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Atlantic Herring

2020 Assessment Update Report

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

Compiled May 2020

This assessment of the Atlantic Herring (Clupea harengus) stock is a management track assessment of the existing 2018 benchmark ASAP assessment (NEFSC 2018). Based on the previous assessment, the stock was not overfished and overfishing was not occurring. This assessment updated fishery catch data, survey indices, life history parameters (e.g., weights-at-age), and the ASAP assessment model and reference points through 2019. The methods used for short-term projections have changed from the previous assessment. More specifically, the projections now explicitly include two fishing fleets, mobile and fixed gears, consistent with the ASAP assessment. A supplementary document detailing the changes to the projection methodology has been provided.

State of Stock: Based on this management track assessment, the Atlantic Herring (*Clupea harengus*) stock is overfished and overfishing is not occurring (Figures 1-2). Retrospective adjustments were unnecessary. Spawning stock biomass (SSB) in 2019 was estimated to be 77,883 (mt) which is 29% of the biomass target (SSB_{MSY} *proxy* = 269,000; Figure 1). The 2019 average fishing mortality for ages 7-8 (fully selected ages for the mobile fleet) was estimated to be 0.25267 which is 47% of the overfishing threshold proxy (F_{MSY} *proxy* = 0.543; Figure 2).

Table 1: Catch and status table for Atlantic Herring. All weights are in mt, recruitment is in 000s, and $\bar{F}_{7-8}$ is the average fishing mortality on ages 7 to 8, which are fully selected by the mobile fleet. Model results are from the current updated ASAP assessment.

	2012	2013	2014	2015	2016	2017	2018	2019
				Data				
US Catch	87,171	95,191	93,084	81,204	62,597	48,796	45,527	12,782
Canadian Catch	504	6,431	2,149	146	4,060	2,103	11,574	5,054
Total Catch	87,675	101,622	95,233	81,350	66,657	50,899	57,101	17,836
				Model Results				
Spawning Stock Biomass	240,920	202,410	317,080	256,880	170,720	133,700	90,765	77,883
$\bar{F}_{7-8}$	0.60885	0.66113	0.51489	0.47881	0.47538	0.46961	0.5727	0.25267
recruits (age1)	6,689,400	1,579,000	1,509,600	809,350	283,230	983,810	407,910	666,050

Table 2: Comparison of reference points estimated in an earlier assessment and from the current assessment. An $F_{40\%}$ proxy was used for the overfishing threshold, and the biomass proxy reference point was based on long-term, stochastic, projections.

	2018	2020
F_{MSY} *proxy*	0.51	0.54
SSB_{MSY} (mt)	189,000 (corrected 266,000)	269,000 (155,699 - 444,290)
MSY mt	112000 (corrected 100,011)	99,400 (62,644 - 151,814)
Median recruits (age 1)	3,449,817,600	3,430,614,650 (915,478,855 - 10,132,087,450)
Overfishing	No	No
Overfished	No	Yes

Projections: The projection results included here should be considered preliminary and subject to change based on future assessment and management decisions. This example projection applied the harvest control rule described in Amendment 8 of the hering Fishery Management Plan to the mobile fleet. The fixed gear catches are assumed constant during the projection period and equaled 4,778 mt. This fixed gear catch equals the sum of the ten year (2010-2019) averages of the Canadian (4,669 mt) and US (109 mt) fixed gear catches. The US fixed gear catches are those from stop seines, weirs, and pound nets. The reported $\bar{F}_{7-8}$ are those for the mobile fleet.

Table 3: Projection results were not provided. See supplementary document.

Year	Catch mt	SSB (mt)	$\bar{F}_{7-8}$
2020	16,319	56,375	0.243

Year	Catch mt	SSB (mt)	$\bar{F}_{7-8}$
2021	9,483	48,841	0.119
2022	8,767	45,921	0.089
2023	11,025	130,616	0.077

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).

  While not an uncertainty from a statistical estimation standpoint, a definitive explanation for the continued poor recruitment has not been identified. While identifying a causal mechanism for poor recruitment would be immensely beneficial, finding explanations for patterns in recruitment have been elusive in fisheries science for decades. Another uncertainty in this assessment is natural mortality. In this assessment, natural mortality was assumed constant among ages and years. Justifications for including age- or time-varying natural mortality in previous assessments have quickly deteriorated. Uncertainty in natural mortality affects the scale of abundance and fishing mortality estimates, but is unlikely to be related to the recent poor recruitments. Stock structure, particularly mixing with Nova Scotian herring, is also an uncertainty. Migration can be conflated with changes in mortality and contribute to retrospective patterns. Again, however, this is unlikely to explain recent poor recruitment.

- 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 $\bar{F}_{7-8}$ lies outside of the approximate joint confidence region for SSB and $\bar{F}_{7-8}$).

  This assessment model did not have a retrospective pattern, or at worst the pattern was minor.

- 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?

  The projections are uncertain, especially in regards to recruitment. Terminal year, 2019, recruitment was imprecisely estimated with a CV > 2.0, which contributes to relatively large

uncertainty bounds. Likwise, recruitment in 2022 is assumed to approximately equal average recruitment, which may be unlikely given recent estimates. For additional projection details, see the supplemental document.

- 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 Atlantic Herring assessment.

- If the stock status has changed a lot since the previous assessment, explain why this occurred.
  The stock status has not changed a lot since the previous assessment. The change from not overfished to overfished was anticipated based on previous projections.

- Provide qualitative statements describing the condition of the stock that relate to stock status.
  Continued poor recruitment is the main issue driving stock status. Management decisions that reduced US catches had the effect of avoiding overfishing.

- Indicate what data or studies are currently lacking and which would be needed most to improve this stock assessment in the future.
  Studies related to stock structure and movement would be beneficial, as this has been proposed as a possible explanation for previous retrospective patterns. While this assessment did not have a retrospective pattern, the pattern may reemerge (NEFSC 2018). While an explanation for drivers of recruitment would be beneficial, it would not directly effect the assessment, and as noted, such explanations are difficult to identify.

- Are there other important issues?
  No other important issues were identified.

References:

NEFSC (Northeast Fisheries Science Center). 2018. 65^{th} Northeast Regional Stock Assessment Workshop (65^{th} SAW) Assessment Report. US Dept. of Commerce, NEFSC Ref. Doc. 18-11.

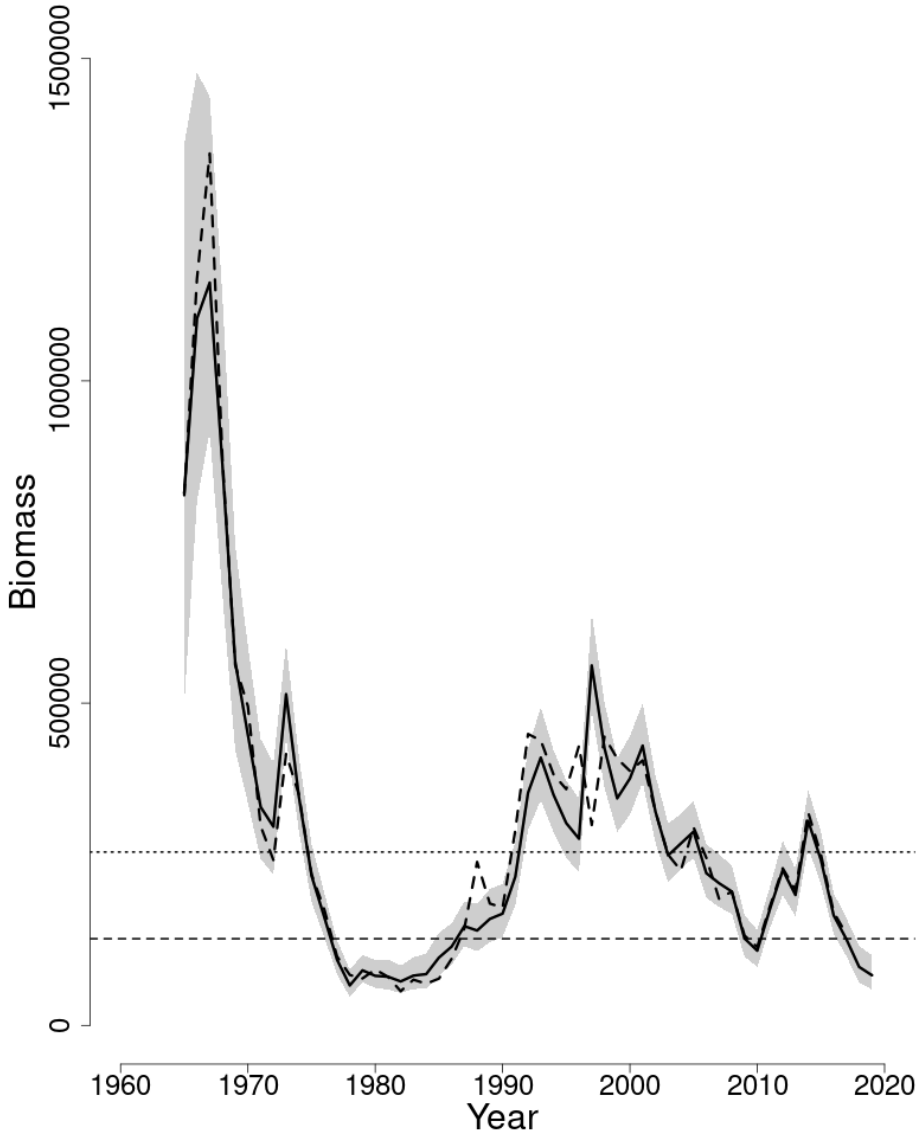

Figure 1: Trends in spawning stock biomass of Atlantic Herring between 1965 and 2019 from the current (solid line) and previous (dashed line) assessment and the corresponding $SSB_{Threshold}$ ($\frac{1}{2}$ SSB_{MSY} *proxy*; horizontal dashed line) as well as SSB_{Target} (SSB_{MSY} *proxy*; horizontal dotted line) based on the 2020 assessment. The approximate 90% confidence intervals are shown.

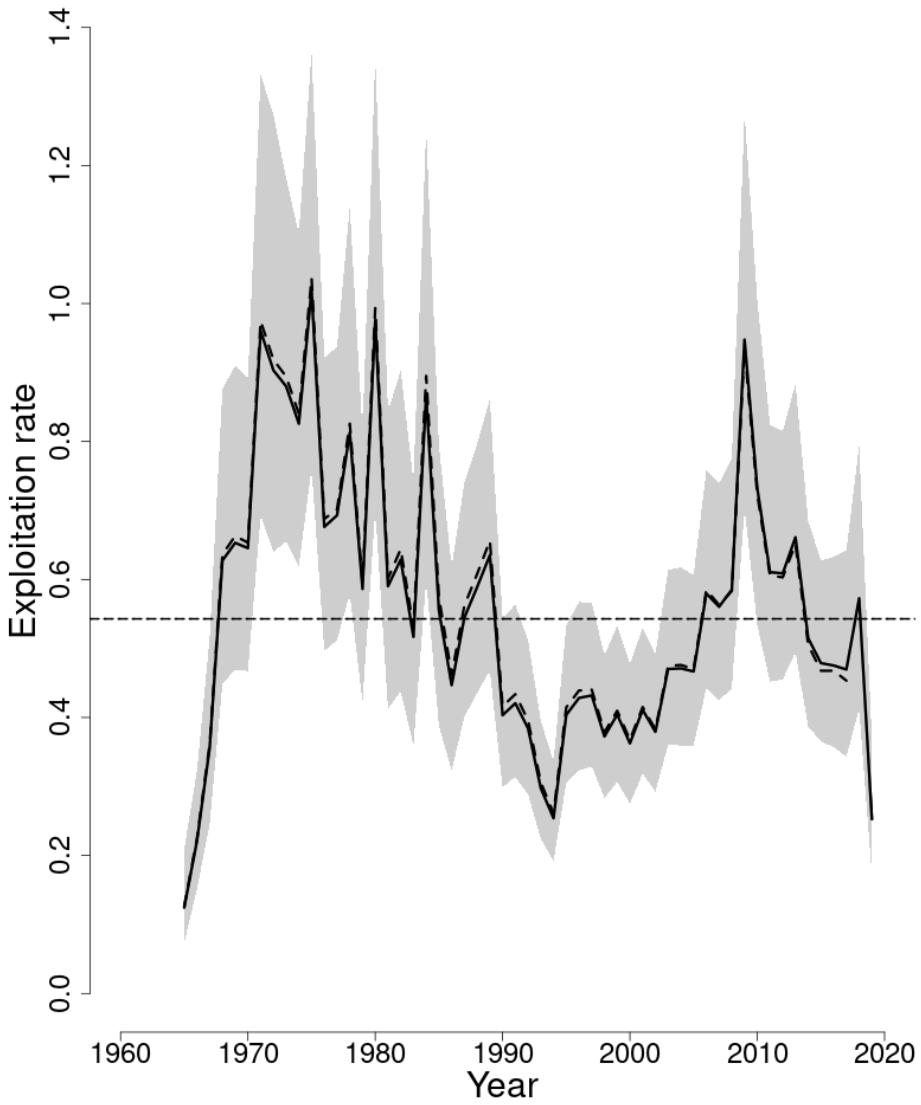

Figure 2: Trends in the average fishing mortality rate for ages 7-8, which are fully selected by the mobile fleet ($\bar{F}_{7-8}$), between 1965 and 2019 from the current (solid line) and previous (dashed line) assessment and the corresponding $F_{Threshold}$ (F_{MSY} *proxy*=0.543; horizontal dashed line). The approximate 90% confidence intervals are shown.

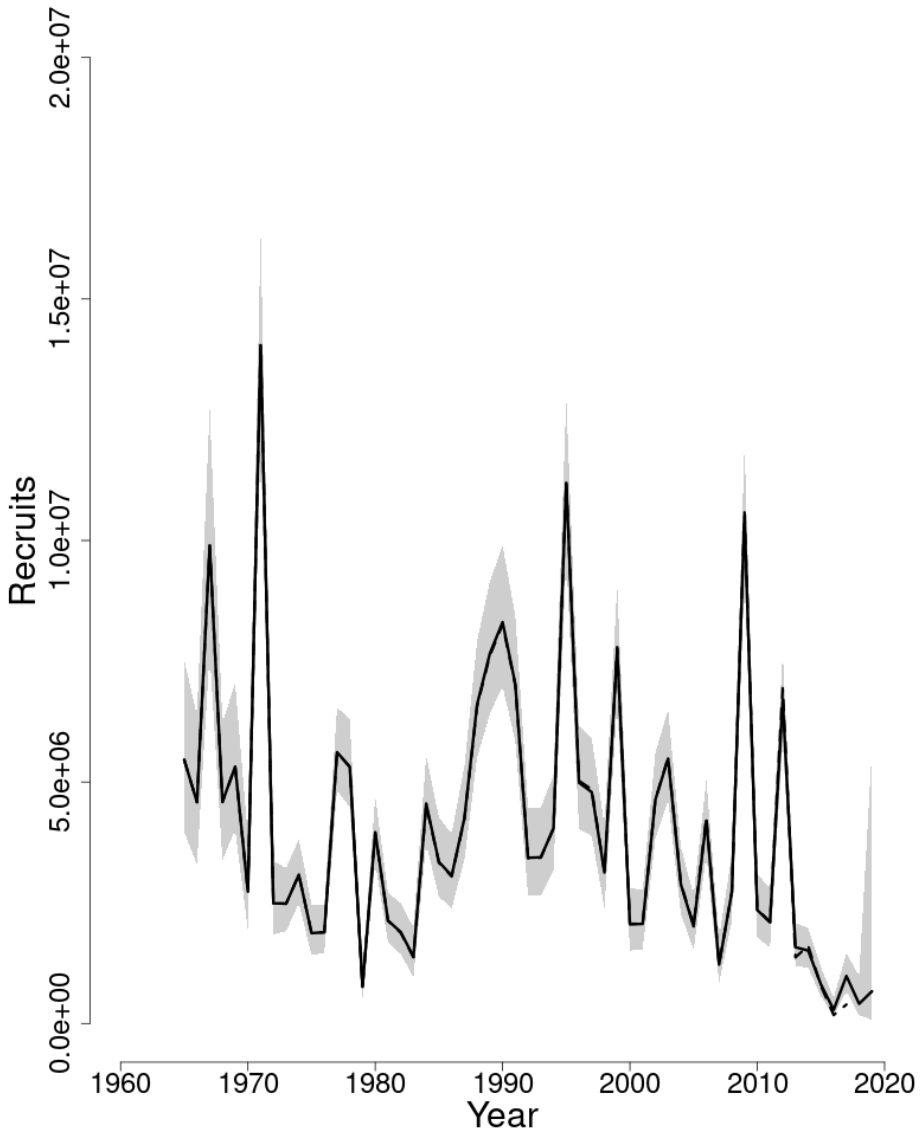

Figure 3: Trends in recruits (age-1)(000s) of Atlantic Herring between 1965 and 2019 from the current (solid line) and previous (dashed line) assessment. The approximate 90% confidence intervals are shown.

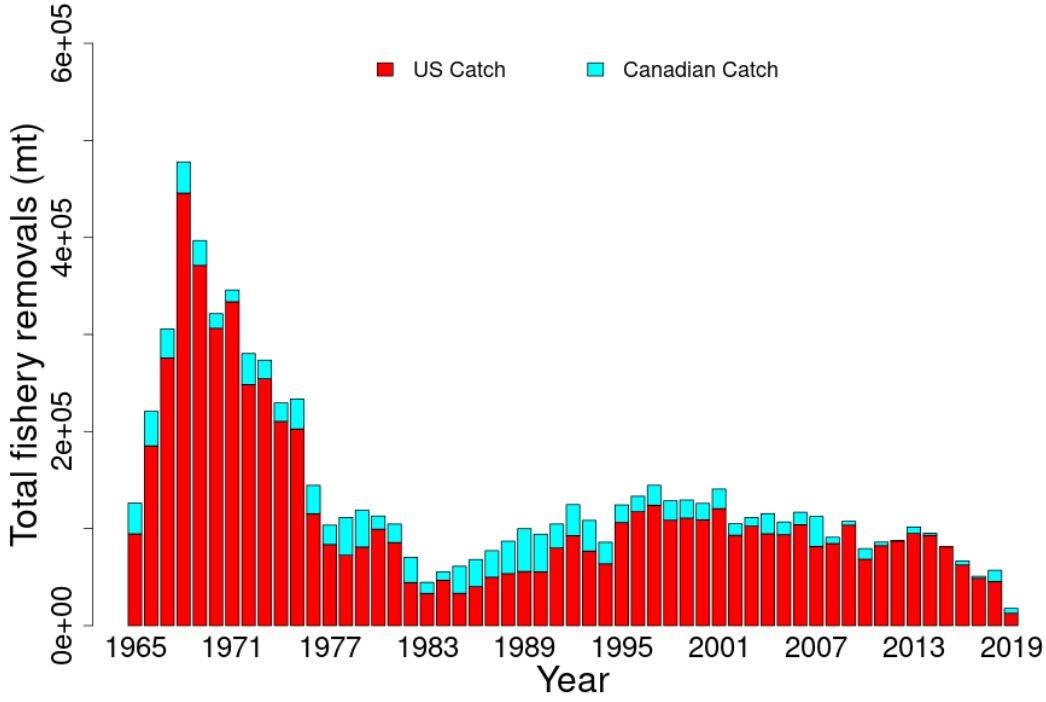

Figure 4: Total catch of Atlantic Herring between 1965 and 2019 by US and Canadian fleets.

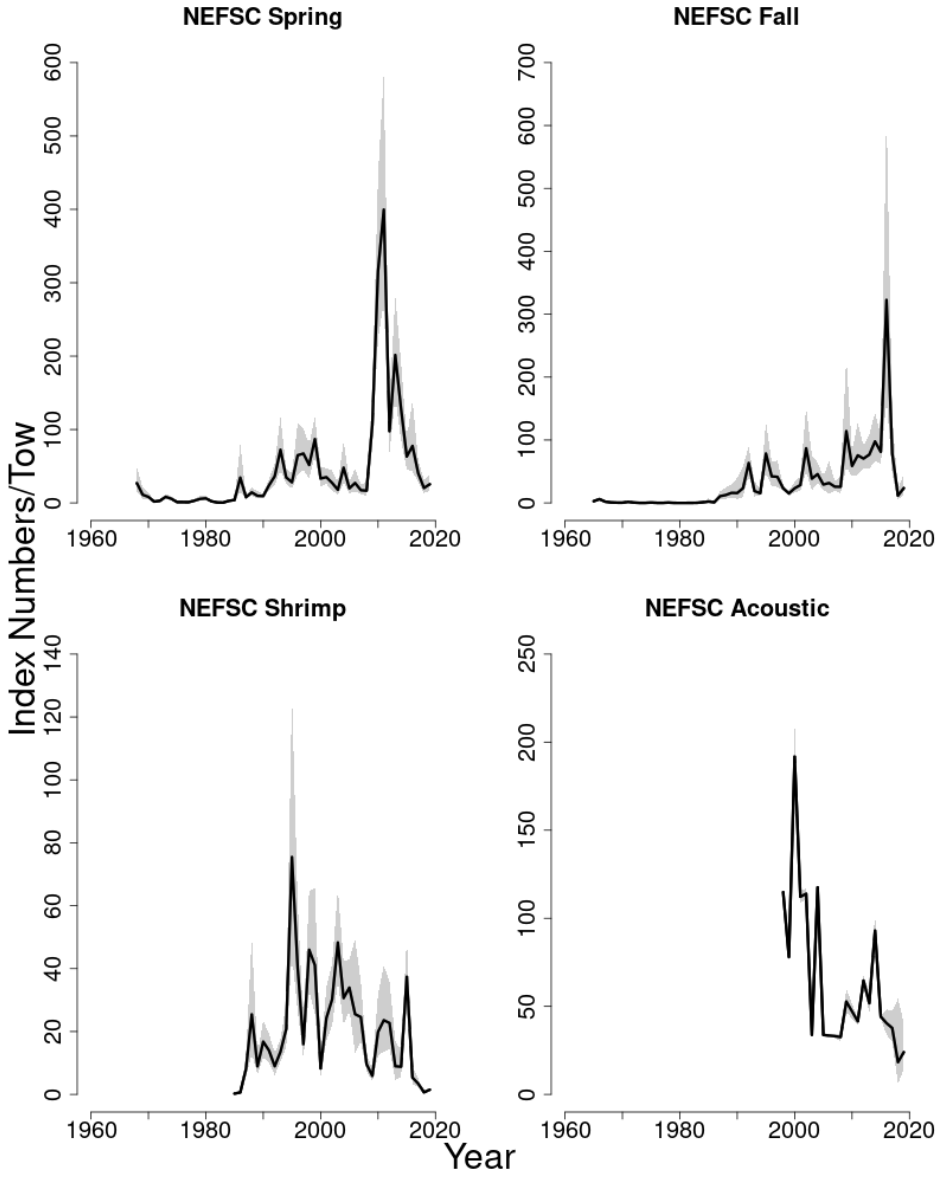

Figure 5: Indices of abundance for Atlantic Herring between 1965 and 2019 for the Northeast Fisheries Science Center (NEFSC) spring, fall, and shrimp bottom trawl surveys. The NEFSC acoustic index is collected during the fall bottom trawl survey and is in units of acoustic backscatter, not absolute numbers. The approximate 90% confidence intervals are shown.