Operational Assessment of the Black Sea Bass, Scup, Bluefish, and Monkfish Stocks, Updated Through 2018 *

by the Northeast Fisheries Science Center

*This is a **Prepublication Copy** of the August 2019 Operational Stock Assessment Report. This report is currently "in preparation" for publication by the NEFSC. This pre-publication copy is intended for use by Fishery Management Council staff and SSC. (~~8/23/2019~~ 9/4/2019 : BSB chapter had some revisions)

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Preface

This document represents the findings of an Operational Assessment of Black sea bass, scup, bluefish, and monkfish. The meeting was held August 5-7, 2019 at the Northeast Fisheries Science Center, National Marine Fisheries Service, Woods Hole, MA. The Review Panel comprised Thomas Miller (chair), Jean-Jacques Maguire, Kate Siegfried, and Michael Wilberg. Dr. Siegfried is from the Southeast Fisheries Science Center, while the other reviewers are members of the New England or Mid-Atlantic Fishery Management Councils' Science and Statistical Committees. Comments by the Operational Assessment Review Committee are included in their entirety in this report.

The Terms of Reference for the Operational Assessments were based on the 2011 Operational Assessment Process White Paper developed by the NRCC, with some revisions made by the NEFSC SAW Chair on June, 3, 2019. The Assessment Oversight Panel (AOP), which included Paul Rago and Jason McNamee and Russ Brown, met on May 20, 2019 to review the assessment plans. The full AOP report is attached as an Appendix to this report.

Thanks to the assessment scientists and colleagues for their efforts to implement this operational assessment. I also thank the review panel and especially the Chair, for their timely and insightful reviews. This document is part of an overall program to streamline the stock assessment process and provide more timely information to the New England and Mid Atlantic Fishery Management Councils and the Atlantic States Marine Fisheries Commission. I thank the executive staff of the NEFMC and MAFMC for their efforts to identify, coordinate, and support the peer review panel. All meetings of the AOP and Review Panel were open to the public and we appreciate the valuable input we received.

James Weinberg
NEFSC Stock Assessment Workshop Chairman
August 13, 2019

Northeast Regional Coordinating Council (NRCC). 2011. A new process for assessment of managed fishery resources off the Northeastern United States. Unpublished white paper. 26 pages.

Report of the 2019 Operational Assessment Review Committee (OARC) (Aug. 2019)

Thomas J. Miller[1] , Jean-Jacques Maguire[2] , Kate I. Siegfried.[3], Michael J. Wilberg[1]

1. University of Maryland Center for Environmental Science Chesapeake Biological Laboratory, Solomons, MD. & Mid-Atlantic Fishery Management Council Scientific and Statistical Committee
2. Quebec City, Quebec, G1T 2E4, Canada & New England Fishery Management Council Scientific and Statistical Committee
3. NOAA/NMFS Southeast Fisheries Science Center Beaufort Laboratory

The 2019 Operational Assessment Review Committee (OARC) met at the Northeast Fisheries Science Center in Woods Hole, MA on August 5-7th. The OARC were asked to provide technical reviews of operational assessments for monkfish (*Lophius americanus*), black sea bass (*Centropristis striata*), scup (*Stenotomus chrysops*) and bluefish (*Pomatomus saltatrix*). The assessments for these four species were prepared under guidelines prepared by 2019 Assessment Oversight Panel (AOP). These guidelines provided a structured pathway for transitioning assessments for each species from a previously accepted benchmark assessment to one that incorporates the most recent data and understanding of the biology of the species being assessed. The 2019 Assessment Oversight Panel considered monkfish to be a level 2 assessment and the other three species were considered level 3 assessments. As a result of this designation, the assessments for all four species required peer-review.

We wish to thank Dr. Russ Brown (Population Dynamics Branch Chief), Dr. Jim Weinberg (SAW/SARC Process Chair), and Michele Traver (Stock Assessment Coordinator) 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 OARC. Our thanks extend not only to the analysts directly responsible for each assessment, but to the members of the Population Dynamics Branch who participated actively during the meeting. Finally, the OARC also wishes to thank the IT and other staff at NEFSC for supporting the logistics during the meeting.

The OARC endorsed the assessments for all four species presented at the meeting. An analytical assessment for monkfish was not possible as a result of challenges of ageing this species. Instead, the lead assessment analyst brought forward a swept area-based approach that estimated a multiplier that could be used to adjust the current ABC by the PDT, SSC and Council of the New England Fishery Management Council as was done in the previous stock assessment. Analytical assessments were produced for black sea bass, scup and bluefish, each of which used a statistical catch at age model. In each case the OARC endorsed the model and the inferences that resulted as representing the best scientific information available (BSIA), thereby providing a foundation for staff, the SSC and the Mid-Atlantic Fishery Management Council to evaluate stock status and provide scientific advice.

OARC Comments on 2019 Operational Assessment: Monkfish

The OARC determined that the 2019 operational assessment for monkfish represents the best available scientific information and provides an appropriate foundation to provide scientific advice to managers. The assessment represents the BSIA for this stock for management purposes. No analytical model was presented because of challenges of aging monkfish and so no stock status determination was possible. The OARC agrees with the assessment report that an ad hoc approach to updating catch advice is appropriate for monkfish.

A length-based analytical approach for monkfish using the SCALE program in the National Fishery Toolbox (NFT) was first accepted in 2007 (NEDPSWG 2007 a,b) and continued for monkfish at SARC 50 (NEFSC 2010). This model was used to evaluate stock status and biological reference points until age and growth work (Bank 2016) indicated that the growth information was in error. The 2016 Operational Assessment Panel concluded that the SCALE model used previously could no longer be considered a reliable basis to estimate stock status and provide management advice.

The 2016 Operational Assessment Panel concluded that an *ad hoc* "Plan B" approach, using the changes in the most recent three years in the NEFSC Autumn and Spring biomass estimates to adjust the North and South management areas TACs should be used instead (Richards 2016). Adoption of this approach precludes a determination of stock status.

The 2019 OARC had no basis to disagree with the conclusions of the 2016 Operational Assessment Panel. The 2019 operational assessment for monkfish is an update of the ad hoc Plan B approach adopted in the 2016 operational assessment (Richards 2016). Applying this approach in 2016 implied essentially status quo in both management areas. This year, because of the recruitment of the strong 2015 year class, particularly in the north management area, the approach implies a relatively large (~20%) increase in the TAC for the north management area. While biomass (kg/tow) continued to increase through the 2018 autumn survey, abundance (numbers/tow) peaked in 2016 and decreased in later years. In the spring survey, both biomass and abundance indices peaked in 2018 and decreased in 2019. The OARC is concerned that biomass in the autumn survey may also have peaked in 2018 and that the approach might exaggerate the allowable increase in TAC for the north area. In the future it may be useful to evaluate approaches that would limit the variability in TAC adjustments as an alternate plan B.

The 2019 OARC concludes that the *ad hoc* Plan B operational assessment for monkfish is sufficient to provide scientific advice, but might exaggerate the allowable increase in TAC for the north area. The OARC notes that the results of the 2019 Operational Assessment and the recommendations of this OARC report will be used by the NEFMC PDT to develop recommendations that will be reviewed by the NEFMC SSC. The Panel expects that these concerns will be taken into account by the PDT and SSC.

Operational Assessment Terms of Reference: Monkfish

Stock assessments normally include 6 Terms of references. Not all ToRs were met because the Operational Assessment for monkfish was based on the Plan B approach accepted in the 2016 Operational Assessment,

1. *Update fishery-dependent data (landings, discards, catch-at-age, etc.) and fishery-independent data (research survey information) that had been used in the previous accepted assessment. Also, describe and present any new or revised data sets that are being used in the assessment.*

This ToR was completed successfully. No new data sources were added to the assessment. Commercial landings and fishery-independent survey data from the NEFSC spring and fall surveys were updated.

2a. Estimate annual fishing mortality, recruitment, and stock size for the time series ("Plan A"). Include estimates of uncertainty, retrospective analyses (both historical and within-model), and bridge runs to sequentially document any changes from the previously accepted model to the updated model proposed for this peer review.

This ToR was not met. An analytical, length-based assessment using the NFT SCALE assessment model could not be developed because of uncertainties in ageing of monkfish and thus in growth parameters which are essential to the application of SCALE. Accordingly, no estimates of F, recruitment, and stock size for monkfish were produced.

2b. Prepare a "Plan B" assessment that would serve as an alternate approach to providing scientific advice to management. "Plan B" will be presented for peer review only if the "Plan A" assessment were to not pass review.

As agreed by the Assessment Oversight Panel, Plan B was used for monkfish as in the previous Operational Assessment in 2016. This ad hoc approach uses a slope value estimated from a regression analysis of the last three years of the fishery-independent surveys. Slope estimates for both the northern and southern regions are developed by appropriate sampling of stations from the NEFSC surveys. The exponentiated value of this slope is used as a multiplier to update the TAC for both the northern and southern regions.

3. Update the values of biological reference points (BRPs) for this stock.

This ToR could not be met as there is no accepted assessment model for monkfish.

4a. Recommend what stock status appears to be based on comparison of assessment results to BRP estimates.

There are no accepted biological reference points for monkfish and, thus, this ToR could not be met.

4b. Include 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 met.

5. Perform short-term (2-year) population projections. The projection results should include an estimate of the catch at F_{MSY} or at an F_{MSY} proxy (i.e. this catch represents the overfishing level, OFL) as well as its statistical distribution (i.e., probability density function).

This ToR could not be met as there is no accepted assessment model for monkfish.

6. Comment on research areas or data issues to consider that might lead to improvements when this stock is assessed again in the future.

This ToR was met. SARC 34 (NEFSC 2002) recommended, "*Surplus production modeling should continue with special emphasis placed on uncertainty in under-reported catches and population size prior to 1980*." SARC 50 (NEFSC 2010) concluded: -"*Bayesian surplus production was explored unsuccessfully for SAW 40 (NEFSC 2005) and NDPSWG (2007).*" The Data Poor Working Group for monkfish (NDPSWG 2007) concluded that long-term production models were inappropriate for status determination of monkfish because of the general lack of correspondence between reported catch and survey trends.

Recent developments in general production modeling (JABBA, Winker et. al. 2018; SPiCT, Pedersen and Berg, 2016) may have addressed the concerns expressed in SARC 50. In particular, these modeling approaches allow for observation and process errors which make it possible to improve the estimate of the stock size and fit to the indices. The OARC suggests that these methods be investigated in the next research track assessment as an alternative to age/length based methods regardless of whether the age and growth problems have been resolved.

The OARC also recommend that the next assessment review and revise, if appropriate, the Plan B approach based on approaches in the DLMtool (http://www.datalimitedtoolkit.org/) and on the approaches used by ICES (https://www.ices.dk/sites/pub/Publication%20Reports/Advice/2018/2018/Introduction_to_advice_2018.pdf).

Major sources of uncertainty: Monkfish

Recent studies using mtDNA did not find differences between the north and south management areas, suggesting that there is a single stock. This is not a major source of uncertainty under the current Plan B, but could become so if and when a new analytical approach is adopted. At that time, stock structure should be evaluated carefully and both hypotheses (i.e., a single stock area, or a multiple area model) should be evaluated.

As indicated above, the three-year smoother may be risky since recruitment after the 2015-year class is estimated to have been average or less. Given previous large fluctuations in biomass, an increase of 20% or more may not be sustainable if the recruitment remains below average.

References

Bank, C. (2016). Validation of age determination methods for monkfish (Lophius americanus). Master of Science Thesis, School of Marine Science and Technology, Univ. Mass.

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OARC Comments on 2019 Operational Assessment: Black Sea Bass
The operational assessment for black sea bass is an update to the 2017 benchmark assessment accepted by the SARC-62 Panel (NEFSC 2017).

The OARC concludes that the 2019 operational assessment for black sea bass is technically sufficient to evaluate stock status and provide scientific advice. The assessment represents the BSIA for this stock for management purposes. The OARC agrees with the assessment report that black sea bass is not overfished and overfishing is not occurring.

In 2017, the SARC-62 Panel approved a single stock, two area model developed to determine stock status, biological reference points (BRPs) and proxies, and to project probable short-term trends. $F_{40\%}$ proxy was recommended as a proxy for F_{MSY}. Although the two-area model had a more severe retrospective pattern in opposite directions in each area sub-unit than when a single unit was assumed, it provides reasonable model estimates after the retrospective corrections and combining the two spatial units. Thus, even though reference points are generated and stock status determinations are conducted for each subunit, the combined projections should be used.

Operational Assessment Terms of Reference: Black Sea Bass
The 2019 operational assessment updated the SARC-62 model under guidelines provided by the 2019 Assessment Oversight Panel (see appendix report from May 20, 2019) and the following Terms of references (TORs).

1. *Update fishery-dependent data (landings, discards, catch-at-age, etc.) and fishery-independent data (research survey information) that had been used in the previous accepted assessment. Also, describe and present any new or revised data sets that are being used in the assessment.*

This TOR was completed satisfactorily. The analyst updated all data streams consistent with the Benchmark, including the new MRIP estimates of recreational landings and discards. The new MRIP estimates are 9% to 161% larger than the previous estimates and are the only change in methodology for this TOR.

2a. Estimate annual fishing mortality, recruitment, and stock size for the time series ("Plan A"). Include estimates of uncertainty, retrospective analyses (both historical and within-model), and bridge runs to sequentially document any changes from the previously accepted model to the updated model proposed for this peer review.

This TOR was completed satisfactorily. The uncertainty around SSB and F was provided. Although the two-area model had a moderate retrospective pattern in each area sub-unit (which mostly cancel one another out when the two areas are combined), it provides reasonable model estimates after the retrospective corrections. Using retrospective corrections is also consistent with the practices in the Benchmark.

2b. Prepare a "Plan B" assessment that would serve as an alternate approach to providing scientific advice to management. "Plan B" will be presented for peer review only if the "Plan A" assessment were to not pass review.

This TOR was completed satisfactorily. The OARC was provided a brief overview of the Plan B model, though it was not thoroughly discussed or considered for use.

3. Update the values of biological reference points (BRPs) for this stock.

This TOR was completed satisfactorily. The BRPs were carried over from the Benchmark and recalculated using the 2019 Operational Assessment model results.

4a. Recommend what stock status appears to be based on comparison of assessment results to BRP estimates.

This TOR was completed satisfactorily. The report provides the biomass and fishing status based on the F_{MSY} proxy ($F_{40\%}$).

4b. Include 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 completed satisfactorily. The report provides a qualitative description of stock status based on species distribution, survey series trends, and recruitment.

5. Perform short-term (2-year) population projections. The projection results should include an estimate of the catch at F_{MSY} or at an F_{MSY} proxy (i.e. this catch represents the overfishing level, OFL) as well as its statistical distribution (i.e., probability density function).

This TOR was completed satisfactorily. The report provides OFL projections using a 2019 ABC that has been adjusted to reflect the new MRIP estimates. The 2020 and 2021 projected catches are based on the $F_{40\%}$ value from the Operational Assessment.

The OARC note the following important sources of scientific uncertainty

i. The MRIP recalibrated data received a thorough examination by the 2019 OARC. The lead assessment analyst drew attention to a large estimate in 2016 that was considered implausible. The impact of this observation on overall model results is uncertain. Various treatments of the anomalous MRIP data point (smoothing, exclusion, etc.) did not qualitatively affect the overall model results. However, the uncertainty in the MRIP estimates is not an input to the model.

ii. The reweighting of likelihood components during model fitting was not well described. It is unclear what weights, if any, were applied to the likelihood components. This adds to the uncertainty of the overall reliability of the model.

iii. As the weights-at-age have been changing over time, using a five year running average may have an important effect on the reference points, adding uncertainty to the reliability of model results.

iv. Uncertainty in the indices was characterized by the CVs of the standardization.

v. The retrospective pattern was large enough to need the corrections (outside the 90% confidence intervals), and the additional uncertainty caused by applying the correction is unclear. The model for the northern area has a larger retrospective pattern than the model for the southern area.

vi. The combination of the values from the northern and southern areas is done without weighting based on landings or biomass. It's unclear whether or how the uncertainty should be treated when the BRPs are combined using simple addition.

6. Comment on research areas or data issues to consider that might lead to improvements when this stock is assessed again in the future.

This TOR was completed satisfactorily. The report outlines three main areas of research interest: examining recruitment events, distribution shifts and the changing environment, management strategy evaluations.

The OARC note the following recommendations for future work.

i. A re-evaluation of splitting the stock into two area subunits is warranted. This evaluation should include evaluating:

  a. Whether year classes can be tracked in a single stock model, as the inability to do this was a major factor motivating the decision to use the two area subunits;

  b. Genetic evidence on the structure of the population north of Cape Hatteras;

  c. Movement estimates from traditional and acoustic tagging.

ii. The fishery-independent indices included in the model should be re-examined. Only the ones that are a priori considered to capture the trends in the stock should be considered.

iii. Evaluation of natural mortality (M) used in the model. The protogynous life history of black sea bass may suggest a constant M at age is not appropriate for this species.

iv. Consideration of the impacts of range expansion on coverage of the stock in surveys and model applicability.

v. The 2011-year class was dominant in the northern area, whereas the 2015-year class was strong throughout the stock area. Exploration of the causes of the pattern and magnitude of recruitment in black sea bass is warranted.

References

Northeast Fisheries Science Center. (2017). 62nd Northeast Regional Stock Assessment Workshop (62nd SAW) Assessment Report. US Dept Commer, Northeast Fish Sci Cent Ref Doc. 17-03; 822 p. doi: 10.7289/V5/RD-NEFSC-17-03

OARC Comments on 2019 Operational Assessment: Scup

The Operational Assessment Review Committee (OARC) determined that the 2019 operational assessment for scup represents the best available scientific information and provides an appropriate foundation to a) provide stock status determination and b) provide scientific advice to managers.

The OARC considered the analyses conducted within the guidelines provided to the NEFSC assessment scientists by the 2019 Assessment Oversight Panel (see appendix report from May 20, 2019). Scup have been assessed within a statistical catch at age framework at the Data Poor Working Group assessment (NDPSWG 2009), the 60th SAW (NEFSC 2015) , in a 2017 model update and now at the 2019 Operational Assessment Review in all cases using ASAP. The structure of the SCAA model for scup has remained largely unchanged over these assessments. This most recent assessment added 2017-2018 fishery and research survey data which included new calibrated MRIP data for 1981-2018.

Operational Assessment Terms of Reference: Scup

1. *Update fishery-dependent data (landings, discards, catch-at-age, etc.) and fishery-independent data (research survey information) that had been used in the previous accepted assessment. Also, describe and present any new or revised data sets that are being used in the assessment*.*

This TOR was completed successfully. Incorporation of the new MRIP data indicated that the removals of scup are now comprised of ~60% commercial (landings and discards) and 40% recreational (landings and discards). The new calibrated MRIP data indicated relatively consistent increases in recreational catch and discard for the first 2/3 of the times series. However, MRIP recreational catch and discard levels diverge increasingly from the previous estimates after 2000, particularly so for recreational discards. This pattern of divergence was expected given the hypothesized causes for the differences between the MRIP mail and phone surveys.

2a. *Estimate annual fishing mortality, recruitment, and stock size for the time series ("Plan A"). Include estimates of uncertainty, retrospective analyses (both historical and within-model), and bridge runs to sequentially document any changes from the previously accepted model to the updated model proposed for this peer review.*

This TOR was completed successfully. The bridging of assessment models from the SAW 60 assessment to the 2019 operational assessment was appropriate. Fit of the 2019 operational SCAA model to the new data revealed no substantially anomalous model diagnostics and accordingly, the model provides a suitable foundation for management. The 2019 Operational Assessment for scup indicates higher stock abundance and SSB and lower Fs than in earlier assessments. Neither internal retrospective biases, evaluated using a 7-year data peel, nor external retrospective biases, evaluated using a comparisons of sequential assessments, were substantial and no bias corrections were necessary.

2b. Prepare a "Plan B" assessment that would serve as an alternate approach to providing scientific advice to management. "Plan B" will be presented for peer review only if the "Plan A" assessment were to not pass review.

This ToR was completed successfully. The OARC reviewed the *ad hoc* "Plan B" approach, but considers the analytical statistical catch at age model a more reliable foundation for management

3. Update the values of biological reference points (BRPs) for this stock.

This ToR was completed successfully. Biological reference points were estimated. The F_{MSY} proxy ($F_{40\%}$) estimate was similar to that estimated in earlier assessments. MSY and SSB_{MSY} were also similar to earlier estimates, although expected recruitments were higher. Based on model results, stock status for scup is not overfished and overfishing is not occurring.

4a. Recommend what stock status appears to be based on comparison of assessment results to BRP estimates.

The OARC agrees with the stock status determination for scup derived from the 2019 operational assessment that the stock is not overfished and overfishing is not occurring.

4b. Include 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 completed successfully.

5. Perform short-term (2-year) population projections. The projection results should include an estimate of the catch at F_{MSY} or at an F_{MSY} proxy (i.e. this catch represents the overfishing level, OFL) as well as its statistical distribution (i.e., probability density function).

This TOR was completed successfully. Short term projections were made for 2020 and 2021. These projections assume the 2019 ABC will be caught (after adjustment of the recreational catch for the new MRIP estimates of recreational catch and discard), and relied on recruitments sampled from 1984-2018.

The OARC notes the following *Important Sources of Scientific Uncertainty*

1. Following the record 2015-year class, recruitments in 2016, 2017 and 2018 have all been below the time series mean. If this trend continues, short-term projections, which assume random values from the recruitment distribution over the 1983-2018 time series, may become overestimate allowable catches.
2. The record high 2015-year class has contributed to high rates of discarding in the commercial fishery. These can be expected to decline as this year class recruits to the fishery and is fished down. The effects of this on estimates of SSB and F are uncertain.
3. The scup SCAA uses multiple selectivity blocks. The final selectivity block (2006-2018) is the longest in the model. The applicability of the most recent selectivity block to the current fishery condition is uncertain. If the fishery selectivity implied in this block changes, estimates of stock number, spawning stock biomass and fishing mortality become less reliable.

4. Most of the fishery-independent indices used in the model provide estimates of the abundance of scup < age 3. One consequence is that much of the information on the dynamics of scup of older ages arise largely from the fishery catch at age and from assumptions of the model and are not conditioned on fishery-independent observations. As a result, the dynamics of these older fish remains uncertain. Knowledge of the dynamics of these older age classes will become more important as the age structure continues to expand.

6. Comment on research areas or data issues to consider that might lead to improvements when this stock is assessed again in the future.

The OARC notes the following recommendations for additional research or data collection.

1. Explore the applicability of the pattern of fishery selectivity in the model to the most recent catch data to determine whether a new selectivity block in the model is warranted.
2. Mean weights at age and age at maturity have declined in recent years. Continued monitoring of both is warranted to determine if these are reversible density-dependent responses or arise from a different mechanism.
3. It was conjectured that the increase in stock biomass since 2000 resulted from increased recruitments resulting from the imposition of gear restriction areas (GRAs) to minimize interactions between scup and squid fisheries and from increases in commercial mesh sizes. Low frequency climate variations is a potential alternative explanation for increased recruitments from 2000-20015. Research to explore the validity of both hypotheses is warranted.

References

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Northeast Fisheries Science Center. (2015). 60th Northeast Regional Stock Assessment Workshop (60th SAW) Assessment Report. US Dept Commer, Northeast Fish Sci Cent Ref Doc. 15-08; 870 p. doi: 10.7289/V5W37T9T

OARC Comments on 2019 Operational Assessment: Bluefish

The operational assessment for bluefish is an update of the approach adopted in the 2015 benchmark assessment. A statistical catch-at-age approach was adopted for bluefish at SARC 60 (NEFSC 2015) and was updated for this operational assessment.

The OARC concludes that the 2019 operational assessment for bluefish is technically sufficient to evaluate stock status and provide scientific advice. The assessment represents the BSIA for this stock for management purposes. The OARC agrees with the assessment report that bluefish is overfished but overfishing is not occurring. The OARC notes that if retrospective adjustments were applied to the assessment results, the stock biomass would be even further below the overfished definition. However, the standard procedures used by stock assessment analysts at the NEFSC would not call for the application of a retrospective correction as the retrospectively adjusted values do not exceed the 90% confidence intervals for the base model output.

Terms of Reference: Bluefish

1. *Update fishery-dependent data (landings, discards, catch-at-age, etc.) and fishery-independent data (research survey information) that had been used in the previous accepted assessment. Also, describe and present any new or revised data sets that are being used in the assessment.*

The OARC determined that TOR 1 was addressed sufficiently. The primary change to the previous benchmark was the updated estimates of recreational landings and discards. These estimates differed both in their magnitude and trend from the previous estimates, with the new estimates being higher in magnitude and showing a somewhat different trend in the most recent years. In addition, all the other data series were updated, and the model fits and diagnostics seemed reasonable.

The committee noted that the revised MRIP time series did not decrease to the original estimates in the early 80s as would be expected if the original MRFSS telephone survey was accurate. Additionally, the relative differences in catches were different for bluefish than for the other species reviewed. It was not clear why there was a large increase in the new MRIP estimates in the early 1980s. The difference between the old and new MRIP estimates was different for retained catch and discards. It was not clear why this difference occurred, but it was noted that supplemental data programs are used to describe the length composition of discards because discarded fish are larger on average than kept fish.

Additionally, the committee noted that there was a recent increase in average weight at age. This increase may be due to changing availability of large offshore fish. Changing availability of these large fish may also explain the recent decrease in commercial catch.

2. *a.) Estimate annual fishing mortality, recruitment, and stock size for the time series ("Plan A"). Include estimates of uncertainty, retrospective analyses (both historical and within-*

model), and bridge runs to sequentially document any changes from the previously accepted model to the updated model proposed for this peer review.

The OARC agreed that TOR 2 was met. The updated stock assessment included estimates of fishing mortality rates, recruitment and stock size. The updated stock assessment also included estimates of uncertainty, retrospective analyses and bridge runs to document changes from the benchmark.

The largest change in the updated stock assessment was an increase in the scale of the population that was caused by the substantially higher estimates of recreational catch. Additionally, the stock assessment results indicated somewhat different trends in fishing mortality rates and biomass from the previous benchmark with fishing mortality rates remaining high (instead of decreasing) and biomass decreasing (instead of remaining relatively flat). These changes in the trends of fishing mortality and biomass were caused by the changes in the trends of the new recreational catch time series while the indices were unchanged.

2. *b.) Prepare a "Plan B" assessment that would serve as an alternate approach to providing scientific advice to management. "Plan B" will be presented for peer review only if the "Plan A" assessment were to not pass review.*

The OARC looked at the plan B for information purposes only because the updated stock assessment was accepted.

3. Update the values of biological reference points (BRPs) for this stock.

The OARC agreed that this TOR was met. The fishing mortality rate reference point ($F_{35\%}$) was very similar to the estimate from the previous benchmark. However, the SSB reference points approximately doubled from the previous benchmark values. This increase in the SSB reference points was caused by the increased scale of the population estimates when the new MRIP estimates were used.

4. a.) Recommend what stock status appears to be based on comparison of assessment results to BRP estimates.

b.) Include qualitative descriptions of stock status based on simple indicators/metrics (e.g., age- and size-structure, temporal trends in population size or recruitment indices, etc.).

The OARC agreed that this TOR was met. The stock assessment results indicated that overfishing was not occurring, but the stock is overfished because of the increase $B_{Threshold}$. The committee notes that adjusting the estimates for the model's retrospective pattern resulted in the same determination of overfished for stock status (although the retrospective corrections were not applied because the adjusted values fell within the 90% confidence intervals). Qualitative descriptions of stock status were included.

5. Perform short-term (2-year) population projections. The projection results should include an estimate of the catch at F_{MSY} or at an F_{MSY} proxy (i.e. this catch represents the overfishing level, OFL) as well as its statistical distribution (i.e., probability density function).

The OARC agreed that this TOR was met. Projections were conducted to calculate potential OFLs and MCMC was used to characterize uncertainty in the OFL. Short term projections were made for 2020 and 2021. These projections assume the 2019 ABC will be caught.

The revised MRIP estimates are an important new source of uncertainty. In particular, the trend of the recreational catch estimates has an important influence on recent estimates of biomass and on the stock status estimates. The revised MRIP estimates had a different trend (relative to the old estimates) than was present for the other species reviewed. The pattern in the new MRIP data are an important source of uncertainty in determination of stock status and in short term projections.

The assumption that the 2019 ABC will be fully caught is a source of uncertainty in the model projections, as the bluefish ABC has not been attained in recent years.

6. Comment on research areas or data issues to consider that might lead to improvements when this stock is assessed again in the future.

The OARC agreed that this TOR was met. In addition to the research ideas presented in the report, the committee highlights that a primary source of uncertainty is the recreational catch time series. The MRIP trend does not seem consistent with hypothesized reasons for differences between the mail and phone surveys. This historical correction to the MRIP estimates for bluefish should be explored further to evaluate the causes of differences from other species and to consider their plausibility.

References

Northeast Fisheries Science Center. 2015. 60th Northeast Regional Stock Assessment Workshop (60th SAW) Assessment Report. US Dept Commer, Northeast Fish Sci Cent Ref Doc. 15-08; 870 p. doi: 10.7289/V5W37T9T

OARC Recommendations for Process Improvements

The OARC makes the following suggestions to improve the process for peer review of operational assessments.

1) Documentation of model fits and diagnostics. The Operational Assessment Review Committee was asked to determine whether the operational assessments under consideration were "technically sufficient to (a) evaluate stock status and (b) provide scientific advice." The OARC believe that such a determination requires access to appropriate statistics and diagnostic plots of model fit. Without such information, the OARC believes it would not be possible to evaluate the performance of the updated assessments required to make the determinations requested of the committee. The model fit and diagnostic materials should be provided routinely to OARC members in the future. These do not need to be included in the assessment summary or in the presentations, but appropriate output files should be available for the review committee to review. More specifically, there is a need to identify explicitly descriptions of the decisions regarding likelihood components, coefficients of variation on data inputs and restrictions on estimability of individual parameters.

2) The OARC received an assessment summary and a detailed presentation that provided many of the technical details of the operational assessments under consideration. The OARC believes strongly that both the assessment summary and the detailed presentations be published as a record of the review meeting.

3) The terms of reference for this meeting did not specifically include a ToR that addressed documenting and evaluating the principal sources of scientific uncertainty associated with the assessment for each species. Such an evaluation would be very useful to the relevant SSCs and Councils in developing management recommendations. The OARC recommends that a ToR that explicitly addresses scientific uncertainty as it relates to biological reference points and projections be added in the future.

4) In developing guidelines for each assessment, the AOP should charge the assessment team to respond explicitly to the sources of uncertainty identified by the relevant SSC related to the estimation to the distribution and point estimates of OFL associated with the previous assessments. It is expected that the update assessment will not be able to address all important sources of uncertainty identified by the SSC, deferring action on these questions to a future research or benchmark assessment. In such cases, the update assessment report would simply conclude "Action to address this source of uncertainty is beyond the scope of an update assessment and is deferred to a subsequent research track assessment." However, where progress has been made, it should be noted and clearly reported to the staff, SSC and members of the relevant Council.

Stock Assessment Terms of Reference

Operational Stock Assessment TORs for Aug. 2019 Review

(Based on: 2011 Operational Assessment Process White Paper, and NEFSC edits. v.6/3/2019)

1. Update fishery-dependent data (landings, discards, catch-at-age, etc.) and fishery-independent data (research survey information) that had been used in the previous accepted assessment. Also, describe and present any new or revised data sets that are being used in the assessment[*].

2. a.) Estimate annual fishing mortality, recruitment, and stock size for the time series ("Plan A"). Include estimates of uncertainty, retrospective analyses (both historical and within-model), and bridge runs to sequentially document any changes 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. "Plan B" will be presented for peer review only if the "Plan A" assessment were to not pass review.

3. Update the values of biological reference points (BRPs) for this stock.

4. a.) Recommend what stock status appears to be based on comparison of assessment results to BRP estimates.

   b.) Include qualitative descriptions of stock status based on simple indicators/metrics (e.g., age- and size-structure, temporal trends in population size or recruitment indices, etc.).

5. Perform short-term (2-year) population projections. The projection results should include an estimate of the catch at F_{MSY} or at an F_{MSY} proxy (i.e. this catch represents the overfishing level, OFL) as well as its statistical distribution (i.e., probability density function).

6. Comment on research areas or data issues to consider that might lead to improvements when this stock is assessed again in the future.

[*] Major changes from the previous stock assessment require pre-approval by the Assessment Oversight Panel.

A: Black Sea Bass Operational Assessment for 2019

(Lead: Gary Shepherd)

State of Stock

This assessment of black sea bass (*Centropristis striata*) is an update through 2018 of commercial and recreational catch data, research survey and fishery-dependent indices of abundance, and the analyses of those data. The black sea bass stock was not overfished and overfishing was not occurring in 2018 relative to the updated biological reference points (Figure A1). Spawning stock biomass (retro adjusted SSB) was estimated to be 33,407 mt in 2018, about 2.4 times the updated biomass target reference point SSB_{MSY} proxy = $SSB_{40\%}$ = 14,092 mt (Table A1, Figure A2). There is a 90% chance that SSB in 2018 was between 25,946 and 41,932 mt. Fishing mortality on the fully selected ages 6-7 fish was 0.42 in 2018 after adjusting for retrospective biases, which was 91% of the updated fishing mortality threshold reference point F_{MSY} proxy = $F_{40\%}$ = 0.46 (Table A1, Figure A3). There is a 90% probability that the fishing mortality rate in 2018 was between 0.32 and 0.60. The average recruitment from 1989 to 2018 is 36 million fish at age 1. The 2011 year class was estimated to be the largest in the time series at 144.7 million fish and the 2015 year class was the second largest at 79.4 million fish. Recruitment of the 2017 year class as age 1 in 2018 was estimated at 16.0 million, well below average (Table A1, Figures A2 & A4). The 2018 model estimates of F and SSB adjusted for internal retrospective error are outside the model estimate 90% confidence intervals and so the terminal year estimates have been adjusted for stock status determination and projections (Figure A1).

OFL Projections

Projections using the 2019 Operational Assessment ASAP model (data through 2018) were made to estimate the OFL catches for 2020-2021. The projections assume that the 2019 ABC of 6,716 mt in the north and 1,200 mt in the south (both adjusted for new MRIP estimates) will be taken in 2019 and sampled from the estimated recruitment for 2000-2018. The OFL projection for combined regions uses F_{2020}-F_{2021} = updated F_{MSY} proxy = $F_{40\%}$ = 0.46. The OFL catches are 8,795 mt in 2020 (CV =20%) and 7,377 mt in 2021 (CV =17%).

OFL for 2020-2021
Catches and SSB in metric tons

Year	Total Catch	F	SSB
2019	7,917	0.33	27,659
2020	8,795	0.46	22,699
2021	7,377	0.46	20,379

Catch

Reported 2018 commercial landings were 1,515 mt = 3.338 million lbs. Estimated 2018 recreational landings were 4,008 mt = 8.836 million lbs. Total commercial and recreational landings in 2018 were 5,522 mt = 12.174 million lbs. Estimated 2018 commercial discards were 722 mt = 1.591 million lbs. Estimated 2018 recreational discards were 1,033 mt = 2.277 million lbs. The estimated total catch in 2018 was 7,277 mt = 16.043 million lbs.

In July 2018, the Marine Recreational Information Program (MRIP) replaced the existing estimates of recreational catch (‘Old’ MRIP) with a calibrated 1981-2017 time series (‘New’ MRIP) that corresponds to new survey methods that were fully implemented in 2018. For comparison with the existing estimates noted above, the New MRIP estimate of 2017 recreational landings is 5,692 mt = 12.549 million lbs, 2.6 times the Old estimate. The New MRIP estimate of 2017 recreational discards is 1,634 mt = 3.603 million lb, 2.8 times the Old estimate. The New MRIP recreational catch estimates increased the 1981-2017 total catch by an average of 73% (from 1,687 mt = 3.719 million lb to 2,927 mt = 6.453 million lb), ranging from +9% in 1995 to +161% in 2017. The increase in 2017 was from 2,802 mt = 6.177 million lb to 7,327 mt =16.153 million lb. The 2019 updated assessment model includes the New MRIP estimates of recreational landings and discards (Catch and Status Table below; Table A2).

Catch and Status Table: Black Sea Bass
(Weights in mt, recruitment in millions, arithmetic means, includes New MRIP estimates)

Year	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Commercial landings	523	751	765	782	1,027	1,088	1,113	1,133	1,808	1,514
Commercial discards[2]	167	134	227	116	278	459	423	757	1,027	722
Recreational landings	2,525	3,502	1,421	3,162	2,685	3,510	4,448	6,131	5,692	4,008
Recreational discards[2]	623	733	358	1,048	749	839	985	1,391	1,634	1,033
Catch used in assessment	3,838	5,121	2,771	5,108	4,739	5,896	6,969	9,412	10,162	7,277
Spawning stock biomass	11,125	14,061	14,129	16,730	23,657	34,712	33,242	30,736	26,176	22,199
Recruitment (age 1, millions)	34.1	34.4	39.6	144.7	47.8	26.2	34.2	79.4	47.3	10.1
F full[3]	0.67	0.76	0.41	0.60	0.57	0.42	0.33	0.35	0.52	0.39

Year	Min[1]	Max[1]	Avg[1]
Commercial landings	523	1,808	1,152
Commercial discards[2]	10	1,027	213
Recreational landings	681	6,131	2,399
Recreational discards[2]	99	1,634	583
Catch used in assessment	2,263	10,162	4,274
Spawning stock biomass	3,044	34,712	11,499
Recruitment (age 1, millions)	10.1	144.7	36.1
F full[3]	0.33	114	0.66

[1] Years 1989-2018

[2] dead discards

[3] Average F on fully selected ages 6-7. Note that table values are not retro adjusted.

Stock Distribution and Identification

The Mid-Atlantic Fishery Management Council (MAFMC) and Atlantic States Marine Fisheries Commission (ASMFC) Fishery Management Plan for black sea bass defines the management unit as all black sea bass from Cape Hatteras, North Carolina northeast to the US-Canada border (MAFMC 1999). The stock was partitioned into two sub-units to account for spatial differences in the assessment model. The sub-units are not considered to be separate stocks.

Assessment Model

The assessment models (separate north and south models) for black sea bass is a complex statistical catch-at-age model (ASAP SCAA; Legault and Restrepo 1998; NFT 2013) incorporating a broad range of fishery and survey data (NEFSC 2017). The model assumes an instantaneous natural mortality rate (M) = 0.4. The fishery catch in each region is modeled as two fleets: trawl catch and non-trawl catch, which includes recreational landings, recreational discards, commercial fish pot and hand-line catch and catches from other non-trawl sources.

Indices of stock abundance for the north region used in the model were from NEFSC Albatross spring, MA DMF spring trawl, RI DFW spring trawl, CT DEEP spring Long Island trawl, New York DEC juvenile seine, NEFSC Bigelow spring, NEAMAP spring bottom trawl and MRIP catch per angler trip. The indices of abundance for the southern region were from NEFSC Albatross winter, NEFSC Albatross spring, New Jersey DEP spring trawl, DE DFW spring trawl, MD DNR spring coastal bays trawl, VIMS Chesapeake Bay juvenile trawl, NEAMAP spring trawl, NEFSC Bigelow spring trawl and MRIP catch per angler trip. Indices for both regions were comparable to those used in the 2016 benchmark assessment.

There remains a significant retrospective pattern in both the northern and southern assessment models. The retrospective pattern in the north over-estimates F by 44% over the last 5 terminal years and under-estimates SSB by 43%. In the southern region, the opposite pattern prevails where F is under-estimated by 22% and SSB is over-estimated by 22%. The 2018 regional model estimates of F and SSB were adjusted for internal retrospective error (north F (0.46) adjusted for retrospective = 0.32, north SSB (15,924 mt) adjusted for retrospective = 28,063 mt; south F (0.38) adjusted for retrospective = 0.49, south SSB (6,539 mt) adjusted for retrospective = 5,361 mt). Since the retrospective corrected values generally fell outside the 90% confidence intervals of the terminal year estimates, the retrospective adjusted values were used for status determination and OFL's. The historical retrospective analysis (comparison between assessments) indicates that the trends in spawning stock biomass, recruitment and fishing mortality have been consistent between the benchmark assessment (2016) and the 2019 update.

Biological Reference Points (BRPs)

Reference points were calculated using the non-parametric yield and SSB per recruit long-term projection approach. The cumulative distribution function of the 2000-2018 recruitments (equivalent to years used in 2016 benchmark assessment) was re-sampled to provide future recruitment estimates for the projections used to estimate the biomass reference point.

The existing biological reference points for black sea bass are from the 2016 SAW 62 benchmark assessment (NEFSC 2017). The reference points are $F_{40\%}$ as the proxy for F_{MSY}, and the corresponding $SSB_{40\%}$ as the proxy for the SSB_{MSY} biomass target. The $F_{40\%}$ proxy for F_{MSY}

=0.36; the proxy estimate for SSB_{MSY} = $SSB_{40\%}$ = 9,667 mt = 21.312 million lbs; the proxy estimate for the ½ SSB_{MSY} biomass threshold = ½ $SSB_{40\%}$=4,834 mt = 10.657 million lbs; and the proxy estimate for MSY = $MSY_{40\%}$ = 3,097 mt=6.828 million lbs.

The $F_{40\%}$ and corresponding $SSB_{40\%}$ proxy biological reference points for black sea bass were updated for this 2019 Operational Assessment. The update fishing mortality threshold $F_{40\%}$ proxy for F_{MSY} = 0.46. The updated biomass target proxy estimate for SSB_{MSY} = $SSB_{40\%}$ = 14,092 mt = 31.067 million lbs. and the updated biomass threshold proxy estimate for ½ SSB_{MSY} = ½ $SSB_{40\%}$ = 7,046mt = 15.534 million lbs. The update proxy estimate for MSY = $MSY_{40\%}$ = 4,773 mt =10.522 million lbs.

Qualitative status description

The distribution of the fishery and catches has shifted north over the past decade. Most survey aggregate biomass indices are near their time series high. Recent survey indices suggest the recruitment of a large 2011 year class in the northern region and a strong 2015 year class in both regions. Modest catches over the past few years would indicate that current mortality from all sources is lower than recent recruitment inputs to the stock, which has resulted in a spawning biomass that is well above the management target. Despite uncertainty associated with the most recent year estimates, exploitable biomass is expected to decrease in coming years due to poor recruitment by the 2017 cohort along with declining abundance of the 2015 cohort.

Research and Data Issues

The recent recruitment of large year classes in the assessment time series (the 2011 and 2015 year class) has contributed to increases in catch, particularly in the northern region. Additional research examining recruitment events, distribution shifts and the changing environment should be explored.

Spatial differences in recruitment and fisheries have been accounted for with independent assessment models for north and south regions. A single model which tracks the spatial differences in the population dynamics should be developed.

Allocation issues continue to be an important management issue. Development of a Management Strategy Evaluation (MSE) model could be helpful in determining the best approach.

References

Legault CM, Restrepo VR. 1998. A flexible forward age-structured assessment program. ICCAT. Col. Vol. Sci. Pap. 49:246-253.

Mid-Atlantic Fishery Management Council. (MAFMC). 1999. Amendment 12 to the summer flounder, scup, and black sea bass fishery management plan. Dover, DE. 398 p + appendix.

Northeast Fisheries Science Center (NEFSC). 2017. 62th Northeast Regional Stock Assessment Workshop (62th SAW) Assessment Report. US Dept Commerce, Northeast Fish Sci Cent Ref Doc. 17-03; 822 p.

NOAA Fisheries Toolbox (NFT). 2013. Age Structured Assessment Program (ASAP) version 3.0.11. (Internet address: http://nft.nefsc.noaa.gov).

Tables

Table A1. Summary Black Sea Bass assessment results; Spawning Stock Biomass (SSB) in metric tons (mt); Recruitment (R) at age 0 in millions; Fishing Mortality (F) for age of peak fishery selection, ages 6-7. North-South averages, unadjusted for retrospective bias.

	SSB	R	F
1989	3,181	24,387	1.14
1990	3,044	29,781	1.09
1991	3,134	34,070	1.04
1992	3,433	29,042	0.93
1993	3,449	19,965	1.06
1994	3,475	28,660	0.87
1995	4,089	36,892	0.74
1996	4,308	26,613	0.92
1997	4,131	26,816	0.84
1998	4,636	22,880	0.60
1999	5,893	37,237	0.55
2000	7,483	46,765	0.54
2001	9,557	27,538	0.62
2002	10,081	31,597	0.66
2003	9,580	19,697	0.58
2004	8,247	15,713	0.57
2005	7,771	16,564	0.52
2006	6,443	30,816	0.55
2007	6,726	35,359	0.55
2008	9,544	45,513	0.49
2009	11,125	34,059	0.67
2010	14,061	34,419	0.76
2011	14,129	39,651	0.41
2012	16,730	144,684	0.60
2013	23,657	47,802	0.57
2014	34,712	26,240	0.42
2015	33,242	34,338	0.33
2016	30,736	79,373	0.35
2017	26,176	47,293	0.52
2018	22,199	10,058	0.39

Table A2. Total catch (metric tons) of black sea bass from Maine through North Carolina. Includes the 'New' MRIP estimates of recreational catch. Recreational discards assume 15% mortality.

	Commercial Landings	Commercial Discards	Recreational Landings	Recreational Discards	Total
1989	1,105	109	1,881	99	3,194
1990	1,402	53	1,354	231	3,040
1991	1,190	10	1,766	175	3,142
1992	1,264	141	1,344	165	2,914
1993	1,353	78	2,022	120	3,573
1994	848	37	1,347	210	2,443
1995	889	24	1,860	397	3,171
1996	1,448	285	2,755	236	4,724
1997	1,197	55	2,470	251	3,973
1998	1,152	121	681	310	2,263
1999	1,290	45	856	545	2,736
2000	1,186	44	1,836	873	3,939
2001	1,279	240	2,621	886	5,025
2002	1,564	46	2,528	1,381	5,518
2003	1,347	114	2,492	641	4,595
2004	1,405	380	1,362	374	3,521
2005	1,297	89	1,437	350	3,173
2006	1,285	33	1,243	371	2,933
2007	1,037	104	1,425	354	2,920
2008	875	66	1,606	585	3,132
2009	523	167	2,525	623	3,838
2010	751	134	3,502	733	5,121
2011	765	227	1,421	358	2,771
2012	782	116	3,162	1,048	5,108
2013	1,027	278	2,685	749	4,739
2014	1,088	459	3,510	839	5,896
2015	1,113	423	4,448	985	6,969
2016	1,133	757	6,131	1,391	9,412
2017	1,808	1,027	5,692	1,634	10,162
2018	1,514	722	4,008	1,033	7,277

Figures

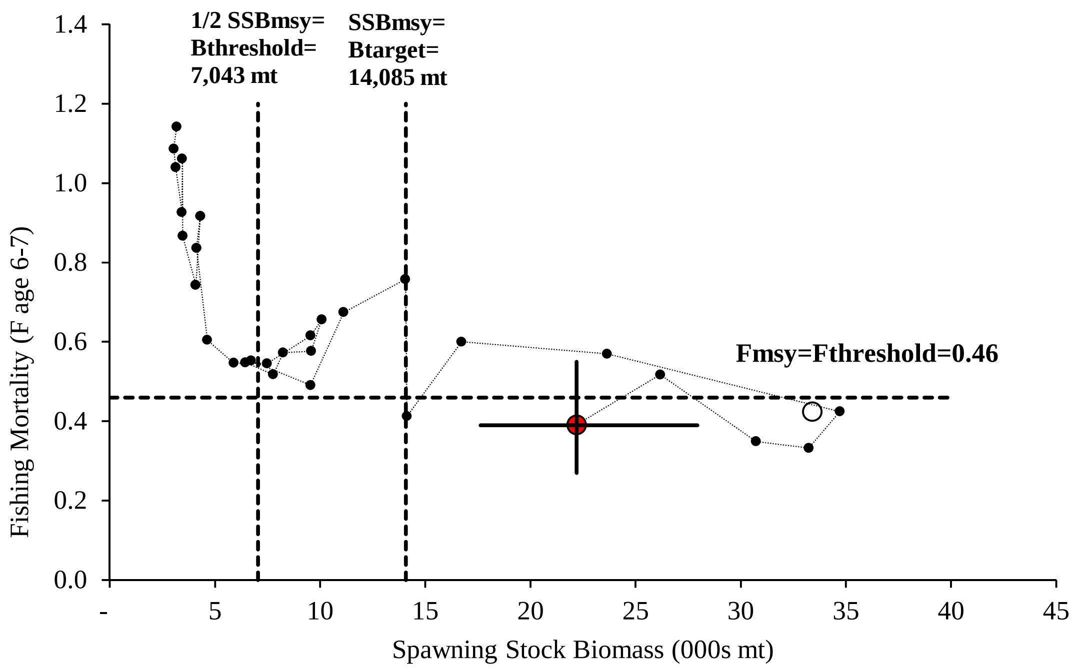

Figure A1. Estimates of black sea bass spawning stock biomass (SSB) and fully-recruited fishing mortality (F, peak at ages 6-7) relative to the updated 2019 biological reference points. Filled circle with 90% confidence intervals shows the assessment point estimates. The open circle shows the retrospectively adjusted estimates.

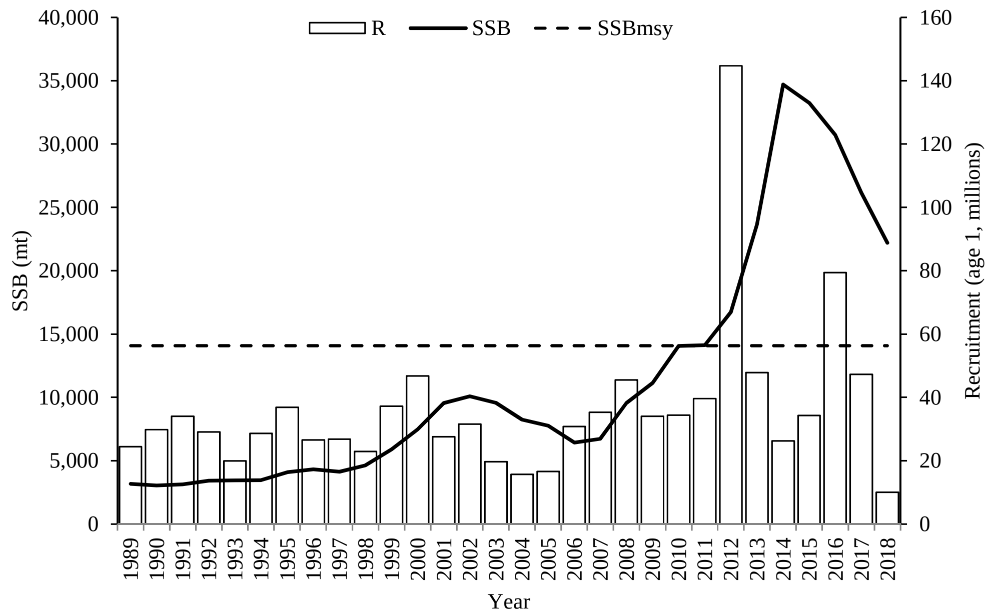

Figure A2. Black sea bass spawning stock biomass (SSB; solid line) and recruitment at age 0 (R; vertical bars) by calendar year. The horizontal dashed line is the updated SSB_{MSY} proxy = $SSB_{40\%}$ = 14,092 mt.

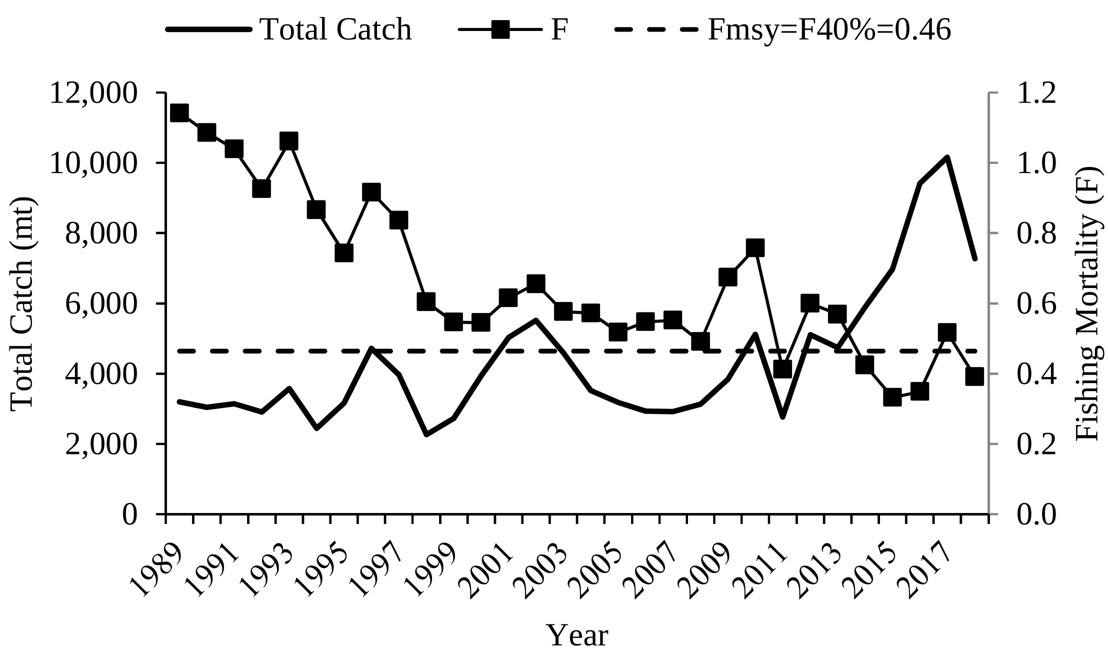

Figure A3. Total fishery catch (metric tons; mt; solid line) and fishing mortality (F, peak at age 6-7; squares) for black sea bass. The horizontal dashed line is the updated F_{MSY} proxy = $F_{40\%}$ = 0.46.

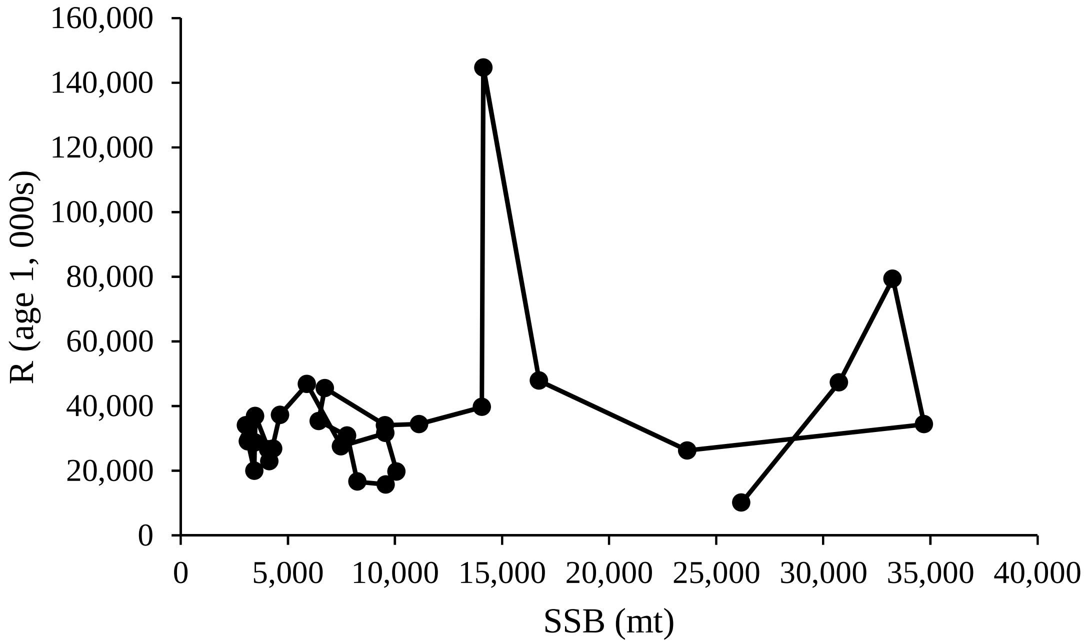

Figure A4. Spawning Stock Biomass (SSB) and Recruitment (R) scatter plot for black sea bass.

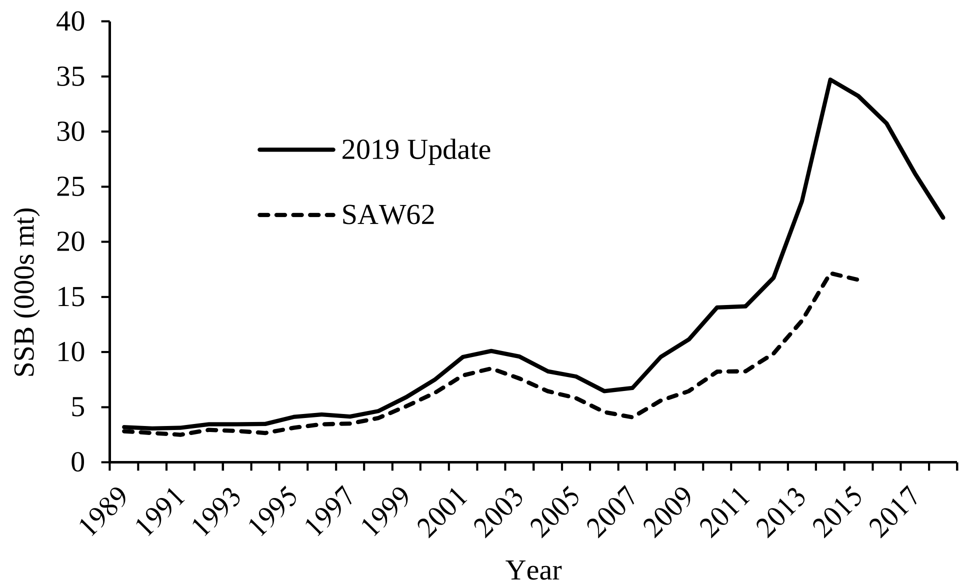

Figure A5. Historical retrospective of the 2016 (SAW 62; NEFSC 2017) and 2019 (Operational Assessment) stock assessments of black sea bass. The heavy solid lines are the 2019 Operational Assessment estimates that include the New MRIP recreational catch.

B: Scup Operational Assessment for 2019

(Lead: Mark Terceiro)

State of Stock

This assessment of scup (*Stenotomus chrysops*) is an update through 2018 of commercial and recreational fishery catch data, research survey indices of abundance, and analyses of those data. The scup stock was not overfished and overfishing was not occurring in 2018 relative to the updated biological reference points (Figure B1). Spawning stock biomass (SSB) was estimated to be 186,578 mt in 2018, about 2 times the updated biomass target reference point SSB_{MSY} proxy = $SSB_{40\%}$ = 94,020 mt (Table B1, Figure B2). There is a 90% chance that SSB in 2018 was between 159,746 and 221,281 mt. Fishing mortality on the fully selected age 3 fish was 0.158 in 2018, 73% of the updated fishing mortality threshold reference point F_{MSY} proxy = $F_{40\%}$ = 0.215 (Table B1, Figure B3). There is a 90% probability that the fishing mortality rate in 2018 was between 0.123 and 0.195. The average recruitment from 1984 to 2018 is 134 million fish at age 0. The 2015 year class is estimated to be the largest in the time series at 326 million fish, while the 2016-2018 year classes are estimated to be below average. (Table B1, Figures B2, B4). The 2018 model estimates of F and SSB adjusted for internal retrospective error are within the model estimate 90% confidence intervals and so no adjustment of the terminal year estimates has been made for stock status determination or projections (Figure B1). The stock has sustained catches above MSY since 2013. However, stock biomass is projected to further decrease toward the target unless more above average year classes recruit to the stock in the short term.

OFL Projections

Projections using the 2019 Operational Assessment ASAP model (data through 2018) were made to estimate the OFL catches for 2020-2021. The projections assume the 2019 ABC of 16,525 mt with recreational catch in 'New' MRIP equivalents will be taken in 2019, providing an estimated catch of 20,711 mt in 2019. The projections sample from the estimated recruitment for 1984-2018. The OFL projection uses F2020-F2021 = updated F_{MSY} proxy = $F_{40\%}$ = 0.215. The OFL catches are 18,674 mt in 2020 (CV = 17%) and 15,696 mt in 2021 (CV = 16%).

OFL for 2020-2021
Catches and SSB in metric tons

Year	Total Catch	Landings	Discards	F	SSB
2019	20,711	16,642	4,070	0.208	183,137
2020	18,674	15,472	3,664	0.215	163,495
2021	15,696	12,530	3,714	0.215	149,089

Catch

Reported 2018 commercial landings were 6,064 mt = 13.369 million lb. Estimated 2018 recreational landings were 5,887 mt = 12.979 million lb. Total commercial and recreational landings in 2018 were 11,951 mt = 26.347 million lb. Estimated 2018 commercial discards were 3,293 mt = 7.260 million lb. Estimated 2018 recreational discards were 644 mt = 1.420 million lb. The estimated total catch in 2018 was 15,888 mt = 35.027 million lb (Catch and Status Table below; Table B2).

In July 2018, the Marine Recreational Information Program (MRIP) replaced the existing estimates of recreational catch (‘Old’ MRIP) with a calibrated 1981-2017 time series (‘New’ MRIP) that corresponds to new survey methods that were fully implemented in 2018. For comparison with the existing estimates noted above, the ‘New’ MRIP estimate of 2017 recreational landings is 6,143 mt = 13.543 million lb, 2.5 times the ‘Old’ estimate. The ‘New’ MRIP estimate of 2017 recreational discards is 1,079 mt = 2.372 million lb, 2.7 times the ‘Old’ estimate. The ‘New’ MRIP recreational catch estimates increased the 1981-2017 total catch by an average of 18% (from 9,575 mt = 21.109 million lb to 11,310 mt = 24.934 million lb), ranging from +1% in 1986 to +51% in 2000. The increase in 2017 was +30%, from 14,608 mt = 32.205 million lb to 18,961 mt = 41.802 million lb. The 2019 updated assessment model includes the ‘New’ MRIP estimates of recreational landings and discards (Catch and Status Table below; Table B2).

Catch and Status Table: Scup

Catch weights in metric tons (mt); spawning stock biomass thousands of metric tons; recruitment in millions of age 0 fish; min, max and arithmetic mean values are for 1984-2018. Commercial catches are latest reported landings and estimated discards. Recreational catches are 'New' MRIP 2018 calibrated landings and discard estimates.

Year	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
Commercial landings	3,721	4,866	6,819	6,751	8,105	7,239	7,725	7,147	7,006	6,064
Commercial discards	3,189	2,638	1,234	1,029	1,279	1,004	1,774	2,772	4,733	3,293
Recreational landings	2.851	5,660	4,682	3.751	5,739	4,659	5,527	4,536	6,143	5,887
Recreational discards	552	787	516	636	568	480	581	862	1,079	644
Catch used in assessment	10,313	13,951	13,252	12,166	15,692	13,382	15,606	15,317	18,961	15,888
Spawning stock biomass	194	234	237	237	237	224	191	200	193	187
Recruitment (age 0)	128	143	199	114	106	235	326	112	93	83
Fully selected F (age 4)	0.074	0.090	0.086	0.086	0.119	0.113	0.158	0.140	0.167	0.158

Year	**Min**	**Max**	**Mean**
Commercial landings	1,207	8,105	4,887
Commercial discards	436	4,733	1,819
Recreational landings	824	6,430	3,893
Recreational discards	30	1,079	336
Catch used in assessment	3,485	18,961	11,430
Spawning stock biomass	3.5	237.5	93.1
Recruitment (age 0)	37.5	325.9	133.5
Fully selected F (age 4)	0.066	1.593	0.521

Stock Distribution and Identification
The Mid-Atlantic Fishery Management Council (MAFMC) and Atlantic States Marine Fisheries Commission (ASMFC) Joint Fishery Management Plan defines the management unit as all scup from Cape Hatteras, North Carolina northeast to the US-Canada border (MAFMC 1999).

Assessment Model
The assessment model for scup is a complex statistical catch-at-age model (ASAP SCAA; Legault and Restrepo 1998; NFT 2013) incorporating a broad range of fishery and survey data (NEFSC 2015). The model assumes an instantaneous natural mortality rate (M) = 0.2. The fishery catch is modeled as four fleets: commercial landings, recreational landings, commercial discards and recreational discards.

Indices of stock abundance from NEFSC winter, spring, and fall, Massachusetts DMF spring and fall, Rhode Island DFW spring and fall, University of Rhode Island Graduate School of Oceanography (URIGSO), RI Industry Cooperative trap, Connecticut DEEP spring and fall, New York DEC, New Jersey DFW, Virginia Institute of Marine Science (VIMS) Chesapeake Bay, VIMS juvenile fish trawl, and NEAMAP spring and fall trawl surveys were used in the 2015 SAW 60 benchmark assessment (NEFSC 2015) and the 2017 assessment update. All indices were updated for this 2019 Operational Assessment.

There is not a major retrospective pattern evident in the scup assessment model. The minor internal model retrospective error tends to overestimate F by +26% and underestimate SSB by -11% over the last 7 terminal years. The 2018 model estimates of F and SSB adjusted for internal retrospective error (F = 0.124; SSB = 213,721 mt) are within the model estimate 90% confidence intervals and so no adjustment of the terminal year estimates has been made for stock status determination or projections. The ‘historical’ retrospective analysis (comparison between assessments) indicates that the general trends in spawning stock biomass, recruitment, and fishing mortality have been consistent for the last decade (Figure B5).

Biological Reference Points (BRPs)
Reference points were calculated using the non-parametric yield and SSB per recruit long-term projection approach. The cumulative distribution function of the 1984-2018 recruitment (corresponding to the period of input fishery catches-at-age) was re-sampled to provide future recruitment estimates for the projections used to estimate the biomass reference point.

The existing biological reference points for scup are from the 2015 SAW 60 benchmark assessment (NEFSC 2015). The reference points are $F_{40\%}$ as the proxy for F_{MSY}, and the corresponding $SSB_{40\%}$ as the proxy for the SSB_{MSY} biomass target. The $F_{40\%}$ proxy for F_{MSY} = 0.220; the proxy estimate for SSB_{MSY} = $SSB_{40\%}$ = 87,302 mt = 192.468 million lbs; the proxy estimate for the ½ SSB_{MSY} biomass threshold = ½ $SSB_{40\%}$ = 43,651 mt = 96.234 million lbs; and the proxy estimate for MSY = $MSY_{40\%}$ = 11,752 mt = 25.909 million lbs.

The $F_{40\%}$ and corresponding $SSB_{40\%}$ proxy biological reference points for scup were updated for this 2019 Operational Assessment. The updated fishing mortality threshold $F_{40\%}$ proxy for F_{MSY} = 0.215. The updated biomass target proxy estimate for SSB_{MSY} = $SSB_{40\%}$ = 94,020 mt = 207.279 million lbs and the updated biomass threshold proxy estimate for ½ SSB_{MSY} = ½

$SSB_{40\%}$ = 47,010 mt = 103.639 million lbs. The updated proxy estimate for MSY = $MSY_{40\%}$ = 12,927 mt = 28.499 million lbs.

Qualitative status description
The age structure in current fishery and survey catches is greatly expanded compared to the truncated distribution observed in the early 1990s. Most survey aggregate biomass indices are near their time series high. Recent survey indices suggest the recruitment of several large year classes over the last 15 years. These simple metrics indicate that current mortality from all sources is lower than recent recruitment inputs to the stock, which has resulted in a spawning stock biomass that is well above the management target.

Research and Data Issues
The recent recruitment of the largest year class in the assessment time series (the 2015 year class) has contributed to recent high commercial fishery discards. The exploration of management actions to reduce discarding in the event of future high recruitment events might include modification of the commercial fishery Gear Restricted Areas and modified commercial mesh sizes.

There is evidence of a decreasing trend in mean weights at age and maturity, perhaps indicative of density dependent effects. Potential effects on reference points and projected fishery yield should continue to be closely monitored.

The stock has sustained catches above MSY since 2013. However, spawning stock biomass is projected to further decrease toward the target unless more above average year classes recruit to the stock in the short term.

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Tables

Table B1. Summary assessment results; Spawning Stock Biomass (SSB) in metric tons (mt); Recruitment (R) at age 0 in millions; Fishing Mortality (F) for age of peak fishery selection (S = 1) age 3.

Year	SSB	R	F
1984	11,091	147	0.944
1985	14,688	134	1.053
1986	13,928	93	0.966
1987	11,667	70	1.017
1988	9,353	130	1.041
1989	8,809	75	0.922
1990	11,291	112	0.799
1991	9,290	99	1.321
1992	7,518	40	1.378
1993	5,713	40	1.316
1994	4,229	73	1.593
1995	3,548	43	1.248
1996	6,209	37	0.989
1997	6,505	96	0.727
1998	7,932	110	0.437
1999	16,868	231	0.279
2000	33,108	154	0.227
2001	61,166	143	0.124
2002	85,072	91	0.091
2003	106,588	92	0.125
2004	118,173	142	0.111
2005	121,024	226	0.069
2006	132,421	264	0.097
2007	145,789	262	0.093
2008	172,480	231	0.066
2009	194,081	128	0.074
2010	234,435	143	0.090
2011	236,631	199	0.086
2012	236,703	114	0.086
2013	237,483	106	0.119
2014	224,139	235	0.113
2015	191,237	326	0.158
2016	199,856	112	0.140
2017	193,258	93	0.167
2018	186,578	83	0.158

Table B2. Total catch (metric tons) of scup from Maine through North Carolina. Commercial landings include revised Massachusetts landings for 1986-1997. Commercial discards for 1981-1988 calculated from the mean ratio of discards to landings for 1989-1991. Commercial discard estimate for 1998 is the mean of 1997 and 1999 estimates. Includes the 'New' MRIP estimates of recreational catch.

Year	Commercial Landings	Commercial Discards	Recreational Landings	Recreational Discards	Total Catch
1981	9,856	4,495	5,054	108	19,514
1982	8,704	3,970	3,908	169	16,751
1983	7,794	3,555	3,911	76	15,336
1984	7,769	3,543	1,489	34	12,836
1985	6,727	3,068	5,122	72	14,989
1986	7,176	3,273	6,430	86	16,965
1987	6,276	2,862	4,722	42	13,902
1988	5,943	2,710	3,191	38	11,882
1989	3,984	1,277	4,781	54	10,096
1990	4,571	2,466	3,254	59	10,350
1991	7,081	3,388	5,857	75	16,401
1992	6,259	1,885	4,288	63	12,496
1993	4,726	1,510	2,101	31	8,367
1994	4,392	962	1,964	30	7,348
1995	3,073	974	1,030	38	5,115
1996	2,945	870	2,004	55	5,874
1997	2,188	675	1,152	38	4,053
1998	1,896	705	824	60	3,485
1999	1,505	735	2,098	51	4,390
2000	1,207	592	5,167	249	7,216
2001	1,729	1,671	4,434	417	8,251
2002	3,173	1,284	2,826	427	7,710
2003	4,405	436	7,806	462	13,109
2004	4,209	1,324	5,819	620	11,972
2005	3,711	565	1,949	413	6,637
2006	4,081	896	2,688	639	8,304
2007	4,193	1,363	3,221	407	9,183
2008	2,370	1,693	2,613	608	7,284
2009	3,721	3,189	2,851	552	10,313
2010	4,866	2,638	5,660	787	13,951
2011	6,819	1,234	4,682	516	13,252
2012	6,751	1,029	3,751	636	12,166
2013	8,105	1,279	5,739	568	15,692
2014	7,239	1,004	4,659	480	13,382
2015	7,725	1,774	5,527	581	15,606

2016	7,147	2,772	4,536	862	15,317
2017	7,006	4,733	6,143	1,079	18,961
2018	6,064	3,293	5,887	644	15,888

Figures

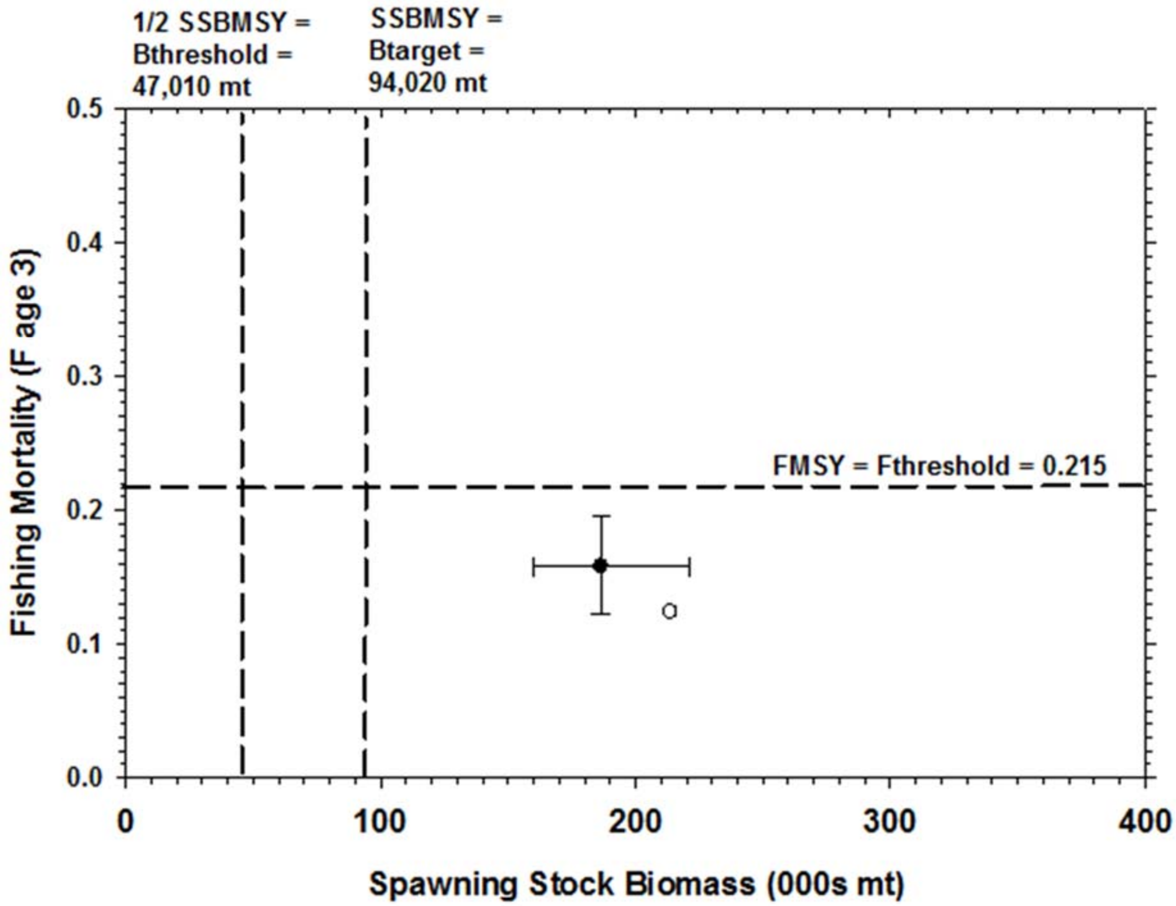

Figure B1. Estimates of scup spawning stock biomass (SSB) and fully-recruited fishing mortality (F, peak at age 3) relative to the updated 2019 biological reference points. Filled circle with 90% confidence intervals shows the assessment point estimates. The open circle shows the retrospectively adjusted estimates.

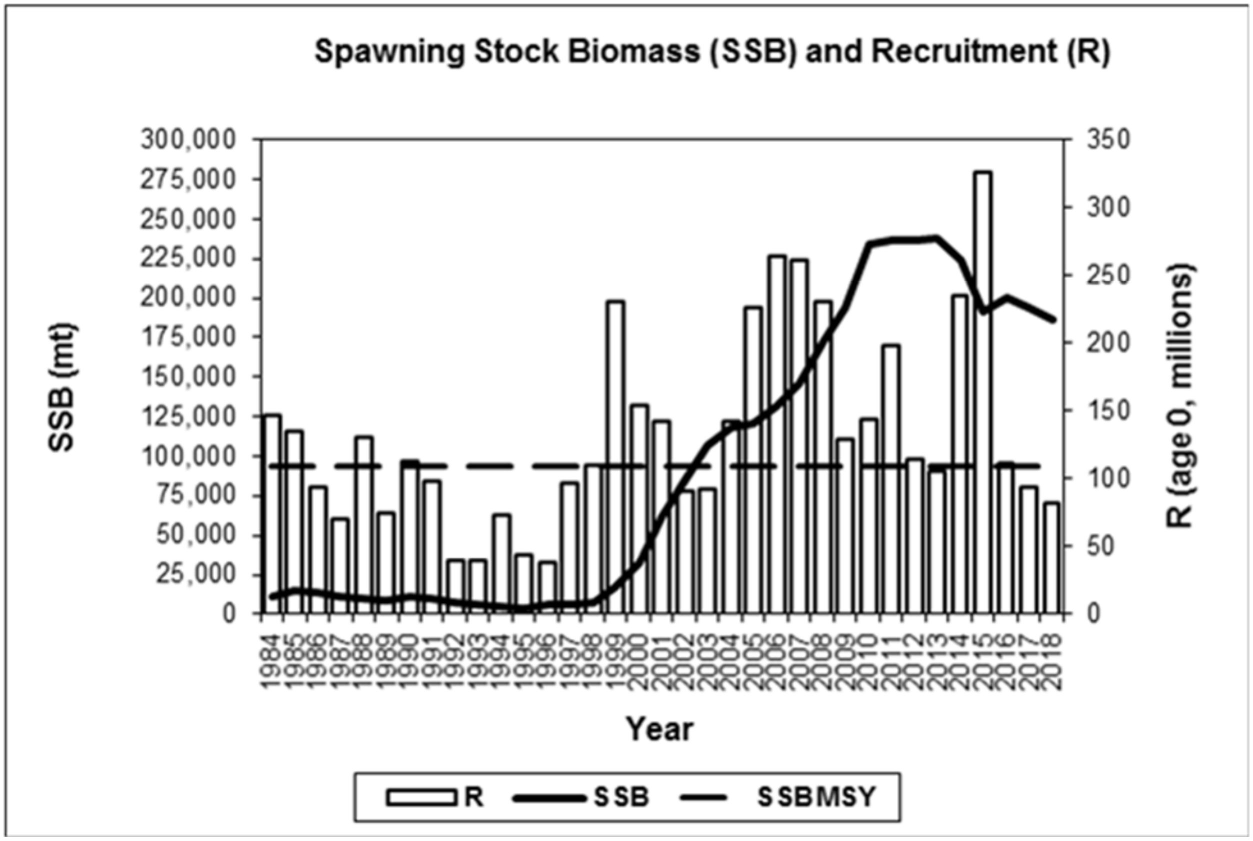

Figure B2. Scup spawning stock biomass (SSB; solid line) and recruitment at age 0 (R; vertical bars) by calendar year. The horizontal dashed line is the updated SSB_{MSY} proxy = $SSB_{40\%}$ = 94,020 mt. Note this figure only shows years when fishery age data are available in the model.

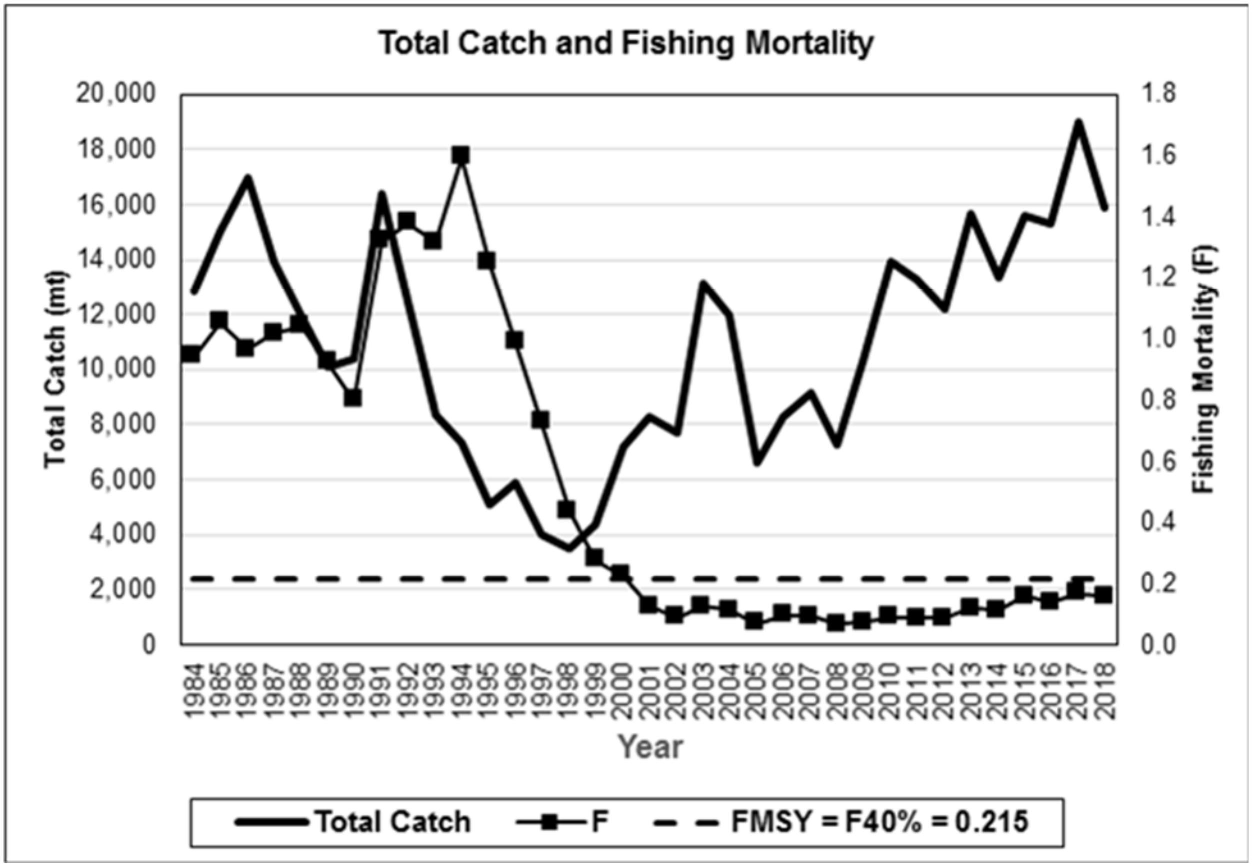

Figure B3. Total fishery catch (metric tons; mt; solid line) and fishing mortality (F, peak at age 3; squares) for scup. The horizontal dashed line is the updated F_{MSY} proxy = $F_{40\%}$ = 0.215. Note this figure only shows years when fishery age data are available in the model.

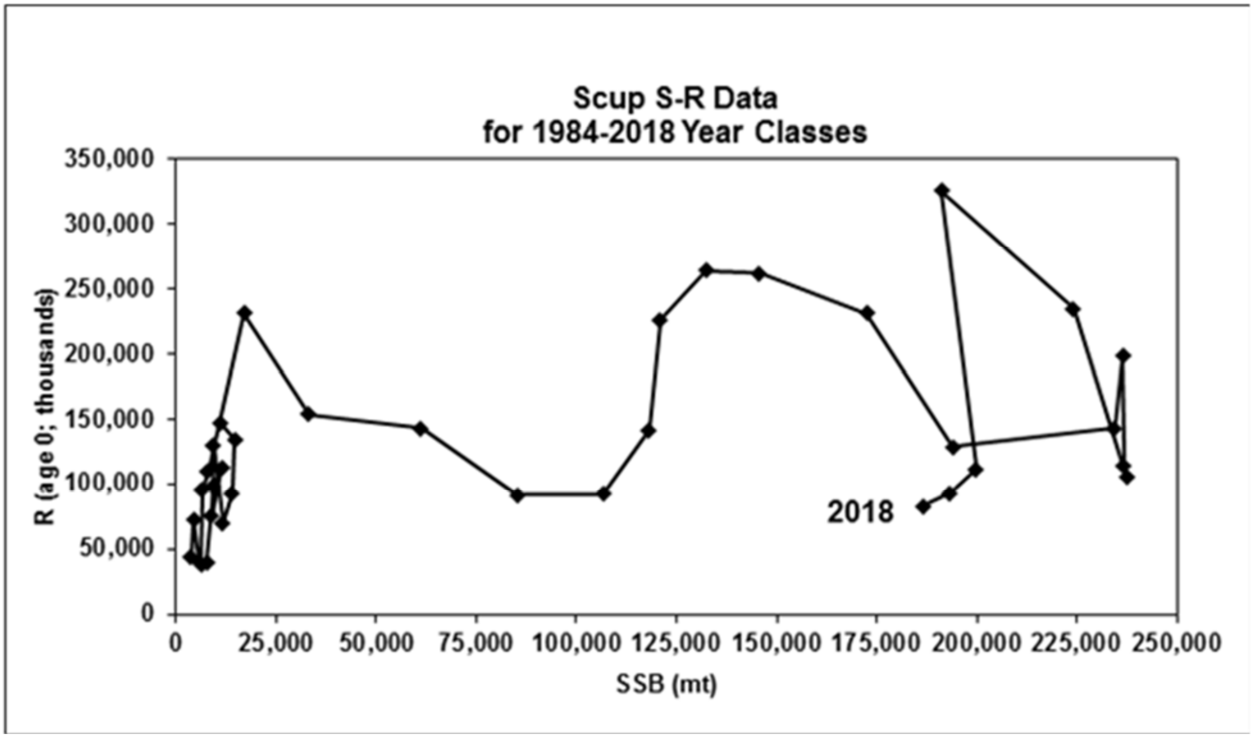

Figure B4. Spawning Stock Biomass (SSB) and Recruitment (R) scatter plot for scup. Note this figure only shows years when fishery age data are available in the model.

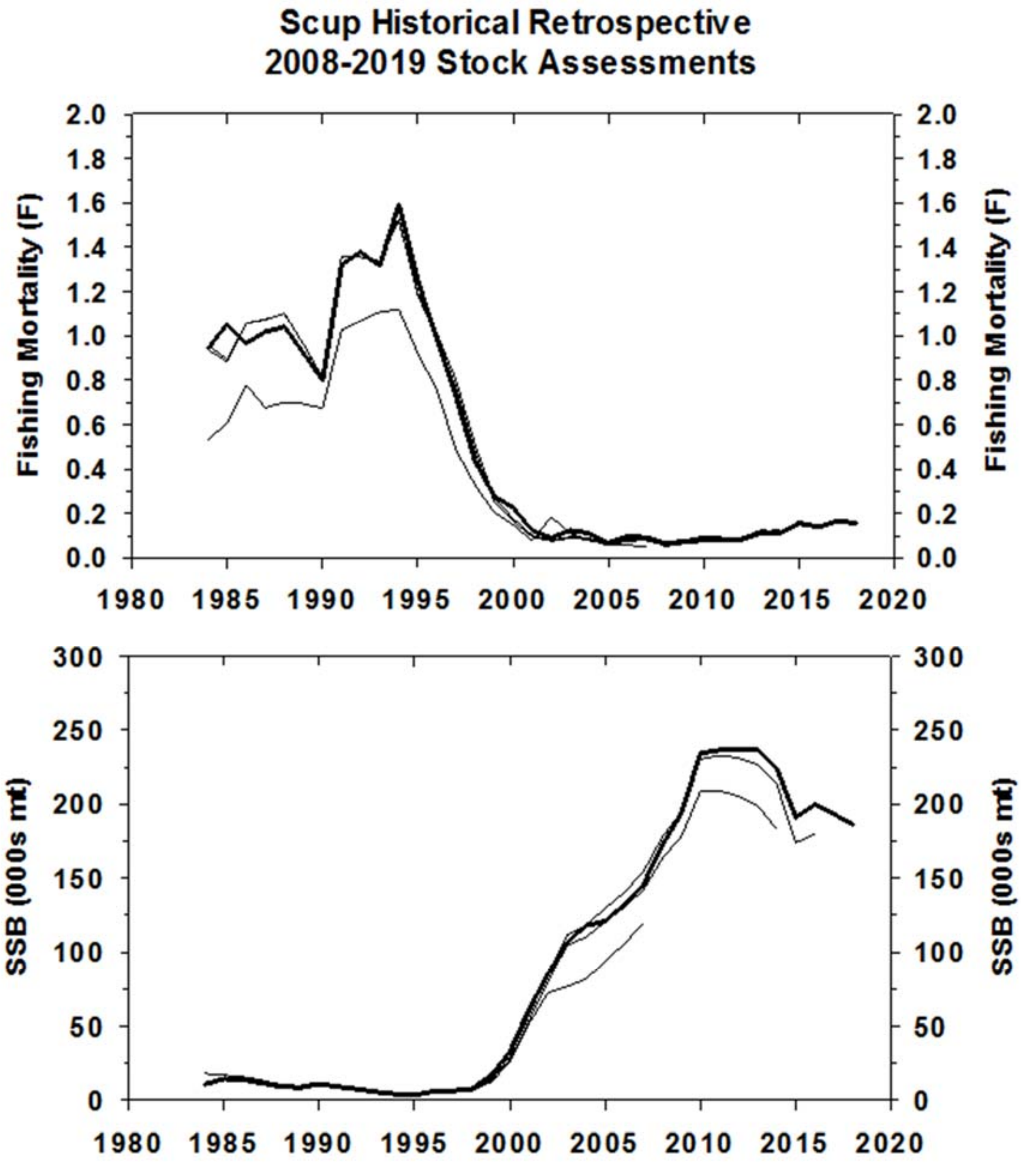

Figure B5. Historical retrospective of the 2008 (Data Poor Stocks; NEFSC 2009), 2015 (SAW 60; NEFSC 2015), 2017 (MAFMC SSC Update; unpublished) and 2019 (Operational Assessment) stock assessments of scup. The heavy solid lines are the 2019 Operational Assessment estimates that include the 'New' MRIP recreational catch.

C: Atlantic Bluefish Operational Assessment for 2019

(Lead: Anthony Wood)

State of Stock

This assessment of Atlantic bluefish (*Pomatomus saltatrix*) is an update through 2018 of commercial and recreational catch data, research survey indices of abundance, and the analyses of those data. The bluefish stock was overfished and overfishing was not occurring in 2018 relative to the updated biological reference points (Figure 1). Spawning stock biomass (SSB) was estimated to be 91,041 MT in 2018, about 46% of the updated biomass target reference point SSB_{MSY} proxy = $SSB_{35\%}$ = 198,717 MT, and 92% of the $SSB_{threshold}$ = 99,359 MT (Table 1, Figure 2). There is a 90% chance that SSB in 2018 was between 66,840 and 99,299 MT. Fishing mortality on the fully selected age 2 fish was 0.146 in 2018, 80% of the updated fishing mortality threshold reference point F_{MSY} proxy = $F_{35\%}$ = 0.183 (Table 1, Figure 3). There is a 90% probability that the fishing mortality rate in 2018 was between 0.119 and 0.205. The average recruitment from 1985 to 2018 was 46 million fish at age 0. The largest recruitment in the time series occurred in 1989 at 99 million fish, and the lowest recruitment was in 2016 at 29 million fish. Recruitment over the last decade has been below the time series average, except for 2013 where recruitment was 48 million fish (Table 1, Figures 2 & 4). Recruitment in 2018 was 42 million fish. The 2018 model estimates of F and SSB adjusted for internal retrospective error are within the model estimate 90% confidence intervals and so no adjustment of the terminal year estimates has been made for stock status determination of projections (Figure 1).

OFL Projections

Projections using the 2019 bluefish Operational Assessment ASAP model (data through 2018) were made to estimate the OFL catches for 2020-2021. Projections assumed that the 2019 ABC of 9,893 MT was harvested and sample from the estimated recruitment for 1985-2018. The 2019 ABC was converted into 'new MRIP' units using a 5-year average ratio of new to old recreational estimates. The OFL projection uses F_{2020}-F_{2021} = updated F_{MSY} proxy = F35% = 0.183. The OFL catches are 14,956 MT in 2020 (CV = 11%) and 16,016 MT in 2021 (CV = 10%).

Atlantic bluefish OFL for 2020-2021
Catches and SSB in metric tons

Year	Total Catch	F	SSB
2019	22,614	0.281	92,773
2020	14,956	0.183	98,353
2021	16,016	0.183	102,213

Catch

Reported 2018 commercial landings were 1,105 MT = 2.435 million lb. Estimated 2018 recreational landings were 5,695 MT = 12.556 million lb. Total commercial and recreational landings in 2018 were 6,800 MT = 14.991 million lb. Estimated 2018 recreational discards were 4,489 MT = 9.896 million lb. Commercial discards are not considered significant and not included in the assessment. The estimated total catch in 2018 was 11,288 MT = 24.887million lb.

In July 2018, the Marine Recreational Information Program (MRIP) replaced the existing estimates of recreational catch with a calibrated 1981-2017 time series ('New' MRIP) that corresponds to new survey methods that were fully implemented in 2018. For comparison with the existing estimates noted above, the 'New' MRIP estimate of 2017 recreational landings is 15,421 MT = 33.997 million lb, 3.3 times the 'Old' estimate. The 'New' MRIP estimate of 2017 recreational discards is 10,111 MT = 22.291 million lb, 5.4 times the 'Old' estimate. The 'New' MRIP recreational catch estimates increased the 1985-2017 total catch by an average of 116% (from 13,578 MT = 29.935 million lb to 29,291 MT = 64.576 million lb), ranging from +63% in 1986 to +291% in 2017. The increase in 2017 was 291%, from 6,532 MT = 14.400 million lb to 25,532 MT = 56.288 million lb. The 2019 updated assessment model includes the 'New' MRIP estimates of recreational landings and discards (Catch and Status Table; Table 2).

Catch and Status Table: Atlantic bluefish

(Weights in mt, recruitment in thousands, arithmetic means, includes New MRIP estimates)

Year	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Commercial landings	3,119	3,304	2,453	2,212	1,974	2,236	1,902	1,929	1,873	1,105
Recreational landings	18,040	21,013	15,430	15,051	15,526	12,050	13,524	10,433	15,421	5,695
Recreational discards[2]	10,071	11,965	14,606	11,039	9,537	9,848	6,953	8,008	10,111	4,489
Catch used in assessment	31,231	36,281	32,489	28,303	27,037	24,135	22,379	20,370	27,404	11,288
Spawning stock biomass	121,382	118,142	115,427	112,703	110,627	94,203	85,924	96,805	92,794	91,041
Recruitment (age 0, thousands)	36,453	40,079	35,654	31,643	48,315	41,454	44,071	28,904	45,171	41,890
F full[3]	0.27	0.32	0.32	0.32	0.35	0.38	0.37	0.26	0.40	0.15

	Min[1]	Max[1]	Avg[1]
Commercial landings	1,105	7,162	3,807
Recreational landings	5,695	74,988	21,012
Recreational discards[2]	1,440	14,850	7,717
Catch used in assessment	11,288	84,201	32,536
Spawning stock biomass	75,510	185,654	105,254
Recruitment (age 0, thousands)	28,461	98,997	46,159
F full[3]	0.15	0.58	0.35

[1] Years 1985-2018

[2] dead discards

[3] F on fully selected age 2. Note that table values are not retro adjusted.

Stock Distribution and Identification
The Atlantic States Marine Fisheries Commission (ASMFC) and Mid-Atlantic Fishery Management Council (MAFMC) jointly developed the Fishery Management Plan (FMP) for the bluefish fishery and adopted the plan in 1989 (ASMFC 1989, MAFMC 1990). The Secretary of Commerce approved the FMP in March 1990. The FMP defines the management unit as bluefish (*Pomatomus saltatrix*) in U.S. waters of the western Atlantic Ocean.

Assessment Model
The assessment model for Atlantic bluefish is a complex statistical catch-at-age model (ASAP SCAA; Legault and Restrepo 1998; NFT 2013) incorporating a broad range of fishery and survey data (NEFSC 2015). The model assumes an instantaneous natural mortality rate (M) = 0.2. The fishery catch is modeled as two fleets: 1. Commercial landings, and 2. Combined recreational landings and recreational discards.

Indices of stock abundance included a recreational catch-per-unit-effort index developed from the MRIP intercept data. In addition, eight fishery-independent indices were included in the model. Age-0+ fishery-independent indices included the NEFSC fall Bigelow trawl survey, the New Jersey ocean trawl survey, the Connecticut Long Island Sound trawl survey, the NEAMAP fall inshore trawl survey, and the North Carolina Pamlico Sound independent gillnet survey. Young-of-year indices included the SEAMAP fall trawl survey and a composite index developed from state seine indices from New Hampshire to Virginia. In 2018, all indices except the composite seine juvenile survey showed a decrease from 2017 values.

There is not a major retrospective pattern evident in the bluefish assessment model. The minor internal model retrospective error tends to underestimate F by 18% and overestimate SSB by 19% over the last 7 terminal years. The 2018 model estimates of F and SSB adjusted for internal retrospective error (F = 0.179; SSB = 76,312 MT) are within the model estimate 90% confidence intervals and so no adjustment of the terminal year estimates has been made for stock status determination or projections. The ‘historical’ retrospective comparison between the SARC60 benchmark, a 2017 continuity run using old MRIP data, and this update, indicates similar trends for SSB, F, and recruitment for most of the time-series (Figure 5). The addition of the new calibrated MRIP data in 2019 resulted in the model scaling estimates of SSB, F, and recruitment higher compared to the using the old data. Near the end of the time-series low catch in 2016 and 2018 leads to large drops in F.

Biological Reference Points (BRPs)
Reference points were calculated using the non-parametric yield and SSB per recruit long-term projection approach. The cumulative distribution function of the 1985-2018 recruitments (corresponding to the period of input fishery catches-at-age) was re-sampled to provide future recruitment estimates for the projections used to estimate the biomass reference point.

The existing biological reference points for bluefish are from the SSC review of the SAW 60 benchmark assessment (NEFSC 2015). The reference points are $F_{35\%}$ as the proxy for F_{MSY}, and the corresponding $SSB_{35\%}$ as the proxy for the SSB_{MSY} biomass target. The $F_{35\%}$ proxy for F_{MSY} = 0.19; the proxy estimate for SSB_{MSY} = $SSB_{35\%}$ = 101,343 MT = 223 million lbs; the proxy estimate for the ½ SSB_{MSY} biomass threshold = ½ $SSB_{35\%}$ = 50,672 MT = 112 million lbs; and the proxy estimate for MSY = $MSY_{35\%}$ = 14,443 MT = 32 million lbs.

The $F_{35\%}$ and corresponding $SSB_{35\%}$ proxy biological reference points for bluefish were updated for this 2019 Operational Assessment. The updated fishing mortality threshold $F_{35\%}$ proxy for F_{MSY} = 0.183; the updated biomass target proxy estimate for SSB_{MSY} = $SSB_{35\%}$ = 198,717 MT = 438 million lbs; the updated biomass threshold proxy estimate for ½ SSB_{MSY} = ½ $SSB_{35\%}$ = 99,359 MT = 219 million lbs; and the updated proxy estimate for MSY = $MSY_{35\%}$ = 29,571 MT = 65 million lbs.

Qualitative status description

The bluefish stock has experienced a decline in SSB over the past decade, coinciding with an increasing trend in F. Recruitment has remained fairly steady, fluctuating just below the time-series mean of 46 million fish. Both commercial and recreational fisheries had poor catch in 2016 (20,370 MT), and 2018 (11,288 MT), resulting in the second lowest and lowest catches on record, respectively. As a result of the very low catch in 2018, fishing mortality was estimated below the reference point for the first time in the time-series. These lower catches are possibly a result of availability. Anecdotal evidence suggests larger bluefish stayed offshore and inaccessible to most of the recreational fishery during these two years.

Research and Data Issues

The large increase in recreational landings and discards from the new MRIP calibration has further increased the importance of the recreational data to this assessment. Accurately characterizing the recreational discard lengths is an important component of the assessment and research that improves the methodology used to collect these data is recommended.

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NOAA Fisheries Toolbox (NFT). 2013. Age Structured Assessment Program (ASAP) version 3.0.11. (Internet address: http://nft.nefsc.noaa.gov).

Tables

Table C1. Summary assessment results for Atlantic Bluefish; Spawning Stock Biomass (SSB) in metric tons (MT); Recruitment (R) at age 0 in thousands; Fishing Mortality (F) for age of peak fishery selection (S = 1) age 2.

Year	SSB	R	F
1985	185,654	66,750	0.322
1986	165,351	52,276	0.491
1987	138,473	38,531	0.581
1988	102,815	47,993	0.547
1989	96,055	98,997	0.493
1990	85,487	48,818	0.534
1991	78,506	55,975	0.506
1992	75,510	28,461	0.447
1993	75,901	30,001	0.417
1994	77,018	42,217	0.350
1995	77,789	32,381	0.302
1996	76,446	42,664	0.304
1997	80,924	42,066	0.328
1998	94,032	40,385	0.299
1999	97,647	63,230	0.295
2000	107,896	35,554	0.297
2001	118,111	55,720	0.351
2002	101,029	44,238	0.288
2003	105,989	59,680	0.268
2004	117,967	31,811	0.267
2005	132,223	59,630	0.260
2006	107,584	67,106	0.303
2007	109,312	46,148	0.297
2008	131,873	44,782	0.229
2009	121,382	36,453	0.267
2010	118,142	40,079	0.324
2011	115,427	35,654	0.318
2012	112,703	31,643	0.324
2013	110,627	48,315	0.351
2014	94,204	41,454	0.381
2015	85,924	44,071	0.374
2016	96,805	28,904	0.257
2017	92,794	45,171	0.404
2018	91,041	41,890	0.146

Table C2. Total catch (metric tons) of Atlantic bluefish from Maine through Florida from 1985-2018. Does not include commercial discards as they are not considered significant for this stock. Includes the 'New' MRIP estimates of recreational catch.

Year	Commercial Landings	Recreational Landings	Recreational Discards	Total Catch
1985	6,124	47,376	1,655	55,154
1986	6,657	74,988	2,556	84,201
1987	6,579	63,834	3,198	73,610
1988	7,162	36,337	1,440	44,938
1989	4,740	36,250	2,029	43,019
1990	6,250	31,268	4,999	42,516
1991	6,138	26,485	6,137	38,760
1992	5,208	22,262	4,351	31,820
1993	4,819	16,170	5,955	26,943
1994	4,306	14,085	6,126	24,517
1995	3,629	13,228	4,400	21,257
1996	4,213	10,623	6,477	21,313
1997	4,109	12,516	7,829	24,455
1998	3,741	15,243	5,693	24,676
1999	3,325	10,501	11,809	25,634
2000	3,660	10,950	12,431	27,041
2001	3,953	14,888	14,850	33,691
2002	3,116	13,612	8,241	24,970
2003	3,359	14,758	7,281	25,398
2004	3,661	17,264	9,050	29,975
2005	3,211	17,661	9,571	30,443
2006	3,252	16,653	10,379	30,284
2007	3,390	18,077	10,136	31,603
2008	2,730	17,185	9,173	29,088
2009	3,119	18,040	10,071	31,231
2010	3,304	21,013	11,965	36,281
2011	2,453	15,430	14,606	32,489
2012	2,212	15,051	11,039	28,303
2013	1,974	15,526	9,537	27,037
2014	2,236	12,050	9,848	24,135
2015	1,902	13,524	6,953	22,379
2016	1,929	10,433	8,008	20,370
2017	1,873	15,421	10,111	27,404
2018	1,105	5,695	4,489	11,288

Figures

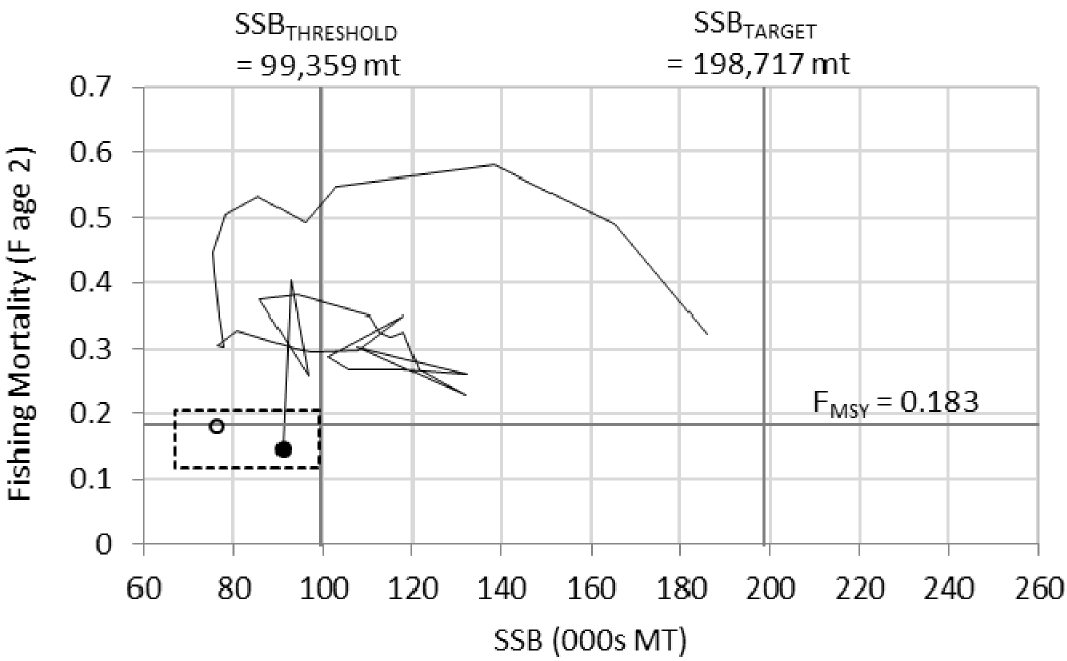

Figure C1. Estimates of Atlantic bluefish spawning stock biomass (SSB) and fully-recruited fishing mortality (F, peak at age 2) relative to the updated 2019 biological reference points. Filled circle with 90% confidence intervals (dotted box) shows the assessment point estimates. The open circle shows the retrospectively adjusted estimates.

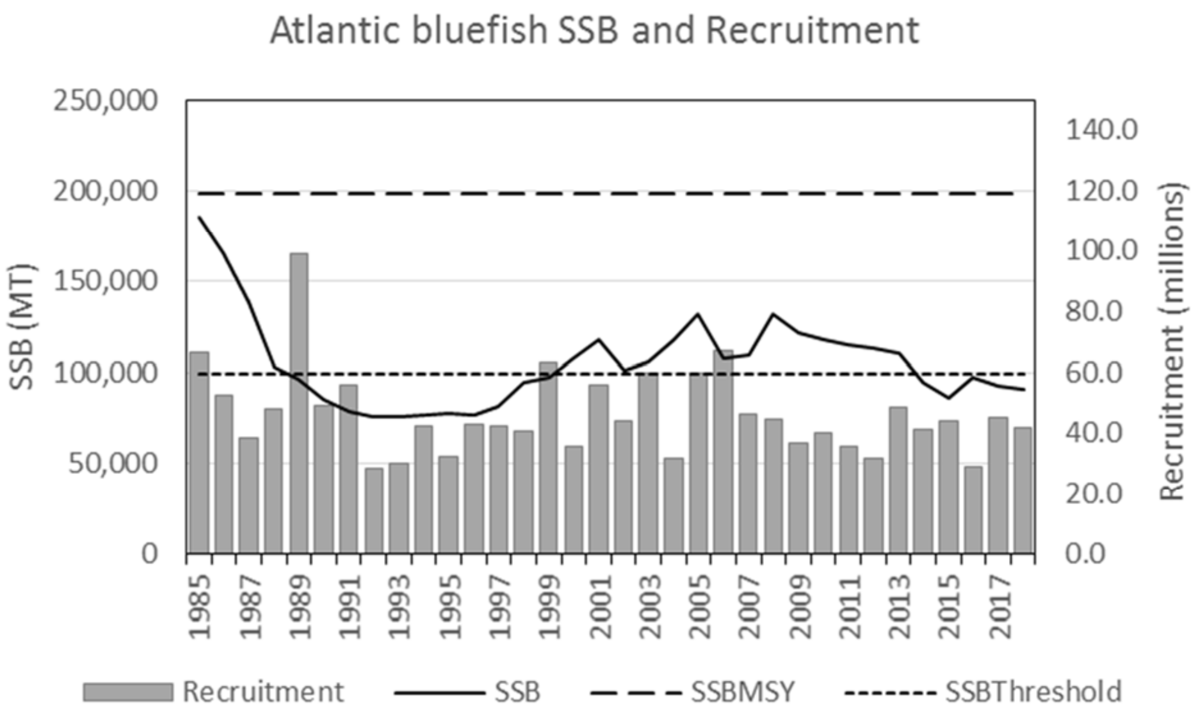

Figure C2. Atlantic bluefish spawning stock biomass (SSB; solid black line) and recruitment at age 0 (R; gray vertical bars) by calendar year. The horizontal dashed line is the updated SSB_{MSY} proxy = $SSB_{40\%}$ = 198,717 MT, and the dotted black line is the $SSB_{Threshold}$ = 99,359 MT.

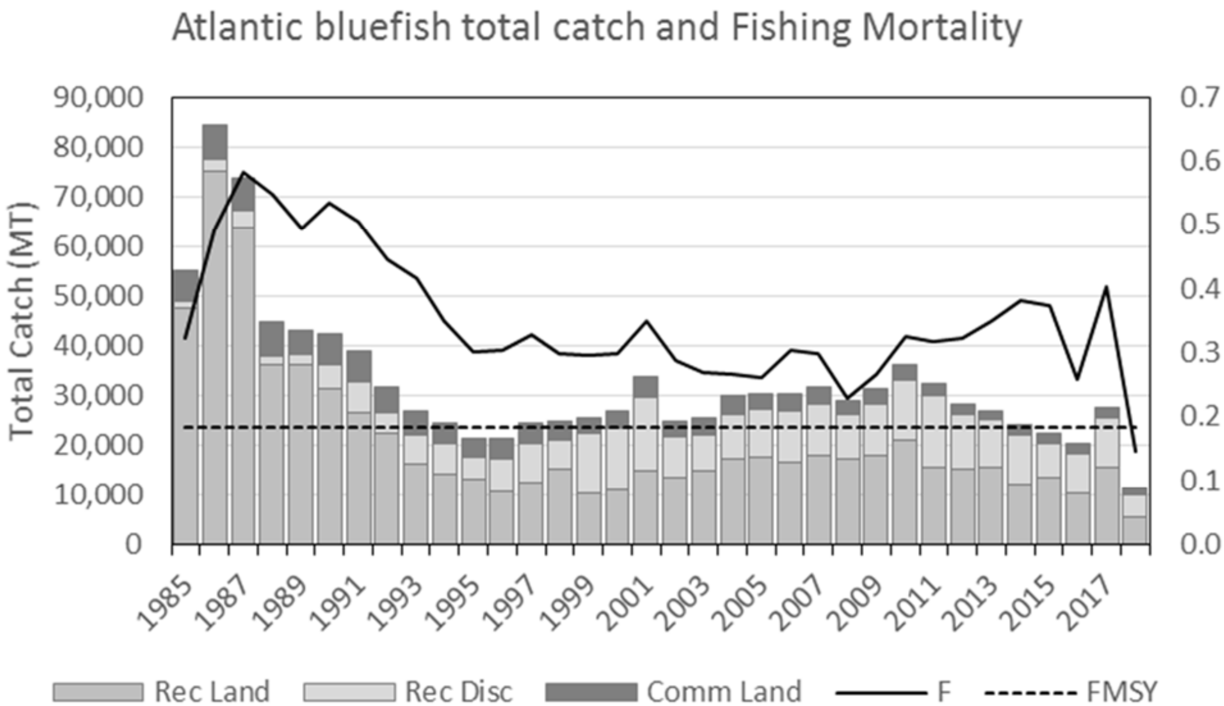

Figure C3. Total fishery catch (metric tons; MT; solid line) and fishing mortality (F, peak at age 3; squares) for Atlantic bluefish. The horizontal dashed line is the updated F_{MSY} proxy = $F_{35\%}$ = 0.183.

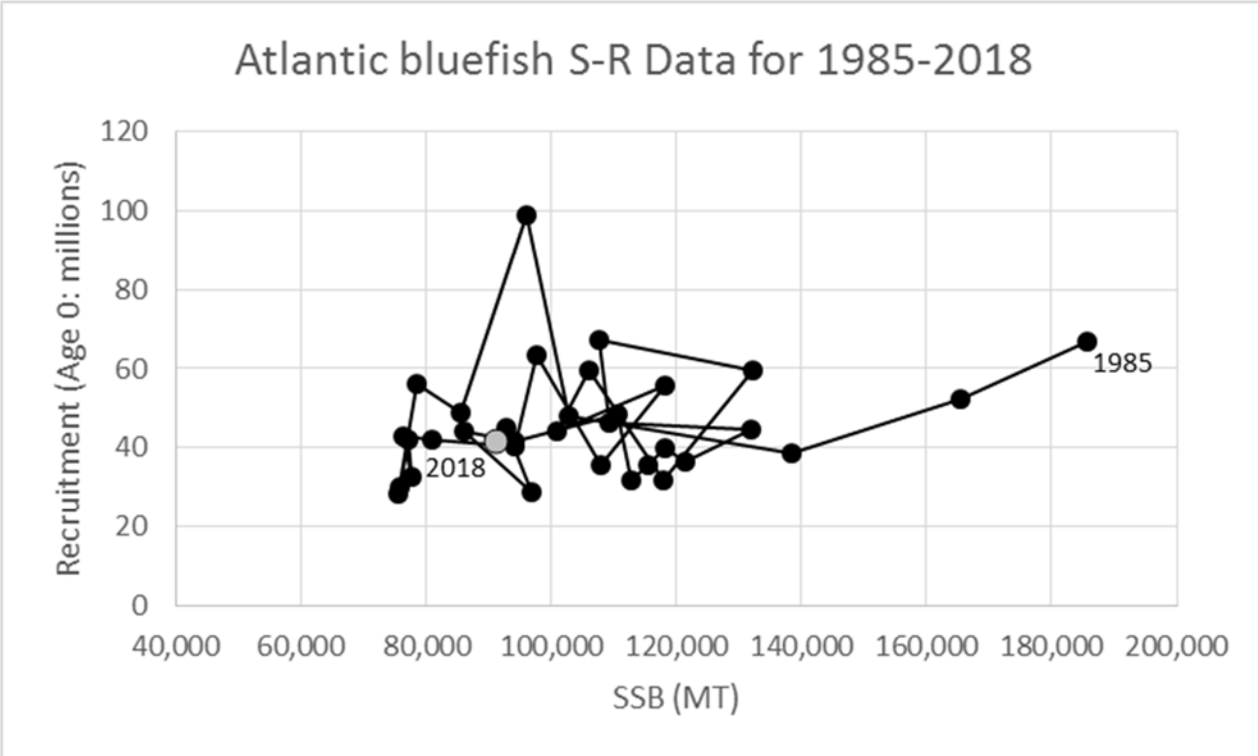

Figure C4. Spawning Stock Biomass (SSB) and Recruitment (R) scatter plot for Atlantic bluefish.

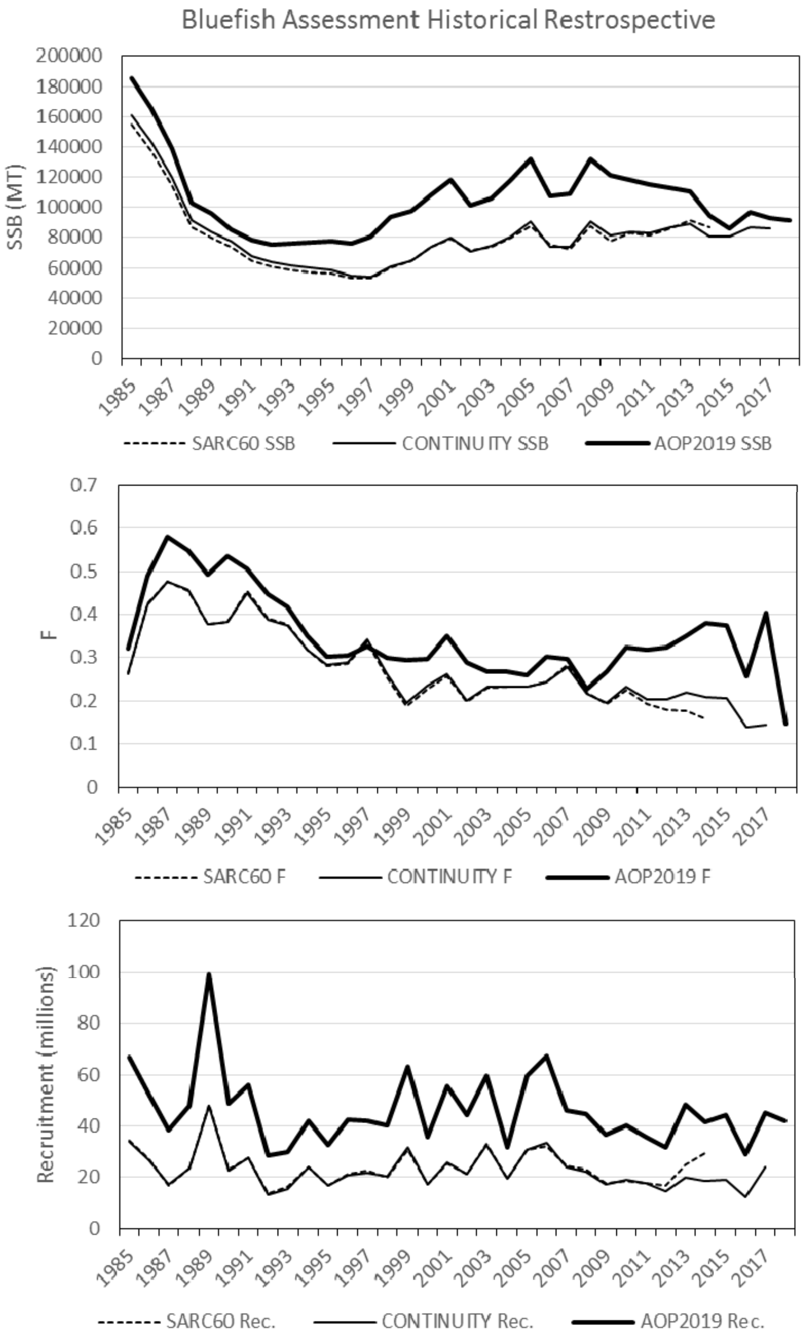

Figure C5. Historical retrospective analysis of the 2015 (dotted), 2017 (continuity run: slim black line), and 2019 (bold black line) stock assessments of Atlantic bluefish.

D. Monkfish Operational Assessment for 2019

(Lead: Anne Richards)

Executive Summary

Assessment data for northern and southern management units of monkfish were updated with minimal changes to the approaches of the previous index-based assessment (NEFSC 2016). No age data are available for monkfish, and the assessment does not include analytic models.

TOR 1. Update fishery-dependent and fishery-independent data from previous assessment.

Commercial fishery statistics for monkfish were updated for 2015-2018. In the north, landings and catch have fluctuated around a steady level since 2009, but increased after 2015. In the south, landings and catch had been declining since around 2000, but catch increased after 2015 due to discarding of a strong 2015 year class.

Survey data updated through 2018 indicate an increasing trend in biomass in both management areas since 2014; exploitable biomass (43+cm total length) indices have more than doubled in both areas since 2015, reflecting growth of the strong 2015 year class. Abundance also increased, and remains relatively high but has been decreasing in most series since 2016. Recruitment indices were high in the north in 2015 and 2016, and in the south in 2015.

New estimates of area-swept minimum biomass and abundance were developed using results from a study of relative efficiency of chain and rock-hopper sweeps on the net used for NEFSC bottom trawl surveys.The area-swept estimates are approximately 3 times (total biomass) or 5 times (total abundance) higher than the un-adjusted estimates, but follow the same trends.

TOR 2. Prepare an approach to providing scientific advice to management in the absence of an analytical model.

The monkfish assessment does not include an analytical model because the aging method has been invalidated, thus invalidating the growth model that is the foundation for the previously-approved model.

A simple model-free method previously used to derive Georges Bank cod catch limits was applied to current monkfish data. The method calculates the proportional rate of change in smoothed survey indices over the most recent 3 years for potential application to revising catch limits. In the NMA, the estimated rate of change was 1.2-1.3 depending on which surveys were included, and in the SMA, the estimated rate of change was 0.96-1.04.

TOR 3. Update the values of biological reference points (BRPs) for this stock.

BRPs defined in the management plan are dependent on output from the now-invalidated population model, therefore they have not been updated.

TOR 4. Include qualitative descriptions of stock status based on simple indicators/metrics.

Strong recruitment in 2015 fueled an increase in stock biomass in 2016-2018, though abundance has since declined as recruitment returned to average levels. Biomass increases were greater in the northern area than in the southern area, and biomass has declined somewhat in the south.

TOR 5. Perform short-term (2-year) population projections.

Not relevant to this assessment.

6. Comment on research areas or data issues that might lead to improvements in future stock assessments.

Development of a growth curve and/or an accurate aging method would allow application of age-based models. A better understanding of stock structure and movement patterns, especially mxing between management areas, would be helpful.

Introduction

Life History

The monkfish (*Lophius americanus*), also called goosefish, is distributed in the Northwest Atlantic from the Grand Banks and northern Gulf of St. Lawrence south to Cape Hatteras, North Carolina (Collette and Klein-Macphee 2002). Monkfish may be found from inshore areas to depths of at least 900 m (500 fathoms). Seasonal onshore-offshore migrations occur and appear to be related to spawning and possibly food availability (Collette and Klein-MacPhee 2002).

Monkfish rest partially buried on soft bottom substrates and attract prey using a modified first dorsal fin ray that resembles a fishing pole and lure. Monkfish are piscivorous and can eat prey as large as themselves. Despite the behavior of monkfish as a demersal 'sit-and-wait' predator, recent information from electronic tagging suggests seasonal off-bottom movements which may be related to migration (Rountree et al. 2006).

Growth rates of monkfish are not well understood and recent studies call into question the growth curves used in prior assessments (2007, 2010, 2013). One recent study has shown that the method currently used to age monkfish in the U.S. (counting rings on vertebrae) does not consistently identify the correct number of presumed-annual rings at the margin of the vertebra (Bank 2016). Further work conducted at the NEFSC has confirmed this using samples from the strong 2015 yearclass at presumed ages 1, 2 and 3 (Sandy Sutherland, NEFSC, personal communication). In addition, it appears that growth of immature monkfish may be much faster than previously understood. Growth estimated by modal progression of the 2015 yearclass suggests that monkfish may grow to ~25 cm by age 1 and reach the size at maturity (approximately 40 cm) by age two (Figure D1).

The estimated size at 50% maturity of monkfish is 41 cm for females and 37 cm for males (Richards et al. 2008). Few males are found larger than 70 cm, but females can reach sizes greater than 130 cm. Spawning takes place from spring through early autumn, progressing from south to north, with most spawning occurring during the spring and early summer (Richards et al. 2008). Females lay a buoyant mucoid egg raft or veil which can be as large as 12 m long and 1.5 m wide and only a few mm thick. The eggs are arranged in a single layer in the veil, and the larvae hatch after about 1-3 weeks, depending on water temperature. Females likely produce more than one egg veil per year (McBride et al. 2017). The larvae and juveniles spend several months in a pelagic phase before settling to a benthic existence at a size of about 8 cm (Collette and Klein-MacPhee 2002).

Stock Structure

The Fishery Management Plan (FMP) defines two management areas for monkfish (northern management area (NMA) and southern management area (SMA)), divided roughly by a line bisecting Georges Bank (Figure D2). The two assessment and management areas for monkfish were defined in the 1999 FMP based on differences in temporal patterns of recruitment (estimated from NEFSC surveys), perceived differences in growth patterns, and differences in the contribution of fishing gear types (mainly trawl, gill net, and dredge) to the landings. Since then, genetic studies using mitochondrial DNA have suggested a homogeneous population of monkfish off the U.S. east coast (Chikarmane et al. 2000; Johnson et al. in prep.); however research in progress using microsatellite DNA suggests a possible delination off Delaware Bay in the Mid-Atlantic Bight (Housbrouck et al. 2015).

Monkfish larvae are distributed over deep (< 300 m) offshore waters of the Mid-Atlantic Bight in March-April, and across the continental shelf (30 to 90 m) later in the year, but relatively few larvae have been sampled in the northern management area (Steimle et al. 1999). NEFSC surveys continue to indicate different recruitment patterns in the two management units in recent years.

The perceived differences in growth in the two management areas were based on studies about 10 years apart and under different stock conditions (Armstrong et al. 1992: Georges Bank to Mid-Atlantic Bight, 1982-1985; Hartley 1995: Gulf of Maine, 1992-1993). Age, growth, and maturity information from the NEFSC surveys and the 2001, 2004 and 2009 cooperative monkfish surveys indicated only minor differences in age, growth, and maturity between the areas (Richards et al., 2008; Johnson et al., 2008). However these growth studies used the vertebral aging method which is now called into question.

The southern deepwater extent of the range of American monkfish (*L. americanus*) overlaps with the northern extent of the range of blackfin monkfish (*L. gastrophysus*; Caruso 1983). These two species are morphologically similar, which may create a problem in identification of survey catches and landings from the southern extent of the range of monkfish. The potential for a problem however is believed to be small. The NEFSC closely examined winter and spring 2000 survey catches for the presence of blackfin monkfish and found none. The cooperative monkfish survey conducted in 2001 caught only eight blackfin monkfish of a total of 6,364 monkfish captured in the southern management area.

Fisheries Management

Commercial fisheries for monkfish occur year-round using gillnets, trawls and scallop dredges. No significant recreational fishery exists. The primary monkfish products are tails, livers and whole gutted fish. Peak fishing activity occurs during November through June, and value of the catch is highest in the fall due to the high quality of livers during this season.

U.S. fisheries for monkfish are managed in the Exclusive Economic Zone (EEZ) through a joint New England Fishery Management Council - Mid-Atlantic Fishery Management Council Monkfish Fishery Management Plan (FMP). The primary goals of the Monkfish FMP are to end and prevent overfishing and to optimize yield and economic benefits to various fishing sectors involved with the monkfish fisheries (NEFMC and MAFMC 1998; Haring and Maguire 2008). Current regulatory measures vary with type of permit but include limited access, limitations on days at sea, mesh size restrictions, trip limits, minimum size limits and annual catch limits (Tables 1 and 2).

Biological reference points for monkfish were established in the original Fishery Management Plan (FMP), but were revised after SAW 34 (NEFSC 2002), after the Data Poor Stocks Working Group (DPSWG) in 2007 (NEFSC 2007a), and after SAW 50 in 2010. The overfishing definition on record is F_{max}. Prior to 2007, $B_{threshold}$ was defined as one-half of the median of the 1965-1981 3-year average NEFSC autumn trawl survey catch (kg) per tow). After acceptance of an analytical assessment in 2007 (NEFSC 2007a), B_{target} was redefined as the average of total biomass for the model time period (1980-2006) and $B_{threshold}$ as the lowest observed value in the total biomass time series from which the stock had then increased (termed "B_{Loss}"). According to the earlier (survey index-based) reference points, monkfish were overfished and overfishing status could not be determined (NEFSC 2005); however, with adoption of the analytical assessment in 2007, monkfish status was changed to no longer overfished and overfishing was not occurring. Assessments in 2010 and 2013 (NEFSC 2010; 2013) also concluded that both stocks were not overfished and overfishing was not occurring, while recognizing the continuing significant uncertainty in the determination. With the invalidation of the growth curve and analytic assessment model, the estimated BRPs are no longer relevant.

TOR 1. Update data: fishery-dependent data (landings, discards, catch-at-age, etc.) and fishery-independent data (research survey information) that had been used in the previous accepted assessment. Also, describe and present any new or revised data sets that are being used in the assessment.

Fishery-Dependent Data

Landings

Landings of monkfish tails are converted from landed weight to live weight, because a substantial fraction of the landings occur as tails only (or other parts). The conversion of landed weight of tails to live weight of monkfish in the NEFSC weigh-out database is made by multiplying landed tail weight by a factor of 3.32.

Early catch statistics (before ~1980) are uncertain, because much of the monkfish catch was sold outside of the dealer system or used for personal consumption until the mid-1970s. For 1964 through 1989, there are two potential sources of landings information for monkfish; the NEFSC 'weigh-out' database, which consists of fish dealer reports of landings, and the 'general canvass' database, which contains landings data collected by NMFS port agents (for ports not included in the weigh-out system) or reported by states not included in the weigh-out system (Table D3). All landings of monkfish are reported in the general canvass data as 'unclassified tails.' Consequently, some landed weight attributable to livers or whole fish in the canvass data may be inappropriately converted to live weight. This is not an issue for 1964-1981 when only tails were recorded in both databases. For 1982-1989, the weigh-out database contains market category information that allows for improved conversions from landed to live weight. The two data sources produce the same trends in landings, with general canvass landings slightly greater than weigh-out landings. It is not known which of the two measures more accurately reflects landings, but the additional data sources suggest that the general canvass is most reliable for 1964-1981 landings, whereas the availability of market category details suggests that the weigh-out database is most reliable for 1982-1989.

Beginning in 1990, most of the extra sources of landings in the general canvass database were incorporated into the NEFSC weigh-out database. However, North Carolina reported landings of monkfish to the Southeast Fisheries Science Center and until 1997 these landings were not added to the NEFSC general canvass database. Since these landings most likely come from the southern management area, they have been added to the weigh-out data for the southern management area for 1977-1997 for the landings statistics used for stock assessment.

Beginning in July 1994, the NEFSC commercial landings data collection system was redesigned to consist of vessel trip reports (VTR) and dealer weigh-out records. The VTRs include area fished for each trip which is used to apportion dealer-reported landings to statistical areas. The northern management area includes statistical areas 511-515, 521-523 and 561; and the southern management area includes areas 525-526, 562, 537-543 and 611-636 (Figure D2).

Total U.S. landings (live weight) remained at low levels until the mid-1970s, increasing from less than 1,000 mt to around 6,000 mt in 1978 (Table D3, Figure D3). Annual landings remained stable at between 8,000 and 10,000 mt until the late 1980s. Landings increased from the late 1980s to over 20,000 mt per year during 1992-2004, peaking at 28,500 mt in 1997. Landings declined steadily after 2003, and stabilized around an average of 8,600 mt during 2009-2015. During 2008-2015, fishing year landings in the NMA remained well below the TAL, but during 2016-2018 were close to or higher than the TAL (Table D2). In the SMA, fishing year landings have been below the TAL since 2009. The most recent TALs are ~50% higher in the SMA than in the NMA.

Monkfish landings began to increase in the northern management region in the mid-1970s and in the late 1970s in the southern area. Most of the increase in landings during the late 1980s through mid-1990s was from the southern area. Historical under-reporting of landings should be considered in the interpretation of this series.

Trawls, scallop dredges and gill nets are the primary gear types that land monkfish (Table D4, Figure D4). Trawls have been the predominant gear in the north, accounting for approximately 75% of the landings on average. In the south, trawls and dredges dominated the landings before about 2002, but were subsequently replaced by gillnets as regulations changed. Gillnets accounted for about 75% of the landings from the southern management area during 2016-2018.

Until the late 1990s, total U.S. landings were dominated by landings of monkfish tails. From 1964 to 1980 landings of tails rose from 19mt to 2,302mt, and peaked at 7,191mt in 1997 (Tables 5, 6). Landings of tails declined after 1997, but are still an important component of the landings. Landings of gutted whole fish have increased steadily since the early 1990s and are now the largest market category on a landed-weight basis. On a regional basis, more tails were landed from the northern area than the southern area prior to the late 1970s (Tables 5 and 6). From 1979 to 1989, landings of tails were about equal from both areas. In the 1990's, landings of tails from the south predominated, but since 2000, landings of tails have been greater in the north.

Beginning in 1982, several market categories were added to the system (Tables 5, 6). Tails were broken down into large (> 2.0 lbs), small (0.5 to 2.0 lbs), and unclassified categories and the liver market category was added. In 1989, unclassified round fish were added, in 1991 peewee tails (<0.5 lbs) and cheeks, in 1992 belly flaps, and in 1993 whole gutted fish were added. Landings of unclassified round (whole) or gutted whole fish jumped in 1994 to 2,045 mt and 1,454 mt, respectively; landings of gutted fish continued to increase through 2003. The tonnage of peewee tails landed increased through 1995 to 364 mt and then declined to 153 mt in 1999 and 4 mt in 2000 when the category was essentially eliminated by regulations.

Foreign Landings

Landings (live wt) from NAFO areas 5 and 6 by countries other than the US are shown in Table D3 and Figure D3. Reported landings were high but variable in the 1960s and 1970s with a peak in 1973 of 6,818 mt. Landings were low but variable in the 1980s, declined in the early 1990s, and have generally been below 300 mt since 1996. NAFO data for monkfish were not updated for this assessment update.

Discard Estimates

Catch data from the fishery observer, dealer and VTR databases were used to investigate discarding frequencies and rates using standardized bycatch reporting methodology (SBRM, Rago et al. 2005; Wigley et al. 2007). The number of trips with monkfish discards available for analysis varied widely among management areas and gear types (Tables 7, 8). As in previous monkfish assessments (NEFSC 2007a, NEFSC 2010, NEFSC 2013, NEFSC 2016), monkfish discards were estimated on a gear, half-year and management area basis using observed discard-per-kept-monkfish expanded to total discards for otter trawls and gillnets, and observed discard-per-all-kept-catch to expand for scallop dredges and shrimp trawls. Discards for 1980-1988 (before observer sampling) were estimated by applying average discard ratios by management area and gear type (trawl, shrimp trawl, gillnet, dredge) from 1989-1991 to landings for 1980-1988 as follows:

Area	**Shrimp Trawls**	**Trawls**	**Gillnets**	**Dredges**
North				
Years included	1989-1991	1989-1991	1989-1991	1992-1997
Number of trips	124	253	1191	54
South				
Years included	n/a	1989-1991	1991-1992	1991-1993
Number of trips		334	177	32

The proportion of discards in the northern area catch was about 13% in the 1980s, 7% during 2002-2006, became slightly higher on average (12%) during 2007-2009, was 14% for 2010-2015 and 18% during 2016-2018 (Table D9, Figures 5, 6). The proportion of discards in the southern area catch has generally increased since the 1980s (average 16% 1980-1989), with an annual average of 29% during 2002-2006, 24% during 2007-2009, and 27% in 2010-2015 (Table D9, Figures 5 and 6). During 2016-2018, the proportion of discards in the catch was 51%, and estimated discards (mt) exceeded landings in 2017 and 2018. These high discard rates are due primarily to regulatory discards in the scallop dredge fishery (Table D8). Gill nets consistently have had the lowest discard ratios in both areas.

Overall, discarding has increased steadily in both management areas since 2015 (Table D9). In 2015, a large increase in discarding of small fish was observed in southern area dredge and trawl fisheries (Figure D8), reflecting the strong 2015 recruitment event. This yearclass now appears to have grown into the exploitable size range (43+cm) (Figure D1).

Size Composition of U.S. Catch

Tail lengths were converted to total lengths using relations developed by Almeida et al. (1995). As in previous assessments, (NEFSC 2007a and later), length composition of landings and discard were estimated from fishery observer samples by management area, gear-type (trawls, dredges and gillnets), catch disposition (kept or discarded) and variable time periods (Table D11). Landings in unknown gear categories were allocated proportionately to the 3 major gear types before assigning lengths. The estimated length composition of landings and discard is shown in Figures 7-10. Age composition of the catch was not estimated.

Effort and CPUE

Evaluating trends in effort or catch rates in the monkfish fishery is difficult for several reasons. Much of the catch is taken in multi-species fisheries, and defining targeted monkfish trips is difficult. There have been programmatic changes in data collection from port interviews (1980-1993) to logbooks (1994-2009), and comparison of effort statistics among programs is difficult. Catch rates may not reflect patterns of abundance, because they have been affected by regulatory changes (e.g., 1994 closed areas, 2000 trip limits, 2006 reductions in trip limits).

CPUE data have not been used in the assessment model for monkfish, therefore they were not examined for this assessment update.

Fishery-Independent Data

Resource surveys used in the 2016 assessment were updated, including NEFSC spring and autumn offshore surveys, ASMFC northern shrimp surveys (NFMA only), ME/NH spring and fall inshore surveys, and scallop dredge surveys conducted by NEFSC and Viginia Institute of Marine Science (VIMS) (SMA only). Very few strata in the SMA were sampled during the 2017 fall survey, so indices were not calculated for the 2017 fall survey in the SMA.

The NEFSC survey strata used to define the northern and southern management areas are:

Survey	Northern Area	Southern Area
NEFSC offshore bottom trawl	20-30, 34-40	1-19, 61-76
ASMFC Shrimp	1,3,5-8	
Shellfish		6,7,10,11,14,15,18,19,22-31,33-35,46,47,55,58-61,621,631

NEFSC spring and autumn bottom trawl survey indices for 1963-2008 were standardized to adjust for statistically significant effects of trawl type (Sissenwine and Bowman 1977) on catch rates. The trawl conversion coefficients apply only to the spring survey during 1973-1981.

NEFSC indices derived from surveys on the FSV Henry Bigelow (starting spring 2009) were adjusted using calibration coefficients estimated during experimental work (Miller et al. 2009). The FSV *Henry B. Bigelow*, which became the main platform for NEFSC research surveys in spring 2009, has significantly different size, towing power, and fishing gear characteristics than the previous survey platform (*Albatross IV)*, resulting in different fishing power and catchability for most species. Calibration experiments to estimate these differences were conducted during 2008 (Brown 2009, NEFSC 2007b,). Following guidelines developed by a peer-review panel (Anonymous 2009), monkfish catches were converted using a simple ratio estimator without a seasonal (spring vs. fall) or length-specific correction. The low catch rates of monkfish in the Albatross series made development of more detailed coefficients infeasible. The overall coefficients for monkfish were 7.1295 for numbers and 8.0618 for biomass (kg) (Anonymous 2009; Miller et al. 2009). The Bigelow time series is also presented as an independent, uncalibrated series.

NEFSC spring and fall survey estimates of minimum biomass and abundance were derived using relative efficiency estimates for monkfish from a set of paired-tow experiments comparing chain sweep (industry standard on soft bottom) vs. rock hopper gear (used on all tows on the FSV Bigelow) (Miller et al. 2017a, 2017b, 2018).

Northern Management Area (NMA)

Biomass indices from NEFSC autumn and spring research trawl surveys fluctuated without trend between 1963 and 1975, increased briefly in the late 1970's, but declined thereafter to near historic lows during the 1990's (Tables 12-13, Figures 11 and 12). From 2000 to 2003, indices increased, reflecting recruitment of a relatively strong 1999 yearclass. Subsequently, biomass indices declined and remained relatively low until 2016, when both biomass and abundance began to increase. Abundance declined slightly in 2017 and 2018 but biomass indices continued to increase in the fall survey (Figure D12). Exploitable biomass (43+cm) has increased steadily since 2014 (fall survey) or 2016 (spring survey) (Figure D13). ME-NH survey data has shown similar trends in total biomass and abundance as the NEFSC surveys (Figure D14).

Length composition of NEFSC and ME/NH fall survey catches (Figures15 and 18) suggest production of relatively strong yearclasses in 2015 and 2016; however, strong recruitment was not apparent in the spring or summer shrimp surveys (Figures 16 and 17).

Recruitment indices (abundance) were estimated for monkfish of lengths corresponding to presumed young-of-year (YOY, age 0). The size ranges used were based on length frequencies observed for the strong 2015 yearclass, and were adopted in the 2016 assessment, as follows:

	2013		2016	
	Putative		Putative	
North	age	cm range	age	cm range
Fall NEFSC	1	11-19	0	6-18
Fall ME-NH	1	11-19	0	8-18
South				
Spring/summer scallop	1	11-19	0	7-18
Fall NEFSC	1	11-17	0	12-28

Based on the recruitment indices (Figure D20), the frequency of recruitment events in the northern area has increased since the late 1980s, with strong yearclasses produced in 1993, 1994, 2000, 2015 and 2016. There appears to be a negative relationship between recruitment and size of monkfish in the NMA (Figure D20). One possible interpretation is that that cannibalism plays a role in stock dyanmics. Armstrong et al (1996) and Johnson et al. (2008) both found higher rates of cannibalism in relatively large monkfish.

Additional surveys that catch monkfish in portions of the northern area include the ASMFC shrimp survey, the Massachusetts Division of Marine Fisheries fall and spring surveys, and ME/NH inshore surveys (Table D15, Figures 11, 14, 17-19). The shrimp survey samples the western Gulf of Maine during summer and caught more monkfish than the spring or fall surveys prior to 2009 (when the FSV Bigelow survey series began). Patterns of abundance and biomass have been relatively consistent among the NEFSC spring and fall, ME-NH, and shrimp surveys (Figure D21). The Massachusetts surveys catch few monkfish and were not considered to reflect patterns of abundance for the entire management area (NEFSC 2007a); therefore have not been included in recent assessments.

Figure D22 shows the distribution of monkfish in surveys in the northern management area.

Southern Management Area

Inconsistent geographic coverage should be considered in the interpretation of southern survey indices. The NEFSC fall survey did not sample south of Hudson Canyon until 1967. The NEFSC scallop dredge survey has been limited to the southern flank of Georges Bank since 2014, and NEFSC sampling intensity over the entire mid-Atlantic Bight declined starting in 2011. In addition, the timing of the scallop dredge survey shifted in 2009 from mid-summer to late spring. The Virginia Institute of Marine Science VIMS is now conducting the scallop dredge survey in the areas south of Georges Bank (beginning in 2012), but the data are not incorporated into the NEFSC survey data base. This makes it laborious to fold the VIMS dredge survey data into the assessment calculations; however, the VIMS data have been included for most of the series presented in this assessment. NEAMAP inshore surveys in the Mid-Atlantic catch relatively few monkfish, so are not included here.

Biomass and abundance indices from NEFSC spring and autumn research surveys were high during the mid-1960s, fluctuated around an intermediate level during the 1970s-mid 1980s, and have been relatively low since the late 1980s (Tables 16-17, Figures 23 and 24). A sharp increase in abundance was observed in the 2015 scallop and fall surveys and in the 2016 spring survey (Tables 16-18 Figure D23), reflecting an apparent recruitment event in 2015. Exploitable biomass (43+cm) increased in the spring survey in 2017 and 2018, likely as a result of the growth of the 2015 yearclass (Figure D25). The fall survey also showed elevated exploitable biomass in 2018 (no survey in 2017).

Length distributions from the southern area show truncation over time but somewhat less dramatically than in the north (Figures 25-27). As in the northern area, fish greater than 60 cm have been rare since the 1980s, especially when compared to the 1960s. Recruitment indices (presumed YOY) (Figure D29) indicate two exceptional recruitment events in the south, occurring in 1972 and 2015. The negative relationship between median size in the population and recruitment seen in the north is not evident in the SMA (Figure D29); however, the median size has generally been lower in the south than in the north. Distribution plots suggest that the 2015 recruits were broadly distributed in the SMA (Figure D32).

TOR 2. Estimate F, R, B

TOR2a.) Estimate annual fishing mortality, recruitment, and stock size for the time series (“Plan A”). Include estimates of uncertainty, retrospective analyses (both historical and

within-model), and bridge runs to sequentially document any changes from the previously accepted model to the updated model proposed for this peer review.

In the absence of an approved model, this TOR was not addressed through modeling efforts; however relative exploitation rates were calculated from landings or catch and survey estimates of minimum area-swept abundance or biomass estimated using adjustments for the rockhopper sweep (Miller et al. 2017a, 2017b, 2018) (Table D19, Figures 33-34). The area-swept estimates account for missed strata by applying average density from sampled strata in each management area to the un-sampled strata. The estimates assume that 100% of the monkfish encountered by the trawl are captured. Missing strata in monkfish assessment areas and total area of sampled strata during 2009-2018 were the following:

North	Missing strata	Area surveyed nmi2	South Missing strata	Area surveyed nmi2
2009		26,265	68	37,029
2010		26,265		37,081
2011	20, 25	24,654	17, 66	36,166
2012	25	25,875		37,081
2013	25	25,875	18	36,909
2014	20, 40	24,466	8	36,851
2015		26,265		37,081
2016		26,265		37,081
2017		26,265	1-12, 61-76	9,226
2018	30, 34, 351,39	22,617		37,081

b.) Prepare a "Plan B" assessment that would serve as an alternate approach to providing scientific advice to management. "Plan B" will be presented for peer review only if the "PlanA" assessment were to not pass review.

A model-free method used to derive Georges Bank cod catch limits in 2015 (NEFSC 2015) was applied to monkfish in the northern and southern management areas in the 2016 assessment (NEFSC 2016) and is updated here. The method calculates the rate and direction of change in survey indices using the slope of a log-linear regression of LOESS-smoothed survey indices during the most recent three years. In the case of cod, the proportional change in the indices (re-transformed slope, "catch multiplier") was applied to average cod catch in the three previous years to derive new cod catch limits.

The monkfish analysis calculated the multiplier using total biomass indices from either the NEFSC fall survey only or the average of the NEFSC spring and fall surveys. The missing 2017 fall survey index for the south was interpolated by averaging 2016 and 2018 biomass indices for the south. The spring survey may be affected more strongly than the fall survey by availability of monkfish to the gear due to timing of seasonal migrations. Biomass indices for 1986-2018 in each area were LOESS-smoothed (smoothing parameter=0.30, 9.9 year smoothing window) before being entered into a log-linear regression to estimate the proportional change during 2016-2018. The estimated proportional change (multiplier) for monkfish in the north was 1.26 (fall survey only, 26% increase) or 1.22 (spring and fall surveys combined, 22% increase). In the south, the proportional change was 0.96 (fall survey only, 4% decrease) or 1.04 (spring and fall surveys combined, 4% increase) (Figure D35).

TOR 3. Update BRPs

TOR 3. Update the values of biological reference points (BRPs) for this stock.
Biological reference points specified in the management plan are no longer relevant due to invalidation of the growth model, therefore they were not updated for this assessment update.

TOR 4. Stock Status

TOR4. a.) Recommend what stock status appears to be based on comparison of assessment results to BRP estimates.
This TOR was not addressed because monkfish BRPs have been invalidated.

b.) Include 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.).

Based on trends in survey results, monkfish stock status has been improving (north) or remained steady (south) in both management regions in the past three years, likely due primarily to the 2015 recruitment event. Biomass continued to increase in the north in 2018 while abundance dropped, reflecting an increase in the proportion of large individuals in the population (likely of the 2015 year class). In the south, biomass increased after the 2015 recruitment event, but was lower in 2018 (fall 2017 data missing), as abundance of the 2015 year class declined. Recruitment has returned to average levels in the south, and in the north, to average levels observed since the late 1980s. Abundance and biomass patterns may be influenced by movement of monkfish between the management areas, which is poorly understood.

TOR 5. Population Projections

5. Perform short-term (2-year) population projections. The projection results should include an estimate of the catch at FMSY or at an FMSY proxy (i.e. this catch represents the overfishing level, OFL) as well as its statistical distribution (i.e., probability density function).
Not relevant to this assessment.

TOR 6. Research areas and data issues

TOR 6: Comment on research areas or data issues to consider that might lead to improvements when this stock is assessed again in the future.

A benchmark assessment should consider the feasibility of using both observer and port samples in estimating length composition of commercial landings.

Ongoing research on age and growth of monkfish may lead to an acceptable growth curve, even if not an aging method that could be used for routine aging. If so, age structured models could be explored assuming static growth.

A better understanding of monkfish movements and stock structure would be helpful to interpretation of monkfish population data.

Future modeling efforts may want to consider the possible role of cannibalism in stock dynamics of monkfish in light of the strong negative relationship observed in the north between median size of monkfish in the population and recruitment indices.

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Tables

Table D1. Timeline of fishery management actions for monkfish.

(http://www.greateratlantic.fisheries.noaa.gov/sustainable/species/monkfish/)

1999 – Monkfish FMP was implemented which included a limited access permit program, a DAS management system, trip limits, and minimum size limits.

1999 – Amendment 1 (FR Notice) approved to ensure compliance with essential fish habitat requirements of the Magnuson-Stevens Act.

2002 – Framework Adjustment 1 (FR Notice) was disapproved by NMFS. NMFS instead published an emergency rule that implemented measures based upon the best available science to temporarily suspend the restrictive Year 4 default management measures that would have become effective May 1, 2002.

2003 –Framework Adjustment 2 (FR Notice) modified the overfishing definition and implemented annual adjustments to the management measures.

2003 - Final rule implemented a series of seasonal closures that prohibited the use of large mesh gillnets in Federal waters off the coast of Virginia and North Carolina to reduce the impact of the monkfish fishery on endangered and threatened species of sea turtles.

2005 – Amendment 2 (FR Notice) addressed essential fish habitat, bycatch concerns, and issues raised by public comments.

2006 – Framework Adjustment 3 (FR Notice) implemented to prohibit targeting monkfish on Multispecies B-regular DAS.

2007 – Interim management measures Framework 4 (FR Notice) adopted in May to address overfishing while NMFS conducted a stock assessment. Framework 4 was implemented in October to establish 3-year target total allowable catches (TACs), a target TAC backstop provision, and adjustments to DAS allocations and trip limits.

2007 – Amendment 3 (FR Notice) was implemented as an Omnibus Amendment to standardize bycatch reporting methodology for monkfish and other fisheries.

2008 – NMFS implemented Framework 5 (FR Notice) to ensure the Monkfish FMP succeeds in keeping landings within the target total allowable catch levels. Measures include reduction in carryover DAS, reduction in bycatch or incidental catch limits, and revision in the biological reference points used to determine if the stock is overfished.

2008 – Framework 6 (FR Notice) eliminated the backstop provision adopted in Framework Adjustment 4 to the FMP, October 2007.

Table D1, continued.

2011 – Amendment 5 (FR Notice) implemented a suite of measures including annual catch limits and accountability measures, measures to promote efficiency and reduce waste, and bring the biological reference points into compliance.

2011 – Framework Adjustment 7 (FR Notice) implemented measures that were disapproved in Amendment 5 due to newly available science. Specifically, DAS allocations, trip limits, and an annual catch target for the Northern Area.

2012 – Amendment 6 is still being developed in considering a catch shares management system for the fishery. Information on Amendment 6 is located here.

2013 - NMFS implements an emergency action (FR Notice) to suspend the monkfish possession limits in the Northern Fishery Management Area for monkfish permit categories C and D under a monkfish DAS.

2014 - Framework Adjustment 8 (FR Notice) implemented measures to incorporate results of latest stock assessment, increase monkfish day-at-sea allocations and landing limits to better achieve optimum yield, and increase operational flexibility by allowing all limited access monkfish vessels to use an allocated monkfish-only day-at-sea at any time throughout the fishing year and Category H vessels to fish throughout the Southern Fishery Management Area.

2016 – Framework Adjustment 9 (FR Notice) implemented measures to increase landings in the NFMA by eliminating the possession limit while fishing under both a NE multispecies and monkfish day-at-sea and increasing flexibility in the SFMA by reducing the minimum mesh size for roundfish gillnets.

2017 – Framework Adjustment 10 (FR Notice) implemented measures to incorporate results of the 2016 operational assessment, increase monkfish day-at-sea allocations and possession limits.

Table D2. Management measures for monkfish, fishing years 2000-2018. Regulations pertain to fishing years (FY, May 1- April 30), thus landings do not correspond to calendar year landings in Table D3. Trip limits apply to vessels fishing on declared monkfish days at sea.

Northern Fishery Management Area

Fishing Year	Target TAC/TAL (mt)	Trip Limits* Cat. A & C	Trip Limits* Cat. B & D	DAS Restrictions**	FY Landings (mt)	Percent of TAC
2000	5,673	n/a	n/a	40	11,859	209%
2001	5,673	n/a	n/a	40	14,853	262%
2002	11,674	n/a	n/a	40	14,491	124%
2003	17,708	n/a	n/a	40	14,155	80%
2004	16,968	n/a	n/a	40	11,750	69%
2005	13,160	n/a	n/a	40	9,533	72%
2006	7,737	n/a	n/a	40	6,677	86%
2007	5,000	1,250	470	31	5,050	101%
2008	5,000	1,250	470	31	3,528	71%
2009	5,000	1,250	470	31	3,344	67%
2010	5,000	1,250	470	31	2,834	57%
2011	5,854	1,250	600	40	3,699	63%
2012	5,854	1,250	600	40	3,920	67%
2013	5,854	1,250	600	40	3,596	61%
2014	5,854	1,250	600	45	3,403	58%
2015	5,854	1,250	600	45	4,080	70%
2016	5,854	1,250	600	45	5,447	93%
2017	6,338	1,250	600	45	6,807	107%
2018	6,338	1,250	600	45	6,168	97%

* Trip limits in pounds tail weight per DAS

** Excluding up to 10 DAS carryover, became 4 DAS carryover in FY2007

In 2011, the target TAC became a target TAL

Table D2, continued.

Southern Fishery Management Area

Fishing Year	Target TAC/TAL (mt)	Trip Limits* Cat. A,C,G	Trip Limits* Cat. B, D, H	DAS Restrictions**	FY Landings (mt)	Percent of TAC
2000	6,024	1,500	1,000	40	7,960	132%
2001	6,024	1,500	1,000	40	11,069	184%
2002	7,921	550	450	40	7,478	94%
2003	10,211	1,250	1,000	40	12,198	119%
2004	6,772	550	450	28	6,223	92%
2005	9,673	700	600	39.3	9,656	100%
2006	3,667	550	450	12	5,909	161%
2007	5,100	550	450	23	7,180	141%
2008	5,100	550	450	23	6,751	132%
2009	5,100	550	450	23	4,800	94%
2010	5,100	550	450	23	4,484	88%
2011	8,925	550	450	28	5,801	65%
2012	8,925	550	450	28	5,184	58%
2013	8,925	550	450	28	5,088	57%
2014	8,925	610	500	32	5,415	61%
2015	8,925	610	500	32	4,733	53%
2016	8,925	700	575	37	4,345	49%
2017	9,011	700	575	37	3,802	42%
2018	9,011	700	575	37	4,600	51%

* Trip limits in pounds tail weight per DAS
** Excluding up to 10 DAS carryover, became 4 DAS carryover in FY2007
In 2011, the target TAC became a target TAL

Table D3. Landings (calculated live weight, mt) of monkfish as reported in NEFSC weigh-out data base (1964-1993) and vessel trip reports (1994-2014) (North = SA 511-523, 561; South = SA 524-639 excluding 551-561 plus landings from North Carolina for years 1977-1995); General Canvas database (1964-1989, North = ME, NH, northern weigh out proportion of MA; South = Southern weigh-out proportion of MA, RI-VA); Foreign landings from NAFO database areas 5 and 6. Shaded cells denote suggested source for landings which are used in the total column at the far right (see text for details).

	Weigh Out Plus NC			General Canvas				
Year	US North	US South	US Total	US North	US South	US Total	Foreign	Total
1964	45	19	64	45	61	106	0	106
1965	37	17	54	37	79	115	0	115
1966	299	13	312	299	69	368	2,397	2765
1967	539	8	547	540	59	598	11	609
1968	451	2	453	449	36	485	2,231	2716
1969	258	4	262	240	43	283	2,249	2532
1970	199	12	211	199	53	251	477	728
1971	213	10	223	213	53	266	3,659	3925
1972	437	24	461	437	65	502	4,102	4604
1973	710	139	848	708	240	948	6,818	7766
1974	1,197	101	1,297	1,200	183	1,383	727	2110
1975	1,853	282	2,134	1,877	417	2,294	2,548	4842
1976	2,236	428	2,663	2,256	608	2,865	341	3206
1977	3,137	830	3,967	3,167	1,314	4,481	275	4756
1978	3,889	1,384	5,273	3,976	2,073	6,049	38	6087
1979	4,014	3,534	7,548	4,068	4,697	8,765	70	8835
1980	3,695	4,232	7,927	3,623	6,035	9,658	132	9790
1981	3,217	2,380	5,597	3,171	4,142	7,313	381	7694
1982	3,860	3,722	7,582	3,757	4,492	8,249	310	7,892
1983	3,849	4,115	7,964	3,918	4,707	8,624	80	8,044
1984	4,202	3,699	7,901	4,220	4,171	8,391	395	8,296
1985	4,616	4,262	8,878	4,452	4,806	9,258	1,333	10,211
1986	4,327	4,037	8,364	4,322	4,264	8,586	341	8,705
1987	4,960	3,762	8,722	4,995	3,933	8,926	748	9,470
1988	5,066	4,595	9,661	5,033	4,775	9,809	909	10,570
1989	6,391	8,353	14,744	6,263	8,678	14,910	1,178	15,922
1990	5,802	7,204	13,006				1,557	14,563
1991	5,693	9,865	15,558				1,020	16,578
1992	6,923	13,942	20,865				473	21,338
1993	10,645	15,098	25,743				354	26,097
1994	10,950	12,126	23,076				543	23,619
1995	11,970	14,361	26,331				418	26,749
1996	10,791	15,715	26,507				184	26,691
1997	9,709	18,462	28,172				189	28,361
1998	7,281	19,337	26,618				190	26,808

Table D3, continued

	Weigh Out Plus NC			General Canvas				
Year	US North	US South	US Total	US North	US South	US Total	Foreign	Total
1999	9,128	16,085	25,213				151	25,364
2000	10,729	10,147	20,876				176	21,052
2001	13,341	9,959	23,301				142	23,443
2002	14,011	8,884	22,896				294	23,190
2003	14,991	11,095	26,086				309	26,395
2004	13,209	7,978	21,186				166	21,352
2005	10,140	9,177	19,317				206	19,523
2006	6,974	7,980	14,955				279	15,234
2007	4,953	7,388	12,341					12,341
2008	3,942	7,250	11,192					11,192
2009	3,210	5,532	8,742					8,742
2010	2,424	4,996	7,420					7,420
2011	3,227	5,371	8,599					8,599
2012	4,033	5,724	9,757					9,757
2013	3,332	5,253	8,586					8,586
2014	3,402	5,135	8,537					8,537
2015	4,027	4,609	8,636					8,636
2016	4,633	4,422	9,055					9,055
2017	7,008	3,893	10,901					10,901
2018	5,954	4,465	10,419					10,419

Table D4. U.S. landings of monkfish (calculated live weight, mt) by gear type. A. Northern management area, B. Southern management area, C. Regions combined.

A. North											
Year	Trawl	Gill Net	Dredge	Other	Total	Year	Trawl	Gill Net	Dredge	Other	Total
1964	45	0			45	2005	6,876	2,567	99	598	10,140
1965	36	0			37	2006	5,054	1,573	185	162	6,974
1966	299	0		0	299	2007	3,482	1,172	243	56	4,953
1967	532		8		539	2008	3,055	802	52	34	3,942
1968	447		4		451	2009	2,491	651	21	47	3,210
1969	253	1	4		258	2010	1,947	460	12	6	2,424
1970	198	0		0	199	2011	2,696	482	45	5	3,227
1971	213		0		213	2012	3,551	347	134	1	4,033
1972	426	8	1	2	437	2013	2,799	421	112	0	3,332
1973	661	29	12	8	710	2014	2,950	418	33	0	3,402
1974	1,060	105	7	25	1,197	2015	3,256	670	100	1	4,027
1975	1,712	123	10	9	1,853	2016	3,937	608	86	2	4,633
1976	2,031	143	47	15	2,236	2017	6,030	946	32	0	7,008
1977	2,737	230	142	28	3,137	2018	4,935	860	151	8	5,954
1978	3,255	368	212	54	3,889						
1979	2,967	393	584	71	4,014						
1980	2,526	518	596	56	3,696						
1981	2,266	461	443	47	3,217						
1982	3,040	421	367	32	3,860						
1983	3,233	314	266	37	3,849						
1984	3,648	315	196	43	4,202						
1985	3,982	315	264	55	4,616						
1986	3,412	326	553	36	4,327						
1987	3,853	374	695	38	4,960						
1988	3,554	304	1,172	36	5,066						
1989	3,429	349	2,584	30	6,391						
1990	3,298	338	2,141	25	5,802						
1991	3,299	338	2,033	24	5,694						
1992	4,330	359	2,211	24	6,923						
1993	5,890	695	4,034	26	10,645						
1994	7,574	1,571	1,808	86	11,039						
1995	9,119	1,531	1,266	54	11,970						
1996	8,445	1,389	913	45	10,791						
1997	7,363	988	1,318	40	9,709						
1998	5,421	885	948	27	7,281						
1999	7,037	1,470	598	24	9,128						
2000	8,234	2,102	316	76	10,729						
2001	9,990	2,959	381	11	13,341						
2002	10,839	2,978	181	13	14,011						
2003	12,028	2,488	222	254	14,991						
2004	9,918	2,866	14	411	13,209						

Table D4, continued.

B. South											
Year	**Trawl**	**Gill Net**	**Dredge**	**Other**	**Total**	**Year**	**Trawl**	**Gill Net**	**Dredge**	**Other**	**Total**
1964	19				19	2005	1,706	4,673	1,581	1,216	9,177
1965	17				17	2006	1,457	3,970	1,532	1,022	7,980
1966	13			0	13	2007	1,084	3,782	1,594	928	7,388
1967	8				8	2008	1,041	4,098	1,370	741	7,250
1968	2				2	2009	721	3,117	826	868	5,532
1969	4				4	2010	590	2,738	579	1,089	4,996
1970	12				12	2011	1,178	3,480	565	149	5,371
1971	10				10	2012	1,144	3,688	739	153	5,724
1972	24				24	2013	1,112	3,366	599	176	5,253
1973	132		5	1	137	2014	1,028	3,142	879	86	5,135
1974	98			0	98	2015	673	3,308	538	91	4,610
1975	265	0	2	2	269	2016	578	3,332	349	162	4,421
1976	333		7	0	340	2017	550	2,832	400	112	3,894
1977	508		57	26	591	2018	496	3,404	471	93	4,464
1978	605	0	507	26	1,138						
1979	944	6	1,015	16	1,981						
1980	1,139	10	1,274	7	2,429						
1981	1,100	16	782	105	2,003						
1982	1,806	12	1,507	27	3,352						
1983	1,819	11	2,119	17	3,966						
1984	1,714	15	1,704	18	3,452						
1985	1,739	17	2,347	3	4,106						
1986	1,841	32	2,068	12	3,954						
1987	1,680	26	1,997	3	3,707						
1988	1,828	58	2,594	3	4,483						
1989	3,240	17	5,036	3	8,297						
1990	2,361	32	4,744	5	7,142						
1991	5,515	363	3,907	16	9,800						
1992	6,528	977	6,409	11	13,925						
1993	5,987	1,722	7,158	192	15,059						
1994	5,233	2,342	3,995	556	12,126						
1995	5,785	3,800	4,030	746	14,361						
1996	7,141	4,211	4,330	33	15,715						
1997	8,161	5,203	4,890	208	18,462						
1998	7,815	6,198	5,190	134	19,337						
1999	6,364	6,187	3,481	54	16,085						
2000	4,018	4,005	1,975	150	10,147						
2001	3,091	5,119	1,719	30	9,959						
2002	1,584	5,410	1,847	43	8,884						
2003	2,034	7,262	1,717	83	11,095						
2004	1,228	4,605	671	1,474	7,978						

Table D4, continued.

C.	Regions combined										
Year	**Trawl**	**Gill Net**	**Dredge**	**Other**	**Total**	**Year**	**Trawl**	**Gill Net**	**Dredge**	**Other**	**Total**
1964	64	0			64	2005	8582.4	7240.61	1680.16	1813.63	19,317
1965	53	0			53	2006	6510.9	5542.37	1716.94	1184.43	14,955
1966	311	0		0	312	2007	4566.1	4953.89	1837.33	983.87	12,341
1967	540		8		547	2008	4095.4	4899.6	1421.79	775.09	11,192
1968	449		4		453	2009	3212	3767.96	846.58	914.98	8,742
1969	257	1	4		262	2010	2537.3	3197.79	590.48	1094.13	7,420
1970	210	0		0	211	2011	3874.2	3962.29	609.1	153.23	8,599
1971	223		0		223	2012	4695.4	4035.07	872.89	154	9,757
1972	451	8	1	2	461	2013	3910.6	3787.2	711.45	176.42	8,586
1973	794	29	17	9	848	2014	3977.9	3560.22	911.91	86.55	8,537
1974	1,160	105	7	25	1,297	2015	3929	3978	638	92	8,637
1975	1,990	123	12	10	2,135	2016	4515	3940	435	164	9,054
1976	2,459	143	54	15	2,670	2017	6580	3778	432	112	10,902
1977	3,487	230	202	53	3,973	2018	5431	4264	622	101	10,418
1978	4,016	368	774	80	5,238						
1979	3,989	399	2,070	87	6,545						
1980	3,723	528	2,276	62	6,589						
1981	3,483	477	1,399	152	5,512						
1982	4,998	433	2,061	60	7,551						
1983	5,166	325	2,431	56	7,977						
1984	5,513	330	1,968	61	7,871						
1985	5,757	332	2,611	58	8,758						
1986	5,318	358	2,621	48	8,345						
1987	5,561	400	2,692	41	8,694						
1988	5,399	363	3,765	39	9,567						
1989	6,679	366	7,620	33	14,698						
1990	5,697	372	6,885	30	12,984						
1991	8,847	700	5,941	39	15,528						
1992	10,860	1,336	8,619	35	20,850						
1993	11,879	2,417	11,192	218	25,707						
1994	12,707	3,884	5,759	638	22,988						
1995	14,905	5,331	5,296	800	26,331						
1996	15,586	5,599	5,243	78	26,507						
1997	15,524	6,192	6,208	249	28,172						
1998	13,236	7,083	6,138	161	26,618						
1999	13,401	7,656	4,079	78	25,213						
2000	12,252	6,107	2,291	226	20,876						
2001	13,081	8,078	2,100	41	23,301						
2002	12,423	8,389	2,028	56	22,896						
2003	14,062	9,750	1,939	336	26,086						
2004	11,145	7,471	685	1,885	21,186						

Table D5. Landed weight (mt) of monkfish by market category for the northern management area.

Year	Belly Flaps	Cheeks	Liver	Head on, Gutted	Round	Dressed	Heads	Tails Unc.	Tails Large	Tails Small	Tails Peewee	Tails All
1964	0	0	0	0	0	0	0	14	0	0	0	14
1965	0	0	0	0	0	0	0	11	0	0	0	11
1966	0	0	0	0	0	0	0	90	0	0	0	90
1967	0	0	0	0	0	0	0	163	0	0	0	163
1968	0	0	0	0	0	0	0	136	0	0	0	136
1969	0	0	0	0	0	0	0	78	0	0	0	78
1970	0	0	0	0	0	0	0	60	0	0	0	60
1971	0	0	0	0	0	0	0	64	0	0	0	64
1972	0	0	0	0	0	0	0	132	0	0	0	132
1973	0	0	0	0	0	0	0	214	0	0	0	214
1974	0	0	0	0	0	0	0	360	0	0	0	360
1975	0	0	0	0	0	0	0	558	0	0	0	558
1976	0	0	0	0	0	0	0	673	0	0	0	673
1977	0	0	0	0	0	0	0	945	0	0	0	945
1978	0	0	0	0	0	0	0	1,171	0	0	0	1,171
1979	0	0	0	0	0	0	0	1,209	0	0	0	1,209
1980	0	0	0	0	0	0	0	1,113	0	0	0	1,113
1981	0	0	0	0	0	0	0	969	0	0	0	969
1982	0	0	10	0	0	0	0	1,146	15	2	0	1,163
1983	0	0	9	0	0	0	0	1,152	5	2	0	1,159
1984	0	0	15	0	0	0	0	1,262	4	0	0	1,266
1985	0	0	11	0	0	0	0	1,386	2	3	0	1,390
1986	0	0	14	0	0	0	0	1,303	0	0	0	1,303
1987	0	0	24	0	0	0	0	1,492	2	1	0	1,494
1988	0	0	47	0	0	0	0	1,517	6	3	0	1,526
1989	0	0	59	0	11	0	0	1,465	327	130	0	1,922
1990	0	0	78	0	30	0	0	1,174	411	154	0	1,738
1991	0	3	70	0	0	0	0	1,014	539	153	9	1,715
1992	0	1	83	0	0	0	0	911	590	505	79	2,085
1993	0	1	208	98	351	0	0	1,034	868	1,062	103	3,067
1994	0	1	208	533	981	0	0	403	1,206	1,075	136	2,820
1995	0	1	46	1,224	1,113	0	0	362	1,180	1,003	304	2,850
1996	0	0	65	1,116	745	0	0	90	930	1,399	224	2,643
1997	0	0	51	634	244	0	0	26	1,126	1,361	119	2,633
1998	0	0	24	551	144	0	0	16	1,055	810	79	1,960
1999	0	0	40	1,701	511	0	0	28	996	848	139	2,012
2000	0	0	94	3,213	912	0	0	17	783	1,050	3	1,853
2001	0	0	93	3,084	231	0	0	128	1,115	1,647	0	2,890
2002	0	0	75	3,789	24	0	0	80	1,055	1,777	0	2,912
2003	0	0	61	2,364	14	0	0	95	1,573	2,032	0	3,699
2004	0	0	56	647	960	0	0	3	1,883	1,580	1	3,467

Table D5, continued.

				Head on,				Tails	Tails	Tails	Tails	Tails
Year	**Belly Flaps**	**Cheeks**	**Liver**	**Gutted**	**Round**	**Dressed**	**Heads**	**Unc.**	**Large**	**Small**	**Peewee**	**All**
2005	0	0	42	1,706	22	0	0	3	1,440	1,017	2	2,462
2006	0	0	22	1,622	20	0	0	9	899	627	3	1,538
2007	0	0	13	682	0	0	1	9	870	378	1	1,258
2008	0	0	5	391	0	4	0	1	739	311	0	1,051
2009	0	0	2	290	0	11	0	2	560	299	0	861
2010	0	0	1	208	0	0	0	2	396	261	0	658
2011	0	17	72	187	44	0	8	1	527	367	1	896
2012	0	24	89	142	0	0	3	1	609	556	2	1,168
2013	0	0	76	137	0	0	4	1	549	407	3	960
2014	0	0	71	117	0	0	25	2	560	423	4	988
2015	0	0	73	179	0	0	31	2	594	556	0	1,151
2016	0	0	86	105	0	0	127	4	672	683	0	1,359
2017	0	0	114	151	0	0	140	13	1006	1041	0	2,060
2018	0	0	73	195	1		174	3	931	792	0	1,726

Table D6. Landed weight (mt) of monkfish by market category for the southern management area.

				Head on,				Tails	Tails	Tails	Tails	Tails
Year	**Belly Flaps**	**Cheeks**	**Liver**	**Gutted**	**Round**	**Dressed**	**Heads**	**Unc.**	**Large**	**Small**	**Peewee**	**All**
1964	0	0	0	0	0	0	0	6	0	0	0	6
1965	0	0	0	0	0	0	0	5	0	0	0	5
1966	0	0	0	0	0	0	0	4	0	0	0	4
1967	0	0	0	0	0	0	0	2	0	0	0	2
1968	0	0	0	0	0	0	0	1	0	0	0	1
1969	0	0	0	0	0	0	0	1	0	0	0	1
1970	0	0	0	0	0	0	0	4	0	0	0	4
1971	0	0	0	0	0	0	0	3	0	0	0	3
1972	0	0	0	0	0	0	0	7	0	0	0	7
1973	0	0	0	0	0	0	0	42	0	0	0	42
1974	0	0	0	0	0	0	0	30	0	0	0	30
1975	0	0	0	0	0	0	0	85	0	0	0	85
1976	0	0	0	0	0	0	0	129	0	0	0	129
1977	0	0	0	0	0	0	0	250	0	0	0	250
1978	0	0	0	0	0	0	0	403	0	0	0	403
1979	0	0	0	0	0	0	0	1,016	0	0	0	1,016
1980	0	0	0	0	0	0	0	1,189	0	0	0	1,189
1981	0	0	0	0	0	0	0	685	0	0	0	685
1982	0	0	0	0	0	0	0	912	138	51	0	1,102
1983	0	0	2	0	0	0	0	858	237	136	0	1,231
1984	0	0	10	0	0	0	0	860	183	45	0	1,087
1985	0	0	17	0	0	0	0	1,081	85	71	0	1,237
1986	0	0	23	0	0	0	0	1,063	76	52	0	1,191
1987	0	0	330	0	0	0	0	972	138	6	0	1,116
1988	0	0	65	0	0	0	0	1,129	190	32	0	1,350
1989	0	0	88	0	5	0	0	2,037	230	230	0	2,498
1990	0	0	102	0	187	0	0	1,428	443	223	0	2,095
1991	0	5	200	0	415	0	0	1,215	1,123	461	28	2,827
1992	0	3	239	0	386	0	0	1,868	1,318	788	104	4,078
1993	0	1	252	0	178	0	0	2,469	1,065	789	159	4,483
1994	0	4	251	921	1,064	0	0	854	1,025	989	122	2,989
1995	2	0	451	1,529	1,539	0	0	518	1,341	1,419	59	3,337
1996	0	0	504	2,352	318	0	0	996	1,160	1,629	46	3,830
1997	0	0	577	2,559	551	0	0	647	1,924	1,913	32	4,516
1998	0	0	582	3,036	438	0	0	842	1,952	1,840	16	4,650
1999	0	0	558	4,047	621	0	0	509	1,393	1,352	14	3,268
2000	0	4	530	3,701	179	0	0	276	797	657	2	1,732
2001	0	0	466	3,944	300	0	0	217	844	494	0	1,555
2002	0	0	433	4,013	551	0	0	167	629	336	0	1,132
2003	0	1	426	4,959	667	0	0	242	790	405	1	1,438
2004	0	2	355	2,758	1,066	8	0	186	671	274	0	1,130

Table D6, continued.

				Head on,				Tails	Tails	Tails	Tails	Tails
Year	**Belly Flaps**	**Cheeks**	**Liver**	**Gutted**	**Round**	**Dressed**	**Heads**	**Unc.**	**Large**	**Small**	**Peewee**	**All**
2005	0	55	330	3,695	187	18	0	105	771	550	2	1,428
2006	0	108	293	3,351	27	20	5	69	658	506	1	1,233
2007	0	44	258	3,030	107	12	0	88	727	329	1	1,145
2008	0	5	253	3,008	44	13	1	61	768	300	0	1,130
2009	1	0	199	2,540	4	9	11	47	505	235	0	788
2010	0	0	188	2,117	9	4	27	61	476	235	0	772
2011	0	0	154	2,195	491	6	31	47	422	243	0	713
2012	0	0	110	2,921	0	4	40	44	405	269	1	720
2013	1	0	130	2,247	5	4	106	58	462	286	2	809
2014	0	0	111	2,049	2	14	116	45	540	250	3	837
2015	0	0	99	2,339	2	18	96	43	358	174	0	574
2016	0	0	86	2,399	`1	10	104	56	295	151	0	502
2017	0	0	72	2020	6	10	83	45	246	180	0	471
2018	0	0	93	2022	10	10	105	84	406	152	0	642

Table D7. Estimated monkfish discards (live weight) in the northern management region. Dredge and shrimp trawl discards are based on SBRM monkfish discards relative to kept of all species; trawl and gillnet are based on monkfish discards relative to monkfish kept.

North		Trawl					Gillnet				
Year	Half	No. trips	D/K ratio	CV	Dlr monk (mt)	Discard (mt)	No. trips	D/K ratio	CV	Dlr monk (mt)	Discard (mt)
1989	1	30	0.037	0.58	1,550	58	1	0.036		84	3
	2	63	0.141	0.44	1,830	257	103	0.027	0.32	265	7
1990	1	16	0.082	0.60	1,562	128	73	0.036	0.41	121	4
	2	36	0.039	0.45	1,690	66	65	0.029	0.37	219	6
1991	1	27	0.042	0.45	1,233	52	191	0.030	0.47	120	4
	2	81	0.167	0.25	1,999	334	758	0.036	0.10	213	8
1992	1	51	0.122	0.30	1,674	203	403	0.065	0.16	105	7
	2	35	0.224	0.43	2,624	587	618	0.040	0.24	248	10
1993	1	19	0.067	0.30	2,821	189	271	0.086	0.21	119	10
	2	19	0.084	0.26	3,032	254	338	0.032	0.24	560	18
1994	1	18	0.035	0.29	3,273	115	65	0.065	0.29	270	18
	2	6	0.024	0.59	4,385	107	44	0.055	0.19	779	43
1995	1	30	0.164	0.36	4,643	762	38	0.141	0.30	469	66
	2	48	0.090	0.31	4,478	403	69	0.088	0.23	1,023	90
1996	1	21	0.190	0.23	4,294	814	28	0.137	0.43	340	47
	2	49	0.132	0.57	4,057	534	34	0.132	0.19	934	123
1997	1	13	0.100	0.49	3,795	378	19	0.036	0.32	329	12
	2	7	0.076	0.23	3,225	244	26	0.194	0.84	742	144
1998	1	7	0.124	0.37	3,150	392	39	0.028	0.41	238	7
	2	3	0.093	0.10	2,398	223	72	0.043	0.28	606	26
1999	1	3	0.098	0.04	3,947	388	36	0.067	0.65	282	19
	2	42	0.069	0.21	3,011	207	66	0.036	0.51	1,051	38
2000	1	80	0.069	0.32	3,916	271	58	0.041	0.30	501	21
	2	61	0.088	0.31	3,798	333	65	0.077	0.24	2,033	157
2001	1	61	0.102	0.20	5,088	518	41	0.061	0.69	880	53
	2	113	0.066	0.10	4,588	303	33	0.108	0.93	2,208	238
2002	1	47	0.076	0.25	5,634	428	33	0.045	0.39	760	34
	2	274	0.100	0.10	4,532	455	67	0.053	0.27	2,230	118
2003	1	206	0.101	0.14	6,642	671	112	0.037	0.24	628	23
	2	218	0.055	0.12	4,721	261	273	0.058	0.13	1,570	91
2004	1	163	0.042	0.12	5,307	225	212	0.021	0.22	739	16
	2	377	0.036	0.10	4,039	147	728	0.059	0.09	1,788	105
2005	1	500	0.047	0.07	3,971	187	153	0.098	0.26	516	51
	2	601	0.057	0.10	3,038	174	660	0.074	0.12	1,450	108
2006	1	292	0.055	0.08	2,852	158	93	0.063	0.41	262	17
	2	201	0.071	0.11	2,285	162	80	0.080	0.17	1,025	82
2007	1	221	0.050	0.10	2,075	104	42	0.061	0.32	228	14
	2	303	0.072	0.10	1,448	104	190	0.062	0.16	693	43
2008	1	277	0.088	0.10	1,821	160	61	0.076	0.28	141	11
	2	383	0.082	0.10	1,045	86	156	0.051	0.22	541	28

Table D7, continued.

North		Trawl					Gillnet				
Year	Half	No. trips	D/K ratio	CV	Dlr monk (mt)	Discard (mt)	No. trips	D/K ratio	CV	Dlr monk (mt)	Discard (mt)
2009	1	351	0.166	0.13	1,666	276	129	0.209	0.46	149	31
	2	408	0.079	0.11	832	66	195	0.119	0.27	467	55
2010	1	339	0.097	0.08	1,537	149	305	0.056	0.15	112	6
	2	671	0.090	0.07	857	77	1364	0.102	0.07	303	31
2011	1	671	0.120	0.07	1,461	175	554	0.050	0.10	120	6
	2	743	0.058	0.08	1,174	69	1244	0.080	0.10	361	29
2012	1	739	0.057	0.06	1901	108	548	0.047	0.17	93	4
	2	664	0.078	0.05	1446	112	900	0.060	0.07	184	11
2013	1	471	0.125	0.07	1669	208	172	0.044	0.14	98	4
	2	440	0.097	0.10	1073	104	567	0.083	0.11	323	27
2014	1	405	0.143	0.07	1908	272	278	0.090	0.30	82	7
	2	528	0.100	0.09	927	93	830	0.062	0.11	336	21
2015	1	298	0.155	0.10	1891	294	87	0.056	0.21	120	7
	2	381	0.117	0.11	1223	143	475	0.063	0.12	549	34
2016	1	253	0.121	0.09	2058	249	82	0.064	0.32	94	6
	2	237	0.141	0.10	1702	241	201	0.094	0.21	514	48
2017	1	186	0.156	0.13	3002	467	36	0.018	0.28	152	3
	2	340	0.052	0.12	2814	147	245	0.035	0.15	794	28
2018	1	255	0.088	0.11	2841	250	72	0.031	0.35	136	4
	2	263	0.072	0.14	1980	142	124	0.079	0.24	719	57

Table D7, continued.

North		Scallop Dredge					Shrimp Trawl				
Year	Half	No. trips	D/K ratio	CV	Dlr all spp (mt)	Discard (mt)	No. trips	D/K ratio	CV	Dlr all spp (mt)	Discard (mt)
1989	1		0.001		18,213	17	31	0.002	0.33	3,412	5.5
	2		0.008		24,053	185	9	0.001	0.62	931	1.2
1990	1		0.001		9,864	9	27	0.002	0.34	4,494	8.1
	2		0.008		19,293	149	4	0.058	1.01	620	35.8
1991	1		0.001		16,608	16	46	0.004	0.19	3,536	12.8
	2	1	0.002		21,312	40	7	0.046	0.40	340	15.7
1992	1	3	0.000	0.98	14,179	1	76	0.003	0.23	3,285	9.6
	2	6	0.001	0.41	20,033	26	6	0.003	0.28	161	0.4
1993	1	7	0.002	0.26	13,702	25	78	0.001	0.26	1,890	2.5
	2	4	0.018	0.45	12,674	230	4	0.001	0.70	316	0.3
1994	1	2	0.001	1.21	5,486	5	71	0.002	0.38	2,443	5.9
	2	5	0.010	0.38	6,230	59	6	0.001	0.44	906	0.7
1995	1	1	0.014		2,318	32	64	0.000	0.23	4,452	1.8
	2	5	0.018	0.50	6,544	119	9	0.001	0.43	1,377	0.7
1996	1	8	0.003	0.94	5,338	14	30	0.000	0.34	7,580	0.8
	2	5	0.022	0.40	11,375	246	5	0.000	0.79	1,418	0.4
1997	1	4	0.004	0.48	10,567	42	17	0.000	0.61	5,416	0.9
	2	4	0.020	0.76	9,148	180		0.001		649	0.4
1998	1	2	0.004	0.32	7,482	28		0.001		3,095	2.7
	2	7	0.014	0.16	6,400	90		0.001		168	0.1
1999	1	2	0.004	0.65	8,347	29		0.001		1,407	1.2
	2	6	0.004	0.44	6,797	30		0.001		33	0.0
2000	1		0.004		6,993	31		0.001		2,068	1.8
	2	95	0.004	0.13	13,019	56		0.001		35	0.0
2001	1	17	0.003	0.42	14,926	41	3	0.000	0.14	813	0.1
	2		0.005		11,525	60		0.001			0.0
2002	1		0.005		8,712	45		0.001		308	0.3
	2	10	0.008	0.97	11,533	88		0.001			0.0
2003	1	5	0.001	0.89	16,053	9	15	0.000	1.01	855	0.0
	2	8	0.015	0.41	10,361	157		0.001			0.0
2004	1	3	0.000	0.69	5,633	0	12	0.000	0.25	1,069	0.1
	2	19	0.096	0.48	3,705	355		0.001		44	0.0
2005	1	20	0.001	0.57	5,745	6	17	0.000	0.52	836	0.1
	2	39	0.008	0.21	23,131	184		0.001		40	0.0
2006	1	5	0.001	0.42	20,833	14	17	0.000	0.56	847	0.0
	2	39	0.021	0.32	14,291	305	3	0.000	0.10	449	0.2
2007	1	28	0.002	0.22	11,600	26	14	0.001	0.72	1,899	1.0
	2	68	0.021	0.18	23,644	487		0.001		333	0.2
2008	1	25	0.001	0.22	7,065	11	16	0.000	0.77	1,834	0.9
	2	22	0.011	0.34	3,696	42	3	0.001	0.90	167	0.1

Table D7, continued.

North		Scallop Dredge					Shrimp Trawl				
Year	Half	No. trips	D/K ratio	CV	Dlr all spp (mt)	Discard (mt)	No. trips	D/K ratio	CV	Dlr all spp (mt)	Discard (mt)
2009	1	7	0.001	0.47	1,960	3	7	0.001	0.61	998	0.8
	2	22	0.003	0.26	11,642	34	5	0.000	0.92	347	0.0
2010	1	16	0.001	0.80	3,350	4	11	0.000	1.00	2,911	0.1
	2	25	0.003	0.31	15,930	50	4	0.000	0.91	780	0.0
2011	1	23	0.002	0.80	6,660	16	1	0.000		3,745	0.0
	2	81	0.004	0.13	35,600	158		0.001		78	0.0
2012	1	54	0.003	0.31	21,717	67	19	0.000	0.49	1,761	0.2
	2	90	0.010	0.24	28,609	300				132	0.0
2013	1	131	0.003	0.22	43,664	118	24	0.001	0.79	195	0.1
	2	67	0.010	0.35	12,980	128					
2014	1	66	0.000	0.33	10,688	4					
	2	61	0.029	0.21	5,406	155					
2015	1	77	0.002	0.49	12,489	28					
	2	50	0.020	0.16	4,912	96					
2016	1	79	0.013	0.37	12,841	170					
	2	43	0.038	0.27	4,300	162					
2017	1	45	0.000	0.36	10,814	5					
	2	19	0.157	0.32	1,502	235					
2018	1	78	0.011	0.27	18,115	203					
	2	48	0.079	0.17	19,019	1,504					

Table D8. Estimated monkfish discards (live weight) in the southern management region. Dredge discards are based on SBRM monkfish discards relative to kept of all species; trawl and gillnet are based on monkfish discards relative to monkfish kept.

South		Trawl					Gillnet				
Year	Half	No. trips	D/K ratio	CV	Dlr monk (mt)	Discard (mt)	No. trips	D/K ratio	CV	Dlr monk (mt)	Discard (mt)
1989	1	46	0.709	0.50	2,195	1,556		0.031		12	0
	2	53	0.169	0.59	733	124	3	0.054		5	0
1990	1	50	0.064	0.26	1,567	100	1	0.031		14	0
	2	35	0.118	0.32	759	90	13	0.054		18	0
1991	1	73	0.258	0.30	1,257	324	3	0.031		209	2
	2	77	0.020	0.39	3,831	78	8	0.000		154	0
1992	1	62	0.061	0.38	3,947	239	94	0.011	0.31	786	8
	2	41	0.028	0.83	2,135	60	72	0.020	0.20	176	3
1993	1	40	0.092	0.68	2,598	238	78	0.034	0.70	1,306	44
	2	34	0.028	0.49	1,301	36	87	0.061	0.20	341	21
1994	1	43	0.095	0.29	2,925	277	124	0.079	0.33	1,565	124
	2	30	0.323	0.56	2,027	655	173	0.056	0.18	967	55
1995	1	61	0.175	0.55	2,789	488	260	0.044	0.20	2,758	121
	2	103	0.115	0.57	2,946	340	170	0.050	0.34	1,172	59
1996	1	56	0.164	0.36	3,187	523	226	0.077	0.27	2,615	202
	2	85	0.095	0.18	4,021	380	134	0.052	0.28	1,434	75
1997	1	60	0.025	0.47	4,130	102	238	0.067	0.34	3,089	206
	2	29	0.089	0.15	4,215	374	106	0.015	0.34	1,313	20
1998	1	31	0.108	0.33	3,991	431	228	0.070	0.20	3,606	252
	2	28	0.027	0.52	3,946	108	64	0.062	0.44	2,053	128
1999	1	39	0.045	0.30	4,370	195	52	0.052	0.34	4,207	220
	2	34	0.214	0.57	2,306	494	35	0.046	0.57	1,917	88
2000	1	67	0.786	0.32	2,255	1,773	60	0.063	0.30	2,683	170
	2	47	0.107	0.62	1,709	182	44	0.051	0.81	1,157	59
2001	1	61	0.946	0.47	1,703	1,611	57	0.030	0.42	2,248	67
	2	96	0.404	0.73	1,348	545	35	0.033	0.38	2,788	92
2002	1	50	0.338	0.38	1,123	379	34	0.017	0.80	3,590	61
	2	94	0.327	0.39	566	185	40	0.063	0.44	1,967	124
2003	1	120	0.331	0.36	1,172	388	50	0.016	0.35	4,452	69
	2	99	0.406	0.45	1,177	478	56	0.070	0.31	2,849	199
2004	1	237	0.240	0.44	1,012	243	78	0.073	0.22	3,441	252
	2	436	0.300	0.31	733	220	74	0.089	0.22	1,043	93
2005	1	534	0.175	0.14	945	165	100	0.104	0.22	3,217	334
	2	654	0.064	0.11	1,588	102	82	0.081	0.20	1,372	111
2006	1	327	0.180	0.19	1,008	181	43	0.054	0.19	2,865	155
	2	277	0.055	0.15	1,010	56	35	0.082	0.32	967	79
2007	1	335	0.125	0.25	741	93	59	0.220	0.37	2,139	471
	2	420	0.159	0.40	657	104	45	0.054	0.33	1,569	84
2008	1	343	0.098	0.19	744	73	54	0.108	0.25	2,882	311
	2	316	0.017	0.31	594	10	39	0.104	0.29	993	104

Table D8, continued.

South		Trawl					Gillnet				
Year	Half	No. trips	D/K ratio	CV	Dlr monk (mt)	Discard (mt)	No. trips	D/K ratio	CV	Dlr monk (mt)	Discard (mt)
2009	1	414	0.080	0.30	646	52	62	0.052	0.19	2,438	128
	2	529	0.088	0.31	280	25	32	0.074	0.24	610	45
2010	1	569	0.248	0.24	474	118	114	0.060	0.21	2,034	122
	2	545	0.190	0.51	369	70	95	0.077	0.18	695	54
2011	1	573	0.123	0.13	634	78	178	0.078	0.12	2,357	185
	2	601	0.088	0.11	598	53	84	0.122	0.19	1,066	130
2012	1	476	0.147	0.13	812	119	203	0.051	0.13	3,015	153
	2	337	0.180	0.18	366	66	32	0.058	0.18	576	33
2013	1	594	0.117	0.24	720	84	60	0.058	0.15	2,142	124
	2	500	0.053	0.28	447	24	34	0.101	0.37	1,168	118
2014	1	633	0.171	0.22	616	105	126	0.056	0.16	2,249	127
	2	700	0.107	0.15	518	56	131	0.030	0.28	861	26
2015	1	563	0.179	0.15	487	87	225	0.022	0.16	2,403	52
	2	527	0.521	0.12	318	165	273	0.027	0.20	823	22
2016	1	557	0.381	0.26	521	198	361	0.023	0.15	2,627	62
	2	854	0.838	0.24	227	191	343	0.041	0.27	564	23
2017	1	819	1.155	0.25	510	589	448	0.036	0.16	2,211	79
	2	1088	0.402	0.23	245	98	372	0.065	0.24	543	35
2018	1	591	0.594	0.21	395	235	302	0.041	0.16	2,494	102
	2	925	0.774	0.17	198	153	332	0.048	0.44	832	40

Table D8, continued.

South		Scallop Dredge				
Year	Half	No. trips	D/K ratio	CV	Dlr all spp (mt)	Discard (mt)
1989	1		0.010	0.010	59,696	577
	2		0.015	0.015	35,498	528
1990	1		0.010		64,314	622
	2		0.015		53,040	789
1991	1		0.010		67,829	656
	2	2	0.001	0.07	36,015	19
1992	1	7	0.001	0.69	48,686	29
	2	7	0.012	0.50	39,126	460
1993	1	12	0.008	0.30	23,971	197
	2	4	0.032	0.53	18,379	587
1994	1	10	0.020	0.26	26,657	538
	2	10	0.015	0.29	24,222	370
1995	1	14	0.030	0.17	34,108	1,011
	2	9	0.050	0.45	18,456	917
1996	1	19	0.020	0.23	27,505	547
	2	15	0.029	0.26	19,621	562
1997	1	16	0.028	0.18	19,067	543
	2	8	0.041	0.39	14,997	612
1998	1	8	0.008	0.24	17,094	136
	2	15	0.012	0.57	15,300	177
1999	1	13	0.010	0.26	30,059	291
	2	56	0.004	0.16	34,102	150
2000	1	38	0.014	0.16	47,847	666
	2	133	0.009	0.16	43,879	382
2001	1	42	0.015	0.11	64,029	972
	2	48	0.014	0.15	70,044	973
2002	1	34	0.019	0.09	83,888	1,571
	2	61	0.018	0.10	81,620	1,475
2003	1	46	0.014	0.15	82,660	1,192
	2	71	0.017	0.12	91,638	1,542
2004	1	82	0.014	0.08	107,728	1,543
	2	193	0.015	0.10	95,117	1,432
2005	1	108	0.014	0.18	99,628	1,419
	2	174	0.019	0.19	67,548	1,290
2006	1	43	0.009	0.31	87,842	767
	2	166	0.022	0.14	99,456	2,210
2007	1	138	0.010	0.14	103,992	1,083
	2	156	0.013	0.15	68,914	920
2008	1	374	0.006	0.11	106,134	686
	2	245	0.010	0.13	74,506	717

Table D8, continued.

South		Scallop Dredge				
Year	Half	No. trips	D/K ratio	CV	Dlr all spp (mt)	Discard (mt)
2009	1	370	0.006	0.08	122,576	725
	2	103	0.009	0.15	73,175	652
2010	1	132	0.010	0.11	108,617	1,098
	2	174	0.008	0.12	81,139	648
2011	1	156	0.010	0.13	107,870	1,132
	2	150	0.010	0.12	62,873	623
2012	1	205	0.016	0.0756	98,241	1,545
	2	130	0.017	0.1489	46,675	797
2013	1	154	0.017	0.1682	49,832	864
	2	177	0.016	0.1282	45,168	709
2014	1	174	0.014	0.0931	62,720	892
	2	188	0.012	0.1405	44,960	518
2015	1	227	0.008	0.1204	56,595	464
	2	202	0.008	0.1409	58,643	444
2016	1	306	0.018	0.1006	60,595	1,100
	2	237	0.017	0.1263	69,514	1,204
2017	1	337	0.025	0.1199	95,113	2,364
	2	253	0.025	0.1255	83,173	2,084
2018	1	211	0.030	0.1051	91,400	2,759
	2	241	0.021	0.0928	86,776	1,861

Table D9. Estimated annual catch (landings plus discards, mt) of monkfish by management region and combined.

	North			South			Areas Combined			Foreign	
Year	Landings	Discard	Total (mt)	Landings	Discard	Total (mt)	Landings	Discard	Total (mt)	Landings	Total (mt)
1980	3,623	635	4,258	6,035	563	6,598	9,658	1,197	10,855	132	10,987
1981	3,171	754	3,925	4,142	451	4,593	7,313	1,204	8,517	381	8,898
1982	3,860	699	4,559	3,722	586	4,308	7,582	1,285	8,867	310	9,177
1983	3,849	664	4,513	4,115	659	4,774	7,964	1,323	9,287	80	9,367
1984	4,202	616	4,818	3,699	684	4,383	7,901	1,301	9,202	395	9,597
1985	4,616	640	5,256	4,262	636	4,898	8,878	1,276	10,154	1,333	11,487
1986	4,327	548	4,875	4,037	618	4,655	8,364	1,166	9,530	341	9,871
1987	4,960	766	5,726	3,762	1,039	4,801	8,722	1,805	10,527	748	11,275
1988	5,066	784	5,850	4,595	1,030	5,625	9,661	1,814	11,475	909	12,384
1989	6,391	534	6,925	8,353	2,786	11,139	14,744	3,320	18,064	1,178	19,242
1990	5,802	406	6,208	7,204	1,602	8,806	13,006	2,008	15,014	1,557	16,571
1991	5,693	481	6,174	9,865	1,080	10,945	15,558	1,561	17,119	1,020	18,139
1992	6,923	844	7,767	13,942	801	14,743	20,865	1,644	22,509	473	22,982
1993	10,645	730	11,375	15,098	1,123	16,221	25,743	1,853	27,596	354	27,950
1994	10,950	353	11,303	12,126	2,019	14,145	23,076	2,372	25,448	543	25,991
1995	11,970	1,475	13,445	14,361	2,935	17,297	26,331	4,410	30,741	418	31,159
1996	10,791	1,780	12,572	15,715	2,289	18,004	26,507	4,069	30,576	184	30,760
1997	9,709	1,002	10,712	18,462	1,856	20,318	28,172	2,858	31,030	189	31,219
1998	7,281	769	8,050	19,337	1,231	20,568	26,618	2,000	28,618	190	28,808
1999	9,128	713	9,841	16,085	1,438	17,523	25,213	2,151	27,364	151	27,515
2000	10,729	871	11,599	10,147	3,232	13,379	20,876	4,103	24,979	176	25,155
2001	13,341	1,213	14,554	9,959	4,260	14,219	23,301	5,473	28,773	142	28,915
2002	14,011	1,169	15,180	8,884	3,796	12,680	22,896	4,964	27,860	294	28,154
2003	14,991	1,212	16,203	11,095	3,869	14,964	26,086	5,080	31,167	309	31,476
2004	13,209	847	14,056	7,978	3,782	11,760	21,186	4,629	25,816	166	25,982
2005	10,140	711	10,851	9,177	3,421	12,597	19,317	4,132	23,449	206	23,655
2006	6,974	738	7,712	7,980	3,448	11,428	14,955	4,186	19,140	279	19,419
2007	4,953	778	5,732	7,388	2,755	10,143	12,341	3,533	15,875	8	15,883
2008	3,942	338	4,280	7,250	1,901	9,151	11,192	2,240	13,432	2	13,434
2009	3,210	465	3,675	5,532	1,626	7,158	8,742	2,092	10,833		10,833
2010	2,424	317	2,741	4,996	2,109	7,105	7,420	2,426	9,846		9,846
2011	2,362	452	2,814	6,344	2,200	8,545	8,707	2,652	11,359		11,359
2012	4,033	602	4,635	5,724	2,714	8,438	9,757	3,316	13,073		13,073
2013	3,332	589	3,922	5,253	1,922	7,176	8,586	2,512	11,097		11,097
2014	3,402	552	3,954	5,135	1,724	6,859	8,537	2,276	10,813		10,813
2015	4,027	603	4,630	4,609	1,235	5,844	8,636	1,838	10,474		10,474
2016	4,633	875	5,508	4,422	2,777	7,199	9,055	3,652	12,707		12,707
2017	7,008	886	7,894	3,893	5,250	9,143	10,901	6,136	17,037		17,037
2018	5,954	2161	8,115	4,465	5,150	9,615	10,419	7,311	17,730		17,730

Table D10. Number of length samples available for kept and discarded monkfish from observer database.

North							
Trawl		Kept Lengths			Discard Lengths		
Year	Half-year	No. trips	No. hauls	No. Lengths	No. trips	No. hauls	No. Lengths
2000	1	16	54	751	24	65	1393
	2	19	57	548	19	46	1046
2001	1	14	41	578	11	40	487
	2	26	74	659	28	45	1621
2002	1	7	28	391	12	32	342
	2	77	274	3452	153	388	7038
2003	1	74	333	4648	100	361	6340
	2	72	308	4193	81	363	4387
2004	1	67	226	3156	81	294	4278
	2	141	505	6122	179	657	5059
2005	1	177	751	8255	238	1426	14806
	2	214	841	7698	228	827	8134
2006	1	100	403	4960	126	672	7238
	2	71	333	2828	100	529	5615
2007	1	60	257	2580	98	555	4507
	2	118	554	3432	140	714	4992
2008	1	75	320	2973	121	657	6748
	2	98	341	2244	154	664	5705
2009	1	70	194	1869	113	502	4978
	2	83	181	1474	99	257	1762
2010	1	55	224	2875	68	303	3736
	2	23	72	906	42	140	960
2011	1	35	83	1076	73	259	3389
	2	34	82	795	60	147	1311
2012	1	25	60	853	76	262	2460
	2	23	44	556	87	203	2270
2013	1	12	31	260	38	102	1253
	2	13	47	307	60	154	1552
2014	1	32	61	596	79	227	2993
	2	12	20	190	40	103	925
2015	1	8	13	116	73	198	3021
	2	9	30	185	64	173	1244
2016	1	5	6	42	19	46	853
	2	11	26	204	24	59	573
2017	1	8	15	96	39	167	1864
	2	13	35	435	54	163	1859
2018	1	14	29	429	67	198	3061
	2	10	21	90	32	92	720

Table D10, continued

North							
Gillnet		Kept Lengths			Discard Lengths		
Year	Half-year	No. trips	No. hauls	No. Lengths	No. trips	No. hauls	No. Lengths
2000	1	37	49	311	9	14	59
	2	66	110	2708	8	16	87
2001	1	27	45	362	4	8	12
	2	50	76	1940	4	12	27
2002	1	29	50	976	10	18	60
	2	60	115	2493	25	47	198
2003	1	51	163	2564	30	72	321
	2	131	341	5099	58	121	696
2004	1	70	220	2212	27	49	133
	2	434	1314	15334	138	243	672
2005	1	29	54	459	8	10	32
	2	399	1251	14565	81	129	413
2006	1	43	102	651	5	8	15
	2	57	152	1404	12	15	26
2007	1	14	27	262	4	10	16
	2	134	415	3442	22	28	45
2008	1	19	55	320	6	7	22
	2	75	174	909	13	17	35
2009	1	9	32	48	4	7	13
	2	67	128	899	11	12	30
2010	1	31	88	677	8	9	11
	2	63	120	773	22	32	78
2011	1	9	13	38	3	4	4
	2	65	123	583	14	22	37
2012	1	20	44	118	11	18	22
	2	52	87	331	25	33	58
2013	1	13	29	163	7	8	9
	2	64	125	469	27	41	64
2014	1	27	72	148	11	25	35
	2	64	113	542	32	47	72
2015	1	13	26	164	7	10	12
	2	69	149	1501	19	42	121
2016	1	10	20	142	5	6	8
	2	52	68	474	8	14	29
2017	1	6	9	82	2	3	6
	2	83	162	1306	8	10	14
2018	1	10	12	66	5	15	30
	2	50	76	396	6	10	17

Table D10, continued.

North							
Scallop Dredge		Kept Lengths			Discard Lengths		
Year	Half-year	No. trips	No. hauls	No. Lengths	No. trips	No. hauls	No. Lengths
2000	1						
	2	3	29	89	3	19	29
2001	1	1	2	8	1	3	4
	2						
2002	1						
	2	4	66	191	4	9	28
2003	1				1	5	9
	2	5	48	161	4	49	321
2004	1				1	2	2
	2	4	10	13	11	42	120
2005	1	1	18	27	5	29	109
	2	6	25	113	27	192	979
2006	1	2	4	4	2	18	26
	2	15	76	356	29	170	711
2007	1	4	20	25	16	58	106
	2	23	212	1094	50	368	2082
2008	1	1	3	3	9	48	70
	2	6	22	96	15	45	158
2009	1				3	7	12
	2	5	9	90	12	77	219
2010	1				3	7	10
	2	1	8	12	8	41	100
2011	1	2	2	3	3	6	27
	2	14	44	120	57	178	559
2012	1	1	1	1	24	134	481
	2	27	107	294	56	280	1340
2013	1	3	4	9	44	203	495
	2	7	24	53	28	73	213
2014	1	4	4	5	13	25	34
	2	4	8	23	35	79	349
2015	1	3	5	11	19	38	105
	2	9	29	70	34	102	409
2016	1	7	42	118	7	42	118
	2	10	41	87	10	41	87
2017	1	2	5	7	2	5	7
	2	4	7	26	4	7	26
2018	1	4	5	15	4	5	15
	2	6	14	46	6	14	46

Table D10, continued.

South							
Trawl		Kept Lengths			Discard Lengths		
Year	Half-year	No. trips	No. hauls	No. Lengths	No. trips	No. hauls	No. Lengths
2000	1	14	27	86	11	22	216
	2	16	32	306	14	40	181
2001	1	12	26	126	12	56	338
	2	9	13	42	2	4	103
2002	1	16	37	85	2	4	11
	2	22	54	367	10	32	255
2003	1	62	196	1397	36	123	975
	2	38	141	740	23	43	359
2004	1	98	304	2301	66	275	2051
	2	129	494	2983	124	444	3406
2005	1	234	794	5760	184	759	8029
	2	218	982	9097	203	656	4960
2006	1	154	574	5490	126	498	4184
	2	92	337	3501	87	299	2330
2007	1	121	467	3078	72	426	1648
	2	102	236	1658	76	207	1198
2008	1	97	291	3024	88	265	2018
	2	77	239	2567	36	87	529
2009	1	64	190	1286	36	118	694
	2	68	161	1036	49	105	629
2010	1	65	166	1265	72	187	1777
	2	40	113	585	50	160	694
2011	1	47	109	569	66	165	1145
	2	41	86	823	64	167	2160
2012	1	36	100	732	65	212	2250
	2	13	31	176	19	63	342
2013	1	19	34	411	32	99	823
	2	17	33	204	33	88	463
2014	1	28	54	235	69	158	1143
	2	27	60	314	46	144	949
2015	1	23	44	210	59	125	758
	2	22	45	200	52	171	1405
2016	1	24	61	224	87	226	1476
	2	23	51	115	82	283	2047
2017	1	50	104	334	120	284	1944
	2	46	104	304	82	225	838
2018	1	60	107	448	113	240	881
	2	45	94	289	115	412	2539

Table D10, continued.

South							
Gillnet		Kept Lengths			Discard Lengths		
Year	Half-year	No. trips	No. hauls	No. Lengths	No. trips	No. hauls	No. Lengths
2000	1	70	94	2854	7	18	95
	2	22	42	952	3	4	47
2001	1	216	253	8634	3	4	9
	2	20	38	1543			
2002	1	58	88	2981	2	6	65
	2	13	15	391	2	3	39
2003	1	45	112	3937	6	14	35
	2	60	192	6047	13	35	113
2004	1	130	335	11691	36	103	747
	2	68	195	4337	11	20	174
2005	1	113	253	8853	14	31	215
	2	90	253	6705	16	31	120
2006	1	153	216	7833	10	15	30
	2	25	36	1290	5	7	10
2007	1	115	189	4789	15	35	245
	2	52	96	1966	2	3	3
2008	1	94	179	3976	9	24	333
	2	40	90	1485	6	9	14
2009	1	89	189	3819	7	13	45
	2	23	62	938	4	11	58
2010	1	69	154	3398	4	4	20
	2	43	95	1883	5	7	9
2011	1	56	125	2775	5	11	29
	2	15	27	605	2	4	75
2012	1	42	78	1304	4	4	14
	2	13	39	425	4	5	7
2013	1	41	75	1480	3	3	5
	2	18	39	414	0	0	0
2014	1	101	205	2463	5	10	30
	2	48	98	819	2	2	6
2015	1	117	244	2903	15	31	84
	2	51	99	820	4	5	7
2016	1	153	287	3255	8	9	31
	2	75	152	1595	13	15	24
2017	1	180	383	4134	31	49	120
	2	72	122	1366	4	5	22
2018	1	119	252	2382	12	17	48
	2	44	85	641	3	7	16

Table D10, continued.

South							
Scallop Dredge		Kept Lengths			Discard Lengths		
Year	Half-year	No. trips	No. hauls	No. Lengths	No. trips	No. hauls	No. Lengths
2000	1	12	415	2481	9	340	2317
	2	7	49	186	10	90	464
2001	1	5	52	215	6	65	303
	2	3	14	33	3	14	250
2002	1						
	2	7	60	155	16	141	675
2003	1	16	171	395	24	250	1115
	2	18	100	268	34	270	1215
2004	1	33	449	1205	50	767	5615
	2	63	1010	2962	157	2500	15145
2005	1	51	697	1782	67	901	5268
	2	88	377	1300	111	929	6274
2006	1	12	49	341	26	125	794
	2	57	465	1607	92	741	4625
2007	1	46	318	746	98	804	3384
	2	48	308	1144	116	900	4386
2008	1	96	443	1137	272	1492	4593
	2	60	370	1053	175	1131	3702
2009	1	109	727	1796	219	1549	4461
	2	34	235	808	62	502	2364
2010	1	50	360	615	89	915	4094
	2	41	283	703	117	898	3612
2011	1	36	342	940	104	951	5053
	2	38	167	565	110	536	2622
2012	1	58	257	855	162	1160	7150
	2	28	106	634	75	328	2549
2013	1	41	139	438	91	483	2264
	2	75	286	948	108	531	2398
2014	1	72	255	630	119	704	3868
	2	63	238	746	123	720	3014
2015	1	56	189	463	127	659	2362
	2	46	226	557	134	831	3218
2016	1	59	208	405	59	208	405
	2	36	211	472	36	211	472
2017	1	59	173	441	59	173	441
	2	36	79	244	36	79	244
2018	1	38	105	428	38	105	428
	2	34	68	222	34	68	222

Table D11. Temporal stratification used in expanding landings and discards to length composition of the monkfish catch. Unless otherwise indicated, sampling was expanded within gear type and area.

	Trawl		**Gillnet**		**Dredge**	
North	**Kept**	**Discarded**	**Kept**	**Discarded**	**Kept**	**Discarded**
1994	annual	annual	1994-1999	1994-1999	1994-1999	1994-1999
1995	annual	annual	1994-1999	1994-1999	1994-1999	1994-1999
1996	annual	annual	1994-1999	1994-1999	1994-1999	1994-1999
1997	annual	annual	1994-1999	1994-1999	1994-1999	1994-1999
1998	annual	annual	1994-1999	1994-1999	1994-1999	1994-1999
1999	annual	annual	1994-1999	1994-1999	1994-1999	1994-1999
2000	annual	annual	annual	2000-2002 N+S	annual N+S	annual N+S
2001	annual	annual	annual	2000-2002 N+S	annual N+S	annual N+S
2002	annual	annual	annual	2000-2002 N+S	annual N+S	annual N+S
2003	half-year	half-year	annual	annual N+S	annual N+S	annual N+S
2004	half-year	half-year	annual	annual N+S	annual N+S	annual N+S
2005	half-year	half-year	annual	annual N+S	annual N+S	annual N+S
2006	half-year	half-year	annual	2006-2008 N+S	annual N+S	annual N+S
2007	half-year	half-year	annual	2006-2008 N+S	annual N+S	annual N+S
2008	half-year	half-year	annual	2006-2008 N+S	annual N+S	annual N+S
2009	half-year	half-year	annual	2009-2011 N+S	annual N+S	annual N+S
2010	half-year	half-year	annual	2009-2011 N+S	annual N+S	annual N+S
2011	half-year	half-year	annual	2009-2011 N+S	annual N+S	annual N+S
2012	half-year	half-year	annual	2012-2014 N+S	annual N+S	annual N+S
2013	half-year	half-year	annual	2012-2014 N+S	annual N+S	annual N+S
2014	half-year	half-year	annual	2012-2014 N+S	annual N+S	annual N+S
2015	annual N+S	half-year	annual	annual N+S	annual N+S	annual N+S
2016	annual N+S	half-year	annual	annual N+S	annual N+S	annual N+S
2017	annual N+S	half-year	annual	annual N+S	annual N+S	annual N+S
2018	annual N+S	half-year	annual	annual N+S	annual N+S	annual N+S

Table D11, continued.

	Trawl		**Gillnet**		**Dredge**	
South	**Kept**	**Discarded**	**Kept**	**Discarded**	**Kept**	**Discarded**
1994	annual		annual	annual	annual	annual
1995	annual		annual	annual	annual	annual
1996	annual		annual	annual	annual	annual
1997	annual		annual	annual	annual	annual
1998	annual		annual	annual	annual	annual
1999	annual		annual	annual	annual	annual
2000	annual N+S	annual N+S	annual	2000-2002 N+S	annual	annual
2001	annual N+S	annual N+S	annual	2000-2002 N+S	2000-2002	2000-2002
2002	annual N+S	annual N+S	annual	2000-2002 N+S	2000-2002	2000-2002
2003	annual	half-year	annual	annual N+S	annual	annual
2004	annual	half-year	annual	annual N+S	annual	annual
2005	annual	half-year	annual	annual N+S	annual	annual
2006	annual	half-year	annual	2006-2008 N+S	annual	annual
2007	annual	half-year	annual	2006-2008 N+S	annual	annual
2008	annual	half-year	annual	2006-2008 N+S	annual	annual
2009	annual	half-year	annual	2009-2011 N+S	annual	annual
2010	annual	half-year	annual	2009-2011 N+S	annual	annual
2011	annual	half-year	annual	2009-2011 N+S	annual	annual
2012	annual	half-year	annual	2012-2014 N+S	annual	annual
2013	annual	half-year	annual	2012-2014 N+S	annual	annual
2014	annual	half-year	annual	2012-2014 N+S	annual	annual
2015	annual	half-year	annual	annual N+S	annual	annual
2016	annual	half-year	annual	annual N+S	annual	annual
2017	annual	half-year	annual	annual N+S	annual	annual
2018	annual	half-year	annual	annual N+S	annual	annual

Table D12a. Survey results from NEFSC offshore autumn bottom trawl surveys in the northern management region (strata 20-30, 34-40). Values from 2009 forward are adjusted for change in survey methods. Indices are arithmetic stratified means with bootstrapped variance estimates.

	Biomass Index				Abundance Index			
Year	Mean	CV	L90%	U90%	Mean	CV	L90%	U90%
1963	3.79	0.17	2.79	4.87	0.81	0.15	0.62	1.02
1964	1.89	0.21	1.30	2.54	0.39	0.20	0.26	0.52
1965	2.52	0.20	1.73	3.41	0.35	0.15	0.26	0.44
1966	3.33	0.15	2.52	4.16	0.51	0.14	0.39	0.64
1967	1.24	0.33	0.65	1.96	0.19	0.26	0.11	0.27
1968	2.05	0.34	1.01	3.41	0.29	0.27	0.17	0.41
1969	3.69	0.23	2.36	5.15	0.42	0.15	0.31	0.53
1970	2.32	0.26	1.33	3.42	0.40	0.20	0.27	0.53
1971	2.90	0.21	1.93	3.93	0.49	0.17	0.36	0.63
1972	1.39	0.25	0.87	2.02	0.32	0.18	0.22	0.42
1973	3.19	0.20	2.16	4.36	0.53	0.19	0.38	0.72
1974	2.02	0.21	1.38	2.78	0.32	0.19	0.22	0.44
1975	1.71	0.19	1.20	2.25	0.30	0.18	0.21	0.39
1976	3.22	0.21	2.16	4.41	0.42	0.20	0.28	0.56
1977	5.43	0.17	3.94	6.99	0.76	0.12	0.50	0.75
1978	4.73	0.13	3.77	5.84	0.70	0.13	0.47	0.71
1979	4.91	0.14	3.83	6.04	0.55	0.11	0.39	0.57
1980	4.04	0.20	2.75	5.48	0.64	0.14	0.41	0.67
1981	1.98	0.18	1.39	2.59	0.45	0.13	0.32	0.49
1982	0.94	0.25	0.57	1.32	0.14	0.22	0.09	0.19
1983	1.61	0.19	1.11	2.13	0.47	0.18	0.34	0.61
1984	2.82	0.20	1.95	3.82	0.49	0.14	0.38	0.59
1985	1.48	0.33	0.75	2.40	0.37	0.22	0.24	0.52
1986	2.23	0.22	1.47	3.10	0.61	0.17	0.45	0.78
1987	0.88	0.33	0.42	1.38	0.26	0.26	0.16	0.38
1988	1.53	0.31	0.78	2.40	0.31	0.27	0.18	0.47
1989	1.32	0.30	0.77	2.03	0.51	0.18	0.31	0.55
1990	1.01	0.28	0.56	1.48	0.71	0.15	0.44	0.74
1991	1.20	0.24	0.75	1.67	0.70	0.17	0.42	0.74
1992	1.12	0.23	0.74	1.57	0.94	0.17	0.67	1.21
1993	1.10	0.34	0.58	1.80	1.23	0.16	0.75	1.31
1994	0.90	0.23	0.58	1.26	1.34	0.12	1.08	1.61
1995	1.60	0.23	1.00	2.20	0.93	0.12	0.74	1.11
1996	1.07	0.25	0.66	1.55	0.63	0.17	0.46	0.81
1997	0.67	0.23	0.43	0.92	0.50	0.18	0.36	0.66
1998	0.96	0.20	0.65	1.26	0.62	0.19	0.44	0.82
1999	0.78	0.22	0.51	1.06	1.08	0.15	0.82	1.36
2000	2.41	0.20	1.66	3.22	2.34	0.14	1.84	2.88
2001	1.84	0.16	1.38	2.33	1.61	0.11	1.31	1.91
2002	1.83	0.17	1.35	2.34	1.28	0.13	1.01	1.56
2003	1.81	0.18	1.30	2.33	1.07	0.12	0.86	1.28
2004	0.64	0.27	0.38	0.96	0.52	0.19	0.36	0.68
2005	1.01	0.23	0.64	1.38	0.60	0.18	0.42	0.79
2006	1.04	0.23	0.66	1.46	0.77	0.15	0.58	0.98

2007	1.08	0.28	0.62	1.62	0.64	0.15	0.48	0.80

Table D12a, continued.

	Biomass Index				Abundance Index			
Year	Mean	CV	L90%	U90%	Mean	CV	L90%	U90%
2008	0.99	0.29	0.54	1.48	0.79	0.21	0.53	1.10
2009	0.44	0.17	0.32	0.57	0.39	0.10	0.32	0.45
2010	0.64	0.14	0.49	0.78	0.51	0.09	0.44	0.58
2011	0.88	0.15	0.68	1.10	0.67	0.07	0.60	0.74
2012	0.81	0.12	0.65	0.96	0.68	0.07	0.61	0.76
2013	0.62	0.11	0.50	0.73	0.73	0.07	0.65	0.81
2014	0.76	0.08	0.66	0.86	0.95	0.09	0.81	1.09
2015	1.14	0.11	0.92	1.34	1.22	0.09	1.03	1.39
2016	1.50	0.10	1.25	1.76	1.84	0.07	1.63	2.07
2017	1.78	0.09	1.52	2.04	1.47	0.09	1.25	1.68
2018	2.16	0.07	1.92	2.42	1.29	0.06	1.16	1.42

Table D12b. Survey results from NEFSC offshore autumn bottom trawl surveys in the northern management region (strata 20-30, 34-40). Values are indices calculated without adjustment for change in survey methods in 2009. Indices are arithmetic stratified means with bootstrapped variance estimates.

	Biomass Index				Abundance Index			
Year	Mean	CV	L90%	U90%	Mean	CV	L90%	U90%
2009	3.55	0.18	2.51	4.58	2.78	0.10	2.33	3.22
2010	5.13	0.15	3.88	6.38	3.65	0.09	3.13	4.17
2011	7.09	0.15	5.32	8.86	4.77	0.06	4.26	5.28
2012	6.50	0.11	5.33	7.68	4.88	0.07	4.34	5.41
2013	4.97	0.11	4.05	5.90	5.21	0.07	4.64	5.79
2014	6.11	0.09	5.23	6.98	6.79	0.09	5.82	7.76
2015	9.20	0.11	7.47	10.93	8.71	0.09	7.41	10.02
2016	12.11	0.10	10.08	14.14	13.09	0.07	11.52	14.66
2017	14.38	0.09	12.30	16.46	10.45	0.08	9.01	11.88
2018	17.39	0.07	15.33	19.45	9.20	0.06	8.23	10.17

Table D13a. Survey results from NEFSC offshore spring bottom trawl surveys in the northern management region (strata 20-30, 34-40). Values from 2009 forward are adjusted for change in survey methods. Indices are arithmetic stratified means with bootstrapped variance estimates.

	Biomass Index				Abundance Index			
Year	Mean	CV	L90%	U90%	Mean	CV	L90%	U90%
1968	1.01	0.33	0.50	1.59	0.17	0.29	0.09	0.25
1969	1.34	0.42	0.54	2.37	0.18	0.36	0.09	0.30
1970	2.02	0.26	1.17	2.94	0.34	0.18	0.24	0.44
1971	1.05	0.29	0.61	1.58	0.16	0.29	0.09	0.25
1972	4.63	0.15	3.45	5.85	0.65	0.15	0.50	0.81
1973	1.89	0.21	1.23	2.53	0.44	0.23	0.27	0.60
1974	1.49	0.20	1.04	1.99	0.44	0.14	0.35	0.55
1975	0.94	0.17	0.69	1.21	0.34	0.15	0.26	0.43
1976	2.51	0.13	1.94	3.02	0.67	0.13	0.53	0.81
1977	0.93	0.18	0.66	1.19	0.26	0.19	0.18	0.34
1978	0.56	0.20	0.38	0.75	0.14	0.16	0.10	0.18
1979	0.67	0.21	0.45	0.92	0.14	0.14	0.11	0.17
1980	1.43	0.18	1.00	1.87	0.38	0.13	0.30	0.47
1981	1.67	0.20	1.16	2.25	0.38	0.12	0.30	0.44
1982	2.97	0.25	1.80	4.26	0.35	0.25	0.22	0.50
1983	1.53	0.31	0.85	2.38	0.42	0.24	0.27	0.60
1984	1.57	0.27	0.93	2.31	0.33	0.22	0.22	0.46
1985	2.12	0.22	1.39	2.94	0.35	0.20	0.24	0.46
1986	2.13	0.26	1.21	3.09	0.34	0.20	0.24	0.45
1987	1.73	0.27	0.95	2.48	0.24	0.20	0.17	0.33
1988	2.03	0.23	1.30	2.89	0.61	0.17	0.44	0.79
1989	1.60	0.30	0.90	2.46	0.62	0.21	0.41	0.81
1990	1.01	0.30	0.56	1.56	0.28	0.21	0.18	0.38
1991	1.61	0.24	0.99	2.23	0.59	0.18	0.42	0.77
1992	0.89	0.57	0.24	1.92	0.49	0.31	0.27	0.76
1993	1.16	0.19	0.82	1.55	0.68	0.13	0.53	0.82
1994	0.98	0.30	0.51	1.42	0.45	0.18	0.31	0.58
1995	1.84	0.28	1.04	2.72	1.01	0.16	0.75	1.29
1996	0.98	0.24	0.60	1.36	0.67	0.22	0.43	0.92
1997	0.55	0.36	0.25	0.91	0.34	0.25	0.21	0.50
1998	0.44	0.27	0.26	0.65	0.42	0.14	0.32	0.52
1999	1.15	0.19	0.80	1.53	0.83	0.16	0.62	1.04
2000	1.40	0.18	1.03	1.83	1.13	0.12	0.91	1.36
2001	1.85	0.28	1.07	2.83	1.67	0.12	1.36	2.01
2002	1.93	0.13	1.54	2.35	1.74	0.10	1.46	2.04
2003	1.87	0.20	1.30	2.51	0.81	0.20	0.56	1.09
2004	2.26	0.26	1.31	3.31	0.91	0.17	0.67	1.15
2005	1.47	0.21	0.99	2.02	0.72	0.16	0.53	0.92
2006	0.93	0.40	0.39	1.61	0.37	0.27	0.22	0.53
2007	1.05	0.41	0.39	1.82	0.55	0.23	0.35	0.77

Table D13a, continued.

	Biomass Index				Abundance Index			
Year	Mean	CV	L90%	U90%	Mean	CV	L90%	U90%
2008	1.29	0.30	0.70	1.90	0.67	0.17	0.49	0.86
2009	0.47	0.15	0.36	0.58	0.33	0.10	0.27	0.39
2010	0.63	0.14	0.49	0.78	0.38	0.14	0.30	0.47
2011	0.89	0.15	0.69	1.13	0.46	0.13	0.37	0.57
2012	0.61	0.13	0.47	0.74	0.54	0.14	0.42	0.67
2013	0.58	0.11	0.48	0.69	0.55	0.07	0.49	0.61
2014	0.63	0.16	0.46	0.81	0.61	0.12	0.50	0.74
2015	0.73	0.16	0.56	0.93	0.54	0.09	0.46	0.62
2016	0.74	0.09	0.64	0.85	0.69	0.07	0.61	0.76
2017	1.13	0.13	0.89	1.39	0.68	0.10	0.57	0.79
2018	1.65	0.07	1.47	1.83	1.04	0.08	0.91	1.17
2019	1.32	0.08	1.16	1.51	0.87	0.08	0.76	1.00

Table D13b. Survey results from NEFSC offshore spring bottom trawl surveys in the northern management region (strata 20-30, 34-40). Values are indices calculated without adjustment for change in survey methods in 2009. Indices are arithmetic stratified means with bootstrapped variance estimates.

	Biomass Index				Abundance Index			
Year	Mean	CV	L90%	U90%	Mean	CV	L90%	U90%
2009	3.80	0.14	2.91	4.70	2.36	0.10	1.96	2.76
2010	5.08	0.14	3.89	6.27	2.72	0.13	2.12	3.32
2011	7.20	0.16	5.31	9.08	3.31	0.14	2.55	4.07
2012	4.90	0.14	3.79	6.00	3.83	0.13	3.00	4.67
2013	4.70	0.11	3.82	5.57	3.93	0.07	3.48	4.38
2014	5.07	0.16	3.77	6.38	4.38	0.12	3.52	5.23
2015	5.90	0.16	4.33	7.47	3.83	0.09	3.24	4.41
2016	6.00	0.08	5.21	6.79	4.88	0.06	4.37	5.40
2017	9.14	0.14	7.03	11.25	4.86	0.10	4.08	5.64
2018	13.30	0.07	11.81	14.79	7.42	0.07	6.52	8.32
2019	10.66	0.08	9.26	12.07	6.23	0.08	5.41	7.05

Table D14. Survey results from ASMFC summer shrimp surveys in the northern management region (strata 1, 3, 5, 6-8). Indices are arithmetic stratified means with bootstrapped variance estimates.

Year	Biomass Mean	CV	L90%	U90%	Abundance Mean	CV	L90%	U90%
1991	1.88	0.17	1.40	2.45	2.88	0.10	2.45	3.36
1992	2.69	0.16	2.04	3.46	2.90	0.10	2.45	3.42
1993	3.07	0.25	1.85	4.39	3.70	0.13	2.93	4.52
1994	1.66	0.21	1.11	2.25	3.42	0.13	2.70	4.20
1995	1.55	0.23	0.95	2.15	2.08	0.18	1.44	2.71
1996	3.36	0.31	1.83	5.30	2.99	0.13	2.37	3.69
1997	2.08	0.21	1.36	2.84	1.57	0.14	1.21	1.94
1998	2.27	0.29	1.24	3.36	2.12	0.13	1.70	2.58
1999	6.26	0.09	5.56	7.57	6.75	0.08	6.00	7.89
2000	3.84	0.16	2.87	4.84	5.72	0.13	4.49	7.09
2001	7.27	0.11	6.02	8.58	10.89	0.09	9.29	12.54
2002	12.44	0.10	10.25	14.51	11.65	0.09	9.99	13.33
2003	7.36	0.16	5.68	9.74	5.80	0.12	4.82	7.23
2004	4.45	0.10	3.70	5.17	3.38	0.10	2.85	3.92
2005	7.25	0.13	5.73	8.87	5.25	0.10	4.45	6.08
2006	6.54	0.12	5.29	7.77	4.31	0.07	3.82	4.80
2007	4.10	0.21	2.69	5.52	4.46	0.13	3.53	5.37
2008	3.79	0.19	2.62	5.03	2.82	0.12	2.29	3.37
2009	3.21	0.19	2.23	4.25	3.12	0.11	2.57	3.72
2010	2.76	0.21	1.89	3.76	2.54	0.15	1.96	3.14
2011	2.66	0.15	2.04	3.37	2.25	0.09	1.93	2.62
2012	3.14	0.16	2.34	3.97	3.55	0.12	2.85	4.31
2013	4.07	0.16	3.05	5.20	4.13	0.13	3.30	5.12
2014	3.31	0.15	2.57	4.19	4.94	0.09	4.23	5.68
2015	1.45	0.23	0.91	2.00	2.76	0.21	1.79	3.69
2016	5.01	0.13	3.98	6.17	6.61	0.07	5.83	7.43
2017	4.78	0.16	3.56	5.99	4.63	0.10	3.90	5.39
2018	5.36	0.25	3.34	7.83	4.88	0.13	3.86	6.02

Table D15. Monkfish indices from Maine-New Hampshire inshore surveys, strata 1-4, regions 1-5.

Fall Year	Mean Wt (kg)	CV	L95%	U95%	Mean Number	CV	L95%	U95%
2000	1.6	0.39	1.1	2.2	4.8	0.29	3.6	6.0
2001	4.7	0.20	3.9	5.6	10.7	0.21	8.5	13.0
2002	3.4	0.66	1.2	5.7	4.1	0.56	1.8	6.3
2003	3.6	0.38	2.0	5.2	3.7	0.31	2.4	5.0
2004	3.6	0.41	1.9	5.3	2.9	0.31	1.9	4.0
2005	2.0	0.35	1.1	3.0	1.8	0.22	1.3	2.3
2006	1.8	0.23	1.4	2.2	2.9	0.22	2.3	3.5
2007	2.1	0.32	1.4	2.8	3.1	0.26	2.3	4.0
2008	2.9	0.27	2.1	3.8	4.1	0.33	2.7	5.5
2009	1.9	0.59	0.9	3.0	2.0	0.45	1.2	2.8
2010	0.7	0.35	0.5	0.9	1.0	0.32	0.7	1.4
2011	1.1	0.38	0.7	1.5	1.0	0.37	0.6	1.3
2012	0.5	0.51	0.2	0.8	0.8	0.35	0.5	1.1
2013	0.6	0.59	0.3	1.0	0.8	0.39	0.5	1.1
2014	0.3	0.43	0.2	0.4	1.0	0.32	0.8	1.3
2015	1.6	0.30	1.2	2.1	7.0	0.33	4.9	9.1
2016	1.3	0.33	0.9	1.7	6.8	0.21	5.4	8.1
2017	2.2	0.33	1.6	2.8	4.1	0.30	3.2	5.1
2018	2.3	0.31	1.6	3.1	2.9	0.24	2.2	3.5

Spring Year	Mean Wt (kg)	CV	L95%	U95%	Mean Number	CV	L95%	U95%
2000								
2001	1.0	0.35	0.7	1.3	6.0	0.35	4.2	7.9
2002	1.1	0.37	0.8	1.5	2.4	0.31	1.7	3.0
2003	0.6	0.52	0.3	1.0	1.0	0.26	0.7	1.2
2004	0.4	0.60	0.2	0.6	1.4	0.23	1.1	1.7
2005	0.8	0.35	0.5	1.1	1.1	0.22	0.8	1.4
2006	0.1	0.45	0.1	0.2	0.3	0.42	0.2	0.4
2007	0.4	0.49	0.2	0.6	1.1	0.30	0.8	1.5
2008	0.5	0.30	0.3	0.7	1.4	0.26	1.0	1.7
2009	0.2	0.44	0.1	0.3	0.8	0.31	0.6	1.0
2010	0.2	0.49	0.1	0.3	0.6	0.41	0.4	0.8
2011	0.2	0.69	0.1	0.3	0.3	0.35	0.2	0.4
2012	0.3	0.95	0.0	0.5	0.4	0.36	0.2	0.5
2013	0.2	1.01	0.0	0.3	0.4	0.45	0.2	0.5
2014	0.2	0.97	0.0	0.4	0.9	0.39	0.6	1.1
2015	0.2	0.32	0.1	0.2	1.1	0.28	0.8	1.3
2016	0.5	0.31	0.4	0.6	2.5	0.28	1.9	3.0
2017	0.4	0.64	0.2	0.6	1.2	0.28	0.9	1.4
2018	0.3	0.36	0.2	0.4	1.5	0.27	1.2	1.8

Table D16a. Survey results from NEFSC offshore autumn bottom trawl surveys in the southern management region (strata 1-19, 61-76). Strata 61-76 were not sampled until 1967; survey sampled only a small portion of the southern management area in 2017, therefore indices were not calculated for 2017. Values from 2009 forward are adjusted for change in survey methods. Indices are arithmetic stratified means with bootstrapped variance estimates.

	Biomass Index				Abundance Index			
Year	Mean	CV	L90%	U90%	Mean	CV	L90%	U90%
1963	3.60	0.24	2.30	5.09	1.20	0.18	0.87	1.58
1964	5.50	0.17	3.89	7.19	1.64	0.15	1.17	1.98
1965	4.90	0.17	3.60	6.41	1.15	0.15	0.90	1.44
1966	7.01	0.12	5.71	8.61	1.93	0.14	1.53	2.41
1967	1.14	0.22	0.74	1.56	0.52	0.17	0.37	0.66
1968	0.91	0.22	0.60	1.25	0.40	0.21	0.28	0.56
1969	1.34	0.30	0.75	2.06	0.54	0.21	0.37	0.76
1970	1.29	0.22	0.79	1.77	0.35	0.16	0.26	0.44
1971	0.79	0.36	0.38	1.30	0.28	0.21	0.18	0.37
1972	4.89	0.14	3.83	6.05	4.11	0.22	2.48	5.26
1973	1.83	0.16	1.33	2.27	1.18	0.11	0.95	1.35
1974	0.72	0.26	0.43	1.06	0.22	0.21	0.15	0.30
1975	2.00	0.16	1.50	2.54	0.75	0.16	0.50	0.84
1976	1.00	0.18	0.72	1.30	0.31	0.19	0.23	0.43
1977	1.88	0.18	1.37	2.45	0.45	0.14	0.29	0.46
1978	1.40	0.18	1.00	1.83	0.31	0.16	0.19	0.33
1979	1.93	0.16	.451	2.45	0.84	0.13	0.55	0.85
1980	1.85	0.17	1.35	2.38	0.87	0.16	0.51	0.87
1981	2.26	0.17	1.66	2.90	1.16	0.16	0.72	1.23
1982	0.65	0.21	0.43	0.88	0.61	0.18	0.44	0.79
1983	1.76	0.21	1.18	2.40	0.78	0.17	0.57	0.99
1984	0.77	0.40	0.34	1.36	0.31	0.31	0.17	0.49
1985	1.29	0.19	0.93	1.72	0.62	0.16	0.40	0.68
1986	0.55	0.27	0.33	0.81	0.36	0.23	0.22	0.46
1987	0.28	0.29	0.16	0.42	0.48	0.18	0.35	0.63
1988	0.55	0.28	0.32	0.83	0.23	0.26	0.14	0.33
1989	0.62	0.25	0.37	0.87	0.46	0.22	0.24	0.51
1990	0.37	0.32	0.20	0.58	0.35	0.27	0.17	0.43
1991	0.77	0.29	0.45	1.19	0.83	0.28	0.40	1.08
1992	0.32	0.22	0.22	0.44	0.34	0.16	0.25	0.43
1993	0.27	0.34	0.14	0.44	0.35	0.23	0.19	0.41
1994	0.55	0.23	0.35	0.75	0.60	0.19	0.42	0.79
1995	0.39	0.27	0.23	0.57	0.49	0.21	0.33	0.68
1996	0.39	0.21	0.26	0.53	0.23	0.21	0.16	0.32
1997	0.59	0.19	0.42	0.79	0.31	0.17	0.23	0.39
1998	0.50	0.24	0.32	0.72	0.33	0.24	0.21	0.46
1999	0.30	0.15	0.23	0.38	0.45	0.12	0.36	0.54
2000	0.47	0.20	0.32	0.63	0.42	0.17	0.31	0.54
2001	0.65	0.18	0.47	0.85	0.38	0.17	0.27	0.49
2002	1.25	0.18	0.88	1.61	0.83	0.14	0.64	1.02
2003	0.82	0.15	0.61	1.04	0.95	0.17	0.71	1.24
2004	0.74	0.18	0.53	0.97	0.47	0.20	0.32	0.62
2005	0.77	0.23	0.50	1.09	0.58	0.20	0.41	0.80

2006	0.76	0.24	0.49	1.07	0.45	0.19	0.33	0.60

Table D16a, continued.

	Biomass Index				Abundance Index			
Year	Mean	CV	L90%	U90%	Mean	CV	L90%	U90%
2007	0.50	0.24	0.31	0.71	0.20	0.22	0.12	0.27
2008	0.41	0.35	0.19	0.68	0.20	0.25	0.12	0.29
2009	0.24	0.12	0.19	0.28	0.22	0.13	0.17	0.27
2010	0.36	0.17	0.27	0.47	0.40	0.19	0.29	0.54
2011	0.30	0.12	0.24	0.36	0.62	0.13	0.48	0.75
2012	0.43	0.14	0.33	0.54	0.28	0.14	0.22	0.34
2013	0.27	0.15	0.21	0.34	0.29	0.17	0.21	0.37
2014	0.15	0.18	0.11	0.19	0.16	0.12	0.13	0.19
2015	0.37	0.22	0.25	0.51	1.96	0.28	1.20	3.05
2016	0.42	0.23	0.27	0.59	0.63	0.20	0.44	0.84
2017								
2018	0.26	0.13	0.21	0.32	0.47	0.17	0.35	0.62

Table D16b. Survey results from NEFSC offshore autumn bottom trawl surveys in the southern management region (strata 1-19, 61-76). Values are indices calculated without adjustment for change in survey methods in 2009. Only a small portion of the southern management area was sampled in 2017, therefore indices were not calculated for 2017. Indices are arithmetic stratified means with bootstrapped variance estimates.

	Biomass Index				Abundance Index			
Year	Mean	CV	L90%	U90%	Mean	CV	L90%	U90%
2009	1.92	0.13	1.52	2.33	1.56	0.15	1.18	1.93
2010	2.92	0.18	2.04	3.79	2.87	0.21	1.89	3.85
2011	2.42	0.13	1.89	2.95	4.36	0.15	3.27	5.44
2012	3.50	0.18	2.46	4.53	1.96	0.16	1.45	2.47
2013	2.19	0.17	1.58	2.81	2.07	0.18	1.44	2.69
2014	1.20	0.23	0.75	1.65	1.14	0.15	0.86	1.42
2015	2.96	0.23	1.82	4.10	13.96	0.31	6.85	21.06
2016	3.37	0.22	2.14	4.61	4.46	0.19	3.06	5.85
2017								
2018	2.13	0.13	1.66	2.60	3.38	0.17	2.45	4.31

Table D17a. Survey results from NEFSC offshore spring bottom trawl surveys in the southern management region (strata 1-19, 61-76). Strata 61-76 were not sampled until 1967. Values from 2009 forward are adjusted for change in survey methods. Indices are arithmetic stratified means with bootstrapped variance estimates.

	Biomass Index				Abundance Index			
	Mean	CV	L90%	U90%	Mean	CV	L90%	U90%
1968	1.16	0.23	0.77	1.61	0.21	0.19	0.15	0.28
1969	0.92	0.23	0.58	1.31	0.23	0.20	0.15	0.30
1970	1.00	0.25	0.58	1.40	0.18	0.19	0.12	0.23
1971	0.76	0.29	0.43	1.15	0.21	0.25	0.13	0.29
1972	1.88	0.18	1.36	2.47	0.36	0.12	0.29	0.44
1973	1.82	0.08	1.59	2.06	1.04	0.08	0.91	1.17
1974	1.16	0.16	0.87	1.47	0.49	0.11	0.40	0.57
1975	0.91	0.15	0.70	1.15	0.44	0.12	0.36	0.54
1976	1.13	0.11	0.91	1.33	0.41	0.12	0.33	0.48
1977	1.16	0.14	0.90	1.45	0.30	0.10	0.25	0.35
1978	0.73	0.13	0.58	0.89	0.34	0.09	0.28	0.39
1979	0.70	0.17	0.51	0.90	0.27	0.15	0.21	0.34
1980	0.74	0.15	0.56	0.92	0.45	0.10	0.38	0.53
1981	1.74	0.15	1.33	2.20	0.77	0.12	0.62	0.92
1982	2.60	0.17	1.92	3.33	0.93	0.12	0.75	1.11
1983	0.95	0.26	0.58	1.35	0.27	0.16	0.20	0.35
1984	0.74	0.31	0.36	1.12	0.18	0.23	0.11	0.25
1985	0.33	0.32	0.17	0.52	0.16	0.25	0.10	0.23
1986	0.83	0.28	0.48	1.23	0.28	0.27	0.18	0.43
1987	0.50	0.48	0.17	0.95	0.11	0.23	0.07	0.15
1988	0.43	0.13	0.34	0.52	0.44	0.16	0.33	0.55
1989	0.36	0.16	0.27	0.47	0.20	0.23	0.13	0.28
1990	1.00	0.20	0.67	1.34	0.21	0.11	0.17	0.24
1991	0.58	0.24	0.37	0.82	0.32	0.25	0.20	0.46
1992	0.22	0.33	0.11	0.34	0.18	0.25	0.11	0.25
1993	0.26	0.28	0.15	0.39	0.20	0.23	0.12	0.28
1994	0.33	0.28	0.19	0.50	0.11	0.23	0.07	0.16
1995	0.52	0.39	0.20	0.90	0.20	0.20	0.13	0.27
1996	0.28	0.20	0.19	0.38	0.14	0.20	0.09	0.18
1997	0.13	0.22	0.09	0.18	0.12	0.21	0.08	0.16
1998	0.28	0.15	0.22	0.35	0.25	0.14	0.20	0.31
1999	0.64	0.20	0.44	0.86	0.34	0.14	0.26	0.42
2000	0.30	0.18	0.21	0.39	0.24	0.17	0.18	0.31
2001	0.26	0.31	0.14	0.41	0.24	0.20	0.16	0.31
2002	0.38	0.30	0.21	0.60	0.32	0.33	0.18	0.52
2003	1.38	0.15	1.03	1.72	0.31	0.16	0.23	0.39
2004	0.18	0.27	0.11	0.27	0.12	0.25	0.07	0.17
2005	0.37	0.16	0.28	0.47	0.26	0.27	0.16	0.39
2006	0.54	0.27	0.32	0.78	0.17	0.20	0.12	0.23
2007	0.55	0.22	0.37	0.77	0.26	0.16	0.20	0.33
2008	0.39	0.31	0.22	0.60	0.19	0.31	0.11	0.29

Table D17a, continued.

	Biomass Index				Abundance Index			
	Mean	CV	L90%	U90%	Mean	CV	L90%	U90%
2008	0.39	0.31	0.22	0.60	0.19	0.31	0.11	0.29
2009	0.30	0.15	0.23	0.38	0.16	0.14	0.12	0.19
2010	0.22	0.19	0.15	0.29	0.16	0.21	0.11	0.22
2011	0.42	0.11	0.34	0.50	0.28	0.14	0.22	0.34
2012	0.35	0.11	0.29	0.42	0.30	0.09	0.26	0.34
2013	0.34	0.14	0.27	0.44	0.20	0.17	0.15	0.26
2014	0.25	0.19	0.17	0.33	0.14	0.13	0.11	0.17
2015	0.20	0.18	0.14	0.26	0.11	0.16	0.08	0.14
2016	0.28	0.11	0.23	0.32	0.46	0.10	0.38	0.54
2017	0.49	0.16	0.37	0.62	0.46	0.18	0.33	0.59
2018	0.63	0.16	0.46	0.78	0.33	0.16	0.24	0.41
2019	0.36	0.10	0.30	0.42	0.29	0.11	0.24	0.34

Table D17b. Survey results from NEFSC offshore spring bottom trawl surveys in the southern management region (strata 1-19, 61-76). Values are indices calculated without adjustment for change in survey methods in 2009. Indices are arithmetic stratified means with bootstrapped variance estimates.

	Biomass Index				Abundance Index			
	Mean	CV	L90%	U90%	Mean	CV	L90%	U90%
2009	2.45	0.16	1.81	3.09	1.11	0.15	0.85	1.38
2010	1.73	0.19	1.19	2.28	1.15	0.22	0.73	1.56
2011	3.41	0.11	2.80	4.01	1.99	0.14	1.54	2.44
2012	2.86	0.11	2.36	3.35	2.14	0.09	1.83	2.45
2013	2.76	0.14	2.10	3.42	1.43	0.17	1.03	1.82
2014	2.03	0.19	1.41	2.65	1.03	0.13	0.80	1.25
2015	1.58	0.17	1.14	2.02	0.77	0.15	0.58	0.97
2016	2.22	0.10	1.85	2.59	3.25	0.11	2.68	3.82
2017	3.93	0.16	2.92	4.94	3.25	0.18	2.26	4.24
2018	5.04	0.16	3.72	6.36	2.36	0.16	1.73	2.99
2019	2.89	0.10	2.42	3.36	2.07	0.11	1.70	2.43

Table D18. Survey results from NEFSC (1984-2011) and NEFSC and VIMS (2012-2018) offshore scallop dredge surveys in the southern management region (shellfish strata 6, 7, 10, 11, 14, 15, 18, 19, 22-31, 33-35, 46, 47, 55, 58-61, 621, 631). The survey vessel used by NEFSC and survey timing change in 2009. VIMS conducted an increasing portion of the survey starting in 2012. Indices are arithmetic stratified means with bootstrapped variance estimates (where available).

	Abundance Index Mean	CV	L90%	U90%
1984	1.34	0.1	1.17	1.51
1985	1.57	0.1	1.37	1.79
1986	1.29	0.1	1.12	1.46
1987	3.17	0.1	2.89	3.46
1988	1.69	0.1	1.49	1.89
1989	1.00	0.1	0.88	1.13
1990	1.53	0.1	1.40	1.69
1991	2.26	0.1	2.05	2.46
1992	1.95	0.1	1.75	2.18
1993	2.83	0.0	2.62	3.06
1994	3.33	0.1	3.06	3.62
1995	2.26	0.1	2.03	2.49
1996	2.01	0.1	1.80	2.23
1997	1.12	0.1	0.99	1.26
1998	1.06	0.1	0.95	1.18
1999	2.57	0.1	2.28	2.89
2000	2.29	0.1	2.04	2.58
2001	1.73	0.1	1.56	1.92
2002	1.70	0.1	1.54	1.86
2003	2.75	0.1	2.48	3.01
2004	2.89	0.1	2.59	3.23
2005	2.01	0.1	1.81	2.21
2006	1.44	0.1	1.31	1.57
2007	0.83	0.1	0.73	0.94
2008	1.03	0.1	0.89	1.17
2009	0.78	9.8	0.65	0.92
2010	0.74	9.9	0.61	0.87
2011	0.94	12.5	0.73	1.12
2012	1.00			
2013	0.81			
2014	0.55			
2015	2.29			
2016	2.17			
2017	1.62			
2018	0.99			

Table D19. Area-swept estimates of minimum abundance and biomass, and relative exploitation indices for monkfish from NEFSC fall surveys. Estimates are adjusted for sweep type (adjusted to chain sweep), assume that 100% of monkfish encountered by the trawl are captured and account for missed strata in some years.

North	Catch (millions of fish)	Landings (millions of fish)	Catch mt	adjusted AS total abund	adjusted AS 43 cm+ abund	adjusted AS Biomass mt	C/Total N Rel F	L/43+cm Rel F	C mt/ B mt Rel F
2009	1.559	1.066	3,675	36,717,874	8,662,877	32,406	0.04	0.12	0.11
2010	1.169	0.819	2,741	40,524,791	10,999,269	42,178	0.03	0.07	0.06
2011	1.445	0.970	2,814	51,328,487	14,797,117	49,936	0.03	0.07	0.06
2012	1.995	1.390	4,635	57,008,552	13,828,353	51,063	0.04	0.10	0.09
2013	1.724	1.109	3,922	60,967,483	8,414,414	40,838	0.03	0.13	0.10
2014	1.865	1.139	3,954	84,100,939	13,314,746	54,125	0.02	0.09	0.07
2015	2.137	1.395	4,630	105,281,189	17,990,848	77,578	0.02	0.08	0.06
2016	2.552	1.670	5,508	174,643,487	26,516,683	103,686	0.01	0.06	0.05
2017	3.222	2.478	7,894	115,927,590	39,300,789	113,147	0.03	0.06	0.07
2018	3.210	2.090	8,115	100,164,292	35,993,154	140,801	0.03	0.06	0.06

South	Catch (millions of fish)	Landings (millions of fish)	Catch mt	adjusted AS total abund	adjusted AS 43 cm+ abund	adjusted AS Biomass mt	C/Total N Rel F	L/43+cm Rel F	C mt/ B mt Rel F
2009	2.14	1.282	7,158	26,947,935	4,900,883	20,592	0.08	0.26	0.35
2010	2.64	1.095	7,105	47,905,108	8,873,105	32,509	0.06	0.12	0.22
2011	2.66	1.236	8,545	62,976,941	6,254,672	25,878	0.04	0.20	0.33
2012	3.35	1.439	8,438	24,635,364	7,309,501	31,016	0.14	0.20	0.27
2013	2.46	1.398	7,176	36,089,410	7,908,464	23,849	0.07	0.18	0.30
2014	2.49	1.243	6,859	25,860,088	4,769,114	20,359	0.10	0.26	0.34
2015	2.29	1.057	5,844	298,342,595	3,536,976	50,510	0.01	0.30	0.12
2016	4.51	0.971	7,199	77,586,702	5,136,276	52,014	0.06	0.19	0.14
2017	2.96	0.934	9,143						
2018	2.98	1.112	9,615	67,592,308	6,726,308	26,619	0.04	0.17	0.36

Figures

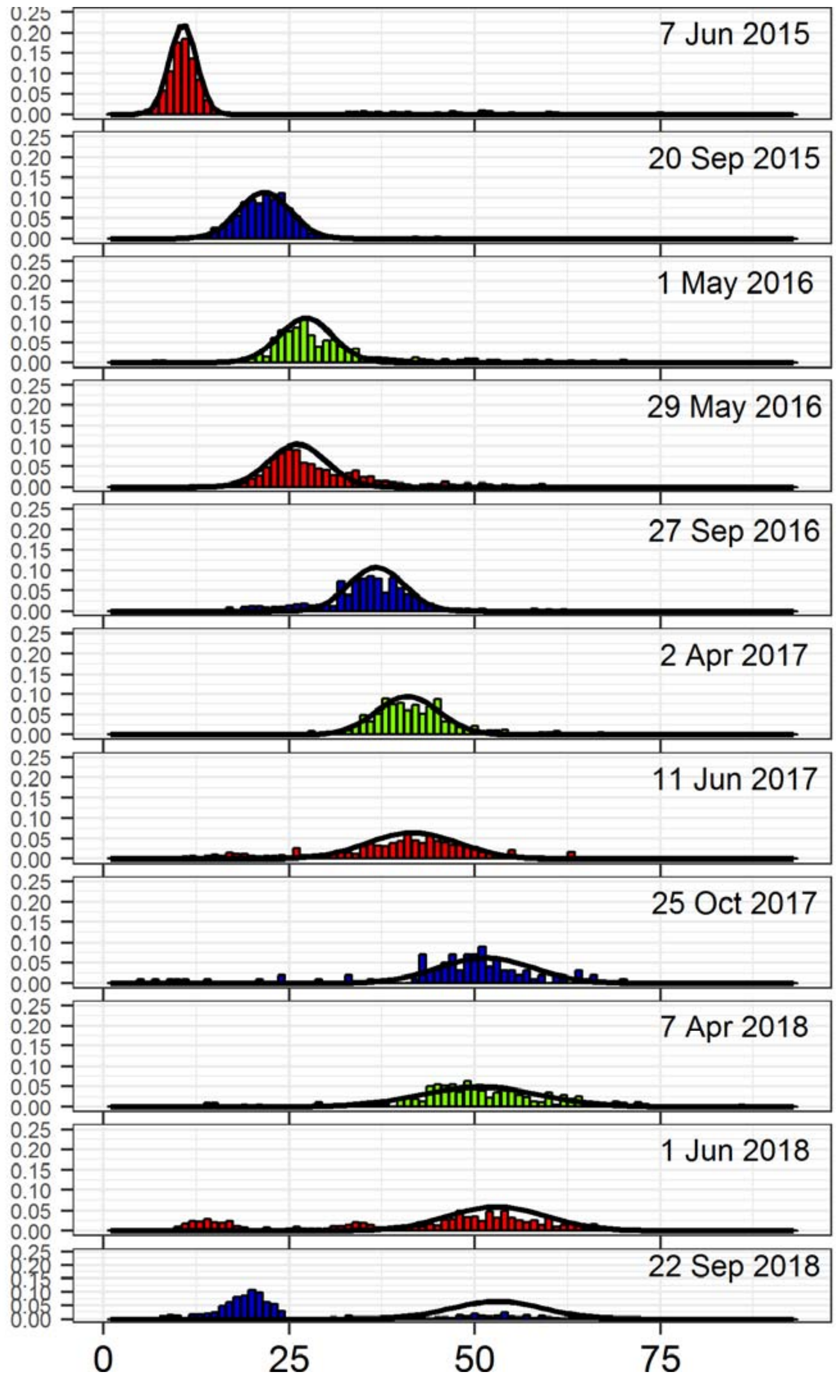


Figure D1. Length frequency distributions of monkfish in southern management area from NEFSC spring (green), scallop dredge (NEFSC and VIMS, red), and NEFSC fall surveys (blue) illustrating growth rates of presumed 2015 year class of monkfish. Normal curves were fit to dominant mode using NORMSEP. Monkfish settle to the benthos at about 8 cm. Geographic scope of sampling was limited to southern flank of Georges Bank in fall 2017.

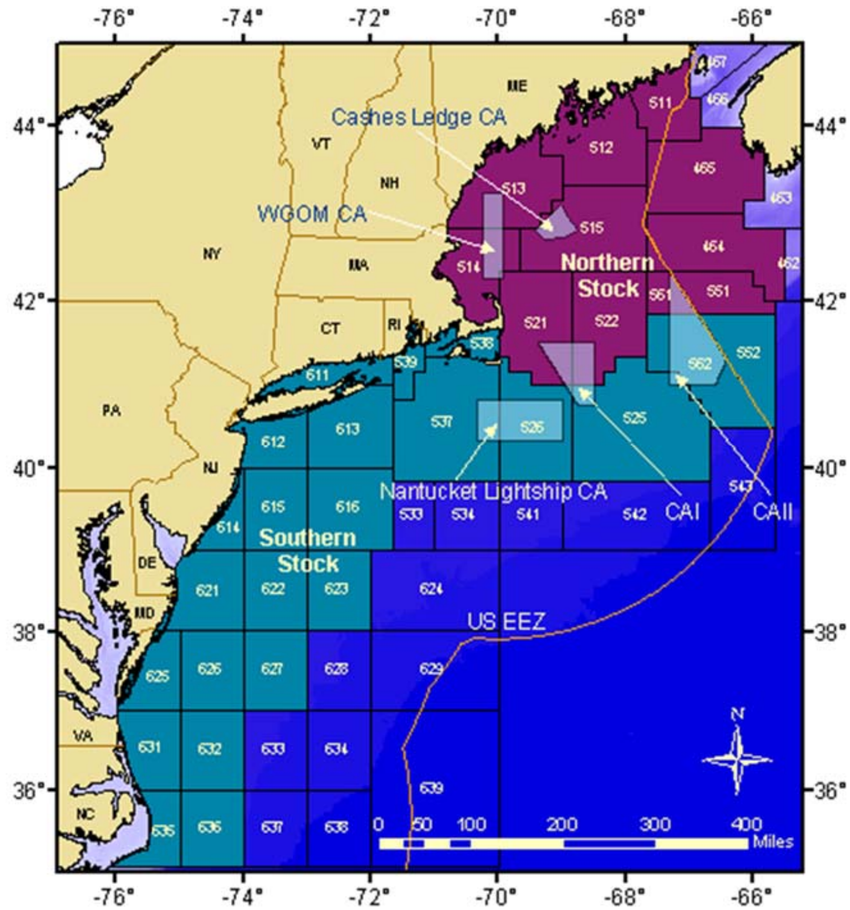


Figure D2. Fishery statistical areas used to define northern and southern monkfish management areas.

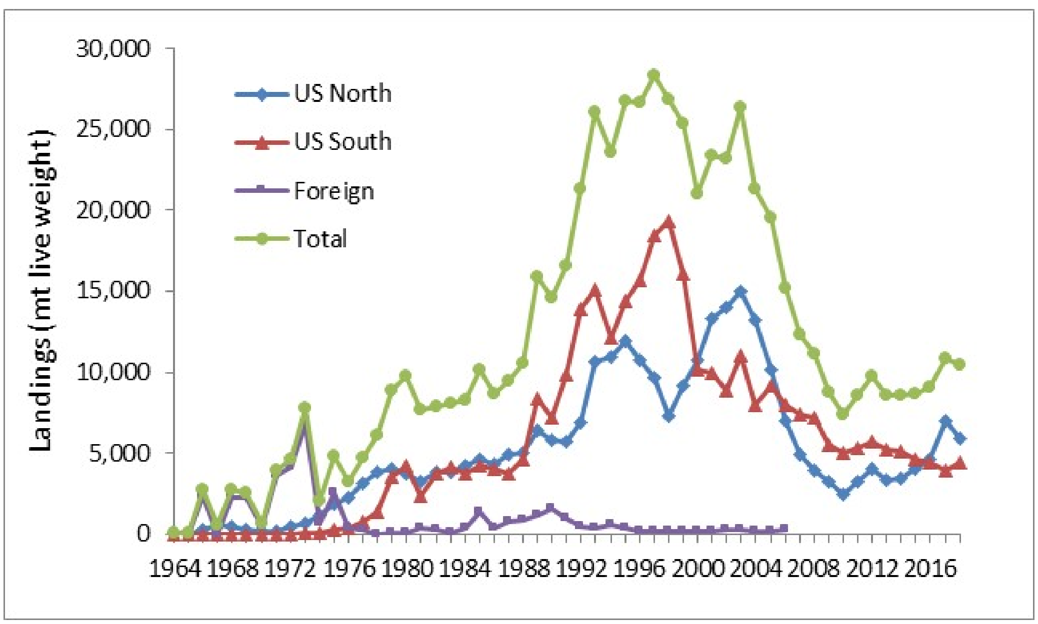


Figure D3. Monkfish landings by management area and combined areas, 1964-2018.

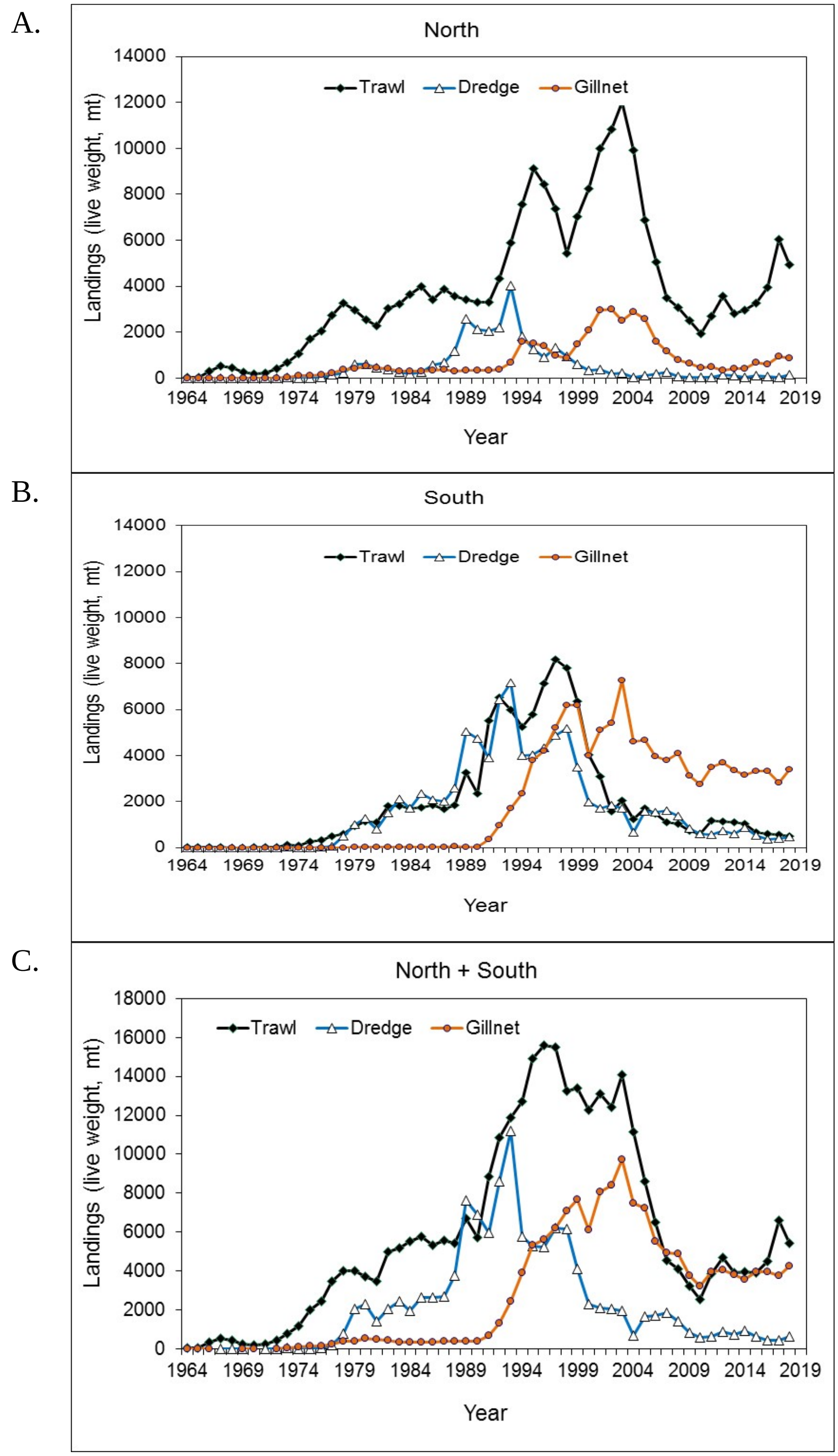


Figure D4. Commercial landings of monkfish by gear type and management area, 1964-2018. A. Northern management area, B. Southern management area, C. Management areas combined.

North South

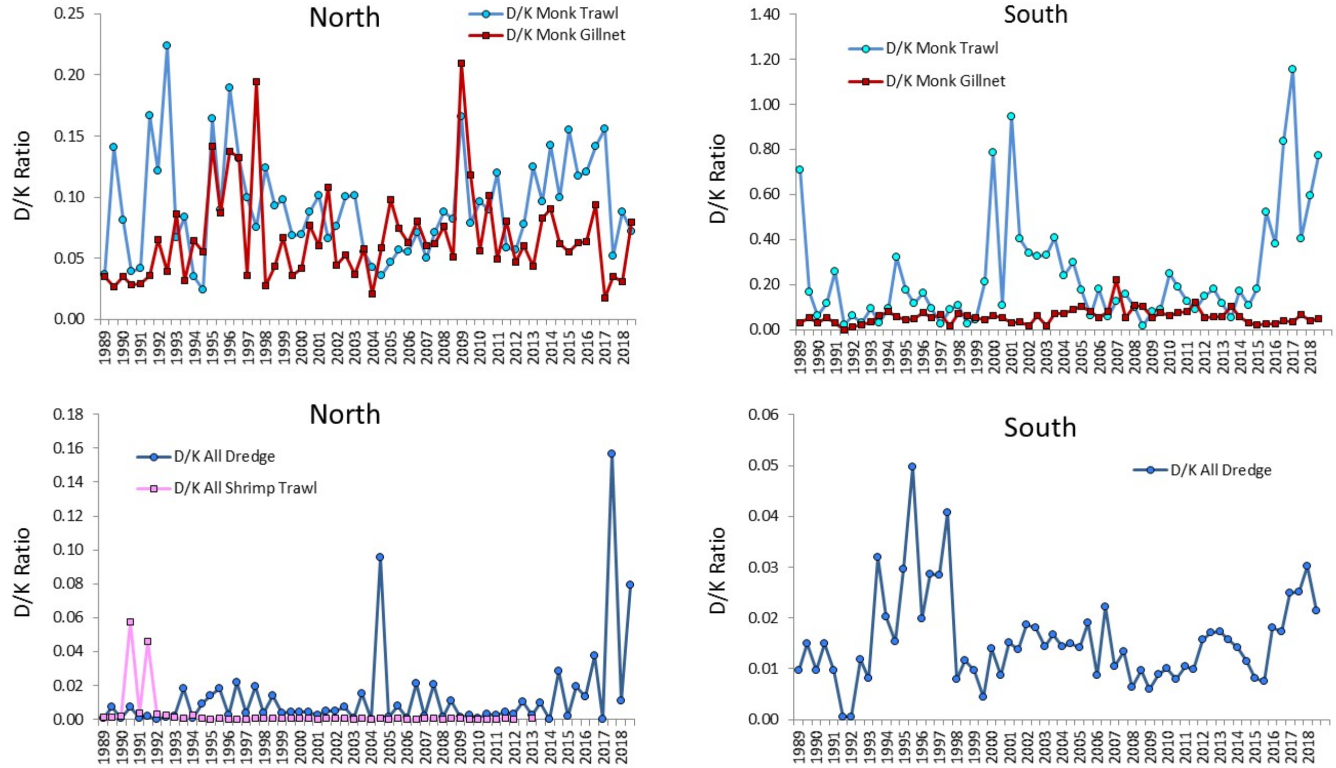


Figure D5. Discard ratios by half year for trawls and gillnets (top panels), and dredges and shrimp trawls (bottom panels) for North (left column) and South (right column). Trawls and gillnets ratios were based on kept monkfish; dredge and shrimp trawl were based on kept of all species.

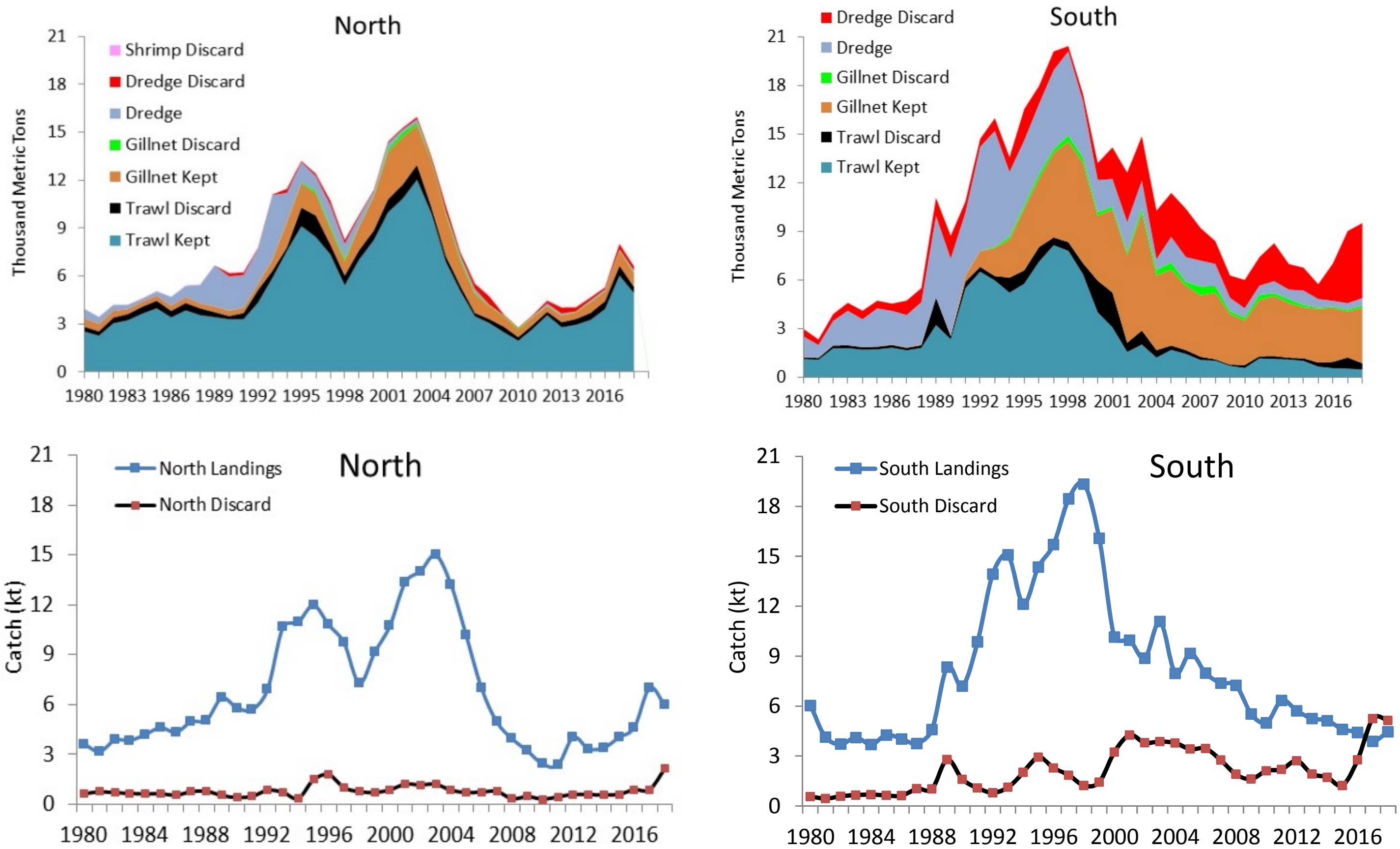


Figure D6. Monkfish landings and discard by gear type (top panels) and total (bottom panels) for North (left) and South (right).

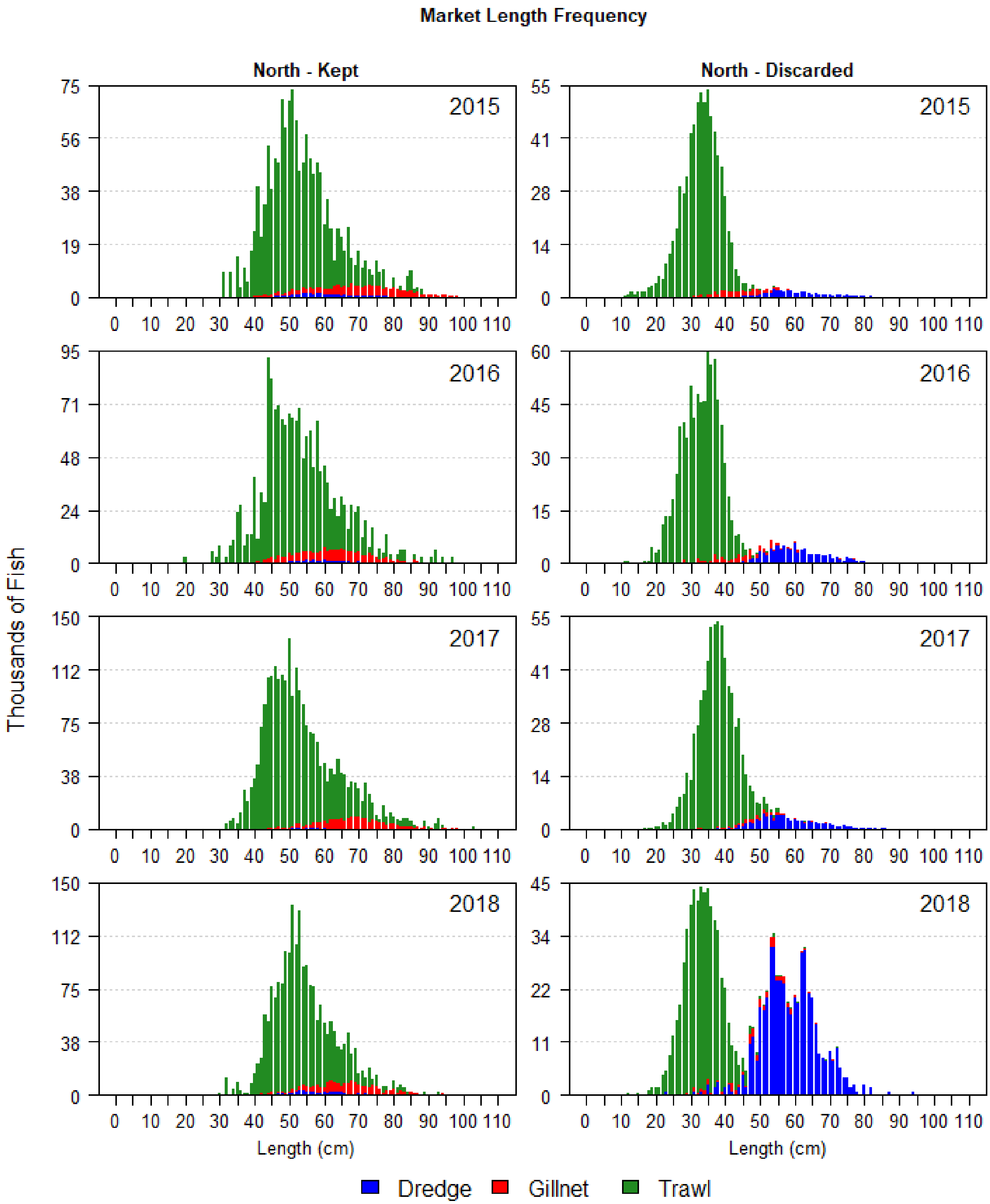


Figure D7. Estimated length composition of kept and discarded monkfish by gear type in the northern management area.

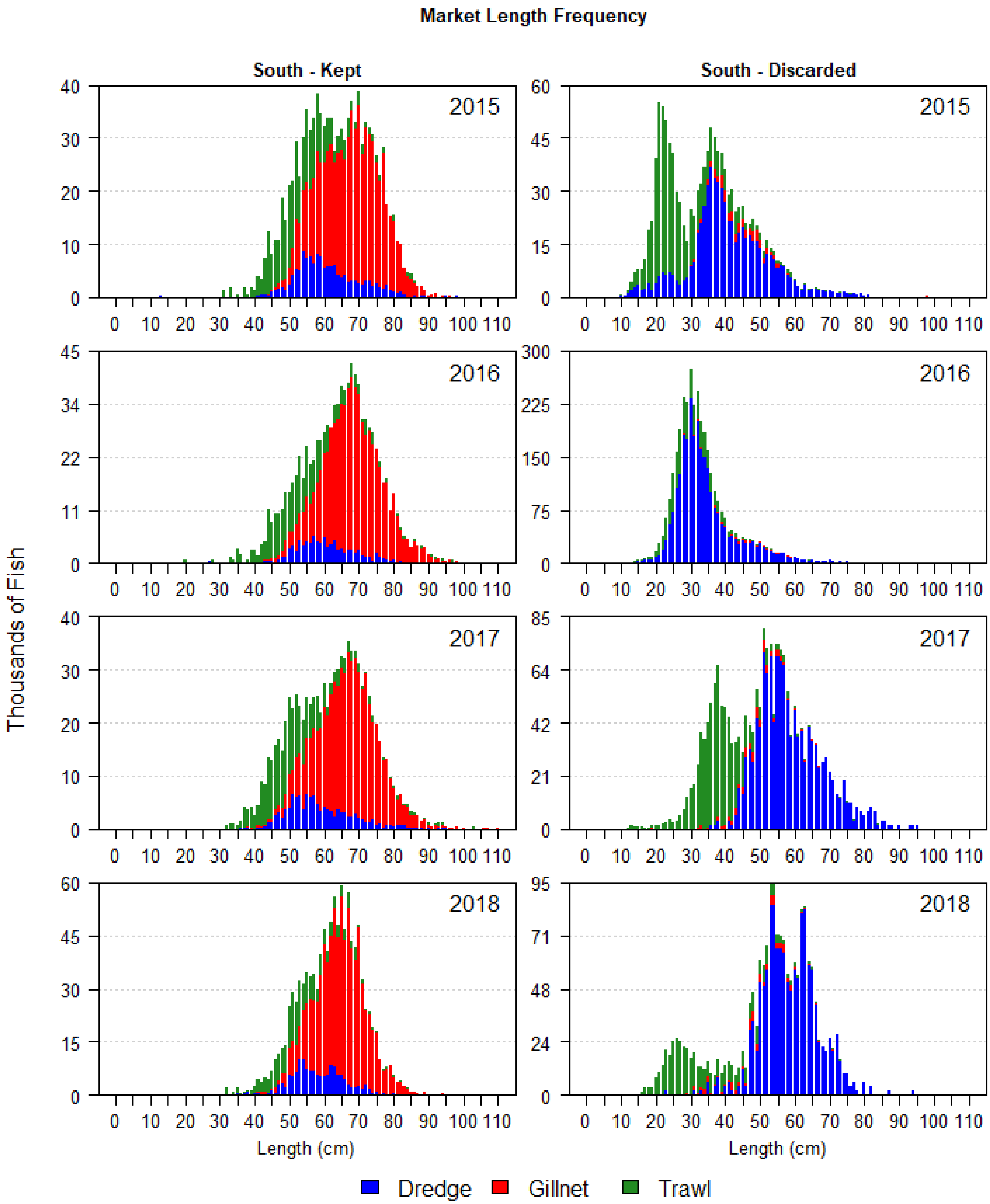


Figure D8. Estimated length composition of kept and discarded monkfish by gear type in the southern management area.

North Y-axis scale variable Y-axis scale standardized

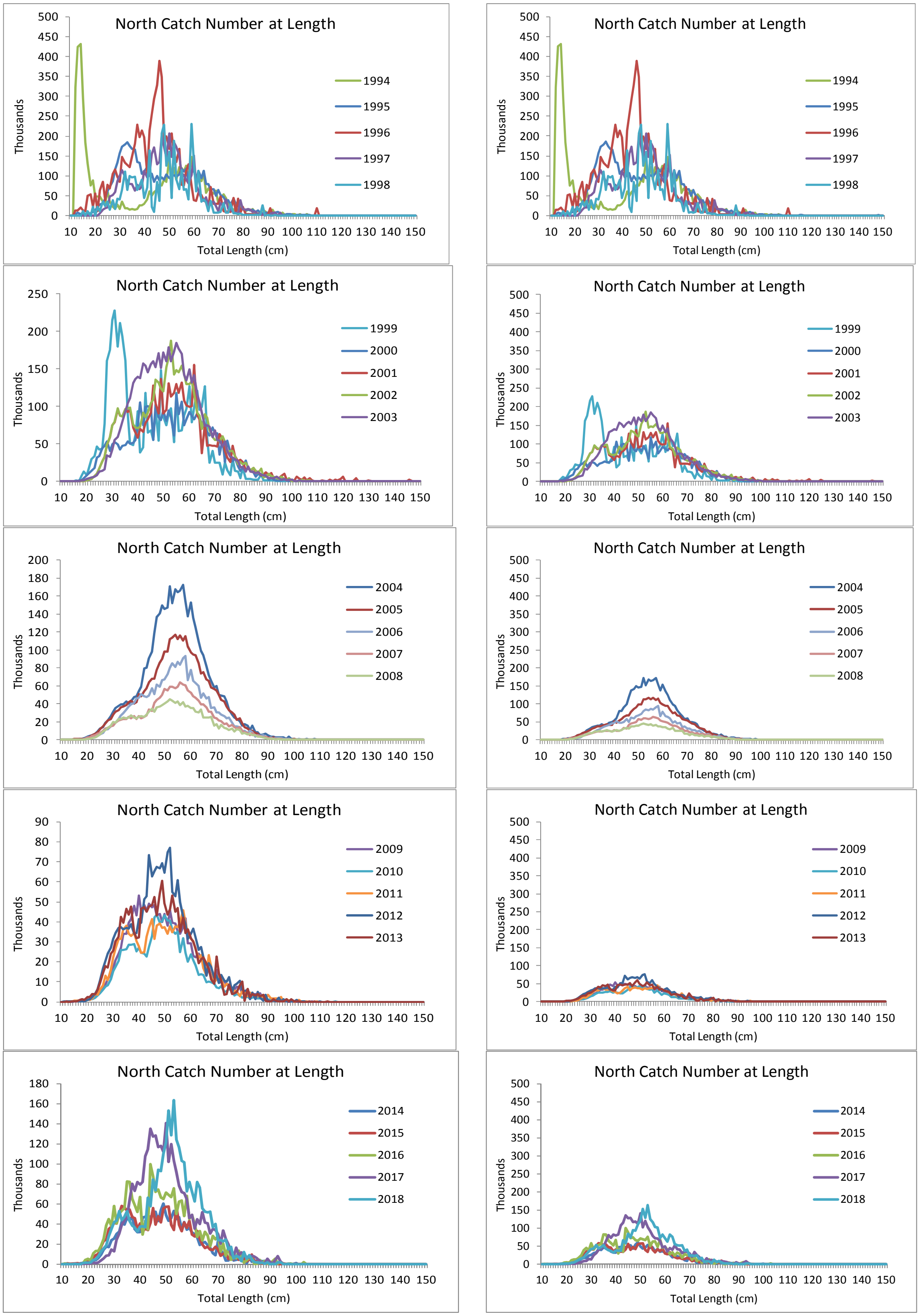


Figure D9. Estimated length composition of commercial monkfish catch, northern management area.

South Y-axis scale variable Y-axis scale standardized

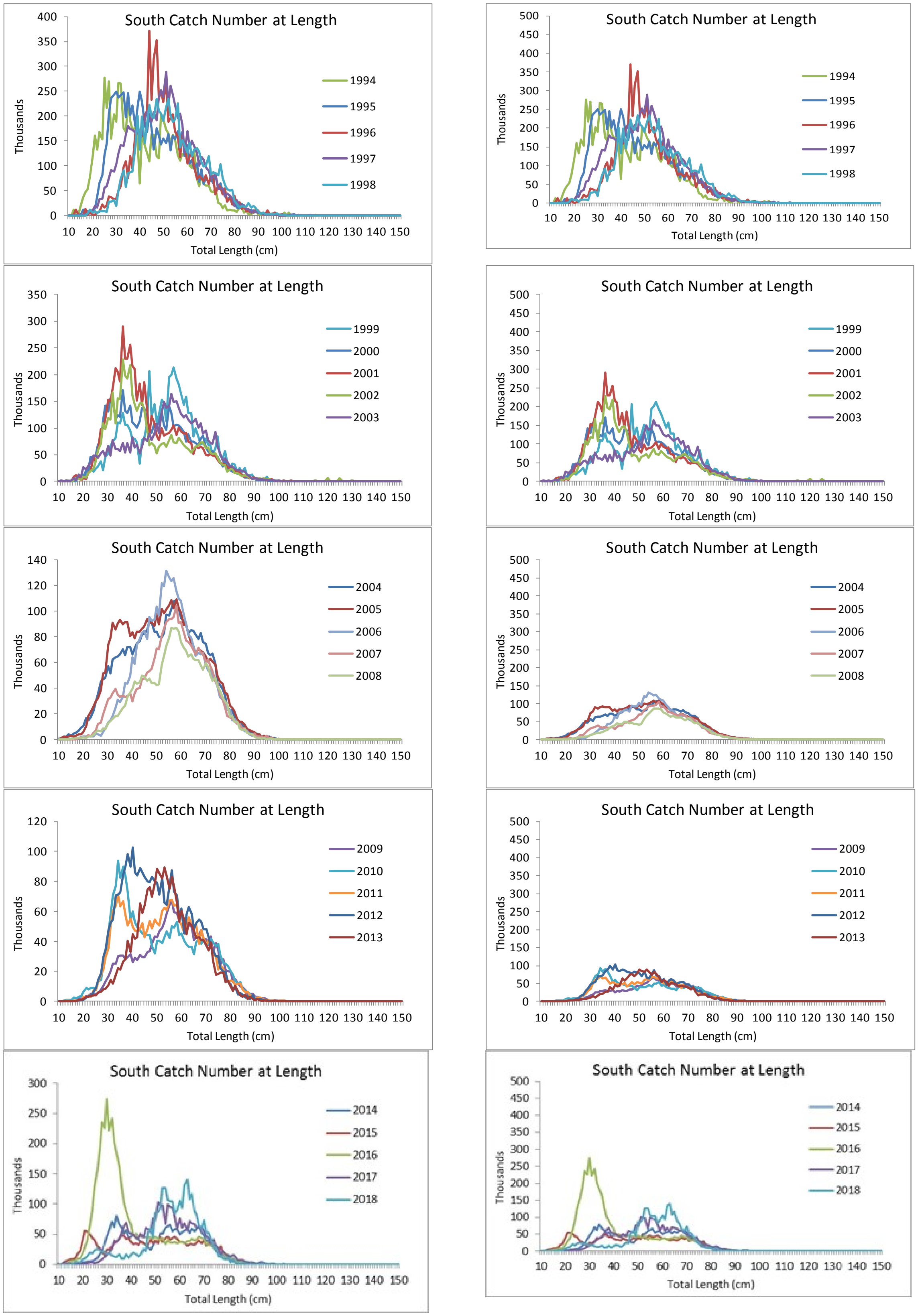


Figure D10. Length composition of monkfish commercial catch estimated using length frequency data collected by fishery observers in the southern management area.

North

Biomass | Abundance

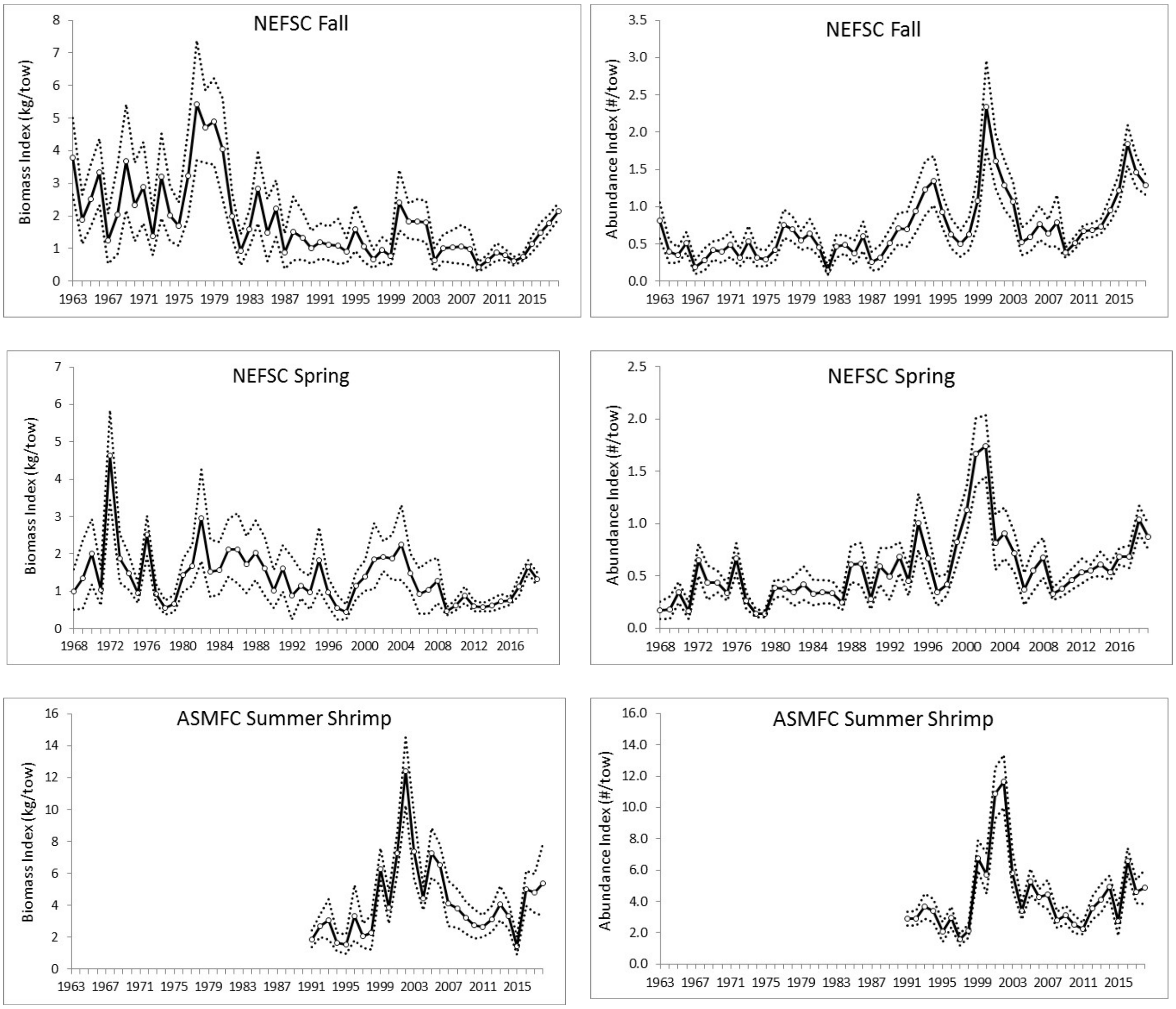


Figure D11. Survey indices for monkfish in the northern management area. Points after 2008 in spring and fall surveys are from surveys conducted on the FSV Bigelow, converted to Albatross units as described in the text.

North

Biomass | Abundance

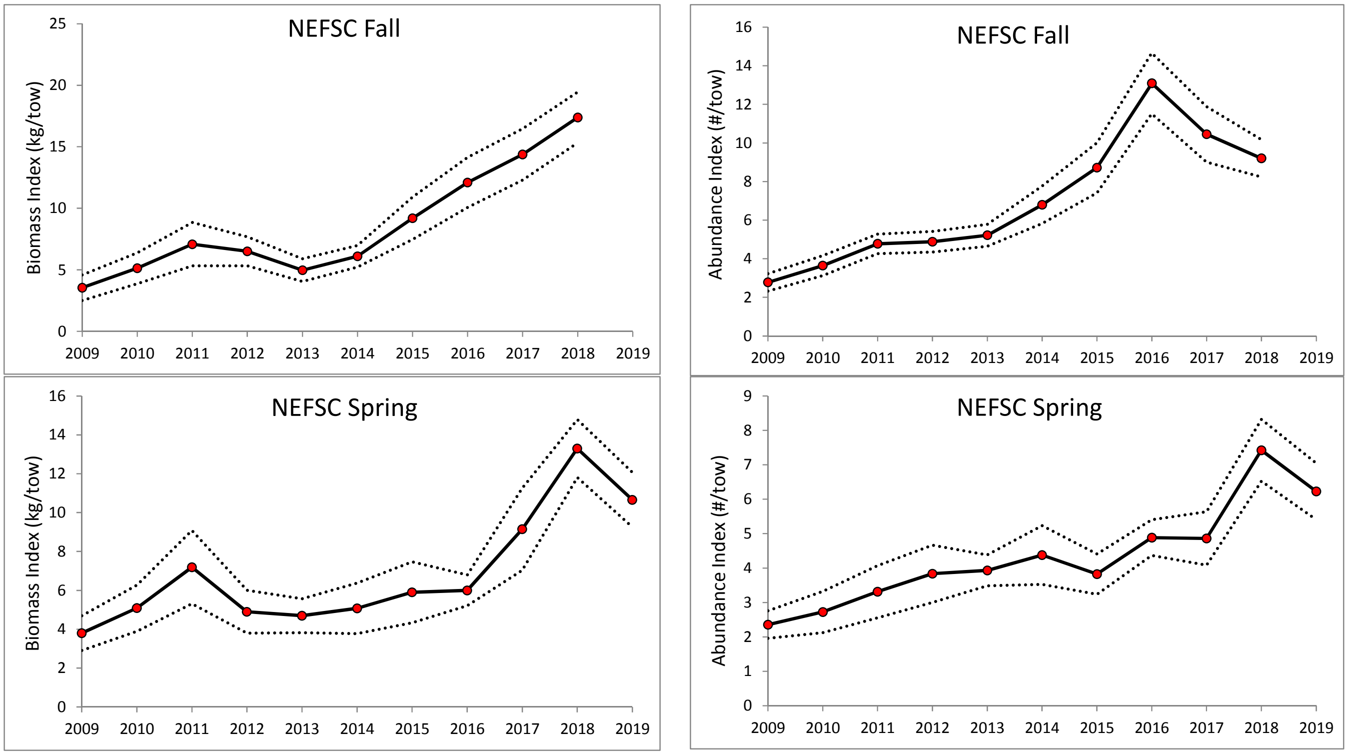


Figure D12. Survey indices from surveys conducted on the FRSV Bigelow in the northern management area, not converted to Albatross units. Note: y-axis scale varies.

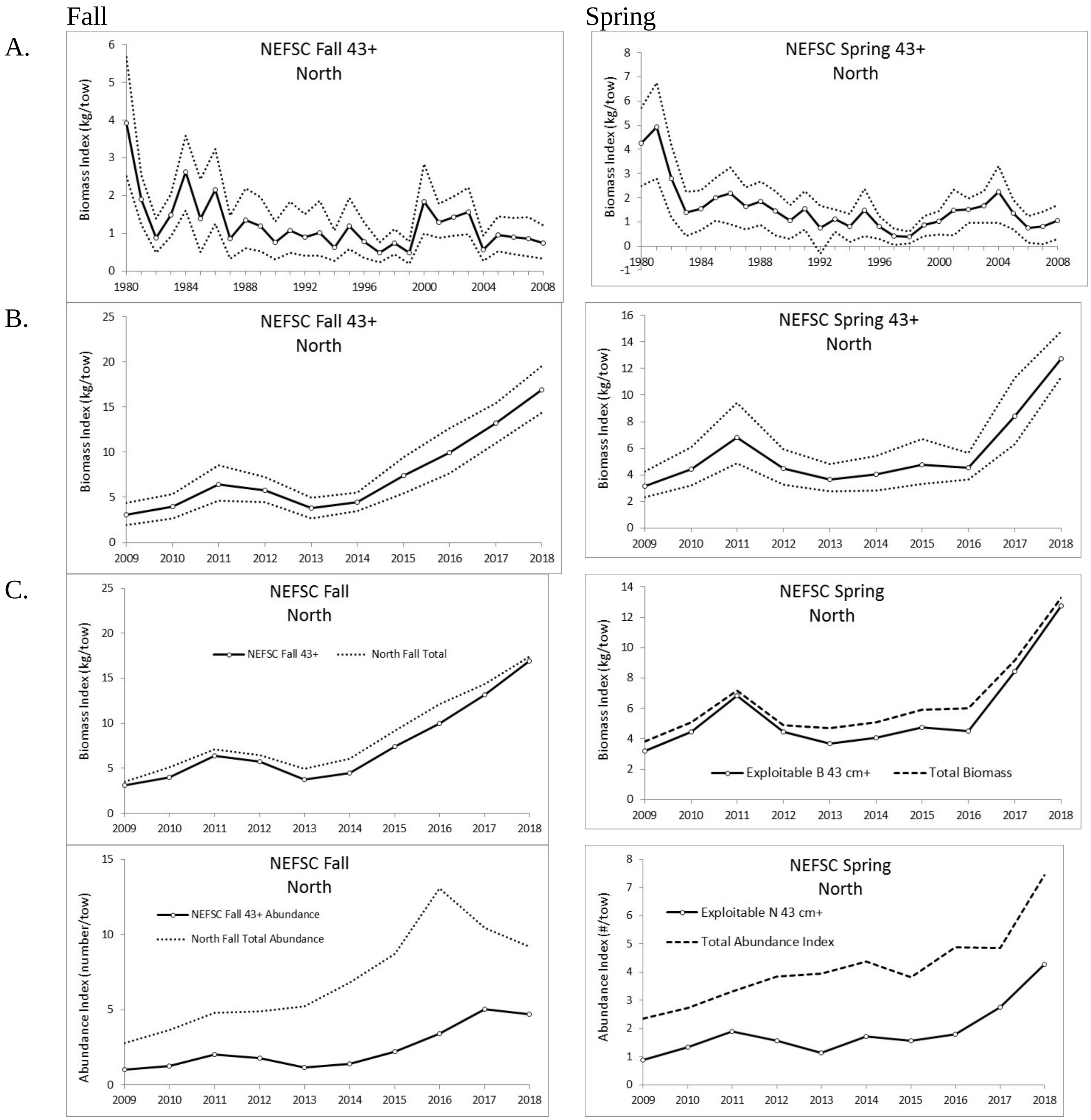


Figure D13. Exploitable biomass (≥ 43 cm total length) indices for monkfish from fall and spring surveys in the NMA. A. Exploitable biomass indices with 95% confidence intervals, 1980-2008 (surveys conducted on RV Albatross). B. Exploitable biomass indices with 95% confidence intervals, 2009-2018 (surveys conducted on RV H.B. Bigelow) C. Total biomass vs. exploitable biomass indices, 2009-2018, D. total abundance vs. exploitable abundance, 2009-2018.

North

Biomass Abundance

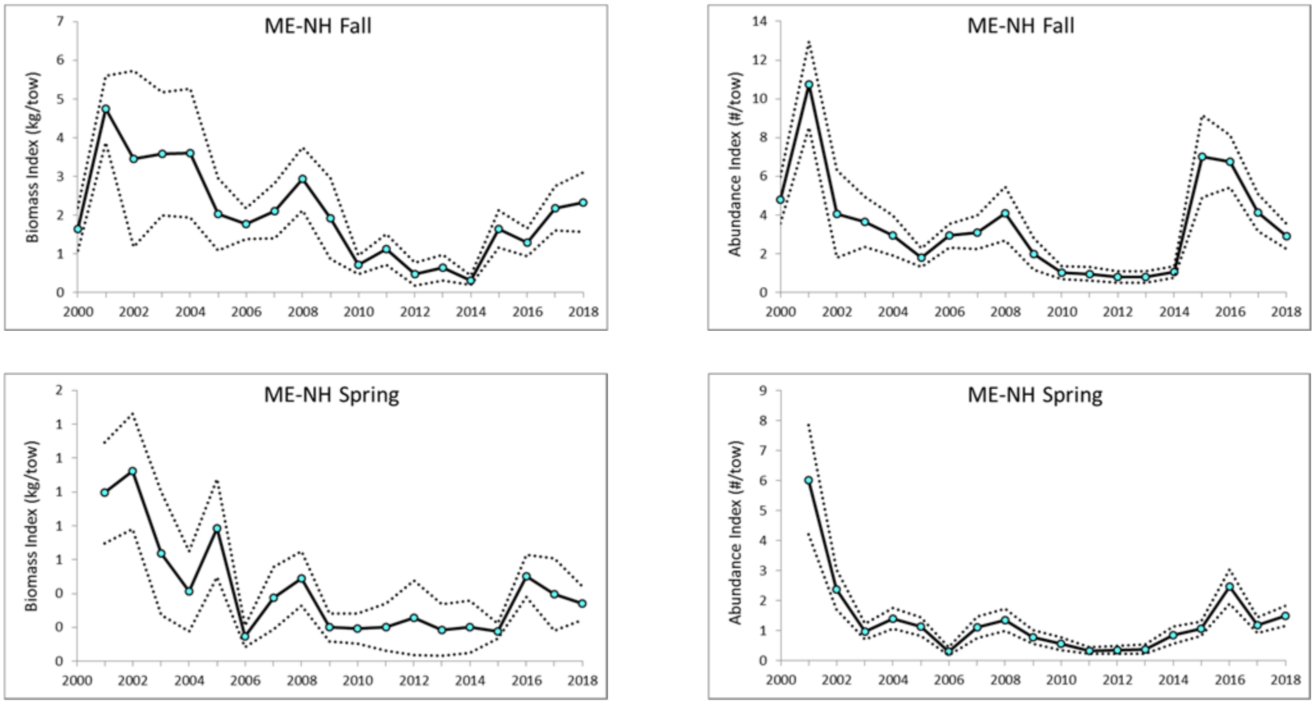


Figure D14. Survey indices for monkfish from Maine-New Hampshire inshore surveys. Data courtesy of Maine Department of Marine Resources.

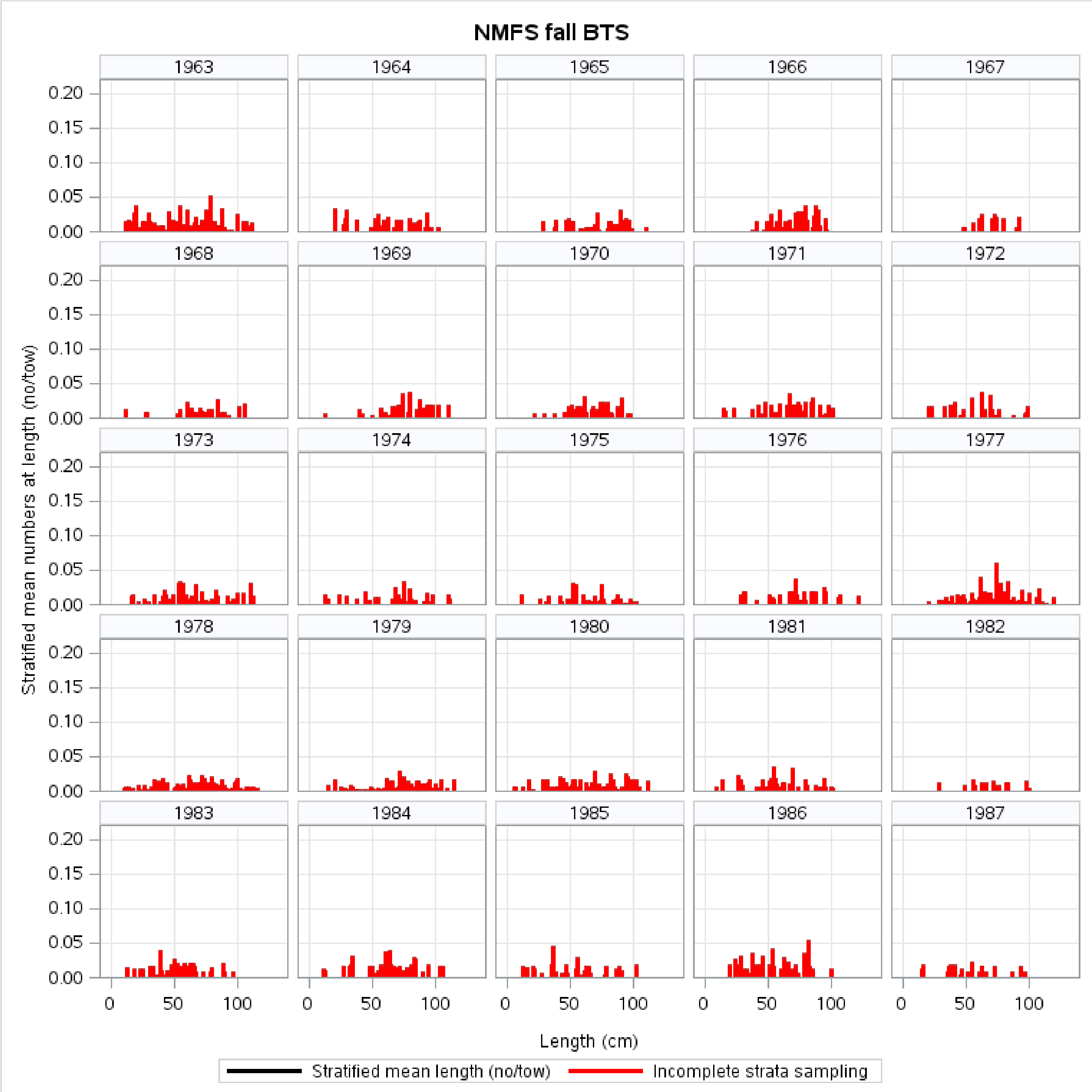
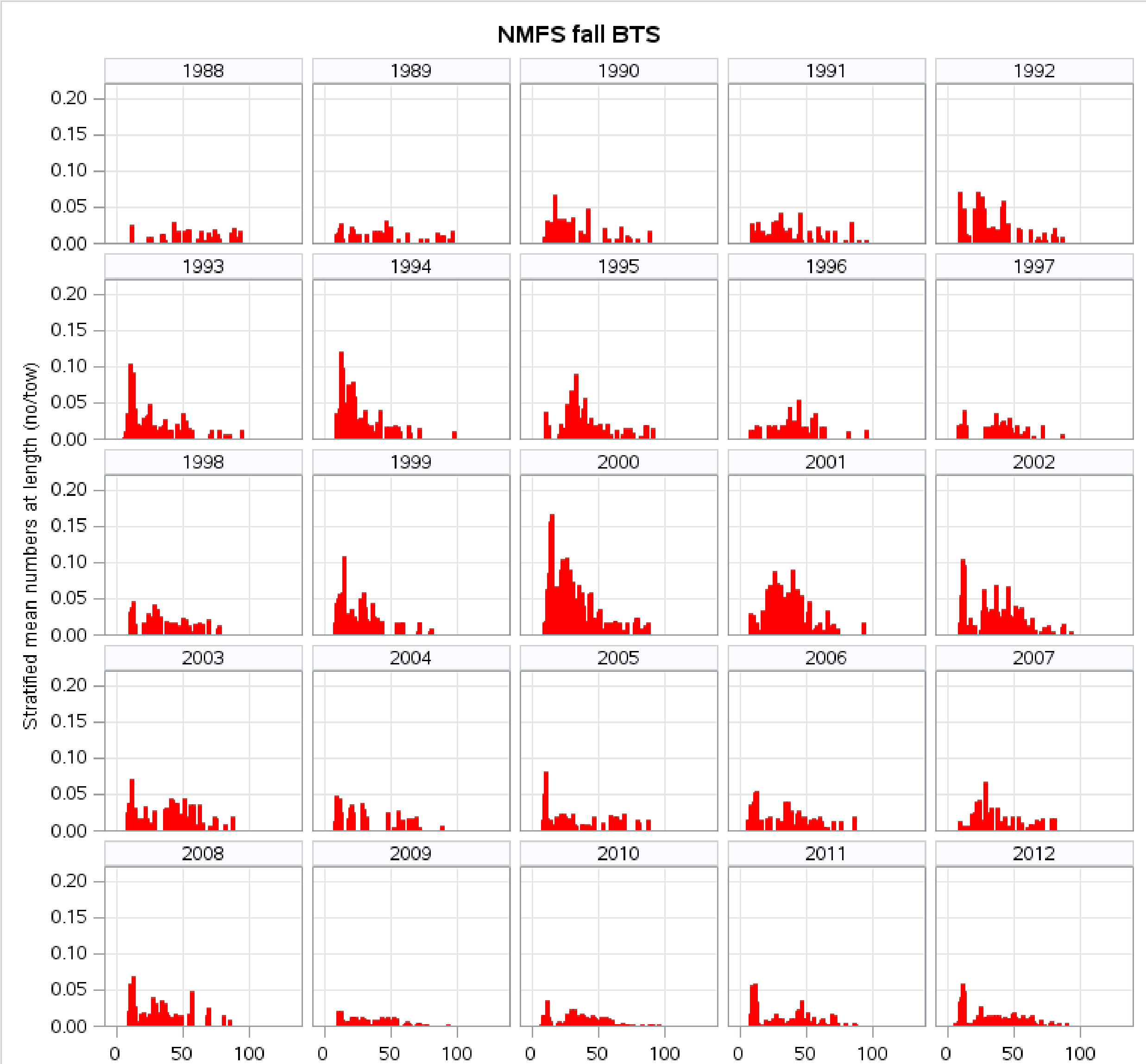


Figure D15. Abundance at length from NEFSC fall surveys in the northern management area.



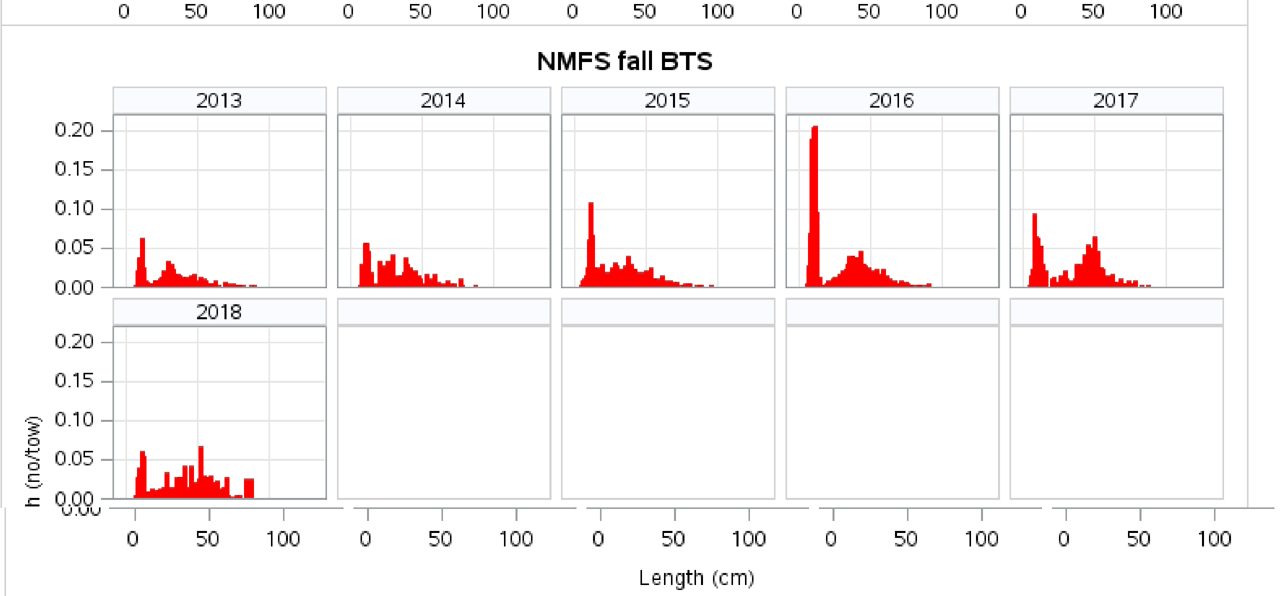


Figure D15, cont'd. (fall surveys, north)

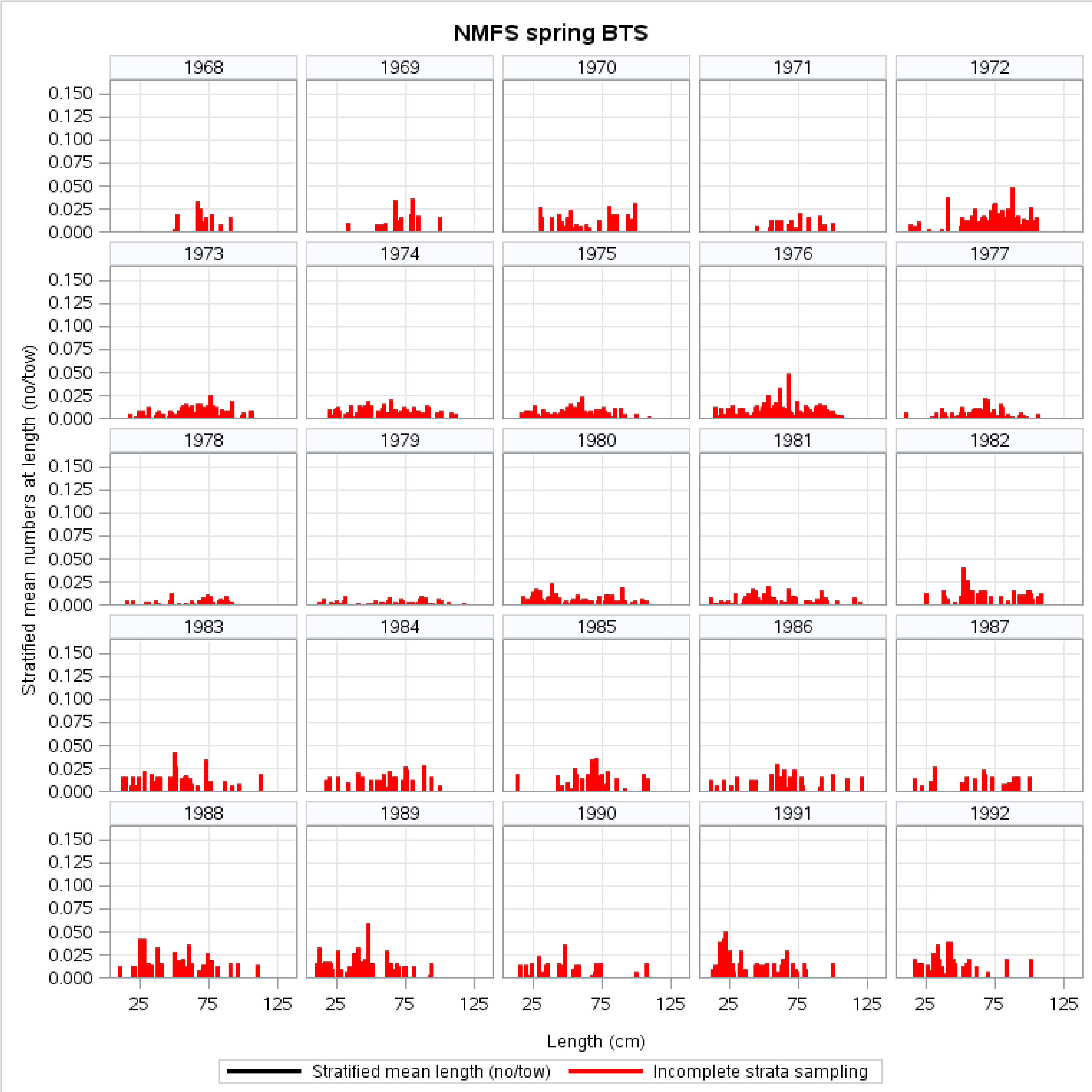


Figure D16. Abundance at length from NEFSC spring surveys in the northern management area.

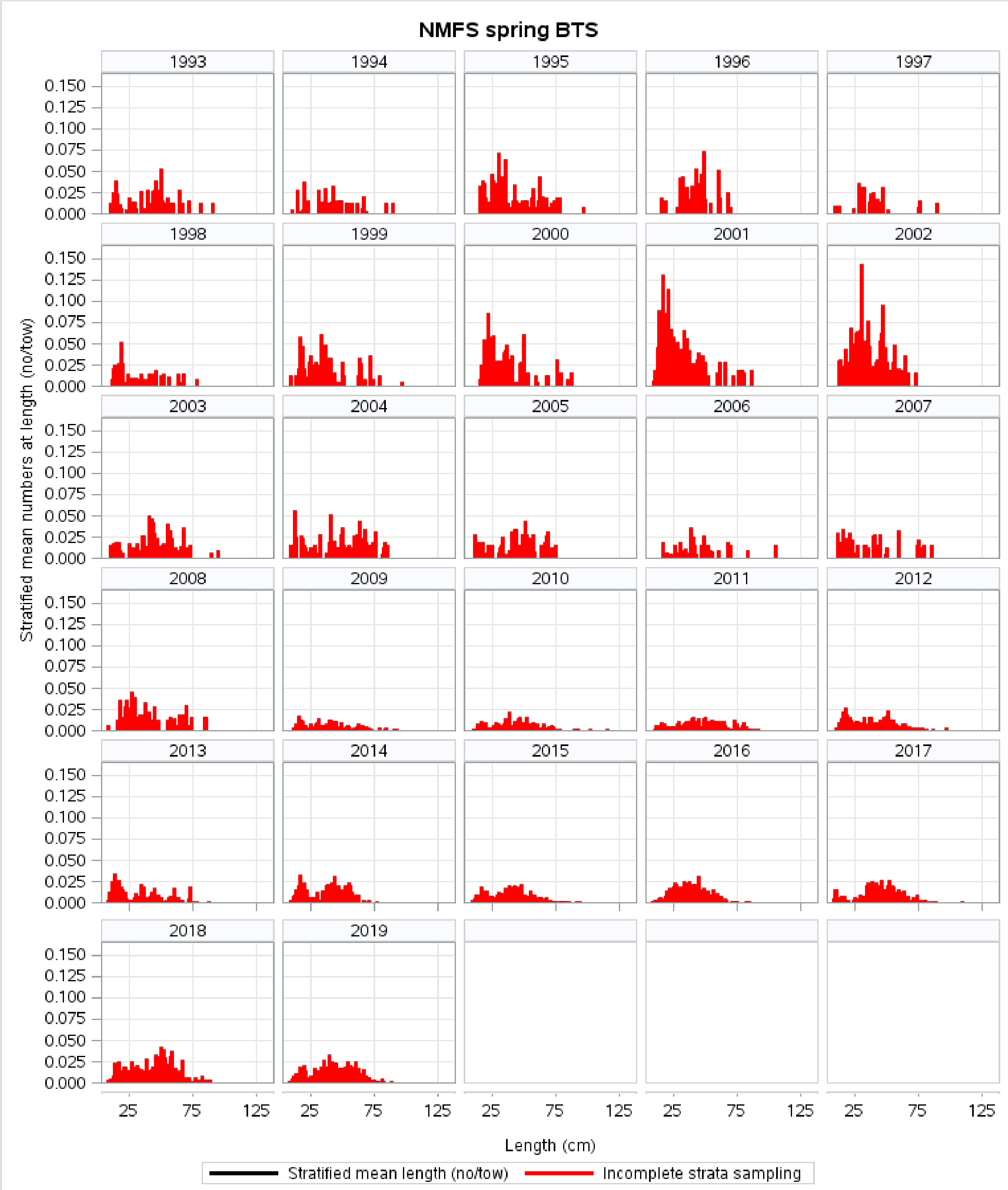


Figure D16, cont'd. (spring surveys, north)

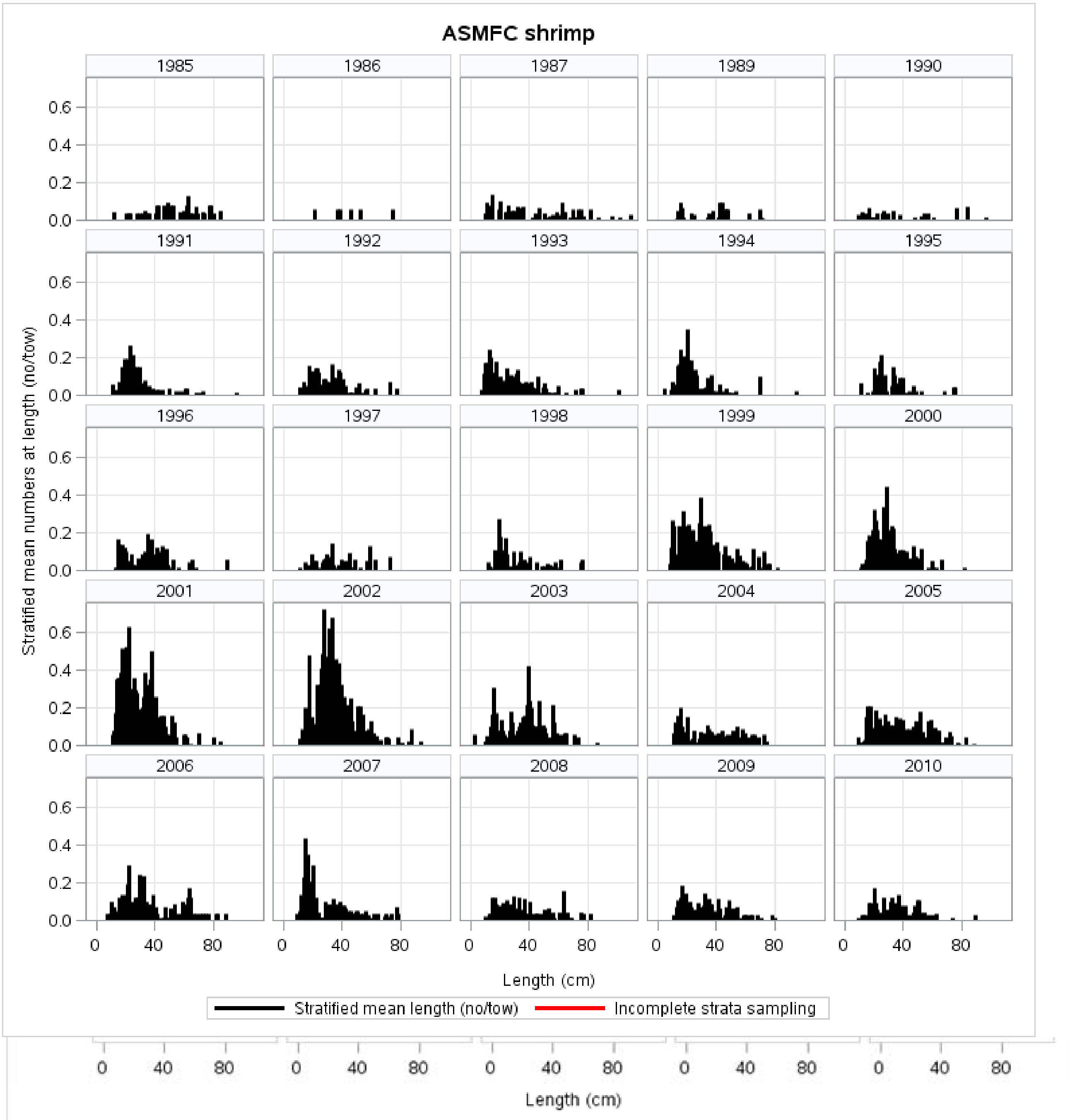


Figure D17. Abundance at length from ASMFC summer shrimp surveys in the northern management area.

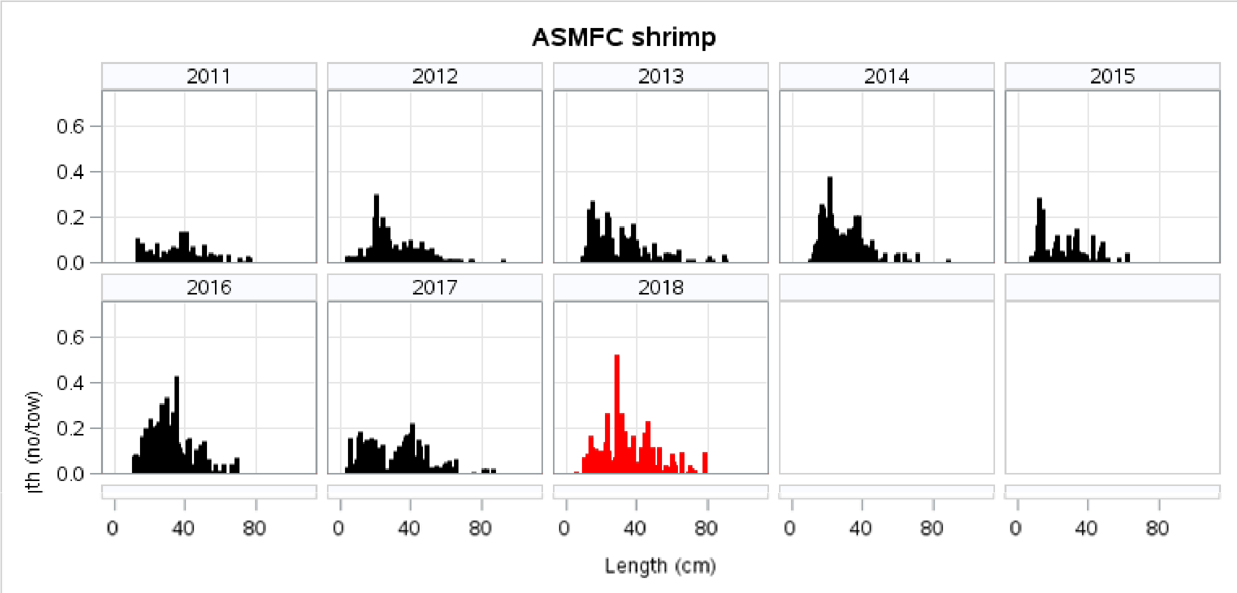


Figure D17, continued (shrimp surveys, north)

Fall

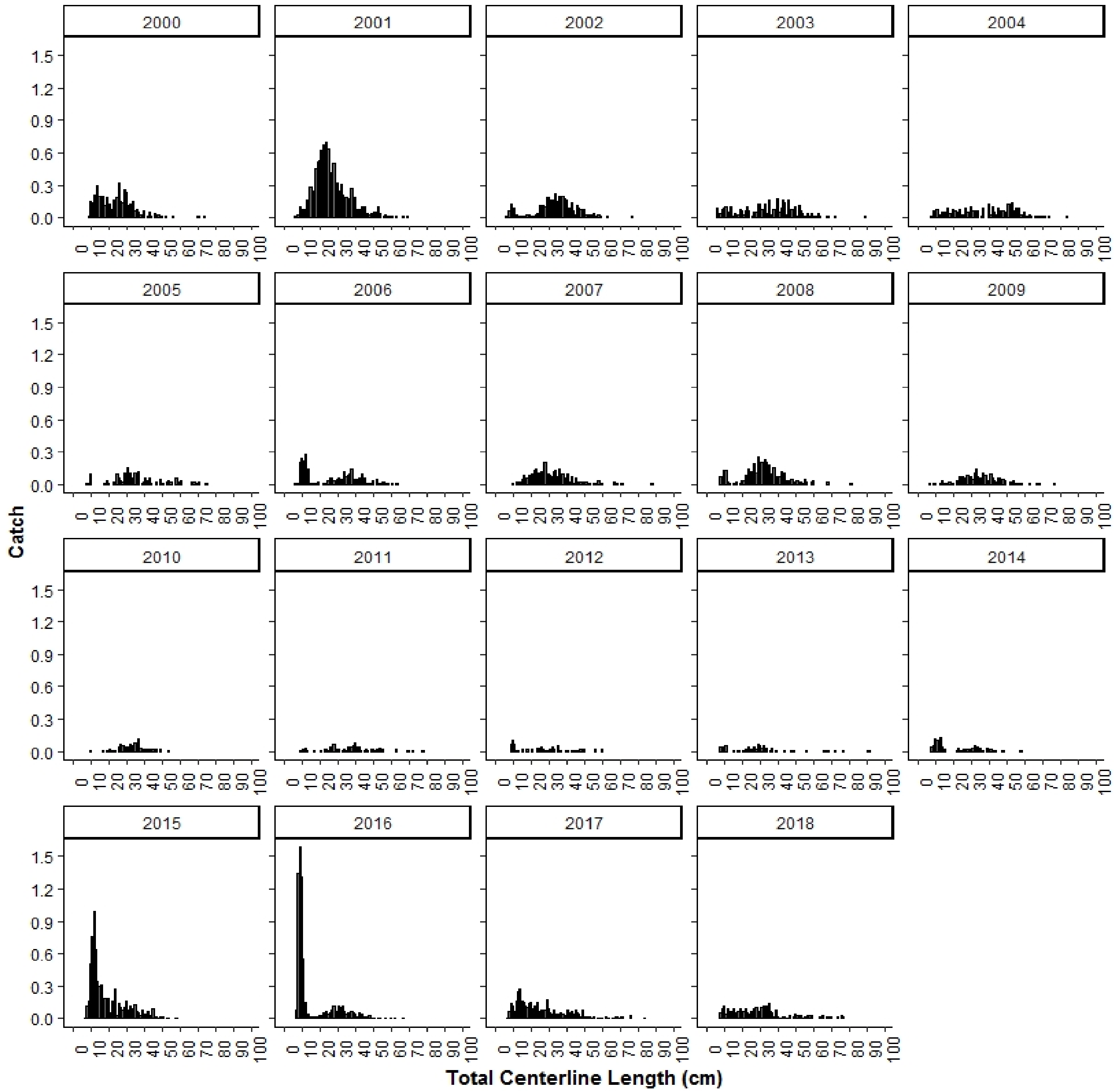


Figure D18. Abundance at length from ME/NH fall inshore trawl surveys in the northern management area. Data courtesy of Maine Department of Marine Resources.

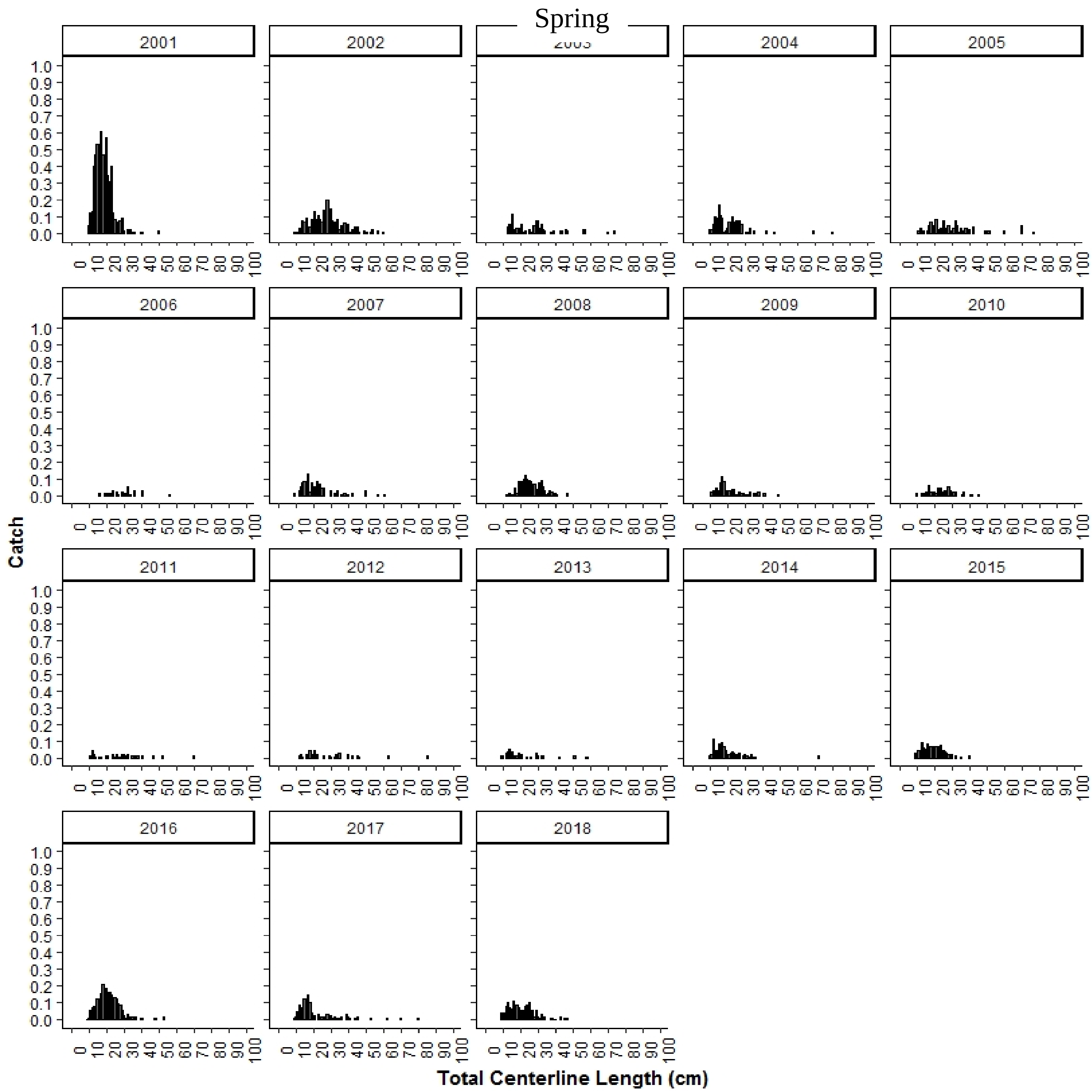


Figure D19. Abundance at length from ME/NH spring inshore trawl surveys in the northern management area. Data courtesy of Maine Department of Marine Resources.

A.

B.

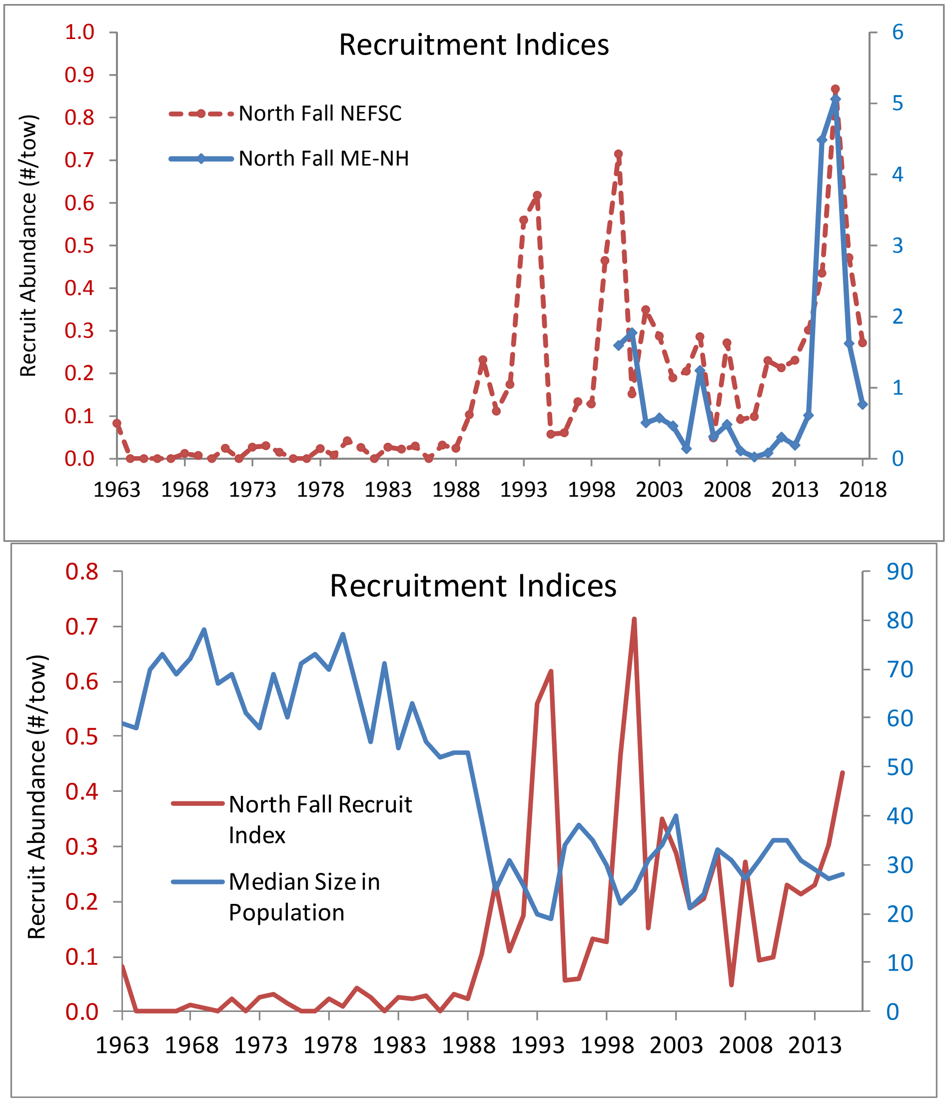


Figure D20. A. Recruitment indices for monkfish in the northern management area. Indices include monkfish in size ranges thought to represent young-of-year (age 0) in each area and season. B. Recruitment indices vs. median size of monkfish in the population (based on NEFSC fall surveys).

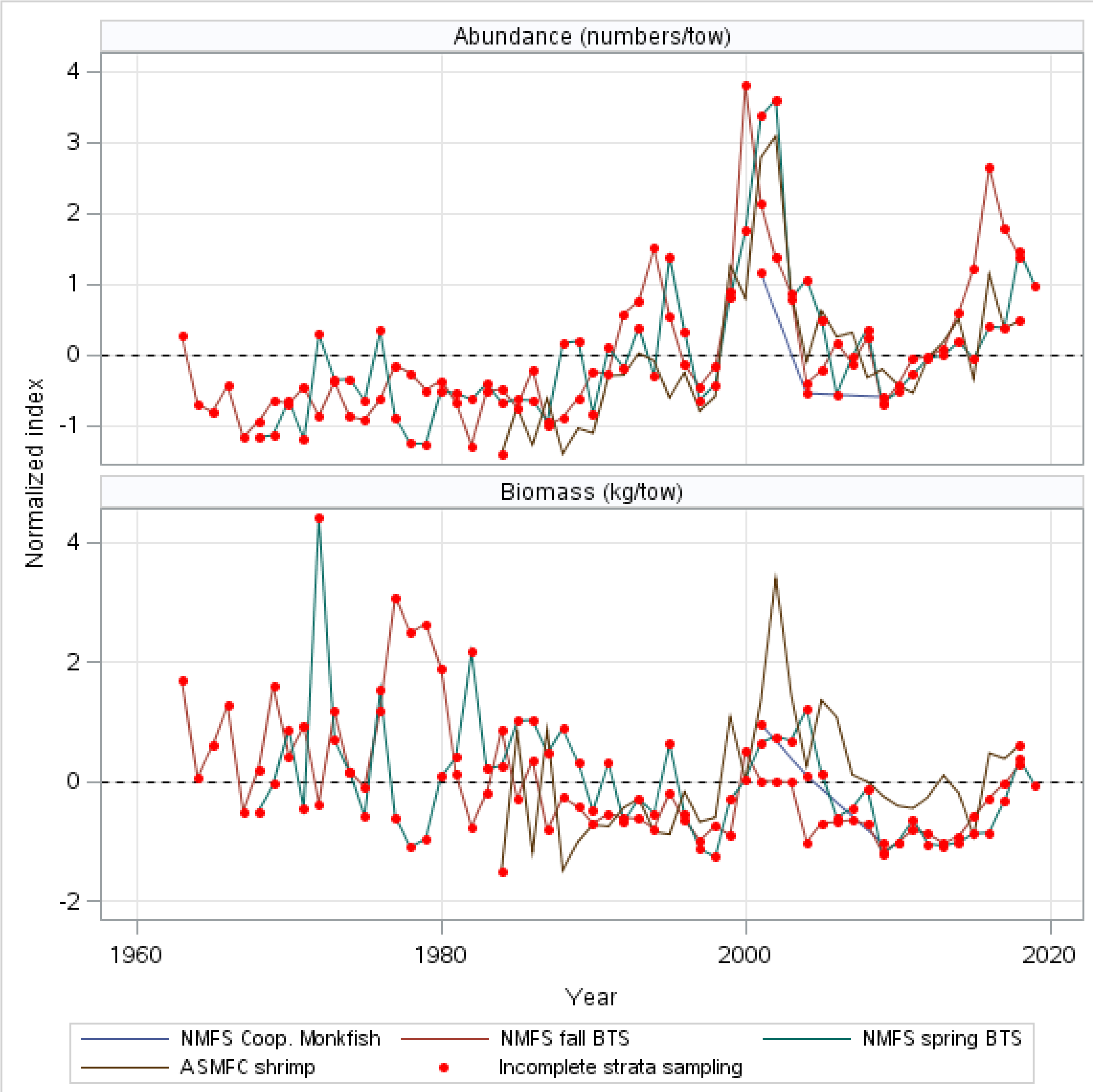
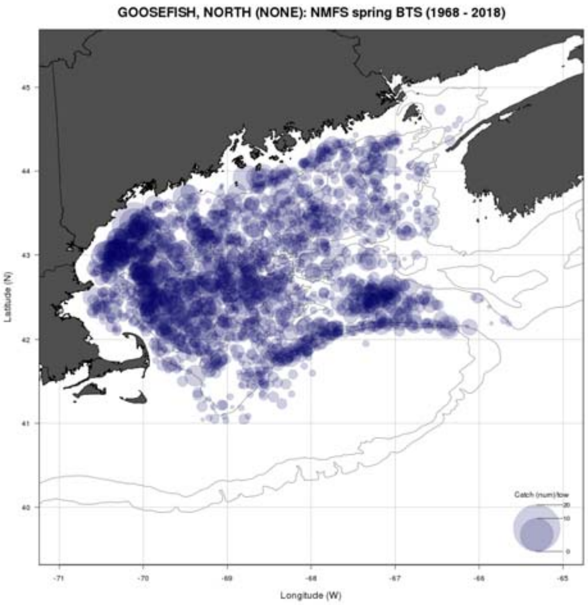
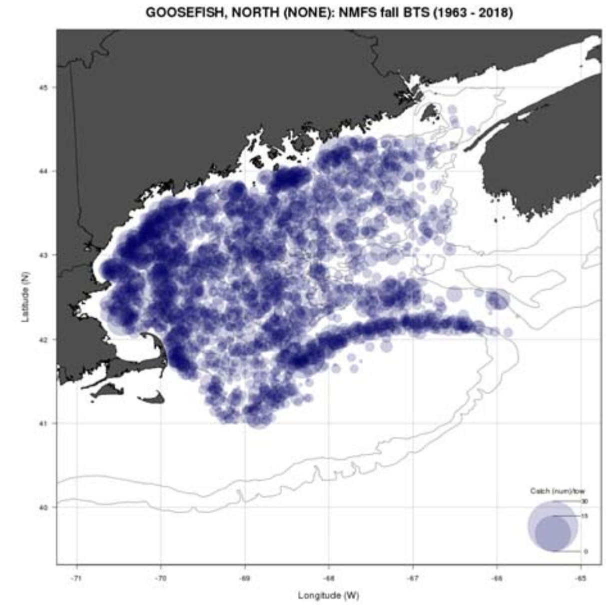


Figure D21. Normalized surveys for monkfish in the NMA.

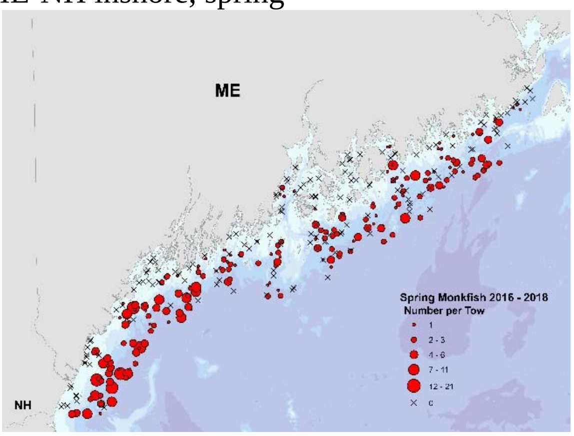
Spring



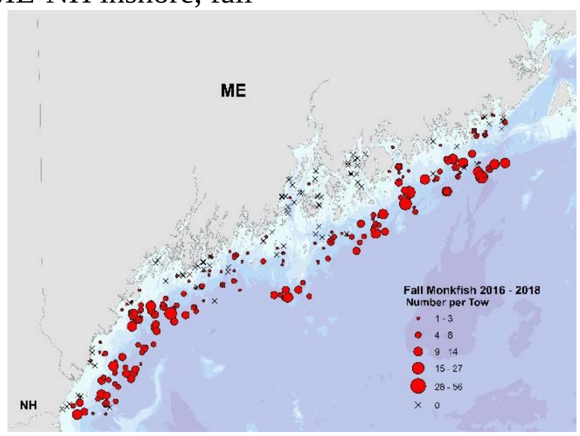
Fall



ME-NH inshore, spring



ME-NH inshore, fall



Summer shrimp

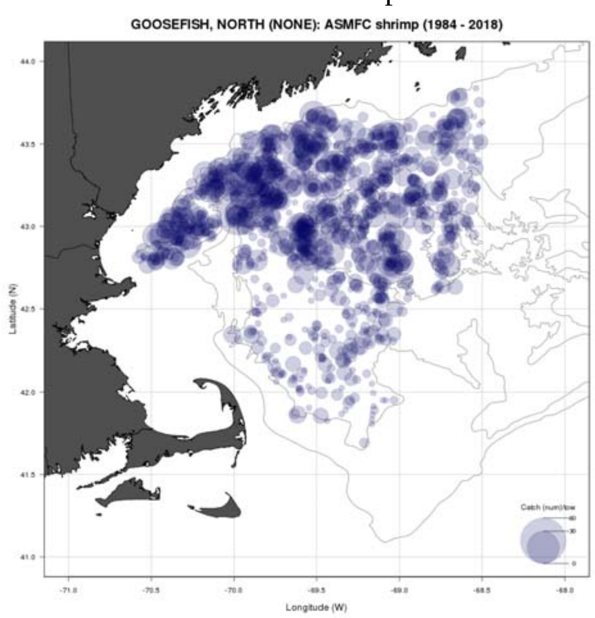


Figure D22. Distribution of monkfish in surveys in the northern management area.

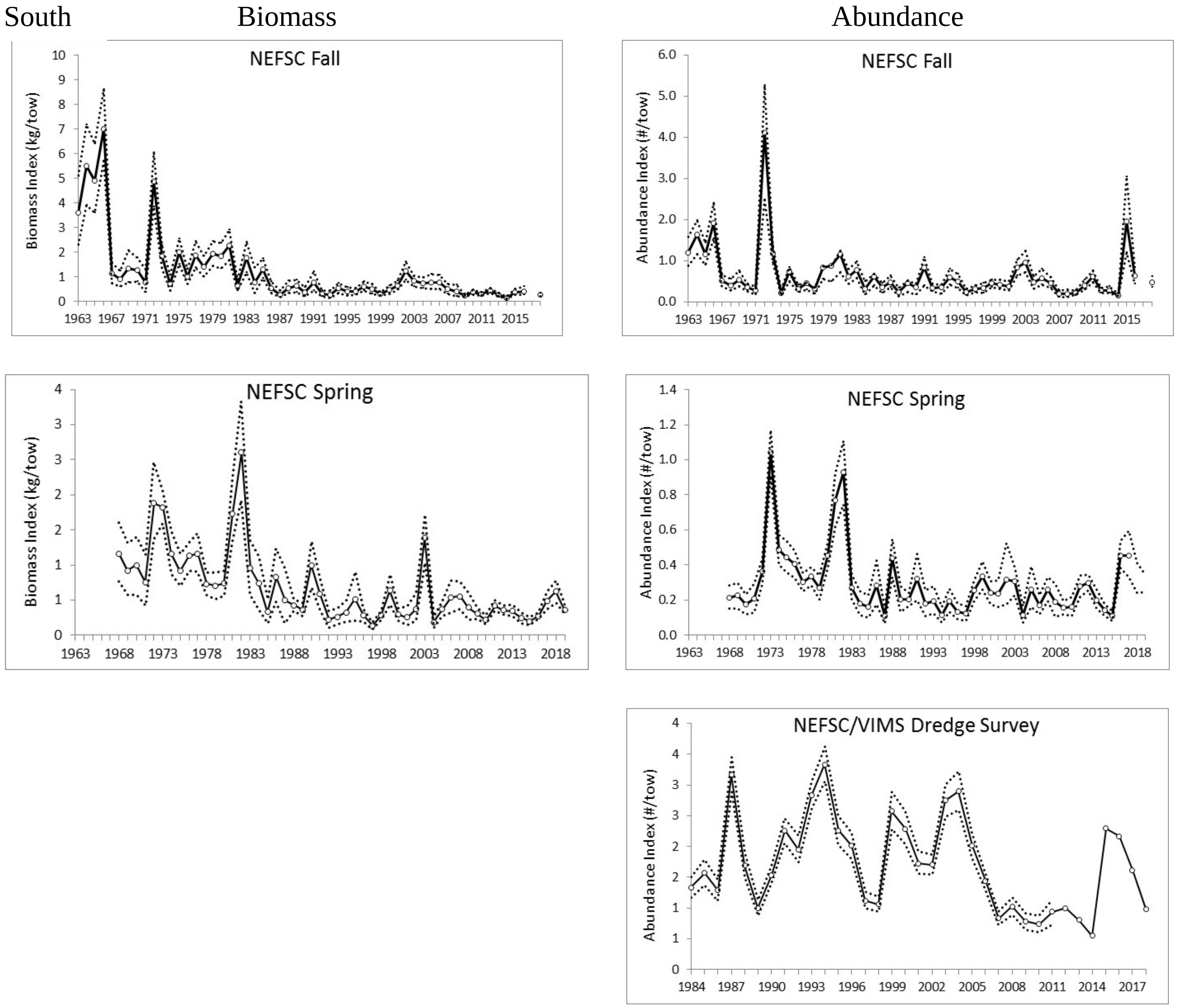


Figure D23. Survey indices for monkfish in the southern management area. Points after 2008 for NEFSC trawl surveys were conducted on the FSV Bigelow, converted to Albatross units as described in the text. Scallop dredge survey indices after 2011 were calculated from combined data from surveys conducted by NEFSC and Virginia Institute of Marine Science.

South

Biomass

Abundance

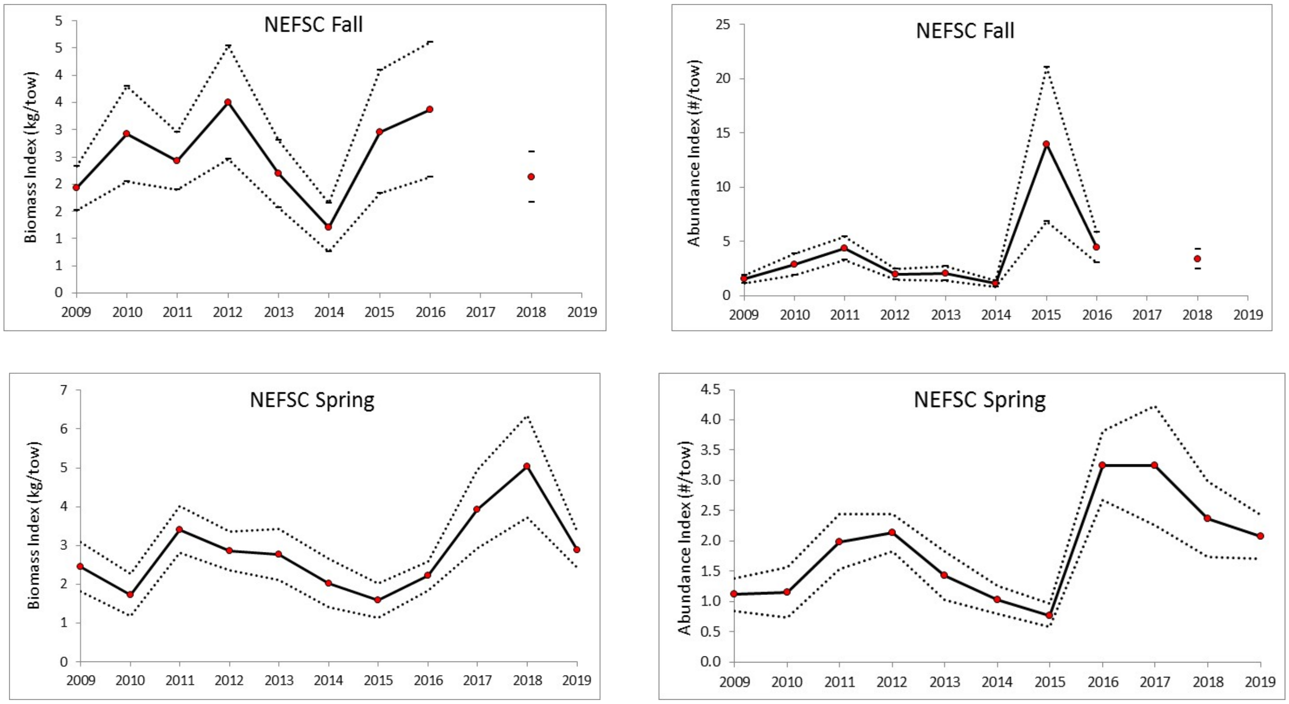


Figure D24. Survey indices from surveys conducted on the FRSV Bigelow in the southern management area, not converted to Albatross units.

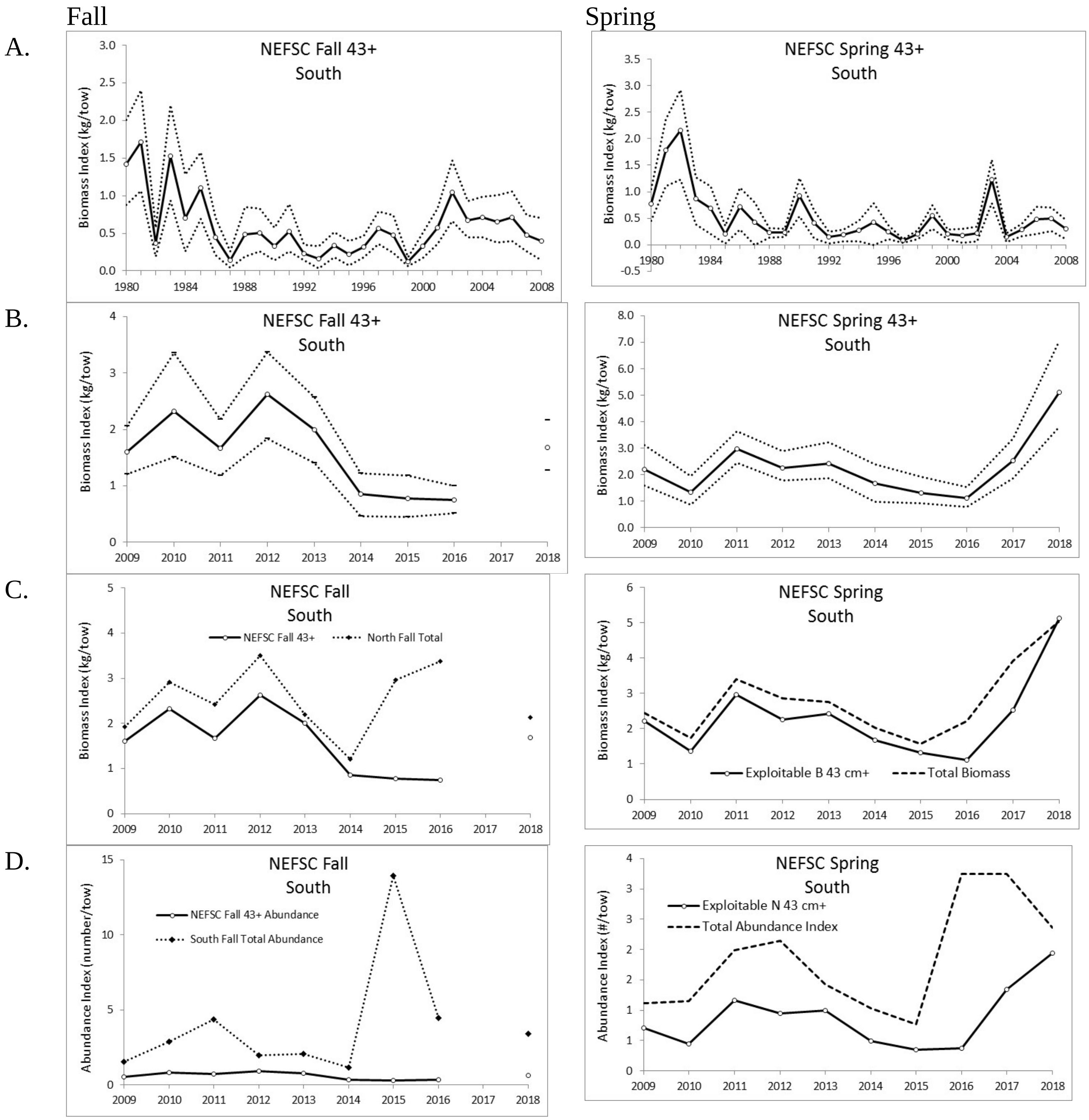


Figure D25. Exploitable biomass ($\geq$ 43 cm total length) indices for monkfish from fall and spring surveys in the SMA. A. Exploitable biomass indices with 95% confidence intervals, 1980-2008 (surveys conducted on RV Albatross). B. Exploitable biomass indices with 95% confidence intervals, 2009-2018 (surveys conducted on RV H.B. Bigelow) C. Total biomass vs. exploitable biomass indices, 2009-2018, D. total abundance vs. exploitable abundance, 2009-2018.

South

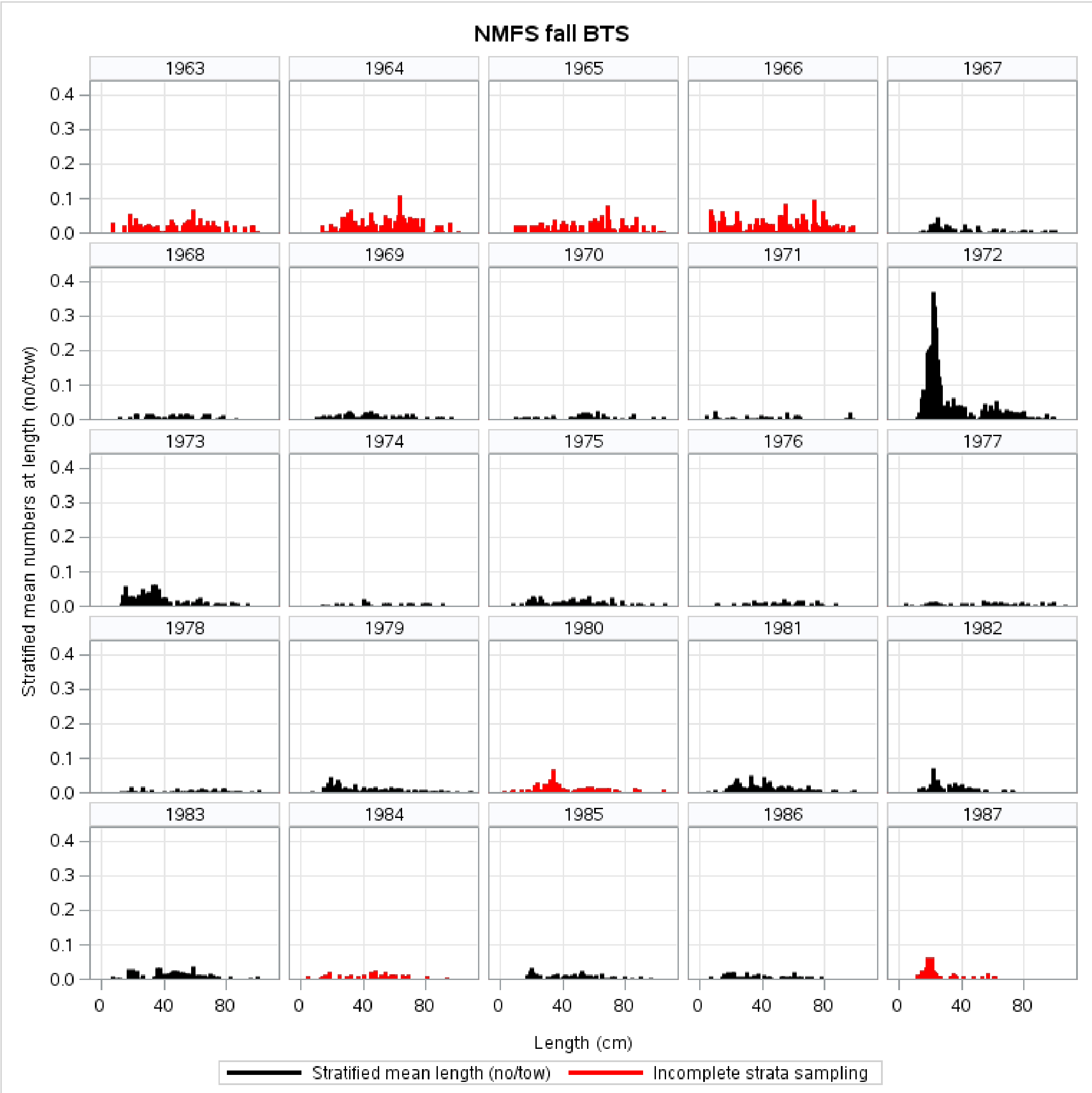


Figure D26. NEFSC fall survey indices of abundance at length, southern management area.

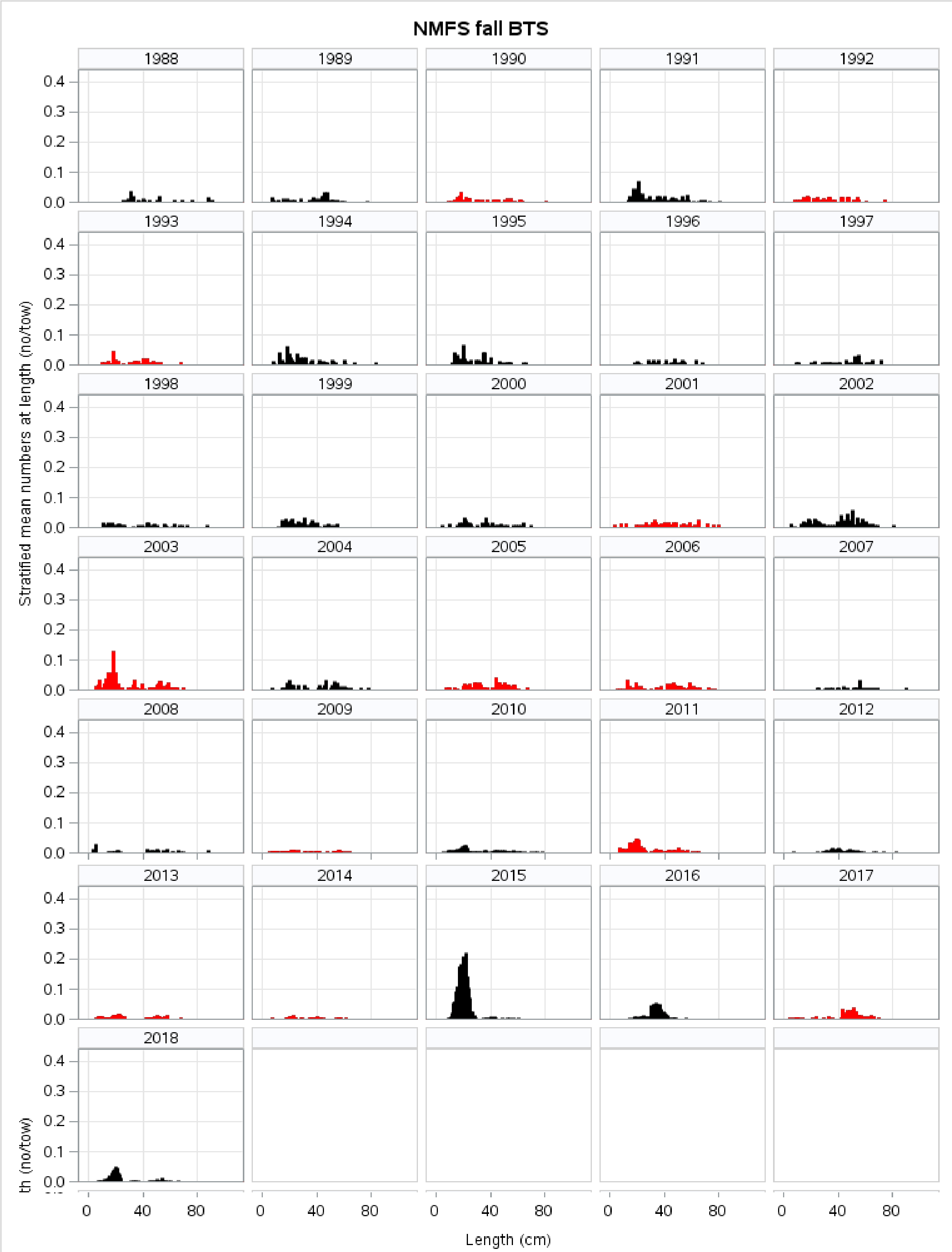


Figure D26, cont'd. (fall survey, south)

South

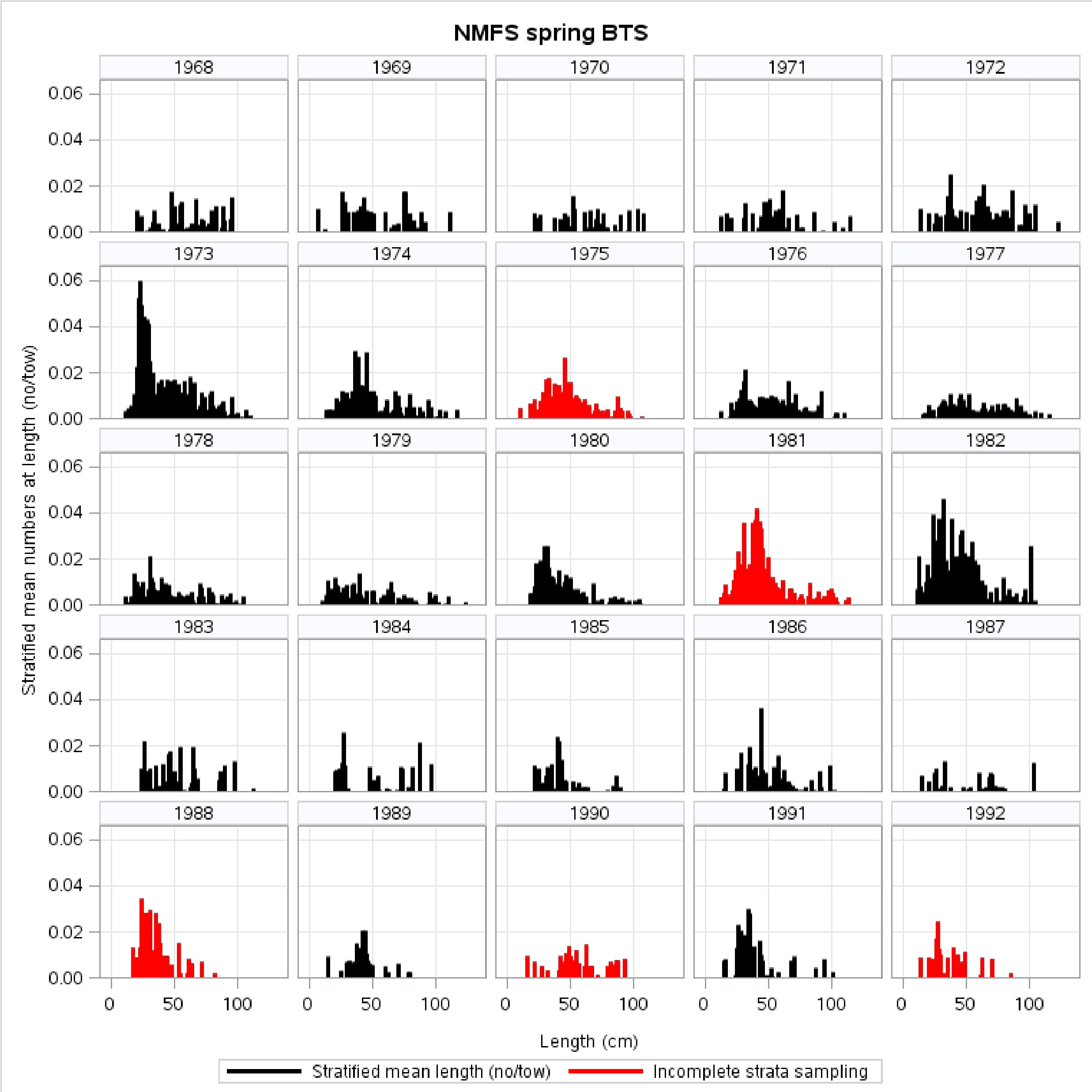


Figure D27. NEFSC spring survey indices of abundance at length, southern management area.

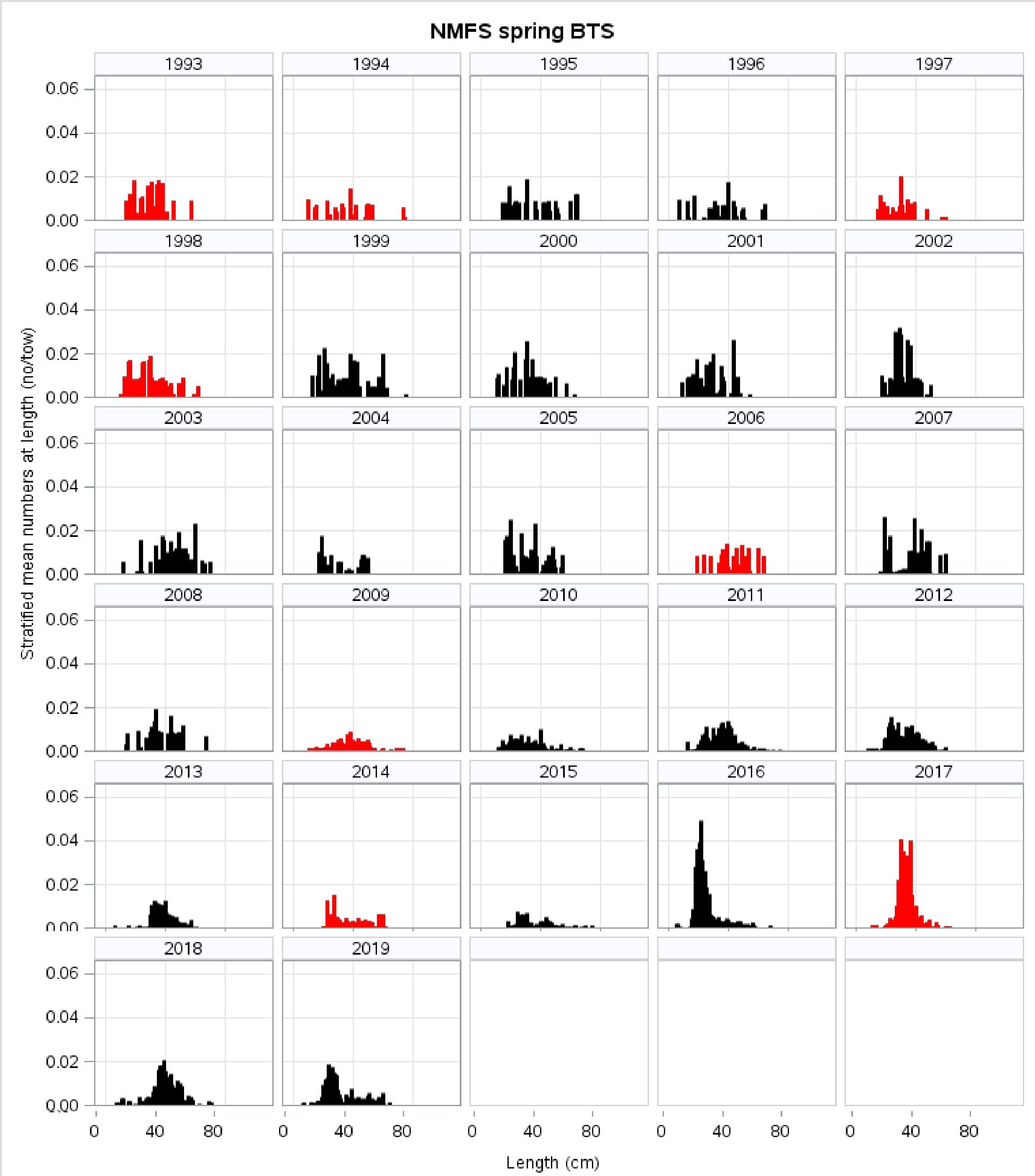


Figure D27, cont’d. (spring survey, south)

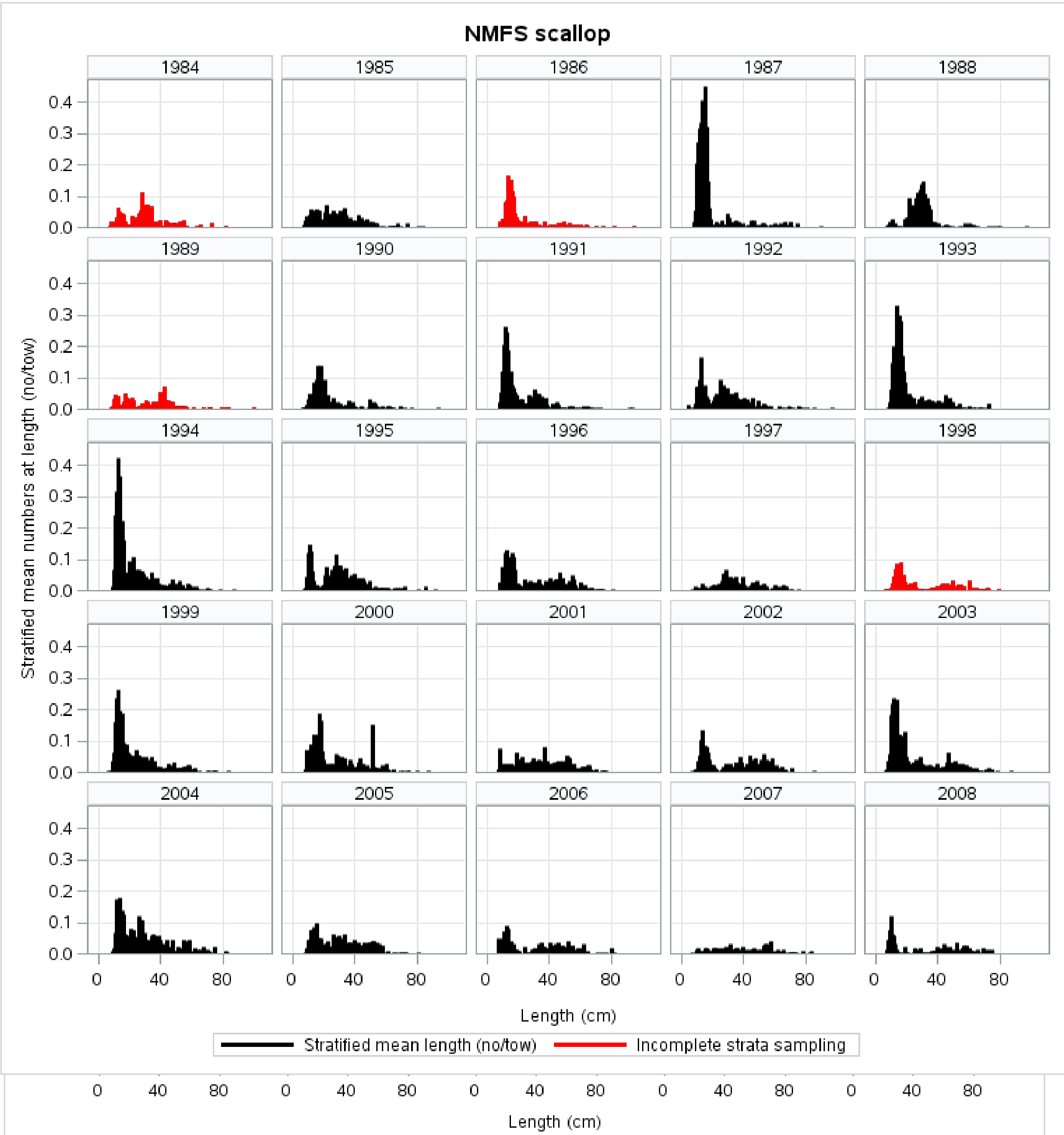


Figure D28. NEFSC spring/summer scallop dredge surveys. Survey timing shifted from summer to spring in 2009. These plots do not include sampling conducted by VIMS after 2011 (see Figure D23).

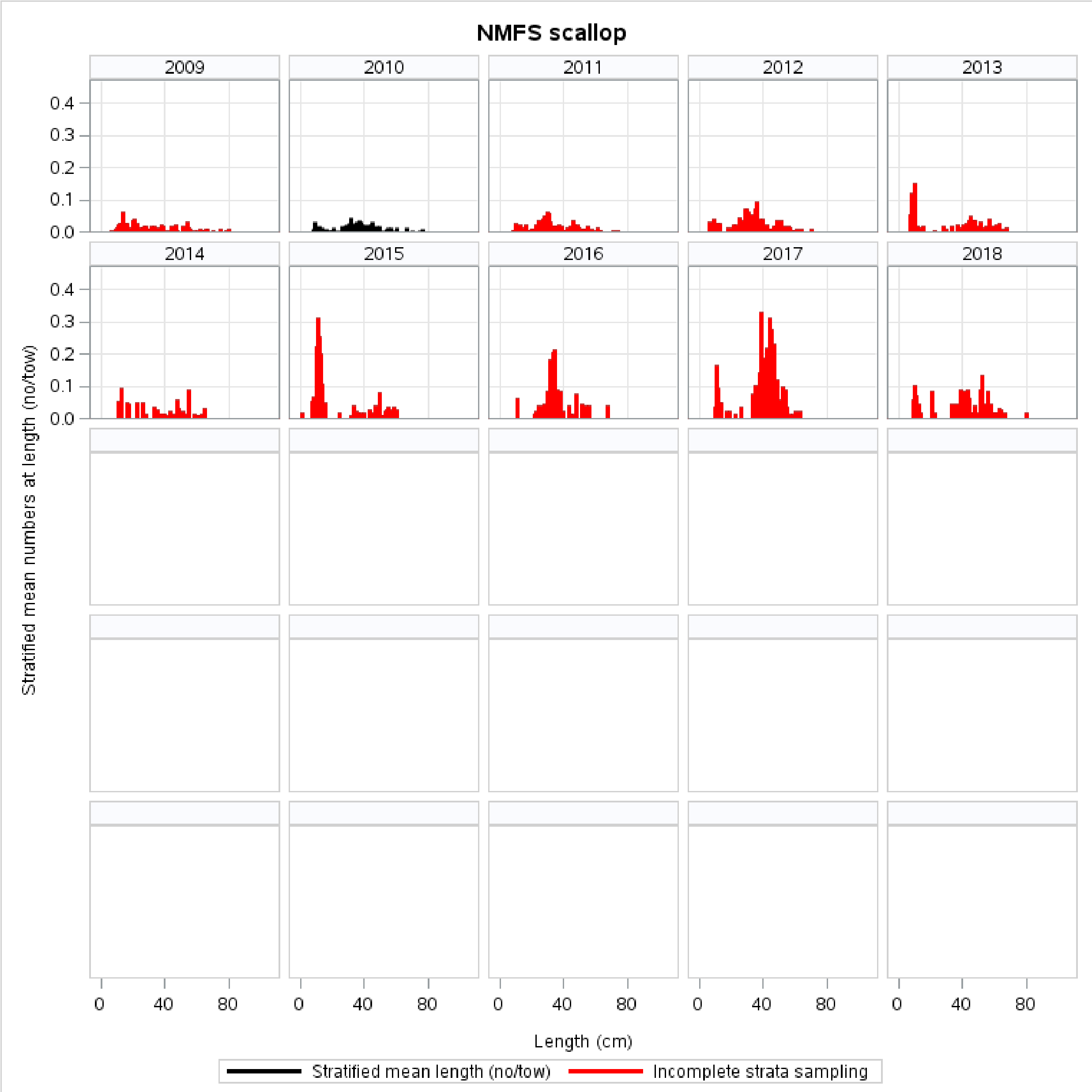
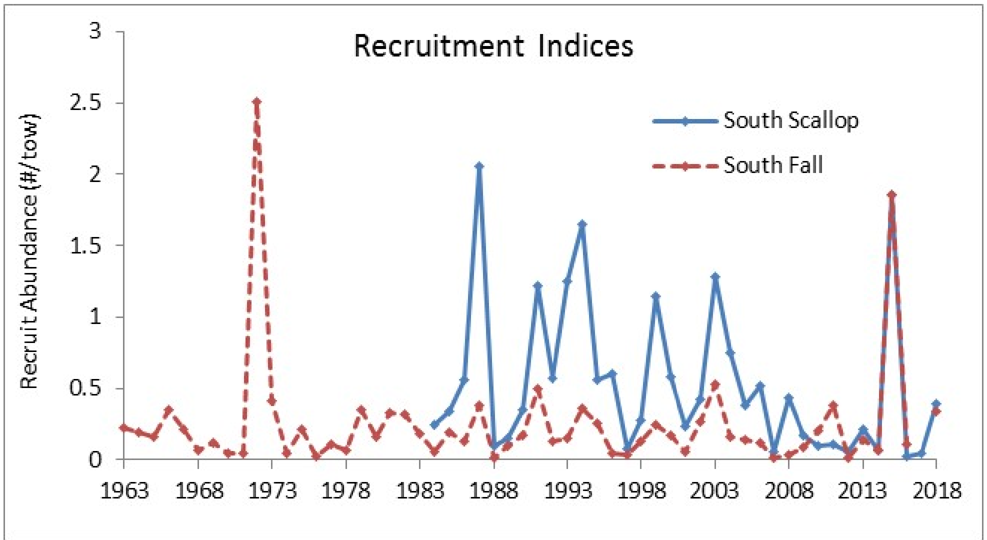


Figure D28, continued (NEFSC scallop dredge survey, south)

A.



B.

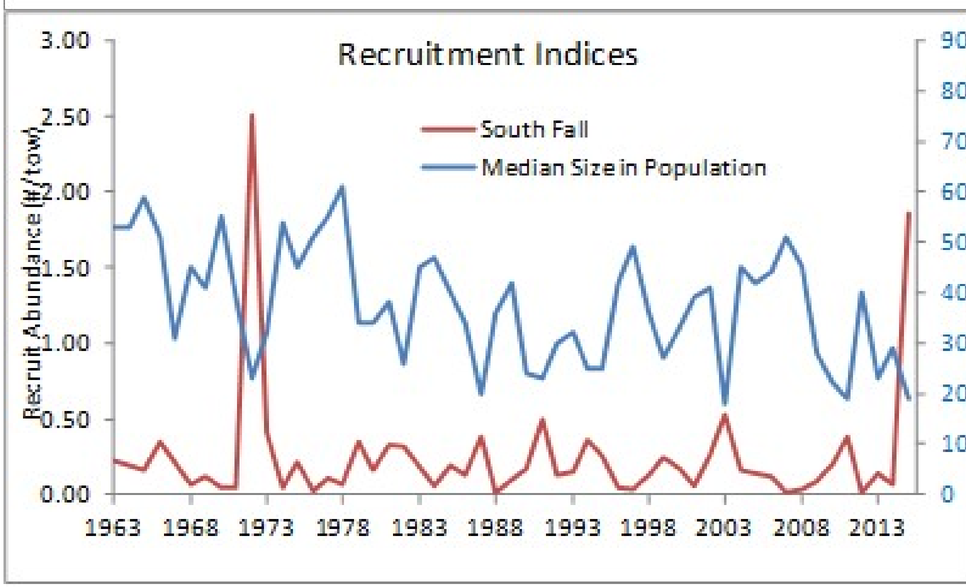


Figure D29. A. Recruitment indices for monkfish in the southern management area. Indices include monkfish in size ranges currently thought to represent young-of-year (age 0) in each season. There are no data for the fall survey in 2017 for the SMA. B. Recruitment indices vs. median size of monkfish in the population (based on NEFSC fall surveys).

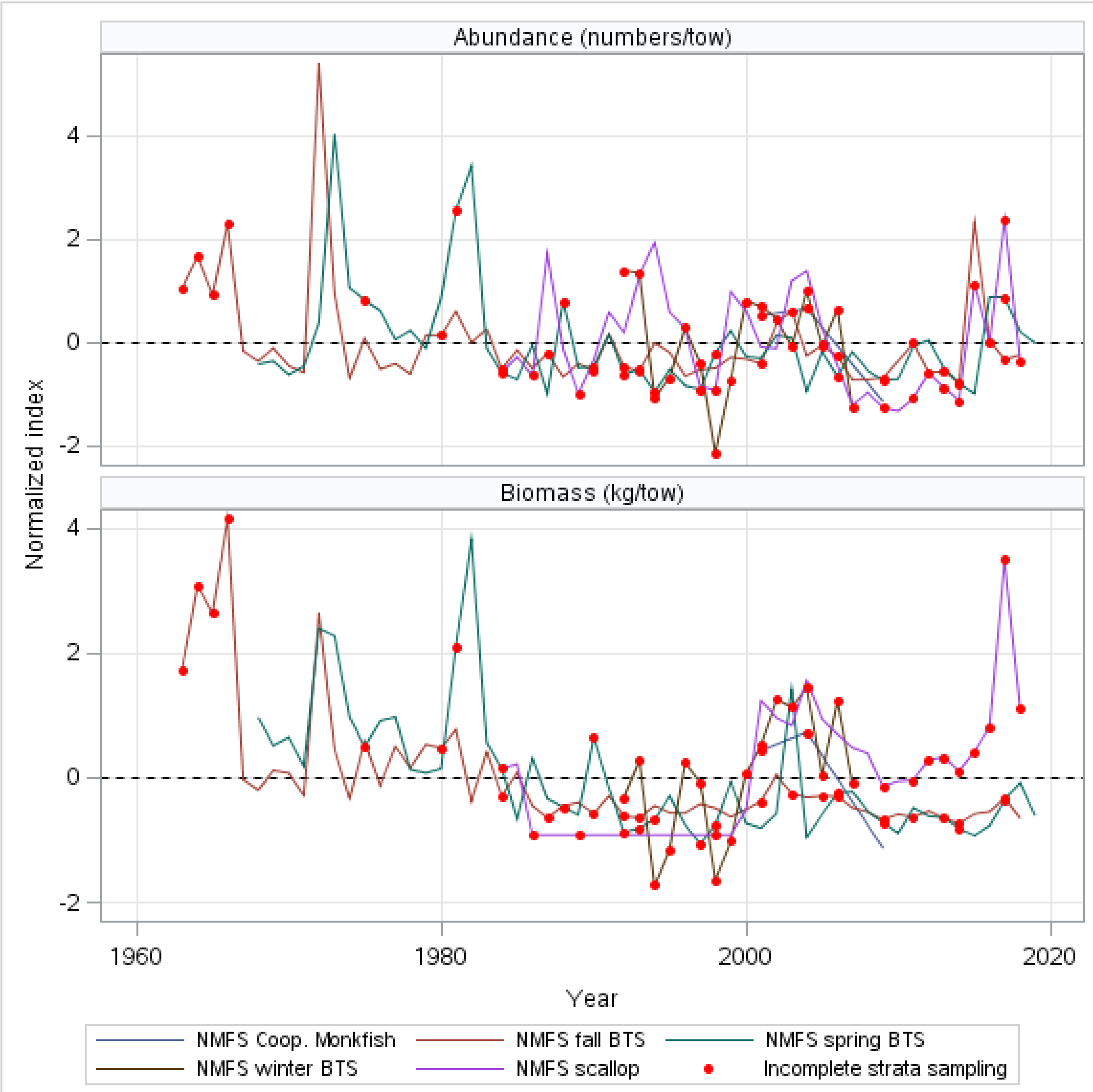
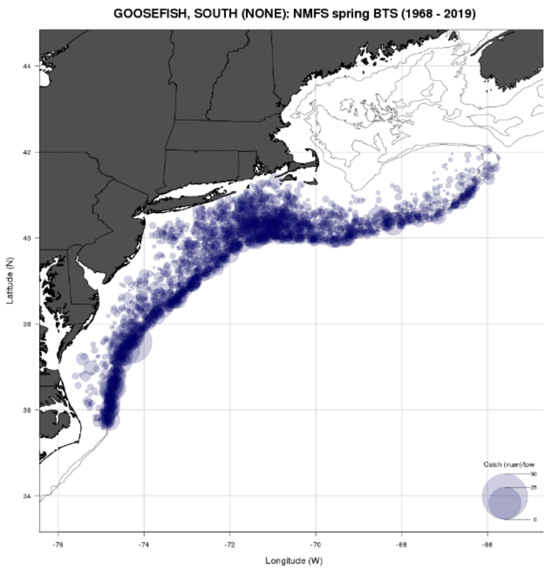
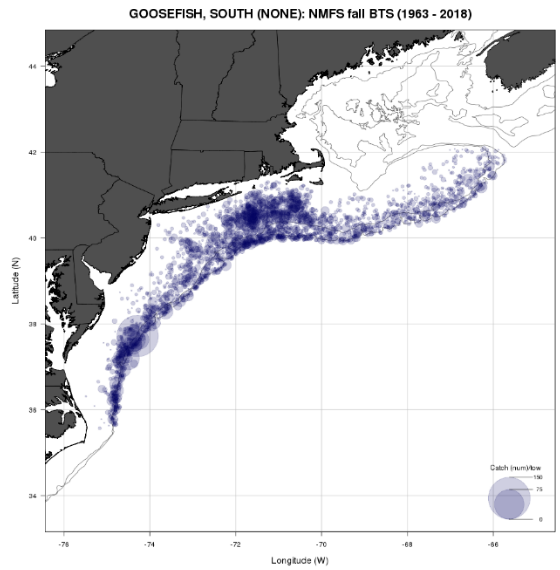


Figure D30. Normalized survey indices for monkfish in the southern management area. Scallop survey indices do not include VIMS portion of the survey starting in 2012.

Spring | Fall

NEFSC bottom trawl surveys





Spring/Summer Scallop Survey

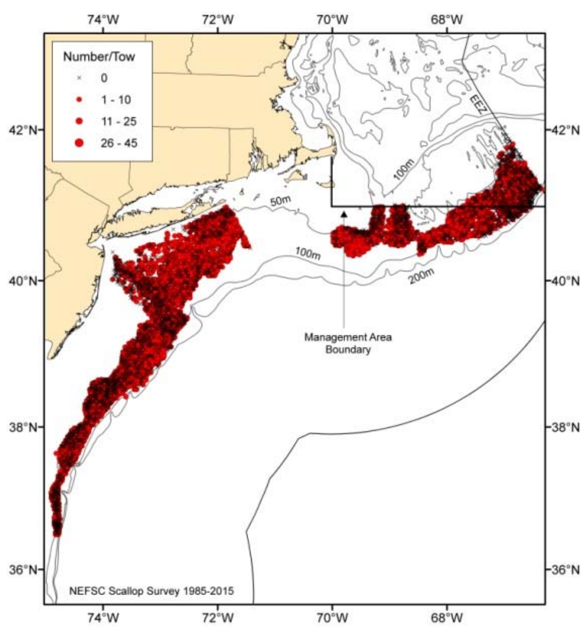
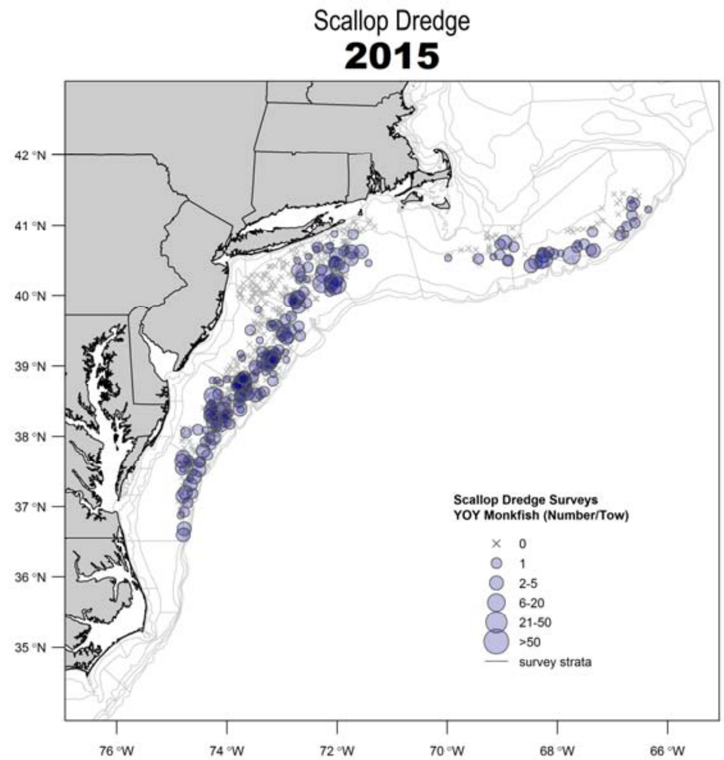


Figure D31. Distribution of monkfish in the southern management area from NEFSC spring (1968-2019) and fall (1963-2018) bottom trawl surveys and NEFSC and NEFSC/VIMS spring/summer scallop dredge surveys (1984-2015).

A.



B.

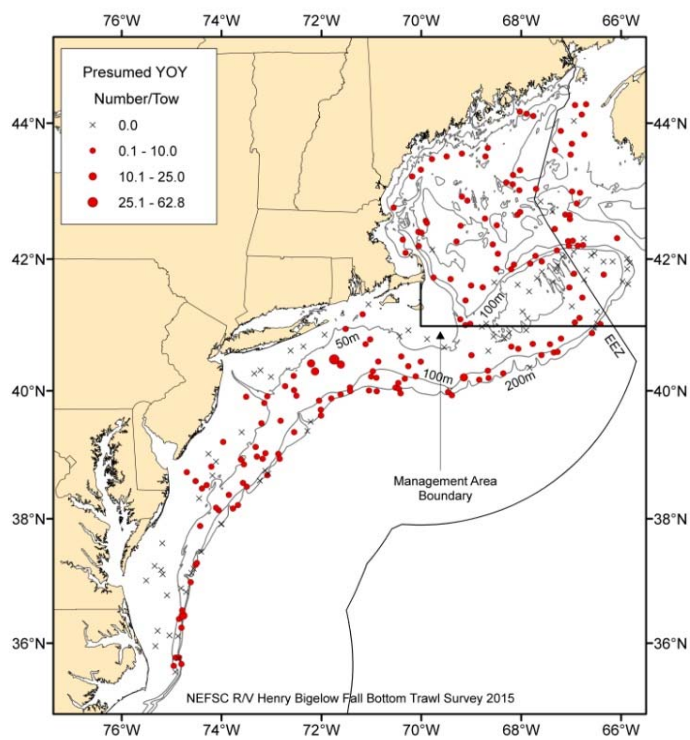


Figure D32. Distribution of presumed young-of-year monkfish in 2015 in (A.) NEFSC and VIMS scallop dredge survey tows (late spring), and (B.) NEFSC fall surveys.

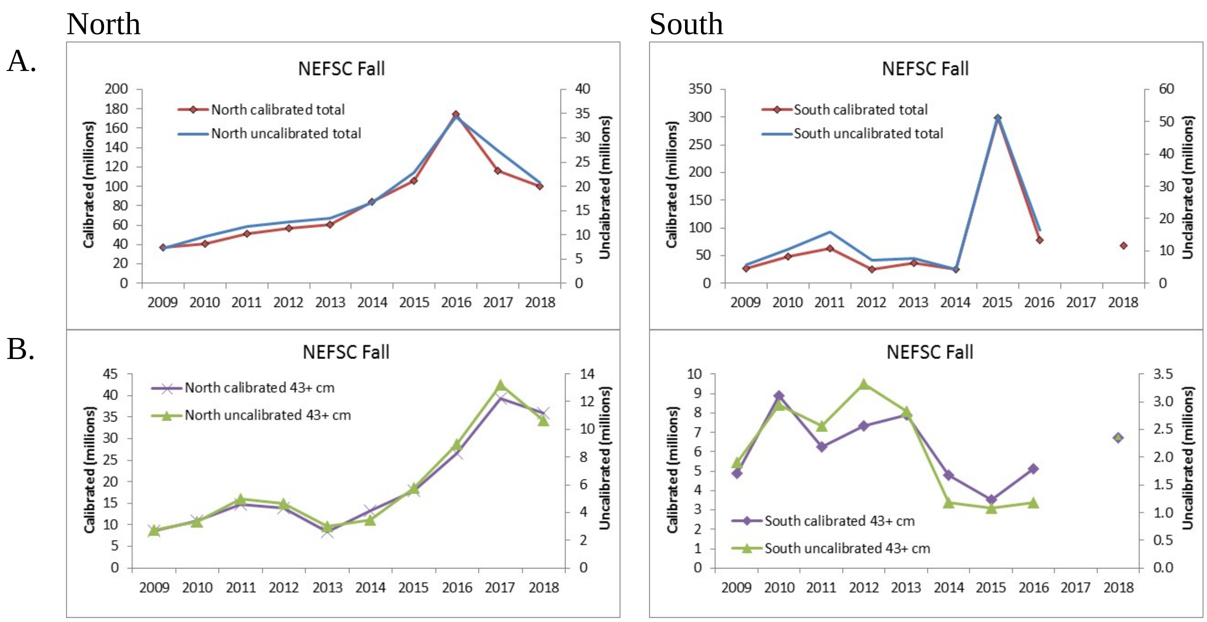
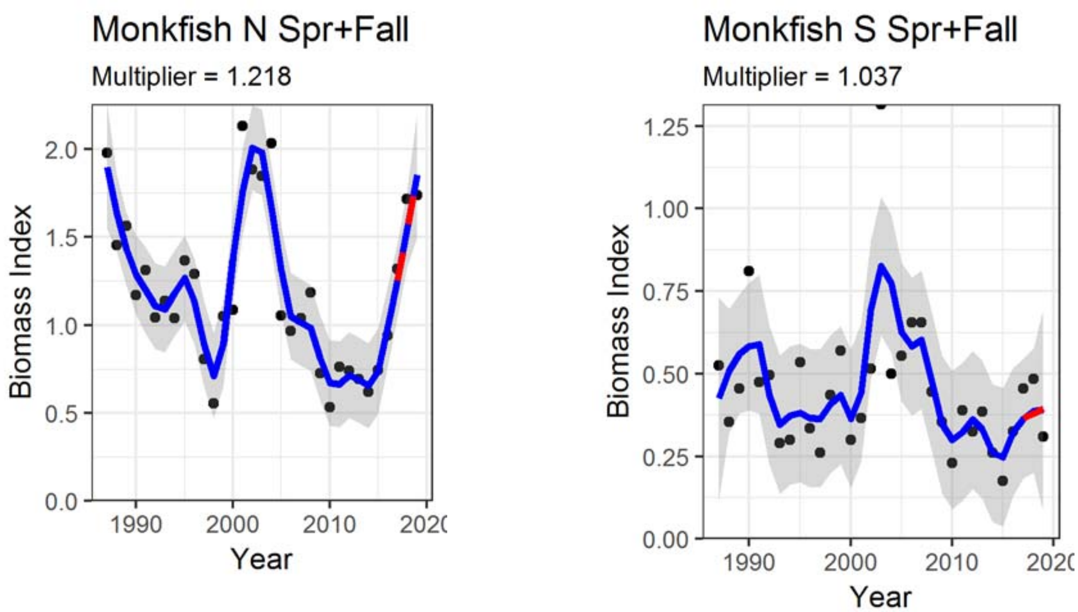


Figure D33. Area-swept abundance estimated from NEFSC fall surveys using adjustments from chain-sweep study compared to unadjusted estimates. A. total abundance, B. exploitable abundance (43+ cm).

Figure D34. Estimates of relative exploitation from NEFSC fall surveys using minimum area-swept numbers or biomass adjusted for sweep type (adjusted to chain sweep), assuming that 100% of monkfish encountered by the trawl are captured and accounting for missed strata in some years.

A.



B.

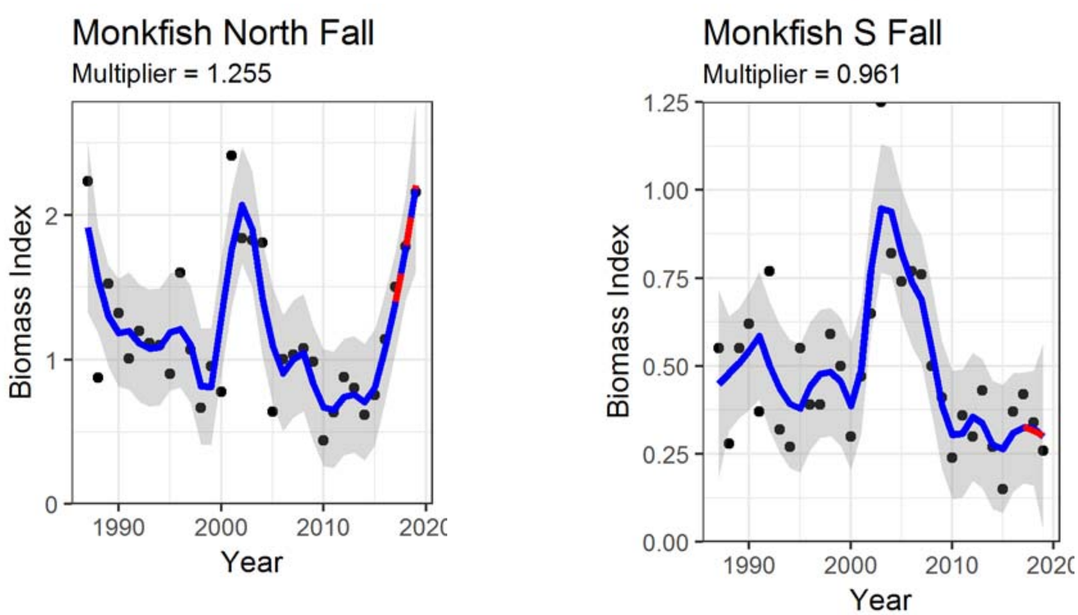


Figure D35. Results of "Plan B" analysis. Points are observed biomass indices, lines are loess-smoothed indices, "multiplier" is slope of log-linear regression through terminal three smoothed points. A. Results using both spring and fall indices, B. Results using fall survey indices only.

Appendix 1. Summary of Assessment Oversight Panel Meeting (May 20, 2019)

May 20, 2019
Woods Hole, Massachusetts

The NRCC Assessment Oversight Panel (AOP) met to review the operational stock assessment plans for four stocks/species (scup, black sea bass, bluefish, monkfish). The stock assessments for these stocks/species will be peer reviewed during a meeting from August 5-7, 2019.

The AOP consisted of:

Mike Celestino, Atlantic States Marine Fisheries Commission, NJ Division of Fish and Wildlife

Jason McNamee, Chair NEFMC Scientific and Statistical Committee, RI Department of Environmental Management

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

Russell W. Brown, Population Dynamics Branch Chief, Northeast Fisheries Science Center, Woods Hole

Meeting Participants:
The participants in Woods Hole included: Mark Terceiro (NEFSC), Gary Shepherd (NEFSC), Tony Wood (NEFSC), Anne Richards (NEFSC), Michele Traver (NEFSC), Michael Simpkins (NEFSC), Steve Cadrin (SMAST), Fiona Hogan (NEFMC - staff), Larry Alade (NEFSC), Kathy Sosebee (NEFSC), Kiersten Curti (NEFSC), Brian Linton (NEFSC), Dan Hennen (NEFSC).

Remote participants via webinar included: Adam Nowalsky (MAFMC), Allison Murphy (GARFO), Cate O'Keefe (MADMF), Charles Perreti (NEFSC), Chris Batsavage (MAFMC), Chris Spires, Cynthia Ferrio (GARFO), Harvey Yekinson, James Dopin, Jason Boucher (DEDFW), Jennifer Courte, Kiley Dancy (MAFMC – staff), Jessica Blaylock (NEFSC), John Maniscalco (NYDEC), Julia Beaty (MAFMC – staff), Matt Seeley (MAFMC – staff), Mike Plaia (MAFMC – advisor), Nichola Merserve (MD-DMF), Rich Wong (DE-DFW), Steve Heins, Steven Doctor, Tony DeLernia (MAFMC), Victor Hartman (MAFMC – advisor), Vince Cannuli (MAFMC – advisor), Greg DiDomenico (MAFMC – Advisor).

Meeting Details:
This meeting represented the initial implementation of the newly approved Management Track stock assessment process outlined in the NRCC stock assessment guidance memo. Four background documents were provided to the Panel: (1) an updated prospectus for each stock; (2) an overview summary of all salient data and model information for each stock; (3) the NRCC Guidance memo on the Management Track Assessments; and (4) Operational Stock Assessment TORs for August 2019 review. 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. Before the meeting, the AOP panel met to preview the meeting and clearly outline the expectations of the panel.

The meeting began at 1:12 pm. Approximately 17 people participated in Woods Hole and another 25 individuals participated via teleconference and Webinar. There were some technical glitches with the audio portion of webinar/teleconference that required attention during the meeting.

The 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 one case (monkfish) the stock was already being assessed using an "index-based" or "empirical" approach.

Common Issues Across the Species Reviewed:
For scup, black sea bass and bluefish a significant issue of concern is the introduction of the new recalibrated MRIP recreational catch estimates. For bluefish there seemed to be a simple rescaling across all years. The MRIP estimates have a temporal trend in rescaling which may pose problems for model performance for black sea bass. The most likely change is that the selectivity stanzas may need to be adjusted.

The proposed alternate assessment (Plan B) approach for scup, black sea bass and bluefish was a Loess smooth of survey index to adjust catch upwards or downwards based on recent trends. This should perform well for scup and bluefish, but for black sea bass an alternative to the proposed Plan B may be to use an area combined model (as opposed to the current two area assessment).

A question was raised about the designated length of the projections. It was decided that the AOP would inquire about the preference of the MAFMC (scup, black sea bass, bluefish) and recommend projection lengths most useful to the management process. As a result, the AOP is recommending 2 year projections for scup, black sea bass, and bluefish. Projections cannot be generated for monkfish given the current assessment approach.

Scup:
In the most recent stock assessment, spawning stock biomass was estimated to be approximately twice the SSB_{MSY} threshold and F is approximately 60% of the F_{MSY} threshold. The selectivity pattern for this stock has remained relatively stable over time. The discard to landings ratios have changed through time primarily due to dominate year classes passing through the population. The historically large 2015 year class is now fully recruited to the fishery so discards from this year class should decline.

During preliminary runs, the retrospective pattern from the previous assessment appears to degrade slightly with the inclusion of revised recreational catch data. The assessment will continue to use a continuous calibrated time series for the NEFSC multispecies bottom trawl survey (not splitting the Albatross and Bigelow time series). The AOP discussed the possibility of recommending a Level 2 peer review, but ultimately recommended a Level 3 review due to the revised recreational catch estimates.

Black Sea Bass:
Two separate ASAP models (north and south of Hudson Canyon) will be developed with the result combined for final stock status determination as was done in the most recent assessment. In the previous assessment, spawning stock biomass in 2015 was ~2.3 times SSB_{MSY} and F was approximately 75% of F_{MSY}.

In the southern area, the new MRIP catch estimates generally scale up across the time series. However in the northern area, there is a change in both scale and trend starting around 2010, and the 2011 year class seems to drive the catch in the north. There was some discussion about changing the M estimate for black sea bass if the model experiences diagnostic problems. Since the M parameter rescales the population and may change other key parameters, notably catchability, this should be done as a last resort. Given the temporal trend in the ratio of new to old MRIP estimates there may be some value in reconsidering introduction of one or more selectivity stanzas between 1989 and 2018.

Concern was expressed about the larger retrospective pattern in the northern area which may make this model unacceptable in this update. Potential solutions include increasing the CV on the non-trawl (recreational) catch input, reducing M in the northern area from 0.4 to 0.2 which conforms to the approximate minimum AIC in the northern ASAP likelihood profile (least preferred option), or eliminating the two-region approach and producing a single overall model. The combined model appears to perform about as well as the split model (northern and southern stock) and may be a viable alternative to the proposed Plan B if the split model has diagnostic problems.

During public comment, concern was expressed about considering the assessment history and noting that the single area ASAP model was not supported by the 2015 peer review. A major concern is that the stock appears to have a very strong 2015 year class. Concern was expressed that a simple index smoother is likely to miss the signals of incoming year class strength and may create similar catch and management problems that arose when the 2011 year class was not factored into catch projections.

The AOP recommended a Level 3 peer review based on the significant revisions to the recreational catch estimates and the potential for significant modifications to the existing ASAP models.

Bluefish:

The recreational fishery accounts for approximately 80% of the catch so revised recreational catch estimates will have a significant impact on the assessment. The assessment is likely to be a simple rescaling of the population since there does not appear to be any temporal trend in the ratio of new to old recreational catch estimates. Discards have a minor trend so problems could arise but these can probably be handled by changing selectivity. Another generic approach that was addressed for all species was to reduce the effective sample size for catch at age estimates (or equivalently, increasing the CV). This approach allows some deviation between the observed and predicted catch at age.

There is an issue with missing recreational discard length data for Rhode Island recreational discards for 2018. The AOP agreed that the assessment lead should do whatever is required to recover the data but if not possible some sort of imputation may be necessary. That decision should fall to the assessment lead.

It was noted in the last assessment that an $F_{40\%}$ reference point was set by the working group, and subsequently the peer review panel accepted those values. The MAFMC SSC then changed the reference point to $F_{35\%}$. The assessment lead plans to re-estimate the $F_{35\%}$ and the associated spawning stock biomass reference point.

The AOP recommended a Level 3 assessment review, given revised recreational catch estimates that may necessitate model changes (e.g. changes in CVs or implementation of selectively blocks to accommodate increased catch) may be necessary to achieve satisfactory performance. Additionally, the treatment of the missing length information may require additional review, so a level 3 Management Track would allow for these contingencies.

Monkfish:
Monkfish were previously assessed using a SCALE model (forward projecting age-structured model), but this approach was abandoned in 2016 when ageing methods were invalidated.
The absence of a validated growth curve precludes any length or age based approaches. To date, various research efforts to address this have not been definitive. It appears that monkfish grow faster than predicted which may help explain its relatively stable productivity. The monkfish assessment was proposed as a “Plan B” assessment approach based on the last operational stock assessment review. The assessment lead plans to employ this approach for the 2019 assessment update.

The AOP recommended an expedited (Management Track Level 2) assessment to address potential ways of dealing with the missing 2017 survey information in the southern stock. This was recommended because of transparency concerns and the fact that the NEFMC sets 3 year specifications. In the last assessment the trend adjustment from the status quo were -2% in the north and -14% (or -11%) in the south. The PDT recommended no change in either area but that determination was based on expert judgment rather than a specific statistical threshold. It may be useful to get some input from the peer review panel on different techniques that can be used for the survey information, and there may be some discussion about tweaking the sensitivity of the loess smooth to allow for more sensitivity to trend in the most recent years.   The AOP recommends including existing research recommendations in the final report.

Major Recommendations:
In general, the AOP approved the plans presented, but highlighted a number of clarifications that are summarized below:

Stock	Lead	Major Recommendations
Overview of the Process	Russell Brown	The NRCC approved, generic Terms of Reference for operational stock assessment be used.
Scup	Mark Terceiro	Management Track Level 3 – Enhanced ReviewIncorporate new MRIP recreational catch estimates. Alternative assessment approach: Loess smooth of relevant survey indices 2 Year projections should be generated
Black Sea Bass	Gary Shepherd	Management Track Level 3 – Enhanced Review Incorporate new MRIP recreational catch estimates Alternate assessment approach: Consider a combined area model if the split area models are problematic or Loess smooth of relevant survey indices 2-Year projections should be generated
Bluefish	Tony Wood	Management Track Level 3 – Enhanced Review Incorporate new MRIP recreational catch estimates Attempt to recover missing length data for Rhode Island recreational discarded fish for 2018 Alternative assessment approach: Loess smooth of relevant survey indices 2-Year projections should be generated
Monkfish	Anne Richards	Management Track Level 2 – Expedited Review Address potential ways of dealing with the missing 2017 survey information in the southern stock Alternative approach is to recommend status quo catch.

In summary, the meeting was productive and a good implementation of the new assessment planning document. The meeting concluded at 4:30 pm. The peer review panel will meet from August 5-7, 2019 to complete their review.

Appendix 2. Operational Assessment, Aug. 5-7, 2019, Attendee List

Tom Miller (MAFMC SSC – Review Chair)
Kate Seigfried (SEFSC – Reviewer)
Mike Wilberg (MAFMC SSC – Reviewer)
J .J. Mcquire (NEFMC – Reviewer)
Anne Richards (NEFSC – Monkfish Assess Lead)
Gary Shepherd (NEFSC – Black Sea Bass Assess Lead)
Mark Terceiro (NEFSC – Scup Assessment Lead)
Tony Wood (NEFSC – Bluefish Assessment Lead)
Jon Deroba (NEFSC)
Susan Wigley (NEFSC)
Kiersten Curti (NEFSC)
Katherine Sosebee (NEFSC)
Tim Miller (NEFSC)
Chris Legault (NEFSC)
Steve Cadrin (SMAST)
Cate O'Keefe (MADMF)
Russ Brown (NEFSC, PDB Chair)
Toni Chute (NEFSC)
Michele Traver (NEFSC)
Mike Celestino (NJDFW)
Richard Merrick (NEFMC SSC)
Alan Bianchi (NCDMF)
Eric Schneider (RIDMF)
Greg DeCelles (MADMF)
Jennifer Couture (GARFO)
Jessica Blaylock (NEFSC)
Pater Lu (Harvard)
Libby Etrie (NEFMC)
Patricia Clay (NEFSC)
Charles Perreti (NEFSC)
Mike Fogarty (NEFSC)
Ariele Baker (NEFSC)
Julia Beaty (MAFMC – staff)
Fiona Hogan (NEFMC – staff)
Brandon Muffley (MAFMC – staff)
Caitlin Starks (ASMFC – staff)
Tara Trinko (NEFSC)
Mark Wuenschel (NEFSC)
Kiley Dancy (MAFMC – staff)
Jeff Brust (NJDEP)
Sam Truesdell (MADMF)
Shanna Madsen (ASMFC)
John Maniscalco (NYDEC)
Doug Zemeckis (Rutgers University)
Emily Slesinger (Rutgers University)
Allison Murphy
Cynthia Ferrio
Alicia Long (NEFSC)
Paul Nitschke (NEFSC)
Charles Adams (NEFSC)
Thomas Heimann (CFRF)
Karson Coutre (MAFMC – Staff)
Matt Seeley (MAFMC – Staff)
Scott Steinback (NEFSC)
Richard McBride (NEFSC)
James Weinberg (NEFSC, SAW Chair)

Appendix 3. Operational Assessment, Aug. 5-7, 2019, Meeting Agenda

Operational Assessment Peer Review Meeting
Monkfish, Black Sea Bass, Scup, Bluefish
Clark Conference Room, NEFSC, Woods Hole, MA
August 5-7, 2019

Monday, August 5, 2019

Time	Activity	Lead
1:00 p.m.	Welcome and Introductions	Russ Brown/Jim Weinberg
1:10 p.m.	Overview and Process	Russ Brown
1:30 p.m.	Monkfish	Anne Richards
3:00 p.m.	Break	
3:10 p.m.	Monkfish Discuss/Review/Summary	Review Panel
4:10 p.m.	Black Sea Bass	Gary Shepherd
5:40 p.m.	Public Comment	Public
5:55 p.m.	Adjourn	

Tuesday, August 6, 2019

Time	Activity	Lead
8:30 a.m.	Brief Overview and logistics	Russ Brown/Jim Weinberg
8:40 a.m.	Black Sea Bass cont.	Gary Shepherd
10:10 a.m.	Break	
10:25 a.m.	Black Sea Bass Discussion/Review/Summary	Review Panel
11:25 a.m.	Scup	Mark Terceiro
12:40 p.m.	Lunch	
1:40 p.m.	Scup Cont.	Mark Terceiro
2:55 p.m.	Break	
3:10 p.m.	Scup Discussion/Review/Summary	Review Panel
4:10 p.m.	Bluefish	Tony Wood
5:25 p.m.	Public Comment	Public
5:40 p.m.	Adjourn	

Wednesday, August 7, 2019

Time	Activity	Lead
8:30 a.m.	Brief Overview and logistics	Russ Brown/Jim Weinberg
8:40 a.m.	Bluefish cont.	Tony Wood
9:55 a.m.	Break	
10:10 a.m.	Bluefish Discussion/Review/Summary	Review Panel
11:10 a.m.	Public Comment	Public
11:25 a.m.	Lunch	
12:30 p.m.	Report Writing/Species Summaries	Review Panel
2:25 p.m.	Break	
2:40 p.m.	Report Writing/Species Summaries	Review Panel
4:30 p.m.	Adjourn	