

Northeast Fisheries Science Center Technical Memorandum 308

# Management Track Assessments Spring 2023

by Northeast Fisheries Science Center

June 2023

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**U.S. Department of Commerce**  
National Oceanic and Atmospheric Administration  
National Marine Fisheries Service  
Northeast Fisheries Science Center  
Woods Hole, Massachusetts

June 2023

### NOAA Technical Memorandum, Editorial Notes

**Editorial Treatment:** In the interest of expedited publication, this report has undergone a truncated version of the NEFSC Editorial Office's typical technical and copy editing procedure. Aside from the front and back matter included in this document, all writing and editing have been performed by the authors included on the title page.

**Information Quality Act Compliance:** In accordance with section 515 of Public Law 106-554, the NEFSC completed both technical and policy reviews for this report. These predissemination reviews are on file at the NEFSC Editorial Office.

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This document may be cited as:

NEFSC. 2023. Management Track Assessments Spring 2023. US Dept Commer, Northeast Fish Sci Cent Tech Memo. 308; 69p.+x. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026, or online at <http://www.nefsc.noaa.gov/nefsc/publications/>.

# TABLE OF CONTENTS

Page

LISTS

List of Tables. . . . . ii

List of Figures . . . . . iii

GLOSSARIES

Abbreviations for fish stocks reviewed . . . . . iv

Abbreviations and Acronyms . . . . . v

Statistical/review concepts, parameters, etc. . . . . vii

Locations/regions: state, country, etc. . . . . x

FISH STOCK REPORTS

1. Panel Report. . . . . 1

    Appendix A. AOP Meeting Summary . . . . . 3

        Appendix A.1. Meeting participants . . . . . 12

    Appendix B. Terms of Reference. . . . . 13

    Appendix C. Peer Review Meeting Attendees. . . . . 14

    Appendix D. Peer Review Meeting Agenda . . . . . 16

2. Atlantic Bluefish . . . . . 17

    2.1. Reviewer Comments: Atlantic Bluefish . . . . . 21

3. Deep sea red crab . . . . . 28

    3.1. Reviewer Comments: Deep sea red crab . . . . . 33

4. Longfin inshore squid . . . . . 37

    4.1. Reviewer Comments: Longfin inshore squid . . . . . 42

5. Summer flounder . . . . . 49

    5.1. Reviewer Comments: Summer flounder . . . . . 52

6. Scup . . . . . 59

    6.1. Reviewer Comments: Scup . . . . . 62

Photo Gallery . . . . . 69

## LIST OF TABLES

1	Stocks reviewed at June 2023 Management Track Assessment Peer Review meeting . . .	2
2	Stocks reviewed at February 2023 Management Track Assessment Stock Assessments meeting . . . . .	4
3	Catch and status table for Atlantic Bluefish . . . . .	17
4	Estimated reference points for Atlantic Bluefish . . . . .	18
5	Short term projections for Atlantic Bluefish . . . . .	18
6	Catch and status table for deep-sea red crab . . . . .	28
7	Estimated reference points for deep sea red crab . . . . .	28
8	Catch and status table for longfin inshore squid . . . . .	38
9	Estimated reference points for longfin inshore squid . . . . .	38
10	Catch and status table for Summer flounder . . . . .	49
11	Estimated reference points for Summer flounder . . . . .	50
12	Short term projections for Summer flounder . . . . .	50
13	Catch and status table for Scup . . . . .	59
14	Estimated reference points for Scup . . . . .	60
15	Short term projections for Scup . . . . .	60



Healthy seafood delights: shrimp, mussels, scallop, and fish dish.

## LIST OF FIGURES

1	Estimated trends in biomass for Atlantic Bluefish . . . . .	23
2	Estimated trends in fishing mortality for Atlantic Bluefish . . . . .	24
3	Trends in estimated recruitment for Atlantic Bluefish . . . . .	25
4	Total catch of Atlantic Bluefish . . . . .	26
5	Indices of abundance for Atlantic Bluefish . . . . .	27
6	Total catch of deep sea red crab . . . . .	35
7	Indices of abundance for deep sea red crab . . . . .	36
8	Estimated trends in biomass for longfin inshore squid . . . . .	45
9	Estimated trends in fishing mortality for longfin inshore squid . . . . .	46
10	Total catch of longfin inshore squid . . . . .	47
11	Indices of abundance for longfin inshore squid . . . . .	48
12	Estimated trends in biomass for Summer flounder . . . . .	54
13	Estimated trends in fishing mortality for Summer flounder . . . . .	55
14	Trends in estimated recruitment for Summer flounder . . . . .	56
15	Total catch of Summer flounder . . . . .	57
16	Indices of abundance for Summer flounder . . . . .	58
17	Estimated trends in biomass for Scup . . . . .	64
18	Estimated trends in fishing mortality for Scup . . . . .	65
19	Trends in estimated recruitment for Scup . . . . .	66
20	Total catch of Scup . . . . .	67
21	Indices of abundance for Scup . . . . .	68

## Abbreviations for fish stocks reviewed

These are the abbreviations for fish stock names, as used in the footers of each of the fish stock reports. Links are to the reports, summary pages and tables.

**AMACKUNIT** (*Scomber scombrus*) Atlantic mackerel [3](#), [5](#)

**BLFUNIT** (*Pomatomus saltatrix*) Atlantic bluefish [2](#), [3](#), [6](#), [17–27](#)

**CRDUNIT** (*Chaceon quinque-dens*) Atlantic deep-sea red crab [2](#), [3](#), [7](#), [28–36](#)

**DORYUNIT** (*Doryteuthis pealeii*) longfin squid, from New England to Mid-Atlantic and the Southeast [2](#), [3](#), [7](#), [37–48](#)

**FLKUNIT** (*Scophthalmus aquosus*) summer flounder [2](#), [3](#), [10](#), [49–58](#)

**SCPUNIT** (*Stenotomus chrysops*) scup [2](#), [3](#), [9](#), [59–68](#)

**SPDUNIT** (*Squalus acanthia*) Atlantic spiny dogfish [3](#), [8](#)



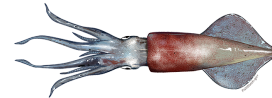
Atlantic Mackerel



Bluefish



Atlantic Deep-Sea Red Crab



Longfin Squid



Summer Flounder



Scup



Spiny Dogfish

Images from [NOAA Fisheries](#) and [FishWatch.gov](#).



Fresh seafood on ice, ready for sale.

Photo credit: Shutterstock.

## Abbreviations and Acronyms

**Albatross** refers to activities of the **NOAA** vessel **Albatross IV** 58, 62, 68

**Albatross IV** Research vessel **NOAAS** Albatross IV, in service until November 2008 v

**AOP** Assessment Oversight Panel 1, 3, 5–12, 22, 33, 42, 52, 62

**ASMFC** Atlantic States Marine Fisheries Commission 12–14

**Bigelow** refers to activities of the **NOAA** vessel **Henry B. Bigelow** 3, 5, 11, 62

**CAMS** Catch Accounting and Monitoring System 2, 3, 5–11, 39, 42

**CHESMAP** Chesapeake Bay Multispecies Monitoring and Assessment Program 6, 21

**CRD** Center Reference Document LXXXIV

**CSE** Council of Science Editors LXXXIV

**DFO** Department of Fisheries and Oceans, Canadian 5

**ECOMON** Ecosystem Monitoring 5

**GARFO** Greater Atlantic Regional Fisheries Office 6, 14, 15, 39

**Henry B. Bigelow** **NOAA** research vessel Henry B. Bigelow, with specialized trawling net mechanisms; commissioned July 2007, used for surveys 2009–2019 v, 58

**ICES** International Council for the Exploration of the Sea (European Union) 34, 44

**MA DMF** Massachusetts Division of Marine Fisheries 14

**MAFMC** Mid-Atlantic Fisheries Management Council 3, 11–14, 17–19, 21

**MARMAP** Marine Resources Monitoring and Assessment Program 5

**MRIP** Marine Recreational Information Program 3, 6, 8, 19–21

**MTA** Management Track Assessment 8, 10, 11, 21, 33

**MT** Management Track 12

**NCDMF** North Carolina Division of Marine Fisheries 14

**NEAMAP** Northeast Area Monitoring and Assessment Program 3, 7, 8, 37, 41, 42

**NEFMC** New England Fisheries Management Council 3, 12, 14, 15

**NEFOP** Northeast Fishery Observer Program 2

**NEFSC** Northeast Fisheries Science Center III, 1, 3, 5–8, 10–15, 17, 19, 21, 29, 33, 37–39, 41, 42, 44, 46, 48, 49, 52, 53, 58, 59, 62, 63, 68, 70, LXXXIV



**NMFS** National Marine Fisheries Service ix, 1, 5, 8, 14, 22, 69, 70  
**NOAA** National Oceanographic and Atmospheric Administration iv–vi, 2, 3, 21, 22, 52, 53, 63, 69, 70  
**NOAAS** NOAA ship v  
**NRCC** Northeast Regional Coordinating Council 3, 8, 11, 40  
**NTAP** Northeast Trawl Advisory Panel 39  
**RT** Research Track 21  
**RTA** Research Track Assessment 10, 21  
**SARC 51** 51st Stock Assessment Review Committee meeting, 2010 7, 37, 42  
**SASINF** Stock Assessment Support Information 39  
**SAW** Stock Assessment Workshop 42, 44  
**SAW 60** 60th Stock Assessment Workshop, 2015 10, 21  
**SAW 64** 64th Stock Assessment Workshop, 2018 5  
**SAW 66** 66th Stock Assessment Workshop, 2019 10  
**SEAMAP** Southeast Area Monitoring and Assessment Program 6, 21  
**SMAST** School for Marine Science and Technology (New Bedford, Maine) 13, 15  
**SSC** Scientific and Statistical Committee 1, 5, 6, 11, 13  
**StockEff** Stock Assessment Efficiency Initiative 6, 19  
**TOR** Term of Reference 21, 33  
**UMASS** University of Massachusetts 14  
**WHAM** Woods Hole Assessment Model 1, 3, 6, 17, 19–21  
**WHOI** Woods Hole Oceanographic Institute, MA ix, 15, 69

## Statistical/review concepts, parameters, etc.

000s thousands 17, 18, 25, 49, 56, 59, 66

ABC acceptable biological catch 6, 10, 11, 17–19, 21, 52

**AGEPRO** Age Structured Projection Model ([source](#)) 52

ALK age-length-key 19

ASAP Age-Structured Assessment Program, modelling software 1, 3, 5, 6, 10, 21, 49, 52, 59, 62

ASM At Sea Monitoring 2

Bayes following a Bayesian approach to statistics and probability 33

$B_{MSY}$  biomass maximum sustainable yield 3, 7, 8, 42, 43

$B_{MSY\ proxy}$  proxy estimate for biomass maximum sustainable yield 37, 39, 44

BRP biological reference point 9, 11, 13, 30, 32, 43

BSIA Best Scientific Information Available 42, 62

$B_{Threshold}$  threshold for biomass that indicates overfished status 3, 7, 44

CI confidence interval 19, 37

CPUE catch per unit effort 3, 6, 19–21

CV coefficient of variation 3, 10, 11, 17, 39, 51, 61

DCAC Depletion-corrected average catch model 30, 33

DWF Distant Water Fleets 37, 47

EFP Exempted Fishing Permit 29

ESP Ecosystem and Socioeconomic Profile 6

ESS Expeditionary Support Ship 3, 11

$F$  (instantaneous) fishing mortality rate 5, 8, 9, 18–21, 37, 50, 52, 60, 62

$F_{35\%}$  fishing mortality rate at 35% of the total catch 18, 21, 49

$F_{35\%SPR}$  fishing mortality for 35% of spawning potential rate 18, 52

$F_{40\%SPR}$  fishing mortality for 40% of spawning potential rate 5, 59

$F_{60\%SPR}$  fishing mortality for 60% of spawning potential rate 8

$F_{Full}$  fishing mortality rate on fully selected ages 17–19, 24, 39, 49, 50, 55, 59, 60, 65

**FMP** fishery management plan 29, 30, 34

$F_{MSY}$  fishing mortality rate for maximum sustainable yield 5, 8, 42, 43, 62

$F_{MSY\ proxy}$  proxy estimate of fishing mortality rate for maximum sustainable yield 17, 18, 20, 24, 37, 49, 52, 55, 59, 65

$F_{Rebuild}$  fishing mortality rate consistent with the stock rebuilding plan 5, 17–19, 21

$F_{\rho}$  fishing rate adjusted for the  $\rho$  value 19, 60, 62

$F_{Threshold}$  threshold fishing mortality level that indicates overfishing status 24, 55, 65

**GLM** Generalized Linear Model 33

**lsmooth** renaming of **PlanBsmooth**: a model using log-linear regression and **Loess** smoothing 3, 5, 11

**lb** pounds, imperial measurement unit for weight 36

**LLC** Limited Liability Company 15

**Loess** loess curve fitting (local polynomial regression) viii

**log-normal** probability distribution whose logarithm is normally distributed 22, 24, 25, 27, 53, 55, 58, 64, 65, 68

**Lorenzen** model for natural mortality using Lorenzen curve 3, 6, 8, 9, 21

**LPUE** Landings Per Unit Effort 7, 28, 30, 32, 33, 36

$M$  (instantaneous) natural mortality rate 3, 5, 6, 9, 10, 21, 22, 62

$\rho$  Mohn’s rho parameter: the average relative bias of retrospective estimates viii, ix, 19, 50, 60

$MSP$  maximum spawning potential 41

$MSY$  maximum sustainable yield 5, 8, 18, 30, 33, 37, 49, 59

**mt** metric ton 5–7, 10, 11, 17, 18, 20, 21, 28, 33, 37, 39, 42, 44, 48, 49, 52, 59, 62

**multinomial** the multinomial probability distribution 6, 19, 21

$NA$ , **N/A** not applicable 29, 37

**OFL** overfishing limit 1, 11, 49, 52, 59, 62

**PlanBsmooth** ‘Plan B’ model using log-linear regression and **Loess** smoothing viii

$q$  catchability coefficient 7, 37, 44, 48

**R** programming environment for statistical processing and presentation 1

$R$  expected recruitment numbers 21

RMSE root mean square error 53

SBRM Standardized Bycatch Reporting Methodology 8, 11

*SPR* spawning potential ratio 18

*SPR*<sub>60%</sub> 60% of the spawning potential ratio 8

SS3 Stock Synthesis 3 model 1, 8, 9

*SSB* spawning stock biomass 3, 5, 6, 8, 17–21, 39, 49–52, 59–62, 64

*SSB*<sub>40%</sub> the approximate equilibrium spawning stock biomass that results from fishing at forty percent of maximum sustainable yield 5

*SSB*<sub>MSY</sub> spawning stock biomass consistent with maximum sustainable yield 5, 8, 18, 49, 59, 62

*SSB*<sub>MSY proxy</sub> proxy value for spawning stock biomass estimation for maximum sustainable yield 17–19, 22, 49, 52, 53, 59, 62, 64

*SSB* <sub>$\rho$</sub>  spawning stock biomass level adjusted according to the  $\rho$  value 19, 60, 62

*SSB*<sub>Target</sub> theoretically ideal spawning stock biomass level 21, 22, 53, 64

*SSB*<sub>Threshold</sub> threshold for spawning stock biomass that indicates overfished status 21, 22, 53, 64

VTR Vessel Trip Report 28, 33

WAA Weight-at-age 21



Aerial view of NMFS building and surrounds, Woods Hole Laboratory, MA; photo ©WHOI

## Locations/regions: state, country, etc.

CA Canada x

CT Connecticut x, 3

GB Georges Bank x

GOM Gulf of Maine x

MA Massachusetts vi, ix, x, 13, 15, 69

MAB Mid-Atlantic Bight x

ME Maine x

NC North Carolina 12

NH New Hampshire x

NJ New Jersey x, 14

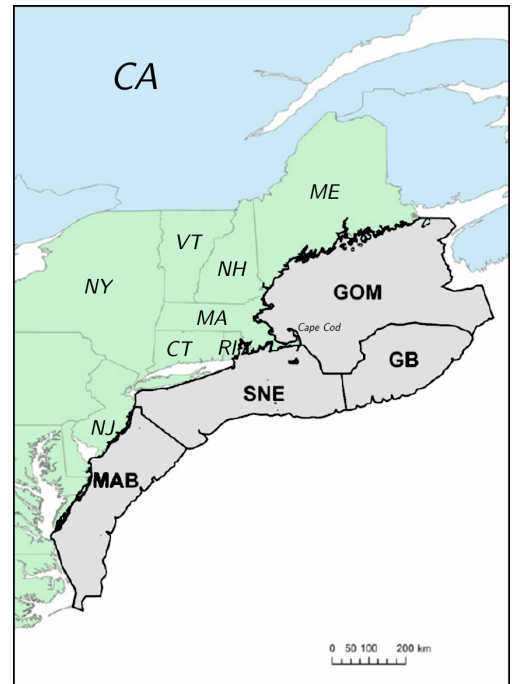
NY New York x

RI Rhode Island x

SNE Southern New England x

US United States 7, 37, 46

VT Vermont x



# 1. 2023 MANAGEMENT TRACK PEER REVIEW PANEL REPORT

Cynthia M. Jones (Chair)<sup>1</sup> (chair), Katie Drew<sup>2</sup>, Alexei Sharov<sup>3</sup> and John Wiedenmann<sup>4</sup>.

Five fish stock assessments were reviewed by the June 2023 Management Track peer review panel. All were Level 2 Expedited Reviews: deep-sea red crab (*Chaceon quinquedens*), scup (*Stenotomus chrysops*), longfin inshore squid (*Doryteuthis (Amerigo) pealeii*), summer flounder (*Paralichthys dentatus*), and bluefish (*Pomatomus saltatrix*). Spiny dogfish (*Squalus acanthias*) was identified as a Level 3 Enhanced review assessment during the AOP, but was not addressed during the June Management Track Peer Review meeting and instead will be reviewed during the September Management Track Peer Review meeting. Atlantic mackerel (*Scomber scombrus*) was elevated to a Level 2 Expedited Review as a result of a putative status change and will be reviewed in September. Levels of review were as recommended by the Assessment Oversight Panel (Appendix A).

The Peer Review Panel (Panel) for the June 2023 Management Track Assessments met via webinar on June 26–28, 2023. The Panel was to determine whether the completed management track assessment was technically sufficient to (a) evaluate stock status, (b) provide scientific advice and (c) successfully address the assessment Terms of Reference (Appendix B). Table 1 presents a list of the stocks, name of the lead analyst/presenters, and conclusions about stock status.

Attendance at the meeting is provided in Appendix C with the Agenda shown in Appendix D.

We thank Russ Brown (Population Dynamics Branch Chief) and Michele Traver (Assessment Process Lead) for their support during the meeting and to the staff of the Population Dynamics Branch at NEFSC for the open and collaborative spirit with which they engaged the Panel.

Our thanks also extend to the rapporteurs for taking extensive notes during the meeting and to staff of the Mid-Atlantic Fishery Management Council.

The Panel has suggestions for improvements that could be made for review of Management Track assessments:

- The Panel suggests that review materials be posted a week prior to the meeting and include, in addition to the NMFS analyst report, supporting materials and model diagnostics such as the standard R plots from ASAP, WHAM, and SS3, where such information is available.

The Panel also has several crosscutting recommendations with respect to the individual stock assessments:

1. For both summer flounder and bluefish, estimates of unusually high recruitment near the end of the time-series are propagated through the OFL projections, as these fish enter the fishery at relatively young ages (summer flounder are fully recruited to directed fisheries at age-4 and bluefish at age-2).

---

<sup>1</sup>Old Dominion University (retired)

<sup>2</sup>Atlantic States Marine Fisheries Commission

<sup>3</sup>Maryland Department of Natural Resources

<sup>4</sup>Rutgers University

If these recruitment events are overestimated (as the summer flounder event in 2018 turned out to be), the resulting **OFL** will be too high and may increase the risk of overfishing. The **SSC** may want to consider retrospectively adjusting anomalously high recruitment events near the terminal year of the assessment when doing **OFL** projections to mitigate this risk.

2. The 2023 peer review of the Catch Accounting and Monitoring System (**CAMS**; O’Keefe et al. 2023) concluded, with some caveats, that **CAMS** can be implemented to provide a single source of commercial fishery data for the primary purposes of quota monitoring and stock assessment. Where presented during the review, the differences between the commercial landings from **CAMS** and from the previously used databases were minimal; differences in the estimates of commercial discards were somewhat greater, although the **CAMS** estimates were generally within the confidence intervals of the previous estimates. The differences could not be explained. The Panel recommends that future stock assessment updates continue to check **CAMS** estimates against current or historical estimates of discards and harvest, where available to ensure that the differences remain negligible.
3. Reduction in Port sampling for individual lengths and age structures represents a significant threat to the stock assessment enterprise. **NOAA** should decide whether it can return Port sampling to levels comparable with those achieved prior to 2019. If they cannot, they should increase catch sampling by observers (either **ASM** or **NEFOP**) to balance the loss of these data.
4. **NOAA** should continue to evaluate the use of dynamic reference points with analytic assessments.

**Table 1: Stocks reviewed at June 2023 Management Track Assessment Peer Review meeting**

Stock	Lead Analyst/Presenter	Peer review conclusion
Deep sea red crab Expedited Review	Toni Chute	Stock’s overfished and overfishing status is unknown
Scup Expedited Review	Mark Terceiro	Stock is not overfished and overfishing is not occurring
Longfin inshore squid Expedited Review	Lisa Hendrickson	Stock is not overfished and overfishing status is unknown
Summer flounder Expedited Review	Mark Terceiro	Stock is not overfished and overfishing is not occurring
Bluefish Expedited Review	Tony Wood	Stock is not overfished and overfishing is not occurring



## Appendix A. Summary of Assessment Oversight Panel Meetings for February 2023 Management Track Stock Assessments

The **NRCC** Assessment Oversight Panel (**AOP**) met to review the operational stock assessment plans for Atlantic mackerel, bluefish, deep sea red crab, longfin inshore squid, spiny dogfish, scup and summer flounder stocks on February 23, 2023. One assessment was recommended for Level 1 Review (Direct Delivery) and this assessment will undergo an internal review before being delivered to the appropriate management body. The assessments for stocks/species recommended for Level 2 and 3 peer reviews will be reviewed during the peer review meeting scheduled for June 26–30, 2023.

The **AOP** consisted of: Russell W. Brown, Ph.D.<sup>5</sup> (chair), Michael Celestino<sup>6</sup>, Cate O’Keefe, Ph.D.<sup>7</sup>, Paul Rago, Ph.D.<sup>8</sup>

### *Meeting Details:*

These meetings were guided by the **NRCC** approved stock assessment guidance documents. Background documents were provided to the Panel: (1) an updated prospectus for each stock; and (2) an overview summary of all the salient data and model information for each stock. Prior to the meeting, each assessment lead prepared a proposal for their Management Track Assessment. The proposal reflected the research track or most recent assessment results, the peer review panel Summary Report results, and any initial investigations conducted for the management track assessment.

At the meeting, each assessment lead gave a presentation on the data to be used, model specifications (if applicable), evaluation of model performance, the process for updating the Biological Reference Points, the basis for catch projections, and an alternate assessment approach if their analytical assessment is rejected by the peer review panel.

### *Major Recommendations for Review of Individual Stocks*

In general, the **AOP** approved the plans presented, but recommended several points of emphasis to the recommended review levels as summarized in Table 2 below. **AOP** guidelines can be found in the [stock assessment process document](#).

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<sup>5</sup>Northeast Fisheries Science Center, Woods Hole, Massachusetts.

<sup>6</sup>Atlantic States Marine Fisheries Commission, New Jersey Fish and Wildlife.

<sup>7</sup> vice-chair of the **NEFMC** Scientific and Statistical Committee, Fishery Applications Consulting Team, LLC.

<sup>8</sup>Chair of the **MAFMC** Scientific and Statistical Committee, **NOAA** Fisheries (retired).



**Table 2: Stocks reviewed at February 2023 Management Track Assessment Stock Assessments meeting**

Stock	Lead	Review Level	Rationale and Comments
Atlantic mackerel	Kiersten Curti	Level 1 Direct Delivery (Provisional)	The assessment will be updated with three years of data (2020–2022). There are questions about the availability of the 2022 egg/biomass index. If the 2022 egg/biomass index is not available, the review level should be elevated to Level 2. Ecosystem and Socioeconomic Profile will be provided as supplementary information. <b>Ismooth</b> approach will be used as an alternate assessment approach.
Bluefish	Tony Wood	Level 2 Expedited Review	A Research Track assessment was completed in December 2022, which updated the previous <b>ASAP</b> model to a state space <b>WHAM</b> model. The Management Track assessment will add one additional year of data. Guild approach used to modify the <b>CPUE</b> index and represents a novel approach. Significant change in constant natural mortality to age based natural mortality. <b>SSB</b> target has been reduced by 50%. Regional estimation of discard weights, which accounts for regional differences.
Deep-sea red crab	Toni Chute	Level 2 Expedited Review	Data poor species with no assessment model. This assessment will add 4 years of data (2019–2022). No issue with missing 2020 data since there were reported catches and some observed trips. The sexes segregate by depth and the fishery targets areas with higher densities of males. During the <b>CAMS</b> review, there were issues with the discards for some gear types. <b>CAMS</b> data are not used in the data update. A tagging project had low return rates indicating the potential for high mortality of tagged individuals, or a super abundant population. A Level 2 review of the available data and to highlight the limitations of analyses that have been attempted for this species is recommended to suggest potential approaches and generate useful research recommendations.
Longfin inshore squid	Lisa Hendrickson	Level 2 Expedited Review	This assessment will use the same methods as 2020 Management Track assessment including updating annualized $B_{MSY}$ proxy and $B_{Threshold}$ with data, but will explore changing the baseline time period from 1976–2022 to 1997–2022. This change in the time period is a primary reason for recommending a Level 2 review. The <b>AOP</b> would like to see results for both time periods presented to the peer review panel. The <b>AOP</b> panel would like to see consideration of any changes caused by the <b>CAMS</b> transition. Research recommendations from the peer reviewers will be important to contributing to the work of the planned 2026 Research Track assessment.
Spiny dogfish	Dvora Hart	Level 3 Enhanced Review	A Research Track assessment was completed in December 2022, which updated the previous stochastic estimator (swept area calculations) to a length based Stock Synthesis 3 model. The Management Track assessment will add three years of data (2020–2022). There was a significant change in natural mortality ( <b>Lorenzen M</b> ), which resulted in a reduction in the females reaching maturity. There is a significant change in the length at maturity. There is a chance that there could be a status change to overfished. The <b>AOP</b> encourages a careful look at the impacts of transitioning to the use of <b>CAMS</b> catch (landings and discards). The <b>AOP</b> recommends reporting the fishing mortality rate and biomass estimates for the male component of the population.
Scup	Mark Terceiro	Level 2 Expedited Review	The management track will add three years of updated catch for 2020–2022 ( <b>CAMS</b> landings and discards; <b>MRIP</b> recreational). <b>CAMS</b> discards have a lot of uncertainty and it is unclear what the format of that data will look like and when they'll be available. Revision to <b>NEFSC Bigelow</b> indices (“by-tow” swept area). Minor changes in model input settings ( <b>CV</b> , <b>ESS</b> ). Near threshold for retro adjustments. Projections carrying forward using previously reviewed methods.
Summer flounder	Mark Terceiro	Level 2 Expedited Review	The assessment will update the fishery and survey catches for 2020–2022 using <b>CAMS</b> estimates of landings and discards. It will revise the <b>NEFSC</b> survey indices for 2009–2022 to include area swept adjustments by tow. In terms of model adjustments, plan to inflate input <b>CV</b> s of a few survey indices ( <b>CT</b> spring, <b>NEAMAP</b> fall, <b>Bigelow</b> fall) and recenter input catch <b>ESS</b> to improve model diagnostics. Also plan to test split of terminal fishery selectivity blocks from 2008–2022 to 2008–2015 and 2016–2022.

## Individual Stock Discussion Summaries:

### Atlantic mackerel (AOP Lead: Cate O'Keefe)



Recommendation: Level 1 (Direct Delivery, Provisional)

Atlantic mackerel were last assessed in 2021 via a Management Track assessment; the most recent benchmark was in 2017 at SAW 64. 2021 results indicated the stock was overfished based on *SSB* in 2019 (42,862 mt) being 24% of the *SSB*<sub>MSY</sub> proxy (*SSB*<sub>40%</sub> = 181,090 mt), and overfishing was occurring based on *F*<sub>2019</sub> (0.46) being 208% of the *F*<sub>MSY</sub> proxy (*F*<sub>40%SPR</sub> = 0.22). The assessment included three indices: the NMFS Spring bottom trawl survey Albatross years from 1968–2008; the NMFS Spring bottom trawl survey Bigelow years from 2009–2019; and a range wide *SSB* index for 1977–2019 developed from the Canada DFO dedicated egg survey and the NEFSC MARMAP and ECOMON surveys. The assessment assumed constant natural mortality (*M* = 0.2) and included one fishery fleet with time-invariant, flat-topped selectivity.

Kiersten Curti presented the proposed assessment plan for Atlantic mackerel in 2023, which will use the current ASAP model configuration with no changes and updated fishery and survey data through 2022. CAMS estimates of commercial landings and discards will be used for 2020–2022. Survey updates will include the 2021 and 2022 NMFS Spring bottom trawl survey (2020 survey was not conducted) and the *SSB* index for 2021 and 2022, if available. Reference points will be updated using the SAW 64 projection approach with *MSY* level proxies of *F*<sub>40%SPR</sub> and *SSB*<sub>40%</sub>. Rebuilding projections for 2023–2024 will be based on an assumed bridge year catch in 2023, two-stanza recruitment, and *F*<sub>Rebuild</sub> = 0.12 as defined in the Atlantic Mackerel Rebuilding Amendment 2.0. The proposed backup assessment approach is the lsmooth method using the *SSB* index developed from egg surveys.

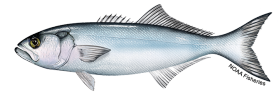
The AOP raised questions about DFO data to support the *SSB* index and availability of data to support the assessment. Dr. Curti explained that the 2020 *SSB* index will be treated as missing, the 2021 *SSB* index is available, and the 2022 samples to support the *SSB* index are currently in transit. She expects that the 2022 *SSB* index will be available to support the assessment but noted that delays are possible. The AOP asked about model sensitivity to terminal year estimates and suggested that sensitivity analysis to examine the impacts of missing the terminal year *SSB* index may be warranted if the index is not available. The AOP also noted that this is the first iteration of the Atlantic mackerel assessment using CAMS data and recommended comparisons of CAMS landings and discards to outputs from previous methods to assess any substantial differences.

The AOP raised questions about application of the two-stanza recruitment assumptions for reference points and projections. Dr. Curti highlighted previous deliberations by the 2021 Management Track assessment process and the SSC. She noted that there is no clear evidence of environmental conditions impacting recruitment. Despite high adult condition since the mid-2010s, recruitment has been low, but Dr. Curti indicated there is little evidence of a shift in environmental conditions. Research in Canada has indicated that *SSB* and temporal/spatial overlap of larvae with preferred prey are significant drivers of strong year classes. Without clear evidence that recruitment is environmentally driven, the 2021 Management Track assessment did not change the SAW 64 assumptions for reference points and there are no proposed changes for the 2023 Management Track assessment.

The **AOP** supported continued development of the Ecosystem and Socioeconomic Profile (**ESP**) for Atlantic mackerel, which describes ongoing examinations of natural mortality and stock productivity. The **ESP** will be provided as supporting information in 2023 and results to date do not indicate that changes to the assessment model are warranted.

The **AOP** recommended a provisional Level 1 review for Atlantic mackerel. The **AOP** supported a direct delivery of the assessment to the **SSC** based on the proposal to maintain the model configuration and update three years of fishery and survey data. The **SSC** recommended that a Level 2 review may be warranted if the 2022 **SSB** index is not available for the assessment update or if large differences in **CAMS** data are detected. The **NEFSC** will consider all available data in the coming months and determine if the review needs to be elevated to a Level 2.

### **Bluefish (**AOP** Lead: Russ Brown)**



Recommendation: Level 2 (Expedited Review)

Bluefish was last assessed in the Management Track in 2021 with data updated through 2019. That assessment utilized an **ASAP** statistical catch at age model to conclude that the stock was overfished, but overfishing was not occurring. Bluefish completed a Research Track assessment that was peer reviewed in December 2022. The newly accepted assessment developed a **WHAM** state space statistical catch-at-age model with deviations on the numbers at age estimates. Natural mortality, which was previously assumed constant at age-2, is now assumed to vary by age. The model employs two fishery fleets (recreational landings & discards and commercial landings), and 5 fleet selectivity blocks (2 commercial and 3 recreational). Three new indices were added to the model: **MRIP CPUE** Guild Approach index (1985–2021), **SEAMAP** Age-1 (1989–2021) and **CHESMAP** Trawl survey (1985–2018). The 2022 Research Track assessment (data through 2021) concluded that the stock was not overfished and overfishing was not occurring.

The 2023 Management Track assessment will update the current Research Track assessment with one year of additional data (2022). To address concerns of Research Track peer reviewers, the assessment will shift from full **multinomial** age length keys to only using **multinomial** approaches to fill in holes in age length keys (consistent with the approach used by **StockEff**). This may allow for exploration of alternate likelihoods for age compositions.

The assessment update will conduct short term projections in **WHAM**, which allows for incorporation of model uncertainty, auto-regressive processes and uncertainty in recruitment and numbers-at-age. Removals in 2023 will be assumed to be equal to the 2023 **ABC** (13,890 **mt**) and projections will be carried forward for years 2024–2026.

The **AOP** was concerned that the spawning biomass target has declined by 50% and is likely caused by changes in **M** using the **Lorenzen** curve resulting in a reduction in the recruits to fishable sizes. However, the previous target had never been achieved in the fishery and was likely overinflated. This approach may represent a more reasonable level of reference points. It was noted that the **SSC** was concerned that the average weight of discards has disparities between the **MRIP** and angler surveys, likely due to higher average weights of large discarded fish. It was noted that the **NEFSC** and **GARFO** have agreed to use the same values in setting specifications. Previously, the approach was overestimating discards, particularly

in the south (southern fish are generally smaller). The use of regionally stratified estimates is considered to be a more realistic and appropriate approach. The **AOP** recommended a Level 2 review for bluefish due to the significant reduction in the biomass target and proposed changes to the age-length key approach.

### Deep-sea red crab (**AOP** Lead: Russ Brown)



Recommendation: Level 2 (Expedited Review)

Deep-sea red crab is a data poor species that has not been considered in previous Management Tracks. A specifications update was completed in 2019 to set specifications for fishing years 2020–2023. This update included a time series from 2002–2019 including landings data from the limited access fleet, incidental landings, **LPUE** estimates for the limited access fleet and biological information from port samplers and observed trips. There is no assessment model, no biological reference points for this stock and none will be developed during this Management Track cycle.

This data update will add 4 years of data (2019–2022) including landings; **LPUE** estimates; port sampled carapace lengths for landed males; observer sampled carapace lengths for males; females and discarded males; and observer data on egg-bearing females and discards. There are no issues with missing 2020 survey data since the update relies on reported catches and some observed trips. The sexes segregate by depth and the fishery targets areas with higher densities of males. During the **CAMS** review, there were issues with the discards for some gear types. However, **CAMS** data are not used in the data update. A tagging project had low return rates indicating the potential for high mortality of tagged individuals, or a super abundant population. A Level 2 review of the available data and to highlight the limitations of analyses that have been attempted for this species is recommended to suggest potential approaches and generate useful research recommendations.

### Longfin inshore squid (**AOP** Lead: Paul Rago)



Recommendation: Level 2 (Expedited Review)

Longfin squid was last assessed in 2020 at a Management Track assessment. The overfishing status was unknown, but the stock was not overfished. The “not overfished” status was based on a comparison of the average of the 2018 and 2019 annualized,  $q$ -adjusted swept area biomass estimates (i.e., averages of the **NEFSC** spring and fall survey biomass for each year), 63,349 **mt**, to the threshold  $B_{MSY}$  proxy ( $B_{Threshold}$ ) based on a long-term average (1976–2019). The threshold  $B_{MSY}$  proxy is 50% of the  $B_{MSY}$  target (i.e.,  $0.5 \times 42,405 \text{ mt} = 21,203 \text{ mt}$ ). It was also noted that the **NEAMAP** fall survey biomass estimates are added to those from the **NEFSC** fall survey.

Lisa Hendrickson’s presentation highlighted the complexity of longfin squid life history and the seasonal nature of the fishery which has both inshore and offshore components. Unlike *Illex* squid, longfin squid are neritic (i.e. residents of shelf waters). Hence, both the spring and fall **NEFSC** bottom trawl surveys likely sample most of the stock inhabiting **US** waters. The **SARC 51** (2010) assessment approach considered the seasonal dynamics of the fisheries by calculating exploitation rates (catch/survey biomass) between the seasonal surveys. **SARC 51** concluded that annualized survey biomass estimates were more appropriate. Dr. Hendrickson noted cohort-based estimates of biomass and exploitation rates have always



been computed for squid caught in the spring versus fall surveys because the two cohorts have different growth rates and productivity levels. Although an approach based on analyzing each intra-annual cohort independently would be more realistic since it would capture the reliance of summer and fall fisheries on the recruits produced from the spring stock estimates, this approach has been deemed not permissible under the Management Track and will be suggested for exploration under the next Research Track. Similarly, the winter and spring fisheries depend on recruits produced from the fall survey stock estimates. Such a model would also allow inclusion of seasonal differences in growth rates.

Dr. Hendrickson recommended a change in the time series used to compute the  $B_{MSY}$  average from 1976–2008 to 1997–2022. The rationale was based on consideration of rapid warming and other changes in environmental conditions, and possibly productivity in recent years. Changes in fleet characteristics, data quality (i.e. mandatory fishery data reporting as of 1997), and in-season management as of 2000 were also considered relevant by the assessment lead to this proposed change. Questions from the AOP addressed the basis for the proposed change in years to compute the  $B_{MSY}$  average and whether there was any evidence of trends in the surveys. No trends have been observed but further analyses are needed. The selection of appropriate stanzas of years for projections or measures of productivity are always controversial, so justifying any changes should be data driven and well supported.

Additional questions from the AOP and other meeting attendees included the methods used to estimate catchability in the trawl surveys, comparisons with assessments of species similarly impacted by environmental changes (e.g., Atlantic mackerel), and whether any preliminary changes had been detected. To account for diel vertical migrations, abundance and biomass estimates are based on daytime tows where “daytime” is defined by solar zenith angle because the species is most available to bottom trawls during the daytime. These values vary with location and date. The exclusion of tows outside the solar zenith angle ranges for the NEFSC spring and fall surveys reduces the frequency of low and zero tows, and generally improves precision but also reduces sample sizes within strata. The NEAMAP fall trawl survey swept area estimates will be updated because they are added to those of the NEFSC fall surveys. The NEAMAP spring survey’s intermittent encounters of longfin squid are attributed to varying availability of squid to the survey area; the stock is generally farther offshore in the spring.

Collectively, these considerations led the AOP to recommend a Level 2 review and a continuation of the current assessment methodology. The selection of an alternative basis for the  $B_{MSY}$  average should be fully explored and compared to the existing span of years. Results of both approaches should be presented to the MTA reviewers. The inclusion of newly developed CAMS estimates of landings and particularly discards, should be fully explored. Finally, MTA review can lay the groundwork for the Research Track assessment now scheduled for 2026. The groundwork could include any pending or required research on basic biology, alternative modeling approaches, and required data streams from the commercial fleets. The Terms of Reference for the assessment have not been set; the newly chartered Research Track Steering Committee of the NRCC will likely be involved in this process.

### Spiny dogfish (AOP Lead: Cate O’Keefe)



Recommendation: Level 3 (Enhanced Review)

A Research Track assessment for spiny dogfish was peer reviewed in December 2022. The Stock Synthesis 3 (SS3) model was used with a time series of 1989–2019. The stock was not overfished based on

Reproductive Output in 2019 (239.9 million pups) being 65% of the  $SSB_{MSY}$  proxy (Reproductive Output Target = 370.8 million pups), and overfishing was occurring based on  $F_{2019}$  (0.032) being 128% of the  $F_{MSY}$  proxy ( $F_{60\%SPR} = 0.025$ ). The assessment included the NMFS Spring and Fall bottom trawl survey indices and lengths, two landings fleets and three discard fleets, Lorenzen natural mortality estimates, and two maturity-growth relationship blocks. Dvora Hart presented the proposed assessment plan for spiny dogfish in 2023, which will use the current SS3 model configuration with explorations and potential modification to the influence of the stock-recruit relationship and updated fishery and survey data through 2022. CAMS and SBRM derived estimates of commercial landings and discards and MRIP estimates of recreational landings will be used for 2020–2022. Landed and discarded length and sex data by gear type will be updated based on available information. Survey updates include the 2021 and 2022 (2020 survey was not conducted) NMFS Spring and Fall bottom trawl survey indices and lengths. Reference points will be updated using the Research Track approach with  $MSY$  level proxies based on  $SPR_{60\%}$ . The projection method will be investigated to consider disproportional landings and discards. The proposed backup assessment approach is the previously used Stochastic Estimator model, which estimates  $F$  and  $SSB$  using swept area from the NMFS Spring survey with propagation of uncertainties.

The AOP raised questions about the backup assessment plan and potential challenges with applying reference points from the SS3 model to the outputs from the Stochastic Estimator model. The AOP noted that it is unlikely that the SS3 model would be rejected during the Management Track Peer Review as it was recently approved during the Research Track assessment. Dr. Hart noted that the new BRPs were approved through the Research Track assessment and would remain in place. The AOP asked about the influences of changes in natural mortality assumptions and age information included in the SS3 assessment. Dr. Hart commented that the use of the Lorenzen  $M$  provides better results from the model and is more biologically realistic. Estimates of  $M$  range from 0.3 for newborn pups to 0.08 for large adult females, which influence the per recruit calculations and result in less females reaching the reproductive age. She noted that the only ageing study with a large scope was conducted  $\approx 40$  years ago and there is evidence that growth rates have changed. Length at maturity has decreased suggesting that either growth has slowed, or females are maturing at earlier ages. Smaller, slower growing females indicate reduced reproductive output. The 2022 Research Track assessment suggested that reproductive output has rapidly declined in recent years, and the stock may be approaching an overfished status.

The AOP and other meeting attendees inquired about providing estimates of  $F$  and biomass for males. Dr. Hart commented that this question has been raised in the past and she could provide these estimates but does not propose deriving reference points for males.

The AOP recommended a Level 3 review for spiny dogfish. The AOP supported the proposed explorations and potential changes to the assessment and recommended that ample time be allotted for presentation and review during the Management Track Peer Review. The AOP noted the need for review of CAMS data and the potential for a change in stock status. They also highlighted that the 2023 Management Track is the first iteration of the SS3 assessment since the Research Track in 2022 and highlighted major changes in estimates of natural mortality and length at maturity.

**Scup (AOP Lead: Paul Rago)**

Recommendation: Level 2 (Expedited Review)



Scup were most recently assessed in 2021 via a Management Track assessment; the most recent benchmark assessment was in 2015 at [SAW 60](#). Mark Terceiro presented the proposed assessment plan for scup in 2023 that will rely on the model structure ([ASAP](#)) but include updated fishery and survey data through 2022. [CAMS](#) estimates of commercial landings and discards will be used for 2020–2022, but questions remain about the commercial discard estimates. [NEFSC](#) trawl survey indices will include “by tow” area swept estimates but the effect of such changes on general trends are negligible. Some minor changes in tuning parameters will be used to improve model diagnostics. These parameters include the Coefficients of Variation ([CV](#)) for some state abundance indices. Population projections will assume a catch in 2023 equal to the approved [ABC](#) of 13,458 [mt](#).

The [AOP](#) inquired about the potential effects of missing [NEFSC](#) survey data in 2020 and the effects of large year classes now moving into the plus group of the population. Such factors can increase the likelihood of retrospective patterns. Dr. Terceiro acknowledged these concerns and noted that noisy indices might cause problems in future years. The model also includes a dome shaped selectivity pattern for the fishery. This creates a large “cryptic” biomass. Consideration of age-based natural mortality rates might be necessary in future benchmarks for this species.

Additional questions from the [AOP](#) inquired about the potential utility of methods to aggregate several indices to detect relative abundance and trend. Dr. Terceiro noted that various GLM approaches had been explored but previous reviewers expressed concerns about over-smoothing of abundance estimates outside of the assessment model. In theory, modern models are designed to address competing signals in the composite likelihood function, but they do not address the spatial arrangement of the indices or their covariance. Recent recruitment indices have been low, but attempts to estimate a parametric stock recruitment relationship have not been successful. The low values in recent years do not seem sufficient to support a change in the stanza of years used for stock and catch projections. Moreover, in view of Dr. Terceiro’s responsibilities for summer flounder at the June [MTA](#), the analyses to justify such a change are unlikely to be completed.

No [RTA](#) are currently planned for scup but likely topics for consideration include the aforementioned topics of age-specific [M](#) and aggregation of young of the year indices as well as concerns about discard estimates in the earlier decades of the assessment. The model currently starts in 1963, but estimates of age structure only began in 1984. There appears to be sufficient contrast in recent survey indices such that the earlier years of the time series could be dropped. The tradeoff between contrast in the surveys and uncertainty in the discards and age composition of earlier years may justify truncation at an [RTA](#). The [AOP](#) unanimously endorsed a Level 2 review for Scup.

### Summer flounder ([AOP](#) Lead: Mike Celestino)



Recommendation: Level 2 (Expedited Review)

The currently approved stock assessment model for summer flounder is a 2021 Management Track assessment ([MTA](#)) with data through 2019, that builds on the 2018 [SAW 66](#) benchmark assessment. This is an [ASAP](#) model with four fishery fleets, three selectivity periods, and a variety of federal, state, and academic fishery surveys. Results of the 2021 [MTA](#) indicated the stock is not overfished, and overfishing is not occurring.

New sources of information considered for the 2023 MTA include an update of fishery and survey catches for 2020–2022. CAMS will be queried for commercial landings and discards for these same years; Mark Terceiro noted that preliminary comparisons of SBRM and CAMS for 2018–2021 were within 10%, likely due to differences in stratification, while differences in landings were trivial. Revision of the NEFSC trawl survey indices for the Bigelow years (2009–2020) to include “by-tow” swept area calculations are also proposed. Model configuration changes that are proposed as part of this MTA include changes to survey input CVs and adjustments to input catch ESS; each expected to have minor changes on assessment results, but result in improved model diagnostics. Dr. Terceiro noted that if time allows (depending on exactly when data are available), he will experiment with splitting the terminal fishery selectivity blocks from 2008–2022 to 2008–2015 and 2016–2022 to determine impacts on model performance.

Consistent with past summer flounder assessments, BRPs will be derived from projections that include recruitment estimates that use the entire time series (1982–2022), while OFL projections will extend the SSC-recommended low-recruitment time series that started in 2011 (2011–2022). For 2024–2025 OFL projections, Dr. Terceiro will assume catch in 2023 as the final ABC (15,023 mt), and follow MAFMC risk policy for ABC (e.g., OFL CV = 60%).

Dr. Terceiro is proposing as a backup assessment plan, should one be necessary, of either recent trends in all normalized survey indices (e.g., the SSC data update procedure) or lsmooth using the NEFSC Bigelow spring and fall indices.

The AOP further inquired about the source(s) of differences between SBRM and CAMS, to which Dr. Terceiro noted that the differences were not consistent in one direction and that further diagnosis of specific differences will require a line-by-line, stratum-by-stratum examination of discards; he noted there may not be sufficient time to perform that analysis. The AOP noted that highlighting differences to the review panel could be helpful. The AOP supported extending the low recruitment timeseries for OFL projections but inquired as to whether there was a contingency plan if one of the new recruitment estimates (2020–2022) was anomalously high to which Dr. Terceiro indicated that early signs suggest there is a low risk of this happening, but if it should, he is likely to explore an alternate projection run with the anomalous recruitment(s) removed. The AOP also discussed whether exploration of revisions to historical selectivity blocks would elevate the assessment to Level 3, but the AOP felt comfortable that should time allow for this exploration, given the other modest changes proposed for this assessment, there would be adequate review time under a Level 2 review; moreover, it appears as though past practice has been to maintain Level 2 assessments for this type of proposed change (e.g. scup).

The AOP supported a Level 2 assessment review for summer flounder. Justification for this recommendation included the notion that the time available for a Level 2 review is sufficient to address all proposed changes.

### *AOP Meeting Conclusions:*

The AOP met on February 23, 2023 to review the stock assessment plans for 7 stocks scheduled for the June 2023 Management Track cycle. The panel concluded that a Level 1 review (Direct Delivery) was warranted for Atlantic mackerel; Level 2 reviews (Expedited Review) for bluefish, deep-sea red crab, longfin inshore squid, scup and summer flounder; and Level 3 review (Enhanced Review) for spiny



dogfish. The Level 2 and 3 reviews will occur during the June 2023 Management Track Peer Review scheduled for June 26–28, 2023. In the case of spiny dogfish, the **NRCC** decided to delay the review until the September Management Track peer review. Changes in the required review level would be triggered by a Northeast Fisheries Science Center request to increase the review level for a given stock. The **AOP** could concur to increase the review level via email or request to reconvene the **AOP** panel to have further discussions with the stock assessment lead. In the case of Atlantic mackerel, if the 2022 egg/biomass index is not available, the **AOP** agreed to raise the review level to Level 2 (Expedited Review) via correspondence. Any need to reconvene the panel would be a publicly announced meeting and any subsequent changes to the review level would be publicized to assessment partners and stakeholders.

### *Appendix A.1. Meeting participants*

#### **Panel, February 2023:**

Russ Brown – **AOP** Chair (**NEFSC**)  
Paul Rago – **AOP** (**MAFMC**)  
Mike Celestino – **AOP** (**ASMFC**)  
Cate O’Keefe – **AOP** (**NEFMC**)  
Michele Traver – **NEFSC**

#### **Online Attendees and Presenters, February 2023:**

Abigail Tyrell – **NEFSC**  
Alex Dunn – **NEFSC**  
Andy Jones – **NEFSC**  
Anthony Wood – **NEFSC**  
Brandon Muffley – **MAFMC**  
Charles Adams – **NEFSC**  
Charles Perretti – **NEFSC**  
Chelsea Tuohy – **ASMFC**  
Chris Kellogg – **NEFMC**  
Chris Legault – **NEFSC**  
Cynthia Jones – Old Dominion University (June **MT** peer review chair)  
David McCarron – **NEFMC**  
Dvora Hart – **NEFSC**  
Emily Bodell – **NEFMC**  
Eric Reid – Fisheries Consultant  
Greg DiDomenico – Lund’s Fisheries  
Haley Clinton – **NC** Division of Marine Fisheries  
Hannah Hart – **MAFMC**  
James Boyle – University of Miami  
Jamie Cournane – **NEFMC**  
Jason Boucher – **NEFSC**  
Jason Didden – **MAFMC**  
Jeff Kaelin – Lund’s Fisheries  
Jon Deroba – **NEFSC**

Jui-Han Chang – NEFSC  
Julie Nieland – NEFSC  
Karson Cisneros – MAFMC  
Kathy Sosebee – NEFSC  
Katie Almeida – Town Dock  
Katie Drew – ASMFC  
Kiersten Curti – NEFSC  
Lisa Hendrickson – NEFSC  
Mark Terceiro – NEFSC  
Meghan Lapp – Sea Freeze  
Melanie Griffin – MA Marine Fisheries Institute  
Michael Waine – American Sportfishing Association  
Paul Nitschke – NEFSC  
Steve Cadrin – SMAST  
Susan Wigley – NEFSC  
Toni Chute – NEFSC

## Appendix B. Management Track Stock Assessment

### Terms of Reference

1. Estimate catch from all sources including landings and discards.
2. Evaluate indices used in the assessment (e.g., indices of relative or absolute abundance, recruitment, state surveys, age-length data, etc.).
3. Estimate annual fishing mortality, recruitment and stock biomass (both total and spawning stock) as possible (depending on the assessment method) for the time series using the approved assessment method and estimate their uncertainty. Include retrospective analyses if possible (both historical and within-model) to allow a comparison with previous assessment results and projections, and to examine model fit.
  - a. Include bridge runs to sequentially document each change from the previously accepted model to the updated model proposed for this peer review.
  - b. Prepare a backup assessment approach that would serve as an alternative for providing scientific advice to management if the analytical assessment were to not pass review.
4. Re-estimate or update the BRPs as defined by the management track level and recommend stock status. Also, provide qualitative descriptions of stock status based on simple indicators/metrics (e.g., age- and size-structure, temporal trends in population size or recruitment indices, etc.).
5. Conduct short-term stock projections when appropriate.
6. Respond to any review panel comments or SSC concerns from the most recent prior research or management track assessment.

Note: Major changes from the previous stock assessment require pre-approval by the Assessment Oversight Panel.

## Appendix C. June 2023 Management Track Peer Review meeting attendees.

### Panel, June 2023:

Cynthia Jones – Chair  
Alexei Sharov – Panel  
John Wiedenmann – Panel  
Katie Drew – Panel

### NEFSC Leadership:

Russ Brown – NEFSC  
Michele Traver – NEFSC

### Online Attendees and Presenters:

Alan Bianchi – NCDMF  
Alex Dunn – NEFSC  
Alex Hansell – NEFSC  
Allison Murphy – GARFO  
Ben Levy – NEFSC  
Brandon Muffley – MAFMC staff  
Brian Linton – NEFSC  
Charles Adams – NEFSC  
Charles Perretti – NEFSC  
Chelsea Tuohy – ASMFC  
Chris Kellogg – NEFMC staff  
Chris Legault – NEFSC  
Cynthia Ferrio – GARFO  
Gary Nelson – MADMFC  
Greg DiDomenico – Lund's Fisheries  
Hannah Hart – MAFMC staff  
Jason Boucher – NEFSC  
Jessica Blaylock – NEFSC  
Jon Deroba – NEFSC  
Jose Montanez – MAFMC staff  
Karson Cisneros – MAFMC staff  
Kate Wilke – Nature Conservancy (Virginia)  
Kathy Sosebee – NEFSC  
Kiersten Curti – NEFSC  
Kiley Dancy – MAFMC staff  
Kristan Blackhart – NMFS Office of Science and Technology  
Lauran Brewster – UMASS Dartmouth  
Lisa Hendrickson – NEFSC  
Mark Grant – GARFO  
Mark Terceiro – NEFSC  
Michael Waite – American Sportfishing Association  
Mike Celestino – NJ Bureau of Shellfisheries

Paul Nitschke – NEFSC  
Rachel Feeney – NEFMC staff  
Sefatia Romeo Theken – Deputy Commissioner, MA Department of Fish and Game  
Sharon Benjamin – GARFO  
Steve Cadrin – SMAST  
Susan Wigley – NEFSC  
Toni Chute – NEFSC  
Tony Wood – NEFSC  
Willy Goldsmith – Pelagic Strategies LLC  
Will Poston – American Saltwater Guides Association



Aerial view of Woods Hole Oceanographic Institute, MA; photo ©WHOI

## Appendix D. Realized Agenda for June 2023 Management Track peer review

Time	Subject	Lead
<b>Tuesday, June 26, 2023</b>		
9:30–9:45 am	Welcome/Logistics/Conduct of Meeting	Michele Traver, Russ Brown, Cynthia Jones, Chair
9:45–11:15 am	Deep Sea Red Crab Discussion/Questions	Toni Chute, Panel
11:15–11:30 am	— Break —	
11:30–12:00 pm	Discussion/Summary	Panel
12:00–12:15 pm	Public Comment	Public
12:15–1:15 pm	— Lunch —	
1:15–3:30 pm	Scup Discussion/Questions	Mark Terceiro, Panel
3:30–3:45 pm	— Break —	
3:45–4:15 pm	Discussion/Summary	Panel
4:15–4:30 pm	Public Comment	Public
4:30 pm	— Adjourn —	
<b>Wednesday, June 27, 2023</b>		
9:30–9:35 am	Welcome/Logistics	Michele Traver, Cynthia Jones, Chair
9:35–11:15 am	Longfin inshore squid Discussion/Questions	Lisa Hendrickson, Panel
11:15–11:30 am	— Break —	
11:30–12:00 pm	Discussion/Summary	Review Panel
12:00–12:15 pm	Public Comment	Public
12:15–1:15 pm	— Lunch —	
1:15–3:30 pm	Summer flounder Discussion/Questions	Mark Terceiro, Panel
3:30–3:45 pm	— Break —	
3:45–4:15 pm	Discussion/Summary	Review Panel
4:15–4:30 pm	Public Comment	Public
4:30 pm	— Adjourn —	
<b>Thursday, June 28, 2023</b>		
9:00–10:00 am	Closed session	Panel
10:00–12:00 am	— No session —	
12:00–1:00 pm	— Lunch —	
1:00–2:30 pm	Bluefish, Discussion/Questions	Tony Wood, Panel
2:30–2:45 pm	— Break —	
2:45–3:15 pm	Discussion/Summary	Panel
3:15–3:30 pm	Public Comment	Public
3:30–4:30 pm	Report Writing	Review Panel
4:30 pm	— Adjourn —	

## 2. ATLANTIC BLUEFISH

Anthony Wood

*This assessment of the Atlantic Bluefish (*Pomatomus saltatrix*) stock is a management track update assessment of the existing 2022 research track assessment (NEFSC 2022). Stock status for bluefish from the research track assessment (data through 2021) found the stock was not overfished, and overfishing was not occurring. The current assessment updates commercial fishery catch data, recreational fishery catch data, research survey indices of abundance, and the analytical state-space WHAM assessment model and reference points through 2022. Additionally, stock projections have been updated through 2025.*

**State of Stock:** Based on this updated assessment, the Atlantic Bluefish (*Pomatomus saltatrix*) stock is not overfished and overfishing is not occurring (Figures 1–2). Retrospective bias in model results was considered minor and retrospective adjustments were not necessary. Spawning stock biomass (*SSB*) in 2022 was estimated to be 52,747 (mt) which is 60% of the biomass target ( $SSB_{MSY\ proxy} = 88,131$  (mt); Figure 1). The 2022 fully selected fishing mortality was estimated to be 0.152 which is 64% of the overfishing threshold ( $F_{MSY\ proxy} = 0.239$ ; Figure 2).

**Table 3: Catch and status table for Atlantic Bluefish. All weights are in (mt) recruitment is in (000s) and  $F_{Full}$  is the fishing mortality on fully selected ages (age-2). Model results are from the current updated WHAM assessment.**

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
<i>Data</i>										
Recreational landings	15,732	12,324	13,725	10,634	15,620	5,857	6,800	5,923	5,471	5,002
Recreational discards	2,472	2,880	3,690	1,838	1,794	1,578	1,702	1,253	1,391	1,400
Commercial landings	1,977	2,251	1,917	1,946	1,876	1,105	1,359	1,112	1,090	1,025
Commercial discards	12	18	14	14	7	8	10	7	12	9
Catch for Assessment	20,194	17,473	19,345	14,431	19,297	8,548	9,871	8,294	7,963	7,436
<i>Model Results</i>										
Spawning Stock Biomass	67,325	53,698	46,283	43,981	41,153	35,152	41,702	42,811	44,979	52,747
$F_{Full}$	0.34	0.353	0.438	0.345	0.495	0.232	0.231	0.196	0.19	0.152
Recruits (age-0)	136,314	120,570	101,743	69,713	112,997	111,734	68,541	74,543	97,120	137,139

**Projections:** Short-term projections were conducted in WHAM, and incorporate model uncertainty, auto-regressive processes and uncertainty in recruitment and numbers-at-age. Removals in 2023 were assumed to be equal to the 2023 ABC (13,890 mt), and projections were carried forward for years 2024–2025 at  $F_{Rebuild} = 0.183$ . The MAFMC council risk policy ( $CV = 100\%$ ) was used to develop ABC values in each year, and the projection was re-iterated using these values as annual removals in place of  $F_{Rebuild}$ . Projected ABC catch in 2024 and 2025 based on this approach is 7,929 mt and 9,903 mt, respectively.



The projection uses 5-year averages for natural mortality, maturity, fishery selectivity and weights-at-age. The 5-year average was selected for those parameters to capture the most recent conditions while still smoothing some interannual variability. Projections were not retrospectively adjusted, as the adjusted terminal year estimates of  $F$  and  $SSB$  fell within the 90% confidence intervals of the unadjusted values.

**Table 4: Comparison of reference points estimated in the 2022 research track assessment and from the current assessment update. An  $F_{35\%}$  proxy was used for the overfishing threshold and was based on  $SPR$  calculations. The  $SSB_{MSY\ proxy}$  is calculated using the value of  $F_{35\%SPR}$  % and mean recruitment.**

	2022	2023
$F_{MSY\ proxy}$	0.249	0.239 (0.199–0.287)
$SSB_{MSY}$ (mt)	91,987	88,131 (65,576–118,445)
$MSY$ (mt)	19,618	18,979 (14,025–25,684)
Median recruits (age-0) (000s)	103,133	108,035
Overfishing	No	No
Overfished	No	No

**Table 5: Short term projections of total fishery catch and spawning stock biomass for Atlantic Bluefish based on a harvest scenario assuming annual  $ABC$  values calculated from  $F_{Rebuild}$  (0.183) and the  $MAFMC$  risk policy between 2024 and 2025. Catch in 2023 was assumed to be the previously established  $ABC$  value of 13,890 (mt).**

Year	Catch (mt)	$SSB$ (mt)	$F_{Full}$
2023	13,890	59,135 (39,120–89,391)	0.239
Year	Catch (mt)	$SSB$ (mt)	$F_{Full}$
2024	7929	66,706 (41,439–107,379)	0.121
2025	9903	75,757 (43,303–132,534)	0.137

### Special Comments:

- What are the most important sources of uncertainty in this stock assessment? Explain, and describe qualitatively how they affect the assessment results (such as estimates of biomass,  $F$ , recruitment, and population projections).

*Some of the important sources of uncertainty relate to assessment data inputs and the availability of information that would help better understand the dynamics of bluefish. Research recommendations from the recent research track assessment fully detail these uncertainties and data needs. A list of some of the research ideas designed to improve the bluefish stock assessment and reduce some of the uncertainties include:*

1. *Expanding the collection of recreational release length frequency data. The bluefish assessment stratifies recreational release lengths by region, and data in the southern region is lacking. These southern fish tend to be smaller and improved information pertaining to the size distribution of the southern fish would help refine the estimate of recreational discard weight.*

2. Addressing the uncertainty around temporal availability of bluefish to the fisheries and surveys. The research track assessment made significant advancements in developing an index of bluefish availability based on forage fish in the diets of bluefish like predators. This forage fish index was incorporated into a companion assessment model as a covariate on *MRIP CPUE* catchability. Further developing this index will help improve the assessment model fit to the *MRIP CPUE* information, which is an important index that helps scale biomass estimates from the model.
  3. Develop fishery dependent or independent sampling programs to provide information on larger, older bluefish. The dynamics of this size class are not well sampled or understood.
  4. Develop an updated recreational release mortality study to derive a more informed estimate of recreational discard mortality. Recreational discards are a significant proportion of the total catch so reducing the uncertainty around the release mortality is important.
- Does this assessment model have a retrospective pattern? If so, is the pattern minor, or major? (A major retrospective pattern occurs when the adjusted *SSB* or  $F_{Full}$  lies outside of the approximate joint confidence region for *SSB* and  $F_{Full}$ ).

The 7-year Mohn's  $\rho$ , relative to *SSB*, was 0.14 in the 2022 assessment and was 0.22 in this assessment. The 7-year Mohn's  $\rho$ , relative to *F*, was 0.10 in the 2022 assessment and was 0.14 in this assessment. This is considered a minor retrospective pattern for both *SSB* and *F* because the  $\rho$ -adjusted estimates of 2022 *SSB* ( $SSB_{\rho} = 43,235$ ) and 2022 *F* ( $F_{\rho} = 0.177$ ) were within the approximate 90% confidence regions around *SSB* (36,194–76,871) and *F* (0.105–0.219).

- Based on this stock assessment, are population projections well determined or uncertain? If this stock is in a rebuilding plan, how do the projections compare to the rebuilding schedule?

Population projections for Atlantic Bluefish are reasonably well determined. Shifting to *WHAM* for model projections has allowed for the incorporation of model uncertainty, auto-regressive processes, and the uncertainty in recruitment and numbers-at-age. The retrospective pattern in *F* and *SSB* is considered minor (within the 90% *CI* of both *F* and *SSB*), however, the  $\rho$  values of *F* and *SSB* have increased when compared to the previous research track assessment.

The Atlantic Bluefish stock is in a rebuilding plan with a rebuild date of 2028.  $F_{Rebuild}$  was re-calculated using a projection that assumes a constant *F* strategy, such that biomass in 2028 has a 50% chance of exceeding the *SSB*<sub>MSY proxy</sub>;  $F_{Rebuild}$  was calculated to be 0.183. The *MAFMC* risk policy was applied using this  $F_{Rebuild}$  strategy in short term projections to generate *ABC* values that are consistent with the rebuilding schedule for the next two years.

- Describe any changes that were made to the current stock assessment, beyond incorporating additional years of data and the effect these changes had on the assessment and stock status.

A change to the way the age-length keys (*ALK*) were developed from the research track, which used full *multinomial* age-length keys, was implemented for this Atlantic Bluefish assessment update. Instead of using full *multinomial* age-length keys, a hybrid approach was used, and the holes in the *ALK* were filled with the *multinomial* model fits. This approach to filling *ALK* holes is



now consistent with the methodology used for other **NEFSC** stock assessments and with the **NEFSC StockEff** program. This new method resulted in minor changes to the results of **SSB** and **F** compared to the 2022 research track assessment results.

- If the stock status has changed a lot since the previous assessment, explain why this occurred.

*Stock status of Atlantic Bluefish has not changed from the status determined in the research track assessment.*

- Provide qualitative statements describing the condition of the stock that relate to stock status.

*The Atlantic Bluefish stock has experienced a slight increase in **SSB** over the past 5 years, coinciding with a decrease in **F**. Recruitment has increased each year since 2019, and the terminal year recruitment (137 million fish) is the highest value since 2005. Both commercial and recreational fisheries have had low catches since 2018, all well below the time series average of 26,386 mt. With the low catches since 2018, fishing mortality has decreased and remained well below  $F_{MSY\ proxy}$  (0.239). The low catches in recent years are partially a result of bag limit implementation as part of the rebuilding plan. However, these lower catches could also be due to decreased bluefish availability. Anecdotal evidence suggests larger bluefish stayed offshore and inaccessible to most of the recreational fishery in recent years.*

- Indicate what data or studies are currently lacking and which would be needed most to improve this stock assessment in the future.

*The recent bluefish research track identified several new research recommendations that would improve our understanding of bluefish dynamics and help better assess the population through the current or future models. These recommendations include: expand collection of recreational release length frequency data, continue development and refinement of the forage fish / availability index as well as incorporation of this index into a base model for bluefish management advice, initiate additional fisheries-independent surveys or fishery-dependent sampling programs to provide information on larger, older bluefish, continue coastwide collection of length and age samples from fishery-independent and -dependent sources, refinement and development of indices of abundance, and develop a recreational demand model.*

- Are there other important issues?

***WHAM** allows for incorporation of environmental covariates on the catchability of survey indices, and a companion model was developed for the research track that leveraged this capability. The companion model investigated a forage fish index as a covariate on catchability of the **MRIP CPUE** and showed promise for continued development. The covariate led to an overall decreasing trend in catchability over time. This model will be further developed leading up to the 2025 management track assessment, at which time it could be considered for the primary model.*

## 2.1. Reviewer Comments: Atlantic Bluefish

A Research Track Assessment (RTA) was recently completed for Atlantic bluefish (*Pomatomus saltatrix*) in 2022. Bluefish had previously been assessed using NOAA ToolBox Age-Structured Assessment Program (ASAP). The RTA accepted the WHAM model, a state-space model, for use in bluefish assessments. The 2023 update used WHAM and included one year of data (2022). Commercial and recreational landings have declined through the time series. Recreational landings of 5,002 mt are below the series average of 19,625 mt and are a series low. Total catch in 2022 was 7,436 mt, a series low. Eighty-six percent of the catch are from the recreational fishery.

The model also included new indices: an MRIP CPUE index based on a guild approach which considered a bluefish trip either when bluefish or a species associated with bluefish was caught, SEAMAP age-1, and the calibrated CHESMAP Trawl Survey. Other new input data include recreational discards by season and region, the use of multinomial age-length keys to fill in missing values and 2 selectivity blocks for Commercial landings and 3 for Recreational. An improvement to the analysis is the use of lengths and weights of southern bluefish to estimate discard weights. There was concern that using lengths and weights from only northern fish would overestimate discards but also because the model fits both landings and discards. These modifications resulted in significant changes in natural mortality ( $M$  is now age-specific) and reduced the target  $SSB$  by 50%. The model retrospective  $SSB$  and  $F$  fell within the 95% confidence bands and were not adjusted.

The Management Track Assessment (MTA) in 2021 which used the ASAP model and determined that bluefish was overfished and overfishing was not occurring. The 2023 data update estimated a total bluefish population of 217 million, a moderate increase. Recruitment is estimated at 137 million, above the average and highest since 2005. The 2022  $SSB$  is estimated to be 52,747 mt, above the  $SSB_{Threshold}$  of 44,066 mt and below the 2022  $SSB_{Target}$  of 88,131 mt. The  $F_{35\%}$  reference point was 0.239. In the 2021 ASAP assessment the  $SSB_{Target}$  was greater than twice the  $SSB_{Target}$  in the RT 2022 WHAM model with the resulting  $SSB_{Threshold}$  in 2022 half that from the previous assessment. Those results in 2021 were twice the values from the previous assessment (SAW 60) (NEFSC 2021) and believed to be the result of the MRIP calibration that scaled up recreational catch. The change in reference points presented in the MTA 2023 are believed to be the result of the use of WHAM that has less reliance on MRIP, uses a guild CPUE and inclusion of different indices used. The modeling also used a decreased discard mortality rate (15%–9.4%), discard lengths by season and region, and Lorenzen WAA to produce age-specific natural mortality. The MTA 2023 update resulted in evaluation that Atlantic bluefish was not overfished and overfishing was not occurring. The recent fishing mortalities were among the lowest in the series, as was the catch in both the commercial and recreational fisheries.

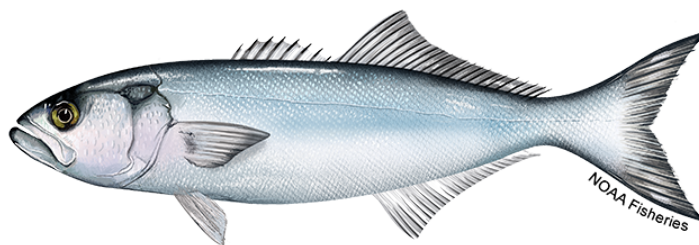
Short-term projections were done in WHAM using Removals were assumed to be 13,890 mt, the 2023 ABC and were projected with the  $F_{Rebuild}$  (0.183) under the MAFMC 100% risk policy. The projected  $SSB$  increased from 59,135 mt in 2023 to 75,757 mt in 2025.

*The Panel concluded that the TORs had been met. The Panel discussed the value of the WHAM model to further explore environmental variables that might be driving availability of bluefish. Of particular interest is the episodic spatial distribution of large bluefish. Their presence inshore and availability to the fishery is inconsistent with attributed numbers and the drivers of this availability uncertain. Another concern of the Panel was the estimate of higher recruitment given that it is among the highest in recent*

years. It falls within the confidence intervals but the model evidenced a tendency to overestimate *R*.

The Panel had some research recommendations: Obtaining better data on recreational discard lengths would be valuable. This endeavor relies on volunteer angler reporting such as was done previously in South Carolina. *NMFS* should consider developing an app that can be used by anglers to report discard lengths. Because self-reporting can introduce bias, the statistical issues should also be explored. The Panel also commented that the *M* was high on young fish and evaluating the underlying causes might be a valuable project for funding.

The Panel concluded that the 2022 assessment update for Atlantic bluefish fulfilled the recommendations of the *AOP*, is technically sufficient to provide scientific advice and meets the Terms of Reference for the stock's assessment.



*Pomatomus saltatrix*, Bluefish.

## References:

Northeast Fisheries Science Center. 2022. 2022 Bluefish Research Track Assessment *NOAA Fisheries*, Northeast Fish Sci Cent Ref Doc. XXX; 116p. <https://apps-nefsc.fisheries.noaa.gov/saw/sasi.php>

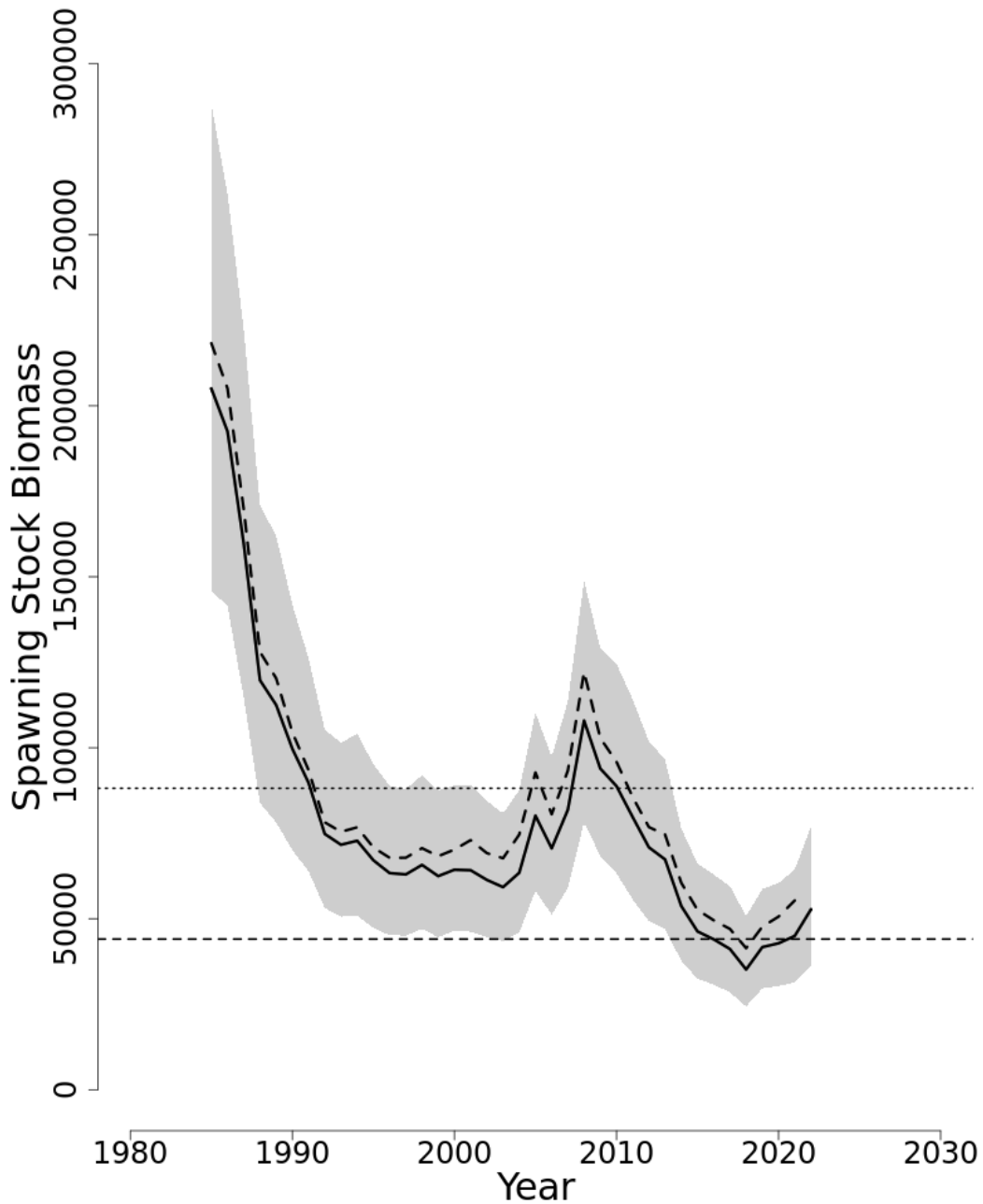


Figure 1: Trends in spawning stock biomass of Atlantic Bluefish between 1985 and 2022 from the current (solid line) and previous (dashed line) research track assessment and the corresponding  $SSB_{Threshold}$  ( $\frac{1}{2}SSB_{MSY\ proxy}$ ; horizontal dashed line) as well as  $SSB_{Target}$  ( $SSB_{MSY\ proxy}$ ; horizontal dotted line) based on the 2023 assessment. The approximate 90% log-normal confidence intervals are shown.

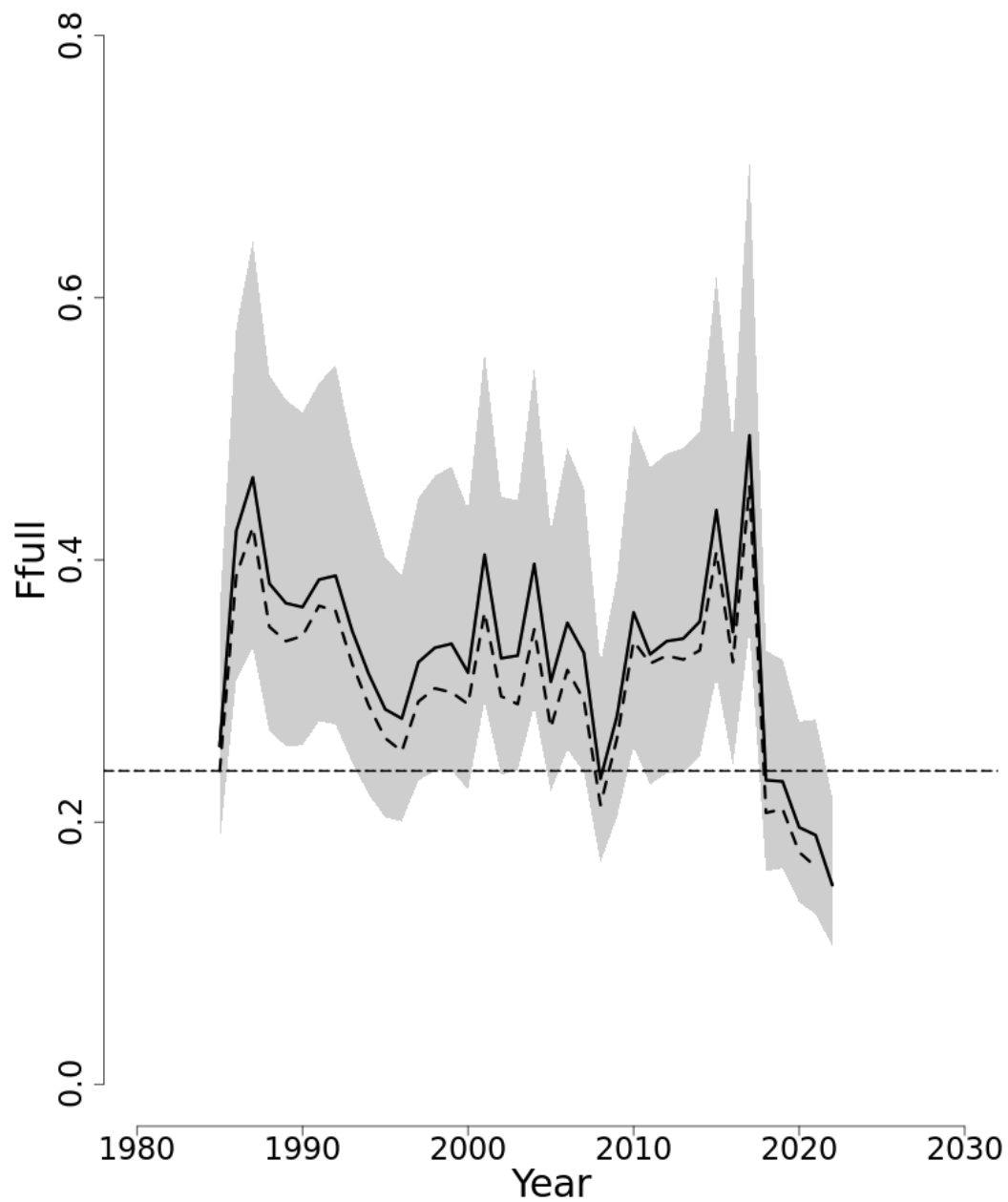


Figure 2: Trends in the fully selected fishing mortality ( $F_{Full}$ ) of Atlantic Bluefish between 1985 and 2022 from the current (solid line) and previous (dashed line) research track assessment and the corresponding  $F_{Threshold}$  ( $F_{MSY\ proxy} = 0.239$ ; horizontal dashed line). The approximate 90% log-normal confidence intervals are shown.

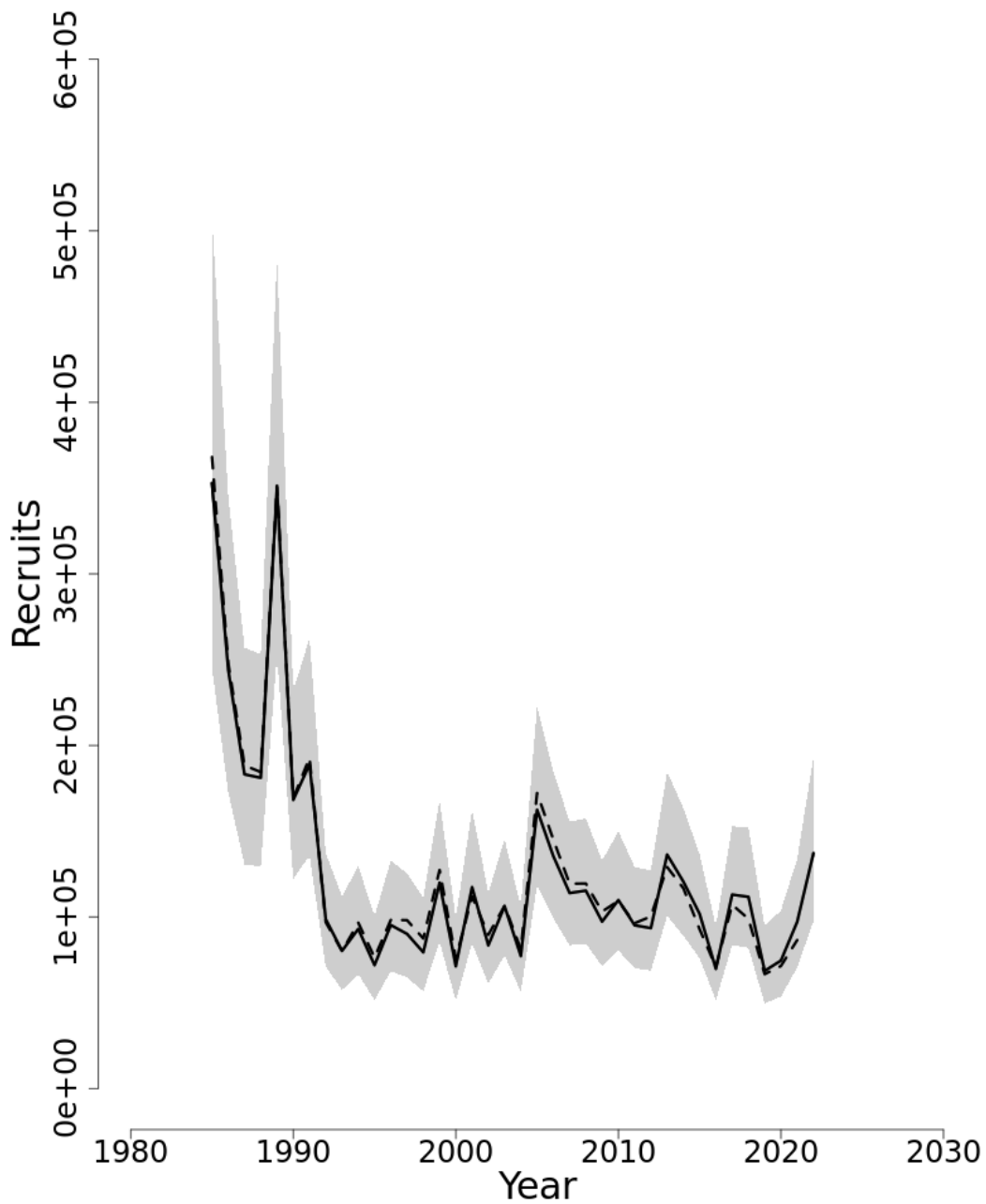


Figure 3: Trends in Recruits (age-0) (000s) of Atlantic Bluefish between 1985 and 2022 from the current (solid line) and previous (dashed line) research track assessment. The approximate 90% log-normal confidence intervals are shown.

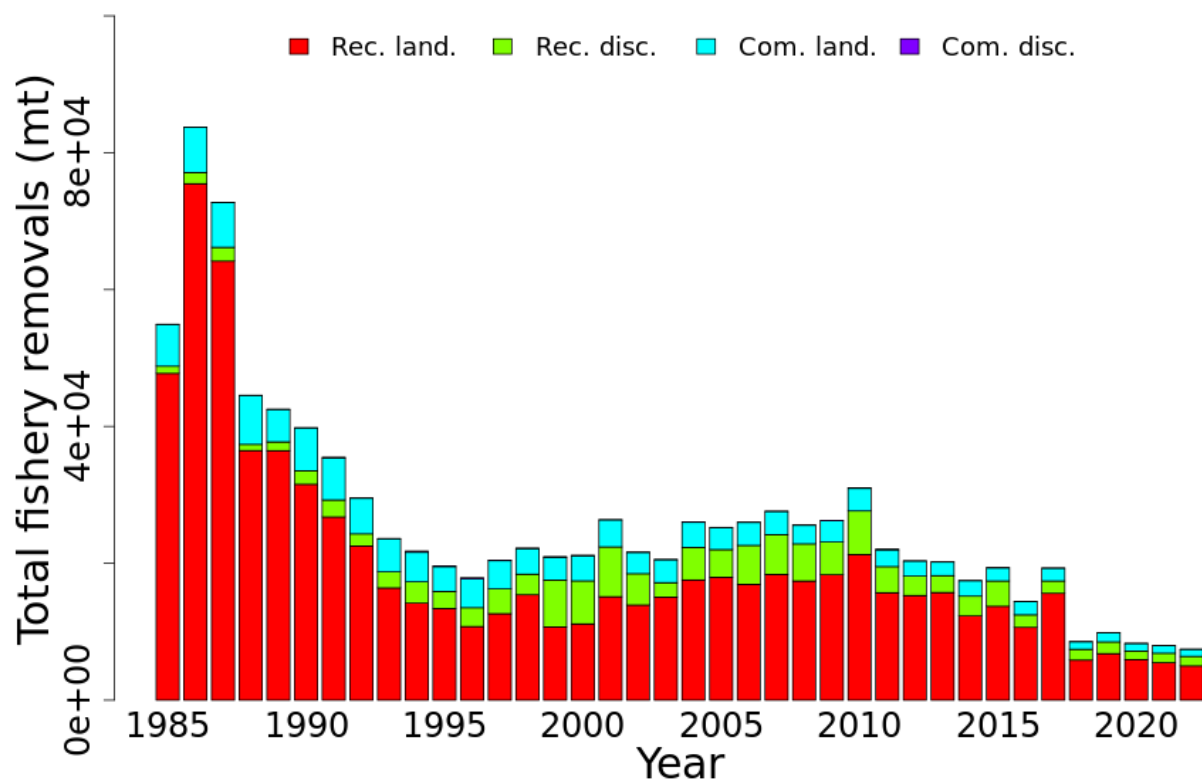


Figure 4: Total catch of Atlantic Bluefish between 1985 and 2022 by fleet (Recreational and Commercial) and disposition (landings and discards).

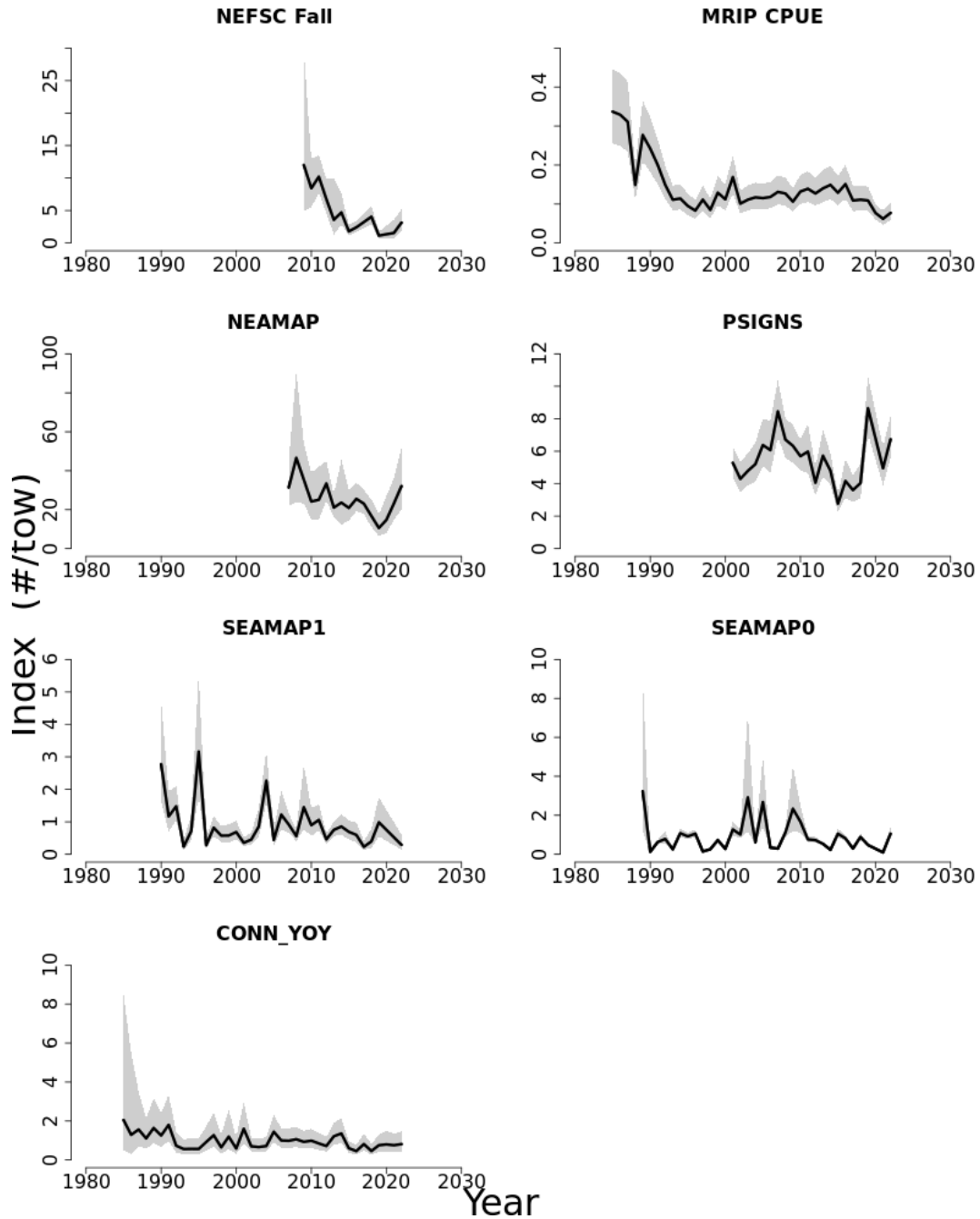


Figure 5: Atlantic Bluefish indices of abundance for the most important regional and state surveys. The approximate 90% **log-normal** confidence intervals are shown.



### 3. DEEP SEA RED CRAB

Toni Chute

A data update for deep-sea red crab (*Chaceon quinquedens*) occurs every four years during the specifications-setting process. The last data update occurred in 2019 when the specifications for fishing years 2020–2023 were set. The data updates do not result in a determination of the stock status as there are no biological reference points for red crab. Commercial fleet landings, incidental landings, estimated fleet *LPUE*, and port sampled length frequencies are compiled for this update. Data from observed red crab trips are also updated.

**Table 6: Catch table for deep-sea red crab. All weights are in (mt)**

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
	<i>Data: landings</i>												
Commercial fleet	1,412	1,625	1,180	928	985	1,613	1,387	1,366	1,631	1,670	1,952	1,559	2,067
Incidental	2	1	0	0	0	0	1	0	2	1	4	3	5

**Table 7: Estimated reference points for deep sea red crab**

	2019	2023
<i>Overfishing</i>	Unknown	Unknown
<i>Overfished</i>	Unknown	Unknown

#### Special Comments:

- What are the most important sources of uncertainty in red crab data?  
*Estimates of *LPUE* are made in two ways: per trap hauled, and per day fished. The two estimates generally track each other well. In the case of per day fished, steam time is not considered which increases uncertainty. In the case of traps hauled, the number of traps per string noted in the *VTR* trip entry is not always the number of traps emptied per haul due to a number of causes normal for fishing, which increases uncertainty.*  
*Especially in a potentially food-limited environment, there also may be uncertainty in calculating *LPUE* in a baited trap fishery. If the pot is left to soak long enough, it can attract enough crabs to fill the pot and appear as if the population has not changed in density over time. The crabs must travel longer distances to reach the bait.*  
*There is very little uncertainty in landings due to the specialized fleet and processing needs.*

- Does this assessment model have a retrospective pattern? If so, is the pattern minor, or major?  
N/A
- Based on this stock assessment, are population projections well determined or uncertain? If this stock is in a rebuilding plan, how do the projections compare to the rebuilding schedule?  
N/A
- Describe any changes that were made to the current stock assessment, beyond incorporating additional years of data and the effect these changes had on the assessment and stock status.  
N/A
- If the stock status has changed a lot since the previous assessment, explain why this occurred.  
N/A
- Provide qualitative statements describing the condition of the stock that relate to stock status.  
N/A
- Indicate what data or studies are currently lacking and which would be needed most to improve this stock assessment in the future.

*After implementation of the FMP in 2002, the red crab fishery was restricted to five full-access permits. The vessels fish cooperatively and over a wide area. The footprint of the fishery stretches from the Hague line to Virginia. The fishery is, by regulation, male-only. Landings include some females landed under an EFP during the years 2010 and 2011 but this did not continue. Red crabs are known to segregate loosely by sex and perhaps even size, with the smallest individuals being found further down the continental slope in deeper water. This is one aspect of the fishery that makes discarding highly variable, as the fishing vessels find areas where there is a high concentration of large males but there are always a certain number of females and undersized males which are discarded depending on where the pots are set.*

*Red crab is considered a data-poor species. They live outside the range of NEFSC surveys (they are sometimes caught in the northern shrimp survey and non-random deep stations in the bottom trawl survey, but in very small numbers) so there is no fishery-independent index of abundance.*

*Almost nothing is known about deep sea red crab growth and longevity, and methods of crustacean ageing are still in development and highly uncertain. There have been some studies on mating behavior of captive red crabs, but they do not live long in captivity so controlled growth studies have not been possible. A tagging study for growth was attempted in 2010 with poor results. Very few tagged crabs were ever recovered, for reasons unknown.*

*There have been two surveys of the deep-sea red crab resource in the past; one in 1974 (Wigley, Theroux and Murray, 1975) and another during the summers of 2003–2005 (Wahle et al. 2008). The first survey was undertaken soon after the fishery began and the second shortly after the deep sea red crab FMP was implemented in 2002. The methods used by the two surveys were the same, and the 2003–2005 survey attempted to replicate the survey gear used in 1974 as closely as possible. At some stations a benthic sled equipped with a camera and strobe light was towed along the bottom for 30–75 minutes, taking a picture every 10 seconds. The area of bottom illuminated in the images was estimated, and counting the red crabs visible in each image, then extrapolating that*

number out to the area of the survey resulted in an estimate of swept-area abundance. At other stations, a trawl net was deployed to determine red crab sex ratios, weights and length frequencies by sex. Mean weights were used to estimate swept-area biomass.

After the second survey, it was possible to see the effect the fishery had on red crab population structure. As would be expected, the number of large male crabs was reduced. However, the number of smaller males and females appeared to have increased. After the results of the second survey were presented at the Northeast Data Poor Stocks Working Group in 2008 (citation below), the potential for sperm limitation in the red crab population caused concern. It was noted in the mating studies and seen in the benthic sled images that male red crabs needed to be about 50% larger than the females to be able to mate, since the male carries the female underneath his body during the process. If the larger males were being removed from the population, there was concern that the largest females with the highest reproductive potential would not be able to find mates and recruitment would diminish.

There have been efforts to estimate **MSY** for red crab, most recently also at the Northeast Data Poor Working Group meeting. The group tried several models and methods at the time, and reviewed estimates that had taken place in the past. Specifically the models were the depletion-corrected average catch (**DCAC**) model and the two-point boundary model. The **DCAC** model works from the idea that for a new fishery, in calculating average catch for an estimate of sustainable yield, the windfall at the start of a fishery will represent a certain number of units of sustainable yield and increase beyond the actual number of years of fishing, with that increase being based on an estimate of natural mortality. The two-point boundary model estimates the average recruitment needed to sustain the catch time series based on mature biomass at two points in time defined as the initial and final survey values, then estimates equilibrium catch based on recruitment, final biomass and survival. At the end of the day there was not one widely accepted value due to many factors, and the group determined there was substantial uncertainty in any potential **BRP** estimates that came out of the workshop based on current information about the stock. Survey-based **BRPs** were also relying on assumptions that the population was stationary and the fishing area did not extend beyond the surveyed area.

In terms of other effects of the fishery on the population, the percent mortality for discarded crabs is unknown. Crabs apparently survive being brought to the surface and returned to the bottom still contained in a special crab hotel at a high percentage, but method of discard (dropping vs. sliding) can increase mortality (Tallack 2007). Little is known about the survival of crabs discarded from a vessel that must descend down through hundreds of meters of water without protection after handling.

Since the **FMP** was put in place, the information originally available to assess the sustainability of the fishery has been total landings and port sampled carapace widths from which estimates of **LPUE** could be made and the size of landed crabs could be monitored. Estimates of **LPUE** used as a proxy for abundance can be uncertain in a pot fishery (see above). There are also economic and/or market factors that may affect culling patterns, fishing effort, location and catch for red crab. The fishery is market-driven and annual variations in landings reflect this.

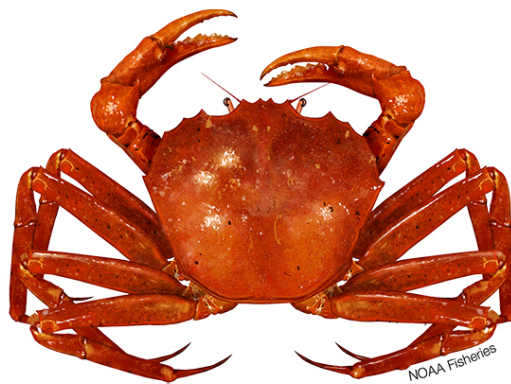
In recent years (2016+) observer coverage of the red crab fishery has increased substantially and the data observed trips provide have allowed us to look at other aspects of red crab biology and the

*fishery. Since we never had information about undersized males that were discarded at sea, their numbers and length frequencies recorded by observers give us some information about recruitment. Since we never had information about females as they were all discarded at sea, their length frequencies and reproductive status (egg) data recorded by observers give us some information about the potential for sperm limitation. Most of the egg observations have been presence/absence but there have been some observers who stage the eggs, which determines if they are viable; important to note on the larger females especially where sperm limitation is a concern. The measurements of females, which have not had the same level of fishery removals as the males, have provided evidence that the crabs caught at the southern end of the fishery footprint reach greater maximum sizes than those caught in the more northern regions. Anecdotally, the red crabs found in the Gulf of Maine are the smallest, so there is likely a latitudinal size gradient.*

*Based on this information and previous recommendations, questions for research are listed below. They include the recommendations from the 2008 Northeast Data-poor Stocks Working Group report, past assessments, Tallack (2007) and Wahle et al. (2008).*

- What is the lifespan of a red crab?*
- How often do red crabs molt, and what is the percent increase in body size after a molt? Do red crabs, especially females, have a terminal molt? Molt frequency of females would be especially important too, as they mate during the molt period.*
- Do red crabs store sperm and if so for how long? Although some crabs are known to store sperm from a single mating to produce several clutches of eggs, it is unclear whether red crabs have this ability.*
- What percent of females with eggs are carrying viable eggs? Unmated females may produce clutches of unfertilized eggs.*
- How long do red crabs incubate their eggs? This would be useful to know in conjunction with molt frequency and sperm storage capability as it could relate to how many clutches of eggs a female could have in an intermolt period.*
- How many eggs are carried in a clutch and how does this vary by the size of the crab? Are there patterns that might indicate sperm storage?*
- Can we gather additional information on the relative sizes of mating pairs and any possible effects on reproductive potential? Could simulation modeling be used to explore the response of population sex ratios and size ratios to different fishing patterns? Is there a way to evaluate the importance of large male red crabs in reproduction considering the size distribution of females?*
- How can we design a successful tagging study to explore red crab growth rates, fishing mortality rates and molt frequencies in situ?*
- Are there any new, innovative ageing methods that might work for red crab?*
- What is the main food source for red crabs? Are they cannibalistic?*
- How much and when do red crabs move about their range? Is there a seasonal migration of one or both sexes?*

- *Can we improve estimates of total discard mortality by considering seasonality, predation and displacement?*
  - *Could gear design studies help reduce discard and increase efficiency in the red crab fishery?*
  - *Could soak time studies help reduce uncertainty in **LPUE** as an estimate of abundance?*
  - *Traditional reference points for the deep sea red crab stock are difficult to estimate due to lack of basic information. Are there non-traditional reference points that could be used to determine stock status? Could **BRPs** based on size and sex ratios be useful due to the importance of preventing sperm limitation? It would require regular surveying.*
  - *How do economic factors alter the distribution and interpretation of fishing effort for the red crab fishery?*
  - *Can we collect biological data from a large number of red crabs over a wide area, crabs that have not been selected by a commercial trap (say, with a trawl) and are therefore more representative of the population at large? What questions could that help us answer: percentage of females with eggs, sperm storage, percentage in different shell conditions and states of molting, degree of segregation of the population by sex and size?*
  - *Would regular surveys of the red crab population provide useful information on the continuing effects of the fishery and the current population structure? What methods could be used? Can we get a better understanding of the habitat-abundance relationship for allocation of effort for any potential survey?*
- Are there other important issues?  
*None.*



*Chaceon quinque-dens*, Atlantic Deep Sea Red Crab.

### 3.1. Reviewer Comments: Deep sea red crab

Deep-sea red crab (*Chaceon quinque-dens*) is a data-poor species with little known of its growth or longevity. They are found in areas outside the NEFSC surveys and so there is no fishery-independent estimate of abundance. A tagging study was attempted in 2010 but tag returns were very low and insufficient to derive any information about the species. The fishery is small with only 5 license holders and by regulation is a male-only fishery. Data input included the calculation of LPUE based on 3 methods: 1) per trap, 2) per day, and 3) per day with constant steam time.

Management advice for deep-sea red crab is based on DCAC, the depletion-corrected average catch model used for data poor stocks, and historical landings. The best estimate of MSY was based on 2 surveys conducted in 1974 and 2003–2005. The second survey showed a depletion of large males, potentially impacting mating success. The 2023 Management Tract Assessment (MTA) updates the last 2019 data update. This 2023 data update includes all information through 2022 including: landings, LPUE, carapace length of landed males, and observer data of length of kept and discard crabs and egg status of females.

An MSY estimated from the DCAC ranged from 1785–1862 mt and the 2-point boundary model estimated 1987–2044 mt. The range of 1700–1900 is now being used as the best estimate of MSY. Natural mortality used for MSY estimates are between 0.05–0.15.

*The Peer Review Panel (Panel) discussed the importance of evaluating the time series of size-frequencies quantitatively to see patterns for landed males but also to evaluate discard lengths of smaller males and females for any patterns. We are aware that high grading may add some bias to results. They also discussed the availability of other modeling approaches to improve data input, such as the use of GLMs. The Panel also felt that the observer data was a valuable source of information for estimating female reproductive productivity.*

*Research suggestion: The assessment report included a number of research recommendations, all of which the Panel agreed would be useful information to obtain. However, the Panel prioritized the collection of growth and natural mortality information, the refinement of the LPUE index, and simulation modeling to develop reference points appropriate for this species' life history as the most important areas of research to move the assessment to a more analytical approach. The Panel emphasized the importance of obtaining basic information of growth and, if possible, age. The Panel suggests that use of a GLM might be a better way to develop the LPUE indices that improve information on stock status. The Panel suggests that one way to improve the consistency of VTR reporting going forward would be to contact the license holders to address how they fill out these reports because there are only 5 of them. This would also help improve the LPUE calculations. Additionally, the Panel suggested the potential value of a boundary model simulation, a quasi-Bayes approach, and the fisheries behavior of similar species. Finally, the Panel emphasizes the importance of undertaking recommendations made since 2008 because deep-sea red crab is a valuable food resource.*

*The Panel concluded that the 2023 assessment update for deep-sea red crab fulfilled the recommendations of the AOP, is the Best Scientific Information Available evaluate stock status and meets the Terms of Reference for the stock's assessment (TORs 3–5 were not evaluated because this is a data poor stock).*





Measuring the size of a deep-sea red crab.

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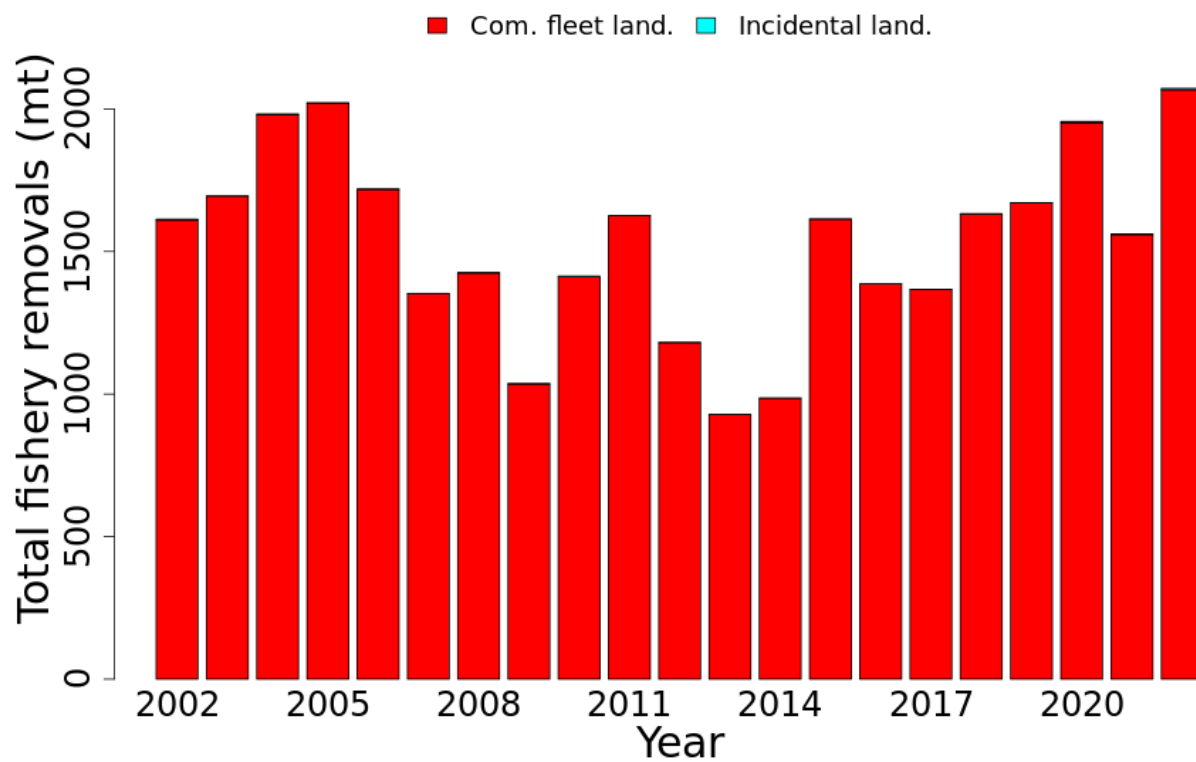


Figure 6: Total annual (calendar year) landings of deep-sea red crab since the **FMP** was implemented and the fleet was limited to five permits. Incidental landings are so small they are not visible in this plot.

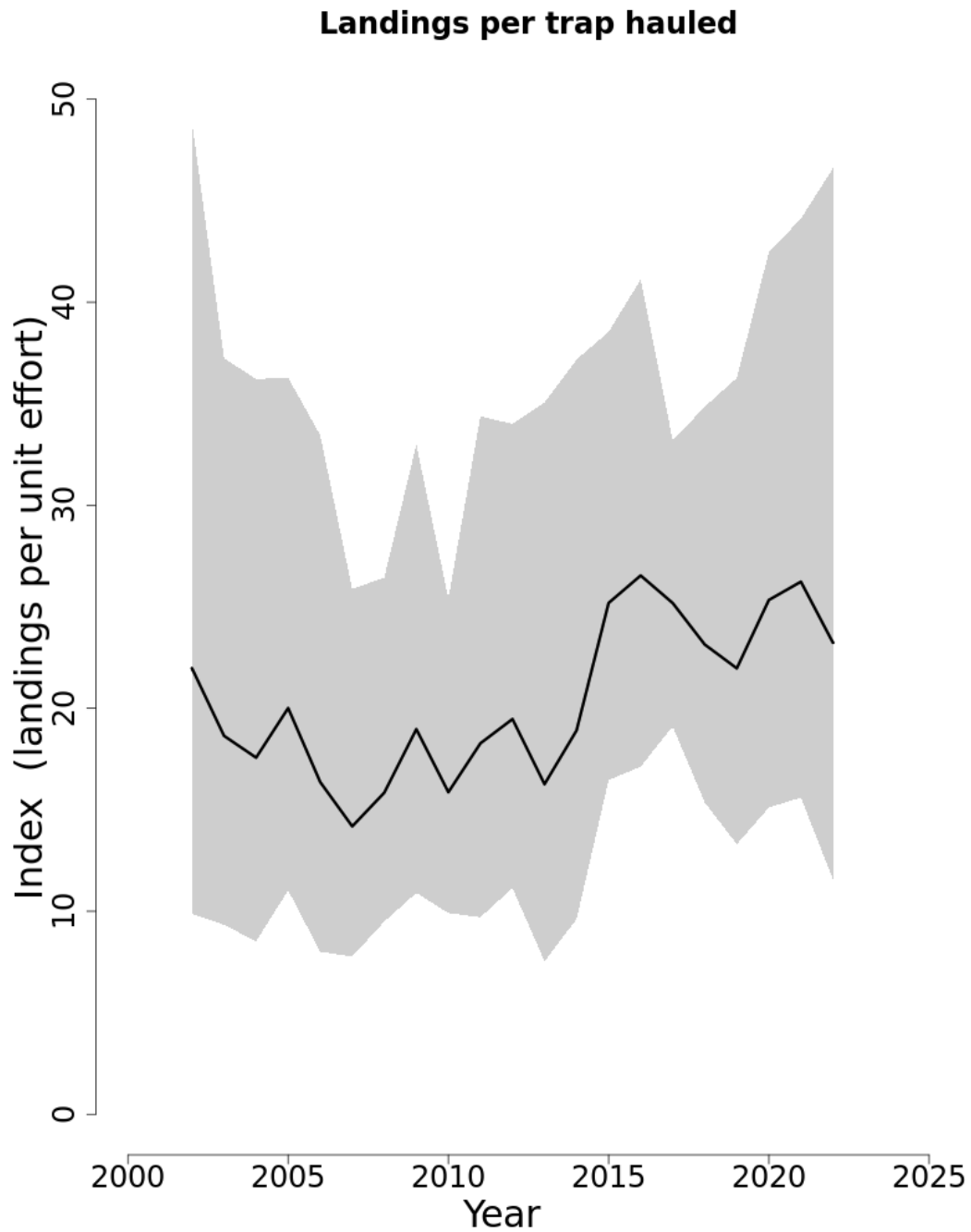


Figure 7: Estimated mean annual **LPUE** for the deep-sea red crab fleet in units of landings (**lb.**) per trap hauled. Trips with less than 1000 pounds of catch were excluded, and one vessel that fished shorter trips from 2016 to 2020 was excluded.

## 4. LONGFIN INSHORE SQUID

Lisa Hendrickson

*This Level 2 Management Track Assessment of longfin inshore squid (*Doryteuthis (Amerigo) pealeii*) is an update of the 2020 Level 3 peer-reviewed Management Track Assessment. The methodologies used to conduct the 2010 benchmark assessment during SARC 51 (NEFSC, 2011a; NEFSC, 2011b) were used in this assessment as well as the 2017 and 2020 assessment updates. Based on the 2020 assessment results the stock was not overfished and overfishing was unknown during 2019 (NEFSC, 2020).*

*This assessment provides updates of commercial fishery catches (Table 8, Figure 10),  $q$ -adjusted, swept-area biomass estimates, and exploitation indices (catch/biomass) through 2022 (Figure 11). Cohort-specific biomass was estimated separately for the NEFSC spring surveys versus NEFSC fall + NEAMAP fall surveys. Annualized biomass estimates, recommended by the SARC 51 Working Group as annually averaged spring and fall survey biomass estimates, were also updated. Cohort-specific exploitation indices (Jan.–June catch/spring survey biomass versus July–December catch/fall survey biomass) and annualized exploitation indices (annual catch/annually averaged spring and fall survey biomass) were updated as well.*

**State of Stock:** Based on this updated assessment, the annualized stock status for longfin inshore squid (*Doryteuthis (Amerigo) pealeii*) is not overfished and overfishing is unknown. The annualized catchability-adjusted, swept-area biomass in 2022 (defined as the two-year moving average of the 2022 and 2021 annually averaged NEFSC spring and fall survey biomasses) was estimated to be 121,836 **mt** (80%  $CI$  = 106,748–136,923) (Figure 8), which was more than five times greater than the threshold  $B_{MSY\ proxy}$  of 21,203 **mt**. Overfishing status could not be determined because there are no approved fishing mortality Reference Points for the stock. The 2022 annualized exploitation index (2022 catch divided by 121,836 **mt**) was estimated to be 0.155 (Figure 9), which was 20.1% less than the 1987–2021 median of 0.195. However, as recommended by the 2020 assessment review panel, cohort-specific biomass and biomass Reference Points should be used to determine stock status. The recommended stock status for the cohorts caught in both the spring and fall NEFSC surveys is not overfished and overfishing is unknown. The catchability-adjusted, swept-area biomass in 2022 was estimated to be 46,336 **mt** (80%  $CI$  = 42,545–50,128) (Figure 10) for the spring survey cohort and 197,335 **mt** (80%  $CI$  = 167,403–227,268) (Figure 10) for the fall survey cohort, both of which were well above the threshold  $B_{MSY\ proxy}$  of 11,152 **mt** for the spring survey cohort and 56,268 **mt** for the fall survey cohort.

**Projections:** Near-term stock size projections were not possible due to the lack of an analytical assessment model that accounts for the species unique life history.

### Special Comments:

- What are the most important sources of uncertainty in this stock assessment? Explain, and describe qualitatively how they affect the assessment results (such as estimates of biomass,  $F$ , recruitment,

**Table 8: Catch and biomass assessment results for longfin inshore squid. All weights are in (mt). DWF landings are the landings from the Distant Water Fleets. Total biomass estimates in this table were not used for stock status determination because they are the two-year moving averages of the annualized  $q$ -adjusted, swept-area biomass estimates for the NEFSC spring and fall bottom trawl surveys (i.e., averages of the two surveys). Exploitation indices represent the catch in year  $y$  divided by the two-year moving average of the annualized biomass estimate in year  $y$ .**

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
<i>Data</i>											
US Landings	12,820	11,090	12,070	11,953	18,182	8,188	11,632	12,458	9,449	10,759	18,489
DWF Landings	0	0	0	0	0	0	0	0	0	0	0
US Discards	368	246	208	97	498	131	134	315	586	580	447
Catch for Assessment	13,187	11,336	12,278	12,050	18,680	8,319	11,766	12,773	10,035	11,339	18,936
<i>Model Results</i>											
Total Biomass	93,975	109,573	NA	NA	73,762	NA	NA	63,349	NA	NA	121,836
Exploitation Index	0.14	0.103			0.253			0.195			0.155

**Table 9: Comparison of Reference Points estimated in the 2020 and current assessment updates.**

	2020	2023
$F_{MSY\ proxy}$	NA	NA
$B_{MSY\ proxy}$	42,405	42,405
$MSY\ (mt)$	NA	NA
Overfishing	Unknown	Unknown
Overfished	No	No

and population projections).

For the estimation of biomass using NEFSC bottom trawl survey data, the most important source of uncertainty is the apparent productivity differences between the two intra-annual cohorts. The biomass of the cohort caught during the fall surveys is about five-fold higher than the biomass of the cohort caught in the spring surveys (NEFSC, 2011a; 2011b). However, the mean exploitation rate for the Jan.–June fishery was more than three times higher on the apparently less productive spring survey cohort. Using annualized biomass and exploitation rates to determine stock status does not account for these differences, and therefore, may impact resource sustainability. The review panel for the 2020 Level 3 assessment of this stock agreed and concluded that Annual averaging of the spring and fall survey biomasses assumes that a single population is being exploited and does not account for the large difference in apparent productivity of the two intra-annual cohorts. Cohort-specific stock size estimates and Reference Points are required to determine the stock status of cephalopod species with subannual lifespans because maturation and growth rates of intra-annual cohorts exhibit a high degree of seasonal and interannual variability (Arkhipkin et al. 2020). Because the generation time for longfin squid is only 6–8 months, overfishing of a single cohort potentially could jeopardize stock sustainability due to recruitment overfishing.

*During the 2020 assessment, cohort-specific biomass Reference Points were derived separately for squid caught in the NEFSC spring versus fall bottom trawl surveys because annualized biomass estimates and Reference Points (i.e., averages of the spring and fall survey biomasses) do not account for the apparent productivity differences that exist between the two intra-annual cohorts caught during these surveys.*

- Does this assessment model have a retrospective pattern? If so, is the pattern minor, or major? (A major retrospective pattern occurs when the adjusted  $SSB$  or  $F_{Full}$  lies outside of the approximate joint confidence region for  $SSB$  and  $F_{Full}$ ).

*These questions are not applicable to the subject assessment because an analytical model was not utilized.*

- Based on this stock assessment, are population projections well determined or uncertain? If this stock is in a rebuilding plan, how do the projections compare to the rebuilding schedule?

*Projections were not possible, because there is no analytical model from which to do so. The stock is not currently subject to a rebuilding plan but has been in the past.*

- Describe any changes that were made to the current stock assessment, beyond incorporating additional years of data and the effect these changes had on the assessment and stock status.

*The 2009–2020 NEFSC spring and fall survey biomass indices now include actual rather than nominal tow distances, at the request of the NTAP. This resulted in minor changes to the indices that did not affect stock statuses for either cohort. For example, the difference between the two-year moving average biomass estimates for 2019 during this assessment versus the 2020 assessment represented a 3.5% increase of 2,290 mt which is inconsequential in relation to the magnitude of the 2019 biomass estimate in relation to the threshold  $B_{MSY\ proxy}$ .*

*The other assessment methodology change involved the discard estimates for 2020–2022. Since the 2007 implementation of trimester-based quotas, discards have represented a minor portion of the catch; an average of 1.6% during 2007–2019. Nevertheless, the 2020–2022 discards were estimated using a new method with data from a new database, both of which differ from those used to estimate the 1989–2019 discards for the 2020 assessment. The new database, the CAMS database, was created and is maintained by GARFO. Some of the major differences between the two discard estimation methods and comparisons between the discard estimates for each method, during 2019–2021, are summarized in Tables 3 and 4 of the 2023 longfin squid tables file at SASINF (see 2023\_DORY\_UNIT\_TAB.pdf). The 2019 landings were compared between the two discard estimation methods, as were the 2019–2021 discards, but only the CAMS discard estimates were available for 2022. The 2019 CAMS landings (12,489 mt) were only 31 mt (0.25%) higher than the 2019 landings from the Area Allocation database formerly used in the discard estimation method as the denominator (kept weight of all species). The higher 2019 CAMS discard estimate (357 mt,  $CV = 0.18$ ) was more precise than the discard estimate based on the former discard estimation method (315 mt,  $CV = 0.32$ ). However, only the CAMS discard estimates for 2020–2022 were used in this assessment, because 2019 was the terminal year of the previous assessment and the 2019 discard estimate was accepted for use in the stock status determination. When the 2019–2021 CAMS discard estimates were compared with those from the former discard estimation*

method, most of the CAMS estimates were slightly higher, but most fell within the 90% confidence interval of the discards estimated using the former method.

- If the stock status has changed a lot since the previous assessment, explain why this occurred.

*Overfishing status is unknown for this stock because an analytical model could not be developed by the most recent benchmark assessment Working Group given the available data. There has been no change in the overfished status of longfin inshore squid since the 2020 operational assessment, for either of the two cohorts or for both cohorts combined (i.e., based on annualized biomass and biomass Reference Points). Under the current assessment process, however, stock status for this subannual species is always reported for the prior year (i.e., for multiple generations past) and this stock status is assumed to remain the same for the next three years when the next Management Track Assessment occurs. It is imperative that both squid stocks be assessed annually so that the timing of their stock status updates are appropriate for their short lifespans.*

- Provide qualitative statements describing the condition of the stock that relate to stock status.

*The use of conventional stock assessment models to assess squid stocks such as longfin inshore squid (*Doryteuthis (Amerigo) pealeii*), is inappropriate because they do not account for the species' subannual lifespan and semelparous reproduction. This neritic species has a lifespan of 6–8 months, and like many other loliginids, there are two dominant intra-annual cohorts; winter-hatched and summer-hatched cohorts that have different growth rates and median sizes-at-maturity (Brodziak and Macy 1996; Macy and Brodziak 2001). Length-based models are not generally used to assess squid stocks because time-consuming, expensive aging (counting of daily increments in statoliths) must be used to identify the intra-annual cohorts due to the high plasticity in individual growth rates (Arkhipkin et al., 2015). Like most squid stocks, stock size estimates of longfin inshore squid exhibit high interannual variability because each year, the population relies on new recruits to each intra-annual cohort, and recruitment levels depend on the favorability of environmental conditions (Brodziak and Hendrickson 1999; Hatfield et al. 2001).*

- Indicate what data or studies are currently lacking and which would be needed most to improve this stock assessment in the future.

*Based on the NRCC assessment schedule, this stock is currently assessed every three years. Instead, it is recommended that this subannual species be assessed on an annual basis, as was done historically. A Research Track Assessment is scheduled for review in 2026, following two years of research dedicated to developing a stock assessment model and Reference Points that account for the life history of this semelparous species and its two intra-annual cohorts. The research topics identified here and in previous assessments should be reviewed and prioritized by the Working Group prior to conducting any research on the stock.*

*During the upcoming longfin squid Research Track Assessment, the top priority should be the development of a cohort-specific assessment model that incorporates, for example, their different growth rates and median ages-at-maturity, along with spawning and non-spawning natural mortality rates.*

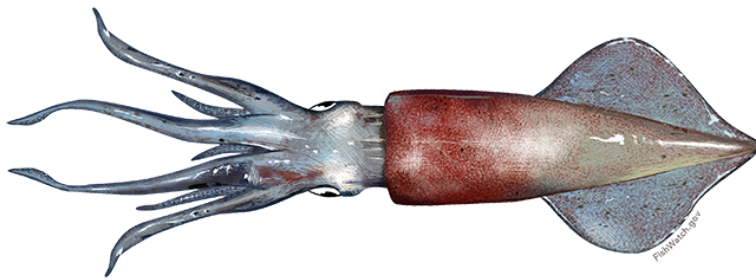
*Simulation testing should be conducted to evaluate the model's ability to accurately and precisely estimate stock conditions under a wide range of scenarios, including process and measurement errors.*

*A method that accounts for the species' semelparous reproduction should be used to estimate separate **MSP** based Biological Reference Point proxies for each of the two intra-annual cohorts to ensure adequate spawner escapement.*

*Annual pre-season biomass estimates for each cohort will be necessary to set cohort-specific Annual Biological Catches and quotas. This requires a streamlined regulatory process that allows for rapid implementation of the cohort-specific quotas in order to avoid foregone yield during years of high stock size and to avoid recruitment overfishing of either cohort during years when stock size is low.*

*Extend the work that has been conducted on estimation of the **NEFSC** bottom trawl catchability of this species in both the spring versus fall bottom trawl surveys (**NEFSC** 2011a; Jacobson et al. 2015). Additional empirical data for estimating these catchabilities are needed to investigate the apparent productivity differences between the two cohorts caught in the **NEFSC** spring versus fall bottom trawl surveys. Biomass estimates for the fall **NEAMAP** surveys were only a small percentage of the total fall biomass, averaging 5.5% during 2009–2022, but a comparison of longfin squid catchability differences between the **NEAMAP** and **NEFSC** fall surveys might also be useful.*

- Are there other important issues?  
*Life history, life history, life history!*



*Doryteuthis (Amerigo) pealeii, Longfin Squid.*



## 4.1. Reviewer Comments: Longfin inshore squid

This Level 2 Management Track Assessment of longfin inshore squid (*Doryteuthis (Amerigo) pealeii*) is an update of the 2020 Level 3 peer-reviewed Management Track Assessment. The assessment methodology has been consistent since the 2010 benchmark assessment SAW/SARC 51 (NEFSC, 2011a; NEFSC, 2011b), followed by the 2017, 2020 and this management track update.

The assessment uses catchability corrected swept area biomass to estimate stock size. A threshold equal to half of the  $B_{MSY}$  proxy estimate ( $B_{MSY} = 42,405$  mt) is used to define the overfished status of the stock. A measure of relative stock exploitation rate is calculated as a ratio of total removals to biomass, but no reference point for fishing mortality or exploitation rate is currently employed and the overfishing status is not determined.

This assessment satisfactorily updated commercial fishery harvest and discards, catchability adjusted, swept-area biomass estimates, and exploitation indices (catch/biomass) through 2022. Catches and discards for 2020–2022 were derived using the CAMS database. The indices for both surveys were corrected for the actual tow distances for each trawl tow rather than using nominal value. These corrections did not result in any significant changes.

Annualized biomass estimates as annually averaged spring and fall survey biomass estimates and annualized exploitation indices (annual catch/annually averaged spring and fall survey biomass), were also updated. Cohort-specific biomass was estimated separately for the NEFSC spring surveys versus NEFSC fall + NEAMAP fall surveys. Cohort-specific exploitation indices (Jan–June catch / spring survey biomass versus July–December catch / fall survey biomass) were updated as well. The 2022 annualized exploitation index was estimated to be 0.155 (Figure 2), which was 20.1% less than the 1987–2021 median of 0.195.

The current assessment approach does not allow the estimation of recruitment, complete retrospective analysis or do bridge runs. A Plan B assessment was not possible for this stock. Short-term projections were not conducted because there is no accepted assessment model for longfin squid.

There are currently no accepted fishing mortality reference points available for this stock. The biomass reference point  $B_{MSY}$  proxy was defined in the past based on the historic data set when the population was lightly exploited and therefore cannot be redefined within the management track assessment. The  $B_{MSY}$  proxy remained the same as the 2010, 2017 and 2020 assessments. Although cohort specific estimates are not currently used for the definition of the status of the stock, results suggested that neither of two cohorts were overfished.

*The Review Panel supports an alternative to the annualized stock size approach for using cohort-specific reference points to provide annual stock status.*

*The Panel concludes that the 2023 management track assessment fulfilled the recommendations of the AOP and is technically sufficient to evaluate stock status for biomass. The assessment represents the BSIA for this stock for management purposes and meets the Terms of Reference applicable for the stock's assessment. The Panel agrees with the assessment report that longfin squid is not overfished. The panel further notes that while the overfishing status is unknown, due to the lack of an  $F_{MSY}$  or*

proxy reference point, exploitation rates generated by the historic removals resulted in both cohort and annualized estimates of biomass near or above the  $B_{MSY}$  target values in recent years. The Panel concurs with the previous peer review recommendation to consider cohort-specific reference points based on the understanding of two dominant and largely non-overlapping intra-year cohorts of longfin squid, at the next research track assessment.

*Recommendations:*

- The Review Panel recommends considering further an option of cohort-specific reference points for determining stock status in addition to the annualized single stock BRPs.
- The Review Panel recommends continuing development of a stock assessment approach that is specifically tailored to the squid life cycle and data availability to develop biologically-based estimates of  $B_{MSY}$  and  $F_{MSY}$  instead of the historical proxy used currently.
- It is important to understand the growth and mortality of each of the two major cohorts to determine their contribution to the total stock biomass within the season, on a monthly, or other appropriate timestep. This will also help to address the question at what stage of biomass development each cohort is intercepted by the spring and the fall survey and how changes in survey timing may affect the biomass estimates.
- The Panel noted that in some years the exploitation rate was above 1 when the biomass estimates from the spring survey were used. This raises an issue of the appropriateness of current gear efficiency coefficient, since we can not be removing the entire cohort in the spring. Population biomass from the spring survey is likely to be underestimated. Survey catchability and stock distribution needs to be explored in further detail to evaluate true contribution of spring cohort to stock biomass.



Well camouflaged on the sandy bottom.

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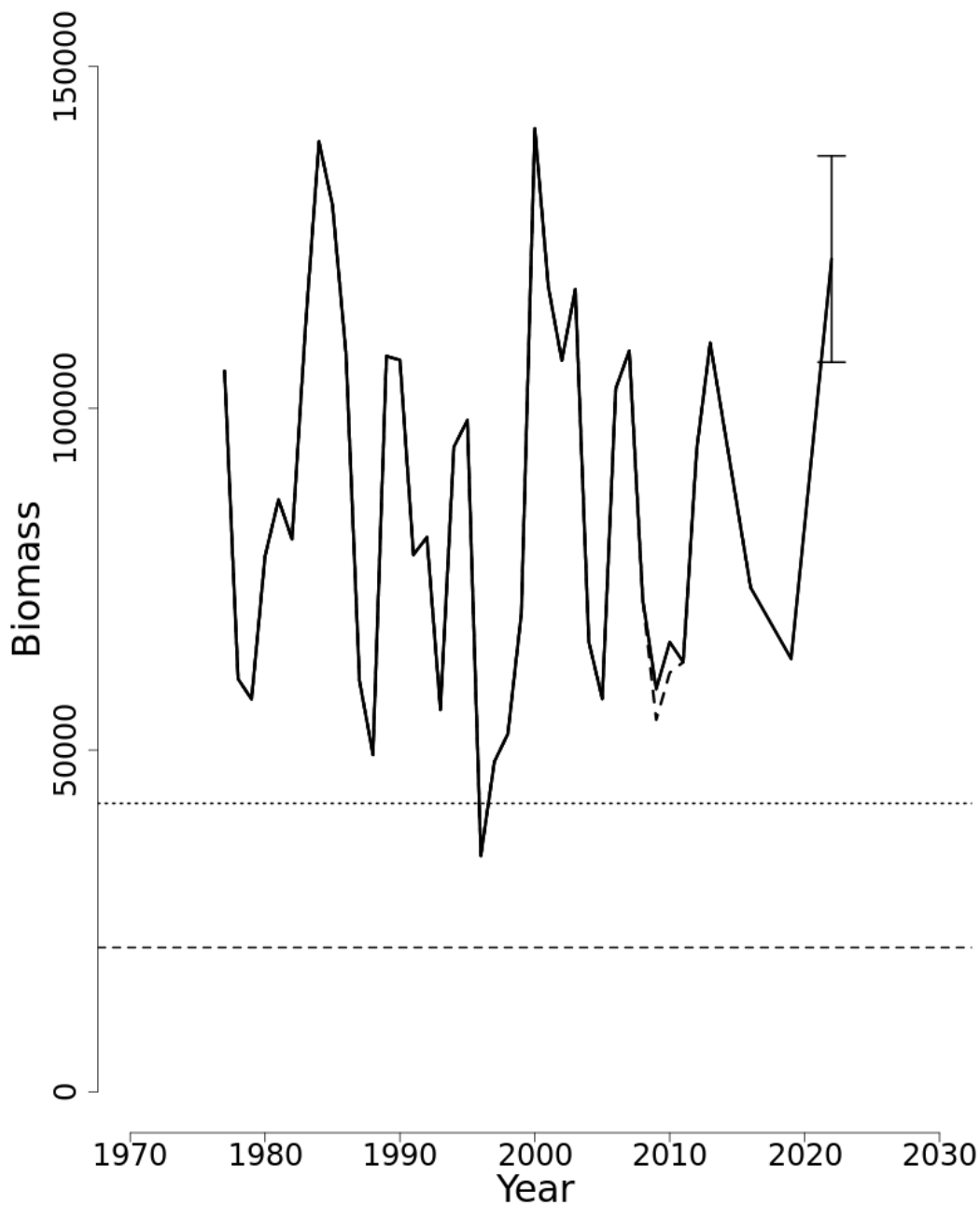


Figure 8: Trends in the two-year moving averages of annualized  $q$ -adjusted, swept-area biomass (i.e., annually averaged NEFSC spring and fall survey biomasses, in mt) of longfin inshore squid from the current assessment (solid line) and the 2020 assessment updates (dashed line). Biomass estimates are shown as interpolated values for years where biomass could not be estimated due to inadequate survey sampling coverage of longfin squid habitat (i.e., 2014 and 2020 spring and 2017 and 2020 fall surveys). The 80% confidence limits (106,748–136,923) are shown for the 2022 biomass estimate (121,836 mt) in relation to the  $B_{MSY\ proxy}$  (42,405 mt) and  $B_{Threshold}$  (21,203 mt).

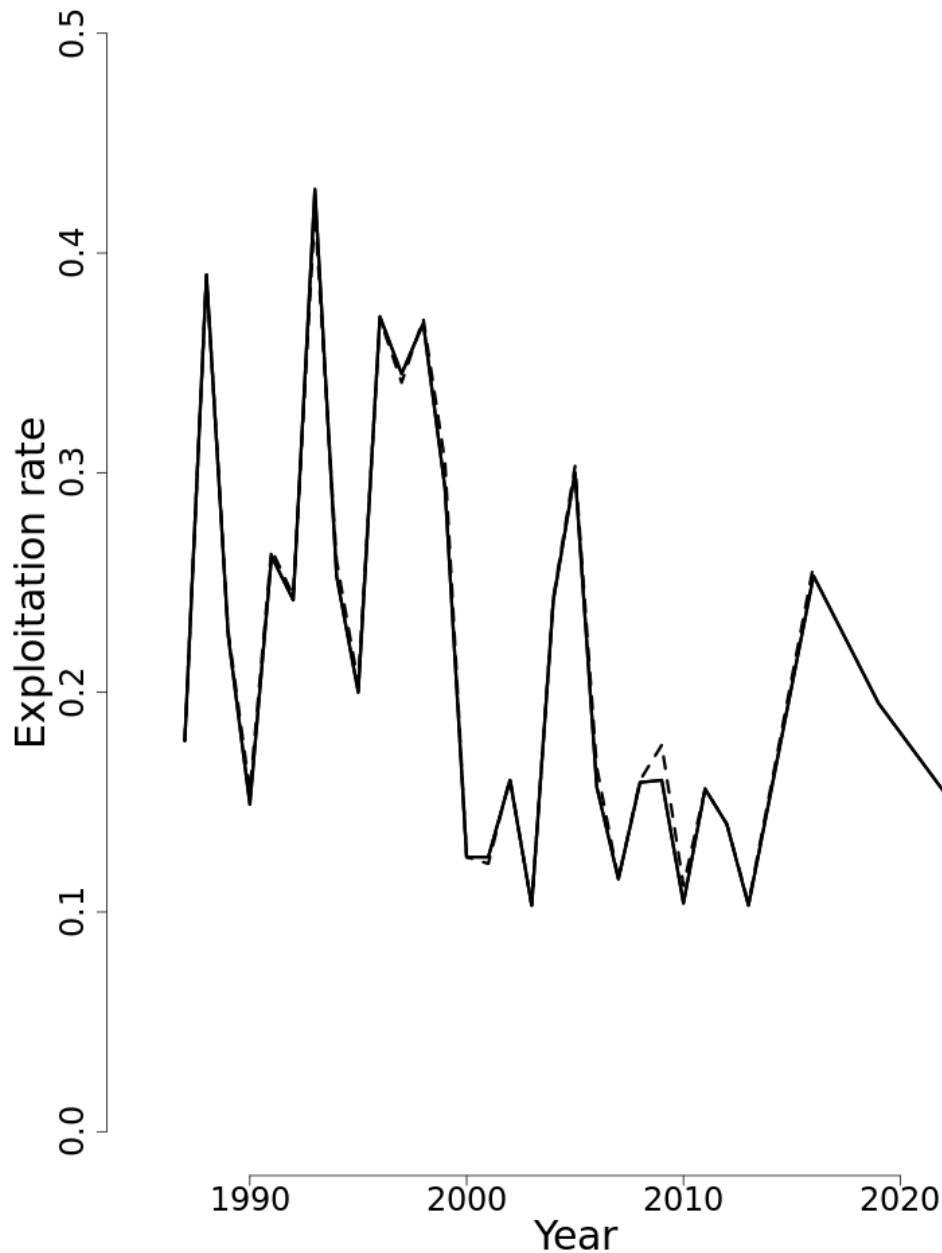


Figure 9: Trends in annualized exploitation indices (annual catch/two-year moving average of the annualized NEFSC spring and fall survey biomass estimates) of longfin inshore squid during the US fishery time period (between 1987 and 2022 from the current assessment (solid line) and the 2020 assessment updates (dashed line). Exploitation rates are shown as interpolated values for years with only a single biomass estimate due to inadequate survey sampling coverage of longfin squid habitat (i.e., the 2014 and 2020 spring and 2017 and 2020 fall surveys).

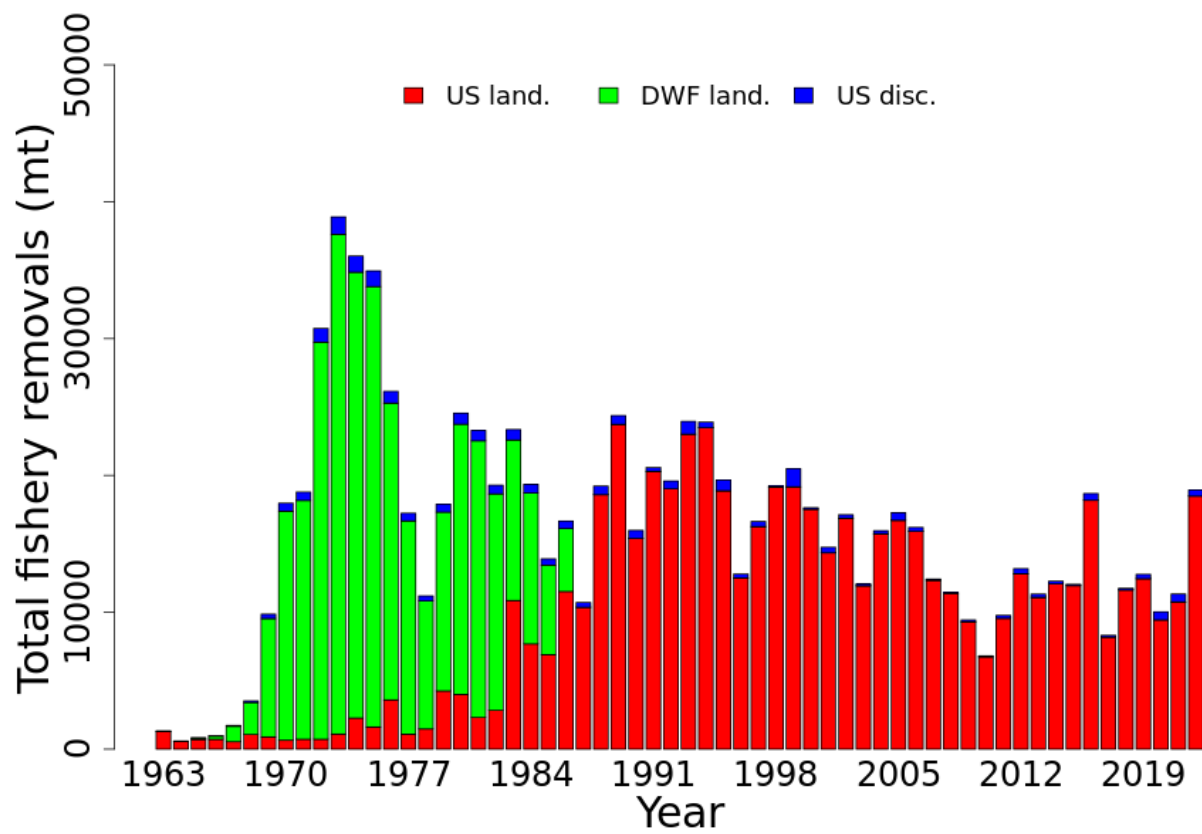


Figure 10: Total catches of longfin inshore squid between 1963 and 2022 by fleet (commercial) and disposition (landings or discards). **DWF** landings are the Distant Water Fleet landings, but the discards for this fleet are unknown.

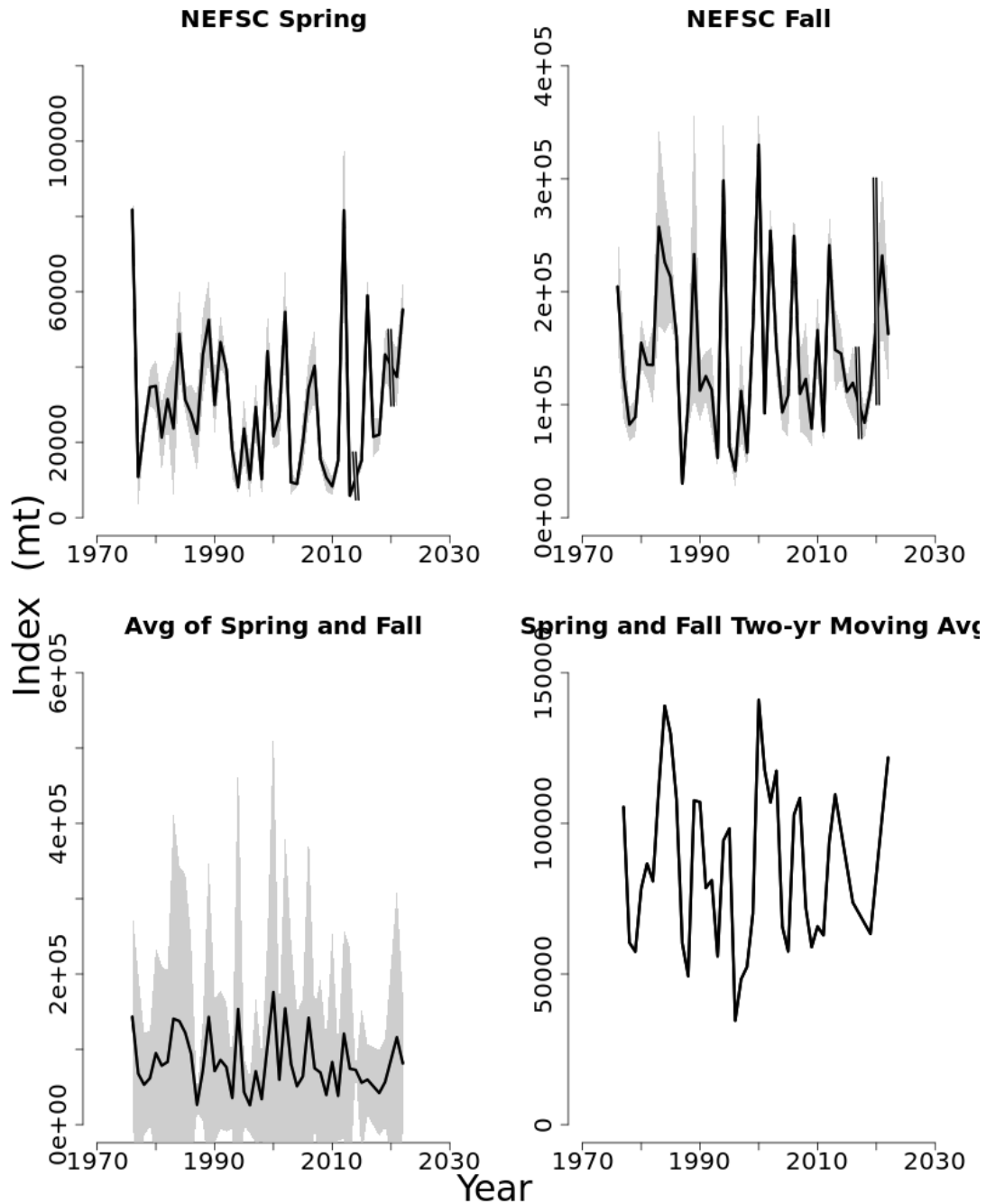


Figure 11: Swept-area,  $q$ -adjusted biomass estimates (mt) for longfin inshore squid between 1976 and 2022 for the NEFSC spring and fall bottom trawl surveys (top panels), annualized NEFSC survey biomass (i.e., averages of the biomass estimates for these two surveys) and two-year moving averages of the annualized biomass estimates. Due to inadequate survey sampling coverage of longfin squid habitat during the 2014 and 2020 spring surveys and the 2017 and 2020 fall surveys, biomass estimates during these years are not shown in the two top panels, but have been interpolated in the biomass time series shown in the bottom panels.



## 5. SUMMER FLOUNDER

Mark Terceiro

*This assessment of the Summer flounder (*Paralichthys dentatus*) stock is an update of the existing 2021 Management Track Assessment (NEFSC 2022). Based on the previous assessment the stock was not overfished and overfishing was not occurring. This 2023 Management Track Assessment updates fishery catch data, research survey indices of abundance, the ASAP assessment model, and biological reference points through 2022. Additionally, stock projections have been updated through 2025.*

**State of Stock:** Based on this updated assessment, the Summer flounder (*Paralichthys dentatus*) stock is not overfished and overfishing is occurring (Figures 12–13). Retrospective adjustments were not made to the model results. Spawning Stock Biomass (*SSB*) in 2022 was estimated to be 40,994 **mt** which is 83% of the biomass target for this stock ( $SSB_{MSY\ proxy} = 49,561$ ; Figure 12). The 2022 fully selected fishing mortality was estimated to be 0.464 which is 103% of the overfishing threshold proxy ( $F_{MSY\ proxy} = 0.451$ ; Figure 13).

**Table 10: Catch and model results for Summer flounder. All weights are in (**mt**), recruitment is in (**000s**), and  $F_{Full}$  is the fishing mortality on fully selected age 4. Model results are unadjusted values from the current updated ASAP assessment.**

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
<i>Data</i>										
Commercial landings	5,696	4,989	4,858	3,537	2,644	2,787	4,109	4,282	4,936	5,683
Commercial discards	863	830	703	772	906	979	783	1,163	873	680
Recreational landings	8,806	7,364	5,366	6,005	4,565	3,447	3,537	4,571	3,092	3,916
Recreational discards	2,119	2,092	1,572	1,482	1,496	1,003	1,379	1,141	997	1,336
Catch for Assessment	17,483	15,275	12,498	11,796	9,611	8,216	9,808	11,157	9,898	11,615
<i>Model Results</i>										
Spawning Stock Biomass	52,155	47,841	42,424	39,209	37,040	37,599	38,846	43,024	41,615	40,994
$F_{Full}$	0.473	0.439	0.427	0.428	0.345	0.304	0.37	0.417	0.371	0.464
Recruits (age-0)	35,208	38,700	27,000	30,551	38,876	43,028	39,933	35,629	42,323	38,371

**Projections:** Short term projections of catch (**OFL**) and Spawning Stock Biomass (*SSB*) were derived by sampling from an empirical cumulative distribution function of the 12 most recent recruitment estimates from the ASAP model results (2011–2022). The annual fishery selectivity, maturity ogive, and mean weights-at-age used in projections are the most recent 5-year averages; no retrospective adjustments were applied in the projections.

**Table 11: Comparison of biological reference points estimated in the previous assessment and from the current assessment update. An  $F_{35\%}$  proxy was used for the overfishing threshold and  $SSB$  and  $MSY$  proxies were based on long-term stochastic projections.**

	2021	2023
$F_{MSY\ proxy}$	0.422	0.451
$SSB_{MSY}$ (mt)	55,217	49,561 (38,181–64,301)
$MSY$ (mt)	15,872	14,097 (11,020–18,114)
Median recruits (age-1) (000s)	49,954	46,966
Overfishing	No	Yes
Overfished	No	No

**Table 12: Short term projections of total fishery catch (OFL) and Spawning Stock Biomass (SSB) for Summer flounder based on a harvest scenario of fishing at  $F_{MSY\ proxy}$  between 2024 and 2025. Catch in 2023 was assumed to be 15,023 (mt).**

Year	Catch (mt)	$SSB$ (mt)	$F_{Full}$
2023	15,023	37,233 (30,000–46,000)	0.622
Year	Catch (mt)	$SSB$ (mt)	$F_{Full}$
2024	10,422	38,541 (32,000–46,000)	0.451
2025	10,839	39,127 (33,000–46,000)	0.451

### Special Comments:

- What are the most important sources of uncertainty in this stock assessment? Explain, and describe qualitatively how they affect the assessment results (such as estimates of biomass,  $F$ , recruitment, and population projections).

*Declining trends in growth rates and changes in the sex-ratio at age may change the productivity of the stock and in turn affect estimates of the biological reference points. Changes in growth, maturity, and recruitment may be environmentally mediated but mechanisms are unknown.*

- Does this assessment model have a retrospective pattern? If so, is the pattern minor, or major? (A major retrospective pattern occurs when the adjusted  $SSB$  or  $F_{Full}$  lies outside of the approximate joint confidence region for  $SSB$  and  $F_{Full}$ ).

*The 7-year Mohn's  $\rho$ , relative to  $SSB$ , was 0.03 in the 2021 assessment and was 0.06 in this assessment. The 7-year Mohn's  $\rho$ , relative to  $F$ , was 0.01 in the 2021 assessment and was 0.03 in this assessment. No retrospective adjustment of  $SSB$  or  $F$  in 2022 was required.*

- Based on this stock assessment, are population projections well determined or uncertain? If this stock is in a rebuilding plan, how do the projections compare to the rebuilding schedule?

*Population projections for Summer flounder are reasonably well determined.*

- Describe any changes that were made to the current stock assessment, beyond incorporating additional years of data and the effect these changes had on the assessment and stock status.

*No major changes, other than the addition of three years of data, were made to the Summer flounder assessment for this update. Minor changes to the survey input CVs and fishery and survey input Effective Sample Sizes improved model diagnostics but had limited affects on the model results.*

- If the stock status has changed a lot since the previous assessment, explain why this occurred.  
*Overfishing status has changed since the last assessment for Summer flounder. The stock status remains as not overfished but overfishing is occurring.*
- Provide qualitative statements describing the condition of the stock that relate to stock status.  
*The current fishing mortality rate is near the threshold, and so recent near-average recruitment has resulted in relatively stable SSB. SSB is projected to remain relatively stable in the short term at current fishing rates.*
- Indicate what data or studies are currently lacking and which would be needed most to improve this stock assessment in the future.  
*The Summer flounder assessment could be improved with more intensive and comprehensive sampling of the fishery catch by sex.*
- Are there other important issues?  
*Sufficient length and age sampling of the fishery catch needs to be maintained.*



*Paralichthys dentatus*, Summer Flounder.

## 5.1. Reviewer Comments: Summer flounder

The 2023 assessment of the summer flounder (*Paralichthys dentatus*) stock is the Management Track update of the 2021 management track assessment (NEFSC 2022). The last benchmark assessment for this stock was in 2018 (NEFSC 2018). This assessment uses the NOAA ToolBox Age-Structured Assessment Program (ASAP) and updates commercial and recreational fishery catch data, research survey indices of abundance, weights and maturity at age, and reference points through 2022. Stock projections have been updated through 2025. Splitting the final selectivity block for all fleets was also explored, but it resulted in marginally worse diagnostics and was not included in the final model.

Retrospective adjustments of the model results were not necessary. Spawning stock biomass ( $SSB$ ) in 2022 was estimated to be 40,994 mt which is 83% of the biomass target for this stock ( $SSB_{MSY\ proxy} = 49,561\text{ mt}$ ). The 2022 fully selected fishing mortality was estimated to be 0.464 which is 103% of the overfishing threshold proxy ( $F_{MSY\ proxy} = F_{35\%SPR} = 0.451$ ). Based on this updated assessment, the summer flounder stock is not overfished but overfishing is occurring.

Short term projections were conducted in AGEPRO. For projection specifications, 2023 removals were assumed equal to the 2023 ABC of 15,023 mt, as approximately 96% of the ABC has been caught in recent years, and then fishing mortality was set equal to  $F_{35\%SPR}$  for 2024–2025. The projections used the most recent 5-year averages for the annual fishery selectivity, maturity ogive, and mean weights at age; no retrospective adjustments were applied in the projections. The estimated OFLs from the short term projections were 10,422 mt for 2024 and 10,839 mt for 2025.

*The Panel concluded that the 2023 assessment update for Summer flounder fulfilled the recommendations of the AOP, is technically sufficient to evaluate stock status and provide scientific advice and meets the Terms of Reference for the stock's assessment. The assessment represents Best Scientific Information Available for this stock for management purposes.*

*The Panel discussed the change in the estimated size of the 2018 year-class from the 2021 Management Track Assessment to this assessment, the potential decline in productivity in recent years due to decreasing weight-at-age and proportion female-at-age, and the resulting impact on stock status and catch advice. The 2021 assessment estimated the 2018 year-class at 61 million fish, well above the time-series average, while the 2023 assessment estimated it at 43 million fish, more in line with recent estimates of recruitment and below the time-series average. The estimates of  $SSB$  in recent years were also revised downwards, a function of the minor retrospective pattern that this model exhibits. Lower estimates of abundance in recent years, the lower estimate of the 2018 year-class, and the lower mean weight-at-age in recent years combined to produce OFL estimates that were lower than the 2021–2023 OFLs from the 2021 assessment. The increasing trend in biomass from 2017 onwards was somewhat arrested from 2020–2022 by the higher  $F$  and lower weights-at-age, but the stock remains above the biomass threshold, consistent with the increasing trends in survey indices and the expanded age-structure of the catch, especially for males. The Panel discussed concerns raised by previous panels about the impact of increasing size limits on a species where females grow faster and reach larger sizes than males do. The proportion of females in the survey data has declined since the start of the time series, but has stabilized at about 50% for all ages in recent years; more older males have been observed in the survey and catch data as well, indicating that the lower overall  $F$  rate on the population has allowed the males to survive to older ages*

*and may balance out the potential negative effects of the higher size limit on females.*

*The Panel agreed with the analyst's conclusion not to split the final selectivity blocks, as it did not improve model performance and there was no evidence presented for changes in the fisheries to justify the split.*

*The Panel recommended reevaluating the suite of indices used to fit the model in the next research track assessment, as the model currently includes 14+ indices, some of which provide conflicting information and end up being down-weighted to get a **RMSE** near one.*



Summer Flounder on pebbly bottom. Photo credit: **NOAA** Fisheries.

## **References:**

**NEFSC**. 2022. Northeast Fisheries Science Center. Management Track Assessment June 2021. US Dept Commer, Northeast Fish Sci Cent Ref Doc. 22–10; 79p. [CRD22-10](#)



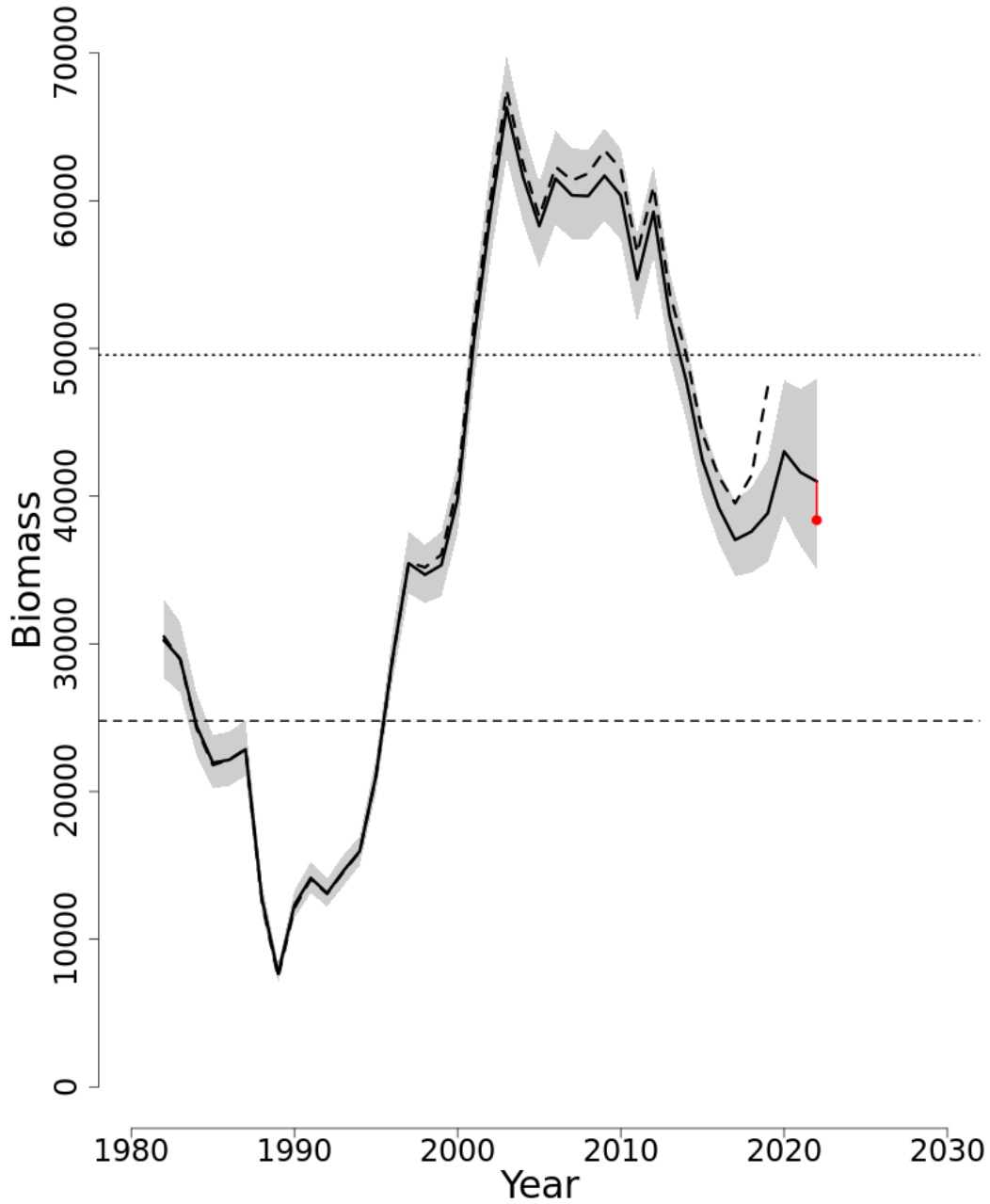


Figure 12: Trends in spawning stock biomass of Summer flounder between 1982 and 2022 from the current (solid line) and previous (dashed line) assessment and the corresponding  $SSB_{Threshold}$  ( $\frac{1}{2} SSB_{MSY proxy}$ ; horizontal dashed line) as well as  $SSB_{Target}$  ( $SSB_{MSY proxy}$ ; horizontal dotted line) based on the 2023 assessment. Biomass adjusted for a retrospective pattern is shown in red, but not used for stock status or projections. The approximate 90% log-normal confidence intervals are shown.

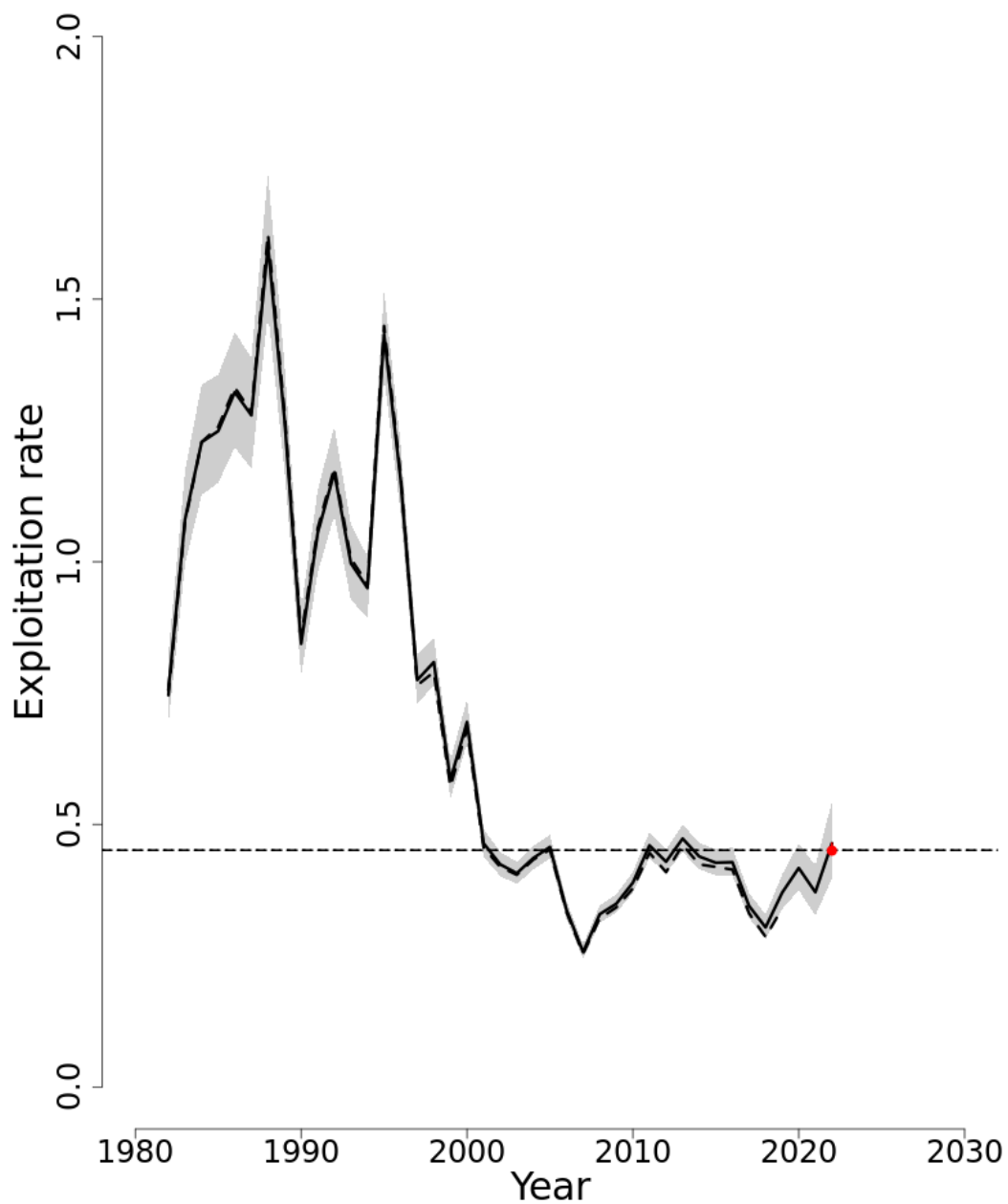


Figure 13: Trends in the fully selected fishing mortality ( $F_{Full}$ ) of Summer flounder between 1982 and 2022 from the current (solid line) and previous (dashed line) assessment and the corresponding  $F_{Threshold}$  ( $F_{MSY\ proxy} = 0.451$ ; horizontal dashed line).  $F_{Full}$  adjusted for a retrospective pattern is shown in red, but not used for status or projections. The approximate 90% log-normal confidence intervals are shown.



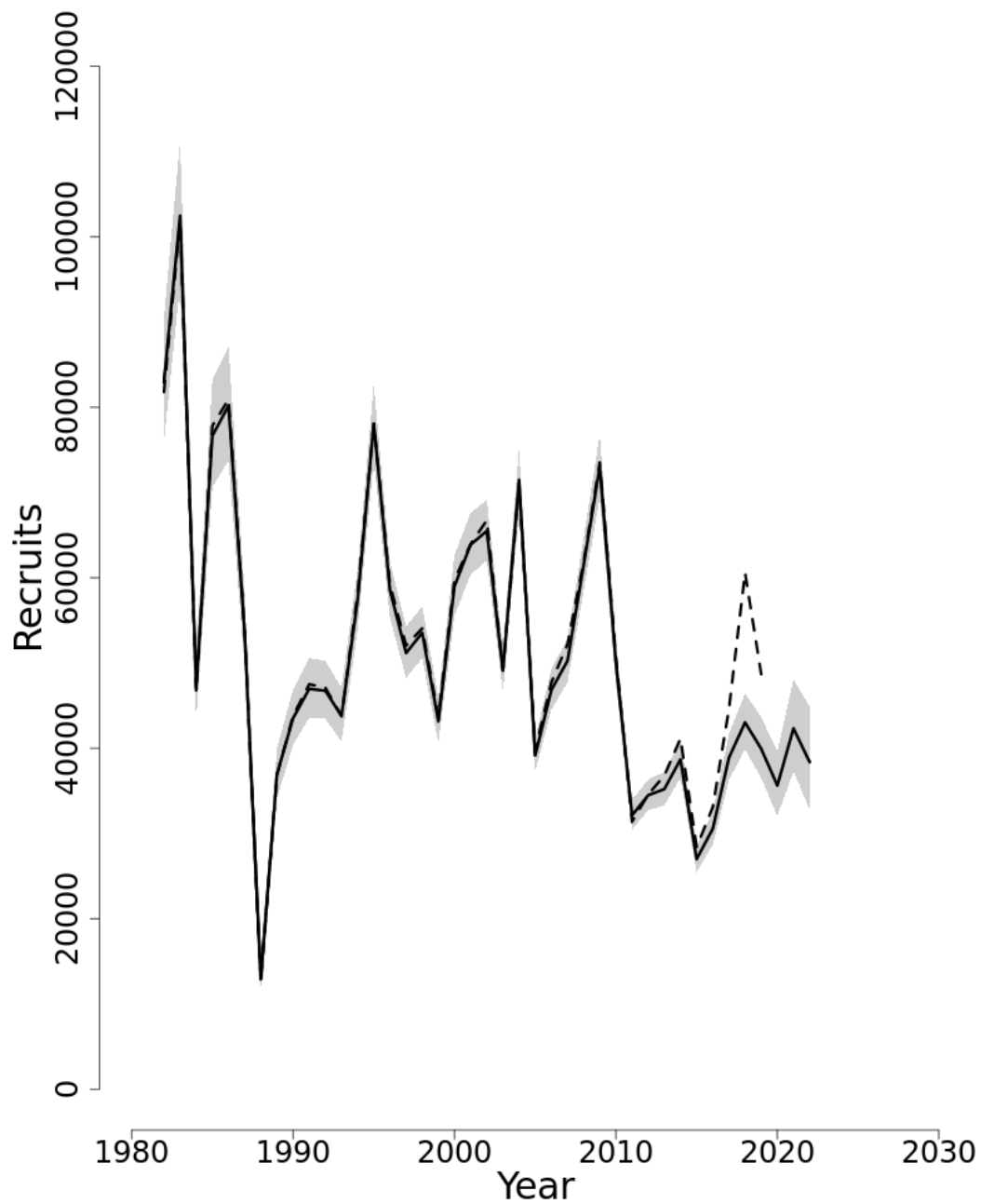


Figure 14: Trends in Recruits (age-0) (000s) of Summer flounder between 1982 and 2022 from the current (solid line) and previous (dashed line) assessment.

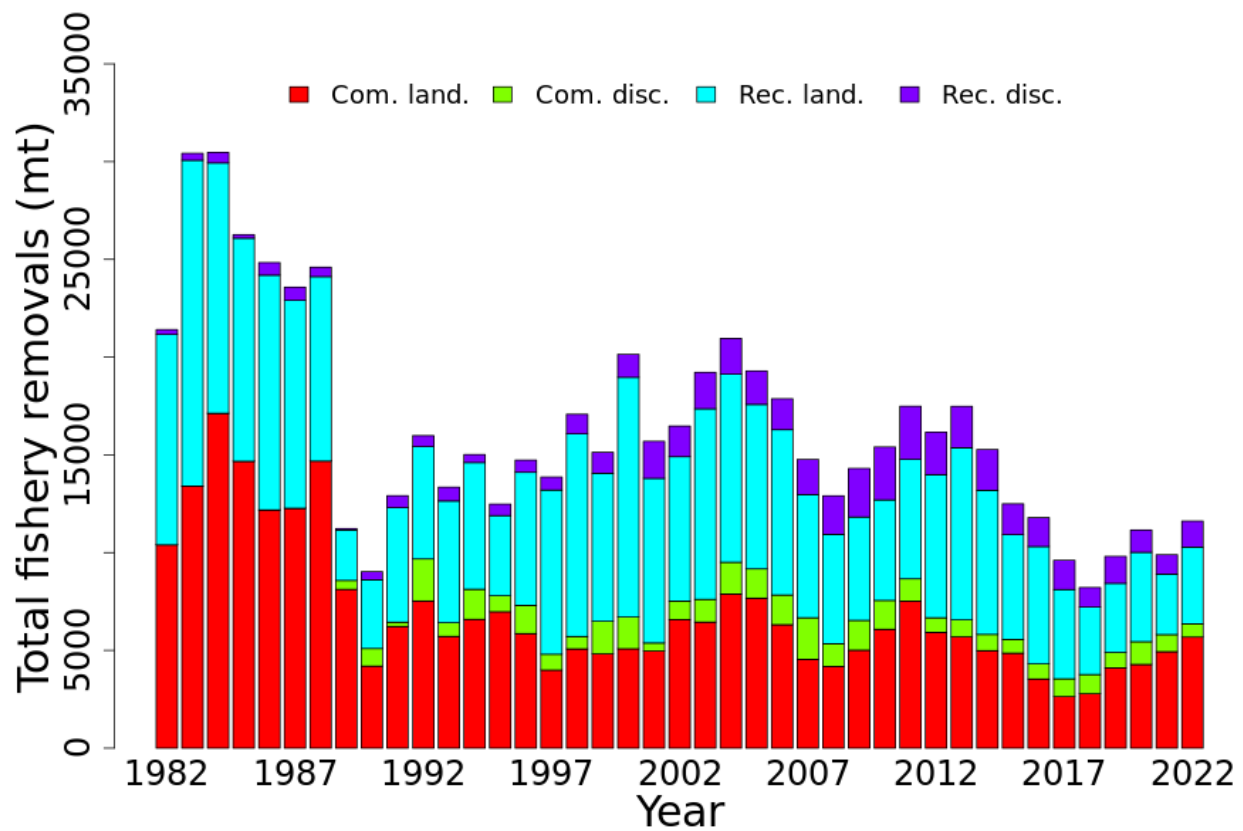


Figure 15: Total catch of Summer flounder between 1982 and 2022 by fishery (commercial and recreational) and disposition (landings and discards).

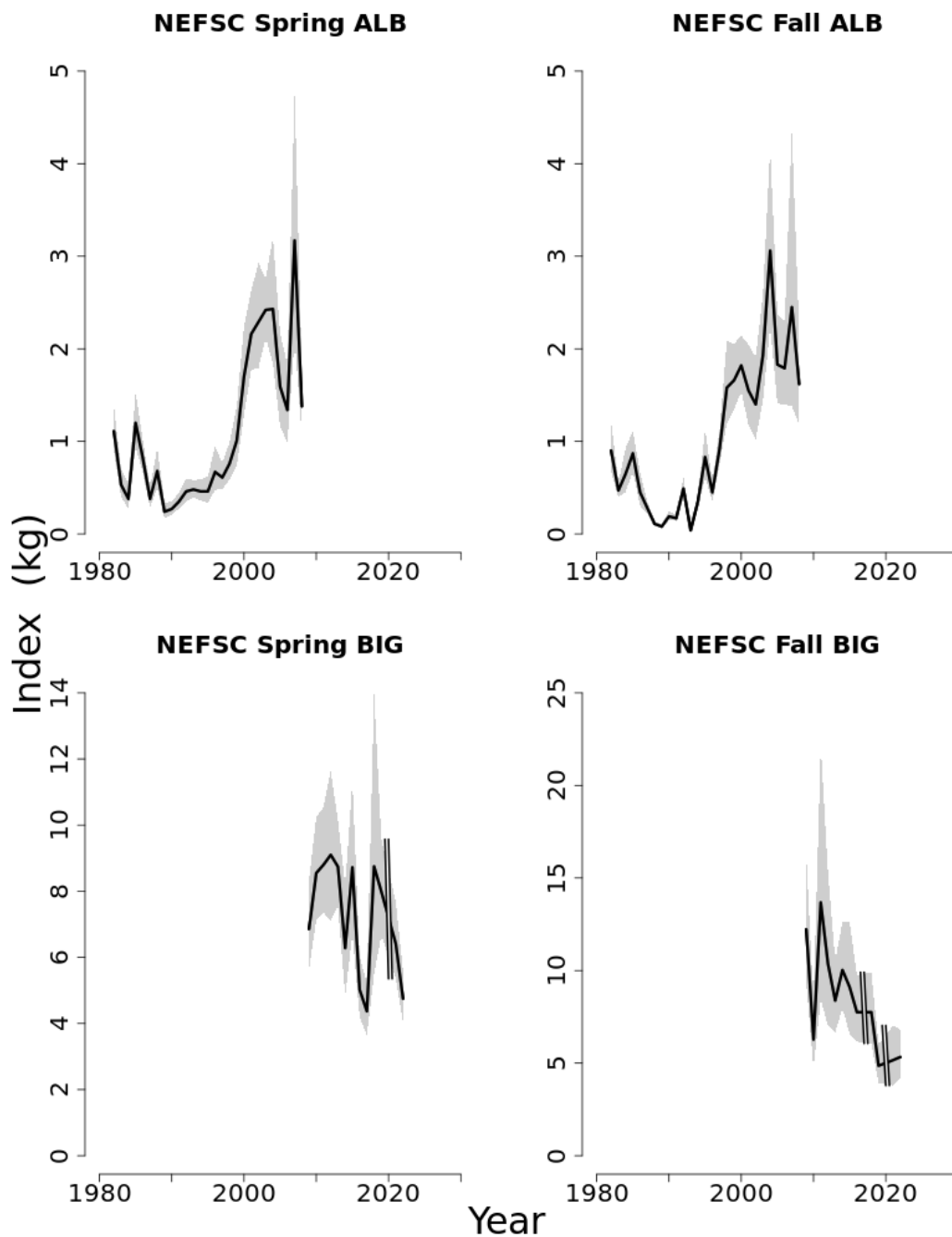


Figure 16: Indices of biomass for the Summer flounder between 1982 and 2022 for the Northeast Fisheries Science Center (NEFSC) Albatross (ALB) and Henry B. Bigelow (BIG) spring and fall research bottom trawl survey series. The approximate 90% log-normal confidence intervals are shown.

## 6. SCUP

Mark Terceiro

*This assessment of the Scup (*Stenotomus chrysops*) stock is an update of the existing 2021 Management Track Assessment (NEFSC 2022). Based on the previous assessment the stock was not overfished and overfishing was not occurring. This 2023 Management Track Assessment updates fishery catch data, research survey indices of abundance, the ASAP assessment model, and biological reference points through 2022. Additionally, stock projections have been updated through 2025.*

**State of Stock:** Based on this updated assessment, the Scup (*Stenotomus chrysops*) stock is not overfished and overfishing is not occurring (Figures 17–18). Retrospective adjustments were made to the model results. Adjusted Spawning Stock Biomass (*SSB*) in 2022 was estimated to be 193,087 *mt* which is 246% of the biomass target for this stock ( $SSB_{MSY\ proxy} = 78,593$ ; Figure 17). The adjusted 2022 fully selected fishing mortality was estimated to be 0.098 which is 52% of the overfishing threshold proxy ( $F_{MSY\ proxy} = 0.19$ ; Figure 18).

**Table 13: Catch and model results for Scup. All weights are in (*mt*), recruitment is in (*000s*), and  $F_{Full}$  is the fishing mortality on fully selected age-4. Model results are unadjusted values from the current updated ASAP assessment.**

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
<i>Data</i>										
Commercial landings	8,105	7,239	7,725	7,147	7,007	6,064	6,252	6,177	5,944	5,507
Commercial discards	1,350	981	1,718	2,778	4,733	3,293	2,779	2,611	1,895	2,171
Recreational landings	5,739	4,659	5,527	4,536	6,143	5,887	6,403	5,863	7,540	7,875
Recreational discards	568	480	581	862	1,079	644	560	541	653	738
Catch for Assessment	15,762	13,359	15,550	15,322	18,961	15,888	15,994	15,192	16,032	16,291
<i>Model Results</i>										
Spawning Stock	229,544	224,345	202,517	224,568	242,893	240,870	226,966	216,046	184,801	159,050
Biomass										
$F_{Full}$	0.105	0.093	0.118	0.094	0.1	0.08	0.09	0.092	0.129	0.171
Recruits (age-0)	145,750	360,860	569,175	256,961	119,279	138,889	64,735	118,918	124,873	106,037

**Projections:** Short term projections of catch (*OFL*) and Spawning Stock Biomass (*SSB*) were derived by sampling from an empirical cumulative distribution function of the time series of recruitment estimates from the ASAP model results for 1984–2022. The annual fishery selectivity, maturity ogive, and mean weights at age used in projections are the most recent 5 year averages; retrospective adjustments were applied in the projections.

Table 14: Comparison of biological reference points estimated in the previous assessment and from the current assessment update. An  $F_{40\%SPR}$  proxy was used for the overfishing threshold and  $SSB$  and  $MSY$  proxies were based on long-term stochastic projections.

	2021	2023
$F_{MSY\ proxy}$	0.200	0.190
$SSB_{MSY}$ (mt)	90,019	78,593 (55,125–113,507)
$MSY$ (mt)	12,671	11,959 (8,447–17,427)
Median recruits (age-1) (000s)	123,492	129,293
Overfishing	No	No
Overfished	No	No

Table 15: Short term projections of total fishery catch ( $OFL$ ) and Spawning Stock Biomass ( $SSB$ ) for Scup based on a harvest scenario of fishing at  $F_{MSY\ proxy}$  between 2024 and 2025. Catch in 2023 was assumed to be 13,458 (mt).

Year	Catch (mt)	$SSB$ (mt)	$F_{Full}$
2023	13,458	209,407 (155,000–286,000)	0.115
Year	Catch (mt)	$SSB$ (mt)	$F_{Full}$
2024	20,295	185,475 (138,000–252,000)	0.190
2025	18,363	162,716 (121,000–221,000)	0.190

### Special Comments:

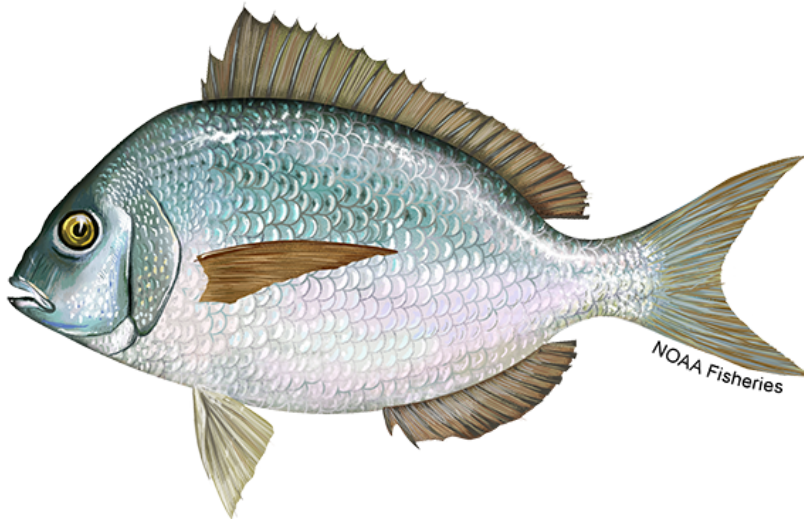
- What are the most important sources of uncertainty in this stock assessment? Explain, and describe qualitatively how they affect the assessment results (such as estimates of biomass,  $F$ , recruitment, and population projections).

*Declining trends in growth rates and maturity at age may change the productivity of the stock and in turn affect estimates of the biological reference points. Changes in growth, maturity, and recruitment may be environmentally mediated but mechanisms are unknown.*

- Does this assessment model have a retrospective pattern? If so, is the pattern minor, or major? (A major retrospective pattern occurs when the adjusted  $SSB$  or  $F_{Full}$  lies outside of the approximate joint confidence region for  $SSB$  and  $F_{Full}$ ).

*The 7-year Mohn's  $\rho$ , relative to  $SSB$ , was  $-0.14$  in the 2021 assessment and was  $-0.21$  in this assessment. The 7-year Mohn's  $\rho$ , relative to  $F$ , was  $0.20$  in the 2021 assessment and was  $0.42$  in this assessment. There was a major retrospective pattern for this assessment because the  $\rho$ -adjusted estimates of 2022  $SSB$  ( $SSB_{\rho} = 193,087$ ) and 2022  $F$  ( $F_{\rho} = 0.098$ ) were outside the approximate 90% confidence regions around  $SSB$  (131,720–192,050) and  $F$  (0.14–0.208). A retrospective adjustment was made for both the determination of stock status and for projections of catch and biomass in 2024 and 2025. The retrospective adjustment changed the 2022  $SSB$  from 159,050 to 193,087 and the 2022  $F_{Full}$  from 0.171 to 0.098.*

- Based on this stock assessment, are population projections well determined or uncertain? If this stock is in a rebuilding plan, how do the projections compare to the rebuilding schedule?  
*Population projections for Scup are reasonably well determined.*
- Describe any changes that were made to the current stock assessment, beyond incorporating additional years of data and the effect these changes had on the assessment and stock status.  
*No major changes, other than the addition of three years of data, were made to the Scup assessment for this update. Minor changes to the survey input CVs and fishery and survey input Effective Sample Sizes improved model diagnostics but had limited affects on the model results.*
- If the stock status has changed a lot since the previous assessment, explain why this occurred.  
*As in recent assessments for Scup the stock status remains as not overfished and overfishing not occurring.*
- Provide qualitative statements describing the condition of the stock that relate to stock status.  
*The current fishing mortality rate is relatively low, but recent below average recruitment has resulted in a decrease in SSB. SSB is projected to continue to decrease in the short term.*
- Indicate what data or studies are currently lacking and which would be needed most to improve this stock assessment in the future.  
*The Scup assessment could likely be improved with more intensive sampling of the fishery catch.*
- Are there other important issues?  
*Sufficient length and age sampling of the fishery catch needs to be maintained.*



*Stenotomus chrysops*, Scup.

## 6.1. Reviewer Comments: Scup

The 2023 assessment for scup (*Stenotomus chrysops*) updates the 2021 management track ASAP assessment (NEFSC 2022). This assessment updates recreational and commercial fishery catch (landings and discards), survey indices of abundance, the analytical ASAP model, and reference points through 2022. Additionally, stock projections have been updated through 2025. There was a retrospective pattern in both  $SSB$  and  $F$  ( $SSB_{\rho} = -21\%$ ;  $F_{\rho} = +43\%$ ) that required adjustments to the terminal estimates in the model, as the adjusted values fell outside the 90% confidence interval estimates from the model. The adjusted spawning biomass in 2022 of 193,097 mt is 246% of the biomass target ( $SSB_{MSY\ proxy} = 78,593\text{ mt}$ ), and the adjusted fully-selected  $F$  of 0.098 was 52% of the overfishing threshold ( $F_{MSY} = 0.19$ ). Based on these estimates from the updated model, scup is not overfished, and overfishing is not occurring.

Short-term projections of biomass were done, starting with the retrospectively-adjusted terminal abundance. Future recruitments were sampled from a cumulative distribution function of updated model estimates (1984–2022 year class), and future selectivity, maturity, and weight-at-age were based on the most recent five year averages (2018–2022). Projections were run with  $F = F_{MSY}$  to determine the OFL in 2024 and 2025 for use in the Mid-Atlantic control rule. The estimated OFL from the projection was 20,295 mt in 2024, and 18,363 mt in 2025.

*The Panel concluded that the 2023 assessment update for scup fulfilled the recommendations of the AOP, is technically sufficient to evaluate stock status and provide scientific advice and meets the Terms of Reference for the stock's assessment. The assessment represents Best Scientific Information Available (BSIA) for this stock for management purposes.*

*The Panel noted that the retrospective pattern has increased from previous assessments, and there was some discussion about the possible causes. The analyst noted that possible mechanisms include decreasing  $M$ , overestimated catches, and changes in catchability. The panel feels that exploration into these mechanisms is warranted if the retrospective pattern continues, but acknowledges that it is very challenging to quantify changes in  $M$  and bias in catch estimates. The model currently uses a combined index of abundance of the NEFSC survey (Albatross and Bigelow), and splitting the survey time series into two may help address the retrospective pattern.*

*Port sampling of commercial landings has declined for scup in recent years, with the lowest number of samples in 2022. This reduced port sampling is affecting all commercially-exploited stocks, but the Panel is concerned that it may be particularly problematic for a stock like scup where older ages are primarily collected in the commercial fishery.*

*The Panel noted that all four fleets in the model (recreational and commercial landings and discards) had dome-shaped selectivity. The Panel recommends continued exploration of the functional form of the selectivity across fleets, and whether there could be a mechanistic explanation for the dome across fleets.*

*Scup has exhibited declines in mean weights-at-age over time, and these declines contributed to the large change in  $SSB_{MSY}$  from the previous assessment. The analyst noted that the declines in weight-at-age were coincident with increases in scup biomass, and the Panel agrees that exploration of the potential for density-dependent growth is worthwhile, as it might allow for more accurate forecasts of weight in the projections.*



## References:

[NEFSC](#). 2022. Northeast Fisheries Science Center. Management Track Assessment June 2021. US Dept Commer, Northeast Fish Sci Cent Ref Doc. 22-10; 79p. [CRD22-10](#)



Scup catch, in a basket. Photo credit: [NOAA Fisheries](#).

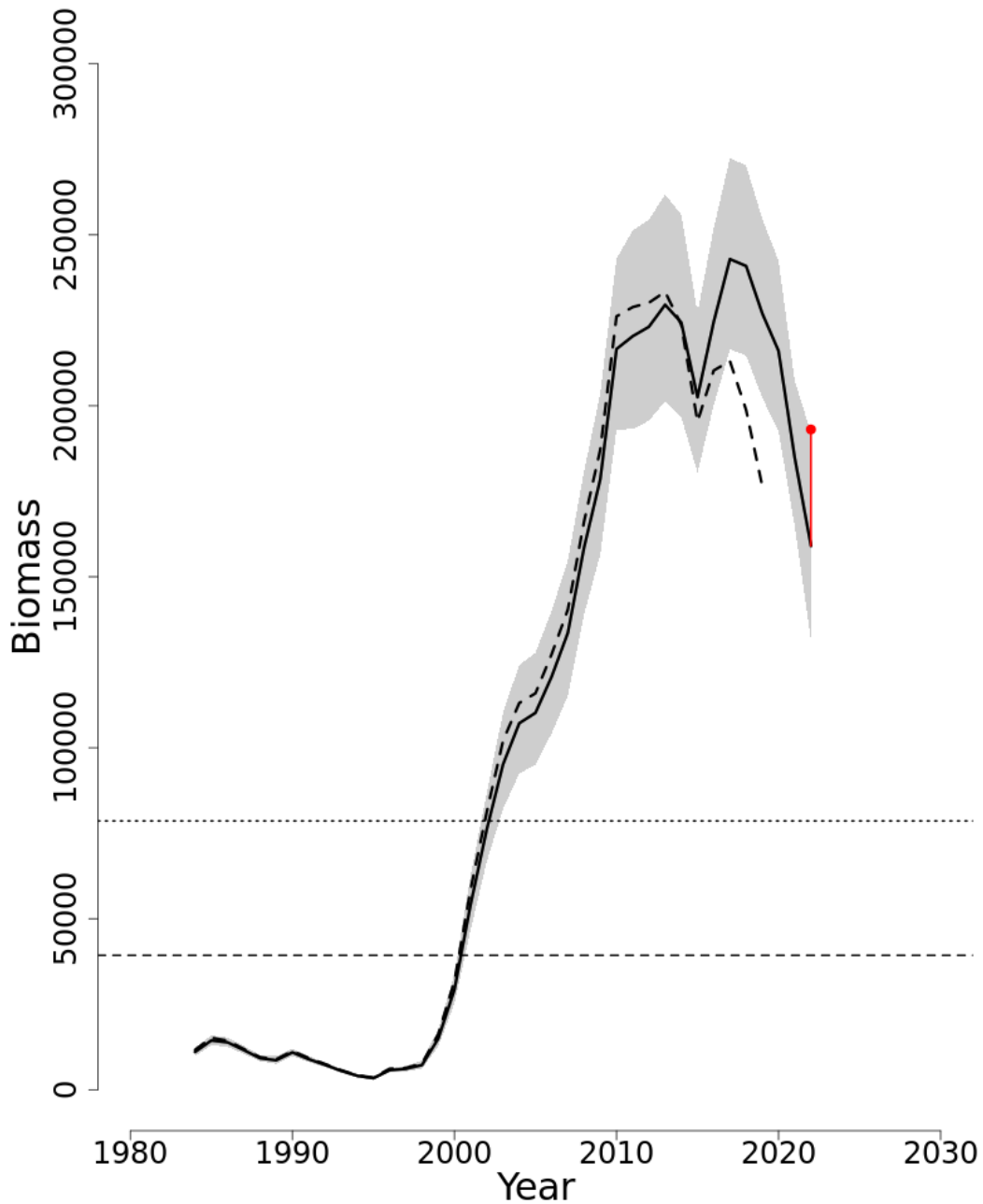


Figure 17: Trends in  $SSB$  of Scup between 1984 and 2022 from the current (solid line) and previous (dashed line) assessment and the corresponding  $SSB_{Threshold}$  ( $\frac{1}{2}SSB_{MSY proxy}$ ; horizontal dashed line) as well as  $SSB_{Target}$  ( $SSB_{MSY proxy}$ ; horizontal dotted line) based on the 2023 assessment.  $SSB$  was adjusted for a retrospective pattern and the adjustment is shown in red. The approximate 90% log-normal confidence intervals are shown.

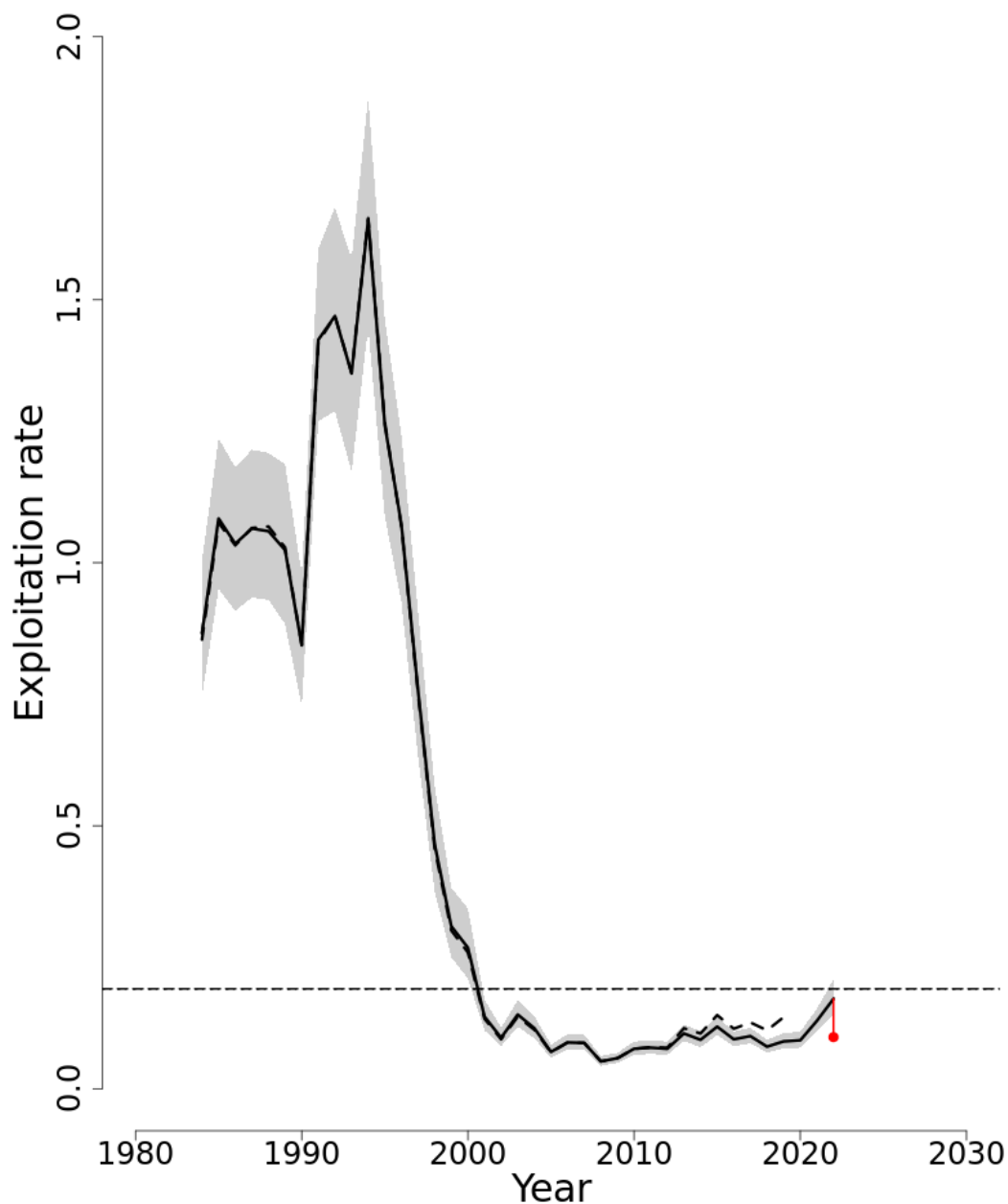


Figure 18: Trends in the fully selected fishing mortality ( $F_{Full}$ ) of Scup between 1984 and 2022 from the current (solid line) and previous (dashed line) assessment and the corresponding  $F_{Threshold}$  ( $F_{MSY\ proxy} = 0.19$ ; horizontal dashed line) based on the 2023 assessment.  $F_{Full}$  was adjusted for a retrospective pattern and the adjustment is shown in red. The approximate 90% log-normal confidence intervals are shown.

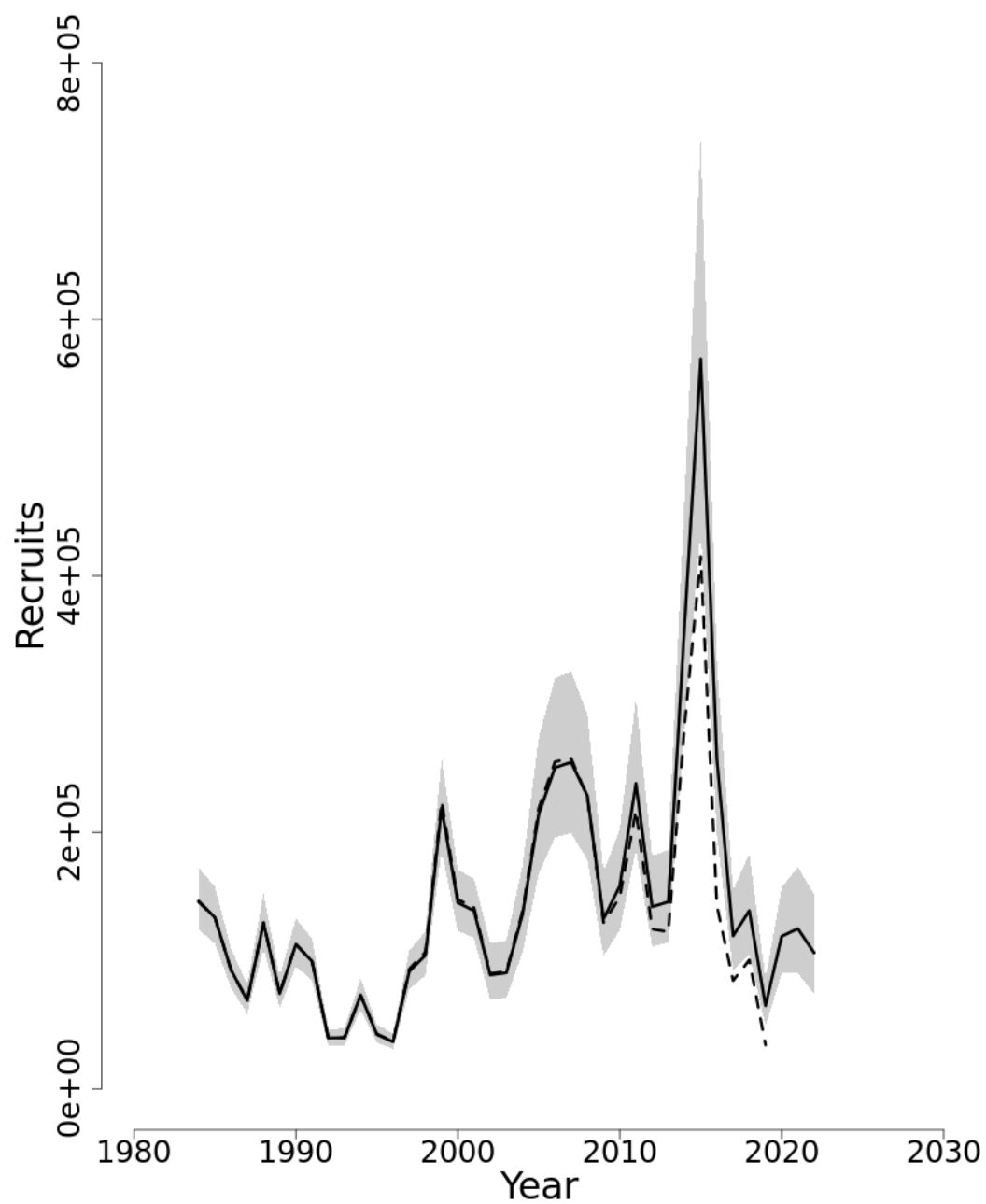


Figure 19: Trends in Recruits (age-0) (000s) of Scup between 1984 and 2022 from the current (solid line) and previous (dashed line) assessment.

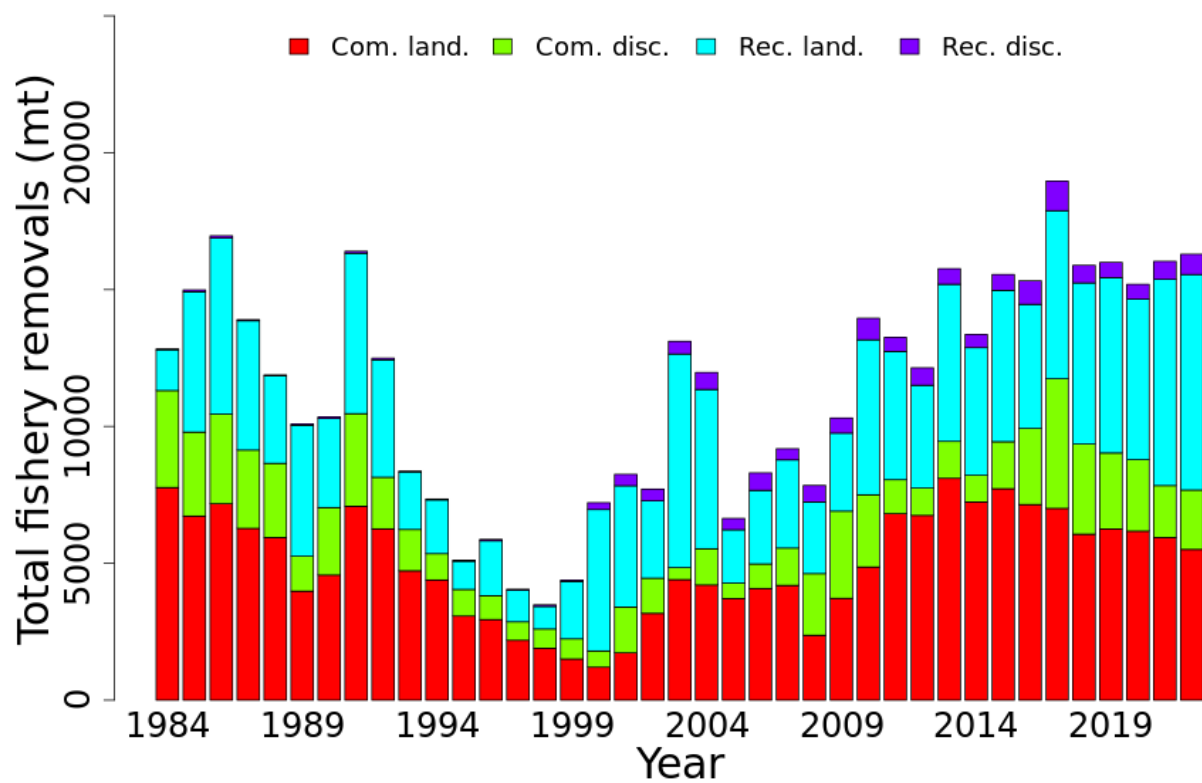


Figure 20: Total catch of Scup between 1984 and 2022 by fishery (commercial and recreational) and disposition (landings and discards).

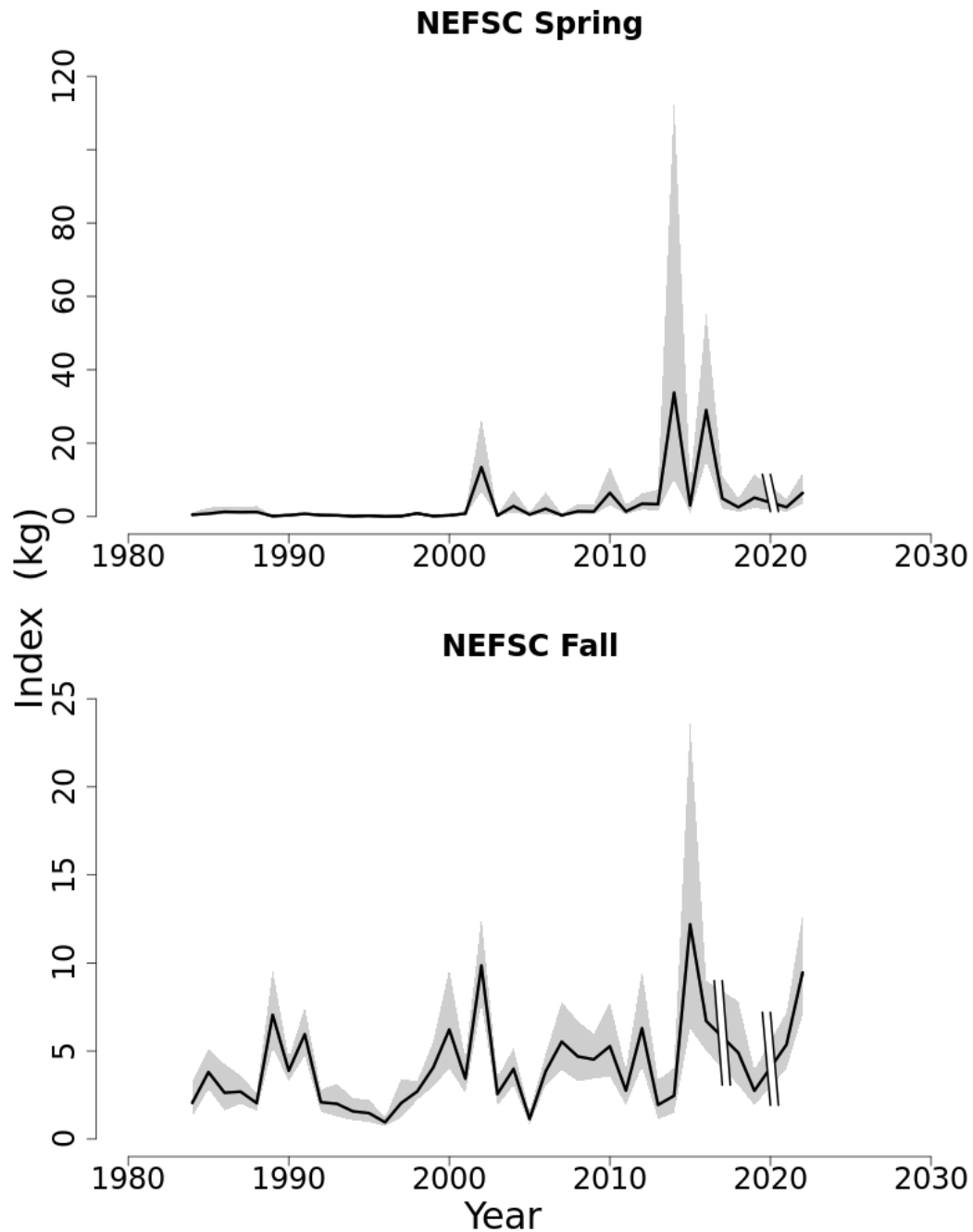


Figure 21: Indices of biomass for Scup between 1984 and 2022 for the Northeast Fisheries Science Center (NEFSC) spring and fall research bottom trawl survey series calibrated to Albatross equivalents. The approximate 90% log-normal confidence intervals are shown.

## Photo Gallery

Here is provided descriptive text for the photographs and artwork that are scattered throughout the preceding pages.

Longfin squid well camouflaged on the sandy bottom. Photo [NOAA](#). On page 43

Aerial view of the [NMFS](#) building and surrounds, Woods Hole Laboratory, [MA](#).  
The enclosed body of water behind is Eel Pond. Photo [WHOI](#). On page ix

Measuring the size of a deep-sea red crab. Photo [NOAA](#). On page 34

Scup catch, in a basket. Credit: [NOAA Fisheries](#). On page 63

Fresh seafood on ice, ready for sale. Credit: Shutterstock. On page iv

Shrimp, mussels, scallop, and fish dish. Credit: iStock. On page ii

Summer Flounder on pebbly bottom. Photo [NOAA](#). On page 53

Aerial view of the buildings and wharves at the Woods Hole Oceanographic Institute, [MA](#).  
Two research vessels are docked for re-supply. Photo [WHOI](#). On page 15

*Chaceon quinque-dens* (Atlantic Deep-Sea Red Crab), also known as Red Crab; range: New England/Mid-Atlantic. Artwork from [NOAA atlantic deep-sea red crab website](#). On pages 32

*Pomatomus saltatrix*, commonly known as Bluefish, Tailor, Snapper, Baby blues, Choppers, Elfs; range: New England/Mid-Atlantic, Southeast. Artwork from [NOAA bluefish website](#). On page 22

*Doryteuthis (Amerigo) pealeii*, commonly known as Longfin Squid, Longfin inshore squid, Loligo, Winter squid, Boston squid; range: New England/Mid-Atlantic. Artwork from [NOAA longfin squid website](#). On page 41

*Stenotomus chrysops* (Scup), also known as Porgy, Maiden, Fair maid, Ironsides, Northern porgy; range: New England/Mid-Atlantic, Southeast. Artwork from [NOAA scup website](#). On pages 61

*Paralichthys dentatus*, commonly known as Flounder, Fluke, Northern fluke, Hiram; range: New England/Mid-Atlantic, Southeast. Artwork from [NOAA summer flounder website](#). On page 51



## **Procedures for Issuing Manuscripts in the Northeast Fisheries Science Center Reference Document (CRD) Series and the Technical Memorandum (TM) Series**

The mission of NOAA's National Marine Fisheries Service (NMFS) is "stewardship of the nation's ocean resources and their habitat." As the research arm of the NMFS's Greater Atlantic Region, the Northeast Fisheries Science Center (NEFSC) supports the NMFS's mission by "conducting ecosystem-based research and assessments of living marine resources, with a focus on the Northeast Shelf, to promote the recovery and long-term sustainability of these resources and to generate social and economic opportunities and benefits from their use." Results of NEFSC research are largely reported in primary scientific media (e.g., anonymously-peer-reviewed scientific journals). However, to assist itself in providing data, information, and advice to its constituents, the NEFSC occasionally releases its results in its own media.

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