6 Cape Cod-Gulf of Maine yellowtail flounder

Larry Alade

This assessment of the Cape Cod-Gulf of Maine yellowtail flounder (Limanda ferruginea) stock is an operational assessment of the existing 2015 VPA assessment (Alade 2015). 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 2017 assessment updates commercial fishery catch data, research survey indices of abundance, weights at age, and the analytical VPA assessment model and reference points through 2016. Additionally, stock projections have been updated through 2020.

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 29-30). Retrospective adjustments were made to the model results. Spawning stock biomass (SSB) in 2016 was estimated to be 1,191 (mt) which is 26% of the biomass target (SSB_{MSY} *proxy* = 4,640; Figure 29). The 2016 fully selected fishing mortality was estimated to be 0.314 which is 115% of the overfishing threshold proxy (F_{MSY} *proxy* = 0.273; Figure 30).

Table 20: 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.

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
				Data						
Commercial discards	141	156	175	87	74	146	86	54	45	66
Commercial landings	492	543	464	546	684	946	590	421	306	302
Total Catch for Assessment	633	699	639	633	758	1,092	676	475	351	368
				Model Results						
Spawning Stock Biomass	740	869	1,040	1,357	1,499	1,117	873	941	1,439	2,093
F_{Full}	1.058	1.17	0.756	0.504	0.677	1.093	1.102	0.521	0.259	0.193
Recruits (age 1)	3,411	3,735	3,959	3,251	2,988	2,685	4,046	5,728	7,774	10,165

Table 21: 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.

	2015	2017
F_{MSY} *proxy*	0.279	0.273
SSB_{MSY} (mt)	5,259	4,640 (3,499 - 6,342)
MSY (mt)	1,285	1,154 (873 - 1,570)
Median recruits (age 1) (000s)	6,562	6,186
Overfishing	Yes	Yes
Overfished	Yes	Yes

Projections: Short term projections of biomass were derived by sampling an empirical cumulative distribution function of 38 recruitment estimates from the VPA model results. Recruitment estimates were hindcasted 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 (2015 and 2016) were not included in the series of recruitment values due to high uncertainty in these estimates. This resulted in a total of 38 recruitment values: 8 from the hindcast predictions (years 1977-1984) and 30 from the VPA (years 1985-2014). 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 22: 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 2019 and 2020. Catch in 2017 was assumed to be 353 (mt).

Year	Catch (mt)	SSB (mt)	F_{Full}
2017	353	2,226 (1,747 - 2,853)	0.183

Year	Catch (mt)	SSB (mt)	F_{Full}
2018	662 (508 - 876)	2,723 (2,052 - 3,655)	0.273
2019	701 (544 - 924)	2,758 (2,172 - 3,579)	0.273
2020	775 (600 - 1,016)	3,230 (2,436 - 4,312)	0.273

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).

  Retrospective pattern remains a source of uncertainty in this assesment. This has persisted for a number of years, causing SSB estimates to decrease and F estimates to increase as more years of data are added. Other sources of uncertainty include the

patterning in the survey residuals (although the magnitude of the residuals are small) and the application the NEFSC survey age-length keys to the Maine-New Hamphire state survey to derive survey abundance-at-age as tunning index in the VPA model. Finally, catchability is a source of uncertainty. Catchability estimates derived from the cooperative research study are substantially different from those estimated in the model.

- 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 Table 8).

  The 7-year Mohn's ρ, relative to SSB, was 0.98 in the 2015 assessment and was 0.76 in 2016. The 7-year Mohn's ρ, relative to F, was -0.45 in the 2015 assessment and was -0.38 in 2016. There was a major retrospective pattern for this assessment because the ρ adjusted estimates of 2016 SSB (SSB_{ρ}=1,191) and 2016 F (F_{ρ}=0.314) were outside the approximate 90% confidence region around SSB (1,722 - 2,626) and F (0.15 - 0.26). A retrospective adjustment was made for both the determination of stock status and for projections of catch in 2018. The retrospective adjustment changed the 2016 SSB from 2,093 to 1,191 and the 2016 F_{Full} from 0.193 to 0.314.

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

  Population projections for Cape Cod-Gulf of Maine yellowtail flounder are reasonably well determined with the 2018 estimates of SSB and yield from this assessment well within the bounds of values projected in the 2015 operational 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 major 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.

  As in recent assessments for Cape Cod-Gulf of Maine yellowtail flounder the stock status remains as overfished and overfishing is occurring.

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

  The current fishing mortality rate in this assessment is low. The recent above average recruitment has contiributed to the increase in spawning stock biomass (SSB).

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

  The Cape Cod-Gulf of Maine yellowtail flounder assessment could potentially benefit from updated growth and maturity studies. The current values are based on GARM III estimates (NEFSC 2008) which are apprximately 10 years old. Future modeling efforts should consider forward-projecting statistical catch-at-age models to account for uncertainty in the data inputs.

- Are there other important issues?

  No.

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

Assessment Recommendation:

The panel concluded that the operational assessment with adjustments for retrospective bias was acceptable as a scientific basis for management advice, although noting that there are appreciable model fitting issues and uncertainties to consider.

Alternative Assessment Approach:

Not applicable

Status Recommendation:

Based on this operational assessment, the panel agrees with the recommendation that the Cape Cod-Gulf of Maine yellowtail flounder stock is overfished and overfishing is occurring. However, recent recruitment is above average, and spawning stock biomass has increased.

Key Sources of Uncertainty:

A retrospective pattern remains a source of uncertainty in this assessment as well as patterning in some residuals. The application of National Marine Fisheries Service trawl survey age-length keys to the Maine-New Hampshire survey is another source of uncertainty. Catchability is a source of uncertainty. Catchability estimates derived from the cooperative research study are substantially different from those estimated in this assessment.

Research Needs:

The panel recommends studies to update estimates of growth and maturity. The current estimates are based on Groundfish Assessment Review Meeting (GARM) III estimates which are approximately 10 years old. Future modeling efforts should consider forward-projecting statistical catch-at-age models to account for uncertainty in the data inputs. Also, given recent low recruitment, there should be future research to evaluate potential causes of low recruitment, and whether a regime shift should be considered, particularly in the calculation of reference points. Finally, the panel recommends further research and consideration of survey catchability estimates.

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 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. 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

Alade, L. 2015. In Northeast Fisheries Science Center. 2015. Operational Assessment of 20 Northeast Groundfish Stocks, Updated Through 2014. US Dept Commer, Northeast Fish Sci CentRef Doc. 15-24; 251 p.

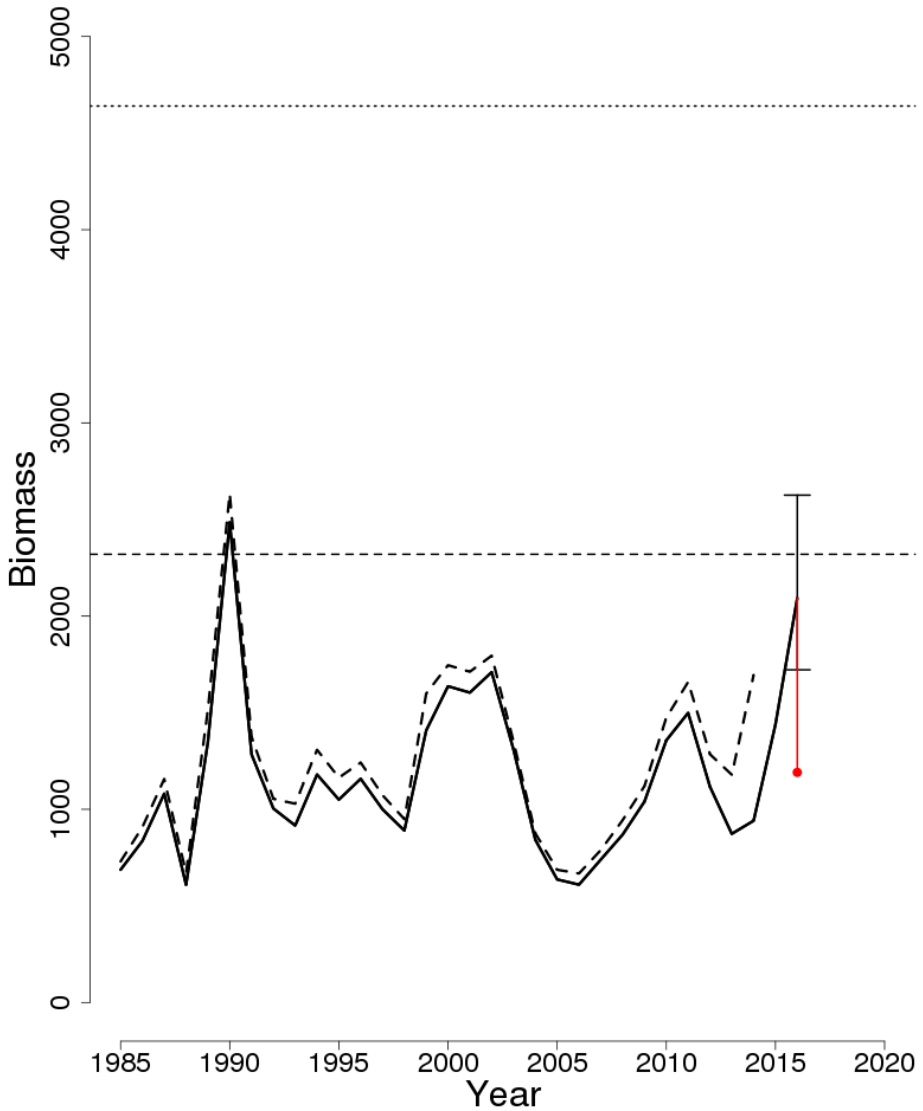

Figure 29: Trends in spawning stock biomass of Cape Cod-Gulf of Maine yellowtail flounder between 1985 and 2016 from the current (solid line) and previous (dashed line) assessment and the corresponding $SSB_{Threshold}$ ($\frac{1}{2}$ SSB_{MSY} *proxy*; horizontal dashed line) as well as SSB_{Target} (SSB_{MSY} *proxy*; horizontal dotted line) based on the 2017 assessment. Biomass was adjusted for a retrospective pattern and the adjustment is shown in red. The 90% bootstrap probability intervals are shown.

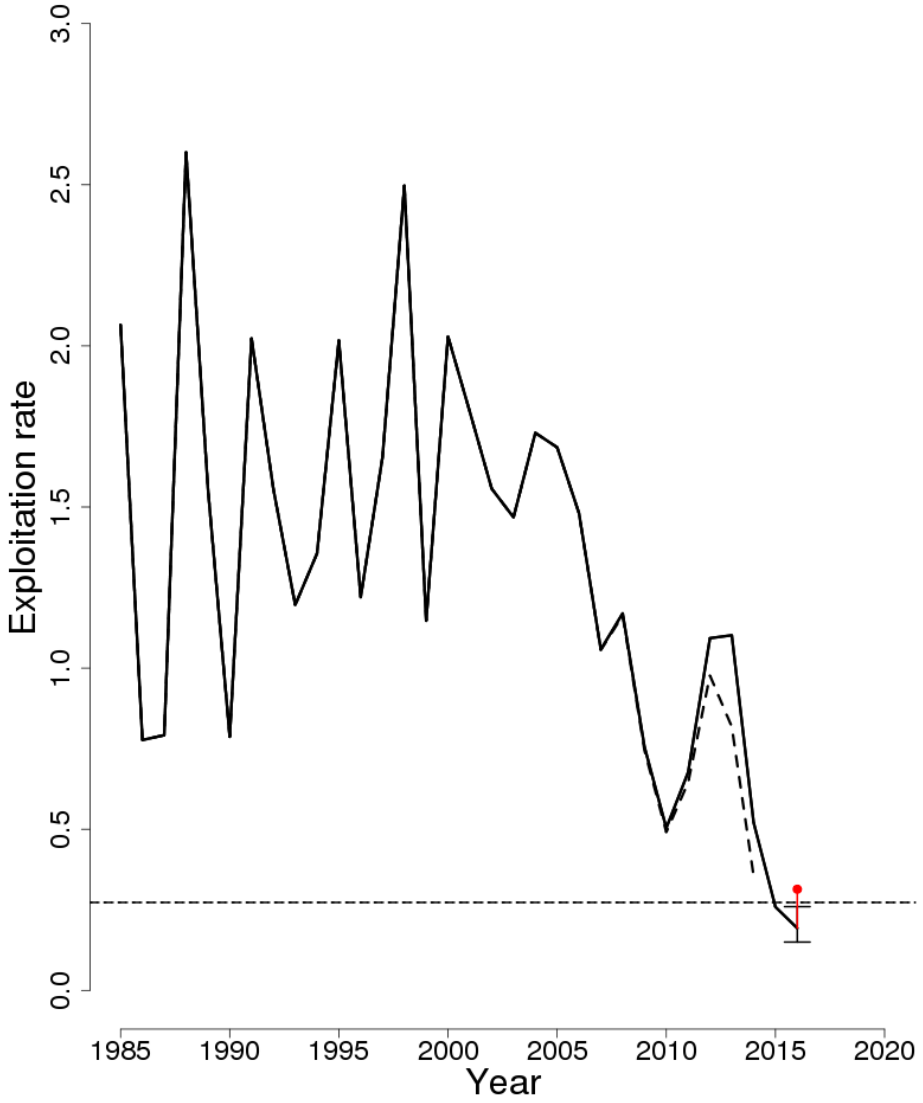

Figure 30: Trends in the fully selected fishing mortality (F_{Full}) of Cape Cod-Gulf of Maine yellowtail flounder between 1985 and 2016 from the current (solid line) and previous (dashed line) assessment and the corresponding $F_{Threshold}$ (F_{MSY} *proxy*=0.273; horizontal dashed line). F_{Full} was adjusted for a retrospective pattern and the adjustment is shown in red based on the 2017 assessment. The 90% bootstrap probability intervals are shown.

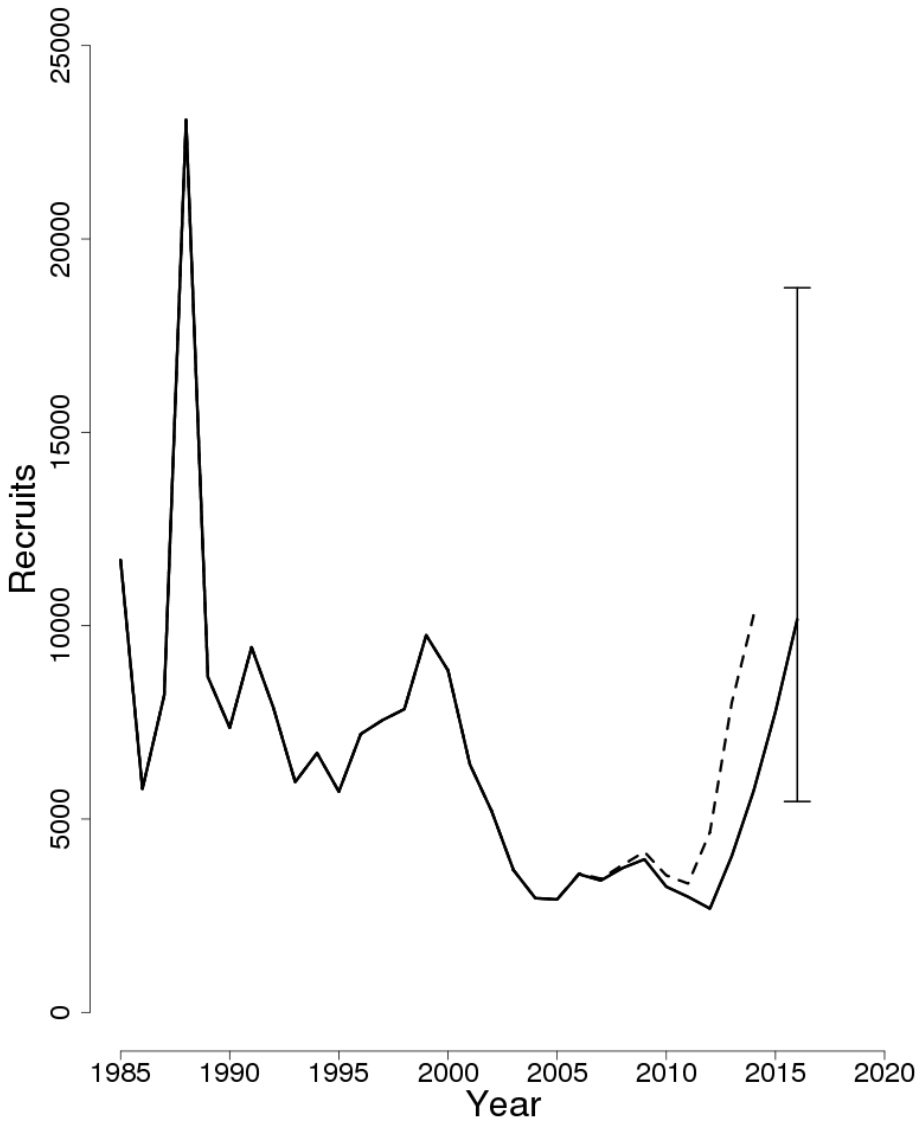

Figure 31: Trends in Recruits (age 1) (000s) of Cape Cod-Gulf of Maine yellowtail flounder between 1985 and 2016 from the current (solid line) and previous (dashed line) assessment. The 90% bootstrap probability intervals are shown.

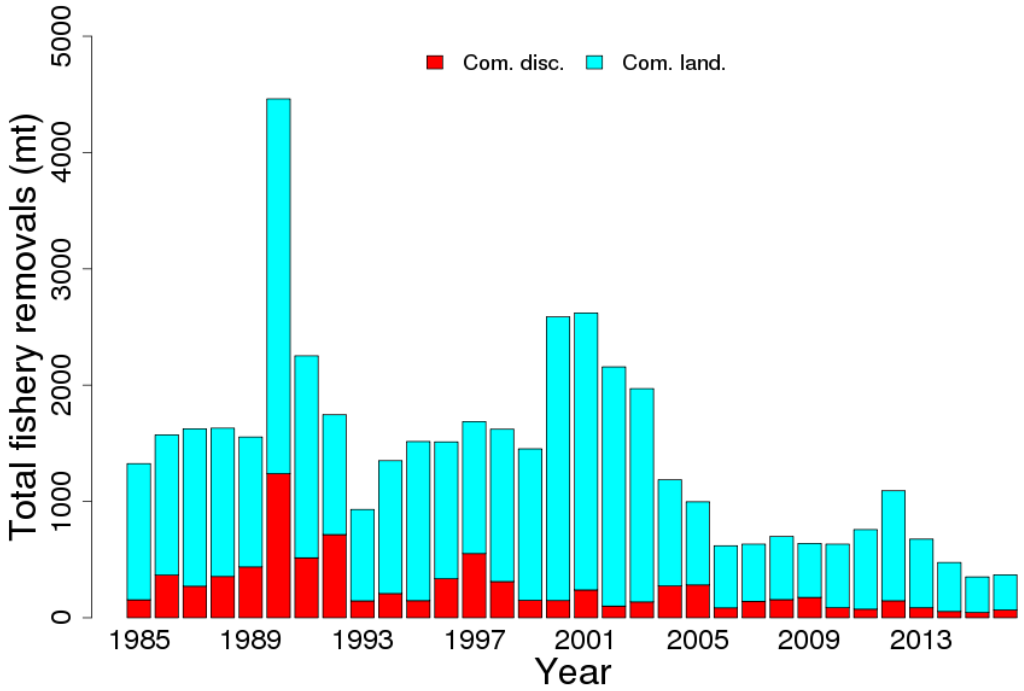

Figure 32: Total catch of Cape Cod-Gulf of Maine yellowtail flounder between 1985 and 2016 by disposition (landings and discards).

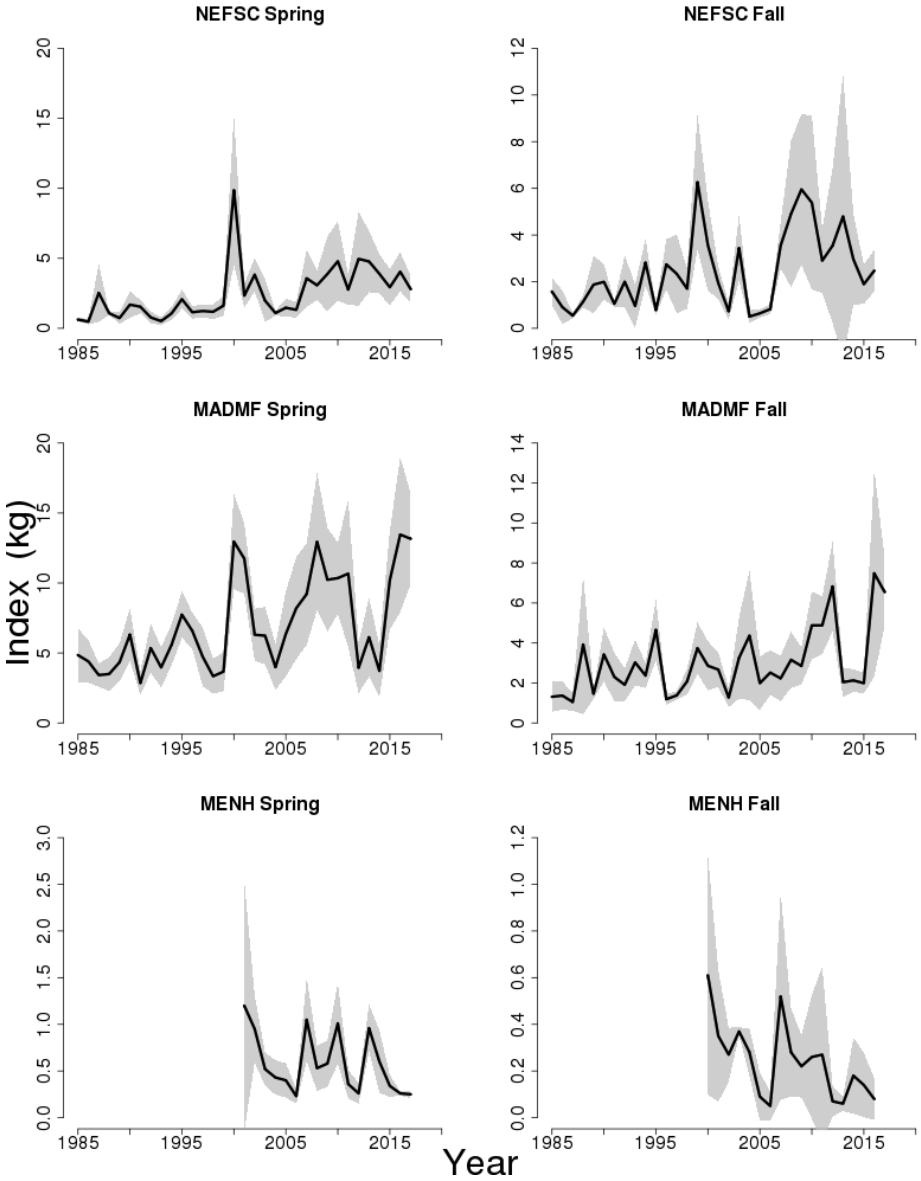

Figure 33: Indices of biomass for the Cape Cod-Gulf of Maine yellowtail flounder between 1985 and 2017 for the Northeast Fisheries Science Center (NEFSC) spring and fall bottom trawl surveys, Massachusetts Department of Marine Fisheries (MADMF) inshore state spring and fall bottom trawl surveys,and the Maine New Hampshire inshore state spring and fall state surveys. The 90% bootstrap probability intervals are shown.