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MEMORANDUM

DATE: July 28, 2009

TO: Scientific and Statistical Committee (SSC) Members

FROM: Lori Steele, NEFMC Staff, Herring PDT Chair

SUBJECT: **Atlantic Herring Assessment Results and Preliminary Guidance Re. Specification of Allowable Biological Catch (ABC)**

Background

The Transboundary Resource Assessment Committee (TRAC) Atlantic Herring Stock Assessment was conducted in early June 2009 in St. Andrews, New Brunswick, Canada. This assessment served as an update; Atlantic herring for the Gulf of Maine/Georges Bank area were last assessed in a benchmark assessment in May 2006 (O'Boyle and Overholtz 2006). At the 2006 assessment meeting, it was agreed that the Age Structured Assessment Program (ASAP) Base model showed the least retrospective pattern and was the preferred approach amongst all the model formulations. The purpose of the 2009 assessment meeting was to update both independent and dependent data, and use it in the established benchmark formulation to determine the current status of the Atlantic herring resource. The updated assessment model also prompted revision of the biological reference points to reflect the new results.

The TRAC update assessment results estimate that Atlantic herring biomass was 651,700 mt at the beginning of 2008, which is below B_{MSY} (670,600 mt). Estimated fishing mortality in 2008 was 0.14, which is below F_{MSY} (0.27).

The Atlantic herring stock complex is above ½ B_{MSY} and fishing mortality is below F_{MSY}, so the stock is not overfished and overfishing is not occurring. The current overfishing definition for Atlantic herring is provided below.

> *If stock biomass is equal or greater than B_{MSY} , overfishing occurs when fishing mortality exceeds F_{MSY}. If stock biomass is below B_{MSY} , overfishing occurs when fishing mortality exceeds the level that has a 50 percent probability to rebuild stock biomass to B_{MSY} in 5 years ($F_{Threshold}$). The stock is in an overfished condition when stock biomass is below ½ B_{MSY} and overfishing occurs when fishing mortality exceeds $F_{Threshold}$. These reference points are thresholds and form the basis for the control rule.*

The control rule also specifies risk averse fishing mortality targets, accounting for the uncertainty in the estimate of F_{MSY}. If stock biomass is equal to or greater than $1/2B_{MSY}$, the target fishing mortality will be the lower level of the 80 percent confidence interval about F_{MSY}. When biomass is below B_{MSY} , the target fishing mortality will be reduced consistent with the five-year rebuilding schedule used to determine $F_{Threshold}$.

Table 1 Current (TRAC 2009) Biomass and Fishing Mortality Status/Reference Points for the Atlantic Herring Stock Complex

	BIOMASS	**FISHING MORTALITY**
REFERENCE POINTS	B_{MSY}= 670,600 mt	F_{MSY} = 0.27
(MSY = 178,374 mt)	$B_{Threshold}$ = 335,290 mt	F_{Target} = Unknown*
2008 ESTIMATES (TRAC 2009)	651,700 mt	0.14

**The methods for calculating reference points in the TRAC assessment do not yield probability distributions, so the 80% confidence interval cannot be calculated.*

Several issues associated with the current overfishing definition for Atlantic herring, which is provided from the original Herring FMP (1999), need attention. The current control rule (with target F) may be inconsistent in light of the new MSRA requirements and associated National Standard Guidelines or have estimation problems (developing confidence limits around F_{MSY}). The definition of overfishing is contingent on the relationship of current biomass to B_{MSY}. For biomass at or above B_{MSY}, overfishing is defined as fishing above F_{MSY}. However, when biomass is between ½ B_{MSY} and B_{MSY}, overfishing is defined as exceeding the rebuilding F, specified as an F that allows rebuilding within 5 years with 50% probability. Currently, the population does not rebuild to B_{MSY} using long-term projections using F_{MSY} and empirical recruitment model. The inconsistency between the long-term projections (required to develop rebuilding F and time periods and stock determination overfishing criterion when B is below B_{MSY}) and the reference points (to define stock status) needs reconciling in order to have a functional control rule.

More importantly, the FMP utilizes target F, defined as the lower bound of the percentile of the confidence limits around F_{MSY}. The explicit goal of the Ftarget is to take into account the uncertainty with the F_{MSY} estimate. Two problems with the Ftarget approach are: the current external Fox production model used to define the Fthreshold does not generate 80% confidence limits of the F_{MSY} estimate needed to estimate the Ftarget; and the Ftarget does not explicitly account for other sources of scientific uncertainty such as retrospective pattern in the assessment because confidence intervals are not generated from the model. Without the necessary information, overfishing determinations and target fishing mortality rates cannot be determined. However, given current F (about ½ F_{MSY}) and current B (97% of B_{MSY}), assuming that overfishing is not occurring is reasonable. An appropriate target F based on the current control rule definition still remains unknown, and whether Ftarget is even necessary under the new approach to specifying an ABC and ABC control rule is unclear. A benchmark stock assessment is needed to resolve the technical issues related to the current overfishing definition, and guidance from the NMFS Regional Office is appropriate regarding the need to specify a target F.

Atlantic herring fishery specifications for the 2007-2009 fishing years are based on the 2006 TRAC assessment results and include a specification of allowable biological catch equivalent to the 2006 MSY value of 194,000 mt (Table 2). Optimum yield for the fishery is currently set at 145,000 mt, and the buffer between MSY and OY accounts for Canadian catch (20,000 mt), the retrospective pattern in the stock assessment, other sources of assessment/scientific uncertainty, and the important role of herring in the Northwest Atlantic ecosystem. The herring fishery specifications for 2010-2012 should be adjusted to ensure compliance with new provisions of the Magnuson-Stevens Reauthorization Act (MSRA) and the National Standard 1 Guidelines published by NOAA Fisheries in January 2009.

Table 2 Atlantic Herring Fishery Specifications for the 2007-2009 Fishing Years (January 1 – December 31)

	2007	2008/2009
Allowable Biological Catch (ABC)	194,000	194,000
U.S. Optimum Yield	145,000	145,000
Domestic Annual Harvesting (DAH)	145,000	145,000
Domestic Annual Processing (DAP)	141,000	141,000
Joint Venture Processing Total (JVPt)	0	0
JVP	0	0
Internal Waters Processing (IWP)	0	0
U.S. At-Sea Processing (USAP)	20,000 (Areas 2 and 3 only)	20,000 (Areas 2 and 3 only)
Border Transfer (BT)	4,000	4,000
Total Allowable Level of Foreign Fishing (TALFF)	0	0
RESERVE	0	0
TAC Area 1A	50,000 (5,000 Jan-May)	45,000 (43,650 fishery; 5,000 Jan-May)
TAC Area 1B	10,000	10,000 (9,700 fishery)
TAC Area 2	30,000	30,000 (29,100 fishery)
TAC Area 3	55,000	60,000 (58,200 fishery)
Research Set-Aside (RSA)	N/A	Area 1A RSA 1,350 Area 1B RSA 300 Area 2 RSA 900 Area 3 RSA 1,800

Table 3 provides IVR catches for the 2008 fishing year. Overall, the IVR reports totaled 80,800 mt of herring across all management areas in 2008, which represents about 56% of the OY for the U.S. fishery (145,000 mt) . Consistent with previous years, the majority of the landings were taken from Area 1 (1A and 1B). Part of the reduction in total landings since 2006 is attributable to a 15,000 mt decrease in the TAC for Area 1A. In 2008, the Area 1A fishery closed on November 14, 2008.

Table 4 reports IVR catches to date for the 2009 fishing year (through July 6, 2009). State restrictions (ME, NH, MA) preclude landings from Area 1A until June 1, so the fishery in Area 1A is just beginning, but it is expected that 95% of the 1A TAC will be taken before December 31. There was more activity in the Area 2 winter fishery (Jan-April) in 2009 than 2008, and the majority of the Area 2 TAC has already been taken. It is anticipated that all of the Area 1A quota will be taken during 2009. With the additional catch from Area 2, total 2009 catch is predicted to be about 8,000 mt higher than in 2008.

Table 3 IVR Herring Catch for 2008 Fishing Year

Management Area	**IVR Catch (mt)**	**% of TAC**
Area 1A (Jan 1st – May 31st)	0	N/A
Area 1A (June 1st – Dec 31st)	41,640	N/A
Area 1A TOTAL	41,640	92.5%
Area 1B	8,104	81%
Area 2	19,256	64.2%
Area 3	11,800	19.7%
Total	**80,800**	**55.7%**

Table 4 2009 IVR Herring Catch (Supplemented with Dealer Data, through July 6, 2009)

Management Area	**IVR Catch (mt)**	**% of TAC**
Area 1A (Jan 1st – May 31st)	0	N/A
Area 1A (June 1st – Dec 31st)	5,105	N/A
Area 1A TOTAL	5,105	10%
Area 1B	1,589	16%
Area 2	27,087	90%
Area 3	1,296	2%
Total	**35,076**	**24%**

Amendment 4 to the Atlantic Herring FMP establishes a process for developing annual catch limits (ACLs) and accountability measures (AMs) consistent with the MSRA, including provisions for the SSC to specify an acceptable biological catch (ABC) for the herring fishery. As previously noted, the current overfishing limit for the Atlantic herring fishery is specified as *allowable biological catch,* which is based on the most recent scientifically-accepted estimate of MSY for the stock complex. The current specification of ABC is different from the MSRA's requirement to specify ABC, the *acceptable biological catch,* and changes are proposed in Amendment 4 to reflect the new requirements of the MSRA. The MSRA's interpretation of

ABC includes consideration of biological uncertainty (stock structure, stock mixing, and other stock assessment issues, for example), and recommendations for ABC should come from the SSC.

Several modifications to the specification process are required to bring the Atlantic Herring FMP into compliance with the MSRA, most notably the introduction of new terminology, changes to the ABC specification, the addition of the Council's SSC to the process for setting ABC, and separate consideration of scientific and management uncertainty during the ACL-setting process. Based on the new MSRA requirements, once scientific uncertainty is accounted for and the OFL for Atlantic herring is adjusted accordingly to a level corresponding to *acceptable biological catch* (ABC) based on recommendations from the Council's SSC, an ACL for the stock complex may be established, and the ACL can be divided into TACs or sub-ACLs, which can be specified for each management area. The sub-ACLs (TACs for the management areas) should be set such that the risk of overfishing a stock component is minimized to the extent possible.

Overfishing Level

The overfishing level (OFL) is defined in Amendment 4 as the *catch that results from applying the maximum fishing mortality threshold to a current or projected estimate of stock size*. When the stock is not overfished and overfishing is not occurring, the maximum fishing mortality threshold is F_{MSY} or its proxy. The Atlantic herring stock complex is not overfished, and the current (2009 TRAC) estimate of F_{MSY} is 0.27.

To estimate the 2010 OFL, the Herring PDT applied the 2008 catch to the 2008 biomass estimate for the herring complex to estimate the 2009 starting biomass. The PDT then estimated a fishing mortality rate for 2009 based on the 2008 landings plus an additional 7,800 mt to account for the increased catch in Area 2. The projected F for 2009 is 0.16. Applying 0.16 to the estimated biomass in 2009 yields a projected biomass in 2010. F_{MSY} can then be applied to the 2010 biomass projection to derive an overfishing level (F_{MSY} x B) for 2010. The resulting OFL for 2010 is **143,845 mt** (Table 5).

Table 5 Projected OFL for 2010

LANDINGS	**(000 mt)**		**2009F = 0.16 2010F and 2011F = 0.27**						
YEAR	**AVG**	**STD**							
2009	93.292	12.135							
2010	144.806	19.827							
2011	132.512	21.913							
PERCENTILES OF LANDINGS			**(000 MT)**						
YEAR	**1%**	**5%**	**10%**	**25%**	**50%**	**75%**	**90%**	**95%**	**99%**
2009	68.5	75.3	78.1	84.5	92.078	101.0	109.9	115.6	124.2
2010	104.7	114.5	119.7	130.0	143.845	158.3	171.4	178.9	193.7
2011	88.7	98.3	104.0	116.0	132.019	147.3	162.2	170.3	183.7

Addressing Scientific Uncertainty and Specifying ABC

Allowable Biological Catch (ABC) is defined in Amendment 4 as the maximum catch that is recommended for harvest, consistent with meeting the biological objectives of the management plan. ABC can equal but never exceed the OFL. While the amendment states that ABC should be based on F_{MSY} or its proxy for the stock if overfishing is not occurring and/or the stock is not in a rebuilding program, the specification of ABC must consider/address scientific uncertainty.

At its September 16, 2009 meeting, the SSC is scheduled to review available information and provide its recommendations regarding the specification of allowable biological catch (ABC) for the 2010-2012 fishing years as well as the ABC control rule. The Herring PDT will provide projections and other information related to the specification of ABC for the Atlantic herring fishery. However, uncertainty related to the recent stock assessment update warrants some initial discussion with the SSC; the Herring PDT is seeking preliminary guidance from the SSC regarding approaches that may be used to account for scientific uncertainty.

The most significant source of uncertainty relates to the **retrospective pattern** that continues to be apparent in the stock assessment and has worsened since the last benchmark (see TRAC Assessment Document). Substantial retrospective patterns persisted in all model variations examined. Generally, fishing mortality estimates behaved better than biomass, biomass estimates averaged + 42%/year, and ranged between 14-56%.

Three primary sources of uncertainty exist within the model applied to the 2009 update: (1) the effects of changing the catch-at-age input; (2) the effects of the model formulation and the variation within the model (input data); and (3) the retrospective pattern. The effects of the estimates of natural mortality are also uncertain. There also appears to be considerable uncertainty regarding the estimation of the biological reference points (BRPs). BRPs for Gulf of Maine/Georges Bank Atlantic herring were calculated using biomass and landing estimates from 1967-2008. The first two years in the time series are highly influential in fitting the Fox surplus production model. Removal of either one or two of these values produce B_{MSY} estimates ranging from 575,700 mt to 707,401 mt. In addition, a 30 year projection of 2008 age 2+ biomass at F_{MSY} (0.27) produces average biomass of 591,000 mt ($\pm$ 1 std dev ranges from 423,100 to 759,400 mt).

While other sources of scientific uncertainty clearly exist, the retrospective pattern is significant enough that the PDT feels that accounting for the retrospective pattern will account for other uncertainty related to the stock assessment. The PDT is seeking preliminary guidance on how to address issues related to the retrospective pattern in the assessment when specifying ABC for 2010-2012.

Herring PDT Questions

- Given the scientific uncertainties in this assessment and given time/analysis constraints (documents for the SSC need to be finalized no later than September 3, 2009): What kind(s) of ABC control rule(s) should the Herring PDT evaluate? For example:
    - ABC based on a general approach using a target F (a fraction of F_{MSY} or a percentile of the F_{MSY} estimate)?
    - ABC based on a specified fraction of the OFL?
    - ABC based on a quantitative adjustment (reduction) to account for the retrospective pattern and/or other scientific uncertainty? How could this adjustment be made (direct rho-based adjustment to catch, direct rho-based adjustments to exploitable biomass, rho-adjusted starting number-at-age projections)?
- The herring stock complex is believed to be composed of individual spawning components that mix seasonally in different areas. Considerable uncertainty exists about the mixing rates as well as the exploitation rates on the individual components. This element of scientific uncertainty may play a role when setting the sub-ACLs in order to prevent localized overfishing on the individual spawning components. The stock-wide ABC will be adjusted to a stock-wide ACL (after accounting for management uncertainty), which will be separated into sub-ACLs based on the management areas for the herring fishery. The PDT believes that taking all of the ABC to be taken from one management area is undesirable, as overfishing of a stock subcomponent would likely result. The sub-ACLs are intended to minimize the risk of overfishing on individual stock components while still allowing for full exploitation. In general, should the PDT account for this stock structure uncertainty in setting ABC for a stock complex or should this scientific uncertainty be incorporated in the setting of sub-ACLs (analogous to the previous practice of setting subarea TACs)?