2020 Management Track Peer Review Committee Report

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The Peer Review Committee (PRC) for Management Track Assessments met via webinar on June 22-25, 2020. Attendance at the meeting is provided in Appendix A. The PRC was asked to provide technical reviews of management track assessments for Atlantic herring (*Clupea harengus*), butterfish (*Peprilus triacanthus*), Atlantic surfclam (*Spisula solidissima*) and longfin inshore squid (*Doryteuthis (Amerigo) pealeii*). The assessments for these four species were prepared under guidelines prepared by 2020 Assessment Oversight Panel (AOP). These guidelines provide a pathway for continuing development of previously accepted assessments for each species including incorporation of the most recent data and understanding of biology of the species being assessed. The 2020 Assessment Oversight Panel considered Atlantic herring and butterfish to be Level 2 assessments and Atlantic surfclam and longfin squid as Level 3 assessments. As a result of this designation, the assessments for all four species required peer review.

We thank Russ Brown (Population Dynamics Branch Chief) and Michele Traver (Assessment Process Lead) for their support during the meeting. We thank the staff of the Population Dynamics Branch at NEFSC for the open and collaborative spirit with which they engaged the PRC. Our thanks extend not only to the analysts for each assessment, but also to the rapporteurs for taking extensive notes during the meeting. We also thank the other participants for helping make the meeting productive and collegial. Finally, the PRC thanks the staff at NEFSC for supporting the logistics during the meeting.

The PRC endorsed the assessments for all four species presented at the meeting for use in management. Analytical assessments were produced for Atlantic herring, butterfish, and Atlantic surfclam, each of which used a statistical catch-at-age model (Atlantic herring and butterfish) or a catch-at-age-and-length model (Atlantic surfclam). The assessment for longfin squid uses swept area biomass to estimate stock status. In each case the PRC endorsed the model and the inferences that resulted as representing the best scientific information available (BSIA), thereby providing a foundation for staff and the Mid-Atlantic and New England Fishery Management Councils and their SSCs to evaluate stock status and provide scientific advice.

Atlantic Herring

The 2020 assessment update for Atlantic herring is a Level 2 assessment in accord with the decision at the 29 April 2020 meeting of the AOP. The 2020 assessment is an update from the 2018 benchmark assessment (SAW 65) that used an ASAP modeling framework.

The PRC concludes that the 2020 assessment update for Atlantic herring is technically sufficient to evaluate stock status and provide scientific advice. The assessment represents BSIA for this stock for management purposes. The PRC agrees with the assessment report that the Atlantic herring stock is overfished and overfishing is not occurring. This is a change in status from the results of the 2018 benchmark assessment that indicated that the stock was not overfished and overfishing was not occurring.

The 2020 assessment used different methods to derive biological references points (BRPs) and conduct short-term projections than those in the 2018 benchmark assessment. The BRPs in the 2020 assessment were derived using only the selectivity of the mobile fleet (exclusively a USA fleet) because the fixed gear fleet (>90% Canadian) is not quota regulated and not subject to the same harvest control rules as the USA mobile fleet. However, the short-term projections included catches from both fleets to ensure that the stock dynamics and probability of overfishing and overfished were still subject to the total stock harvests.

Terms of Reference (TOR)

1. *Estimate catch from all sources including landings and discards.*

This TOR was satisfactorily addressed. Landings and discard data from 2018 and 2019 were added to those used in the 2018 benchmark. Because Canadian fixed gear catches markedly increased in 2018 (11,912 mt) and remained high in 2019 (5,115 mt) while USA mobile catches declined (45,189 mt in 2018; 12,721 mt in 2019) due to regulatory changes, the percent of the annual total catch taken by the Canadian fishery significantly increased to 21% in 2018 and 29% in 2019. From 2012 to 2017, Canadian catches accounted for between 1% and 7% of the annual total catches.

The age compositions of catches from the two fleets also differ. The USA mobile fleet primarily harvests fish that are age 3 and older, while the Canadian fixed gear fleet generally harvests herring that are age 2 and younger (although in 2019, age 3 fish were also caught).

2. *Evaluate indices used in the assessment (e.g., indices of relative or absolute abundance, recruitment, state surveys, age-length data, etc.).*

This TOR was satisfactorily addressed. All four of the survey indices used in the benchmark assessment (NEFSC spring bottom trawl survey, NEFSC fall bottom trawl survey, NEFSC shrimp bottom trawl survey, and the NEFSC fall survey acoustic index) were updated through 2019. As well, survey age composition and age-length data were updated through 2019 from the NEFSC spring and fall surveys. Age data from the summer shrimp survey were collected for the first time in 2019.

Trends in relative abundance of herring from all four surveys indicate a substantial decline in stock abundance during the past few years. All four of the survey indices in 2019 were at or near record-low values. The most relevant Canadian assessments of the stock show similar trends in abundance.

Although the surveys do not efficiently catch age-0 or age-1 fish, they do track cohorts well from age 2 onwards and thereby provide information on year class strength.

3. *Estimate annual fishing mortality, recruitment and stock biomass (both total and spawning stock) as possible (depending on the assessment method) for the times series using the approved assessment method and estimate their uncertainty. Include retrospective analyses if possible (both historical and within-model) to allow a comparison with previous assessments, and to examine model fit.*

a. Include bridge runs to sequentially document each change from the previously accepted model to the updated model proposed for this peer review.

b. Prepare a "Plan B" assessment that would serve as an alternate approach to providing scientific advice to management if the analytical assessment were to not pass review.

This TOR was satisfactorily addressed. The same ASAP model configuration used in the 2018 benchmark assessment was used in the 2020 update. Diagnostic and residual patterns were evaluated for all of the model input data (fleet catches, fleet age compositions, survey abundance indices and age compositions), as well as for the estimates of fishing mortality, biomass, spawning stock biomass, and recruitment. The diagnostic and residual patterns were acceptable (i.e., residuals generally randomly distributed) and similar to those in the 2018 benchmark assessment.

No retrospective adjustments were needed in the assessment. A Plan B assessment was not necessary because the model-based assessment was accepted.

4. *Re-estimate or update BRP's as defined by the management track level and recommend stock status. Also provide quantitative descriptions of stock status based on simple indicators/metrics (e.g., age-size-structure, temporal trends in population size or recruitment, indices.).*

This TOR was satisfactorily addressed. BRPs were re-estimated in the 2020 assessment using only the selectivity of the USA mobile fishing fleet and exclude any mortality from the catches from the unregulated Canadian fixed gear fleet. This is likely to result in biased reference points to an unknown degree, but there are no widely accepted methods for calculating BRPs when one of the fleets is not controlled. The fixed gear catches are treated as management uncertainty and a risk issue that needs to be addressed by managers. In essence, the re-estimated BRPs are US-based reference points and allow stock status relative to these reference points to be affected by Canadian fixed gear catches, which are unregulated and outside of US control.

The re-estimated BRPs are the following:

F_{msy} proxy = 0.54; SSB_{msy} proxy = 269,000 mt; SSB threshold (1/2 SSB_{msy}) = 134,500 mt; MSY = 99,400 mt.

An F40% proxy was used for the overfishing threshold and the SSB proxy reference points are based on long-term stochastic projections.

Estimated spawning stock biomass has been declining since 2014 (when SSB was 317,080 mt) and in 2019 was estimated to be 77,883 mt, the lowest value since the late 1980s. The 2019 SSB is 29% of the SSB_{msy} value (269,000 mt) and below the SSB threshold. Therefore, the stock is now overfished.

Fishing mortality (F) on the fully-recruited age groups to the USA mobile fleet (ages 7-8) has markedly declined since 2010, and F in 2019 was estimated to be 0.25, the lowest value since the early 1990s, and well below the overfishing threshold F_{msy} proxy value (0.54). Therefore, overfishing is not occurring

Recruitment has shown high variability over the past 50+ years, which is attributed to the episodic nature of herring recruitment. Since 2013, recruitment has declined to record-low levels. Median age 1 recruitment in the stock is 3.43 billion fish at age 1. Recruitment of age 1 fish in 2019 was estimated to be 666 million fish.

5. *Conduct short-term stock projections when appropriate.*

This TOR was satisfactorily addressed. Short-term (2021-2023) projections were conducted using the harvest control rule described in Amendment 8 of the Atlantic Herring Fishery Management Plan as applied solely to the US mobile gear fleet. Annual catches by the Canadian fixed gear fleet were assumed to be constant at 4,778 mt, the sum of the 10-year (2010-2019) averages of the Canadian (4,669 mt) and US (109 mt) fixed gear catches. For 2020, the total catch was assumed to be 16,319 mt, resulting in an SSB of 56,375 mt and F=0.243 for the US mobile gear fleet.

6. *Respond to any review panel comments or SSC concerns from the most recent prior research or management track assessment.*

This TOR was satisfactorily addressed. However, several uncertainties exist in the stock assessment. These include:

- There is uncertainty in the natural mortality rate (M), which is assumed in the assessment to be constant among ages and years. This assumption is common in stock assessments of many fish species because studies to determine natural mortality rates in exploited fish populations are difficult to conduct. Some insight on M for herring might be gained from the results of multispecies models that incorporate prey and predator relationships.
- The projections are uncertain because (1) recruitment in 2019 is imprecisely estimated and (2) recruitment in 2022 was drawn from the CDF of the long-term recruitment estimates, which results in a mean value about

equal to the long term average. The PRC notes that achieving mean recruitment is unlikely given the very low recruitment estimates in the most recent years.

- Continued poor recruitment will be the principal factor influencing stock status in the near future, as fishing mortality is now low compared to historical levels.

Recommendations

1. Because acoustic methods are regularly used to survey and assess herring stocks in other areas of the world, use of a dedicated acoustic survey should be explored further.
2. The reference points assume an absence of fixed gear fishing, which means that fishing at the $F_{40\%}$ rate would not be expected to achieve $SSB_{40\%}$. The panel suggests modifying the current approach to include the effect of catches in the fixed gear fleet. For example, the SSB reference points could be modified to also estimate the F reference point. The approach would involve conducting long-term projections of the population under different assumptions of mobile gear F. The fixed gear catches would remain the same as in the current approach. The unfished condition would have the mobile gear F = 0 and the fixed gear catch = 0. A grid search over the mobile gear F could be used to find the mobile gear F that achieves 40% of the unfished SSB. The PRC recommends attempting this approach for the next management track or research track stock assessment.

draft working paper for peer review only

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 June 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: The methods used to derive biological reference points and conduct short-term projections were changed as part of this management track assessment and details are provided in a supplementary document. Briefly, the reference points were calculated using only the selectivity from the mobile fishing fleet with no inclusion of mortality from the fixed fleet, which is likely to result in biased reference points to an unknown degree. No widely accepted methods for calculating reference points exist, however, in a multifleet context, especially when one of the fleets is that of a foreign country and is not controlled with quotas. Using an aggregated selectivity that combines the mobile and fixed fleets for reference points and projections, as in previous assessments (NEFSC 2018), was also problematic because the resulting projections either produced an unrealistic catch-at-age that allotted far too much catch to the fixed fleet, or assumed that the fixed fleet was subjected to the same harvest control rule as the mobile fleet, which is also incorrect. Note, however, that although the reference points were calculated using only the mobile fleet selectivity, short-term projections included fixed fleet catches such that stock dynamics and probability of overfishing and overfished were still affected by this source of mortality. 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. See above and supplementary document for details.

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. Likewise, 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.

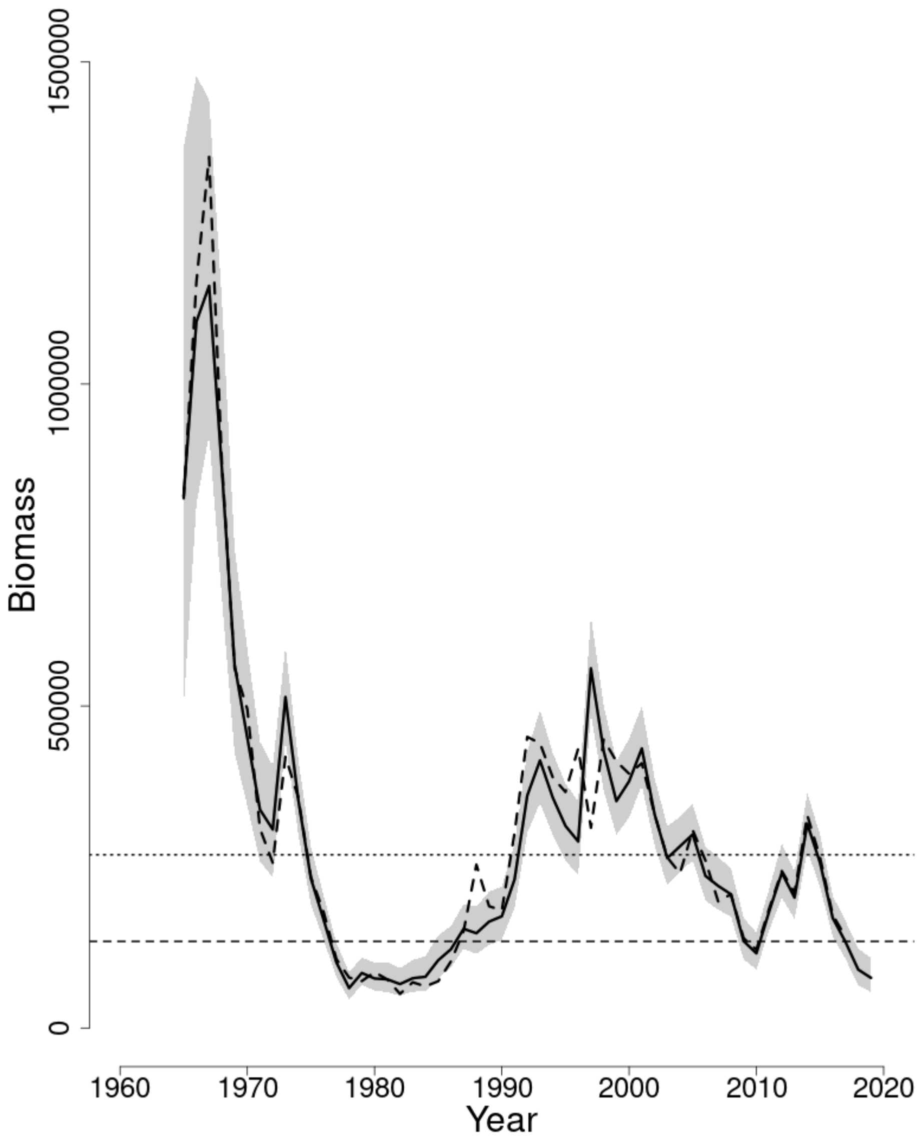

Figure 1: Trends in spawning stock biomass of Atlantic Herring between 1965 and 2019 from the current (solid line) and previous (dashed line) assessment and the corresponding $SSB_{Threshold}$ ($\frac{1}{2}$ SSB_{MSY} *proxy*; horizontal dashed line) as well as SSB_{Target} (SSB_{MSY} *proxy*; horizontal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

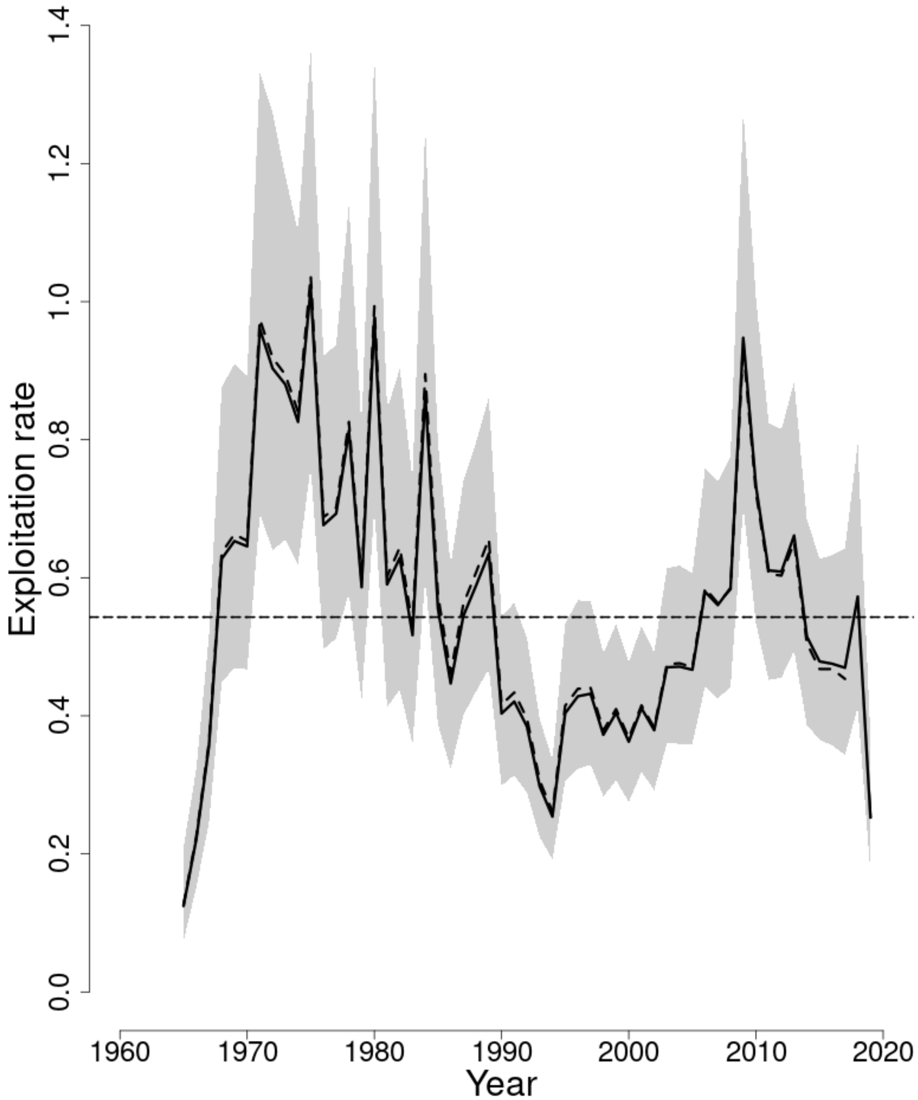

Figure 2: Trends in the average fishing mortality rate for ages 7-8, which are fully selected by the mobile fleet ($\bar{F}_{7-8}$), between 1965 and 2019 from the current (solid line) and previous (dashed line) assessment and the corresponding $F_{Threshold}$ (F_{MSY} *proxy*=0.543; horizontal dashed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

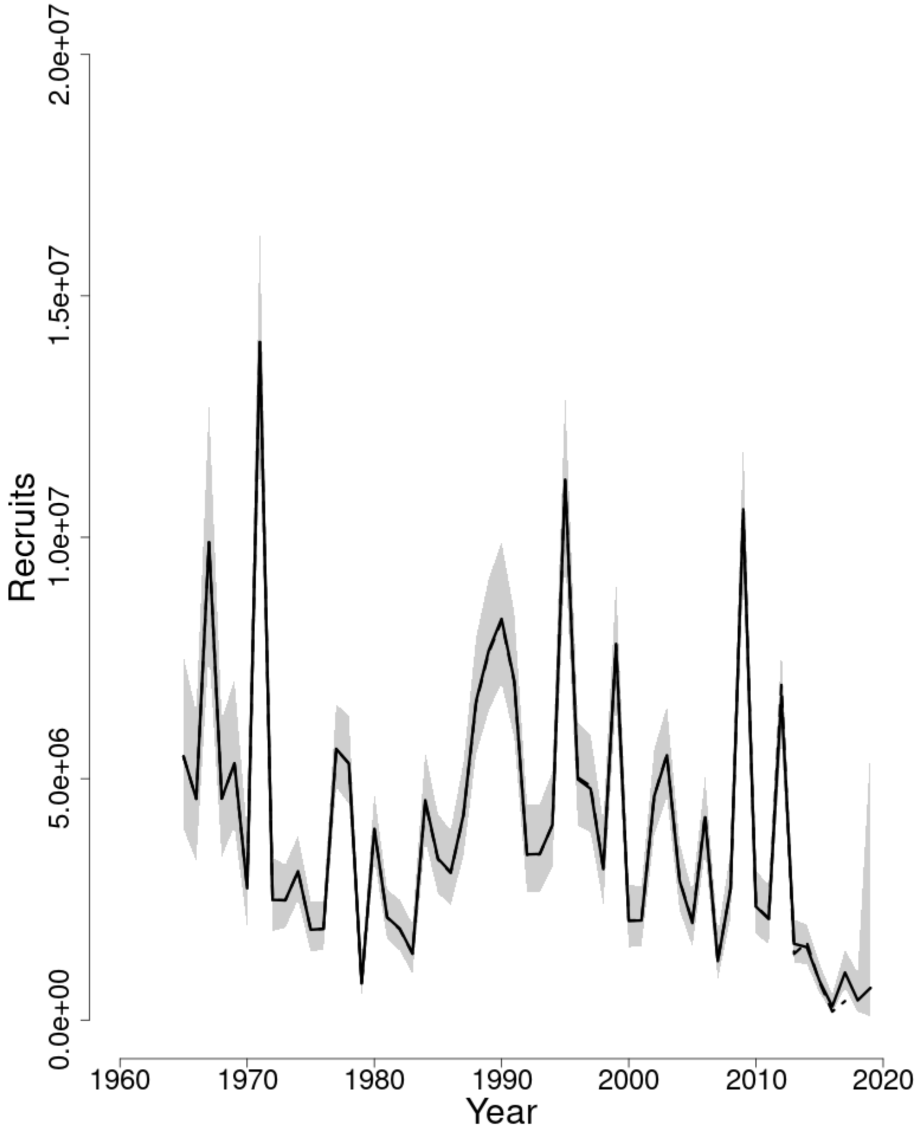

Figure 3: Trends in recruits (age-1)(000s) of Atlantic Herring between 1965 and 2019 from the current (solid line) and previous (dashed line) assessment. The approximate 90% confidence intervals are shown.

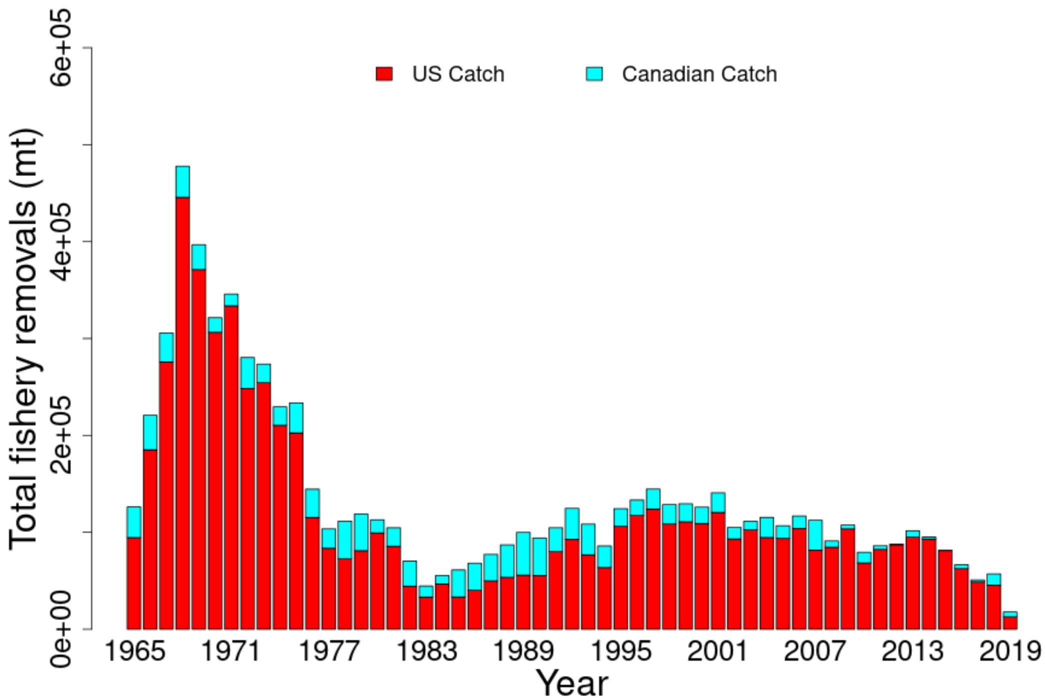

Figure 4: Total catch of Atlantic Herring between 1965 and 2019 by US and Canadian fleets.

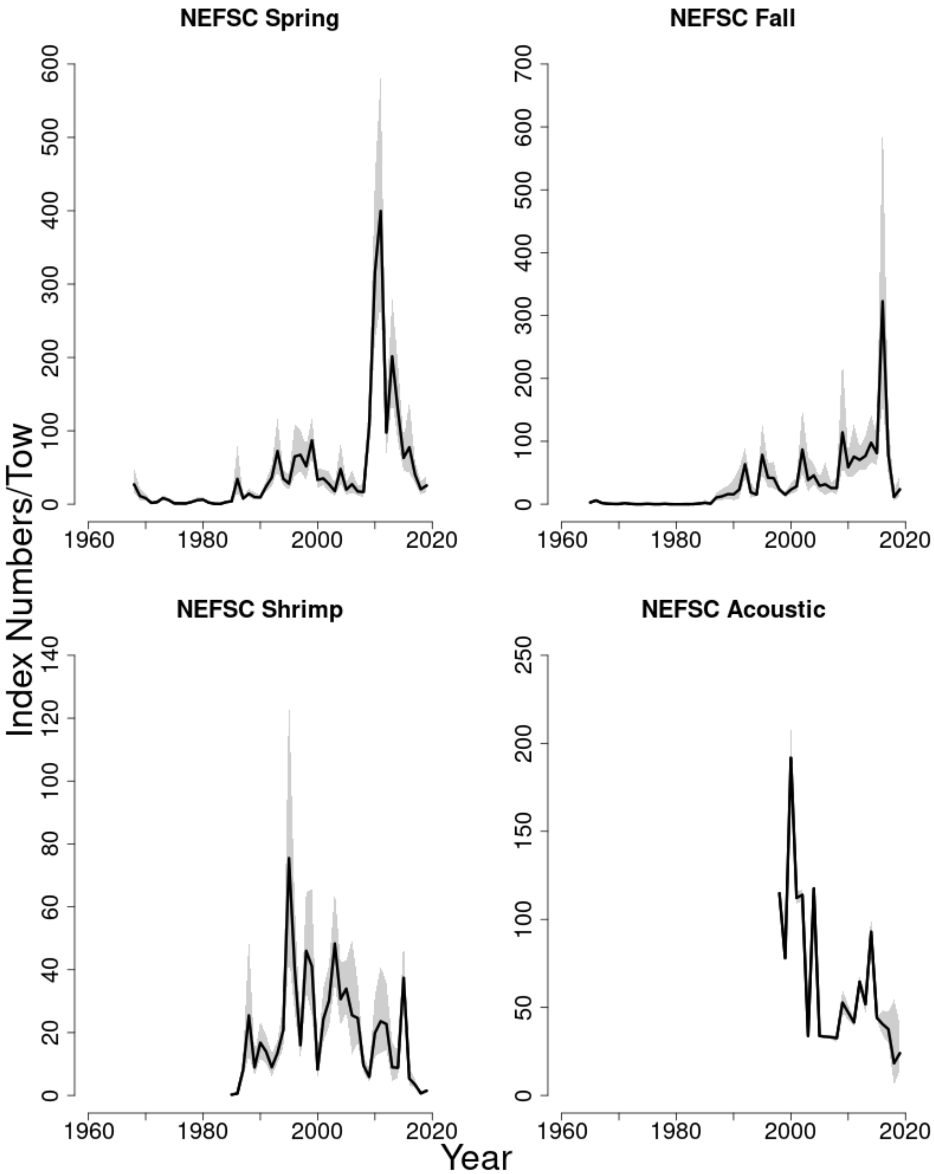

Figure 5: Indices of abundance for Atlantic Herring between 1965 and 2019 for the Northeast Fisheries Science Center (NEFSC) spring, fall, and shrimp bottom trawl surveys. The NEFSC acoustic index is collected during the fall bottom trawl survey and is in units of acoustic backscatter, not absolute numbers.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

A Detailed Description of Changes to Projection Methodology for the Atlantic Herring Management Track Assessment: 2020

Jonathan J. Deroba

Overview of the Methods Used in the 2018 Benchmark Assessment

No stock-recruit relationship was able to be estimated in the base ASAP model, therefore $F_{40\%}$ was used as a proxy for F_{MSY} and long-term projections were used to derive other MSY BRP proxies. The average of the last five years (2013-2017) of weights at age and maturity at age were used to calculate $F_{40\%}$ and in long-term projections. The base ASAP model has two fishing fleets, a mobile fleet that is an entirely US fishery, and a fixed gear fleet that is almost (~$\geq$ 90%) entirely Canadian. The two fleets have different selectivity patterns (Figure 1). These two selectivity patterns were aggregated into one in order to define reference points. This aggregation was achieved by summing the year specific F-at-age for each fleet to define a year by age sized matrix of total F. The average of the last five years of total F-at-age was calculated, and this vector was normalized to have a maximum of 1.0. This normalized vector served as the aggregated selectivity pattern, and was generally similar to the mobile fleet selectivity given that this fleet accounts for most of the catch in those years (Figures 1-2). Recruitment in each year of the projections was drawn from the empirical cumulative distribution of the estimated recruitments from 1965-2015. The estimates of recruitment from 2016-2017 were excluded because they were imprecisely estimated with CVs equal to 95% and 251%, respectively (as a point of comparison the CV for 2015=38%). In drawing recruitments from the empirical distribution, a uniform random value is drawn between 0-1 each year, and the recruitment associated with that probability from the cumulative distribution is applied. Thus, any recruitment between the minimum and maximum in the estimated time series has an equal probability of selection each year. F_{MSY} proxy = 0.51, SSB_{MSY} proxy = 189,000 mt (½ SSB_{MSY} = 94,500 mt), and MSY proxy = 112,000 mt.

Updating the 2018 Benchmark Approach for the 2020 Management Track

Updating the 2018 Benchmark projection approach for the 2020 assessment resulted in a larger than anticipated change in reference points. F_{MSY} proxy = 0.38, SSB_{MSY} proxy = 271,000 mt. The change in SSB_{MSY} proxy was caused by an error in calculating this value in 2018. The error involved using the incorrect selectivity pattern (i.e., a copy/paste mistake) for long-term projections used to determine SSB_{MSY} proxy. The 2018 SSB_{MSY} proxy value should have been 266,000 mt. Had SSB_{MSY} proxy been correctly calculated in 2018, the overall overfished and overfishing conclusions would not have changed, but the stock would have been closer to an overfished status than previously thought (SSB_{2017}/ SSB_{MSY}

proxy = 0.75 with the incorrect value, but 0.53 with the corrected value). The change in F_{MSY} proxy, however, was driven by a shift in the aggregated selectivity pattern of the mobile and fixed gear fleets. Typically, the fixed fleet accounts for 1-7% of the total catch, but in 2018-2019, the fixed gear fleet was responsible for 21-29% of the total (Table 1). Thus, the fixed gear fleet was responsible for a larger proportion of the total F, and the process used to estimate an aggregated selectivity pattern between the fishing fleets resulted in a shape increasingly representative of the fixed gear fleet, particularly at younger ages (Figure 3).

Management Approach and Consequences

An OFL and ABC are specified using short-term projections. For Atlantic herring, the ABC is reduced for management uncertainty, which includes some reduction based on anticipated fixed gear catch. Typically, a recent average of Canadian fixed gear catch is deducted from the ABC to establish the (US) Domestic Allowable Harvest, or annual catch limit (ACL). The implicit assumption of the existing projection methodology is that the aggregated selectivity pattern used for projections will produce an ABC that includes approximately the same amount of fixed gear catch that will later be defined by managers and deducted from the ABC. This assumption, however, is not necessarily true, and will be violated to varying degrees depending on projected cohort strength and how well realized Canadian catches match a recent average. If the aggregated selectivity pattern is largely reflective of the mobile fleet, then this inconsistency between implied fixed gear catch in projections and that defined as management uncertainty is likely of little consequence. The aggregate selectivity pattern as updated for the 2020 management track, however, does not resemble the mobile fleet. The consequence is that the implied amount of fixed gear catch would likely be overestimated (e.g., because age-2 fish are ~50% selected) and larger than what would typically be deducted for management uncertainty. This process would produce a Domestic Annual Harvest or ACL that is overly inflated by projected catches of relatively young fish that the US mobile fleet generally does not catch. In short, the reference points produced by updating the herring assessment using the existing projection method from the 2018 assessment, and projected catches based on those reference points, would be unduly affected by the selectivity of a foreign fleet. Thus, the existing projection methodology is inappropriate.

Proposed Solution

The proposed solution was to base reference points on the mobile fleet selectivity pattern only. More specifically, $F_{40\%}$ as calculated using the mobile fleet selectivity was used as a proxy for F_{MSY}, and long-term projections were used to derive other MSY BRP proxies. The average of the last five years (2015-2019) of weights at age and maturity at age were used to calculate $F_{40\%}$ and in long-term projections. Recruitment was handled in projections as before. Recruitment in each year of the projections was drawn from the empirical cumulative distribution of the estimated recruitments from 1965-2017. The estimates of recruitment from 2018-2019 were excluded because they were imprecisely estimated with CVs equal to 58% and 210%, respectively. In drawing recruitments from the empirical distribution, a uniform random value is drawn between 0-1 each year, and the recruitment associated with that probability from the cumulative distribution is applied. Thus, any recruitment between the minimum and maximum in the estimated time series has an equal probability of selection each year. F_{MSY} proxy = 0.54, SSB_{MSY} proxy = 269,000 mt, (½ SSB_{MSY} proxy = 134,500 mt), and MSY proxy = 99,400 mt.

Short-term projections will include two fleets, mobile and fixed gear, consistent with the previous stock assessment. In all short-term projections, fixed gear catches will be specified as some constant amount in each year. The fixed gear catch amount will be specified by managers, just as before, and may still be considered management uncertainty. OFL will equal the sum of the mobile fleet catches that result from the mobile fleet fishing at F_{MSY} proxy and the specified fixed gear catch. ABC will equal the sum of mobile fleet catches that result from applying the NEFMC's selected harvest control rule and the specified fixed gear catch. The probability of overfishing would be based on comparing the projected, fully selected, mobile fleet fishing mortality rate to F_{MSY} proxy, while probability of overfished would be calculated as under the existing approach (noting that SSB_{MSY} proxy is based exclusively on the mobile fleet selectivity). While the probability of overfishing would be based on comparing the projected, fully selected, mobile fleet fishing mortality rate to F_{MSY} proxy, the OFL (defined as above, summed across both fleets) would represent the catch that if exceeded would result in overfishing.

This proposed solution removes the influence of a foreign fleet, which is not currently managed using catch limits, on reference points developed to manage the US Atlantic herring fishery. This approach should also stabilize reference points in future assessments because the reference points will no longer change in relationship to the relative amount of catch from each fleet. By using two fleets for short-term projections, the catch of the fixed gear fleet will still affect probability of overfishing and overfished. The amount of fixed gear catch specified in short-term projections will now also be explicit, as opposed to an implicit amount under the previous approach.

Managers have not yet decided on a level of management uncertainty and fixed gear catch, but example projection results are provided in Table 2. In this example projection, the mobile fleet fishing mortality was specified by applying the harvest control rule defined in Amendment 8 of the herring fishery management plan. Fixed gear catches were set equal to their 10-year averages (2010-2019). Note that the projection values are unofficial and may change based on additional assessment changes or management decisions.

Table 1. Herring catches by fleet and the % of the total catch attributable to the fixed gear fleet.

	Mobile	Fixed	%Fixed
2012	87162	513	0.006
2013	95182	6440	0.063
2014	92566	2667	0.028
2015	80465	884	0.011
2016	61808	4849	0.073
2017	48531	2368	0.047
2018	45189	11912	0.209
2019	12721	5115	0.287

Table 2. An example projection table using the short-term projection methodology proposed as part of the 2020 Management Track.

Canadian Catch = 4669 mt; US Fixed Fleet (i.e., stop seine, weir, and pound nets) = 109 mt

	Mobile Fleet F	SSB	P(overfishing)	P(overfished)	OFL	ABC	SSB/SSBmsy
2020	0.243	56375	0.002	0.999	–	–	0.210
2021	0.119	48841	0.000	0.932	23423	9483	0.182
2022	0.089	45921	0.000	0.903	26292	8767	0.171
2023	0.077	130616	0.000	0.525	44600	11025	0.486

Figure 1. Fleet specific selectivity as estimated by the 2018 Benchmark stock assessment ASAP model.

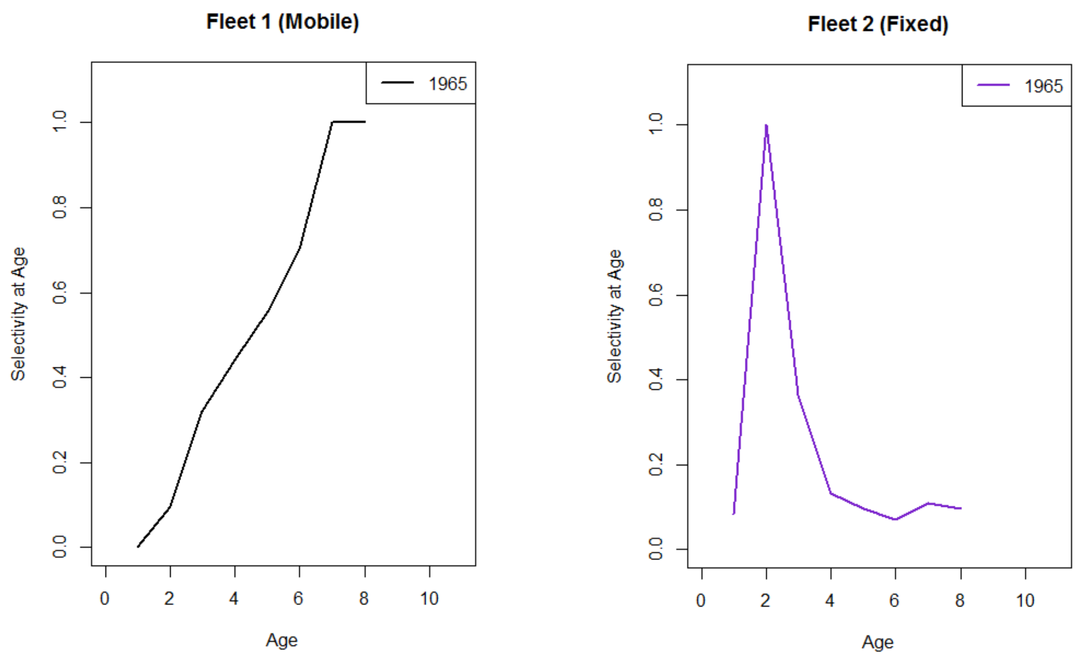

Figure 2. The selectivity pattern used to define reference points during the 2018 Benchmark stock assessment.

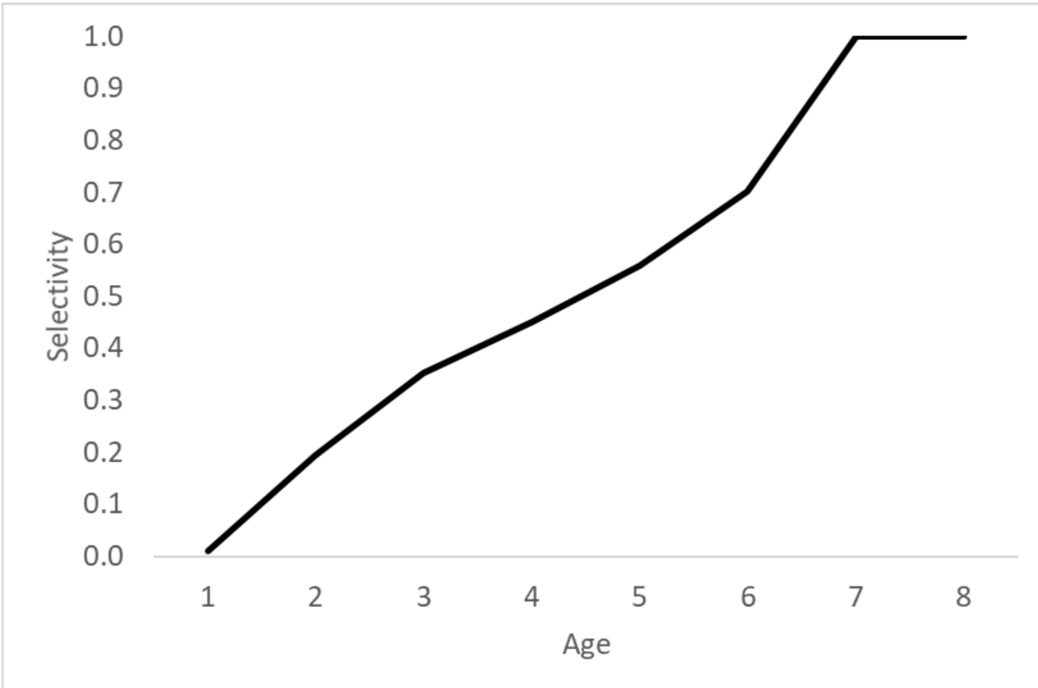

Figure 3. The aggregate selectivity pattern between the mobile and fixed fleets as updated in the 2020 Management Track assessment.