draft working paper for peer review only

Western Gulf of Maine cod

2024 Management Track Assessment Report

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

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This assessment of the Western Gulf of Maine cod (Gadus morhua) stock is a Management Track assessment update of the 2023 Atlantic Cod Research Track assessment (NEFSC In Prep). This assessment updates fishery catch data, research survey indices of abundance, and the Research Track assessment model and reference points through 2023. Additionally, stock projections have been updated through 2027.

State of Stock: Based on this updated assessment, the Western Gulf of Maine cod (*Gadus morhua*) stock is overfished and overfishing is occurring (Figures 1-2). Retrospective adjustments were not made to the model results because the retrospective pattern was minor. Spawning stock biomass (SSB) in 2023 was estimated to be 1,847 (mt) which is 3% of the biomass target (SSB_{MSY} *proxy* = 62,677; Figure 1). The 2023 fully selected fishing mortality was estimated to be 0.31 which is 163% of the overfishing threshold proxy (F_{MSY} *proxy* = 0.19; Figure 2).

Table 1: Catch and status table for Western Gulf of Maine cod. All weights are in (mt), recruitment is in (000s), and F_{Full} is the fishing mortality on fully selected ages (ages 6 and 7). Model results are from the current updated WHAM assessment.

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
					Data					
Recreational discards	170	192	376	690	390	122	164	139	147	144
Recreational landings	817	11	192	176	10	40	12	167	66	80
Commercial discards	36	24	23	26	30	14	35	56	27	29
Commercial landings	1,401	675	662	568	720	767	514	425	401	410
Catch for Assessment	2,424	903	1,252	1,461	1,151	943	725	787	641	662
					Model Results					
Spawning Stock Biomass	2,390	3,003	3,559	3,570	2,896	1,993	1,432	1,440	1,491	1,847
F_{Full}	0.75	0.23	0.26	0.28	0.29	0.38	0.41	0.41	0.32	0.31
Recruits (age 1)	1,747	1,058	451	375	1,094	487	1,418	1,916	1,798	887

Table 2: Reference points from the current assessment. Comparison of reference points to an earlier assessment is not available as this is a newly defined stock. An $F_{40\%}$ proxy was used for the overfishing threshold, and SSB_{MSY} *proxy* and MSY (mt) are based on the Spawning Potential Ratio (SPR).

	NA	2024
F_{MSY} *proxy*		0.19 (0.17 - 0.21)
SSB_{MSY} (mt)		62,677 (47,959 - 81,912)
MSY (mt)		11,271 (8,591 - 14,786)
Median recruits (age 1) (000s)		8,243
Overfishing	Unknown	Yes
Overfished	Unknown	Yes

Projections: Short term projections of biomass and catch were performed using standard WHAM projections from the assessment model. The most recent five-year averages of annual fishery selectivity, maturity, and mean weight-at-age were used in the projections.

Table 3: Short term projections of total fishery catch and spawning stock biomass for Western Gulf of Maine cod based on a harvest scenario of fishing at F_{MSY} *proxy* between 2025 and 2027. The catch in 2024, 662 (mt), is assumed to be equal to the terminal year catch.

Year	Catch (mt)	SSB (mt)	F_{Full}
2024	662	1,942 (953 - 3,958)	0.269

Year	Catch (mt)	SSB (mt)	F_{Full}
2025	507	2,144 (864 - 5,316)	0.188
2026	585	2,492 (879 - 7,067)	0.188
2027	733	3,178 (928 - 10,879)	0.188

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 Review Panel chose to exclude the 2023 spring Bottom Longline Survey data due to their concerns about the low estimate of SSB in the terminal year (see Reviewer Report for details). That exclusion increased terminal SSB by 150%, and decreased terminal F by 58%. This is an important source of uncertainty.

- 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}).

  The 7-year Mohn's ρ, relative to SSB, was 0.04 in 2023. The 7-year Mohn's ρ, relative to F, was 0.04 in 2023. This is a minor retrospective pattern because the ρ adjusted estimates of 2023 SSB (SSB_{ρ}=1779) and 2023 F (F_{ρ}=0.3) are within the approximate 90% confidence regions around SSB (1,194 - 2,857) and F (0.2 - 0.48).

- 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?

  When projections from the last assessment (2023 Research Track) are updated with the known catch in 2022 and 2023, the projections of SSB are above the estimates of SSB in this assessment. In addition, for 2023, the lower bound of the 90% projection interval is above the point estimate of SSB in this assessment (see slide 110 of presentation). Therefore, the last assessment provided excessively high projected SSB and corresponding catch advice, particularly for 2023.

  The risk of excessively high projections in this assessment is further heightened by the decision to drop the 2023 spring Bottom Longline Survey observation. For comparison, the rejected Base model projected catch for 2025-2027 is 83mt, 140mt, and 264mt, respectively.

  This stock is not yet 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.

  CAMS discard data (2020+) was incorporated in this assessment, including discards from the lobster fleet. A sensitivity run showed minimal effect of including the lobster fleet discards. Following guidance from ongoing research and the 2023 State-space Research Track assessment, an exploratory run excluding the lognormal adjustment for process error and observation error resulted in a minor improvement in diagnostics and was therefore retained. These changes had minimal impact on model results and no change to stock status.

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

  This is the first Management Track assessment for this newly created stock, therefore official stock status

was unknown prior to this assessment. However, the stock status of overfished with overfishing occurring is consistent with the previous Gulf of Maine cod stock assessment (NEFSC 2021).

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

  The stock shows a truncated age structure, with terminal SSB the fourth lowest on record, and terminal recruitment the fifth lowest on record. The terminal year of this assessment is 2023, however the 2024 spring NMFS Bottom Trawl Survey index of abundance is the lowest on record. Stock status is poor.

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

  Collecting the data needed to fully differentiate the spring-spawning stock from the winter-spawning stock would be a potential improvement. Based on limited data, the spring-spawning stock appears to be more depleted than the combined WGOM stock. In addition, if stock projections continue to be biased high, an understanding of the cause of that bias would be helpful.

- Are there other important issues?

  The validity of historical catch estimates for this stock is an issue that remains unresolved.

References:

Northeast Fisheries Science Center. 2021. Management Track Assessments Fall 2021. US Dept Commer, Northeast Fish Sci Cent Ref Doc. 22-07; 53 p.

Northeast Fisheries Science Center. In Prep. Research Track Assessment of Atlantic Cod. US Dept Commer, Northeast Fish Sci Cent Ref Doc. XX-XX; XXX p.

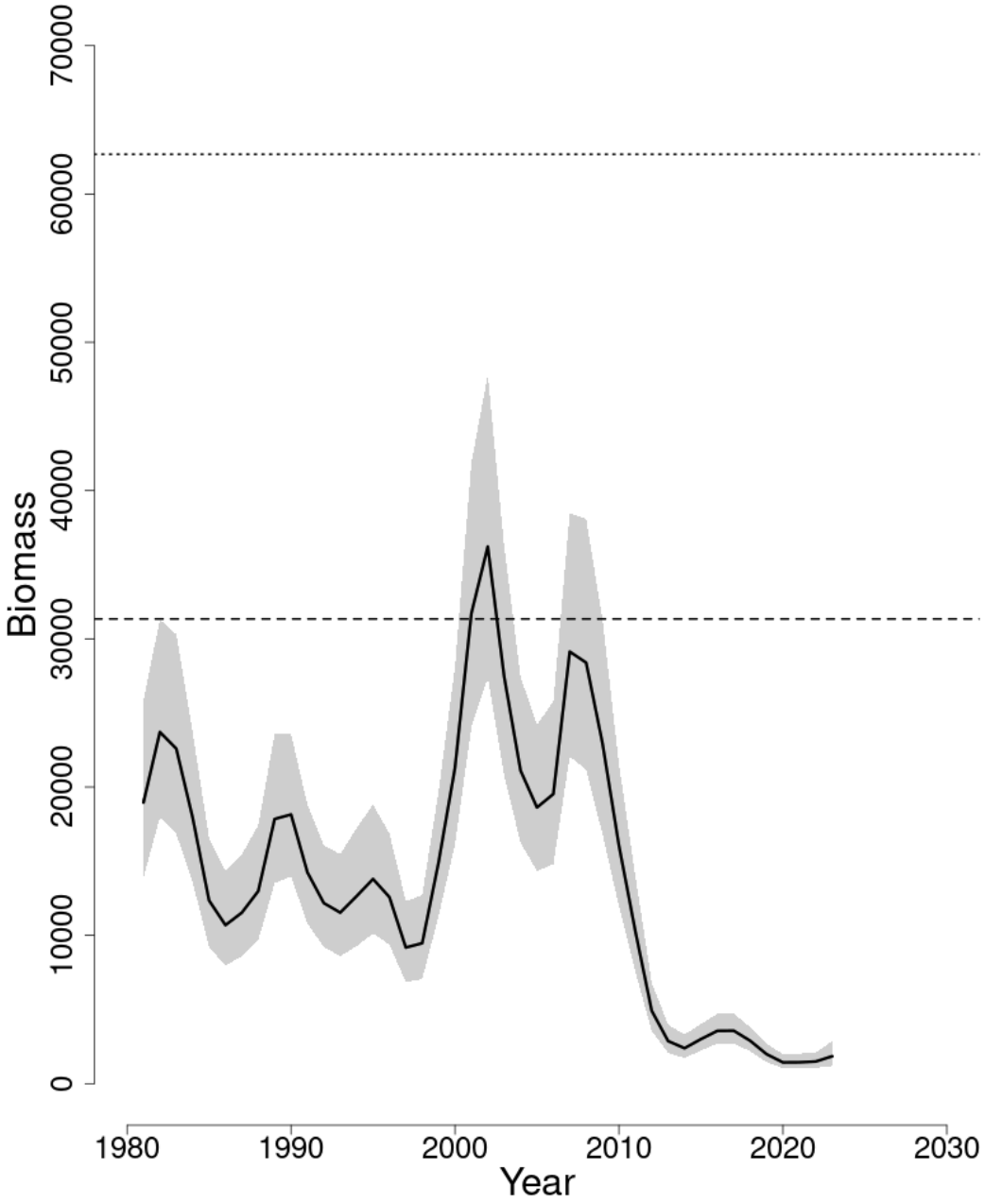

Figure 1: Trends in spawning stock biomass of Western Gulf of Maine cod between 1981 and 2023 from the current assessment and the corresponding $SSB_{Threshold}$ ($\frac{1}{2}$ SSB_{MSY} *proxy*; horizontal dashed line) as well as SSB_{Target} (SSB_{MSY} *proxy*; horizontal dotted line) based on the 2024 assessment. SSB was not adjusted for a retrospective pattern because the retrospective pattern was minor. The approximate 90% lognormal confidence interval is shown.

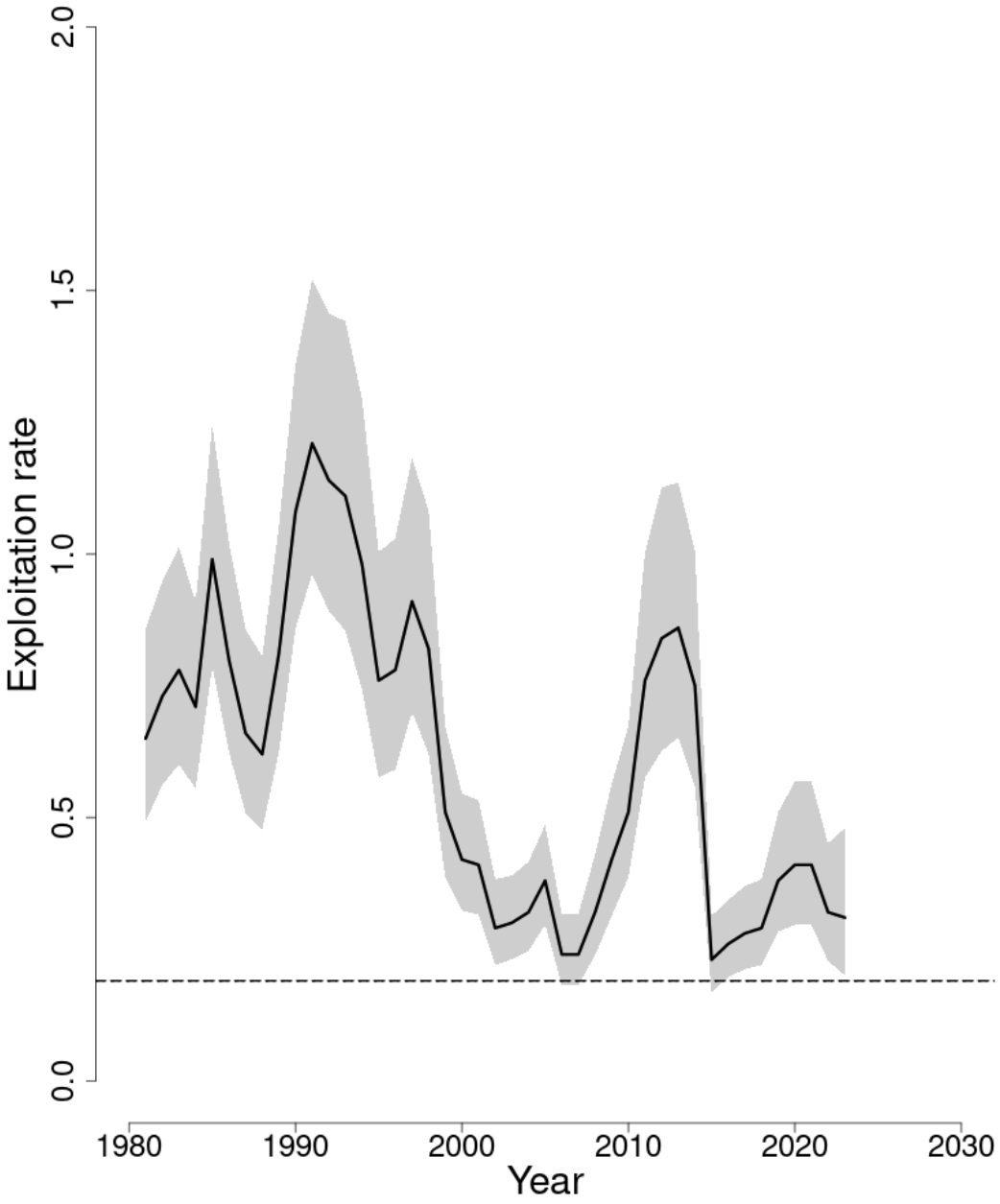

Figure 2: Trends in the fully selected fishing mortality (F_{Full}) of Western Gulf of Maine cod between 1981 and 2023 from the current assessment and the corresponding $F_{Threshold}$ (F_{MSY} *proxy*=0.19; horizontal dashed line). F_{Full} was not adjusted for a retrospective pattern because the retrospective pattern was minor. The approximate 90% lognormal confidence interval is shown.

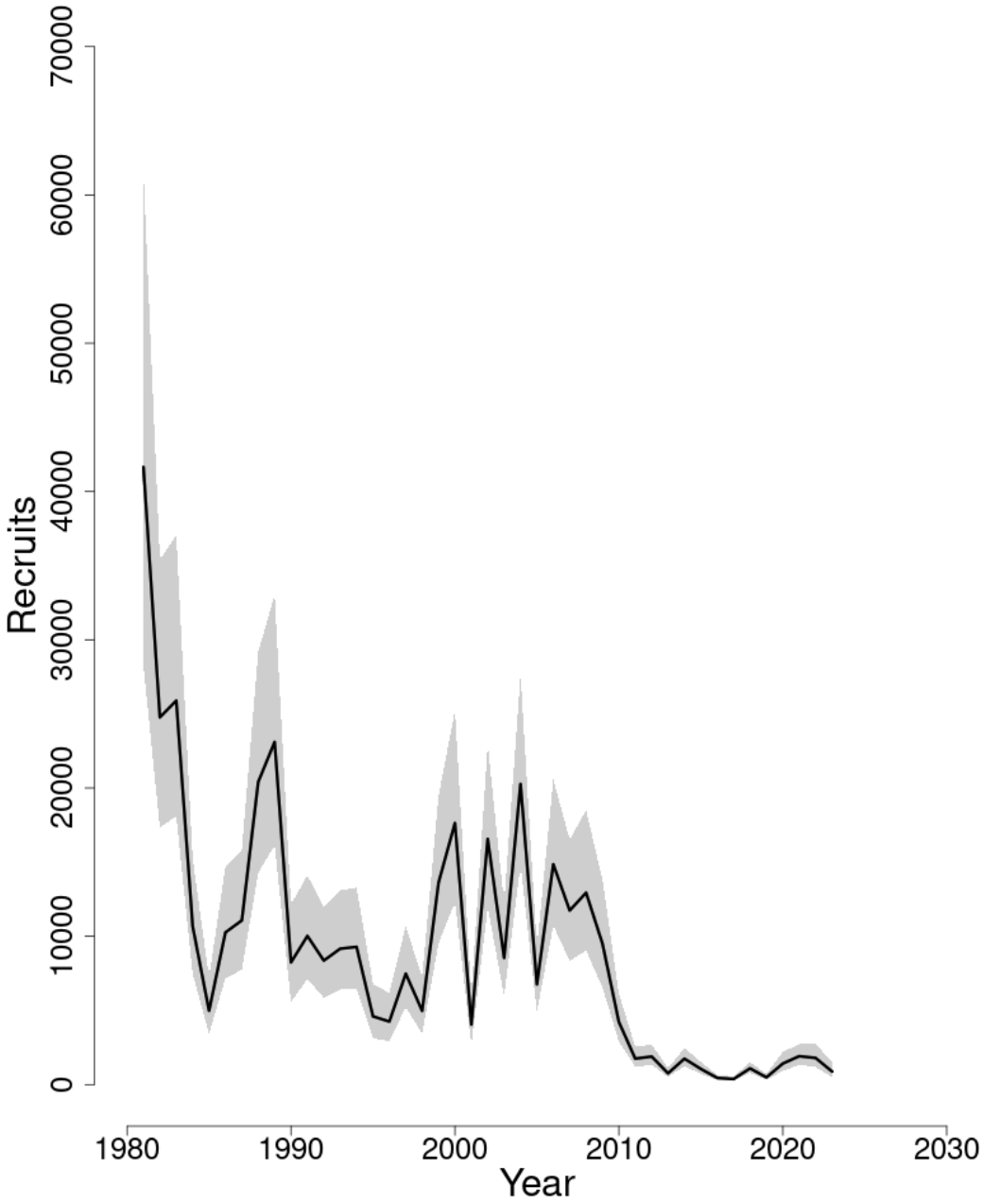

Figure 3: Trends in Recruits (age 1) (000s) of Western Gulf of Maine cod between 1981 and 2023 from the current assessment. The approximate 90% lognormal confidence interval is shown.

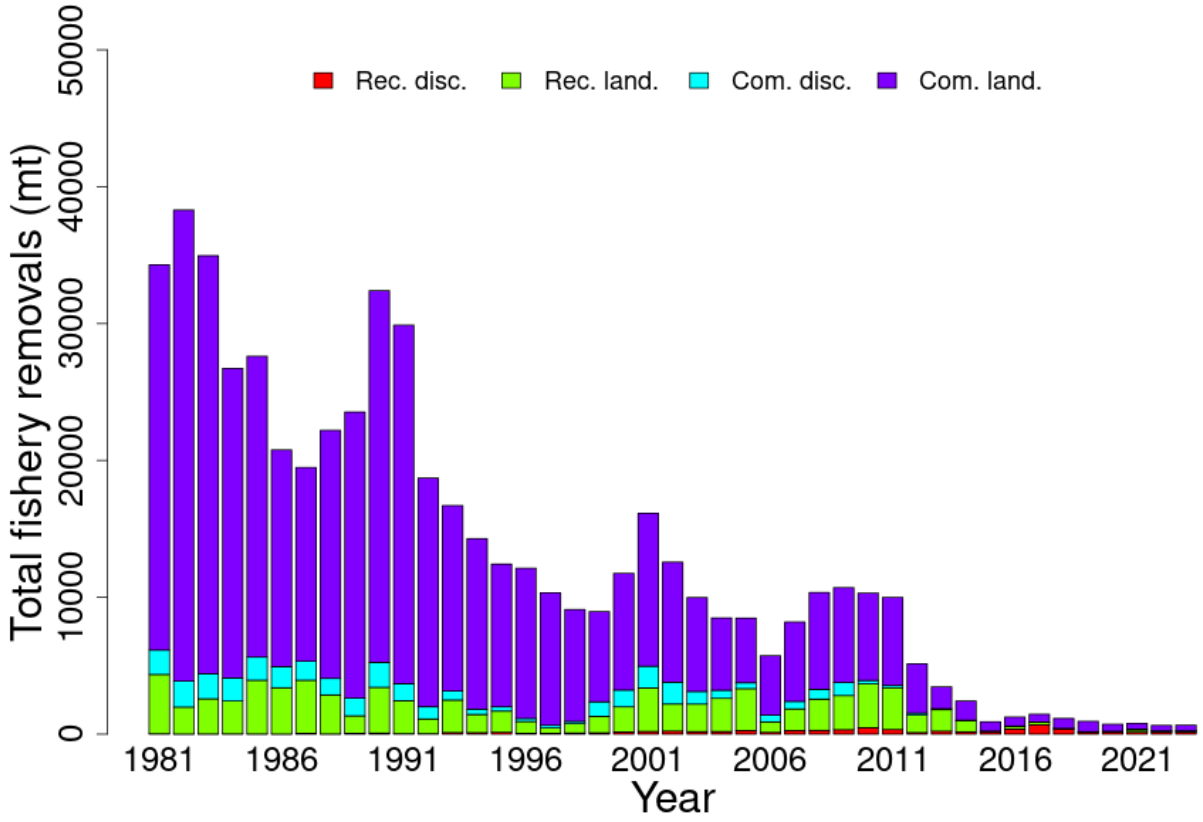

Figure 4: Total catch of Western Gulf of Maine cod between 1981 and 2023 by fleet (commercial and recreational) and disposition (landings and discards).

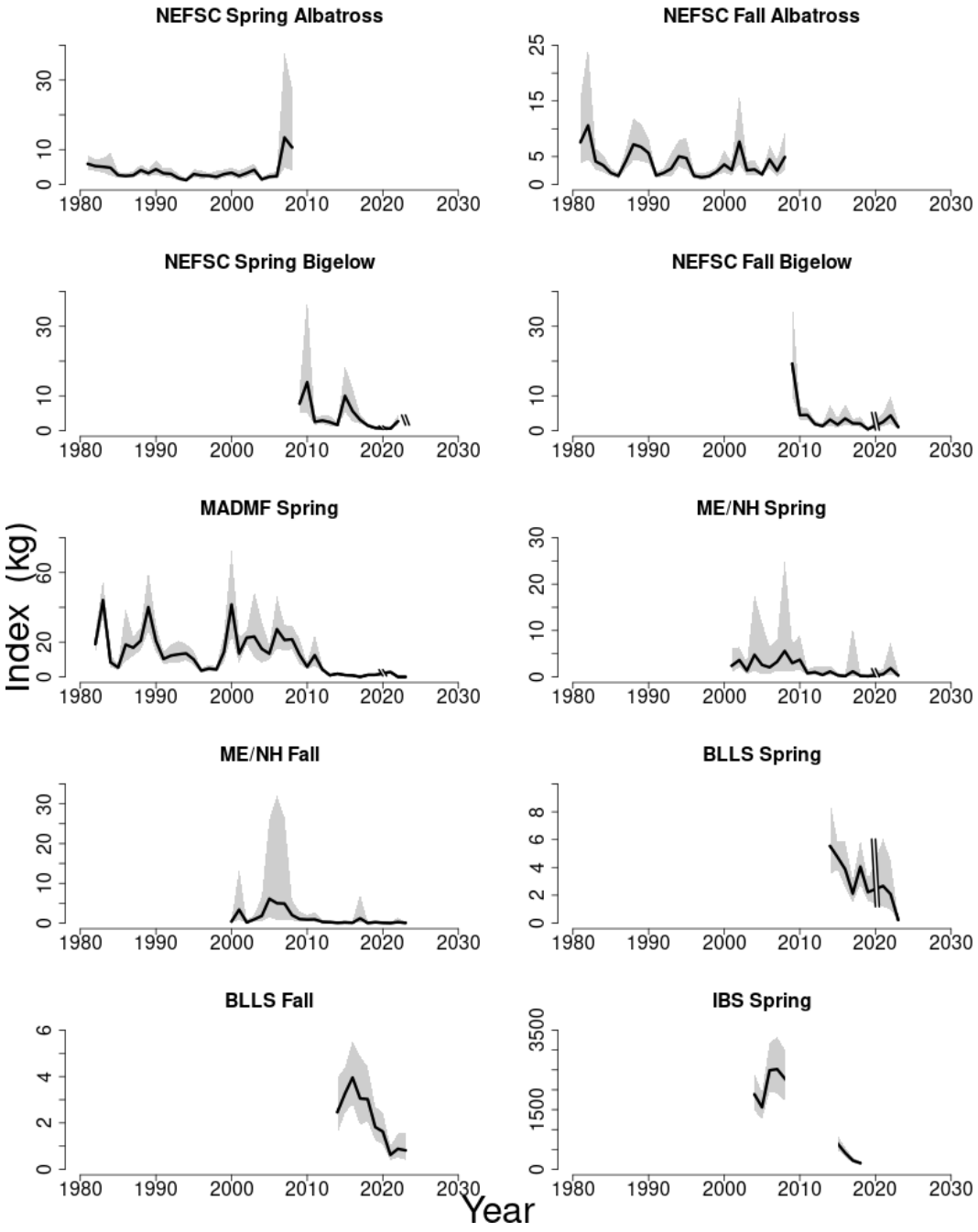

Figure 5: Indices of biomass for the Western Gulf of Maine cod between 1981 and 2023 for the Northeast Fisheries Science Center (NEFSC) Albatross and Bigelow Research Vessels, as well as the Massachusetts Division of Marine Fisheries (MADMF), Maine-New Hampshire (ME/NH), Bottom Longline Survey (BLLS), and Industry Based Survey (IBS). Note that the 2023 value of the Bottom Longline Survey was excluded in the final model. The approximate 90% lognormal confidence intervals are shown.