Northeast Fisheries Science Center Technical Memorandum 290

Management Track Assessments Spring 2022

by Northeast Fisheries Science Center

June 2022

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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 2022

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.

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Species Names: The NEFSC Editorial Office's policy on the use of species names in all technical communications is generally to follow the American Fisheries Society's lists of scientific and common names for fishes, mollusks, and decapod crustaceans and to follow the Society for Marine Mammalogy's guidance on scientific and common names for marine mammals. Exceptions to this policy occur when there are subsequent compelling revisions in the classifications of species, resulting in changes in the names of species.

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13 Estimated reference points for northern shortfin squid 61

The reason behind it all.

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17 Indices of abundance for northern shortfin squid . . . 64

Abbreviations and Acronyms

Albatross refers to activities of the NOAA vessel Albatross IV 11, 13, 23, 30, 51

Albatross IV Research vessel NOAAS Albatross IV, in service until November 2008 iv, 64

AOP Assessment Oversight Panel 1, 3, 4, 10, 11, 13–19, 24, 36, 50, 61

ASAP Age-Structured Assessment Program 11, 13, 24, 31, 33, 34, 36, 38, 45, 50, 53, 55

ASMFC Atlantic States Marine Fisheries Commission 7, 8, 16, 17

Bigelow refers to activities of the NOAA vessel Henry B. Bigelow 11, 13, 14, 24, 30, 47, 51

BTS bottom trawl survey 47

CAMS Catch Accounting and Monitoring System 1, 3, 9, 11, 13, 15, 24, 33, 36, 37

CIE Center for Independent Experts 11

CJFAS Canadian Journal of Fisheries and Aquatic Sciences 39

CLF Conservation Law Foundation 7, 8

CRD Center Reference Document LXXIX

CSE Council of Science Editors LXXIX

CT LISTS Connecticut Long Island Sound Trawl Survey 44

DFO Department of Fisheries and Oceans, Canadian 51, 54

DMF Division of Marine Fisheries 8

DMIS Data Matching Imputation System 13

F/V fishing vessel 64

GARFO Greater Atlantic Regional Fisheries Office 7, 8, 16, 17

Henry B. Bigelow NOAA research vessel Henry B. Bigelow, with specialised trawling net mechanisms; commissioned July 2007, used for surveys 2009–2019 iv, 49, 64, 65

MA DMF Massachusetts Division of Marine Fisheries 7, 8, 44

MAFMC Mid-Atlantic Fisheries Management Council 7, 10, 14, 16, 17

ME DMR Maine Department of Marine Resources 7, 8

MRIP Marine Recreational Information Program 31

NAFO Northwest Atlantic Fisheries Organization viii

NCDMF North Carolina Division of Marine Fisheries 7

NEAMAP Northeast Area Monitoring and Assessment Program 11, 14, 15, 24, 30, 36, 38

NEFMC New England Fisheries Management Council 5, 7, 8, 10, 16, 17, 53

NEFSC Northeast Fisheries Science Centre III, v, 1, 3, 4, 7, 8, 11, 13–17, 24, 30, 31, 33, 34, 36, 38, 39, 44, 47, 48, 50, 51, 55, 60, 64, LXXVIII, LXXIX

NMFS National Marine Fisheries Service 47–49, LXXVIII

NOAA National Oceanographic and Atmospheric Administration iv–vi, 1, 3, 8, 49, 51, 65, LXXVIII

NOAAS NOAA ship iv

NRCC Northeast Regional Coordinating Council 6, 10

PopDy Population Dynamics Branch of NEFSC 9

QUEST Quantitative Ecology and Socioeconomics Training, NOAA program 8

RI DFW Rhode Island Department of Fish and Wildlife 44

RTA Research Track Assessment 61, 62

R/V research vessel 13, 47, 51, 64

SAS Statistical Analysis Software application viii, 24

SAW Stock Assessment Workshop 11, 39, 55

SMAST School for Marine Science and Technology (New Bedford, Maine) 7, 16

SSC Scientific and Statistical Committee 3–6, 10, 11, 14, 38, 54

SUNY State University of New York 39

TOR Term of Reference 37, 38, 50, 51, 53, 54

URI University of Rhode Island 13

USFWS US Fish and Wildlife Service. 49

WHAM Woods Hole Assessment Model 14, 22, 23, 34, 35

WHOI Woods Hole Oceanographic Institute, MA vi, 65

Abbreviations for fish stocks reviewed

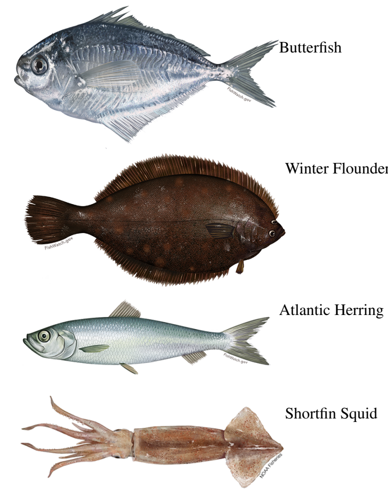
These are the abbreviations for fish stock names, as seen in the footers of each of the fish stock reports.

BUTUNIT Butterfish vi, 22–30

FLWSNEMA winter flounder from Southern New England to Mid-Atlantic vi, 31–44

HERUNIT Atlantic Herring vi, 45–60

ILXUNIT northern shortfin squid vi, 61–64



Images from NOAA Fisheries and FishWatch.gov.

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

Statistical/review concepts, parameters, etc.

000s thousands 31, 42, 45, 58

AA Annual Allocation 15, 24, 33, 37

ABC acceptable biological catch 11

ACL annual catch limit 32

ALK age-length-key 51, 54

AR Autoregressive: an autoregressive model specifies that the output variable depends linearly on its own previous value(s) and a stochastic term 11, 46–48

arima R package for time series forecasting 46

$\boldsymbol{B_{50\%SPR}}$ biomass at 50% of spawning potential rate 22

$\boldsymbol{B_{MSY\,proxy}}$ proxy estimate for biomass maximum sustainable yield 22, 61

BRP biological reference point 4, 5, 11, 15, 18, 20, 34, 38, 45, 48, 53

CDF cumulative distribution function 13

CI confidence interval 31–33, 46

Covid refers to coronavirus pandemic years, 2020–2021 11, 24

changepoint R package for ChangePoint analysis 45, 55

CV coefficient of variation 23, 52

$\boldsymbol{F}$ (instantaneous) fishing mortality rate 1, 2, 5, 23, 32, 33, 36, 38, 45, 47, 50, 53, 61

$\boldsymbol{\bar{F}_{7:8}}$ average fishing mortality for fish aged 7 to 8 years 45–47, 57

$\boldsymbol{F_{\text{Full}}}$ fishing mortality on fully selected ages 22, 23, 27, 31–33, 41, 62

$\boldsymbol{F_{50\%SPR}}$ fishing mortality for 50% of spawning potential rate 22

$\boldsymbol{F_{MSY}}$ fishing mortality for maximum sustainable yield 31, 41

$\boldsymbol{F_{MSY\,proxy}}$ proxy estimate of fishing rate for maximum sustainable yield 1, 2, 22, 23, 27, 31, 32, 36, 45, 46, 50, 54, 57, 61

$\boldsymbol{F_{\text{Threshold}}}$ threshold fishing mortality level that indicates overfishing status 27, 41, 57

$\boldsymbol{F_{40\%}}$ fishing rate at 40% of the total catch 1, 2, 31, 36, 38, 46, 50, 54

Int International landings 61

kg/tow kilograms per tow 64

Loess loess curve fitting (local polynomial regression) viii, 11, 15

log-normal probability distribution whose logarithm is normally distributed 25, 27, 28, 30, 39, 41, 42, 44, 64

M (instantaneous) natural mortality rate 2, 7, 19, 20, 24, 36, 50, 53

ρ Mohn's rho parameter: the average relative bias of retrospective estimates 5, 23, 33, 45

MSY maximum sustainable yield 22, 31, 38, 46, 61

mt metric ton 1, 2, 14, 22, 23, 31, 32, 35–38, 45–47, 50, 54, 61, 63

NA not applicable 61

PlanBsmooth 'Plan B' model using log-linear regression and Loess smoothing 11, 14, 15

q catchability coefficient 23, 36

QA/QC quality assurance and quality control 4, 11

R expected recruitment numbers 55

R/S recruits-per-spawner 54, 55

R programming environment for statistical processing and presentation vii, 46, 55

SA Subarea as specified by NAFO 61, 63

SPR spawning potential ratio 38

SSB spawning stock biomass 1, 2, 5, 22, 23, 31–36, 39, 45, 47, 50, 55, 62

SSB_{MSY} spawning stock biomass consistent with maximum sustainable yield 13, 31, 34, 36, 37, 46, 50, 55

$SSB_{MSY\,proxy}$ proxy value for spawning stock biomass estimation for maximum sustainable yield 22, 25, 39, 45, 56

SSB_{proxy} proxy value for spawning stock biomass estimate 1, 50, 54

SSB_{Target} theoretically ideal spawning stock biomass level 25, 39, 56

$SSB_{\mathrm{Threshold}}$ threshold for spawning stock biomass that indicates overfished status 25, 31, 39, 56

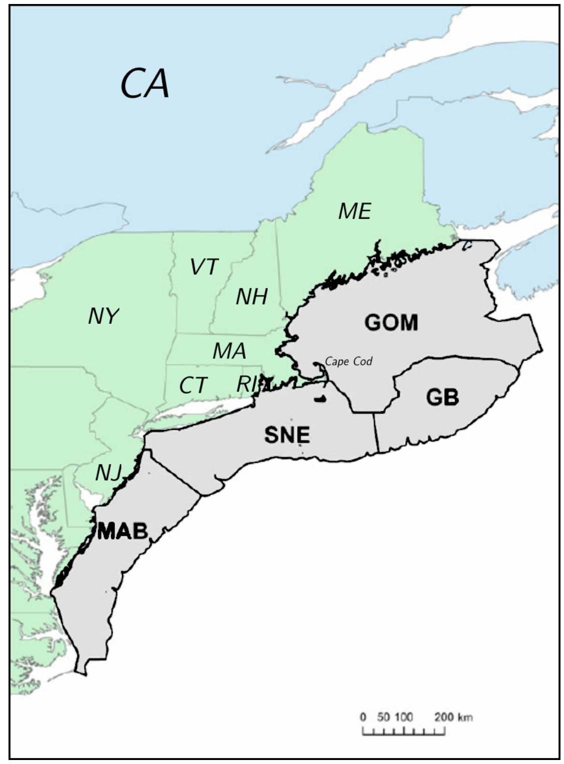
SURVEYMEANS SAS procedure for estimating characteristics of a survey population using statistics computed from a survey sample. 24

TAC total allowable catch 63

VPA virtual population analysis 11, 13, 34

YoY young of the year or age 0 24, 30, 44

Locations/regions: state, country, etc.



CA Canada ix

CC Connecticut ix

GB Georges Bank ix, 36

GOM Gulf of Maine ix, 36, 37

MA Massachusetts III, v, vi, ix, 39, 65

MAB Mid-Atlantic Bight ix

MD Maryland 1

ME Maine ix, 16

NC North Carolina 8

NH New Hampshire ix

NJ New Jersey ix, 1, 44

NY New York ix, 1

RI Rhode Island ix

SNE Southern New England ix

SNEMA Southern New England and Mid-Atlantic Bight 2, 9, 11, 13, 34, 36, 37

US United States 39, 45, 46, 48, 50, 55, 59

VA Virginia 1

VT Vermont ix

1. 2022 MANAGEMENT TRACK PEER REVIEW PANEL REPORT

Thomas Miller[1] (chair), Yong Chen[2], Yan Jiao[3] and John Wiedenmann[4]

Executive Summary

In the spring 2022 Assessment Oversight Panel (AOP) meetings, both Atlantic herring (*Clupea harengus*) and Southern New England/Mid-Atlantic winter flounder (*Pseudopleuronectes americanus*) were recommended for an enhanced peer review via a Management Track Peer Review. The Management Track meeting was conducted virtually on June 27–29, 2022. In addition to the reviews of the assessments for the two stocks, the Management Track Peer Review meeting was also briefed on progress on both the Catch Accounting and Monitoring System (CAMS) in the National Oceanic and Atmospheric Administration's (NOAA) northeast region, and on development of standardized area-swept indices derived from the NOAA Northeast Fisheries Science Center (NEFSC) spring and fall fishery-independent trawl surveys.

Atlantic herring

The Peer Review Panel (hereafter, the Panel) concluded that the 2022 assessment for Atlantic Herring provides the Best Scientific Information Available as a basis for management decision making in the northeast. The Panel concluded that the assessment met each of the 5 terms of reference fully. Based on its review, the Panel supports the following statements. Herring was assessed to be overfished. Herring spawning stock biomass (SSB) in 2022 was estimated to be $61,645$ mt after correcting for a retrospective bias, approximately 33% of the $SSB_{proxy} = 185,750$ mt. Herring was assessed not to be experiencing overfishing. The exploitation rate of the mobile fleet fishery was $F = 0.097$ approximately 19% of the $F_{40\%} = F_{MSY\ proxy} = 0.5$.

In reaching these conclusions, the Panel made several recommendations for continued sampling and future work. The Panel highlights the four recommendations to be of particular significance.

1. The NEFSC should continue the collection of direct age composition data from the summer shrimp trawl. The resulting age compositions from using direct observations are notably different from those developed from borrowed age length data, as shown in the comparison of data from 2018–2019 and 2021.

2. Missing data from 2020 affected the herring assessment and will likely similarly affect other assessments. A synthesis of the impacts and potential remedies that missing data from 2020 may have on the estimation of parameters in NEFSC assessment models is warranted.

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[3]Department of Fish and Wildlife Conservation, Virginia Polytechnic Inst. and State University, Blacksburg, VA
[4]Department of Ecology, Evolution and Natural Resources, Rutgers University, New Brunswick, NJ

3. A unified approach to representing natural mortality (M) in the assessment model should be considered. Over different iterations of the herring assessment, M has been represented as age- and time-invariant, age-dependent, or tuned to predator demand. This approach suggests the form and level of M has been selected as a way of resolving poor model fits. A systematic and foundational approach to modeling mortality in key forage species is warranted.

4. An analysis of herring recruits per spawner indicated that data from 1992 onwards was most representative of future productivities. This approach is appropriate for a pelagic species such as Atlantic herring that tend to be sensitive to changes in its environment. More research needs to be done to continue developing such a "dynamic reference points" approach to identify causal hypotheses explaining the patterns.

Southern New England/Mid-Atlantic Winter Flounder

The Peer Review Panel (Panel) concluded that the 2022 assessment for SNEMA winter flounder provides the Best Scientific Information Available as a basis for management decision making in the northeast. The Panel concluded that the assessment met each of the 5 terms of reference fully. Based on its review, the Panel supports the following statements. SNEMA winter flounder was assessed to not be overfished and overfishing was not occurring. This is a substantial change in the perceived status of the SNEMA winter flounder stock, resulting largely from the change in how reference points were calculated. SNEMA winter flounder spawning stock biomass (SSB) in 2022 was estimated to be $3,353$ mt, approximately twice the biomass threshold of $1,657$ mt. The exploitation rate experienced by SNEMA winter flounder was $F = 0.061$ approximately 23% of the $F_{40\%} = F_{MSY\,proxy} = 0.265$.

In reaching these conclusions, the Panel made several recommendations for continued sampling and future work. The Panel highlights the four recommendations to be of particular significance.

1. The assessment considered the dynamics of the SNEMA winter flounder stock in isolation from the dynamics in other neighboring stocks of this species on Georges Bank and in the Gulf of Marine. The focus on SNEMA limits the ability to detect shifts in fishery activity, or in stock distributions among the three stock areas. These three stocks should be assessed at the same time, to the extent practicable.

2. A comprehensive evaluation of spatial processes in this species is warranted. The evaluation should include analysis of temporal changes in the distribution of thermal habitats, changes in movement phenology and changes in availability of fish to the fishery and to surveys. These analyses should consider correlation structure among potential predictor variables and population responses at the local scale as well as at regional scales. Such analyses may identify the causes resulting in systemic patterns in lack of model fit for the recent years for some state and inter-state coastal surveys.

3. The Panel discussed adoption of a moving recruitment window of the last 20 years of observations. The Panel recognized the attractiveness of this approach as it reflects current patterns of stock productivity. When coupled with the concept that recruitments in SNEMA winter flounder are driven by temperature, this approach would explicitly recognize the impacts of climate change on the productivity of this stock. However, the adoption of a moving window approach lacks a firm quantitative grounding that is provided by the current regression tree-based identification of the change point.

In the spring 2022 Assessment Oversight Panel (AOP) meetings, both Atlantic herring (*Clupea harengus*) and southern New England/Mid-Atlantic winter flounder (*Pseudopleuronectes americanus*) were recommended for an enhanced peer review via a Management Track Peer Review. The assessments were prepared under guidelines provided by the Spring 2022 AOP. These guidelines provide a pathway for continuing development of previously accepted assessments for each species including incorporation of the most recent data and understanding of biology of the species.

The Management Track meeting was conducted virtually on June 27–29, 2022. In addition to the reviews of the assessments for the two stocks, the Management Track Peer Review meeting was also briefed on progress on both the Catch Accounting and Monitoring System (CAMS) in the National Oceanic and Atmospheric Administration's (NOAA) northeast region, and on development of standardized area-swept indices derived from the NOAA Northeast Fisheries Science Center (NEFSC) spring and fall fishery-independent trawl surveys. The meeting agenda is provided in Appendix A and a list of meeting attendees in Appendix B.

We thank Russ Brown (Population Dynamics Branch Chief) and Michele Traver (Assessment Process Lead) for their support during the meeting. We thank the staff of the Population Dynamics Branch at NEFSC for the open and collaborative spirit with which they engaged the Panel. Our thanks extend not only to the analysts for each assessment, but also to the rapporteurs for taking extensive notes during the meeting, to staff of the New England Fishery Management Council/NOAA Fisheries Greater Atlantic Regional Fisheries Office, and to representatives of the fishing industry who provide context and additional background.

The Panel has suggestions for improvements that should be made for future Management Track Assessments with respect to information needs:

1. It was very helpful to have all background documents, information, and presentations available prior to the beginning of a stocks' review. Provided materials should include the full AOP report and summary, documentation of the current assessment, documentation of the preceding assessments back to the most recent benchmark (including peer review reports and relevant SSC reports), the most recent benchmark research track assessment (if different from the preceding), a table of the stock's status and reference points, and at least a draft version of the PowerPoint presentations. These should be provided to the reviewers in a single folder, rather than available through an online search tool.

2. Assessment update reports should match the requirements laid out in the Management Track Assessment Terms of Reference. For example, the analyst should list and respond to any review panel or SSC concerns relevant to the most recent prior assessments.

Appendix A. New England and Mid-Atlantic Management Track Stock Assessments Levels of Peer Review

Level 1: Direct delivery

A Level 1 management track assessment is essentially a simple update of the previously approved assessment with new data. This level of assessment update will be delivered directly from the NEFSC to the appropriate Council or Commission technical body (e.g., SSC) and will not undergo peer review beyond that conducted by those technical bodies. Furthermore, although there will be opportunities for public input on assessments in advance during the input phase described below, there will be limited opportunity for public engagement during the assessment review, which will occur during the public comment period of the technical body's meeting.

Given the limited peer review and public engagement, only minor changes, such as those detailed below, are permissible.

- Model that has been updated with revised data, with minor changes (such as small adjustments to data weights, fixing parameters estimated at bounds, correcting minor errors in previous model)
- Incorporation of updated data from recent years in the estimation of biological information (growth, maturity, length-weight relationship)
- Calculate updated values for the existing BRPs using same methods
- Evaluating effects of delayed seasonal surveys or missing strata on fishery-independent measures of abundance
- If adding or revising data reveals problems in model performance, analyst should identify concerns that may need further analyses and/or review
- If adding or revising data and implementing a Level 1 assessment after the AOP meeting results in a proposed change in stock status, the assessment warrants additional peer review and therefore qualifies for a Level 2, expedited peer review. This upgrade from Level 1 to Level 2 does not require additional AOP review, though the AOP should be informed.
- Standard QA/QC procedures employed by the NEFSC

Level 2: Expedited review

A Level 2 management track assessment can involve a little more flexibility for deviations from the previously accepted assessment, but that flexibility is limited to allow for efficient peer review of multiple assessments in one peer review meeting, similar to what previously had been carried out for groundfish operational assessments for the NEFMC. Level 2 assessments will undergo a formal, but expedited (1–2 hour maximum), peer review by a small panel of SSC members from the relevant Council(s), along with additional external experts if desired, before submission to the appropriate Council or Commission technical body. In addition to opportunities for public input on assessments in advance, opportunities for public engagement will occur during the public comment periods of the public review meeting and the subsequent meeting of the Council or Commission technical body. Given the moderate level of peer review and engagement, Level 2 assessments will generally use the same assessment structure and data as the previously accepted assessment, but some changes are permitted (detailed below) that warrant review by an external body. In this level, the cumulative impacts of the number of changes should also be considered; any individual change may be minor, but if there are several changes, the overall impact could be substantial and may warrant shifting an assessment to Level 3 and providing enhanced peer review.

Changes permitted in Level 2 assessments include those noted in Level 1, and:

- Updated discard mortality estimates, when based on peer-reviewed experimental evidence
- Evaluating effects of delayed seasonal surveys or missing strata on fishery independent measures of abundance if significant analysis is required to characterize the effects
- Recalibrated catch estimates (e.g., transition to Marine Recreational Information Program, area allocation tables, conversion factors (whole to gutted weight))
- Simple changes, corrections, or updates to selectivity, including but not limited to:
- Changes to most recent selectivity stanza
- Changes to historical selectivity stanza if they are corrections or reinterpretations of previously used block timeframes
- Retrospective adjustment to management metrics following established retrospective adjustment protocols Technically, when either the ρ-adjusted SSB or F (point estimate / (1 + Mohn's ρ)) falls outside the 90% confidence interval of the terminal year estimate, the retrospective adjustment is applied for both status determination and to the starting population for projections.
- Adjustment of method for estimating biological information (growth, maturation, sex ratio, changes to length-weight relationships, etc.), when based on methods developed with sufficient peer review or justification for its use
- Calculate new values for the existing BRPs using new or modified approach (e.g., new methods, different assumptions, etc.)
- Changes in stock status, even if the underlying assessment structure and data are largely unchanged from prior assessments

Level 3: Enhanced review

A Level 3 management track assessment will permit more extensive changes than a Level 2 assessment and therefore requires a more extensive peer review (one-half to a one full day). The flexibility in Level 3 provides an opportunity to make progress within the management track toward the Next Generation Assessments envisioned in the Stock Assessment Improvement Plan, by including more detailed spatial, temporal, environmental and species interactions within existing model frameworks. It is important to note, however, that full achievement of Next Generation Assessments will likely require research track efforts as well. As in Level 2 assessments, public engagement opportunities will occur during the public comment periods of both the public review and the subsequent meeting of the Council or Commission technical body, as well as during the input phase of the assessment process as described below. Level 3 assessments will be reviewed by a small panel of SSC members from the relevant Council(s) as well as additional external experts as needed; any external reviewers outside of the SSC will be nominated by the Council or Commission and confirmed by the NRCC Deputies. Given the enhanced peer review, changes to most assessment elements, with the exception of stock structure, would be permitted in Level 3 assessments; however, cumulative impacts should be considered when making a determination between the changes permissible within the "enhanced review" level and changes that would require switching to the research track process.

Changes permitted in Level 3 assessments include those noted in Levels 1 and 2, and:

- Inclusion of new or alternate interpretations of existing indices
- Changes to estimation method of catchability, including but not limited to:
  - Empirical estimations
  - Changes in habitat/availability/distribution on catchability
  - Use of informed priors on catchability in a model
- Updating of priors based on new research if done on a previously approved model
- Recommend significant changes to biological reference points, including but not limited to:
  - Change in the recruitment stanza
  - Number of years to include for recent means in biological parameters
  - Suggestions of alternate reference points if based off a similar modeling approach (e.g. age-based, length-based, etc.)
- Updating of historical selectivity stanzas
- Changing recruitment option used, meaning using a stock-recruitment relationship, or cumulative distribution function, etc.
- Changes to selectivity functional form (i.e., such as a new selectivity model) if supported by substantial empirical evidence.

- Changes to fleet configuration
- Changes to natural mortality (M)
- New modeling framework, if the new framework was evaluated during a previous research track topic investigation, and the species in question was one of the examples evaluated. Through research track topics focused on methods, new models could be implemented in parallel with an accepted model and provide a basis for eventual shift to a new model through a Level 3 management track assessment. This would allow model evolution, technical innovations, and testing without the penalty of forgoing research on stock dynamics until a new Research Track process is scheduled.

Appendix B. September 2021 management track peer review meeting attendees

Key:

ASMFC – Atlantic States Marine Fisheries Commission
NEFSC – Northeast Fisheries Science Center
NEFMC – New England Fisheries Management Council
MAFMC – Mid-Atlantic Fisheries Management Council
MA DMF – Massachusetts Division of Marine Fisheries
ME DMR – Maine Department of Marine Resources
SMAST – School of Marine Science and Technology, Univ. of Massachusetts, Dartmouth
GARFO – Greater Atlantic Regional Fisheries Office
NCDMF – North Carolina Division of Marine Fisheries
CLF – Conservation Law Foundation

Panel:

Tom Miller – Chair
Yong Chen – Panel
John Weidenmann – Panel
Yan Jiao – Panel
Russ Brown – NEFSC
Michele Traver – NEFSC

Attendees and Presenters:

Alex Dunn – NEFSC
Alex Hansell – NEFSC
Angela Forristall – NEFMC Staff
Anthony Wood – NEFSC
Ashely Asci – GARFO
Benjamin Levy – NEFSC
Brad Schondelmeier – MA DMF
Brian Linton – NEFSC

Cameron Day – NEFSC
Carrie Nordeen – GARFO
Charles Adams – NEFSC
Charles Perretti – NEFSC
Chris Legault – NEFSC
Daniel Caless – GARFO
Daniel Hocking – GARFO
David Mussina – NEFMC Herring Advisory Panel
Emilie Franke – ASMFC
Erica Fuller – CLF
Gerry O'Neill – Cape Seafoods
Jamie Cournane – NEFMC staff
Jeff Kaelin – Lund's Fisheries
Jon Deroba – NEFSC
Kathy Sosebee – NEFSC
Katie Almeida – Town Dock
Kelly Whitmore – MA DMF
Kiersten Curti – NEFSC
Larry Alade – NEFSC
Liz Sullivan – GARFO
Melissa Smith – ME DMR
Maria Fenton – GARFO
Mark Terceiro – NEFSC
Mary Beth Tooley – O'Hara Corporation (Maine)
Matt Cieri – ME DMR
Megan Ware – ME DMR
Mike Celestino – New Jersey Fish and Wildlife
Pat Campfield – ASMFC Director of Fisheries Science Program
Paul Nitschke – NEFSC
Rachel Feeney – NEFMC staff
Raymond Kane – Cape Cod Fishermen's Alliance
Richard Klyver – Maine stakeholder
Robin Frede – NEFMC staff
Sara Weeks – NEFSC
Tara Dolan – NOAA QUEST program
Talya tenBrink – NEFSC (on detail)
Tom Nies – NEFMC Executive Director
Toni Chute – NEFSC
Tracey Bauer – NC DMF

Appendix C. Agenda for the June Management Track Peer Review Meeting, June 27–29, 2022

Day/Date	Time	Activity	Lead
Monday, June 27	10:00 am	Welcome/Introductions /Conduct of Meeting	Michele Traver, Russ Brown, Tom Miller – chair
	10:15 am	CAMS Discussion/Questions	PopDy Panel
	11:00 am	Atlantic Herring	Jon Deroba
	12:15 am	Discussion/Questions	Panel
	12:30 am	Public Comment	Public
	12:45 am	Lunch	
	1:30 pm	Atlantic Herring cont.	Jon Deroba
	3:30 pm	Break	
	3:45 pm	Atlantic Herring cont.	Jon Deroba
	5:30 pm	Discussion/Questions	Panel
	5:45 pm	Public Comment	Public
	6:00 pm	Adjourn	
Tuesday, June 28	9:00 am	Welcome/Logistics	Michele Traver, Tom Miller – chair
	9:05 am	Atlantic Herring cont.	Jon Deroba
	10:45 am	Break	
	12:00 pm	Summary/Discussion	Panel
	12:30 pm	Public Comment	Public
	12:45 pm	Lunch	
	1:45 pm	SNEMA winter flounder	Tony Wood
	3:15 pm	Break	
	4:00 pm	SNEMA winter flounder cont.	Tony Wood
	4:45 pm	Summary/Discussion	Panel
	5:15 pm	Public Comment	Public
	5:30 pm	Adjourn	
Wednesday, June 29	9:00 am	Report Writing	Panel

Appendix D. Summary of February 24th and April 11th, 2022 Assessment Oversight Panel Meetings for Spring 2022 Management Track Stock Assessments

Via Video Conference

The NRCC Assessment Oversight Panel (AOP) met to review the operational stock assessment plans for the Atlantic Herring and Southern New England Winter Flounder assessment on February 26, 2022 and the Illex and Butterfish assessments on April 11, 2022. The assessments for stocks/species recommended for Level 2 and 3 peer reviews will be reviewed during a meeting the week of June 27, 2022.

The AOP consisted of:

- Russell W. Brown, Ph.D. (AOP Chair), Northeast Fisheries Science Center, Woods Hole, Massachusetts. (Both meetings)
- Michael Celestino, representing the Atlantic States Marine Fisheries Commission, New Jersey Fish and Wildlife (Both meetings)
- Olaf Jensen, Ph.D., member of the MAFMC Scientific and Statistical Committee, University of Wisconsin, Madison. (February 24, 2022 meeting only)
- Lisa Kerr, Ph.D., Chair of the NEFMC Scientific and Statistical Committee, Gulf of Maine Research Institute (April 11, 2022 meeting only)
- Cate O'Keefe, Ph.D., vice-chair of the NEFMC Scientific and Statistical Committee, Fishery Applications Consulting Team, LLC (February 24, 2022 meeting only)
- Michael Wilberg, Ph.D., vice-chair of the MAFMC Scientific and Statistical Committee, University of Maryland. (April 11, 2022 meeting only)

Meeting Details

These meetings were guided by the NRCC-approved stock assessment guidance documents. Three background documents were provided to the Panel: (1) an updated prospectus for each stock; (2) an overview summary of all the salient data and model information for each stock; and (3) the NRCC Guidance memo on the Operational Assessments. Prior to the meeting, each assessment lead prepared a proposal for their Management Track Assessment. The proposal reflected the Research Track or recent Assessment results, the review panel Summary Report results and any initial investigations conducted for the Management Track Assessment.

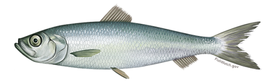
At the meeting, each assessment lead gave a presentation on the data to be used, model specifications (if applicable), evaluation of model performance, the process for updating the Biological Reference Points, the basis for catch projections, and an alternate assessment approach if their analytical assessment was rejected by the peer review panel. In the case of Illex, the stock was already being assessed annually by the SSC using an "index-based" or "empirical" approach.

Appendix D.1. 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 1 on the next page.

Appendix D.2. Individual Stock Discussion Summaries

Atlantic Herring (AOP Lead: Michael Celestino)



Recommendation: Level 3 (Enhanced Review)

Atlantic Herring was last assessed using the 35th SAW accepted ASAP model updated in 2020 using data through 2019. The stock is currently overfished, while overfishing is not occurring. For the current management track assessment, no new sources of information are anticipated, save NEFSC swept area adjusted survey indices. The assessment scientist did not anticipate this transition to create any problems given the variation already observed in the survey. Regarding the use of commercial landings, the assessment lead did not anticipate using the newly available CAMS, as the state of Maine handles QA/QC data and is considered the official catch record for herring. There were no objections from the AOP on this proposal.

No changes to the assessment model are proposed. Following a recommendation from the 2020 management track review, biological reference point calculations will account for fixed fleet fishing mortality (which are almost entirely Canadian catches). One notable proposed change is to the recruitment stanza and/or projection methods used in short term projections and projections to define the BRPs in light of approximately 10 years of unprecedented low recruitment; the past approach drew from the full time series of recruitments, which the assessment scientist viewed as increasingly inappropriate. Proposed examples included autocorrelated models [for example, AR(1), empirical dynamic modelling], or the use of environmental covariates (such as bird diet data as an early indicator of recruitment strength). The latter was viewed as unlikely, but included in the event this effort progressed rapidly. Discussion ensued regarding the types of covariates that would be of most use and the interest in ensuring that they too could be projected. The AOP suggested consideration of alternative time series methods as well, such as regime shift models, for example.

In terms of a 'Plan B' assessment, the assessment scientist proposed a Loess smooth of all indices used in the assessment since 2009. The assessment scientist indicated that to operationalize this approach, all indices would be rescaled to their respective means, then averaged; the Loess would be applied to the mean index. In response to a question about the influence of missing 2020 data (due to covid), the assessment scientist envisioned an in-depth, thorough treatment of interpolation methods and implications, similar to what has been done for groundfish stocks. There were no objections from the AOP on the 'Plan B' approach.

The AOP concurred with the lead analyst's proposed Level 3 review. Justification from the AOP included concerns related to the recent pattern of poor recruitment used in the time series for projections and biological reference points, as well as allowance for exploration of methods to determine appropriate recruitment stanzas and/or modifications to projection methods (e.g., environmental covariates, autocorrelation processes, time series analyses).

Table 1: Stocks reviewed at September 2022 Management Track Assessment Peer Review meeting

Stock	Lead	Review Level	Rationale and Comments
Atlantic Herring	Jonathan Deroba	Level 3 – Enhanced Review	Justification from the AOP included concerns related to the recent pattern of poor recruitment used in the time series for projections and biological reference points, as well as allowance for exploration of methods to determine appropriate recruitment stanzas and/or modifications to projection methods (e.g., environmental covariates, autocorrelation processes, time series analyses). Missing 2020 survey and sampling information due to Covid.
SNEMA Winter Flounder	Tony Wood	Level 3 – Enhanced Review	Concerns about the recent pattern of poor recruitment and the time series used for projections and biological reference points. Unknown effect of splitting the Albatross & Bigelow time series. NEFSC fall survey index is currently input as bumped Ages 2–7+, this is a carryover from when the model was a VPA. This survey will be input as un-bumped Ages 1–7+ for this assessment. Uncertainty in the CAMS landings allocation to stock area. Missing 2020 survey and sampling information due to Covid.
Illex Squid	Lisa Hendrickson	Data Update – Direct Delivery	Research Track peer review was completed in March 2022. The AOP saw little value in providing an alternate assessment approach (PlanBsmooth) and concluded that the management track report will consist of a data update with 2020–2021 catch and 2020–2021 survey information. Once the 2022 catch and 2022 Autumn NEFSC survey data are available in 2023, the Rago “Indirect Method” (which relies on an assumed BRP to annually estimate an ABC), should be updated by the assessment lead and provided to the SSC.
Butterfish	Charles Adams	Level 1 – Direct Delivery	Research Track peer review in March 2022, the management track report will consist of a model update that will include the 2020–2021 catch and 2020–2022 survey information. The AOP has some concerns given that the individual CIE reports were not available at the time of the meeting. The AOP recommended reaching out to NEAMAP staff to understand the source of changes in the index time series.

Southern New England Mid-Atlantic (SNEMA) Winter Flounder (AOP Lead: Cate O'Keefe)

Recommendation: Level 3 (Enhanced Review)

Dr. Tony Wood provided an overview of the current stock assessment for SNEMA winter flounder and his recommendations to the Assessment Oversight Panel for the 2022 management track assessment. The stock is currently overfished, and overfishing is not occurring. The current assessment method for SNEMA winter flounder is a statistical catch-at-age (ASAP) model that includes age-specific commercial and recreational landings and discards, and 12 age-specific trawl indices from the NEFSC, four state fisheries agencies, and URI Graduate School of Oceanography.

The SNEMA winter flounder model will be updated with information through 2021, including all fishery and survey data, and no new information sources will be introduced. The assessment will apply the ASAP model configuration as updated during the 2020 management track assessment with a proposed change to use ages 1–7+ for the NEFSC fall survey index. Currently, the NEFSC fall survey index has been input as bumped ages 2–7+, as a carryover from the previous VPA model. The assessment will explore splitting the NEFSC bottom trawl survey time series to separate the R/V Albatross and Bigelow indices. Additionally, an environmental assessment model (Bell et al., 2018) will be updated and the results will be used to inform a stanza of recruitment more representative of the current stock regime. Current projections draw from the empirical cumulative distribution function (CDF) of recruitment using estimates from the full time-series, 1981–2019. It is expected that results from the environmental assessment model will suggest a truncation of the recruitment time series. Since estimates of recruitment in the early time-series are higher in magnitude, removing these estimates from the recruitment stanza is expected to lower median recruitment estimates in the projections, leading to a reduction in the projected estimate of SSB_{MSY} 40%.

The AOP discussed the application of results from the environmental assessment model to inform the SNEMA winter flounder recruitment stanza and approved the recommendation to use this external model to inform biological reference points and projections. SNEMA winter flounder is not scheduled for a research track assessment until 2026 and using the environmental model to inform a more representative recruitment stanza was considered appropriate for the management track assessment.

The AOP expressed concerns about potential uncertainties associated with the use of CAMS data for the SNEMA winter flounder assessment. Landings data for 2020 and 2021 will be generated differently from previous assessments, and the AOP discussed the potential need for additional comparisons of landings data from different sources (e.g., DMIS and CAMS). The AOP also discussed the missing 2020 survey and sampling information for several of the indices included in the SNEMA winter flounder assessment and supported the proposed sensitivity analyses to address missing data points.

The AOP agreed that a Level 3 assessment was appropriate based on changes to the recruitment time series used to estimate biological reference points and projections, uncertainties in CAMS data, missing survey data for 2020, splitting the Albatross and Bigelow survey time series, and changing the fall survey ages to 1–7+.

Illex Squid (AOP Lead: Russell Brown)

Recommendation: Level 1 (Direct Delivery)

Stock assessment approaches developed through the Research Track process were peer reviewed in March 2022. The panel did not support the Depletion model tabled for the peer review and had concerns about several other approaches that were explored by the working group. Efforts to develop biological reference points were unsuccessful and the status of the stock is currently unknown. However, the panel did conclude that there was evidence to suggest that the stock was "lightly fished".

Lisa Hendrickson presented information concluding application of the alternate stock assessment approach (in this case, PlanBsmooth), given that the Research Track peer review panel did not support the Depletion Model tabled by the Illex Research Track working group. The panel discussed the utility of applying the PlanBsmooth approach to inform 2023 specification setting and concluded that this would not be a valuable exercise.

The MAFMC Scientific and Statistical Committee (SSC) has been utilizing an approach developed by Dr. Paul Rago to set quotas for the past two years. Management specifications including a quota of 40,000 mt has already been set for the 2022 fishing season, so results of the Management Track process would be used to inform 2023 specifications. Given that the Rago method requires the 2022 catch and the 2022 Autumn NEFSC survey index information, this approach cannot be updated for the June 2022 Management Track peer review.

After discussing the utility of the alternate assessment approach and the inability to update the Rago approach for the June 2022 Management Track meeting, the AOP concluded that a data update should be completed in this management track cycle and be provided to the MAFMC SSC for review at their July 2022 meeting. This data update would review a Level 1 Data Update (Direct Delivery) review. Once the 2022 catch and 2022 Autumn NEFSC survey indices are available, the Rago method would be updated and presented at the March 2023 meeting of the MAFMC SSC.

Butterfish (AOP Lead: Michael Celestino)

Recommendation: Level 1 (Direct Delivery)

Butterfish was last assessed in March 2022 through a Research Track assessment and was peer reviewed resulting in a new accepted model, the Woods Hole Assessment Model (WHAM) with included data through 2019. The stock is currently not overfished, and overfishing is not occurring. For the present management track assessment, all fishery and survey data will be updated through 2021. Several new/revised sources of data are available, including revised spring and fall NEFSC Bigelow survey indices of abundance, and revised NEAMAP survey indices of abundance. The revisions to the Bigelow index resulted from a change to station-specific swept area based calculations. It was unclear what led to revisions in the NEAMAP survey index and NEFSC staff are going to follow up with NEAMAP survey staff and will include a description of this change in the June management track assessment report. The revisions to the survey indices resulted in minor changes.

Another source of new data will be commercial landings from CAMS. The AOP concurred with the assessment scientist's conclusion that there were no notable differences between the AA tables and CAMS; the AOP recommended documenting this comparison in the management track assessment document. The research track assessment included data through 2019; commercial data from CAMS will be included in this management track assessment for 2020 and 2021.

No changes to the assessment model or the projection methods are planned. Biological reference points (BRPs) will be updated using the 2022 research track approved methodology. Discussion ensued between the AOP and assessment scientist regarding consideration of revising reference points based on discussion during the 2022 research track assessment. The assessment scientist indicated that changes were not likely due to data availability timing, though he was likely to use an alternative reference point (e.g., 2/3 of the natural mortality estimate) as a sensitivity run. Additionally, should information come to light in the research track peer review report, the AOP was comfortable relying on the assessment scientist's judgment to determine if any changes to reference points (or other assessment aspects) are appropriate for the June management track.

In terms of a 'Plan B' assessment, the assessment scientist proposed a Loess smooth of NEFSC and NEMAP spring and fall indices (i.e., PlanBsmooth approach). The AOP was supportive of this approach. While it did not seem likely a 'Plan B' would be needed, discussion ensued as to how or if to treat missing survey values in the timeseries (e.g., 2020). The assessment scientist was reluctant to interpolate missing values due to the volatility of the indices. This point led to AOP discussion as to whether the index volatility calls into question the performance of the PlanBsmooth, and an examination of the PlanBsmooth performance for butterfish and butterfish-like species could be appropriate at some point.

The AOP concurred with the assessment scientist's proposed Level 1 review. Justification from the AOP included that no changes to the assessment model are planned, only minor changes to the input data are planned (i.e., prescribed adjustments to NEFSC and NEAMAP trawl survey indices), and the BRPs will be updated (no change in methodology; inputs updated to reflect updated average weight at age, average selectivity, etc). Should the assessment scientist determine that the peer review panel report (when it becomes available) requires substantive changes to the current proposal, the assessment level assignment may need to be revisited.

AOP Meeting Conclusions:

The AOP met on February 24th and April 11th, 2022 to review the stock assessment plans for four species scheduled for the Spring 2022 Management Track cycle. The panel concluded that Level 1 reviews (Direct Delivery) were warranted for Illex Squid and Butterfish and that Level 3 reviews (Enhanced Review) were warranted for Atlantic Herring and Southern New England Winter Flounder. The Level 3 reviews will occur during the Spring 2002 Management Track Peer Review scheduled for the week of June 27, 2022. 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. 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 D.3. Meeting Participants

February 24, 2022 Meeting Participation:

Russ Brown, AOP Chair (NEFSC)
Olaf Jensen, AOP (MAFMC)
Mike Celestino, AOP (ASMFC)
Cate O'Keefe, AOP (NEFMC)
Michele Traver – NEFSC
Alex Hansell – NEFSC
Andrew Applegate – NEFMC staff
Andrew Jones – NEFSC
Angela Forristall – NEFMC staff
Anthony Wood – NEFSC
Ashley Asci – GARFO
Carrie Nordeen – GARFO
Charles Adams – NEFSC
Chris Kellogg – NEFMC staff
Chris Legault – NEFSC
Chris Tholke – NEFSC
Deirdre Bohelke – NEFMC staff
Dustin Colson Leaning – ASMFC staff
Elizabeth Siddon – NEFSC (on detail)
Jamie Cournane – NEFMC staff
Janice Plante – NEFMC staff
Jon Deroba – NEFSC
Jonathan Peros – NEFMC staff
Kiersten Curti – NEFSC
Larry Alade – NEFSC
Mark Terceiro – NEFSC
Mary Beth Tooley – O'Hara Corporation (Maine)
Matt Cieri – Maine Department of Marine Resources
Melissa Smith – Maine Department of Marine Resources
Paul Nitschke – NEFSC
Phil Politis – NEFSC
Raymond Kane – Cape Cod Commercial Fishermen's Alliance
Richard Klyver – stakeholder (artist from Eastport, ME)
Rick Bellavance – NEFMC Council Member
Samuel Asci – NEFSC
Sean Hardison – University of Virginia
Steve Cadrin – SMAST, University of Massachusetts
Susan Wigley – NEFSC
Tom Miller, Chair for June 2022 Management Track Peer Review
Tom Nies – NEFMC Executive Director

Toni Chute – NEFSC, Rapporteur
Tracey Bower – ASMFC staff
Zack Klyver – Blue Planet Strategies

April 11, 2022 Meeting Participation:

Russ Brown, AOP Chair (NEFSC)
Mike Wilberg, AOP (MAFMC)
Mike Celestino, AOP (ASMFC)
Lisa Kerr, AOP (NEFMC)
Michele Traver – NEFSC
Alex Dunn – NEFSC
Alex Hansell – NEFSC
Andrew Jones – NEFSC
Anna Mercer – NEFSC
Anthony Wood – NEFSC
Brandon Muffley – MAFMC staff
Brian Linton – NEFSC
Carly Bari – GARFO
Cate O'Keefe – Fisheries Applications Consulting Team
Charles Adams – NEFSC
Chris Legault – NEFSC
Eric Reid – Fisheries Consultant
Gregory DiDomenico – Lunds Fisheries
Jeff Kaelin – Lunds Fisheries
Jon Deroba – NEFSC
Katie Almeida – Town Dock
Kim Hyde – NEFSC
Larry Alade – NEFSC
Lisa Hendrickson – NEFSC
Mark Terceiro – NEFSC
Meghan Lapp – Sea Freeze Ltd.
Paul Nitschke – NEFSC
Sarah Salois – NEFSC
Tim Miller – NEFSC
Tom Miller, Chair for 2022 June Management Track Peer Review

Appendix D.4. Assessment Oversight Panel related guidelines

Overarching statement from the Guidance Document. "If a change proposed by an analyst is not detailed below, the AOP will determine whether the modification is permissible and which level of peer review would be required."

The following list describes elements considered by the Panel. The Panel may comment on the most appropriate level of review for each element irrespective of the suggested Guidance Level. The final recommendation should be based on the panel comments. Synthesis of these comments could potentially shift the review level even if an element from the list below does not meet the threshold for a particular recommendation.

Guidance Template for Deriving Recommended Level of Assessment Review

1. Level 1 Direct Delivery
   - Model has been updated with revised data, with minor changes (such as small adjustments to data weights, fixing parameters estimated at bounds, correcting minor errors in previous model)
   - Incorporation of updated data from recent years in the estimation of biological information (growth, maturity, length-weight relationship)
   - Effects of delayed seasonal surveys or missing strata on fishery-independent measures of abundance
   - Identification by lead analyst on potential problems of adding or revising data on model performance
2. Level 2 Expedited Review
   - Updated discard mortality estimates, when based on peer-reviewed experimental evidence
   - Evaluating effects of delayed seasonal surveys or missing strata on fishery independent measures of abundance if significant analysis is required to characterize the effects
   - Recalibrated catch estimates (e.g., transition to Marine Recreational Information Program, area allocation tables, conversion factors (whole to gutted weight))
   - Simple changes, corrections, or updates to selectivity, including but not limited to:
     - Changes to most recent selectivity stanza.
     - Changes to historical selectivity stanza if they are corrections or reinterpretations of previously used block time frames
   - Retrospective adjustment to management metrics following established retrospective adjustment protocols
   - Adjustment of method for estimating biological information (growth, maturation, sex ratio, changes to length-weight relationships, etc.), when based on methods developed with sufficient peer review or justification for its use.
   - Calculate new values for the existing BRPs

3. Level 3 Enhanced Review
    - Inclusion of new or alternate interpretations of existing indices
    - Changes to estimation method of catchability, including but not limited to:
        - Empirical estimations
        - Changes in habitat/availability /distribution on catchability
        - Use of informed priors on catchability in a model
    - Updating of priors on parameter estimates based on new research AND if done on a previously approved model
    - Recommend significant changes to biological reference points, including but not limited to:
        - Change in the recruitment stanza
        - Number of years to include for recent means in biological parameters
        - Suggestions of alternate reference points if based off a similar modeling approach (e.g. age based, length-based, etc.)
    - Updating of historical selectivity stanzas
    - Changing recruitment option used, meaning using a stock-recruitment relationship, or cumulative distribution function, etc.
    - Changes to selectivity functional form (i.e. such as a new selectivity model) if supported by substantial empirical evidence.
    - Changes to fleet configuration
    - Changes to natural mortality (M)
    - New modeling framework, if the new framework was evaluated during a previous research track topic investigation, and the species in question was one of the examples evaluated.

Appendix D.5. Assessment Oversight Panel Guidance Template

Overarching statement from the Guidance Document. "If a change proposed by an analyst is not detailed below, the AOP will determine whether the modification is permissible and which level of peer review would be required."

Table elements in the columns 3 to 5 would be factors considered by the Panel. The Panel would put its comments in the most appropriate box irrespective of the Guidance Level (column 2). The final recommendation would be based on the preponderance of the evidence of comments in each column. A summary of the cumulative effects of within each Guidance Level is a row following each level. This would be an opportunity for synthesis of the evidence regarding the above factors.

Table 2: Guidance Template for Deriving Recommended Level of Assessment Review

Task	Guidance Level	Direct Delivery (1)	Expedited Review (2)	Enhanced Review (3)
Model has been updated with revised data, with minor changes (such as small adjustments to data weights, fixing parameters estimated at bounds, correcting minor errors in previous model)	1			
Incorporation of updated data from recent years in the estimation of biological information (growth, maturity, length-weight relationship)	1			
Effects of delayed seasonal surveys or missing strata on fishery-independent measures of abundance	1			
Identification by lead analyst on potential problems of adding or revising data on model performance	1			
Cumulative Impact of Level 1 changes				
Updated discard mortality estimates, when based on peer-reviewed experimental evidence	2			
Evaluating effects of delayed seasonal surveys or missing strata on fishery independent measures of abundance if significant analysis is required to characterize the effects	2			
Recalibrated catch estimates (e.g., transition to Marine Recreational Information Program, area allocation tables, conversion factors (whole to gutted weight))	2			
Simple changes, corrections, or updates to selectivity, including but not limited to: – Changes to most recent selectivity stanza. – Changes to historical selectivity stanza if they are corrections or reinterpretations of previously used block time frames	2			
Retrospective adjustment to management metrics following established retrospective adjustment protocols	2			
Adjustment of method for estimating biological information (growth, maturation, sex ratio, changes to length-weight relationships, etc.), when based on methods developed with sufficient peer review or justification for its use.	2			
Calculate new values for the existing BRPs	2			
Cumulative Impact of Level 2 changes				

Guidance Template (continued)

Inclusion of new or alternate interpretations of existing indices	3			
Changes to estimation method of catchability, including but not limited to: – Empirical estimations – Changes in habitat/availability /distribution on catchability – Use of informed priors on catchability in a model	3			
Updating of priors on parameter estimates based on new research AND if done on a previously approved model	3			
Recommend significant changes to biological reference points, including but not limited to: – Change in the recruitment stanza – Number of years to include for recent means in biological parameters – Suggestions of alternate reference points if based on a similar modeling approach (e.g. age based, length-based, etc.)	3			
Updating of historical selectivity stanzas	3			
Changing recruitment option used, meaning using a stock-recruitment relationship, or cumulative distribution function, etc.	3			
Changes to selectivity functional form (i.e. such as a new selectivity model) if supported by substantial empirical evidence.	3			
Changes to fleet configuration	3			
Changes to natural mortality (M)	3			
New modeling framework, if the new framework was evaluated during a previous research track topic investigation, and the species in question was one of the examples evaluated.	3			
Cumulative Impact of Level 3 changes. *Determine if Research Track is warranted.*				
Overall recommendation of Assessment Oversight Panel				

2. BUTTERFISH

Charles Adams

This assessment of the butterfish (Peprilus triacanthus) stock is a level-1 management track assessment of the existing 2021 research track assessment. Based on the previous research track, the stock was not overfished, and overfishing was not occurring. This assessment updates commercial fishery catch data, research survey indices of abundance, the analytical WHAM assessment model, and reference points through 2021. Additionally, stock projections have been updated through 2024.

State of Stock: Based on this updated assessment, the butterfish (*Peprilus triacanthus*) stock is not overfished and overfishing is not occurring (Figures 1–2). Retrospective adjustments were not made to the model results. Spawning stock biomass (SSB) in 2021 was estimated to be $66,566$ mt which is 169% of the biomass target ($SSB_{MSY\ proxy} = 39,436$; Figure 1). The 2021 fully selected fishing mortality was estimated to be 0.191 which is 3% of the overfishing threshold proxy ($F_{MSY\ proxy} = 5.6$; Figure 2).

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

	2013	2014	2015	2016	2017	2018	2019	2020	2021
Data									
Commercial landings	1,091	3,135	2,104	1,194	3,681	1,673	3,431	2,547	1,566
Commercial discards	441	1,054	830	1,537	948	1,388	1,655	2,430	1,755
Catch for Assessment	1,532	4,189	2,934	2,731	4,629	3,061	5,085	4,977	3,321
Model Results									
Spawning Stock Biomass	49,417	79,537	79,274	95,457	57,722	84,363	87,645	50,304	66,566
F_{Full}	0.059	0.224	0.142	0.117	0.218	0.121	0.195	0.234	0.191
Recruits (age-0)	7,907	7,967	9,207	5,616	8,301	10,299	4,489	7,006	9,813

Table 4: Comparison of reference points estimated in the 2021 research track and from the current management track update. $F_{50\%SPR}$ and $B_{50\%SPR}$ were calculated internally in WHAM assuming: 1) average recruitment since 2011; and 2) average SSB per recruit inputs (i.e., selectivity, maturity and weight-at-age) over the last five model years (2017–2021). The mean and 95% confidence interval for $B_{50\%SPR}$ and MSY are shown.

	2021	2022
$F_{MSY\ proxy}$	6.68	5.60
$B_{MSY\ proxy}$ (mt)	37,597 (25,998–54,391)	39,436 (28,508–54,553)
MSY (mt)	31,798 (21,998–45,964)	42,232 (30,520–58,437)
Median recruits (age-0) (millions)	7,950	8,293
Overfishing	No	No
Overfished	No	No

Projections: Short term projections of catch and SSB were derived by sampling from a cumulative distribution function of WHAM recruitment estimates for 2011–2021. The annual fishery selectivity, maturity ogive, and mean weights at age used in the projections are the most recent 5-year averages. Retrospective adjustments were not applied in the projections.

Table 5: Short term projections of total fishery catch and spawning stock biomass for butterfish based on a harvest scenario of fishing at the $F_{MSY\ proxy}$ in 2023 and 2024. Catch in 2022 was assumed equal to the highest annual catch since the resumption of the directed fishery in 2013 (5085 mt). F in 2022 was specified to achieve the assumed catch. The mean and 95% confidence interval for catch and SSB are shown.

Year	Catch (mt)	SSB (mt)	F_{Full}
2022	5085	76,278 (43,316–134,322)	0.263

Year	Catch (mt)	SSB (mt)	F_{Full}
2023	67,900 (36,451–126,481)	45,573 (22,253–93,330)	5.596
2024	43,109 (22,001–84,468)	39,352 (18,230–84,948)	5.596

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).

  The largest source of uncertainty in this assessment is the scale of the population. A q of 0.2 for the fall Albatross survey is required to reasonably scale the popluation size. This value of q is based on an analysis of habitat distribution to estimate availability to the survey. A q of 0.2 implies that 80% of the stock is not within the survey area, which seems potentially problematic given that butterfish are widely caught throughout the survey that covers most of their range. Another source of uncertainty is that the discard estimates prior to 2010 are highly variable and imprecise, with CVs > 0.3 in 17 of 21 years.

- 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}).

  This assessment has essentially no retrospective pattern, with Mohn's ρ of 0.014 and 0.032 for F and SSB, respectively.

- 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 butterfish are well determined. The stock is not in a rebuilding plan.

- 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 data source for commercial landings changed to the Catch Accounting and Monitoring System (CAMS) beginning in 2020. Supplemental Figure 20 was presented to the Assessment Oversight Panel (AOP) on April 11, 2022; the AOP concurred that there were no notable differences between the AA tables and CAMS.

The time series of Bigelow indices was recalculated using station-specific swept areas. Supplemental Figure 21 was also presented to the AOP; the AOP agreed that differences were minor.

The time series of NEAMAP indices were revised due to a change in the algorithm used to calculate the stratified means. Previously, the stratum weights were manually calculated and then applied to the stratum means, expanded up, etc., in SAS. The newer algorithm uses SAS procedure SURVEYMEANS to do similar calculations. Supplemental Figure 22 was presented to the AOP; the AOP agreed that differences were minor.

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

  Stock status has not changed since the previous assessment.

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

  Discards have accounted for roughly half of the catch in recent years. The NEFSC fall survey index continues to show large interannual swings in abundance.

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

  The peer-review panel from the 2021 research track identified a number of research recommendations, the most important one being a new evaluation of survey catchability to address the concerns described above.

- Are there other important issues?

  The ASAP 4 natural mortality estimate from the 2020 management track ($M = 1.278$) was assumed in the 2021 research track and the current assessment update.

  Two 2017 bottom trawl surveys were treated as missing in the 2021 research track: the NEFSC fall survey (only 29 of 77 strata were sampled); and the NEAMAP spring survey (only 63 of 150 stations were sampled); this decision was carried forward for the current assessment.

  Three bottom trawl surveys used in this assessment were not conducted in 2020 due to Covid-19: the NEFSC spring and fall surveys, and the NEAMAP spring survey; these surveys were treated as missing for the current assessment.

  The young-of-the-year (YoY) index combines state survey data from Maine/New Hampshire, Massachusetts, Rhode Island, Connecticut, New Jersey and the Delaware 30-ft headrope survey using the hierarchical method of Conn (2010).

2.1. Reviewer Comments: Butterfish

Butterfish was not peer reviewed in 2022.

References:

Conn P.B. 2010. Hierarchical analysis of multiple noise abundance indices. Canadian Journal of Fisheries and Aquatic Sciences 67(1):108–120. CJFAS

Supplemental Figures:
https://apps-nefsc.fisheries.noaa.gov/saw/sasi/uploads/2022_BUT_UNIT_FIG_ALL.pdf

Peprilus triacanthus, Butterfish.

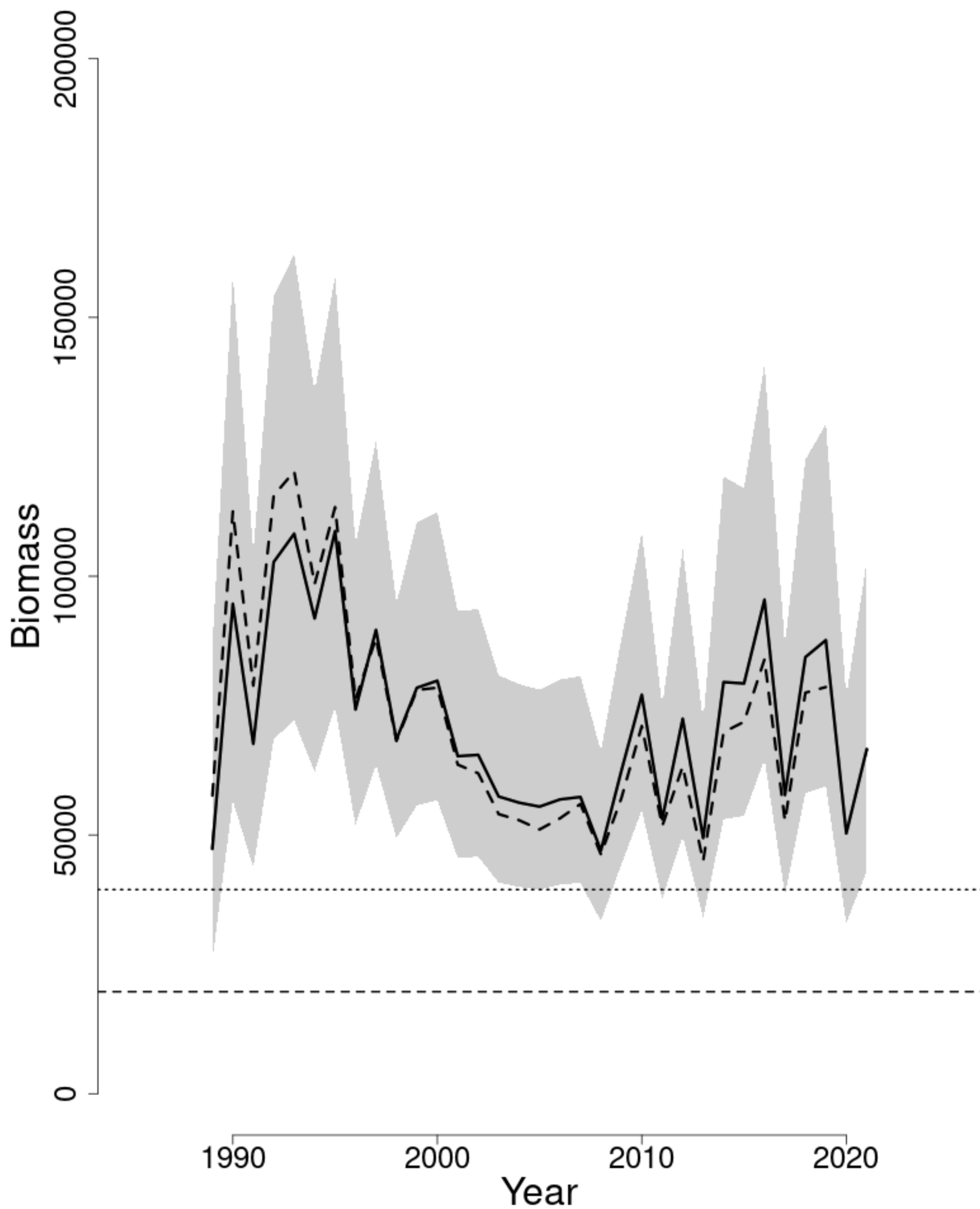


Figure 1: Trends in spawning stock biomass of butterfish between 1989 and 2021 from the current (solid line) and previous (dashed line) assessment and the corresponding $SSB_{\text{Threshold}}$ ($\frac{1}{2}SSB_{MSY\ proxy}$; horizontal dashed line) as well as SSB_{Target} ($SSB_{MSY\ proxy}$; horizontal dotted line) based on the 2022 assessment. Biomass was not adjusted for a retrospective pattern. The approximate 90% log-normal confidence intervals are shown.

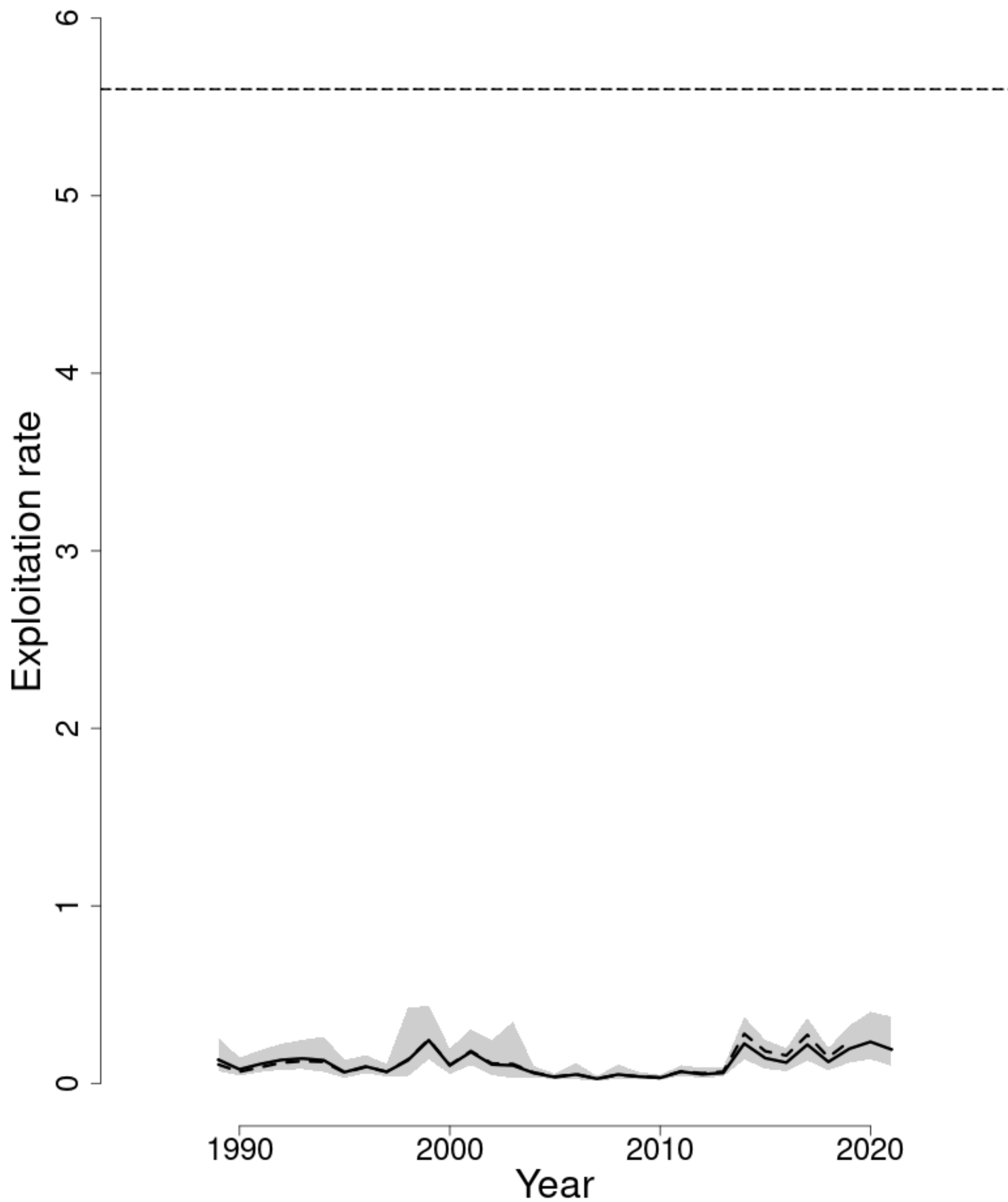


Figure 2: Trends in the fully selected fishing mortality (F_{Full}) of butterfish between 1989 and 2021 from the current (solid line) and previous (dashed line) assessment and the corresponding $F_{\text{Threshold}}$ ($F_{MSY\ proxy} = 5.6$; horizontal dashed line). F_{Full} was not adjusted for a retrospective pattern. The approximate 90% log-normal confidence intervals are shown.

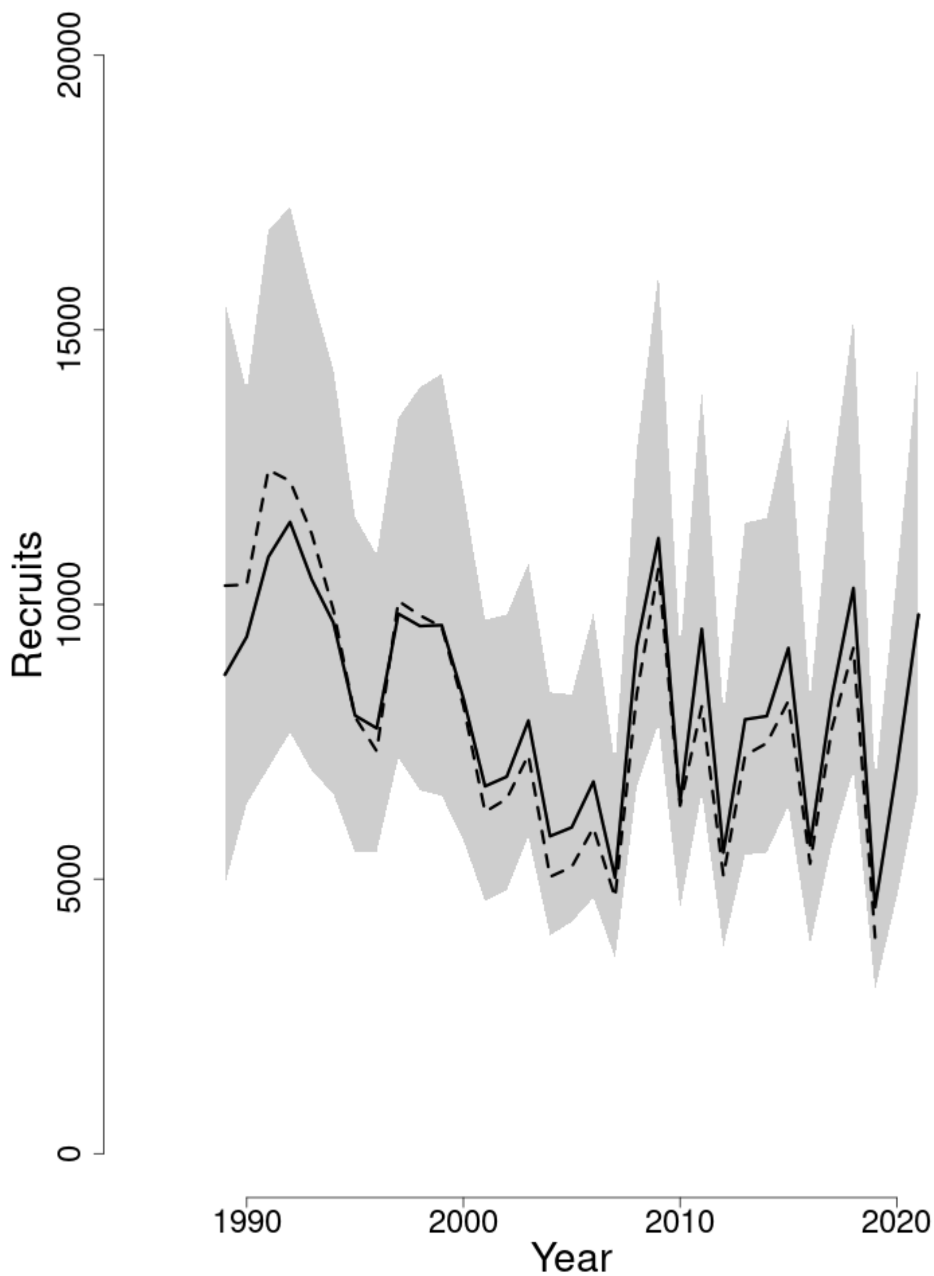


Figure 3: Trends in age-0 recruits (millions) of butterfish between 1989 and 2021 from the current (solid line) and previous (dashed line) assessment. The approximate 90% log-normal confidence intervals are shown.

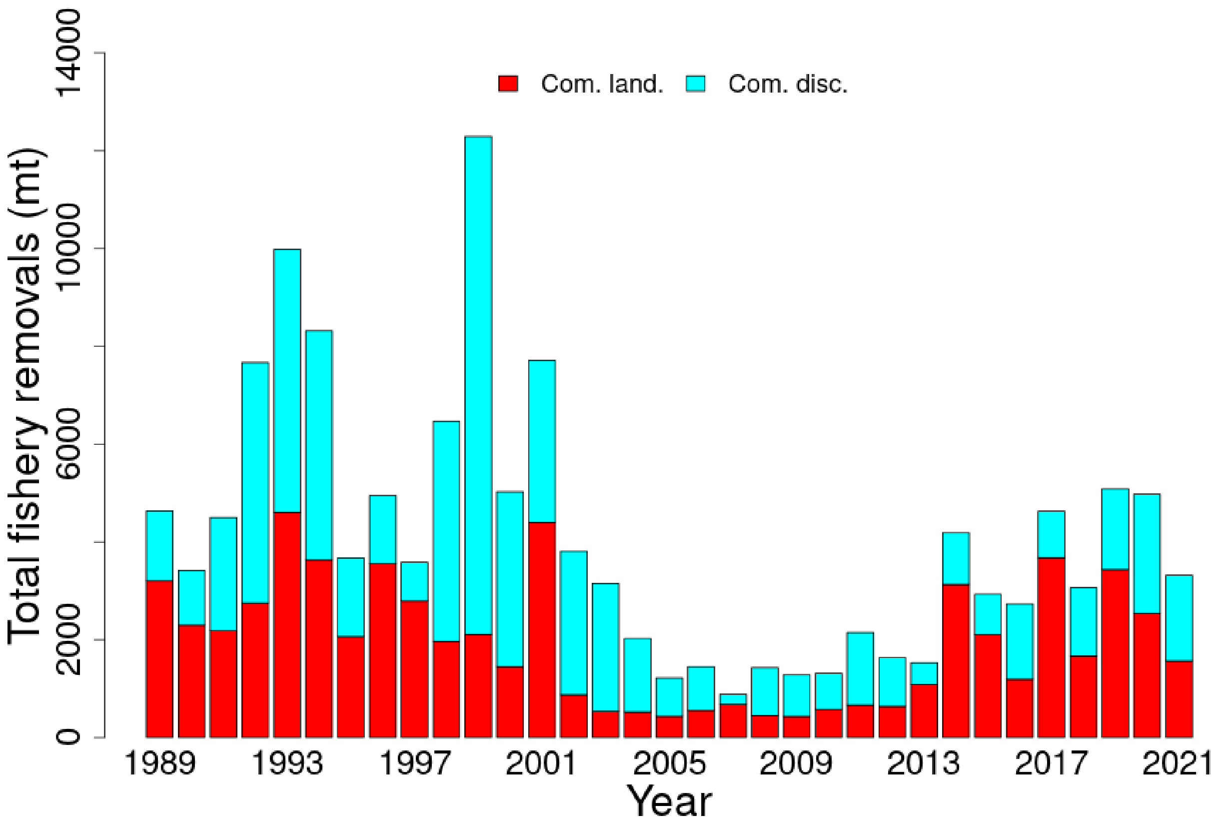


Figure 4: Total commercial catch of butterfish between 1989 and 2021 by disposition (landings and discards).

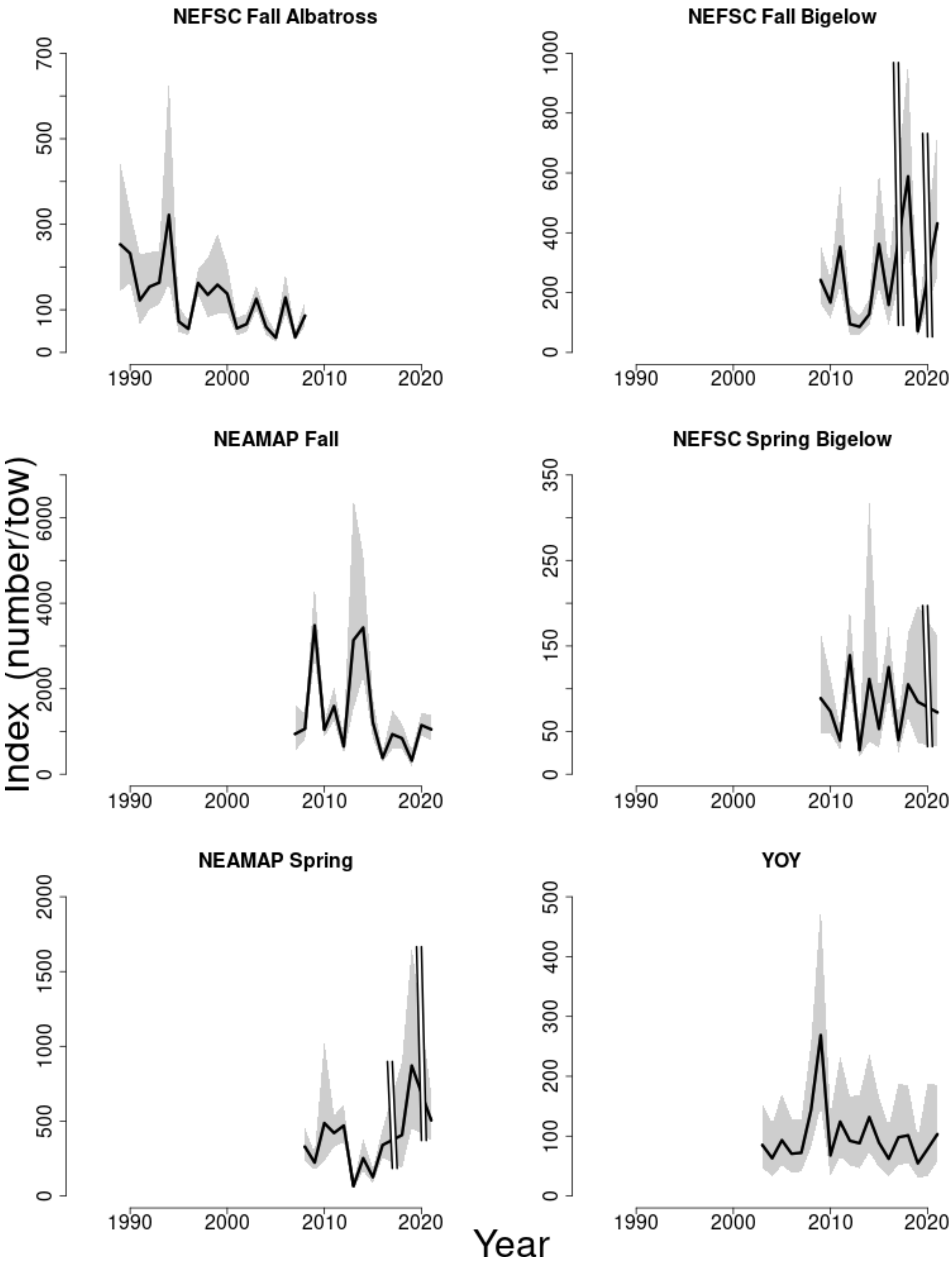


Figure 5: Indices of abundance for butterfish between 1989 and 2021 for the Northeast Fisheries Science Center (NEFSC) fall Albatross, fall Bigelow and spring Bigelow bottom trawl surveys, the Northeast Area Monitoring and Assessment Program (NEAMAP) fall and spring bottom trawl surveys, and the young-of-the-year (YoY) index. The approximate 90% log-normal confidence intervals are shown.

3. SOUTHERN NEW ENGLAND MID-ATLANTIC WINTER FLOUNDER

Anthony Wood

This assessment of the Southern New England Mid-Atlantic winter flounder (Pseudopleuronectes americanus) stock is an operational assessment of the existing benchmark assessment (NEFSC 2011), and follows operational updates in 2015, 2017, and 2020. In each assessment since the benchmark the stock was overfished, but overfishing was not occurring (NEFSC 2015, 2017, 2022). The current assessment updates commercial fishery catch data, recreational fishery catch data (using new MRIP calibrated data), research survey indices of abundance, and the analytical ASAP assessment models and reference points through 2021. Additionally, stock projections have been updated through 2025.

State of Stock: Based on this updated assessment, the Southern New England Mid-Atlantic winter flounder (*Pseudopleuronectes americanus*) stock is not overfished and overfishing is not occurring (Figures 6–7). Retrospective adjustments were not made to the model results. Spawning stock biomass (SSB) in 2021 was estimated to be 3,353.2 (mt) which is 101% of the biomass target ($3,314$ mt), and 202% of the biomass threshold for an overfished stock ($SSB_{\text{Threshold}} = 1657$ mt); Figure 6). The 2021 fully selected fishing mortality was estimated to be 0.061 which is 23% of the overfishing threshold ($F_{MSY} = 0.265$; Figure 7).

Table 6: Catch and status table for Southern New England Mid-Atlantic winter flounder. All weights are in (mt), recruitment is in ($000s$), and F_{Full} is the fishing mortality on fully selected ages (ages 4 and 5). Model results are from the current updated ASAP assessment.

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Data										
Recreational discards	11	8	4	13	3	2	4	2	3	1
Recreational landings	126	15	99	39	61	10	10	0	9	5
Commercial discards	482	206	64	82	125	101	108	127	47	122
Commercial landings	132	857	659	654	519	515	337	212	120	87
Catch for Assessment	750	1,085	826	787	708	629	460	342	180	216
Model Results										
Spawning Stock Biomass	6,186	6,632	5,174	4,528	3,819	3,574	3,570	3,271	3,522	3,353
F_{Full}	0.121	0.178	0.173	0.175	0.187	0.167	0.125	0.092	0.044	0.061
Recruits	4,227	2,380	4,033	4,862	4,641	3,187	4,623	3,001	3,264	4,365

Table 7: Comparison of reference points estimated in the 2020 operational assessment and from the current assessment update. $F_{40\%}$ was used as a proxy for F_{MSY} and an SSB_{MSY} proxy was calculated from a long-term stochastic projection drawing from the last 20 years of empirical recruitment. Recruitment estimates are median values of the time-series. 90% CI are shown in parentheses.

	2020	2022
$F_{MSY\ proxy}$	0.284	0.265
SSB_{MSY} (mt)	12,322	3,314 (2,432–4,687)
MSY (mt)	3,906	1,025 (755–1,441)
Median recruits (000s)	16,649	15,742
Overfishing	No	No
Overfished	Yes	No

Projections: Short term projections of biomass were derived by sampling from a cumulative distribution function of the last 20 years of recruitment estimates. The annual fishery selectivity, maturity ogive, and mean weights at age used in the projection are the most recent 5-year averages. The model exhibited a minor retrospective pattern in F and SSB so retrospective adjustments were not applied in the projections.

Table 8: Short term projections of total fishery catch and spawning stock biomass for Southern New England Mid-Atlantic winter flounder based on a harvest scenario of fishing at $F_{MSY\ proxy}$ between 2023 and 2025. Catch in 2022 was assumed to be 441 mt, which is the 2022 ACL for the stock. 90% CI are shown next to SSB estimates.

Year	Catch (mt)	SSB (mt)	F_{Full}
2022	441	3,472 (2,859–4,222)	0.114

Year	Catch (mt)	SSB (mt)	F_{Full}
2023	1,142	3,447 (2,845–4,156)	0.265
2024	1,276	3,894 (3,367–4,491)	0.265
2025	1,256	4,186 (3,666–5,011)	0.265

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).

  A source of uncertainty is the estimate of natural mortality based on longevity, which is not well studied in Southern New England Mid-Atlantic winter flounder, and assumed constant over time. Natural mortality affects the scale of the biomass and fishing mortality estimates. Natural mortality was adjusted upwards from 0.2 to 0.3 during the last benchmark assessment (2011), assuming a max age of 16. However, there is still uncertainty in the true max age of the population and the resulting natural mortality estimate.

Other sources of uncertainty include the length distribution of the recreational discards. The recreational discards are a small component of the total catch, but the assessment suffers from very little length information used to characterize the recreational discards (1 to 2 lengths in recent years). For this assessment a compiled discard length distribution over all years was used to characterize the recreational discards. In addtion, the poor sampling of recreational fishery information could be an issue for this assessment moving forward.

The population projections are sensitive to the recruitment model chosen, as well as the temporal period selected from which recruitment estimates are drawn. In addition, recruitment and natural mortality are likely both dependant on environmental conditions, which can not be explored within the framework of ASAP

- 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 retrospective patterns for both F_{Full} and SSB are minor and a retrospective adjustment in 2021 was not 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 Southern New England Mid-Atlantic winter flounder are reasonably well determined. However, the results are sensitive to both the recruitment model and the time-period of recruitment used. In addition, while the retrospective pattern is considered minor (within the 90% CI of both F and SSB), the ρ-adjusted terminal value of F and SSB are close to falling outside of the confidence bounds, which would indicate a major retrospective pattern. This would lead to retrospective adjustments being needed for the projections.

  The stock is in a rebuilding plan with a rebuild date of 2023. The projections for this assessment update used a truncated stanza for recruitment, incorporating values from 2002–2021 (last 20 years). Previous assessments have used the entire time-series of recruitment, with historical recruitments that are well beyond the current productivity of the stock. The truncated recruitment stanza led to a much reduced biomass target and as a result the overfished status of the stock has changed. The current status is that the stock is not overfished, overfishing is not occurring, and the stock has rebuilt by the 2023 deadline.

- 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.

  There has been a change in the commercial data processing for the NEFSC over the past few years. The NEFSC has switched to the Catch Accounting and Monitoring System (CAMS) from the AA table procedure. CAMS estimates of landings were available for 2020 and 2021. CAMS will be used going forward for commercial catch information and historical catch from 1981–2019 will remain based upon the AA table estimates.

A minor change was made to the assessment model data for this update. The NEFSC fall survey index was previously input as an age 2–7+ index. This input format was carried over from when the model was a VPA. The index was un-bumped to an age 1–7+ index, which did not have any noticeable impacts on model performance or estimates.

There was a change to the stanza of recruitment that is used in the projections for this update (which led to the level 3 review requirement). This new recruitment stanza uses the last 20 years of estimates (2002–2021) for both short term projections, and to estimate the biomass target (SSB_{MSY}) from a long term (100 yr) projection. Previous assessments have used the entire time-series of recruitment (1981–present). Many of the historical recruitment estimates are overly optimistic, if not impossible, for the current stock size and productivity to achieve. Very early recruitment estimates are 20 times the levels seen in recent years. At the 2020 management track review the main recommendation from the review panel was:

The Peer Review Panel notes, as had been done in previous reviews, that recruitment had been declining throughout the period and was currently very low. As for several other stocks under the purview of the NEFSC it would be helpful to evaluate if the previously observed high recruitment are possible; i.e., is it simply a matter of building back SSB and recruits will follow, or are there other factors at play. If the productivity of the resource(s) has decreased, it would be helpful to adjust reference points accordingly. This would be unlikely to change fisheries yield much but would be more realistic in terms of setting expectations.

Extensive work has been carried out to evaluate the effects of climate change on recruitment for southern New England winter flounder. Two assessment models that include environmental covariates have been developed: an environmental ASAP model *(Bell et al. 2018) and the transition of this environmental model into the state space Woods Hole Assessment Model (WHAM). In order to move to one of these alternative models for management, SNEMA winter flounder would have to go through a research track assessment. To help bridge the gap from now until the next research track (2026) more realistic reference points were estimated in this assesment. The environmental index (time-series of mean winter estuary temperatures) applied in the alternative assessment models was used as support in this assessment for choosing a more representative time period of recruitment for the projections.*

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

The stock status of Southern New England Mid-Atlantic winter flounder has changed since the previous operational updates and from the status determined at the last benchmark assessment in 2011. The overfished status of the stock has changed to not overfished, and the stock is now considered rebuilt by the 2023 deadline. The reason for this change in status determination is directly due to changing the recruitment stanza going into the projections. Previous assessments used the full time-series of recruitment, however, for this assessment a more recent range of recruitment (the last 20 years) was chosen. This truncated recruitment stanza eliminates the highest estimates of historical recruitment and greatly reduces the median recruitment used by the projections. The lower median recruitment estimates in the long term BRP projection results in a *much lower SSB value for the SSB_{MSY} reference point. While the stock status has changed, the perception of the stock has not, and recent model estimates and fishery independent survey indices all reveal a poor stock condition for southern New England winter flounder.*

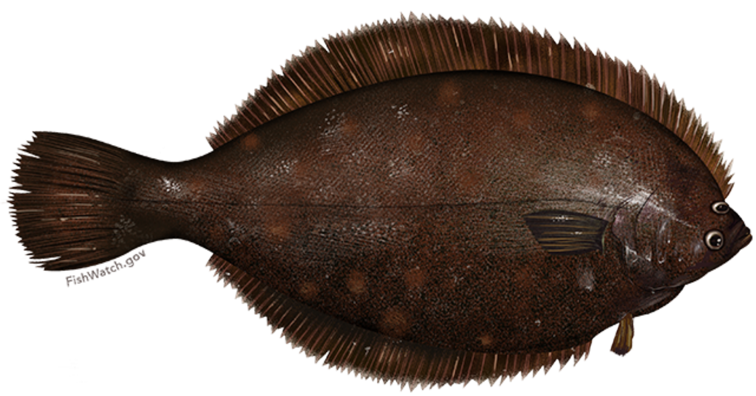
- Provide qualitative statements describing the condition of the stock that relate to stock status.

  *The Southern New England Mid-Atlantic winter flounder stock shows an overall declining trend in SSB over the time series, with the current estimate 3,353 (*mt*) at the second lowest in the time series. Estimates of fishing mortality have been declining since 2015 and the current value (0.061) is also the second lowest of the time-series. Recruitment has reamined low and steady over the past decade with a current value of 4.4 million fish, which is above the 10 year average of 3.9 million fish*

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

  The Southern New England Mid-Atlantic winter flounder assessment could be improved with additional studies on maximum age, as well as improved recreational discard length information. In addition, further investigation into the localized struture/genetics of the stock is warranted. Finally, a future shift to WHAM (during the next research track assessment) will provide the ability to model envirionmental factors that may influence recruitment and mortality, and help develop more informed population projections.

- Are there other important issues?
  None.



Pseudopleuronectes americanus, Winter Flounder.

3.1. Reviewer Comments: Southern New England Mid-Atlantic winter flounder

Winter flounder (*Pseudopleuronectes americanus*) has been distributed historically from Nova Scotia and as far south as Virginia. The species is divided into three stock areas for management purposes: the Gulf of Maine (GOM) stock, the Georges Bank (GB) stock and the southern New England–Mid Atlantic stock (SNEMA). The SNEMA stock of winter flounder was assessed as a part of the management track peer review meeting. The SNEMA winter flounder assessment is an operational assessment of the existing age-structured model approved at the 52nd Stock Assessment Workshop in 2011. The species was previously assessed at the 2020 management track peer review meeting during which assessment models for all three species were considered.

For the 2020 assessment, catch was derived from four different sources: commercial landings, commercial discards, recreational landings and recreational discards. The existing model considers a single fishing fleet partitioned into three selectivity blocks (1981–1993, 1994–2009, 2010–present). Age-dependent selectivities differing among the three blocks, but all are constrained to have selectivities of $q = 1$ for fish of age 4 and older. The scale of the population is derived from multiple surveys including the synoptic Northeast Fisheries Science Center's spring, winter and fall surveys, the NEAMAP survey as well as a number of state surveys. A time and age invariant natural mortality rate ($M = 0.3$) was assumed. The 2020 assessment provided management reference points: an $F_{MSY\ proxy} = F_{40\%} = 0.284$, and a $SSB_{MSY} = 12,322$ mt. Based on the most recent analysis of stock status in 2020, SNEMA winter flounder was overfished ($SSB = 3,638$ mt), but was not experiencing overfishing ($F = 0.077$).

The 2022 assessment update for SNEMA winter flounder was subject to an enhanced review (Level 3 assessment) in accord with the decision at the spring 2022 AOP. The new assessment used the same general configuration of the previous age structured assessment model (ASAP). Changes to the model included updates of catch data to include data to 2021 developed through the new NEFSC CAMS approach, incorporation of swept area-based indices of relative abundance for the NEFSC spring and fall surveys. The calculation of reference points was also changed, using a shorter period of recent recruitments reflective of a sustained period of low recruitments for longer than the last decade. This change resulted in a large reduction in the SSB_{MSY} reference point. The new estimate of $SSB_{MSY} = 3,314$ mt is approximately 25% of the previous estimated

The Peer Review Panel (Panel) concluded that the 2022 assessment for SNEMA winter flounder provides the Best Scientific Information Available as a basis for management decision making in the northeast. SNEMA winter flounder was assessed to not be overfished and overfishing was not occurring. This is a substantial change in the perceived status of the SNEMA winter flounder stock, resulting largely from the change in how reference points were calculated. SNEMA winter flounder spawning stock biomass (SSB) in 2022 was estimated to be $3,353$ mt, approximately twice the biomass threshold of $1,657$ mt. The exploitation rate experienced by SNEMA winter flounder was $F = 0.061$ approximately 23% of the $F_{40\%} = F_{MSY\ proxy} = 0.265$.

In the sections that follow, the Panel review information provided during the Management Track peer review to evaluate the extent to which each Term of Reference was met. We also offer research recommendations that we believe will improve our understanding of winter flounder biology, ecology and fisheries.

And in the table under TOR 4 the SSB_{MSY} value needs to be changed to $12,322$ mt.

Southern New England Mid-Atlantic winter flounder Terms of Reference

1. *Estimate catch from all sources including landings and discards.*

   Work completed fully met this TOR. The 2022 assessment for SNEMA winter flounder is the first assessment to use the new CAMS approach to estimating catch. Statistical area catches from CAMS were compared to equivalent estimates derived from the area allocation (AA) approach. The two approaches differed by approximately 50 mt, which although small in absolute magnitude, represents almost one third of the total catch for the stock area. CAMS catches were slightly more than 50 mt lower than those estimated by the AA approach, with the amount reallocated approximately evenly between the GOM and Georges Bank stocks. The specific reasons for these differences are not clear and remain under investigation.

   Landings time series from all four sources show a broad pattern of decline from 1981–2021. Commercial landings for SNEMA winter flounder declined from in excess of $10,000$ mt in 1981 to 87 mt in 2021. Commercial discards demonstrate a broadly similar pattern. Recreational landings and discards show initial increases early in the time series, but exhibit consistently low levels after 2010. Overall, total catch of SNEMA winter flounder declined from about $18,000$ mt in 1981 to 216mt in 2021, well below the time series average of $5,396$ mt.

   The catch composition was well characterized.

   The Panel makes the following observations and recommendations relative to TOR 1:

   - The Panel concluded that the impacts of changes in catch reporting from AA to CAMS had been fully addressed in subsequent sensitivity model runs.
   - Although small in absolute terms, the difference between the CAMS and AA estimates of catch in the stock area was a significant portion of the total SNEMA catch. The Panel recommends that further evaluation and comparison of CAMS and AA estimates is essential to provide a fuller understanding of how CAMS derived data may alter our perception of stock status and resilience.

2. *Evaluate indices used in the assessment (e.g., indices of relative or absolute abundance, recruitment, state surveys, age-length data, etc.).*

   This TOR was satisfactorily addressed. Fishery independent indices of stock sizes for 1981–2019 and ages 0–7+ were used. In total, twelve indices were used, including two for recruits. Surveys generally showed declining stock sizes with much lower values since the early 2000s compared with previous years. The Massachusetts Division of Marine Fisheries age-0 survey showed variability without clear trend.

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 'Plan B' assessment that would serve as an alternate approach to providing scientific advice to management if the analytical assessment were to not pass review.*

   This TOR was satisfactorily addressed. Bridge runs were made for each change. Adding a third selectivity block from 2010 resulted in very similar selectivities for the three blocks. Assuming flat topped selectivity rather than dome-shaped reduced the biomass estimate and increased (marginally) the retrospective. Recreational catches were small and have little influence on the ASAP results. The NEAMAP survey was included but did not produce large changes in estimates. A 'Plan B' was prepared but was not necessary.

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.).*

   This TOR was satisfactorily addressed. In previous assessments, MSY reference points were calculated based on a stock and recruitment relationship with recent recruitments being consistently and significantly below predicted values. In addition, most other groundfish stocks assessed by the NEFSC use $F\%SPR$ to estimate reference points. $F_{40\%}$ values can be seen in Table 7.

5. *Conduct short-term stock projections when appropriate.*

   This TOR was satisfactorily addressed. Short-term projections were made following standard protocols, without retrospective adjustment, assuming a catch of 251 mt in 2020 and fishing at $F_{40\%}$ in 2021–2023.

6. *Respond to any review panel comments or SSC concerns from the most recent prior research or management track assessment.*

   All recommendations directly related to the assessments have been implemented. The main research recommendations for stock suggest additional studies on maximum age, maturity, movement, localized stock structure and environmental influence on recruitment. Considerable progress has been made on some of these topics since the last benchmark assessment and much of this research continues.

   There has been new research investigating maturity at the science center which can be used to update the maturity ogive during the next research track.

A 2020 publication out of SUNY Stony Brook details work on otolith micro-chemistry that reveals new information on localized stock structure. A simulation study could be carried out to investigate the impacts on overall stock dynamics and the current stock assessment.

An environmental model for this stock has been developed and is presented in a 2018 publication (Bell et al., 2018). This model and indices were updated for this assessment cycle. However, in order to fully investigate and possibly shift to a new assessment model a research track assessment will be needed.

Additional Recommendations

The Peer Review Panel notes, as had been done in previous reviews, that recruitment had been declining throughout the period and was currently very low. As for several other stocks under the purview of the NEFSC it would be helpful to evaluate if the previously observed high recruitment are possible; i.e., is it simply a matter of building back *SSB* and recruits will follow, or are there other factors at play. If the productivity of the resource(s) has decreased, it would be helpful to adjust reference points accordingly. This would be unlikely to change fisheries yield much but would be more realistic in terms of setting expectations.

References:

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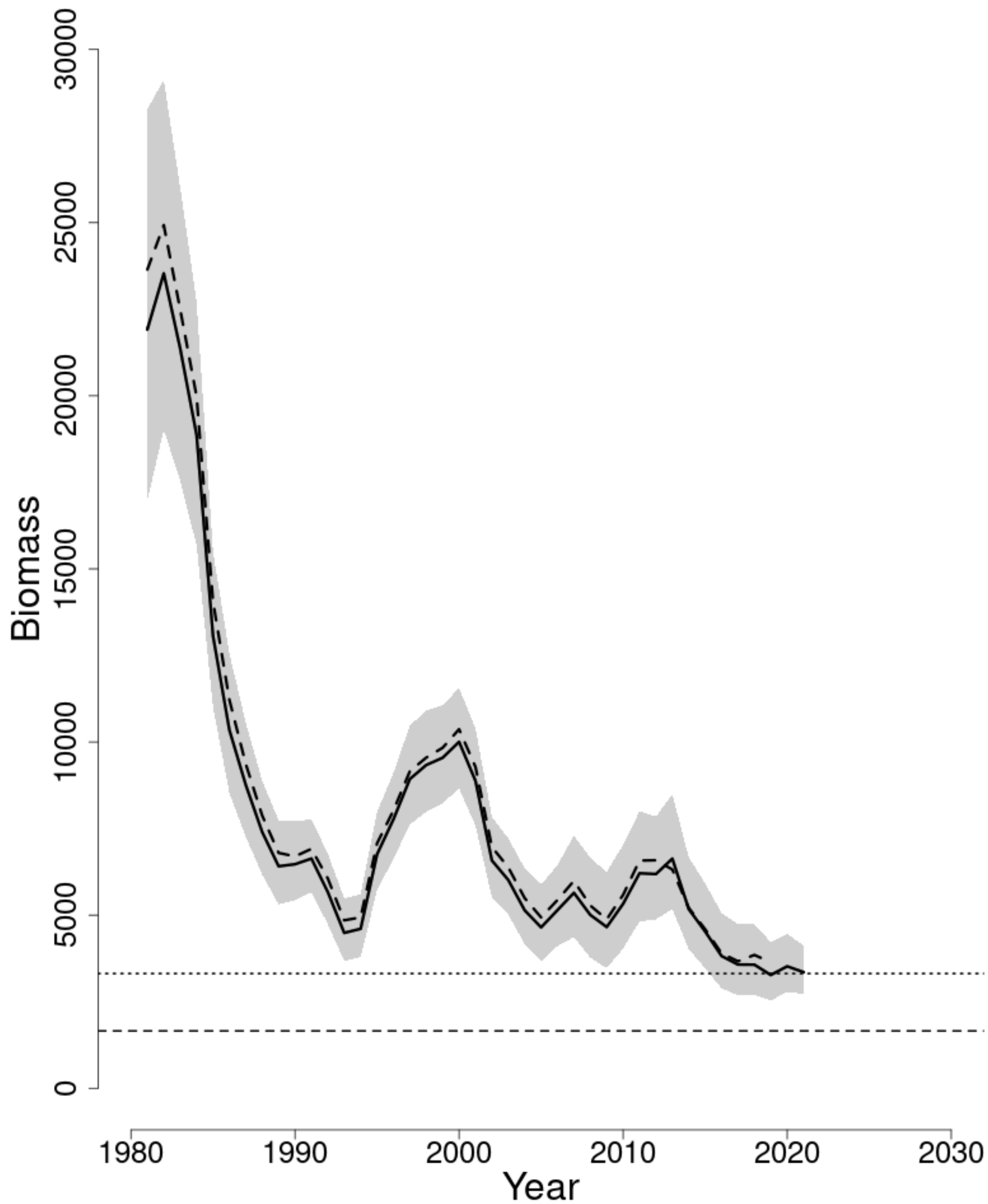


Figure 6: Trends in spawning stock biomass of Southern New England Mid-Atlantic winter flounder between 1981 and 2021 from the current (solid line) and previous (dashed line) assessment and the corresponding $SSB_{\text{Threshold}}$ ($\frac{1}{2}SSB_{MSY\ proxy}$; horizontal dashed line) as well as SSB_{Target} ($SSB_{MSY\ proxy}$; horizontal dotted line) based on the 2022 assessment. The approximate 90% log-normal confidence intervals are shown.

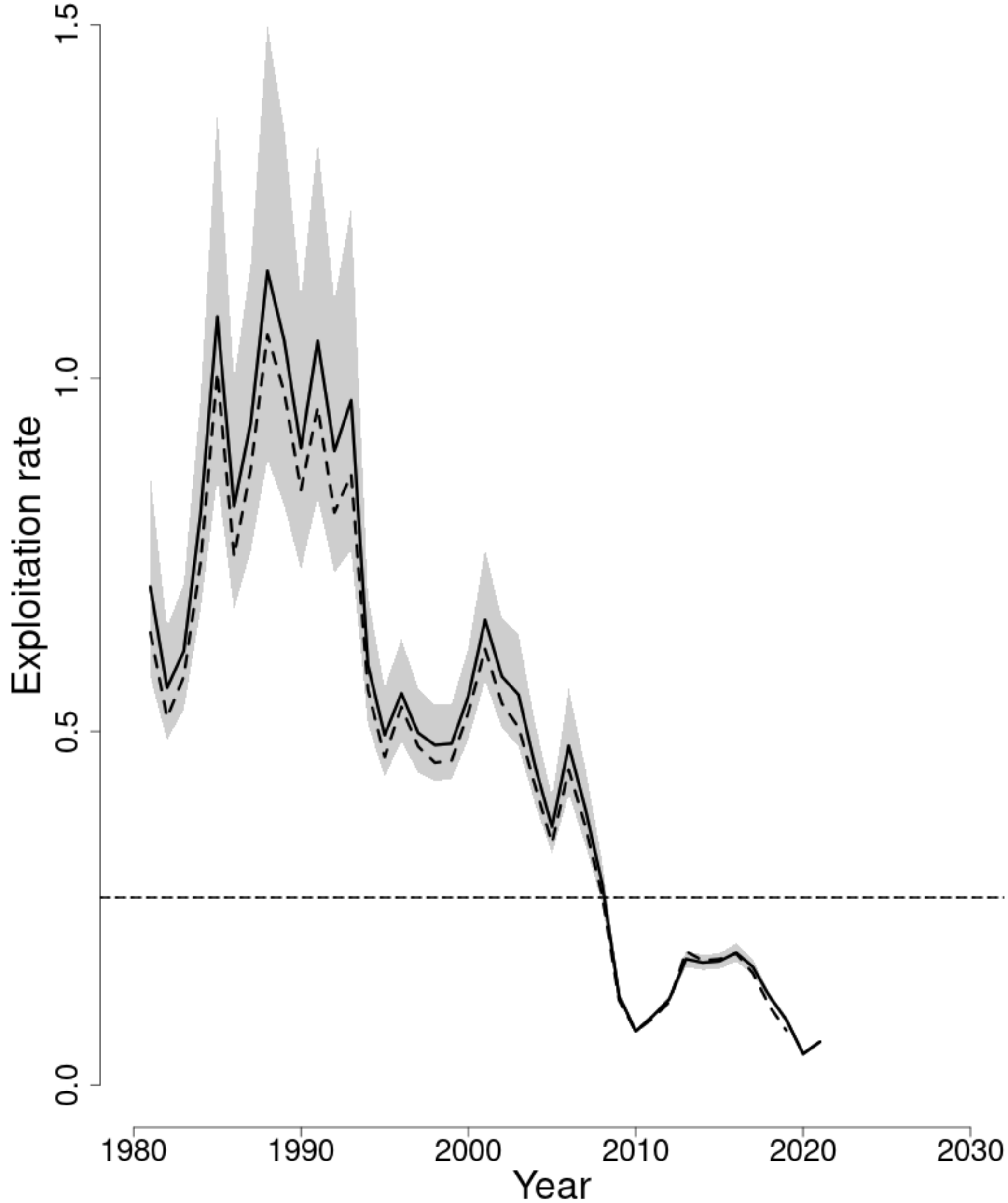


Figure 7: Trends in the fully selected fishing mortality (F_{Full}) of Southern New weights are based on an average and 2021 from the current (solid line) and previous (dashed line) assessment and the corresponding $F_{\text{Threshold}}$ ($F_{MSY} = 0.265$; horizontal dashed line) based on the 2022 assessment. The approximate 90% log-normal confidence intervals are shown.

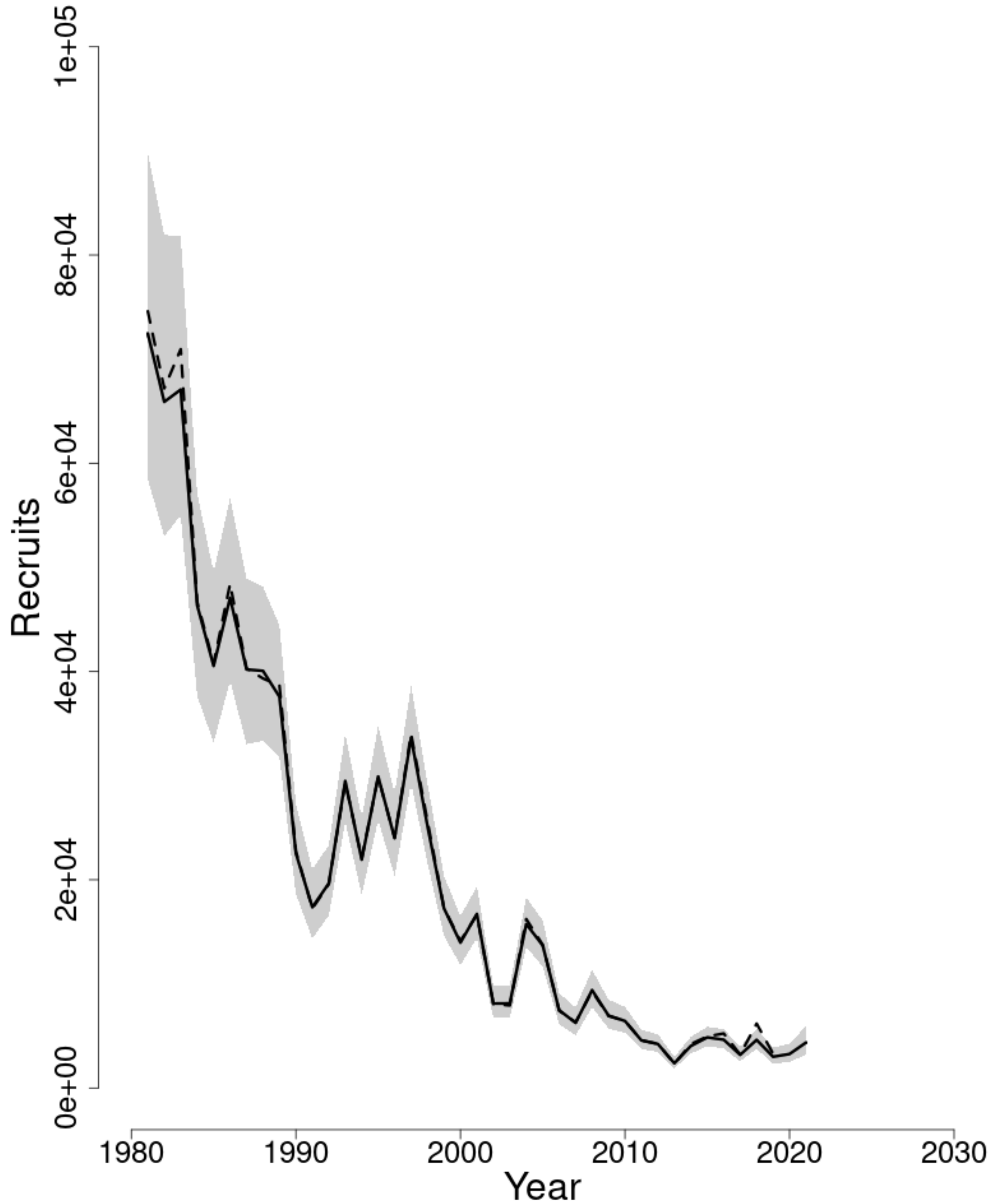


Figure 8: Trends in Recruits (000*s*) of Southern New England Mid-Atlantic winter flounder between 1981 and 2021 from the current (solid line) and previous (dashed line) assessment. The approximate 90% log-normal confidence intervals are shown.

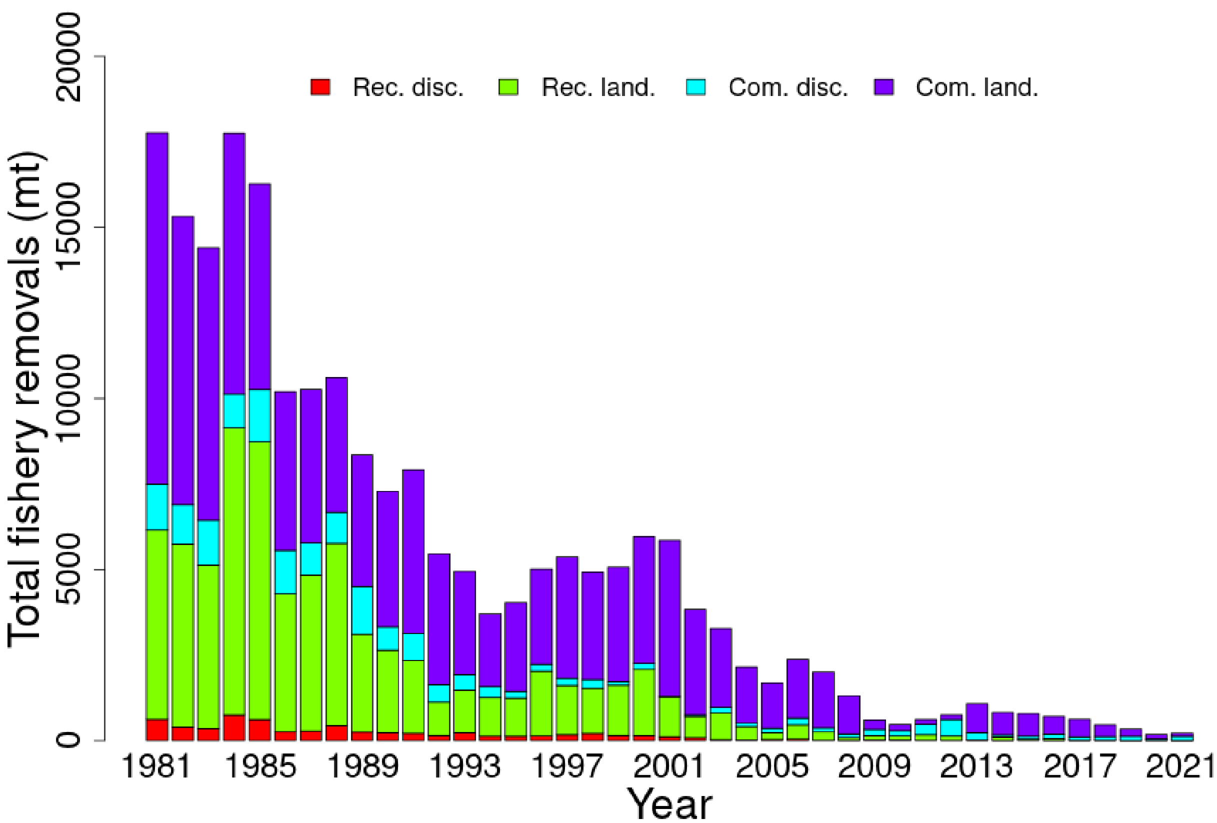


Figure 9: Total catch of Southern New England Mid-Atlantic winter flounder between 1981 and 2021 by fleet (commercial, recreational) and disposition (landings and discards).

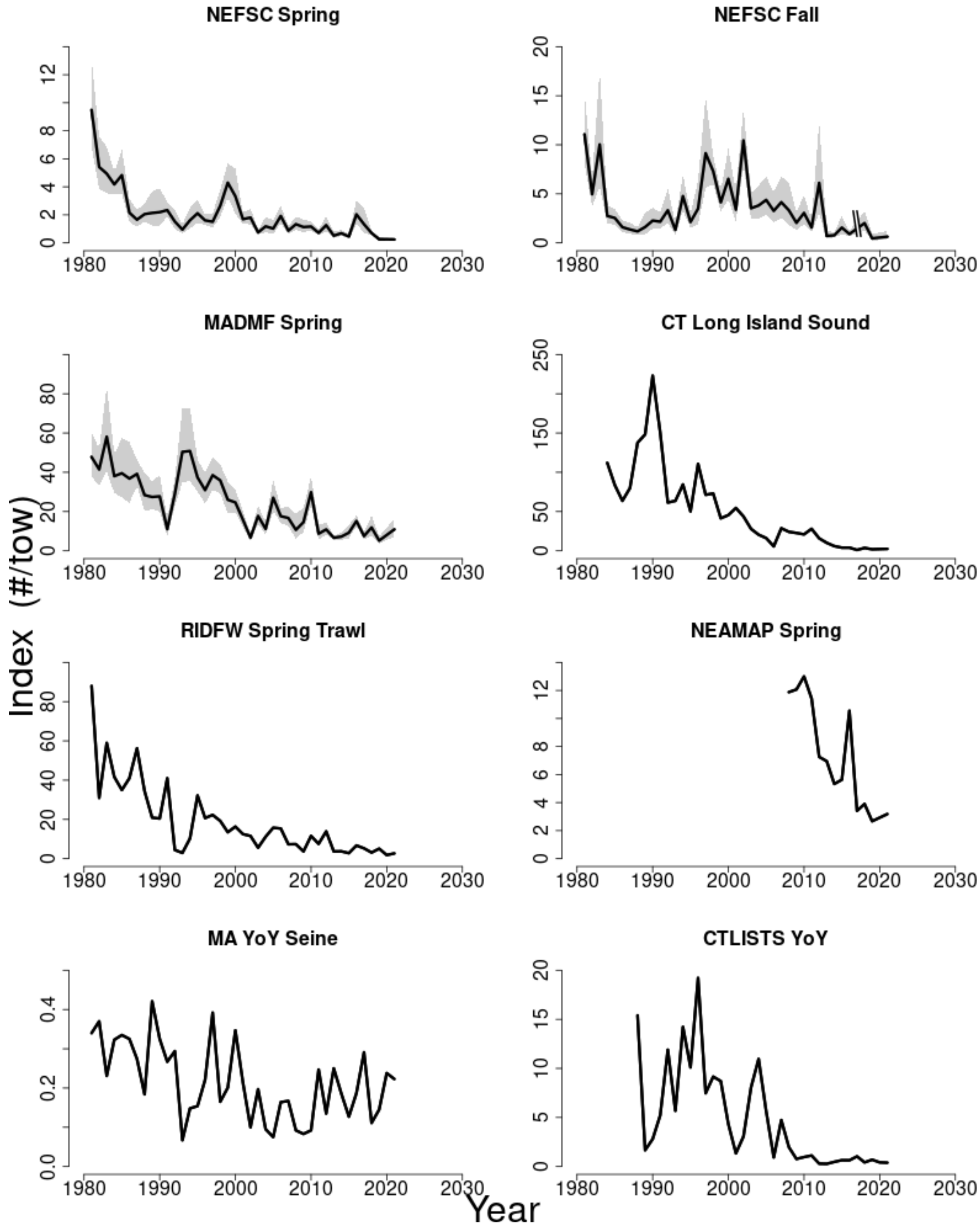


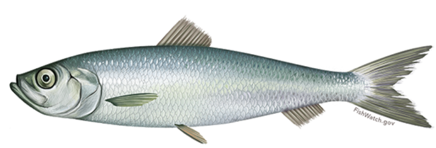
Figure 10: Indices of biomass for the Southern New England Mid-Atlantic winter flounder between 1981 and 2021 for the Northeast Fisheries Science Center (NEFSC) spring and fall bottom trawl surveys, the MA DMF spring survey, the CT LISTS survey, the RI DFW Spring Trawl survey, the NJ Ocean Trawl survey, and two YoY surveys from MA DMF and CT LISTS. Where available, the approximate 90% log-normal confidence intervals are shown. Slashes through the solid line indicate a hole in the survey time series.

4. ATLANTIC HERRING

Jon Deroba

This assessment of the Atlantic Herring (Clupea harengus) stock is a management track assessment of the existing 2020 management track assessment conducted using the ASAP model. Based on the previous assessment, the stock was overfished but overfishing was not occurring. This assessment updated fishery catch data, survey indices, life history parameters (e.g., weights-at-age), and the ASAP assessment model and reference points (BRPs) through 2021. Several notable changes were made and these were described more thoroughly below.

State of Stock: The methods used to derive BRPs and conduct short-term projections were changed as part of this management track assessment. Briefly, two notable changes were made to the methods used to calculate BRPs: 1) as recommended in the previous management track, long-term projections used to define BRPs accounted for mortality from the fixed gear fishery. The fishing mortality equaled the average of the estimated fishing mortalities from the most recent 10 years. 2) The recruitment stanza used to define BRPs was 1992–2019. The sequence of poor recruitments at the end of the time series suggested an unprecedented situation that made continued use of the entire time series (i.e., beginning 1965) untenable. It is likely that some combination of spawning stock size and environmental conditions are driving recruitment. A changepoint analysis (Killick and Eckley 2014) was applied to the recruitment and recruits/spawner time series to disentangle these effects. The analysis identified a 'changepoint' in 1992 in the recruits/spawner time series that was not identified in the recruitment time series, suggesting a shift in environmental conditions effecting recruitment happened at that time. Thus the range of years used to define BRPs was 1992–2019 (2020–2021 estimates were not used due to uncertainty, as in previous assessments). Based on this management track assessment, the Atlantic Herring (*Clupea harengus*) stock is overfished and overfishing is not occurring (Figures 11–12). Retrospective adjustments were necessary (SSB Mohn's $\rho = 0.447$ and F Mohn's $\rho = -0.21$). Spawning stock biomass (SSB) in 2021 was estimated to be $39,091$ mt which is 21% of the biomass target ($SSB_{MSY\ proxy} = 185,750$; Figure 11). The 2021 average fishing mortality for ages 7–8 (fully selected ages for the mobile fleet) was estimated to be 0.153 which is 31% of the overfishing threshold proxy ($F_{MSY\ proxy} = 0.5$; Figure 12).



Clupea harengus, Atlantic Herring.

Table 9: Catch and status table for Atlantic Herring. All weights are in mt, recruitment is in 000s, and $\bar{F}_{7:8}$ is the average fishing mortality on ages 7 to 8, which are fully selected by the mobile fleet. Model results are from the current updated ASAP assessment and the values in this table are not adjusted for the retrospective pattern.

	2014	2015	2016	2017	2018	2019	2020	2021
				Data				
US Catch	93,084	81,204	62,597	48,796	45,527	12,792	8,076	5,202
Canadian Catch	1,465	146	4,132	2,133	13,036	5,821	6,041	2,663
Total Catch	94,549	81,350	66,729	50,929	58,563	18,613	14,117	7,865
				Model Results				
SSB	292,370	228,600	145,350	105,790	65,529	53,441	51,749	56,566
$\bar{F}_{7:8}$	0.48934	0.48842	0.50347	0.53369	0.7291	0.3394	0.19665	0.1207
recruits (age-1)	1,316,100	704,910	343,530	859,750	692,800	1,571,000	863,790	2,144,500

Table 10: Comparison of reference points estimated in an earlier assessment and from the current assessment. An $F_{40\%}$ proxy was used for the overfishing threshold, and the biomass proxy reference point was based on long-term, stochastic, projections. 95% CI were reported in parentheses.

	2020	2022
$F_{MSY\ proxy}$	0.54	0.5
SSB_{MSY} (mt)	269,000 (155,699–444,290)	185,750 (91,100–355,800)
MSY (mt)	99,400 (62,644–151,814)	68,980 (37,390–120,154)
Median recruits (age-1)	3,430,614 (915,478–10,132,087)	2,820,600 (578,900–10,441,500)
Overfishing	No	No
Overfished	Yes	Yes

Projections: The short-term projections presented here differed from the previous assessment in that they assumed recruitment followed an autoregressive process (AR(1)) rather than random draws from the cumulative distribution of estimated recruitments. The paramters defining the AR process were estimated using recruitment estimates from 1992–2019 using the R package arima (R Core Team 2020). The AR process was initiated using the rho adjusted 2021 recruitment estimate (i.e., 1,483,061). The projection results included here should be considered preliminary and subject to change based on future assessment and management decisions. This example projection applied the harvest control rule described in Amendment 8 of the herring Fishery Management Plan to the mobile fleet. The fixed gear catches are assumed constant during the projection period and equaled 4,238 mt. This fixed gear catch equals the sum of the ten year (2012–2021) averages of the Canadian (4,220 mt) and US (18 mt) fixed gear catches. The US fixed gear catches are those from stop seines, weirs, and pound nets. The reported $\bar{F}_{7:8}$ are those for the mobile fleet.

Table 11: Projection results. See above and supplementary document for details.

Year	Catch (mt)	SSB (mt)	$\bar{F}_{7:8}$
2022	8,767	61,645	0.097

Year	Catch (mt)	SSB (mt)	$\bar{F}_{7:8}$
2023	16,649	79,231	0.232
2024	23,409	76,795	0.327
2025	28,181	103,645	0.313

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).

  A definitive explanation for the continued poor recruitment has not been identified. While identifying a causal mechanism for poor recruitment would be immensely beneficial, finding explanations for patterns in recruitment have been elusive in fisheries science for decades. Another uncertainty in this assessment is natural mortality. In this assessment, natural mortality was assumed constant among ages and years. Justifications for including age- or time-varying natural mortality in previous assessments have quickly deteriorated. Uncertainty in natural mortality affects the scale of abundance and fishing mortality estimates, but is unlikely to be related to the recent poor recruitments. Stock structure, particularly mixing with Nova Scotian herring, is also an uncertainty. Migration can be conflated with changes in mortality and contribute to retrospective patterns. Again, however, this is unlikely to explain recent poor recruitment.

- 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 $\bar{F}_{7:8}$ lies outside of the approximate joint confidence region for SSB and $\bar{F}_{7:8}$).

  This assessment model had a retrospective pattern that could be classified as major and required adjustments. While recent assessments have not had major retrospective patterns, these assessments also suggested that the lack of a retrospective pattern could be due to structural changes in the model (e.g., splitting the NMFS BTS survey in 2009 when the R/V Bigelow came into service; NEFSC 2018) and so the reemergence of a retrospective pattern was not suprising.

- 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?

  The projections are uncertain, especially in regards to recruitment. The lack of 2020 survey data, and the fact that neither indices of abundance or the fishery consistently harvest age-1 herring, made estimation of the most recent two years of recruitment impossible without the addition of a likelihood penalty. Without other information about recruitment, the likelihood penalty has the effect of pulling the more recent recruitment estimates (i.e., 2020 and 2021) *upwards towards the median. The upward increase in recent recruitments was partially offset in projections by applying a retrospective adjustment. Furthermore, assumptions about terminal year recruitment do not have much effect on projection results for 3 or more years because herring are 50% selected by the mobile fleet at about age-4, which causes a delay in the effect of terminal year recruitment assumptions. Just the same, recruitment is a significant uncertainty. Based on the projections done during this management track, the stock is behind the rebuilding schedule (See Framework 9 table 26). The rebuilding plan suggested the population would have a 43% chance of rebuilding by 2025, but this assessment projects only an 11% chance in that year. The rebuilding plan, however, used the full time series of recruitments when defining reference points and proejctions, which makes them more optimistic than the shortened time frame of recruitments and the AR(1) process applied in this assessment. A sensitivity using an AR(1) process was done during development of the rebuilding plan, but even those projections were more optimistic (25% chance of rebuilding in 2025) than those done during this assessment.*

- 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.

  NMFS bottom trawl indices of abundance since 2009 were calculated using tow-specific measured tow distance, instead of an assumed constant for all tows. This change had a negligible effect. The methodology used to calculate Canadian catches, age composition, and weights at age was revised, resulting in entirely new time series, but the effect on the assessment was negligible. The age composition of the NEFSC shrimp survey was previously based on an average of the NMFS spring and fall age-length keys. Three years of age data collected during this survey replaced the use of borrowed age-length keys, and this had a negligible effect on the assessment. The addition of a likelihood penalty on recruitment became necessary given the lack of information about recent cohort sizes (i.e., missing 2020 survey data). The likelihood penalty had the effect of increasing the estimates of recent recruitments toward the median level. The two most recent recruitments were still relatively poor, however, and were excluded when calculating BRPs and when estimating parameters of the AR(1) process used in short-term projections. Thus, the overall effect of the penalty on the assessment and stock status was negligible. An attempt was made to avoid using the likelihood penalty by deriving an age-1 recruitment index from seabird diet data. While an assessment that included such an index did not require a likelihood penalty, the model did not fit the index well (e.g., patterned residuals). Concerns about non-linearity between the seabird index and herring recruitment, and a lack of time to understand this novel data source, precluded its use in this assessment. An index derived from seabird diet data has promise, however, and could be persued in the future.

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

  The stock status has not changed a lot since the previous assessment.

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

  Continued poor recruitment is the main issue driving stock status. Management decisions that reduced US catches had the effect of avoiding overfishing.

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

Studies related to stock structure and movement would be beneficial, as this has been proposed as a possible explanation for retrospective patterns. While an explanation for drivers of recruitment would be beneficial, it would not directly effect the assessment, and as noted, such explanations are difficult to identify. An index of age-1 recruitment based on seabird diet data was attempted in this assessment, but was ultimately not included. This index could be especially informative because the fishery and indices based on bottom trawls do not consistently capture age-1 herring, and information on recent recruitments in this assessment was especially lacking due to the absence of 2020 bottom trawl surveys. The seabird diet data are collected by multiple entities (National Audubon Society, USFWS, University of New Brunswick, and University of New Hampshire). Collating this data and developing the index was a tremendous undertaking, only made possible by willing collaborators that collect the data and a volunteer student (Sean Hardison, University of Virginia). Continued consideration of this data would benefit from more formal and streamlined sharing agreements with NMFS.

- Are there other important issues?
  No other important issues were identified.

NOAA research vessel Henry B. Bigelow underway

4.1. Reviewer Comments: Atlantic Herring

The 2022 assessment for Atlantic herring (hereafter herring) is an operational assessment of the existing age-structured model approved at the 65th Stock Assessment Workshop in 2018. The model represents herring as a single well-mixed population occupying a region from southern Nova Scotia, Canada, throughout the Gulf of Maine, and into waters of southern New England. Herring is modeled to comprise age classes from ages-1 to age 8+. The existing model considers two fishing fleets as harvesting removals from the herring stock: a fixed gear fleet that comprises nearshore seine and weir fisheries, principally in Canadian waters, and a mobile-gear fleet that comprises mobile coastal boats that deploy gear, principally purse seines and midwater trawls. The dynamics of the population is derived from four principal fishery-independent surveys: the NEFSC spring and fall surveys, the NEFSC summer shrimp survey and an NEFSC acoustic survey conducted during the fall bottom trawl survey. A time and age invariant natural mortality rate ($M = 0.35$) was assumed. The current model was used to derive management reference points: an $F_{MSY\,proxy} = F_{40\%} = 0.54$, and a $SSB_{MSY} = 269{,}000$ mt. Based on the most recent analysis of stock status in 2020, herring is overfished ($SSB = 77{,}883$ mt; $29\% of\, SSB_{MSY}$), but is not experiencing overfishing ($F = 0.25$; $46\% F_{MSY\,proxy}$)

The 2022 assessment update for herring underwent an enhanced review (Level 3 assessment) in accord with the decision at the spring 2022 AOP. The new assessment used the same general configuration of an age structured assessment model (ASAP Version 3.0). Changes to the model configuration included updates of US catch data up to 2021 inclusive, improvements to the reliability and accuracy of the Canadian catch data, incorporation of updated fishery-independent surveys, consideration of unprecedented low levels of recruitment evident in the stock since 2013, inclusion of exploitation by the fixed-gear fleet in calculation of reference points and incorporation of an autoregressive approach to estimate future recruitments in short-term forecasts.

The Peer Review Panel (hereafter, the Panel) concluded that the 2022 assessment for Atlantic herring provides the Best Scientific Information Available as a basis for management decision making in the northeast. Herring was assessed to be overfished. Herring spawning stock biomass (SSB) in 2022 was estimated to be a retro-adjusted level $61{,}645$ mt, approximately 33% of the $SSB_{proxy} = 185{,}750$ mt. Herring was assessed not to be experiencing overfishing. The exploitation rate of the mobile fleet fishery was $F = 0.097$ approximately 19% of the $F_{40\%} = F_{MSY\,proxy} = 0.5$.

In the sections that follow, the Panel reviews information provided during the Management Track review to evaluate the extent to which each Term of Reference was met. We also offer research recommendations that we believe will improve our understanding of herring population dynamics and fisheries.

Atlantic Herring Terms of Reference

1. *Estimate catch from all sources including landings and discards.*

   The Panel concluded that the work completed fully met this TOR. The assessment included commercial catch data from 1965–2021. Commercial discard data are generally only available since 1996. These data indicate that commercial discards are generally less than 1% the commercial landings. There are no appreciable recreational fisheries for herring. Thus, for the assessment catch and commercial landings were assumed as synonymous.

The evidence presented to the Panel indicates that the catch was fully accounted for, and the age-composition of the catch was estimated comprehensively.

The Panel makes the following observations and recommendations relative to TOR 1:

- The Panel recommends that NOAA NEFSC provide more detail on the DFO Canada program for enhancing and standardizing the processing and reporting of catch data, particularly as there are several prominent fisheries that are shared between the two nations.

2. *Evaluate indices used in the assessment (e.g., indices of relative or absolute abundance, recruitment, state surveys, age-length data, etc.).*

The Panel concluded that this TOR was addressed satisfactorily. Data from four fishery-independent surveys were updated to 2021 with no surveys being conducted in 2020. The four surveys include NEFSC spring and fall trawl surveys (1965–2021), a shrimp summer bottom trawl survey (1983–2021) and an acoustic survey (1998–2021). The NEFSC spring and fall surveys were entered as six separate surveys to account for vessel and gear differences R/V Albatross (door type A), 1968–1984 spring survey and 1965–1984 fall survey; R/V Albatross (door type B), 1985–2008; R/V Bigelow 2009–2021). In these early time series of NEFSC surveys, every tow was assumed to be equivalent samples. Enhancements in net mensuration allowed the switch to an area-swept approach to index development for data after 2008.

One potential index based on seabird diet analysis was explored. However, it was not used in the final assessment model due to poor model fitting and a lack of understanding of ecological and sampling aspects of the data.

Improvements in age-composition data associated with the shrimp summer survey were a second significant improvement in the fishery-independent for the 2022 herring assessment. Prior 2019, age-composition for this survey borrowed data from the NEFSC spring and fall trawl survey and were estimated as the average of the spring and fall survey age compositions. This may introduce additional errors in the estimated age compositions because of mismatched seasons. In 2019, direct aging of summer survey catches was initiated. Clear differences exist between the estimated selectivity pattern from using the borrowed averaged survey approach and the direct aging approach.

The Panel makes the following observations and recommendations relative to TOR 2:

- The Panel concluded that the swept area-based indices are a substantial improvement in the treatment of survey data derived from the NEFSC spring and fall surveys.
- Arithmetic means were used for all survey indices. The Panel suggests exploration of model based approaches to standardizing relative abundance indices. The Panel suggests also exploration of spatio-temporal dynamics of Atlantic herring. Such approaches can also test hypotheses on changes in phenology and distributions.
- The Panel encourages NEFSC to continue the collection of direct age composition data from the summer shrimp trawl. The resulting age compositions from using direct observations are notably different from those developed from borrowed age length data, as shown in the comparison of data from 2018–2019 and 2021. The dataset may provide a good opportunity to explore ALK differences among the three surveys to model seasonal growth for the herring

stock, which may be further used for the length frequency data between 1983–1998 that were not used in the current assessment.

- The Panel remains unclear why the change from average age composition to direct age composition data had the sizeable impact on assessment results that was observed. The influence is confounded further by the influence of the missing 2020 surveys. Hypotheses and mechanisms related to this pattern are worthy of further work. One hypothesis that the Panel suggested to explore is the influence of the old length compositions from the shrimp survey. The current assessment model used the age-composition from the three most recent years with direct observations in model fitting, which may influence the stability of the model.

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*

The Panel concludes that the 2022 assessment provides a thoughtful, staged transition between the 2020 assessment and the final recommended data selections and model configurations accepted in the 2022 assessment.

Runs of the 2020 assessment with sequential improvements to reflect the adoption of area swept-based relative indices, directly estimated age composition data from the summer shrimp trawl survey and revision of Canadian catch-at-age time series suggest these improvements do not material affect assessment results. However, the model that included all three sources of improvements demonstrated pathological forensic features, including 70 parameters with high CVs (> 0.5) and strong correlations ($\sim \pm 1$) among $1,654$ parameter pairs. The panel found that the use of results from these stepwise explorations to support a conclusion that their impacts were likely small somewhat incongruous with the poor model diagnostics of the final exploratory model. The analyst suggested that the poor diagnostics were the result of missing survey data from 2020 and its impacts on the ability of the model to estimate recruitment in 2020 and 2021. The Panel discussed the impacts of the missing survey data for 2020, expressing surprise that a single missing year of data could have such impacts on model fit.

Efforts to resolve the deficiencies in the exploratory models focused on improving recruitment estimates. The Panel found one approach that used indices of nest provisioning of seabirds, mostly terns, worthy of continued exploration, but insufficient for use at this time. The Panel found a second approach of including a penalty on deviations in estimated recruitments from the median value was more satisfactory. Model results indicated much improved model diagnostics, with substantially lower CVs and few strong correlations among parameter pairs. Although the model with penalized recruitments did improve a range of diagnostics related to parameter uncertainty, the model still demonstrated strong retrospective patterns of a magnitude that required post-model adjustments. The Panel concluded that despite the presence of retrospective patterns, this model represents an appropriate basis for management decisions.

A 'Plan B' assessment was prepared but unnecessary because the current ASAP assessment model was accepted; however we appreciated having the option of a failsafe approach had the principal approach using ASAP not been successful.

The Panel makes the following observations and recommendations relative to TOR 3:

- The Panel inquired whether parameter estimates reaching bounds of parameter space may account for some of the poor model performance in early runs. Answers suggested this may be the case in some model configurations.
- The Panel is unclear on why the presence of missing survey data for 2020 had such a sizeable impact on fits of early model runs, yet these effects were dampened by the addition of recruitment deviation penalties. The Panel was also unclear how missing data in 2020 seemed to have an impact on the model estimate of recruitment in 2021, given that these data do not provide any information on the size of the 2021 year class. To what extent do we understand the characteristics of input data sets that lead to the apparent stability in ASAP model outputs? Simulations designed to explore the parameter space more fully; e.g., runs with stronger and or weaker recruitment penalties, may help enhance understanding.
- Inclusion of a recruitment deviation penalty was novel for herring, but common in assessments for many other species in the region. The Panel suggested systematic exploration of the role of recruitment penalties in the performance over the range of species assessments that employ them.
- The Panel also recommended monitoring of the impact that missing data from 2020 has on other assessments in the region to understand better the impacts and potential remedies that missing data may have on the estimation of parameters in the assessment model.
- The Panel expressed interest in promoting the development of a unified approach to representing natural mortality (M) in the assessment model. Over different iterations of the herring assessment, M has been represented as age- and time-invariant, age-dependent, or tuned to predator demand. This approach suggests the form and level of M has been selected as a way of resolving poor model fits. The Panel recommends a more systematic and foundational approach to modeling mortality in a key forage species.

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.).*

   The Panel concluded that this TOR was satisfactorily addressed.

   The Panel accepted the change point analysis that identified distinct phases in recruit-per-spawner time series, specifically the identification of a final 1992–2021 period.

   The Panel also accepted the use of a fixed F for the fixed gear fleet in projections to account for Canadian catches, which are not under management control of the NEFMC but do nevertheless affect estimation of stock productivity.

The Panel accepted the biological reference points of: $F_{MSY\,proxy} = F_{40\%} = 0.5$ and $SSB_{proxy} = 185,750$ mt.

Applying the required retrospective corrections, the revised biological reference points indicate that herring is overfished, but is not experiencing overfishing.

The Panel makes the following observations and recommendations relative to TOR 4:

- The Panel would have felt more confidence in the identification of these distinct phases in the recruit-per-spawner (R/S) time series had there been causal hypotheses explaining the patterns.
- Improvements in estimation of reproductive status and condition of herring over time would improve our understanding of the patterns observed in recruits-per-spawner.

5. *Conduct short-term stock projections when appropriate.*

   The Panel concluded that this TOR was met.

   Short-term projections of herring were conducted under two scenarios. In one scenario, the method used for projections in earlier assessments was applied. In a second scenario, and the one accepted by the Panel, an autoregressive model of rank 1 was fit to the recent recruitments as a foundation to project future recruitments.

   The projections accepted as the Best Scientific Information Available are given in Table 11.

   The Panel noted that these projections suggest that in 2025, herring will have a 10.5% chance of attaining their rebuilding biomass; a lower than expected probability estimated in the current rebuilding plan.

6. *Respond to any review panel comments or SSC concerns from the most recent prior research or management track assessment.*

   The Panel commends the assessment team for addressing two key research recommendations from the 2020 assessment: Accounting for fishing mortality from the fixed-gear fleet in calculating reference points, and refine and consider autoregressive models for short-term projections.

   Recommendations remaining from previous assessment reviews that the Panel believe have merit include:

   - Further research on the use of acoustic technology for inclusion in stock assessment
   - Evaluate data collected in a study fleet program for informing assessment data that may include information on the distribution of herring in the water column
   - Evaluate the ability of state space models to estimate reliably observation and process error variances under a range of scenarios.

   The Panel offers these additional recommendations.

   - Work to understand the protocols used by DFO Canada to modify their landings and develop ALKs for their fixed gear fishery.
   - Improve our understanding of fleet dynamics of the herring fishery and how it might be related to changes in the spatial dynamics of the herring population.

- Although there is no evidence suggesting that the herring is moving out of the survey area, possible directional change in phenology of Atlantic herring (e.g., movement, growth and maturation) may introduce additional errors in survey abundance indices and biological data, giving the relatively fixed survey schedule. Further research may be needed to evaluate the impacts of changes in phenology on the Atlantic herring stock assessment modeling. Developing model-based abundance indices may also be useful to remove possible uncertainty in survey indices introduced by the directional changes in the environments.
- Further research might be needed to evaluate how the missing year 2020 survey might impact the assessment outcome and why the model performance deteriorated so much while the assessment outcome was still relatively stable. Was this related to the built-in constraints for parameters and model structure (e.g., survey selectivity) in the ASAP? The Panel recommends a systematic exploration of the role of recruitment penalties in the performance of the range of species assessments that employ them.
- A change-point analysis was conducted for the recruits-per-spawner (R/S) values to identify different stanzas for stock productivity. The R/S was used, instead of recruitment alone, for isolating the influence of environmental drivers on the stock productivity. The latest R/S stanza was then used in the long-term projection to estimate SSB_{MSY}. This approach is appropriate for a pelagic species such as Atlantic herring that tend to be sensitive to changes in its environment. More research needs to be done to continue developing such a 'dynamic reference points' approach. The assessment team may also consider the SSB level in the projection since the change point analysis is based on R/S not R.
- Further research is needed to analyze herring condition and growth data collected by the Maine Department of Marine Resources to understand temporal changes in Atlantic herring fecundity and condition better.
- Further research is needed to continue development of recruitment indices based on seabird diet data.
- Major sources of natural mortality and their temporal changes need to be carefully evaluated and quantified, and should be incorporated in the stock assessment in a systematic way, instead of using them in an ad hoc way to address issues arising in model diagnostics.

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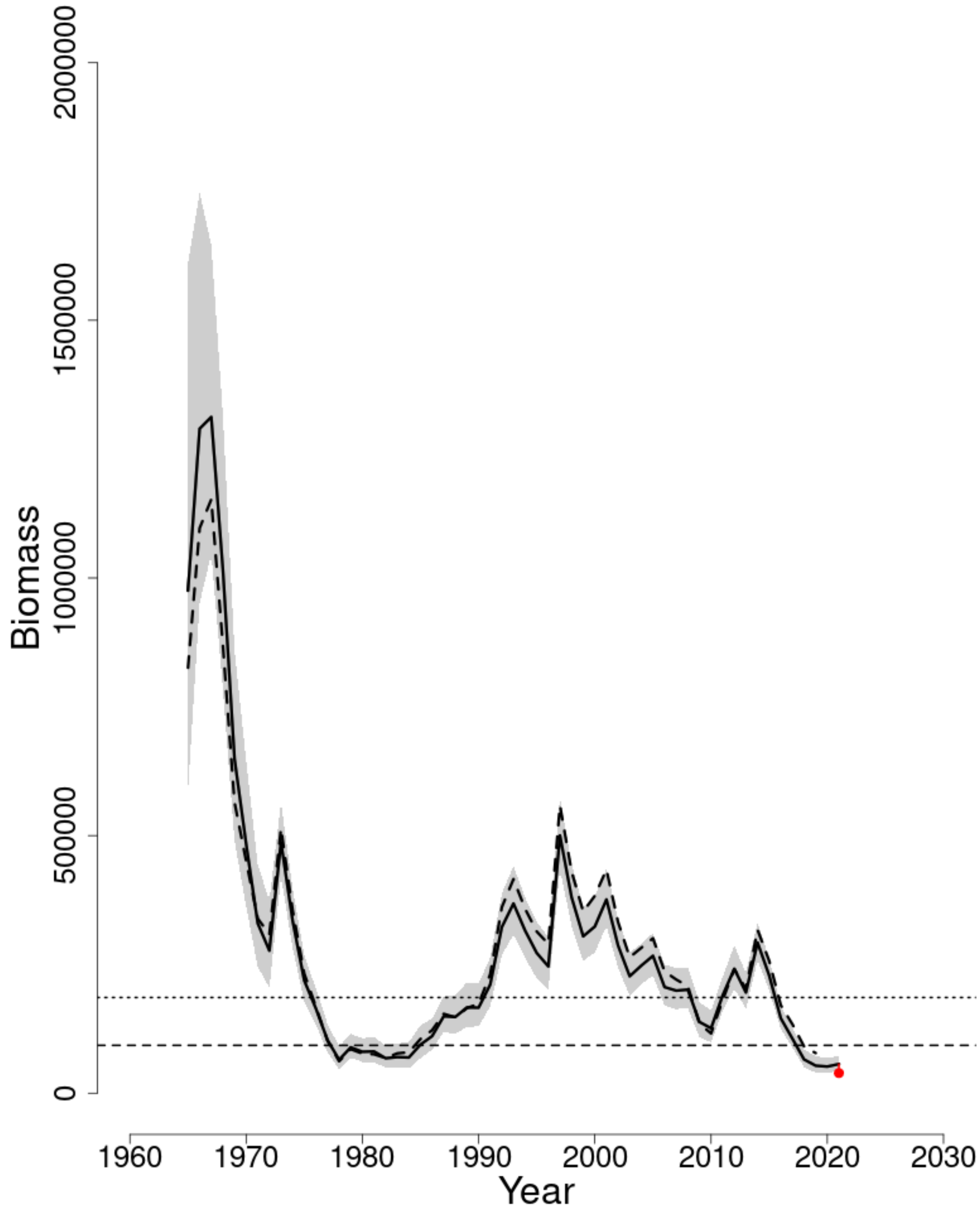


Figure 11: Trends in spawning stock biomass of Atlantic Herring between 1965 and 2021 from the current (solid line) and previous (dashed line) assessment and the corresponding $SSB_{\text{Threshold}}$ ($\frac{1}{2}SSB_{MSY\ proxy}$; horizontal dashed line) as well as SSB_{Target} ($SSB_{MSY\ proxy}$; horizontal dotted line) based on the 2022 assessment. The approximate 90% confidence intervals are shown.

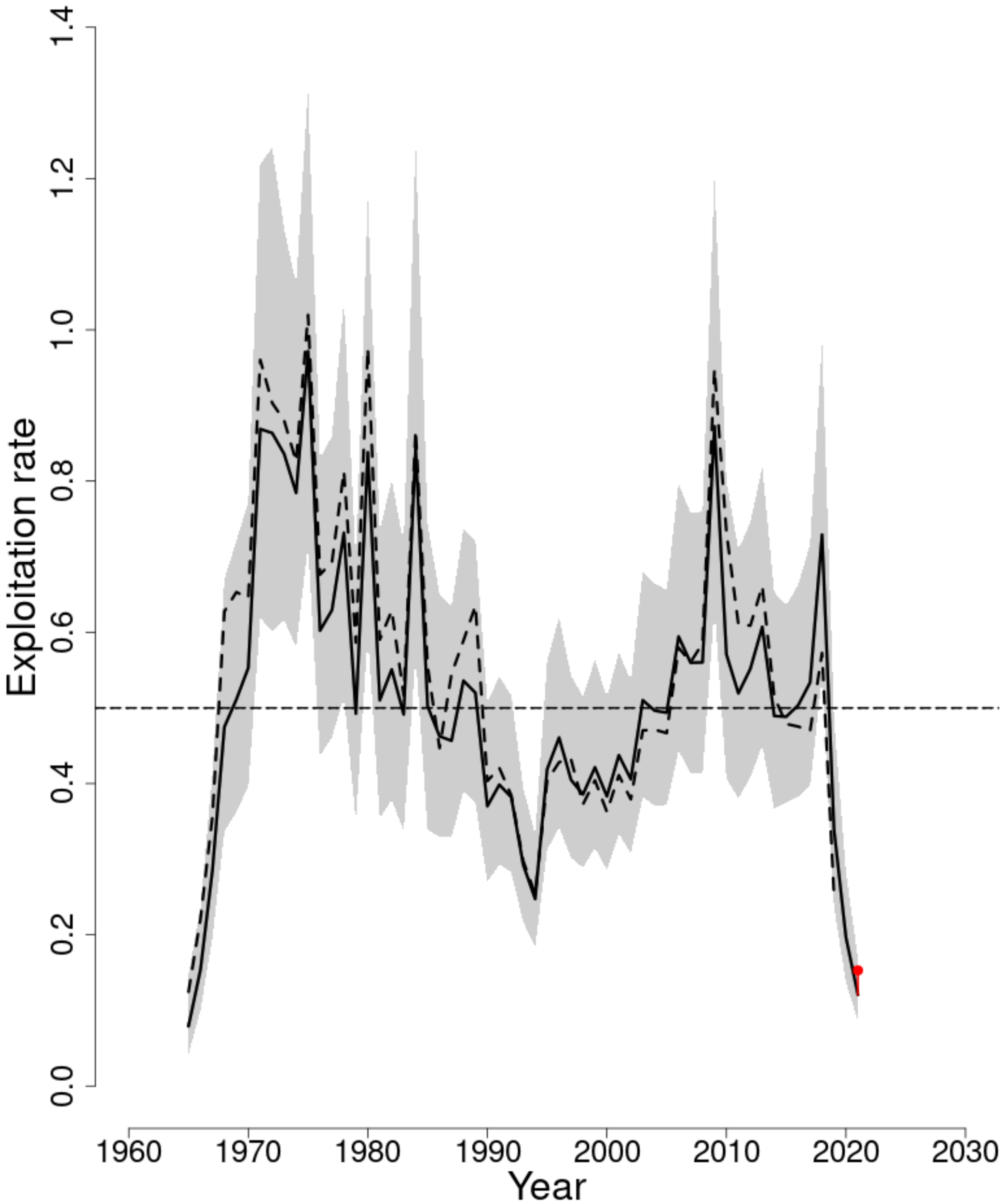


Figure 12: Trends in the average fishing mortality rate for ages 7–8, which are fully selected by the mobile fleet ($\bar{F}_{7:8}$), between 1965 and 2021 from the current (solid line) and previous (dashed line) assessment and the corresponding $F_{\text{Threshold}}$ ($F_{MSY\ proxy} = 0.5$; horizontal dashed line). The approximate 90% confidence intervals are shown.

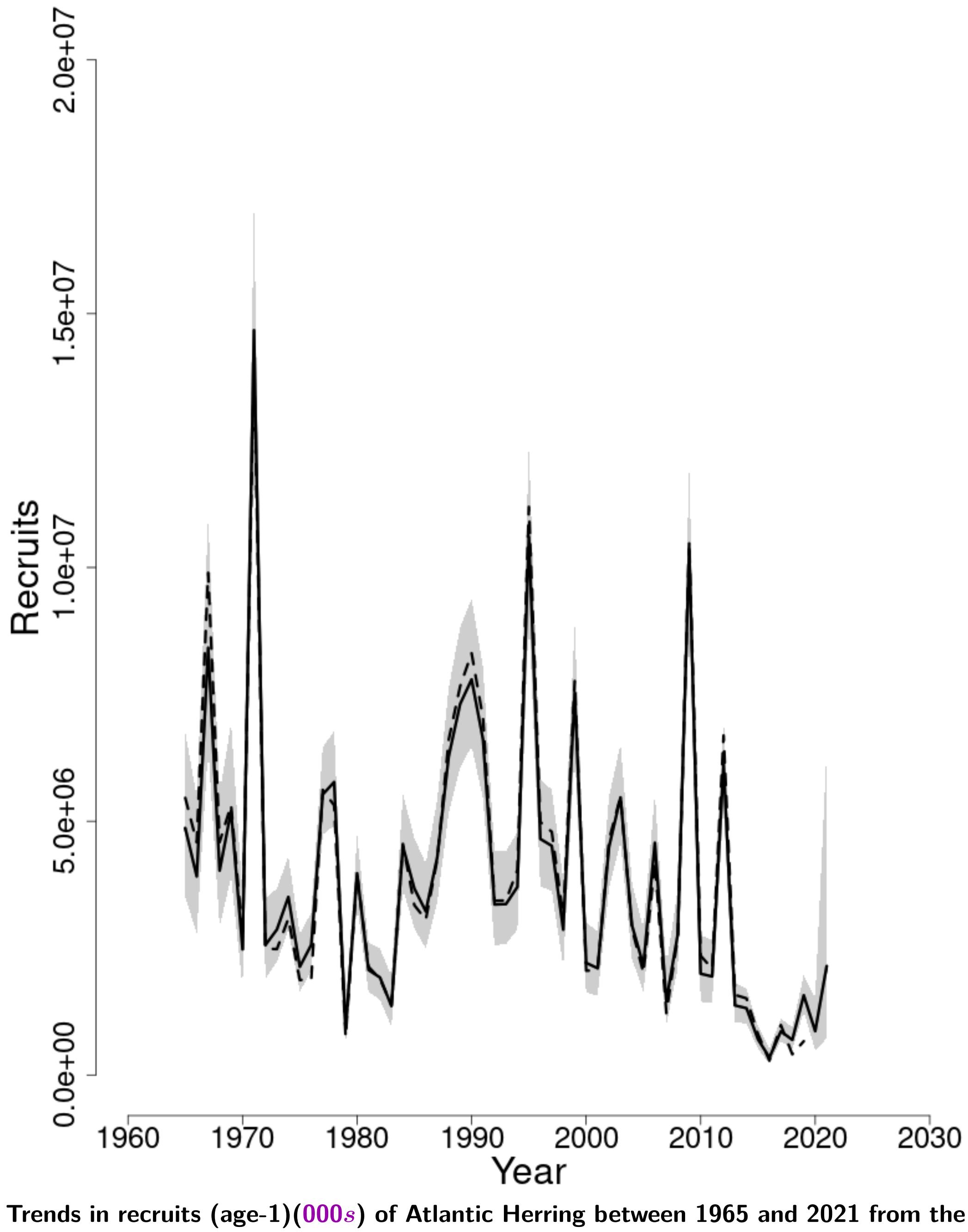


Figure 13: Trends in recruits (age-1)(000s) of Atlantic Herring between 1965 and 2021 from the current (solid line) and previous (dashed line) assessment. The approximate 90% confidence intervals are shown.

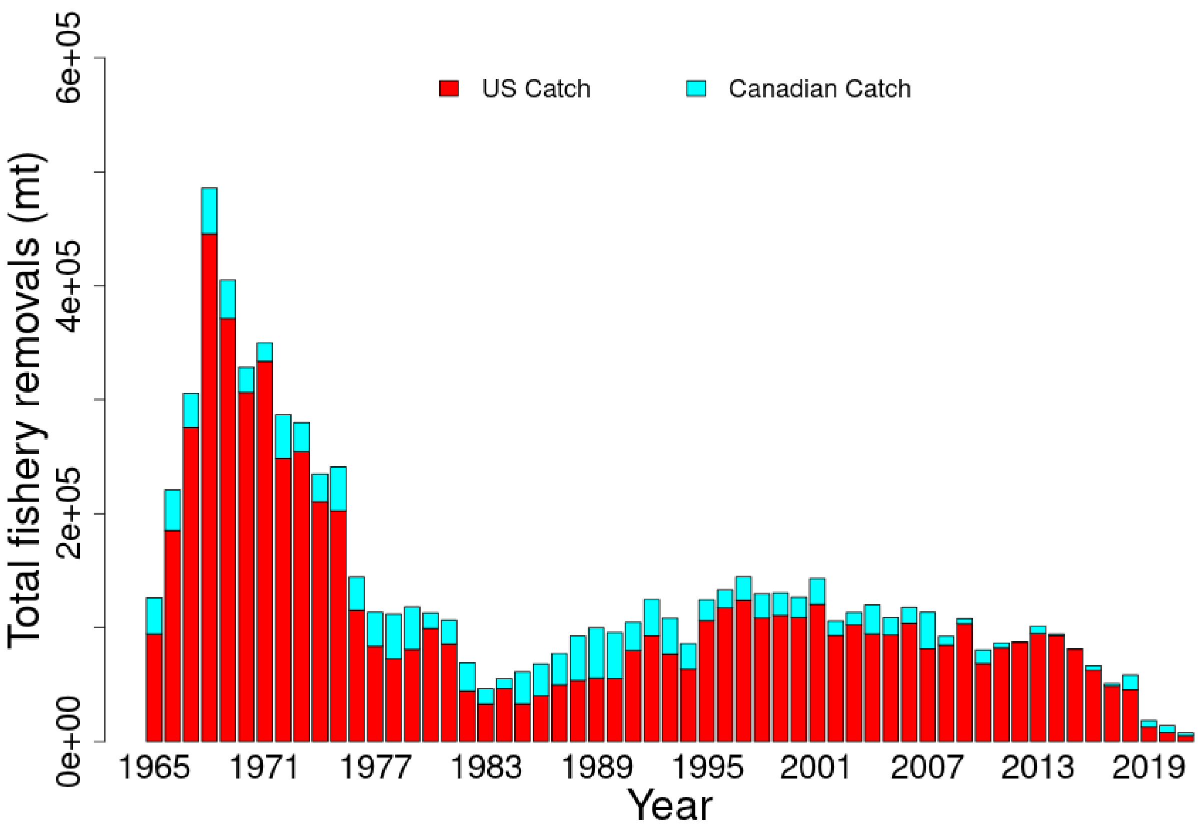


Figure 14: Total catch of Atlantic Herring between 1965 and 2021 by US and Canadian fleets.

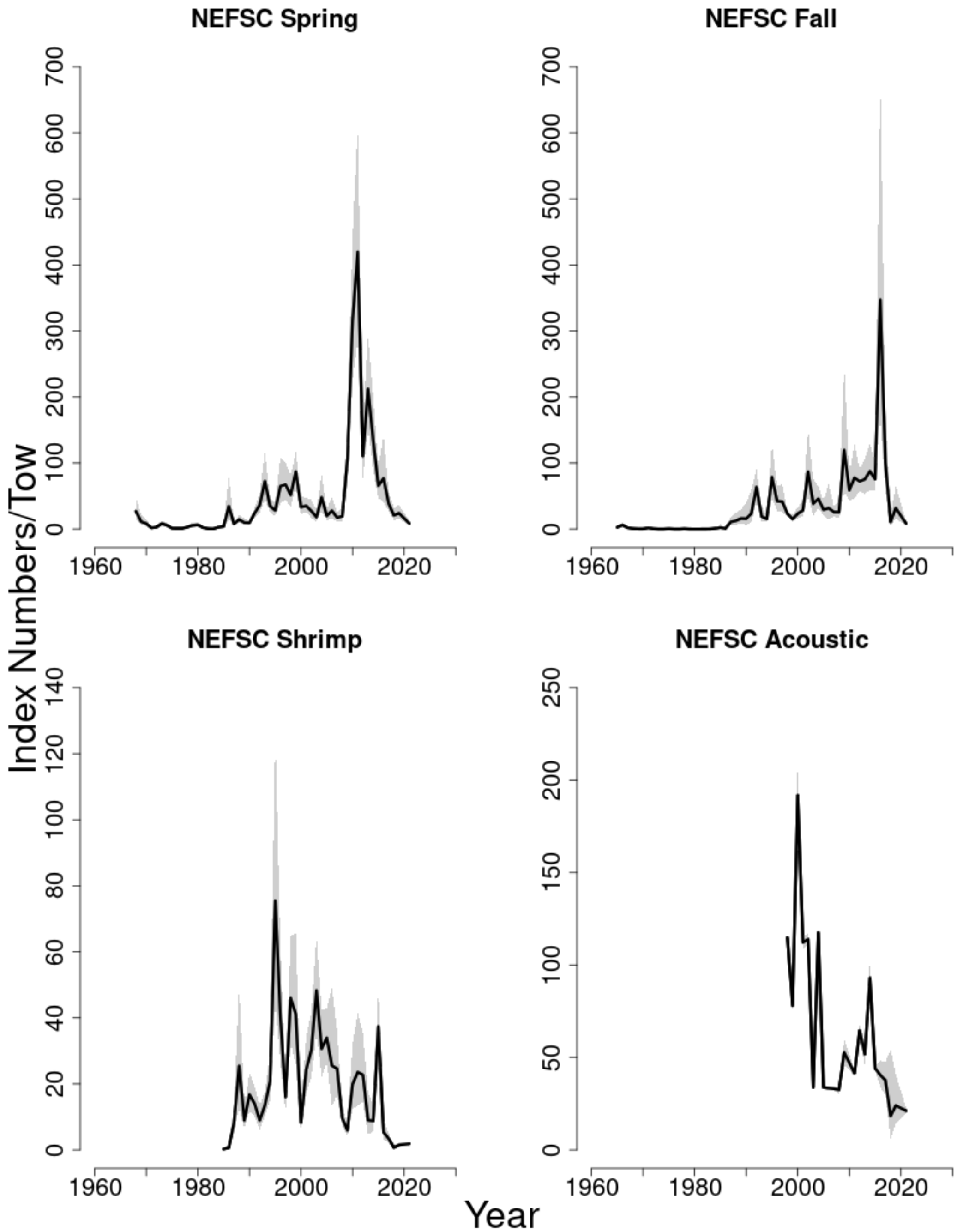


Figure 15: Indices of abundance for Atlantic Herring between 1965 and 2021 for the Northeast Fisheries Science Center (NEFSC) spring, fall, and shrimp bottom trawl surveys. The NEFSC acoustic index is collected during the fall bottom trawl survey and is in units of acoustic backscatter, not absolute numbers. The approximate 90% confidence intervals are shown.

5. NORTHERN SHORTFIN SQUID

Lisa Hendrickson

This Level 1 report of northern shortfin squid (Illex illecebrosus) is a data update of the data presented in the 2021 Research Track Assessment (RTA). The RTA methods were not accepted for management and the Assessment Oversight Panel (AOP) decided the proposed alternative assessment method presented at the February 2022 AOP meeting would not be useful for management either. This report updates commercial fishery catch data and survey indices (Table 12, Figure 16), through 2021 (Figure 17).

State of Stock: The stock status for northern shortfin squid (*Illex illecebrosus*) is unknown and unknown. Stock status could not be determined because there are no reference points for the stock and no accepted methods for the estimation of fishing mortality rates and biomass.

Table 12: Catch and biomass assessment results for northern shortfin squid. All weights are in (mt). SA 5+6 Int. represents International fleet landings from SA 5+6.

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
SA 5+6 Landings	18,797	11,709	3,792	8,767	2,422	6,684	22,516	24,117	27,164	28,447	30,886
SA 5+6 Int. Landings	0	0	0	0	0	0	0	0	0	0	0
SA 3+4 Landings	126	47	27	21	14	152	365	1,545	2,914	3,099	11,455
SA 5+6 Discards	690	502	315	575	451	320	855	1,407	1,331	1,365	535
Total catch	19,613	12,258	4,134	9,363	2,887	7,156	23,736	27,069	31,409	32,911	42,876

Table 13: Reference points are not available for northern shortfin squid.

	2021	2022
$F_{MSY\ proxy}$	*NA*	*NA*
$B_{MSY\ proxy}$	*NA*	*NA*
MSY (mt)	*NA*	*NA*
Overfishing	Unknown	Unknown
Overfished	Unknown	Unknown

Projections: Stock size projections for this species were not possible due to the lack of an assessment model.

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).
  There is no accepted stock assessment for northern shortfin squid.

- 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}
  Not applicable.

- 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 anaytical model from which to do so. The stock is not subject to a rebuilding plan.

- 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.
  There is no accepted stock assessment for northern shortfin squid.

- If the stock status has changed a lot since the previous assessment, explain why this occurred.
  There has been no change in the stock status of northern shortfin squid.

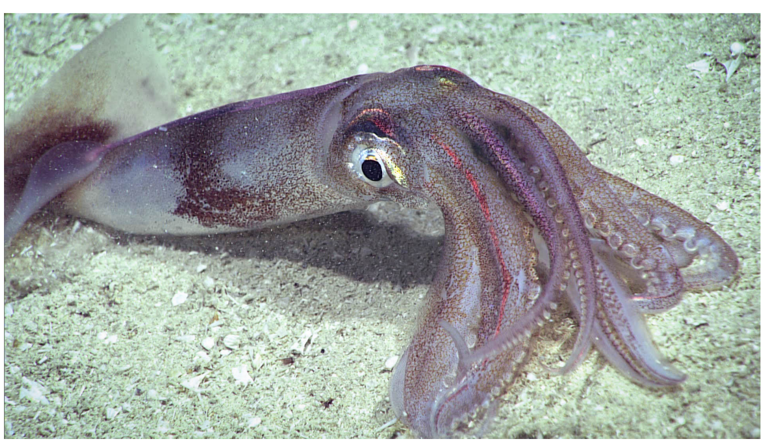
- Provide qualitative statements describing the condition of the stock that relate to stock status.
  Please see the SASINF data portal entry for the northern shortfin squid RTA in 2022.

- Indicate what data or studies are currently lacking and which would be needed most to improve this stock assessment in the future.
  Please see the SASINF data portal entry for the northern shortfin squid RTA in 2022.

- Are there other important issues?
  Please see the SASINF data portal entry for the northern shortfin squid RTA in 2022.

5.1. Reviewer Comments: Northern shortfin squid

Northern shortfin squid was not peer reviewed in 2022.



Illex illecebrosus, Northern Shortfin Squid.

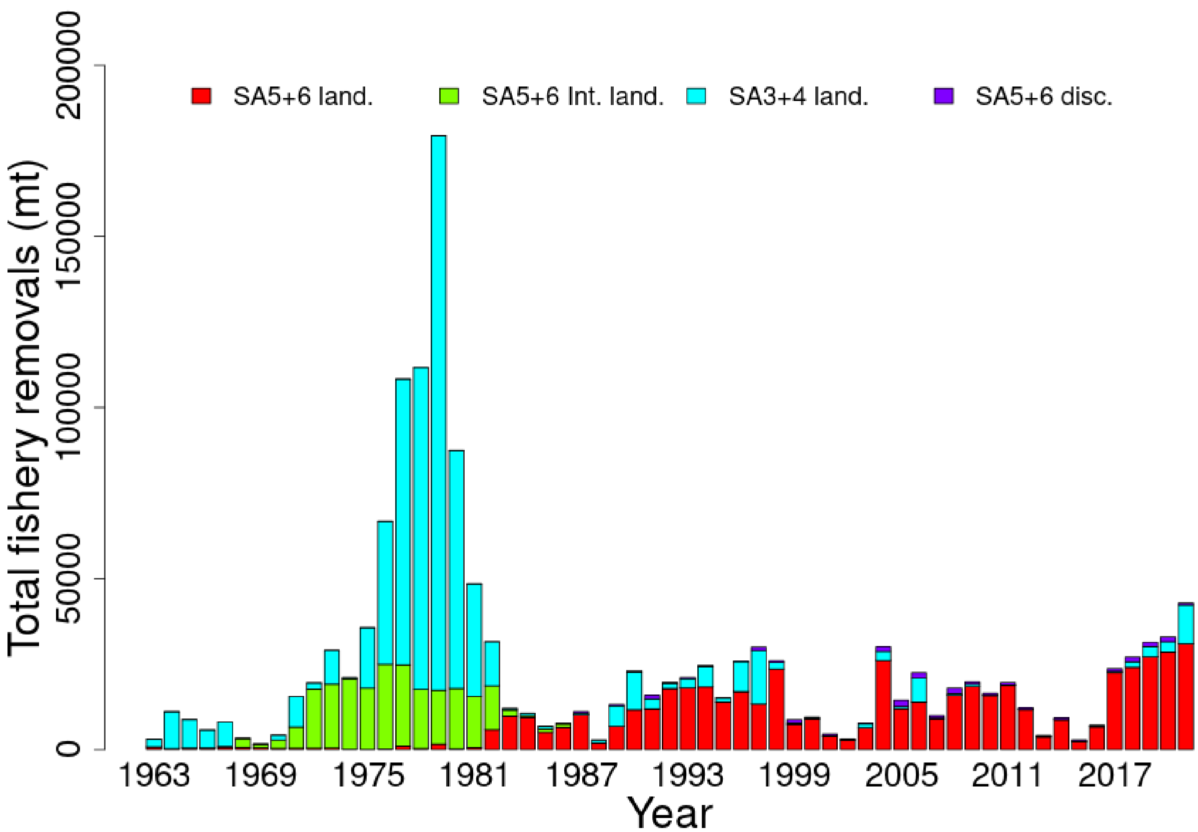


Figure 16: SA 5+6 northern shortfin squid landings (mt) from the international (1964–1986) and domestic (1963–2021) fleets and discards (mt) from the domestic fleet (1987–2021) and SA 3+4 landings (mt) (1963–2021). Domestic fishery closures occurred during 1998, 2004 and 2017–2021 when the quota buffer (a percentage of the TAC defined by regulations to avoid exceeding the quota) was projected to be harvested.

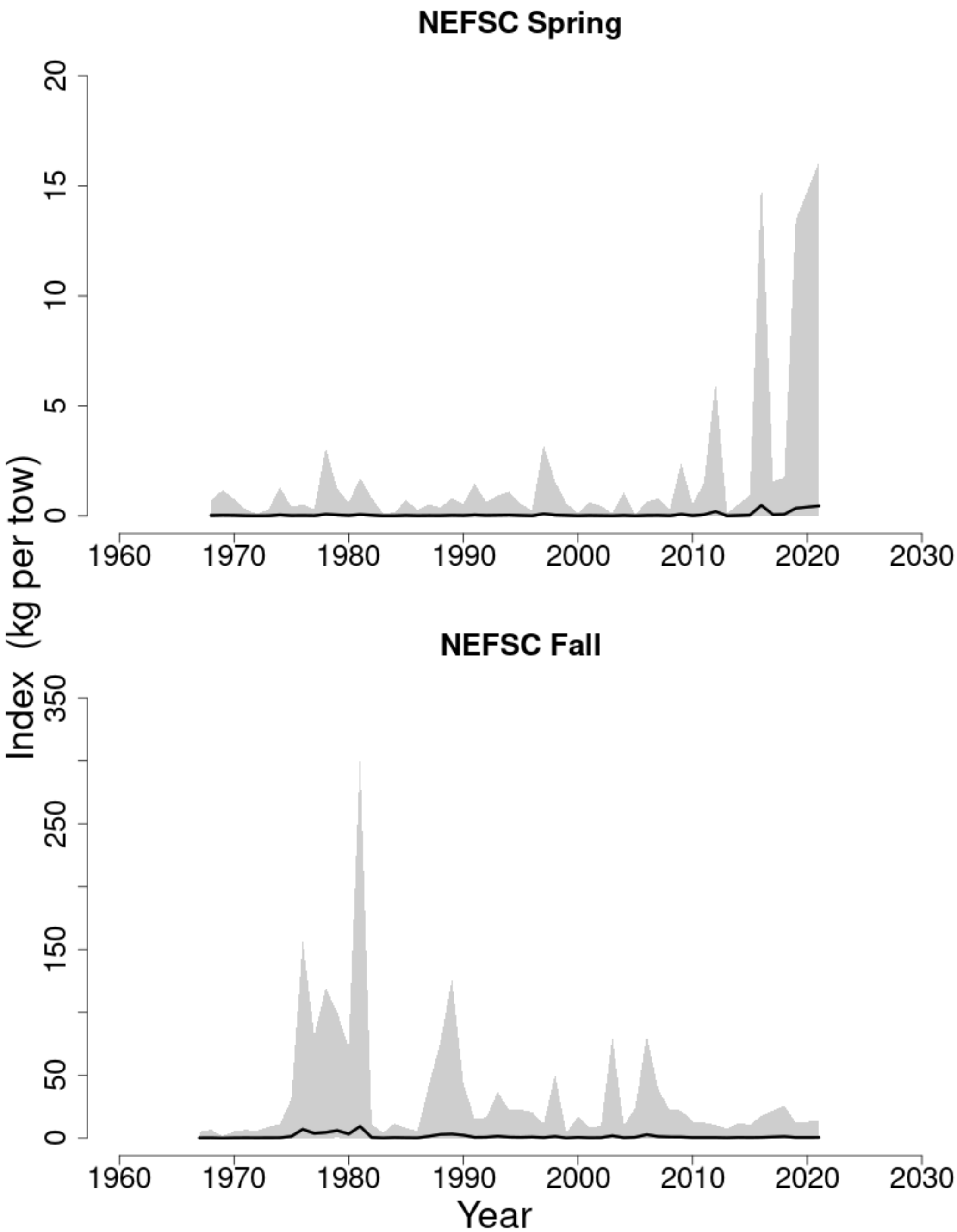


Figure 17: relative biomass indices (standardized stratified mean kg/tow), and 80%log-normal confidence intervals, derived from delta-transformed catch data from the NEFSC spring and fall bottom trawl surveys (offshore strata 1–40 and 61–76) conducted during 1968–2021 and 1967–2021, respectively. Biomass indices for 2009 onward were converted from F/V Henry B. Bigelow to R/V Albatross IV units using the *I. illecebrosus* combined-season conversion factor. Uncertainty from 2009 onward account for the variance associated with the F/V Henry B. Bigelow conversion factors.

Photo Gallery

Here we provide descriptive text for the photographs and artwork that are scattered throughout the preceding pages.

NOAA research vessel Henry B. Bigelow, named after Henry Bryant Bigelow (1879–1967), oceanographer and marine biologist. Photo from NOAA website. On page 49

The reason behind it all: seafood display case at a local supermarket. Photo NOAA. On page ii

Fresh seafood on ice, ready for sale. Credit: Shutterstock. On page 65

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 vi

Clupea harengus, commonly known as Atlantic Herring, Herring, Sea herring, Sild, Common herring, Labrador herring, Sardine, Sperling; range: New England/Mid-Atlantic. Artwork from NOAA website. On page 45

Peprilus triacanthus, commonly known as Butterfish, American butterfish, Atlantic butterfish, Dollarfish, Shiner, Skipjack, Sheepshead, Harvestfish; range: New England/Mid-Atlantic. Artwork from NOAA website. On page 25

Illex illecebrosus, commonly known as Shortfin squid, Illex squid, Summer squid; range: New England/Mid-Atlantic. Image courtesy of the NOAA Office of Ocean Exploration and Research, Gulf of Mexico 2018; website. On page 62

Pseudopleuronectes americanus, commonly known as Winter Flounder, Flounder, Sole, Lemon sole, Georges Bank flounder, Blackback flounder; range: New England/Mid-Atlantic, Southeast. Artwork from NOAA website. On pages 35

Fresh seafood on ice, ready for sale. Photo credit: Shutterstock.

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