Center for Independent Experts (CIE) Independent Peer Review of Status Review Report: Alewife (*Alosa pseudoharengus*) and Blueback Herring (*Alosa aestivalis*)

Prepared on behalf of the Center for Independent Experts (CIE)

Dr. Joseph E. Hightower
PO Box 158
Jefferson, NC 28640

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Executive Summary

Alewife (*Alosa pseudoharengus*) and blueback herring (*Alosa aestivalis*), collectively known as river herring, are anadromous species occurring along the Atlantic coast of North America from Canada to the southeastern United States. The two species have overlapping marine distributions and return as adults to their natal rivers to spawn in spring. River herring historically supported large commercial fisheries, but abundance declined dramatically beginning around the 1970s. The Atlantic States Marine Fisheries Commission (ASMFC) prohibited harvest in 2012 except as permitted through a sustainable fisheries management plan. Despite the moratoria, the most recent assessment indicated that the coastwide meta-population complex of river herring stocks on the U.S. Atlantic coast remains depleted to near historical lows (ASMFC 2017).

The National Marine Fisheries Service (NMFS) is conducting a review of the status of alewife and blueback herring. Steps in their evaluation are to examine scientific information on each species' status, evaluate factors contributing to that status, assess whether either species consists of Distinct Population Segments (DPSs), and assess the risk of extinction. NMFS uses that information to assess whether listing of either species (or its DPSs) is warranted under the Endangered Species Act.

This report is my assessment of the NMFS draft status review document. That document relies heavily on ASMFC stock assessments (ASMFC 2012; ASMFC 2017), but also includes an up-to-date review of relevant literature, including a number of recent genetic studies. Those studies document a regional population genetic structure, and four DPSs were defined for alewife and three for blueback herring. The possible loss of two other regional complexes for blueback herring was not considered to represent a significant gap in range. Risk of extinction was assessed using expert opinion through a risk matrix approach. That is appropriate for these species because of the lack of data to support quantitative model-based extinction risk analyses. The risk matrix approach is a structured way of working through a list of potential threats and can be done at the appropriate spatial scales (rangewide and by DPS). The evaluation was done for the "foreseeable future" which was defined as a 12-18 year timeframe (three generations). The overall conclusion was that extinction risk for both species was mostly low. That conclusion seems appropriate given the available information and management actions taken to date. I have included some suggestions for potential refinements of the analyses.

Background

In 2011, the Natural Resources Defense Council (NRDC) petitioned to list alewife (*Alosa pseudoharengus*) and blueback herring (*Alosa aestivalis*) under the Endangered Species Act (ESA) as threatened throughout all or a significant portion of their ranges. Alternatively, the petitioner requested that the National Marine Fisheries Service (NMFS) designate Distinct Population Segments (DPSs) of alewife and blueback herring as specified in the petition. NMFS determined in 2013 that listing was not warranted for either species, but committed to revisiting the status of both species in three to five years.

The NRDC and Earthjustice filed suit against NMFS in 2015, challenging the decision not to list blueback herring as threatened or endangered. The presiding judge issued a finding in 2017 vacating the blueback herring listing determination, and remanded the listing determination back to NMFS. The NMFS initiated a new status review for alewife and blueback herring on August 15, 2017. The review synthesizes the best available scientific and commercial information regarding status of each species, including life history, demographic trends and threats. Important factors to consider include 1) absolute numbers of individuals and their spatial and temporal distribution; 2) current abundance relative to historical abundance and carrying capacity; 3) trends in abundance; 4) natural and human-influenced factors that affect survival or abundance; 5) possible threats to genetic integrity; and 6) recent events (e.g., a drought) that have predictable short-term consequences for abundance. An extinction risk assessment is conducted to project the health of the species into the future.

The draft status report was made available for Center for Independent Experts (CIE) scientific peer review on September 28, 2018. Scientific peer review is defined as the organized review process where one or more qualified experts review scientific information to ensure quality and credibility. For this review, three CIE experts were tasked with conducting a peer review impartially, objectively, and without conflicts of interest. Each reviewer must also be independent from the development of the science, without influence from any position that the agency or constituent groups may have.

Description of Reviewer's Role in the Review Activities

The activities undertaken for this review include: 1) review of background materials (Appendix 1); 2) review of the draft status review report; and 3) preparation of this CIE report. Specific tasks are listed in the Performance Work Statement included as Appendix 2.

Summary of Findings

In this section, I provide comments regarding strengths and weaknesses of the draft report relative to each of the Terms of Reference (ToR; highlighted in bold and italics). I will refer to "river herring", the collective term for alewife and blueback herring, when a comment applies to both species or when the two species are not differentiated (as in some landings records). References cited below that are not contained in either the Bibliography of Materials Provided for Review or the River Herring Status Review References document are listed in the Additional References section.

1. Is the information regarding the life history and population dynamics of the species the best scientific information available? If not, please indicate what information is missing and if possible, provide sources.

Stock assessment documents prepared for the Atlantic States Marine Fisheries Commission (ASMFC) were a key source of information about the life history and population dynamics in the draft status review. The most recent report (ASMFC 2017a; ASFMC 2017b) includes data through 2015 and was an update to the 2012 benchmark assessment (ASMFC 2012). These documents were based on extensive efforts to gather data from U.S. federal and state agencies, power generating companies, and universities. Similar to previous ASMFC documents, the 2017 report contains state- and river-specific information that varies in quantity and quality but typically includes harvest, with some fishery-independent surveys and biological characteristics such as age, length, weight, and the percentage of repeat spawners. Data gaps for river herring can be attributed in large part to their low priority in monitoring within some agencies (ASMFC 2017a). The 2017 report also includes some coastal trawl surveys that provide an indication of mixed-stock abundance and trends. In addition to the reliance on ASMFC documents, the draft status report also includes a broad and up-to-date survey of information from the primary literature.

The 2017 ASMFC report generally used assessment methods designed for data-poor stocks. Fishery-dependent and fishery-independent indices of abundance were used to estimate trends in relative abundance and to look for regional patterns. That information is helpful when considering current relative to historical abundance, as one aspect of considering the appropriateness of listing a species as threatened or endangered. The primary limitation of the fishery-independent surveys of adult abundance is that few of them extend back to the early period of dramatic declines in landings (ASMFC 2017a, Appendix 1). As noted in the status review, this creates a shifted baseline so the extent of decline tends to be underestimated.

One potential area for improvement in the draft status review is to prioritize survey datasets. Rather than treating all surveys equally, greater weight should be given to surveys that are longer (especially those that extend back to the period of higher abundance), more precise, cover a wide range of sizes and ages, and that monitor historically significant populations.

More information should be provided for the datasets reviewed for DPS abundance scoring (Draft status report appendix). For example, the run counts from the Chowan River (Supplemental Figure 5(B)) appear to represent estimates of population size from a stock assessment model (ASMFC 2017). It would also be an improvement to make clear the life stage represented by the various surveys. For example, Supplementary Figure 3(A) shows one Albemarle Sound survey for adults (IGNS) and one for young-of-year (Seine Survey). The adult survey suggests a gradual upward trend with lots of variation whereas the young-of-year survey suggests fairly constant recruitment. Knowing the life stage represented by each survey is critical for proper interpretation of temporal patterns.

The 2017 ASMFC report used age composition data to estimate the total instantaneous mortality rate and to look for trends in total mortality over time. Information about total mortality is useful for judging the combined impact of fishing (including bycatch), spawning mortality, predation, and downstream passage at hydroelectric dams in some systems (ASMFC 2017a). Age data for river herring have traditionally been obtained using scales, which have not been validated. Comparative studies for a variety of fish species have shown that otoliths typically provide more accurate ages than other structures (Maceina et al. 2007). The 2017 ASMFC report indicated that some labs have switched to using otoliths for river herring, although these structures have also not been validated. Potential biases in mortality estimates due to ageing errors (and potential effects on judging threats) will remain unknown until validation studies can be done.

Almost no river herring stocks have sufficient information to partition total mortality among sources (ASMFC 2017a). The 2017 report further notes that “Uncertainty about natural mortality is perhaps the biggest limiting factor in drawing strong conclusions about the status of river herring.” They note that there are no empirical estimates of natural mortality associated with spawning and that “Considerable uncertainty also exists about the magnitude of predation.” Uncertainty about the potential impact of predation is discussed in the draft status report (pages 68-70), but in my view is underemphasized as a risk factor for both species. The draft report notes that “Predation typically does not pose a large threat to either species, unless their abundance becomes suppressed at very low levels.” The basis for judging the level of threat posed by predation is unclear, especially given the current low abundance. Only one study (Davis et al. 2012), to my knowledge, provides information on the absolute magnitude of predation relative to river herring abundance (counts at a dam). The lack of similar information for other river systems is not evidence for lack of impact, but rather points out the urgent need for more research.

Some recent studies are providing new information on absolute abundance of river herring, and in some cases striped bass, a key predator which co-occurs with river herring in many coastal rivers and estuaries during spring. Ogburn et al. (2017b) estimated 2014 run sizes for the Choptank River, Maryland of 581,000 for alewife and 726,000 for blueback herring. The report mentions additional unpublished blueback herring estimates for the Choptank, Patapsco and Marshyhope rivers (page 148). Other recent studies not cited in the draft report contain similar hydroacoustic estimates of absolute abundance. For the Roanoke River, North Carolina, Waine (2010) estimated spawning run sizes for alewife (419,000 and 395,000 for 2008-2009) and blueback herring (142,000 and 100,000) that were similar in magnitude to estimates for striped bass (160,000 and 226,000). Estimates for 2010-2011 (Hughes and Hightower 2015) were lower for alewife (214,000 and 269,000) and blueback herring (210,000 and 457,000) than for striped bass (354,000 and 551,000). Estimates for 2015 (McCargo 2018) were also lower for alewife (32,000) and blueback herring (478,000) than for striped bass (986,000). The high abundance of Roanoke River striped bass is also supported by an independent study using harvest, tagging and telemetry data (Harris and Hightower 2017). They estimated a striped bass run size of 695,000 for 2011, 499,000 for 2012, and 715,000 for 2013. Absolute abundance estimates for river herring and key predators are challenging to obtain, have many potential biases, and have only been done for a few systems. Nevertheless, they have potential to provide new insights regarding predation impacts, especially when predator abundance is high relative to river herring. The estimates for alewife and blueback herring are also very helpful in judging the risk of extinction (absolute abundance: page 7).

The 2017 ASMFC report included minimum swept-area estimates of total river herring biomass from the NEFSC bottom-trawl survey. Those estimates are valuable in that they extend from 1976 to 2015, cover most of the U.S. range of both species, and are based on a survey with consistent methods (so are unaffected by fishery closures). The analysis was done only for river herring (presumably for comparison with river herring landings data) but should also be done separately by species. Species-specific estimates would not address DPS-level questions (other than perhaps serving as a lower bound for risk) but should be valuable for judging status and extinction risk at the species level.

Landings data for river herring are generally thought to be fairly reliable, but there is high uncertainty about the magnitude and stock composition of incidental catch (discarded and landed as other, target species) in ocean waters (ASMFC 2017a). These uncertainties and efforts to improve ocean monitoring are well documented in the status review, but they present a challenge in assessing the threat of overutilization. Where possible, it is very important to compare bycatch estimates to absolute abundance data such as spawning run counts (Ogburn et al. 2017a). The status review used total catch (reported U.S. landings plus incidental catch) and the minimum swept-area estimates to calculate an index of relative exploitation. That index (for species and genetic stocks combined) indicates a currently low relative impact of fishing on stock dynamics (status review report, Figure 10), and is useful for judging one of the potential ESA Section 4(A)(1) threats (overutilization).

The use of data for river herring (not separated to species) should be minimized to the extent possible. The two species have very similar life history strategies but different distributions, reported abundance levels, regional genetic structures, and inferred risks of extinction. If the two species happen to have opposing trends in abundance, a pooled analysis would be in error for both. Most importantly, decisions about listing are done by species.

The statement in the draft status review report "Of the available CPUE datasets considered in the ASMFC stock assessment, none reflected declining trends over the last ten years of the update (2006-2015)." does not appear to be correct, unless I am misinterpreting Figure 7.

2. Does the information on river herring genetics, physiological, behavioral, and/or morphological variation presented for the species' range represent the best scientific information available? If not, please indicate what information is missing and if possible, provide sources.

The draft status review report contains an up-to-date summary of the primary literature regarding river herring population genetic structure. This is an active research area for river herring, and new articles not included in the status report (Evans et al. 2018; Kan et al. 2017; Ogburn et al. 2017a) will be useful additions to future assessments and status evaluations. The studies cited in the status report, and the new articles cited above, appear to show a consistent pattern of population genetic structure that varies regionally and with increasing differences with distance.

Genetic information for river herring is not only helpful for judging the need for and boundaries of DPSs, but also in understanding the impact of river herring bycatch in ocean waters. The impact of marine bycatch varies regionally (Hasselman et al. 2016). Abundance will also vary regionally so estimating marine bycatch by DPS is an important first step in assessing its impact.

3. Based on the scientific information presented, are the conclusions regarding species, subspecies, or distinct population segment delineations supported by the information presented? If not, please indicate what scientific information is missing and if possible, provide sources.

As noted in ToR #2, recent genetic studies indicate robust regional patterns of population genetic structure that were used to define DPSs. Samples collected over multiple years indicate temporal stability as well (Reid et al. 2018).

Is it possible to use straying rates or field data on recolonization in deciding whether the loss of a population segment would result in a significant gap in range? The status report states that alewife (page 89) and blueback herring (page 92) have a relatively high straying rate. What is the specific source for that conclusion and what does "relatively high" mean in this context? Reid et al. (2018) reported gene flow between regional genetic groups that was substantially greater than estimated in previous studies, and noted clearly transitional populations at genetic group boundaries. How do their qualitative results relate to straying rates? Homola et al. (2012) demonstrated an approach using genetic data to quantify the contemporary rate of straying in Lake Michigan populations of lake sturgeon. They compared their estimates of straying rates to published rates for other species, and tested for factors including geography that might explain differences among rivers. A similar analysis for alewife and blueback herring would appear to be useful for making the jump from genetic studies to inferences about recolonization. It makes sense qualitatively that a smaller region (e.g., blueback herring in Mid-New England, page 93) might be recolonized more quickly but these small regions maintain unique population genetic structures. If a recolonization model based on probabilities of straying is not feasible, are there instances where rivers or streams lacking runs have been recolonized by alewife or blueback herring, that would provide an empirical guide to the time frame needed?

4. Based on the scientific information presented in the extinction risk assessment report, does this analysis consider all of the best available data and are the conclusions appropriate and scientifically sound? If not, please indicate what information is missing and if possible, provide sources.

Extinction risk is ideally estimated using a quantitative population model. However, the possibility of constructing such models for alewife or blueback herring has decreased over time due to population declines and the loss of harvest data. A 1990 stock assessment for river herring included population models for 15 stocks (Crecco and Gibson 1990). The 2012 assessment (ASMFC 2012) contained information on 57 river systems from Maine through Florida but population models were constructed for only three river systems (alewife:Monument River in Massachusetts, both species:Nanticoke River in Maryland, blueback herring:Chowan River in North Carolina). The 2012 models were considered useful for studying population dynamics but not for guiding coastwide management (ASMFC 2012). The 2012 assessment also contained a coastwide model developed using stock reduction analysis and combined (river herring) harvest data, but it was not considered adequate for assessing status (ASMFC 2012). The moratoria implemented in 2012 have resulted in even less information now for constructing population models, and the most recent update was based primarily on river-specific trends in relative abundance and total mortality (ASMFC 2017). It also included minimum swept-area estimates of river herring biomass. As noted above, that analysis should also be done separately by species. Mixed-stock estimates by species would not address extinction risk by DPS but would still be useful as a rangewide indicator of population trends.

Extinction risk is assessed qualitatively in the draft status report through using a risk matrix approach. This method relies on expert opinion and has been used in other NMFS status reviews when sufficient data are lacking for a quantitative model-based extinction risk analysis. Advantages of this approach are that it is a structured way of working through a list of potential threats and can be done at the appropriate spatial scales (rangewide and by DPS). The evaluation was done for the “foreseeable future”, which was defined as a 12-18 year timeframe (three generations). The overall conclusion of the report was that extinction risk for both species was mostly low. That conclusion seems appropriate given the available information, including the observation that ASMFC is allowing harvest to continue in five states (Maine, New Hampshire, Massachusetts, New York, and South Carolina) through approved Sustainable Fisheries Management Plans. Nevertheless, it is worth noting that the factors currently regulating population dynamics are poorly understood. Fisheries were closed in most states because it was assumed that harvest was a significant impact, but stocks have not recovered. It is difficult to have high confidence in assessing extinction risk when it is not clear which factors are regulating abundance.

The draft status report refers to rangewide MARSS models from 2012 that were updated. MARSS presumably refers to Multivariate Autoregressive State-Space models, which are used to analyze multiple survey indices of relative abundance in order to estimate population growth rate (Holmes 2001; Holmes et al. 2012b; NEFSC 2013). The acronym should be defined, and method described in more detail within the status report, with specific references provided. It would be helpful to add MARSS models done at the DPS level, since the status review is done at the DPS level. The risk of decline or extinction is presumably greater within a DPS compared to rangewide, so DPS estimates of population growth rate could be compared to rangewide estimates. NEFSC (2013) reported that some stock-specific models did not converge, but any information about population growth rate and its variance by DPS would seem quite valuable for judging risk of extinction. MARSS models can also be used to test hypotheses about spatial structure (Holmes et al. 2012), which should be useful for examining within-DPS variation in abundance trends (which is very high, based on the status report appendix). Holmes (2001) illustrates how estimates of population growth and its variance can be used to estimate risk metrics (mean rate of population growth, probability of a 90% decline within a given time horizon). Holmes (2001) notes that mean rate of population change tends to be well estimated even with very poor data, whereas estimates of the probability of reaching a specific threshold tend to be biased and have large confidence intervals.

The draft status report notes that information on predator abundance is needed to judge the impact of predation. I agree that predator diet studies are not sufficient for making that judgement, but question the conclusion for both species that “Predation also does not appear to be increasing this species’ risk of extinction rangewide.”

5. In general, is the best scientific and commercial data available for the status review and extinction risk analysis of river herring presented in the report? If not, please indicate or provide sources of information on which to rely.

As noted above, the draft status review report relies heavily on the series of ASMFC assessments that utilize data from state and federal agencies, utilities and universities. The data used in ASMFC reports are obtained through the Atlantic Coastal Cooperative Statistics Program (http://www.asmfc.org/data/program-overview). I am not aware of any significant data sources that are not included in the ASMFC assessments. The draft status report also includes a broad and up-to-date summary of the literature, especially genetic studies that inform decisions about DPSs.

6. In general, are the scientific conclusions in the reports sound and interpreted appropriately from the information? If not, please indicate why not and if possible, provide sources of information on which to rely.

Any assessment of the status of alewife and blueback herring must take into account their complex life history patterns and variation among rivers in life history characteristics, threats, and status (ASMFC 2017). It would also need to account for marine bycatch, which is a shared threat among stocks but impacts DPSs differentially. Ideally, information about abundance, mortality and reproduction would be combined in a spatially-explicit population model to estimate extinction risk. In reality, however, almost none of the required data are available so the risk matrix approach seems appropriate. The scientific conclusions and interpretations generally seem valid, but I would give greater emphasis to the point that the reason(s) for the lack of recovery are not known. Trends for indices of abundance vary widely within DPSs, and there is no information to explain the variation. Moratoria on harvest have been in place for several years, and a rapid response would be expected for a short-lived (r-selected) species. Thus, it seems likely that factors other than harvest are keeping abundance low in most systems. Estimates of extinction risk and recovery times will be speculative until those factors can be identified.

The regional population genetic structure in alewife and blueback herring provides a useful framework for examining trends in abundance. Rather than organizing by methods (e.g., separate sections for commercial CPUE, seine surveys, trawl surveys), the focus could be to look for internal consistency (or lack thereof) in abundance indices within each DPS. As noted above, surveys could be prioritized based on factors such as length of time series and precision. If all surveys are given equal weight, then the signal contained in the best surveys may be obscured. I was not familiar with MARSS prior to this review, but it appears to be an ideal approach for combining various data sources to test for spatial structure in population trends. Model selection can be used to decide whether populations within a DPS have consistent trends in abundance.

The draft report uses a mix of methods (visual assessment, cluster analysis, ARIMA, MARSS) without a clear justification for when each approach is used. Ogburn et al. (2017a) looked for consistent patterns in stock structure and survey data for river herring in five upper Chesapeake Bay rivers. Their analysis made use of relative abundance data for juveniles, which provides information about trends in recruitment but not adult population size. An analysis that included both juvenile and adult abundance data would seem especially helpful in making a connection between status and population genetic structure. Palkovacs et al. (2014) used US rangewide adult abundance data within genetically distinct units to prioritize genetic stocks for conservation efforts.

The overall conclusion of the section regarding Distribution and Abundance is that the coastwide meta-complex (species and populations combined) remains depleted to near historic lows. That seems valid, but it would be helpful to investigate further the increase since 2008 in minimum swept-area biomass of river herring (Figure 10). The baseline for the analysis may be distorted by the lack of historical (pre-1970) data but the recent upward trend seems encouraging. As noted above, those estimates should also be produced by species.

The status report references a statement (ASMFC 2017b) that Maine's nine largest rivers contain millions of fish. What data were used to reach that conclusion? Information on absolute abundance is valuable in judging the risk of extinction (absolute abundance: page 7).

Is the Analysis of ESA Section 4(A)(1) Factors based on the same 12-18 year time frame as the extinction analysis? If so, it would be helpful to have a clearer description of the expected changes over that time frame, particularly for factors that change gradually over time (climate change, climate variability).

One thing to consider is the timing of threats and whether they match the timing of population declines. In the Extinction Risk section, dams were the highest-rated threat to blueback herring rangewide (Table 22), despite the observation (page 75) that few new dams have been constructed in the past 50 years. Dams historically contributed to habitat loss for river herring, but the timing of dam construction does not appear to be synchronous with the declines in abundance.

7. Where available, are opposing scientific studies or theories acknowledged and discussed? If not, please indicate why not and if possible, provide sources of information on which to rely.

I am not aware of publications with an opposing view regarding the declines in abundance or current status of alewife and blueback herring. There are different theories about the causes of the population declines, but the status report has good coverage of those articles. As noted above, one strategy for evaluating potential causes of the decline is to look at timing. Schmidt et al. (2003) examined long-term data sets from large rivers throughout the range of river herring to assess the current status and potential causes of declines. They suggested that striped bass predation was not likely the cause of the decline in Chowan River blueback herring abundance, but might make recovery more difficult.

Although not my area of expertise, there appears to be some disagreement, or at least an evolution of thinking, about the merits of microsatellite markers versus single nucleotide polymorphism (SNP) genetic markers. The most recent article (Reid et al. 2018) offers some limitations of microsatellite markers and recommends use of SNP markers. The status review includes studies using both approaches, and in fact, several of the authors are common on recent studies using both methods. Information about regional structure appeared to be similar between methods, but Reid et al. (2018) did note that the SNP approach suggested a higher rate of gene flow between regional genetic groups than was apparent from previous studies.

Conclusions and Recommendations

This status review for alewife and blueback herring was conducted using expert opinion through a risk matrix approach, because of the lack of data to support a quantitative model-based extinction risk analysis. The review generally appears to be based on the best available information regarding life history, population dynamics, and genetics. The distinct population segments are well supported by recent genetic studies. The extinction risk analysis is based on a thorough qualitative assessment of threats, and the conclusion of a mostly low risk of extinction appears to be reasonable. I am not aware of any opposing scientific studies regarding the historical decline or current abundance of alewife or blueback herring.

I recommend the following:

- Minimize use of river herring data (species combined). The two species have different distributions, reported abundance levels, regional genetic structures, and inferred risks of extinction.
- On a related note, obtain species-specific rangewide indicators of population trends, using spring NEFSC trawl survey data.
- Provide more support for conclusions regarding recolonization of regions that currently support a unique genetic structure.
- Examine timing of threats (e.g., dam construction, nutrient loading) relative to population declines.
- Prioritize survey data used in analyses based on factors such as length of the time series, whether the series extends back to period of higher abundance, the age range represented, survey precision, and the assumed or historical importance of the surveyed population.
- Where sufficient data are available, evaluate population growth by DPS and evaluate within-DPS variation using MARSS.

Additional References

ASMFC. 2012b. River herring benchmark stock assessment. Vol II. Stock Assessment Report No. 12-02 of the Atlantic States Marine Fisheries Commission, Washington, DC.

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Evans, H. K., K. B. Carlson, R. Wisser, M. E. Raley, K. M. Potoka, and K. J. Dockendorf. 2018. Genetics and hatchery management: a parentage-based tagging approach to blueback herring conservation. Journal of FIsh & Wildlife Management 9:4-13.

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Ogburn, M. B., D. J. Hasselman, T. F. Schultz, and E. P. Palkovacs. 2017a. Genetics and juvenile abundance dynamics show congruent patterns of population structure for depleted river herring populations in the upper Chesapeake Bay. North American Journal of FIsheries Management 37:1083-1092.

Schmidt, R. E., B. M. Jessop, and J. E. Hightower. 2003. Status of river herring stocks in large rivers. American Fisheries Society Symposium 35:171-182.

Waine, M. W. 2010. Assessing Spawning Runs of Anadromous Fishes Using a Bayesian Analysis of Split-beam and DIDSON Count Data. Master of Science thesis, North Carolina State University, Raleigh.

Appendix 1: Bibliography of Materials Provided for Review

Required Pre-review Documents

ASMFC, 2017a. River Herring Stock Assessment Update. Volume I. Coastwide Summary. Arlington, VA. 193 pp.

ASMFC, 2017b. River Herring Stock Assessment Update. Volume II. State Specific Reports. Arlington, VA. 682 pp.

NMFS. 2011. 90-Day Finding on a Petition To List Alewife and Blueback Herring as Threatened Under the Endangered Species Act. Federal Register, Volume 76, No. 212. Wednesday, November 2, 2011.

NMFS. 2012. River Herring Stock Structure Working Group Report. Report to the National Marine Fisheries Service, Northeast Regional Office. August 13, 2012, 60pp. Appendices A and B.

NMFS, 2013. Endangered and Threatened Wildlife and Plants; Endangered Species Act Listing Determination for Alewife and Blueback Herring. Federal Register, Volume 78, No. 155. Monday, August 12, 2013.

NRDC, 2011. Petition to List Alewife (Alosa pseudoharengus) and Blueback Herring (Alosa aestivalis) as Threatened Species and to Designate Critical Habitat.

Recommended Pre-review Documents

Baetscher, D. S., D. J. Hasselman, K. Reid, E. P. Palkovacs, and J. C. Garza. 2017. Discovery and characterization of single nucleotide polymorphisms in two anadromous alosine fishes of conservation concern. Ecology and Evolution 1:1-11, doi:10.5061/dryad.v4q83.

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Appendix 2: CIE Statement of Work

Performance Work Statement (PWS)
National Oceanic and Atmospheric Administration (NOAA)
National Marine Fisheries Service (NMFS)
Center for Independent Experts (CIE) Program
External Independent Peer Review

Endangered Species Act (ESA) Status Review and Extinction Risk Assessment
of River Herring (Alewife and Blueback Herring)

Background
The National Marine Fisheries Service (NMFS) is mandated by the Magnuson-Stevens Fishery Conservation and Management Act, Endangered Species Act, and Marine Mammal Protection Act to conserve, protect, and manage our nation's marine living resources based upon the best scientific information available (BSIA). NMFS science products, including scientific advice, are often controversial and may require timely scientific peer reviews that are strictly independent of all outside influences. A formal external process for independent expert reviews of the agency's scientific products and programs ensures their credibility. Therefore, external scientific peer reviews have been and continue to be essential to strengthening scientific quality assurance for fishery conservation and management actions.

Scientific peer review is defined as the organized review process where one or more qualified experts review scientific information to ensure quality and credibility. These expert(s) must conduct their peer review impartially, objectively, and without conflicts of interest. Each reviewer must also be independent from the development of the science, without influence from any position that the agency or constituent groups may have. Furthermore, the Office of Management and Budget (OMB), authorized by the Information Quality Act, requires all federal agencies to conduct peer reviews of highly influential and controversial science before dissemination, and that peer reviewers must be deemed qualified based on the OMB Peer Review Bulletin standards[1]. Further information on the Center for Independent Experts (CIE) program may be obtained from www.ciereviews.org.

Scope
NMFS is required to use the best available scientific and commercial data in making determinations and decisions under the ESA. We conduct a review of the species through a process known as the status review. The status review is used to prepare a determination on whether listing under the ESA is warranted. The status review synthesizes the best available scientific and commercial information regarding the species status, which includes its life history, demographic trends and susceptibility threats. Following the assessment of threats to the species, an extinction risk assessment is conducted to project the health of the populations into the future.

[1] http://www.cio.noaa.gov/services_programs/pdfs/OMB_Peer_Review_Bulletin_m05-03.pdf

We are currently conducting a status review of alewife and blueback herring to determine whether listing either species as endangered or threatened under the ESA is warranted. On August 12, 2013, based on a previous status review, we determined that listing alewife and blueback herring as threatened or endangered under the ESA was not warranted. The Natural Resources Defense Council and Earthjustice filed suit on February 10, 2015 challenging this decision. On March 25, 2017, the court vacated the blueback herring listing determination and remanded the listing determination back to us. As part of a negotiated agreement in this case, we are required to publish a revised listing determination for blueback herring no later than January 31, 2019. Alewife and blueback herring are included in our current review.

The information and analysis contained in these reports will include essential factual elements upon which the agency may base its ESA-listing determination. Accordingly, it is critical that these reports contain the best available information on the status of alewife and blueback herring, species delineation and extinction risk of the species, and that all scientific findings be both reasonable and supported by valid information contained in the documents. Therefore, the CIE reviewers will conduct a peer review of the scientific information in the two reports on river herring based on the Terms of Reference (ToRs) to be developed. The CIE reviewers will ensure an independent, scientific review of information for a management process that is likely to be highly controversial regardless of our listing decision. Given the public interest in river herring, it will be important for NMFS to have a transparent and independent review process for the status report and extinction risk assessment.

Requirements

NMFS requires three reviewers to conduct an impartial and independent peer review in accordance with the PWS, OMB Guidelines, and the TORs below. The reviewers shall have working knowledge and recent experience in one or all of the following: 1) fisheries population dynamics, expertise in stock assessment and life history of anadromous species; 2) expertise in extinction risk analysis and population modeling; and/or 3) expertise in stock structure and genetics analysis. It is desirable that as part of the extinction risk analysis expertise, reviewers should be familiar with applications in fisheries, particularly anadromous species.

Tasks for reviewers

Each CIE reviewers shall complete the following tasks in accordance with the PWS and Schedule of Milestones and Deliverables.

- Pre-review Background Documents: (Listed separately in Appendix 1).
- Desk Review: Each CIE reviewer shall conduct the independent peer review in accordance with the PWS and TORs, and shall not serve in any other role unless specified herein. Modifications to the PWS and TORs can not be made during the peer review, and any PWS or TORs modifications prior to the peer review shall be approved by the NMFS Project Contact.
- Contract Deliverables - Independent CIE Peer Review Reports: Each CIE reviewer shall complete an independent peer review report in accordance with the PWS. Each CIE

reviewer shall complete the independent peer review according to required format and content as described in Annex 1. Each CIE reviewer shall complete the independent peer review addressing each TOR as described in Annex 2.

Place of Performance
Each CIE reviewer shall conduct an independent peer review as a desk review, therefore no travel is required.

Period of Performance
The period of performance shall be from the time of award through August 2018. Each reviewer's duties shall not exceed 10 days to complete all required tasks.

Schedule of Milestones and Deliverables: The contractor shall complete the tasks and deliverables in accordance with the following schedule.

Within two weeks of award: Contractor selects and confirms reviewers
No later than two weeks prior to the review: Contractor provides the pre-review documents to the reviewers
June 2018: Each reviewer conducts an independent peer review as a desk review
Within two weeks after review:Contractor receives draft reports
Within two weeks of receiving draft reports: Contractor submits final reports to the Government

Applicable Performance Standards
The acceptance of the contract deliverables shall be based on three performance standards: (1) The reports shall be completed in accordance with the required formatting and content; (2) The reports shall address each TOR as specified; and (3) The reports shall be delivered as specified in the schedule of milestones and deliverables.

Travel
Since this is a desk review travel is neither required nor authorized for this contract.

Restricted or Limited Use of Data
The contractors may be required to sign and adhere to a non-disclosure agreement.

NMFS Project Contact:
Tara Trinko Lake
tara.trinko@noaa.gov
NMFS, Greater Atlantic Region
55 Great Republic Drive, Gloucester, MA 01930

Annex 1: Peer Review Report Requirements

1. The report must be prefaced with an Executive Summary providing a concise summary of the findings and recommendations, and specify whether or not the science reviewed is the best scientific information available.

2. The main body of the reviewer report shall consist of a Background, Description of the Individual Reviewer's Role in the Review Activities, Summary of Findings for each ToR in which the weaknesses and strengths are described, and Conclusions and Recommendations in accordance with the TORs.

3. The reviewer report shall include the following appendices:
a. Appendix 1: Bibliography of materials provided for review
b. Appendix 2: A copy of the CIE Statement of Work

Annex 2: Terms of Reference for the Peer Review

Endangered Species Act (ESA) Status Review and Extinction Risk Assessment of River Herring (Alewife and Blueback Herring)

1. Is the information regarding the life history and population dynamics of the species the best scientific information available? If not, please indicate what information is missing and if possible, provide sources.

2. Does the information on river herring genetics, physiological, behavioral, and/or morphological variation presented for the species' range represent the best scientific information available? If not, please indicate what information is missing and if possible, provide sources.

3. Based on the scientific information presented, are the conclusions regarding species, subspecies, or distinct population segment delineations supported by the information presented? If not, please indicate what scientific information is missing and if possible, provide sources.

4. Based on the scientific information presented in the extinction risk assessment report, does this analysis consider all of the best available data and are the conclusions appropriate and scientifically sound? If not, please indicate what information is missing and if possible, provide sources.

5. In general, is the best scientific and commercial data available for the status review and extinction risk analysis of river herring presented in the report? If not, please indicate or provide sources of information on which to rely.

6. In general, are the scientific conclusions in the reports sound and interpreted appropriately from the information? If not, please indicate why not and if possible, provide sources of information on which to rely.

7. Where available, are opposing scientific studies or theories acknowledged and discussed? If not, please indicate why not and if possible, provide sources of information on which to rely.