Atlantic States Marine Fisheries Commission

American Lobster Management Board

October 16, 2023
9:45 – 11:45 a.m.
Hybrid Meeting

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. McNamee)*	9:45 a.m.
2.	Board Consent • Approval of Agenda • Approval of Proceedings from May 2023	9:45 a.m.
3.	Public Comment	9:50 a.m.
4.	Consider 2023 Jonah Crab Benchmark Stock Assessment and Peer Review Report **Action** • Presentation of Stock Assessment Report *(J. Carloni)* • Presentation of Peer Review Panel Report *(R. Wong)* • Consider Acceptance of Benchmark Stock Assessment and Peer Review Report for Management Use • Consider Management Response, if necessary	10:00 a.m.
5.	Consider Annual Data Update of American Lobster Indices *(K. Reardon)* **Possible Action** • Update on Addendum XXVII Trigger Index	10:45 a.m.
6.	Consider Terms of Reference and Timeline for the American Lobster Benchmark Stock Assessment *(J. Kipp)* **Action**	11:10 a.m.
7.	Consider Pursuing a Management Strategy Evaluation for American Lobster *(C. Starks)*	11:15 a.m.
8.	Consider Fishery Management Plan Reviews and State Compliance Reports for American Lobster and Jonah Crab for the 2022 Fishing Year *(C. Starks)* **Action**	11:35 a.m.
9.	Other Business/ Adjourn	11:45 a.m.

The meeting will be held at Beaufort Hotel (2440 Lennoxville Road, Beaufort, North Carolina; 252.728.3000) and via webinar; click here for details

MEETING OVERVIEW

American Lobster Management Board
October 16, 2023
9:45 – 11:45 a.m.
Hybrid Meeting

Chair: Dr. Jason McNamee (RI) Assumed Chairmanship: 02/22	Technical Committee Chair: Kathleen Reardon (ME)	Law Enforcement Committee Representative: Rob Beal (ME)
Vice Chair: Pat Keliher (ME)	Advisory Panel Chair: Grant Moore (MA)	Previous Board Meeting: May 1, 2023
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 1, 2023

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

4. Consider 2023 Jonah Crab Benchmark Stock Assessment and Peer Review Report (10:00-10:45 a.m.) Action
Background • The first benchmark stock assessment for Jonah crab was completed earlier in 2023 (**Briefing Materials**). • The assessment was peer-reviewed virtually by a panel of independent experts in August 2023. The Peer Review Report provides the panel's evaluation of the assessment findings (**Briefing Materials**). • After reviewing the stock assessment, the Board may consider management response if warranted by the assessment results.
Presentations • Presentation of Stock Assessment Report by J. Carloni • Presentation of Peer Review Panel Report by R. Wong
Board Actions for Consideration at the Meeting • Consider Acceptance of Benchmark Stock Assessment and Peer Review Report for Management Use

5. Consider Annual Data Update of American Lobster Indices (10:45-11:10 a.m.)
Background • An annual Data Update process between American lobster stock assessments was recommended during the 2020 stock assessment to more closely monitor changes in stock abundance. The objective of this process is to present information—including any potentially concerning trends—that could support additional research or consideration of changes to management. Data sets updated during this process are generally those that indicate exploitable lobster stock abundance conditions expected in subsequent years and include: young-of-year settlement indicators, trawl survey indicators, and ventless trap survey sex-specific abundance indices. • This is the third Data Update and provides an update of last year's review with the addition of 2022 data. Indicator status (negative, neutral, or positive) was determined relative to the percentiles of the stock assessment time series (i.e., data set start year through 2018) **(Briefing Materials).** • As part of this Data Update, the Technical Committee also updated the trigger index approved under Addendum XXVII. With the addition of survey indices from 2022, the combined trigger index has exceeded the threshold established in Addendum XXVII (a 35% decline from the reference period), which triggers the implementation of management measures **(Briefing Materials).**
Presentations • Annual Data Update of American Lobster Indices and Addendum XXVII Trigger Index Update by K. Reardon

6. Consider Terms of Reference and Timeline for American Lobster Benchmark Stock Assessment (11:10-11:15 a.m.) Action
Background • A benchmark stock assessment for American Lobster is scheduled for completion in 2025. • The Technical Committee reviewed and recommended Terms of Reference and a timeline for the stock assessment **(Briefing Materials).**
Presentations • Terms of Reference and Timeline for American Lobster Benchmark Stock Assessment by J. Kipp
Board Actions for Consideration at the Meeting • Approve Terms of Reference and Timeline for American Lobster Benchmark Stock Assessment

7. Consider Pursuing a Management Strategy Evaluation for American Lobster (11:15-11:35 a.m.)

Background

- In May 2021 the Board reviewed TC recommendations on a Management Strategy Evaluation (MSE) for the lobster fishery. The TC recommended the Board pursue a two-phase MSE focused on the GOM/GBK stock, with the goal of providing short-term management guidance at the stock-wide scale while concurrently building the framework to expand the MSE to provide long-term, spatially-explicit management advice. As next steps, the TC recommended a formal process to develop management goals and objectives for the future of the lobster fishery, and forming a steering committee for additional scoping and work plan development **(Briefing Materials)**.
- The Board expressed interest in pursuing an MSE but postponed any action on development of an MSE in order prioritize work on Draft Addendum XXVII. This issue was last discussed by the Board in August 2021.

Presentations

- Review of MSE recommendations from Technical Committee by C. Starks

Board Actions for Consideration at the Meeting

- Consider pursuing an MSE for lobster

8. Consider Fishery Management Plan Reviews and State Compliance Reports for American Lobster and Jonah Crab for the 2022 Fishing Year (11:35-11:45 a.m.) Action

Background

- State compliance reports for American lobster and Jonah crab were due August 1, 2023.
- The Plan Review Teams reviewed state compliance reports and compiled the annual FMP Reviews for lobster and Jonah crab for the 2022 Fishing Year (**Briefing Materials**).
- Delaware, Maryland, and Virginia have requested and meet the requirements for *de minimis* in the lobster and Jonah crab fisheries.

Presentations

- FMP Reviews for American Lobster and Jonah Crab for the 2022 Fishing Year by C. Starks

Board Actions for Consideration at the Meeting

- Approve Fishery Management Plan Reviews and state compliance reports for American Lobster and Jonah Crab for the 2022 Fishing Year
- Approve de minimis requests.

9. Other Business/ Adjourn

American Lobster and Jonah Crab TC Task List

Activity level: High

Committee Overlap Score: Medium

Committee Task List
Lobster TC • August 1, 2024: Annual Compliance Reports Due • Fall 2024: Annual data update of lobster abundance indices • Spring-Summer 2024: Development of lobster stock assessment *Jonah Crab TC* • August 1, 2024: Annual Compliance Reports Due

TC Members
American Lobster: Kathleen Reardon (ME, TC Chair), Joshua Carloni (NH), Jeff Kipp (ASMFC), Catherine Fede (NY), Conor McManus (RI), Chad Power (NJ), Tracy Pugh (MA), Burton Shank (NOAA), Craig Weedon (MD), Somers Smott (VA), Renee St. Amand (CT)
Jonah Crab: Derek Perry (MA, TC Chair), Joshua Carloni (NH), Chad Power (NJ), Jeff Kipp (ASMFC), Conor McManus (RI), Allison Murphy (NOAA), Kathleen Reardon (ME), Chris Scott (NY), Burton Shank (NOAA), Somers Smott (VA), Corinne Truesdale (RI), Craig Weedon (MD)

Lobster Stock Assessment Subcommittee (SAS) Members
Jonah Crab: Tracy Pugh (MA, TC Chair), Conor McManus (RI), Joshua Carloni (NH), Kathleen Reardon (ME), Burton Shank (NOAA), Jeff Kipp (ASMFC)

DRAFT PROCEEDINGS OF THE

ATLANTIC STATES MARINE FISHERIES COMMISSION

AMERICAN LOBSTER MANAGEMENT BOARD

The Westin Crystal City
Arlington, Virginia
Hybrid Meeting

May 1, 2023

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

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INDEX OF MOTIONS

1. **Approval of agenda** by consent (Page 1).

2. **Approval of Proceedings of January 31, 2021** by consent (Page 1).

3. **Main Motion**
Move to select under Issue 2, Option B a trigger level of 38% (Page 16).
Motion by Mr. Pat Keliher; second by Mr. Doug Grout. Motion amended (Page 16).

Motion to Amend
Motion to amend to select under Issue 2, Option B a trigger level of 35% (Page 16).
Motion by Ms. Cheri Patterson; second by Mr. Dan McKiernan. Motion passes (Roll Call: In Favor – NH, RI, CT, NY, NJ; Opposed – MA; Abstentions – DE, MD, VA, NMFS; Null – ME) (Page 18).

Motion to select under Issue 2, Option B a trigger level of 35% (Page 18).
Motion passes (10 in favor and one abstention from NMFS) (Page 18).

4. **Main Motion**
Move to select under Issue 2, Option B a modified "Measures Option 2" in which LMA3 and OCC move to a 6½ maximum gauge size in the final year of changes and do not decrease their maximum gauge size further. Initial changes to the gauge sizes for all GOM/GBK management areas should occur on June 1st in the following year. For example, if a trigger is tripped at the fall Annual meeting in 2023, a minimum gauge size change would be implemented June 1, 2024. Should a future stock assessment conclude that the GOM and GBK stocks are not a single biological stock, the Board can revisit the max gauge size decrease in OCC and LMA 3 (Page 18).
Motion by Mr. Pat Keliher; second by Ms. Cheri Patterson (Page 19).

	LMA 1	LMA 3	OCC
Initial gauge size changes (Year 1 implementation)	**Min: 3 5/16" (84mm)** Max: Status quo Vent: Status quo	Min: Status quo Max: Status quo Vent: Status quo	Min: Status quo Max: Status quo Vent: Status quo
Intermediate gauge sizes (Year 3 implementation)	**Min: 3 3/8" (86mm)** Max: Status quo **Vent: 2x5 ¾" rect; 2 5/8" circular**	Min: Status quo Max: Status quo Vent: Status quo	Min: Status quo Max: Status quo Vent: Status quo
Final gauge size (Year 5 implementation)	Min: 3 3/8" (86mm) Max: Status quo Vent: Status quo	Min: Status quo **Max: 6 ½"** Vent: Status quo	Min: Status quo **Max: 6 ½"** Vent: Status quo

Move to Amend
Move to amend that the increase in the escape vent size in LCMA 1 be implemented in year 5 after the trigger has been reached (Page 19).
Motion by Mr. Doug Grout; second by Mr. Steve Train. Motion fails (3 in favor, 5 opposed, 3 abstentions) (Page 20).

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The Board will review the minutes during its next meeting.

	LMA 1	LMA 3	OCC
Initial gauge size changes (Year 1 implementation)	**Min: 3 5/16" (84mm)** Max: Status quo Vent: Status quo	Min: Status quo Max: Status quo Vent: Status quo	Min: Status quo Max: Status quo Vent: Status quo
Intermediate gauge sizes (Year 3 implementation)	**Min: 3 3/8" (86mm)** Max: Status quo **Vent: status quo**	Min: Status quo Max: Status quo Vent: Status quo	Min: Status quo Max: Status quo Vent: Status quo
Final gauge size (Year 5 implementation)	Min: 3 3/8" (86mm) Max: Status quo **Vent: 2x5 ¾" rect; 2 5/8" circular**	Min: Status quo **Max: 6 ½"** Vent: Status quo	Min: Status quo **Max: 6 ½"** Vent: Status quo

Motion to Amend

Move to amend that the increase in the escape vent size in LCMA 1 be implemented in year 4 after the trigger has been reached (Page 20).

Motion by Mr. David Borden; second by Mr. Steve Train. Motion passes (10 in favor, 1 abstention) (Page 21).

	LMA 1	LMA 3	OCC
Initial gauge size changes (Year 1 implementation)	**Min: 3 5/16" (84mm)** Max: Status quo Vent: Status quo	Min: Status quo Max: Status quo Vent: Status quo	Min: Status quo Max: Status quo Vent: Status quo
Intermediate gauge sizes (Year 3 implementation)	**Min: 3 3/8" (86mm)** Max: Status quo **Vent: status quo**	Min: Status quo Max: Status quo Vent: Status quo	Min: Status quo Max: Status quo Vent: Status quo
Year 4	**Vent: 2x5 ¾" rect; 2 5/8" circular**		
Final gauge size (Year 5 implementation)	Min: 3 3/8" (86mm) Max: Status quo	Min: Status quo **Max: 6 ½"** Vent: Status quo	Min: Status quo **Max: 6 ½"** Vent: Status quo

Main Motion as Amended

Move to select under Issue 2, Option B a modified "Measures Option 2" in which LMA3 and OCC move to a 6½ maximum gauge size in the final year of changes and do not decrease their maximum gauge size further. Initial changes to the gauge sizes for all GOM/GBK management areas should occur on June 1st in the following year. For example, if a trigger is tripped at the fall Annual meeting in 2023, a minimum gauge size change would be implemented June 1, 2024. Should a future stock assessment conclude that the GOM and GBK stocks are not a single biological stock, the Board can revisit the max gauge size decrease in OCC and LMA 3. The increase in the escape vent size in LCMA 1 would be implemented in year 4 after the trigger has been reached.

Motion to Amend

Motion to amend to strip the motion of the maximum size changes in OCC and LCMA 3 that are scheduled to go in this motion (Page 21).

	LMA 1	LMA 3	OCC

Initial gauge size changes (Year 1 implementation)	**Min: 3 5/16" (84mm)** Max: Status quo Vent: Status quo	Min: Status quo Max: Status quo Vent: Status quo	Min: Status quo Max: Status quo Vent: Status quo
Intermediate gauge sizes (Year 3 implementation)	**Min: 3 3/8" (86mm)** Max: Status quo **Vent: status quo**	Min: Status quo Max: Status quo Vent: Status quo	Min: Status quo Max: Status quo Vent: Status quo
Year 4	**Min: 3 3/8" (86mm)** Max: Status quo **Vent: 2x5 ¾" rect; 2 5/8" circular**		
~~**Final gauge size (Year 5 implementation)**~~	~~Min: 3 3/8" (86mm)~~ ~~Max: Status quo~~	~~Min: Status quo~~ ~~**Max: 6 ½"**~~ ~~Vent: Status quo~~	~~Min: Status quo~~ ~~**Max: 6 ½"**~~ ~~Vent: Status quo~~

Motion by Mr. Dan McKiernan; second by Mr. David Borden. Motion fails (4 in favor, 6 opposed, 1 abstention) (Page 23).

Main Motion as Amended

Move to select under Issue 2, Option B a modified "Measures Option 2" in which LMA3 and OCC move to a 6½ maximum gauge size in the final year of changes and do not decrease their maximum gauge size further. Initial changes to the gauge sizes for all GOM/GBK management areas should occur on June 1st in the following year. For example, if a trigger is tripped at the fall Annual meeting in 2023, a minimum gauge size change would be implemented June 1, 2024. Should a future stock assessment conclude that the GOM and GBK stocks are not a single biological stock, the Board can revisit the max gauge size decrease in OCC and LMA 3. The increase in the escape vent size in LCMA 1 would be implemented in year 4 after the trigger has been reached.

Motion passes 9 in favor, 1 opposed, 1 abstention (Page 23).

	LMA 1	LMA 3	OCC
Initial gauge size changes (Year 1 implementation)	**Min: 3 5/16" (84mm)** Max: Status quo Vent: Status quo	Min: Status quo Max: Status quo Vent: Status quo	Min: Status quo Max: Status quo Vent: Status quo
Intermediate gauge sizes (Year 3 implementation)	**Min: 3 3/8" (86mm)** Max: Status quo **Vent: status quo**	Min: Status quo Max: Status quo Vent: Status quo	Min: Status quo Max: Status quo Vent: Status quo
Year 4	**Vent: 2x5 ¾" rect; 2 5/8" circular**		
Final gauge size (Year 5 implementation)	Min: 3 3/8" (86mm) Max: Status quo	Min: Status quo **Max: 6 ½"** Vent: Status quo	Min: Status quo **Max: 6 ½"** Vent: Status quo

Move to approve Issue 1, sub-option B1 and sub-option B4. This combination of options will set a standard v-notch definition of 1/8" in LCMAs 3 and OCC, maintain the zero tolerance definition in LCMA1, and

establish a maximum gauge size in OCC of 6 ¾" for state and federal permit holders. It will also limit the issuance of trap tags to equal harvester trap tag allocations (Page 24).
Motion by Mr. Pat Keliher; second by Mr. David Borden. Motion separated (Page 24).

Move to Separate
Motion to separate B1 and B4.
Motion by Mr. David Borden; second by Mr. Dan McKiernan. Motion passes by consent (Page 25).

Move to approve Issue 1, sub-option B1. This option will set a standard v-notch definition of 1/8" in LCMAs 3 and OCC, maintain the zero tolerance definition in LCMA1, and establish a maximum gauge size in OCC of 6 ¾" for state and federal permit holders.
Motion passes (8 in favor, 1 opposed, 1 abstention) (Page 26).

5. **Main Motion**
Move to approve Issue 1, sub-option B4. This will limit the issuance of trap tags to equal harvester trap tag allocations (Page 26).

Motion to Amend
Move to amend to exempt the OCC from this requirement (Page 26).
Motion by Mr. Dan McKiernan; second by Mr. Pat Keliher. Motion passes (6 in favor, 5 abstentions) (Page 29).

Main Motion as Amended
Move to approve Issue 1, sub-option B4, except for OCC. This will limit the issuance of trap tags to equal harvester trap tag allocations for LCMA 1 and LCMA 3.
Motion passes (3 in favor, 1 opposed, 7 abstentions) (Page 30).

Move to approve Lobster Addendum XXVII, as modified today, with an implementation date of January 1, 2024 (Page 30).
Motion by Ms. Cheri Patterson; second by Mr. Emerson Hasbrouck. Motion passes (10 in favor and one vote in opposition from MA) (Page 31).

Move to request the Interstate Fisheries Management Policy Board approve the creation of a subcommittee to engage Canada's Department of Fisheries and Oceans to discuss transboundary issues related to the importation of lobster as it relates to different minimum gauge sizes in the two countries. The subcommittee shall be made up of up to four members of the Lobster Management Board who have license holders that fish in Area 1 and/or 3, one representative from the National Marine Fisheries Service, and the Commission's Executive Director or his designee (Page 32).
Motion by Mr. Pat Keliher; second by Mr. David Borden. Motion passes by consent with one abstention from NMFS (Page 34).

6. **Move to adjourn** by consent (Page 34).

ATTENDANCE

Board Members

Pat Keliher, ME (AA)
Stephen Train, ME (GA)
Rep. Allison Hepler, ME (LA)
Cheri Patterson, NH (AA)
Doug Grout, NH (GA)
Sen. David Watters, NH (LA)
Dan McKiernan, MA (AA)
Raymond Kane, MA (GA)
Rep. Sarah Peake, MA (LA)
Jason McNamee, RI (AA)
David Borden, RI (GA)
Eric Reid, RI, proxy for Sen. Sosnowski (LA)
Colleen Bouffard, CT, proxy for J. Davis (AA)
Bill Hyatt, CT (GA)
Jim Gilmore, NY, proxy for B. Seggos (AA)
Emerson Hasbrouck, NY (GA)
Jeff Brust, NJ, proxy for J. Cimino (AA)
Tom Fote, NJ (GA)
Adam Nowalsky, NJ, proxy for Sen. Gopal (LA)
John Clark, DE (AA)
Roy Miller, DE (GA)
Craig Pugh, DE, proxy for Rep. Carson (LA)
Mike Luisi, MD, proxy for L. Fegley (AA, Acting)
Russell Dize, MD (GA)
Dave Sikorski, MD, proxy for Del. Stein (LA)
Shanna Madsen, VA, proxy for J. Green (AA)
Jay Hermsen, NOAA proxy for A. Murphy
Mike Pentony, NMFS

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

Ex-Officio Members

Kathleen Reardon, Technical Committee Chair
Derek Perry, Technical Committee Chair
Rob Beal, Law Enforcement Committee Rep.

Staff

Bob Beal
Toni Kerns
Madeline Musante
Tina Berger
Lindsey Aubart
Tracy Bauer
Julie DeFilippi Simpson
Chris Jacobs
Adam Lee
Mike Rinaldi
Caitlin Starks
Anna-Mai Christmas-Svajdlenka
Chelsea Tuohy

Guests

Dennis Abbott, NH, Leg Proxy
Max Appelman, NMFS
Mike Armstrong, MA DMF
Brendan Adams
Sydney Alhale, NOAA
Chris Batsavage, NC DENR
Alan Bianchi, NC DENR
Delayne Brown, NH F&G
Debbie Campbell
Josh Carloni, NH F&G
Beth Casoni, MLA
Barry Clifford, NOAA
Haley Clinton, NC DENR
Caitlin Craig, NYS DEC
Scott Curatolo-Wagemann, Cornell
Monty Deihl, Ocean Fleet Svcs.
Steve Doctor, MD DNR
Sam Duggan, NOAA
Bill Dunn
Julie Evans
Catherine Fede, NYS DEC
Glen Fernandes
James Fletcher
Marty Gary, PRFC
Matt Gates, CT DEEP
Diedre Gilbert, ME DMR
Angela Giuliano, MD DNR
Robert Glenn, MA DMF
Melanie Griffin, MA DMF
Bo Hale, USCG
Amalia Harrington, Univ ME
Heidi Henninger, AOLA
Jay Hermsen, NOAA
Peter Himchak, Cooke Aqua
Jesse Hornstein NYS DEC
Jeff Kaelin, Lund's Fisheries
Emily Keiley, NOAA
Tom Lilly
Chip Lynch, NOAA

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The Board will review the minutes during its next meeting.

Guests (continued)

John Maniscalco, NYS DEC
Conor McManus, RI DMF
Kevin McMenamin, Annapolis
Nichola Meserve, MA DMF
Kyle Miller, FL FWC
Lorraine Morris, ME DMR
Allison Murphy, NOAA
Jeff Nichols, ME DMR
Scott Olszewski, RI DEM
Gerry O'Neill, Cape Seafoods
Justin Pellegrino, NYS DEC
Stephen Pickard
Chris Pickard
Nicole Pitts, NOAA
Tracy Pugh, MA DMF
Marianne Randall, NOAA
Marcel Reichert, Walhalla, SC
Paul Risi, City Univ NY
Mike Ruccio, NOAA
Somers Smott, VMRC
Renee St. Amand, CT DEEP
Jesica Waller, ME DMR
Craig Weedon, MD DNR
Angel Willey, MD DNR
Erin Wilkinson, ME DMR
Chris Wright, NOAA
Phil Zalesak
Rene Zobel, NH F&G

The American Lobster Management Board of the Atlantic States Marine Fisheries Commission convened in the Jefferson Ballroom of the Westin Crystal City Hotel, Arlington, Virginia, via hybrid meeting, in-person and webinar; Monday, May 1, 2023, and was called to order at 12:45 p.m. by Chair Jason McNamee.

CALL TO ORDER

CHAIR JASON McNAMEE: Hi everybody; I think we're going to get started here. I'm still sorting a few folks out online, but I think I've got enough to get the meeting started here. Welcome everybody to the American Lobster Management Board. We had an agenda that was published, so I'm going to start with that. Are there any changes, or additions, or anything else to the agenda that we would like for today? Yes, Pat.

MR. PATRICK C. KELIHER: Under Other Business I would like to, after we've finished with the addendum issues, I would like to raise an issue around Canada. Then a second issue would be the northern edge that the Council has just taken up.

CHAIR McNAMEE: Thank you, Pat. Any other changes to the agenda? Yes, Dan.

MR. DANIEL McKIERNAN: I'm not sure it's a change to the agenda, but when we get into the action items, I would like to take certain aspects of Addendum XXVII out of order. Is that something we can deal with when we get to that item?

CHAIR McNAMEE: Yes, thanks, Dan. I was actually thinking the same exact thing. I will be sure to highlight that. Okay, any other changes to the agenda?

APPROVAL OF AGENDA

CHAIR McNAMEE: We've had two additions under Other Business. Not seeing any other changes to the agenda, look to approve the agenda as modified. Are there any objections to approving the agenda as modified? Not seeing any; we will consider the agenda approved.

APPROVAL OF PROCEEDINGS

CHAIR McNAMEE: Next, we'll move to the proceedings from the January 2023 meeting. Are there any changes, additions, deletions to those proceedings from anybody on the Board? Okay, not seeing any hands around the table, Caitlin, anybody online with a hand up? Okay, with that are there any objections to approving the proceedings as submitted? Please, raise your hand. Seeing none; we will consider the proceedings approved.

PUBLIC COMMENT

CHAIR McNAMEE: The next agenda item is for public comment. This is public comment for things that are not currently on the agenda. Is there anyone from the public that wishes to make a comment on something, again that we're not already covering on today's agenda? Looking around the room here first, not seeing anyone. Looking over at Caitlin; nobody online either. We will consider there to be no additional public comment. I will come back to public comment in a few moments here, but we'll move past that item for now.

CONSIDER ADDENDUM XXVII ON INCREASING PROTECTION OF SPAWNING STOCK BIOMASS OF THE GULF OF MAINE/GEORGES BANK STOCK FOR FINAL APPROVAL

CHAIR McNAMEE: Next up is the main event. We're going to consider Addendum XXVII on Increasing Protection of Spawning Stock Biomass of the Gulf of Maine/Georges Bank Stock for Final Approval.

We're going to have a presentation from Caitlin Starks; both on the Addendum itself, as well as the Advisory Panel report. Then we'll come back, and then I wanted to offer a couple of comments. Dan McKiernan mentioned one of them, but I'll hit that stuff after the presentations and after you've cleared up any questions that you have. With that I will pass it over to you, Caitlin, to take us through the presentation.

REVIEW OPTIONS

MS. CAITLIN STARKS: I'll be giving a pretty quick, hopefully, presentation on Draft Addendum XXVII itself, which is again on increasing protection of the spawning stock in the Georges Bank and Gulf of Maine stock. I'll start off today with some brief background. The Addendum timeline, background information on the draft Addendum, and then go over the proposed management options that are in the document.

Then after that I'll summarize the public comments on this Addendum and present the AP report, and then we'll wrap up with the Board's actions for consideration today. This Addendum was originally initiated in 2017, and then work on the Addendum was paused for several years, as the Board had to prioritize work on right whale risk reduction efforts, and then work on this Addendum was restarted in February of 2021.

In 2021 and 2022, the Plan Development Team developed this draft Addendum document with guidance from the management board, and in January of 2023 the Board approved the draft Addendum for public comment. Our public comment period occurred earlier this year from March to April 8th of 2023, and during that time we had 8 hearings that were held from Maine to New York.

Today the Board will consider selecting a management program and final approval of draft Addendum XXVII. As I mentioned, the Board originally initiated Draft Addendum XXVII in August of 2017, and this was in response to concerns about decreasing trends in larval settlement indices for the Gulf of Maine, which have been showing declines since about 2012.

At that time the Addendum was focused on standardizing management measures across the lobster conservation and management areas, or LCMAs within the Gulf of Maine/Georges Bank stock. Then in 2021, after the Board received the results of the 2020 stock assessment and reinitiated work on this Addendum, the 2020 stock assessment highlighted some continued negative trends in the lobster stock indices in the Gulf of Maine and Georges Bank.

In the last five years settlement surveys have remained below the 75th percentile of their time series, and since the 2020 stock assessment was completed, which only included data through 2018, we've also seen some declines in the recruit abundance indices in the ventless trap survey and trawl surveys for the Gulf of Maine and Georges Bank. To give a visual of this, this slide shows the Gulf of Maine Young of Year Survey indices through 2021, sort of our last year of data that we have. The last three years of data are shown in red. You can see that there has been an overall downward trend in the settlement indices over about the past decade, with only one of the survey areas showing an increase in the last three years. Then this figure shows the Gulf of Maine recruit abundance indices from the trawl survey through 2021.

Again, the last few years of data are shown in red. You can see here that after it increased for a while in the 2000s and 2010, the recruits have also started to show declines in the last two or three years in most of the survey areas. With these trends in mind, the Board revised the objective for this Addendum, and it is now shown on the screen.

Given persistent low settlement indices and recent decreases in recruit indices, the Addendum should consider a trigger mechanism, such that upon reaching the trigger, measures would be automatically implemented to increase the overall protection of spawning stock biomass of the Gulf of Maine/Georges Bank stock.

The Draft Addendum also considers some options that would standardize some of the existing management measures within the Gulf of Maine and Georges Bank stock, which are aimed at improving or resolving some of the discrepancies between measures in different management areas within the stock.

The proposed options are expected to have benefits for the stock assessment, as well as law enforcement and interstate commerce. Next, I'm going to go over the proposed options that were included in the Draft Addendum for public comment. Our proposed options in Draft Addendum XXVII are separated into two issues.

Issue 1 addresses the standardization of a subset of management measures within LCMAs and across the stock. Then Issue 2 considers implementing biological management measures that are expected to provide increased protection of the spawning stock biomass. Before I go into the proposed changes, I want to review the relevant current measures for the areas within the stock.

You've got Area 1, Area 3 and Outer Cape Cod, just make sure everyone is on the same page for what are the measures that were considered in the status quo options. The Area 1 minimum gauge size is currently 3 and 1/4 inch. Area 3 slightly larger at 3 inches and 17/32 of an inch, and Outer Cape is at 3 and 3/8 of an inch.

V-notching is required in Area 1 and in Area 3 above the latitude of 42 degrees and 30 seconds, and then Outer Cape Cod does not have mandatory v-notching. In Area 1 there is a 0-tolerance definition for possession of v-notched lobster, and in Area 3 the definition is a notch that is 1/8 of an inch, with or without setal hairs.

In Outer Cape Cod there are two definitions. For state permitted fishermen in state waters the definition is 1/4 of an inch without setal hairs, and for federal permit holders, regardless of location, the definition is 1/8 of an inch, with or without setal hairs. Then for maximum gauge sizes, LCMA 1 is at 5 inches, LCMA 3 is at 6 and 3/4 of an inch, and Outer Cape Cod there are two maximum sizes. For state waters there is no maximum size, and in federal waters it is 6 and 3/4 of an inch. The options under Issue 1 are status quo, which is A, or B, which would implement some standardized measures upon final approval of this Addendum. Under Option B there are four sub-options that would define what those standardized measures would include. From the four sub-options the Board can select as many as desired, depending on which issues it wants to address. These are the four sub-options under B.

B1 would implement standardized measures within the Gulf of Maine and Georges Bank stock LCMAs, if there is a discrepancy within one LCMA to the most conservative measures where there are inconsistencies. This would result in the maximum gauge size in Outer Cape Cod going to 6 and 3/4 of an inch for both state and federal permit holders, and it would result in a v-notch possession definition of 1/8 inch, with or without setal hairs.

Option B2 would standardizes the v-notch requirement across LCMAs, such that v-notching would be mandatory for all eggers in LCMAs 1, 3, and Outer Cape Cod. Option B3 is to standardize the v-notch possession definition to 1/8 of an inch, with or without setal hairs for LCMA 1, 3 and Outer Cape Cod. Then Option B4 would standardize the regulations across the LCMAs, to limit the issuance of trap tags to equal the Harvester Trap Tag Allocation.

This means that no surplus tags would be automatically issued until trap losses occur and are documented. Moving on to Issue 2. These options focus on implementing management measures that would increase the protection of the spawning stock biomass. The options consider changes to the minimum and maximum gauge sizes, as well as corresponding escape vent sizes.

These are expected to increase the spawning stock biomass, and allow more lobsters to reproduce before they are harvested by the fishery. Including our status quo option, there are three total options under Issue 2. Within the options there are two approaches for implementing management changes.

The first approach is what is included in Option B, and this would establish a trigger mechanism, such that when a trigger is reached, it would result in predetermined management measures being implemented. The trigger would be based on a certain amount of decline in index, and I'll go into that in a moment. The proposed trigger index that would be used is based on multiple recruit abundance indices that are averaged over three years.

Then the second approach that we have is applied in Option C, and this would establish a predetermined schedule for future changes to the management measures. Under Option B the Board would establish a trigger mechanism to implement predetermined management measures when the trigger is reached. In this option that means the Board would need to define what the trigger level is, and what management measures would be implemented when that trigger is reached.

For selecting a trigger level, we have two options. Trigger Option 1 is that if the trigger index declines from its reference level by 32 percent, that would trigger the implementation of the management measures that are selected by the Board. Then Trigger Option 2 is a 45 percent decline in the trigger index. Just as a reminder, these two trigger levels are meant to approximate similar declines in lobster abundance. Our 45 percent trigger approximates the 75th percentile of the moderate abundance regime from the stock assessment. This figure is showing the trigger index that would be used under Option B to determine when the management measures would be implemented. This is calculated through 2021, with the available data, and the top left panel shows the combined index that would be used to determine when the trigger level is reached.

Then the three survey indices that go into that combined index are shown individually in the other three panels. These are the fall and spring trawl survey recruit indices and the ventless trap recruit index. The two horizontal lines on each graph represent the proposed trigger levels of 32 percent and 45 percent.

The reference level that the index is compared to is based on the reference abundance timeframe from the stock assessment, which was 2016 through 2018. The index is scaled to that reference level. On the Y axis one represents the reference level and that is the 2016 to 2018 average of the indices that go into the index.

Then as the index values change over time, depending on additional years of survey data, they will either decline below 1 or increase above 1. Our most recent index value, which is the 3-year average from 2019 to 2021, is 0.765, and that is about a 23 percent decline from the reference value.

If Option B is selected the Board would also need to select the biological management measures that would be automatically implemented in the Gulf of Maine and Georges Bank stock when that trigger level is reached. We have two options for management measures that were proposed in the Addendum.

Measures Option 1 would change the minimum and maximum gauge sizes, and the escape vent sizes in a single year. Then Measures Option 2 would involve a series of gradual changes to the gauge and escape vent sizes over several years. Again, these are the current gauge and vent sizes in the management areas in the Gulf of Maine and Georges Bank stock.

This table shows the measures that would change under Measures Option 1. The changes from status quo are shown in bold. Under Measures Option 1, when the established trigger level is reached for the following fishing year, the minimum gauge size for LCMA 1 would increase from the current size to 3 3/8 of an inch. The escape vent size in LCMA 1 would be adjusted, corresponding with that minimum gauge size change.

The maximum gauge size in LCMA 3 and Outer Cape Cod would decrease to 6 inches. The proposed increase to the minimum gauge size in LCMA 1 is expected to increase the proportion of the population that is able to reproduce before harvested by the fishery. This is expected to have a short-term negative impact on the Area 1 harvest, but over time the harvest in weight is expected to increase slightly with the minimum gauge size increase.

The proposed decrease to the maximum gauge sizes in LCMA 3 an Outer Cape Code are expected to enhance the stock resiliency by placing forever protections on a small proportion of the population, which includes the larger lobsters of both sexes. That change would be expected to have a small negative impact on the harvest number and weight. The proposed combinations of gauge and vent sizes are expected to maintain similar retention rates of legal-size lobsters and protection of sublegal sizes. The vent size that is proposed for Area 1 here is also consistent with the current vent size that is used in the southern New England management areas, where the minimum gauge size is also 3-3/8 of an inch.

Then this next table lists the management measures that would be implemented if Measures Option 2 is selected when the trigger point is reached. Again, the changes in each of the years are shown in bold. I want to note here that these final measures in this option in the last row are the same as what you saw in the previous option.

The difference is just that these changes occur gradually, as opposed to all at once. Under Measures Option 2, when the trigger level is reached it would start a series of gradual changes in gauge sizes for the areas in the stock, and the changes would occur every other year. The minimum gauge size in Area 1 would increase twice in increments of 1/16 of an inch.

The maximum gauge size for Area 3 and Outer Cape Cod area would decrease twice in increments of 1/4 of an inch. The escape vent size in LCMA 1 would be adjusted a single time when the final minimum gauge size is implemented in that area. Then the last option under Issue 2 is Option C, and this considers implementing gradual changes to the gauge and escape vent sizes on an established schedule, as opposed to using a trigger mechanism.

There are three steps for proposed changes in this option. This table shows the measures that would change in each of those steps in bold font. The first set of measures would be implemented no later than the 2026 fishing year. In the first step there would be an increase in the minimum gauge size in Area 1 by 1/16 of an inch to 3-5/16 of an inch, and a decrease in the maximum gauge size in LCMA 3 and outer Cape Cod to 6-1/2 inches.

Then one year following that there would be a decrease to the maximum gauge size in LCMA 3 and Outer Cape Cod to 6 and 1/4 inches, and no change in LMA 1 in that year. Then in the third and final step, which would occur one year later, it would increase the minimum gauge size in LMA 1 to 3-3/8 of an inch, and decrease the maximum gauge sizes for LMA 3 and Outer Cape Cod to 6 inches.

The vent size in LMA 1 would also be adjusted in our third and final step. As a note, for any of the proposed options for LCMA 3 measures, the Addendum specifies that whatever measures are selected would apply to all of Area 3 permit holders, including those that fish in the southern New England stock.

PUBLIC COMMENT SUMMARY

MS. STARKS: That covers all of the options in the Draft Addendum, and I am now going to go over the public comment summary. Our public comment period started in early March, and ended on April 8. During that time, we had eight public hearings that were held for Maine, New Hampshire, Massachusetts, Rhode Island and New York.

Four of those hearings were in person and four were held virtually. Across the eight hearings there were 214 public attendees. There might be some overlap in the individuals who attended multiple hearings. But in total during the comment period, we received 67 written public comments, 6 of those were letters from letters from organizations. These tables show the breakdown of the public hearing attendees and the number of comments that were provided at each of the hearings, which totaled to 159 comments provided within the public hearings, and then the breakdown of the written comments as well.

Then this larger table, I know it might be a bit hard to see, but I wanted to break down the number of comments that were in support of each option. Each of the options or sub-options that are included in the Addendum are shown in separate rows of this table, and in the far-right column are the total comments that were in support of each of those options.

The takeaway here is that the majority of comments were in support of status quo. But there were a number of comments that supported one or more of the other options. I will go into the reasons behind the support for each of those in the next slide. Across the comments that we received there were a few themes that were repeated by a significant number of people.

One of these is that there was a lot of concern about the economic impacts that could result from increasing the minimum size in Area 1, while still allowing imports of Canadian lobster that are smaller than the U.S. minimum size. Within the comments that address the options for v-notching, there were a significant number of folks that supported standardizing the v-notch definition.

However, it did seem that there was a preference among those individuals to go to a zero-tolerance definition, rather than 1/8 of an inch with or without setal hairs, because they didn't want to move backwards from the zero-tolerance definition in Area 1.

Regarding the proposed changes to the gauge sizes, a majority of the comments about this issue expressed a preference for smaller gradual changes to the measures, as opposed to implementing all of the changes at once. Then there were a lot of comments submitted, specifically about the proposed changes for the Outer Cape Cod management area.

In these comments people spoke about the unique situation of the Outer Cape fishery, and felt that it was not adequately considered in the Addendum options. In the comments that expressed a preference for status quo under Issue 1, which is to not standardize any of the management measures across or within LCMAs.

A number of people were concerned about the proposed changes would hurt the lobster industry and lobster population, specifically they referred to the increased restrictions that would go on to the commercial harvest, and the financial strain that would be caused by needing to replace or update their gear to meet the new requirements.

There were also many comments that said they were in support of the status quo option because the current measures are working and they don't need to be changed. They also thought that the proposed options for standardizing measures were not really for the benefit of the stock, but rather for the benefit of law enforcement. In the comments that supported some parts of Option B under Issue 1 to standardize some measures, there were a good number that felt that standardizing and increasing the strictness of v-notch requirements across the LCMAs will have benefits to the stock. Some people noted that it's a problem that lobsters that must be thrown back in one area can just be harvested in an adjacent area. One comment supported Sub-option B4, which would limit the trap tag issuance to the harvester allocation unless losses are documented, because they felt that this would help reduce the issue of lost and derelict gear.

Among the comments that were in support of status quo under Issue 2, that would not implement any management changes to the biological management measures to increase spawning stock protection. A lot of these comments cited market or economic concerns, and many specifically mentioned the concern about Canada gaining a market advantage over the U.S. fishery if the LCMA 1 minimum gauge size is increased. As I mentioned at the beginning, a lot of comments in favor or status quo came from fishermen in the Outer Cape Cod management area.

Their comments expressed that because of its unique situation, the Outer Cape would be disproportionately harmed by the proposed gauge size changes. They mentioned that Outer Cape has a unique catch demographic, as well as a niche market for large lobster, and that also because of the cost of living in the area, which is relatively higher than in other areas, they would face more economic hardship due to the changes than other areas would.

Then in a handful of comments that were in support of the trigger approach for implementing management changes under Issue 2, there was a majority preference for gradual changes over a single change. Supporters of Option B felt that the proposed changes would increase the overall health of the stock, that it could bring higher quality product to the market and fetch higher prices, and provide more value to the marketplace.

Some comments mentioned that they supported a minimum gauge size increase over the maximum size decreases that are proposed, because of the greater overall positive impact it is expected to have on the stock. It was also noted that decreasing the maximum gauge would result in a permanent loss of landings, but increasing the minimum size would just delay those landings temporarily.

The comments that supported Option C for scheduled changes to measures, that they preferred this option because changing the measures as soon as possible would be the best thing for the stock. They also said a minimum gauge increase is essential for the fishery to remain viable in the years ahead.

Some mentioned that they observed after the last time the gauge increased that there were benefits to the stock, and that we should act now while there is still time to reverse the negative trends that have been observed.

ADVISORY PANEL REPORT

MS. STARKS: Now I'm going to switch over to the Advisory Panel Report. Unfortunately, our AP Chair, Grant Moore, was unable to attend today so I'm going to give the AP Report on his behalf.

The AP met virtually to discuss Draft Addendum XXVII on April 10. Ten advisors were able to attend the virtual meeting and provide input. There was not consensus on a preferred set of management options that came out of that meeting. But the Advisors each provided their preferences and some comments on the proposed option. First, I want to go over the areas where the Advisors all agreed. There were a number of issues they agreed on. This includes a shared desired among them to look after the lobster resource. Some of them mentioned that they do not want to see Gulf of Maine have a similar outcome to southern New England. Many of the Advisors agree that v-notching has a positive impact on the stock, and they were supportive of standardizing the v-notch definition across the LCMAs in the Gulf of Maine and Georges Bank stock.

All of the Advisors also agreed that there could be economic impacts associated with the proposed increase to the LCMA 1 minimum gauge size, and that could create a disadvantage for the U.S. lobster fishery. Regarding the Issue 1 options, 5 Advisors supported Option B, with Sub-option B3, which would standardize the v-notch definition, and 1 Advisor also supported the other three sub-options as well.

Regarding Issue 2, 5 Advisors preferred status quo measures, stating that there is not a need to change them at this point in time. Two of the Advisors did not give a preferred option, they were expressing that they were torn between the status quo option and Option B, but they generally felt unsure if changing measures at this point is really needed, or worth the cost to the fishery.

But they don't want to see the stock end up in a bad condition. Then when asked if they had to choose one of the options other than status quo, the majority of Advisors would prefer the trigger mechanism over the scheduled changes. All right, so that wraps up the AP report and leads us to the Board's Actions for consideration today.

First, the Board would need to select a management program from the proposed options in Addendum XXVII, including Issue 1 and Issue 2, and alternatively could propose modifications to the options.

CONSIDER FINAL APPROVAL OF ADDENDUM XXVII

MS. STARKS: Then once the Board has selected a management program then the Board can consider final approval of Draft Addendum XXVII, and that says VIII, but it should say XXVII. All right, and with that I can wrap up my presentation and take any questions.

CHAIR McNAMEE: Thanks so much, Caitlin. That is what we'll start with here are just questions for now, just clarifying questions, and we'll come back around to do the deliberations after that. Any questions for Caitlin on what she just presented? I see Jim Gilmore first, go ahead, Jim.

MR. JAMES J. GILMORE: Great presentation, Caitlin. I want to just clarify I have this right. If we did go to a gradual gauge change, that all of those numbers would be predetermined, so that we don't have regulatory authority in New York, and based upon our experience with Jonah crab the last two years, we've really got to do this in one shot. If we're going to go through this we have to go through legislation. This would all be pre-prescribed, whatever and then we could do it in one event for our legislation, is that correct?

MS. STARKS: Yes, I believe that is accurate.

CHAIR McNAMEE: Next up I have Dan. No, okay, next up I have Steve Train.

MR. STEPHEN TRAIN: Thank you, Caitlin, for that that. I have a question that I think maybe Kathleen could answer it best. Sorry to put you on the spot. I was jotting down things while this was being presented. Basically, we're looking at things that show a decline, pull a trigger. We may need to increase the measure that will result in more eggs, and eventually those eggs will result in more lobsters. This is the process that we're looking at if any of this goes through, right?

MS. STARKS: Yes.

MR. TRAIN: We've had several years of declines. How many years after the trigger is pulled, did we put more lobsters back? Would those lobsters have eggs and become part of the fishery, be mature enough to be harvested or egging out?

MS. KATHLEEN REARDON: There would be an immediate… for the lobsters that are not caught there would be an immediate benefit, because those lobsters would have the opportunity to reproduce, the ones that are not caught. But the recruitment subsidy would definitely be a time lag. That recruitment subsidy is not actually considered in our simulation models. That would probably have a time lag of 6 to 8, 8 to 10 years. But there is immediate benefit for having those lobsters that are not caught to be able to reproduce, having the opportunity to reproduce rather than be caught.

MR. TRAIN: Just want to make sure I fully understand. I thought it was like 5 or 6 years. Whatever year we do this, or whatever year we actually have to trigger this, which may not be yet, probably isn't yet, will further decline until 6 to 8 years, maybe 10 until the recruit of the eggs of those lobsters can start coming into the fishery to pick it up.

MS. REARDON: If you're talking about the eggs that need to hatch and then grow large enough to then reproduce again. That is where there is a time lag. There is uncertainty around that how fast they are growing. But there is an immediate benefit by having more of those lobsters available to reproduce, if other changes are happening within the system, where not as many of those eggs are surviving. That is where we see a potential buffer to ecosystem change.

CHAIR McNAMEE: Okay, next up I have Mike Luisi.

MR. MICHAEL LUISI: Thanks, Caitlin, for the presentation. My question I guess is a simple one. From the graphs that you showed, and please correct me if I'm interpreting this wrong, but there seemed to be reasonable declines happening, which was just mentioned, as well as in the juvenile production. Was I right? Did I see the graph right on juvenile production has also been in decline over the past few years?

I guess the question that I would like to ask about that is, with everything that I saw in your presentation, declines, the status quo seems to be heavily favored. I know that you went over the public comment as to some of the reasons why. I'm just trying to understand if there are these declines, why status quo seems to be the favorite for everyone involved.

MS. STARKS: I can try to speak to the public comments that I heard during the process. I think a lot of the favor for status quo comes from concerns about economic impacts to the fishery, associated with changing the gauge sizes. I think that those impacts are to be expected whenever you potentially restrict measures in this way. I think there was a lot of concern about that, which caused people to favor status quo. But like I mentioned, there were a handful of folks that did not see status quo as an option, and felt that it is necessary to change the measures, in order to protect the stock.

CHAIR McNAMEE: Okay, two more in the queue here, David Borden.

MR. DAVID V. BORDEN: I also have a question for Kathleen. Kathleen, there was a lot of what I would characterize consternation voiced about the three surveys that are used in the index. I listened to; I think five different public hearings. In almost every single one of them it came up where members voiced concerns about it, how it was developed, how well it tracks future or predicts future landings. The question is, relative to those surveys, how well in the minds of the technical people do those surveys predict future landings? You can include the Rick Wahle survey in there, so it's four.

MS. REARDON: The combined index that Caitlin presented is actually only ventless trap, spring trawl survey and fall trawl survey from inshore Maine/New Hampshire survey as well as Massachusetts and ventless throughout the region. We are not considering part of the settlement survey from the different states as part of that trigger mechanism. It is informationally considered, but it is not part of that trigger index.

That trigger index is also focused on just one size of lobster, it's just under legal size. These are the sub-legals that we would expect to recruit into the fishery the next year. It's very close to that harvestable size, what will be legal very soon in the future. Within the conversations of the Technical Committee, we were looking at work that was done in the 2020 assessment. We wanted to create a trigger index that was related to the abundance of the whole lobster population.

In the process of the 2020 assessment, we did look at that recruit index of the 71-to-80-millimeter lobsters, and how those trends related to the abundance. We found that those trends in the surveys of those three surveys, do correlate well with the abundance. That is where we have some certainty on using those surveys between assessments as a proxy for what might be going on with abundance.

MR. BORDEN: How about with the Rick Wahle Survey? Did that also track well and predict future abundance catch?

MS. REARDON: It is not actually Rick Wahle's Survey; it is the state survey's data that is considered.

MR. BORDEN: I apologize.

MS. REARDON: We look at it as part of the data update, look at the settlement. But those lobsters are at least 6-8 years out from legal size. It is only surveying in shallow areas. We use it as kind of a red flag canary in the coal mine to say, something is changing. We did see changes since 2012, at least in Maine. We've had low levels of settlement in that survey. We were looking for trends in the recruitment indices from the trawl survey and the ventless trap since the assessment. That is one of the reasons we instituted the data update between the assessments.

CHAIR McNAMEE: Senator Watters.

SENATOR DAVID WATTERS: This is another kind of related to Steve's question, but from a different approach. I mean I can see our management technique is to do what we do to try to have increase in reproduction, and the assumption being that that will lead to abundance because of more recruitment.

But I guess my question to that though is, if the lack of recruitment is being driven by other factors, like warm air acidification or whatever it may be. I guess I had two questions. What confidence do we have then that these management methods will work, and then secondly, when might we know that they are not, and it may be these other factors that are driving the lack of recruitment?

MS. REARDON: The mechanisms for change is not something we have a lot of certainty about. We think it's changes in productivity, whether that is warmer water temperatures, survivability, larval starvation, more predation from fish. It could be any of those things.

The guidance that we got from the Board and what the Technical Committee talked about, was if we have changes in the ecosystem ahead. How could we propose management options for the Board to consider that might provide more of a buffer to that ecosystem change. Increasing the protection of spawning stock biomass was the mechanism that was focused on and proposed.

CHAIR McNAMEE: Okay, all set with that? Great. Representative Peake.

REPRESENTATIVE SARAH PEAKE: Pat Keliher at the beginning asked to have added to the end of our agenda a discussion about Canadian competition and in effect Canadian regulations. The public hearings that I attended, some of those status quo people were concerned about an increase in the minimum gauge size, that that would lead to, and the question was then raised, well will Canada have to abide by that increase in the minimum gauge size?

If not, that puts us at an economic and marketing disadvantage, because there is a market for some of those smaller lobsters. I am wondering, as you reviewed all of the options again, and many of them include either through trigger or through timing, an increase in a minimum gauge size. If we need to have a Canadian competition discussion up front, so that we can understand what the total picture is, before we start to discuss these various options and going to them.

I would like to know what the impact of a decision I'm making is, maybe in the short term if there is no change in the Canadian regulations, or long term if that is going to be a number of years, a number of months, or never that they would match what our minimum gauge size is.

CHAIR McNAMEE: They are good comments, Representative Peake. I think, and so it sounds like your concern is like with a sequence of things here. Point taken, we will have the discussion, and the folks around the table have had a chance to hear your concerns up front, so thanks. Tom Fote.

MR. THOMAS P. FOTE: I guess I always assumed that what Jersey does is what up and down the coast does, and I guess I'm wrong. We do not allow lobsters in that are below our legal-size limit, so Canadian lobsters less than our size limit cannot come in. Are we the only state that does that?

MS. STARKS: I'll say I don't know if you're the only state that does that, but it is a state decision to make the gauge sizes a possession limit as well as a harvest limit. The Commission's FMP makes it a harvest limit, but some states, such as New Jersey, have implemented that as a possession standard as well, so that those lobsters cannot be anywhere in the supply chain in the state.

CHAIR McNAMEE: Ray.

MR. RAYMOND W. KANE: A question of Kathleen. The way I heard you explain it to the Senator from Maine. This whole management action is based on previous management models, static models. We're talking about the livelihoods of lobstermen, and we hear a lot about EBFM, we hear a lot about the changing temperatures in the Gulf of Maine.

When does this all get brought to light, because the way I'm looking at this is we're trying to manage this fishery the way we have in the past, with your trawl surveys, your ventless trap. When do we start accounting for temperature changes, salinity, acidification, different predator species in the Gulf of Maine that might be consuming eggs, young of the year when it's settled to the bottom? When do we bring that into our management actions?

MS. REARDON: I'm not actually sure how to answer that question, although I think in the 2020 assessment, we did bring in more of the environmental datasets to consider as part of our Model 3 evaluation of what is going on with the stock. Looking at kind of stress indicators, temperature, other zooplankton. We looked at a number of different datasets as part of trying to understand what was going on with the lobster stock.

MS. STARKS: I just wanted to add something to that as well. During the discussions that the Technical Committee had when the PDT tasked them with trying to come up with some potential management options for this document. One of the things that the Technical Committee kept coming back to was that we don't have control over the environmental conditions.

But if we are able to have a larger spawning stock biomass, that if there is a good year, where the conditions of the environment are really good for the eggs and for recruitment, that there is a large spawning stock base there to provide that additional input into the population.

CHAIR McNAMEE: We've had one hand raised from the public, I'm going to just request, before I go to this person. We're still on the question-and-answer portion of the meeting here, so just keep that in mind. But with that I will go to Beth Casoni.

MS. BETH CASONI: I actually had my hand raised by accident; I apologize. I don't have a question at this time.

CHAIR McNAMEE: Okay, thanks, Beth, at least we know we can hear you when you do.

MS. CASONI: Right, thank you.

CHAIR McNAMEE: It looks like we've cleared up all of the questions, oh, no we haven't. Go ahead, David.

MR. BORDEN: I have one other question that relates to the issue of the impacts of the gauge increases. I talked to Kathleen briefly before the meeting. There was a lot of discussion about the impacts, at least in some of those hearings about the impacts being in a range of 20 to 30 percent decline in landings, associated with a gauge increase.

I was just wondering what, and I realize this is a really difficult issue for the technical folks to answer, because there are a lot of different moving parts in it. But what is the technical do, how much of a loss, and how much of a gain we would get out of the gauge increase?

MS. REARDON: Thanks, David, for the question. There is a difference between short term cost and long-term cost. It's more straightforward in Area 1, where it's a recruitment-based fishery. We are fishing on that first molt of lobsters coming into the fishery that is being recruited. Short term, yes there is a cost in that first year.

But when you look at it in the more long-term, that is a delayed harvest, so those lobsters that are not caught in that year have that opportunity to reproduce, but also molt again, and can be caught at a heavier size. In the long term we would anticipate a lower number of lobsters being caught, but at a higher weight in the long term.

In the short term the Technical Committee talked about this. There was a meeting summary from April of 2021, where we did put some numbers to it, based on the growth matrix, and a 32ndth of an inch would be about 8 percent proportion of lobsters that wouldn't be caught if you changed a 32ndth of an inch, and a 16th of an inch would be about a 16 percent.

But the timing of management, whether you do it January 1st or in the middle of the year, that percentage is very uncertain, depending on how that management is carried out. Many of the Technical Committee members were not as comfortable throwing those numbers around. We were focused more about the long-term benefit of increasing the spawning stock biomass, and then what that impact would be over the long term. That's where we saw a lower number but a higher weight total in the longer term.

MR. BORDEN: Follow up, Mr. Chairman. They gain in weight, Kathleen, after they molt? How does it affect the weight? I think Burton had done an analysis that indicated 6 percent increase in weight. But what I'm asking you is, what was the consensus of the Technical Committee?

MS. REARDON: In the simulation models that Burton and Jeff ran, and I will defer to Jeff if he wants to step in here. But going to 3 and 3/8, we estimated about a 5 percent increase, I believe, in weight and a decrease of 3.6. But those numbers are an estimate based on a model, and where the Technical Committee has uncertainty about where those numbers fall.

We do have some certainty about that directionality, of which direction it is likely to go. You are likely to see that benefit. We also estimated that we would have up to that size a 38 percent increase in spawning stock biomass. Those numbers are not certain, they are from a model. But the directionality, you would see, we would anticipate a big bump in that spawning stock biomass by changing that minimum gauge size.

CHAIR McNAMEE: Yes, Roy Miller.

MR. ROY W. MILLER: A quick question. Since the prevailing public sentiment at the hearings seemed to be in favor of gradual changes, as opposed to a one-year change. Refresh my memory with the options. There weren't times when more than one vent size change would occur in a fishery, was there, or was the vent size changed at most one time in the options? Which was it, Caitlin?

MS. STARKS: Yes, that is correct. The vent size is only proposed to change one time in any of the proposed management options, and that would be whenever the final minimum gauge size is implemented for the area. We're just talking about Area 1, because Area 1 is the only one where there is a proposed minimum gauge size increase.

Whenever Area 1 reaches its final minimum gauge size, the vent size would also change.

CHAIR McNAMEE: Eric Reid.

MR. ERIC REID: Just a question about the math. You said we would catch less lobsters, but they would be heavier. Why would we catch less? Is that a very short-term thing? I'm not exactly sure. It's probably short term.

MS. REARDON: You would catch less lobsters, because you have natural mortality as they are growing. You are going to lose some lobsters on an annual basis to natural mortality, plus some of those lobsters would be reproductive. But I'll defer to Jeff or Caitlin if they want to add to that.

IMPLEMENTING MANAGEMENT MEASURES

MS. STARKS: Just in general, the proposed changes would decrease the window of sizes that are available to the fishery. There would be a smaller amount of lobsters available to be caught.

CHAIR McNAMEE: Are you okay, Eric? Okay. I think that does it for questions, so let's go ahead and move into, oh, go ahead, Dan.

ISSUE 2

MR. McKIERNAN: No, not a question, but I wanted to move into the sequencing of some of our deliberations. What I would like to speak to is reversing, kind of the order that has been presented in the document, which is Issue 1, Issue 2. By taking out Issue 2 first, Issue 2 is the potential minimum size increase that's either based on a trigger or automatic.

That's where most of the resiliency is going to come. The Issue 1 tend to be more housekeeping measures or have smaller effect on the spawning stock biomass, and the resiliency, and it would be difficult to rationalize why we would do the Issue 1 actions if Issue 2 failed. I would like to see the Board Tackle Issue 2 first.

CHAIR McNAMEE: Yes, thank you, Dan. I'm in complete agreement and was going to suggest the same thing myself. Maybe I'll look around, is there anyone on the Board who does not like that idea? The suggestion is to just reverse the issues, tackle Issue 2 first and then come back to Issue 1.

The suggestion was made by Dan McKiernan and I was also contemplating making the same suggestion. Looking around the table, not seeing anyone jumping up raising their hand. We will move forward in that manner, thanks for that, Dan. One other thing I just wanted to say up front. This is simply because at least one of the options that we may take off, it's these triggers.

There are two numbers, right. They sort of bound the issue, but there is a continuum in between those two things. Over the years watching boards when they have that kind of situation, bounding back and forth a whole bunch of times on different numbers, and all of the substitutes and things like that.

I just want to say up front, I'm only going to allow one substitution at a time, so if somebody makes a motion, there is a substitution, we'll dispense with that. I don't want to layer substitutions on top of substitutions. I think that is procedurally correct anyways, I just wanted to be up front about that. One other thing I would like to attempt is, there were a couple of items in here that didn't get much discussion, so I am going to try and simplify our job here in a couple of spots, just to see if we can quickly drop out one of the multitude of options here.

When we get to those parts I'll ask the question, and see if we can simplify our job a little bit here. I just wanted to let you know what I was thinking there. I'm not trying to limit discussion or anything like that, just trying to gain some efficiencies if possible. Then finally, I will plan on at least one opportunity for public comment. I'm going to do that once we are ready to take action on some sort of a final motion on the Addendum, so before we take action on it, but once we get through all of the Board deliberations.

You know there has been a lot of comments on this Addendum already, and mostly I'm concerned about time and we don't have a lot of time on the agenda here for this, so I want to make sure we are efficient and can get done what we need to get done today. If we're doing good, I will entertain additional opportunities, but I do promise to go to the public, but probably only do that one time once we get the two issues in some semblance of final shape. All right, so with that why don't we jump right to it. The first item here that we're going to tackle is Issue 2. This is the Implementing Management Measures to Increase Protection of Spawning Stock Biomass in the Gulf of Maine and the Georges Bank Stock.

Here is the first spot where I will ask the question, is there any discussion or any need to address the potential option to adopt management changes without the institution of a trigger mechanism? That is Option C. Is there anybody who wants to speak to that Option C? Dave Borden.

MR. BORDEN: I'll keep this really quick. I favor that option, but I talked to enough people around the table to gauge the sentiment on it. I just don't think it's going to go anyplace. The reason I favor that option, and I'm going to be really brief, is that having gone through the southern New England collapse, I was basically the State Director at the time.

Having gone through that, that was a totally awful experience, not only for the industry, but for the regulators. It was just astounding what the negative consequences were for a whole group of really hard working, dedicated individuals who had generations in their families that had grown up working the water.

Anything we can do to avoid that type of situation; I think we should do. It's the main reason that I am very concerned about the triggers. It goes back to Steve Train's comment, he hit the nail on the head, the delays. If we set a trigger, we're essentially acknowledging the fact that we're going to allow the stock conditions to deteriorate until we hit that trigger.

Now I'll say right up front, I operate under no delusions here. I don't think that we can maintain the stock at historic highs. I think it's going to decline anyways. But it's a question of timing, when you react, because once we react if we get optimal conditions, it is still going to take eight years before you're going to see the recruitment in the indices.

That's a long time to allow a fishery that's worth two billion dollars, employs 30,000 people, and has particularly in eastern Maine, has coastal communities that have a 90 percent reliance on this for their economic activity. This is a really major decision on a part of the Commission. We're in a leadership position on it.

Now I'm concerned that these triggers, when we were talking about triggers originally, I was an enthusiastic supporter of the trigger, because we were talking about a trigger at 15 percent. Now we're talking about triggers at 30 percent, 50 percent, and it goes back to the question I asked Kathleen, about how well these indices track future landings.

If they do, you are essentially saying to coastal communities, you're going to lose 50 percent of your income before you recover from it. That's what my reservation is, I'm not going to make a motion, but I think it's the wrong strategy at the wrong time.

CHAIR McNAMEE: Thanks, David, words of caution are appreciated. You are not making a motion on that option, okay. Mike Pentony.

MR. MIKE PENTONY: Hi everybody, it's been quite a while since I've been able to attend a Lobster Board meeting in person, so I appreciate being here this afternoon. Yes, similar to David Borden, I'm not going to speak specifically to making a motion on the immediate or specified approach.

But I did want to offer some sort of general comments about the resiliency framework, or resiliency addendum. You know I think we all acknowledge that the lobster fishery, particularly in the Gulf of Maine is under significant existential threats, I think from three avenues, you know the effects of climate change that we're seeing on the stock and recruitment. That's what we're focused on today.

But nobody around the table is forgetting or ignoring the threats to the lobster fishery, as we try to recover North Atlantic Right Whales in a way that preserves and maintains that fishery. There is also the train that's left the station for offshore wind, that I think we all acknowledge is coming to the Gulf of Maine.

Those are all presenting extreme threats to the lobster fishery. Unless we see some statutory changes, the challenges around recovering Right Whales in your lobster fishery, that is going to be something that we continue to face. The offshore wind issue I think, we sense that coming, and that is going to remain a challenge.

Ideally, I think we would be looking at ways to preserve and ensure the resiliency of this fishery, in ways that look for synergies across those three threats, in ways that we can mitigate those threats as meaningfully as possible. You know effort reductions, effort issues, aren't on the table today. The one thing that is on the table is gauge increases, to look at promoting increased recruitment.

I encourage the Board to be as aggressive as possible. We've heard some of the concerns, the concerns that David Borden raised, the concerns we've seen in some of the public comment and letters from some states, around the need to take action sooner rather than later, because of the delayed effect we see before we're going to see increased recruitment to the fishery.

Like David Borden, I recognize that where we're going to end up is probably with some sort of trigger approach. But I just strongly encourage the Board to be as aggressive and thoughtful as possible, so that we can really ensure that we have a resilient fishery, rather than having a reactive fishery, where we are struggling to adapt or adopt to a stock in collapse. Thank you.

CHAIR McNAMEE: Thank you, Mike. Just maybe one favor for me. My ears never un-popped from the plane ride this morning, so just make sure you get that microphone up close. I did hear you, Mike, and thank you for that. But I'm just nervous that I might not hear folks, so thanks for that. You know a couple of notes of caution, but nobody looking to make a motion on Option C, so I think that kind of drops us back to, we're on Issue 2, remember. We've got Options A and B remaining. Pat Keliher.

MR. KELIHER: Back in 2017 I was the originator of the motion that started this Addendum. A lot has happened since then. I started to get gray hair; we have survived a global pandemic. I think Borden may have had more hair back then too. I think we may have set a record from delays, but those delays were needed, based on the issues that we were dealing with. I think we're at a time now, we're in a very different time in making this decision if we had of done these back in 2017.

We were at an even higher abundance. I appreciate David's words of caution here. I'm not willing to go there, but we do need to start a conversation around this trigger. I'm going to start with a motion, I think Caitlin has that. Besides the three public hearings in Maine, I've held seven zone council meetings, they were excellent conversations.

We've seen certainly an embracing of the use of a trigger, including in our easternmost areas, Zones A and B actually asking for probably the highest trigger on the coast, because they are seeing more, probably because of what they are seeing in their traps for juvenile lobsters. But as you can imagine, with a 3,000 plus mile coastline, the opinions vary greatly.

But the need for action, I think, was certainly coming to the forefront. **I would like to make a motion, and actually Caitlin, if you could change the 40 to 38, please. I would like to make a motion to select under Issue 2, Option B, a trigger level of 38 percent,** and if I get a second, I'll give additional rationale.

CHAIR McNAMEE: Thank you, Pat, second from Doug Grout. Great, so back to you, Pat.

MR. KELIHER: Thank you, 38 percent is the halfway point within the range of the trigger mechanism from 32 to 45. It certainly is going to put us below 100 million pounds from a fishery standpoint for just the state of Maine. What I've heard consistently up and down the coast was we need to act, but we're coming down from an all-time high.

I think that is why people were willing to actually push for even the 45 percent. But frankly, from a biological standpoint, and for some of the issues that have been raised already, I'm uncomfortable going that far. I know frankly, some of the members around the table are not even comfortable with 38. I'm open for discussion, but would like to start it with this motion.

CHAIR McNAMEE: Doug, do you wish to add anything?

MR. DOUGLAS E. GROUT: Yes, I would support this. I also don't believe that we can wait until we get to 42 percent. I think that would be extremely dangerous. This might be a good compromise between 32 and 42, so thank you.

CHAIR McNAMEE: Cheri.

MS. CHERI PATTERSON: While I appreciate this motion and appreciate the compromise, I am still concerned about even a 38 percent trigger level. I think that we need to continue to be a little bit more proactive than reactive. While we will likely be able to see if the trigger is tripped, we would be able to see if there is young of the year recruitment sooner than 8 years. You know we have the young of the year survey out there, we have the trawl surveys out there that would be picking up samples to determine what our recruitment will be coming into the fishery at least. But I still think that we need to be a little bit more proactive. **I would like to have a motion to amend to select under Issue 2, Option B, a trigger level of 35 percent, and if I can get a second then I can move forward with a reason.**

CHAIR McNAMEE: Seconded by Dan McKiernan, thanks, Dan. Okay, Cheri, back to you.

MS. PATTERSON: Again, this is a compromise, because I would have liked to have gone to the 32 percent, but I think this is the compromise between the 32 and the 38, and I think that this is still being on the proactive side than a reactive side.

CHAIR McNAMEE: Okay, Dan as the seconder.

MR. McKIERNAN: I endorse Cheri's comments.

CHAIR McNAMEE: Senator Watters.

SENATOR WATTERS: My question is, if our numbers are from 2021, when will we know if we may have already hit this trigger amount level?

CHAIR McNAMEE: Do you have a comment on that, Kathleen or Caitlin does, hang on one second.

MS. STARKS: Sorry, I had to move locations, but the data update would have this information in it, and we will be presenting that at the annual meeting.

CHAIR McNAMEE: Okay, other comments.

SENATOR WATTERS: I guess that it makes it a little difficult to know, you know what we're saying in terms of implementation. I think if one imagines that we're not there yet then we've set a trigger and we wait awhile. But if we find out in the fall that as a matter of fact, we are up pretty high or well beyond what is even being proposed. I guess that I am kind of affirming what Cheri has noted, that we probably need to maybe set a little more aggressive level, because we may already be beyond it.

CHAIR McNAMEE: Thank you, Senator. Ray Kane.

MR. KANE: I just have a couple of questions to the maker of the first motion, and then to Cheri on the amended motion. Pat, you said that your zones down east were more in favor of the highest trigger, which brings me back to my thought pattern that we all know that we've got this dynamic shift of all species to the east/northeast.

I can understand the lobstermen down east wanting the highest trigger. I would almost support a 40 percent trigger, but that being said, these are the motions on the table. I don't understand why we're talking about 35 percent, you just want to mediate, Cheri?

CHAIR McNAMEE: Go ahead, Cheri.

MS. PATTERSON: Yes, actually. I think that 32 percent was not very appetizing from the industry perspective, and from around this table. I wouldn't want to go above 35 percent, to be honest with you. If 38 percent is something that was presented in this motion, so I chose to take the halfway point to go there.

MR. KANE: Thank you, Cheri, thank you, Pat.

CHAIR McNAMEE: All right, so we had a motion that has been amended. Any additional discussion before we take the vote on the amended motion? All right, seeing none; why don't I give folks a minute or two to caucus, in particular if you don't have folks here at the table. I don't know, two minutes to caucus.

Okay, does anybody need a little more time? Mike is still standing up, are you okay? It looks like he's heading back. **I think we are ready to go, so we will vote on the amended motion here. This is the motion to amend to select under Issue 2, Option B, a trigger level of 35 percent. Motion made by Ms. Patterson, seconded by Mr. McKiernan. All those in favor of the motion, please raise your hand. Is it a question, Roy? Go ahead.**

MR. MILLER: Could I request a roll call on that vote?

CHAIR McNAMEE: Yes, that would be.

MR. MILLER: I have my reasons for that, we want to see how much unanimity there are among the principal lobster states to the north of us.

CHAIR McNAMEE: Yes, thank you, Roy, I think that will help too with the hybrid situation we have here as well.

MS. TONI KERNS: I can just call the states out if you have everybody raise their hand.

CHAIR McNAMEE: You said you could do it, Toni.

MS. KERNS: Yes, if everyone just re-raises their hand that said yes, I'll call our name out. Put their hands up and I'll call the states out. If everybody puts their hands up, I will call your state name, and then that will be the roll call.

CHAIR McNAMEE: Okay, got you, I got you. Let's try again. **All those in favor, please raise your hand, and then Toni will call the roll here.**

MS. KERNS: Rhode Island, Connecticut, New York, New Jersey, and New Hampshire.

CHAIR McNAMEE: Did we get the hands online as well? Okay. All right, all those opposed please raise your hand.

MS. KERNS: Massachusetts.

CHAIR McNAMEE: Okay, any abstentions?

MS. KERNS: NOAA Fisheries, Virginia, Delaware, and Maryland.

CHAIR McNAMEE: Any null votes?
MS. KERNS: Maine.

CHAIR McNAMEE: Just checking down the table. Can you give me the numbers again, either Caitlin or Toni? It was 6 to approve.

MS. KERNS: It was 5, 1, 4, 1.

CHAIR McNAMEE: Okay, thank you. The motion passes 5 to 1 with 4 abstentions and 1 null. Thank you for that. Now the amended motion is the main motion. Any discussion on this now as the main motion, before we move forward with our follow up vote? Okay, seeing no hands, we're kind of in the same spot, so I don't know if there is a need to caucus.

I'm not seeing heads shaking around the table. Why don't we move forward and take the vote. We now have a main motion. **The main motion is motion to select under Issue 2, Option B a trigger level of 35 percent.** The amended motion is still the maker and the seconder, correct?

MS. KERNS: Property of the Board.

CHAIR McNAMEE: Okay, so we can go to the vote. All those in favor of the main motion, please raise your hand, we'll call them out again, please.

MS. KERNS: Rhode Island, Massachusetts, Connecticut, New York, New Jersey, Virginia, Maryland, Delaware, Maine, New Hampshire.

CHAIR McNAMEE: All those opposed, please raise your hand. Okay, didn't see any hands there. Any abstentions?

MS. KERNS: NOAA Fisheries.

CHAIR McNAMEE: Any null votes? No nulls. All right, so the motion passes. I got 10 to approve with 1 abstention. It looks like I counted right that time. Great, okay thank you for that everyone. Let's move along here and I'll go to Pat Keliher.

MR. KELIHER: To continue on with Issue 2, I have a second motion prepared, I think staff has that. **With this motion is a creation of a table to help us kind of follow the bouncing ball here, if you will. I would move to select under Issue 2, Option B a modified "Measures Option 2" in which LMA3 and Outer Cape Cod move to a 6-1/2 minimum gauge size in the final year of changes, and do not decrease their maximum gauge size further. Initial changes to the gauge sizes for all Gulf of Maine/Georges Bank management areas should occur on June 1st in the following year. For example, if a trigger is tripped at the fall Annual meeting in 2023, a minimum gauge size change would be implemented June 1, 2024. Should a future stock assessment conclude that the Gulf of Maine and Georges Bank stocks are not a single biological stock, the Board can revisit the max gauge size decrease in Outer Cape Cod and LMA 3.**

CHAIR McNAMEE: There is a motion on the board is there a second to that motion? Cheri Patterson with a second. Go ahead, Bob.

EXECUTIVE DIRECTOR ROBERT E. BEAL: Yes, just a quick comment for the record. I think when Mr. Keliher read that into the record, I think he said minimum after 6 and 1/2, in the first sentence. I think he meant maximum.

MR. KELIHER: I did.

EXECUTIVE DIRECTOR BEAL: I just want to make sure the record is clear.

MR. KELIHER: Thank you for that clarity.

CHAIR McNAMEE: Thank you for that clarification. Pat Keliher with the motion, seconded by Cheri Patterson. Pat, as the maker of the motion, I'll come back to you.

MR. KELIHER: One thing that I heard really clear from fishermen in Maine is the fact that if this is a resiliency addendum, and that we all should be playing a part in the resiliency of the stock. Certainly, we heard from our Technical Committee Chair the bigger biological benefit being those smaller lobsters in the minimum gauge size change.

But it is clear, based on comments that I've heard that the protection of those bigger, older lobsters, it's still incredibly important when it comes to stock resiliency. After having conversations with fishermen back home, looking at the data, understanding what the potential economic impact would be.

I've created this motion to be kind of less threatening for that standpoint on the max gauge size decrease, by pushing it out to the final year of implementation, so five years out. Again, I would just reiterate that this is one stock. There is some additional tagging data that is coming in that has raised some questions about that one stock. That is why I include information or a piece of this regarding the future stock assessment, where we could revisit that and make adjustments accordingly.

CHAIR McNAMEE: Great, thank you, Pat. Cheri, as the seconder, would you like to make a comment?

MS. PATTERSON: Yes, thank you. I do agree with what Pat had indicated, as well as get back to Mr. Pentony's comment on what is going to be happening in the future with the Atlantic Large Whale Take Reduction Team, and how that might be addressing resiliency in our future. It would be aligning better to have this offshore; you know the LMA 3 and such to be a size maximum change later on.

CHAIR McNAMEE: Other comments from the Board on the motion before us. Tom Fote.

MR. FOTE: I just asked a question for everybody over here and nobody has an answer, so I figured a Mainer could tell me. How much does a 6-inch carapace lobster weigh? Steve's got it.

MR. TRAIN: Well, off the top of my head I would say 6 to 7 pounds, depending whether it's a male or female. But I'm not allowed to land them, so I'm not sure.

CHAIR McNAMEE: Doug Grout.

MR. GROUT: I will express support for this motion, although I do have one small adjustment that I would like to propose, based on some of the comments that we got in our public hearings regarding when the vent size change would take place. My motion which I sent out just recently is to **move to amend that the increase in the escape vent size in LCMA 1 be implemented in Year 5 after the trigger has been reached.** Essentially, move it down to that Year 5 implementation, as opposed to Year 3 implementation. If I can get a second, I will be glad to give my rationale before the Board.

CHAIR McNAMEE: **There is a motion to amend here, it has to do with the escape vent size.** Is there a second to the motion to amend? Seconded by Steve Train. Okay, back to you, Doug, for your reasoning.

MR. GROUT: When we were at public hearing, our lobstermen expressed more concern about having that vent size increase in the same year that we have the final gauge increase, because they already are going to be taking a hit in Year 1, and then Year 3 at least a temporary hit in their landings. They know that right now some of the current vent size, some of the legal sized lobsters are able to escape through the escape vent.

They were feeling that if we could delay the implementation of the vent size change, it would make it easier to handle the third-year increase in size. If we all remember, what we put in as vent size changes in the past, I'm pretty sure they were occurring after the gauge increases that we had.

It wasn't in the same year. That's my rationale, I'm just trying to see if there might be some support for this just waiting a couple years. Some lobstermen may end up implementing it themselves right away on their own, but I think it's reasonable to give them a little bit of a cushion, or a little bit of a breather here.

CHAIR McNAMEE: Steve, do you wish to make a comment?

MR. TRAIN: I could live without this, but I do like this idea, it kind of slows down the too much at once thing a little bit. I think Doug hit the nail on the head with, a lot of people may do it anyway. You fill that parlor up with shorts, you're not going to get many counters in it anyway. Once those things start to change, I think you'll see people voluntarily moving that vent up before it's due anyway.

CHAIR McNAMEE: Okay, further discussion? Dave Borden.

MR. BORDEN: I'm still not fully understanding why this would be Year 5 vs Year 4. I mean we did this when I worked for the state of Rhode Island, we did this a number of times. I think we went through eight-gauge changes, maybe even ten. We always tried to follow the gauge change immediately, either the same year as the gauge change or the year after it we would change the vent size. This is talking about a two-year delay. I just don't get the logic of it. These two measures work hand in hand, and that is the way they are intended to work. I could see Year 4, you know some logic in that, but not Year 5.

CHAIR McNAMEE: Okay. Additional comments from the Board. Dan McKiernan.

MR. McKIERNAN: Question on protocol. What David Borden just said, wanting to insert Year 4, do we need to vote this down consistent with your desires to only have one substitute or amended motion at a time, so that we can come back with a Year 4 implementation of that, if that is the desire of the Board, given David's logic?

CHAIR McNAMEE: Looking down the table for a little help.

MS. KERNS: Go through the motions, it's the property of the Board at this point.

CHAIR McNAMEE: Right, so yes, we have to vote up or down, and then we can sort of move on from there. Thanks. Okay, so we have an amended motion before us. Why don't we take another two-minute caucus to discuss, then we'll come back and take the vote. Two minutes, please, that seemed to work last time.

Okay, it looks like everybody is back to the table, done discussing. I think we can go ahead and call the vote here. I will follow the same procedure. I will have you raise your hands and Toni will call out the states. **All those in favor of the amended motion, please raise your hand.**

MS. KERNS: Maine, New Hampshire, Connecticut.

CHAIR McNAMEE: Okay, all those opposed, please raise your hand.

MS. KERNS: Rhode Island, Massachusetts, New York, New Jersey, NOAA Fisheries.

CHAIR McNAMEE: Any abstentions?

MS. KERNS: Virginia, Maryland, Delaware.

CHAIR McNAMEE: Any null votes? Okay, by my count the motion fails, I had 3 to approve, 5 to oppose, 3 abstentions. The motion fails. We're back to the original motion, and I have a hand up from David Borden.

MR. BORDEN: I would like to make the same motion that Doug Grout made, basically move to amend that the increase in the escape vent size in LCMA 1 be implemented in Year 4 after the trigger has been reached.

CHAIR McNAMEE: There is a new motion to amend, okay there we go. We have a new motion to amend made by David Borden, is there a second to that motion? I saw Steve Train first. Back to you, David, to make comments.

MR. BORDEN: I won't belabor the point. I made it before, so that still stands. There is a synergy between these two, and this just line that up. You want these two actions to follow each other.

CHAIR McNAMEE: Okay, Steve. Steve is good, any other discussion on the amended motion? Doug, go ahead.

MR. GROUT: I just wanted to say I support this motion, since mine failed. It sounds like a good idea.

CHAIR McNAMEE: Well, that bodes well, thank you. Okay, can anyone raise their hand if you need some time to caucus. **Okay, so we have an amended motion here. It is similar to the one that was just made, but it drops it back a year, so it would be implemented in Year 4. Let's go ahead and call the vote. All those in favor of the amended motion, please raise your hand.**

MS. KERNS: Maine, New Hampshire, Rhode Island, Massachusetts, Connecticut, New York, New Jersey, Delaware, Maryland, Virginia.

CHAIR McNAMEE: Any opposed? I don't think there is anyone left. Any abstentions?

MS. KERNS: NOAA Fisheries.

CHAIR McNAMEE: Okay, there was one person left. Any null votes? No null votes, okay so the amended motion passes. That now becomes the main motion. I'll let that get up on the board here and then we'll go ahead. Dan, go ahead.

MR. McKIERNAN: Yes, I would like to make a motion to amend to essentially strip this motion of the maximum size changes in Area 3 and Outer Cape Cod that is scheduled to go in according to this motion. Shall I give a rationale now?

CHAIR McNAMEE: Looking for a little help. We had an amended motion that passed. We didn't vote on it as the main motion, but can we entertain another amendment?

EXECUTIVE DIRECTOR BEAL: Yes, because you've cleared the slate of all the previous amendments, and now you are back to one main motion. Now, Dan is suggesting a motion that would amend the main motion again, so it's fair.

CHAIR McNAMEE: Thank you, Bob. Okay, so we've got a new motion to amend, has to do with the maximum gauge. I saw a second from David Borden, so back to you, Dan, for a rationale.

MR. McKIERNAN: I'm seeking to make the maximum size in Area 3 and Outer Cape static at the 6 and 3/4-inch size, because of the historic contributions that those areas made to the resiliency in the Gulf of Maine when the measures went in to protect the southern New England stock. We know that Outer Cape Cod and Area 3 both have portions of their fishery in the southern New England area.

For the last 15 years or so we did very little action concerning the Gulf of Maine/Georges Bank. We did a lot of activity attributable to the southern New England stock, which included aggressive trap cuts, included gauge increases. I would like to give those fleets the credit for those that have already been made.

CHAIR McNAMEE: We're still getting the motion up on the board here. But David, while that is being typed out, anything to add?

MR. BORDEN: Yes, I would just add to the points that Dan just made. You know since all the gauges were standardized in 1989, not to give everybody a history lesson. Since 1989 the minimum size in Area 1 has been 3 and 1/4. There have been 9-gauge changes in Area 3 since that period. Most of those gauge changes took place right in proximity to the southern New England collapse.

When that took place the Area 3 industry, and I would point out that this is not just a New England issue, it goes all the way down. We have Maryland boats, six New Jersey boats, three New York boats. They are all fishing in Area 3. The industry opted to implement the most conservative measures throughout Area 3, instead of applying it just to southern New England and the Georges portion of it. We've been adopting more restrictive regulations for quite a period of decades actually.

The only think I would add to Dan's point. This doesn't get implemented according to the motion for five years. I think at least in our case, we're looking at other ways to contribute to the protection of spawning stock biomass, through things like a ring size, and so forth. We've got dialogues going with the Center staff about that. We oppose it at this time, but we are going to continue to work on it. I think that the Commission can easily add it to some subsequent addendum later on.

CHAIR McNAMEE: We've got the motion up there. I'm wondering, is the table correct? Okay. Further discussion on the amended motion? Steve Train.

MR. TRAIN: With all respect to my fellow Commissioners from Rhode Island and Massachusetts, I'm going to speak against this. We are dealing with a situation that was requiring the possible rebuilding the stock through egg production, and this needs to be shared through the range of the resource in the Gulf of Maine and Georges Bank stock are currently one stock. This is their share of what we need to do. It appears this motion would do away with that.

CHAIR McNAMEE: Pat.

MR. KELIHER: I'm going to speak against the motion to amend. What I was trying to do is put some forever protections in place. It is clear that these management areas don't operate in biological isolation, so recruitment from Area 3 comes from growth of lobster within that area, and immigration of lobsters outside of that area.

The Addendum says that 70 percent of the new females in LMA 3 come from that immigration. This connectivity means that we all need to be chipping in, as far as resiliency is concerned. It's also trying to offset economic impacts here. With my original motion the addendum shows that when we do a 6-inch minimum, it would result in a 4.6 percent decrease. That was why I only made a motion to move it down a quarter of an inch, to help offset what that impact would be.

But again, I just want to stress that this is a joint stock between Area 3 and Area 1, Gulf of Maine/Georges Bank. It is one management stock. There is no isolation between these stocks as it currently exists, and I would urge the Board to support something that is in place in the future. I would also point out that the language that I included, if there is a determination that there is isolation, the Board can revisit this issue.

CHAIR McNAMEE: Cheri.

MS. PATTERSON: At this point I can't support the motion to amend. I think that since this is one stock that we are speaking of, that all need to be participating in the resiliency action. This was a very gradual, thought-out process to not have LMA 3 involved up until the fifth year, so if there is any further information in the future, then we can take action if need be.

CHAIR McNAMEE: Representative Peake.

REPRESENTATIVE PEAKE: I would like to speak in support of this motion. As we're talking about sharing responsibility, I would like to point out that status quo right now for the Outer Cape area is there is no maximum gauge size. Going from no maximum gauge to a 6 and 1/2 is a major, major contribution, on top of the contributions that have already been made towards stock resiliency by the Outer Cape lobstermen.

I can live with 6 and 3/4, for both LMA 3 and OCC. But given that already the OCC lobster area, they have a larger minimum gauge size than any of the other lobster management areas, they are contributing in that way. For all intents and purposes, they have a shortened season because of right whale protections.

As I drove to get to Boston just yesterday, driving through the Beach Point Area I could see boats ready and traps ready and buoys ready. But the right whales are still in Cape Cod Bay. It used to be May 1, May 15 for the last several years, who knows. It could be after Memorial Day. The point is, there is no fishing that is going on in Cape Cod Bay, and on the back side of the beach. I think that 6 and 3/4 is a compromise that we should go with here. Again, as I said, I would like to point out for the OCC lobstermen, whose management plan was approved, that they are going from no maximum gauge to 6 and 1/2 under the original proposal, and this is why I believe this amendment offers a fair compromise.

CHAIR McNAMEE: Looking around the table, I don't see hands for further discussion. Can you please raise your hand if anybody needs time to caucus before we call the vote. Okay, let's do a one-minute caucus on this one. We're starting to get close to Menhaden time. One minute caucus. That was the one minute, New York, are you okay? I got a thumb up, great. **Let's call the question on the amended motion. All those in favor, please raise your hand.**

MS. KERNS: Rhode Island, Massachusetts, Connecticut, New York.

CHAIR McNAMEE: All those opposed, please raise your hand.

MS. KERNS: Maine, New Hampshire, New Jersey, NOAA Fisheries, Maryland and Virginia.

CHAIR McNAMEE: Abstentions.

MS. KERNS: Delaware.

CHAIR McNAMEE: Null votes, none. The amended motion fails. That brings us back. I think that is back to the previously amended motion, which is now the main motion. Anything else before we vote on the main motion? Toni.

MS. KERNS: I just want to make it abundantly clear that the language in the motion itself plus the table, are the things that we will be implementing. Since the table has vent sizes which are not in the language of the motion, it is in the text of the options that it does say is modified, but I want to put it on record, make it clear to you, the Board and the public for transparency.

CHAIR McNAMEE: Thank you, Toni, I appreciate that clarification. I'll wait for the cleaned-up motion to get back on the board here. I believe that is the correct motion that is up before us. I see nodding heads. Does anybody need time before we take a vote? Nobody is raising their hands, so **all those in favor of the motion up on the board here, please raise your hand.**

MS. KERNS: Maine, New Hampshire, Rhode Island, Connecticut, New York, New Jersey, Delaware, Maryland and Virginia.

CHAIR McNAMEE: All those opposed, please raise your hand.

MS. KERNS: Massachusetts.

CHAIR McNAMEE: Abstentions.

MS. KERNS: NOAA Fisheries.

CHAIR McNAMEE: Null votes. None. Okay, the main motion passes, 8 with 1 opposed and 1 abstention; 9 in favor, sorry. I'm missing somebody. I must not be turning my head far enough. Thank you for that, so it was 9 to approve, 1 to oppose, 1 abstention. I believe that is it for Issue 2, I see nodding heads.

ISSUE 1

CHAIR McNAMEE: We are now back to Issue 1. Is there anybody who wishes to get a motion on the table for Issue 1? Pat.

MR. KELIHER: I think staff has a motion. Thank you. I've combined two here, so bear with me, and I'll ask the Executive Director to watch out for my dyslexia. **Move to approve Issue 1, Sub-option B1 and Sub-option B4. This combination of options will set a standard v-notch definition of 1/8 inch in LCMA 3 and Outer Cape Cod, maintain the zero-tolerance definition in LCMA 1, and establish a maximum gauge size in Outer Cape Cod of 6 and 3/4 for state and federal permit holders. It will also limit the issuance of trap tags to equal the harvester trap tag allocations.**

CHAIR McNAMEE: Okay, is there a second to the motion. Dave Borden with a second. Pat, back to you for rationale.

MR. KELIHER: Just briefly. The one thing that this Addendum was going to work to achieve was some consistency in regulations. As we all know, especially with v-notch definitions, they are all over the place. I think it doesn't bring them totally in line, but it brings them in line to a point where the LCMAs will be operating in a consistent fashion.

I've had some additional conversations with Dan McKiernan about some of the commerce issues that Dan has, which I was sympathetic to. That is one of the reasons I left them separate. Just quickly on the trap tag allocations. Maine has a very administratively heavy issue associated with ensuring that people aren't fishing 880 traps.

You have to go through a process to request trap tags if they are lost. We do not give the 880-up front. Honestly, I think we need to have equity here. There is, and Cheri has brought this up several times with the other motions. We all know we have a whale problem, so ensuring that those 880 are not fished, does help eliminate some additional endlines, which I think, be it small, it's an important step in the right direction for those conversations.

CHAIR McNAMEE: David, as the seconder.

MR. BORDEN: The only thing I would like to comment on, I think Pat summarized things well. These are really two different motions. It might make sense to take the last sentence in the motion, separate them into two motions and discuss them separately and vote on them separately, because I think if we try to do it together it's going to get a little bit confusing.

I support what Pat has suggested here, but I have a number of suggestions to make when we get to the trap issuance. I think there is going to be a lot of discussion on that. My suggestion to Pat is he just agree to a perfection and separate it into two motions, just the last line, Pat.

MS. KERNS: David, are you making a motion to split?

MR. BORDEN: Well, I was hoping he would do it by a perfection, which I would agree to.

MS. KERNS: You already seconded it. It's a motion of the Board.

MR. BORDEN: Oh, I'll make a motion to separate it into two questions.

CHAIR McNAMEE: Okay, motion to separate, is there a second to that motion? Dan McKiernan. Just to clarify, David, you are just talking about separating out the last sentence of the original motion, correct?

MR. BORDEN: Correct.

CHAIR McNAMEE: There is a motion to split, let's go ahead and vote on that. All those in favor, please raise your hand. Okay, we'll go faster. Are there any objections to the motion to split? Seeing none, thank you, you probably saved us several minutes. Okay, so now we will have two separate

motions on this, because that motion passed by consent. Dan McKiernan, go ahead.

MR. McKIERNAN: Just a point of clarification. The Addendum states that these actions, which is Issue 1, would be enacted immediately upon adoption of the Addendum, but that is subject to rulemaking, so I'm hoping that it's within the expectations of the Board should this be approved, that that would likely be 2024. For the Commonwealth to enact any of these changes, I would be going to rulemaking so we would get done by the end of the year.

CHAIR McNAMEE: Pat, did you want to add to that?

MR. KELIHER: Obviously, every state is going to have different processes by which we have to go through from a rulemaking perspective. To that point I agree with Dan McKiernan that the implementation is upon final, we may have two dates on implementation at the end. I will look to Caitlin when we get to that point. We're going to have to have time to do rulemaking, but they will have to have time to do rulemaking.

CHAIR McNAMEE: Understanding that sort of pragmatism of that, is that kind of implicit in the motion, or do we need to say something explicit in the motion?

MS. KERNS: I think you can take it up during the implementation date of the document. But if anybody is concerned, we can add it to the motion.

CHAIR McNAMEE: Excellent. We are back to now the first half of the split motion. Are we okay to move forward with this? Representative Peake, to ahead.

REPRESENTATIVE PEAKE: I would like to make a motion to amend this motion before us now, please.

CHAIR McNAMEE: Okay.

REPRESENTATIVE PEAKE: To read as follows. Move to approve Issue 1, Sub-option B1. This option will set a v-notch definition of 1/8 inch in LCMA 3, and will set a v-notch definition of 1/8 inch in OCC to be implemented upon the trigger previously voted on by this Board in Option 2 being met. Then the rest of the language stays as written.

CHAIR McNAMEE: Okay, there is a motion to amend. Is there a second to the motion to amend? Last call for a second for the motion to amend. Okay, motion fails for a lack of a second.

MS. KERNS: Sarah, is that the intent of what you said?

REPRESENATIVE PEAKE: Let me read it. What my intent was, was that the change in the v-notch definition would only be implemented when the trigger was met.

MS. KERNS: For Outer Cape only, right?

REPRESENTATIVE PEAKE: For Outer Cape only, correct.

CHAIR McNAMEE: Since the motion wasn't up there when I called for the second, I'll do one last shot at a second. Okay, so still no second for the amended motion, so it fails for lack of a second. Okay, Roy.

MR. ROY W. MILLER: Mr. Chairman, wondering if you could help me clear up a little bit. With the wording in this motion, are we consistent with what we just passed, which is no longer before us, regarding Issue 2? I think we are, at least for the OCC of 6-3/4 inches. But how about LCMA Area 3? This motion is silent, I think, for LCMA 3, is it not? In terms of maximum gauge size? It's already set at 6 and 3/4?

CHAIR McNAMEE: Correct.

MR. MILLER: Okay, thank you.

CHAIR McNAMEE: Back to the split motion here. Are we ready to call the question? Does anybody need time to caucus? All right, so let's go ahead and call the question. **All those in favor of the motion, please raise your hand.**

MS. KERNS: Maine, New Hampshire, Rhode Island, New York, New Jersey, Delaware, Maryland, Virginia.

CHAIR McNAMEE: All those opposed, please raise your hand.

MS. KERNS: Massachusetts.

CHAIR McNAMEE: Any abstentions?

MS. KERNS: NOAA Fisheries.

CHAIR McNAMEE: Any null votes? Okay, so the first half of the split motion passes 6 to approve, 1 opposed, 1 abstention. I think now the second half of the split motion, move to approve Issue 1, Sub-option B4. This will limit the issuance of trap tags to equal harvester trap tag allocations. Discussion on the motion. Go ahead, Dan.

MR. McKIERNAN: I would like to request a friendly amendment, and create an exemption for the Outer Cape lobster permit holders, and I'll tell you why. It's a very unique area, in that there are 66 permit holders fishing about 27,000 traps, and the average among these fishermen is about 420. The area is trap starved, and just about, I would say everyone is fishing to their limit.

Including many who fish single trap operations because of the challenges of the harbors that they leave, such as Nauset Inlet, where about a third of our fishery is. I would ask that the Outer Cape fishermen still be given a 10 percent extra trap tag allowance. The difference between us and Maine is that Maine is responsible for the trap tag issuance, whereas we allow the fishermen to go directly to the vendor.

If we go to this kind of a system, there is going to be inordinate delays, whereas each fisherman loses a few traps, and that's going to happen season long. They would be contacting us, and then contacting the vendor. I just don't think administratively it is worth it. I would beg for the Commission's indulgence to create an exemption for the Outer Cape Cod. Like I said, there is at least more than half of the fishermen fish less than 500 traps.

As opposed to like in Area 1, where the average might be like 5 or 600, but people are still allowed to get 800 trap tags. There are some extra trap tags, even in the Area 1 system, for those who aren't fishing up to the limit. But that is a trap limit, whereas in the Outer Cape it is a trap allocation. **I would beg the Board, or someone to give me a second on my motion to amend, to exempt the outer Cape Cod from this particular motion.**

CHAIR McNAMEE: Thanks, Dan, there is a motion to amend to exempt the Outer Cape from the rest of the motion there. Is there a second to that motion? Seconded by Pat Keliher. Dan, you gave reasoning on it, anything else? Okay, Pat, anything you want to add?

MR. KELIHER: Just concur. After I understood the issue of the fishery down there in discussions with Dan, I can see what the need is so I'm okay with it.

CHAIR McNAMEE: Steve.

MR. TRAIN: I just have a question for Dan. I think I support this. You said most of the guys fished 500 or less. But how many are fishing 800? Do you have a lot of guys from Area 1 fishing 800 that you're not going to give it to, or are you going to give the extra tags to the guys with 800 in that area?

MR. McKIERNAN: The answer is 8. Out of the 64 permit holders there are 8 of them, and they fish in the kind of the very rough area, that eastern cape shore with a lot of storm surge, and trap losses happen.

MR. TRAIN: Thank you.

CHAIR McNAMEE: Mike Luisi.

MR. LUISI: I can support this. I just thought that Dan had mentioned a percentage over an equal harvester trap tag allocation. Dan, did you say something about 10 percent? Maybe that should be in there if that is the case.

MR. McKIERNAN: Currently my state and New Hampshire issue, or allow the issuance of 10 percent additional tags over the trap limit, or in this case the trap allocation for Outer Cape. I would like status quo to allow them to continue to get 10 percent.

MR. LUISI: Okay, that clears it up, thanks.

CHAIR McNAMEE: Toni.

MS. KERNS: It's the FMP that allows for that, just as an FYI.

CHAIR McNAMEE: It is already codified, great, okay. Mike Pentony.

MR. PENTONY: Not a question to the motion to amend, but the overarching motion. You know the Addendum document just says to limit issuance until trap losses occur and are documented. I just want to ensure, because ultimately a piece of this will fall to the federal side to implement as well.

I just would like some additional information, or clarification in terms of what are the states requiring or accepting as sufficient documentation? What would be acceptable, to make sure that we've got consistency, not only in the regulations, but in the documentation standards we're using that we're applying before we issue the additional 10 percent.

Because there are a couple handfuls of permit holders that get their trap tags from us. Right now, we just issue the full 110 percent, and want to make sure that we're operating in a consistent manner. But also, because we're the Feds, we have to make sure that we're being really clear or transparent, in terms of what is required in order to do the document for the trap losses. If somebody can provide me a little bit more information, I would appreciate it.

CHAIR McNAMEE: Does anybody, I wonder, does the Commission have a comment on this, so it's kind of a state situation? Dan, go ahead.

MR. McKIERNAN: I guess I would ask that we be given time to resolve this question. I don't have a good answer, because we get so few requests now, except in a catastrophic loss situation, and we allow them to get a completely new set. But for someone to get just a small number of replacement trap tags, I agree with Mr. Pentony that we probably need consistency.

If we could do that as a committee after this meeting, consulting the state of Maine, what their standards are, because Cheri in New Hampshire and I will be doing something a little bit new, in terms of that standard. I would welcome developing that standard with our federal partners.

CHAIR McNAMEE: Okay, so it sounds like, oh David, go ahead.

MR. BORDEN: This is a question I ask out of ignorance. If somebody has an Outer Cape endorsement, and an Area 1 endorsement, are there any permit holders that have permits in both? If so, how do we handle that, because you're going to have two different rules.

CHAIR McNAMEE: Go ahead, Dan.

MR. McKIERNAN: The answer is no. We don't have any individuals who are permitted in more than one area in Massachusetts, and since the Outer Cape to my knowledge is exclusively a Massachusetts fleet, it is not an issue.

CHAIR McNAMEE: David.

MR. BORDEN: My problem with the exemption, I am supportive of the attempt here to kind of simplify the rules on this. I talked to Pat about the burden on his staff. Then when you start factoring in, as Mr. Pentony said earlier. There are a multitude of other considerations we should think about, like whales and vertical lines.

It's highly desirable to kind of start winnowing down the traps that are in the water. In my own case, in another capacity to represent the offshore guys. Most of the offshore guy's fish their full allocations. I'm not exaggerating, they've done it through a very rigorous criteria put in. To get them they had to land 25,000 pounds of lobsters over two years and so forth. The trap allocations are really tight, in the case of some of the offshore boats.

If you do this then what happens when a scalloper comes along and it clips the end of a trawl, and takes 15 or 20 pots? There is no mechanism other than catastrophic loss for them to get those tags back. I actually came to the meeting more in the mindset of supporting cutting the percent down from10 percent to say, 3 percent to move in the right direction. But also, to recognize that to try to lessen the burden on people like Pat and his staff.

CHAIR McNAMEE: Just quickly back to Mike Pentony's comments. It sounds like this sort of defined what triggers that is something that will be dealt with after the meeting, so just getting that recorded into the meeting proceedings here, so that we do in fact follow up on that is good. Go ahead, David.

MR. BORDEN: I would just like to pursue the response Dan gave. I appreciate the response, but we all have to factor in, we've got other areas. We've got Area 4, Area 5, Area 2, and I know for a fact there are lots of multi-area boats, so we have to factor those considerations into any of this. I think this is only applying to 3, but we have two 3 boats, right? If an Area 2 boat can get 10 percent and an Area 3 boat gets 0, how are we going to handle that?

CHAIR McNAMEE: I do not have an answer to that. Any response, Dan to David's questions?

MR. McKIERNAN: David is right. In Massachusetts we allow the Area 2 fishermen to also order 10 percent additional tags, because like Outer Cape, many of them are trap-starved. They took a 50 percent cut in traps, so it is very similar. He brings up a good point. I guess I don't have an answer to that.

CHAIR McNAMEE: Okay, David, one more time, and then I think we're going to need to make a motion.

MR. BORDEN: I apologize for my repeated dunks in the tank. My suggestion here is a somewhat complex issue. I think we recognize; it may make some sense to table this and just include consideration of this in a subsequent action, that's all.

CHAIR McNAMEE: Toni or Bob.

MS. KERNS: One, for all of our rules when we have two different rules, the most restrictive rule applies if you're fishing in multiple areas. That could apply. I mean if someone would ask me what I would have said to you, I would have said the most restrictive. But if it's the Board's intent to not move forward with this, then you would just vote this down and it would be status quo, you wouldn't have to table it.

CHAIR McNAMEE: Okay, so we will take the vote on this, and depending on the way the Board feels about it, it can be voted up or down. Go ahead, David.

MR. BORDEN: I had somebody whispering in my ear that the other way to solve this is to exempt Area 3 in the same motion. I think you have provided us guidance, Mr. Chairman, you don't want motions to amend. You want to deal with one motion at a time, is that correct? We have a motion to amend on the floor.

CHAIR McNAMEE: Right, so if we were to move on this motion, what you're thinking about we could make a subsequent amendment to the main motion, would that work?

MR. BORDEN: Correct.

CHAIR McNAMEE: Okay, so we have a motion to amend here, let's dispense with that motion. **I'm going to call the vote. All those in favor, please raise your hand.**

MS. KERNS: Maine, New Hampshire, Massachusetts, Connecticut, New York, New Jersey.

CHAIR McNAMEE: Okay, all those opposed.

MS. KERNS: No hands.

CHAIR McNAMEE: No hands, any abstentions?

MS. KERNS: Rhode Island, NOAA Fisheries, Virginia, Maryland, Delaware.

CHAIR McNAMEE: Any null votes? Okay. All right, so the motion to amend passes, 6 to 0 with 5 abstentions. Thank you, Jeff, I should just stop giving the numbers and just look over at Jeff's hand signals. **No null votes.** Now we have a complete motion, I'll wait for that to get crafted up on the board here. I see, except for OCC, got it. We have a main motion up on the board. I'll give folks a minute to take a look, and then David, anything to add here?

MR. BORDEN: Could I request a one-minute caucus?

CHAIR McNAMEE: Yes, in fact let's do a two-minute caucus. All right, we have a motion in front of us. Is there anything further before we go ahead and vote on this motion? Pat.

MR. KELIHER: I'm kind of in a bind because of what may come next here, but if there is a subsequent action. If this goes through, then everybody has to issue 800, minus Outer Cape Cod, right. The Outer Cape Cod would be exempt. If there is a subsequent action to exempt another area, or allow a small percentage. Then we have an equity issue between LMA 1 and any other area. I'm very cautious. It's a fairness issue, right?

Maine has done the right thing for years in a very administratively burdensome process. If we're going to go in that direction, and other areas are going to get a pass or to allow to do something different, then Maine should be given the same opportunity. I'm just a little concerned about the direction we're going to go here.

CHAIR McNAMEE: David.

MR. BORDEN: A question for Bob Beal or Toni, I guess. Do we have an option here of postponing this, while we do what Pat wants us to do, which is get together and talk about it? In other words, we approved the Addendum without this provision, but postpone this provision to a subsequent meeting?

EXECUTIVE DIRECTOR BEAL: Well, you could approve this Addendum without this, and that would be it. If you wanted to then take this issue up, you would have to initiate a new Addendum. You could pause the consideration to this Addendum right now, and not approve anything today.

Try to sort something out here and bring that back at a subsequent meeting. You couldn't approve the Addendum today, sort of hold this issue in a parking lot, and then come back and make it part of an addendum that you approved today. It's you either approve the Addendum today without this, or you pause the whole thing and try it at a subsequent meeting.

CHAIR McNAMEE: Thanks for that, Bob. Dan.

MR. McKIERNAN: I appreciate Pat's concerns, but the motion itself is even a little bit misleading, because it talks about issuance and trap tags equal to harvest or trap tag allocations. When the truth is, we talk about trap tag allocations in an area that has an effort control plan, and so that is Outer Cape, Area 2, Area 3 et cetera. Really, Area 1 has a trap limit of 800, and I think Cheri and I are both sensitive to the concerns of Gulf of Maine Area 1 fishermen with the different standards on trap tag issuance. I would be certainly willing in Massachusetts, because the plan doesn't require us to issue an extra 10 percent.

I'm certainly willing to constrain the Area 1 fishermen to 800 tags, and use a Maine-like standard, because when Maine didn't op for the 10 percent extra tags, they did it on their own volition, and they were very successful. We're kind of looking to kind of adopt that model to some degree.

But Area 3 and Outer Cape have trap limits that are license specific, and it's just really painful to squeeze down those last few trap tags out of the business, because if they loose or if they want o replace a trawl, it's nice having a few extra trap tags. But these are really trap-starved areas. I would ask that the Board approve these, and it's my intention to adopt a Maine-like approach to Area 1.

CHAIR McNAMEE: Any further discussion? I think we're ready to call the question here. **All those in favor of the motion up on the board please raise your hand.**

MS. KERNS: New Hampshire, Maine, Massachusetts.

CHAIR McNAMEE: All those opposed.

MS. KERNS: Rhode Island.

CHAIR McNAMEE: Abstentions.

MS. KERNS: Connecticut, New York, New Jersey, Delaware, Maryland, Virginia and NOAA Fisheries.

CHAIR McNAMEE: Null votes, none. Okay, I'm not going to say numbers until I see them up on the board here, but I'm fairly certain that the motion passed. **Motion passed 3 to approve, 1 opposed with 7 abstentions and no nulls.** All right, I believe that is it for Issue 1. I think we have now dealt with both issues in the Addendum, so we're ready for a final motion to approve the Addendum as modified today. Is anybody ready to make that motion? Toni.

MS. KERNS: Mr. Chair, in order to move us a little bit faster, we have suggested that you add an implementation date when you make that motion.

CHAIR McNAMEE: Okay, so when we make that motion, we would like to also add an implementation date. Cheri, did you want to make that motion, and if you would be so kind as to add the implementation date as well.

MS. PATTERSON: Yes, I would like to move to approve Lobster Addendum XXVII, as modified today, with an implementation date of January 1, 2024.

CHAIR McNAMEE: Okay, we have a motion before us, is there a second? I see Emerson with a second, Emerson Hasbrouck. Cheri, anything you want to add as the maker of the motion?

MS. PATTERSON: Dan, would that work for your rulemaking process? I mean that is several months out.

MR. McKIERNAN: Yes.

CHAIR McNAMEE: Anything else, Cheri?

MS. PATTERSON: No, I think that that would be able to address everybody's concerns to actually have it implemented in time. Thanks.

CHAIR McNAMEE: Great, thank you, Cheri. Emerson, anything to add?

MR. EMERSON C. HASBROUCK: No, but I am going to defer my time to my co-commissioner here, Jim Gilmore.

CHAIR McNAMEE: I see another hand, Representative Peake.

REPRESENTATIVE PEAKE: Just before we take a vote, I'll telegraph to the Board that I don't know how the delegation will be voting, but inside our delegation I will not be supporting this, not because I don't support conservation measures, but I feel that the economic impact and what we are asking the Outer Cape lobstermen to do in participating in this. I cannot support this motion, and the lack of support for seeking a compromise leads me to the unfortunate position, being somebody who I consider myself a conservationist, having to take a no vote for this particular motion.

CHAIR McNAMEE: Thank you, Representative. Jim Gilmore, go ahead.

MR. GILMORE: I'm not opposed to the motion, it's just as my comments were earlier. We have to do this legislatively, so we will try to make that deadline, but I will just about guarantee you we are not going to make it. For again, our history with Jonah crab. It took us two years to get that in. Secondly, we don't have a legislative commissioner right now to help us with our legislature.

We could have some challenges facing that. That being said, our fishery is extremely small. We have 9 permit holders left, and I think only 4 of them are actually fishing. If that delay does occur, I don't think it's going to have a drastic impact on the resource. Just with that caveat, we'll be supporting the motion.

CHAIR McNAMEE: Okay, further discussion? Pat.

MR. KELIHER: Just quickly. Understanding Mr. Gilmore's issues on timing. I think the biggest issue from compliance is going to be gauge. I think you would have well beyond 2024 to deal with that issue.

CHAIR McNAMEE: Okay, does anybody need time to caucus, please raise your hand. We're way over time. Thank you for not raising your hand. I did sort of promise I would go to the public. Is there anybody, we're kind of way over time, so I'm hoping there are no hands. Okay, no hands online, thank you for that.
Why don't we go ahead and call the question and get this done. **All those in favor of the motion to approve Lobster Addendum XXVII, as modified today, with an implementation date of January 1st 2024. All those in favor, please raise your hand.**

MS. KERNS: Maine, New Hampshire, Rhode Island, Connecticut, New York, New Jersey, NOAA Fisheries, Maryland, Delaware, Virginia.

CHAIR McNAMEE: Any opposed?

MS. KERNS: Massachusetts.

CHAIR McNAMEE: Any abstentions? Any null votes? All right, the motion passes 10 to approve, 1 opposed, 0 abstentions, 0 null votes. Great, thank you all very much, good job. We have a few agenda items left here.

UPDATE FROM WORK GROUP ON IMPLEMENTATION OF ADDENDUM XXIX: TRACKER DEVICES IN THE FEDERAL LOBSTER AND JONAH CRAB FISHERY

CHAIR McNAMEE: I think what we decided is we'll do the quick update on the tracker devises. We'll do a quick update on the Jonah crab assessment, but we are going to skip the Conservation Management Team roles agenda item, and we'll address that at some other point. With that, Toni, I'll turn it over to you for the update on the trackers.

MS. KERNS: I'm going to skip my slides and just quickly go through the trackers. We are well on our way in moving forward with the trackers. Massachusetts has already gotten over 200 trackers on vessels. ACCSP is seeing those tracks in the database. Things have, I think, been going pretty smoothly along the way, so it's great news. Three states have put in their implementation plans to NOAA Fisheries, two of them have been approved.

Maine is the one that has not yet, but being under consideration, and we are working on the southern states. If you see an e-mail from me, please make sure that you respond either in the affirmative or the negative from the southern states, so I can finalize that up. We, just as an FYI for the trackers. The Tracker Workgroup is going to consider a new tracker in June, so we may have another device onboard by the end of June. Any questions?

CHAIR McNAMEE: Questions for Toni? Seeing no one around the table, anyone online with questions? Any hands raised? No, okay, thank you, Toni. Appreciate that.

PROGRESS UPDATE ON 2023 JONAH CRAB BENCHMARK STOCK ASSESSMENT

CHAIR McNAMEE: Let's move on to an update from the Jonah crab assessment. Whenever you're ready, Jeff.

MR. JEFF J. KIPP: For a quick update on the Jonah crab stock assessment. The Jonah Crab Stock Assessment Subcommittee met two weeks ago in New Bedford for the Assessment Workshop. We anticipate at least two more meetings, depending on how our next goes, which will be a SAS meeting to tie up some loose ends that remain from that Stock Assessment Workshop. Then we will meet with the full Technical Committee in July, to present and hopefully have the assessment approved by the Technical Committee for peer review. Our peer review is being planned currently for slightly later than what we originally had on our timeline of July, we're planning for late August, but we still are on track to present out the assessment and the peer review to the Board at the annual meeting. That's it for my update.

CHAIR McNAMEE: Thank you, Jeff, questions for Jeff on the Jonah Crab Stock Assessment process? Not seeing any hands around the table, any hands online? No hands online. All right, thanks for that, Jeff, appreciate it.

OTHER BUSINESS

CHAIR McNAMEE: As I mentioned, we were going to skip the second to last agenda item, but we still have Other Business that was brought up at the beginning of the meeting. The first had to do with consultation with our Canadian counterparts, so Pat, I'll look to you to address that one.

MR. KELIHER: Caitlin does have a motion that I've prepared for this conversation. It was noted by several people, including Representative Peake, around the issues of uncertainty with importation of lobster. Maine in particular has our own unique problem with the gray zone, where it is disputed waters around the border between Maine and Canada.

Around Machias Seal Island, where we have roughly about 130 fishermen, who if the trigger is pulled and they are fishing under a smaller gauge, or a larger gauge at the minimum end, will be catching lobsters, throwing them back, and Canadian fishermen will be catching them and able to retain them, literally fishing right beside each other.

I think the time has come for us to address this gauge issue directly with Canada, and I would **move to request that the Interstate Fisheries Management Policy Board approve the creation of a subcommittee to engage Canada's Department of Fisheries and Ocean to discuss transboundary issues related to the importation of lobster, as it relates to different minimum gauge sizes in the two countries.**

The Subcommittee shall be made up of four members of the Lobster Management Board, who have license holders that fish in Area 1 and/or 3, and one representative from the National Marine Fisheries Service, and the Commission's Executive Director or his designee.

CHAIR McNAMEE: We have a motion on the board. The motion is seconded by David Borden. Pat, do you wish to offer anything else on the motion?

MR. KELIHER: No, I think that was offered up front. I front loaded, Mr. Chairman, I front loaded.
CHAIR McNAMEE: David, anything as the seconder?

MR. BORDEN: Nothing to add, other than the fact that these are fairly complicated issues, and I think we need to get on with the discussion.

CHAIR McNAMEE: Ray Kane.

MR. KANE: I turn to Mike Pentony. I have been told to understand these transboundary meetings are always difficult. What are your thoughts on this, Mike?

CHAIR McNAMEE: It looks like Mr. Pentony is consulting with legal counsel, so give him a minute. Mike, do you wish to answer Ray's question?

MR. PENTONY: Could I ask the indulgence of the Board to restate the question?

MR. KANE: Yes, Mike, thank you. I understand these transboundary discussions are always difficult. Can you give us your feed on this, your thoughts?

MR. PENTONY: Yes, they are difficult. I was consulting with legal counsel, because this motion, it's difficult to understand what the structure would be, in terms of a normal bilateral government to government discussion between the U.S. and Canada. My inclination is to abstain on this.

Then discuss with our International Affairs partners in the Department of State to see what might be made of this motion, should it pass. I wasn't prepared to fully comprehend and think through the implications of this, so I hope the Board will understand that I don't have any kind of definitive answer for how this might work.

CHAIR McNAMEE: Representative Peake.

REPRESENTATIVE PEAKE: Of course, as a legislator, my bias is always in favor of legislation. I know that Maine has an active federal delegation, and particularly your Senators, who care deeply about all of your fisheries that are there, but in particular the lobster fishery there. I guess a question for you, Pat is, are they in the loop on this?

Is this something that we should be speaking with our federal partners? My congressmen, my two senators, other members of the Congressional Delegation from Massachusetts, to put this on their radar screen so we have, either as a negotiating stick that federal legislation is possible, or to more fully engage them in whatever this rulemaking process might be.

CHAIR McNAMEE: Pat, go ahead.

MR. KELIHER: Thanks for that question, Representative. The Maine delegation is very informed when it comes to the gray zone issues. Senator Collins, in particular, has met with the fishermen that fish the gray zone out of Cutler. She has not, I don't believe, been brought up to speed so much on the importation issues.

But we'll certainly be having conversations with here on those. Here I'm not thinking this is a federal legislation issue, right. This is going to have to be an agreement between the countries. But I look at this as kind of a who's on first, right? The United States Marine Fisheries Commission is the primary management responsibilities for American Lobster.

Not to cut out the Agency, but the Agency is also very involved with those direct country-to-country conversations. We deal from a state of Maine perspective, directly with EFO on issues of concern one-on-one. I believe that they would engage with us on this. The gray zone this year in particular won't get resolved, unless the World Court steps in. But conversations around the inequities that are in place with them. If Canada understands that volume of lobster that may not be able to come into the United States for processing, would be significant. I would think that alone would be something that they would want to discuss with us, and how we could potentially rectify it in the long term.

REPRESENTATIVE PEAKE: Thank you.
CHAIR McNAMEE: Okay, any further discussion on this? Oh, sorry, Bob, go ahead.

EXECUTIVE DIRECTOR BEAL: Yes, I just wanted to follow up on Mike Pentony's comments, and buy him and his Agency 48 hours. Just remember this is going to go to Policy Board for consideration. I think two days from now, maybe there can be a little bit more insight from NOAA Fisheries. They probably can't fully analyze it, brought to State Department and all those other things. We can see what we can do, or they have some more insight on Wednesday.

CHAIR McNAMEE: Okay, **let's go ahead and call the question here. All those in favor of the motion, please raise your hand. Sorry, I'm going to go backwards here. Are there any objections to the motion? I will call are there any abstentions, one abstention. The motion passes by consent.**

NORTHERN EDGE SCALLOP FISHERY, NEW ENGLAND COUNCIL

CHAIR McNAMEE: All right, so Pat, I've got one more from you and that was on the interaction with the scallop fishery.

MR. KELIHER: Thank you, Mr. Chairman, I'll be quick. The New England Fisheries Management Council is considering allowing scallop access on the northern edge of Georges Bank. At their April meeting the Council initiated the action, and approved goals and objections for the action. Given the population of large female lobsters in this area, this action is likely going to be of interest to this Board, because of those interactions.

I don't think we need to task the TC with anything at this point, but I wanted to put it on the Board's radar screen. I think it's an important issue. The Lobster Board did provide comments at a previous action, the Omnibus Habitat Amendment 2 Action. That is when the scallop access to Northern Edge was considered in the past. Maybe we could just dust off those comments, and then take this issue up at the next Lobster Management Board.

CHAIR McNAMEE: Toni, go ahead.
MS. KERNS: Just to let the Board know. Michelle Bachman did reach out to Caitlin, and Caitlin has reached out to the TC. We've provided them the last report that we had, which is, I believe from 2012. Then Burton gave us some new information that we will work with Michelle to give her as well. We did engage the TC some.

CHAIR McNAMEE: Okay, great, thanks for bringing that up, Pat. Do you need anything on that beyond? Go ahead.

MR. KELIHER: Just one very quick issue. We've passed an addendum, Addendum XXVII. We still obviously have pending whale rules. Mike Pentony talked about it from a resiliency standpoint at the beginning. This probably goes without saying, but if we do see new whale rules before this trigger, before any triggers are pulled, or even in the interim between triggers. I think we as a Board and the TC need to understand what the relationship to resiliency is, and we may need to revisit that issue. But I just wanted to put that on the record.

ADJOURNMENT

CHAIR McNAMEE: Thanks for that, Pat. Okay, I think that brings us to the end of our agenda. Can I get a motion to adjourn? Motion made by Ray, second by Mike Luisi. Any objections to adjourning? Seeing no hands; we are adjourned.

(Whereupon the meeting adjourned at 3:25 p.m. on Tuesday, Monday, May 1, 2023)

Atlantic States Marine Fisheries Commission

Jonah Crab Benchmark Stock Assessment and Peer Review Report

For Review by the
American Lobster Management Board
October 16, 2023

Sustainable and Cooperative Management of Atlantic Coastal Fisheries

ACKNOWLEDGEMENTS

The Atlantic States Marine Fisheries Commission appreciates the efforts of Commission staff Jeff Kipp, Caitlin Starks, and Tina Berger in development and review of this report. The Commission thanks the numerous data providers that summarized and shared their data for this report. The Commission also recognizes Atlantic Coastal Cooperative Statistics Program staff, especially Adam Lee for support with commercial data.

Prepared by the

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PREFACE

The Jonah Crab Benchmark Stock Assessment and Peer Review Report is divided into two sections:

Section A – Jonah Crab Benchmark Stock Assessment Peer Review
PDF pages 4-26

This section provides a summary of the Jonah Crab Benchmark Stock Assessment results supported by the Peer Review Panel. The Terms of Reference Report provides a detailed evaluation of how each Term of Reference was addressed by the Stock Assessment Subcommittee and provides recommendations from the Panel for further improvement of the assessment in the future.

Section B – Jonah Crab Benchmark Stock Assessment
PDF pages 27-242

This section is the Jonah Crab Benchmark Stock Assessment report that describes the background information, data used, and analysis for the assessment submitted to the Peer Review Panel.

Atlantic States Marine Fisheries Commission

Jonah Crab Benchmark Stock Assessment Peer Review Report

Conducted on
August 29-31, 2023
Providence, Rhode Island

Prepared by the
ASMFC Jonah Crab Stock Assessment Review Panel

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Sustainable and Cooperative Management of Atlantic Coastal Fisheries

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The Review Panel gratefully recognizes the work conducted by the Jonah Crab Technical Committee in preparing the 2023 Benchmark Assessment and for the professional, open, and constructive spirit of discussion during the review workshop. The Review Panel also thanks the Science staff of the Atlantic States Marine Fisheries Commission for their role in organizing the meeting, and providing materials to the Review Panel in a timely fashion.

Acronyms

CFRF—Cooperative Fisheries Research Foundation
CPUE—Catch per unit effort
CSA—Catch Survey Analysis
CV—Coefficient of Variation
DFO—Department of Fisheries and Oceans, Canada
DRM—Direct Residual Mixture
FD—Fishery Dependent
FI—Fishery-independent
GAMS—Generalized Additive Models
IBM—Index Based Model
IGOM—Inshore Gulf of Maine
ISNE—Inshore Southern New England
LBSPR—Length-Based Spawning Potential Ratio
LOESS—Locally Estimated Scatterplot Smoothing
LPUE—Landings Per Unit Effort
M—Natural Mortality Rate (instantaneous)
MSL—Minimum Size Limit
MSE—Management Strategy Evaluation
OGOM—Offshore Gulf of Maine
OSNE—Offshore Southern New England
SAS—Stock Assessment Subcommittee
SPR—Spawning Potential Ratio
TC—Technical Committee
TOR—Term of Reference
VMS—Vessel Monitoring System
VTS—Vessel Trip/Tracking Survey/System
YOY—Young-of-the-year

EXECUTIVE SUMMARY

The Jonah Crab Stock Assessment is data-limited, preventing estimates of population size, fishing mortality rates, and determinations of overfishing and overfished statuses. The assessment explores other Status Determining Criteria (SDC), relying primarily on fishery-independent (FI) survey and fishery-dependent (FD) indices of abundance.

Despite the limited availability of current data, there is considerable urgency for the assessment due to a very steep, three-year, decline in landings. Commercial landings have declined 51% in three years, after an unprecedented 30-fold rise in landings. Although the recent decline is not well-detected in FI stock indicators, there is some evidence of declining fishery CPUE, creating substantial concern and uncertainty for the status of the stock. Given the mixed signals, the status of the Jonah Crab stock is highly uncertain.

Current conditions closely resemble early stages of the collapse of the Canada Jonah Crab fishery in the early 2000s. In the first three years of the crash, Canada landings dropped 58%. Within five years, landings fell 97%, and stock biomass could no longer support a fishery. FI trawl indicators had not fully captured the signals of a rapidly declining stock. However, declining fishery CPUE was observable preceding and during the landings crash.

Given the high level of uncertainty in the status of the Jonah Crab stock, the Panel strongly recommends close monitoring of annual stock indicators in the next few years. Annual indicators can determine whether sharply declining recent landings are signaling the start of a 'bust' phase of a boom-and-bust arc, or are due to fishery and market-related factors uncoupled with Jonah Crab abundance.

In the following report, we evaluate the assessment work by Term of Reference, and provide an Advisory section that may be useful to the Board for making decisions on future management actions, and for setting the direction of research and assessment efforts.

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, sample size),**
    d. **Calculation and/or standardization of abundance indices.**

Data collection for the assessment was comprehensive and thoroughly assembled. The Stock Assessment Subcommittee (SAS) presented 53 fishery-independent (FI) survey indices covering four life stages (young-of-the-year, recruit, post-recruit, spawners) and five regions (IGOM, OGOM, ISNE, OSNE, Coastwide). Indices included: five young-of-the-year (YOY) indices (an additional three surveys were evaluated but not included); and 48 post-YOY indices (plus 20 evaluated but not included). Four fishery-dependent (FD), exploitable-size, male crab CPUE indices were presented covering four regions (IGOM, OGOM, ISNE, OSNE).

The SAS presented data source variance where appropriate and necessary. While error estimates were presented in tabular form for the CFRF VTS results and trawl survey estimates, having those estimates on their corresponding figures would be useful.

The inclusion (and exclusion) of all the data sources presented was well justified. In addition to tracking the mean sizes of the largest 5% of exploitable males, it would be informative to see the full-size distributions of crabs (by sex if available) from annual FI and FD collections. Continued monitoring of potential changes in size distributions may be important for detecting overfishing. Importantly, size compositions could yield initial estimates of mortality rates using length-based catch curves and estimates of spawning potential ratio (SPR) as growth parameters are further refined. Further investigation into defining the instantaneous natural mortality rate (M) will be essential for future population models and interpreting mortality rates derived from simple catch curves.

The SAS did a commendable job describing the strengths and weaknesses of the data and how they vary across the four stocks, particularly during the review workshop. The calculations and standardization of all indices were all detailed and appropriate to help interpret complex fishery-dependent data (e.g., the Direct Residual Mixture Model CPUE). Some presentation of raw vs. standardized metrics could be helpful in the future to understand the magnitude of improvements and also what factors were most influential to CPUE metrics and their interpretations. Overall, this was an impressive body of work and the Review Panel is grateful for the breadth of knowledge and attention to detail presented by the SAS.

2. **Evaluate empirical indicators of stock abundance, stock characteristics, and fishery characteristics for their appropriateness to monitor the stock between assessments.**

The Review Panel recommends continued monitoring of all current indicators of stock abundance, and stock and fishery characteristics. However, the SAS's prioritization of importance of indicators was difficult to interpret from the assessment document. Upon discussion with the SAS, opinions varied regarding the most informative indices in providing management advice. Further exploration and the accompanying rationale would be extremely useful in making the management decision process transparent and repeatable.

The utility of any indicator depends on its relationship to the true measure of abundance or underlying rate (e.g., fishing mortality). Fishery-independent data sources for Jonah crab can be difficult to interpret if the efficiency of the sampling gear is unknown or thought to be low. Similarly, fishery-dependent measures of abundance, such as commercial landings per unit effort, often require substantial analyses to isolate the effects of economic factors from measures of abundance. The Review Panel recommends additional work by the SAS to separate the essential from the desirable indicators.

Several proposed indicators of stock status were considered less useful for either measures of overall stock status or future modeling efforts. Measures of YOY settlement, while important region-wide indicators of the ecosystem, can rarely be related to the spawning biomass that produced them or their subsequent recruits to the fishery. Measures of crab biomass and length frequencies for legal and sublegal males, as well as mature females are likely to be critical for future modeling efforts.

Trawl surveys were typically the most valuable data stream since they are likely to be the only synoptic measure of relative density for most stocks. As noted elsewhere, capture efficiency was likely to be low and dependent on unobservable variations in behavior of the crabs. Collaboration with harvesters is encouraged to obtain their perspectives on changes in catchability especially with respect to seasonal factors and spatial distribution. Further development of fishing area maps (composite, not individual harvesters) could be helpful for interpreting fishery-independent surveys.

Details of the trawl survey estimates should be presented for each stock area. Over the past 15 years, the NEFSC allocated about 380 stations per year over 82 strata. Since the crab stock areas bisect some of the strata, there is a possibility that the number of stations in a stock area is very low in some years. ISNE seems to be prone to lower station numbers with consistent patterns of CV>0.70 in many years. Various model-based methods of 'small area estimation' may be useful, although not yet applied to NEFSC or other surveys in the crab stock areas.

Efforts should be made to document empirical sex ratios in FI and FD collections. There is also need to monitor for changes in survey-specific 'operational sex ratios' as potentially important early warning signals of overfishing, given the predominantly male crab fishery. In this regard, the abrupt decline of Jonah Crab in Canada (DFO 2009) suggests further collaboration with Canadian colleagues and harvesters would be useful to evaluate early warning signs that may be evident in retrospect. The post-mortem analysis should also consider evidence of recovery, or lack thereof.

In view of the potential sensitivity of the stocks to rapid collapse, the use of Kendall's method for evaluating overall trend may not allow for detection of important short-term trends. More 'adaptive' measures of local trends such as LOESS smoothers or Generalized Additive Models (GAMS) should be explored.

Preliminary examination of Jonah crab prices, in conjunction with Landings Per Unite Effort (LPUE) measures, strongly suggest the need to incorporate economic factors when interpreting LPUE trends. Low CPUE when prices are at record highs may be indicative of low availability in traditional fishing areas, or reduced overall abundance. Results of a Rhode Island trip-level LPUE analysis conducted during the review meeting were informative. Continuation of such analyses is strongly encouraged for subsets of data deemed reliable.

For metrics most useful to tracking crab population dynamics, the Review Panel recommends focusing on synoptic trawl surveys with high efficiency gear (e.g., the NEFSC winter survey, 1992-2007); LPUE models informed by economics and harvester inputs; and expansion of the CFRF ventless trap survey to all harvesters, particularly if a design component could be imposed.

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

The SAS evaluated the utility of several data-poor methods based on rates of change in fishery-independent indicators and measures of relative exploitation. Fishery-independent (FI) indicators included one or more trawl surveys in each stock area. In OSNE, the SAS defined relative exploitation as the ratio of landings to the relative abundance from the NEFSC bottom trawl survey. The SAS conducted fishery-independent index-based methods (IBM), called 'Islope' and 'Plan B', and a relative exploitation method called 'Skate'. All of the methods rely on an adjustment of current landings in response to some measure of recent rates of change in fishery abundance index. Islope and Plan B rely on the slope of the indices. The Skate method adjusts catches in response to the ratio of recent exploitation rates to a historical period judged to be a period of stability.

The SAS concluded none of the index-based methods were applicable to Jonah crabs in any stock area. Justifications included the short duration of the time series, the high variability of survey estimates, and the wide range of catch recommendations. Perhaps most importantly, the relationship between total catch (or rates of removal) and population response has not been validated for any index or stock area. An Ensemble method, based on the median of alternative estimates, was also judged inappropriate.

The Review Panel largely agreed with the SAS's conclusions. Longer time series may improve the utility of such methods. However, the general increases in multiple indices over the period in which landings have also increased much more rapidly, suggests fishing mortality is not yet a major factor controlling stock dynamics. However, very recent declines in several fishery-dependent (FD) indicators could be early warning signals of increased exploitation. Without further analyses and the benefits of hindsight and additional data, the Review Panel concluded that further work on Index-Based Methods would not be particularly useful.

The Review Panel suggested that future work on IBMs should be subordinate to the development of other modeling approaches. Further consideration should be given to the application of Catch Survey Analyses (CSA). Such dynamic stage-based models have the advantage of being simple and readily interpretable. Initial attempts to apply these types of models were not successful, often because the size frequency data necessary to identify pre-recruits from recruits was insufficient for the range of years included in the assessment. A related concern is a general lack of knowledge on the molt increment of pre-recruit sized crabs. This is important because CSA requires information on the number of unexploited animals growing into the recruited size range between years. Further examination of existing experimental data and perhaps other experiments may be useful for improving the utility of CSA in at least some areas.

Probably the single most impactful advancement towards generating Jonah Crab population parameters is the development of an unbiased ageing method, based on a thorough examination of marine crustacean ageing research and techniques (e.g., Kilada et al. 2017, Fairfield et al. 2021). At a minimum, simple catch curves of FI and FD age compositions would be feasible, yielding highly informative mortality estimates and providing much insight into Jonah Crab population dynamics. More complex population models and operating models would naturally evolve. The Review Panel does recognize the difficulties in ageing crustaceans. Given the substantial upside of unbiased ageing for practical applications in management, we feel it is worth investigating the method further for Jonah crab.

The Review Panel was impressed with initial results from a Length Based Spawner per Recruit (LBSPR) model parameterized in response to a request from the Panel. Such models often require substantial “borrowing” of growth parameters and natural mortality assumptions from other stock areas and/or related species. Current data are insufficient to support full implementation of the LBSPR approach. However, the Review Panel recommends further development of an LBSPR model in order to guide monitoring efforts and analyze relationships among surveys and landings data. For example, the expected ratio of males to females at length under varying levels of fishing mortality could be derived and monitored routinely to derive static estimates of total mortality by sex. Alternatively, some data suggest that availability of female crabs to the fishery and fishery-independent surveys varies seasonally. If so, an LBSPR model could be useful to interpret such anomalies and distinguish seasonal migrations from changes in mortality rates.

4. **Evaluate the diagnostic analyses performed - e.g., sensitivity analyses to determine model stability and potential consequences of major model assumptions, and retrospective analysis.**

Overall, the SAS presented thorough diagnostics for the analyses they performed while balancing the length and level of detail of the report. Additional diagnostics on model selections (e.g., table of AICs) and their interpretations regarding the magnitude of various factors would have been helpful and interesting, especially in the sections on the CFRF VTS catch rates and the Direct Residual Mixture Model CPUE.

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

In general, the SAS did not formally evaluate the implications of precision of estimates, in part due to the lack of model-based approaches available to limited Jonah crab data. There was however substantial discussion of the relative merits of indices, particularly with respect to their utility for various index-based methods.

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 SAS was unable to develop analytical models of abundance or exploitation. Reasons included concerns about measurement error in abundance indices and insufficient knowledge of basic crab biology, particularly growth. The Review Panel agreed that a credible model could not be developed at this time. A simple catch-survey analysis model may be a useful starting point to explore the feasibility of creating a dynamic model. The Review Panel noted that static models, such as within year depletion models, would be useful for generating biomass and fishing mortality rates. Such models could be useful even when they fail, because results could indicate the relative magnitude of fishing mortality rates. Ultimately, Jonah crab models useful for management will depend on additional years of data, especially from recently initiated data collection programs.

The Review Panel noted that female Jonah crab are uncommon in the fishery, owing largely to the minimum size limit and associated trap vent sizes. In addition, selectivity of smaller sized crabs may be low in fishery-independent surveys, particularly trawls with rockhopper gear. As a result, there are relatively few data streams that would allow application of sex-based methods for mortality estimation. More importantly, there are relatively few empirical measures that could provide early warning signs of overexploitation. The Review Panel encourages further development of monitoring programs that allow for monitoring of size composition of male and female abundances, and evidence of reduced egg production. Ventless traps may be useful, particularly if the current CFRF Ventless Trap Survey could be expanded to the larger fishery. See TOR 8 for more details.

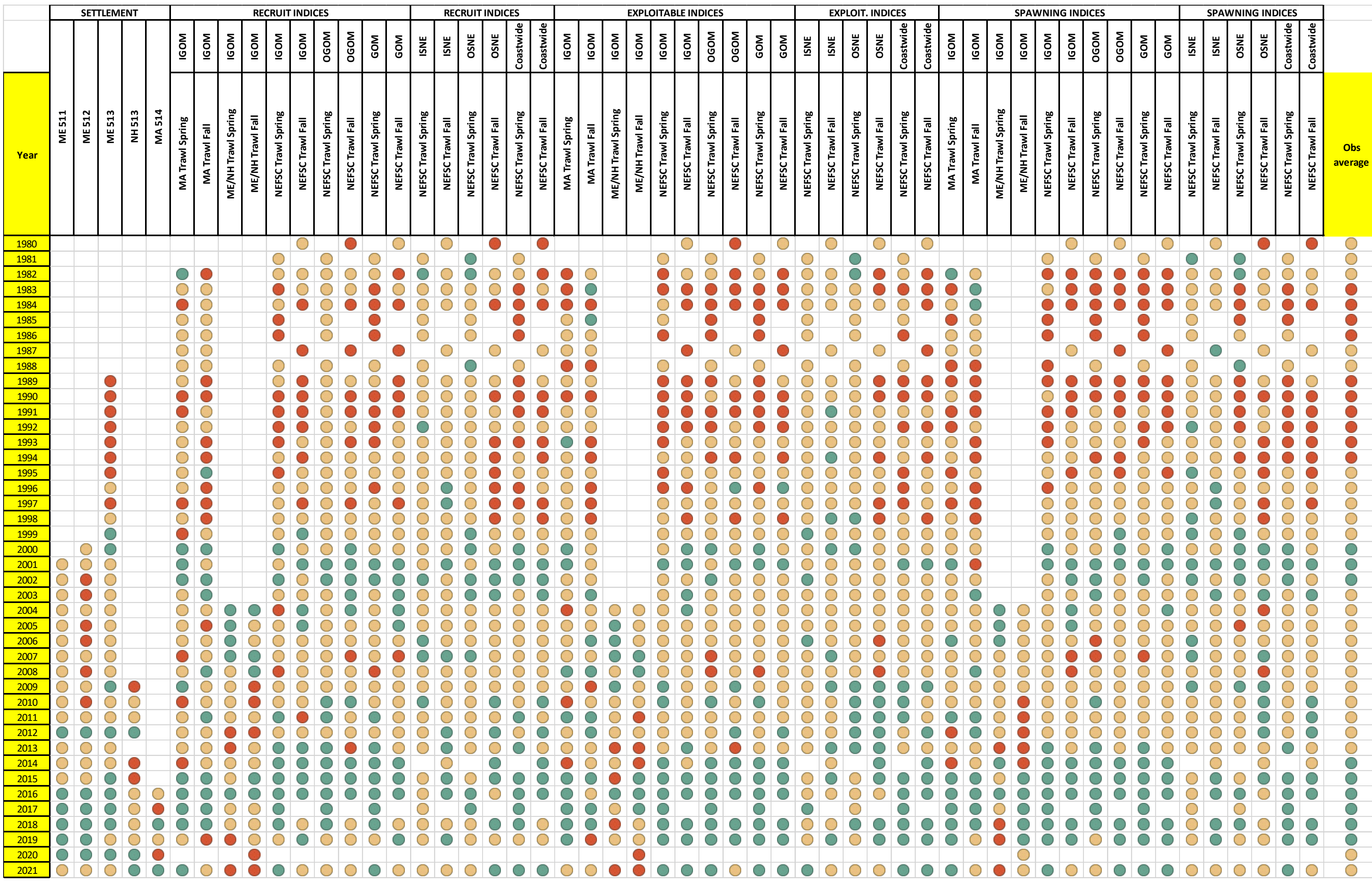
7. **Evaluate the choice of reference points and the methods used to estimate them. Recommend stock status determination from the assessment, or, if appropriate, specify alternative methods/measures.**

While exploitation-based or abundance-based reference points were not yet feasible given essential life history gaps and data constraints, the SAS was able to present numerous indicators and other important fishery and biological background that provided information about stock status. A number of favorable factors exist, such as a cohesive, coastwide, regulatory framework implementing a protective minimum size limit (MSL) that appears to conserve most mature male crabs, particularly in the region where the fishery primarily operates. Furthermore, the fishery selectivity appears to operate at even larger sizes than the MSL, given discussions with the SAS and from a preliminary, post-hoc, Panel-requested, length-based Spawning Potential Ratio (LBSPR) analysis. Importantly, the fishery also does not select female crabs, providing a significant moat to the potential depletion of female spawning biomass. The obvious danger to the stocks' reproductive potential would occur from male depletion and sperm limitation.

An evaluation of stock SPR using the LBSPR approach is a promising status determining criterion for Jonah Crab, given its minimal data requirements. For Jonah Crab, the LBSPR analysis only requires further refinement of growth parameters and natural mortality assumptions, and can be explored for both FD and FI survey size compositions for both sexes.

Fishery-Independent (FI) stock indicators, in bulk, tend to portray a population at higher levels of abundance than at the start of survey time series' (Table 1). However, the positive signals are assessed across a time span up to 42 years, and should be interpreted with caution since there appears to be a regime shift occurring circa 2010.

Table 1. Graphic depiction of ordinal measures of relative abundance indices by stock area and year. Lowest 25% quartile is coded red, interquartile range is coded in yellow, and highest quartile (>75%ile) is coded green. Each index is coded separately. Shorter time series may create bias when compared to longer time series.



Although long-term FI indicators are positive, we see a clear, sharp decline in recent fishery landings and other highly concerning, corroborating, fishery metrics. Jonah Crab landings have declined 51% in the most-recent three-year period (2019-2021) in the OSNE, even while market prices have increased. While we acknowledge other industry and market factors need to be investigated, it is highly concerning to see similar, recent, sharp declines beginning in 2019 in the fishery-dependent (FD) CFRF CPUE, the generally declining FD CPUE in the DRM analysis, and the sharp recent decline in the post-hoc, Panel-requested investigation of directed FD CPUE from RI trip level data (Figure 1). There were also large single-year drops in FI CPUE in the NEFSC OSNE trawl in Fall 2019 and Spring 2020.

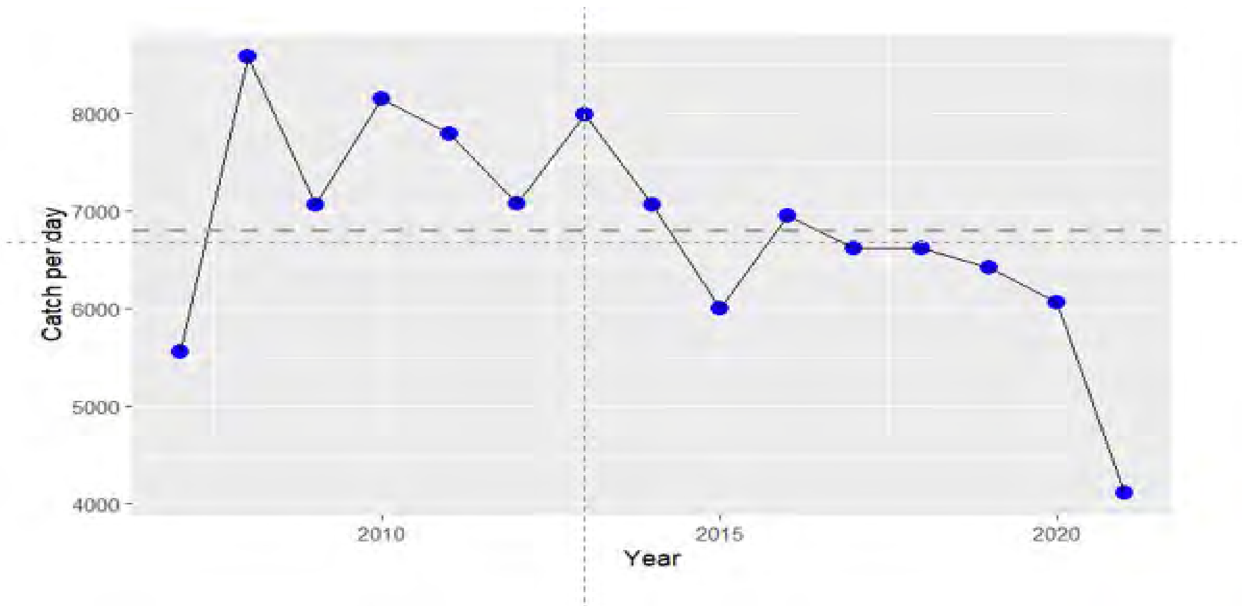


Figure 1. Rhode Island commercial Jonah Crab CPUE (harvest per fishing day) of a harvester group targeting Jonah Crab. (Analysis is preliminary)

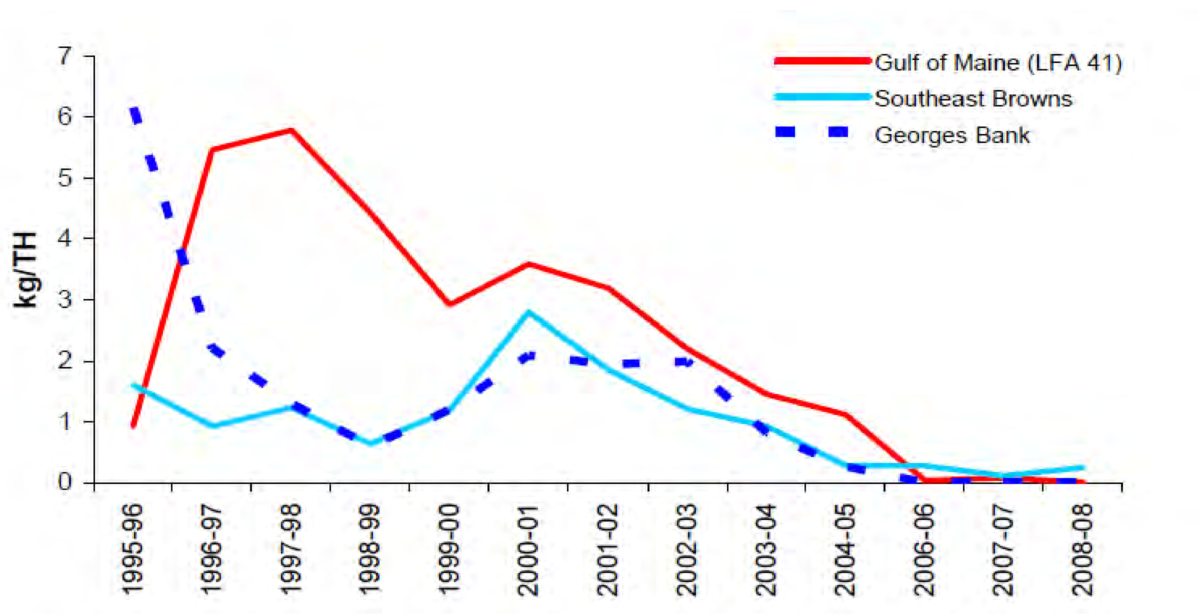


Figure 2. Commercial harvest CPUE (kg/trap) of Jonah Crab during the collapse of the Canada fishery landings that occurred primarily from 2001 to 2004.

It is very worrisome that the extremely rapid collapse of the Canada Jonah crab fishery in the early '00s occurred without noticeable declines in FI indicators (see Canadian Science Advisory Report 2009/034). Canada landings declined by 58% in the first three years of the fishery collapse, comparable to the current, three-year, 51% drop in OSNE landings. Although Canada Fisheries and Oceans (DFO) FI trawl indicators did not capture the deteriorating condition of the stock, declining fishery CPUE was observable preceding and during the landings crash (Figure 2).

8. **Review the research, data collection, and assessment methodology recommendations provided by the Technical Committee 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 Technical Committee presented a number of research priorities in their report and, upon the Panel's request, further refined their highest priority research recommendations to improve future Jonah crab stock assessments. The Review Panel thoroughly discussed the High Priority Short-term topics proposed by the TC. The Review Panel recommends the highest priority should be given to determining how to best interpret fishery-dependent data along with potentially new metrics (see pg 47 of Jonah Benchmark Assessment Report). In light of a new indicator brought forward (catch per trip) and the new, higher, resolution fishery dependent data streams (e.g., VMS data) this avenue of research is likely to provide the most-timely improvement in future assessments.

Additional research topics recommended by the Review Panel include: 1) potential expansion of the CFRF ventless trap sampling, 2) examination of the now defunct (ending in 2007) NEFSC Winter Bottom Trawl Survey (Terceiro 2003, NEFSC 2019), 3) more detailed evaluation of female data, and 4) development of interim measures for evaluating 'stock health'.

1) The CFRF ventless trap research provides an intermediate design between fishery-dependent and fishery-independent data collection. Increasing its spatial extent would be valuable, especially in Southern New England (SNE) where current trawl surveys catch very few Jonah crabs. Consideration of expansion and a thoughtful design approach (e.g., stratified random within current fishing grounds) may provide an improved index of abundance through time. A broad-based program might include of one or more ventless traps deployed by all harvesters over the course of the regular fishing operations. While such a survey would not include random selection, ancillary data, such as historical survey, observer data, and new VMS data could be used to generate appropriate weighting factors for relative estimating abundance.

2) Crabs are scarce in the current NEFSC trawl survey in SNE. However, reasonable catches in the previously conducted NEFSC Winter Bottom Trawl Survey, suggest there may be data available to provide historical context to Jonah crab abundance, and may facilitate a small, strategic, and likely cooperative survey utilizing a gear that effectively catches crab (including females) and does not have concerns regarding behavioral interactions with lobster.

3) Similarly, a more exhaustive examination of the currently available female data (including male/female sex ratios, LBSPR) will likely prove to be an informative metric of stock health. Along with the addition of metrics on females, continued research is warranted on repeatable

and transparent methods to better summarize multiple indicators for each of the four stocks. Formalizing the methods will support decision making into the future until more quantitative methods are available.

4) Lastly, the Review Panel would like the TC to consider a more formal approach to incorporate harvesters' Local Knowledge (LK) to provide context to best interpret fishery dependent data. While we recognize fisheries agency staff have good interactions with harvesters, developing a repeatable and consistent metric(s) of local knowledge could lead to improved interpretation and "buy in" from harvesters on assessment outcomes.

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

It is unlikely that sufficient research will be completed to support a stock assessment within the next five years. Up to 10 years may be needed to complete the many tasks identified by the Stock Assessment Subcommittee and Reviewers. New time series of fine-scale spatial data from the fleet should be particularly informative for future assessments. Moreover, potential new surveys, critical laboratory experiments, and more extensive analyses of existing data have been proposed. Sufficient time is needed to summarize and evaluate these projects before conducting a formal assessment.

The proposed interval for the next assessment poses problems for planning. In order to maintain a focus on the assessment, the Review Panel recommends an interim meeting within five years. The purpose of the meeting will be to summarize ongoing work and to set a date for the formal assessment. A meeting coupled with a review of ongoing status derived from indicators, will help fine tune ongoing projects, drop projects unlikely to be useful, and allow for consideration of candidate modeling approaches.

The Review Panel also expressed concerns about the lack of a decision process that will be necessary before the next assessment. Experience with other crustacean stocks suggests that rapid collapses can occur, particularly when the underlying biology of the stock and patterns of fishing mortality are not fully understood. Preliminary analyses reported at the review meeting suggest declines in catch per unit effort from a subset of directed harvesters in the Offshore Southern New England stock. To address these concerns the Review Panel emphasizes the need to:

- Identify and prioritize candidate indicators of relative abundance and fishery performance.
- Conduct a formal annual evaluation of important indicators, and
- Develop a methodology for making decisions based on ordinal data. Analyses by the SAS showed the utility of binning data into 3 bins corresponding to the first quartile, the inter quartile range, and the fourth quartile.

Ideally, the methodology would identify the probability of observing the observed trends in indicators. Simultaneous drops in multiple indicators may be indicative of true declines or coincidence. Randomization tests may be helpful for distinguishing between these alternatives.

Concomitantly the SAS, in collaboration with managers, will need to define appropriate actions in response to indicator patterns. For example, a decision rule might be to reduce catch by 10% if the probability of observing the observed trend is less than 5% due to chance alone, and to reduce catch by 25% if the probability level is less than 1%. The probability thresholds for decisions and the magnitude of management measures should not be ad hoc. Instead, simulation testing or some form of MSE will be necessary and should be considered by ASMFC. This problem is, of course, not unique to Jonah crabs. Therefore, evaluation of national and international research may be helpful.

ADVISORY REPORT

A. Status of the Stock

The Stock Assessment Subcommittee (SAS) brought forward a large assemblage of Jonah crab data in a cohesive and thorough manner. At present, the availability of data was not sufficient to estimate population parameters and biological reference points in order to determine traditional overfishing and overfished statuses. Other status determining criteria (SDC) were explored, including important fishery and biological background and trend analyses of 53 fishery-independent (FI) survey indices and four fishery-dependent (FD) indices. Interpreting stock status was difficult because longer-term trends in stock indicators appear positive, but disturbing, recent indicators signal a potentially, sharply declining stock. The conflicting indicators depicted an uncertain stock status for Jonah crab.

A number of favorable factors exist, such as a cohesive, coastwide, regulatory framework that implements an appropriate minimum size limit (MSL) that reduces harvest of immature crabs. Furthermore, the fishery selects crabs at even larger sizes than the MSL, based on discussions with the SAS and supported by a preliminary Length-Based Spawning Potential Ratio (LBSPR) analysis requested by the Review Panel. Importantly, the fishery also does not select female crabs, which provides a significant moat to the potential depletion of female spawning biomass. Given these fishery dynamics, the larger danger to population reproductive productivity would occur from male depletion/sperm limitation.

Fishery-Independent (FI) stock indicators, in bulk, tend to portray a population at higher levels of abundance than at the start of survey time series (Table 1). However, the positive signals are assessed across a time span up to 42 years, and should be interpreted with caution since there appears to be a potential regime shift occurring circa 2010, when young-of-the-year recruitment indices become conspicuously elevated in the GOM. When examining indicators over a shorter-term, post-regime-shift time span (2010-2021), there are much fewer positive (>75th percentile) index values in the terminal years (2020, 2021) across the range of indices (Table 2).

Table 2. Graphic depiction of ordinal measures of relative abundance indices by stock area and year from 2010-2021. Lowest 25% quartile is coded red, interquartile range is coded in yellow, and highest quartile (>75%ile) is coded green. Each index is coded separately. Shorter time series may create bias when compared to longer time series.

Year	SETTLEMENT					RECRUIT INDICES									
						IGOM	IGOM	IGOM	IGOM	IGOM	IGOM	OGOM	OGOM	GOM	GOM
	ME 511	ME 512	ME 513	NH 513	MA 514	MA Trawl Spring	MA Trawl Fall	ME/NH Trawl Spring	ME/NH Trawl Fall	NEFSC Trawl Spring	NEFSC Trawl Fall	NEFSC Trawl Spring	NEFSC Trawl Fall	NEFSC Trawl Spring	NEFSC Trawl Fall
2010	Red	Red	Yellow	Yellow		Red	Yellow	Yellow	Yellow	Red	Red	Yellow	Yellow	Red	Yellow
2011	Red	Red	Yellow	Yellow		Yellow	Yellow	Yellow	Yellow	Yellow	Red	Yellow	Red	Yellow	Red
2012	Green	Green	Green	Green		Red	Yellow	Yellow	Red	Red	Yellow	Red	Red	Red	Red
2013	Yellow	Yellow	Red			Yellow	Red	Red	Yellow	Yellow	Yellow	Yellow	Red	Yellow	Yellow
2014	Yellow	Yellow	Yellow	Red		Red	Red	Green	Yellow	Green	Green	Green	Green	Green	Green
2015	Red	Yellow	Yellow	Red		Green	Green	Green	Green	Yellow	Green	Green	Green	Yellow	Green
2016	Green	Green	Green	Red	Yellow	Green	Yellow	Green	Green	Green	Green	Green	Green	Green	Green
2017	Yellow	Yellow	Yellow	Yellow	Red	Yellow	Green	Yellow	Green	Green		Yellow		Green	
2018	Green	Green	Green	Yellow	Green	Green	Green	Yellow	Yellow	Yellow	Red	Yellow	Yellow	Yellow	Red
2019	Yellow	Yellow	Red	Yellow	Yellow	Yellow	Red	Red	Yellow	Red	Yellow	Red	Yellow	Red	Yellow
2020	Yellow	Yellow	Yellow	Green	Red				Red						
2021	Yellow	Red	Red	Green	Green	Yellow	Yellow	Red	Red	Yellow	Yellow	Red	Yellow	Yellow	Yellow

Year	RECRUIT INDICES						EXPLOITABLE INDICES									
	ISNE	ISNE	OSNE	OSNE	Coastwide	Coastwide	IGOM	IGOM	IGOM	IGOM	IGOM	IGOM	OGOM	OGOM	GOM	GOM
	NEFSC Trawl Spring	NEFSC Trawl Fall	NEFSC Trawl Spring	NEFSC Trawl Fall	NEFSC Trawl Spring	NEFSC Trawl Fall	MA Trawl Spring	MA Trawl Fall	ME/NH Trawl Spring	ME/NH Trawl Fall	NEFSC Trawl Spring	NEFSC Trawl Fall	NEFSC Trawl Spring	NEFSC Trawl Fall	NEFSC Trawl Spring	NEFSC Trawl Fall
2010	Green	Yellow	Yellow	Green	Red	Yellow	Red	Red	Yellow	Yellow	Yellow	Red	Yellow	Red	Yellow	Red
2011	Yellow	Red	Green	Red	Yellow	Red	Yellow	Yellow	Yellow	Yellow	Red	Red	Red	Red	Red	Red
2012	Yellow	Green	Red	Green	Red	Yellow	Yellow	Green	Yellow	Yellow	Red	Yellow	Red	Yellow	Red	Yellow
2013	Yellow	Yellow	Yellow	Yellow	Green	Red	Red	Red	Red	Yellow	Red	Yellow	Red	Red	Red	Red
2014		Yellow		Yellow		Green	Red	Yellow	Green	Red	Green	Red	Green	Yellow	Green	Yellow
2015	Yellow	Green	Red	Yellow	Yellow	Green	Green	Green	Yellow	Green	Yellow	Yellow	Yellow	Green	Yellow	Green
2016	Yellow	Green	Green	Red	Green	Green	Green	Yellow	Green	Green	Green	Green	Green	Green	Green	Green
2017	Yellow		Green		Green		Green	Green	Green	Green	Yellow		Yellow		Yellow	
2018	Yellow	Red	Yellow	Yellow	Yellow	Red	Yellow	Yellow	Red	Yellow	Green	Green	Green	Green	Green	Green
2019	Yellow	Yellow	Red	Red	Red	Yellow	Yellow	Red	Yellow	Yellow	Yellow	Green	Yellow	Yellow	Yellow	Yellow
2020										Red						
2021	Yellow	Red	Yellow	Green	Yellow	Yellow	Yellow	Yellow	Red	Red	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow

Year	EXPLOIT. INDICES						SPAWNING INDICES									
	ISNE	ISNE	OSNE	OSNE	Coastwide	Coastwide	IGOM	IGOM	IGOM	IGOM	IGOM	IGOM	OGOM	OGOM	GOM	GOM
	NEFSC Trawl Spring	NEFSC Trawl Fall	NEFSC Trawl Spring	NEFSC Trawl Fall	NEFSC Trawl Spring	NEFSC Trawl Fall	MA Trawl Spring	MA Trawl Fall	ME/NH Trawl Spring	ME/NH Trawl Fall	NEFSC Trawl Spring	NEFSC Trawl Fall	NEFSC Trawl Spring	NEFSC Trawl Fall	NEFSC Trawl Spring	NEFSC Trawl Fall
2010	Yellow	Yellow	Green	Yellow	Yellow	Red	Red	Yellow	Yellow	Yellow	Red	Yellow	Yellow	Red	Red	Red
2011	Yellow	Yellow	Green	Yellow	Red	Red	Yellow	Yellow	Yellow	Yellow	Red	Red	Red	Yellow	Red	Yellow
2012	Yellow	Yellow	Yellow	Green	Red	Yellow	Red	Yellow	Yellow	Red	Red	Red	Red	Red	Red	Red
2013	Yellow	Green	Yellow	Yellow	Red	Red	Yellow	Red	Red	Red	Yellow	Red	Yellow	Red	Yellow	Red
2014		Yellow		Yellow		Yellow	Red	Yellow	Green	Red	Green	Yellow	Green	Green	Green	Yellow
2015	Yellow	Green	Yellow	Red	Green	Yellow	Green	Green	Green	Green	Yellow	Green	Green	Green	Green	Green
2016	Yellow	Yellow	Red	Red	Green	Green	Green	Yellow	Green	Yellow	Green	Yellow	Green	Green	Green	Green
2017	Green		Yellow		Yellow		Green	Green	Yellow	Yellow	Yellow		Yellow		Yellow	
2018	Yellow	Yellow	Green	Green	Green	Green	Yellow	Green	Yellow	Green	Green	Green	Yellow	Yellow	Yellow	Yellow
2019	Yellow	Green	Red	Green	Yellow	Green	Yellow	Red	Red	Green	Yellow	Green	Red	Yellow	Yellow	Green
2020										Yellow						
2021	Green	Yellow	Red	Red	Yellow	Yellow	Yellow	Red	Red	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow

Year	SPAWNING INDICES						Obs average
	ISNE	ISNE	OSNE	OSNE	Coastwide	Coastwide	
	NEFSC Trawl Spring	NEFSC Trawl Fall	NEFSC Trawl Spring	NEFSC Trawl Fall	NEFSC Trawl Spring	NEFSC Trawl Fall	
2010	Yellow	Yellow	Yellow	Green	Red	Yellow	Yellow
2011	Green	Red	Red	Green	Red	Yellow	Red
2012	Yellow	Red	Yellow	Green	Red	Green	Yellow
2013	Yellow	Yellow	Green	Red	Yellow	Red	Red
2014		Yellow		Yellow		Red	Yellow
2015	Yellow	Green	Red	Yellow	Green	Green	Green
2016	Yellow	Green	Green	Red	Green	Green	Green
2017	Yellow		Yellow		Yellow		Green
2018	Yellow	Yellow	Green	Yellow	Green	Yellow	Yellow
2019	Yellow	Green	Red	Red	Yellow	Yellow	Yellow
2020							Yellow
2021	Green	Red	Yellow	Yellow	Yellow	Red	Yellow

Although long-term FI indicators appear positive, we see a clear, sharp decline in recent fishery landings and other highly concerning, corroborating fishery metrics. Jonah crab landings have declined 51% in the most-recent three-year period in the OSNE, even while market prices have increased. While we acknowledge other industry and market factors should be investigated, it is highly concerning to see similar, recent, sharp declines in the fishery-dependent (FD) CFRF OSNE CPUE beginning in 2017, the generally declining FD CPUE in the inshore RI DRM analysis, and a recent decline in the post-hoc, Panel-requested, investigation of directed FD CPUE from RI trip level data (Figure 1). There were also large single-year drops in FI CPUE in the NEFSC OSNE trawl in Fall 2019 and Spring 2020.

It is particularly worrisome that the extremely rapid collapse of the Canada Jonah crab fishery in the early 2000s occurred without noticeable declines in FI trawl indicators (DFO 2009). In the first three years of the Canada fishery collapse, crab landings declined by 58%, comparable to the current, three-year, 51% drop in OSNE landings. Although Canada Fisheries and Oceans (DFO) FI trawl indicators did not fully capture the deteriorating condition of the stock, declining fishery CPUE was observable preceding and during the landings crash (Figure 2).

Given a data-limited assessment lacking population estimates and biological reference points (BRPs), generally conflicting long- versus short-term indicators, and recent, declining fishery signals, the Panel considers the status of the Jonah crab stock to be highly uncertain and recommends close, annual monitoring of stock indicators to further evaluate recent signals.

B. Data and Assessment

Data collection for the assessment was comprehensive and thoroughly assembled. The SAS presented 53 fishery-independent (FI) survey indices covering four life stages (young-of-the-year, recruit, post-recruit, spawners) and five regions (IGOM, OGOM, ISNE, OSNE, Coastwide). They included: five young-of-the-year (YOY) indices (an additional three surveys were evaluated but not included); and 48 post-YOY indices (plus 20 evaluated but not included). Four fishery-dependent (FD), exploitable-sized, male crab CPUE indices were presented covering four regions (IGOM, OGOM, ISNE, OSNE).

Given life history gaps and tempered confidence in synoptic indices, attempts to construct population models were not detailed in the assessment. Trend analyses of survey and relative exploitation indices were explored, showing mixed results between GOM and SNE regions, and were fairly inconclusive from a coastwide perspective and for the important OSNE region that supports the bulk of the fishery. Index-based methods were also explored and were not recommended for management use, given the apparent disconnect between indices and fishery removals, and concern regarding trawls as an appropriate survey gear for structure-associated Jonah crabs.

Challenges

Age and Growth

Assessing marine invertebrate fishery stocks is notoriously difficult, largely due to the prevailing lack of ageing methods for invertebrates, especially crustaceans. The inability to age individuals and characterize age distributions is particularly troublesome for assessments when the species is long-lived, without highly conspicuous life stages that can be monitored practicably and described using stage-based population models. Significant life history gaps still exist for Jonah crab, particularly with respect to modeling growth and understanding longevity, that could prove highly useful in developing length- or stage-based population models or developing other SDC such as Length-Based Spawning Potential Ratio (LBSPR) modeling. Longevity is particularly important, since maximum age is a powerful, useful predictor of natural mortality rate (M). Growth rate and M are also key elements in constructing basic yield-per-recruit (YPR) and spawner-per-recruit models that can produce fishing mortality-based reference points for Jonah crab and reveal how vulnerable the stock is to overfishing.

Surveys

The SAS did an excellent job producing a long list of FI relative abundance indices, based notably on trawl surveys for all post-young-of-the-year (YOY) FI indices. The potential ineffectiveness of mobile trawl gears for capturing benthic, structure-associated Jonah crabs was a prominent discussion point amongst the Panel and SAS. As an illustration of this potential issue, one out of every five (21.3%) annual trawl index values was zero in the assessment. Trawl ineffectiveness was especially pronounced in certain indices, particularly the Northeast Fisheries Science Center (NEFSC) trawl indices in the ISNE and OSNE (to a lesser degree than the ISNE). Such heavy reliance on trawls is a substantial concern for monitoring Jonah crab indicators.

FD indices based on passive traps and pots offer promise as stock indicators. However, the usual caveats need investigation, such as inter-specific (e.g., lobster) and intra-specific interactions, shifting bait practices, gear saturation, hyperstability in catch rates due to commercial fishing practices, regulation changes, and fluctuations in fleet composition influenced by market factors. Taking these caveats into consideration, during the Review Workshop, at the request of the Panel, the SAS produced a very promising FD catch-per-unit-effort (CPUE) indicator using Rhode Island trip-level data subset to a core group of dedicated Jonah crab harvesters. The CPUE was especially useful because it best incorporated the SAS's practical knowledge of their State fisheries as it relates to the aforementioned caveats. As seen in the Canada DFO Jonah crab assessment, FD CPUE was effective at detecting declining crab abundance during the landings crash in Canada in the early 2000s (DFO 2009).

C. Population Dynamics

The assessment provided for a better understanding of Jonah crab population dynamics that should hopefully aid future assessment efforts to estimate population parameters and biological reference points.

Growth and Reproduction

Jonah crab growth rate was described by Huntsberger (2019) across multiple approaches, including length frequency analysis of field collections, a probabilistic model based on laboratory growth, and ageing of the gastric mill, a calcified structure in the digestive system. Jonah crabs exhibited rather slow growth, taking at least four years, but most likely seven years, to reach the fishery legal size (see Figure 2.7 from Huntsberger (2019)). The slower growth rate does not imply great resiliency to fishing pressure.

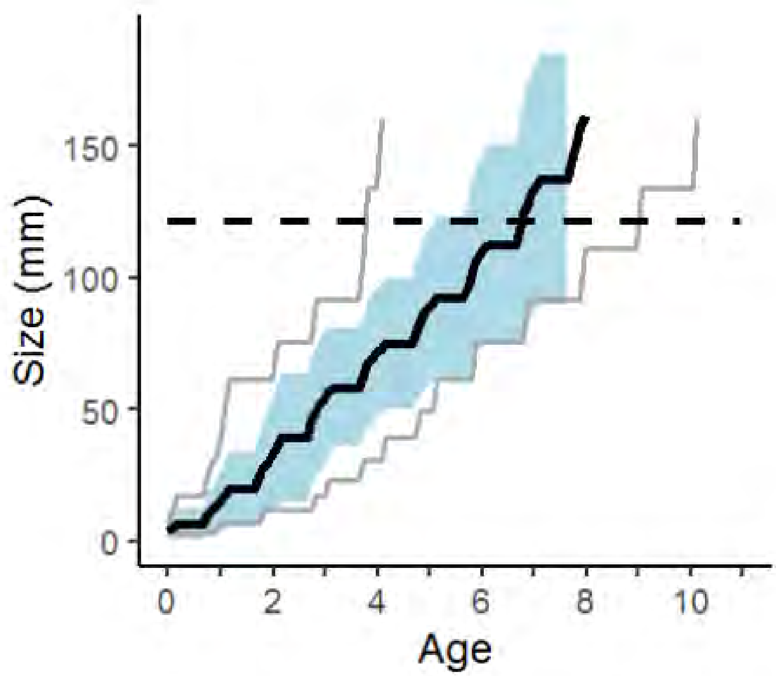


Figure 2.7 Final output of 1000 runs of the probabilistic growth model for male Jonah crabs. The average size (CW) is the solid black line with the gray lines displaying the minimum and maximum sizes and the blue shaded area as the 95% confidence interval. The dotted line is legal size.

The growth models also have value for potential length-based population modeling, YPR and spawning potential ratio models for generating fishery reference points, and SDC models such as LBSPR. Furthermore, direct ageing of individuals using the gastric mill method would enable the SAS to determine fishing mortality rates from basic catch curves of age distributions, gain insight into Jonah crab longevity, and eventually construct desired age-structured population models.

Size-at-maturity (SM50) estimates documented from a range of sources indicate the fishery minimum size limit is specified at-or-above male SM50s, and far above female size-at-maturity estimates. However, better knowledge of the Jonah crab reproductive biology, particularly maturation rates (e.g., age-at-maturity), terminal molting, spawning frequency, reproductive lifespan, operational sex-ratios, etc. would be useful to gain greater insight into crab population dynamics and vulnerability to overfishing.

Stock-Recruit Relationship

Preliminary stock-recruit (s-r) plots requested by the Panel showed a potential relationship between spawning and YOY indices. However, there are questions about the potential spatial mismatch between GOM (YOY index) and coastwide indices (spawning abundance index) (Figure 3). A s-r relationship seen between indices is encouraging for future population modeling efforts.

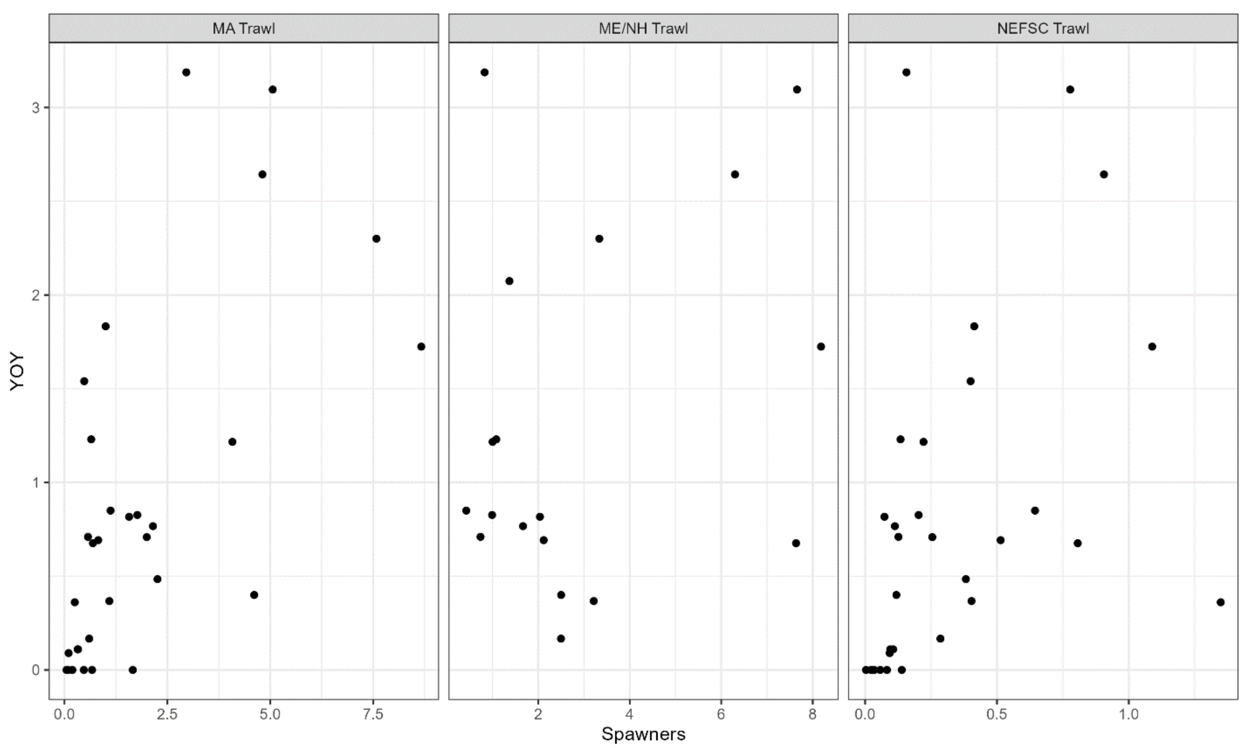


Figure 3. Stock-Recruit plots provided to the Panel during the Review Workshop. Independent axes=Spawner indices, dependent axes=GOM YOY indices (ostensibly lagged, year+1).

D. Fishery

The Jonah crab fishery is dynamic, having recently expanded and shifted towards a more targeted fishery in the past two decades, while also continuing to be strongly tied to the American lobster fishery and its markets. The stock supports a substantial fishery, with recent ex-vessel values peaking at nearly $20 million (Figure 4). Jonah crab harvest is concentrated in one particular region, in the northern area of Offshore Southern New England (OSNE), and is prosecuted mainly by the Massachusetts and Rhode Island fisheries. Considerably smaller state fisheries do operate throughout most of the Jonah crab distribution, from the Gulf of Maine to the Mid-Atlantic.

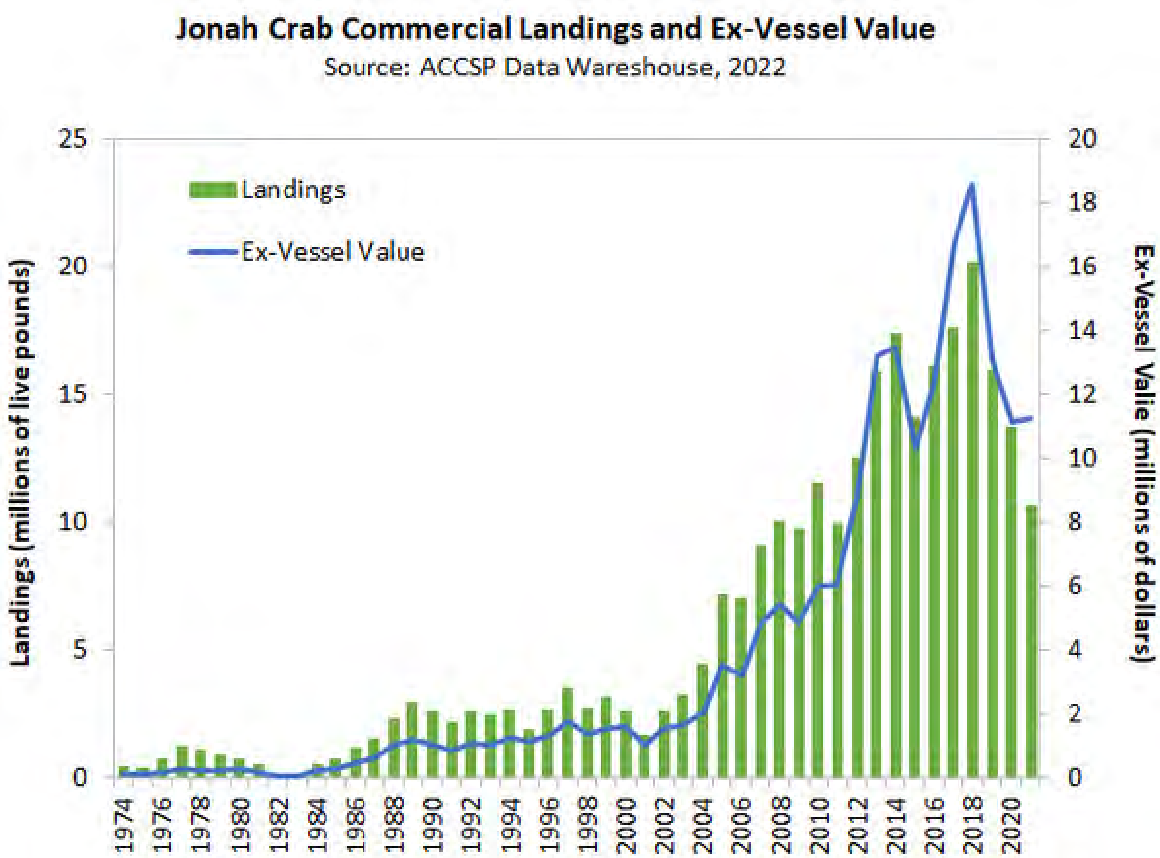


Figure 4. Jonah Crab commercial landings and ex-vessel value.

Jonah crab landings grew substantially (30-fold) in the 2000s and 2010s, and have now declined very sharply (-51%) in the three most-recent years of the assessment. The decline is similar in scope to the beginning stages of the Canada Jonah crab fishery collapse in the early 2000s. In the first three years of the Canada collapse, landings declined 58%. Within five years, landings dropped 97%. In retrospect, Canada DFO concluded that biomass had been severely overfished despite relatively low fishing pressure on a male-only fishery. The ASMFC stock assessment is occurring at a critical time, since it is imperative to determine whether the current steep decline is the start of a 'bust' phase of a boom-and-bust arc, or driven more by market factors.

The SAS brought forward two fishery-dependent (FD) CPUE indicators for the OSNE and ISNE regions in the assessment. CPUE results were mixed, as the ventless trap survey CPUE showed a three-year decline from 2017-2020 in the OSNE, while the Directed Residual Mixture Model (DRM), Rhode Island CPUE showed a declining trend in the ISNE, but no trend in the OSNE. The ventless trap survey possessed a short time-series (2015-2020) and lacked a terminal-year CPUE value for 2021. It is uncertain how well the modeled approach in the DRM performed for identifying targeted trips. After trend analyses, the SAS recommended to not use DRM indicators as measures of exploitable abundance.

Fishery-independent stock indicators, unfortunately, also provided a somewhat unclear perspective on the most-recent three-year period, largely due to the low catchability issues of trawl surveys (see Stock Status, Data and Assessment sections, and TORs for greater detail). As seen in the Canada Jonah Crab Stock Assessment, FI trawl indicators did not detect the rapidly declining stock during the fishery crash in the late 1990s and 2000s (DFO 2009). However, declining fishery-dependent CPUE was evident.

Jonah crab fishery-dependent CPUE analyses are challenging because measuring directed effort is complicated by the mixed Jonah crab and lobster fisheries, and the interplay in fishing effort for both species. Given this uncertainty, the Panel requested a fishery dependent analysis during the Review Workshop that focused on a subset of directed, core Jonah crab harvesters. Based on knowledge of the Rhode Island fishery, the SAS developed basic criteria to subset fishery data to directed Jonah crab trips (>6,000 lb landings) and to participants that were active throughout the time-series. Preliminarily, it does appear that recent fishery CPUE has declined in the OSNE. Further exploration into the directed FD CPUE should continue, with emphasis on investigating caveats typical of FD analyses (i.e., changing market factors and trends in catchability). The Panel also recommended applying the analysis to the Massachusetts fishery data, and to include both as indicators to monitor annually over the next few years, in order to understand the nature and severity of recent falling landings.

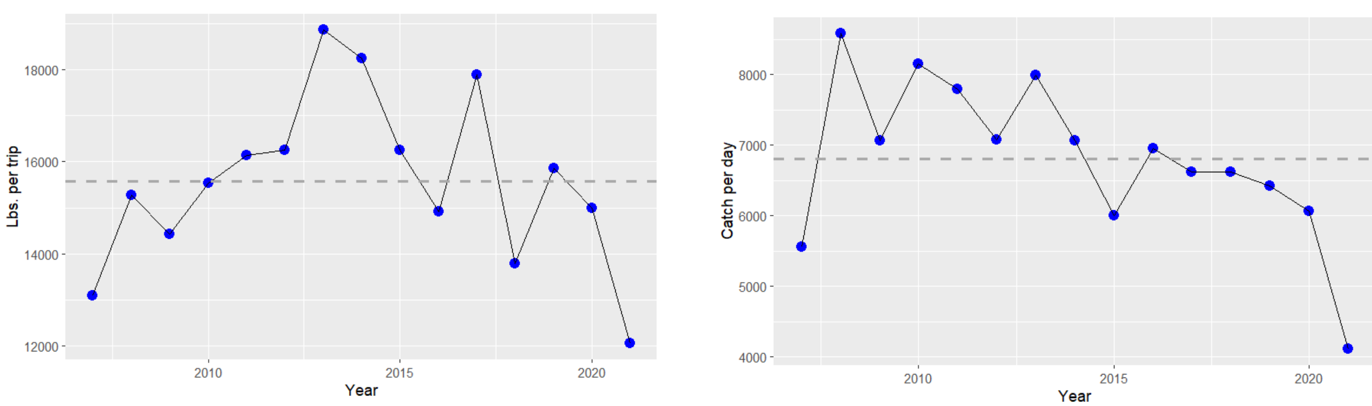


Figure 5. Preliminary analysis of Jonah Crab directed fishery commercial CPUE for select Rhode

E. Future Guidance

The greatest value in this stock assessment may be measured by how well it propels the SAS forward in generating eventual population estimates, reference points, and a clear stock status determination in the ensuing benchmark assessment. Identifying target models and related data needs should logically steer the future research and monitoring efforts of ASFMC partners.

In this assessment, the SAS did a commendable job summarizing available life history information, and constructing and vetting all possible survey and fishery indices. Looking ahead, reasonable target models to pursue would be a Catch-Survey Analysis (CSA) or surplus production model, given their simplicity and minimal data requirements. However, the main barrier to pursuing these and any other population model is the absence of a synoptic Jonah crab abundance index.

Developing a reliable index of abundance is a top priority for the next assessment. If the SAS can further develop the fishery-dependent, directed CPUE in the OSNE, it could fuel first attempts at surplus production modeling. The CPUE is useful because it leverages existing data, and will ostensibly contain a moderately duration time series over a period of substantial contrast in fishery effort and landings. Another direction is to pursue length-based models, possibly using the GMACS (Generalized Model for Assessing Crustacean Stocks) platform. This would likely require much more intensive fishery biosampling to complement the size compositions in existing FI trap and trawl surveys.

Another avenue to explore is the viability of direct ageing of individuals using Huntsberger's (2019) gastric mill method. Direct ageing of specimens would be a game-changer, as it would enable the SAS to generate first estimates of fishing mortality rates from age distributions, gain insight into Jonah crab longevity and natural mortality rate, and enable pursuit of age-structured population models. The time and effort needed to extract and age crab structures will be important factors to consider in understanding its feasibility.

Immediate Steps

The Jonah crab stock is at a pivotal junction. Fishery landings are sharply declining (-51% in the most-recent three years) following a two-decade period of unprecedented growth (30-fold increase). Although FI signals are inconclusive, it appears that fishery CPUE is declining, corroborating the fall in landings. These conditions are highly concerning because they closely resemble the early stages of the Canada Jonah crab fishery collapse in the early 2000s. There is great uncertainty in whether the very large, recent decline in landings is the beginning of a 'bust' stage of a classic boom and bust arc, or merely a short-term drop caused by markets or factors unrelated to Jonah crab abundance.

Given this uncertainty, combined with the lack of population estimates, fishing mortality rates, and reference points, the Panel recommends the SAS/TC closely monitor stock indicators on an annual basis to examine the nature and severity of the recent decline. In addition to any indicators deemed important by the SAS, we highly recommend the ASMFC monitor the directed, fishery-dependent CPUE for Rhode Island and Massachusetts fisheries. This core-fishery CPUE index was preliminarily constructed by the SAS during the Review Workshop at the request of the Panel. Continued development, exploration, and refinement to this fishery analysis are recommended. Additional, potentially-important indicators to consider are 'operational' sex-ratios in FI surveys and FD biosamples. Changes in baseline sex-ratios may signal male depletion and resulting population-level sperm limitation, and could serve as warning signals preceding a population decline.

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Atlantic States Marine Fisheries Commission

Jonah Crab Benchmark Stock Assessment Report

Prepared by the
ASMFC Jonah Crab Stock Assessment Subcommittee

And

Approved by the
ASMFC Jonah Crab Technical Committee
July 18, 2023

Sustainable and Cooperative Management of Atlantic Coastal Fisheries

EXECUTIVE SUMMARY

Stock Structure

Four Jonah crab stocks were defined during the stock assessment based on a combination of biological aspects, management considerations, fishery characteristics, and data availability. These stocks include the Inshore Gulf of Maine stock (IGOM), Offshore Gulf of Maine stock (OGOM), Inshore Southern New England stock (ISNE), and Offshore Southern New England stock (OSNE).

Data

Commercial Landings

Validated commercial landings of Jonah crab are available coastwide back to 1981, but the accuracy of the reporting and the location of where those landings were harvested is uncertain, so this assessment focused on the landings since 2010. However, it is also important to understand the context of the increases in reported landings over time and the changing structure of the fishery. Coastwide landings register a steady increase over most of the time series, but decreased from the record high in 2018 (22.8 million pounds) during the last three years of the stock assessment (2019-2021). These changes are believed to be influenced by relatively variable Jonah crab markets. Historically, Jonah crab has been a bycatch species in the American lobster trap fishery, but in the last two decades, the fishery has shifted with regional differences.

Most U.S. Jonah crab landings come from the OSNE stock which is considered a directed Jonah crab fishery in recent years. From 2010 to 2021, annual landings for this region have accounted for 70 to 85% of the total U.S. Jonah crab landings. The other three Jonah crab stocks are considered to support bycatch fisheries that are primarily targeting American lobster. Landings from the IGOM stock account for 9 to 24% of the coastwide landings from 2010-2021. The OGOM and ISNE stocks have never exceeded 5% of coastwide Jonah crab landings for any year between 2010 and 2021. Although these fisheries currently catch Jonah crab as bycatch, they represent considerable potential growth of Jonah crab fisheries if they become a target species in the future.

Commercial Size Compositions

Commercial biosample data were available from sea sampling and port sampling programs. Data are still too sparse to calculate landings-weighted stockwide statistics, but snapshots of data by stock and statistical area were evaluated for trends. Overall, trends in mean size statistics are stable over the relatively short time series. General lack of trend seen here could be a favorable indication of stock condition (i.e., stable exploitation) or it could indicate that these data are unreliable indicators of stock condition, as appeared to be the case in other crab stock assessments reviewed. These data should be revisited as potential indicators in future stock assessments when longer time series are available and, ideally, there is sufficient coverage to generate landings-weighted stockwide time series, but are not recommended at this time for stock indicators.

Fishery-Independent Indices of Abundance
Five settlement indices of young-of-year (YOY) Jonah crabs were used in the assessment as measures of year class strength. These included ME settlement surveys from three statistical areas in ME waters (statistical area 511, 512, 513), the NH settlement survey (statistical area 513), and the MA settlement survey (statistical area 514). All surveys are in IGOM waters. Indices that extend back into earlier periods in the early to mid-2000s show increasing trends over time. All available indices agree on relatively strong year classes in 2012 and 2018.

Three post-settlement abundance metrics were used as measures of relative abundance including recruit abundance, exploitable abundance, and spawning abundance. Recruit abundance is defined as male Jonah crabs 90-119mm carapace width (CW). Exploitable abundance includes all male Jonah crabs greater than these recruit sizes (120mm+ CW) and is a measure of abundance currently available to the fisheries. Spawning abundance is defined as female Jonah crabs 80mm+ CW. Three survey platforms provided these post-settlement abundance indices including the MA Trawl Survey covering the IGOM stock, the ME/NH Trawl Survey covering the IGOM stock, and the NEFSC Trawl Survey covering all four stocks (although, determined to not be of utility for ISNE stock abundance indices). All three platforms have separate surveys in the spring and fall.

Indices of each post-settlement metric across stocks generally show increasing trends over time series covering historical periods back to the 1980s and 1990s. Indices in GOM stocks show considerable, but brief pulses of abundance around the mid-2010s.

Assessment Methods
Given limitations of available data sets and poor understanding of life history characteristics needed for traditional assessment approaches, data sets were used to develop empirical indicators of stock conditions and fishery performance. These indicators provide a categorical characterization of recent condition (positive, neutral, or negative) relative to historical levels. The stock assessment terminal three years (2019-2021) are averaged to provide a smoothed measure of recent stock condition due to interannual variability reflective, in part, of observation error.

Stock abundance indicators include the YOY settlement, recruit abundance, exploitable abundance, and spawning abundance indices. Fishery performance indicators include landings, the number and proportion of pot/trap trips that landed Jonah crabs, and the number and proportion of active (i.e., reported catch during the year) lobster/crab permits that landed Jonah crab.

Stock Status
According to stock indicators, there have been declines in post-settlement abundance for the IGOM and OGOM stocks from time series highs in the mid-2010s, but conditions in the last three years of the time series are neutral or positive. The one exception is from the ME/NH Trawl survey, but this is due to the shorter time series of this survey not capturing historical lows in earlier years. Indicators for the OSNE stock also indicate neutral or positive post-

settlement abundance conditions in the last three years of the time series. Indicators agree across these stocks that abundance has not been depleted to historical lows. There are no reliable abundance indicators for the ISNE stock and inference cannot be made about condition of this stock's abundance at this time.

YOY indicators generally indicate neutral conditions and do not indicate that recruitment in GOM stocks will decline to historical lows in the near future. Settlement conditions are unknown for SNE stocks.

Landings have steadily declined in the OSNE stock which is the primary stock with targeted/mixed effort for Jonah crab and the stock accounting for the vast majority of coastwide landings. This trend is believed to be influenced by factors other than available abundance but should continue to be monitored closely. There was not sufficient information to make statements about fishing mortality or exploitation with confidence and these population parameters remain major uncertainties.

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TERMS OF REFERENCE

For the 2023 ASMFC Jonah Crab Benchmark Stock Assessment
Board Approved January 2022

Terms of Reference for the Jonah Crab Assessment

1. Characterize precision and accuracy 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.

2. Discuss the effects of data strengths and weaknesses (e.g., temporal and spatial scale, gear selectivities, sample size) on model inputs and outputs.

3. Develop simple, empirical indicators of stock abundance, stock characteristics, and fishery characteristics that can be monitored annually between stock assessments.

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. Constant ecosystem (abiotic and trophic) conditions.

6. Characterize uncertainty of model estimates and biological or empirical reference points.

7. 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?

8. Other potential scientific issues:
    a. Compare reference points derived in this assessment with what is known about the general life history of the exploited stock. Explain any inconsistencies.
    b. Explore, identify, describe, and, if possible, quantify environmental/climatic drivers.

9. 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.

10. 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.

11. Recommend timing of next benchmark assessment and intermediate updates, if necessary relative to biology and current management of the species.

Terms of Reference for the Jonah Crab Peer Review

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, sample size),
    d. Calculation and/or standardization of abundance indices.

2. Evaluate empirical indicators of stock abundance, stock characteristics, and fishery characteristics for their appropriateness to monitor the stock between assessments.

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

4. Evaluate the diagnostic analyses performed (e.g., sensitivity analyses to determine model stability and potential consequences of major model assumptions, retrospective analysis).

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

6. If a minority report has been filed, review minority opinion and any associated analyses. If possible, make recommendation on current or future use of alternative assessment approach presented in minority report.

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

8. 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.

9. 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.

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

11. Prepare a peer review panel terms of reference and advisory report summarizing the panel's evaluation of the stock assessment and addressing each peer review term of reference. Develop a list of tasks to be completed following the workshop. Complete and submit the report within 4 weeks of workshop conclusion.

1 INTRODUCTION

Cooperative interstate management of Jonah crab (*Cancer borealis*) in U.S. waters was first implemented in 2015 with the adoption of the Atlantic States Marine Fisheries Commission's (ASMFC) Interstate Fishery Management Plan (FMP; ASMFC 2015). However, there has been no stock assessment of U.S. Jonah crab to date, stock status is unknown, and there has been limited science-based advice available to support management of Jonah crab fisheries.

The Jonah Crab Technical Committee (TC) met in August 2017 to review research projects and discuss data limitations. This review identified limitations on understanding of basic life history processes, but also identified several projects in progress that could help fill some information gaps in coming years. The TC met again in April 2020 and reviewed ongoing research as well as regular agency monitoring efforts. During this meeting, the TC recommended a more in-depth review of available data to better understand limitations and identify stock assessment approaches that could be supported with available data. Subsequently, the ASMFC American Lobster Management Board (Board) tasked the TC in August 2020 with conducting a pre-assessment workshop for Jonah crab and providing a report on available data and recommended assessment approaches. A series of webinars was held November 16-18, 2020, February 11, 2021, June 3, 2021, and June 29, 2021, to review and discuss available Jonah crab data sets, potential assessment approaches, and remaining data limitations.

The TC's evaluation of the data sets, findings on potential approaches for a near-term stock assessment to provide management advice, and research recommendations to advance future stock assessments were provided in a pre-assessment report in July 2021 (ASMFC 2021). In summary, the TC noted limitations in life history information, limitations with available index of abundance information such as lack of overlap with the core fishery area and poorly understood catchability, and limitations with landings data prior to 2006. Despite these limitations, the TC did acknowledge the need for a full benchmark stock assessment to provide information with which to manage the fishery as well as additional information on data needed to improve future stock assessments. The TC presented these finding to the Board and recommended conducting a benchmark assessment to be completed in 2023. The Board accepted this recommendation and initiated an assessment at the ASMFC 2021 Summer Meeting in August.

The TC and Jonah Crab Stock Assessment Subcommittee (SAS) met via webinar for a Data Workshop June 13-15, 2022 to review the available data sets and discuss data development for the assessment. The SAS than met again via webinar October 3-5, 2022 for a Methods Workshop to review updates on data development and discuss potential assessment methods. The SAS met a final time, in-person in New Bedford, MA April 18-20, 2023 to finalize assessment results which the following report covers.

1.1 Brief Overview and History of the Fishery

Until recently, Jonah crab were predominantly a bycatch species in the American lobster fishery—annual commercial Jonah crab landings were generally lower than 6 million pounds through 1996. Since then, as the lobster fishery has declined in southern New England (SNE) and the market for crab has expanded, harvesters have pivoted to target Jonah crab in addition to (or instead of) lobster. A mixed crustacean fishery now exists in which fishers seasonally adjust their fishing strategies to target Jonah crab or lobster. Harvest pressure on Jonah crab has increased substantially over the past two decades, with landings increasing steadily since around 1996 (Figure 1). Between 2010 and 2021, annual landings of Jonah crab averaged about 16 million pounds, ranging between 12.0 million and 22.8 million pounds (2018). Total Jonah crab commercial catch in 2021 was 12.2 million pounds, with a total ex-vessel value of about $12.8 million.

The Jonah crab commercial fishery occurs predominantly in SNE. Most of the U.S. Jonah crab commercial catch is landed in Massachusetts (54%, 2019-2021 average) and Rhode Island (21%), and most harvest occurs offshore in NOAA Fisheries statistical areas (hereafter, statistical area) 537 (50.6%), 526 (12.5%), and 525 (11.4%). Most Jonah crab commercial landings are reported as having been caught in traps and pots.

Coastwide, commercial landings of Jonah crab are highest in the late autumn and winter months (October to February). In an interview study, fishermen indicated that this seasonal shift was driven by the lobster fishery—lobster are less abundant in winter, so harvesters transition to target Jonah crab during these months (Truesdale et al. 2019a). Based on interviews with fifteen Jonah crab fishermen from Rhode Island and Massachusetts, the number of traps set to target Jonah crab over lobster increased by 73% in the winter compared with the summer months. Fishing strategy adjustments made to transition between Jonah crab and lobster include escape vent modifications, bait type, and fishing location changes.

A small Jonah crab claw fishery operates in Delaware, Maryland, and Virginia, wherein the claws of large Jonah crabs are removed and the animal is returned to the ocean alive. Claw harvest comes mostly from lobster vessels fishing in Lobster Conservation Management Area (LCMA) 5 and accounts for less than 1% of the coastwide commercial landings.

There is no regulatory distinction between a lobster trap and a Jonah crab trap, and a vessel's target species can often not be determined from trip reports and dealer data. Inability to identify a target species, and the recency of the development of the Jonah crab fishery makes it challenging to characterize fishing effort, and there is little literature describing the seasonal dynamics, fishing strategies, and socioeconomic aspects of the fishery. Some anecdotal information has been summarized and may provide a starting point for analyzing and characterizing the fishery (Truesdale et al. 2019a). Additionally, some model-based approaches for standardizing catch-per-unit-effort (CPUE) in mixed crustacean fisheries may serve as a path forward for estimating fishery catch rates (Maunder and Punt 2004; Okamura et al. 2018). Quantifying fishing effort for Jonah crab versus lobster remains a data need for future assessments.

1.2 Management Unit Definition

The management unit for Jonah crab includes the U.S. Atlantic states from Maine through Virginia, though the biological range of the species extends from Newfoundland, Canada to Florida.

1.3 Regulatory History

The ASMFC coordinates the interstate management of Jonah crab in state waters (from 0-3 miles offshore). The ASMFC manages Jonah crab through the FMP, which was approved by the Board in August 2015 under the authority of the Atlantic Coastal Fisheries Cooperative Management Act (1993). Management authority in the exclusive economic zone (EEZ), which extends from 3-200 miles offshore, lies with NOAA Fisheries. The FMP was initiated in response to concern about increasing targeted fishing pressure for Jonah crab, which has long been considered a bycatch species in the lobster fishery. The multi-species nature of the fishery created a challenge for managing a Jonah crab fishery completely separate from the lobster fishery without impacting the number of vertical lines and traps in state and federal waters. Furthermore, a lack of universal permitting and reporting requirements made it difficult to characterize catch and effort to the full extent in order to manage the fishery.

The goal of the FMP is to promote conservation, reduce the possibility of recruitment failure, and allow for the full utilization of the resource by the industry. The FMP lays out specific management measures in the commercial fishery to limit effort and protect spawning stock biomass in the absence of a range-wide stock assessment. These include a 4.75 inch (120.65 mm) minimum carapace width (CW) and a prohibition on the retention of egg-bearing females. To prevent the fishery from being open access, the FMP limits participation in the directed Jonah crab trap fishery to lobster permit holders or those who can prove a history of crab-only pot fishing. All others must obtain an incidental permit. In the recreational fishery, the FMP sets a possession limit of 50 whole crabs per person per day and prohibits the retention of egg-bearing females. Due to the lack of data on the Jonah crab fishery, the FMP implements a fishery-dependent data collection program. The FMP also requires harvester and dealer reporting along with port and sea sampling.

Addendum I was approved by the Board in May 2016, and states were required to implement the management measures in Addendum I by January 1, 2017. Addendum I establishes a bycatch limit of 1,000 pounds of crab per trip for non-trap gear (e.g., otter trawls, gillnets) and non-lobster trap gear (e.g., fish and whelk pots). In doing so, the Addendum caps incidental landings of Jonah crab across all non-directed gear types with a uniform bycatch allowance. While the gear types in Addendum I make minimal contributions to total landings in the fishery, the 1,000-pound limit provides a cap to potential increases in effort and trap proliferation.

Addendum II was approved in January 2017, with associated measures required by January 1, 2018. Addendum II establishes a coastwide standard for claw harvest. Specifically, it permits Jonah crab fishermen to detach and harvest claws at sea, with a required minimum claw length (measured along the bottom of the claw, from the joint to the lower tip of the claw) of 2.75” if the volume of claws landed is greater than five gallons. Claw landings less than five gallons do not have to meet the minimum claw length standard. The Addendum also establishes a definition of bycatch in the Jonah crab fishery, whereby the total pounds of Jonah crab caught as bycatch must weigh less than the total amount of the targeted species at all times during a fishing trip. The intent of this definition is to address concerns regarding the expansion of a small-scale fishery under the bycatch limit.

In response to concerns regarding deficits in existing reporting requirements, the Board approved Addendum III in February 2018, which improves the collection of harvester and biological data in the Jonah crab fishery. Specifically, the Addendum improves the spatial resolution of harvester data collection by requiring fishermen to report via 10-minute squares. It also expands the required harvester reporting data elements to collect greater information on gear configurations and effort. In addition, the Addendum established a deadline that within five years, states are required to implement 100% harvester reporting, with the prioritization of electronic harvester reporting development during that time. Finally, the Addendum improves the biological sampling requirements by establishing a baseline of ten sampling trips/year, and encourages states with more than 10% of coastwide landings to conduct additional sampling trips. The provisions of Addendum III went into effect January 1, 2019, however, implementation of the requirement for commercial harvesters to report their fishing location by 10 minute longitudinal/latitudinal square was delayed until January 1, 2021.

Federal regulations complementing the majority of measures included in the FMP and Addenda I and II became effective on December 12, 2019. Commercial measures included requiring a federal lobster permit, a minimum CW, a prohibition on retaining egg-bearing females, incidental catch limits, and federal dealer permitting and reporting requirements. Recreational measures included a daily catch limit and a prohibition on retaining egg-bearing females. The Jonah crab claw-only fishery is not directly regulated in federal waters; harvesters must abide by state requirements.

In March 2022, the Board approved Addendum IV, which expands on the Addendum III reporting improvements by establishing electronic tracking requirements for federally-permitted vessels in the American lobster and Jonah crab fisheries. Specifically, electronic tracking devices will be required for vessels with commercial trap gear area permits for LCMAs 1, 2, 3, 4, 5, and Outer Cape Cod to collect high resolution spatial and temporal effort data. The addendum requirements seek to enhance data for the stock assessment, identify areas where fishing effort might present a risk to endangered North Atlantic right whales, and document the footprint of the fishery to help reduce spatial conflicts with other ocean uses like wind energy development and aquaculture.

1.4 Assessment History

1.4.1 Previous Jonah Crab Assessments

The only stock assessments conducted for Jonah crab to date have been in Canadian waters. The most recent was conducted for Lobster Fishing Area (LFA) 41 where a directed Jonah crab fishery started in 1995. In response to the developing fishery, a total allowable catch (TAC) of 720 metric tons that was not based on scientific advice was implemented for the fishery. This TAC was fully or nearly caught in all seasons from the 1996-1997 fishing season through the 2000-2001 fishing season and was followed by a continuous decline in catch through the 2008 fishing season. Assessments were conducted in 2000 (Robichaud et al. 2000) and 2009 (Pezzack et al. 2009). These assessments provided empirically-based stock indicators developed from existing monitoring programs. Indicators included abundance indicators (fishery-independent indices of abundance, fishery CPUE, and total landings) and fishing pressure indicators (number of traps hauled and median size of Jonah crabs harvested). Indicators were categorized as positive, neutral, or negative and used to provide qualitative characterizations of stock status. In the most recent assessment, all indicators were negative relative to the previous assessment time-period (1995-1999), except for median size. Abundance indicators from surrounding LFAs where directed Jonah crab fisheries had not developed indicated no clear abundance declines over the same time-period. Although the assessment notes some uncertainty in the cause(s) of negative stock conditions, the results suggest the TAC was not sustainable and declines are due to fishing down the biomass from the start of the fishery.

1.4.2 Other Crab Species Assessments

Assessing crab stocks can be challenging, as demonstrated by other assessments reviewed to inform this assessment. Crabs generally lack age estimates, limiting the types of models that can be used. Their growth is incremental, and growth rates can vary by size, age, or maturity status. Some have a terminal molt. Further, selectivity of survey gear can be inconsistent based on substrate type, temperature, interactions with other species, and life-history characteristics. Below are summaries of selected stock assessments used to make management decisions for other crab species.

Brown Crab Stock Assessment, EIFCA, 2019

The Eastern Inshore Fisheries and Conservation Authority's (EIFCA) brown crab (*C. pagurus*) assessment uses an indicator-based model and defines stock boundaries based on pre-existing mixed-species fisheries management areas (EIFCA 2019). The primary fishery landing brown crab is a mixed-crustacean pot fishery, which also targets European lobster (*Homarus gammarus*). Unlike the Jonah crab fishery, female brown crab are regularly landed because they are of similar size to males. The main data sources used in the assessment are commercial trip reports (landings per unit of effort (LPUE)) and port sampling data. The stock is considered stable based on the stability of LPUE data (pot hauls), and recruitment is sufficient to offset harvest, though there was a slight decrease in the most heavily exploited zone. The assessment acknowledges the challenges associated with using effort data in a mixed-crustacean fishery (e.g. uncertainty in primary target species, species interactions impacting catch probability). The EIFCA is looking into the efficacy of using Length Converted Catch Curve fisheries models for future brown crab assessments but is concerned about violating assumptions of the model (e.g., recruitment and natural mortality are consistent) and the application of these models to crustaceans with incremental growth.

Snow Crab Stock Assessment, DFO Canada, 2020

Fisheries and Oceans Canada's (DFO) snow crab (*Chionoecetes opilio*) assessment (DFO 2020) uses a conditional, autoregressive, spatiotemporal model, and a logistic population model, and utilizes fisheries management areas as stock boundaries. The main data sources used in the assessment are commercial landings, commercial sea sampling, and environmental data. Sea sampling data is used to create "age" classes. The fishery is male-only and targets hard shelled-animals. Abundance is modeled using depth, substrate, temperature, and species composition as covariates. The resulting index is used with a logistic population dynamics model to estimate fishable biomass, carrying capacity, and F_{MSY}. Size composition, female recruits, sex ratios, and predator abundance are used as indicators.

Stone Crab Stock Assessment, FWC, 2011

The Florida Fish and Wildlife Conservation Commission's (FWC) 2011 Stone crab (*Menippe spp*.) assessment was conducted using the Gulf Coast of Florida as a management unit (FFWCC 2011). The stone crab fishery targets two species of stone crab, and a hybrid. Specific stone crab species abundance varies along the coast. This is a claw-based fishery where claws from male and female crabs are removed, and the crab is returned to the water. Mortality rates of de-clawed crabs is low if done properly but can be high if both claws are removed improperly. Nearly all Florida stone crab landings (~99%) come from the Gulf Coast. The assessment uses a Surplus Production model and a modified DeLury depletion model to estimate recruitment needed to offset fishing mortality (*F)* and natural mortality (*M)*. The main data sources are commercial landings, port sampling (claw size and stage), maximum age estimates, and octopus catch rates in crab traps (stone crabs avoid traps with octopus). CPUE data (per trip and per trap) are used as indicators. Assessment methods are limited due to a lack of fisheries independent data, claw size not being correlated with crab size or age, and a lack of recreational fishery data (unknown magnitude of landings).

Tanner and King Crab Stock Assessment, NPFMC, 2022

The North Pacific Fishery Management Council conducts assessments for several crab species including multiple species of tanner and king crab (NPFMC 2022). Data used in the assessments included multiple fisheries independent trawl surveys, commercial landings, bycatch from dragger fleet, sea sampling, port sampling, and pot surveys (limited in scale). The 2022 assessment used several models depending on the data available for a given species, including size and sex-based models (mature/immature, new shell/old shell), population dynamics models, random effects models, length-based models (e.g., generalized modeling for Alaskan Crab Stocks (GMACS)), and index-based models. Indicators were used for species with insufficient data to run a model (e.g., mean weight and CW of landed crabs).

Blue Crab, CBSAC, 2022

The Chesapeake Bay Stock Assessment Committee conducts annual status updates of the 2011 benchmark assessment for blue crab in Chesapeake Bay (CBSAC 2022). The main data sources used in the 2022 update were the Maryland Department of Natural Resources (MD DNR)/Virginia Institute of Marine Science (VIMS) winter dredge survey, commercial landings, and recreational landings. The assessment used a sex-specific catch, multiple survey model with four stages, age-0 males, age-0 females, age-1+ males, and age-1+ females. Reproduction was modeled using the abundance of age-1+ females in a Ricker stock-recruit model, and population density was dependent on the number of age-1+ females and males. Estimates of Bay-wide total abundance, recruits, adult female crabs, over-wintering mortality, and reference points were generated.

2 LIFE HISTORY

2.1 Migration

Catch rates of Jonah crab in traps targeting American lobster provide evidence that Jonah crab migrate to deeper water in the winter and return to shallower water in the spring (Jeffries 1966, Krouse 1980, Truesdale et al. 2019b). However, analysis of catch rates from mid-Atlantic trawl surveys indicated that Jonah crab move very little based on the consistency of Jonah crab catch rates in relation to depth and temperature (Haefner 1977).

There have been two Jonah crab tagging studies, one conducted by Rhode Island Department of Environmental Management (RI DEM; Ordzie and Satchwill 1983) and another conducted by Massachusetts Division of Marine Fisheries (MA DMF) with the Atlantic Offshore Lobstermen's Association (AOLA; Perry et al. 2019). Both studies tagged male and female crabs, but females were rarely recaptured in either study. The RI DEM study tagged 1,383 crabs in Rhode Island Sound, Block Island Sound, and mid-shelf (offshore) south of Rhode Island, and had a 1.7% return rate. All recaptures were tagged and recaptured in Rhode Island Sound. The MA DMF/AOLA study tagged 32,294 crabs on Georges Bank (GB), and the inshore and offshore regions of Gulf of Maine (GOM) and SNE, and had a 2.9% return rate. Movements in both studies were generally limited, on the scale of a few kilometers, though a few individuals from the MA DMF/AOLA study traveled between 100 and 416 km. Other *Cancer* crabs (e.g., *C. pagurus*) have been known to move similar distances, though long-distance travel is more common for female *Cancer* crabs, than male (Fahy and Carroll 2008). Movement between offshore SNE and GB was observed in the MA DMF/AOLA study as well as some small-scale seasonal movement patterns. While Jonah crab appear to be capable of moving long distances, most evidence suggests their movements are generally limited, including seasonal movements.

2.2 Growth

Jonah crab growth has been examined in several recent studies, each of which focused on different life stages of Jonah crab in distinct stock regions. A growth study including techniques for age determination was completed by Huntsberger (2019) for Jonah crabs from the GOM. Three independent methods of age determination were compared: (1) length frequency analysis of crabs sampled periodically in wild nursery populations including young-of-year (YOY) crabs, (2) building a probabilistic growth model informed with data from a laboratory growth study, and (3) applying the method of direct gastric mill band counts from crabs collected in two contrasting temperature regimes along Maine's coast. Length frequency analyses provided size-at-age estimates for the first three year classes, clear size ranges for YOY (3.8-6.6 mm CW), and showed correlation between YOY and legal size crabs four to six years later. For the laboratory growth study, 464 Jonah crabs from mid-coast Maine between 3.1 and 143mm CW were monitored in captivity for up to two years. The data collected were used to build a probabilistic molt model estimating the growth of an individual male crab until it reached legal size. Modeled growth of 1,000 crabs highlighted variability in growth, and males reached minimum legal size at an estimated four to nine years of age. Finally, while gastric mill band counts were found to have a one-to-one relationship with Jonah crab age in years, the mechanism by which annuli are formed is not yet understood. Using this method, Huntsberger (2019) estimated that Jonah crabs recruited to the fishery at four to ten years of age.

The molt increment models for males from the GOM study aligned with a laboratory-based growth study conducted at the University of Rhode Island in 2016 and 2017 (Truesdale et al. 2019a), wherein molt increments were collected for 91 male Jonah crabs ranging in pre-molt CW from 97 to 149 mm. This study also measured molt increments for 119 female Jonah crabs ranging in pre-molt CW from 73 to 113 mm, finding that there were diverging trends in the relationship between crab size and molt increment between the sexes: male molt increments increased with size, while female molt increments became smaller with increasing size. This sexual dimorphism in growth-per-molt aligns with historical growth description from Rhode Island (Ordzie and Satchwill, 1983). Considering the Rhode Island study focused on crabs above the size-at-maturity, it was hypothesized that the divergence in molt increment trends relates to somatic investment in reproduction by females (Truesdale et al. 2019a).

The Rhode Island study also examined molting seasonality for mature male Jonah crabs via year-round crab collection and observation, finding that the annual molt period was in June for the inshore Rhode Island fishery. This molting seasonality aligned with the laboratory growth observations from Huntsberger (2019), which saw a peak in molting in late spring and early summer. Additionally, the Rhode Island study found that annual molt probability decreased with increasing CW for male Jonah crabs (Truesdale et al. 2019a). A slowdown in growth with increasing size for mature individuals is evident across studies; in the MA DMF/AOLA tagging study, a few mature crabs had not molted after more than 700 days at large (Perry et al. 2019). The intermolt period for crabs larger than the legal minimum size has not yet been estimated, and the occurrence of a terminal molt for the species is not known.

2.3 Reproduction, Maturity and Fecundity

2.3.1 Reproduction

Cancer crab mating takes place immediately after the female has molted (Elner et al. 1985, Christy 1987, Orensanz et al. 1995, Tallack 2007). The female crab is cradled by the male pre- and post-copulation using his chelae and first two pairs of walking legs (Elner et al. 1985). Males attain larger sizes than females (Carpenter 1978) and use their size advantage to guard females from other potential mates and predators, as seen in other brachyurans (Christy 1987). Sexual maturity in crabs is generally described based on gonadal development, which corresponds to physiological maturity (physiologically capable of producing eggs or sperm), and morphometrically, by using changes in allometric growth patterns in a particular body part. In crustaceans, morphometric maturity is often determined by male chela length or height, and abdominal width for females (Hartnoll 1978, Lizárraga-Cubedo et al. 2008, Öndes et al. 2017). Larger males out-compete smaller males for mating opportunities (Orensanz et al. 1995), similar to other Brachyuran crabs (Sainte-Marie and Lovrich 1994, Sainte-Marie et al. 1997, Comeau et al. 1998). Gonadal maturity may not be enough for Jonah crabs to mate successfully, and morphometric maturity may be an important factor in determining reproductive ability (Conan and Comeau 1986, Comeau and Conan 1992, Stevens et al. 1993).

2.3.2 Size-at-Maturity

Jonah crab size-at-maturity studies have been conducted from the mid-Atlantic Bight through Nova Scotia, Canada (Carpenter 1978, Ordzie and Satchwill 1983, Moriyasu et al. 2002, Perry et al. 2017, Olsen and Stevens 2020, Lawrence et al. 2021, ongoing investigations – see below). Though methods and sample sizes vary over these studies, they generally show that males mature at larger sizes than females, size-at-maturity estimates increase with increasing latitude, and size-at-maturity estimates for inshore regions are generally smaller than estimates for adjacent offshore areas (Table 1 and Table 2). Some of these studies also indicate that males reach gonadal maturity before they reach morphometric maturity, whereas females reach gonadal and morphometric maturity at roughly the same time. All maturity studies conducted in the U.S. estimate Jonah crab to reach sexual maturity below the current U.S. coastwide-Atlantic minimum legal size (120.65 mm CW) except for the GOM region, where male crabs are estimated to reach maturity at 122 mm CW.

Ongoing investigations into geographic variations in size-at-maturity

Morphometric Jonah crab data collected between 2015-2021 by MA DMF, NOAA Northeast Fisheries Science Center (NEFSC), and the University of Maryland Eastern Shore (UMES, Olsen and Stevens 2020) were pooled to estimate the size at which 50% of Jonah crab reached sexual maturity (SM50), by sex and region. Samples sizes by region and data source are shown in Table 3.

We examined the performance of three different statistical models against simulated data, a broken stick model (Olsen and Stevens 2020), a two-line model with a logistic transition (Hall et al. 2006) and the hierarchical clustering method described by Somerton 1980. The Somerton method involves subjectively splitting the data into three subsets based on size (CW): immature, mature, and unknown, where "unknown" individuals are of intermediate size and span the size range where crabs are transitioning between juvenile and adult morphologies. Linear regressions are then fit to both the immature and mature portions of the data set and individuals of intermediate size are categorized as either immature or mature based on nearness to the regression models extrapolated into the intermediate range. The regression modes are then iteratively re-fit and the intermediate-sized individuals re-categorized until the model stabilizes. The simulated data were built from two-line models with logistic transitions, approximately parameterized by exploration of existing data. This model assumes that individuals displaying mature morphology was a probabilistic process around transitional sizes and appropriately recognizes that all individuals will not switch to adult morphologies at the same size due to biological and environmental variations within regions and discontinuous growth processes.

Of the three models tested, the broken-stick model consistently under-estimated SM50. The two-line logistic model, which matched the structure of the simulated data, often estimated unbiased parameters, in aggregate, but was unstable and sometimes failed to converge. The Somerton method can be sensitive to the subjective initial group classifications and produced biased logistic parameters but unbiased derived estimates of SM50. Here, we present only the results from the Somerton method and recognize additional modeling approaches need to be developed to better stabilize these models and improve performance. To derive confidence limits on the SM50 estimates, we bootstrapped the data 1,000 times for each sex and region and refit the models.

A strong geographic gradient in SM50 for female crabs was not detected. SM50 estimates varied from 89.6 to 97.5 across the regions (Table 3 and Figure 2). Bootstrapped medians were within two millimeters of estimates for all regions except SNE Inshore which was 6 mm larger than the estimate (Figure 3). Distributions of bootstrapped SM50 estimates were bi-modal for both GB and SNE Inshore, suggesting that the estimates are unstable and sensitive to anomalous observations. The maturity estimate for the GOM Offshore turned out to be highly sensitive to the assumed range of “unknown” sizes provided to the Somerton method, though this estimate is comparable to adjacent regions.

Males matured at larger sizes in offshore and more northerly regions than in inshore and southerly regions, showing strong geographical size-at-maturity gradients (Table 3 and Figure 4). A pattern of increasing size at maturity is evident for inshore habitats, increasing from 101.7 mm in the Mid Atlantic to 109.7 in inshore GOM. However, size at maturity was less variable offshore, increasing only from 119.4 mm in the offshore SNE to 121.3 mm in offshore GOM.

In general, male size of maturity is near or below minimum legal size across all regions. GOM Inshore is the only region with a history of producing high landings of Jonah crabs where crabs reach maturity at sizes much smaller than legal size. Additionally, the size of crabs generally pursued by the fishing industry is currently larger than the minimum size, suggesting that most crabs are probably reaching maturity before being captured and retained by the fishery. It is informative that the largest geographic variation in maturity occurs between inshore and offshore SNE, a difference of 16mm over about 100km, corresponds to what is probably the largest thermal gradient in bottom temperatures.

2.3.3 Fecundity

Estimated female clutch size for large female Jonah crab (105-135 mm CW) is between 400,000 and 1.8 million eggs (Hines 1991). The number of eggs per clutch increases significantly with increasing CW (Hines 1991). Though data is limited, female Jonah crab are believed to produce a maximum of one clutch of eggs per year (Hines 1991). There are four zoeal and a megalopa stage for Jonah crabs, which are morphologically identical to Atlantic rock crabs *(Cancer* *irroratus*) except for the number of setae on some appendages (Sastry 1977). This study also reported similar larval developmental times for Atlantic rock crabs at 15°C, and Jonah crabs at 20°C, which implies full larval development from hatch to megalopa would take around 25 days at 20°C for Jonah crabs (Johns 1981).

2.4 Natural mortality

Natural mortality rates for Jonah crab have not been estimated, in part due to a lack of empirical and fishery-dependent data needed for commonly applied estimation methods (Maunder et al. 2023). There are various factors known to influence natural mortality for crustaceans, including molt stage (Ryer et al. 1997), size (Canales et al. 2019), life stage (Lorenzen 1996; Vogt 2011), disease (Vogan et al. 2008), and predation (Maunder et al. 2023), which are also expected to affect Jonah crab natural mortality rates.

Epizootic shell disease has been described for the American lobster stock and is known to impact molting and natural mortality for the species (Vogan et al. 2008, Castro et al. 2012). This condition, which has increased in prevalence in lobster since 1996, occurs on a north to south gradient of increasing disease prevalence related to interacting factors of water temperature, size-at-maturity, and intermolt period (ASMFC 2020; Castro et al. 2013; Glenn and Pugh 2006). Larger lobsters and ovigerous females tend to have higher rates of shell disease, likely related to the extended intermolt duration for these groups (Castro and Angell 2000; Glenn and Pugh 2006; Castro et al. 2013; Reardon et al. 2018; DNC 2019). Lobster shell disease prevalence in the population is highest just prior to the time of molting (Tlusty et al. 2014; Groner et al. 2018) and severity has been shown to worsen more rapidly as waters warm (Barris et al. 2018).

A similar condition to lobster epizootic shell disease has been reported for Jonah crab, particularly in SNE (Haefner 1977, Truesdale et al. 2019a), attributed to chitinoclastic bacteria, including Gram-negative bacteria such as Vibrio (Sindermann et al. 1989, Austin and Alderman 1987). Prevalence of disease occurrence is not well described, but shell disease condition data have recently started being collected as part of several state sea sampling and port sampling programs. In inshore Rhode Island waters, it was observed that shell disease prevalence follows a seasonal cycle aligning with the molt season, as with lobster (Truesdale et al. 2019a). Recently, this shell disease has been reported in Jonah crabs as far north as the Bay of Fundy (Carlon et al. 2018). Like lobster shell disease, Jonah crab disease presents as dark spotting on the carapace and claws, in some cases with lesions that erode the shell's structural integrity. This presentation is similar to that of "black spot" caused by bacterial infection in the European brown crab (Stentiford 2008). The extent to which shell disease impacts internal systems and modifies mortality rates in European brown crab is not well described, but injection of bacterial species isolates was shown to lead to systemic infection and increased mortality (Stentiford 2008). Black spotting disease has been noted to be more common among older crabs, likely due to a longer intermolt duration (Ayres and Edwards 1982).

Other pathogens of Jonah crab have not been well described; however, a comprehensive review of diseases impacting the European brown crab characterized several viral, bacterial, and fungal diseases associated with increased mortality rates (Stentiford 2008). Understanding diseases as mortality drivers, including the impacts of fishing practices on disease transmission and severity (e.g., declawing practices, interspecific interactions in traps) has been emphasized as a management consideration (Stentiford 2008).

Predation on Jonah crab has also not been comprehensively described but is expected to comprise an important source of natural mortality for the species based on the available literature and diet data, which indicate that Jonah crab is a major component of the diets of several important predator species on the northeast US continental shelf. In a recent diet study, Cancer crabs were the largest component of the diets of black sea bass (*Centropristis striata*) and Atlantic cod (*Gadus morhua*) in nearshore SNE waters (Santos 2020). Jonah crab have also been found to be important prey species for skates (*Rajidae*), smooth dogfish (*Musteus canis*), spiny dogfish (*Squalus acanthias*), and longhorn sculpin (*Myoxocephalus octodecemspinosus*) in the NEFSC seasonal trawl survey (pers. comm., B. Smith, NOAA NEFSC). Given the importance of Jonah crab as a prey item, it is of interest how the shifting predator field in the region may have influenced Jonah crab mortality rates over time.

2.5 Stock Structure

Four Jonah crab stocks were defined based on a combination of biological aspects, management considerations, fishery characteristics, and data availability. These stocks (Figure 5) include the Inshore Gulf of Maine stock (IGOM), Offshore Gulf of Maine stock (OGOM), Inshore Southern New England stock (ISNE), and Offshore Southern New England stock (OSNE).

Size-at-maturity was the primary biological basis for defining the stock areas, while the available tagging information suggests limited movement of Jonah crab that would be indicative of adult connectivity throughout the population. Larval distribution and supply remain uncertainties for connectivity and stock structure. Individuals generally mature at larger sizes offshore compared to individuals inshore at the same latitudes, and individuals generally mature at smaller sizes moving south within inshore/offshore areas (Table 1 and Table 2). Inshore/offshore boundaries and the inshore GOM/SNE split were matched to existing LCMAs, where possible, recognizing these would be the likely boundaries for any future Jonah crab regulations. Assessing crab stocks at spatial scales defined in part by management and fishery characteristics is a common practice applied in other crab stock assessments (Pezzack et al. 2009, Marcussen 2022). Statistical areas were used for stock boundaries when LCMAs needed to be split because this is the finest level of spatial data available with landings.

The IGOM stock covers LCMA 1 extending from ME through central MA, while offshore stocks primarily cover LCMA 3. LCMA 3 covers offshore waters throughout the entire range of Jonah crab, so there was the need to split this area into GOM/SNE stocks using statistical area boundaries. The GOM/SNE split between offshore stocks was defined as the southern boundaries of statistical areas 521, 522, and 561. Statistical area 521 contains most of the OCC LCMA and most Jonah crab landings within this statistical area are likely to come from offshore areas in LCMA 3, so OCC was grouped with the OGOM stock. Fisheries in OGOM waters, where lobster abundance remains relatively high, target lobsters and tend to catch Jonah crab as bycatch (Section 4). This region has the potential to develop a directed Jonah crab fishery with increased and differential exploitation patterns if lobster abundance declines. These potential patterns could be masked if grouped at a broader scale with statistical areas to the south more associated with mixed crustacean fisheries and fisheries targeting Jonah crab. There is no clear separation of crabs between statistical area 562 and statistical area 525 and no evidence of connectivity between statistical area 562 and statistical area 561 according to MA DMF/AOLA tagging work (Perry et al. 2019), so statistical area 562 is grouped with the OSNE stock. Index of abundance development during the assessment showed different patterns of abundance in these areas further supporting this split (Figure 6). All Mid-Atlantic areas (LCMAs 3, 4, and 5) were grouped with the OSNE stock due to this component of the population being relatively small and located in deep canyons offshore and the expectation they would be more similar to Jonah crab populations offshore of SNE. The available maturity estimates present a more mixed picture for comparison between Mid-Atlantic crabs and those from offshore SNE proper, but the recent studies by Perry et al. 2017 and Olson and Stevens 2020 indicate similar size-at-maturity based on morphometrics for females in these two areas.

The ISNE stock primarily covers LCMA 2. LCMA 5 (Long Island Sound), which opens into LCMA 2 and accounts for minimal Jonah crab harvest, was grouped with the ISNE stock. Statistical area 537 accounts for the majority of Jonah crab harvest and extends into both inshore waters in LCMA 2 and offshore waters in LCMA 3, so there is the need to split this statistical area between SNE stocks. The northern boundary of the LCMA 2/3 overlap, which is in the middle of statistical area 537 and has more similar depths in its western section as the waters just into the LCMA 3 portion of 537 (Figure 7), was set as the boundary between ISNE and OSNE stocks within statistical area 537. The small section of LCMA 2 that extends into statistical area 521 (OGOM stock) and statistical area 526 (OSNE stock) was assumed part of these respective offshore stocks for pragmatic reasons of splitting landings data.

3 HABITAT DESCRIPTION

Jonah crabs can be found from Newfoundland to Florida at depths ranging from the intertidal to 800m but are most abundant in the northern latitudes (Haefner 1977, Stehlik et al. 1991, Pezzack et al. 2011). Limited specific information is available for the distribution as depth, season, habitat, and temperature affect the abundance of Jonah crabs (Stehlik et al. 1991, Carpenter 1978, Haefner 1977, Krouse 1980). The highest abundance of Jonah crab is found in water temperatures of 6-14^{o}C (Stehlik et al. 1991, Haefner 1977, Krouse 1980, Pezzack et al. 2011). Krouse (1980) suggests Jonah crabs have a narrower temperature range tolerance than the similar species, Atlantic rock crab, and may stay further offshore to attain more stable bottom temperatures. Laboratory studies by Lewis and Ayers (2014) found Jonah crabs thermoregulate and will move to a preferred temperature, but previously experienced temperatures significantly impacted temperature preference. At the southern end of their range, Jonah crab prefer greater depths (Jeffries 1966). In the Mid Atlantic Bight, Haefner (1977) provides evidence for an increase in size as depth increases while Carpenter (1978) suggests relative abundances of distinct size groups can be found at different depths depending on the time of year. Carpenter (1978) found female Jonah crabs are more abundant at depths less than 150m while males prefer deeper water.

Historic offshore trawl surveys and recent interviews with SNE fishermen found the highest abundance of Jonah crabs in silty sand and flat muddy habitats (Haefner 1977, Stehlik et al. 1991, Truesdale et al. 2019a), but studies, mostly in the GOM based on inshore SCUBA work, trapping, and video survey, found Jonah crabs associated with more complex cobble, boulder, and sand substrate (Jeffries 1966, Krouse 1980, Richards 1992, Palma et al. 1999, Reardon 2006). YOY and juvenile Jonah crabs are found in relatively high numbers during settlement surveys (Section 6.1) in cobble habitat. Whether offshore areas provide important settlement or nursery habitat is poorly understood. The discrepancy of observed crab habitat could be due to lower catchability of crabs by trawl surveys and commercial pot gear in complex habitat, difference of primary substrate type by life stage, or correlation of substrate with depth.

4 FISHERY CHARACTERIZATION

While landings are available coastwide back to 1981 (Figure 1), the accuracy of the reporting and the location of where those landings were harvested is uncertain, so this assessment has focused on the landings since 2010. However, it is also important to understand the context of the increases in reported landings over time and the changing structure of the fishery. The coastwide landings register a steady increase in Jonah crab landings over time. Historically, Jonah crab has been a bycatch species in the American lobster trap fishery, but in the last two decades, the fishery has shifted with regional differences. The differences in characterization are important to recognize when interpreting catch and participation data. In areas where lobsters are still abundant and available to the commercial fleet, Jonah crab remains primarily a bycatch species, but in areas where lobster abundance has decreased significantly, Jonah crab has become a directed fishery. The numbers of participants vary by states and inshore versus offshore regions. In some areas, the pounds landed per trip are significantly higher, and total landings of Jonah crab are high while the number of active harvesters is low, indicating a more directed fishery. In other areas, the number of active harvesters is significantly higher while the pounds per trip remain low, indicating a bycatch fishery. The inshore fleets tend to be bycatch fisheries while the offshore fleets are directed fisheries. In this section, we provide the characterization of the Jonah crab fishery components by state.

4.1.1.1.1 Spatial Distribution

Most U.S. Jonah crab landings come from the OSNE stock. From 2010 to 2021, annual landings for this region have accounted for 70 to 85% of the total U.S. Jonah crab landings (Figure 8-Figure 19). Landings from the IGOM stock account for 9 to 24% of the coastwide landings over the same period. The OGOM and ISNE regions have never exceeded 5% of coastwide Jonah landings for any year between 2010 and 2021.

Though Jonah crab landings are reported from a wide geographic area, most landings are concentrated in the northern portion of the OSNE stock. In recent years, more than half of the Jonah crab landed in the U.S. are caught in the offshore portion of statistical area 537 (Figure

20-Figure 31), within LCMA 3. Statistical areas 526 and 525 are also important areas. Each area often accounts for more than 10% of the annual U.S. Jonah crab landings.

4.2 State-Specific Fishery Characterizations

Maine

Jonah crab has historically been a bycatch species of the lobster fishery in Maine in LCMA 1. Misreporting is common because the fishing fleet refers to *Cancer borealis* (Jonah crab) as "rock crab" and *Cancer irroratus* (Atlantic rock crab) as numerous local names, but not "rock crab". This misidentification creates challenges in understanding the dynamics of the fishery from landings data. Anecdotally from the fishery, Atlantic rock crab is caught close to shore, predominantly in state waters in bays and rivers, while Jonah crab is predominantly caught in deeper federal waters. Most reported crabs are assumed to be Jonah crab. In the landings data, both species were often reported as "crab unclassified", prior to reporting requirements, and misreporting problems persist. The Jonah crab harvest primarily consist of whole crab, but Maine does allow a personal use exemption for Jonah crab claws. There was a pulse of very high landings of Jonah crab in the early 2000s leading to a peak of almost 10 million pounds landed, but most of that catch was reported as "crab unclassified".

Effort and landings of Jonah crab in Maine are driven by the combination of abundance of lobster, abundance of Jonah crab, and market availability. If the lobster catch is very high or markets for Jonah crab are unavailable, the fleet will actively avoid Jonah crab, even if the crabs are abundant. While poundage has been decreasing in the lobster fishery in recent years, the abundance of lobster is still high and worth much more than Jonah crab, leading to the continued preference for lobster. The bycatch fishery for Jonah crab remains at low levels characterized by low poundage per trip (Figure 32) where a majority of the trips between 2018-2021 are 100lb or less. While the poundage of the trips is low, the scale of the Maine lobster fishery compared to other regions represents high numbers of trips and permits participating in the fishery (Figure 33 and Figure 34). Since 2008, 10% or less of the Maine trap/pot trips reported harvesting Jonah crab, representing between 10,000-30,000 trips annually. Permits actively harvesting Jonah crab represent 14-25% of the active trap/pot permits, totaling 600-1,136 permits annually.

New Hampshire

In New Hampshire, Jonah crabs have historically been harvested as bycatch of the lobster fishery in both LCMA 1 and 3. The LCMA 1 fleet is made up of day boats generally fishing within 25 miles of shore, while the LCMA 3 fleet is characterized by multi-day trips to offshore GOM and GB. Vessels in both LCMAs target lobster and Jonah crab as bycatch with the magnitude of landings for crabs being driven by a number of factors, including but not limited to: 1) abundance of lobster, when lobster catch is high Jonah crabs are more apt to be thrown back, 2) markets for Jonah crab, if dealers are seeking Jonah crabs and make it easy for captains, they will be more likely to harvest crabs, 3) price per pound of Jonah crab, higher price provides more incentive, and 4) desire of captain's helper to retain crabs to sell on their own. Jonah crabs from the inshore fleet have historically been a source of additional income for helpers as they will put them aside and sell once they have enough crabs to go to market. These are the primary factors driving landings and the reason why this bycatch fishery is generally characterized by low catch per trip.

Jonah crab landings in New Hampshire from LCMA 1 averaged 36,061 from 2016-2022, whereas in LCMA 3 they averaged 77,716 pounds. In both LCMAs, Jonah crab landings comprised only 2% of total lobster/Jonah crab landings. During this same time period, 25% of vessels in LCMA 1 and 44% of vessels in LCMA 3 landed Jonah crab. Lobster is the target species for NH vessels fishing in both state and federal waters and Jonah crab makes up a very small percentage of total state landings.

Massachusetts

Jonah crab was traditionally considered a bycatch of the trap-based lobster fishery until the collapse of the SNE lobster stock in the late 1990s. The collapse of the lobster fishery forced many Massachusetts fishers to diversify. State permits that allowed for the harvest of lobster or edible crabs, and simple gear modifications, made it easy for lobster fishers to redirect effort towards Jonah crab. Increasing Jonah crab price per pound due to expanding markets and redirected effort from the lobster fishery led Jonah crab to rapidly become one of the most valuable fisheries in the state based on ex-vessel value. More Jonah crab are landed in Massachusetts than any other state.

Most Jonah crab landed in Massachusetts are caught in federal waters from statistical area 537, 526, or 525 and landed in the ports of New Bedford, Sandwich, or Gloucester. A small number of boats targeting Jonah crab are usually responsible for a large portion of the state landings, but there are numerous fishery participants targeting lobster that land smaller amounts of Jonah crab. Most trips landing Jonah crab catch less than 100 pounds per trip, but trips targeting crab often catch over 10,000 pounds (Figure 35). Some trips have reported over 100,000 pounds. The proportion trips landing Jonah crab in IGOM, OGOM, and ISNE using a Massachusetts lobster/edible crab trap permit is low (Table 4). However, about 75% of OSNE trips by those possessing a Massachusetts lobster/edible crab trap permit, land Jonah crab. The IGOM and ISNE fleet tend to be smaller vessels conducting day trips. The OGOM and OSNE fleet are larger vessels conducting multiday trips.

Crabs are landed whole, and sold to be marketed live, or processed at meat picking facilities. Nearly all the Massachusetts Jonah crab landings come from the lobster/edible crab trap fishery, and nearly all are male due to market preferences for larger crabs. The fishery targets hard-shelled crabs because recently molted crabs have little market value due to low meat yield and lower survival rates.

Rhode Island

The Rhode Island Jonah crab commercial fishery is composed of inshore and offshore fleets, with inshore vessels harvesting Jonah crab in LCMA 2 and offshore vessels harvesting Jonah crab in LCMA 3, corresponding to the inshore and offshore SNE stocks. The inshore fleet generally comprises small vessels conducting day trips, while the offshore fleet is made up of more vessels that conduct multi-day trips. As a result, Jonah crab landings per trip are higher for the offshore fleet (Figure 36). In general, because of the price differential between Jonah crab and lobster and differences in catch rates, Jonah crab harvest per trip is often higher than lobster harvest per trip, even when lobster was the predominant target species, which warrants caution in interpretation of CPUE data. However, there appears to be a decrease in lobster landings for trips landing more than 6,000 lbs. of Jonah crab, suggesting a potential threshold for examination of trips targeting Jonah crab (Figure 37).

Historically, Jonah crab was predominantly a bycatch fishery in Rhode Island, but around 2010, harvesters pivoted to target crab in addition to, or in place of, lobster (Truesdale et al. 2019b). The fishery now comprises vessels that target either species as well as those that switch between target species based on fishing location, season, market factors, and other variables. The offshore fleet includes several vessels that have highly capitalized in the Jonah crab fishery; on average, Jonah crab make a much higher percentage of mixed-crustacean trip landings for the offshore fleet than the inshore fleet (Figure 38). Inshore trips are more frequently mixed-crustacean trips wherein Jonah crabs are retained as bycatch. Only whole Jonah crabs may be retained and sold in Rhode Island.

Overall, Rhode Island's lobster and crab commercial fleets have declined in numbers since 2007, which is attributed in part to the decline of the SNE lobster stock and related management actions over the past decade. The inshore fleet has experienced a decline in number of participants, from nearly 250 permits to just over 100 from 2007 to 2021. However, the number of vessels landing Jonah crab has been largely stable for the inshore fleet at around 35 vessels. The Rhode Island offshore Jonah crab and lobster fleet has decreased from around 30 permits in 2007 to 14 permits in 2021 (Figure 39). However, the offshore fishery accounts for the bulk of Rhode Island's Jonah crab landings; nine offshore vessels brought in more than 65% of the annual landings from 2017 to 2021, on average.

Southern States

The states of Connecticut through Virginia represent a relatively small proportion of the overall Jonah crab fishery. Since 2010, the states of Connecticut through Virginia have contributed under 10% of the coastwide total Jonah crab landings, with New Jersey and New York consistently contributing the large majority of that percentage. According to state compliance reports New York and New Jersey had 19 and 24 Jonah crab fishery participants in 2021, respectively; in Connecticut, Delaware, Maryland, and Virginia there were fewer than five Jonah crab fishery participants in each state.

In New York, the majority of participants fish in offshore SNE, though there are three to five participants that fish in the inshore SNE area, and two or fewer that fish in the GOM (Figure 40). In New Jersey, Delaware, Maryland, and Virginia, all participants fish in the offshore SNE area (Figure 41 and Figure 42).

While the majority of Jonah crab is harvested as whole crabs, fishermen from some states, particularly New York, New Jersey, Delaware, Maryland and Virginia, land Jonah crab claws. Jonah crab claws are relatively large and can be an inexpensive substitute for stone crab claws. As a result, they can provide an important source of income for fishermen. Claws can also be harvested for personal consumption; however, these landings are not well documented. A historic claw fishery takes place along the Delmarva Peninsula. These traditionally small-boat fishermen harvest Jonah crab claws because they do not have a seawater storage tank on board to store whole crabs. As a result, landing claws avoids economic inefficiencies for this small fleet. Jonah crab is also landed as bycatch in non-trap gear, such as bottom otter trawls and gillnets, and non-lobster trap gears, such as whelk pots, crab pots, and fish pots.

In Virginia, the Jonah crab claw fishery was the dominant fishery in the early 2000s and 2010s, where 100% of the catch by weight was claws. In 2015, the claw fishery declined to 1% of the total state catch by weight and whole crab landings became dominant. Since then, claws have represented 0% of the catch by weight in Virginia. In recent years Virginia's fishery in general has decreased significantly, with only one active harvester. This harvester holds a Jonah Crab Incidental Commercial Permit with Virginia, and only harvests Jonah crab as bycatch in other directed fisheries.

4.3 Market Factors

Effort and landings of Jonah crab are driven by the combination of abundance of lobster, abundance of Jonah crab, and market availability. The markets for Jonah crab are volume driven so there may be a lower threshold of volume when markets are not accessible. Markets and price may also be locally driven, or dependent on whole crab versus claw only categories. Southern states are more likely to have claw fisheries so price and pound data should be interpreted with caution.

Price per pound trends by state for states landing whole crabs have generally increased over the time period of 2010-2021 (Table 5). Rhode Island and Massachusetts prices are higher overall and track together. These are also the locations of the highest volume and likely available and consistent markets. The highest prices were experienced in 2021. The price data from Maine should be used with caution because of the misidentification issues discussed in Section 4.2. Jonah crab are typically worth more than Atlantic rock crab. While the average price is lower in Maine, it does track the same trend as Massachusetts and Rhode Island, except in 2014, when it dipped slightly.

Unlike the American lobster, there is not a species recognition for Jonah crab in the seafood consumer markets. Jonah crab is often used as a crab option and can be substituted among multiple species like the Dungeness crab, snow crab, stone crab, or king crab. Markets can be driven by demand but also may depend on the availability and cost of other crab species.

5 FISHERY DEPENDENT DATA SOURCES

5.1 Commercial

5.1.1 Landings Data Collection and Treatment

5.1.1.1 Maine

A Lobster and Crab Fishing License is required to commercially harvest Jonah crab in Maine, and it has historically been a bycatch species of the lobster fishery. A permit endorsement is also available for the drag fishery, which allows a limit of 200 pounds per day and 500 pounds of Jonah crab per trip. Traps are subject to the lobster rules including maximum size, escape vents, and trap tags. There is a recent prohibition of claw harvest, except for a personal use exemption of a 5-gallon bucket maximum. While the market has always dictated a male-only fishery, the FMP provided the guidelines for regulations on size of greater than 4.75 inches.

Misidentification of Jonah crab creates challenges in the landings data because both *Cancer irroratus* (Atlantic rock crab) and *Cancer borealis* (Jonah crab) are harvested as bycatch and have an identical common name of “rock crab”. Historically, crab landings were reported on a monthly basis, but were not mandatory until 2004 and were not linked to state harvester identification numbers in the CFDERS database. In 2006, Maine shifted to using the Atlantic Coastal Cooperative Statistics Program’s (ACCSP) Standard Atlantic Fisheries Information System (SAFIS) and Maine’s MARVIN database for monthly mandatory reporting of landings with associated harvester identification numbers that add accountability. In 2008, the mandatory reporting was required on a trip and species level, yet there are still “crab unclassified” landings in recent years, albeit much reduced as compared to prior to 2008.

Both *Cancer* crab species were considered lower value species compared to lobster and were commonly sold for cash prior to reporting requirements; as such, landings prior to (and potentially after) 2008 should be considered an underestimate. Of the reported landings, ME DMR expects most reported volume and market demand has been for Jonah crab as opposed to Atlantic rock crab, so it is expected that historical and recent landings for Jonah crab should include the “crab unclassified” and “rock crab” landings. It may be possible to identify likely Jonah crab landings based on price (> $0.35/pound), but there is uncertainty on this threshold, especially earlier in the time series.

5.1.1.2 New Hampshire

New Hampshire lobster and crab harvesters have been reporting catch and effort from state waters since 1969 to the NH F&G. Beginning in 2006, all state licensed lobster and crab harvesters were required to report catch and effort. In 2016, with the adoption of the Jonah crab FMP, New Hampshire implemented mandatory Jonah crab harvest reporting on both monthly-summary and trip-level reports. While reporting of Jonah crab catch and effort was not mandatory prior to 2016, harvesters were provided the opportunity to report crab bycatch at the monthly level. Only commercial harvest by state lobster and crab license holders is included.

Historically, the quantity of lobsters and crabs landed in New Hampshire harvested from federal waters was derived from a combination of the NOAA Fisheries weigh out and canvas database and federal VTRs. Currently, NOAA Fisheries has mandatory reporting of harvest data for the majority of federally permitted vessels that land in New Hampshire through VTRs. Those not required to report to NOAA Fisheries are captured under NH F&G harvest reporting.

In cooperation with NOAA Fisheries, New Hampshire instituted mandatory lobster dealer reporting in 2005 and began collecting all data required under ACCSP standardized data submission standards. New Hampshire lobster dealers report transaction-level data on a monthly basis through use of paper logbooks or directly through electronic dealer reports (EDR). NOAA Fisheries mandated dealer reporting for lobster landings in 2010. Dealers report all species harvested and both state and federal dealers have been able to report Jonah crab since implementation. Jonah crab landings in New Hampshire have been reported by dealers since 1994.

In order to assign areas to the dealer report records and calculate effort estimates, VTRs and state logbooks are used to identify statistical areas and effort values as dealer reports do not contain area and effort data.

5.1.1.3 Massachusetts

Participation in the Massachusetts Jonah crab fishery has been limited to those that hold a commercial lobster/edible crab permit since 1948. Reporting of landings through Massachusetts trip level reports (MATLR) or NOAA Fisheries VTRs has been mandatory since 2010. On MATLR, fishermen are asked to report location of catch, gear type, amount of gear, soak time, number of trawls, and quantity landed.

Most Jonah crab landed in Massachusetts are caught in federal waters and reported on NOAA Fisheries VTRs. A small number of boats targeting Jonah crab are usually responsible for a large portion of the state Jonah crab landings, but there are numerous fishery participants targeting lobster that land smaller amounts of Jonah crab. Some inshore fishers will crate, or hold their catch, combining landings from multiple trips, until they reach a quantity that is deemed worth selling. Thus, dealer transactions may represent landings from multiple trips. Landings are generally in pounds, but occasionally bushels of crabs are reported. In these cases, a bushel to pounds conversion is made by multiplying the number of bushels by 65. The landing of anything other than whole crabs is prohibited. There is speculation that landings may have been under-reported prior to 2010, as Jonah crab was considered a low value species and some catch may have been sold for cash at the dock.

5.1.1.4 Rhode Island

Commercial landings in Rhode Island before 2003 are derived using NOAA Fisheries' data collection methods. Beginning in 2003, 100% electronic dealer reporting was implemented in Rhode Island through the Rhode Island Fisheries Information System, the predecessor of the SAFIS. It took a period of about three years to develop consistency in reporting among all dealers with the new trip-level system but from 2006 on, electronic dealer reports are believed to account for all Jonah crab landings. For the stock assessment, landings of Jonah crab and Atlantic rock crab were reviewed on a trip-by-trip basis, particularly for years prior to 2011, due to concerns about inconsistency in species identification. Using each vessel's full fishing history, fishing location, harvest weight, and in some cases direct consultation with harvesters, some of the landings reported as Atlantic rock crab were reassigned to Jonah crab. As a result, the time series of Atlantic rock crab landings was adjusted to be more stable over time, consistent with anecdotal reports of the Atlantic rock crab fishery's trajectory.

5.1.1.5 Connecticut

Landings are recorded in the NOAA Fisheries weigh out and general canvas database as landings at state ports. Connecticut also records landings by licensed commercial fishermen in any port (inside or outside Connecticut) by means of a mandatory logbook system that provides catch and effort information from 1979 to the present. This mandatory monthly logbook system provides detailed daily catch data by species, area, and gear as well as port landed, traps hauled, set over days, and hours trawled (for draggers). The logbook provides a means to look at fundamental changes in the operating characteristics of the lobster fishery within Long Island Sound. Since 1995, the program has required fishermen to report information on the sale and disposition of the catch, including the state or federal permit number of the dealer to whom they sold their catch. Seafood dealers are also required to report all of their individual purchases from commercial fishermen using either the NOAA form Purchases from Fishing Vessels, a Connecticut Seafood Dealer Report, Abbreviated Form for Lobster Transactions Only, or through the ACCSP's SAFIS. A quality assurance program has been established to verify the accuracy of reported statistics through law enforcement coverage and electronic crosschecking of harvester catch reports and seafood dealer reports.

5.1.1.6 New York

The commercial harvesting of Jonah crab requires a New York commercial crab permit. The crab permit has been limited entry since 6/29/1999. The limited entry stipulates that no new permits are issued, but a certain percentage of forfeited permits from the previous year are made available the following year. The limited entry permit resulted in an overall decrease in permits over time. Permit holders have until December 30th and may renew anytime during the calendar year.

New York's commercial fishery harvest data has been collected through state and federal VTRs since 2012 for food fish, lobster, and crab commercial permits. State VTR data is entered by staff into the New York Fishery Information on Sales and Harvest (NYFISH) database or entered directly by fishermen into the ACCSP's eTrips online database. New York landings reported through federal VTRs are entered by federal staff and shared with New York on a weekly basis in order to provide timely and accurate landings estimates. Landings data are reported by statistical area.

5.1.1.7 New Jersey

The commercial harvest of Jonah Crab within state waters of New Jersey does not occur, therefore data are not collected. New Jersey reported landings are obtained from NOAA Fisheries VTRs.

5.1.1.8 Delaware

The commercial harvest of Jonah Crab in Delaware requires either a Directed Jonah Crab Landing Permit issued to those who hold a valid Delaware Commercial Lobster Pot License or federal lobster permit, or an Incidental Jonah Crab Landing Permit issued by the Delaware Department of Natural Resources and Environmental Control. Delaware's commercial landings are collected through state logbooks. State logbook data are entered into a state-owned database and uploaded annually to the ACCSP data warehouse. Logbooks report daily catch and are required to be submitted on a monthly basis.

5.1.1.9 Maryland

Maryland is a *de minimis* state and all Jonah crab landings are caught in federal waters and reported on NOAA Fisheries VTRs and through SAFIS. There is no directed fishery of Jonah crab and landings are predominately claws. A small fleet of commercial fishing vessels targeting lobster harvest Jonah crab, predominately in LCMA 5, statistical area 626. In addition to the required federal lobster permit, the Maryland Limited Entry Cancer Crab License is required. The Maryland limited entry Jonah crab claw permit was eliminated by Addendum II (2017).

5.1.1.10 Virginia

Virginia data are collected via required monthly harvester reporting. The majority of landings are from a single harvester and all landings are confidential.

5.1.2 Biological Sampling Methods

5.1.2.1 NOAA Fisheries

Sea Sampling

The Northeast Fisheries Observer Program (NEFOP) has collected data from vessels engaged in the lobster fishery, including the associated Jonah crab fishery, as funding allows since 1991. Because there is no mandate under the Standardized Bycatch Reporting Methodology (SBRM) to monitor the federal lobster and Jonah crab fishery to support the management of these fisheries, the number of NEFOP sea days are allocated based on the needs to monitor bycatch of species included in SBRM, including groundfish. Thus, sampling intensity is inconsistent and varies across years. In recent years, NEFOP observer coverage peaked at 60 sea days in 2015 but coverage has since dropped to about 4 sea days per year. Data collected by NEFOP observers include CW (mm), sex, presence of eggs, kept and discarded catch weights, bycatch data (including finfish lengths and weights), gear and bait characteristics, haul locations, water depth, trip costs, and incidental takes.

Port Sampling

The NOAA Fisheries Greater Atlantic Regional Fisheries Office initiated a port sampling program for the targeted Jonah crab fishery in 2021. Annual sample requests are stratified by region, stock area, gear type, and calendar quarter and are allocated to focus on the regions where most of the Jonah crab fishery occurs and to be complementary to spatial coverage of port and sea sampling by state agencies. Port samplers select vessels for sampling based on current and historical landings data, real-time vessel tracking, and local knowledge of the fisheries. NOAA Fisheries anticipates collecting 74 port samples per year with a standard sample consisting of 40 individuals with CW measurements and gender recorded.

5.1.2.2 Commercial Fisheries Research Foundation

Sea Sampling

The Commercial Fisheries Research Foundation (CFRF) has conducted a fishery-dependent Jonah crab data collection project since 2014. The CFRF project has involved 25 vessels over the time series and offered coverage of inshore and offshore SNE, GB, and offshore GOM. Typically, three sampling sessions are conducted per month from fishermen's regular commercial catch. A sampling session consists of sampling catch from a trawl starting with the first trap hauled until 20 traps have been sampled or 50 crabs have been sampled, whichever comes first. For sampling the regular catch, fishermen decide which day(s) sampling sessions are conducted, but the trawl(s) sampled on those days is selected at random. Data collected include vessel ID, date, time, location, depth (feet), sex, CW (mm), egg-bearing status, shell hardness, and disposition (kept or discarded). Data are collected on Samsung tablets using CFRF's On Deck Data application and periodically uploaded to a database at CFRF where they are QA/QC'd and provided to ACCSP.

5.1.2.3 Maine

Sea Sampling

ME DMR does not have a formal Jonah crab sea sampling program as it has been considered a low value species as compared to lobster and is not a target species for the Maine fishery. ME DMR sampling program samples in both state and federal waters on Maine permitted boats. Some research trips were completed in 2003 and 2004 when the ME DMR was exploring experimental Jonah crab traps that would exclude lobsters yet catch Jonah crab. Those trips included subsampled biological data from both the experimental traps and standard commercial lobster traps. Since 2017, the Lobster Sea Sampling program includes an opportunistic protocol to collect Jonah crab data if they are harvested for commercial sale and the sampler has the capacity to do so. If crabs are sampled, the protocol includes collecting biological data including CW, sex, reproductive status, cull status, and shell hardness. In the future, a standardized subsampling protocol will be developed. ME DMR proposes only using data from trips with more than 20 crabs measured.

5.1.2.4 New Hampshire

Sea Sampling

Jonah crabs have been sampled by NH F&G as bycatch on lobster sea sampling trips since 2015. Samples are collected monthly from May through November at two different locations: the Isles of Shoals, and the coast (Portsmouth harbor to Massachusetts Border). Bycatch is sampled on all observed hauls (50% or more of the total hauls for the day). Data collected on Jonah crabs include sex, CW, shell condition, and cull status. Bycatch data are entered into an Access Database along with the coordinates of the trawl, number of set days, bait type, and water depth.

Port Sampling

NH F&G has conducted Jonah crab port sampling at local dealers on the New Hampshire coast since 2016. Initially, samples were collected from commercial lobster boats harvesting from several different statistical areas throughout the GOM and GB. More recently, due to a lack of fishing effort in some of the statistical areas farther offshore, samples have been obtained from dealers who purchase crabs from vessels fishing in statistical area 513, which includes both state and federal waters. Biological data (CW, sex, molt stage, shell disease, and cull status) are collected on the landed catch, and information is obtained from the dealer to determine total catch and effort where available.

5.1.2.5 Massachusetts

Sea Sampling

MA DMF does not have a formal Jonah crab sea sampling program because roughly 99% of Massachusetts landings come from federal waters, though some samples have been collected opportunistically. Jonah crab sea sampling data were collected during directed lobster trips in Cape Cod Bay (southern statistical area 514) from 2016 to 2018, and during a Jonah crab tagging project in statistical areas 537, 526, 525 from 2016 to 2017. Target species (lobster or Jonah crab) varied during the Jonah crab tagging project trips. Samplers recorded CW (mm), sex, cull status, mortalities, and presence of extruded eggs. The percent cover of shell disease (black spotting) was characterized starting in 2017. Catch was separated by trap. The start of each trawl was recorded using a handheld GPS.

Port Sampling

MA DMF began a Jonah crab port sampling program in the fall of 2013. Sampling intensity was low during 2013 (2 trips) and 2014 (4 trips). A minimum of 10 trips have been conducted annually since 2015. Starting in 2015, vessels and dealers with the most state landings were targeted for sampling. The vast majority of the sampled catch is from statistical areas 537 and 526. Statistical areas 525, 562, and 514 have been sampled with less regularity. A minimum of five crates or the entire catch, whichever is less, is sampled per trip. Data collected include: CW (mm), sex, and cull status. Shell disease and mortalities have been recorded since 2017.

5.1.2.6 Rhode Island

Sea Sampling

Rhode Island does not currently have a sea sampling program for Jonah crab as funds are not available for this purpose. In 2016 and 2017, 12 sea sampling trips did occur as part of a URI research project. These trips occurred in inshore statistical areas 539 and 537. Data collected include number of traps per trawl, soak time, bait, bottom type, depth, trap location (latitude/longitude), and trap configuration. From each sampled trawl, effort was made to sample all captured Jonah crabs—whenever this was not feasible, a systematic random sampling frame was used to census every second or third trap in a trawl. The following data were recorded for each sampled crab: CW, sex, ovigerous condition, shell disease level, molt condition, and number of claws missing.

Port Sampling

The RIDEM DMF initiated Jonah crab port sampling efforts in 2015; four trips were sampled during the initial year, before staffing and funding limitations placed this program on hold until 2019. Since the resumption of the program in late 2019, RIDEM DMF has strived to conduct ten port sampling trips for Jonah crabs per year. Most port samples have come from fishing trips taking place in offshore statistical areas 525 and 526. Port samplers reach out to captains and owners of offshore fishing vessels and coordinate with these parties to intercept a portion of their catch before it is offloaded to seafood transporters and dealers. At the trip level, samplers collect information from vessel captains on fishing area, bait, soak type, bottom type in fishing area, number of traps set, and average depth. Biological data are collected from a minimum of two totes of Jonah crab per port sample (about 200 crabs). Collected biological variables include CW, sex, shell disease level, molt condition, and cull status (number of claws missing).

5.1.2.7 New York

Sea Sampling

New York State Department of Environmental Conservation (NYDEC) sea sampling data are collected on cooperating commercial vessels in Long Island Sound (statistical area 611) and the Atlantic Ocean side of Long Island (statistical areas 612 and 613). However, Jonah crab were not included in the program until 2017, after the ASMFC Jonah crab FMP was adopted, and no Jonah crab have been sampled during the program. Much of the sea sample effort has been in statistical area 611, where few Jonah crab reside.

Port Sampling

A port sampling program began in 2005. The main objective of the program is to enhance the collection of biological data from lobsters harvested from LCMAs 3, 4 and 5. A communication network was developed with cooperating dealers and fishermen who fish these areas. This network is contacted to identify days and times of vessel landings to provide sampling opportunities. Utilizing this network of contacts allows for the sampling of lobster fishing trips landed in New York from the appropriate LCMAs. Sampling protocol adheres to the standards and procedures established in NOAA Fisheries Fishery Statistics Office Biological Sampling Manual. This program was expanded to collect data from LCMA 6 starting in 2013. Limited

Jonah crab sampling was conducted in 2014 and directed sampling was initiated in 2017. Jonah crab have only been sampled during market sampling.

5.1.2.8 Maryland

Sea Sampling

Maryland is a *de minimis* state and does not currently have a sea sampling program for Jonah crab, as funds are not available and there is no requirement to do so. However, state biologists have conducted sea sampling in previous years aboard federally permitted lobster fishing vessels in Ocean City, Maryland. Sampling occurred during calendar years 2015, 2016, 2018 and 2019 with 315 randomly selected Jonah crab caught in lobster pots from LCMA 5 (statistical area 626) sampled for CW and sex. Biologists attempt to randomly measure Jonah crab during lobster sea sampling with the goal of 100 crabs per multiday trip.

5.1.3 Trends

5.1.3.1 Commercial Landings

Coastwide dealer reported Jonah crab landings were queried from the ACCSP Data Warehouse and validated for accuracy with state partners. Additionally, landings reported as rock crabs or unclassified crabs in Maine were included due to the misidentification issues described in Section 5.1.1.1 and expectation that the majority of these landings are Jonah crabs. Stock-specific commercial landings across states were generated through a combination of applying proportions of harvest across statistical areas from harvester reports to dealer reported total landings, direct use of total harvest by statistical area from harvester reports and assigning statistical area to dealer reported landings based on port of landing. For landings from statistical areas other than 537 in RI and MA that overlap multiple stocks, landings were assigned to a stock based on expected areas fished and these assignments are in Table 6. For landings from statistical area 537 in RI and MA where the majority of Jonah crabs are harvested, landings were split between ISNE and OSNE stocks using permit LCMA data from harvester reports. Small proportions of remaining landings without statistical area information could not be assigned to a stock. These landings and proportions of the coastwide totals they make up in each year are in Table 7. Proportions range from 0.0002 to 0.0329 and average 0.0108 across years.

The start year for reliable landings identified in ASMFC 2021 was 2006. However, spatial landings are not available from the primary landing state, MA, until 2010, limiting the start of the time series for stock-specific landings to this year. The vast majority of landings have come from the OSNE stock (Table 7 and Figure 43), averaging just short of 13 million pounds over the time series, followed by the IGOM stock (averaging 2.5 million pounds), the ISNE stock (averaging 460 thousand pounds), and the OGOM stock (averaging 317 thousand pounds). Landings from SNE stocks show similar trends increasing at the beginning of the time series and declining briefly in the mid-2010s, before increasing to time series highs in the later 2010s. Landings then decline sharply in 2019. Landings inshore increase during the following two years at the end of the time series, while landings offshore continue declining to their lowest point of the time series in 2021. The two largest and distinct peaks offshore occur in 2014 and 2018, while two of largest peaks inshore, also relatively distinct, occur a year earlier than seen offshore in 2013 and 2017. Trends in GOM stocks differ both between stocks and from trends in SNE stocks. Landings inshore decline sharply at the beginning of the time series to their lowest levels in the early to mid-2010s. Landings then increase sharply to their time series highs in the later 2010s and are highly variable over the last three years of the time series. Landings offshore are variable around their highest levels in the early 2010s, then decline through the late 2010s before a slight uptick in the last two years of the time series. The peak landings offshore occur during the same year as the first peak in the OSNE stock (2014), while the peak landings inshore occur during the same year as the second peak in the OSNE stock (2018).

Seasonally, landings from the IGOM stock have shifted from being concentrated in quarter two and three to being more evenly distributed across quarters since 2016 (Figure 44). Jonah crabs from the OSNE stock have primarily been landed in quarters one and four with slightly smaller proportions in quarters two and three (Figure 45). Seasonality of landings has been more variable for the two stocks with lower landings (OGOM and ISNE), but have occurred primarily during waves one and two in the OGOM stock (Figure 46) and waves three and four in the ISNE stock (Figure 47) across the time series.

The vast majority of landings (>90%) across stocks come from pot and trap gears.

5.1.3.2 Commercial Biosampling

Commercial biosample data were compiled from all sources. Sea sampling is useful to characterize the biological attributes of the total Jonah crab catch including discarded Jonah crabs. Port or market sampling is useful to characterize the biological attributes of the landed Jonah crab catch. Biosample data through 2019 were summarized in ASMFC 2021 for some background information and are updated through 2021 and split into stock units here. The number of sea and port sampling trips conducted by year, stock, and statistical area are in Table 8 and Table 9, respectively.

Annual summary statistics, including mean size of males in the overall catch and mean size of the largest 5% males in the overall catch, were calculated from sea sampling data as measures of size structure change and potential indicators of mortality changes. Mean size of the largest 5% males was initially compared to 90% of an unpublished von Bertalanffy L_{inf} estimate (Mid-Coast, Maine males gastric mill band count analysis estimate; C. Huntsberger, personal communication, October 11, 2022) as a potential reference point, as was done by Marcussen 2022. However, there are no estimates for SNE Jonah crabs and the estimate used here appears larger than would be expected given maximum sizes of Jonah crabs observed throughout time. Therefore, only trend information was ultimately considered for these data and not the 90% of L_{inf} reference point.

Summary statistics were calculated as weighted averages across trips, weighted by the number of crabs sampled during each trip. Trips with <29 crabs sampled were excluded and strata (Stock+Statistical Area+Year+Quarter) with <2 sampling trips were excluded from the data set.

There were no strata with five years of port sampling data, so these data were not included in the analysis. Data were too sparse to calculate landings-weighted stockwide statistics, even across quarters (Figure 48), so time series by stock and statistical area were evaluated for trends. A Mann-Kendall test, which is nonparametric test for monotonic (i.e., one-way) trends, was applied to data sets to evaluate for trends. Test results with a p-value <0.05 were considered detected trends. For pragmatic reasons, time series with at least five data points were tested and the maximum time series length across data sets was eight years. Tests of these short time series should be considered with caution.

Overall, trends in mean size statistics are stable over the relatively short time series (Table 10-Table 11 and Figure 49-Figure 55). Only one significant trend was detected across data sets, an increasing trend for the ISNE stock in statistical area 539 during quarter four. Note that there were no strata with five data points for the IGOM stock. Mean sizes are typically larger for the offshore stocks. The mean sizes of the 5% largest males are well below the 90% of L_{inf} estimate in all stocks and years, highlighting concerns about the reliability of this estimate as an appropriate reference point.

General lack of trend seen here could be a favorable indication of stock condition or it could indicate that these data are unreliable indicators of stock condition, as appeared to be the case in Pezzack et al. 2009. These data should be revisited as potential indicators in future stock assessments when longer time series are available and, ideally, there is sufficient coverage to generate landings-weighted stockwide time series but are not recommended at this time for stock indicators.

5.1.4 Catch Rates

5.1.4.1 CFRF VTS

In addition to regular commercial trap (i.e., vented) sampling, CFRF provides each vessel with up to three ventless traps to use during the course of the Lobster and Jonah Crab Research Fleet project. To maintain general consistency with most configuration specifications of other ventless trap sampling programs in Rhode Island, Massachusetts, New Hampshire, and Maine, the fleet deploys ventless traps with the following configurations: 40” length x 21” width x 14” height, single parlor, 1” square rubber-coated 12-guage wire, standard mesh netting, cement runners, and a 4” x 6” disabling door. One ventless trap is typically deployed at a fixed temperature monitoring station while the others may be deployed as the lobstermen see fit. Lobstermen also decide to record a session at their discretion and can decide not to record a session after hauling the traps (e.g., poor weather conditions). Ventless trap sampling is not associated with commercial trap sampling, and thus is recorded in a different sampling session. However, harvesters can and do attach the ventless traps to strings of their commercial gear if they choose. CFRF encourages fishing vessels to record at least one ventless Jonah crab sampling session per month at the bottom temperature monitoring site.

This sampling is intended to provide information on presence of sublegal lobsters and crabs and some temperature information. It is not designed to measure size structure of the retained crabs for harvest or abundance. However, given the data limitations faced during the assessment and because this is the only non-trawl sampling of catch rates in the core area of the fishery, CPUE time series were calculated from these data to evaluate as potential measures of abundance.

Data were standardized with negative binomial generalized additive models (GAMs) using catch of male exploitable sized crabs (121+mm CW) per session as the response. Catch is not recorded to the trap level, but rather collectively at the session level. However, only 19 of 658 sessions fished more than one trap and these sessions were excluded so the response was effectively catch per trap. Factors considered in the models for both the ISNE and OSNE stocks included year, month, depth, and soak time. Additionally, statistical area was considered for the ISNE stock, but not the OSNE stock because some less-sampled areas were only sampled in one year leading to multicollinearity between area and year. Both depth and soak time were modeled with smoothers. Model selection was performed with stepwise Akaike's information criterion (AIC) and the model with the lowest AIC was identified as the final model for standardizing CPUE.

Number of sampling sessions and number of crabs sampled are in Table 12. There were only two sampling sessions for the OSNE stock in 2021, so these data were excluded from the data set. For the ISNE stock, the model with year, month, SA, depth, and soak time was identified as the final model. For the OSNE stock, the model with year, month, and depth was identified as the final model. The CPUE trends were similar between stocks, increasing in the first few years of the time series and decreasing in the latter half of the time series (Figure 56). The CPUE inshore increases slightly in 2021 and is not available offshore. Catch rates offshore are about double the catch rates inshore and the rate of change offshore is also greater during the time series.

5.1.4.2 Direct Residual Mixture Model CPUE

5.1.4.3

Fishery-dependent data can be used for deriving indices of abundance for exploited marine species when the catch per unit of effort can be interpreted as an indicator of relative population abundance. However, CPUE is influenced by numerous environmental and temporal variables, which can preclude straightforward interpretation of fishery-dependent data. Standardization techniques for catch and effort data can be used to remove the impact of these other factors on CPUE, allowing fishery-dependent data to be used in deriving an index of abundance (Maunder and Punt 2004). These methods generally comprise model-based approaches, including generalized linear models (GLMs) and GAMs.

Beyond environmental and temporal variables, fishing behavior influences catch rates of exploited species and is therefore impactful to interpretations of CPUE data for abundance indices. In mixed-species fisheries, incorporating fishing behavior into standardization procedures is particularly challenging, as it requires accounting for the fisher's target species, since fishing techniques typically vary among target species and thus impact multispecies catch rates (Stephens and MacCall 2004; Okamura et al. 2018). Several methods have been developed for standardizing catch data in mixed-species fishery to produce indices of abundance. Most commonly, these have involved applying an absolute or proportional landings threshold to identify and subset to trips targeting the species of interest (Biseau 1998; Stephens and MacCall 2004). However, such subsetting methods have been criticized because they lose information and do not allow for comparison of CPUE models before and after subsetting (Okamura et al. 2018). A recently-developed method for CPUE standardization in mixed-species fisheries, called directed residual mixture models (DRMs), allows for use of a full mixed-species fishery dataset without subsetting (Okamura et al. 2018). Here, DRMs were used to standardize Jonah crab CPUE in the Rhode Island mixed species lobster and Jonah crab fishery in inshore and offshore SNE.

The DRM includes variables related to fishing tactics (including targeted species), as well as variables that do not relate to fishing tactics. In model equation form, the DRM can be written:

$$\log\left(CPUE_{s,i}\right) = X_{s,i}^{T}\alpha_s + Z_{s,i}^{T}\beta_s + \varepsilon_{s,i}$$

where in the i^{th} fishing operation for species *s*, $X_{s,I}$ is a vector of variables excluding the variable related to fishing tactics (target species) and its interactions and $Z_{s,I}$ denotes a vector of variables that includes the variable related to fishing tactics and its interactions. The first element of $X_{s,I}$ corresponds to the intercept, and α_s and β_s are the regression parameter vectors for $X_{s,I}$ and $Z_{s,I}$, respectively. The last term, $\varepsilon_{s,I}$ denotes independently and identically distributed random variables. Because the variable related to fishing tactics is not observed, the model that is fitted to the data is:

$$\log\left(CPUE_{s,i}\right) = X_{s,i}^{T}\alpha_s + v_{s,i}$$

where $v_{s,I} \sim N(0, \eta^2)$. The residual $\hat{v}_{s,i}$ = log(CPUE$_{s,i}$) - $X_{s,i}^{T}\hat{\alpha}_s \approx Z_{s,i}^{T}\hat{\beta}_{s,i} + \hat{\varepsilon}_{s,i}$, where $\hat{\alpha}_s$ is the maximum likelihood estimator for α_s and contains information on the variable related to fishing tactics. Essentially, if $\hat{v}_{s,i}$ is large when species *s* is targeted, indicating a high fishing efficiency for species *s* in fishing operation *i,* then the exponentiated $\hat{v}_{s,i}$ divided by the sum of exponentiated residuals for all species, should be large. This transformed residual is written as:

$$\hat{p}_{s,i} = \frac{\exp\left(\hat{v}_{s,i}\right)}{\sum_{u=1}^{S}\exp\left(\hat{v}_{s,i}\right)}$$

It is assumed that the logit transformation of $\widehat{p}_{s,i}$ (($\hat{z}_{s,i} = logit(\hat{p}_{s,i}) = \log[\hat{p}_{s,i}/(1 - \hat{p}_{s,i})]$) has a normal mixture model of linear regressions with *K* components:

$$f(\hat{z}_{s,i}) = \sum_k \pi_k \Phi(\hat{z}_{s,i}: u_{k,i}, \sigma_k^2)$$

where $\Phi(\hat{z}_{s,i}: u_{k,i}, \sigma_k^2)$ is normally distributed and $\{\pi_k\}$ are the missing proportions, with $\sum_k \pi_k = 1$. The parameter $\mu_{k,i} = M_{k.i}^T \omega_k$ is the expectation given the fishing tactics k, $M_{k,i}$ is a vector of explanatory variables for which the first element is 1 and the rest are related to observed variables, ω_k is the regression coefficient, and σ_k is the standard deviation of the normal distribution for fishing tactics *k.* The parameters are estimated by the expectation-maximization (EM) algorithm, producing a variable that indicates whether the individual trip was targeted or bycatch, based on the posterior probability of belonging in components of the mixture. This variable, called the "target variable" is categorical and assigns the target species for the trip.

Once the target variable has been assigned using the EM algorithm, a GLM can be fitted to the CPUE data of species s (in this case, Jonah crab), with the target variable included as a covariate. Extraction of the year effect from this GLM gives the standardized CPUE index.

Jonah crab DRM model fitting and selection

The Jonah crab DRM was fitted in R using the 'mgcv' package and the EM algorithm code from Okamura et al. (2018). Month, year, and stock region were explored as covariates for derivation of transformed residuals and for the final GLM model. Candidate models were compared using AIC and diagnostic plots (Figure 58).

Trip-level Jonah crab and lobster landings data from Rhode Island for all trips landing Jonah crab from 2007 through 2021 were queried from Rhode Island state harvester logbooks, eTrips data, and federal VTRs. Data were subsetted to the inshore and offshore SNE stock regions and to trips fishing with pot/trap gear. Data were also subsetted to trips landing more than 250 pounds of Jonah crab, as initial data analysis and model exploration indicated that inclusion of trips landing few Jonah crab had an impact on model target species assignment and model estimates. Since trips landing so few Jonah crab could be interpreted not to be targeting Jonah crab, even as a secondary target, and the catch could be highly impacted by factors unrelated to catch rates (e.g., retaining versus discarding low catch due to market factors), these trips were not included in the CPUE standardization process.

The model to derive transformed residuals for the Jonah crab fishery incorporated year and stock covariates as factors predicting log-transformed Jonah crab and lobster landings. Target species as assigned by the EM algorithm was included in the final GLM fitting process. The selected GLM for CPUE was:

```
mod<- glm(log(Jonah)~as.factor(Year)*Stock+TargetSpecies*Stock+as.factor(Month)*Stock)
```

Stock was incorporated as an interactive term with year, target species, and month (Table 14). The interaction with year was included to allow for examination of CPUE trends in the inshore and offshore stock individually. The stock interactions with target species and month align with fishery characteristics since the Jonah crab fishery has distinct inshore and offshore components with different behaviors in terms of fishing seasonality and with regard to targeting behavior (Truesdale et al. 2019).

The stock trajectories for inshore and offshore SNE Jonah crab differ in terms of scale and trend (Table 13 and Figure 57). The offshore stock appears relatively stable over the period of interest without a significant trend. For the inshore stock, there appears to be a period of higher CPUE at the beginning of the time series, with a lower CPUE period beginning around 2014.

5.1.4.4 Reference Fleet CPUE

We used commercial catch-per-trap from LCMA 3 to investigate whether there were any relationships between catch rates from a fishery-dependent “reference fleet” and fishery-independent trawl surveys throughout the GOM/GB. Only vessels landing >199lbs in a statistical area were included in this analysis, and we assessed the years 2004 through 2021 due to limitations in mining data further back than 2004. The reference fleet CPUE correlated with the ME/NH trawl survey catch for both fall males 120mm+ (see Section 6.2 for description of survey and selected size structure, Spearman’s r=0.53, P=0.0232) and spring males 120mm+ (Spearman’s r=0.49, P=0.0458), note Spearman’s was used due to skewed distributions with data. NEFSC trawl survey only showed correlation with a two year lag (Spearman’s r=0.5118 and P=0.427) fall trawl 120mm+ males. The correlation in the reference fleet and ME/NH trawl survey suggests some relationship between what was caught in trawl and traps within a year, though the NEFSC trawl takes place within the same region and there was only a correlation with a two year lag. This lag between the trawl survey and commercial catch in this region could be due to the gear selectivity of commercial harvesters and larger size of crabs being landed offshore compared to inshore, although our uncertainty around growth, catchability and incentives for harvesters to retain Jonah crabs is confounding. Nonetheless, we found general agreement between the reference fleet and trawl surveys within the GOM suggesting some spatial and temporal coherence in abundance trends between fishery-dependent and fishery-independent indices.

5.1.5 Commercial Discards/Bycatch

Although the taking of whole crabs is the current harvest practice in most areas of the Jonah crab fishery, claw-only harvesting is also practiced in other areas (e.g,. mid-Atlantic states; Seafood Watch 2014), where harvesters remove both claws from a single Jonah crab (ASMFC, 2015, ASMFC 2019) and then release it at-sea. Although at present, this harvest practice comprises only a small proportion of the overall commercial fishery effort (~ 1 %; ASMFC, 2015), given the potential expansion and growth of this fishery to other areas, it is plausible that a claw-based fishery could become more widespread. Historically, other crab fisheries utilize claw removal prior to releasing animals back to the sea with the assumption that declawed crabs will survive and continue their cycle of molting and regenerating new claws to again be harvested. This practice includes the highly valued stone crab (*Menippe mercenaria;* Duermit et al. 2015; Gandy et al. 2016; Kronstadt et al. 2018; Orrell et al. 2019), northeast Atlantic deep-water red crab (*Chaceon affinis*; Robinson 2008), European brown or edible crab (*Cancer pagurus*; Fahy et al. 2004), and fiddler crab (*Uca tangeri*; Oliveira et al. 2000). Until recently the mortality and sublethal effects of declawing Jonah crabs was unknown but recent work has helped to evaluate the impacts of declawing on harvestable Jonah crabs along with assessing the sublethal effects (e.g., mating, activity, stress, movement) on overall health and function as well (Goldstein and Carloni 2021, Dorrance et al. 2022). Goldstein and Carloni (2021) found markedly higher mortality in Jonah crabs when removing both claws (70%), compared to a single claw (51%), and mortality was significantly correlated with wound size, temperature, and shell condition. Furthermore, they found using a mechanical tool to declaw crabs where crabs would naturally autotomize reduces mortality by over 50%.

In a follow-up study Dorrance et al. (2022) investigated the sublethal effects declawing had on mating, locomotion and feeding ability. First, mating trials revealed that males with both claws removed could successfully mate with recently molted females. Second, through laboratory-based trials, crabs with claws removed were significantly less active compared to control crabs where both claws were intact; this was corroborated by a passive tagging study where declawed crabs moved about half the distance of control crabs. Additionally, declawed crabs were still able to feed, however they were unable to effectively open mussels which may influence their diet in their natural habitat. These data along with Goldstein and Carloni (2021) suggest that those Jonah crabs that do survive the claw removal process might be impaired, but should be able to forage, mate, and potentially help sustain the population.

6 FISHERY INDEPENDENT DATA SOURCES

6.1 Settlement/YOY Surveys

Settlement indices of abundance are provided for Jonah crabs <13mm CW. This size cut-off corresponds closely with size cut-offs identified by Huntsberger 2019 for YOY crabs (10mm CW). Preliminary correlation analyses applied to lagged age-specific settlement indices for ages 0-2 based on cut-offs from Huntsberger 2019 (<10mm CW for age-0, 10-19.9mm CW for age-1, and 20-40mm CW for age-2) failed to detect strong support of cohort tracking within surveys (Figure 59 and Figure 60). These analyses were likely impacted by small sample sizes but may also be indication of growth uncertainty and overlap with age. The YOY indices represent the smallest sizes that may be less affected by overlap in size-at-age and presumably would be the least mobile age class, therefore providing the best measure of year class strength.

Five settlement indices were identified as providing most utility for the assessment. These included ME settlement surveys from three statistical areas in ME waters (statistical area 511, 512, 513), the NH settlement survey (SA 513), and the MA settlement survey (SA 514). All surveys are in IGOM waters.

6.1.1 ME DMR Settlement Surveys

The ME DMR settlement survey primarily was designed to quantify lobster YOY but has also collected Jonah crab data from the sites throughout the time series. The survey was started in 1989 in a smaller regional area close to Boothbay Harbor within statistical area 513E but was expanded to statistical areas 513 W, 512, and 511 in 2000. Therefore, some indices include separate trends for areas in 513 due to the differing time series. The Maine survey currently monitors 40 sites coastwide within 1-10m in depth. The timing of this survey has shifted over time due to dive staff availability to complete the work, but it has generally occurred between September and December annually. Jonah crab information collected includes CW and location. Notations are made if small crabs carry eggs.

6.1.2 NH F&G Settlement Survey

NH F&G has participated in the American Lobster Settlement Index (ALSI) since 2008, and biological information has been collected on Jonah crabs since 2009. New Hampshire follows the standardized coastwide procedures and monitors three sites along the NH Coast.

6.1.3 MA DMF Settlement Survey

Massachusetts has conducted a juvenile lobster settlement survey since 1995. The survey begins in mid to early August, and generally runs through late September. The survey started with nine fixed stations in three regions and by 2018, had grown to include 23 fixed stations in seven different regions. The survey extent contracted in 2019 to 14 sites in five regions. The Vineyard Sound region and two of the Buzzards Bay sites were discontinued because juvenile lobsters are rarely encountered in these areas. The Cape Cod region and some South Shore stations were discontinued due to the increasing presence of white sharks at survey sites during the survey time-period.

The survey is conducted at fixed stations by a team of divers. Divers selectively place 0.5 m^2 quadrats over areas of cobble. Twelve quadrats are sampled per station, which are then immediately sorted on the boat.

Jonah crabs have been consistently identified to species in the survey since 2011. Though the survey has not always identified crabs to species, it has consistently identified *Cancer* crabs to genus over the entire time series. Jonah crabs are counted, measured (CW in mm) and sexed when possible. Crabs less than 5 mm are generally too small to sex or identify to species.

6.1.4 Other Settlement Surveys Considered

Three additional surveys were considered, but not recommended for use at this time (Table 15). These included the RI settlement survey, University of Maine Deepwater Collector survey, and Normandeau Plankton Survey. The RI settlement survey occurs in ISNE waters, but infrequently encounters Jonah crab. The University of Maine Deepwater Collector Survey, which uses collector boxes to sample across a range of depths, was useful for the assessment in that it indicates trends are tracked from shallow to deep waters (Figure 61), improving confidence that accepted settlement surveys, all occurring in shallower waters, are accurately reflecting overall settlement trends. However, settlement indices from this survey do not correlate well with the accepted state surveys which use suction sampling and may provide biased measures of interannual settlement due to the attractive nature of collectors placed in otherwise less ideal habitat. The Normandeau Plankton Survey offers a long time series in IGOM waters but does not record *Cancer* crab species to the species level.

6.2 Post-Settlement Surveys

Three post-settlement abundance metrics were identified based on biology and exploitation of Jonah crab. These metrics are intended to improve interpretation of abundance indices by filtering aggregate indices that encounter intermittent catches of small crabs, behind which the mechanisms of catchability are not well understood (e.g., catch through the trawl mesh as the bag comes into contact with the ground). Because catch rates of larger, older Jonah crabs are also low, these intermittent catches can lead to noise that has considerable impact on the abundance signal and its interpretation. Post-settlement abundance metrics include recruit abundance, exploitable abundance, and spawning abundance. Recruit abundance is defined as male Jonah crabs 90-119 mm CW. Male Jonah crabs 95mm CW are expected to grow to legal size after their next molt, on average, according to the regression equation from Truesdale et al. 2019a (PostMoltCW=1.22*PreMoltCW+5.47; expected PostMoltCW for PreMoltCW of 95mm is 121.37mm). Trawl surveys have historically measured Jonah crabs to the nearest cm, so the recruit size class was structured to include the cm bins capturing 95mm CW crabs up to the largest fully sublegal cm size bin (11cm; current minimum size is 4.75 inches or 120.65mm). Exploitable abundance includes all male Jonah crabs greater than these recruit sizes (120mm+ CW) and is a measure of abundance currently available to the fisheries. Spawning abundance is defined as female Jonah crabs 80mm+ CW. The spawning abundance size structure includes the smallest cm size bin associated with recent SM50 estimates along the coast (Table 1).

Three survey platforms were identified as providing most utility for abundance indices based on broad spatial footprints that overlap with Jonah crab habitat, long time series that cover the period of available stock-specific landings, availability of biological data that allow for filtering to the post-settlement abundance metrics, and similarities in trends measured in the respective stock. These platforms included the MA Trawl Survey covering the IGOM stock, the ME/NH Trawl Survey covering the IGOM stock, and the NEFSC Trawl Survey covering all four stocks (although, later determined to not be of utility for the ISNE stock – see Section 7). All three platforms have separate surveys in the spring and fall.

6.2.1 NEFSC Trawl Survey

The NEFSC bottom trawl survey began collecting Jonah crab data in 1979. The spring survey is generally conducted from March to May and the fall survey is generally conducted in September and October.

The NEFSC bottom trawl survey utilizes a stratified random sampling design that provides estimates of sampling error or variance. The study area, which now extends from the Scotian Shelf to Cape Hatteras including the GOM and GB, is stratified by depth (Figure 7). The stratum depth limits are < 9 m, 9-18 m, >18-27 m, >27-55 m, >55-110 m, >110-185 m, and >185-365 m. Stations are randomly selected within strata with the number of stations in the stratum being proportional to stratum area. The total survey area is 2,232,392 km^2. Approximately 320 hauls are made per survey, equivalent to one station roughly every 885 km^2.

Most survey cruises prior to 2008 were conducted using the NOAA ship R/V Albatross IV, a 57 m long stern trawler. However, some cruises were made on the 47 m stern trawler NOAA ship R/V Delaware II. On most spring and fall survey cruises, a standard, roller rigged #36 Yankee otter trawl was used. The standardized #36 Yankee trawls are rigged for hard-bottom with wire foot rope and 0.5 m roller gear. All trawls were lined with a 1.25 cm stretched mesh liner. BMV oval doors were used on all surveys until 1985 when a change to polyvalent doors was made (catch rates are adjusted for this change). Trawl hauls are made for 30 minutes at a vessel speed of 3.5 knots measured relative to the bottom (as opposed to measured through the water).

Beginning in 2009, the spring and fall trawl surveys were conducted from the NOAA ship R/V Henry B. Bigelow; a new, 63 m long research vessel. The standard Bigelow survey bottom trawl is a 3-bridle, 4-seam trawl rigged with a rockhopper sweep. This trawl utilizes 37 m long bridles and 2.2 m^2, 550 kg Poly-Ice Oval trawl doors. The cod-end is lined with a 2.54 cm stretched mesh liner. The rockhopper discs are 40.64 cm diameter in the center section and 35.56 cm in each wing section. Standard trawl hauls are made for 20 minutes on-bottom duration at a vessel speed over ground of 3.0 kts. Paired tow calibration studies were carried out during 2008 to allow for calibration between the R/V Bigelow and R/V Albatross IV and their net types. However, calibrations have not been estimated for Jonah crab. Thus, it is appropriate to treat this survey as separate time series since 2009 until a calibration can be produced.

6.2.2 Maine/New Hampshire Trawl Survey

The ME/NH Inshore Trawl Survey began in 2000 to fill a significant information gap in resource assessment surveys on approximately two-thirds of the inshore portion of the GOM. The survey is conducted in collaboration with NH F&G and its industry partner, Robert Michael, Inc. Conducted biannually, spring and fall, the survey operates on a random stratified sampling design. A goal of 120 survey stations are sampled in 20 strata that are distributed over four depths: 5-20 fathoms, 21-35 fathoms, 36-55 fathoms, and >56 fathoms roughly bounded by the 12-mile limit in five longitudinal regions (Figure 62). The survey samples a portion of 3 statistical areas, 513, 512, and 511. Jonah crab biological data were not fully collected until 2004.

6.2.3 MA DMF Resource Assessment Program Trawl Survey

Since 1978, the MA DMF Resource Assessment Program has conducted an annual spring (May) and fall (September) bottom trawl survey within state territorial waters. The survey obtains fishery-independent data on the distribution, relative abundance and size composition of finfish and select invertebrates, including Jonah crab. A random stratified sampling design is used to select stations from five bio-geographic regions and six depth zones (Figure 63). Stations are selected before each survey and drawn proportional to the area each stratum occupies within the survey area. A minimum of two stations are drawn per stratum. Stations chosen in un-towable locations are redrawn.

The F/V Frances Elizabeth conducted all surveys through fall 1981. All subsequent surveys have been conducted onboard the NOAA ship R/V Gloria Michelle. A 3/4 size North Atlantic type two seam otter trawl (11.9 m headrope/15.5 m footrope) with a 7.6 cm rubber disc sweep; 19.2 m, 9.5 mm chain bottom legs; 18.3 m, 9.5 mm wire top legs; and 1.8 x 1.0 m, and 147 kg wooden trawl doors have been used for the duration of the survey. A 6.4 mm knotless liner is used in the codend to retain small organisms. Standard tows are 20 minutes but tows of at least 13 minutes are accepted as valid and expanded to the 20 minute standard. Tows are conducted during daylight hours at a tow speed of 2.5 kts. More information on the MA DMF trawl survey can be found by visiting https://www.mass.gov/files/documents/2016/08/tm/tr-38.pdf.

Jonah crabs have been weighed collectively for each tow to the nearest 0.1 kg since 1978, and by sex since 1981. From 1978 through 2009, Jonah crab CW measurements were taken on a wooden measuring board and recorded to the nearest cm on paper logs. Starting during the 2010 spring survey, crabs were measured on electronic length boards and recorded directly in to Fisheries Scientific Computer System (FSCS) data tables. Since the fall 2014 survey, Jonah crab measurements have been recorded with digital calipers to the nearest cm and recorded directly into FSCS. The change to digital calipers was made to improve measurement accuracy, as crab legs sometimes made it difficult to measure crabs on a length board. Female crabs have been inspected for extruded eggs since the fall 2014 survey, but observations of egg bearing crabs are very rare.

Jonah crab are infrequently encountered in SNE (survey regions 1 and 2; Figure 63), so indices of abundance are only calculated for GOM strata (survey region 3-5).

6.2.4 Other Post-Settlement Surveys Considered

Several additional fishery-independent surveys that have encountered Jonah crab were considered during this assessment (Table 16). These surveys were generally more limited in the information provided, reducing their utility for the assessment. Primary limitations of these data sets included poor spatial coverage, short or discontinuous time series, relatively inefficient catchability or low catch rates, and/or lack of biological data. Most of these data sets were identified as having low utility in ASMFC 2021, including several using ventless trap gears. Ventless trap gear catchability issues impacting this gear's ability to reliably track Jonah crab abundance is further evaluated and described in Section 6.2.5.2.

There was uncertainty in the utility of the NJ Trawl survey in ASMFC 2021 and there was a new survey not considered in ASMFC 2021 but subsequently identified as a survey with relatively high encounters of Jonah crab, the Northern Shrimp Trawl Survey. These surveys were evaluated with preliminary correlation analysis to examine consistency of trends with the other trawl surveys. The NJ Trawl survey has both spring and fall surveys, while the Northern Shrimp Trawl survey has a summer survey only. Both surveys have collected limited biological data, so sex- and size-aggregate abundance indices were used in the correlation analysis. Additionally, it's important to note that there was a gear change for the Northern Shrimp Trawl survey in 2017 and gear change calibration factors are not available, so indices of abundance have not been adjusted for this gear change.

The NJ Trawl index was not correlated with the NEFSC Trawl index which has better spatial overlap with the fishery (Figure 64). This lack of correlation along with the lack of sex data until 2021 limit the utility of this survey and indices were not included in further analyses. The Northern Shrimp Survey was positively correlated with the NEFSC Trawl indices among seasons and spatial domains of indices (IGOM, OGOM and combined GOM areas; Figure 65). These results indicate that trawl surveys are tracking a consistent signal in the GOM. Unfortunately, length data has not been collected during the Northern Shrimp Trawl survey to allow calculation of the Jonah crab abundance metrics and should be prioritized given these correlation results so this survey provides more utility in future stock assessments.

6.2.5 Catchability Analyses

6.2.5.1 Temperature in Trawl Surveys

Given rapidly changing environmental conditions within the Jonah crab range and effects on catchability observed in cohabitating species like lobster (ASMFC 2020), Jonah crab catch rates and temperature time series were evaluated to identify potential temperature-driven catchability effects that may explain noise observed in indices of abundance and provide a better understanding of catchability effects. Because temperature can affect both abundance and survey catchability simultaneously, annual anomalies in catch rate and temperature from underlying trends were evaluated for relationships.

Seasonal catch rates of exploitable Jonah crabs (Figure 6) and temperature time series (Figure 66) from the NEFSC Trawl Survey were generated from adjacent statistical areas associated with high and low commercial landings. There was a period of anomalously low temperatures in the 1980s through 1990 that are not consistent with the underlying trend in other years, so data prior to 1991 were excluded from the analysis. There was a clear linear trend in temperature that was estimated with linear regression and used to calculate residuals as temperature anomalies in the analysis (Figure 67). Identifying the underlying trend in catch rates was more difficult, so two potential trends were included. The first trend was a two-year running average and the second trend was predicted with a LOESS smoother. The span was set at 0.33 to be consistent with the methodology used for the Plan B index-based method applied to Jonah crab index and landings time series (Appendix 14.1). As with the temperature time series, residuals were used as anomalies in catch rates for the analysis (Figure 68 and Figure 69). There was some change in magnitude in residuals, so Spearman's rank correlation was used in the analysis to better handle potential outliers in the relationship.

No significant correlations were detected with a Spearman's rho $\geq \pm 0.5$ in the eight data sets tested (Table 17 and Table 18, Figure 70 and Figure 71). The data for the low catch areas in the spring had a p-value<0.05, but the Spearman's rho indicated only a weak positive association while no other data sets indicated a clear relationship between temperature and catch rate anomalies. These results do not support seasonal temperature being a primary driver of Jonah crab catchability in trawl surveys.

6.2.5.2 Assessing utility of ventless trap surveys for providing Jonah crab abundance indices

The Coastwide Ventless Trap Survey (VTS) was initiated in 2006 from Maine through New York. The impetus for this survey was to track the abundance of juvenile lobster populations, particularly in areas where trawl surveys are not able to tow due to complexity of habitat (ASMFC 2006). Early in the time series, data on bycatch species were not collected on a consistent basis throughout the survey area, and although Jonah crab are now being enumerated for all cooperating organizations, questions remain as to the utility of these surveys for tracking abundance of Jonah crabs. Studies on the interactions between lobsters and Jonah crabs reveal that lobsters are both competitive dominants (Richards et al. 1983, Richards and Cobb 1986, Richards 1992), and common predators of *Cancer* crabs (Ojeda and Dearborn, 1991, Sainte-Marie and Chabot, 2002; Jones and Shulman, 2008). As a result, the presence of lobsters causes crabs to shift their activity decreasing trap entry (Richards et al. 1983). Additionally, there are other covariates that may affect Jonah crab catch rates such as depth, habitat, temperature and/or soak time. With this information in mind, we assessed two historic trap surveys to better understand the effect of soak time and lobster abundance on Jonah crab catch, with the goal of better understanding the ability of these surveys to track Jonah crab abundance over time. The two surveys were: 1) Southern New England Ventless Trap Survey (SNECVTS) conducted off the coasts of Massachusetts and Rhode Island, and 2) Normandeau Associates Inc. Ventless Trap Survey (NAI-VTS) conducted along the coast of New Hampshire.

Southern New England Ventless Trap Survey

We used trap-level data from the SNECVTS in 2018 to test the effect of a number of covariates, including lobster catch, on the catch rate of Jonah crabs. The SNECVTS program sampled 24 stations in the MA/RI wind energy area, twice per month from May to November. At each station, a 10-trap trawl was set with ventless (V) and standard (S) traps in the configuration: V-S-V-S-V-V-S-V-S-V. Target soak time was 5 nights with an acceptable range of 4 to 8 nights (Collie et al. 2019).

Jonah crab catch ranged from 0 to 130, and lobster catch ranged from 0 to 35 per trap. Both distributions were highly skewed with long tails. Jonah crab catch rate was modeled with a GLM with a negative binomial error distribution. The null model included trap type (V or S), latitude*longitude, soak time, and month. Additional candidate models tested the effects of habitat type, lobster and Atlantic rock crabs.

Based on the best-fit model, ventless traps catch more Jonah crabs than standard traps. Jonah crabs are more abundant on sand and soft sediments. Jonah crab catch rate is affected by lobsters but not rock crabs (Figure 72). Catch rate was a dome-shaped function of soak time with a peak at 6 days (Figure 72). In conclusion, Jonah crab and lobster catch rates are inversely related, after accounting for known covariates. The fitted relationship implies that the presence of two lobsters in a trap reduced Jonah crab catch by 11%. These results may account for some of the variability in Jonah crab catch rates in ventless trap surveys. They also suggest that Jonah crab catch rates could be adjusted for lobster abundance in the same traps, as has been done to Figure 72.

Normandeau Associates Ventless Trap Survey

Normandeau Associates conducted a ventless trap survey at two stations along the NH coast since the early 1980s. American lobster, Jonah crab, and Atlantic rock crab were enumerated and measured during trap hauls. Traps were hauled on two-day intervals approximately three times per week from June through November. Trawls consisted of fifteen 1" mesh single parlor traps. Data were aggregated by trawl, as trap-level data were not available. Jonah crab catch peaked during the late 1980s through early 1990s, followed by another peak in the early to mid-2000s and low catch rates from 2009 through 2021 (Figure 73). Lobster catch shows a general upward trend throughout the 40-year time series with highest catch rates being observed over the most recent twelve years (2010-2021). This period of extremely high catch of lobsters coincides with the lowest catch rates of Jonah crabs of the entire time series. Interestingly, the ME/NH trawl survey, picks up the pulse in Jonah crab abundance in the early 2000s, similar to the NAI-VTS, however the pulse picked up by the trawl survey in the mid to late 2010s is not picked up by traps, which coincides with a time period of high lobster catch, suggesting increasing numbers of lobsters within a trap may be deterring Jonah crabs from entering as documented by Richards et al. (1983).

A GAM with a negative binomial error distribution was fit to NAI-VTS data with Jonah crab catches per trawl (15 traps) as the response and year, month, station and lobster catches as covariates. Lobster catches were included as a smooth term. All covariates were retained according to AIC comparisons of reduced models with excluded covariates. Figure 74 shows the estimated effect of lobster catch on Jonah crab catches with a slight increase to catches of ≈80 lobsters per trawl, followed by a steady decrease in Jonah crab catches as lobster catches increase.

Summary

We assessed two trap-based surveys in different geographic areas to evaluate the ability of lobster centric surveys to pick up signals of abundance for Jonah crabs. The analysis of the SNECVTS data shows a positive effect of soft bottom on Jonah crab catch rates, indicating Jonah crabs are more associated with soft bottom that are towable by trawl surveys and not the complex habitat that may be more associated with ventless trap surveys. There were differences in soak times between these surveys, the SNECVTS was designed with a target soak time of 5 days, with a range between 4 and 8 days, whereas the NAI-VTS was designed with a target of 2 days, although longer sets were not uncommon. We found an increasing catch rate of Jonah crab up to six days followed by decreasing catch through eight day sets with SNECVTS. Catch rates increased in the NAI-VTS through 3 days, followed by decreasing catch with increasing soak time (NAI 2016). Although there are some discrepancies in results of catch with soak time between these two surveys, there is still general agreement between both of increasing catch for a number of days followed by decreases likely due to escapes. Similar soak-time dynamics have been observed in American lobster (NAI 2016, Clark et al. 2018). The differences we report here could be due to trap design, bait type/deterioration (Watson et al. 2019), and/or differences in species assemblage and inter and intraspecific competition.

The forty-year time series of the NAI-VTS survey provides a unique opportunity to assess trends of both lobster and crab over a long time series. It becomes even more informative when including an independent measure of crab abundance from the ME/NH trawl survey. Similar to the NAI-VTS, there was a peak in Jonah abundance in the early 2000s, however when the ME/NH trawl peaked again in the mid to late 2010s, this increase was not seen in the NAI-VTS. This time period coincides with unprecedented levels of lobster abundance in the region (ASMFC 2020) and suggests the high catch of lobsters may have deterred Jonah from entering traps, decreasing catchability to a degree that the index is not informative of Jonah crab abundance. Similarly, the models we applied to both surveys showed a decreasing catch of Jonah crabs with increasing lobster catch (Figure 72 and Figure 74), a dynamic which is in agreement with past studies (Richards et al. 1983). Our results, combined with literature on the subject, provide evidence that ventless trap surveys are not ideal for assessing abundance of Jonah crabs, largely due to lobsters being competitively dominant. As demonstrated in Figure 72, there are ways we may be able to adjust crab catch based on number of lobsters in the trap at some levels of lobster catches, though additional work is needed to apply our results to long-term surveys.

7 DATA EVALUATION

7.1 Trend and Correlation Analyses

7.1.1 Methods

After stock structure and abundance metrics were defined, data sets discussed in previous sections were evaluated with correlation analyses to identify consistencies in trends among data sets as an indication of reliability for stock indicators and trend analyses to identify signs of change over time, including:

- YOY settlement indices (<13mm CW; Table 17 and Figure 75)
- Recruit abundance indices (males 90-119mm CW; Table 21-Table 22 and Figure 76)
- Exploitable abundance indices (males 120+mm CW or fishery CPUE; Table 25-Table 27 and Figure 77)
- Spring recruit abundance indices and fall exploitable abundance indices within surveys (Figure 78)
- Exploitable abundance indices and YOY settlement indices lagged from 2-7 years
- Spawning abundance indices (females 80+mm CW; Table 29-Table 31 and Figure 79)
- Jonah crab landings (Table 7 and Figure 43)

Spring recruit abundance indices were evaluated against fall exploitable abundance indices under the assumption that recruits in the spring molt during the summer and recruit to legal-sized abundance in the fall and, therefore, share trend information. For comparisons of exploitable abundance indices and lagged settlement indices, indices from ME settlement surveys and the ME/NH and NEFSC trawl surveys were included because they occur in adjacent areas and cover relatively long time series.

Additional time series were calculated to explore exploitation signals and included:

- Ratios of spring recruit indices and fall exploitable abundance indices (Figure 80)
- Relative exploitation (landings/exploitable abundance index; Figure 81)

Data sets were structured by (1) stock, (2) with the IGOM and OGOM stocks combined due to similarities in trends during preliminary analyses (Section 6.2.4), and (3) coastwide for a perspective on the U.S. population as a whole.

Data sets were evaluated with Spearman's correlation and any results with Spearman's rho (ρ) ≥ ±0.5 and a p-value<0.05 were considered detected correlations. Mann-Kendall trend analysis was applied to test for monotonic trends over time and results with a p-value <0.05 were considered detected trends. Mann-Kendall trend analysis was applied to data sets from 2010-2021 to test for trends since the beginning of the available landings time series which covers the initial ascent of coastwide landings as the fishery developed (Figure 1). However, some data sets started later than 2010 and any with at least five data points were included. Results for these shorter time series should be viewed with caution. Trend analysis was also applied to full time series to provide a historical perspective on trends. It's important to reiterate that vessel change calibration factors for the NEFSC Trawl Survey are not available and indices of abundance have not been adjusted for the vessel change in 2009.

Given limited and noisy data (low encounter rates, high CVs; Table 17-Table 32), emphasis in interpreting results was placed on patterns among all analysis results and less emphasis on individual analysis results between two data sets.

7.1.2 Results

Settlement indices showed correlation among areas in ME waters, but not correlation with indices in waters to the south that had shorter time series (NH and MA; Figure 82). Despite the lack of correlation, all available indices agree on relatively strong year classes in 2012 and 2018. No trends were detected since 2010, but there are increasing trends over the longer time series of all three ME settlement surveys (Table 33).

Recruitment indices showed some consistency between seasons within surveys in GOM and coastwide, but not in SNE stocks (Figure 83 and Figure 84). There were not correlations detected between surveys. No trends were detected in recruitment indices for any areas since 2010, but increasing trends were detected over full time series in eleven surveys covering all areas (Table 34). One decreasing trend over the full time series occurred IGOM in the ME/NH spring survey and is due to the survey beginning later than others during a pulse of abundance in the mid-2000s.

Exploitable abundance also showed consistency between seasons within surveys in GOM and coastwide, as well as some consistency between surveys in GOM (MA and ME/NH; Figure 85 and Figure 86). As with recruit indices, there was no seasonal consistency in SNE and no consistency between fishery-independent indices and fishery-dependent CPUE time series (although there was some correlation in GOM between stocks or with lags, Section 5.1.4.4). Increasing trends since 2010 were detected for the NEFSC fall indices in GOM waters (combined and inshore), while decreasing trends were detected in the ISNE stock with DRM CPUE and the OSNE stock with the NEFSC trawl spring index (Table 35). Over full time series, increasing trends were detected in ten surveys covering all stocks except ISNE. As with recruit indices, the MA/NH spring survey showed a decline from the pulse of abundance at the beginning of its time series. Additionally, the DRM CPUE for the ISNE stock had a declining trend, but this time series was only three years longer than the time series tested since 2010.

Spring recruit indices and fall exploitable abundance indices showed consistency in GOM and coastwide, but not in SNE (Figure 87 and Figure 88). An increasing trend since 2010 was detected in recruit to exploitable abundance ratios with the MA Trawl survey in the IGOM stock, but no other surveys (Table 36). No trends were detected over the full time series.

Given correlations detected among ME settlement surveys, correlation results between the trawl survey exploitable abundance indices and YOY settlement indices were similar across ME settlement indices. Therefore, only results for the central area (statistical area 512) are reported. No positive correlations were detected between the ME/NH indices and lagged settlement indices (Figure 89). However, there were correlations detected between the NEFSC indices and settlement indices lagged from 2-4 years (Figure 90). These correlations decrease as the lag increases and fall apart by a 5-year lag.

Spawning abundance indices showed similar patterns in consistency as male indices, with some seasonal consistency within surveys in GOM and coastwide, but not in SNE (Figure 91 and Figure 92). Additionally, there was some consistency between IGOM surveys. The only trend detected since 2010 was a declining trend for the OSNE stock in the fall (Table 37). During the full time series, increasing trends were detected in twelve indices covering all areas. One declining trend was detected for the ME/NH spring survey.

Landings are not correlated between stocks in GOM and no indices are positively correlated with the landings (Figure 93). In SNE, landings are correlated between stocks and CFRF VTS CPUE is correlated between stocks, while also being correlated with landings ISNE (Figure 94). Coastwide, the indices are not positively correlated with landings (Figure 95). A decreasing trend in relative exploitation was detected using both OGOM seasonal indices, while an increasing trend was detected using the OSNE NEFSC spring index, but not the fall index (Table 38).

7.1.3 Discussion

The only reliable information on settlement comes from IGOM waters. There have been increases in settlement since the 1990s and 2000s, while settlement appears to have become more stable at higher levels in about the last decade. The strong 2012 year class measured across surveys appears to have supported large pulses of abundance that show up in the IGOM and OGOM post-settlement surveys in the mid-2010s. Despite relatively limited correlations detected between surveys in the GOM and some interannual variability in when peak abundances occur, it is clear that brief pulses of increased abundance were detected in GOM waters in the mid-2010s across surveys, as well as during the early 2000s. This cohort signal tracking was measured consistently between the ME settlement surveys and NEFSC trawl survey and the strongest correlations for a two-year lag indicates a slightly shorter lag than detected by Huntsberger 2019 (four year lag between YOY and 110-120mm Jonah crabs). Post-settlement indices also show strong seasonal consistency indicating they are tracking a common signal as opposed to noise alone.

The observed pulses in abundance occur over a very short duration without any clear indication of increased exploitation. Despite the decline of the pulse near the end of the time series, there are no indications of longer-term decreasing abundance or increasing exploitation over approximately the last decade, but rather only indication of increasing abundance and decreasing exploitation.

Settlement trends are unknown in SNE stocks and there was no indication of increased recruitment in the mid-2010s in SNE post-settlement indices. Even indices at a reduced spatial scale in adjacent statistical areas of the OGOM and OSNE stocks that account for low and high magnitudes of overall landings, respectively, show very distinct abundance differences in the mid-2010s (Figure 6). It became clear during these analyses that indices from ISNE are of little utility given low sample sizes (avg. annual tows≈9), infrequency of encounters (multiple zero catch years), and considerable noise (high CVs). These indices were not considered further for information on stock abundance. Additionally, the fishery-dependent CPUE time series for both SNE stocks are not recommended as a measure of exploitable abundance. Despite a trend detected in DRM CPUE, the Mann-Kendall test provides no information on magnitude of changes and the time series shows relatively little change in catch rates despite large changes in landings. Additionally, the CFRF VTS CPUE shows similarities to the landings time series while the fishery-independent indices do not. The methodology of attaching ventless traps to commercial trap strings likely contributes to this and confounds the CPUE's refection of a true abundance trend.

The general consistencies seen in GOM, particularly seasonal consistency, fall apart in the OSNE stock where the bulk of the fishery occurs, making interpretation of these indices more difficult and reducing confidence in their ability to accurately reflect interannual changes in relative abundance. Inconsistencies lead to conflicting pictures of stock condition between seasons, with some signs of increased exploitation and decreased abundance according to spring data that are not apparent with fall data. The spring exploitable abundance index occurs after the primary landings quarters (one and four) and before incoming recruitment and should provide better information on exploitation, but encounter rates are noticeably lower during this season unlike in GOM.

The coastwide data sets present a spatial mismatch with the indices being driven by higher catch rates in GOM areas and landings being driven by the greater magnitude coming from SNE areas. This mismatch could bias true stock-specific exploitation signals.

7.2 Limitations for Assessment Methods

Some analyses of abundance index and landings time series were attempted in order to provide tactical management advice (Appendix 14.1). However, the correlation and trend analyses conducted here highlight two primary limitations for using available data sets in these traditional assessment approaches. First, there does not appear to be a clear relationship between abundance and fishery removals that assessment approaches would depend on and attempt to estimate. The observed abundance “pulse” population dynamics result in short-term, large-scale changes in abundance that appear to be driven by factors other than exploitation given there were no similar changes in landings in the bycatch-driven fisheries of GOM that would explain the rapid decline of these pulses. Another limitation is poor understanding of Jonah crab catchability and low encounter rates for available trawl survey indices. Catch rates have regularly been at or near zero and likely only provide a coarse, qualitative approximation of abundance changes between periods of time as opposed to a reliable quantitative tracking of interannual abundance changes. Therefore, estimates from the index-based methods in Appendix 14.1 are not recommended for management use. Instead, qualitative characterizations of stock status are provided in the next section with empirical stock indicators.

8 STOCK INDICATORS

Given limitations of data sets for traditional assessment approaches, data sets were used to develop empirical indicators of stock conditions and fishery performance. These indicators provide a categorical characterization of recent condition relative to historical levels. The terminal three years (2019-2021) are averaged to provide a smoothed measure of recent stock condition due to interannual variability reflective, in part, of observation error. As is done in American lobster stock assessments (ASMFC 2020), categories are defined as positive, neutral, and negative according to the 25th and 75th percentiles of each indicator’s time series.

8.1 Abundance Indicators

Stock abundance indicators include the YOY settlement, recruit abundance, exploitable abundance, and spawning abundance indices evaluated in the previous section. Indicators are categorized as positive if above their 75th percentile, neutral if between their 75th and 25th percentile, and negative if below their 25th percentile.

8.2 Fishery Performance Indicators

Fishery performance indicators include landings, the number and proportion of pot/trap trips that landed Jonah crabs, and the number and proportion of active (i.e., reported catch during the year) lobster/crab permits that landed Jonah crab. NH harvesters are active in the IGOM and OGOM stocks, but trip and permit data are only available for this state since 2016. Trends and conditions were compared with and without NH data and were very similar, so NH data are excluded from these indicators to maintain the time series back to 2010.

Landings provide indicators of the biomass removed from the stock due to fishing, but, as discussed in Section 4.3, are affected by factors other than available biomass and are not interpreted as an indication of stock biomass. Low landings are not favorable for fishery performance and these indicators are categorized as positive if above their 75th percentile, neutral if between their 75th and 25th percentiles, and negative if below their 25th percentile.

Trip and permit indicators are also affected by factors other than biomass that affect total landings (reduced lobster abundance/target switching, price changes). Due to these confounding factors and that these are presented as fishery performance indicators, these are interpreted similar to landings with lower levels, below their 25th percentile, interpreted as negative conditions due to lower access/participation in the fishery. Moderate levels between their 25th and 75th percentiles are considered neutral and higher levels are interpreted as positive conditions due to greater access/participation in the fishery. The lack of large changes observed in the proportion-based indicators for all stocks result in small interquartile ranges indicative of neutral conditions and conditions will be sensitive to relatively small changes.

A major caveat to the interpretation of these fishery performance indicators is that, at some point, participation in the fishery could result in more fishing pressure (i.e., exploitation) than the stocks can support. The relationship between participation and exploitation is unknown.

8.3 Results

8.3.1 IGOM

YOY settlement indicators in ME all declined in 2021 and were neutral (Table 17 and Figure 96). Indicators to the south of ME (NH and MA) were both positive in 2021. These indicators have the shortest time series but are unavailable during earlier years when low settlement was observed in ME and recent conditions likely are not inflated due to the short time series. Three-year averages are neutral for all surveys except ME 512, which is positive.

Post-settlement indicators generally agree on declines in abundance in recent years from time series highs in the mid-2010s but provide more of a mixed picture in terminal conditions across surveys (Table 21, Table 25, Table 29, and Figure 97-Figure 99). Three-year average conditions are positive across surveys and metrics for the NEFSC trawl survey, vary between positive (exploitable and spawning abundance in spring) and neutral (all metrics in fall and recruit abundance in spring) for the MA trawl survey, and are negative across surveys and metrics for the ME/NH trawl with only one exception (positive fall index of spawning abundance). The negative conditions observed by the ME/NH trawl survey are influenced by the start year of the survey. The survey began during the abundance pulse in the early 2000s and did not capture earlier years when indices observed by both the MA and NEFSC trawl surveys generally were at or near time series lows.

All fishery performance indicators are neutral (Figure 100-Figure 102). Proportional indicators indicate potential for fishery growth in this stock, with observed proportions being very low across the time series. This stock by far accounts for the highest number of trips and permits landing Jonah crabs, being an order of magnitude higher than OSNE indicators despite landings about five times lower than the OSNE stock.

8.3.2 OGOM

All settlement indicators are from IGOM, but, as seen with the data evaluation analyses, have similarities with exploitable abundance trends seen in OGOM and may be reflective of recruitment to this stock.

As with the IGOM stock, post-settlement indicators indicate declines in abundance in recent years from time series highs in the mid-2010s (Table 21, Table 25, Table 29, and Figure 103-Figure 105). Recruit abundance indicators declined to neutral conditions in both seasons, while exploitable abundance indicators remain in positive conditions in both seasons. The spring spawning abundance indicator declined to neutral while the fall indicator remains positive.

The proportion trips landings Jonah crab and both permit indicators are positive due to an upward trend at the end of the time series to the highest levels of the time series in 2021 (Figure 101 and Figure 102). The number of trips indicator is more variable during these years and neutral on average. As with the IGOM stock, proportional indicators are very low and indicate potential for fishery growth in this stock. Unlike the IGOM stock, trips and permits landings Jonah crabs through time have been the lowest observed across stocks. Landings are negative due to general decline during the time series (Table 7 and Figure 100).

8.3.3 ISNE

There are no reliable abundance indicators for the ISNE stock and abundance conditions are unknown.

The landings indicator shows an upward trend during the final three years and is neutral on average (Table 7 and Figure 100). Trip indicators and the number of permits landings Jonah crab indicator are neutral, while the proportion permits landing Jonah crab indicator is positive (Figure 101 and Figure 102). Proportional indicators indicate potential for fishery growth in this stock, but this growth may be constrained by available abundance in these more southerly, inshore waters relative to the GOM stocks.

8.3.4 OSNE

There are no settlement indicators for the OSNE stock and conditions are unknown.

Post-settlement indicators provide a mixed picture on conditions between seasons (Table 23, Table 27, Table 31, and Figure 106-Figure 108). Fall indicators generally show abundance increases to higher abundance from time series lows in the first half of the time series, while spring indicators are more variable without trend. Terminal spring indicators are neutral for all metrics, while fall indicators are positive for recruit and exploitable abundance. The fall spawning abundance indicator shows some decline to neutral conditions. It's important to note that encounter rates are considerably lower for spring indicators and the 25th percentile for the exploitable abundance indicator is actually zero due to several years when no Jonah crabs were encountered.

The landings indicator shows a consistent downward trend since 2018, with the terminal three-year average being neutral and above the terminal year value which is negative (Table 7 and Figure 100). Total count and proportional indicators show opposing trends and conditions in the terminal three years, with counts of trips and permits trending down across the times series and ending in negative (trips) or just neutral (permits) conditions while proportions trend up across the time series ending in positive conditions (Figure 101 and Figure 102). This shows a declining fishery capacity that has increasingly utilized the Jonah crab resource and could indicate shifting targeting towards Jonah crab, increasing Jonah crab abundance, or a combination of both. Greater than half of trips and active permits land Jonah crab in this fishery, contributing to the highest magnitude of landings across stocks.

9 STOCK STATUS

Inference about stock abundance condition is based on the stock abundance indicators. According to these indicators, there have been declines in post-settlement abundance for the IGOM and OGOM stocks from time series highs in the mid-2010s, but conditions in the last three years of the time series are neutral or positive. The one exception is from the ME/NH Trawl survey, but this is due to the shorter time series of this survey not capturing historical lows in earlier years. Indicators for the OSNE stock also indicate neutral or positive post-settlement abundance conditions in the last three years of the time series. Indicators agree across these stocks that abundance has not been depleted to historical lows. There are no reliable abundance indicators for the ISNE stock and inference cannot be made about condition of this stock's abundance at this time.

YOY indicators generally indicate neutral conditions and do not indicate that recruitment in GOM stocks will decline to historical lows in the near future. Settlement conditions are unknown for SNE stocks.

Landings have steadily declined in the OSNE stock which is the primary stock with targeted/mixed effort for Jonah crab and the stock accounting for the vast majority of coastwide landings. This trend is believed to be influenced by factors other than available abundance but should continue to be monitored closely. There was not sufficient information to make statements about fishing mortality or exploitation with confidence and these population parameters remain major uncertainties.

10 RESEARCH RECOMMENDATIONS

The TC recommends updating the stock indicators in five years and evaluating any new information that may allow for advanced methods to provide management advice at that time. In the meantime, the TC provides the following recommendations to improve the information base for Jonah crab. The TC strongly encourages that any prospective researchers considering projects to address these recommendations reach out to the TC to ensure project results would be of most utility for future stock assessments.

High Priority

- Surveys to track abundance in SNE during all life stages (settlement, recruitment to legal size, exploitable abundance, and spawning abundance) are essential for future stock assessments and potential management advice. Current surveys are not adequate for these goals.
- Research should be conducted to provide a more comprehensive understanding of recruitment dynamics, including tracking of spatio-temporal settlement dynamics and the source of recruitment to offshore SNE, to inform development of Jonah crab settlement surveys.
- Appropriate survey methodologies need to be researched to track abundance of Jonah crab. Trawl surveys are available, but encounter rates are very low and detection ability is uncertain. Behavioral interactions with survey gear need to be better understood. Video surveys are recommended to examine these interactions. Video surveys could also be used for snapshot estimates of total stock size (i.e., swept-area biomass) that could be used to gain a better understanding on exploitation levels.
- Female migration pathways/seasonality and distribution needs to be researched. Anecdotal information suggests seasonal aggregations in inshore areas, but research would help to understand these mechanisms and inform connectivity. Ventless trap surveys (state-run and windfarm impact) offer a potential data set to explore interannual variability in distribution
- Information on larval duration in the field, mortality, and dispersal are needed to better understand possible connectivity. Spawning female distribution information would supplement efforts to model these processes. Evaluate larval data sets for species identification and to explore abundance, seasonality, and interannual variability.
- Inter-molt duration of adult crabs is currently unknown and growth increment data for mature crabs is limited. There are no growth data from offshore SNE where the bulk of the fishery occurs and differences in growth between regions are unknown. These data will be necessary for advanced modeling methods.
- Research growth mechanisms for both sexes (e.g., potential for terminal molt, lack of growth associated with molting, high natural mortality for adults) to explain lack of exploitation signal (i.e., lack of size structure change) in available data sets. Dissection of larger crabs with old shells and evaluation of shell formation underneath external shell might help inform this research.
- Increase and improve the consistency of fisheries-dependent monitoring and biosampling. Sampling intensity by statistical area should be based on landings.

- Continue to improve accuracy of commercial reporting to improve quantification of effort in the directed and mixed-crustacean fisheries. Evaluate new spatial data (i.e., vessel tracking data) to better understand spatial dynamics of the fishery.
- Study the effect of temperature on Jonah crab behavior/activity.
- Little is known about ecosystem/environmental drivers of Jonah crab population dynamics. Studies should be done to identify and understand these drivers.
- Determine how to interpret fisheries-dependent data considering interactions between fishery response to abundance, economic drivers, and lobster fishery dynamics.

Moderate Priority

- Explore historical data sets from the scallop dredge survey and video surveys like HabCam to understand habitat use/suitability, abundance, distribution, and to inform potential covariates for catchability effects.
- Food habits data should be analyzed, with an emphasis on offshore areas, to better understand predation of Jonah crab and as a potential measure of abundance and distribution.
- Evaluate evidence for a defined stock-recruit relationship or lack thereof. If lack of evidence, identify recruitment drivers and mechanisms of population abundance change.

Low Priority

- Information should be collected to help delineate stock boundaries and understand possible connectivity, with an emphasis on the GOM/SNE boundary.
- Reproductive studies pertaining to male-female spawning size ratios, the possibility of successful spawning by physiologically mature but morphometrically immature male crabs, and potential for sperm limitations should be conducted.
- If improved abundance data with higher encounter rates becomes available, cohort tracking analyses should be conducted across and within surveys to better understand if surveys are tracking true abundance signals and provide information on growth, mortality, and other demographic factors.
- The development of aging methods or determination of the mechanism responsible for the suspected annuli formation found in the gastric mill should be explored.

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12 TABLES

Table 1. **Estimates of female Jonah crab size-at-maturity (SM50) by study, region, and type of maturity (morphometric and gonadal).**

Study	Year	Region	Morphometric	Gonadal
This Assessment	2023	GOM offshore	98	
Perry et al.	2017	GOM offshore		98
This Assessment	2023	GOM inshore	94	
This Assessment	2023	Georges Bank	97	
Perry et al.	2017	Georges Bank		93
This Assessment	2023	SNE offshore	94	
Perry et al.	2017	SNE offshore		89
This Assessment	2023	SNE inshore	95	
Perry et al.	2017	SNE inshore		86
Ordzie and Satchwill	1983	SNE inshore	40-50	40-50
This Assessment	2023	Mid Atlantic	90	
Carpenter	1978	Mid Atlantic	85	
Olsen and Stevens	2020	Mid Atlantic	88	

Table 2. **Estimates of male Jonah crab size-at-maturity (SM50) by study, region, and type of maturity (morphometric and gonadal).**

Study	Year	Region	Morphometric	Gonadal
Moriyasu et al.	2002	Nova Scotia	128	69
This Assessment	2023	GOM offshore	121	
This Assessment	2023	GOM inshore	110	
This Assessment	2023	Georges Bank	120	
This Assessment	2023	SNE offshore	119	
Lawrence et al.	2021	SNE Inshore	106	
This Assessment	2023	SNE inshore	103	
Ordzie and Satchwill	1983	SNE inshore		50-60
This Assessment	2023	Mid Atlantic	102	
Carpenter	1978	Mid Atlantic	90-100	
Olsen and Stevens	2020	Mid Atlantic	98	

Table 3. **Size-at-maturity (SM50), Boostrapped SM50, Confidence Intervals, and sample sizes by data source. The SM50 estimate for Gulf of Maine Offshore Females (*) was unstable and highly sensitive to the range of "Unknowns" assumed.**

				95% CI		Sample Size and Data Source		
Sex	Region		SM50_Boot	Lower	Upper	MassDMF	NEFSC	UMES
Fem	GOM_OFF	97.5*	97.7	94.6	99.7	161	810	0
Fem	GOM_IN	93.6	94.5	89.5	100.7	170	125	0
Fem	GB	97.3	95.7	88.6	100.2	177	340	0
Fem	SNE_OFF	93.6	93.6	87.4	97.8	250	132	0
Fem	SNE_IN	94.7	100.7	89.2	104.9	237	40	0
Fem	MAB	89.6	91.5	88.0	102.8	0	168	798
Mal	GOM_OFF	121.3	122.6	120.8	124.3	275	1222	0
Mal	GOM_IN	109.7	110.6	104.6	115.3	209	124	0
Mal	GB	120.1	120.0	117.7	122.1	251	382	0
Mal	SNE_OFF	119.4	119.1	117.0	121.3	304	165	0
Mal	SNE_IN	103.2	105.0	101.5	109.3	407	44	0
Mal	MAB	101.7	101.6	99.1	104.3	0	326	564

Table 4. **Proportion of trips landing Jonah crab using a Massachusetts lobster/edible crab trap permit by year and region.**

Year	IGOM	OGOM	ISNE	OSNE
2010	0.02	0.04	0.07	0.72
2011	0.02	0.04	0.06	0.79
2012	0.03	0.03	0.05	0.76
2013	0.04	0.03	0.11	0.82
2014	0.03	0.04	0.15	0.77
2015	0.03	0.06	0.07	0.71
2016	0.04	0.05	0.09	0.79
2017	0.06	0.05	0.11	0.81
2018	0.05	0.03	0.08	0.77
2019	0.05	0.03	0.04	0.73
2020	0.04	0.07	0.03	0.74
2021	0.05	0.07	0.06	0.83

Table 5. **Annual ex-vessel price per pound for whole body Jonah crab landings by state. Asterisks indicate confidential data.**

Year	ME	NH	MA	RI	CT	Mean	MA/RI Mean
2010	$0.34	*	$0.56	$0.52	$0.60	$0.51	$0.54
2011	$0.35	*	$0.68	$0.57	$0.54	$0.54	$0.62
2012	$0.39	*	$0.74	$0.68	$0.65	$0.61	$0.71
2013	$0.49	$0.69	$0.90	$0.72	$0.71	$0.70	$0.81
2014	$0.30	$0.71	$0.78	$0.75	$0.75	$0.66	$0.76
2015	$0.51	*	$0.76	$0.69	$0.84	$0.70	$0.72
2016	$0.51	$0.70	$0.77	$0.77	$0.61	$0.67	$0.77
2017	$0.54	$0.72	$0.98	$0.96	$0.54	$0.75	$0.97
2018	$0.59	$0.66	$0.94	$0.92	$0.81	$0.79	$0.93
2019	$0.55	$0.60	$0.84	$0.80	$0.98	$0.75	$0.82
2020	$0.54	$0.63	$0.82	$0.83	$0.97	$0.76	$0.82
2021	$0.77	$0.76	$1.20	$1.20	$1.00	$0.99	$1.20

Table 6. **Jonah crab stock assignments to statistical area-specific landings for statistical areas that overlap multiple stocks. Blanks indicate no landings in the statistical area and state combination. Proportions are the proportion of landings from the statistical area relative to coastwide landings from all known statistical areas since 2010.**

Statistical Area	ME	NH	MA	RI	CT	NY	NJ	DE-NC	Proportion
510	IGOM								0.0049
511	IGOM								0.0613
512	IGOM			OGOM		OGO M			0.0735
513	IGOM		IGOM	IGOM		IGOM	IGOM		0.0048
515	OGOM		OGOM	OGOM					0.0112
521			OGOM	OGOM			OGOM		0.0019
526			OSNE	OSNE		OSNE			0.1166
537 (for states other than MA and RI)		OSNE			Unknown	OSNE	Unknown	OSNE	0.0129
538	ISNE		ISNE	ISNE					0.0004
539	ISNE		ISNE	ISNE	ISNE	ISNE		ISNE	0.0104
611	ISNE			ISNE	ISNE	ISNE		ISNE	0.0002

Table 7. **Stock-specific Jonah crab landings and landings (total and proportion of coastwide total) that could not be assigned to a stock.**

Year	IGOM	OGOM	ISNE	OSNE	Unknown	Unknown Proportion
2010	3,296,917	495,594	251,663	10,908,252	13,656	0.0009
2011	2,573,190	431,245	292,623	8,784,679	2,336	0.0002
2012	1,805,257	301,728	306,694	11,479,530	8,360	0.0006
2013	1,542,279	431,196	716,553	14,260,261	21,538	0.0013
2014	1,981,181	560,151	400,057	16,648,366	72,590	0.0037
2015	1,890,398	422,987	387,902	13,043,052	70,085	0.0044
2016	2,168,085	393,607	460,474	14,210,751	327,863	0.0187
2017	3,397,455	233,020	912,620	14,619,539	524,715	0.0267
2018	3,673,281	83,833	782,416	17,611,400	615,568	0.0270
2019	3,164,910	55,882	284,094	13,989,900	167,475	0.0095
2020	2,038,465	187,250	299,548	11,642,200	481,767	0.0329
2021	2,944,330	205,669	428,611	8,626,968	41,035	0.0034
2019-2021 average	2,715,902	149,600	337,418	11,419,689	230,092	0.0152
25th Percentile	1,958,485	201,065	297,817	11,336,711	19,568	0.0012
75th Percentile	3,197,912	431,208	524,494	14,350,081	366,339	0.0207

Table 8. **Number of Jonah crab sea sampling trips. Colors are scaled to the minimum and maximum number of trips, with green indicating the greatest sampling intensity and red indicating the lowest sampling intensity.**

Year	IGOM				OGOM								ISNE		OSNE										
	511	512	513	514	464	465	511	512	515	521	522	561	537	539	525	526	537	562	613	615	616	622	623	626	627
2003	1	9																							
2004		2	1																						
2005				1												1									
....																									
2014													17	60	18	2	7	7	1		3				
2015					1	2		2				4	17	80	20	20	21	9	3		1			1	
2016				4	9	2		4	3			13	18	113	22	5	15	7	1					1	
2017	1	2	3	6	1	1		4	2			15	16	113	17	7	5	3	21			5			
2018	6	1	6	13	10	5		7	1			8	10	97	8	25	23	8			13	4		2	
2019	1	7	8		6	12		6	9			23	9	98	3	22	40	2			11	3	1	3	1
2020	1	1	9		9	7	1	6	1		3	16	13	90	21	30	25	2		1	16	1		1	
2021			4	6	12	3	3	5	1	1		15	9	83	15	12	8	2			2				

Table 9. **Number of Jonah crab port sampling trips. Colors are scaled to the minimum and maximum number of trips, with green indicating the greatest sampling intensity and red indicating the lowest sampling intensity.**

Year	IGOM		OGOM		ISNE		OSNE						
	513	514	521	561	537	611	525	526	537	562	612	613	616
2013					2								
2014					2					2			
2015		3						4	6				
2016							1	8	8	1	1		
2017	2		1	2			2	5	10			5	
2018	6		1		1		3	3	7	1			
2019	4					1	4	5	2	1			
2020	4	5					8	4	1				1
2021	5			1				4		1			

Table 10. **Mann-Kendall test results for mean size of males in the overall catch from sea sampling data.**

Stock	Statistical Area	Quarter	n years	tau	p-value
OGOM	561	2	5	-0.40	0.462
OGOM	561	4	6	-0.47	0.260
OGOM	464	1	5	-0.60	0.221
OGOM	464	3	5	0.20	0.806
ISNE	537	2	5	-0.20	0.806
ISNE	537	3	7	-0.62	0.072
ISNE	537	4	6	-0.33	0.452
ISNE	539	1	8	0.21	0.536
ISNE	539	2	8	0.07	0.902
ISNE	539	3	8	-0.29	0.386
ISNE	539	4	8	-0.29	0.386
OSNE	525	1	5	0.00	1.000
OSNE	525	2	7	-0.62	0.072
OSNE	525	3	7	-0.24	0.548
OSNE	525	4	5	-0.40	0.462
OSNE	526	2	8	-0.29	0.386
OSNE	526	3	7	0.62	0.072
OSNE	526	4	5	0.20	0.806
OSNE	537	1	6	0.20	0.707
OSNE	537	3	8	-0.21	0.536

Table 11. **Mann-Kendall test results for mean size of the largest 5% males in the overall catch from sea sampling data. Bold and italicized font indicates a significant trend.**

Stock	Statistical Area	Quarter	n years	tau	p-value
OGOM	561	2	5	0.00	1.000
OGOM	561	4	6	-0.20	0.707
ISNE	537	3	7	-0.52	0.133
ISNE	537	4	5	-0.20	0.806
ISNE	539	1	8	0.57	0.063
ISNE	539	2	8	0.29	0.386
ISNE	539	3	8	-0.29	0.386
ISNE	539	4	8	***0.64***	***0.035***
OSNE	525	2	6	-0.07	1.000
OSNE	525	3	6	-0.07	1.000
OSNE	525	4	5	-0.20	0.806
OSNE	526	2	7	0.14	0.764
OSNE	526	3	6	0.60	0.133
OSNE	526	4	5	0.60	0.221
OSNE	537	1	5	0.20	0.806
OSNE	537	3	6	0.20	0.707

Table 12. **CFRF VTS summary for exploitable-sized (>121mm CW) male crabs.**

Year	Inshore SNE					Offshore SNE				
	n Sessions	Proportion Positive	n Crabs	Mean CPUE	CPUE CV	n Sessions	Proportion Positive	n Crabs	Mean CPUE	CPUE CV
2015	42	0.95	268	7.08	0.40	57	0.89	527	9.97	0.29
2016	49	0.84	338	7.52	0.36	45	0.93	512	12.16	0.24
2017	29	1.00	251	8.82	0.30	72	0.99	1,724	17.81	0.17
2018	30	0.97	214	9.49	0.27	97	0.98	1,882	16.63	0.19
2019	39	0.97	264	7.63	0.34	34	1.00	549	15.45	0.21
2020	25	0.84	175	6.33	0.41	35	0.97	589	12.14	0.29
2021	31	0.84	190	6.71	0.39	NA	NA	NA	NA	NA

Table 13. **Directed Residual Model CPUE (catch per trip) predictions for Rhode Island Jonah crab harvest in inshore and offshore SNE in February. Predictions are in log space.**

	Inshore SNE			Offshore SNE		
Year	Number Trips	Predicted CPUE	Prediction S.E.	Number Trips	Predicted CPUE	Prediction S.E.
2007	51	8.17	0.13	525	9.65	0.06
2008	70	7.85	0.11	591	9.72	0.05
2009	89	8.10	0.10	572	9.61	0.05
2010	81	8.03	0.11	493	9.54	0.06
2011	67	7.75	0.12	414	9.52	0.06
2012	103	8.08	0.10	419	9.65	0.06
2013	328	8.02	0.07	373	9.76	0.06
2014	219	7.70	0.08	420	9.78	0.06
2015	208	7.54	0.08	386	9.80	0.06
2016	153	7.50	0.09	369	9.78	0.06
2017	212	7.71	0.08	372	9.69	0.06
2018	213	7.82	0.08	411	9.66	0.06
2019	96	7.62	0.10	375	9.84	0.06
2020	70	7.73	0.11	301	9.75	0.06
2021	101	7.32	0.10	266	9.55	0.07

Table 14. **Model summary table for DRM fitted to Rhode Island trip-level landings data.**

```
Call:
glm(formula = lCRJ ~ Year * Stock + Stock * P1 + Month * P1,
    data = alldat)

Deviance Residuals:
    Min       1Q   Median       3Q      Max
-3.2666  -0.5437   0.0224   0.5689   2.7492

Coefficients:
                Estimate Std. Error t value Pr(>|t|)
(Intercept)      6.65350    0.14977  44.425  < 2e-16 ***
Year2008        -0.32670    0.15920  -2.052 0.040187 *
Year2009        -0.07114    0.15188  -0.468 0.639523
Year2010        -0.14206    0.15456  -0.919 0.358074
Year2011        -0.42222    0.16075  -2.627 0.008642 **
Year2012        -0.09723    0.14832  -0.656 0.512148
Year2013        -0.15305    0.13020  -1.176 0.239822
Year2014        -0.47852    0.13460  -3.555 0.000380 ***
Year2015        -0.62914    0.13519  -4.654 3.31e-06 ***
Year2016        -0.66976    0.13977  -4.792 1.68e-06 ***
Year2017        -0.46667    0.13475  -3.463 0.000536 ***
Year2018        -0.35018    0.13472  -2.599 0.009357 **
Year2019        -0.55310    0.14988  -3.690 0.000225 ***
Year2020        -0.44303    0.15910  -2.785 0.005372 **
Year2021        -0.85532    0.14915  -5.735 1.01e-08 ***
Stock1           0.90913    0.12805   7.100 1.35e-12 ***
P1               1.46652    0.10128  14.480  < 2e-16 ***
Month10          0.18152    0.09364   1.938 0.052597 .
Month11          0.36240    0.09556   3.793 0.000150 ***
Month12          0.26642    0.10667   2.498 0.012521 *
Month2          -0.01692    0.17157  -0.099 0.921419
Month3           0.16735    0.14770   1.133 0.257217
Month4           0.14593    0.11497   1.269 0.204392
Month5           0.10440    0.09930   1.051 0.293086
Month6           0.09948    0.09486   1.049 0.294355
Month7          -0.07951    0.09397  -0.846 0.397537
Month8          -0.09166    0.09301  -0.985 0.324443
Month9           0.07784    0.09280   0.839 0.401599
Year2008:Stock1  0.39636    0.16739   2.368 0.017910 *
Year2009:Stock1  0.02806    0.16056   0.175 0.861294
Year2010:Stock1  0.03693    0.16379   0.225 0.821606
Year2011:Stock1  0.29547    0.17042   1.734 0.083001 .
Year2012:Stock1  0.09707    0.15877   0.611 0.540948
Year2013:Stock1  0.26762    0.14272   1.875 0.060805 .
Year2014:Stock1  0.61212    0.14599   4.193 2.78e-05 ***
Year2015:Stock1  0.78430    0.14708   5.332 9.95e-08 ***
Year2016:Stock1  0.80358    0.15168   5.298 1.20e-07 ***
Year2017:Stock1  0.50773    0.14703   3.453 0.000556 ***
Year2018:Stock1  0.36928    0.14644   2.522 0.011694 *
Year2019:Stock1  0.74128    0.16102   4.604 4.21e-06 ***
Year2020:Stock1  0.54627    0.17096   3.195 0.001402 **
Year2021:Stock1  0.75229    0.16279   4.621 3.87e-06 ***
Stock1:P1        0.56470    0.04667  12.101  < 2e-16 ***
P1:Month10      -0.84037    0.11452  -7.338 2.36e-13 ***
P1:Month11      -0.92095    0.11344  -8.118 5.40e-16 ***
P1:Month12      -0.61971    0.11926  -5.196 2.08e-07 ***
P1:Month2        0.07140    0.17994   0.397 0.691548
P1:Month3       -0.35201    0.15764  -2.233 0.025574 *
P1:Month4       -0.60371    0.12992  -4.647 3.42e-06 ***
P1:Month5       -0.70646    0.11474  -6.157 7.77e-10 ***
P1:Month6       -0.90512    0.11392  -7.945 2.20e-15 ***
P1:Month7       -0.86350    0.11732  -7.360 2.01e-13 ***
P1:Month8       -0.98593    0.11666  -8.451  < 2e-16 ***
P1:Month9       -0.90097    0.11323  -7.957 2.00e-15 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for gaussian family taken to be 0.74397)

    Null deviance: 16147.0  on 8347  degrees of freedom
Residual deviance:  6170.5  on 8294  degrees of freedom
AIC: 21277

Number of Fisher Scoring iterations: 2
```

Table 15. **Surveys encountering settling Jonah crabs considered for the stock assessment, but lacking utility for tracking abundance metrics of interest. Reasons identified for limitations of utility were lack of Cancer crab species identification (SID) and inadequate catch rates/inefficient catchability (CR).**

Survey	***Time Series***	***CWs***	***Limitations***	***Notes***
Normandeau Plankton Survey	1982-present	N	SID	
RIDEM DMF Settlement Survey	1990-present	Y	CR	
UMaine Deepwater Collectors	2007-present	Y	CR	Sampling discontinued from 2009-2015

Table 16. **Surveys encountering post-settlement Jonah crabs considered for the stock assessment, but lacking utility for tracking abundance metrics of interest. Data fields collected after the start year when Jonah crab counts were added to survey protocols are included in parentheses. Reasons identified for limitations of utility were lack of spatial overlap between the survey domain and Jonah crab population and/or small spatial domain (SS), short and/or discontinuous time series (TS), inadequate catch rates/inefficient catchability (CR), and lack of biological data (BD).**

Survey	*Time Series*	*CWs*	*Sex*	*Limitations*	*Notes*
ME Urchin Survey	2004-present	Y	Y	SS	
ME VTS	2016*-present	Y (2016)	Y (2016)	SS, CR	Counts collected prior to 2016, but ID issues render counts unreliable
NH VTS	2009-present	Y (2015)	Y (2015)	SS, CR	
Normandeau VTS	1982-present	Y	Y	SS, CR	
MA VTS	2007-present	Y	Y (2015)	SS, CR	
SMAST VTS	2019	Y	Y	SS, TS, CR	
CFRF SNE Cooperative VTS	2014-2018	Y	Y	SS, TS, CR	
RI VTS	2006-present	Y	Y	SS, CR	
NY VTS	2006-2010	N	N	SS, TS, CR, BD	
NJ Fixed Gear Survey	2016-present	Y	Y	SS, CR	
DE Structure Oriented Survey	2018-present	Y	Y (2020)	SS, TS, CR, BD	
CFRF-South Fork Wind Farm Cox's Ledge/RI Sound Trawl	2020-present	Y	Y	SS, TS	

Coonamessett Farm Foundation Scallop Dredge	2010-present	N	N	TS, BD	Data collection ceased from 2016-August 2021 and only resumed at limited stations
RI Trawl Survey	2015-present	Y	Y	CR	
URI GSO Trawl Survey	2016-present	Y	Y	CR	
CT Trawl Survey	1979-present	Y	Y	SS, CR	
NY Trawl Survey	2017-present	Y	Y	SS, TS	
NJ DFW Ocean Trawl Survey	1989-present	Y	Y (2021)	SS, BD	
NEAMAP Trawl Survey	2007-present	Y	Y	CR	
Northern Shrimp Trawl Survey	1984-present	N	Y	BD	

Table 17. **Spearman correlation results for seasonal catch rate and temperature anomalies using a two-year running average as the underlying trend in catch rates to calculate anomalies.**

Season and Areas	Spearman's Rho	p-value
Spring 521, 522, 561	0.302	0.11
Fall 521, 522, 561	0.089	0.64
Spring 537, 526, 525, 562	-0.091	0.64
Fall 537, 526, 525, 562	-0.047	0.81

Table 18. **Spearman correlation results for seasonal catch rate and temperature anomalies using a LOESS smoother fit as the underlying trend in catch rates to calculate anomalies.**

Season and Areas	Spearman's Rho	p-value
Spring 521, 522, 561	0.407	0.03
Fall 521, 522, 561	-0.119	0.53
Spring 537, 526, 525, 562	-0.044	0.82
Fall 537, 526, 525, 562	-0.034	0.86

Table 19. **Jonah crab settlement indices in GOM areas.**

Year	ME 511	ME 512	ME 513	NH 513	MA 514
1989			0.000		
1990			0.000		
1991			0.000		
1992			0.000		
1993			0.000		
1994			0.090		
1995			0.000		
1996			0.110		
1997			0.000		
1998			0.110		
1999			1.540		
2000		0.039	1.833		
2001	0.040	0.223	0.361		
2002	0.000	0.000	0.709		
2003	0.000	0.000	0.485		
2004	0.000	0.057	0.368		
2005	0.000	0.000	0.167		
2006	0.000	0.000	0.767		
2007	0.000	0.031	0.817		
2008	0.030	0.016	0.400		
2009	0.000	0.021	1.230	0.222	
2010	0.030	0.011	0.827	0.722	
2011	0.000	0.131	1.217	0.667	
2012	1.500	1.571	3.188	4.333	
2013	0.350	0.180	0.710		
2014	0.350	0.303	0.850	0.222	
2015	0.040	0.334	1.725	0.056	
2016	0.600	1.526	2.643	0.444	1.817
2017	0.470	0.450	2.300	2.389	1.033
2018	1.140	1.154	3.096	4.111	8.967
2019	0.380	0.368	0.676	2.167	1.617
2020	0.380	0.615	2.074	4.667	1.583
2021	0.057	0.119	0.692	4.222	2.417
2019-2021 average	***0.272***	***0.367***	***1.147***	***3.685***	***1.872***
25th Percentile	***0.000***	***0.017***	***0.110***	***0.389***	***1.592***
75th Percentile	***0.380***	***0.359***	***1.230***	***4.139***	***2.267***

Table 20. **Coefficient of variation for Jonah crab settlement indices in GOM areas.**

Year	ME 511	ME 512	ME 513	NH 513	MA 514
1989			0.000		
1990			0.000		
1991			0.000		
1992			0.000		
1993			0.000		
1994			0.556		
1995			0.000		
1996			1.000		
1997			0.000		
1998			0.455		
1999			0.377		
2000		1.341	0.244		
2001	1.000	0.563	0.530		
2002	0.000	0.000	0.233		
2003	0.000	0.000	0.396		
2004	0.000	1.276	0.484		
2005	0.000	0.000	1.270		
2006	0.000	0.000	0.244		
2007	0.000	2.089	0.234		
2008	1.000	2.880	0.851		
2009	0.000	1.929	0.242	NA	
2010	1.000	2.824	0.323	NA	
2011	0.000	0.663	0.210	NA	
2012	0.200	0.120	0.144	NA	
2013	0.371	0.472	0.245		
2014	0.743	0.515	0.164	NA	
2015	1.000	0.533	0.163	NA	
2016	0.450	0.138	0.089	NA	0.148
2017	0.277	0.222	0.178	NA	0.171
2018	0.494	0.221	0.211	NA	0.082
2019	0.500	0.164	0.203	NA	0.117
2020	0.368	0.316	0.146	NA	0.195
2021	1.000	0.469	0.246	NA	0.116

Table 21. **Jonah crab recruit abundance indices in GOM areas.**

Year	IGOM	IGOM	IGOM	IGOM	IGOM	IGOM	OGOM	OGOM	GOM	GOM
	MA Trawl Spring	**MA Trawl Fall**	**ME/NH Trawl Spring**	**ME/NH Trawl Fall**	**NEFSC Trawl Spring**	**NEFSC Trawl Fall**	**NEFSC Trawl Spring**	**NEFSC Trawl Fall**	**NEFSC Trawl Spring**	**NEFSC Trawl Fall**
1980						0.149		0.000		0.050
1981					0.065		0.029		0.041	
1982	0.410	0.060			0.033	0.032	0.075	0.025	0.050	0.026
1983	0.030	0.440			0.000	0.045	0.000	0.032	0.000	0.037
1984	0.010	0.150			0.034	0.000	0.000	0.006	0.013	0.004
1985	0.020	0.410			0.000		0.000		0.000	
1986	0.020	0.080			0.000		0.000		0.000	
1987	0.070	0.290				0.000		0.000		0.000
1988	0.020	0.220			0.183		0.000		0.054	
1989	0.090	0.000			0.017	0.000	0.000	0.032	0.016	0.020
1990	0.000	0.040			0.000	0.000	0.000	0.000	0.000	0.000
1991	0.000	0.100			0.000	0.000	0.013	0.005	0.008	0.003
1992	0.020	0.120			0.000	0.024	0.000	0.072	0.000	0.062
1993	0.080	0.030			0.000	0.100	0.009	0.000	0.006	0.029
1994	0.040	0.040			0.189	0.026	0.000	0.041	0.058	0.035
1995	0.020	0.920			0.000	0.076	0.127	0.072	0.091	0.077
1996	0.060	0.050			0.016	0.044	0.000	0.135	0.006	0.114
1997	0.000	0.030			0.045	0.026	0.036	0.000	0.042	0.009
1998	0.060	0.000			0.158	0.060	0.047	0.035	0.082	0.045
1999	0.000	0.440			0.078	0.382	0.080	0.086	0.077	0.178
2000	0.140	0.760			0.490	0.160	0.033	0.203	0.202	0.189
2001	0.270	0.260			0.216	1.593	0.186	0.458	0.206	0.859
2002	0.120	0.690			0.454	0.264	0.232	0.319	0.315	0.297
2003	0.020	0.770			0.123	0.256	0.104	0.310	0.116	0.291
2004	0.070	0.490	1.588	1.810	0.009	0.307	0.055	0.204	0.040	0.245
2005	0.100	0.070	2.580	0.782	0.053	0.616	0.061	0.029	0.057	0.198
2006	0.040	0.360	2.610	0.981	0.011	0.127	0.040	0.009	0.029	0.051
2007	0.010	0.260	0.805	1.562	0.032	0.064	0.062	0.004	0.047	0.025
2008	0.030	0.850	0.779	1.325	0.009	0.164	0.000	0.033	0.003	0.074
2009	0.120	0.230	0.574	0.286	0.210	0.152	0.079	0.053	0.128	0.079
2010	0.000	0.560	0.305	0.308	0.178	0.038	0.142	0.230	0.155	0.160
2011	0.060	0.790	0.449	0.417	0.451	0.022	0.187	0.041	0.241	0.029
2012	0.020	0.430	0.268	0.290	0.207	0.116	0.056	0.045	0.113	0.070
2013	0.040	0.160	0.203	0.417	0.376	0.283	0.532	0.000	0.481	0.098
2014	0.000	0.350	0.578	0.341	2.266	0.795	1.894	0.385	2.123	0.516
2015	0.400	2.710	0.566	5.429	0.356	0.683	0.538	0.784	0.483	0.724
2016	0.850	0.770	2.437	3.017	1.290	0.443	1.790	0.395	1.548	0.392
2017	0.150	1.210	0.491	0.616	0.825		0.484		0.596	
2018	0.160	0.910	0.304	0.482	0.592	0.064	0.146	0.050	0.270	0.051
2019	0.040	0.040	0.237	0.343	0.187	0.377	0.056	0.081	0.115	0.216
2020				0.177						
2021	0.110	0.680	0.165	0.147	0.619	0.173	0.069	0.070	0.217	0.109
2019-2021 average	***0.075***	***0.360***	***0.201***	***0.222***	***0.403***	***0.275***	***0.062***	***0.075***	***0.166***	***0.162***
25th Percentile	***0.020***	***0.075***	***0.304***	***0.316***	***0.010***	***0.030***	***0.000***	***0.008***	***0.014***	***0.029***
75th Percentile	***0.105***	***0.685***	***0.805***	***1.239***	***0.286***	***0.269***	***0.134***	***0.152***	***0.204***	***0.191***

Table 22. **Coefficient of variation for Jonah crab recruit abundance indices in GOM areas.**

Year	IGOM MA Trawl Spring	IGOM MA Trawl Fall	IGOM ME/NH Trawl Spring	IGOM ME/NH Trawl Fall	IGOM NEFSC Trawl Spring	IGOM NEFSC Trawl Fall	OGOM NEFSC Trawl Spring	OGOM NEFSC Trawl Fall	GOM NEFSC Trawl Spring	GOM NEFSC Trawl Fall
1980						0.658		Inf		0.658
1981					0.604		0.464		0.372	
1982	0.670	0.760			1.000	0.777	1.000	0.707	0.799	0.534
1983	1.000	0.260			Inf	0.604		1.000	Inf	0.597
1984	1.000	0.610			0.938	Inf	Inf	1.000	1.005	1.000
1985	1.000	0.470			Inf		Inf		Inf	
1986	1.000	0.500			Inf		Inf		Inf	
1987	0.710	0.460				Inf		Inf		Inf
1988	1.000	0.250			0.893		Inf		0.883	
1989	0.750				1.000	Inf	Inf	1.000	1.000	1.000
1990		0.750			Inf	Inf	Inf	Inf	Inf	Inf
1991		0.600			Inf	Inf	1.000	1.000	1.000	1.000
1992	1.000	1.000			Inf	1.211	Inf	1.000	Inf	0.905
1993	0.590	0.710			Inf	1.000	1.000	Inf	1.000	1.000
1994	0.720	0.710			1.000	1.000	Inf	0.741	1.000	0.610
1995	1.000	0.390			Inf	0.769	0.412	0.713	0.420	0.553
1996	0.520	0.730			1.211	0.779	Inf	0.605	1.382	0.550
1997		1.000			0.612	1.000	1.000	Inf	0.699	1.000
1998	0.580				0.382	0.672	0.583	1.000	0.346	0.602
1999		0.380			0.791	0.581	0.618	0.889	0.487	0.474
2000	0.550	0.330			0.623	0.431	0.811	0.440	0.571	0.328
2001	0.400	0.290			0.417	0.194	0.426	0.357	0.318	0.178
2002	0.330	0.510			0.291	0.420	0.443	0.342	0.258	0.270
2003	1.000	0.240			1.000	0.473	0.436	0.346	0.481	0.275
2004	0.610	0.420	0.479	0.265	1.000	0.972	0.725	0.545	0.665	0.530
2005	0.480	0.570	0.294	0.354	1.000	0.757	0.719	0.892	0.584	0.717
2006	0.710	0.400	0.471	0.666	1.211	0.546	1.467	1.000	1.223	0.517
2007	1.000	0.360	0.385	0.291	1.000	0.541	0.658	1.000	0.570	0.497
2008	0.580	0.330	0.325	0.270	1.000	0.523	Inf	0.601	1.000	0.428
2009	0.470	0.460	0.411	0.569	0.359	0.528	0.467	0.711	0.286	0.424
2010		0.190	0.527	0.554	0.507	0.670	0.865	0.628	0.540	0.582
2011	0.580	0.310	0.533	0.539	0.562	0.584	0.621	0.801	0.385	0.599
2012	1.000	0.250	0.569	0.437	0.329	0.571	0.584	0.708	0.295	0.444
2013	1.000	0.420	0.604	0.620	0.541	0.345	0.464	Inf	0.406	0.355
2014		0.340	0.684	0.539	0.290	0.218	0.209	0.299	0.174	0.198
2015	0.290	0.430	0.487	0.545	0.495	0.251	0.266	0.371	0.219	0.235
2016	0.210	0.270	0.340	0.340	0.253	0.348	0.347	0.425	0.242	0.307
2017	0.400	0.260	0.443	0.392	0.318		0.248		0.204	
2018	0.400	0.320	0.662	0.516	0.611	0.614	0.562	0.707	0.413	0.487
2019	0.500	1.000	0.879	0.498	0.641	0.300	0.722	0.554	0.465	0.279
2020				0.721						
2021	0.720	0.710	0.672	0.794	0.565	0.488	0.784	0.528	0.333	0.361

Table 23. **Jonah crab recruit abundance indices in SNE areas and coastwide.**

Year	ISNE	ISNE	OSNE	OSNE	Coastwide	Coastwide
	NEFSC Trawl Spring	NEFSC Trawl Fall	NEFSC Trawl Spring	NEFSC Trawl Fall	NEFSC Trawl Spring	NEFSC Trawl Fall
1980		0.000		0.005		0.019
1981	0.000		0.064		0.050	
1982	0.125	0.000	0.091	0.026	0.061	0.021
1983	0.000	0.000	0.000	0.059	0.000	0.044
1984	0.000	0.000	0.000	0.007	0.004	0.005
1985	0.000		0.006		0.007	
1986	0.000		0.010		0.005	
1987		0.100		0.043		0.026
1988	0.000		0.047		0.043	
1989	0.000	0.000	0.000	0.060	0.007	0.038
1990	0.000	0.000	0.000	0.000	0.000	0.000
1991	0.000	0.000	0.000	0.048	0.002	0.025
1992	0.449	0.000	0.000	0.058	0.023	0.043
1993	0.000	0.000	0.000	0.007	0.002	0.013
1994	0.000	0.000	0.000	0.002	0.018	0.012
1995	0.000	0.000	0.002	0.000	0.032	0.029
1996	0.000	0.501	0.001	0.000	0.004	0.052
1997	0.000	0.288	0.001	0.000	0.012	0.008
1998	0.000	0.073	0.009	0.008	0.041	0.020
1999	0.000	0.000	0.066	0.010	0.060	0.065
2000	0.000	0.090	0.040	0.055	0.093	0.106
2001	0.000	0.294	0.019	0.103	0.076	0.350
2002	0.147	0.090	0.086	0.134	0.149	0.183
2003	0.000	0.090	0.033	0.154	0.058	0.180
2004	0.000	0.058	0.000	0.027	0.021	0.097
2005	0.000	0.000	0.010	0.012	0.023	0.073
2006	0.159	0.000	0.010	0.051	0.016	0.044
2007	0.042	0.137	0.041	0.087	0.038	0.068
2008	0.000	0.000	0.019	0.027	0.015	0.042
2009	0.000	0.088	0.014	0.057	0.048	0.062
2010	0.021	0.058	0.009	0.163	0.063	0.142
2011	0.000	0.000	0.023	0.052	0.089	0.047
2012	0.000	0.154	0.004	0.144	0.041	0.111
2013	0.000	0.111	0.009	0.075	0.168	0.071
2014		0.064		0.117		0.224
2015	0.000	0.469	0.002	0.111	0.147	0.298
2016	0.000	0.171	0.032	0.040	0.513	0.176
2017	0.000		0.028		0.294	
2018	0.000	0.000	0.018	0.100	0.126	0.073
2019	0.000	0.128	0.000	0.021	0.038	0.087
2020						
2021	0.000	0.012	0.020	0.177	0.102	0.127
2019-2021 average	***0.000***	***0.070***	***0.010***	***0.099***	***0.070***	***0.107***
25th Percentile	***0.000***	***0.000***	***0.000***	***0.009***	***0.013***	***0.026***
75th Percentile	***0.000***	***0.103***	***0.027***	***0.090***	***0.073***	***0.107***

Table 24. **Coefficient of variation for Jonah crab recruit abundance indices in SNE areas and coastwide.**

Year	ISNE	ISNE	OSNE	OSNE	Coastwide	Coastwide
	NEFSC Trawl Spring	NEFSC Trawl Fall	NEFSC Trawl Spring	NEFSC Trawl Fall	NEFSC Trawl Spring	NEFSC Trawl Fall
1980		Inf		0.756		0.568
1981	Inf		0.361		0.256	
1982	1.000	Inf	0.304	0.597	0.276	0.429
1983	Inf	Inf	Inf	0.461	Inf	0.372
1984	Inf	Inf	Inf	0.764	1.076	0.609
1985	Inf		1.515		0.909	
1986	Inf		1.000		1.000	
1987		1.400		0.410		0.333
1988			0.492		0.459	
1989	Inf	Inf	Inf	0.468	0.781	0.418
1990	Inf	Inf	Inf	Inf	Inf	Inf
1991	Inf	Inf	Inf	0.532	1.000	0.514
1992	1.000	Inf	Inf	0.473	1.000	0.444
1993	Inf	Inf	Inf	1.000	1.000	0.770
1994	Inf	Inf	Inf	1.000	1.000	0.557
1995		Inf	1.519	Inf	0.406	0.477
1996	Inf	0.803	1.000	Inf	0.862	0.440
1997	Inf	0.783	1.000	Inf	0.632	0.625
1998	Inf	1.000	1.000	1.000	0.358	0.493
1999	Inf	Inf	0.633	1.000	0.422	0.424
2000	Inf	1.000	0.917	0.435	0.448	0.253
2001	Inf	1.000	0.956	0.285	0.302	0.149
2002	1.000	1.400	0.490	0.351	0.232	0.212
2003	Inf	1.400	0.673	0.294	0.370	0.192
2004	Inf	1.000	Inf	0.556	0.498	0.427
2005	Inf	Inf	1.000	1.000	0.507	0.608
2006	0.783	Inf	1.000	0.418	0.514	0.320
2007	1.000	1.000	0.947	0.266	0.585	0.220
2008	Inf	Inf	0.710	0.537	0.546	0.320
2009	Inf	0.638	0.708	0.334	0.267	0.247
2010	1.000	1.000	1.000	0.380	0.434	0.309
2011	Inf	Inf	0.580	0.342	0.338	0.295
2012	Inf	1.093	1.000	0.451	0.277	0.322
2013		0.661	1.000	0.479	0.345	0.296
2014		0.949		0.332		0.159
2015		1.000	1.000	0.356	0.217	0.192
2016	Inf	1.000	0.430	0.396	0.227	0.247
2017	Inf		0.560		0.282	
2018	Inf	Inf	0.828	0.262	0.302	0.231
2019	Inf	1.000	Inf	0.556	0.435	0.230
2020						
2021	Inf	0.000	0.729	0.306	0.273	0.243

Table 25. **Jonah crab exploitable abundance indices in GOM areas.**

Year	IGOM	IGOM	IGOM	IGOM	IGOM	IGOM	OGOM	OGOM	GOM	GOM
	MA Trawl Spring	**MA Trawl Fall**	**ME/NH Trawl Spring**	**ME/NH Trawl Fall**	**NEFSC Trawl Spring**	**NEFSC Trawl Fall**	**NEFSC Trawl Spring**	**NEFSC Trawl Fall**	**NEFSC Trawl Spring**	**NEFSC Trawl Fall**
10						0.087		0.025		0.045
1981					0.062		0.204		0.160	
1982	0.020	0.150			0.000	0.056	0.075	0.012	0.038	0.026
1983	0.000	0.630			0.022	0.000	0.000	0.009	0.007	0.006
1984	0.010	0.080			0.095	0.000	0.000	0.000	0.037	0.000
1985	0.120	0.680			0.088		0.000		0.023	
1986	0.040	0.310			0.000		0.000		0.000	
1987	0.090	0.430				0.000		0.033		0.021
1988	0.000	0.090			0.081		0.025		0.039	
1989	0.030	0.140			0.000	0.000	0.006	0.064	0.004	0.036
1990	0.010	0.030			0.000	0.000	0.041	0.007	0.015	0.005
1991	0.040	0.230			0.000	0.000	0.013	0.005	0.008	0.003
1992	0.100	0.210			0.000	0.000	0.012	0.036	0.008	0.028
1993	0.130	0.080			0.000	0.200	0.092	0.150	0.072	0.169
1994	0.040	0.000			0.126	0.062	0.008	0.000	0.044	0.023
1995	0.100	0.320			0.000	0.031	0.063	0.076	0.048	0.068
1996	0.100	0.040			0.000	0.000	0.026	0.321	0.019	0.261
1997	0.070	0.020			0.071	0.075	0.031	0.087	0.042	0.080
1998	0.080	0.060			0.261	0.000	0.072	0.007	0.139	0.004
1999	0.030	0.220			0.075	0.267	0.165	0.052	0.125	0.124
2000	0.130	0.440			0.269	0.295	0.314	0.186	0.314	0.224
2001	0.170	0.240			0.586	0.482	0.275	0.414	0.413	0.437
2002	0.050	0.400			0.262	0.098	0.338	0.072	0.295	0.083
2003	0.070	0.860			0.215	0.288	0.034	0.212	0.117	0.236
2004	0.020	0.350	1.173	0.864	0.083	0.349	0.203	0.069	0.160	0.187
2005	0.060	0.170	1.825	0.709	0.106	0.280	0.036	0.034	0.057	0.102
2006	0.120	0.450	1.351	0.845	0.099	0.061	0.021	0.041	0.047	0.049
2007	0.080	0.430	2.208	1.435	0.124	0.045	0.000	0.087	0.043	0.072
2008	0.210	0.680	1.305	2.195	0.036	0.050	0.000	0.071	0.025	0.072
2009	0.050	0.030	1.457	0.427	0.477	0.128	0.194	0.280	0.295	0.214
2010	0.020	0.280	0.649	0.674	0.542	0.085	0.286	0.083	0.399	0.091
2011	0.130	0.560	0.675	0.291	0.405	0.181	0.233	0.261	0.299	0.233
2012	0.080	0.620	0.704	0.316	0.318	0.224	0.139	0.282	0.208	0.259
2013	0.030	0.150	0.332	0.234	0.240	0.286	0.257	0.018	0.259	0.113
2014	0.000	0.300	0.944	0.142	2.354	0.172	1.936	0.435	2.154	0.357
2015	0.290	1.470	0.636	1.812	1.144	0.335	0.933	0.783	1.042	0.625
2016	0.710	0.380	2.310	1.535	1.459	0.449	1.466	1.166	1.446	0.907
2017	0.250	2.140	0.796	1.436	0.851		0.846		0.862	
2018	0.180	0.500	0.616	0.735	1.485	0.420	1.095	0.834	1.215	0.674
2019	0.180	0.080	0.686	0.523	0.408	0.561	0.652	0.508	0.547	0.560
2020				0.065						
2021	0.080	0.300	0.299	0.146	1.250	0.393	0.640	0.265	0.914	0.314
2019-2021 average	***0.130***	***0.190***	***0.492***	***0.245***	***0.829***	***0.477***	***0.646***	***0.387***	***0.730***	***0.437***
25th Percentile	***0.030***	***0.115***	***0.649***	***0.298***	***0.029***	***0.024***	***0.017***	***0.031***	***0.038***	***0.034***
75th Percentile	***0.125***	***0.445***	***1.351***	***1.292***	***0.407***	***0.286***	***0.280***	***0.269***	***0.307***	***0.242***

Table 26. **Coefficient of variation for Jonah crab exploitable abundance indices in GOM areas.**

Year	IGOM	IGOM	IGOM	IGOM	IGOM	IGOM	OGOM	OGOM	GOM	GOM
	MA Trawl Spring	**MA Trawl Fall**	**ME/NH Trawl Spring**	**ME/NH Trawl Fall**	**NEFSC Trawl Spring**	**NEFSC Trawl Fall**	**NEFSC Trawl Spring**	**NEFSC Trawl Fall**	**NEFSC Trawl Spring**	**NEFSC Trawl Fall**
1980						0.655		1.000		0.550
1981					0.599		0.280		0.251	
1982	1.000	0.490			Inf	0.606	1.000	1.000	1.000	0.532
1983		0.310			1.000	Inf		1.000	1.000	1.000
1984	1.000	0.520			0.819	Inf	Inf	Inf	0.732	Inf
1985	0.610	0.190			1.000		Inf		1.000	
1986	1.000	0.390			Inf		Inf		Inf	
1987	0.540	0.310				Inf		1.000		1.000
1988		0.720			1.000		1.000		0.722	
1989	0.710	0.330			Inf	Inf	1.000	0.707	1.000	0.713
1990	1.000	1.000			Inf	Inf	1.000	1.000	1.000	1.000
1991	0.710	0.430			Inf	Inf	1.000	1.000	1.000	1.000
1992	0.660	0.640			Inf	Inf	1.000	1.000	1.000	1.000
1993	0.630	0.730			Inf	1.000	0.808	0.443	0.814	0.394
1994	0.720				1.000	1.000	1.000	Inf	0.888	1.000
1995	0.470	0.290			Inf	0.758	0.718	0.467	0.719	0.423
1996	0.670	0.810			Inf	Inf	1.000	0.576	1.000	0.555
1997	0.500	1.000			0.532	0.638	1.000	0.486	0.551	0.396
1998	0.640	0.780			0.438	Inf	0.614	1.000	0.352	1.000
1999	1.000	0.270			0.821	0.372	0.648	0.663	0.559	0.304
2000	0.430	0.280			0.399	0.494	0.459	0.441	0.364	0.341
2001	0.470	0.380			0.441	0.242	0.253	0.278	0.262	0.190
2002	0.590	0.570			0.291	0.786	0.311	0.569	0.233	0.478
2003	0.500	0.220			0.474	0.470	0.728	0.444	0.387	0.325
2004	1.000	0.320	0.454	0.304	0.900	0.525	1.000	0.573	0.819	0.363
2005	0.760	0.520	0.451	0.279	0.000	0.517	1.000	0.734	0.392	0.439
2006	0.390	0.300	0.282	0.319	0.627	1.000	1.000	0.710	0.541	0.603
2007	0.440	0.310	0.363	0.335	0.698	0.713	Inf	0.500	0.720	0.420
2008	0.330	0.330	0.289	0.237	0.798	0.654	Inf	0.581	0.887	0.455
2009	0.580	1.000	0.295	0.326	0.389	0.636	0.311	0.415	0.264	0.344
2010	1.000	0.300	0.419	0.603	0.363	0.691	0.372	0.539	0.260	0.407
2011	0.560	0.320	0.415	0.502	0.346	0.511	0.543	0.785	0.281	0.685
2012	0.450	0.350	0.354	0.433	0.278	0.500	0.483	0.440	0.246	0.335
2013	0.720	0.580	0.438	0.556	0.468	0.305	0.296	1.000	0.246	0.298
2014		0.450	0.454	0.645	0.254	0.401	0.275	0.423	0.189	0.377
2015	0.500	0.250	0.432	0.424	0.314	0.251	0.278	0.283	0.194	0.226
2016	0.190	0.220	0.392	0.321	0.480	0.272	0.194	0.271	0.228	0.224
2017	0.360	0.550	0.405	0.316	0.202		0.312		0.204	
2018	0.420	0.340	0.377	0.502	0.144	0.446	0.340	0.279	0.161	0.245
2019	0.380	0.510	0.748	0.332	0.429	0.319	0.358	0.332	0.285	0.215
2020				0.905						
2021	0.510	0.450	0.590	0.708	0.226	0.334	0.464	0.272	0.273	0.225

Table 27. **Jonah crab exploitable abundance indices in SNE areas and coastwide.**

Year	ISNE	ISNE	OSNE	OSNE	Coastwide	Coastwide
	NEFSC Trawl Spring	NEFSC Trawl Fall	NEFSC Trawl Spring	NEFSC Trawl Fall	NEFSC Trawl Spring	NEFSC Trawl Fall
1980		0.000		0.014		0.021
1981	0.000		0.059		0.093	
1982	0.000	0.000	0.123	0.006	0.073	0.011
1983	0.000	0.000	0.007	0.009	0.006	0.007
1984	0.000	0.000	0.024	0.023	0.024	0.013
1985	0.000		0.027		0.022	
1986	0.000		0.003		0.001	
1987		0.000		0.010		0.012
1988	0.000		0.000		0.017	
1989	0.000	0.000	0.000	0.009	0.006	0.018
1990	0.000	0.000	0.007	0.000	0.009	0.001
1991	0.000	0.392	0.022	0.027	0.014	0.022
1992	0.000	0.000	0.000	0.019	0.002	0.019
1993	0.000	0.055	0.000	0.010	0.016	0.061
1994	0.000	0.259	0.000	0.000	0.014	0.018
1995	0.000	0.000	0.000	0.013	0.013	0.031
1996	0.000	0.000	0.000	0.025	0.006	0.087
1997	0.000	0.000	0.000	0.000	0.013	0.027
1998	0.000	0.110	0.089	0.001	0.095	0.005
1999	0.062	0.000	0.016	0.021	0.051	0.051
2000	0.000	0.180	0.054	0.023	0.125	0.100
2001	0.000	0.052	0.024	0.019	0.153	0.156
2002	0.147	0.000	0.022	0.037	0.113	0.047
2003	0.000	0.000	0.036	0.067	0.062	0.106
2004	0.000	0.000	0.000	0.016	0.054	0.073
2005	0.000	0.000	0.010	0.014	0.023	0.041
2006	0.042	0.000	0.000	0.009	0.019	0.024
2007	0.000	0.128	0.037	0.038	0.039	0.047
2008	0.000	0.000	0.017	0.009	0.019	0.034
2009	0.000	0.167	0.091	0.147	0.151	0.148
2010	0.000	0.031	0.054	0.118	0.156	0.109
2011	0.000	0.000	0.059	0.080	0.138	0.120
2012	0.000	0.073	0.047	0.199	0.110	0.198
2013	0.000	0.184	0.047	0.125	0.112	0.118
2014		0.000		0.138		0.178
2015	0.000	0.469	0.039	0.077	0.346	0.273
2016	0.000	0.000	0.020	0.039	0.486	0.322
2017	0.042		0.030		0.303	
2018	0.000	0.000	0.108	0.163	0.489	0.313
2019	0.000	0.196	0.000	0.181	0.170	0.304
2020						
2021	0.058	0.076	0.012	0.067	0.270	0.147
2019-2021 average	***0.029***	***0.136***	***0.006***	***0.124***	***0.220***	***0.226***
25th Percentile	***0.000***	***0.000***	***0.000***	***0.010***	***0.014***	***0.021***
75th Percentile	***0.000***	***0.084***	***0.045***	***0.070***	***0.135***	***0.127***

Table 28. **Coefficient of variation for Jonah crab exploitable abundance indices in SNE areas and coastwide.**

Year	ISNE	ISNE	OSNE	OSNE	Coastwide	Coastwide
	NEFSC Trawl Spring	NEFSC Trawl Fall	NEFSC Trawl Spring	NEFSC Trawl Fall	NEFSC Trawl Spring	NEFSC Trawl Fall
1980		Inf		0.586		0.412
1981	Inf		0.295		0.201	
1982	Inf	Inf	0.302	1.000	0.285	0.480
1983	Inf	Inf	1.000	1.000	0.727	0.790
1984	Inf	Inf	0.655	0.689	0.485	0.597
1985	Inf		0.514		0.478	
1986	Inf		1.000		1.000	
1987		Inf		1.000		0.726
1988			Inf		0.594	
1989	Inf	Inf	Inf	0.874	0.795	0.550
1990	Inf	Inf	1.613	Inf	0.868	1.000
1991	Inf	0.741	1.609	0.667	1.315	0.463
1992	Inf	Inf	Inf	0.710	1.000	0.598
1993	Inf	1.000	Inf	0.852	0.659	0.350
1994	Inf	1.000	Inf	Inf	0.884	0.609
1995		Inf	Inf	1.000	0.711	0.412
1996	Inf	Inf	Inf	0.579	1.000	0.477
1997	Inf		Inf	Inf	0.551	0.413
1998	Inf	1.000	0.546	1.000	0.322	0.622
1999	1.000	Inf	0.886	0.744	0.467	0.293
2000	Inf	0.500	0.689	0.661	0.278	0.286
2001	Inf	1.000	0.537	0.654	0.238	0.189
2002	1.000	Inf	0.649	0.783	0.216	0.403
2003	Inf	Inf	0.800	0.409	0.361	0.260
2004	Inf	Inf	Inf	0.723	0.832	0.304
2005	Inf	Inf	1.000	1.141	0.384	0.411
2006	1.000	Inf	Inf	0.874	0.490	0.495
2007	Inf	1.000	0.621	0.552	0.415	0.300
2008	Inf	Inf	1.000	1.000	0.620	0.390
2009	Inf	0.837	0.288	0.292	0.194	0.218
2010	Inf	1.000	0.529	0.284	0.230	0.212
2011	Inf	Inf	0.516	0.357	0.238	0.251
2012	Inf	0.500	0.516	0.326	0.206	0.223
2013		0.862	0.624	0.343	0.228	0.223
2014		Inf		0.311		0.199
2015		1.000	0.520	0.538	0.181	0.189
2016	Inf	Inf	0.647	0.431	0.214	0.222
2017	1.000		0.530		0.183	
2018	Inf	Inf	0.460	0.255	0.161	0.189
2019	Inf	0.756	Inf	0.227	0.278	0.155
2020						
2021	1.000	0.923	0.848	0.314	0.193	0.170

Table 29. **Jonah crab spawning abundance indices in GOM areas.**

Year	IGOM	IGOM	IGOM	IGOM	IGOM	IGOM	OGOM	OGOM	GOM	GOM
	MA Trawl Spring	**MA Trawl Fall**	**ME/NH Trawl Spring**	**ME/NH Trawl Fall**	**NEFSC Trawl Spring**	**NEFSC Trawl Fall**	**NEFSC Trawl Spring**	**NEFSC Trawl Fall**	**NEFSC Trawl Spring**	**NEFSC Trawl Fall**
1980						0.199		0.057		0.103
1981					0.345		0.045		0.134	
1982	0.970	0.610			0.000	0.073	0.000	0.020	0.000	0.032
1983	0.000	2.950			0.064	0.091	0.000	0.013	0.023	0.040
1984	0.120	2.750			0.000	0.000	0.000	0.000	0.000	0.000
1985	0.040	1.670			0.000		0.000		0.000	
1986	0.130	1.040			0.000		0.000		0.000	
1987	0.230	1.420				0.103		0.000		0.035
1988	0.000	0.430			0.000		0.111		0.070	
1989	0.040	0.050			0.000	0.041	0.000	0.032	0.000	0.035
1990	0.090	0.080			0.017	0.026	0.000	0.021	0.004	0.023
1991	0.000	0.470			0.000	0.000	0.098	0.005	0.075	0.003
1992	0.030	0.670			0.000	0.094	0.019	0.038	0.013	0.057
1993	0.150	0.190			0.000	0.133	0.031	0.073	0.020	0.083
1994	0.130	0.100			0.126	0.219	0.008	0.027	0.044	0.093
1995	0.020	1.660			0.096	0.022	0.063	0.028	0.067	0.025
1996	0.140	0.320			0.000	0.119	0.057	0.073	0.034	0.095
1997	0.030	0.090			0.197	0.221	0.049	0.083	0.094	0.139
1998	0.200	0.330			0.498	0.120	0.152	0.097	0.284	0.106
1999	0.110	0.480			0.019	0.283	0.109	0.441	0.082	0.400
2000	0.220	1.000			0.815	0.242	0.205	0.500	0.437	0.414
2001	0.650	0.250			1.486	1.375	0.647	1.191	0.978	1.349
2002	0.110	2.000			0.429	0.492	0.709	0.112	0.605	0.255
2003	0.080	2.260			0.144	0.454	0.361	0.308	0.304	0.382
2004	0.220	1.090	2.596	3.214	0.044	0.713	0.092	0.230	0.077	0.403
2005	0.240	0.600	4.553	2.498	0.159	0.694	0.242	0.110	0.204	0.285
2006	0.430	2.150	3.458	1.668	0.226	0.105	0.000	0.107	0.085	0.113
2007	0.090	1.570	1.913	2.038	0.009	0.073	0.000	0.074	0.003	0.073
2008	0.230	4.610	1.578	2.501	0.101	0.074	0.014	0.144	0.051	0.118
2009	0.130	0.650	1.315	1.083	0.331	0.259	0.216	0.055	0.261	0.134
2010	0.050	1.770	1.150	0.992	0.551	0.252	0.525	0.153	0.543	0.203
2011	0.460	4.080	1.005	1.003	0.500	0.114	0.166	0.269	0.279	0.221
2012	0.000	2.960	0.808	0.829	0.515	0.116	0.173	0.169	0.289	0.157
2013	0.060	0.570	0.529	0.739	0.681	0.154	0.485	0.096	0.546	0.126
2014	0.020	1.120	1.992	0.428	3.569	0.783	3.124	0.583	3.410	0.644
2015	0.880	8.670	1.718	8.181	1.293	0.858	1.551	1.373	1.532	1.089
2016	3.650	4.810	5.933	6.301	1.803	0.848	1.830	0.907	1.776	0.906
2017	0.880	7.580	1.291	3.335	1.211		0.598		0.815	
2018	0.540	5.060	0.751	7.657	1.307	1.303	0.358	0.480	0.691	0.778
2019	0.420	0.690	0.528	7.635	0.915	1.331	0.221	0.353	0.599	0.806
2020				1.371						
2021	0.350	0.820	0.433	2.120	1.291	0.360	0.275	0.484	0.619	0.514
2019-2021 average	***0.385***	***0.755***	***0.481***	***3.709***	***1.103***	***0.846***	***0.248***	***0.419***	***0.609***	***0.660***
25th Percentile	***0.045***	***0.475***	***0.808***	***1.023***	***0.005***	***0.093***	***0.011***	***0.036***	***0.029***	***0.069***
75th Percentile	***0.295***	***2.205***	***1.992***	***3.305***	***0.616***	***0.464***	***0.317***	***0.319***	***0.545***	***0.401***

Table 30. **Coefficient of variation for Jonah crab spawning abundance indices in GOM areas.**

Year	IGOM	IGOM	IGOM	IGOM	IGOM	IGOM	OGOM	OGOM	GOM	GOM
	MA Trawl Spring	MA Trawl Fall	ME/NH Trawl Spring	ME/NH Trawl Fall	NEFSC Trawl Spring	NEFSC Trawl Fall	NEFSC Trawl Spring	NEFSC Trawl Fall	NEFSC Trawl Spring	NEFSC Trawl Fall
1980						0.520		0.814		0.442
1981					0.407		0.369		0.328	
1982	0.740	0.520			Inf	0.664	Inf	1.142	Inf	0.639
1983		0.430			1.000	0.437		1.000	1.000	0.402
1984	0.560	0.640			Inf	Inf	Inf	Inf	Inf	Inf
1985	0.500	0.370			Inf		Inf		Inf	
1986	0.600	0.160			Inf		Inf		Inf	
1987	0.890	0.440				0.577		Inf		0.577
1988		0.180			Inf		0.430		0.475	
1989	1.000	1.000			Inf	0.757	Inf	1.000	Inf	0.673
1990	0.610	0.510			1.069	1.000	Inf	1.000	1.000	0.718
1991		0.450			Inf	Inf	0.500	1.000	0.500	1.000
1992	0.720	0.290			Inf	1.000	0.733	0.709	0.733	0.585
1993	0.790	0.420			Inf	0.792	1.000	0.740	1.000	0.523
1994	0.500	0.720			0.612	0.439	1.000	1.000	0.569	0.409
1995	1.000	0.300			1.069	1.000	0.718	1.000	0.551	0.773
1996	0.450	0.430			Inf	0.469	0.711	0.556	0.712	0.369
1997	0.720	0.580			0.515	0.435	0.733	0.671	0.412	0.340
1998	0.660	0.740			0.390	0.539	0.359	0.765	0.285	0.465
1999	0.530	0.360			0.737	0.380	0.507	0.409	0.439	0.304
2000	0.570	0.190			0.408	0.534	0.351	0.359	0.305	0.294
2001	0.420	0.300			0.251	0.311	0.258	0.275	0.185	0.218
2002	0.520	0.510			0.338	0.492	0.251	0.457	0.204	0.400
2003	0.810	0.140			0.514	0.348	0.376	0.292	0.306	0.216
2004	0.600	0.300	0.581	0.584	0.661	0.641	0.558	0.340	0.456	0.422
2005	0.750	0.420	0.348	0.457	0.538	0.737	0.522	0.443	0.410	0.554
2006	0.510	0.280	0.684	0.451	0.411	0.507	Inf	0.456	0.426	0.342
2007	0.470	0.190	0.422	0.360	1.000	0.489	Inf	0.529	1.000	0.382
2008	0.420	0.240	0.283	0.326	0.715	0.571	1.000	0.527	0.612	0.431
2009	0.330	0.470	0.310	0.422	0.410	0.644	0.333	0.660	0.259	0.434
2010	0.580	0.260	0.625	0.346	0.409	0.658	0.622	0.507	0.410	0.403
2011	0.570	0.250	0.438	0.417	0.309	0.454	0.447	0.740	0.254	0.661
2012		0.260	0.358	0.350	0.320	0.514	0.556	0.461	0.256	0.363
2013	0.820	0.240	0.556	0.324	0.397	0.399	0.339	0.511	0.255	0.346
2014	1.000	0.420	0.443	0.482	0.214	0.211	0.175	0.239	0.139	0.162
2015	0.420	0.220	0.426	0.593	0.247	0.243	0.159	0.424	0.155	0.286
2016	0.210	0.200	0.537	0.333	0.178	0.509	0.225	0.435	0.153	0.319
2017	0.240	0.290	0.340	0.293	0.335		0.348		0.251	
2018	0.400	0.220	0.368	0.416	0.502	0.568	0.364	0.414	0.286	0.389
2019	0.390	0.460	0.475	0.215	0.258	0.230	0.515	0.404	0.304	0.221
2020				0.678						
2021	0.780	0.620	0.488	0.402	0.210	0.403	0.454	0.326	0.196	0.271

Table 31. **Jonah crab spawning abundance indices in SNE areas and coastwide.**

Year	ISNE	ISNE	OSNE	OSNE	Coastwide	Coastwide
	NEFSC Trawl Spring	**NEFSC Trawl Fall**	**NEFSC Trawl Spring**	**NEFSC Trawl Fall**	**NEFSC Trawl Spring**	**NEFSC Trawl Fall**
1980		0.000		0.042		0.057
1981	0.064		0.134		0.123	
1982	0.000	0.000	0.149	0.110	0.079	0.072
1983	0.000	0.000	0.005	0.165	0.010	0.104
1984	0.000	0.157	0.000	0.078	0.000	0.049
1985	0.000		0.005		0.003	
1986	0.000		0.057		0.031	
1987		0.890		0.215		0.157
1988	0.000		0.121		0.087	
1989	0.000	0.000	0.005	0.149	0.003	0.094
1990	0.000	0.000	0.002	0.053	0.002	0.040
1991	0.000	0.135	0.000	0.063	0.015	0.043
1992	0.180	0.042	0.000	0.062	0.012	0.050
1993	0.000	0.000	0.016	0.010	0.018	0.034
1994	0.000	0.000	0.002	0.022	0.015	0.042
1995	0.064	0.000	0.036	0.035	0.061	0.038
1996	0.005	0.501	0.023	0.106	0.039	0.103
1997	0.000	0.425	0.010	0.000	0.036	0.055
1998	0.125	0.302	0.071	0.030	0.137	0.060
1999	0.062	0.058	0.084	0.216	0.081	0.236
2000	0.000	0.205	0.092	0.295	0.193	0.296
2001	0.092	0.617	0.076	0.263	0.381	0.636
2002	0.796	0.263	0.149	0.224	0.311	0.214
2003	0.010	5.155	0.027	0.605	0.147	0.561
2004	0.000	0.173	0.009	0.060	0.034	0.169
2005	0.000	0.000	0.008	0.126	0.070	0.158
2006	0.449	0.000	0.031	0.135	0.057	0.114
2007	0.042	0.000	0.055	0.314	0.030	0.200
2008	0.000	0.000	0.018	0.054	0.035	0.077
2009	0.104	0.029	0.082	0.270	0.138	0.203
2010	0.000	0.318	0.034	0.592	0.187	0.394
2011	0.010	0.000	0.026	0.377	0.110	0.319
2012	0.000	0.061	0.038	0.914	0.128	0.572
2013	0.000	0.211	0.050	0.129	0.225	0.119
2014		0.220		0.134		0.318
2015	0.000	0.979	0.020	0.230	0.491	0.475
2016	0.000	0.542	0.078	0.120	0.616	0.403
2017	0.000		0.030		0.277	
2018	0.000	0.394	0.126	0.199	0.336	0.374
2019	0.000	0.574	0.021	0.132	0.205	0.362
2020						
2021	0.030	0.012	0.045	0.173	0.247	0.273
2019-2021 average	***0.015***	***0.293***	***0.033***	***0.152***	***0.226***	***0.317***
25th Percentile	***0.000***	***0.000***	***0.009***	***0.061***	***0.030***	***0.059***
75th Percentile	***0.039***	***0.337***	***0.074***	***0.225***	***0.192***	***0.319***

Table 32. **Coefficient of variation for Jonah crab spawning abundance indices in SNE areas and coastwide.**

Year	ISNE	ISNE	OSNE	OSNE	Coastwide	Coastwide
	NEFSC Trawl Spring	NEFSC Trawl Fall	NEFSC Trawl Spring	NEFSC Trawl Fall	NEFSC Trawl Spring	NEFSC Trawl Fall
1980		Inf		0.506		0.334
1981	1.000		0.266		0.196	
1982	Inf	Inf	0.425	0.465	0.424	0.391
1983	Inf	Inf	1.000	0.290	0.788	0.256
1984	Inf	1.000	Inf	0.370	Inf	0.331
1985	Inf		1.000		1.000	
1986	Inf		0.555		0.554	
1987		0.644		0.260		0.222
1988			0.467		0.365	
1989	Inf	Inf	1.424	0.284	1.362	0.254
1990	Inf	Inf	1.000	0.377	0.707	0.318
1991	Inf	1.000	Inf	0.341	0.655	0.298
1992	1.000	1.000	Inf	0.685	0.767	0.471
1993	Inf	Inf	0.719	0.632	0.517	0.429
1994	Inf	Inf	1.000	0.596	0.540	0.328
1995	1.000	Inf	0.501	0.592	0.284	0.400
1996	1.000	0.345	1.000	0.314	0.545	0.209
1997	Inf	0.577	1.000	Inf	0.370	0.299
1998	1.399	0.707	0.461	0.589	0.233	0.314
1999	1.000	1.000	0.395	0.215	0.279	0.177
2000	Inf	0.900	0.517	0.346	0.253	0.220
2001	1.000	1.395	0.608	0.320	0.175	0.165
2002	0.637	1.049	0.378	0.216	0.169	0.198
2003	1.399	0.797	0.581	0.172	0.274	0.183
2004	Inf	1.000	1.000	0.383	0.386	0.327
2005	Inf	Inf	1.000	0.292	0.393	0.337
2006	0.784	Inf	0.544	0.407	0.305	0.281
2007	1.000	Inf	0.611	0.197	0.580	0.173
2008	Inf	Inf	0.708	0.457	0.406	0.283
2009	1.000	1.000	0.373	0.310	0.209	0.248
2010	Inf	0.837	0.483	0.201	0.371	0.177
2011	1.000	Inf	0.489	0.272	0.224	0.257
2012	Inf	0.721	0.536	0.677	0.207	0.575
2013		0.783	0.573	0.247	0.227	0.194
2014		0.800		0.252		0.156
2015		0.481	0.915	0.316	0.155	0.217
2016	Inf	0.948	0.542	0.266	0.144	0.262
2017	Inf		0.542		0.233	
2018	Inf	0.663	0.641	0.225	0.265	0.272
2019	Inf	0.900	0.964	0.303	0.274	0.181
2020						
2021	1.000	1.000	0.710	0.244	0.193	0.181

Table 33. **Mann-Kendall results for young-of-year settlement indices.**

Stock	Survey	SA	Since 2010			Full Time Series		
			n	tau	p-value	n	tau	p-value
IGOM	ME Settlement	511	12	0.18	0.45	21	0.53	0.00
IGOM	ME Settlement	512	12	0.24	0.30	22	0.50	0.00
IGOM	ME Settlement	513	12	0.00	1.00	33	0.62	0.00
IGOM	NH Settlement	513	11	0.35	0.16	12	0.41	0.07
IGOM	MA Settlement	514	6	0.07	1.00	6	0.07	1.00

Table 34. **Mann-Kendall results for recruit abundance indices.**

Stock	Survey	Season	Since 2010			Full Time Series		
			n	tau	p-value	n	tau	p-value
IGOM	MA Trawl	Spring	11	0.31	0.21	39	0.19	0.10
IGOM	MA Trawl	Fall	11	0.02	1.00	39	0.32	0.00
IGOM	ME/NH Trawl	Spring	11	-0.20	0.44	17	-0.56	0.00
IGOM	ME/NH Trawl	Fall	12	-0.15	0.54	18	-0.31	0.08
IGOM	NEFSC Trawl	Spring	11	0.20	0.44	39	0.49	0.00
IGOM	NEFSC Trawl	Fall	10	0.24	0.37	36	0.42	0.00
OGOM	NEFSC Trawl	Spring	11	-0.13	0.64	39	0.53	0.00
OGOM	NEFSC Trawl	Fall	10	0.16	0.59	36	0.35	0.00
GOM	NEFSC Trawl	Spring	11	0.05	0.88	39	0.54	0.00
GOM	NEFSC Trawl	Fall	10	0.16	0.59	36	0.41	0.00
ISNE	NEFSC Trawl	Spring	10	-0.45	0.16	38	-0.03	0.81
ISNE	NEFSC Trawl	Fall	10	0.04	0.93	36	0.29	0.02
OSNE	NEFSC Trawl	Spring	10	0.02	1.00	38	0.15	0.19
OSNE	NEFSC Trawl	Fall	10	-0.20	0.47	36	0.37	0.00
Coastwide	NEFSC Trawl	Spring	10	0.07	0.86	38	0.47	0.00
Coastwide	NEFSC Trawl	Fall	10	0.11	0.72	36	0.50	0.00

Table 35. **Mann-Kendall results for exploitable abundance indices.**

Stock	Survey	Season	Since 2010			Full Time Series		
			n	tau	p-value	n	tau	p-value
IGOM	MA Trawl	Spring	11	0.20	0.43	39	0.32	0.00
IGOM	MA Trawl	Fall	11	0.00	1.00	39	0.22	0.05
IGOM	ME/NH Trawl	Spring	11	-0.09	0.76	17	-0.41	0.02
IGOM	ME/NH Trawl	Fall	12	-0.18	0.45	18	-0.29	0.10
IGOM	NEFSC Trawl	Spring	11	0.24	0.35	39	0.59	0.00
IGOM	NEFSC Trawl	Fall	10	0.69	0.01	36	0.53	0.00
OGOM	NEFSC Trawl	Spring	11	0.20	0.44	39	0.51	0.00
OGOM	NEFSC Trawl	Fall	10	0.42	0.11	36	0.52	0.00
OGOM	Reference Fleet CPUE	All	12	-0.15	0.54	18	-0.32	0.07
GOM	NEFSC Trawl	Spring	11	0.24	0.35	39	0.58	0.00
GOM	NEFSC Trawl	Fall	10	0.51	0.05	36	0.58	0.00
ISNE	NEFSC Trawl	Spring	10	0.47	0.12	38	0.22	0.10
ISNE	NEFSC Trawl	Fall	10	0.17	0.58	36	0.24	0.07
ISNE	DRM CPUE	All	12	-0.55	0.02	15	-0.58	0.00
ISNE	CFRF VTS	NA	7	-0.14	0.76	7	-0.14	0.76
OSNE	NEFSC Trawl	Spring	10	-0.56	0.03	38	0.16	0.18
OSNE	NEFSC Trawl	Fall	10	-0.07	0.86	36	0.51	0.00
OSNE	DRM CPUE	All	12	0.03	0.95	15	0.03	0.92
OSNE	CFRF VTS	NA	6	0.07	1.00	6	0.07	1.00
Coastwide	NEFSC Trawl	Spring	10	0.33	0.21	38	0.52	0.00
Coastwide	NEFSC Trawl	Fall	10	0.47	0.07	36	0.66	0.00

Table 36. **Mann-Kendall results for spring recruit and fall exploitable abundance index ratios.**

Stock	Survey	n	tau	p-value
IGOM	MA Trawl	11	0.55	0.02
IGOM	ME/NH Trawl	11	-0.02	1.00
IGOM	NEFSC Trawl	10	-0.11	0.72
OGOM	NEFSC Trawl	10	-0.42	0.11
GOM	NEFSC Trawl	10	-0.33	0.21
ISNE	NEFSC Trawl	6	-0.58	0.24
OSNE	NEFSC Trawl	9	0.00	1.00
Coastwide	NEFSC Trawl	9	-0.11	0.75

Table 37. **Mann-Kendall results for spawning abundance indices.**

Stock	Survey	Season	Since 2010			Full Time Series		
			n	tau	p-value	n	tau	p-value
IGOM	MA Trawl	Spring	11	0.22	0.39	39	0.29	0.01
IGOM	MA Trawl	Fall	11	0.02	1.00	39	0.30	0.01
IGOM	ME/NH Trawl	Spring	11	-0.31	0.21	17	-0.53	0.00
IGOM	ME/NH Trawl	Fall	12	0.24	0.30	18	0.03	0.88
IGOM	NEFSC Trawl	Spring	11	0.35	0.16	39	0.61	0.00
IGOM	NEFSC Trawl	Fall	10	0.60	0.02	36	0.47	0.00
OGOM	NEFSC Trawl	Spring	11	-0.02	1.00	39	0.55	0.00
OGOM	NEFSC Trawl	Fall	10	0.33	0.21	36	0.60	0.00
GOM	NEFSC Trawl	Spring	11	0.24	0.35	39	0.61	0.00
GOM	NEFSC Trawl	Fall	10	0.33	0.21	36	0.57	0.00
ISNE	NEFSC Trawl	Spring	10	0.11	0.80	38	0.02	0.87
ISNE	NEFSC Trawl	Fall	10	0.29	0.28	36	0.25	0.04
OSNE	NEFSC Trawl	Spring	10	0.16	0.59	38	0.17	0.14
OSNE	NEFSC Trawl	Fall	10	-0.38	0.15	36	0.28	0.02
Coastwide	NEFSC Trawl	Spring	10	0.33	0.21	38	0.52	0.00
Coastwide	NEFSC Trawl	Fall	10	-0.20	0.47	36	0.48	0.00

Table 38. **Mann-Kendall results for relative exploitation time series.**

Stock	Survey	Season	n	tau	p-value
IGOM	MA Trawl	Spring	10	-0.16	0.59
IGOM	MA Trawl	Fall	11	0.09	0.76
IGOM	ME/NH Trawl	Spring	11	0.20	0.44
IGOM	ME/NH Trawl	Fall	12	0.24	0.30
IGOM	NEFSC Trawl	Spring	11	-0.13	0.64
IGOM	NEFSC Trawl	Fall	10	-0.42	0.11
OGOM	NEFSC Trawl	Spring	11	-0.60	0.01
OGOM	NEFSC Trawl	Fall	10	-0.60	0.02
OGOM	Reference Fleet CPUE	All	12	-0.33	0.15
GOM	NEFSC Trawl	Spring	11	-0.27	0.28
GOM	NEFSC Trawl	Fall	10	-0.42	0.11
ISNE	NEFSC Trawl	Fall	6	-0.33	0.45
ISNE	DRM CPUE	All	12	0.36	0.11
ISNE	CFRF VTS	NA	7	-0.05	1.00
OSNE	NEFSC Trawl	Spring	9	0.56	0.05
OSNE	NEFSC Trawl	Fall	10	0.29	0.28
OSNE	DRM CPUE	All	12	0.15	0.54
OSNE	CFRF VTS	NA	6	-0.47	0.26
Coastwide	NEFSC Trawl	Spring	10	-0.29	0.28
Coastwide	NEFSC Trawl	Fall	10	-0.33	0.21

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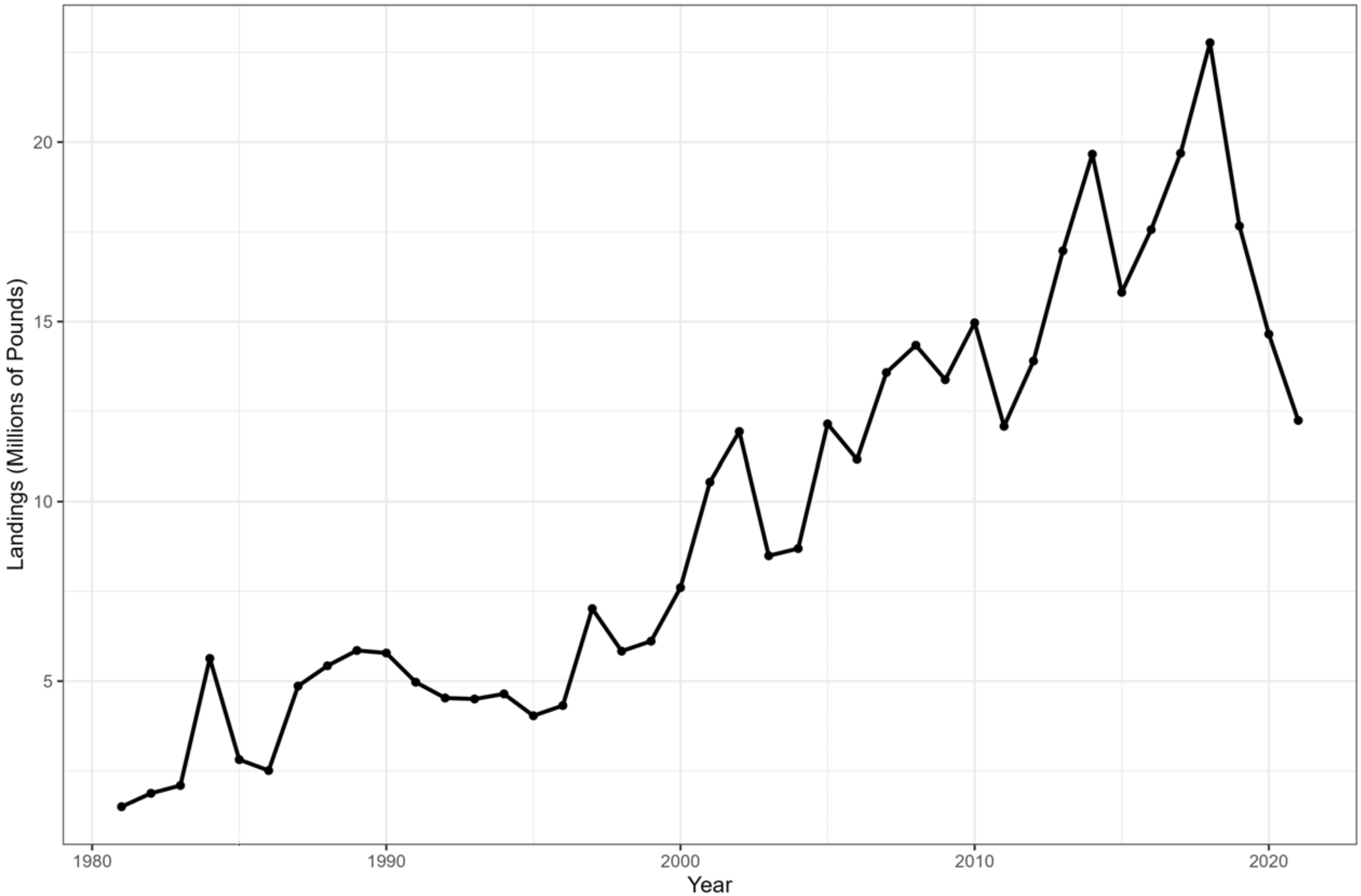

Figure 1. Coastwide landings of Jonah crab 1981-2021.

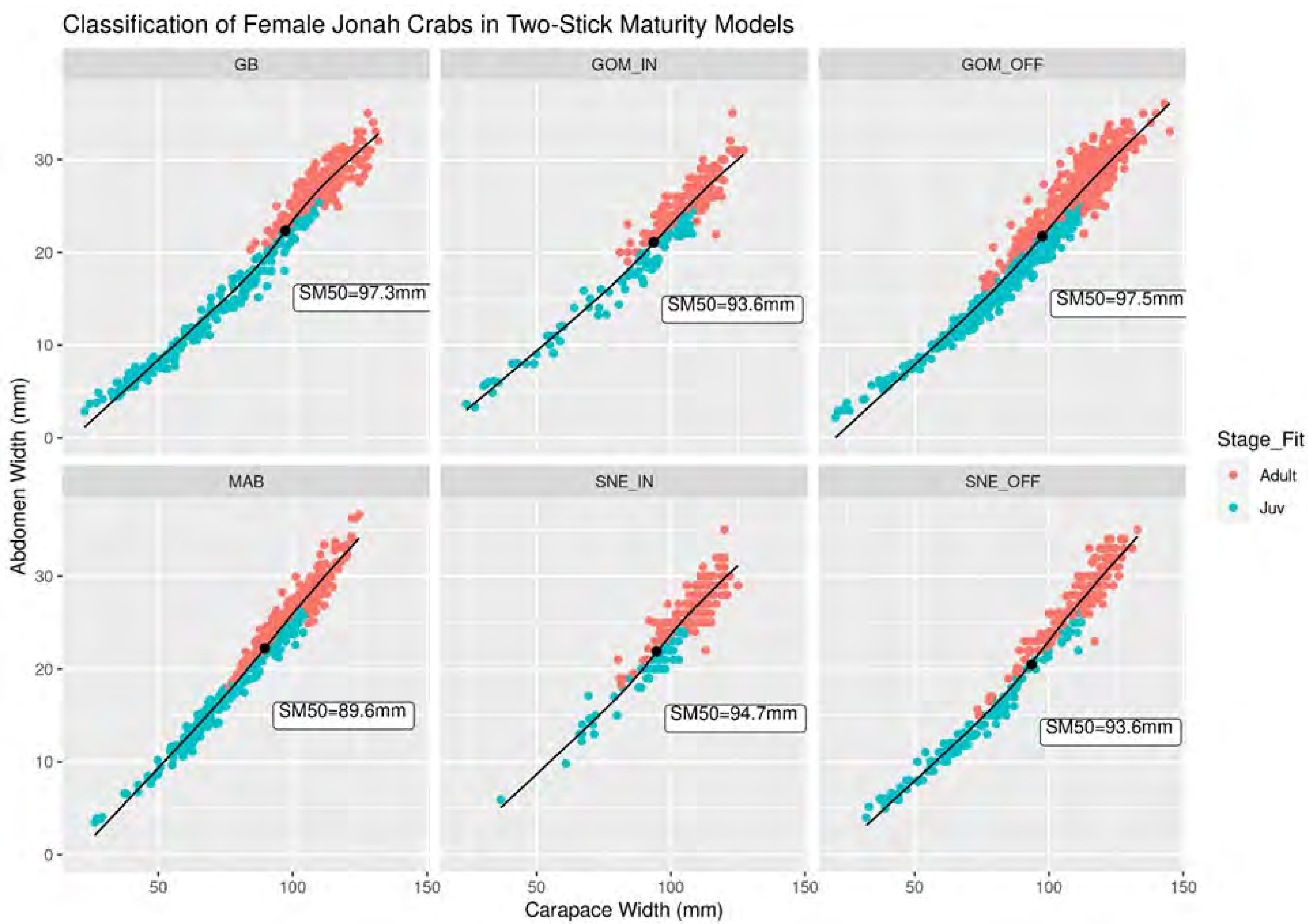

Figure 2. **Relationship between abdomen width and carapace width (CW) for female Jonah crabs with fitted mean prediction at CW and estimated size-at-maturity (SM50). Color indicates predicted maturity based on Somerton method.**

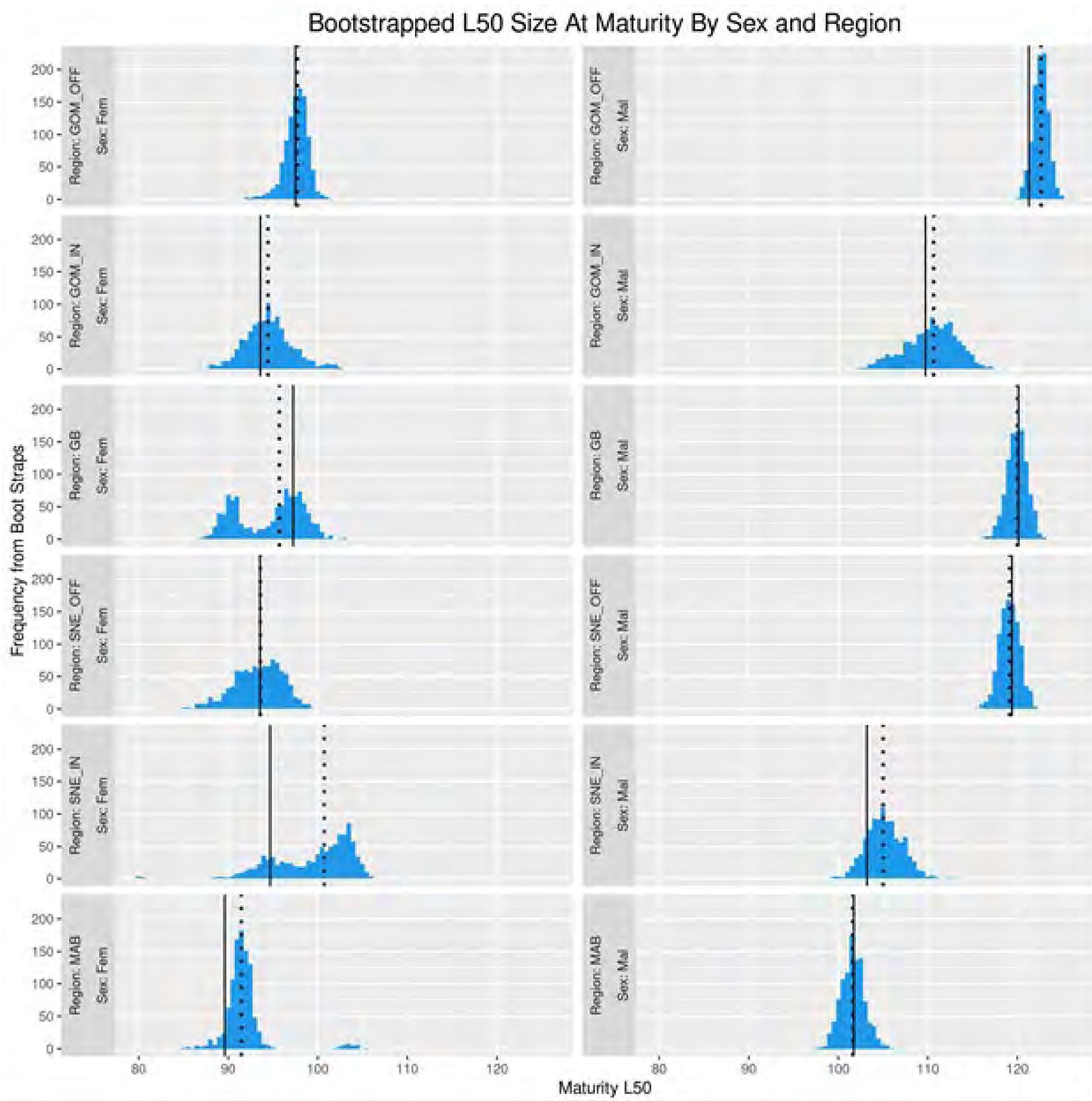

Figure 3. Bootstrapped distribution of size-at-maturity (SM50) by region and sex. Solid black line represents estimated SM50 while dotted line represents median of bootstrap.

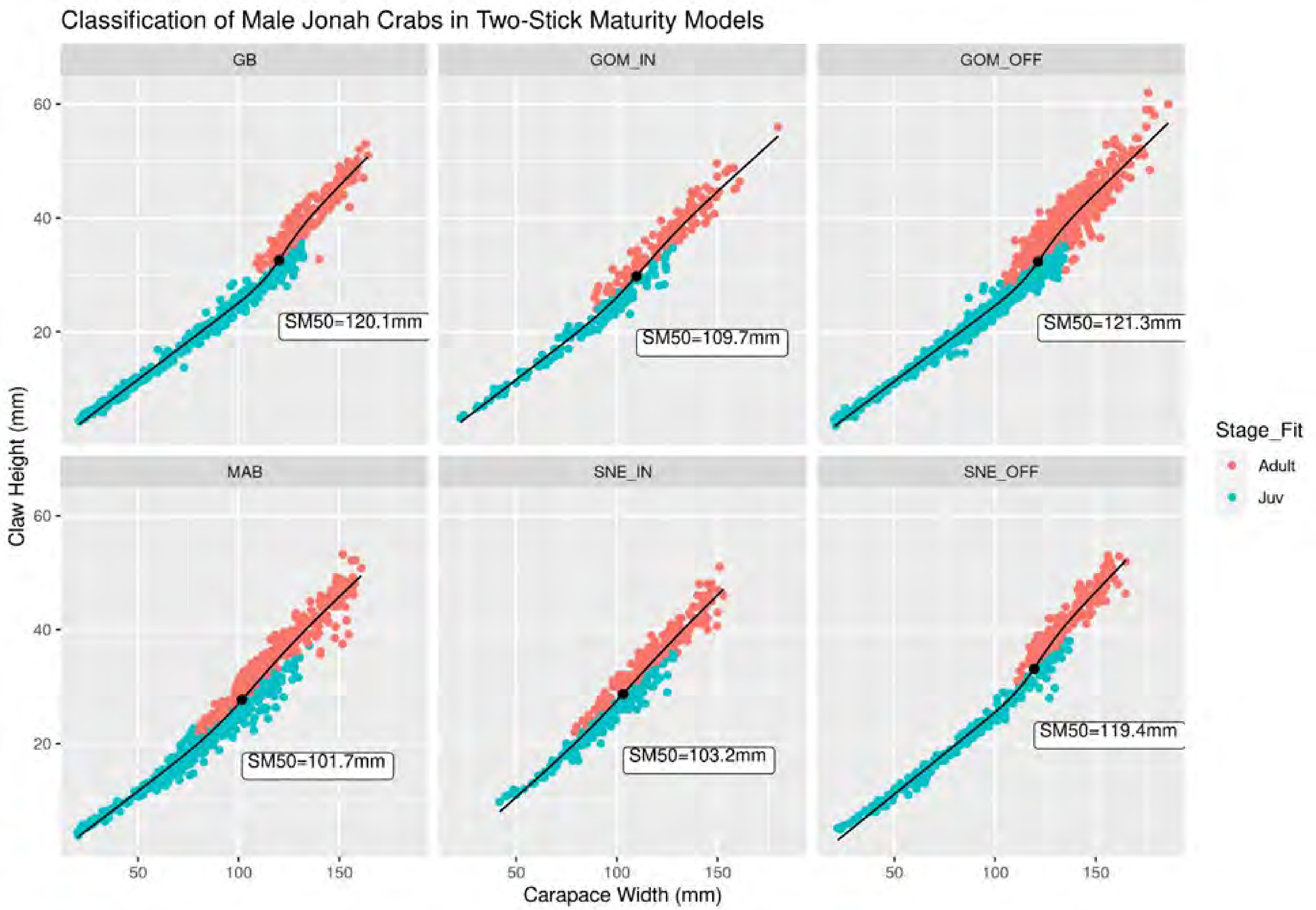

Figure 4. Relationship between claw height and carapace width (CW) for male Jonah crabs with fitted mean prediction at CW and estimated size-at-maturity (SM50). Color indicates predicted maturity based on Somerton method.

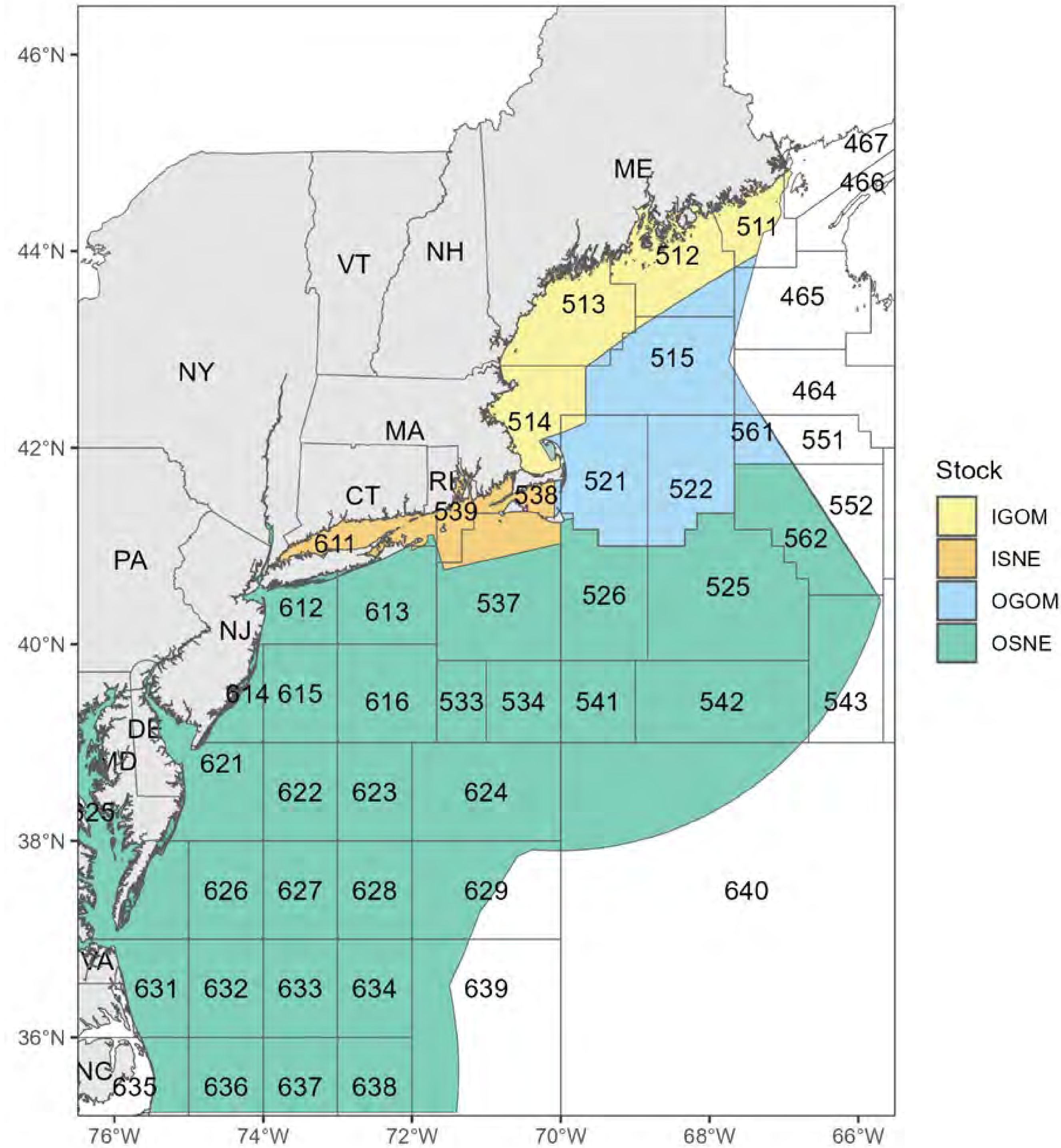

Figure 5. US Jonah crab stocks.

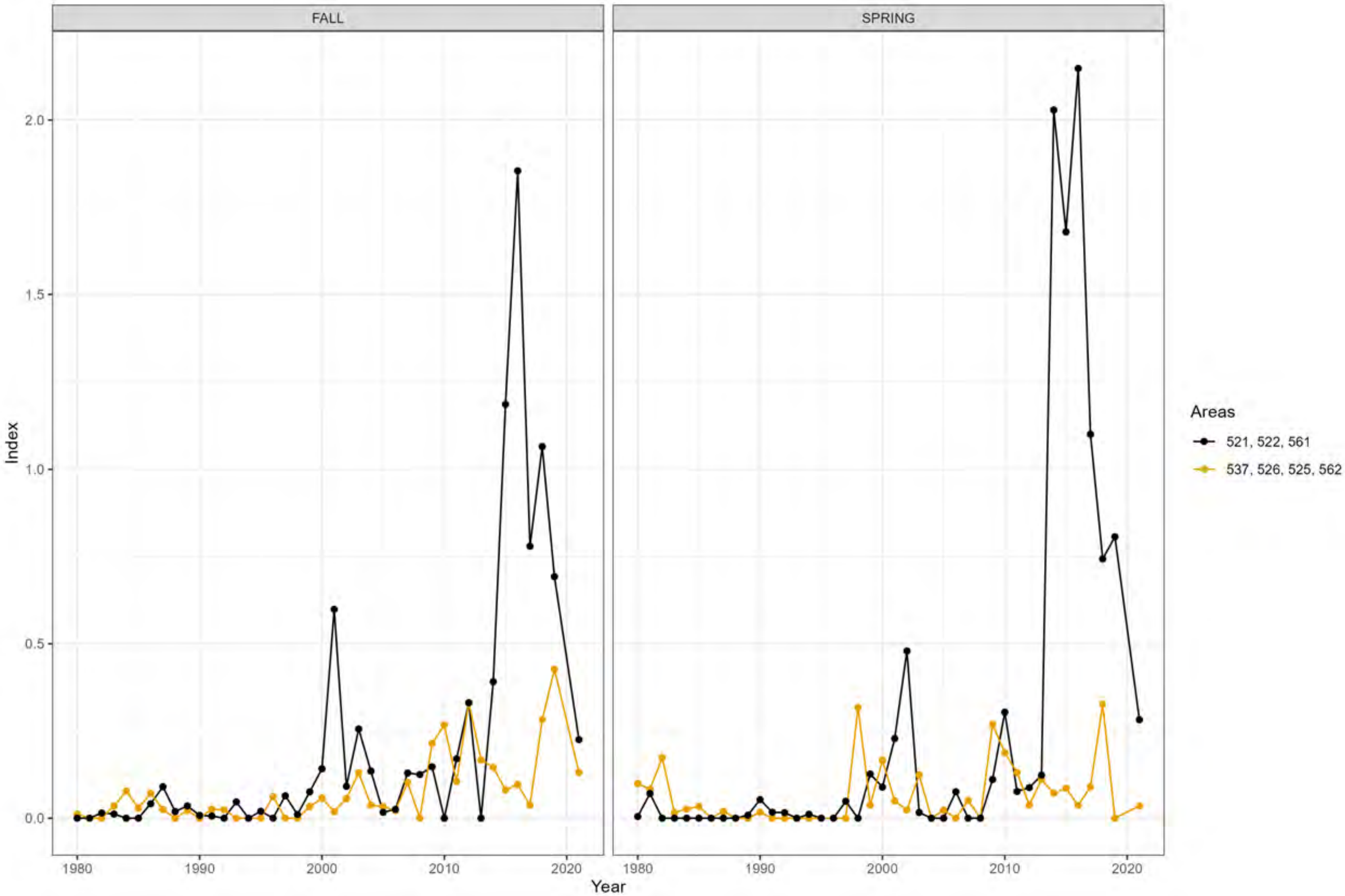

Figure 6. NEFSC Trawl Survey exploitable abundance indices (males 120mm+ CW) for adjacent NOAA statistical areas associated with high landings of Jonah crabs (Areas 537, 526, 525, 562) and low landings of Jonah crabs (Areas 521, 522, 561).

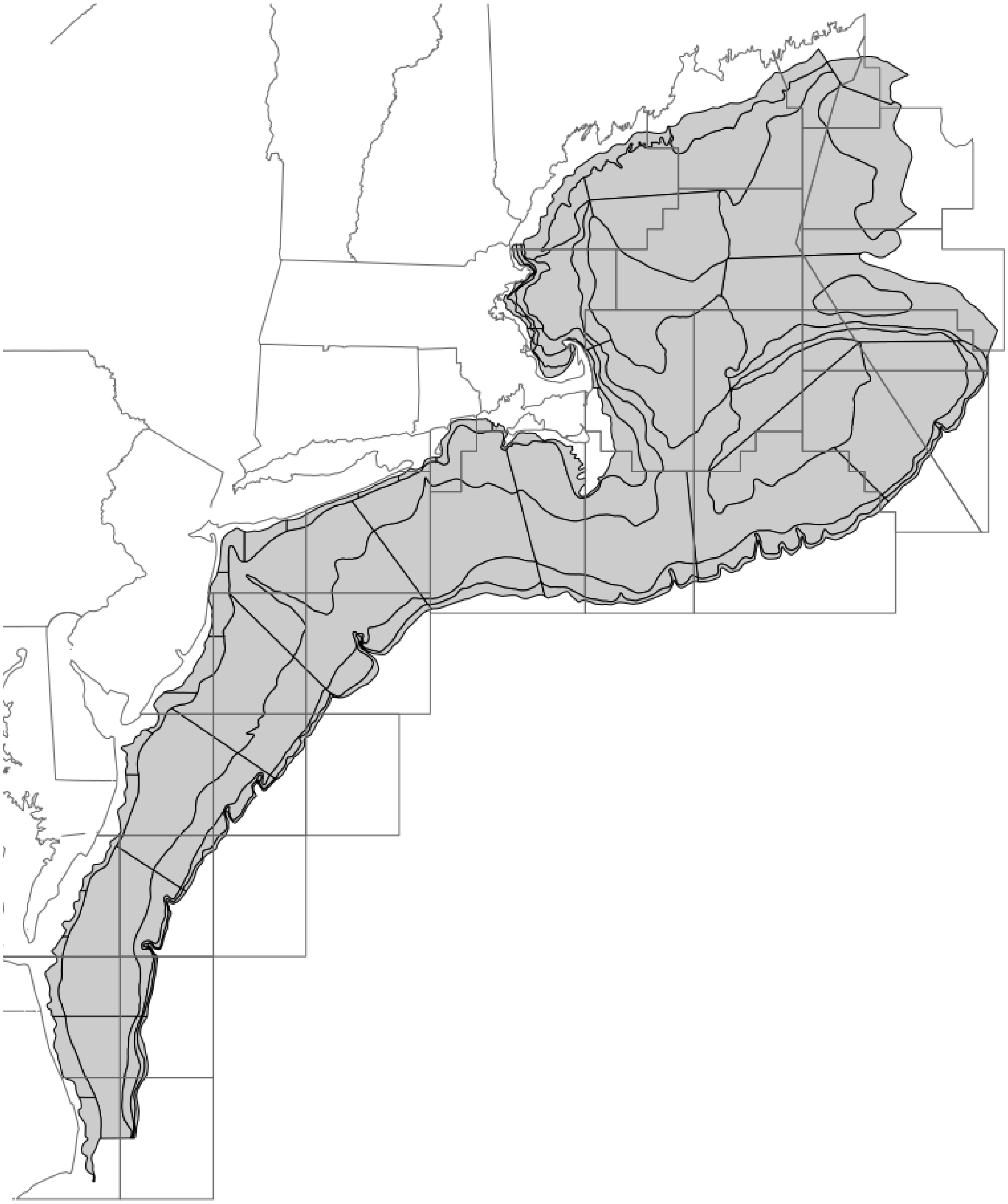

Figure 7. Survey footprint for the NEFSC Trawl Survey overlayed with NOAA statistical areas and depth contours.

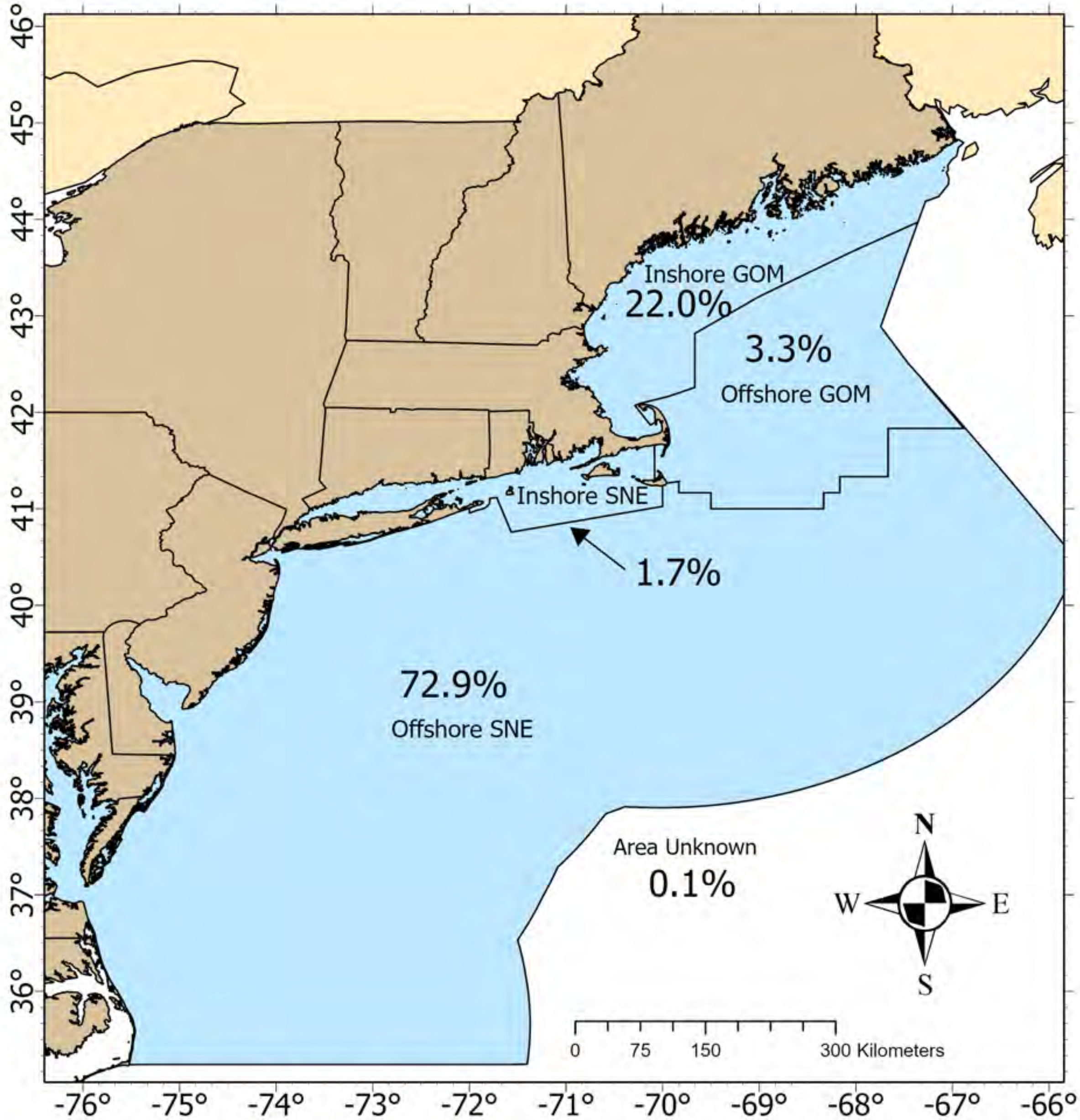

Figure 8. Percent of 2010 U.S. Jonah crab landings by stock area.

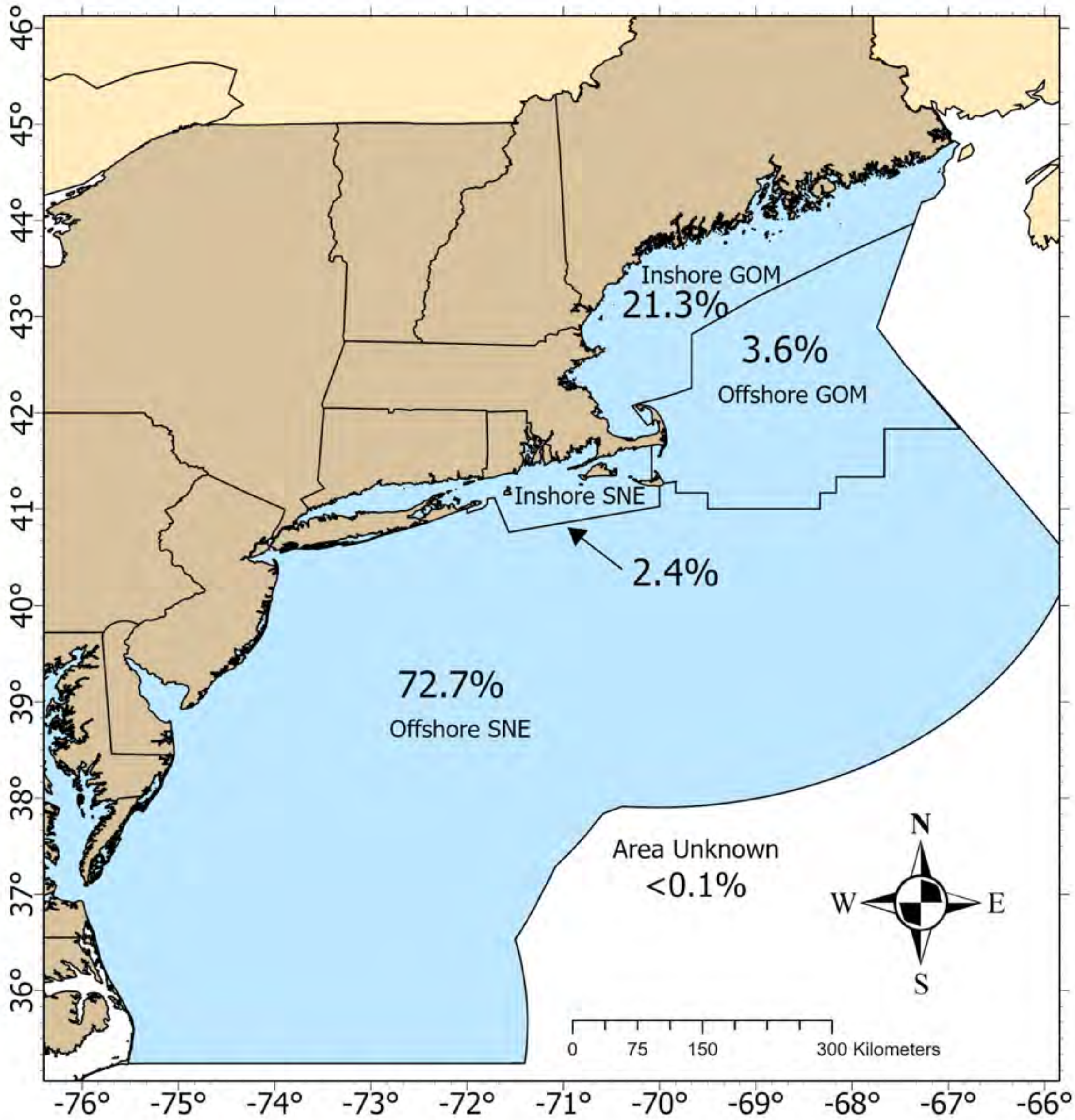

Figure 9. Percent of 2011 U.S. Jonah crab landings by stock area.

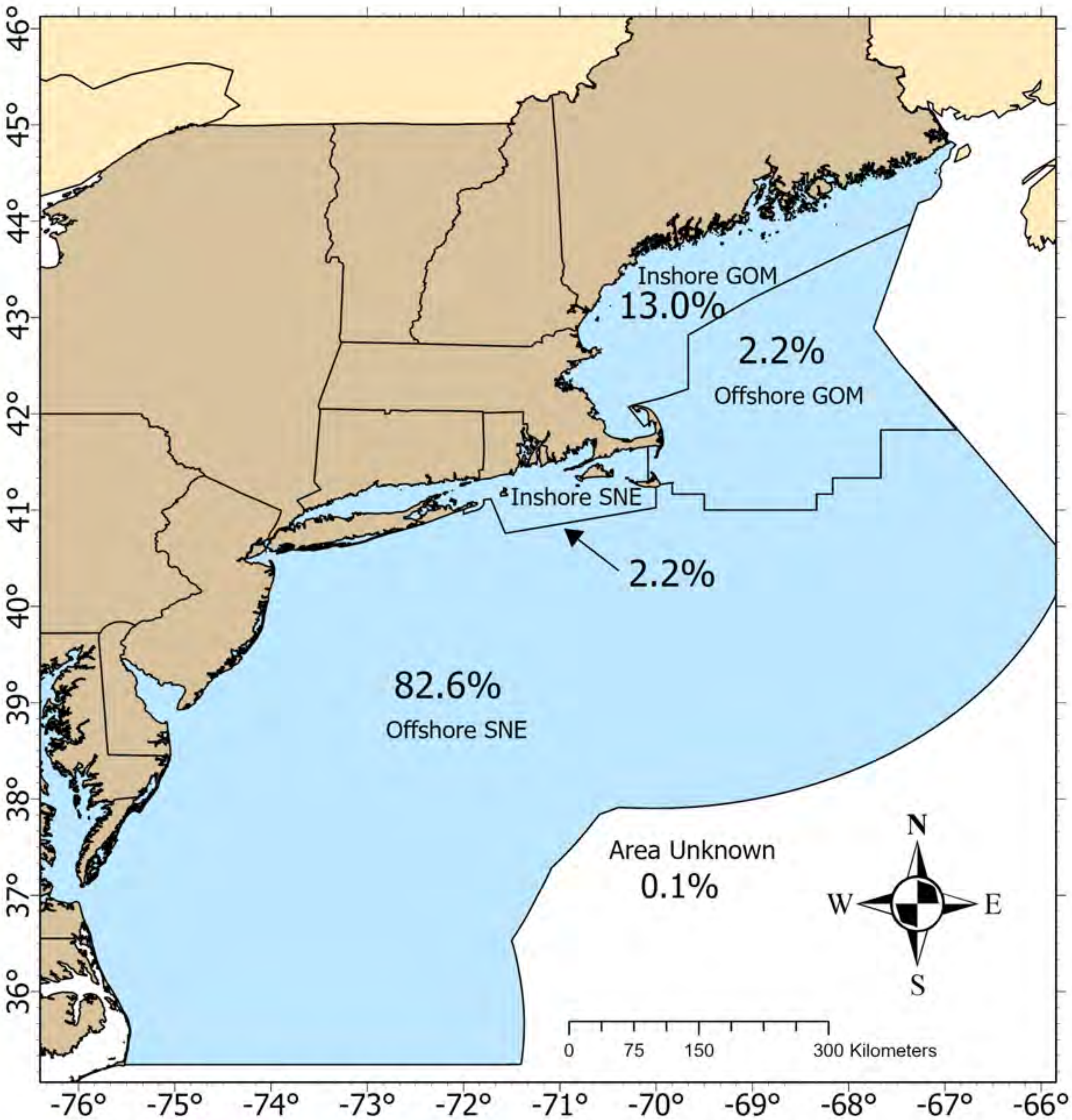

Figure 10. Percent of 2012 U.S. Jonah crab landings by stock area.

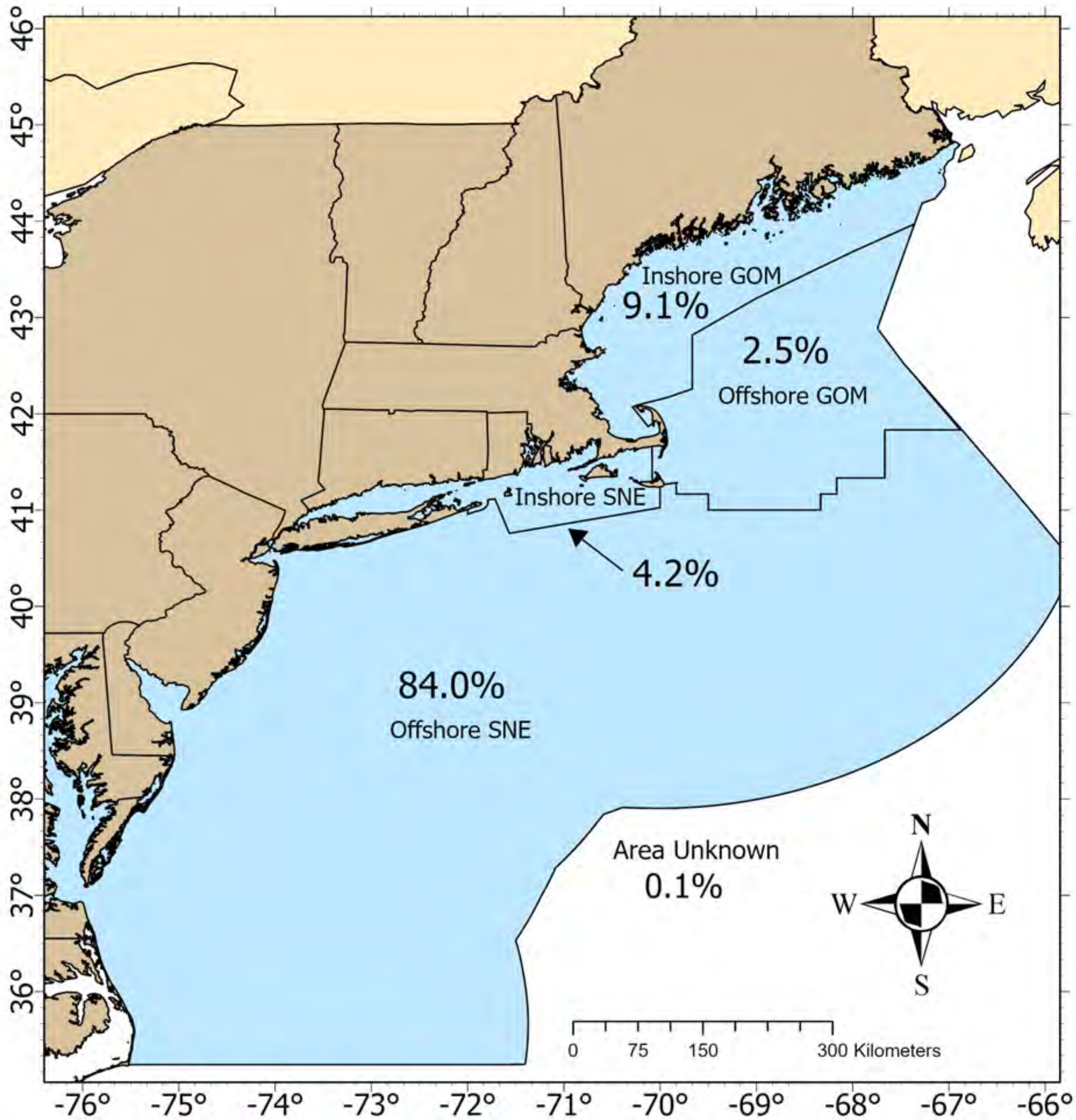

Figure 11. Percent of 2013 U.S. Jonah crab landings by stock area.

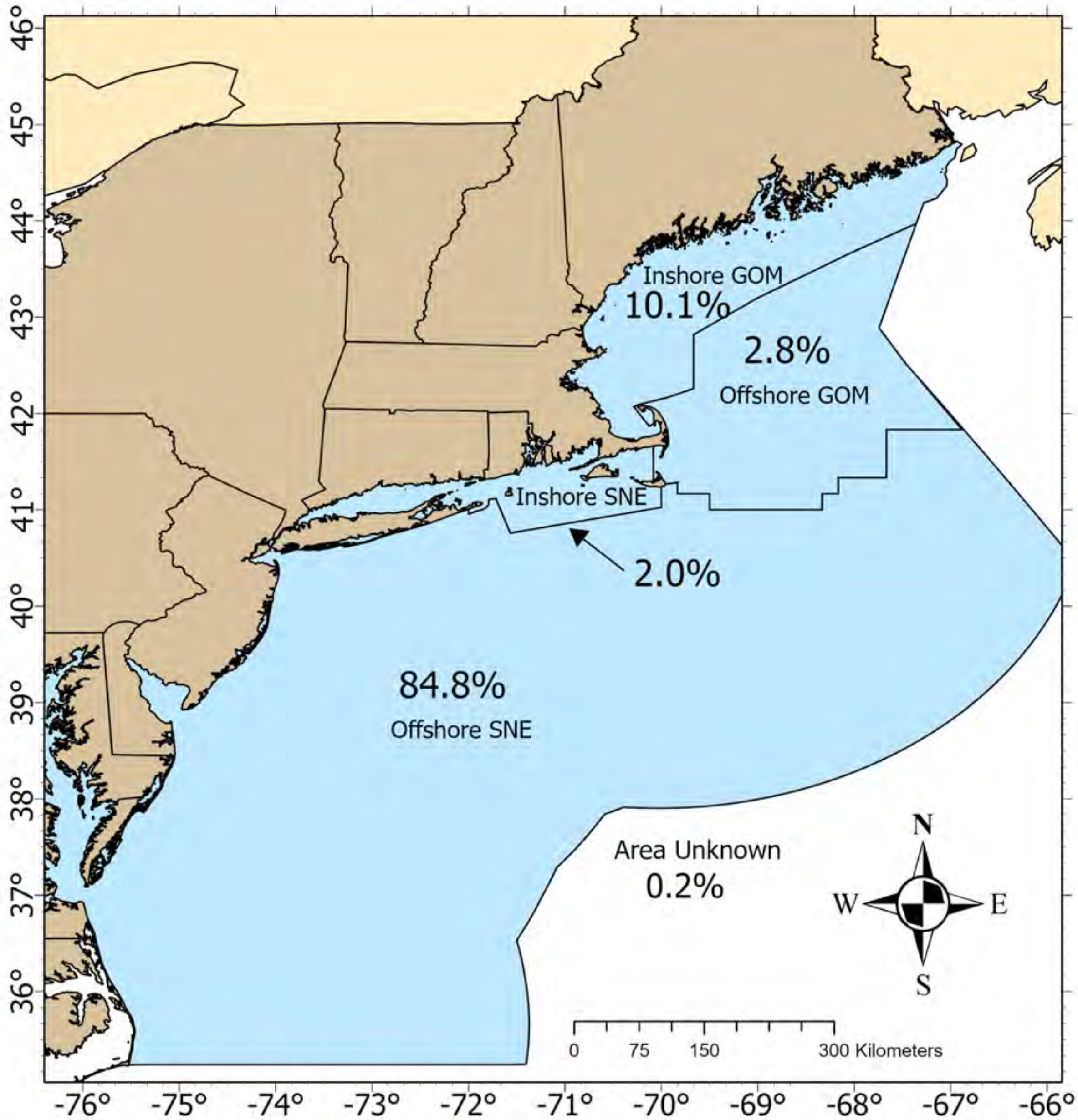

Figure 12. Percent of 2014 U.S. Jonah crab landings by stock area.

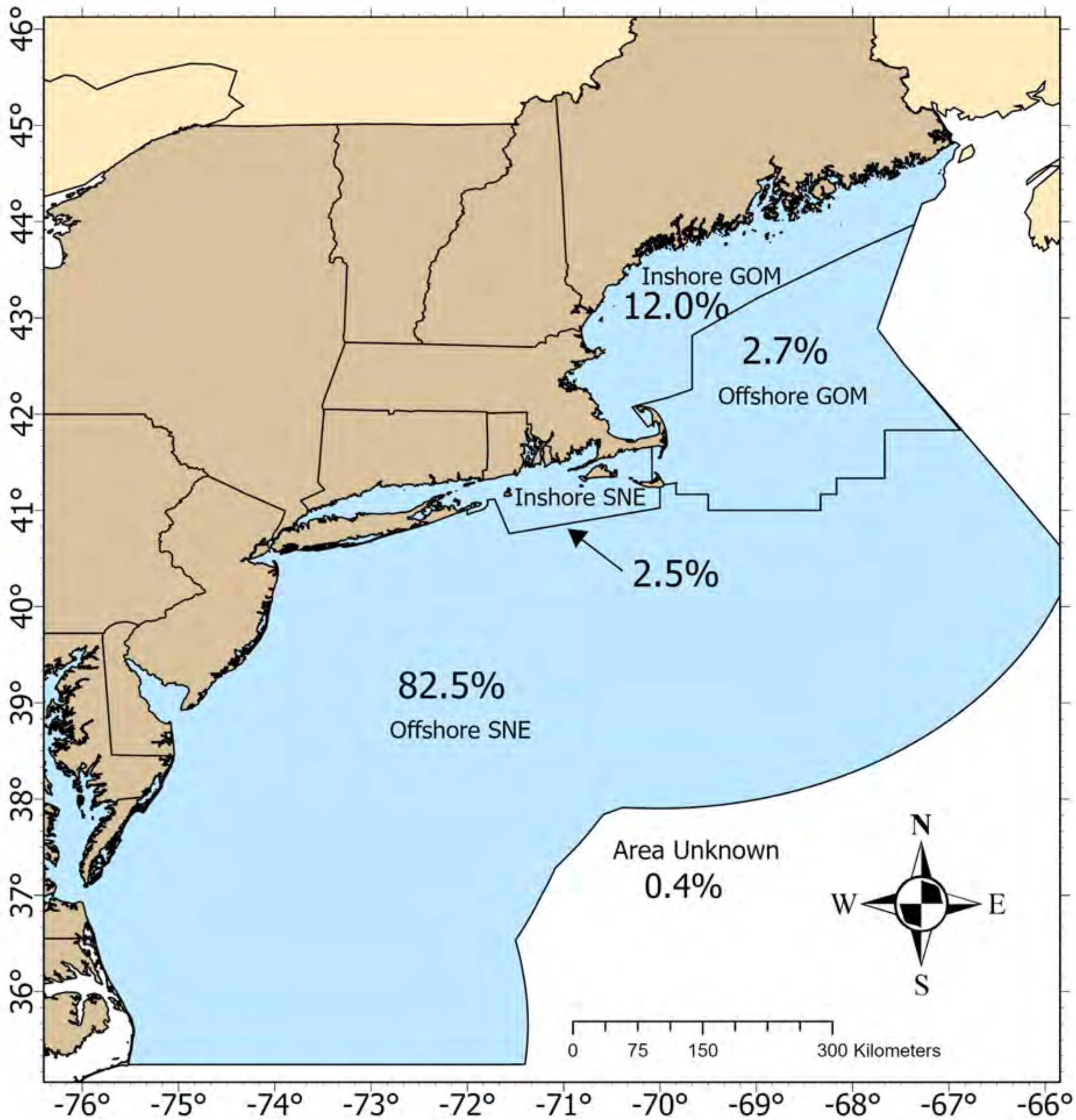

Figure 13. Percent of 2015 U.S. Jonah crab landings by stock area.

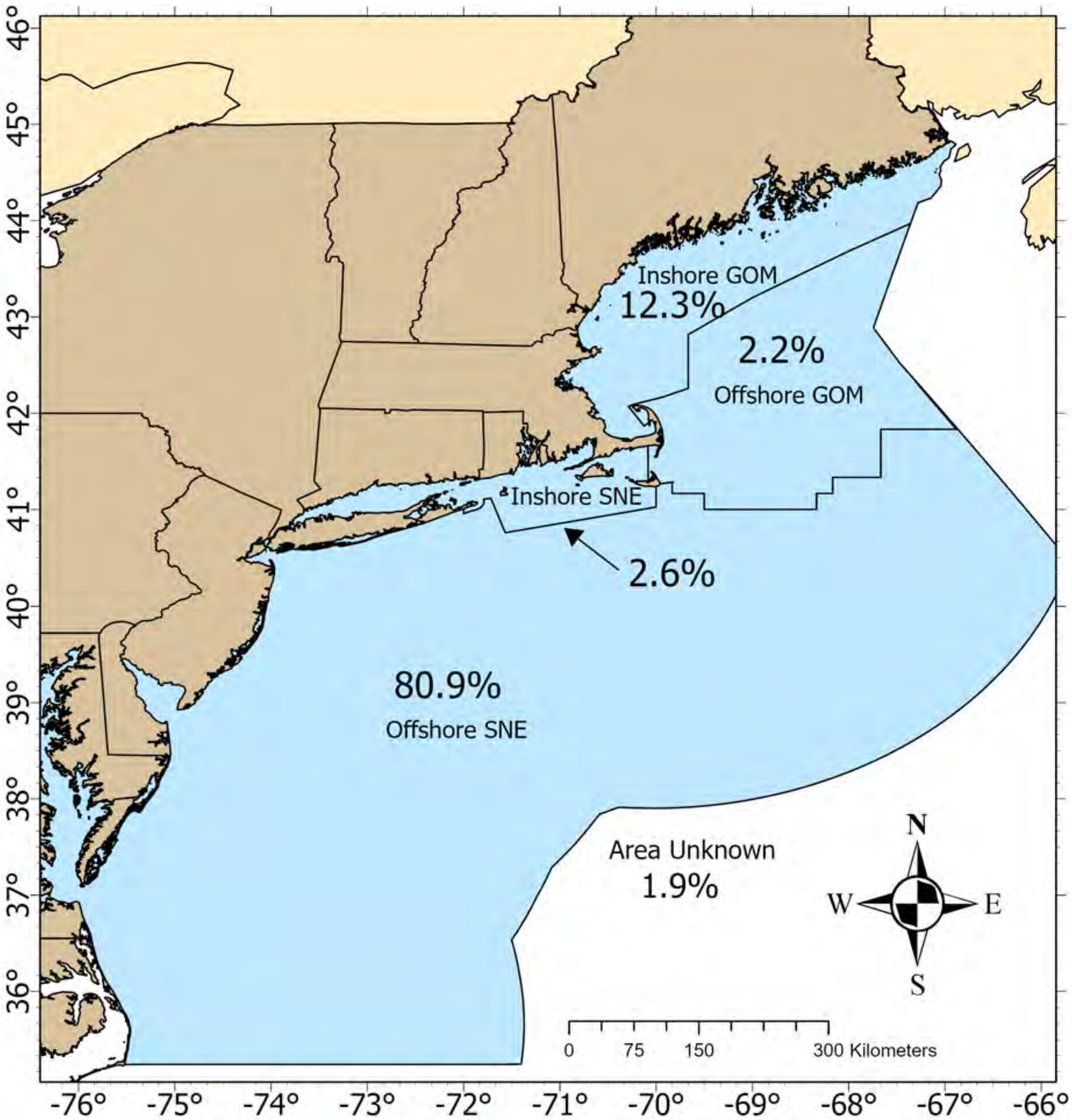

Figure 14. Percent of 2016 U.S. Jonah crab landings by stock area.

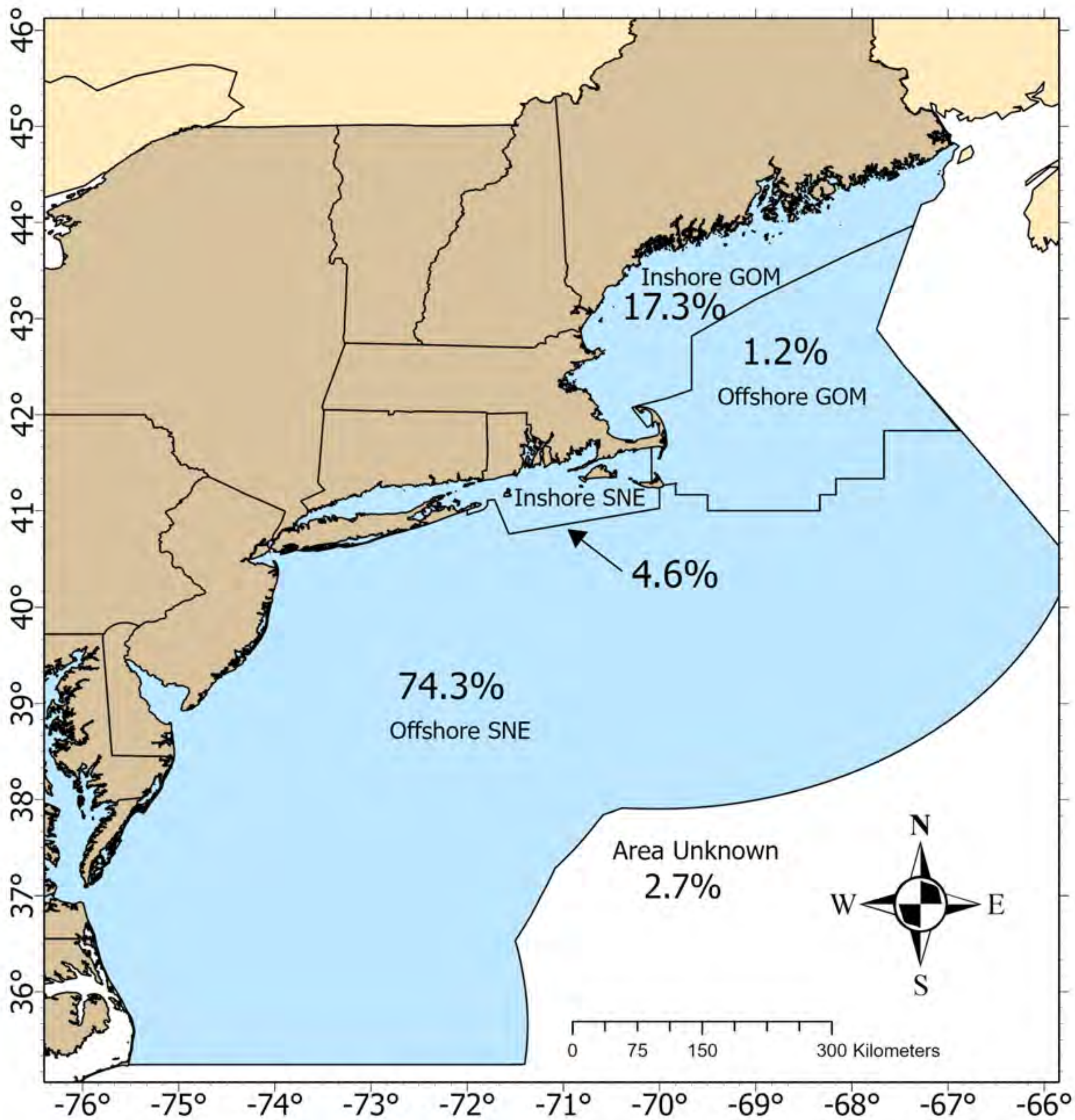

Figure 15. Percent of 2017 U.S. Jonah crab landings by stock area.

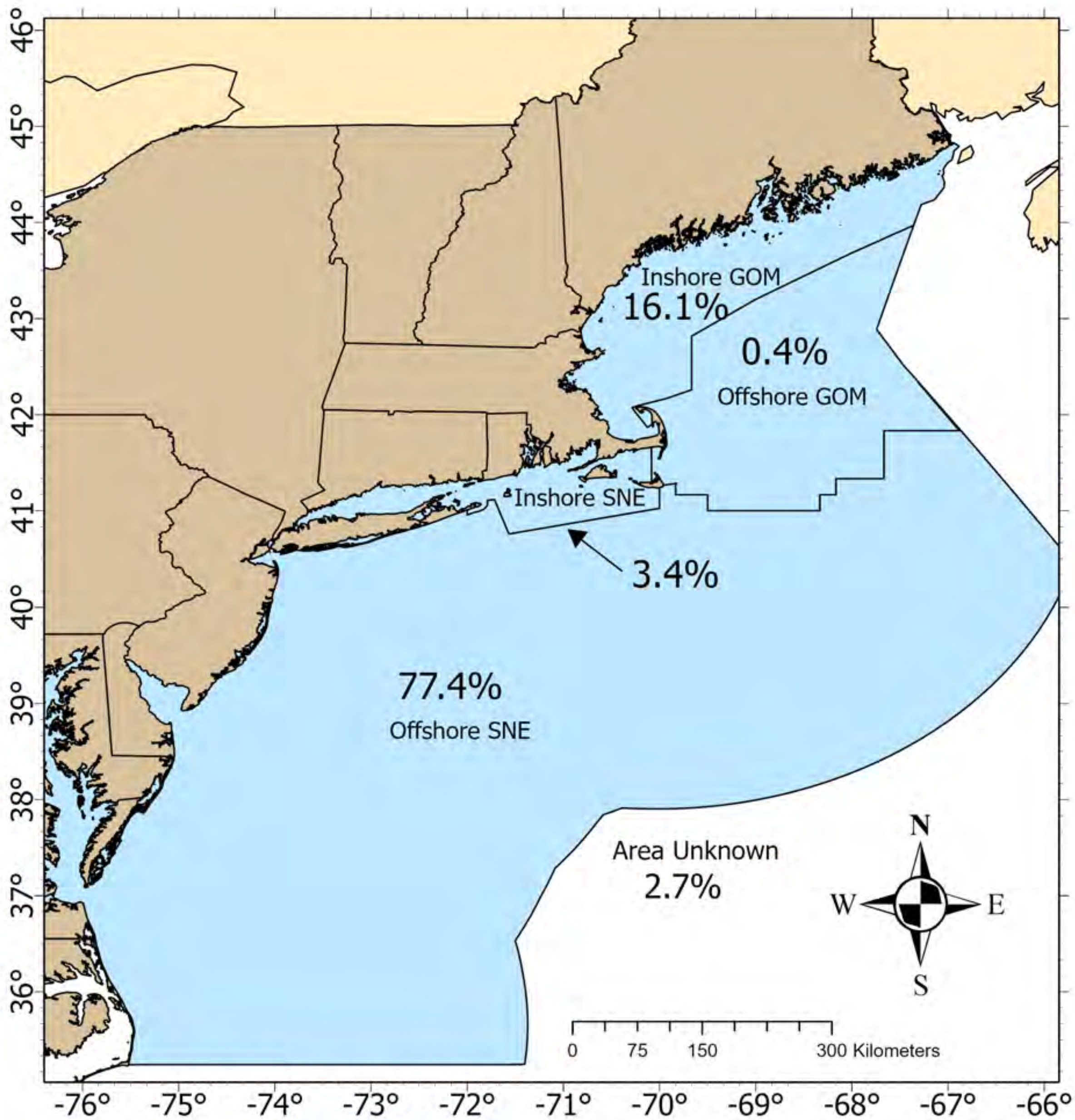

Figure 16. Percent of 2018 U.S. Jonah crab landings by stock area.

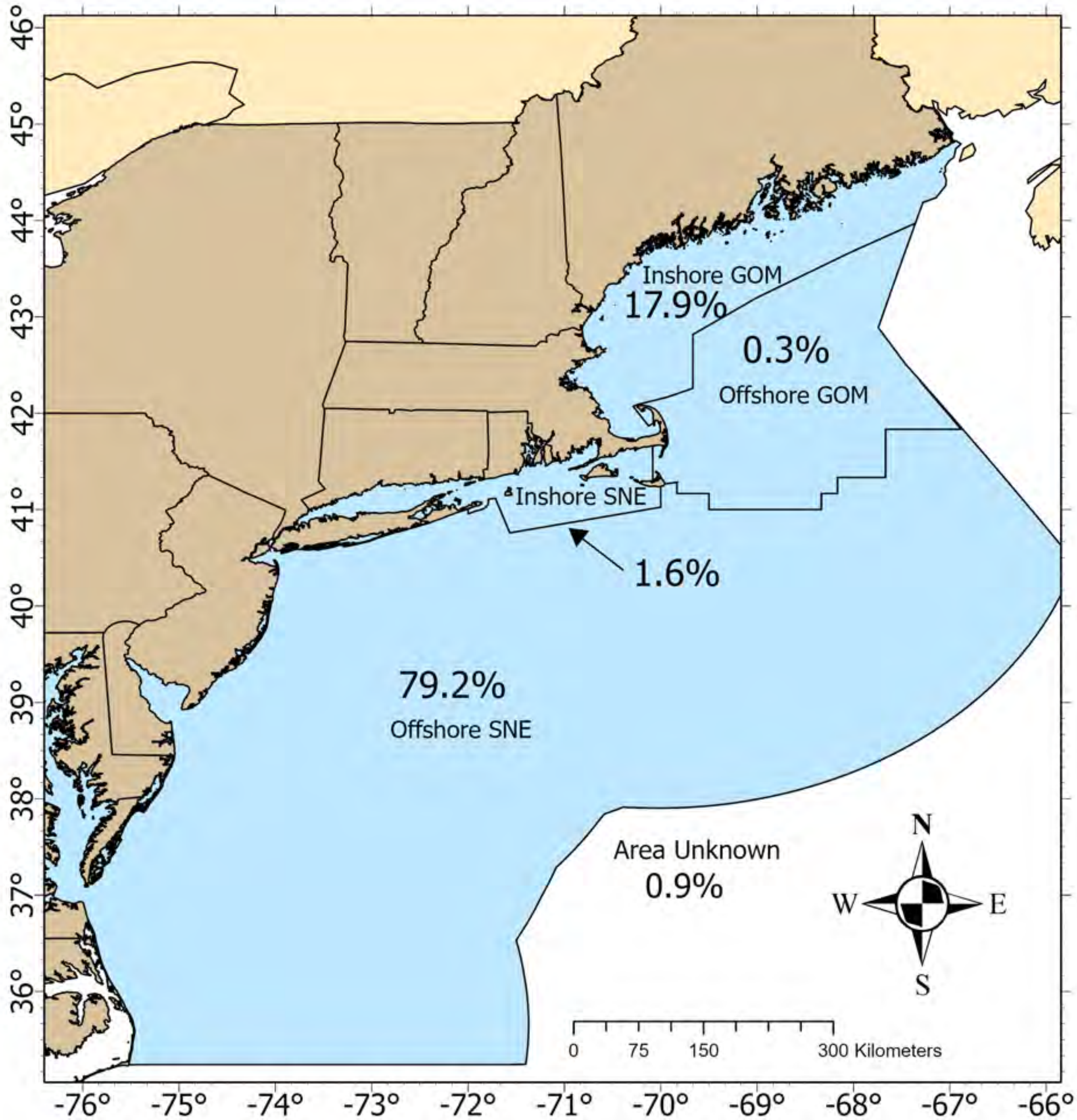

Figure 17. Percent of 2019 U.S. Jonah crab landings by stock area.

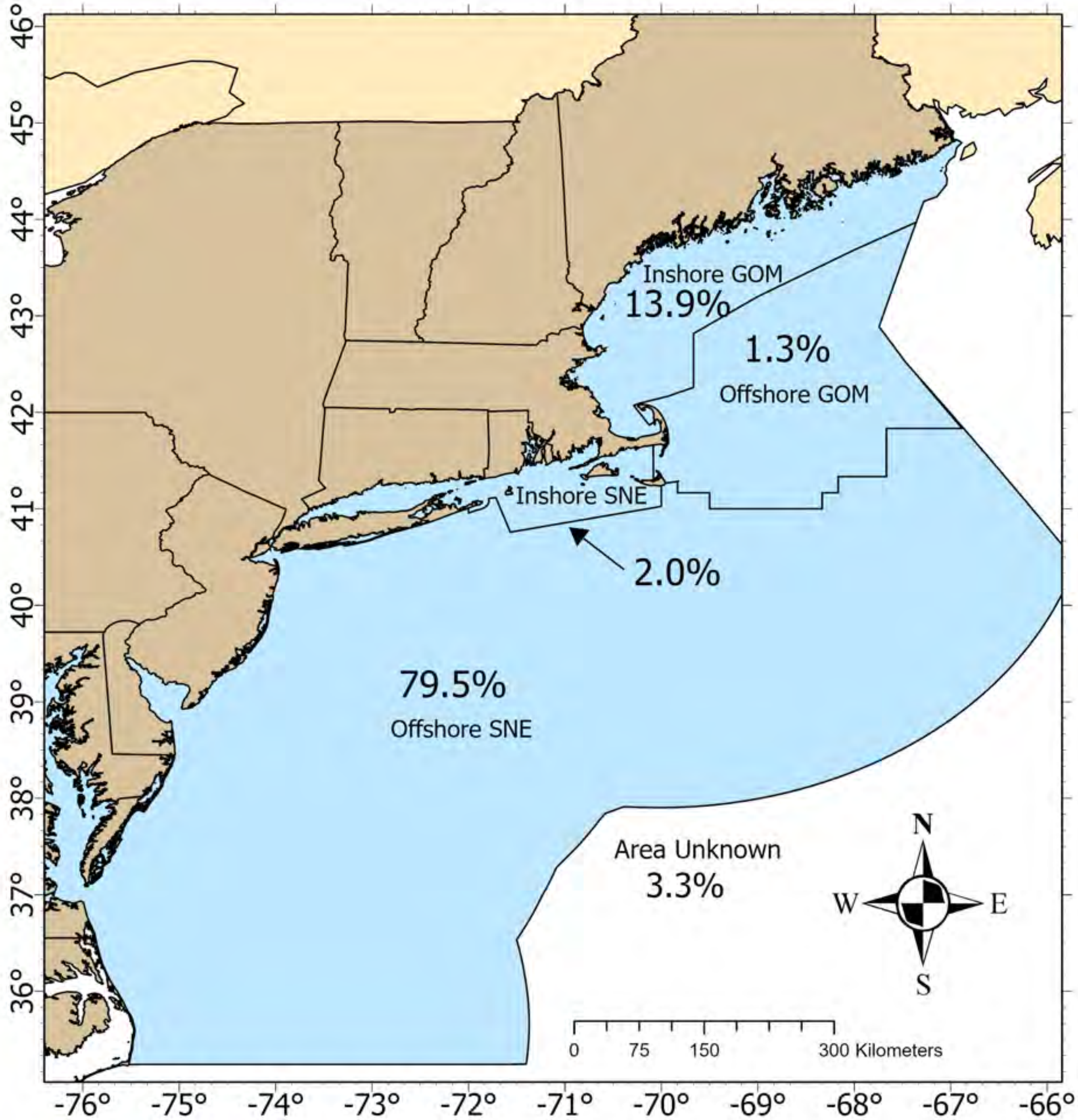

Figure 18. Percent of 2020 U.S. Jonah crab landings by stock area.

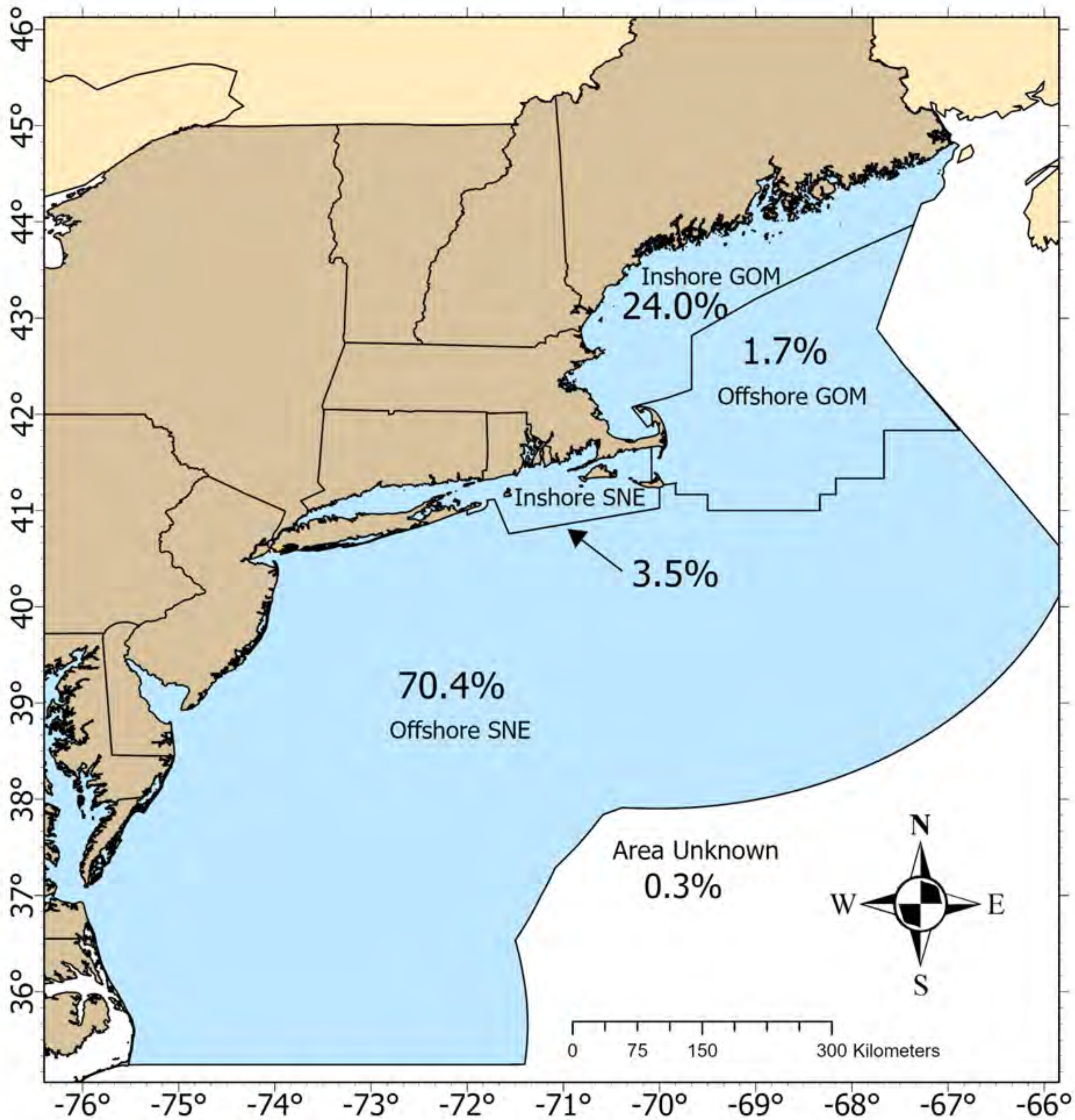

Figure 19. Percent of 2021 U.S. Jonah crab landings by stock area.

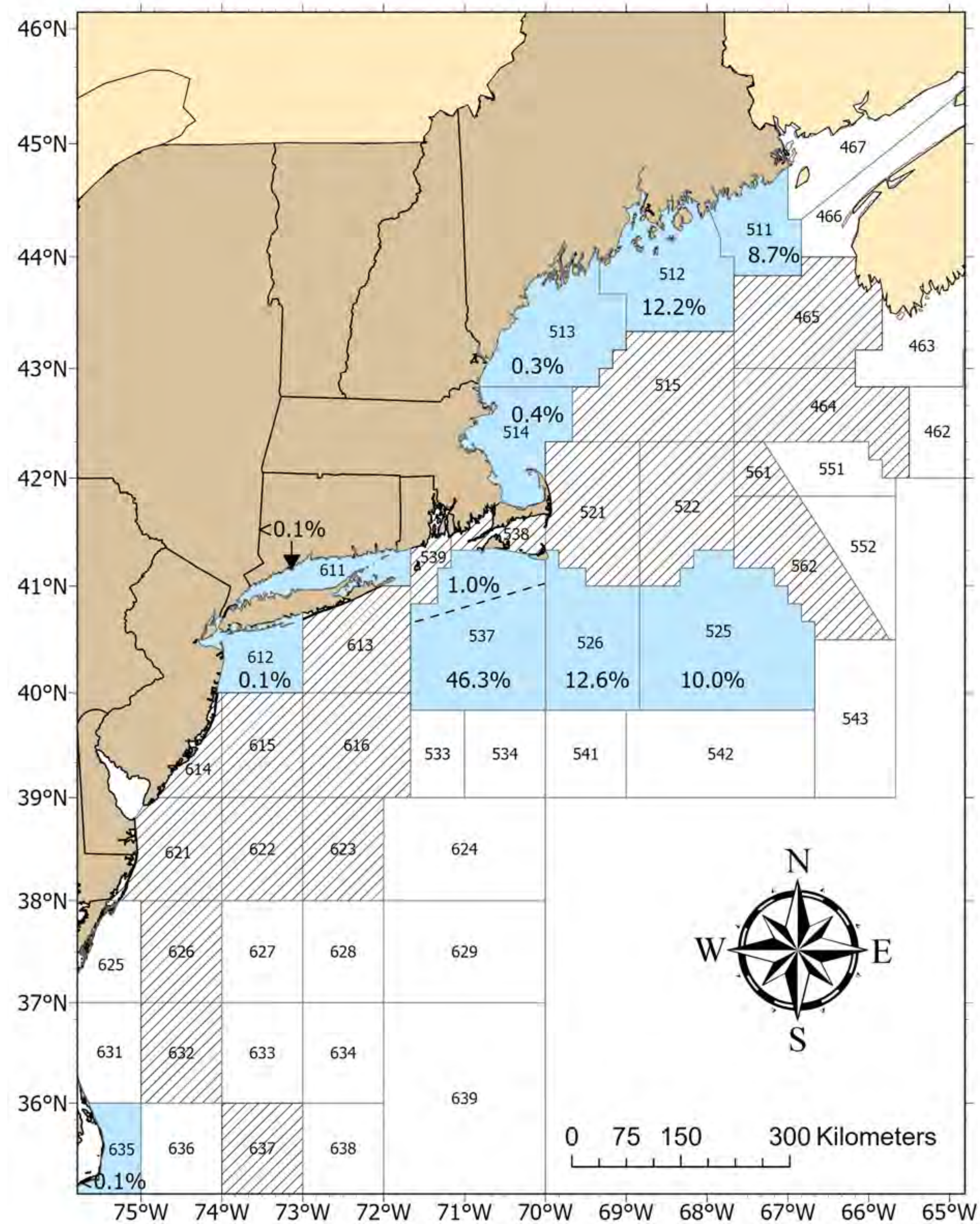

Figure 20. Percent of 2010 U.S. Jonah crab landings by NMFS statistical area. Statistical area 537 is divided (dashed line) into inshore (LMA 2) and offshore (LMA 3) regions. NMFS statistical areas with hash marks represent confidential data (fewer than three fishers reported landings). Areas with no reported landings are white.

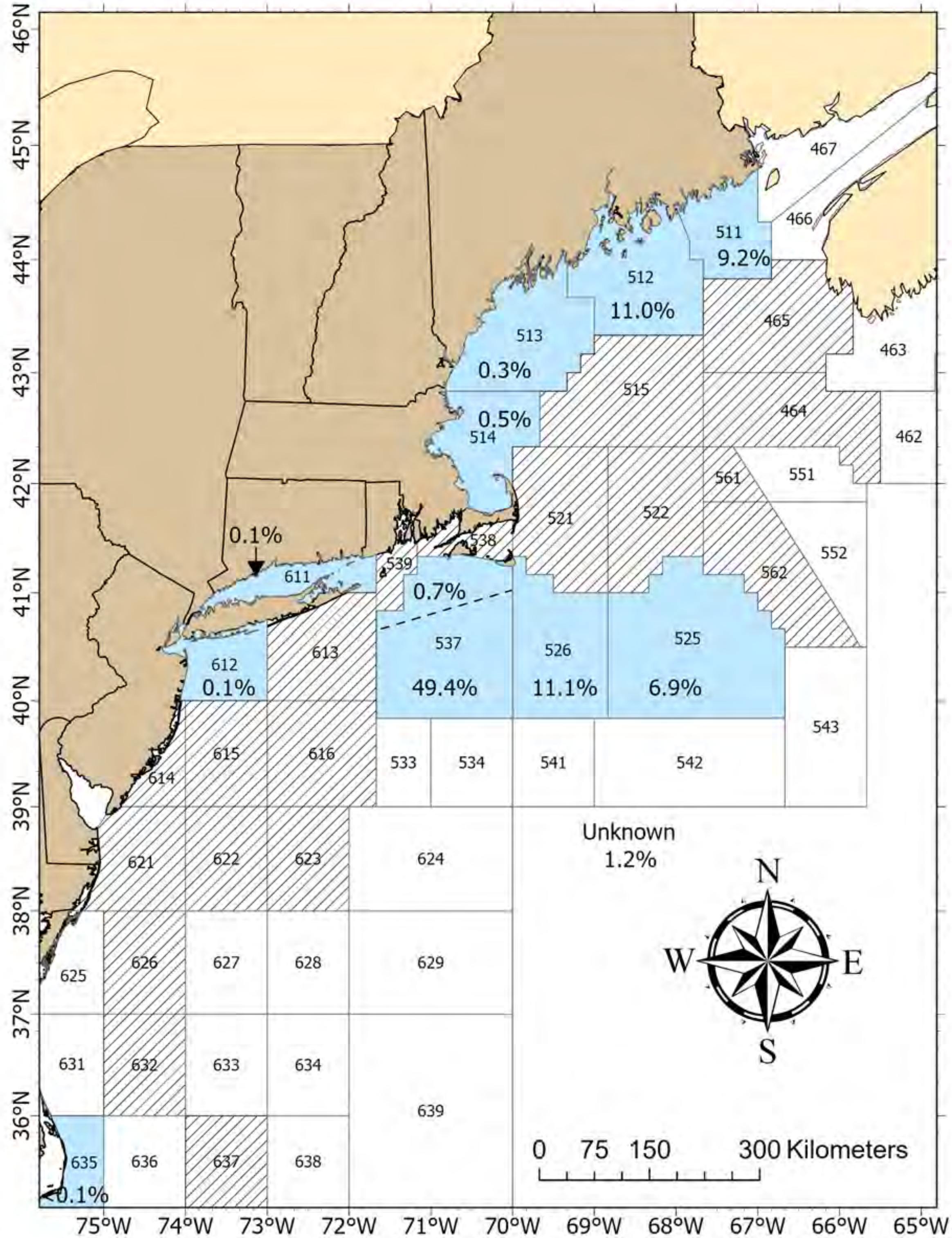

Figure 21. Percent of 2011 U.S. Jonah crab landings by NMFS statistical area. Statistical area 537 is divided (dashed line) into inshore (LMA 2) and offshore (LMA 3) regions. NMFS statistical areas with hash marks represent confidential data (fewer than three fishers reported landings). Areas with no reported landings are white.

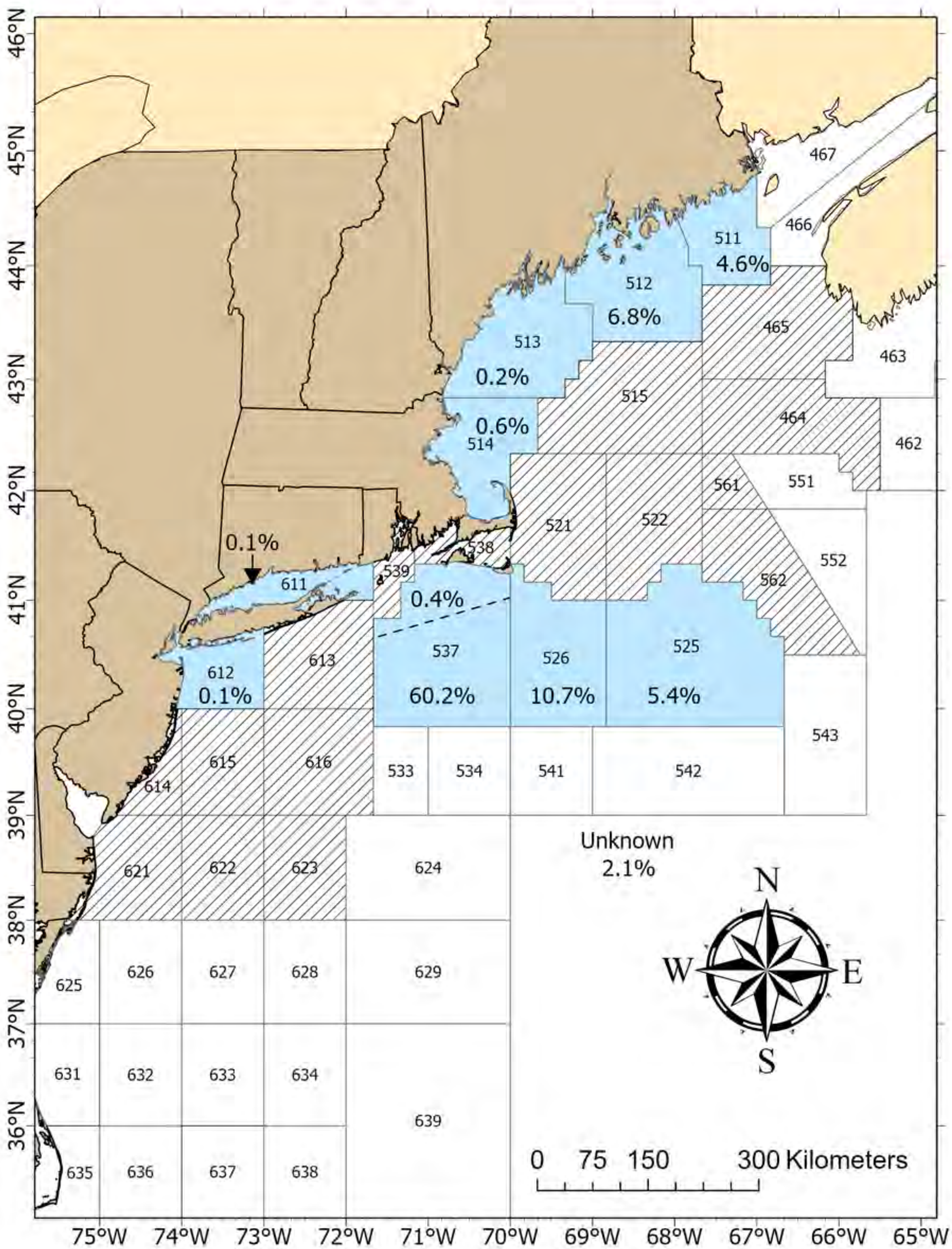

Figure 22. Percent of 2012 U.S. Jonah crab landings by NMFS statistical area. Statistical area 537 is divided (dashed line) into inshore (LMA 2) and offshore (LMA 3) regions. NMFS statistical areas with hash marks represent confidential data (fewer than three fishers reported landings). Areas with no reported landings are white.

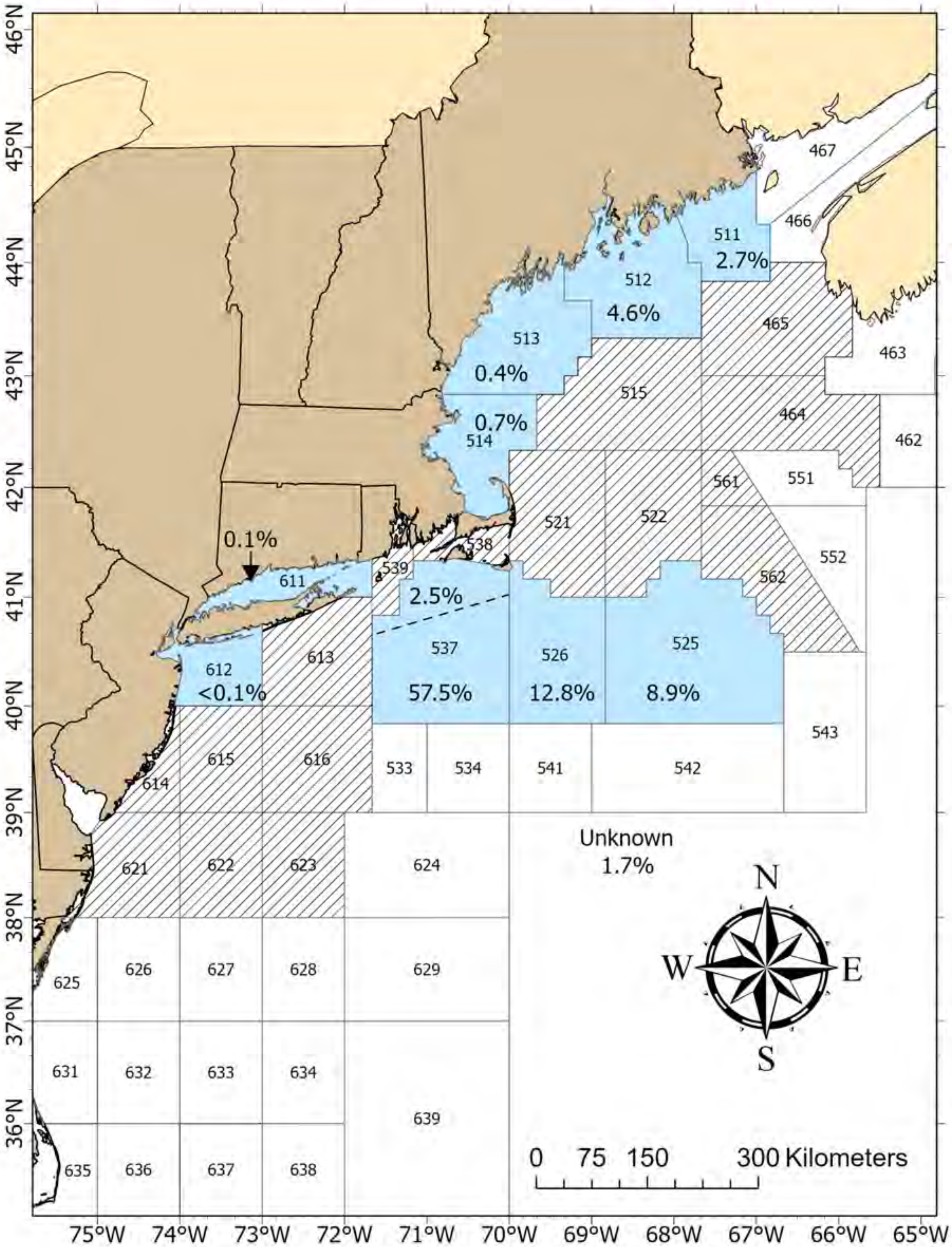

Figure 23. Percent of 2013 U.S. Jonah crab landings by NMFS statistical area. Statistical area 537 is divided (dashed line) into inshore (LMA 2) and offshore (LMA 3) regions. NMFS statistical areas with hash marks represent confidential data (fewer than three fishers reported landings). Areas with no reported landings are white.

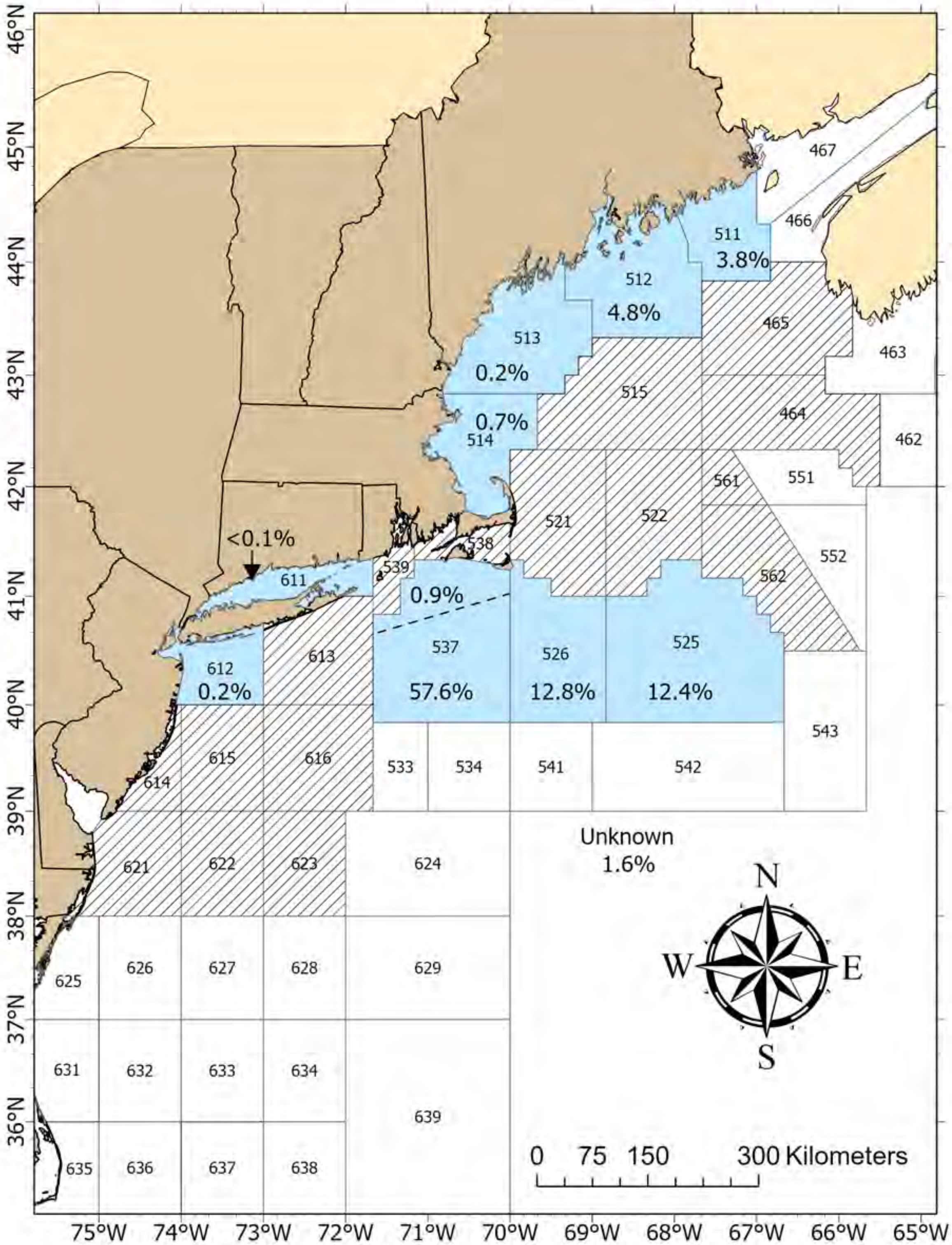

Figure 24. Percent of 2014 U.S. Jonah crab landings by NMFS statistical area. Statistical area 537 is divided (dashed line) into inshore (LMA 2) and offshore (LMA 3) regions. NMFS statistical areas with hash marks represent confidential data (fewer than three fishers reported landings). Areas with no reported landings are white.

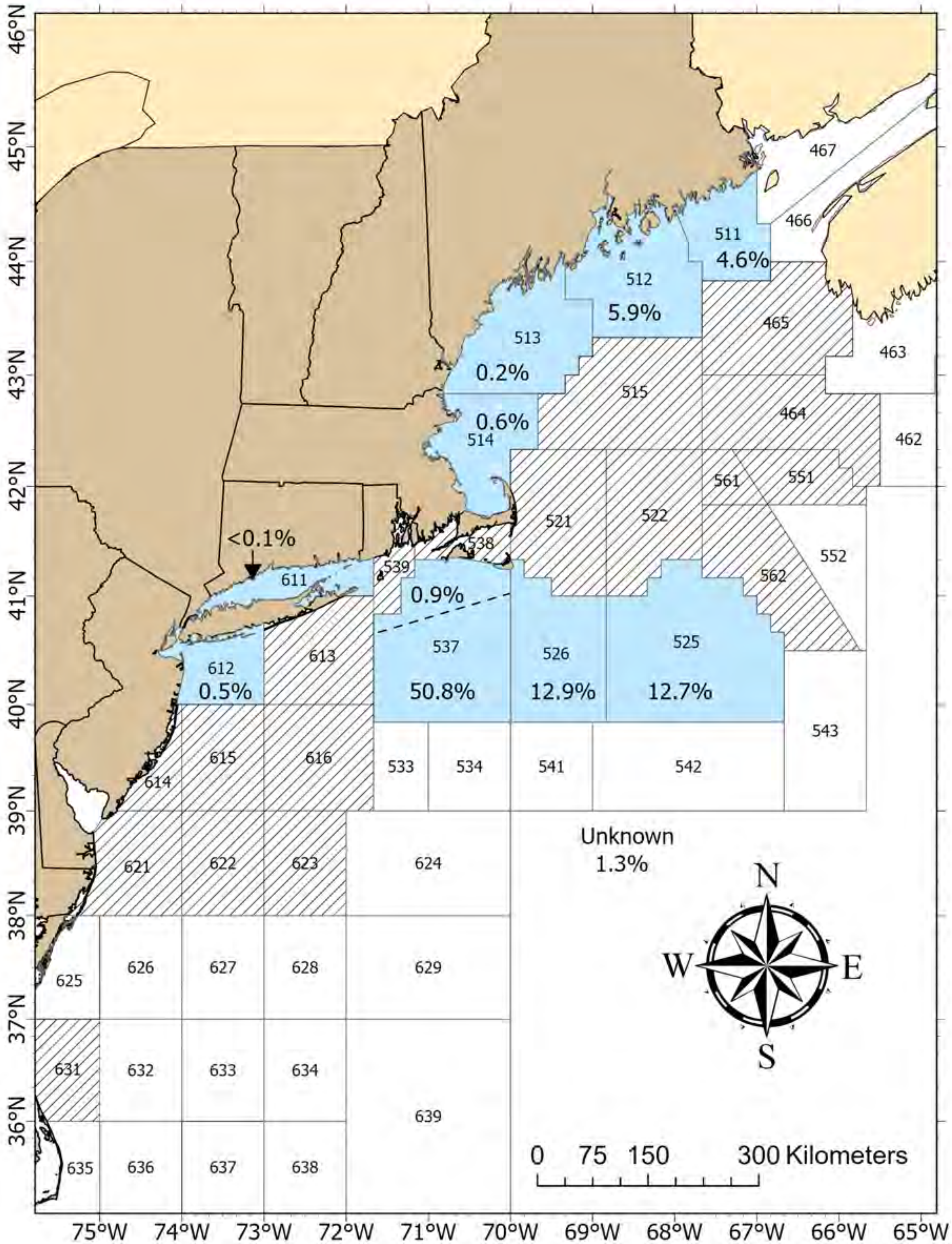

Figure 25. Percent of 2015 U.S. Jonah crab landings by NMFS statistical area. Statistical area 537 is divided (dashed line) into inshore (LMA 2) and offshore (LMA 3) regions. NMFS statistical areas with hash marks represent confidential data (fewer than three fishers reported landings). Areas with no reported landings are white.

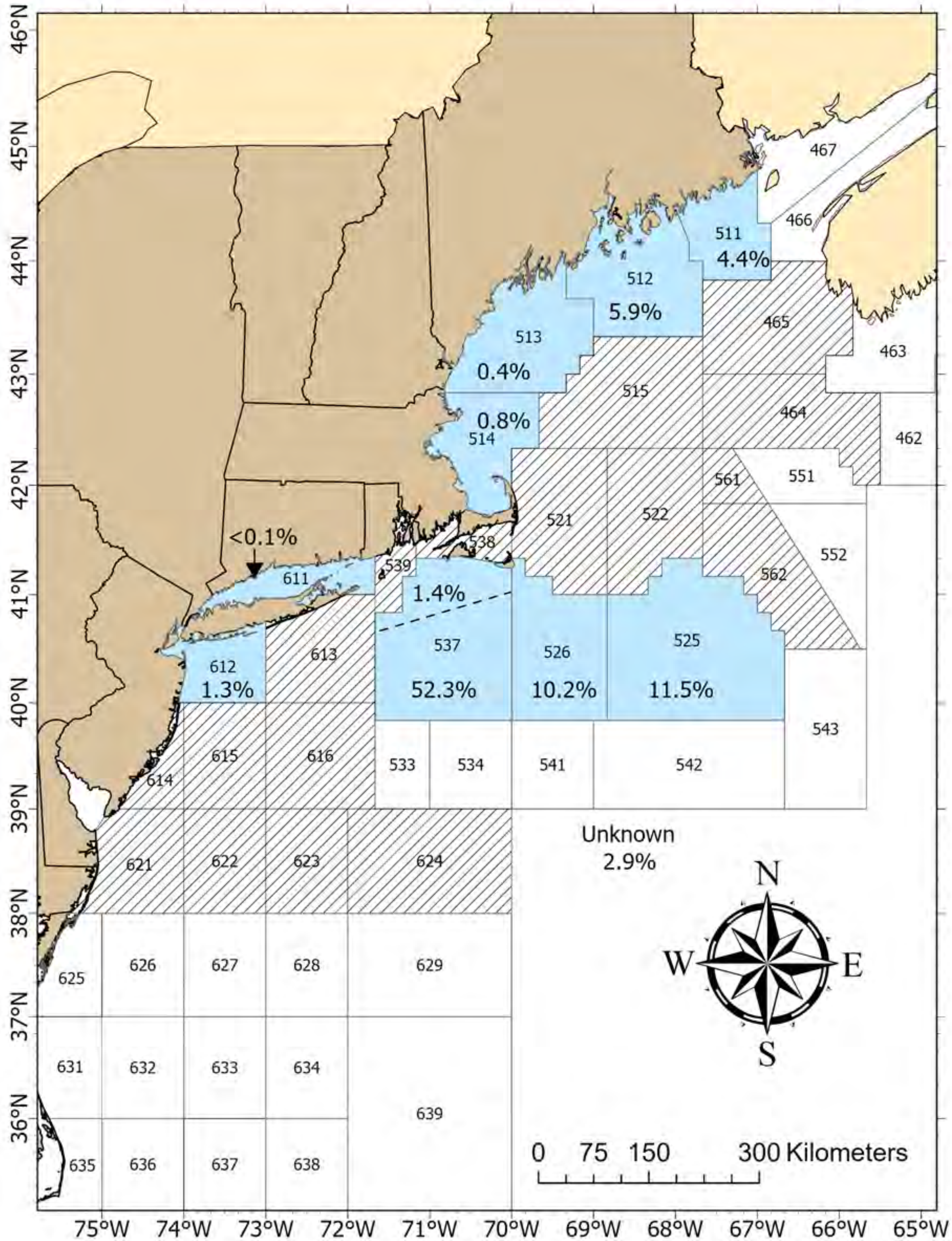

Figure 26. Percent of 2016 U.S. Jonah crab landings by NMFS statistical area. Statistical area 537 is divided (dashed line) into inshore (LMA 2) and offshore (LMA 3) regions. NMFS statistical areas with hash marks represent confidential data (fewer than three fishers reported landings). Areas with no reported landings are white.

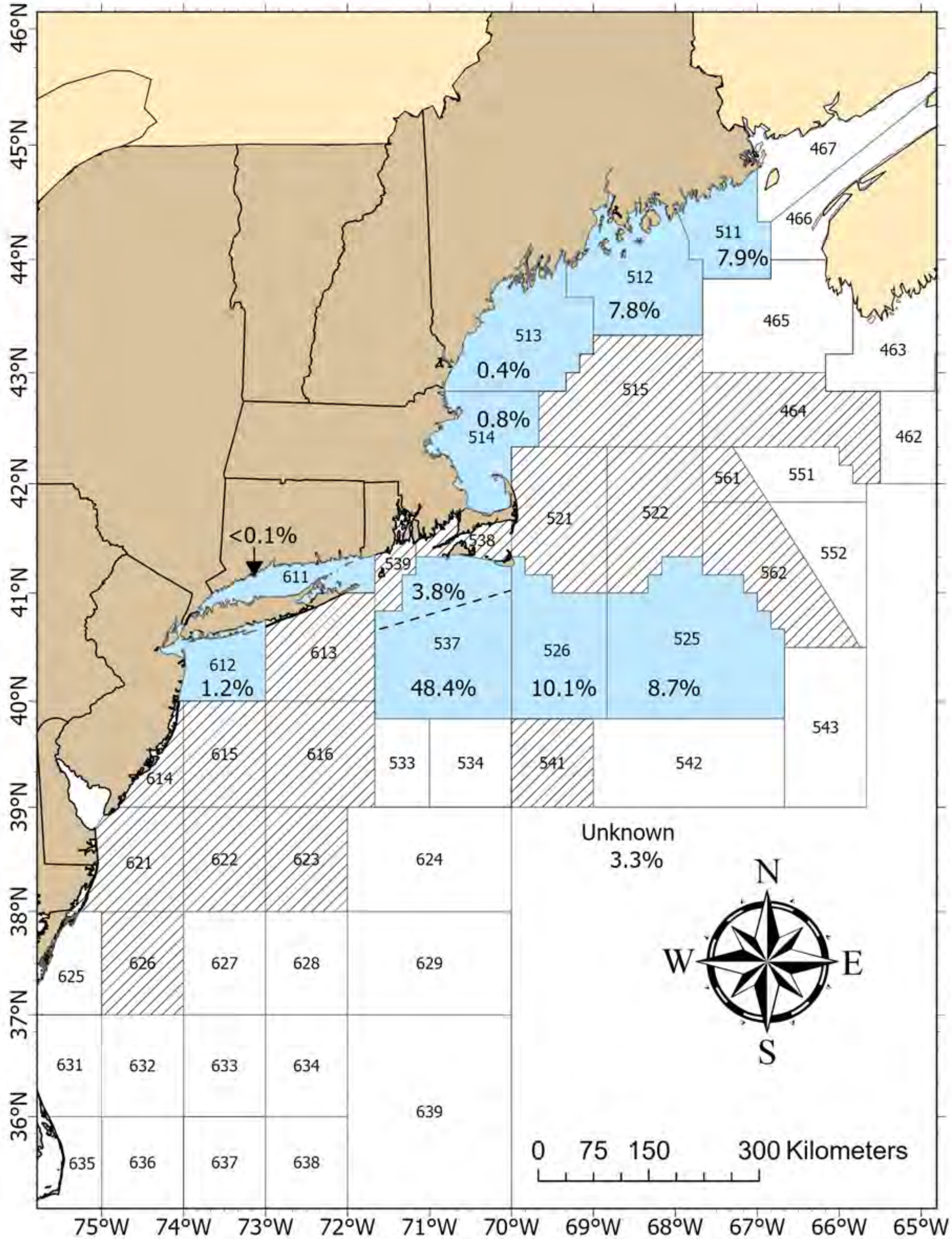

Figure 27. Percent of 2017 U.S. Jonah crab landings by NMFS statistical area. Statistical area 537 is divided (dashed line) into inshore (LMA 2) and offshore (LMA 3) regions. NMFS statistical areas with hash marks represent confidential data (fewer than three fishers reported landings). Areas with no reported landings are white.

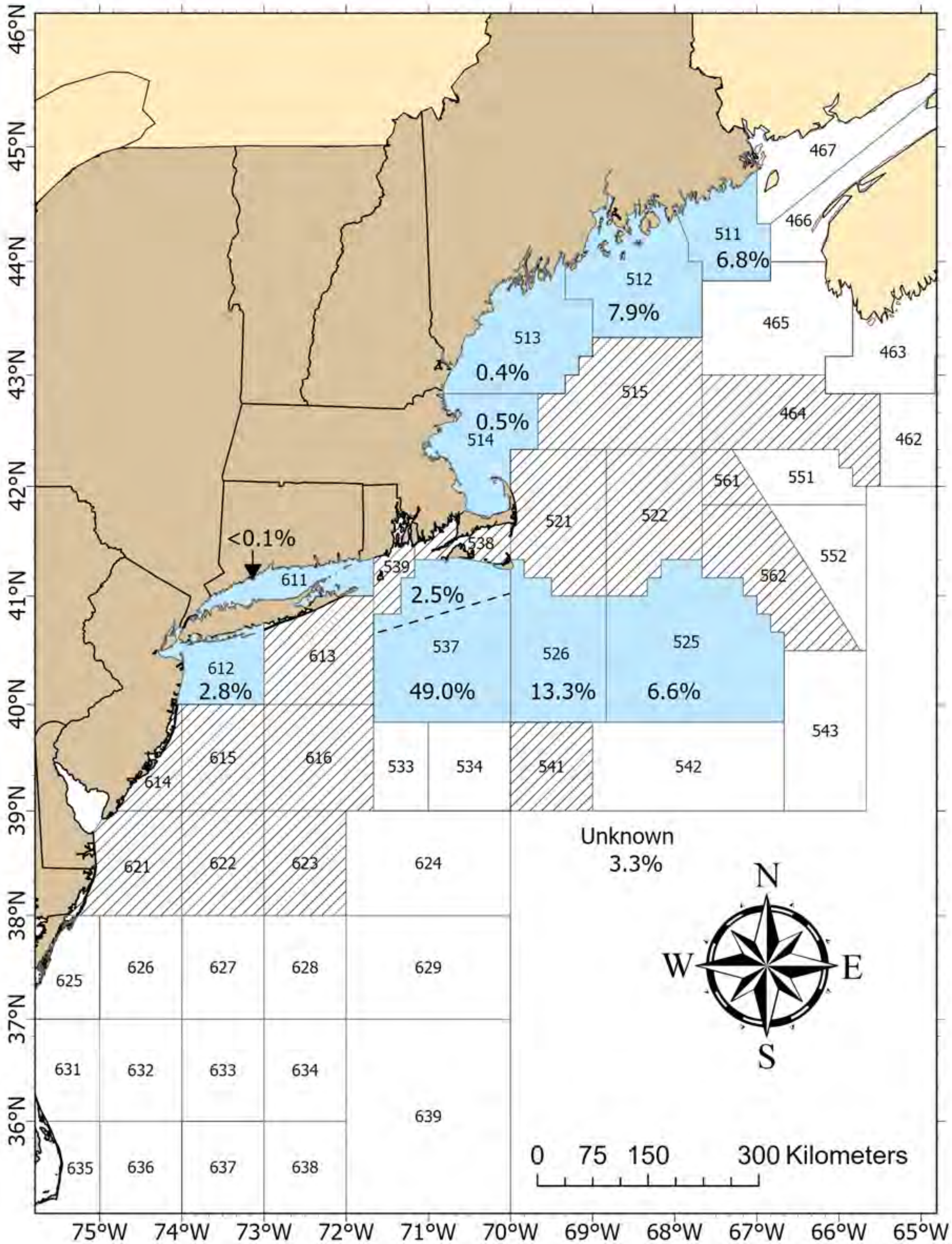

Figure 28. Percent of 2018 U.S. Jonah crab landings by NMFS statistical area. Statistical area 537 is divided (dashed line) into inshore (LMA 2) and offshore (LMA 3) regions. NMFS statistical areas with hash marks represent confidential data (fewer than three fishers reported landings). Areas with no reported landings are white.

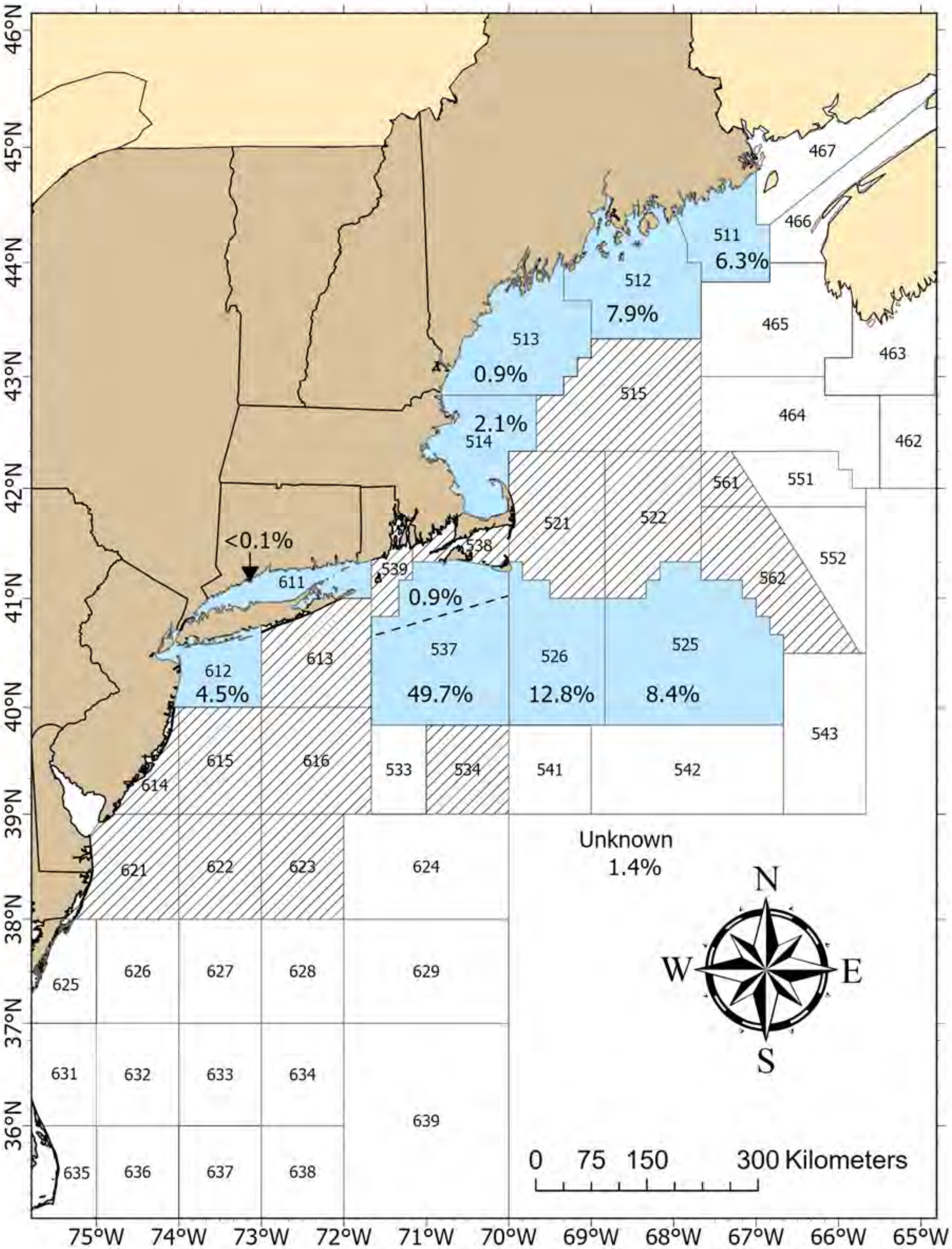

Figure 29. Percent of 2019 U.S. Jonah crab landings by NMFS statistical area. Statistical area 537 is divided (dashed line) into inshore (LMA 2) and offshore (LMA 3) regions. NMFS statistical areas with hash marks represent confidential data (fewer than three fishers reported landings). Areas with no reported landings are white.

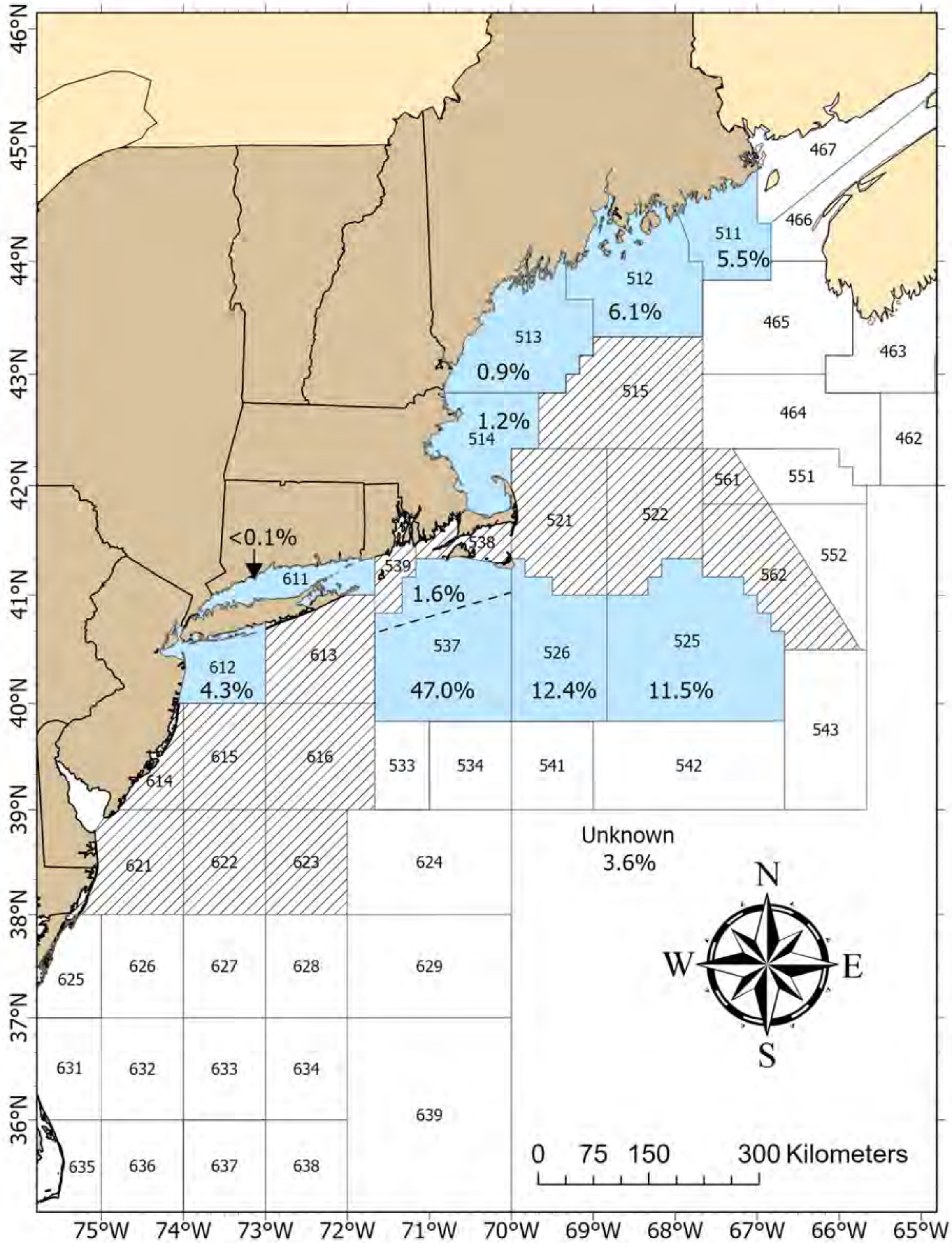

Figure 30. Percent of 2020 U.S. Jonah crab landings by NMFS statistical area. Statistical area 537 is divided (dashed line) into inshore (LMA 2) and offshore (LMA 3) regions. NMFS statistical areas with hash marks represent confidential data (fewer than three fishers reported landings). Areas with no reported landings are white.

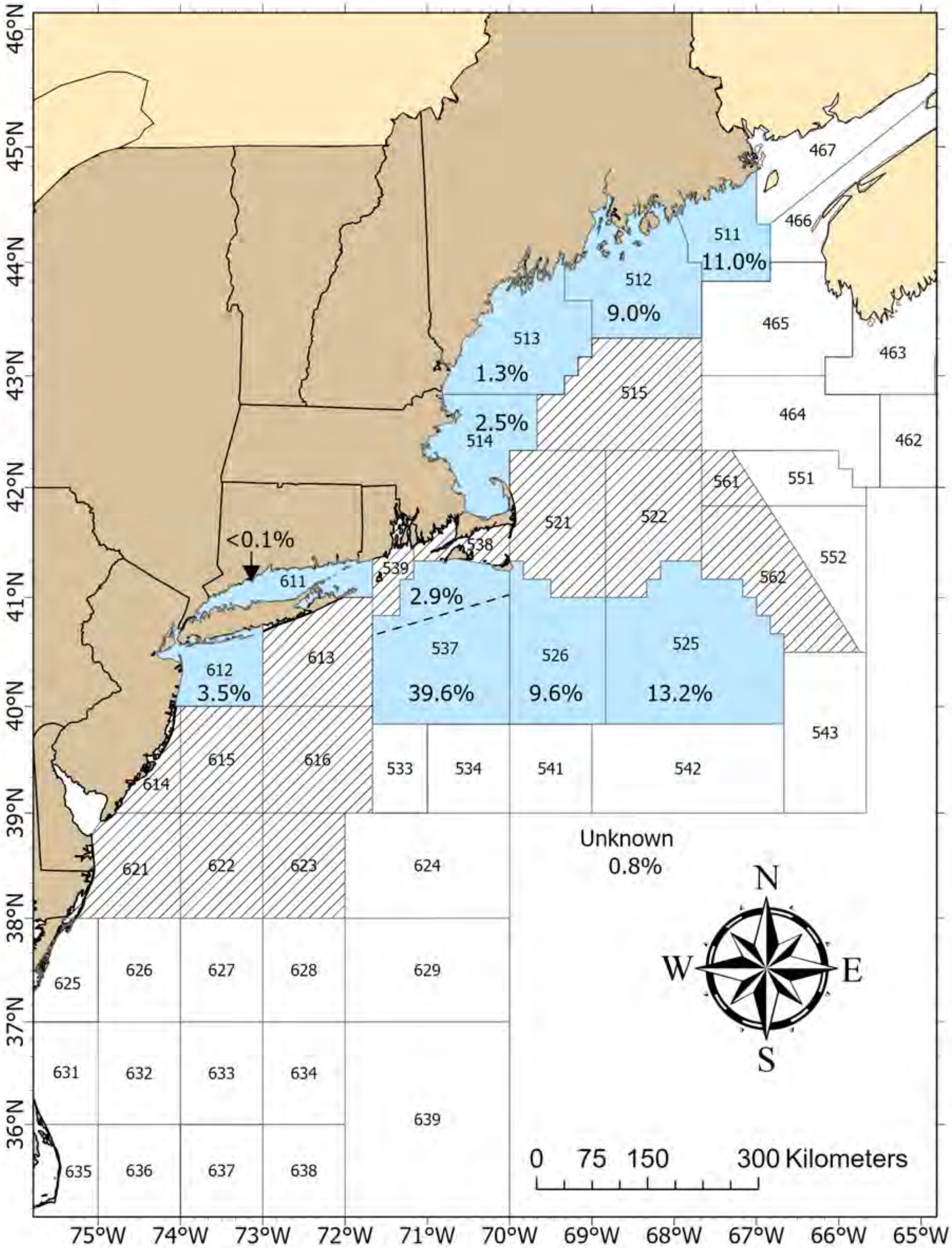

Figure 31. Percent of 2021 U.S. Jonah crab landings by NMFS statistical area. Statistical area 537 is divided (dashed line) into inshore (LMA 2) and offshore (LMA 3) regions. NMFS statistical areas with hash marks represent confidential data (fewer than three fishers reported landings). Areas with no reported landings are white.

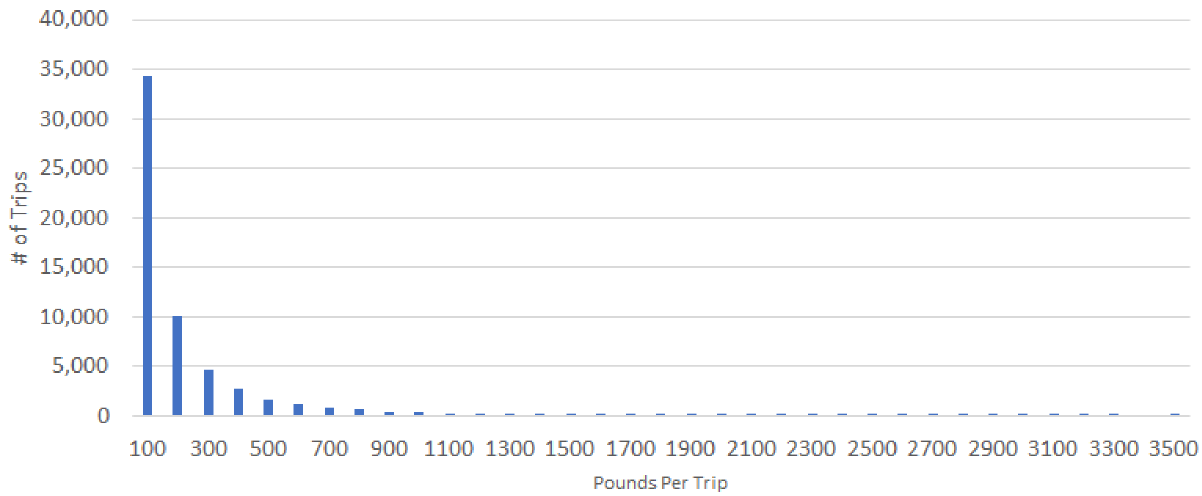

Figure 32. Landings per trip of Jonah crab for Maine trips, all ME trips landing Jonah crab, 2018-2021.

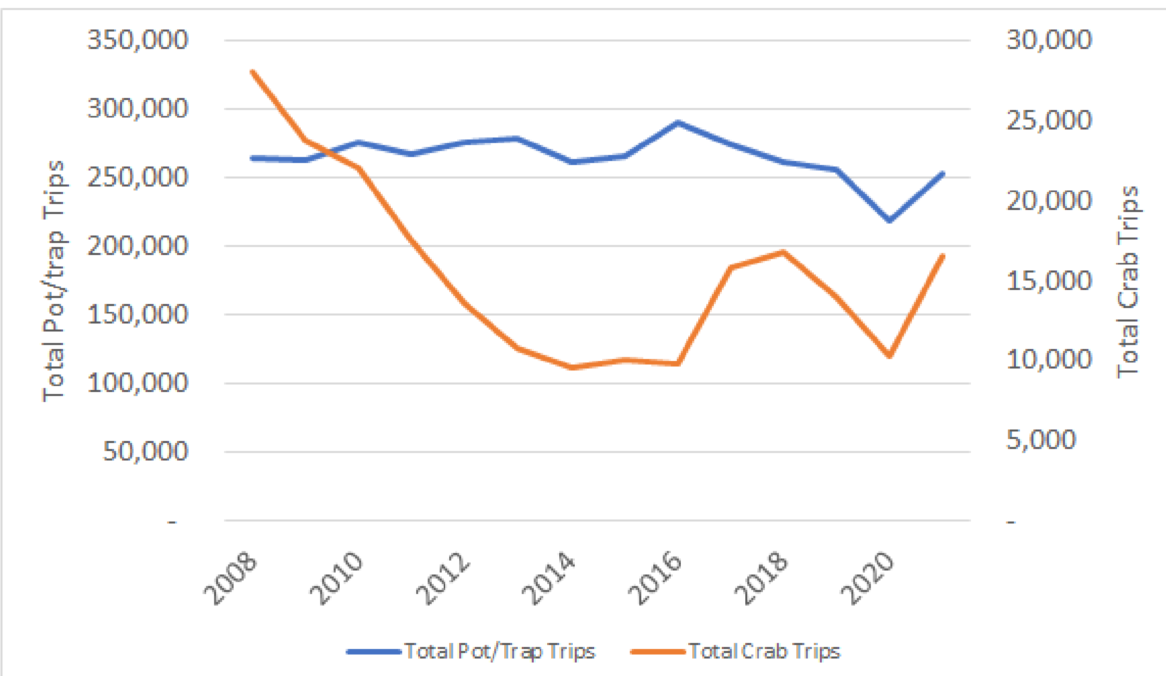

Figure 33. Total active trap/pot trips and total trips with Jonah crab 2008-2021.

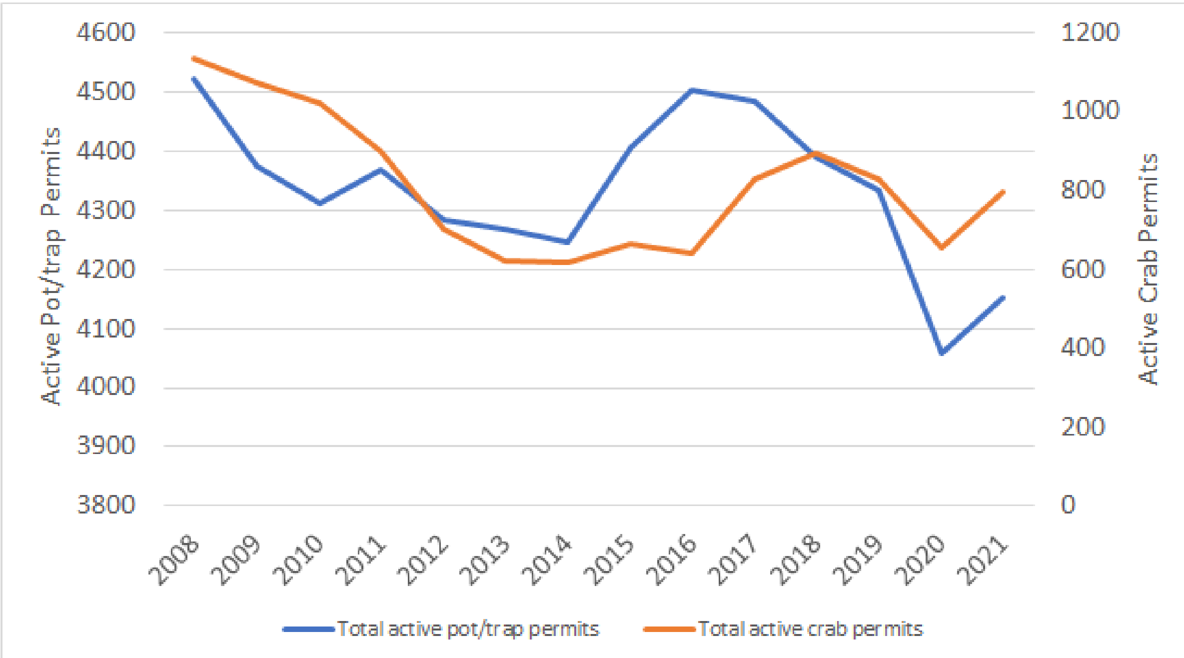

Figure 34. Total active trap/pot permits and active permits landing Jonah crab 2008-2021.

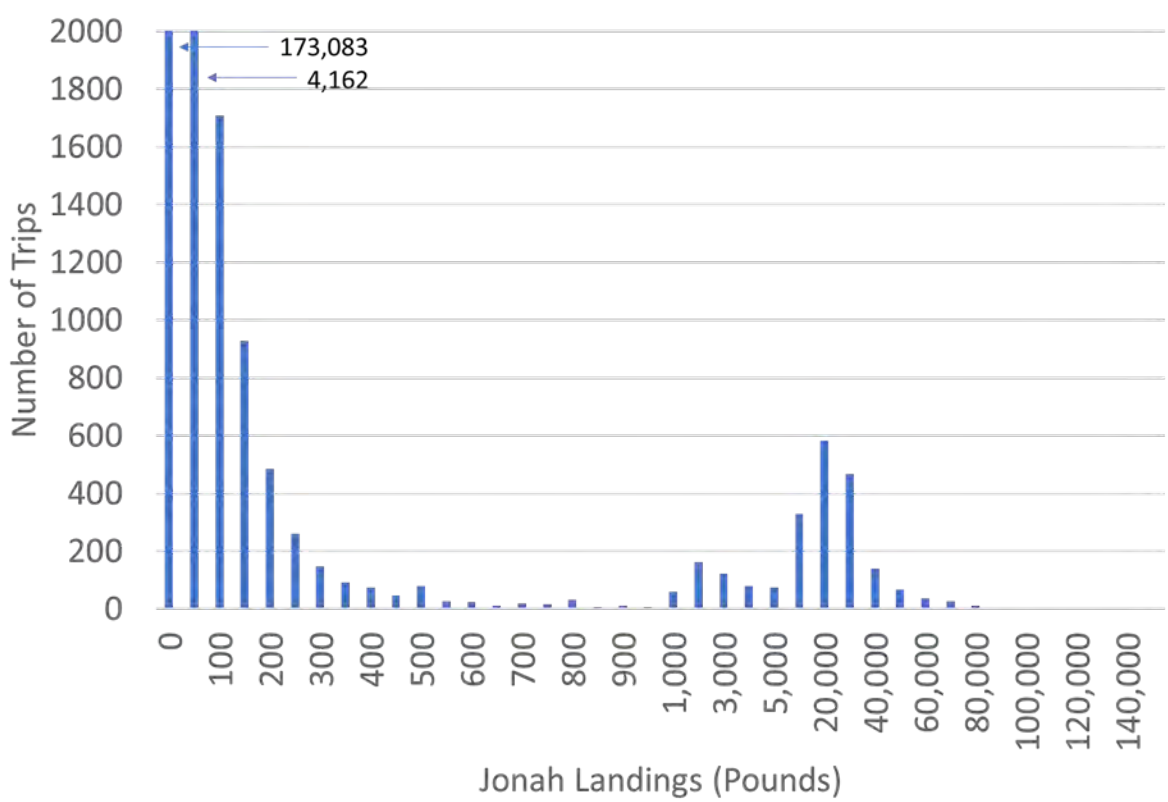

Figure 35. Number of Massachusetts lobster/edible crab pot trips landings Jonah crab pooled from 2018 through 2021. X-axis is discontinuous to account for high variability of trips with greater landings.

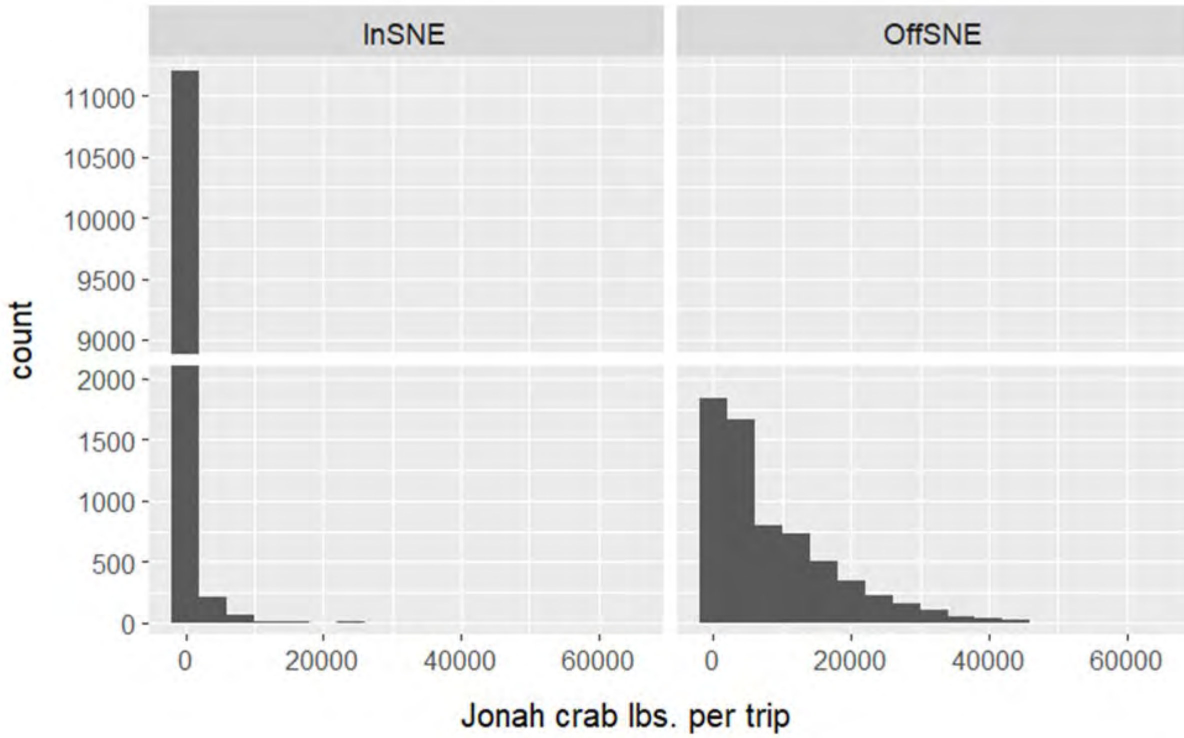

Figure 36. Histogram of landings per trip of Jonah crab for Rhode Island Inshore SNE and Offshore SNE trips, all RI trips landing Jonah crab, 2007-2021.

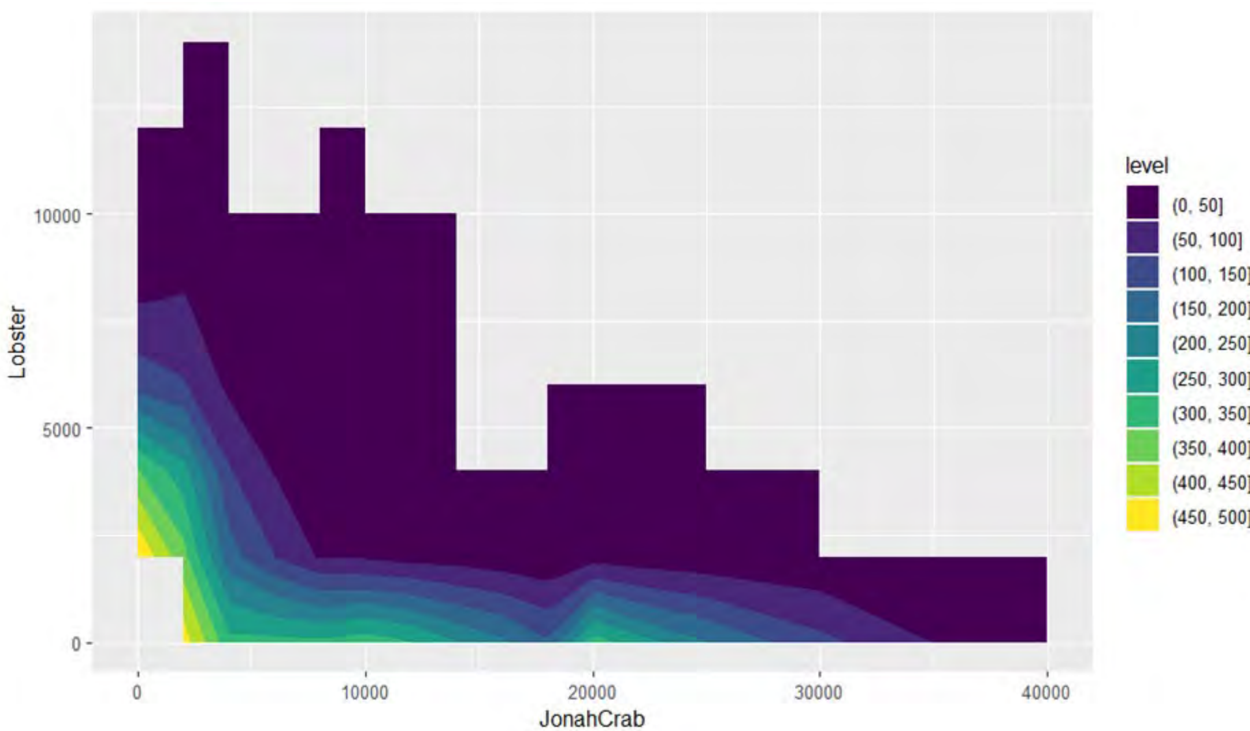

Figure 37. Density plot of Jonah crab versus lobster landings, all trips landing more than 500 lb. Jonah crab, 2007-2021.

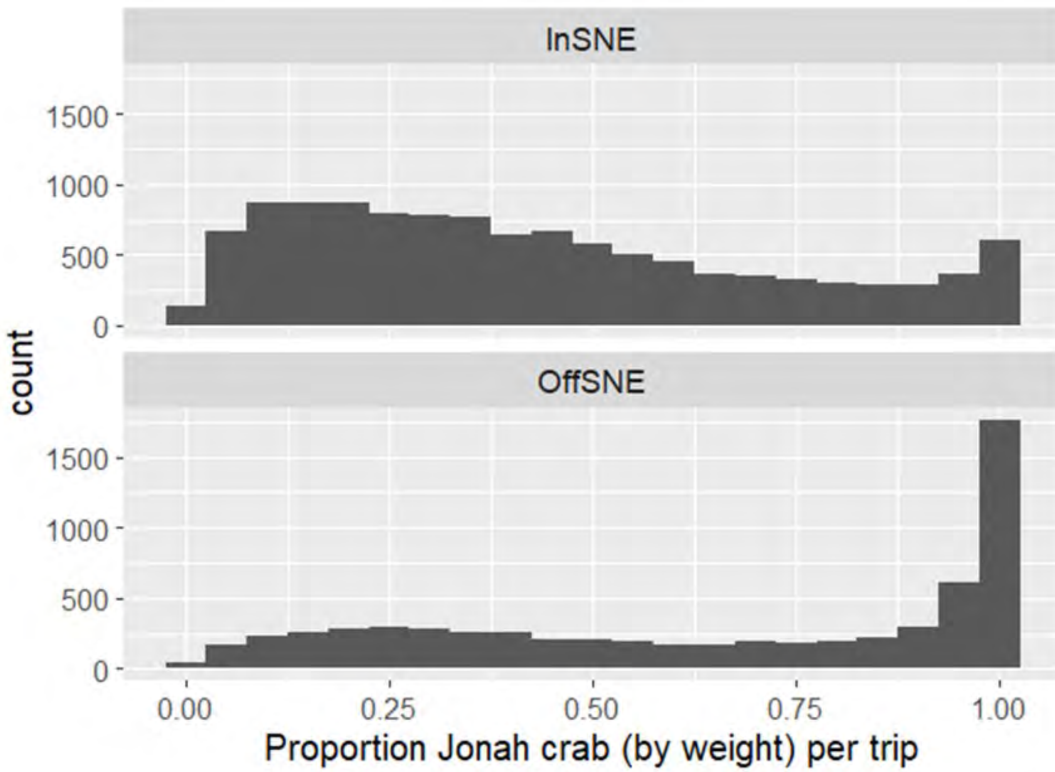

Figure 38. Histogram of Jonah crab proportion of harvest by weight (compared with lobster) for inshore and offshore SNE stocks. All RI trips landing Jonah crab, 2007-2021.

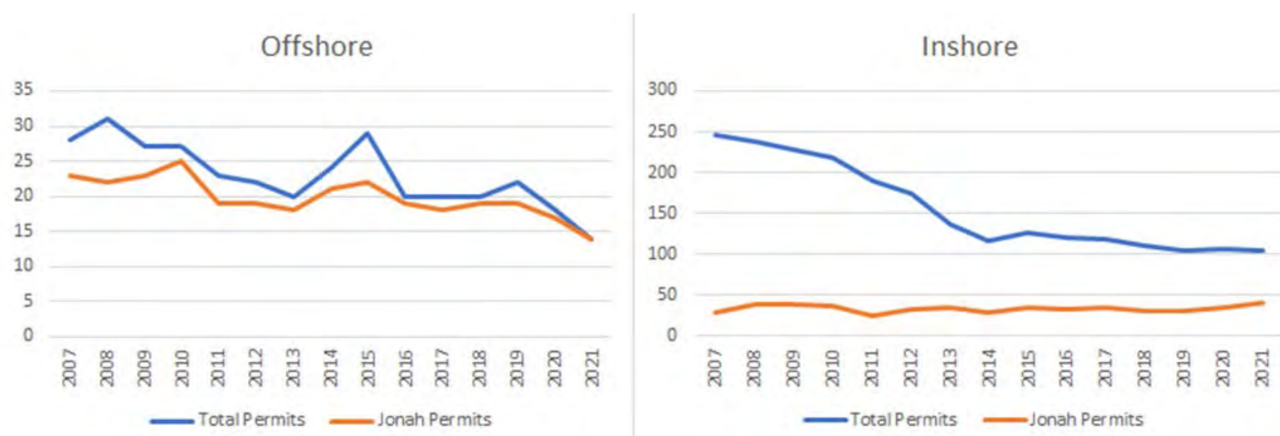

Figure 39. Number of active lobster permits and Jonah crab permits, Rhode Island Offshore SNE and Inshore SNE harvesters, 2007 to 2021.

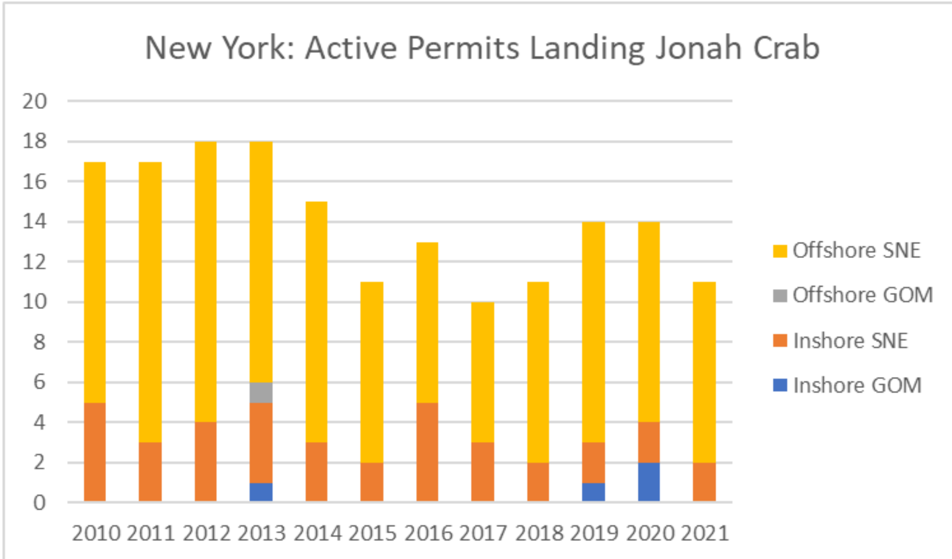

Figure 40. Active New York lobster/crab permits landings Jonah crab from each Jonah crab stock.

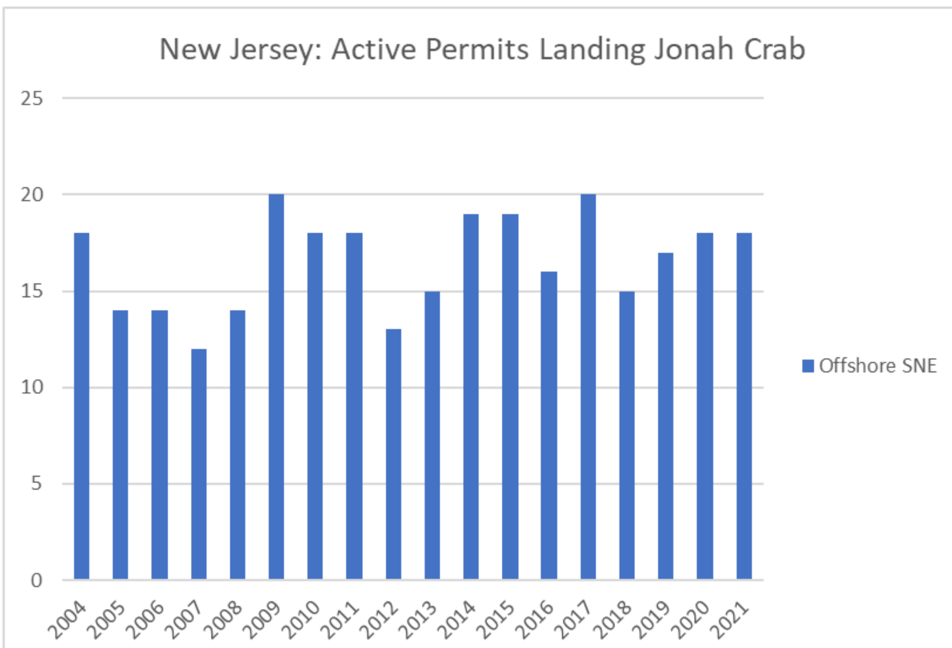

Figure 41. Active New Jersey lobster/crab permits landings Jonah crab from the OSNE Jonah crab stock.

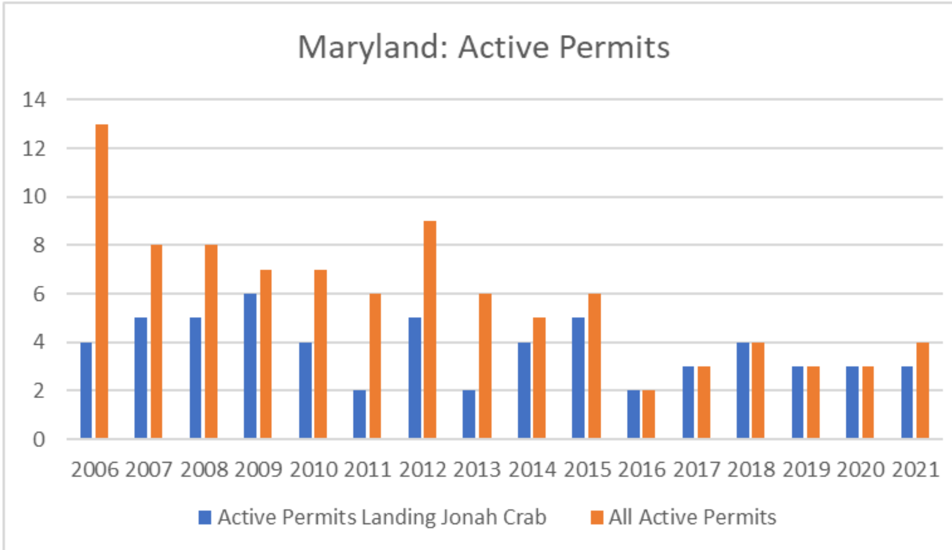

Figure 42. Maryland lobster/crab permit summary including those that have landed Jonah crab from the OSNE Jonah crab stock.

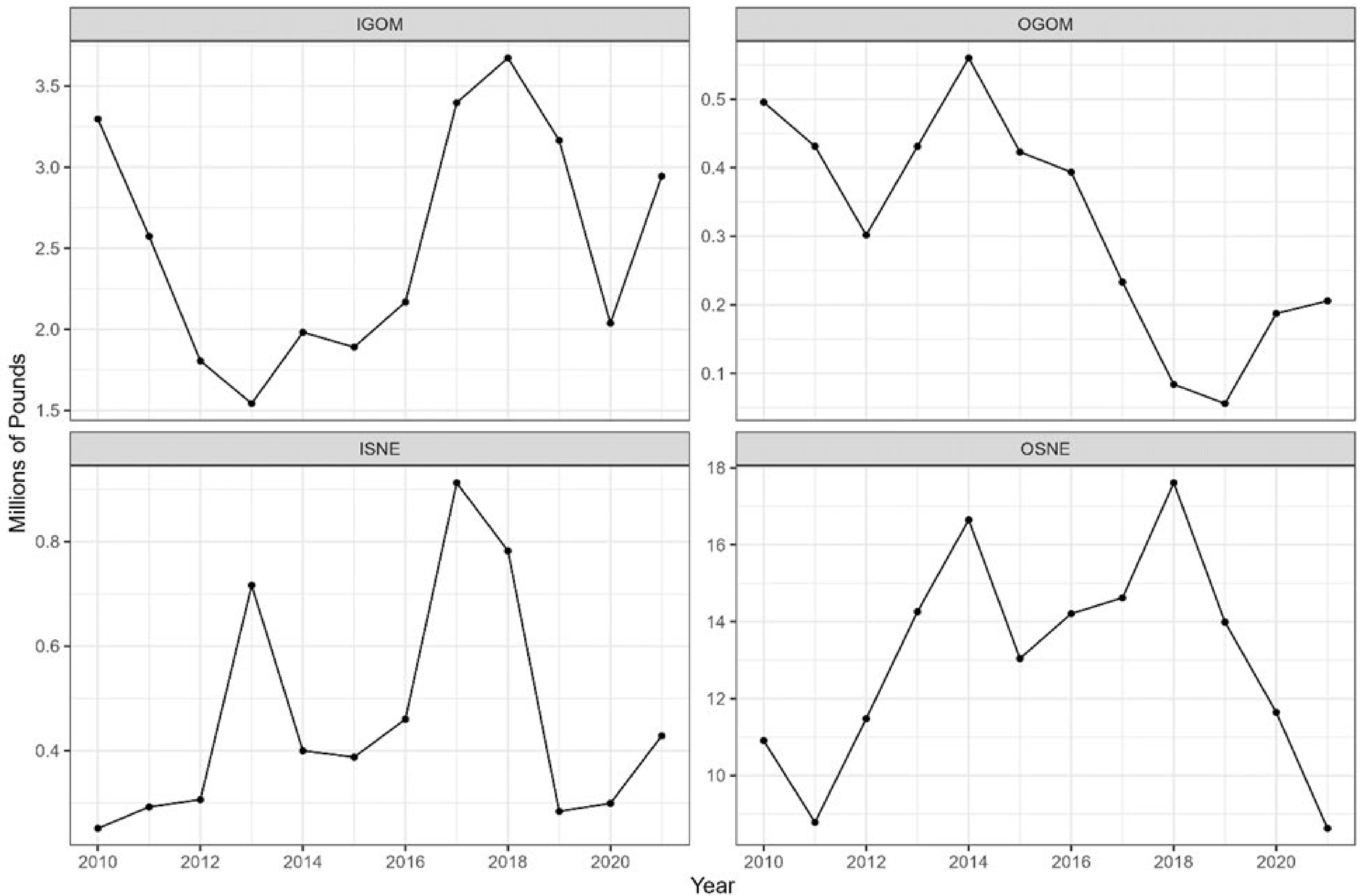

Figure 43. Stock-specific Jonah crab landings.

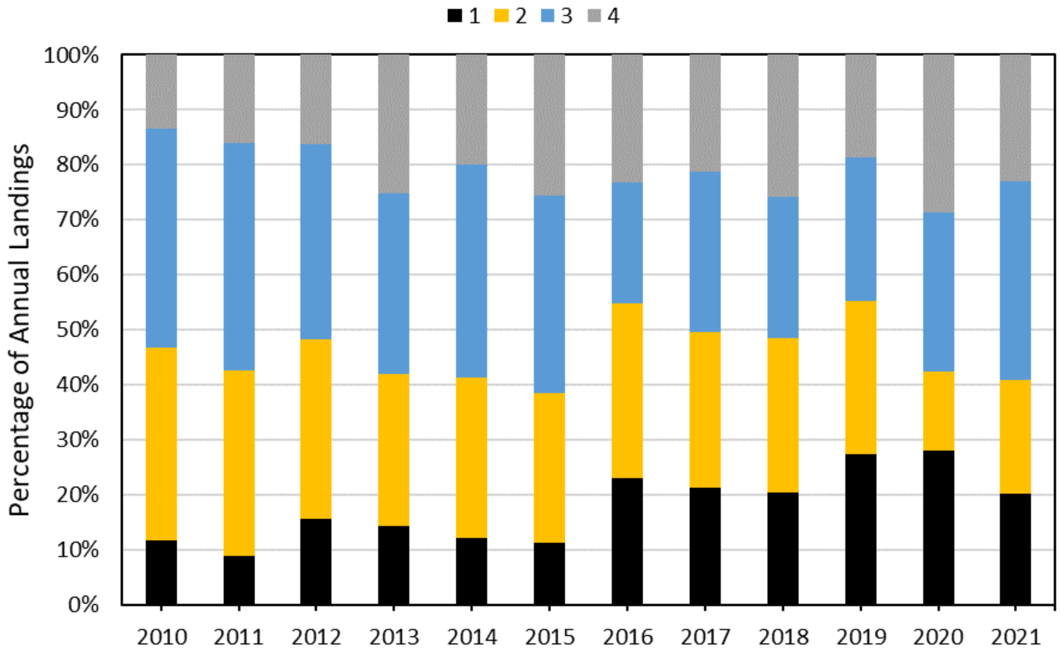

Figure 44. Quarterly breakdown of annual landings from the IGOM Jonah crab stock.

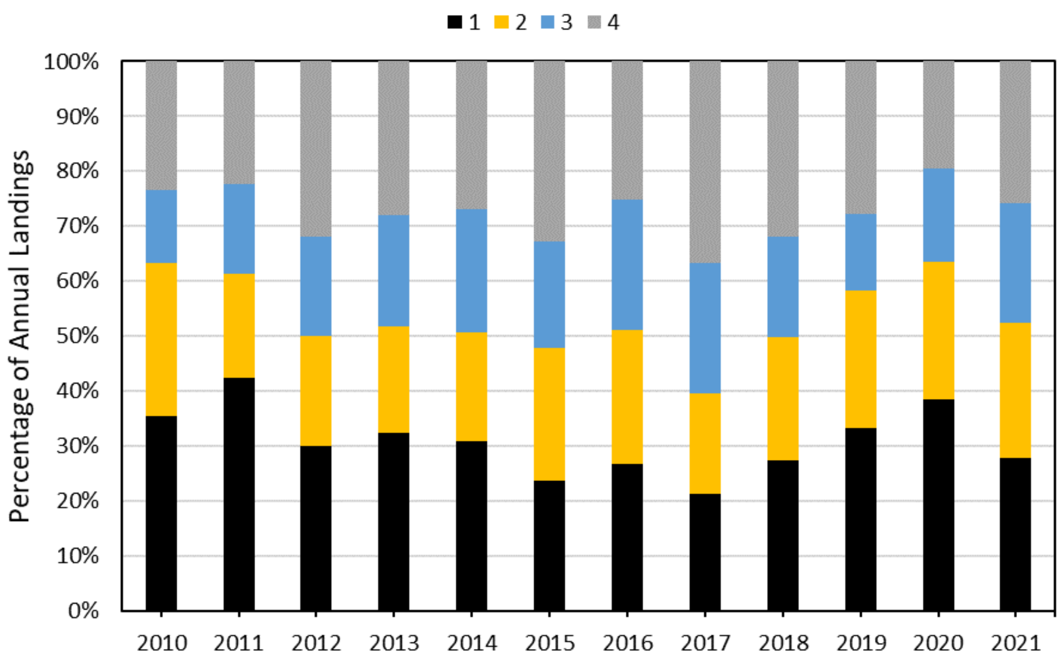

Figure 45. Quarterly breakdown of annual landings from the OSNE Jonah crab stock.

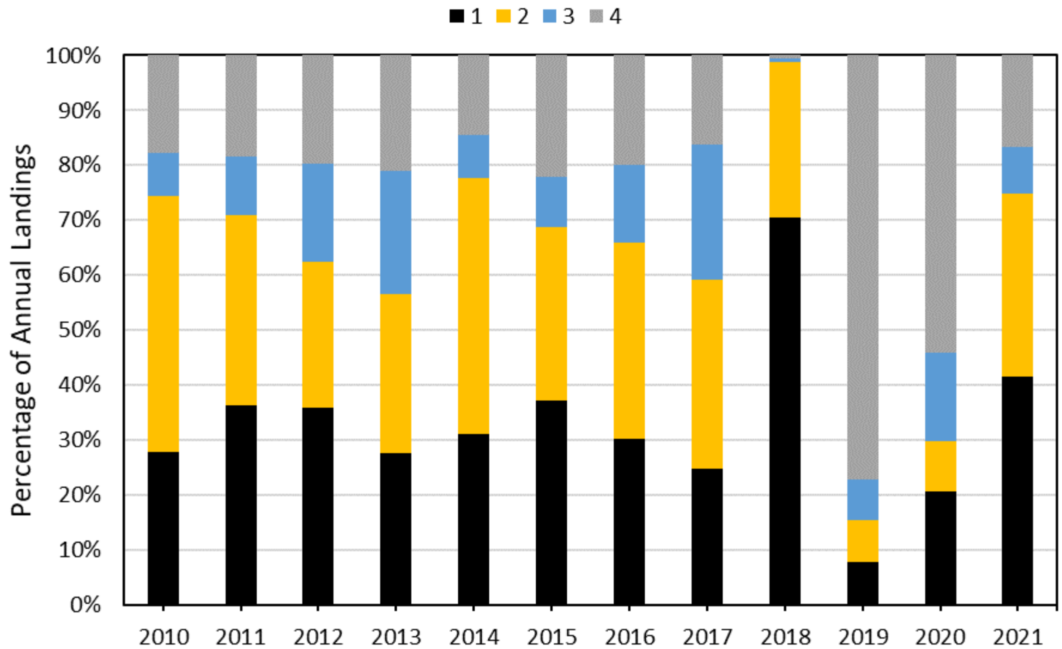

Figure 46. Quarterly breakdown of annual landings from the OGOM Jonah crab stock.

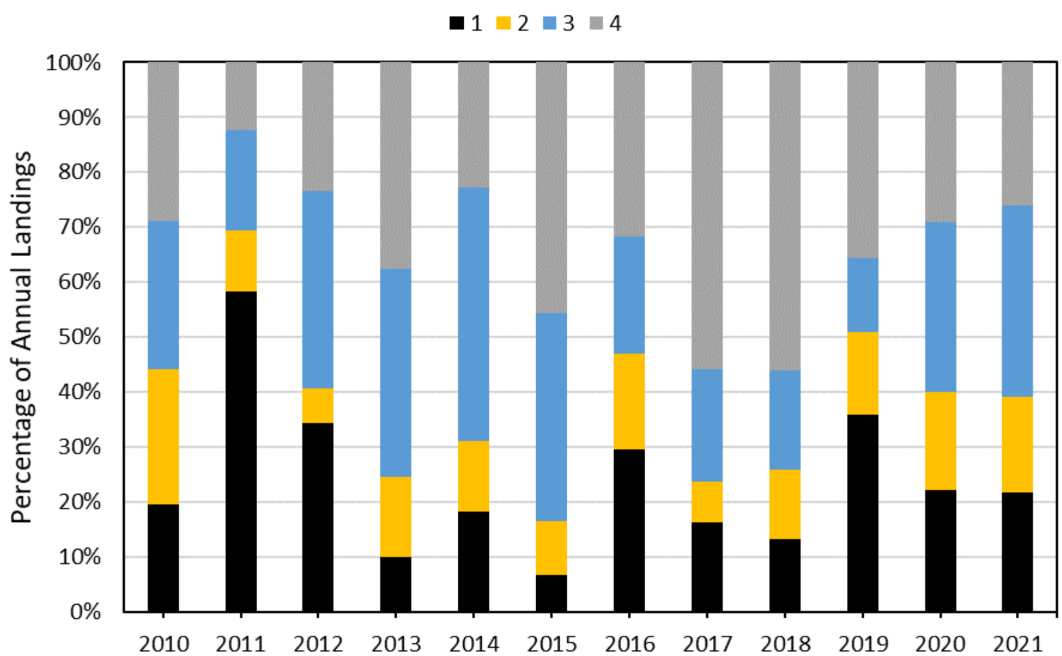

Figure 47. Quarterly breakdown of annual landings from the ISNE Jonah crab stock.

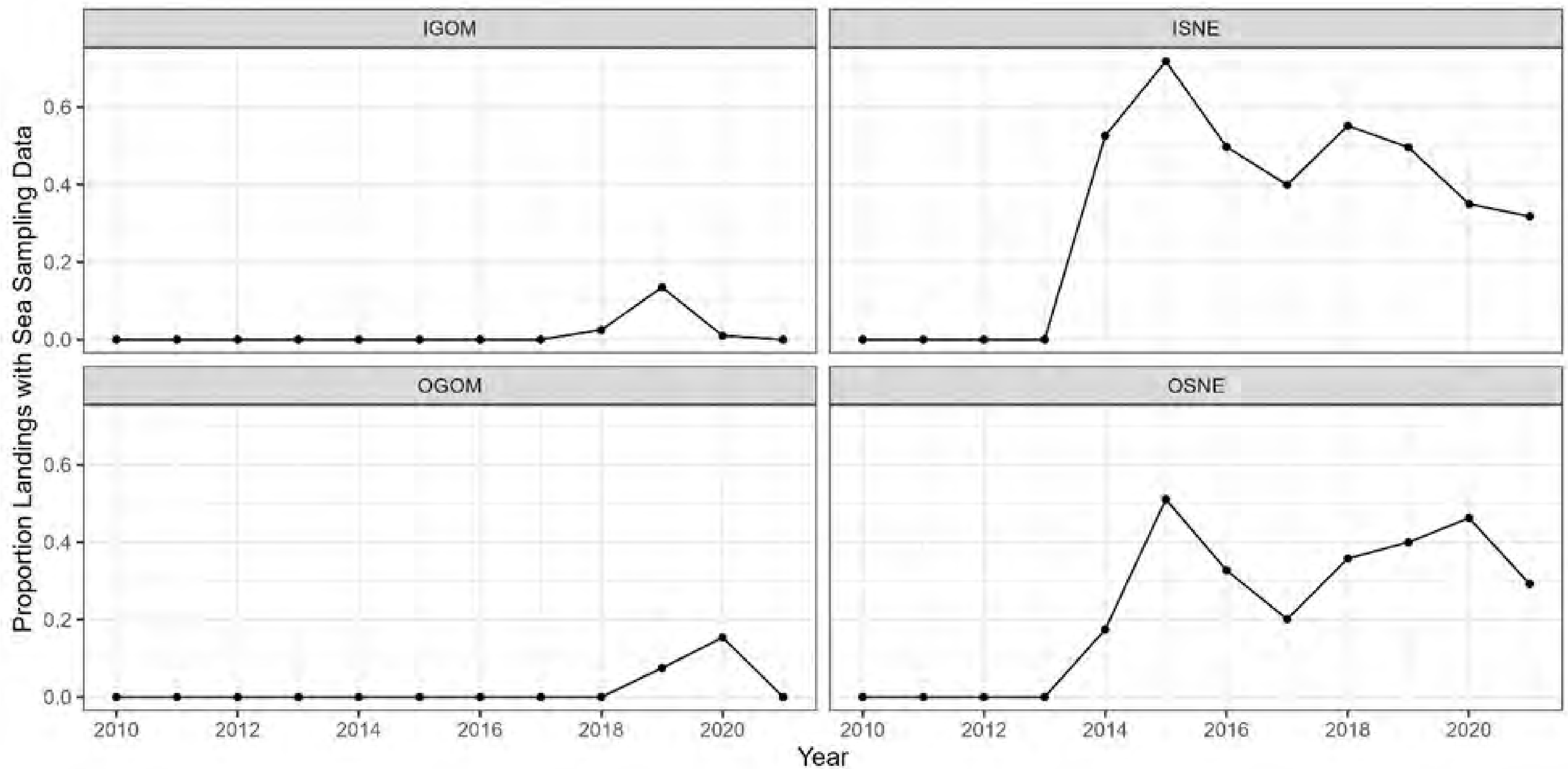

Figure 48. Proportion of landings with associated sea sampling data.

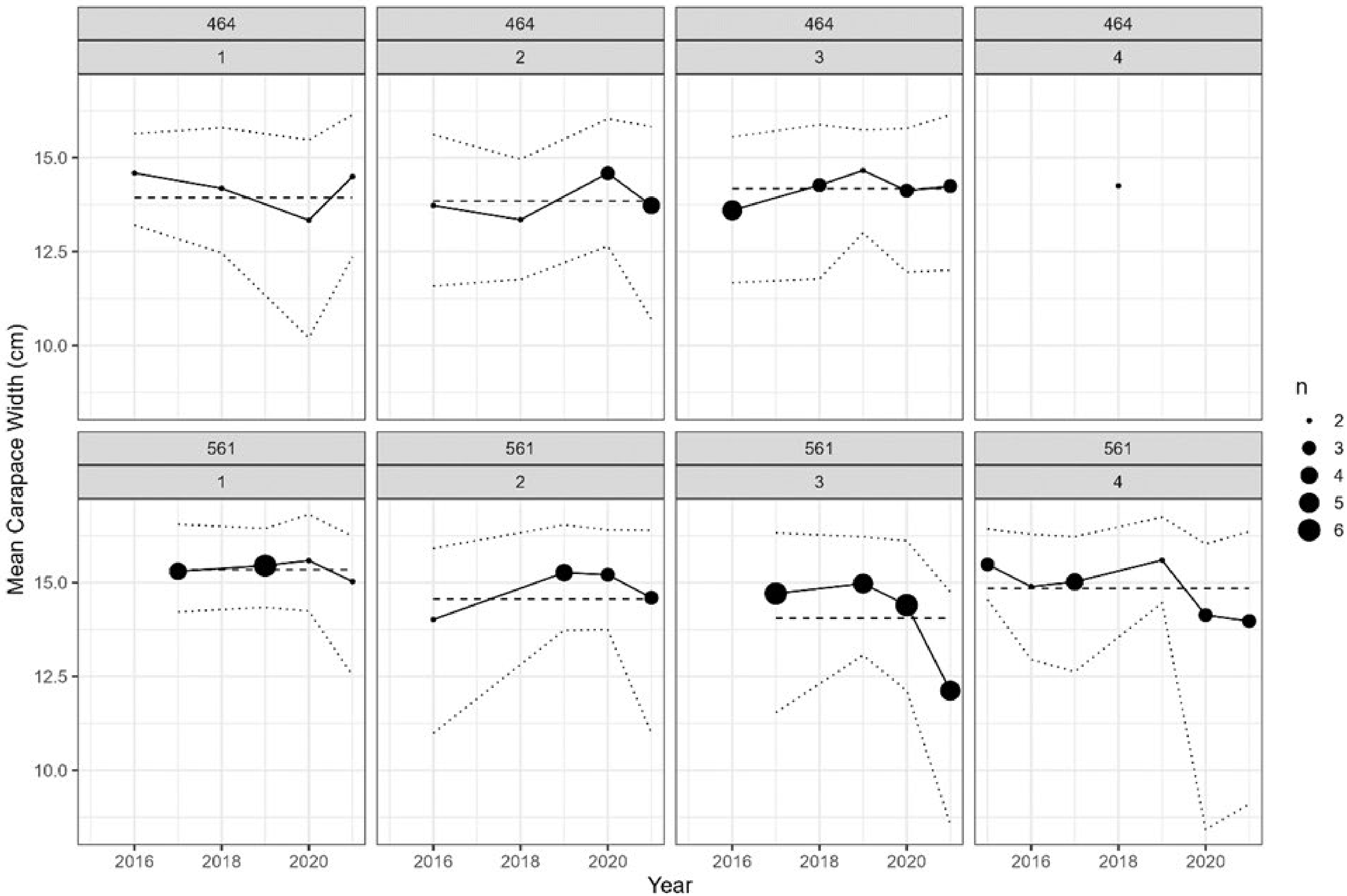

Figure 49. Mean CW (solid circles with size scaled to number of sampling trips) of males in the overall catch from OGOM sea sampling data by statistical area (top panel ribbon) and quarter (bottom panel ribbon). Dotted lines indicate the 5th and 95th percentile of CW and the dashed line indicates the mean CW across years. Data points from statistical areas 465, 511, 512, 515, and 522 are not included because there were no quarters in these statistical areas with at least five data points.

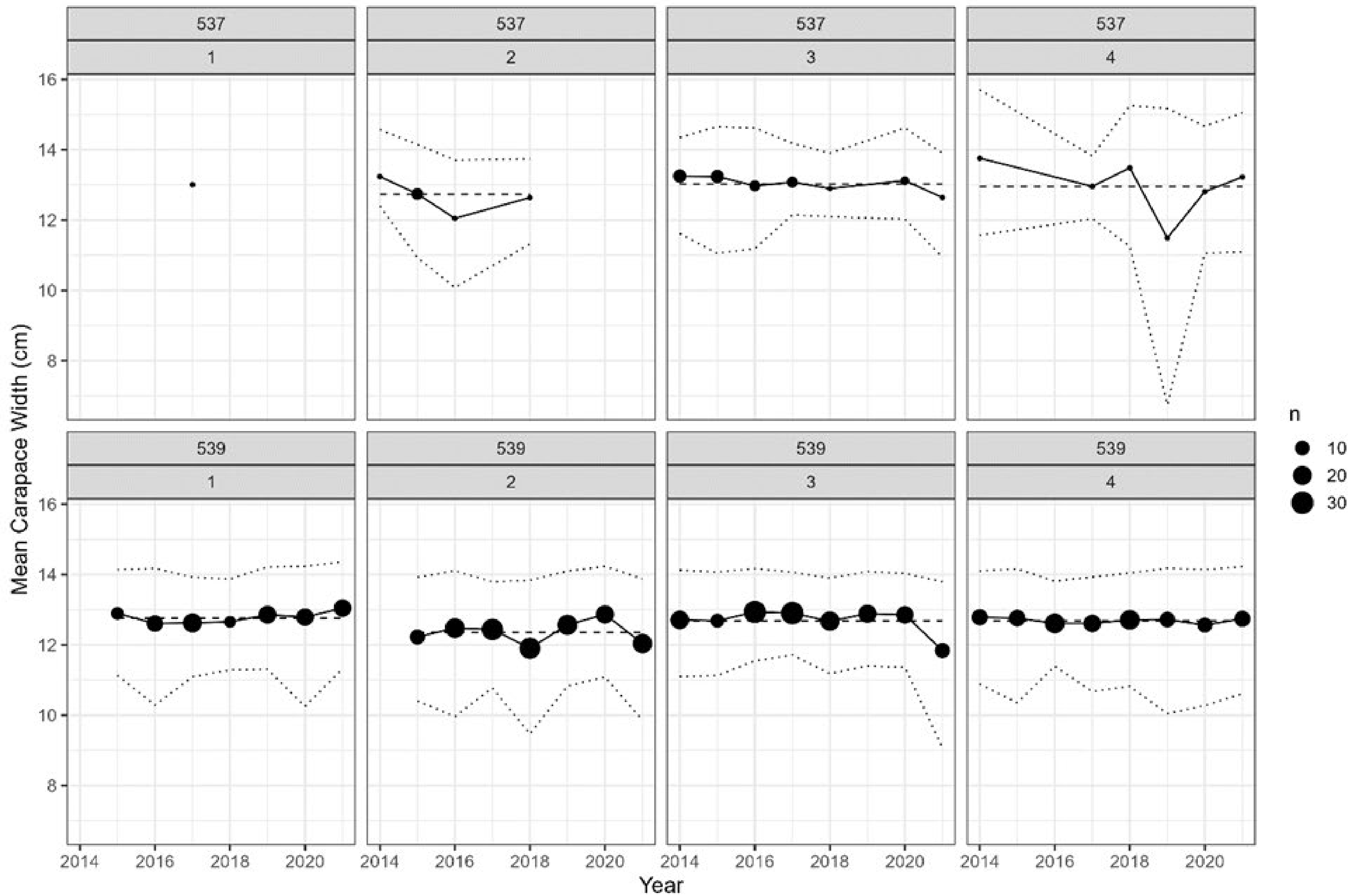

Figure 50. Mean CW (solid circles with size scaled to number of sampling trips) of males in the overall catch from ISNE sea sampling data by statistical area (top panel ribbon) and quarter (bottom panel ribbon). Dotted lines indicate the 5th and 95th percentile of CW and the dashed line indicates the mean CW across years.

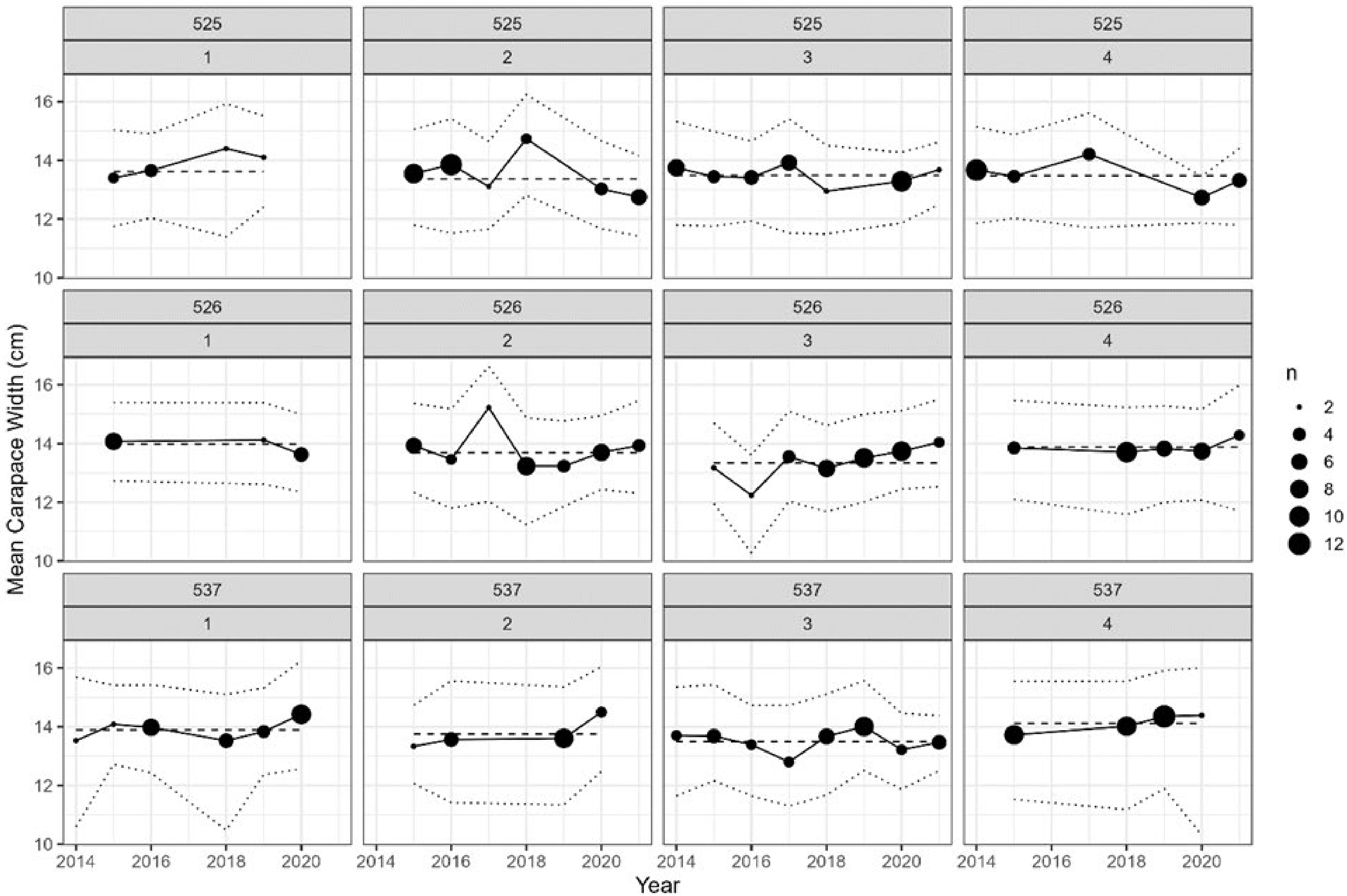

Figure 51. Mean CW (solid circles with size scaled to number of sampling trips) of males in the overall catch from OSNE sea sampling data by statistical area (top panel ribbon) and quarter (bottom panel ribbon). Dotted lines indicate the 5th and 95th percentile of CW and the dashed line indicates the mean CW across years. Data points from statistical areas 562, 613, 616, and 622 are not included because there were no quarters in these statistical areas with at least five data points.

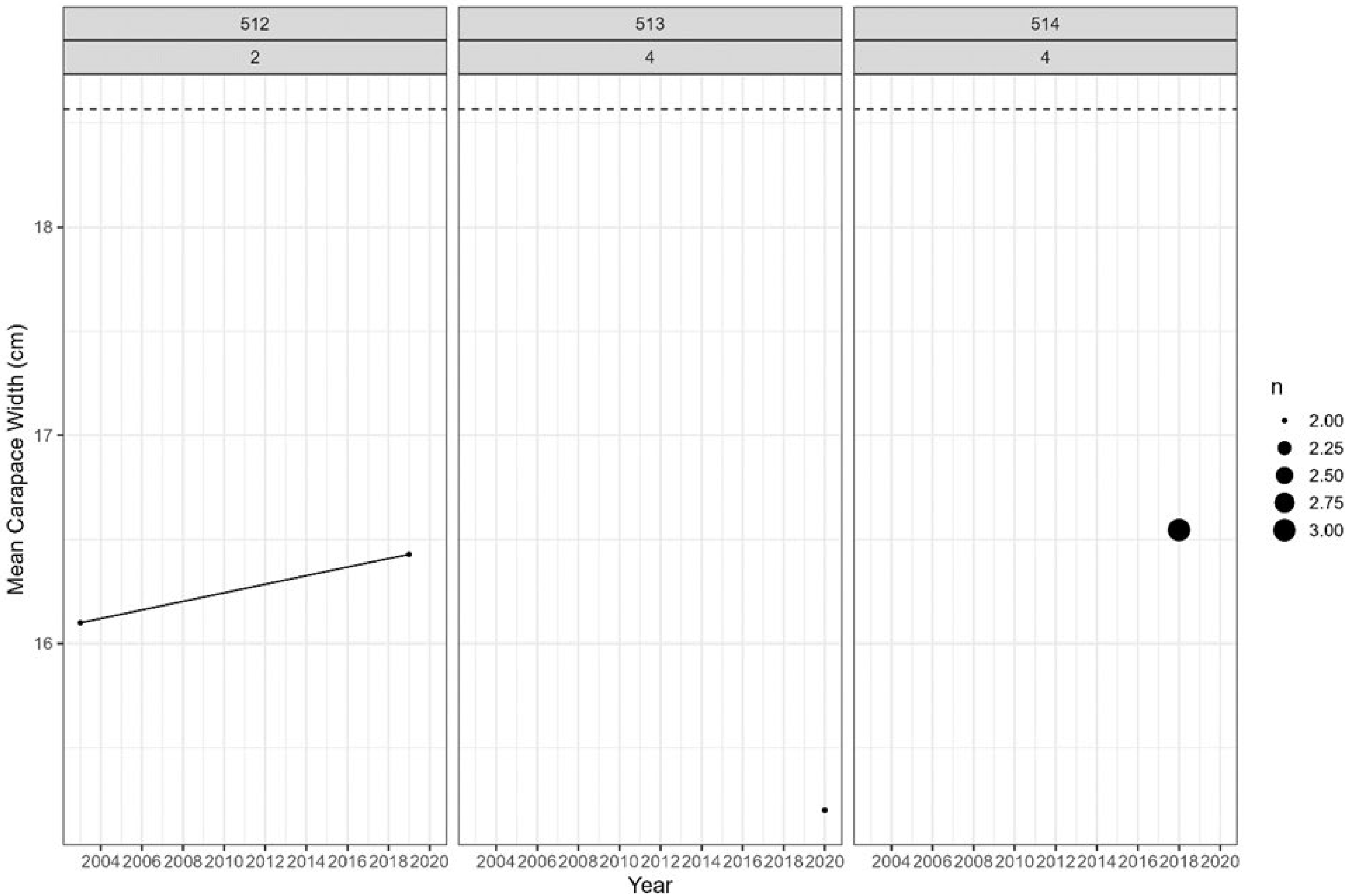

Figure 52. Mean CW (solid circles with size scaled to number of sampling trips) of the 5% largest males in the overall catch from IGOM sea sampling data by statistical area (top panel ribbon) and quarter (bottom panel ribbon). The dashed line indicates 90% of an Linf estimate for Mid-Coast, Maine males (C. Huntsberger, personal communication, October 11, 2022).

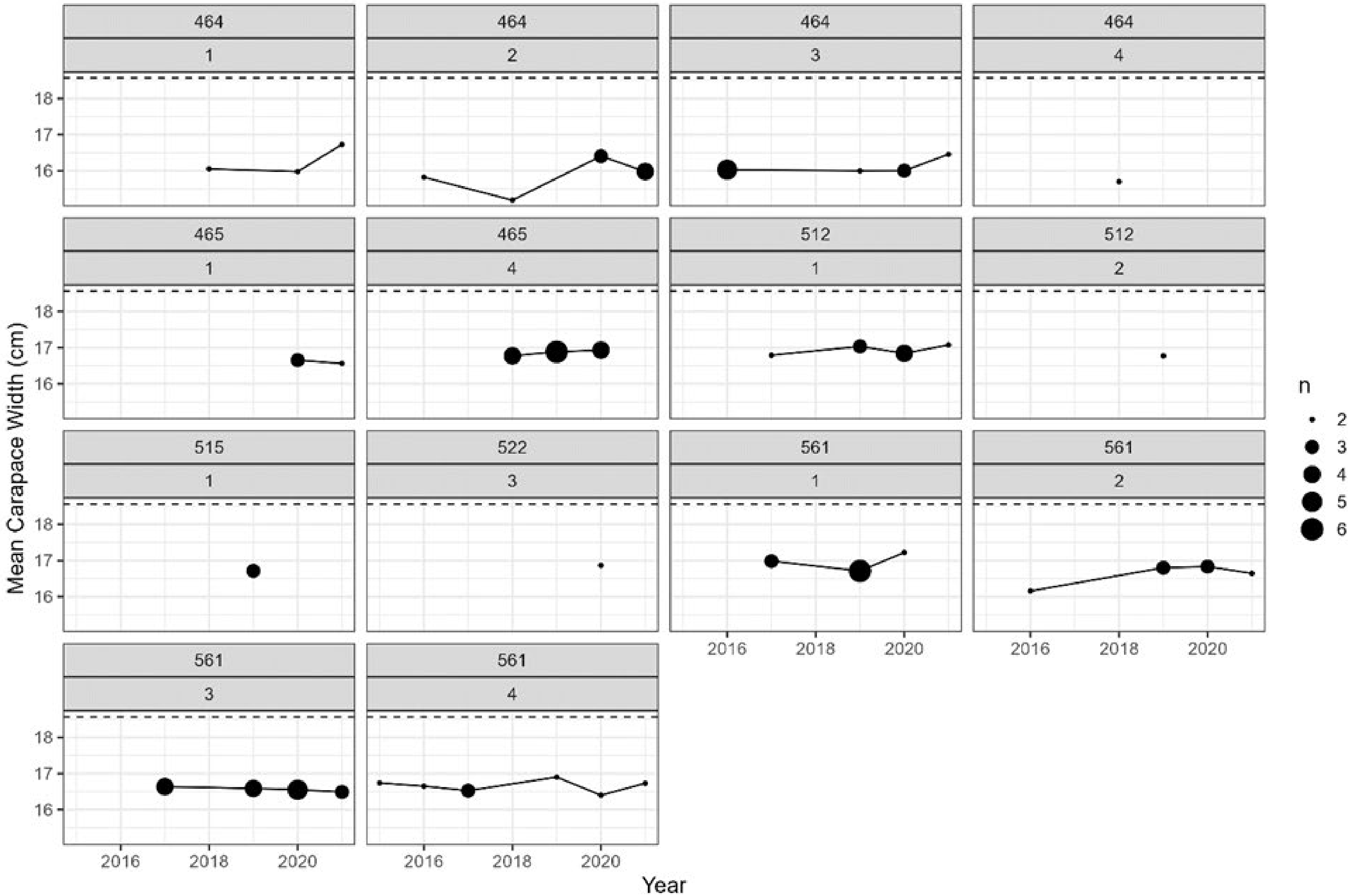

Figure 53. Mean CW (solid circles with size scaled to number of sampling trips) of the 5% largest males in the overall catch from OGOM sea sampling data by statistical area (top panel ribbon) and quarter (bottom panel ribbon). The dashed line indicates 90% of an Linf estimate for Mid-Coast, Maine males (C. Huntsberger, personal communication, October 11, 2022).

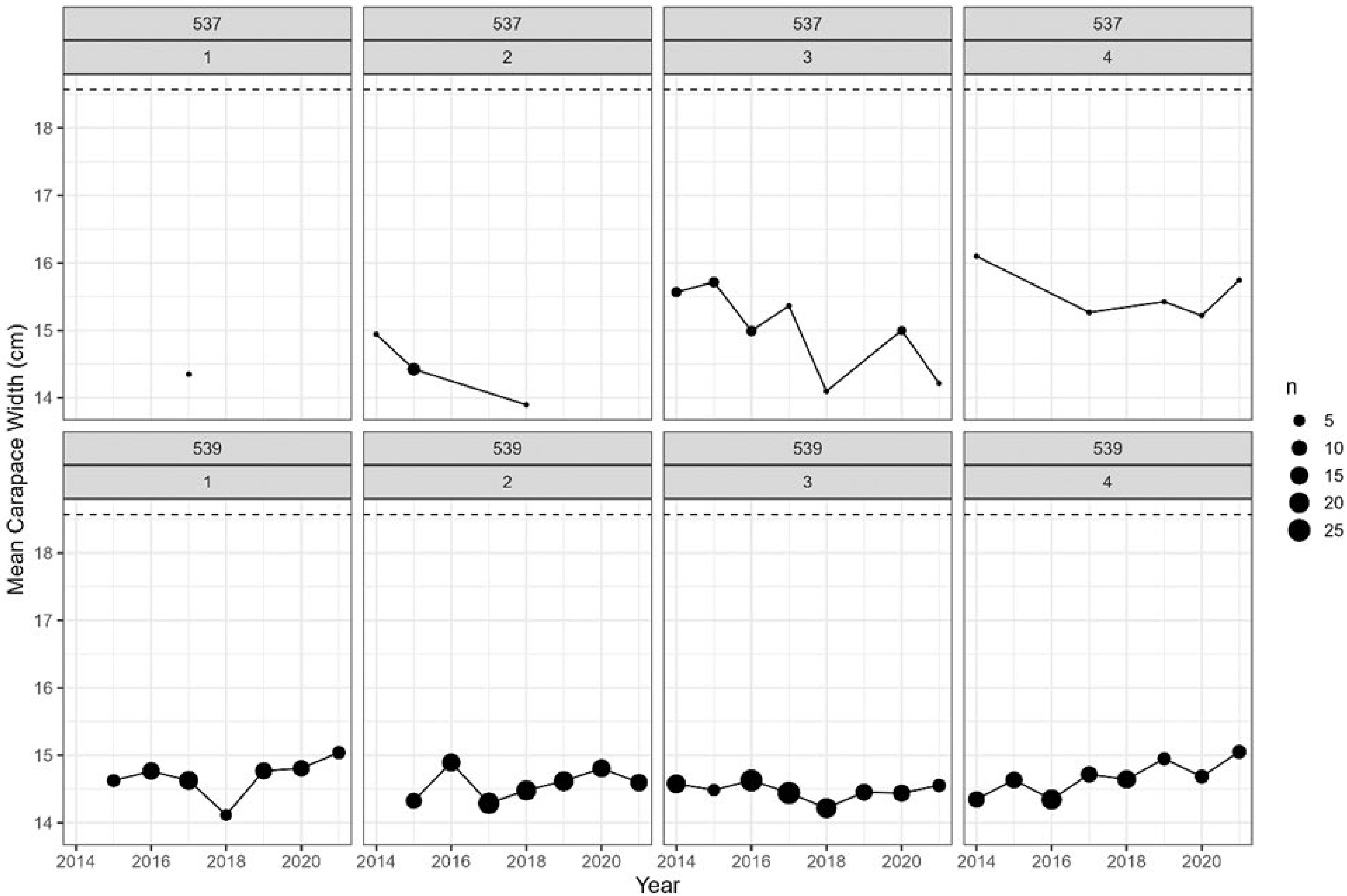

Figure 54. Mean CW (solid circles with size scaled to number of sampling trips) of the 5% largest males in the overall catch from ISNE sea sampling data by statistical area (top panel ribbon) and quarter (bottom panel ribbon). The dashed line indicates 90% of an Linf estimate for Mid-Coast, Maine males (C. Huntsberger, personal communication, October 11, 2022).

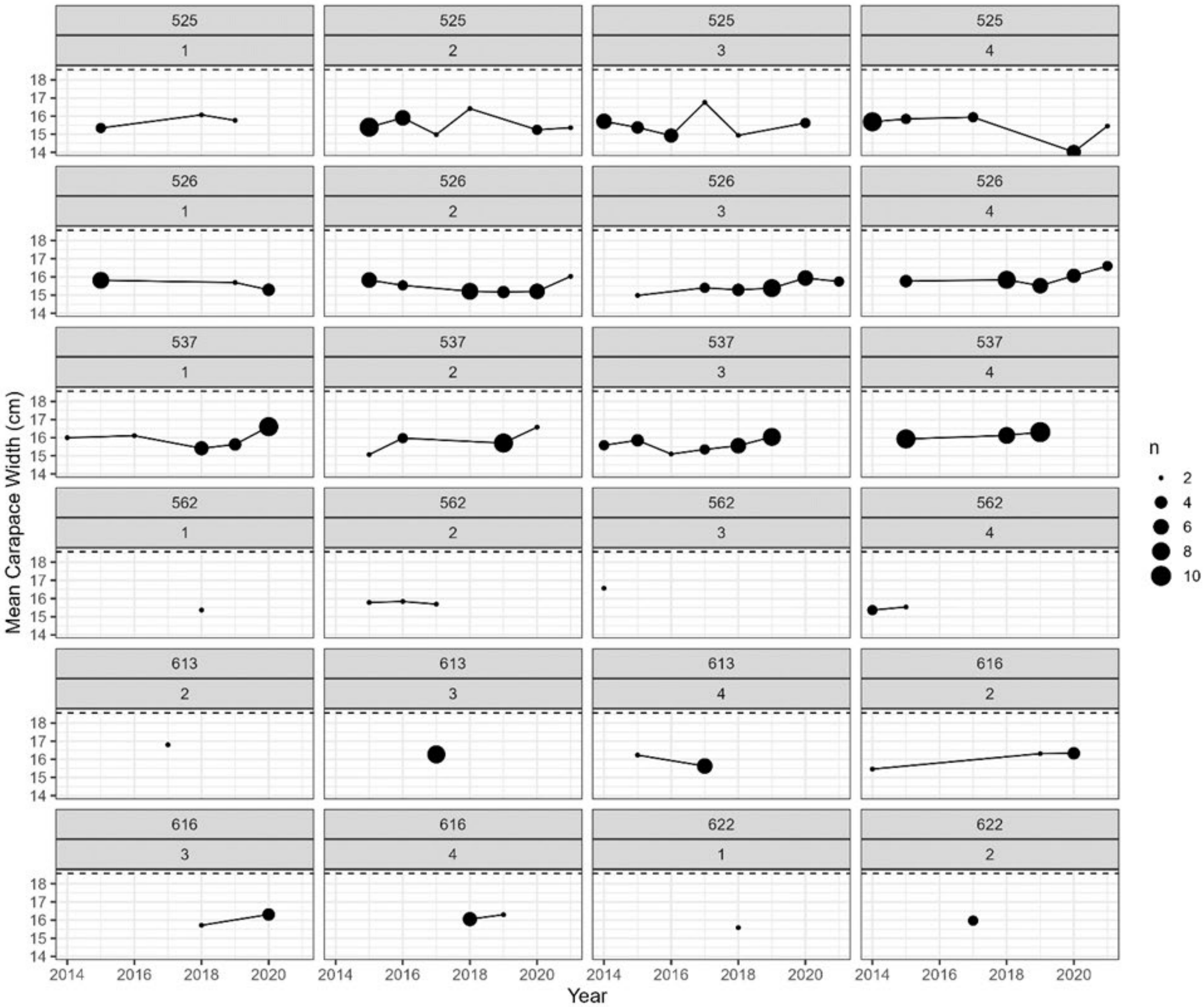

Figure 55. Mean CW (solid circles with size scaled to number of sampling trips) of the 5% largest males in the overall catch from OSNE sea sampling data by statistical area (top panel ribbon) and quarter (bottom panel ribbon). The dashed line indicates 90% of an Linf estimate for Mid-Coast, Maine males (C. Huntsberger, personal communication, October 11, 2022).

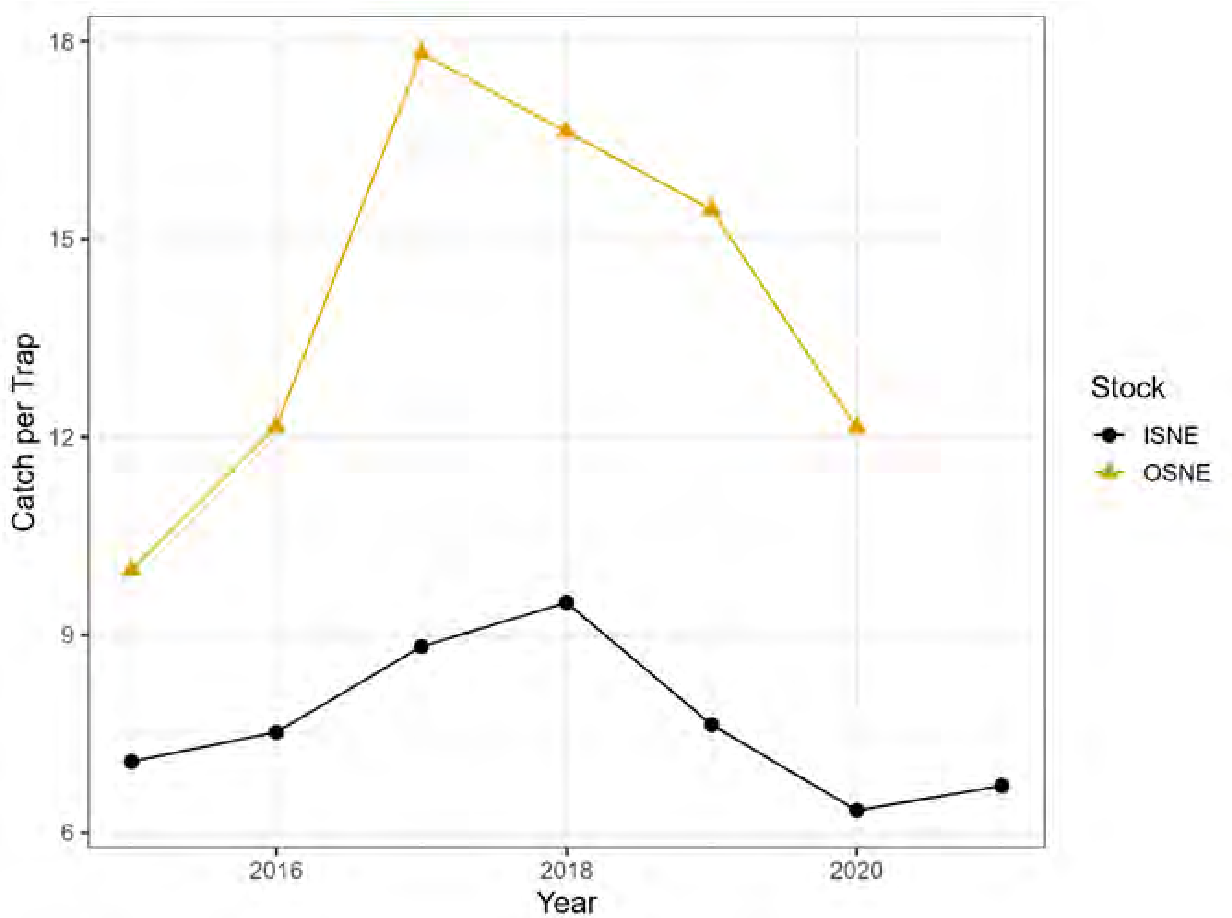

Figure 56. CFRF VTS CPUE for exploitable-sized (>121mm CW) male crabs.

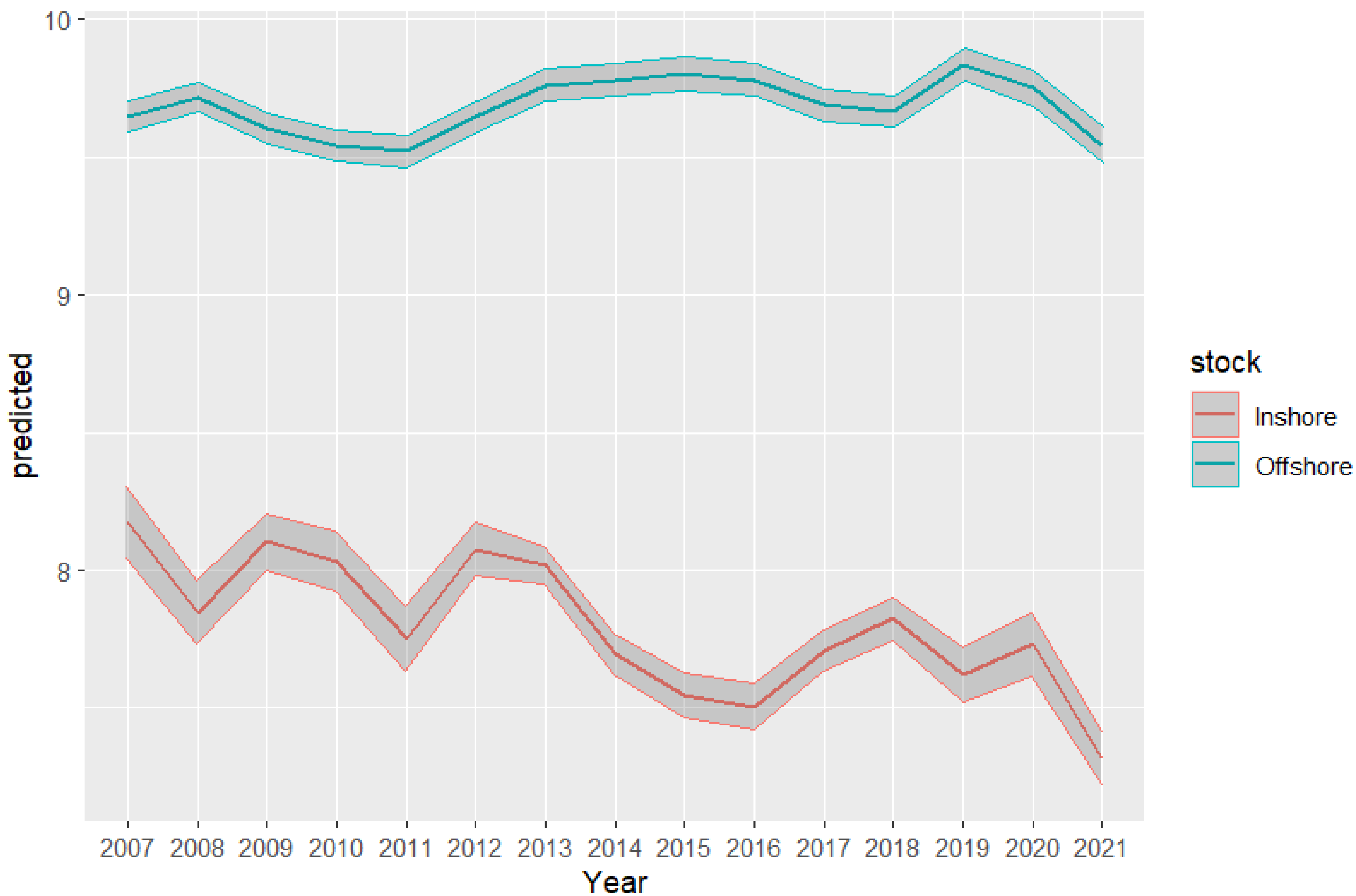

Figure 57. Jonah crab CPUE indices derived from directed residual model fitted to Rhode Island trip-level landings data.

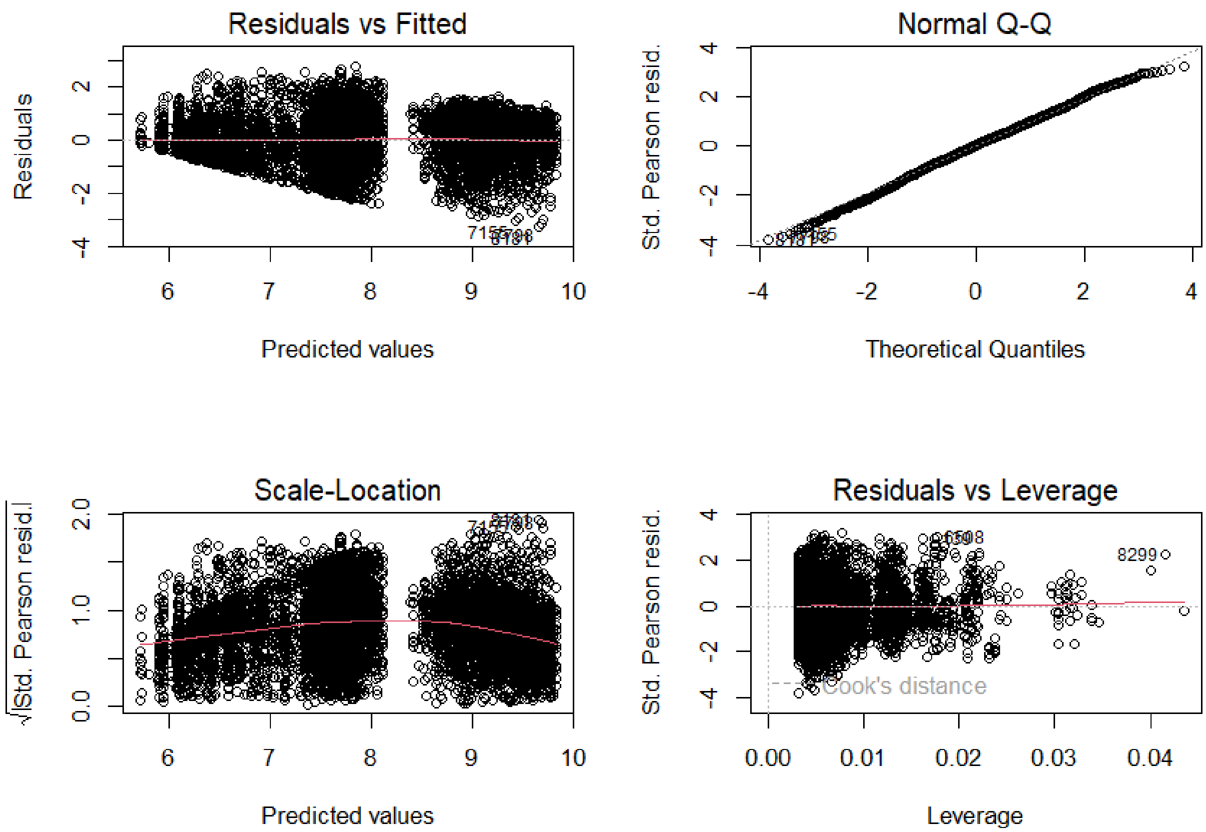

Figure 58. Diagnostic plots for selected DRM fitted to Rhode Island trip-level landings data.

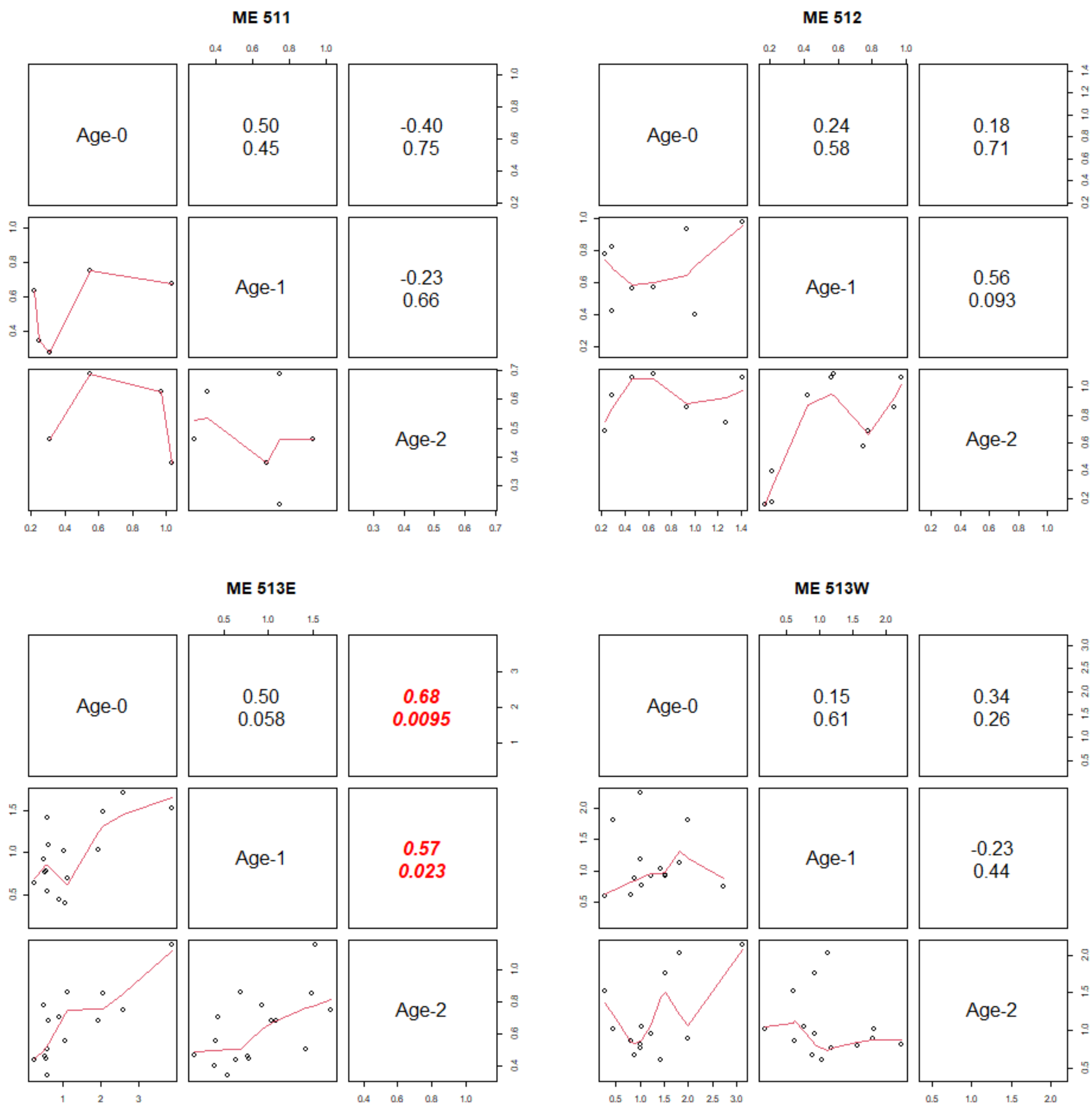

Figure 59. Spearman correlation results for age-specific settlement indices from the ME settlement surveys. Panels above the diagonal include the Spearman's ρ as the top number and the p-value as the bottom number.

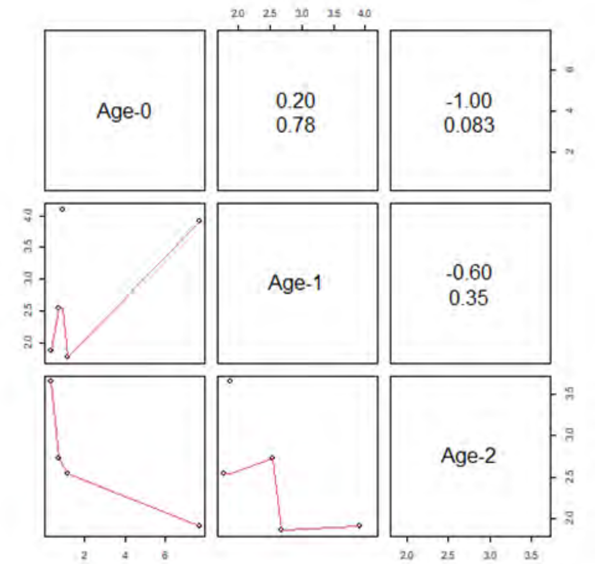

Figure 60. Spearman correlation results for age-specific settlement indices from the MA Statistical Area 514 settlement survey. Panels above the diagonal include the Spearman's ρ as the top number and the p-value as the bottom number.

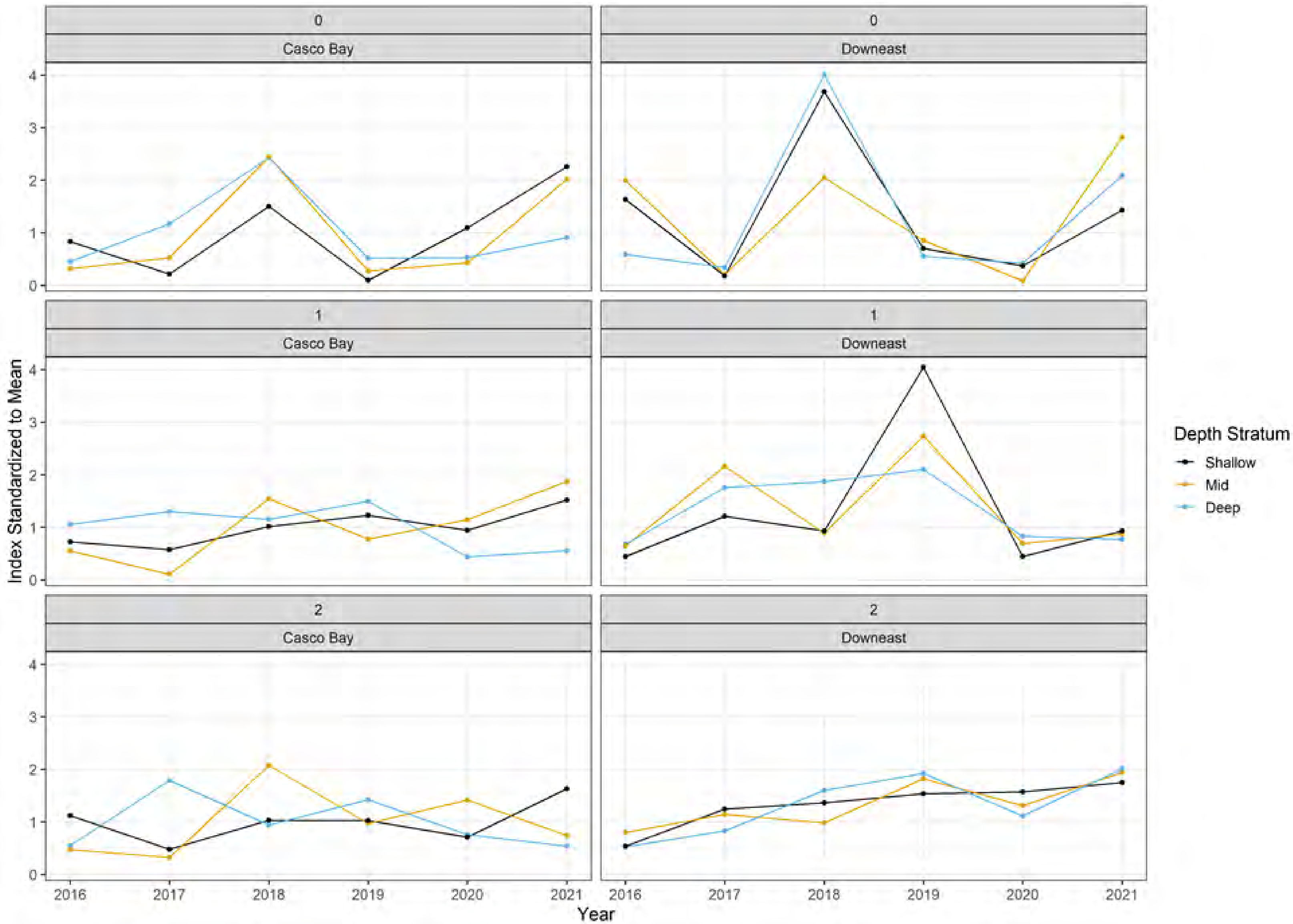

Figure 61. Comparison of depth specific indices from the University of Maine Deepwater Collector survey. Indices are age-specific (top ribbon in each panel) and region-specific (bottom ribbon in each panel).

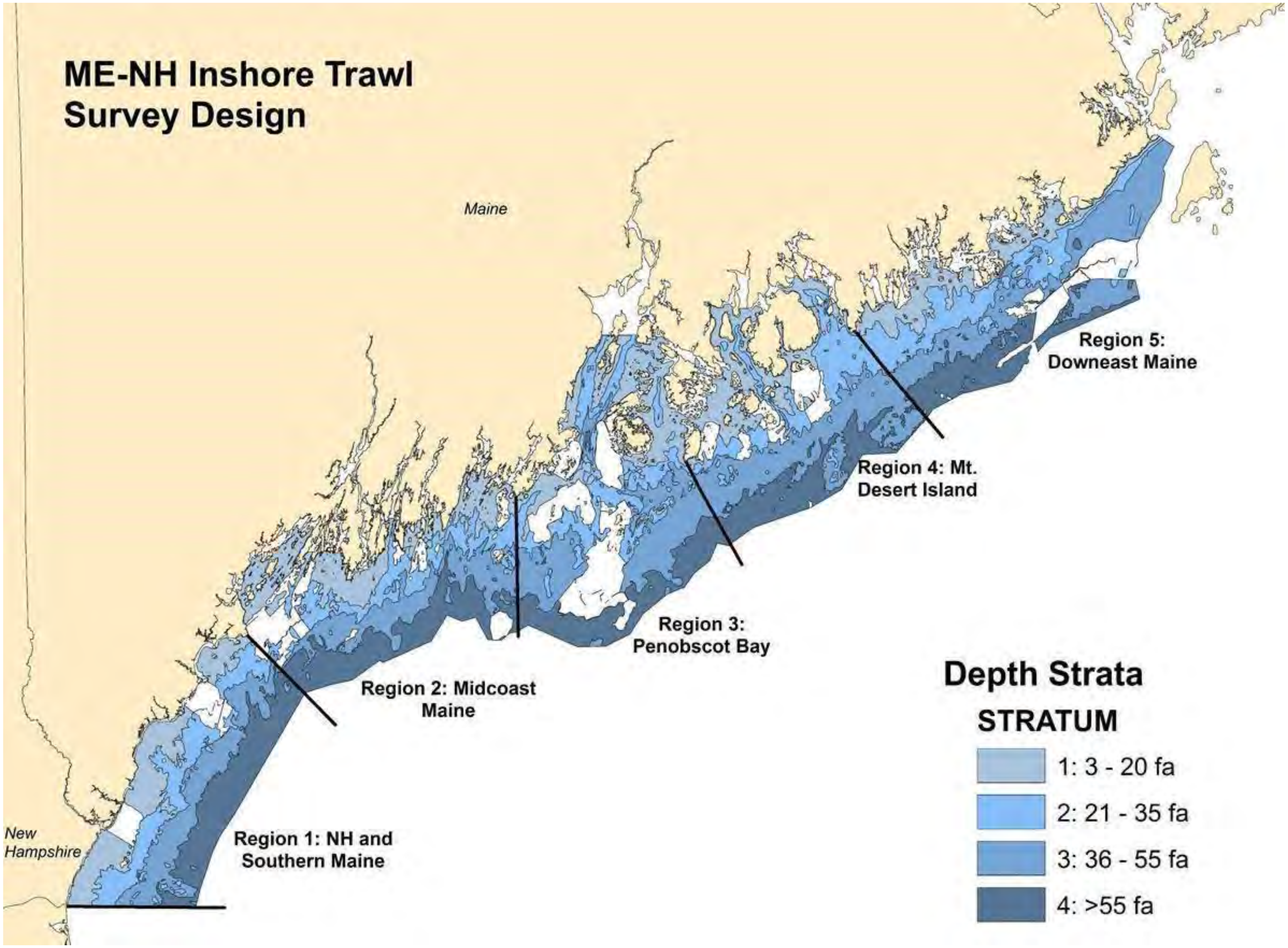

Figure 62. Sampling regions and depth strata for the Maine/New Hampshire trawl survey

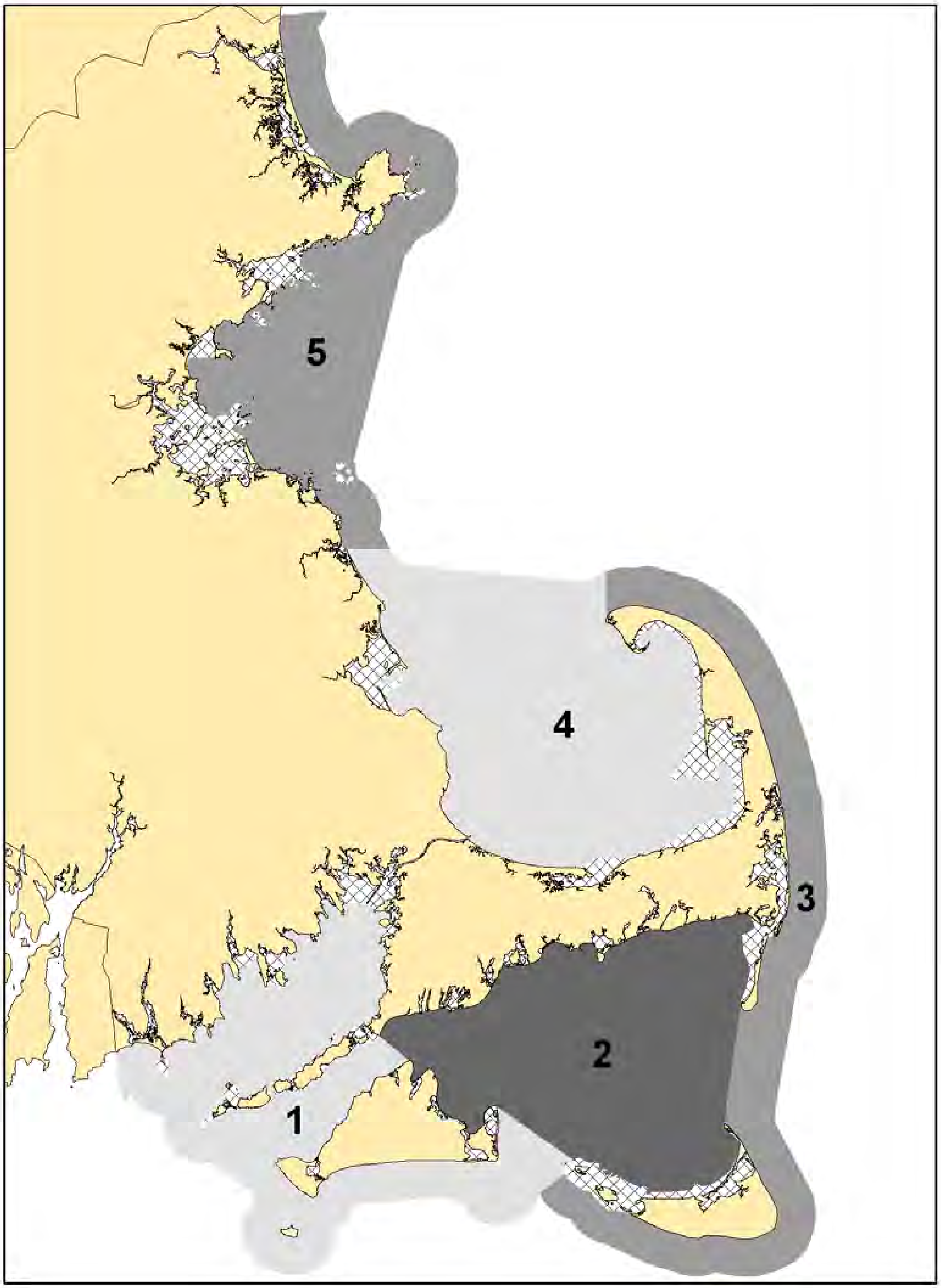

Figure 63. Sampling regions for the MA DMF trawl survey.

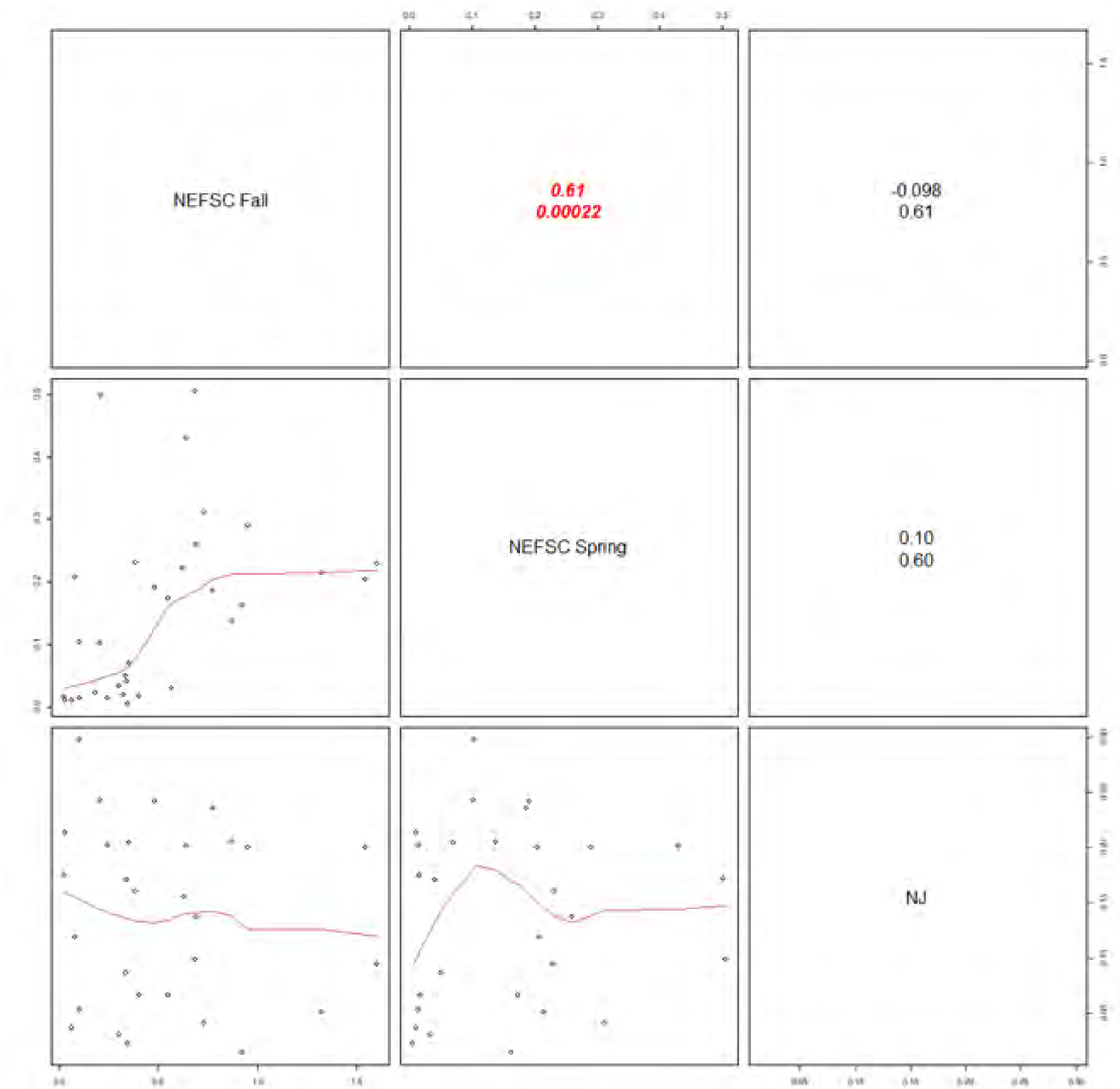

Figure 64. Spearman correlation results for sex- and size-aggregate indices from the NEFSC and NJ trawl surveys. Panels above the diagonal include the Spearman's ρ as the top number and the p-value as the bottom number. Italicized and red numbers indicate significant correlations (p-value<0.05).

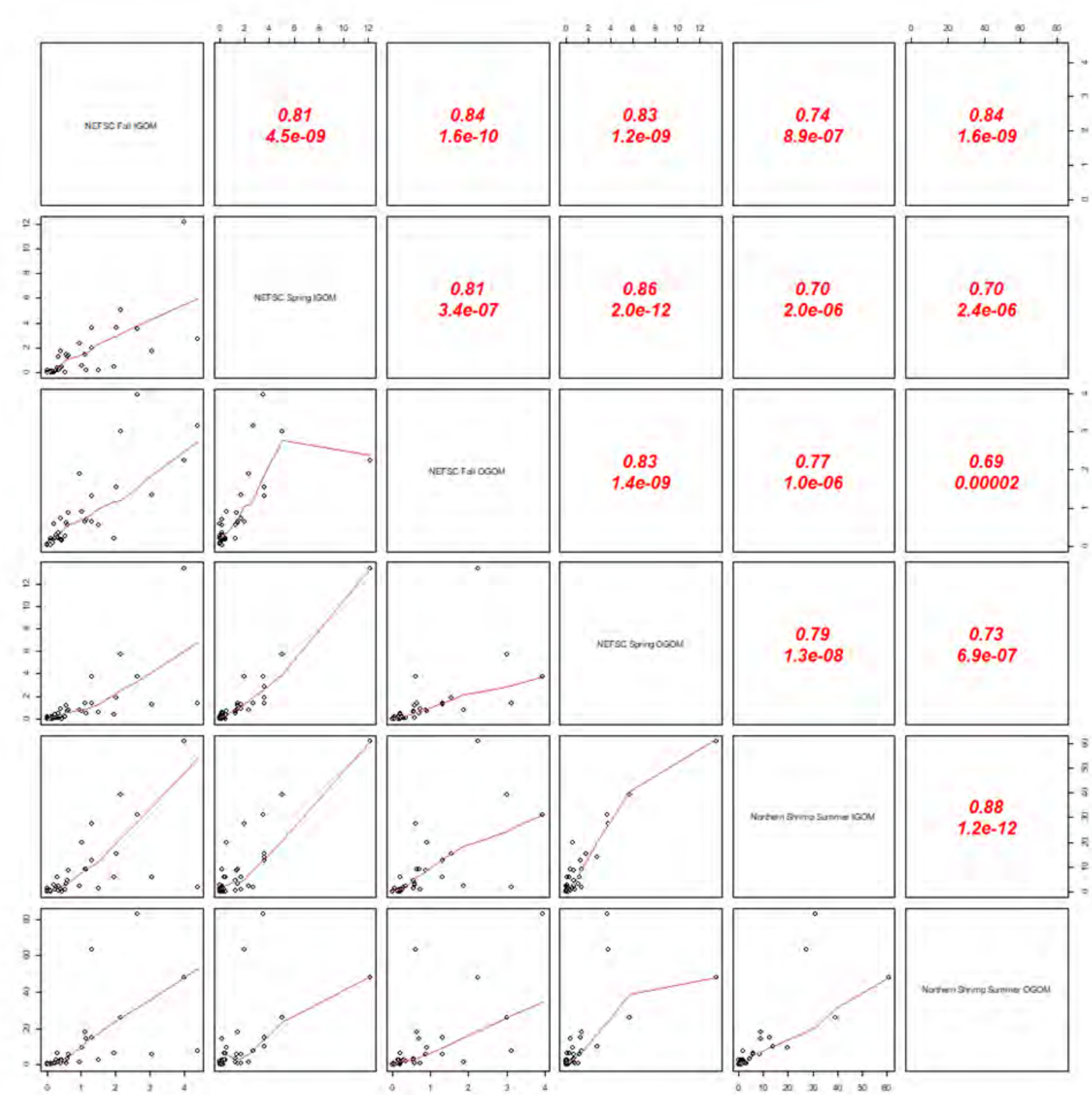

Figure 65. Spearman correlation results for sex- and size-aggregate indices from the NEFSC and Northern Shrimp trawl surveys. Panels above the diagonal include the Spearman's ρ as the top number and the p-value as the bottom number. Italicized and red numbers indicate significant correlations (p-value<0.05).

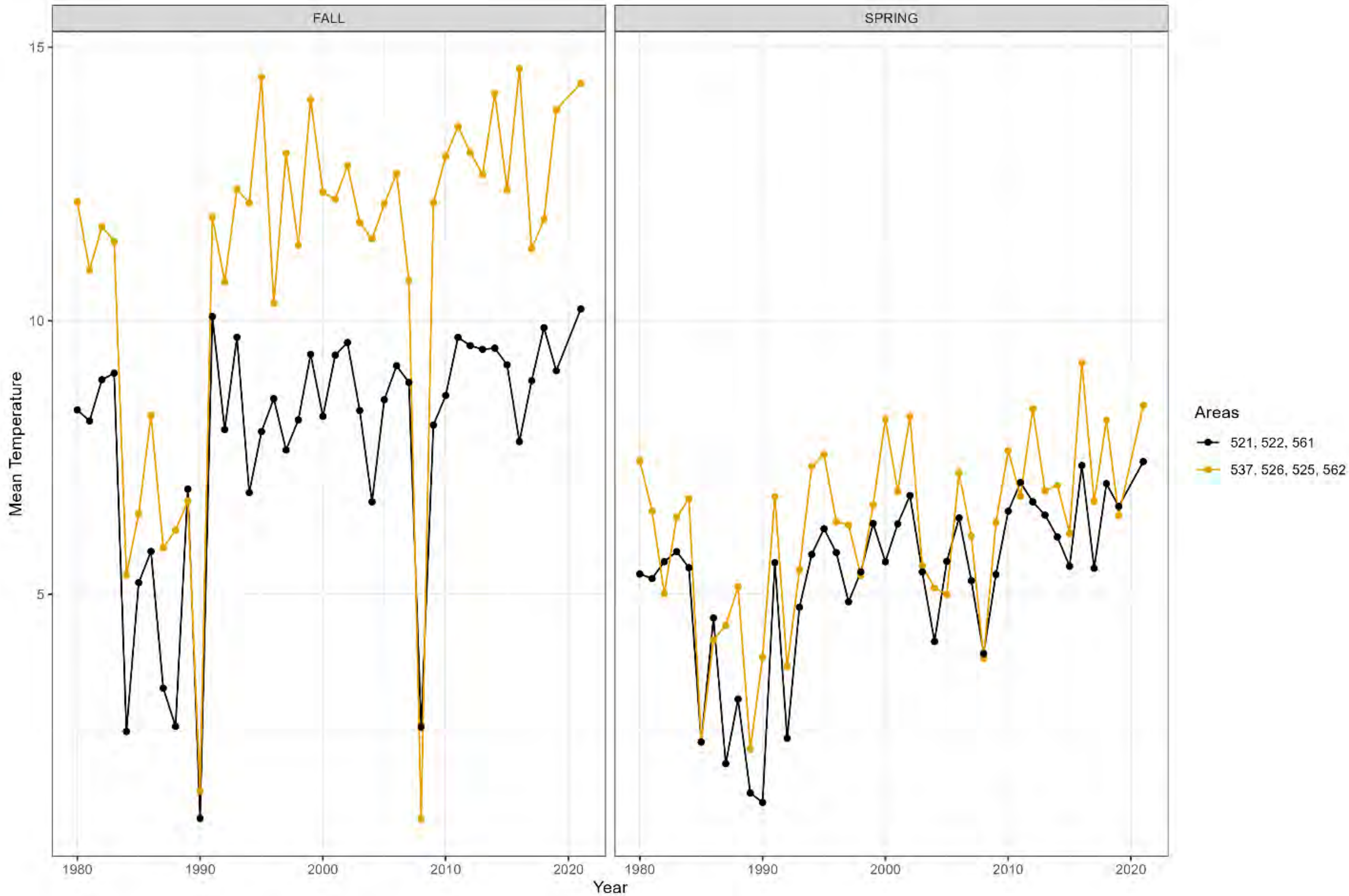

Figure 66. NEFSC Trawl Survey seasonal bottom temperature indices for adjacent NOAA statistical areas associated with high landings of Jonah crabs (Areas 537, 526, 525, 562) and low landings of Jonah crabs (Areas 521, 522, 561).

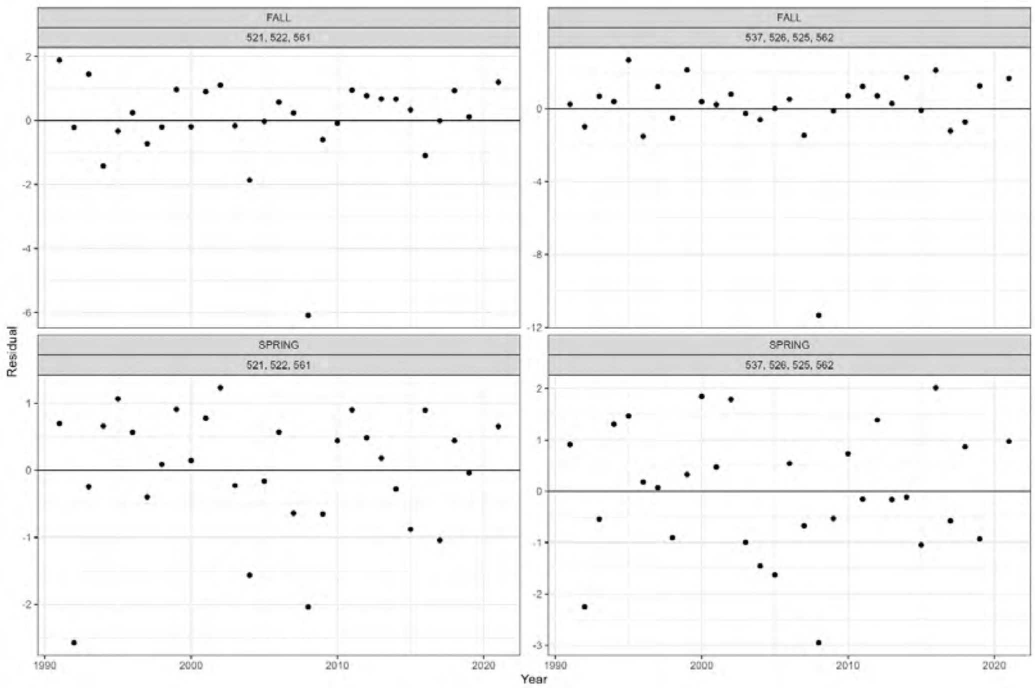

Figure 67. Residuals for linear regression fits to NEFSC Trawl Survey seasonal bottom temperature indices for adjacent NOAA statistical areas associated with high landings of Jonah crabs (Areas 537, 526, 525, 562) and low landings of Jonah crabs (Areas 521, 522, 561).

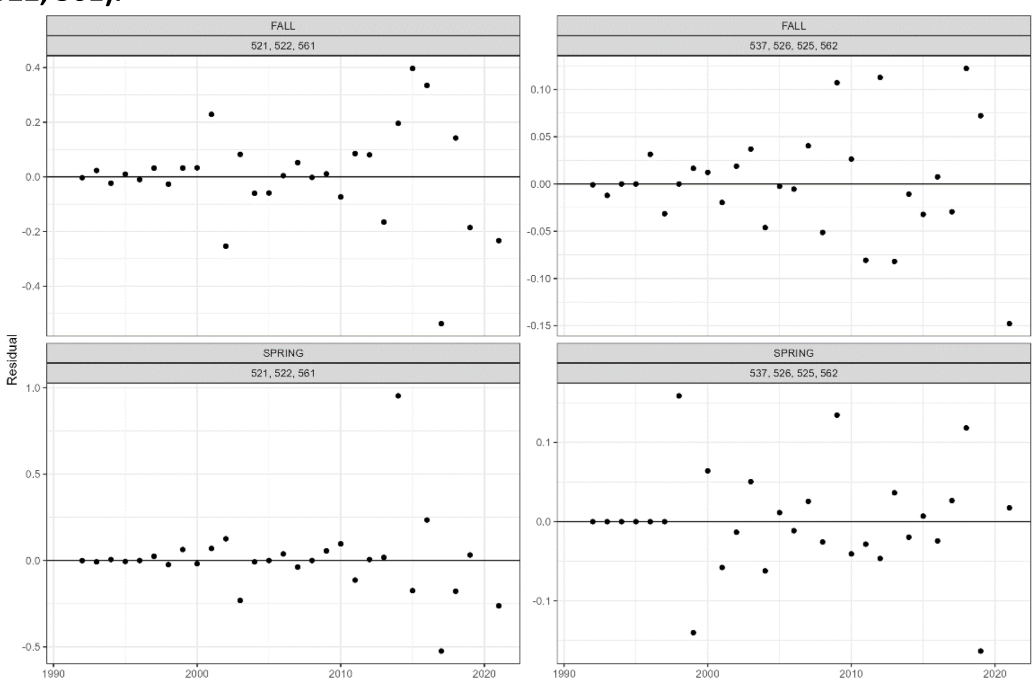

Figure 68. Residuals for two-year running average fits to NEFSC Trawl Survey seasonal exploitable abundance indices for adjacent NOAA statistical areas associated with high landings of Jonah crabs (Areas 537, 526, 525, 562) and low landings of Jonah crabs (Areas 521, 522, 561).

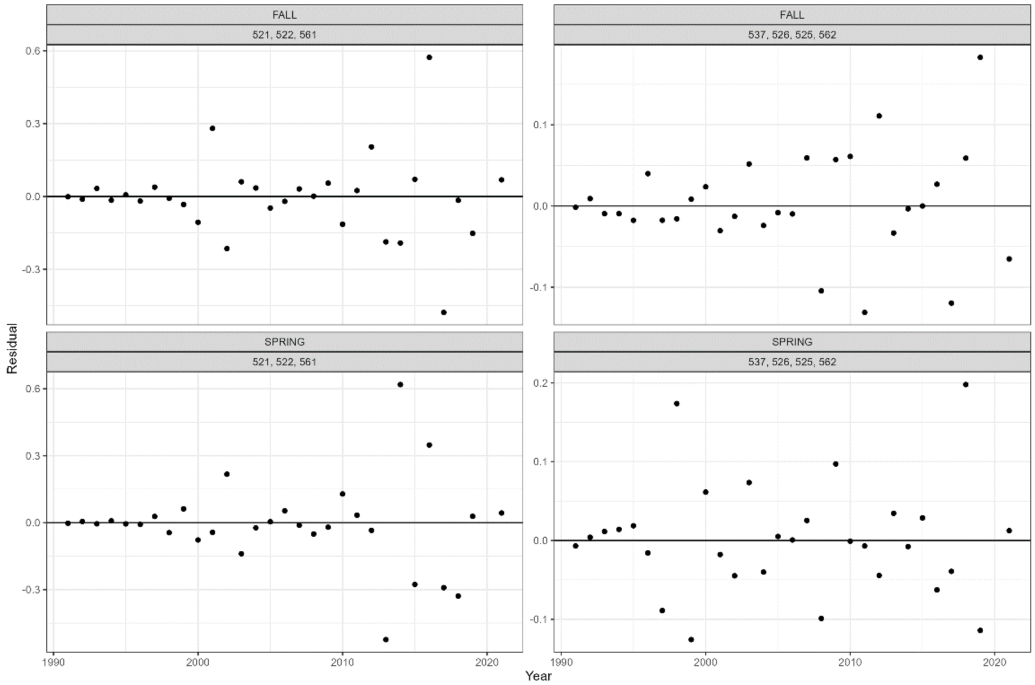

Figure 69. Residuals for LOESS smoother fits to NEFSC Trawl Survey seasonal exploitable abundance indices for adjacent NOAA statistical areas associated with high landings of Jonah crabs (Areas 537, 526, 525, 562) and low landings of Jonah crabs (Areas 521, 522, 561).

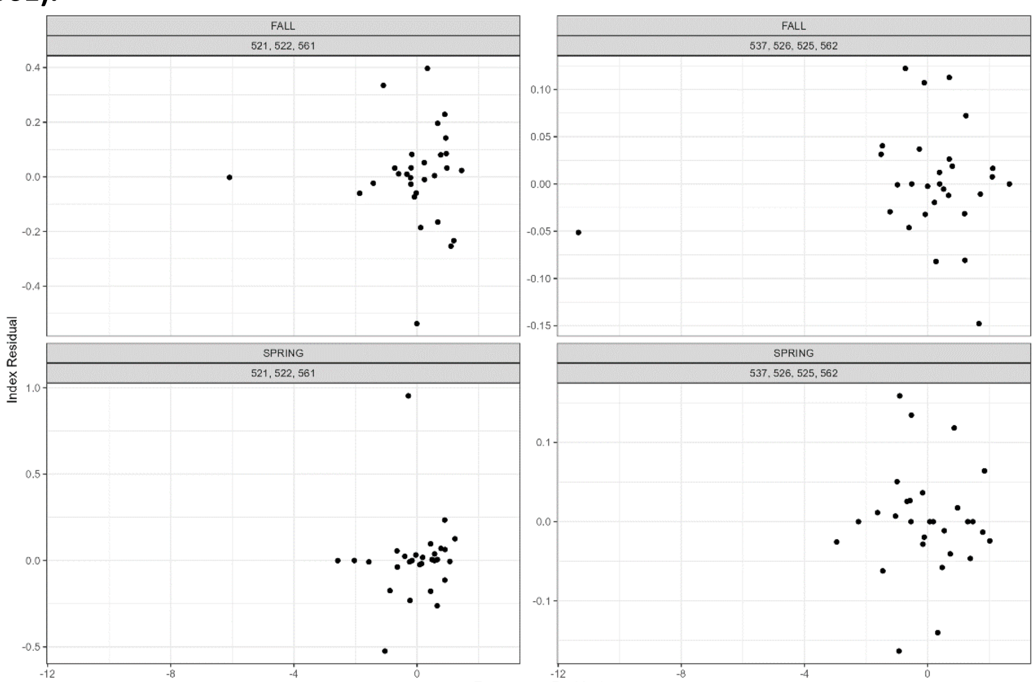

Figure 70. Residuals for NEFSC Trawl Survey seasonal exploitable abundance indices (using two-year running average fit) and temperature indices (using linear regression fit) for adjacent NOAA statistical areas associated with high landings of Jonah crabs (Areas 537, 526, 525, 562) and low landings of Jonah crabs (Areas 521, 522, 561).

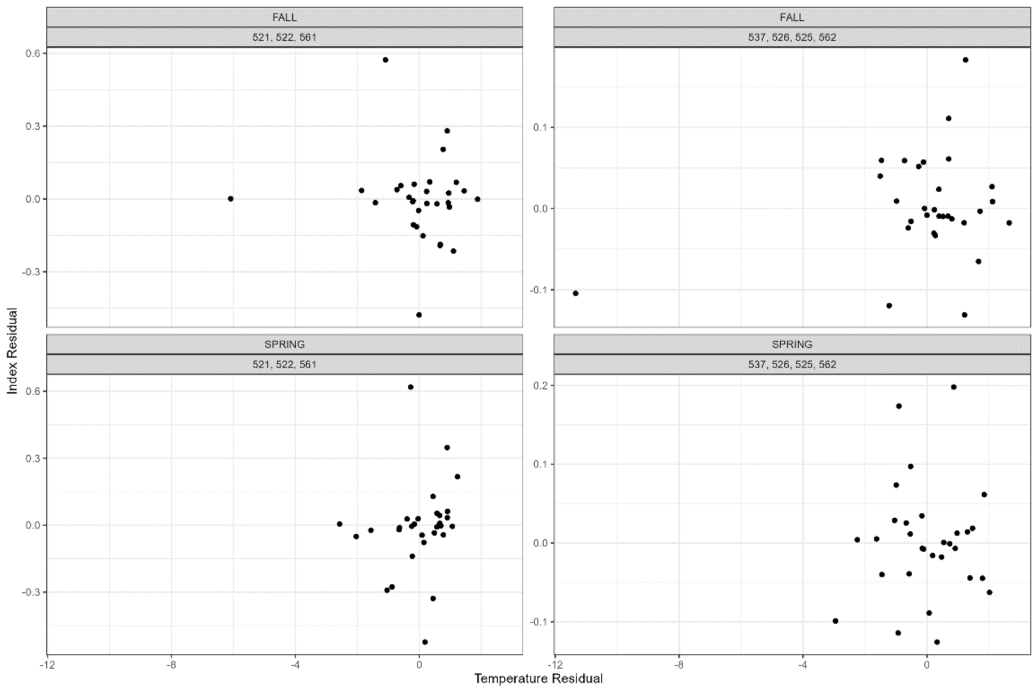

Figure 71. Residuals for NEFSC Trawl Survey seasonal exploitable abundance indices (using LOESS smoother fit) and temperature indices (using linear regression fit) for adjacent NOAA statistical areas associated with high landings of Jonah crabs (Areas 537, 526, 525, 562) and low landings of Jonah crabs (Areas 521, 522, 561).

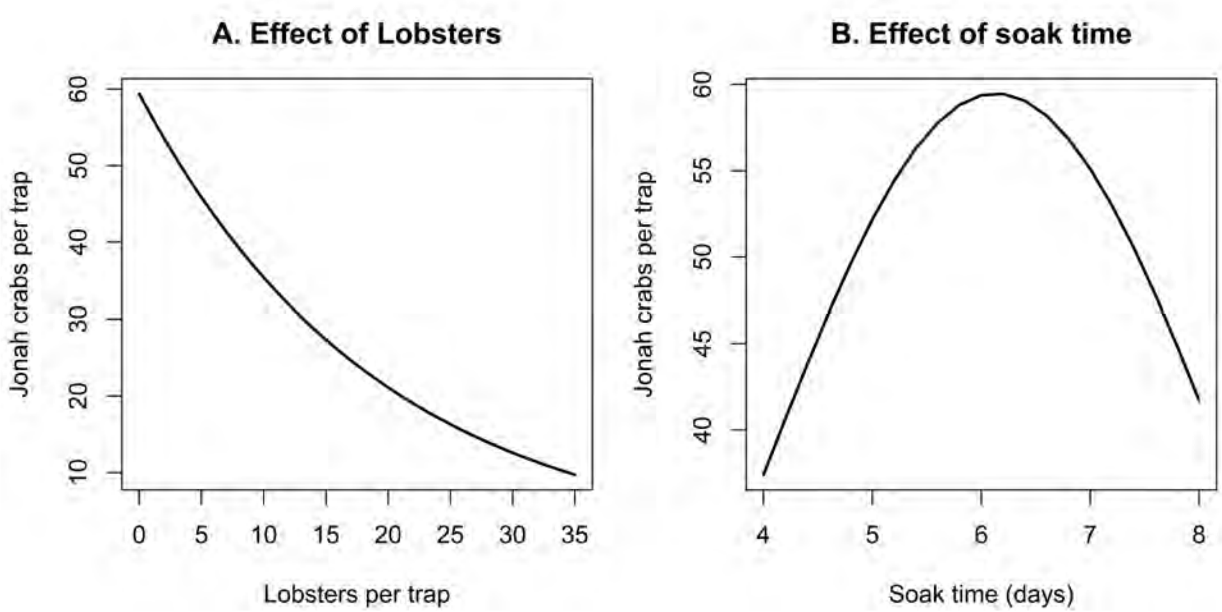

Figure 72. Results of negative binomial GLM fit to Jonah crab catch per trap. For predicting these effects, the values of other covariates were set as follows: trap_type=ventless, lat=41.2N, long=71W, habitat=sand, month=October. A. Partial effect of lobsters with soak_time=6. B. Partial effect of soak_time with lobsters=0.

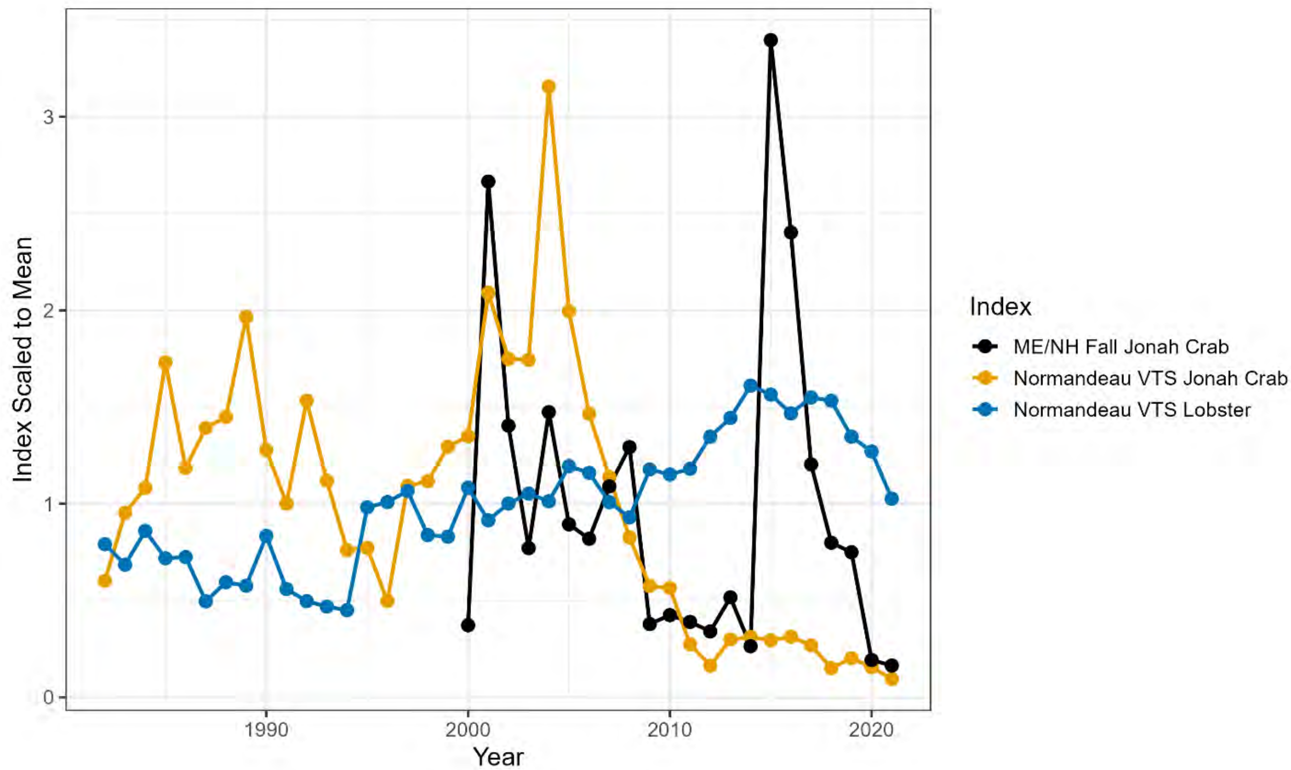

Figure 73. Comparison of nominal indices scaled to their time series mean for lobster and Jonah crab from the Normandeau Ventless Trap Survey (catch per trawl) and Jonah crab from the Maine/New Hampshire Trawl Survey (catch per tow).

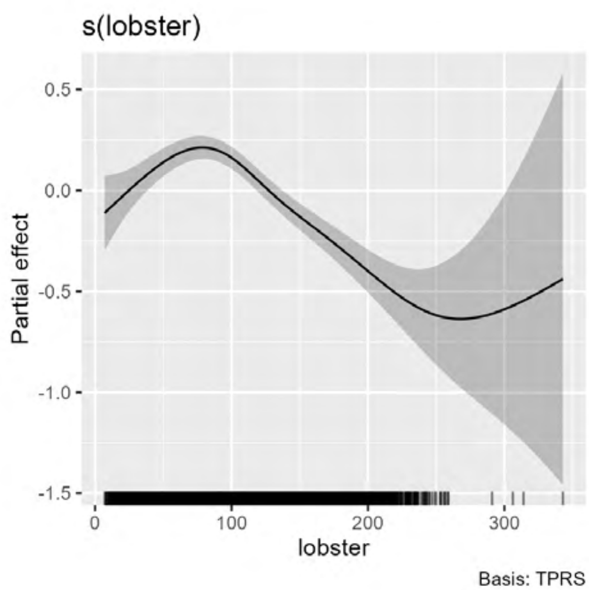

Figure 74. Estimated partial effect of lobster catch (x-axis) on Jonah crab catch (y-axis; on link scale) from generalized additive model applied to the Normandeau Ventless Trap Survey.

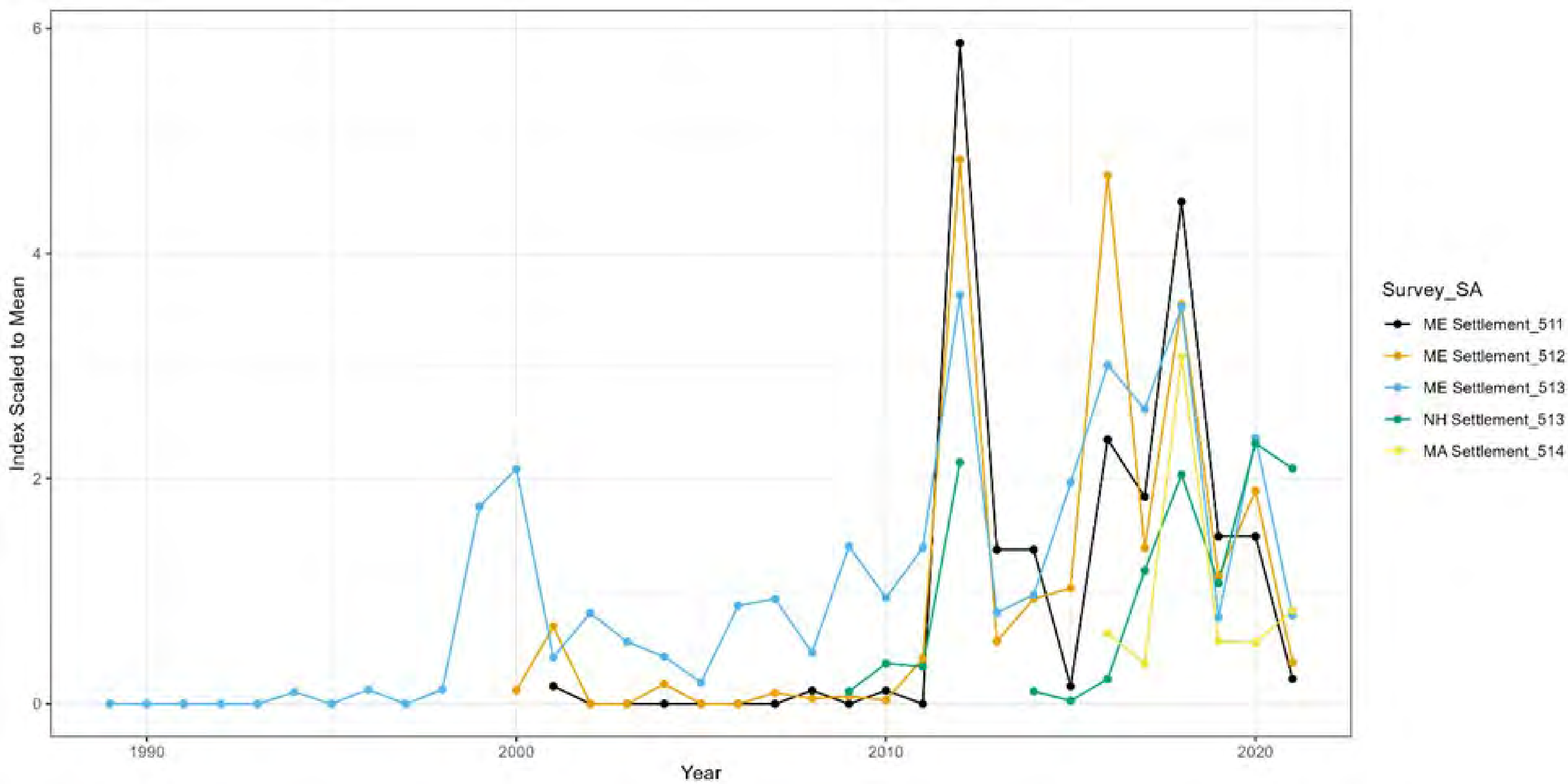

Figure 75. Jonah crab young-of-year settlement indices for the IGOM stock.

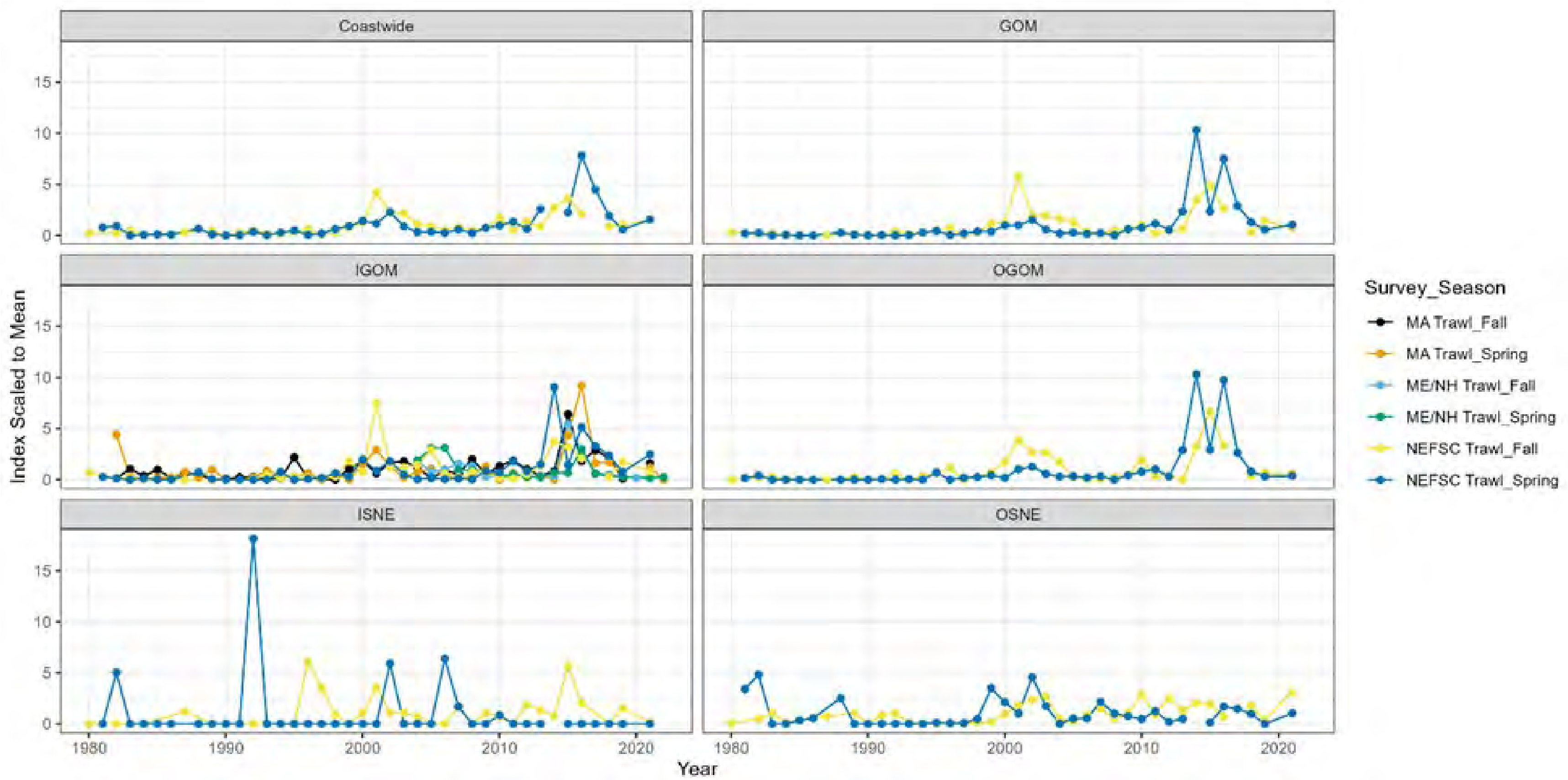

Figure 76. Jonah crab recruit abundance indices.

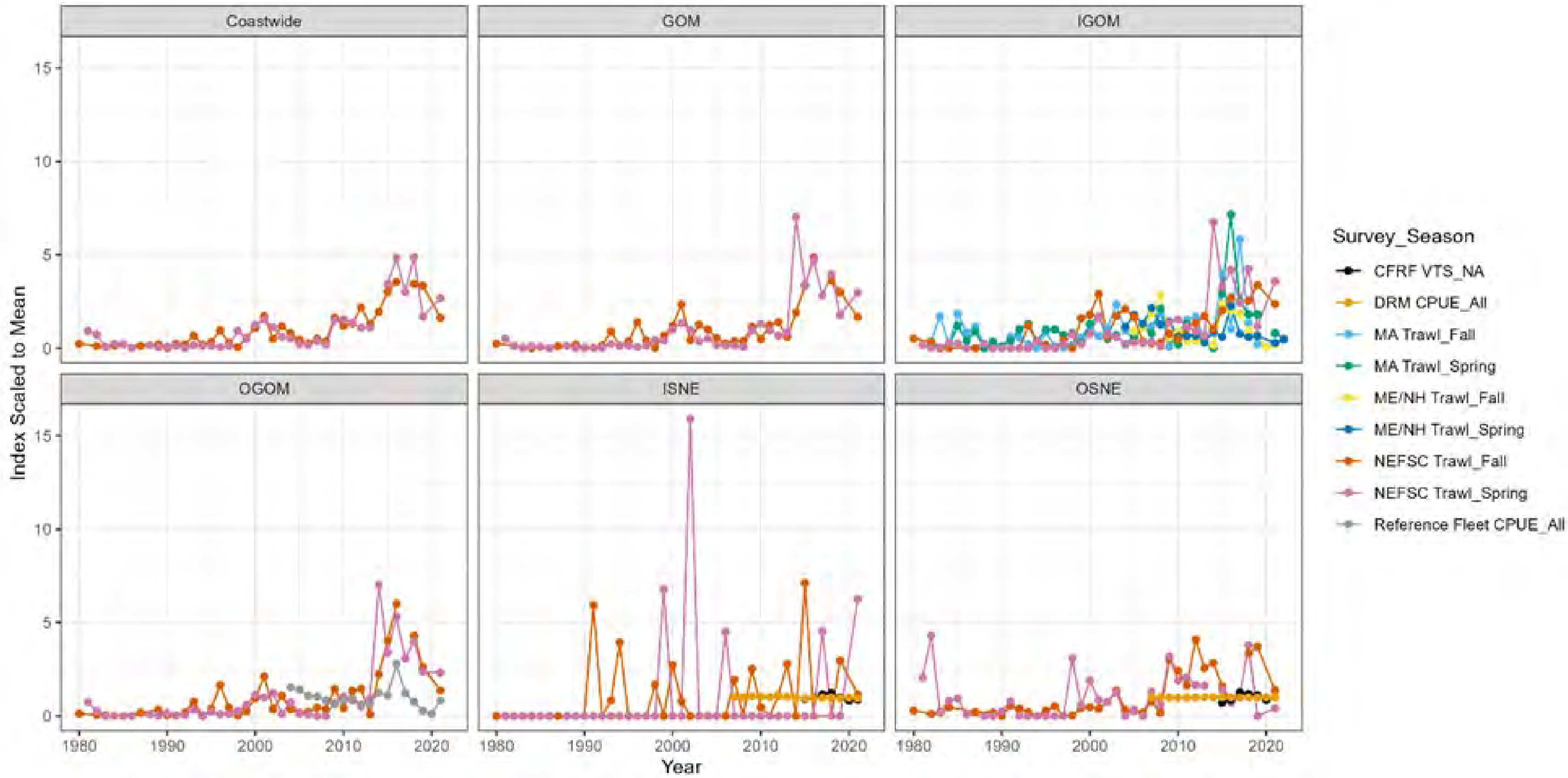

Figure 77. Jonah crab exploitable abundance indices.

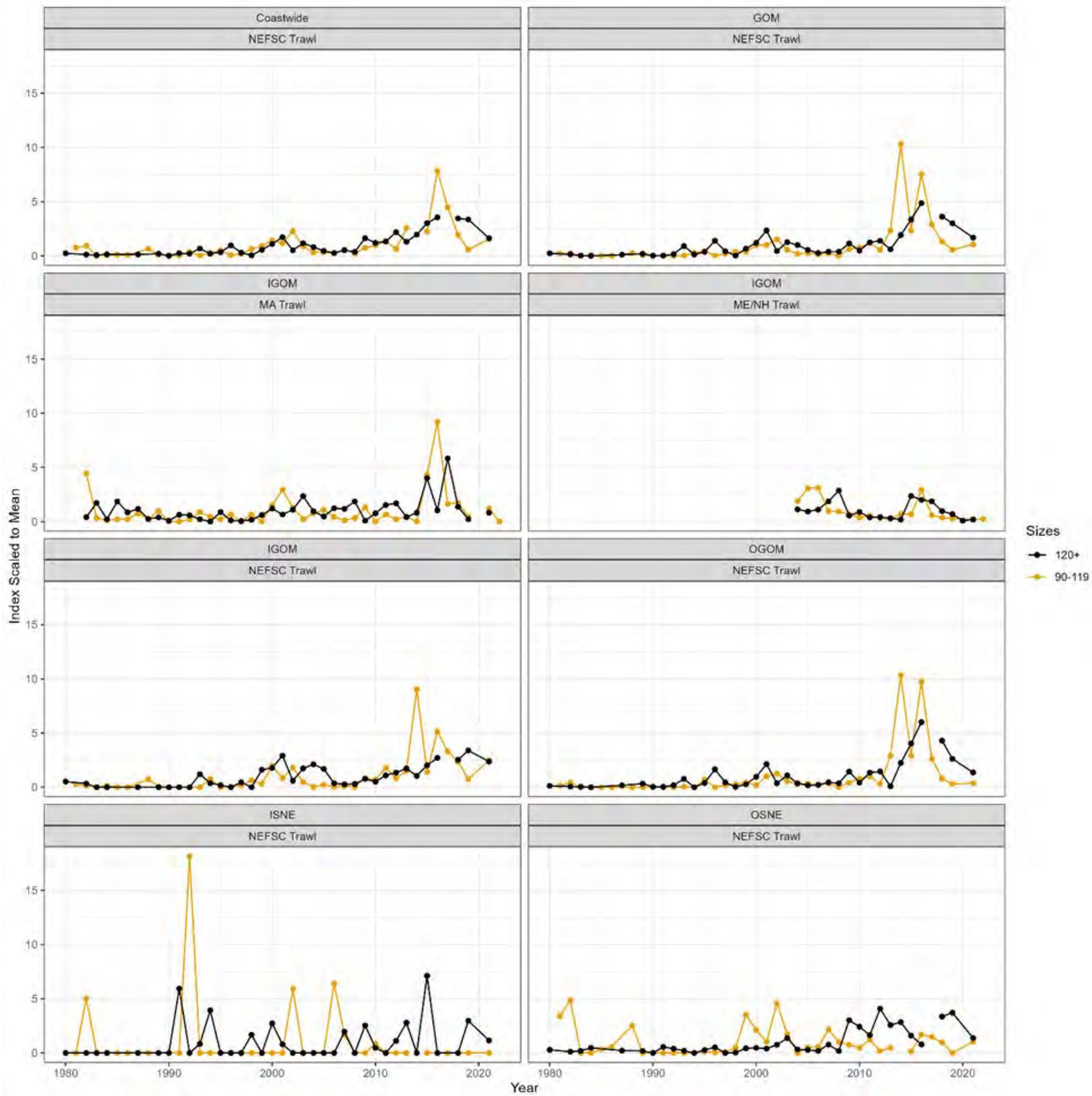

Figure 78. Jonah crab spring recruit abundance and fall exploitable abundance indices.

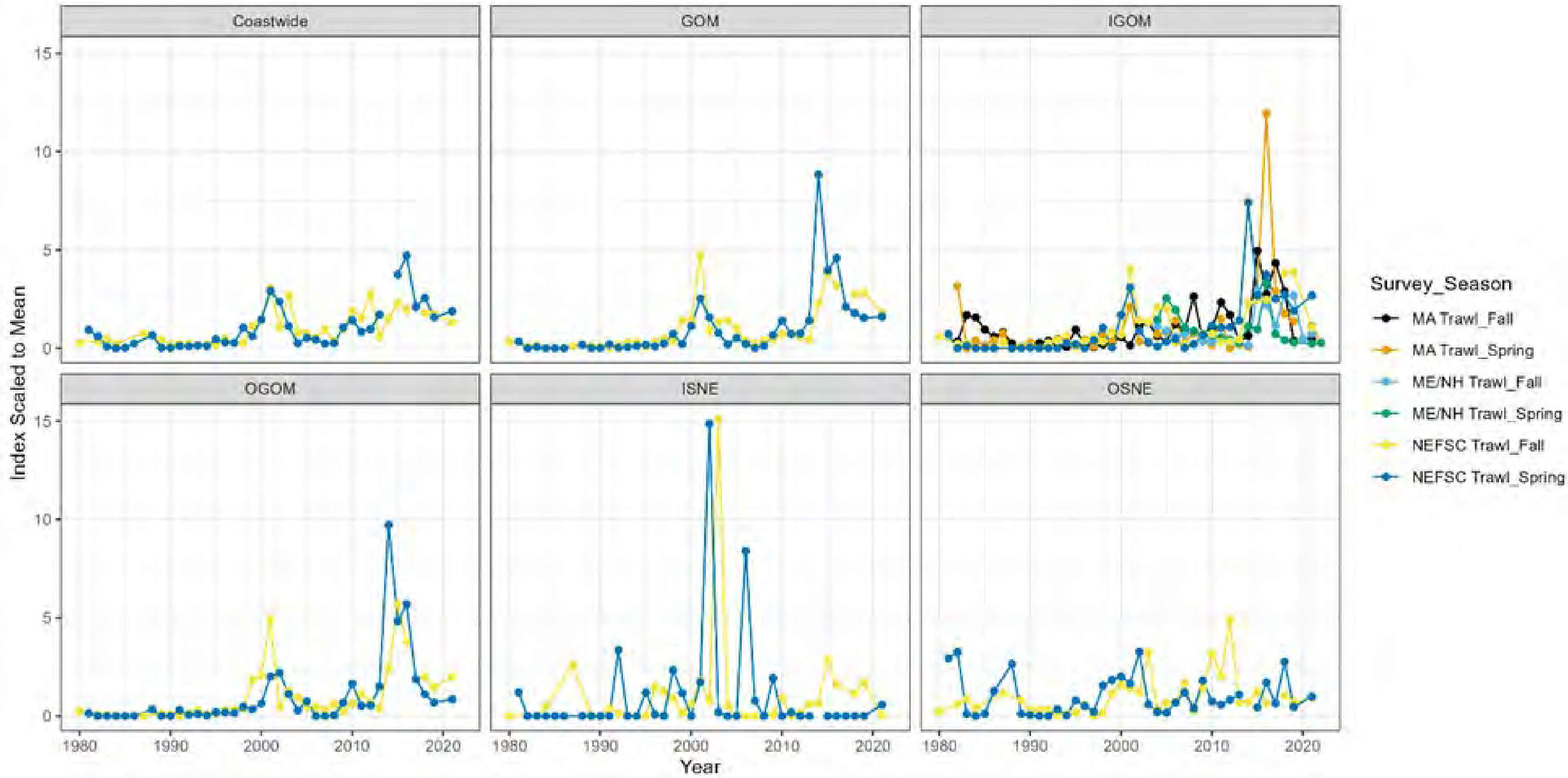

Figure 79. Jonah crab spawning abundance indices.

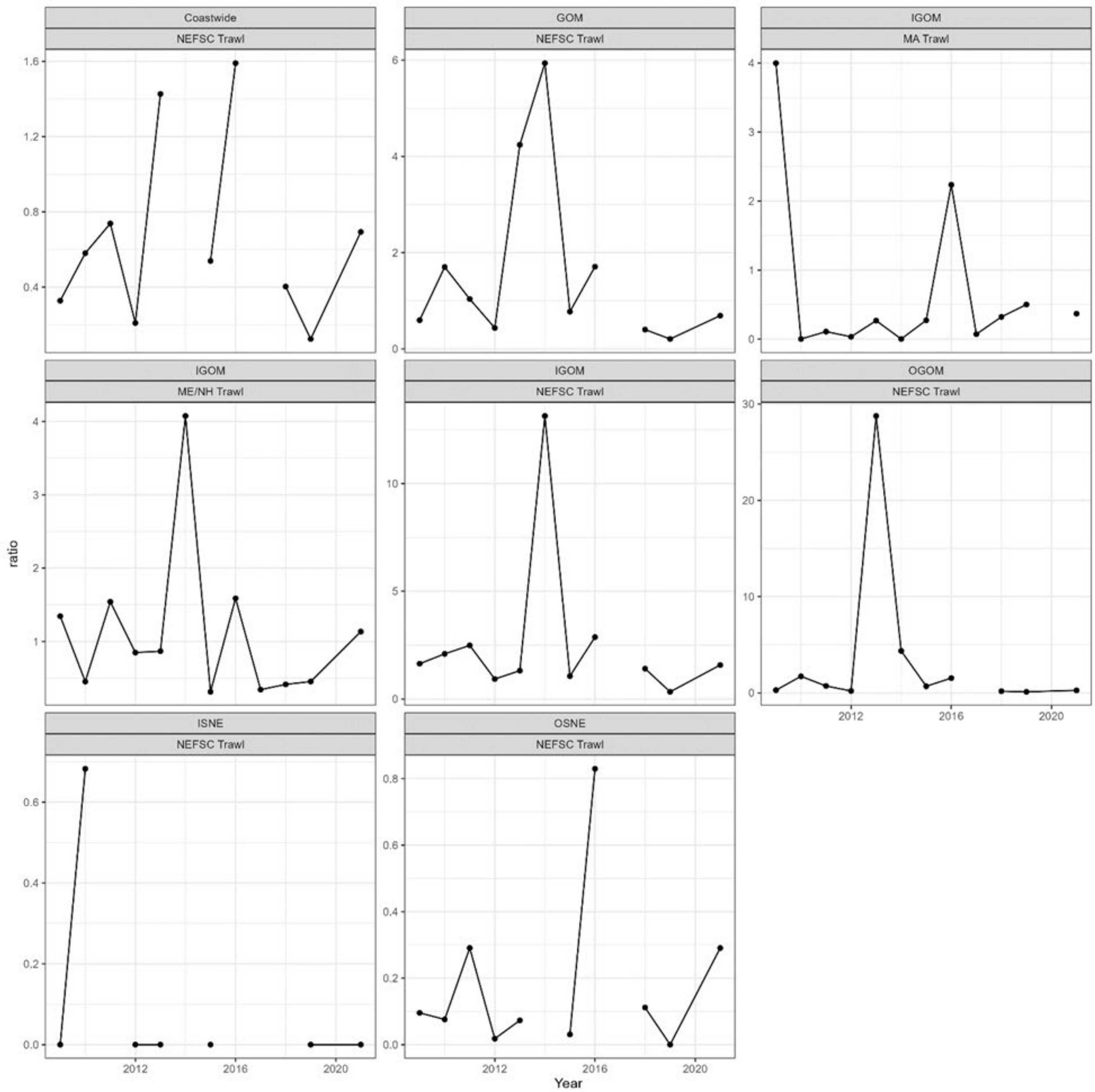

Figure 80. Jonah crab spring recruit abundance:fall exploitable abundance index ratios.

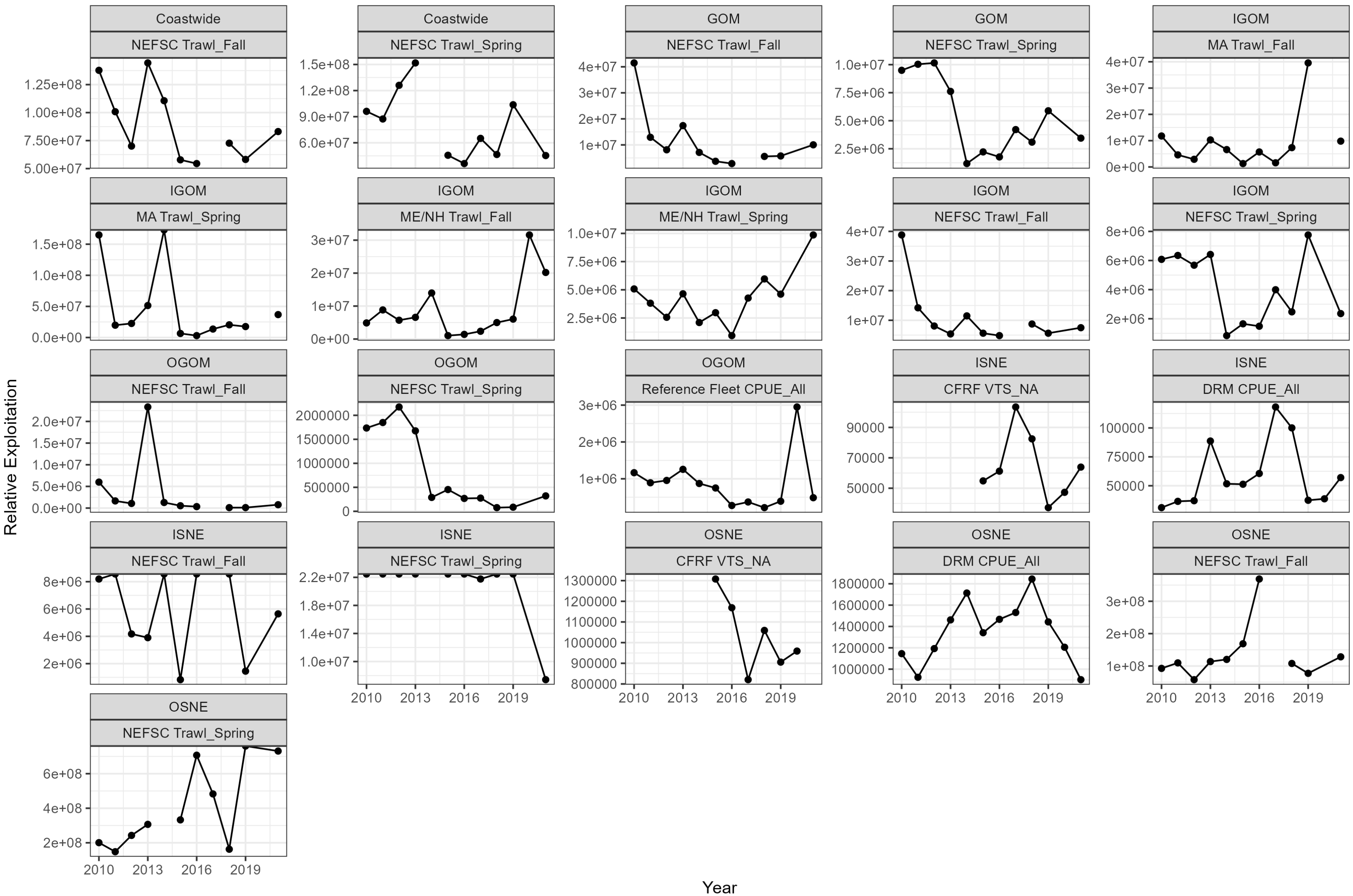

Figure 81. Jonah crab relative exploitation time series.

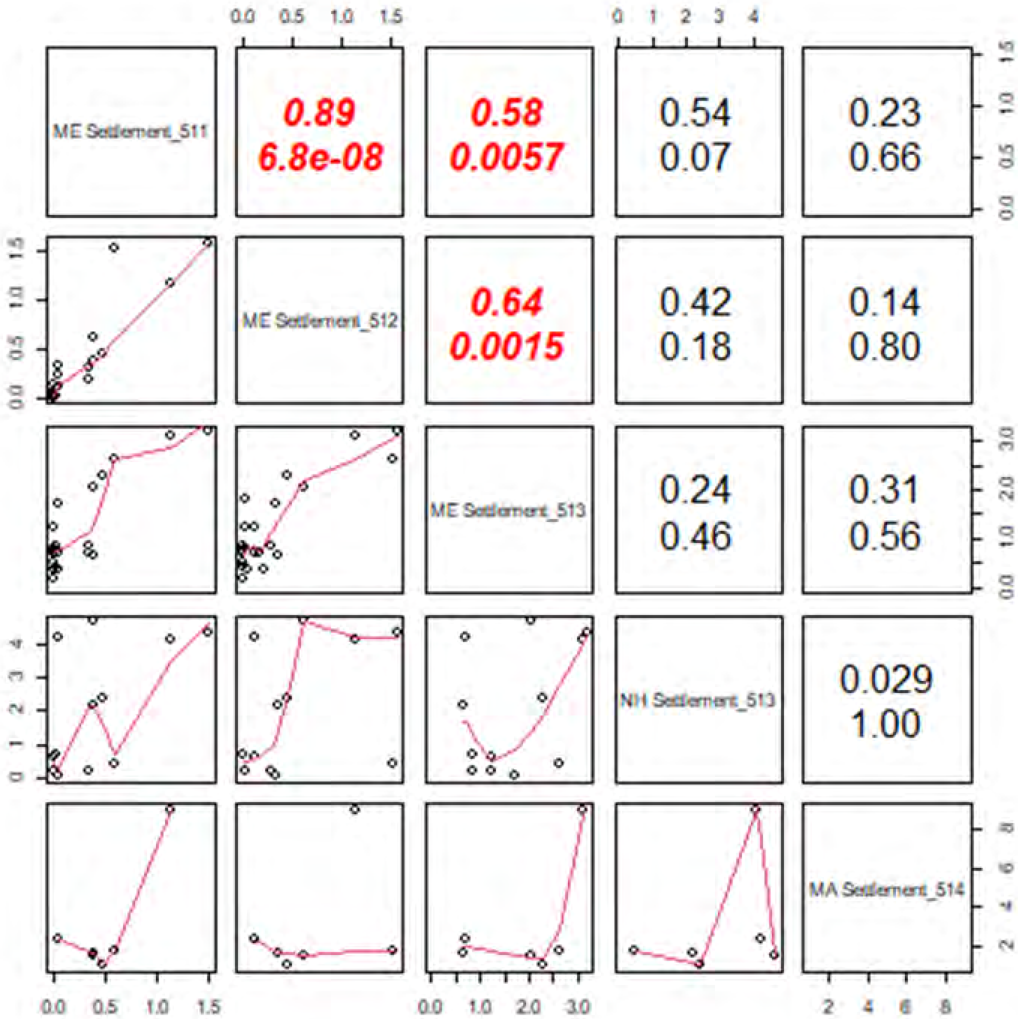

Figure 82. Spearman correlation results for young-of-year settlement indices for the IGOM stock. Panels above the diagonal include the Spearman's ρ as the top number and the p-value as the bottom number. Italicized and red numbers indicate significant correlations (p-value<0.05).

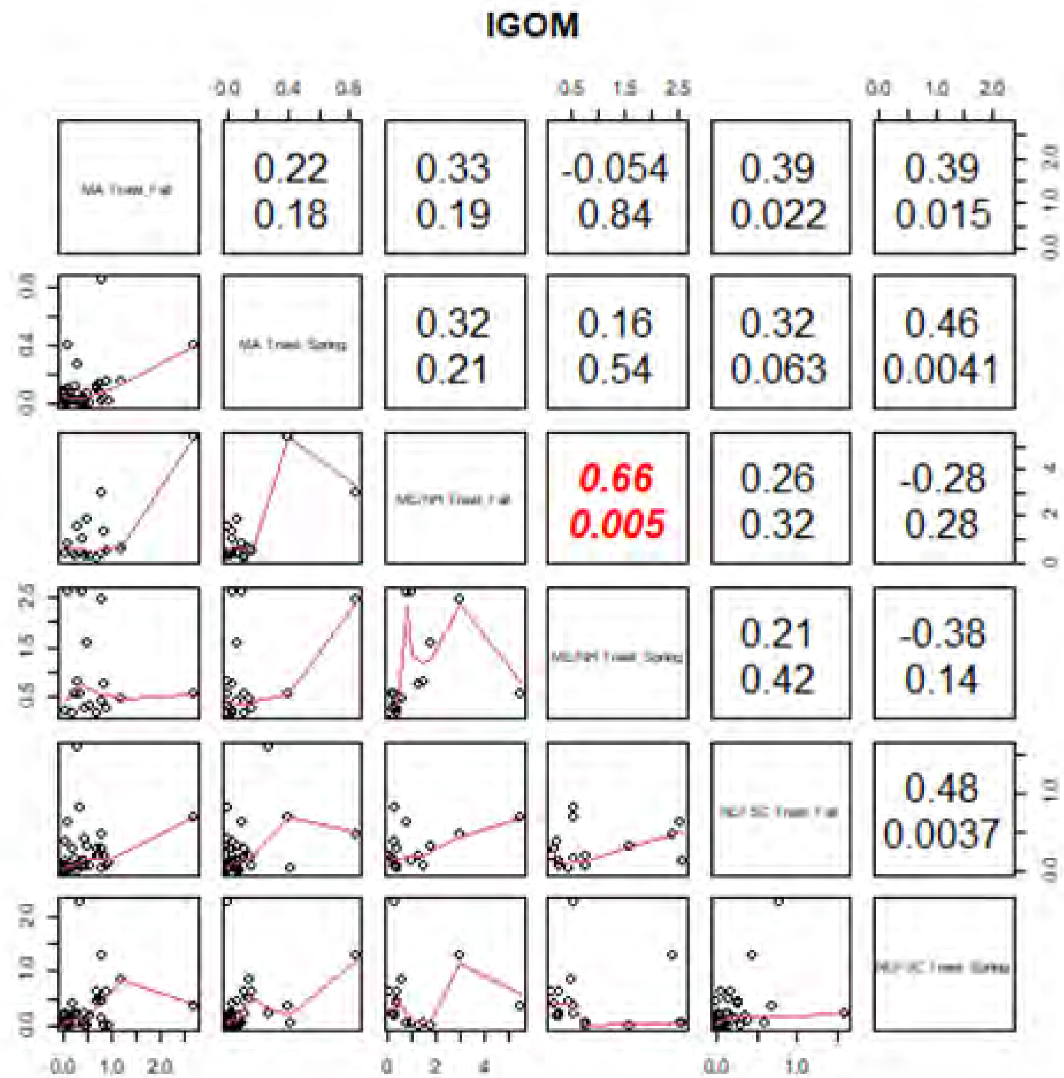

Figure 83. Spearman correlation results for IGOM recruit indices. Panels above the diagonal include the Spearman's ρ as the top number and the p-value as the bottom number. Italicized and red numbers indicate significant correlations (p-value<0.05).

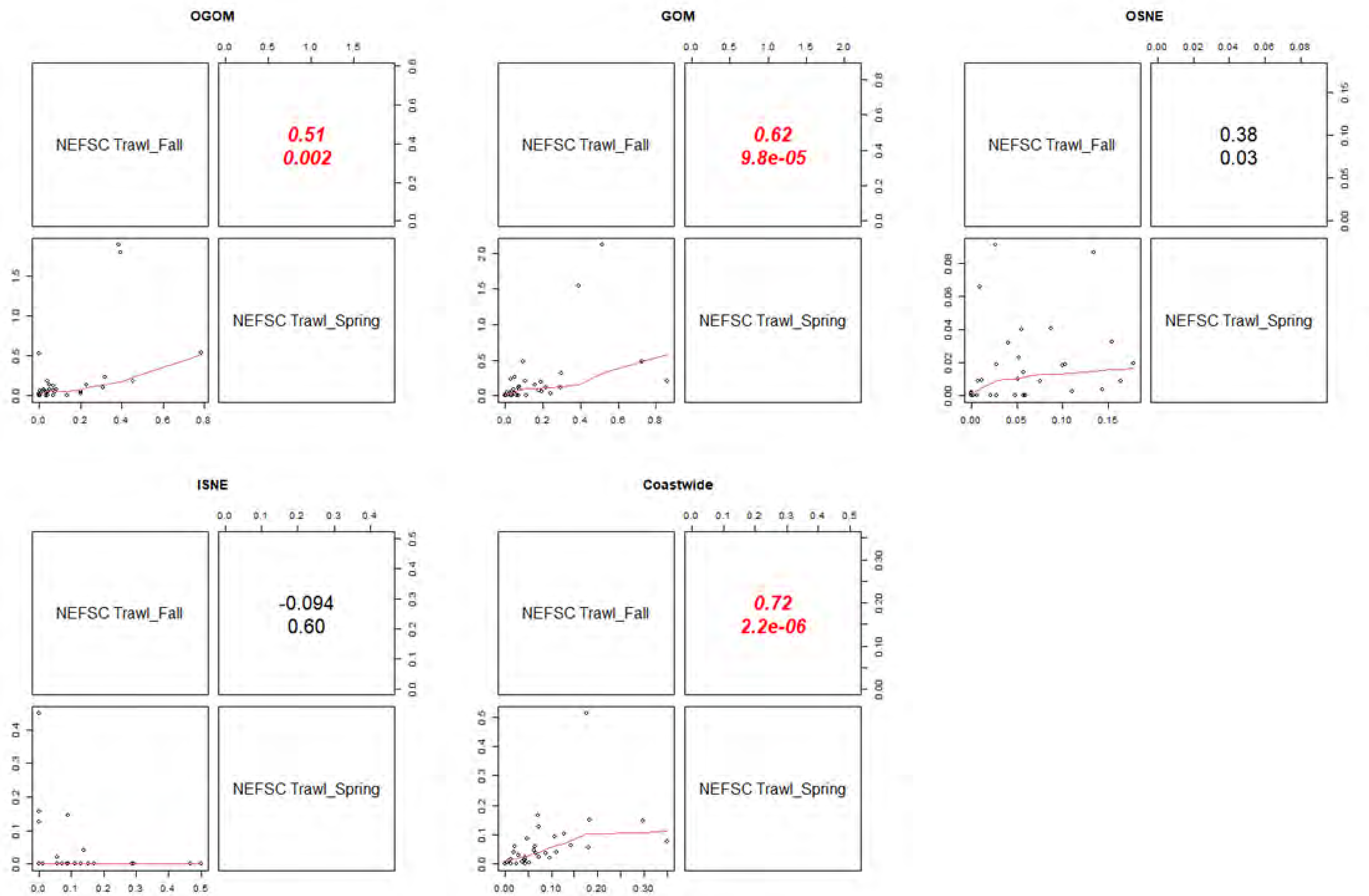

Figure 84. Spearman correlation results for OGOM, GOM, OSNE, ISNE, and coastwide recruit indices. Panels above the diagonal include the Spearman's ρ as the top number and the p-value as the bottom number. Italicized and red numbers indicate significant correlations (p-value<0.05).

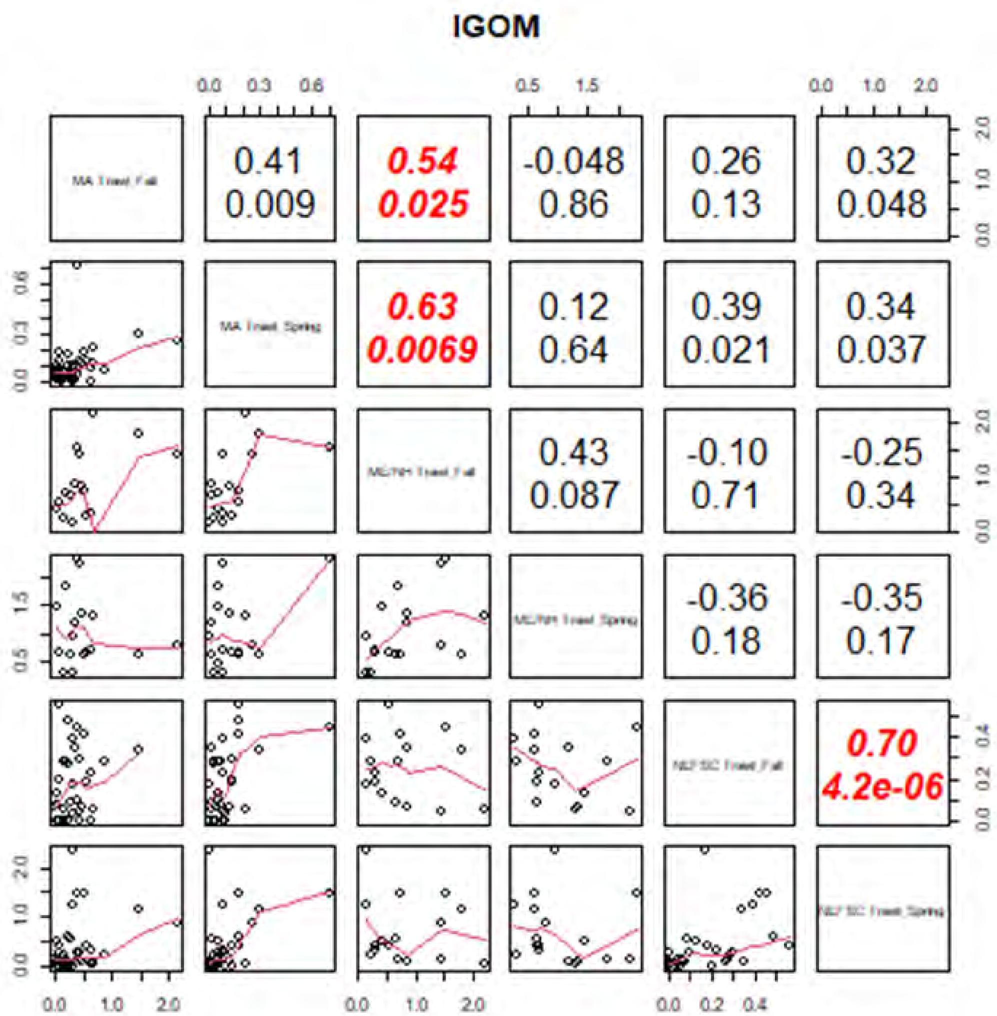

Figure 85. Spearman correlation results for IGOM exploitable abundance indices. Panels above the diagonal include the Spearman's ρ as the top number and the p-value as the bottom number. Italicized and red numbers indicate significant correlations (p-value<0.05).

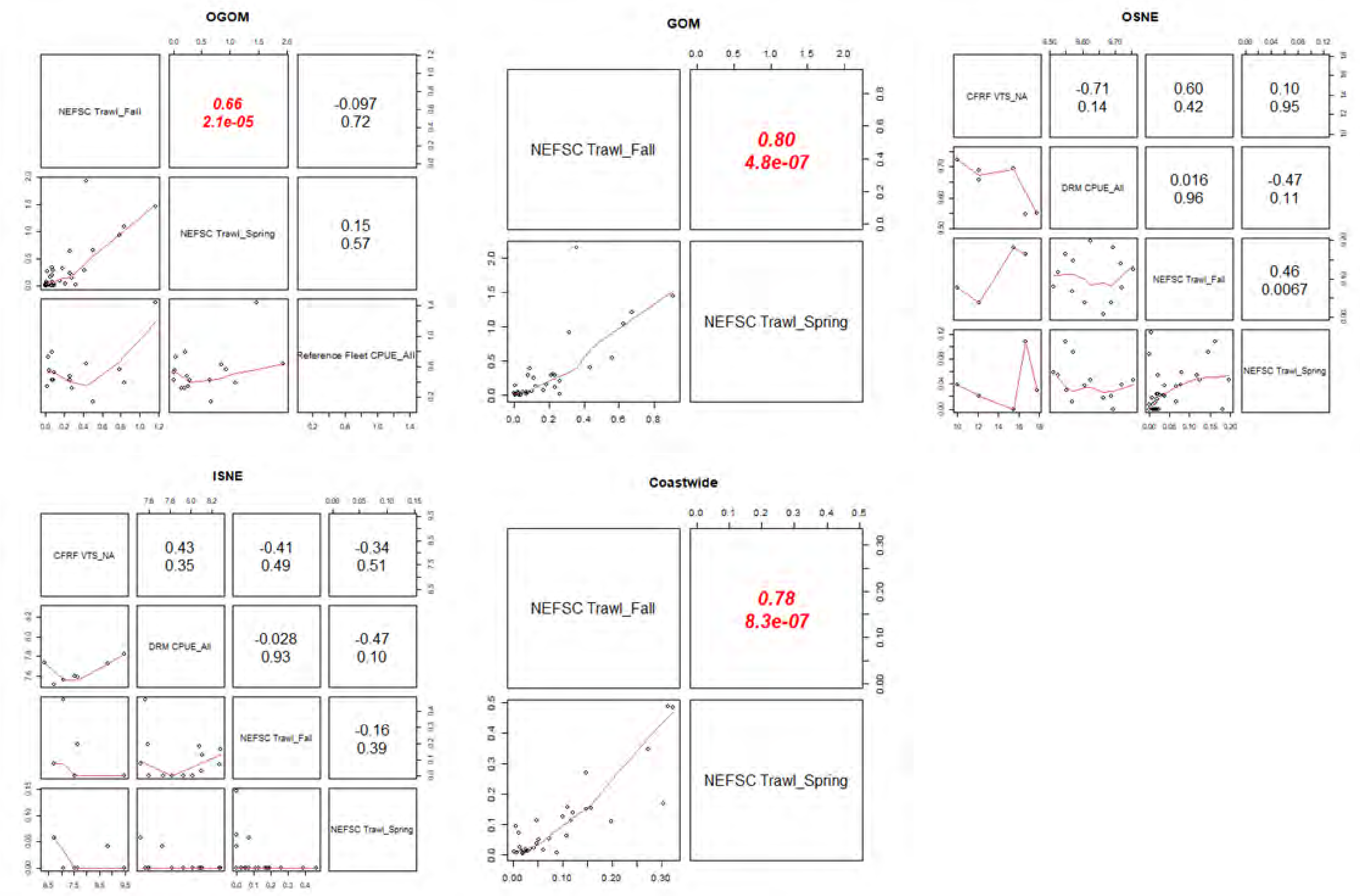

Figure 86. Spearman correlation results for OGOM, GOM, OSNE, ISNE, and coastwide exploitable abundance indices. Panels above the diagonal include the Spearman's ρ as the top number and the p-value as the bottom number. Italicized and red numbers indicate significant correlations (p-value<0.05).

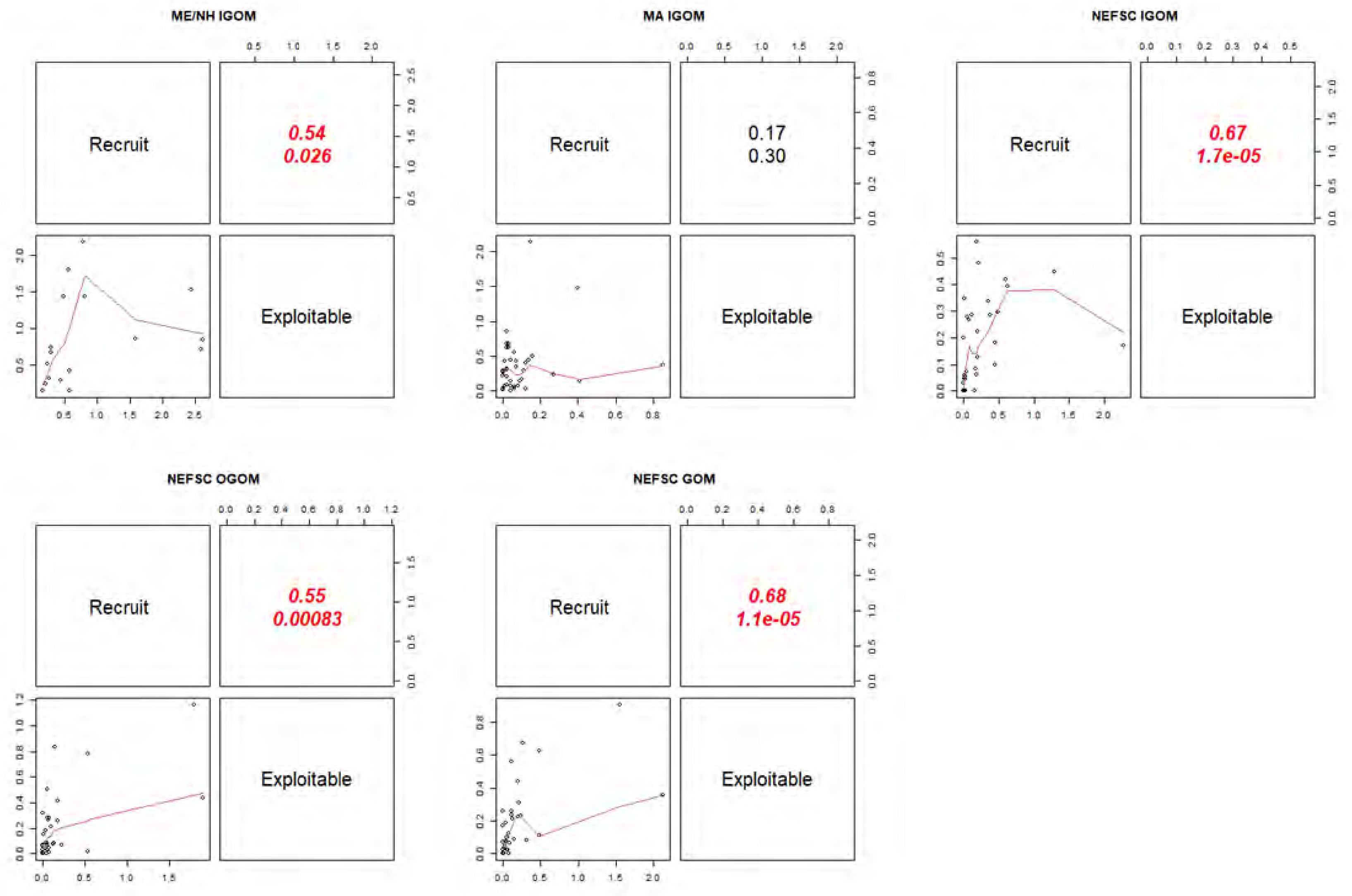

Figure 87. Spearman correlation results for IGOM, OGOM, and GOM spring recruit and fall exploitable abundance indices. Panels above the diagonal include the Spearman's ρ as the top number and the p-value as the bottom number. Italicized and red numbers indicate significant correlations (p-value<0.05).

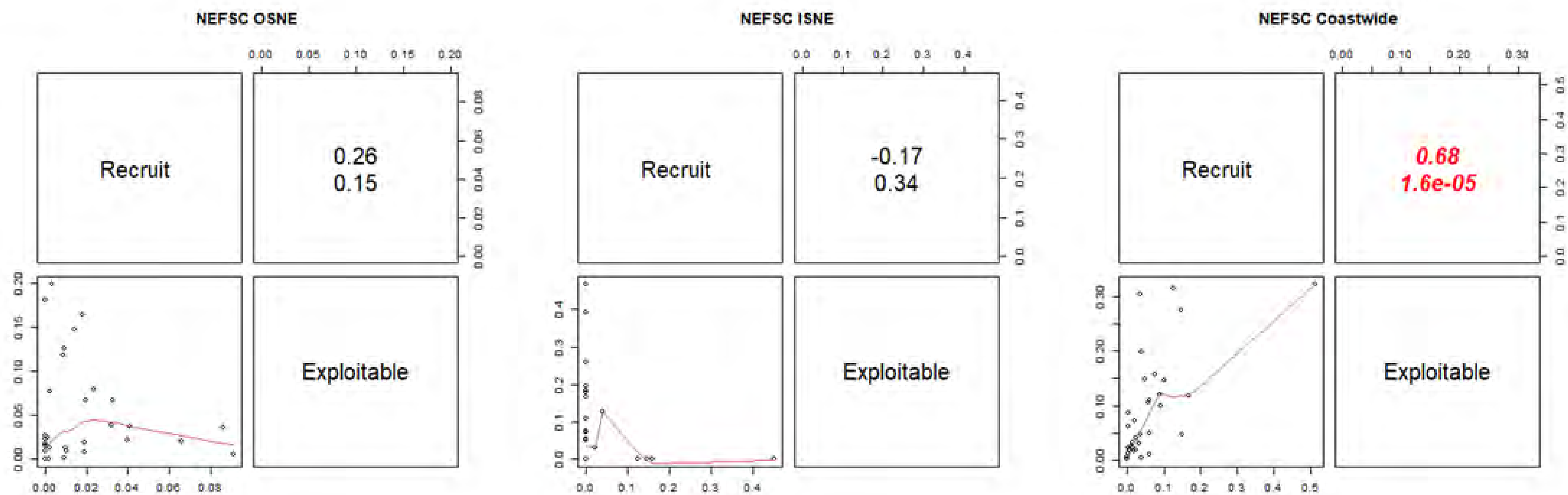

Figure 88. Spearman correlation results for OSNE, ISNE, and coastwide spring recruit and fall exploitable abundance indices. Panels above the diagonal include the Spearman's ρ as the top number and the p-value as the bottom number. Italicized and red numbers indicate significant correlations (p-value<0.05).

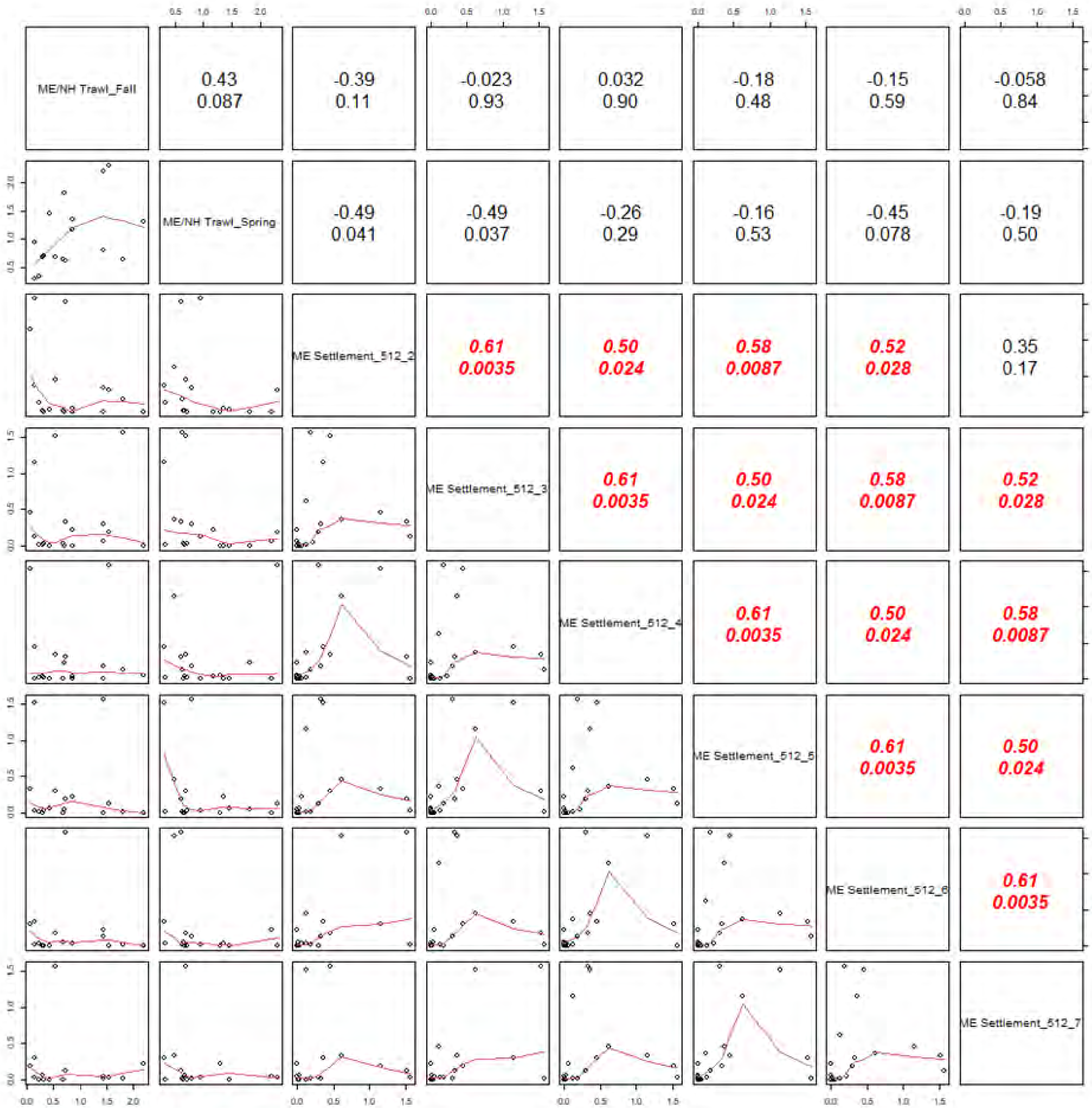

Figure 89. Spearman correlation results for ME/NH trawl survey exploitable abundance indices and lagged ME 512 settlement survey indices. Panels above the diagonal include the Spearman's ρ as the top number and the p-value as the bottom number. Italicized and red numbers indicate significant correlations (p-value<0.05).

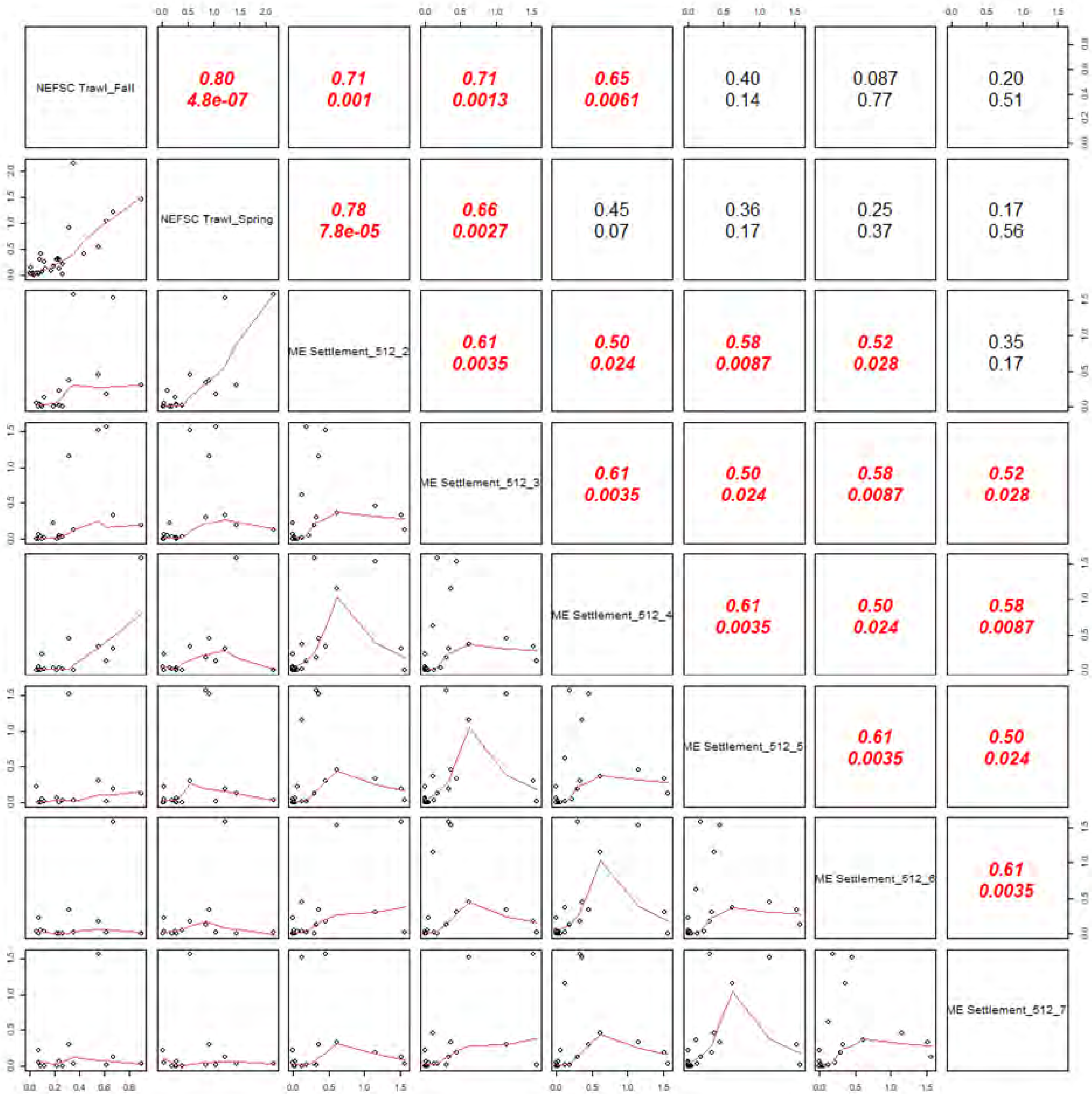

Figure 90. Spearman correlation results for NEFSC trawl survey exploitable abundance indices and lagged ME 512 settlement survey indices. Panels above the diagonal include the Spearman's ρ as the top number and the p-value as the bottom number. Italicized and red numbers indicate significant correlations (p-value<0.05).

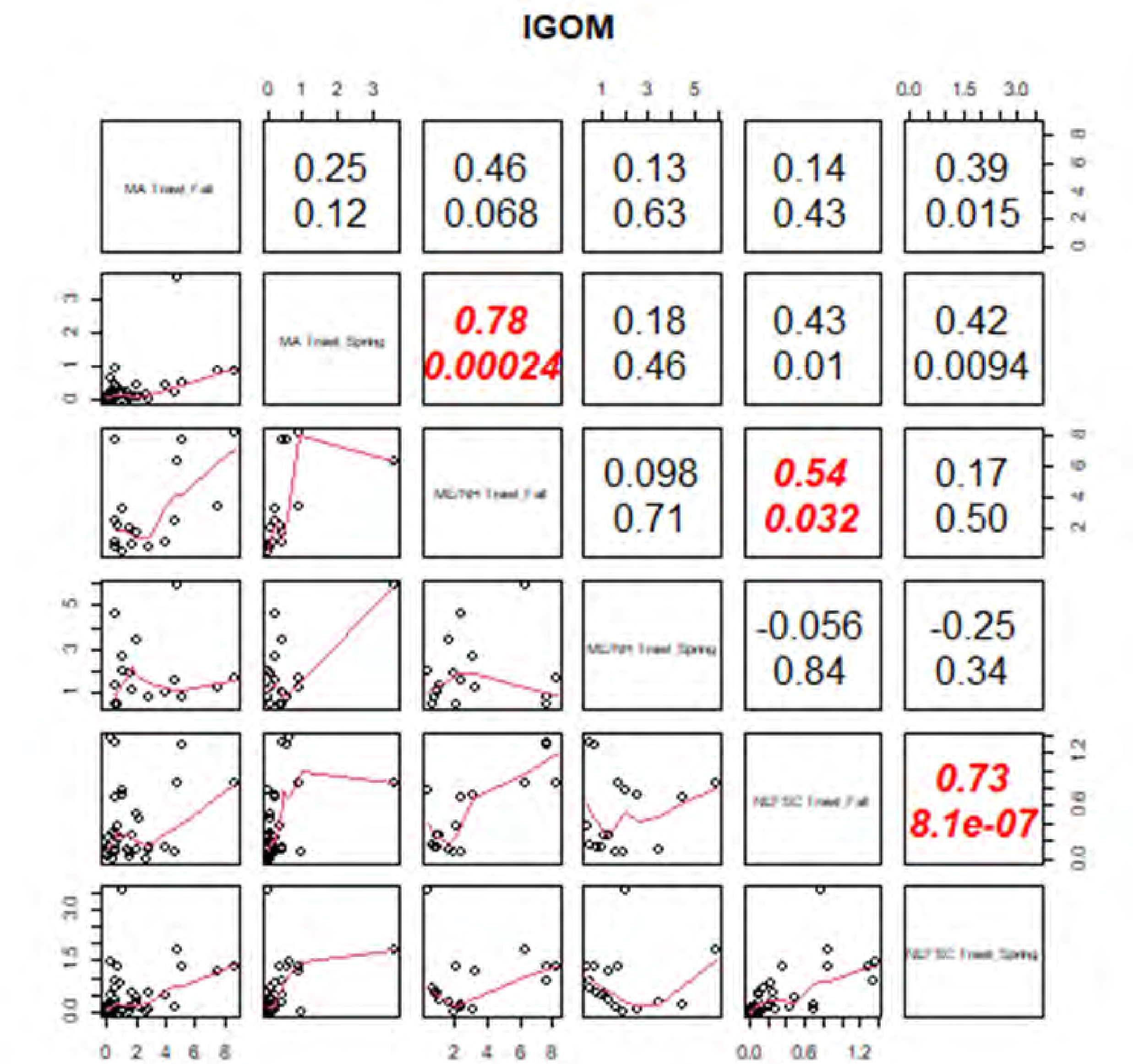

Figure 91. Spearman correlation results for IGOM spawning abundance indices. Panels above the diagonal include the Spearman's ρ as the top number and the p-value as the bottom number. Italicized and red numbers indicate significant correlations (p-value<0.05).

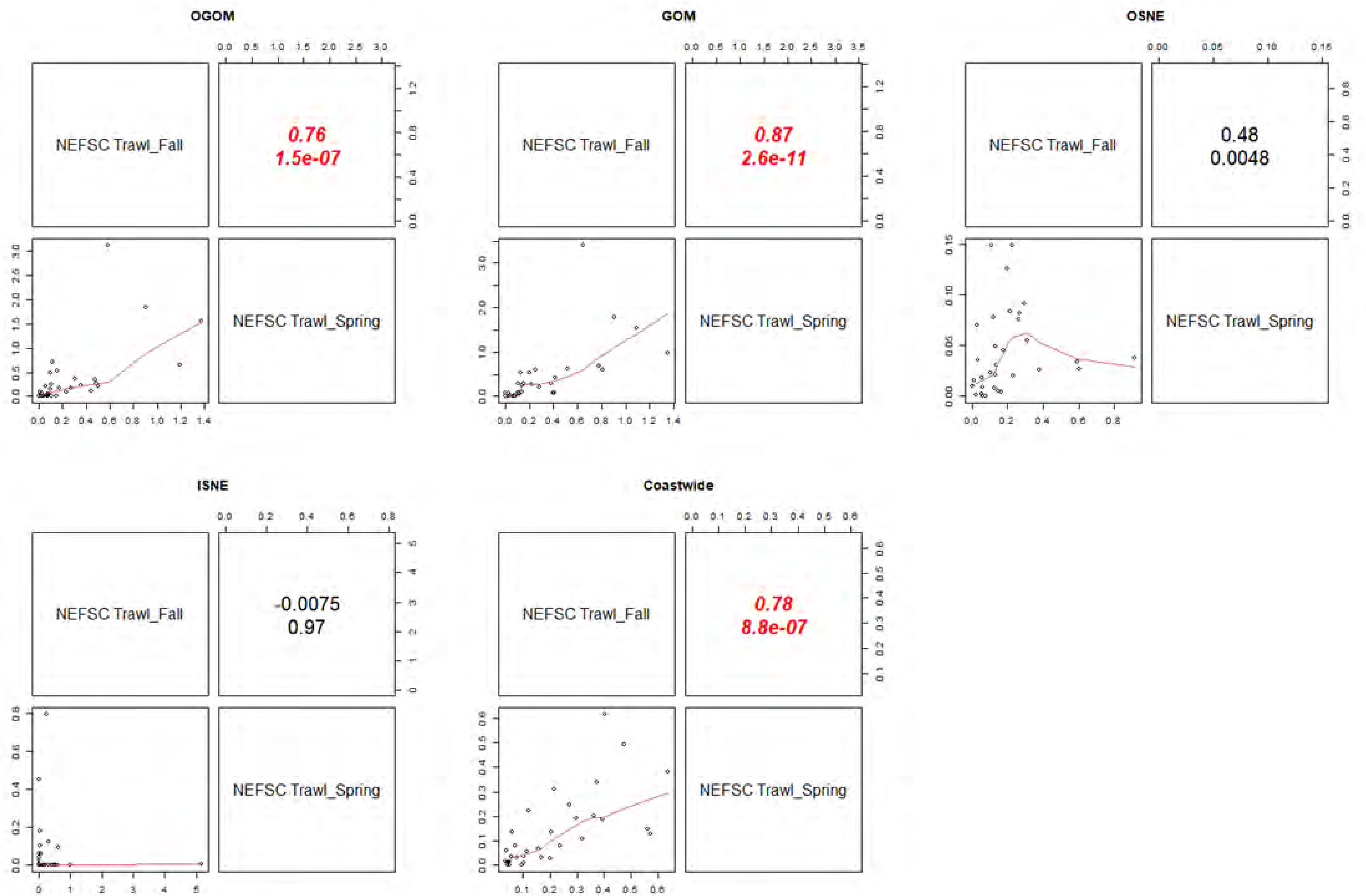

Figure 92. Spearman correlation results for OGOM, GOM, OSNE, ISNE, and coastwide spawning abundance indices. Panels above the diagonal include the Spearman's ρ as the top number and the p-value as the bottom number. Italicized and red numbers indicate significant correlations (p-value<0.05).

Figure 93. Spearman correlation results for GOM exploitable abundance indices and landings. Panels above the diagonal include the Spearman's ρ as the top number and the p-value as the bottom number. Italicized and red numbers indicate significant correlations (p-value<0.05).

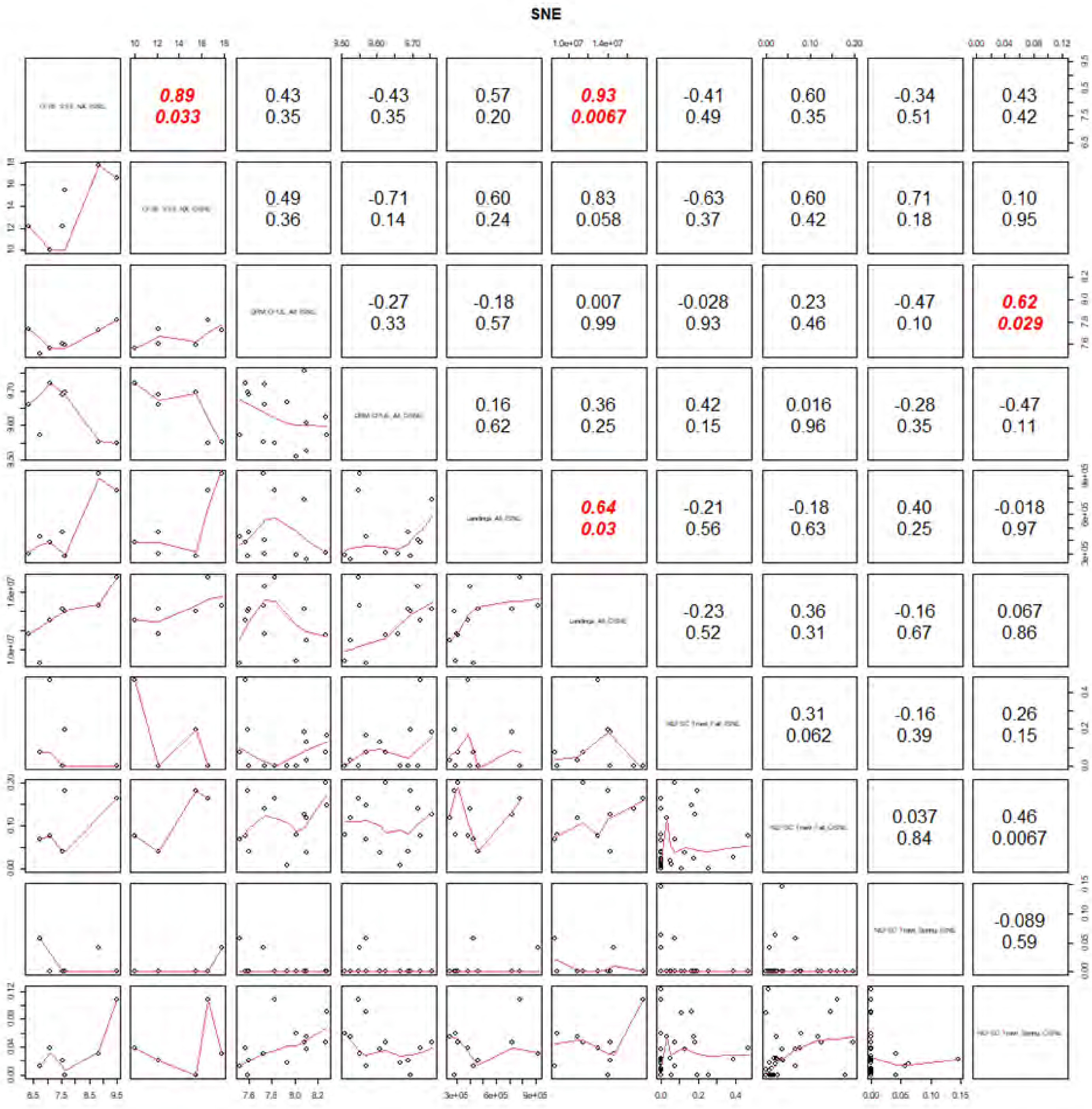

Figure 94. Spearman correlation results for SNE exploitable abundance indices and landings. Panels above the diagonal include the Spearman's ρ as the top number and the p-value as the bottom number. Italicized and red numbers indicate significant correlations (p-value<0.05).

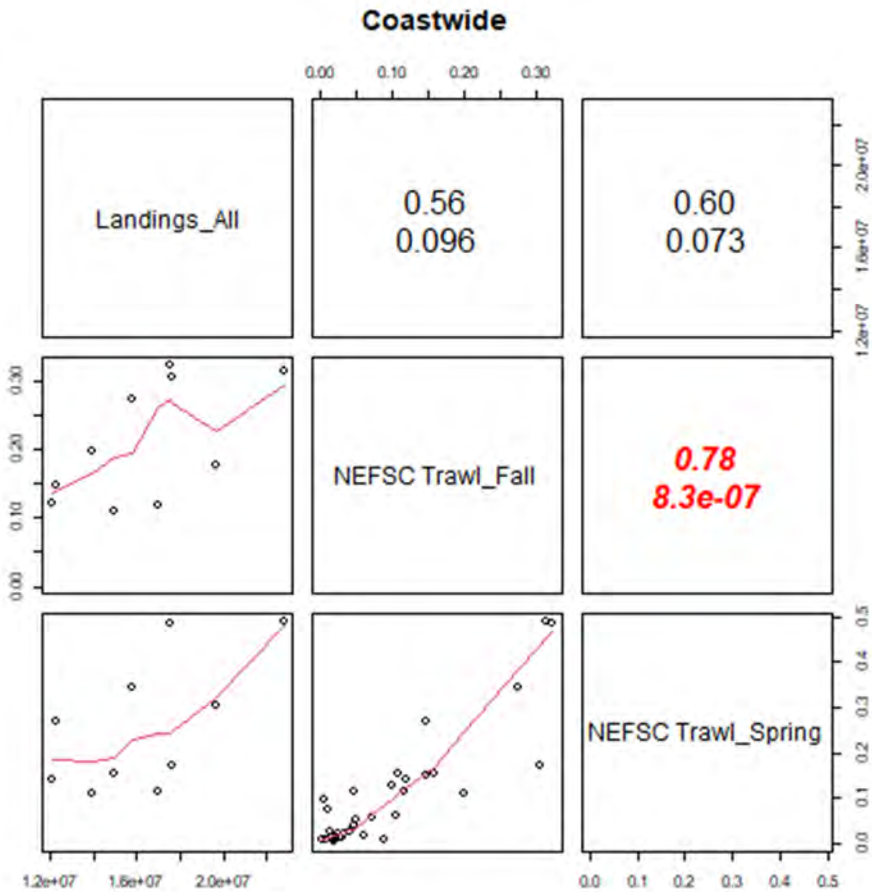

Figure 95. Spearman correlation results for coastwide exploitable abundance indices and landings. Panels above the diagonal include the Spearman's ρ as the top number and the p-value as the bottom number. Italicized and red numbers indicate significant correlations (p-value<0.05).

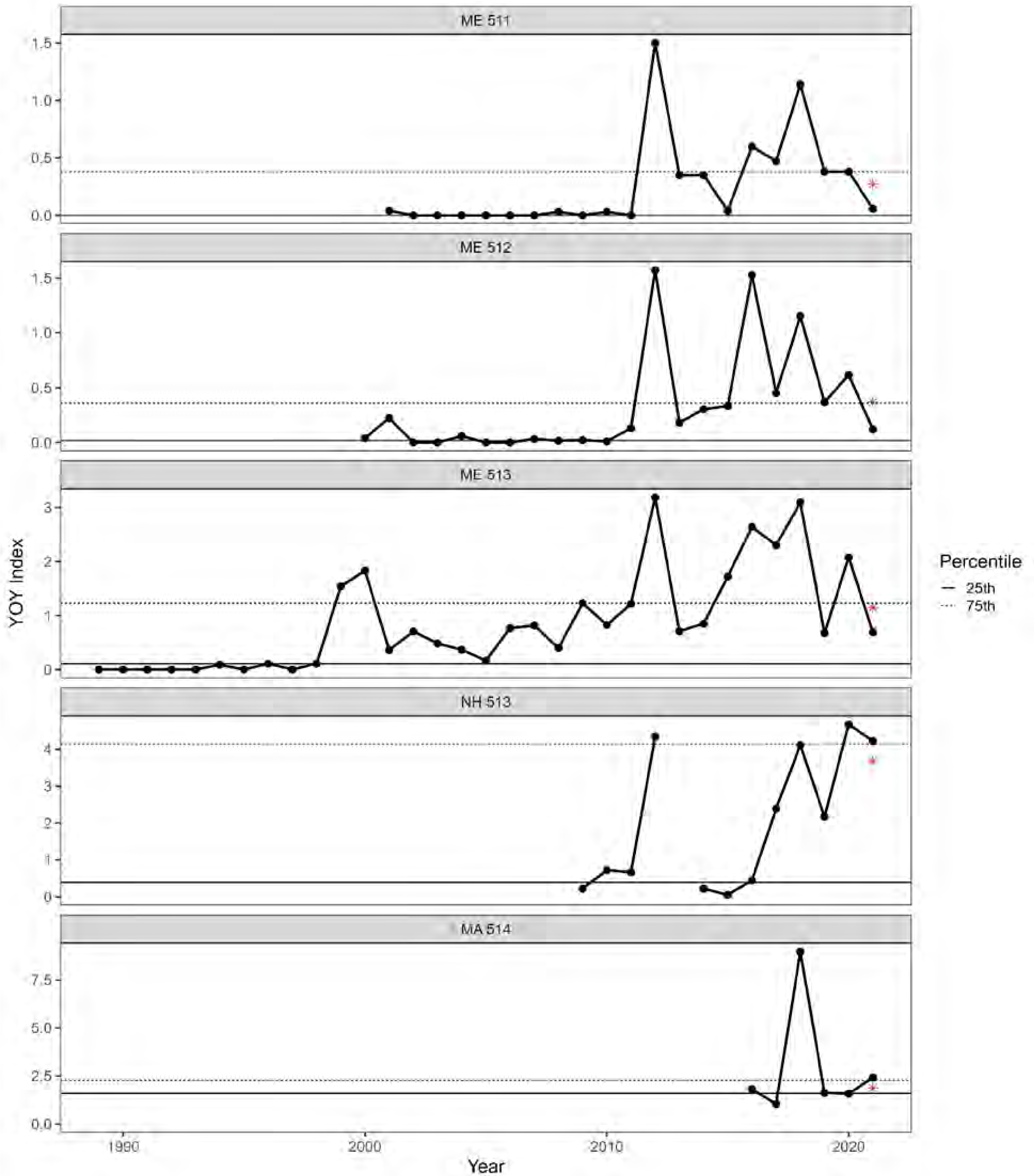

Figure 96. YOY settlement indicators for the IGOM Jonah crab stock. Red asterisks indicate the terminal three-year (2019-2021) average.

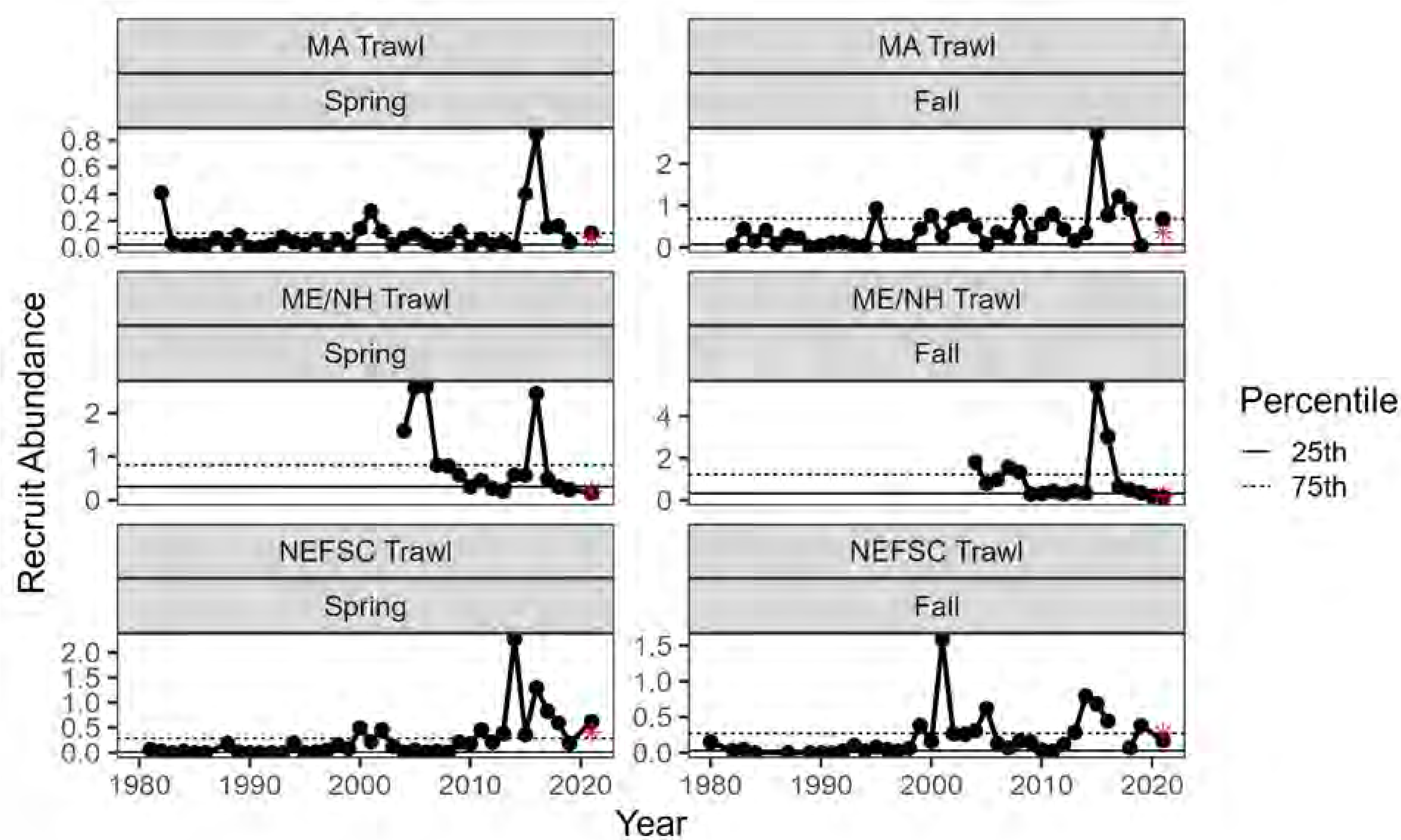

Figure 97. Recruit abundance indicators for the IGOM Jonah crab stock. Red asterisks indicate the terminal three-year (2019-2021) average.

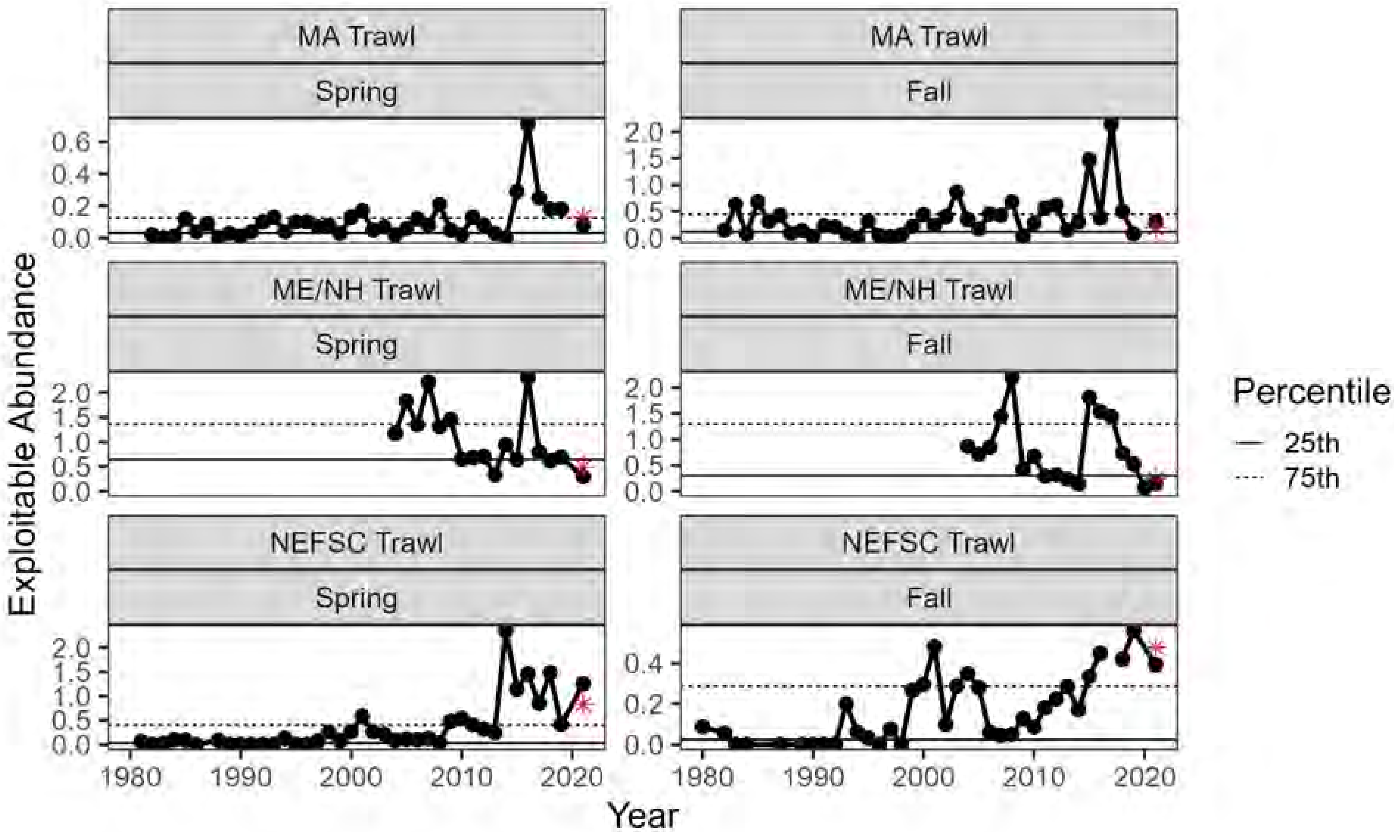

Figure 98. Exploitable abundance indicators for the IGOM Jonah crab stock. Red asterisks indicate the terminal three-year (2019-2021) average.

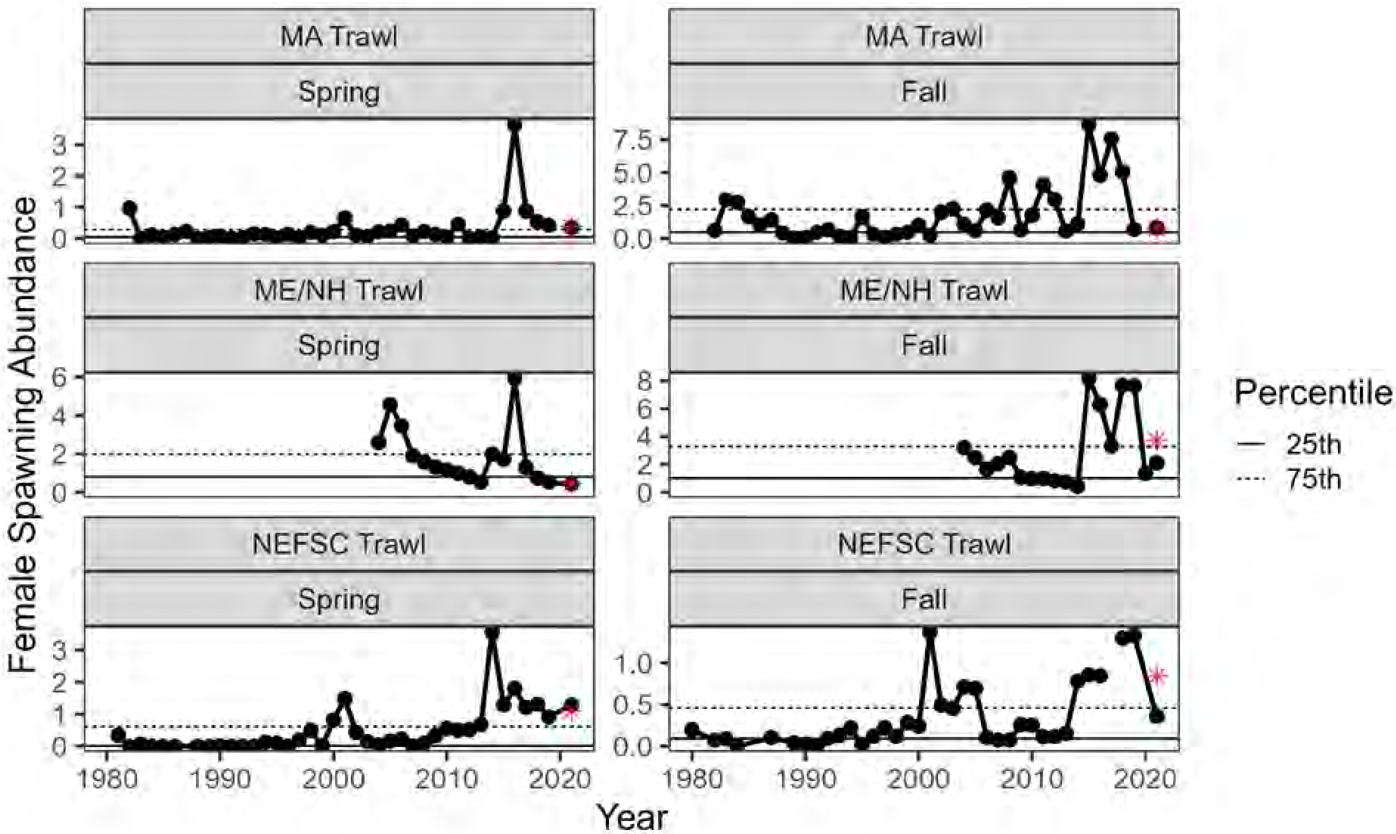

Figure 99. Spawning abundance indicators for the IGOM Jonah crab stock. Red asterisks indicate the terminal three-year (2019-2021) average.

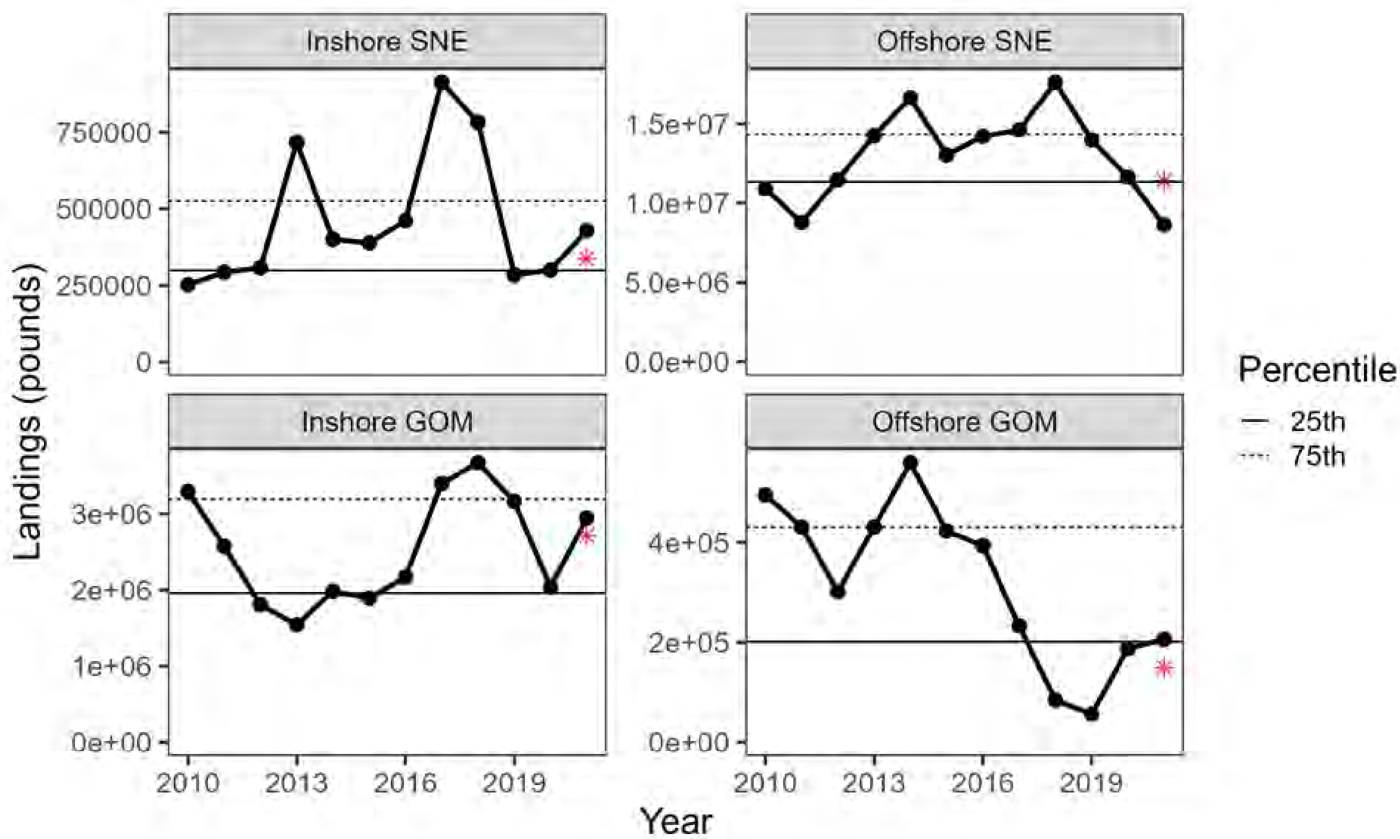

Figure 100. Landings fishery performance indicators for the Jonah crab stocks. Red asterisks indicate the terminal three-year (2019-2021) average.

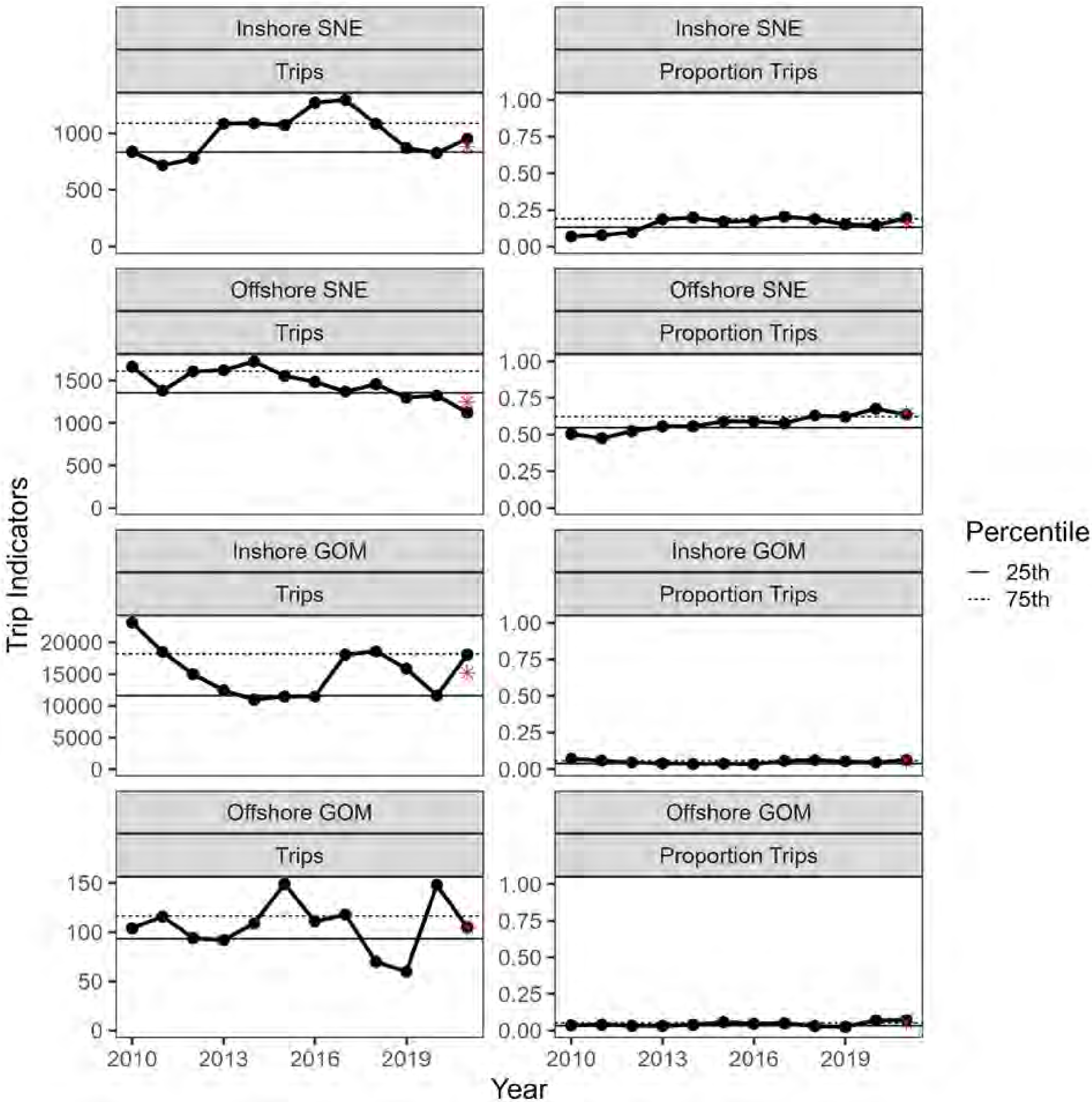

Figure 101. **Trip-based fishery performance indicators for the Jonah crab stocks. Red asterisks indicate the terminal three-year (2019-2021) average.**

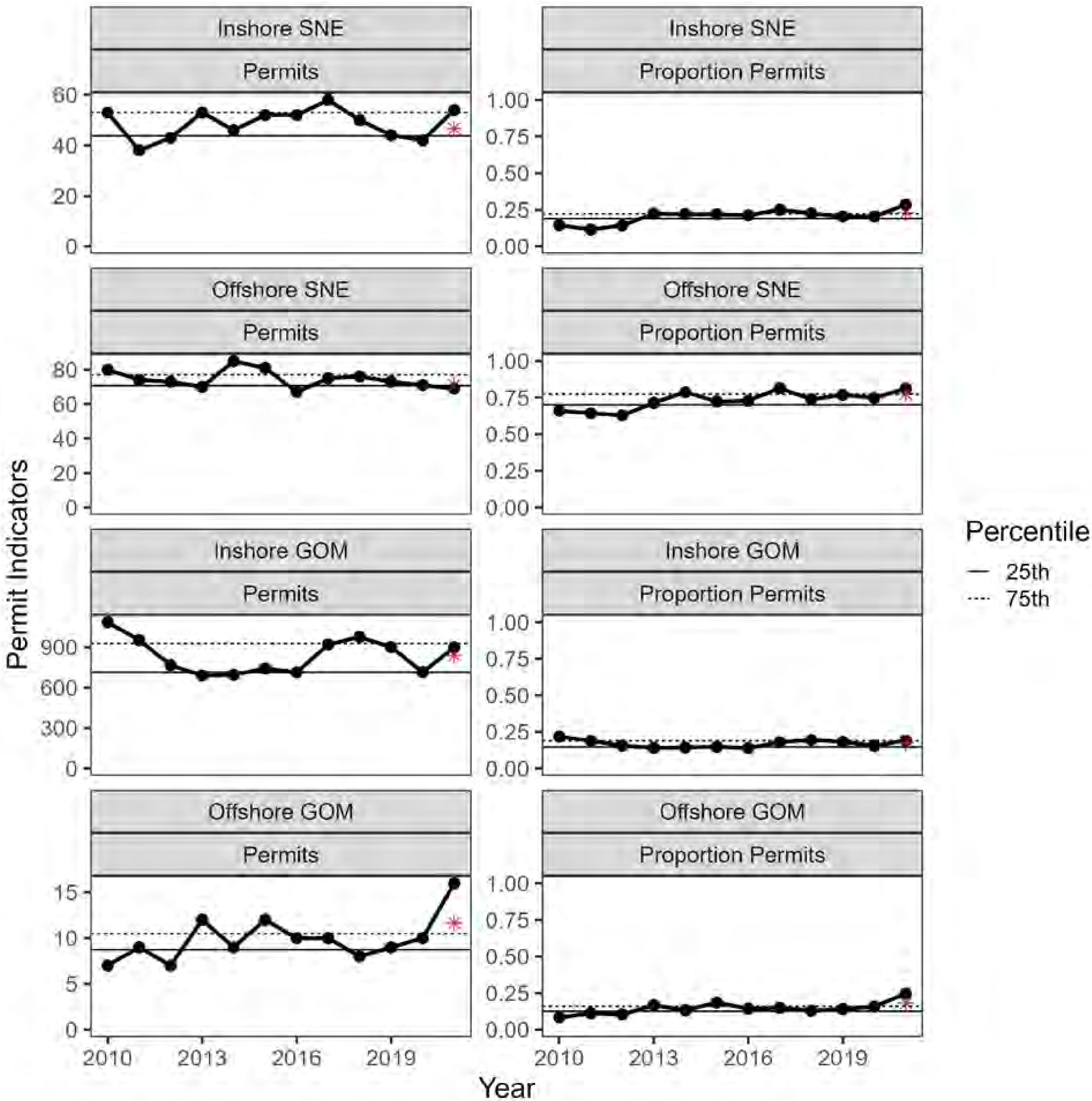

Figure 102. Permit-based fishery performance indicators for the Jonah crab stocks. Red asterisks indicate the terminal three-year (2019-2021) average.

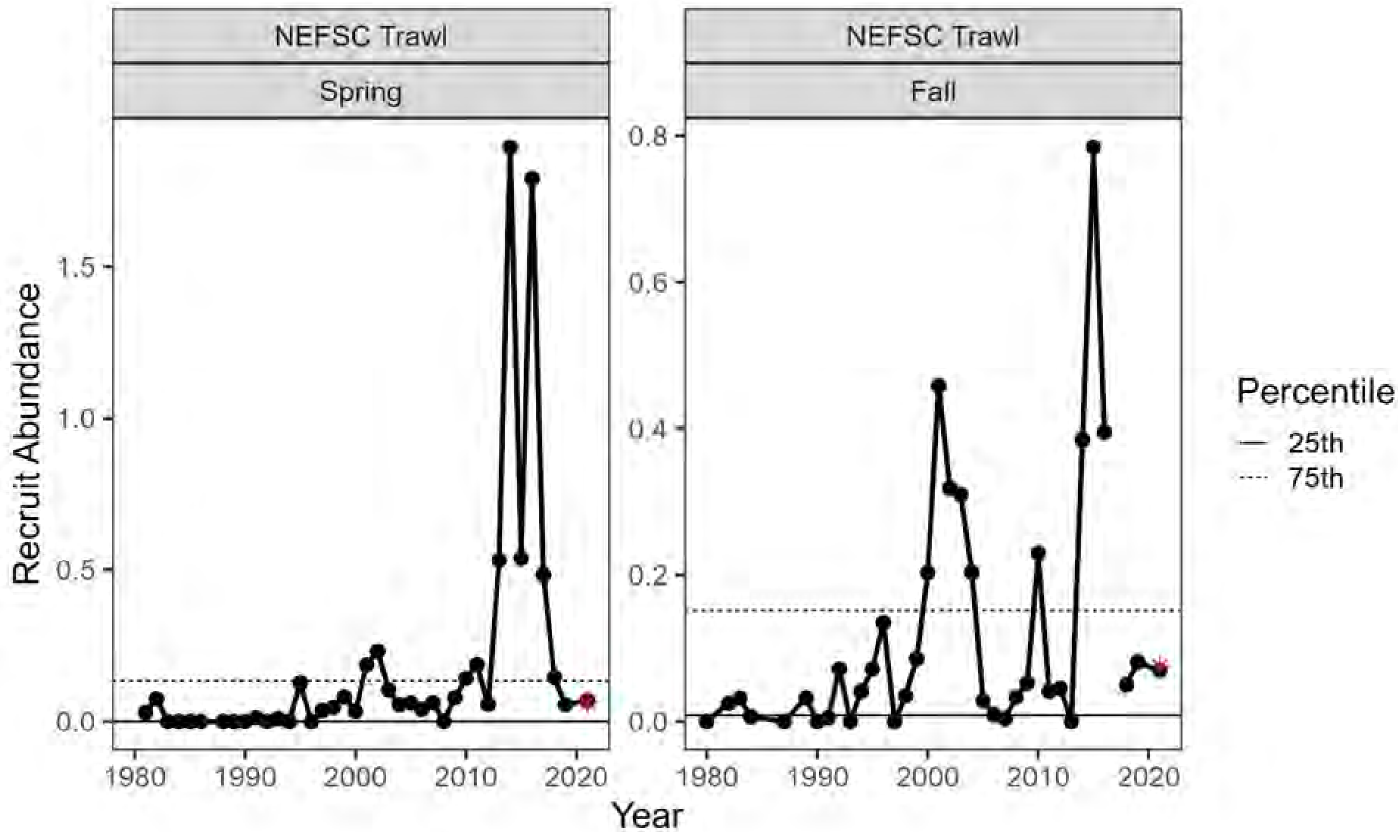

Figure 103. **Recruit abundance indicators for the OGOM Jonah crab stock. Red asterisks indicate the terminal three-year (2019-2021) average.**

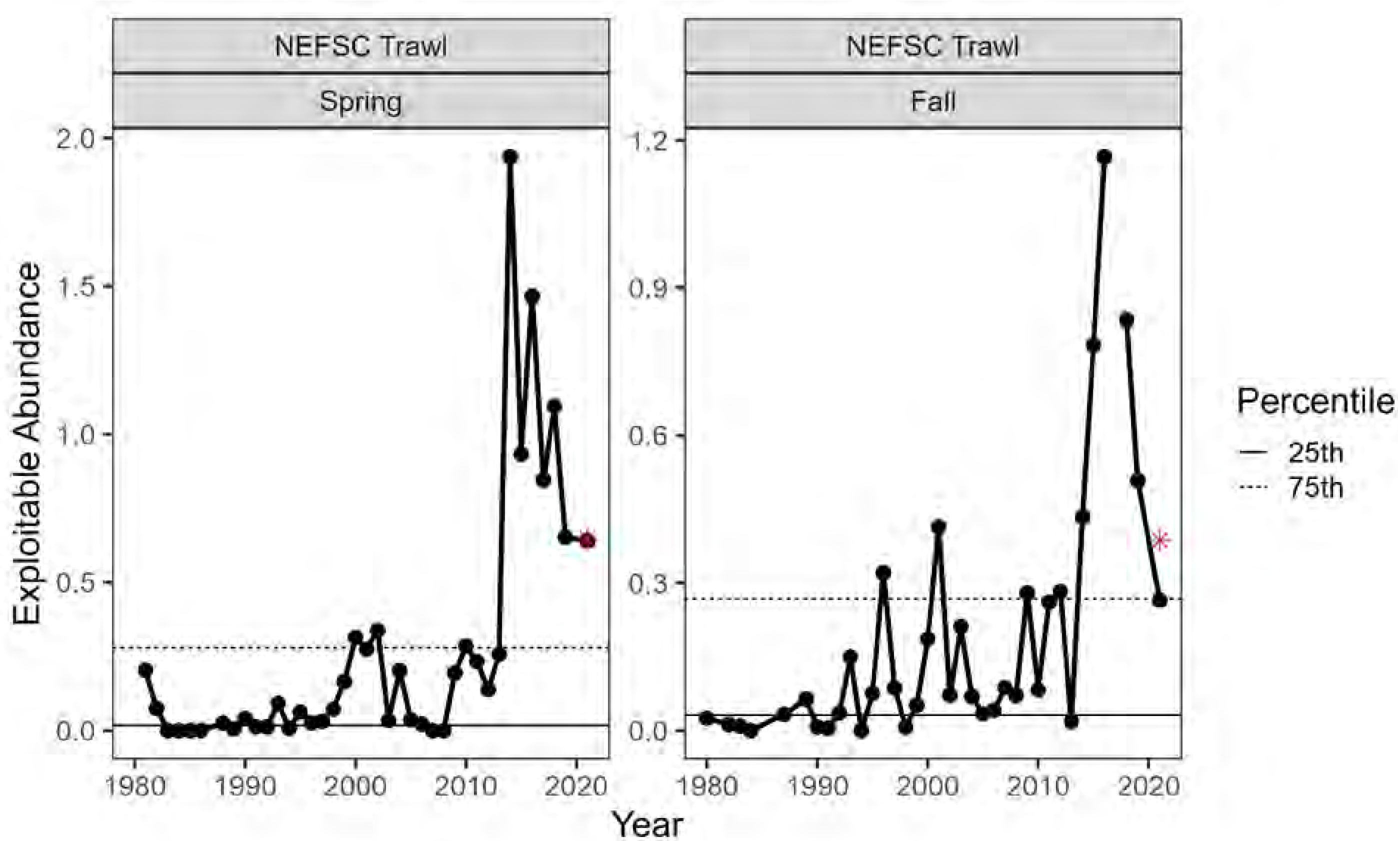

Figure 104. Exploitable abundance indicators for the OGOM Jonah crab stock. Red asterisks indicate the terminal three-year (2019-2021) average.

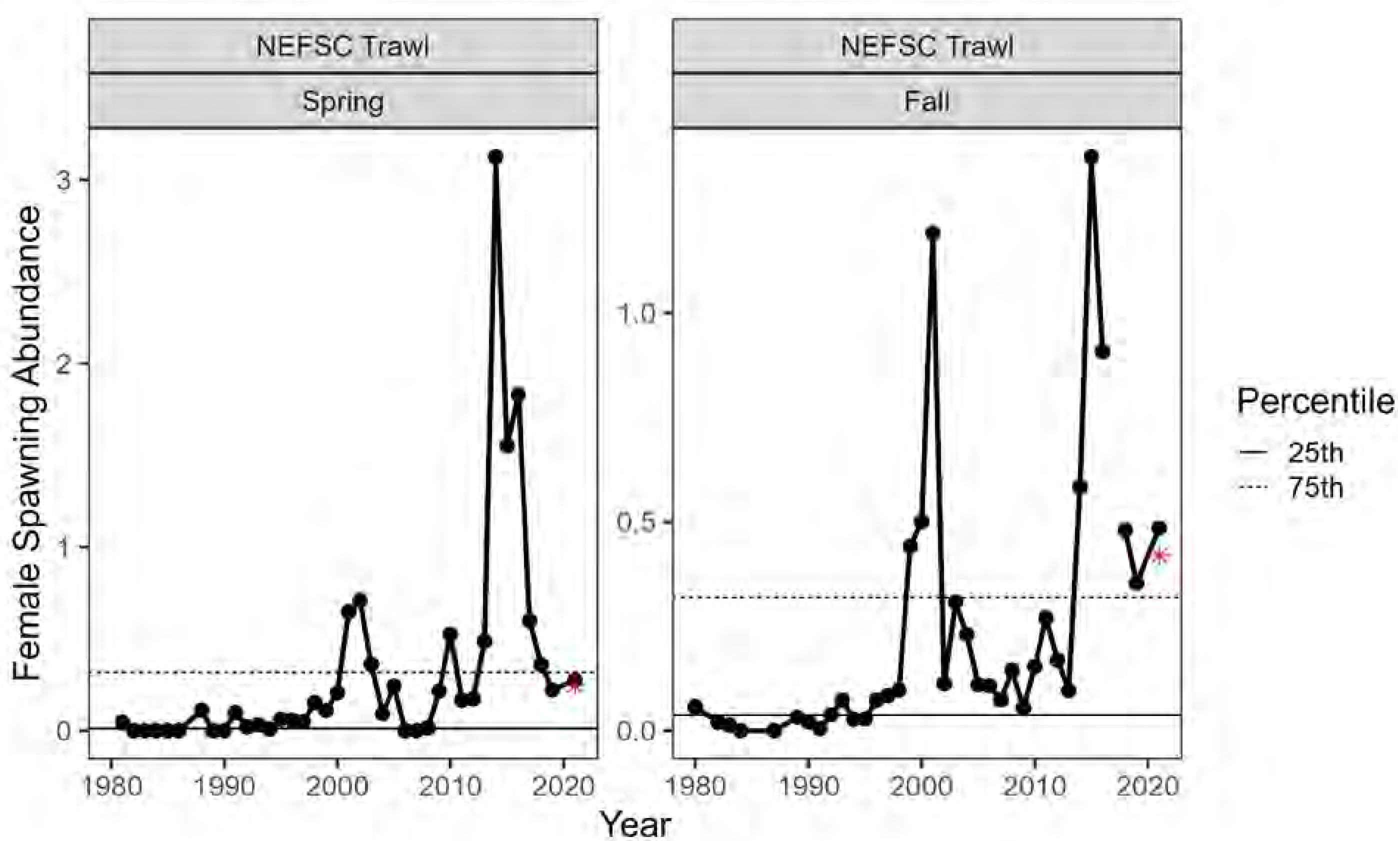

Figure 105. Spawning abundance indicators for the OGOM Jonah crab stock. Red asterisks indicate the terminal three-year (2019-2021) average.

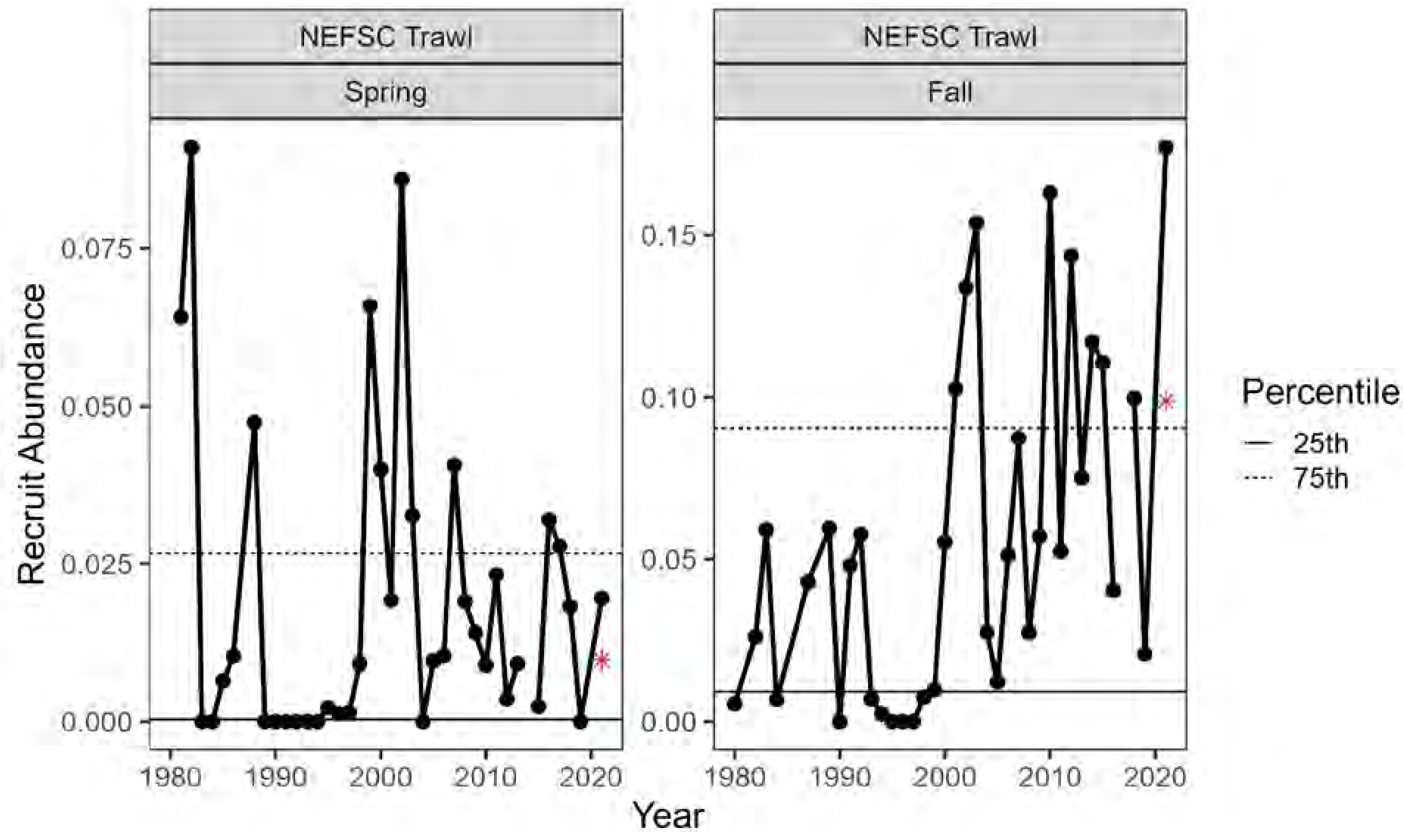

Figure 106. **Recruit abundance indicators for the OSNE Jonah crab stock. Red asterisks indicate the terminal three-year (2019-2021) average.**

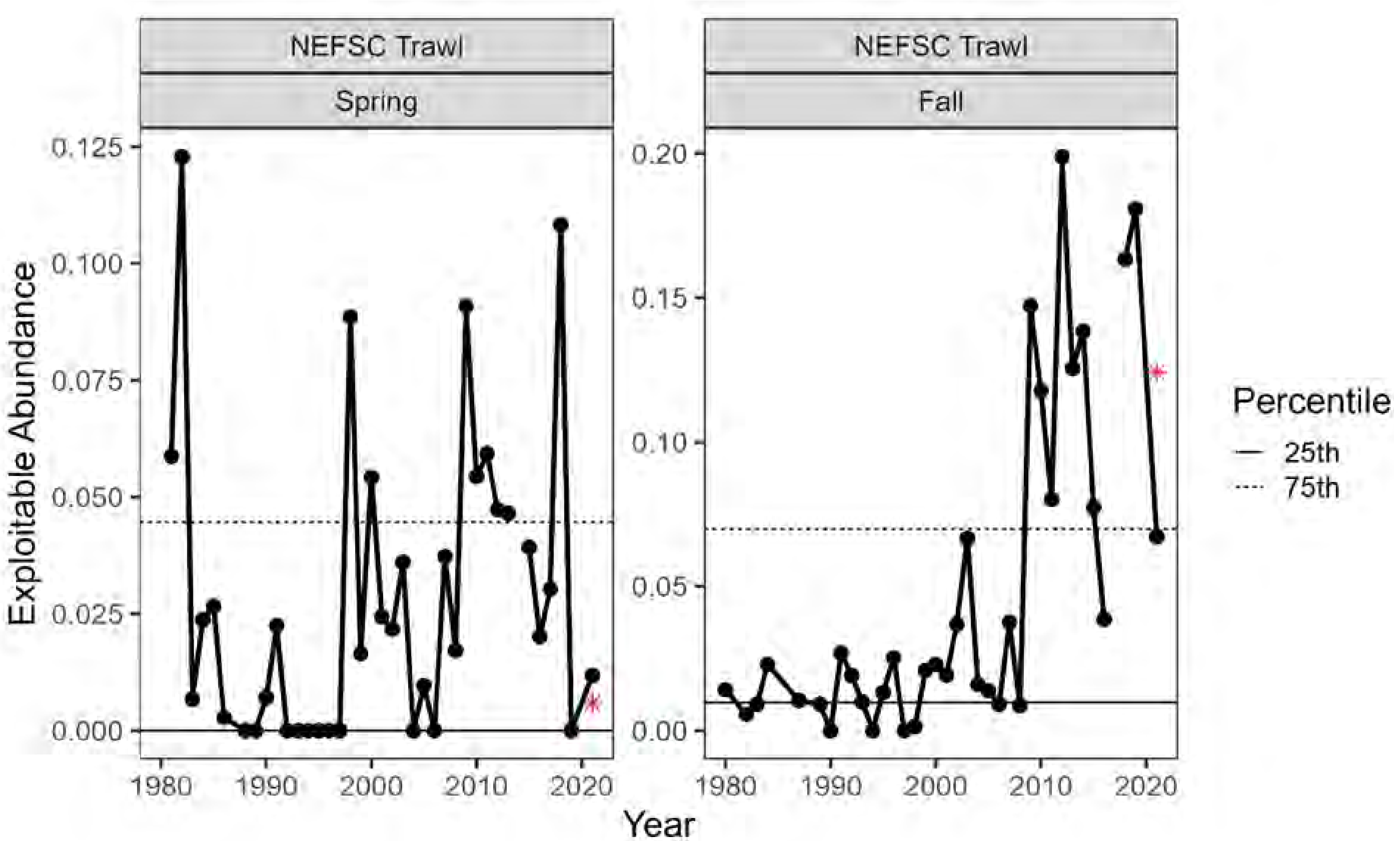

Figure 107. Exploitable abundance indicators for the OSNE Jonah crab stock. Red asterisks indicate the terminal three-year (2019-2021) average.

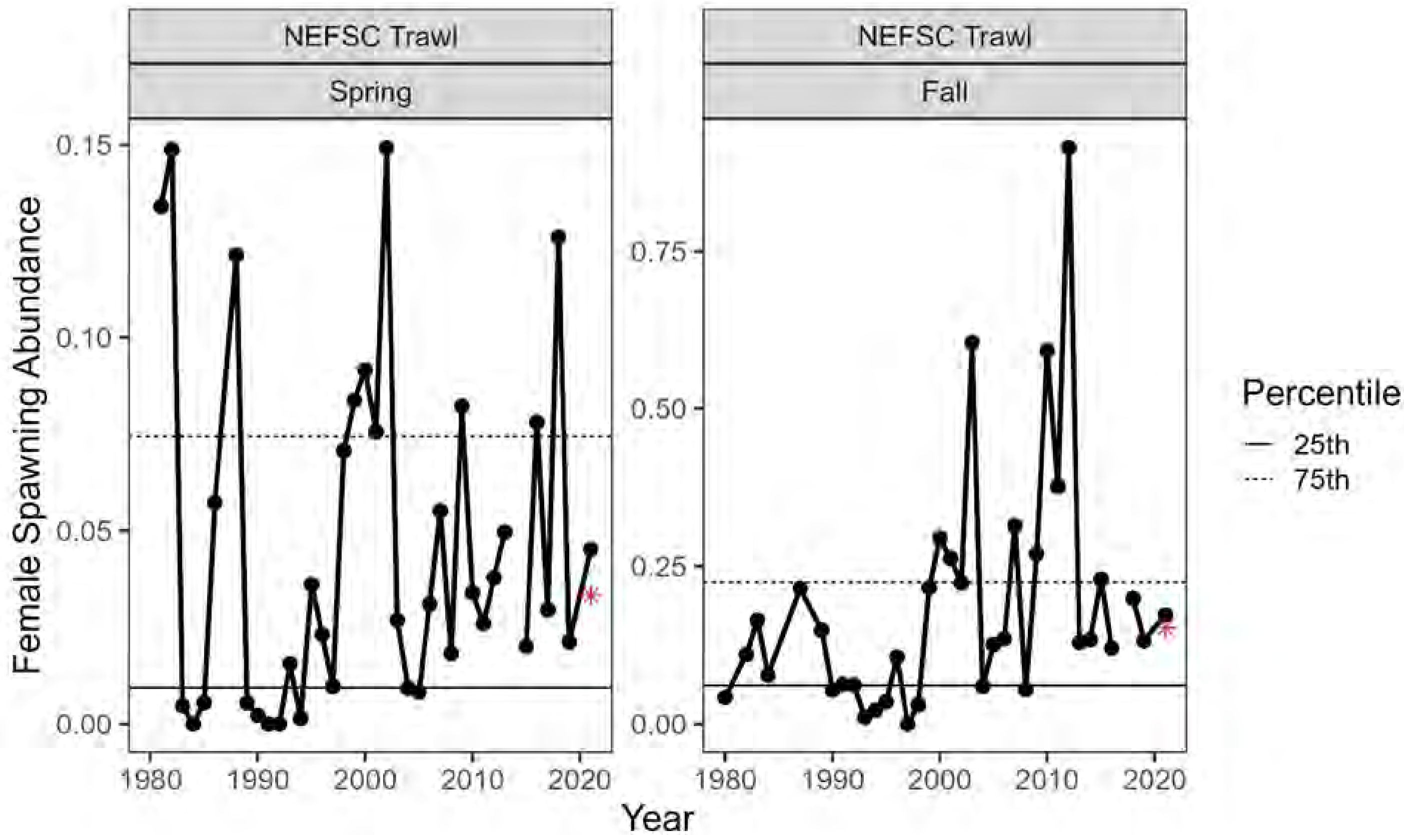

Figure 108. Spawning abundance indicators for the OSNE Jonah crab stock. Red asterisks indicate the terminal three-year (2019-2021) average.

14 APPENDICES

14.1 Index-Based Methods

Introduction

Simple index-based methods were applied to landings and exploitable abundance indices as an interim approach to generate management advice for the Jonah crab stocks until more robust data can be collected. These methods were considered ideal for Jonah crab because they rely on only a few years of data in the most recent years and do not require life history information, which is limited at this time for Jonah crab.

The typical objective of these methods is providing catch advice. However, Jonah crab and lobster fisheries are not currently managed with catch limits. Therefore, the objective of using these methods was to provide inference on exploitation levels that could be used for management advice such that catch advice that is lower than terminal year catch suggests an over-exploited stock and need for reduced exploitation, catch advice equal to terminal year catch suggests a fully-exploited stock and appropriate exploitation levels, and catch advice greater than terminal year catch suggests an under-exploited stock with potential to increase exploitation.

Three methods were evaluated including Islope, Plan B, and Skate. Islope was proposed in Geromont and Butterworth (2015) as a generic, empirical control rule using a recent abundance index trend to adjust observed catch. A log-linear regression is applied to a specified period at the end of the index time series and the estimated slope is used as a multiplier along with two additional predetermined multipliers (λ and *Cmult*) to adjust the average catch observed over the same time period. The catch advice in the form of an annual catch target (*ACT*) is calculated with equation 1:

$$Equation\ 1: ACT = Cmult * \overline{Catch} * (1 + \lambda * e^{slope})$$

where $\overline{Catch}$ is the average catch over the period selected for the log-linear regression, *slope* is the slope of the log-linear regression, and *Cmult* and λ are defined based on one of four versions proposed below ranging from least conservative (version 1) to most conservative (version 4).

$$version\ 1: \lambda = 0.4, Cmult = 0.8$$
$$version\ 1: \lambda = 0.4, Cmult = 0.7$$
$$version\ 1: \lambda = 0.4, Cmult = 0.6$$
$$version\ 1: \lambda = 0.2, Cmult = 0.6$$

Plan B was developed for and used in assessments of multiple Northeast U.S. stocks including one Atlantic cod stock and two monkfish stocks. The method is conceptually similar to Islope with a key distinction being that the abundance index is first smoothed with a LOESS smoother and the log-linear regression is then applied to the smoothed values. The *ACT* is calculated with equation 2:

$$Equation\ 2: ACT = \overline{Catch} * e^{slope}$$

Skate is a custom method developed for Northeast U.S. skate stocks. For this method, both the catch and abundance index time series are smoothed with a running average. Relative exploitation (here denoted as *F*) is estimated by diving the smoothed index by the smoothed catch and the median relative exploitation is used as a multiplier for the smoothed index in a recent period to generate a catch limit. The use of the median relative exploitation is based on the assumption that the stock has been exploited appropriately, on average, across the time series. The catch limit can then be adjusted further to account for uncertainty with a specified multiplier to generate an *ACT* with equation 3:

$$ACT = median\ Relative\ F * s\left(\overline{Index}\right) * U_{buffer}$$

where $s\left(\overline{Index}\right)$ is the smoothed average index over the selected period and U_{buffer} is the multiplier to account for uncertainty.

Skate application has also used assumptions about abundance index percentiles to generate biomass reference points and status estimates from the recent index, but these components of the method were not used due to short time series of Jonah crab abundance indices.

All of these methods assume that the index of abundance used is reliably tracking the abundance signal and that there is a relationship between catch and the index such that increased catch will result in decreased abundance. Performance of these methods was evaluated with simulation analyses in a research track assessment conducted by NOAA's NEFSC (Legault et al. 2020). These are data-limited methods and similar methods can perform differently (Legault et al. 2020). Therefore, the ensemble method evaluated in the research track assessment, simply the median of catch advice across methods, is included as an alternative method influence by all other methods applied.

Data and Methods

Both spring and fall exploitable abundance indices from the NEFSC, MA, and ME/NH trawl surveys were used in the analysis. Seasonal indices were averaged for comparison to total annual catch in these methods. The fall index from year *y* and spring index from year *y+1* were averaged and compared to catch from year *y*. This averaging is done so the average index value approximates the January 1 index from year *y+1* that would reflect the impact from catch in year *y*. Two index values were zero and these were imputed to avoid computational errors by dividing the minimum observed positive index value over the time series by ten. There were also some missing data points, primarily due to covid-19 pandemic sampling restrictions. To impute these missing values, first the ratio of year *y* fall indices and year *y+1* spring indices were calculated for each survey (Figure A1). The mean ratio over the time series was then multiplied by the observed spring index to impute a missing fall index or divided by the observed fall index to impute a missing spring index. Season-averaged indices used in the methods are compared to each seasonal index with imputed values in Figure A2. For the IGOM stock where there are multiple trawl surveys, an additional index was calculated by scaling each trawl survey's index to its time series mean and averaging across surveys (average scaled survey indices).

No modifications were necessary for the catch time series.

Each method has a few specifications that typically include defaults used for analyses elsewhere, but that can be adjusted if there is information supporting doing so. As described previously, Islope requires specification of one of the four versions defining *Cmult* and λ. Version 3 was used in the original simulation study for this method which was applied to a severely depleted stock (Geromont and Butterworth 2015). Version 2 was used in this analysis because of the relatively recent development of the Jonah crab fisheries with no indication of severely depleted stocks while still recognizing uncertainty in stock status (i.e., not selecting version 1). The default period for the log-linear regression and average catch of five years was used in this analysis.

Specifications for Plan B are the LOESS smoother span (default=9.9/n years of index data) and time period used for log-linear regression and average catch (default=three years). These defaults were maintained in this analysis and the default time period offers an alternative to that used for the Islope method.

Specifications for Skate include the time period of the running average smoother and index value for catch advice (default=three years), the moving average type (default=current and preceding years), and the uncertainty buffer multiplier for generating a catch target (default=0.25). These defaults were also maintained in this analysis. Additionally, the assumption of appropriate exploitation, on average, across the time series can be relaxed by changing the percentile of relative *F* from the median. However, there was no good information to guide this change and it was maintained. Due to this, Skate was only applied to the OSNE stock that has supported the majority of landings and not the GOM stocks because they have experienced much lower landings and are not believed to be fully-exploited across the time series.

Results

IGOM

Catch advice was highly variable among methods but similar with MA and ME/NH indices (Figures A3-A4). Advice was least conservative with the NEFSC index and also more similar between methods (Figure A5). Slopes were actually positive with the NEFSC index, resulting in catch multipliers greater than 1 and a slight increase in catch from Plan B (Table A1). Similarities between the ME/NH and MA results drive the results of the average scaled index results (Figure A6).

OGOM

Catch advice was similar from both methods, being just slightly greater from Islope (Figure A7). This catch advice was similar to the terminal three-year average catch used for Plan B (Table A1) and was lower than catches observed during the first half of the time series.

OSNE

Catch advice varied widely among methods (Figure A8). Islope estimated the highest catch at 12.6 million pounds which is only a slight reduction from the five-year average catch used for this method (13.3 million pounds, Table A1), followed by Skate (and the ensemble estimate, 8.5 million pounds) which was just slightly lower than the terminal year catch, and finally Plan B which estimates catch advice lower than any catch observed during the time series at 7 million pounds. Skate estimates increasing relative *F* over the first half of the time series followed by decreasing relative *F* from 2017-2020. There was a slight uptick in 2021.

Discussion

The longer time period of Islope generally leads to the most optimistic catch advice because it includes the peak catch years and also a period of higher index values earlier in the time series leading to a flatter slope. Based on correlation analyses of trawl surveys and lagged settlement surveys done during the assessment that found stronger correlations for shorter lag times (2-3 years), the three-year averaging period specified for Plan B may better reflect a recruitment generation time than the longer five-year time period specified for Islope and provide a more appropriate averaging period for Jonah crab. Another appealing aspect of Plan B is lack of a subjective decision on addition multipliers needed for the Islope method. The Plan B and Skate methods are also better suited for noisy data such as that available for Jonah crab because they smooth the observations first before estimating the catch multiplier.

Despite the appealing aspects of some of these methods, during deliberations about the data sets used and apparent population dynamics of Jonah crabs, advice using these methods was not recommended. In the bycatch-driven fisheries of GOM, there may yet to be a defined relationship between catch and abundance that is necessary for robust catch advice estimates from these methods. Advice, particularly for the OGOM stock, appeared unintuitive given the low magnitude of landings from this stock and presumed low exploitation. This is influenced by the decline in indices near the end of the time series from time series highs. There was no clear indication that fishing was driving this decline and, rather, it appears there are intermittent pulses of abundance that occur over short durations that are driven by unknown factors. An additional concern for all stocks is the quality of the index data. Catch rates by trawl surveys are low and have often hovered around zero. Being a species that burrows in soft bottoms, trawls may not efficiently capture Jonah crabs and indices from these surveys may only provide coarse, qualitative information on abundance changes, particularly increases when catch rates can move away from the lower bound of zero.

References

Geromont, H.F. and Butterworth, D.S., 2015a. Generic management procedures for data-poor fisheries: forecasting with few data. ICES Journal of Marine Science, 72(1), pp.251-261.

Legault, C., R. Bell, J. Cournane, J. Deroba, G. Fay, A. Jones, T. Miller, B. Muffley, and J. Weidenmann. 2020. Draft report of the index based methods working group. 59 p.

Tables

Table A1. Index-based method results for Jonah crab stocks.

Stock	Survey	Method	Slope	exp(Slope)	Catch Advice	2019-2021 Average Catch	2017-2021 Average Catch
IGOM	MA Trawl	Plan B	-0.97	0.38	1,029,669	2,715,902	3,043,688
IGOM	MA Trawl	Islope	-0.35	0.70	2,728,777	2,715,902	3,043,688
IGOM	MA Trawl	Ensemble	NA	NA	1,879,223	2,715,902	3,043,688
IGOM	ME/NH Trawl	Plan B	-0.96	0.38	1,036,612	2,715,902	3,043,688
IGOM	ME/NH Trawl	Islope	-0.43	0.65	2,684,763	2,715,902	3,043,688
IGOM	ME/NH Trawl	Ensemble	NA	NA	1,860,688	2,715,902	3,043,688
IGOM	NEFSC Trawl	Plan B	0.08	1.08	2,944,041	2,715,902	3,043,688
IGOM	NEFSC Trawl	Islope	0.05	1.05	3,026,068	2,715,902	3,043,688
IGOM	NEFSC Trawl	Ensemble	NA	NA	2,985,055	2,715,902	3,043,688
IGOM	Average Scaled Survey Indices	Plan B	-0.40	0.67	1,826,671	2,715,902	3,043,688
IGOM	Average Scaled Survey Indices	Islope	-0.18	0.84	2,844,820	2,715,902	3,043,688
IGOM	Average Scaled Survey Indices	Ensemble	NA	NA	2,335,746	2,715,902	3,043,688
OGOM	NEFSC Trawl	Plan B	-0.25	0.78	116,431	149,600	153,131
OGOM	NEFSC Trawl	Islope	-0.17	0.85	143,480	149,600	153,131
OGOM	NEFSC Trawl	Ensemble	NA	NA	129,956	149,600	153,131
OSNE	NEFSC Trawl	Plan B	-0.49	0.61	7,008,359	11,419,689	13,298,001
OSNE	NEFSC Trawl	Islope	-0.14	0.87	12,551,963	11,419,689	13,298,001
OSNE	NEFSC Trawl	Skate	NA	NA	8,482,925	11,419,689	13,298,001
OSNE	NEFSC Trawl	Ensemble	NA	NA	8,482,925	11,419,689	13,298,001

Figures

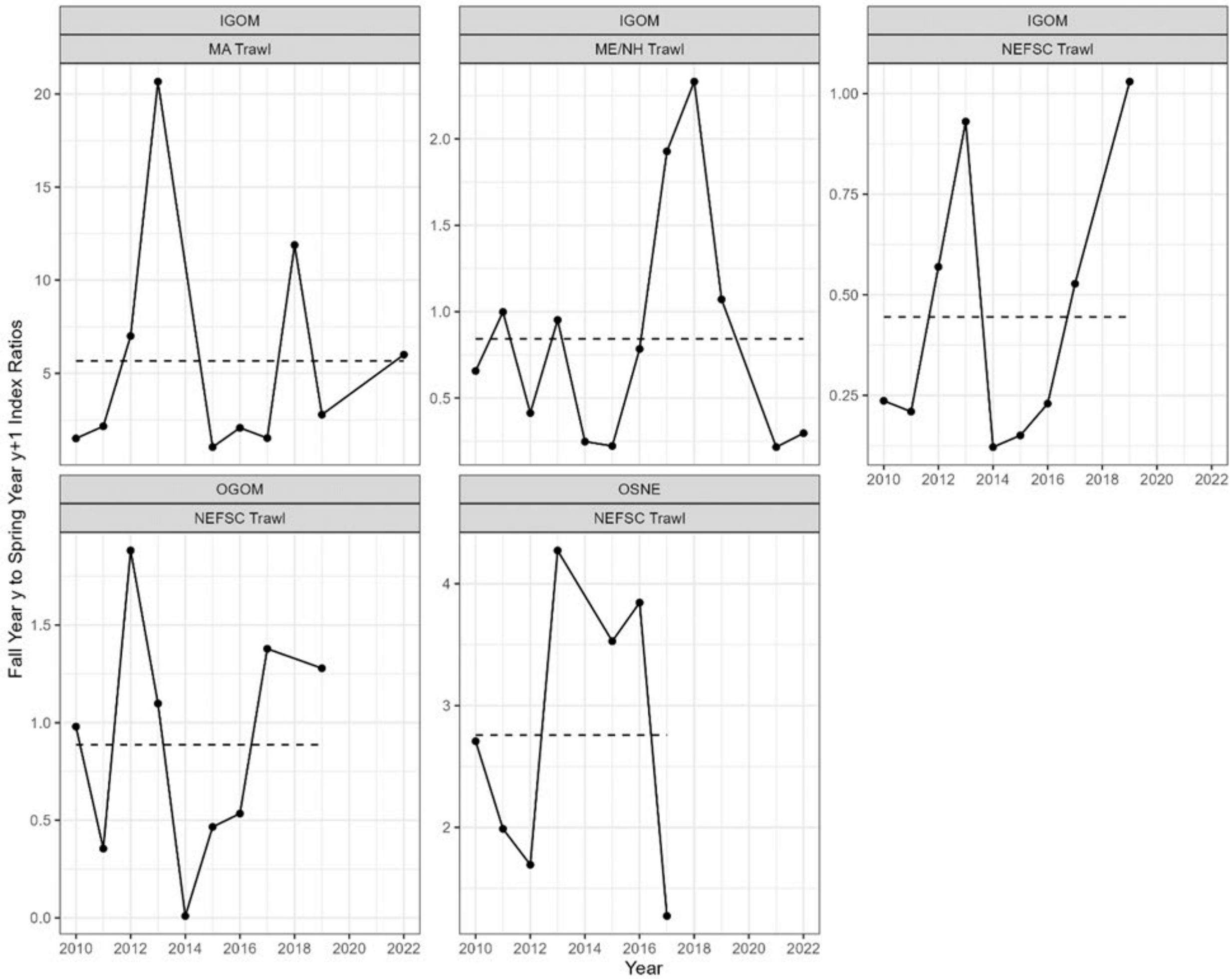

Figure A1. Ratios of fall indices in year *y* and spring indices in year *y+1.* The dashed line is the median ratio which was used to impute missing index values.

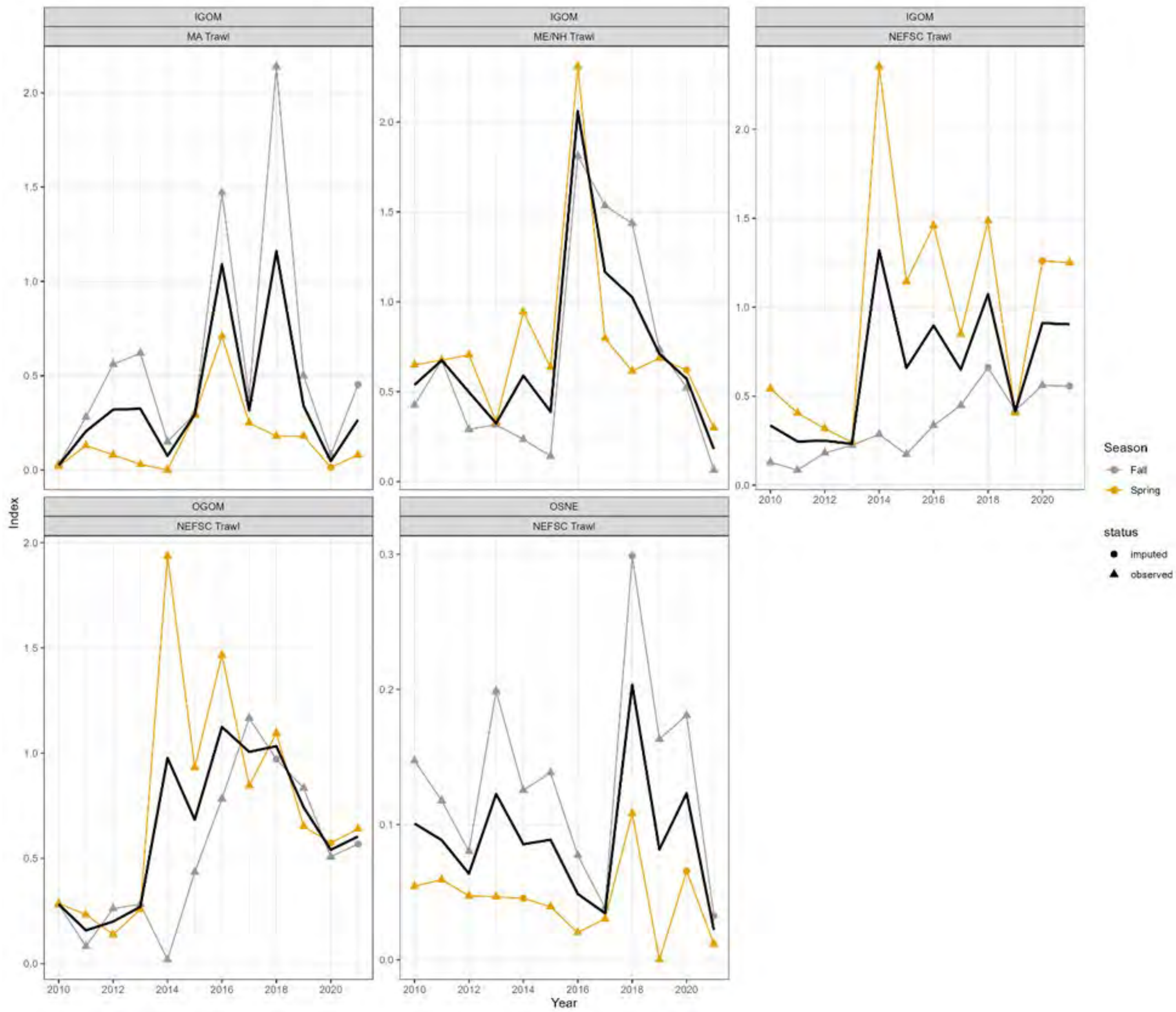

Figure A2. Final indices used in index-based methods (black line) compared to seasonal indices averaged to generate the final indices. Shapes for the seasonal index points indicate whether the value was observed or imputed.

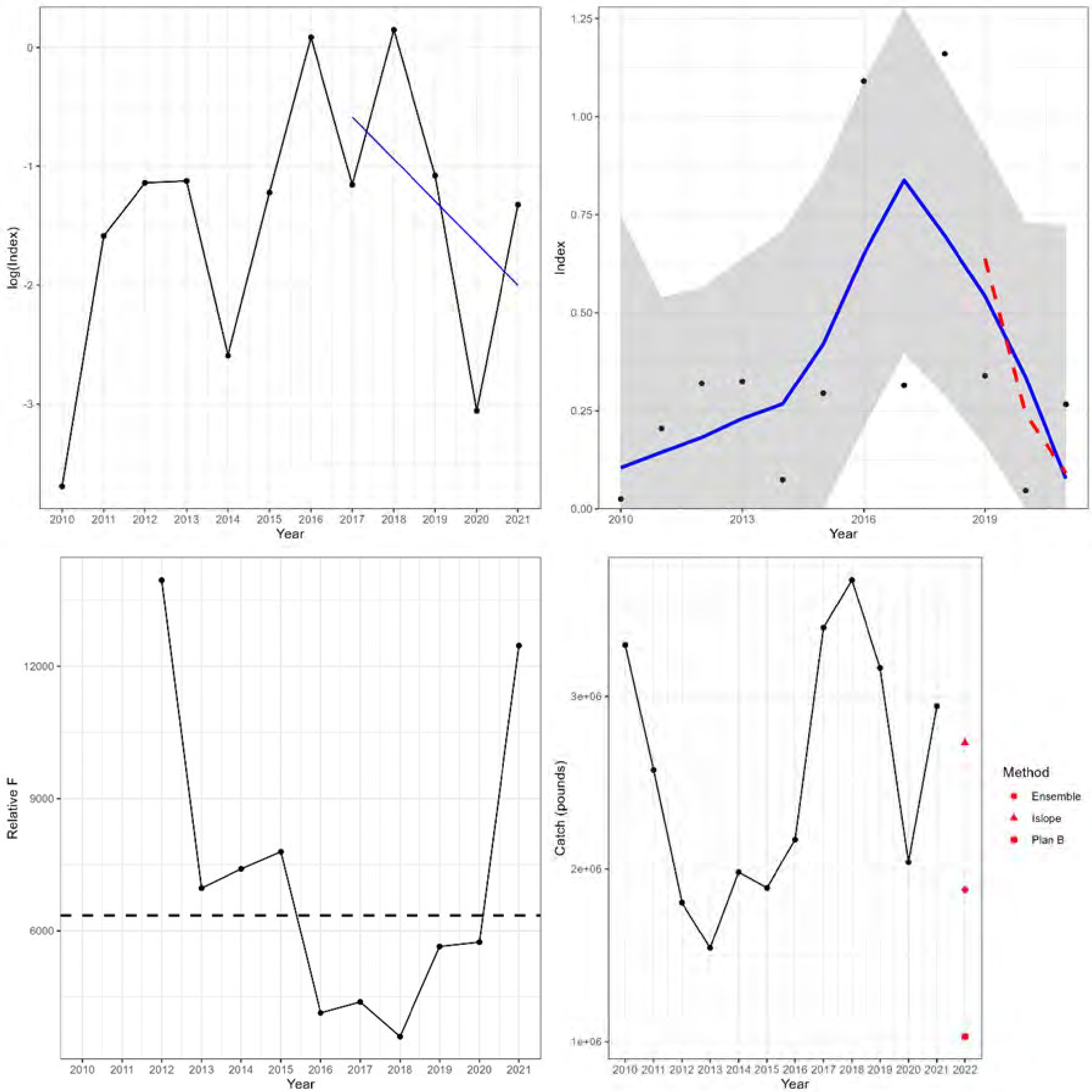

Figure A3. Index-based method results for the IGOM Jonah crab stock with the MA Trawl index including the Islope log-linear regression line and observed index on the log scale (upper left), Plan B log-linear regression line (transformed to original index scale) and LOESS smoother (blue line, upper right), Skate relative *F* time series and median (dashed line, lower left), and comparison of catch advice from all methods to the observed landings (lower right).

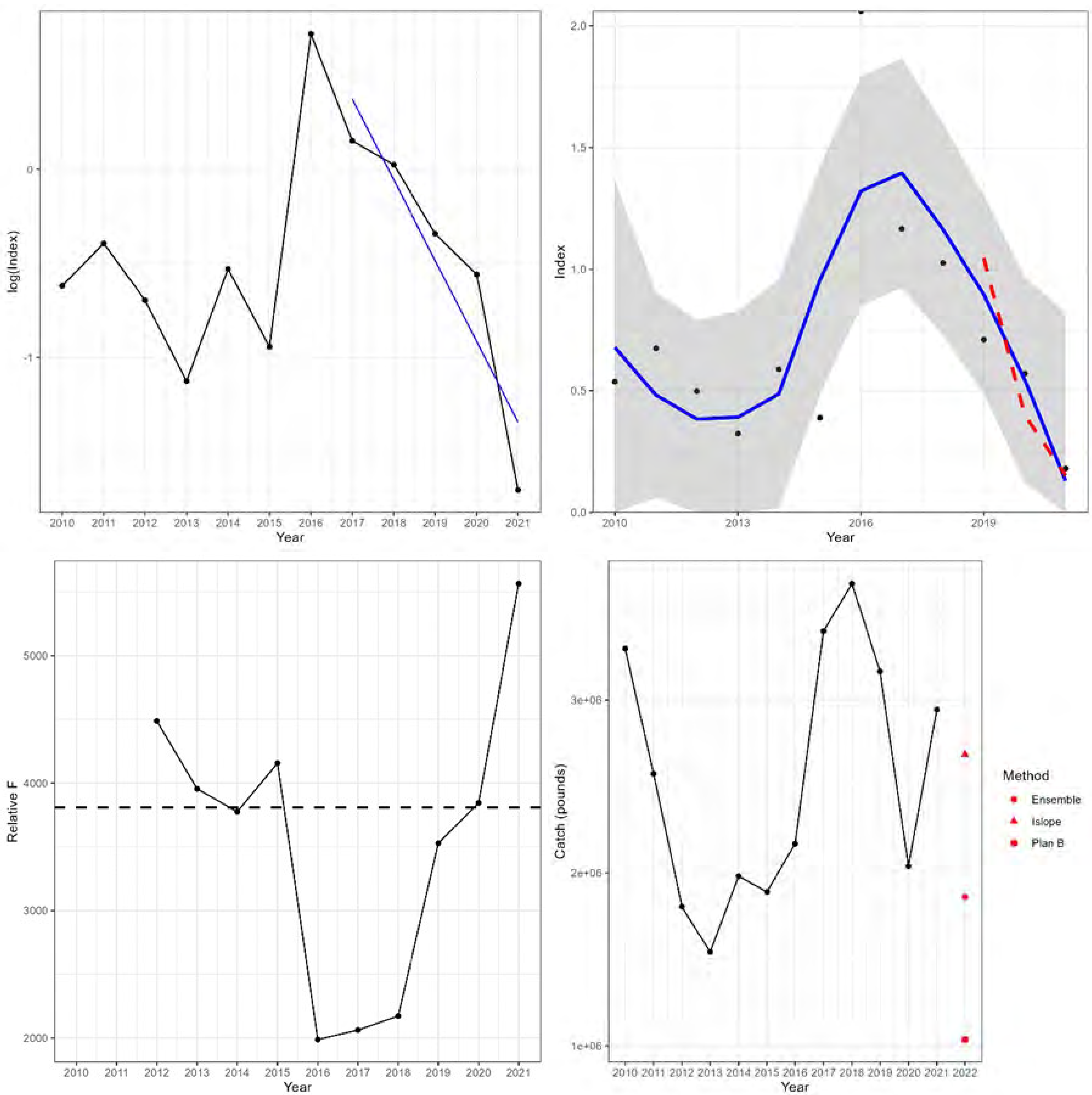

Figure A4. Index-based method results for the IGOM Jonah crab stock with the ME/NH Trawl index including the Islope log-linear regression line and observed index on the log scale (upper left), Plan B log-linear regression line (transformed to original index scale) and LOESS smoother (blue line, upper right), Skate relative *F* time series and median (dashed line, lower left), and comparison of catch advice from all methods to the observed landings (lower right).

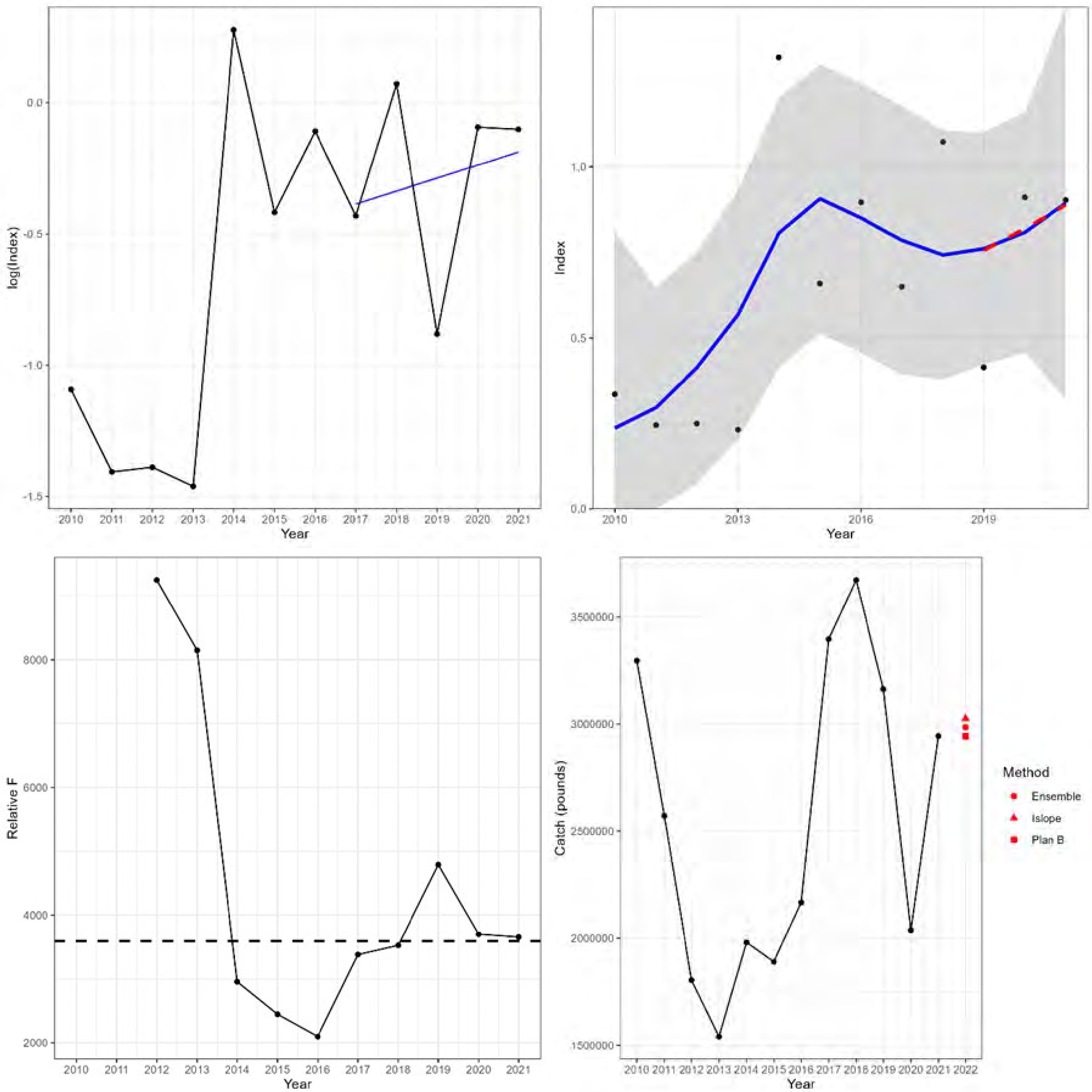

Figure A5. Index-based method results for the IGOM Jonah crab stock with the NEFSC Trawl index including the Islope log-linear regression line and observed index on the log scale (upper left), Plan B log-linear regression line (transformed to original index scale) and LOESS smoother (blue line, upper right), Skate relative *F* time series and median (dashed line, lower left), and comparison of catch advice from all methods to the observed landings (lower right).

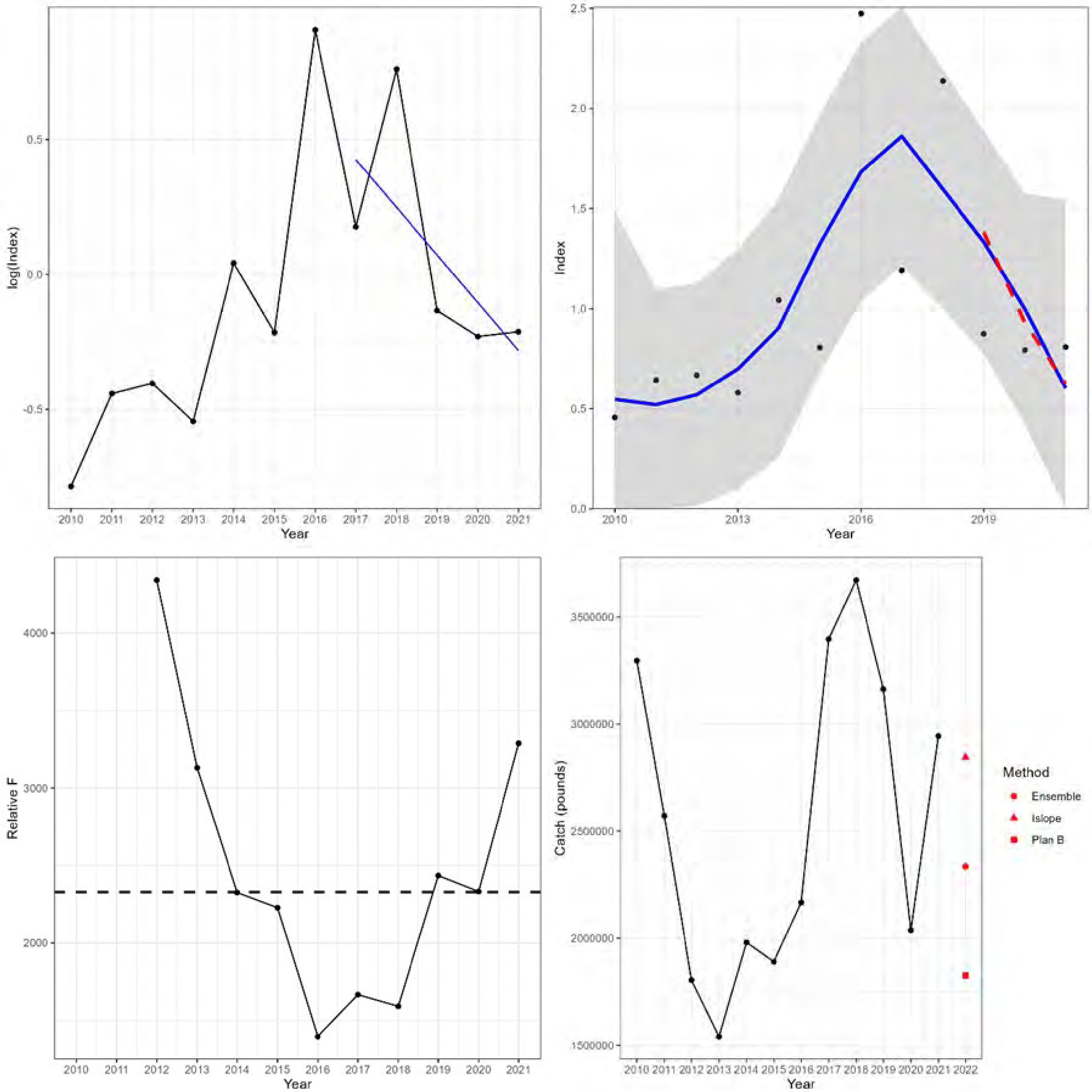

Figure A6. Index-based method results for the IGOM Jonah crab stock with the average scaled survey indices including the Islope log-linear regression line and observed index on the log scale (upper left), Plan B log-linear regression line (transformed to original index scale) and LOESS smoother (blue line, upper right), Skate relative *F* time series and median (dashed line, lower left), and comparison of catch advice from all methods to the observed landings (lower right).

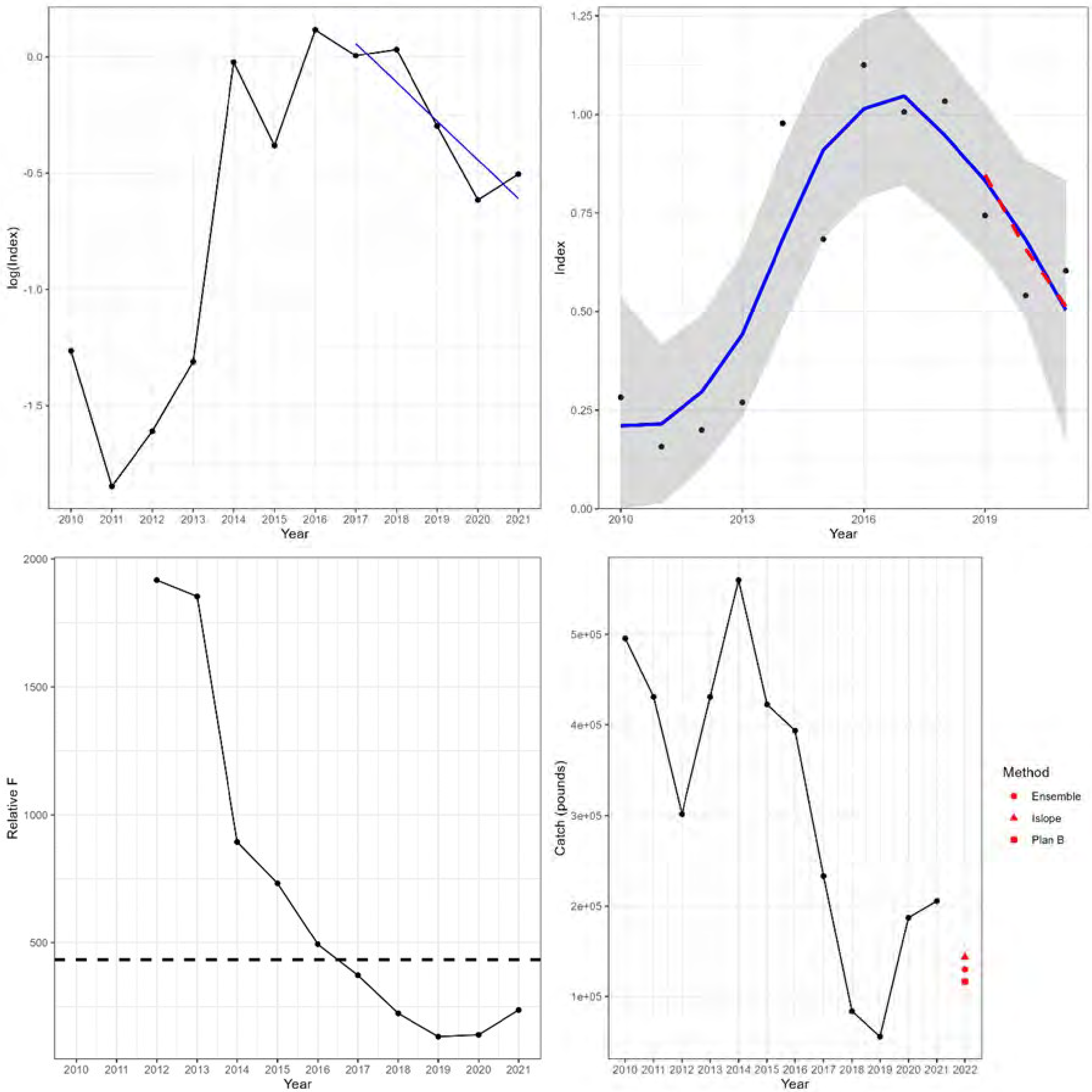

Figure A7. Index-based method results for the OGOM Jonah crab stock including the Islope log-linear regression line and observed index on the log scale (upper left), Plan B log-linear regression line (transformed to original index scale) and LOESS smoother (blue line, upper right), Skate relative *F* time series and median (dashed line, lower left), and comparison of catch advice from all methods to the observed landings (lower right).

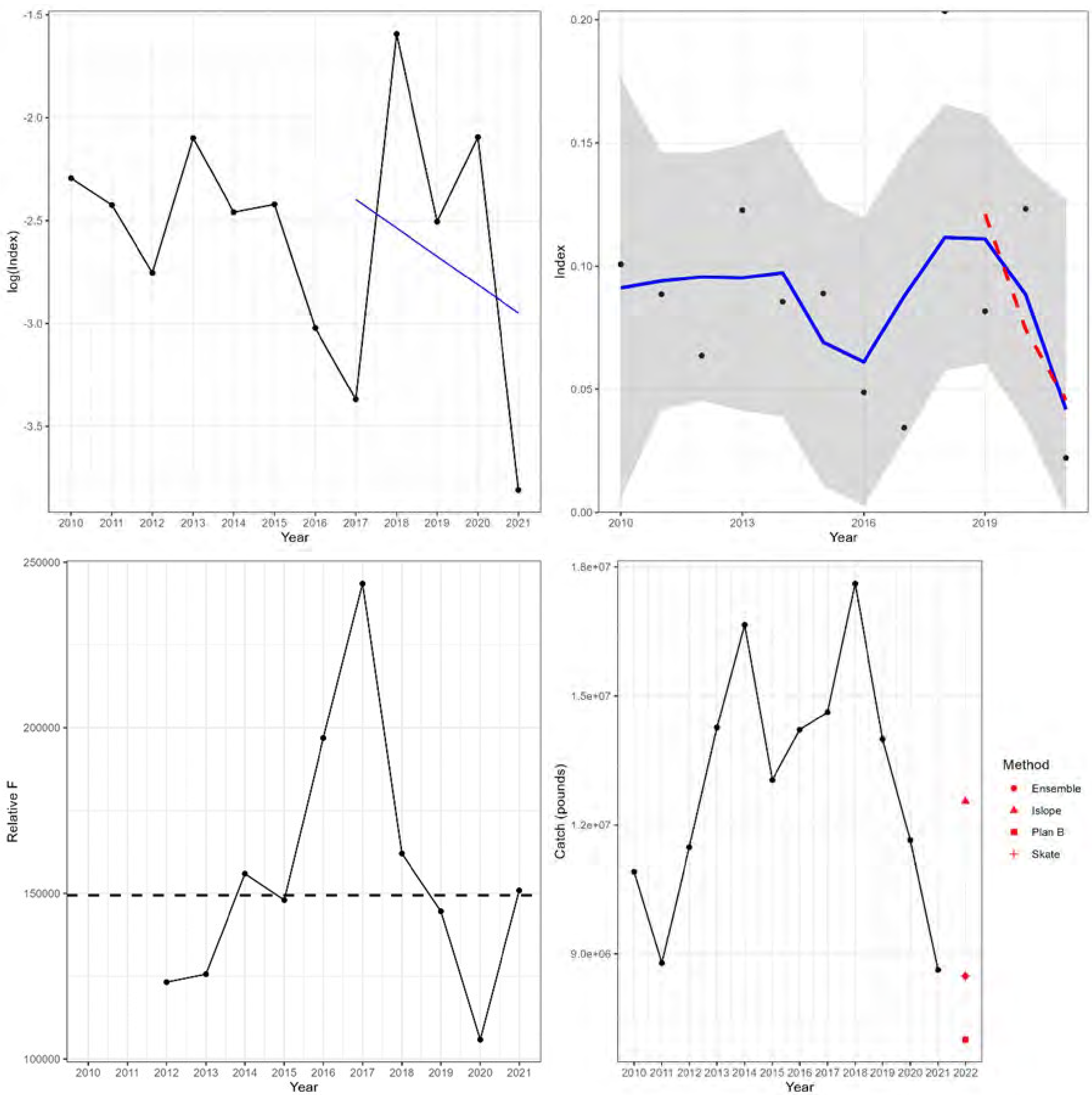

Figure A8. Index-based method results for the OSNE Jonah crab stock including the Islope log-linear regression line and observed index on the log scale (upper left), Plan B log-linear regression line (transformed to original index scale) and LOESS smoother (blue line, upper right), Skate relative *F* time series and median (dashed line, lower left), and comparison of catch advice from all methods to the observed landings (lower right).

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MEMORANDUM

TO: American Lobster Management Board

FROM: American Lobster Technical Committee

DATE: October 2, 2023

SUBJECT: 2023 American Lobster Data Update and Addendum XXVII Trigger Index Update

Data Update

An annual Data Update process between American lobster stock assessments was recommended during the 2020 stock assessment to more closely monitor changes in stock abundance. The objective of this process is to present information—including any potentially concerning trends—that could support additional research or consideration of changes to management. Data sets updated during this process are generally those that indicate exploitable lobster stock abundance conditions expected in subsequent years and include:

- YOY settlement indicators
- Trawl survey indicators, including recruit abundance (71-80 mm carapace length lobsters) and survey encounter rate
- Ventless trap survey sex-specific abundance indices (53 mm+ carapace length lobsters)

This is the third Data Update and provides an update of last year's review with the addition of 2022 data. Indicator status (negative, neutral, or positive – see table below) was determined relative to the percentiles of the stock assessment time series (i.e., data set start year through 2018).

Indicator	< 25th percentile	Between 25th and 75th percentile	> 75th percentile
YOY settlement (larval or YOY)	Negative	Neutral	Positive
Trawl survey recruit abundance	Negative	Neutral	Positive
Trawl survey encounter rate	Negative	Neutral	Positive
Ventless trap survey abundance	Negative	Neutral	Positive

The five-year means provided during the stock assessment (2014-2018) for terminal indicator status determinations were also updated with new years of data. This treatment of data is consistent with stock indicators provided during stock assessments (see Section 5 in the 2020 stock assessment report for more detail). Ventless trap survey abundance indices have been added to indicators used in the stock assessment for this Data Update process. Note that updated five-year means (2018-2022) for several trawl survey-based indicators remain impacted by covid-19 data collection disruptions. Additionally, some data changes have occurred for various reasons since the stock assessment or previous year's Data Updates. Please see the appendix for details on these data changes. Below are the results of the data updates by sub-stock.

Gulf of Maine (GOM)

Overall, Gulf of Maine indicators show declines from time series highs observed during the stock assessment.

- YOY conditions showed improvements since the stock assessment, but were still not positive (Table 1 and Figure 1).
    - Updated five-year means were all neutral, indicating improvement since the stock assessment when two of the five-year means were negative (both southwest areas).
    - 2022 values showed increases from 2021 values with one exception (MA 514). Two improved from negative to neutral, two remained neutral, and one remained negative.
- Trawl survey recruit abundance indicators showed signs of decline since the stock assessment (Table 2 and Figure 2).
    - Two updated five-year means changed from positive to neutral since the stock assessment. The other four remained positive. Both indicators that declined to neutral are for inshore GOM waters.
    - 2022 values were similar to 2021 values, with three of six being neutral and three of six being positive.
    - Five of six indicators were not available for 2020 due to covid-19 sampling restrictions.
- Trawl survey encounter rates show deteriorating conditions inshore since the stock assessment (Table 3 and Figure 3).
    - All four updated five-year means for inshore indicators were neutral, whereas only one was neutral during the stock assessment. Updated five-year means for the two offshore indicators remain positive.
    - The first negative annual value since 2008 was observed in 2022.
    - Five of six indicators were not available for 2020 due to covid-19 sampling restrictions.
- Ventless trap survey indices show abundance declining since the stock assessment (Table 4 and Figure 4).
    - Six of eight updated five-year means were neutral and two were negative, compared to four positive means and no negative means during the stock assessment.
    - 2022 values were similar to 2021 values with four neutral and four negative.
    - 2022 values for both sexes in statistical areas 512 and 514 were among the lowest values observed during the time series.

Georges Bank (GBK)

Overall, Georges Bank indicators show slight improvement since the stock assessment. Note that there are no YOY or VTS indicators for this sub-stock area.

- Trawl survey recruit abundance indicators showed slight improvements (Table 5 and Figure 5).
    - One updated five-year mean changed from neutral to positive since the stock assessment, while the other remained neutral.
    - 2022 values were both positive and relatively high, as were 2021 values.
    - No indicators were available for 2020 due to covid-19 sampling restrictions.
    - These indicators tend to be noisier than some of the other abundance indicators, with high interannual variability and lack of discernible trends.

- Trawl survey encounter rates showed similar conditions since the stock assessment (Table 6 and Figure 6).
    - The updated means both remained positive.
    - No indicators were available for 2020 due to covid-19 sampling restrictions.

Southern New England (SNE)

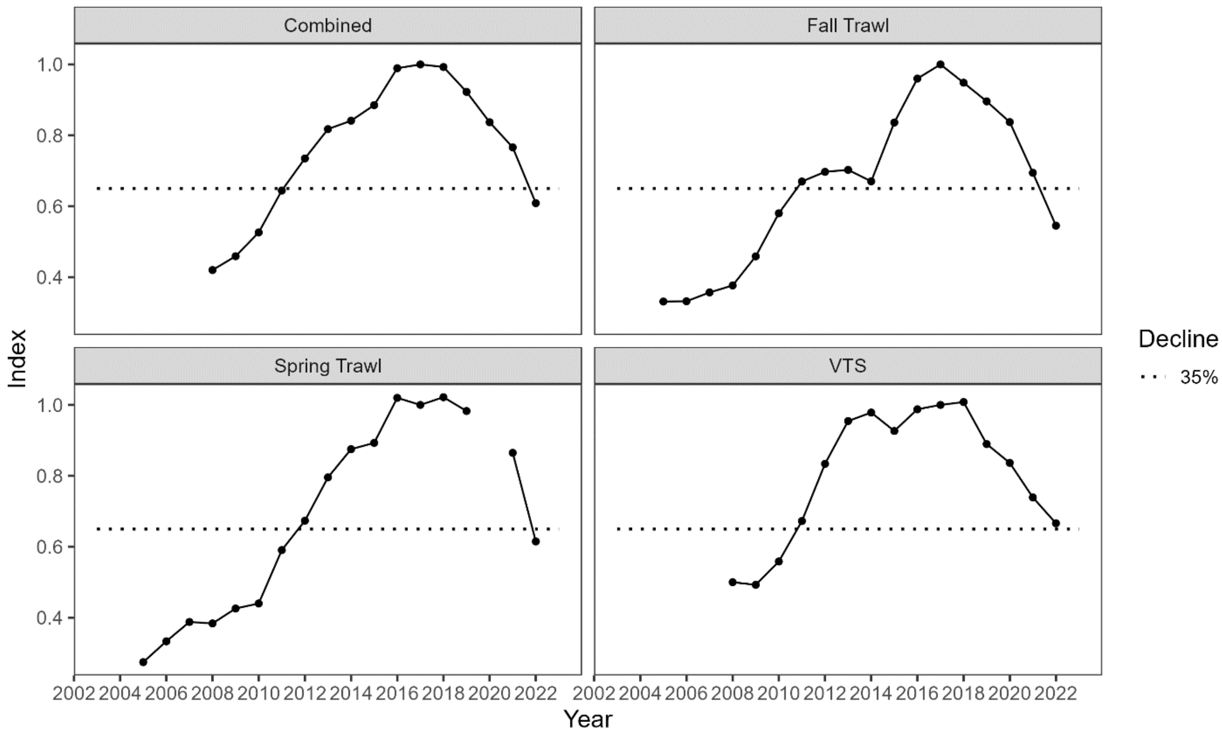
Overall, Southern New England indicators show continued unfavorable conditions with some further signs of decline since the stock assessment.

- YOY conditions were negative across the stock with some decline since the stock assessment (Table 7 and Figure 7).
    - Updated five-year means were all negative, whereas one of three was neutral during the stock assessment.
    - No YOY have been caught during the MA survey for the last eight years.
- Trawl survey recruit abundance indicators showed declines since the stock assessment (Table 8 and Figure 8).
    - The updated five-year means were all negative, with three of eight moving to negative conditions since the stock assessment.
    - All 2022 values were negative and this is the first year values have been negative across all indicators.
    - Six of eight indicators were not available for 2020 due to covid-19 sampling restrictions.
- Trawl survey encounter rates showed deteriorating conditions since the stock assessment (Table 9 and Figure 9).
    - Updated five-year means for all eight indicators were negative, with two changing from neutral to negative since the stock assessment.
    - All 2022 values were negative as was observed in 2021.
    - Six of eight indicators were not available for 2020 due to covid-19 sampling restrictions.
- Ventless trap survey indices show declines since the stock assessment (Table 10 and Figure 10).
    - Two updated five-year means changed from neutral to negative since the stock assessment. The other two remained neutral.
    - All 2022 values were negative, the second year during the time series values have been negative across all indicators.
    - It is important to note that the ventless trap survey has only taken place during depleted stock conditions coinciding with an adverse environmental regime, so interannual variability can be misleading without the context of a longer time series encompassing varying stock conditions.

Addendum XXVII Trigger Index Update

Addendum XXVII (2023) establishes a trigger mechanism to implement management measures to provide additional protection of the GOM/GBK spawning stock biomass. The trigger index is based on recruit conditions observed in three surveys used to inform the assessment model estimates of reference abundance and stock status for the GOM/GBK stock. These recruit (71-80mm carapace length lobsters) indices include: 1) combined Maine/New Hampshire and Massachusetts spring trawl survey index, 2) combined Maine/New Hampshire and Massachusetts fall trawl survey index, and 3) model-based VTS index. The management trigger is defined as a 35% decline in the combined trigger index from the reference period (average of the index values from 2015-2017).

The figure below (top left panel) shows the calculated trigger index including data through 2022 compared to the selected trigger level of 35%. Including the 2022 survey data as the terminal year, the most recent trigger index value is 0.609, which equates to a 39.1% decline from the reference period.



The TC evaluated the indices and data inputs. The TC noted that the trends across all indices are in agreement and have all been following a decreasing trend since 2018. They also noted that in 2020, several surveys did not occur due to the COVID-19 pandemic. In particular, no spring trawl surveys were completed, resulting in a missing 2020 value for the spring trawl combined index (bottom left panel). Additionally, the Massachusetts fall trawl survey was not completed in 2020, which means the 2020 value for the fall trawl index (upper right panel) is based only on the Maine/New Hampshire fall trawl survey data. Because the final index values are calculated using a three-year rolling average, the 2020, 2021, and 2022 combined index values are affected by these missing data.

Tables and Figures

Table 1. GOM abundance indicators: YOY indices.

YOUNG-OF-YEAR INDICES					
	ME				MA
Survey	*511*	*512*	*513 East*	*513 West*	*514*
1981					
1982					
1983					
1984					
1985					
1986					
1987					
1988					
1989			1.64		
1990			0.77		
1991			1.54		
1992			1.30		
1993			0.45		
1994			1.61		
1995		0.02	0.66		0.91
1996		0.05	0.47		
1997		0.05	0.46		0.10
1998		0.00	0.14		0.03
1999		0.04	0.65		0.43
2000	0.00	0.10	0.13	0.17	0.07
2001	0.24	0.43	2.08	1.17	0.39
2002	0.13	0.29	1.38	0.85	1.00
2003	0.22	0.27	1.75	1.22	0.75
2004	0.18	0.36	1.75	0.67	1.02
2005	1.42	1.25	2.40	1.12	1.06
2006	0.49	1.06	1.57	1.08	0.45
2007	0.59	1.11	2.23	1.30	1.27
2008	0.32	0.59	1.27	1.10	0.33
2009	0.66	0.33	1.51	0.48	0.17
2010	0.16	0.64	1.25	0.63	0.44
2011	0.41	0.98	2.33	0.90	0.58
2012	0.44	0.62	1.27	0.30	0.08
2013	0.09	0.22	0.34	0.12	0.00
2014	0.16	0.47	1.04	0.42	0.11
2015	0.15	0.22	0.42	0.03	0.00
2016	0.13	0.21	0.42	0.14	0.08
2017	0.21	0.36	0.65	0.23	0.08
2018	0.27	0.34	0.62	0.22	0.03
2014-2018 mean	0.18	0.32	0.63	0.21	0.06
2019	0.43	0.64	0.94	0.45	0.06
2020	0.29	0.51	1.06	0.33	0.19
2021	0.06	0.12	0.38	0.28	0.28
2022	0.13	0.59	0.71	0.42	0.11
2018-2022 mean	0.23	0.44	0.74	0.34	0.13
25th	0.15	0.18	0.51	0.23	0.08
median	0.22	0.34	1.26	0.63	0.33
75th	0.42	0.60	1.60	1.09	0.67

Figure 1. GOM abundance indicators: YOY indices.

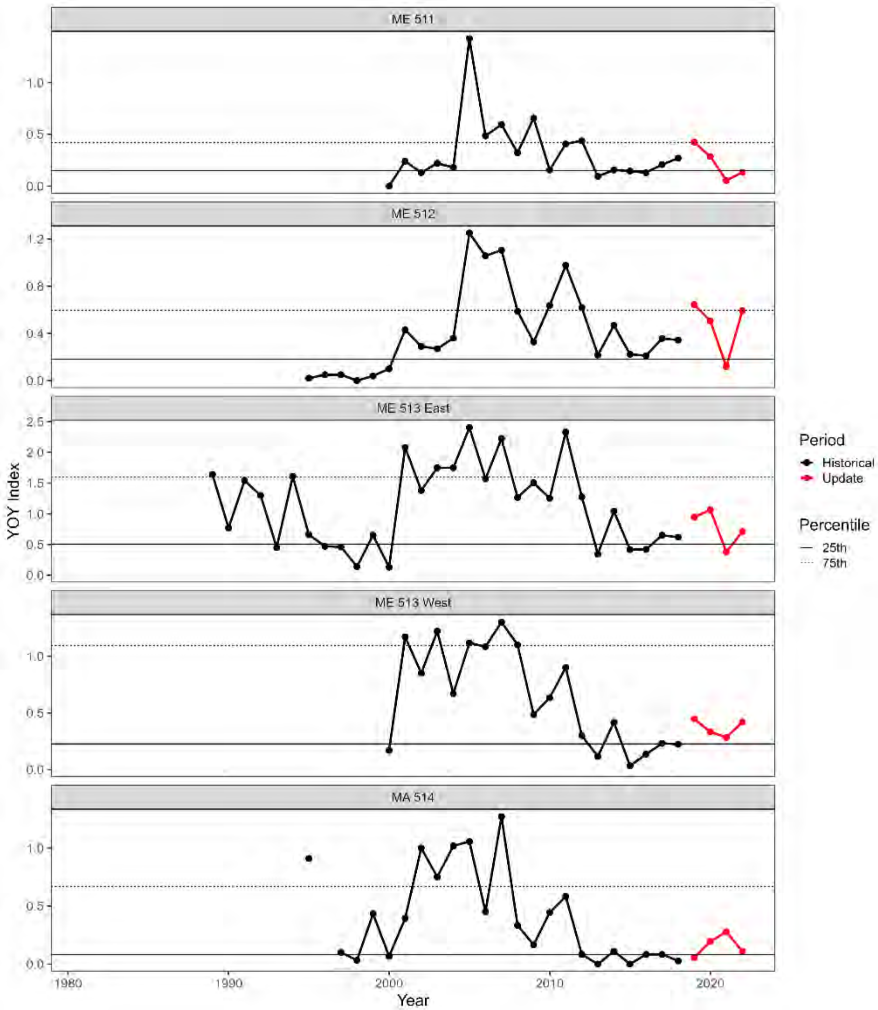


Table 2. GOM abundance indicators: trawl survey recruit abundance.

RECRUIT ABUNDANCE (SURVEY)						
Abundance of lobsters 71 - 80 mm CL (sexes combined)						
Survey	***NEFSC***		***ME/NH***		***MA 514***	
	Spring	***Fall***	***Spring***	***Fall***	***Spring***	***Fall***
1981	0.13	0.06			6.38	4.84
1982	0.29	0.42			2.74	3.85
1983	0.28	0.90			1.76	9.76
1984	0.20	0.31			2.15	6.13
1985	0.14	1.41			4.48	9.60
1986	0.27	1.29			3.01	3.80
1987	0.67	0.57			2.47	1.16
1988	0.67	1.21			2.52	4.12
1989	0.00	1.61			4.48	7.51
1990	0.27	1.76			6.11	15.36
1991	0.55	1.41			2.73	7.55
1992	0.50	1.37			4.31	8.95
1993	0.25	0.86			5.12	3.19
1994	0.15	2.75			7.59	13.77
1995	1.45	1.44			4.54	12.12
1996	0.76	4.59			3.09	12.10
1997	2.02	2.12			4.59	6.46
1998	1.59	2.16			4.50	7.47
1999	1.51	3.01			4.29	8.73
2000	4.64	3.01		24.09	4.24	8.87
2001	1.05	1.51	9.28	17.81	4.32	1.58
2002	1.08	1.91	22.00	22.41	3.43	5.00
2003	1.41	0.36	10.65	18.32	1.96	0.66
2004	0.84	2.26	7.55	12.29	2.46	1.30
2005	0.34	0.87	18.51	25.90	4.35	2.11
2006	2.17	1.27	18.07	18.30	6.09	5.30
2007	1.62	0.64	15.91	16.82	0.77	1.61
2008	0.99	2.41	17.88	31.61	2.54	6.12
2009	4.88	4.90	24.72	32.67	3.19	8.88
2010	2.98	4.53	17.66	37.35	2.22	9.39
2011	10.27	11.83	39.25	46.09	5.24	15.04
2012	11.25	6.74	36.55	37.12	3.03	11.30
2013	10.93	18.12	34.50	37.86	4.83	12.20
2014	11.66	21.54	50.79	41.95	3.35	7.06
2015	14.44	17.89	38.51	67.99	7.05	17.91
2016	13.25	22.54	50.83	60.07	13.61	17.44
2017	15.74		48.42	48.13	7.85	13.58
2018	14.15	15.87	42.77	55.84	5.25	25.69
2014-2018 mean	13.84	19.46	46.27	54.80	7.42	16.34
2019	16.69	7.62	46.37	50.85	10.69	14.59
2020				34.65		
2021	10.05	8.04	32.86	32.19	6.39	10.16
2022	11.82	8.29	22.78	24.86	8.61	6.27
2018-2022 mean	13.17	9.96	36.19	39.68	7.74	14.18
25th	0.30	1.21	17.72	20.36	2.73	4.30
median	1.07	1.76	23.36	32.67	4.30	7.53
75th	4.23	4.53	39.07	44.02	5.05	11.90

Figure 2. GOM abundance indicators: trawl survey recruit abundance.

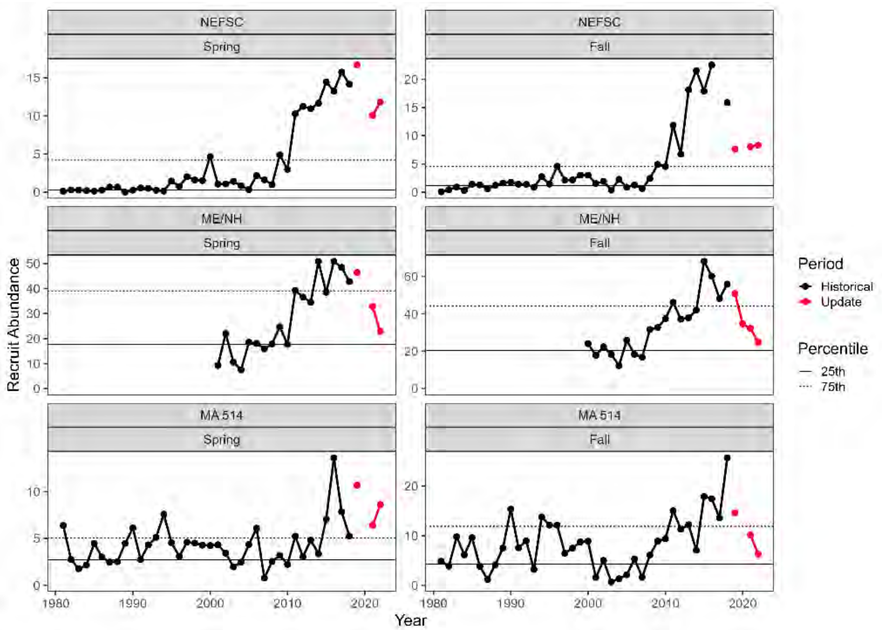


Table 3. GOM abundance indicators: trawl survey encounter rate.

SURVEY LOBSTER ENCOUNTER RATE						
Proportion of postive tows						
Survey	***NEFSC***		***ME/NH***		***MA 514***	
	Spring	***Fall***	***Spring***	***Fall***	***Spring***	***Fall***
1981	0.44	0.25			0.86	0.72
1982	0.34	0.18			0.50	0.70
1983	0.26	0.33			0.76	0.76
1984	0.28	0.36			0.76	0.76
1985	0.38	0.49			0.71	0.67
1986	0.33	0.47			0.68	0.83
1987	0.43	0.24			0.85	0.54
1988	0.31	0.30			0.76	0.58
1989	0.19	0.35			0.78	0.95
1990	0.41	0.32			0.86	0.95
1991	0.42	0.32			0.87	0.94
1992	0.40	0.24			0.93	0.77
1993	0.41	0.39			0.97	0.82
1994	0.45	0.40			1.00	0.93
1995	0.41	0.37			0.93	0.93
1996	0.54	0.54			0.91	0.95
1997	0.64	0.35			0.93	0.86
1998	0.52	0.40			0.76	0.69
1999	0.51	0.42			0.73	0.91
2000	0.63	0.42		0.94	0.93	0.98
2001	0.57	0.40	0.88	0.86	0.93	0.72
2002	0.75	0.53	0.94	0.95	0.91	0.73
2003	0.69	0.44	0.92	0.85	0.82	0.55
2004	0.87	0.31	0.89	0.86	0.84	0.56
2005	0.77	0.36	0.95	0.91	0.95	0.67
2006	0.72	0.60	0.93	0.93	0.91	0.88
2007	0.72	0.43	0.97	0.85	0.51	0.54
2008	0.84	0.49	0.92	0.86	0.83	0.75
2009	0.82	0.63	0.98	0.92	0.89	0.87
2010	0.85	0.75	0.98	0.96	0.87	0.98
2011	0.83	0.74	0.99	0.96	0.89	0.85
2012	0.86	0.78	0.98	0.98	0.91	0.95
2013	0.87	0.73	1.00	0.93	0.96	0.95
2014	0.90	0.71	1.00	0.99	0.79	0.96
2015	0.93	0.69	1.00	0.96	0.98	0.95
2016	0.94	0.75	1.00	0.96	0.96	0.97
2017	0.86		0.99	0.94	0.84	0.98
2018	0.86	0.71	0.98	0.96	0.84	0.90
2014-2018 mean	0.90	0.72	0.99	0.96	0.88	0.95
2019	0.83	0.71	0.99	0.95	0.85	0.92
2020				0.96		
2021	0.90	0.75	1.00	0.91	0.86	0.90
2022	0.79	0.76	0.98	0.90	0.78	0.85
2018-2022 mean	0.84	0.73	0.99	0.93	0.83	0.89

25th	0.41	0.35	0.93	0.89	0.78	0.72
median	0.60	0.42	0.98	0.94	0.87	0.86
75th	0.84	0.60	0.99	0.96	0.93	0.95

Figure 3. GOM abundance indicators: trawl survey encounter rate.

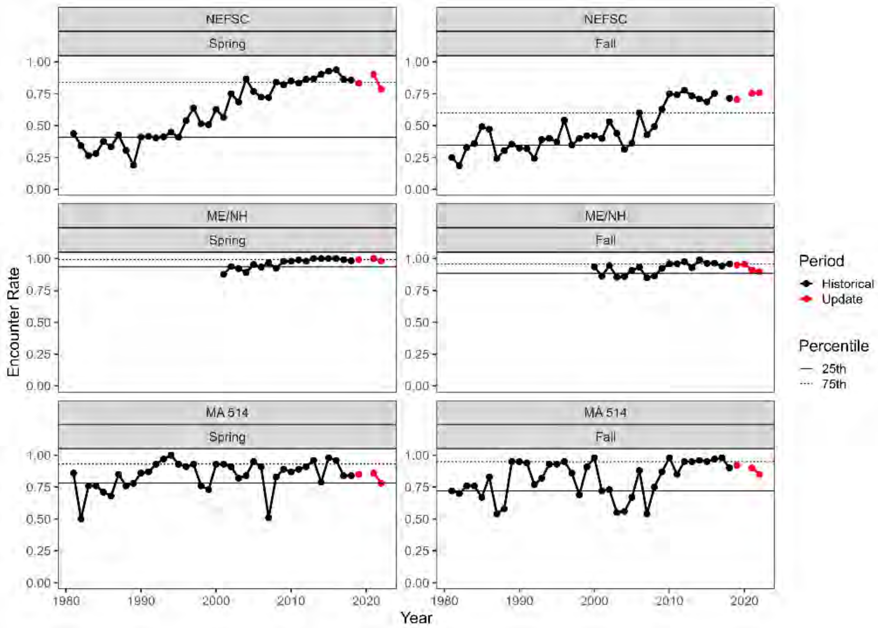


Table 4. GOM abundance indicators: ventless trap survey abundance.

VENTLESS TRAP ABUNDANCE								
Abundance of lobsters ≥ 53 mm CL								
Survey	***511***		***512***		***513***		***514***	
	Female	***Male***	***Female***	***Male***	***Female***	***Male***	***Female***	***Male***
1981								
1982								
1983								
1984								
1985								
1986								
1987								
1988								
1989								
1990								
1991								
1992								
1993								
1994								
1995								
1996								
1997								
1998								
1999								
2000								
2001								
2002								
2003								
2004								
2005								
2006	7.65	5.34	6.87	5.38	5.73	4.37	3.10	3.40
2007	5.06	3.91	3.95	3.83	5.82	4.35	1.85	1.84
2008	4.94	3.87	5.78	4.95	5.78	4.97	2.77	2.51
2009	3.60	2.65	6.31	5.35	6.89	5.53	2.72	2.66
2010	5.66	3.90	6.95	5.69	6.61	5.27	2.49	2.22
2011	8.70	6.52	11.10	8.48	7.32	5.60	3.47	2.60
2012	10.95	7.64	12.06	9.47	11.40	7.72	5.21	4.52
2013	11.14	7.95	11.87	8.64	9.36	6.49		
2014	10.38	6.63	11.92	8.04	7.74	4.96	3.15	2.35
2015	8.47	4.63	10.39	7.70	8.54	5.48	4.01	3.16
2016	14.59	9.15	14.34	10.75	10.78	7.56	4.79	3.56
2017	11.69	7.07	11.61	8.52	8.46	5.56	3.38	2.45
2018	15.10	9.43	11.26	8.23	9.57	6.37	3.47	2.43
2014-2018 mean	12.05	7.38	11.90	8.65	9.02	5.99	3.76	2.79
2019	12.91	8.31	8.22	5.94	8.68	5.25	2.85	1.93
2020	7.66	5.47	7.91	5.96	9.29	6.61	2.50	1.69
2021	7.34	5.44	5.88	5.18	8.27	5.95	1.77	1.37
2022	6.68	4.96	4.83	4.21	7.81	6.20	1.63	0.96
2018-2022 mean	9.94	6.72	7.62	5.91	8.72	6.07	2.44	1.68

25th	5.66	3.91	6.87	5.38	6.61	4.97	2.76	2.41
median	8.70	6.52	11.10	8.04	7.74	5.53	3.27	2.56
75th	11.14	7.64	11.87	8.52	9.36	6.37	3.61	3.22

Figure 4. GOM abundance indicators: ventless trap survey abundance.

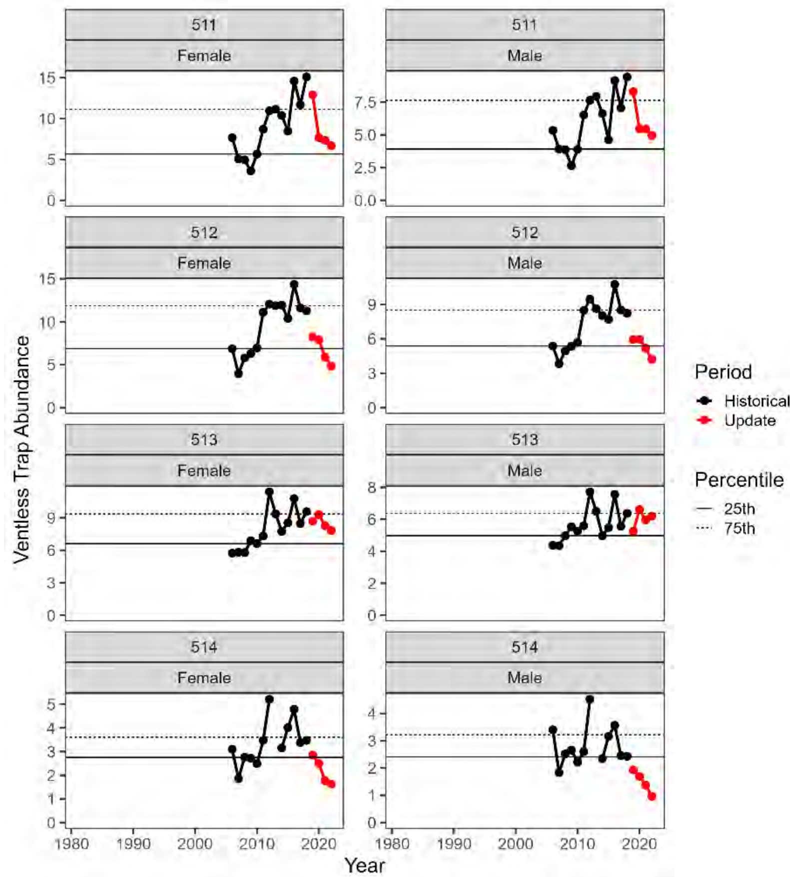


Table 5. GBK abundance indicators: trawl survey recruit abundance.

RECRUIT ABUNDANCE (SURVEY)		
Abundance of lobsters 71 - 80 mm CL (sexes combined)		
Survey	*NEFSC*	
	Spring	*Fall*
1981	0.08	0.28
1982	0.18	0.41
1983	0.16	0.33
1984	0.09	0.40
1985	0.19	0.26
1986	0.57	0.64
1987	0.43	0.54
1988	0.09	0.36
1989	0.04	0.23
1990	0.44	0.47
1991	0.08	0.34
1992	0.13	0.62
1993	0.50	0.22
1994	0.01	0.13
1995	0.03	0.14
1996	0.00	0.35
1997	0.06	0.90
1998	0.01	0.33
1999	0.07	0.29
2000	0.27	0.33
2001	0.47	0.45
2002	0.06	0.56
2003	0.29	0.16
2004	0.04	0.18
2005	0.09	0.13
2006	0.16	0.12
2007	0.03	0.23
2008	0.05	0.17
2009	0.30	0.33
2010	0.30	0.15
2011	0.09	0.35
2012	0.15	0.17
2013	0.14	0.24
2014	0.16	0.21
2015	0.06	0.44
2016	0.15	0.13
2017	0.35	
2018	0.04	0.22
2014-2018 mean	0.15	0.25
2019	0.16	0.13
2020		
2021	0.41	0.43
2022	0.42	0.62
2018-2022 mean	0.26	0.35

25th	0.06	0.18
median	0.11	0.29
75th	0.25	0.40

Figure 5. GBK abundance indicators: trawl survey recruit abundance.

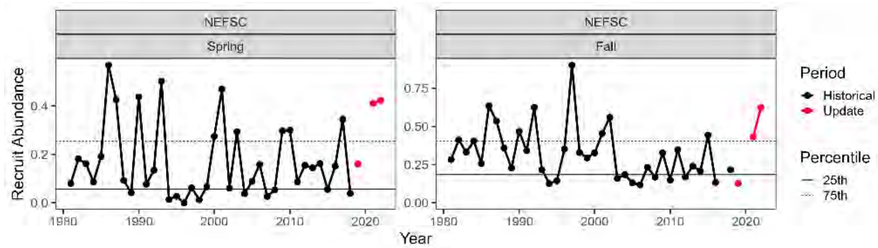


Table 6. GBK abundance indicators: trawl survey encounter rate.

SURVEY LOBSTER ENCOUNTER RATE		
Proportion of postive tows		
Survey	***NEFSC***	
	Spring	***Fall***
1981	0.23	0.52
1982	0.23	0.43
1983	0.18	0.38
1984	0.12	0.34
1985	0.19	0.35
1986	0.27	0.36
1987	0.18	0.35
1988	0.34	0.40
1989	0.14	0.38
1990	0.18	0.44
1991	0.19	0.45
1992	0.26	0.49
1993	0.22	0.36
1994	0.11	0.38
1995	0.14	0.42
1996	0.16	0.40
1997	0.10	0.48
1998	0.10	0.40
1999	0.16	0.58
2000	0.23	0.41
2001	0.23	0.49
2002	0.29	0.55
2003	0.27	0.44
2004	0.18	0.53
2005	0.16	0.58
2006	0.24	0.54
2007	0.26	0.46
2008	0.29	0.55
2009	0.34	0.54
2010	0.38	0.62
2011	0.30	0.69
2012	0.35	0.57
2013	0.33	0.65
2014	0.37	0.61
2015	0.27	0.59
2016	0.45	0.55
2017	0.40	
2018	0.29	0.59
2014-2018 mean	0.36	0.58
2019	0.36	0.57
2020		
2021	0.41	0.48
2022	0.34	0.64
2018-2022 mean	0.35	0.57

25th	0.18	0.40
median	0.23	0.48
75th	0.29	0.55

Figure 6. GBK abundance indicators: trawl survey encounter rate.

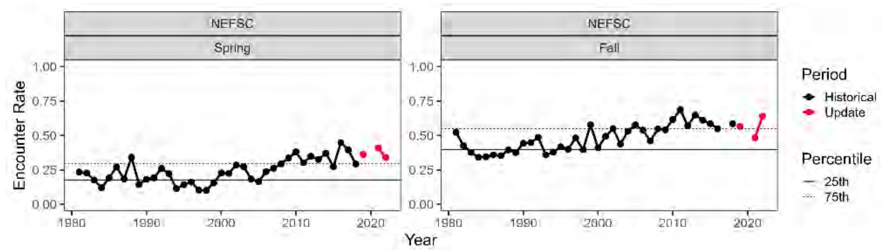


Table 7. SNE abundance indicators: YOY indices.

YOUNG-OF-YEAR INDICES			
Survey	***MA***	***RI***	***CT / ELIS Larvae***
1981			
1982			
1983			
1984			0.43
1985			0.53
1986			0.90
1987			0.78
1988			0.74
1989			0.74
1990		1.18	0.81
1991		1.51	0.55
1992		0.63	1.44
1993		0.51	1.19
1994		1.27	0.98
1995	0.17	0.34	1.46
1996	0.00	0.15	0.31
1997	0.08	0.98	0.21
1998	0.28	0.57	0.55
1999	0.06	1.03	2.83
2000	0.33	0.33	0.78
2001	0.11	0.75	0.32
2002	0.11	0.25	0.64
2003	0.00	0.73	0.25
2004	0.06	0.42	0.45
2005	0.17	0.54	0.49
2006	0.22	0.44	0.71
2007	0.17	0.36	0.37
2008	0.00	0.14	0.37
2009	0.06	0.06	0.19
2010	0.00	0.11	0.35
2011	0.00	0.00	0.26
2012	0.00	0.09	0.12
2013	0.17	0.19	0.16
2014	0.11	0.22	0.06
2015	0.00	0.17	0.19
2016	0.00	0.06	0.45
2017	0.00	0.03	0.10
2018	0.00	0.03	0.17
2014-2018 mean	0.02	0.10	0.19
2019	0.00	0.03	0.21
2020	0.00	0.14	0.10
2021	0.00	0.08	0.19
2022	0.00	0.03	0.25
2018-2022 mean	0.00	0.06	0.18

25th	0.00	0.14	0.26
median	0.06	0.34	0.45
75th	0.17	0.63	0.76

Figure 7. SNE abundance indicators: YOY indices.

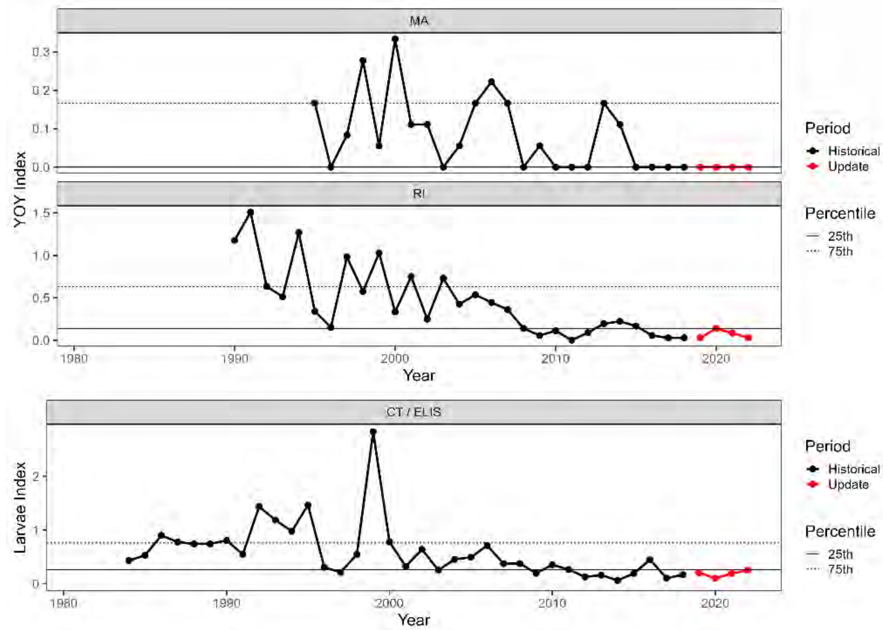


Table 8. SNE abundance indicators: trawl survey recruit abundance.

RECRUIT ABUNDANCE (SURVEY)								
Abundance of lobsters 71 - 80 mm CL (sexes combined)								
Survey	***NEFSC***		***MA***		***RI***		***CT***	
	Spring	***Fall***	***Spring***	***Fall***	***Spring***	***Fall***	***Spring***	***Fall***
1981	0.10	0.89	0.65	0.07	0.89	1.31		
1982	0.74	0.74	0.10	0.04	0.26	0.64		
1983	0.45	0.62	0.09	0.04	0.94	0.43		
1984	0.10	0.81	0.42	0.01	1.03	1.35	10.09	6.80
1985	1.99	1.01	0.34	0.09	0.28	0.97	3.08	3.93
1986	0.18	0.59	0.17	0.20	0.91	1.28	2.77	5.76
1987	1.04	0.45	0.26	0.17	0.79	3.14	2.93	6.86
1988	0.55	0.60	0.24	0.16	0.47	4.05	1.85	4.88
1989	0.09	1.65	0.14	0.43	0.90	3.26	4.86	5.28
1990	0.71	0.83	2.29	0.31	2.17	2.69	6.89	7.74
1991	0.31	0.51	1.18	0.87	4.77	3.10	10.83	10.32
1992	0.19	0.94	0.10	0.57	0.62	1.97	10.31	10.65
1993	0.59	0.42	0.25	0.52	7.81	8.29	7.78	15.18
1994	0.15	0.38	0.95	0.42	1.00	3.88	5.07	11.51
1995	0.01	0.61	1.14	0.03	1.33	4.50	12.13	11.20
1996	0.40	2.39	0.40	0.32	1.60	6.55	11.37	11.08
1997	1.64	1.60	1.45	0.12	2.58	6.10	15.42	24.99
1998	0.78	1.06	1.09	0.11	1.63	3.24	24.06	12.72
1999	2.43	0.66	0.75	0.19	1.71	2.07	24.57	12.96
2000	0.67	1.27	0.56	0.13	1.54	1.83	13.37	8.27
2001	0.39	0.45	0.18	0.03	2.97	2.17	10.77	7.41
2002	1.63	0.39	0.34	0.00	2.68	0.73	8.07	2.75
2003	0.34	0.33	0.07	0.00	0.29	0.93	3.52	4.08
2004	0.27	0.28	0.05	0.00	1.86	1.48	2.38	3.37
2005	0.11	0.24	0.08	0.00	1.07	2.53	2.26	1.54
2006	0.19	0.32	0.08	0.03	3.63	2.24	2.02	1.38
2007	0.19	0.35	0.08	0.00	0.68	2.68	2.65	1.12
2008	0.21	0.29	0.16	0.01	0.64	2.95	2.20	1.27
2009	0.15	0.35	0.16	0.05	1.14	1.36	1.20	1.33
2010	0.21	0.73	0.06	0.18	0.44	1.21	1.26	
2011	0.10	0.64	0.18	0.00	0.42	1.02	0.43	0.18
2012	0.11	0.99	0.07	0.21	0.30	0.18	0.44	0.08
2013	0.23	0.44	0.11	0.04	0.16	0.02	0.23	0.06
2014		0.67	0.04	0.00	0.02	0.14	0.15	0.05
2015	0.03	0.28	0.07	0.30	0.05	0.37	0.15	0.06
2016	0.83	0.69	0.05	0.14	0.57	0.25	0.16	0.00
2017	0.10		0.13	0.16	0.14	0.41	0.03	0.00
2018	0.08	0.38	0.02	0.01	0.18	0.68	0.00	0.01
2014-2018 mean	0.26	0.51	0.06	0.12	0.19	0.37	0.10	0.03
2019	0.06	0.32	0.01	0.02	0.52	0.50	0.03	0.00
2020					0.23	0.32		
2021	0.01	0.59	0.01	0.00	0.27	0.07	0.03	0.00
2022	0.09	0.19	0.00	0.00	0.09	0.16	0.00	0.01
2018-2022 mean	0.06	0.37	0.01	0.01	0.26	0.35	0.01	0.01

25th	0.11	0.38	0.08	0.02	0.42	0.78	1.23	1.16
median	0.23	0.61	0.17	0.10	0.91	1.65	2.93	4.48
75th	0.67	0.83	0.42	0.20	1.62	3.07	10.20	9.81

Figure 8. SNE abundance indicators: trawl survey recruit abundance.

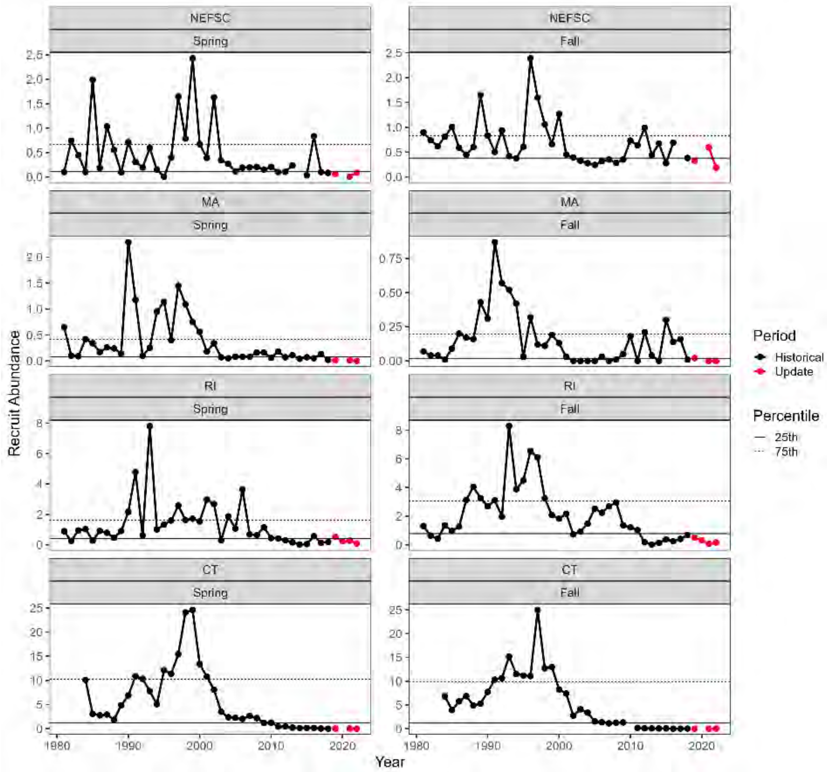


Table 9. SNE abundance indicators: trawl survey encounter rate.

SURVEY LOBSTER ENCOUNTER RATE								
Proportion of postive tows								
Survey	***NEFSC***		***MA***		***RI***		***CT***	
	Spring	***Fall***	***Spring***	***Fall***	***Spring***	***Fall***	***Spring***	***Fall***
1981	0.18	0.47	0.38	0.15	0.49	0.41		
1982	0.26	0.35	0.28	0.21	0.30	0.43		
1983	0.14	0.26	0.21	0.16	0.46	0.37		
1984	0.08	0.32	0.40	0.18	0.59	0.44	0.63	0.76
1985	0.21	0.34	0.51	0.22	0.31	0.50	0.57	0.69
1986	0.17	0.25	0.39	0.38	0.64	0.46	0.67	0.61
1987	0.13	0.23	0.28	0.18	0.35	0.47	0.63	0.76
1988	0.09	0.28	0.39	0.21	0.49	0.55	0.65	0.66
1989	0.13	0.40	0.50	0.33	0.52	0.57	0.75	0.63
1990	0.14	0.44	0.66	0.44	0.64	0.53	0.73	0.76
1991	0.14	0.33	0.41	0.39	0.77	0.69	0.81	0.77
1992	0.22	0.34	0.51	0.23	0.40	0.57	0.77	0.68
1993	0.12	0.27	0.54	0.26	0.50	0.71	0.73	0.75
1994	0.09	0.25	0.51	0.20	0.58	0.57	0.73	0.74
1995	0.05	0.35	0.44	0.12	0.55	0.67	0.77	0.68
1996	0.10	0.39	0.30	0.16	0.79	0.76	0.66	0.78
1997	0.25	0.28	0.45	0.21	0.75	0.71	0.71	0.81
1998	0.12	0.34	0.54	0.13	0.59	0.55	0.83	0.71
1999	0.22	0.28	0.41	0.21	0.76	0.59	0.78	0.79
2000	0.13	0.31	0.45	0.15	0.68	0.63	0.81	0.73
2001	0.21	0.25	0.28	0.18	0.65	0.60	0.77	0.58
2002	0.19	0.24	0.28	0.03	0.61	0.45	0.73	0.59
2003	0.11	0.26	0.14	0.03	0.51	0.40	0.71	0.64
2004	0.10	0.19	0.28	0.03	0.54	0.50	0.61	0.66
2005	0.08	0.19	0.34	0.15	0.49	0.45	0.63	0.54
2006	0.14	0.23	0.42	0.03	0.79	0.62	0.61	0.51
2007	0.13	0.21	0.34	0.10	0.44	0.54	0.70	0.53
2008	0.10	0.22	0.32	0.10	0.55	0.52	0.63	0.65
2009	0.17	0.32	0.50	0.05	0.57	0.40	0.49	0.55
2010	0.12	0.33	0.22	0.24	0.47	0.45	0.54	
2011	0.13	0.35	0.17	0.05	0.30	0.23	0.46	0.28
2012	0.13	0.34	0.17	0.15	0.27	0.16	0.43	0.20
2013	0.10	0.28	0.18	0.08	0.20	0.09	0.28	0.15
2014		0.26	0.13	0.08	0.07	0.23	0.26	0.10
2015	0.06	0.27	0.10	0.05	0.12	0.16	0.27	0.10
2016	0.15	0.25	0.08	0.11	0.30	0.14	0.25	0.03
2017	0.08		0.07	0.16	0.16	0.23	0.08	0.03
2018	0.08	0.29	0.11	0.06	0.09	0.18	0.09	0.01
2014-2018 mean	0.09	0.27	0.10	0.09	0.15	0.19	0.19	0.05
2019	0.05	0.26	0.05	0.11	0.16	0.11	0.09	0.00
2020					0.16	0.16		
2021	0.04	0.18	0.07	0.00	0.20	0.12	0.06	0.03
2022	0.08	0.17	0.00	0.00	0.14	0.09	0.01	0.04
2018-2022 mean	0.06	0.23	0.06	0.04	0.15	0.13	0.06	0.02

25th	0.10	0.25	0.21	0.09	0.32	0.40	0.52	0.52
median	0.13	0.28	0.34	0.16	0.51	0.49	0.65	0.64
75th	0.17	0.34	0.45	0.21	0.60	0.57	0.73	0.74

Figure 9. SNE abundance indicators: trawl survey encounter rate.

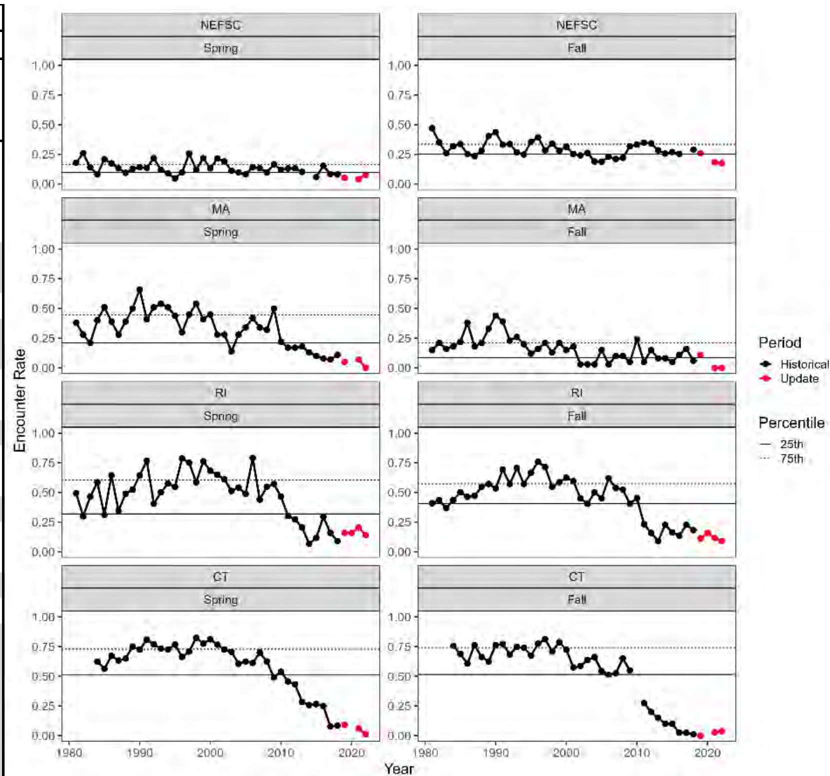
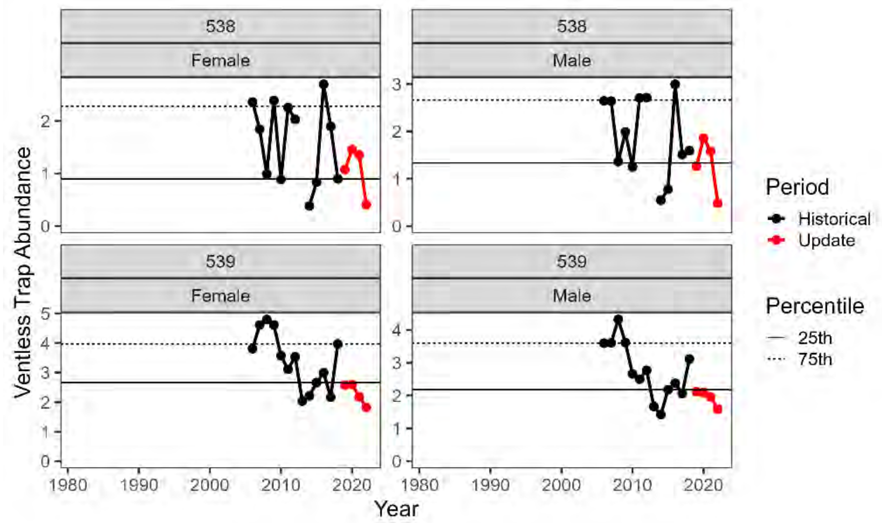


Table 10. SNE abundance indicators: ventless trap survey abundance.

VENTLESS TRAP ABUNDANCE				
Abundance of lobsters ≥ 53 mm CL				
Survey	*538*		*539*	
	Female	*Male*	*Female*	*Male*
1981				
1982				
1983				
1984				
1985				
1986				
1987				
1988				
1989				
1990				
1991				
1992				
1993				
1994				
1995				
1996				
1997				
1998				
1999				
2000				
2001				
2002				
2003				
2004				
2005				
2006	2.36	2.64	3.81	3.60
2007	1.84	2.64	4.61	3.61
2008	0.99	1.36	4.80	4.32
2009	2.39	1.99	4.61	3.62
2010	0.89	1.25	3.57	2.67
2011	2.25	2.71	3.11	2.50
2012	2.03	2.71	3.53	2.77
2013			2.03	1.67
2014	0.38	0.55	2.22	1.42
2015	0.84	0.77	2.66	2.18
2016	2.70	3.00	2.99	2.38
2017	1.90	1.51	2.17	2.06
2018	0.90	1.59	3.97	3.12
2014-2018 mean	1.34	1.48	2.80	2.23
2019	1.08	1.26	2.57	2.12
2020	1.46	1.86	2.60	2.10
2021	1.36	1.58	2.19	1.95
2022	0.41	0.48	1.82	1.59
2018-2022 mean	1.04	1.36	2.63	2.18
25th	0.90	1.33	2.66	2.18
median	1.87	1.79	3.53	2.67
75th	2.28	2.66	3.97	3.60

Figure 10. SNE abundance indicators: ventless trap survey abundance.



Appendix: Data Update Data Changes

Addendum XXVII Trigger Index

During the update of the Addendum XXVII trigger index in 2023 (terminal data year of 2022), an error was discovered in the calculation of the spring trawl index three-year average. Neither the Massachusetts or Maine/New Hampshire trawl surveys sampled in spring 2020 resulting in a missing data point. The three-year average spring index for 2021 was intended to be an average of 2021 and 2019 due to the missing 2020 data point, but was mistakenly calculated as the average of 2021, 2019, and 2018. This error affected the 2021 trigger index value published in Addendum XXVII. The 2021 value in the addendum for the spring trawl index was 0.878 and the value for the combined trigger index was 0.765. These values were corrected to 0.865 (for the spring trawl index) and 0.766 (for the combined trigger index) during the 2023 update.

Maine

During the 2023 Data Update (terminal data year of 2022), a few errors were found in the upload process where data was not uploaded correctly and treated in a consistent manner as the assessment. For the Fall 2021 ME/NH Trawl Survey, the sex of sampled lobsters did not upload correctly, leading to 7 tows being excluded in error. These data have now been corrected and included. During the 2020 assessment, the stock assessment team, in consultation with survey staff, determined that a very large outlier tow in the Spring 2014 ME/NH Trawl Survey should be excluded from the assessment. However, this outlier tow was not excluded in the 2022 Data Update. It is excluded for the 2023 Data Update, consistent with the stock assessment. For the Maine settlement survey, data for 2013 was not uploaded completely and this has now been corrected.

Massachusetts

Two changes following the stock assessment have impacted the SNE VTS Statistical Area 538 (MA) abundance indicators. Following the 2021 Data Update (terminal data year of 2020), there was a reduction in the spatial coverage of the survey due to reduced participation. This change necessitates dropping out data collected during earlier years from areas no longer sampled to calculate an index from a consistent survey footprint, resulting in changes to the indices. Note that the updated index increased slightly in scale (the reduced footprint excludes most of the interior of Buzzards Bay), but the pattern over time is generally consistent with the previous index. Additionally, following the 2022 Data Update (terminal year of 2021), an error was discovered in the data pull that did not filter the frequency of trawl hauls per month in historical data to match the reduced sampling frequency in data since the footprint reduction (reduced to 1 haul/month). This error was corrected in the data pull for the 2023 Data Update.

Rhode Island

Some changes to the SNE VTS Statistical Area 539 (RI) data occurred between the 2021 Data Update (terminal data year of 2020) and 2022 Data Update (terminal data year of 2021). Upon further QA/QC in site or sample location, strata classification for select stations over time were rectified. Data as such were updated to reflect these changes during the 2022 Data Update.

Atlantic States Marine Fisheries Commission

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MEMORANDUM

TO: American Lobster Management Board

FROM: American Lobster Technical Committee

DATE: October 2, 2023

SUBJECT: Terms of Reference and Timeline for the 2025 American Lobster Benchmark Assessment

The next American lobster benchmark stock assessment is scheduled to be completed in 2025. The American Lobster Technical Committee (TC) has recommended the Board consider the following terms of reference and timeline for the benchmark assessment and peer review panel:

Terms of Reference for the 2025 American Lobster Benchmark Stock Assessment

1. Estimate catch and catch-at-length from all appropriate fishery-dependent data sources including commercial and potential discard data.
    a. Provide descriptions of each data source (e.g., geographic location, sampling methodology, variability, outliers). Discuss data strengths and weaknesses (e.g., temporal and spatial scale, gear selectivities, sample size, confidence/uncertainty) and their potential effects on the assessment.
    b. Justify inclusion or elimination of each data source.

2. Present the abundance data being considered and/or used in the assessment (e.g., regional indices of abundance, length data, etc.).
    a. Characterize uncertainty in these sources of data.
    b. Justify inclusion or elimination of each data source.
    c. Describe calculation or standardization of abundance indices.

3. Evaluate new information on life history such as growth rates, size at maturation, natural mortality rate, and migrations.
    a. Consider any new information on growth for potential to update the growth transition matrices.

4. Identify, describe, and, if possible, quantify environmental/climatic drivers.

5. Use length-based model(s) to estimate population parameters (e.g., effective exploitation rate, abundance) for each stock unit and analyze model performance.
    a. Evaluate stability of model(s). Perform and present model diagnostics.
    b. Perform sensitivity analyses to examine implications of important model assumptions, including but not limited to growth and natural mortality.
    c. Explain model strengths and limitations.
    d. Justify choice of CVs, effective sample sizes, or likelihood weighting schemes.

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    e. State assumptions made and explain the likely effects of assumption violations on synthesis of input data and model outputs.
    f. Conduct projections assuming uncertainty in current and future conditions for all stocks. Compare projections retrospectively with model estimates.

6. Update simple, empirical, indicator-based trend analyses of abundance, exploitation, fishery performance, and environmental stress for stock or sub-stock areas. Modify or develop new indicators, if warranted.

7. Evaluate the current regime-based exploitation and abundance reference points (i.e., targets and thresholds). Recommend modifications to these reference points, if necessary.

8. Characterize uncertainty of model estimates, reference points, and stock status.

9. Perform retrospective analyses, assess magnitude and direction of retrospective patterns detected, and discuss implications of any observed retrospective pattern for uncertainty in population parameters and reference points.

10. Report stock status as related to overfishing and depleted reference points (both current and any alternative recommended reference points). Include simple description of the historical and current condition of the stock in layman's terms.

11. Address and incorporate to the extent possible recommendations from the 2020 Benchmark Peer Review.

12. 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.

13. Recommend timing of next benchmark assessment and intermediate updates, if necessary relative to biology and current management of the species.

Terms of Reference for the Peer Review of the 2025 American Lobster Benchmark Stock Assessment

1. Evaluate thoroughness of data collection and presentation and treatment of fishery-dependent and fishery-independent data in the assessment, including the following but not limited to:
    a. Consideration of data strengths and weaknesses,
    b. Justification for inclusion or elimination of available data sources,
    c. Calculation of catch-at-length matrix,
    d. Calculation and/or standardization of abundance indices.

2. Evaluate the methods and models used to estimate population parameters and reference points for each stock unit, including but not limited to:
    a. Use of available life history information to parameterize the model(s)
    b. Model parameterization and specification (e.g., choice of CVs, effective sample sizes, likelihood weighting schemes, etc.).
    c. The choice and justification of the preferred model. Was the most appropriate model used given available data and life history of the species?

3. Evaluate the identification and characterization of environmental/climatic drivers.

4. Evaluate the estimates of stock abundance and exploitation from the assessment for use in management. If necessary, specify alternative estimation methods.

5. Evaluate the methods used to characterize uncertainty in estimated parameters. Were the implications of uncertainty in technical conclusions clearly stated?

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

7. Evaluate the preparation and interpretation of indicator-based analyses for stocks and sub-stock areas.

8. Evaluate the current and recommended reference points and the methods used to calculate/estimate them. Recommend stock status determination from the assessment or specify alternative methods.

9. Review the research, data collection, and assessment methodology recommendations provided by the Technical Committee 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.

10. Review the recommended timing of the next benchmark assessment relative to the life history and current management of the species.

11. Prepare a Peer Review Panel TOR and Advisory Report summarizing the Panel's evaluation of the stock assessment and addressing each Peer Review Term of Reference. Develop a list of tasks to be completed following the workshop. Complete and submit the Report within 4 weeks of workshop conclusion.

Timeline for the 2025 American Lobster Benchmark Stock Assessment

- Data request: November 1, 2023
- Data deadline (data through 2022 with 2023 data to be added later in 2024): January 8, 2024
- Data Workshop: February 2024
- Assessment Workshop 1 (review continuity models through 2022): June 2024
- Assessment Workshop 2 (finalize model results/stock status determination): October 2024
- Assessment report draft finalized by Stock Assessment Subcommittee: January 2025
- Assessment reviewed by TC: February 2025
- Peer Review Workshop: May 2025
- Present Assessment and Peer Review Reports to the Board: August 2025

Atlantic States Marine Fisheries Commission

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MEMORANDUM

TO: American Lobster Management Board

FROM: American Lobster Technical Committee

DATE: April 16, 2021

SUBJECT: Lobster Management Strategy Evaluation Options

The Atlantic States Marine Fisheries Commission's Lobster Technical Committee (TC) was tasked by the American Lobster Management Board (Board) at the Commission's 2021 Winter Meeting to develop a set of prioritized options, timelines, and draft budgets to assist the Board in considering if management strategy evaluation (MSE) could be of use for management of the lobster fisheries. The TC met via webinar two times following the Winter Meeting to develop and prioritize these options. Options are outlined at the end of the memorandum, and include anticipated personnel needs, major budget line items, and timelines with milestones that would incur a substantial cost. However, the TC indicated that due to the highly interdisciplinary nature of MSE, additional perspectives are needed to provide a comprehensive work plan. Therefore, the TC has provided some recommendations for next steps for MSE development in addition to a recommended option to pursue. In addition to the line item cost estimates for each option, it is important to keep in mind that these costs do not include time and, consequently, indirect costs of several participants' time being allocated to participating in the MSE process (e.g., TC members); workloads would have to be prioritized and modified to accommodate the MSE workload. Competing workloads include the next lobster stock assessment (tentatively scheduled for 2025) and a potential Jonah crab stock assessment (tentatively scheduled for 2023), at a minimum. The details of the options provided at the end of the memorandum are considered preliminary and may change dependent on management goals and objectives (e.g., need to include anthropologists to address human dimensions objectives).

TC Recommendations on MSE Focus

The TC recommends the option for a two-phase MSE of the Gulf of Maine/Georges Bank (GOM/GBK) stock. The first phase of this option would provide an intermediate MSE at a coarser spatial resolution (i.e., stock level) that can be used to support a management framework in a relatively short timeframe, while also allowing time to build knowledge and tools to develop a subsequent, spatially-explicit MSE in phase two. This phased approach provides short term management guidance, while concurrently building the framework to expand to a spatially explicit approach in phase two. The extended timeframe may also allow several large-scale changes on the horizon for the lobster fishery to develop that could impact the lobster fishery and management goals, and thus better guide the cost and focus of incorporating spatial considerations explicitly into the MSE.

The TC believes MSE has potential for supporting a management framework for the Southern New England (SNE) stock, but believes a SNE-focused MSE is a lower priority option for several reasons. First, the scale of the fisheries in terms of fleet size and landings make the GOM/GBK stock a higher priority. Second, MSEs are generally focused on proactive management strategies for the future of the fishery, such as strategies intended to promote stock resilience, as opposed to reactive management strategies responding to stock conditions estimated in past stock assessments; the TC believes this further skews

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cost-benefit considerations of MSE in favor of the GOM/GBK stock. Third, the TC anticipates unique challenges that would require more complex tools to provide a successful SNE MSE. These challenges include the dominant mixed-crustacean nature of the fishery, and the degree and rate at which the lobster population and fishery have changed in response to climate change. These factors require modeling aspects of both Jonah crab and lobster population dynamics and distributions, as well as spatial dynamics of the fishery in any MSE option. There is also a high likelihood for an MSE to require customized model development and data collection by stock (e.g., socio-economic indicators), making MSE focused on one stock at a time most feasible.

TC Recommendations on Next Steps

The TC recommends two next steps for development of an MSE. First, a formal process is recommended to develop management goals and objectives for the future of the lobster fisheries. A good example is the process used by the Ecosystems Management Objectives Workshop conducted by the Commission to guide development of ecological reference points for Atlantic menhaden. Objectives developed from such a process would be used to further develop an MSE work plan for lobster. The second recommendation is to form a steering committee for additional scoping and development of a comprehensive work plan with a detailed timeline, including: outreach components that are not anticipated to incur a substantial cost but are imperative to the success of an MSE (e.g., outreach at regularly scheduled industry association meetings), identification of funding sources for the MSE costs, and identification of personnel. Representation recommended for the steering committee includes Board members, TC members, Commission staff, members of the Commission’s Committee on Economics and Social Sciences, industry stakeholders (preferably those with past experience in MSE), and members of the Commission’s Assessment and Science Committee or Management and Science Committee with past experience in MSE. To be effective, the number of people in the steering committee should be limited to approximately a dozen members.

The TC discussed two ongoing developments that will potentially streamline the development of a formal MSE approximately a year from now. First, University of Maine researchers have submitted a proposal to the current round of the Sea Grant’s American Lobster Research Program funding; while funding is uncertain, the project is to evaluate population dynamics simulations that will incorporate environmental effects into the biological modeling framework likely to be used in a lobster MSE. Second, work towards the conceptualization of an economics model and economic data gathering is being funded by NOAA Fisheries; this will support development of an economic model within the MSE modeling framework. These developments support the TC recommendation for the formation of a steering committee, with a start date for the MSE to be determined pending the results of the steering committee’s findings.

GOM/GBK MSE Option (high priority)

Phase One - Stockwide GOM/GBK MSE

Purpose: Evaluate performance of management strategies at the stock level for the GOM/GBK stock in response to changes in recruitment with biological, fishery, and other socio-economic performance metrics.

Timeline: Three years. One modeler workshop in the first year and one modeler and one stakeholder workshop in years two and three.

Personnel and responsibilities:

- ASMFC Lobster TC – Stakeholder recruitment and engagement, data gathering, guidance on technical aspects of the MSE, report writing, and training for using the MSE tools in future updates
- ASMFC Staff – Project management, data gathering, workshop coordination, and report writing/publishing
- ASMFC Lobster Board Members – Define management goals and provide guidance on the direction of the MSE based on established goals, participate in stakeholder input gathering (webinars and workshops)
- Stakeholders – Identify desired objectives and outcomes of an MSE and provide guidance on the direction of the MSE, participate in stakeholder input gathering (surveys, webinars, and workshops)
- Biological modeler – Couple existing assessment model and operating model in a closed-loop model (six months to program, six months to modify based on workshop feedback and to provide training to TC members)
- Economics modeler – Develop an economics model guided by NOAA Fisheries' economic model conceptualization and data gathering work and couple with the assessment model and operating model in a closed-loop model.
- Professional facilitator - Facilitate stakeholder webinars and workshops, assist with stakeholder input survey development and analysis

Costs:

- Facilitator - $25,000
- Travel - $37,500 for two in-person stakeholder workshops (30 people), $22,500 for three in-person modeler workshops (12 people)
- Biological model development - $85,000 (one year postdoc with ASMFC indirect cost cap)
- Economic model development - $115,000 (one year full time or two six month full time contractors)
- Total - $285,000

Phase Two - Spatially-Explicit GOM/GBK MSE

Purpose: Evaluate performance of spatially-directed management strategies for the GOM/GBK stock triggered by external forces (e.g., whale interactions, wind farm development and operation, climate change).

Costs: Estimates to be developed during phase one.

<u>Spatially-Explicit SNE MSE Option (low priority)</u>

Purpose: Evaluate performance of spatially-directed management strategies for the SNE stock in response to changes in recruitment and diversification of the fishery (targeting lobster and Jonah crab) with biological, fishery, and other socio-economic performance metrics.

Timeline: Five years. One modeler workshop in years one through five. One stakeholder workshop in years two, four, and five.

Personnel and responsibilities:

- ASMFC Lobster TC – Stakeholder recruitment and engagement, data gathering, guidance on technical aspects of the MSE, report writing, and training for using the MSE tools in future updates
- ASMFC Staff – Project management, data gathering, workshop coordination, and report writing/publishing
- ASMFC Lobster Board Members – Define management goals and provide guidance on the direction of the MSE based on those pre-defined goals, participate in stakeholder input gathering (webinars and workshops)
- Stakeholders – Identify desired objectives and outcomes of an MSE and provide guidance on the direction of the MSE, participate in stakeholder input gathering (surveys, webinars, and workshops)
- Biological modeler – Conceptualize modeling of the spatial dynamics necessary to address stakeholder objectives by integrating lobster population distribution models along with Jonah crab population distribution and the resulting fleet dynamics. Identify biological and fleet spatial dynamics and resolution of each that can and cannot be modeled with available data to guide configuration of operating and assessment model. Couple assessment model and operating model in a closed-loop model (eighteen months to program, eighteen months to modify based on workshop feedback and provide training to TC members).
- Economics modeler – Conceptualize modeling of the economic processes driven by lobster landings, and interactions between lobster and Jonah crab effort and landings. Identify processes that can and cannot be modeled with available data to guide configuration of model. Couple economics model with the assessment model and operating model in a closed-loop model.
- Professional facilitator – Facilitate stakeholder webinars and workshops, assist with stakeholder input survey development and analysis
- ***Potentially others dependent on management and stakeholder objectives (e.g., reduce whale interactions would require a whale biologist and protected resource personnel)***

Costs:

- Facilitator - $42,000
- Travel - $56,250 for three in-person stakeholder workshops (30 people), $46,875 for five in-person modeler workshops (15 people)
- Spatially-explicit closed-loop model development: $255,000 (three year postdoc with ASMFC indirect cost cap)
- Economic model development: $345,000 (three year full time or two one and half year full time contractors)
- Total - $745,125 (minimum with potential for additional costs dependent on stakeholder objectives)

ATLANTIC STATES MARINE FISHERIES COMMISSION

REVIEW OF THE INTERSTATE FISHERY MANAGEMENT PLAN

FOR AMERICAN LOBSTER
(*Homarus americanus*)

2022 FISHING YEAR

Prepared by the Plan Review Team

October 2023

Sustainable and Cooperative Management of Atlantic Coastal Fisheries

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1.0 Status of the Fishery Management Plan

Year of ASMFC Plan's Adoption:	Amendment 3 (1997)
Plan Addenda:	
Addendum II (2001)	Addendum XV (2009)
Addendum III (2002)	Addendum XVI (2010)
Addendum IV (2003)	Addendum XVII (2012)
Addendum V (2004)	Addendum XVIII (2012)
Addendum VI (2005)	Addendum XIX (2013)
Addendum VII (2005)	Addendum XX (2013)
Addendum VIII (2006)	Addendum XXI (2013)
Addendum IX (2006)	Addendum XXII (2013)
Addendum X (2007)	Addendum XXIII (2014)
Addendum XI (2007)	Addendum XXIV (2015)
Addendum XII (2008)	Addendum XXVI (2018)
Addendum XIII (2008)	Addendum XXIX (2022)
Addendum XIV (2009)	Addendum XXVII (2023)
Management Unit:	Maine through North Carolina
States with a Declared Interest:	Maine through Virginia (Excluding Pennsylvania and DC)
Active Committees:	American Lobster Management Board, Technical Committee, Lobster Conservation Management Teams, Plan Development Team, Plan Review Team, Advisory Panel, Electronic Reporting Subcommittee, Electronic Tracking Subcommittee, Stock Assessment Subcommittee

2.0 Status of the Fishery

2.1 Commercial Fishery

The lobster fishery has seen incredible expansion in landings over the last 40 years. Between 1950 and 1975, landings were fairly stable around 30 million pounds; however, from 1976 to 2008 the average coastwide landings tripled, exceeding 98 million pounds in 2006. Landings continued to increase until reaching a high of 159 million pounds in 2016 (Table 1). In 2022, coastwide commercial landings were approximately 121 million pounds, a 10% decrease from 2021 landings of 135 million pounds. The largest contributors to the 2022 fishery were Maine and Massachusetts with 81% and 13% of landings, respectively. The ex-vessel value for all lobster landings in 2022 was approximately $517.6 million, which is a 41% decrease from the 2021 record high value of $875 million.

Historically, Lobster Conservation Management Area (LCMA) 1 has had the highest landings, and accounted for 80% of total harvest between 1981 and 2012. This is followed by LCMA 3 which accounted for 9% of total landings during the same time period. In general, landings have increased in LCMA 1 and have decreased in LCMAs 2, 4, and 6. According to state compliance reports, in 2022, approximately 92% of the total landings came from LCMA 1, while the remaining 8% were contributed by the other LCMAs. A map of the LCMAs is found in Figure 1.

Landings trends between the two biological stocks have also changed, as a greater percentage of lobster are harvested from the Gulf of Maine/Georges Bank (GOM/GBK) stock. In 1997, 26.3% of coastwide landings came from the Southern New England (SNE) stock. However, as the southern stock declined and abundance in the Gulf of Maine increased, proportional harvest has significantly changed. In 2000, only 15.6% of landings came from the SNE stock and by 2006, this declined to 7%. In 2022, approximately 1.5% of coastwide landings came from the SNE stock.

2.2 Recreational Fishery

Lobster is also taken recreationally with pots, and in some states, by hand while SCUBA diving. While not all states collect recreational harvest data, some do report the number of pounds landed recreationally and/or the number of recreational permits issued. Recreational landings for Massachusetts are only available through 2021, and have averaged 1.1% of total Massachusetts landings over the most recent five years of data. In 2022, New Hampshire reported 6,301 pounds of lobster harvested recreationally and New York reported 1,333 pounds. Maine, Rhode Island, and Connecticut do not collect information on the number of pounds recreationally harvested. For 2022, Rhode Island issued 544 lobster licenses, and 255 lobster licenses were sold in Connecticut in 2022.

3.0 Status of the Stock

The recent 2020 American Lobster Benchmark Stock Assessment presents contrasting results for the two American lobster stock units, with record high abundance and recruitment in the Gulf of Maine and Georges Bank stock (GOM/GBK) and record low abundance and recruitment in the Southern New England stock (SNE) in recent years.

The assessment found that abundance estimates for the GOM/GBK stock show an increasing trend beginning in the late 1980s. After 2008, the rate of increase accelerated to a record high abundance level in 2018, the terminal year of the assessment. The GOM/GBK stock shifted from a low abundance regime during the early 1980s through 1995 to a moderate abundance regime during 1996-2008, and shifted once again to a high abundance regime during 2009-2018 (Figure 2). Current spawning stock abundance and recruitment and are near record highs. Exploitation (commercial landings relative to stock abundance) declined in the late 1980s and has remained relatively stable since.

The GOM/GBK stock is in favorable condition based on the new recommended reference points adopted by the Board (Table 2). The average abundance from 2016-2018 was 256 million lobster, which is greater than the fishery/industry target of 212 million lobster. The average exploitation from 2016-2018 was 0.459, below the exploitation target of 0.461. Therefore, the GOM/GBK lobster stock is not depleted and overfishing is not occurring.

In contrast to GOM/GBK, model results for SNE show a completely different picture of stock health. Abundance estimates in SNE have declined since the late 1990s to record low levels. Model estimates of recruitment and spawning stock biomass have also declined to record low levels. Analysis of these estimates indicates a declining trend in stock productivity, indicating reproductive rates are insufficient to sustain a stable population at current exploitation rates. Exploitation of the SNE stock was high and stable through 2002, declined sharply in 2003, and has remained lower and stable since.

Based on the new abundance threshold reference point, the SNE stock is significantly depleted. The average abundance from 2016-2018 was 7 million lobster, well below the threshold of 20 million lobster (Table 2, Figure 3). However, according to the exploitation reference points the SNE stock is not experiencing overfishing. The average exploitation from 2016-2018 was 0.274, falling between the exploitation threshold of 0.290 and the exploitation target of 0.257.

The assessment and peer review panel recommended significant management action be taken to provide the best chance of stabilizing or improving abundance and reproductive capacity of the SNE stock.

4.0 Status of Management Measures

4.1 Implemented Regulations

Amendment 3 established regulations which require coastwide and area specific measures applicable to commercial fishing (Table 3). The coastwide requirements from Amendment 3 are summarized below; additional requirements were established through subsequent Addenda.

Coastwide Requirements and Prohibited Actions

- Prohibition on possession of berried or scrubbed lobsters
- Prohibition on possession of lobster meats, detached tails, claws, or other parts of lobsters by fishermen
- Prohibition on spearing lobsters
- Prohibition on possession of v-notched female lobsters
- Requirement for biodegradable "ghost" panel for traps
- Minimum gauge size of 3-1/4"
- Limits on landings by fishermen using gear or methods other than traps to 100 lobsters per day or 500 lobsters per trip for trips 5 days or longer
- Requirements for permits and licensing
- All lobster traps must contain at least one escape vent with a minimum size of 1-15/16" by 5-3/4"
- Maximum trap size of 22,950 cubic inches in all areas except area 3, where traps may not exceed a volume of 30,100 cubic inches.

<u>Amendment 3 to the Interstate Fishery Management Plan for American Lobster (December 1997)</u>

American lobster is managed under Amendment 3 to the Interstate FMP for American Lobster. Amendment 3 establishes seven lobster management areas. These areas include the: Inshore Gulf of Maine (LCMA 1), Inshore Southern New England (LCMA 2), Offshore Waters (LCMA 3), Inshore Northern Mid-Atlantic (LCMA 4), Inshore Southern Mid-Atlantic (LCMA 5), New York and Connecticut State Waters (LCMA 6), and Outer Cape Cod (OCC). Lobster Conservation Management Teams (LCMTs) comprised of industry representatives were formed for each management area. The LCMTs are charged with advising the Lobster Board and recommending changes to the management plan within their areas.

Amendment 3 also provides the flexibility to respond to current conditions of the resource and fishery by making changes to the management program through addenda. The commercial fishery is primarily controlled through minimum/maximum size limits, trap limits, and v-notching of egg-bearing females.

Addendum I (August 1999)
Establishes trap limits in the seven LCMAs.

Addendum II (February 2001)
Establishes regulations for increasing egg production through a variety of LCMT proposed management measures including, but not limited to, increased minimum gauge sizes in LCMAs 2, 3, 4, 5, and the Outer Cape.

Addendum III (February 2002)
Revises management measures for all seven LCMAs in order to meet the revised egg-rebuilding schedule.

Technical Addendum 1 (August 2002)
Eradicates the vessel upgrade provision for LCMA 5.

Addendum IV (January 2004)
Changes vent size requirements; applies the most restrictive rule on an area trap cap basis without regard to the individual's allocation; establishes LCMA 3 sliding scale trap reduction plan and transferable trap program to increase active trap reductions by 10%; and establishes an effort control program and gauge increases for LCMA 2; and a desire to change the interpretation of the most restrictive rule.

Addendum V (March 2004)
Amends Addendum IV transferability program for LCMA 3. It establishes a trap cap of 2200 with a conservation tax of 50% when the purchaser owns 1800 to 2200 traps and 10% for all others.

Addendum VI (February 2005)
Replaces two effort control measures for LCMA 2 – permits an eligibility period.
Addendum VII (November 2005)
Revises LCMA 2 effort control plan to include capping traps fished at recent levels and maintaining 3 3/8" minimum size limit.

Addendum VIII (May 2006)

Establishes new biological reference points to determine the stock status of the American lobster resource (fishing mortality and abundance targets and thresholds for the three stock assessment areas) and enhances data collection requirements.

Addendum IX (October 2006)
Establishes a 10% conservation tax under the LCMA 2 trap transfer program.

Addendum X (February 2007)
Establishes a coastwide reporting and data collection program that includes dealer and harvester reporting, at-sea sampling, port sampling, and fishery-independent data collection replacing the requirements in Addendum VIII.

Addendum XI (May 2007)
Establishes measures to rebuild the SNE stock, including a 15-year rebuilding timeline (ending in 2022) with a provision to end overfishing immediately. The Addendum also establishes measures to discourage delayed implementation of required management measures.

Addendum XII (February 2009)
Addresses issues which arise when fishing privileges are transferred, either when whole businesses are transferred, when dual state/federal permits are split, or when individual trap allocations are transferred as part of a trap transferability program. In order to ensure the various LCMA-specific effort control plans remain cohesive and viable, this addendum does three things. First, it clarifies certain foundational principles present in the Commission's overall history-based trap allocation effort control plan. Second, it redefines the most restrictive rule. Third, it establishes management measures to ensure history-based trap allocation effort control plans in the various LCMAs are implemented without undermining resource conservation efforts of neighboring jurisdictions or LCMAs.

Addendum XIII (May 2008)
Solidifies the transfer program for OCC and stops the current trap reductions.

Addendum XIV (May 2009)
Alters two aspects of the LCMA 3 trap transfer program. It lowers the maximum trap cap to 2000 for an individual that transfers traps. It changes the conservation tax on full business sales to 10% and for partial trap transfers to 20%.

Addendum XV (November 2009)
Establishes a limited entry program and criteria for Federal waters of LCMA 1.

Addendum XVI: Reference Points (May 2010)
Establishes new biological reference points to determine the stock status of the American lobster resource (fishing mortality and abundance targets and thresholds for the three stock assessment areas). The addendum also modifies the procedures for adopting reference points to allow the Board to take action on advice following a peer reviewed assessment.

Addendum XVII (February 2012)
Institutes a 10% reduction in exploitation for LCMAs within Southern New England (2, 3, 4, 5, and 6). Regulations are LCMA specific but include v-notch programs, closed seasons, and size limit changes.

Addendum XVIII (August 2012)
Reduces traps allocations by 50% for LCMA 2 and 25% for LCMA 3.

Addendum XIX (February 2013)
Modifies the conservation tax for LCMA 3 to a single transfer tax of 10% for full or partial business sales.

Addendum XX (May 2013)
Prohibits lobstermen from setting or storing lobster traps in Closed Area II from November 1 to June 15 annually. Any gear set in this area during this time will be considered derelict gear. This addendum represents an agreement between the lobster industry and the groundfish sector.

Addendum XXI (August 2013)
Addresses changes in the transferability program for LCMAs 2 and 3. Specific measures include the transfer of multi-LCMA trap allocations and trap caps.

Addendum XXII (November 2013)
Implements Single Ownership and Aggregate Ownership caps in LCMA 3. Specifically, it allows LCMA 3 permit holders to purchase lobster traps above the cap of 2000 traps; however, these traps cannot be fished until approved by the permit holder's regulating agency or once trap reductions commence. The Aggregate Ownership Cap limits LCMA fishermen or companies from owning more traps than five times the Single Ownership Cap.

Addendum XXIII (August 2014)
Updates Amendment 3's habitat section to include information on the habitat requirements and tolerances of American lobster by life stage.

Addendum XXIV (May 2015)
Aligns state and federal measure for trap transfer in LCMA's 2, 3, and the Outer Cape Cod regarding the conservation tax when whole businesses are transferred, trap transfer increments, and restrictions on trap transfers among dual permit holders.

Addendum XXVI (February 2018)
Advances the collection of harvester and biological data in the lobster fishery by improving the spatial resolution of data collection, requiring harvesters to report additional data elements, and establishing a deadline that within five years, states are required to implement 100% harvester reporting. The Addendum also improves the biological sampling requirements by

establishing a baseline of ten sampling trips per year, and encourages states with more than 10% of coastwide landings to conduct additional sampling trips. Required reporting of additional data elements went into effect on January 1, 2019. The Addendum XXVI requirement for commercial harvesters to report their fishing location by 10 minute longitudinal/latitudinal square was implemented in 2021.

<u>Addendum XXIX (2022)</u>
Implements electronic tracking requirements for federally-permitted vessels in the American lobster and Jonah crab fisheries to collect high resolution spatial and temporal effort data. Specifically, electronic tracking devices will be required for vessels with commercial trap gear area permits for LCMAs 1, 2, 3, 4, 5, and Outer Cape Cod. Requirements will become effective in 2023.

<u>Addendum XXVII (2023)</u>
Establishes a trigger mechanism to implement management measures (gauge and escape vent sizes) to provide additional protection of the GOM/GBK spawning stock biomass (SSB). It also implements changes to management measures for LCMAs 1, 3, and Outer Cape Cod to improve the consistency of measures across the GOM/GBK stock.

5.0 Fishery Dependent Monitoring
The following provisions of Addendum XXVI went into effect January 1, 2019:

- Required reporting of additional data elements;
- Requirement to implement 100% harvester reporting within five years;
- Baseline biological sampling requirement of ten sea and/or port sampling trips per year.

The Addendum XXVI requirement for commercial harvesters to report their fishing location by 10 minute longitudinal/latitudinal square was not implemented until 2021. Table 5 describes the level of reporting and monitoring programs by each state. *De minimis* states are not required to conduct biological sampling of their lobster fishery.

In 2022, Rhode Island, Connecticut, New York, and New Jersey were unable to complete the ten required sea and/or port sampling trips for fishery dependent monitoring. Rhode Island completed seven out of ten trips, and New York completed eight port sampling trips. New Jersey completed zero trips and continues to have difficulty with vessel Captains accommodating an observer aboard. No fishery dependent sampling has been conducted by Connecticut since 2014 due to reductions in funding and staffing levels.

6.0 Status of Fishery Independent Monitoring
Addendum XXVI also requires fishery independent data collection by requiring statistical areas be sampled through one of the following methods: annual trawl survey, ventless trap survey, or young-of-year survey.

7.1 Trawl Surveys

Maine and New Hampshire: The Maine-New Hampshire Inshore Trawl survey began in 2000 and covers approximately two-thirds of the inshore portion of Gulf of Maine. The spring survey began May 2, 2022 in Portsmouth, NH. However, during the first day of the survey a positive covid case occurred; as a result the survey was stopped while staff and crew quarantined. During this time the decision was made to restart the survey following the current schedule due the lack of accommodations and increase issues with gear in regions 4 and 5 in mid-June, and region 3 started back up on time on May 16, 2022 and ended on June 6, 2021 off of Lubec, Maine. Regions 1 and 2 were then rescheduled after the original end date of the survey and were completed on the weeks of June 6th and June 13th, respectively. Due to covid and gear conflicts, 101 out of the 120 scheduled tows were completed leading to an 84% completion rate for the survey. A total of 10,854 lobsters were caught and sampled, with 5,133 females, 5,719 males and 2 unsexed caught and measured (Figure 4). The fall survey began on September 26, 2022 in Portsmouth, New Hampshire and finished on October 28, 2022 off of Lubec, Maine. Due to the adverse weather and gear conflicts, 87 out of the 120 scheduled tows were completed leading to a 73% completion rate for the survey. A total of 10,423 lobsters were caught and sampled, with 5,100 females, 5,319 males, and 4 unknown sexes sampled (Figure 5).

Massachusetts: Since 1978, the Division of Marine Fisheries has conducted spring and autumn bottom trawl surveys in the territorial waters of Massachusetts. For the first time since 1978, neither the spring nor fall bottom trawl surveys were conducted in 2020 due to the COVID-19 pandemic, but the survey resumed in 2021. After low levels observed in the GOM during the early to mid 2000s, relative abundance indices have increased over the last decade Legal abundance has remained high relative to the time series median since 2015, although the 2022 value was the lowest observed since 2015. Sublegal-sized abundance has been at or below the median for the past three years with data (no data in 2020). In SNE, relative abundance from the spring and fall surveys remains low. There were no lobsters observed in the SNE fall or spring surveys in 2022 (Figure 6).

Rhode Island: The Rhode Island DFW Trawl Survey program conducted seasonal surveys in the spring and fall, as well as a monthly survey. In 2022, 44 trawls were conducted in the Spring and 44 in the Fall. Monthly Survey includes monthly trawls throughout Narragansett Bay. There were 156 trawls performed as part of the Monthly program in 2022. Spring 2022 mean CPUEs were 0.07 and 0.61 for legal and sub legal lobsters (respectively), where Fall 2022 CPUE was 0.02 for legal lobsters and 0.23 for sublegal lobsters. The 2022 mean Monthly trawl CPUEs were 0.04 and 0.41 per-tow for legal and sublegal lobsters, respectively (Figure 7).

Connecticut and New York: Juvenile and adult abundance are monitored through the Long Island Sound Trawl Survey during the spring (April, May, June) and the fall (September, October) cruises all within NMFS statistical area 611. Due to the COVID-19 pandemic, the spring and fall 2020 Long Island Sound Trawl Surveys were not conducted; an estimated index is shown as the average of 2019 and 2021. The spring 2022 lobster abundance index (geometric mean = 0.01 lobsters/tow) was the lowest in the time series. Spring abundance in the last eleven years (2011-2022) remains less than 1.0. All indices from 2004-2022 are below the time series median (2.93, see figure below). The fall 2022 lobster abundance index (geometric mean = 0.03 lobsters/tow) was a slight improvement from 2019 when no lobsters were caught in September and October. The fall time series median (3.18, see figure below) has not been exceeded since 2004. Analyses of legal and sublegal size composition for the 2022 research trawl spring and fall survey catches were not available at the time of this report (Figure 8).

New York: New York initiated a stratified random trawl survey in the near shore ocean waters off the south shore of Long Island in 2018 from the Rockaways to Montauk Point and the New York waters of Block Island Sound. Seven sampling cruises were conducted in 2022 during the winter (February), spring (April, May, June), summer (August) and fall (October, November). Twenty-one stations were sampled during the winter cruise in February. Thirteen, seventeen, and twenty-three stations were sampled during the spring cruises. Thirty stations were sampled during the summer cruise in August. During the fall, 20 stations were sampled in October and eight stations were sampled in November. Ten lobsters were caught during the 2022 surveys.

New Jersey: An independent Ocean Trawl Survey is conducted from Sandy Hook, NJ to Cape May, NJ each year. The survey stratifies sampling in three depth gradients, inshore (18'-30'), mid-shore (30'-60'), offshore (60'-90'). The mean CPUE is calculated as the sum of the mean number of lobsters per size class collected in each sampling area weighted by the stratum area. Due to the COVID-19 pandemic, the survey did not take place for 2020 and 2021, but the 2022 CPUE is an increase from the 2019 value (Figure 9).

Maryland: Maryland conducted a 16-foot otter trawl survey in the coastal bays and has not encountered an American lobster in this survey (1989 - 2022).

7.2 Young of Year Index

Several states conduct young-of-year (YOY) surveys to detect trends in abundance of newly-settled and juvenile lobster populations. These surveys attempt to provide an accurate picture of the spatial pattern of lobster settlement. States hope to track juvenile populations and generate predictive models of future landings.

Maine: There are currently 40 fixed stations along the Maine coast. Of these 40 stations 38 have been sampled consistently since 2001 with two additional sites added to Zone D, off midcoast Maine, in 2005. In recent years, these sites are sampled October to December. Only 33 sites were sampled in 2022 due to staffing and weather limitations. Sites were selected based on orientation to surface winds, position in bays, water temperature during settlement period (for eastern Maine sites) and presence of suitable habitat. A new R script was developed in 2022 to pull the data directly from Maine's MARVIN archive database to create a replicable and transparent data query, but these numbers differ slightly from past data pulled. Cut-off values for YOY vary by year. This data query process is still being vetted (Figure 10).

New Hampshire: New Hampshire Fish and Game conducted a portion of the coastwide American Lobster Settlement Index (ALSI). In 2022, a total of 46 juvenile lobsters were sampled from three sites; 36 older juveniles, five young-of-year (YOY) lobster, and five one-year-old (Y+). Figure 11 depicts the CPUE (#/m2) of all sampled lobsters, YOY and Y+, for all New Hampshire sites combined from 2008 through 2022. For each of these indices, CPUE shows a general upward trend to a time series high in 2011 with sustained moderate to low levels from 2012 through 2022.

Massachusetts: Annual sampling for early benthic phase/juvenile (EBP) lobsters was conducted during August and September, 2022. Prior to 2019, sampling was completed at 21 sites spanning 7 regions in Massachusetts coastal waters. As of 2022, suction sampling is conducted in the GOM stock unit at 10 sites from Cape Ann to the South Shore area, and in the SNE stock unit at 4 sites in Buzzards Bay. In 2022 densities of YOY lobsters remained low compared to the time series average in Boston Harbor and Salem Sound (Figure 1). For the two newer sampling areas, 2022 values in Cape Ann were below the time series mean, while in the South Shore the 2022 value was at the time series mean (Figure 12). In SNE there were no YOY lobsters found in the Buzzards Bay sampling locations in 2022.

Rhode Island: In 2022, the RI DEM DMF YOY Settlement Survey (Suction Sampling) was conducted at six fixed stations with twelve randomly selected 0.5 m^2 quadrats sampled at each survey station. The survey stations are located outside of Narragansett Bay along the southern Rhode Island coast, from Sachuest Point (east) to Point Judith (west). The index represents the average annual densities for YOY (≤ 13mm) and total lobsters caught (Figure 13). The 2022 YOY Settlement Survey index was 0.03 lobsters/m^2, and with all lobsters was 0.11/m2.

Connecticut: The CT DEEP Larval Lobster Survey in western Long Island Sound was discontinued after 2012. Alternative monitoring data are available for the eastern Sound from the Millstone Power Station entrainment estimates of all stages of lobster larvae. Abundance indices in both programs are delta mean density of larvae per 1000 cubic meters of water, entrained into the power plant in the case of the Millstone program and stage 4 only captured in surface plankton samples in the CT DEEP program. Both programs show a protracted decline in recruitment following the 1999 die-off (correlation between programs: R=0.35, p=0.066) (Figure 14).

7.3 Ventless Trap Survey

To address a need for a reliable index of lobster recruitment, a cooperative random stratified ventless trap survey was designed to generate accurate estimates of the spatial distribution of lobster length frequency and relative abundance while attempting to limit the biases identified in conventional fishery dependent surveys.

Maine: The Maine Ventless Trap Survey changed strategies in 2015 to cover more area by eliminating the vented traps at each site. This change allowed the survey to double the number of sites with ventless traps and increase the sampling coverage spatially to 276 sites. Traps were set during the months of June, July, and August. The stratified mean was calculated for each area using depth and statistical area for ventless traps only. Compared to the previous years, in 2022 there were decreases in the number of sublegal (<83 mm CL) lobsters in all areas and legal sized (≥ 83 mm CL) lobsters caught in the Schoodic Point to Friendship (512). In 2022 there were increases in the number of legal sized (≥ 83 mm CL) lobsters caught in the NH-Friendship (513) and the Schoodic Pt-Cutler (511) areas (Figure 15).

New Hampshire: Since 2009, NHF&G has been conducting the coastwide Random Stratified Ventless Trap Survey in state waters (statistical area 513). A total of six sites were surveyed twice a month from June through September in 2022. Catch per unit effort (stratified mean catch per trap haul) from 2009 through 2022 is presented in Figure 16. Annual stratified mean catch per trap haul values varied without significant positive or negative trend throughout the fourteen year time series.

Massachusetts: The coast-wide ventless trap survey was initiated in 2006 and expanded in 2007 with the intention of establishing a standardized fishery-independent survey designed specifically to monitor lobster relative abundance and distribution. The survey was not conducted in 2013 due to a lack of funding; however, starting in 2014 the survey has been funded with lobster license revenues and will continue as a long-term survey.

Due to lack of interested participants in the SNE survey area (Area 538) in 2021, the SNE survey footprint was reduced, the number of hauls was reduced to one per month, and the time frame was reduced by one month to just June through August. These changes to the SNE survey necessitated re-analysis of the abundance time series to adjust to the reduced survey design. The data presented in Figure 17 and Figure 18 are the results of the new analysis. The entire SNE time series now represents June – August only, first haul of the month, and only those stations that occurred in the newly reduced footprint.

The time series of relative abundance for sublegal (< 83 mm CL) and legal-sized (≥ 83 mm CL) lobsters for Area 514 (part of LMA 1) is shown in Figure 17 as the stratified mean CPUE (± S.E.). Note that the index includes data from vented and non-vented traps, and includes all four survey months (June – Sept). The average catch of sublegal lobsters is much higher than the catch of legal-sized lobsters, and generally increased from 2006 through 2016 but has been declining since, with values from the last four years (2019-2022) falling below the time series average of 4.48 sublegal lobsters/trap. The 2022 value (2.68 sublegals/trap) was the lowest in the time series. The stratified mean catch per trap of legal-sized lobsters in 2022 was 0.50 (± 0.01), and was below the time series average of 0.56.

The time series of relative abundance (stratified mean CPUE ± S.E.) for sublegal (<86 mm CL) and legal-sized (≥ 86 mm CL) lobsters in the Area 538 (MA SNE survey area) is shown in Figure 18. The mean sublegal CPUE in 2022 was 0.47 (± 0.02), well below the time series average of 1.87 sublegal lobsters/trap haul. The CPUE of legal-sized lobsters in 2022 was 0.13 (±0.02), below the time series average of 0.33 legal lobsters/trap haul. The re-analysis of the time series to account for the reduced time period and survey area resulted in a similar trend over time for both sublegal and legal-sized lobster abundance, but a slight increase in the scale.

Rhode Island: Rhode Island conducted the 2022 ventless trap survey in June, July, and August at a total of 27 stations divided between Block Island Sound, Rhode Island Sound, and

Narragansett Bay. Over the 18 trips and 818 pots (ventless and vented) hauled, 2,695 lobsters were sampled. The depth-stratified abundance index of sublegal lobsters in the 2022 survey, 3.34 lobsters per ventless trap, remains below the time series mean of 5.87 lobsters per ventless trap. The abundance index for legal-sized lobsters was equal to the time series mean of 0.37 lobsters per ventless trap (Figure 19).

Delaware: A pilot study was initiated in 2018 to assess the population structure of structure-oriented fish in the lower Delaware Bay and nearshore Atlantic Ocean. Sampling was conducted in the lower Delaware Bay and the nearshore Atlantic Ocean using commercial-sized ventless fish pots during April through December 2022. Six American lobsters were caught in lower Delaware Bay and 610 American lobsters in the nearshore Atlantic Ocean with a ratio of 60% males, 31% female and 9% egg laden. The sampled lobsters ranged in length from 43 mm to 138 mm.

8.0 State Compliance

States are currently in compliance with all required biological management measures under Amendment 3 and Addendum I-XXIV. However, the Plan Review Team (PRT) notes that Connecticut and New Jersey and did not conduct sea/port sampling in 2022, as required by Addendum XXVI. Rhode Island and New York did conduct some sampling, but were unable to complete the ten required sampling trips.

9.0 De Minimis Requests

The states of Virginia, Maryland, and Delaware have requested *de minimis* status. According to Addendum I, states may qualify for *de minimis* status if their commercial landings in the two most recent years for which data are available do not exceed an average of 40,000 pounds. Delaware, Maryland, and Virginia meet the *de minimis* requirement.

10.0 Regulatory Changes

Maine

- In the 2022 fishing year, Maine DMR adopted rules to incorporate the measures in the 2021 Atlantic Large Whale Take Reduction Plan (ALWTRP) final rule, including requirements for 1700-pound weak link inserts, gear marking requirements, minimum trawl lengths, and the establishment of the LMA1 Restricted Area. In addition, DMR modified an existing 3-trap trawl maximum in Zone B to a 5-trap trawl maximum for compliance with the ALWTRP.
- There were two statutory changes impacting lobster management in 2022:
    - Public Law 2021, chapter 512 allowed the Commissioner of Marine Resources to adopt routine technical rules to amend the minimum and maximum lobster size and the dimensions of vents in lobster traps when necessary to comply with changes to the Atlantic States Marine Fisheries Commission Interstate Fishery Management Plan for American Lobster. It requires the Commissioner to notify the joint standing committee of the Legislature having jurisdiction over marine resources matters within 15 days of initiating such rulemaking.

- Public Law 2021, chapter 498 changed the legal start time for lobster fishing to 4:00 a.m. in the month of September.

New Hampshire

- Changes were made to weak inserts and gear marking for NH state waters to comply with the modified Atlantic Large Whale Take Reduction Plan. A copy of changes can be found in Appendix I under Fis 602.09.

Massachusetts

- Buoy line marking regulations amended to clarify that MA trap gear buoy lines shall only bear red marks.
- Requirement for all lobster traps set on or after May 1 to have current year trap tags in them for all LMAs.

11.0 Enforcement Concerns

Maine

- In 2022 Maine Marine Patrol Officers documented 336 lobster-related violations, with 67 being summonses. Marine Patrol's highest profile cases in 2022 were four individuals being charged with molesting lobster gear and two separate individuals found in possession of 13 v-notched/mutilated female lobsters. Officers documented a considerable effort inspecting lobster gear throughout the year; between gear being hauled from our fleet of large patrol vessels, and documented vessel boardings at-sea, Marine Patrol inspected an estimated 20,000 lobster traps in 2022. The majority of the violations documented by Marine Patrol were for possessing illegal lobsters, protected resource violations, and for fishing untagged lobster gear. Eighteen summonses were issued to Maine lobsterman for fishing untagged/illegally tagged lobster traps.

Massachusetts

- Aiello case – Violation of seasonal trap gear closure; buoy line marking violations; buoy line breaking strength violations; weak link violations; trap tag violations; ghost panel violation. Agreed to transfer out of the fishery and not reapply.
- D. Duhaime case – Violation of seasonal trap gear closure; buoy line breaking strength violations; maximum buoy line diameter violations; buoy line marking violations; and surface buoy and configuration marking violations. Agreed to 3-year suspension of lobster permit (2023 – 2025).
- Edwards case – Violation of seasonal trap gear closure. Agreed to 2-month annual suspension (November – December) for period of 5-years (2023 – 2027) requiring all gear to be hauled out by Oct 31 annually.
- Hamilton case – Possession of lobster in excess of gillnet trip limit. Agreed to 2-year suspension of lobster permit (2023 – 2024) and three-year probationary period following reinstatement. Criminal proceedings are ongoing.
- O'Keefe case – Violation of seasonal trap gear closure; weak link violations; buoy line breaking strength violations; maximum buoy line diameter violations; buoy line marking

violations; surface buoy marking and configuration violations. Agreed to 2-year suspension of lobster permit (2023 – 2024).

- R. Duhaime case - Violation of seasonal trap gear closure; buoy line breaking strength violations; maximum buoy line diameter violations; buoy line marking violations; and surface buoy marking and configuration marking violations. Agreed to 2-year suspension of lobster permit (2023 – 2024).
- Roche case – Impeding safe boarding by enforcement; failure to display commercial fishing permit; trap tag violations; buoy line marking violations; buoy line breaking strength violations; buoy line maximum diameter violations; surface buoy marking and configuration violations; maximum trawl length violations. Proceeded to hearing and resulted in permanent revocation of permit. Criminal proceedings are ongoing.

New Jersey

- Two summonses were issues due to failure to notify the Department before deploying lobster on an artificial reef.

12.0 Research Recommendations

The full list of research recommendations can be found in the 2020 Stock Assessment Report. Below is a summarized list of the high priority research recommendations from the 2020 Stock Assessment that were compiled by the Lobster Technical Committee (TC) and Stock Assessment Subcommittee (SAS).

Port and Sea Sampling - The quality of landings data has not been consistent spatially or temporally. Limited funding, and in some cases, elimination of sea sampling and port sampling programs will negatively affect the ability to characterize catch and conservation discards, limiting the ability of the model to accurately describe landings and stock conditions. It is imperative that funding for critical monitoring programs continues, particularly for offshore areas from which a large portion of current landings originate in SNE. Sea sampling should be increased in Long Island Sound (statistical area 611), and in the statistical areas in federal waters, particularly those fished by the LCMA 3 fleet, via a NMFS-implemented lobster-targeted sea sampling program.

Commercial Data Reporting – Finer resolution spatial data are paramount in understanding how landings align between statistical area and LCMAs. Vessel tracking is recommended for federal vessels. Once in place, the new spatial data should be analyzed for comparison to current spatial understanding of harvest. The growing Jonah crab fishery in SNE continues to complicate the differentiation of directed lobster versus Jonah crab effort. More sea sampling and landings data must be collected to better differentiate the two fisheries' activities.

Ventless Trap Survey - Calibration work to determine how catch in the ventless trap surveys relates to catch in the bottom trawl surveys remains an important and unaddressed topic of research. Ventless traps may be limited in their ability to differentiate between moderately high and extremely high abundance, and calibration with bottom trawl surveys may help to clarify how q might change with changes in lobster density.

NEAMAP Trawl Survey Protocols - The SAS recommends that the NEAMAP Trawl Survey sampling protocol be modified for all lobsters caught to be sorted by sex. If a subsample is necessary, subsamples be taken by sex for additional biological data (size, egg presence and stage, vnotch, etc.) This modification would align the biological sampling methodology with other trawl surveys used in the assessment, and perhaps allow the survey to not be collapsed by sex into survey slots.

Time Varying Growth - Growth of American lobster has been found to change through time (McMahan et al. 2016), yet the ability to incorporate this dynamic in the assessment model currently is unavailable. Accounting for interannual changes in the growth matrix, including those in increment, probability, and seasonality, is imperative for model convergence. Modification to the assessment model is needed to allow for time varying growth matrices to be used to reflect changing growth in the stocks.

Expansion of Growth Matrices - Exploration of expanding the model size structure to smaller sizes could allow the SAS to better capture changes in recruitment for the population by incorporating < 53mm lobster abundances from the surveys currently used, as well as incorporating additional surveys that currently are not model inputs for the assessment, such as those from the young of year settlement surveys. Due to decreased recruitment in SNE and some areas in GOMGBK, available survey data should be evaluated to determine whether current data sources for small sizes are sufficient for expanding the size structure and growth matrices.

Temperature-Molt Dynamics - Understanding how the timing for molting, molt increments, and probability by size vary with temperature for all stocks would allow for more accurate and realistic depictions of growth via updated annual growth matrices. The work of Groner et al. (2018) should be expanded by using the Millstone data to specifically analyze how molt frequency and increment has changed seasonally and interannually.

Larval Ecology - Spatial expansion of larval surveys and further testing is warranted, particularly in areas like the eastern GOM and GBK that lack any studies of this nature. Studies that explore greater spatial coverage of larval sampling and examine lobster larval diets, in situ development time in current conditions, larval interactions with well-mixed versus stratified water columns, and varying growth and mortality with temperature would allow for greater context on these variables' influence on recruitment.

Deepwater Settlement - There is a need to determine settlement success in habitat not currently sampled and its contribution to overall stock productivity. Research needs to explore the levels of detectability, impact of stratification, and interannual temperature effects on the indices. Additionally, it will be important to understand whether there are differences in growth and survival in these deeper habitats, particularly relative to the desire to expand the growth matrix into smaller size ranges for modeling purposes.

SNE Recruitment Failure - The direct cause of the precipitous declines in recruitment under less variable spawning stock biomass is largely unknown. Research designed to understand the causes driving recruitment failure is vital for any efforts toward rebuilding the SNE stock. In addition, being able to predict similar conditions in GOMGBK could allow management the opportunity to respond differently.

Stock Structure Working Group - The SAS recommends that a workshop on stock boundaries be convened prior to the initiation of the next assessment to review results of any new research and re-evaluate appropriate stock boundaries. Inclusion of Canadian researchers at this workshop would be beneficial to share data and knowledge on this shared resource.

Spatial Analyses of Fisheries-Independent Data – Northeast Fisheries Science Center (NEFSC) trawl survey data remains one of the richest data sources to understand abundance and distribution patterns through time for lobsters by size and sex. Formal analyses of NEFSC trawl survey and the ME/NH trawl survey and should be performed. The Ecosystem Monitoring (EcoMon) Program's larval lobster information should also be considered.

Reevaluate Baseline Natural Mortality Rate - Intensive hypothesis-driven sensitivity analyses should be conducted to evaluate the base mortality rate for both stocks by season and year. Canadian tagging data should be examined to determine how natural mortality rates derived from these data compare to the assumptions used currently in the model and sensitivity analyses. Exploration of additional time series representing natural mortality hypotheses (e.g. sea temperature, shell disease prevalence, predators) should be continued to either inform time-varying natural mortality or correlate to rates produced in sensitivity analyses.

Predation Studies - It is suspected that a given predator's role in lobster natural mortality has changed through time. Predation laboratory studies and gut content analyses would provide greater guidance on individual species' roles in lobster natural mortality. With this information, predation-indices as a function of predator annual abundances and their contribution to stock-specific lobster mortality would be immensely valuable, particularly in SNE.

Management Strategy Evaluation - Developing a true management strategy evaluation tool that can iteratively project and refit the operating model would best inform future management discussions on rebuilding the SNE stock or providing resiliency for the GOM stock and fishery.

Economic Reference Points - Economic analyses considering landings, ex-vessel value, costs, associated economic multipliers, number of active participants, and other factors are imperative to truly discern how declines in the population would impact the GOMGBK industry. The SAS strongly recommends a thorough economics analysis be conducted by a panel of experts to more properly inform economic-based reference points, and ultimately provide resiliency to both the GOMGBK stock and fishery.

13.0 Plan Review Team Recommendations

During their review of the state compliance reports, the PRT noted the following issues:

- Massachusetts was unable to provide compliance reports by the August 1 deadline. This has been a recurring issue over the last few years due to delays in data availability and limited staff resources.
- In 2022, Rhode Island, Connecticut, New Jersey, and New York did not meet the Addendum XXVI minimum requirement of ten sea/port sampling trips. Given persistent issues with states being unable to meet the sampling requirement, the Board should consider how to address this issue moving forward.

The PRT Recommends the Board approve the *de minimis* requests of DE, MD, and VA. Other than the issues noted above, all states appear to be in compliance with the requirements of the FMP.

The following are general recommendations the PRT would like to raise to the Board:

- The PRT recommends the Board consider reviewing the monitoring requirements in SNE given the status of the stock and the difficulty obtaining sea sampling trips in a fishery with reduced effort. The TC has discussed the need for additional sampling trips in federal waters as the fishery has shifted offshore.

14.0 Tables

Table 1. Landings (in pounds) of American Lobster by the states of Maine through Virginia. Source: ACCSP Data Warehouse for 1981-2021 landings; state compliance reports for 2022 landings. *C= confidential data.*

	ME	NH	MA	RI	CT	NY	NJ	DE	MD	VA	Total
1981	22,631,614	793,400	11,420,638	1,871,067	807,911	890,218	593,801	55,700	63,108	2,173	**39,129,630**
1982	22,730,253	807,400	11,265,840	3,173,650	880,636	1,121,644	846,215	90,700	64,788	4,713	**40,985,839**
1983	21,976,555	1,310,560	12,867,378	5,114,486	1,654,163	1,207,442	769,913	56,700	76,192	20,619	**45,054,008**
1984	19,545,682	1,570,724	12,446,198	5,259,821	1,796,794	1,308,023	927,474	103,800	98,876	37,479	**43,094,871**
1985	20,125,177	1,193,881	13,702,702	5,140,131	1,381,029	1,240,928	1,079,723	118,500	82,295	42,881	**44,107,247**
1986	19,704,317	941,100	12,496,125	5,667,940	1,253,687	1,416,929	1,123,008	109,000	57,593	93,105	**42,862,804**
1987	19,747,766	1,256,170	12,856,301	5,317,302	1,571,811	1,146,613	1,397,138	84,100	49,820	60,241	**43,487,262**
1988	21,739,067	1,118,900	12,977,313	4,758,990	1,923,283	1,779,908	1,557,222	66,200	22,966	53,696	**45,997,545**
1989	23,368,719	1,430,347	15,645,964	5,786,810	2,076,851	2,344,932	2,059,800	76,500	17,502	45,107	**52,852,532**
1990	28,068,238	1,658,200	16,572,172	7,258,175	2,645,951	3,431,111	2,198,867	68,300	24,941	58,260	**61,984,215**
1991	30,788,646	1,802,035	15,998,463	7,445,172	2,673,674	3,128,246	1,673,031	54,700	26,445	7,914	**63,598,326**
1992	26,830,448	1,529,292	14,969,350	6,763,087	2,534,161	2,651,067	1,213,255	21,000	27,279	753	**56,539,692**
1993	29,926,464	1,693,347	14,350,595	6,228,470	2,177,022	2,667,107	906,498	24,000	46,650	2,940	**58,023,093**
1994	38,948,867	1,650,751	16,176,551	6,474,399	2,146,339	3,954,634	581,396	8,400	7,992	460	**69,949,789**
1995	37,208,324	1,834,794	15,903,241	5,362,084	2,541,140	6,653,780	606,011	25,100	26,955	5,210	**70,166,639**
1996	36,083,443	1,632,829	15,312,826	5,295,797	2,888,683	9,408,519	640,198	20,496	28,726	C	**71,311,517**
1997	47,023,271	1,414,133	15,010,532	5,798,529	3,468,051	8,878,395	858,426	C	34,208	2,240	**82,487,785**
1998	47,036,836	1,194,653	13,167,803	5,617,873	3,715,310	7,896,803	721,811	1,359	19,266	1,306	**79,373,020**
1999	53,494,418	1,380,360	15,875,031	8,155,947	2,595,764	6,452,472	931,064	C	41,954	6,916	**88,933,926**
2000	57,215,406	1,709,746	14,988,031	6,907,504	1,393,565	2,883,468	891,183	C	62,416	C	**86,051,319**
2001	48,617,693	2,027,725	11,976,487	4,452,358	1,329,707	2,052,741	579,753	C	31,114	C	**71,067,578**
2002	63,625,745	2,029,887	13,437,109	3,835,050	1,067,121	1,440,483	264,425	C	20,489	C	**85,720,309**
2003	54,970,948	1,958,817	11,321,324	3,561,391	C	946,449	209,956	C	22,778	C	**72,991,663**
2004	71,574,344	2,851,262	11,675,852	3,059,319	646,994	996,109	370,536	13,322	14,931	27,039	**91,229,708**
2005	68,729,623	C	11,291,145	3,174,852	713,901	1,154,470	369,003	C	39,173	21,988	**85,494,155**
2006	75,419,802	2,612,389	12,090,423	3,949,299	806,135	1,252,146	470,878	3,706	26,349	28,160	**96,659,287**
2007	63,987,073	2,468,811	10,046,120	2,299,744	568,696	911,761	334,097	C	26,804	C	**80,643,106**
2008	69,910,434	2,568,088	10,606,534	2,782,000	427,168	712,075	304,479	C	32,932	C	**87,343,709**
2009	81,124,201	2,986,981	11,789,536	2,842,088	412,468	731,811	C	6,064	30,988	21,472	**99,945,239**
2010	96,244,299	3,648,004	12,772,159	2,928,688	441,622	813,513	692,869	C	29,989	16,345	**117,586,675**
2011	104,957,224	3,919,195	13,385,393	2,754,067	198,928	344,232	697,883	8,879	41,077	12,879	**126,320,059**
2012	127,464,332	4,229,227	14,486,344	2,706,384	247,857	550,441	919,351	C	65,813	10,823	**150,680,338**
2013	128,015,530	3,817,707	15,259,573	2,155,762	127,420	496,535	660,367	C	62,601	9,061	**150,604,556**
2014	124,941,312	4,374,656	15,312,852	2,412,875	127,409	222,843	526,368	26,330	57,414	11,099	**148,013,158**
2015	122,685,803	4,721,826	16,450,853	2,316,458	205,099	147,414	445,060	22,894	29,284	9,474	**147,034,165**
2016	132,750,487	5,782,098	17,784,921	2,260,335	254,346	218,846	349,880	C	29,254	2,854	**159,433,020**
2017	112,153,057	5,645,434	16,493,125	2,031,143	130,015	150,317	409,062	32,364	29,136	1,630	**137,075,281**
2018	121,226,274	6,199,365	17,697,243	1,905,689	110,580	112,685	344,547	C	24,893	2,727	**147,624,004**
2019	102,219,067	6,093,615	17,029,462	1,795,212	111,573	112,107	291,072	C	11,831	1,840	**127,665,778**
2020	97,915,188	5,014,169	15,711,853	1,695,279	159,173	111,678	309,197	11,098	10,176	C	**120,937,811**
2021	110,585,121	5,712,122	16,826,704	1,351,415	148,758	109,117	290,982	6,193	12,827	3,099	**135,046,339**
2022	98,650,231	5,262,246	15,651,988	1,176,530	66,454	82,834	258,289	C	11,144	C	**121,159,716**

Table 2. Above: Current (2016-2018) reference abundance estimates (millions), current target and threshold abundance (millions), and new recommended abundance reference points for both stocks. Below: Current (2016-2018) exploitation, current target and threshold exploitation, and new recommended target and threshold exploitation for both stocks.

Quantity	GOMGBK	SNE
Current (2016-2018 average)	256	7
Current Target	119	32
Current Threshold	58	25
Fishery/Industry Target	212	NA
Abundance Limit	125	NA
Abundance Threshold	89	20

Quantity	GOMGBK	SNE
Current (2016-2018 average)	0.459	0.274
Current Target	0.457	0.379
Current Threshold	0.510	0.437
Recommended Target	0.461	0.257
Recommended Threshold	0.475	0.290

Table 3. 2022 LCMA specific management measures

Management Measure	LCMA 1	LCMA 2	LCMA 3	LCMA 4	LCMA 5	LCMA 6	OCC
Min Gauge Size	3 $^{1}/_{4}$”	3$^{3}/_{8}$”	3 $^{17/32}$”	3$^{3}/_{8}$”	3$^{3}/_{8}$”	3$^{3}/_{8}$”	3$^{3}/_{8}$”
Vent Rect.	1$^{15}/_{16}$ x 5$^{3}/_{4}$”	2 x 5$^{3}/_{4}$”	2 $^{1}/_{16}$ x 5$^{3}/_{4}$”	2 x 5$^{3}/_{4}$”	2 x 5$^{3}/_{4}$”	2 x 5$^{3}/_{4}$”	2 x 5$^{3}/_{4}$”
Vent Cir.	2 $^{7}/_{16}$”	2 $^{5}/_{8}$”	2 $^{11}/_{16}$”	2 $^{5}/_{8}$”	2 $^{5}/_{8}$”	2 $^{5}/_{8}$”	2 $^{5}/_{8}$”
V-notch requirement	Mandatory for all eggers	Mandatory for all legal size eggers	Mandatory for all eggers above 42°30’	Mandatory for all eggers in federal waters. No v-notching in state waters.	Mandatory for all eggers	None	None
V-Notch Definition[1] (possession)	Zero Tolerance	$^{1}/_{8}$” with or w/out setal hairs[1]	$^{1}/_{8}$” with or w/out setal hairs[1]	$^{1}/_{8}$” with or w/out setal hairs[1]	$^{1}/_{8}$” with or w/out setal hairs[1]	$^{1}/_{8}$” with or w/out setal hairs[1]	State Permitted fisherman in state waters $^{1}/_{4}$” without setal hairs Federal Permit holders $^{1}/_{8}$” with or w/out setal hairs[1]
Max. Gauge (male & female)	5”	5 ¼”	6 $^{3}/_{4}$”	5 ¼”	5 ¼”	5 ¼”	State Waters none Federal Waters 6 $^{3}/_{4}$”
Season Closure				April 30-May 31[2]	February 1-March 31[3]	Sept 8-Nov 28[4]	February 1-April 30

[1] A v-notched lobster is defined as any female lobster that bears a notch or indentation in the base of the flipper that is at least as deep as 1/8”, with or without setal hairs. It also means any female which is mutilated in a manner that could hide, obscure, or obliterate such a mark.
[2] Pots must be removed from the water by April 30 and un-baited lobster traps may be set one week prior to the season reopening.
[3] During the February 1 – March 31 closure, trap fishermen will have a two week period to remove lobster traps from the water and may set lobster traps one week prior to the end of the closed season.
[4] Two week gear removal and a 2 week grace period for gear removal at beginning of closure. No lobster traps may be baited more than 1 week prior to season reopening.

Table 6. 2022 sampling requirements and state implementation. All states have 100% active harvester reporting except for Maine which has 10% harvester reporting. 100% harvester reporting will be required of all states in 2024. Sufficient sea sampling can replace port sampling. *De minimis* states (denoted by *) are not required to conduct biological sampling of their lobster fishery.

State	100% Dealer Reporting	10% Harvester Reporting	Sea Sampling	Port Sampling	Ventless Trap Survey	Settlement Survey	Trawl Survey
ME	✓	✓ (10%)	✓		✓	✓	✓
NH	✓	✓	✓	✓	✓	✓	✓
MA	✓	✓	✓		✓	✓	✓
RI	✓	✓		✓	✓	✓	✓
CT	✓	✓	[a]	[a]		[b]	✓
NY	✓	✓	✓	✓			✓
NJ	✓	✓					✓
DE*	✓	✓			✓		✓
MD*	✓	✓					✓
VA*	✓	✓					

[a] No fishery dependent sampling has been conducted by CT since 2014 due to reductions in funding and staffing levels.

[b] Larval data are available for the eastern Sound (ELIS) from the Millstone Power Station entrainment estimates of all stages of lobster larvae (Dominion Nuclear CT, Annual Report 2016).

Table 7. 2022 sea and port sampling trips and samples by state. *De minimis* states (denoted by *) are not required to conduct biological sampling of their lobster fishery.

State	**Sea Sampling**			**Port Sampling**		**Market Sampling**		**Totals**	
	Trips	**Samples**	**Traps**	**Trips**	**Samples**	**Trips**	**Samples**	**Trips**	**Samples**
ME	163	191,793	38,022	0	0	0	0	163	191,793
NH	14	6,828		11	1,074	0	0	25	7,902
MA	58	23,902	1,110	0	0	0	0	58	23,902
RI	0	0	0	7	1,353	0	0	7	1,353
CT	0	0	0	0	0	0	0	0	0
NY	0	0	0	8	839	0	0	8	839
NJ	0	0	0	0	0	0	0	0	0
DE*	0	0	0	0	0	0	0	0	0
MD*	1	230	280	0	0	0	0	1	230
VA*	0	0	0	0	0	0	0	0	0
Total	236	222,753	39,412	26	3,266	0	0	262	226,019

15.0 Figures

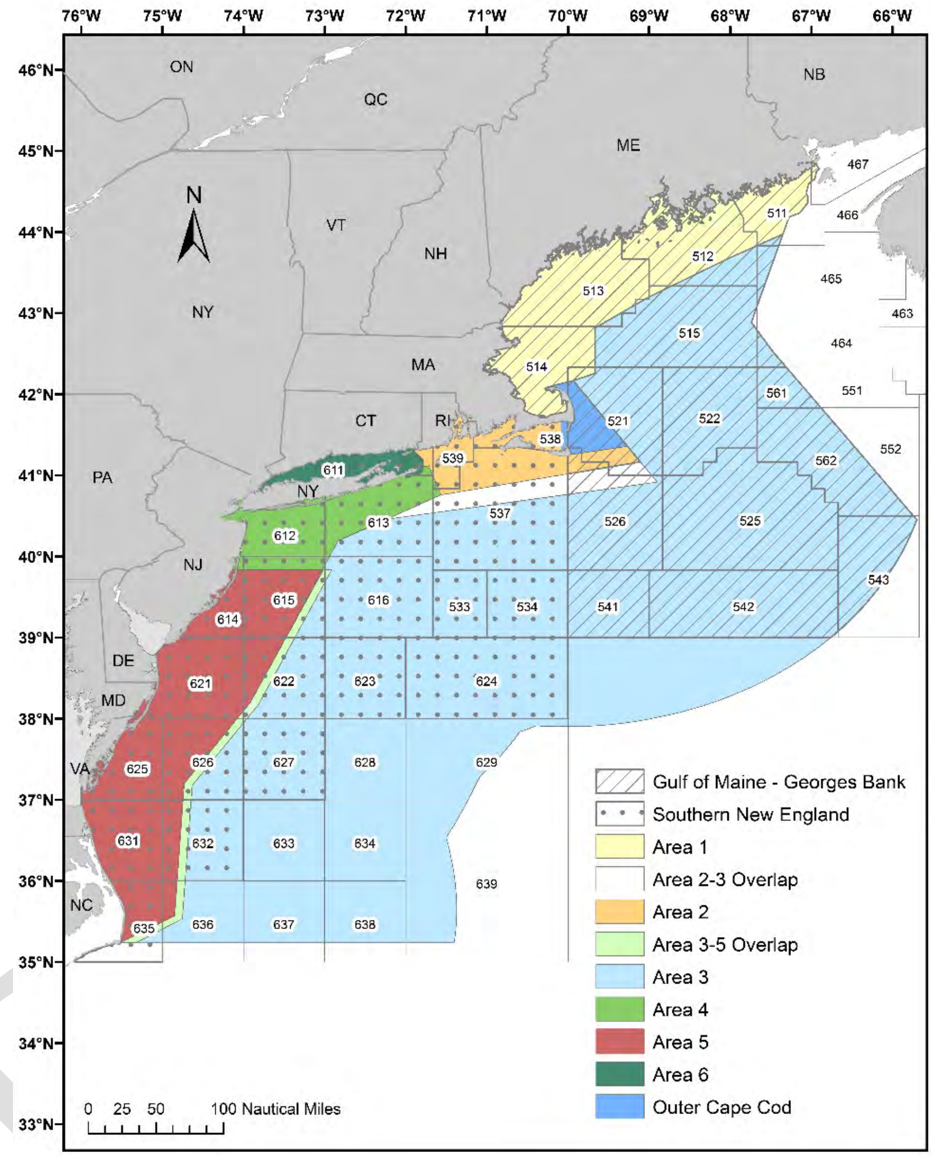

Figure 1. Lobster Conservation Management Areas (LCMAs) and stock boundaries for American lobster.

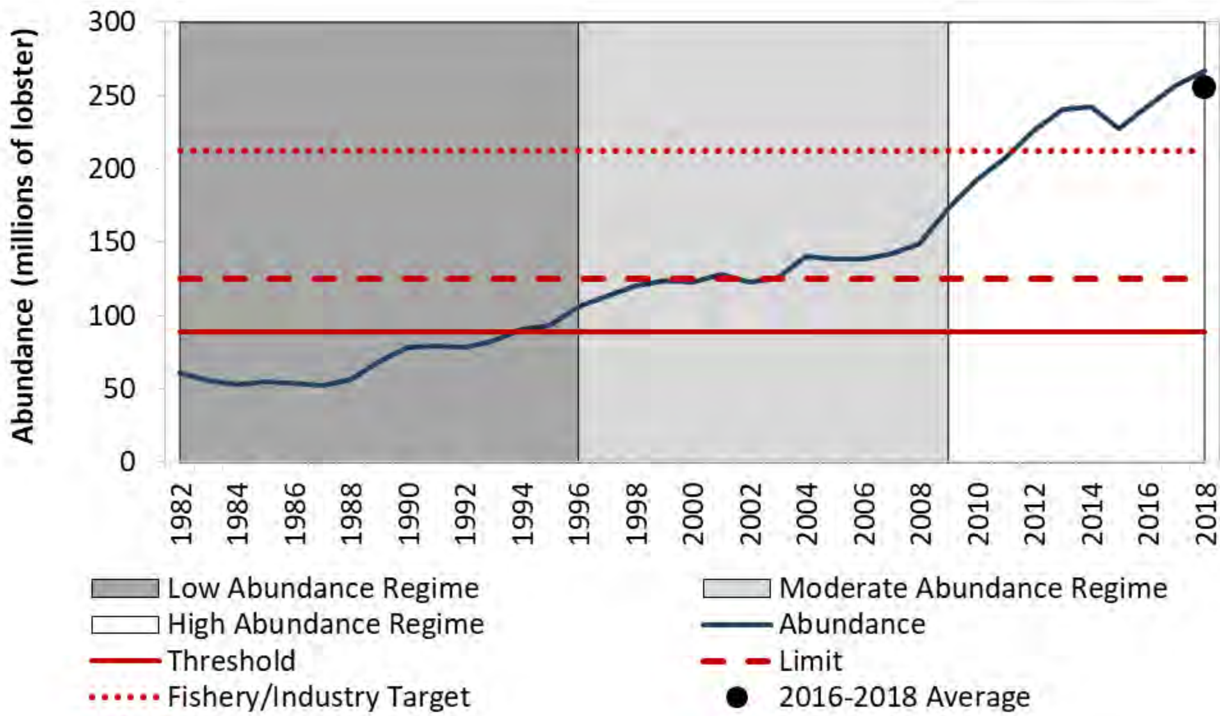

Figure 2. Abundance for GOM/GBK Relative to Reference Points. Source: 2020 Benchmark Stock Assessment for American Lobster.

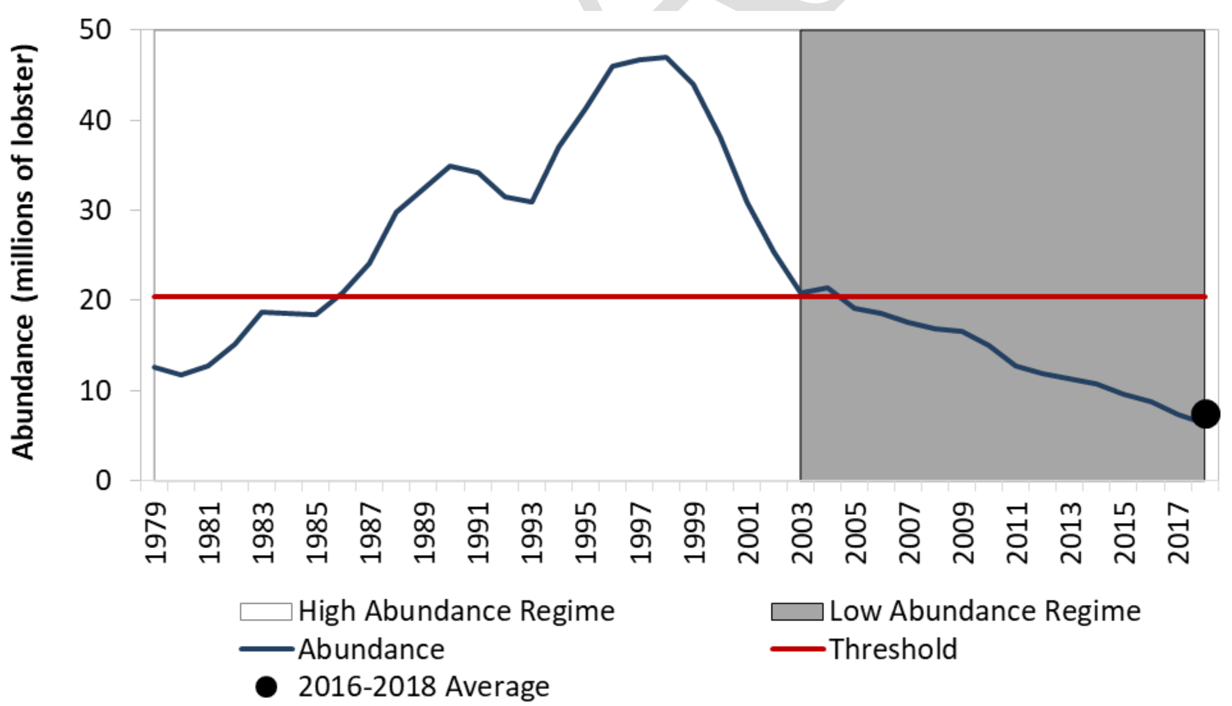

Figure 3. Abundance for SNE Relative to Reference Points. Source: 2020 Benchmark Stock Assessment for American Lobster.

Figure 4. Stratified mean catch and recruit abundance for American lobster on the Spring ME/NH Inshore Trawl Survey (2000-2022). Top: Mean catch of sublegals (<83). Middle: Mean catch of legal sized lobsters (>82). Bottom: Recruit abundance (71-80 mm lobsters).

Figure 5. Stratified mean catch and recruit abundance for American lobster on the Fall ME/NH Inshore Trawl Survey (2000-2022). Top: Mean catch of sublegals (<83). Middle: Mean catch of legal sized lobsters (>82). Bottom: Recruit abundance (71-80 mm lobsters).

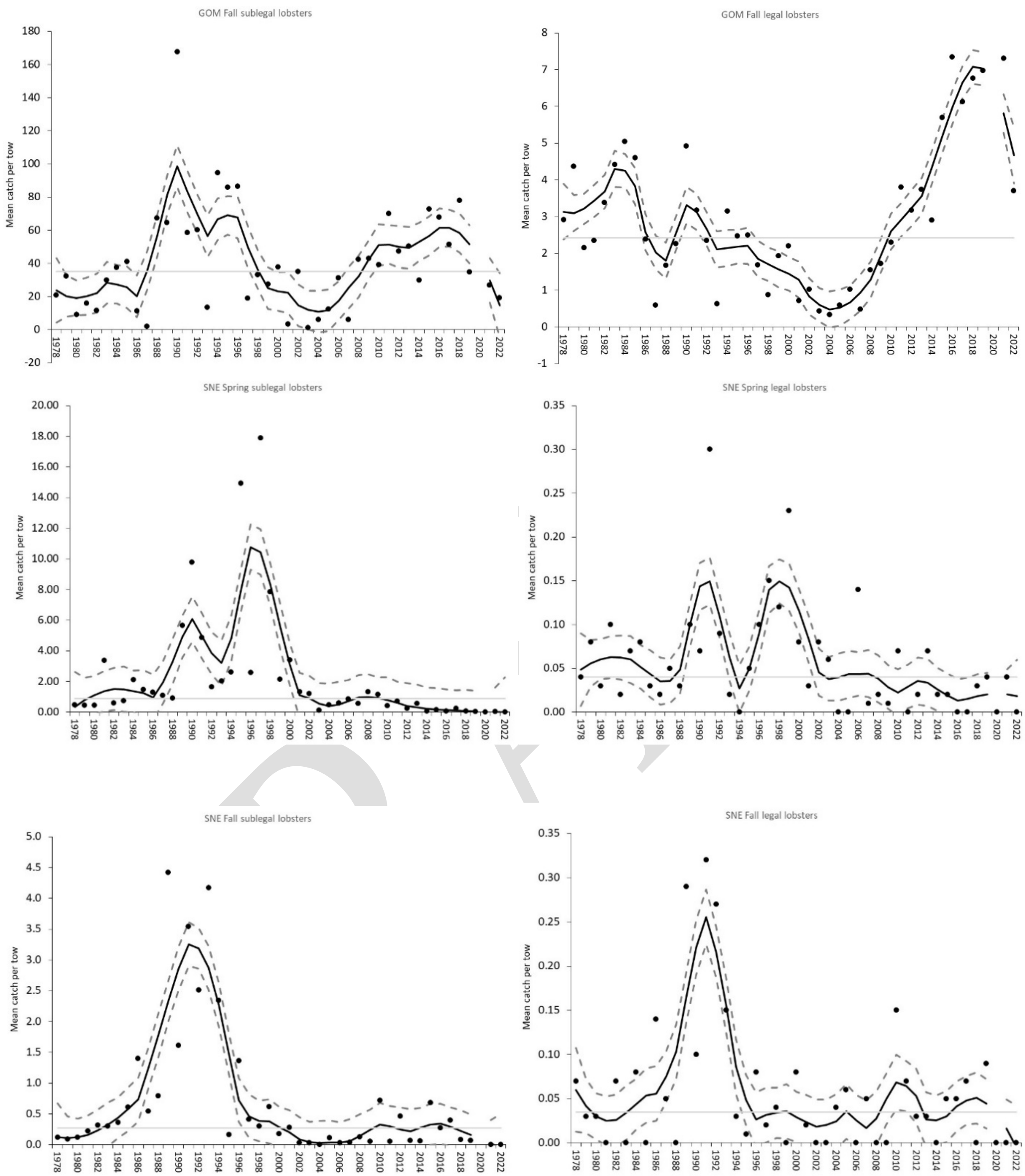

Figure 6. MADMF Fall Trawl Survey sublegal (left) and legal (right) indices from 1978-2019 sexes combined. The top two charts are from Gulf of Maine and the bottom four charts are from Southern New England.

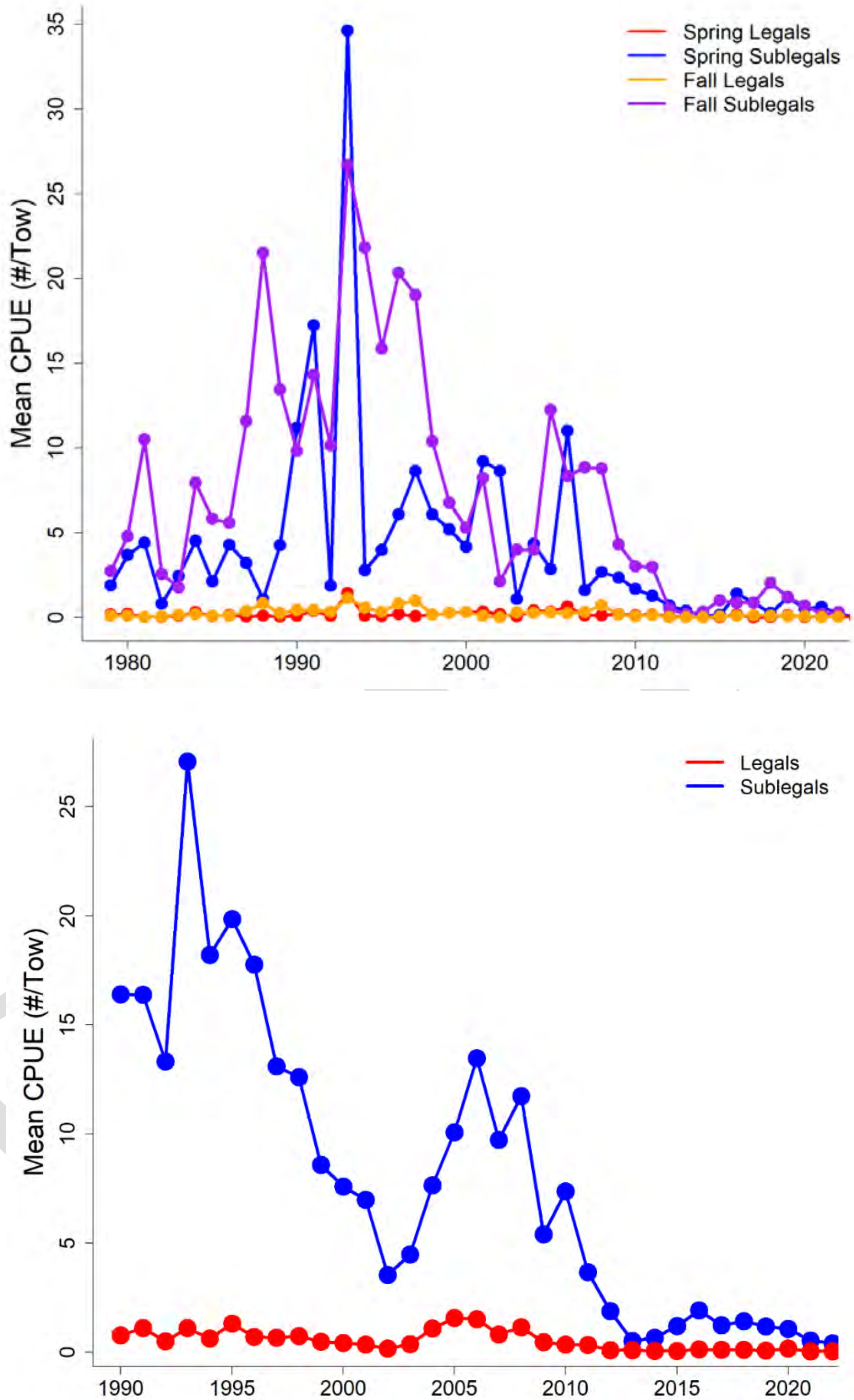

Figure 7. RIDFW Seasonal (spring and fall) Trawl lobster abundances (top) and Monthly Trawl lobster abundances (bottom). CPUE is expressed as the annual mean number per tow for sub-legal (<85.725mm CL) and legal sized (>=85.725mm CL) lobsters.

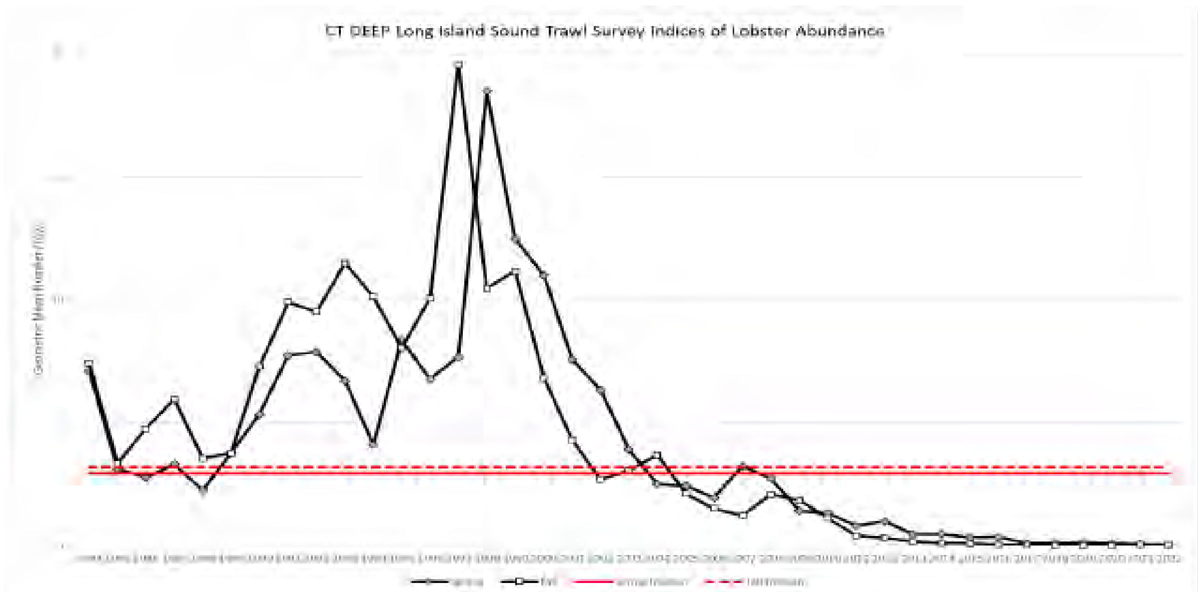

Figure 8. Results of the Long Island Sound Trawl Survey during spring (April-June) and fall (September-October) within NMFS statistical area 611.

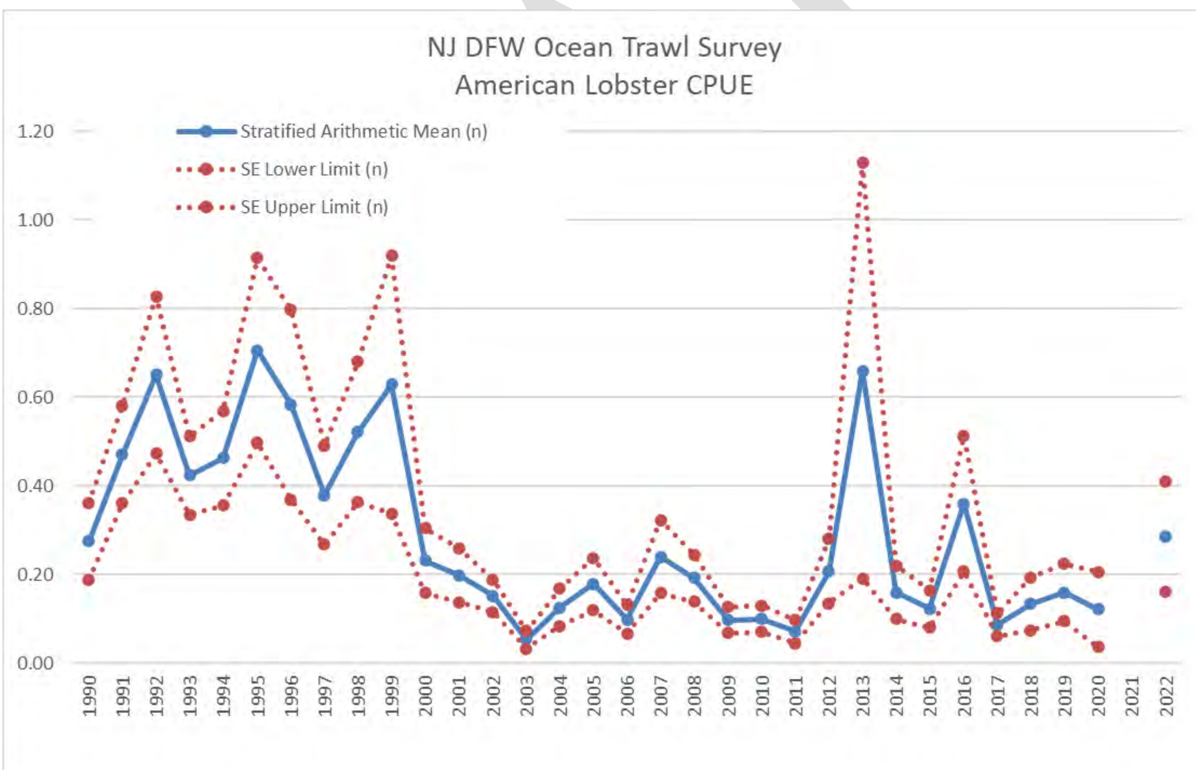

Figure 9. Stratified mean CPUE of all lobsters collected aboard the NJDFW Ocean Trawl Survey. *NOTE: No April 2019 Survey was conducted due to Research vessel mechanical issues. Due to the COVID-19 pandemic, Apr-Oct 2020 and 2021 CPUE and indices were not obtained.

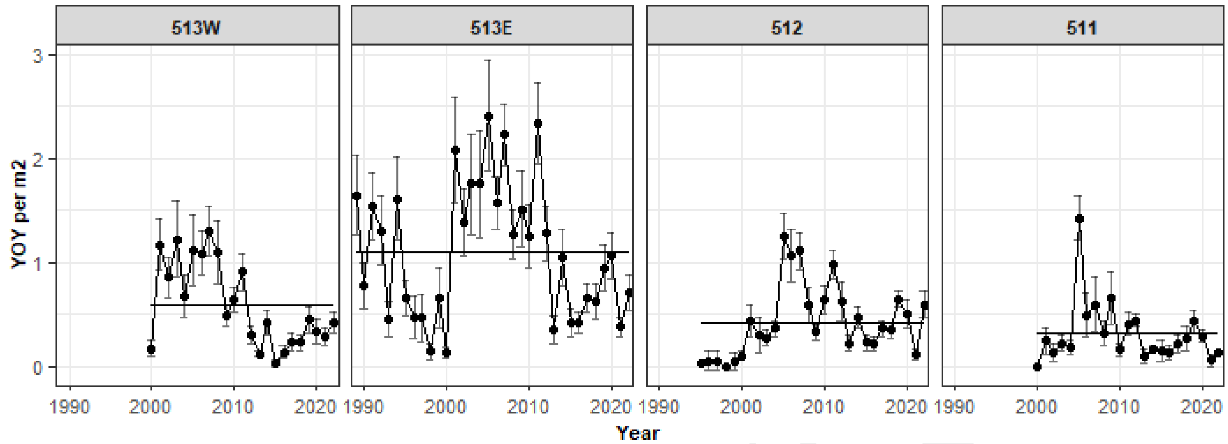

Figure 10. Maine Lobster Settlement Survey Index 1989-2022 for each statistical area with series average (solid horizonal line) for each region with standard error bars.

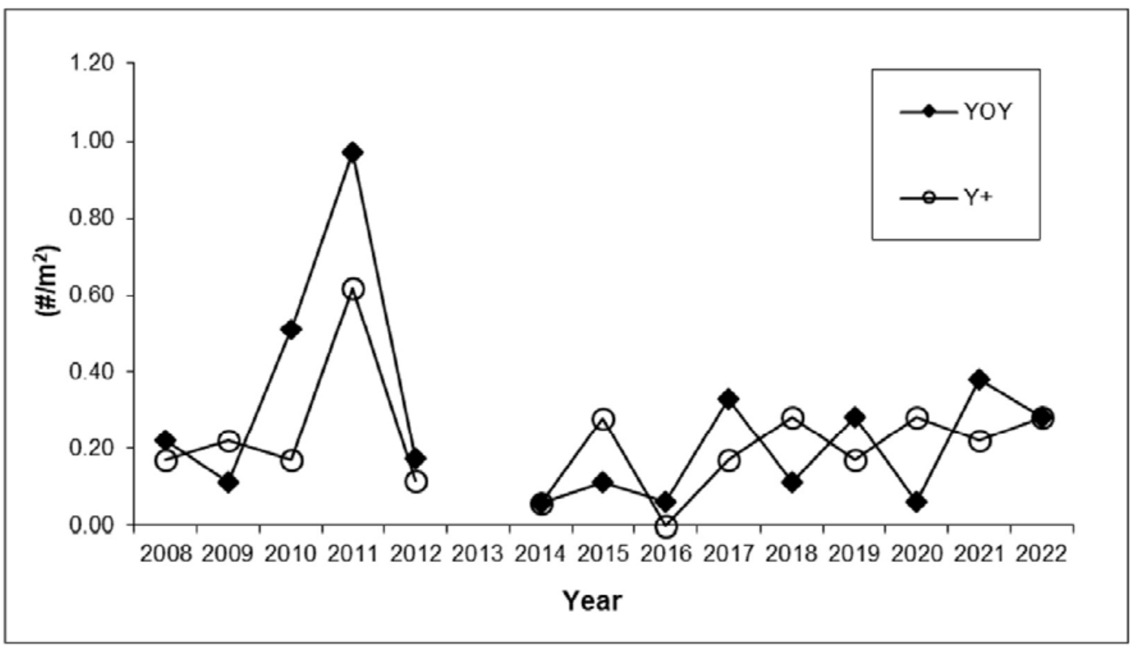

Figure 11. Catch per unit effort (#/m2) of young-of-year (YOY), one-year-olds (Y+), YOY and Y+ combined, and all lobsters during the American Lobster Settlement Index, by location, in New Hampshire, from 2008 through 2022.

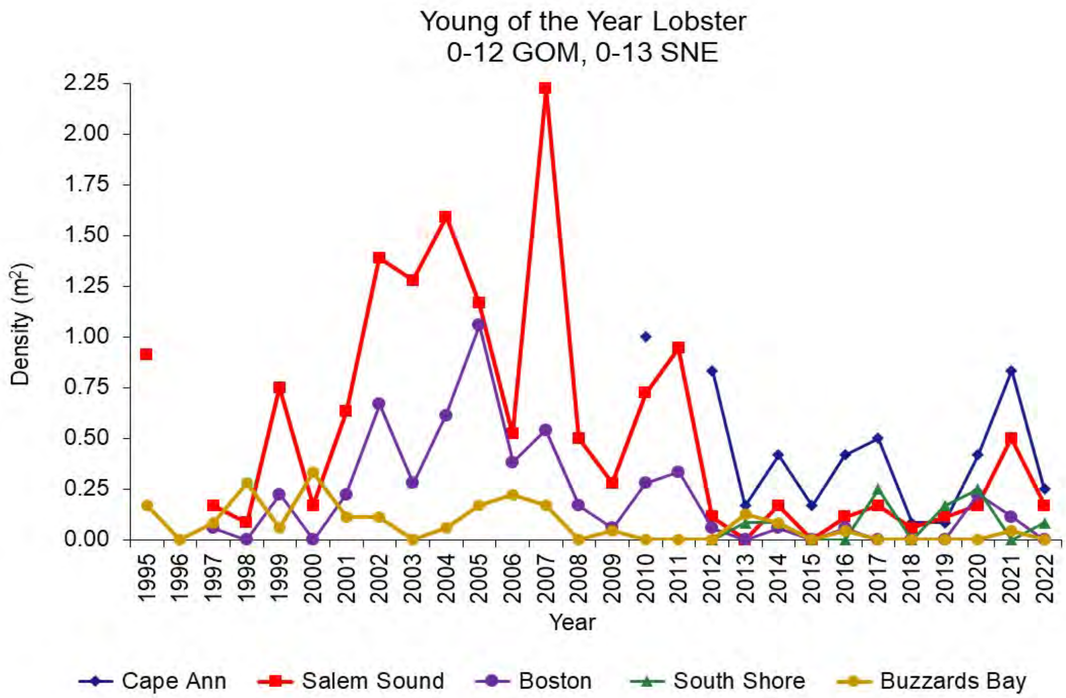

Figure 12. Young-of-year lobster density in four regions within the GOM stock unit – Cape Ann, Salem Sound, Boston, and South Shore, and one region in the SNE stock unit - Buzzards Bay. In GOM locations, lobsters ≤ 12 mm CL are considered YOY, while in SNE locations YOYs are ≤ 13 mm CL.

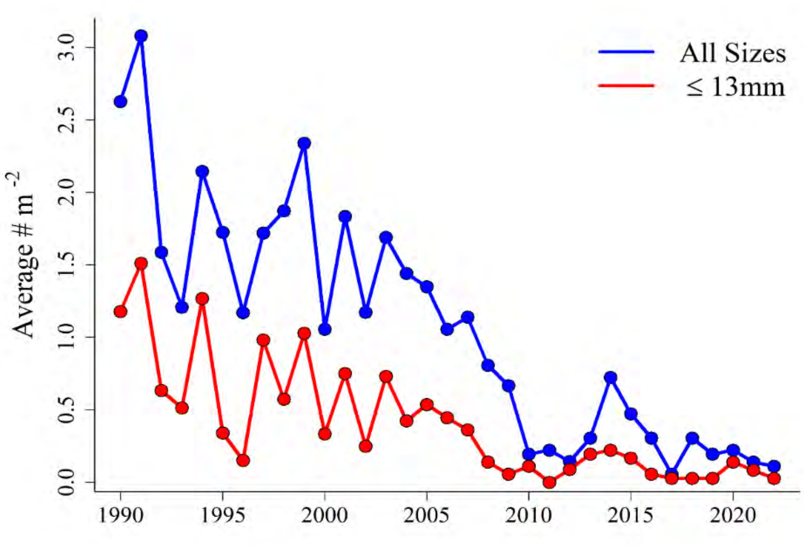

Figure 13. Average abundance of American lobster in Rhode Island suction sampling sites. Abundances are presented for YOY lobsters 13 mm or smaller (red line) and all sizes (blue line).

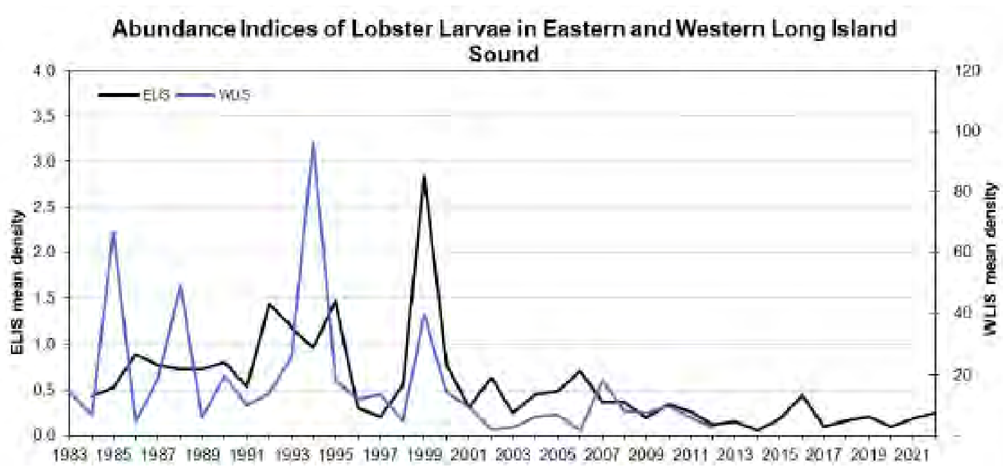

Figure 14. Abundance indices of lobster larvae from the Connecticut DEEP Larval Lobster Survey in western Long Island Sound and from the Millstone Power Station entrainment estimates in eastern Long Island Sound. The Connecticut DEEP survey was discontinued in 2013.

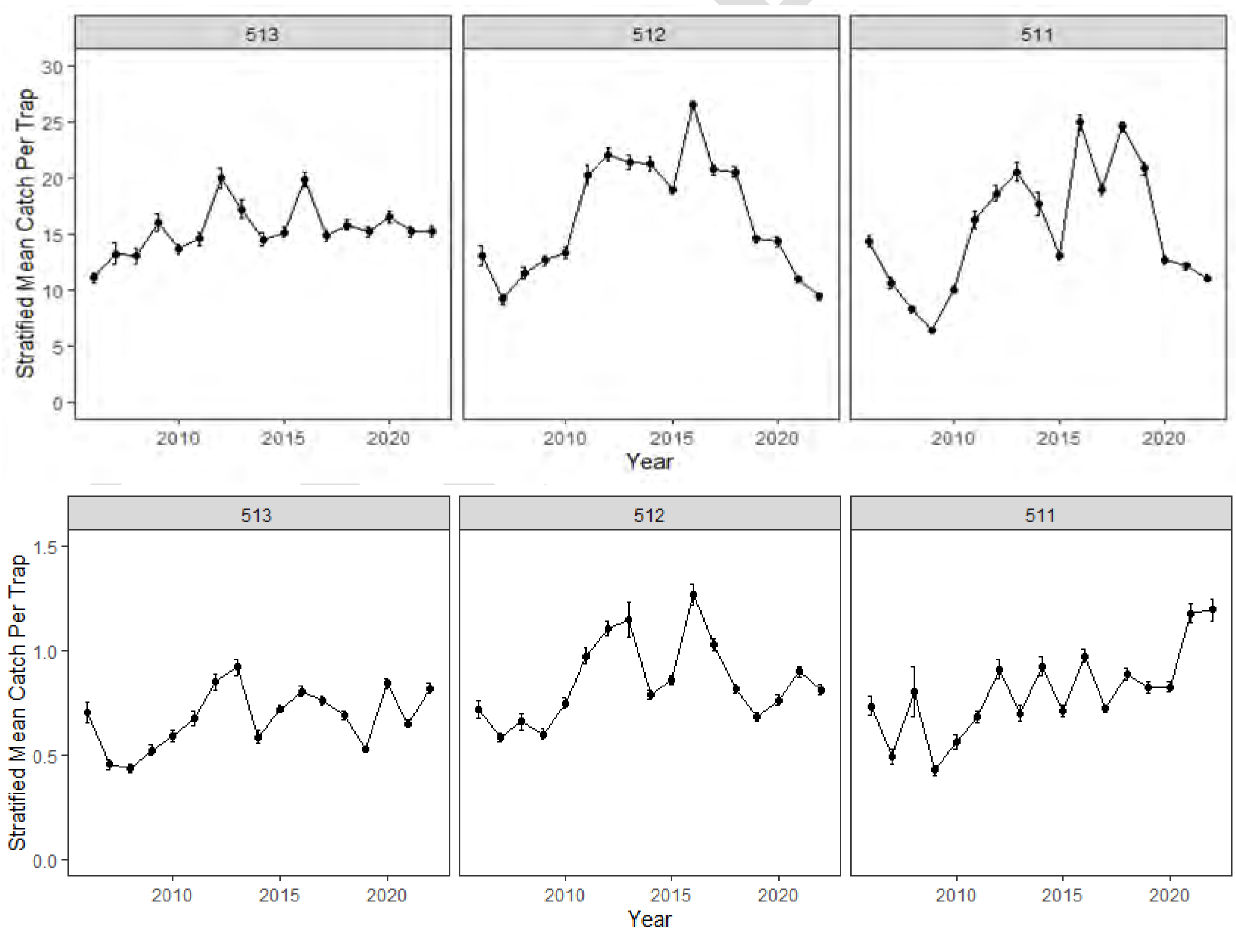

Figure 15. Stratified mean catch per trap for sublegal (top) and legal (bottom) sized lobsters from Maine's Ventless Trap Survey 2006-2022 by statistical area from ventless traps only. Standard error is shown.

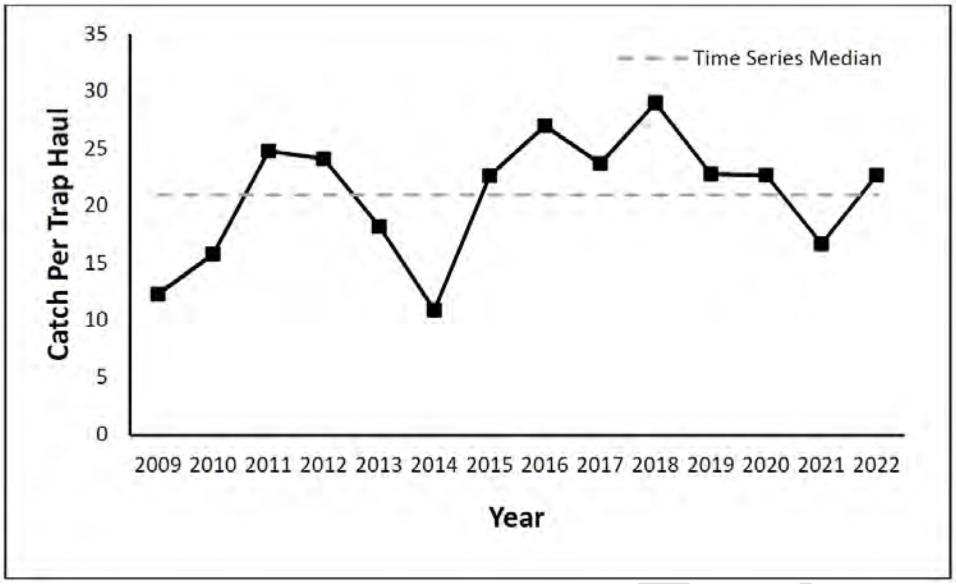

Figure 16. Stratified mean catch per trap haul (ventless traps only) for all lobsters captured during the coast-wide random stratified Ventless Trap Survey in New Hampshire state waters from 2009 through 2022.

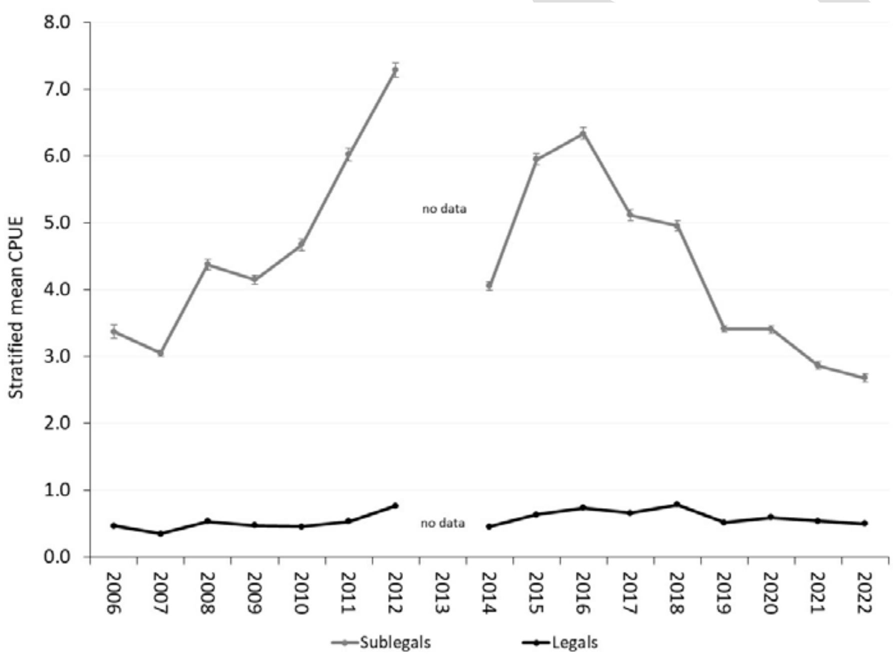

Figure 17. Stratified mean catch per trap haul (±S.E.) of sublegal (< 83 mm, grey line) and legal (≥ 83 mm, black line) lobsters in NMFS Area 514 from MADMF ventless trap survey from 2006-2022.

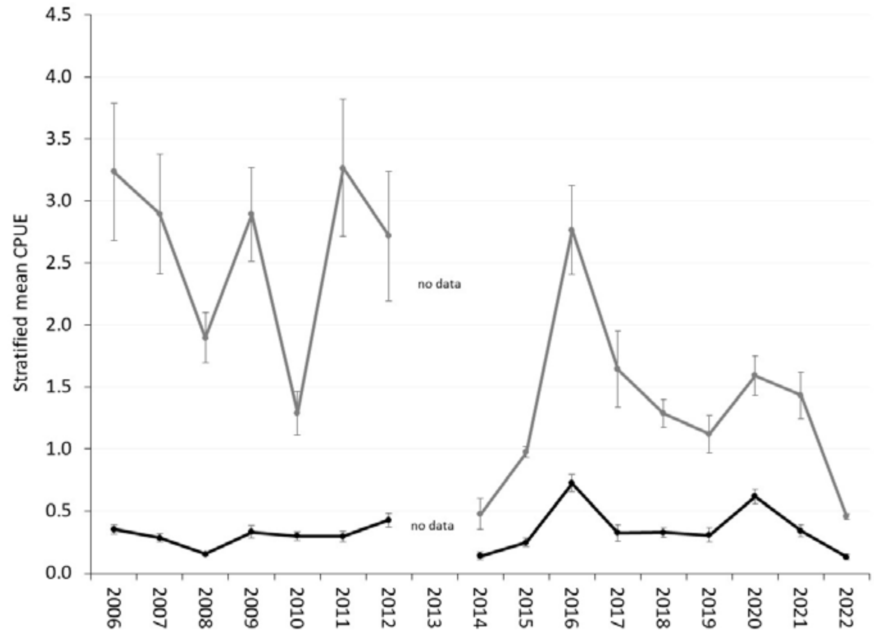

Figure 18. Stratified mean catch per trap haul (±S.E.) of sublegal (< 86 mm, grey line) and legal (≥ 86 mm, black line) lobsters in the reduced MA SNE survey area, Area 538.

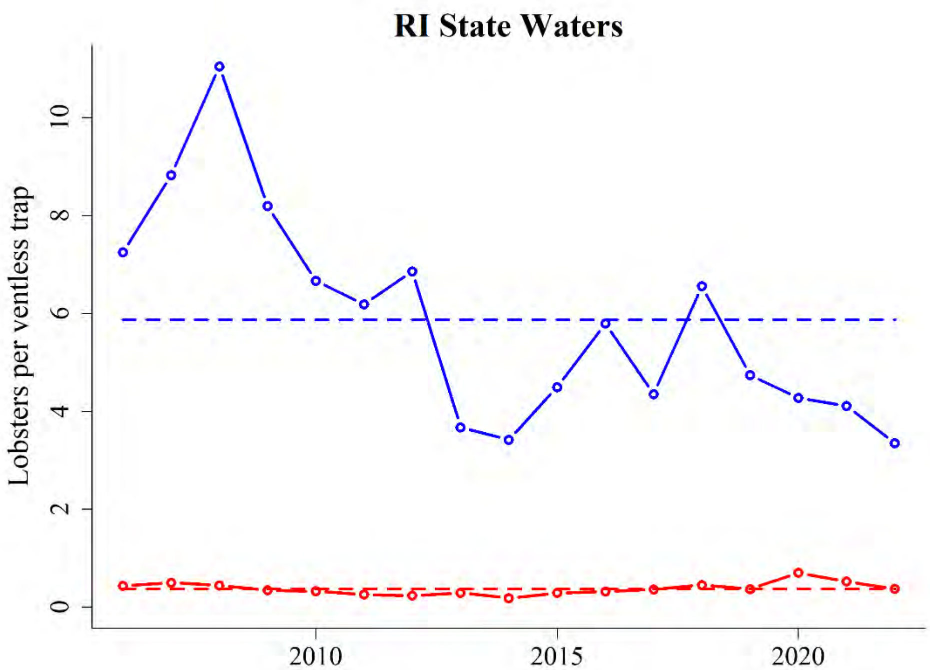

Figure 19. Depth-stratified mean catch of sublegal lobsters in the RIDEM DMF ventless trap survey, 2006-2022.

ATLANTIC STATES MARINE FISHERIES COMMISSION

REVIEW OF THE INTERSTATE FISHERY MANAGEMENT PLAN

For Jonah Crab
(*Cancer borealis*)

2022 FISHING YEAR

Prepared by the Plan Review Team

October 2023

Sustainable and Cooperative Management of Atlantic Coastal Fisheries

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REVIEW OF THE ATLANTIC STATES MARINE FISHERIES COMMISSION FISHERY MANAGEMENT PLAN FOR JONAH CRAB (*Cancer borealis*)

2022 FISHING YEAR

1.0 Status of the Fishery Management Plan

Year of ASMFC Plan's Adoption:	FMP (2015)
Framework Adjustments:	Addendum I (2016) Addendum II (2017) Addendum III (2018) Addendum IV (2022)
Management Unit:	Maine through North Carolina
States with a Declared Interest:	Maine through Virginia (Excluding Pennsylvania and DC)
Active Committees:	American Lobster Management Board, Technical Committee, Plan Review Team, Advisory Panel, Electronic Reporting Subcommittee, Electronic Tracking Subcommittee

2.0 Status of the Fishery

2.1 Commercial Fishery

Historically, Jonah crab was taken as bycatch in the lobster fishery; however, in recent years a directed fishery has emerged causing landings to rapidly increase. Throughout the 1990s, landings fluctuated between approximately 2 and 3 million pounds, and the overall value of the fishery was low. In the early 2000's landings began to increase, with over 7 million pounds landed in 2005. By 2014, landings had almost tripled to 17 million pounds and a value of nearly $13 million. This rapid increase in landings can be attributed to an increase in the price of other crab (such as Dungeness), creating a substitute market for Jonah crab, as well as a decrease in the abundance of lobsters in Southern New England, causing fishermen to redirect effort on Jonah crab. It should be noted that there is some uncertainty in the landings data—especially prior to 2008—due to species misidentification issues as well as underreporting of landings before the implementation of reporting requirements. Despite the uncertainty, the overall trend in landings is likely accurate.

Today, Jonah crab and lobster are harvested in a mixed crustacean fishery in which fishermen can target lobster or crab at different times of the year based on slight gear modifications and small shifts in the areas in which the traps are fished. While the majority of Jonah crab landings is harvested as whole crabs, fishermen from several states, including New York, Maryland and Virginia, land claws. Jonah crab claws are relatively large and can be an inexpensive substitute for stone crab claws. As a result, they can provide an important source of income for fishermen.

Along the Delmarva Peninsula, small boat fishermen have historically harvested Jonah crab claws because they do not have seawater storage tanks on board to store whole crabs.

In 2022, landings along the Atlantic Coast totaled approximately 14 million pounds of Jonah crab, representing $22.6 million in ex-vessel value. Landings increased 17% from 2021 landings of 11.9 million pounds, while ex-vessel value increased 76% from the 2021 value. The states of Massachusetts (55%), Maine (21%), and Rhode Island (17.5%) were the largest contributors to landings. Almost all coastwide landings came from trap gear.

2.2 Recreational Fishery
The magnitude of the Jonah crab recreational fishery is unknown at this time; however, it is believed to be quite small in comparison to the size of the commercial fishery.

3.0 Status of the Stock
Jonah crab are distributed in the waters of the Northwest Atlantic Ocean primarily from Newfoundland, Canada to Florida. The life cycle of Jonah crab is poorly described, and what is known is largely compiled from a patchwork of studies that have both targeted and incidentally documented the species. Based on tagging studies, male Jonah crab movements are generally limited to a few kilometers, though some individuals have been documented to travel over 100 km. Female movement patterns are poorly understood due to limited reported tag recaptures. Due to the lack of a widespread and well-developed aging method for crustaceans, Jonah crab size-at-age, and age-at-maturity are poorly described.

There is currently very limited information available on the status of the Jonah crab resource. The first range-wide stock assessment was completed and is scheduled for peer review in 2023. Massachusetts, Rhode Island, Maine, and New Hampshire conduct inshore state water trawl surveys, and NOAA Fisheries conducts a trawl survey in federal waters which collects data on Jonah crab abundance and distribution.

4.0 Status of Management Measures
Interstate Fishery Management Plan for Jonah Crab (2015)
Jonah crab is managed under the Interstate Fishery Management Plan (FMP) which was approved by the American Lobster Management Board in August 2015. The goal of the FMP is to promote conservation, reduce the possibility of recruitment failure, and allow for the full utilization of the resource by the industry. The FMP lays out specific management measures in the commercial fishery. These include a 4.75” minimum size and a prohibition on the retention of egg-bearing females. To prevent the fishery from being open access, the FMP states that participation in the directed trap fishery is limited to lobster permit holders or those who can prove a history of crab-only pot fishing. All others must obtain an incidental permit. In the recreational fishery, the FMP sets a possession limit of 50 whole crabs per person per day and prohibits the retention of egg-bearing females. Due to the lack of data on the Jonah crab fishery, the FMP implements a fishery-dependent data collection program. The FMP also requires harvester and dealer reporting along with port and/or sea sampling.

Addendum I (2016)
Addendum I establishes a bycatch limit of 1,000 crabs per trip for non-trap gear (e.g., otter trawls, gillnets) and non-lobster trap gear (e.g., fish, crab, and whelk pots). In doing so, the Addendum caps incidental landings of Jonah crab across all non-directed gear types with a uniform bycatch allowance. While the gear types in Addendum I make minimal contributions to total landings in the fishery, the 1,000 crab limit provides a cap to potential increases in effort and trap proliferation.

Addendum II (2017)
Addendum II establishes a coastwide standard for claw harvest. Specifically, it permits Jonah crab fishermen to detach and harvest claws at sea, with a required minimum claw length (measured along the forearm of the claw) of 2.75" if the volume of claws landed is greater than five gallons. Claw landings less than five gallons do not have to meet the minimum claw length standard. The Addendum also establishes a definition of bycatch in the Jonah crab fishery, whereby the total pounds of Jonah crab caught as bycatch must weigh less than the total amount of the targeted species at all times during a fishing trip. The intent of this definition is to address concerns regarding the expansion of a small-scale fishery under the bycatch limit.

Addendum III (2018)
Addendum III improves the collection of harvester and biological data in the Jonah crab fishery. Specifically, the Addendum improves the spatial resolution of harvester data collection by requiring fishermen to report via 10-minute squares. It also expands the required harvester reporting data elements to collect greater information on gear configurations and effort. In addition, the Addendum established a deadline that within five years, states are required to implement 100% harvester reporting, with the prioritization of electronic harvester reporting development during that time. Finally, the Addendum improves the biological sampling requirements by establishing a baseline of ten sampling trips/year, and encourages states with more than 10% of coastwide landings to conduct additional sampling trips.

Addendum IV (2022)
Addendum IV expands on reporting improvements by establishing electronic tracking requirements for federally-permitted vessels in the American lobster and Jonah crab fisheries. Specifically, electronic tracking devices will be required for vessels with commercial trap gear area permits for Lobster Conservation Management Areas (LCMAs) 1, 2, 3, 4, 5, and Outer Cape Cod to collect high resolution spatial and temporal effort data.

5.0 Fishery Monitoring
The provisions of Addendum III went into effect January 1, 2019. Specifically, Addendum III requires reporting of additional data elements, the implementation of 100% harvester reporting within five years, and the completion of a minimum of ten sea and/or port sampling trips per year for biological sampling of the lobster/Jonah crab fishery. The Addendum III requirement for commercial harvesters to report their fishing location by 10 minute longitudinal/latitudinal square was implemented in 2021. *De minimis* states are not required to conduct fishery-independent sampling or port/sea sampling.

Overviews of the states' port and sea sampling in 2022 are as follows:

- Maine: Maine conducted 163 sea sampling trips, 34 of which had Jonah crab measurements, for a total of 2,925 sampled Jonah crabs. Only 20 of the trips in 2022 measured more than 20 Jonah crabs. Types of information collected included: shell width, sex, discards, egg bearing status, cull status, shell hardness, and whether landings are whole crabs or parts. Maine's lobster port sampling program was suspended in 2011.
- New Hampshire: Staff sampled 29 Jonah crab on 14 sea sampling trips and collected information on sex, the presence of eggs, cull condition, molt stage, and carapace length. NH initiated a quarterly port sampling program in late 2016. Quarterly sampling took place at shellfish dealers, where an interview with the captain occurred and a biological sample was taken. A total of 426 Jonah crab were sampled (sexed, measured for carapace width, and weighed when feasible).
- Massachusetts: Massachusetts made 15 port sampling trips and sampled 7,103 Jonah crab from 8 different vessels. Data collected include carapace width, sex, egg bearing status, cull status, and shell hardness. No Jonah crab sea sampling trips were conducted.
- Rhode Island: Rhode Island did not conduct sea sampling for Jonah crab in 2022, due to funding and staff limitations. Five port sampling trips were conducted in 2022, measuring 971 Jonah crabs caught in four different Statistical Areas. Types of information collected included: carapace width, sex, egg bearing status, cull status, shell hardness, and shell disease condition.
- Connecticut: No sea sampling or port sampling trips were conducted for Jonah crab.
- New York: Staff conducted 7 market sampling trips, sampling 370 Jonah crab. No sea sampling trips were conducted for Jonah crab in 2022.
- New Jersey: No sea or port sampling trips were conducted for Jonah crab in 2022.
- Delaware: No sea or port sampling trips were conducted for Jonah crab in 2022.
- Maryland: No sea or port sampling trips were conducted for Jonah crab in 2022.
- Virginia: No sea or port sampling trips were conducted for Jonah crab in 2022.

6.0 Status of Surveys

The FMP for Jonah crab encourages states to expand current lobster surveys (i.e. trawl surveys, ventless trap surveys, settlement surveys) to collection biological information on Jonah crab. The following outlines the fishery-independent surveys conducted by each state.

Maine

A. Settlement Survey

The Maine settlement survey was primarily designed to quantify lobster young-of-year (YOY), but has also collected Jonah crab data from the sites throughout the survey. Jonah crab information collected includes carapace width, sex (when large enough), ovigerous condition, claw status, shell hardness, and location. The density of YOY Jonah crab increased over the past two decades with high values in 2012 and 2016, then declined slightly in recent years (Figure 1). In 2022, density of YOY Jonah crab increased from 2021 in Area 513 and 512, and decreased in 511.

B. State Trawl Survey

The ME/NH Inshore Trawl Survey began in 2000 and is conducted biannually (spring and fall) through a random stratified sampling scheme. Jonah crab data has been collected since 2003. The 2022 spring survey ran from May to June and completed 101 out of 120 scheduled tows. A total of 143 Jonah crabs were caught and sampled, with 54 females and 89 males caught and measured. The 2022 fall survey completed 87 out of 120 scheduled tows; a total of 115 Jonah crabs were caught and sampled, with 52 females, 62 males, and 1 unsexed crab caught and measured. Abundance indices for Jonah crab increased in 2022 after declining since 2016 (Tables 2 and 3).

C. Ventless Trap Survey

Maine began its Juvenile Lobster Ventless Trap Survey in 2006. Since the beginning of the survey, Jonah crab counts were recorded by the contracted fishermen, but the confidence in early years of this data is low because of the confusion between the two *Cancer* crabs (Jonah crab vs. rock crab) and similar common names. In 2016, the survey began collecting biological data for Jonah crab including carapace width, sex, ovigerous condition, claw status, shell hardness, and location. In 2022 Jonah crab catch in the survey decreased in all areas from 2021. Concentrations of Jonah crab were highest in Statistical Area 512 and lowest in 513 (Figure 2).

New Hampshire

A. Settlement Survey

Since 2009, species information has been collected on Jonah crab in the New Hampshire Fish and Game portion of the American Lobster Settlement Index. Figure 3 shows the CPUE ($\#/m^2$) of Jonah crab for all NH sites combined, from 2009 through 2022. The time series shows a general upward trend with a time series high in 2022.

B. Ventless Trap Survey

Since 2009, New Hampshire Fish and Game has been conducting the coastwide Random Stratified Ventless Trap Survey in state waters (Statistical Area 513). A total of six sites were surveyed twice a month from June through September in 2022. Beginning in 2016, all Jonah crabs were evaluated for sex, carapace width (mm), cull condition, and molt stage. A total of 17 Jonah crab over 8 trips were measured during the 2022 sampling season.

Massachusetts

A. Settlement Survey

The Juvenile Lobster Suction Survey has consistently identified *Cancer* crabs to genus level since 1995, and Jonah crab have been consistently identified to species in the survey since 2011. The mean number of Jonah crab observed in the MA DMF Settlement Survey in the GOM region has been higher from 2016 through 2022 than it was from 2011 to 2015 (Figure 4).

B. Ventless Trap Survey

The Massachusetts Division of Marine Fisheries (MA DMF) Ventless Trap Survey is conducted in MA territorial waters of NMFS statistical areas 514 and 538. Stratified mean catch per trawl haul (CPUE) for the survey is standardized to a six-pot trawl with three vented and three ventless traps. The index produced from the MA DMF Ventless Trap Survey has been increasing since 2012 and is approaching time series highs (Figure 5).

C. Trawl Survey

The aggregation of DMF trawl survey regions has changed compared to previous reports. Regions 1 and 2 are considered SNE, regions 3-5 are considered GOM. Previously, region 3, which extends southwards from the tip of Cape Cod along the eastern side of the outer Cape to south of Nantucket, was included with SNE. Except for the fall survey in the GOM region, Jonah crabs are infrequently caught in the MA DMF Trawl Survey. Since generally increasing in abundance since the mid-1990's, the last couple of years of the fall survey in the GOM have generally been near or below time series medians (Figure 6).

Rhode Island

A. Settlement Survey

The RI DEM lobster YOY Settlement Survey (Suction Sampling) intercepts Jonah crabs. Jonah crab catches in this survey are generally low. In 2022, the Jonah Crab Index was zero crabs per m^2, compared with the time series (1990-2022) mean of 0.18 crabs per m^2 (Figure 7).

B. Ventless Trap Survey

Since its inception in 2006, the RI Ventless Trap Survey (VTS) has recorded counts of Jonah crab per pot. Carapace width, sex, ovigerous condition, and location data have been collected for all Jonah crabs encountered in the survey since 2015; prior to this, only counts of Jonah crab were recorded. In 2022, the stratified abundance index of Jonah crabs was 2.40 crabs per ventless trap, higher than the time series mean of 1.40 crabs per ventless trap (Figure 8).

B. Trawl Survey

RI DEM has conducted spring and fall trawl surveys since 1979, and a monthly trawl survey since 1990. However, the survey did not begin counting Jonah crab specifically until 2015. Jonah crabs are rarely encountered in this survey, and abundance indices are variable yet low, averaging 0.04 crabs per tow over the time series.

Connecticut

A. Trawl Survey

Jonah crab abundance is monitored through the Long Island Sound Trawl Survey (LISTS) during the spring (April, May, June) and fall (September and October) cruises, all within NMFS statistical area 611. The survey documents the number of individuals caught and total weight per haul by survey site in Long Island Sound. The LISTS caught one Jonah crab in the fall 2007 survey and two in the fall 2008 survey. Both observations occurred in October at the same trawl site in eastern Long Island Sound. No trawl survey sampling was conducted in 2020 due to restrictions on field sampling caused by the global COVID-19 pandemic. No Jonah crabs were observed in the 2021 or 2022 spring or fall surveys.

New York

A. Trawl Survey

New York initiated a stratified random trawl survey in the near shore ocean waters off the south shore of Long Island in 2018 from the Rockaways to Montauk Point and the New York waters of Block Island Sound. Seven sampling cruises were conducted in 2022 during the winter (February), spring (April, May, June), summer (August) and fall (October, November). Twenty-one stations were sampled during the winter cruise in February. Thirteen, seventeen, and twenty-three stations were sampled during the spring cruises. Thirty stations were sampled during the summer cruise in August. During the fall, 20 stations were sampled in October and eight stations were sampled in November. A total of 256 Jonah crabs were caught. A total of 35 females were measured ranging from 18mm to 111mm with an average of 55mm; 58 males were measured ranging from 16mm to 141mm, with an average shell width of 84mm.

New Jersey

A. Trawl Survey

A fishery-independent Ocean Trawl Survey is conducted from Sandy Hook, NJ to Cape May, NJ each year. The survey stratifies sampling in three depth gradients, inshore (18'-30'), mid-shore (30'-60'), and offshore (60'-90'). The mean CPUE, which is calculated as the sum of the mean weight of Jonah crab collected in each sampling area weighted by the stratum area, has remained low throughout the time series, but increased slightly in 2019. A cruise was not conducted in April 2019. Due to the COVID-19 pandemic, 2020 and 2021 CPUE and indices were not obtained (Figure 9).

7.0 Recent and On-Going Research Projects

A. Declawing Study

NH F&G, Wells National Estuarine Research Reserve, and the University of New Hampshire have been conducting a variety of collaborative research on Jonah crabs since 2014. Two of those studies were published in 2021. Goldstein and Carloni (2021) assessed the implications of live claw removal, and Dorrance et al. (2021) conducted follow-up research on that study to better understand the sublethal effects of declawing. These manuscripts provide estimates of mortality for declawed animals, and information on the effects of claw removal on feeding, movement and mating.

In addition to the above-mentioned publications, an acoustic telemetry study was conducted in 2018 and 2019 by same collaborators to assess the movement patterns of both controls and declawed animals. These data are currently the basis for Maureen Madray's thesis (Furey lab-UNH) and will be finalized in the coming months.

B. Growth and Fishery Dependent Data

In 2019, two collaborative studies between the University of Rhode Island and Rhode Island DEM were published. The first of these was a growth study, which described molt increments for adult females and males and molting seasonality and molt probabilities for adult males in Rhode Island Sound. The second was an interview study in which fifteen in-person interviews were conducted with Jonah crab fishermen to collect their knowledge concerning Jonah crab biology and fishery characteristics. The interviews provided insight into aspects of the species biology and life history that have not been characterized in the literature (e.g., seasonal distribution patterns); identified topics requiring further study (e.g., stock structure and spawning seasonality); and highlighted predominant concerns related to fishery management (e.g., inshore-offshore fleet dynamics).

New Hampshire Fish and Game, Wells National Estuarine Research Reserve and the University of New Hampshire conducted research on growth rates of crabs held at ambient and controlled temperatures for sizes ranging from 5 mm (YOY) to 100 mm. These data are currently being analyzed, and will be available for population assessment purposes.

C. CFRF Research Fleet

The Commercial Fisheries Research Foundation (CFRF) has expanded its lobster commercial research fleet to sample Jonah crab. Biological data collected include carapace width, sex, shell hardness, egg status, and disposition. As of July 31, 2023, 124,325 Jonah crabs have been sampled through the program.

8.0 State Compliance

All states except New York have implemented the provisions of the Jonah Crab FMP and associated addenda. The implementation deadline for the Jonah Crab FMP was June 1, 2016; the implementation deadline for Addendum I was January 1, 2017; the implementation deadline for Addendum II was January 1, 2018; and the implementation deadline for Addendum III was January 1, 2019 (with the exception of the 10 minute square reporting requirement).

- NY is in the process of implementing the full suite of management measures required under the Jonah Crab FMP or Addendum I and II. Specifically, NYSDEC has initiated a rulemaking which will limit participation in the Jonah crab directed trap fishery to those vessel and permit holders which already hold a lobster permit, or those who can prove prior participation in the crab fishery before the control date of June 2, 2015. This rulemaking will also establish a bycatch limit for Jonah crab of no more than 1,000 crabs per trip for non-trap gear and non-lobster trap gear. This rulemaking should be in effect before 2024.

9.0 De Minimis Requests

The states of Delaware, Maryland, and Virginia, have requested *de minimis* status. According to the Jonah crab FMP, states may qualify for *de minimis* status if, for the preceding three years for which data are available, their average commercial landings (by weight) constitute less than 1% of the average coastwide commercial catch. Delaware, Maryland, and Virginia meet the *de minimis* requirement.

10.0 Research Recommendations

A stock assessment for Jonah crab has been completed and is scheduled for peer review in 2023. Research recommendations will be made by the Stock Assessment Subcommittee and

Peer Review Panel.

11.0 Plan Review Team Recommendations

The following are recommendations and comments from the Plan Review Team:

- The PRT recommends the Board approve the *de minimis* requests of DE, MD, and VA.
- The PRT notes that MA has been unable to meet the August 1 deadline for compliance reports for the last several years.
- Rhode Island, Connecticut, New York, and New Jersey were not able to complete the sea and/or port sampling required by the FMP. These states have noted concerns with staff availability, funding, and lack of agreement by fishermen, which have contributed to the inability to complete the required sampling trips.

12.0 Tables

Table 1. Landings (in pounds) of Jonah crab by the states of Maine through Virginia. 2010-2021 landings were provided by ACCSP based on state data submissions. 2022 landings were submitted by the states as a part of the compliance reports and should be considered preliminary. *C= confidential data*

	ME	NH	MA	RI	CT	NY	NJ	DE	MD	VA	Total
2010	1,093,962	C	5,689,431	3,720,440	C	968,122	30,441		17,845	C	11,690,787
2011	1,096,592	C	5,379,792	3,213,119	C	69,440	27,025		92,401	C	9,947,142
2012	556,675	C	7,540,510	3,774,300	2,349	410,349	68,606		C	C	12,552,537
2013	379,073	340,751	10,117,542	4,651,796	51,462	371,713	8,143		C	C	16,075,636
2014	348,295	404,703	11,904,611	4,435,934	49,998	83,060	33,156		153,714	C	17,413,503
2015	312,063	C	9,128,876	4,298,894	C	207,424	68,116	C	39,750	C	14,253,327
2016	602,206	150,341	10,660,653	4,224,092	C	165,427	261,287	C	14,656	C	16,084,217
2017	1,043,418	114,155	11,698,342	4,111,281	C	158,231	433,132	C	23,564	C	17,594,666
2018	1,054,795	22,434	13,250,803	4,665,701	C	231,642	880,192	C	60,628	C	20,175,488
2019	763,807	70,818	9,698,145	4,222,305	C	125,391	1,061,194	C	47,829	C	15,968,414
2020	696,309	31,658	8,605,007	3,319,652	C	105,841	975,522	C	35,606	C	13,744,904
2021	1,426,959	123,729	6,539,131	2,142,424	C	72,066	1,597,748	C	34,327	C	12,345,330
2022	2,956,697	295,529	7,765,545	2,458,416	C	34,550	526,680	C	C	C	14,037,417

Table 2. Jonah crab stratified mean weight (kg/tow) for the Spring Maine-New Hampshire Inshore Trawl Survey 2001-2022 (with no 2020)

Survey	StratMean_Weight	CV_Weight	SE_Weight
SP01	0.97	0.68	0.26
SP02	0.95	0.71	0.27
SP03	0.92	0.33	0.15
SP04	1.11	0.48	0.28
SP05	1.71	0.33	0.32
SP06	1.27	0.47	0.29
SP07	1.13	0.34	0.17
SP08	0.82	0.23	0.09
SP09	0.85	0.25	0.10
SP10	0.52	0.40	0.11
SP11	0.53	0.32	0.08
SP12	0.41	0.25	0.05
SP13	0.26	0.37	0.05
SP14	0.85	0.44	0.15
SP15	0.61	0.36	0.09
SP16	2.11	0.43	0.38
SP17	0.56	0.33	0.07
SP18	0.44	0.30	0.06
SP19	0.36	0.59	0.08
SP21	0.20	0.43	0.03
SP22	0.30	0.32	0.04

Table 3. Jonah crab stratified mean weight (kg/tow) for the Spring Maine-New Hampshire Inshore Trawl Survey 2001-2022 (with no 2020)

Survey	StratMean_Weight	CV_Weight	SE_Weight
FL00	0.45	0.47	0.09
FL01	2.23	0.27	0.32
FL02	1.37	0.66	0.40
FL03	0.63	0.22	0.08
FL04	1.11	0.36	0.23
FL05	0.69	0.34	0.16
FL06	0.69	0.38	0.13
FL07	0.94	0.28	0.15
FL08	1.29	0.17	0.12
FL09	0.38	0.30	0.06
FL10	0.46	0.43	0.09
FL11	0.34	0.35	0.07
FL12	0.29	0.30	0.04
FL13	0.29	0.26	0.04
FL14	0.16	0.36	0.02
FL15	2.52	0.42	0.48
FL16	2.01	0.27	0.28
FL17	1.14	0.24	0.13
FL18	0.75	0.46	0.14
FL19	0.68	0.20	0.06
FL20	0.15	0.62	0.05
FL21	0.13	0.36	0.02
FL22	0.19	0.46	0.04

13.0 Figures

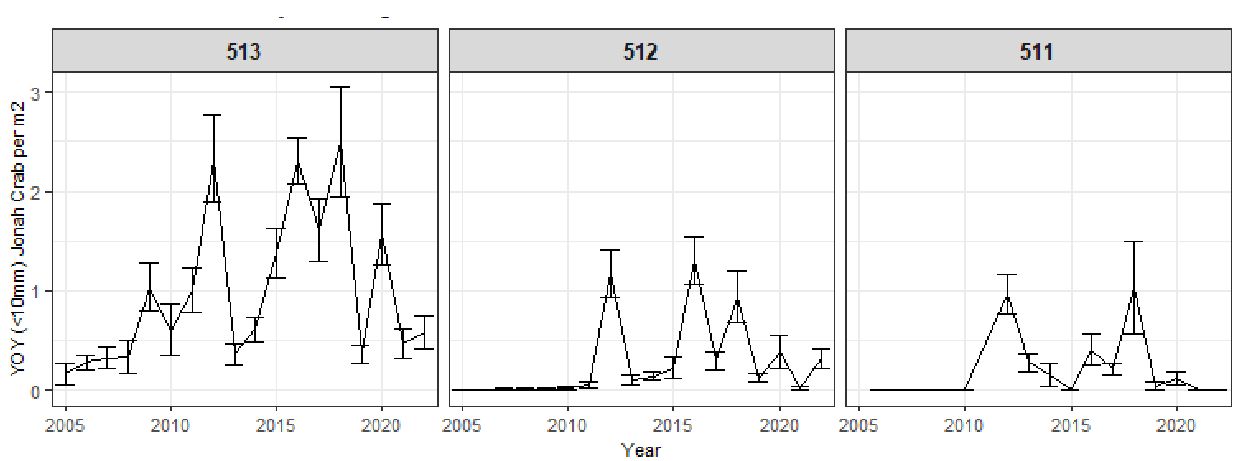

Figure 1. Density of YOY (<10mm carapace width) Jonah crab over time in the Maine Settlement Survey by statistical area.

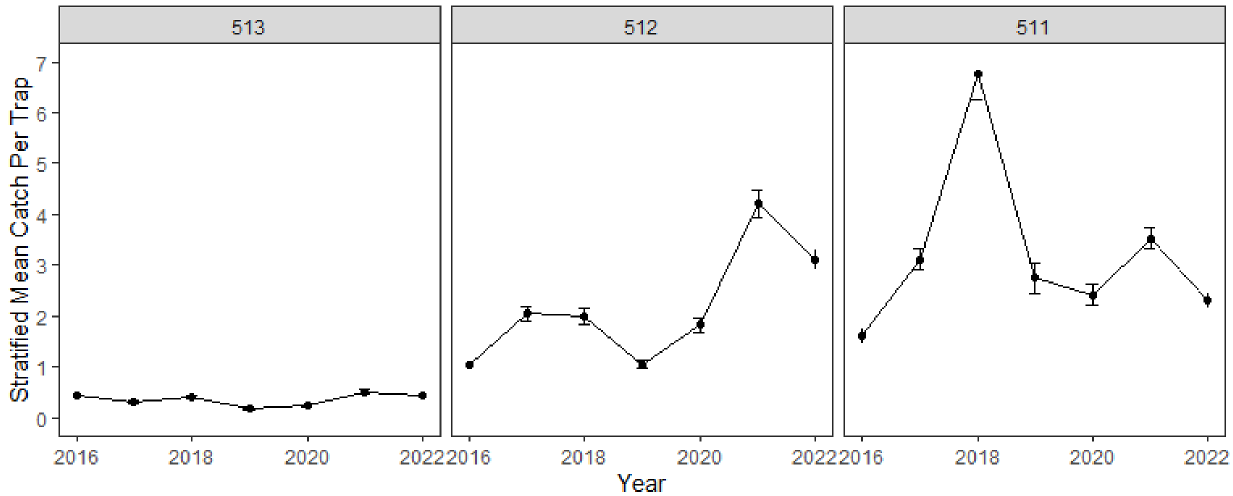

Figure 2. Stratified mean of Jonah crab from Maine Ventless Trap Survey 2016-2022. Standard error shown.

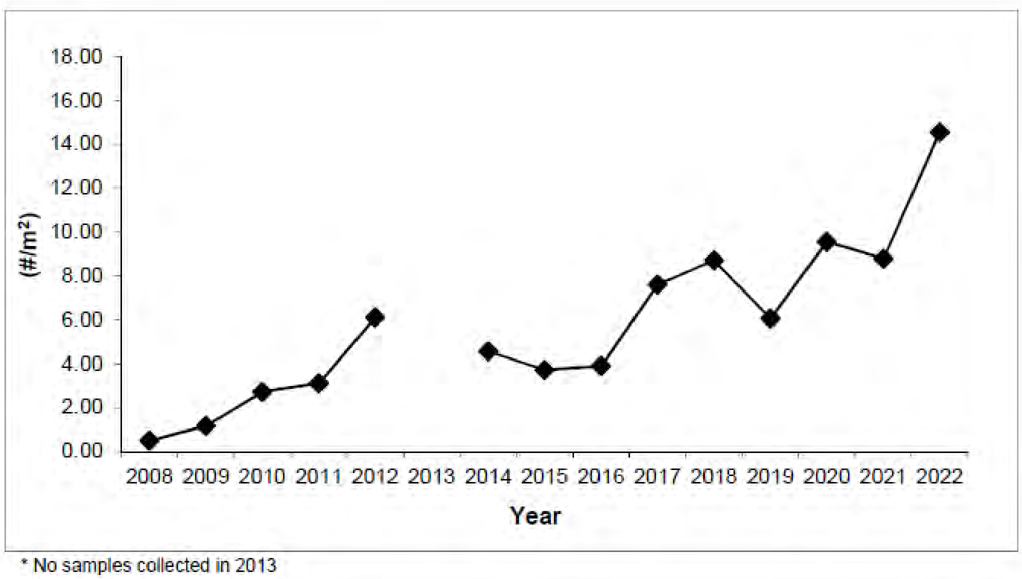

Figure 3. Catch per unit effort (#/m^2) of Jonah crab during the American Lobster Settlement Index Survey, in New Hampshire, from 2009 through 2022.

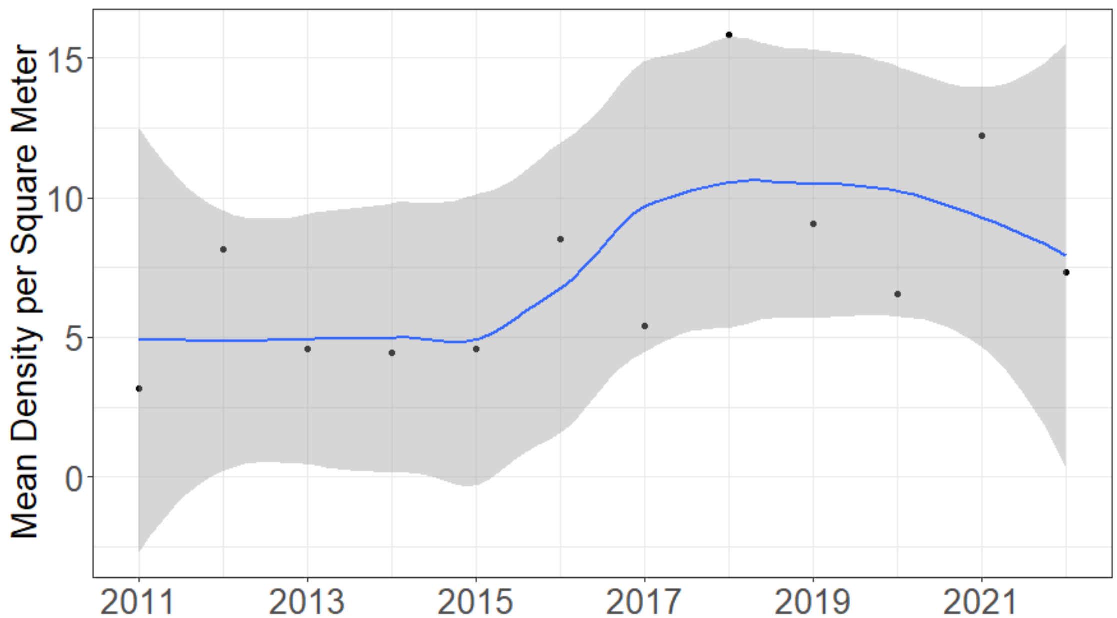

Figure 4. Mean number of Jonah crab per square meter from the MA DMF Settlement Survey from the Gulf of Maine (GOM) region. Black dots are annual means, blue line is a Loess soother, gray area is confidence interval around the Loess smoother.

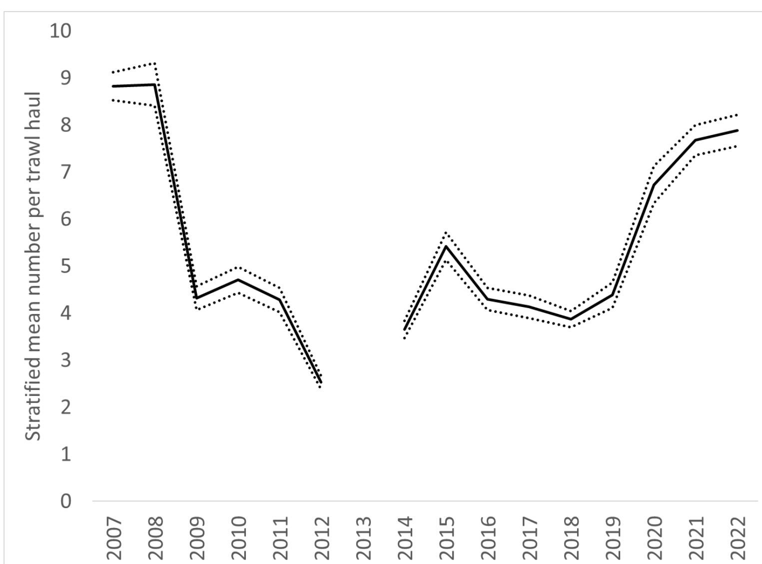

Figure 5. Mean number of Jonah crabs per trawl haul from ventless traps from GOM region of the MA DMF Ventless Trap Survey (standardized to a 6-pot trawl with three vented and three ventless traps). Error bars are two times the standard error. The survey was not conducted in 2013 due to a gap in funding.

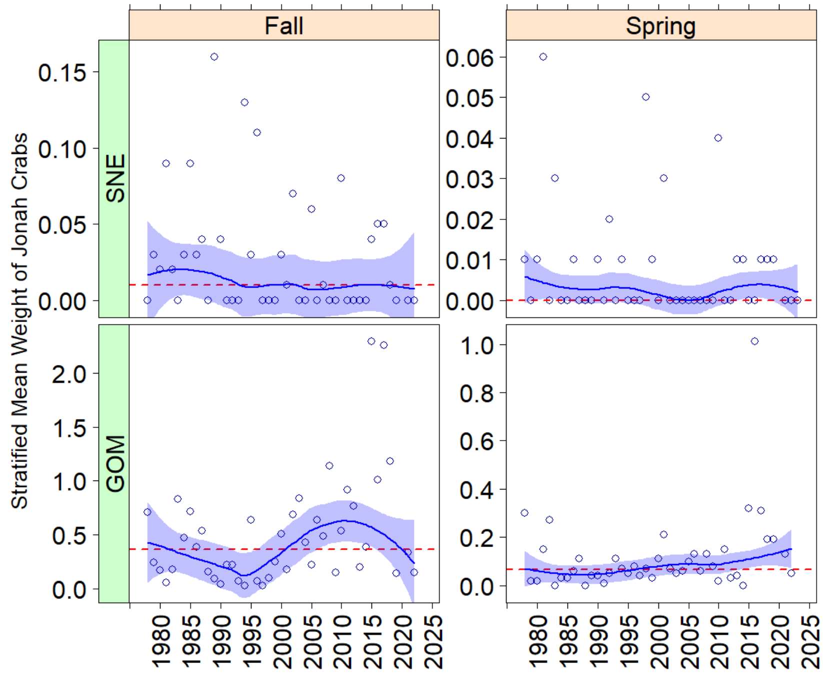

Figure 6. Stratified mean weight (kg) of Jonah crab from the MA DMF Trawl Survey. The left column shows the fall surveys, the right columns show the spring surveys. Southern New England (SNE) is on the top row, Gulf of Maine (GOM) is on the bottom. Red dashed line is the time series median. Blue line is a trend line (Loess smoother), and the blue shaded area is the confidence interval around the trend line. The survey was not conducted in 2020 due to the Covid-19 pandemic.

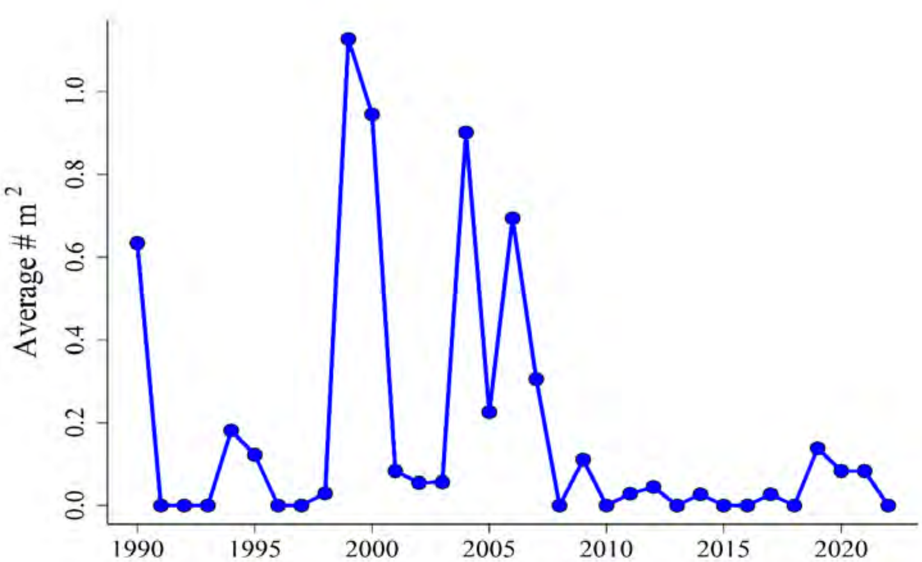

Figure 7. Rhode Island YOY Settlement Survey trend for all Jonah crabs caught per m^2, 1990-2022.

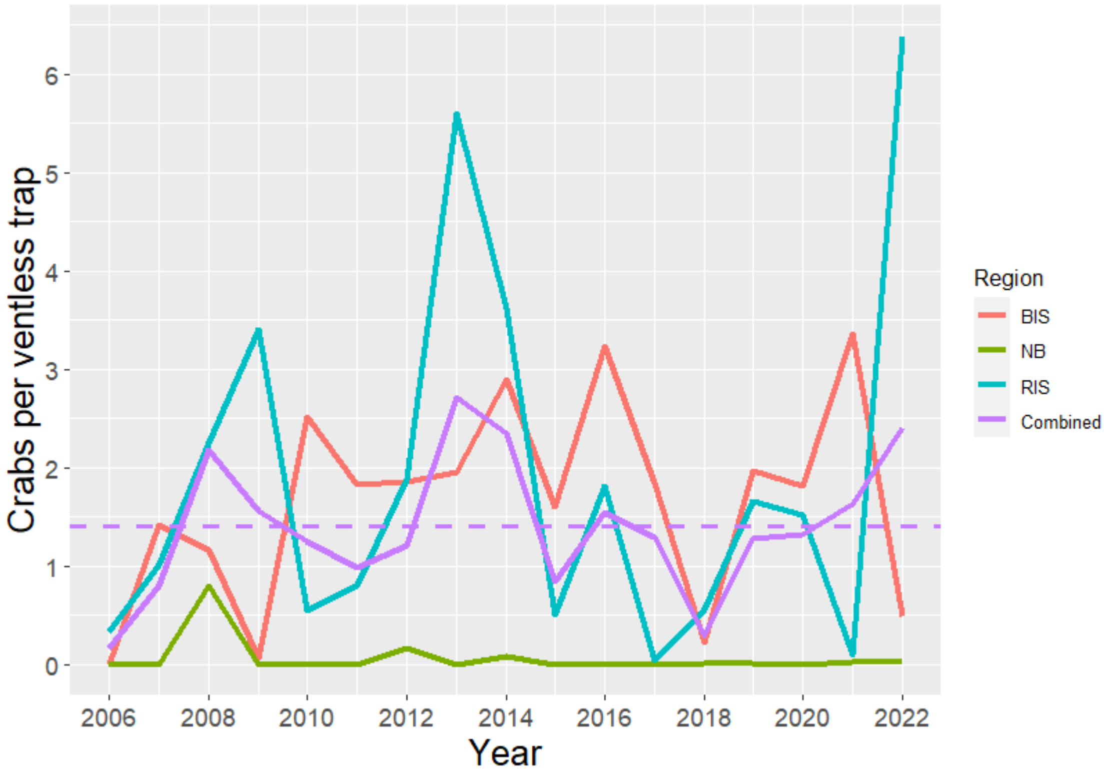

Figure 8. Rhode Island ventless trap survey index of Jonah crab abundance by region: Narragansett Bay (NB), Rhode Island Sound (RIS), and Block Island Sound (BIS). Time series mean for the combined region is presented as a dashed purple line.

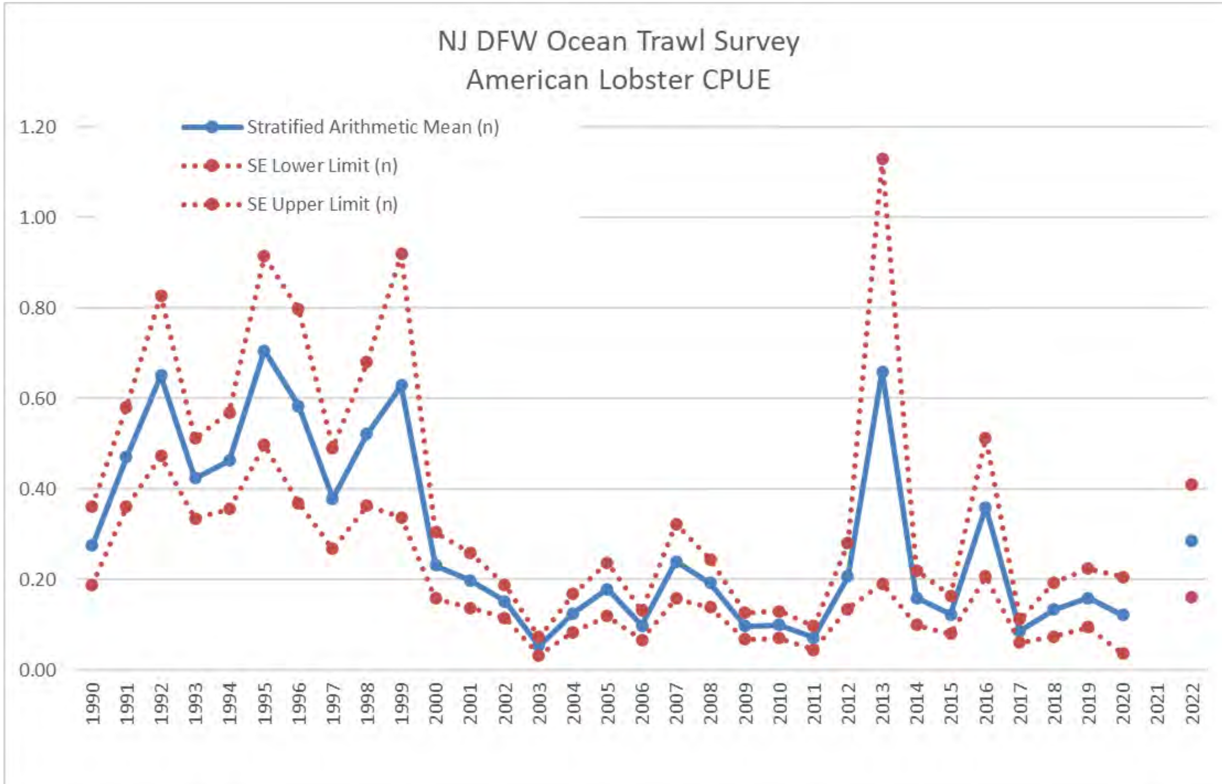

Figure 10. Stratified mean CPUE of all Jonah crab collected aboard the NJDFW Ocean Trawl Survey. The survey stratifies sampling in three depth gradients, inshore (18’-30’), mid-shore (30’-60’), offshore (60’-90’). The mean CPUE was calculated as the sum of the mean weight (in kg) of Jonah crab per size class collected in each sampling area weighted by the stratum area. ***NOTE: No April 2019 Survey was conducted due to Research vessel mechanical issues. Due to the COVID-19 pandemic, Apr-Oct 2020 and 2021 CPUE and indices were not obtained.**

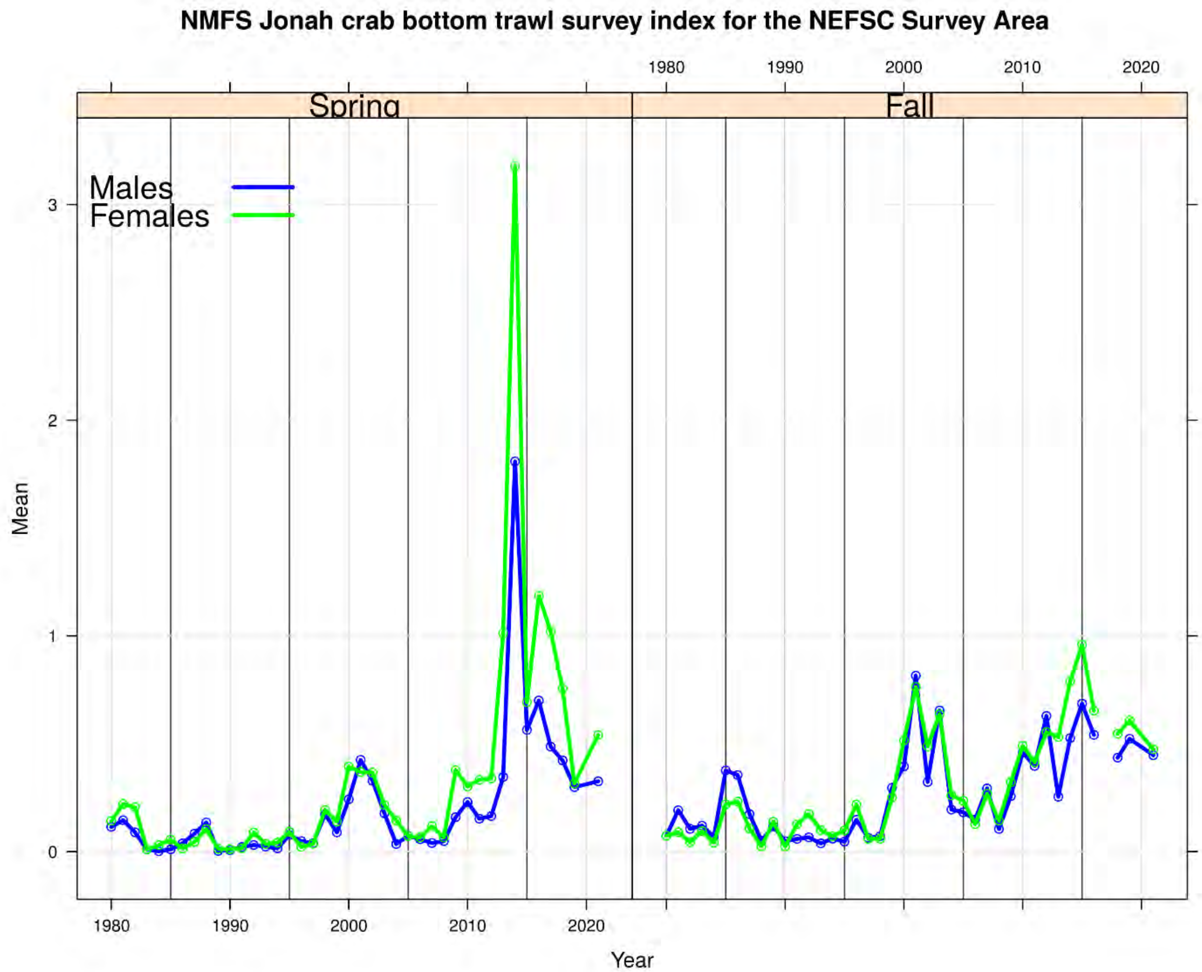

Figure 11. NMFS Jonah Crab index (mean number per tow) from the bottom trawl survey for the NEFSC Survey Area, through fall 2021 There was no survey conducted in 2020 due to the COVID-19 pandemic.