6 Cape Cod-Gulf of Maine yellowtail flounder

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This assessment of the Cape Cod-Gulf of Maine yellowtail flounder (Limanda ferruginea) stock is an operational assessment of the existing 2012 VPA assessment (Legault et al., 2012). The last benchmark for this stock was in 2008 (Legault et al., 2008). Based on the previous assessment the stock was overfished, and overfishing was occurring. This assessment updates commercial fishery catch data, research survey indices of abundance, weights 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, Cape Cod-Gulf of Maine yellowtail flounder (*Limanda ferruginea*) stock is overfished and overfishing is occurring (Figures 31-32). Retrospective adjustments were made to the model results. Spawning stock biomass (SSB) in 2014 was estimated to be 857 (mt) which is 16% of the biomass target (SSB_{MSY} *proxy* = 5,259; Figure 31). The 2014 fully selected fishing mortality was estimated to be 0.64 which is 229% of the overfishing threshold proxy (F_{MSY} *proxy* = 0.279; Figure 32).

Table 21: Catch and model results for Cape Cod-Gulf of Maine yellowtail flounder. All weights are in (mt), recruitment is in (000s) and F_{Full} is the average fishing mortality on ages (ages 4 and 5). Model results are from the current updated VPA assessment without any retrospective adjustment.

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
					Data					
Commercial discards	282	85	141	156	175	87	74	146	86	54
Commercial landings	715	534	492	543	464	546	684	946	590	421
Total Catch for Assessment	997	620	633	699	639	633	758	1,092	676	475
					Model Results					
Spawning Stock Biomass	687	668	789	944	1,120	1,474	1,659	1,285	1,179	1,695
F_{Full}	1.685	1.48	1.056	1.163	0.745	0.491	0.645	0.977	0.818	0.355
Recruits $age1$	2,927	3,593	3,458	3,816	4,151	3,542	3,332	4,666	8,013	10,268

Table 22: 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 SSB_{MSY}. The median recruits are descriptive and do not reflect the R_{MSY} proxy.

	2012	Current
F_{MSY} *proxy*	0.259	0.279
SSB_{MSY} (mt)	7,080	5,259 (3,950 - 7,412)
MSY (mt)	1,600	1,285 (968 - 1,806)
Median recruits (age 1) (000s)	7,279	6,562
Overfishing	Yes	Yes
Overfished	Yes	Yes

Projections: Short term projections of biomass were derived by sampling from a cumulative distribution function of recruitment estimates from ADAPT VPA. Recruitment estimates were hindcast based on a simple linear regression between the NEFSC Fall survey abundance at age 1 and the VPA estimate at age 1. The most recent two years (2013 and 2014) were not included in the series of values due to high uncertainty in these estimates. This resulted in a total of 36 recruitment values: 8 from the hindcast predictions (years 1977-1984) and 28 from the VPA (years 1985-2012). 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 23: Short term projections of total fishery catch and spawning stock biomass for Cape Cod-Gulf of Maine yellowtail flounder based on a harvest scenario of fishing at F_{MSY} *proxy* between 2017 and 2018. Catch in 2015 was assumed to be 376 (mt).

Year	Catch (mt)	SSB (mt)	F_{Full}
2015	376	1,762 (1,364 - 2,300)	0.276
2016	555 (426 - 750)	2,429 (1,846 - 3,341)	0.279
2017	680 (542 - 892)	2,847 (2,313 - 3,656)	0.279
2018	814 (645 - 1,075)	3,518 (2,706 - 4,832)	0.279

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 source of the retrospective pattern. This pattern has persisted for a number of years causing SSB estimates to decrease and F estimates to increase as more years of data are added.

- 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 RhoDecisionTab.ref).

  The 7-year Mohn's ρ, relative to SSB, was 0.68 in the 2012 assessment and was 0.98 in 2014. The 7-year Mohn's ρ, relative to F, was -0.19 in the 2012 assessment and was -0.45 in 2014. There was a major retrospective pattern for this assessment because the ρ adjusted estimates of 2014 SSB (SSB_ρ=857) and 2014 F (F_ρ=0.64) were outside the approximate 90% confidence region around SSB (1,375 - 2,111) and F (0.25 - 0.52). A retrospective adjustment was made for both the determination of stock status and for projections of catch in 2016. The retrospective adjustment changed the 2014 SSB from 1,695 to 857 and the 2014 F_{Full} from 0.355 to 0.64.

- Based on this stock assessment, are population projections well determined or uncertain?

  Population projections for Cape Cod-Gulf of Maine yellowtail flounder are uncertain as projected biomass from the last assessment was above the confidence bounds of the biomass estimated in the current assessment.

- 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.

  No changes, other than the incorporation of new data, were made to the Cape Cod-Gulf of Maine yellowtail flounder assessment for this update.

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

  The stock status has not changed since the previous assessment.

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

  Extensive studies have examined the causes of the retrospective patterns with no definitive conclusions. A change in model did not resolve the issue.

- Are there other important issues?

  No.

6.1 Reviewer Comments: Cape Cod-Gulf of Maine yellowtail flounder

Recommendation: The Panel concluded that the updated assessment with retrospective adjustment was acceptable as a scientific basis for management advice. The GARMIII benchmark stock assessment had a minor retrospective pattern (i.e., retrospective differences were within the confidence limits of the estimate). The 2012 update assessment had a major retrospective pattern (i.e., SSB rho=68% which was outside the confidence limits of the SSB estimate), so a retrospective adjustment was applied for stock status determination and projections. The 2015 operational assessment has a stronger retrospective pattern (SSB rho=98%, which is outside the confidence limits). Despite the major retrospective pattern, the operational assessment generally fits the data and is currently considered the most appropriate basis for status determination and projection.

Alternative Assessment Approach: Not applicable.

Sources of Uncertainty: The major source of uncertainty is the retrospective pattern. Misspecification of the assumed rate of natural mortality (M) was considered as a potential source of the retrospective pattern. The assumed M (0.2) is inconsistent with the recently revised assumptions for other New England yellowtail flounder stocks (M=0.4), which is based on life history attributes and equilibrium age distributions (SAW54, TRAC 2014). Although an exploratory analysis that assumed M=0.4 had less of a retrospective pattern, the pattern was still 'major' (outside the confidence limits). The apparent shift to deeper water may produce changes in fishery selectivity or survey catchability.

Research Recommendations: The Panel recommends that the sources of the retrospective pattern need to be addressed. Considering that retrospective patterns are a common problem, the generic problem may be most appropriately addressed in a research track topic, and all possible sources of the retrospective problem should be investigated (misspecified natural mortality, changes in natural mortality, under-reported catch, changes in survey catchability and misspecified selectivity, etc.). If analytical models cannot resolve the source of the retrospective pattern, empirical assessment approaches and simulation-based performance testing may be needed.

References:

Legault, C, L. Alade, S. Cadrin, J. King, and S. Sherman. 2008. In. Northeast Fisheries Science Center. 2008. Assessment of 19 Northeast Groundfish Stocks through 2007: Report of the 3^{rd} 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. CRD08-15

Legault, C, L. Alade, S. Emery, J. King, and S. Sherman. 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. CRD12-06

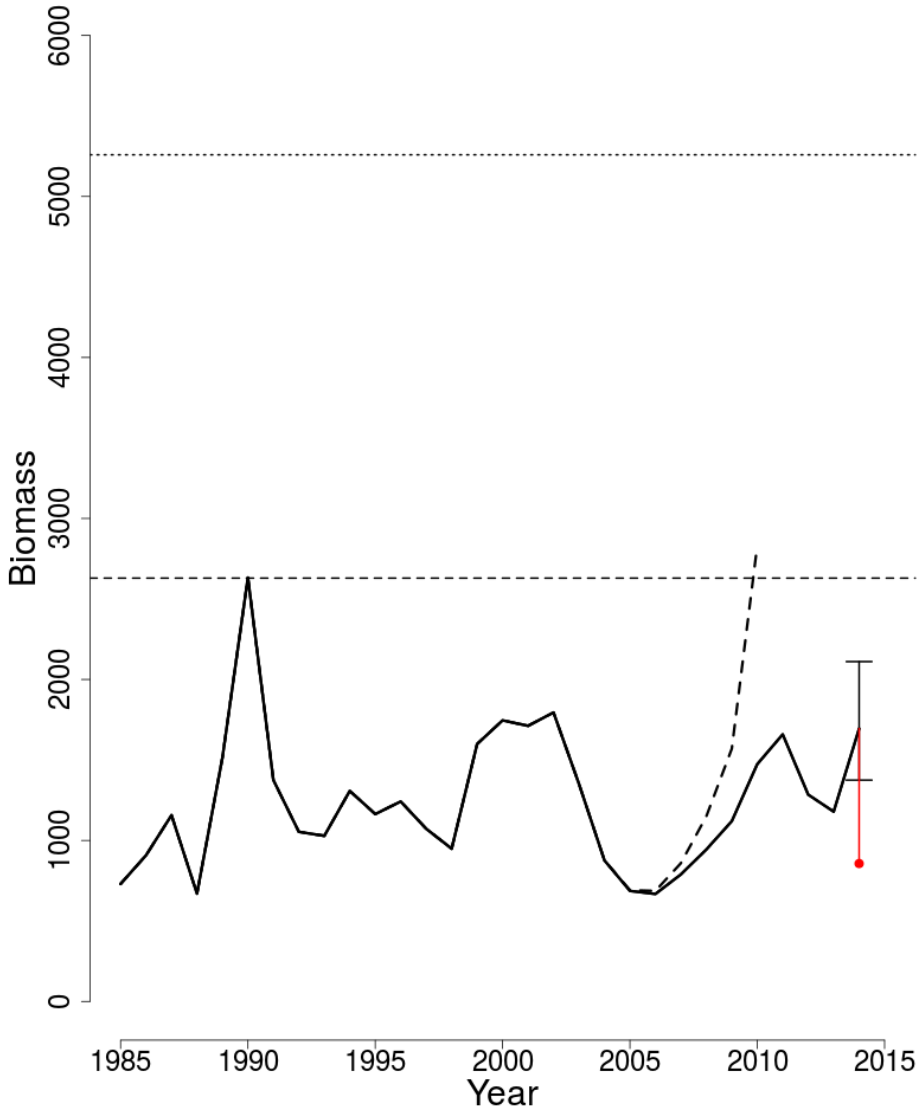

Figure 31: Trends in spawning stock biomass of Cape Cod-Gulf of Maine yellowtail flounder between 1985 and 2014 from the current (solid line) and previous (dashed line) assessment and the corresponding $SSB_{Threshold}$ ($\frac{1}{2}$ SSB_{MSY} *proxy*; horizontal dashed line) as well as SSB_{Target} (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.

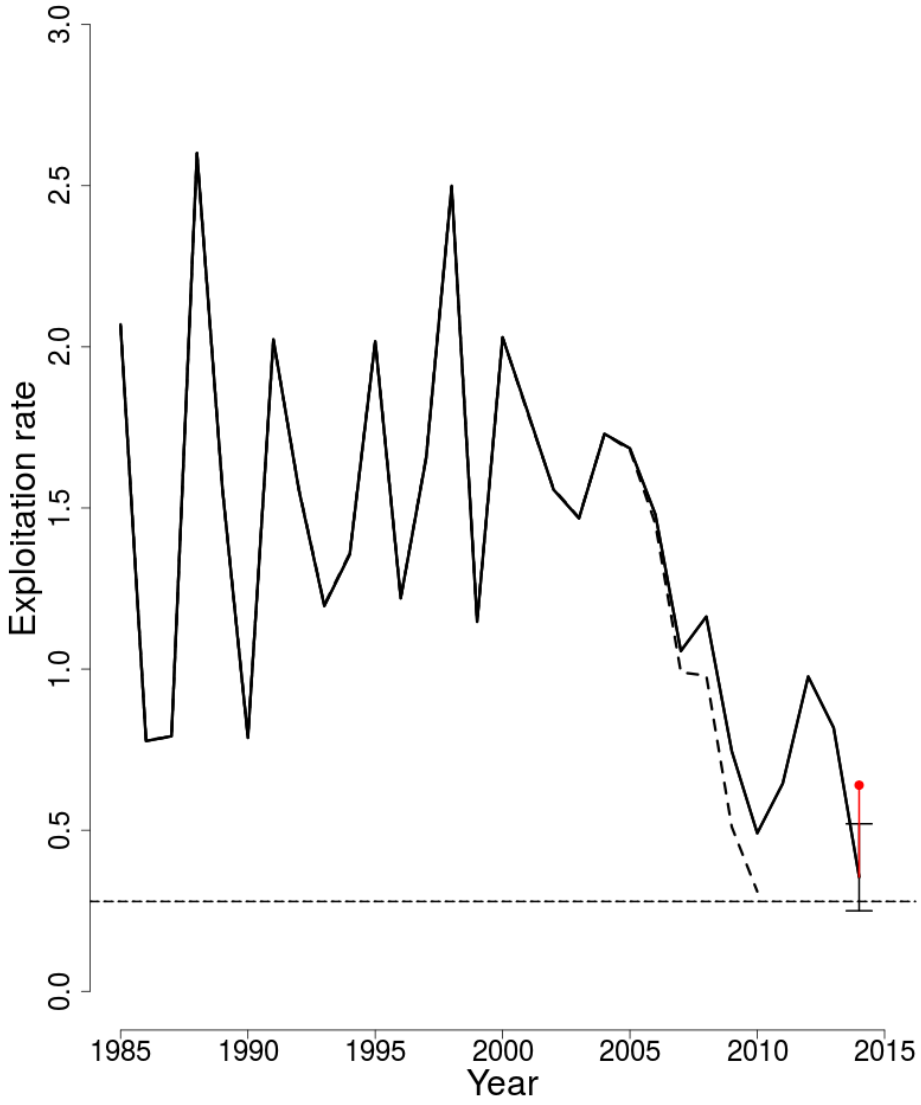

Figure 32: Trends in the fully selected fishing mortality (F_{Full}) of Cape Cod-Gulf of Maine yellowtail flounder between 1985 and 2014 from the current (solid line) and previous (dashed line) assessment and the corresponding $F_{Threshold}$ (F_{MSY} *proxy*=0.279; horizontal dashed line). F_{Full} 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.

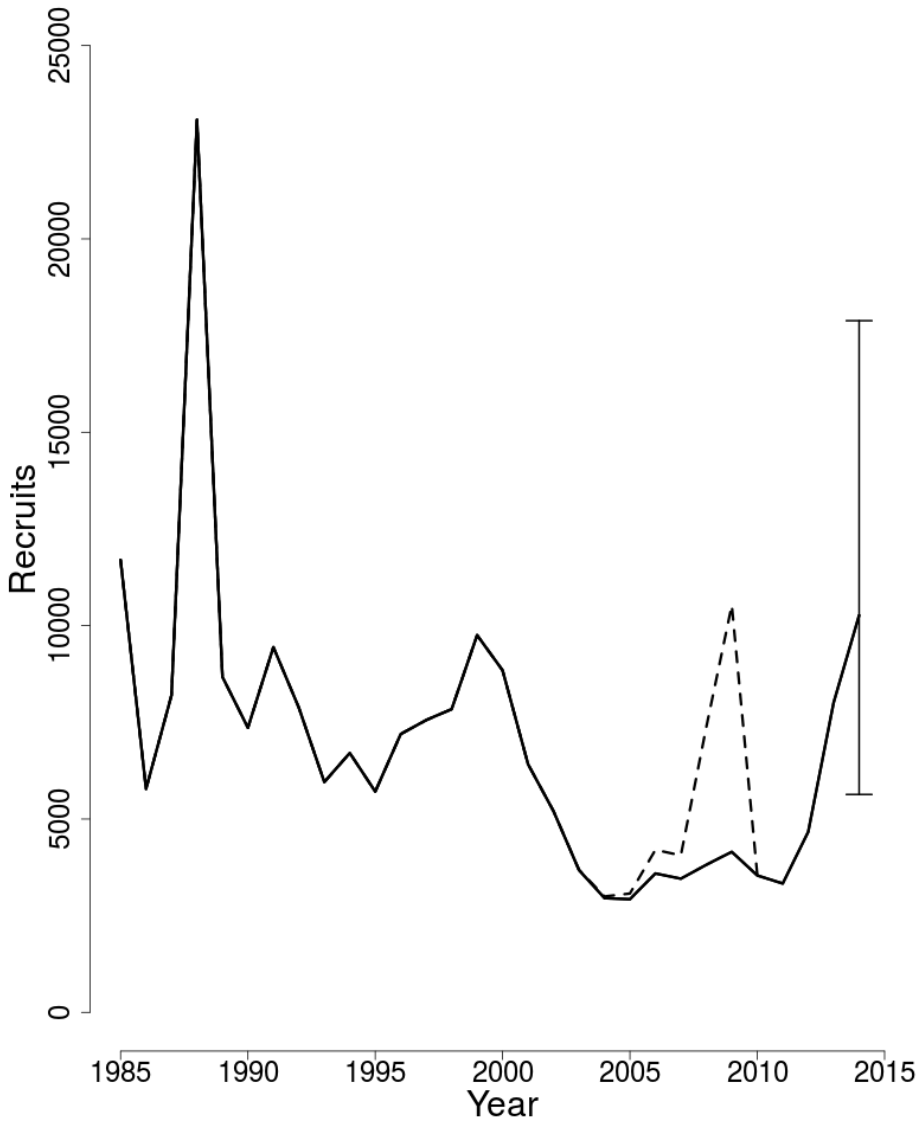

Figure 33: Trends in Recruits (age 1) (000s) of Cape Cod-Gulf of Maine yellowtail flounder between 1985 and 2014 from the current (solid line) and previous (dashed line) assessment. The 90% bootstrap probability intervals are shown.

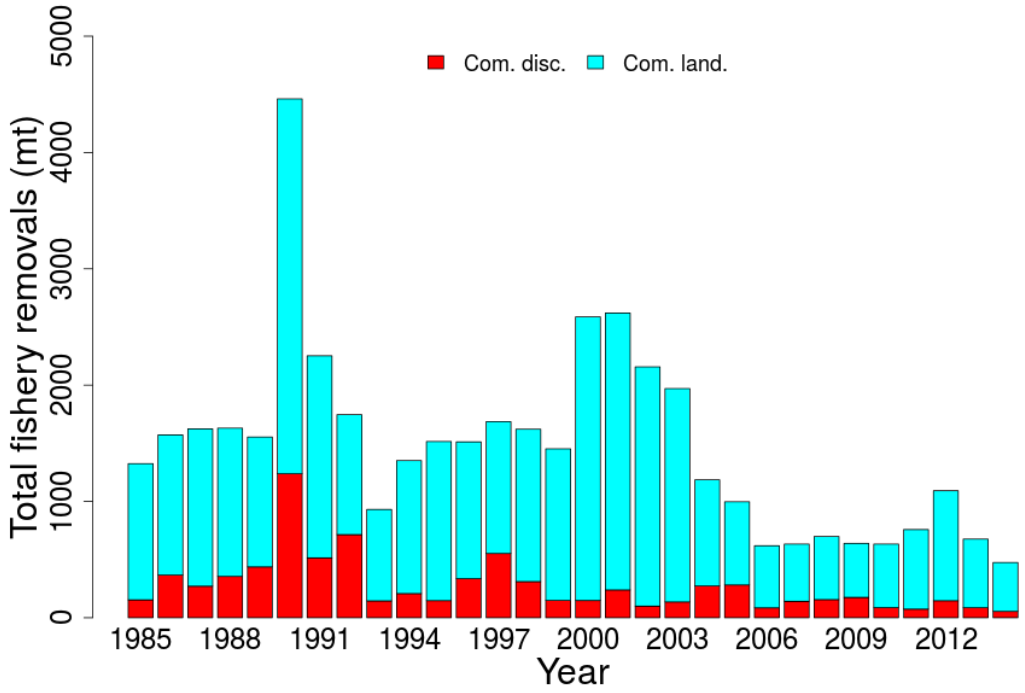

Figure 34: Total catch of Cape Cod-Gulf of Maine yellowtail flounder between 1985 and 2014 by disposition (landings and discards).

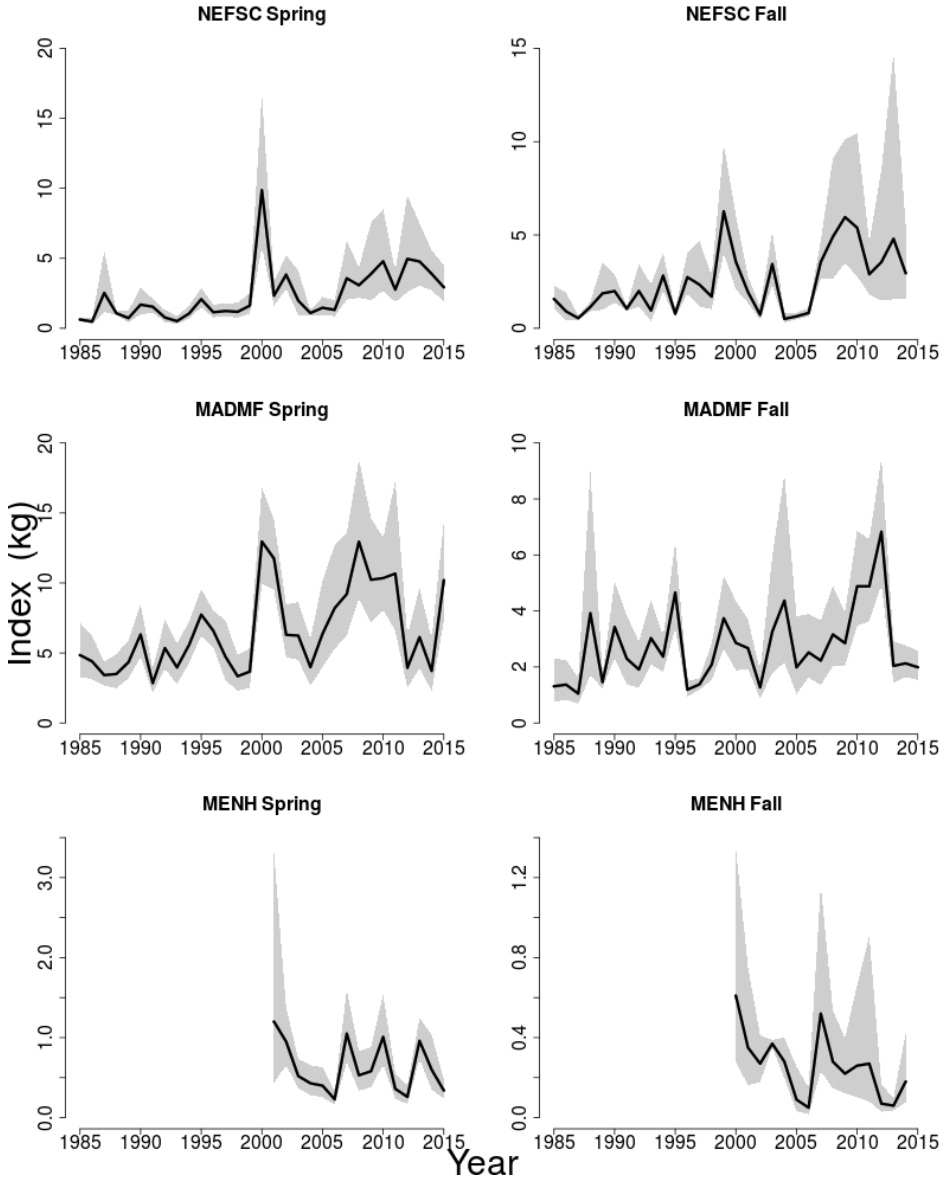

Figure 35: Indices of biomass for the Cape Cod-Gulf of Maine yellowtail flounder between 1985 and 2015 for the Northeast Fisheries Science Center (NEFSC) spring and fall bottom trawl surveys, Massachusetts Department of Marine Fisheries (MADMF) inshore state spring and fall bottom trawl surveys,and the Maine New Hampshire inshore state spring and fall state surveys. The 90% bootstrap probability intervals are shown.