# 5 Gulf of Maine haddock

Michael Palmer

*This assessment of the Gulf of Maine haddock (Melanogrammus aeglefinus) stock is an operational assessment of the existing benchmark assessment (NEFSC 2014). Based on the previous assessment (NEFSC 2015), the stock was not overfished, and overfishing was not occurring. This assessment updates commercial and recreational fishery catch data, research survey indices of abundance, and the analytical ASAP assessment model and reference points through 2016. Additionally, stock projections have been updated through 2020.*

**State of Stock:** Based on this updated assessment, the stock status for the Gulf of Maine haddock (*Melanogrammus aeglefinus*) stock is not overfished and overfishing is not occurring (Figures 24-25). Retrospective adjustments were not made to the model results (see Special Comments section of this report). Spawning stock biomass (SSB) in 2016 was estimated to be 47,821 (mt) which is 706% of the biomass target ($SSB_{MSY}$ *proxy* = 6,769; Figure 24). The 2016 fully selected fishing mortality was estimated to be 0.137 which is 30% of the overfishing threshold proxy ($F_{MSY}$ *proxy* = $F_{40\%}$ = 0.455; Figure 25).

Table 17: Catch and status table for Gulf of Maine haddock. All weights are in (mt) recruitment is in (000s) and $F_{Full}$ is the fully selected fishing mortality. Model results are from the current updated ASAP assessment.

| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|
| | | | | *Data* | | | | |
| Recreational discards | 27 | 20 | 11 | 66 | 273 | 359 | 176 | 345 |
| Recreational landings | 409 | 320 | 230 | 250 | 298 | 317 | 238 | 554 |
| Commercial discards | 12 | 3 | 6 | 18 | 32 | 22 | 42 | 72 |
| Commercial landings | 500 | 623 | 499 | 417 | 212 | 314 | 650 | 1,342 |
| Foreign landings | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Catch for Assessment | 948 | 966 | 745 | 751 | 816 | 1,012 | 1,106 | 2,313 |
| | | | | *Model Results* | | | | |
| Spawning Stock Biomass | 6,263 | 5,401 | 4,667 | 5,733 | 9,325 | 14,775 | 29,833 | 47,821 |
| $F_{Full}$ | 0.226 | 0.264 | 0.23 | 0.293 | 0.239 | 0.191 | 0.116 | 0.137 |
| Recruits (age 1) | 519 | 1,590 | 15,858 | 5,496 | 25,080 | 93,341 | 4,724 | 3,638 |

Table 18: Comparison of reference points estimated in an earlier assessment and from the current operational assessment. The overfishing threshold is the $F_{MSY}$ *proxy* ( $F_{40\%}$). The biomass target, ( $SSB_{MSY}$ *proxy*) was based on long-term stochastic projections of fishing at the $F_{MSY}$ *proxy*. Median recruitment reflects the median estimated age-1 recruitment from 1977 - 2012. Intervals shown reflect the $5^{th}$ and $95^{th}$ percentiles.

| | 2015 | 2017 |
|---|---|---|
| $F_{MSY}$ *proxy* | 0.468 (0.391 - 0.547) | 0.455 (0.380 - 0.538) |
| $SSB_{MSY}$ (mt) | 4,623 (2,036 - 9,283) | 6,769 (2,525 - 27,545) |
| MSY (mt) | 1,083 (489 - 2,148) | 1,547 (584 - 6,160) |
| Median recruits (age 1) (000s) | 1,335 (253 - 8,198) | 1,498 (275 - 17,307) |
| *Overfishing* | No | No |
| *Overfished* | No | No |

**Projections:** Short term projections of median total fishery yield and spawning stock biomass for Gulf of Maine haddock were conducted based on a harvest scenario of fishing at the $F_{MSY}$ *proxy* between 2018 and 2020. Catch in 2017 has been estimated at 2,306 mt. Recruitment was sampled from a cumulative distribution function of model estimated age-1 recruitment from 1977-2014. The age-1 estimate in 2017 was generated from the geometric mean of the 1977-2016 recruitment series. The annual fishery selectivity, maturity ogive, and mean weights at age used in the projections were estimated from the most recent 5 year averages; retrospective adjustments were not applied in the projections.

Table 19: Short term projections of total fishery catch and spawning stock biomass for Gulf of Maine haddock based on a harvest scenario of fishing at $F_{MSY}$ *proxy* ( $F_{40\%}$) between 2018 and 2020. Catch in 2017 was assumed to be 2,306 (mt).

| Year | Catch (mt) | SSB (mt) | $F_{Full}$ |
|---|---|---|---|
| 2017 | 2,306 | 68,429 | 0.077 |

| Year | Catch (mt) | SSB (mt) | $F_{Full}$ |
|---|---|---|---|
| 2018 | 16,954 | 65,130 | 0.455 |
| 2019 | 15,023 | 49,069 | 0.455 |
| 2020 | 11,289 | 34,123 | 0.455 |

**Special Comments:**

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

  *The strength of terminal year classes had been a large source of uncertainty in previous assessments. The 2012 and 2013 year classes are now reasonably well estimated and the relative size of more recent year classes is expected to be near average and unlikely to have*

*much impact on the terminal estimates of stock size or in the performance of stock projections. The largest current source of uncertainty in the assessment is the veracity of fishery catch data. A recent report indicated that contemporary commercial landings of Gulf of Maine haddock may have been underestimated (Palmer 2017). Additional work is needed to investigate the accuracy and completeness not only of commercial landings, but all sources of anthropogenic removals (e.g., commercial discards, recreational catch, scientific removals).*

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

  *This assessment exhibits a minor retrospective pattern and therefore no retrospective adjustments were made to the terminal model results or the short-term catch projections. The 7-year Mohn's rho values on SSB (-0.18) and F (0.20) are small.*

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

  *Population projections for Gulf of Maine haddock are reasonably well determined. The projected biomass from the last assessment is near the lower confidence bound of the biomass estimated in the current assessment; however, this is primarily due to the positive rescaling of the 2012 and 2013 year classes in this most recent assessment which was informed by additional catch and survey data. This stock is not currently in a rebuilding plan.*

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

  *Recreational catch estimates were re-estimated as part of this update to account for any updates to the MRIP data, and more importantly, to adjust the recreational post-release discard mortality rate. Previous assessments have assumed 50% post-release mortality, but this current assessment has introduced season- and size-specific post-release discard mortality estimates from Mandelman et al. (2017) for the years 2004-2016. No changes were made prior to 2004 due to the sparseness of avaialble length samples. These changes had minimal impact on the estimates of total fishery removals (see Palmer 2017 for a full description of the methods and impact analysis). Additionally, an automated procedure was used to fill holes in the survey age-legth keys rather than using visual imputation which was subjective and generally not reproducible. The procedure relies on a multinomial logistic model to describe the proportions at age for a given length in situations where no age samples are available for that length bin (Gerritsen et al. 2006). Summaries of the impacts of all changes are provided in the Supplemental Information Report (SASINF).*

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

  *There has been no change in stock status since the previous assessment (2015).*

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

  *The Gulf of Maine haddock has experienced several large recruitment events since 2010. The population biomass is currently at an all time high and overall, the population is experiencing low mortatity.*

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

  *Better information is needed on overall uncertainty and possible biases in the fishery catch estimates. Additionally, a better understanding of recruitment processes may help to improve recruitment forecasting.*

- Are there other important issues?

  *None.*

## 5.1 Reviewer Comments: Gulf of Maine haddock

**Assessment Recommendation:**

The panel concluded that the operational assessment with no adjustment for retrospective bias was acceptable as a scientific basis for management advice with minor changes in the approach, including the revised recreational discard mortality estimates and automated approach to interpolating missing length-at-age.

**Alternative Assessment Approach:** Not applicable

**Status Recommendation:**

The panel supports the conclusion that the stock status for the Gulf of Maine haddock stock is not overfished and overfishing is not occurring. The Gulf of Maine haddock stock has experienced several large recruitment events since 2010. The population biomass is currently at an all-time high and overall, the population appears to be experiencing low mortality.

**Key Sources of Uncertainty:**

The largest source of uncertainty with this stock is in the quality of recreational and commercial landings and discard estimates. The Marine Recreational Information Program (MRIP) estimates of historical recreational harvest and releases are expected to change in 2018. The commercial discard estimates from the observer program may be biased due to potential changes in fisher behavior when observers are onboard vessels. Another source of uncertainty may be attributed to the ability to accurately estimate recent/terminal recruitment.

**Research Needs:**

The panel recommends research be conducted to reduce uncertainty and address possible biases in the fishery catch estimates. Additionally, a better understanding of recruitment processes may help to improve recruitment forecasting.

**References:**

Gerritsen HD, McGrath D, Lordan C. 2006. A simple method for comparing age-length keys reveals significant regional differences within a single stock of haddock (Melanogrammus aeglefinus). ICES J. Mar. Sci. 63: 1096-1100.

Mandelman JW, Zemeckis DR, Hoffman WS, Dean MJ, Cadrin SX, Sulikowski JA. 2017. Addendum to Determining the post-release mortality rate and best capture and handling methods for haddock (Melanogrammus aeglefinus) discarded in the Gulf of Maine recreational fisheries. Final Report to the Northeast Consortium. Grant: FNA10NMF4410008. Award Period: March 1, 2015 February 29, 2016. 30 p.

Northeast Fisheries Science Center. 2014. $59^{th}$ Northeast Regional Stock Assessment Workshop ($59^{th}$ SAW) Assessment Report. US Dept Commer, Northeast Fish Sci Cent Ref Doc. 14-09; 782 p. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026. CRD14-09

Northeast Fisheries Science Center. 2015. Operational Assessment of 20 Northeast Groundfish Stocks, Updated Through 2014. US Dept Commer, Northeast Fish Sci Cent Ref Doc. 15-24; 251 p. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026. CRD15-24

Palmer MC. 2017. Vessel trip reports catch-area reporting errors: Potential impacts on the monitoring and management of the Northeast United States groundfish resource. US Dept Commer, Northeast Fish Sci Cent Ref Doc. 17-02; 47 p. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026. CRD17-02

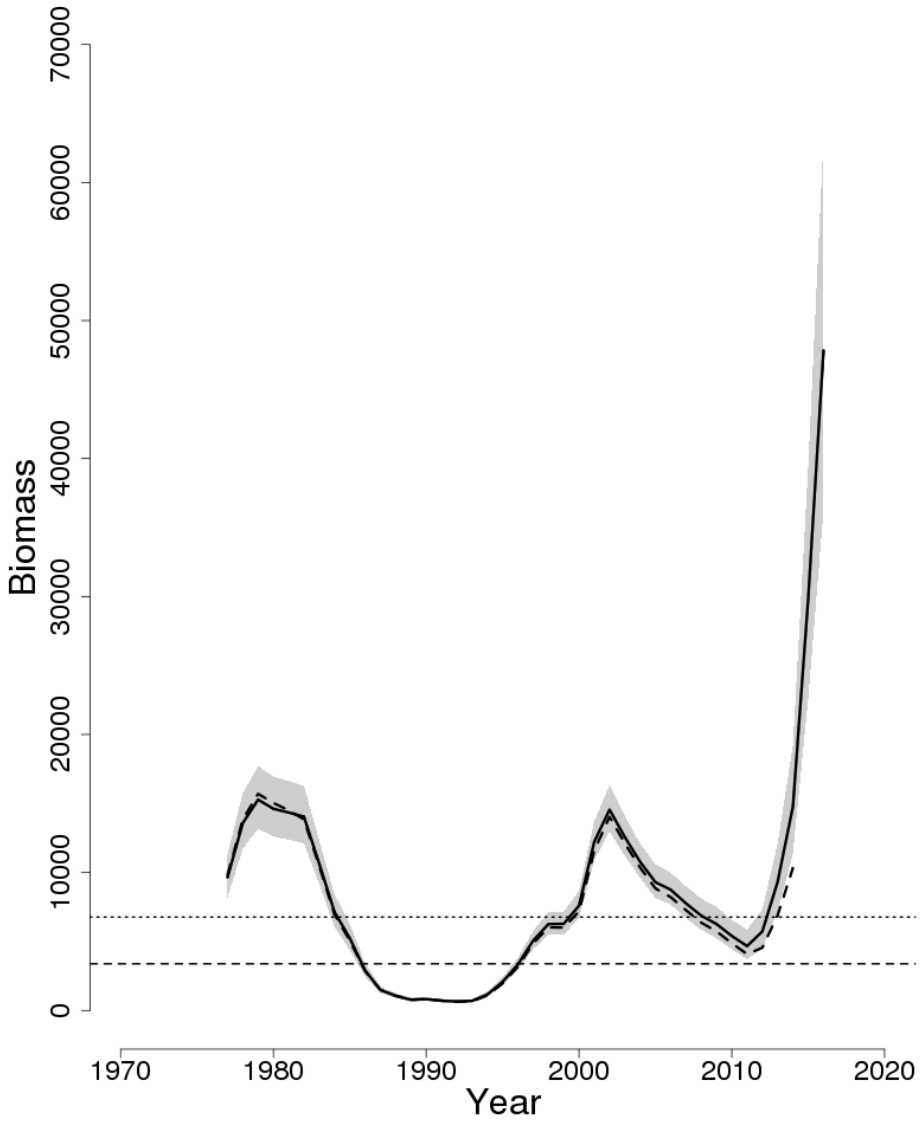


Figure 24: Trends in spawning stock biomass (SSB) of Gulf of Maine haddock between 1977 and 2016 from the current (solid line) and previous (dashed line) assessment and the corresponding $SSB_{Threshold}$ ($\frac{1}{2}$ $SSB_{MSY}$ *proxy*; horizontal dashed line) as well as $SSB_{Target}$ ($SSB_{MSY}$ *proxy*; horizontal dotted line) based on the 2017 assessment. The approximate 90% lognormal confidence intervals are shown. The red dot indicates the rho-adjusted SSB values that would have resulted had a retrospective adjusment been made to either model (see Special Comments section).

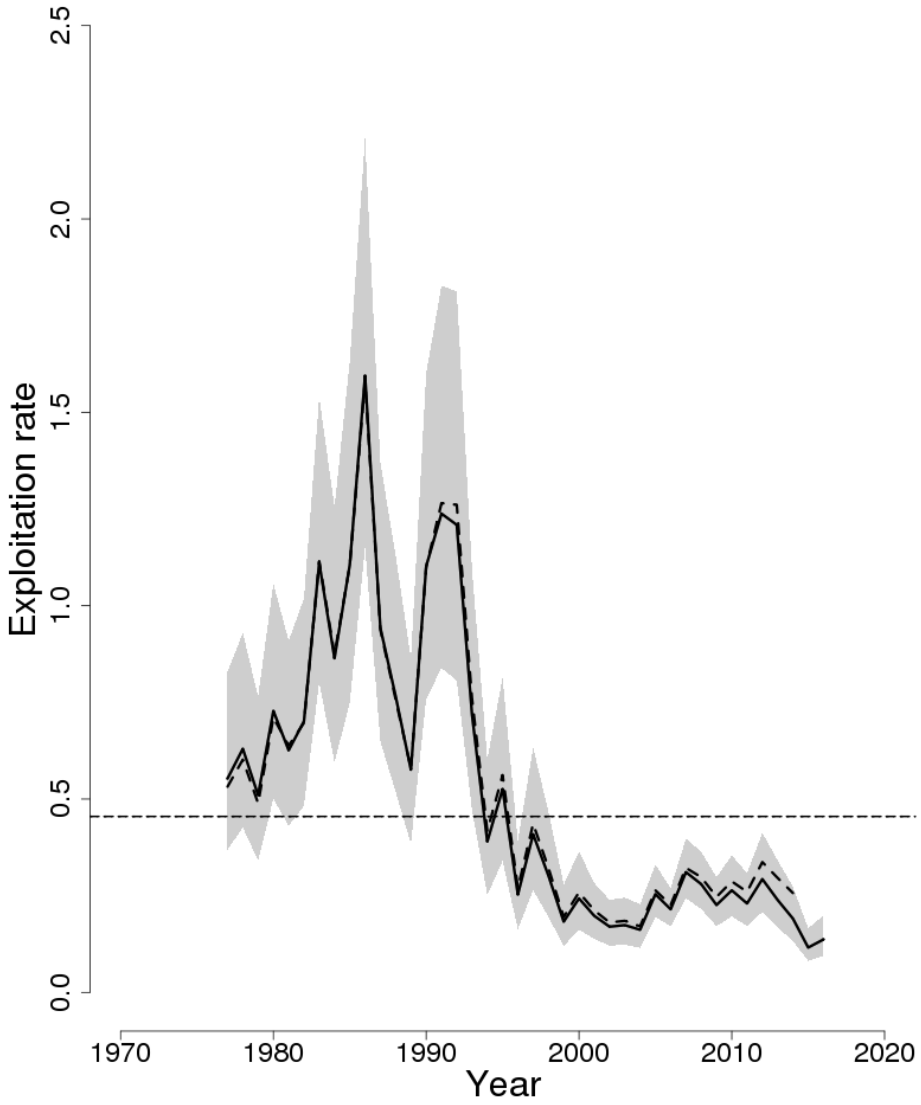


Figure 25: Trends in the fully selected fishing mortality (F) of Gulf of Maine haddock between 1977 and 2016 from the current (solid line) and previous (dashed line) assessment and the corresponding $F_{Threshold}$ ($F_{MSY}$ *proxy*=0.455; horizontal dashed line) from the 2017 assessment model. The approximate 90% lognormal confidence intervals are shown. The red dot indicates the rho-adjusted F values that would have resulted had a retrospective adjusment been made to either model (see Special Comments section).

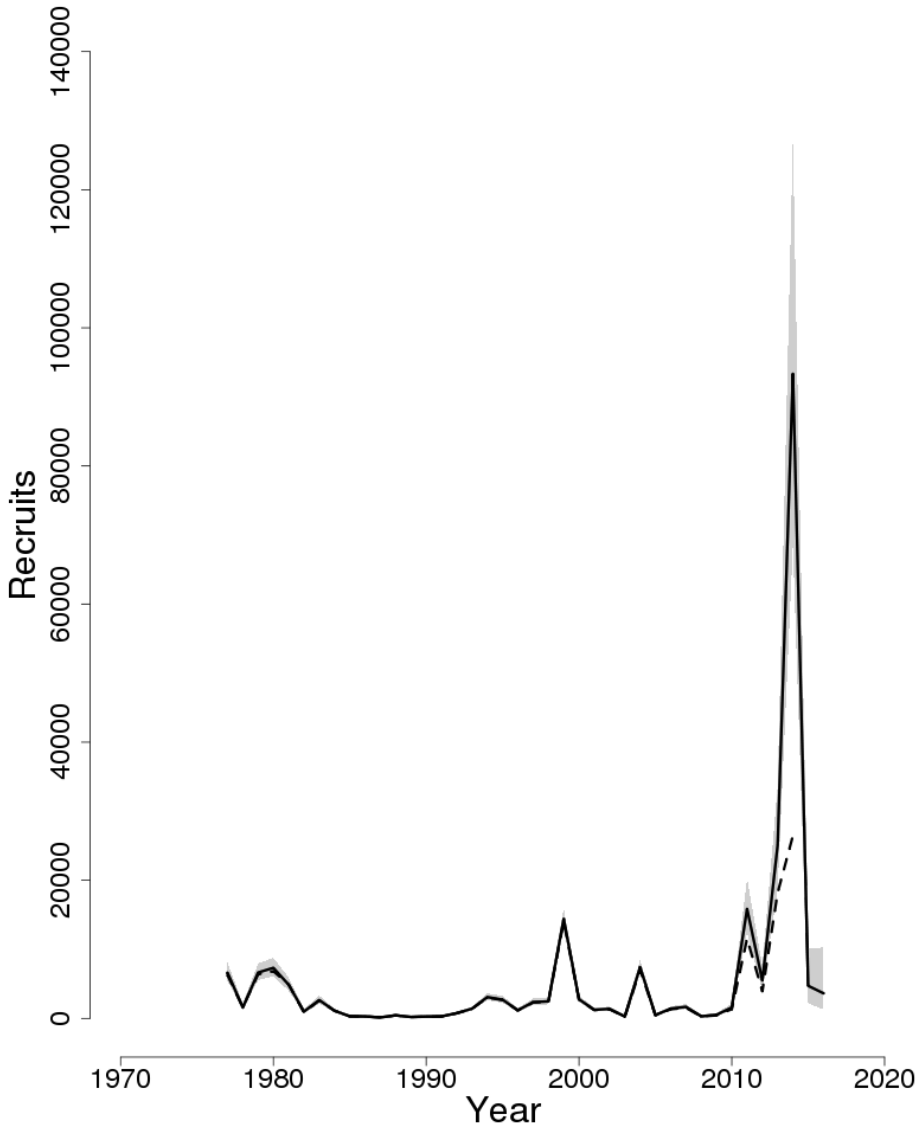


Figure 26: Trends in Recruits (age 1) (000s) of Gulf of Maine haddock between 1977 and 2016 from the current (solid line) and previous (dashed line) assessment. The approximate 90% lognormal confidence intervals are shown.

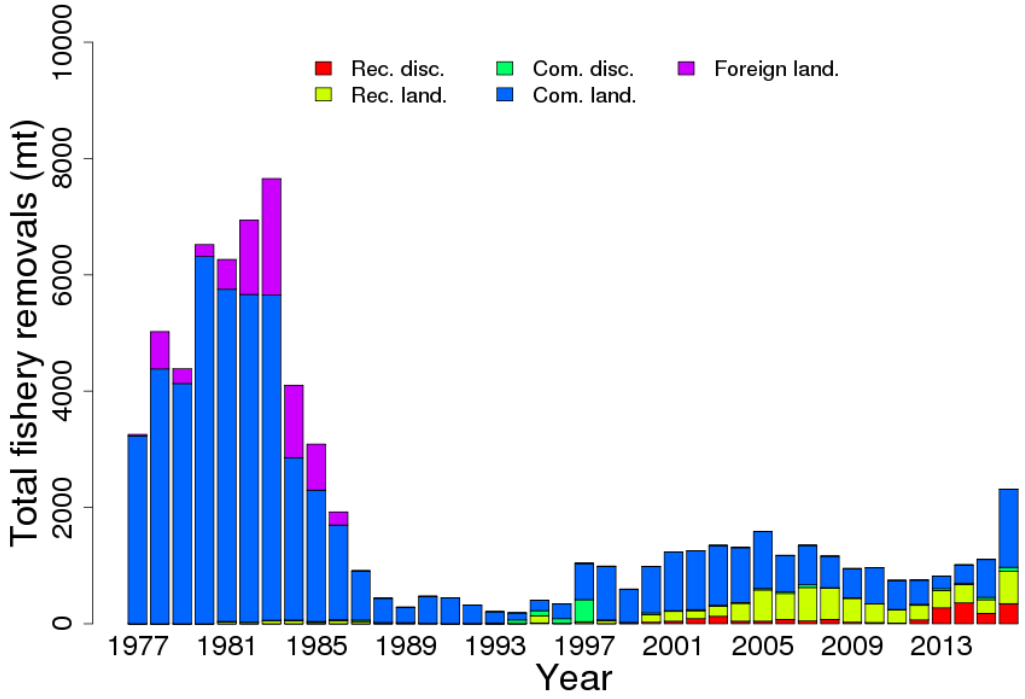


Figure 27: Total catch of Gulf of Maine haddock between 1977 and 2016 by fleet (commercial, recreational, or foreign) and disposition (landings and discards).

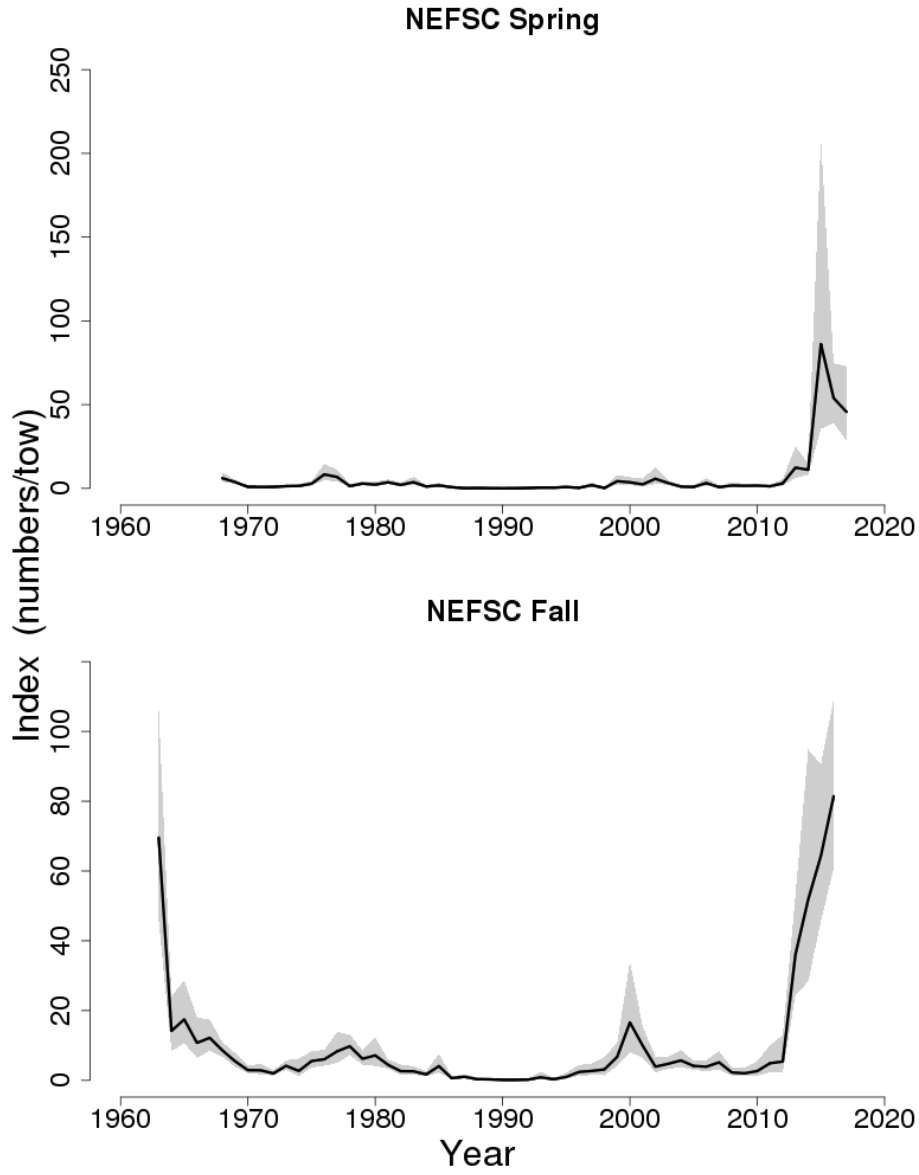


Figure 28: Indices of biomass for the Gulf of Maine haddock between 1963 and 2017 for the Northeast Fisheries Science Center (NEFSC) spring and fall bottom trawl surveys. The approximate 90% lognormal confidence intervals are shown.