12 Acadian redfish

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This assessment of the Acadian redfish (Sebastes fasciatus) stock is an operational assessment of the existing 2015 operational assessment (NEFSC 2015). This assessment updates commercial fishery catch data, research survey indices of abundance, the ASAP analytical model, and biological reference points through 2016. Additionally, stock projections have been updated through 2020. The most recent benchmark assessment of the Acadian redfish stock was in 2008 as part of the 3rd Groundfish Assessment Review Meeting (GARM III; NEFSC 2008), which includes a full description of the model formulations.

State of Stock: Based on this updated assessment, the Acadian redfish (*Sebastes fasciatus*) stock is not overfished and overfishing is not occurring (Figures 58-59). Retrospective adjustments were made to the model results. Retrospective adjusted spawning stock biomass (SSB) in 2016 was estimated to be 359,970 (mt) which is 145% of the biomass target (SSB_{MSY} *proxy* of SSB at $F_{50\%}$ = 247,918; Figure 58). The retrospective adjusted 2016 fully selected fishing mortality (F) was estimated to be 0.011 which is 29% of the overfishing threshold (F_{MSY} *proxy* of $F_{50\%}$ = 0.038; Figure 59).

Table 37: Catch and status table for Acadian redfish. All weights are in (mt), and F_{Full} is the fishing mortality on fully selected ages. Unadjusted SSB and F estimates are reported. Model results are from the current updated ASAP assessment.

	2009	2010	2011	2012	2013	2014	2015	2016
			Data					
Commercial landings	1,461	1,644	2,015	3,848	3,544	4,574	4,930	3,889
Commercial discards	202	206	212	341	422	509	110	36
Catch for Assessment	1,663	1,850	2,227	4,189	3,966	5,083	5,040	3,925
			Model Results					
Spawning Stock Biomass	233,719	255,536	280,625	308,901	339,804	372,523	404,690	435,852
F_{Full}	0.007	0.007	0.008	0.015	0.012	0.014	0.013	0.009
Recruits (age 1)	184,196	40,650	45,719	49,695	56,379	145,953	94,951	79,711

Table 38: Comparison of biological reference points for Acadian redfish estimated in the 2015 assessment and from the current assessment update. An F_{MSY} *proxy* of $F_{50\%}$ was used for the overfishing threshold, and was based on yield per recruit analysis. Recruits represent the median of the predicted recruits from 1969 to the final assessment year. Intervals shown are 5th and 95th percentiles.

	2015	2017
F_{MSY} *proxy*	0.038	0.038
SSB_{MSY} (mt)	281,112	247,918 (173,856 - 347,655)
MSY (mt)	10,466	9,318 (6,489 - 13,160)
Median recruits (age 1) (000s)	31,391	31,266
Overfishing	No	No
Overfished	No	No

Projections: Short term projections of median total fishery yield and spawning stock biomass for Acadian redfish 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 4,630 (mt). Recruitments were sampled from a cumulative distribution function derived from ASAP estimated age 1 recruitment between 1969 and 2014. The annual fishery selectivity, natural mortality, maturity ogive, and mean weights used in projections are the same as those used in the assessment model. Retrospective adjusted SSB and fully selected F in 2016 fell outside the 90% confidence intervals of the unadjusted 2016 values. Therefore, age-specific abundance rho values were applied to the initial numbers at age in the projections.

Table 39: Retrospective adjusted short term projections of median total fishery yield and spawning stock biomass for Acadian redfish based on a harvest scenario of fishing at an F_{MSY} *proxy* of $F_{50\%}$ between 2018 and 2020. Catch in 2017 has been estimated at 4,630 (mt). F_{Full} is the fully selected F.

Year	Catch (mt)	SSB (mt)	F_{Full}
2017	4,630	382,980	0.012

Year	Catch (mt)	SSB (mt)	F_{Full}
2018	15,451	400,038	0.038
2019	15,614	406,382	0.038
2020	15,677	410,365	0.038

Special Comments:

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

  The largest source of uncertainty in the Acadian redfish assessment is the lack of age data, particularly from the commercial fishery. Age measurements from landings were not collected after 1985 due to relatively low landings. Current landings have increased to levels

seen in the mid-1980s. If landings continue to increase, then age data from the fishery will become increasingly important. Dimorphic growth is another source of uncertainty in this assessment, with females growing faster than males. The use of female weights at age in the stock projections may lead to overestimation of stock productivity, as well as having an unknown effect on biological reference points.

- Does this assessment model have a retrospective pattern? If so, is the pattern minor, or major? (A major retrospective pattern occurs when the adjusted SSB or F_{Full} lies outside of the approximate joint confidence region for SSB and F_{Full}; see Table 8).

  The 7-year Mohn's ρ, relative to SSB, was 0.256 in the 2015 assessment and was 0.211 in 2016. The 7-year Mohn's ρ, relative to F, was -0.190 in the 2015 assessment and was -0.152 in 2016. There was a major retrospective pattern for this assessment because the ρ adjusted estimates of 2016 SSB (SSB_{ρ}=359,970) and 2016 F (F_{ρ}=0.011) were outside the approximate 90% confidence region around SSB (394,927 - 481,018) and F (0.008 - 0.01). A retrospective adjustment was made for both the determination of stock status and for projections of catch in 2018. The retrospective adjustment changed the 2016 SSB from 435,852 to 359,970 and the 2016 F_{Full} from 0.009 to 0.011.

- 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 Acadian redfish appear to be reasonably well determined. The stock is not in a rebuilding plan.

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

  Only one major change was made to the Acadian redfish assessment as part of this update. A multinomial logistic model was used to estimate proportions at age for length bins where no age samples were available (Gerritsen et al. 2006) in survey-age length keys. Survey age-length key holes were filled manually based on the expert judgment of the assessment analyst in previous assessments. There was little difference in the survey indices at age produced by the multinomial filling method compared to the indices at age produced by the manual filling method. The multinomial filling method is part of an effort by Northeast Fisheries Science Center (NEFSC) staff to standardize construction of survey indices.

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

  There has been no change in the stock status of Acadian redfish since the previous assessment.

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

  Total removals of Acadian redfish generally have increased since the early 2000s. The spring survey index has varied without trend since the late 1990s, while the fall survey index in 2013 through 2016 has been at a lower level than in previous years. Fall survey data suggests the exisitence of relatively strong year classes in 2008 and 2009. Fall survey data suggests that older fish have begun to reappear in the stock since the 1990s.

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

The Acadian redfish assessment could be improved by 1) including additional age data, particularly from the commercial fishery, and 2) investigating the sensitivity of biological reference points and stock projections to the mean weights at age.

- Are there other important issues?

  NEFSC fall bottom trawl index values for 2013 through 2016 are lower than in previous years (Figure 62), but the current assessment model continues to predict an increase in SSB for the last four years (Figure 58). If future index values remain low (i.e., if the index is responding to a change in abundance, rather than interannual variability), then the predicted trend in SSB may change abruptly in a future assessment. Such an abrupt change may lead to an increase in the retrospective pattern.

12.1 Reviewer Comments: Acadian redfish

Assessment Recommendation:

The panel concluded that the operational assessment with adjustments for retrospective bias was acceptable as a scientific basis for management advice.

Alternative Assessment Approach:

Not applicable

Status Recommendation:

Based on this operational assessment, the panel agrees with the conclusion that the Acadian redfish stock is not overfished and overfishing is not occurring. Total removals of Acadian redfish generally have increased since the early 2000s. Fall survey data show relatively strong year classes in 2007 and 2008. Fall survey data also show that older fish have begun to reappear in the stock since the 1990s.

Key Sources of Uncertainty:

The largest source of uncertainty in the Acadian redfish assessment is the lack of age data, particularly from the commercial fishery. Dimorphic growth is another source of uncertainty in this assessment, with females growing faster than males. The use of female weights at age in the stock projections may lead to overestimation of stock productivity, as well as having an unknown effect on biological reference points. Some of the spikes observed in the survey should be interpreted cautiously because there is a possibility of immigration/emigration into and out of the survey area. Overall, these assessment results are highly precise, yet there are notable data gaps, so this precision should also be interpreted cautiously.

Research Needs:

The Acadian redfish assessment could be improved by including additional age data, particularly from the commercial fishery, and by investigating the sensitivity of biological reference points and stock projections to the mean weights at age. Future assessments should explore whether it is better to estimate the stock-recruit relationship inside the model or externally. Also, the panel recommends an evaluation of the survey trends, including potential factors that may cause the trends to not reflect patterns in relative abundance and the validity of the fall survey trend. Finally, the precision of the results appears to be high, and the panel suggests exploring data weighting scenarios to better reflect the completeness and reliability of available data.

References:

Gerritsen, H.D., D. McGrath, and C. Lordan. 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.

Northeast Fisheries Science Center. 2008. Assessment of 19 Northeast Groundfish Stocks through 2007: Report of the 3rd Groundfish Assessment Review Meeting (GARM III), Northeast Fisheries Science Center, Woods Hole, Massachusetts, August 4-8, 2008. US Dept Commer, Northeast Fish Sci Cent Ref Doc. 08-15; 884 p + xvii. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026. CRD08-15

Northeast Fisheries Science Center. 2015. 2014 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

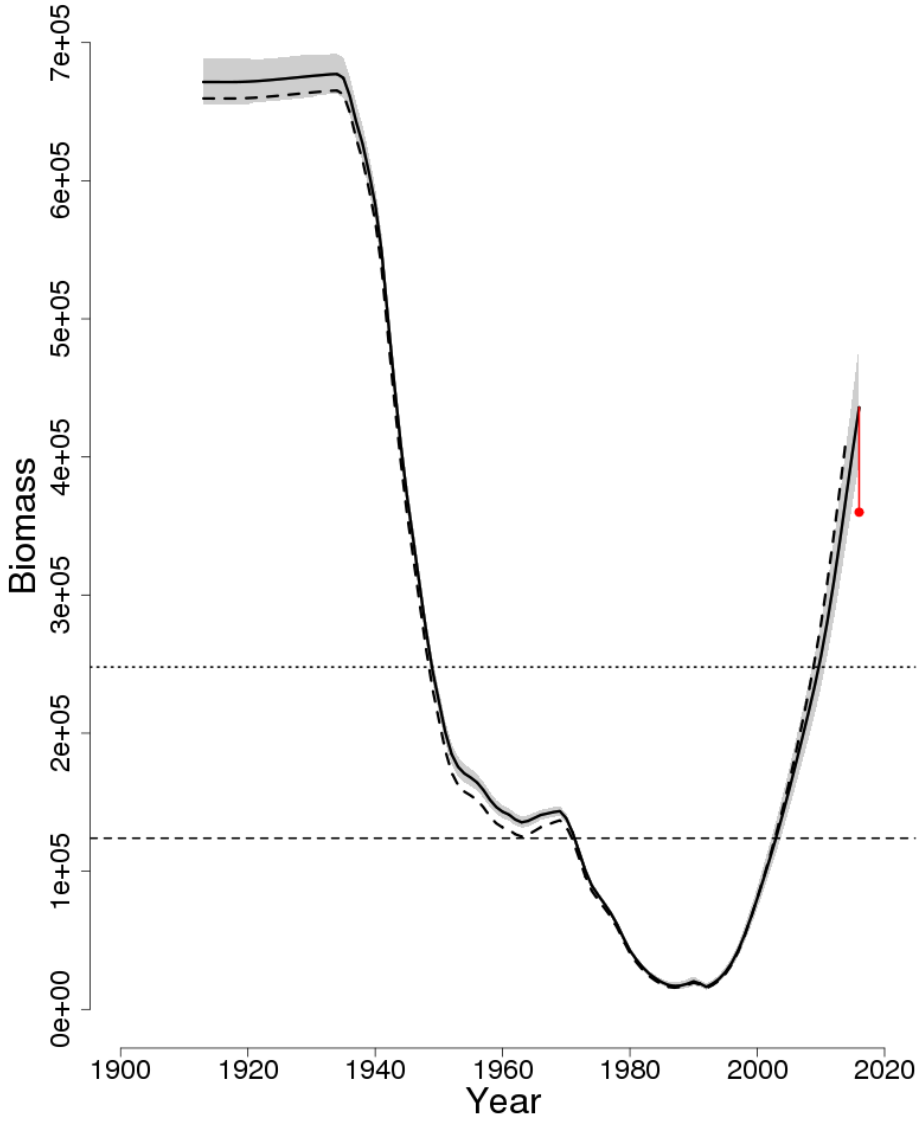

Figure 58: Trends in spawning stock biomass of Acadian redfish between 1913 and 2016 from the current (solid line) and previous (dashed line) assessment and the corresponding $SSB_{Threshold}$ (0.5 * SSB_{MSY} *proxy*; horizontal dashed line) as well as SSB_{Target} (SSB_{MSY} *proxy*; horizontal dotted line) based on the 2017 assessment. Biomass was adjusted for a retrospective pattern and the adjustment is shown in red. The approximate 90% lognormal confidence intervals are shown.

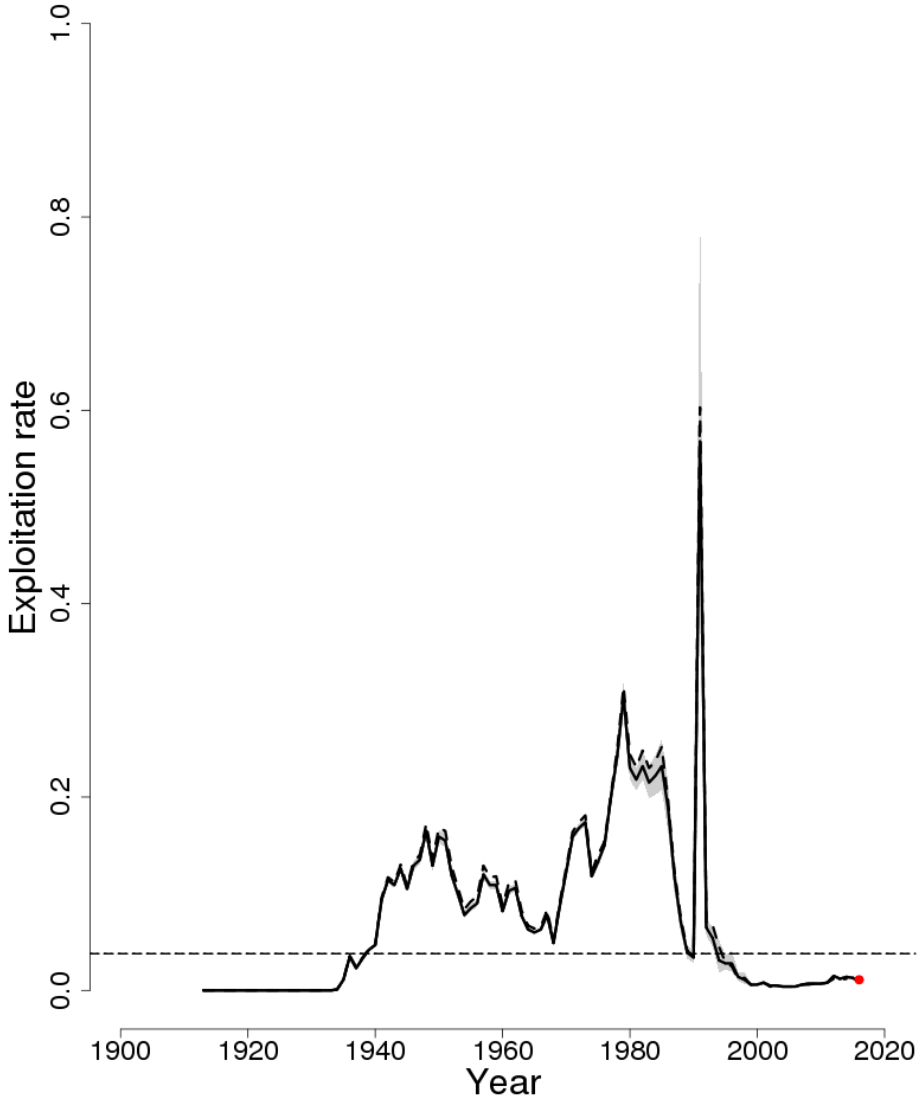

Figure 59: Trends in the fully selected fishing mortality (F_{Full}) of Acadian redfish between 1913 and 2016 from the current (solid line) and previous (dashed line) assessment and the corresponding $F_{Threshold}$ (F_{MSY} *proxy*=0.038; horizontal dashed line) based on the 2017 assessment. F_{Full} was adjusted for a retrospective pattern and the adjustment is shown in red. The approximate 90% lognormal confidence intervals are shown.

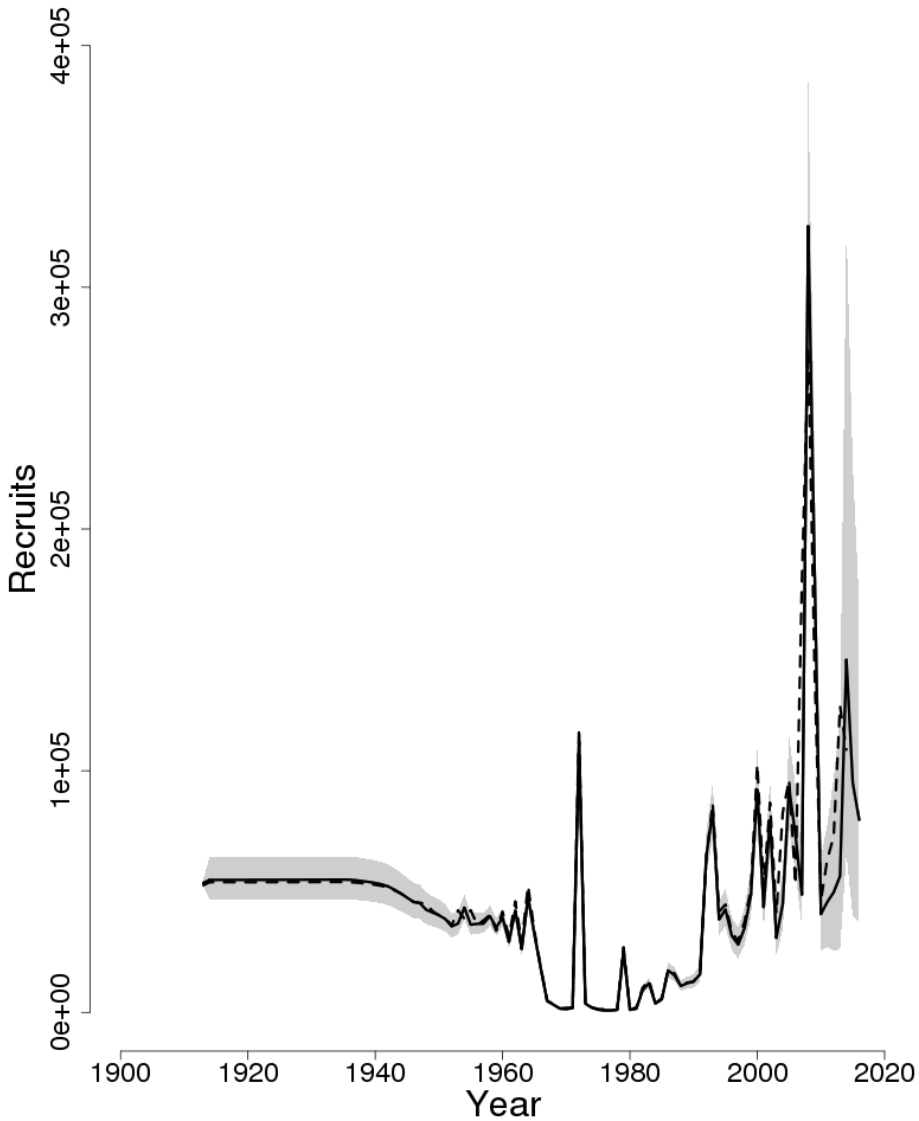

Figure 60: Trends in Recruits (age 1) (000s) of Acadian redfish between 1913 and 2016 from the current (solid line) and previous (dashed line) assessment. The approximate 90% lognormal confidence intervals are shown.

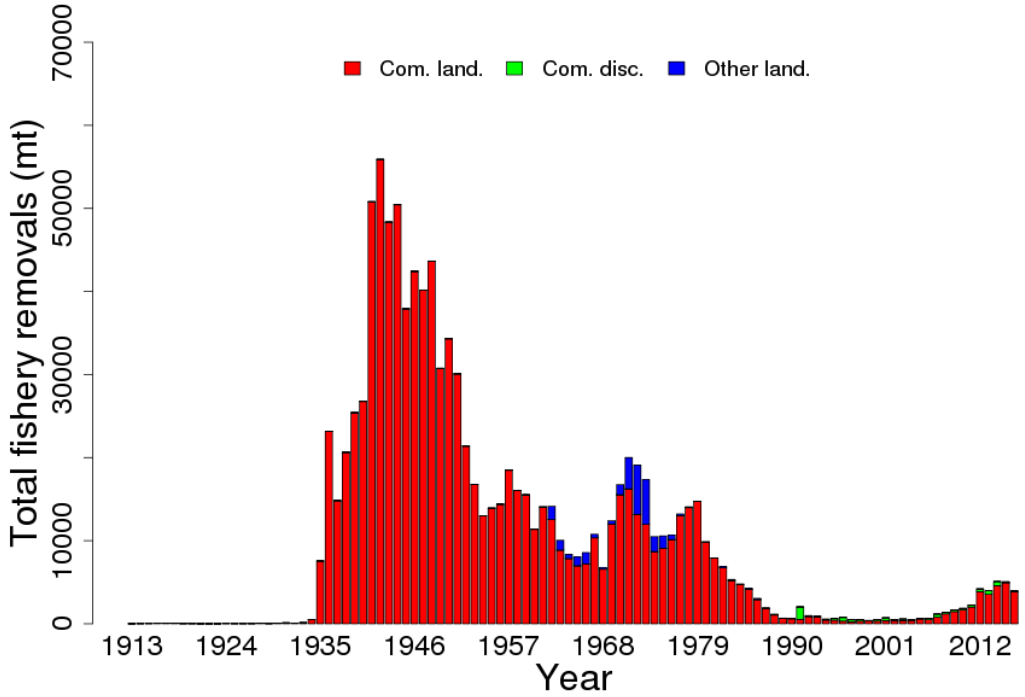

Figure 61: Total catch of Acadian redfish between 1913 and 2016 by fleet (commercial and other) and disposition (landings and discards).

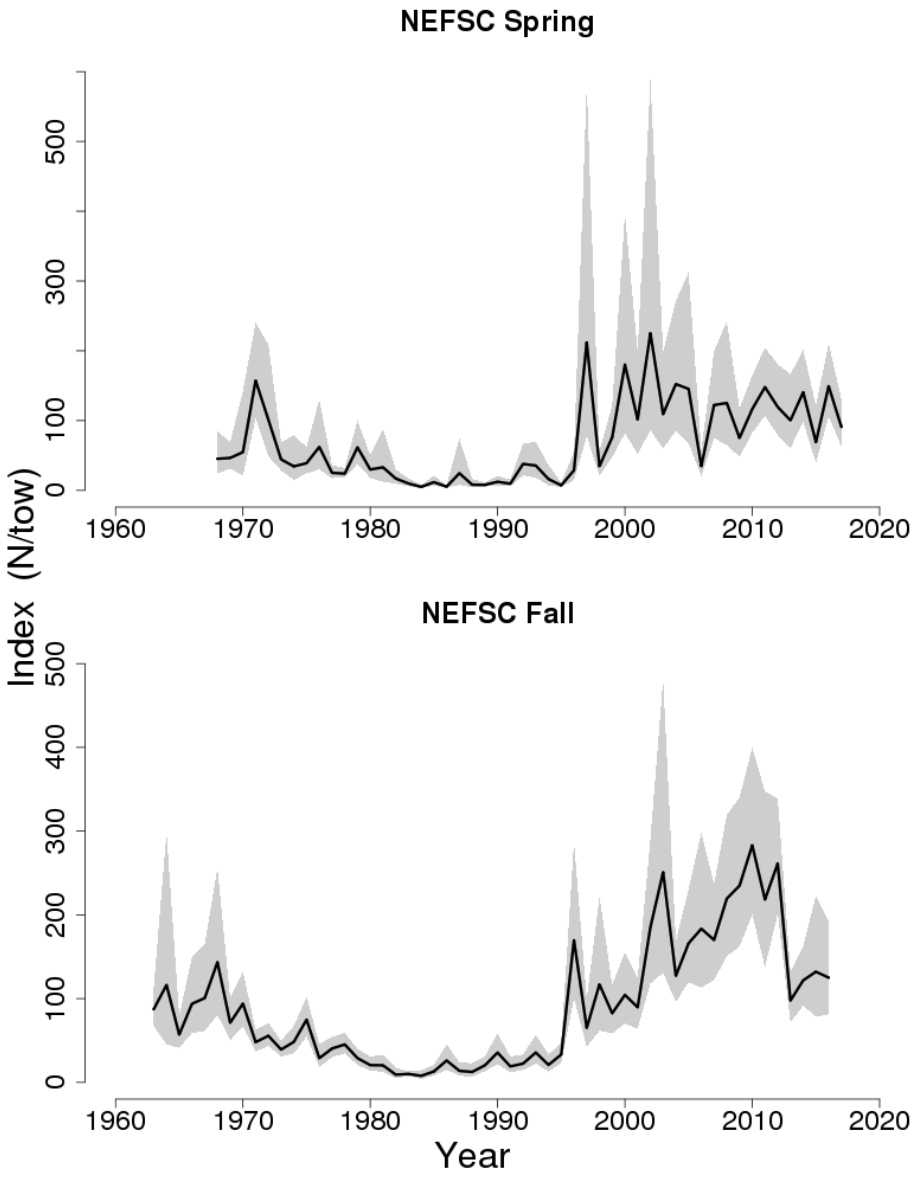

Figure 62: Indices of abundance for Acadian redfish from the Northeast Fisheries Science Center (NEFSC) spring (1963 to 2017) and fall (1963 to 2016) bottom trawl surveys. The approximate 90% lognormal confidence intervals are shown.