draft working paper for peer review only

Georges Bank Atlantic cod

2021 Management Track Assessment Report

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National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Northeast Fisheries Science Center
Woods Hole, Massachusetts

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This assessment of the Georges Bank Atlantic cod (Gadus morhua) stock is a Management Track assessment of the existing 2019 operational update assessment (NEFSC in press). In the 2019 assessment the stock status could not be quantitatively determined but was qualitatively determined to be overfished based on poor stock condition, while overfishing status remained unknown (see Table 2 Legend). This 2021 assessment updates commercial fishery catch data through 2020 (Table 1, Figure 3) and updates research survey indices of abuandance and the PlanBsmooth assessment model through 2021 (Figure 4).

State of Stock: Based on this updated assessment, the Georges Bank Atlantic cod (*Gadus morhua*) stock status cannot be quantitatively determined due to a lack of biological reference points associated with the PlanBsmooth approach but is recommended to be overfished due to poor stock condition, while recommended overfishing status is unknown (Table 2). Retrospective adjustments were not made to the model results. The survey biomass in 2021 (normally the arithmetic average of the 2021 NEFSC spring and 2020 NEFSC fall surveys smoothed using a loess, however there is no fall survey in 2020) was estimated to be 1.409 (kg/tow) (Figure 1). The 2020 relative exploitation rate (2020 catch divided by 2020 smoothed survey biomass) was estimated to be 0.19 (Figure 2).

Table 1: Catch and model results for Georges Bank Atlantic cod. Catch weights are in (mt), Biomass is the average survey biomass in (kg/tow) smoothed using a loess, and Rel. Exploit. Rate is the relative exploitation rate (catch/smoothed survey). Model results are from the PlanBsmooth assessment.

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
					Data					
US Catch	3,659	2,209	1,403	1,795	1,838	2,227	1,277	666	948	676
CA Catch	745	470	424	458	492	440	488	517	396	377
Catch for Assessment	4,404	2,679	1,827	2,253	2,330	2,667	1,765	1,183	1,344	1,053
					Model Results					
Biomass	3.13	3.175	3.022	2.428	2.919	4.257	5.09	4.532	3.768	2.698
Rel. Exploit. Rate	0.683	0.409	0.293	0.45	0.387	0.304	0.168	0.127	0.173	0.19

Table 2: Comparison of reference points estimated in the previous assessment and from the current assessment update. Note: based on NOAA's policy, the Agency decided after the 2015 assessment that the stock status would remain as overfishing occurring and overfished based on an earlier benchmark assessment.

	2019	2021
F_{MSY} *proxy*	NA	NA
SSB_{MSY} (kg/tow)	NA	NA
MSY (mt)	NA	NA
Overfishing	Unknown	Unknown
Overfished	Yes	Yes

Projections: Short term projections cannot be computed using the PlanBsmooth approach. The PlanBsmooth approach estimates the rate of change in the recent three years of the smoothed survey biomass to be 0.611. This multiplier is applied to the average of the recent three years of catch (1,193 mt) to produce the catch advice for 2022 of 729 mt. The PlanBsmooth approach is fully described in NEFSC (2015) and available as an R package. A Shiny app demonstrating the performance of the PlanBsmooth approach is also available. Simulations were run to examine the impact of missing survey data on PlanBSmooth. There were not large impacts found. This analysis and code are available on GitHub. An additional sensitivity run was conducted filling in the missing surveys by using fall 2019 as fall 2020 and averaging spring 2019 and 2021 to fill in spring 2020. The resulys of this sensitivity run changed the multiplier to 0.632 and resulted in a change in catch advice of 25 mt. The missing data code referenced above was also updated to evaluate the impact of filling in missing values. The result was that there

does appear to be some general improvement using filled over missing surveys, but when the data fill approach is in error it can be wildly in error.

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 major source of uncertainty is the cause of the retrospective pattern that led to the analytical assessment of this stock not being accepted during the 2015 operational update meeting. The missing 2020 spring and fall surveys are also a source of uncertainty in the 2021 assessment.

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

  No retrospective adjustment of spawning stock biomass or fishing mortality was required because there is not an accepted analytical model.

- 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 the Georges Bank Atlantic cod stock are not computed. Catch advice is derived from applying an estimate of recent change in the smoothed survey biomass to the average of the recent three years of catch and thus is influenced by uncertainty in survey estimates. The smoothed survey biomass is decreasing, but without a biomass reference point it is not known if rebuilding is on schedule.

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

  The US catches were estimated by the Groundfish Plan Development Team for the 2021 assessment of Georges Bank Atlantic cod and could not be broken down by catch disposition as has been done in past assessments.

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

  The stock status for Georges Bank Atlantic cod remains overfished based on a qualitative evaluation of poor stock condition.

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

  The Georges Bank Atlantic cod stock continues to show a truncated age structure. The most recent survey values remain below the mean of their time series. The 2013 year class was larger than recent year classes, but has not continued to be large as it ages and is below the average from the 1970s at every age in both surveys.

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

  The Georges Bank Atlantic cod assessment could be improved with additional studies on natural mortality, the potential for missing catch, and other possible sources of retrospective patterns in analytical assessments.

- Are there other important issues?

  The differences in modeling approaches between the full Georges Bank cod assessment (reported here) and the TRAC cod assessment of eastern Georges Bank (a portion of the whole bank) remain a potential problem.

References:

Northeast Fisheries Science Center. In press. Operational Assessment of 14 Northeast Groundfish Stocks, Updated Through 2018.

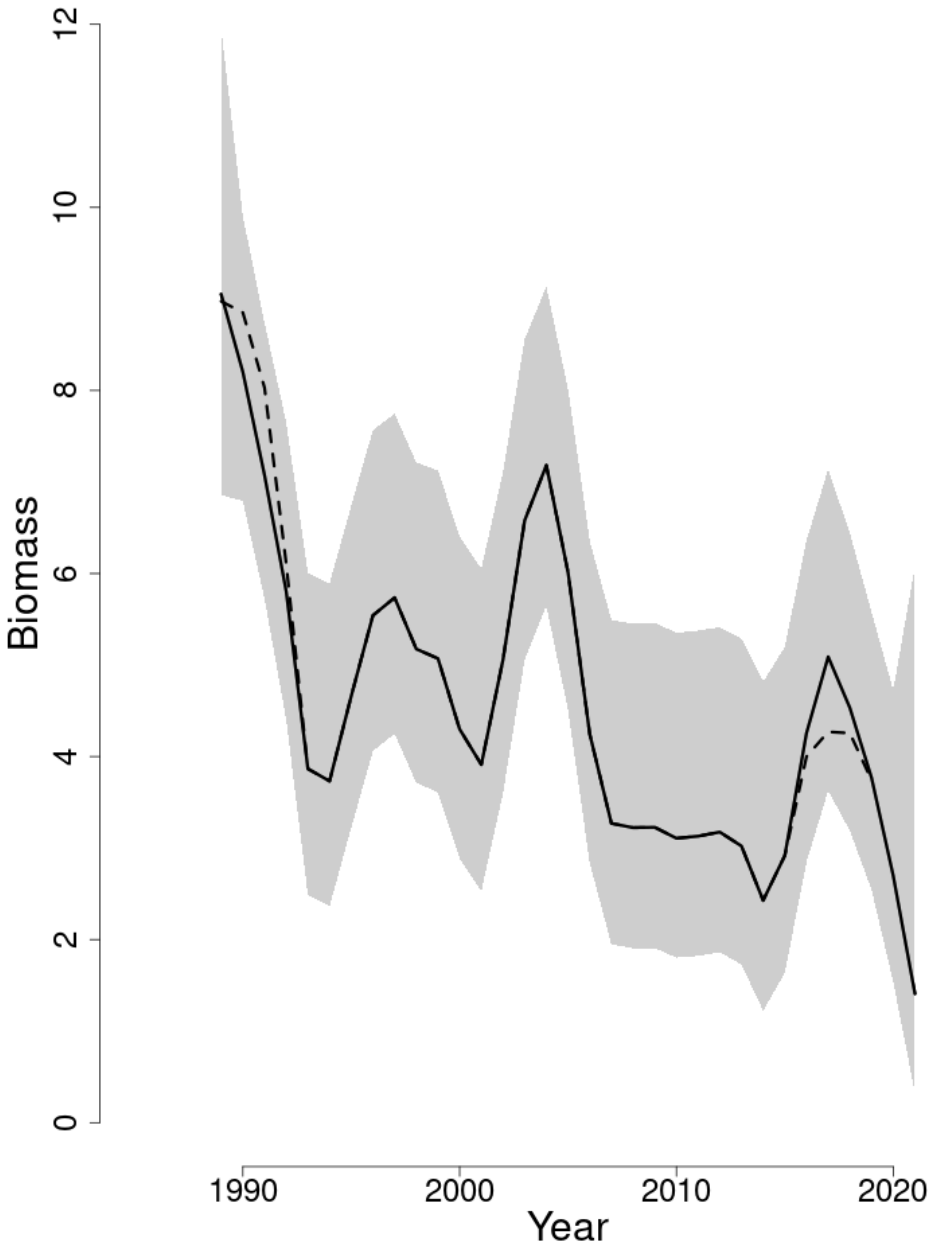

Figure 1: Trends in smoothed survey biomass (kg/tow) of Georges Bank Atlantic cod between 1989 and 2021 from the current (solid line) and previous (dashed line) assessment. The approximate 90% lognormal confidence intervals are shown. The 2020 value is based only on the 2019 fall survey while the 2021 value is based only on spring 2021.

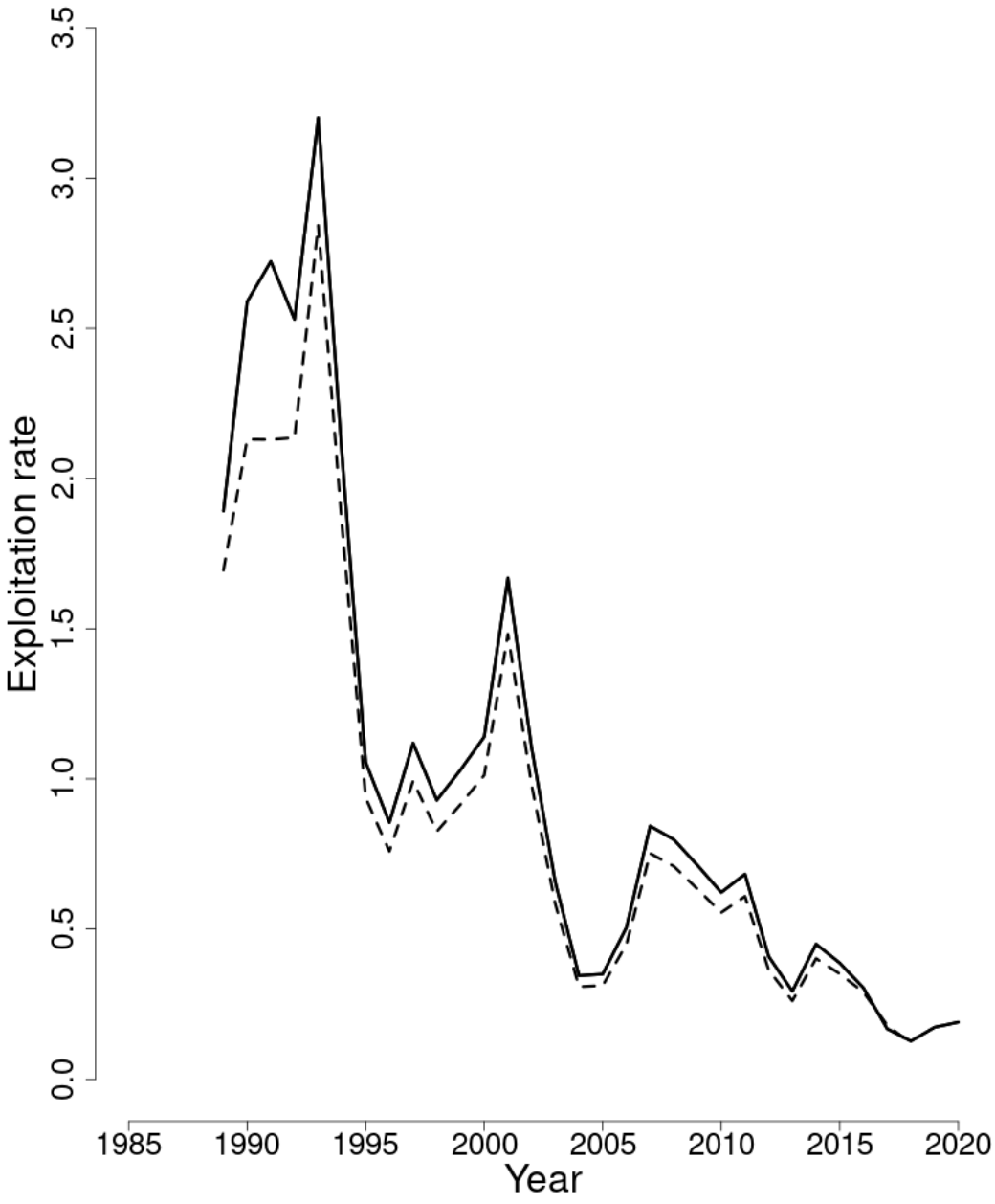

Figure 2: Trends in the relative exploitation rate (catch/smoothed survey) of Georges Bank Atlantic cod between 1989 and 2020 from the current (solid line) and previous (dashed line) assessment.

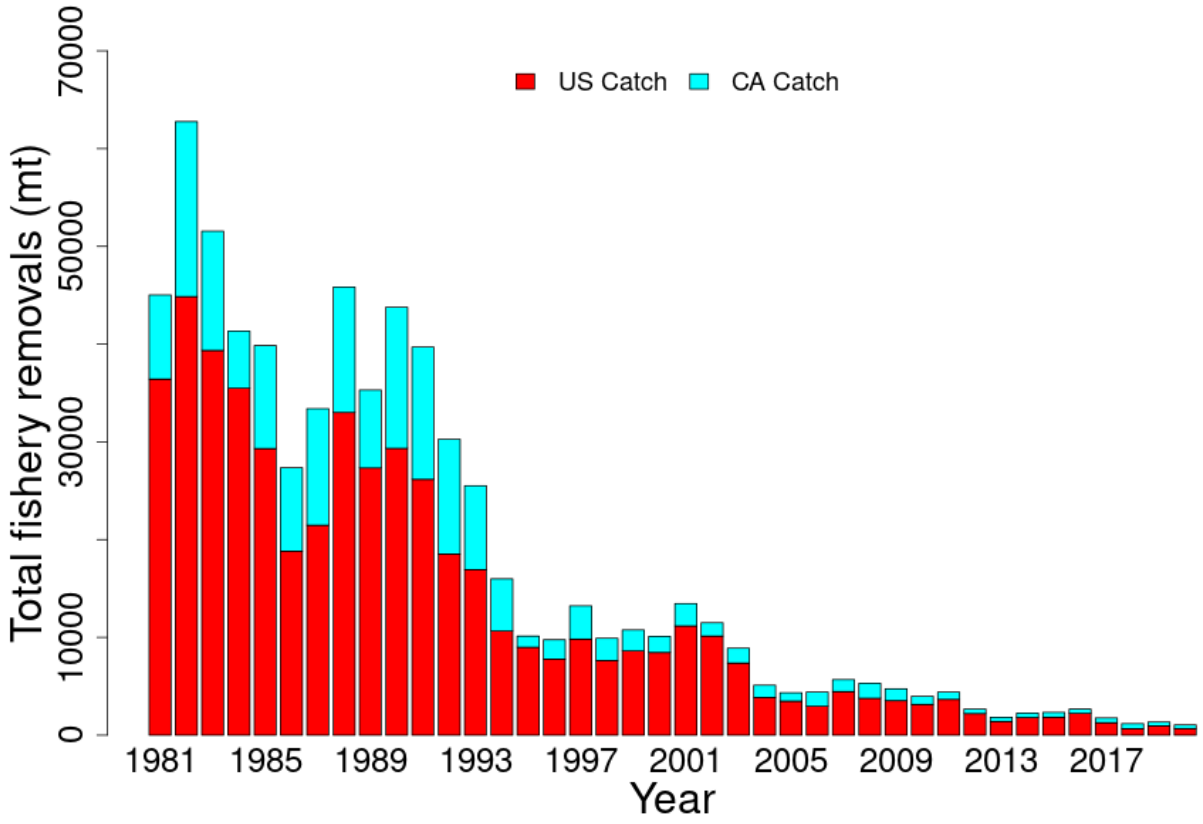

Figure 3: Total catch of Georges Bank Atlantic cod between 1981 and 2020 by fleet (US or Canadian). 2020 catches were estimated by the Groundfish Plan Development Team.

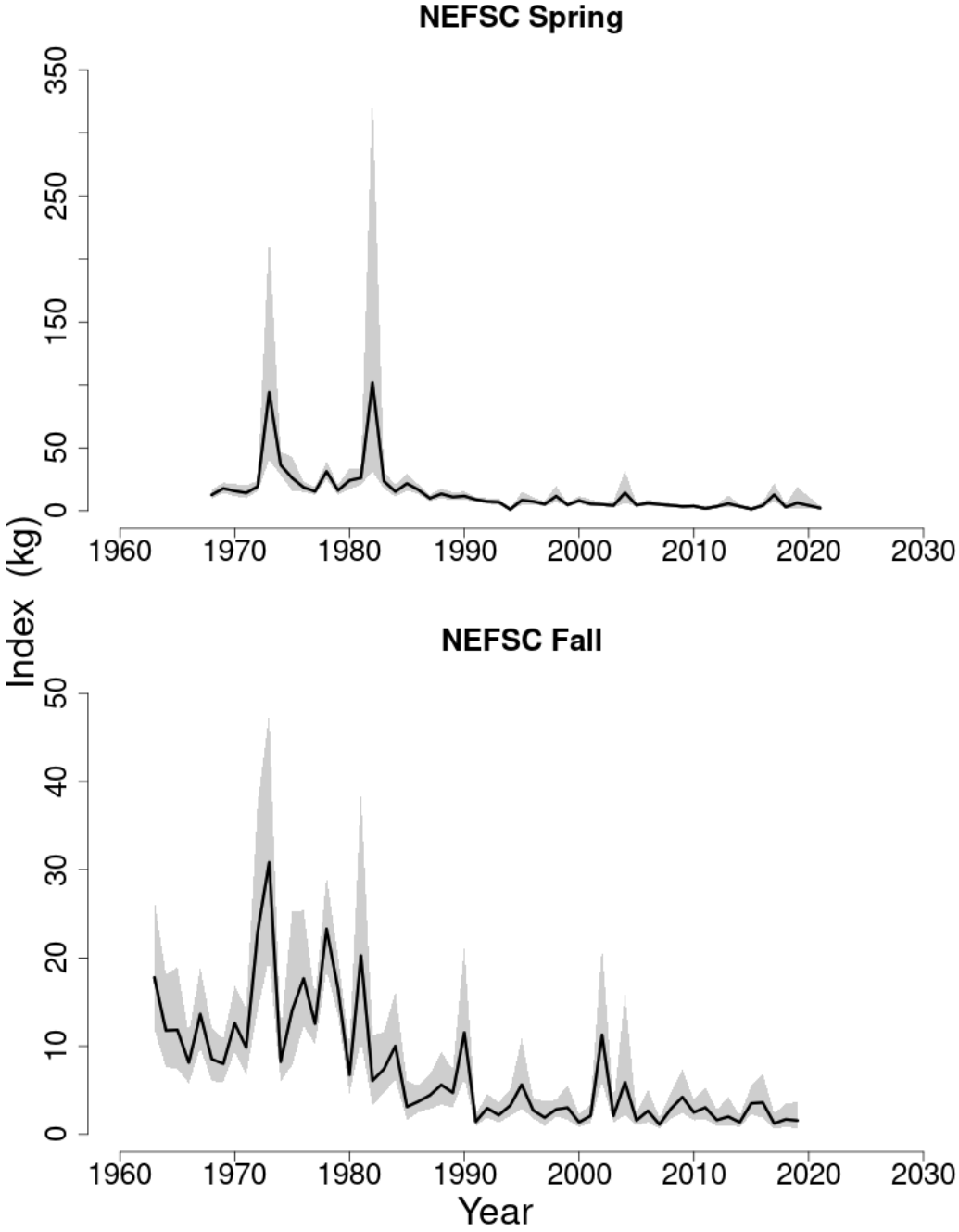

Figure 4: Indices of biomass for the Georges Bank Atlantic cod between 1963 and 2021 for the Northeast Fisheries Science Center (NEFSC) spring and fall trawl surveys. The approximate 90% lognormal confidence intervals are shown.The 2020 spring and fall surveys are missing even though the spring survey line goes through 2020.