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

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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.

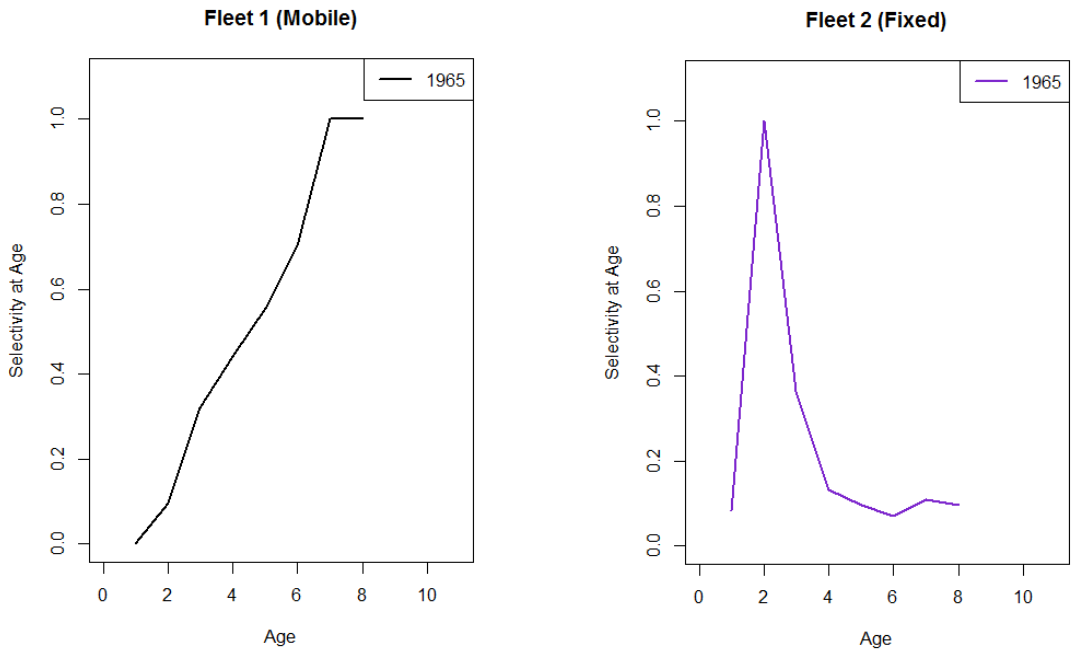

Figure 2. The selectivity pattern used to define reference points during the 2018 Benchmark stock assessment.

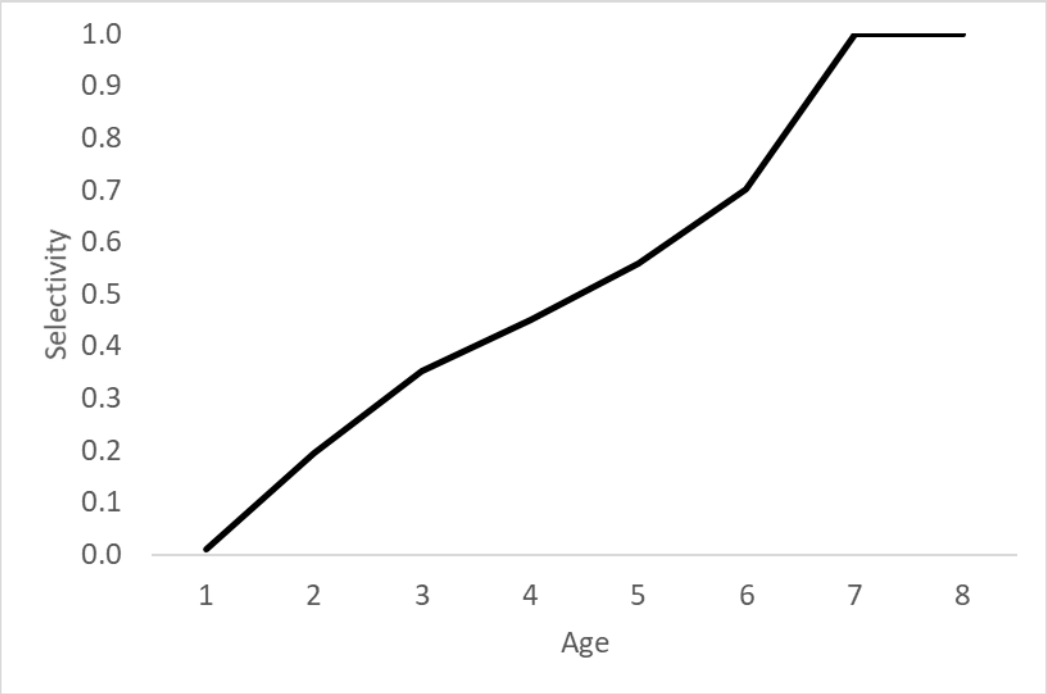

Figure 3. The aggregate selectivity pattern between the mobile and fixed fleets as updated in the 2020 Management Track assessment.