Northeast Fisheries Science Center Reference Document 22-09

Management Track Assessments Completed in Spring 2020

April 2022

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Management Track Assessments Completed in Spring 2020

Northeast Fisheries Science Center[1]

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US DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Northeast Fisheries Science Center
Woods Hole, Massachusetts

April 2022

Northeast Fisheries Science Center (NEFSC) Reference Documents

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TABLE OF CONTENTS

Page

LISTS

List of Tables . . . ii

List of Figures . . . iii

GLOSSARIES

Abbreviations and Acronyms . . . iv

Abbreviations for fish stocks reviewed . . . vi

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

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

DOCUMENT CONTENTS

2020 Management Track Peer Review Panel Report . . . 1

Executive Summary . . . 1

Peer Review Panel Report . . . 2

Recommendations for Future Management Track Reviews . . . 3

Peer review meeting attendees . . . 3

Butterfish . . . 5

Reviewer Comments: Butterfish . . . 8

Longfin inshore squid . . . 17

Reviewer Comments: Longfin inshore squid . . . 22

Atlantic Herring . . . 30

Reviewer Comments: Atlantic Herring . . . 34

Ocean quahog . . . 43

Reviewer Comments: Ocean quahog . . . 46

Atlantic surfclam . . . 52

Reviewer Comments: Atlantic surfclam . . . 57

Photo Gallery . . . 66

List of Tables

1 Catch and status table for butterfish 5
2 Estimated reference points for butterfish 5
3 Short term projections for butterfish 6
4 Catch and status table for longfin inshore squid 17
5 Estimated reference points for longfin inshore squid 18
6 Catch and status table for Atlantic Herring 31
7 Estimated reference points for Atlantic Herring 31
8 Short term projections for Atlantic Herring 32
9 Catch and status table for ocean quahog 43
10 Estimated reference points for ocean quahog 44
11 Short term projections for ocean quahog 44
12 Catch and status table for Atlantic surfclam 52
13 Estimated reference points for Atlantic surfclam 53
14 Short term projections for Atlantic surfclam 53

List of Figures

1 Estimated trends in biomass for butterfish . . . 12
2 Estimated trends in fishing mortality for butterfish . . . 13
3 Trends in estimated recruitment for butterfish . . . 14
4 Total catch of butterfish . . . 15
5 Indices of abundance for butterfish . . . 16
6 Estimated trends in biomass for longfin inshore squid . . . 26
7 Estimated trends in fishing mortality for longfin inshore squid . . . 27
8 Total catch of longfin inshore squid . . . 28
9 Indices of abundance for longfin inshore squid . . . 29
10 Estimated trends in biomass for Atlantic Herring . . . 38
11 Estimated trends in fishing mortality for Atlantic Herring . . . 39
12 Trends in estimated recruitment for Atlantic Herring . . . 40
13 Total catch of Atlantic Herring . . . 41
14 Indices of abundance for Atlantic Herring . . . 42
15 Estimated trends in biomass for ocean quahog . . . 47
16 Estimated trends in fishing mortality for ocean quahog . . . 48
17 Trends in estimated recruitment for ocean quahog . . . 49
18 Total catch of ocean quahog . . . 50
19 Indices of abundance for ocean quahog . . . 51
20 Estimated trends in biomass for Atlantic surfclam . . . 61
21 Estimated trends in fishing mortality for Atlantic surfclam . . . 62
22 Trends in estimated recruitment for Atlantic surfclam . . . 63
23 Total catch of Atlantic surfclam . . . 64
24 Indices of abundance for Atlantic surfclam . . . 65

Abbreviations and Acronyms

AOP Assessment Oversight Panel 1, 2, 17, 19, 22, 34, 57

CRD Center Research Document LXXIX

CSE Council of Science Editors LXXIX

Henry B. Bigelow Research vessel NOAAS Henry B. Bigelow, with specialised trawling net mechanisms; commissioned July 2007, used for surveys 2009–2019 6, 11, 66

ICES International Council for the Exploration of the Sea (European Union) 25

ISO International Organization for Standardization iii, LXXIX

MA DMF Massachusetts Division of Marine Fisheries 4

MAFMC Mid-Atlantic Fisheries Management Council 3, 4, 17

NEAMAP Northeast Area Monitoring and Assessment Program 7, 8, 16

NEFMC New England Fisheries Management Council 3, 4

NEFSC Northeast Fisheries Science Centre III, 2, 5–8, 11, 16–21, 23, 25, 27, 29, 30, 33, 34, 37, 42, 43, 45, 51, 52, 54, 57, 65, LXXIX, LXXX

NJDEP New Jersey Department of Environmental Protection 3

NMFS National Marine Fisheries Service LXXX

NOAA National Oceanographic and Atmospheric Administration iii, v, 1, 3, 4, 66, LXXX

NOAAS NOAA ship or fishing vessel iii, 11, 66

OA Operational Assessment, biennial 55

PDF Portable Document Format, ISO 32000 III

PRP Peer Review Panel 2, 3, 8–10, 22–24, 34, 36, 57–59

SARC Stock Assessment Review Committee 25

SASINF Stock Assessment Support Information 44, 45, 53–55

SAW 34 34th Stock Assessment Workshop, 2002: loligo squid, winter flounder, monkfish 25

SAW 51 51st Stock Assessment Workshop, 2011: offshore hake, red hake, silver hake, loligo squid 25

SAW 58 58th Stock Assessment Workshop, 2014: butterfish, tilefish, northern shrimp 11

SAW 61 61st Stock Assessment Workshop, 2016–17: Atlantic surfclam 58–60

SAW 63 63rd Stock Assessment Workshop, 2017: ocean quahog 46

SAW 65 65th Stock Assessment Workshop, 2018: sea scallop, Atlantic herring 34, 37

SMAST School for Marine Science and Technology (New Bedford, Maine) 4

SSC Scientific and Statistical Committee 2, 9, 17, 23, 36, 59

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

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.

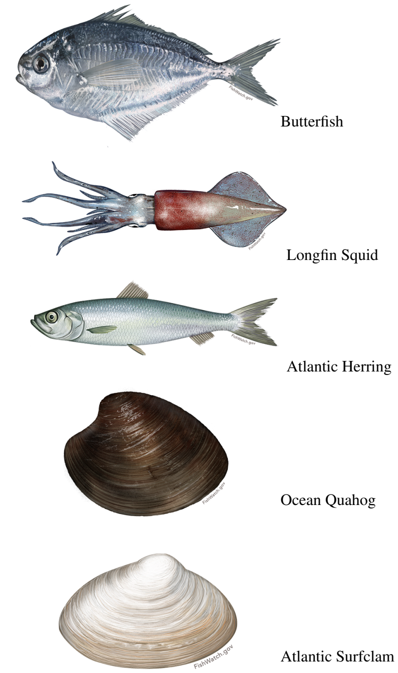
BUTUNIT Butterfish v, 5–16

DORYUNIT Longfin Squid from the New England/ Mid-Atlantic and the Southeast v, 17–29

HERUNIT Atlantic Herring v, 30–42

OQUNIT Ocean quahog v, 43–51

SCUNIT Atlantic surfclam v, 52–65



Images from NOAA Fisheries and FishWatch.gov.

The reason behind it all.

Statistical/review concepts, parameters, etc.

ASAP Age-Structured Assessment Program, software developed using the commercial package AD Model Builder for optimization 5–9, 30, 31, 34, 35

$\boldsymbol{B}$ biomass 1, 9, 59

$\boldsymbol{B_{MSY\,proxy}}$ proxy estimate for biomass maximum sustainable yield 17, 19, 20

BRP biological reference point 34

BRPs biological reference points 2, 9, 23, 34, 35, 58

BSIA Best Scientific Information Available 2, 8, 22, 34, 57

$\boldsymbol{B_{\text{Target}}}$ theoretically ideal biomass 1, 58

$\boldsymbol{B_{\text{Threshold}}}$ threshold for biomass that indicates overfished status 1, 9, 20, 58, 59

cdf cumulative distribution function 36

CI confidence interval 17

CV coefficient of variation 6, 32

DAH Domestic Annual Harvest 9

$\boldsymbol{F}$ (instantaneous) fishing mortality rate 1, 6, 9, 18, 22, 32, 35, 36, 44, 45, 48, 53–55, 58, 59, 62

$\boldsymbol{\bar{F}_{7-8}}$ average fishing mortality for fish aged 7 to 8 years 31, 32, 39

$\boldsymbol{F_{\text{Full}}}$ fishing mortality on fully selected ages 5, 6, 13, 19, 43–45, 48, 54, 62

$\boldsymbol{F_{MSY}}$ fishing mortality for maximum sustainable yield 10, 43, 52, 55

$\boldsymbol{F_{MSY\,proxy}}$ proxy estimate of fishing rate for maximum sustainable yield 1, 5–7, 9, 13, 17, 30, 31, 35, 39, 43, 44, 48, 52, 53, 62

$\boldsymbol{\frac{F}{F_{\text{Threshold}}}}$ ratio of F to its threshold value 48, 52, 53, 62

$\boldsymbol{F_{\text{Threshold}}}$ threshold fishing mortality level that indicates overfishing status 1, 9, 13, 39, 48, 58, 59, 62

$\boldsymbol{F_{40\%}}$ fishing rate at 40% of the total catch 31, 35, 36

kg kilograms 51, 65

log-normal probability distribution whose logarithm is normally distributed 11, 13, 14, 16, 29, 46, 48, 49, 51, 60, 62, 63, 65

LPUE landing per unit effort 59

$\boldsymbol{M}$ (instantaneous) natural mortality rate 1, 5–7, 9, 10, 36, 60

MCD Marine Conservation District 51, 54, 65

MCMC Markov Chain Monte Carlo analysis 59

000s thousands 31, 40

ρ Mohn's rho parameter: the average relative bias of retrospective estimates 45, 54

MSP maximum spawning potential 21

MSY maximum sustainable yield 5, 17, 31, 35, 43

mt metric ton 1, 5–7, 9, 17, 19, 20, 25, 29–32, 34–36, 43, 44, 52, 53

NA not applicable 16, 17

OFL overfishing limit 44, 53

q catchability coefficient 6, 17, 25, 29

RD research data 51, 65

R annual recruitment value 49, 63

R/R_0 ratio of recruitment over unfished equilibrium recruitment 49, 52, 63

SS Stock Synthesis 43, 52

SSB spawning stock biomass 1, 5–7, 9, 19, 30, 32, 35, 36, 43–46, 52–54, 60

SSB_{MSY} spawning stock biomass consistent with maximum sustainable yield 1, 5, 31, 35, 43, 52

$SSB_{MSY\,proxy}$ proxy value for spawning stock biomass estimation for maximum sustainable yield 5, 7, 9, 11, 30, 35, 37, 43, 46, 52, 60

$\frac{SSB}{SSB_{\text{Threshold}}}$ ratio of spawning stock biomass to spawning stock biomass threshold 46, 52, 60

SSB_{Target} theoretically ideal spawning stock biomass level 11, 37, 46, 60

$SSB_{\text{Threshold}}$ threshold for spawning stock biomass that indicates overfished status 7, 9, 11, 35, 37, 46, 60

$SSB_{40\%}$ the approximate equilibrium spawning stock biomass that results from fishing at forty percent of maximum sustainable yield 36

TOR Term of Reference 3, 8, 9, 22, 23, 34–36, 57–59

Von Bertalanffy K parameter in von Bertalanffy model growth function 55

VTR Vessel Trip Report 21

Locations/regions: state, country, etc.

CA Canada viii

CC Connecticut viii

GB Georges Bank viii

GOM Gulf of Maine viii

MA Massachusetts III, viii, 57, LXXX

MAB Mid-Atlantic Bight viii

ME Maine viii

NE Northeast LXXX

NH New Hampshire viii

NJ New Jersey viii

NY New York State viii

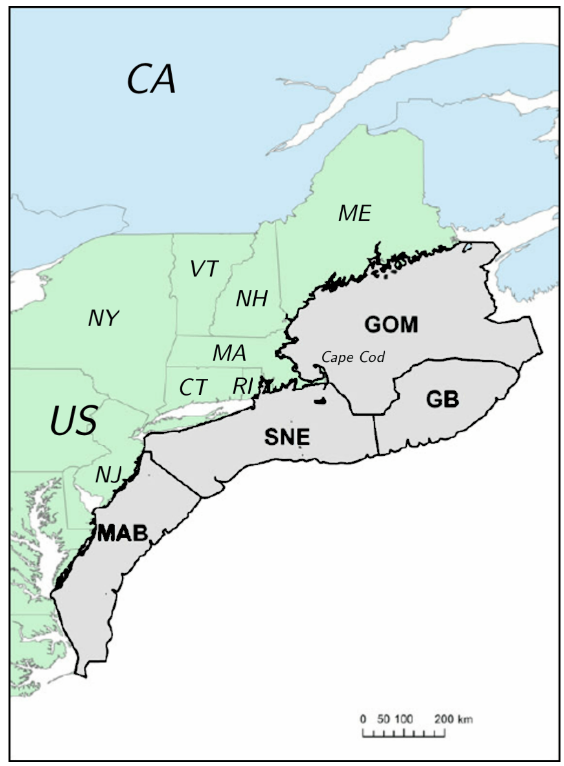
RI Rhode Island viii

SNE Southern New England viii

US United States viii, 11, 17, 25, 31, 33, 35–37, 41, 46, 60

USA United States of America 1, 34, 35

VT Vermont viii



2020 Management Track Peer Review Panel Report

Michael Wilberg[1] (chair), Ed Houde[2] and Fred Serchuk[3]

Executive Summary

The Spring 2020 Management Track cycle originally had six stock assessments scheduled for review. The Assessment Oversight Panel (AOP) review the assessment plans and recommended that four assessments be reviewed during the Management Track Peer Review and two assessments receive 'Level 1 — Direct Delivery' reviews. The AOP held a subsequent meeting to review issues related to the assessment plans for Atlantic Herring and Atlantic Mackerel. As a result of COVID-19 data availability issues, the Atlantic Mackerel assessment was delayed until 2021. The Ocean Quahog assessment was recommended for a 'Level 1 — Direct Delivery' and was not reviewed during the Management Track Peer Review.

The four stocks reviewed during the June peer review were Atlantic Herring, Butterfish, Surfclams and Longfin Inshore Squid.

For Atlantic Herring, the review panel concluded that each of the terms of references were satisfactorily addressed. Estimated spawning stock biomass has been declining since 2014 (when SSB was 317,080 mt) and in 2019 was estimated to be 77,883 mt, the lowest value since the late 1980s. The 2019 SSB is 29% of the SSB_{MSY} value (269,000 mt) and below the SSB threshold. Therefore, the stock is now overfished. Fishing mortality (F) on the fully-recruited age groups to the USA mobile fleet (ages 7–8) has markedly declined since 2010, and F in 2019 was estimated to be 0.25, the lowest value since the early 1990s, and well below the overfishing threshold $F_{MSY\,proxy}$ value (0.54). Therefore, overfishing is not occurring. Recruitment has shown high variability over the past 50+ years, which is attributed to the episodic nature of herring recruitment. Since 2013, recruitment has declined to record-low levels. Median age-1 recruitment in the stock is 3.43 billion fish at age 1. Recruitment of age-1 fish in 2019 was estimated to be 666 million fish.

For Butterfish, the review panel concluded that each of the terms of references were satisfactorily addressed. The butterfish model estimates the natural mortality rate (M). The revised estimate of M was somewhat higher than the previous estimate (1.29 *vs.* 1.25), but this was within the range of expected estimation variability. The stock assessment estimated a trend of decreasing biomass, decreasing recruitment, and increasing fishing mortality. The increasing fishing mortality was expected given the substantial increase in catches in recent years. However, the peer review committee found the decline in biomass and recruitment to be of potential concern.

For Surfclams, the review panel concluded that each of the terms of references were satisfactorily addressed. Stock biomass remains slightly above B_{Target}, and well above $B_{\text{Threshold}}$, and fishing mortality remains well below $F_{\text{Threshold}}$. The conclusions are consistent with previous determinations of stock status and indicate that the stock is neither overfished nor experiencing overfishing. Short-term projections were

[1]University of Maryland Center for Environmental Science
[2]University of Maryland Center for Environmental Science
[3]NOAA Northeast Fisheries Science Center (retired)

conducted under three scenarios. These indicated that only at $F_{\text{Threshold}}$ does the stock show substantial decline. Status quo and quota fishing levels had little effect on stock status, with $B/B_{\text{Threshold}}$ remaining > 2 and $F/F_{\text{Threshold}}$ well below 1.0, except at $F_{\text{Threshold}}$, an unlikely fishing level under the present management and market conditions for surfclam.

For Longfin Inshore Squid, the review panel concluded that each of the terms of references were satisfactorily addressed. There are currently no accepted fishing mortality reference points available for this stock. The BRPs for biomass remained the same as the 2010 and 2017 assessments, but spring- and fall-specific biomass reference points were also proposed in the current management track assessment. Given current understanding that longfin squid live approximately 6–8 months and that the summer cohort produces the following winter cohort which subsequently produces the next summer cohort, it is possible that the current averaging approach to determine whether the stock is overfished could fail to detect if biomass falls below the threshold with respect to each cohort. Annual averaging of the spring and fall survey biomasses assumes that a single population is being exploited and does not account for the large difference in apparent productivity of the two intra-annual cohorts. Estimates of squid biomass derived from the fall bottom trawl survey (which mainly catches the summer cohort) are about fivefold higher than those from the spring survey (which mainly catches the winter cohort). In addition, exploitation rates from the January–June fishery (predominantly on the summer cohort) are much higher than those of the July–December fishery (predominantly on the winter cohort). Because the generation time for longfin squid is only 6–8 months, overfishing of a single cohort potentially could jeopardize stock sustainability due to recruitment overfishing.

Peer Review Panel Report

The Peer Review Panel (PRP) for Management Track Assessments met via webinar on June 22–25, 2020. Attendance at the meeting is provided below. The PRP was asked to provide technical reviews of management track assessments for Atlantic herring (*Clupea harengus*), butterfish (*Peprilus triacanthus*), Atlantic surfclam (*Spisula solidissima*) and longfin inshore squid (*Doryteuthis (Amerigo) pealeii*). The assessments for these four species were prepared under guidelines prepared by 2020 Assessment Oversight Panel (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 being assessed. The 2020 Assessment Oversight Panel considered Atlantic herring and butterfish to be 'Level 2' assessments and Atlantic surfclam and longfin squid as 'Level 3' assessments. As a result of this designation, the assessments for all four species required peer review.

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 PRP. Our thanks extend not only to the analysts for each assessment, but also to the rapporteurs for taking extensive notes during the meeting. We also thank the other participants for helping make the meeting productive and collegial. Finally, the PRP thanks the staff at NEFSC for supporting the logistics during the meeting.

The PRP endorsed the assessments for all four species presented at the meeting for use in management. Analytical assessments were produced for Atlantic herring, butterfish, and Atlantic surfclam, each of which used a statistical catch-at-age model (Atlantic herring and butterfish) or a catch-at-age-and-length model (Atlantic surfclam). The assessment for longfin squid uses swept area biomass to estimate stock status. In each case the PRP endorsed the model and the inferences that resulted as representing the best scientific information available (BSIA), thereby providing a foundation for staff and the Mid-Atlantic and New England Fishery Management Councils and their SSCs to evaluate stock status and provide scientific advice.

Recommendations for Future Management Track Reviews

1. Include an analysis of projection accuracy for those stocks for which projections are made. This analysis would involve comparing previous projections of biomass, recruitment, and fishing mortality rates to the estimates from later assessments. It would allow for improved understanding of the performance of projections and the validity of assumptions used to make projections (e.g., recruitment, fishing mortality rates).
2. Provide the analysts' presentations in advance of the review meeting. It would be helpful to have the presentations at least one day in advance of the meeting.
3. The analysts organized their presentations using the TORs provided. The PRP appreciated this approach which facilitated its evaluation of the materials and recommends continuing this protocol in future reviews.

June 2020 management track peer review meeting attendees

Panel:

Mike Wilberg – Chair
Ed Houde – Reviewer
Fred Serchuk – Reviewer

Attendees and Presenters:

Alicia Miller (NOAA)
Alissa Wilson (NJDEP)
Allison Murphy (NOAA)
Alyson Pitts (NOAA)
Andrew Jones (NOAA)
Ariele Baker (NOAA)
Audy Peoples (NOAA)
Brandon Muffley (MAFMC)
Brian Linton (NOAA)
Brian Stock (NOAA)
Brooke Wright (NOAA)
Carrie Nordeen (NOAA)
Charles Adams (NOAA)
Charles Perretti (NOAA)
Cheri Patterson
Chris Kellog (NEFMC)
Chris Legault (NOAA)
Corinne Truesdale
Dan Hennen (NOAA)
Daphne Munroe
Dave Wallace
David Mussina
David Nelson (NOAA)
David Richardson (NOAA)

Deirdre Bolke (NEFMC)
Douglas Christel (NOAA)
Elizabeth Ng
Emily Gilbert (NOAA)
Eric Powell
Erica Fuller
Gary Shepard (NOAA)
Gerry O'Neill
Glenn Chamberlain (NOAA)
Greg DiDominico
Greg Early
Hannah Welch
James Fletcher
Janice Plante (NEFMC)
Jason Didden (MAFMC)
Jeff Kaelin
Jessica Blaylock (NOAA)
Jessica Coakley (MAFMC)
John Manderson
John-Paul Bilodeau
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Jose Montanez (MAFMC)
Karen Cogliati
Katey Marancik (NOAA)
Kathleen Hemeon
Kathy Sosbee (NOAA)
Katie Almeida
Kelly Whitmore (MA DMF)
Kiersten Curti (NOAA)
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Lisa Hendrickson (NOAA)
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Megan Ware
Meghan Plourde
Melanie Griffin
Micheal Simpkins (NOAA)
Michele Traver (NOAA)
Owen Nichols
Paul Nitschke (NOAA)
Paul Rago (MAFMC)
Peter Himchak
Rachel Feeney (NEFMC)
Raymond Kane
Renee Zobel
Richard Kyvlar
Robert Latour
Roger Mann
Russ Brown (NOAA)
Sara Weeks (NOAA)
Sarah Gaichas (NOAA)
Steve Cadrin (SMAST)
Susan Wigley (NOAA)
Tara Trinko Lake (NOAA)
Thao Le (NOAA)
Thomas Alspach (SeaWatch)
Tom Nies (NEFMC)
Toni Chute (NOAA)
Tony fr (BumbleBee)
Tony Wood (NOAA)
Wendy Gabriel (NOAA)
Yong Chen

1. BUTTERFISH

Charles Adams

This assessment of the butterfish (Peprilus triacanthus) stock is a level-2 management track assessment of the existing benchmark assessment (NEFSC 2014). Based on the previous assessment update (Adams 2018), the stock was not overfished, and overfishing was not occurring. This assessment updates commercial fishery catch data, research survey indices of abundance, the analytical ASAP 4 assessment model, and reference points through 2019. Additionally, stock projections have been updated through 2022.

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 2019 was estimated to be 29,308 (mt) which is 69% of the biomass target ($SSB_{MSY\ proxy}$ = 42,427; Figure 1). The 2019 fully selected fishing mortality was estimated to be 0.21 which is 24% of the overfishing threshold proxy ($F_{MSY\ proxy}$ = 0.86; Figure 2).

Table 1: 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 (ages 2–4). Model results are from the current updated ASAP4 assessment.

	2013	2014	2015	2016	2017	2018	2019
Data							
Commercial landings	1,091	3,135	2,104	1,194	3,681	1,673	3,431
Commercial discards	434	1,047	826	1,520	940	1,380	1,651
Catch for Assessment	1,525	4,182	2,930	2,714	4,621	3,053	5,082
Model Results							
Spawning Stock Biomass	36,325	53,665	67,674	51,243	35,347	27,508	29,308
F_{Full}	0.04	0.09	0.05	0.05	0.14	0.11	0.21
Recruits (age-0)	6,439	9,586	4,540	3,295	2,768	3,782	2,932

Table 2: Comparison of reference points estimated in the 2017 assessment and from the current assessment update. An $F_{MSY\ proxy}$ was used for the overfishing threshold and was based on $\frac{2}{3}M$ (Patterson 1992).

	2017	2020
$F_{MSY\ proxy}$	0.82	0.86
SSB_{MSY} (mt)	48,681	42,427
MSY (mt)	38,694	31,136
Median recruits (age-0) (millions)	8,368	8,693
Overfishing	No	No
Overfished	No	No

Projections: Short term projections of catch and SSB were derived by sampling from a cumulative distribution function of ASAP 4 recruitment estimates for 1989–2019. The annual fishery selectivity, maturity ogive, and mean weights at age used in the projections are the time series averages. Retrospective adjustments were not applied in the projections.

Table 3: Short term projections of total fishery catch and spawning stock biomass for butterfish based on a harvest scenario of fishing at $F_{MSY\ proxy}$ between 2021 and 2022. Catch in 2020 was assumed equal to the Domestic Annual Harvest quota 23,752 (mt). Note that this assumed catch is 5 to 8 times higher than any of the annual catches since 2017 (Table 1).

Year	Catch (mt)	SSB (mt)	F_{Full}
2020	23,752	17,324	1.305

Year	Catch (mt)	SSB (mt)	F_{Full}
2021	19,588	29,784	0.860
2022	28,239	39,956	0.860

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).

  Discard estimates are highly variable and imprecise with CVs prior to 2010 ranging from 0.23 to 1.44.

  The commercial catch is aged with NEFSC survey age–length keys so the catch at age and mean weights at age are uncertain.

  The application of an assumed q to estimate M is a source of uncertainty. Additionally, this estimated q assumes that the Henry B. Bigelow is 100% efficient at sampling butterfish during the daytime.

- 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}).

  No retrospective adjustment of spawning stock biomass or fishing mortality in 2019 was required.

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

  Population projections for butterfish are reasonably 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 time series of discards was re-estimated to incorporate changes made to the underlying data. The NEAMAP indices at age were re-estimated using the NEAMAP age–length key. These changes had no impact on stock status.

- 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.
  Fishing mortality during 2017–2019 has been the highest in the time series, but in 2019 it still remains 76% below the $F_{MSY\ proxy} = 0.86$. While SSB has been below the $SSB_{MSY\ proxy}$ during the same time period, it is 38% above the $SSB_{\text{Threshold}}$ (21,214 mt) in the terminal year.

- Indicate what data or studies are currently lacking and which would be needed most to improve this stock assessment in the future.
  There is stakeholder interest in evaluating approaches to include the various state surveys in the assessment model. This will be addressed in the upcoming research track assessment scheduled for fall 2021. Additional research recommendations can be found in the most recent benchmark assessment (NEFSC 2014).

- Are there other important issues?
  As in the previous assessment update (Adams 2018) biological references points were recalculated based on advice from the Mid-Atlantic Fishery Management Council Science and Statistical Committee to enable internal consistency with the ASAP 4 estimate of M.
  The natural mortality estimate from the previous assessment update ($M = 1.25$) changed to $M = 1.29$ in the current assessment update.
  Updates to the thermal habitat index are no longer available. Thus, the time series mean ($A = 0.62$) for 1989–2015 from the previous assessment update (Adams 2018) was used for the current assessment update.
  The NEFSC fall offshore index for 2017 was set to -999 in the ASAP 4 model due to only 11 of 59 strata being sampled that year.

Peprilus triacanthus, Butterfish.

1.1. Reviewer Comments: Butterfish

The butterfish stock assessment is an update of the approach adopted in the 2014 benchmark stock assessment (NEFSC 2014) based on the 2017 assessment update. The butterfish assessment is a statistical catch-at-age model implemented in ASAP that assumes catchability of the NEFSC fall trawl survey is known. In addition, the model estimates the natural mortality rate.

The PRP concludes that the 2020 management track assessment for butterfish is technically sufficient to evaluate stock status and provide scientific advice. The assessment represents the BSIA for this stock for management purposes. The PRP agrees with the assessment report that butterfish is not overfished and overfishing is not occurring. However, concerns were expressed because biomass and recruitment have shown a negative trend in recent years.

Butterfish Terms of Reference (TOR)

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

   This TOR was satisfactorily addressed. The landings were updated. The algorithm for calculating discards was modified to that typically used by the Center, so the discard time series changed somewhat from the previous assessment. The PRP believed the change in the protocol to estimate discards is appropriate. The landings have been increasing in recent years as a directed fishery has reemerged, and discards remain an important component of the catch.

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. The NEFSC fall survey and NEAMAP fall survey indices (the only indices included in the assessment model currently) were updated for use in the assessment model. The main change was to use the NEAMAP age–length key for that index instead of applying the NEFSC age–length key. The PRP considers this change in the age–length key to be an improvement and supports its use.

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. The ASAP model from the 2017 update was updated with the most recent data. The model diagnostics indicated that the model results appeared to be stable and reliable. The PRP noted some inconsistencies in the input weights-at-age for cohorts, where mean weights-at-age appeared to decline for ages 3–4+ or remain the same for ages 0–1. These patterns warrant a revisit of how weights-at-age are calculated.

The butterfish model estimates the natural mortality rate (M). The revised estimate of M was somewhat higher than the previous estimate (1.29 *vs.* 1.25), but this was within the range of expected estimation variability.

The stock assessment estimated a trend of decreasing biomass, decreasing recruitment, and increasing fishing mortality. The increasing fishing mortality was expected given the substantial increase in catches in recent years. However, the PRP found the decline in biomass and recruitment to be of potential concern.

A 'Plan B' assessment was prepared, but because the assessment model was accepted there was no need to review the 'Plan B' approach.

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. The natural mortality rate is estimated in the stock assessment model, which then directly feeds into the calculation of the maximum fishing mortality threshold. The PRP agrees with the assessment report that butterfish is not overfished ($B > B_{\text{Threshold}}$) and overfishing ($F < F_{\text{Threshold}}$) is not occurring. Fishing mortality during 2017–2019 has been the highest in the time series, but in 2019 F still remains 76% below the $F_{MSY\ proxy}$ 0.86. While SSB has been below the $SSB_{MSY\ proxy}$ during the same period, it is 38% above the $SSB_{\text{Threshold}}$ (21,214 mt) in the terminal year.

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

   This TOR was satisfactorily addressed. Short-term projections were conducted assuming that the catch limits (DAH) would be fully realized. However, recent catches of butterfish indicate this is unlikely to occur. Therefore, the projections likely overestimate the near-term effects of fishing. In particular, it was noted that if the catch limit in 2020 was achieved, the projections indicate the stock would likely be considered overfished in 2021. However, the catch limits are 5–8 times the observed catches in recent years, which indicates it is extremely unlikely that the limit will be realized. Using the whole time series of recruitment for the projections may result in the projections being overly optimistic if recruitment continues to be in the range of $\frac{1}{3}$–$\frac{1}{2}$ of the long-term average (8,336 million age-0 fish).

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

   This TOR was satisfactorily addressed. Changes in model structure were not made in this assessment because a research track assessment is scheduled to start in 2021. Reference points were recalculated to ensure internal consistency with the estimated M.

Additional Recommendations

Recommendations for projections:

The PRP thought that the assumptions about recruitment and 2020 catches in the projections were unlikely to be realized and would affect the accuracy of the projections. The assumption of achieving the catch limit was unlikely to occur because the catch limit has been 5–8 times higher than the observed catches during 2017–2019. Adding projections with an estimated catch closer to what is likely to be realized provides additional context for potential dynamics of the stock and performance of the fishery. The PRP noted that recruitment has been trending downward in recent years. However, the projections use the full time series of recruitment. Because the average recruitment for the whole time series is higher than that in recent years, it may cause the projections to overestimate biomass. Using a recent period of recruitment may improve the accuracy of projections.

Recommendations for the upcoming research track assessment:

1. Weights-at-age. As described above, the mean weights-at-age for a cohort indicated fish were not growing between ages 0 and 1 or were shrinking between ages 3 and 4+ in some years. Alternative approaches for estimating mean weights at age should be considered (e.g., averaging across years instead of using individual years).
2. Fishery selectivity. Currently fishery selectivity is specified at 1.0 for ages 2–4+. However, a pattern in the age composition residuals indicates that selectivity for age-2 may be lower than that for age-3. The PRP recommends reconsidering a selectivity function that estimates the age-2 fishery selectivity. Changing the fishery selectivity may affect the estimated natural mortality rate.
3. Reconsider the fishing mortality rate reference point. Recent research has suggested that using $F_{MSY} \approx \frac{2}{3}M$ may not be a robust approximation.
4. Given the observation of declining recruitment with declining stock size, it may be possible to estimate a stock-recruitment function for this stock which could be used for reference point estimation.

References:

Adams C.F. 2018. Butterfish 2017 Stock Assessment Update. US Dep Commer, Northeast Fish Sci Cent Ref Doc. 18-05. 31 p. CRD18-05

Northeast Fisheries Science Center (NEFSC). 2014. 58th Northeast Regional Stock Assessment Workshop (SAW 58) Assessment Report. US Dep Commer, Northeast Fish Sci Cent Ref Doc. 14-04. 784 p. CRD14-03

Patterson K. 1992. Fisheries for small pelagic species: an empirical approach to management targets. Rev Fish Biol Fisher 2(4):321–338.

Research vessel NOAAS Henry B. Bigelow underway

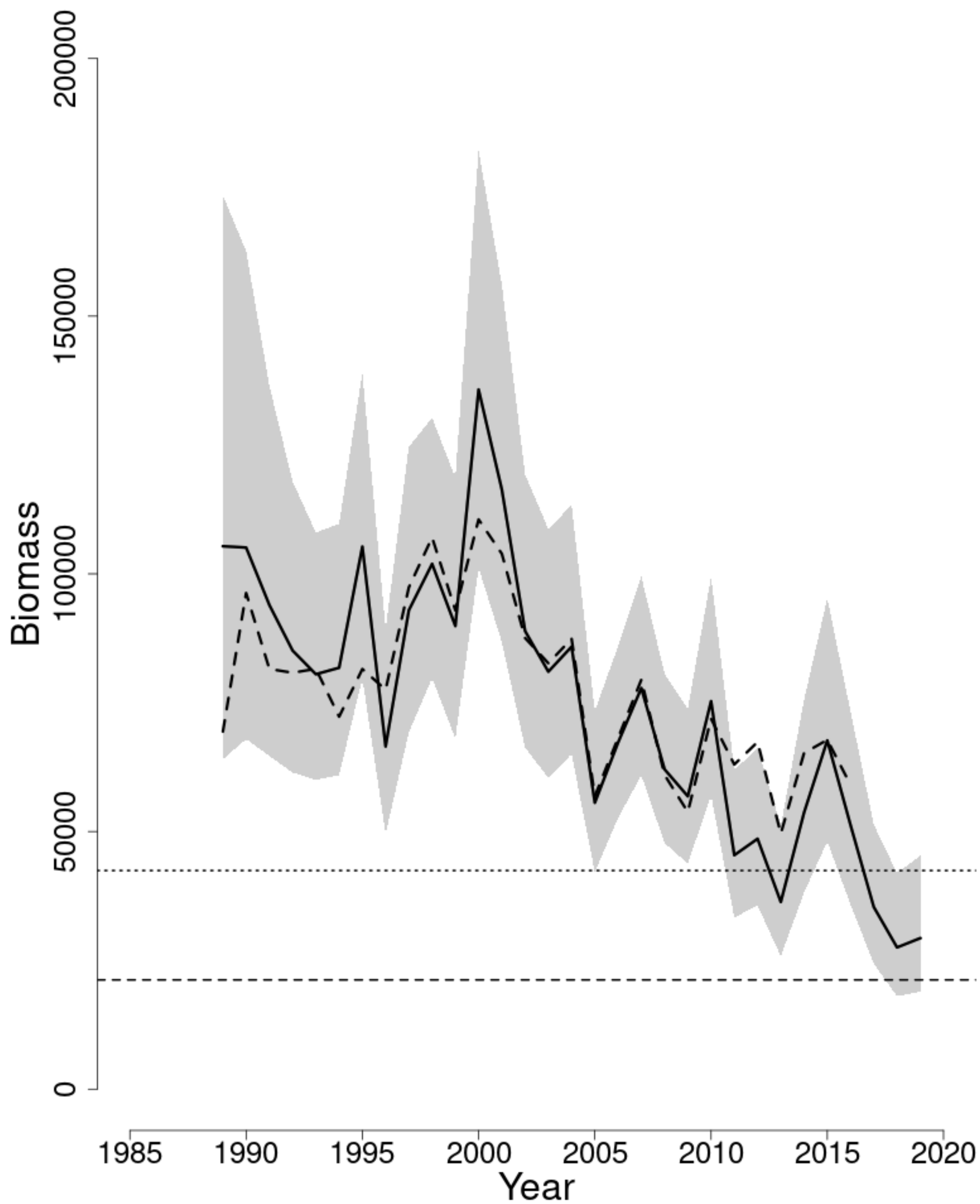


Figure 1: Trends in spawning stock biomass of butterfish between 1989 and 2019 from the current (solid line) and previous (dashed line) assessment and the corresponding $SSB_{\text{Threshold}}(\frac{1}{2}SSB_{MSY\ proxy}$; horizontal dashed line) as well as $SSB_{\text{Target}}(SSB_{MSY\ proxy}$; horizontal dotted line) based on the 2020 assessment. Biomass was not adjusted for a retrospective pattern. The approximate 90% log-normal confidence intervals are shown.

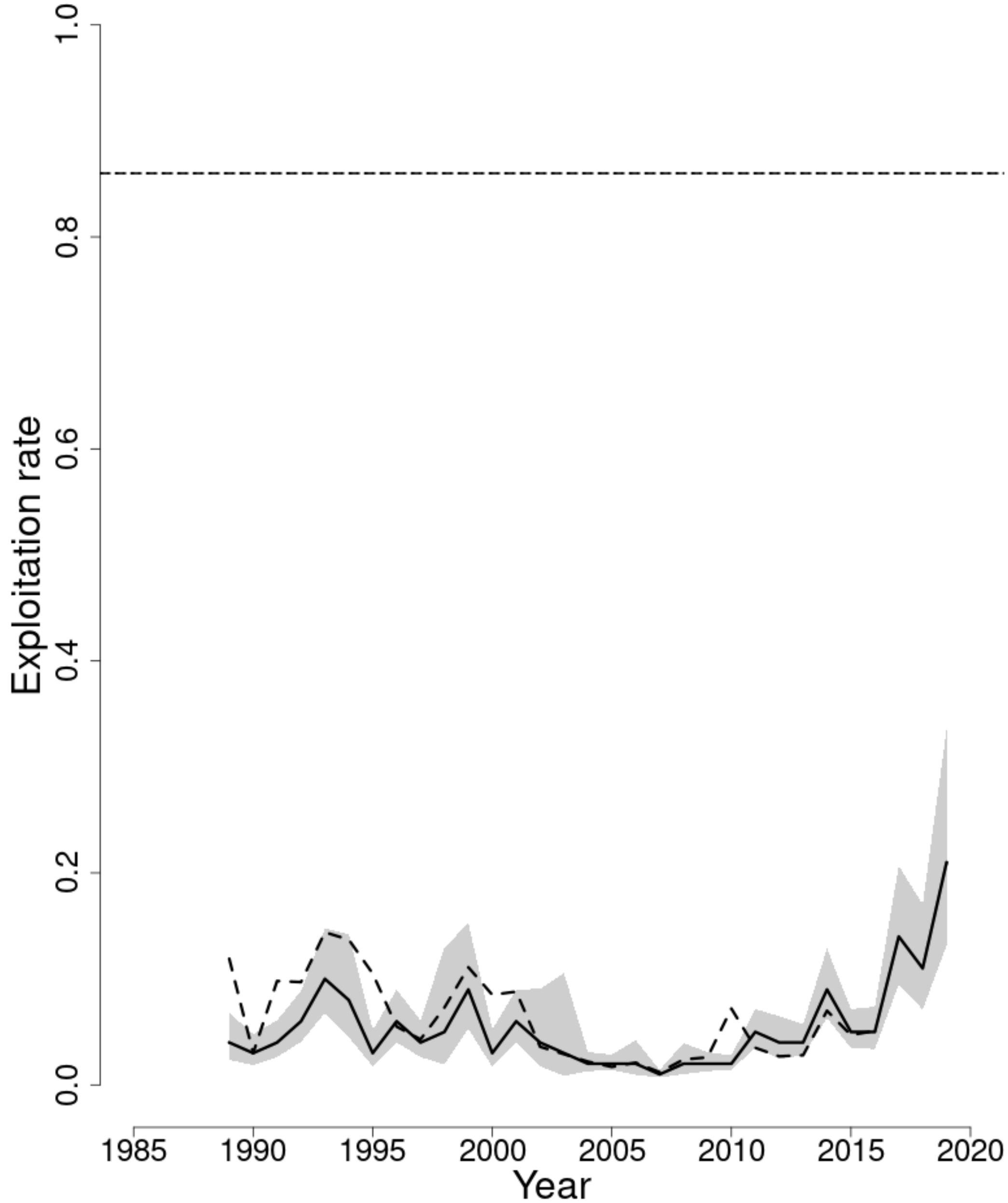


Figure 2: Trends in the fully selected fishing mortality (F_{Full}) of butterfish between 1989 and 2019 from the current (solid line) and previous (dashed line) assessment and the corresponding $F_{\text{Threshold}}$ ($F_{MSY\ proxy} = 0.86$; horizontal dashed line). F_{Full} was not adjusted for a retrospective pattern. The approximate 90% log-normal confidence intervals are shown.

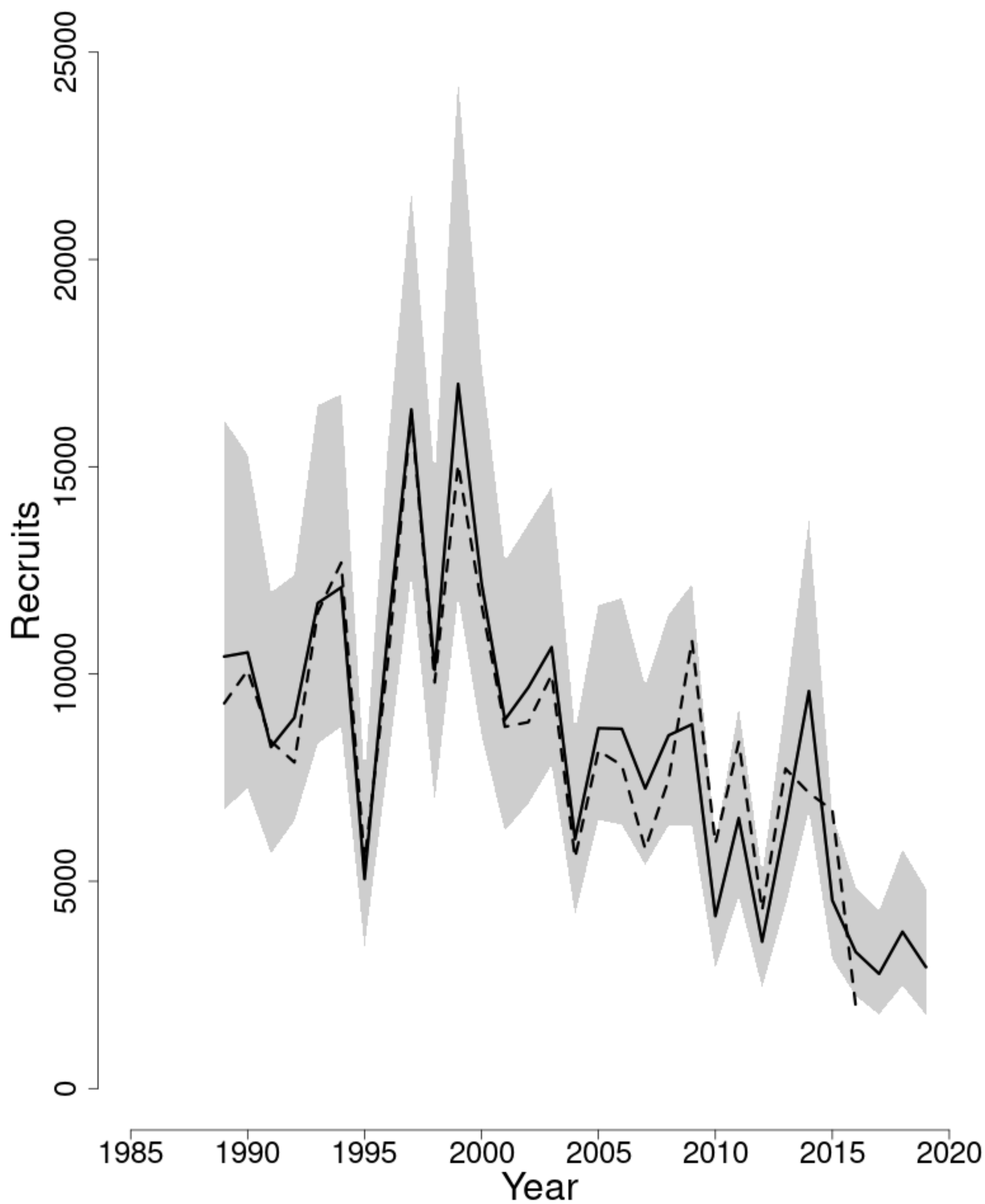


Figure 3: Trends in age-0 recruits (millions) of butterfish between 1989 and 2019 from the current (solid line) and previous (dashed line) assessment. The approximate 90% log-normal confidence intervals are shown.

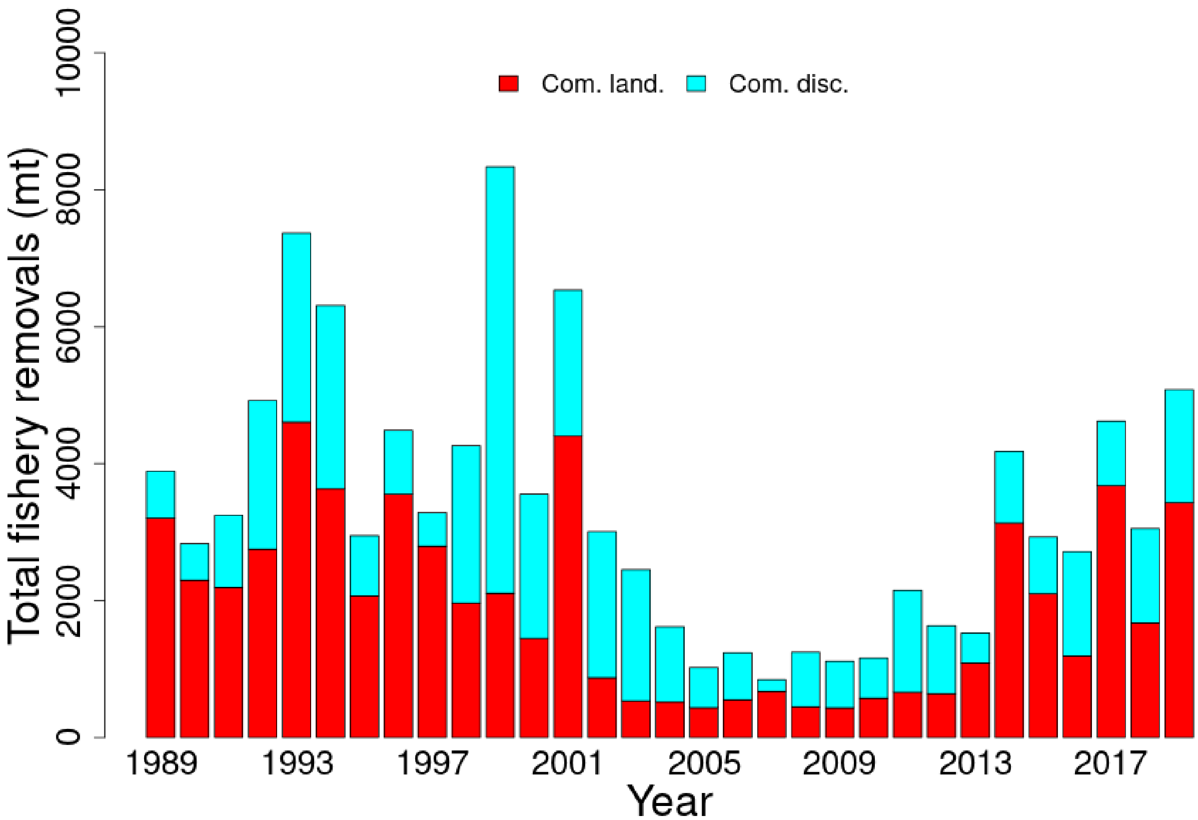


Figure 4: Total commercial catch of butterfish between 1989 and 2019 by disposition (landings and discards).

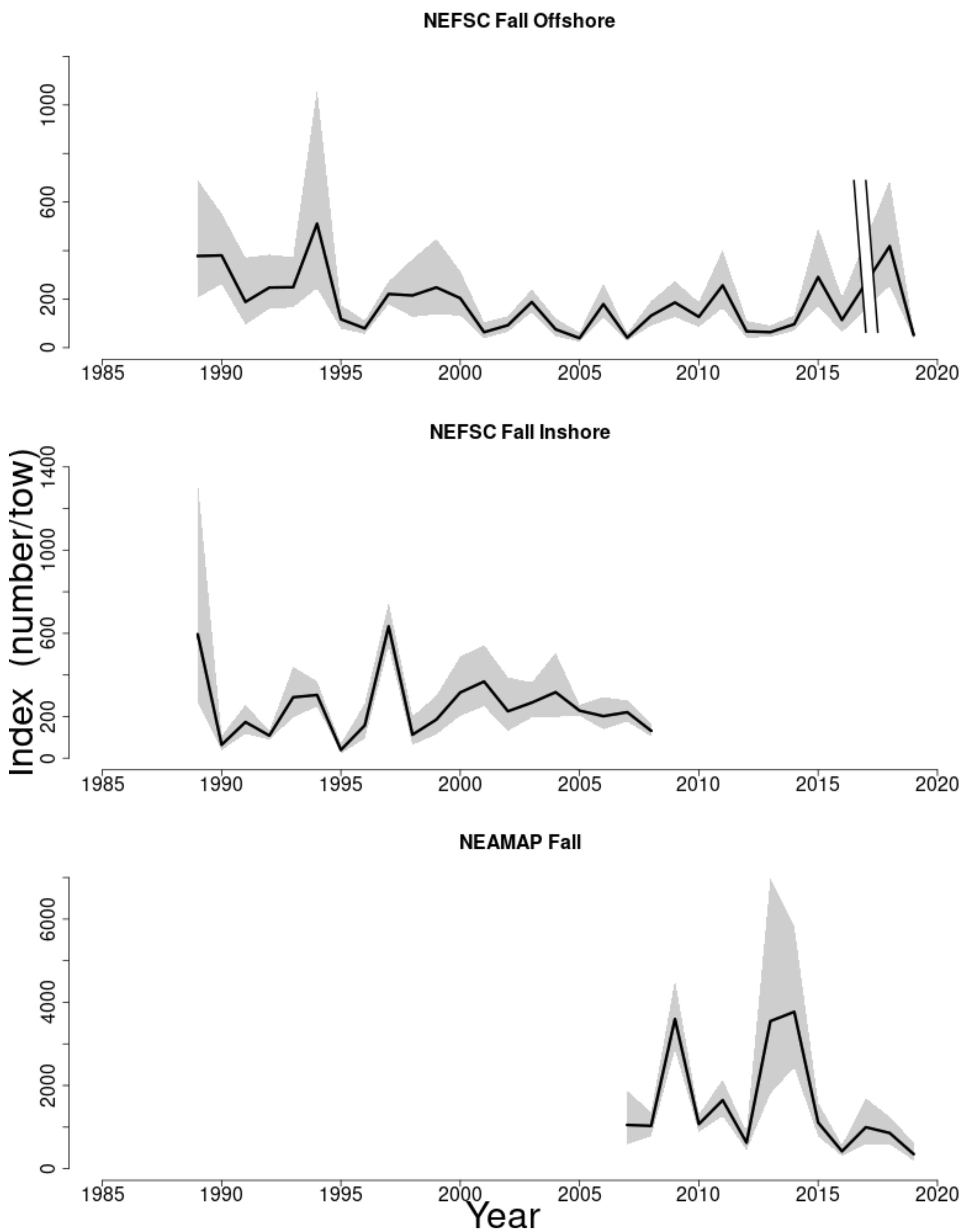


Figure 5: Indices of abundance for butterfish between 1989 and 2019 for the Northeast Fisheries Science Center (NEFSC) fall offshore and inshore bottom trawl surveys, and the Northeast Area Monitoring and Assessment Program (NEAMAP) fall survey. The approximate 90% log-normal confidence intervals are shown. The NEFSC fall offshore index for 2017 is *NA* due to only 11 of 59 strata being sampled that year.

2. LONGFIN INSHORE SQUID

Lisa Hendrickson

This Level 3 Management Track Assessment of longfin inshore squid (Doryteuthis (Amerigo) pealeii) is an update of the 2017 operational assessment reviewed by the MAFMC SSC. The methodologies used to conduct the 2010 benchmark assessment (NEFSC, 2011a; NEFSC, 2011b) were used in this assessment and the 2017 assessment. Based on the 2017 assessment, the stock was not overfished and overfishing was unknown in 2016 (Hendrickson, 2017). This assessment updates commercial fishery catch data (Table 4, Figure 8), q-adjusted, swept-area biomass estimates and exploitation indices (catch/biomass) through 2019 (Figure 9). In keeping with the Level 3 Management Track Assessment guidelines, and with the permission of the AOP, cohort-specific biomass reference points are proposed because the existing biomass reference points are annualized (averages of the NEFSC spring and fall survey biomass estimates) and do not take into account the biological and productivity differences between the two intra-annual cohorts caught during these surveys.

State of Stock: Based on this updated assessment, the recommended stock status for longfin inshore squid (*Doryteuthis (Amerigo) pealeii*) is not overfished and overfishing is unknown. The catchability-adjusted, swept-area biomass in 2019 (defined as the two-year moving average of the 2019 and 2018 annually averaged NEFSC spring and fall survey biomass estimates) was estimated to be 63,349 mt (80% $CI =$ 58,989–67,709) (Figure 6) which was much greater than the threshold $B_{MSY\ proxy}$ of 21,203 mt. Overfishing status could not be determined because there are no fishing mortality reference points for the stock. The 2019 exploitation index (2019 catch divided by 63,349 mt) was estimated to be 0.202 (Figure 7). The 2019 exploitation index was greater than the 1987–2018 median of 0.189.

Table 4: Catch and biomass assessment results for longfin inshore squid. All weights are in (mt). Total biomass estimates in this table were used for stock status determination and are two-year moving averages of the annually averaged, q-adjusted, swept-area biomass estimates for the NEFSC spring and fall bottom trawl surveys. Exploitation indices represent the catch in year y divided by the total biomass estimate in year y.

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Data											
US Landings	9,307	6,748	9,556	12,820	11,090	12,070	11,953	18,182	8,188	11,632	12,458
International Landings	0	0	0	0	0	0	0	0	0	0	0
US Discards	135	69	221	368	246	208	97	498	131	134	314
Catch for Assessment	9,442	6,817	9,777	13,187	11,336	12,278	12,050	18,680	8,319	11,766	12,772
Model Results											
Total Biomass	58,934	65,798	62,870	93,975	109,573	NA	NA	73,762	NA	NA	63,349
Exploitation Index	0.16	0.104	0.156	0.14	0.103			0.253			0.202

Table 5: Comparison of reference points estimated in the 2017 and current assessment updates.

	2017	2020
$F_{MSY\ proxy}$	*NA*	*NA*
$B_{MSY\ proxy}$	42,205	42,205
MSY (mt)	*NA*	*NA*
Overfishing	Unknown	Unknown
Overfished	No	No

Projections: Stock size projections for this subannual, semelparous 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).

  The most important source of uncertainty is that the apparent productivity differences for the two intra-annual cohorts are unaccounted for in the assessment because their biomasses are annualized (averaging of the annual NEFSC spring and fall survey biomasses). Individuals from the summer-hatched cohort have faster growth rates and larger sizes-at-maturity than individuals from the winter-hatched cohort (Brodziak and Macy, 1996; Macy and Brodziak, 2001). The average lifespan of each cohort and the time between the NEFSC spring and fall surveys is about six months. Individuals caught during NEFSC spring surveys (March) were hatched about six months prior, during the previous fall, and individuals caught in the NEFSC fall (September) surveys were hatched during the previous spring and early summer (NEFSC, 2011a; NEFSC 2011b). The current assessment method assumes that biomass estimates for the NEFSC spring and fall surveys represent mean biomass estimates for the intra-annual cohorts that are available to the January–June and July–December fisheries, respectively. The biomass of the cohort caught during the fall surveys is about five-fold higher than the biomass of the cohort caught in the spring surveys (NEFSC, 2011a; 2011b). However, the mean exploitation rate for the Jan–June fishery was more than three times higher on the apparently less productive cohort caught during the spring surveys than the mean exploitation rate for the July–December fishery that occurs on the cohort caught in the fall surveys. The current method of determining stock status does not account for these differences, and therefore, likely impacts resource sustainability.
  Another source of uncertainty involves the disconnect between the half-year periods used assessments (computing of exploitation rates and biomass) and trimester periods used to manage the fishery. The current assessment method utilizes annualized estimates of biomass and exploitation rates to overcome this issue, but the negative aspects of using these annualized estimates outweigh the use of them for ease of management. Importantly, trimester-based assessment and management allows fishing effort to be distributed differentially across the year, to take into account fishing effort during the inshore spawning period when the directed bottom trawl

fishery occurs on the spawning grounds. However, other assessment and management periods (e.g., half-years) could also be utilized for cohort-specific management.

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

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

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

  Projections were not possible, because there is no 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.

  Instead of adding only the new years of discard data to the time-series, as in the 2017 assessment update, the entire discard time-series was updated for the subject assessment. Instead of computing quarterly-based discard estimates throughout all years, discards were estimated by trimester for the trimester-based quota period (2000 and 2007–2019). Discards comprised a small percentage (1.6%) of the average catch (11,462 mt) during this time period, so the changes in catches were minor. Although precision of the trimester discard estimates was low to moderate, the change to trimester discard estimation showed that discarding was highest in the Mid-Atlantic region mainly during Trimester 2. Updating of the entire discard time-series also required updating of the exploitation indices, but as previously stated, the impact on catches was small.

- 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 longfin inshore squid since the 2010 benchmark assessment. However, this result is likely attributable to the use of annualized swept-area biomass estimates (annual averages of the NEFSC spring and fall survey biomass estimates) for stock status determinations. The existing $B_{MSY\ proxy}$ *is based on the 2010 stock assessment working group's assumption that the stock was 'lightly exploited' during 1976–2008, because the 1976–2008 median annualized biomass estimate was much higher than the catches during the same time period and did not result in multi-year decreases in annualized biomass. As a result, the working group concluded that this median biomass level represented 90% of the stock's carrying capacity and set the* $B_{MSY\ proxy}$ *at 50% of this amount (NEFSC, 2011a; NEFSC, 2011b). As previously noted, these annualized biomass estimates do not take into account the biological differences between the two dominant subannual cohorts, and consequently, cohort-specific biomass reference points should be utilized instead. For further details, please refer to the responses to Special Comments bullets 1, 6 and 7.*

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

  This is a Level 3 assessment because the AOP allowed me to address the reasons why cohort-specific rather than the current annualized biomass reference points should be used to determine the status of this sub-annual species. According to the guidelines for a Level 3 *assessment, the assessment scientist may 'Recommend significant changes to biological reference points, including but not limited to: a change in the recruitment stanza; the number of years to include for recent means in biological parameters; and suggestions of alternate reference points if based off a similar modeling approach (e.g., age-based, length-based, etc.).'*

In other parts of the world (e.g., Japan, Falklands, Chile and Mexico), intra-annual cohorts of fished loliginid and ommastrephid squid species are assessed and managed as separate stocks because of their differences in growth rates, sizes-at-maturity, distributions and spawning areas (Arkhipkin et al., 2015). Similar differences exist for the D. pealeii *resource. Previously described biological and apparent productivity differences between the two intra-annual cohorts warrant assessing and managing them as separate stocks. This will require a change from annualized to cohort-specific reference points. It has been 10 years since the most recent benchmark assessment and the existing biomass reference points ignore the biology and life history of this sub-annual species. Although empirical survey catch efficiency data are needed to further investigate the apparent spring and fall survey biomass differences, waiting another decade to possibly obtain funding for such a study ignores the existence of these obvious differences and may result in cohort-specific overfishing and impact the sustainability of both stocks. In addition, there is no* D. pealeii *stock assessment scheduled through 2025.*

It is unclear what the annualized biomass estimates actually represent for this species given its 6–8-month lifespan. Furthermore, such biomass estimates seem to be extraordinarily high in relation to the existing $B_{\text{Threshold}}$ (i.e., 50% of the $B_{MSY\ proxy}$). Based on the current stock status determination method, the stock would never have been overfished during the past 44 years (1976–2019). The annualized biomass time-series is driven by the much higher (five-fold) of the two biomass time-series, the fall survey time-series. However, the annualized exploitation indices are dominated by the exploitation indices for the January–June fishery which occurs on the cohort with much lower biomass levels (the cohort caught in the spring surveys). The summer-hatched (May–October) cohort supports the winter (November–April) offshore fishery and the winter-hatched (November–April) cohort supports the May–October mainly inshore fishery (Brodziak and Macy, 1996; Macy and Brodziak). The NEFSC fall survey primarily catches individuals hatched during the spring and early summer and the NEFSC spring survey primarily catches individuals hatched during the fall (NEFSC, 2011a; NEFSC, 2011b).

Cohort-specific biomass and exploitation indices have previously been presented in the most recent benchmark assessment as well as in this and the 2017 assessment updates. For the reasons stated above, the two cohorts caught in the NEFSC spring and fall surveys should be assessed and managed as separate stocks. In keeping with the guidelines for this Level 3 Management Track assessment, cohort-specific biomass reference points are proposed (refer to Table 11 of the tables file associated with this assessment) and were computed using the same NEFSC spring and fall survey biomass time-series that were used to compute the existing biomass reference points; the only differences being that the time-series are not averaged together and that the reference points are based on the 1987–2018 rather than 1976–2008 NEFSC spring and fall survey medians and without the assumption that both cohorts were lightly exploited during 1987–2018. Based on the new cohort-specific biomass reference points, the spring survey cohort was not overfished in 2019 because the 2018–2019 average biomass estimate (32,092 mt) was well above the biomass threshold of 11,152 mt (Table 11). During 2019, the fall survey cohort was also not overfished *because the 2018–2019 average biomass estimate (94,606 mt) was 68% above the biomass threshold of 56,268 mt.*

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

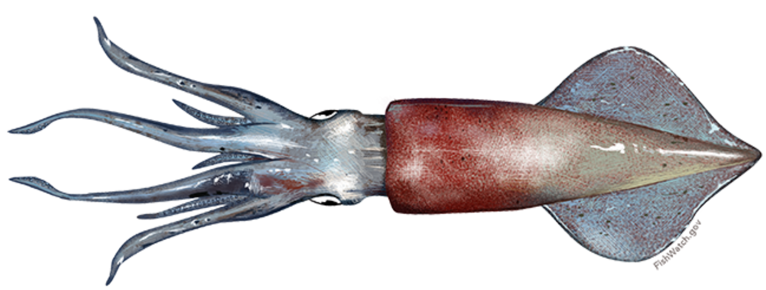
  Research is currently being conducted to assess cohort growth rates and sizes-at-maturity throughout the year in an effort to further characterize these differences between the D. pealeii *intra-annual cohorts.*

  For in-season assessment, daily reporting of landings and e-VTR fishery data are required, as are improvements to the collection of fishery biological data and pre-season surveys, conducted using a commercial squid vessel, to estimate initial stock size.

  Empirical survey catch efficiency data are needed to further investigate the apparent biomass differences between the cohorts caught in the NEFSC spring and fall bottom trawl surveys.

- Are there other important issues?

  As has been previously recommended for Illex illecebrosus*, assessment and management of the* D. pealeii *resource should be conducted in-season, and when adequate data are available, separate %MSP-based Biological Reference Points should be estimated for each of the two stocks to ensure adequate spawner escapement, using a method that accounts for the species' semelparous life history.*



Doryteuthis (Amerigo) pealeii, Longfin Squid.

2.1. Reviewer Comments: Longfin inshore squid

The longfin squid stock assessment is an update of the 2017 operational stock assessment. The assessment uses swept area biomass to estimate stock size. The stock size biological reference points are fixed fractions of estimated swept area biomass. Currently no fishing mortality rate reference points are available for this stock.

The PRP concludes that the 2020 management track assessment is technically sufficient to evaluate stock status for biomass and provide scientific advice. The assessment represents the BSIA for this stock for management purposes. The PRP agrees with the assessment report that longfin squid is not overfished and overfishing is undetermined because there is not an established F reference point. The PRP concurs with the AOP and recommends considering cohort-specific reference points based on the understanding of two dominant and largely non-overlapping intra-year cohorts of longfin squid, at the next management track assessment in 2023.

Longfin Inshore Squid Terms of Reference (TOR)

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

   This TOR was satisfactorily addressed. The approach for calculating discards for 2000 and 2007–2019 was slightly modified from the previous assessment to align with trimester-based quota management during this period, and the PRP agreed that this was an improvement. Since 1987 (when the domestic fishery for longfin squid began) landings of all species of squid have been assigned to individual species, so that the landings for longfin squid used in the assessment are considered to be accurate.

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. The assessment uses the spring and fall bottom trawl surveys with assumptions about catchability and availability to estimate biomass for the cohorts caught in the spring and fall surveys (the winter cohort is predominately present in the spring and the summer cohort predominates in the fall). No changes in the index methods were made from the previous assessments.

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. NEFSC spring and fall survey biomasses and exploitation rates were estimated as in the previous assessment. A 'Plan B' assessment was not possible for this stock.

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. There are currently no accepted fishing mortality reference points available for this stock. The BRPs for biomass remained the same as the 2010 and 2017 assessments, but spring- and fall-specific biomass reference points were also proposed in the current management track assessment. Given current understanding that longfin squid live approximately 6–8 months and that the summer cohort produces the following winter cohort which subsequently produces the next summer cohort, it is possible that the current averaging approach to determine whether the stock is overfished could fail to detect if biomass falls below the threshold with respect to each cohort. Annual averaging of the spring and fall survey biomasses assumes that a single population is being exploited and does not account for the large difference in apparent productivity of the two intra-annual cohorts. Estimates of squid biomass derived from the fall bottom trawl survey (which mainly catches the summer cohort) are about five-fold higher than those from the spring survey (which mainly catches the winter cohort). In addition, exploitation rates from the January–June fishery (predominantly on the summer cohort) are much higher than those of the July–December fishery (predominantly on the winter cohort). Because the generation time for longfin squid is only 6–8 months, overfishing of a single cohort potentially could jeopardize stock sustainability due to recruitment overfishing. In the recommendations, the PRP provides an alternative approach for using cohort-specific reference points to provide annual stock status.

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

   Short-term projections were not conducted because there is no accepted assessment model for longfin squid.

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

   This TOR was satisfactorily addressed. Several projects to understand longfin squid dynamics are currently underway, and other research priorities would require additional funding. One of the most important assumptions of this stock assessment is the catchability in the spring and fall trawl surveys. A study of catchability would be extremely useful to improve the stock assessment but would require substantial funding resources.

Additional Recommendations

1. The PRP recommends considering cohort-specific reference points for determining stock status. One approach to determine annual stock status using information on two intra-annual cohorts would be to calculate separate stock statuses for the two cohorts sampled in the NEFSC spring and fall surveys. This alternative would involve comparing biomass estimates to the cohort-specific biomass

reference points. If either of the cohort-specific biomass estimates fell below its respective biomass threshold, then the stock would be considered overfished in that year. The PRP notes that this recommendation also could apply to other subannual species (e.g., shortfin squid).

2. The PRP recommends continuing development of a stock assessment approach that is specifically tailored to the squid life cycle and data availability. One avenue is to consider if assessment or management approaches for other semelparous species, for example Pacific salmons, might be useful because they share some life history traits with longfin squid.

3. To assist panelists in future assessment reviews for longfin squid, the PRP recommends including a figure that illustrates spawning and fishing periods that identify the two predominant intra-annual cohorts.

Well camouflaged on the sandy bottom.

References:

Arkhipkin, Alexander, I., Paul G.K. Rodhouse, Graham J. Pierce, Warwick Sauer, Mitsuo Sakai, Louise Allcock, Juan Arguelles, John R. Bower, Gladis Castillo, Luca Ceriola, Chih-Shin Chen, Xinjun Chen, Mariana Diaz-Santana, Nicola Downey, Angel F. González, Jasmin Granados Amores, Corey P. Green, Angel Guerra, Lisa C. Hendrickson, Christian Ibáñez, Kingo Ito, Patrizia Jereb, Yoshiki Kato, Oleg N. Katugin, Mitsuhisa Kawano, Hideaki Kidokoro, Vladimir V. Kulik, Vladimir V. Laptikhovsky, Marek R. Lipinski, Bilin Liu, Luis Mariátegui, Wilbert Marin, Ana Medina, Katsuhiro Miki, Kazutaka Miyahara, Natalie Moltschaniwskyj, Hassan Moustahfid, Jaruwat Nabhitabhata, Nobuaki Nanjo, Chingis M. Nigmatullin, Tetsuya Ohtani, Gretta Pecl, J. Angel A. Perez, Uwe Piatkowski, Pirochana Saikliang, Cesar A. Salinas-Zavala, Michael Steer, Yongjun Tian, Yukio Ueta, Dharmamony Vijai, Toshie Wakabayashi, Tadanori Yamaguchi, Carmen Yamashiro, Norio Yamashita and Louis D. Zeidberg. 2015. World squid fisheries. Rev. in Fish. Sci. and Aquacult., 23:2, 92–252.

Brodziak, J.K.T., and W.K. Macy, III. 1996. Growth of long-finned squid, *Loligo pealeii*, in the northwest Atlantic. Fish. Bull., 94: 212–236.

Hendrickson, L. Longfin Inshore Squid (*Doryteuthis (Amerigo) pealeii*) Stock Assessment Update for 2017. Presented to the Mid-Atlantic Fishery Management Council Science and Statistical Committee on April 25, 2017. 11 p.

Macy, W.K. III and J.K.T. Brodziak. 2001. Seasonal maturity and size at age of *Loligo pealeii* in waters of southern New England. ICES J. Mar. Sci. 58 (4): 852–864.

Northeast Fisheries Science Center [NEFSC]. 2011a. 51st Northeast Regional Stock Assessment Workshop (SAW 51) Assessment Summary Report. US Dept Commer, Northeast Fish. Sci. Cent. Ref. Doc. 11-02, 856 p.

Northeast Fisheries Science Center [NEFSC]. 2011b. 51st Northeast Regional Stock Assessment Workshop (SAW 51) Assessment Summary Report. US Dept Commer, Northeast Fish. Sci. Cent. Ref. Doc. 11-01, 70 p.

NEFSC (Northeast Fisheries Science Center). 2002a. Report of the 34th Northeast Regional Stock Assessment Workshop (SAW 34): Stock Assessment Review Committee (SARC) consensus summary of assessments. Northeast Fisheries Science Center Reference Document. 02-06, 346 p.

NEFSC (Northeast Fisheries Science Center). 2002b. Report of the 34th Northeast Regional Stock Assessment Workshop (SAW 34): Public Review Workshop. Northeast Fisheries Science Center Reference Document. 02-07; 32 p.

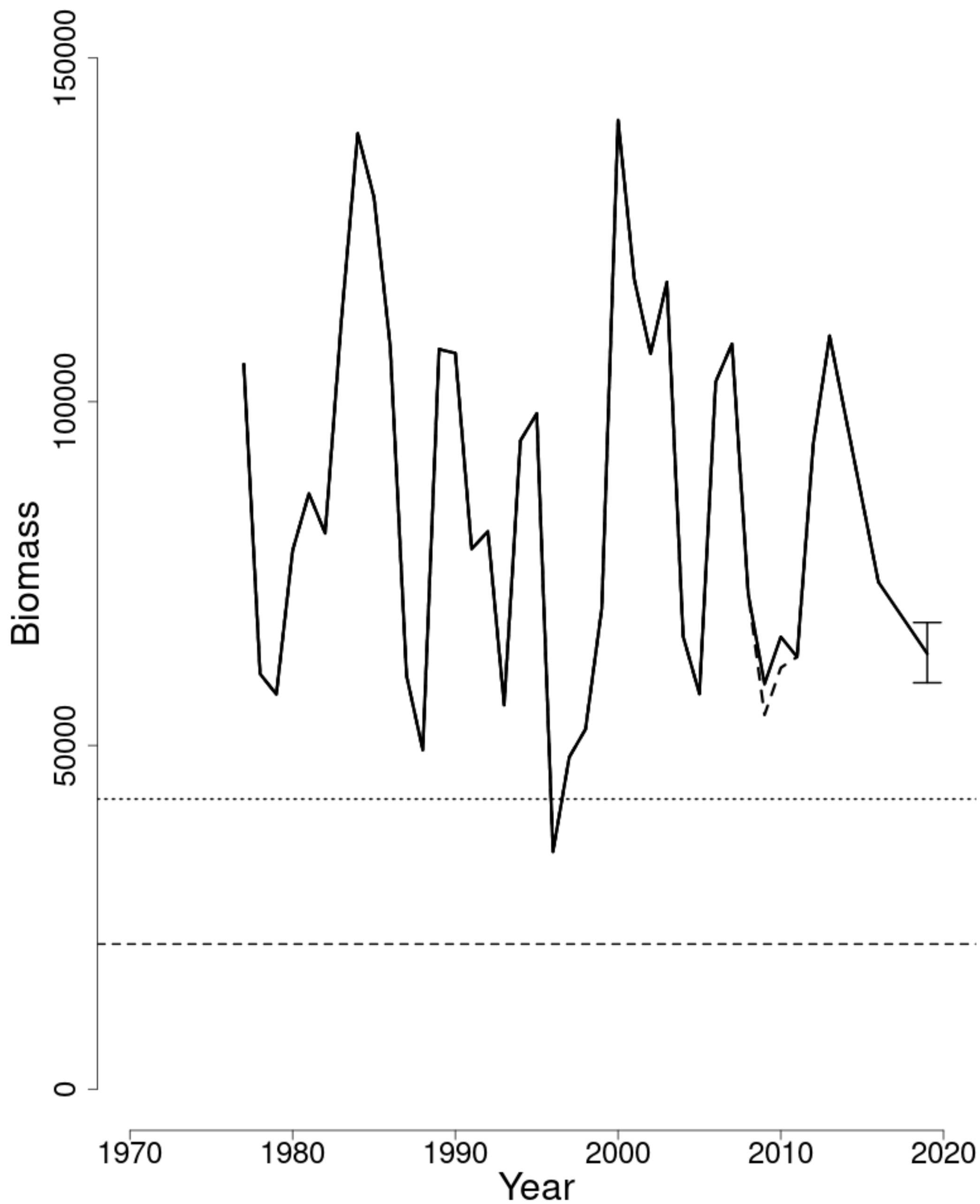


Figure 6: Trends in the total biomass (mt) of longfin inshore squid between 1977 and 2019 from the current assessment (solid line) and the 2017 assessment update (dashed line). Total biomass was used for the stock status determination and represents two-year moving averages of the annually averaged q-adjusted, swept-area biomass estimates for the NEFSC spring and fall bottom trawl surveys. Biomass estimates are shown as interpolated values for years where biomass could not be estimated due to inadequate survey sampling coverage of longfin squid habitat (2013 spring and 2017 fall surveys). The approximate 80% confidence intervals (58,989−67,709) are shown for the 2019 biomass estimate.

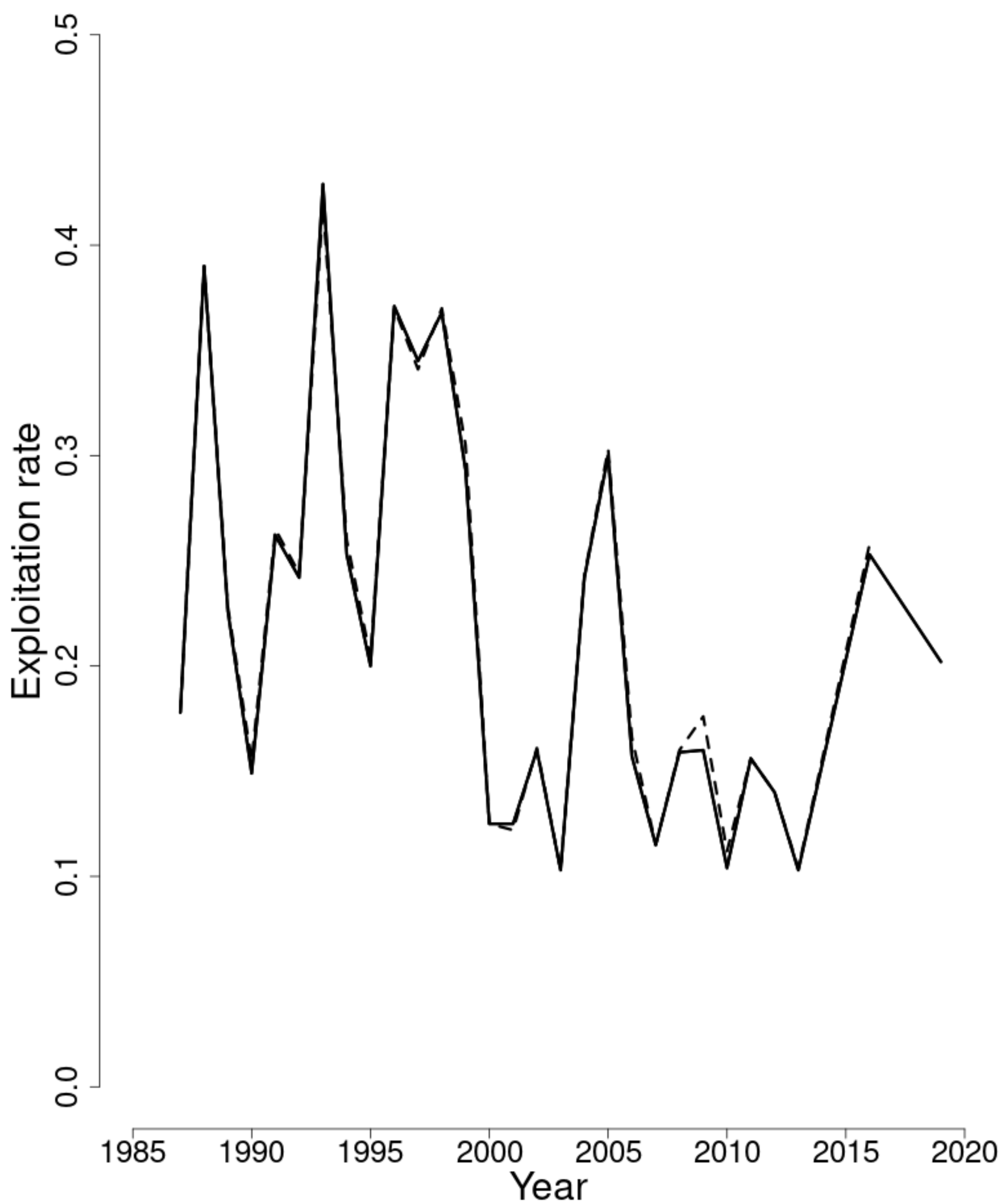


Figure 7: Trends in exploitation indices (catch/two-year moving average of the annually averaged NEFSC spring and fall survey biomass estimates) of longfin inshore squid between 1987 and 2019 from the current assessment (solid line) and the 2017 assessment update (dashed line). Exploitation rates are shown as interpolated values for years with only a single biomass estimate due to inadequate survey sampling coverage of longfin squid habitat (2013 spring and 2017 fall surveys).

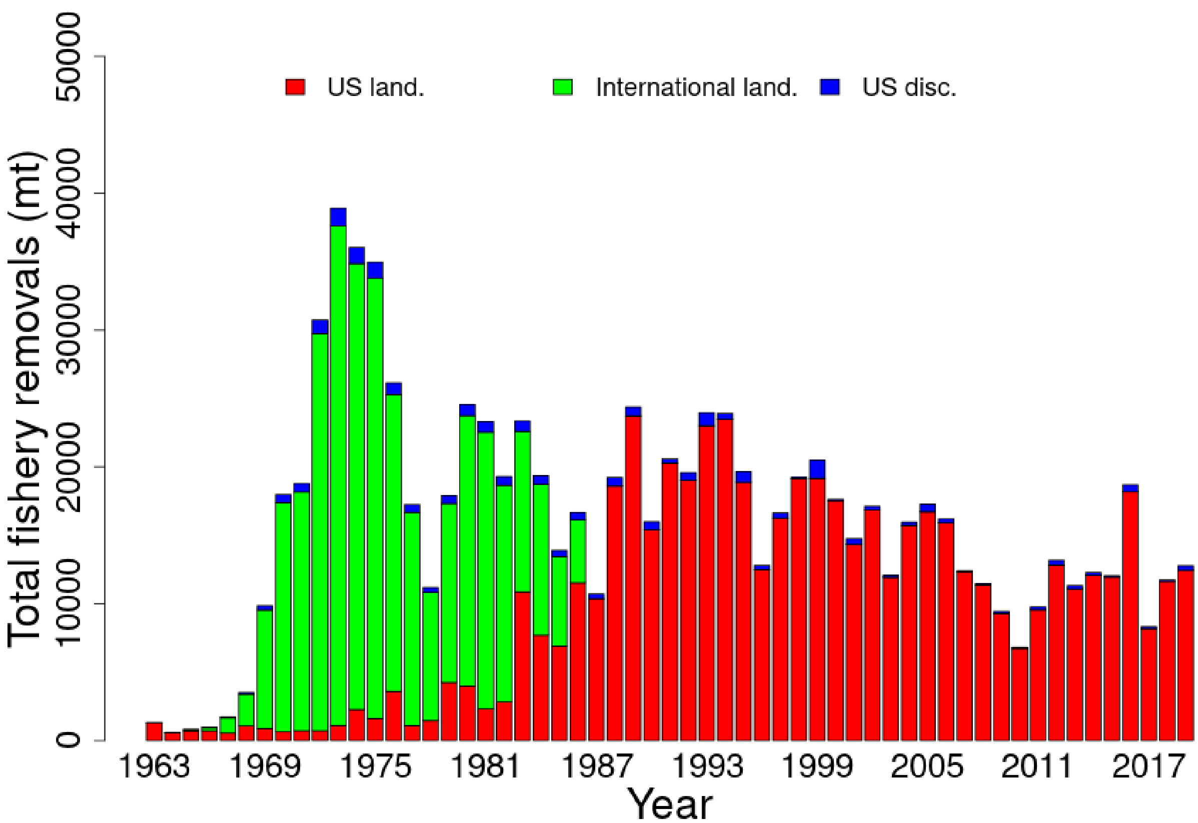


Figure 8: Total catch of longfin inshore squid between 1963 and 2019 by fleet (commercial) and disposition (landings or discards).

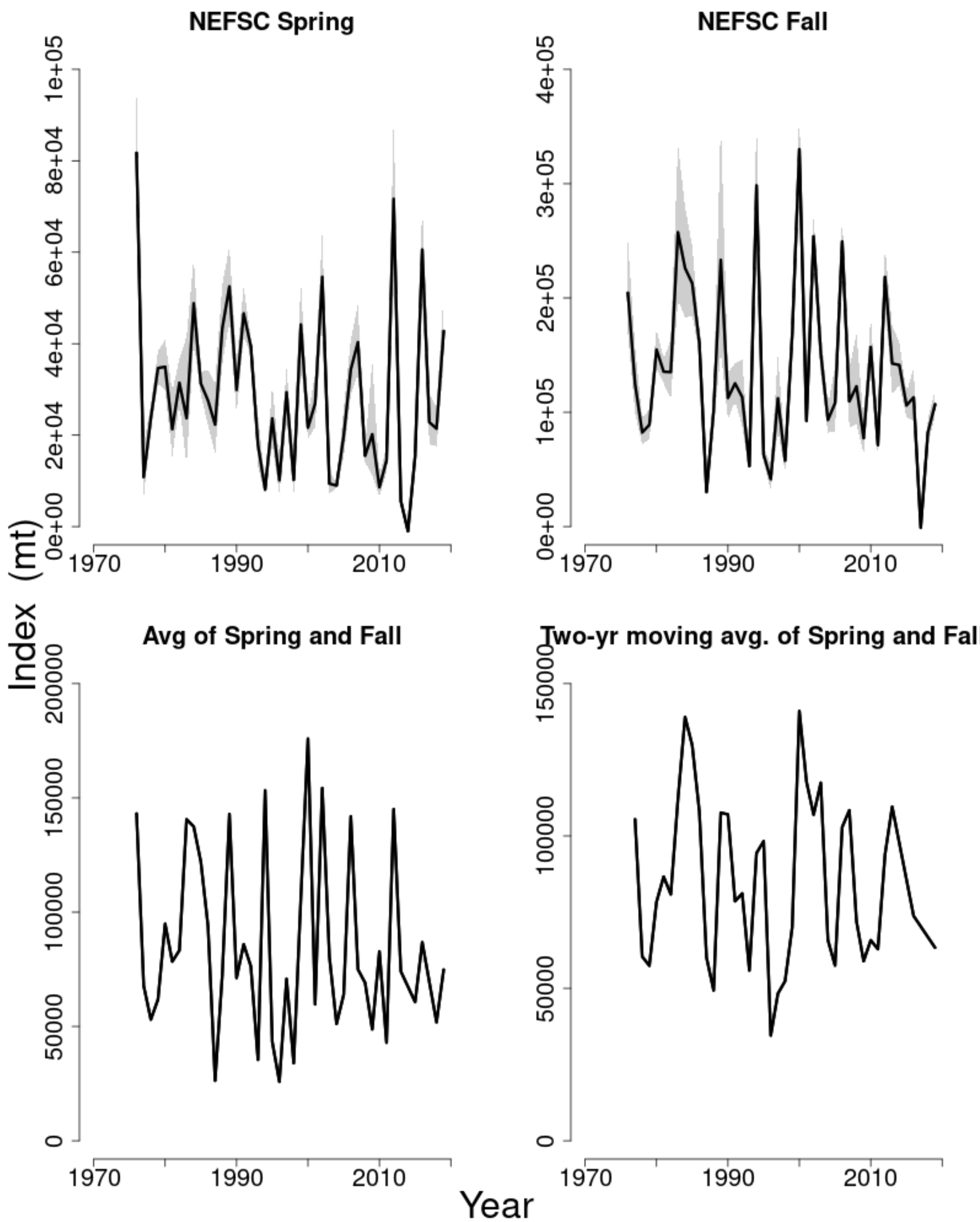


Figure 9: Swept-area, q-adjusted biomass (mt) for longfin inshore squid between 1976 and 2019 based on annual averages of the NEFSC spring and fall bottom trawl survey biomass estimates. Survey sampling coverage of longfin squid habitat was inadequate for biomass estimation during the 2013 spring survey and 2017 fall survey, so years with missing biomass data are shown as interpolated values in the two bottom panels. The approximate 80% log-normal confidence intervals are shown.

3. ATLANTIC HERRING

Jon Deroba

This assessment of the Atlantic Herring (Clupea harengus) stock is a management track assessment of the existing 2018 benchmark ASAP assessment (NEFSC 2018). Based on the previous assessment, the stock was not overfished and 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 through 2019. The methods used for short-term projections have changed from the previous assessment. More specifically, the projections now explicitly include two fishing fleets, mobile and fixed gears, consistent with the ASAP assessment. A supplementary document detailing the changes to the projection methodology has been provided.

State of Stock: The methods used to derive biological reference points and conduct short-term projections were changed as part of this management track assessment and details are provided in a supplementary document. Briefly, the reference points were calculated using only the selectivity from the mobile fishing fleet with no inclusion of mortality from the fixed fleet, which is likely to result in biased reference points to an unknown degree. No widely accepted methods for calculating reference points exist, however, in a multifleet context, especially when one of the fleets is that of a foreign country and is not controlled with quotas. Using an aggregated selectivity that combines the mobile and fixed fleets for reference points and projections, as in previous assessments (NEFSC 2018), was also problematic because the resulting projections either produced an unrealistic catch-at-age that allotted far too much catch to the fixed fleet, or assumed that the fixed fleet was subjected to the same harvest control rule as the mobile fleet, which is also incorrect. Note, however, that although the reference points were calculated using only the mobile fleet selectivity, short-term projections included fixed fleet catches such that stock dynamics and probability of overfishing and overfished were still affected by this source of mortality. Based on this management track assessment, the Atlantic Herring (*Clupea harengus*) stock is overfished and overfishing is not occurring (Figures 10–11). Retrospective adjustments were unnecessary. Spawning stock biomass (SSB) in 2019 was estimated to be 77,883 (mt) which is 29% of the biomass target ($SSB_{MSY\ proxy} = 269,000$; Figure 10). The 2019 average fishing mortality for ages 7–8 (fully selected ages for the mobile fleet) was estimated to be 0.25267 which is 47% of the overfishing threshold proxy ($F_{MSY\ proxy} = 0.543$; Figure 11).

Table 6: 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.

	2012	2013	2014	2015	2016	2017	2018	2019
			Data					
US Catch	87,171	95,191	93,084	81,204	62,597	48,796	45,527	12,782
Canadian Catch	504	6,431	2,149	146	4,060	2,103	11,574	5,054
Total Catch	87,675	101,622	95,233	81,350	66,657	50,899	57,101	17,836
			Model Results					
Spawning Stock Biomass	240,920	202,410	317,080	256,880	170,720	133,700	90,765	77,883
$\bar{F}_{7-8}$	0.60885	0.66113	0.51489	0.47881	0.47538	0.46961	0.5727	0.25267
recruits (age-1)	6,689,400	1,579,000	1,509,600	809,350	283,230	983,810	407,910	666,050

Table 7: 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.

	2018	2020
$F_{MSY\ proxy}$	0.51	0.54
SSB_{MSY} (mt)	189,000 (corrected 266,000)	269,000 (155,699–444,290)
MSY mt	112000 (corrected 100,011)	99,400 (62,644–51,814)
Median recruits (age-1)	3,449,817,600	3,430,614,650 (915,478,855–10,132,087,450)
Overfishing	No	No
Overfished	No	Yes

Projections: 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 4,778 mt. This fixed gear catch equals the sum of the ten year (2010–2019) averages of the Canadian (4,669 mt) and US (109 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 8: **Projection results. See above and supplementary document for details.**

Year	Catch mt	SSB (mt)	$\bar{F}_{7\text{–}8}$
2020	16,319	56,375	0.243

Year	Catch mt	SSB (mt)	$\bar{F}_{7\text{–}8}$
2021	9,483	48,841	0.119
2022	8,767	45,921	0.089
2023	11,025	130,616	0.077

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).

  While not an uncertainty from a statistical estimation standpoint, 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 $\bar{F}_{7\text{–}8}$ lies outside of the approximate joint confidence region for SSB and $\bar{F}_{7\text{–}8}$).

  This assessment model did not have a retrospective pattern, or at worst the pattern was minor.

- 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. Terminal year, 2019, recruitment was imprecisely estimated with a $CV > 2.0$, which contributes to relatively large uncertainty bounds. Likewise, recruitment in 2022 is assumed to approximately equal average recruitment, which may be unlikely given recent estimates. For additional projection details, see the supplemental document.

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

No changes, other than the incorporation of new data, were made to the Atlantic Herring assessment.

- 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. The change from not overfished to overfished was anticipated based on previous projections.

- 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 previous retrospective patterns. While this assessment did not have a retrospective pattern, the pattern may reemerge (NEFSC 2018). 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.

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

Clupea harengus, Atlantic Herring.

3.1. Reviewer Comments: Atlantic Herring

The 2020 assessment update for Atlantic herring is a Level 2 assessment in accord with the decision at the 29 April 2020 meeting of the AOP. The 2020 assessment is an update from the 2018 benchmark assessment (SAW 65) that used an ASAP modeling framework.

The PRP concludes that the 2020 assessment update for Atlantic herring is technically sufficient to evaluate stock status and provide scientific advice. The assessment represents BSIA for this stock for management purposes. The PRP agrees with the assessment report that the Atlantic herring stock is overfished and overfishing is not occurring. This is a change in status from the results of the 2018 benchmark assessment that indicated that the stock was not overfished and overfishing was not occurring.

The 2020 assessment used different methods to derive biological references points (BRP) and conduct short-term projections than those in the 2018 benchmark assessment. The BRPs in the 2020 assessment were derived using only the selectivity of the mobile fleet (exclusively a USA fleet) because the fixed gear fleet ($> 90\%$ Canadian) is not quota regulated and not subject to the same harvest control rules as the USA mobile fleet. However, the short-term projections included catches from both fleets to ensure that the stock dynamics and probability of overfishing and overfished were still subject to the total stock harvests.

Atlantic Herring Terms of Reference (TOR)

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

   This TOR was satisfactorily addressed. Landings and discard data from 2018 and 2019 were added to those used in the 2018 benchmark. Because Canadian fixed gear catches markedly increased in 2018 (11,912 mt) and remained high in 2019 (5,115 mt) while USA mobile catches declined (45,189 mt in 2018; 12,721 mt in 2019) due to regulatory changes, the percent of the annual total catch taken by the Canadian fishery significantly increased to 21% in 2018 and 29% in 2019. From 2012 to 2017, Canadian catches accounted for between 1% and 7% of the annual total catches.

   The age compositions of catches from the two fleets also differ. The USA mobile fleet primarily harvests fish that are age-3 and older, while the Canadian fixed gear fleet generally harvests herring that are age-2 and younger (although in 2019, age-3 fish were also caught).

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. All four of the survey indices used in the benchmark assessment (NEFSC spring bottom trawl survey, NEFSC fall bottom trawl survey, NEFSC shrimp bottom trawl survey, and the NEFSC fall survey acoustic index) were updated through 2019. As well, survey age composition and age-length data were updated through 2019 from the NEFSC spring and fall surveys. Age data from the summer shrimp survey were collected for the first time in 2019. Trends in relative abundance of herring from all four surveys indicate a substantial decline in stock abundance during the past few years. All four of the survey indices in 2019 were at or near record-low values. The most relevant Canadian assessments of the stock show similar trends in abundance.

   Although the surveys do not efficiently catch age-0 or age-1 fish, they do track cohorts well from age-2 onwards and thereby provide information on year class strength.

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. The same ASAP model configuration used in the 2018 benchmark assessment was used in the 2020 update. Diagnostic and residual patterns were evaluated for all of the model input data (fleet catches, fleet age compositions, survey abundance indices and age compositions), as well as for the estimates of fishing mortality, biomass, spawning stock biomass, and recruitment. The diagnostic and residual patterns were acceptable (i.e., residuals generally randomly distributed) and similar to those in the 2018 benchmark assessment. No retrospective adjustments were needed in the assessment. A 'Plan B' assessment was not necessary because the model-based assessment was accepted.

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. BRPs were re-estimated in the 2020 assessment using only the selectivity of the USA mobile fishing fleet and exclude any mortality from the catches from the unregulated Canadian fixed gear fleet. This is likely to result in biased reference points to an unknown degree, but there are no widely accepted methods for calculating BRPs when one of the fleets is not controlled. The fixed gear catches are treated as management uncertainty and a risk issue that needs to be addressed by managers. In essence, the re-estimated BRPs are US-based reference points and allow stock status relative to these reference points to be affected by Canadian fixed gear catches, which are unregulated and outside of US control.

   The re-estimated BRPs are the following: $F_{MSY\,proxy} = 0.54$; $SSB_{MSY\,proxy} = 269,000$ mt; SSB threshold ($\frac{1}{2}\,SSB_{MSY}$) $= 134,500$ mt; $MSY = 99,400$ mt. An $F_{40\%}$ proxy was used for the overfishing threshold and the SSB proxy reference points are based on long-term stochastic projections.

   Estimated spawning stock biomass has been declining since 2014 (when SSB was 317,080 mt) and in 2019 was estimated to be 77,883 mt, the lowest value since the late 1980s. The 2019 SSB is 29% of the SSB_{MSY} value (269,000 mt) and below the $SSB_{\text{Threshold}}$. Therefore, the stock is now overfished.

   Fishing mortality (F) on the fully-recruited age groups to the USA mobile fleet (ages 7–8) has markedly declined since 2010, and F in 2019 was estimated to be 0.25, the lowest value since the early 1990s, and well below the overfishing threshold $F_{MSY\,proxy}$ value (0.54). Therefore, overfishing is not occurring.

Recruitment has shown high variability over the past 50+ years, which is attributed to the episodic nature of herring recruitment. Since 2013, recruitment has declined to record-low levels. Median age-1 recruitment in the stock is 3.43 billion fish at age-1. Recruitment of age-1 fish in 2019 was estimated to be 666 million fish.

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

   This TOR was satisfactorily addressed. Short-term (2021–2023) projections were conducted using the harvest control rule described in Amendment 8 of the Atlantic Herring Fishery Management Plan as applied solely to the US mobile gear fleet. Annual catches by the Canadian fixed gear fleet were assumed to be constant at 4,778 mt, the sum of the 10-year (2010–2019) averages of the Canadian (4,669 mt) and US (109 mt) fixed gear catches. For 2020, the total catch was assumed to be 16,319 mt, resulting in an SSB of 56,375 mt and $F = 0.243$ for the US mobile gear fleet.

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

   This TOR was satisfactorily addressed. However, several uncertainties exist in the stock assessment. These include:

   - There is uncertainty in the natural mortality rate (M), which is assumed in the assessment to be constant among ages and years. This assumption is common in stock assessments of many fish species because studies to determine natural mortality rates in exploited fish populations are difficult to conduct. Some insight on M for herring might be gained from the results of multi-species models that incorporate prey and predator relationships.
   - The projections are uncertain because (1) recruitment in 2019 is imprecisely estimated and (2) recruitment in 2022 was drawn from the cdf of the long-term recruitment estimates, which results in a mean value about equal to the long term average. The PRP notes that achieving mean recruitment is unlikely given the very low recruitment estimates in the most recent years.
   - Continued poor recruitment will be the principal factor influencing stock status in the near future, as fishing mortality is now low compared to historical levels.

Additional Recommendations

1. Because acoustic methods are regularly used to survey and assess herring stocks in other areas of the world, use of a dedicated acoustic survey should be explored further.

2. The reference points assume an absence of fixed gear fishing, which means that fishing at the $F_{40\%}$ rate would not be expected to achieve $SSB_{40\%}$. The panel suggests modifying the current approach to include the effect of catches in the fixed gear fleet. For example, the SSB reference points could be modified to also estimate the F reference point. The approach would involve conducting long-term projections of the population under different assumptions of mobile gear F. The fixed gear catches would remain the same as in the current approach. The unfished condition would have the mobile gear $F = 0$ and the fixed gear catch $= 0$. A grid search over the mobile gear F could be used to find the mobile gear F that achieves 40% of the unfished SSB. The PRP recommends attempting this approach for the next management track or research track stock assessment.

References:

NEFSC (Northeast Fisheries Science Center). 2018. 65th Northeast Regional Stock Assessment Workshop (SAW 65) Assessment Report. US Dept. of Commerce, NEFSC Ref. Doc. 18-11.

typical Herring catch.

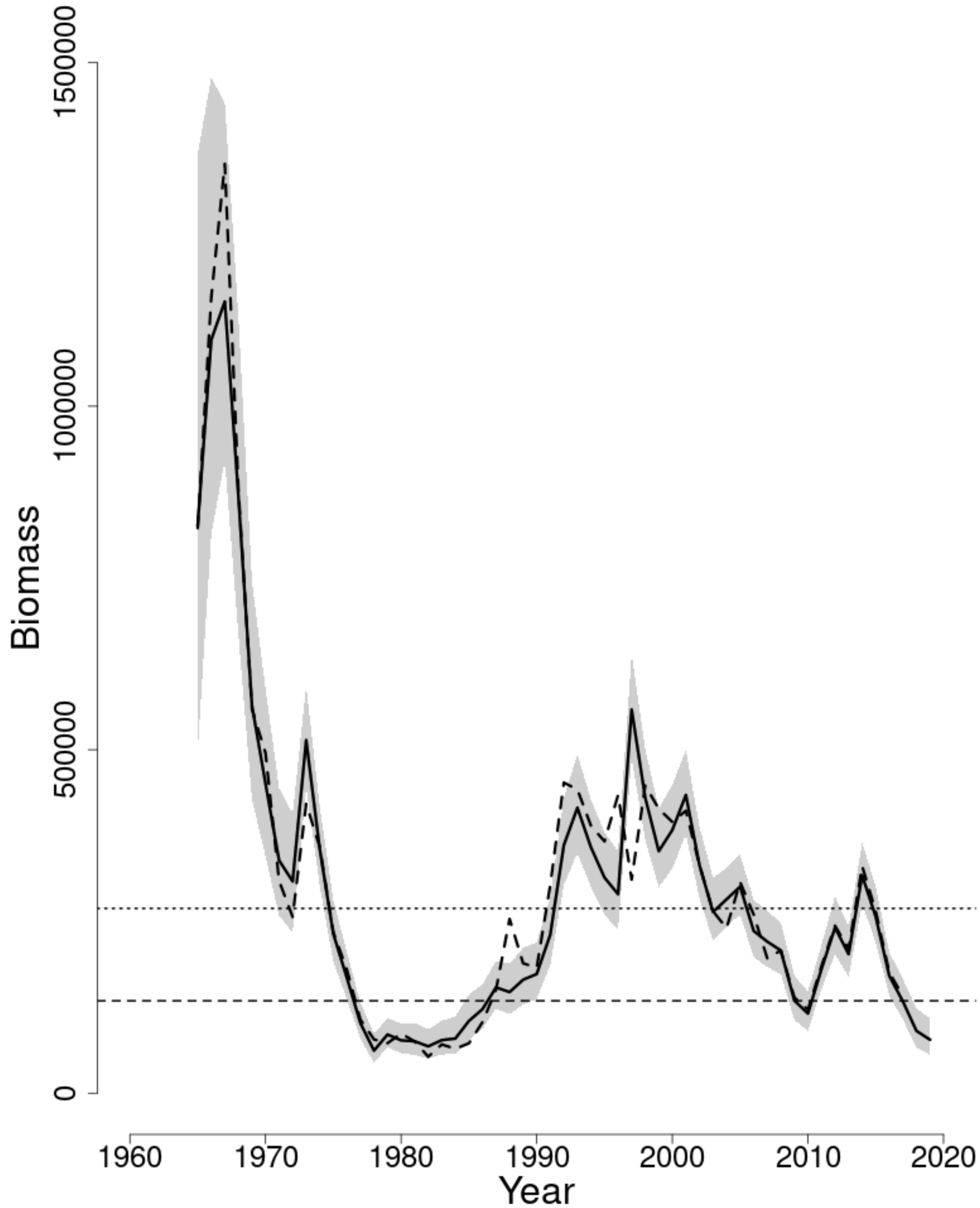


Figure 10: Trends in spawning stock biomass of Atlantic Herring between 1965 and 2019 from the current (solid line) and previous (dashed line) assessment and the corresponding $SSB_{\text{Threshold}}$($\frac{1}{2}SSB_{MSY\ proxy}$; horizontal dashed line) as well as SSB_{Target}($SSB_{MSY\ proxy}$; horizontal dotted line) based on the 2020 assessment. The approximate 90% confidence intervals are shown.

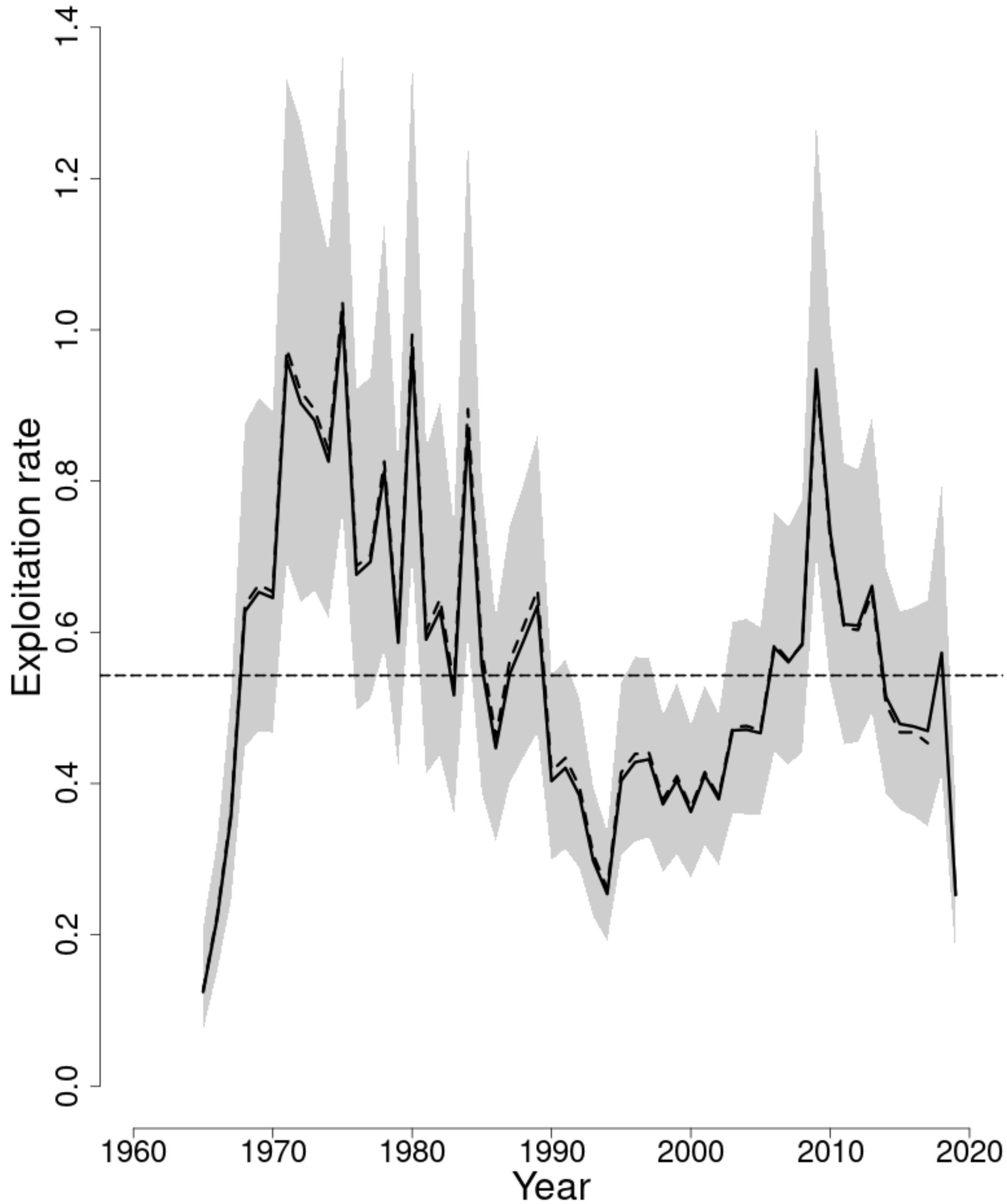


Figure 11: Trends in the average fishing mortality rate for ages 7–8, which are fully selected by the mobile fleet ($\bar{F}_{7-8}$), between 1965 and 2019 from the current (solid line) and previous (dashed line) assessment and the corresponding $F_{\text{Threshold}}$ ($F_{MSY\ proxy} = 0.543$; horizontal dashed line). The approximate 90% confidence intervals are shown.

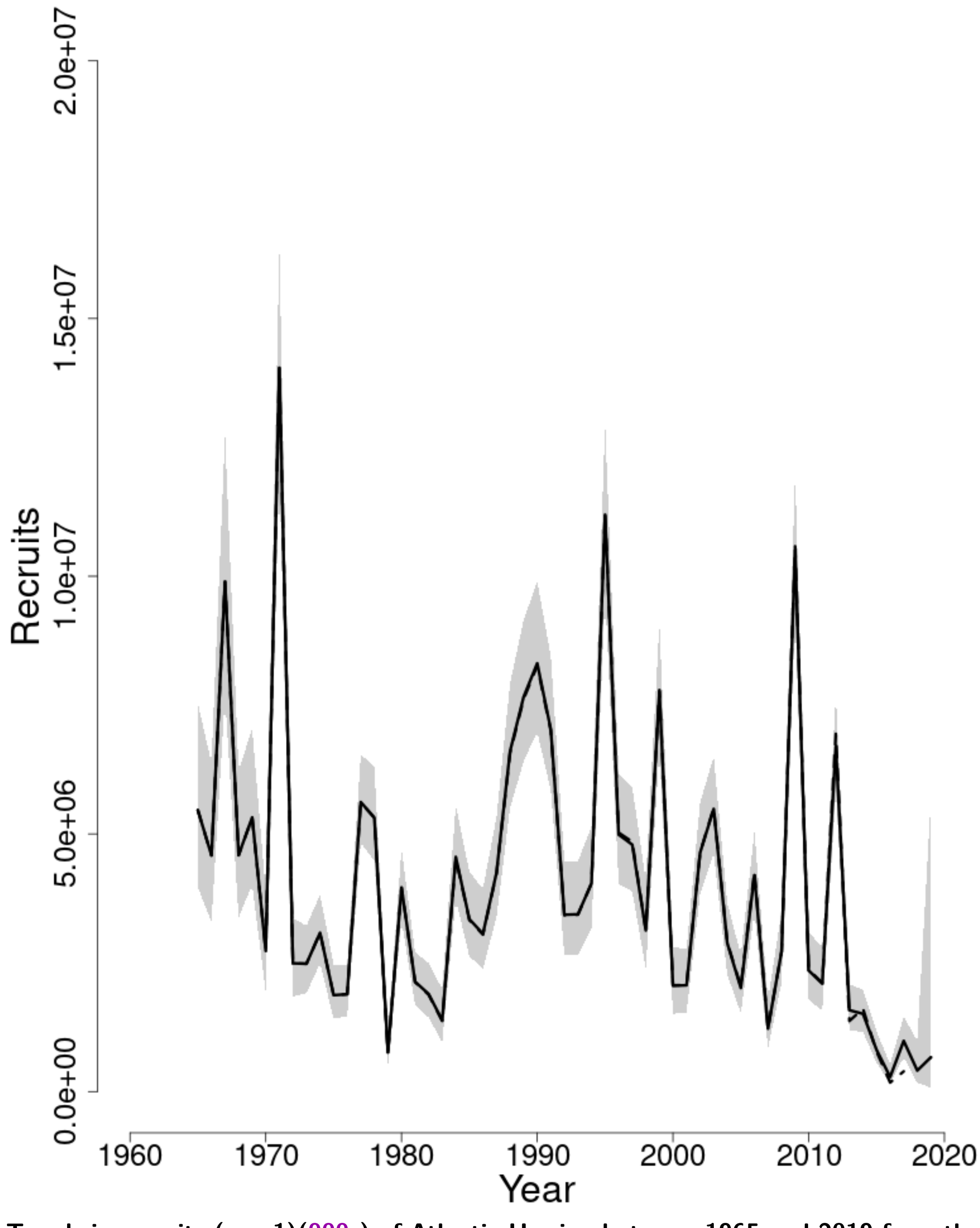


Figure 12: Trends in recruits (age-1)(000s) of Atlantic Herring between 1965 and 2019 from the current (solid line) and previous (dashed line) assessment. The approximate 90% confidence intervals are shown.

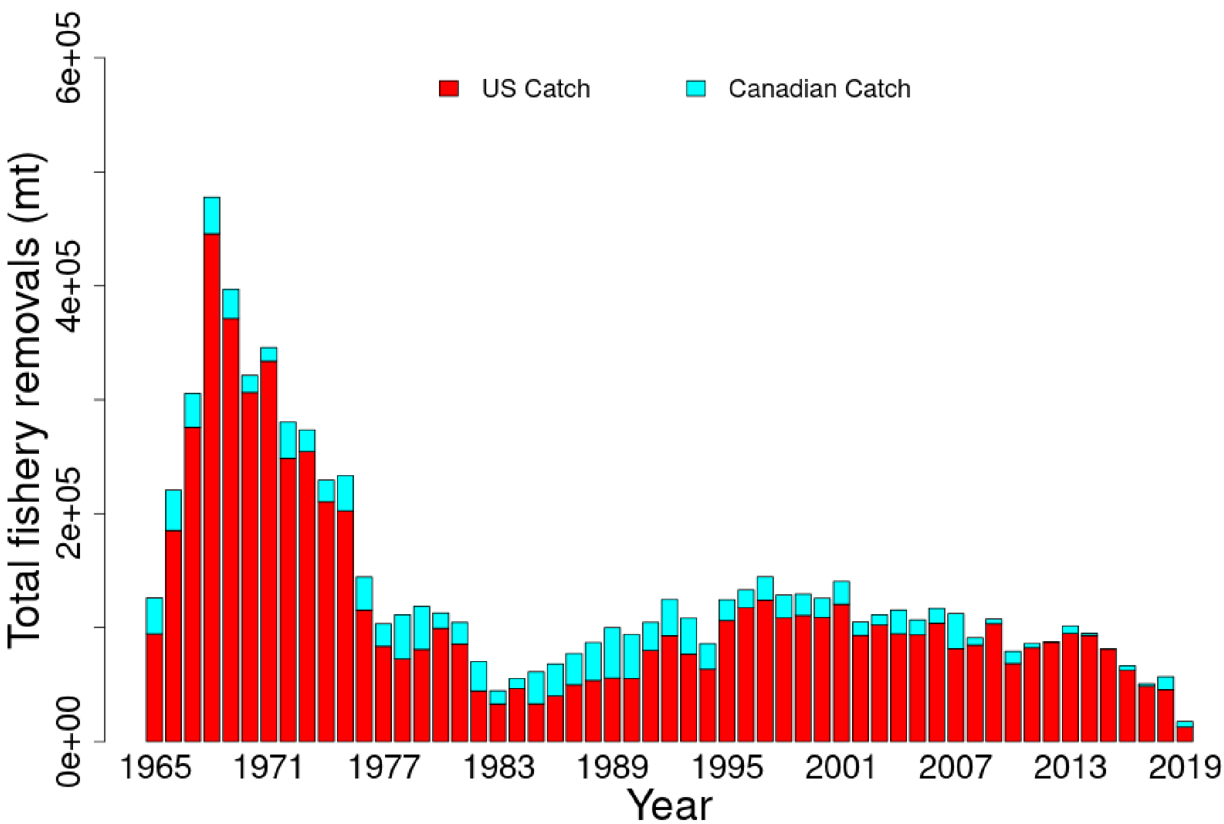


Figure 13: Total catch of Atlantic Herring between 1965 and 2019 by US and Canadian fleets.

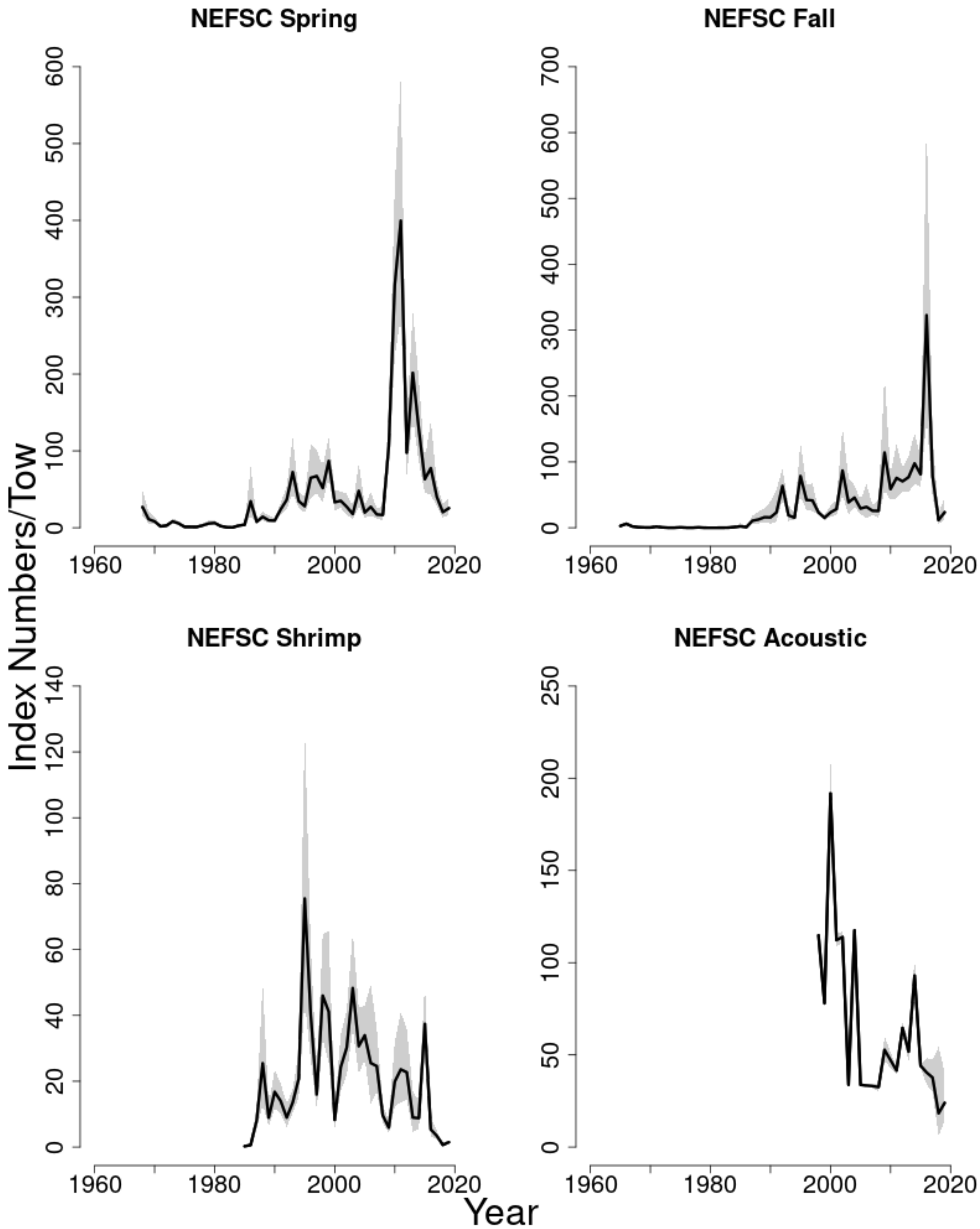


Figure 14: Indices of abundance for Atlantic Herring between 1965 and 2019 for the Northeast Fisheries Science Center (NEFSC) spring, fall, and shrimp bottom trawl surveys. The NEFSC acoustic index is collected during the fall bottom trawl survey and is in units of acoustic backscatter, not absolute numbers. The approximate 90% confidence intervals are shown.

4. OCEAN QUAHOG

Daniel Hennen

This assessment of the ocean quahog (Arctica islandica) stock is a management track assessment of the existing 2017 benchmark Stock Synthesis (SS) assessment (NEFSC 2017). Based on the previous assessment the stock was not overfished, and overfishing was not occurring. This assessment updates commercial fishery catch data, and commercial length composition data, as well as the analytical SS assessment model and reference points through 2019. No new survey data have been collected since the last assessment. Stock projections have been updated through 2026

State of Stock: Based on this updated assessment the ocean quahog (*Arctica islandica*) stock is not overfished and overfishing is not occurring (Figures 15–16). Retrospective adjustments were not made to the model results. Spawning stock biomass (*SSB*) in 2019 was estimated to be 3,651 ('000 mt) which is 172.8% of the biomass target ($SSB_{MSY\ proxy} = 2,113$; Figure 15). The 2019 fully selected fishing mortality was estimated to be 0.005 which is 25.5% of the overfishing threshold proxy ($F_{MSY\ proxy} = 0.019$; Figure 16).

Table 9: Catch and status table for ocean quahog. All data weights are in (mt) model results are ratios relative to reference points. Model results are from the current SS assessment.

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Data										
Landings South	16,257	14,332	15,757	14,555	13,817	13,629	13,689	13,406	14,328	10,928
Landings North	13	0	106	166	681	81	276	980	258	232
Discards South	5	7	104	5	2	1,682	566	623	795	0
Discards North	0	0	1	0	0	10	11	46	14	0
Catch for Assessment	16,275	14,339	15,968	14,726	14,500	15,402	14,542	15,055	15,396	11,160
Model Results										
Spawning Stock Biomass	2.02	2.04	2.06	2.07	2.09	2.11	2.12	2.14	2.15	2.16
F_{Full}	0.406	0.354	0.391	0.356	0.347	0.363	0.34	0.35	0.354	0.255
Recruits (age 3)	0.995	0.997	0.997	0.997	0.997	0.998	0.998	0.998	0.998	0.998

Table 10: Comparison of reference points estimated in an earlier assessment and from the current assessment update. An F_{MSY} proxy was used for the overfishing threshold and was based on a simulation study and scaled to the current assessment.

	2017	2020
$F_{MSY\ proxy}$	0.019	0.019 (0.011–0.032)
SSB_{MSY} ('000 mt)	2,014	2,113 (1,754–2,473)
MSY ('000 mt)	73	77
Overfishing	No	No
Overfished	No	No

Projections: Short term projections of biomass were derived by assuming average recruitment in each forecast year. Growth, fishery selectivity, and maturity ogive, were constant over time for each area and used in projection. Three projection scenarios were developed for use in management: status quo, which sets annual catch in each forecast year equal to the average catch over the last five years in each area; quota in which the current quota is caught each year and the proportions taken from each area are equal to the average proportions removed from each area over the last five years, and finally, OFL in which the catch is equal to the OFL applied to the terminal biomass in each area. These projections are available in the document entitled OceanQuahogUpdateMT2020....pdf and found on the upload site for SASINF.

Table 11: Short term projections of total fishery catch and spawning stock biomass for ocean quahog based on a harvest scenario of fishing at $F_{MSY\ proxy}$ between 2020 and 2026.

Year	Catch (mt)	SSB ('000 mt)	F_{Full}
2020	44893	3694	1.02

Year	Catch (mt)	SSB ('000 mt)	F_{Full}
2021	44961	3686	1.02
2022	45001	3675	1.02
2023	45012	3664	1.02
2024	44994	3650	1.02
2025	44948	3636	1.02
2026	44875	3620	1.02

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).

Scale has been uncertain in all previous ocean quahog assessments. Scale uncertainty is driven by the the fact that the stock is lightly fished. Survey indices generally do not respond to contrast in fishing intensity and the model has difficulty deciding on scale once there are enough animals to make fishing an unimportant driver of total mortality. Additionally, the NEFSC clam survey did not survey the northern area very well in the early part of the time series. Evidence for this includes relatively low precision and improbably large changes in abundance for a very long lived species that was not being fished at the time. Recent changes to the NEFSC clam survey have improved performance of the survey and the assessment for Atlantic surfclam. Scale is expected to be better defined in future assessments once new ocean quahog survey data are collected.

Estimates of recruitment remain uncertain as the survey gear does not select well for younger animals. Uncertainty in recruitment is relatively unimportant in this stock due to their longevity and low fishing mortality.

- 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}).

  No retrospective adjustment of spawning stock biomass or fishing mortality in 2019 was required. The 7-year Mohn's ρ, relative to SSB, was 0.008 in 2019. The 7-year Mohn's ρ, relative to F, was −0.038 in 2019.

- 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 ocean quahog, are reasonably well determined and projected biomass from the last assessment was within the confidence bounds of the biomass estimated in the current assessment. This stock was 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.

  No changes were made to the ocean quahog assessment for this update beyond updating to the latest version of Stock Synthesis. No new survey data was available, but the NEFSC clam survey was re-stratified see the section 'Build a Bridge' in OceanQuahogUpdateMT2020....pdf found on the upload site for SASINF.

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

  Stock status did not change. Without any new survey data since the last assessment, there was very little change of any kind.

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

  The assessment shows that the ocean quahog stock remains lightly fished and at relatively high abundance. Empirical estimates of abundance and exploitation rate support assessment results—see the section entitled 'Plan B assessment' in OceanQuahogUpdateMT2020....pdf found on the upload site for SASINF.

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

There is little age data for ocean quahog available due to the high cost of aging. Therefore growth changes over time are relatively poorly known. Additional work on age and growth would be useful.

- Are there other important issues?
  No.

4.1. Reviewer Comments: Ocean quahog

Ocean quahog was not peer reviewed in 2020.

References:

Northeast Fisheries Science Center. 2017. In: 63rd Northeast Regional Stock Assessment Workshop (SAW 63) Assessment Summary Report. US Dept Commer, Northeast Fish Sci Cent Ref Doc. 17-10; 409 p. http://www.nefsc.noaa.gov/publications/

Arctica islandica, Ocean Quahog.

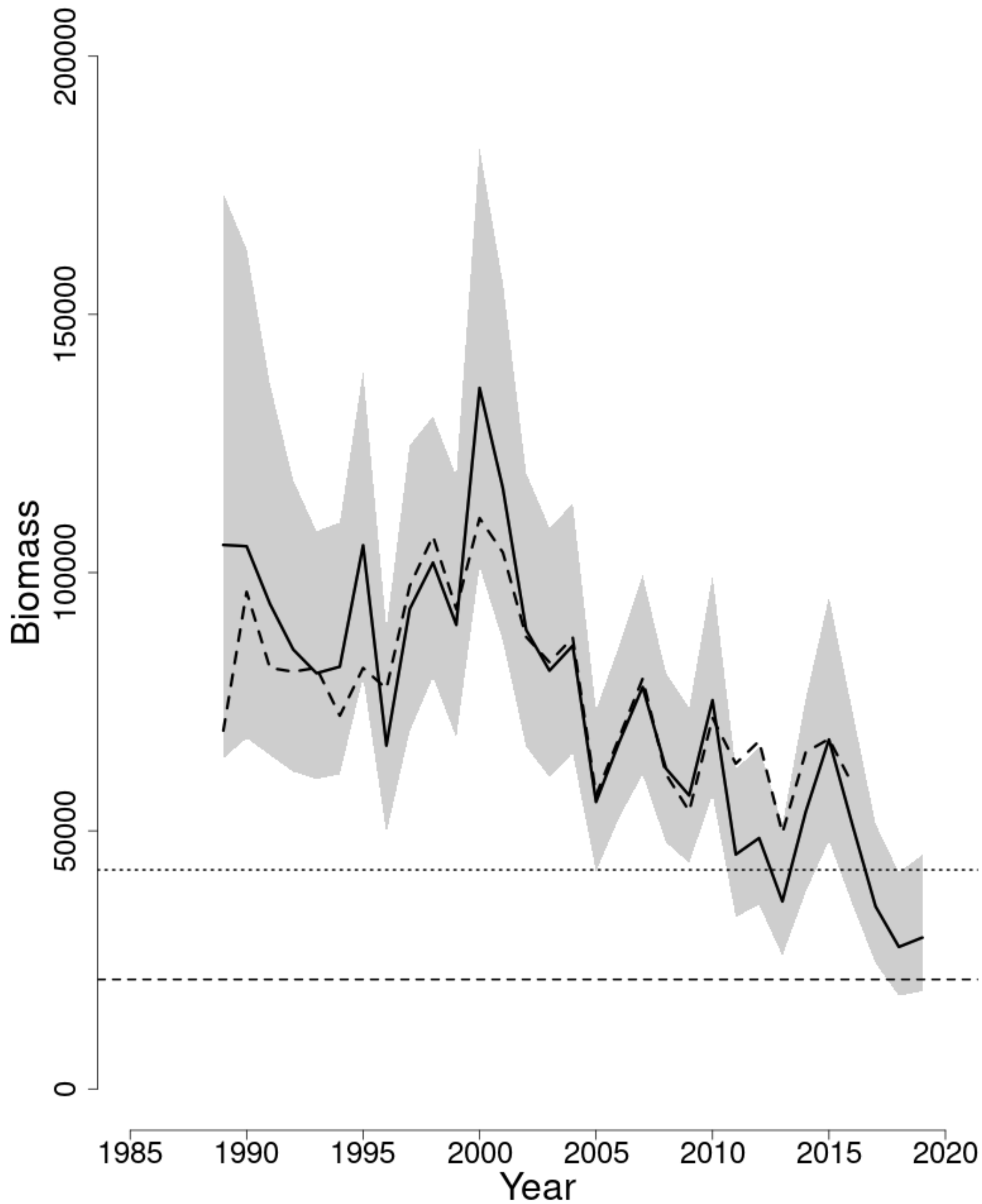


Figure 15: Trends in spawning stock biomass of ocean quahog between 1982 and 2020 from the current (solid line) and previous (dashed line) assessment and the corresponding $SSB_{\text{Threshold}}(\frac{1}{2}\,SSB_{MSY\ proxy}$; horizontal dashed line) as well as $SSB_{\text{Target}}(SSB_{MSY\ proxy}$; horizontal dotted line) based on the 2020 assessment. Units of SSB are the ratio of annual biomass to the biomass threshold ($\frac{SSB}{SSB_{\text{Threshold}}}$). The approximate 90% log-normal confidence intervals are shown.

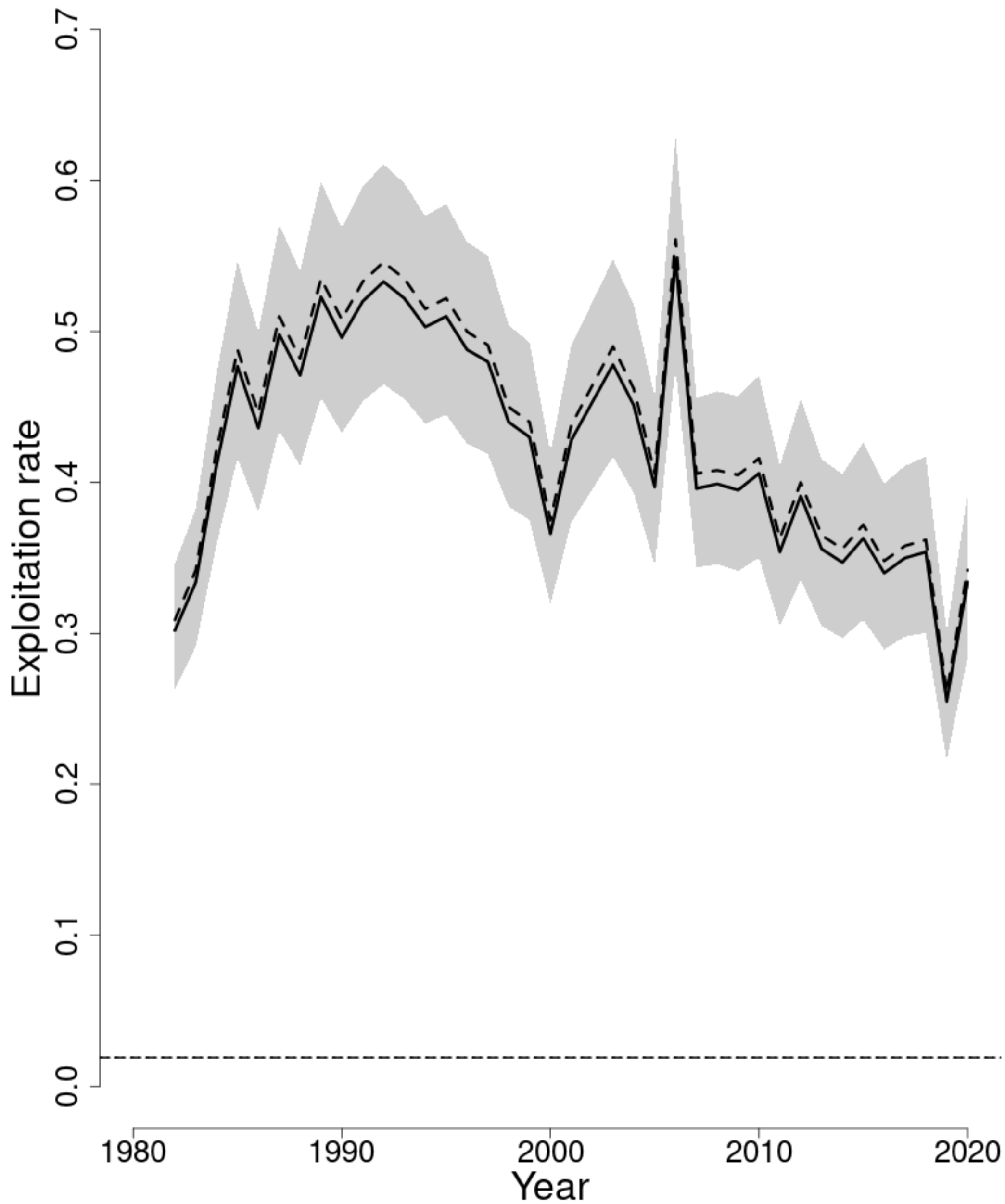


Figure 16: Trends in the fully selected fishing mortality (F_{Full}) of ocean quahog between 1982 and 2020 from the current (solid line) and previous (dashed line) assessment and the corresponding $F_{\text{Threshold}}$ ($F_{MSY\ proxy} = 0.019$; horizontal dashed line), based on the 2020 assessment. Units of fishing mortality are the ratio of annual F to the $F_{\text{Threshold}}$ ($\frac{F}{F_{\text{Threshold}}}$). The approximate 90% log-normal confidence intervals are shown.

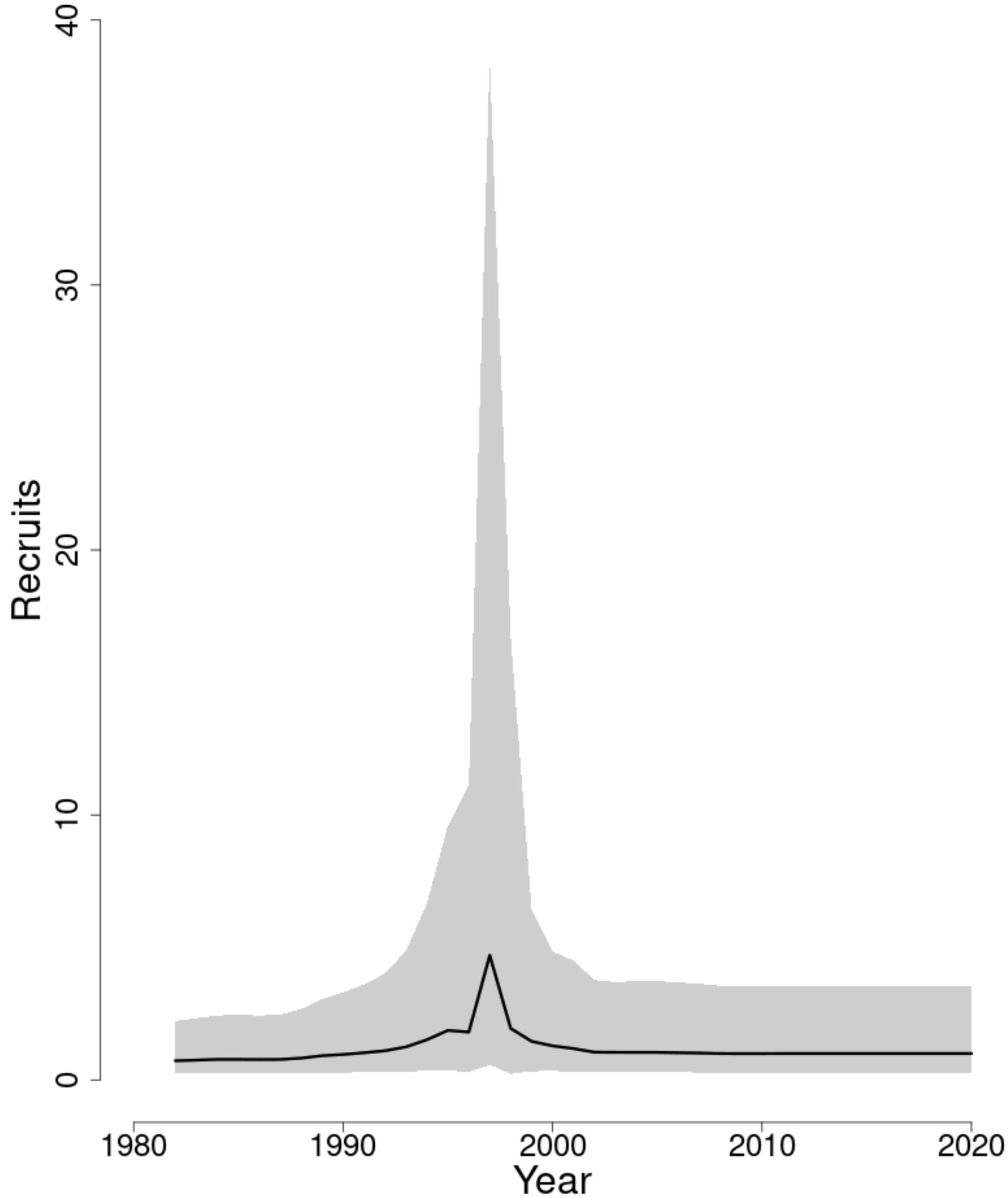


Figure 17: Trends in Recruits (age-3) of ocean quahog between 1982 and 2020 from the current (solid line) and previous (dashed line) assessment. Units of recruitment are the ratio of annual R to the unfished R (R/R_0). The approximate 90% log-normal confidence intervals are shown.

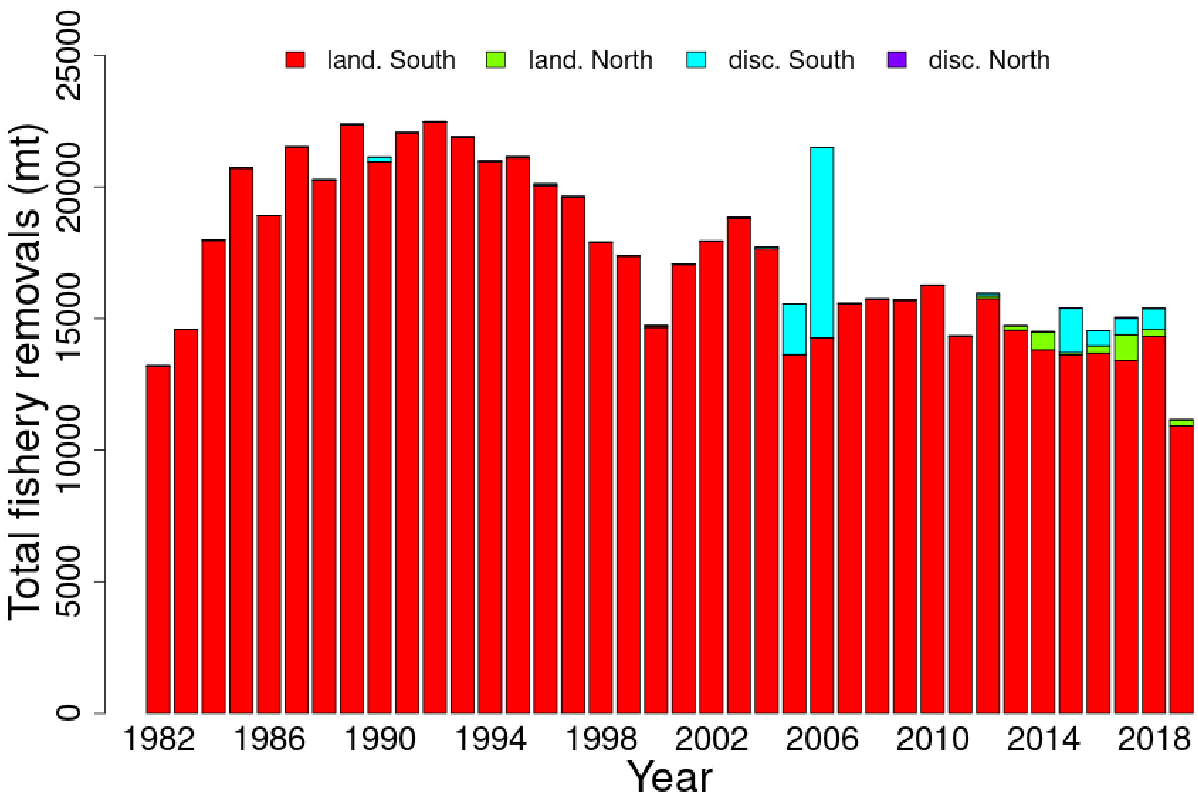


Figure 18: Total catch of ocean quahog between 1982 and 2020 by fleet and disposition (landings and discards).

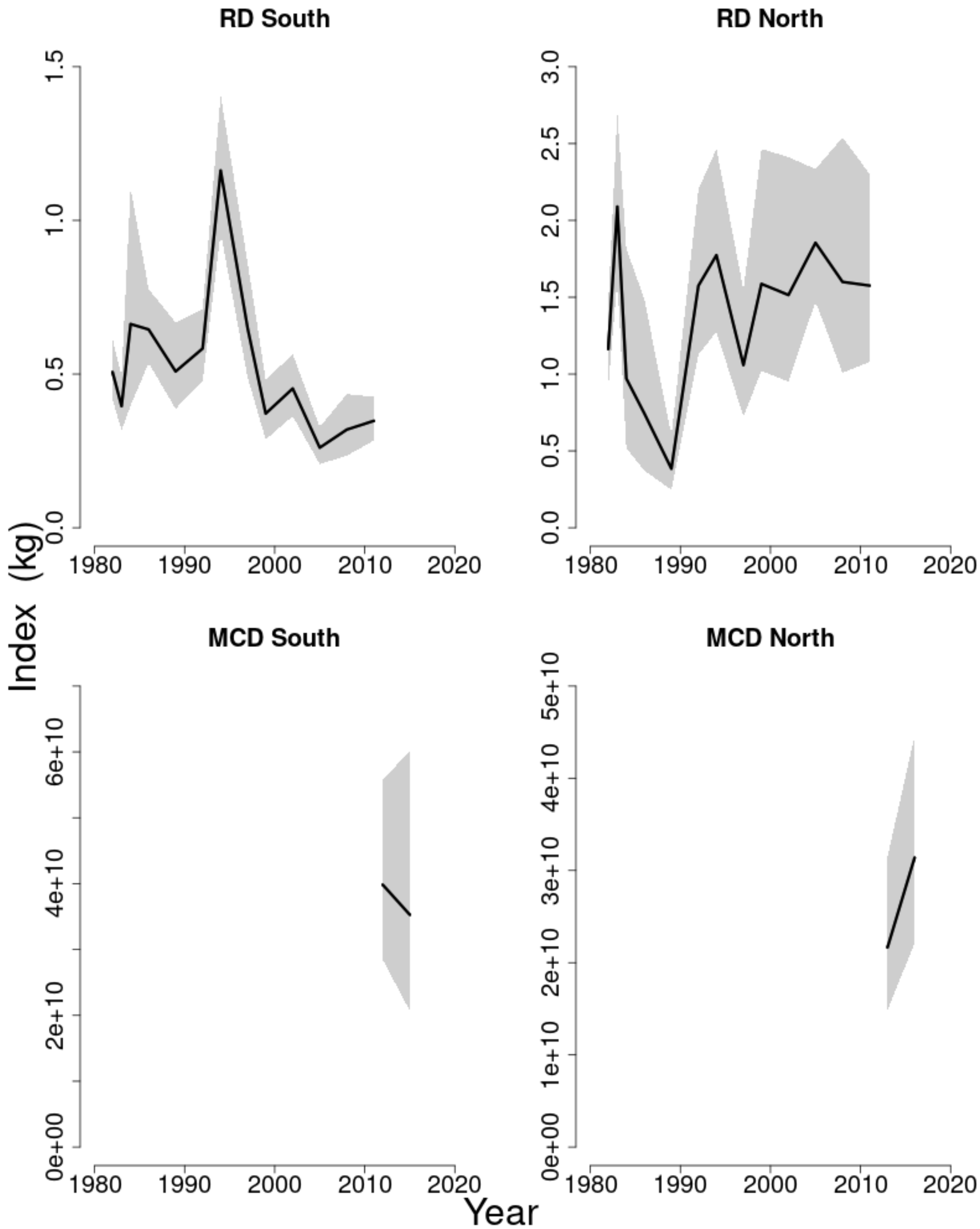


Figure 19: Indices of biomass for the ocean quahog between 1982 and 2016 for the Northeast Fisheries Science Center (NEFSC) clam surveys in the north and south. The RD survey units are weight per tow (kg) and the MCD survey units are swept area numbers (n). The approximate 90% log-normal confidence intervals are shown.

5. ATLANTIC SURFCLAM

Daniel Hennen

This assessment of the Atlantic surfclam (Spissula solidissima) stock is a management track assessment of the existing 2017 benchmark Stock Synthesis (SS) assessment (NEFSC 2017). Based on the previous assessment the stock was not overfished, and overfishing was not occurring. This assessment updates commercial fishery catch data, research survey indices of abundance, commercial length composition, survey length composition and conditional age at length data as well as the analytical SS assessment model and reference points through 2019. Stock projections have been updated through 2026

State of Stock: Based on this updated assessment, the Atlantic surfclam (*Spissula solidissima*) stock is not overfished and overfishing is not occurring (Figures 20–21). Retrospective adjustments were not made to the model results. Spawning stock biomass (SSB) in 2019 was estimated to be 1,222 ('000 mt) which is 119% of the biomass target ($SSB_{MSY\ proxy} = 1,027$; Figure 20). The 2019 fully selected fishing mortality was estimated to be 0.036 which is 25.8% of the overfishing threshold proxy ($F_{MSY\ proxy} = 0.141$; Figure 21).

Table 12: Catch and status table for Atlantic surfclam. All data weights are in (mt) model results are ratios relative to reference points. Model results are from the current SS assessment.

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Data										
Landings South	16,672	16,452	14,408	14,148	14,992	15,014	13,502	12,083	12,307	11,728
Landings North	1,311	2,387	3,646	4,403	3,236	4,104	4,837	4,819	3,962	3,245
Discards South	9	4	0	3	2	79	42	21	130	0
Discards North	1	1	0	1	0	22	15	8	42	0
Catch for Assessment	17,992	18,844	18,054	18,555	18,230	19,219	18,396	16,932	16,441	14,973
Model Results										
$\frac{SSB}{SSB_{\text{Threshold}}}$	2.49	2.44	2.42	2.44	2.47	2.49	2.48	2.46	2.44	2.38
$\frac{F}{F_{\text{Threshold}}}$	0.246	0.273	0.272	0.287	0.293	0.308	0.293	0.271	0.273	0.258
R/R_0	1.155	1.217	0.961	0.78	1.105	0.808	0.784	0.583	0.793	0.991

Table 13: Comparison of reference points estimated in an earlier assessment and from the current assessment update. An F_{MSY} proxy was used for the overfishing threshold and was based on a simulation study and scaled to the current assessment.

	2017	2020
$F_{MSY\ proxy}$	0.019	0.141 (0.087 − 0.222)
SSB_{MSY} ('000 mt)	2688	1027 (583 − 1470)
Overfishing	No	No
Overfished	No	No

Projections: Short term projections of biomass were derived by assuming average recruitment in each forecast year. Growth was assumed to be equal to the growth in the final year of each area. Fishery selectivity for each fleet, and maturity ogive were constant over time for each area. Three projection scenarios were developed for use in management: status quo, which sets annual catch in each forecast year equal to the average catch over the last five years in each area; quota in which the current quota is caught each year and the proportions taken from each area are equal to the average proportions removed from each area over the last five years, and finally, OFL in which the catch is equal to the OFL applied to the terminal biomass in each area.

These projections are available in the document entitled AtlanticSurfclamUpdateMT2020...pdf and found at the upload site for SASINF.

Table 14: Short term projections of total fishery catch and spawning stock biomass for Atlantic surfclam based on a harvest scenario of fishing at $F_{MSY\ proxy}$ between 2020 and 2026.

Year	Catch (mt)	SSB ('000 mt)	$\frac{F}{F_{\text{Threshold}}}$
2020	55337	1124	1.02

Year	Catch (mt)	SSB ('000 mt)	$\frac{F}{F_{\text{Threshold}}}$
2021	51361	1069	1.02
2022	48202	1039	1.02
2023	45959	1026	1.02
2024	44629	1019	1.02
2025	44048	1018	1.02
2026	43886	1021	1.02

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 scale of abundance has been uncertain in all previous Atlantic surfclam assessments. In past assessments scale uncertainty was driven by the combination of an uncertain survey abundance index in the northern area and the fact that the stock is lightly fished. Both factors have been mitigated by recent changes and scale is better defined in this assessment. Improvements to the NEFSC clam survey, additional data and increased fishing pressure have reduced uncertainty in the survey abundance estimates in the northern area.

Survey indices in the northern area appear to have responded to fishing pressure. Swept area abundance estimates have gone down by approximately the amount removed by the fishery over the saame time period. This represents the first time Atlantic surfclam indices have responded to fishing. Percieved fishing mortality has therefore changed, which influences the overall assessment in several important ways. Scale is difficult to determine in low F fisheries, a problem that has plaugued the Atlantic surfclam assessment for many years. Increased fishing pressure has led to increased precision of both fishing mortality and biomass estimates in north since the last assessment. Uncertainty in scale for the whole stock has therefore decreased. It should be noted however, that the improved NEFSC clam survey has run for only one season in each area. The benefits to the assessment described here accrue in part because of re-stratification, which may induce spatial biases as past surveys were not conducted under the current stratification. Additional survey years using the new stratification will be important in bearing out, or reducing confidence in, the current model outputs.

Estimates of recruitment remain uncertain as the survey and commercial gear does not select for younger animals. Uncertainty in recruitment is relatively unimportant in this stock due to species longevity, and relatively low fishing mortality overall.

- 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}).

  Retrospective adjustments to F are not appropriate for this stock because the reference points are based on trend rather than scale and adjusting the terminal estimate of F would require adjusting the reference point as well. Furthermore a 7-year Mohn's ρ cannot be calculated because there are no observations of the MCD survey in the north before 2013. Therefore components of the model relevant to that survey cannot be estimated. Future assessments of Atlantic surfclam could provide a seven year Mohn's ρ calculation, but unless the F reference point is changed to more traditional values, retrospective adjustments do not make sense. Retrospective adjustments to biomass based on a 6-year Mohn's ρ are possible, but not warranted in this case as the retrospective pattern in SSB is minor (see the document AtlanticSurfclamUpdateMT2020...pdf at the upload site for SASINF for more discussion of retrospective patterns).

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

  Population projections for Atlantic surfclam, are reasonably well determined and projected biomass from the last assessment was within the confidence bounds of the biomass estimated in the current assessment. This stock was 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.

Several changes were made to the Atlantic surfclam assessment for this update. The most significant of these was the shift from two models with one area each, to one model with two areas. Other important changes were the inclusion of time varying growth in the southern area, and allowing the model to estimate selectivity parameters. Time varying growth was modeled as a trend in the average maximum size as well as a trend in the Von Bertalanffy K parameter. The assessment model estimated most of the selectivity parameters for both commercial and survey fleets in this update, where previously they were fixed. These changes are discussed in more detail the section 'Build a Bridge' in the document entitled AtlanticSurfclamUpdateMT2020...pdf and found at the upload site for SASINF.

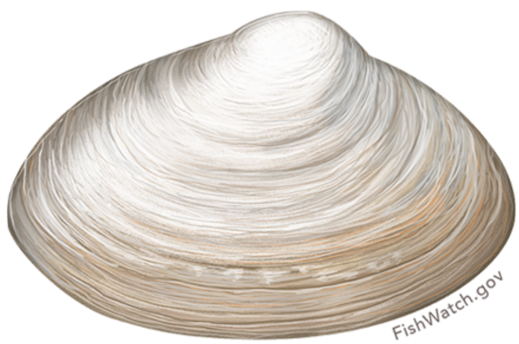
- If the stock status has changed a lot since the previous assessment, explain why this occurred.
  Stock status did not change. Perception of abundance in the northern area, however, has changed. At one time abundance in the northern area was believed to be about equal to abundance in the south. Currently, abundance in the northern area appears low and there is no evidence of strong recruitment in recent years. Early survey data from the northern area is not fit well by the model, but is likely to be of relatively low quality. Therefore the unfished abundance in the northern area is probably not well described. Abundance in the northern area may never have been very high compared to the abundance in the southern area.
  One consequence of the perception of lower biomass in the north is that fishing mortality there appears to be higher. This in turn affects the F trend for the whole stock and thus the estimate of the F reference point.

- Provide qualitative statements describing the condition of the stock that relate to stock status.
  The Atlantic surfclam stock remains lightly fished and at relatively high abundance in the southern area. The scale of the abundance agrees closely with the swept area abundance estimates for each area (see the section 'Plan B Assessment' in the document entitled AtlanticSurfclamUpdateMT2020...pdf at the upload site for SASINF.

- Indicate what data or studies are currently lacking and which would be needed most to improve this stock assessment in the future.
  While the overall abundance of Atlantic surfclam remains at or above it's target abundance, the clam industry may be concerned about declining catch rates as the remaining dense aggregations of Atlantic surfclam are fished down. If reduced density makes the Atlantic surfclam fishery economically non-viable, the fishery could contract or even collapse without the stock ever being overfished or experiencing overfishing. Some management on smaller spatial scales, with the objective of maintaining dense aggregations, may be waranted, and should probably be investigated.

- Are there other important issues?
  Atlantic surfclam mature very quickly (< 2 years) and are not selected by commercial gear until they are 5 to 7 years old. A traditional F_{MSY} reference point will therefore be nearly infinite. A trend based alternative has been used here, and in the previous assessment, but the methods for deriving it should perhaps be revisited given the changes in growth in the southern area. Previous assumptions regarding growth under warming conditions (faster growth to a smaller

maximum size) may not be correct. The model estimated here shows a reduced Von Bertalanffy K *parameter, as well as a reduced average maximum size over time in the southern area. This would be consistent with slower growth to a smaller maximum size. There is new research supporting this hypothesis. Pousse et al. (in review) studied Atlantic surfclam and ocean acidification and their results indicate that scope for growth is likely to be much lower under OA conditions. In addition, the current low stock size in the northern area may provide a basis for estimating the steepness parameter of the stock recruitment relationship in Atlantic surfclam, which has not previously been possible due to the lack of any observed low stock abundance condition. A new management strategy evaluation of Atlantic surfclam may be warranted.*



Spisula solidissima, Atlantic Surfclam.

5.1. Reviewer Comments: Atlantic surfclam

Several significant changes and updates are described in this assessment, the most notable of which is to assess the current stock areas (Georges Bank, Mid-Atlantic/Southern New England) within a single Stock Synthesis (3.30) model structure. In this Management Track Assessment, the SS3.30 model is configured with two areas to assess overall stock status. The Assessment Oversight Panel (AOP) had endorsed that approach and noted the improved efficiency of assessing the resource within a single model structure. Concerns were expressed by the AOP about potential problems with implementation, but the data and parameterization required only modest changes from those for the separate models in the previous assessments. Owing to the cumulative proposed changes in the ongoing assessment, the AOP recommended an Enhanced Review (Level 3) for surfclams in this Management Track Assessment.

The Management Track Assessment also includes new information from the redesigned Atlantic surfclam/Ocean quahog abundance survey that is conducted using a commercial fishing vessel. Results for Georges Bank suggest a lower abundance there than had been estimated in previous assessments.

The PRP agrees with the assessment's conclusion that the surfclam resource is not overfished and is not experiencing overfishing. The assessment also benefitted from improved survey abundance information obtained in the first implementation of the redesigned NEFSC surfclam survey. This assessment represents the first use of data from the new survey. The PRP concludes that the 2020 management track assessment for surfclam is technically sufficient to evaluate stock status and provide scientific advice. The assessment represents the BSIA for this stock for management purposes.

Atlantic Surfclam Terms of Reference (TOR)

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

   This TOR was satisfactorily addressed. Landings, discards, and their trends, are described in detail. Catches that include both ocean quahog and Atlantic surfclam have become more common in recent years, resulting in significant ocean quahog discards, which could result in changes in catches and discard patterns in the future. Landings data are believed to be accurate, and landings well below quotas are reflective of market conditions more than availability of the resource.

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. The newly implemented NEFSC clam survey effectively reduced "data borrowing" by analyzing the old survey data using the new survey strata. Abundance on Georges Bank is estimated to be substantially lower than in older assessments. This change is largely due to improved survey methods (more efficient dredge, better coverage of the area) in recent years. Index data on age-length composition are adequate to characterize the age-size structure and support growth analyses. Recruitment of young surfclams ($<$age-5) and its variability are poorly known due to the selectivity of the survey gear. The only ongoing state survey (MA) is not currently included in the assessment.

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. The new management track assessment addressed several of the criticisms of the previous assessment (SAW 61).

   As in past assessments, scaling of abundance estimates has been difficult to accomplish, but the trends remain consistent. Scaling is better in this most recent assessment in that results are now more in agreement with the catchability studies and the estimated biomass is more precise. The PRP still has questions about domed survey selectivity in the model because the selectivity experiments largely support flat-topped selectivity.

   The increased F now estimated for Georges Bank indicates that fishing may measurably affect biomass of the stock. This outcome should assist analysts in determining effects of fishing on the stock in future assessments.

   Time-varying growth was included in the Mid-Atlantic/Southern New England region to account for observed decreases in mean size-at-age. The PRP agrees that including time-varying growth is warranted and represents an improvement in the assessment.

   The assessment model appears to be highly dependent on the prior for survey catchability to estimate stock biomass. Previous assessments estimated sufficiently low fishing mortality rates that catches did not provide a sufficient signal in the data to estimate biomass without an informative prior on survey catchability. However, with increasing fishing mortality, catches should have a larger effect on the population, which may be seen in future surveys (particularly on Georges Bank).

   Detailed bridge runs and sensitivity analyses were conducted, and detailed diagnostics were presented. The model performs sufficiently well for provision of management advice.

   Because the PRP accepted the assessment model results, the 'Plan B' assessment (swept area estimates) was not considered further.

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. The PRP agrees that stock status has been accurately characterized. Stock biomass remains slightly above B_{Target}, and well above $B_{\text{Threshold}}$, and fishing mortality remains well below $F_{\text{Threshold}}$. The conclusions are consistent with previous determinations of stock status and indicate that the stock is neither overfished nor experiencing overfishing.

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

   This TOR was satisfactorily addressed. Short-term projections were conducted under three scenarios. These indicated that only at $F_{\text{Threshold}}$ does the stock show substantial decline. Status quo and quota fishing levels had little effect on stock status, with $B/B_{\text{Threshold}}$ remaining >2 and $F/F_{\text{Threshold}}$ well below 1.0, except at $F_{\text{Threshold}}$, an unlikely fishing level under the present management and market conditions for surfclam.

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

   This TOR was satisfactorily addressed. A long list of recommendations or issues to be addressed emanated from SAW 61. Many were successfully addressed in this management track assessment (including improving growth modeling, reducing "data borrowing", the redesign of the survey strata, and combining the previous two separate models into one model with two areas) or are being addressed. Others, including some that would require substantial research effort, remain to be considered. Overall, continuing progress in addressing issues and concerns is substantial and commendable.

Additional Recommendations

1. The PRP noted that selectivity in the survey is substantially lower for large individuals than intermediate size individuals. There are substantial differences in the selectivity curves generated by the selectivity experiments and those modeled for the fishery. To potentially improve estimates of abundance, the PRP recommends that the possibility of flat-topped selectivity be explored for the survey and include a prior based on the selectivity experiment results.

2. The PRP had questions about the MCMC simulations and diagnostics, and whether effective sample sizes were adequate to provide reliable outcomes. The PRP recommends that additional exploratory runs be conducted with higher sample sizes to improve estimates of selectivity parameters. Specifically, the effective sample sizes for all estimated parameters should be calculated. Also, best practices include running multiple chains from different starting values to determine if they converge to the same stable mixing distributions (e.g., Gelman–Rubin plots).

3. Trends in LPUE and the survey abundance indices in the Mid-Atlantic/Southern New England are not congruent. A review of patterns in commercial LPUE may help to determine if commercial landing statistics support the changes in abundance estimated from the redesigned survey. Commercial LPUE is an imperfect measure of abundance because it is tightly linked to areas fished and is responsive to harvester fishing strategies that concentrate fishing effort on high-density aggregations of surfclams. Analyses and evaluation of LPUE may be most relevant if the assessment moves to a finer spatial scale.

4. The effects of time-varying growth on reference points and recruitment to the fishery will benefit from more research.

References:

Northeast Fisheries Science Center. 2016. In: 61st Northeast Regional Stock Assessment Workshop (SAW 61) Assessment Summary Report. US Dept Commer, Northeast Fish Sci Cent Ref Doc. 16-13; 26 p. http://www.nefsc.noaa.gov/publications/

Pousse, E., Hennen D., Munroe, D., Hart, D., Redman, D., Wikfors, G., Sennefelder, G., Lindsay, J., White, L., Dixon, *M*., Poach, *M*., Meseck, S., Li, Y. In Review. Physiological response of Atlantic surfclam, *Spisula solidissima*, to ocean acidification. Science of the Total Environment. In Review.

A handful of surf clams.

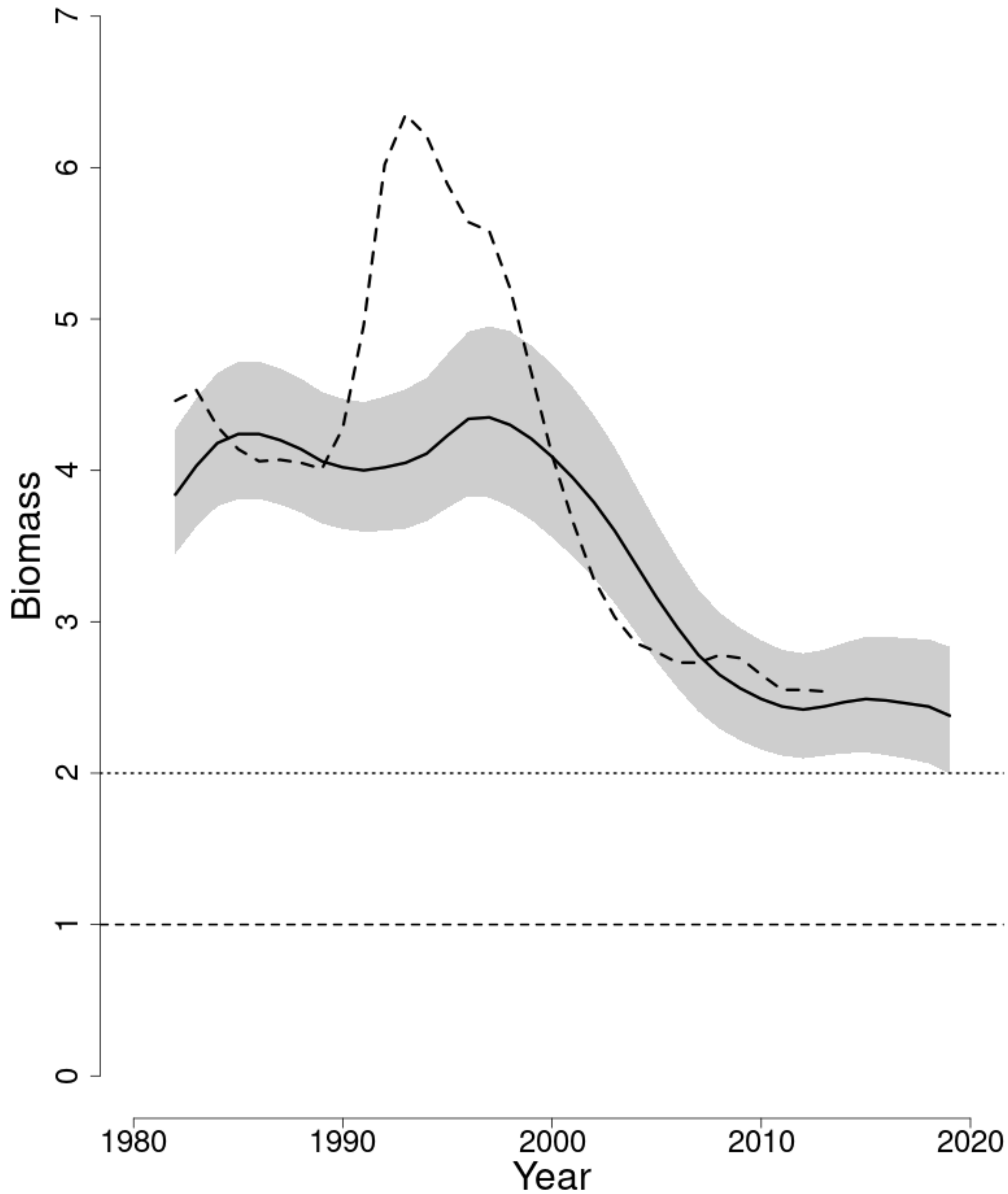


Figure 20: Trends in spawning stock biomass of Atlantic surfclam between 1982 and 2019 from the current (solid line) and previous (dashed line) assessment and the corresponding $SSB_{\text{Threshold}}$($\frac{1}{2}$ $SSB_{MSY\ proxy}$; horizontal dashed line) as well as SSB_{Target}($SSB_{MSY\ proxy}$; horizontal dotted line) based on the 2020 assessment. Units of SSB are the ratio of annual biomass to the biomass threshold ($\frac{SSB}{SSB_{\text{Threshold}}}$). The approximate 90% log-normal confidence intervals are shown.

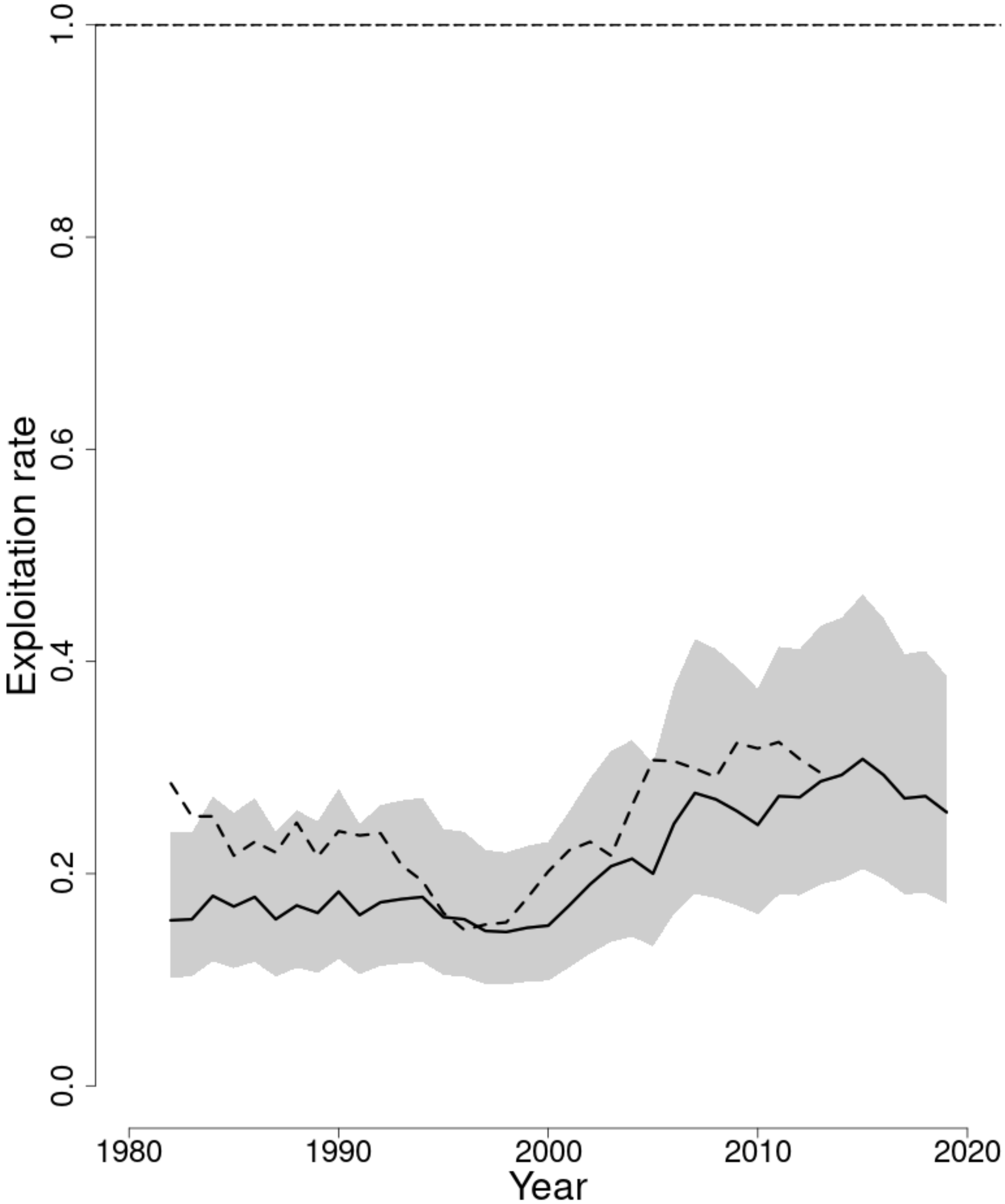


Figure 21: Trends in the fully selected fishing mortality (F_{Full}) of Atlantic surfclam between 1982 and 2019 from the current (solid line) and previous (dashed line) assessment and the corresponding $F_{\text{Threshold}}$ ($F_{MSY\ proxy} = 0.141$; horizontal dashed line), based on the 2020 assessment. Units of fishing mortality are the ratio of annual F to the $F_{\text{Threshold}}$ ($\frac{F}{F_{\text{Threshold}}}$). The approximate 90% log-normal confidence intervals are shown.

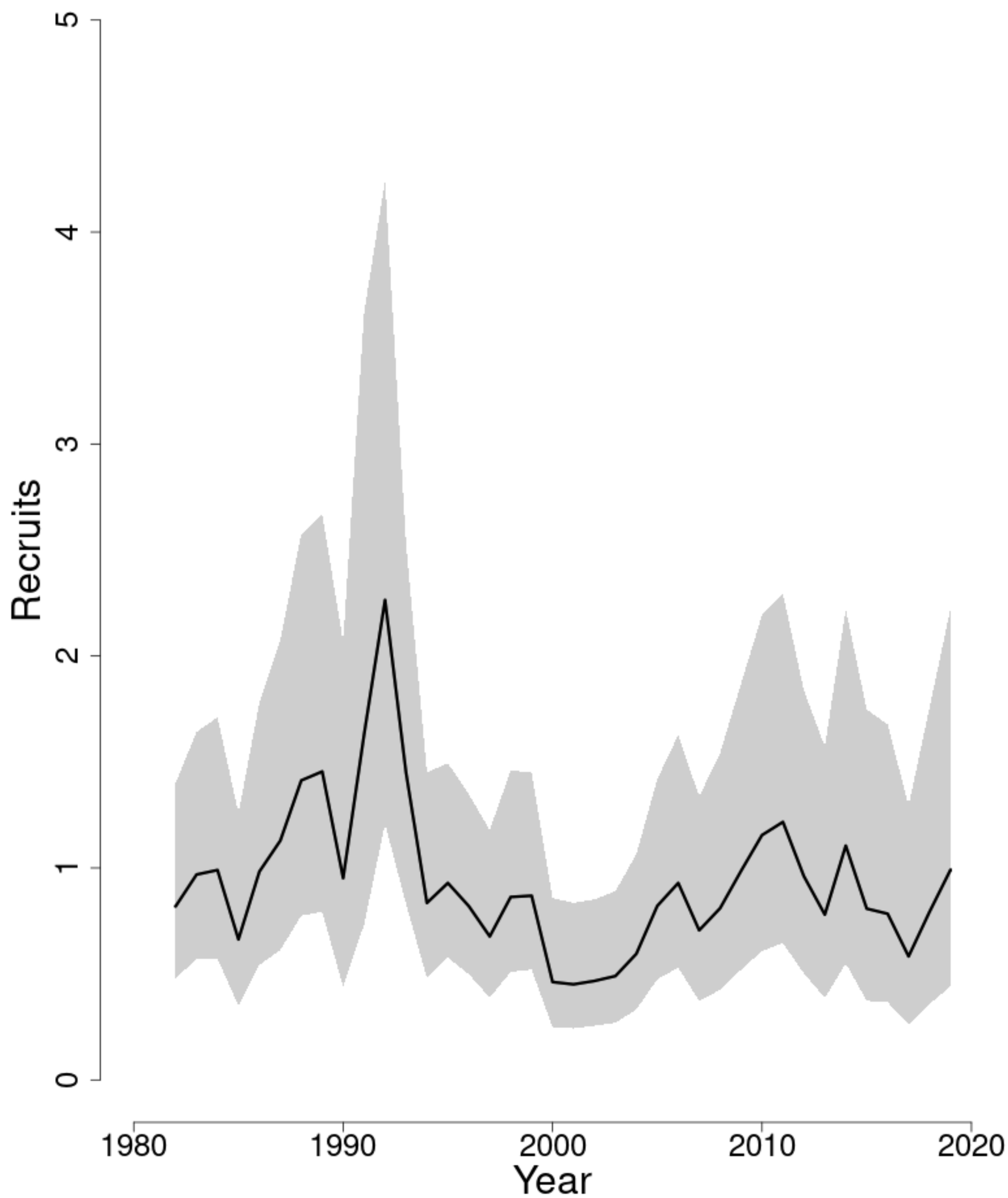


Figure 22: Trends in R/R_0 of Atlantic surfclam between 1982 and 2019 from the current (solid line) and previous (dashed line) assessment. Units of recruitment are the ratio of annual R to the unfished R (R/R_0). The approximate 90% log-normal confidence intervals are shown.

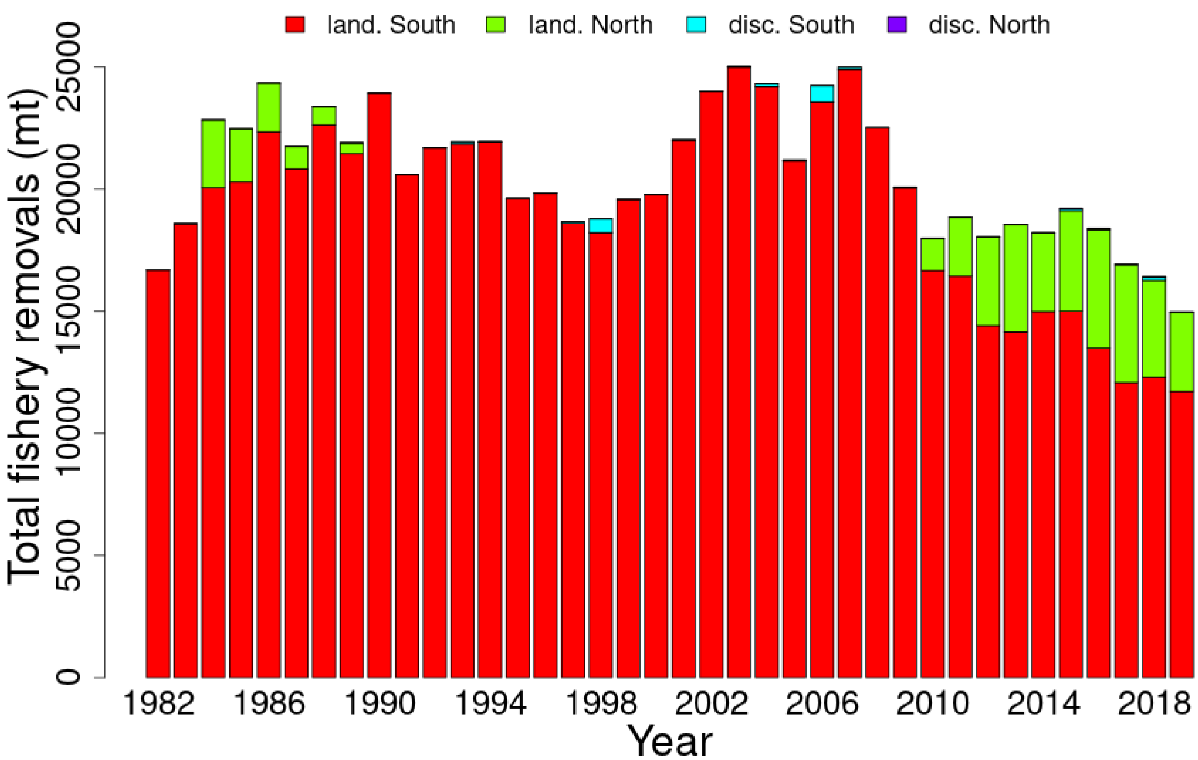


Figure 23: Total catch of Atlantic surfclam between 1982 and 2019 by fleet and disposition (landings and discards).

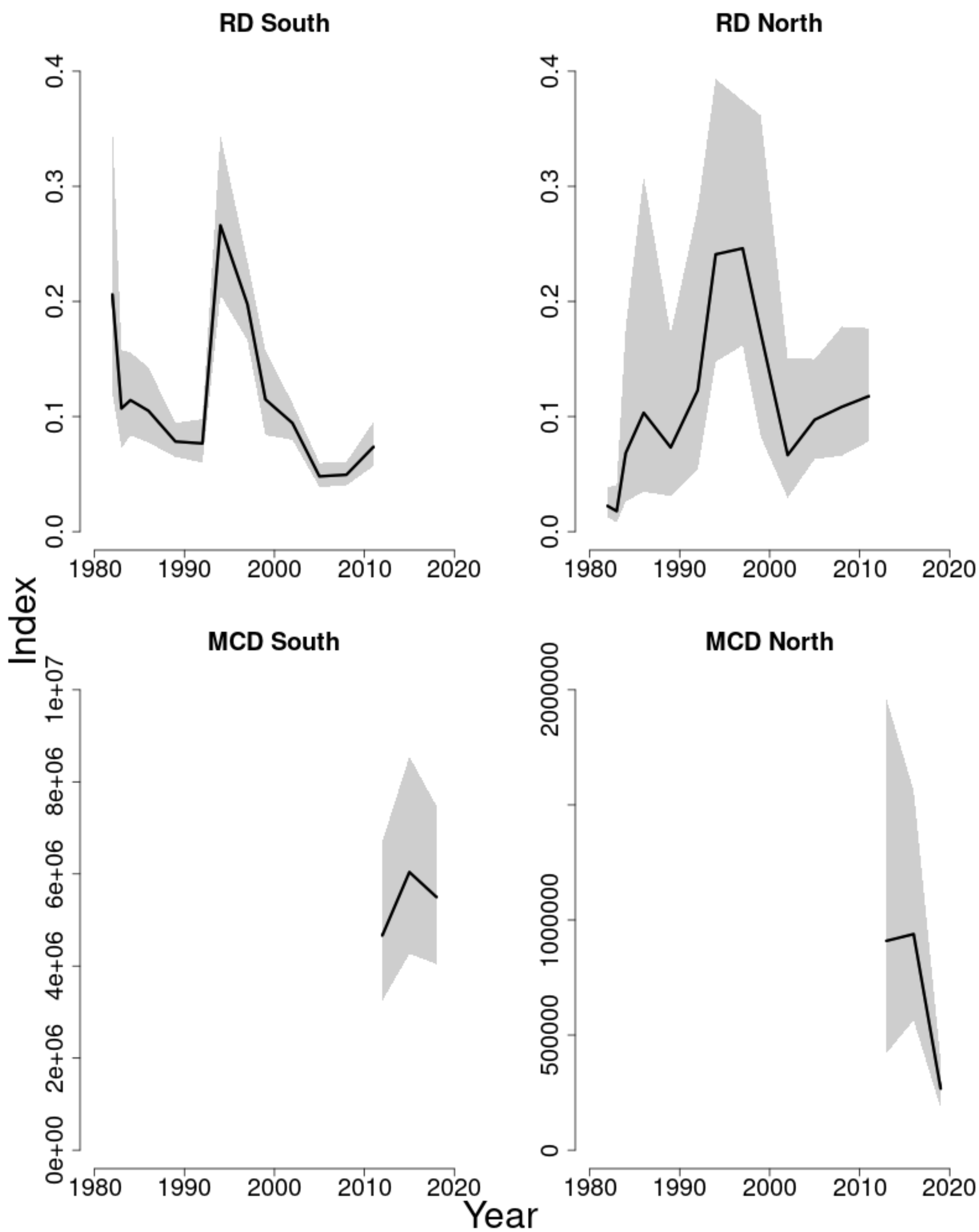


Figure 24: Indices of biomass for the Atlantic surfclam between 1982 and 2019 for the Northeast Fisheries Science Center (NEFSC) clam surveys in the north and south. The RD survey units are weight per tow (kg) and the MCD survey units are swept area numbers (n). The approximate 90% log-normal confidence intervals are shown.

Photo Gallery

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

Research vessel NOAAS Henry B. Bigelow, named after Henry Bryant Bigelow (1879–1967) oceanographer and marine biologist. Photo from NOAA website. On page 11

Sample of the Herring catch after a typical trawl. Photo NOAA. On page 37

Longfin squid well camouflaged on the sandy bottom. Photo NOAA. On page 24

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

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

A handful of surf clams. Photo NOAA. On page 60

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 33

Spisula solidissima, commonly known as Atlantic Surfclam, Surfclam, Hen clam, Bar clam, Sea clam; range: New England/Mid-Atlantic. Artwork from NOAA website. On page 56

Clupea harengus, commonly known as Butterfish, American butterfish, Atlantic butterfish, Dollarfish, Shiner, Skipjack, Sheepshead, Harvestfish; range: New England/Mid-Atlantic. Artwork from NOAA website. On page 7

Doryteuthis (Amerigo) pealeii, commonly known as Longfin Squid, Longfin inshore squid, Loligo, Winter squid, Boston squid; range: New England/Mid-Atlantic. Artwork from NOAA website. On page 21

Arctica islandica, commonly known as Ocean Quahog, Clam, Quahog, Black clam, Mahogany quahog; range: New England/Mid-Atlantic. Artwork from NOAA website. On page 46

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Summary of Assessment Oversight Panel Meeting

February 25, 2020 (all species)
Woods Hole, Massachusetts

April 29, 2020 (Atlantic Herring only)
Via Video Conference

The NRCC Assessment Oversight Panel (AOP) met to review the operational stock assessment plans for 6 stocks/species on February 25, 2020. The AOP held at subsequent video conference call on April 29, 2020 to re-evaluate the review level for the Atlantic herring assessment. The stock assessments for these stocks/species will be peer reviewed during a meeting from June 22-25, 2020.

The AOP consisted of:

Jason McNamee, Rhode Island Department of Environmental Management, representing the New England Fisheries Management Council

Mike Celestino, New Jersey Division of Fish and Wildlife, representing the Atlantic States Marine Fisheries Commission

Paul Rago, Ph.D., member of the MAMFC Scientific and Statistical Committee, NOAA Fisheries (retired)

Russell W. Brown, Ph.D. (Chair), Northeast Fisheries Science Center, Woods Hole, Massachusetts.

Meeting Participants (February 25, 2020):
The participants in Woods Hole included: the AOP members (4), James Weinberg (Stock Assessment Process Chair), Michele Traver (Stock Assessment Process Lead), Ariele Baker (Communications Specialist), Alicia Miller (Rapporteur) , Brian Stock (Rapporteur), Dan Hennen, Lisa Hendrickson, Kiersten Curti, Charles Adams, Jon Deroba, Kathy Sosebee, Dave Wallace, Tom Alsphalt, Tara Trinko Lake, Larry Alade, Mark Terceiro, Chris Legault, and Tony Wood.

Remote participation included: Jessica Coakley, Jessica Blaylock, Doug Potts, Diedre Bolke, Andrew Jones, Cate O'Keefe, Brandon Muffley, Steve Cadrin, Alyson Pitts, Benjamin Galuardi, Doug Christel, Chris Kellogg, Janice Plante, Dave Bethany, and Renee Zobel.

Meeting Participants (April 29, 2020):
Participants on the video/conference call included: the AOP members (4), Michele Traver, Brad Schondelmeir, Brandon Muffley, Erica Fuller, Greg Power, Carrie Nordeen, Corrine Truesdale, Janice Plante, Jon Deroba, Alyson Pitts, Charles Adams, Chris Legault, Chris Weiner, David Bethany, David Richardson, Elizabeth Etrie, Erica Fuller, Gary Shepherd, Katey Marancik,

Kiersten Curti, David Musina, Diedre Bolke, Mary Beth Tooley, Maria Fenton, Mark Terceiro, Mathew Cieri, Megan Ware, Melanie Griffin, Pam Thames, Peter Kendall, Richard Klyver, Sarah Gaichas, Steve Cadrin, Susan Wigley, Zoe Goozner, Raymond Kane and Heidi Leaman.

Meeting Details:

This meeting included implementation of the newly approved NRCC stock assessment guidance document. Three background documents were provided to the Panel: (1) an updated prospectus for each stock; (2) an overview summary all the salient data and model information for each stock; and (3) the NRCC Guidance memo on the Operational Assessments. The NRCC guidance memo was recognized as particularly relevant during the deliberations of the AOP. Prior to the meeting, each assessment lead prepared a plan for their assessments. The reports were consistent across species and reflected both the past assessment and initial investigations.

At the February 25th meeting, each lead scientist for each stock gave a presentation on the data to be used, model specifications, evaluation of model performance, the process for updating the biological reference points, the basis for catch projections, and an alternate assessment approach if their analytic assessment was rejected by the peer review panel. In some cases stocks were already being assessed using an “index-based” or “empirical” approach.

At the April 29th meeting, the lead scientist for the Atlantic herring stock gave a short presentation outlining emerging issues and requesting a reconsideration of the recommended review level.

Major Recommendations for Review of Individual Stocks:

In general, the AOP approved the plans presented, but recommended several revisions to recommended review levels as summarized below:

Stock	Lead	Major Recommendations
Atlantic Surfclam	Dan Hennen	Level 3 – Enhanced Review Plan B – Swept area biomass estimate based on survey and median q from depletion studies
Ocean Quahog	Dan Hennen	Level 1 – Direct Delivery Plan B – Swept area biomass estimate based on survey and median q from depletion studies
Butterfish	Charles Adams	Level 2 – Expedited Review Plan B – LOESS smoothing of NEFSC fall survey indices to infer future catch increase
Doryteuthis (Longfin Squid)	Lisa Hendrickson	Level 3 – Enhanced Review Plan B – This assessment currently involves Plan B approach.

Atlantic Herring	John Deroba	Level 2 – Expedited Review (changed from Level 1 during the April 29th meeting) Plan B – LOESS smoothing fit to mean of all survey indices
Atlantic Mackerel	Kiersten Curti	As a result of data availability issues the occurred after the February 25th meeting, the NRCC approved delaying this assessment until Spring 2021.

Individual Stock Discussion Summaries:

Atlantic Surfclam:
Several significant changes are proposed for this assessment, the most notable of which is to assess the current stock areas (Georges Bank, everywhere else) within a single model. The proposed change is consistent with the peer-reviewed modeling approach used for ocean quahog. Currently surfclams are assessed with two separate models and the results are pooled to create a combined reference points and measure of stock status. The Panel endorsed this proposal and noted the improved efficiency of assessing the resource within a single model structure. Concerns were expressed about possible unforeseen problems with implementation, but the data streams and parameterization require only modest changes from those used for the separate models. The model will be implemented with the latest version of Stock Synthesis (3.30).

This assessment will also include new information from the redesigned abundance survey conducted on commercial fishing vessels. This will represent the first implementation of the new survey, although the survey itself has been conducted on commercial vessels since 2012. Results for Georges Bank appear to suggest a lower abundance on Georges Bank and much smaller confidence intervals. The potential influence of this terminal year change on model estimates is unknown. Additional review of patterns in commercial LPUE will be considered to determine if there is additional support for the changes in survey abundance. It was recognized that LPUE is an imperfect measure of total abundance as it is conflated with changes in area fished as harvesters move to more economically valuable fishing areas over time.

The Plan B proposal for use of swept area biomass, using previous depletion experiment results as a priors on catchability was endorsed by the Panel. Because the stock is lightly exploited overall, the model has difficulty defining absolute abundance. Catchability priors in the model tend to keep these estimates within reasonable bounds. It is anticipated that this will hold true for the revised two area model.

Owing to the cumulative proposed changes, the Panel recommended an Enhanced Review (Level 3) for surfclams.

Ocean Quahog:
The stock will be assessed using approaches from the most recent stock assessment (SARC 63) which includes two stock areas within one model. Details on the model structure and data sets were provided. No new survey data are available for this stock as the newly designed industry-based survey has focused on a survey of surfclams in its first two years. However, the existing survey data will be analyzed using the revised survey strata that had been previously reviewed by

the MAFMC SSC. The post stratified estimates are essentially the same as earlier estimates and the revised strata include 99% of the historical abundance regions. Hence no changes in trend are expected but precision of the estimates is expected to improve slightly.

No changes to the model parameterization or parameter values are anticipated as the only change will be the addition of commercial landings data through 2019. Reference points will be updated but no major changes are anticipated. The Plan B proposal for use of swept area biomass, using previous depletion experiment results as priors on catchability was endorsed by the Panel.

The Panel recommended a Direct Delivery review (Level 1) for ocean quahog.

Butterfish:
The assessment update will include an updated time series of discards, updated NEAMAP indicates using the NEAMAP age length key, and use of the time series mean (1989-2015) thermal habitat index for 2016-2019. The lead analyst indicated that the thermal habitat index will no longer be available going forward.

The same projection methodology as the last benchmark will be used. Biological reference points will be updated with new estimates of natural mortality estimated by the model. Little change in the estimated natural morality rate is anticipated. While a change in natural mortality is permitted under a Level 3 review, in the present case, the natural mortality change is the result of a model update (estimated internally in ASAP 4) rather than a wholesale modification of the rate.

The entire time series of discards will be revised with either ADIOS estimates (if available) or the 2014 SAW 58 SBRM SAS code, with several incorrect settings restored to defaults. The AOP discussed that this was not a methodological change, simply a data retrieval change, and supported a level 2 assignment based on this criterion. The AOP agreed with the analyst that the change to ageing an existing index using data from that survey from which the index is derived is permissible under level 1. The analyst noted that the swept area abundance estimates and associated CV will remain unchanged.

The Panel recommended an Expedited review (Level 2) for butterfish due to the data input updates and a LOESS smoothing of the NEFSC fall survey as a Plan B approach.

Longfin Squid (Doryteuthis):
The lead analyst provided background information on the life history of the species as well as a description of fisheries. The AOP spent considerable time discussing the analyst’s proposal to change the assessment from a combined season swept-area biomass approach (with single B_{msy} proxy), to keeping the seasonal swept area biomass estimates separate, and calculate separate B_{msy} proxies. The analyst represented that this would be consistent with how squid species are assessed and managed around the globe and is consistent with advice from the most recent peer review (SAW 51). The analyst was concerned that annualizing the seasonal cohorts does

not properly account for differences in cohort productivity, growth & maturation. This change would result in 2 B_{msy} estimates and hence 2 stock statuses. The AOP discussed that this is analogous to changing stock structure and was concerned that such a change is not permissible under management track assessments.

The AOP discussed that the change to two-stock management may require quota reallocation and a host of associated changes associated with operationalizing such a change. One or members of the public pointed out that the annualized exploitation ratio suggested the stock was lightly exploited, but on a seasonal basis this might no longer be the case. All of which illustrated some of the structural changes to management that might be necessitated with a stock definition change. Nevertheless, the AOP pointed out that level 3 reviews allow for testing of new ideas and as such supported the analyst's proposal that level 3 enhanced review was appropriate. However, the AOP supported a status-quo model update (just lengthen the timeseries of index values) for stock status determination, but to also submit exploratory work fleshing out the seasonal approach to address biological differences between cohorts.

The panel recommended an Enhanced review (Level 3) to allow for exploration of seasonal cohort reference points and management, but status quo-based calculations for determining stock status would be presented. The panel endorsed a swept area biomass as Plan B (equal to status quo Plan A). The AOP discussed the idea of using seasonal cohort calculations as plan B but declined to support that option noting that the review panel will only see plan B if plan A is rejected.

Atlantic Herring: In February 2020, the lead analyst indicated that there were no new sources of information for this assessment, no changes anticipated to the assessment model, and no changes to the projection methodology. Based on those expectations, the AOP recommended a level 1 assessment (direct delivery). The analyst proposed a LOESS smooth to the mean of all survey indices with the justification that the proposed plan B is data driven, and although noisy, the indices are consistent for this species, and the approach is familiar in this region. The analyst also noted there was little basis to consider alternatives, and most data limited tools require a guess as to current depletion levels or some other quantity with which he was not comfortable making.

Step 4 in the guidance document (assessment conducted) indicates that if any changes to the AOP-approved assessment plan are needed in response to new data or model dynamics, the assessment lead will propose revisions, and if those revisions could result in changes to the peer review level, the AOP will reconvene to provide technical review. Such an event happened and the AOP reconvened in April 2020.

Preliminary modelling suggested a substantive change in selectivity used for the stock projections. This change, driven by a quick and drastic change in the proportion of relative harvest from the fixed gear fleet (largely Canadian, and historically < 10%, but in recent years approximately 50% of total removals) resulted in a dramatic change to biological reference points. The outcome is increased selection of younger fish, which are not generally selected by the US mobile fleet. Using this combined fleet selectivity would result in a disconnect between fish actually selected by the US fleet relative to sustainable harvest suggested by updated BRPs. Consequently, the analyst proposed using the US mobile fleet selectivity for BRPs (so as to reduce influence of Canadian fleet on BRPs); since this is a change in methodology from that used in the previous assessment, the AOP recommended a level 2, expedited review. The AOP cautioned however that given the time spent discussing the change, as well as perhaps comparing results from the new method and old (potentially including calculation of ACL), some additional time outside of a typical level 2 assessment (1-2 hours) may be helpful.

Atlantic Mackerel: Substantive data availability issues (e.g., a critical fishery independent egg index, Canadian catch at age compositions) will prevent completion of this assessment in 2020. The lead analyst is proposing to postpone the assessment until 2021, at which time these issues are expected to be resolved. Rescheduling an assessment is outside the purview of the AOP, but the AOP was supportive of the proposed postponement as it would allow for resolution of data availability issues and would also synchronize timing with the Canadian assessment that is also scheduled for 2021. The lead analyst noted that heretofore, timing between US and Canadian assessments occur one year apart (e.g., US assessment in year y, Canadian assessment in year y+1); the AOP was supportive of any attempts to maintain synchrony between US and Canadian assessments (for data availability reasons, etc).

AOP Process Discussion and Summary:

The AOP held a pre-meeting call with NEFSC Assessment Leadership on January 14, 2020 to discuss ensuring consistency in the implementation of the NRCC assessment guidelines.

The NEFSC continues to seek meaningful stakeholder engagement in formulating stock assessment plans for management track assessments. Lead assessment biologists held discussions with the Mackerel, Squid, Butterfish advisory panel prior to the AOP meeting to elicit information relative to assessment related questions. There is an active group of stakeholders who regularly interact with Center scientists relative to questions related to the surfclam and ocean quahog stock assessments.

Several important process questions arose during the discussions. Each of these issues reflect a natural process of evolution as the assessment guidelines are implemented. We can expect such changes to continue in the future.

1. There is some ambiguity of interpretation for updating of BRPs in the level 1 assessments. Concerns were raised that any updates to the values of biological reference points would justify/trigger an Enhanced Review. The rationale is that such changes could be significant for management, especially when large changes occur. As this is generally unknown when the AOP meeting occurs, the default position under this premise would be that each assessment would be level 2 or 3. However, the direct delivery option (level 1) has no ambiguity in allowing projections to be updated with new model and data estimates. When mean weights, maturation or selectivity change in the projection, the BRP should also change in order to be consistent. Otherwise one is

comparing non-commensurate quantities. Clarifying the guidance on this issue could be a topic at the next NRCC.

2. There was also discussion about the need for a firewall between the current status and level of review. In other words, guidance on the level of an assessment should not be influenced by how controversial a stock is, or if it is near overfished or in a rebuilding program. However, given the potential for change in status for populations approaching overfished or nearing rebuilt status, it seems logical to consider such factors when considering the assessment review level. To do otherwise could be inefficient because a status change is likely to create a demand for another assessment review. Inserting another follow-up review is likely to be costly to implement, to disrupt the planning of future assessments, and to impede the Council and RO from acting on new information. Discussion of this topic by the NRCC may also be useful.

3. Finally, there was some discussion of formalizing the decision framework of the AOP. One option would be to use something like the "punch list" approach used by the MAFMC SSC for evaluating the CV level for deriving the ABC from the OFL. A sacrificial straw man option is provided below.

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.

Guidance Template for Deriving Recommended Level of Assessment Review

Task	***Gui-dance 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 timeframes	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	2			
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	3			

○ 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	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 off 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	xx	A pithy summary here.		

In summary, the meetings were productive and an effective implementation of the new assessment planning document. The peer review panel will meet from June 22-26, 2020 to complete their review.

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