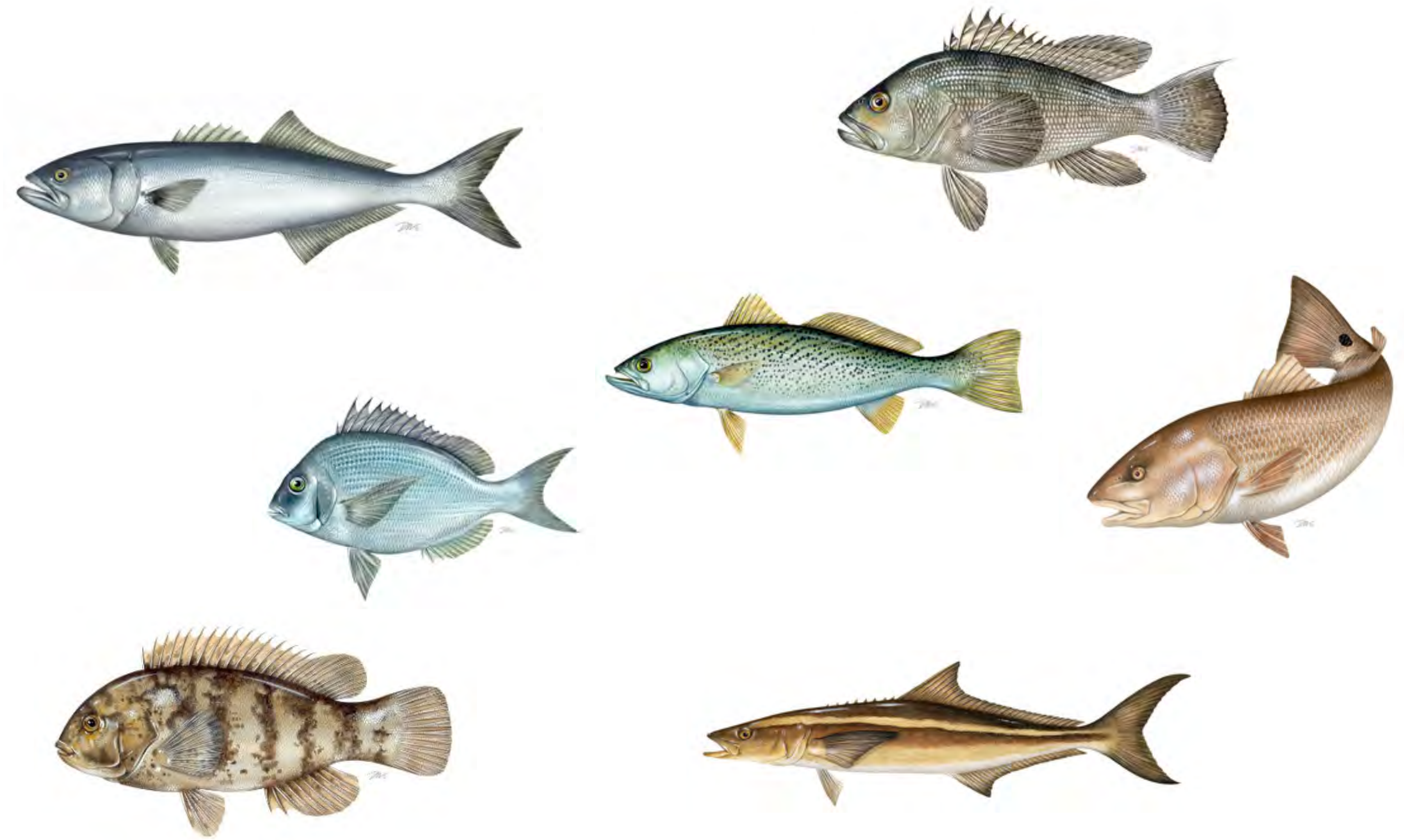
Atlantic States Marine Fisheries Commission

Report of the Quality Assurance/Quality Control Fish Ageing Workshop
St. Petersburg, Florida



March 7-9, 2023

Sustainable and Cooperative Management of 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: Scott Elzey (MA DMF), Eric Robillard (NEFSC), Nicole Lengyel Costa (RI DMF), David Ellis (CT DEEP), Ana Shore (NY DEC), Jamie Darrow (NJ DW), Michael Greco (DE DFW), Katherine Messer (MD DNR), Jessica Branscome (VMRC), Jameson Gregg (VIMS), Sara Pace (NC DNR), Jonathan Tucker (SC DNR), Donna McDowell (GA DNR), and Jessica Carroll (FL FWC). A special thanks to Jessica Carroll, Kristin Cook, David Westmark, Kiley Gray, and Brittany Bottom with FL FWC for hosting, preparing the samples, and leading the group through the workshop. 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 stock assessments for 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. 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 an annual QA/QC fish ageing workshop a research priority.

The ASMFC has held an annual QA/QC Fish Ageing Workshop since 2016, with the exception of the pandemic years of 2020-2022, to provide a yearly check-in for species that have had their own ageing workshop or are assessed with an age-structured model. The full QA/QC sample collection contains approximately 20 samples from each of the following species: Atlantic croaker *Micropogonias undulatus*, Atlantic menhaden *Brevoortia tyrannus*, Atlantic striped bass *Morone saxatilis*, American eel *Anguilla rostrata*, black sea bass *Centropristis striata*, bluefish *Pomatomus saltatrix*, cobia *Rachycentron canadum*, red drum *Sciaenops ocellatus*, scup *Stenotomus chrysops*, summer flounder *Paralichthys dentatus*, tautog *Tautoga onitis*, weakfish *Cynoscion regalis*, and winter flounder *Pseudopleuronectes americanus*. The collection previously included river herring (alewife *Alosa pseudoharengus* and blueback *A. aestivalis*), but in 2018, the Ageing Committee decided to remove this species from future workshops 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. Samples in the full QA/QC collection include scales, whole otoliths, sectioned otoliths, spines, and/or opercula depending on the species and which hard part is used to provide ages to the ASMFC during stock assessments. The Ageing Committee decided to rotate species every few years so that more species could be included in the workshop. Black sea bass, bluefish, cobia, red drum, scup, tautog, and weakfish were identified as species to evaluate for the 2023 workshop which took place from March 8-9th at the Florida Fish and Wildlife Research Institute (FL FWRI) in St. Petersburg, FL. This is the first year that cobia and weakfish have been evaluated by the workshop.

Workshop Objectives

The objectives of the workshop were to:

(1) Age samples collected and prepared from labs along the Atlantic coast for black sea bass, bluefish, cobia, red drum, scup, tautog, and weakfish

(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

Ageing Workshops and Stock Assessment History

All species aged during the 2023 QA/QC Fish Ageing Workshop are assessed using an age-structured model and have previously had their own ageing workshop with the exception of cobia and weakfish (Table 1). 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. 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. The most recent benchmark assessment was completed in 2016 (NEFSC 2017) and updated in 2021 (NEFSC 2021). The assessment used an age-structured assessment model (ASAP) with age-8 as the plus group in the model (Table 1).

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 2013). 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 2013 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.

II. Bluefish

The most recent research track stock assessment used in the management of bluefish was NEFSC 2015. The assessment has undergone five data updates since then with the most recent in 2021 (ASMFC 2021d). The research track assessment noted that 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; NC DMF 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. A new research track assessment was completed in 2022.

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 Old Dominion University's (ODU) Ageing Lab (now Virginia Marine Resource Commission Ageing Lab) and Robillard et al. (2009). Following the workshop, Addendum I to the Bluefish Fishery Management Plan (FMP) 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.

III. Cobia

The most recent stock assessment for Atlantic cobia was completed in 2020 and included age data from several fishery-independent and -dependent sources, although more ages were available from the recreational fishery than the commercial (SEDAR 2020). Ages were used for describing life history traits, such as growth, and for describing the age composition of the landings. A catch-at-age model was used in the assessment with a plus group of 12 (Table 1). There were a few concerns about the cobia age data including the non-random nature of carcass donation programs for obtaining ageing hard parts and the inclusion of age samples collected from tournament fish.

The ASMFC has not held an ageing workshop for cobia, nor has one been requested by the Ageing Committee or Cobia Technical Committee.

IV. Red Drum

Age data for red drum was used in the 2017 benchmark stock assessment in 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.

In 2022, a simulation assessment for red drum passed peer review and proposed moving forward with an age-structured model for the 2024 benchmark assessment using a plus group of 7 (Table 1).

V. Scup

Scup underwent a research track assessment in 2015 (NEFSC 2015), which was updated in 2021. The Northeast Fishery Science Center (NEFSC) provided the age information from their trawl survey 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. The age-structured model used to assess scup included a plus group of 7 (Table 1).

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 and 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.

VI. Tautog

A statistical catch-at-age model was developed for the 2015 stock assessment (ASMFC 2015; Table 1) which has been updated several times, most recently in 2021. 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.

With the publication of Elzey and Trull (2016), there was increased interest in the use of pelvic spines for ageing tautog. From 2019-2021, tautog agers took part in an ageing workshop and sample exchange of opercula, spines, and otoliths (ASMFC 2021c). Following that project, agers advised the Tautog Technical Committee (TC) to use spine ages from ageing labs that have demonstrated that their spine ages are consistent with either opercula or otoliths.

VII. Weakfish

The most recent benchmark stock assessment was conducted in 2016 and an assessment update was completed in 2019 (ASMFC 2019). The stock is assessed using age data from along the Atlantic coast in a statistical catch-at-age model (Table 1). Age data in the assessment is from both scales and otoliths, although otoliths are the preferred ageing structure. Scale ages are converted to otolith ages for use in the model. The peer review panel noted that consistency between ageing techniques and the scale-otolith age conversion should be investigated in the future.

While weakfish has not had an ageing workshop through ASMFC, Lowerre-Barbieri et al. (1994) concluded that sectioned otoliths are the best ageing structure for the species since they show the clearest annuli. Scale ageing was deemed to be less precise than otoliths.

State Sample Collection, Preparation, and Ageing Methodology

Previous QA/QC reports included samples and participation from the Old Dominion University (ODU) Age and Growth Lab which processed commercial and recreational fish ageing samples for Virginia Marine Resources Commission (VMRC). In 2019, the ODU Lab moved to the VMRC offices and now will be referred to in this report as VMRC.

I. Black Sea Bass

Northeast Fisheries Science Center (NEFSC)

Scales and otoliths from black sea bass have been collected since 1984 during fall and spring fishery-independent trawl surveys conducted by NOAA Fisheries 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 4-60 cm. 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.

Massachusetts Division of Marine Fisheries (MA DMF)

Black sea bass scales were collected from commercially captured fish at the fish houses (2013-2015) and from recreationally captured fish (2013-2022). 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 have been read whole, submerged in mineral oil with reflected light under a stereo microscope. Otoliths aged 6 and older are then sectioned and re-aged. Beginning in 2021, all otoliths are sectioned prior to reading. Scales are pressed into acetate with a heat press and aged with a microfiche projector.

Rhode Island Division of Marine Fisheries (RI DMF)
Scales have traditionally been collected on fishery-independent surveys, at recreational fishing tournaments, and from the commercial fishery. In 2016, DMF began collecting otoliths when the whole fish was available and being sacrificed. Since then, sample collection has exclusively included otoliths. The annual target number of samples is 100. 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. Starting 2023, DMF will be changing protocols to age all otoliths whole and then section and re-age otoliths 6 and older.

New Jersey Fish and Wildlife (NJ FW)
The NJ FW initiated sampling for black sea bass in 2010. Otoliths have been collected exclusively for ageing (no scales), and samples have been derived from fishery-independent survey efforts and fishery-dependent sources. Samples are collected throughout the year which includes length, weight, sex, diet, and otoliths. Once otoliths are extracted, they are sent to the NEFSC for processing and ageing.

Virginia Institute of Marine Science (VIMS)
Scales and otoliths from black seas bass have been collected from two fishery-independent trawl surveys, the Chesapeake Bay Multispecies Monitoring and Assessment Program (ChesMMAP) since 2002 and NorthEast Area Monitoring and Assessment Program (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 6,891 total black sea bass from 2002-2022 (ChesMMAP 1,263; NEAMAP 5,628). 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. Black sea bass otolith collections started in 2011. A total of 1,219 samples were collected in the first two years of the original study, but collections have continued since, at an average of ~200 otoliths

annually. 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.

II. 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 DEM

Bluefish otoliths have been collected 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 FMP. 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 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 FW

The NJ FW 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. 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.

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 VMRC’s (previously ODU). However, VIMS wet-sands the sections to a thinner width than VMRC 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 8,500 total bluefish between ChesMMAP and NEAMAP from 2002-2022 (ChesMMAP 904; NEAMAP 7,596). 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.

Virginia Marine Resources Commission (VMRC)
VMRC obtains bluefish otoliths from the commercial catch and have been collected by VMRC since 1998. A random subsample of otoliths in each length bin are chosen to age.

The VMRC Ageing Lab 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. In addition to recording the number of annuli, the margin or the growth width after the last annulus is coded from 1 to 4. The margin code "1", "2", "3", and "4" stands for no growth, the growth width less than or equal to one third of, larger than one third but less than or equal to two thirds of, and larger than two thirds of the growth width formed in the previous year, respectively. If a fish is captured after the end of the species-specific annulus deposition period and before January 1, it is assigned an age class as the same as its annulus number without referencing its margin code. If a fish has a margin code of "1", it is assigned an age class as the same as its annulus number no matter in which month it is captured. If a fish is captured after December 31 and before its annulus deposition period, it is assigned an age class as its annulus number plus one when its margin code is "2", "3", or "4". If a fish is captured during its annulus deposition period, it is assigned an age class as the same as its annulus number when its margin code is "2" and as its annulus number plus one when its margin code is "3" or "4". VMRC uses March to June as the annuli deposition period.

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

North Carolina Division of Marine Fisheries (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 2005) 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. Bluefish are collected through fishery dependent sampling programs including commercial fish house sampling, recreational fishing tournaments, and the carcass collection program, and are also collected through an independent gill net survey. An average of 800 bluefish otoliths are aged annually.

Despite training at ODU's lab, NC DMF could not replicate ODU's process to produce readable otolith sections and began ageing whole otoliths for fish less than 500 mm in fork length. The left otoliths from individuals with a fork length ≥ 500 mm are sectioned on a Hillquist thin-sectioning machine using a rapid processing technique described in Cowan et al. (1995), and sections are ground down along the transverse plane to a final thickness of 0.35 mm. The otolith sections are aged under either reflected or transmitted light by Age Lab staff with second reads completed by the lead biologist. The readers record annuli count and margin code (1-4). Ages are bumped during the period of annulus formation when there is a margin code of 3 or 4. Discrepancies between the ages of two readers are resolved, and if an age cannot be agreed upon the sample is discarded.

South Carolina Department of Natural Resources (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 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, most bluefish samples are small, young fish. From 2000 to 2010 before SEAMAP took over sample processing, SC DNR Inshore Fisheries section was using SEAMAP caught bluefish for otolith ageing. Otoliths are embedded in epoxy resin and a thin section is cut through the core with a Buehler low-speed saw. 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. Bluefish spawn during the summer, and first annulus formation is the following spring to summer.

FL FWRI

Bluefish otoliths are collected on fishery-independent monitoring surveys, and are typically incidental collections. Fishery collections come from primarily from commercial samplers, but because bluefish is not a highly-targeted species, annual collections are typically around fifty samples. Otoliths are embedded in epoxy resin and a thin section is cut through the core with a Buehler low-speed saw. 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 size of fish. Ages are determined using annuli count and margin code at date of capture.

III. Cobia

VIMS

Cobia 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 cobia as a priority species and provide data when applicable for assessment needs. A total of 41 paired otoliths have been collected and processed between the two surveys (5 NEAMAP; 36 ChesMMAP). Otoliths are sectioned and wet-sanded to a thinner width. 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.

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.

VMRC

VMRC obtains cobia otoliths from the recreational catch and have been collected by VMRC since 1999. All samples are processed for ageing.

The VMRC Ageing Lab uses sectioned otoliths to age cobia. Each section is read under transmitted light using a polarizing filter. Cobia are assigned a January 1st birthdate by convention. In addition to recording the number of annuli, the margin or the growth width after the last annulus is coded from 1 to 4. The margin code “1”, “2”, “3”, and “4” stands for no growth, the growth width less than or equal to one third of, larger than one third but less than or equal to two thirds of, and larger than two thirds of the growth width formed in the previous year, respectively. If a fish is captured after the end of the species-specific annulus deposition period and before January 1, it is assigned an age class as the same as its annulus number without referencing its margin code. If a fish has a margin code of "1", it is assigned an age class as the same as its annulus number no matter in which month it is captured. If a fish is captured after December 31 and before its annulus deposition period, it is assigned an age class as its annulus number plus one when its margin code is "2", "3", or "4". If a fish is captured during its annulus deposition period, it is assigned an age class as the same as its annulus number when its margin code is “2” and as its annulus number plus one when its margin code is “3” or “4”. VMRC uses June to July as the annuli deposition period.

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 cobia.

- Otolith Preparation Protocol

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

- Otolith Ageing Protocol

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

SC DNR

SCDNR Mariculture section direct targets cobia, with hook and line, to use as broodstock in a marine gamefish stocking program. A subsample of these fish is kept for life history analysis of the species. Otoliths are embedded in epoxy resin and a thin section is cut through the core with a Buehler low-speed saw. 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. Cobia are summer spawners with the first annulus formation during the following summer.

FL FWRI

FL FWRI primarily collects cobia as part of a multi-year study on reproductive characteristics; samples are obtained from fishery dependent and independent collections. Cobia samples are also obtained from the recreational fishery, but are irregular collections.

Otoliths are embedded in epoxy resin and a thin section is cut through the core with a Buehler low-speed saw. 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 size of fish. Ages are determined using annuli count and margin code at date of capture.

IV. 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 109 pairs of red drum otoliths have been collected and processed for age determination from both surveys (NEAMAP 80; ChesMMAP 29). 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.

VMRC

VMRC obtains red drum otoliths from the commercial and recreational catch. Red drum otoliths have been collected by VMRC since 1998. All samples are processed for ageing.

The VMRC Ageing Lab 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.

The VMRC Ageing Lab uses sectioned otoliths to age red drum. Each section is read under transmitted light using a polarizing filter. Red Drum are assigned a January 1st birthdate by convention. In addition to recording the number of annuli, the margin or the growth width after the last annulus is coded from 1 to 4. The margin code "1", "2", "3", and "4" stands for no growth, the growth width less than or equal to one third of, larger than one third but less than or equal to two thirds of, and larger than two thirds of the growth width formed in the previous year, respectively. If a fish is captured after the end of the species-specific annulus deposition period and before January 1, it is assigned an age class as the same as its annulus number without referencing its margin code. If a fish has a margin code of "1", it is assigned an age class as the same as its annulus number no matter in which month it is captured. If a fish is captured after December 31 and before its annulus deposition period, it is assigned an age class as its annulus number plus one when its margin code is "2", "3", or "4". If a fish is captured during its annulus deposition period, it is assigned an age class as the same as its annulus number when its margin code is "2" and as its annulus number plus one when its margin code is "3" or "4". VMRC uses March to July as the annuli deposition period.

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 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 (approximately 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 a Buehler 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 help 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, so one year must be factored into the fish age to place the individuals into the proper year class (age group). This way, year class is based on the spawning season of the actual calendar year of birth.

Georgia Department of Natural Resources (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 and 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 and 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.

V. 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 has processed scup scales collected by volunteer recreational anglers (2013-2022). The scales are wiped clean, pressed into acetate using a heated press, and aged by examining the impressions on a microfiche projector.

RI DEM

Scales have traditionally been collected on fishery-independent surveys, at recreational fishing tournaments, and from the commercial fishery. In 2017, DMF began collecting otoliths when the whole fish was available and being sacrificed. Since 2019, sample collection has exclusively included otoliths. The annual target number of samples is 100. 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 21,152 pairs of scup otoliths have been collected and processed for age determination from both surveys (NEAMAP 19,369; ChesMMAP 1,783). 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.

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.

VI. 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 collections began in 1995 and ceased in 2019. 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 (2016-2018). 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. Sections are affixed to a slide with a liquid coverslip and aged through a compound microscope with transmitted light.

RI DEM

Opercula have been collected by RI DEM since 1987, primarily from donated recreational carcasses. The annual target number of samples is 200 per the requirements of Addendum III to the FMP for Tautog. Sample collection has primarily included operculum; however, otoliths have also been collected since 2012 following the recommendations of the 2012 Tautog Ageing Workshop. Additionally, in 2017, RI DEM began collecting tautog pelvic spines for ageing.

Following the recommendations of the 2023 QA/QC workshop, RIDEM will conduct one year of paired otolith/spine age readings in 2022. In 2023, RIDEM will fully transition to collecting and ageing spines as the primary ageing structure. Collection and processing will follow Elzey and Trull (2016). 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 for each structure to obtain precision estimates.

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 two 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 FW

Sampling for tautog was initiated in 2007, collecting samples primarily from commercial and party/ charter vessels. Currently, NJ collects its samples primarily from fishery-dependent party/charter vessels and supplements sample for outside the recreational catch limits with fishery-independent sources, the NJ FW Ocean Trawl Survey and NJ's Artificial Reef Ventless Trap Survey. 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 using transmitted and reflected light.

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 10 mm 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, pelvic spines, 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. Additionally, paired pelvic spines have been collected since 2017. Prior to 2010 only opercula were collected. A total of 579 Tautog have been aged by the two surveys (ChesMMAP 51; NEAMAP 528). To date, VIMS tautog data has not been requested but not used in assessments 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.

VMRC

VMRC obtains tautog otoliths, operculum, and pelvic fin spines from the commercial and recreational catch. Tautog have been collected as part of VMRC's Biological Sampling Program since 1998. All samples are processed for ageing.

Operculum and pelvic fin spines are removed and frozen until prepared for age reading. Thawed samples are boiled 5-6 minutes to loosen attached tissue. When the 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. Pelvic fin spines are allowed to air dry for at least 24hrs after cleaning. Then they are embedded in epoxy resin and sectioned. 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://mrc.virginia.gov/ageing-lab/Tautog-Otolith-Preparation-Latex.pdf

- Operculum Preparation Protocol

https://mrc.virginia.gov/ageing-lab/Tautog-Operculum-Preparation-Protocol.pdf

VII. Weakfish

RI DEM

Weakfish otoliths have been collected by the RI DEM since 2005 on fishery-independent surveys and from the commercial fishery. The annual target number of samples is 3 ages and 6 lengths per metric ton of weakfish landed per the requirements of Addendum I to Amendment 4 to the FMP for weakfish. Otoliths are dried, mounted in epoxy resin, and thin-sectioned using an IsoMetTM slow speed saw. Thin sections are then mounted onto microscope slides with Flo-TexxTM 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 weakfish since 2003. The majority of samples are collected from fishery dependent sampling of commercial markets, with additional samples of larger weakfish coming from the recreational fishery. Staff sample as many weakfish as possible to collect. Otoliths are embedded in West System Epoxy and sectioned using an Isomet Low-Speed Saw to a thickness of ~0.6mm. Otoliths are aged on a compound microscope using transmitted light. Samples are processed and read by one person.

VIMS

Weakfish 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 weakfish. Otoliths are sectioned and wet-sanded to a thinner width. 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 24,811 total weakfish between ChesMMAP and NEAMAP from 2002-2022 (ChesMMAP 10,707; NEAMAP 14,104). Weakfish have been aged from age-0 to a max age of 4. The majority of the specimens sampled were ages 0-1.

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.

VMRC

VMRC obtains weakfish otoliths from the commercial catch and have been collected by VMRC since 1998. A random subsample of otoliths in each length bin are chosen to age.

The VMRC Ageing Lab uses sectioned otoliths to age weakfish. Each section is read under transmitted light using a polarizing filter. Weakfish are assigned a January 1st birthdate by convention. In addition to recording the number of annuli, the margin or the growth width after the last annulus is coded from 1 to 4. The margin code “1”, “2”, “3”, and “4” stands for no growth, the growth width less than or equal to one third of, larger than one third but less than or equal to two thirds of, and larger than two thirds of the growth width formed in the previous year, respectively. If a fish is captured after the end of the species-specific annulus deposition period and before January 1, it is assigned an age class as the same as its annulus number without referencing its margin code. If a fish has a margin code of "1", it is assigned an age class as the same as its annulus number no matter in which month it is captured. If a fish is captured after December 31 and before its annulus deposition period, it is assigned an age class as its annulus number plus one when its margin code is "2", "3", or "4". If a fish is captured during its annulus deposition period, it is assigned an age class as the same as its annulus number when its margin code is “2” and as its annulus number plus one when its margin code is “3” or “4”. VMRC uses April to June as the annuli deposition period.

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 weakfish.

- Otolith Preparation Protocol

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

- Otolith Ageing Protocol

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

NC DMF

Weakfish have been sampled by NC DMF for aging structures since 1978. Weakfish are collected from both fishery dependent and fishery-independent sampling programs. Fishery-dependent programs include commercial fish house sampling, recreational fishing tournaments, and the carcass collection program. Fishery-independent programs include a gill net survey and the Pamlico Sound survey. Scales were the primary aging structure collected and aged until a comparison study using samples from 1995 and 1996 determined that otoliths were the more accurate structure in assigning a true age to the fish. From 1997 to present, otoliths have been the primary structure for ageing weakfish. An average of 515 otoliths are aged annually.

Otoliths are processed on a Hillquist thin-sectioning machine using a rapid processing technique described in Cowan et al. (1995), and sections are ground down along the transverse plane to a final thickness of 0.5 mm. The left otolith is used for sectioning unless it is broken or was not collected. The otolith sections are aged under either reflected or transmitted light by Age Lab staff with second reads completed by the lead biologist. The readers record annuli count and margin code (1-4). Ages are bumped during the period of annulus formation when there is a margin code of 3 or 4. Discrepancies between the ages of two readers are resolved, and if an age cannot be agreed upon the sample is discarded.

SC DNR

Weakfish are saved from a variety of sampling types including: fishery-independent trammel net survey, fishery-dependent public fishing tournaments, and NOAA MRIP sampling. All sampling combined, there is a limited number of otolith samples per year of approximately 10. Otoliths are embedded in epoxy resin and a thin section is cut through the core with a Buehler low-speed saw. 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. Weakfish spawn during the spring, and the first annulus forms the following year in May-June.

Workshop Proceedings and Methods

Workshop participants met on Wednesday, March 8th, 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, David Westmark, Kiley Gray, and Brittany Bottom set up stations ahead of the workshop for the hard part reading exercise. Participants broke into five groups, each led by a FL FWC employee, 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. Individual ages were also recorded for species that are routinely aged and supplied to ASMFC by that reader.

For each of the seven species, every member of the group aged the samples (n=20-22 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 one 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 9th, the attendees of the workshop met to go over the APE for each species and results from individual age readers, revisit samples with high disagreement, and make recommendations for following workshops or coastwide ageing. The APE varied by species throughout the five years of the workshop (Table 2). Discussion and results for each species follows and sample images are available upon request.

I. Black Sea Bass

The APE for black sea bass has varied for the years it has been evaluated at the workshop from 3.67% in 2016 to 12.71% in 2018 to 7.55% in 2023 (Table 2). Sample #2 (Table 3) had disagreement and the group that aged this sample as an age-0 instead of an age-1 noted that their experienced black sea bass ager (Cook) ages whole otoliths, not sections. Both the NEFSC and FL use whole otoliths for black sea bass ageing, although NEFSC uses the guideline of sectioning otoliths over age 5, while FL uses 8. Florida noted, and the group agreed, that black sea bass samples from FL look very different from those collected elsewhere and age-8 might be an appropriate cutoff given the regional differences. The group also reviewed sample #15 and #19, which were whole otoliths, although it was noted that most groups did not use the water bath provided. Once water was added during the discussion, participants agreed on the ages. The ageing timeline for black sea bass can be seen in Figure 1.

Four scale samples remain in the collection and the group discussed if anyone is still ageing black sea bass with scales. Lengyel Costa noted that RI used to collect scales from their commercial fishery but since most samples now are collected from their trawl survey, they now use otoliths. Elzey agreed that MA had a similar situation where they used to get scales from their recreational fishery but they do not do that anymore. Unless regulations change in the future that require these fisheries to be sampled, no state is using scales anymore to age black sea bass. The group recommended the scales are removed from the collection and the entire sample set (n=20) be replaced with paired whole and sectioned otoliths, if possible.

Agers from MA, NEFSC, RI, NY, DE, VIMS, and FL reported routinely ageing black sea bass. Like the group ages, differences could also be seen in the individual ages, with FL disagreeing with the other agers at a higher rate (Table 4-Table 5). There was one significant p-values from Bowker's test of symmetry indicating some systematic bias between VIMS and DE (Table 4), although most CVs were less than 5%. Exact agreement varied from 65-100% (Table 5) and increased to 90-100% within one year. The differences between agers were attributed to the regional differences in northern and southern samples and the workshop participants did not think this was a cause for concern.

II. Bluefish

The APE for bluefish at the workshop decreased to 5.78%, its lowest value for all years of the workshop (Table 2). Similar to 2016-2018, 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 and #7 (Table 6) and discussed the timeline for the species (Figure 2) which varies along the coast and can confuse readers when determining when to bump a sample to the next year class. Additionally, readers agreed that the timeline for bluefish may be changing in recent years and the sample collection should include newer samples (e.g., 2020 or later). It was also noted that some samples should have Flo-Texx™ added, such as sample #15, since oil is not available during the workshop to add to samples. The labs who provided the samples agreed that FL can add Flo-Texx™ to their samples for future workshops.

For individual reader comparisons, readers from MA, NEFSC, RI, CT, NY, DE, VMRC, VIMS, SC, and FL 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 7). CVs ranged from 0-19% and 29 out of the 45 comparisons had CVs greater than 5%, indicating some imprecision. Exact agreement varied from 65-100% and increased to 95-100% for all readers for agreement within one year (Table

8). 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.

III. Cobia

This was the first year that cobia was included in the QA/QC workshop and its samples had high agreement between readers at the workshop with an APE of 4.35% (Table 2; Table 9), despite the unfamiliarity of most readers with this species. Branscome walked the participants through sample #3 as an example since she is one of the experienced cobia readers. She pointed out an indentation often seen at age-1 on the otolith, which she referred to as a "hat." She also reviewed sample #8 for the group. Sample #8 had some doubling on the second annulus and Branscome noted that the first couple years often have wide bands. Both samples #12 and #13 should be replaced if possible. The ageing timeline for cobia can be seen in Figure 3.

For individual reader comparisons, readers from VMRC, VIMS, and FL indicated they routinely age cobia. For the other species, Cook was considered the reader for FL, but for cobia, ages from Carroll and Cook were included. When comparing the experienced cobia readers, there were no significant p-values from Bowker's test of symmetry this year, indicating no systematic bias between the readers (Table 10). CVs ranged from 1-7%, indicating some imprecision. Exact agreement varied from 65-95% and increased to 95-100% for all readers for agreement within one year (Table 11).

IV. Red Drum

Red drum had the second highest APE of the 2018 workshop at 26.77% which was attributed to the 'smudge' issue, but in 2023, the APE for red drum dropped to 0.31% (Table 2). It was acknowledged that as per ASMFC rules from the ageing workshop (ASMFC 2008), the 'smudge' should not be counted. The participants of the workshop reviewed sample #15 (Table 12), the only sample with disagreement with the majority ageing it as a 5-year-old and one group ageing it as a 6-year-old. Additionally, the group discussed the timeline since the one provided seemed to represent the Gulf states, not the Atlantic states (Figure 4). The biological birthday was listed as September/October while most Atlantic states use a January 1st birthday. NC noted that they bump from September on.

For individual reader comparisons, readers from NEFSC, VMRC, VIMS, NC, 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 13). CVs ranged from 0-1% and, indicating no imprecision. Exact agreement varied from 95-100% and increased to 100% for agreement within one year (Table 14). Among all the samples, only one was aged differently by NEFSC than the rest of the group (sample #15, which was aged as a 6-year-old by NEFSC and a 5-year-old by the other readers). Otherwise, there was total agreement among readers for the red drum samples.

V. Scup

The APE for scup decreased to 5.32% in 2023 from 11.60% in 2018 (Table 2). In the collection, there are three paired otolith and scale samples. CT uses scales to age scup and they do not collect other hard parts from the species. RI used to use scales and, like black sea bass, they now collect both but use otoliths to age scup. The group reviewed paired sample #8 (otolith) and #20 (scale) since the scale was aged as a 6-year-old and the otolith was aged from 8-9 years (Table 15). The ageing timeline for scup can be seen in Figure 5.

The NEFSC, RI, CT, and VIMS all routinely age scup although CT only uses scales. There were no significant p-values from Bowker's test of symmetry indicating no systematic bias and CVs ranged from 4-6% (Table 16). Exact agreement between readers on otoliths ranged from 67-73% and increased to 87-100% for agreement within 1 year (Table 17). Scale samples (n=5) had 100% agreement on all samples.

VI. Tautog

Tautog has been evaluated during the QA/QC Workshop every year (2016-2019, 2023; Table 2). Over the years, the sample set for tautog has changed. For 2016-2018, the tautog samples included 20 opercula. In 2019, additional paired samples were added to include pelvic spines and otoliths since both were approved hard parts for ageing the species following its recent ageing workshop (ASMFC 2021). For 2023, the workshop included only the paired samples, although not all paired samples had all three hard parts (Table 18). The ageing timeline for tautog can be seen in Figure 6.

The APE for tautog has varied from 6.09% in 2016 to 11.28% in 2018 and was 9.55% in 2023 (Table 2). Otolith samples had the lowest APE at 3.98%, followed by pelvic spines at 7.24%, and then opercula at 16.68% (Table 18). Paired samples #4 (operculum), #35 (otolith), and #39 (spine) was reviewed since the ages varied between ageing structure. The operculum ages ranged from 2-4 years, while the otolith was aged unanimously as age-1, and the spine varied from 1-2 years. Participants noted that opercula had the highest disagreement and their use should be discouraged going forward. Greco said he supported the use of otoliths and spines, but he was not sure DE could collect the samples and may need to continue using opercula. Messer agreed since MD also ages using opercula, although that state may be able to make the change to otoliths in the coming years. The group noted that the plus group for the assessment is age 12 and the oldest sample in the current sample collection is 11. Older paired samples should be added in the future if they are available.

For individual reader comparisons, readers from MA, RI, CT, NY, DE, NJ, VMRC, and VIMS all indicated they routinely age tautog, although DE and MD age only opercula. Only MA routinely ages spines, but all states were included in the analysis to evaluate the agreement on the structure given its recent ageing workshop. When comparing the experienced tautog readers by ageing structure, there were no significant p-values from Bowker's test of symmetry, indicating no systematic bias between the readers (Table 19). CVs ranged across the ageing structures with several CVs > 5% for opercula and spines and a few for otoliths, indicating some imprecision. Exact agreement also varied across hard parts with the highest agreement on otoliths and spines. Agreement increased to greater than 75% within one year for all structures, but spines had the highest within-one-year agreement percentages with all readers having 100% agreement (Table 20). Comparing ages from paired samples, opercula and spines overaged samples at younger ages and underaged at older ages compared to otoliths. (Figure 7-Figure 9). The p-values indicate some systematic bias and differences between ages in the paired structures except between opercula and spines. The highest CVs and lowest agreement between ages on paired structures was for otoliths and opercula. Overall, the group noted that there was fairly high agreement on the spine samples given that people generally do not have experience with them.

VII. Weakfish

This was the first year that weakfish were aged at the QA/QC Workshop and the APE was 0% (Table 2; Table 21). The participants did not review any weakfish samples as a group on the second day of the workshop. The ageing timeline for weakfish can be found in Figure 10.

NEFSC, NY, DE, NJ, MD, VMRC, VIMS, and SC all indicated they routine age weakfish. Weakfish had 100% agreement on all samples (Table 22-Table 23).

Workshop Recommendations

Overall, the participants of the workshop were satisfied with the ageing agreement among species. The group made the following recommendations:

- Black sea bass, striped bass, tautog, croaker, bluefish, summer flounder, winter flounder, scup, cobia, spot, and black drum should be aged at the 2024 QA/QC Fish Ageing Workshop. Spot and black drum would be new additions to the workshop.
- For black sea bass, the scale samples should be archived and the entire sample set (n=20) be replaced with paired whole and sectioned otoliths.
- For cobia, samples #12 and #13 should be replaced by VMRC.
- For tautog, using opercula for determining ages is discouraged and otoliths and spines are encouraged. Older paired samples (age 11+) should be added to the collection in the future if available.
- The state where the sample was collected should be provided on the data sheet in addition to collection date for the workshop ageing exercise.
- New samples (2020 or later) should be added to the collection, particularly for species like bluefish that might be experiencing changing ageing timelines.
- For the 2024 QA/QC Fish Ageing Workshop, individual ages and group ages should still be collected.

References

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

_____. 2011. Bluefish Ageing Workshop Report. ASMFC, Arlington, VA.

_____. 2012. Proceedings of the Tautog Ageing Workshop. ASMFC, Arlington, VA.

_____. 2013. Proceedings of the 2013 Black Sea Bass Ageing Workshop. ASMFC, Arlington, VA.

_____. 2015. Tautog 2015 Benchmark Stock Assessment. ASMFC, Arlington, VA.

_____. 2016. Weakfish Stock Assessment and Peer Review Report. ASMFC, Arlington, VA.

_____. 2017. Red Drum Benchmark Stock Assessment and Peer Review Report. ASMFC, Arlington VA.

_____. 2019. Weakfish Stock Assessment Update. ASMFC, Arlington VA.

_____. 2021a. Striped Bass Stock Assessment Update. ASMFC, Arlington, VA.

_____. 2021b. Tautog Stock Assessment Update. ASMFC, Arlington, VA.

_____. 2021c. Summary of the 2020-2021 Tautog Ageing Sample Exchange. ASMFC, Arlington, VA.

_____. 2021d. Weakfish Stock Assessment Update. ASMFC, Arlington, VA.

_____. 2022a. American Eel Benchmark Stock Assessment. ASMFC, Arlington, VA.

_____. 2022b. Atlantic Menhaden Stock Assessment Update. ASMFC, Arlington, VA.

_____. 2022c. Red Drum Simulation 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 J.H. Jr, R.L. Shipp, H.K. Bailey IV, and D.W. Haywick. 1995. Procedure for rapid processing of large otoliths. Transactions of the American Fisheries Society 124(2): 280-282.

Elzey, S.P., and K.J. Trull. 2016. Identification of a nonlethal method for aging tautog (*Tautoga onitis*). Fishery Bulletin 114(4).

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.

Gulf States Marine Fisheries Commission (GSMFC). 2020. A Practical Handbook for Determining the Ages of Gulf of Mexico and Atlantic Coast Fishes. Third Edition. Ocean Springs, MD. 294 pp.

Lowerre-Barbieri, S.K., M.E. Chittenden Jr, and C.M. Jones. 1994. A comparison of a validated otolith method to age weakfish, *Cynoscion regalis*, with the traditional scale method. Fishery Bulletin 92(3).

Murphy, M.D., and R.G. Taylor. 1990. Reproduction, growth, and mortality of red drum Sciaenops ocellatus in Florida waters. Fishery Bulletin 3.

North Carolina Division of Marine Fisheries (NC DMF). 2000. Comparison of Age Assignment and Reader Agreement for Bluefish (*Pomatomus saltatrix*) Based on Scales, Whole Otoliths, and Sectioned Otoliths. NCDMF, NC Department of Health and Natural Resources.

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

_____. 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.

_____. 2005. 41st Northeast Regional Stock Assessment Workshop (41st SAW): 41st SAW Assessment Report. Northeast Fisheries Science Center Reference Document 05-14.

_____. 2011. 52nd Northeast Regional Stock Assessment Workshop (52nd SAW) Assessment Summary Report. US Dept Commer, Northeast Fish Sci Cent Ref Doc. 11-11.

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

_____. 2017. 62nd Northeast Regional Stock Assessment Workshop (62nd SAW) Assessment Report. US Dept Commer, Northeast Fish Sci Cent Ref Doc. 17-03.

_____. 2019. 66th Northeast Regional Stock Assessment Workshop (66th SAW) Assessment Report. US Dept Commer, Northeast Fish Sci Cent Ref Doc. 19-01.

_____. 2021. Black Sea Bass Operational Assessment for 2021.

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

SEDAR. 2020. SEDAR 58 – Atlantic Cobia Stock Assessment Report. SEDAR, North Charleston SC.

Tables

Table 1. Species included in the QA/QC reference collection along with the model used in the stock assessment and age plus group used in the model. Stock assessment models include trend analyses or statistical catch-at-age models (SCA), including the Beaufort Assessment Model (BAM) and ASAP (Age-Structured Assessment Program).

Species	Model	Age Plus Group	Source
American eel	Trend analyses	N/A	ASMFC 2022a
Atlantic croaker	Trend analyses	N/A	2022 TLA Report
Atlantic menhaden	BAM	6+	ASMFC 2022b
Black sea bass	ASAP	8+	SAW 62 (NEFSC 2017)
Bluefish	ASAP	6+	SAW 60 (NEFSC 2015)
Cobia	BAM	12+	SEDAR 58 (2020)
Red drum	SCA	7+	ASMFC 2022c
Scup	ASAP	7+	SAW 60 (NEFSC 2015)
Striped bass	SCA	15+	ASMFC 2021a
Summer flounder	ASAP	7+	SAW 66 (NEFSC 2019)
Tautog	ASAP	12+	ASMFC 2021b
Weakfish	SCA	6+	ASMFC 2019
Winter flounder	Swept-area (Gulf of Maine Stock) or ASAP (S. New England/MA Stock)	7+	SAW 52 (NEFSC 2011)

Table 2. 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**	**2019**	**2023**
Alewife herring	scales (5), otoliths (5)	13.23%	------	29.20%	-------	-------
American eel	otoliths (20)	-------	-------	-------	10.37%	-------
Atlantic croaker	otoliths (20)	7.76%	10.57%	-------	0.62%	-------
Atlantic menhaden	scales (19)	-------	15.42%	13.45%	-------	-------
Black sea bass	scales (4), otoliths (16)	3.67%	------	12.71%	-------	7.55%
Blueback herring	scales (5), otoliths (5)	13.23%	------	23.09%	-------	-------
Bluefish	otoliths (20)	23.06%	25.60%	17.69%	-------	5.78%
Cobia	otoliths (20)	-------	-------	-------	-------	4.35%
Red drum	otoliths (20)	-------	-------	26.77%	-------	0.31%
Scup	otoliths (14), scales (6)	-------	-------	11.60%	-------	5.32%
Striped bass	scales (15), otolith (15)[1]	4.96%	------	7.54%	5.90%	-------
Summer flounder	scales (6), otoliths (14)	-------	3.63%	-------	6.85%	-------
Tautog	opercula (8), pelvic spine (6), otolith (8)[2]	6.09%	10.89%	11.28%	8.17%	9.55%
Weakfish	otoliths (20)	-------	-------	-------	-------	0.00%
Winter flounder	scales (5), otoliths (15)	-------	4.41%	-------	7.78%	-------

[1] For 2016-2018, the sample set for striped bass was 10 scales and 10 otoliths. For 2019, additional paired samples were added.
[2] For 2016-2018, the sample set for tautog was 20 opercula. For 2019, additional paired samples were added for a total of opercula (28), pelvic spines (6), otoliths (8). For 2023, the sample size was reduced to only the paired samples.

Table 3. Ageing worksheet for black sea bass at the workshop with the sample number, lab providing the sample, ageing structure, 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	Structure	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	Section	5/8/2009	5	1	5	5	1	5	5	1	5	4	4	5	5	1	5	5	0%
2	VIMS	Section	10/21/2015	1	4	1	0	4	0	1	4	1	1	3	1	1	4	1	0.8	40%
3	VIMS	Section	10/4/2007	3	3	3	2	4	2	3	3	3	3	3	3	3	3	3	2.8	11%
4	VIMS	Section	5/15/2008	7	1	7	7	1	7	7	1	7	6	4	7	7	1	7	7	0%
5	VIMS	Section	9/23/2010	11	3	11	11	2	11	11	1	11	11	2	11	11	2	11	11	0%
6	FL	Section	5/16/2012	6	4	7	6	4	7	6	4	7	6	4	7	6	4	7	7	0%
7	MA	Section	Spring	5	3	6	7	4	8	5	4	6	8	2	8	7	3	8	7.2	13%
8	MA	Section	Spring	6	4	7	7	4	8	6	4	7	8	1	8	6	4	7	7.4	6%
9	MA	Section	Spring	3	1	3	2	4	3	3	1	3	3	1	3	3	1	3	3	0%
10	RI	Scale	5/29/2015	2	4	3	2	4	3	2	4	3	2	4	3	4	1	4	3.2	10%
11	RI	Scale	5/22/2014	5	4	6	3	4	4	5	3	6	5	2	6	5	4	6	5.6	11%
12	MA	Scale	8/14/2015	3	1	3	2	2	2	2	1	2	3	2	3	2	2	2	2.4	20%
13	MA	Scale	8/21/2015	6	2	6	5	2	5	6	2	6	6	2	6	6	2	6	5.8	6%
14	NEFSC	Whole Oto	3/15/2013	0	4	1	0	4	1	0	4	1	0	3	1	0	4	1	1	0%
15	NEFSC	Whole Oto	3/18/2013	2	4	3	2	1	2	2	4	3	2	3	3	2	3	3	2.8	11%
16	NEFSC	Whole Oto	4/13/2014	5	1	5	4	4	5	4	4	5	4	4	5	5	1	5	5	0%
17	FL	Whole Oto	11/27/2012	4	4	4	4	3	4	4	3	4	4	3	4	4	3	4	4	0%
18	NJ	Whole Oto	10/11/2012	0	4	0	0	4	0	0	3	0	0	3	0	0	3	0	0	0%
19	NJ	Whole Oto	6/19/2013	7	1	7	5	4	6	6	1	6	5	1	5	7	4	8	6.4	14%
20	FL	Whole Oto	5/6/2012	4	3	5	4	1	4	4	1	4	4	2	4	4	2	4	4.2	8%

Average APE	7.55%
Section APE	7.92%
Scales APE	11.74%
Whole APE	4.69%

Table 4. **Symmetry test p-values for inter-lab age comparisons using Bowker's test and CVs (%) for black seas bass. P-values appear above the shaded diagonal line and CVs are below. Significant p-values and CVs > 5% highlighted in orange.**

	MA	NEFSC	RI	NY	DE	VIMS	FL
MA		1.00	0.09	0.32	0.42	0.09	0.42
NEFSC	0		0.09	0.32	0.42	0.09	0.42
RI	5	5		0.08	0.13	0.42	0.26
NY	0	0	5		0.42	0.09	0.54
DE	3	3	5	3		0.014 *	0.42
VIMS	5	5	3	4	1		0.11
FL	12	12	14	13	11	12	

Table 5. **Percent exact agreement (below the shaded diagonal line) and agreement within one year (above the shaded diagonal line) between readers for black sea bass.**

	MA	NEFSC	RI	NY	DE	VIMS	FL
MA		100	95	100	95	95	95
NEFSC	100		95	100	95	95	95
RI	80	80		95	90	90	90
NY	95	95	75		100	100	95
DE	80	80	75	80		100	90
VIMS	75	75	80	75	95		90
FL	70	70	65	65	80	75	

Table 6. **Ageing worksheet for bluefish at the workshop with the sample number, lab providing the sample, ageing structure, 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	Structure	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	Otolith	6/4/2014	3	4	4	3	1	3	4	1	4	3	1	3	3	4	4	3.6	13%
2	NC	Otolith	3/29/2014	3	4	4	3	4	4	3	4	4	3	4	4	3	4	4	4	0%
3	VIMS	Otolith	9/25/2009	1	2	1	1	3	1	1	2	1	1	3	1	1	2	1	1	0%
4	ODU	Otolith	3/10/2015	11	4	12	10	4	11	11	1	11	11	3	12	10	4	11	11.4	4%
5	SC	Otolith	7/12/2014	1	3	2	1	2	1	1	2	1	1	4	2	1	4	2	1.6	30%
6	MA	Otolith	9/16/2015	7	2	7	6	2	6	6	1	6	6	2	6	6	2	6	6.2	5%
7	SC	Otolith	9/22/2014	1	3	1	1	3	1	0	4	0	1	1	1	2	2	2	1	40%
8	RI	Otolith	11/2/2012	2	4	2	2	3	2	2	2	2	2	3	2	2	3	2	2	0%
9	FL	Otolith	5/23/2012	6	4	7	6	4	7	6	3	7	7	1	7	6	3	7	7	0%
10	NJ	Otolith	6/14/2014	2	4	3	2	4	3	2	4	3	2	4	3	2	4	3	3	0%
11	ODU	Otolith	8/12/2015	0	3	0	0	3	0	0	3	0	0	4	0	0	3	0	0	0%
12	NY	Otolith	5/3/2012	3	4	4	3	4	4	3	4	4	3	3	4	3	3	4	4	0%
13	RI	Otolith	6/10/2012	6	4	7	6	4	7	6	4	7	6	3	7	6	1	6	6.8	5%
14	VIMS	Otolith	10/9/2009	1	3	1	1	3	1	1	2	1	1	3	1	1	2	1	1	0%
15	NY	Otolith	10/23/2013	3	4	3	3	4	3	3	3	3	4	1	4	3	2	3	3.2	10%
16	NC	Otolith	2/20/2014	6	4	7	6	4	7	6	4	7	6	4	7	5	4	6	6.8	5%
17	NC	Otolith	2/20/2014	9	1	9	9	4	10	8	4	9	8	4	9	8	4	9	9.2	3%
18	MA	Otolith	8/28/2015	0	3	0	0	3	0	0	4	0	0	3	0	0	4	0	0	0%
19	VIMS	Otolith	5/11/2014	8	4	9	8	4	9	8	4	9	8	4	9	8	4	9	9	0%
20	NY	Otolith	5/31/2013	2	1	2	1	4	2	2	1	2	1	4	2	2	1	2	2	0%
																			Average APE	5.78%

Table 7. Symmetry test p-values for inter-lab age comparisons using Bowker's test and CVs (%) for bluefish otoliths. P-values appear above the shaded diagonal line and CVs are below. CVs > 5% are highlighted in orange.

	MA	NEFSC	RI	CT	NY	DE	VMRC	VIMS	SC	FL
MA		0.37	0.57	0.39	0.32	0.17	0.39	0.17	0.42	0.42
NEFSC	3		0.41	0.26	0.32	0.29	0.26	0.29	0.22	0.24
RI	10	13		0.39	0.39	0.22	0.39	0.22	0.42	0.41
CT	10	11	19		0.26	0.16	1.00	0.16	0.41	0.29
NY	1	2	10	11		0.26	0.26	0.26	0.31	0.32
DE	1	4	10	10	2		0.16	1.00	0.24	0.25
VMRC	10	11	19	0	11	10		0.16	0.41	0.29
VIMS	1	4	10	10	2	0	10		0.24	0.25
SC	4	7	11	8	5	5	8	5		0.32
FL	11	14	4	16	12	12	16	12	7	

Table 8. 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	NY	DE	VMRC	VIMS	SC	FL
MA		100	100	100	100	100	100	100	100	100
NEFSC	90		100	95	100	100	95	100	100	100
RI	75	65		100	100	100	100	100	100	100
CT	85	80	70		100	100	100	100	100	100
NY	95	95	70	80		100	100	100	100	100
DE	85	75	80	80	80		100	100	100	100
VMRC	85	80	70	100	80	80		100	100	100
VIMS	85	75	80	80	80	100	80		100	100
SC	80	70	75	85	75	75	85	75		100
FL	75	65	80	80	70	70	80	70	95	

Table 9. Ageing worksheet for cobia at the workshop with the sample number, lab providing the sample, ageing structure, 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.

Sample #	Lab	Structure	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	VMRC	Otolith	7/9/2018	3	1	3	3	2	3	3	1	3	3	1	3	3	1	3	3	0%
2	VMRC	Otolith	9/2/2018	7	3	7	8	3	8	8	2	8	8	2	8	8	2	8	7.8	4%
3	FL	Otolith	10/8/2021	3	3	3	4	4	4	3	3	3	3	3	3	4	2	4	3.4	14%
4	VIMS	Otolith	9/1/2012	4	3	4	4	3	4	4	2	4	4	2	4	5	3	5	4.2	8%
5	SC	Otolith	6/11/2016	4	1	4	4	1	4	5	1	5	4	1	4	5	1	5	4.4	11%
6	FL	Otolith	10/11/2021	5	3	5	5	1	5	5	3	5	5	3	5	5	2	5	5	0%
7	FL	Otolith	10/8/2021	4	2	4	4	3	4	4	2	4	5	3	5	4	2	4	4.2	8%
8	VMRC	Otolith	6/1/2018	7	1	7	8	1	8	6	1	6	8	1	8	7	1	7	7.2	9%
9	SC	Otolith	5/24/2016	7	1	7	6	4	7	7	1	7	7	1	7	7	1	7	7	0%
10	SC	Otolith	5/26/2016	9	4	10	9	4	10	10	1	10	9	4	10	9	4	10	10	0%
11	SC	Otolith	5/17/2016	7	4	8	7	4	8	8	1	8	7	4	8	8	4	9	8.2	4%
12	VIMS	Otolith	9/2/2016	8	2	8	8	3	8	9	3	9	8	2	8	9	1	9	8.4	6%
13	VIMS	Otolith	7/5/2016	3	1	3	3	2	3	4	1	4	3	1	3	4	1	4	3.4	14%
14	VIMS	Otolith	5/1/2019	3	1	3	2	4	3	3	1	3	3	1	3	4	2	4	3.2	10%
15	SC	Otolith	6/9/2016	9	1	9	9	1	9	9	1	9	9	1	9	9	1	9	9	0%
16	FL	Otolith	3/15/2021	1	4	2	1	4	2	2	1	2	1	4	2	1	4	2	2	0%
17	VMRC	Otolith	8/11/2018	11	2	11	11	2	11	11	1	11	11	2	11	11	1	11	11	0%
18	VMRC	Otolith	6/16/2018	5	1	5	4	4	5	5	1	5	5	1	5	5	1	5	5	0%
19	VIMS	Otolith	9/1/2017	2	3	2	2	3	2	2	3	2	2	3	2	2	3	2	2	0%
20	FL	Otolith	2/26/2021	2	1	2	1	4	2	2	1	2	1	4	2	2	1	2	2	0%
																			Average APE	4.35%

Table 10. **Symmetry test p-values for inter-lab age comparisons using Bowker's test and CVs (%) for cobia otoliths. P-values appear above the shaded diagonal line and CVs are below. CVs > 5% are highlighted in orange. Two readers in Florida were included.**

	VMRC	VIMS	FL-KC	FL-JC
VMRC		0.44	0.19	0.44
VIMS	3		0.08	0.32
FL-KC	7	5		0.12
FL-JC	5	1	7	

Table 11. **Percent exact agreement (below the shaded diagonal line) and agreement within one year (above the shaded diagonal line) between readers for cobia otoliths. Two readers in Florida were included.**

	VMRC	VIMS	FL-KC	FL-JC
VMRC		100	95	100
VIMS	75		100	100
FL-KC	65	75		100
FL-JC	70	95	70	

Table 12. **Ageing worksheet for red drum at the workshop with the sample number, lab providing the sample, ageing structure, catch date of the sample, workshop group annulus counts, margin codes (scored 1-4), and final age as well as average percent error (APE) values between groups.**

Sample #	Lab	Structure	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	Otolith	11/19/2002	17	4	17	17	4	17	17	4	17	17	4	17	17	4	17	17	0%
2	ODU	Otolith	3/7/2016	0	4	1	0	4	1	1	1	1	0	4	1	1	1	1	1	0%
3	VIMS	Otolith	10/30/2009	12	4	12	12	4	12	12	2	12	12	2	12	12	3	12	12	0%
4	SC	Otolith	1/3/2017	2	4	3	2	4	3	2	4	3	2	4	3	2	4	3	3	0%
5	FL	Otolith	12/14/2015	2	4	2	2	4	2	2	4	2	2	4	2	2	4	2	2	0%
6	GA	Otolith	11/19/2002	17	4	17	17	4	17	17	2	17	17	3	17	17	3	17	17	0%
7	ODU	Otolith	5/18/2016	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	0%
8	VIMS	Otolith	10/25/2013	1	4	1	1	4	1	1	4	1	1	3	1	1	3	1	1	0%
9	SC	Otolith	7/12/2017	1	3	1	1	2	1	1	3	1	1	2	1	1	3	1	1	0%
10	FL	Otolith	8/2/2014	4	2	4	4	3	4	4	3	4	4	2	4	4	3	4	4	0%
11	GA	Otolith	11/19/2002	28	4	28	28	4	28	28	2	28	28	3	28	28	4	28	28	0%
12	ODU	Otolith	10/19/2016	0	4	0	0	4	0	0	4	0	0	3	0	0	3	0	0	0%
13	VIMS	Otolith	8/30/2016	4	2	4	4	2	4	4	2	4	4	2	4	4	2	4	4	0%
14	SC	Otolith	10/24/2017	12	4	12	12	4	12	12	3	12	12	3	12	12	3	12	12	0%
15	FL	Otolith	3/5/2015	5	1	5	5	1	5	5	1	5	5	2	5	5	3	6	5.2	6%
16	GA	Otolith	11/19/2002	33	4	33	33	4	33	33	1	33	33	4	33	33	3	33	33	0%
17	ODU	Otolith	12/6/2016	0	4	0	0	4	0	0	3	0	0	3	0	0	4	0	0	0%
18	VIMS	Otolith	8/30/2016	23	2	23	23	1	23	23	1	23	23	1	23	23	2	23	23	0%
19	SC	Otolith	6/13/2017	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	0%
20	FL	Otolith	2/3/2015	0	4	1	0	4	1	0	4	1	0	3	1	0	4	1	1	0%
																			Average APE	0.31%

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

	NEFSC	VMRC	VIMS	NC	SC	GA	FL
NEFSC		1.00	1.00	1.00	1.00	1.00	1.00
VMRC	1		1.00	1.00	1.00	1.00	1.00
VIMS	1	0		1.00	1.00	1.00	1.00
NC	1	0	0		1.00	1.00	1.00
SC	1	0	0	0		1.00	1.00
GA	1	0	0	0	0		1.00
FL	1	0	0	0	0	0	

Table 14. **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	VMRC	VIMS	NC	SC	GA	FL
NEFSC		100	100	100	100	100	100
VMRC	95		100	100	100	100	100
VIMS	95	100		100	100	100	100
NC	95	100	100		100	100	100
SC	95	100	100	100		100	100
GA	95	100	100	100	100		100
FL	95	100	100	100	100	100	

Table 15. Ageing worksheet for scup at the workshop with the sample number, lab providing the sample, ageing structure, 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. Paired samples are color coded in the catch date column.

Sample #	Lab	Structure	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	Otolith	7/13/2016	2	1	2	2	1	2	2	1	2	2	1	2	2	1	2	2	0%
2	NEFSC	Otolith	1/26/2017	5	2	5	4	4	5	5	2	6	4	3	5	5	2	6	5.4	9%
3	VIMS	Otolith	10/13/2016	3	1	3	2	4	2	3	2	3	3	2	3	3	2	3	2.8	11%
4	VIMS	Otolith	5/20/2015	10	4	11	9	4	10	9	4	10	9	3	10	9	4	10	10.2	3%
5	RI	Otolith	5/17/2016	1	2	1	1	1	1	1	1	1	1	1	1	1	2	1	1	0%
6	NEFSC	Otolith	2/4/2017	3	4	4	3	4	4	4	4	5	4	2	5	3	4	4	4.4	11%
7	VIMS	Otolith	10/15/2016	8	2	8	8	3	8	8	3	8	8	2	8	8	2	8	8	0%
8	RI	Otolith	7/13/2016	7	4	8	8	1	8	8	1	8	8	2	8	9	1	9	8.2	4%
9	NEFSC	Otolith	1/26/2017	11	3	12	10	4	11	11	4	12	11	3	12	11	4	12	11.8	3%
10	NEFSC	Otolith	2/4/2017	3	3	4	3	3	4	4	1	4	3	3	4	3	3	4	4	0%
11	VIMS	Otolith	10/15/2016	9	2	9	8	4	8	9	2	9	9	3	9	9	2	9	8.8	4%
12	VIMS	Otolith	10/14/2016	5	3	5	5	3	5	5	3	5	5	2	5	5	2	5	5	0%
13	VIMS	Otolith	10/12/2016	6	3	6	6	4	6	6	3	6	6	2	6	6	2	6	6	0%
14	VIMS	Otolith	5/18/2015	1	4	2	1	4	2	2	1	2	2	4	3	1	3	2	2.2	15%
15	MA	Scale	5/21/2016	8	4	9	11	1	11	16	1	16	6	3	7	8	4	9	10.4	24%
16	RI	Scale	5/17/2016	0	4	1	0	4	1	0	4	1	1	2	1	0	4	1	1	0%
17	MA	Scale	7/6/2016	4	3	5	5	2	5	5	1	5	5	2	5	5	1	5	5	0%
18	RI	Scale	7/13/2016	1	4	2	2	2	2	2	1	2	2	1	2	2	2	2	2	0%
19	MA	Scale	6/17/2016	3	4	4	4	2	4	4	1	4	2	2	2	3	4	4	3.6	18%
20	RI	Scale	7/13/2016	6	1	6	5	2	5	6	2	6	6	1	6	6	2	6	5.8	6%

Average APE	5.32%
Otolith APE	4.23%
Scale APE	7.86%

Table 16. Symmetry test p-values for inter-lab age comparisons using Bowker's test and CVs (%) for scup otoliths. P-values appear above the shaded diagonal line and CVs are below. CVs > 5% are highlighted in orange. Scup scales had 100% agreement and are not included in the table.

	NEFSC	RI	VIMS
NEFSC		0.43	0.41
RI	6		0.50
VIMS	4	6	

Table 17. Percent exact agreement (below the shaded diagonal line) and agreement within one year (above the shaded diagonal line) between readers for scup otoliths. Scup scales had 100% agreement and are not included in the table.

	NEFSC	RI	VIMS
NEFSC		93	100
RI	67		87
VIMS	67	73	

Table 18. **Ageing worksheet for tautog at the workshop with the sample number, lab providing the sample, ageing structure, catch date of the sample, workshop group annulus counts, margin codes, and final age as well as average percent error (APE) values between groups. Samples are grouped in pairs and paired samples are color coded in the catch date column.**

Sample #	Lab	Structure	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		
2	DE	Opercle	12/13/2018	7	1	7	8	4	8	8	1	8	8	3	8	9	2	9	8	5%
34	DE	Otolith	12/13/2018	10	4	10	8	4	8	10	3	10	8	3	8	9	4	10	9.2	10%
37	DE	Spine	12/13/2018	9	1	9	8	3	8	8	4	8	8	3	8	8	3	8	8.2	4%
4	VIMS	Opercle	10/4/2017	4	4	4	7	4	7	2	3	2	2	3	2	2	3	2	3.4	49%
35	VIMS	Otolith	10/4/2017	1	4	1	1	4	1	1	4	1	1	3	1	1	4	1	1	0%
39	VIMS	Spine	10/4/2017	2	3	2	2	4	2	2	4	2	2	2	2	1	4	1	1.8	18%
7	RI	Opercle	11/28/2017	4	4	4	5	2	5	4	4	4	5	3	5	6	2	6	4.8	13%
36	RI	Otolith	11/28/2017	5	2	5	4	4	4	5	2	5	5	2	5	5	2	5	4.8	7%
11	MA	Opercle	5/31/2018	10	4	11	9	4	10	10	4	11	10	4	11	10	4	11	10.8	3%
29	MA	Otolith	5/31/2018	9	4	10	9	4	10	10	4	11	10	4	11	9	4	10	10.4	5%
38	MA	Spine	5/31/2018	9	4	10	8	4	9	9	4	10	9	4	10	10	4	11	10	4%
19	DE	Opercle	11/18/2018	3	3	3	5	4	5	4	4	4	4	3	4	4	4	4	4	10%
31	DE	Otolith	11/18/2018	3	3	3	3	4	3	3	4	3	3	3	3	3	2	3	3	0%
40	DE	Spine	11/18/2018	4	4	4	4	4	4	4	3	4	4	3	4	4	3	4	4	0%
23	MA	Opercle	7/5/2016	1	1	1	1	2	1	2	1	2	1	2	1	2	2	2	1.4	34%
33	MA	Otolith	7/5/2016	1	4	2	2	1	2	2	1	2	2	1	2	1	4	2	2	0%
41	MA	Spine	7/5/2016	2	1	2	1	1	1	2	1	2	2	1	2	2	1	2	1.8	18%
25	VIMS	Opercle	10/1/2017	2	3	2	2	4	2	3	4	3	3	2	3	3	4	3	2.6	18%
32	VIMS	Otolith	10/1/2017	3	3	3	3	4	3	3	4	3	3	3	3	2	3	2	2.8	11%
42	VIMS	Spine	10/1/2017	3	3	3	3	4	3	3	4	3	3	3	3	3	3	3	3	0%
14	RI	Opercle	11/28/2017	4	4	4	4	4	4	4	4	4	4	3	4	4	4	4	4	0%
30	RI	Otolith	11/28/2017	4	2	4	4	3	4	4	4	4	4	3	4	4	2	4	4	0%

Average APE	9.55%
Opercle APE	16.68%
Otolith APE	3.98%
Spine APE	7.24%

Table 19. Symmetry test p-values for inter-lab age comparisons using Bowker's test and CVs (%) for tautog opercula (a), otoliths (b), and pelvic spines (c). P-values appear above the shaded diagonal line and CVs are below. CVs > 5% are highlighted.

(a)

	MA	RI	CT	NY	DE	NJ	VMRC	VIMS
MA		0.32	0.39	0.39	0.37	0.26	0.39	0.37
RI	9		0.32	0.32	0.55	0.39	0.32	0.42
CT	5	8		1.00	0.29	0.22	1.00	0.29
NY	5	8	0		0.29	0.22	1.00	0.29
DE	21	13	17	17		0.61	0.29	0.32
NJ	10	2	6	6	11		0.22	0.39
VMRC	5	8	0	0	17	6		0.29
VIMS	24	15	19	19	3	13	19	

(b)

	MA	RI	NY	NJ	VMRC	VIMS
MA		0.37	0.32	0.37	0.37	0.32
RI	6		0.32	1.00	1.00	0.32
NY	1	5		0.32	0.32	0.37
NJ	6	0	5		1.00	0.32
VMRC	4	2	4	2		0.32
VIMS	4	3	4	3	1	

(c)

	MA	RI	CT	NY	DE	NJ	VMRC	VIMS
MA		0.42	0.42	1.00	0.42	0.42	0.42	0.42
RI	9		1.00	0.42	1.00	1.00	1.00	1.00
CT	9	0		0.42	1.00	1.00	1.00	1.00
NY	0	9	9		0.42	0.42	0.42	0.42
DE	10	1	1	10		1.00	1.00	1.00
NJ	9	0	0	9	1		1.00	1.00
VMRC	9	0	0	9	1	0		1.00
VIMS	10	1	1	10	0	1	1	

Table 20. Percent exact agreement (below the shaded diagonal line) and agreement within one year (above the shaded diagonal line) between readers for tautog opercula (a), otoliths (b), and pelvic spines (c).

(a)

	MA	RI	CT	NY	DE	NJ	VMRC	VIMS
MA		100	88	88	75	88	88	63
RI	63		100	100	100	100	100	88
CT	75	75		100	100	100	100	88
NY	75	75	100		100	100	100	88
DE	25	38	38	38		100	100	100
NJ	63	88	88	88	50		100	88
VMRC	75	75	100	100	38	88		88
VIMS	25	38	38	38	88	50	38	

(b)

	MA	RI	NY	NJ	VMRC	VIMS
MA		88	100	88	100	100
RI	63		88	100	88	88
NY	88	75		88	100	100
NJ	63	100	75		88	88
VMRC	75	88	88	88		100
VIMS	88	75	75	75	88	

(c)

	MA	RI	CT	NY	DE	NJ	VMRC	VIMS
MA		100	100	100	100	100	100	100
RI	67		100	100	100	100	100	100
CT	67	100		100	100	100	100	100
NY	100	67	67		100	100	100	100
DE	50	83	83	50		100	100	100
NJ	67	100	100	67	83		100	100
VMRC	67	100	100	67	83	100		100
VIMS	50	83	83	50	100	83	83	

Table 21. **Ageing worksheet for weakfish at the workshop with the sample number, lab providing the sample, ageing structure, 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.**

Sample #	Lab	Structure	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	NC	Otolith	4/25/2012	4	1	4	4	1	4	4	1	4	4	1	4	4	1	4	4	0%
2	RI	Otolith	9/20/2018	5	3	5	5	3	5	5	3	5	5	2	5	5	2	5	5	0%
3	VMRC	Otolith	6/5/2018	2	1	2	2	1	2	2	1	2	2	1	2	2	2	2	2	0%
4	RI	Otolith	9/17/2018	2	4	2	2	4	2	2	3	2	2	3	2	2	3	2	2	0%
5	NY	Otolith	6/3/2009	15	1	15	15	1	15	15	1	15	14	4	15	15	1	15	15	0%
6	SC	Otolith	11/15/2016	1	4	1	1	4	1	1	4	1	1	4	1	1	4	1	1	0%
7	NC	Otolith	4/20/2016	3	1	3	3	1	3	3	1	3	3	1	3	3	1	3	3	0%
8	VMRC	Otolith	1/11/2018	2	4	3	2	4	3	2	4	3	2	4	3	2	4	3	3	0%
9	SC	Otolith	6/4/2016	3	2	3	3	2	3	3	2	3	3	1	3	3	2	3	3	0%
10	VMRC	Otolith	11/2/2018	0	4	0	0	4	0	0	3	0	0	4	0	0	3	0	0	0%
11	SC	Otolith	6/4/2016	2	1	2	2	2	2	2	1	2	2	1	2	2	2	2	2	0%
12	VMRC	Otolith	9/19/2018	4	3	4	4	4	4	4	3	4	4	3	4	4	4	4	4	0%
13	NY	Otolith	5/1/2007	12	4	13	12	4	13	12	4	13	12	4	13	12	4	13	13	0%
14	NY	Otolith	9/17/2008	9	3	9	9	3	9	9	2	9	9	2	9	9	3	9	9	0%
15	VIMS	Otolith	5/15/2013	4	1	4	4	1	4	4	1	4	4	1	4	4	1	4	4	0%
16	VIMS	Otolith	10/1/2013	3	4	3	3	4	3	3	4	3	3	3	3	3	3	3	3	0%
17	RI	Otolith	9/17/2018	1	3	1	1	4	1	1	3	1	1	3	1	1	3	1	1	0%
18	NY	Otolith	5/1/2007	10	1	10	10	1	10	10	1	10	9	4	10	10	1	10	10	0%
19	VIMS	Otolith	11/1/2017	1	4	1	1	4	1	1	3	1	1	3	1	1	3	1	1	0%
20	SC	Otolith	10/9/2015	0	4	0	0	4	0	0	4	0	0	3	0	0	3	0	0	0%
																			Average APE	0.00%

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

	NEFSC	NY	DE	NJ	MD	VMRC	VIMS	SC
NEFSC		1	1	1	1	1	1	1
NY	0		1	1	1	1	1	1
DE	0	0		1	1	1	1	1
NJ	0	0	0		1	1	1	1
MD	0	0	0	0		1	1	1
VMRC	0	0	0	0	0		1	1
VIMS	0	0	0	0	0	0		1
SC	0	0	0	0	0	0	0	

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

	NEFSC	NY	DE	NJ	MD	VMRC	VIMS	SC
NEFSC		100	100	100	100	100	100	100
NY	100		100	100	100	100	100	100
DE	100	100		100	100	100	100	100
NJ	100	100	100		100	100	100	100
MD	100	100	100	100		100	100	100
VMRC	100	100	100	100	100		100	100
VIMS	100	100	100	100	100	100		100
SC	100	100	100	100	100	100	100	

Figures

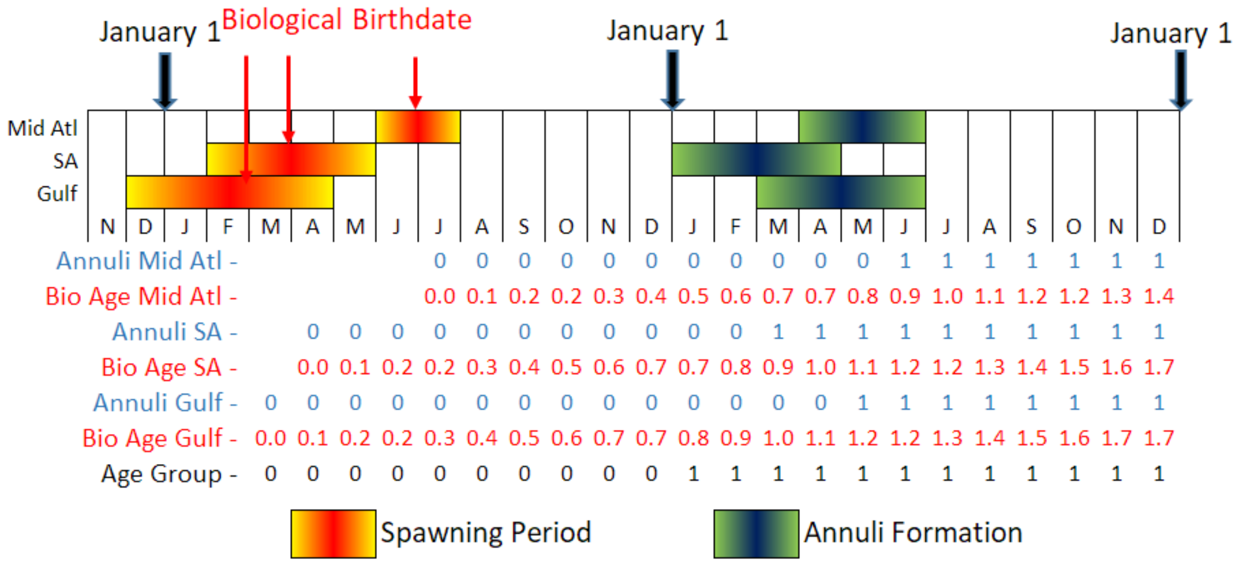


Figure 1. Timeline showing spawning period and annuli deposition ranges for black sea bass from the North Atlantic to the Gulf of Mexico. Source: GSMFC 2020.

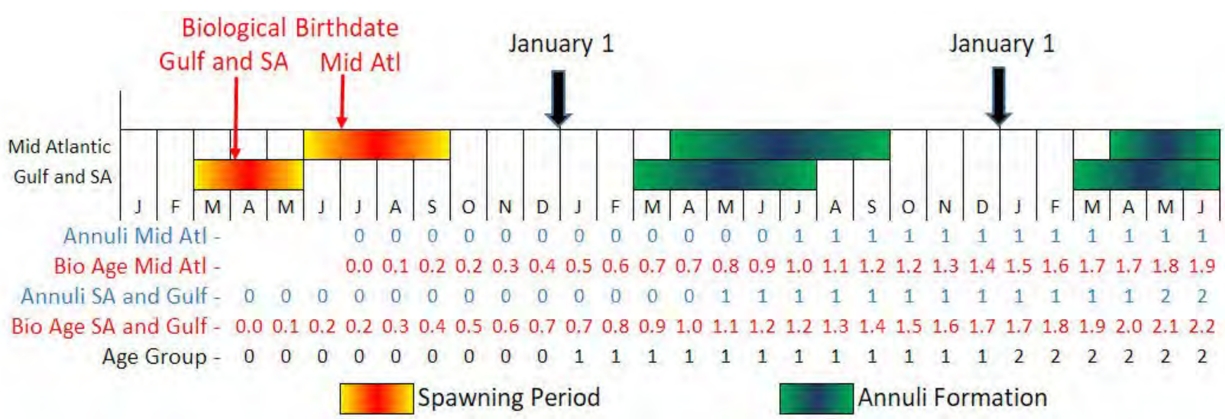


Figure 2. Birthdate assignment timeline for bluefish. Age and year group are based on biological birthdate of July 1 in the Mid-Atlantic and April 1 in the South Atlantic and Gulf. Early spawned fish can have a mark in the core region, or smudge, but it is not generally counted as an annulus. Source: GSMFC 2020.

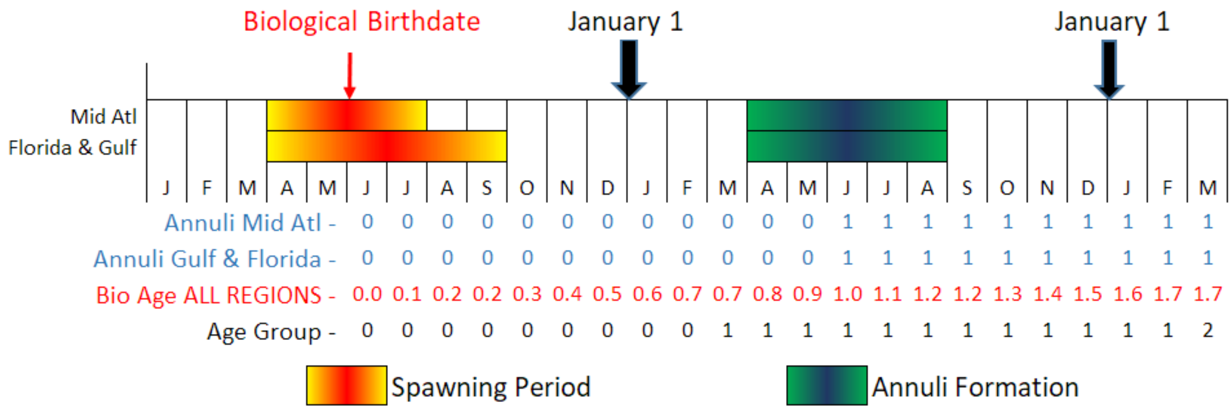


Figure 3. Birthdate assignment timeline for cobia in the Mid-Atlantic (VA to GA), Florida, and Gulf. Biological age is the same for all regions with the accepted June 1 birthdate. Source: GSMFC 2020.

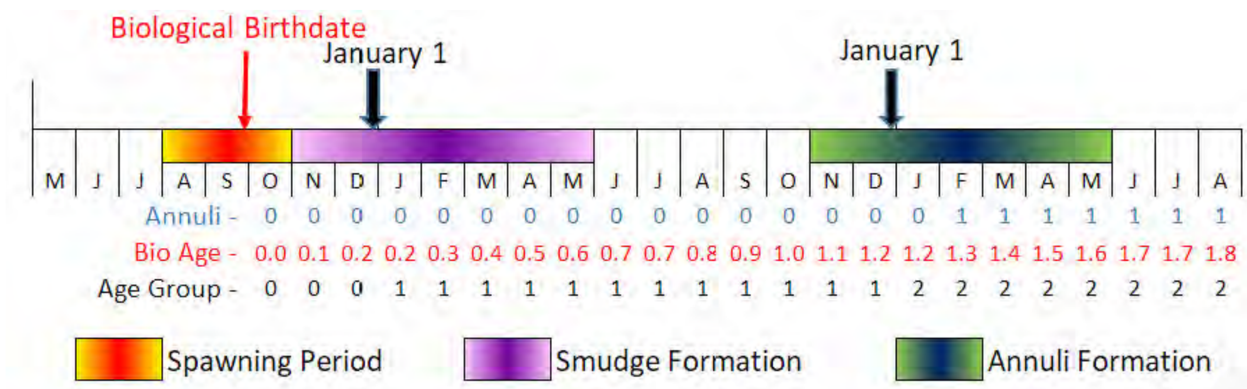


Figure 4. Timeline showing spawning period and annulus deposition ranges for red drum in the Atlantic and Gulf. Source: GSMFC 2020.

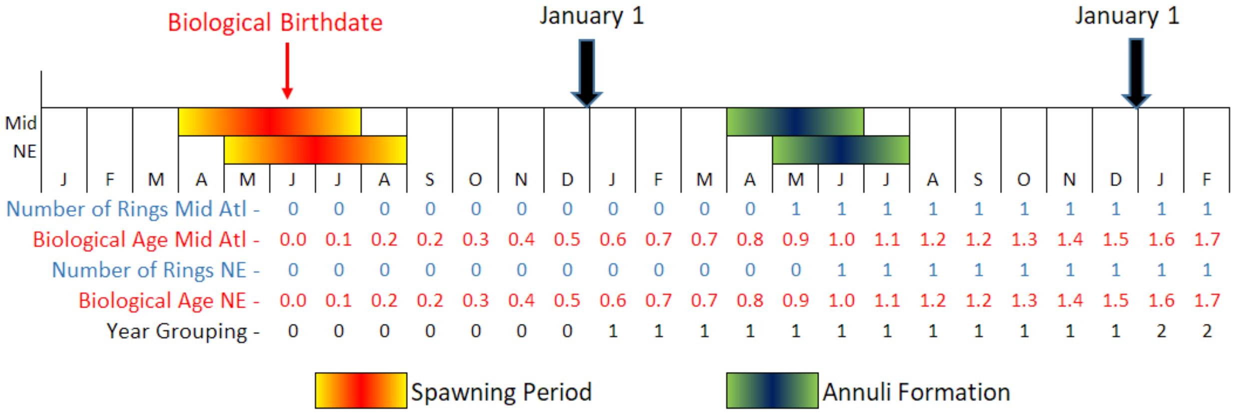


Figure 5. Spawning periodicity and age assignment timeline for scup in New England and Mid-Atlantic waters. Source: GSMFC 2020.

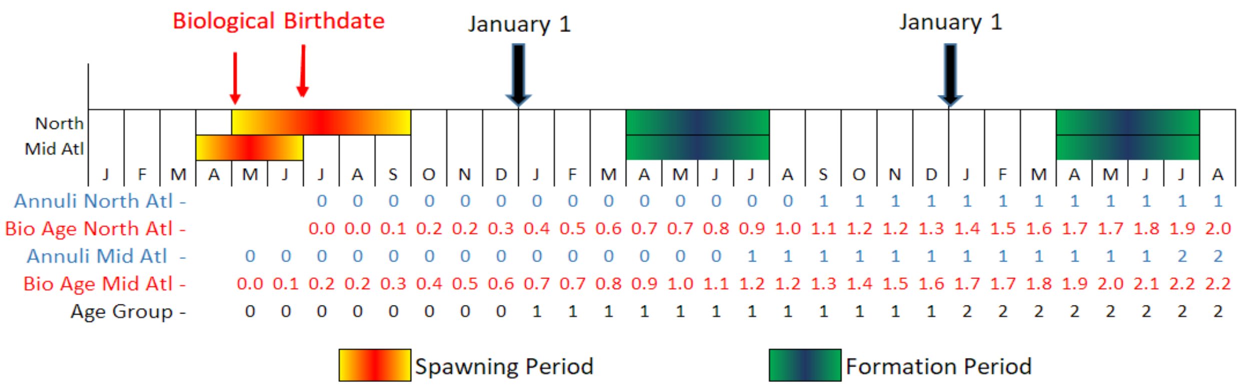


Figure 6. Spawning periodicity and age assignment timeline for tautog in the Mid-Atlantic (VA to GA), and northeastern US. Source: GSMFC 2020.

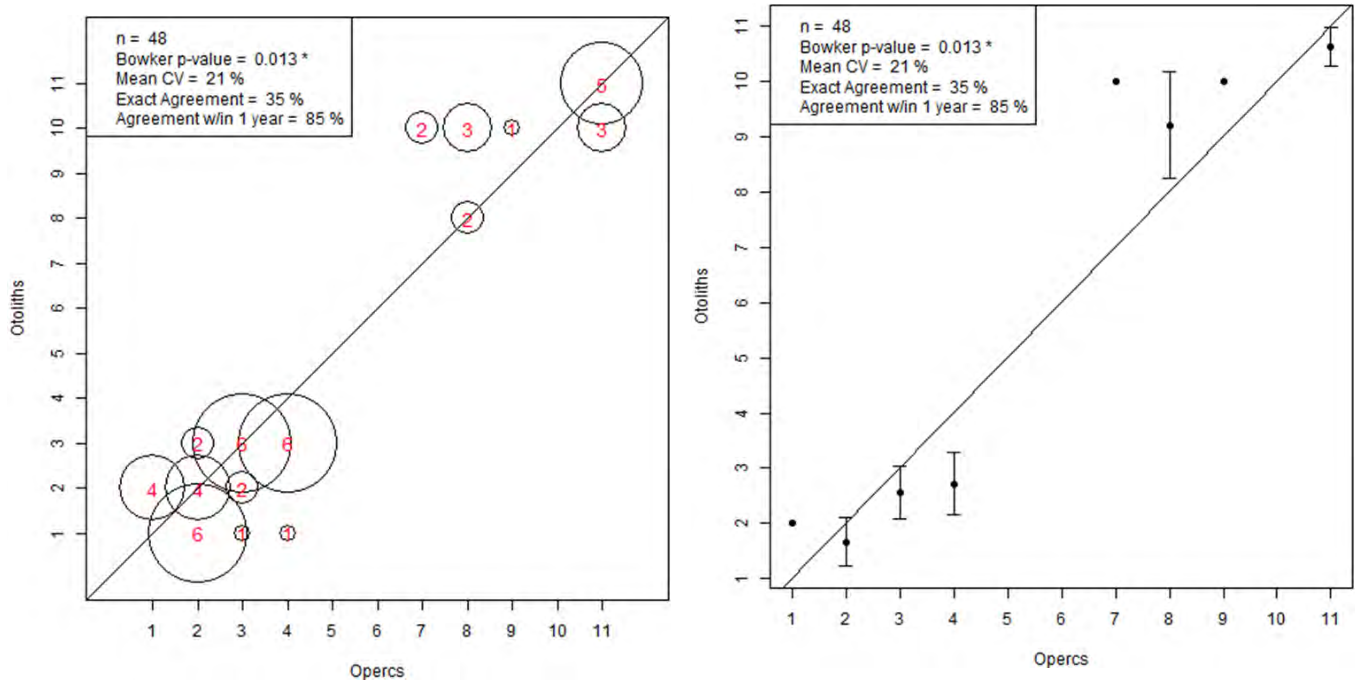


Figure 7. Age frequency (left) and age bias (right) plots for tautog paired opercula and otolith samples. Circles are proportional to number of observations.

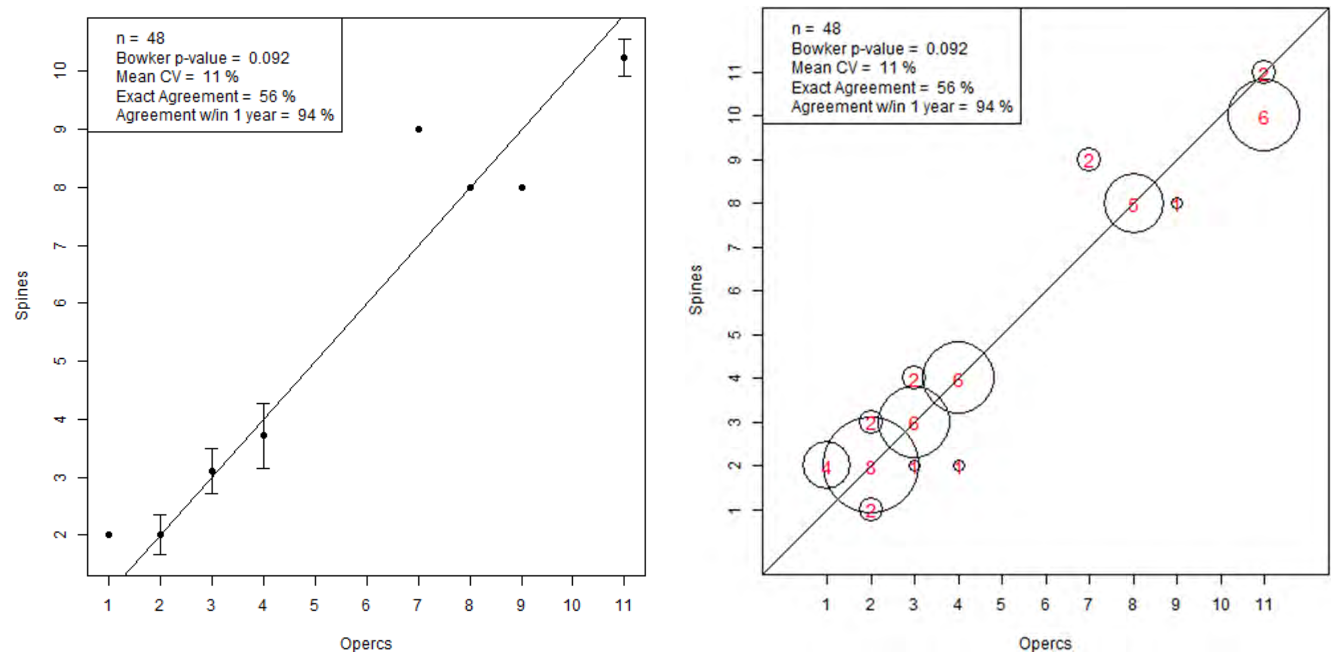


Figure 8. Age frequency (left) and age bias (right) plots for tautog paired opercula and pelvic spine samples. Circles are proportional to number of observations.

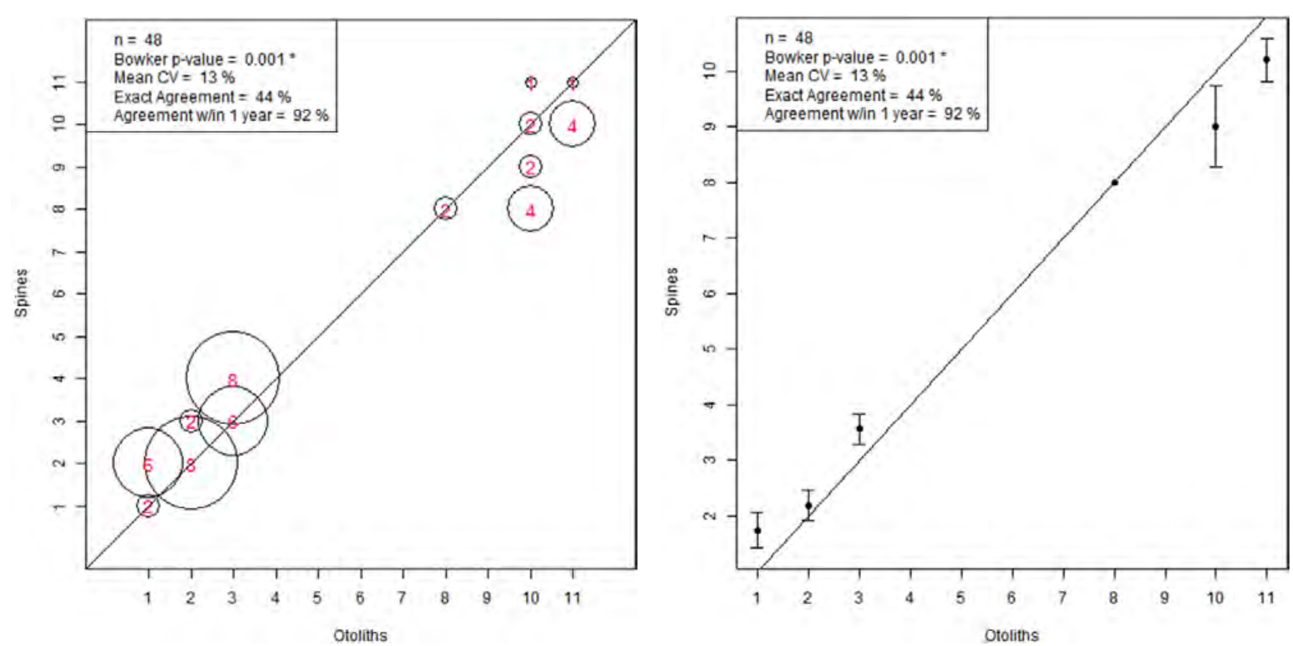


Figure 9. Age frequency (left) and age bias (right) plots for tautog paired otolith and pelvic spine samples. Circles are proportional to number of observations.

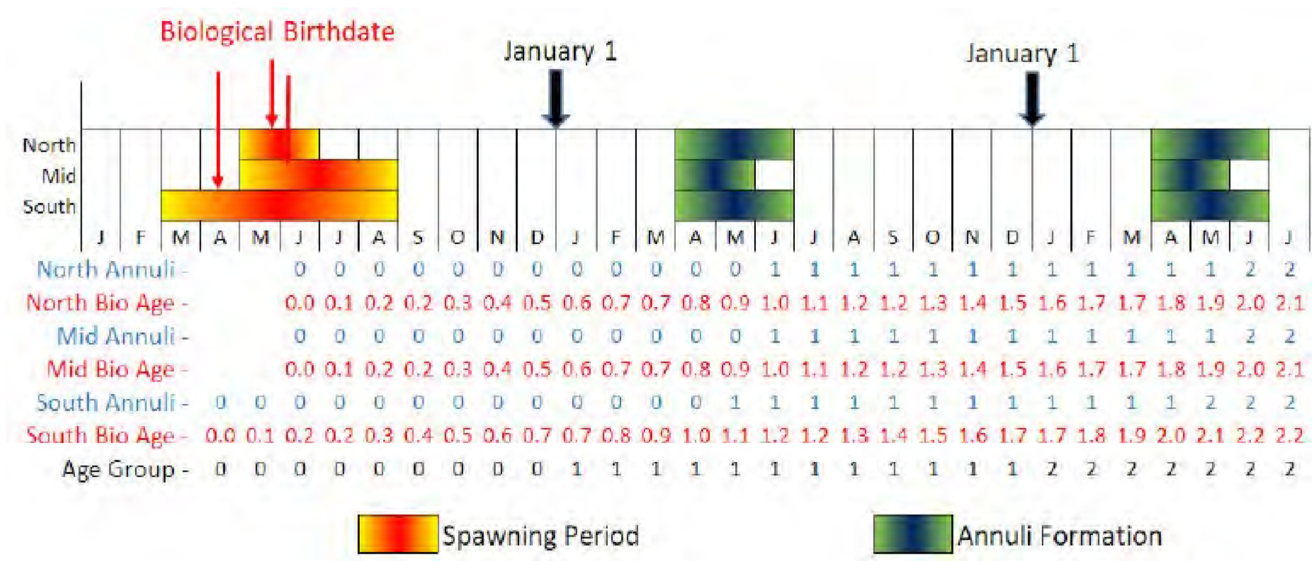


Figure 10. Spawning periodicity and age assignment timeline for weakfish from New England to the South Atlantic. Source: GSMFC.

Appendix A: Agenda

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

Wednesday, March 8th, 2023 – 9:00 a.m. to 5:00 p.m.
Thursday, March 9th, 2023 – 9:00 a.m. to ~12:00 p.m.

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

Agenda

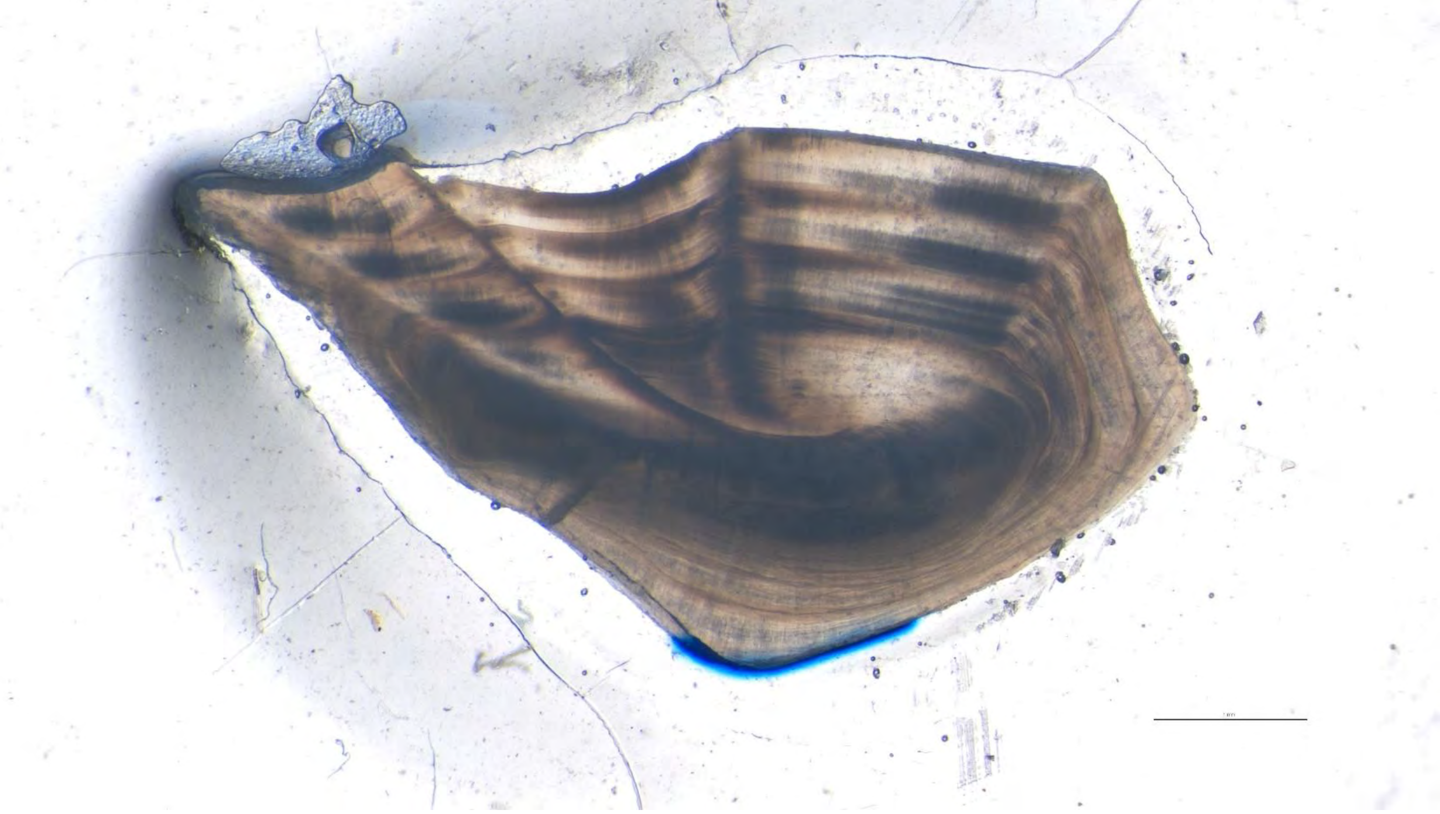
Wednesday, March 8th

- Introductions
- Conduct age readings for tautog, black sea bass, bluefish, scup, red drum, cobia (new), and weakfish (new)

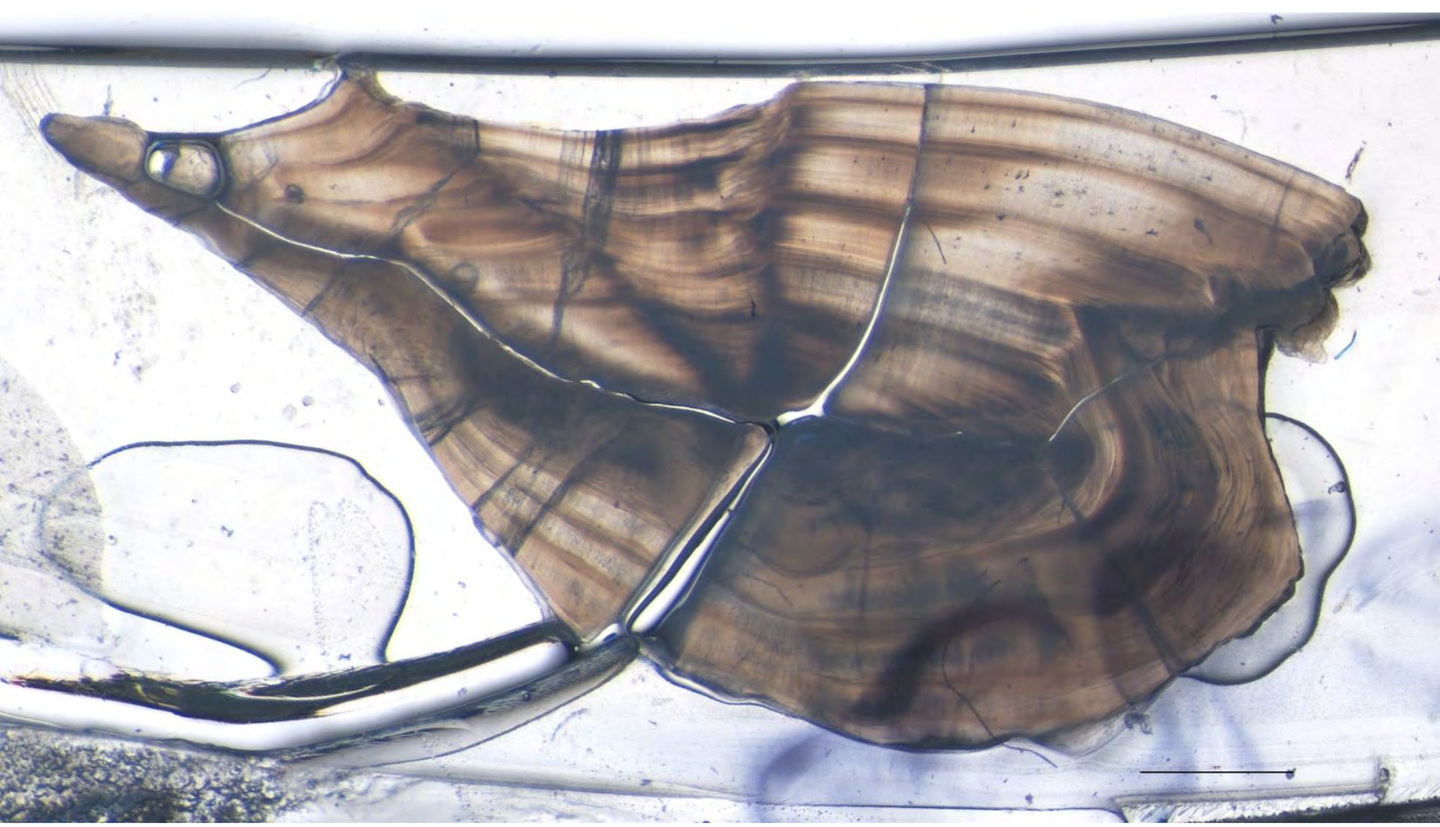
Thursday, March 9th

- Review comparison of ages by group and participant
- Discussion of issues and differences encountered during age reading exercise
- Make recommendations
- Other Business
- Adjourn

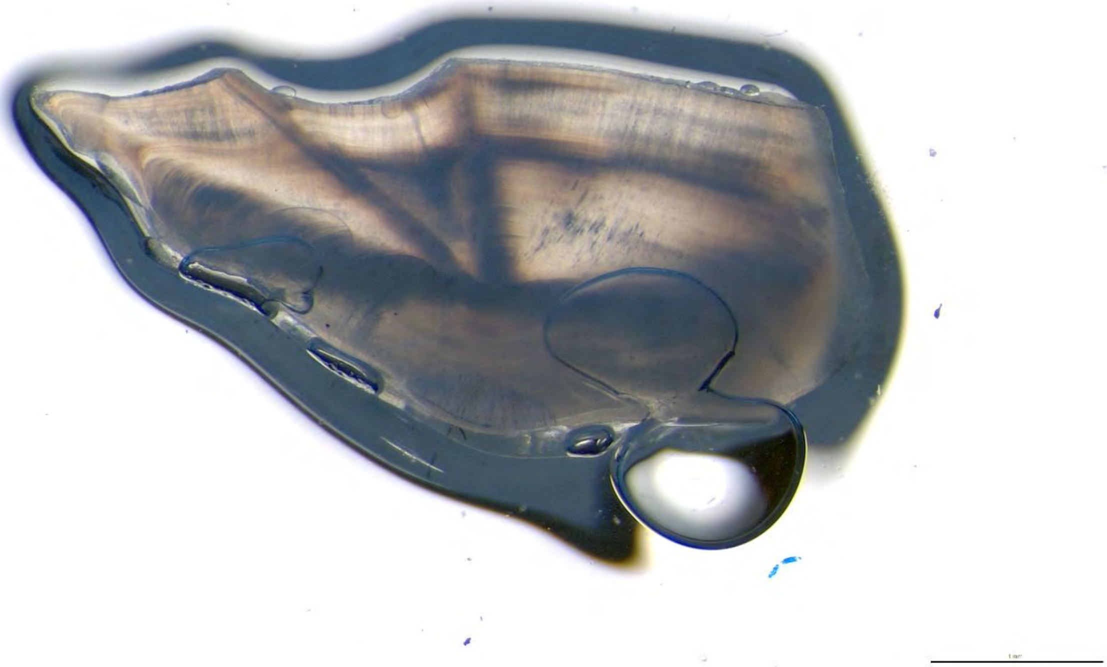
Appendix B: Sample Photos



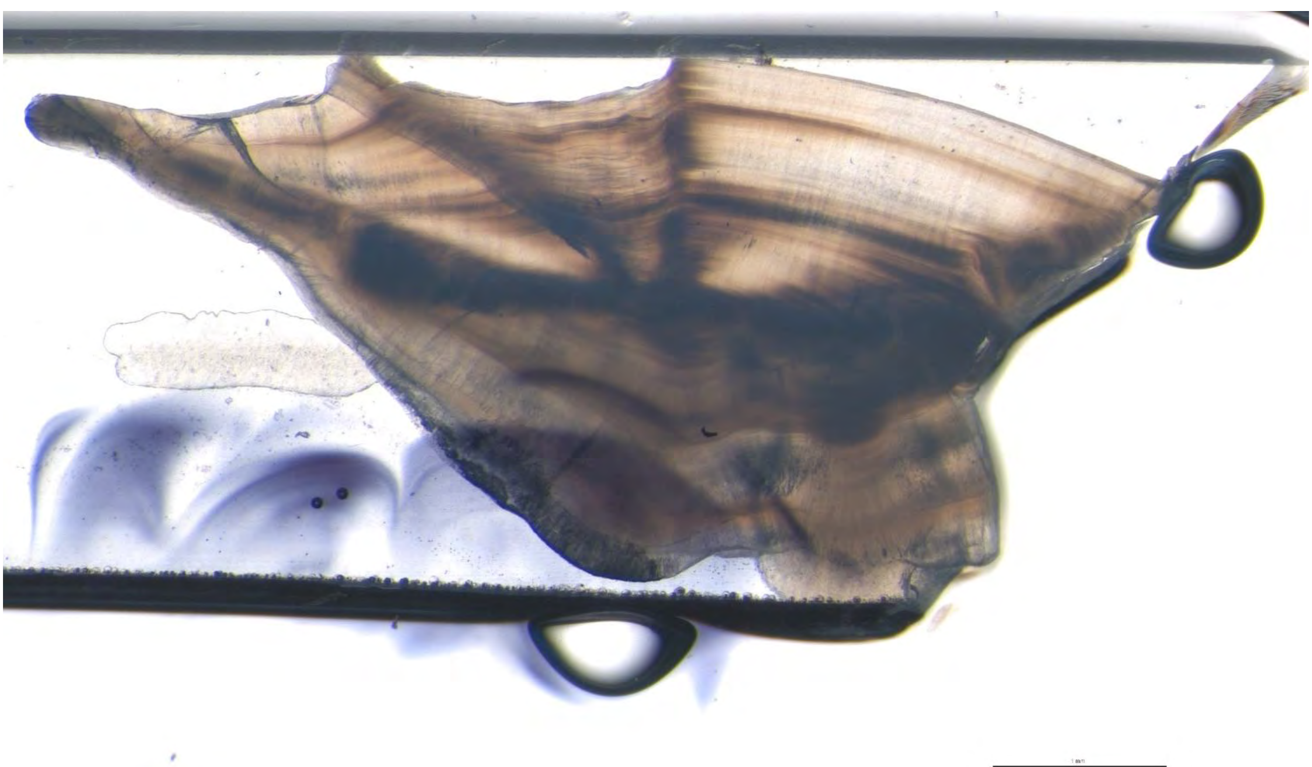
Weakfish 1 4/25/2012



Weakfish 2 9/20/2018



Weakfish 3 6/5/2018

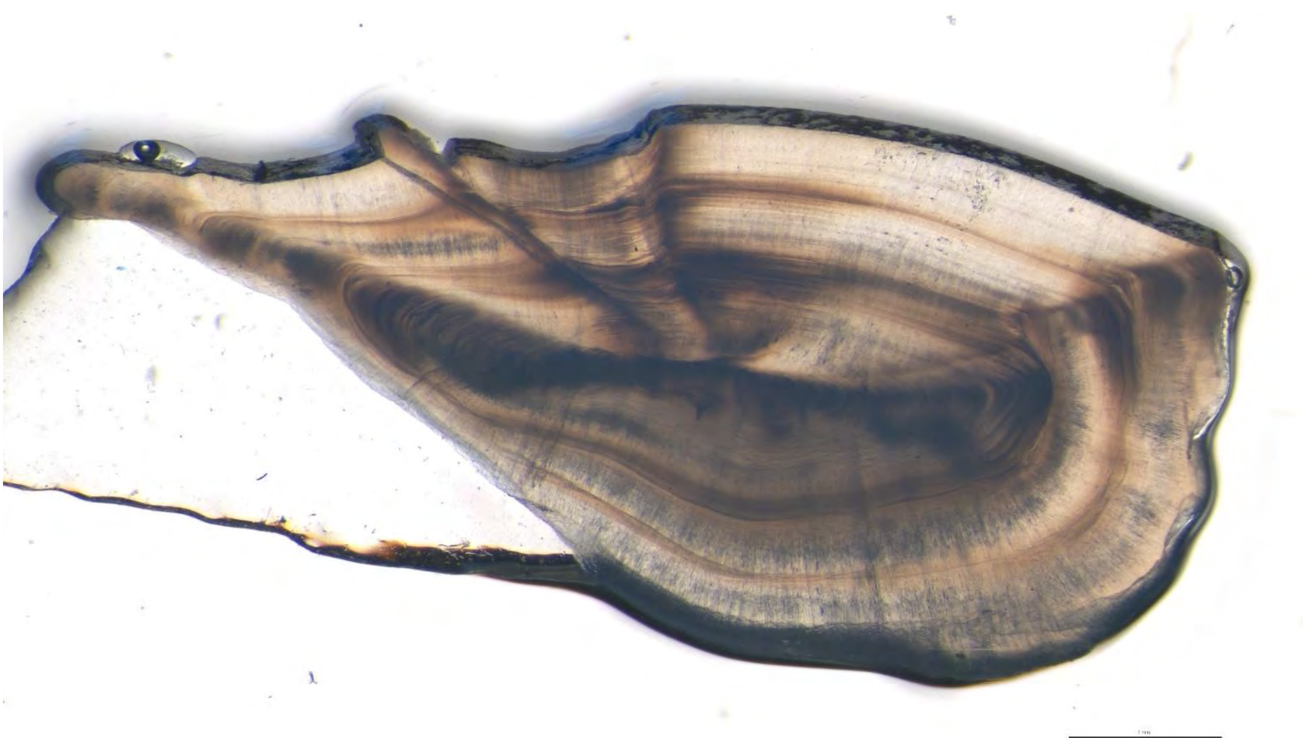


Weakfish 4 9/17/2018

Weakfish 5 6/3/2009

Weakfish 6 11/15/2016

Weakfish 7 4/20/2016

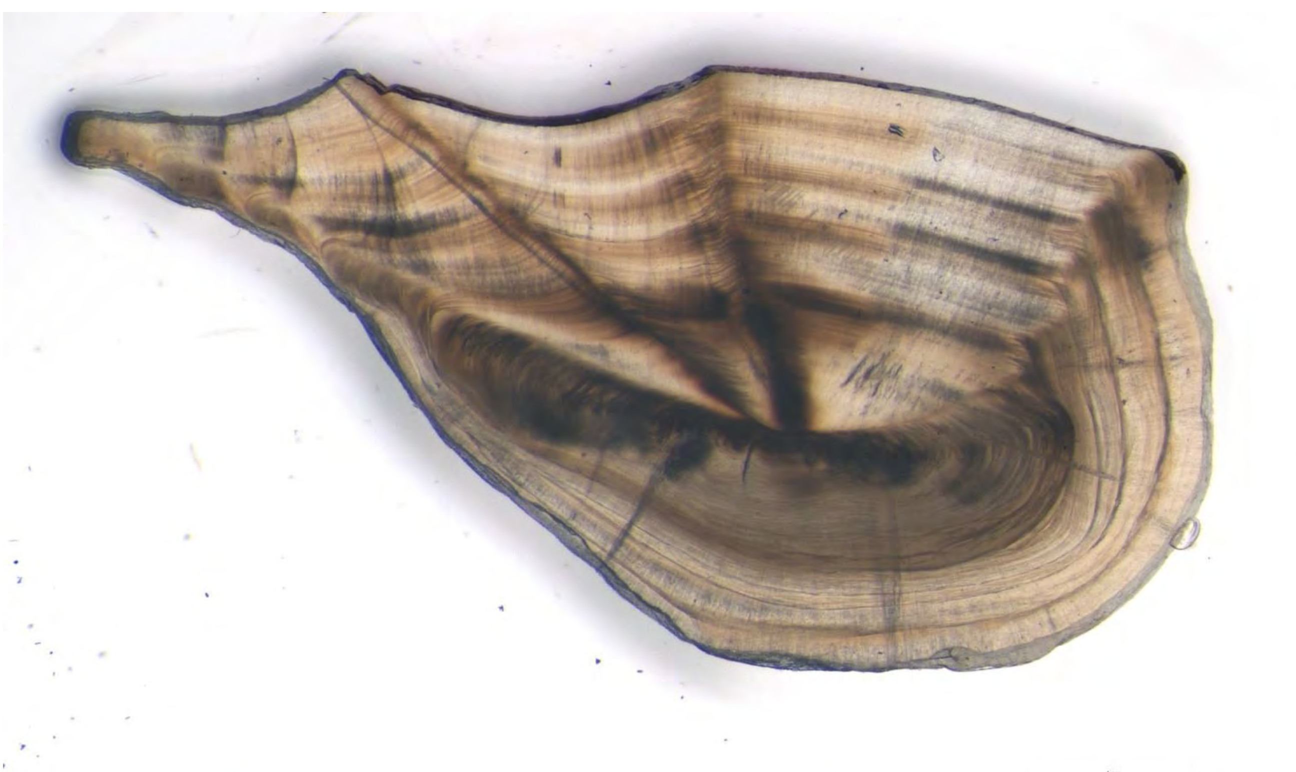


Weakfish 8 1/11/2018

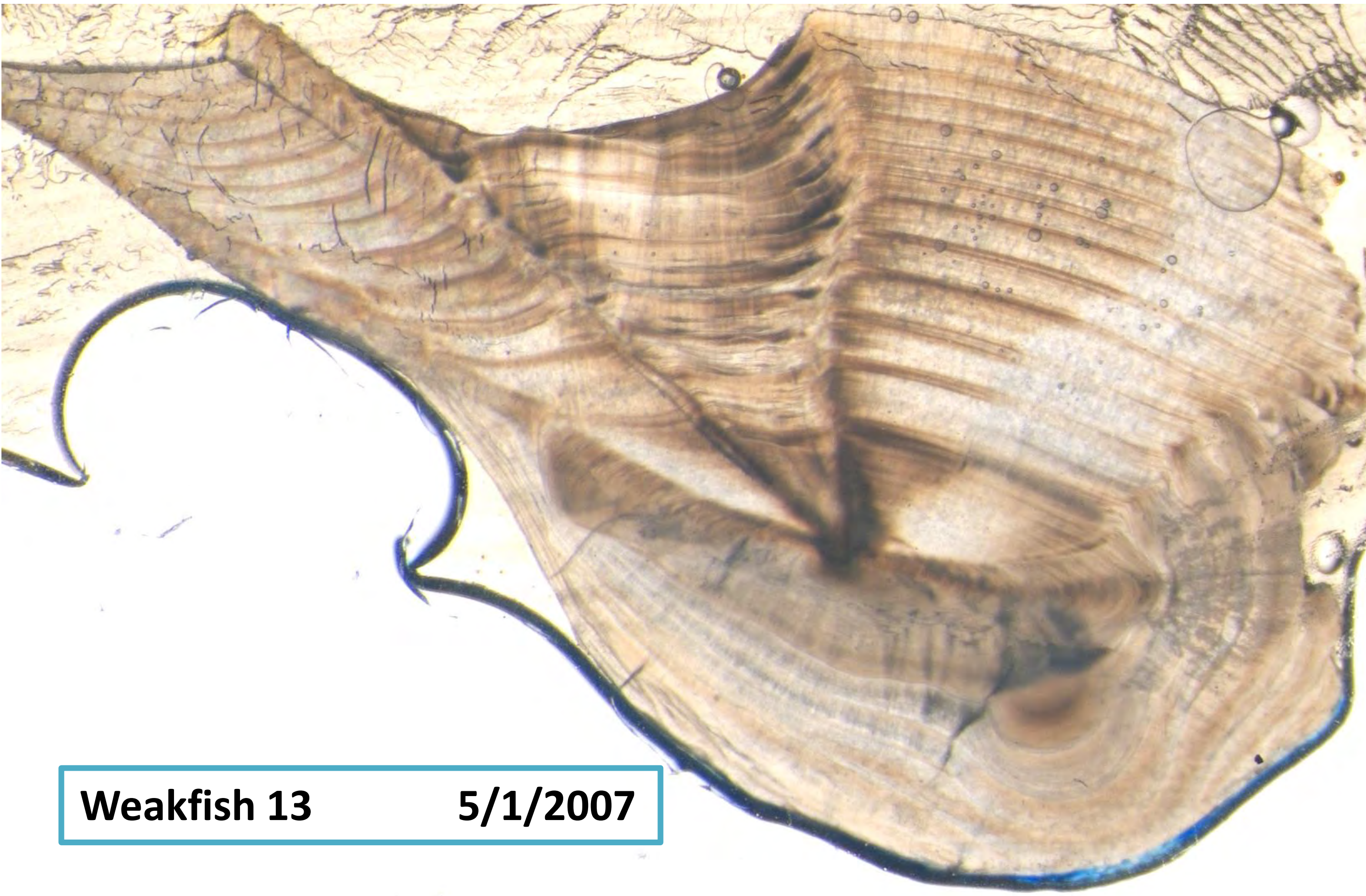
Weakfish 9 6/4/2016

Weakfish 10 11/2/2018

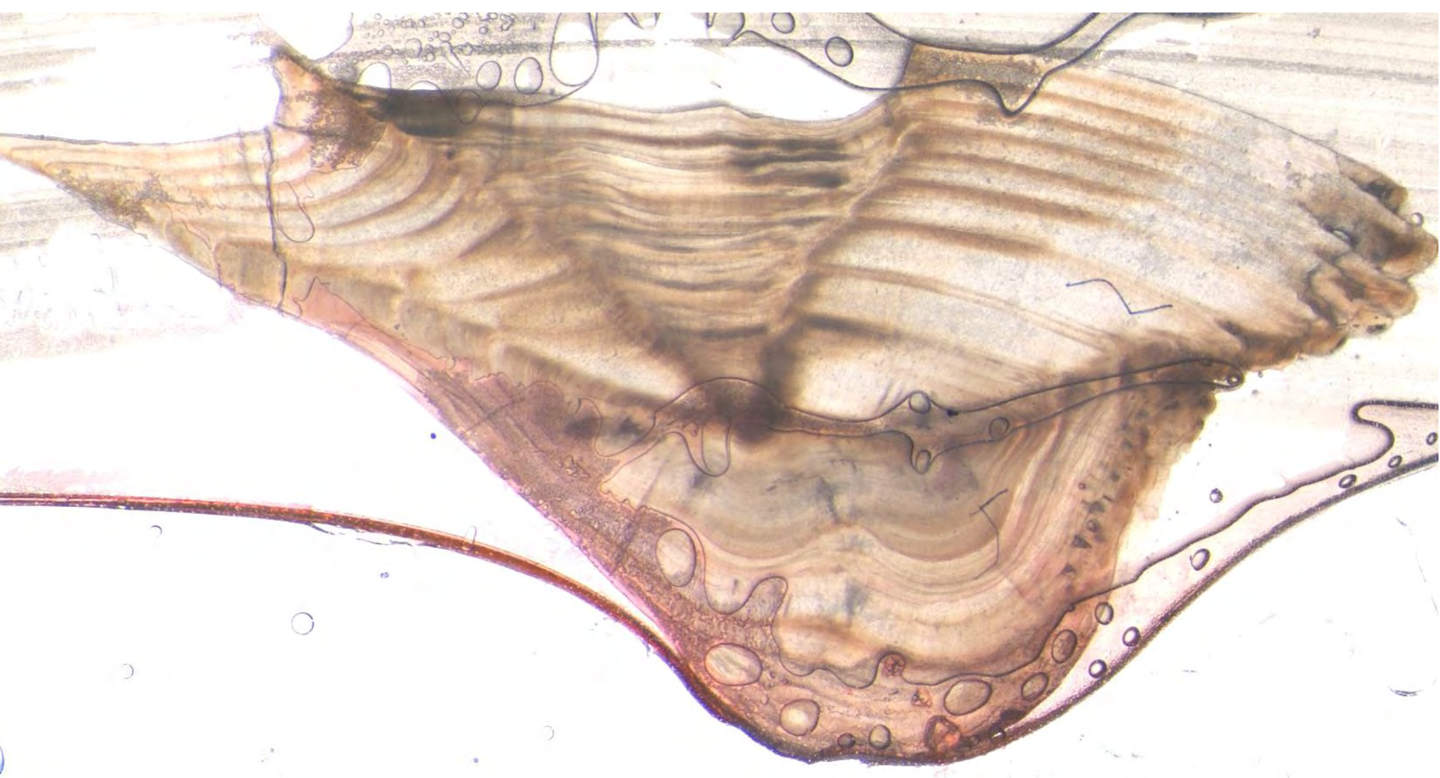
Weakfish 11 6/4/2016



Weakfish 12 9/19/2018



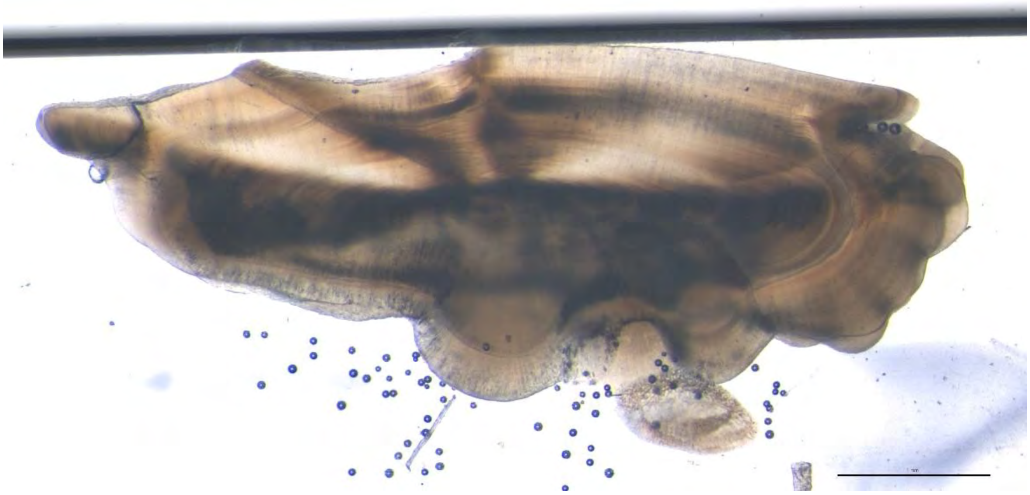
Weakfish 13 5/1/2007



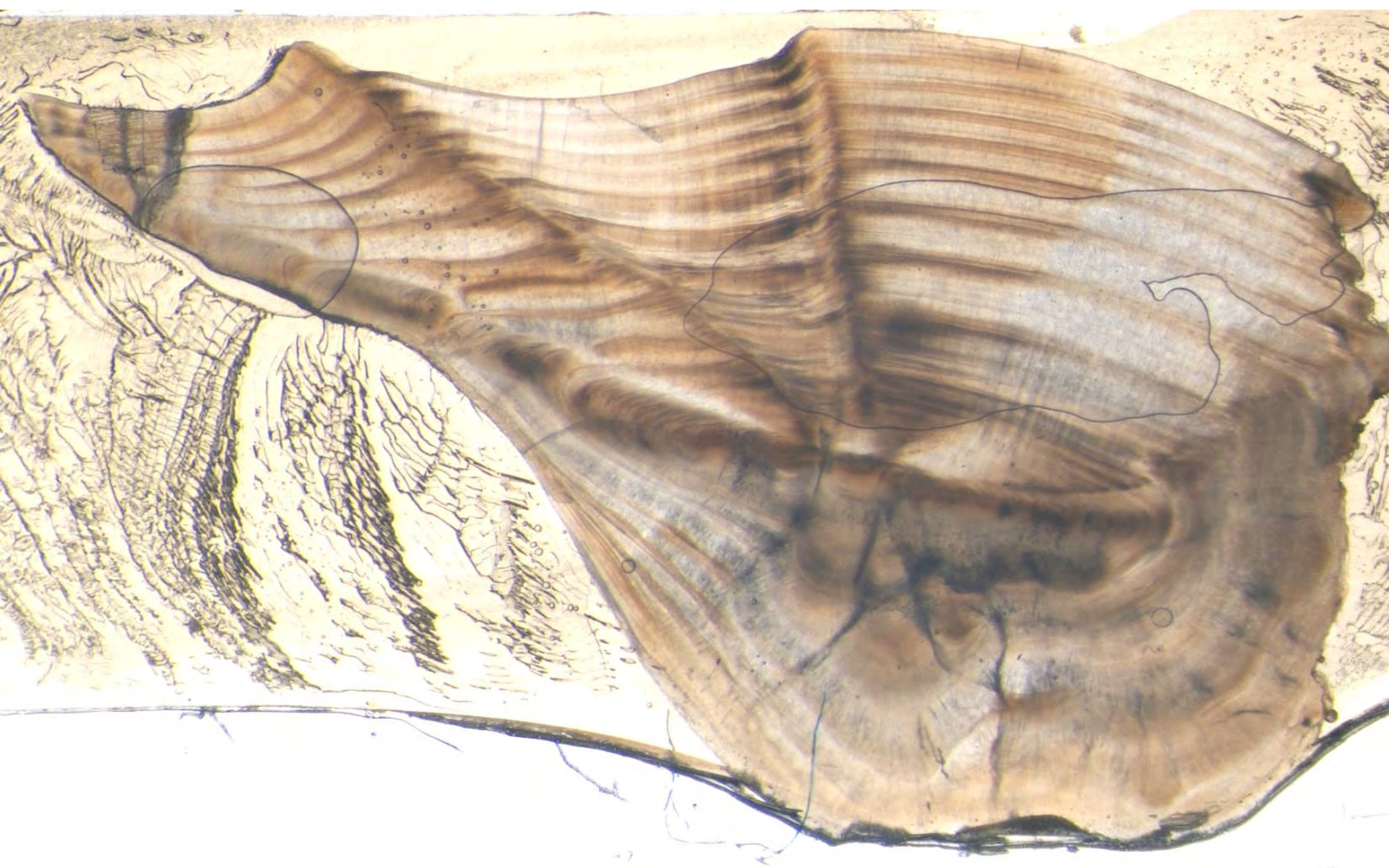
Weakfish 14 9/17/2008

Weakfish 15 5/15/2013

Weakfish 16 10/1/2013



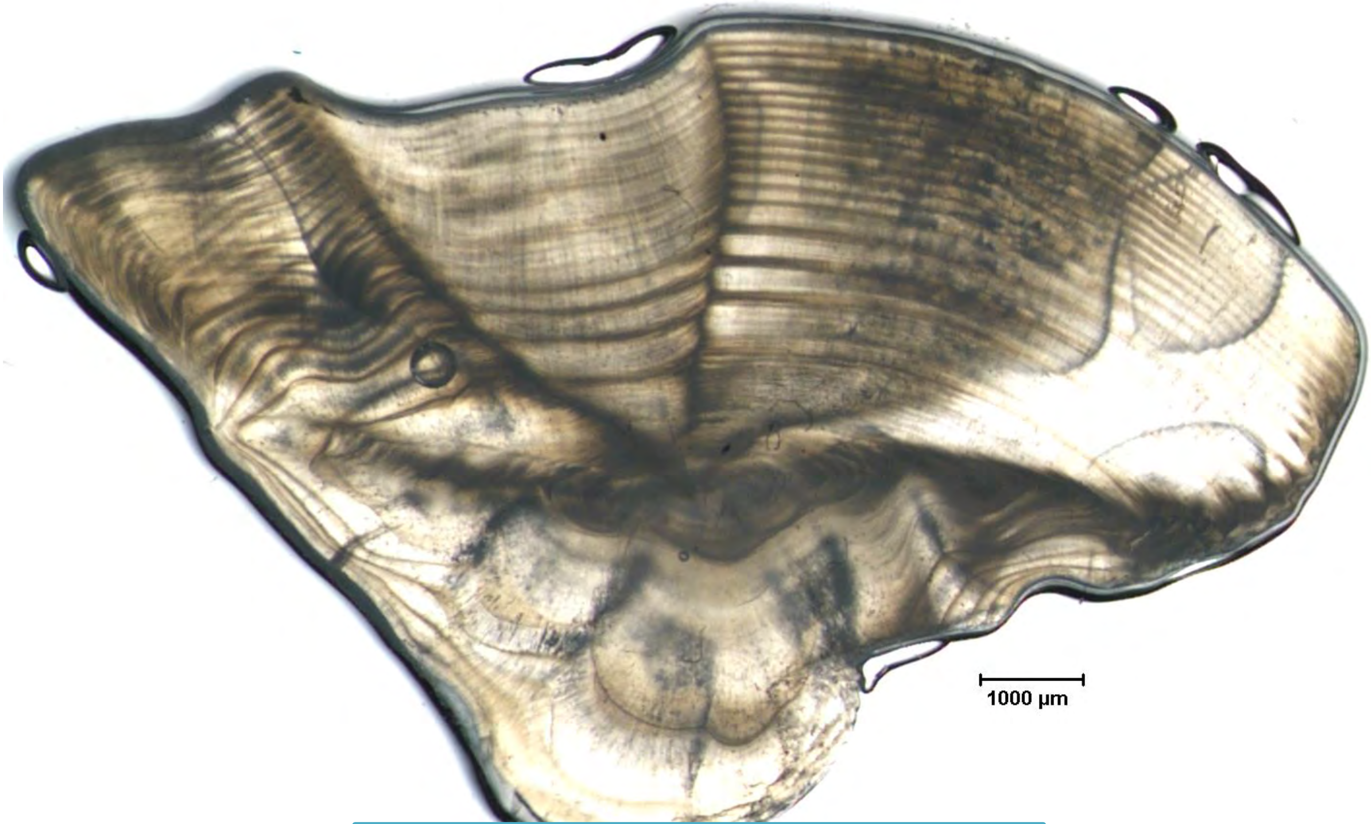
Weakfish 17 9/17/2018



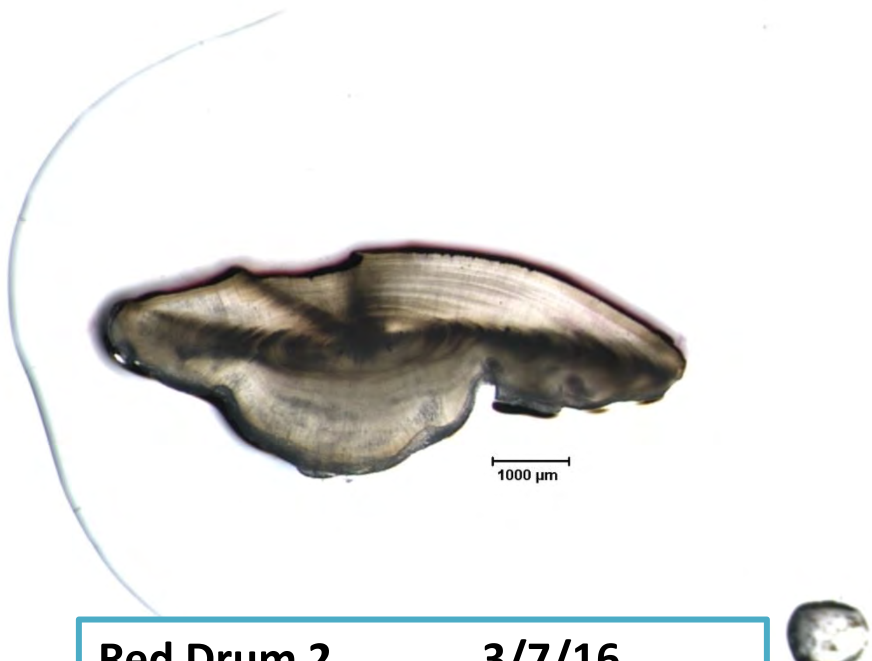
Weakfish 18 5/1/2007

Weakfish 19 **11/1/2017**

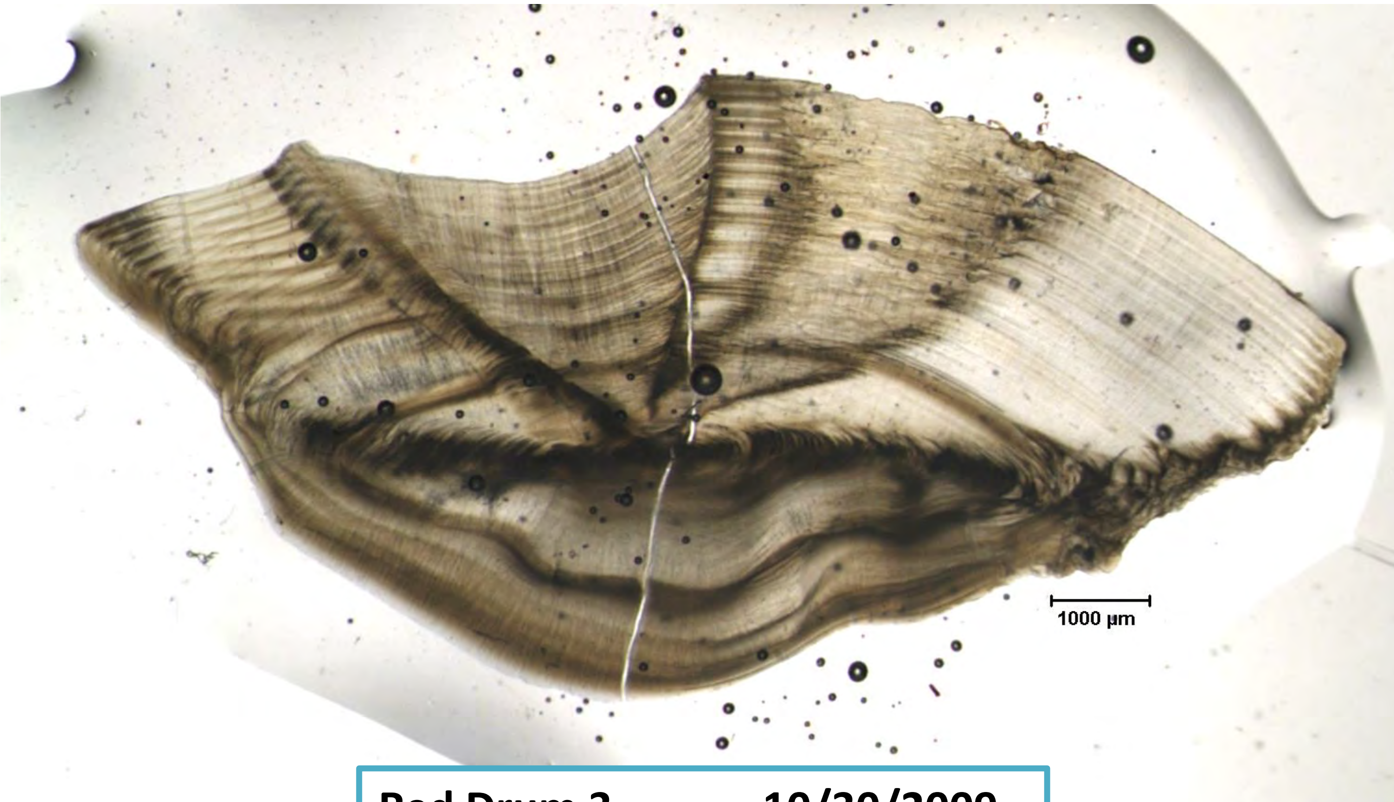
Weakfish 20 **10/9/2015**



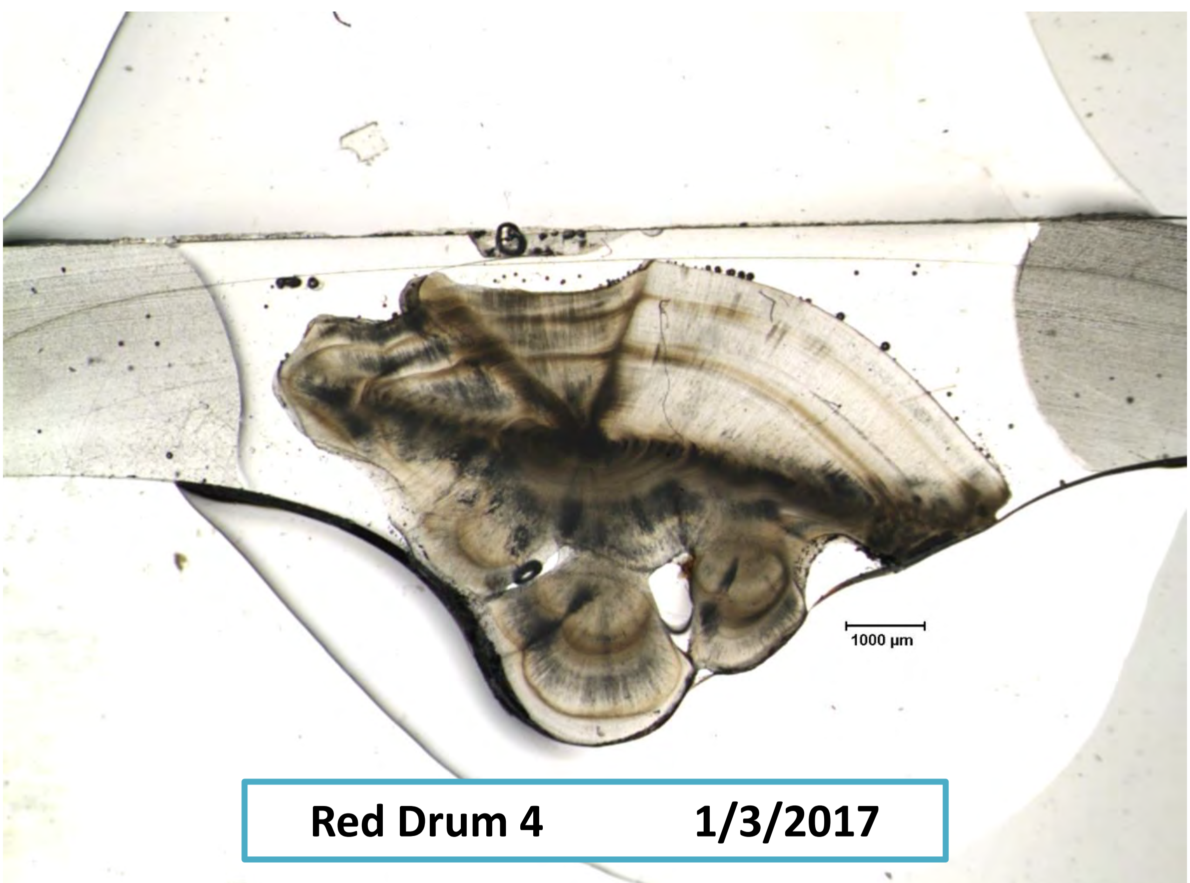
Red Drum 1 11/19/2002



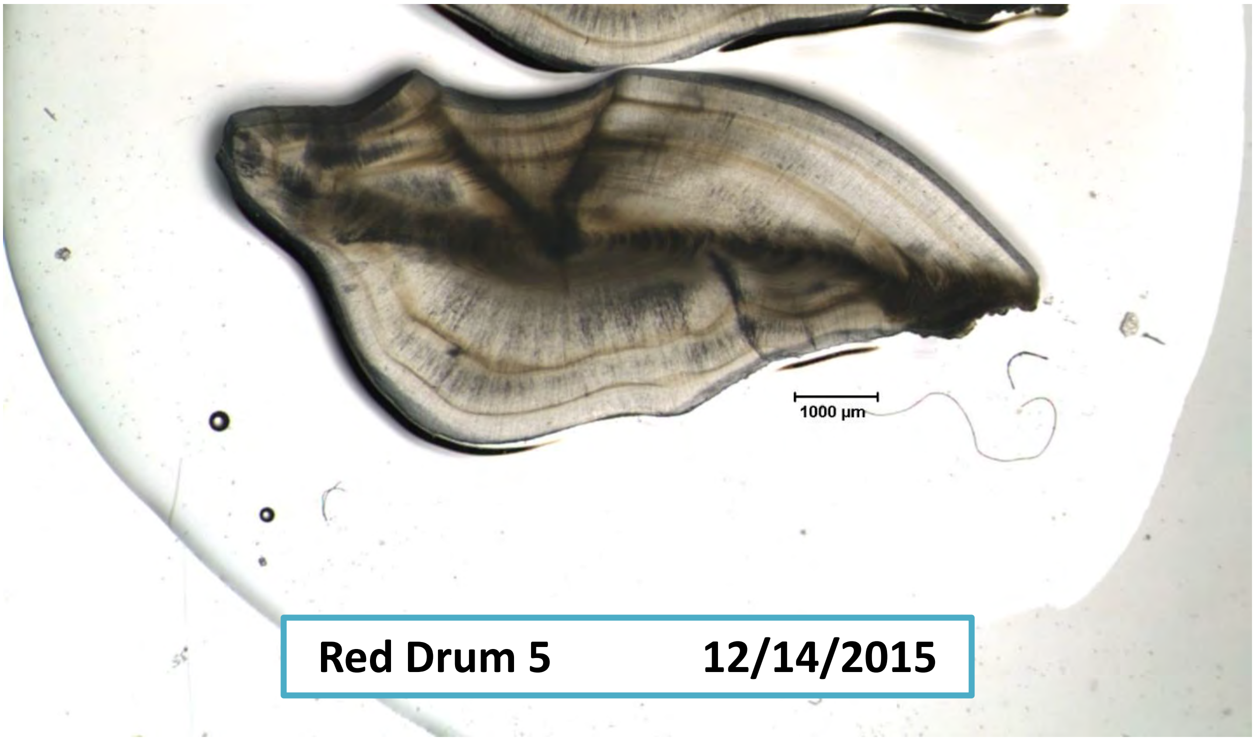
Red Drum 2 3/7/16



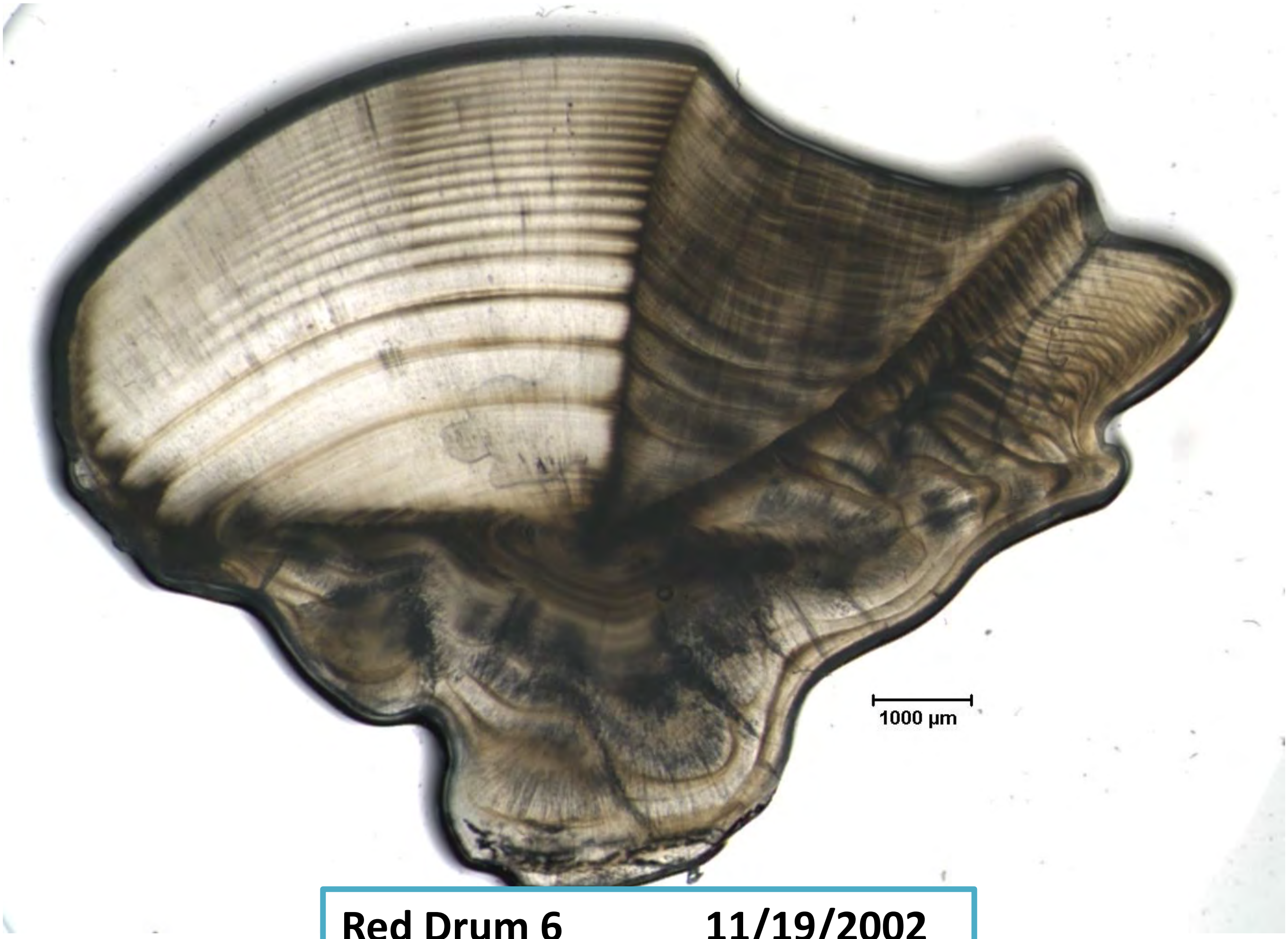
Red Drum 3 10/30/2009



Red Drum 4 1/3/2017



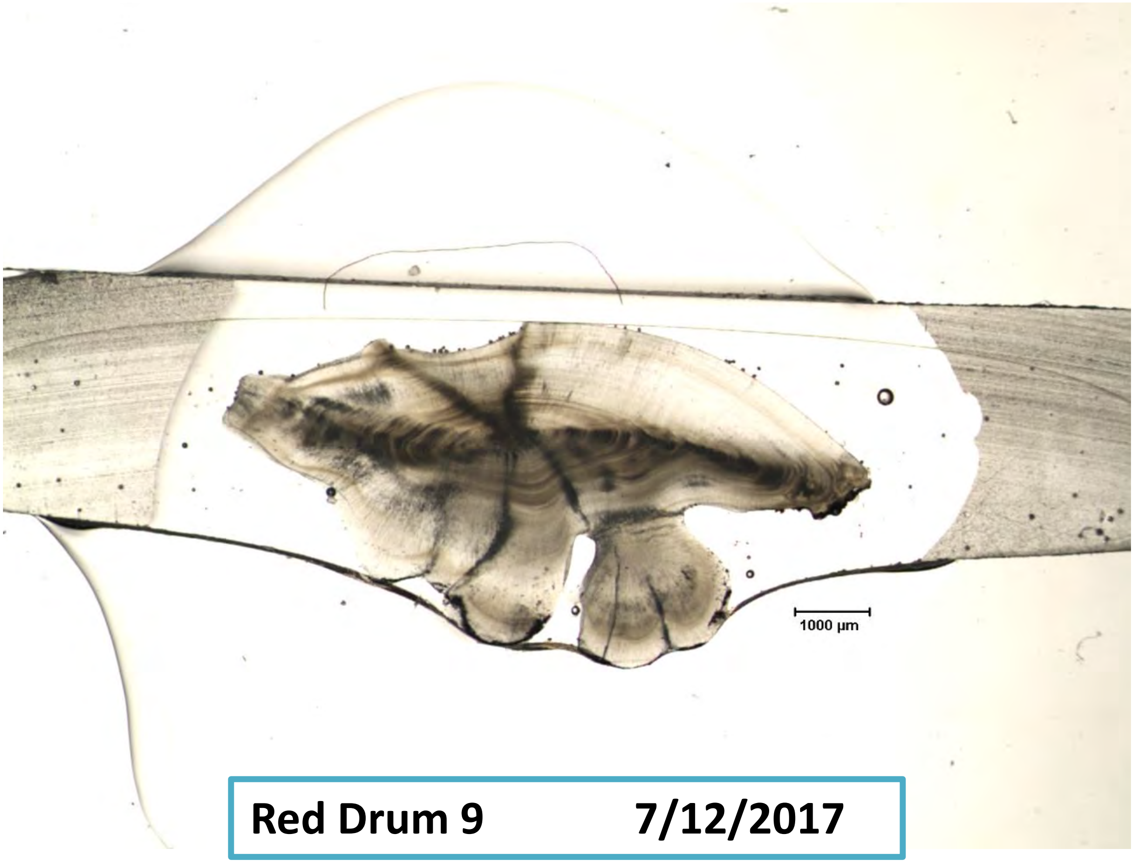
Red Drum 5 12/14/2015



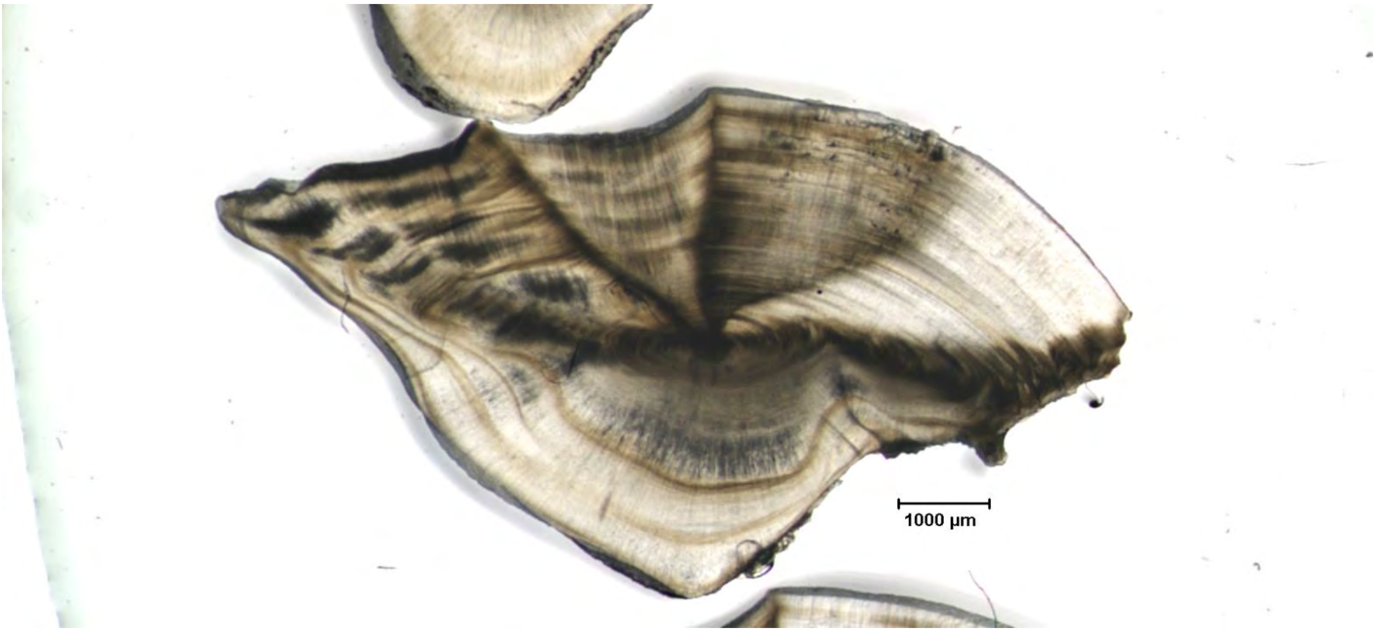
Red Drum 6 11/19/2002

Red Drum 7 5/18/2016

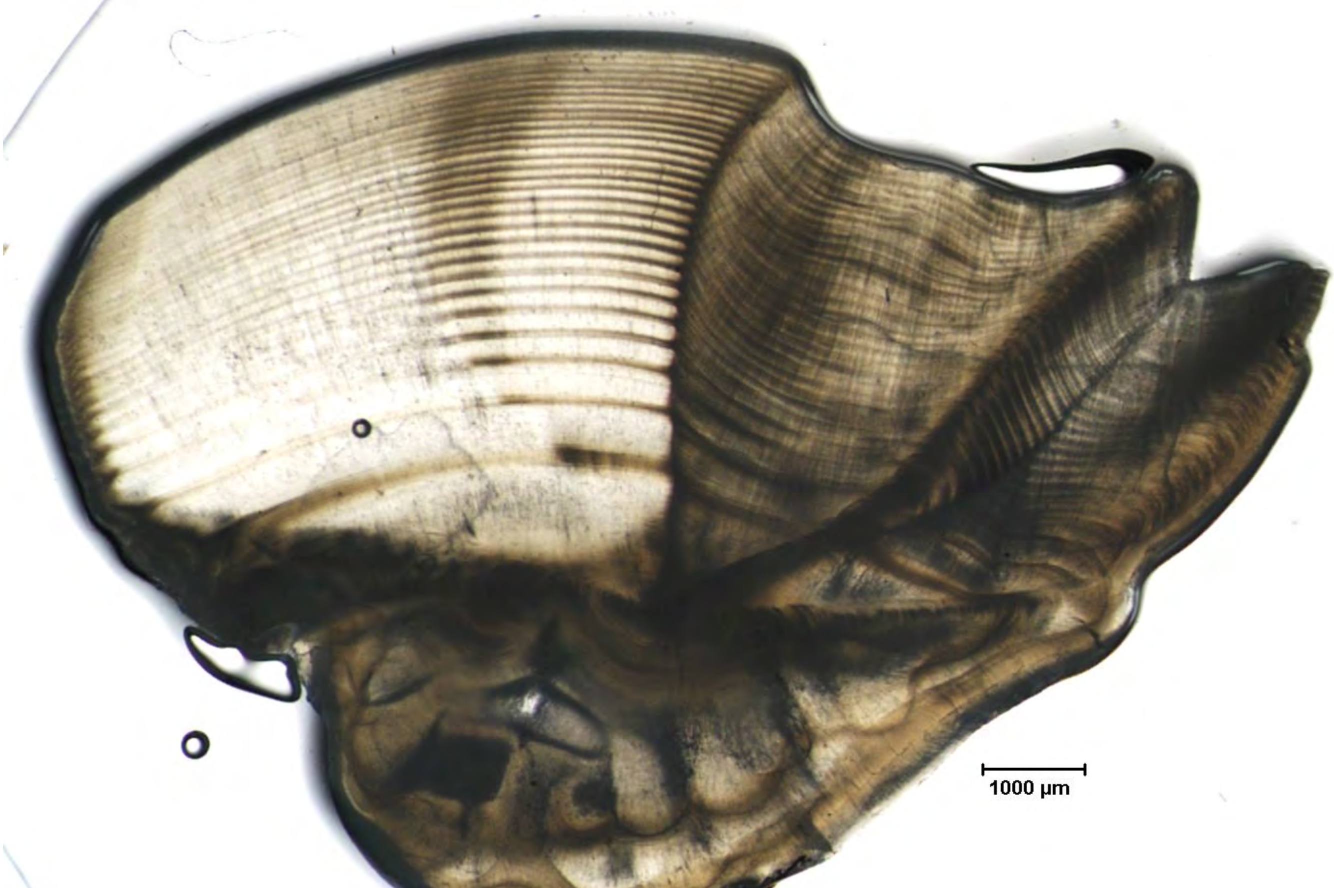
Red Drum 8 10/25/2013



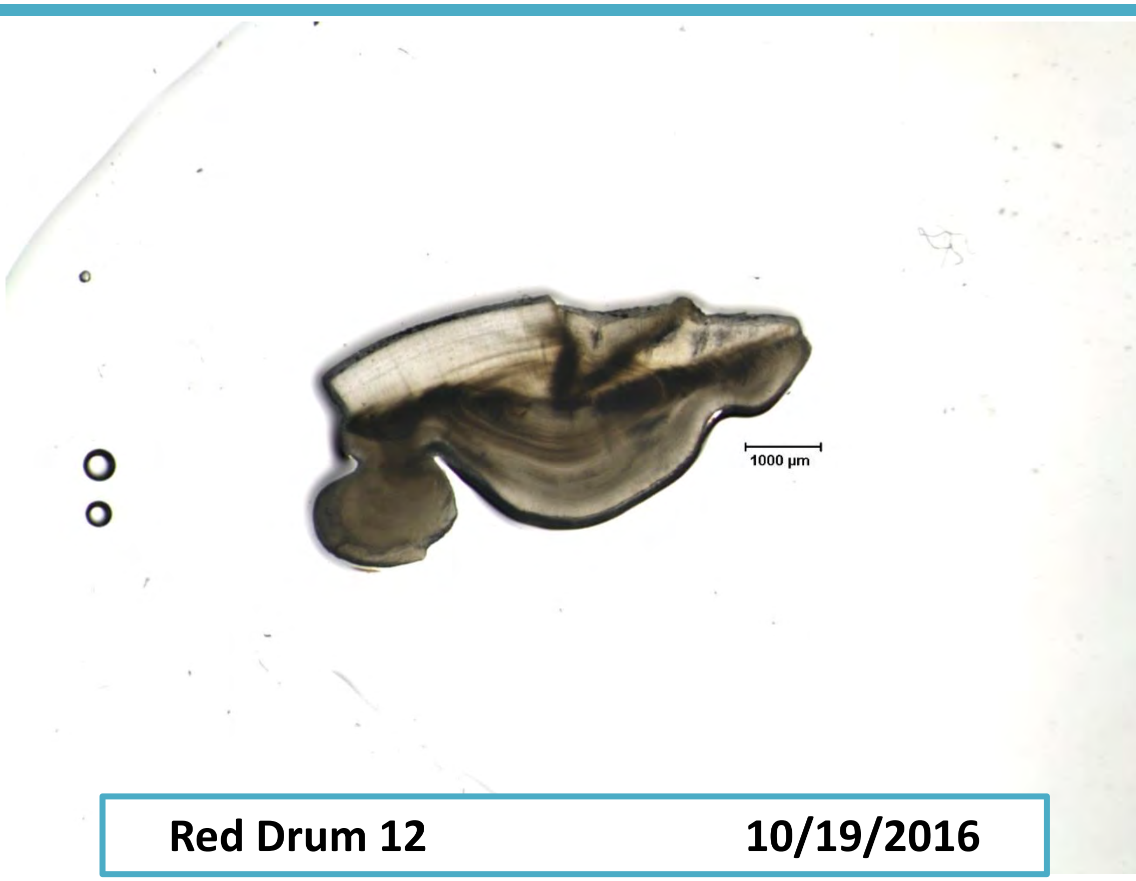
Red Drum 9 7/12/2017



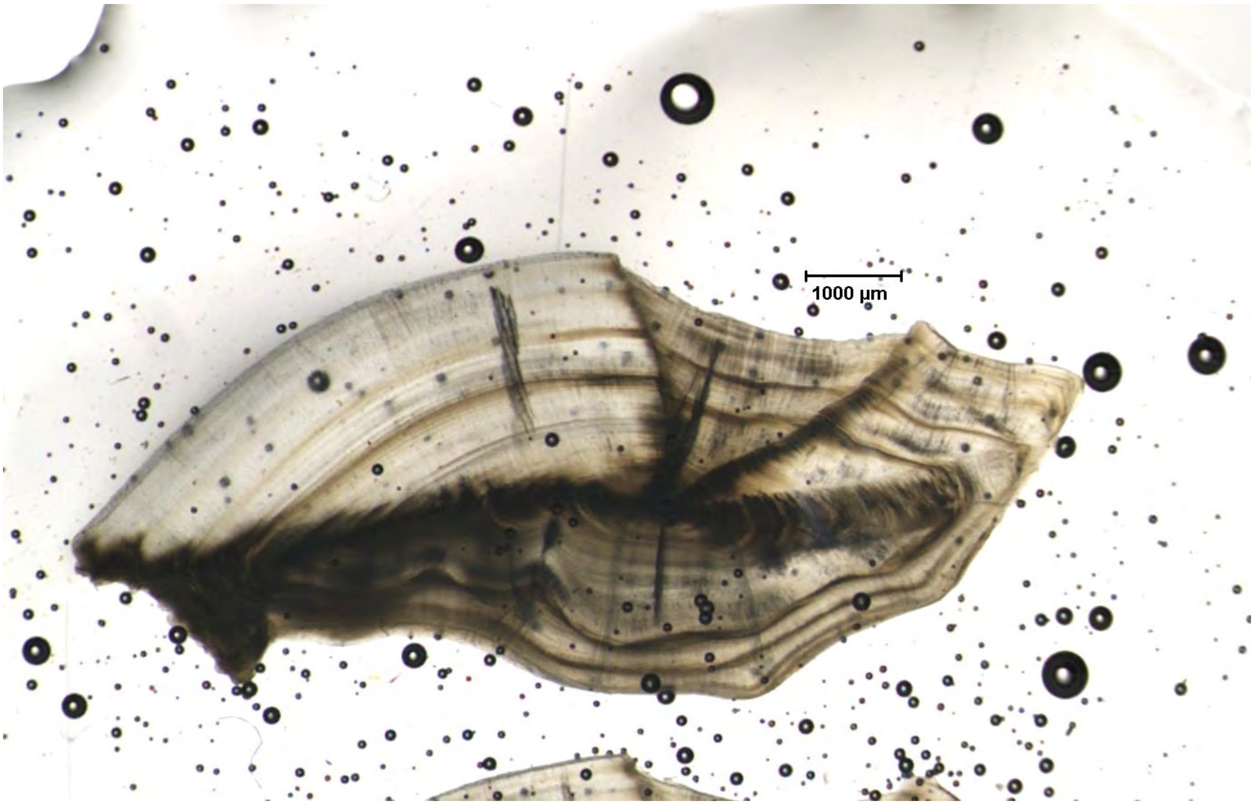
Red Drum 10 8/2/2014



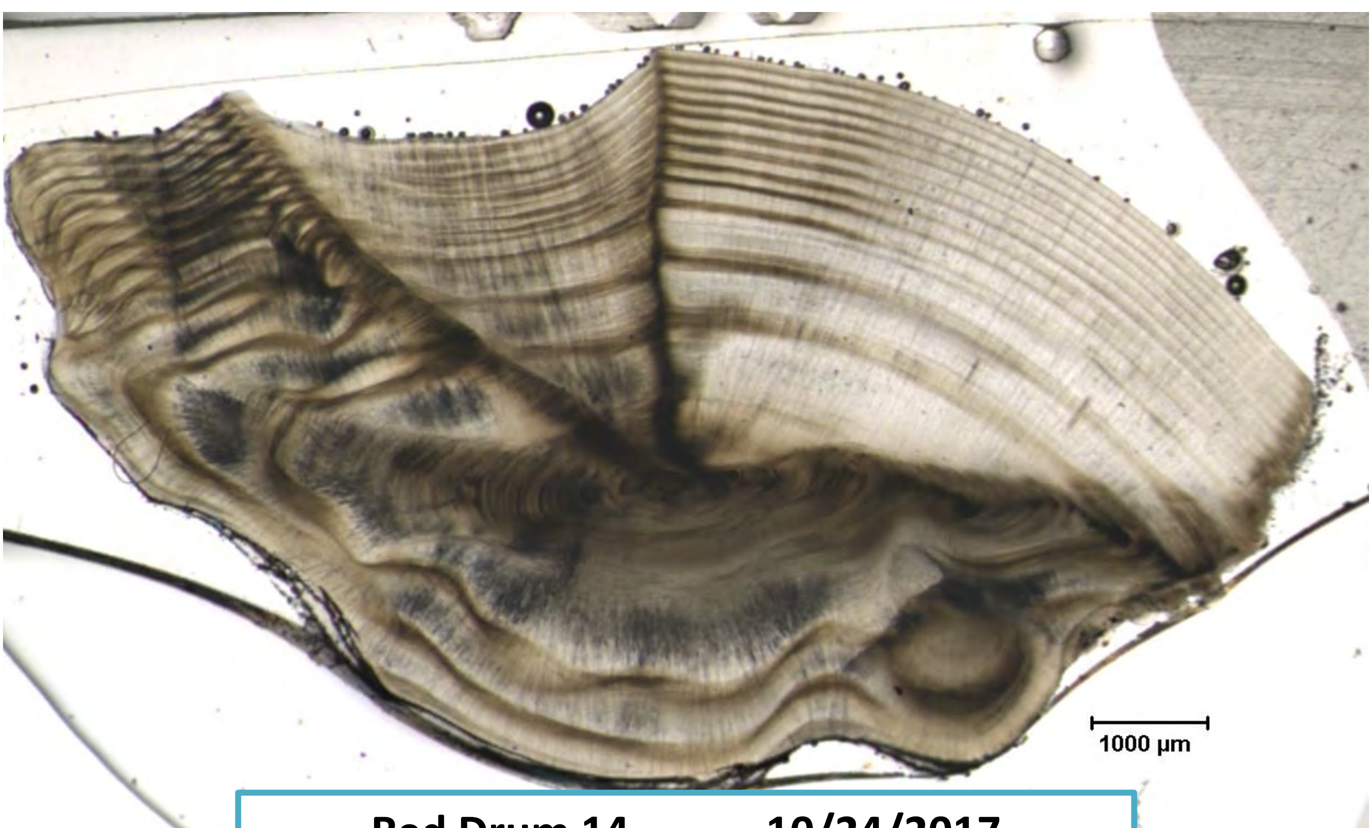
Red Drum 11 11/19/2002



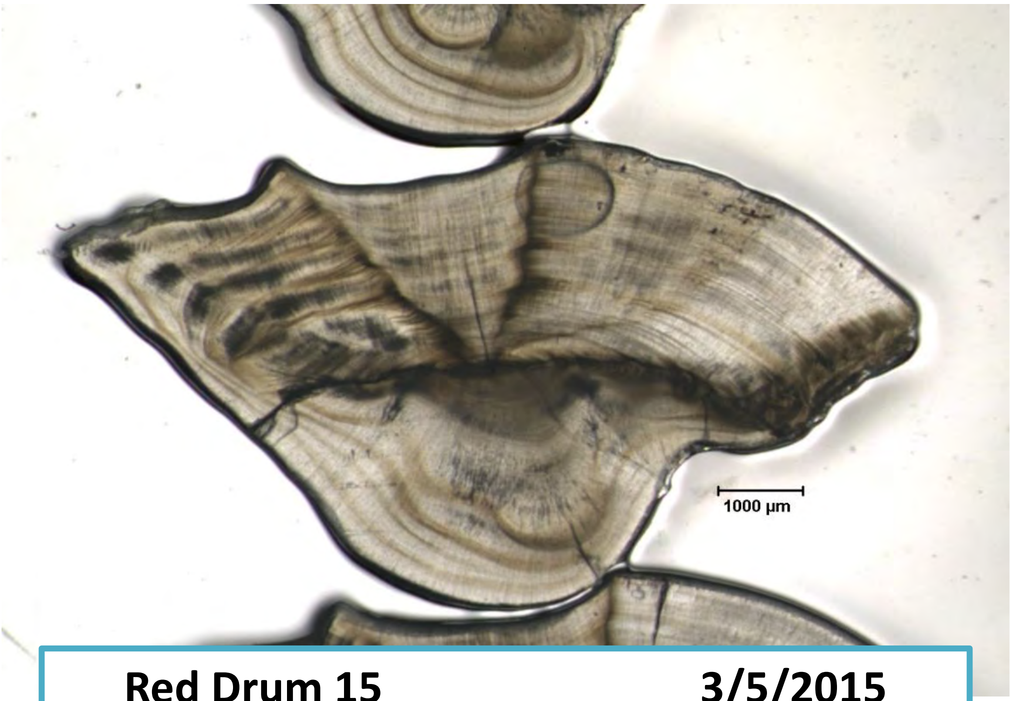
Red Drum 12 10/19/2016



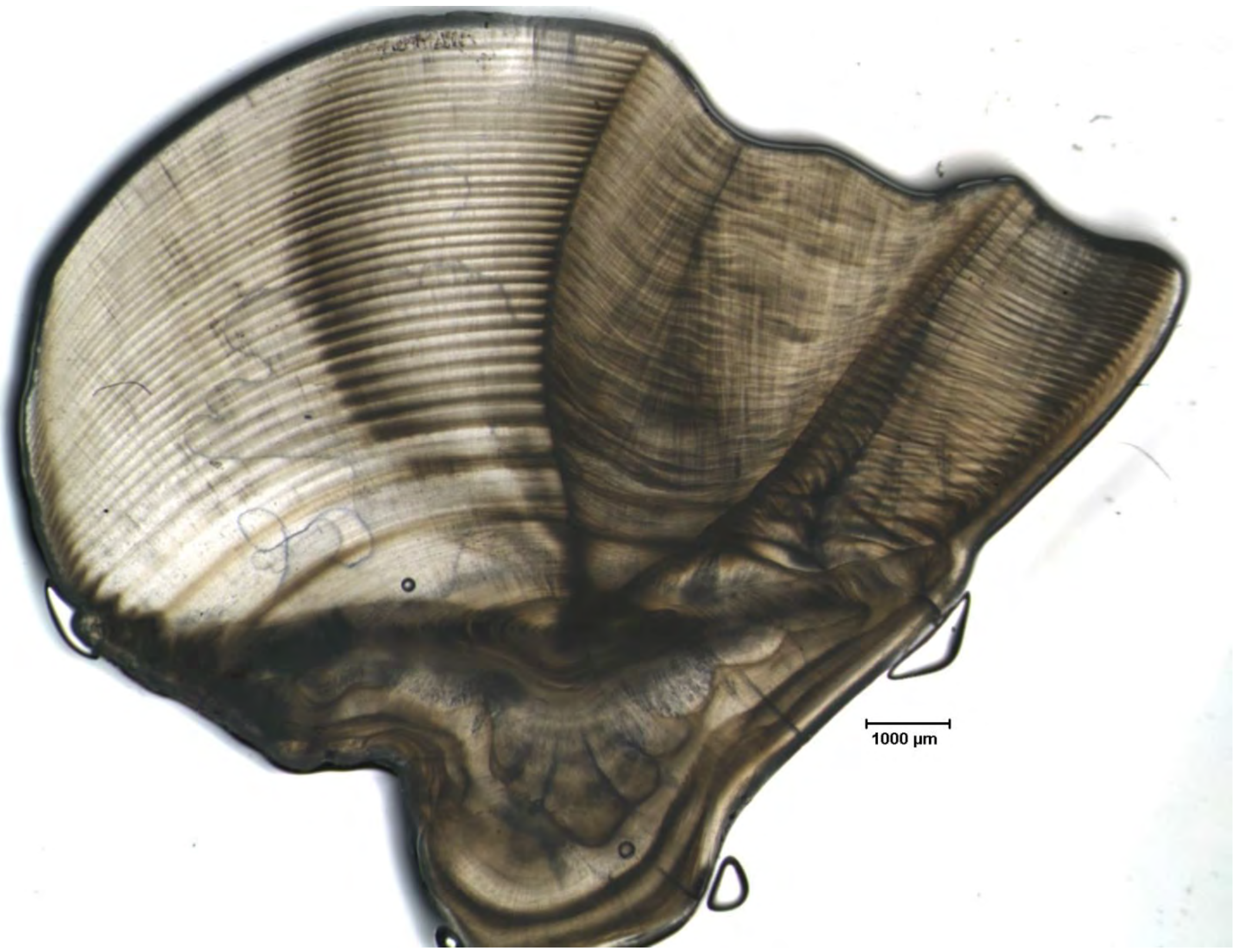
Red Drum 13 8/30/2016



Red Drum 14 10/24/2017

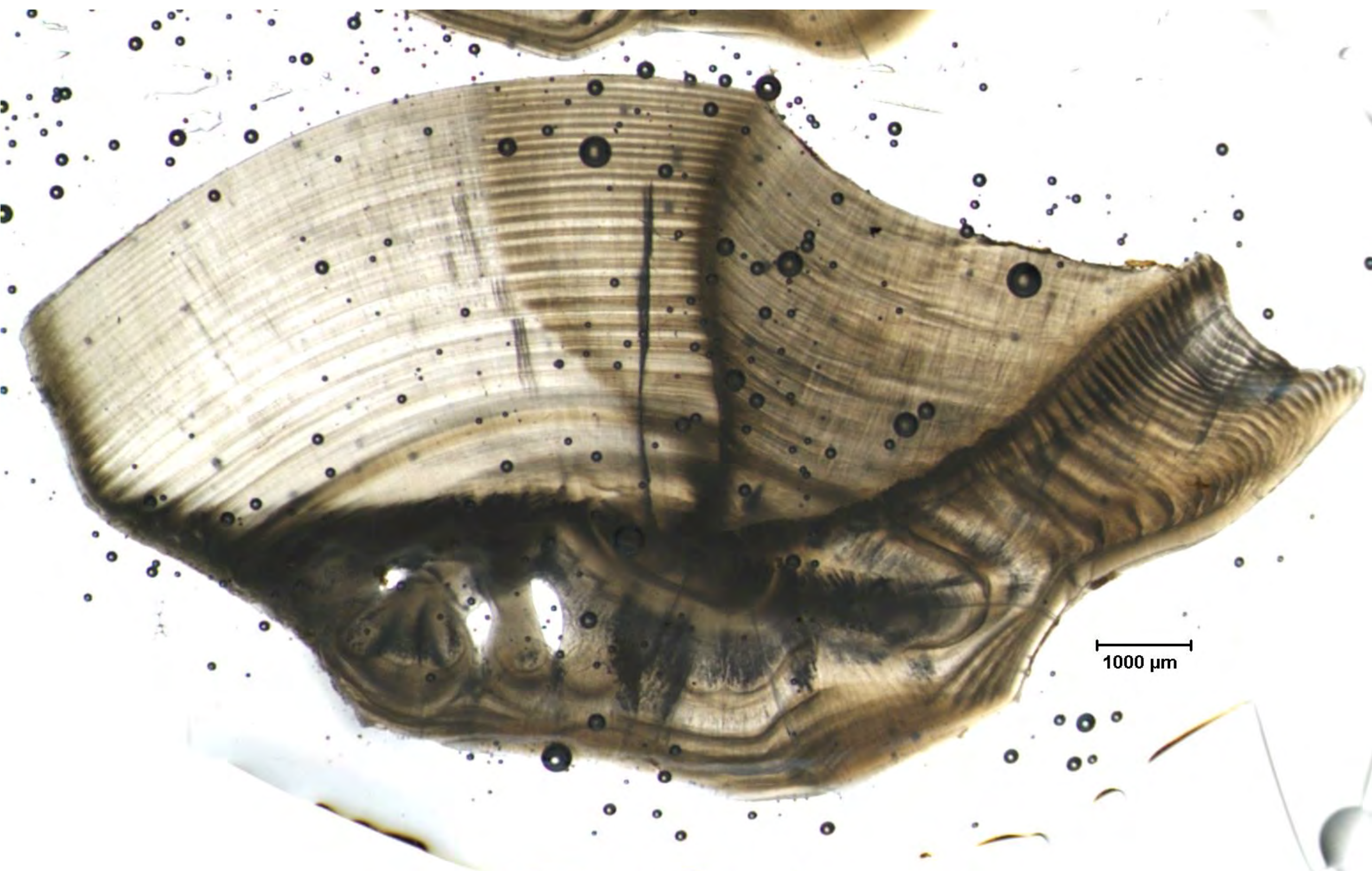


Red Drum 15 3/5/2015

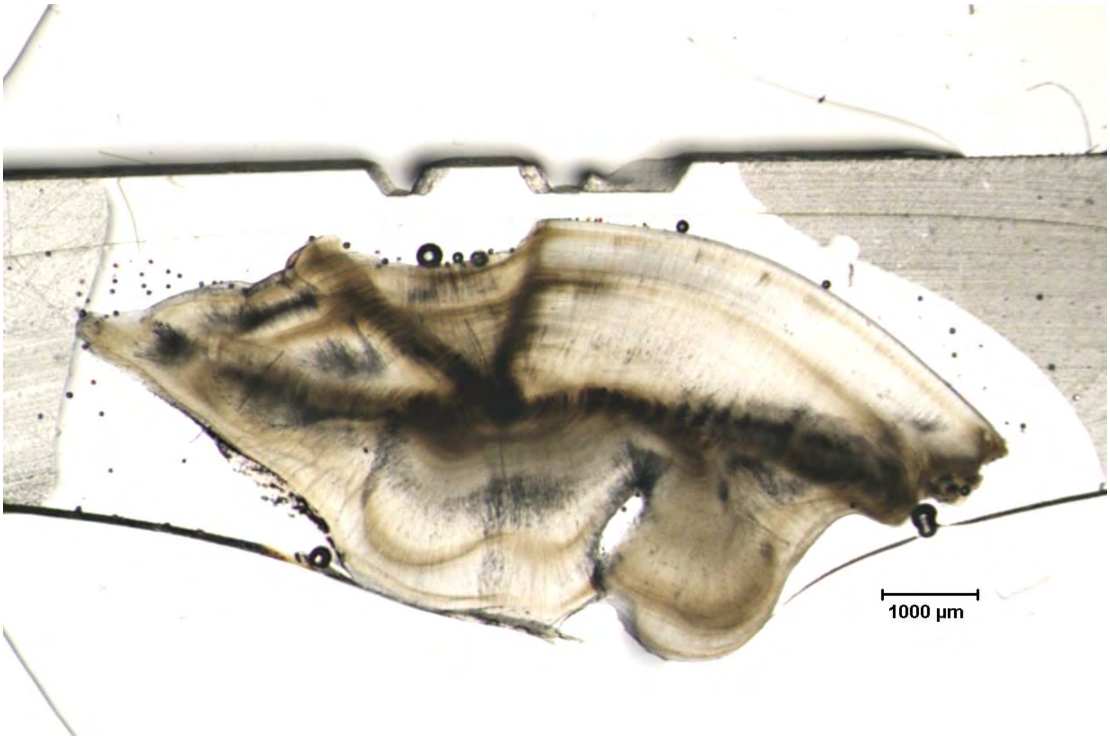


Red Drum 16 11/19/2002

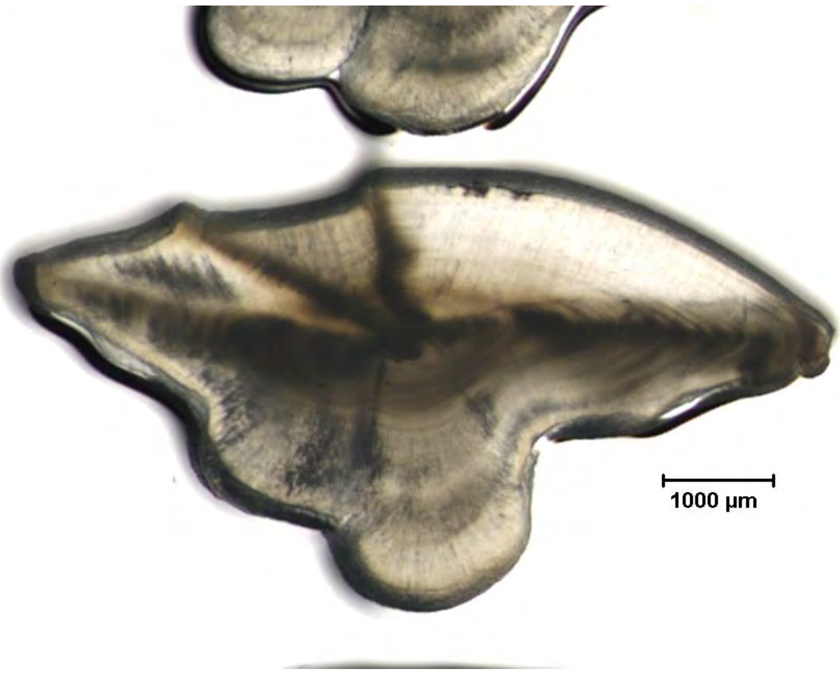
Red Drum 17 12/6/2016



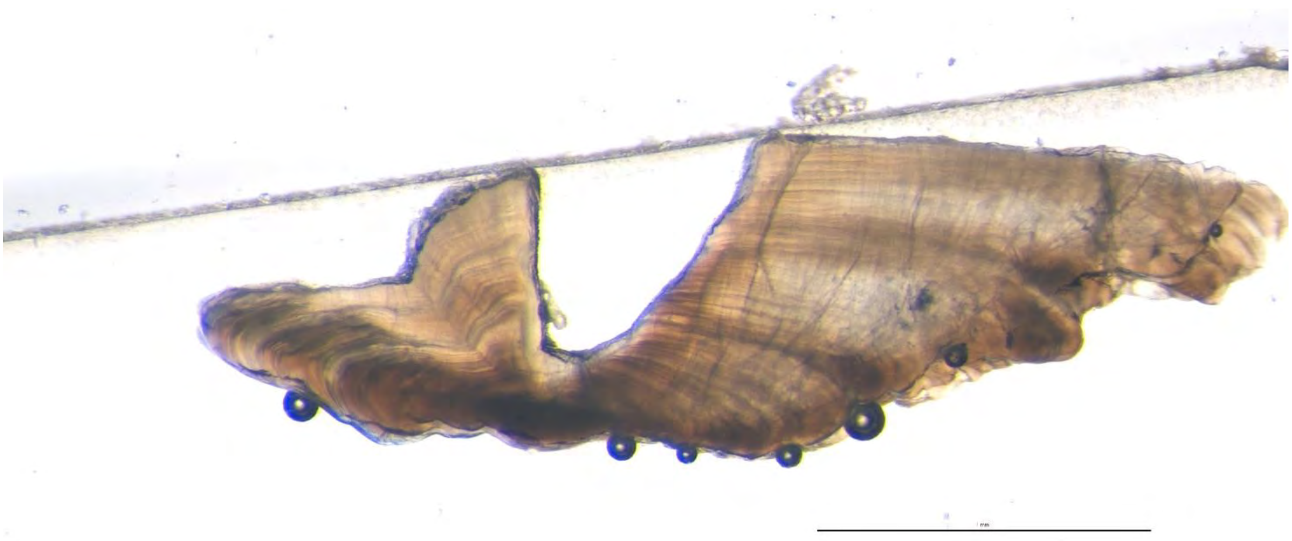
Red Drum 18 8/30/2016



Red Drum 19 6/13/2017



Red Drum 20 2/3/2015

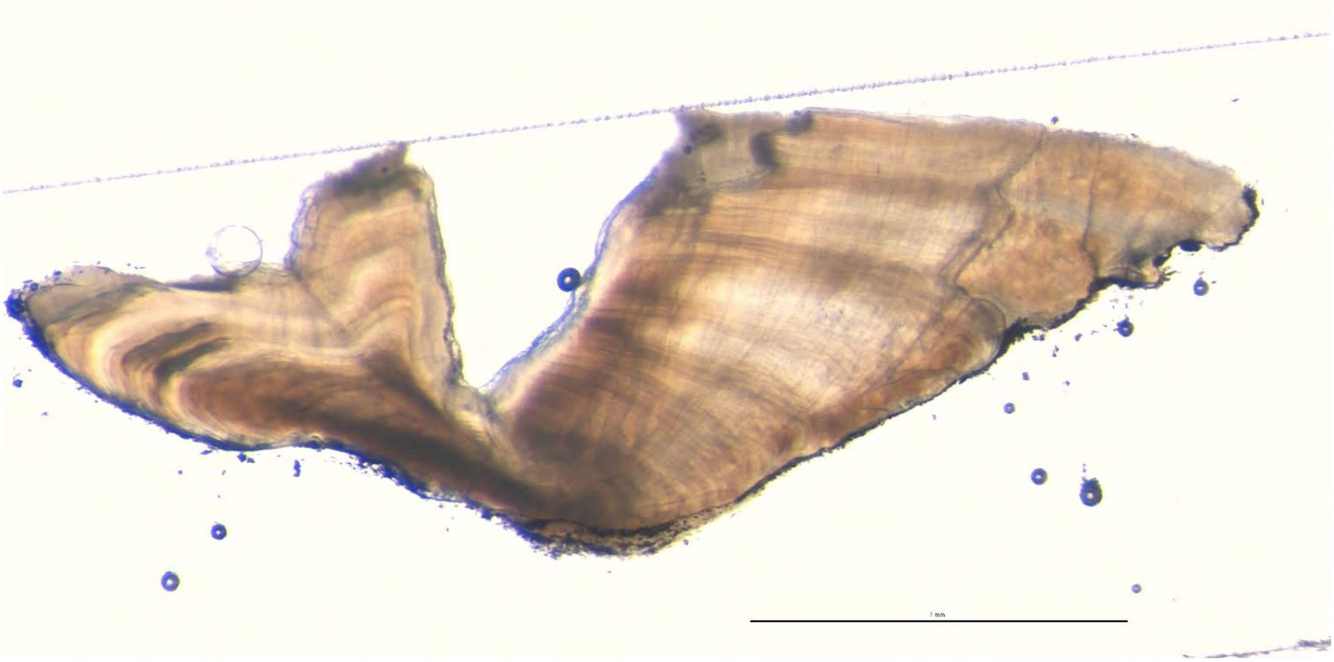


Cobia 1 7/9/2018

Cobia 2 9/2/2018

Cobia 3 10/8/2021

Cobia 4 9/1/2012

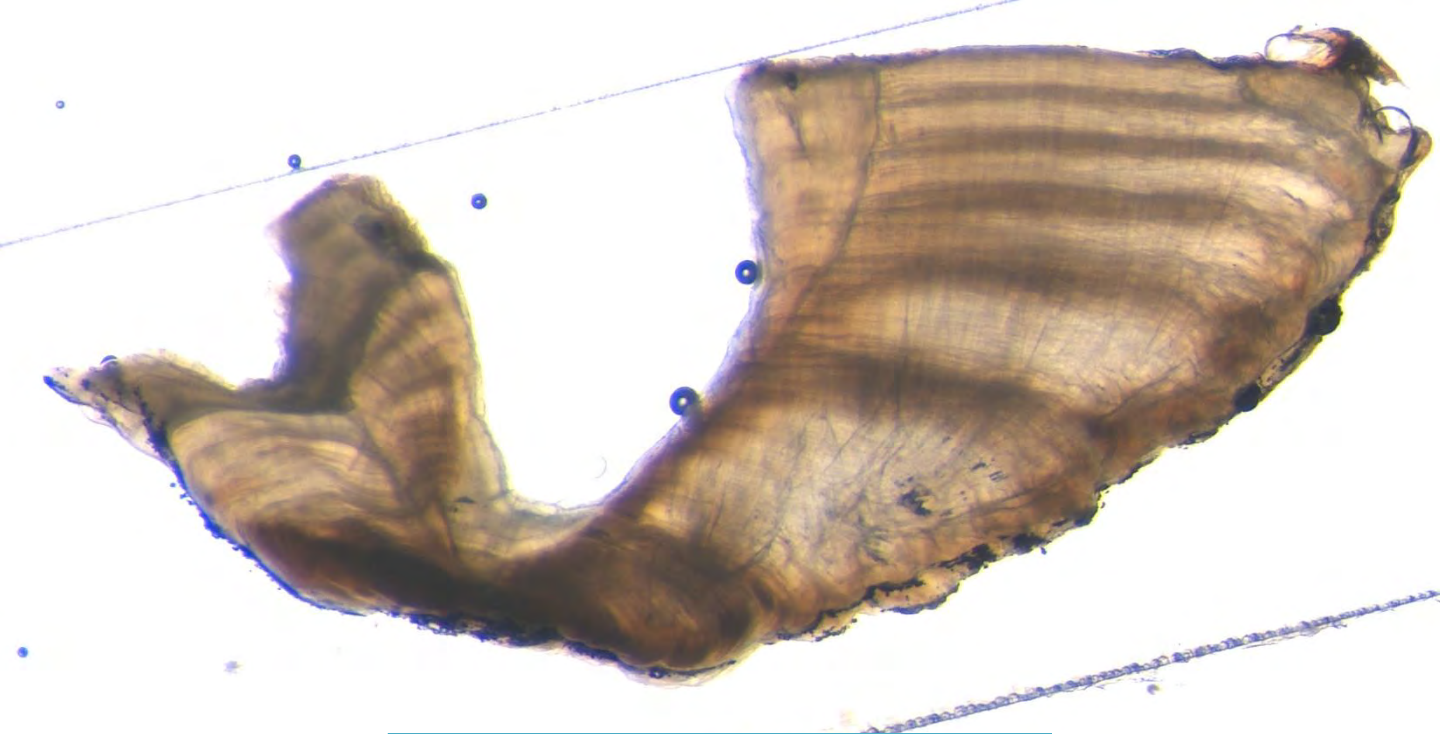


Cobia 5 6/11/2016

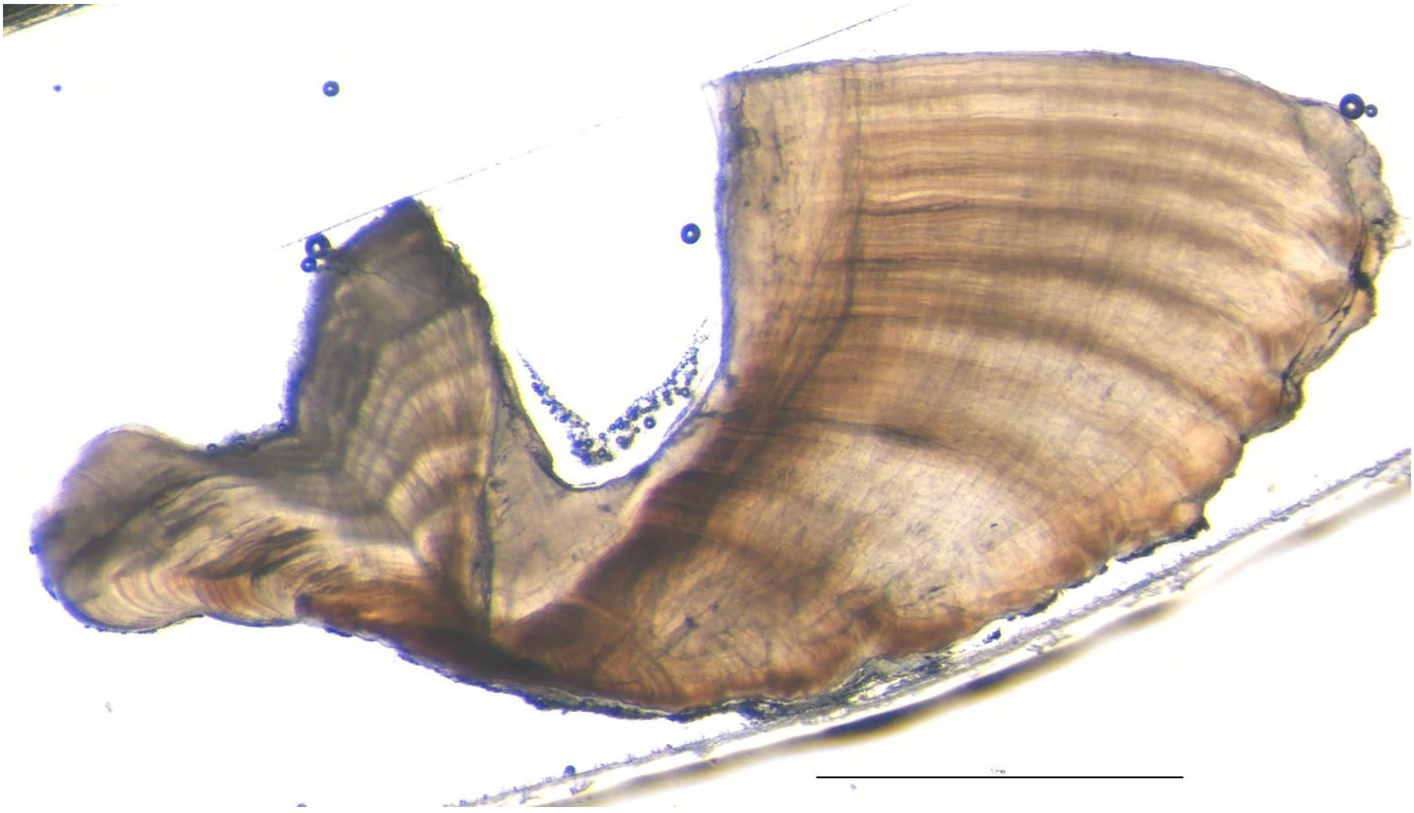
Cobia 6 10/11/2021

Cobia 7 10/8/2021

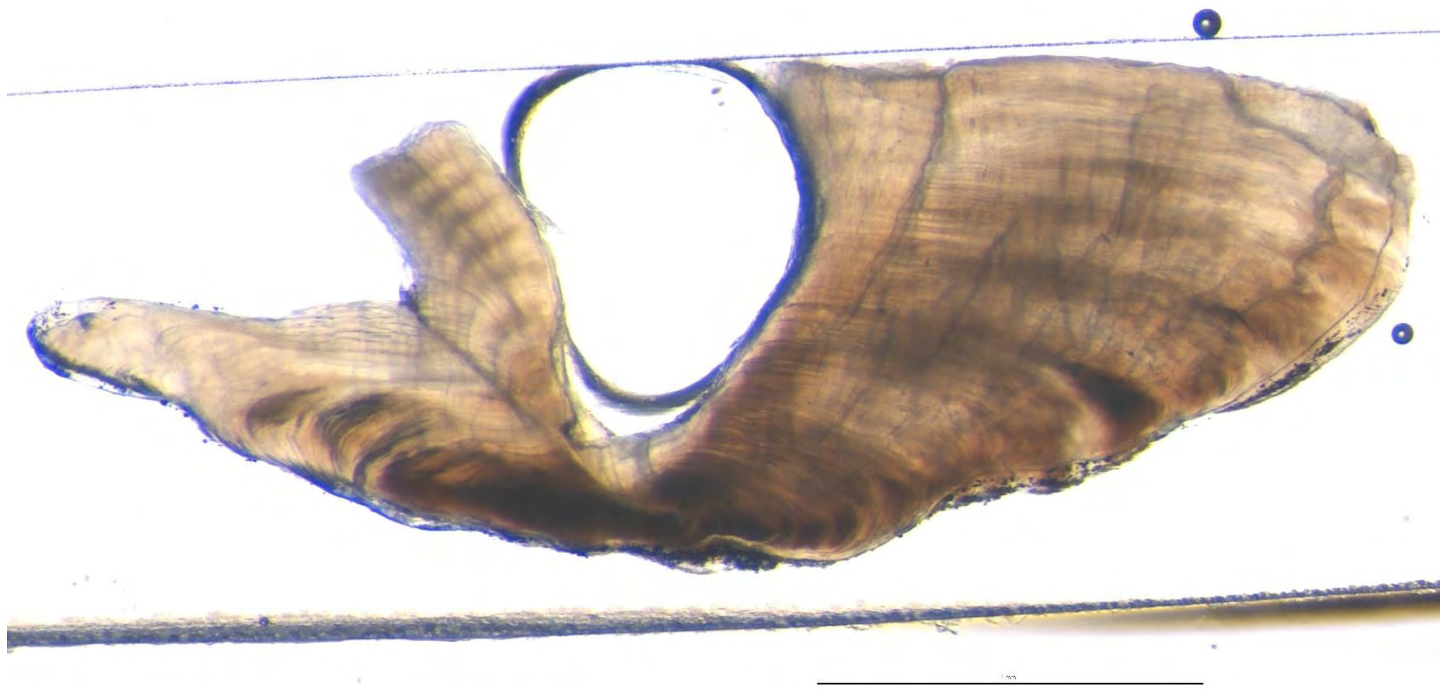
Cobia 8 6/1/2018



Cobia 9 5/24/2016

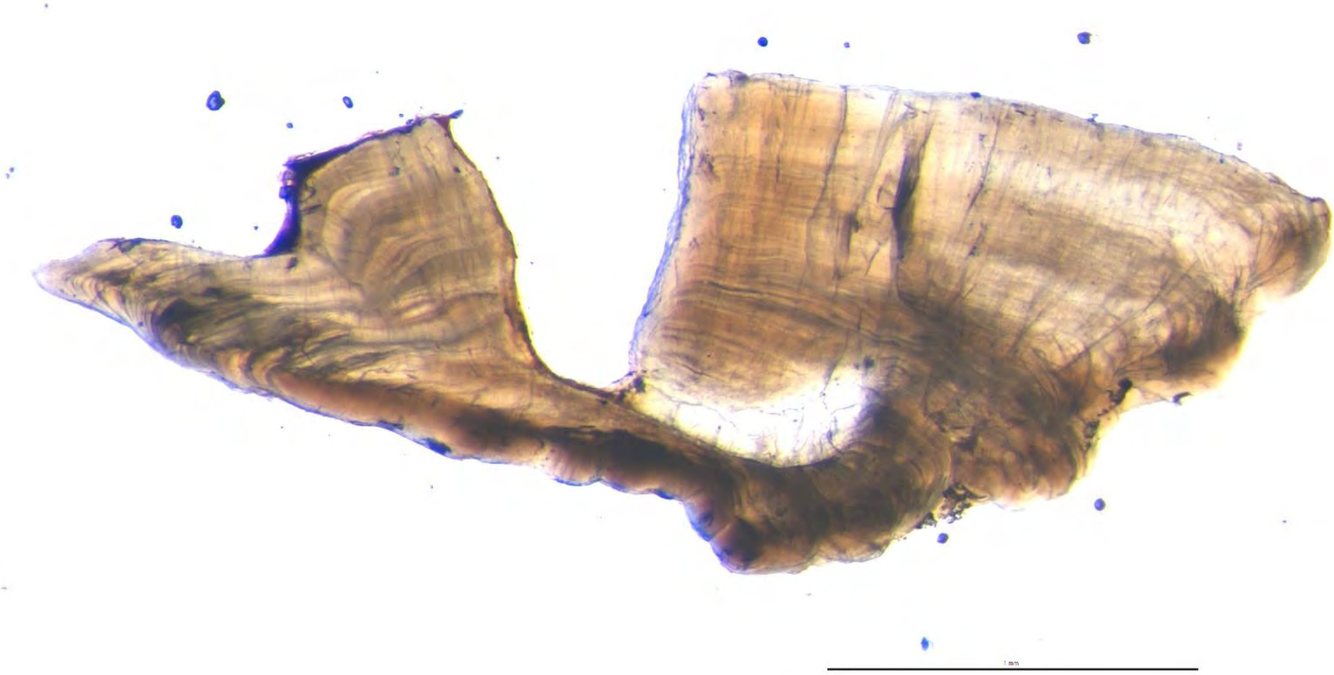


Cobia 10 5/26/2016



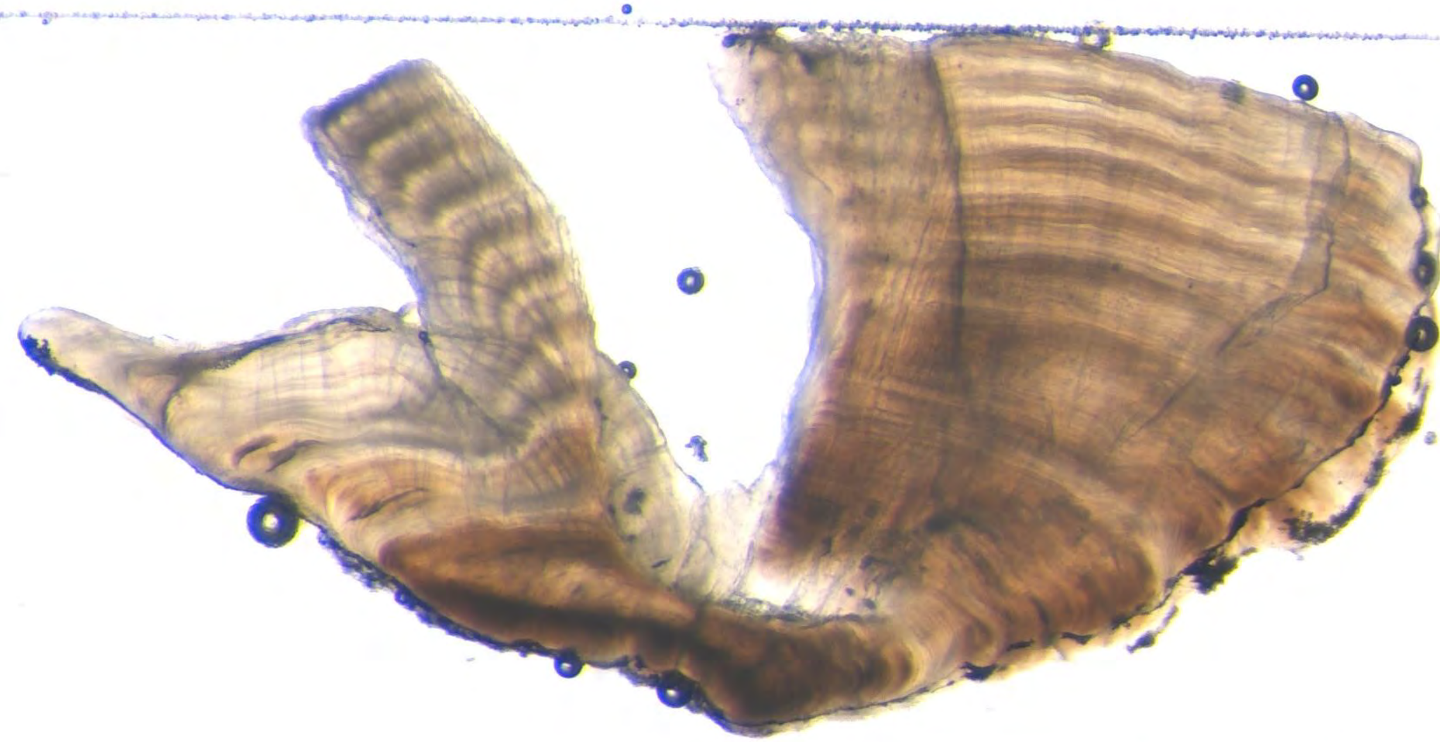
Cobia 11 5/17/2016

Cobia 12 9/2/2016



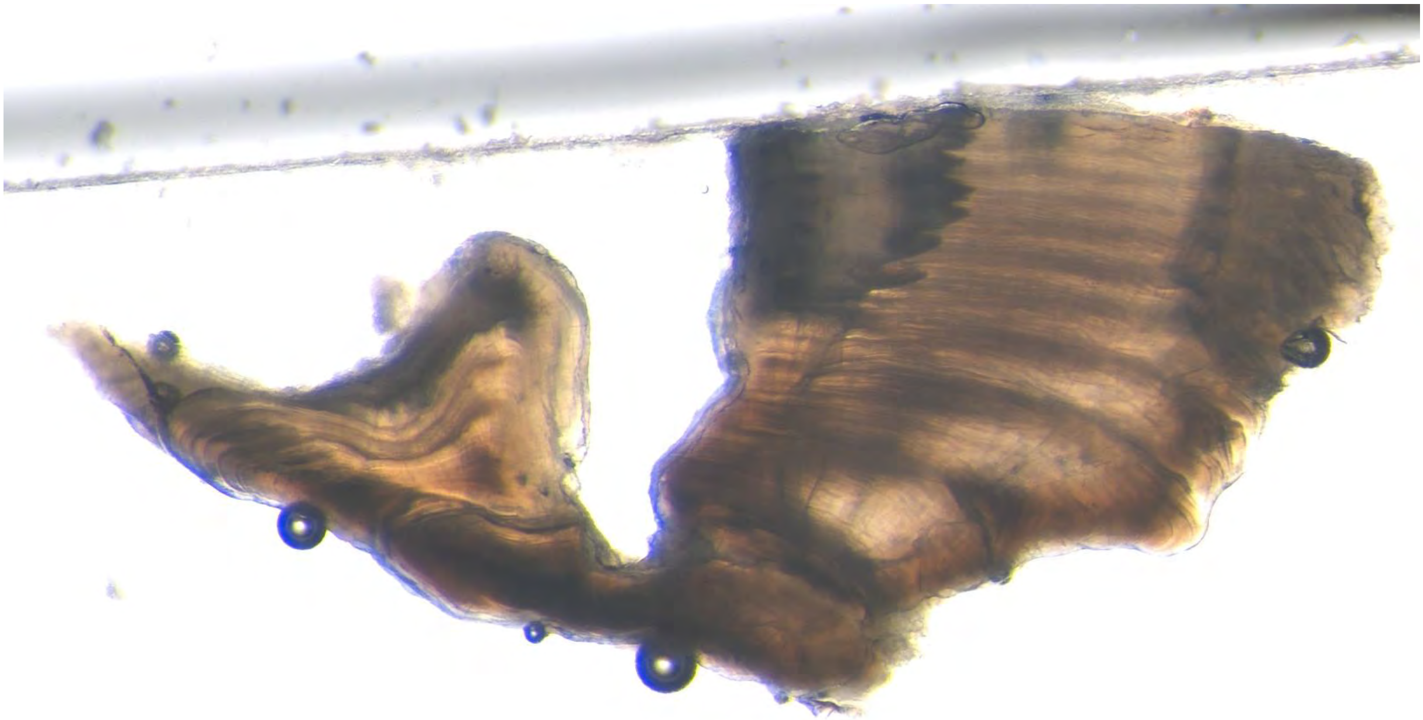
Cobia 13 7/5/2016

Cobia 14 5/1/2019

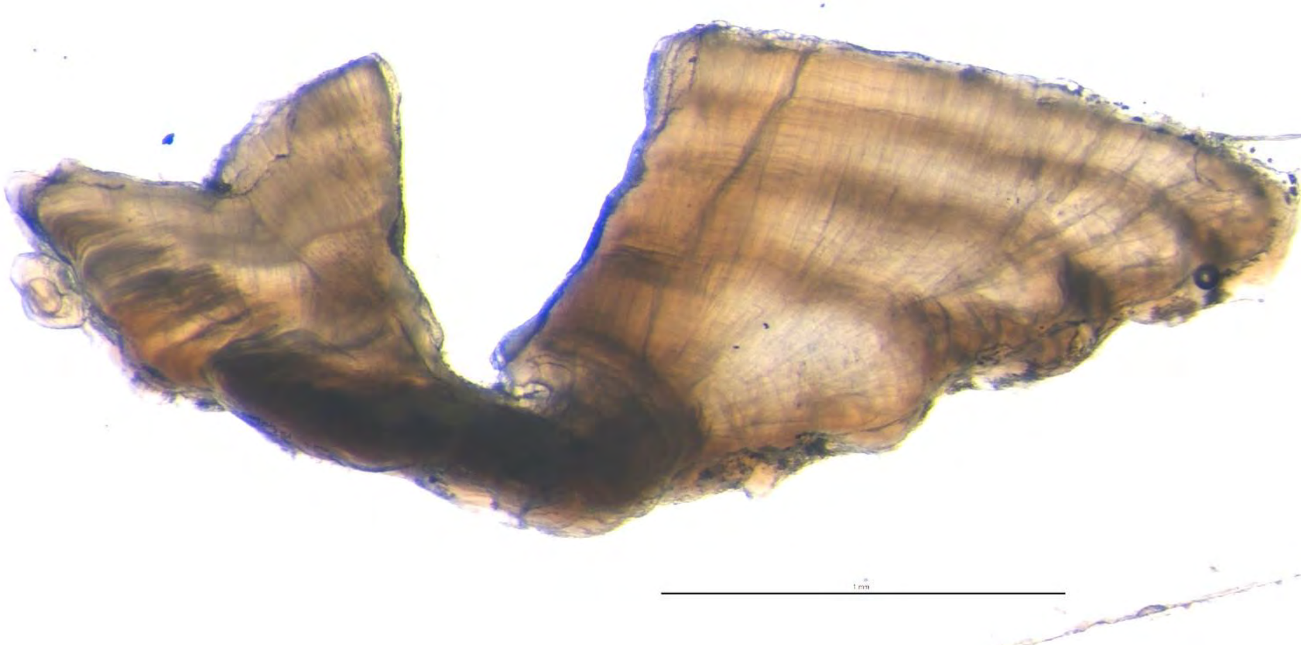


Cobia 15 6/9/2016

Cobia 16 3/15/2021



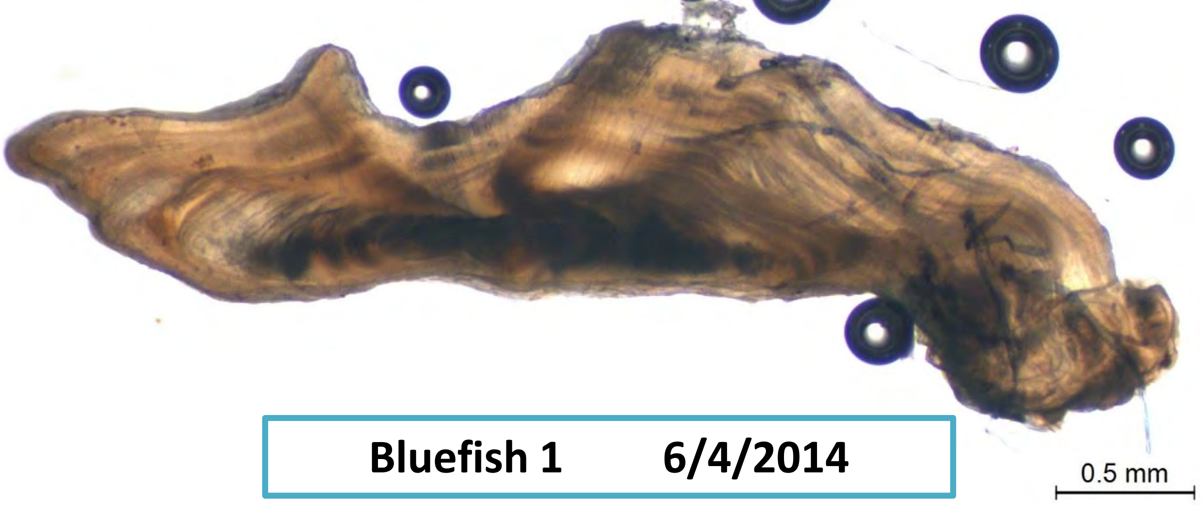
Cobia 17 8/11/2018



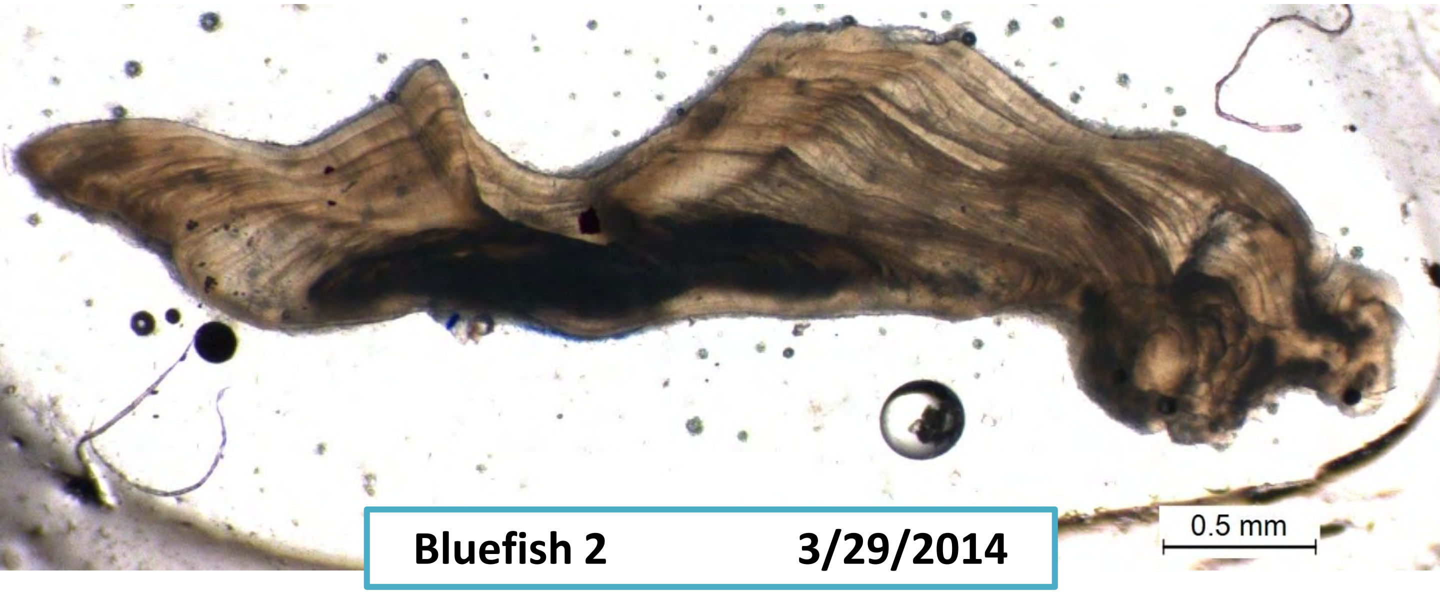
Cobia 18 6/16/2018

Cobia 19 9/1/2017

Cobia 20 2/26/2021

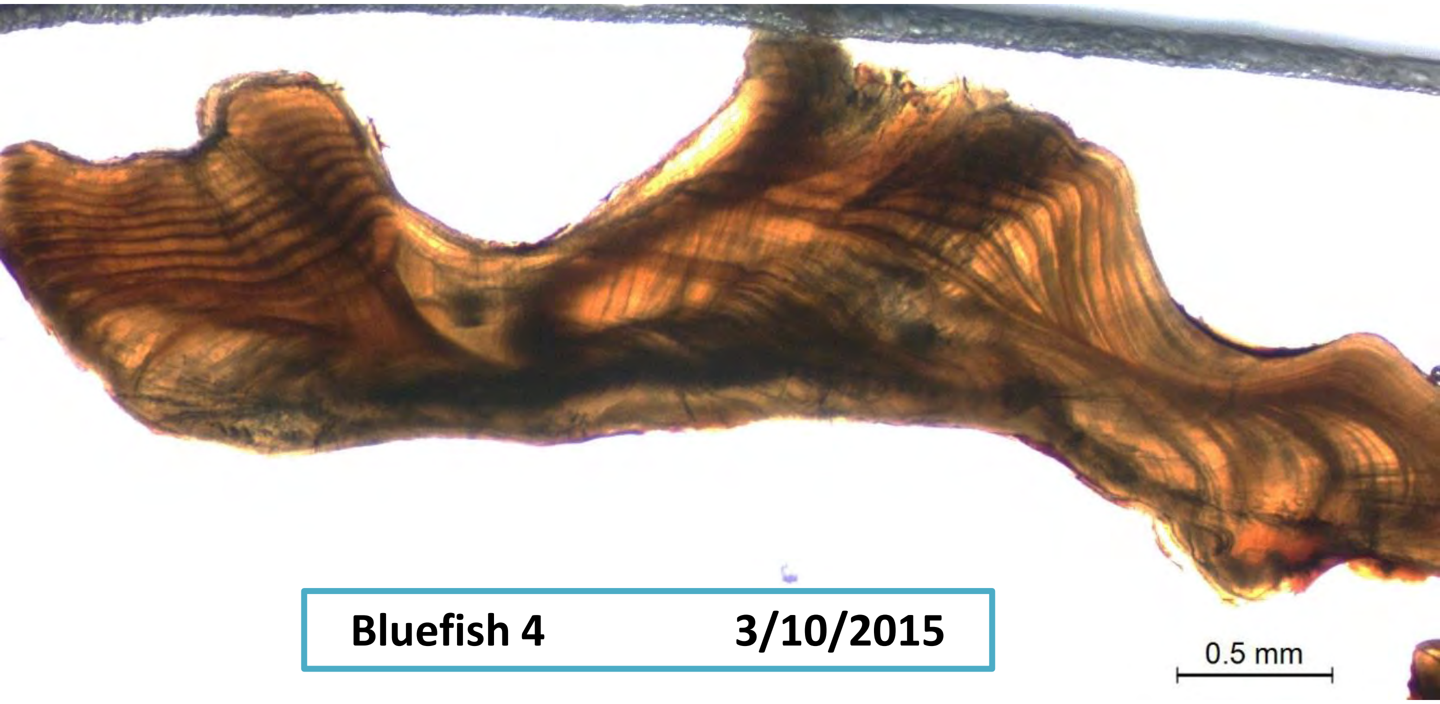


Bluefish 1 6/4/2014

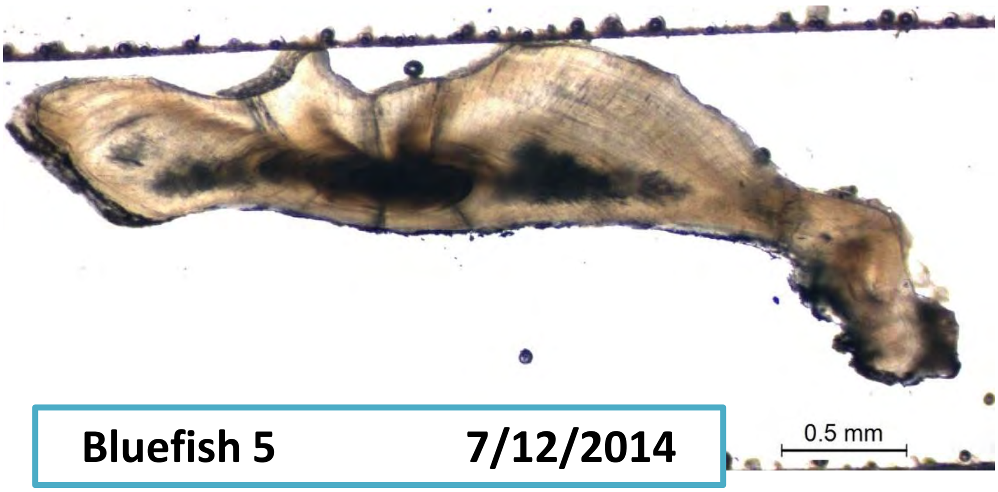


Bluefish 2 3/29/2014

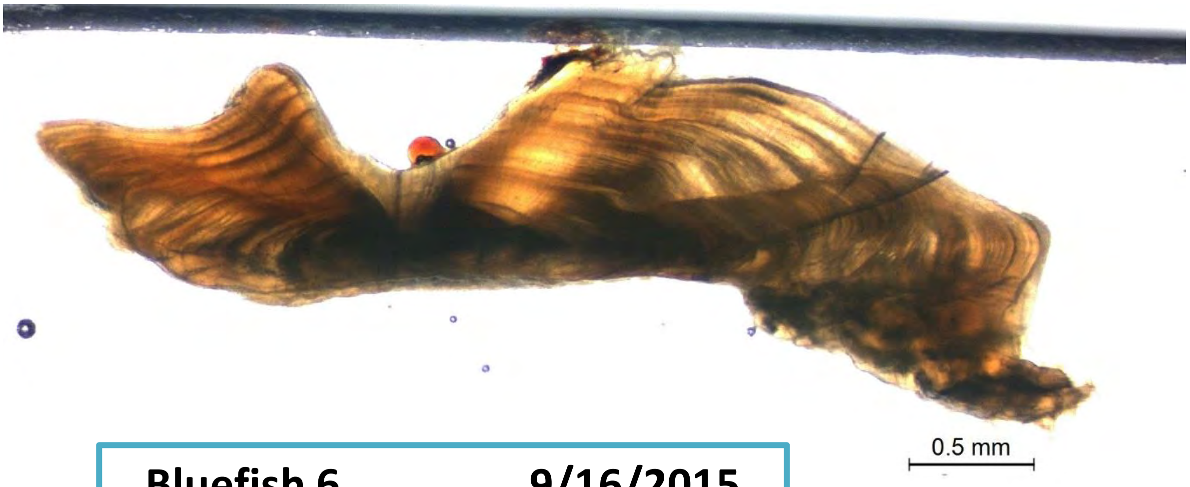
Bluefish 3 9/25/2009



Bluefish 4 3/10/2015



Bluefish 5 7/12/2014

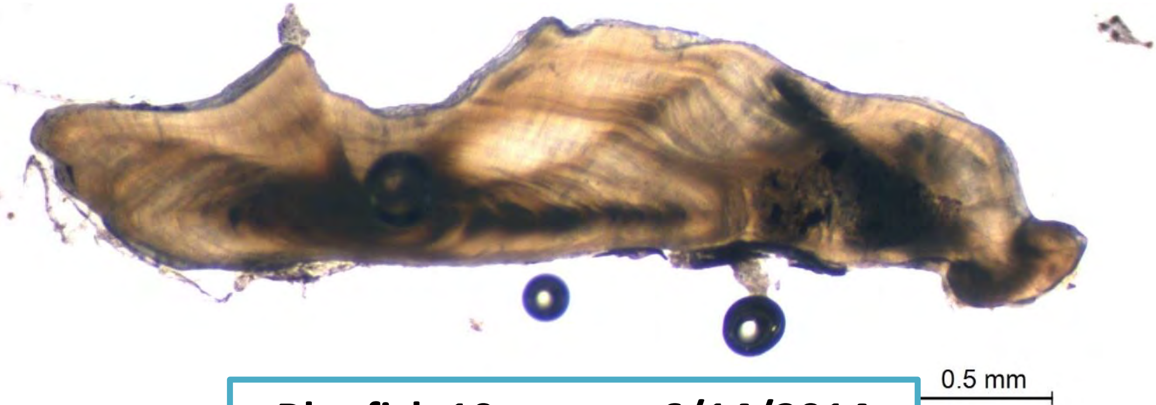


Bluefish 6 9/16/2015

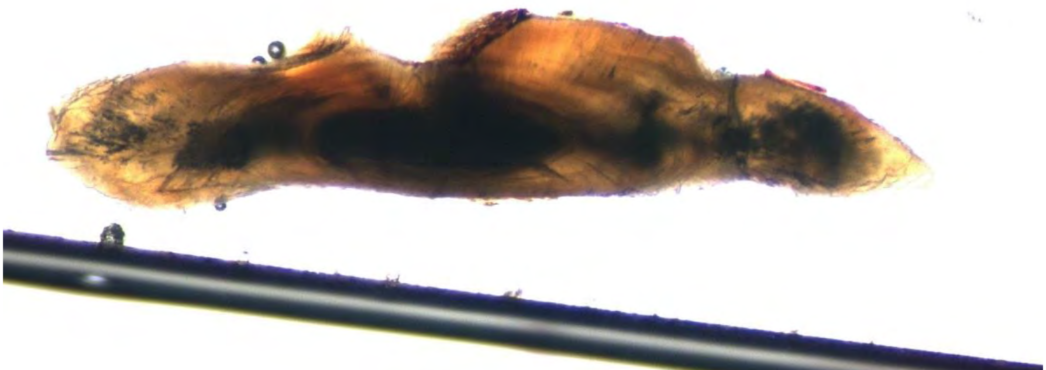
Bluefish 7 **9/22/2014**

Bluefish 8 **11/2/2012**

Bluefish 9 **5/23/2012**

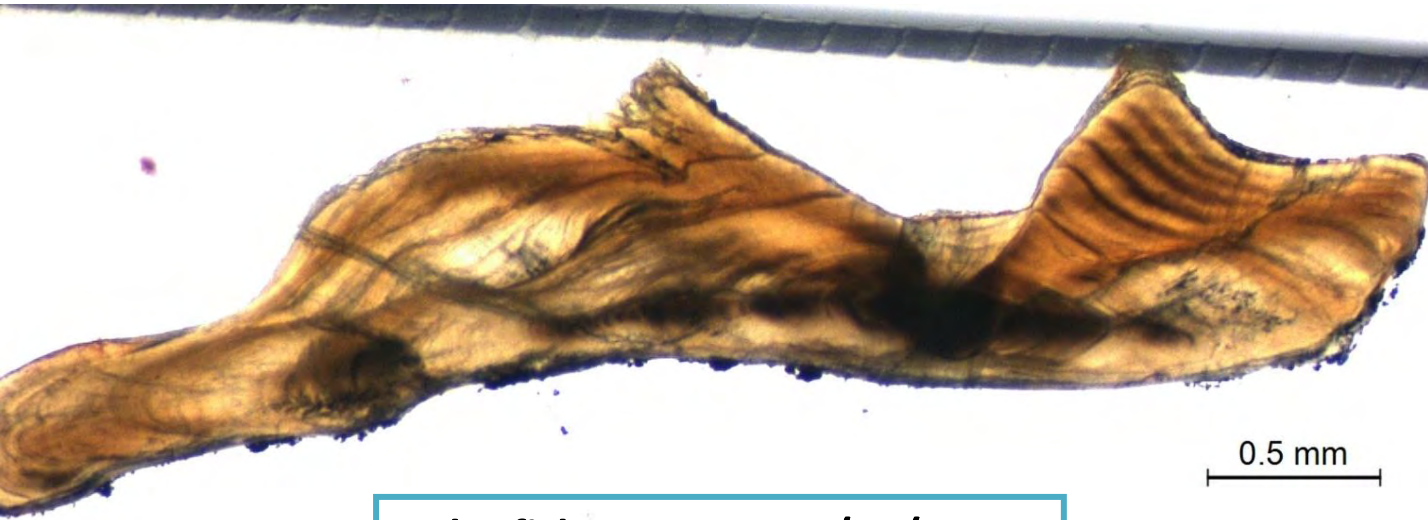


Bluefish 10 6/14/2014

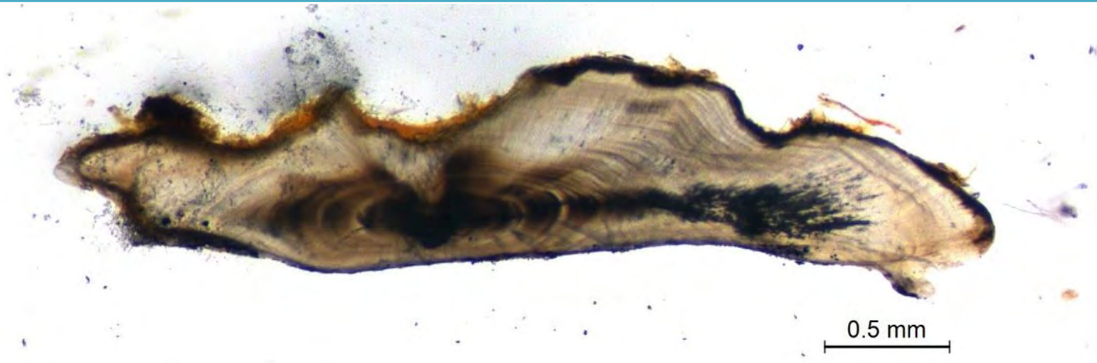


Bluefish 11 8/12/2015

Bluefish 12 5/3/2012

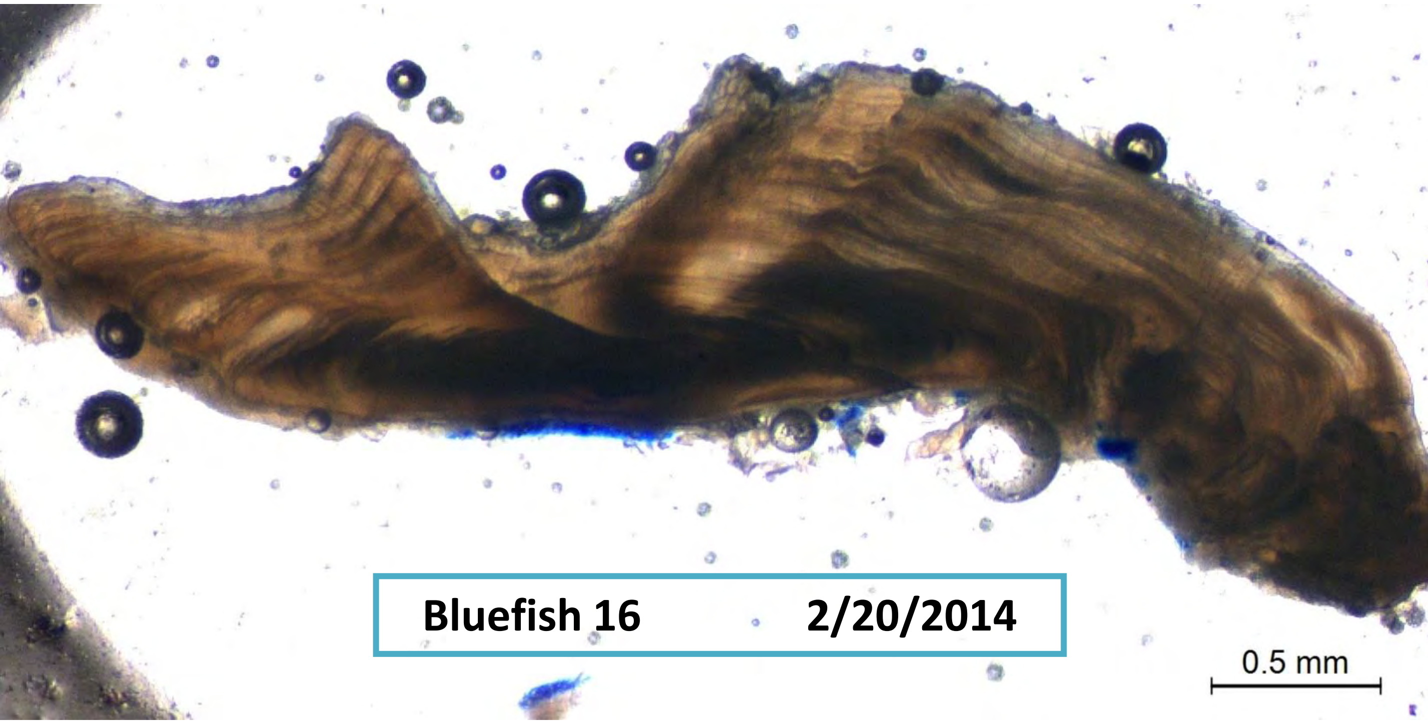


Bluefish 13 6/10/2012

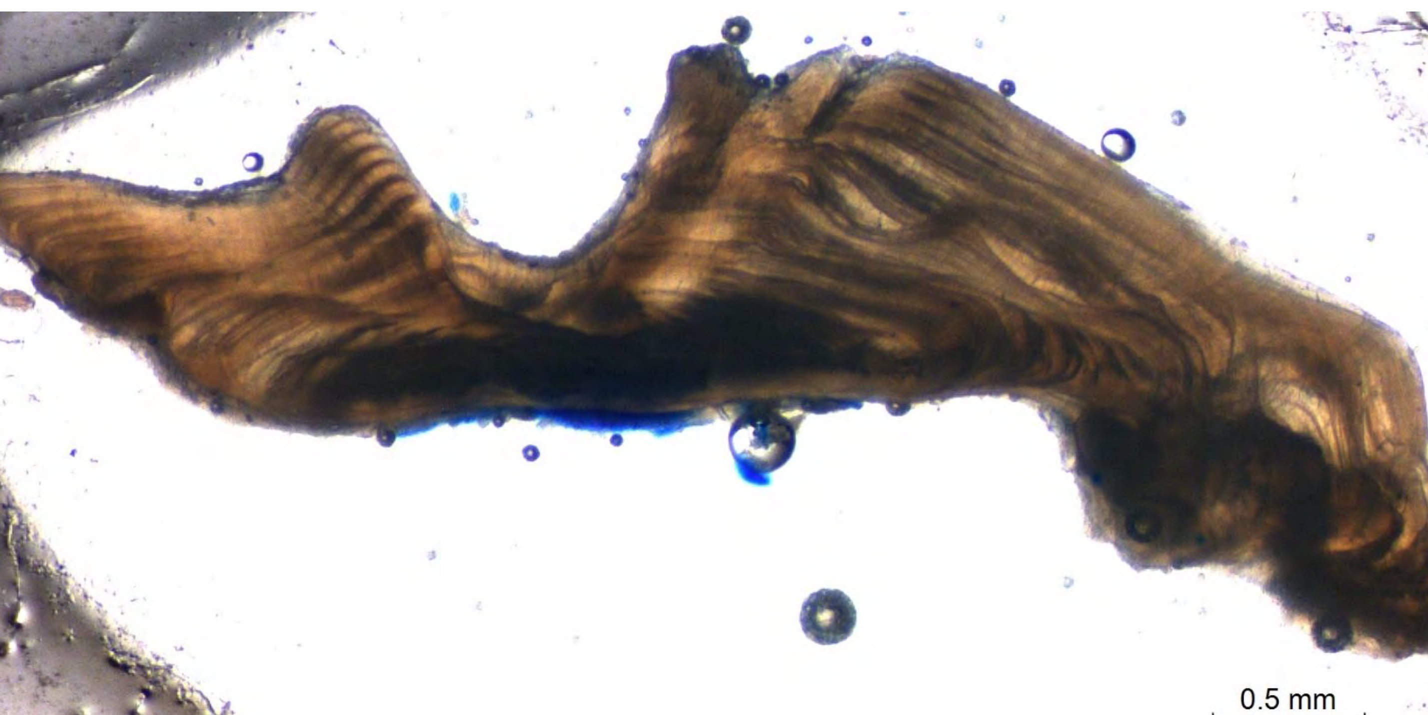


Bluefish 14 10/9/2009

Bluefish 15 10/23/2013



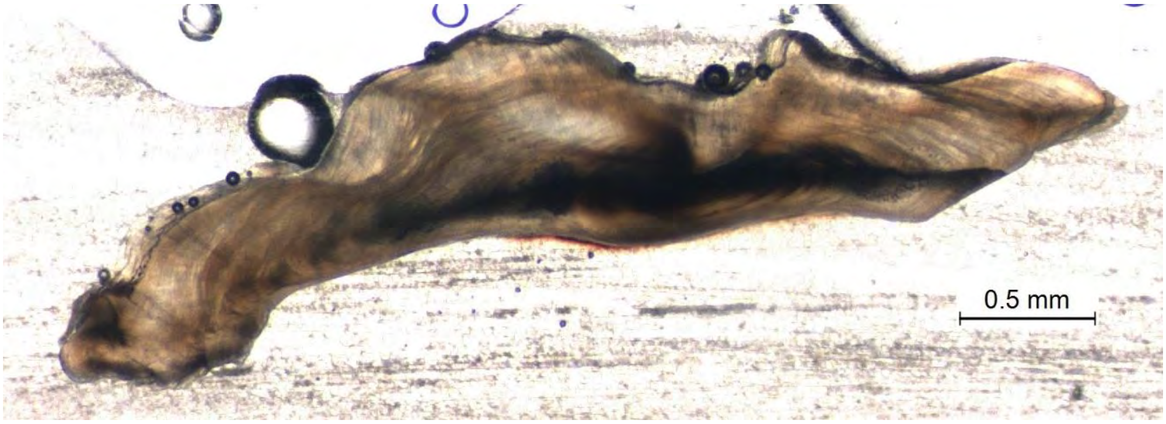
Bluefish 16 2/20/2014



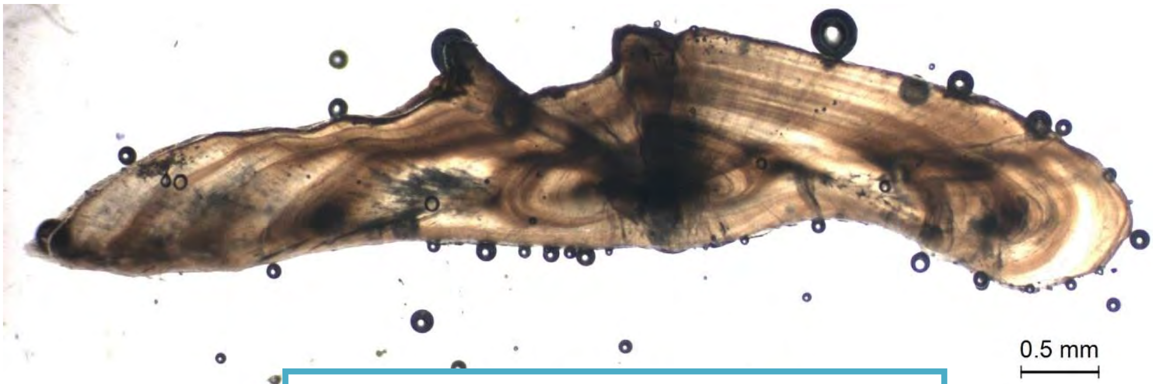
Bluefish 17 2/20/2014

Bluefish 18 8/28/2015

Bluefish 19 5/11/2014



Bluefish 20 5/31/2013



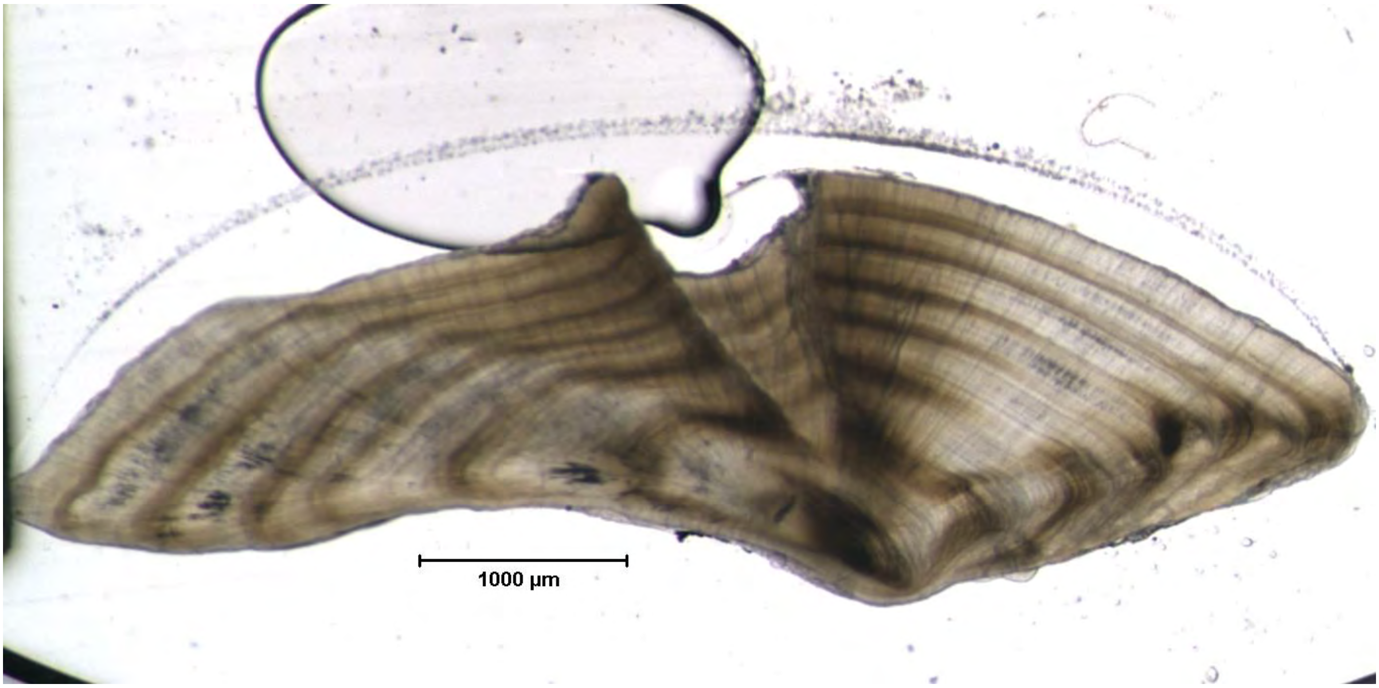
BSB 1 5/8/2009

BSB 2 10/21/2015

BSB 3 10/4/2007

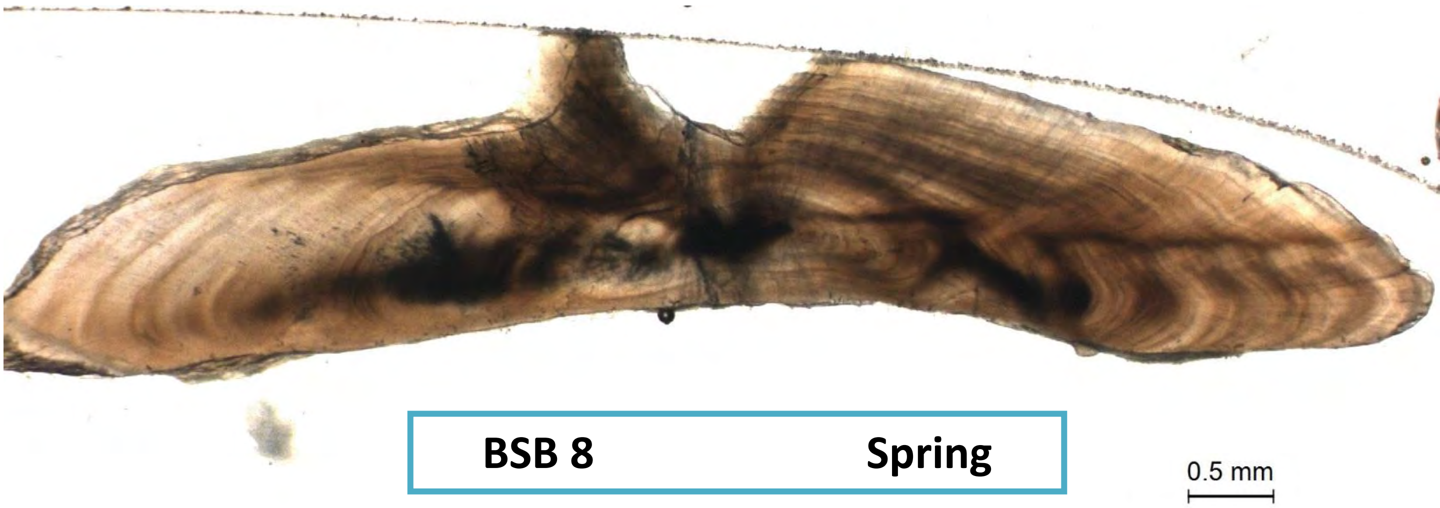
BSB 4 5/15/2008

BSB 5 9/23/2010



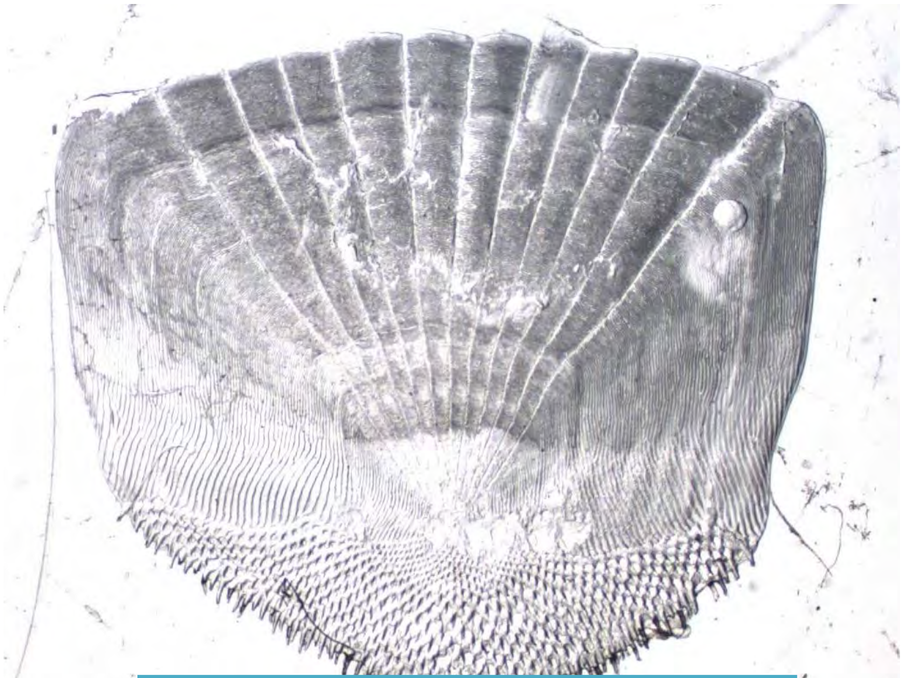
BSB 6 5/16/2012

BSB 7 Spring

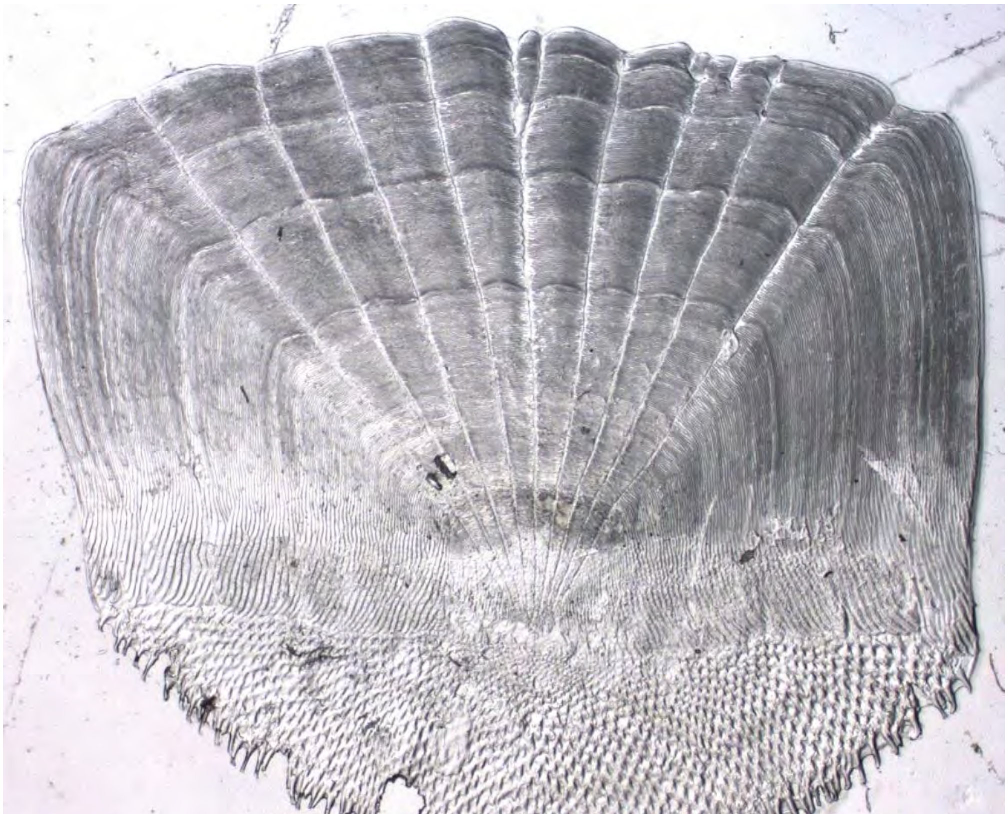


BSB 8 Spring

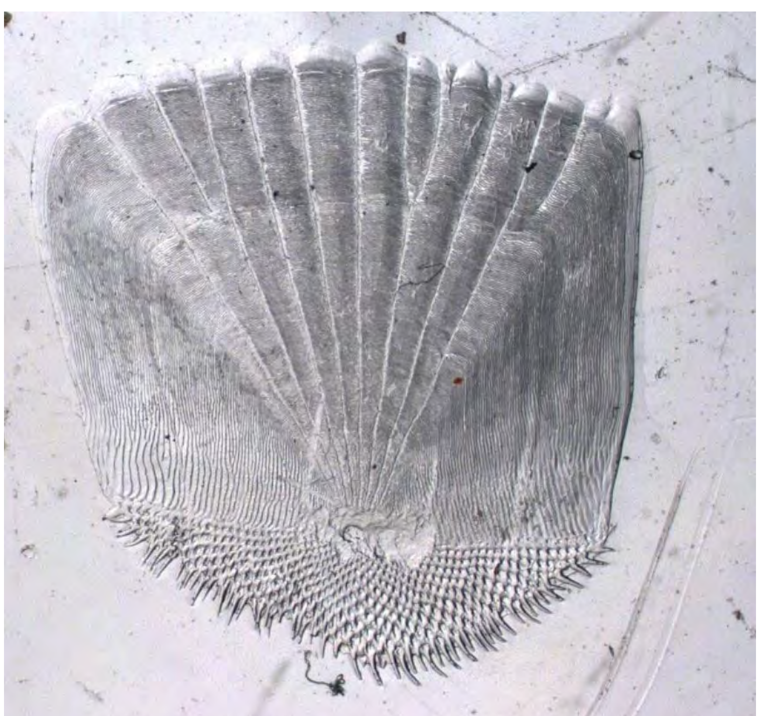
BSB 9 Spring



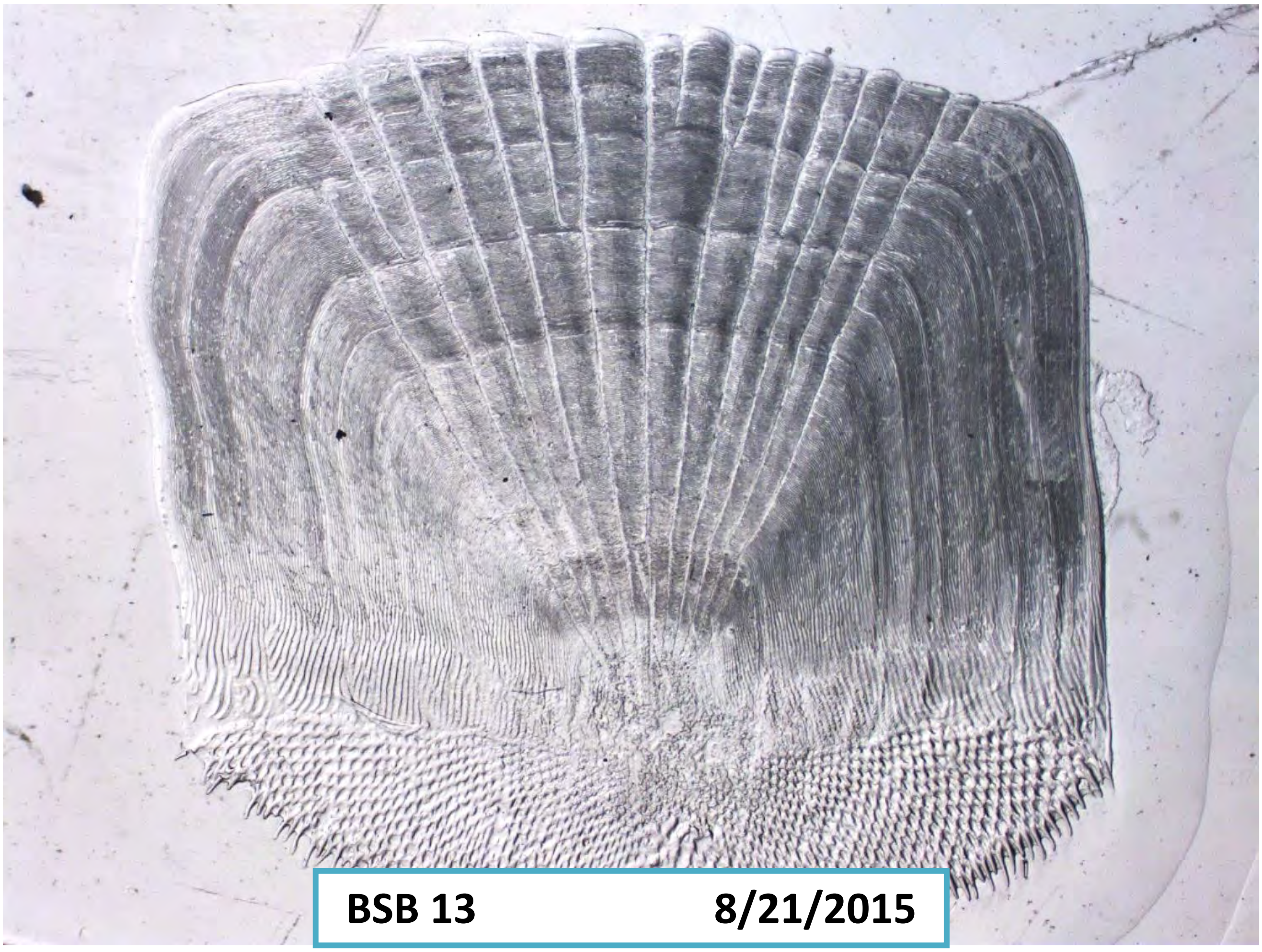
BSB 10 5/29/2015



BSB 11 5/22/2014



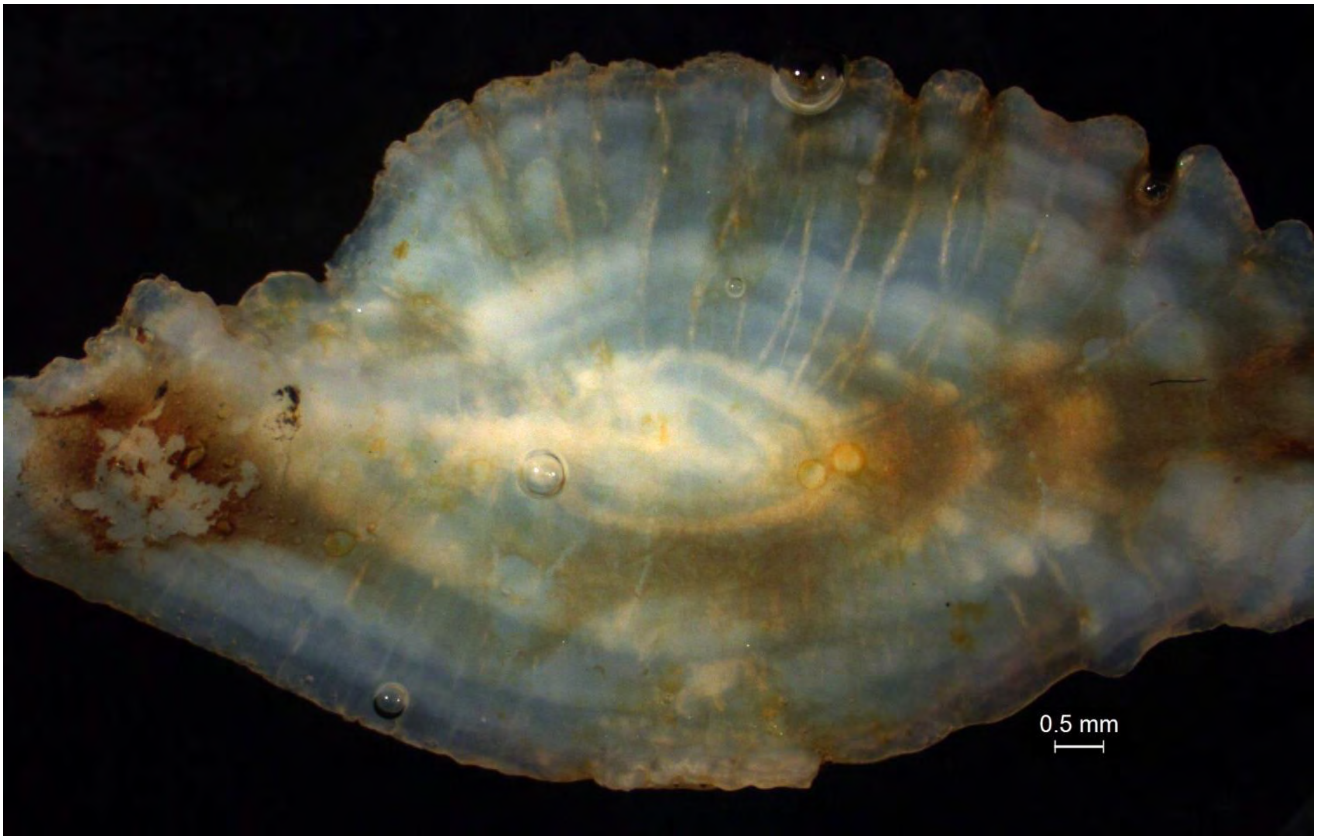
BSB 12 8/14/2015



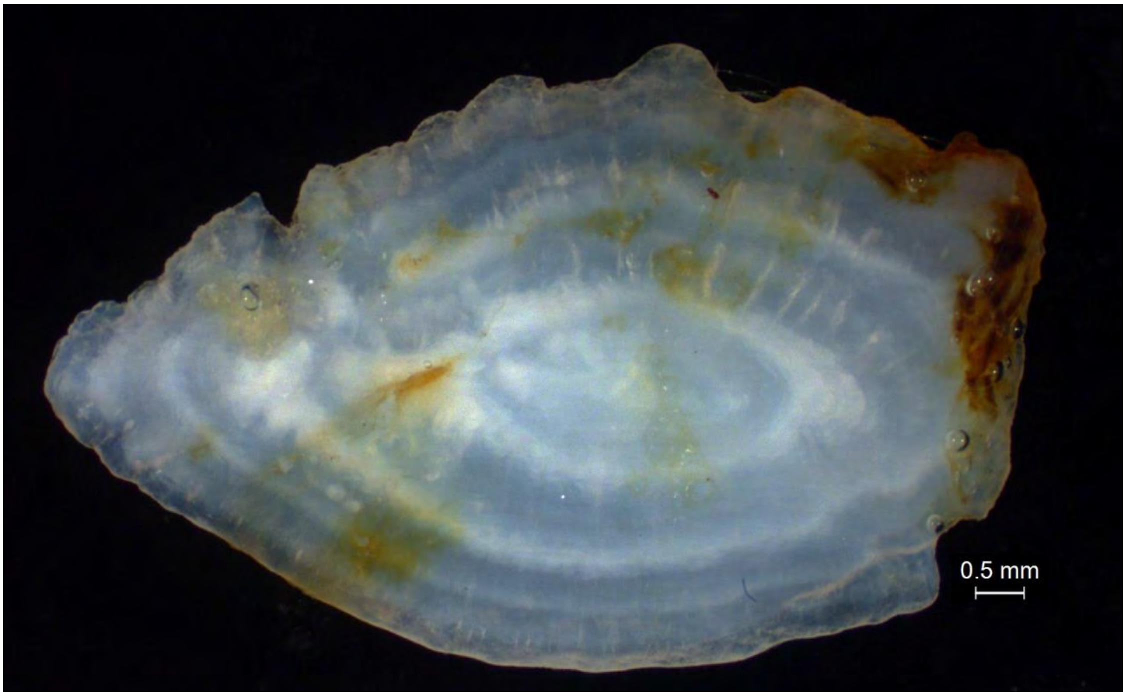
BSB 13 8/21/2015

BSB 14 3/15/2013

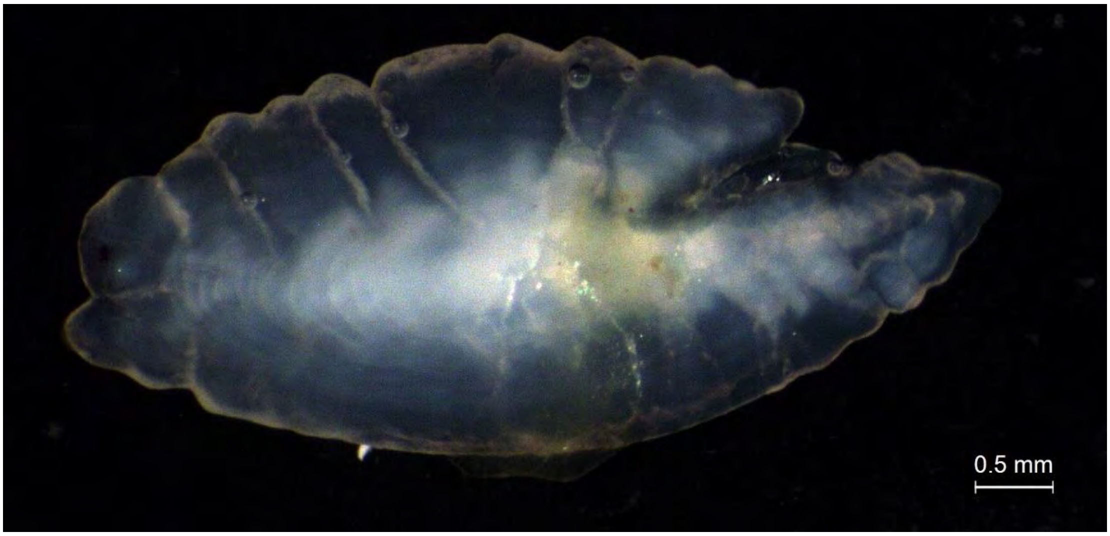
BSB 15 3/18/2013



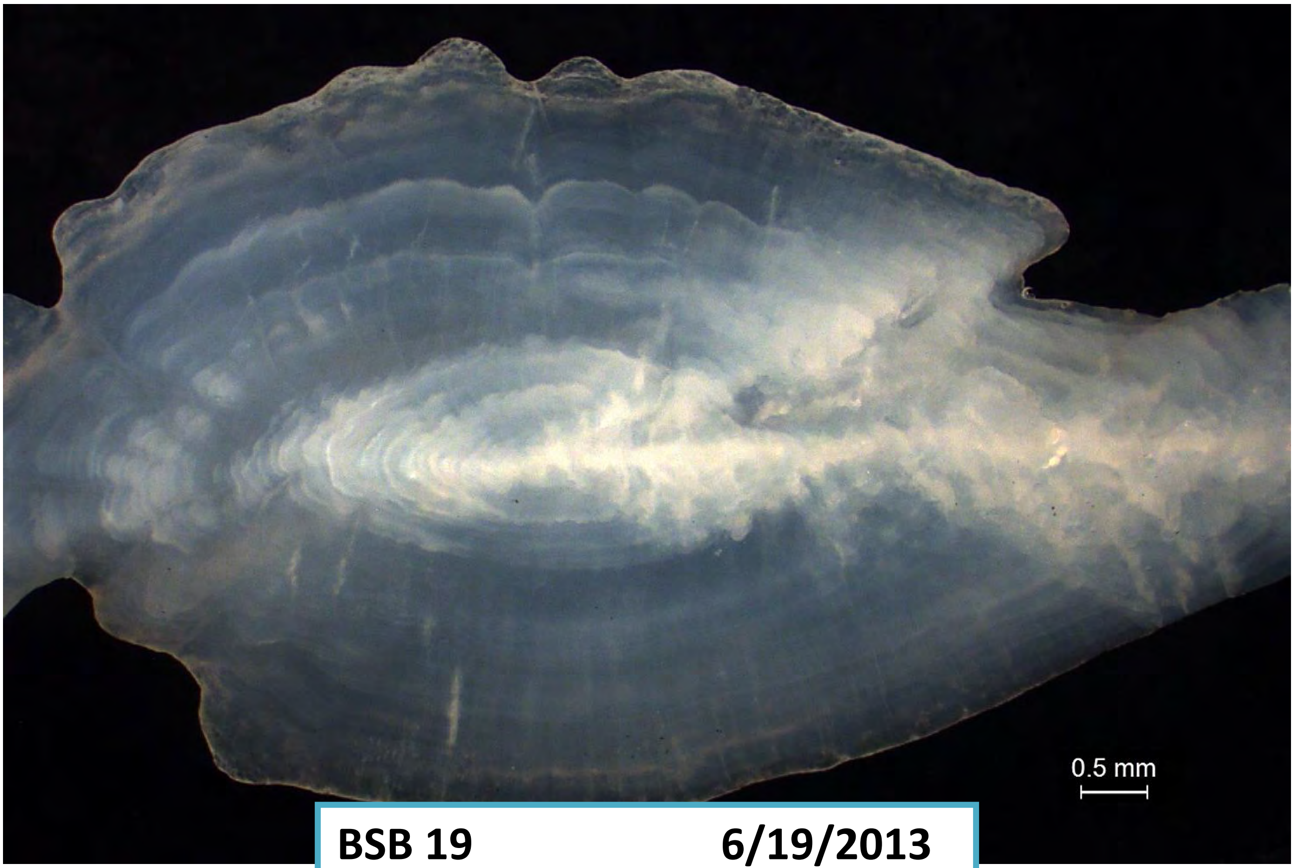
BSB 16 4/13/2014



BSB 17 11/27/2012



BSB 18 10/11/2012



BSB 19 6/19/2013

BSB 20 5/6/2012

Tautog 2 12/13/2018

Tautog 4 10/4/2017

Tautog 7 11/28/2017

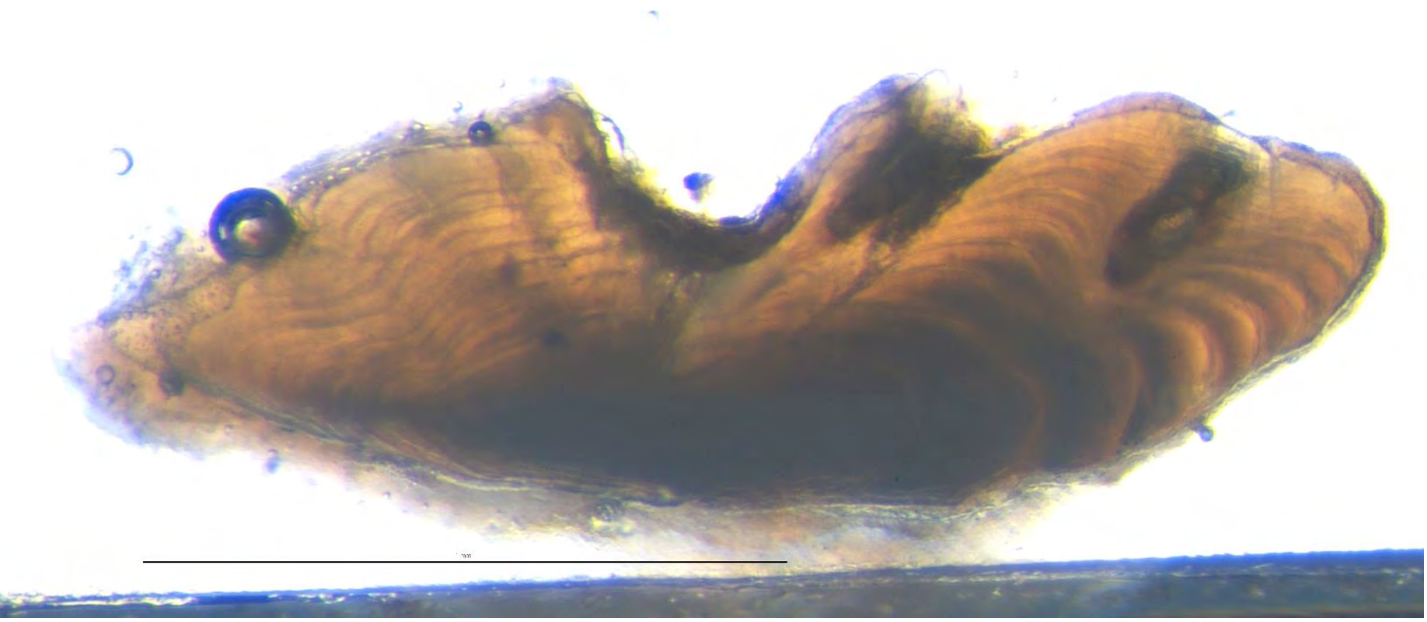
Tautog 11 5/31/2018

Tautog 14 11/28/2017

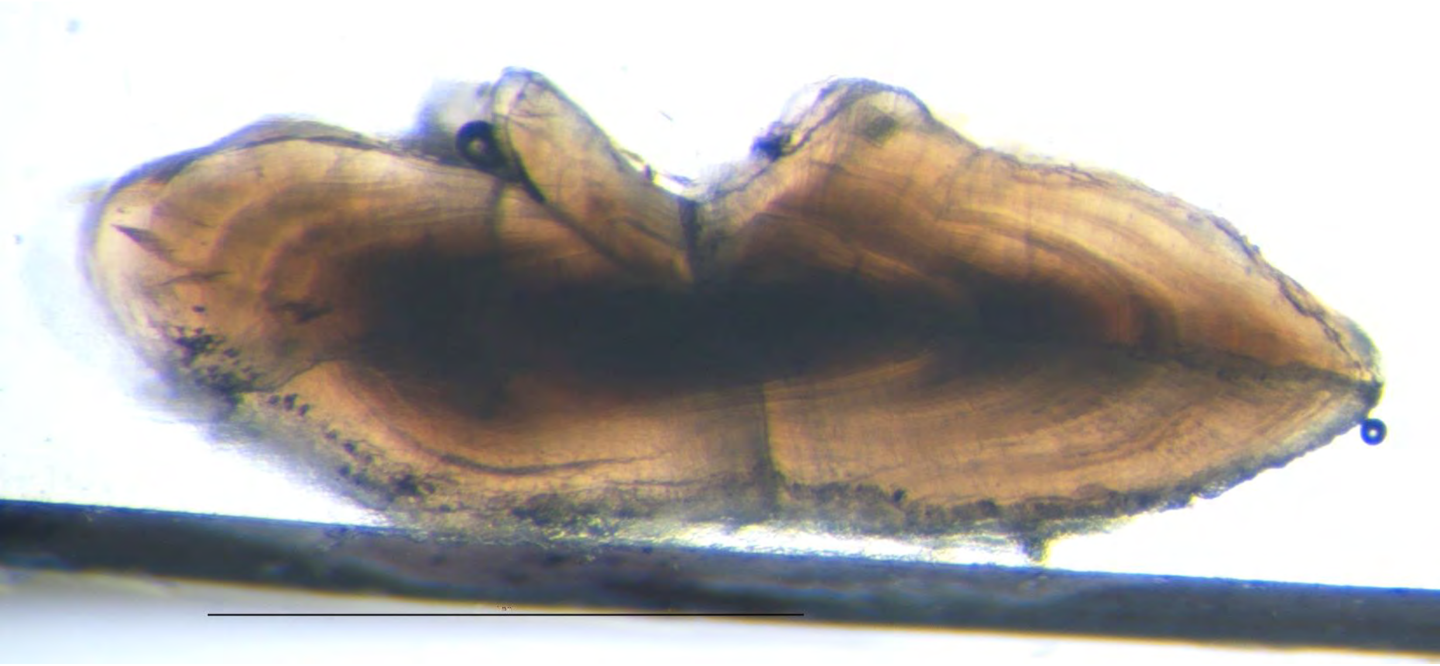
Tautog 19 11/18/2018

Tautog 23 7/5/2016

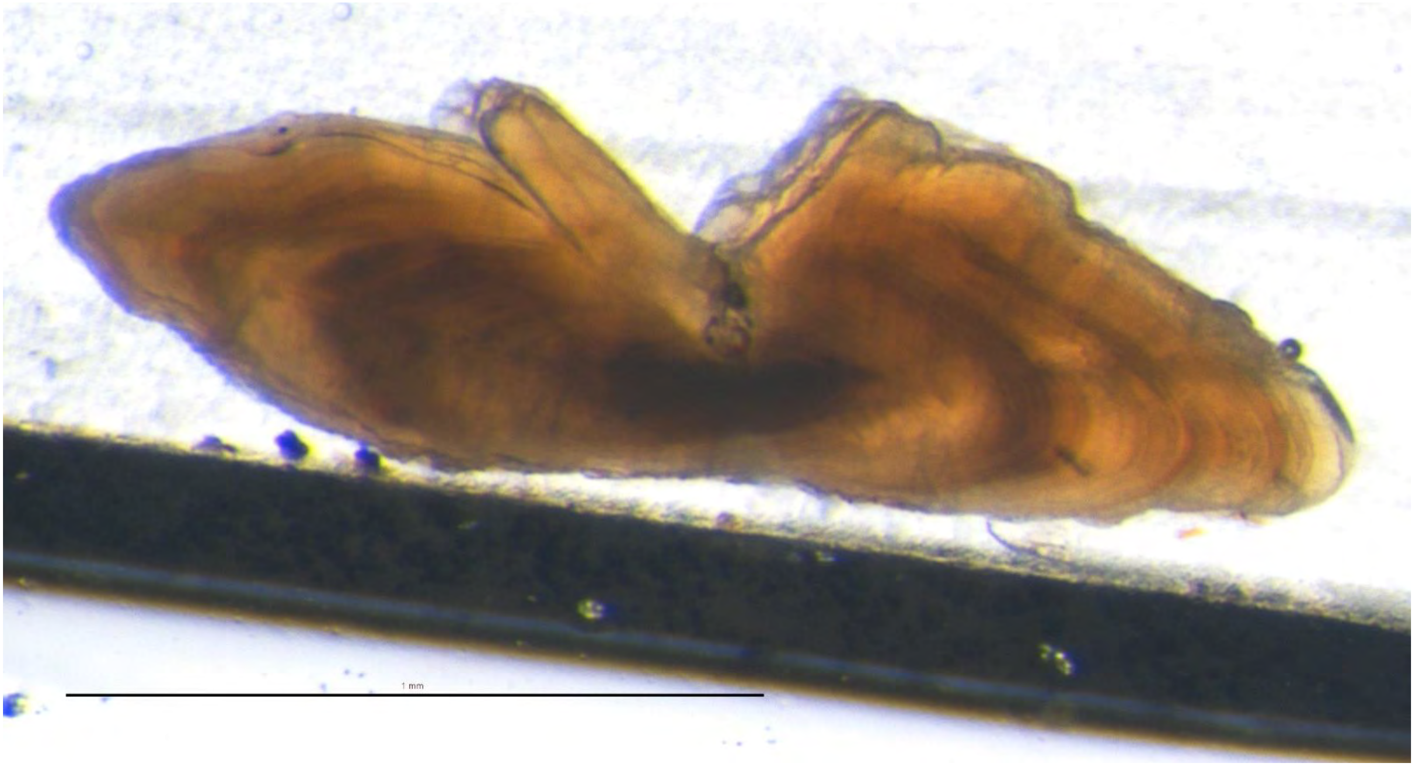
Tautog 25 10/1/2017



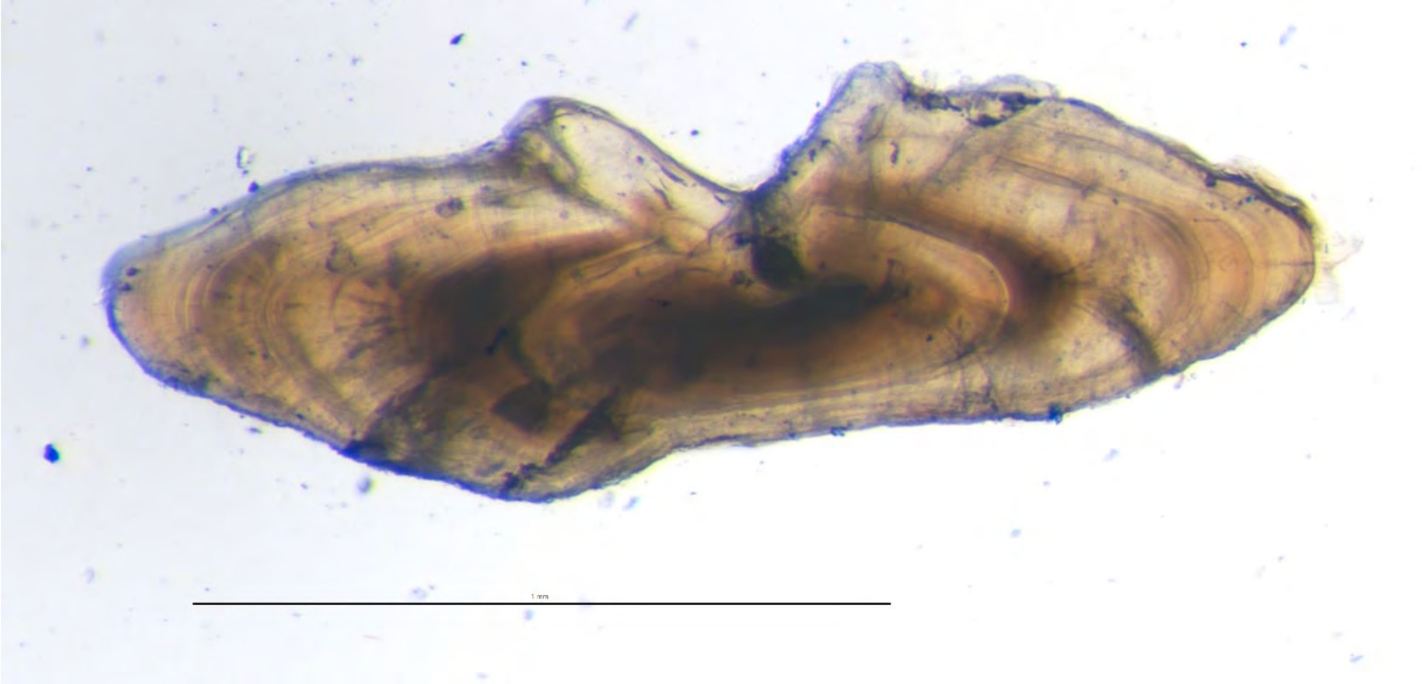
Tautog 29 5/31/2018



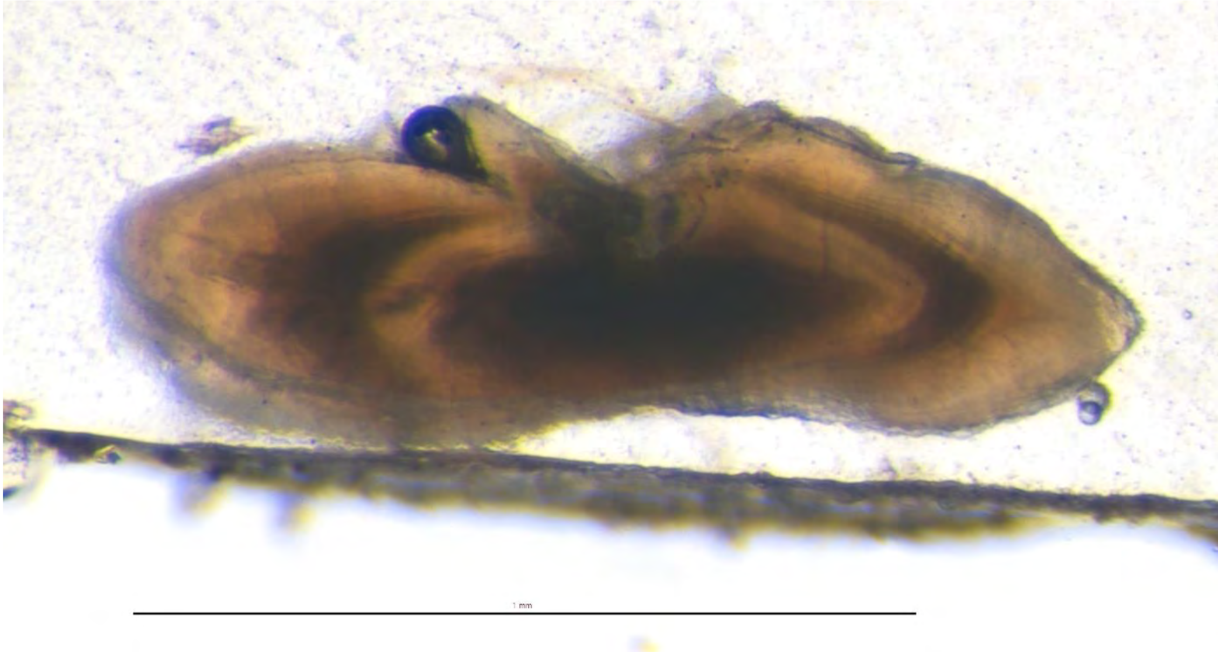
Tautog 30 11/28/2017



Tautog 31 11/18/2018

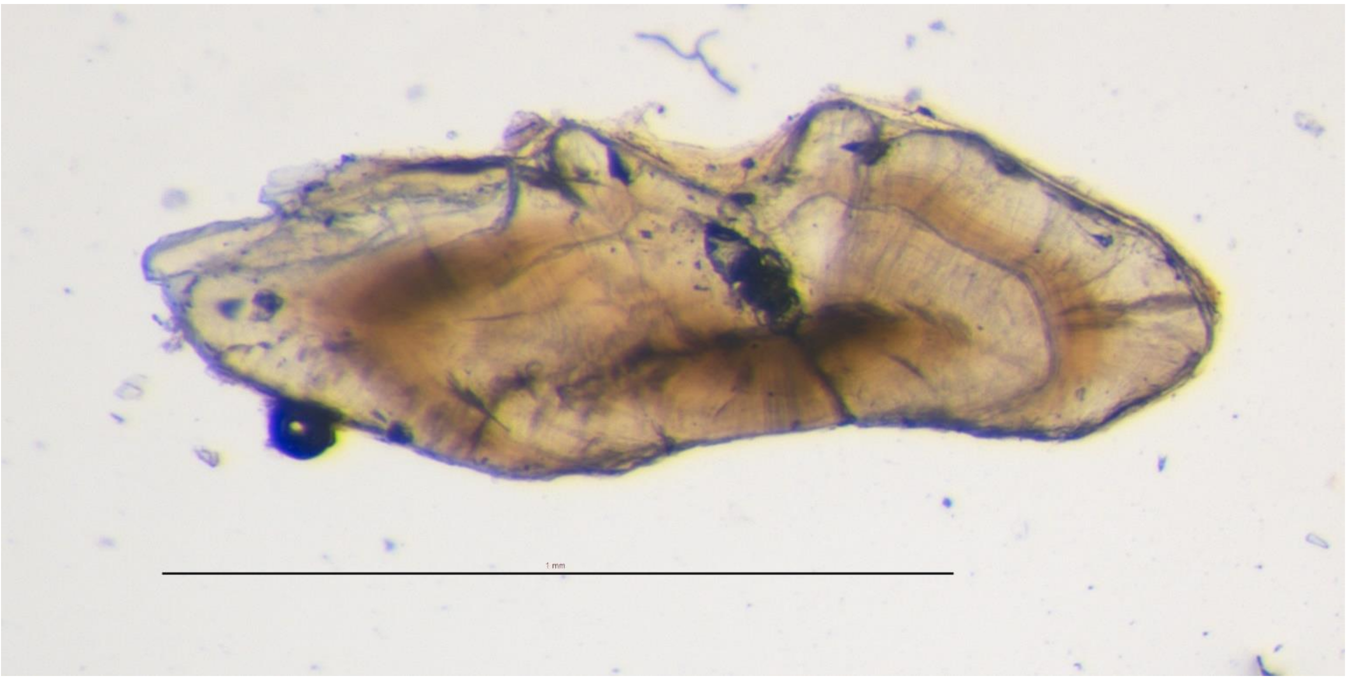


Tautog 32 10/1/2017



Tautog 33 7/5/2016

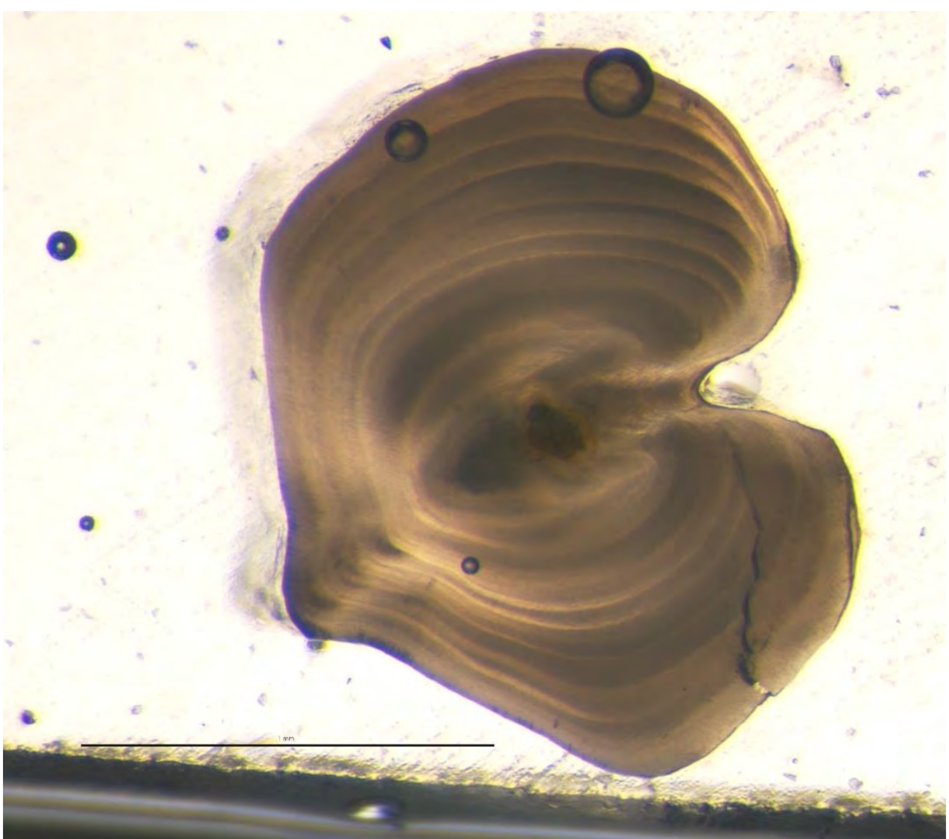
Tautog 34 12/13/2018



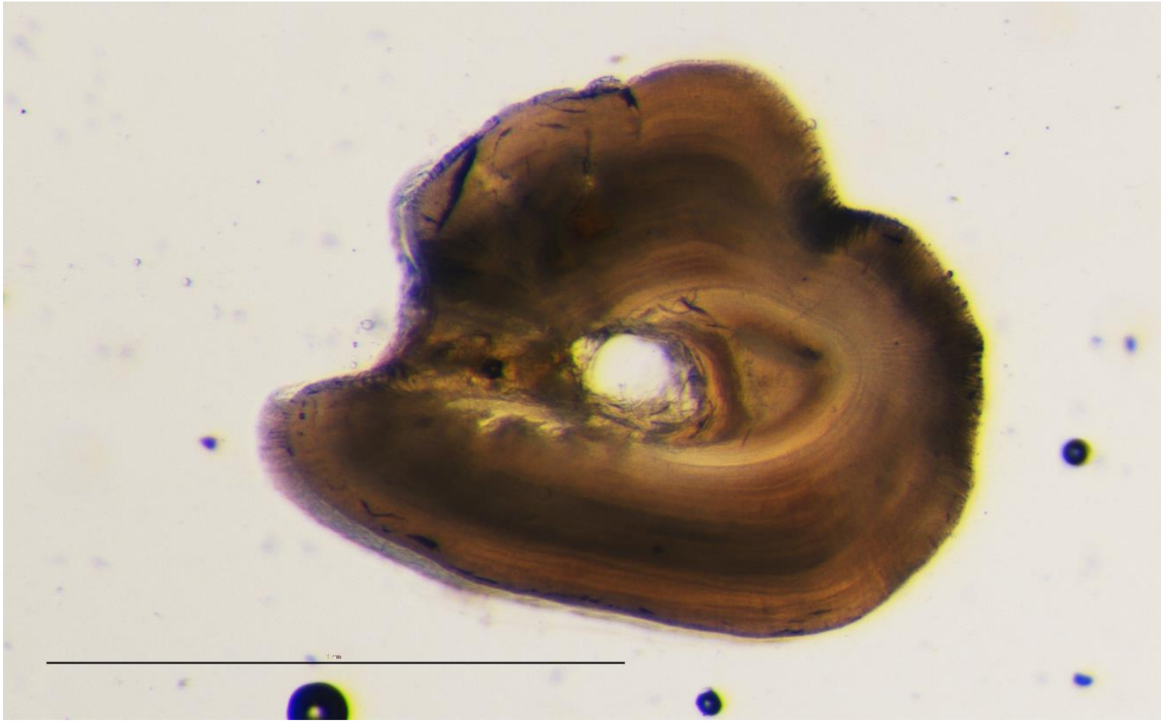
Tautog 35 10/4/2017

Tautog 36 11/28/2017

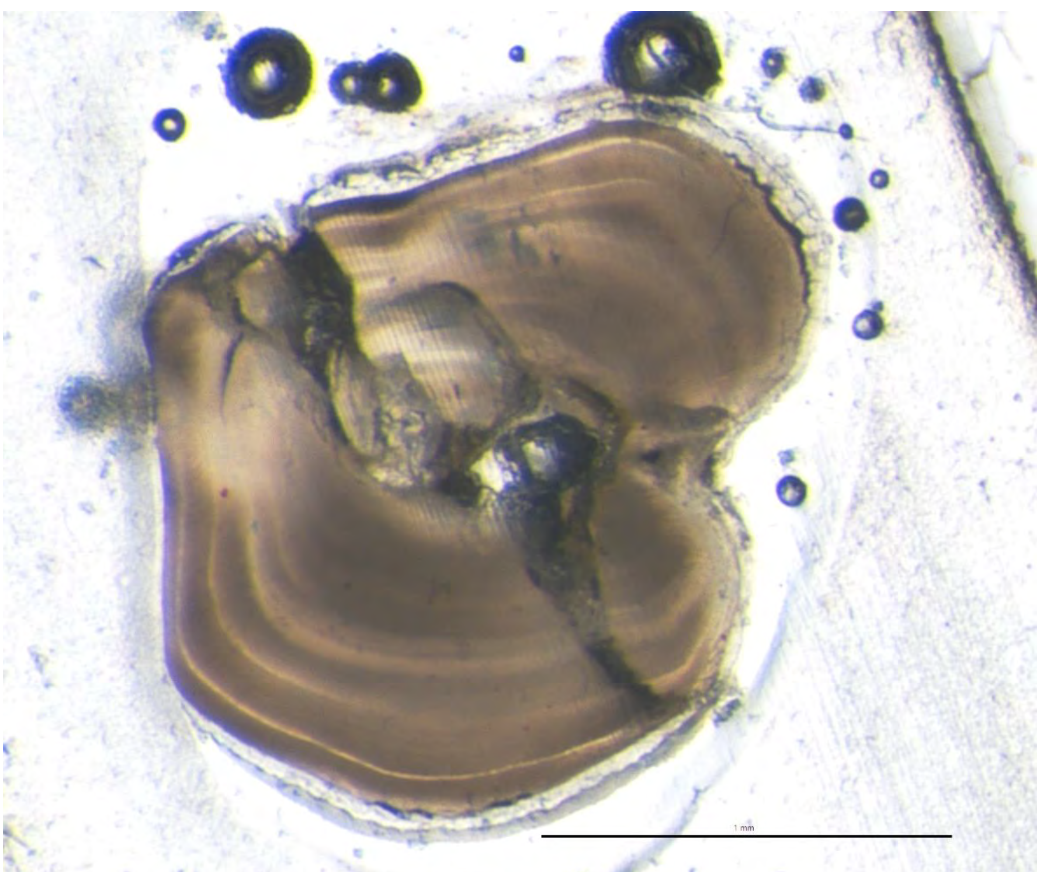
Tautog 37 12/13/2018



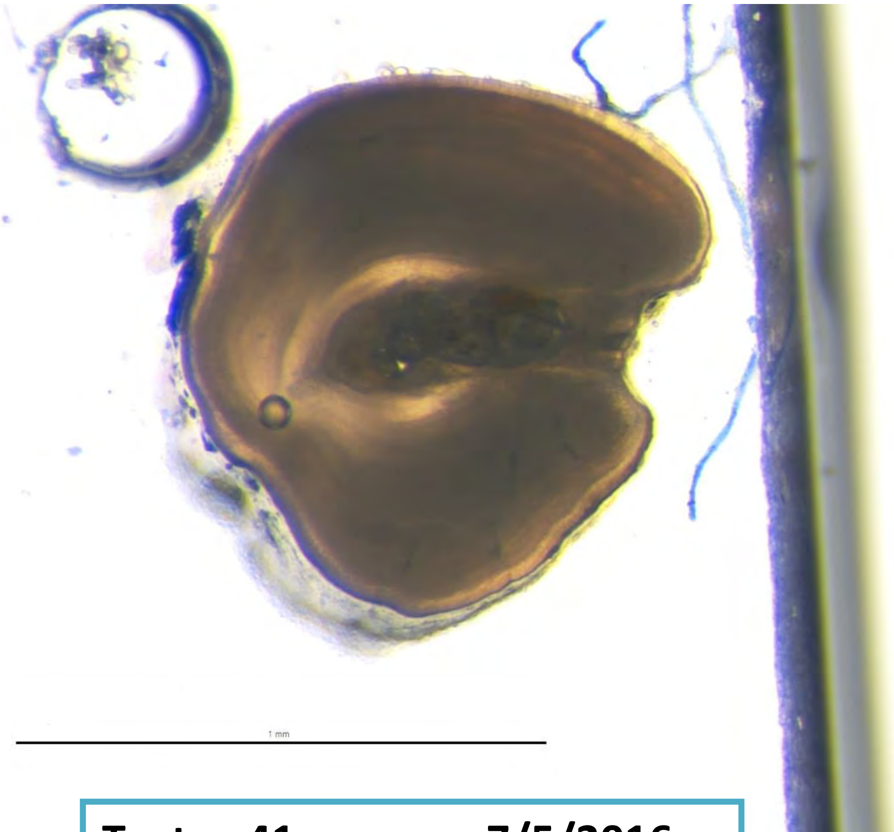
Tautog 38 5/31/2018



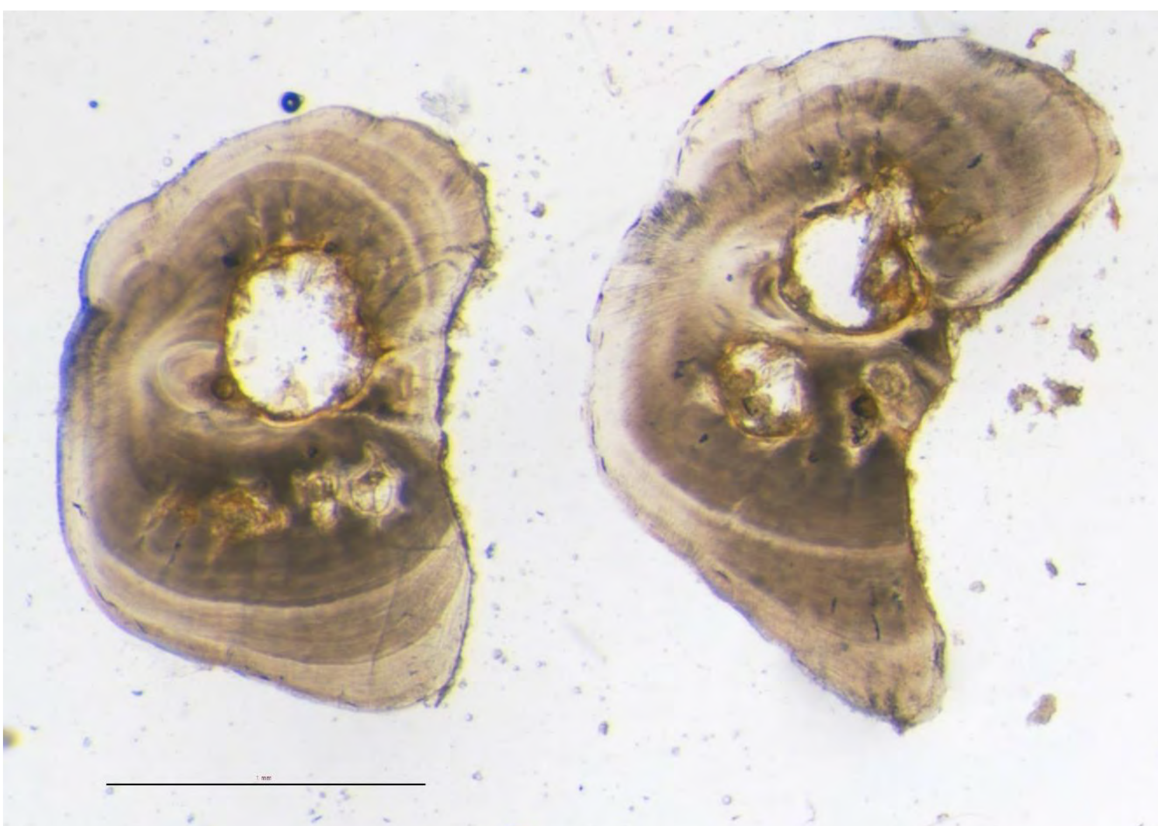
Tautog 39 10/4/2017



Tautog 40 11/18/2018



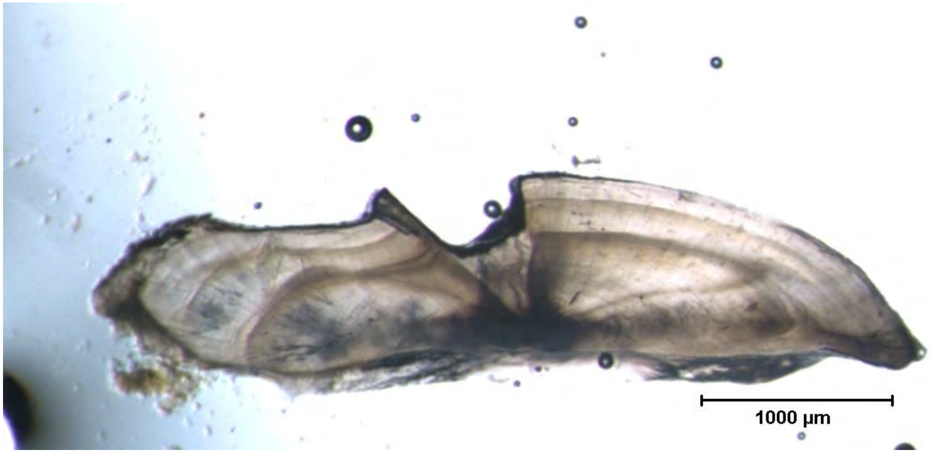
Tautog 41 7/5/2016



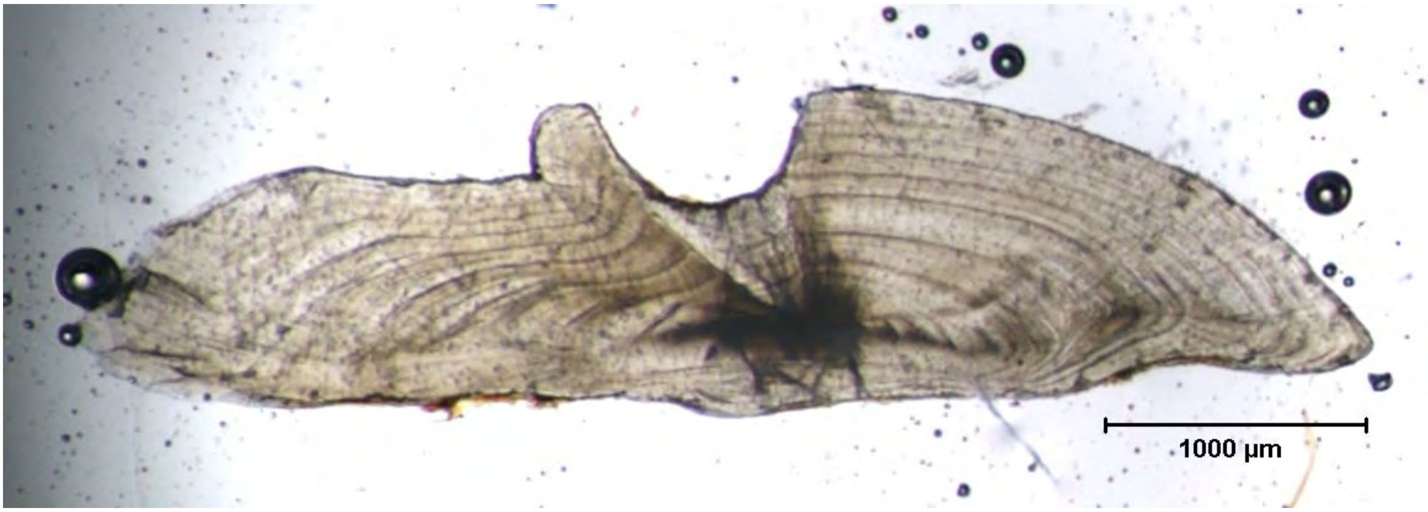
Tautog 42 10/1/2017

Scup 1 7/13/2016

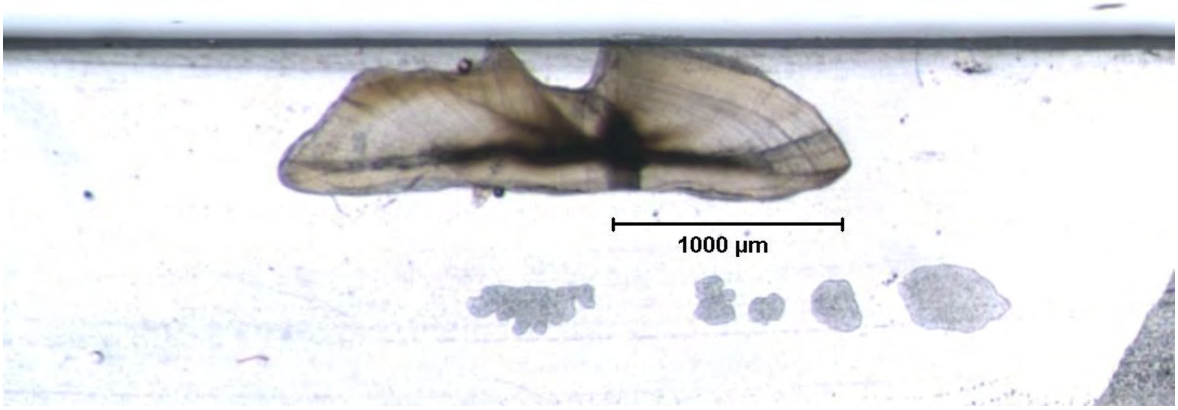
Scup 2 1/26/2017



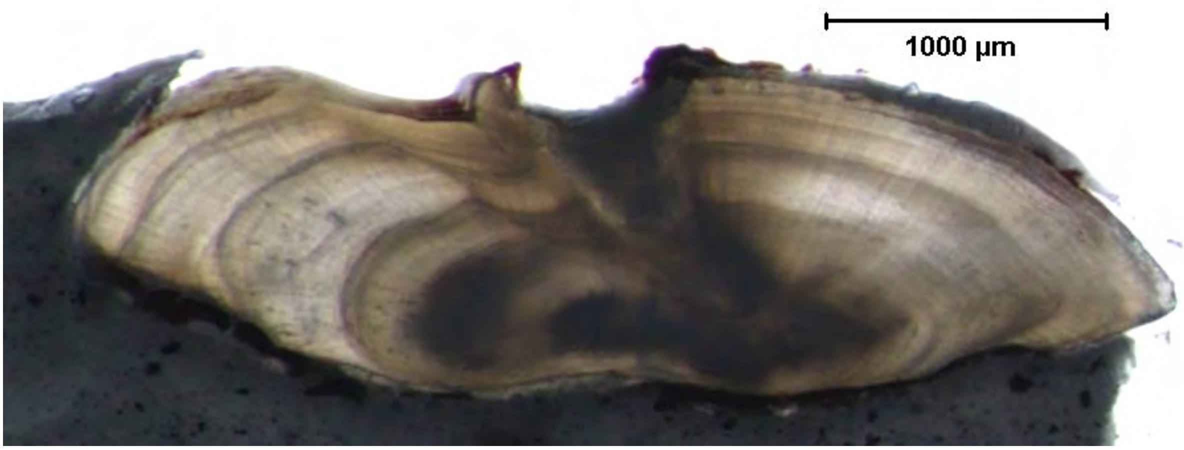
Scup 3 10/13/2016



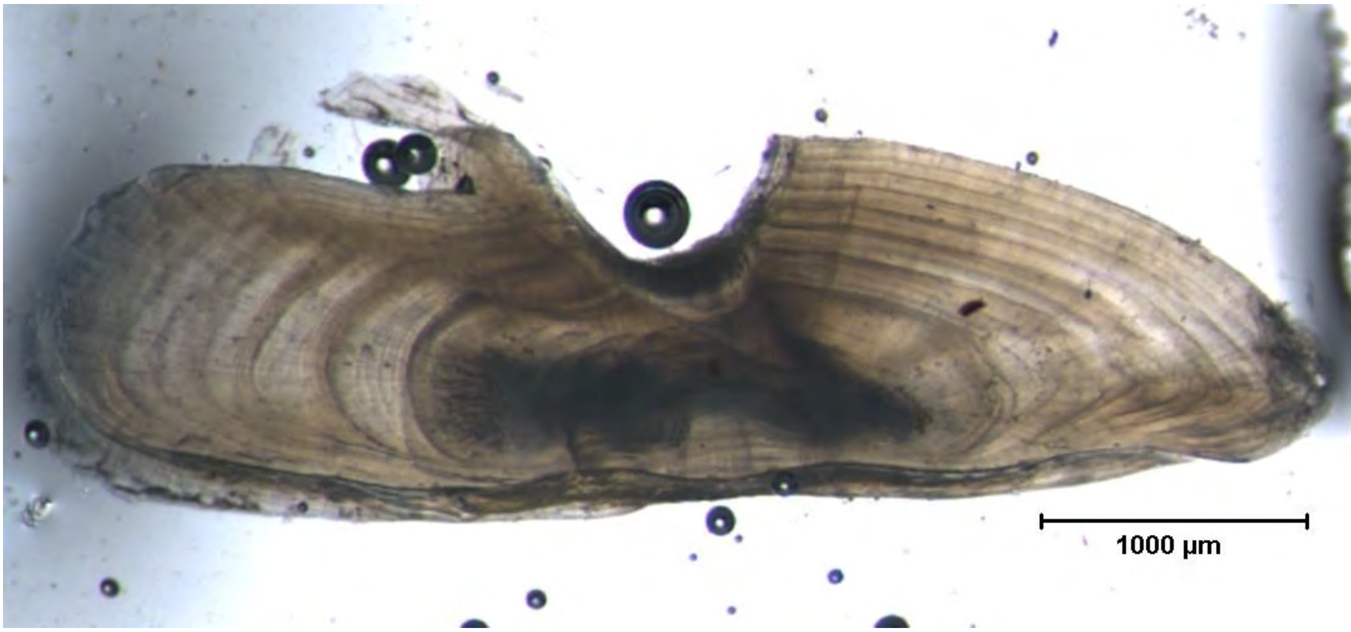
Scup 4 5/20/2015



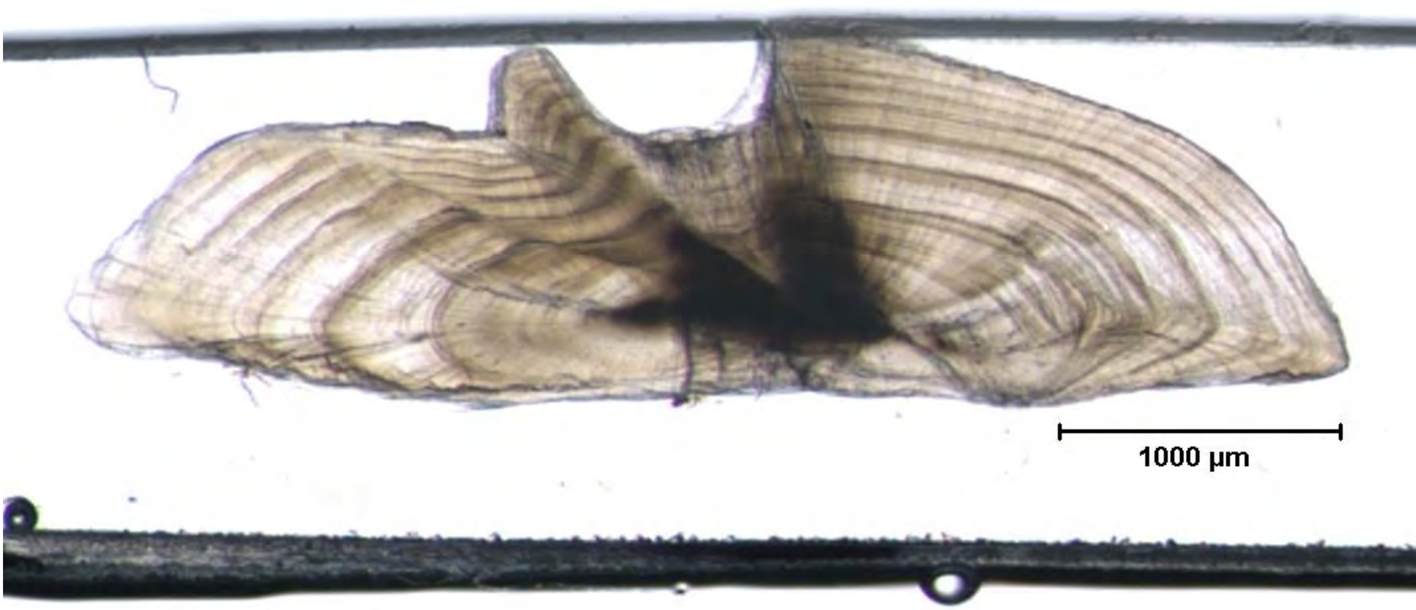
Scup 5 5/17/2016



Scup 6 2/4/2017



Scup 7 10/15/2016

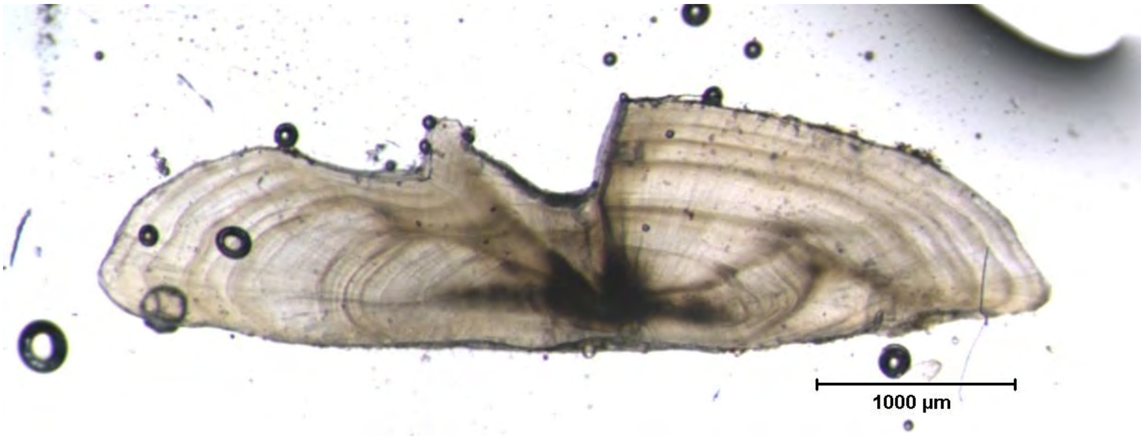


Scup 8 7/13/2016

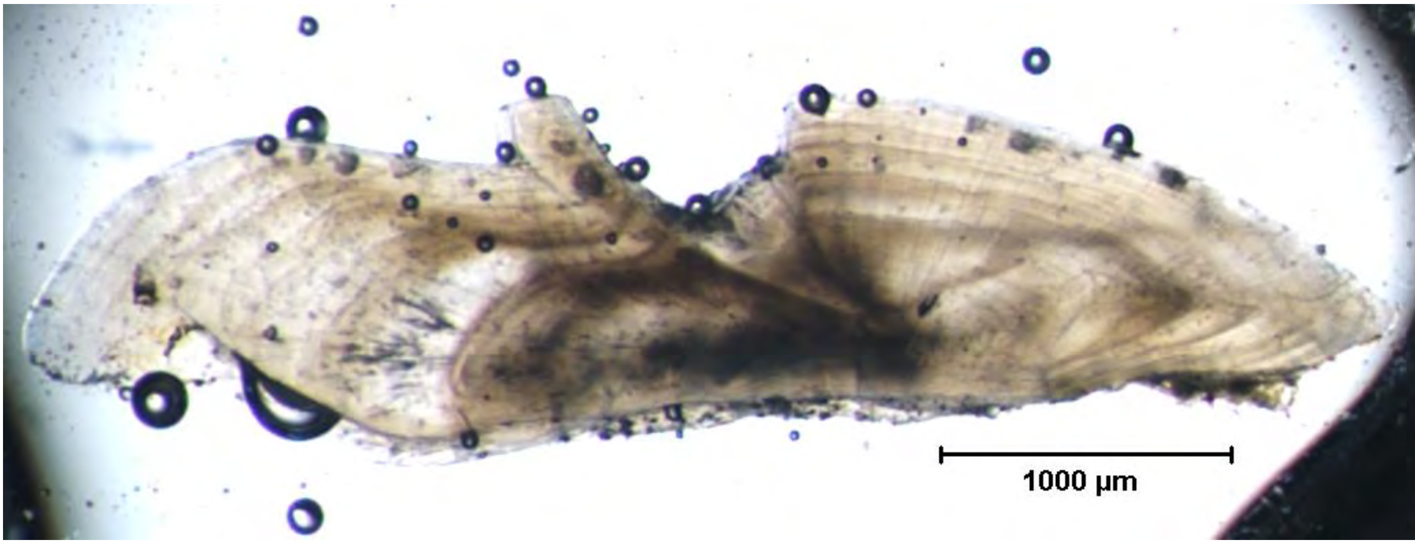
Scup 9 1/26/2017

Scup 10 2/4/2017

Scup 11 10/15/2016

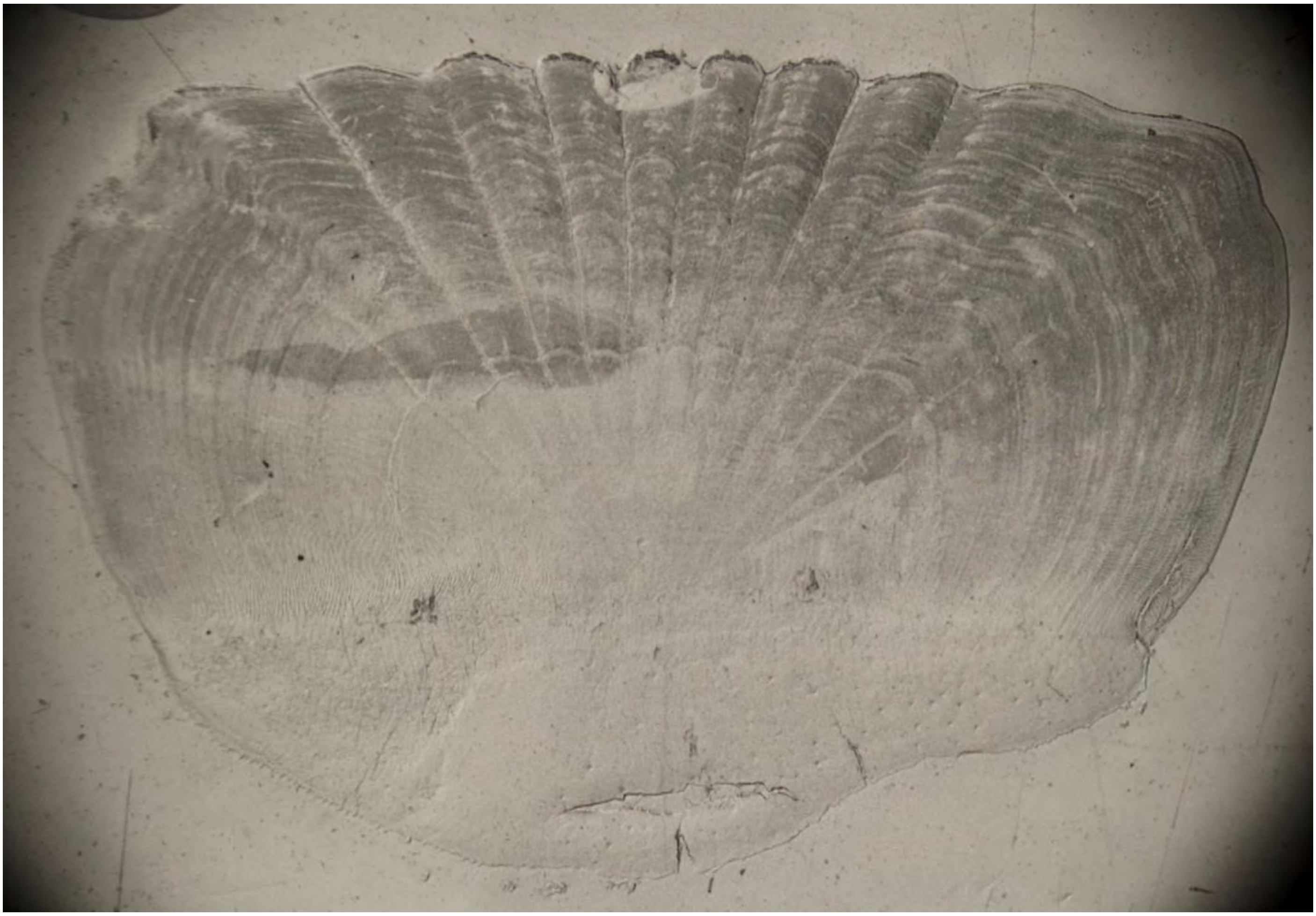


Scup 12 10/14/2016



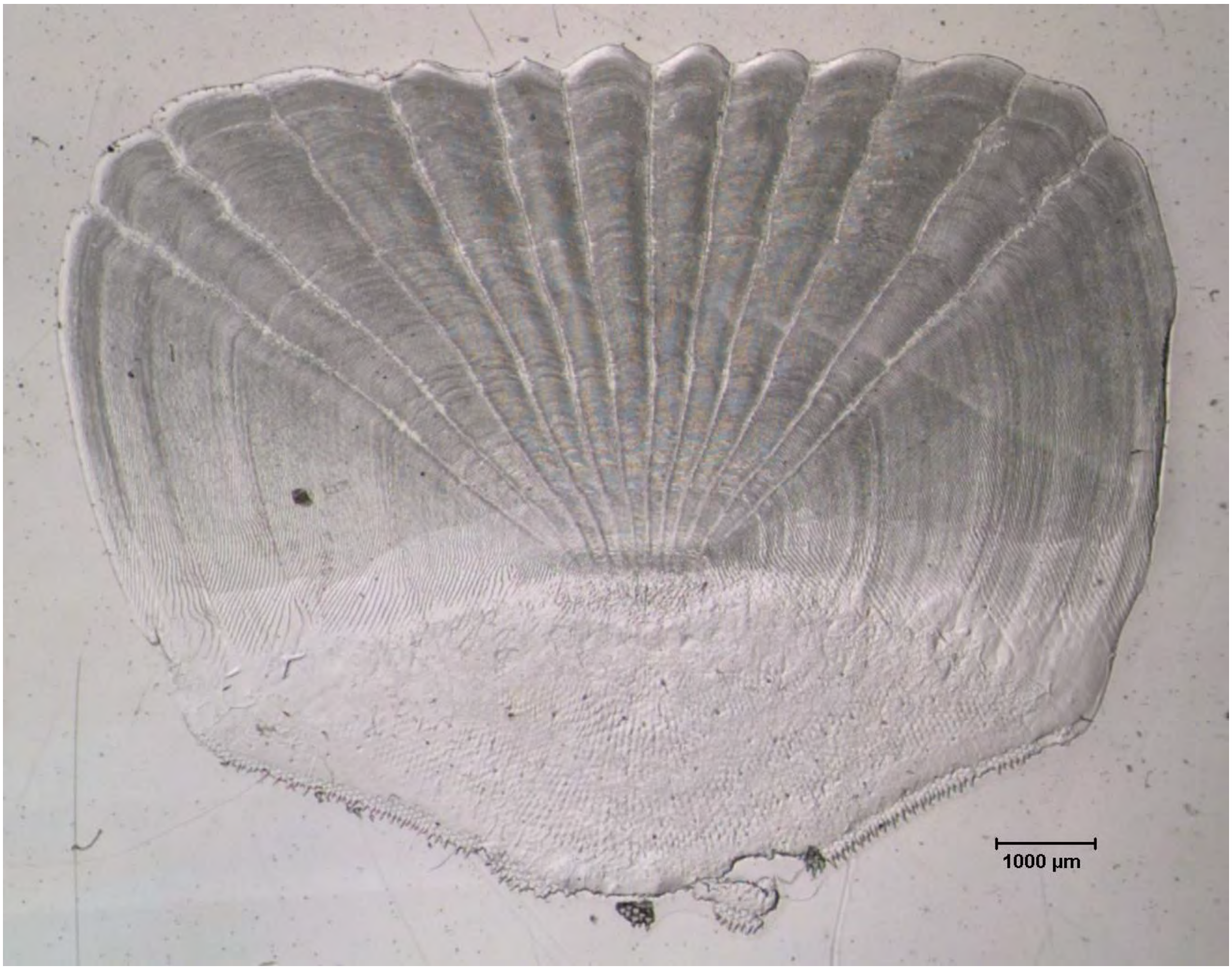
Scup 13 **10/12/2016**

Scup 14 **5/18/2015**

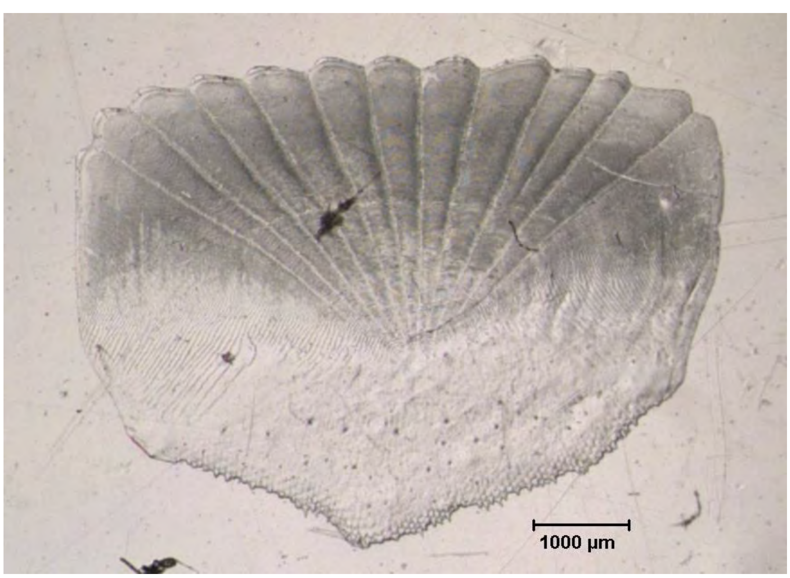


Scup 15 5/21/2016

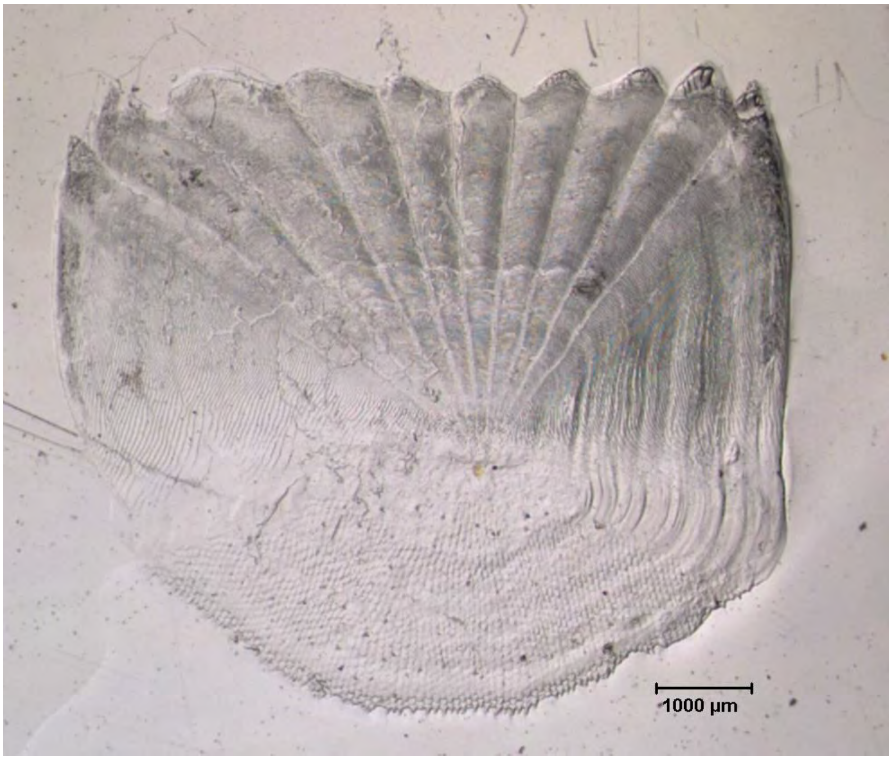
Scup 16 5/17/2016



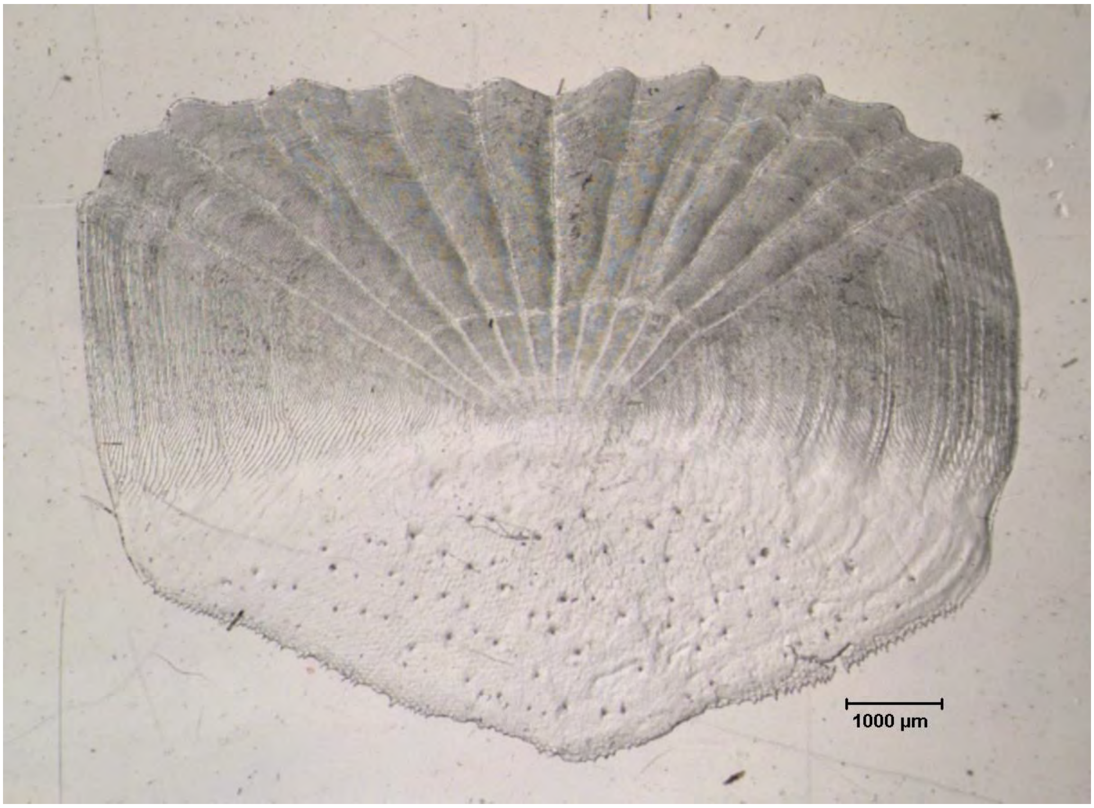
Scup 17 7/6/2016



Scup 18 7/13/2016



Scup 19 **6/17/2016**



Scup 20 **7/13/2016**