoke Dam	412,656	0
Pennsylvania/Maryland/Delaware		
Susquehanna (Conowingo)	8,341	13
Susquehanna (Holtwood)	5,286	2
Susquehanna (Safe Harbor)	3,896	0
Susquehanna (York Haven)	43	0
South Carolina		
St. Stephen Dam	85,417	244,631
Total 2015	611,368	3,825,435
Total 2014	426,073	3,031,753
Total 2013	776,162	2,922,985
Total 2012	205,928	2,493,322
Total 2011	307,793	3,152,748

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

In addition to the mandatory monitoring requirements stipulated under Amendments 2 and 3, some states and jurisdictions continue important research initiatives for these species. For example, Massachusetts, Pennsylvania, Delaware, Maryland, District of Columbia, Virginia, North Carolina, South Carolina, and USFWS are actively involved in shad restoration using hatchery-cultured fry and fingerlings. All hatchery fish are marked with oxytetracycline marks on otoliths to allow future distinction from wild fish. During 2015, several jurisdictions reared American shad, stocking a total of 21,034,024 American shad (Table 4).

Table 4. Stocking of Hatchery-Cultured Alosines in State Waters, 2015.

State	American Shad	Alewife
Maine		
Androscoggin River		
Kennebec River		
Union River		
Massachusetts		
Merrimack River	2,300,000	
Nashua River		
Charles River	1,700,000	
Rhode Island		
Pawcatuck River	1,400,000	
Pawtuxet River	900,000	
Pennsylvania		
Susquehanna River	1,994,571	
Lehigh River	247,649	
Schuykill River	198,855	
Maryland		
Choptank River	1,129,000	
District of Columbia		
Anacostia River	0	
Virginia		
James River	3,540,734	
North Carolina		
Roanoke River	4,816,360	
South Carolina		
Edisto River		
Santee River	2,806,855	
Total	**21,034,024**	**0**

V. Status of Management Measures

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

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

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

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

2017 SFMP Timeline

February Board Meeting

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

August Board Meeting

- PRFC (shad)
- South Carolina (shad and RH)
- Georgia (shad)
- Florida (shad)

October Board Meeting

- North Carolina (shad)
- Connecticut (shad)

V. Prioritized Research Needs

Fishery-Dependent Priorities

High

- Expand observer and port sampling coverage to quantify additional sources of mortality for alosine species, including bait fisheries, as well as rates of bycatch in other fisheries to reduce uncertainty.[1]

Moderate

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

Low

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

Fishery-Independent Priorities

Moderate

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

Modeling / Quantitative Priorities

High

- Conduct population assessments on river herring, particularly in the south.[2]
- Analyze the consequences of interactions between the offshore bycatch fisheries and population trends in the rivers.
- Quantify fishing mortality for major river stocks after ocean closure of directed fisheries (river, ocean bycatch, bait fisheries).
- Improve methods to develop biological benchmarks used in assessment modeling (fecundity-at-age, sex specific mean weight-at-age, partial recruitment vector/maturity schedules) for river herring and American shad of both semelparous and iteroparous stocks.
- Improve methods for calculating M.

Moderate

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

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

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

Low

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

Life History, Biological, and Habitat Priorities

High

- Conduct studies to quantify and improve fish passage efficiency and support the implementation of standard practices.
- Assess the efficiency of using hydroacoustics to repel alosines or pheromones to attract alosines to fish passage structures. Test commercially available acoustic equipment at existing fish passage facilities. Develop methods to isolate/manufacture pheromones or other alosine attractants.
- Investigate the relationship between juvenile river herring/American shad and subsequent year class strength, with emphasis on the validity of juvenile abundance indices, rates and sources of immature mortality, migratory behavior of juveniles, and life history requirements.
- Develop an integrated coastal remote telemetry system or network that would allow tagged fish to be tracked throughout their coastal migration and into the estuarine and riverine environments. UPDATE: currently available for American shad but not in use due to tagging mortality
- Continue studies to determine river herring population stock structure along the coast and enable determination of river origin of catch in mixed stock fisheries and incidental catch in non-targeted ocean fisheries. Spatially delineate mixed stock and Delaware stock areas within the Delaware system. Methods to be considered could include otolith microchemistry, oxytetracycline otolith marking, genetic analysis, and/or tagging.[3]
- Validate the different values of M for river herring and American shad stocks through shad ageing techniques and repeat spawning information.
- Continue to assess current ageing techniques for river herring and American shad, using known-age fish, scales, otoliths, and spawning marks. Conduct biannual ageing workshops to maintain consistency and accuracy of ageing fish sampled in state programs.[4]
- Summarize existing information on predation by striped bass and other species. Quantify consumption through modeling (e.g., MSVPA), diet, and bioenergetics studies.
- Refine techniques for tank spawning of American shad. Secure adequate eggs for culture programs using native broodstock.

Moderate

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

[3] Genetic research currently underway in combination with otolith chemistry.
[4] River herring ageing workshop occurred in 2013.

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

Low

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

VII. PRT Recommendations

State Compliance

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

Currently a recreational angler can possess up to 8 shad on any Georgia river. However, only two rivers (Altamaha and Savannah) are included in Georgia's Shad Sustainable Fishery Management Plan. The Technical Committee and the PRT recommend one of two options: 1) all rivers that allow shad harvest be included in the revised sustainable fishery management plan (as required by Amendment 3), or 2) prohibit harvest for rivers that are not in Georgia's Sustainable Fishery Management Plan.

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

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

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

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

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

REVIEW OF SHAD AND RIVER HERRING ANNUAL COMPLIANCE REPORTS

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

MAINE
De minimis

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

Comments or trends highlighted in state report:

- American shad recreational catch estimates = 779 fish caught (A+B1+B2) and 779 harvested (A+B1) (MRIP).
- Comparing the juvenile CPUE to past years, American shad CPUE were above average in the Upper Kennebec River, the Abbagaadasset, and Eastern, Androscoggin and, but below average in the Merrymeeting Bay , Cathance rivers, and lower Kennebec rivers.
- In 2015, harvester reports indicate that 1,162,198 pounds of alewife and 133,800 pounds of blueback herring were kept. Harvest reports also indicate that 1,999 pounds of blueback herring were discarded. Dealer reports indicate that 1,295,998 pounds of river herring were sold for a value of $415,432.74. MRIP estimates for alewife are 3,485 caught and 1,038 harvested. For blueback herring, were 1,745 caught and harvested.
- Comparing the JAI CPUE to past years, alewife CPUE was above average in the upper Kennebec, Androscoggin, and Eastern rivers, but below average in all other river portions. Blueback herring CPUE was below average in all river segments.
- River herring run counts were above average for Androscoggin, Kennebec, Saco, and Sebasticock rivers and below average in the St. Croix river.
- Spawning Stock Survey: In 2015, fisheries personnel counted and passed upstream 26 American shad in the trap at the Lockwood Dam on the Kennebec River, and 47 at the Benton Falls fishlift on the Sebasticook River. At the Brunswick Fishway on the

Androscoggin River, 58 American shad were captured in the fish lift. , On the Saco River, Brookfield Energy biologists counted a total of 6,171 American shad (5,940 passing the East Channel Dam, and 231 passing the West Channel Dam). Additionally 109 shad mortalities were noted, representing a total fishway mortality of 1.8%, which is lower compared to past years.

Unreported information / Compliance Issues:

- River herring scale samples collected from commercial harvesters are being processed. Information should be sent to FMP Coordinator as soon as data are available.

Sturgeon bycatch report:

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

NEW HAMPSHIRE

***De minimis*:**

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

Comments or trends highlighted in state report:

- No American shad were harvested form New Hampshire waters in 2015.
- Since 2006, a total of 11 American shad have been observed in the Exeter River.
- River herring SFMP target met for 2015 – exploitation rate <20% (9.5%) and returns >72,293 fish (119,909 fish).
- In 2015, 7,566 lbs of river herring were reported harvested from New Hampshire waters through mandatory coastal harvest reports. It is noted that this harvest is for personal use and is no longer included with NMFS harvest.
- Recreational harvest estimates for river herring were 452 alewives and 0 blueback herring in NH through the Access-Point Angler Intercept Survey (APAIS).
- There is a general increase for alewife herring runs in New Hampshire waters for the last 6 years.
- The highest JAI was observed in 2015 for alewife, but blueback herring JAI has been declining since 2007.

Unreported information / Compliance Issues:

- None identified.

Sturgeon bycatch report:

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

MASSACHUSETTS

***De minimis*:**

- The Commonwealth of Massachusetts requests *de minimis* for the commercial fishing year 2016 for the American shad and river herring fisheries.

Comments or trends highlighted in state report:

- Dealer reporting = 0 pounds of shad landed.
- Merrimack Dam American shad counts have been increasing since 2010.
- Connecticut River Holyoke Dam American shad counts have seen a general increase since 2004, and appear to be relatively stable since 2012.
- River herring spawning runs were monitored by volunteers in 19 rivers in 2015. The general trend emerging is of increasing run size estimates since 2011.
- Census counts of river herring spawning runs were monitored in 12 rivers in 2015. Only the Merrimack and Parker rivers saw increases compared to 2014.

Unreported information / Compliance Issues:

- Catch composition data was not available for the American shad recreational fishery.
- A juvenile abundance index was not reported for the Merrimack River American shad.

- A description of Amendment 2 requirements should be included in the compliance report.
- Degree of repeat spawning was not evaluated in the river herring spawning stock assessment.

Sturgeon bycatch report:
- No sturgeon interactions were reported in 2015.

<u>RHODE ISLAND</u>

Comments or trends highlighted in state report:
- JAI in 2015 highest since 2004.
- A total of 159 American Shad passed through the fishway in 2015.
- River herring run counts at Gilbert Stuart (11,135), Nonquit (32,330), and Buckeye Brook (15,333) were all lower in 2015 than 2014.

Unreported information / Compliance Issues:
- Herring scale samples were collected but not aged; mortality estimates are unavailable for 2015 – finished January 2016.
- Due to low returns at Gilbert Stuart in 2015, no biological data was collected.

Sturgeon bycatch report:
- One Atlantic sturgeon was observed by the NOAA Fisheries Observer Program in 2014.

<u>CONNECTICUT</u>

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

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

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

<u>NEW YORK</u>

Comments and trends highlighted in state report:
- Commercial and recreational shad fishery closed in 2010.
- Mandatory reporting of river herring harvest = 5,869 pounds landed in Hudson River.

- Shad landings were reported through ACCSP, however due to confidentiality agreements, this data cannot be disclosed.
- 2015 American shad spawning stock survey sex ratio was 64:36 (male:female)
- 2015 river herring spawning stock survey sex ratio: 63:37 (male:female) alewife and 47:53 (male:female) blueback herring.
- The 2015 index for YOY American Shad was 6.16, which is second highest in elven years.

Unreported Information / Compliance Issues:

- No data for commercial or recreational "other loss" of river herring is available.
- A river herring recreational creel survey was not conducted in 2015.
- Other losses (research, fish passage) attributed to river herring are reported as no data.
- Degree of repeat spawning data for shad is not yet complete.

Sturgeon bycatch report:

- No data collected due to fishery closure.

NEW JERSEY

No Comment

PENNSYLVANIA

No Comment

DELAWARE – NANTICOKE RIVER

No Comment

DELAWARE BASIN F&W COOPERATIVE

No Comment

MARYLAND

Comments or trends highlighted in state report:

- American shad and river herring commercial fishery is closed; catch and release only.
- In 2015, pounds of dead American shad from the spring pound and fyke net commercial fishery targeting perch and catfish cannot be reported due to confidentiality.
- Total recreational release mortality is estimated to be 144 American shad per year (estimate based on two studies, one from 1997 and one from 2010).
- No trend in Nanticoke River shad JAI; increasing in Upper CB and Potomac River.
- American Shad Stocking continues in Choptank River.
- In 2015, the Conowingo Dam tailrace American shad population was estimated at 139,973.
- In 2015, The JAI CPUE for alewife and blueback herring both increased in the Upper Bay and remained low in the Nanticoke River.

Unreported / Compliance Issues:

- Spawning stock assessment for river herring began with 2013 gillnet survey for adult river herring in the North East River. Longer time series needed for this assessment.

- No characterization of other losses in commercial fishery due to lack of spring pound and fyke net fishery for perch and catfish on Nanticoke River due to ice.

Sturgeon bycatch report:

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

DISTRICT OF COLUMBIA

Comments or trends highlighted in state report:

- Commercial and recreational fisheries for river herring and shad remained closed.
- American shad fry stocking did not occur in 2015.
- In 2015, the American shad CPUE (fish per 6,000 sqft of net) decreased to 2.04 compared to 4.26 in 2014.

Unreported information / Compliance Issues:

- No estimate of potential other losses in any of the fisheries.
- The required harvest & losses table is not included.
- Include which rivers were sampled by the seine survey.
- No ageing has been done for American shad or river herring, thus age frequency, degree of repeat spawning and mortality estimates have not been reported.

Sturgeon bycatch report:

- No sturgeon captures were reported in the District of Columbia during 2015.

POTOMAC RIVER FISHERIES COMMISSION

Comments or trends highlighted in state report:

- Since 2012, all fisheries are closed to the taking and/or possession of river herring.
- The Potomac River is closed to the directed harvest, commercial and recreational, of American and hickory shad.
- Bycatch landings in 2015 included 1,889 pounds of American shad and no hickory shad.
- In 2015, the American shad restoration target (31.1) was exceeded for the fifth year in a row with a value of (41.4)
- The 2015 JAI index for American shad (19.81) increased to the highest level on record and the alewife and blueback herring indices increased slightly.

Unreported information / Compliance Issues:

- Please include spawning stock assessment information in the same report.
- Harvest and losses table could be improved by including number of fish per gear type and mean weight per gear type.
- Variances for juvenile indices are missing.

Sturgeon bycatch report:

- In 2015, there were no Atlantic sturgeon captures reported in the Potomac River.

VIRGINIA

Comments or trends highlighted in state report:

- 343 American shad (1,185 lbs) were taken under the 10 American shad per vessel per day bycatch allowance.
- Juvenile abundance for American shad was high in 2015 for all rivers, and was a record high for the Rappahannock River.
- The 2015 American shad spawning stock catch index was the lowest on record for the James and York Rivers.
- The overall assessment of the James River American shad population is that the stock remains at historically low levels and is dependent on hatchery inputs (hatchery contribution was 44% in 2015).
- In 2015, river herring fishery remained closed to both commercial and recreational harvest and possession.
- Alewife and blueback herring juvenile abundance increased in 2015 in the James River.

Unreported information / Compliance Issues:

- A river herring spawning stock survey for the Rappahannock River will begin in 2016.
- Degree of repeat spawning was not evaluated in the river herring spawning stock assessment.

Sturgeon bycatch report:

- In 2015, a total of 10 Atlantic sturgeon were caught as bycatch in the staked gill nets used by VIMS to monitor abundance of adult American shad and released alive.

NORTH CAROLINA

Comments and trends highlighted in state report:

- Amendment 2 to the NC River Herring Fishery Management Plan (FMP) approved by the North Carolina Marine Fisheries Commission (MFC) in May of 2015, eliminated the discretionary harvest season for river herring, prohibited the possession of river herring (blueback and alewife) greater than six inches aboard a vessel while fishing from shore, and removed river herring (blueback and alewife) from the mutilated finfish exception.
- In 2015, American shad landings totaled 98,119 pounds and were approximately 50% lower than 2014 due to various factors including weather and fish availability during the shortened season.
- The 2015 JAI for blueback herring (5.42) was above 2014 but below the time series average of 55.08. The alewife JAI (7.13) was above 2014 (0.00) and also the time series average (2.62).
- A total of 589 blueback herring and 998 alewife samples were obtained from four contracted Chowan River pound net fishermen.
- A total of 148,714 pounds of hickory shad were harvested in 2015 worth $49,552.

Unreported information / Compliance Issues:

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

Sturgeon bycatch report:

- In 2015, 89 Atlantic sturgeon were observed or reported from the Albemarle Sound; –8 via the DMF observer data (all released alive), and 81 via the DMF IGNS (15 fatalities).
- One Atlantic sturgeon was reported captured and released alive via onboard observers within the Pamlico Sound, Pamlico, Neuse and Cape Fear River Areas.
- In the Cape Fear River, DMF observer data recorded two Atlantic sturgeon interactions alive and released. The DMF IGNS captured one Atlantic sturgeon which was released alive.
- Observer trips completed in the Pamlico and Neuse rivers recorded no sturgeon interactions.
- The DMF IGNS in the Pamlico, Pungo, and Neuse Rivers captured 17 Atlantic sturgeon. Five were dead and the rest were released alive.
- The DMFIGNS in the Pamlico Sound captured and released alive one sturgeon, identified to the genus.

SOUTH CAROLINA

Comments and trends highlighted in state report:

- In 2015, total estimated commercial landings of American (including hickory) shad, as reported through NMFS, was 254,034 pounds (100% in-river)
- In 2015, observed sex ratios for American shad were not available for the Santee River (females only) and 12.5 females per male in the Waccamaw River. The high occurrence of females in these samples is most likely due to the marketability of females vs. males.
- In 2015, three year running average for blueback herring on the Santee Cooper was u = 0.031, which was below the sustainability benchmark of 0.050.
- In 2015, the three year running average for blueback herring on the Pee Dee River exceeded the benchmark of 500 kg.

Unreported information / Compliance Issues:

- None.

Sturgeon bycatch report:

- Atlantics – Ten total from Carolina DPS.
- Shortnose – Seven total, with two from the Santee River and five from the Waccamaw River.

GEORGIA

Comments and trends highlighted in state report:

- In 2015, commercial American shad landings was 29,536 pounds on the Altamaha and 6,878 pounds on the Savannah River.
- A recreational fishery at 8 shad per day (combination of American and/or Hickory) exists only on Savannah and Ogeechee River.
- The population of American shad in the Altamaha River in 2015 was estimated at 240,642 shad, a 57% decrease from 2014.
- In the 2015 recreational creel survey, 463 American shad were harvested on the Ogeechee River.

- American shad fry were stocked into Altamaha tributaries and the Ogeechee River.

Unreported information / Compliance Issues:

- Shad recreational harvest data was not reported for the Savannah River.
- Currently a recreational angler can possess up to 8 shad on any Georgia river. However, only two rivers (Altamaha and Savannah) are included in Georgia's Shad Sustainable Fishery Management Plan. The Technical Committee and the PRT recommend one of two options: 1) all rivers that allow shad harvest be included in the revised sustainable fishery management plan (as required by Amendment 3), or 2) prohibit harvest for rivers that are not in Georgia's Sustainable Fishery Management Plan.

Sturgeon bycatch report:

- Atlantic and shortnose sturgeon are caught in gill nets. In drift nets, essentially 100% of the sturgeon can be released unharmed. During 31 field days of monitoring adult shad in 2015, one Atlantic and two shortnose sturgeon were captured in drift gill nets from the Altamaha River. All sturgeon were released unharmed. Shad fishermen also reported capturing eighteen Atlantic and ten shortnose sturgeon from the Altamaha River. In addition, commercial fishermen reported one incidental catch of an Atlantic and one shortnose on the Savannah River during the 2015 commercial shad season.

<u>FLORIDA</u>

Comments and trends highlighted in state report:

- No commercial fishery exists for shad or river herring.
- There is no recreational harvest of river herring.
- An access point creel total estimated shad catch was 870 fish in Mullet Creel area and 436 in Puzzle Lake Creel area.
- In 2015, 590 American shad and 121 blueback herring were caught during eighty electrofishing transects on the St. Johns River.

Unreported information / Compliance Issues:

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

Sturgeon bycatch report:

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

Atlantic States Marine Fisheries Commission

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Shad & River Herring Technical Committee
Call Summary

March 23, 2017

Technical Committee Members: Brad Chase, Ken Sprankle, Mike Brown, Mike Dionne, Bryant Bowen, Brian Neilan, Genine Lipkey, Bill Post, Joe Swann, Jeremy McCargo, Eric Hilton, Holly White, Phil Edwards, Jacque Benway Roberts, Ruth Hass-Castro, Bob Adams, Johnny Moore, Reid Hyle, Chad Holbrook

ASMFC Staff: Jeff Kipp and Ashton Harp

The Shad and River Herring Technical Committee (TC) met via conference call to review sustainable fishery management plans (SFMP) from Florida (shad), Georgia (shad) and South Carolina (blueback herring). Each SFMP has been updated (from the original version that was implemented in 2010/2011) to include recent data and new sustainability benchmarks, if necessary.

The next SFMPs to be reviewed by the TC are Potomac River Fisheries Commission (shad) and South Carolina (shad). The states will submit the SFMP by **June 20, 2017** and the TC will convene via conference call in early July to review.

1. **Review of the Florida SFMP for Shad**

The Florida Fish and Wildlife Conservation Commission (FWC) submitted an updated SFMP for recreational harvest of America shad in the St. Johns River. The plan includes recent data and requests to maintain the existing recreational management measures from the 2011 SFMP. There are no commercial fisheries operating in state waters that take shad deliberately or that are likely to take shad as bycatch.

The plan includes the existing sustainability benchmark of fishery independent spawning stock index biomass. The index is based on electrofishing response rate. The spawning stock index has been at the 25th percentile (i.e. the management trigger) for two consecutive years following several years with values above the median. This warrants caution but no action at this time.

The plan adds a new JAI-based benchmark. The JAI has the potential to capture recruitment issues stemming from habitat and water quality changes. Management action is triggered if there are three consecutive years below the 25th percentile.

Reid Hyle (FWC) reviewed the details of the plan with the TC and responded to TC questions, summary below:

- Current there are two spawning stock indices based on two different portion of the St. Johns River. Is it possible to combine the indices into one index to reduce variability or is it possible to standardize the indices with a GLM?
    - The river discharge is fairly stable from year-to-year. Although the very high water in 2015/16 shifted the spawning grounds and resulted in higher catches downstream. If the river is high then catches are low because shad transit the area very quickly, and then they stay in the estuary regardless of what is happening upstream.
    - For the adult indices, it could be combined into one index. However, the river stretch (278-298) was the primary index because that is where the fishery has traditionally been. However, the river in this stretch is wide and deep, which may be the reason for low catches via the electrofisher. A secondary sampling area (314-358) was added (hence the second index) and it has become the primary index.
- **If the index is standardized by discharge then there may be different trends. Would you consider for the next SFMP?**
    - **Yes, FWC will consider.**
- Can you summarize the sustainability benchmarks and associated management triggers into an overview table?
    - Yes.

The TC recommends the Board approve the Florida SFMP.

2. Review of the Georgia SFMP for Shad

The Georgia Department of Natural Resources submitted an updated SFMP for recreational harvest of America shad on the Altamaha and Savannah River. The plan includes a CPUE benchmark for the Altamaha River. The TC requested a secondary benchmark based on JAI or biological data.

The Savannah River did not include a sustainability benchmark—Georgia voiced that it would be included in the South Carolina Shad SFMP. The TC requested the measures that are in the SC plan be included in the GA plan for the Savannah River. In addition, it was noted that Georgia has an 8 fish creel limit which applies to all Georgia rivers. The TC requested all rivers that allow harvest be included in the SFMP. Alternatively, as required in Amendment 2, Georgia can restrict harvest for rivers that do not have a SFMP.

The TC requests Georgia modify the SFMP based on the TC recommendations.

3. **Review of the South Carolina Blueback Herring SFMP**

The South Carolina Department of Natural Resources submitted an updated SFMP for commercial and recreational harvest of blueback herring. The plan includes recent data and requests to maintain the existing management measures from the 2010 SFMP.

Bill Post (SC DNR) reviewed the details of the plan with the TC and responded to TC questions, summary below:

- How is the Pee Dee oxbow lake regulated?
    - One can fish anywhere along the Pee Dee but most of the fishing takes place in the oxbow lake via gillnets.
- Is there age data for the Santee?
    - Yes, but it is not presented because the benchmark was not changed. They have age data from 2009-2015.
- The scaling value was derived from mark-recapture during 1986-90. The minimum population numbers were small, so how good was the passage data in that period and is there anything presently that could affect this?
    - There is not 100% passage at the St. Stevens fish lift so it represents a minimum population estimate for the Santee River System. SC DNR believes more fish can pass, but they don't have another estimate to use.
    - **TC recommends a second sustainability benchmark for the next SFMP, potentially based on biological triggers.**

The TC recommends the Board approve the South Carolina SFMP.

American Shad Sustainable Fishing Plan Update for Florida, St. Johns River

Prepared by

Reid Hyle

June 30, 2017

On Behalf of

Florida Fish and Wildlife Conservation Commission

Fish and Wildlife Research Institute and Division of Marine Fisheries Management

Introduction - Summary

The spawning run of American shad in Florida's St. Johns River, Florida is subjected to a small, primarily catch and release recreational fishery. The stock abundance was last classified as low but stable (ASMFC 2007). There have been no commercial landings of American shad in Florida since 2000. Recreational fishing is open with a 10 fish bag limit. A majority of anglers voluntarily release their catch. Monitoring of relative stock abundance has been in place since 2003 and relative abundance has improved. Monitoring of relative abundance of young of the year has been in place since 2007 and the highly variable index shows successful recruitment in most years with a positive correlation between the juvenile abundance index and year class strength in the spawning stock. Fishery dependent monitoring resumed in 2011 after a six year hiatus and indicates that overall effort and harvest are low with catch per unit effort similar to earlier years. The Florida Fish and Wildlife Conservation Commission (FWC) seeks to maintain the open status of the recreational fishery as its existence should not threaten the maintenance and recovery of the St. Johns River population of American shad.

St. Johns River

The St. Johns River is entirely coastal and drops a total of 9.1 m over its entire 499km length. Most of that drop occurs upstream of river kilometer 314 (McLean 1955). The river passes through three large shallow lakes; Lake Harney (6200 acres) between rkm 306 and 314, Lake Monroe (9400 acres) between rkm 266 and 276, and Lake George (40,000 acres) between rkm 182 and 199. The head of the tide is generally at Lake George. The tidal freshwater reach below Lake George varies in width from 0.18 km to 2 km and has an average tide range of 0.33 m. Weak tides can reach as far as the Lake Monroe outlet at river kilometer 266 during low flow. The St. Johns River has a "southern river flow pattern" (Kelly and Gore 2008) in which low flow typically occurs from late winter into early summer and high flows occur in the late summer and early fall corresponding to a summer wet season. Spawning has been documented from river kilometer 235 to 400 but primarily occurs between river kilometer 276 and 378. The spawning season lasts from late December to Early May with peak activity from mid January to mid March. (Figures 1 and 2).

Description of the Fishery

Gear restrictions have effectively eliminated commercial harvest. Pound nets were phased out through the 1980's and 1990's. None are operating and new licenses will not be issued. Entanglement nets were prohibited by constitutional referendum in all state waters in 1995. There are no commercial fisheries operating in state waters that take shad deliberately or that are likely to take shad as bycatch. Furthermore, hook and line has been the only permissible gear for the taking of all *Alosa* species since 1997. A saltwater fishing license is required to possess anadromous species. The current bag limit is 10 fish per angler per day for American shad and hickory shad in aggregate. The existing recreational fishery is small and dominated by catch and release fly fishermen that target fish on the spawning grounds. The aerial coverage of the fishery is restricted relative to the extent of spawning habitat. Angling primarily occurs between river kilometers 285 and 292 and between river kilometers 314 and 321 whereas spawning grounds primarily occur from river kilometer 280 to 295 and from river kilometer 314 to 378.

Stock Monitoring Programs

a) Fishery Independent

i. Juvenile abundance indices (JAI)

The relative abundance of young of the year American Shad has been assessed annually as catch per tow by a bow mounted push net since 2007. A standard sample night comprises 12 5-minute tows at stations selected at random within a 40 kilometer long sampling reach. Two representative index reaches were selected in 2010 based on a pilot project that ran from 2007 to 2009; one in the river run between river kilometer 210 and 260 and one in tidal freshwater between river kilometer 125 and 165 (Figure 1). Index sampling occurs bi-weekly from the end of March until the CPUE drops below 10% of the peak nighly average. The initial sustainable fishing plan did not identify which sampling index should be used as a benchmark citing a lack of information about which location would best perform in describing recruitment success or failure. The JAI from the tidal freshwater reach was correlated to year class strength in the spawning stock in subsequent years (Figure 3). The JAI has been highly variable but generally increasing (Figure 4). River discharge during the spawning season accounts for a large proportion of the interannual variability in JAI in the lower St. Johns River (Figure 5). The lower St. Johns River American Shad JAI appears to predict both recruitment to the spawning stock and recruitment response to a significant environmental variable.

ii. Spawning stock survey

The spawning stock survey tracks the relative abundance of adult American shad by electrofishing the spawning stock. The spawning stock index is reported as the geometric mean catch per standard sample. The current benchmark is that three consecutive years with the CPUE below the 25th percentile of the time series will trigger a management action. Sampling occurs biweekly from January through March between river kilometers 314 and 357 (Figure 3). A standard sample day includes 10 standard samples at randomly selected sites within the reach. Sampling will continue on an annual basis. Biological samples are collected for length, sex composition, and aging (beginning in 2011) from these electrofishing collections. This is the longest continuous index currently running on the St. Johns River. The CPUE was at the 25th percerntile in the upper river reach between river kilometer 314 and 357 in both 2015 and 2016 (Figure 6). River discharge was above the 90th percentile during the spawning season in both years and this seems to have altered the distribution of fish within the sampling areas. Two peak season sampling trips also occur between river kilometers 279 and 297 (Figure 3). The CPUE was the highest and second highest in the time series between river kilometers 279 and 297 in 2015 and 2016 respectively.

b) Fishery Dependent

A roving creel survey of recreational anglers was conducted between the mouth of Lake Jesup (river kilometer 285) and just south of Iron Bend (river kilometer 298) in 11 out of 13 years from 1992 to 2005 (McBride and Holder 2008). This creel documented declining effort and relatively stable catch rates (Figure 7 and Figure 8). An access point creel was introduced in 2011 and will continue annually as funds allow. The access point creel covers the old creel area (Mullet Lake Creel Area) via two boat ramps and an upstream area (Puzzle Lake Creel Area) via one boat ramp (Figure 3). Canvassing anglers on the water indicated that greater than 95% of shad fishing effort originates at these ramps. These ramps are the primary access points to the ~14 km of river in which most shad fishing occurs. The angler success rate in the Mullet Lake Creel Area from 2011 to 2016 was 0.92 fish/hour compared to the 0.71 fish/hour average for shad between 1992 and 2005 (McBride and Holder 2008). There has been no trend in angler CPUE (Figure 8) but effort continues to decline in the Mullet Lake Creel Area (Figure 7). Effort increased in the Puzzle Lake Creel Area though 2014 but was low in 2015 and 2016 due to high water related access difficulty.

A benchmark angler catch rate of 1 fish per angler hour was selected as a restoration target based on the previous roving creel (ASMFC 2007). However, the nature of the fishery has changed. The fish camp at river kilometer 287, from which much of the shad fishing effort occurred in the past, has closed and some fishing effort has shifted to another section of river (Figure 7). Additionally, fishing techniques have changed from primarily trolling to primarily fly fishing. Therefore we do not believe that angler catch rate should be used as a stand alone benchmark. Annual monitoring of this fishery through an access point creel will continue as long as funding is available.

Sustainable Fishery

FWC requests to maintain the recreational fishery on the St. Johns River as is. The fishery independent benchmark has not triggered a managmet action at this time and new time series have facilitated the establishment of a JAI benchmark.

a) Fishery Independent Spawning Stock Index Benchmark (Table 1)

The fishery independent spawning stock index median for the series 2003 through 2016 was 5.21 and the 25^{th} percentile was 4.04 (Figure 6). The spawning stock index has been at the 25^{th} percentile for two consecutive years following several years with values above the median. This warrants caution but no action at this time. Furthermore, the spawning stock index calculated from a secondary sample area indicated that fish abundance may have been higher than shown by the primary index (Figure 6). This secondary survey may be incorporated into a revised benchmark in the future that better accounts for interannual changes in spawning grounds locations. Monitoring spawning stock relative abundance will continue in both river reaches. The Shad and River Herring Technical committee suggested that a generalized linear model might be used in future sustainable fishing plan updates to reconcile differences in the spawning stock index from the two sampling areas that may arise from catchability differences between years abnormal water levels alter fish distribution in the respective sampling areas.

b) Proposed JAI based Benchmark (Table 1)

The JAI from the lower river has performed well in the period 2007 to 2016 with the adult spawning stock relative abundance at age being predicted by the JAI for the 2007-2011 year classes. Therefore we would like to set a 25^{th} percentile benchmark for this time series with three consecutive years below the 25^{th} percentile to trigger management review. The JAI has the potential to capture recruitment issues stemming from habitat and water quality changes.

c) Possible Future Benchmark to Incorporate Fishery Dependent Data

FWC feels that increasing catch and/or harvest in the recreational fishery without concurrent increases in fishery independent indices would be undesirable. We proposed in the initial SFMP to develop benchmarks based on the ratios of angler harvest and angler total catch to fishery independent electrofishing CPUE in the first SFMP for American Shad. We can calculate the ratio of catch and/or harvest to the fishery independent electrofishing CPUE (Figure 10). We do not know what level or what metric represents a critical value at this time. We propose to monitor the ratio of fishery metrics (e.g. effort, catch, harvest) to fishery independent abundance indexes for any possible trend in the interval until the next SFMP update and consider a relevant benchmark at a later date.

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McBride, R.S and J. C. Holder. 2008. A review and updated assessment of Florida's anadromous shads: American shad and hickory shad. North American Journal of Fisheries Management 28: 1668-1686.

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Table 1. Florida St. Johns River American Shad Management Benchmarks and Triggers

River System	Index	Index Years	Benchmark Value	Benchmark Level	Management Trigger
St. Johns River	Spawning Stock Electrofishing CPUE	2003-2016	4.04 shad/standard sample	25th percentile	3 consecutive years below the benchmark
St. Johns River	Pushnet Juvenile Abundance Index	2007-2016	2.33 shad/standard sample	25th percentile	3 consecutive year below the benchmark

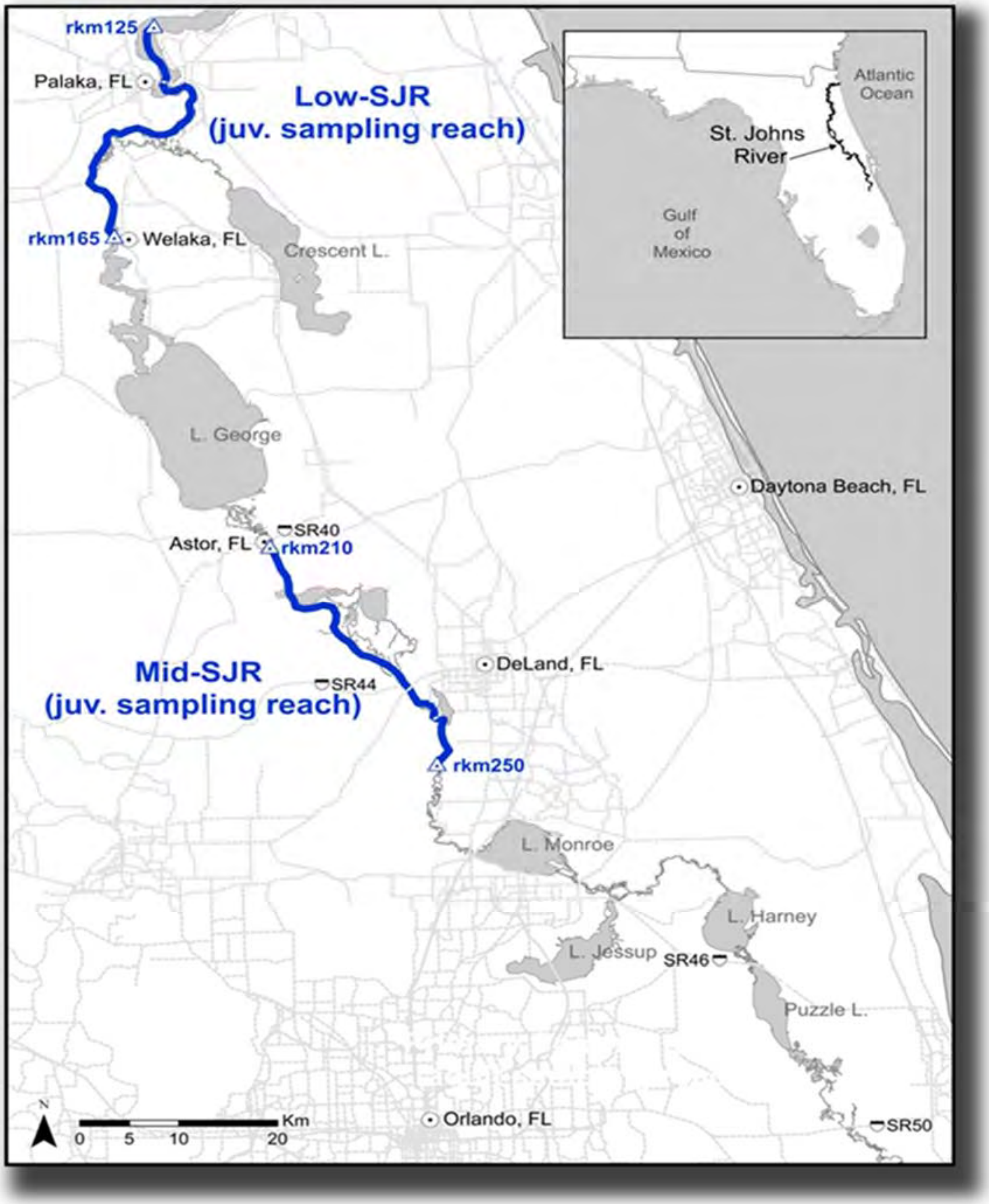
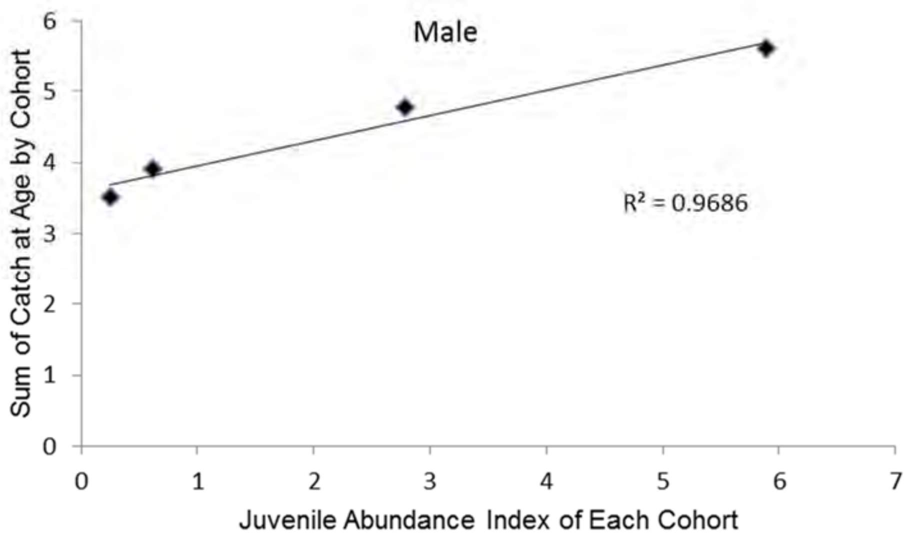


Figure 1. **Middle and lower St. Johns River. Diurnal tides extend up to Lake George. Spawning grounds begin between Lakes George and Monroe but are primarily south of Lake Monroe. Juvenile sampling by pushnet in 2007-2009 extended from rkm 125 to 305 from spring to fall. From 2010 forward, the Mid-SJR Sampling Reach (rkm 210-260) and the Low SJR Sampling Reach (rkm 125-165) are sampled biweekly from the end of the spawning season until the nightly CPUE drops below 10% of the seasonal peak.**



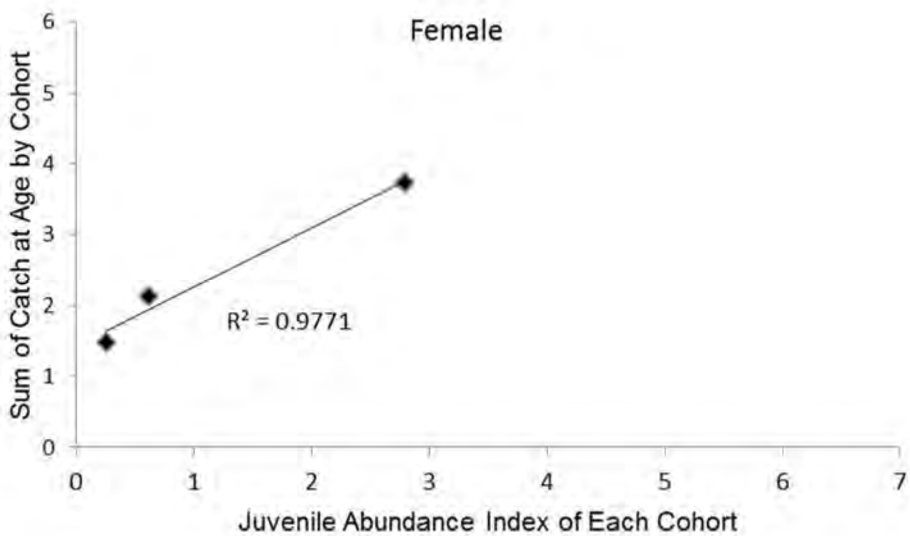


Figure 2. The CPUE at Age of the adult spawning stock versus the JAI in prior years. The electrofishing CPUE was summed across years for each age of each sex, ages 3 through 6 for males and ages 3 through 7 for females. This produced a sum of CPUE at Age for the 2007 through 2010 year classes of male American Shad and the 2007 through 2009 year classes of female American Shad. That value was tested for correlation with JAI. Males are in the top figure and females in the lower. Both simple linear regressions are significant at 0.05. As both regressions are short, the relationship will be tested with more robust methods as additional data are gathered.

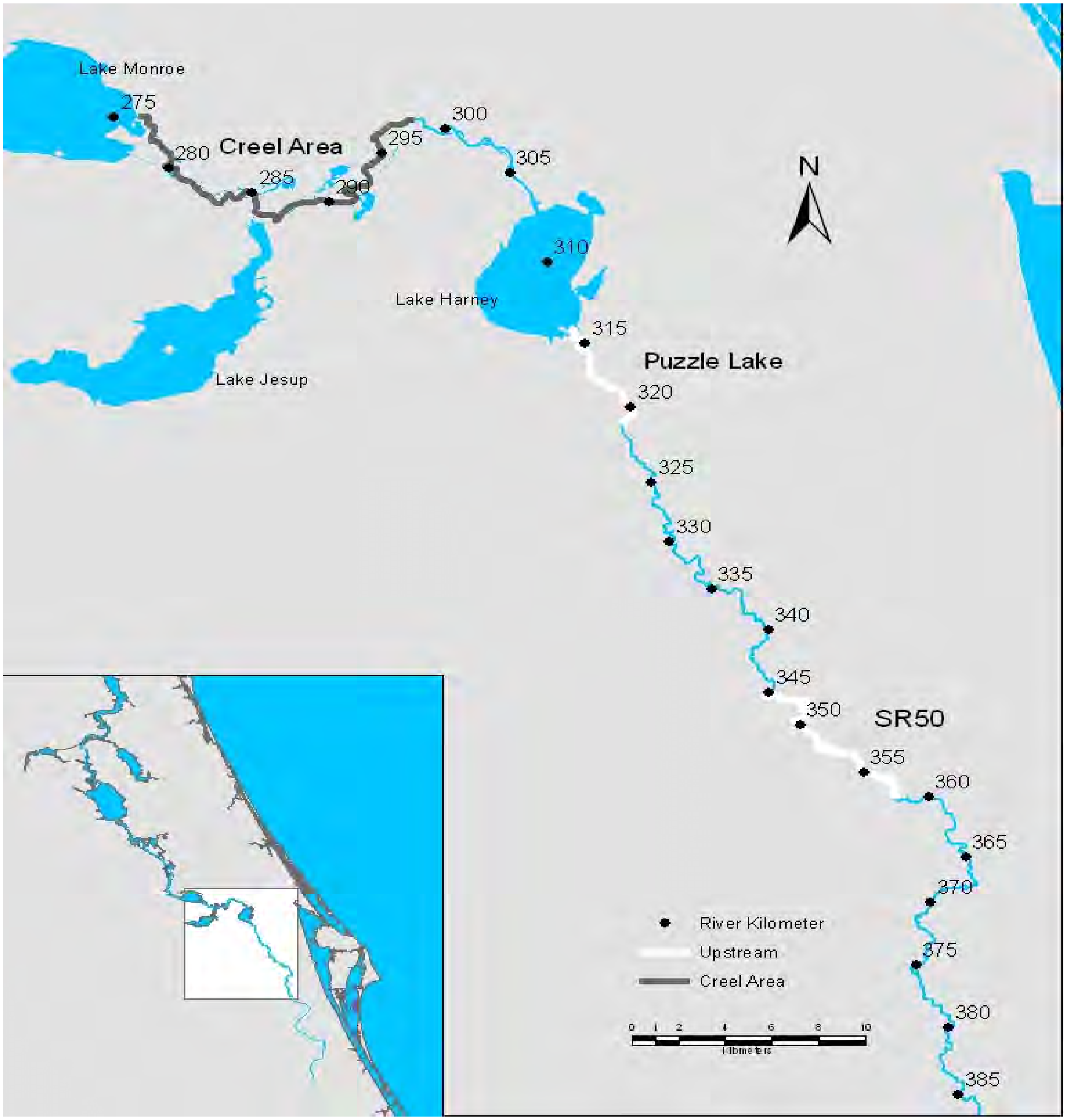


Figure 3. **Upper St. Johns River. Primary spawning grounds occur from river kilometer (rkm) 276 to 378. Fishery independent monitoring for adult American shad occurs at Puzzle Lake (rkm 314-320) and at State Road 50 (SR50, rkm 345-358). Additional fishery independent monitoring occurs at the Mullet Lake Creel Area (rkm 279-297) annoted on this figure as "Creel Area". The recreational fishery occurs mainly at the Creel Area and Puzzle Lake.**

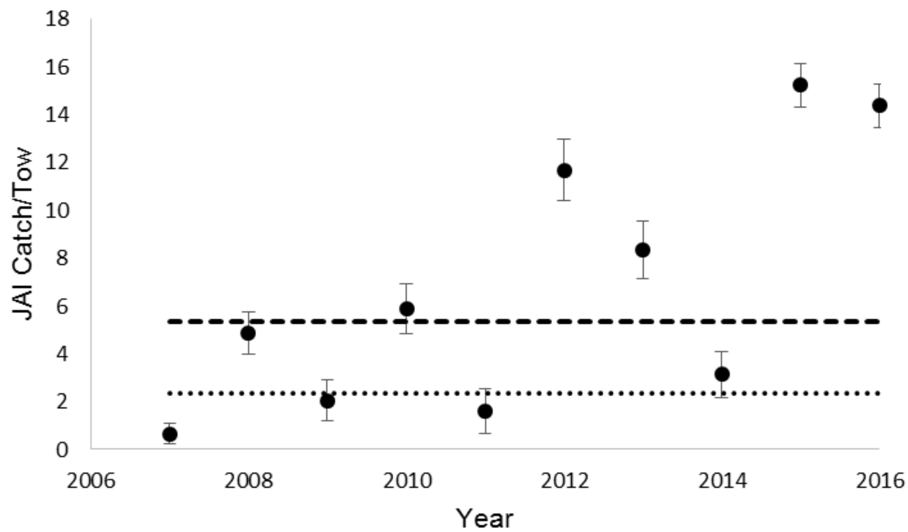


Figure 4. The summer juvenile abundance index, calculated as Geometric Mean, of American Shad from the lower St. Johns River, Florida from 2007 to 2016. Median is the dash line. 25th percentile is the dotted line.

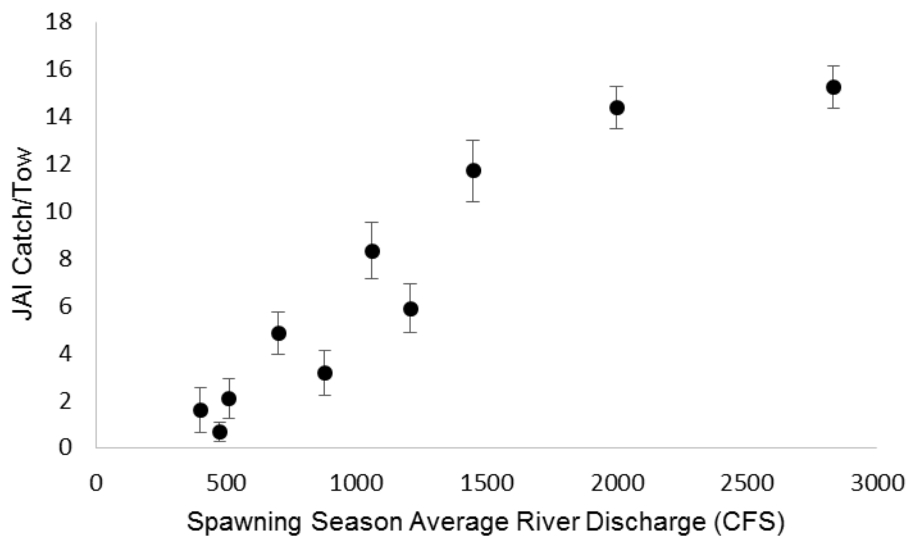
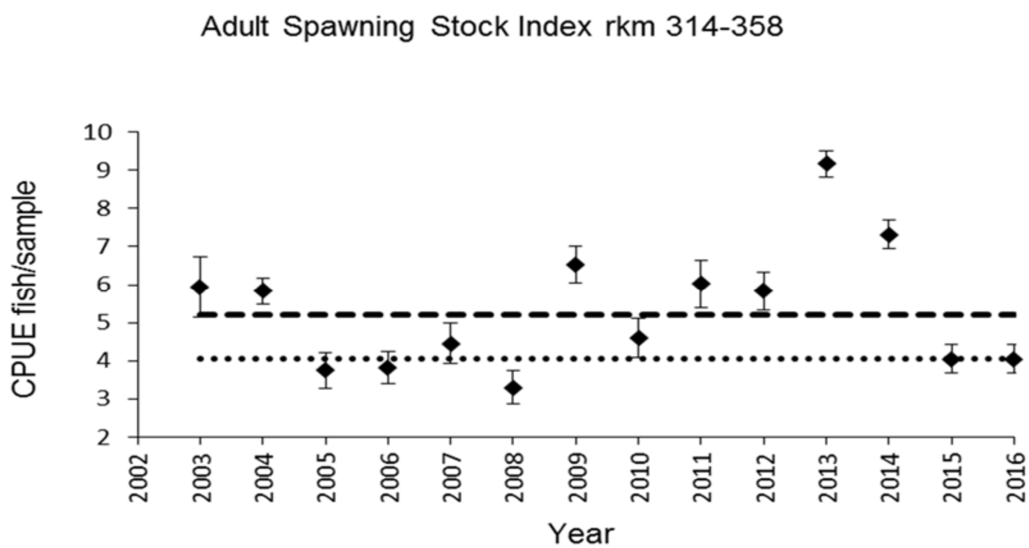


Figure 5. The summer juvenile abundance index of Amerian Shad from the lower St. Johns River, Florida from 2007 to 2016 versus the mean spawning season (January through March) discharge at USGS Gage 02232500 on the spawning grounds of the St. Johns River near State Road 50 in Christmas, Florida.



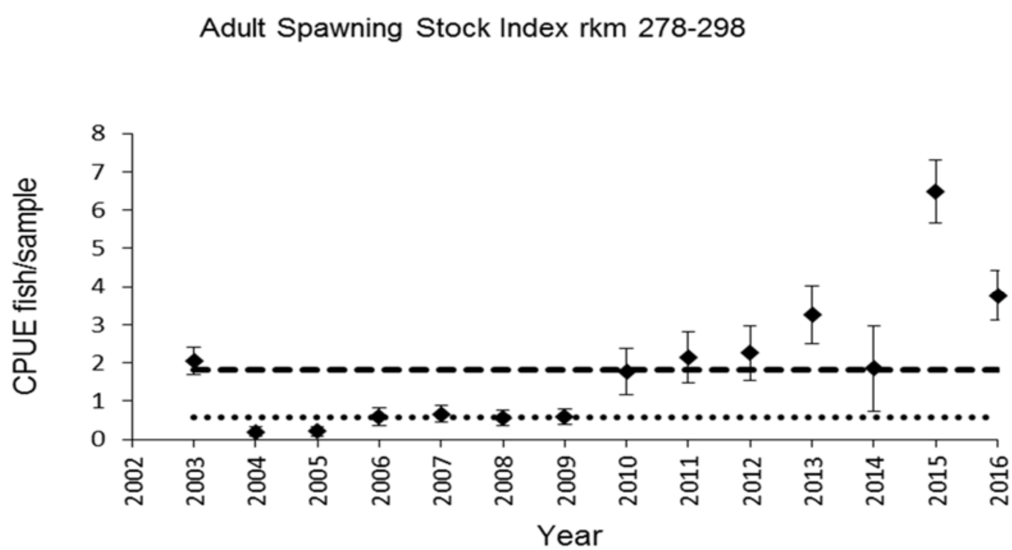


Figure 6. **Electrofishing catch per unit effort (geometric mean catch per 10 minute transect) of American Shad from the St. Johns River in each of two areas. Dashed line is the media. Dotted line is the 25th percentile. The spawning stock index from rkm 314-358 was designated as the index for a fishery independent benchmark in the initial SFMP.The water level in 2015 and 2016 was above the 90th percentile of historic levels during the spawning season and may have impacted the electrofishing survey's ability to correctly index relative abundance by causing the distribution of fish on the spawning ground to shift downstream.**

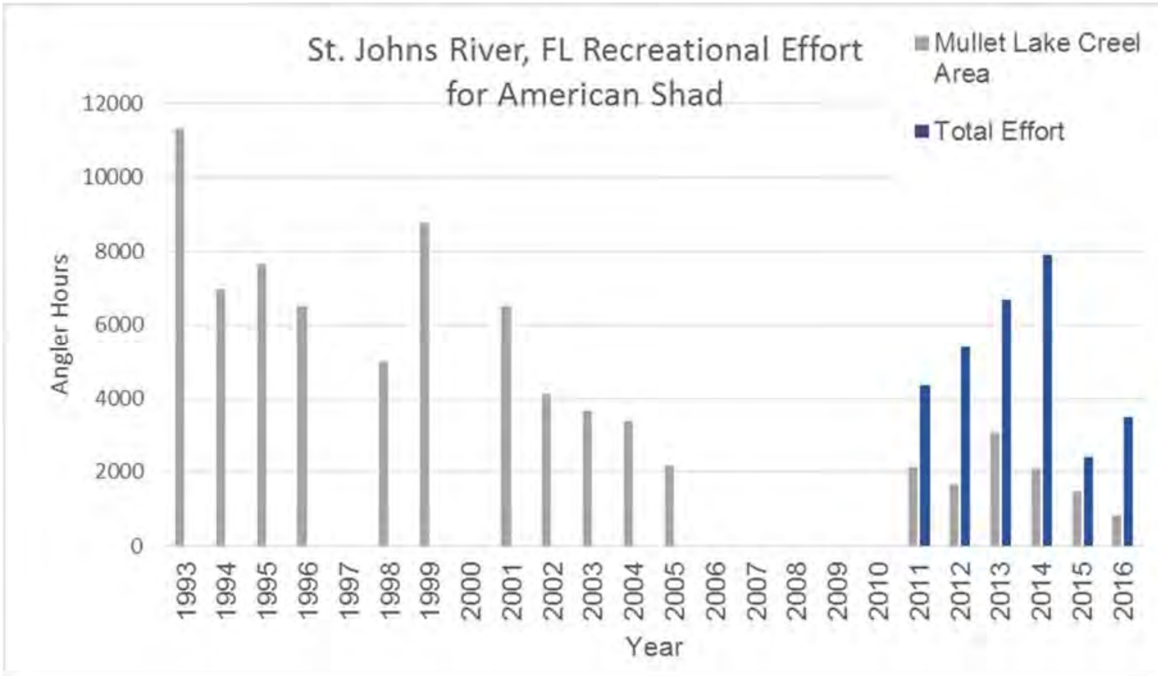


Figure 7. Recreation effort for American Shad in the St. Johns River, Florida expressed as angler-hours. An additional stratum was added in 2011 as effort shifted away from the orginial area. "Mullet Lake Creel Area" is still treated as a unique stratum for comparison to the 1993 to 2005 data.

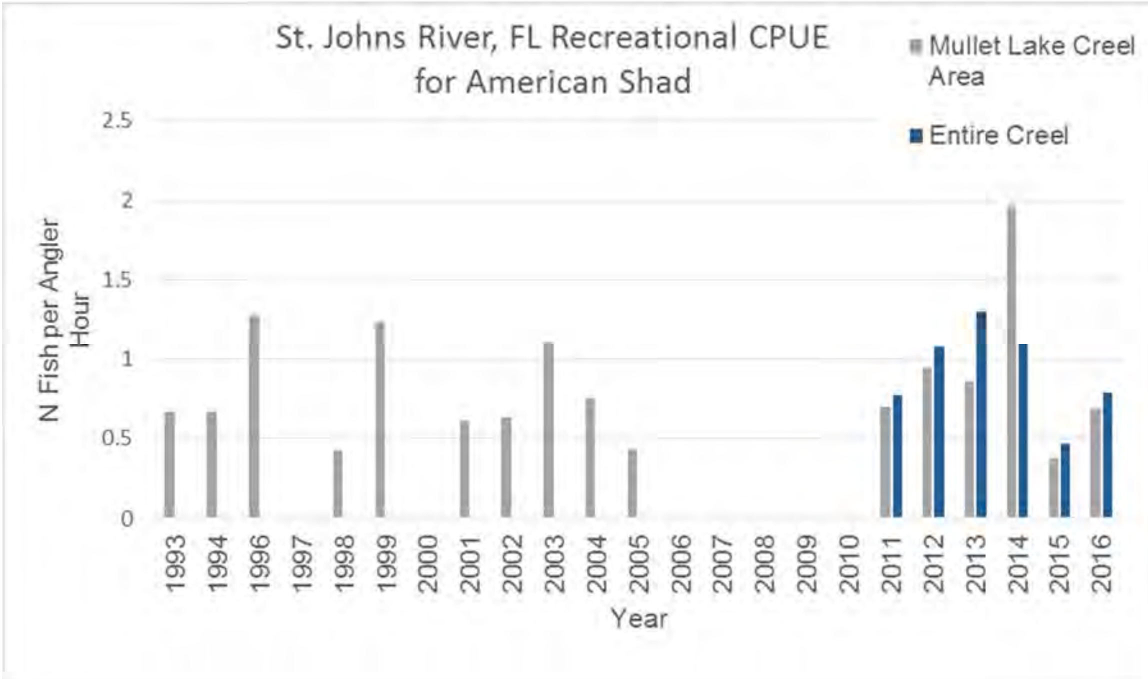


Figure 8. The catch per unit effort of American Shad from the recreational fishery in the St. Johns River, Florida from the Mullet Lake Creel Area stratum and averaged across both creel strata from 2011 to 2016.

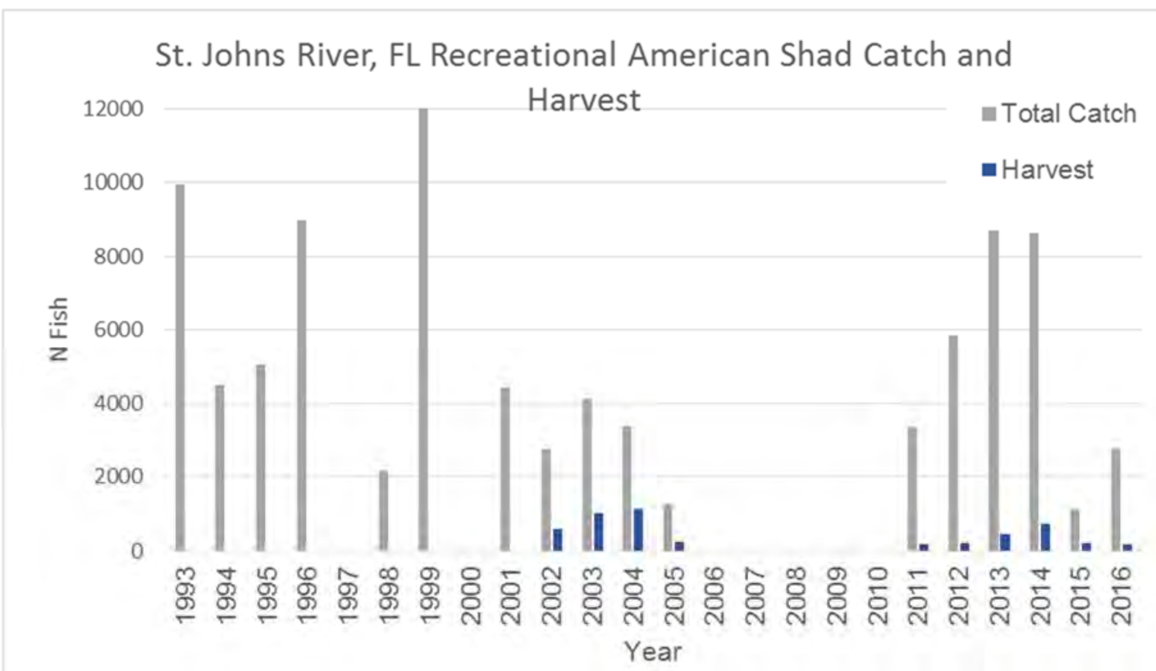


Figure 9. The total catch and harvest of American Shad in the recreational fishery in the St. Johns River, Florida.

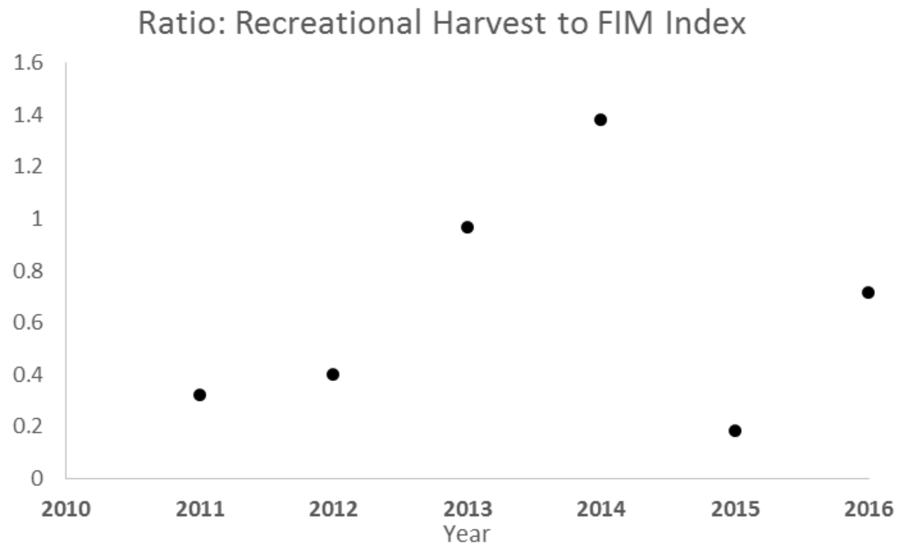


Figure 10. Relative harvest index. This is calculated as the ratio of the total number of American Shad harvested by the recreational fishery to the annual geometric mean electrofishing CPUE multiplied by 100. These data may be suitable to create a benchmark that combines fishery catch/harvest data and independent monitoring data in the future.

Blueback Herring Sustainable Fishing Plan Update for South Carolina

Prepared by

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March 10, 2017

South Carolina Dept. of Natural Resources

Wildlife and Freshwater Fisheries and Office of Fisheries Management

Updated-ASMFC River Herring Sustainable Fishing Plan for South Carolina

Introduction:

The purpose of this sustainable fisheries management plan is to allow existing river herring fisheries that are productive and cause no threat to future stock production and recruitment to remain in place and close all others. Some excerpts from the stock status review for SC's river herring were used in this document (ASMFC 2008). The review, which was prepared and submitted to the ASMFC shad and river herring board by SCDNR and the Stock Assessment Subcommittee (SASC), summarizes SC's fisheries for river herring.

Historically, river herring (blueback herring *Alosa aestivalis*) occurred in most of South Carolina's major rivers (Figure 1). Commercial fisheries for blueback herring in South Carolina occur to a limited extent in open rivers such as Winyah Bay tributaries (Lowther's lake area in the Pee Dee River), but the majority of river fishing activity occurs in hydro-electric tailraces of the Santee-Cooper River system (Figure 2). It remains the most important and the most closely monitored fishery in the state. A brief history of the Santee-Cooper Complex is detailed in Appendix 1. Recreational fisheries for blueback herring exist, but only as a bycatch to the American shad fishery.

Management of blueback herring in South Carolina is shared between the Marine Resources and Freshwater Divisions of the Department of Natural Resources (SCDNR). Management units are defined by stock and the complex of river(s) utilized. Management units include all rivers and tributaries within each area complex: Winyah Bay (Sampit, Lynches, Pee Dee, Bull Creek, Black, and Waccamaw Rivers) and the Santee-Cooper Rivers complex.

Current regulations:

The SCDNR manages commercial herring fisheries using a combination of seasons, gear restrictions, and catch limits. In 1964, commercial blueback herring fishing in Cooper River was restricted to daylight hours with a dip net not more than three feet in diameter and a limit of 100 lb (45.4 kg) per person per day. By 1969, regulations had been liberalized to allow nets with six foot diameters, fishing until ten o'clock p.m., and no limit on the harvest. Between 1966 and 1969, herring were abundant and the fishery expanded. Fishing success declined in the early 1970s and a limit of 600 kg of herring per person day was imposed in 1975. Today, the commercial fishery for blueback herring has a 10 bushel daily limit (227 kg) per boat in the Cooper and Santee Rivers and the Santee-Cooper Rediversion Canal. Seasons generally span the spawning season. All licensed fishermen have been required to report their daily catch and effort to the SCDNR since 1998. Current regulations are summarized in Appendix 2.

The recreational fishery has a 1 bushel (22.7 kg) fish aggregate daily creel for blueback herring in all rivers; however very few recreational anglers target blueback herring.

Brief description - Current status of the stocks:

a. Landings:

Reported commercial landings data of river herring in South Carolina are available from the National Marine Fisheries Service and the state. Landings reported to the NMFS prior to 1979 were collected from major wholesale outlets located near the coast and probably did not account for inland landings which were generally not sold at these outlets. NMFS data collected since 1979 usually include inland landings. However, the wholesale dealer reporting system utilized by the NMFS may not include herring landings because herring sold as bait to licensed bait dealers may not be reported. In 1998, the state of South Carolina instituted mandatory reporting of commercial catch and effort.

In 1969, the South Carolina Department of Natural Resources instituted a commercial creel survey to estimate catch and effort in the fisheries in the Santee Cooper system. Surveys occur at landings used to off-load and transport catch. The majority of herring harvested from the Cooper River (1969-1989) were landed at two locations between the hours of six p.m. and ten p.m. daily. Creel clerks stationed at these locations interviewed individual fishermen as the catch was unloaded. The time, date, type of gear used, catch, and number of fishermen aboard were recorded as each boat landed. The survey was expanded to the major landing below the St. Stephen Dam on the Rediversion Canal starting in 1990 as water flow and fish abundance declined in the Cooper River and increased in the Santee River and the Rediversion Canal. During low flow years when flow is reduced in the Rediversion Canal, herring and the fishery moves to the Santee River below the Wilson Dam or to the Cooper River downstream of Pinopolis Dam. Surveys have been infrequent at those locations. Weight of harvest was estimated from the number of bushels of herring landed and a mean bushel weight of 25.4 kg (Cooke 1998). Numbers of adult blueback herring landed were estimated by dividing kg landed by the mean weight of an adult herring (0.14 kg). Although some landings are occasionally missed during the creel survey, the survey produces the most reliable estimates of catch and effort available for South Carolina waters. Landings were not estimated for reservoir fisheries with landings of mixed species and size composition.

SCDNR has conducted an annual recreational creel survey for American shad since 2001 to estimate exploitation and catch-per-unit-effort in the recreational fishery of the Santee Cooper system. These data consist of access point creel surveys (at end of a party's fishing day) for at least 2 h/d, 4 d/week along with effort estimates made by counting boats below the Pinopolis Dam, the Wilson Dam, or the Rediversion Canal at approximately 1400h each day of survey. Previous data demonstrated that a 1400h boat count measures maximum daily fishing pressure. Blueback herring are caught in this fishery; however, they are not targeted and are caught in minimal numbers.

SCDNR also conducted sportfishing creel surveys on the Cooper and Santee Rivers in 1981 - 1982 and 1991 - 1993 to evaluate the impact of the Rediversion Canal on these recreational fisheries (Cook and Chappelear 1994). These surveys examined the total recreational fisheries on each river, but did not provide data on catch of blueback herring. Thus, the surveys could only be used to indicate change in the size of the fishery.

Recreational creel surveys were conducted on the Savannah River in the late 1990s by the Georgia Department of Natural Resources in 1997 and SCDNR in1998 and 1999. Estimates of catch from these surveys varied from year to year largely due to dramatically different flow conditions. Catch estimates from each of these creel surveys were provided by Boltin (1999).

b. Fishery Independent Indices:

A variety of sample efforts have been conducted to assess the condition of blueback herring stocks in South Carolina. Annual passage counts at the St. Stephen Dam on the Santee-Cooper Rediversion Canal provide the longest times series of data (Table 1). Periodic electro-fishing and gill net sampling occurred in the Santee River below the Wilson Dam and population estimates were obtained for several years at that location. Population estimates (1980-1990) were orders of magnitude larger than passage for the same time frame (Table 2). In addition, annual electro-fishing sampling has been conducted in Winyah Bay and the Santee, Cooper, Edisto, and Combahee Rivers. Ichthyoplankton surveys were made for several years on the Santee and Cooper Rivers. More recently, annual gillnetting has occurred to assess CPUE for adult herring returning to the Santee River. As part of another program, electrofishing sampling now occurs in Lakes Marion and Moultrie (Santee-Cooper Lakes) to assess juvenile recruitment in rivers upstream of impoundments. However, the latter three surveys do not provide a long enough data series to provide sustainability.

c. Fishery Dependent Indices:

Over 1,000,000 kg of river herring were reported from South Carolina commercial fisheries in 1969. Landings declined precipitously soon after. They rebounded to a high of approximately 260,000 kg in the early 1980s and again in the 1990s. They have fluctuated at less than 70,000 kg since 2001. The bulk of the reported landings since 1989 have come from the Santee-Cooper system. Reported landings for the Pee Dee River of the Winyah Bay system have remained at less than 1,000 kg per year since mandatory reporting was initiated in 1998.

Annual variation in reported landings since the early 1970s may have been influenced by changes in allowable catch over the years. Landings in the Santee Cooper system were also affected by changes in discharge from the three dams and concurrent changes in fish migration and gear effectiveness.

Annual estimates of catch in kg, effort in person days, and kg catch/person day (CPUE) are available since 1969 from surveys of the Santee-Cooper fishery (Figure 3). Estimates of all three parameters have fluctuated widely over the time series. Highest estimates of landings and CPUE occurred early in the time series in the Cooper River prior to the diversion of water from the Cooper to the Santee system.

Many factors likely affected effort and landings. To evaluate potential causes of change, we separated data from the Cooper River into two times series (1969 - 1974 and 1975 – 2008) and subset data for the Santee River to those from 1975 – 2008. We then normalized the estimates by dividing annual values by the series mean. Sub setting the Cooper River data reduced the influence of the relatively large estimates obtained early in the time series on the rest of the data. Normalizing the time series placed all parameters on a comparable scale. Effort and landings were highly correlated in both the Cooper River fisheries (1969-1974, r^2=0.90; 1975-2008, r^2=0.85) and the Santee River fisheries (1990-2008, r^2=0.94) (Figure 4). Effort played an important role in dictating landings. However, CPUE was also related to effort. If we assume that CPUE was a measure of relative stock abundance, then we can speculate that changes in stock abundance and related fishing success led to changes in effort and then in landings.

CPUE in the Santee River fishery increased rapidly following increased flows from rediversion. CPUE leveled off in the mid to late 1990s and then declined abruptly following a severe drought that lasted from 1999 through mid 2002. Santee River CPUE has fluctuated without trend since that time. The initial CPUE increase in the Santee River fishery likely resulted from a combination of herring from the Cooper River stock that began to migrate into the Santee River as flow increased and improved production from improved spawning and nursery habitat. We do not know if reduced CPUE since the drought resulted from declining stock levels or from low fishing success caused by low water levels. Fishing did not occur, or was severely limited in 2002, and harvest estimates were not made.

4. Fisheries to be Closed:

a. Commercial: Winyah Bay (Sampit, Lynches, Bull Creek, Black, and Waccamaw Rivers)**. Note: SC believes these fisheries are sustainable based on past and present anecdotal data, but since these data are not statistical in nature and under stipulations of Amendment 2, we must close these fisheries.**

b. Recreational: Winyah Bay (Sampit, Lynches, Pee Dee, Bull Creek, Black, and Waccamaw Rivers)
Ashepoo River
Combahee River
Edisto River
Savannah River

5. Fisheries Requested to be Open:

a. Commercial: The Santee-Cooper Rivers complex and Pee-Dee River

b. Recreational: The Santee-Cooper Rivers complex

6. Sustainability

Systems with a sustainable fishery are defined as those that demonstrate their river herring stocks could support a commercial and / or recreational fishery that will not diminish potential future stock reproduction and recruitment. If fisheries exceed sustainability benchmarks, management action will be taken (Table 1).

Santee-Cooper Rivers complex

The term 'relative exploitation", as appears on Table 2, is calculated as estimated harvest in numbers divided by a minimum population estimate in numbers. The minimum population estimate is calculated as the harvest in numbers plus the passage in numbers at the St. Steven's lift on the Rediversion Canal. Since only a portion of fish in the Rediversion Canal and the Santee River actually move above the St. Steven's Dam, the minimum population estimate is an underestimate of the actual population. During years when both passage counts and population estimates were made (1986-1990), the minimum population estimates averaged 2.3 percent of the population estimate (Table 3). Consequently, estimates of relative exploitation in Table 2 are gross overestimates of the true exploitation rate for the Santee stock. To account for this, adjusted exploitation rates were developed using "scalar" values. These were created by dividing minimum population estimates by population estimates for years when population estimates occurred and calculating a mean for those years (0.023, Table 4). In an attempt to address variation and the possibility that the relationship between population size and fish passage has changed over time, an additional scaler was created in the same manner using the lower confidence limits from the population estimates (0.440, Table 4). When compared to other years in this range, the estimate for 1988 appeared to be an outlyer. As a result, a final scaler was created using the lower confidence limits, but excluding the estimates for 1988 (0.052,Table 4). All scalers (0.023, 0.440, 0.052) were then multiplied by the annual relative exploitation to produce adjusted and more realistic estimates of exploitation rates (Table 2). SC believes the estimate using the 0.052 scaler (lower bound without 1988 value) is the most appropriate and realistic to depict approximate exploitation from this fishery.

Adjusted exploitation rates using the 0.052 scaler were very low and no trend was apparent among years. By comparison, u_{msy} (target exploitation rates) for blueback herring of the Chowan River, North Carolina was $u_{msy} = 0.67$, while that for herring of the Connecticut River, Connecticut and St. John River, New Brunswick were $u_{msy} = 0.75$ (Crecco and Gibson 1990). Adjusted estimates of u imposed by the commercial fishery in the Rediversion Canal are well under all of these benchmarks. Continued harvest at these low rates should be sustainable and should allow for recruitment and future stock reproduction. In addition, numbers of blueback herring passed (438,746), at St. Stephen Dam in 2009, exceeded the past 5 years combined. During the years 1980-1990 concurrent population estimates of the Santee stock below the Rediversion Canal were orders of magnitude greater than fish passed at the dam. Also, recent declines in commercial landings correlate directly to a notable reduction in trips (Figure 5).

SC proposes that the "interim" sustainability benchmark of u = 0.050 continues to be used to manage the Santee-Cooper River herring fishery. Status of the fishery relative to this benchmark will continue to be measured by three year running averages of the scaled annual relative exploitation rates. Annual exploitation rates will be estimated by multiplying annual estimates of relative exploitation by 0.052. Since the development of the original plan, three year running average scaled exploitation rates have not exceeded the sustainability benchmark of 0.050 (Figure 6).

Pee-Dee River

The Pee Dee River is part of the Winyah Bay System which also includes the Sampit, Black, Waccamaw, and Little Pee Dee Rivers. It is a large free flowing river up to river kilometer (rkm) ~302 where the first barrier (Blewett Falls Dam) is located in NC (Figure 7). The Pee Dee River herring fishery takes place in a small oxbow lake area known as Lowthers Lake located at rkm 176 just north of I-95 and Darlington, SC. The herring fishery for the Pee-Dee River is so insignificant (<472 kg avg. for years 1998-2015; in some years <3 kg), it is believed fishing on this river is not having an overall negative impact on herring populations (Table 5, Figure 8). The number of licensed fishermen is declining with each passing year and those that remain in the fishery are subsistence fishermen who only use fish for personal consumption. As part of the requirements for the previous plan, SC collected fishery dependent biological data to assess the relative fitness of the Pee Dee River herring fishery. Scales for ageing, sex, and length information were collected from up to 100 fish during 2011, 2013, 2014, and 2015. Results show normal age distribution, some degree of repeat spawning, and no significant declines in overall length (Figures 9-10, Table 6). SC requests to maintain this fishery with a 1,000kg harvest cap for the season. During this time, length and age data from the spawning stock will continue to be collected and analyzed. Status of the fishery will continue to be measured by three year running averages of total landings. If at any time, landings exceed the proposed cap for three consecutive years, regulation changes would be considered for this fishery. Based on documented low landings (1,000 kg. is equivalent to < 4 days' allowable catch in the commercial fishery) and results of biological data, SC believes this is a reasonable request for the small Pee Dee River herring fishery.

7. Adaptive Management

SCDNR will continue to monitor both fish passage and the commercial fishery landings in the Santee-Cooper system. In addition, fishery independent sampling for spawning adults in the lower Santee River will continue annually.

If collected data indicates changes in exploitation or decreasing abundance in juveniles, action will be taken by SCDNR. These actions may include increasing days for escapement, limiting seasons, etc. In the event these actions are not successful in reversing negative trends, SCDNR would then be forced to close this fishery.

Several recommendations were included for SC as part of the stock status review for river herring. They are highlighted in the following:

"We recommend that age data be obtained from blueback herring of the Santee River, the Santee-Cooper Rediversion Canal, and the Cooper River and that the commercial creel survey of tailrace fisheries in the system be continued." Age and harvest data are important to understanding current stock dynamics and factors affecting recent river herring abundance. "We also recommend that a sample program be developed or existing programs be improved to track annual production of young."

SC has since implemented all suggested recommendations as part of ASMFC/ACFCMA funded work or by utilizing other SCDNR funding sources. With the dissolution of Anadromous Fish Conservation Act funds, SCDNR was forced to be creative in order to meet requirements of Amendment 2. To complete all mandated goals annually, personnel from other areas and funding sources have been used. Once these funds expire it is anticipated SCDNR will simply not have adequate personnel to complete the work. Furthermore, to date SCDNR has had ~48% cut from the state's appropriated operating budget and is expecting more cuts. If a reduction in force (RIF) is implemented and project personnel are affected, SCDNR will not be able to meet the requirements.

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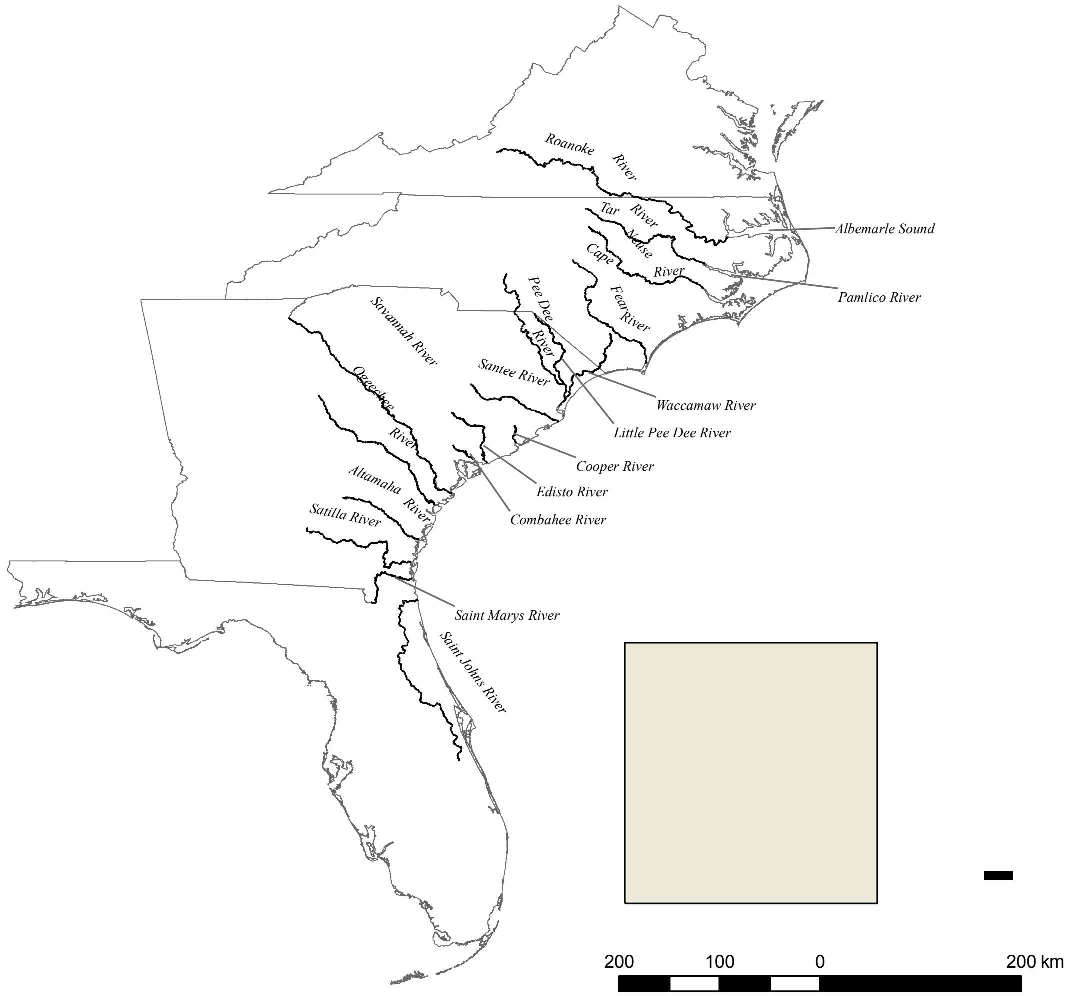


Figure 1. South Carolina Rivers.

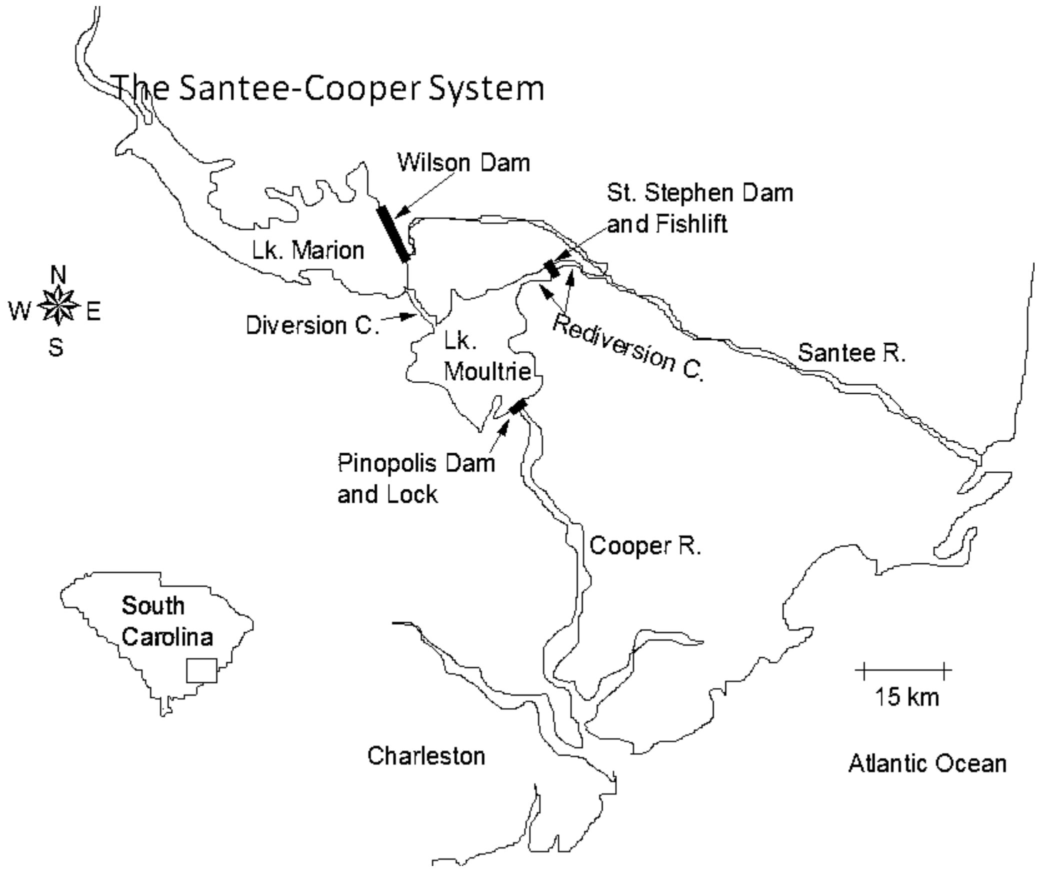


Figure 2. Santee-Cooper Rivers complex in South Carolina.

Table 1. Sustainability values and triggers.

Index	Benchmark Value	Years included in index	Management trigger
Santee-Cooper Rivers Complex	u = 0.050	1990-2015	3 consecutive years below benchmark
Pee Dee River	1000kg	1998-2015	3 consecutive years below benchmark

Table 2. Annual number of blueback herring passed at the St. Stevens Fish Lift, Santee-Cooper Rediversion Canal; harvested in the commercial fishery, minimum population size*, relative exploitation.

							Scalar M-R	Scalar M-R LCI all years		Scalar M-R LCI w/o 1988	
Year	Metric Tons	Harvest Data (Kg)	Number caught (Lbs/.3)	Passage	Minimum Population	Relative Exploitation	0.023	0.440	3-yr running avg.	0.052	3-yr running avg.
1990	1.28	1280	9,408	71,000	80,408	0.12	0.003	0.053		0.006	
1991	9.83	9830	72,251	400,000	472,251	0.15	0.003	0.066		0.008	
1992	91.77	91770	674,510	589,000	1,263,510	0.53	0.012	0.233	0.117	0.027	0.014
1993	180.92	180920	1,329,762	345,000	1,674,762	0.79	0.018	0.348	0.216	0.041	0.025
1994	128.91	128910	947,489	298,000	1,245,489	0.76	0.018	0.335	0.305	0.039	0.036
1995	206.89	206890	1,520,642	561,000	2,081,642	0.73	0.017	0.321	0.335	0.038	0.039
1996	265.06	265060	1,948,191	1,452,285	3,400,476	0.57	0.013	0.251	0.302	0.030	0.036
1997	142.24	142240	1,045,464	176,814	1,222,278	0.86	0.020	0.379	0.317	0.045	0.037
1998	179.61	179610	1,320,134	112,466	1,432,600	0.92	0.021	0.405	0.345	0.048	0.041
1999	**120.38**	**120380**	**884,793**	**182,798**	**1,067,591**	**0.83**	**0.019**	**0.365**	**0.383**	**0.043**	**0.045**
2000	**134.83**	**134830**	**991,001**	**695,586**	**1,686,587**	**0.59**	**0.014**	**0.260**	**0.343**	**0.031**	**0.040**
2001	**24.29**	**24290**	**178,532**	**1,862,015**	**2,040,547**	**0.09**	**0.002**	**0.040**	**0.222**	**0.005**	**0.026**
2002	**0**	**0**	**0**	**421,459**	**421,459**	**0**	**0**	**0**	**0.100**	**0**	**0.012**
2003	52.25	52250	384,038	86,909	470,947	0.82	0.019	0.361	0.134	0.043	0.016
2004	9	9000	66,150	35,545	101,695	0.65	0.015	0.286	0.216	0.034	0.025
2005	35.04	35040	257,544	175,184	432,728	0.6	0.014	0.264	0.304	0.031	0.036
2006	7.5	7500	55,125	105,129	160,254	0.34	0.008	0.150	0.233	0.018	0.027
2007	50.7	50700	372,645	49,343	421,988	0.88	0.021	0.387	0.267	0.046	0.031
2008	**0**	**0**	**0**	**8,503**	**8,503**	**0**	**0**	**0**	**0.179**	**0**	**0.021**
2009	71.6	71600	526,260	438,746	965,006	0.55	0.013	0.242	0.210	0.029	0.025
2010	69.6	69600	511,560	217,750	729,310	0.70	0.016	0.309	0.183	0.036	0.022
2011	37.6	37600	276,360	336,210	612,570	0.45	0.011	0.199	0.249	0.023	0.029
2012	**18.9**	**18900**	**138,915**	**37,117**	**176,032**	**0.79**	**0.018**	**0.348**	**0.285**	**0.041**	**0.034**
2013	**33.5**	**33500**	**246,225**	**113,860**	**360,085**	**0.68**	**0.016**	**0.301**	**0.282**	**0.036**	**0.033**
2014	**52.1**	**52120**	**383,082**	**171,200**	**554,282**	**0.69**	**0.016**	**0.304**	**0.318**	**0.036**	**0.037**
2015	**22.5**	**22500**	**165,375**	**244,631**	**410,006**	**0.40**	**0.009**	**0.178**	**0.261**	**0.021**	**0.031**

*number lifted + number harvested in fishery

Drought years or mechanical failures at the fish lock

Table 3. Mark recapture population estimates of blueback herring in the Santee River, South Carolina.

Year	N	CV	Confidence Interval Lower	Upper
1980	5,895,796	0.25	3,012,000	8,780,000
1981	4,054,521	0.23	2,236,000	5,873,000
1982	664,151	0.17	400,000	888,000
1983	2,352,005	0.45	297,000	4,407,000
1984	2,625,000	0.24	1,417,000	3,833,000
1985	6,205,353	0.71	0	14,822,650
1986	9,061,064	0.41	1,817,496	16,304,632
1987	3,805,457	0.29	1,657,618	5,953,296
1988	5,507,918	0.50	116,348	10,899,488
1989	5,501,964	0.22	3,153,678	7,850,250
1990	9,353,003	0.22	5,358,472	13,347,534

Table 4. Calculation of scalar for adjusting relative exploitation rate for the Santee River.

Year	Minimum Population	M-R Population	M-R Lower CI	M-RLower CI w/o 1988	min/M-R	min/M-R LCI	min/M-R LCI w/o 1988
1986	187,000	9,061,064	1,817,496	1,817,496	0.021	0.103	0.103
1987	74,000	3,805,457	1,657,618	1,657,618	0.019	0.045	0.045
1988	232,000	5,507,918	116,348		0.042	1.994	
1989	147,000	5,501,964	3,153,678	3,153,678	0.027	0.047	0.047
1990	71,162	9,353,003	5,358,472	5,358,472	0.008	0.013	0.013
				Scalar	0.023	0.440	0.052

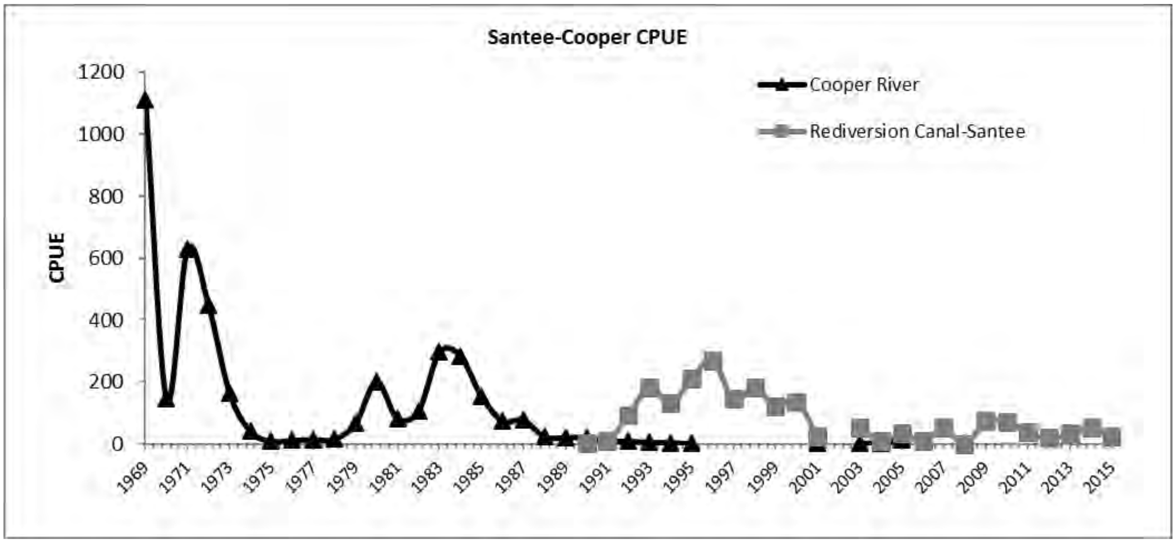
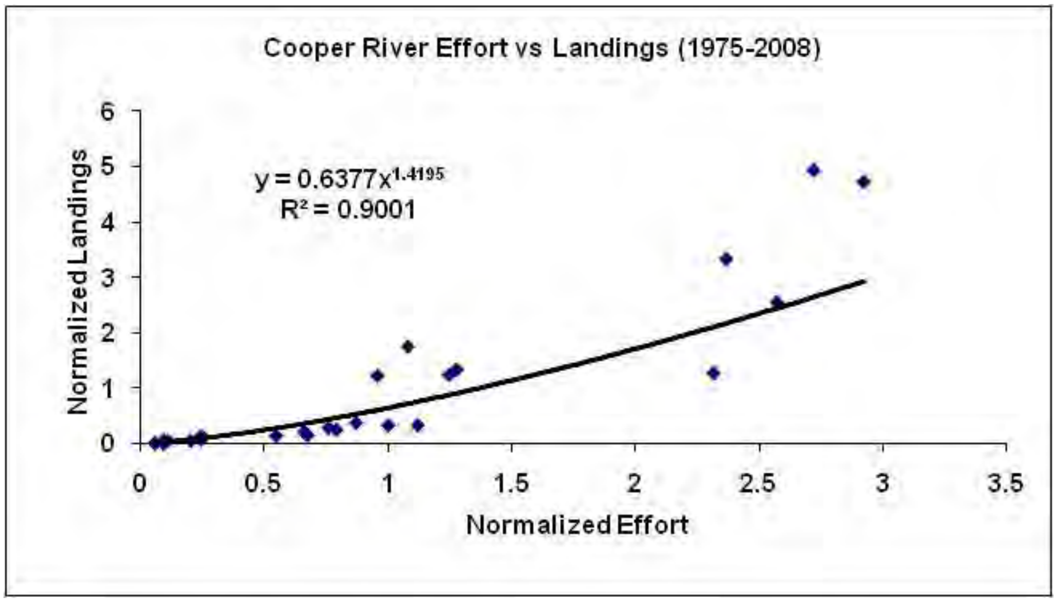


Figure 3. Estimated effort (CPUE) in the commercial fishery for blueback herring in the Cooper River and the Santee-Cooper Rediversion Canal, South Carolina.



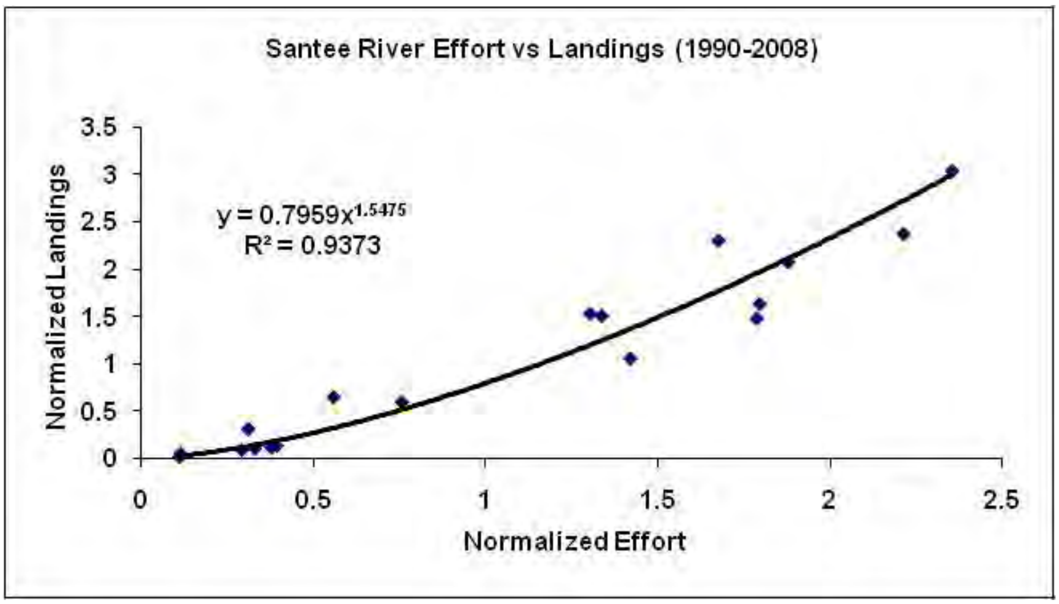


Figure 4. Normalized effort vs. normalized landings in the commercial fisheries of the Cooper and Santee Rivers, South Carolina.

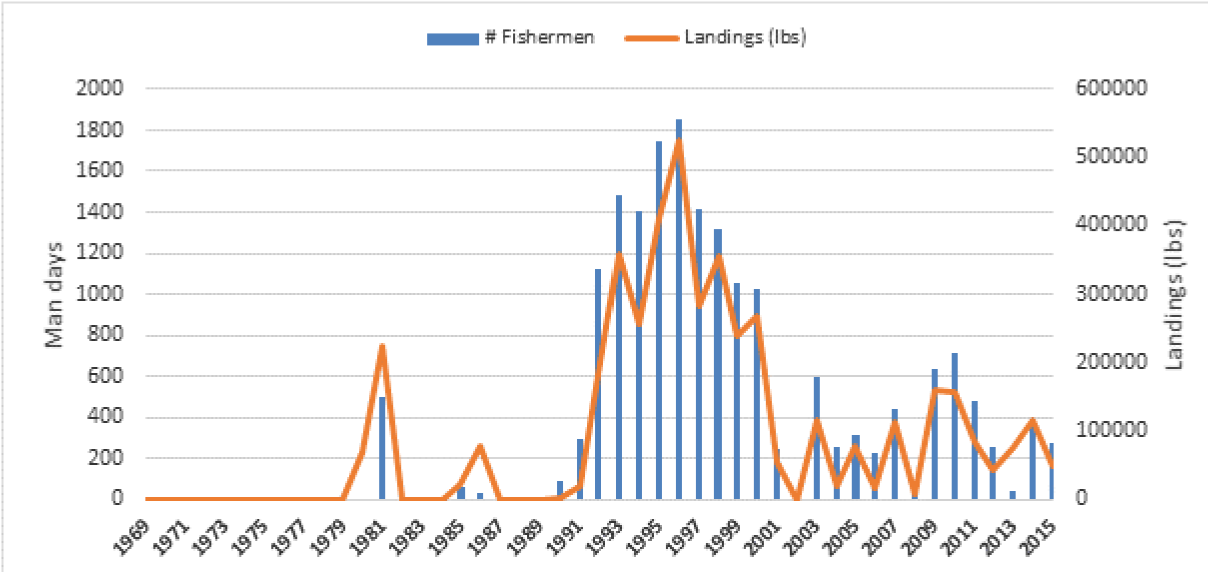


Figure 5. Number of Santee River fishermen versus pounds of herring harvested 1969-2015.

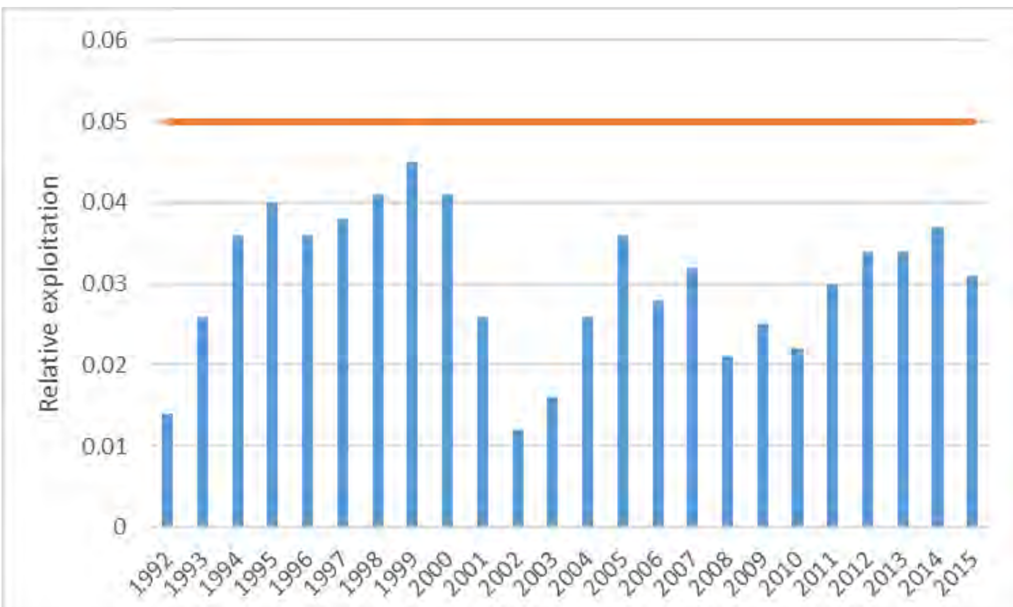


Figure 6. Relative exploitation for the Santee blueback herring fishery compared to .050 benchmark target (1992-2015).

Table 5. Landings of blueback herring from the Pee-Dee River (1998-2015).

Year	Kg.
1998	2
1999	15
2000	323
2001	817
2002	131
2003	350
2004	93
2005	162
2006	14
2007	259
2008	643
2009	660
2010	999
2011	894
2012	855
2013	758
2014	767
2015	919

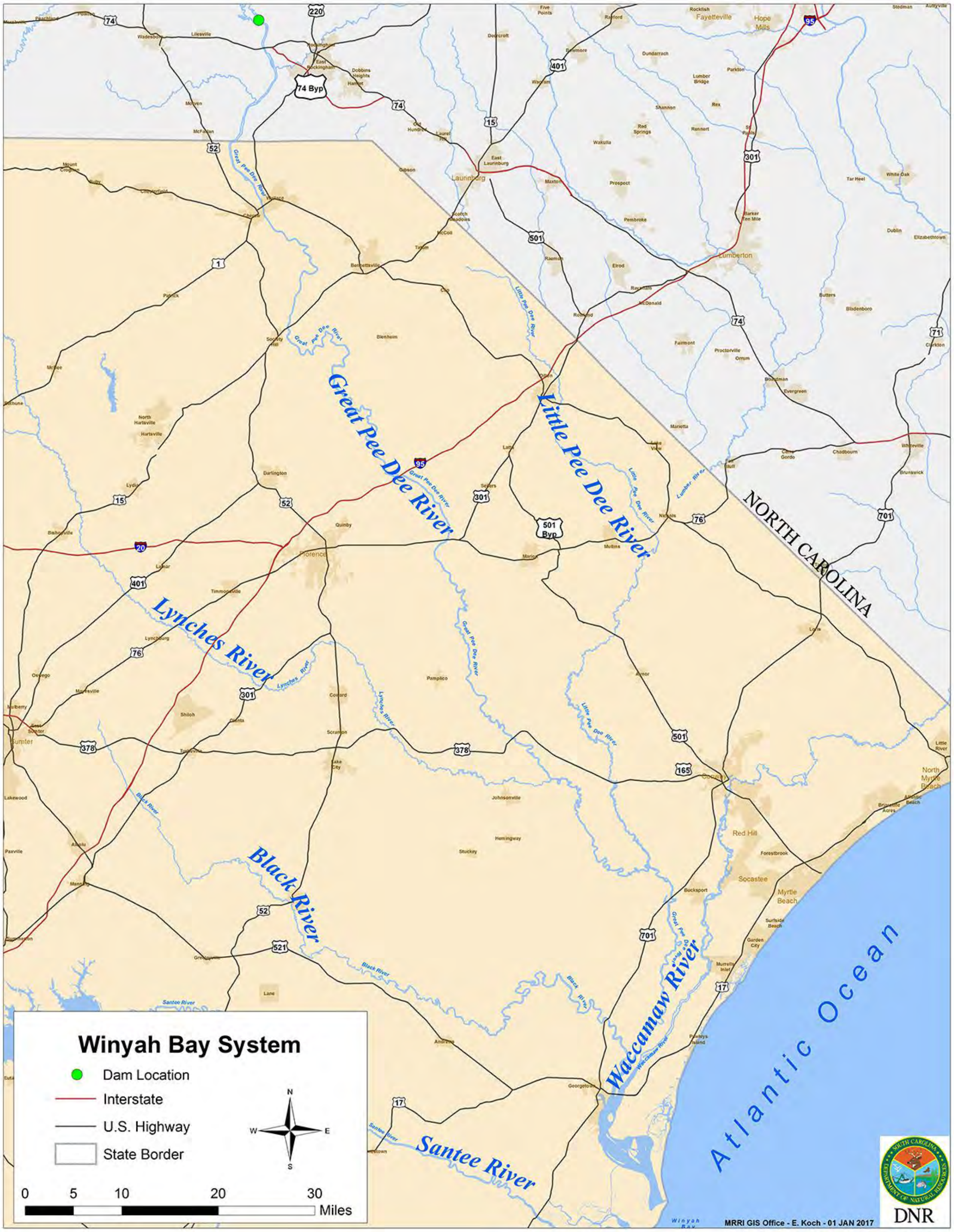


Figure 7. Winyah Bay System including the Pee Dee River.

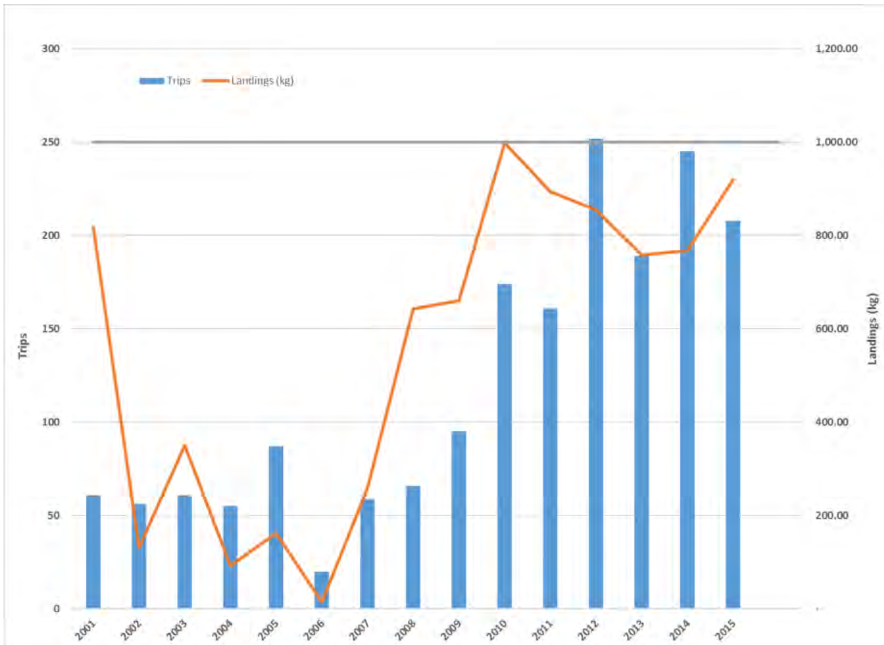


Figure 8. Pee-Dee River blueback herring landings compared to number of trips (2001-2015).

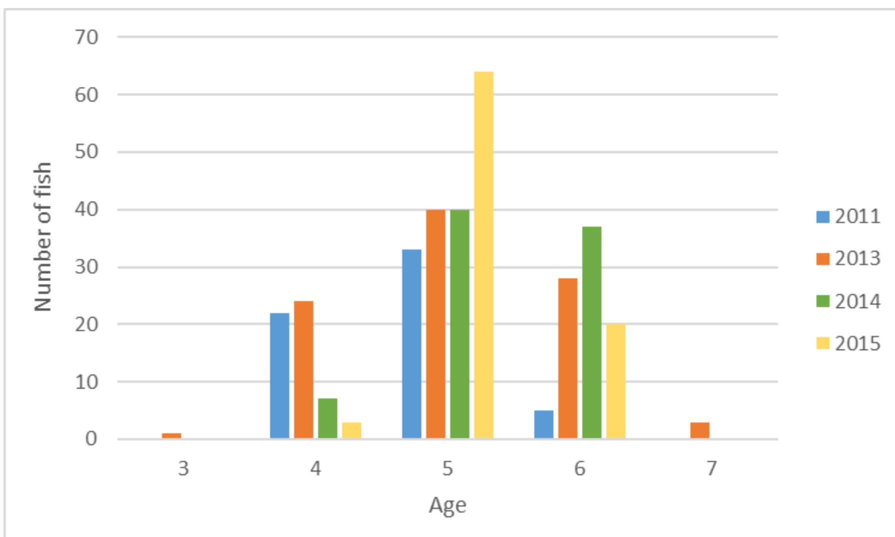


Figure 9. Pee-Dee River blueback herring age distribution (2011, 2013-2015).

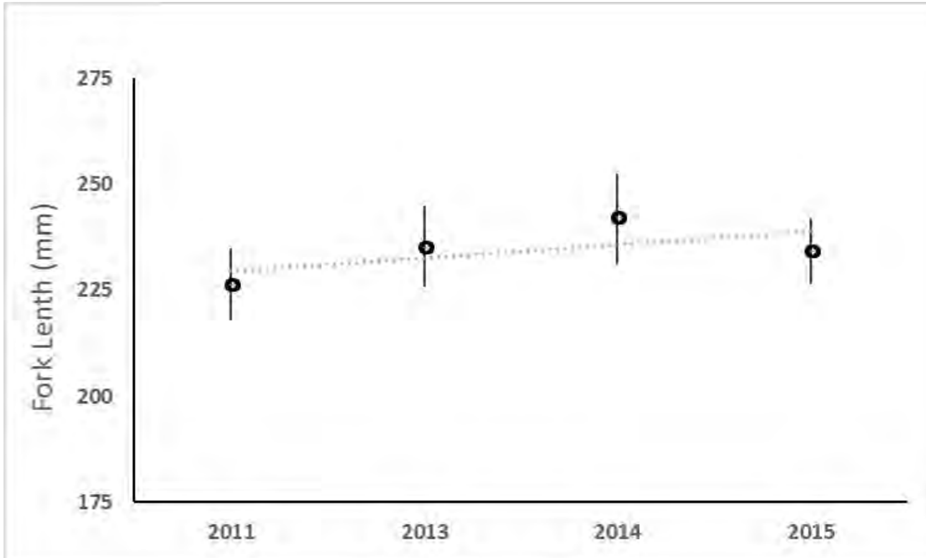


Figure 10. Pee-Dee River blueback herring mean fork length and standard deviations for 2011 and 2013-2015.

Table 6. Percent of repeat spawning Pee-Dee River blueback herring (2011, 2013-2015).

	2011	2013	2014	2015
% with one spawning mark	33	28	25	15
% with two spawning marks	5	11	1	2
% repeat spawners	38	41	26	17

Appendix 1. Brief description of the Santee-Cooper Complex

In 1938, the South Carolina Public Service Authority (SCPSA) initiated the Santee-Cooper Diversion Project. The project dammed Santee River at river km 143.201 and the headwaters of Cooper River creating two reservoirs joined by a canal (Figure 2). The canal allowed Santee River water to be diverted into Lake Moultrie and the Cooper River. Benefits provided were flood control, improved navigation, and hydroelectric power production. Wilson Dam, a flood control structure constructed on Santee River (river km 143) created Lake Marion. Pinopolis Dam (river km 77), a hydroelectric facility and navigation lock, impounded diverted water from Lake Marion along with the headwaters of Cooper River to form Lake Moultrie. In 1957, it was documented that blueback herring, passed into the lakes during boat lockings, provided as much as 25% of the diet of adult Santee-Cooper striped bass (Stevens 1957). Since then, the SCPSA has operated the lock three to six times daily during the spring spawning run, to allow blueback herring to enter the lake system. This action not only supplemented the system's forage base but also provided anadromous fish access to additional spawning areas. From 1975 to 1984, a hydroacoustic survey estimated 2.2 - 10.8 million blueback herring (mean = 5.7 million) were admitted into Lake Moultrie annually (Christie and Barwick 1984).

As a result of the Santee-Cooper Diversion Project, increased flows down the Cooper River from diverted Santee River water accelerated shoaling in Charleston Harbor (USACE 1975). The Cooper River Rediversion Project was proposed to reduce shoaling by reducing the flow to Charleston Harbor. In 1985, the U.S. Army Corps of Engineers (USACE) finished construction of a 9.5-mile canal to re-divert approximately 75% of the Cooper River flow back into Santee River. The project set a maximum weekly average discharge of 127 cms for Cooper River with the remainder being diverted to Santee River via the new Rediversion Canal. During periods of low water inflow (i.e. below 127 cms), virtually all water released from Lake Moultrie flows down Cooper River. This is because power generation at Pinopolis Dam is more efficient than at the new hydro-facility. Discharge is not regulated at the St. Stephen Dam on the Rediversion Canal. Wilson Dam still releases a continuous 14.6 cms from Lake Marion into Santee River. Concern that reduced discharge to Cooper River would attract fewer blueback herring, decreasing the number that annually migrated through Pinopolis Lock into the Santee-Cooper lakes arose. The USACE predicted that while fisheries resources may decline on Cooper River they would increase on Santee River (USACE 1975). To maintain the number of anadromous fish entering the lakes, the USACE constructed a fish lock on the Rediversion Canal to allow Santee River fish access to Lake Moultrie.

In 1985, water flowing from the Cooper River was re-diverted to the Santee River. A fish lock, constructed at the St. Stephen Dam on the Rediversion Canal, was designed to mitigate the decline of fish passage on the Cooper River. Despite this effort, total fish passage rapidly declined after Rediversion. High or intermittent discharges from the St. Stephen Dam hindered fish from entering the lock. In 1990, a flow agreement with the SCPSA was initiated allowing the lock to function more effectively and the numbers of fish passed to increase. Blueback herring passage through the two facilities has never equaled the pre-Rediversion levels that occurred at the navigation lock though. Modifications to the fish lock entrance channel to increase passage efficiency have been ongoing since construction. Phase I of the modifications was completed for the 1995 season. The modification provided a corridor for fish passage that was protected from the turbulence of hydro-production, and is essentially a collection gallery that moved the entrances to the lock farther downstream. Phase IIA provided adjustable weir gates installed in the gallery prior to the 1997 season. Phase IIB became operational about halfway through the 2000 season and included a bypass siphon system that can deliver an additional attraction flow of 14 cms around the facility rather than through the fish lock grating. A juvenile separating device was also constructed to safely pass out-migrants downstream from this attraction flow.

Appendix 2. Summary of current regulations on take of blueback herring in South Carolina.

General

There is no run of the river commercial fishing activity for herring in any statewide waters except the Santee-Cooper Complex and the Pee Dee River.

Season

The open season is 15 February - 15 April in the Pee Dee River. The open season in the Santee River is 15 February - 1 May. The open commercial season for the Rediversion Canal of Santee River and the Tailrace Canal of Cooper River is 1 March – 30 April of each year.

Harvest Limits

The allowable daily take of herring for net fisheries is 10 US bushels per boat in the Tailrace Canal of the Cooper River and 10 US bushels per boat in the Rediversion Canal. There are no other caps or quotas in effect for commercial herring fisheries in South Carolina.

Gears

Approved commercial gears are anchored (set or stationary) and drift gill-nets in all open riverine waters seaward of dams, with the exceptions of open portions of the Santee and Cooper River where other gears are allowed. Circular drop-nets up to six feet in diameter, lift-nets and cast-nets are the only gears allowed in the upper Tailrace Canal of the Cooper River and in the open portions of the Rediversion Canal of the Santee River. Lift-nets, cast-nets, and hook & line may be used within the Santee-Cooper Lakes and cast-nets and/or hook & line are legal gear in other inland reservoirs. Legal minimum mesh size for gill-nets is 2 1/2" stretched mesh in all State waters open to such gear. The length of any gill-net may not exceed one half of the width of the waterway where it is fished. Gill-nets may not be fished within 200 yards of any previously deployed net. Regulatory changes implemented in 2001 restricted net lengths to a maximum of 200 yards in freshwaters and 300 yards in inland marine waters.

Lift Periods

There is a weekly 84-hour lift period in effect for the Pee Dee River during the open gill-netting season. The use of nets in the Cooper River Tailrace Canal is allowed only from sunrise until 10:00. Fishing with nets in the Rediversion Canal is allowed from 7:00 PM - 12:00 midnight EST or 8:00 PM – 12:00 PM EDT, with no lift period. Portions of several rivers are closed to commercial gear.

Actual regulations can be found at: http://www.scstatehouse.gov/code/t50c005.php, under Article15.

Atlantic States Marine Fisheries Commission

American Eel Management Board

August 2, 2017
10:15 – 11:15 a.m.
Alexandria, Virginia

Draft Agenda

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

1. Welcome/Call to Order (*J. Clark*) 10:15 a.m.

2. Board Consent 10:15 a.m.
   - Approval of Agenda
   - Approval of Proceedings from January 2017

3. Public Comment 10:20 a.m.

4. Consider North Carolina Glass Eel Aquaculture Plan for 2018 **Action** (*K. Rootes-Murdy*) 10:30 a.m.
   - Technical Committee Report
   - Law Enforcement Committee Report (*M. Robson*)

5. Consider 2016 Yellow Eel Landings Overage and Coastwide Cap **Possible Action** *(K.Rootes-Murdy)* 11:00 a.m.

6. Consider 2016 American Eel FMP Review and State Compliance **Action** (*K.Rootes-Murdy*) 11:10 a.m.

7. Other Business/Adjourn 11:15 a.m.

The meeting will be held at The Westin Alexandria, 400 Courthouse Square, Alexandria, Virginia; 703.253.8600

Atlantic States Marine Fisheries Commission

MEETING OVERVIEW

American Eel Management Board Meeting
August 2, 2017
10:15 – 11:15 a.m.
Alexandria, Virginia

Chair: John Clark Assumed Chairmanship: 8/15	Technical Committee Chair: Tim Wildman (CT)	Law Enforcement Committee Representative: Cornish
Vice Chair: Martin Gary	Advisory Panel Chair: Mari-Beth Delucia	Previous Board Meeting: January 31, 2017

Voting Members: **ME, NH, MA, RI, CT, NY, NJ, PA, DE, MD, VA, NC, SC, GA, FL, D.C., PRFC, USFWS, NMFS (19 votes)**

2. Board Consent:

- Approval of Agenda
- Approval of Proceedings from January 2017 Board Meeting

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

4. Consider North Carolina Glass Eel Aquaculture Plan for 2018 (10:30 – 11:00 a.m.) Action
Background • In August 2016 meeting, the Board approved the revised North Carolina Aquaculture Plan for 2017. The revised plan sought to improve harvest of glass eels as none were captured in 2016. • North Carolina submitted a new Aquaculture Plan for 2018 through 2020 on behalf of the American Eel Farm (AEF) in June **(Briefing Materials)**. • In July, the Technical Committee met to review the new aquaculture plan and provide technical feedback and recommendations for the Board's consideration (**Briefing Materials**). Later in the month, the Law Enforcement Committee met to review the new plan and provide feedback on enforcement and monitoring changes (**Supplemental Materials**)
Presentations • North Carolina Glass Eel Aquaculture Plan for 2018-2020 by K. Rootes-Murdy

- Technical Committee Report by J. Zimmerman
- Law Enforcement Committee Report by M. Robson

Board actions for consideration at this meeting

- Consider approval of North Carolina's Aquaculture Plan for Implementation in 2018

5. Consider 2016 Yellow Eel Landings Overage and Coastwide Cap (11:00 – 11:10 a.m.) Possible Action

Background

- Addendum IV (2014) specified an annual coastwide cap for yellow eel harvest at 907,671 pounds. Two management triggers are also specified that if either are tripped, would implement state-by-state quotas the following year.
- Based on preliminary 2016 yellow eel landings data, the coastwide landings were 928,358 pounds, exceeding the coastwide cap. If the coastwide cap were exceeded again in 2017, state-by-state quotas would be implemented. (**Briefing Materials**)

Presentation

- 2016 Preliminary yellow eel landings and Addendum IV provisions by K. Rootes-Murdy

Board actions for consideration at this meeting

- Management action in 2017 for the yellow eel fishery

6. Fishery Management Plan Review (11:10 – 11:15 a.m.) Action

Background

- State compliance reports were due on September 1
- The PRT reviewed and compiled the annual FMP Review (**Briefing Materials**)
- New Hampshire, Massachusetts, Pennsylvania, the District of Columbia, South Carolina, and Georgia requested and meet the requirements for *de minimis* for yellow eel
- South Carolina requested but did not meet the requirements for *de minimis* for glass eel

Presentation

- Overview of the 2016 Fishery Management Plan Review by K. Rootes-Murdy

Board actions for consideration at this meeting

- Accept the 2016 FMP Review and approve *de minimis* requests

7. Other Business/ Adjourn

DRAFT PROCEEDINGS OF THE

ATLANTIC STATES MARINE FISHERIES COMMISSION

AMERICAN EEL MANAGEMENT BOARD

The Westin Alexandria
Alexandria, Virginia
January 31, 2017

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

TABLE OF CONTENTS

INDEX OF MOTIONS

ATTENDANCE

Board Members

Pat Keliher, ME (AA)
Steve Train, ME (GA)
Rep. Jeffrey Pierce, ME, proxy for Sen. Langley (LA)
Dennis Abbott, NH, proxy for Sen. Watters (LA)
Cheri Patterson, NH, proxy for D. Grout (AA)
G. Ritchie White, NH (GA)
Sarah Ferrara, MA, proxy for Rep. Peake (LA)
Dan McKiernan, MA, proxy for D. Pierce (AA)
Raymond Kane, MA (GA)
Robert Ballou, RI, proxy for J. Coit (AA)
Lance Stewart, CT (GA)
Colleen Giannini, CT, proxy for M. Alexander (AA)
Jim Gilmore, NY (AA)
Emerson Hasbrouck, NY (GA)
Adam Nowalsky, NJ, proxy for Asm. Andrzejczak (LA)
Russ Allen, NJ, proxy for D. Chanda (AA)
Andrew Shiels, PA, proxy for J. Arway (AA)
John Clark, DE, proxy for D. Saveikis (AA)
Craig Pugh, DE, proxy for Rep. Carson (LA)
Kathy Knowlton, DE, proxy for R. Miller (GA)
Rachel Dean, MD (GA)
Ed O'Brien, MD, proxy for Del. Stein (LA)
Lynn Fegley, MD, proxy for D. Blazer (AA)
Joe Cimino, VA, proxy for J. Bull (AA)
David Bush, NC, proxy for D. Brady (GA)
Michelle Duval, NC, proxy for B. Davis (AA)
Pat Geer, GA, proxy for Rep. Nimmer (LA)
Jim Estes, FL, proxy for J. McCawley (AA)
Sherry White, USFWS
Chris Wright, NMFS
Martin Gary, PRFC

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

Ex-Officio Members

Staff

Bob Beal
Toni Kerns
Kirby Rootes-Murdy
Kristen Anstead

Guests

Darrel Young, MEFA
Angela Young, MEFA
Arnold Leo, E. Hampton, NY

The American Eel Management Board of the Atlantic States Marine Fisheries Commission convened in the Edison Ballroom of the Westin Hotel, Alexandria, Virginia, January 31 2017, and was called to order at 4:15 o'clock p.m. by Chairman John Clark.

CALL TO ORDER

CHAIRMAN JOHN CLARK: This is the American Eel Board; we will be getting started right now. Will everybody on the Board please take your seats? Nobody signed up for public comment.

APPROVAL OF AGENDA

CHAIRMAN CLARK: Has everybody seen the agenda? Are there any changes or additions to the agenda? Seeing none; are there any objections to the agenda, and seeing none it is approved.

APPROVAL OF PROCEEDINGS

CHAIRMAN CLARK: Everybody has had a chance to look at the minutes from the last meeting. Are there any changes to the minutes? Seeing none; the minutes are approved.

REVIEW OF THE 2017 STOCK ASSESSMENT UPDATE SCHEDULE

CHAIRMAN CLARK: Now we'll move right on to Item 4, which is to Review the 2017 Stock Assessment Update Schedule; and I'll turn it over to Kristen.

MS. KRISTEN ANSTEAD: Today I'm going to review our timeline and expectations for our update that is due later this year. Just as a reminder, in April of last year the TC met to discuss the five-year trigger of either an update or a benchmark; and at that time recommended doing an update for 2017.

The TC got together in September to review the young-of-the-year surveys, but also to discuss what sort of timeline they could meet; as far as having the fishery independent data in and establish when we could have our terminal year. In December the SAS was repopulated. We have a couple of new members, Matt Cieri from Maine, and Troy from VIMS.

We had gotten a call in January to go over what datasets would be needed, and to assign tasks and develop a more solid timeline. This is where we are with our update. We've already sent out data requests to the states based on the TC feedback. They thought they could meet a 2016 terminal year, and so that's for the fishery independent data.

We expect that data to be in by March 1st, with the associated biological data to support the modeling. Some states felt that they could have preliminary landings by April or May. We want to make the terminal year for those 2016 as well; but we are fine with not finalizing those until the end of the year, because the landings are not included in the modeling approaches that we'll be updating.

We'll kind of stick that in at the end, so that's fine to not have those finalized until the end of the year. We'll spend the summer doing our analysis, and hope to present it at annual meeting in October; the full update. The update we will be adding more years to the modeling, and I just want to remind you we can't change the modeling structure or that would be a benchmark. That means for this update we will be updating the trend analysis from the last stock assessment, which is the Mann-Kendall, the Manly, the ARIMA, and the Power Analysis; as well as updating the growth analysis, and that is on a regional and coastwide level. We will not be updating the SB-SRA, because additional work is needed. That additional work would require a peer review; so that would have to wait for a benchmark.

We also will not be updating the traffic light approach, because that also needs more improvements that would require a peer review. What you will get out of this update is the updated landings; both on a regional coastwide trends in abundance for the trend analyses. For these coastwide and regional abundances you'll have are they declining, staying the same, increasing. This will be for both young-of-the-year and the yellow eel surveys.

What you will not get out of this is an overfishing or overfished status. AREMA is the only one out of those trend analyses that produces reference points, but the Review Panel did not recommend them for use for management. We will not be getting any reference points out of this, it will just be is the stock depleted, what are the regional trends?

We are also updating the growth analysis, so the length, weight, age-at-length relationships by region and sex and how they differ, and an updated life history section; which we'll pull from the literature and any new research. I will just remind you why we're doing an update instead of a benchmark, and that is because in the last assessment the Review Panel and the SAS and the TC developed a list of required research recommendations that needed to be improved before the next benchmark is considered.

This is the list of sort of the critically needed research in order to start thinking about a benchmark; and when the TC reviewed this list and went back to the states to say has this work been initiated or completed? Not enough work had been done to start a benchmark; so that is why we're doing an update. I'll take any questions you have.

CHAIRMAN CLARK: Any questions for Kristen? Seeing none; I had one, Kristen. I was just wondering the whole idea of the depleted status of eels came from the DB-SRA. From the trend analysis we will not be getting that determination, we'll just know whether the stock has been increasing, decreasing or staying about the same?

MS. ANSTEAD: Correct. We certainly will not be getting an overfished/overfishing, but we will see has any movement happened in the trends regionally and coastwide.

CHAIRMAN CLARK: Okay I was just curious, because that was sort of the basis for going to the last addendum and putting in the coastal cap was based on that depleted status. Interesting that won't go ahead.

TECHNICAL COMMITTEE REPORT

CHAIRMAN CLARK: Seeing no further questions; I will now turn it over to Kirby for the Technical Committee report.

MR. KIRBY ROOTES-MURDY: This will be a pretty short presentation, we were working under the understanding that we were going to have less time, and so we truncated that. In addition, I'm giving this presentation rather than Tim Wildman, our TC Chair, as we were concerned that it wouldn't make sense for him to come down for a ten minute presentation.

Getting into it, I'm going to walk through just some of the items that the Technical Committee discussed when they met back in September of last year; the young-of-year surveys, the updates on nematode research, the Maine-life-cycle study and otolith exchange, and landings versus harvester reports. These were some of the discussion areas the TC had. I've crossed through points that Kirsten has touched on that were pertinent to the stock assessment update and schedule.

REVIEW YOUNG OF YEAR SURVEYS AND MAINE LIFE CYCLE SURVEY

MR. ROOTES-MURDY: The Technical Committee when they met back in September walked through all of the state young-of-year surveys from Maine down to Florida; everything from the methods, the results, and some of the challenges.

For example, Georgia recently moved from having a young-of-year survey to a yellow eel, in part because of an inability to encounter a lot of young-of-year. What a lot of people have noted in these discussions was that many of the survey location sites were selected opportunistically, due to logistics of trying to set up the gear; and also to encounter young-of-year.

With that you don't always get great long term data from that approach. What the Technical Committee has recommended that moving forward if a state looks to try to either move their young-of-year survey to a different location or not conduct the young-of-year survey, because they're not encountering it; that they should replace it with another survey for a life stage, such as yellow or silver.

One of the challenges that did get some discussion by the group was that not all of the young-of-year surveys that the plan requires the states to implement provide equal or important information to the stock assessment process. It is something that they're trying to determine at the Technical Committee level; what the best approach is to really lay out which ones are very helpful in tracking a trend over time, and which ones aren't and then how best to recommend changing those.

One way that they're looking at doing this is that a couple of the members, Brad Chase and Laura Lee are conducting a power analysis. They initially pursued this research about a year or so ago and then stopped. They're looking to pick it back up, but basically try to use this power analysis to indicate which young-of-year surveys are tracking a trend, with regards to the population, which aren't.

Then from there start to hone in on those ones that aren't and how best to improve them or recommend a different survey approach. Other areas that the Technical Committee touched on was nematode research, we had a VIMS grad student Zoemma, who presented her results to the TC; largely trying to pull from information the states all provided regarding presence/absence for detecting nematodes in their coastal waters.

The TC was very interested in her results, and are hoping to have that presented again to the Technical Committee later this year, with the possible recommendation of having the Board receive a presentation from her; because it is very pertinent to management. Regarding the Maine-life-cycle study, we got an update from the Maine TC member who highlighted that due to staffing, gear, construction, at some of the survey sites, it created a lot of challenges in the first year of this survey to try to get great data.

There is a lot more hope on Year 2, because of dedicated staff member has been hired to complete this work, and improvements are expected in the second year. Then with regard to the otolith exchange, there has been a process set up by actually Kristen, to start that exchange among the states of I believe Maine all the way down to Florida. They are looking to discuss the results later this spring, possibly publish a report ahead of the stock assessment update; and there is the potential of an in-person workshop to go over that. Last, in talking about landings versus harvester reports. This was a topic that was brought up regarding how best to inform management coming out of the next stock assessment update. Because these terms have been used interchangeably, over the past few years there has been problems when you set quotas based on data that is a mix of these two; when in fact they're truly two different types of data.

There are efforts underway right now to try to get both landings and harvester report information updated through the terminal year for this 2017 stock assessment update. But in the interim time before that's completed, the stock assessment update is that states should be using harvester reports, and that they should be largely evaluating them against landings.

Whichever of the two is the highest has been the standard approach in the past, but they also need to evaluate where there are discrepancies, to try to make improvements there, and that hopefully coming out of the stock assessment update there could be a more improved approach for reconciling those differences, and providing management with advice on which is more accurate moving forward. With that I'll take any questions.

CHAIRMAN CLARK: Kirby, would you also before you get to the questions, just address the implications of the TC talking about states discontinuing young-of-the-year surveys or transferring them due to the requirements of the plan?

MR. ROOTES-MURDY: Sure, so right now no states are allowed to just drop the survey requirement. What they can do is have these exceptions such as what Georgia went for, which is if you are no longer able to conduct a young-of-year survey based on challenges that have been laid out, to move to another survey type; so looking at a different life stage is primarily the way the Technical Committee is recommending those states work around that challenge in the future, if it arises for other states.

CHAIRMAN CLARK: That does have to be approved by the Board though, correct?

MR. ROOTES-MURDY: That's correct.

CHAIRMAN CLARK: Are there any questions for Kirby? Dan.

MR. DAN McKIERNAN: Kirby, could you elaborate on the nematode research and how that is deemed useful?

MR. ROOTES-MURDY: I can try. We have this grad student from VIMS, Zoemma, who has done work at basically trying to determine how nematodes are affecting early development of eels; and if it's deterring their growth. There are some other components to her study, not just looking at presence/absence. Maybe Kristen, if you remember, could speak to it a little bit more.

MS. ANSTEAD: Yes, I think she's trying to come up with a system where states can like she'll come up with a one-page laminated thing where states have a very easy protocol for determining whether or not there is nematode presence in their eels; and at what stage of development it is. Is it at the last stage of the eel being sick with this nematode or are they just infected? When we get to the next benchmark that could help us kind of talk about productivity in each of the regions, if we have regional data where the nematode is more present than others, we know that this effects the eels. Like Kirby said their growth or their ability to reproduce or their movement. It will factor in.

CHAIRMAN CLARK: Bob Ballou.

MR. BOB BALLOU: Thank you, Mr. Chair. I'm struck by the fact that now five years after the last benchmark, we're still lagging in terms of providing the research necessary to fill the gap and allow for the next benchmark to take place. How are things progressing in that regard? Is there a sense that that gap is likely to close in relatively short order? I guess the related question is, when is the next benchmark planned; and how likely is it that the research will be provided in time to make that happen?

MS. ANSTEAD: One thing the TC did do last year in the spring, was look at every research recommendation that was made in the last assessment and have states go in and say whether this work has started. Some of it has been. But when we thought about doing the benchmark, we thought if we put it off just a little bit longer it would give us better – because there was so much trouble with the modeling in the last one.

Why not wait and get the data we really want, so we hope soon? That was part of the motivation of doing the update, was keep it in people's minds, reevaluate the trends. It is still valuable work and it will restate what we need to try to make that sooner. Three to five years, hopefully, but I can't say.

OTHER BUSINESS

UPDATE ON AMERICAN EEL FARM PROJECT IN NORTH CAROLINA

CHAIRMAN CLARK: Any further questions? Seeing none; moving on to our next agenda item. Under other business, Dr. Duval has an update on the American Eel Farm project in North Carolina, where they're looking at raising glass eels.

DR. MICHELLE DUVAL: Yes, for the opportunity to provide the Board with some input. I just wanted to let folks know that the American Eel Farm attempted to deploy some nets on the White Oak River, on the 18th of the month, but had some boat problems; so that was unsuccessful.

But they did manage to get a net deployed in that river system on the 23rd of last week, and apparently they have harvested 52 glass eels; that is individuals, not pounds.

I also just wanted to let folks know that Marine Patrol did conduct an inspection of the facility; it took about an hour and a half.

The owner was very cooperative, didn't find anything out of alignment. Tanks were ready to hold eels, so everything went according to expectations and I'll just also note that our Legislature is in session again. We're undergoing a transition in terms of administration so things are going to be somewhat unsettled, I think for a little bit.

But we are finalizing our legislative requests for this upcoming year, and one of those as we discussed at the last Board meeting is to amend the statutory language that inadvertently roped our marine patrol officers into not having the ability to inspect folks without a reasonable suspicion. Now that doesn't necessarily apply to the Eel Farm, because they are permitted, there are very stringent permits requirements as we discussed at the last Board meeting; but I did just want to let folks know that.

ADJOURNMENT

CHAIRMAN CLARK: Any questions? Seeing none; and with no other business coming before the Board, we are adjourned.

(Whereupon, the meeting was adjourned at 4:34 o'clock p.m., January 31, 2017.)

North Carolina Aquaculture Plan for American Eel Pursuant to Addendum IV to the ASMFC Interstate Fishery Management Plan for American Eel

North Carolina Department of Environmental Quality
Division of Marine Fisheries
PO Box 769
Morehead City, NC 28557

May 2017

BACKGROUND

Globally, the U.S. is a minor producer of aquaculture products, ranking 15th in a United Nations Food and Agriculture Organization report (FAO 2014). It would be beneficial to expand aquaculture in the U.S. as approximately 91% of seafood (by value) consumed in the U.S. originates overseas. Roughly half of this comes from aquaculture and has driven the U.S. seafood trade deficit to over $11.2 billion annually (NOAA 2016). By passing the National Aquaculture Act of 1980 (and subsequent amendments), Congress put forth that it was in the national interest and the national policy to encourage the development and reduce regulations of aquaculture in the U.S. However, the past 37 years has not changed anything. The US still is only producing about 1% of the annual global production.

In the early 1990s North Carolina was one of several states to impose a 6-inch minimum size limit in part to protect elvers/glass eels for local aquaculture while awaiting recommendations on glass eel/elver fishery development that was expected in the Atlantic States Marine Fisheries Commission fishery management plan for American eel (ASMFC 2000). The April 2000 American eel FMP (Report #36) also shows that the states of New York, Rhode Island, Delaware, Maryland and PRFC also took the same measure to protect aquaculture development between 1992 – 1995.

In October 2014, the ASMFC adopted Addendum IV to the Interstate Fishery Management Plan for American Eel (ASMFC 2014);

http://www.asmfc.org/uploads/file//55318062Addendum_IV_American_Eel_oct2014.pdf).

Addendum IV implemented a provision allowing states and jurisdictions to submit an Aquaculture Plan to allow for the limited harvest of American eel glass eels (hereinafter "glass eels") for use in domestic aquaculture facilities. Specifically, Addendum IV states:

> *"Under an approved Aquaculture Plan, states and jurisdictions may harvest a maximum of 200 pounds of glass eel annually from within their waters for use in domestic aquaculture facilities provided the state can objectively show the harvest will occur from a watershed that minimally contributes to the spawning stock of American eel. The request shall include: pounds requested; location, method, and dates of harvest; duration of requested harvest; prior approval of any applicable permits; description of the facility, including the capacity of the facility the glass eels will be held, and husbandry methods; description of the markets the eels will be distributed to; monitoring program to ensure harvest is not exceeded; and adequate enforcement capabilities and penalties for violations."*

Pursuant to Addendum IV to the Interstate Fishery Management Plan for American Eel, the North Carolina Division of Marine Fisheries (NCDMF) is submitting the following Aquaculture Plan for approval. The NCDMF has selected tributaries in watersheds where the state can objectively show American eels in these areas minimally contribute to the spawning stock of American eel. Only one aquaculture operation, the American Eel Farm (AEF), has requested to be included in the Aquaculture Plan for consideration.

POUNDS REQUESTED

North Carolina requests to harvest 200 lb. of glass eels, the maximum amount allowed under the Aquaculture Plan provision of Addendum IV to the Interstate Fishery Management Plan for American Eel.

DATES OF HARVEST

Glass eels shall be harvested from January 1, through May 30, annually or until 200 lb. of glass eels are harvested, whichever occurs first.

DURATION OF HARVEST

The duration of harvest requested is for a three (3) year period. A renewal plan will be submitted by June 1, 2020 and at that time additional harvest years will be requested along with any modifications deemed necessary to ensure the success and continued approval of the plan.

METHOD OF HARVEST

NCDMF will limit the number of individuals authorized to harvest under this plan (3 individuals). Glass eels shall be harvested using either fyke nets, dip nets or Irish eel ladders. Fyke nets shall be constructed as follows:

- Shall be thirty (30) feet or less in length from cod end to either wing tip (net length equals the wing length plus the distance from throat to cod end)
- Shall be fitted with netting that measures 1/8-inch bar mesh or less
- Shall contain a ½-inch or less bar mesh excluder panel that covers the entrance of the net
- Shall have no more than two funnels, one cod end, and two wings

Dip nets shall be constructed as follows:

- Shall be no more than 30 inches wide at the widest point of the net mouth
- Shall be fitted with netting that measures 1/8-inch bar mesh or less

Irish eel ladders:

- Location and construction shall need final approval

To mitigate the harvest of elvers (fully pigmented eels), all captured eels shall be graded upon capture on the water using a 1/8-inch bar mesh non-stretchable grading screen and any eels that fail to pass through the screen will be immediately returned to the water where captured. Any eels that pass through the screen will be harvested and count toward the 200 lb. annual glass eel harvest limit.

THE CURRENT AND PAST STATUS FOR AQUACULTURE PURPOSES

For more than three or four decades now 100% of our nations' natural resource of glass eels have been exported overseas to the Asian market. With most of these eels being placed in

Chinese fish farms for grow out. Products are then made (mostly kabiaki unagi) and sent back to the US increasing our trade deficit. There have been many cases over the years where the FDA has ban eel products due to unapproved growth hormones as well as other unapproved chemicals being found when tested.

American Eel Farm (formally North Carolina Eel Farm) has been the only exception. Throughout the early to the late 2000's glass eels were purchased from Maine fisherman and brought to the farm for grow out. There was a time when the former owner paid just $60/pound.

Currently, 100% of the glass eels harvested in Maine and South Carolina are exported. No grow out data on any commercial level is being collected. No value-added job opportunities for US employees is realized. No US market being developed.

MINIMAL CONTRIBUTION

While we have no quantitative data on the abundance of glass eels, it could be argued the harvest of 200 lb. of glass eels is limited enough to have a minimal impact on the spawning stock of American eel (see Appendix 1). Natural mortality is thought to be very high during the early life stages (leptocephalus, glass eel, and elver) due to the high fecundity of American eel (ASMFC 2000, 2012). Assuming a mortality rate of ~97-98%, of the 200 lb. of glass eels proposed to be harvested, approximately 195 lb. would otherwise perish naturally in the wild.

The American eel has a broad geographic distribution range from the Caribbean to Canada. And is found in many US interior states as well. It is well known that there is no successful commercial hatchery on the planet for the *Anguilla rosrtata.* It is also accepted by the scientific community that the species dates well back in history and has the characteristic of panmixia (*Conclusive evidence for panmixia in the American eel, Cote). Anguilla rostrata's* panmictic population allows for all individuals to be a potential partner. This provides for a very large single biomass spanning along the entire eastern seaboard of the US.

ATLANTIC SEABOARD WATERSHED

The **Atlantic seaboard watershed** is a watershed of North America along both:

- The Atlantic Canada (Maritimes) coast south of the Gulf of Saint Lawrence Watershed, and
- The East Coast of the United States north of the watershed of the Okeechobee Waterway. The relatively narrow continental area is demarcated on the south by drainage to the Okeechobee Waterway (which drains both westward to the Gulf and eastward to ocean), the Eastern Continental Divide (ECD) to the west, and the Saint Lawrence divide to the north. US physiographic regions of this watershed are the Atlantic Plain and the Appalachian Mountains & Highlands. Major sub-watersheds of the Atlantic Seaboard are the following (north-to-south):

Sub-watersheds adjacent to the Saint Lawrence divide

- Chedabucto Bay: 2,148 square miles (5,560 km^2)
- Gulf of Maine: 69,115 square miles (179,010 km^2)
- Long Island Sound: 16,246 square miles (42,080 km^2)
- Lower New York Bay: >14,000 square miles (36,000 km^2)

Other notable sub-watersheds

- Delaware Bay: 14,119 square miles (36,570 km^2) — larger than several, but not adjacent to either divide
- Chesapeake Bay: 64,299 square miles (166,530 km^2) — adjacent to both divides (at the Triple Divide point)

Sub-watersheds adjacent to the Eastern Continental Divide

- Albemarle Sound: >14,380 square miles (37,200 km^2)
- Winyah Bay: >7,221 square miles (18,700 km^2)
- Santee River: >4,531 square miles (11,740 km^2)
- Savannah River: 9,850 square miles (25,500 km^2)
- St. Johns River: 8,840 square miles (22,900 km^2)
- Biscayne Bay: >2,800 square miles (7,300 km^2)
- Kissimmee River: >3,000 square miles (7,800 km^2)

The catch data of the American eel shows that the majority of wild caught adults come from the Chesapeake Bay and the Delaware Bay water basins. The figure is about 800,000 pounds per year from both. Catch data also reflects that the overwhelming majority of glass eels are harvested in Maine from the Gulf of Maine watershed. Any harvesting in the North Carolina watershed of Albemarle Sound for glass eels would clearly have little impact on the massive biomass migrating along the eastern seaboard with help from the Gulf Stream and Labrador Currents.

Additionally, it is understood that the voting members of ASMFC took into consideration that all states may have applications for an aquaculture quota and included that language in Addendum IV. That would be a total of 2,800 pounds harvested from the biomass migrating out of the Sargasso Sea. In the past three years there has only been an aquaculture plan submitted by the state of North Carolina. Primarily due to the ideal conditions for aquaculture that exist in the southeast and specifically the state of North Carolina.

LOCATION OF HARVEST

North Carolina's internal waters are classified as either inland, joint or coastal fishing waters. The North Carolina Marine Fisheries Commission (NCMFC) and NCDMF have jurisdiction of coastal waters while the North Carolina Wildlife Resources Commission (NCWRC) has jurisdiction of inland waters and both agencies (NCWRC and NCMFC/NCDMF) have authority within joint waters. Other than a few specific regulations, none of which pertain to American eel, commercial activities and recreational activities using commercial gear (devices) occurring in joint waters is under the jurisdiction of the NCMFC/NCDMF. For the purposes of this plan, all glass eel harvest will be restricted to either coastal or joint waters.

GLASS EEL HARVEST SITES

1.) Albemarle Sound and tributaries
2.) Pamlico Sound and tributaries
3.) Newport River and tributaries
4.) North River and tributaries

NCDMF MONITORING PROGRAM

In addition to Aquaculture Operations/Collection General Permit Conditions in rule (NCMFC Rule 15A NCAC 03O .0502) and Aquaculture Operations/Collection Specific Permit Conditions (NCMFC Rule 15A NCAC 03O .0503F), to monitor and regulate the harvest of glass eels, the NCDMF will issue an Aquaculture Collection Permit (ACP) to the AEF with additional permit conditions specific to the N.C. Aquaculture Plan that only apply while engaged in glass eel harvest (ACP) or grow out (AOP) activities authorized under the N.C. Aquaculture Plan for American Eel. To aid in monitoring and enforcement the NCDMF will limit the number of individuals authorized to harvest under the ACP (3 individuals). The permittee listed on the ACP must possess a valid North Carolina Standard Commercial Fishing License (SCFL) or Retired Standard Commercial Fishing License (RSCFL) issued by the NCDMF. The permittee listed on the ACP shall provide names and licensing data for all designees in the harvest of glass eels. Any vessels used for glass eel harvest under the ACP shall have a valid North Carolina Commercial Fishing Vessel Registration (CFVR) issued by the NCDMF. Restrictions will be placed on the ACP requiring certain conditions and procedures to be followed, such as:

GENERAL CONDITIONS

- Glass eels harvested from N.C. coastal fishing waters shall not be exported or sold until they reach the minimum legal size of nine inches total length.
- No more than one (1) permittee and two (2) designees shall be authorized to harvest under the ACP
- No more than two (2) mates will be allowed to assist the permittee or designees while fishing for glass eels
- The permittee/designee(s) and any vessel participating in the glass eel harvest must be properly licensed by the NCDMF and abide by all fisheries rules and permit conditions
- Fyke nets, dip nets, and Irish eel ladders are the only gear authorized to use for glass eel harvest under the ACP
- No more than thirty (30) fyke nets and/or dip nets and/or Irish eel ladders in any combination may be fished by the permittee/designee(s) under the ACP
- A fyke net may not be placed within fifty (50) feet of any part of another fyke net
- All gear shall be removed from the water from 12:01 pm on Friday through 12:01 pm on Sunday. This creates a 48-hour rest period to allow glass eels to migrate up these smaller systems to help minimize the impact to the spawning stock.
- January 1 through May 30, fyke and dip nets for glass eel harvest may be fished at all hours during the week. Fyke nets may have their cod ends closed during the day, however from 12:01 pm on Friday through 12:01 pm on Sunday fyke nets may remain in the water but the terminal portion of a fyke net cod end shall contain a rigid device with an opening not less than three (3) inches in diameter and not exceeding eight (8) inches in length that is not obstructed by any other portion of the net and dip nets may not be used. This creates a 48-hour rest period to allow glass eels to migrate up these smaller systems to help minimize the impact to the spawning stock.
- Immediately report to NCDMF if a net is tampered with and location of the net and the date and time it was noticed
- Report to NCDMF when each fyke net is removed from the water. If a net is moved, the new coordinates must be reported once the net is reset. If multiple nets are moved the

same day, coordinates may be provided once all the nets have been reset. If a net(s) is removed and not reset, it must be reported upon returning to the landing site.

- Purchased American eels (glass eels, elvers, or yellow eels) shall be kept separate from eels that were harvested as glass eels within N.C. and grown out to yellow eels
- All gear and harvest restrictions detailed in the Method of Harvest section will be listed as conditions under the ACP

BEFORE HARVEST

Fishermen harvesting glass eels under the ACP shall call-in to NCDMF the following information:

- Daily:
  - Landing site they will be leaving from and returning to once fishing activity is complete
  - Names of individual(s) involved shall be reported at the beginning of the season and any changes or additions would be immediately reported.
  - Number of fyke nets, dip nets, and Irish eel ramps that will be used
  - Description and registration number of the boat(s) to be used for harvest shall require a one time and report and if any changes occur they would need to be reported
  - Description and license plate number of the vehicle(s) to be used for harvest shall require a one time and report and if any changes occur they would need to be reported

DURING HARVEST

- Require the use of a 1/8-inch bar mesh non-stretchable mesh grading screen to cull the glass eels at the harvest site to limit the harvest of elvers

AFTER HARVEST

- GPS coordinates of each net once they are set, if multiple nets are set the same day, coordinates can be provided once all the nets have been set.
- Require AEF to hold all glass eels that perish during transport to the facility and all eels that perish in the facility for inspection
- All glass eels that perish during transport will count against the 200 lb. harvest limit
- Require AEF to call-in or email to NCDMF by 5:00 pm each day the total harvest for the previous day in pounds to the nearest 0.1 lb. of glass eels received (including those days when no glass eel harvest occurred). Zero pounds shall only be reported if no glass eels are harvested and received.

The above conditions and procedures will allow the NCDMF to limit the effort (amount of gear and number of individuals) involved in glass eel harvest under the Aquaculture Plan. These controls will allow the NCDMF to ensure the glass eel harvest does not exceed what is authorized in the Aquaculture Plan. Any harvest that exceeds the 200 lb. harvest limit shall be immediately returned to the water where captured.

ENFORCEMENT CAPABILITIES AND PENALTIES FOR VIOLATIONS

Violations of the ACP permit conditions will be addressed according to the NCDMF SOP for Permit Violations and suspensions will be carried out in accordance with NCMFC Rule 15A NCAC 03O .0504 (see Appendix II).

All charges for violations will be charged under N.C. General Statute § 113-187 (d) (4): Violating the provisions of a special permit or gear license issued by the Department. All fines will be at the discretion of the court; however, fines may not always be levied for the first offense.

The call-in requirements under the Monitoring Program section will allow enforcement officers to know when and where lawful harvest is occurring. It will also allow for random inspections to take place at the harvest and landing sites to ensure the conditions of the permit and all applicable NCMFC rules and regulations are being followed. Random inspections will also be performed at the aquaculture facility to ensure the proper records are being kept to account for all eels in the facility as required under N.C. General Statute § 113-170.3 and NCMFC Rule 15A NCAC 03O .0502 (8) (see Appendix III).

SIZE LIMIT EXEMPTION

The intent is to raise the eels as close as possible to the legal minimum size of 9 inches total length prior to sale. Given the difficulty in measuring live eels, prior to sale, all eels shall be graded using a ½-inch by ½-inch non-stretchable mesh grading screen. Any eels that do not pass through the grading screen may be sold and any that pass through the grading screen shall remain in the possession of the AEF until such time as the eels are large enough to not pass through the grading screen. On inspection, a 10% tolerance by number will be allowed for eels that pass through the grading screen.

PRIOR APPROVAL OF PERMITS

The AEF has all necessary permit approvals in place with the exception of an Aquaculture Collection Permit from the NCDMF. This permit will be issued upon approval of the Aquaculture Plan by the ASMFC American Eel Management Board. The permits currently held by the AEF are:

- North Carolina Department of Agriculture Aquaculture Operation Permit valid until 2017
- North Carolina Division of Marine Fisheries Aquaculture Operation Permit renewed annually. To be eligible for an ACP, an Aquaculture Operation Permit is required (see Appendix IV: NC Marine Fisheries Commission (NCMFC) Rule 15A NCAC 03O .0501 (e))
- North Carolina Division of Marine Fisheries Standard Commercial Fishing License
- North Carolina Division of Marine Fisheries Dealer License

As noted in NCMFC Rule 15A NCAC 03O .0501 the appropriate licenses from the Division of Marine Fisheries must be held by the permittee. A North Carolina Standard Commercial Fishing license is required to fish commercial gear such as fyke nets, a Commercial Fishing Vessel

Registration (CFVR) is required for vessels used to harvest seafood and a Dealer License is required to sell fish taken from the coastal fishing waters.

DESCRIPTION OF THE MARKET

The AEF indicated they have identified clients for food and bait markets domestically as well as overseas. The long-term intent is to develop and expand the US domestic market as much as possible. For proprietary business reasons, specific details were not provided.

DESCRIPTION OF THE FACILITY

American Eel Farm
1633 NC HWY 41 West
Trenton, NC 28585

History, Design, Capacities and Technical Facts

The AEF, located in Trenton, North Carolina, is a state-of-the-art Recirculated Aquaculture System (RAS) which has been operating since 2003

Below are two You Tube links that show videos of the facility:

https://www.youtube.com/watch?v=4YnQn7aivw4

https://www.youtube.com/watch?v=1wUiwmzO-TI

It is a proven Danish system designed overseas by Inter-Aqua Advance for eel grow-out and imported to the US by William Bokolar and Marty Bouw to US into the state of VA. The state of VA granted an 800 kilogram harvester permit for glass eels in 1999 as outlined in the ASMFC American eel April 2000 FMP Report #36 for this facility.

The AEF was initially operated in North Carolina as the North Carolina Eel Farm (corporate filing date May 21, 2002). It was purchased from the original owners by George Koonce and transported to Jones County. The original location suffered a hurricane and was moved to its current location. The facility has a 15-year operation history in North Carolina. There is no other facility specifically designed to grow out glass eels to yellow eels at a commercial level in the US. The facility has the capacity to easily grow-out in excess of 900 pounds of glass eels. There is historical proprietary data on a large scale commercial level that no current fish farm, University, or government agency in the US can match.

The facility has three separate closed recirculating systems. The two main systems are identical RAS units each containing twelve (12) 1,000 gallon tanks and independent water treatment systems for both RAS units. Each RAS contains twelve (12) raceway tanks with 900 US usable gallons. Water is purified, restructured and super oxygenated.

Raceway Tanks

Each section contains 12 raceway tanks. The facility has two separate treatment sections and 2 large 10,000 gal temporary storage tanks with filtration and aeration. Each raceway tank is equipped with a fine screen outlet complete with a tertiary motorized brush system, to keep the mesh clean. In each tank, there are also level switches that give alarm for high water level. These large rectangular fiberglass tanks hold about 1,000 gallons of water. Here is the home of the eels while we are their stewards.

Each tank is outfitted with aeration provided by large Sweetwater pumps and back-up emergency oxygen lines which automatically activate in case of a power outage. Each tank also can be isolated from the system and individually cleaned if necessary without draining entire system.

There are three automatic feeders for the first three tanks that are ideal for the small eels. As they are graded the larger eels can be fed by hand or additional automatic feeders can be installed.

Monitoring Systems

There is a new Pacific Oxyguard water quality monitoring system that monitors pH, oxygen saturation levels, water levels and temperature. The system can send alarms remotely and is programmed to call to a farm manager's cell phone as well as four other programmed numbers if any levels drop or change as per settings logged into system. The system can be expanded by adding more test probes and programming if desired.

This system design is based on proven *Anguilla anguilla*, *A. mossambica*, *A. bicolor* and *A. marmorata* aquaculture techniques. The systems are technically sound, energy efficient, and easy to operate. The system has been successful with American eels as proven by recorded growth rates, low food conversions and low incidence of disease and mortality.

Mechanical Filtration

Attached to those 24 tanks is a complete water treatment unit equipped with a HydroTech drum filter type 803 / 40 micron mechanical filtration unit. This unit has a max flow of 31,500 gal/hour or 63,000 gal/hour if both sections are in operation. The two drum filters sieve feces and other large particles out of the water. The filters are continuously sprayed (adjustable timing possible) with water to self-clean. The waste water runoff from this event drains into a small channel within the drum filter and then drains into a system pipe which gravity feeds into the main channel in the tank room that runs the full distance from tank #1 to tank #24 where the waste water is then pumped into a small settling pond on the property by a sump pump through a 12" PVC drain pipe.

Biological Filtration

After mechanical filtration, water is gravity fed into 2 parallel 18 foot tall silos (four total for both sections) with patented Inter Aqua Advance (IAA) A/S Moving Bed Bio Reactor (MBBR) technology for biological treatment of the water (removal of ammonia and dissolved organic matter). Each silo has a volume of 1,300 gallons and is 55 % filled with IAA bio-curler bio media. This technology is superior to simple trickling filter bioreactors in that the attached blower motors run constantly to keep the media moving. This also acts as a self-cleaning process within the silos and contributes to the CO_2 stripping process. Nitrifying bacteria create a film on the media and converts ammonia to a nitrate. Safe for the fish and excellent for growing plants! Two steps: NH3 + O2 ? NO-2 + 3H+ + 2e-, NH3 + O2 + 2H+ + 2e- ? NH2OH + ?H2O.

With an optimum temperature for the growth of the eel at 24 degree C. or 74 degree F. The water treatment unit will be able to handle up to 250 lb. dry feed per day per section (500 lb. per day total). After the MBBR water flows by gravity into a common pump sump.

The water can be circulated with 3 separate pumps (per section, 6 pumps total), one 3 HP Low Head main pump and two 3 HP medium pressure pumps with 20 psi into two oxygen-cones (per section 4 total) for supersaturating of liquid oxygen into the water. In total the 3 pumps give a minimum flow capacity of 31,500 gal/hour (63,000 gal/hour total).

CO^2 Stripper

There is a carbon dioxide stripper for tanks #1 - #24 which has counter flow packed tower technology and utilizes structured packing of vacuum formed sheets of PVC. These packing's will provide maximum wettability, thereby maximizing the stripping effort.

Ultraviolet Lighting (UV)

Water flows through the center of a cylindrical housing. The water passes through the device and the UV lighting assists in disinfecting the water by destabilizing the DNA of germicidal bacteria The water is surrounded by UV bulbs in special waterproof housings. The DNA in the bacteria is "blown-up". The UV system has recently had the bulbs updated. However there have been reports that a UV disinfection system is not needed with eels so this system may be reconsidered.

Super Oxygenation

The water is injected through a top mount opening into 10 foot tall Oxygen cones (4 total). As it spills into the pool below a vortex is created and splashing occurs. The water is restructured as bubbles are produced. Liquid Oxygen is injected into these bubbles under 20 PSI pressure (PV=nPT). There is a back-up liquid oxygen system tied into the main oxygen source with two air stones per raceway as a safety net. It is serviced simply by attaching the flow meter to a large liquid oxygen tanks. Should there be the need, the main liquid oxygen source would back feed the 26 tanks with 150 PSI automatically.

Water Supply

The system is supported by three deep water wells all of which are operable and are wired with three phase wiring for better conservation as well as on independent breakers so as to always allow for a water source to be actively supplying water. One is about 300' deep and the other two about 200'. Jones County is part of the North Atlantic Coastal Plain aquifer. And is conveniently located where the Castle Hayne, Pee Dee and Black Creek aquifers intersect. Additionally, there is public water tied into the facility.

Water Softening System

There is a large commercial grade water softening system that all water passes through prior to entering any portion of the facility. The purpose is to change the molecular structure of the Ferrous Iron from the ground water to prevent it from becoming Ferric Iron once oxidized. The rust colored sediment that can cause operating issues.

Valve System

The facility has many valves which assist in directing water flow. Also enables the operator to isolate any section, component or well source.

There is 440 electric service at pole. There is a heating system that can heat the water entering from the wells prior to entering the main water source if needed by passing heated water through several tubes mounted in the well reserve tanks for both sections. These well reserve tanks are equipped with automated on/off valves allowing water to be called automatically from the well when the water level reaches a preset level.

The water is distributed back to the raceway tanks via a common pipe manifold situated on the wall at the end of the tanks, with a separate valve to each tank for maintenance. A flow rate of 31,500 gal/hour (per system or 63,000 gal/hour total) will give an exchange rate of 3 to 5 times/hour to maintain self-cleaning and an adequate oxygen level in the raceway.

There is a third system which has two large 9,000 gallon tanks supported by similar filtration, aeration and small bio-reactors. This system is separate from the other two. Total capacity for AEF is about 50,000 gallons with about 40,000 being usable. Additionally, there is plenty of room to expand on the flat 2-acre site on which the facility is located. With 226 days a year of sun and a mean annual temperature of 70 degrees there is also a great opportunity to develop a medium to large scale aquaponics system on site.

In addition to the main tank room and the state-of-the-art water treatment room there is a main office area, sales office area, employee dinning, a furnished residential area, a full bathroom with laundry, a feed room, packaging room, a mechanical room, an electrical room, storage rooms and two large covered exterior areas one @ 15' X 85' and the other @ 15' X 50'. The grounds are gated and there is a security system with 16 infrared cameras capable of being viewed remotely. The facility has cable connections for internet and TV as well as two satellites for backup. The steel building construction is insulated with pressed foam to help minimize temperature fluctuations on hot or cool days. The roof was replaced with a steel roof about six years ago. There is a heating system but it is not necessary to use when system is running due to local climate and the ground water temp of 68 degrees.

With the general geographic location being the Southeast USA along with the well-insulated building the water temperature for maximum growth rate could be efficiently maintained. Trenton, NC has a climate that is very suitable to aquaculture/agriculture in general. The annual average mean temperature is 70 degrees where the ideal temp for grow-out of eels is 74 degrees. There is no snow fall (very rare) and few days below freezing (very rare).

Eel Grow Out

Eels can be stocked in high densities in the raceway tanks. Stocking densities of 300 kg/m^3 or 2(+) lb./gal are often seen in eel farms. It is estimated that juvenile eels have an oxygen demand of 300 mg/kg/hour. The liquid oxygen system at the AEF is sufficient to reduce mortality and sustain eels in high densities. Estimated grow out time from the glass eel phase to 9 inches averages around 210 days. Individual eels grow at different rates so total grow out time will be longer. Due to the varying growth rates, it is estimated that one-third of the eels will be harvested in 5 - 7 months, another group will be harvested at 8 - 10 months, and the rest will be harvested at 11 - 12 months after harvest.

A large mobile stainless-steel grading machine in the main tank room will be used to grade the eels every four to six weeks. A well-managed RAS eel farm can expect a weaning rate of 80 - 90%. Eels feed ratio is greater than 1:1 in most studies depending on the amount of protein in the feed. There are studies in Japan and China that show a faster grow out however this outline is one the AEF is comfortable with.

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FIGURES

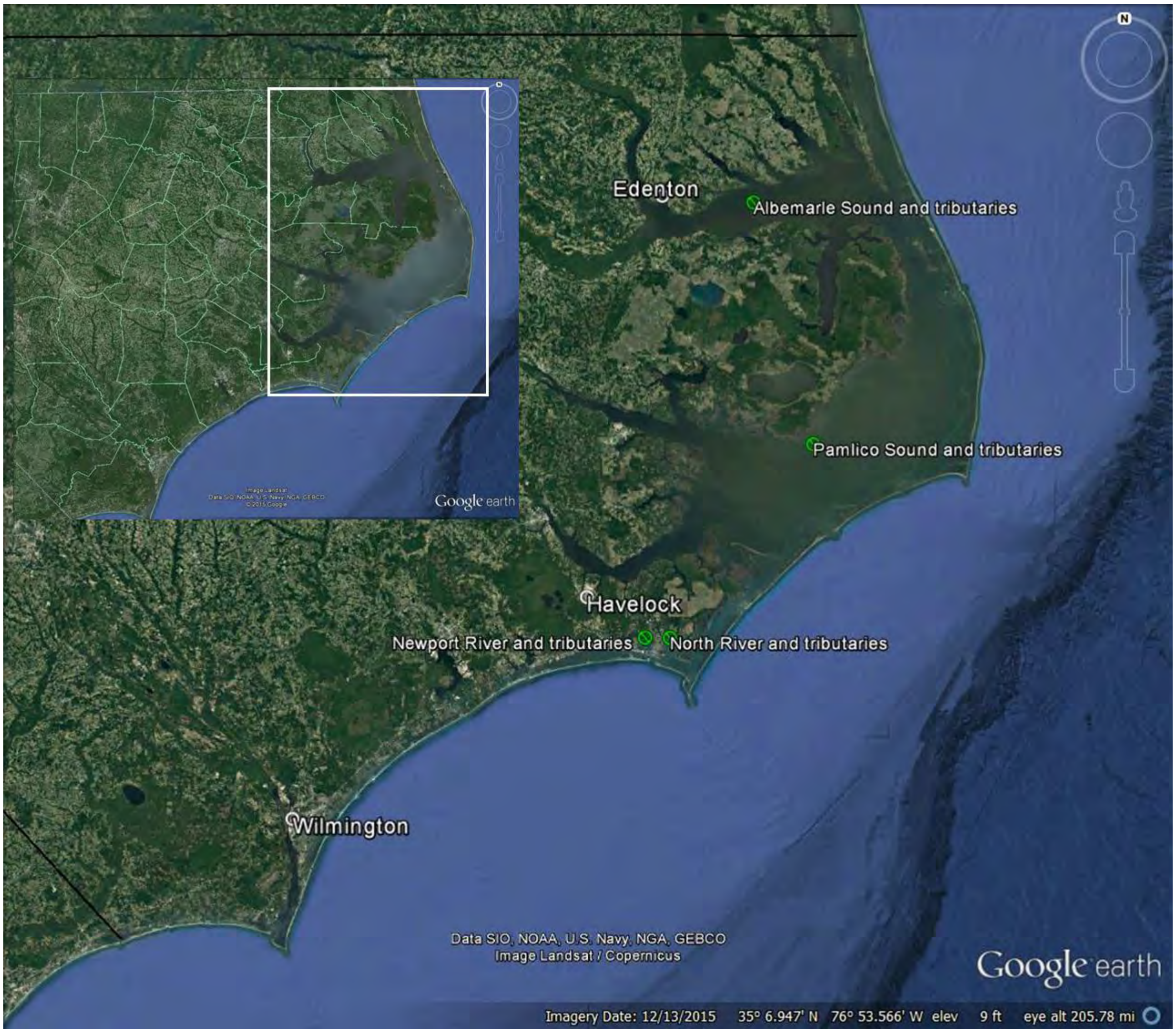

Figure 1. General location of proposed harvest areas (green circles) along the North Carolina coast.

APPENDIX I

TESTIMONY PRESENTED TO THE COMMITTEE ON MARINE RESOURCES RE: H.P. 137, AN ACT TO RESTRICT THE TAKING OF EELS LESS THAN 6 INCHES IN LENGTH FROM MAINE COASTAL WATERS (EMERGENCY)

by
James D. McCleave
February 23, 1995

INTRODUCTION

The purpose of my testimony is primarily to educate the members of the committee, other legislators and interested persons about the unique life cycle of a truly fascinating and somewhat mysterious fish, the American eel. The unusual life cycle has some important implications for management and conservation of this species, which are different than for most species of fishes. I will present several of these implications. Finally, I do offer an opinion on the soundness of this particular bill.

I am a Professor of Oceanography and a Cooperating Professor of Zoology at the University of Maine, where I have been since 1968. I have conducted research on the biology of the American eel and the European eel since the early 1970s and have published more than 25 scientific papers on them. I also teach about eels in my classes at the University, and I occasionally have participated in workshops on eels with my European colleagues. A copy of my résumé is appended.

I offer this testimony as a friend of the eel, an awesome fish, and as a friend of eel fishers of all types. It is not my intention to support one group of harvesters over another. My conclusions and opinions are biologically based. The economics of the eel fishing and aquaculture industries and the economic consequences of management decisions are left to the realm of other experts.

LIFE CYCLE OF THE AMERICAN EEL

American eels are highly migratory, with spawning and larval development occurring in the ocean, and feeding and growth occurring in estuaries and fresh waters (rivers, streams, ponds, and lakes) [catadromous life cycle].[1] Spawning occurs near the surface over very deep water in a large area of the Sargasso Sea (Figure 1) and only there, meaning there is a single breeding population for the species. The Sargasso Sea is a large portion of the western North Atlantic Ocean east of the Bahamas and south of Bermuda. Spawning occurs in winter. Eggs hatch in a day or two in the warm water, releasing a long-lived larval stage [leptocephalus], which is flattened from side-to-side and shaped somewhat like a willow leaf. The leptocephali drift and swim in the upper few hundred feet of the

[1]My language is intended to be understood by the nonspecialist. However, the appropriate scientific terms are included in brackets for completeness and to allow direct reference later in the document.

ocean for several months, growing slowly to a length of 2-2.5 inches. The leptocephali dramatically alter their shape [metamorphose] to resemble a miniature, transparent eel, called a glass eel, during the subsequent autumn and winter. This metamorphosis occurs at sea, perhaps near the edge of the continental shelf. The glass eels enter estuaries and ascend rivers during winter and spring, earlier at the southern end of their range, later at the northern end. (My research group at the University of Maine has contributed substantially to this knowledge.) It is during the spring ascent that glass eels, sometimes termed elvers, are harvested commercially in Maine.

Yr later

The glass eels in estuaries and fresh waters rapidly develop rather drab pigmentation in their skin, dark on the back and often yellowish on the belly, leading to the name yellow eel for this stage. Growth is generally slow, and yellow eels spend several years in estuaries and inland waters. Growth and age at maturity are not well known. Males probably remain as yellow eels for 4-6 years or more, and grow to about 12-18 inches or so. Females remain as yellow eels for many more years, probably 6-20 years in New England and the Maritime Provinces. During this growth period, yellow eels are fished commercially in estuarine and fresh waters, using baited traps or pots.

During late summer and early autumn, maturing yellow eels undergo a second metamorphosis in preparation for a migration to sea to spawn. The pigment on the belly frequently becomes an iridescent silvery, leading to the term silver eel. Silver eels migrate from fresh waters and estuaries to sea in late summer and autumn in the northern part of their range, including Maine, and later in the southern part of the range. During this migration in Maine, silver eels are fished commercially in fixed weirs or nets set across streams and rivers.

Silver eels migrate to the Sargasso Sea, *spawn once and die*. Little is known of this migration or actual spawning, but it seems likely that autumn migrants are the spawners of the subsequent winter. Evidence of the timing and location of spawning comes from the distribution in space and time of small leptocephali. (My research group at the University of Maine has contributed substantially to this knowledge.)

The yellow stage of the American eel ranges from the eastern Gulf of Mexico, all along the east coast of the US, through the states and provinces bordering the Gulf of Maine, to the states and provinces bordering the Gulf of St. Lawrence, to Newfoundland and Labrador. Yet all spawning of the resulting silver eels occurs in the Sargasso Sea.

POINTS OF EMPHASIS FROM THE LIFE CYCLE

- There is a single breeding population for the entire species regardless of where the yellow eels resided [panmixis]. All genetic evidence suggests that a female from Maine is as likely to spawn with a male from Georgia as with a male from Nova Scotia.
  - This means there is no 'homing' of offspring from eels of the Penobscot or Kennebec Rivers to those rivers.

  - Glass eels entering the Maine rivers are just the same genetically as those entering elsewhere within the range.

- There is a single spawning by a female in her lifetime [semelparity]. An adult female may have to grow for 15 years before reaching maturity and spawning *once*.

- Females develop large numbers of eggs [high fecundity], probably 400,000-3,000,000 eggs per female increasing with female size.

- Nearly all the eggs produced by a female and fertilized by a male will die before reaching maturity [high mortality]. This is natural in fecund species; otherwise the earth would be covered with eels.

- Females are much larger at sexual maturity than males [sexual dimorphism].
  - Most females are larger than 20 inches (50 cm) at maturity.
  - Most males are less than 18 inches (45 cm) at maturity.

- Determination of whether an eel becomes a male or female is not completely under genetic (chromosomal) control, but the process of sexual determination is not fully understood.

HYPOTHESES RELEVANT TO CONSERVATION

There are two hypotheses, for which there is some scientific evidence, which are important to decisions on conservation of the species. Both hypotheses follow logically from an overriding hypothesis that eels encountering more productive waters have a greater tendency to become males, while those encountering less productive waters have a greater tendency to become females. (There is a body of life history theory that supports this different life history strategy for males and females.)

- There is a gradual increase in the proportion of eels that become females from the estuary toward the headwater streams, i.e. increasing up a given drainage. Within a river drainage, more productive waters are generally found in the lower reaches, especially the estuary.
  - If correct, this means that Merrymeeting Bay has a lower proportion of females than the higher waters of the Kennebec River.

- There is a gradual increase in the proportion of eels that become females from the southern part of the range to the northern part of the range [a cline]. Along the range of the eel, more productive waters are generally found to the south, less productive waters to the north, including Maine.

- If correct, this means that Maine is likely to have a greater proportion of female eels within its population than, say, Georgia.

MY OPINION ON EEL MANAGEMENT-CONSERVATION

Because of the wide range of the species, and because the species is a single breeding population, one political jurisdiction alone cannot conserve the species. However, Maine can act responsibly from an understanding of the eel's life history.

I will now argue against this bill. The first line of reasoning is on the basis of prudent interpretation of the implications of the life cycle. The second line of reasoning is on the basis of a scenario for interpretation of the high fecundity-high mortality consequences in this species.

From both lines of reasoning, I am led to the conclusion that *there is no biological basis underlying the restriction of harvest proposed by this legislation*. For certain, in my mind, there is *no emergency*. This is not to state that development of sound management and conservation practices are not needed.

IMPLICATIONS FROM THE LIFE CYCLE

In a one-time spawning [semelparous], fecund species with a long lifetime before that one reproduction, prudent conservation strategy would increasingly protect females the closer they get to reproduction. Mortality is high in a fecund species, but the rate of mortality declines exponentially with size. Mortality rate in leptocephali must be enormous; mortality rate in glass eels must be enormous as well. However, mortality rate in females larger than, say, 15 inches is probably very low. (Here I refer to natural mortality, not mortality from people's activities of fishing, damming, polluting, etc.)

Maine, acting in prudent fashion, might choose to protect preferentially maturing females. I stress females because only females produce young. One male may mate with many females, but only females bear eggs.

If the cline in increasing proportion of females from south to north is correct, Maine and the Maritime Provinces might give increased thought to protecting females. A greater proportion of the reproductive potential may be in the northern part of the species' range.

If there is an increasing proportion of females farther up a drainage, it may be prudent to harvest differentially fewer eels farther up drainages.

Weir fisheries, pot fisheries with mesh-size limits, and eel-size limits all shift the harvest toward a greater percentage of females. Because of the sexual dimorphism, the larger the mesh or the larger the size limit, the greater the pressure is transferred to prereproductive females. Further, because females are longer lived than males, greater fishing pressure is transferred to prereproductive females. This is exactly opposite from the desirable effect. It is more logical, if anything, to place a maximum size limit on the harvest of eels. Such a measure is clearly against conventional wisdom for managing fishes, but this is an unconventional species.

States and provinces that do not allow weir fisheries prudently protect females, whether they know it or not. Only Maine and, to a very limited degree, New York allow weir fisheries for eels.

Likewise, states and provinces that restrict commercial fishing in fresh waters prudently protect females, whether they know it or not. Most states have a substantial or complete restriction on such fishing. Not Maine.

On the other hand, most states and provinces have minimum size limits on commercial eel harvest, generally 4 inches, 6 inches or 8 inches. I do not believe these jurisdictions made those regulations on any basis other than transfer of practices from management of other species, such as trout or bass. In the extreme, Prince Edward Island has a minimum size limit of 18 inches for eels. Other Maritime Provinces are considering similar regulations. This practice would ensure that nearly all harvested eels would be females, a completely counterproductive measure.

Just because other jurisdictions have similar regulation, we should not make the assumption that the regulations have biological basis. Maine should strive gain the information necessary to base regulations in accord with the life cycle of the eel.

IMPLICATIONS FROM MORTALITY RATES

Management of commercial and recreational harvest of fishes (or tolerance of dams and pollution) has always been based on the assumption that there are compensatory mechanisms within the biology of the species, i.e. mechanisms that allow increased survival or increased reproduction of the nonharvested individuals, so the population does not decline. This is the concept of sustainable yield. The key to success of this approach is to understand what the compensatory mechanisms are and when they occur in the life cycle with respect to when harvest occurs.

Again, the eel is unique because of its high-fecundity, high-mortality characteristic. It seems unlikely to me that major compensatory mechanisms are to be found in the oceanic stages of the life cycle. The leptocephali probably have the highest mortality. Food limitation and inability to reach the continental shelf may be the critical factors, neither of which is under control of the leptocephali. Silver eels on migration to the Sargasso Sea to spawn probably have the lowest mortality, and they also have little opportunity for compensating mortality earlier in the life cycle.

In the elver-yellow eel stages, there is high mortality, but there is also the greatest likelihood of compensatory mechanisms for added mortality due to human activities. Because this is the growth phase, competition for food may occur among individual eels, causing starvation or at least slowing the growth. Reduced density of eels *may* result in higher survival, greater growth rate, and perhaps higher fecundity. On the other hand, not all outcomes of reduced density are predictable. Because the mechanisms of gender determination are not known for eels, reduced density could increase the ratio of females to males (a positive compensatory mechanism) or decrease the ratio of females to males (a negative compensatory effect). However, most density-dependent effects are negative and have positive compensatory mechanisms.

I illustrate the subtle effects of compensatory mechanisms with a *hypothetical* numerical example. For the example, assume an average female has a fecundity of 1,000,000 eggs. Only one female and (less than) one male need to survive from those million eggs and reproduce to maintain a stable population. In the first scenario, I assume there is a compensatory mechanism for harvesting that can occur anytime after harvesting, regardless of when the harvesting occurs. In the second scenario, I assume there is a slightly greater compensatory mechanism in the yellow eel stage (likely, as described above).

- Scenario 1. Minor compensatory mechanism any time.
  - Fecundity 1,000,000 eggs produced by average female.
  - Assume 99.9% die at sea as leptocephali, leaving 1,000 glass eels.
  - Assume 99.2% of those die becoming silver eels, leaving 8 to migrate seaward.
  - Assume a <u>harvest</u> of half the migrating silver eels (4), leaving 4 migrants.
  - Assume 50% of those die, leaving 2 successful spawners.

  - Fecundity 1,000,000 eggs.
  - 99.9% die as leptocephali, leaving 1,000 glass eels.
  - <u>Harvest</u> half the migrating glass eels, leaving 500.
  - 99.2% die before becoming silver eels, leaving 4 to migrate.
  - 50% of those die leaving 2 successful spawners.

  - Conclusion: In this scenario, it does not matter when in the life cycle eels are harvested as long as the allowed harvest is set by actual mortality rates, rather than the hypothetical ones used in the examples here. Alternatively, harvest of a combination of life stages is possible, again as long as actual mortality rates are applied.

- Scenario 2. Greater compensatory mechanism in yellow eel stage.
  - Fecundity 1,000,000 eggs.
  - 99.9% die as leptocephali, leaving 1,000 glass eels.
  - <u>Harvest</u> half the migrating glass eels, leaving 500.
  - Now, if there is compensation such that mortality is reduced in the yellow eels stage <u>by only 1%</u>, 98.2% die before becoming silver eels, leaving 9 to migrate seaward.
  - <u>Harvest</u> half the migrating silver eels (4 or 5), leaving 4 to migrate.

- ◇ 50% of those die leaving 2 successful spawners.
- ◇ Conclusion: In this scenario, harvest of glass eels has no effect on the harvest of silver eels because of a compensatory mechanism in the yellow eel stage. Again harvest size needs to be determined with actual mortality rates.

CONCLUSIONS

I conclude from the two previous sections that there is no biological basis for assuming that harvest of glass eels *per se* is detrimental to the conservation of the American eel. Under certain conditions, the harvest of glass eels could have less detrimental effect on conservation than harvest of silver eels. Under certain conditions, the harvest of glass eels could occur while having little or no detrimental effect on harvest of silver eels.

I also conclude that the current regulatory structure for eels in the States and Provinces in the eel's range is not based upon sound biological principles. However, unregulated or unsoundly regulated commercial fishing in Maine and other jurisdictions is distinctly unwise. By testifying in opposition to this bill, I am not implying that there is not cause for concern and for possible regulations on commercial fishing for eels.

SCIENTIFIC RECOMMENDATIONS FOR CONSERVATION AND MANAGEMENT

In the short term for decision making in Maine, the following steps are important.

- Mortality rates and sources of mortality in the glass eel, yellow eel and early silver eels stages need to be determined to allow estimates of how much harvest could be allowed in what stages of life without deleterious effect on the stock.
  - ◇ Determine sources and rates of natural mortality, and determine whether there is density-dependent mortality, which involves determination of food-webs and predator-prey relations.
  - ◇ Determine sources and rates of anthropogenic mortality at different stages, which includes fishing mortality and nonfishing mortality (fish passage at dams, pollution, hydroelectric turbines, etc.).
- Fishing mortality needs to be determined from the activities of the fishing industry.
  - ◇ A licensing system for fresh waters and tidal waters specific to commercial fishing for eels should be instituted.
  - ◇ A reporting system for commercial catches by life-cycle stage or gear needs to be associated with the licensing system.

- Growth rates of males and females and fecundity of females of various sizes needs to be determined to allow assesment of harvest practices on the reproductive potential of the migrants that do migrate to sea to spawn.

- The distribution of sex ratio throughout selected drainages needs to be determined to allow assessment of harvest practices on abundance of females and males.

In the long term for decision making over the geographic range of the eel, the following steps are important.

- The mechanism of gender determination in eels needs to be understood, so effects of harvest practice on sex ratios can be determined.

- The distribution of sex ratio over the geographic range needs to be determined, so harvest practice could be adjusted over the range as appropriate to the life cycle.

APPENDIX II

NC Marine Fisheries Commission Rule 15A NCAC 03O .0504:

15A NCAC 03O .0504 SUSPENSION/REVOCATION OF PERMITS

(a) For violation of specific permit conditions (as specified on the permit), permits may be suspended or revoked according to the following schedule:

(1) violation of one specific condition in a three year period, permit shall be suspended for 10 days;
(2) violation of two specific conditions in a three year period, permits shall be suspended for 30 days;
(3) violation of three specific conditions in a three year period, permits shall be revoked for a period not less than six months.

If the permit condition violated is the refusal to provide information upon request by Division staff, either by telephone, in writing or in person, the Fisheries Director may suspend the permit. Such permit may be reinstated 10 days after the requested information is provided.

(b) All permits will be suspended or revoked when the permittee's license privilege has been suspended or revoked as set out in G.S. 113-171. The duration of the suspension or revocation shall be the same as the license suspension or revocation. In the event the person makes application for a new permit during any period of license suspension, no new permit will be issued during the suspension period. In case of revocation of license privileges, the minimum waiting period before application for a new permit to be considered will be six months.

(c) Permit designees shall not be permitted to participate in a permit operation during any period they are under license suspension or revocation.

(d) Upon service of a notice of suspension or revocation of a permit, it is unlawful to fail to surrender any permit so suspended or revoked.

Appendix III

NC General Statute 113-170.3:

G.S. 113-170.3. Record-keeping requirements.

(a) The Commission may require all licensees under this Article to keep and to exhibit upon the request of an authorized agent of the Department records and accounts as may be necessary to the equitable and efficient administration and enforcement of this Article. In addition, licensees may be required to keep additional information of a statistical nature or relating to location of catch as may be needed to determine conservation policy. Records and accounts required to be kept must be preserved for inspection for not less than three years.

(b) It is unlawful for any licensee to refuse or to neglect without justifiable excuse to keep records and accounts as may be reasonably required. The Department may distribute forms to licensees to aid in securing compliance with its requirements, or it may inform licensees of requirements in other effective ways such as distributing memoranda and sending agents of the Department to consult with licensees who have been remiss. Detailed forms or descriptions of records, accounts, collection and inspection procedures, and the like that reasonably implement the objectives of this Article need not be embodied in rules of the Commission in order to be validly required.

(c) The following records collected and compiled by the Department shall not be considered public records within the meaning of Chapter 132 of the General Statutes, but shall be confidential and shall be used only for the equitable and efficient administration and enforcement of this Article or for determining conservation policy, and shall not be disclosed except when required by the order of a court of competent jurisdiction: all records, accounts, and reports that licensees are required by the Commission to make, keep, and exhibit pursuant to the provisions of this section, and all records, accounts, and memoranda compiled by the Department from records, accounts, and reports of licensees and from investigations and inspections, containing data and information concerning the business and operations of licensees reflecting their assets, liabilities, inventories, revenues, and profits; the number, capacity, capability, and type of fishing vessels owned and operated; the type and quantity of fishing gear used; the catch of fish or other seafood by species in numbers, size, weight, quality, and value; the areas in which fishing was engaged in; the location of catch; the time of fishing, number of hauls, and the disposition of the fish and other seafood. The Department may compile statistical information in any aggregate or summary form that does not directly or indirectly disclose the identity of any licensee who is a source of the information, and any compilation of statistical information by the Department shall be a public record open to inspection and examination by any person, and may be disseminated to the public by the Department. (1997-400, s.5.1; 2001-213, s. 2.)

NC Marine Fisheries Commission Rule 15A NCAC 03O .0502:

15A NCAC 03O .0502 PERMIT CONDITIONS; GENERAL

The following conditions apply to all permits issued by the Fisheries Director:

(1) it is unlawful to operate under the permit except in areas, at times, and under conditions specified on the permit;
(2) it is unlawful to operate under a permit without having the permit or copy thereof in possession of the permittee or his or her designees at all times of operation and the permit or copy thereof shall be ready at hand for inspection, except for Pound Net Permits;
(3) it is unlawful to operate under a permit without having a current picture identification in possession and ready at hand for inspection;
(4) it is unlawful to refuse to allow inspection and sampling of a permitted activity by an agent of the Division;
(5) it is unlawful to fail to provide complete and accurate information requested by the Division in connection with the permitted activity;
(6) it is unlawful to hold a permit issued by the Fisheries Director when not eligible to hold any license required as a condition for that permit as stated in 15A NCAC 03O .0501;
(7) it is unlawful to fail to provide reports within the timeframe required by the specific permit conditions;

(8) it is unlawful to fail to keep such records and accounts as required by the rules in this Chapter for determination of conservation policy, equitable and efficient administration and enforcement, or promotion of commercial or recreational fisheries;

(9) it is unlawful to assign or transfer permits issued by the Fisheries Director, except for Pound Net Permits as authorized by 15A NCAC 03J .0504;

(10) the Fisheries Director, or his agent, may, by conditions of the permit, specify any or all of the following for the permitted purposes:

 (a) species;
 (b) quantity or size;
 (c) time period;
 (e) location;
 (d) means and methods;
 (f) disposition of resources;
 (g) marking requirements; or
 (h) harvest conditions.

(11) unless specifically stated as a condition on the permit, all statutes, rules and proclamations shall apply to the permittee and his or her designees; and

(12) as a condition of accepting the permit from the Fisheries Director, the permittee agrees to abide by all conditions of the permit and agrees that if specific conditions of the permit, as identified on the permit, are violated or if false information was provided in the application for initial issuance, renewal or transfer, the permit may be suspended or revoked by the Fisheries Director.

APPENDIX IV

NC Marine Fisheries Commission Rule 15A NCAC 03O .0501:

15A NCAC 03O .0501 PROCEDURES AND REQUIREMENTS TO OBTAIN PERMITS

(a) To obtain any Marine Fisheries permit, the following information is required for proper application from the applicant, a responsible party, or person holding a power of attorney:

- (1) Full name, physical address, mailing address, date of birth, and signature of the applicant on the application. If the applicant is not appearing before a license agent or the designated Division contact, the applicant's signature on the application shall be notarized;
- (2) Current picture identification of applicant, responsible party, or person holding a power of attorney. Acceptable forms of picture identification are driver's license, North Carolina Identification card issued by the North Carolina Division of Motor Vehicles, military identification card, resident alien card (green card), or passport; or if applying by mail, a copy thereof;
- (3) Full names and dates of birth of designees of the applicant who will be acting under the requested permit where that type permit requires listing of designees;
- (4) Certification that the applicant and his designees do not have four or more marine or estuarine resource convictions during the previous three years;
- (5) For permit applications from business entities:
  - (A) Business Name;
  - (B) Type of Business Entity: Corporation, partnership, or sole proprietorship;
  - (C) Name, address, and phone number of responsible party and other identifying information required by this Subchapter or rules related to a specific permit;
  - (D) For a corporation, current articles of incorporation and a current list of corporate officers when applying for a permit in a corporate name;
  - (E) For a partnership, if the partnership is established by a written partnership agreement, a current copy of such agreement shall be provided when applying for a permit; and
  - (F) For business entities, other than corporations, copies of current assumed name statements if filed and copies of current business privilege tax certificates, if applicable; and
- (6) Additional information as required for specific permits.

(b) A permittee shall hold a valid Standard or Retired Standard Commercial Fishing License in order to hold a:

- (1) Pound Net Permit;
- (2) Permit to Waive the Requirement to Use Turtle Excluder Devices in the Atlantic Ocean; or
- (3) Atlantic Ocean Striped Bass Commercial Gear Permit.

(c) A permittee and his designees shall hold a valid Standard or Retired Standard Commercial Fishing License with a Shellfish Endorsement or a Shellfish License in order to hold a:

- (1) Permit to Transplant Prohibited (Polluted) Shellfish;
- (2) Permit to Transplant Oysters from Seed Oyster Management Areas;
- (3) Permit to Use Mechanical Methods for Shellfish on Shellfish Leases or Franchises;
- (4) Permit to Harvest Rangia Clams from Prohibited (Polluted) Areas; or
- (5) Depuration Permit.

(d) A permittee shall hold a valid:

- (1) Fish Dealer License in the proper category in order to hold Dealer Permits for Monitoring Fisheries Under a Quota/Allocation for that category; and
- (2) Standard Commercial Fishing License with a Shellfish Endorsement, Retired Standard Commercial Fishing License with a Shellfish Endorsement or a Shellfish License in order to harvest clams or oysters for depuration.

(e) Aquaculture Operations/Collection Permits:

- (1) A permittee shall hold a valid Aquaculture Operation Permit issued by the Fisheries Director to hold an Aquaculture Collection Permit.
- (2) The permittee or designees shall hold appropriate licenses from the Division of Marine Fisheries for the species harvested and the gear used under the Aquaculture Collection Permit.

(f) Atlantic Ocean Striped Bass Commercial Gear Permit:

(1) Upon application for an Atlantic Ocean Striped Bass Commercial Gear Permit, a person shall declare one of the following gears for an initial permit and at intervals of three consecutive license years thereafter:

(A) gill net;

(B) trawl; or

(C) beach seine.

For the purpose of this Rule, a "beach seine" is defined as a swipe net constructed of multi-filament or multi-fiber webbing fished from the ocean beach that is deployed from a vessel launched from the ocean beach where the fishing operation takes place.

Gear declarations shall be binding on the permittee for three consecutive license years without regard to subsequent annual permit issuance.

(2) A person is not eligible for more than one Atlantic Ocean Striped Bass Commercial Gear Permit regardless of the number of Standard Commercial Fishing Licenses, Retired Standard Commercial Fishing Licenses or assignments held by the person.

(g) Applications submitted without complete and required information shall not be processed until all required information has been submitted. Incomplete applications shall be returned to the applicant with deficiency in the application so noted.

(h) A permit shall be issued only after the application has been deemed complete by the Division of Marine Fisheries and the applicant certifies to abide by the permit general and specific conditions established under 15A NCAC 03J .0501, .0505, 03K .0103, .0104, .0107, .0111, .0401, 03O .0502, and .0503 as applicable to the requested permit.

(i) The Fisheries Director, or his agent may evaluate the following in determining whether to issue, modify, or renew a permit:

(1) Potential threats to public health or marine and estuarine resources regulated by the Marine Fisheries Commission;

(2) Applicant's demonstration of a valid justification for the permit and a showing of responsibility as determined by the Fisheries Director; and

(3) Applicant's history of habitual fisheries violations evidenced by eight or more violations in 10 years.

(j) The Division of Marine Fisheries shall notify the applicant in writing of the denial or modification of any permit request and the reasons therefor. The applicant may submit further information, or reasons why the permit should not be denied or modified.

(k) Permits are valid from the date of issuance through the expiration date printed on the permit. Unless otherwise established by rule, the Fisheries Director may establish the issuance timeframe for specific types and categories of permits based on season, calendar year, or other period based upon the nature of the activity permitted, the duration of the activity, compliance with federal or state fishery management plans or implementing rules, conflicts with other fisheries or gear usage, or seasons for the species involved. The expiration date shall be specified on the permit.

(l) For permit renewals, the permittee's signature on the application shall certify all information as true and accurate. Notarization of signature on renewal applications shall not be required.

(m) For initial or renewal permits, processing time for permits may be up to 30 days unless otherwise specified in this Chapter.

(n) It is unlawful for a permit holder to fail to notify the Division of Marine Fisheries within 30 days of a change of name or address, in accordance with G.S. 113-169.2.

(o) It is unlawful for a permit holder to fail to notify the Division of Marine Fisheries of a change of designee prior to use of the permit by that designee.

(p) Permit applications are available at all Division Offices.

Marine Fisheries
ENVIRONMENTAL QUALITY

ROY COOPER
Governor

MICHAEL S. REGAN
Secretary

BRAXTON C. DAVIS
Director

MEMORANDUM

TO: ASMFC American Eel Technical Committee

FROM: Todd Mathes, N.C. Division of Marine Fisheries

DATE: July 3, 2017

RE: Update on N.C. American Eel Aquaculture Plan with regards to the 2017 harvest season and modifications to the proposed May 2017 Plan (2018-2020 harvest seasons)

<u>May 2016 Plan (2017 Harvest Season) - Background</u>

August 4, 2016, the Atlantic States Marine Fisheries Commission's American Eel Management Board approved North Carolina's Aquaculture Plan for May 2016 (2017 fishing season), allowing up to 200 pounds of glass eels to be harvested for aquaculture purposes.

In May 2016, NCDMF worked with the American Eel Farm (AEF) to develop the new 2017 NC Aquaculture Plan along with input from DMF Biologists, Marine Patrol Officers and MP Communications, Habitat and Enhancement Section, Aquaculture Program Coordinator, and License and Statistics (Trip Ticket). NCDMF had many phone conversations with the AEF, and set up an in person meeting to work through the process of modifying the previous aquaculture plan.

On May 31, 2016, NCDMF submitted the NC Aquaculture Plan to the ASMFC, on July 7, 2016, the N.C. Aquaculture Plan was presented to the ASMFC Technical Committee who recommended the plan for approval, and on August 4, 2016, the American Eel Management Board approved the 2017 N.C. Aquaculture Plan.

Prior to the start of the 2017 harvest season (Jan 1, 2017), NCDMF staff met on a conference call to discuss the upcoming glass eel harvest season and to finalize the permit conditions (completed December 13, 2016).

On December 13, 2016, the Aquaculture Permit Program Coordinator met with the AEF owner to discuss/explain the permit conditions. AEF questioned if several of the previously agreed upon permit conditions could be modified.

From December 14-31, 2016, NCDMF staff worked to figure out if any of their requests could be accommodated. One request that was of high importance to AEF was for a second permittee. Given that the ASMFC Board approved the plan with only one permittee, the only thing we could offer the AEF was to have a different individual listed as the permittee.

On December 31,2016, NCDMF received the required net identification information prior to the deployment of any nets.

On January 5, 2017, the permit conditions were sent via mail and email to the AEF, and on January 10, 2017, the AEF signed the permit conditions (received by NCDMF January 12, 2017).

2017 Glass Eel Harvest Activities

The AEF did not set any nets the first three weeks of January. They attempted to deploy their first fyke nets on January 18, however they had mechanical problems and did not launch the boat. On January 23, 2017, the AEF deployed their first fyke net of the season.

The first week of fishing (January 23-27, 2017), in terms of reporting, were problematic for the AEF. They had many reporting requirements, which they helped develop, they determined were too burdensome.

On January 27, 2017, the AEF received a violation/citation for blocking more than two-thirds of a navigable waterway. On the same day, NCDMF received a phone call from the AEF saying that all nets had been removed from the water and they were not going to fish until the issues with the reporting requirements had been resolved. The AEF believed there were too many reporting requirements and they were being set up for failure. The AEF quit fishing and requested a meeting with the Division Director, Marine Patrol Colonel, and lead managers and biologists to review the reporting requirements. After the meeting, there were two modifications: 1) the AEF could email (previously only call) the American Eel Biologist by noon with the previous days catch, and 2) the permit conditions would be combined from two documents into one document for ease of use. No other modifications were made.

Throughout February, March and the beginning of April, the AEF successfully deployed fyke nets and harvested limited numbers of glass eels. During the entire harvest period, NCDMF staff worked with the AEF to try and accommodate their requests, while staying within the bounds of the May 2016 N.C. Aquaculture Plan.

On April 20, 2017, the AEF removed all their nets from the water and stopped fishing for the 2017 glass eel season.

2017 Glass Eel Harvest Results

- 12 of 17 weeks the AEF had fyke nets deployed; the AEF waited three weeks after the opening of the glass eel season (Jan. 1, 2017) before setting any nets. Also, there were two, one week periods at the end of the season when the AEF decided not to fish.

- Fyke nets were fished 44 out of 85 days available to be fished (there was no fishing on Saturdays and Sundays throughout the season)
- Majority of fishing effort was in the White Oak River, but the AEF also deployed a few nets in Dawson, Orchard, and Pierce creeks within the Neuse system (Figure 1).
- 775 glass eels, weighing approximately 0.25344 pounds (1 glass eel = 0.149747899 grams) were harvested (Table 1, Figure 2)
- 51 glass eels were released alive (Table 1, Figure 2)
- 199.74656 pounds of unused glass eel quota remained
- 23 elvers were captured and released (Table 1)
- The maximum number of deployed fyke nets per week was 14
- CPUE data – poor data due to: 1) changing harvest locations, 2) different net dimensions, 3) gear modifications (crab protection), 4) reporting issues, 5) inconsistent fishing effort, and 6) periods of no fishing.

<u>AEF Violations</u>
Citations by N.C. Marine Patrol in 2017:
- January 27, 2017: the AEF was charged with use of a fixed or stationary net as to block more than two-thirds of any natural or manmade waterway, sound, bay, creek, inlet or any other body of water (rule violation).
- March 24, 2017: the AEF was charged with violating conditions of aquaculture plan for not fishing their gear within the approved timeframe (having fyke nets in water two hours after sunrise without having the rigid device installed in cod end keeping nets open; permit violation).
- April 6, 2017: the AEF was charged with violating conditions of aquaculture plan for not fishing their gear within the approved timeframe (having fyke nets in water two hours after sunrise without having rigid device installed in cod end keeping nets open). In addition, one fyke net was seized (permit violation).

Citations by N.C. Wildlife Resources Commission in 2017:
- March 20, 2017: the AEF was charged with operating a motor vessel without proper navigational lights (rule violation).
- March 20, 2017: the AEF was charged with operating a motor vessel with invalid registration number (vessel was registered in another state and had been in NC for more than 90 days; rule violation).
- March 20, 2017: the AEF was charged with taking nongame fish (American eel) by method other than hook and line from inland waters of N.C. (rule and permit violation)

Hearings have not occurred for any of the above violations so the legal outcome is still unknown.

<u>May 2017 Plan (2018-2020 Harvest Seasons)</u>
The May 2017 N.C. Aquaculture Plan was submitted on behalf of the AEF, who were solely responsible for drafting the new plan for the 2018-2020 harvest seasons. Based on our experience managing the 2017 glass eel harvest season and numerous discussions with the AEF concerning what worked and did not work in the 2016 plan, the NCDMF decided to allow the AEF to draft a plan that would give them the best opportunity to successfully harvest glass eels, while still satisfying the aquaculture plan requirements in Addendum IV. Table 2 outlines the

May 2016 and May 2017 N.C. Aquaculture Plan sections side by side for comparative purposes to better see the modifications that were made.

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Tables

Table 1. American Eel Farm summary catch and effort statistics for the 2017 glass eel harvest season. The double line represents the shift in sampling periods (24 hour sets to 12 hour sets). *There were several weeks when the AEF did not fish or have any nets deployed. +The AEF had a vehicle accident that prevented them from checking their nets – NCDMF Marine Patrol aided the AEF in fishing nets.

	# of nets deployed									
Week date	Average	Min	Max	Total # days fished	Total # hours fished	Average hours fished	Total # glass eels harvested	Total # glass eels released	Total # elvers released	Glass eel CPUE (# glass eels /hour)
2-6 Jan*	-	-	-	-	-	-	-	-	-	-
8-13 Jan*	-	-	-	-	-	-	-	-	-	-
15-20 Jan*	-	-	-	-	-	-	-	-	-	-
22-27 Jan	6.3	0	10	4	623.3	23.1	42	0	0	0.084
29 Jan-3 Feb	3	0	9	1	216	23.3	0	0	0	0
5-10 Feb	3.3	0	10	2	480	23.0	0	0	0	0
12-17 Feb	11.8	9	14	5	1,236.6	22.9	41	0	4	0.032
19-24 Feb	14	14	14	5	1,671.7	23.9	313	0	11	0.187
26 Feb-3 Mar+	7.3	0	11	1	792	72	64	0	1	0.081
5-10 Mar	5.3	0	10	3	278	12.6	239	0	4	0.845
12-17 Mar	5.7	3	7	5	323.5	12.9	26	10	2	0.091
19-24 Mar	5	0	8	5	274	13.0	10	2	0	0.082
26-31 Mar	7.5	5	9	5	472	13.1	0	25	0	0
2-7 Apr	8.3	6	9	5	570.6	13.6	40	14	1	0.085
9-14 Apr*	-	-	-	-	-	-	-	-	-	-
16-21 Apr	2.4	0	3	3	114.4	12.7	0	0	0	0
23-28 Apr*	-	-	-	-	-	-	-	-	-	-
Total	6.7	0	14	44	7052.1	23.2/13	775	51	23	0.124

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Table 2. Comparison between the May 2016 N.C. Aquaculture Plan and the proposed May 2017 N.C. Aquaculture Plan highlighting the modifications.

Section Heading	2016 Plan	2017 Plan	Modification
DATES OF HARVEST	January 1 to April 30	January 1 to May 30	• extended harvest season by 1 month
DURATION OF HARVEST	1-year period	3-year period	• extended plan from a 1-year to a 3-year plan
METHOD OF HARVEST	Fyke and dip nets	Fyke and dip nets + Irish eel ladder	• added Irish eel ladder
THE CURRENT AND PAST STATUS FOR AQUACULTURE PURPOSES		Most harvested glass eels are exported, it's extremely important to support and promote domestic aquaculture	• added new paragraph
MINIMAL CONTRIBUTION	Harvest sites located in areas that have been heavily impacted by human development. No harvest in Albemarle Sound, the Tar-Pamlico River Basin, or areas such as National Wildlife Refuges, National Estuarine Reserves, National Forests, National Seashores, North Carolina Coastal Reserves, North Carolina State Parks, North Carolina Preserves, North Carolina Strategic Habitat Areas, and Natural Heritage Natural Areas.	Harvesting glass eels from any North Carolina waters would have little impact on the massive biomass of eels migrating along the eastern seaboard (most wild caught yellow eels come from Chesapeake Bay and Delaware Bay water basins). Also, the ASMFC has already taken into consideration the impact of the 200 pound per state harvest and allocated an amount that would total 2,800 pounds for aquaculture purposes coastwide.	• changed minimal contribution justification
ATLANTIC SEABOARD WATERSHED		Most yellow eel harvest comes from Chesapeake and Delaware bays, therefore any glass eel harvest in N.C. would have a minimal impact on the population. Also, the ASMCF has already determined that allocating 200 pounds of glass eels per state would have a minimal impact to the population.	• added new paragraph

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Section Heading	2016 Plan	2017 Plan	Modification
LOCATION OF HARVEST – Harvest Sites	Eleven (11) primary sites and three (3) alternate sites: 1. Bradley Creek 2. Futch Creek 3. Goose Creek 4. Howe Creek 5. Mill Creek 6. Queen Creek 7. Sanders Creek 8. Saucepan Creek 9. Shallotte River 10. Whiskey Creek 11. White Oak River, and 1. Dawson Creek 2. Orchard Creek 3. Pierce Creek	Four (4) sites: 1. Albemarle Sound and tributaries 2. Pamlico Sound and tributaries 3. Newport River and tributaries 4. North River and tributaries	• removed the primary sites and alternate sites (n=13), and replaced them with the Albemarle/Pamlico sounds and their tributaries, and the Newport and North rivers
NCDMF MONITORING PROGRAM – General Conditions	It is unlawful to fail to provide a complete inventory of the fyke nets prior to January 1, 2017, including the Net ID number and identifying gear characteristics (e.g., wing mesh, cod end mesh, wing length, funnel length, number of cod ends, number of funnels, etc.).	No requirement	• no Net_ID numbers
	1 harvester; 2 mates	3 harvesters; 2 mates each	• increased number of authorized harvesters (3 total) • increased the number of mates (6 total)
	Fyke and dip nets	Fyke and dip nets + Irish eel ladder	• added Irish eel ladder
	No more than 15 total pieces of gear	No more than 30 total pieces of gear	• increased number of pieces of gear to 30 total

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Section Heading	2016 Plan	2017 Plan	Modification
	January 1 through February 28, 2017, fyke and dip nets for glass eel harvest may be fished at all hours during the week. Fyke nets may have their cod ends closed during the day, however from 12:01 pm on Friday through 12:01 pm on Sunday fyke nets may remain in the water but the terminal portion of a fyke net cod end shall contain a rigid device with an opening not less than three (3) inches in diameter and not exceeding six (6) inches in length that is not obstructed by any other portion of the net and dip nets may not be used.	January 1 through May 30, fyke and dip nets for glass eel harvest may be fished at all hours during the week. Fyke nets may have their cod ends closed during the day, however from 12:01 pm on Friday through 12:01 pm on Sunday fyke nets may remain in the water but the terminal portion of a fyke net cod end shall contain a rigid device with an opening not less than three (3) inches in diameter and not exceeding eight (8) inches in length that is not obstructed by any other portion of the net and dip nets may not be used.	• extended period by 3 months • changed length of the rigid device to 8 inches
	Fyke nets shall be fished at least once every twenty-four (24) hours	No requirement	• removed requirement
	March 1 through April 30, 2017, fyke nets and dip nets for glass eel harvest may only be fished and the cod ends closed from two hours before sunset through two hours after sunrise	No requirement	• removed requirement, will no longer be required to remove nets from the water over the weekend during this period
	During the March 1 through April 30, 2017 period, from two hours after sunrise through two hours before sunset the gear may remain in the water and the terminal portion of a fyke net cod end contain a rigid device with an opening not less than three (3) inches in diameter and not exceeding six (6) inches in length that is not obstructed by any other portion of the net	No requirement	• removed requirement
	Tamper evident tags shall be used to secure the cod ends of the net closed while the gear is fishing	No requirement	• removed requirement
	Tamper evident tags shall be used to secure the cod ends open when the gear is not fishing	No requirement	• removed requirement

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Section Heading	2016 Plan	2017 Plan	Modification
NCDMF MONITORING PROGRAM – Before Harvest	GPS coordinates of each net once they are set, if multiple nets are set the same day, coordinates can be provided once all the nets have been set.		• moved item to After Harvest Section
	Daily - Names of individual(s) involved reported daily	Beginning of the season - Names of individual(s) involved reported only at the beginning of the season; any changes or additions would be immediately reported.	• only reported one time at the beginning of the season
	Daily - Description and registration number of the boat(s)	Beginning of the season - see above	• only reported one time at the beginning of the season
	Daily - Description and license plate number of the vehicle(s)	Beginning of the season - see above	• only reported one time at the beginning of the season
NCDMF MONITORING PROGRAM – During Harvest	Record the time the gear began and ended fishing, and the number of pounds of glass eels harvested from each piece of gear (individual fyke or dip net).	No CPUE data collected	• removed requirement
	Record the weight of elvers captured from each piece of gear	No elver data collected	• removed requirement
NCDMF MONITORING PROGRAM – After Harvest		GPS coordinates of each net once they are set, if multiple nets are set the same day, coordinates can be provided once all the nets have been set.	• moved item from Before Harvest Section
	Require fisherman to call-in to NCDMF the total harvest in pounds prior to leaving the last harvest site and report an estimated time of arrival (within a 15-minute time frame) at the landing site.	No requirement	• removed requirement
	Once all gear is fished, the fisherman must travel directly to the designated landing site	No requirement	• removed requirement
	Once at the designated landing site all eels must be offloaded and transported directly to the AEF facility	No requirement	• removed requirement

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Section Heading	2016 Plan	2017 Plan	Modification
	Require AEF to call-in or email to NCDMF by 12:00 pm (noon) each day the total harvest for the previous day in pounds to the nearest 0.1 lb. of glass eels received	Require AEF to call-in or email to NCDMF by 5:00 pm each day the total harvest for the previous day in pounds to the nearest 0.1 lb. of glass eels received	• change in reporting time (5 hours later)
	Require AEF to provide CPUE data from each piece of gear (individual fyke or dip net) by the 10th of the following month.	No requirement	• removed requirement
DESCRIPRION of the FACILITY			• additional information was provided regarding system specifications

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Figures

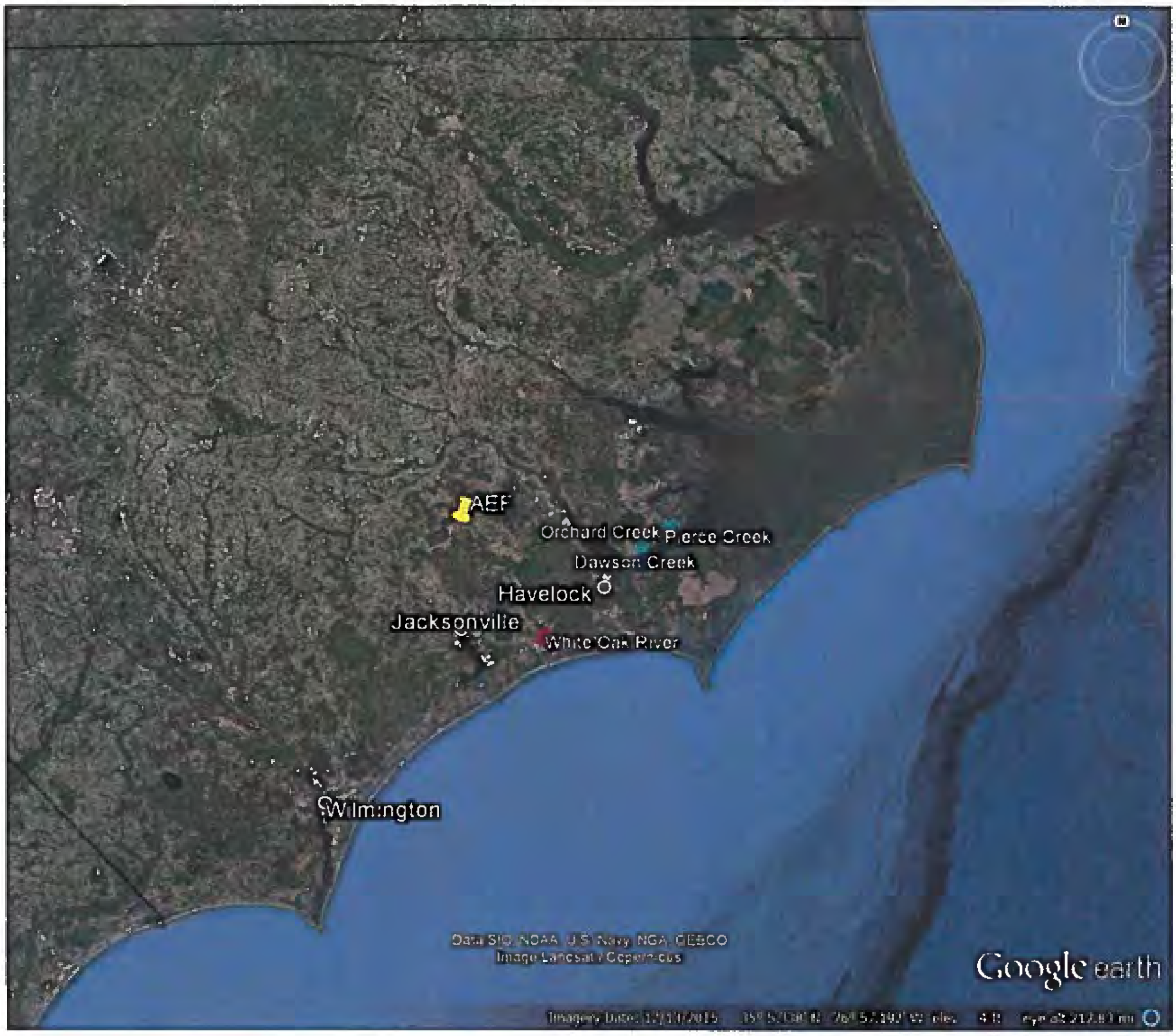

Figure 1. Approved sampling locations with fishing effort in 2017 (most effort occurred in the White Oak River).

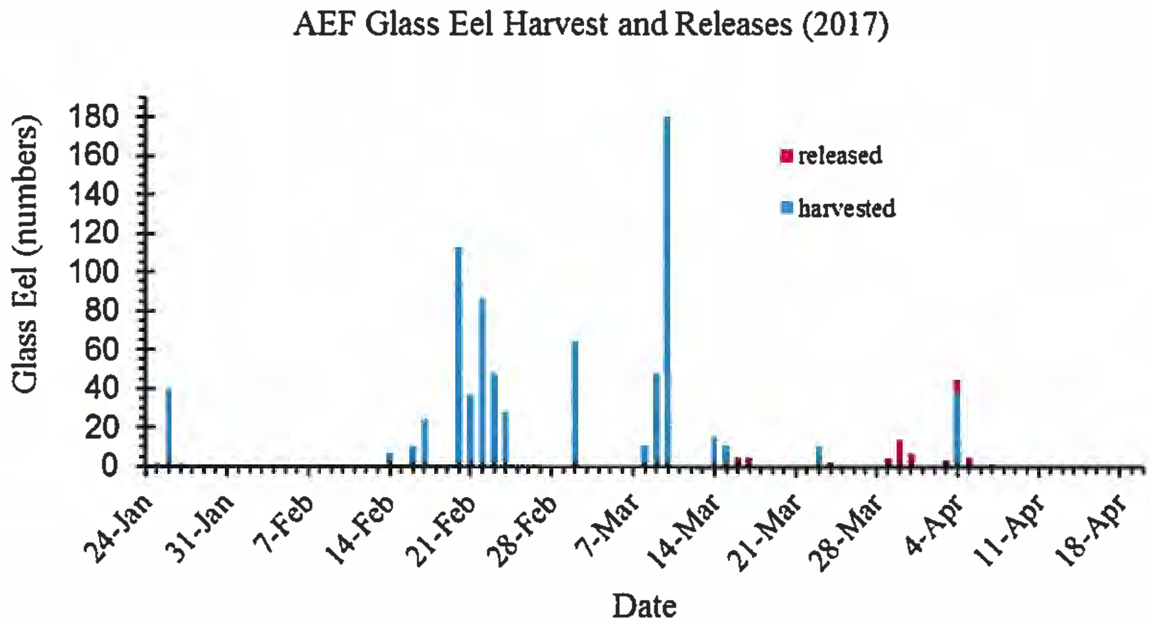

Figure 2. Number of glass eels harvested and released by day during the 2017 fishing season.

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American Eel Technical Committee
Meeting Summary

July 6, 2017

TC Attendance: Robert Eckert (NH), Patrick McGee (RI), Carol Hoffman (NY), Jennifer Pyle (NJ), Michael Kaufmann (PA), Jordan Zimmerman (DE; TC Vice-Chair), Keith Whiteford (MD), Troy Tuckey (VIMS), Todd Mathes (NC), Jason Rock (NC), Andrew Watson (SC), Ryan Harrell (GA) Wilson Laney (USFWS), Sheila Eyler (USFWS), Kirby Rootes-Murdy (ASMFC), Kristen Anstead (ASMFC)

Board Members: Michelle Duval (NCDMF; Commissioner Proxy)

Members of the public: Rick Allyn (AEF), Michael Yates (AEF), Zoemma Warshafsky (VIMS), Steve Murphy (NC DMF)

The American eel Technical Committee (TC) met via conference call July 6th, 2017, to get an update on Zoemma Warshafsky's nematode research project at VIMS, review and make recommendations regarding an aquaculture plan from North Carolina for 2018-2020, get an update on ongoing American eel ageing projects, and discuss the progress and timeline of the stock assessment update.

1) **Updated Nematode Research & Discussion**

Zoemma Warshafsky updated the TC on the progress of her master's thesis work at VIMS investigating if the parasitic nematode, *Anguillicoloides crassus*, is contributing to the decline of the American eel in the Chesapeake Bay. She is also collecting information for upcoming stock assessments to better estimate mortality. Her results indicate that glass eels have more larval stage nematodes than adults and that glass eels have lower infection rates than yellow eels and elvers which are highly infected. The probability of swim bladder damage increases with length and there is more damage in the winter than in the summer months. The highest force of infection, or the transition from disease negative to positive, was at age 2 and during winter months (Nov-Feb). Ultimately she did find that the disease increased mortality for diseased versus healthy fish. If the TC is interested in Warshafsky developing a quick reference field guide so that state samplers who collect biological data for American eels can score the rate of infection using the same protocol coast-wide, she is willing to work with the TC to accomplish that goal. She will also continue to update the TC as her thesis progresses.

2) **NC Update to Eel Aquaculture Plan & Discussion**

Background: Addendum IV to the Interstate Fishery Management Plan for the American Eel includes a provision for states to submit an Aquaculture Plan to allow for the harvest of glass eels. In December 2015, NC and the American Eel Farm (AEF) submitted an aquaculture plan for

2016 which was reviewed by the TC. After amending the plan to reflect the recommendations of the TC, it was presented to the American Eel Management Board and approved in February 2016. Due to delays in NC permitting, fishing began late in the season and no glass eels were captured in 2016. Therefore, NC amended the plan for the TC to consider as a second year pilot program for 2017. This plan was also amended and then approved by the Board.

2017 Glass Eel Harvest Activities: Todd Mathes updated the TC on the 2017 fishing season which served as a second year pilot program. The AEF fishermen encountered some mechanical issues with their boat and gear and were not able to set nets the first few weeks of January. AEF experienced some challenges with the reporting requirements and also received violations by NC Marine Patrol and Wildlife Resources Commission unrelated to reporting requirements. Despite some setbacks, they did fish 12 of the 17 weeks, catching approximately 0.25 lbs (775 glass eels) of the maximum 200 pounds allowed for use in domestic aquaculture.

Proposed 2018-2020 Aquaculture Plan: Todd Mathes presented the NC Aquaculture Plan for American eel for 2018-2020. He indicated that the plan has been revised by the AEF and was being submitted by NCDMF on AEF's behalf. Multiple changes were made from the previously approved plans including an extended 3-year term (2018-2020) and fishing season (addition of one month, now January 1-May 30), use of an Irish eel ladder, expanding the location of the harvest (from 11 creeks and rivers to 2 sounds and 2 rivers), removing multiple monitoring program requirements, and increasing the number of harvesters and allowable pieces of gear. The TC asked questions and discussed the changes. Mathes explained that the extended terms and fishing season, as well as the expanded sites to include northern waters in NC, were to give the AEF more opportunity to be successful and to provide more stability from a business perspective. There was concern that by harvesting in northern waters using an Irish eel ramp, for example, bottlenecks could occur and taking 200 lbs of glass eels from one river system could represent a large proportion of the entire run of glass eels in that river. It was pointed out by Mathes that this could be a concern regardless of gear and that the AEF is restricted to Coastal and Joint fishing waters and not allowed to fish in inland waters where bottlenecks would be present. Similarly, some members of the TC found the expansion of fishing area problematic since the previously stated intent was to target areas that were more urban and in smaller watersheds where removal of glass eel was less likely to affect future adult eel recruitment. As was discussed the last two years, the TC conceded that it was not possible at this time to prove or disprove that the 200 lbs represents a minimal contribution in any of these systems, particularly without a dedicated YOY survey in the region.

The TC was concerned about many of the removed reporting requirements, such as removing ID tags on gear and not requiring tamper evident tags as well as expanding the fishing area but Mathes stated that the NC Marine Patrol Colonel has reviewed this, has officers in all the proposed areas, and feels confident they could enforce the requirements although ID tags should still be used to identify individual gears. Additionally, the tamper evident tags did not work as planned according to Mathes and there was no reported tampering by the AEF. Removing the requirement to fish fyke nets at least once every 24-hours also did not seem prudent to some TC members because of the possibility of eel mortality and bycatch. There were also many concerns about other removed reporting requirements, such as not requiring the collection of CPUE data, since one of the justifications for the previous plan was that it would provide the TC with data on glass eel ingress and abundance from NC. Some TC members acknowledged that the CPUE data may not be that informative initially, but that if this proposal continued for future years the data would be necessary. Ultimately, several TC members expressed that some of their concerns were ameliorated by the fact that the maximum amount of harvest allowed in Addendum IV for aquaculture purposes is 200 lbs of glass eels.

The TC does not support the AEF's proposal in its current form. Given that the project has thus far failed to fish for AEF's full time and gear allocation and has come in well below the quota, the proposal would be accepted by the TC contingent on the following recommendations:

- The proposal should be for one year, not three, and if the 2018 fishing year is successful and in compliance with the requirements then the implementation period could be increased to two years. This would also prevent the AEF from having the entire 200 lbs of allowable harvest for the state for several years, and thus preventing the entry of any other aquaculture companies.
- Remove the language 'While we have no quantitative data on the abundance of glass eels, it could be argued the harvest of 200 lb. of glass eels is limited enough to have a minimal impact on the spawning stock of American eel.' This statement is not the opinion of the TC and the NC Memo further elaborated on this opinion that many TC members found misleading.
- Require net ID numbers and that gear specifications need to be reported so that CPUE calculations can be properly interpreted. [**Please note**: NC staff indicated following the call that AEF will mark their nets with unique ID numbers.]
- Require that fyke nets shall be fished at least once every 24 hours due to concerns over inducing addition mortality. [**Note:** NC DMF staff noted concern with this recommendation in cases of inclement weather that may not allow harvesters to get back to gear location within a 24 period.]
- Require CPUE data collection, including the time the gear began and ended fishing and the number of glass eels harvested from each piece of gear (individual fyke or dip net), as well as the location of the gear (even if location changes daily and/or weekly). This data should continue to be provided by the 10th of the following month.

In addition to the TC recommendations, ASMFC staff indicated that members of the Commission's Law Enforcement Committee will be reviewing the harvest reporting, monitoring, and gear modifications indicated in the new proposal and will aim to provide the Board will feedback at the ASMFC Summer Meeting. Lastly, the TC recommendations will be shared with NC DMF staff and the AEF staff to allow for them to reconsider elements of their proposal the TC raised concerns over.

3) **Progress on the Stock Assessment Update**

Kristen Anstead updated the TC on the progress of the stock assessment update which is scheduled to be presented to the Board in October. Landings and fishery-independent data sets that were previously used in the trend or growth analyses will all be updated. The trend analyses and tests will include ARIMA, Mann-Kendall, Manly, and power. Progress has been made on the analyses and report writing and thus far the stock assessment subcommittee is on target to meet their deadline. The TC should anticipate reviewing and discussing this document in late August-early September.

4) **American Eel Ageing Project**

Anstead also updated the TC on the ASMFC American eel ageing project that has been underway since last year. The sample exchange and analysis indicated a lot of bias and imprecision in eel ageing along the coast. To address this, an in-person ageing workshop is scheduled for January next year. At the workshop, participants will develop processing and age reading protocols and revisit the exchange samples. The ageing workshop will be open to one ager per state/ageing lab with preferential treatment given to those that participated in the exchange. For any questions contact Anstead.

5) **Other Business**

Preliminary yellow eel landings: Kirby Rootes-Murdy presented the preliminary 2016 yellow eel landings to the TC. Addendum IV established a coast-wide catch cap set at 907,671 lbs which was based on the average harvest of 1998-2010. There are two management triggers: (1) the coast-wide cap is exceeded by more than 10% in a given year or (2) the coast-wide cap is exceeded for two consecutive years regardless of percent over. If either triggers is tripped, there would be an implemented state-by-state commercial yellow eel quota. Preliminary 2016 landings indicate that 928,358 lbs of yellow eel were harvested coast-wide, exceeding the catch cap but not by 10%. If the landings also exceed the cap in 2017, there is a likelihood of going to state-by-state quota. In the meantime, Rootes-Murdy is working on drafting a memo to the Board regarding this issue and finalizing the landings.

NC's Senate Bill 410: Dr. Michelle Duval updated the TC on a recent NC bill that was passed by both houses of the NC legislature and has implications for American eel in that state. The bill would exempt American eels imported from Virginia or South Carolina intended for aquaculture operations from some permitting requirements. Currently, imported marine organisms entering NC need an importation permit and health certification from a pathologist to prove that they are disease-free and do not pose a risk to NC. The bill was introduced to address industry concerns regarding the extra expense associated with the health certification which has limited the import of yellow eel sold as bait. The bill is currently on the desk of the governor who will need to sign or veto it in 10 or 30 days or it will automatically become law. As it is written now, it applies to all eel life stages (glass, yellow, silver) although it was noted that Virginia does not have a glass eel fishery.

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MEMORANDUM

July 14, 2017

TO: **American Eel Management Board**

FROM: **Kirby Rootes-Murdy, Senior FMP Coordinator**

SUBJECT: **2016 Preliminary yellow eel landings**

This memo provides information on the preliminary 2016 yellow eel landings and potential implications for the 2018 fishing season. Addendum IV (2014) established a coast-wide catch cap set at 907,671 pounds, which is based on the average harvest level from 1998-2010. Under the cap, there are two management triggers. Upon reaching either of these triggers, the Board is required to alter the management program as specified below in order to ensure the objectives of the management program are achieved.

Management Triggers

1. The coastwide catch cap is exceeded by more than 10% in a given year (998,438 pounds).

2. The coastwide catch cap is exceeded for two consecutive years, regardless of percent over.

Management Response

If either trigger is tripped, then there would be automatic implementation of a state-by-state commercial yellow eel quota. The annual coastwide quota is set at 907,669 pounds, with state allocations specified in Table 1 (last column 'Final Quota').

As of July 2017, the preliminary yellow eel landings for 2016 are 928,358 pounds. Though the 2016 landings are preliminary and subject to change, if the landings remain above the coastwide cap and the cap is exceeded again in 2017 (current fishing year), state-by-state quotas would be implemented in 2018 per the provisions of Addendum IV. While annual compliance reports are due by September 1 annually, preliminary 2017 yellow eel landings could be determined by Spring 2018. Under this potential scenario, the Board would be notified in Spring 2018 of preliminary 2017 landing data and whether management triggers were tripped.

Please contact me if you have any questions by email at krootes-murdy@asmfc.org or by phone at (703)842-0740.

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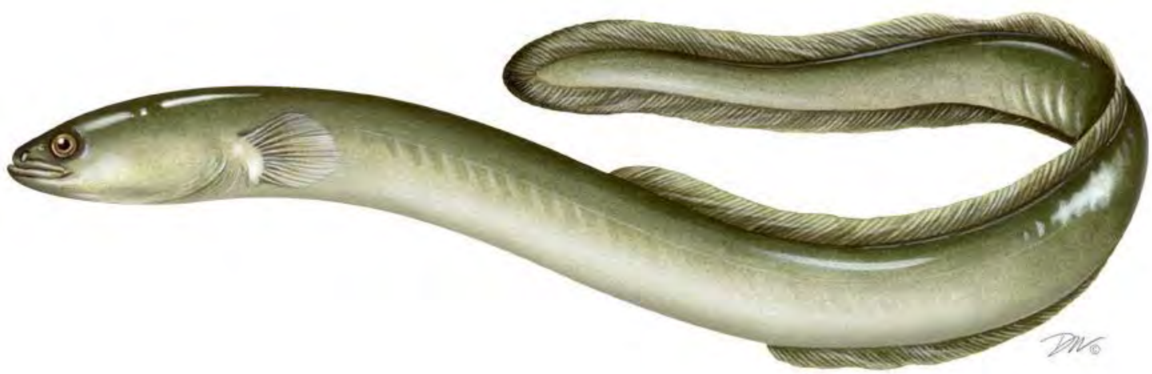
Table 1. State by State yellow eel quotas under Addendum IV.

	2010 Landings	2011-2013 Harvest Average	Initial Allocation Based on Harvest Average	Initial Quota	After Filtering Method is Applied	Final Quota
Maine	2,624	5,104	0.48%	3,943	3,907	3,907
New Hampshire	80	134	0.01%	82	2,000	2,000
Massachusetts	277	450	0.04%	329	2,000	2,000
Rhode Island	4,642	1,750	0.16%	1,314	3,946	4,642
Connecticut	164	2,073	0.19%	1,561	2,000	2,000
New York	13,220	46,058	4.26%	34,997	15,220	15,220
New Jersey	107,803	110,058	10.19%	83,713	91,633	94,899
Delaware	68,666	75,249	6.97%	57,260	58,366	61,632
Maryland	511,201	612,665	56.72%	465,968	465,968	465,968
PRFC	57,755	50,446	4.67%	38,365	49,092	52,358
Virginia	78,076	103,433	9.58%	78,702	78,702	78,702
North Carolina	122,104	53,350	4.94%	40,583	103,788	107,054
South Carolina	2			0	2,000	2,000
Georgia	103	1,162	0.11%	904	2,000	2,000
Florida	11,287	18,231	1.68%	13,802	13,287	13,287
Total	978,004	1,080,160	100%	821,523	893,909	907,669

2016 REVIEW OF THE
ATLANTIC STATES MARINE FISHERIES COMMISSION
FISHERY MANAGEMENT PLAN FOR
AMERICAN EEL
(Anguilla rostrata)

2015 FISHING YEAR



Prepared by the American Eel Plan Review Team
July 2017

2016 REVIEW OF THE ASMFC FISHERY MANAGEMENT PLAN FOR AMERICAN EEL
(Anguilla rostrata)

I. Status of the Fishery Management Plan

Date of FMP approval:	November 1999
Addenda:	Addendum I (February 2006) Addendum II (October 2008) Addendum III (August 2013) Addendum IV (October 2014)
Management unit:	Migratory stocks of American Eel from Maine through Florida
States with a declared interest:	Maine through Florida, including the District of Columbia and the Potomac River Fisheries Commission
Active committees:	American Eel Management Board, Plan Review Team, Technical Committee, Stock Assessment Subcommittee, and Advisory Panel.

The ASMFC American Eel Management Board first convened in November 1995 and finalized the Fishery Management Plan (FMP) for American Eel in November 1999 (ASMFC 2000a). The goal of the FMP is to conserve and protect the American eel resource to ensure ecological stability while providing for sustainable fisheries. In support of this goal, the following objectives are included:

The FMP requires all states and jurisdictions to implement an annual young-of-year (YOY) abundance survey to monitor annual recruitment of each year's cohort. In addition, the FMP requires a minimum recreational size and possession limit and a state license for recreational fishermen to sell eels. The FMP requires that states and jurisdictions maintain existing or more conservative American eel commercial fishery regulations for all life stages, including minimum size limits. Each state is responsible for implementing management measures within its jurisdiction to ensure the sustainability of its American eel population.

In August 2005, the American Eel Management Board directed the American Eel Plan Development Team (PDT) to initiate an addendum to establish a mandatory catch and effort monitoring program for American eel. The Board approved Addendum I at the February 2006 Board meeting.

In January 2007, the Management Board initiated a draft addendum with the goal of increasing escapement of silver eels to the spawning grounds. In October 2008, the Management Board approved Addendum II, which placed increased emphasis on improving the upstream and downstream passage of American eel. The Management Board chose to delay action on management measures in order to incorporate the results of the 2012 stock assessment.

In August 2012, the Management Board initiated Draft Addendum III with the goal of reducing mortality on all life stages of American eel. The addendum was initiated in response to the findings of the 2012 Benchmark stock assessment, which declared American eel stock along the US East Coast as depleted. The Management Board approved Addendum III in August 2013.

Addendum III requires states to reduce the yellow eel recreational possession limit to 25 eel/person/day, with the option to allow an exception of 50 eel/person/day for party/charter employees for bait purposes. The recreational and commercial size limit increased to a minimum of 9”. Eel pots are required to be ½” by ½” minimum mesh size or have at least a 4” by 4” escape panel of ½” by ½” mesh escape panel. The glass eel fishery is required to implement a maximum tolerance of 25 pigmented eels per pound of glass eel catch. The silver eel fishery is prohibited to take eels from September 1st to December 31st from any gear type other than baited traps/pots or spears. The addendum also set minimum monitoring standards for states and required dealer and harvester reporting in the commercial fishery.

In October 2014, the Board approved Addendum IV. The addendum was also initiated in response to 2012 American Eel Benchmark Stock Assessment and the need to reduce mortality on all life stages. The Addendum established a coast-wide cap of 907,671 pounds of yellow eel, reduced Maine’s glass eel quota to 9,688 pounds (2014 landings), and allowed for the continuation of New York’s silver eel weir fishery in the Delaware River. For yellow eel fisheries, the coast-wide cap was implemented for the 2015 fishing year and established two management triggers: (1) if the cap is exceeded by more than 10% in a given year, or (2) the coast-wide quota is exceeded for two consecutive years regardless of the percent overage. If either one of the triggers are met then states would implement state-specific allocation based on average landings from 2011-2013.

II. Status of the Stock

In 2009, the Management Board initiated a benchmark stock assessment. After reviewing over 100 surveys and studies, the American Eel Stock Assessment Subcommittee (SAS) selected 19 YOY surveys and 15 yellow eel surveys along the East Coast for use as indices of abundance in the assessment. Despite the large number of surveys and studies available for use, the American eel stock is still considered data-poor because very few surveys target eels and collect information on length, age, and sex of the animals caught. Additionally, eels have an extremely complex life history that is difficult to describe using traditional stock assessment models. Therefore, several data-poor methods were used to assess the American eel resource.

The first set of analyses (trend analyses) aimed to determine if there was a statistically significant trend in the fishery-independent survey data and whether or not there was evidence for significant trends on the regional and coast-wide scales. The second approach involved a Depletion-Based Stock Reduction Analysis (DB-SRA) model, which uses trends in historical catch to estimate biomass trends and maximum sustainable yield. Both the trend analyses and DB-SRA results indicated that the American eel stock declined in recent decades, and the prevalence of significant downward trends in multiple surveys across the coast is cause for concern. Therefore, the stock status for American eels is depleted, although overfishing and overfished status in relation to the reference points could not be used with confidence. The benchmark stock assessment was peer reviewed in March 2012 and was approved for management use in May 2012.

In 2003, declarations from the International Eel Symposium (AFS 2003, Quebec City, Quebec, Canada) and the Great Lakes Fisheries Commission (GLFC) highlighted concerns regarding the health of eel stocks worldwide. In 2010, Canada Department of Fisheries and Oceans (DFO) conducted a stock assessment on American eels in Canadian waters and found that region-specific status indices show that abundance is very low in comparison to levels in the 1980s for Lake Ontario and upper St. Lawrence River stock, and is either unchanged or increasing in the Atlantic Provinces. A joint stock assessment by both Canada DFO and the Commission was recommended by the SAS as an approach for the next assessment.

The next stock assessment update is scheduled to be completed by fall 2017.

III. Status of the Fishery

American eel currently support commercial fisheries throughout their range in North America, with significant fisheries occurring in the US Mid-Atlantic region and Canada. These fisheries are executed in riverine, estuarine, and ocean waters. In the US, commercial fisheries for glass eel/elver exist in Maine and South Carolina and a silver eel weir fishery exists in New York's Delaware River, whereas yellow eel fisheries exist in all states and jurisdictions with the exception of Pennsylvania and the District of Columbia.

Although eel have been continuously harvested, consistent data on harvest are often not available. Harvest data from the Atlantic coastal states (Maine to Florida) indicate that the harvest fluctuated widely between 1970 and 1980, but showed an increasing trend that peaked in 1979 at 3,951,936 pounds. Harvest has declined since then, with the lowest harvest of 641,225 pounds occurring in 2002. Because fishing effort data are unavailable for the entire time series, finding a correlation between population numbers and landings data is difficult.

Commercial

Commercial landings have decreased from the high of 3.95 million pounds in 1979 to a low of 641,000 pounds in 2002, and have only recently begun to exceed one million pounds. State reported landings of yellow/silver eels in 2015 totaled 865,070 pounds[1] (Table 1), which represents a 18.3% decrease in landings from 2014 (1,059,840 pounds). Yellow eel landings increased in New York but decreased in all other states and jurisdictions. In 2015, state reported landings from Maryland and Virginia together accounted for 66% of the coast-wide commercial total landings. Landings of glass eels were reported from Maine and South Carolina, totaling 5,442 pounds.

Table 1. 2015 Commercial Landings by state and Life Stage[1]

	State Reported	
	Glass	**Yellow**
Maine	5,259.44	4,130
New Hampshire	No Fishery	0
Massachusetts	No Fishery	2,502
Rhode Island	No Fishery	1,538
Connecticut	No Fishery	3,052
New York	No Fishery	53,389
New Jersey	No Fishery	88,828
Pennsylvania	No Fishery	No Fishery
Delaware	No Fishery	44,708
Maryland	No Fishery	493,043
D.C.	No Fishery	No Fishery
PRFC	No Fishery	31,588

[1] Harvest data for 2015 comes from the 2016 State Compliance Reports.

Virginia	No Fishery	78,869
North Carolina	No Fishery	57,791
South Carolina	Glass: 182.29	Confidential
Georgia	No Fishery	Confidential
Florida	Glass: 0 Elver: 0	5,632
Total	**Glass: 5,442 Elver: 0**	**865,070**

Table 2. **State commercial regulations for the 2015 fishing year.***

State	Min Size Limit	License/Permit	Other
ME	Glass no min size	Daily dealer reports/swipe card program; monthly harvester report of daily landings. Tribal permit system in place for some Native American groups.	Harvester license lottery system.
	Yellow 9”	Harvester/dealer license and monthly reporting. Tribal permit system in place for some Native American groups.	Seasonal closures. Gear restrictions. Weekly closures.
NH	9”	Commercial saltwater license and wholesaler license. No dealer reports. Monthly harvester reporting includes dealer information.	Gear restrictions in freshwater.
MA	9"	Commercial permit with annual catch report requirement. Registration for dealers with purchase record requirement. Dealer/harvester reporting.	Traps, pots, spears, and angling only. Mesh restrictions.
RI	9"	Commercial fishing license. Dealer/harvester reporting.	Gear restrictions.
CT	9"	Commercial license (not required for personal use). Dealer/harvester reporting.	Gear restrictions.
NY	9"	Harvester/dealer license and reporting.	Gear restrictions. Maximum limit of 14” in some rivers.
NJ	9"	License required. No dealer reports. Monthly harvester reporting includes dealer information.	Gear restrictions.
PA	NO COMMERCIAL FISHERY		
DE	9"	Harvester reporting, no dealer reporting. License required.	Commercial fishing in tidal waters only. Gear restrictions.
MD	9"	Dealer/harvester license and monthly reporting.	Prohibited in non-tidal waters. Gear restrictions. Commercial crabbers may fish 50 pots per day, must submit catch reports.

DC	NO COMMERCIAL FISHERY		
PRFC	9"	Harvester license and reporting. No dealer reporting.	Gear restrictions.
VA	9"	Harvester license required. Dealer/harvester monthly reporting.	Mesh size restrictions on eel pots. Seasonal closures.
NC	9"	Standard Commercial Fishing License for all commercial fishing. Dealer/harvester monthly combined reports on trip ticket.	Mesh size restrictions on eel pots. Seasonal closures.
SC	Glass no min size	Fyke and dip net only permitted. Dealer/harvester monthly combined reports on trip ticket.	Max 10 individuals. gear and area restrictions.
	Yellow 9”	Pots only permitted. Dealer/harvester monthly combined reports on trip ticket.	Gear restrictions.
GA	9"	Personal commercial fishing license and commercial fishing boat license. Dealer/harvester monthly combined reports on trip ticket.	Gear restrictions on traps and pots. Area restrictions.
FL	9”	Permits and licenses. Harvester reporting. No dealer reporting.	Gear restrictions.

* For specifics on licenses, gear restrictions, and area restrictions, please contact the individual state.

Recreational

Available information indicates that few recreational anglers directly target American eel. For the most part, hook-and-line fishermen catch eel incidentally when fishing for other species. American eel are often purchased by recreational fishermen for use as bait for larger gamefish such as striped bass, and some recreational fishermen may catch their own to use as bait.

The National Marine Fisheries Service (NMFS) Marine Recreational Information Program (MRIP, formerly the Marine Recreational Fisheries Statistics Survey) shows a declining trend in the catch of eel during the latter part of the 1990s. As of 2009, recreational data are no longer provided for American eel, due to the unreliable design of MRIP that focuses on active fishing sites along coastal and estuarine areas.

Table 3. State recreational regulations for the 2015 fishing year.*

State	Size Limit	Possession Limit	Other
ME	9"	25 eels/person/day	Gear restrictions. License requirement and seasonal closures (inland waters only). Bait limit of 50 eels/day for party/charter boat captain and crew.
NH	9"	25 eels/person/day	Coastal harvest permit needed if taking eels other than by angling. Gear restrictions in freshwater.
MA	9"	25 eels/person/day	Nets, Pots, traps, spears, and angling only; seasonal gear restrictions and mesh requirements.

RI	9"	25 eels/person/day	
CT	9"	25 eels/person/day	
NY	9”	25/eels/person/day	Maximum limit of 14” in some rivers. Bait limit of 50 eels/day for party/charter boat captain and crew.
NJ	9"	25 eels/person/day	Bait limit of 50 eels/day for party/charter boat captain and crew.
PA	9"	25 eels/person/day	Gear restrictions. Bait limit of 50 eels/day for party/charter boat captain and crew.
DE	9"	25 eels/person/day	Two pot limit/person.
MD	9"	25 eels/person/day	Gear restrictions.
DC	9"	10 eels/person/day	
PRFC	9"	25 eels/person/day	
VA	9"	25 eels/person/day	Recreational license. Two pot limit. Mandatory annual catch report. Gear restrictions. Bait limit of 50 eels/day for party/charter boat captain and crew.
NC	9"	25 eels/person/day	Gear restrictions. Non-commercial special device license. Two eel pots allowed under Recreational Commercial Gear license. Bait limit of 50 eels/day for party/charter boat captain and crew.
SC	9”	25 eels/person/day	Gear restrictions. Permits and licenses. Two pot limit
GA	9”	25 eels/person/day	
FL	9”	25 eels/person/day	Gear restrictions. Wholesale/Retail purchase exemption applies to possession limit for bait.

* For specifics on licenses, gear restrictions, and area restrictions, please contact the individual state.

IV. Status of Research and Monitoring

The FMP requires states and jurisdictions with a declared interest in the species to conduct an annual YOY survey to monitor annual recruitment of each year’s cohort. In 2015, the states of Rhode Island (Gilbert Stuart), New Jersey (Patcong Creek) and Maryland (Turville Creek) had above average YOY counts. Rhode Island’s Irish elver ramp at Gilbert Stuart recorded its third highest count in the time series and significantly higher than 2014. The 2015 catch at New Jersey’s Patcong Creek site was the third highest in the 15 year time series. The 2015 CPUE at Maryland’s Irish elver ramp on Turville Creek exceeded levels seen in 10 of the last 13 years. All other states with YOY surveys (Maine through Massachusetts; Connecticut-New York, Delaware, PRFC, Carolina, and Florida had below average survey counts. Pennsylvania, D.C., North Carolina, and Georgia do not have YOY surveys, but instead have yellow eel surveys.

The FMP does not require any other research initiatives in participating states and jurisdictions. Nonetheless, the American Eel TC has identified several research topics to further understanding of the species’ life history, behavior, and biology. Research needs for American eel include:

High Priority

- Accurately document the commercial eel fishery to understand participation in the fishery and the amount of directed effort.
- Investigate, develop, and improve technologies for American eel passage upstream and downstream at various barriers for each life stage. In particular, investigate low-cost alternatives to traditional fishway designs for passage of eel.
- A coastwide sampling program for yellow and silver American eels should be formulated using standardized and statistically robust methodologies.
- Regular periodic stock assessments and the establishment of sustainable reference points for eel are required to develop a sustainable harvest rate and to determine whether the population is stable, decreasing, or increasing.
- Research the effects of the swim bladder parasite *Anguillacolla crassus* on the American eel's growth and maturation, migration to the Sargasso Sea, and the spawning potential.
- Evaluate the impact, both upstream and downstream, of barriers to eel movement with respect to population and distribution effects. Determine relative contribution of historic loss of habitat to potential eel population and reproductive capacity**.**

Medium Priority

- Investigate survival and mortality rates of different life stages (leptocephalus, glass eel, yellow eel, and silver eel) to assist in the assessment of annual recruitment. Continuing and initiating new tagging programs with individual states could aid such research.
- Tagging Programs: A number of issues could be addressed with a properly designed tagging program. These include:
    - Natural, fishing, and/or discard mortality; survival
    - Growth
    - Validation of aging method(s)
    - Reporting rates
    - Tag shedding or tag attrition rate
- Research contaminant effects on eel and the effects of bioaccumulation with respect to impacts on survival and growth (by age) and effect on maturation and reproductive success.
- Investigate fecundity, length, and weight relationships for females throughout their range; growth rates for males and females throughout their range; predator-prey relationships; behavior and movement of eel during their freshwater residency; oceanic-behavior, movement, and spawning location of adult mature eel; and all information on the leptocephalus stage of eel.
- Assess characteristics and distribution of eel habitat and the value of habitat with respect to growth and sex determination.
- Identify triggering mechanism for metamorphosis to mature adult, silver eel life stage, with specific emphasis on the size and age of the onset of maturity, by sex. A maturity schedule (proportion mature by size or age) would be extremely useful in combination with migration rates.

Low Priority

- Perform economics studies to determine the value of the fishery and the impact of regulatory management.
- Review the historic participation level of subsistence fishers in wildlife management planning and relevant issues brought forth with respect to those subsistence fishers involved with American eel.

- Examine the mechanisms for exit from the Sargasso Sea and transport across the continental shelf.
- Research mechanisms of recognition of the spawning area by silver eel, mate location in the Sargasso Sea, spawning behavior, and gonadal development in maturation.
- Examine age at entry of glass eel into estuaries and fresh waters.
- Examine migratory routes and guidance mechanisms for silver eel in the ocean.
- Investigate the degree of dependence on the American eel resource by subsistence harvesters (e.g., Native American Tribes, Asian and European ethnic groups).
- Examine the mode of nutrition for leptocephalus in the ocean.
- Provide analysis of food habits of glass eel while at sea.

V. Status of Management Measures and Issues

The FMP requires that all states and jurisdictions implement an annual YOY abundance survey by 2001 in order to monitor annual recruitment of each year's cohort. Addendum III requires a 9 inch minimum size restriction in the commercial and recreational yellow eel fisheries, as well as the use of ½ by ½ mesh in the commercial yellow eel pot fishery. The recreational bag limit is 25 fish/angler/day, and the silver eel fishery is restricted, as is the development of pigmented eel fisheries.

Proposed Endangered Species Act Listing of American Eel
The US Fish and Wildlife Service (USFWS) reviewed the status of American eel in 2007 and found that, at that time, protection under the Endangered Species Act was not warranted. The American eel were later petitioned for listing as threatened under the Endangered Species Act (ESA) in April 2010 by the Center for Environmental Science, Accuracy, and Reliability (CESAR, formally the Council for Endangered Species Act Reliability). The USFWS published a positive 90 day finding on the petition in September 2011, acknowledging that the petition may be warranted and that a status review would be conducted. CESAR filed a lawsuit in August 2012 against the USFWS for failure to comply with the statutes of the ESA, which specifies a proposed rule based on the status review be published within one year of the receipt of the petition. A Settlement Agreement was approved by the court in April 2013, which required the USFWS to publish a 12-month finding by September 30, 2015. In the published finding, the USFWS determined that a listing under the ESA was not warranted.

VI. Current State-by-State Implementation of FMP Compliance Requirements

The PRT reviewed the state compliance reports for 2015. The PRT notes the following changes with states implementing the required provisions of the American Eel Fishery Management Plan:

<u>Glass Eel Fishery Measures:</u>

- The Board exempted Florida from establishing size and bag limits until there is evidence that a fishery exists. In 2013 and 2014 glass eel harvest occurred, but FL imposed a 9" min size in both the recreational and commercial fisheries to end the emerging glass eel fishery in 2015.

<u>Yellow Eel Fishery Measures:</u>

- Connecticut implemented gear specifications for pots to use either constructed of ½" by ½" mesh or that include a 4" by 4" panel of such mesh to allow escape panels. Steps were taken to bring gear into compliance by October 31, 2015.

Silver Eel Fishery Measures:

- Florida does not have a regulation preventing harvest of eels from pound nets from September 1 through December 31, but the state is unaware of any active pound net fishery in the past 10-15 years.

Reporting Measures:

- New Hampshire and New Jersey do not have dealer reporting, but harvesters report some information on dealers. Delaware, the Potomac River Fisheries Commission, and Florida do not have dealer reporting.

In addition to the monitoring program changes implemented with Addendum III and Addendum IV, the following changes were made to the YOY survey in 2015:

- Maine- implemented initiated planning of an eel life cycle study, with the first year to be implemented in 2016.
- New Hampshire – An Irish elver trap was installed on the Lamprey river and a box trap was installed on the Oyster river in order to expand the YOY monitoring program. Sampling occurred on the Oysters River in 2014 and 2015.
- Massachusetts- An Irish elver trap sampled on the Parker River was discontinued due to low to intermittent catches.
- Georgia – Due to changes in the American eel FMP, Georgia ceased to conduct the YOY survey in 2014. It was replaced with a pot survey designed to capture information on yellow-phase eels occurring in the Altamaha River. GA has decided to cease creel survey sampling on the Satilla River in 2015 and solely concentrate on sampling on the Altamaha River.

Section 4.4.2 of the FMP stipulates that states may apply for *de minimis* status for each life stage if (given the availability of data), for the preceding two years, their average commercial landings (by weight) of that life stage constitute less than 1% of the coast-wide commercial landings for that life stage for the same two-year period. States meeting this criterion are exempted from having to adopt commercial and recreational fishery regulations for a particular life stage listed in Section 4 and any fishery dependent monitoring elements for that life-stage listed in Section 3.4.1.

Qualification for *de minimis* is determined from state reported landings found in compliance reports. In 2015, New Hampshire, Massachusetts, Pennsylvania, the District of Columbia, South Carolina, and Georgia requested *de minimis* status for their yellow eel fisheries. All states that applied for *de minimis* of the yellow eel fishery meet the *de minimis* criteria. The state of South Carolina requested *de minimis* status for its glass eel fishery, but does not meet the 1% landings criteria for this life stage.

VII. Recommendations/Findings of the Plan Review Team

1. The PRT recommends the Board consider state compliance issues as detailed in Section VI.

2. The PRT recommends *de minimis* be granted to New Hampshire, Massachusetts, Pennsylvania, the District of Columbia, South Carolina, and Georgia for their yellow eel fisheries.

3. The PRT requests that state personnel highlight notable trends in annual reports. The PRT also requests that state personnel describe any circumstances that prevented sampling from occurring as

required in the FMP and Addendum I, or reasoning for sampling not occurring in a manner consistent with previous years.

4. The PRT requests that states collect biological data from both commercial and recreational landings.

5. The PRT requests that states provide estimates of the percent of harvest going to food versus bait, and of exports by season. The PDT requests that states work with the law enforcement agencies to include information on any confiscated poundage from illegal or undocumented fisheries.

6. The PRT requests that states that do not regulate their personal use fishery be required, at a minimum, to permit participants in this fishery and collect harvest data in order to provide an estimate of effort and catch.