

# 2021-2023 ATLANTIC HERRING OVERFISHING LIMIT (OFL) AND ACCEPTABLE BIOLOGICAL CATCH (ABC) RECOMMENDATIONS

## Herring Plan Development Team (PDT) Report

(DRAFT)

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Prepared by the New England Fishery Management Council

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The Herring Plan Development Team (PDT) met on July 20, 2020 via webinar to develop OFL/ABC recommendations for the July 29, 2020 Scientific and Statistical Committee (SSC) Meeting. This report includes relevant background information and PDT recommendations for 2021-2023 OFL and ABC levels (Table 1).

**Table 1 – Herring PDT recommendations for SSC consideration of 2021-2023 OFL and ABC limits for the Atlantic Herring Fishery Management Plan (FMP). Fixed gear catches were assumed equal to their 10-year averages with Canadian Catch= 4,669 mt US Fixed= 109 mt. and are included in these projections.**

	OFL (mt)	ABC (mt)
<b>2021</b>	<b>23,423</b>	<b>9,483</b>
<b>2022</b>	<b>26,292</b>	<b>8,767</b>
<b>2023</b>	<b>44,600</b>	<b>11,025</b>

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## **1.0 ATLANTIC HERRING MANAGEMENT TRACK STOCK ASSESSMENT (2020)**

### **1.1 TRENDS IN ABUNDANCE AND BIOMASS**

The Atlantic herring stock was most recently assessed during spring 2020 Management Track Assessment (NEFSC, 2020). The 2020 assessment used all the same data sources of the previous assessment (NMFS spring, fall, acoustics collected in fall, and summer shrimp bottom trawl survey). Overall, SSB generally declined from 1965 to a time series low in 1978 and then generally increased from 1978 through the mid-90s. SSB declined again from 1997 to 2010, increased for several years until 2014, and has been declining since. In addition, fishing mortality has been relatively stable since the decreases in the 1990s, with a gradual increase in 2009, followed by a general declining fishing mortality since then (Figure 1).

With data updates, the 2019 SSB was estimated to be 77,883 mt (80% probability interval: 57,150-111,125mt), compared to the full range of estimated biomass of 62,007 mt in 1978 to 1,152,400 mt in 1967 (Figure 1). The average F between ages 7 and 8 was used for reporting results related to fishing mortality (F7-8) because these ages are fully selected by the mobile gear fishery, which has accounted for most of the landings since 1986. F7-8 in 2019 equaled 0.25 (80% probability interval: 0.17-0.37) and ranged from 0.1f2 in 1965 to 1.02 in 1975 (Figure 1).

Age-1 recruitment has been below average since 2013 (Figure 2). The time series high for recruitment was in 1971 (1.4 billion age-1 fish). The time series low (2.8 million fish) occurred in 2016, and the second lowest (4.1 million fish) occurred in 2018, although this estimate is highly uncertain. Five of the six lowest annual recruitment estimates have occurred since 2015 (2015, 2016, 2017, 2018, and 2019).

Figure 1 - Atlantic herring spawning stock biomass (mt) and fishing mortality (F.report averaged over ages 7 and 8; F.full is fully selected) time series from the age structured assessment program (ASAP model) for 1965-2019 (NEFSC 2020)

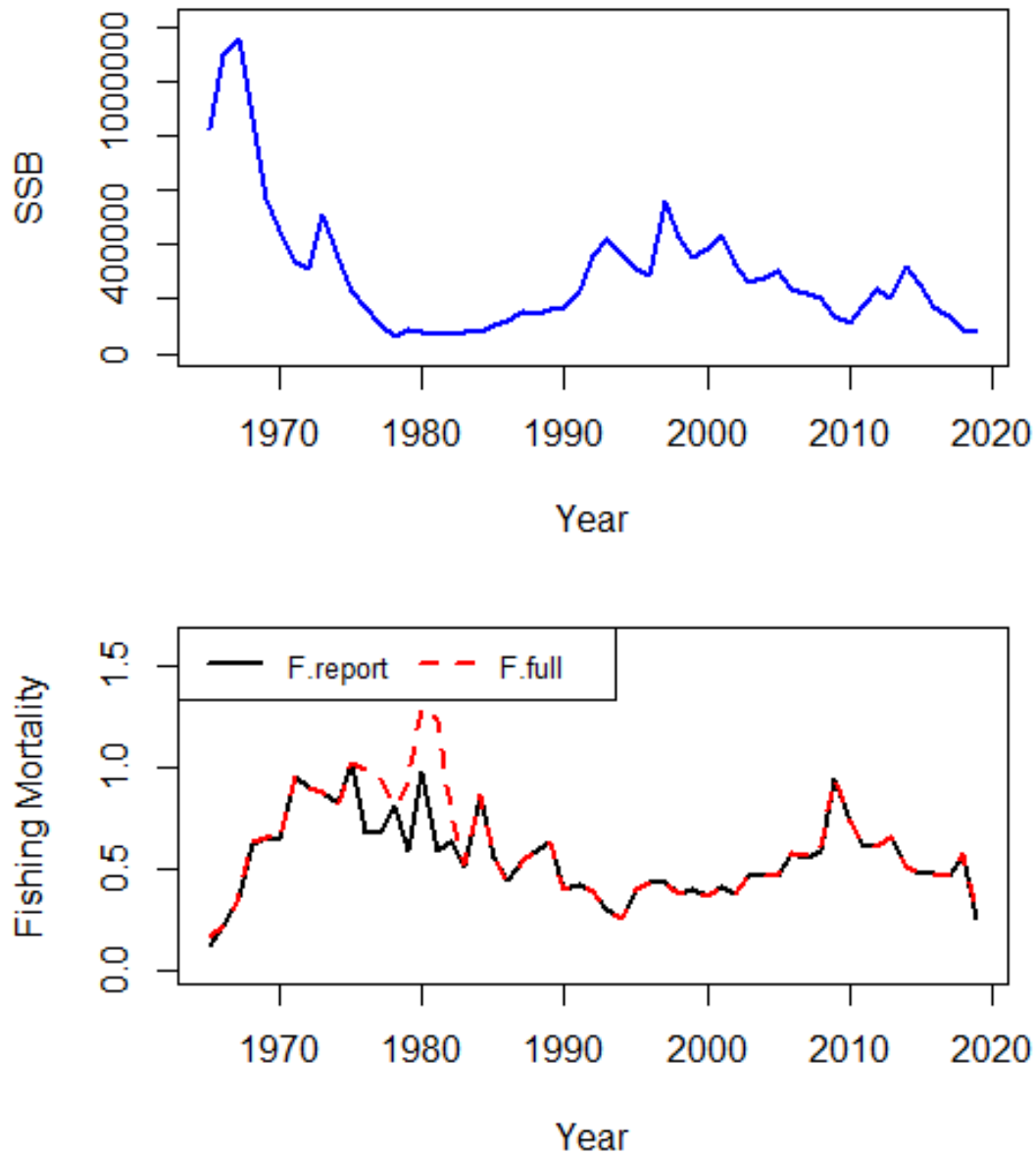
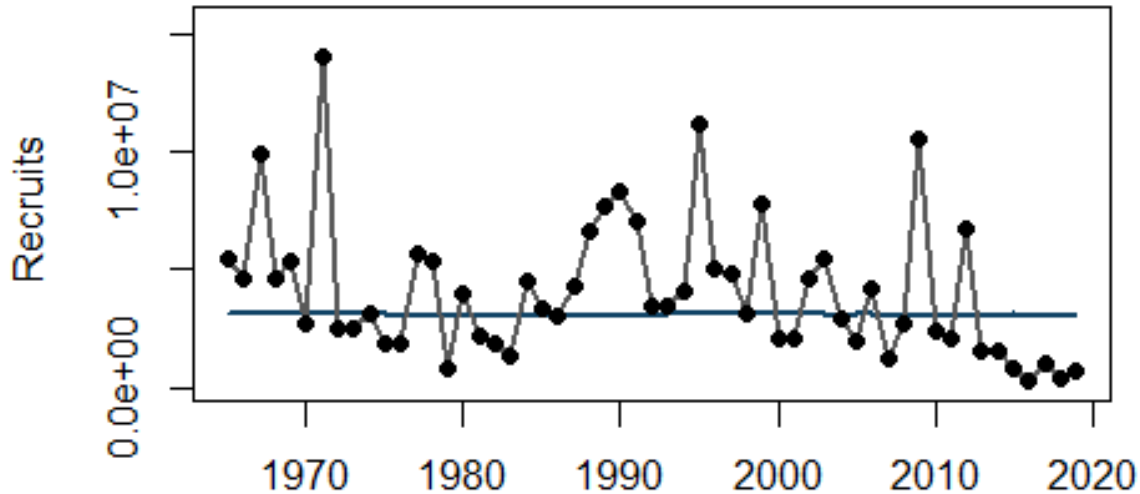


Figure 2 – Atlantic herring annual recruit (000s) time series, 1965-2019. The horizontal line is the average over the time series (NEFSC 2020)



## 1.2 ATLANTIC HERRING STOCK STATUS

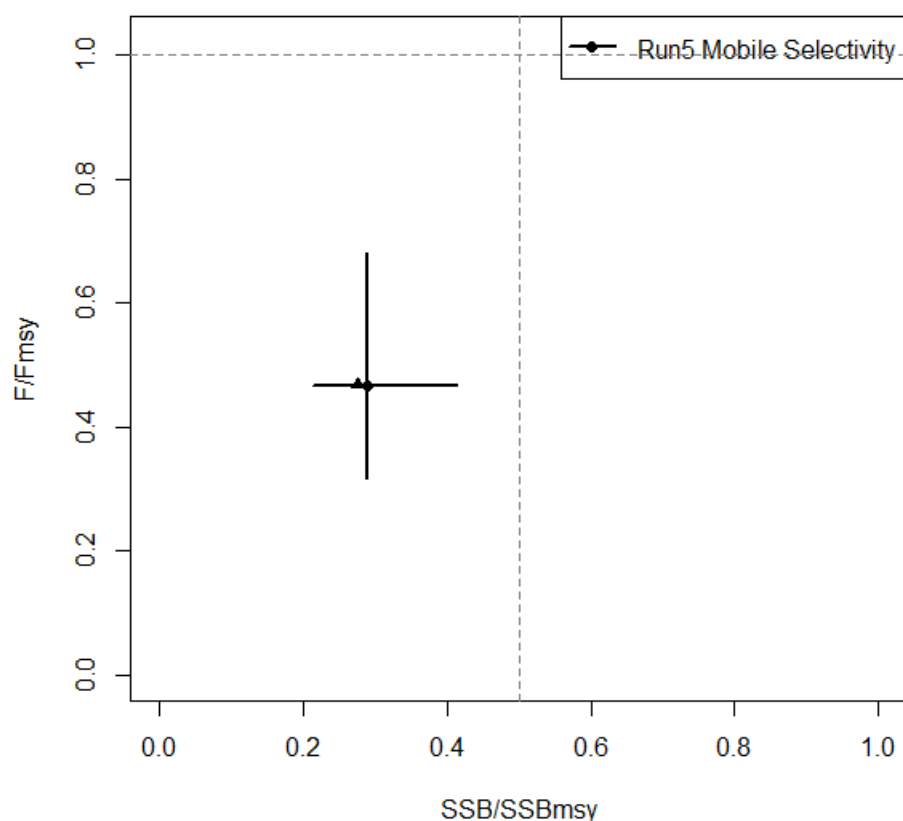
MSY reference points from the 65<sup>th</sup> Stock Assessment Workshop (NEFSC 2018) were based on a selectivity curve aggregated between the mobile and fixed gear fleets. The proportion of the catch coming from the fixed gear fleet has increased in recent years, which made the MSY reference points unduly affected by the Canadian, fixed gear catches, which are not quota controlled. Thus, MSY reference points in the 2020 assessment were estimated based on the mobile fleet selectivity pattern, which is an entirely US fleet. MSY reference points were still premised on a proxy of F40%, as in SAW 65. The newly proposed reference points from the 2020 assessment are no longer affected by the relative amount of mobile and fixed fleet catches.

- $F_{MSYproxy} = 0.543$
- $SSB_{MSYproxy} = 269,000$  mt
- ( $\frac{1}{2} SSB_{MSYproxy} = 134,500$ ), and
- $MSY_{proxy} = 99,400$  mt.

The 2020 management track assessment concluded that for the terminal year of the assessment, 2019, the Atlantic herring resource is below its biomass target (2019 biomass of 77,883mt), and fishing mortality is below the  $F_{MSY}$  threshold (2019  $F_{7-8} = 0.253$ )(Figure 3). Therefore, Atlantic herring is *overfished but not subject to overfishing*.

The assessment did include some cautionary notes about the status of the stock. In the short-term, the relatively poor recruitments in 2013-2019 will increase the probability of the stock remaining overfished. Growth (i.e., weight at age) also continues to be relatively low when compared to the 1990s, and this seems to be a longer-term feature of the stock that also reduces production. The stock, however, seems to be capable of producing relatively large and small year classes regardless of growth, and so recruitment is likely the more significant driver of short-term vulnerability.

**Figure 3 - Atlantic herring stock status based on the ASAP model. Error bars represent the 80% probability intervals. The triangle represents the model result if an adjustment were to be made for the retrospective pattern (NEFSC 2020)**



### 1.3 ASSESSMENT UNCERTAINTY

#### 1.3.1 Natural Mortality (M)

Natural mortality remains an uncertainty in this stock assessment.  $M$  was assumed constant in the 2020 management track, as in SAW 65, but  $M$  is likely to vary among time and age (size). Continued research on the best use of stomach contents data and model diagnostics that might be informative for estimating time-varying  $M$  is warranted, especially because herring are a prey item for many predators in the region.

### 1.3.2 Stock-recruit relationship

A definitive explanation for the continued poor recruitment has not been identified. While finding such an explanation would be hugely beneficial, explaining patterns in recruitment has been generally elusive in the broader field of fisheries science.

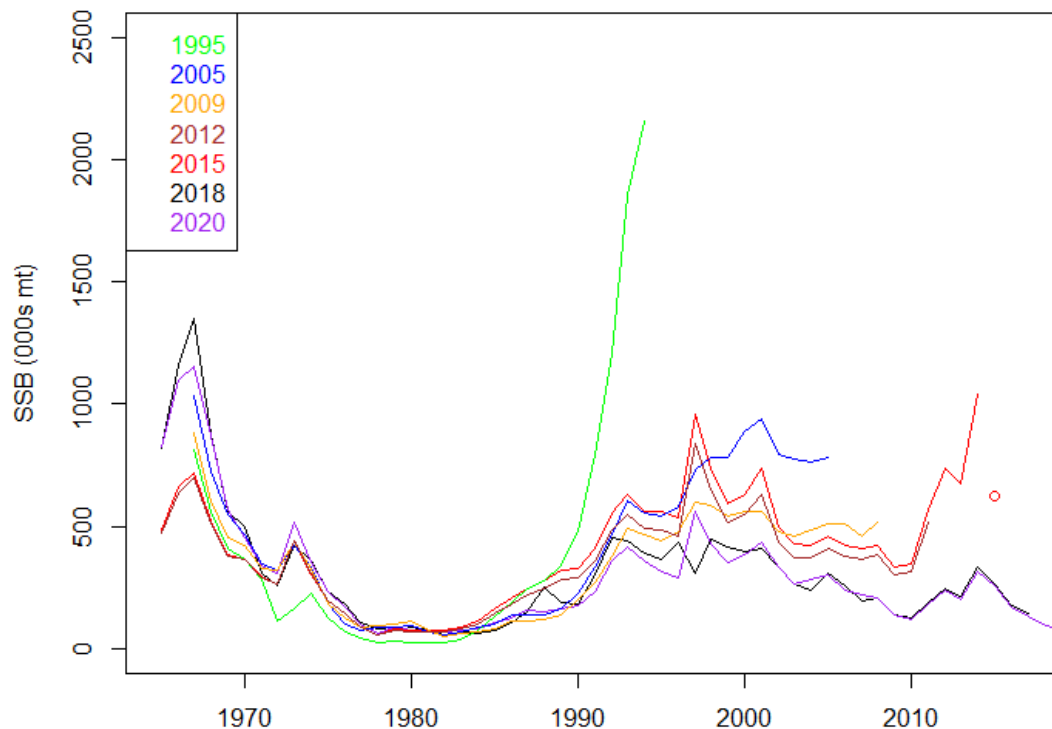
### 1.3.3 Stock Structure

Stock structure remains an uncertainty for this stock assessment, particularly mixing with the Nova Scotian stock. Migration can be conflated with changes in mortality or fishery selectivity and contribute to retrospective patterns. Previous attempt to account for stock structure in the assessment have failed; however, due to uninformative data (NEFSC 2018).

## 1.4 PREVIOUS ASSESSMENT UNCERTAINTY

Figure 4 is the “historical retrospective pattern” that compares the estimates of SSB among previous assessments. Relatively large shifts are likely related to structural changes in the assessment, such as shifting from a virtual population analysis (VPA) (1995) to age structured assessment program (ASAP) (2005-2018), inclusion or exclusion of time-varying M, splitting the NMFS bottom trawl surveys so that the *R/V Bigelow* was its own time series (2015 to 2020), or some combination of these or other structural changes.

Figure 4 - Atlantic herring historic retrospective pattern for SSB



## **2.0 ATLANTIC HERRING FISHERY SPECIFICATIONS**

The Herring PDT updated this section from the report prepared in 2018 to provide a historical perspective on the degree of uncertainty in past Atlantic herring stock assessments, and the buffers that were established in the subsequent fishery specifications packages to account for those uncertainties. Table 2 summarizes the uncertainty identified from previous Atlantic herring stock assessments and the related SSC recommendations for catch advice.

### ***2019-2021 Atlantic Herring Fishery Specifications***

The SSC was prepared to recommend the Council implement the harvest control rule selected through the Amendment 8 MSE process. However, the SSC had reservations about the projections for Atlantic herring and were concerned about the assumptions regarding future recruitment. The SSC was concerned that age 1 recruitment in projections for 2019-2021 was drawn from 1965-2015 and the resulting projected biomass which showed a substantial increase over time. The SSC did not have confidence in the projected increase in biomass in 2021 and were concerned about setting ABC based on this value. Following an extensive discussion on this topic, the SSC resolved to make ABC recommendations for 2019 and 2020 based on the ABC control rule but recommended keeping ABC in 2021 the same as 2020 due to the uncertainty in the projections.

In addition, the SSC recommended the NEFMC request an update assessment in 2020 based on the existing benchmark assessment. The objective of this update would be to verify projected trend in biomass and recruitment with the aim of revising advice for 2021 based on more informed estimates of recent recruitment. That assessment was completed as a management track assessment in 2020. Finally, the SSC recommended further investigation into understanding the recent low recruitment of Atlantic herring and possible drivers.

### ***2016-2018 Atlantic Herring Fishery Specifications***

The SSC reviewed the catch projection included within the operational assessment report (2015) as well as an option developed by the PDT using the same control rule used in the previous specifications. That control rule involved a constant catch approach in fishing years 2016-2018, with the ABC set such that the probability of overfishing does not exceed 50% in any of those years. Based on the projection, the probability of overfishing was estimated to reach 50% in the third year (2018). That control rule resulted in an ABC of 111,000mt for 2016, 2017 and 2018, and associated OFLs of 138,000mt in 2016, 117,000mt in 2017, and 111,000mt in 2018.

The rationale for this recommendation discussed by the SSC was as follows:

- A constant catch strategy is the preferred approach of the Council and industry.
- Key attributes of the stock and assessment (SSB, recruitment, F, survey indices, etc.) have not changed significantly since the benchmark assessment, on which the current control rule was based. However, survey indices suggest that the 2011-year class is the second largest in time series and will contribute significantly to the total population abundance and biomass in 2016-2018.
- The most significant change is that the retrospective pattern has become worse in the operational assessment. The assessment implemented a Mohn's rho correction to SSB in an attempt to account for the retrospective pattern, but there is no guarantee that the retrospective pattern will persist in sign and magnitude.



- Although the probability of overfishing reaches 50% in the third year, the probability of the stock becoming overfished is close to 0% in all years.
- The realized catch in the fishery is generally well below the ABC, which reduces the expected risk of overfishing.
- The current ratio of catch to estimated consumption is 1:4, which means that fishing is likely not the largest driver of stock abundance at present, however this does not negate the need to manage the fishing removals on this stock.

The considerations above led the SSC to conclude that ABC should remain relatively constant, or perhaps be reduced modestly. The recommended ABC of 111,000mt, compared with status quo estimate of 114,000mt, achieves that outcome. The SSC noted that the current high biomass of herring, bolstered by two very large year classes, is likely meeting ecosystem goals; however, meeting this goal is by default and not by design, as ecosystem goals are not identified or captured in the current control rule.

### ***2013-2015 Atlantic Herring Fishery Specifications***

When developing catch advice for the 2013-2015 Atlantic herring fishery specifications, the SSC considered projections at 75%  $F_{MSY}$  as well as a constant catch approach. The SSC also considered two ABC control rules based on those utilized for forage fish in other regions. Given the condition of the Atlantic herring stock complex at that time, the control rules based on constant catch and 75%  $F_{MSY}$  were expected to produce approximately the same cumulative catch over the three years. The SSC noted that there is a higher risk of overfishing in the first year associated with the 75%  $F_{MSY}$  control rule and a higher risk of overfishing in the second and third years associated with the constant catch control rule. However, the SSC could not find any scientific reason to prefer one of these control rules over the other and considered them to be comparable in terms of risk of overfishing, given the information available. All considerations led the SSC to conclude that either control rule can be applied for 2013-2015 with low probability of overfishing or causing the stock to become overfished. The SSC recommended that the Council select either of these alternatives to specify ABC for the 2013-2015 fishing years.

The SSC considered several characteristics of the herring fishery and stock assessment before arriving at this decision regarding the ABC control rule for the 2013-2015 fishing years. The SSC did discuss the role of herring in the ecosystem and options for setting ecosystem-based ABCs. At that time, the SSC concluded that both control rules for the next three years would result in fishing mortality rates well below the natural mortality ( $M$ ) rate and a stock size that is well above the standard biomass target, thereby likely meeting ecosystem-based biomass targets for a forage species by default if not by design. The SSC also agreed with the Herring PDT conclusion that natural mortality and consumption of herring by predators has been addressed in the SAW 54 benchmark assessment to the extent possible. Addressing  $M$  in this manner seems appropriate given herring's role as a forage species and appears to be consistent with other sources of information regarding food consumption and predation. Natural mortality and consumption have been evaluated in this stock assessment more thoroughly than assessments for other species in the Northeast Region.

## ***2010-2012 Atlantic Herring Fishery Specifications***

The Atlantic herring specifications for 2010-2012 were developed based on a 2009 update to the 2006 TRAC benchmark assessment. During the development of the 2010-2012 fishery specifications, the Council considered factors identified by the SSC when setting ABC and accounted for scientific uncertainty, including a retrospective pattern that resulted in an overestimation of stock biomass, MSY reference points estimated from the biomass dynamics model are inconsistent with the age-based - stochastic projection, recruitment, biomass projections, and the importance of herring as a forage species.

The SSC reviewed the TRAC update assessment and pointed out two sources of considerable scientific uncertainty:

*(1) The assessment has a strong ‘retrospective pattern’ in which estimates of stock size are sequentially revised downward as new data are added to the assessment; and (2) Maximum sustainable yield reference points estimated from the biomass dynamics model are inconsistent with the age-based, stochastic projection; such that fishing at the current estimate of  $F_{MSY}$  is expected to maintain equilibrium biomass that is less than the current estimate of  $B_{MSY}$ .*

Other sources of uncertainty were discussed regarding recruitment, biomass projections, and herring as a forage species. Exploitable biomass was projected to decline during 2010–2012 due to the recruitment of poorer than average year-classes. Furthermore, the risk of depleting spawning components and the role of herring in the ecosystem as a forage species was also considered. Given the magnitude of uncertainty in the herring assessment and reference points, the SSC could not derive an ABC control rule at that time and recommended a new benchmark assessment of herring as soon as possible. The SSC suggested that the next benchmark assessment should revise MSY reference points to be consistent with the assessment method and consider including estimates of consumption and spatial structure in the assessment (September 2009 SSC Report).

The average retrospective inconsistency in the estimate of exploitable biomass is approximately 40%, and according to the 2009 TRAC Report, “uncertainty due to model configuration is dwarfed by uncertainty due to retrospective bias.” Therefore, the SSC considered that the magnitude of retrospective inconsistency accounts for the major sources of uncertainty in the assessment, and the buffer between OFL and ABC should be 40% (approximately 90,000 mt in 2010). Alternatively, the assessment suggested that recent catches have maintained a relatively abundant stock size (estimates of stock biomass from 1998 to 2008 have been greater than  $B_{MSY}$ ) and low fishing mortality (estimates 1998 to 2008 fishing mortality have been less than  $F_{MSY}$ ).

Total catch of the herring stock complex by U.S. and Canada in 2008 was 90,000 mt. Given the consistency in catch advice from these two approaches, the SSC’s initial recommendation was that ABC should be 90,000 mt each year until the stock assessment is revised.

At its September 2009 Council meeting, the Council approved a motion to request that “the SSC revisit the size of the 40% buffer between OFL and ABC to consider whether application

of recent years retrospective difference of about 17% is sufficient to account for scientific uncertainty caused by retrospective patterns.” The SSC considered the Council request and concluded that there is no scientific basis for a 17% buffer, and that a 17% buffer is insufficient to account for scientific uncertainty. However, the SSC recommended that, as an alternative approach, annual catches in 2010 to 2012 could be limited to recent catch. Catches were 90,000 mt in 2008; the average for 2006 to 2008 was 106,000 mt; and the average for 2004 to 2008 was 108,000 mt. Acceptable biological catch (ABC) for Atlantic herring was ultimately set by the Council at 106,000 mt for 2010-2012 (Table 2). An additional buffer was taken to account for management uncertainty (primarily Canadian catch), and the stockwide ACL for 2010-2012 was specified at 91,200 mt, with an opportunity to add 3,000 mt to the Area 1A fishery if the Canadian catch did not exceed 9,000 mt by November 1.

**Table 2 - Summary of Previous Specifications for the Atlantic Herring Fishery and Buffers Between OFL/ABC**

	2010-2012			2013-2015			2016-2018			2019-2021		
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
<b>OFL</b>	145,000	134,000	127,000	169,000	136,000	114,000	138,000	117,000	111,000	30,668	38,878	59,788
<b>ABC</b>	106,000	106,000	106,000	114,000	114,000	114,000	111,000	111,000	111,000	21,266	16,131	16,131
<b>Total ACL/OY</b>	91,200*	91,200	91,200	107,800	107,800	107,800	104,800	104,800	104,800 <i>(49,900)*</i>	15,065	11,471	11,471
<b>Catch (U.S.)</b>	68,454	82,444	87,171	95,191	93,084	81,203	63,515	48,796	45,527	12,782	N/A	N/A
<b>Catch (NB Weir)</b>	12,221	4,133	513	6,440	2,667	884	4,849	2,368	11,912	5,115	N/A	N/A
<b>Stock Assessment</b>	2009 TRAC (US/Canada) Update Assessment			SAW/SARC 54 Benchmark Assessment, June 2012			Operational Update Assessment, 2015			SAW/SARC 65 Benchmark Assessment, 2018		
<b>Reference Points</b>	$B_{MSY}$ 670,000; $F_{MSY}$ 0.27; $MSY$ =178,374			$SSB_{MSY}$ 157,000; $F_{MSY}$ 0.27; $MSY$ =53,000			$SSB_{MSY}$ 311,145; $F_{MSY}$ 0.24; $MSY$ =77,247			$SSB_{MSY}$ PROXY 189,000, $F_{MSY}$ proxy 0.51; $MSY$ =112,000		
<b>Status</b>	Not Overfished (651,700; 97%); Not overfishing (0.14)			Rebuilt (518,000); Not overfishing (0.14)			Rebuilt (622,991); Not overfishing (0.16)			Not overfished ( $F=0.45$ ) and overfishing not occurring ( $SSB=141,473$ )		
<b>Uncertainty</b>	(1) Significant retrospective pattern; (2) $MSY$ reference points			(1) 2008 Year Class; (2) Natural Mortality (M); Biological Reference Points			(1) 2011 Year Class; (2) Natural Mortality (M); Biological Reference Points			(1) Natural mortality; (2) stock recruit relationship; (3) stock structure		
<b>Rationale</b>	<ul style="list-style-type: none"> <li>SSC recommended 90,000 ABC (40% buffer) but Council asked SSC to revisit; SSC then recommended recent avg. catch, and Council selected 2006-2008 (106,000);</li> <li>Buffer from ABC/ACL to account for NB weir catch; 3,000 added to 1A if NB weir catch less than 9,000;</li> <li>Herring PDT – accounting for retro pattern should account for other uncertainty</li> </ul>			<ul style="list-style-type: none"> <li>SSC – Constant catch and 75% <math>F_{MSY}</math> produce close to the same catch/result over three years;</li> <li>Provides more buffer in Years 1/2 for the 2008 YC;</li> <li>Addressing M in this manner seems appropriate for this species;</li> <li>Achieves result of ecosystem-based CR by default, if not by design;</li> <li>Supported by industry (stability)</li> </ul>			<ul style="list-style-type: none"> <li>Constant catch is preferred approach of Council and industry.</li> <li>Key attributes of stock and assessment have not changed, but 2011 year class will contribute significantly.</li> <li>Retro has become worse, Mohn's rho correction applied.</li> <li>P overfishing is 50% in year 3, but P overfished is zero.</li> <li>Realized catch generally well below ABC. Catch to estimated consumption is 1:4.</li> </ul>			<ul style="list-style-type: none"> <li>The SSC recommendation - 2019 and 2020 based on the ABC control rule but keep ABC in 2021 the same as 2020 due to the uncertainty in the projections.</li> <li>The SSC recommended the NEFMC request an update assessment in 2020 to verify projected trend in biomass and recruitment.</li> </ul>		

\* In-season action was implemented on August 22, 2018 to reduce the 2018 sub-ACLs to prevent overfishing based on results of 2018 assessment. Note: All numbers are expressed in metric tons (mt). U.S. Atlantic herring catch estimates and NB weir catch are from SAW65 which are calculated differently than final catch estimates from Table 5). Draft Herring PDT Report 11 July 2020

### **3.0 OFL AND ABC PROJECTIONS (2021-2023)**

Short-term projections of future stock status were conducted in the 2020 assessment based on results of the Age Structured Assessment Model (ASAP, Legault and Restrepo 1999) (Table 3). It was not necessary to correct projections for retrospective patterns. Uncertainty in the starting conditions for projections was derived from the results of the assessment model. Age 1 recruitment for 2020 was derived from the estimated recruitments for 2015-2019, whereas that for 2021-2023 was drawn from 1965-2017. The estimates of recruitment from 2018-2019 were excluded from the latter calculations because they were highly uncertain. Projections explicitly included mobile and fixed fleets, each using their respective selectivity-at-age patterns. Fixed fleet catches are comprised of Canadian (New Brunswick) and US sources were assumed to equal their 10-year average in all years, with Canadian catch= 4669mt US fixed= 109mt. Mobile fleet catches were determined by applying the Amendment 8 harvest control rule. Weights at age and maturity at age were the averages over years 2015-2019.

These projections use the ABC control rule approved in Amendment 8 to the Atlantic herring FMP, applied to the mobile fleet, plus the assumed Canadian and US fixed gear catches. It should be noted that the FMP removes a portion of the ABC for management uncertainty to account for uncertain Canadian fixed-gear catch. The New Brunswick weir and shutoff fisheries are not quota managed; therefore, actual catches may be higher or lower than the assumed value used in these projections. The specification package will include several alternatives for management uncertainty where this iss can be addressed and evaluated.

The approved control rule from Amendment 8 is biomass-based, when biomass is greater than 0.5 for the ratio of  $SSB/SSB_{MSY}$ , the maximum fishing mortality allowed is 80% of  $F_{MSY}$ . As biomass declines, fishing mortality declines linearly, and if biomass falls below 0.1 for the ratio of  $SSB/SSB_{MSY}$ , then ABC is set to zero, no fishery allocation. The estimate of 2020 SSB relative to  $SSB_{MSY}$  is about 20%; therefore, relatively low fishing mortality is allowed under the ABC control rule. At these low biomass levels, fishing mortality is low; therefore, the probability of overfishing is very low, essentially zero. However, the probability the stock is still overfished is still high because the stock is at very low biomass, under 20% of  $SSB_{MSY}$ . If recruitment improves back to more average levels, as realized in projections for 2023, the probability of the stock being overfished is reduced to just over 50%. If that is the case then fishing mortality can be higher, with higher associated catches for the fishery.

The PDT reviewed these projections on a conference call on July 20, 2020 and recommended these OFL and ABC values be considered by the SSC for 2021-2023. These projections are consistent with the approved ABC control rule, incorporate an estimate of catch from the New Brunswick fixed gear fishery that is in the range of alternatives under consideration in Framework 8 for management uncertainty, and use the most updated data available.

The PDT recommended a confidence bound be included for the estimate of SSB for SSC consideration. In addition, the PDT would clarify that the projections use a 10-year average for both Canadian and US fixed gear catch estimates. Canadian fixed gear catch is more variable and can swing by relatively large amounts from year to year. US fixed catch however has been relatively stable and much lower for most years, under 30 mt. During the management track assessment, however, the 10-year average was much higher (109 mt) due to a few trips/vessels with incorrectly reported gear codes. Therefore, the projections overestimate catch from the US fixed fleet due to this error; however, the impact is expected to be small.

**Table 3 – Short-term projections of future stock status. Fixed gear catches were assumed equal to their 10-year averages with Canadian Catch= 4669mt US Fixed= 109mt. The Amendment 8 ABC harvest control rule was applied to define the mobile fleet catches.**

	Mobile Fleet F	SSB	P(overfishing)	P(overfished)	OFL	ABC	SSB/SSB <sub>msy</sub>
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

Below are the 95% confidence bounds for SSB (Table 4). The PDT recommended including these with the point estimates of projected SSB to help illustrate the uncertainty around the projections. For 2020, there is <5% chance of the stock biomass being below 10% SSB<sub>MSY</sub>, the level where ABC would be set to zero based on the approved ABC control rule from Amendment 8.

**Table 4 – Confidence bounds for SSB projections (95%) in metric tons for 2020-2023**

	SSB	2.5%	97.5%
<b>2020</b>	56,375	32,491	95,686
<b>2021</b>	48,841	24,479	223,528
<b>2022</b>	45,921	21,619	265,820
<b>2023</b>	130,616	47,883	345,095

#### **4.0 RECENT CATCH AND CURREN (2019-2021) ATLANTIC HERRING FISHERY SPECIFICATIONS**

The U.S. Atlantic herring fishery occurs over the Mid-Atlantic shelf region from Cape Hatteras to Maine, including an active fishery in the inshore Gulf of Maine (GOM) and seasonally on Georges Bank (GB). The herring resource is managed as one stock complex, but this stock is thought to be comprised of inshore and offshore components that segregate during spawning. In recognition of the spatial structure of the herring resource, the herring annual catch limit (ACL) is divided into sub-ACLs and assigned to four herring management areas. Area 1 is the Gulf of Maine (GOM) divided into an inshore (Area 1A) and offshore section (Area 1B); Area 2 is located in the coastal waters between MA and NC, and Area 3 is on Georges Bank (GB) (Figure 5).

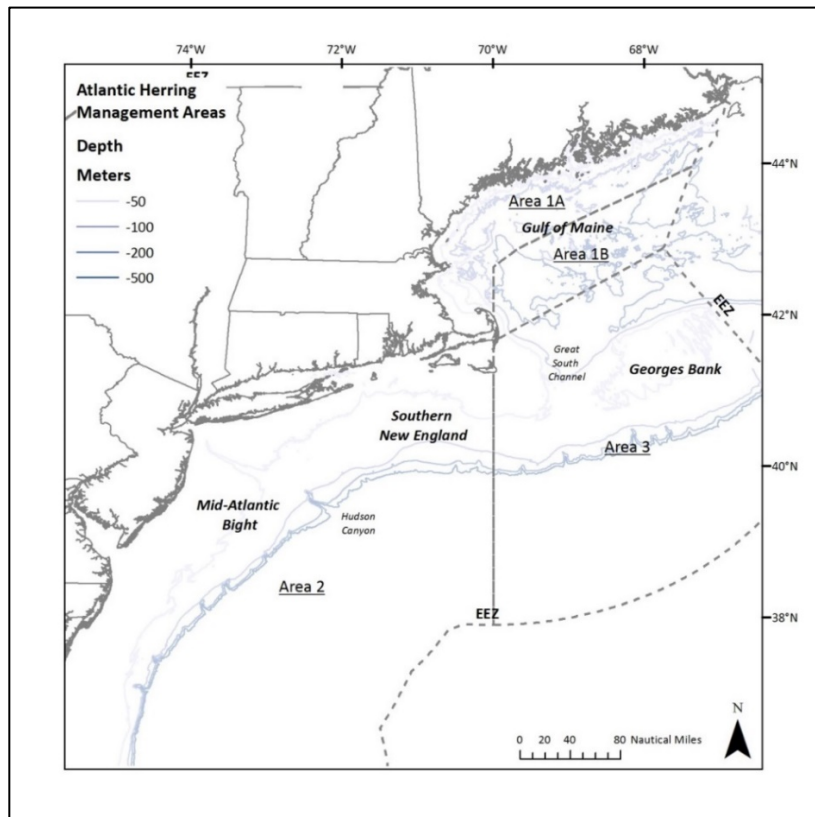
The Atlantic herring fishery is generally prosecuted south of New England in Area 2 during the winter (January-April), and oftentimes as part of the directed mackerel fishery. There is overlap between the herring and mackerel fisheries in Area 2 and in Area 3 during the winter months, although catches in Area 3 tend to be relatively low. The herring summer fishery (May-August) is generally prosecuted throughout the GOM in Areas 1A, 1B and in Area 3 (GB) as fish are available. Restrictions in Area 1A have pushed the fishery in the inshore GOM to later months (late summer). The midwater trawl (single and paired) fleet is restricted from fishing in Area 1A in the months of January through September because of the Area 1A sub-ACL split (0% January-

May) and the purse seine-fixed gear only area (all of Area 1A) that is effective June-September. A sub-ACL split for Area 1B (0% January – April, 100% May – December) is effective for all vessels. Fall fishing (September-December) tends to be more variable and dependent on fish availability; the Area 1A sub-ACL is always fully utilized, and the inshore Gulf of Maine fishery usually closes sometime around November. As the 1A and 1B quotas are taken, larger vessels become increasingly dependent on offshore fishing opportunities (Georges Bank, Area 3) when fish may be available.

The herring fishery uses predominantly single and paired mid-water trawl, bottom trawl, purse seine, and to a lesser extent, gillnet gear throughout the entire range. Herring is used primarily in the U.S. as bait for the American lobster and tuna fisheries but is also frozen whole and canned for human consumption. Herring is managed in federal waters by the New England Fishery Management Council (NEFMC), and there is a complementary management plan also in place under the Atlantic States Marine Fisheries Commission (ASMFC).

Atlantic herring catch has been variable in recent years, but on average about 90,000 mt for the last decade or so. However, the quota allocated to the fishery (stock wide ACL) has decreased during this time. Consequently, the Atlantic herring fishery has become more fully used in recent years, with some exceptions. These exceptions could be related to resource abundance, but there are a variety of factors that have likely caused under harvests of catch limits, including management measures in the plan. Several examples of measures that have the potential to limit herring landings by reducing flexibility and potentially reducing the ability for the fishery to harvest the full TAC in each area are bycatch caps with in-season closures, spawning closures, trip limits in Area 1A, observer requirements to fish in GF closed areas, fishing activity in other fisheries, etc.

Figure 5 - Atlantic Herring Management Areas



Herring catch limits have declined over time since the FMP was implemented in 1999. The first reduction was in 2006 to about 140,000 mt, followed by another relatively large reduction starting in 2010 with total quotas under 100,000 mt. The total catch limit has remained over 100,000 mt until it was dramatically reduced in 2018 to just under 50,000 mt and again in 2019 to just over 20,000 mt.

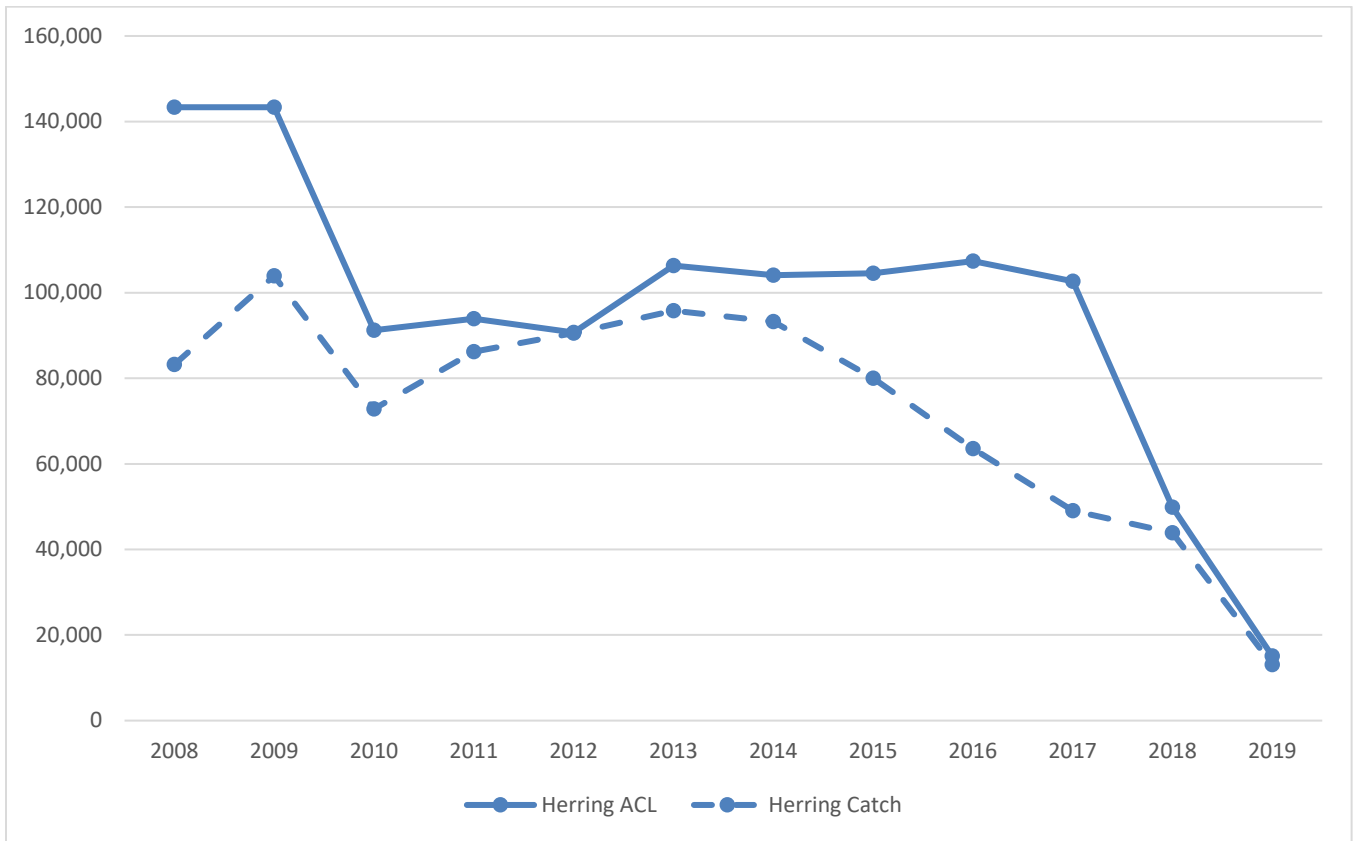
Table 5 and Figure 6 compare the annual Atlantic herring ACL and actual catch for 2008-2019. Utilization was relatively high in 2010-2015, and decreased starting in 2016, until ACLs were dramatically reduced in more recent years (2018 and 2019). It should be noted that the ACL is divided into four management areas (1A, 1B, 2 and 3), and the utilization does vary by area. In most years Area 1A is completely utilized, as well as Area 1B; however, Areas 2 and 3 are not usually fully utilized. In several years, some management areas have been closed to directed herring fishing (a 2,000 lb. possession limit is implemented when 92% of that area’s sub-ACL is projected to be caught). The right hand column in Table 5 highlights the years when in-season possession limits have been implemented, or in-season bycatch caps were reached (RH/S and GB haddock), also closing an area to directed herring fishing.

**Table 5. Summary of Atlantic annual ACL compared to final catch estimates (2008-2019) including relevant in-season actions**

<b>FY</b>	<b>Herring ACL</b>	<b>Herring Catch</b>	<b>Usage (%)</b>	<b>In-season actions that were implemented</b>
2008	143,350	83,240	58.1%	
2009	143,350	103,943	72.5%	
2010	91,200	72,851	79.9%	
2011	93,905	86,245	91.8%	
2012	90,683	90,561	99.9%	<i>Herring Area 2, 3 and 1A closed early</i>
2013	106,375	95,764	90.0%	<i>Herring Area 2, 1A and 3 closed early</i>
2014	104,088	93,247	89.6%	<i>Herring 1B, 1A and 3 closed early</i>
2015	104,566	80,011	76.5%	<i>GB haddock catch cap in-season AM, Herring Area 1A closed early</i>
2016	107,360	63,581	59.2%	<i>Herring Area 1B closed early</i>
2017	102,656	49,072	47.8%	
2018	49,900	43,878	87.9%	<i>RHS:Mack Closure; RHS:Herr SNE MW and CC MW closures, Herring 1B closure</i>
2019	15,065	13,066	86.7%	<i>RHS:Mack Closure; Herring Area 2 closure</i>



**Figure 6 – Comparison of annual Atlantic herring ACL and final catch (2008-2019)**



The 2019-2021 Atlantic herring fishery specifications are summarized in Table 6 and the river herring/shad catch caps remained the same from the previous specification package. As mentioned above, catch limits have decreased dramatically in the last few years to prevent overfishing following the 2018 assessment.

**Table 6. Final measures implemented for 2019-2021 Atlantic herring fishery specifications**

<b>Herring Fishery Specification</b>	<b>2019</b>	<b>2020</b>	<b>2021</b>
Overfishing Limit (OFL)	30,668	41,830	69,064
Acceptable Biological Catch (ABC)	21,266	16,131	16,131
Management Uncertainty	6,200	4,560	4,560
Optimum Yield / Annual Catch Limit (OY/ACL)	15,065*	11,571*	11,571*
Domestic Annual Harvest (DAH)	15,065	11,571	11,571
Border Transfer (BT)	0	100	100
Domestic Annual Processing (DAP)	15,065	11,471	11,471
U.S. At-Sea Processing (USAP)	0	0	0
Area 1A Sub-ACL (28.9%)	4,354	3,344	3,344
Area 1B Sub-ACL (4.3%)	647	498	498
Area 2 Sub-ACL (27.8%)	4,188	3,217	3,217
Area 3 Sub-ACL (39%)	5,876	4,513	4,513
Fixed Gear Set-Aside (FGSA)	39	30	30
Research Set-Aside (RSA) as % of Sub-ACLs	3%	3%	3%
* If the New Brunswick weir fishery catch through Oct. 1 is less than the associated trigger for the management uncertainty buffer then 1,000 mt of the management uncertainty buffer will be added to the ACL.			

*Seasonal sub-ACL divisions – Area 1A is allocated 0% of the sub-ACL for Jan – May and 100% from June – Dec. Area 1B is allocated 0% of the sub-ACL for Jan – April and 100% May – Dec.*