draft working paper for peer review only

Southern New England-Mid Atlantic yellowtail flounder

2022 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 Southern New England-Mid Atlantic yellowtail flounder (Limanda ferruginea) stock is an operational assessment of the existing 2012 benchmark assessment (NEFSC 2012). Based on the previous assessment (NEFSC 2022), the stock was overfished, but overfishing was not occurring. This assessment updates commercial fishery catch data, research survey indices of abundance, and the analytical ASAP assessment model and reference points through 2021. Additionally, stock projections have been updated through 2025.

State of Stock: Based on this updated assessment, the Southern New England-Mid Atlantic yellowtail flounder (*Limanda ferruginea*) stock is overfished and overfishing is not occurring (Figures 1-2). Retrospective adjustments were made to the model results. Spawning stock biomass (SSB) in 2021 was estimated to be 70 (mt) which is 4% of the biomass target (SSB_{MSY} *proxy* = 1,715; Figure 1). The 2021 fully selected fishing mortality was estimated to be 0.082 which is 23% of the overfishing threshold proxy (F_{MSY} *proxy* = 0.349; Figure 2).

Table 1: Catch and status table for Southern New England-Mid Atlantic yellowtail flounder. All weights are in (mt) recruitment is in (000s) and F_{Full} is the fishing mortality on fully selected ages (ages 4 and 5). Model results are from the current updated ASAP assessment. Note: Terminal year estimates of SSB and F reflect the unadjusted values for retrospective error.

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Data										
Commercial discards	221	185	109	53	26	16	8	6	5	4
Commercial landings	342	461	516	284	126	48	11	2	2	1
Catch for Assessment	563	646	625	337	152	64	19	8	7	5
Model Results										
Spawning Stock Biomass	1,610	1,318	865	422	159	59	36	45	142	241
F_{Full}	0.585	0.745	0.906	0.961	1.076	1.272	0.788	0.291	0.1	0.032
Recruitment (age 1)	1,671	1,104	179	88	66	179	226	1,155	449	4,396

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.

	2019	2022
F_{MSY} *proxy*	0.355	0.349
SSB_{MSY} (mt)	1,756	1,715 (908 - 2,739)
MSY (mt)	495	461 (245 - 739)
Median recruitment (age 1) (000s)	6,562	6,004
Overfishing	No	No
Overfished	Yes	Yes

Projections: Short term projections of biomass were derived by sampling from an empirical cumulative distribution function of 30 recruitment estimates from the ASAP model results. Following the previous and accepted benchmark formulation, recruitment was based on recent estimates of recruitments from the model time series (i.e., corresponding to age 1 in years 1990 through 2019) to reflect the low recent pattern of recruitment in the stock. For projections, the annual fishery selectivity is from the most recent selectivity block in the model, the maturity ogive is the same as assumed for all years in the model, and mean weights at age are from 2014-2019 due to low or no sampling in 2020 and 2021; retrospective adjustments were applied in the projections.

Table 3: Short term projections of total fishery catch and spawning stock biomass for Southern New England-Mid Atlantic yellowtail flounder based on a harvest scenario of fishing at F_{MSY} *proxy* between 2023 and 2025. Catch in 2022 was assumed to be 4 (mt) based on an estimate provided by the Groundfish Plan Development Team.

Year	Catch (mt)	SSB (mt)	F_{Full}
2022	4	174 (102 - 293)	0.033 (0.019 - 0.054)

Year	Catch (mt)	SSB (mt)	F_{Full}
2023	55 (33 - 91)	203 (121-343)	0.349
2024	84 (46 - 142)	420 (157 - 930)	0.349
2025	152 (58 - 319)	815 (261 - 1,641)	0.349

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 long-term outlook for this stock. Recent papers (Stock and Miller 2021, du Pontavice et al. 2022) found a relationship between the Cold Pool Index, a measure of cold water in the Mid-Atlantic Bight, and the stock-recruitment relationship. If the hypothesized relationship holds, and the Cold Pool Index continues to warm due to global climate change, the ability of this stock to support a fishery is questionable. This management track assessment followed the approach used in the previous assessment to calculate long-term reference points assuming recruitment remained within the range observed since 1990. If instead recruitment declines in the future, these already low biomass and yield estimates will decrease, providing little potential yield to the fishery.

- 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 0.63 in the 2019 assessment and was 2.43 in 2021. The 7-year Mohn's ρ, relative to F, was -0.31 in the 2019 assessment and was -0.62 in 2021. There was a major retrospective pattern for this assessment because the ρ adjusted estimates of 2021 SSB (SSB_ρ=70) and 2021 F (F_ρ=0.082) were outside the approximate 90% confidence regions around SSB (148 - 405) and F (0.019 - 0.053). A retrospective adjustment was made for both the determination of stock status and for projections of catch in 2023. The retrospective adjustment changed the 2021 SSB from 241 to 70 and the 2021 F_{Full} from 0.032 to 0.082.

- 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 Southern New England-Mid Atlantic yellowtail flounder are uncertain for reasons associated with the retrospective pattern and the low stock size. The 2021 estimate of SSB is within the bounds of the projected SSB from the 2019 assessment, but the rho-adjusted SSB is not. The 2019 estimate of SSB from the current assessment is below the 2019 rho-adjusted SSB from the 2019 assessment, indicating the rho-adjustment applied in the 2019 assessment was not large enough. However, the current low size of this stock makes these comparisons tenuous. This stock is in a rebuilding plan with a rebuilding date of 2029.

- 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.

  Minor changes, in addition to the incorporation of new data, were made to the Southern New England-Mid Atlantic yellowtail flounder assessment for this update. The larval index was treated differently to now use SSB weights-at-age, tuned to the spawning time of the stock instead of the survey time, and used a *fixed selectivity pattern equal to the maturity ogive (assumed constant over time in the assessment). These changes more closely reflect the use of the larval index as an indicator of spawning biomass, but had no noticable impact on the results. The number of fishery selectivity blocks was reduced from 6 to 2 after consideration of a range of alternatives. All of the selectivity block changes produced similar patterns in the residuals (except for using only a single selectivity block), and all showed similar patterns in F and SSB. The decision to change from 6 to 2 selectivity blocks was based on model parsimony.*

- If the stock status has changed a lot since the previous assessment, explain why this occurred.
  The overfishing status of Southern New England-Mid Atlantic yellowtail flounder has not changed since the last 2019 management track assessment. The stock remains at low abundance despite low catches.

- Provide qualitative statements describing the condition of the stock that relate to stock status.
  All three 2021 surveys for Southern New England-Mid Atlantic yellowtail flounder show record low numbers of fish caught, 2, 3, and 2 in the NEFSC spring, NEFSC fall, and larval surveys, respectively. The 2022 NEFSC spring survey, which is not included in this assessment, caught 3 fish. These surveys were all conducted according to standard operating procedures, so the low numbers of fish caught indicate a low population size, not a problem with the surveys. While low fishery catches do not necessarily mean the population is low, the recent catches of <10 mt in every year since 2019 are consistent with a low population size. There are no indications that this stock is doing well.

- Indicate what data or studies are currently lacking and which would be needed most to improve this stock assessment in the future.
  The Southern New England-Mid Atlantic yellowtail flounder assessment has been used as an example of how to include enviromental factors in stock assessments in a number of recent papers (Miller et al. 2016, Xu et al. 2017, Stock and Miller 2021, du Pontavice et al. 2022). All indicate that the environment for this stock is getting worse and causing expected recruitment to decline as the temperature increases in the region. If this trend continues, as expected under nearly all climate models, then the ability of this stock to support a fishery is questionable. Converting the modeling framework for this stock from ASAP to WHAM (or another state-space model) would allow estimation of the relationship between environmental factors and modeled recruitment. The long-term potential yield of this stock associated with climate change could then be considered. A research track assessment for yellowtail flounder stocks in this region is scheduled to begin next month and be peer reviewed in 2024.

- Are there other important issues?
  The catchability (q) survey biomass from the Cooperative Resarch comparative chain sweep experiment (Miller 2013, Jones et al. 2021) estimated similar biomass to the 2021 rho-adjusted SSB from the assessment, but indicated a much higher biomass than the model-estimated SSB in the 2010s. When these data were used directly in the stock assessment, either the model q was unreasonable high (6 or 10 instead of the expected value of 1) or else there were major problems with the fits to the data. The decline in the expanded survey biomass from 2010 through 2019 cannot easily be explained given the catches and age structure of the fish caught. Future research should explore whether an alternative modeling platform, such as WHAM (Stock and Miller 2021), can find a way to reconcile these data with modeled population estimates.

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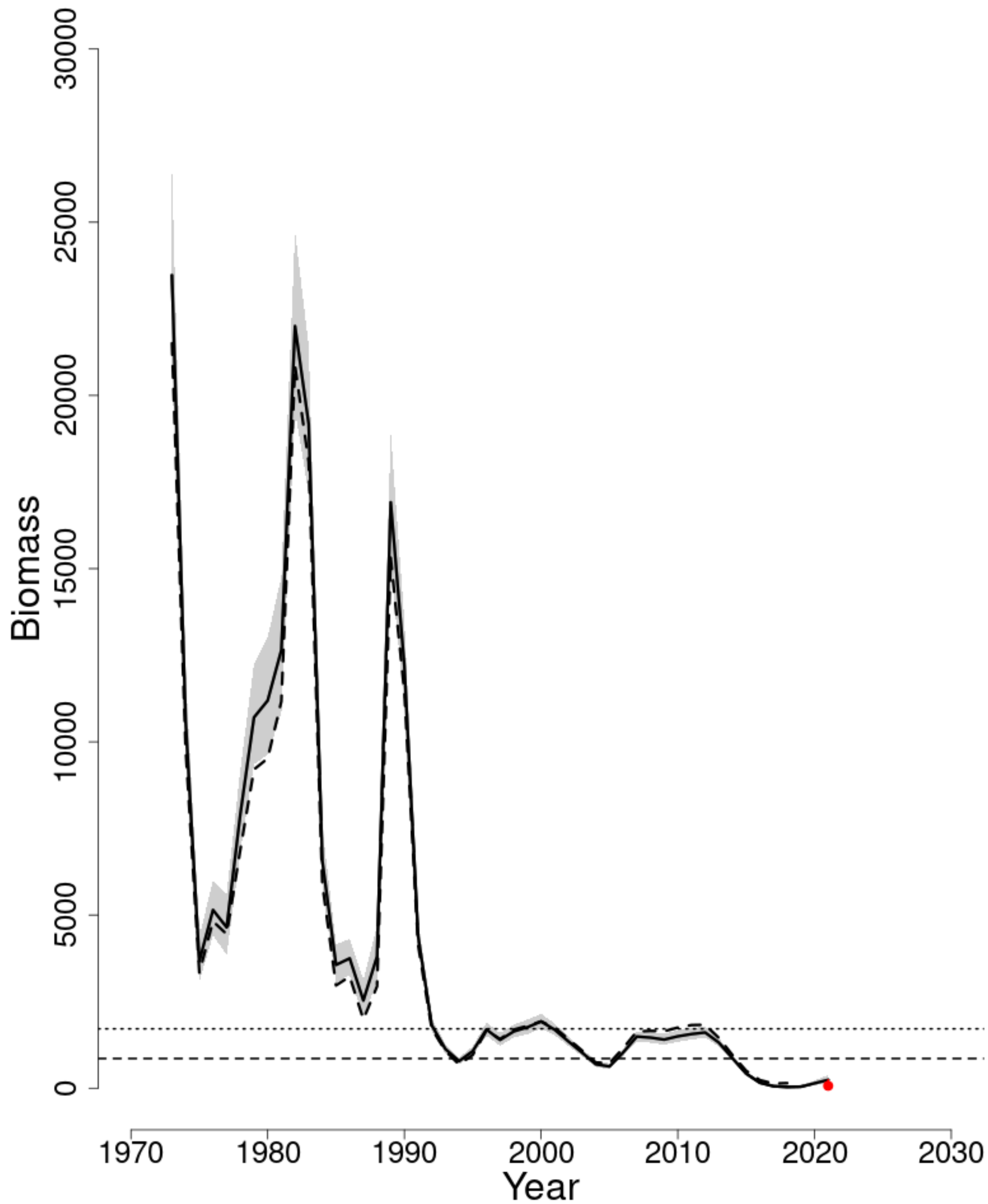

Figure 1: Trends in spawning stock biomass of Southern New England-Mid Atlantic yellowtail flounder between 1973 and 2021 from the current (solid line) and previous (dashed line) assessment and the corresponding $SSB_{Threshold}$ ($\frac{1}{2}$ SSB_{MSY} *proxy*; horizontal dashed line) as well as SSB_{Target} (SSB_{MSY} *proxy*; horizontal dotted line) based on the 2022 assessment. Biomass was adjusted for a retrospective pattern and the adjustment is shown in red. The approximate 90% lognormal confidence intervals are shown.

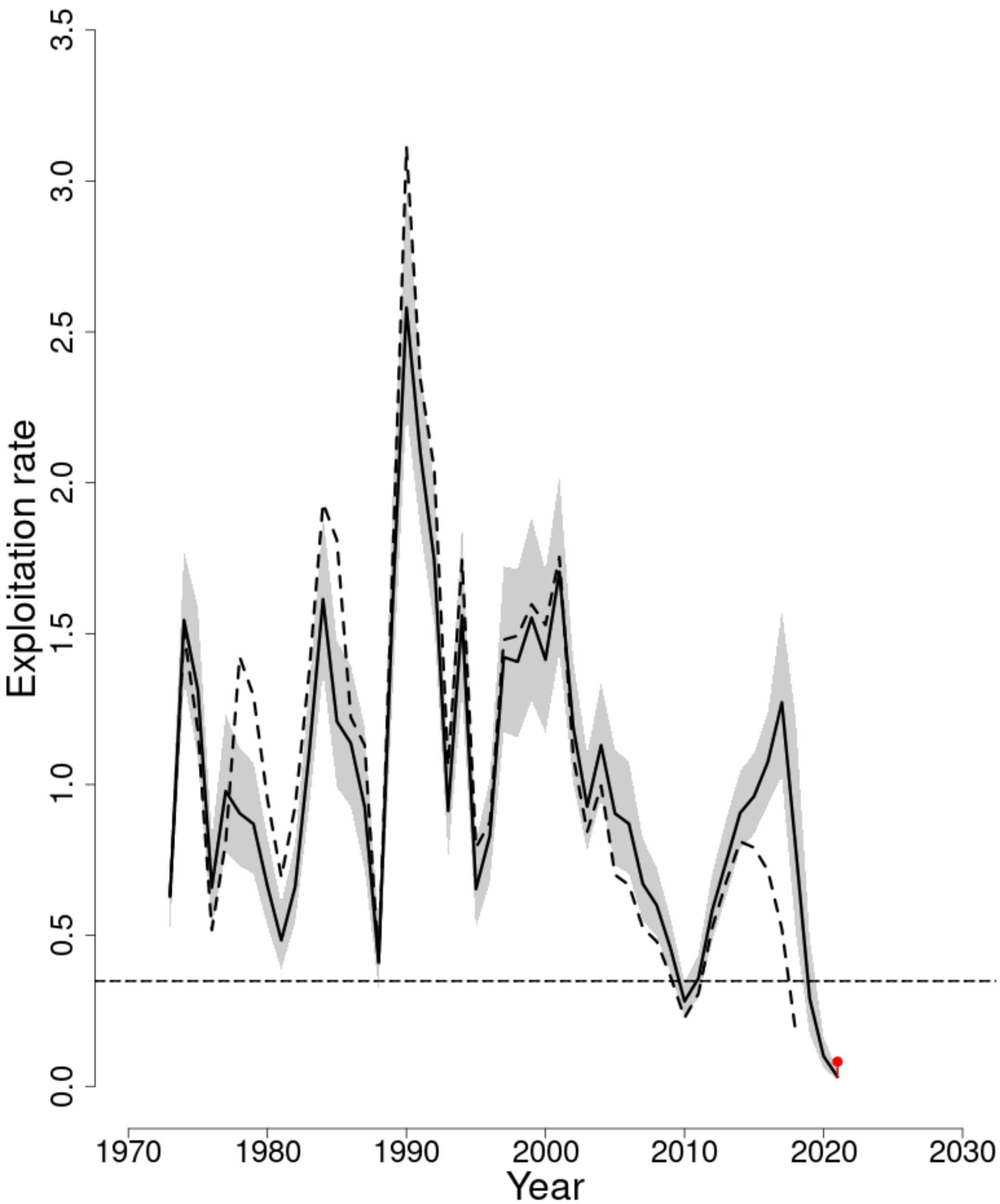

Figure 2: Trends in the fully selected fishing mortality (F_{Full}) of Southern New England-Mid Atlantic yellowtail flounder between 1973 and 2021 from the current (solid line) and previous (dashed line) assessment and the corresponding $F_{Threshold}$ (F_{MSY} *proxy*=0.349; horizontal dashed line). F_{Full} was adjusted for a retrospective pattern and the adjustment is shown in red. based on the 2022 assessment. The approximate 90% lognormal confidence intervals are shown.

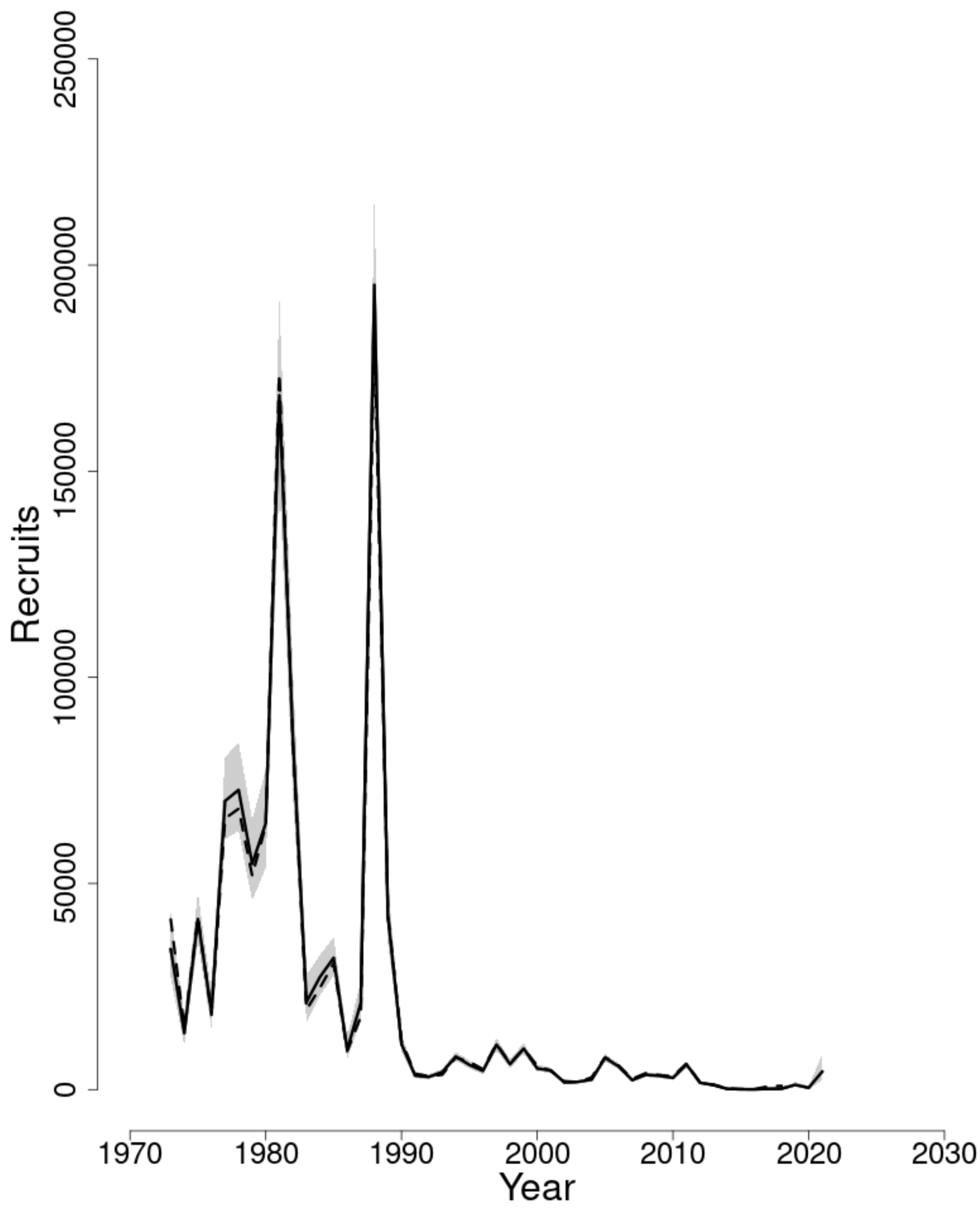

Figure 3: Trends in Recruitment (age 1) (000s) of Southern New England-Mid Atlantic yellowtail flounder between 1973 and 2021 from the current (solid line) and previous (dashed line) assessment. The approximate 90% lognormal confidence intervals are shown.

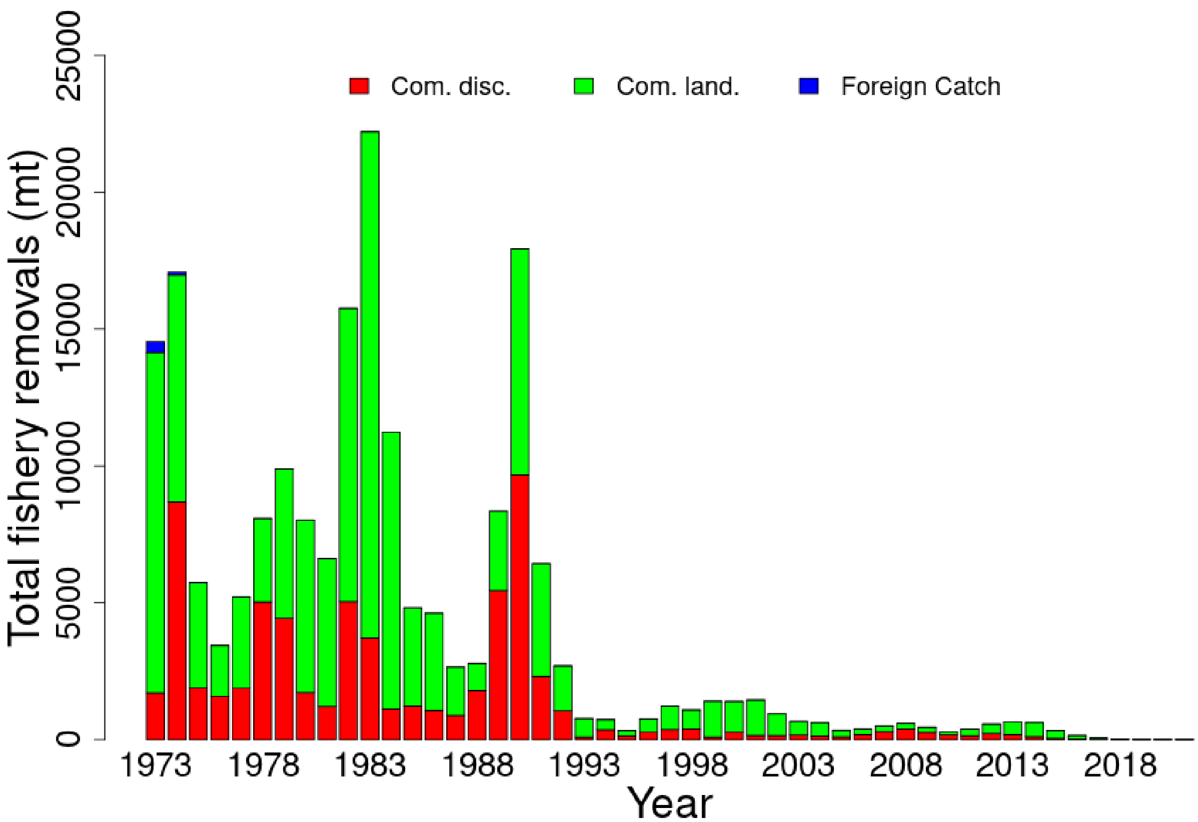

Figure 4: Total catch of Southern New England-Mid Atlantic yellowtail flounder between 1973 and 2021 by fleet (US domestic and foreign catch) and disposition (landings and discards).

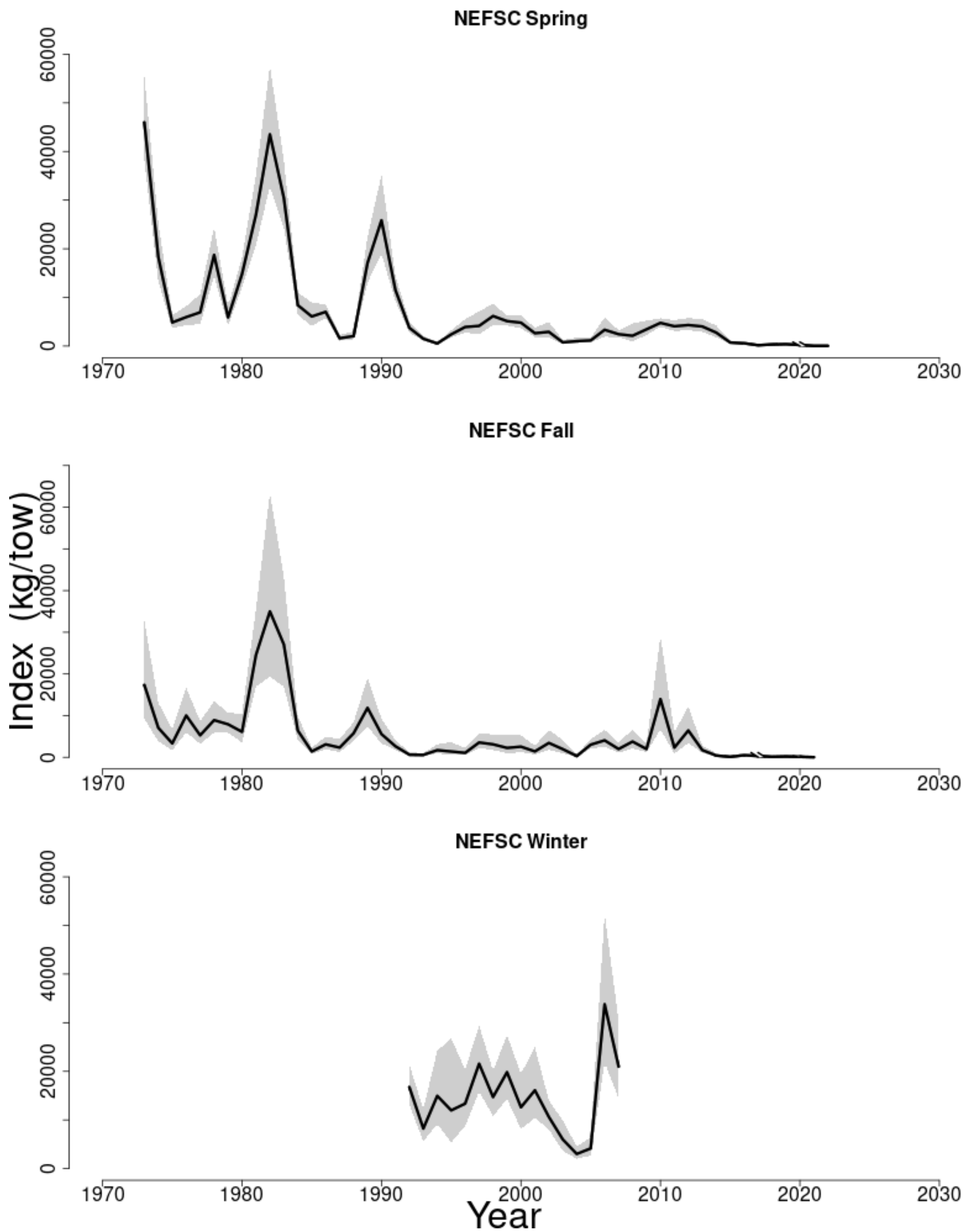

Figure 5: Indices of biomass for the Southern New England-Mid Atlantic yellowtail flounder between 1973 and 2022 for the Northeast Fisheries Science Center (NEFSC) spring and fall bottom trawl surveys. The approximate 90% lognormal confidence intervals are shown. Note: Larval index based on Richardson et al (2009) was also used in this assessment and is available in the supplemental documentation.