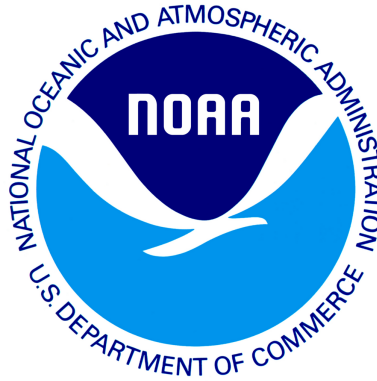


draft working paper for peer review only



Georges Bank haddock

2015 Assessment Update 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 Georges Bank haddock (*Melanogrammus aeglefinus*) stock is an operational update of the existing 2012 update VPA assessment (Brooks et al., 2012). The last benchmark for this stock was in 2008 (Brooks et al., 2008). Based on the previous assessment in 2012, the stock was not overfished, and overfishing was not occurring. This assessment updates commercial fishery catch data, research survey indices of abundance, weights and maturity at age, and the analytical VPA assessment model and reference points through 2014. Additionally, stock projections have been updated through 2018.

State of Stock: Based on this updated assessment, the Georges Bank haddock (*Melanogrammus aeglefinus*) stock is not overfished and overfishing is not occurring (Figures 1-2). Spawning stock biomass (SSB) in 2014 was estimated to be 225,080 mt, which is 208% of the biomass target (SSB_{MSY} proxy = 108,300 mt; Figure 1). The 2014 fishing mortality (average for ages 5-7) was estimated to be 0.159, which is 41% of the overfishing threshold proxy (F_{MSY} proxy = 0.39; Figure 2).

Table 1: Catch and status table for Georges Bank haddock. All weights are in (mt), recruitment is in (000s), and F_{Full} is the average fishing mortality on ages 5 to 7. Model results are from the current updated VPA assessment.

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
	<i>Data</i>									
US Commercial discards	727	1,360	1,968	389	196	144	212	321	538	1,409
US Commercial landings	21,087	14,629	14,837	20,632	22,930	25,759	5,210	1,550	1,659	4,240
Canadian Catch	12,051	11,951	10	0	0	0	11,248	5,064	4,631	12,953
Catch for Assessment	21,814	15,989	16,815	21,021	23,126	25,903	16,670	6,935	6,828	18,601
	<i>Model Results</i>									
Spawning Stock Biomass	102,539	168,119	182,528	166,726	140,278	103,889	71,076	65,848	162,078	225,080
F_{Full}	0.384	0.322	0.241	0.183	0.195	0.308	0.266	0.258	0.16	0.159
Recruits <i>age1</i>	6,634	15,437	5,826	6,488	3,574	7,696	399,497	70,916	29,655	3,406,466

Table 2: Comparison of reference points estimated in an earlier assessment and from the current assessment update. An $F_{40\%}$ proxy was used for the overfishing threshold and was based on long-term stochastic projections. The medians and 90% probability intervals are reported for MSY and SSBMSY. The median recruits is descriptive and does not reflect the RMSY proxy.

	2012	Current
F_{MSY} proxy	0.39	0.39
SSB_{MSY} (mt)	124,900	108,300 (58,200 - 167,900)
MSY (mt)	28,000	24,900 (13,600 - 38,400)
Median recruits (age 1) (000s)	26,141	31,084
<i>Overfishing</i>	No	No
<i>Overfished</i>	No	No

Projections: Short term projections of biomass were derived by sampling from a cumulative distribution function of recruitment estimates from ADAPT VPA (corresponding to $SSB > 75,000$ mt and dropping the extremely large 1963, 2003, and 2010 year classes, as well as the two final year class estimates for 2013 and 2014). The annual fishery selectivity, maturity ogive, and mean weights at age used in projection are the most recent 5 year averages; retrospective adjustments were applied in the projections.

Table 3: Short term projections of total fishery catch and spawning stock biomass for Georges Bank haddock based on a harvest scenario of fishing at F_{MSY} proxy between 2016 and 2018. Catch in 2015 was assumed to be 20,686 mt.

Year	Catch (mt)	SSB (mt)	F_{Full}
2015	20,686	450,644 (295,863 - 677,103)	0.10 (0.073 - 0.14)
2016	160,385 (98,994 - 255,087)	1,171,481 (636,247 - 1,997,691)	0.39
2017	242,187 (132,381 - 414,260)	1,226,513 (655,530 - 2,109,738)	0.39
2018	293,033 (155,255 - 506,597)	962,959 (525,327 - 1,647,905)	0.39

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 is the estimate of 2013 recruitment, which accounts for a substantial portion of catch and SSB in projections. The rho adjusted projections reduce all starting numbers at age by 50%. Based on previous exceptionally large year classes, this adjustment is likely to be sufficient to account for trends in subsequent re-estimates of this year class. In addition, the median recruitment in the projections (the proxy for recruitment at MSY) is 53.4 million, which is greater than 7 of the last 10 recruitments even though SSB is above the SSB_{MSY} proxy (Table 1). While projections of catch and SSB in the near-term are mostly driven by the 2013 year class, it is worth noting the magnitude of median projected recruitment relative to recent recruitment observations.
- Does this assessment model have a retrospective pattern? If so, is the pattern minor, or major?
This assessment has a moderate retrospective pattern, with a Mohn's rho of 0.5 for SSB and -0.34 for F (average F on ages 5 to 7).
- Based on this stock assessment, are population projections well determined or uncertain?
As noted in (1) above, population projections for Georges Bank haddock are uncertain due to uncertainty about the size of the 2013 year class.
- 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.
No changes, other than the incorporation of new data were made to the Georges Bank haddock assessment for this update. However, the criterion for determining acceptable tows on NEFSC surveys used the TOGA protocol rather than the SHG protocol ($TOGA = 132x$).

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

The stock status of Georges Bank haddock has not changed.

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

Projection advice and reference points for Georges Bank haddock are strongly dependent on recruitment. A decade ago, extremely large year classes were considered anomalies (e.g., 1963 and 2003). However, since 2003, there have been two more extremely large (2010 and 2013) and one very large (2012) year classes. Future work could focus on recruitment forecasting and providing robust catch advice.

- Are there other important issues?

The Georges Bank haddock assessment has recently developed a moderate retrospective pattern. This stock assessment has historically performed very consistently. This should continue to be monitored. The switch from SHG to TOGA was ruled out as the cause of the retrospective pattern.

References:

Brooks, E.N, M.L. Traver, S.J. Sutherland, L. Van Eeckhaute, and L. Col. 2008. In. 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 Dep Commer, NOAA Fisheries, Northeast Fish Sci Cent Ref Doc. 08-15; 884 p + xvii.
<http://www.nefsc.noaa.gov/publications/crd/crd0815/>

Brooks, E.N, S.J. Sutherland, L. Van Eeckhaute, and M. Palmer. 2012. In. Northeast Fisheries Science Center. 2012. Assessment or Data Updates of 13 Northeast Groundfish Stocks through 2010. US Dept Commer, NOAA Fisheries, Northeast Fish Sci Cent Ref Doc. 12-06.; 789 p.
<http://nefsc.noaa.gov/publications/crd/crd1206/>

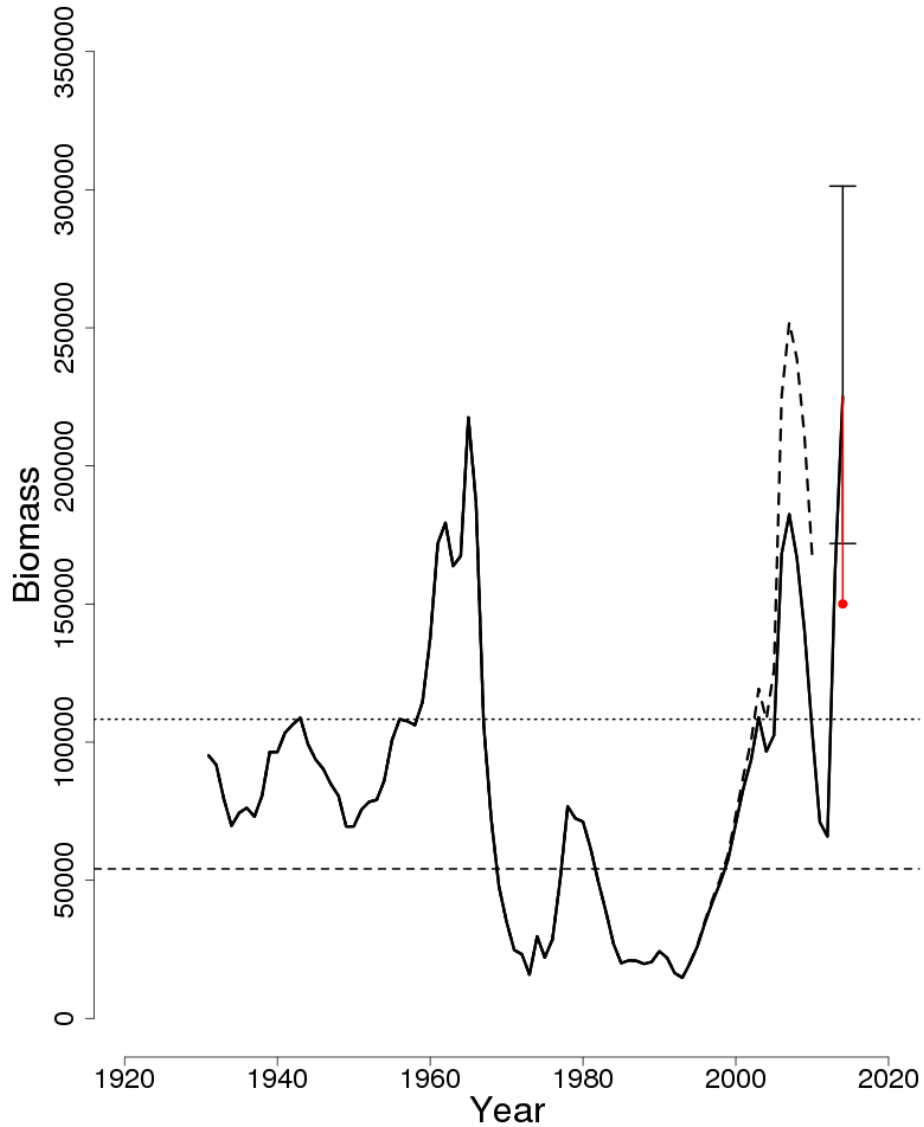


Figure 1: Trends in spawning stock biomass of Georges Bank haddock between 1931 and 2014 from the current (solid line) and previous (dashed line) assessment and the corresponding $SSB_{Threshold}$ ($\frac{1}{2} SSB_{MSY}$ proxy; horizontal dashed line) as well as SSB_{Target} (SSB_{MSY} proxy; horizontal dotted line) based on the 2015 assessment. Biomass was adjusted for a retrospective pattern and the adjustment is shown in red. The 90% bootstrap probability intervals are shown.

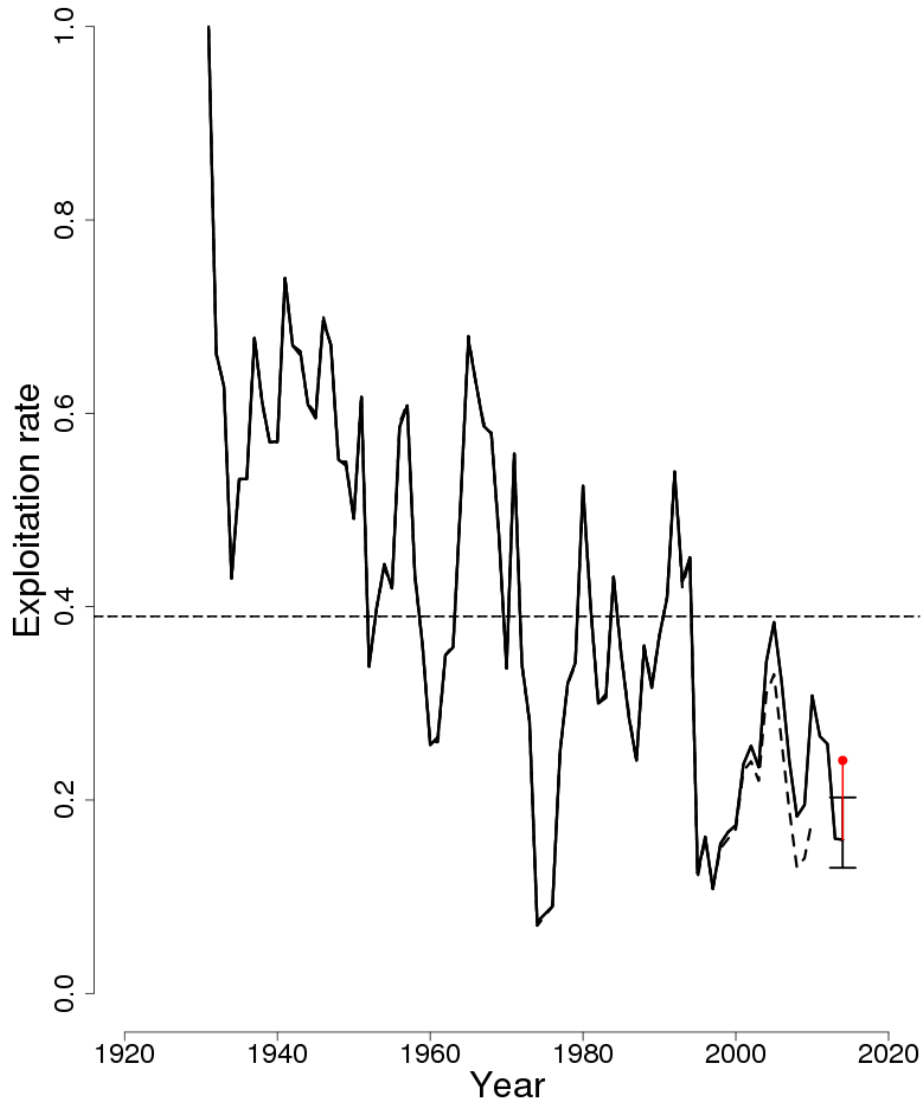


Figure 2: Trends in the fully selected fishing mortality (F_{Full}) of Georges Bank haddock between 1931 and 2014 from the current (solid line) and previous (dashed line) assessment and the corresponding $F_{Threshold}$ (F_{MSY} proxy=0.39; horizontal dashed line). F_{Full} was adjusted for a retrospective pattern and the adjustment is shown in red. based on the 2015 assessment. The 90% bootstrap probability intervals are shown.

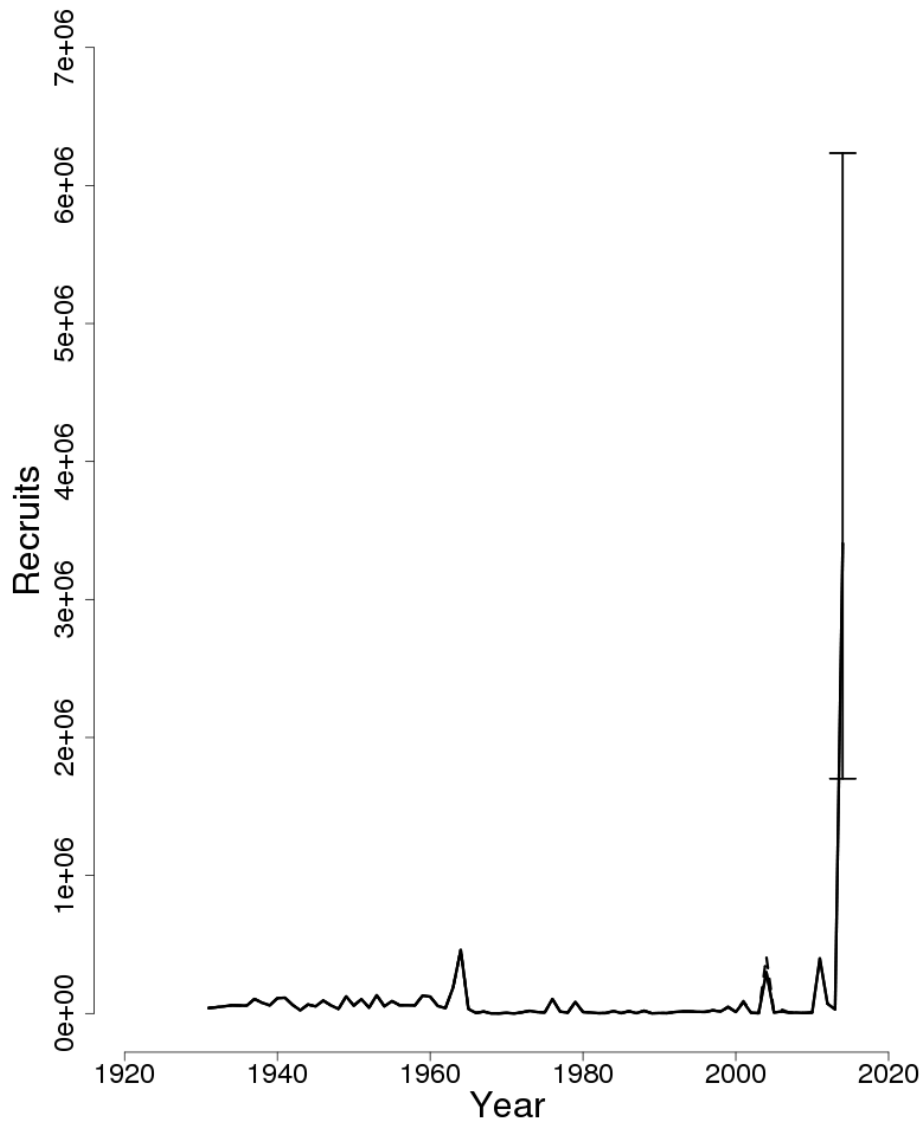


Figure 3: Trends in Recruits (age 1) (000s) of Georges Bank haddock between 1931 and 2014 from the current (solid line) and previous (dashed line) assessment. The 90% bootstrap probability intervals are shown.

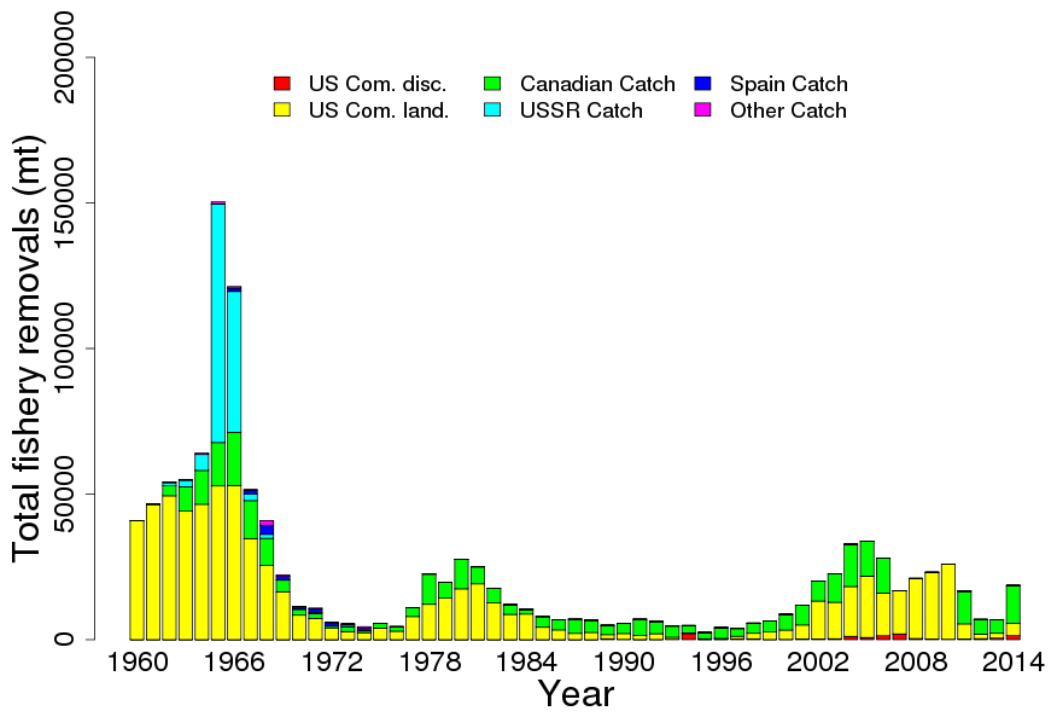


Figure 4: Total catch of Georges Bank haddock between 1931 and 2014 by fleet (US Commercial, Canadian, or foreign fleet) and disposition (landings and discards).

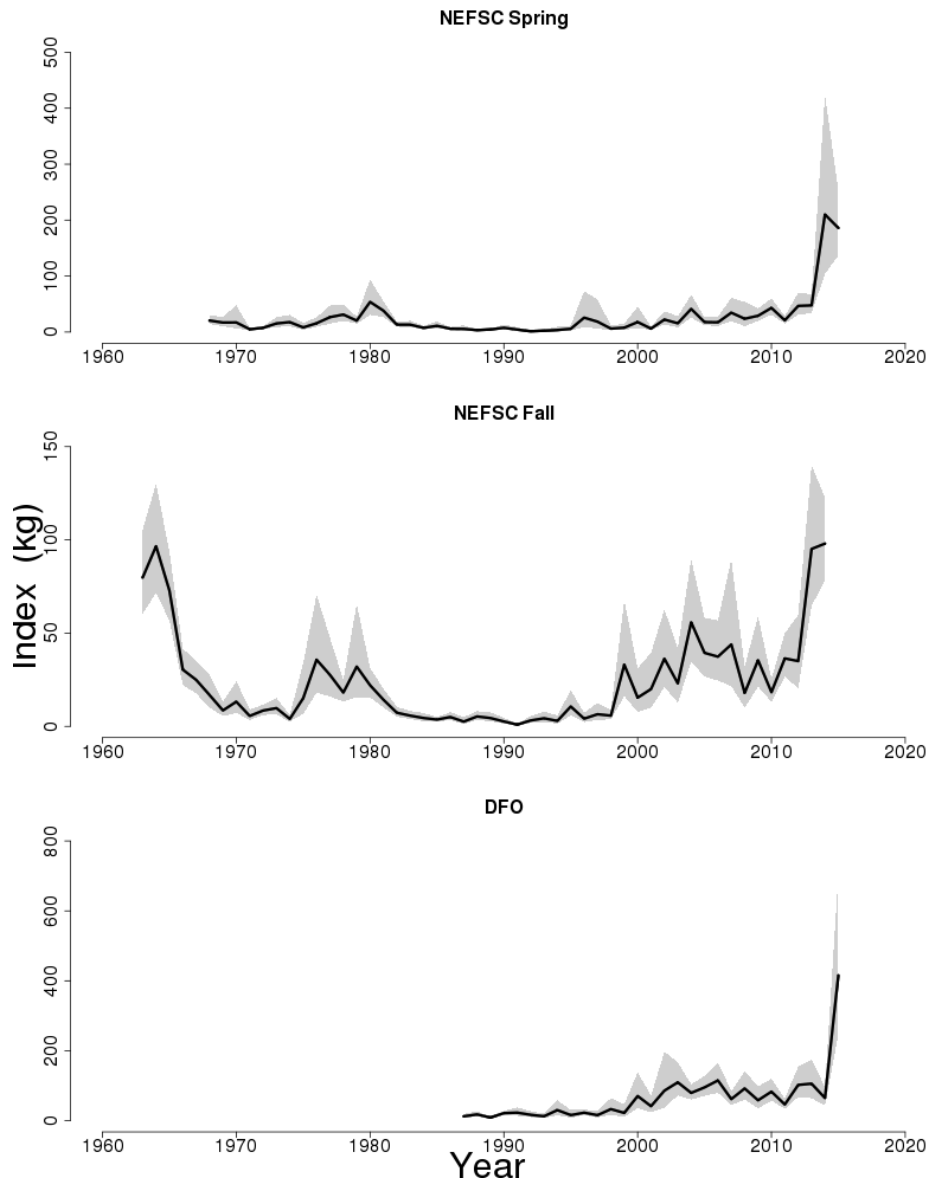


Figure 5: Indices of biomass (Mean kg/tow) for the Georges Bank haddock stock between 1963 and 2015 for the Northeast Fisheries Science Center (NEFSC) spring and fall bottom trawl surveys and the DFO winter bottom trawl survey. The approximate 90% lognormal confidence intervals are shown.