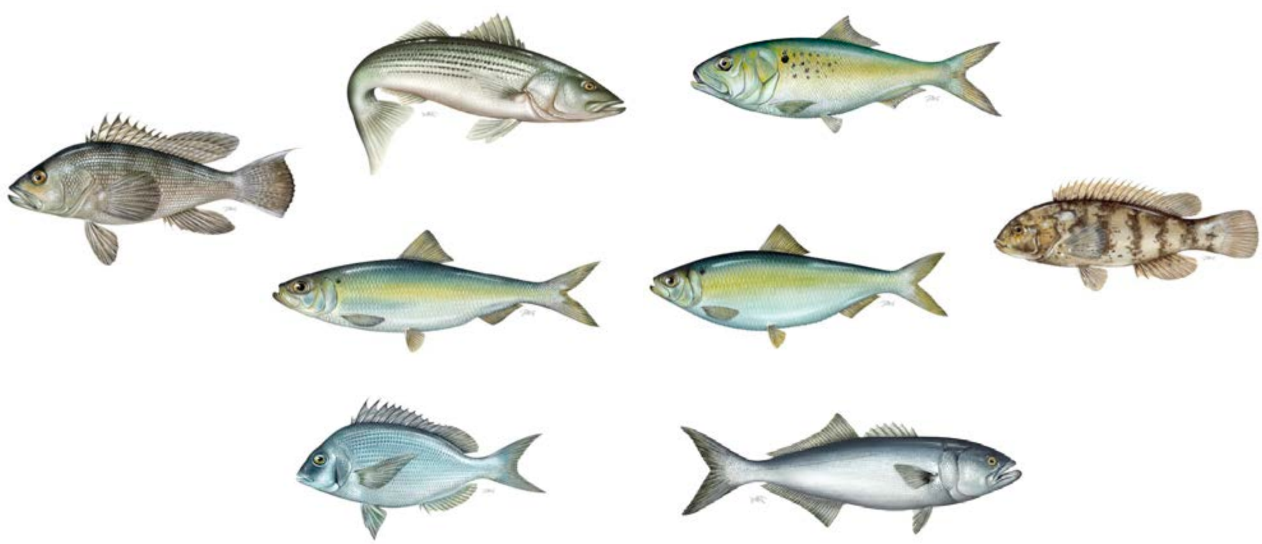
Atlantic States Marine Fisheries Commission

Report of the Quality Assurance/Quality Control Fish Ageing Workshop



St. Petersburg, Florida

March 27-28, 2018

Vision: Sustainably Managing Atlantic Coastal Fisheries

Table of Contents

Acknowledgements

The Atlantic States Marine Fisheries Commission would like to thank those who contributed their time, expertise, and samples prior to and during the workshop: Mark Pasterczyk (ME DMR), Scott Elzey (MA DMF), Eric Robillard (NEFSC), Nicole Lengyel (RI DMF), David Molnar (CT DEEP), Jesse Hornstein (NY DEC), Heather Corbett (NJ DFW), Jamie Darrow (NJ DFW), Michael Greco (DE DFW), Katherine Messer (MD DNR), Jessica Gilmore (ODU CQFE), Jameson Gregg (VIMS), Jeffrey Eckert (VIMS), Jonathan Tucker (SC DNR), Donna McDowell (GA DNR), and Jessica Carroll (FL FWC). A special thanks to Jessica Carroll, Kristin Cook, David Westmark, Kyle Williams, Brittany Barbara, and Kristen Rynerson with FL FWC for hosting, preparing the samples, and leading the group through the workshop. And congratulations to Kristen Rynerson. You were missed at the workshop but welcome Baby Ethan! The Commission also thanks Jessica Carroll for coordinating the workshop and Kristen Anstead (ASMFC) for coordinating the workshop and preparing this report.

Statement of Problem

Many of the fish species managed by the Atlantic States Marine Fisheries Commission (ASMFC) identify the collection of ageing hard parts, development of sample processing and reading protocols, and regular sample exchanges as research priorities in their stock assessments. Several species managed by the ASMFC have had their own ageing structure exchange and workshop to address this. However, there is a continued need for a quality assurance/quality control (QA/QC) workshop because any gradual decline in ageing accuracy could have detrimental effects on stock assessments and consistency should be monitored over time (Campana 2001). Following the Gulf States Marine Fisheries Commission (GSMFC) protocol to hold annual QA/QC workshops for its participating members, the ASMFC made a QA/QC fish ageing workshop a research priority.

The ASMFC has held an annual QA/QC Fish Ageing Workshop since 2016 to provide a yearly check-in for species that have had their own ageing workshop. The full QA/QC sample collection contains approximately 20 samples from each of the following species: Atlantic croaker *Micropogonias undulatus*, black sea bass *Centropristis striata*, bluefish *Pomatomus saltatrix*, river herring (alewife *Alosa pseudoharengus* and blueback *A. aestivalis*), striped bass *Morone saxatilis*, Atlantic menhaden *Brevoortia tyrannus*, winter flounder *Pseudopleuronectes americanus*, summer flounder *Paralichthys dentatus*, red drum *Sciaenops ocellatus*, scup *Stenotomus chrysops*, and tautog *Tautoga onitis* were aged. Samples include scales, whole otoliths, sectioned otoliths, and/or opercula depending on the species and which hard part is used to provide ages to the ASMFC during stock assessments. The QA/QC fish ageing group decided to rotate some species with high agreement out and others in every few years so that more species could be included. Red drum, striped bass, scup, black sea bass, river herring, Atlantic menhaden, bluefish, and tautog were identified as species to evaluate for the 2018 workshop which took place from March 27-28 at the Florida Fish and Wildlife Research Institute (FL FWRI) in St. Petersburg, FL.

Workshop Objectives

The objectives of the workshop were to:

(1) Age samples collected and prepared from labs along the Atlantic coast for Red drum, striped bass, scup, black sea bass, river herring, Atlantic menhaden, bluefish, and tautog

(2) Identify areas of inconsistency that persist for processing or reading ageing structures

(3) Provide information on ageing error for each species to inform future stock assessments, including APE for group consensus ages and comparisons between individual agers that routinely age each species

(4) Develop recommendations to address any problems that emerge from this workshop so as to improve age data along the Atlantic coast

(5) Maintain samples as a reference collection for future QA/QC workshops as well as archive in a digital library

(6) Make a recommendation for how to proceed with Atlantic menhaden ageing at the state-level and confer with the NOAA Beaufort Laboratory following the discussion

Previous Ageing Workshops

All species aged during the 2018 QA/QC Fish Ageing Workshop have previously had their own ageing workshop, with the exception of scup. Complete reports and results from those ageing workshops are available at http://www.asmfc.org/fisheries-science/research and are summarized below along with the history of how age data is used in their respective stock assessments.

I. River Herring

River herring is assessed on a river-by-river basis and the model used depends on the available data. Many rivers lack the data to do a model-based assessment so trend analysis is used. For a few rivers, age data is available and a statistical catch-at-age model is used. However, lack of data has hindered stock assessment scientists from doing a full coastwide assessment and the need for standardizing ageing techniques and collecting more age data was identified by the review panel in the most recent stock assessment.

To address these needs, a sample exchange and ageing workshop was held for both alewife and blueback herring in 2014 (ASMFC 2014). The majority of samples exchanged were paired otoliths and scales. While many challenges were brought up during this workshop including identifying the first true annulus, differences between readers, and regional differences between samples, the group agreed on the standard protocol for collecting, preparing, and ageing river herring.

II. Atlantic Menhaden

The most recent stock assessment for Atlantic menhaden (SEDAR 2015) used an age-structured model based on scale age data. Age data is used throughout the assessment and age is an integral part of the modeling effort and management. All age data provided for the assessment was aged at the NOAA-Beaufort Lab.

To address future plans for states to age Atlantic menhaden scales and the research recommendation to conduct an ageing workshop, the ASMFC organized and held a workshop in 2015 (ASMFC 2015a). An exchange of scale samples took place and was followed with an in-person workshop to discuss the results. False annuli, poor storage of samples, and damaged scales were common issues identified at the workshop. The use of otoliths as an ageing structure was discussed, but it was determined that more work is needed to compare ageing structures.

A benchmark stock assessment is currently underway and scheduled to be completed in 2019. To prepare for supplying the benchmark with ages, Atlantic menhaden agers from Maine to Florida took part in an ageing call in January 2018 to decide how to proceed with ageing Atlantic menhaden samples. Participants decided to have Beaufort continue to age all bait samples for the 2019 benchmark and that states should continue to collect and age their fishery-independent samples. The long-term plan is to maintain ageing training and quality control for menhaden along the coast. On the call it was requested that the QA/QC fish ageing group review this topic at their March 2018 meeting and communicate with Beaufort about moving forward with a reference set and possible future workshop.

III. Black Sea Bass

Early assessments for black sea bass were developed using simple index-based models. Beginning in 2008, a statistical catch at length model was developed. Depending on the lab, age data was taken from scales, sectioned otoliths, and whole otoliths. Ages were used to describe life history parameters, but were also used in an age-based model for the 2011 assessment of the northern stock (New England to Cape Hatteras). One of the research recommendations in the 2004 stock assessment was to develop age information for analytical models (NEFSC 2004). Additionally, concern remained that there could be different methodologies between labs ageing northern and southern stock fish.

A sample exchange and ageing workshop was held for black sea bass in 2013 to standardize ageing methodology and evaluate the consistency of ageing along the Atlantic coast (ASMFC 2013b). Differentiating between check marks and true annuli were discussed as well as the continued need for sample exchanges in the future for consistency. Participants of the workshop recommended that whole and sectioned otoliths can be used to accurately age black sea bass, but difficult to read otoliths and otoliths from fish older than 5 should be sectioned.

IV. Bluefish

Both scales and otoliths have been used to age bluefish, although scale ages tend to overestimate younger fish and underestimate older fish. Scale ages were used in the stock assessment through 1997 and in 1998 the model began using otolith ages. Inaccuracies due to false annuli, regenerated scales, varying annuli counts between scales from the same fish, identifying the first annulus, and identifying annuli on scales from larger fish have all been documented (Richards 1976; NCDMF 2000; Robillard et al. 2009; NEFSC 2015). Because of these challenges, the stock assessment has used a 6+ age group in the statistical catch-at-age model to minimize the effects of ageing error for scales ages from 1985-1995.

In 2011, an ageing workshop was held for bluefish to standardize sample processing and reading procedures (ASMFC 2011). The results of this workshop established sectioned otoliths as the preferred ageing method over scales or whole otoliths and the standard protocol for processing and reading samples is that of ODU and Robillard et al. (2009). Following the workshop, Addendum I to the bluefish fishery management plan was established that required all states with substantial bluefish landings to collect and age at least 100 bluefish samples annually. Additionally, the ASMFC maintains a digital reference collection for reference and training purposes.

V. Red Drum

Age data for red drum was used in the 2017 benchmark stock assessment for the statistical catch-at-age model to assess the northern and southern stocks (ASMFC 2017). The model used age data from the commercial and recreational fisheries as well as fishery-independent surveys along the coast. Red drum had an ageing workshop with Atlantic croaker in 2008 (ASMFC 2008). At the workshop it was determined that scales are accurate through age 4 but should not be used for older ages. Otoliths are the preferred hard part for determining age in this species. Like Atlantic croaker, a 'check-mark' or 'smudge' is often present in close proximity to the core as an annulus. During the 2008 workshop, agers decided not to count the smudge but rather count the first distinct ring as the first annulus.

VI. Scup

Scup underwent a benchmark stock assessment in 2015 (NEFSC 2015). The Northeast Fishery Science Center (NEFSC) provided the age information from their trawl survey (1977-2014) for the stock assessment to estimate growth parameters and maturity at age. Ages were also used in the age-structured model used to determine if the stock was overfished or if overfishing was occurring.

A scup ageing workshop was held by the Northeast Fisheries Science Center (NEFSC 1979) to compare ages and accuracy between fisheries biologists. Both scales and otoliths were evaluated and both were deemed acceptable for ageing scup, although otoliths were better for ages over 5. Disagreement between ages was attributed to difficulty interpreting scale ages, weak first annulus, false "cutting over," and the presence of checks. The ASMFC sponsored an ageing workshop for scup summer flounder in December, 2014, through a partnership with Virginia Institute of Marine Science (VIMS). Scales and otoliths were evaluated and some imprecision and bias was detected between labs.

VII. Striped Bass

Age data for striped bass has been used for both VPA- and SCA-based stock assessments, so ageing consistency among coastwide agencies and ageing labs is critical for the management of this species. Scale ages have been used in the assessment since 1996. Scales have been the most common hard part collected and aged, but it has been acknowledged that they underestimate ages in older fish when compared to otoliths (Secor et al. 1995). Both the technical committee and stock assessment committee for striped bass expressed interest in collecting more paired samples and developing regional and annual scale age-otolith age conversion keys to correct for scale bias (ASMFC 2013a).

In 2003, the ASMFC organized an exchange of 102 known-age scale samples and held an ageing workshop (ASMFC 2003). While there was some overestimation of year 1 and 2 samples by one year, participants felt that this issue could be mitigated by routine training in the labs. Results indicated that there was good agreement between states and readers for scales ages 3-7 and that otoliths were more precise among readers and ages. Overall, the workshop concluded that scales provided accurate and reliable ages until age 10-12 (about 800 mm TL). While the cost of collecting and processing otoliths can be a limiting factor, the ASMFC began working with states to collect otoliths for striped bass 800 mm or larger for future analysis.

VIII. Tautog

From 1995-2011, benchmark and update stock assessments for tautog used a VPA model that relied on age data. A statistical catch-at-age model was developed for the 2015 stock assessment and age data was used to develop life history parameters as well (ASMFC 2015b). Most states use opercular bones for ageing, but in 2001, Virginia began using otoliths to standardize readings of the operculum. Recognizing the importance that age data plays in the assessment of tautog and addressing concerns that were raised over the change in protocols in Virginia, it was recommended that a workshop be organized and conducted among participating states.

In 2012, the ASMFC organized a hard part exchange and ageing workshop for tautog to evaluate the age precision among states and establish best practices for consist age readings (ASMFC 2012). The workshop aged operculum and otoliths, when available, and determined that precision was similar for both hard parts. Participants of the workshop recommended that operculum remain the standard for biological sampling but also encouraged otolith collection for paired sub-samples. Additionally, it concluded that the Virginia data is not significantly different from other states and it should be used in the assessments going forward. In 2013, a follow-up to the workshop was done and states remained consistent in their readings.

Sample Collection, Preparation, & Ageing Methodology

I. Alewife and Blueback River Herring

Maine Department of Marine Resources (ME DMR)

Alewife and blueback herring scales are collected from adults at the ME DMR managed fishways on the major rivers during the spring spawning run. Some otoliths were collected in 2012, but this is not a regular practice and otoliths are not aged during production ageing. Scale samples have also been collected by harvesters and submitted to the River Herring Project at ME DMR since 2008. Scales are cleaned with soap and water and blotted dry with paper towels. Three or four scales are temporarily mounted between glass slides and viewed with microfiche readers. As many as 20 to 30 scales are used on samples when the first slide leaves a doubt in the mind of the person ageing the scales. These extra scales are not cleaned first. They are temporarily mounted between glass slides and viewed on the microfiche reader to see which scales are worth cleaning. Depending on staff availability, 1-2 staff members read each sample.

If multiple readers cannot come to a consensus age, the sample is excluded from production ageing. Regenerated scales are excluded from production ageing. When a sample is done being aged, the scales are put back in the original sample envelope and kept in the archive collection.

The Augusta crew from ME DMR Division of Sea Run Fisheries and Habitat (DSRF&H) now only collects river herring bio-samples at their major fishways or fishlifts (Brunswick Dam - first dam on the Androscoggin River; Lockwood Dam, Waterville- first dam on the Kennebec River; and Benton Falls Dam - first dam on the Sebasticook River). The Augusta crew uses Brunswick fishway and the fishlift at Lockwood Dam as sources of adult river herring for truck stocking. The Kennebec River crew ages their samples (Waterville and Benton Falls) with the same methods described in the previous paragraph. The only difference is that they permanently mount 3 to 4 scales between acetate slides. The large number of scale samples aged each year by the River Herring Project crew makes it impractical to mount them permanently.

The River Herring Project crew (ME DMR DSRF&H) collected scale samples from all of the commercially harvested runs in the state from 2010 to 2013. Bio-sample data (total length, fork length, weight, sex and species) was also taken from every fish along with all of these scale samples. This data was used to compare with the samples that were collected by the harvesters. The harvesters are still collecting samples every year. This is being done to monitor the age structure of the populations of each harvested run. In order to keep harvesting these runs, each run has to be deemed self-sustaining with a healthy spawning stock biomass and high survival rate. In order to ensure this, we are looking for a good representation of older age classes and high repeat spawning ratio. Maine also has volunteer groups from many places in the state that are collecting scale samples from the non-harvested runs during the spring spawning run. Some of these groups are hoping to start a harvest in the future and others are just interested in keeping an eye on their local run.

Massachusetts Division of Marine Fisheries (MA DMF)
Alewife and blueback herring scales and otoliths are collected from spawning adults in MA river systems during the spring spawning run. Otoliths are also collected from samples of the river herring bycatch of the Atlantic herring fishery. Collection of scales in MA has occurred at least sporadically since the mid-1980s. Otolith collection began in 2010 for some sample sources and increased to all sample sources by 2013. Otoliths are the primary structure used for ageing but scales are collected when available for use in spawning check enumeration. Scales to be mounted are first cleaned in an ultrasonic bath with a 5% pancreatin solution. Scales are mounted between glass slides and viewed with digital imaging software and a camera on a macro mirror stand. Otoliths are rinsed with water and allowed to air dry overnight before ageing. Otoliths are aged whole submersed in mineral oil and viewed with a stereomicroscope.

Connecticut Department of Energy and Environmental Protection (CT DEEP)
Alewife and blueback herring scales are collected from spawning adults during the spring spawning run. Scales are rinsed with water and wiped clean. 6-8 scales are mounted between glass slides and viewed with a microfiche reader. Unreadable samples (i.e., regenerated scales,

scales with heavily eroded edges) are excluded from production ageing. Any scale samples of poor quality that two readers cannot reach a consensus age determination for are excluded from production ageing.

New Jersey Department of Fish and Wildlife (NJ DFW)
Alewife and blueback herring otoliths have been collected during the NJ DFW Ocean Trawl Survey in January and April since 2007. This survey collects smaller fish than sampled in other state programs. Scale collection during this survey is not feasible, as few scales are retained on fish collected. At the time of the workshop, NJ DFW staff had just started reviewing river herring ageing materials provided by the MA DMF and practicing ageing otoliths, but had not begun production ageing. Digital imaging software is used to store images of each otolith sample collected. Staff has been slowly ageing the samples according to protocols developed at the ageing workshop but ageing is not complete.

Maryland Department of Natural Resources (MD DNR)
River herring were captured by a multi-panel experimental anchored sinking gill net set in the North East River once a week at four randomly chosen sites from mid-March to mid-May from 2013-2015. Individual net panels were 100 feet long and 6 feet deep. The panels were constructed of 0.33 mm diameter monofilament twine in 2.5, 2.75 and 3 inch mesh. In 2015, the 3 inch mesh panel was replaced with a 2.25 inch mesh panel, as there was evidence the current mesh size selection was not successful in capturing smaller sized blueback herring. The three panels were tied together to fish simultaneously and were soaked for 30 minutes before retrieval. All river herring were sexed and measured to the nearest mm fork length (FL) and total length (TL). Scales were taken from a random subsample, the first 20 fish per species per panel for age and spawning history analysis. Up to 300 scale samples were aged per species.

Virginia Institute of Marine Science (VIMS)
Both species of river herring, alewife and blueback, are “Priority” species for NEAMAP and ChesMMAP, meaning that length, weight, sex, maturity state, stomach, and otoliths are collected for 5 individuals from each length bin on each tow. VIMS have collected whole otoliths for age determination. A total of 2,832 pairs of alewife otoliths have been collected by the two surveys (CM 524; NM 2,308). A total of 2,174 pairs of blueback otoliths have been collected by the two surveys (CM 155; NM 2,019).

VIMS has yet to final age assign these whole otoliths due to discrepancies in ageing protocols coast wide. An ongoing “in-house” at VIMS is currently being conducted to compare scales and whole otoliths from the same specimens to determine the most accurate and efficient method for ageing river herring.

North Carolina Department of Marine Fisheries (NC DMF)
Alewife and blueback herring scales and otoliths are collected from spawning adults in NC river systems during the spring spawning season. Otoliths and scales are collected during fishery-

dependent monitoring (pound net survey) and scales are collected during fishery-independent monitoring (gill net survey).

II. Atlantic Menhaden

Rhode Island Division of Marine Fisheries (RI DMF)

The RI DMF has been ageing scales from Atlantic menhaden since 2015 following the ASMFC Atlantic Menhaden Ageing Workshop. Prior to 2015, all scale samples collected by RI DMF were sent to the NOAA-Beaufort Laboratory for ageing. A target number of 100 scale samples are collected annually from the commercial bait fishery. Scales are cleaned and sandwiched between two glass microscope slides. Scales are aged by a single reader using a microfiche reader. A second read is conducted by the same reader on at least 10% of the samples for each structure to obtain precision estimates.

Additionally, in 2017, RI DMF began collecting menhaden otoliths as a possible structure for ageing. RI DMF will process 2017 samples and explore the use of otoliths for ageing menhaden in 2018.

New York State Department of Environmental Conservation (NY DEC)

NY DEC has also been ageing Atlantic menhaden since the 2015 ASMFC Atlantic menhaden Ageing Workshop. Scales are collected through both fishery dependent and independent sampling. Scales are collected from menhaden caught in the WLI juvenile striped bass seine survey, and additional samples are collected intermittently by cast net. Fishery dependent samples are collected through Cornell Cooperative Extension by sampling commercial fishermen dockside. Scales are cleaned and placed between two slides which are then aged using a microfiche reader. At least two people age the scales, and a group reading is used to settle disagreements. Samples for which no agreement can be reached are discarded from the set.

MD DNR

MD DNR has been collecting length and age (scales) data from Atlantic menhaden since 2005. We collect scales from a fishery independent gill net survey and a dependent pound net survey. We collect an average of 20 samples from each survey each week. This provides us with around 450 scales a year to age. From each sample we select between 4 and 8 non-regenerated scales that are cleaned in soap and water and placed between 2 slides. These slides are then read with a microfiche reader by two trained DNR biologists. These ages are compared and an agreed age is assigned. If an age cannot be agreed upon we will not assign an age.

NC DMF

Scale samples are currently collected from fishery-dependent sampling of bait fisheries. No scale samples are collected during fishery-independent sampling. Scales are processed and aged in-house with a microfiche reader. For Atlantic menhaden samples, NC DMF selects six scales from each envelope, choosing only scales that are symmetrical, uniform in size, and free of defects for mounting. The selected scales are cleaned with water. Scales are arrange the on the bottom slide with pectinations pointed up and the smooth or concave scale side down, and covered with the second slide.

III. Black Sea Bass

Northeast Fisheries Science Center (NEFSC)
Scales and otoliths have been collected since 1984 during fall and spring fishery-independent trawl surveys conducted by NMFS from New England to Cape Hatteras, NC. Approximately 350 samples are collected from each survey annually (≈700 total). Scales are typically collected from the commercial fishery by port samplers. Samples have been collected from the commercial fishery since 2008, with an emphasis on collecting samples from large and jumbo market size fish. A few thousand samples are collected from the commercial fishery annually. The size range of fish sampled is 4 – 60cm. One reader is currently ageing both scales and whole otoliths. Samples that the age reader considers unreliable for age determination are discarded. The NEFSC will phase out scale ages and begin providing age data only from otoliths. The reader tests precision six times a year, once following each trawl survey and each quarter of the commercial fishing season and provides the results of these tests online (http://www.nefsc.noaa.gov/fbp/QA-QC/) . The threshold for precision testing is 80% agreement and a 5% mean CV.

MA DMF
Black sea bass scales are collected from commercially captured fish at the fish houses (since 2014). Scales are also collected from recreationally captured fish (since 2014). The Massachusetts Resource Assessment fishery-independent trawl survey has collected otoliths since 2013. Otolith samples have also been collected from a ventless lobster trap survey since 2015. Otoliths are read whole, submerged in mineral oil with reflected light under a stereo microscope. Otoliths aged 6 and older are then sectioned and re-aged. Scales are pressed into acetate with a heat press and aged with a microfiche projector.

RI DEM
Scales have been collected on fishery-independent surveys, at recreational fishing tournaments, and from the commercial fishery since 2013. The annual target number of samples is 100. Sample collection primarily includes scales; however, otoliths are also collected on fishery-independent surveys when the whole fish is being sacrificed. Scales are cleaned, pressed onto acetate with a heat press, and aged using a microfiche reader. Otoliths are dried, mounted in epoxy resin, and thin-sectioned using an IsoMet™ slow speed saw. Thin sections are then mounted onto microscope slides with Flo-Texx™ and aged with a microscope. All samples are currently aged annually by a single reader. A second read is conducted by the same reader on at least 10% of the samples to obtain precision estimates.

NY DEC
The NY DEC has been collecting length, sex (when available), and age (otoliths) data from black sea bass since 2014. Most of the samples are collected from commercial markets, with

additional samples coming from the recreational fishery. Otoliths are all read whole immersed in water with a black background under a dissecting microscope with direct light. Any otoliths that are difficult to read or aged 6+ are embedded in West System Epoxy and sectioned using an Isomet Low-Speed Saw to a thickness of ~0.3mm. Sectioned otoliths are then aged on a compound microscope using transmitted light. Samples are processed and read by two people.

NJ DFW

Sampling for black sea bass started in 2010 during the NJ DFW Ocean Trawl Survey. Samples are collected throughout the year, and are separated into 4 length classes to distribute sampling totals. To date, 687 black sea bass samples have been collected with 126 samples collected in 2015. Once otoliths are extracted, they are sent to the NEFSC for processing and ageing.

VIMS

Scales and otoliths have been collected from two fishery-independent trawl surveys, ChesMMAP since 2002 and NEAMAP since 2007. Black sea bass is a “Priority” species for NEAMAP, meaning that length, weight, sex, maturity state, stomach, and otoliths are collected for 5 individuals from each length bin on each tow. VIMS ages sectioned otoliths but has conducted comparison studies with scales and whole otoliths from 2010 to 2013.VIMS has aged 3,094 total Black sea bass from 2002-2015 (CM 296; NM 2,798). Black sea bass have been aged from age-0 to a max age of 16.

There are three readers at VIMS and the mode age for each sample is provided as the final age. If there is no mode from the initial read, the readers reread the sample and if there is still no mode, they examine the sample together and come to a consensus age. If a consensus age cannot be determined the sample is discarded. Very few samples are discarded. Precision tests are preformed within each reader (multiple reads of the same sample) and between readers. VIMS uses similar precision and symmetry tests to the NEFSC.

Florida Fish and Wildlife Research Institute (FL FWRI)

Black sea bass otoliths are collected on fishery-independent monitoring surveys. Most black sea bass otoliths in the collection came from a directed project was conducted in 2011 and 2012. Otoliths are read whole, submerged in water with reflected light and a black background under a stereo microscope. Otoliths aged 6 and older, or of poor quality for whole ageing, are embedded, sectioned and aged.

IV. Bluefish

MA DMF

The MA DMF has been sampling and ageing bluefish since 2009. Samples come from a combination of commercial and fishery independent sources. Otoliths are the only hard part aged for bluefish in MA. Otoliths are baked, sectioned, and aged with transmitted light on a compound microscope.

RI DMF

Bluefish otoliths have been collected by the RI DMF since 2012 on fishery-independent surveys and from the recreational and commercial fisheries. The annual target number of samples is 100 per the requirements of Addendum I to Amendment I to the Bluefish Fishery Management Plan. Otoliths are dried, mounted in epoxy resin, and thin-sectioned using an IsoMet™ slow speed saw. Thin sections are then mounted onto microscope slides with Flo-Texx™ and aged with a microscope. All samples are currently aged annually by a single reader. A second read is conducted by the same reader on at least 10% of the samples to obtain precision estimates.

New York State Department of Environmental Conservation (NY DEC)
The NY DEC has been collecting length, sex (when available), and age (otoliths) data from bluefish since 2012. The majority of samples are collected from fishery dependent sampling of commercial markets, with additional samples of larger bluefish coming from the recreational fishery. Staff sample as many bluefish as possible, but age a maximum of 10 fish per 1 cm bin. Otoliths are embedded in West System Epoxy and sectioned using an Isomet Low-Speed Saw to a thickness of ~0.3mm. Otoliths are aged on a compound microscope using transmitted light. Samples are processed and read by one person.

NJ DFW
The NJ DFW initiated a sampling program for bluefish in 2010 with the intent of filling gaps in the stock assessment age-length key. Otoliths have been collected exclusively for bluefish ageing (no scales), and samples have been derived from fishery-independent survey efforts and fishery-dependent sources. Through 2014, the average number of bluefish sampled by the NJ DFW is 90 in the spring (SD = 16 ages) and 101 in the fall (SD = 27). Ageing is complete through 2015, though a summary is not yet available for 2015.

All otolith samples are sent to the NEFSC annually for processing and age determination and protocols follow those specified in the 2011 ASMFC bluefish ageing workshop. The age distribution of samples collected by the NJ DFW is available through 2014. As recommended by the bluefish Technical Committee, NJ DFW will report ages through 8+ (including retrospectively) as ageing techniques have been validated through age 8 (Robillard et al. 2009).

VIMS
Bluefish is a “Priority” species for NEAMAP, meaning that length, weight, sex, maturity state, stomach, and otoliths are collected for 5 individuals from each length bin on each tow. VIMS uses sectioned otoliths to age bluefish. Otoliths are sectioned using a method similar to ODU’s. However, VIMS wet-sands the sections to a thinner width than ODU and does not bake the sections. Annulus counts are adjusted to reflect the timing of sample collection relative to ring formation. Age is assigned as the mode of three independent readings. VIMS has aged 5679 total bluefish between ChesMMAP and NEAMAP from 2002-2016 (CM 528, NM 5151). Bluefish have been aged from age-0 to a max age of 10. The majority of the specimens sampled were ages 0-2. There are three readers at VIMS and the mode age for each sample is provided as the final age. If there is no mode from the initial read, the readers reread the sample and if there is still no mode, they examine the sample together and come to a consensus age. If a consensus

age cannot be determined the sample is discarded. Very few samples are discarded. Precision tests are preformed within each reader (multiple reads of the same sample) and between readers. VIMS uses similar precision and symmetry tests to the NEFSC.

Old Dominion University (ODU)

VMRC obtains bluefish otoliths from the commercial catch and fishery independent sampling programs. Bluefish otoliths have been collected by VMRC since 1998. These otoliths are processed and read by ODU CQFE (Center for Quantitative Fisheries Ecology). ODU CQFE chooses a random subsample of otoliths collected in each length bin to age. In 2015, VMRC collected 682 bluefish otoliths and ODU CQFE aged 442 of them.

ODU CQFE uses sectioned otoliths to age bluefish. Each section is read under transmitted light using a polarizing filter. The characteristics described in Robillard et al. (2009) are used to identify the first ring and false annuli. Bluefish are assigned a January 1st birthdate by convention. The sample date is used to assign the final age. If the sample was taken before the period of annuli formation (March to June), the age is the annulus count plus one. If the sample was taken after that, the age is the annulus count.

Each section is aged by two readers. If the first readings disagree, the readers re-age the fish together. If a consensus cannot be reached, the sample is excluded from further analysis and, if available, another sample from the same length bin replaces it. Each year, readers revisit a reference collection of samples from 2000 to increase consistency across years.

The following are links to the preparation and ageing protocols for bluefish.

- Otolith Preparation Protocol

https://www.odu.edu/content/dam/odu/offices/center-for-quantitative-fisheries/docs/bluefish-otolith-preparation-protocol.pdf

- Otolith Ageing Protocol

https://www.odu.edu/content/dam/odu/offices/center-for-quantitative-fisheries/docs/cqfe-bluefish-otolith-ageing-protocol-black-white-2011.pdf

NC DMF

NC DMF has collected and aged bluefish scales from 1983 – 1998, and collected and aged otoliths from 1996 – 2000 and from 2006 to the present. From 1996 – 1998, NC DMF collected paired samples of scales and otoliths for a comparison of the two structures (NC DMF 2000). NC DMF did not collect any hard parts for bluefish from 2001 – 2005, when the Bluefish TC switched to a surplus production model for assessment purposes. The SAW/SARC review of that assessment (NEFSC 2004) found a lumped biomass model inappropriate for bluefish and recommended the use of an age-structured model instead. Thus, NC DMF began collecting otoliths for bluefish again in 2006. Despite training at ODU's lab, NC DMF could not replicate ODU's process to produce readable otolith sections and discontinued processing of annual samples in favor of archiving whole otoliths.

SC DNR

The Southeast Area Monitoring and Assessment Program (SEAMAP) is a cooperative state-federal program that has operated a fishery independent Shallow Water Trawl Survey in the nearshore waters from Cape Hatteras, NC to Cape Canaveral, FL since 1986. The survey is conducted by South Carolina Department of Natural Resources (SC DNR).

In 2011, bluefish was added to the list of species that received a full work-up including the collection of otoliths for ageing. As with the NEAMAP samples, the majority of bluefish samples are small, young fish; this is not surprising in a trawl survey, as older bluefish can easily out-swim a trawl. From 2000 to 2010 before SEAMAP took over sample processing, SC DNR Inshore Fisheries section was using SEAMAP caught bluefish for otolith ageing.

FL FWRI

Bluefish otoliths are collected on fishery-independent monitoring surveys. Most bluefish otoliths are incidental collections and are not targeted or regularly encountered. Otoliths are embedded in a plastic resin and sectioned on an Isomet ® low speed saw and aged under transmitted light on a stereo microscope.

V. Red Drum

VIMS

Red drum is “Priority” species for the NEAMAP and ChesMMAP surveys. Length, weight, sex, maturity, stomachs for diet analysis and otoliths are collected from 5 specimens from each length bin from each tow. Otoliths have been sectioned for the best results and accuracy with ageing. Despite lower encounters with this species, the surveys maintain red drum as a priority species and provide data when applicable for assessment needs. A total of 79 pairs of red drum otoliths have been collected and processed for age determination from both surveys (NM 57, CM 22). It has been observed that a tight inner ring may form on this Sciaenidae family species. VIMS has observed this formation but it has not been counted when these ages have been submitted to ASMFC for assessments.

ODU

VMRC obtains red drum otoliths from the commercial catch and fishery independent sampling programs. Red drum otoliths have been collected by VMRC since 1998. These otoliths are processed and read by ODU CQFE (Center for Quantitative Fisheries Ecology). In 2017, 83 red drum were collected and processed for ageing.

ODU CQFE uses sectioned otoliths to age red drum. Each section is read under transmitted light using a polarizing filter. The “smudge” near the core is not counted as an annulus based on the 2008 ASMFC recommendation. Red drum are assigned a January 1st birthdate by convention. The sample date is used to assign the final age. If the sample was taken before the period of annuli formation (March to July), the age is the annulus count plus one. If the sample was taken after that, the age is the annulus count.

Two readers age each section. If the first readings disagree, the readers re-age the fish together. If a consensus cannot be reached, the sample is excluded from further analysis. Each year, readers revisit a reference collection of samples from 2000 to increase consistency across years.

The following are links to the preparation and ageing protocols for red drum.

- Otolith Preparation Protocol

https://www.odu.edu/content/dam/odu/offices/center-for-quantitative-fisheries/docs/red-drum-otolith-preparation-protocol.pdf

- Otolith Ageing Protocol

https://www.odu.edu/content/dam/odu/offices/center-for-quantitative-fisheries/docs/red-drum-otolith-ageing-protocol.pdf

SC DNR

SC DNR collects red drum otoliths from five sources: three fishery independent sources (trammel net, electrofishing, and bottom longline) and two fishery dependent sources (freezer fish program and inshore fishing tournaments). The trammel net, electrofishing, freezer fish, and tournament surveys get samples of sub-adult fish (<5 years) while the longline collects samples from adult fish. Annual sample numbers vary greatly, but there has been an average of two hundred otolith samples per year since the trammel net survey began in 1991. SC DNR also used scales for red drum ageing (approx. 30,000 samples from 1986-2006), but found them only reliable to age 3 and phased out this ageing method. The protocol for otoliths is to embed the left otolith in epoxy resin, cut a transverse section with an Isomet low-speed, and mount on a microscope slide with Cytoseal mounting medium. The sections are looked at with transmitted light, by two independent readers, using a stereo microscope. The readers record annuli count and margin code (1 - 4) without knowing the date of capture or the size of fish. Ages are determined using annuli count and margin code at date of capture. The margin codes helps to determine if the fish was caught before or after annulus formation. SC DNR uses September 1st as the biological birthday for red drum instead of October like the ASMFC. The "smudge" due to spawning occurring in late fall is not counted as an annulus. Depending on the capture date being pre- or post-annulus formation, one or two years must be added to the total annuli count to place a fish in the proper year class (age group). One year for fish captured after the annulus formation of a given year, and two years for fish caught before forming an annulus. This way, year class is based on the spawning season of the actual calendar year of birth. The marginal increment is also measured for all red drum to verify margin code and annular deposition of the opaque zone.

GA DNR

GA DNR obtains Red Drum otoliths from both fishery independent and fishery dependent sampling programs. The bulk of the samples are from the Carcass Recovery Program that began in 1997. An average of 400 red drum otoliths are aged annually.

GA DNR uses sectioned otoliths to age Red Drum. One transverse section is cut from the left otolith using a multi-blade setup on Isomet low speed saws. Sections are read under transmitted. Each otolith is aged at least twice, either by two different readers, or by one reader two independent times. Any discrepancies between reads are resolved, and if no resolution can be obtained, the sample is thrown out.

Ageing protocols, as established by Murphy & Taylor (1990) are followed in Georgia. Red Drum are assigned a January 1st birthdate by convention, whereby the sample date is used to assign the final age. If the sample was taken before the period of annulus formation (January to June), the age is annulus count plus one. If the sample was taken after that, the age is equal to annulus count. Georgia does not count "the smudge" as an annual increment.

FL FWRI

FWRI obtains red drum otoliths from both fishery independent and fishery dependent sampling programs. The main collection gear for fishery independent samples is trammel nets, but seine nets (including commercial purse seines), and gill nets have also been used to capture red drum. Biological sample collection began in 1981. In total, 20,662 red drum have been sampled and aged in Florida, and an average of 800 red drum otoliths are aged annually.

FWRI uses sectioned otoliths to age red drum. Three transverse sections are cut from the left otolith using a multi-blade setup on Isomet low speed saws. Sections are read under transmitted or reflected light, depending on the reader. Each otolith is aged at least twice, either by two different readers, or by one reader two independent times. Any discrepancies between reads are resolved, and if no resolution can be obtained, the sample is thrown out.

Ageing protocols, as established by Murphy & Taylor (1990) are followed in Florida. Red drum are assigned a January 1st birthdate by convention, whereby the sample date is used to assign the final age. If the sample was taken before the period of annulus formation (January to June), the age is annulus count plus one. If the sample was taken after that, the age is equal to annulus count. In red drum, a three month mark is visible on the annulus, also known as the 'smudge', and Florida does not count this mark as an annual increment.

VI. Scup

NEFSC

NEFSC samples come from a combination of commercial and fishery independent sources. Prior to 2016, scales were used to age scup. Scales were impressed in acetate using a press and aged by examining impressions on a microfiche projector. Since 2016, otoliths are the hard part aged for scup. Otoliths are sectioned and aged with transmitted light on a compound microscope. Samples that the age reader considers unreliable for age determination are discarded. The reader tests precision six times a year, once following each trawl survey and each quarter of the commercial fishing season and provides the results of these tests online (http://www.nefsc.noaa.gov/fbp/QA-QC/) . The threshold for precision testing is 80% agreement and a 5% mean CV.

MA DMF
MA DMF receives scup scales collected by volunteer recreational anglers. The scales are wiped clean, pressed into acetate using a heated press, and aged by examining the impressions on a microfiche projector.

RI DMF
Scales have been collected on fishery-independent surveys, at recreational fishing tournaments, and from the commercial fishery since 2010. The annual target number of samples is 100. Sample collection primarily includes scales; however, otoliths are also collected on fishery-independent surveys when the whole fish is being sacrificed. Scales are cleaned, pressed onto acetate with a heat press, and aged using a microfiche reader. Otoliths are dried, mounted in epoxy resin, and thin-sectioned using an IsoMet™ slow speed saw. Thin sections are then mounted onto microscope slides with Flo-Texx™ and aged with a microscope. All samples are currently aged annually by a single reader. A second read is conducted by the same reader on at least 10% of the samples to obtain precision estimates.

VIMS
Scup is “Priority” species for the NEAMAP and ChesMMAP surveys. Length, weight, sex, maturity, stomachs for diet analysis and otoliths are collected from 5 specimens from each length bin from each tow. Otoliths have been sectioned for the best results and accuracy with ageing. A total of 14,874 pairs of scup otoliths have been collected and processed for age determination from both surveys (NM 13,617, CM 1,257).

VII. Striped Bass

ME DMR
Historically, ME DMR collected scales from some striped bass caught by rod and reel. Since 2010, scales have been collected from fish that were caught as part of an acoustic tagging program. In this program, striped bass are caught with rod and reel, tagged, and scales were removed from most of the fish for ageing. Additionally, young of the year (YOY) are captured as part of a beach seining project in the summer and fall. Scales were removed from a few of these young of the year fish in the past.

MA DMF
MA DMF primarily collects and ages striped bass scales. Samples are collected from the commercial fishery at the fish houses, the recreational fishery via a scale collection program involving volunteer recreational anglers, and from tagging projects. MA DMF also collects racks from a fishing club and several charter boats that are processed for scales and otoliths. These structures are used to make a yearly comparison between hard parts. Scales are impressed in acetate using a heated press and aged by examining impressions on a microfiche projector. Otoliths are cross-sectioned, baked and read with transmitted light on a compound microscope.

RI DMF

Scales have been collected on from the commercial fishery since 2001 and on fishery-independent surveys and the recreational fishery since 2013. The annual target number of samples is 150 rod and reel and 150 from the commercial floating fish trap fishery. Sample collection primarily includes scales; however, otoliths are also collected on fishery-independent surveys when the whole fish is being sacrificed or when fish racks are donated from the recreational fishery. Scales are cleaned, pressed onto acetate with a heat press, and aged using a microfiche reader. Otoliths are dried, mounted in epoxy resin, and thin-sectioned using an IsoMet™ slow speed saw. Thin sections are then mounted onto microscope slides with Flo-Texx™ and aged with a microscope. All samples are currently aged annually by a single reader. A second read is conducted by the same reader on at least 10% of the samples to obtain precision estimates.

NY DEC

New York began collecting scales from striped bass in 1984. Samples are collected through our fishery-dependent commercial fish market sampling, and recreational fishery cooperative angler program. In addition, scales are collected from our fishery-independent western Long Island juvenile striped bass beach seine survey. A sample of scales is collected from each fish and pressed onto clear acetate sheets using a heated Carver Press. Scales are aged on a microfiche by a minimum of two readers and compared for agreement. A group reading or repress of the sample settles disagreements. Samples for which no agreement can be reached are discarded from the set. Any otoliths collected are archived and stored.

NJ DFW

Striped bass scale samples have been collected regularly during several fishery independent surveys since 1989 including but not limited to the Striped Bass Tagging Survey in Delaware Bay, the Ocean Trawl Survey along the NJ coast, the Delaware River Recruitment Survey, and during sampling at fishing tournaments and on party/charter boats. Approximately 135 paired scale/otolith samples have also been collected annually although no otoliths have been processed or aged. Scales are processed using a heated Carver Press and aged using a microfiche reader.

MD DNR

Since 1985, biologists at MD DNR have been conducting the spawning stock survey in historic spawning locations (http://dnr2.maryland.gov/fisheries/PublishingImages/striped-bass-spawning-map.jpg) on the Upper Chesapeake Bay and the Potomac River. In concurrence with monitoring the spawning stock, MD DNR is part of the Cooperative Coastal Striped Bass Tagging Program (https://www.fws.gov/northeast/marylandfisheries/projects/Striped%20Bass.html). This program tags spawning striped bass with United States Fish and Wildlife Service (USFWS) internal anchor tags to evaluate stock dynamics of the migratory Atlantic Coast striped bass. The goal of this survey is to characterize the age, size, and sex structure, and abundance at age of spawning striped bass in Maryland's portion of the Chesapeake Bay. The survey is conducted up to six days a week from late March to mid-May. Striped bass are sampled using experimental drift gill nets in the Upper Chesapeake Bay and Potomac River. The experimental drift gill nets are a series of different mesh size, nylon multifilament panels (3, 3.75, 4.5, 5.25, 6, 6.5, 7, 8, 9, and 10 inch stretch-mesh). Each panel is approximately 150 feet long and 10 feet deep, with about 10 feet in-between each net. Drift nets are deployed for short periods of time during and near slack tide, twice a day at one random site each, in the Upper Chesapeake Bay and Potomac River.

All striped bass captured in the nets were measured for total length (mm TL), sexed by expression of gonadal products, and released. Scales were taken from 2-3 randomly chosen male striped bass per 10 mm length group, per week, for a maximum of 10 scale samples per length group over the entire season. Scales were also taken from all males over 700 mm TL and from all females regardless of total length. Scales were removed from the left side of the fish, above the lateral line, and between the two dorsal fins. Additionally, if time and fish condition permitted, U. S. Fish and Wildlife Service internal anchor tags were applied.

The scales that are selected for processing are taped shiny side up on the acetate slide. Impressions were made by the Carver press at 170°F and 18,000 lbs. of pressure for 5.5 to 6 minutes depending on the size of the fish. The final impressions were viewed in a microfiche machine to obtain the final age. At least 2 biologists looked at each scale sample to arrive at an agreed age, if they did not agree a 3rd biologist views them, if no agreement then a 4th reader views. If still no agreement, the scales were replaced with different sample, reprocessed with different scales or thrown out.

VIMS

Striped bass are collected as part of NEAMAP and ChesMMAP sampling programs. Additionally, striped bass is a "Priority" species for NEAMAP, meaning that length, weight, sex, maturity state, stomach, and otoliths are collected for 5 individuals from each length bin on each tow. VIMS uses sectioned otoliths for age determination. The ChesMMAP survey encounters everything from Young-Of-Year specimens to fully matured adults. The NEAMAP survey often encounters large mature adults feeding on schools of prey. Ages have ranged from age-0 (YOY) to a max age of 24. A total of 5,755 Striped Bass have been aged by the two surveys (CM 5,300; NM 455).

There are three readers at VIMS and the mode age for each sample is provided as the final age. If there is no mode from the initial read, the readers reread the sample and if there is still no mode, they examine the sample together and come to a consensus age. If a consensus age cannot be determined the sample is discarded. Very few samples are discarded. Precision tests are preformed within each reader (multiple reads of the same sample) and between readers. VIMS uses similar precision and symmetry tests to the NEFSC.

ODU

VMRC has been collecting striped bass biological data since 1988. The field sampling program is designed to sample striped bass harvests within specific water areas. Since 2003, Virginia has managed its Coastal Area and Chesapeake Area harvests by two different ITQ systems, with data collections procedures intending to ensure adequate representation of both harvest areas. Samples of biological data are collected from seafood buyers' places of business or dockside from offloaded striped bass caught by pound nets or haul seines. Some gill net or commercial hook-and-line fishermen's harvests may be sampled directly.

Generally, only 40- 50% of striped bass sampled for scales are also sampled for otoliths. Supplementary data is collected for each biological sample, such as date of collection, harvest location, market grade, harvest area, and gear type. Scale and otolith samples are processed and read by Old Dominion University's Center for Quantitative Fisheries Ecology (ODU CQFE). ODU CQFE chooses a random subsample of hard-parts (scales and otoliths) collected in each length bin to age.

All fish are aged in chronological order based on collection date, without knowledge of the specimen lengths. The two readers must age each otolith independently. When the readers' ages agree, that age is to be assigned to the fish. When the two readers disagree, both readers must re-age the fish together, again without any knowledge of previously estimated ages or specimen lengths and assign a final age to the fish. When the readers are unable to agree on a final age, the fish is excluded from further analysis.

Striped bass are assigned a January 1st birth date by convention. The sample date is used to assign the final age. If the sample was taken before the period of annuli formation (April to June), the age is the annulus count plus one. If the sample was taken after that, the age is the annulus count.

The following are links to the preparation and ageing protocols for striped bass.

- Otolith Preparation Protocol

http://www.odu.edu/content/dam/odu/offices/center-for-quantitative-fisheries/docs/striped-otolith-preparation-protocol.pdf

- Otolith Ageing Protocol

http://www.odu.edu/content/dam/odu/offices/center-for-quantitative-fisheries/docs/striped-bass-otolith-ageing-protocol.pdf

- Scale Preparation Protocol

http://www.odu.edu/content/dam/odu/offices/center-for-quantitative-fisheries/docs/STRIPED%20BASS%20SCALE%20PREPARATION%20LATEX%20MAIN%20DOCUMENT.pdf

SC DNR

Striped bass have been aged in South Carolina since the 1950's by the Wildlife and Freshwater Fisheries Division of SC DNR, which still ages them today. Historically, striped bass were aged with scales although some are now aged with otoliths. Gill nets and electrofishing are the methods used to collect the specimens. SC DNR Marine Research Division released mariculture-raised striped bass from 2006 through 2014. During 2014 some of these fish were recaptured and processed by SC DNR Inshore electrofishing survey and otoliths were kept for ageing.

VIII. Tautog

MA DMF

Tautog otoliths and operculum are collected from several sources; cooperation from commercial fisherman, within division fish potting, and cooperation with several recreational anglers. Opercula have been collected since 1995 and otoliths have been collected since 2012. Otolith and pelvic spine samples have been collected from our ventless lobster trap survey since 2015 as well as from a tautog rod and reel survey since 2016. Opercula are boiled and brushed clean before being dried and aged without magnification. Otoliths are baked, sectioned and aged with transmitted light under a compound microscope.

Tautog pelvic fin spines have been collected from primarily recreational sources since 2014. Spines are boiled for 1-2 minutes, brushed clean with a small brush then allowed to air dry for at least 48 hours. The spines are embedded in epoxy and 0.75 mm sections are cut. Three successive sections are removed starting just above the condyle.

RI DMF

Opercula have been collected by RI DMF since 1987, primarily from donated recreational carcasses. The annual target number of samples is 200 per the requirements of Addendum III to the Fishery Management Plan for Tautog. Sample collection primarily includes operculum; however, a subsample of otoliths has also been collected since 2012 following the recommendations of the 2012 Tautog Ageing Workshop. Operculum are removed from fish racks and subsequently boiled to remove all flesh and tissue. Opercula are aged by a single reader annually by holding the structure up to fluorescent lighting. A second read is conducted by the same reader on at least 10% of the samples for each structure to obtain precision estimates.

Additionally, in 2017, RI DMF began collecting tautog pelvic spines for ageing. Spines collected in 2017 will be processed and aged in 2018 following the protocol of MA DMF.

NY DEC

Fishery dependent tautog samples are primarily collected from commercial markets and headboat fish racks. While the current goal is to satisfy the requirements of the FMP, availability of samples has fluctuated over time. The total length of each fish is measured, and the opercula bone is removed and frozen until further processing. Otoliths from a subset of these fish are also collected. Previously frozen samples are thawed and boiled for 2 minutes and the flesh is gently scraped off the opercula. The bones are allowed to air dry overnight and are then read without magnification using overhead lighting. Aged samples are available from 1993 to the present.

NJ DFW

Sampling for tautog was initiated in 2007, collecting samples primarily from Commercial and Party/ Charter vessels. Fishery Independent samples are also occasionally collected aboard the NJDFW Ocean Trawl Survey when caught. Racks are collected from fishery dependent vessels, where lengths and sex are recorded, and opercula are removed. The opercula are processed and aged at the Nacote Creek Research lab, where they are viewed under a magnisight machine. Since initiation, 7,013 samples have been collected, with 387 samples collected in 2015.

MD DNR

Maryland has collected tautog opercula for ageing since 1996. The current FMP requires that each state collect 200 opercula and 50 otolith samples per year. Tautog have been collected by hook and line, commercial fish pots and on rare occasion spearfishing. Juvenile tautog have also been collected by seining eel grass beds in 2015 which provided samples of the smallest length groups in the population. The most productive method is hook and line with a partnering professional charter boat.

The goal is to randomly sample and fill each 10mm length group with five samples. Each fish is measured (mm total length) and weighed (kg) using the digital scale. The gonads are observed to determine the sex of the fish. These data are recorded on each scale envelope. Both opercula are removed and placed in the envelope(s). The fish heads are tagged with a tuna or yellow perch tag and that tag number is recorded on the opercula envelope(s). All heads are frozen until the otolith bins are calculated to ensure all 10 mm length groups have ample representation; all large fish (>600mm) have otoliths removed. Starting in 2013, DNA was collected for scientists at VIMS.

Each operculum is boiled in water, cleaned, and placed in a new envelope for reading. All readers must re-read the reference collection that contains 20 opercula samples for each year since 1996, (except for 1997 and 1998 which has less than 20) prior to reading the current year samples. The reader uses no magnification. The first year annular line is typically 7-8 mm from the articular apex and the second year around 12-15 mm. The spacing between year's decreases as the fish gets older. The outer edge (new growth) is counted to promote (X+1) if the operculum was collected between 1 Jan to 30 June, otherwise it is not counted. A representative sample of 20 aged opercula is added to the reference collection for the following year.

VIMS

Tautog are collected for both NEAMAP and ChesMMAP surveys and additionally is considered a "Priority" species for NEAMAP, meaning that length, weight, sex, maturity state, stomach, and otoliths are collected for 5 individuals from each length bin on each tow. VIMS uses sectioned otoliths and opercula for age determination. Both opercula and otoliths have been collected since 2010 as per comparison purposes due to the low number of encounters by each survey over their time series. Prior to 2010 only opercula were collected. A total of 280 Tautog have been aged by the two surveys (CM 50, NM 230). To date VIMS tautog data has not been requested due to the low number of samples across the surveys time series.

There are three readers at VIMS and the mode age for each sample is provided as the final age. If there is no mode from the initial read, the readers reread the sample and if there is still no mode, they examine the sample together and come to a consensus age. If a consensus age cannot be determined the sample is discarded. Very few samples are discarded. Precision tests are preformed within each reader (multiple reads of the same sample) and between readers. VIMS uses similar precision and symmetry tests to the NEFSC.

ODU

Tautog have been collected as part of VMRC's Biological Sampling Program since 1998. Both otoliths and operculum are collected. Operculum are removed and frozen until prepared for age reading. Thawed samples are boiled 5-6 minutes to loosen attached tissue. When sample is removed from the water, skin and tissue are removed. Clean opercula are read using transmitted light, usually from a window or overhead light. Otoliths samples are cleaned and baked in a Thermolyne ™ 1400 furnace. After baking, otoliths are embedded in epoxy resin and sectioned.

All tautog samples are aged by two different readers. When readers disagree, they re-age the fish together without knowledge of lengths or previously estimated ages. Fish that do not result in agreement are excluded from analysis.

Tautog are assigned a January 1st birthdate by convention. The sample date is used to assign the final age. If the sample is taken before the period of annuli formation (May to July), the age is the annulus count plus one. If the sample is taken after that, the age is the annulus count.

The following are links to the preparation and ageing protocols for tautog.

- Otolith Preparation Protocol

https://www.odu.edu/content/dam/odu/offices/center-for-quantitative-fisheries/docs/tautog-otolith-preparation-protocol.pdf

- Otolith Ageing Protocol

https://www.odu.edu/content/dam/odu/offices/center-for-quantitative-fisheries/docs/tautog-otolith-ageing-protocol.pdf

- Operculum Preparation Protocol

https://www.odu.edu/content/dam/odu/offices/center-for-quantitative-fisheries/docs/tautog-operculum-prep.pdf

Workshop Proceedings & Methods

Participants in the workshop met on Tuesday, March 27th, in a conference room at the FL FWRI building in St. Petersburg to go over the goals of the workshop, agenda, and to make introductions. Jessica Carroll and the staff at Florida's Fish and Wildlife Conservation (FL FWC) Commission including Kristin Cook, Kyle Williams, David Westmark, and Brittany Barbara set up stations ahead of the workshop for the hard part reading exercise. Participants broke into five groups, each led by one of the FL FWC employees, and began ageing the structures at each station. Not all states or labs routinely age all the species at the workshop, so the groups were developed to mitigate the effects of readers unfamiliar with a species.

For each of the eight species, every member of the group aged the samples (n=19-20 per species) and the group came to a consensus for annulus count, margin code, and final age. Each structure was assigned a margin code from 1-4. A code 1 represented a structure with an annulus just forming or having just finished forming at the edge of the structure. Code 2 was assigned when the growth outside the last visible annulus was less than 1/3 the growth between the two previous annuli. Code 3 represented 1/3 to 2/3 growth and code 4 was for more than 2/3 growth. A catch date was provided for each sample to make final age determinations, but no other information was provided during reading. In addition to group ages, the participants also recorded their individual age readings and experience level for additional analysis.

Ageing precision between groups for consensus ages were evaluated using average percent error (APE). Participants also reviewed individual age comparisons for agers who routinely age each of the species. Exact agreement was tested using Bowker's test of symmetry around the diagonal 1:1 line (Evans and Hoenig 1998) where a significant p-value (<0.05) indicates systematic bias between the age readings. Without knowing the true age of the fish, this test does not identify which reader is more accurate, but rather identifies whether there are differences or not. Mean coefficient of variation (CV), percent of exact agreement between readers, and percent agreement within 1 year was also calculated for each lab and reader to provide a measure of precision. While this does not serve as a proxy for accuracy, it does indicate the level of ease for assigning an age to that ageing structure, the reproducibility of the age, or the skill level of the readers. Generally, CVs of 5% serve as a reference point for determining precision, where greater values indicate ageing imprecision (Campana 2001).

Workshop Results

On March 28th, the attendees of the workshop met to go over the APE for each species, results from individual age readers, to revisit samples with high disagreement, and to make recommendations for following workshops or coastwide ageing. The APE varied by species throughout the three years of the workshop (Table 1). Discussion and results for each species follows and sample images can be found in Appendix B.

I. Alewife and Blueback River Herring

The APE for alewife and blueback river herring increased from 13.23% in 2016 for both species to 29.20% and 23.09%, respectively, in 2018. Only three of the workshop participants had any familiarity ageing this species and high disagreement was attributed to lack of experience.

The group revisited some of the samples beginning with alewife sample #3 (Table 2). This was an April-caught fish from Connecticut. Participants agreed that they saw two distinct annuli but the question of whether to bump it or not was debated. It was noted that growth slows down after the first two years and one would not expect to see wide growth rings at this point. Scott Elzey from MA DMF stated that he saw two annuli and bumped it to an age-3. The group also reviewed alewife sample #8 since it had very different ages between David Molnar from CT DEEP and Mark Pasterczyk from ME DMF. Both Molnar and Pasterczyk routinely age scales for these species, as opposed to Elzey who ages with otoliths. Pasterczyk walked the group through the sample and noted spawning checks at ages 4, 5, 6, 7, and then to the edge makes it an age-8 fish. Molnar said he aged it as a 5-year-old but now sees it as an age-6. Elzey stated that his group counted Pasterczyk's third annulus as a two and then went from there to arrive at age-7. There was a conversation about "first winter" and the freshwater mark. Finally, it was noted by Elzey that these samples vary wildly by river system and agers are experts in their region.

When comparing individual readers for river herring, only Molnar, Pasterczyk, and Elzey reported that they routinely age this species and provide ages to ASMFC for the stock assessment. There were no significant p-values from Bowker's test of symmetry, indicating no systematic bias between the readers, and all CVs were greater than 5%, indicating imprecision (Table 4). Exact agreement varied from 30-70% and increased to70-100% for agreement within one year (Table 5Table 5).

Because only three participating states age river herring, the species varies greatly by river system, and agers use different methods (scales or otoliths) to obtain ages, it was agreed that no meaningful information is obtained from this exercise at the workshop and that river herring should be removed from the workshop sample set. All states ageing river herring do have in-house training sets to maintain their independent QA/QC and the workshop agreed this was the best way to ensure ages remain consistent.

II. Atlantic Menhaden

The APE for Atlantic menhaden was 15.42% in 2017 and decreased to 13.45% in 2018. The slight improvement in agreement was attributed to having a better microfiche this year compared to last year. The group reviewed sample #11 (Table 6) because all groups aged this as an age-5 except one who had it as an age-3. Katherine Messer from MD DNR stated that she was in the group that aged it as a 3-year-old because in MD they look for distinct, clear annuli on the scales. Also, Messer stated that MD does not bump ages for Atlantic menhaden since they catch only summer fish.

For individual reader comparisons, readers from CT DEEP, NY DEC, DE DFW, MD DNR, and one of the two readers present from VIMS (Jameson Gregg) reported that they routinely age Atlantic menhaden. When comparing the experienced Atlantic menhaden readers, there were no significant p-values from Bowker's test of symmetry indicating no systematic bias between the readers and all had CVs greater than 5%, indicating imprecision (Table 7). Exact agreement varied from 26-74% and increased to 74-95% for agreement within one year (Table 8Table 8).

Workshop participants then addressed the topic of how to proceed with Atlantic menhaden ageing, as outlined previously in this report (Previous Ageing Workshop Section II). Most of the participants of the annual QA/QC Fish Ageing Workshop participated in the Atlantic menhaden ageing workshop in 2015 (ASMFC 2015a) where Ethel Hall from Beaufort trained state agers in her methods. Hall was responsible for ageing all commercial Atlantic menhaden samples since the 1970s until her retirement in 2015 and the workshop was a way to address the lack of agers for the species along the Coast. Participants of QA/QC said that since that workshop, they have seen regional nuances in their samples that do not adhere to Hall's methods. For example, Jesse Hornstein from NY DEC stated that they see Atlantic menhaden that are just laying down an annulus in late July/early August which made them become more aware of region-specific timelines for the species. Messer from MD agreed that their samples also do not always fit into the accepted coastwide protocols. Nicole Lengyel from RI DEM and Molnar discussed how their ages had very low agreement with Hall when they exchanged training sets. Ultimately, workshop participants requested that now that state agers have some experience and are noticing deviances in their state from the accepted protocol that the ASMFC host another Atlantic menhaden ageing workshop. An exchange set should be developed with paired scales and otoliths from samples along the Atlantic coast with Beaufort's participation. A workshop should then be held to go through the samples and discuss regional and hard part differences and following the workshop the exchange set should be circulated.

III. Black Sea Bass

The APE for black sea bass increased from 3.67% in 2016 to 12.71% in 2018. Sample #18 (Table 9) was inflating the APE and the group that aged this sample as a 1 instead of an age-0 could not defend their age. If that age was removed, the APE would drop to 4.7% which would make it similar to the 2016 results. Gregg noted that the two samples from FL (#17 and #20) look great but unlike any samples one would see north of SC. Regional differences could also be seen in individual agers.

Agers from MA DMF, both agers at VIMS, and both agers at FL FWC (Kristin Cook and Jessica Carroll) reported routinely ageing black sea bass. There were two significant p-values from Bowker's test of symmetry indicating some systematic bias (Table 10), although most CVs were less than 5% indicating some imprecision within the VIMS lab and between Eckert and Cook. Exact agreement varied from 60-100% (Table 11) and increased to 95-100% within one year. These differences were attributed to the regional differences in northern and southern samples and the workshop participants did not think this was a cause for concern.

IV. Bluefish

The APE for bluefish at the workshop decreased in 2018 to 17.69% from 25.60% the previous year. Similar to 2016 and 2017, problems distinguishing between age-0 and age-1 bluefish dominated the discussion. Eric Robillard from NEFSC reminded the group that one should always look for the crenellation on the side on a sample. If it is present, that sample cannot be an age-0. The group reviewed samples #5, 11, 14, and 15 (Table 12) to remind the group of what to look for to distinguish between ages 0 and 1.

For individual reader comparisons, readers from MA DMF, NEFSC, RI DMF, CT DEEP, VIMS (both Gregg and Jeffrey Eckert), and ODU reported that they routinely age bluefish. When comparing the experienced bluefish readers, there were no significant p-values from Bowker's test of symmetry this year, indicating no systematic bias between the readers (Table 13). CVs ranged from 0-23% and 19 out of the 21 comparisons had CVs greater than 5%, indicating imprecision. Exact agreement varied from 60-100% and increased to 100% for all readers for agreement within one year (Table 14). Workshop participants noted that the age-0 versus age-1 issue occurred in the full group as well as for experienced readers, but that not all experienced readers see those young ages in their samples and so their readings may be influencing the results.

V. Red Drum

Red drum had the second highest APE of the 2018 workshop at 26.77% which was attributed to the 'smudge' issue (see discussion in this report in Previous Ageing Workshop section V). It was acknowledged that as per ASMFC rules from the ageing workshop (ASMFC 2008), the 'smudge' should not be counted. Gregg said that VIMS's ageing protocol is to count the smudge, although they adjust their ages for ASMFC. For this exercise, Eckert counted the smudge as he would following his own lab's protocols, thus the inflated APE. If a year was subtracted from all his ages, the APE would drop to 1%. Gregg, Jessica Gilmore from ODU, and Carroll from FL say that they see a smudge in samples collected from their region, but Messer in MD reported they do not. It was suggested that southern states that interact with red drum should discuss the smudge issue on a conference call. Robillard reminded the group that this is whether or not to count a 6 month or an 18 month old fish as a 1-year-old and it was previously decided that it was better to count the 18 month old as an age-1.

For individual reader comparisons, readers from NEFSC, VIMS, ODU, SC, GA, and FL reported that they routinely age red drum. When comparing the experienced red drum readers, there were no significant p-values from Bowker's test of symmetry, indicating no systematic bias between the readers (Table 16). CVs ranged from 0-33% and 13 out of the 28 comparisons had CVs greater than 5%, indicating some imprecision. Exact agreement varied from 50-100% and increased to 95-100% for agreement within one year (Table 17).

VI. Scup

The APE for scup was 11.60% which was the second lowest of all the species at the workshop. The group reviewed samples #1 and #18 which were paired (Table 18). On #1, the otolith sample, all groups agreed it was an age-2 but there was disagreement on the scale sample where some groups aged it as an age-1 because they lost the annulus on the edge. Participants also reviewed sample #2 and discussed the confusion between the core and the first annulus. Robillard said that when he was trained on scup, he was told to look for clear separation between the core and first annulus and he did not see that here. He also conceded that this sample was not well cut and perhaps a better cut would offer clear separation. Sample #6, for example, has clear separation and there are three annuli and then it gets bumped to an age-4. Sample #3 had some disagreement between age-2 and age-3 and was reviewed. Lengyel argued that there is a third annulus on the edge and people agreed once the microscope was zoomed in. She also noted that scup can have a late annulus deposition and that sometimes in RI they are not seeing it in May or June but as late as October.

The NEFSC, CT DEEP, and VIMS all routinely age scup although CT DEEP uses scales and the other two use otoliths. There were no significant p-values from Bowker's test of symmetry indicating no systematic bias, although all CVs were above 5% indicating imprecision (Table 19). Exact agreement between readers ranged from 45-70% and increased to 90-100% for agreement within 1 year (Table 20).

VII. Striped Bass

The lowest APE of the workshop was for striped bass at 7.54%, although that was a slight increase from 4.96% in 2016. Participants reviewed sample #7, which was paired with sample #13 (Table 21). The scale sample had more disagreement and lower ages than the otolith and it was agreed by participants that more paired samples should be included for this species. Participants also reviewed sample #6 because it was difficult to decide between age-1 and age-2. Sample #6 is from Maine and it is noted that in the Northeast they are more inclined to count a small first annulus than in Virginia, for example. The group also discussed the known-age reference set that exists and its potential as a training tool.

MA DMF, RI DEM, NY DEC, both readers from NJ DEP (Heather Corbett and Jamie Darrow), DE DFW, both readers at VIMS, and ODU all report that they routinely age striped bass. There were no significant p-values from the Bowker's test of symmetry, indicating no systematic bias, and while there were many CVs above 5%, they were all 10% or under so imprecision is fairly low (Table 22). Exact agreement between reader ages was 45-100% and it increased to 75-100% for ages within one year (Table 23).

VIII. Tautog

The APE for tautog went up from 6.09% in 2016 to 10.89% in 2017 to 11.28% in 2018. It was suggested that sample #1 and #7 be removed from future workshops since they are both damaged. Gilmore from ODU suggested that some otoliths and spines get added to the collection as well and people agreed. The group reviewed sample #6 since it had high disagreement (Table 24). The group discussed a band about halfway up the sample which resulted in some age-1s and other age-2s. Elzey stated that there are issues seeing these first bands on opercula that are not an issue for spines or otoliths. In addition, he says that whole otoliths can be read up to age-8 or -9.

For individual reader comparisons, readers from MA DMF, RI DEM, CT DEEP, DE DFW, and ODU reported that they routinely age tautog. When comparing the experienced tautog readers, there were no significant p-values from Bowker's test of symmetry, indicating no systematic bias between the readers (Table 25). CVs ranged from 1-13% and 7 out of the 10 comparisons had CVs greater than 5%, indicating imprecision. Exact agreement varied from 30-80% and increased to 75-100% for agreement within one year (Table 26).

Workshop Recommendations

Overall, the participants of the workshop were satisfied with the ageing agreement among species, noting the persisting disagreement among agers regarding the protocol for red drum ageing, the high APE for bluefish due to difficulties assigning age for young fish, and the regional differences seen in Atlantic menhaden's ageing. The group made the following recommendations:

- River herring, both alewife and blueback, should be removed from this workshop.

- Striped bass, Atlantic menhaden, tautog, winter flounder, summer flounder, and American eel should be aged at the 2019 QA/QC Fish Ageing Workshop.
    - American eel underwent an ageing workshop in 2018 and both whole otoliths (mounted and polished, not loose) and sectioned otolith samples should be added to the workshop set.
    - More paired scale and otolith samples should be added to striped bass, increasing the overall sample size of the species at the workshop.
    - Samples #1 and #7 of tautog should be removed and replaced by samples from similar regions and ages. Additionally, paired spine, otolith, and opercula samples should be added, increasing the overall sample size of the species at the workshop.

- For the 2019 QA/QC Fish Ageing Workshop, individual ages and group ages should still be collected.

- Atlantic menhaden should have an ageing workshop. The exchange set should be developed of paired otolith and scale samples and include participation from Beaufort. Following an in-person workshop, an exchange should take place.

- Red drum agers should participate in a conference call to revisit counting the 'smudge' or not.

References

Atlantic States Marine Fisheries Commission (ASMFC). 2003. Proceedings of the Striped Bass Ageing Workshop. ASMFC, Arlington, VA. 8p.

Atlantic States Marine Fisheries Commission (ASMFC). 2008. Proceedings of the Atlantic Croaker and Red Drum Ageing Workshop. ASMFC, Arlington, VA. 9p.

Atlantic States Marine Fisheries Commission (ASMFC). 2011. Proceedings of the Atlantic States Marine Fisheries Commission Bluefish Ageing Workshop. ASMFC, Arlington, VA. 26p.

Atlantic States Marine Fisheries Commission (ASMFC). 2012. Proceedings of the Tautog Ageing Workshop. ASMFC, Arlington, VA. 88p.

Atlantic States Marine Fisheries Commission (ASMFC). 2013a. 2013 Atlantic Striped Bass benchmark stock assessment. ASMFC, 57th SAW Assessment Report, Arlington, Virginia.

Atlantic States Marine Fisheries Commission (ASMFC). 2013b. Proceedings of the 2013 Black Sea Bass Ageing Workshop. ASMFC, Arlington, VA. 18p.

Atlantic States Marine Fisheries Commission (ASMFC). 2014. River Herring Ageing Workshop Report. ASMFC, Arlington, VA. 114p.

Atlantic States Marine Fisheries Commission (ASMFC). 2015a. 2015 Atlantic Menhaden Ageing Workshop Report. ASMFC, Arlington, VA.

Atlantic States Marine Fisheries Commission (ASMFC). 2015b. Tautog 2015 Benchmark Stock Assessment. ASMFC, Arlington, VA.

Atlantic States Marine Fisheries Commission (ASMFC). 2016. Report of the Quality Assurance/Quality Control Fish Ageing Workshop. ASMFC, Arlington, VA.

Atlantic States Marine Fisheries Commission (ASMFC). 2017. Report of the Quality Assurance/Quality Control Fish Ageing Workshop. ASMFC, Arlington, VA.

Atlantic States Marine Fisheries Commission (ASMFC). 2017. Red Drum Stock Assessment and Peer Review Report. ASMFC, Arlington, VA.

Campana, S. E. 2001. Accuracy, precision and quality control in age determination, including a review of the use and abuse of age validation methods. *Journal of fish biology*, 59(2): 197-242.

Cowan Jr, J. H., R. L. Shipp, H. K. Bailey IV, and D. W. Haywick. 1995. Notes: Procedure for Rapid Processing of Large Otoliths. *Transactions of the American Fisheries Society*, 124(2): 280-282.

Evans, G. T., and J. M. Hoenig. 1998. Testing and viewing symmetry in contingency tables, with application to readers of fish ages. Biometrics: 620-629.

North Carolina Department of Marine Fisheries (NCDMF). 2000. Comparison of age assignment and reader agreement for bluefish (Pomatomus saltatrix) based on scales, whole otoliths, and sectioned otoliths. NC Dept. of Environment and Natural Resources, Division of Marine Fisheries Annual Progress Report 1999.

Northeast Fisheries Science Center (NEFSC). 1979. Report of the State Federal Scup Age and Growth Workshop. National Marine Fisheries Service, Woods Hole, MA. 11 p.

Northeast Fisheries Science Center (NEFSC). 2004. 39th Northeast Regional Stock Assessment Workshop (39th SAW) assessment summary report. US Dept Commer, Northeast Fish Sci Cent Ref Doc. 04-10a; 16 p.

Northeast Fisheries Science Center (NEFSC). 2011. Northeast Regional Stock Assessment Workshop (52nd SAW) Assessment Report. US Dept Commer, Northeast Fish Sci Cent Ref Doc. Technical Report 11–17; 962 pp.

Northeast Fisheries Science Center (NEFSC). 2013. 57th Northeast Regional Stock Assessment Workshop (57th SAW) Assessment Report. US Dept Commer, Northeast Fish Sci Cent Ref Doc. 13-16, 967 p.

Northeast Fisheries Science Center (NEFSC). 2015. 60th Northeast Regional Stock Assessment Workshop (60th SAW) Assessment Summary Report. US Dept Commer, Northeast Fish Sci Cent Ref Doc. 15-07.

Richards, S.W. 1976. Age, growth, and food of bluefish (Pomatomus saltatrix) from East-Central Long Island Sound from July through November 1975. *Transactions of the American Fisheries Society*, 105: 523-525.

Robillard, E., Reiss, C.S., Jones, C.M. 2009. Age-validation and growth of bluefish (Pomatomus saltatrix) along the East Coast of the United States. *Fisheries Research,* 95: 65-75.

SEDAR (Southeast Data Assessment and Review). 2015. SEDAR 40 – Atlantic menhaden stock assessment report. SEDAR, North Charleston, South Carolina.

Tables

Table 1. The ageing structure with sample size in parentheses and average percent error (APE) between the four ageing groups for each species aged at the annual QA/QC Fish Ageing Workshops.

Species	Ageing structure (sample size)	2016	2017	2018
Alewife herring	scales (5), otoliths (5)	13.23%	------	29.20%
Blueback herring	scales (5), otoliths (5)	13.23%	------	23.09%
Black sea bass	scales (4), otoliths (16)	3.67%	------	12.71%
Striped bass	scales (10), otolith (10)	4.96%	------	7.54%
Tautog	opercula (20)	6.09%	10.89%	11.28%
Atlantic croaker	otoliths (20)	7.76%	10.57%	-------
Bluefish	otoliths (20)	23.06%	25.60%	17.69%
Summer flounder	scales (6), otoliths (14)	-------	3.63%	-------
Winter flounder	scales (5), otoliths (15)	-------	10.13%	-------
Atlantic menhaden	scales (19)	-------	15.42%	13.45%
Red drum	otoliths (20)	-------	-------	26.77%
Scup	otoliths (14), scales (6)	-------	-------	11.60%

Table 2. **Ageing worksheet for alewife river herring at the workshop with the sample number, lab providing the sample and their assigned age, catch date of the sample, workshop group annulus counts, margin codes (scored from 1 to 4), and final age as well as average percent error (APE) values between groups. Samples #1-5 are otoliths and samples #6-10 are scales.**

Sample #	Lab	Age	Catch date	Group 1			Group 2			Group 3			Group 4			Group 5			Average Age	APE
				Annulus count	Margin code	Final age	Annulus count	Margin code	Final age	Annulus count	Margin code	Final age	Annulus count	Margin code	Final age	Annulus count	Margin code	Final age		
1	MA	0	12/19/2014	0	4	0	0	4	0	0	3	0	1	4	1	0	4	0	0.2	160.0%
2	NJ	6	1/10/2009	5	4	6	4	4	5	3	4	4	3	3	4	5	4	6	5	16.0%
3	CT	3	4/29/2014	2	2	2	2	1	2	3	1	3	2	1	2	2	4	3	2.4	20.0%
4	NJ	1	1/25/2012	2	1	2	2	1	2	1	4	2	1	4	2	2	4	3	2.2	14.5%
5	MA	5	12/21/2014	5	1	5	5	4	5	7	4	7	5	3	5	5	3	5	5.4	11.9%
6	NC	5	5/1/2014	5	1	5	3	1	3	4	1	4	5	1	5	4	4	5	4.4	16.4%
7	CT	3	4/29/2014	2	4	3	2	4	3	3	4	4	3	1	4	3	4	3	3.4	14.1%
8	ME	8	5/25/2014	7	4	8	5	1	5	5	1	5	4	1	5	6	4	7	6	20.0%
9	MD	5	3/25/2015	4	4	5	3	4	4	4	4	5	4	3	5	4	4	5	4.8	6.7%
10	MD	6	3/18/2015	6	4	7	3	4	4	5	4	6	5	1	6	5	4	6	5.8	12.4%
																	Alewife otolith APE			44.48%
																	Alewife scale APE			13.91%
																	Total Alewife APE			29.20%

Table 3. Ageing worksheet for blueback river herring at the workshop with the sample number, lab providing the sample and their assigned age, catch date of the sample, workshop group annulus counts, margin codes (scored from 1 to 4), and final age as well as average percent error (APE) values between groups. Samples #1-5 are otoliths and samples #6-10 are scales.

Sample #	Lab	Age	Catch date	Group 1			Group 2			Group 3			Group 4			Group 5			Average Age	APE
				Annulus count	Margin code	Final age	Annulus count	Margin code	Final age	Annulus count	Margin code	Final age	Annulus count	Margin code	Final age	Annulus count	Margin code	Final age		
1	MA	2	12/19/2014	2	3	2	2	3	2	2	3	2	2	3	2	2	3	2	2	0.0%
2	MA	0	12/19/2014	0	4	0	0	4	0	1	3	1	1	3	1	0	4	0	0.4	120.0%
3	MA	7	1/12/2015	6	3	7	6	4	7	7	4	8	6	1	7	6	4	7	7.2	4.4%
4	NJ	3	1/10/2009	1	4	2	1	4	2	1	4	2	1	4	2	1	4	2	2	0.0%
5	NJ	4	1/24/2012	1	4	2	1	4	2	1	4	2	2	4	3	1	4	2	2.2	14.5%
6	MD	6	4/29/2015	5	4	6	3	4	4	4	4	5	4	4	5	5	4	6	5.2	12.3%
7	MD	3	4/22/2015	2	4	3	1	4	2	3	3	4	3	4	4	2	4	3	3.2	20.0%
8	NC	5	12/24/2014	5	3	5	4	3	4	5	3	5	5	3	5	5	4	5	4.8	6.7%
9	ME	4	5/11/2010	2	4	3	1	4	2	2	4	3	4	1	4	3	3	4	3.2	20.0%
10	ME	5	6/8/2015	4	4	5	1	4	2	3	4	4	2	2	2	3	4	4	3.4	32.9%
																			Blueback otolith APE	27.80%
																			Blueback scale APE	18.38%
																			Total Blueback APE	23.09%

Table 4. Symmetry test p-values for inter-lab age comparisons using Bowker's test and CVs (%) for river herring age samples. P-values appear under the shaded diagonal line and CVs are above.

	ME	MA	CT
ME	0	6	19
MA	0.08	0	21
CT	0.43	0.59	0

Table 5. Percent exact agreement (below the shaded diagonal line) and agreement within one year (above the shaded diagonal line) between readers for river herring otoliths.

	ME	MA	CT
ME	100	100	75
MA	70	100	70
CT	40	30	100

Table 6. **Ageing worksheet for Atlantic menhaden at the workshop with the sample number, lab providing the sample and their assigned age, catch date of the sample, workshop group annulus counts, margin codes (scored from 1 to 4), and final age as well as average percent error (APE) values between groups. All samples are scales.**

Sample #	Lab	Age	Catch date	Group 1			Group 2			Group 3			Group 4			Group 5			Average Age	APE
				Annulus count	Margin code	Final age	Annulus count	Margin code	Final age	Annulus count	Margin code	Final age	Annulus count	Margin code	Final age	Annulus count	Margin code	Final age		
1	RI	3	5/27/2014	2	1	2	4	1	4	3	2	3	3	1	4	4	1	4	3.4	21.2%
2	MD	4	6/1/2016	4	2	4	4	2	4	4	2	4	4	2	4	5	1	5	4.2	7.6%
3	MD	1	6/1/2016	1	2	1	1	2	1	1	2	1	1	2	1	1	2	1	1	0.0%
4	NC	5	3/20/2014	3	3	4	4	2	4	4	4	5	4	1	5	4	4	5	4.6	10.4%
5	MD	3	9/7/2016	2	3	2	3	3	3	3	4	3	3	4	3	3	3	3	2.8	11.4%
6	NC	4	1/6/2014	1	3	2	1	4	2	2	4	3	2	4	3	2	4	3	2.6	18.5%
7	MD	2	6/1/2016	1	4	2	1	4	2	2	4	2	2	2	2	2	2	2	2	0.0%
8	RI	3	10/7/2014	3	3	3	4	2	4	4	3	4	4	4	4	4	2	4	3.8	8.4%
9	NC	1	1/6/2014	1	4	2	1	4	2	1	4	2	2	1	2	1	4	2	2	0.0%
10	RI	2	5/14/2014	3	3	4	4	1	4	3	4	4	3	1	4	3	4	4	4	0.0%
11	MD	5	7/5/2016	5	2	5	3	2	3	5	2	5	5	1	5	5	2	5	4.6	13.9%
12	MD	1	9/7/2016	2	4	2	1	3	1	3	2	3	2	4	2	3	2	3	2.2	29.1%
13	RI	2	10/7/2014	2	3	2	2	2	2	3	3	3	3	4	3	4	3	4	2.8	22.9%
14	MD	3	7/6/2016	3	2	3	3	2	3	3	2	3	3	2	3	4	2	4	3.2	10.0%
15	NC	5	3/20/2014	3	4	4	3	4	4	3	4	4	3	3	4	4	4	5	4.2	7.6%
16	MD	5	8/23/2016	4	2	4	5	1	5	4	2	4	4	2	4	4	2	4	4.2	7.6%
17	MD	1	9/8/2016	1	3	1	1	3	1	2	4	2	1	4	1	1	3	1	1.2	26.7%
18	NC	2	10/26/2016	1	2	1	0	3	0	2	3	2	2	2	2	2	2	2	1.4	51.4%
19	RI	4	7/8/2014	5	3	5	6	1	6	5	2	5	5	1	5	6	1	6	5.4	8.9%
																			Average APE	13.45%

Table 7. Symmetry test p-values for inter-lab age comparisons using Bowker's test and CVs (%) for Atlantic menhaden scales. P-values appear under the shaded diagonal line and CVs are above.

	CT	NY	DE	MD	VIMS-JG
CT	0	14	16	9	20
NY	0.06	0	10	19	14
DE	0.17	0.32	0	24	7
MD	0.42	0.25	0.39	0	28
VIMS-JG	0.46	0.08	0.20	0.89	0

Table 8. Percent exact agreement (below the shaded diagonal line) and agreement within one year (above the shaded diagonal line) between readers for Atlantic menhaden scales.

	CT	NY	DE	MD	VIMS-JG
CT	100	89	89	89	84
NY	68	100	95	84	89
DE	63	63	100	84	95
MD	74	58	42	100	74
VIMS-JG	53	47	68	26	100

Table 9. **Ageing worksheet for black sea bass at the workshop with the sample number, lab providing the sample and their assigned age, catch date of the sample, workshop group annulus counts, margin codes (scored from 1 to 4), and final age as well as average percent error (APE) values between groups. Samples #1-4 are scales and samples #5-20 are otoliths.**

Sample #	Lab	Age	Catch date	Group 1			Group 2			Group 3			Group 4			Group 5			Average Age	APE
				Annulus count	Margin code	Final age	Annulus count	Margin code	Final age	Annulus count	Margin code	Final age	Annulus count	Margin code	Final age	Annulus count	Margin code	Final age		
1	VIMS	4	5/8/2009	4	4	5	4	4	5	5	2	5	4	4	5	4	4	5	5	0.0%
2	VIMS	1	10/21/2015	1	4	1	1	4	1	0	4	1	1	3	1	1	3	1	1	0.0%
3	VIMS	3	10/4/2007	2	4	2	3	2	3	3	3	3	2	3	2	3	2	3	2.6	18.5%
4	VIMS	7	5/15/2008	7	1	7	7	1	7	6	4	7	6	1	6	6	4	7	6.8	4.7%
5	VIMS	11	9/23/2010	11	3	11	11	1	11	11	2	11	11	2	11	11	3	11	11	0.0%
6	VIMS	16	5/11/2008	6	4	7	6	4	7	6	4	7	6	4	7	6	4	7	7	0.0%
7	MA	7	Spring	5	4	6	5	1	5	7	4	8	2	4	3	6	4	7	5.8	24.8%
8	MA	8	Spring	7	1	7	7	1	7	6	4	7	5	4	6	7	1	7	6.8	4.7%
9	MA	3	Spring	3	1	3	3	1	3	2	4	3	2	4	3	2	4	3	3	0.0%
10	RI	3	5/29/2015	2	4	3	2	3	3	2	4	3	2	4	3	2	4	3	3	0.0%
11	RI	6	5/22/2014	4	4	5	6	1	6	5	4	6	4	4	5	5	4	6	5.6	8.6%
12	MA	2	8/14/2015	2	1	2	1	3	2	3	2	3	2	2	2	3	2	3	2.4	20.0%
13	MA	6	8/21/2015	6	1	6	6	2	6	6	2	6	5	2	5	6	2	6	5.8	5.5%
14	NEFSC	1	3/15/2013	0	4	1	1	1	1	1	1	1	0	4	1	0	4	1	1	0.0%
15	NEFSC	3	3/18/2013	2	4	3	2	4	3	3	2	3	2	3	3	2	4	3	3	0.0%
16	NEFSC	5	4/13/2014	4	4	5	4	5	5	5	1	5	4	4	5	4	4	5	5	0.0%
17	FL	4	11/27/2012	4	4	4	4	3	4	4	4	4	4	3	4	4	3	4	4	0.0%
18	NJ	0	10/11/2012	1	3	1	0	3	0	0	2	0	0	3	0	0	4	0	0.2	160.0%
19	NJ	7	6/19/2013	7	1	7	6	1	6	6	1	6	5	3	6	6	4	7	6.4	7.5%
20	FL	5	5/6/2012	4	2	4	3	3	4	4	2	4	4	1	4	4	1	4	4	0.0%
																			Average APE	12.71%

Table 10. **Symmetry test p-values for inter-lab age comparisons using Bowker's test and CVs (%) for black seas bass scales and otoliths. P-values appear under the shaded diagonal line and CVs are above.**

	MA	VIMS-JG	VIMS-JE	FL-KC	FL-JC
MA	0	0	10	1	4
VIMS-JG	1	0	10	1	4
VIMS-JE	0.13	0.13	0	9	6
FL-KC	0.39	0.39	0.13	0	5
FL-JC	0.04	0.04	0.17	0.13	0

Table 11. **Percent exact agreement (below the shaded diagonal line) and agreement within one year (above the shaded diagonal line) between readers for black sea bass otoliths.**

	MA	VIMS-JG	VIMS-JE	FL-KC	FL-JC
MA	100	100	100	100	100
VIMS-JG	100	100	100	95	100
VIMS-JE	60	60	100	100	95
FL-KC	90	90	65	100	100
FL-JC	80	80	75	75	100

Table 12. **Ageing worksheet for bluefish at the workshop with the sample number, lab providing the sample and their assigned age, catch date of the sample, workshop group annulus counts, margin codes (scored from 1 to 4), and final age as well as average percent error (APE) values between groups. All samples were otoliths.**

Sample #	Lab	Age	Catch date	Group 1			Group 2			Group 3			Group 4			Group 5			Average Age	APE
				Annulus count	Margin code	Final age	Annulus count	Margin code	Final age	Annulus count	Margin code	Final age	Annulus count	Margin code	Final age	Annulus count	Margin code	Final age		
1	NJ	4	6/4/2014	3	4	4	3	4	4	4	1	4	3	3	4	3	4	4	4	0.0%
2	NC	5	3/29/2014	3	4	4	3	4	4	4	4	5	4	1	4	3	4	4	4.2	7.6%
3	VIMS	1	9/25/2009	1	2	1	1	2	1	1	2	1	1	2	1	1	2	1	1	0.0%
4	ODU	12	3/10/2015	11	1	11	11	1	11	11	4	12	10	4	11	10	4	11	11.2	2.9%
5	SC	1	7/12/2014	1	2	1	1	1	1	0	2	0	0	3	0	1	2	1	0.6	80.0%
6	MA	6	9/16/2015	5	4	5	5	4	5	6	2	6	6	3	6	5	3	5	5.4	8.9%
7	SC	1	9/22/2014	1	4	1	0	3	0	1	2	1	0	3	0	0	3	0	0.4	120.0%
8	RI	2	11/2/2012	2	3	2	2	3	2	2	4	2	2	3	2	2	3	2	2	0.0%
9	FL	7	5/23/2012	6	4	7	6	4	7	6	4	7	6	4	7	6	4	7	7	0.0%
10	NJ	3	6/14/2014	2	3	3	2	4	3	2	4	3	2	4	3	2	4	3	3	0.0%
11	ODU	0	8/12/2015	0	3	0	0	2	0	0	3	0	0	3	0	0	3	0	0	0.0%
12	NY	4	5/3/2012	3	4	4	3	4	4	3	4	4	3	3	4	3	4	4	4	0.0%
13	RI	6	6/10/2012	6	4	7	7	1	7	6	4	7	6	1	7	6	4	7	7	0.0%
14	VIMS	1	10/9/2009	1	3	1	1	2	1	0	4	0	0	4	0	0	4	0	0.4	120.0%
15	NY	5	10/23/2013	3	3	3	3	4	3	3	4	3	3	3	3	3	3	3	3	0.0%
16	NC	7	2/20/2014	6	4	7	5	4	6	5	4	6	5	4	6	6	4	7	6.4	7.5%
17	NC	10	2/20/2014	9	4	10	8	3	9	8	4	9	8	1	9	8	4	9	9.2	3.5%
18	MA	0	8/28/2015	0	3	0	0	3	0	0	3	0	0	4	0	0	3	0	0	0.0%
19	VIMS	9	5/11/2014	8	4	9	8	4	9	8	4	9	8	4	9	9	4	10	9.2	3.5%
20	NY	2	5/31/2013	1	4	2	1	4	2	2	1	2	1	4	2	1	4	2	2	0.0%
																			Average APE	17.69%

Table 13. Symmetry test p-values for inter-lab age comparisons using Bowker's test and CVs (%) for bluefish otoliths. P-values appear under the shaded diagonal line and CVs are above.

	MA	NEFSC	RI	CT	VIMS-JG	VIMS-JE	ODU
MA	0	16	18	9	1	10	9
NEFSC	0.39	0	17	8	15	23	8
RI	0.42	0.22	0	23	17	11	23
CT	0.29	0.26	0.51	0	8	16	0
VIMS-JG	0.32	0.37	0.42	0.26	0	9	8
VIMS-JE	0.42	0.2	0.25	0.16	0.41	0	16
ODU	0.29	0.26	0.51	1	0.26	0.16	0

Table 14. Percent exact agreement (below the shaded diagonal line) and agreement within one year (above the shaded diagonal line) between readers for bluefish otoliths.

	MA	NEFSC	RI	CT	VIMS-JG	VIMS-JE	ODU
MA	100	100	100	100	100	100	100
NEFSC	75	100	100	100	100	100	100
RI	60	65	100	100	100	100	100
CT	80	85	70	100	100	100	100
VIMS-JG	95	80	65	85	100	100	100
VIMS-JE	80	75	70	80	85	100	100
ODU	80	85	70	100	85	80	100

Table 15. Ageing worksheet for red drum at the workshop with the sample number, lab providing the sample and their assigned age, catch date of the sample, workshop group annulus counts, margin codes, and final age as well as average percent error (APE) values between groups. All samples are otoliths.

Sample #	Lab	Age	Catch date	Group 1			Group 2			Group 3			Group 4			Group 5			Average Age	APE
				Annulus count	Margin code	Final age	Annulus count	Margin code	Final age	Annulus count	Margin code	Final age	Annulus count	Margin code	Final age	Annulus count	Margin code	Final age		
1	GA	10	11/19/2002	17	4	17	17	4	17	17	4	17	17	4	17	17	3	17	17	0.0%
2	ODU	1	3/7/2016	1	1	1	0	4	1	1	1	1	1	4	2	0	4	1	1.2	26.7%
3	VIMS	11	10/30/2009	12	4	12	12	3	12	12	3	12	12	3	12	12	3	12	12	0.0%
4	SC	4	1/3/2017	2	4	3	2	4	3	2	4	3	3	4	4	2	4	3	3.2	10.0%
5	FL	2	12/14/2015	2	4	2	2	3	2	2	4	2	3	4	3	2	3	2	2.2	14.5%
6	GA	17	11/19/2002	17	4	17	17	3	17	17	4	17	18	4	18	17	3	17	17.2	1.9%
7	ODU	1	5/18/2016	1	1	1	1	1	1	1	1	1	1	4	2	0	4	1	1.2	26.7%
8	VIMS	1	10/25/2013	1	4	1	1	4	1	1	3	1	2	3	2	1	2	1	1.2	26.7%
9	SC	2	7/12/2017	1	2	1	1	2	1	1	2	1	2	2	2	4	2	1	1.2	26.7%
10	FL	4	8/2/2014	4	2	4	4	2	4	4	3	4	5	3	5	4	3	4	4.2	7.6%
11	GA	28	11/19/2002	28	3	28	28	2	28	28	4	28	28	4	28	28	3	28	28	0.0%
12	ODU	0	10/19/2016	0	4	0	0	3	0	0	4	0	1	4	1	0	4	0	0.2	160.0%
13	VIMS	4	8/30/2016	4	2	4	4	2	4	4	3	4	5	3	5	4	2	4	4.2	7.6%
14	SC	13	10/24/2017	12	4	12	12	2	12	12	4	12	13	3	13	12	3	12	12.2	2.6%
15	FL	5	3/5/2015	5	1	5	5	1	5	5	1	5	6	1	6	5	4	6	5.4	8.9%
16	GA	33	11/19/2002	33	3	33	33	3	33	33	4	33	34	4	34	33	3	33	33.2	1.0%
17	ODU	0	12/6/2016	0	4	0	0	3	0	0	4	0	1	4	1	0	4	0	0.2	160.0%
18	VIMS	23	8/30/2016	23	1	23	23	1	23	23	3	23	23	2	24	23	2	23	23.2	1.4%
19	SC	3	6/13/2017	2	2	2	2	2	2	2	2	2	3	4	4	2	2	2	2.4	26.7%
20	FL	1	2/3/2015	0	4	1	0	4	1	0	4	1	1	4	2	0	4	1	1.2	26.7%
																			Average APE	26.77%

Table 16. Symmetry test p-values for inter-lab age comparisons using Bowker's test and CVs (%) for red drum otoliths. P-values appear under the shaded diagonal line and CVs are above.

	NEFSC	VIMS-JG	VIMS-JE	ODU	SC	GA	FL-KC	FL-JC
NEFSC	0	15	33	0	1	2	0	0
VIMS-JG	0.06	0	18	15	14	16	15	15
VIMS-JE	0.31	0.08	0	33	32	31	33	33
ODU	1	0.06	0.31	0	1	1	0	0
SC	1	0.06	0.31	1	0	2	1	1
GA	0.32	0.08	0.32	0.32	0.32	0	1	1
FL-KC	1	0.06	0.31	1	1	0.32	0	0
FL-JC	1	0.06	0.31	1	1	0.32	1	0

Table 17. Percent exact agreement (below the shaded diagonal line) and agreement within one year (above the shaded diagonal line) between readers for red drum otoliths.

	NEFSC	RI	CT	DE	VIMS	ODU	NC
NEFSC	100	95	95	95	95	100	100
RI	80	100	100	100	100	95	95
CT	80	100	100	100	100	95	95
DE	50	65	65	100	100	95	95
VIMS	65	85	85	80	100	95	95
ODU	90	90	90	60	75	100	100
NC	90	90	90	60	75	100	100

Table 18. **Ageing worksheet for scup at the workshop with the sample number, lab providing the sample and their assigned age, catch date of the sample, workshop group annulus counts, margin codes (scored from 1 to 4), and final age as well as average percent error (APE) values between groups. Samples 1-14 are otoliths and samples 15-20 are scales. APEs are provided for all samples, only otoliths, and only scales.**

Sample #	Lab	Age	Catch date	Group 1			Group 2			Group 3			Group 4			Group 5			Average Age	APE
				Annulus count	Margin code	Final age	Annulus count	Margin code	Final age	Annulus count	Margin code	Final age	Annulus count	Margin code	Final age	Annulus count	Margin code	Final age		
1	RI	2	7/13/2016	2	1	2	2	1	2	2	1	2	2	1	2	2	1	2	2	0.0%
2	NEFSC	4	1/26/2017	4	4	5	3	4	4	4	1	4	4	4	5	4	4	5	4.6	10.4%
3	VIMS	3	10/13/2016	2	3	2	2	3	2	3	2	3	3	2	3	2	4	2	2.4	20.0%
4	VIMS	10	5/20/2015	9	4	10	9	1	9	9	4	10	9	1	10	9	4	10	9.8	3.3%
5	RI	1	5/17/2016	1	1	1	1	1	1	1	2	1	1	4	2	1	4	2	1.4	34.3%
6	NEFSC	4	2/4/2017	4	4	5	3	4	4	4	2	4	3	4	4	3	4	4	4.2	7.6%
7	VIMS	8	10/15/2016	8	3	8	8	1	8	8	2	8	8	3	8	8	2	8	8	0.0%
8	RI	7	7/13/2016	8	3	8	6	4	7	8	2	8	7	2	8	7	3	8	7.8	4.1%
9	NEFSC	11	1/26/2017	11	4	12	10	4	11	11	3	12	10	3	11	11	4	12	11.6	4.1%
10	NEFSC	3	2/4/2017	3	3	4	2	4	3	3	3	4	3	2	4	3	4	4	3.8	8.4%
11	VIMS	8	10/15/2016	8	4	8	7	3	7	9	2	9	9	3	9	8	3	8	8.2	7.8%
12	VIMS	5	10/14/2016	5	3	5	5	3	5	5	3	5	6	3	6	5	3	5	5.2	6.2%
13	VIMS	6	10/12/2016	6	3	6	6	4	6	6	2	6	6	3	6	6	3	6	6	0.0%
14	VIMS	2	5/18/2015	1	4	2	1	4	2	1	4	2	1	4	2	1	4	2	2	0.0%
15	MA	11	5/21/2016	8	1	8	5	1	5	12	4	13	9	3	10	9	4	10	9.2	23.5%
16	RI	1	5/17/2016	0	4	1	0	4	1	1	3	2	0	4	1	0	4	1	1.2	26.7%
17	MA	5	7/6/2016	5	1	5	5	1	5	5	4	6	4	1	5	4	4	5	5.2	6.2%
18	RI	2	7/13/2016	1	1	1	1	2	1	2	2	2	0	4	1	2	1	2	1.4	34.3%
19	MA	3	6/17/2016				5	1	5	4	4	5	4	4	5	3	4	4	4.75	26.3%
20	RI	7	7/13/2016	5	1	5	5	1	5	6	2	6	5	1	5	5	4	6	5.4	8.9%
																			Scup Otolith APE	7.59%
																			Scup Scale APE	20.96%
																			Total Scup APE	11.60%

Table 19. **Symmetry test p-values for inter-lab age comparisons using Bowker's test and CVs (%) for scup otoliths and scales. P-values appear under the shaded diagonal line and CVs are above.**

	NEFSC	CT	VIMS-JG	VIMS-JE
NEFSC	0	9	9	10
CT	0.25	0	12	10
VIMS-JG	0.31	0.22	0	7
VIMS-JE	0.24	0.54	0.18	0

Table 20. **Percent exact agreement (below the shaded diagonal line) and agreement within one year (above the shaded diagonal line) between readers for scup otoliths and scales.**

	NEFSC	CT	VIMS-JG	VIMS-JE
NEFSC	100	90	90	90
CT	55	100	95	90
VIMS-JG	70	45	100	100
VIMS-JE	60	55	65	100

Table 21. Ageing worksheet for striped bass at the workshop with the sample number, lab providing the sample and their assigned age, catch date of the sample, workshop group annulus counts, margin codes (scored from 1 to 4), and final age as well as average percent error (APE) values between groups. Samples 1-10 are scales and samples 11-20 are otoliths. APEs are provided for all samples, only otoliths, and only scales.

Sample #	Lab	Age	Catch date	Group 1			Group 2			Group 3			Group 4			Group 5			Average Age	APE
				Annulus count	Margin code	Final age	Annulus count	Margin code	Final age	Annulus count	Margin code	Final age	Annulus count	Margin code	Final age	Annulus count	Margin code	Final age		
1	RI	11	8/5/2015	10	3	10	10	3	10	10	2	10	10	2	10	10	2	10	10	0.0%
2	NY	5	7/15/2015	4	2	4	4	2	4	5	1	5	7	1	7	4	2	4	4.8	20.0%
3	NY	3	7/1/2015	2	3	2	2	2	2	3	2	3	2	2	2	3	2	3	2.4	20.0%
4	NJ	10	3/28/1996	8	3	9	8	2	8	7	4	8	7	3	8	8	3	9	8.4	5.7%
5	RI	4	5/19/2015	2	4	3	4	1	4	4	1	4	2	4	3	3	4	4	3.6	13.3%
6	ME	2	6/20/2012	1	1	1	1	1	1	2	2	2	2	1	2	2	2	2	1.6	30.0%
7	ODU	19	3/19/2015	18	3	19	19	3	20	11	4	12	16	4	17	18	4	19	17.4	13.3%
8	ME	6	6/22/2010	6	4	7	6	1	6	6	2	6	5	3	6	6	1	6	6.2	5.2%
9	MD	8	4/21/2012	6	4	7	8	1	8	8	2	8	6	3	7	6	4	7	7.4	6.5%
10	MA	14	10/15/2015	13	2	13	15	3	15	7	3	7	9	3	9	12	3	12	11.2	22.9%
11	VIMS	3	6/1/2014	3	2	3	3	1	3	3	2	3	3	1	3	3	1	3	3	0.0%
12	VIMS	6	11/13/2014	7	4	7	7	2	7	7	4	7	7	3	7	7	3	7	7	0.0%
13	ODU	25	3/4/2015	22	4	23	24	4	25	25	2	25	24	3	25	25	4	26	24.8	2.9%
14	ODU	4	3/9/2015	3	4	4	3	4	4	3	4	4	3	3	4	3	4	4	4	0.0%
15	MA	11	7/3/2014	10	2	10	10	1	10	11	2	11	11	1	11	8	4	9	10.2	6.3%
16	SC	1	12/18/2014	1	4	1	1	4	1	1	4	1	1	4	1	1	4	1	1	0.0%
17	VIMS	5	6/1/2014	5	1	5	4	4	5	5	1	5	5	1	5	4	4	5	5	0.0%
18	MA	18	9/7/2014	18	2	18	17	2	17	16	3	16	18	3	18	16	3	16	17	4.7%
19	MA	9	9/15/2014	9	2	9	9	2	9	9	3	9	9	3	9	9	3	9	9	0.0%
20	SC	1	4/8/2014	1	1	1	0	4	1	1	2	1	0	4	1	0	4	1	1	0.0%
																			Scale APE	13.69%
																			Otolith APE	1.39%
																			Total APE	7.54%

Table 22. Symmetry test p-values for inter-lab age comparisons using Bowker's test and CVs (%) for striped bass samples. P-values appear under the shaded diagonal line and CVs are above.

	MA	RI	NY	NJ-HC	NJ-JD	DE	VIMS-JG	VIMS-JE	ODU
MA	0	7	5	7	7	7	2	9	5
RI	0.43	0	4	1	0	7	6	8	7
NY	0.43	0.61	0	5	4	3	6	8	8
NJ-HC	0.68	0.42	0.54	0	1	7	7	9	8
NJ-JD	0.43	1	0.61	0.42	0	7	6	8	7
DE	0.54	0.42	0.39	0.44	0.42	0	7	5	9
VIMS-JG	0.16	0.43	0.43	0.68	0.43	0.54	0	9	6
VIMS-JE	0.44	0.68	0.43	0.66	0.68	0.43	0.54	0	10
ODU	0.28	0.2	0.31	0.29	0.2	0.53	0.27	0.53	0

Table 23. Percent exact agreement (below the shaded diagonal line) and agreement within one year (above the shaded diagonal line) between readers for striped bass samples.

	MA	RI	NY	NJ-HC	NJ-JD	DE	VIMS-JG	VIMS-JE	ODU
MA	100	80	85	75	80	75	95	65	95
RI	60	100	90	95	100	80	85	75	90
NY	70	70	100	85	90	95	80	75	90
NJ-HC	55	95	65	100	95	75	80	70	85
NJ-JD	60	100	70	95	100	80	85	75	90
DE	60	65	80	60	65	100	75	90	85
VIMS-JG	80	65	65	60	65	55	100	70	95
VIMS-JE	45	55	60	50	55	65	45	100	75
ODU	55	75	60	70	75	55	55	50	100

Table 24. Ageing worksheet for tautog at the workshop with the sample number, lab providing the sample and their assigned age, catch date of the sample, workshop group annulus counts, margin codes, and final age as well as average percent error (APE) values between groups. All samples were opercula.

Sample #	Lab	Age	Catch date	Group 1			Group 2			Group 3			Group 4			Group 5			Average Age	APE
				Annulus count	Margin code	Final age	Annulus count	Margin code	Final age	Annulus count	Margin code	Final age	Annulus count	Margin code	Final age	Annulus count	Margin code	Final age		
1	VIMS	2	10/6/2011	2	4	2	1	3	1	1	3	1	2	3	2	2	3	2	1.6	30.0%
2	MD	28	2/20/2014	24	4	25	27	4	28	26	4	27	27	4	28	26	4	27	27	3.0%
3	RI	3	9/8/2015	2	3	2	2	4	2	2	3	2	4	4	4	2	3	2	2.4	26.7%
4	VIMS	4	10/6/2011	4	3	4	4	4	4	4	3	4	5	3	5	4	3	4	4.2	7.6%
5	MA	12	11/6/2015	11	4	11	11	4	11	11	3	11	11	4	11	12	3	12	11.2	2.9%
6	RI	2	9/8/2015	1	3	1	1	3	1	2	3	2	2	4	2	2	3	2	1.6	30.0%
7	VIMS	20	10/6/2011	16	4	16	20	4	20	19	3	19	19	3	19	17	3	17	18.2	7.5%
8	MD	19	2/20/2014	17	1	17	20	4	21	18	4	19	18	1	19	19	4	20	19.2	5.4%
9	NY	7	5/19/2015	6	4	7	7	4	8	7	4	8	6	2	7	7	4	8	7.6	6.3%
10	NY	8	6/14/2015	6	1	6	7	2	7	7	2	7	7	2	7	8	2	8	7	5.7%
11	NY	10	11/19/2015	7	3	7	8	4	8	8	4	8	7	4	7	9	2	9	7.8	8.2%
12	MD	6	12/6/2014	5	4	5	6	4	6	6	4	6	6	4	6	6	3	6	5.8	5.5%
13	ODU	6	4/25/2014	5	4	6	6	4	7	6	4	7	9	2	10	6	4	7	7.4	14.1%
14	ODU	17	4/27/2014	16	4	17	18	4	19	17	4	18	13	1	14	15	4	16	16.8	8.6%
15	MD	3	12/16/2014	3	4	3	3	3	3	3	4	3	4	3	4	3	2	3	3.2	10.0%
16	ODU	3	11/22/2014	3	4	3	5	4	5	5	4	5	5	3	5	5	3	5	4.6	13.9%
17	MA	6	10/31/2015	5	4	5	6	4	6	5	4	5	6	3	6	5	3	5	5.4	8.9%
18	MA	9	11/6/2015	7	4	7	9	4	9	8	3	8	9	4	9	8	3	8	8.2	7.8%
19	NJ	9	1/11/2012	8	4	9	10	4	11	10	4	11	9	3	9	9	4	10	10	8.0%
20	NJ	5	1/10/2012	4	1	4	5	4	6	3	4	4	5	4	5	3	4	4	4.6	15.7%
																			Average APE	11.28%

Table 25. Symmetry test p-values for inter-lab age comparisons using Bowker's test and CVs (%) for tautog opercula. P-values appear under the shaded diagonal line and CVs are above.

	MA	RI	CT	DE	ODU
MA	0	11	9	9	8
RI	0.53	0	5	10	5
CT	0.61	0.27	0	13	1
DE	0.21	0.3	0.37	0	12
ODU	0.32	0.35	0.12	0.32	0

Table 26. Percent exact agreement (below the shaded diagonal line) and agreement within one year (above the shaded diagonal line) between readers for tautog opercula.

	MA	RI	CT	DE	ODU
MA	100	85	80	75	85
RI	35	100	95	80	95
CT	45	60	100	75	100
DE	35	50	30	100	75
ODU	35	60	80	40	100

Appendix A: Agenda

Atlantic States Marine Fisheries Commission's
QA/QC Fish Ageing Workshop

Tuesday, March 27th, 2018 – 9:00 a.m. to 5:00 p.m.
Wednesday, March 28th, 2018 – 9:00 a.m. to ~3:00 p.m.

FWC Fish and Wildlife Research Institute
100 8th Ave SE
St. Petersburg, Florida

Agenda

Tuesday, March 27th

1. Call to Order/Introductions
2. Conduct Hard Part Readings Exercise for River Herring, Striped Bass, Black Sea Bass, Bluefish, Red Drum, Scup, Tautog, and Atlantic Menhaden
3. Review NC's Bluefish Samples

Wednesday, March 28th

4. Review and Comparison of Otolith Reading Exercise by Groups and by States
5. Discussion and Review of Issues and Differences Encountered during Reading Exercise
6. Make Recommendations
7. Other Business
    a. Discuss NC's Bluefish Samples & Ageing Issues
    b. Discuss How to Proceed with Atlantic Menhaden Ageing

Adjourn

Name	State/Lab	Provided 2018 Samples of:
Mark Pasterczyk	ME	River Herring, Striped Bass
Scott Elzey	MA	Bluefish, Tautog, Scup, Striped Bass, River Herring, Black Sea Bass
Eric Robillard	NEFSC	Scup, Black Sea Bass
Nicole Lengyel	RI	Bluefish, Tautog, Atlantic Menhaden, Scup, Striped Bass, Black Sea Bass
David Molnar	CT	River Herring
Jesse Hornstein	NY	Bluefish, Tautog, Striped Bass
Heather Corbett	NJ	Bluefish, Tautog, River Herring, Striped Bass, Black Sea Bass
Jamie Darrow	NJ	Bluefish, Tautog, River Herring, Striped Bass, Black Sea Bass
Michael Greco	DE	
Katherine Messer	MD	Bluefish, Tautog, Atlantic Menhaden, Striped Bass, River Herring
Jessica Gilmore	ODU	Bluefish, Tautog, Red Drum, Striped Bass
Jeff Eckert	VIMS	Bluefish, Tautog, Red Drum, Scup, Striped Bass, Black Sea Bass
Jameson Gregg	VIMS	Bluefish, Tautog, Red Drum, Scup, Striped Bass, Black Sea Bass
	NC	Bluefish, Atlantic Menhaden, River Herring
Jonathan Tucker	SC	Bluefish, Red Drum, Striped Bass
Donna McDowell	GA	Red Drum
Jessica Carroll	FL	Bluefish, Red Drum, Black Sea Bass
Kristen Anstead	ASMFC	

Appendix B: Sample Images