draft working paper for peer review only

Atlantic surfclam

2020 Assessment Update Report

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Northeast Fisheries Science Center
Woods Hole, Massachusetts

Compiled June 2020

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

State of Stock: Based on this updated assessment, the Atlantic surfclam (*Spissula solidissima*) stock is not overfished and overfishing is not occurring (Figures 1-2). Retrospective adjustments were not made to the model results. Spawning stock biomass (SSB) in 2019 was estimated to be 1,222 ('000 mt) which is 119% of the biomass target (SSB_{MSY} *proxy* = 1,027; Figure 1). The 2019 fully selected fishing mortality was estimated to be 0.036 which is 25.8% of the overfishing threshold proxy (F_{MSY} *proxy* = 0.141; Figure 2).

Table 1: Catch and status table for Atlantic surfclam. All data weights are in (mt) model results are ratios relative to reference points. Model results are from the current SS assessment.

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

Table 2: Comparison of reference points estimated in an earlier assessment and from the current assessment update. An F_{MSY} proxy was used for the overfishing threshold and was based on a simulation study and scaled to the current assessment.

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

Projections: Short term projections of biomass were derived by assumming average recruitment in each forecast year. Growth was assummed to be equal to the growth in the final year of each

area. Fishery selectivity for each fleet, and maturity ogive were constant over time for each area. Three projection scenarios were developed for use in management: status quo, which sets annual catch in each forecast year equal to the average catch over the last five years in each area; quota in which the current quota is caught each year and the proportions taken from each area are equal to the average proportions removed from each area over the last five years, and finally, OFL in which the catch is equal to the OFL applied to the terminal biomass in each area. These projections are available in the document entitled 'AtlanticSurfclamUpdateMT2020...pdf' and found on the SASINF

Table 3: Short term projections of total fishery catch and spawning stock biomass for Atlantic surfclam based on a harvest scenario of fishing at F_{MSY} *proxy* between 2020 and 2026.

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

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

Special Comments:

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

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

  Survey indices in the northern area appear to have responded to fishing pressure. Swept area abundance estimates have gone down by approximately the amount removed by the fishery over the saame time period. This represents the first time Atlantic surfclam indices have responded to fishing. Percieved fishing mortality has therefore changed, which influences the overall assessment in several important ways. Scale is difficult to determine in low F fisheries, a problem that has plaugued the Atlantic surfclam assessment for many years. Increased fishing pressure has led to increased precision of both fishing mortality and biomass estimates in north since the last assessment. Uncertainty in scale for the whole stock has therfore decreased. It should be noted however, that the improved NEFSC clam survey has run for only one season in each area. The benefits to the assessment described here accrue in part because of restratification, which may induce spatial biases as past

surveys were not conducted under the current stratification. Additional survey years using the new stratification will be important in bearing out, or reducing confidence in, the current model outputs.

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

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

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

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

  Population projections for Atlantic surfclam, are reasonably well determined and projected biomass from the last assessment was within the confidence bounds of the biomass estimated in the current assessment. This stock was not in a rebuilding plan.

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

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

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

  Stock status did not change. Perception of abundance in the northern area, however, has changed. At one time abundance in the northern area was believed to be about equal to abundance in the south. Currently, abundance in the northern area appears low and there is no evidence of strong recruitment in recent years. Early survey data from the northern area is not fit well by the model, but is likely to be of relatively low quality. Therefore the unfished abundance in the northern area is probably not well described. Abundance in the northern

area may never have been very high compared to the abundance in the southern area.

One consequence of the perception of lower biomass in the north is that fishing mortality there appears to be higher. This in turn affects the F trend for the whole stock and thus the estimate of the F reference point.

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

  The Atlantic surfclam stock remains lightly fished and at relatively high abundance in the southern area. The scale of the abundance agrees closely with the swept area abundance estimates for each area (see the section 'Plan B Assessment' in the document entitled 'AtlanticSurfclamUpdateMT2020...pdf' at SASINF.

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

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

- Are there other important issues?

  Atlantic surfclam mature very quickly (<2 years) and are not selected by commercial gear until they are 5 to 7 years old. A traditional F_{MSY} reference point will therefore be nearly infinite. A trend based alternative has been used here, and in the previous assessment, but the methods for deriving it should perhaps be revisited given the changes in growth in the southern area. Previous assumptions regarding growth under warming conditions (faster growth to a smaller maximum size) may not be correct. The model estimated here shows a reduced Von Bertalanffy K parameter, as well as a reduced average maximum size over time in the southern area. This would be consistent with slower growth to a smaller maximum size. There is new research supporting this hypothesis. Pousse et al (in review) studied Atlantic surfclam and ocean acidification and their results indicate that scope for growth is likely to be much lower under OA conditions. In addition, the current low stock size in the northern area may provide a basis for estimating the steepness parameter of the stock recruitment relationship in Atlantic surfclam, which has not previously been possible due to the lack of any observed low stock abundance condition. A new management strategy evaluation of Atlantic surfclam may be warranted.

References:

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

Pousse, E., HennenD., Munroe, D., Hart, D., Redman, D., Wikfors, G., Sennefelder, G., Lindsay, J., White, L., Dixon, M., Poach, M., Meseck, S., Li, Y. In Review. Physiological response of

Atlantic surfclam, Spisula solidissima, to ocean acidification. Science of the Total Environment. In Review.

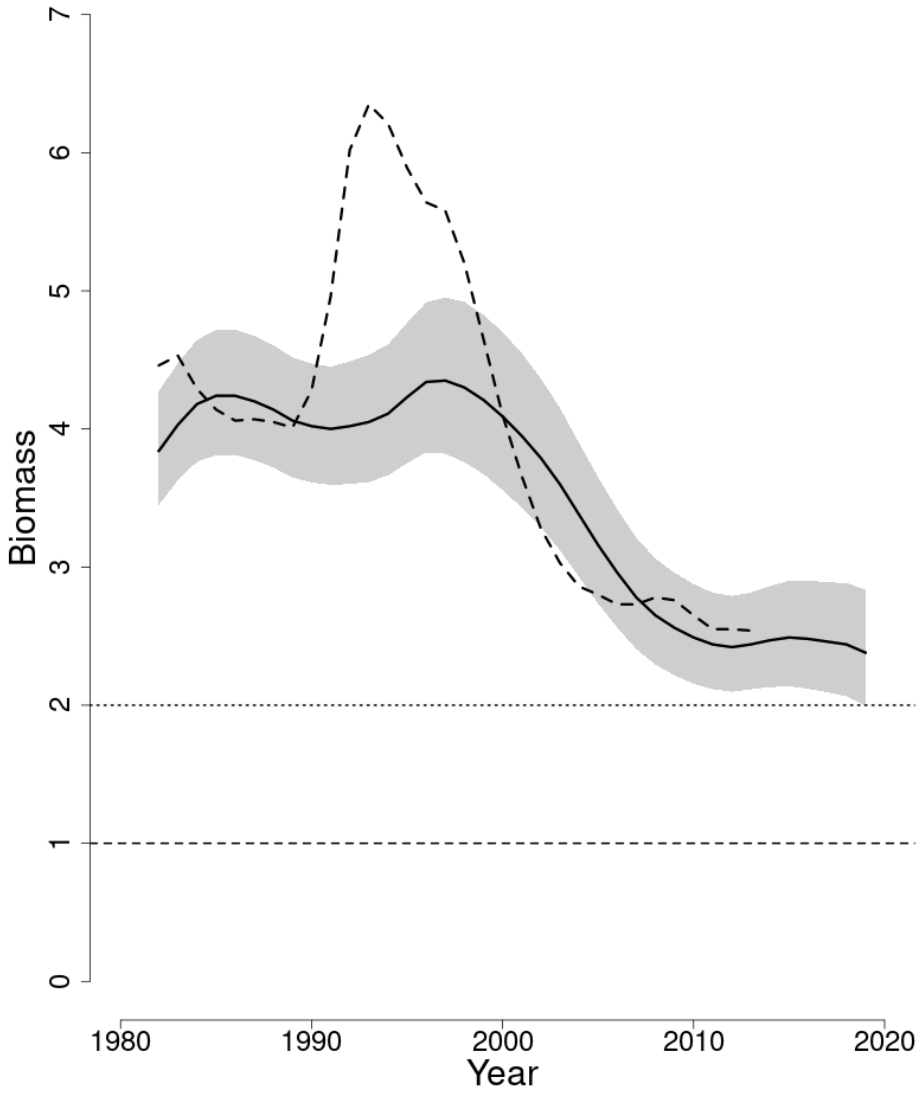

Figure 1: Trends in spawning stock biomass of Atlantic surfclam between 1982 and 2019 from the current (solid line) and previous (dashed line) assessment and the corresponding $SSB_{Threshold}$ ($\frac{1}{2}$ SSB_{MSY} *proxy*; horizontal dashed line) as well as SSB_{Target} (SSB_{MSY} *proxy*; horizontal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

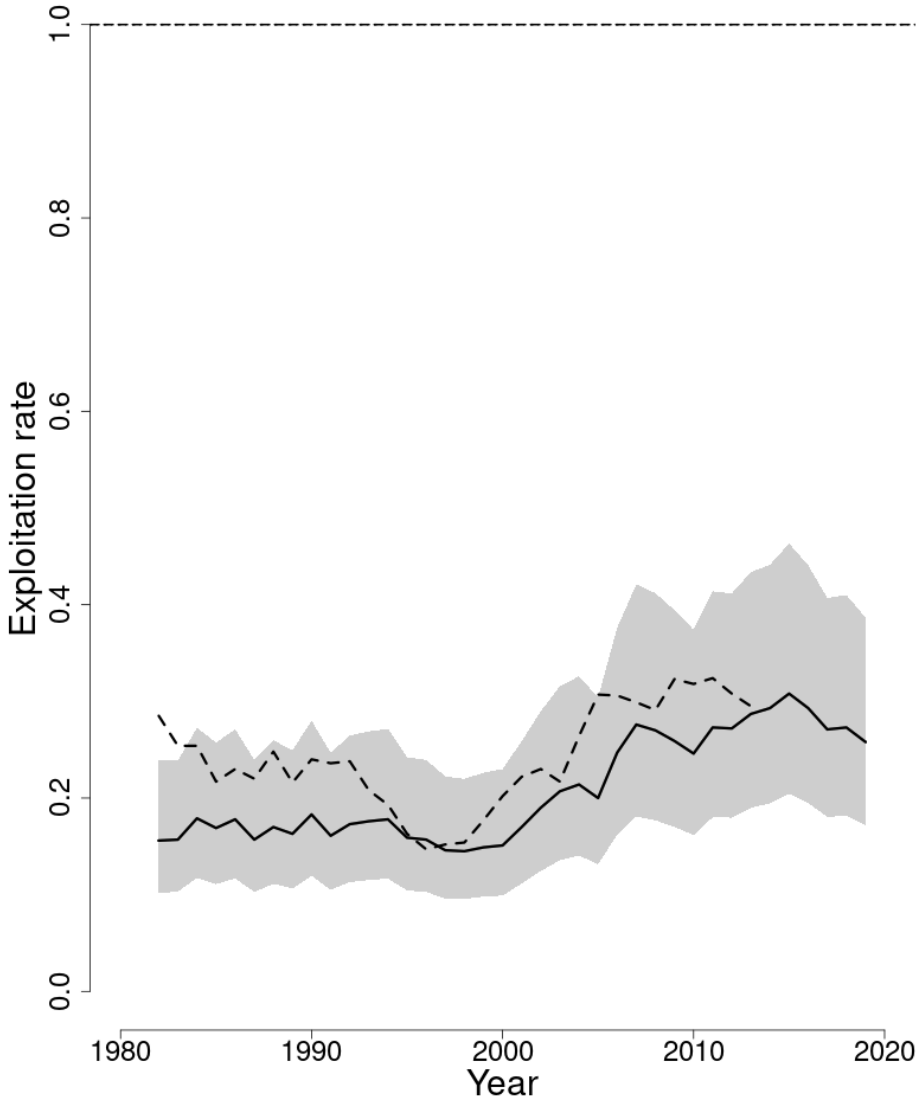

Figure 2: Trends in the fully selected fishing mortality (F_{Full}) of Atlantic surfclam between 1982 and 2019 from the current (solid line) and previous (dashed line) assessment and the corresponding $F_{Threshold}$ (F_{MSY} *proxy*=0.141; horizontal dashed line), based on the 2020 assessment. Units of fishing mortality are the ratio of annual F to the F threshold ($\frac{F}{F_{Threshold}}$). The approximate 90% lognormal confidence intervals are shown.

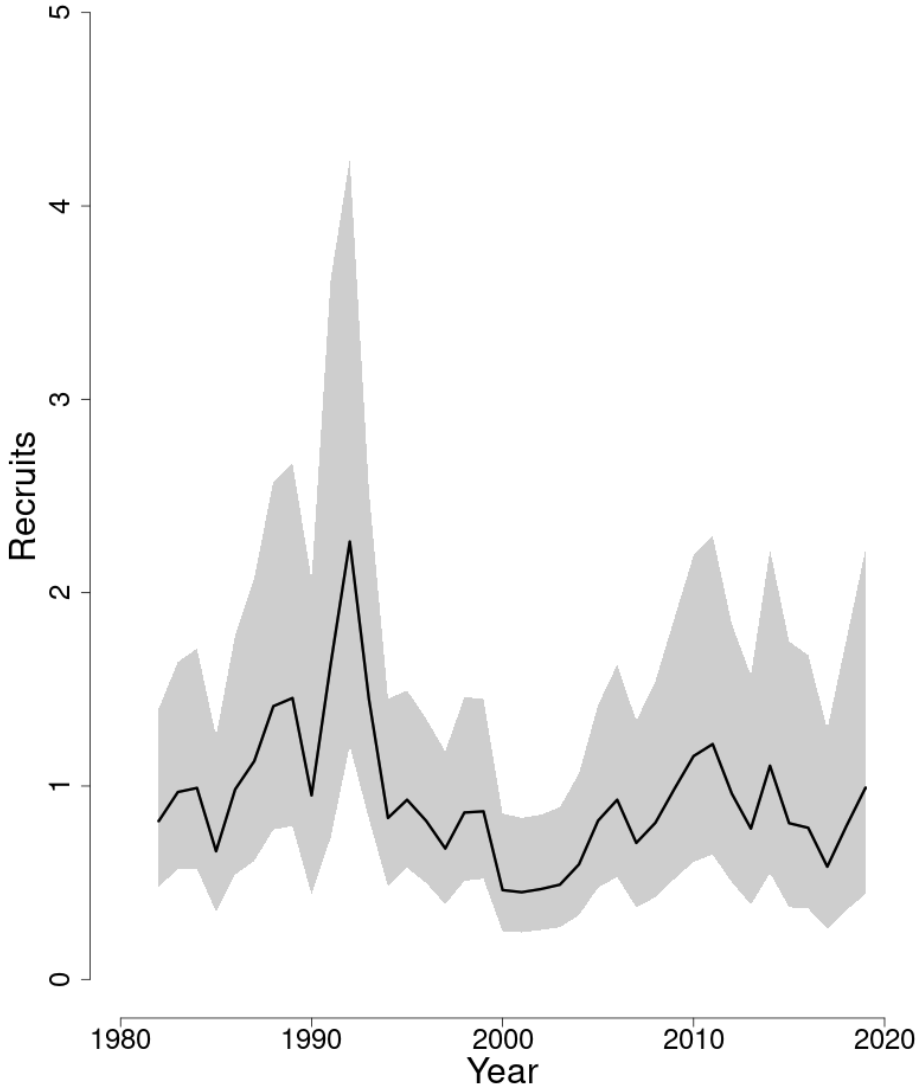

Figure 3: Trends in $\frac{R}{R_0}$ of Atlantic surfclam between 1982 and 2019 from the current (solid line) and previous (dashed line) assessment. Units of recruitment are the ratio of annual R to the unfished R ($\frac{R}{R_0}$). The approximate 90% lognormal confidence intervals are shown.

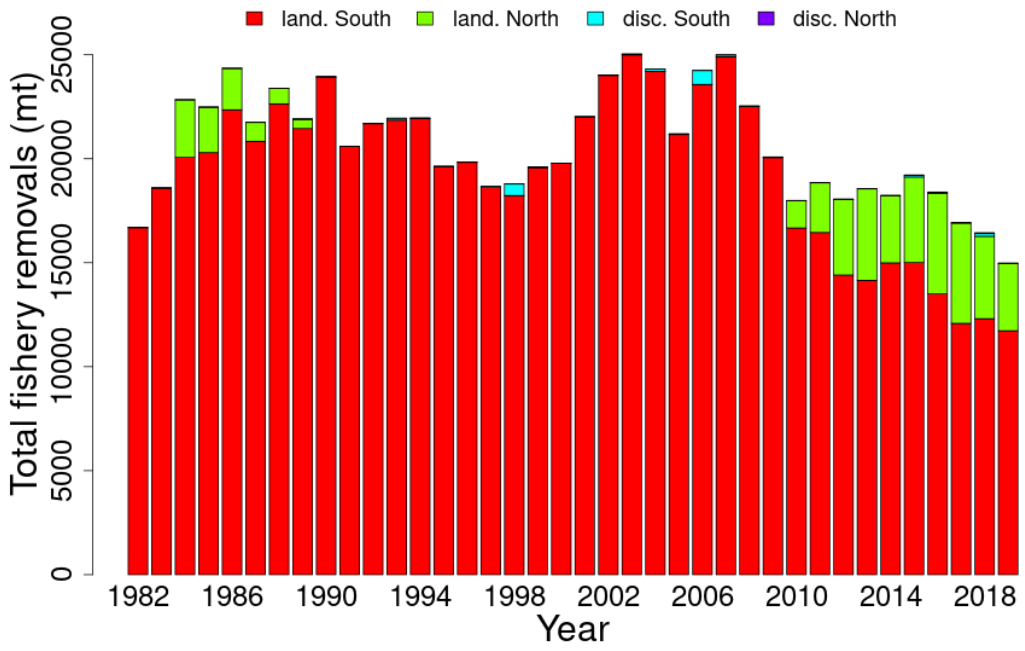

Figure 4: Total catch of Atlantic surfclam between 1982 and 2019 by fleet and disposition (landings and discards).

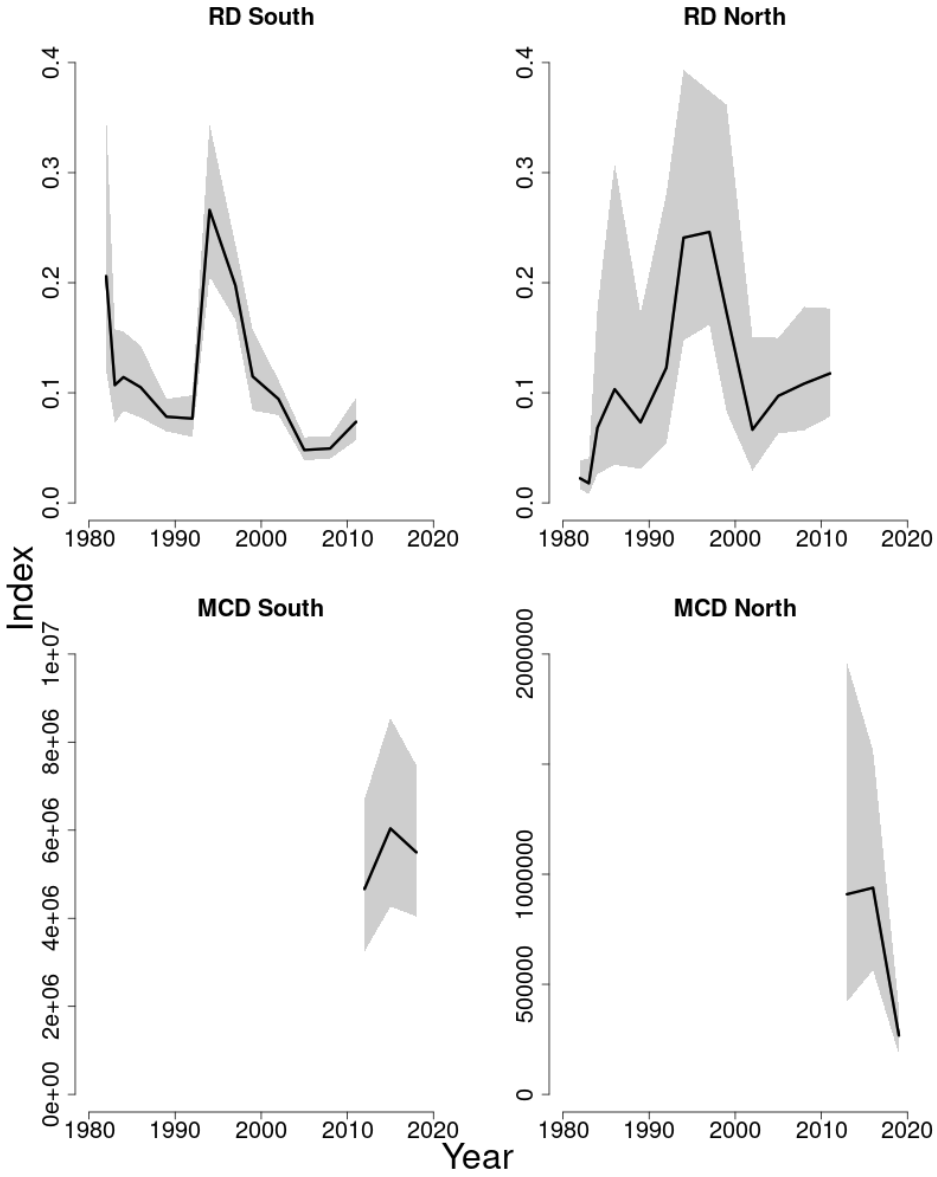

Figure 5: Indices of biomass for the Atlantic surfclam between 1982 and 2019 for the Northeast Fisheries Science Center (NEFSC) clam surveys in the north and south. The RD survey units are weight per tow (kg) and the MCD survey units are swept area numbers (n). The approximate 90% lognormal confidence intervals are shown.