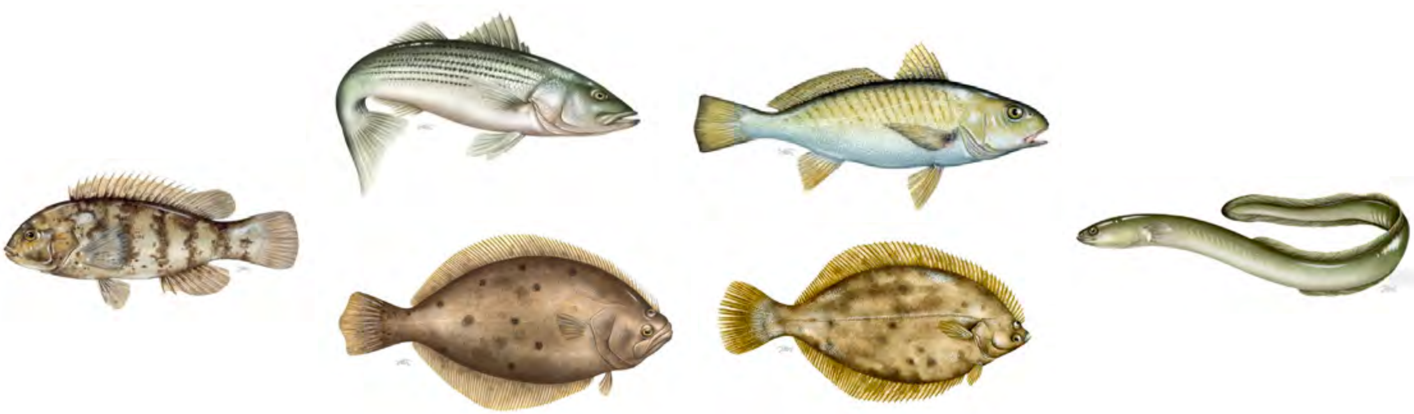
Atlantic States Marine Fisheries Commission

Report of the Quality Assurance/Quality Control Fish Ageing Workshop



March 20-21, 2019
St. Petersburg, Florida

Sustainable and Cooperative Management of Atlantic Coastal Fisheries

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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: Jason Bartlett (ME DMR), Scott Elzey (MA DMF), Eric Robillard (NEFSC), Katie Rogers (NEFSC), Nicole Lengyel (RI DMF), David Molnar and David Ellis (CT DEEP), Caitlin Craig (NY DEC), Jamie Darrow (NJ DFW), Michael Greco (DE DFW), Katherine Messer (MD DNR), Jessica Gilmore (ODU CQFE), Jameson Gregg (VIMS), Caitlin Phelps (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, Kyle Williams, Brittany Barbara, and Kristen Rynerson 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.

This is a report of the Atlantic States Marine Fisheries Commission pursuant to U.S. Department of Commerce, National Oceanic and Atmospheric Administration Award No. NA15NMF4740069.

Statement of Problem

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

The ASMFC has held an annual QA/QC Fish Ageing Workshop since 2016 to provide a yearly check-in for species that have had their own ageing workshop. The full QA/QC sample collection contains approximately 20 samples from each of the following species: Atlantic croaker *Micropogonias undulatus*, American eel *Anguilla rostrata*, black sea bass *Centropristis striata*, bluefish *Pomatomus saltatrix*, striped bass *Morone saxatilis*, Atlantic menhaden *Brevoortia tyrannus*, winter flounder *Pseudopleuronectes americanus*, summer flounder *Paralichthys dentatus*, red drum *Sciaenops ocellatus*, scup *Stenotomus chrysops*, and tautog *Tautoga onitis*. 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 QA/QC fish ageing group decided to rotate some species every few years so that more species could be included. Striped bass, Atlantic croaker, winter flounder, summer flounder, American eel, and tautog were identified as species to evaluate for the 2019 workshop which took place from March 20-21 at the Florida Fish and Wildlife Research Institute (FL FWRI) in St. Petersburg, FL.

Workshop Objectives

The objectives of the workshop were to:

(1) Age samples collected and prepared from labs along the Atlantic coast for striped bass, Atlantic croaker, winter flounder, summer flounder, American eel, and tautog

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

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

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

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

Previous Ageing Workshops

All species aged during the 2019 QA/QC Fish Ageing Workshop have previously had their own ageing workshop. 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. American Eel

American eel underwent an ASMFC benchmark stock assessment in 2012 (ASMFC 2012) and an assessment update in 2017 (ASMFC 2017c). Age data was available for the assessment from otolith samples from DE and MD, as well as some research studies. During the development of the assessment, an age-structured production model was used for ages 2-12, but the model did not converge and it was not recommended for use at that time. While the current stock assessment model is not age-structured, the available ages from fisheries-dependent surveys were used to develop catch curves and age data were used to develop natural mortality rates at age, age-length relationships, and average age at maturity. Concerns raised that analyses indicated age is a poor predictor of length, age samples from estuarine populations may not be representative of freshwater populations, current biological sampling may not provide sufficient spatial coverage, and there is the possibility that during metamorphosis the otolith reabsorbs material and causes discrepancies for ageing.

A hard part exchange for American eel was organized and completed in 2017 and workshop followed in 2018 (ASMFC 2017b). The exchange had participation and samples from Maine to Florida and included whole and sectioned otoliths, many as paired samples. Analysis from the exchange indicated systematic bias and a lack of precision in age readings as well as low agreement between readers both within lab and between states. Varying levels of experience, lack of familiarity reading whole otoliths, identifying the first and last annulus, and knowing when to round ages based on annulus count, catch date, and margin codes were all identified as potential reasons for the exchange results. A workshop followed that recommended that age determination should use sectioned otoliths or whole otoliths that have been mounted to a slide and polished to expose annuli; loose whole otoliths should not be used.

II. Atlantic Croaker

Age data is used to describe the life history of Atlantic croaker in stock assessment reports, as well as in the statistical catch-at-age model in the 2010 assessment. All ages used in the assessment reports have been from otoliths. Recommendations from the stock assessment subcommittee and the review panel during the 2005 and 2010 stock assessments identified the need to standardize ageing protocols for this species (ASMFC 2010).

The ASMFC hosted a joint ageing workshop for Atlantic croaker and red drum in 2008 to standardize methods for processing and reading otoliths (ASMFC 2008). Additionally, a goal of the workshop was to resolve the issue of identifying the first annulus from any smudges, or check marks, laid down near the core. Otolith sections were exchanged and read by participants from NJ to GA and the Southeast Fisheries Science Center (SEFSC). The workshop concluded that the smudge should not be counted but rather the first distinct ring is the first annulus.

III. Striped Bass

Age data for striped bass has been used for both VPA- and SCA-based stock assessments, so ageing consistency among coastwide agencies and ageing labs is critical for the management of this species. Scale ages have been used in the assessment since 1996. Scales have been the most common hard part collected and aged, but it has been acknowledged that they underestimate ages in older fish when compared to otoliths (Secor et al. 1995). Both the technical committee and stock assessment committee for striped bass expressed interest in collecting more paired samples and developing regional and annual scale age-otolith age conversion keys to correct for scale bias (ASMFC 2013a). A benchmark stock assessment was completed in 2019 and included the previously-used forward projecting SCA model using catch-at-age data. For this assessment, states that had otolith ages were allowed to submit those instead of scale ages for use in the model.

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

IV. Summer Flounder

The most recent benchmark stock assessment for summer flounder (NEFSC 2013) used a forward projecting age-structured model. Age data was used throughout the assessment including length and sex at age data, age-dependent values of natural mortality, and discards at age and therefore accurate and precise age data is critical for this assessment and its updates. There are several age-related research recommendations for summer flounder including a need for age frequency data from recreational discards, continued collection of otoliths for catch-at-age matrices, and the need for a reference collection of scales and otoliths to facilitate quality control of summer flounder production ageing.

A significant amount of summer flounder ageing work has been done by the Northeast Fisheries Science Center (see NEFSC 2013 for a more thorough description). Both scales and sectioned otoliths have been used to age summer flounder. The ASMFC sponsored an ageing workshop for scup *Stenotomus chrysops* and summer flounder in December, 2014, through a partnership with Virginia Institute of Marine Science (VIMS). While summer flounder does not have a published age validation study, increased interest in the species necessitated that labs ageing samples used the same protocol and ageing method. Samples were paired scale and otoliths from the NEFSC and VIMS. Agreement between readers for summer flounder was low and attributed to difficulties finding the first annulus and distinguishing check marks from true annuli.

V. Tautog

From 1995-2011, benchmark and update stock assessments for tautog used a VPA model that relied on age data. A statistical catch-at-age model was developed for the 2015 stock assessment and age data was used to develop life history parameters as well (ASMFC 2015). 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.

Since the publication of Elzey and Trull (2016), there has been increased interest in the use of pelvic spines for ageing tautog. In March, 2019, the Tautog Technical Committee (TC) requested that the ASMFC pursue an ageing workshop to evaluate pelvic spines for use in ageing and future stock assessments. Agers participated in a planning call in April, 2019, and the planning stages of an exchange and workshop are underway.

VI. Winter Flounder

Winter flounder was assessed using an age-structured model (NEFSC 2011) and ages were used throughout the assessment for size at age, fishing mortality at age, and calculations of spawning stock biomass and life history parameters. As part of the research recommendations, the assessment suggested that port samplers collect otoliths from large flounder since scales cause under-ageing in larger fish and that the amount of age samples from MRFSS/MRIP should be maintained or increased.

In 1998, the ASMFC organized a winter flounder otolith ageing comparison study between four readers that exhibited systematic differences between them and inconsistent age readings. Identifying a need to develop a protocol for processing and age reading for winter flounder, the ASMFC sponsored a workshop in 2001 (ASFMC 2012b). Participants found that whole otoliths could be used to age samples and that this method was superior to ageing scales for older fish. From this workshop, it was recommended that both scales and otoliths should be collected when possible and age samples from both retained and discarded fish in the recreational fishery should be collected.

Sample Collection, Preparation, & Ageing Methodology

I. American Eel

Maine Department of Marine Resources (ME DMR)

American eel otoliths have been collected since 2017 from eels sampled for the life-cycle study as required by ASMFC. Length, weight, sex, and swim bladder parasite infestation rates are recorded from eels collected in the study area as well as from eels collected in the Kennebec and Sheepscot Rivers. A total of 78 samples have been collected. All sample processing and reading is performed by one individual.

Protocols for otolith processing and ageing developed by Ken Oliveira, University of Massachusetts Dartmouth, are used by ME DMR. Whole otoliths are embedded in epoxy resin and sectioned using a Buehler low-speed Isomet™ saw with (4) 0.1 mm spacers between the blades. Each otolith section is mounted on a glass side with Crystalbond™ adhesive and polished by hand using micron lapping films. To highlight annuli, sectioned otoliths are soaked in a 5% EDTA solution for approximately 5 minutes, rinsed, and then soaked in Toluidine Blue for approximately 5 minutes. Otolith sections are viewed and photographed wet using transmitted light under a microscope with camera attachment.

Whole otoliths from small yellow eels (<200 mm) are mounted on glass slides and sanded with 600-800 grit sandpaper. These are also viewed wet under a microscope and photographed. Eel ages have ranged from 2-17 years old.

New Jersey Division of Fish and Wildlife (NJ DFW)

American eel otoliths have been collected since 2006 from NJ commercial yellow eel fishermen primarily from Delaware Bay, (51%) followed by the Mullica River, and Barnegat Bay (25% combined). Length, weight, and otoliths are collected from an average of 317 eels annually, ranging in number from 140-547. Ages range from 0-15 years, averaging 3-5 years. Annual target lengths are 1,750 and ages are 350.

Protocols developed by Ken Oliveira, University of Massachusetts Dartmouth, are used for processing and for ageing. Whole otoliths are embedded in resin and sectioned with a Bueler low speed Isomet™ saw. The sectioned otolith is mounted to a glass slide with Flotexx and then polished by hand with micron lapping films. The sanded section is soaked in a 5% EDTA solution for 3-5 minutes and then soaked in Toluidine Blue for 5 minutes. Otoliths are read wet with a microscope. Otoliths are read by two agers independently and a third individual ages any tiebreakers.

Delaware Division of Fish and Wildlife (DE DFW)
American eel otoliths have been collected since 2001 as part of the biological sampling program of the commercial yellow eel fishery in Delaware. Staff collects length and weight measurements from the tidal tributaries of Delaware Bay from April to October, depending on availability and cooperation of the fishery. Random pots are selected from commercial observer trips. All eels captured in the selected pots are kept for characterization of the annual commercial catch, including length, weight, and age data. American eels captured in various DDFW fishery-independent surveys are kept for age determination as well. Approximately 125 to 450 American eels are sampled annually. Otoliths are removed in the lab, cleaned, and mounted on microscope slides using Crystalbond™ adhesive. Whole otoliths were sanded with 600 to 1200 grit sandpaper. Slides were viewed and photographed under a Zeiss™ microscope (Axiolab stemi) with camera attachment at 2.5X magnification. Pictures are put into Microsoft Powerpoint slides where color, contrast, and brightness can be adjusted to illuminate annuli. The lab uses two readers who independently age the otolith section to assign an age. Otolith ages with disagreement are re-read until a consensus age is determined or they are removed from the collection. From 2001-2016, a total of 3,463 eels were aged in this program with an age range from 2-12 years old.

Maryland Department of Natural Resources (MD DNR)
A biological sampling program for commercially harvested American eels has been in place in Maryland since 1997. A minimum of two selected tidal tributaries are sampled annually (100 pounds each) from April-June. Biological information collected includes length, weight, sex, and parasite infestation rate. Approximately 8-10 eels are randomly subsampled from 20mm size bins ranging from 260-400mm for age, sex, and presence/absence of swim bladder parasite. A minimum of 5 eels are randomly subsampled from the remaining 20mm size bins.

Upon removal of the sagittal otoliths, any clinging tissue is removed. The otoliths are placed into a polypropylene well plate for storage until they are ready to be mounted. In preparation for mounting, the otoliths are placed in a *Coors Tek* porcelain spot plate and cleaned with a 10% bleach solution for approximately 5 minutes. Then the otoliths are gently rinsed with distilled water and patted dry. Whole otoliths are placed convex side up and mounted on glass slides with *CrystalBond*, a thermoplastic adhesive. Glass slides are heated on a hotplate to liquefy the *CrystalBond*. The adhesive is then drawn over the dorsal side of the otolith. This allows the small crevices on the otolith surface to be filled and provided better clarity for reading.

The otoliths are examined at up to 60X magnification under a compound microscope with both transmitted and an external fiber optic light source. Both light sources are not used at the same time, but independently to increase precision for the aging estimate. If opaque and translucent zones are not readily apparent, the dorsal surface of the otoliths is lightly polished with moistened 600 grit wet/dry sandpaper until the primoridium (nucleus) is reached and the outer edge of the otolith is discernible. A small amount of type b immersion oil is then placed on the sanded otolith. The concave side of the otolith is sometimes read by flipping over the glass slides.

Field information such as, location of capture, date of capture, length, and sex, if available, are used to assist with correct age interpretation (ICES 2009). The first opaque zone out from the nucleus is the transition mark and is laid down as glass eels transition into elvers. The transitional mark is not counted as an annuli when determining freshwater age. In normal conditions, only one opaque and one translucent zone are formed during a single year (Liew 1974). An additional year is included if a translucent zone on the edge is interpreted by the reader as nearly complete. This was recommended for samples collected early in the year where an undifferentiated annulus on the outer margin of the otolith would occur prior to fast summer growth (ICES 2009).

The lab uses two readers who independently age the otolith. Otoliths with disagreement are re-read once to determine consensus age or they are removed from the collection if consensus cannot be reached. From 1997-2015, 3,628 commercially harvested eels were aged in this program with an age range from 1-15 years old. However, 92% of sampled eels are 2-8 years old.

South Carolina Department of Natural Resources (SC DNR)
American eel otoliths have been collected since 2010 as part of DNR's long-term electrofishing sampling of estuarine water bodies. Staff have collected eel length measurements in the field from 5 estuaries year round since 2002, and currently retains specimens for lab workup according to a checkoff sheet divided into bins by total length. During each 2 month "wave" of sampling, a maximum of 35 eels are randomly selected from 7 length bins (5 eels/bin) for sex, maturity, and age determination, or up to 210 eels annually. Otoliths are removed in the lab, cleaned, stored in 100% ethanol for approximately 2 weeks and then dried, marked at the core, embedded in bullet molds, and sectioned on a low speed wafering saw using two blades separated by a plastic spacer with a width of 0.5 mm. Sections are then mounted onto glass slides and polished to a thickness of 0.2-0.25mm. The lab uses two readers who independently read the otolith section to assign an annulus count. Otoliths with disagreement are re-read until a consensus count is determined or they are removed from the collection. After assigning a consensus annulus count, eel otoliths are measured under a microscope using ImagePro software. Distances are measured (in millimeters) from core to core edge, core to each annulus, and marginal increment width. 274 otolith sections were examined from specimens collected in 2012-2013, 268 of which were assigned consensus reads and 6 of which were discarded. Annulus counts ranged from 0 to 10.

Florida Fish and Wildlife Conservation Commission (FL FWC)
FL FWC has conducted electrofishing surveys in several lakes and marshes since 2006. Surveys are generally conducted in the fall between September and December using standard electrofishing methods. Samples provided for this exchange were collected throughout the year in 2014-2015 from multiple sites and paired sectioned and whole otoliths were provided.

II. Atlantic Croaker

NJ DFW
Since 2006, Atlantic croaker have been collected during dockside sampling by NJ DFW staff. Fishery independent samples are also seasonally collected aboard the NJ DFW Ocean Trawl Survey. Samples are weighed, measured, and otoliths are removed as samples are being offloaded from commercial fishing vessels. Once otoliths are extracted, they are sectioned and aged under a microscope at NJ DFW's Nacote Creek Research lab. To date, 3,888 samples have been collected, with 52 samples collected in 2018.

MD DNR
Maryland Atlantic croaker otoliths were collected from commercial pound nets in 2000 and then from 2002 through present (2016). A minimum of 20 samples were taken in 20 mm TL bins annually for all size groups available. Additional randomly collected pound net, gill net, and trawl commercial samples were obtained from fish dealers from 2009 to 2014. These were opportunistic sampling events, did not collect all gear in all year, and may or may not occur in the future. In 2012, croaker otoliths were also sampled randomly from commercial gill nets. All fish sampled for age were measured to the nearest mm TL, weighed to the nearest gram and sex was determined from internal examination of the gonads.

Prior to 2011, Atlantic croaker otoliths were processed and aged by the South Carolina Department of Natural Resources (SC DNR). Otoliths from 2011 to 2015 were aged by MD DNR biologists. The left otolith from each specimen was mounted to a glass slide for sectioning. If the left otolith was damaged, missing, or miscut the right otolith was substituted. Otoliths were mounted in Crystalbond 509 and were sectioned with a Buehler Isomet^{TM} Low SpeedSaw using two blades separated by a 0.4 mm spacer. The Buehler 15 HC diamond wafering blades are 101.6 mm in diameter and 0.3048 mm thick. The 0.4 mm sections were then mounted on microscope slides and viewed under a microscope to determine the number of annuli. All age structures were read by two readers. If readers did not agree, both readers reviewed the structures together, and if agreement still could not be reached the sample was not assigned an age.

Virginia Institute of Marine Science (VIMS)
The Northeast Area Monitoring and Assessment Program (NEAMAP) is a cooperative state-federal program that has operated a Near Shore Trawl Survey in the mid-Atlantic Bight and southern New England since fall 2007. The Virginia Institute of Marine Science (VIMS) has been awarded the contract to carry out the survey. It continues and extends the methods of the Chesapeake Bay Multispecies Monitoring and Assessment Program (ChesMMAP) which started

in 2002. Atlantic croaker is a "Priority" species for NEAMAP, meaning that length, weight, sex, maturity state, stomach, and otoliths are collected for 5 individuals from each length bin on each tow. VIMS uses sectioned otoliths for age determination. A total of 11,659 Atlantic croaker have been aged by the two surveys (CM 7,293, NM 4,366). VIMS has disputed that an interior 1st annulus should be counted for accurate age determination due to the time of year the species spawns and their annuli deposition. For continuity VIMS has made separate ages for including the first annulus as well as excluding it, which is recommended by the Commission for stock assessment purposes among other agencies (ASMFC 2008). Ages have ranged from age-0 to a max age of 18.

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

Old Dominion University (ODU)

The otoliths collected through the Virginia Marine Resources Commission's (VMRC) Biological Sampling Program are processed and read by the ODU's Center for Quantitative Fisheries Ecology (CQFE) laboratory. Atlantic croaker otoliths have been collected by VMRC since 1998. Otoliths are processed following the methods described in Barbieri et al. (1994) with a few modifications. The left or right sagittal otolith is randomly selected and attached to a glass slide with Aremco's clear Crystalbond™ 509 adhesive. One transverse section is cut through the core of each otolith using a Buehler Isomet™ low-speed saw equipped with a three inch, fine-grit Norton diamond-wafering blade. Otolith sections are placed on labeled glass slides and covered with a thin layer of Flo-Texx mounting medium.

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

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

Historically, Virginia has counted the wide band/smudge closest to the otolith core as the first annulus, whereas most other states do not; however, since all Atlantic croaker in Virginia form that band and because Virginia uses the January 1 model birth-date, the sampled fish should be scored as the same age-class assignment as those scored in other states.

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

- Otolith Preparation Protocol

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

- Otolith Ageing Protocol

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

North Carolina Division of Marine Fisheries (NC DMF)
Atlantic croaker sagittal otolith samples are collected monthly from the winter trawl, long haul seine, pound-net, sink-net, recreational hook-and-line fisheries, and NC DMF fisheries independent programs. Sagittal otoliths have been collected since 1996. Each month, samples (n=15) are distributed across the length range in 15-mm length classes starting at 100 mm total length. Sagittal otoliths are removed, cleaned, and stored dry. Samples are weighed to the nearest 0.01 kg and measured for total length to the nearest millimeter. Date, gear, and water location are also recorded for each sample.

A transverse section through the focus on a plane perpendicular to the horizontal axis of the left otolith is prepared using a Hillquist thin-sectioning machine as described by Cowan et al. (1995). The system is calibrated with an ocular micrometer before each reading session. Sections are viewed under reflected light at 21X magnification. Annuli, marginal increment, and otolith size are measured (mm) on an image projected on a high resolution monitor from a video camera mounted on a microscope. Ages are assigned based on the number of otolith annuli viewed. The ageing lab biologist reads the otolith section and measures the annuli. The samples are then independently read by the species lead biologist. If any differences are not resolved, the data are omitted.

The NC DMF publishes three-year reports that include species-specific age-length keys, which have been applied to expanded length-frequency data to estimate length-at-age for total commercial landings on an annual basis. The age-length keys and expansions are applied on a seasonal basis: winter (January–March and October– December); and summer (April–September).

SC DNR
Atlantic croaker samples are collected from several different methods in South Carolina including inshore trammel net survey (2014), SEAMAP nearshore trawl (2001 to present) and MRFSS/MRIP survey. SC DNR Inshore Fisheries section also processes croaker otoliths from National Marine Fisheries Service's Northeast groundfish survey since 1996. Otoliths are embedded in resin to facilitate cutting, cut on a low speed saw to obtain a 0.4mm transverse cross-section and then mounted on microscope slide. The sections are read using a dissecting microscope with an attached camera so that the image can be viewed with a computer program like Image Pro. All samples are aged independently by two readers to insure accurate ages. Some Atlantic croaker otoliths vary with respect to diffuse, undefined marking near the

core of the otolith. These diffuse areas are not interpreted as being a ring. The first annulus is considered the first well-defined, opaque band that can be traced around the entire section.

Georgia Department of Natural Resources (GA DNR)
Atlantic croaker were collected from Georgia's coastal waters using a variety of gear types in 2010-2012 as part of a graduate thesis (Franco 2014). Transverse sections were read from 2,401 otolith samples from age 0-6. The majority (98%) of otoliths exhibited the dark, opaque area near the core that is the smudge or check mark. While the majority of age samples for GA croaker came from this project, in the fall of 1997 GA DNR initiated the Marine Sportfish Carcass Recovery Project. This project takes advantage of the fishing efforts of hundreds of anglers by turning filleted fish carcasses that anglers would normally discard into a source of much needed data on Georgia's marine sportfish. The project is a true partnership of saltwater anglers, marine businesses, conservation groups, and the Coastal Resources Division (CRD). Since 1999, a total of 43 Atlantic croaker have been donated to the project. It was decided that the largest of the croaker would be sectioned and aged for the QA/QC Fish Ageing Workshop.

III. Striped Bass

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

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

Rhode Island Division of Marine Fisheries (RI DMF)
Scales have been collected on from the commercial fishery since 2001 and on fishery-independent surveys and the recreational fishery since 2013. The annual target number of samples is 150 rod and reel and 150 from the commercial floating fish trap fishery. Sample collection primarily includes scales; however, otoliths are also collected on fishery-independent surveys when the whole fish is being sacrificed or when fish racks are donated from the recreational fishery. Scales are cleaned, pressed onto acetate with a heat press, and aged using a microfiche reader. Otoliths are dried, mounted in epoxy resin, and thin-sectioned using an IsoMet™ slow speed saw. Thin sections are then mounted onto microscope slides with Flo-Texx™ and aged with a microscope. All samples are currently aged annually by a single reader.

A second read is conducted by the same reader on at least 10% of the samples to obtain precision estimates.

New York State Department of Environmental Conservation (NY DEC)

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

NJ DFW

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

MD DNR

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

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

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

VIMS

Striped bass are collected as part of NEAMAP and ChesMMAP sampling programs. Additionally, striped bass is a “Priority” species for NEAMAP, meaning that length, weight, sex, maturity state, stomach, and otoliths are collected for 5 individuals from each length bin on each tow. VIMS uses sectioned otoliths for age determination. The ChesMMAP survey encounters everything from Young-Of-Year specimens to fully matured adults. The NEAMAP survey often encounters large mature adults feeding on schools of prey. Ages have ranged from age-0 (YOY) to a max age of 24. Additionally, a striped bass monitoring and tagging program was absorbed by the Multispecies Research Group at VIMS, in which approximately 2000 scales and sectioned otoliths are processed annually. Since 2018 and additional 2000 samples have been processed. A total of 9,052 Striped Bass have been aged by the three surveys (SB 2,000; CM 6,433; NM 619).

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

ODU

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

Generally, only 40- 5020-30% of striped bass sampled for scales are also sampled for otoliths. Supplementary data is collected for each biological sample, such as date of collection, harvest location, market grade, harvest area, and gear type. Scale and otolith samples are processed and read by Old Dominion University's Center for Quantitative Fisheries Ecology (ODU CQFE). ODU CQFE chooses a random subsample of hard-parts (scales and otoliths) collected in each length bin to age.

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

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

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

- Otolith Preparation Protocol

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

- Otolith Ageing Protocol

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

- Scale Preparation Protocol

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

SC DNR

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

IV. Summer Flounder

RI DFW

Summer flounder are sampled by the RI DFW on fishery-independent surveys and from the recreational and commercial fisheries. Each year a target number of 100 samples are collected with scales being the primary ageing structure prior to 2019. As of 2019, DFW will be focusing sampling on the collection of otoliths from fishery-independent surveys and will still collect length-frequency data from the commercial fishery when possible. Otoliths are embedded in epoxy resin, sectioned, mounted on microscope slides, and aged with a microscope. Structures are aged by a single reader annually. A second read is conducted by the same reader on at least 10% of the samples for each structure to obtain precision estimates.

VIMS

Summer flounder 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 summer flounder. Otoliths are sectioned using a method similar to ODU's. However, VIMS wet-sands the sections to a thinner width than ODU and does not bake the sections. Annulus counts are adjusted to reflect the timing of sample collection relative to ring formation. Age is assigned as the mode of three independent readings. VIMS has aged 15,536 total summer flounder between ChesMMAP and NEAMAP from 2002-2018 (CM 5,731, NM 9,805). Summer flounder have been aged from age-0 to a max age of 13. The majority of the specimens sampled were ages 0-7. There are three readers at VIMS and the mode age for each sample is provided as the final age. If there is no mode from the initial read, the readers reread the sample and if there is still no mode, they examine the sample together and come to a consensus age. If a consensus age cannot be determined the sample is discarded. Very few samples are discarded. Precision tests are preformed within each reader (multiple reads of the same sample) and between readers. VIMS uses similar precision and symmetry tests to the NEFSC.

ODU

VMRC has obtained summer flounder otoliths and scales from the commercial and recreational catch and fishery independent sampling programs since 1999. Ageing hard parts are processed and read by ODU CQFE. ODU CQFE chooses a random subsample collected in each length bin to age. In 2015, ODU CQFE aged 884 summer flounder samples, 293 were paired scale and otolith readings.

Otoliths samples are cleaned and baked in a Thermolyne 1400 furnace. After baking, otoliths are embedded in epoxy resin and sectioned. Each section is read under transmitted light using a polarizing filter. Summer flounder are assigned a January 1st birth date by convention. The sample date is used to assign the final age. If the sample was taken before the period of annuli formation (January to June), the age is the annulus count plus one. If the sample was taken after that, the age is the annulus count.

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

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

- Scale Preparation Protocol

http://www.odu.edu/content/dam/odu/offices/center-for-quantitative-fisheries/docs/summer-flounder-scale-prep.pdf

- [Otolith Preparation Protocol](http://www.odu.edu/content/dam/odu/offices/center-for-quantitative-fisheries/docs/summer-flounder-otolith-preparation-latex-main-document.pdf)

http://www.odu.edu/content/dam/odu/offices/center-for-quantitative-fisheries/docs/summer-flounder-otolith-preparation-latex-main-document.pdf

- [Otolith Ageing Protocol](http://www.odu.edu/content/dam/odu/offices/center-for-quantitative-fisheries/docs/summer-flounder-otolith-ageing-protocol.pdf)

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

NC DMF

For all otoliths that need to be sectioned, such as summer flounder, a standard methodology is used regardless of species. Sectioned otoliths are processed using a Hillquist High-Speed Thin Sectioning Saw (Cowan et al. 1995). Two otolith sections are set onto each slide, as long as they are from the same collection. The Hillquist saw is again used to grind off the remaining half of the otolith attached to the slide, so that a section about 0.75mm thick remains on the slide. The sectioned otolith can then be hand polished, if necessary for that species or size. The sectioned otolith is then ready to be aged.

V. Tautog

MA DMF

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

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

RI DMF

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

Additionally, in 2017, RI DMF began collecting tautog pelvic spines for ageing. A tautog ageing workshop is currently being planned by ASMFC for the fall of 2019. Once DMF staff receive training at this workshop, we will begin to age spines. DMF will follow any recommendation that comes from this workshop and the Tautog Technical Committee with regards to which structure should used as the primary structure for ageing tautog going forward.

NY DEC

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

NJ DFW

Sampling for tautog was initiated in 2007, collecting samples primarily from Commercial and Party/ Charter vessels. Fishery Independent samples are also occasionally collected aboard the NJDFW Ocean Trawl Survey when caught. Racks are collected from fishery dependent vessels, where lengths and sex are recorded, and opercula are removed. The opercula are processed and aged at the Nacote Creek Research lab, where they are viewed under a magnisight machine. Since initiation, 7,471 samples have been collected, with 359 samples collected in 2018.

MD DNR

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

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

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

VIMS

Tautog are collected for both NEAMAP and ChesMMAP surveys and additionally is considered a "Priority" species for NEAMAP, meaning that length, weight, sex, maturity state, stomach, and otoliths are collected for 5 individuals from each length bin on each tow. VIMS uses sectioned otoliths, 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 399 Tautog have been aged by the two surveys (CM 50, NM 349). 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.

ODU

Tautog have been collected as part of VMRC's Biological Sampling Program since 1998. Both otoliths and operculum are collected. Operculum are removed and frozen until prepared for age reading. Thawed samples are boiled 5-6 minutes to loosen attached tissue. When 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. Otoliths samples are cleaned and baked in a Thermolyne ™ 1400 furnace. After baking, otoliths are embedded in epoxy resin and sectioned.

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

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

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

- Otolith Preparation Protocol

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

- Otolith Ageing Protocol

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

- Operculum Preparation Protocol

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

VI. Winter Flounder

NJ DFW

Sampling for winter flounder began in 1993 for New Jersey. Winter flounder otoliths are collected during the April ocean trawl survey due to higher occurrence from the fish leaving the estuaries after spawning. From 1995-2005, we had a spawning survey of winter flounder in some of our northern estuaries, and samples also were collected from that survey. The otoliths are then aged whole for younger fish and when the annuli become difficult to read on older individuals they are sectioned using low speed Isomet™ saws. The sections are then read by two individual readers, and discrepancies are then read by a tie breaker. To date, New Jersey has collected 10,645 samples, with 199 samples collected in 2018.

MA DMF

Winter flounder otoliths are collected from our resource assessment trawl survey. Collected otoliths have been aged in the MADMF age and growth lab since 2012. Samples collected from 1982-2011 were aged by the NMFS NEFSC. Otoliths are typically read whole with reflected light. Samples assigned an age of 5 or older are then thin sectioned and read either with a stereoscope using reflected light or with a compound microscope with transmitted light.

RI DFW

RI DFW began sampling winter flounder on fishery-independent surveys in 2014. Additionally, a small number of samples were donated by the commercial fishery in 2016. Each year a target number of 100 paired scale and otolith samples are collected. Although scales are collected, the primary ageing structure for winter flounder is otoliths. Scales are cleaned and pressed onto acetate and aged on a microfiche reader. Otoliths are embedded in epoxy resin, sectioned, mounted on microscope slides, and aged with a microscope. Both structures are aged by a single reader annually. 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

NY DEC has not processed or aged winter flounder since the late 1990s, although archived samples were provided for this workshop. Winter flounder otoliths were embedded in Buehler Epoxy, sectioned to a thickness of ~.4mm on an Isomet™ low-speed saw and read on a compound microscope with transmitted light.

VIMS

Winter Flounder 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 winter flounder. Otoliths are sectioned using a method similar to ODU’s. However, VIMS wet-sands the sections 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 6,022 total winter flounder from the NEAMAP survey from 2007-2018. Winter flounder have been aged from age-1 to a max age of 19. Young of the year fish have not been recruited by the NEAMAP survey gear. The majority of the specimens sampled were ages 2-6. 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.

Workshop Proceedings & Methods

Workshop participants met on Wednesday, March 20th, 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, Kristen Rynerson, Kyle Williams, David Westmark, and Brittany Barbara set up stations ahead of the workshop for the hard part reading exercise. Participants broke into five groups, each led by 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.

There were some changes in the QA/QC reference collection for the 2019 workshop. Additional samples of paired striped bass otoliths and scales and paired tautog opercula, pelvic spines, and otoliths were added to the collection this year to address recommendations from the 2018 workshop. Additionally, two damaged tautog opercula were removed from the collection from last year and not replaced due to the added paired samples.

For each of the six species, every member of the group aged the samples (n=20-42 per species) and the group came to a consensus for annulus count, margin code, and final age. Each structure was assigned a margin code from 1-4. A code 1 represented a structure with an annulus just forming or having just finished forming at the edge of the structure. Code 2 was assigned when the growth outside the last visible annulus was less than 1/3 the growth between the two previous annuli. Code 3 represented 1/3 to 2/3 growth and code 4 was for more than 2/3 growth. A catch date was provided for each sample to make final age determinations, but no other information was provided during reading. In addition to group ages, the participants also recorded their individual age readings and experience level for additional analysis.

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

Workshop Results

On March 21st, the attendees of the workshop met to go over the APE for each species, results from individual age readers, to revisit samples with high disagreement, and to make recommendations for following workshops or coastwide ageing. The APE varied by species throughout the three years of the workshop (Table 1). Discussion and results for each species follows and sample images can be found in Appendix B.

I. American Eel

American eel had the highest APE of the workshop at 10.37% (Table 1), likely because few agers at the workshop had experience ageing American eel. Sectioned otoliths had a lower APE than whole otolith samples (Table 2). Participants reviewed sample #1 and had a discussion about whether to count individual rings or bands when there is clumping, especially near the core. Jason from ME, who provided the sample, advocated for counting every visible ring for smaller eels and counting clumped rings for larger eels, and therefore had a higher age (16 years) than other participants (10-13 years). Similarly, sample #4 had been provided by ME and aged as a 13-year-old but workshop participants aged the sample from age 8 to 21 years due to the issue of whether to count clumps or bands of rings as individual annuli.

Another ageing issue for American eel otoliths is split annuli, as seen in the paired samples #7 and #13 as well as paired samples #9 and #16, which resulted in some varying ages. For #7 and #13, the sectioned otolith was aged predominantly as a 3-year-old fish whereas the whole otolith was aged as a 2-year-old. The group discussed the importance of sanding planes when preparing and reading samples.

Most of the issues identified at the workshop – split annuli, banding, clumping, and sanding planes – reinforce the issues identified at the ageing workshop for American eel. This remains a challenging species to age due to the varying appearance and processing of eel otoliths samples along the Atlantic coast.

Agers from ME, CT, NJ, MD, SC, and FL all indicated that they had some experience or routinely age American eel. Comparing their individual ages, there were no significant p-values from the Bowker's test of symmetry, indicating no systematic bias, and while there were several CVs above 5%, they were all less than 20% so imprecision is fairly low given the challenges of ageing this species (Table 3). Agreement between readers was higher for whole than sectioned otoliths (Table 4). Comparing ages from paired samples, whole otoliths generally resulted in lower ages than sectioned otoliths (Figure 1).

II. Atlantic Croaker

Atlantic croaker had the lowest APE of the workshop at 0.62%. Only two samples had disagreement so the participants reviewed #12 and #20 (Table 5). For sample #12, identifying the first annulus from the smudge was the challenge. The smudge on the sample is closer to the core than one normally finds it and the first annulus is in an atypical location as well. After reviewing the sample, most participants agreed that #12 is an age 6. For sample #20, most people aged it as a 7- or 8-year-old. Most groups had the margin code as a "1" so it did not appear to be a margin code issue as first suggested, but rather an annulus count issue.

Agers from NEFSC, NJ, MD, VIMS, ODU, NC, SC, and GA all indicated that they routinely age Atlantic croaker. Comparing their individual ages, there were no significant p-values from the Bowker's test of symmetry, indicating no systematic bias, and most CVs were less than 5%, indicating precision is fairly high (Table 6). Individual agers had very high agreement when compared to each other and 100% agreement within one year (Table 7).

III. Striped Bass

The APE for striped bass was 6.95%, a slight decrease from 7.54% in 2018 (Table 1) although additional paired samples were added to the collection this year. Otolith samples had an APE of 1.92% and scale samples had an APE of 11.97% (Table 8). Participants decided to focus on the newly added paired samples for the discussion. Paired samples #11 and 27 had some disagreement on the scale sample. Participants agreed that the first annulus was difficult to identify on the scale. Paired samples #13 and 26 were also reviewed and the group agreed that the while the otolith sample had high agreement, the section was too thick. DE provided the sample and said this was the first time the state had processed otoliths. Disagreement on the scale age was attributed to one group counting a check mark near the core. Additionally, the group discussed that in individual labs, ageing may vary depending on the type of equipment used for reading scales.

Paired samples #5 and 23 as well as #7 and 29 were reviewed due to high APE for the scale sample. Participants were not concerned about the ageing variation from #5 since the groups that underaged the sample did not include agers who routinely age the species. For the disagreement for sample #7, a scale from a striped bass older than 15 years, participants commented that variation in ages would be masked in the stock assessment by the use of the 15+ age group in the model.

MA, NEFSC, RI, NY (scales only), NJ, DE (scales only), MD, VIMS, and ODU indicated that they routinely age striped bass. Scales and otoliths were analyzed separately. For both structures, there were no significant p-values from the Bowker's test of symmetry, indicating no systematic bias (Table 9). There were many CVs above 5% for the scale samples indicating imprecision. For otoliths, there were some CVs above 5% for the ager in DE but otherwise imprecision is fairly low for that structure. Exact agreement between reader ages was higher for otoliths than scales on average and results varied for agreement within one year (Table 10). Comparing ages from paired samples, scales generally resulted in lower ages than otoliths (Figure 2). The p-value indicates some systematic bias and differences between ages in the paired structures.

IV. Summer Flounder

The APE for summer flounder at the workshop was 5.90%, an increase from 3.63% in 2017 (Table 1). Otoliths samples had an APE of 3.28% and scale samples had an APE of 12.01% (Table 11). The group reviewed sample #11 and debated whether it was an age 1- or 2-year-old. The workshop participants agreed that it was not a good sample and it should have been recut. Because the first band does not have clear separation from the second, participants agreed that it was an age 1. Sample #20 had group ages from 2 to 5 years. Based on the length, agers agreed it should be an age 3 or 4, but no consensus was reached.

There was more disagreement among scale ages and participants discussed which states are using scales rather than otoliths to age summer flounder. RI is collecting scales but is moving toward otolith ages. DE also collects both scales and otoliths and historically has used scales for ageing but will be moving to otolith ages. ODU uses scales but would like to move to otoliths. Workshop participants recommended that states use otoliths, not scales, to age summer flounder going forward.

Agers from NEFSC, RI, CT (both readers at the workshop), DE, VIMS, ODU, NC, and SC reported that ageing summer flounder is routine in their laboratories. For both scales and otoliths, there were no significant p-values from the Bowker's test of symmetry, indicating no systematic bias (Table 12). There were many CVs above 5% for the scale samples indicating imprecision. For otoliths, there were no CVs greater than 5% and therefore imprecision was low. Exact agreement between reader ages was higher for otoliths than scales on average and otoliths had 100% agreement between agers within one year (Table 13). Comparing ages from paired samples, scales generally resulted in lower ages than otoliths (Figure 3). The p-value indicates some systematic bias and differences between ages in the paired structures.

V. Tautog

The APE for tautog was 8.17%, down from 11.28% in 2018, although several paired samples were added to the collection this year (Table 1). Pelvic spine samples had the highest APE at 14.13%, followed by opercula at 8.58%, and then otoliths at 2.21% (Table 14). Sample #1 was reviewed since there was disagreement between ages 2 and 3. It was noted that the first clear annulus was too far from the core and so a band closer to the core was counted to get to age-3. For paired samples #25, 32, and 42, all participants agreed that the otolith was age 3. The spine and opercula samples had disagreement between ages 3 and 4 years. The spine sample had a hole near the core which made the ageing difficult. The group also associated ageing differences to differences in appearance that result from spatial variation along the Atlantic coast.

For paired samples #23, 33, and 41, ages varied from 1 to 2 years. Identifying the first annulus on the opercula remains an issue that is not as prevalent in pelvic spines or otoliths. On the spine sample, the bright line is the first annulus and the second annulus is on the edge where it did not show up on the otolith as well. There was some discussion about using whole otoliths, not sectioned, for ages up to 9 years.

For individual reader comparisons, readers from MA, RI, CT (both readers), MD, VIMS, and ODU reported that they routinely age tautog. When comparing the experienced tautog readers by hard part, there were no significant p-values from Bowker's test of symmetry, indicating no systematic bias between the readers (Table 15). CVs ranged across the ageing structures with several CVs > 5% for opercula and spines, indicating imprecision. Exact agreement also varied across hard parts with the highest agreement on otoliths. Agreement increased to greater than 80% within one year for all structures, but spines had the highest within-one-year agreement percentages (Table 16). Comparing ages from paired samples, opercula and spines overaged samples compared to otoliths and opercula overaged compared to spines (Figure 4 - Figure 6). The p-values indicate some systematic bias and differences between ages in the paired structures. The lowest CVs and highest overall agreement between ages on paired structures was for otoliths and spines.

VI. Winter Flounder

The APE for winter flounder was 7.78%, up from 4.41% in 2017 (Table 1). The APE for otolith samples was much lower at 1.59% than the APE for scales at 26.35% (Table 17). Participants of the workshop noted that otoliths had much higher agreement than scales and otoliths should be preferentially used for providing ages to ASMFC. None of the ageing laboratories at the workshop reported using scales for ageing winter flounder. Sample #4 was reviewed but the group noted it was a tilted section and VIMS said it would replace it for future workshops.

Agers from MA, NEFSC, RI, CT (both agers), VIMS (otoliths only), and SC reported that they routinely age winter flounder. When comparing the experienced readers by hard part, there were no significant p-values from Bowker's test of symmetry, indicating no systematic bias between the readers (Table 18). CVs ranged across the ageing structures with most CVs < 5% indicating low imprecision. Exact agreement varied but agreement within one-year was 100% for both structures (Table 19).

Workshop Recommendations

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

- Tautog, black sea bass, bluefish, scup, red drum, and cobia should be aged at the 2020 QA/QC Fish Ageing Workshop. Weakfish should also be added if there are indications that the age range has expanded.
    - Atlantic menhaden should not be aged at QA/QC until it goes through an ageing workshop (planned for 2020).
    - American eel sample #8 needs the date of capture to be added by NJ.
    - Winter flounder sample #4 needs to be replaced or recut by VIMS.

- For the 2020 QA/QC Fish Ageing Workshop, individual ages and group ages should still be collected.

- For the scheduled tautog ageing workshop and exchange planned for 2019, agers should consider comparing whole and sectioned otoliths, scales, and pelvic spines for the collection.

- Winter and summer flounder should be aged using otoliths, not scales, when possible.

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Tables

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

Species	Ageing structure (sample size)	2016	2017	2018	2019
Alewife herring	scales (5), otoliths (5)	13.23%	------	29.20%	-------
Blueback herring	scales (5), otoliths (5)	13.23%	------	23.09%	-------
Black sea bass	scales (4), otoliths (16)	3.67%	------	12.71%	-------
Striped bass	scales (15), otolith (15)[1]	4.96%	------	7.54%	5.90%
Tautog	opercula (28), pelvic spine (6), otolith (8)[2]	6.09%	10.89%	11.28%	8.17%
Atlantic croaker	otoliths (20)	7.76%	10.57%	-------	0.62%
Bluefish	otoliths (20)	23.06%	25.60%	17.69%	-------
Summer flounder	scales (6), otoliths (14)	-------	3.63%	-------	6.85%
Winter flounder	scales (5), otoliths (15)	-------	4.41%	-------	7.78%
Atlantic menhaden	scales (19)	-------	15.42%	13.45%	-------
Red drum	otoliths (20)	-------	-------	26.77%	-------
Scup	otoliths (14), scales (6)	-------	-------	11.60%	-------
American eel	otoliths (20)	-------	-------	-------	10.37%

[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.

Table 2. **Ageing worksheet for American eel at the workshop with the sample number, lab providing the sample and their assigned age, catch date of the sample, workshop group annulus counts, margin codes (scored from 1 to 4), and final age as well as average percent error (APE) values between groups. Samples #1-10 are sectioned otoliths and samples #6-10 are whole otoliths. Paired samples include #s 6 & 11, 7 & 13, and 9 & 16.**

Lab	Age	Catch date	Group 1			Group 2			Group 3			Group 4			Group 5			Average Age	APE
			Annulus count	Margin code	Final age	Annulus count	Margin code	Final age	Annulus count	Margin code	Final age	Annulus count	Margin code	Final age	Annulus count	Margin code	Final age		
ME	16	11/16/2016			12	13	3	13	10	3	10	11	3	11	13	2	13	11.8	9%
FL	8	10/28/2015			8	8	3	8	8	3	8	8	4	8	8	4	8	8	0%
SC	4	11/5/2014			4	4	3	4	4	3	4	4	4	4	4	4	4	4	0%
ME	13	9/16/2016			17	15	2	15	8	3	8	14	2	14	21	2	21	15	21%
SC	7	11/5/2014			7	7	3	7	6	3	6	7	3	7	7	4	7	6.8	5%
DE	5	6/28/2012	6		7	6	4	7	5	2	5	5	2	5	7	1	7	6.2	15%
DE	3	9/11/2012			3	3	3	3	4	3	4	3	4	3	3	4	3	3.2	10%
NJ	6				8	7	3	8	6	4	7	7	4	7	7	3	8	7.6	6%
DE	7	10/2/2012			8	7	3	7	5	4	5	6	2	6	9	4	9	7	17%
FL	4	3/10/2015		1	4	4	1	4	4	1	4	4	1	4	4	1	4	4	0%
DE	5	6/28/2012	4		5	4	2	4	4	2	4	4	1	4	6	2	6	4.6	16%
MD	2	4/13/2017		1	2	1	4	2	2	1	2	1	4	2	2	1	2	2	0%
DE	3	9/11/2012			2	2	2	2	2	3	2	3	4	3	3	2	3	2.4	20%
MD	6	4/25/2017	5		6	5	4	6	6	2	6	6	4	7	6	2	6	6.2	5%
ME	4	8/14/2017			3	3	3	3	3	3	3	3	3	3	4	4	4	3.2	10%
DE	5	10/2/2012			5	8	3	8	5	3	5	5	3	5	5	4	5	5.6	17%
MD	5	4/13/2017	4		5	4	4	5	4	4	5	4	4	5	4	4	5	5	0%
MD	8	5/17/2017	8		9	8	4	9	8	4	9	9	4	10	9	1	9	9.2	3%
ME	2	7/17/2017	1		2	1	3	1	1	2	1	1	4	1	2	1	2	1.4	34%
ME	3	8/14/2017	2		2	2	2	2	1	3	1	2	2	2	2	3	2	1.8	18%
																		Average APE	10%
																		Sectioned APE	8%
																		Whole APE	12%

Table 3. **Symmetry test p-values for inter-lab age comparisons using Bowker's test and CVs (%) for American eel sectioned (a) and whole (b) otolith samples. P-values appear above the shaded diagonal line and CVs are below. CVs > 5% are highlighted.**

(a)	ME	CT	NJ	MD	SC	FL
ME		0.31	0.16	0.41	0.42	0.39
CT	5		0.42	0.55	0.42	0.31
NJ	3	7		0.39	0.41	0.41
MD	6	9	3		0.26	0.32
SC	5	2	5	7		0.57
FL	5	10	5	3	10	

(b)	ME	CT	NJ	MD	SC	FL
ME		0.42	0.25	0.55	0.39	0.42
CT	8		0.17	0.39	0.26	0.26
NJ	10	8		0.24	0.25	0.32
MD	18	11	9		0.50	0.32
SC	8	3	11	14		0.38
FL	16	8	6	3	11	

Table 4. **Percent exact agreement (below the shaded diagonal line) and agreement within one year (above the shaded diagonal line) between readers for American eel sectioned (a) and whole (b) otolith samples.**

(a)	ME	CT	NJ	MD	SC	FL
ME		80	90	70	90	70
CT	60		70	70	100	60
NJ	60	50		90	80	80
MD	60	60	70		80	90
SC	50	80	60	70		70
FL	70	60	60	80	50	

(b)	ME	CT	NJ	MD	SC	FL
ME		90	90	80	90	80
CT	70		100	100	100	100
NJ	70	80		100	100	100
MD	40	60	60		90	100
SC	60	70	50	40		90
FL	50	70	70	90	50	

Table 5. Ageing worksheet for Atlantic croaker at the workshop with the sample number, lab providing the sample and their assigned age, catch date of the sample, workshop group annulus counts, margin codes (scored from 1 to 4), and final age as well as average percent error (APE) values between groups. All samples are otoliths.

Sample #	Lab	Age	Catch date	Group 1			Group 2			Group 3			Group 4			Group 5			Average Age	APE
				Annulus count	Margin code	Final age	Annulus count	Margin code	Final age	Annulus count	Margin code	Final age	Annulus count	Margin code	Final age	Annulus count	Margin code	Final age		
1	ODU	10	9/23/2014	10	4	10	10	3	10	10	3	10	10	4	10	10	4	10	10	0%
2	NJ	0	10/1/2012	0	4	0	0	4	0	0	4	0	0	4	0	0	2	0	0	0%
3	GA	6	7/1/2014	5	2	5	5	2	5	5	2	5	5	2	5	5	2	5	5	0%
4	GA	1	5/15/2012	0	4	1	0	4	1	0	4	1	0	4	1	0	3	1	1	0%
5	SCDNR	2	5/14/2014	2	2	2	2	2	2	2	1	2	2	1	2	2	1	2	2	0%
6	NJ	12	9/16/2010	12	3	12	12	3	12	12	2	12	12	3	12	12	3	12	12	0%
7	GA	5	6/29/2011	4	2	4	4	2	4	4	1	4	4	2	4	4	2	4	4	0%
8	VIMS	8	5/10/2014	8	1	8	8	2	8	8	1	8	8	1	8	8	1	8	8	0%
9	ODU	3	4/21/2014	3	1	3	2	4	3	3	1	3	3	1	3	3	1	3	3	0%
10	SCDNR	3	5/14/2014	3	1	3	2	4	3	3	1	3	3	2	3	3	1	3	3	0%
11	NJ	4	10/3/2006	4	3	4	4	4	4	4	3	4	4	3	4	4	4	4	4	0%
12	NCDMF	6	3/26/2013	4	4	5	4	4	5	4	4	5	4	4	5	5	4	6	5.2	6%
13	MD	2	9/15/2015	2	4	2	2	4	2	2	3	2	2	4	2	2	4	2	2	0%
14	ODU	6	8/18/2014	6	3	6	6	4	6	6	2	6	6	3	6	6	3	6	6	0%
15	VIMS	0	11/5/2014	0	4	0	0	4	0	0	3	0	0	4	0	0	4	0	0	0%
16	NCDMF	7	3/26/2013	6	1	6	5	4	6	5	4	6	5	4	6	5	4	6	6	0%
17	MD	3	9/15/2015	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	0%
18	MD	7	8/17/2015	7	2	7	7	2	7	7	2	7	7	3	7	7	3	7	7	0%
19	NCDMF	3	6/13/2013	3	2	3	3	2	3	3	1	3	3	2	3	3	2	3	3	0%
20	VIMS	8	4/26/2014	7	1	7	7	4	8	7	1	7	8	1	8	7	4	8	7.6	6%
																			Average APE	1%

Table 6. Symmetry test p-values for inter-lab age comparisons using Bowker's test and CVs (%) for Atlantic croaker otoliths. P-values appear above the shaded diagonal line and CVs are below. CVs > 5% are highlighted.

	NEFSC	NJ	MD	VIMS	ODU	NC	SC	GA
NEFSC		1.00	0.37	0.32	0.37	0.32	0.07	1.00
NJ	0		0.37	0.32	0.37	0.32	0.07	1.00
MD	1	1		0.32	1.00	0.32	0.08	0.37
VIMS	0	0	1		0.32	1.00	0.06	0.32
ODU	1	1	0	1		0.32	0.08	0.37
NC	0	0	1	0	1		0.06	0.32
SC	8	8	8	7	8	7		0.07
GA	0	0	1	0	1	0	8	

Table 7. Percent exact agreement (below the shaded diagonal line) and agreement within one year (above the shaded diagonal line) between readers for Atlantic croaker otoliths.

	NEFSC	NJ	MD	VIMS	ODU	NC	SC	GA
NEFSC		100	100	100	100	100	100	100
NJ	100		100	100	100	100	100	100
MD	90	90		100	100	100	100	100
VIMS	95	95	95		100	100	100	100
ODU	90	90	100	95		100	100	100
NC	95	95	95	100	95		100	100
SC	90	90	90	95	90	95		100
GA	100	100	90	95	90	95	90	

Table 8. Ageing worksheet for striped bass at the workshop with the sample number, lab providing the sample and their assigned age, catch date of the sample, workshop group annulus counts, margin codes (scored from 1 to 4), and final age as well as average percent error (APE) values between groups. Samples #1-15 are scales and samples #16-30 are otoliths. Paired samples include #s 7 & 29, 11 & 27, 13 & 26, 15 & 24, 5 & 23, 12 & 22, 14 & 18, 8 & 17, and 10 & 30.

Sample #	Lab	Age	Catch date	Group 1			Group 2			Group 3			Group 4			Group 5			Average Age	APE
				Annulus count	Margin code	Final age	Annulus count	Margin code	Final age	Annulus count	Margin code	Final age	Annulus count	Margin code	Final age	Annulus count	Margin code	Final age		
1	RI	11	8/5/2015	11	1	11	9	2	9	10	2	10	10	3	10	10		10	10	4%
2	NY	5	7/15/2015	5	1	5	6	2	6	6	2	6	5	3	5			4	5	12%
3	NY	3	7/1/2015	2	1	2	3	2	3	2	2	2	3	3	3			2	2	20%
4	NJ	10	3/28/1996	7	3	8	7	4	8	8	1	8	8	2	9	8		9	8	6%
5	MA	8	10/13/2018	8	3	8	6	4	6	7	3	7	8	4	8			8	7	10%
6	ME	2	6/20/2012	2	1	2	2	1	2	2	2	2	2	2	2			2	2	0%
7	ODU	19	3/4/2015	22	4	23	17	4	18	15	3	16	16	1	16			18	18	11%
8	DE	6	3/19/2018	7	4	8	3	4	4	6	3	7	5	1	6			7	6	18%
9	MD	8	4/21/2012	9	1	9	5	4	6	7	1	7	6	4	7			7	7	10%
10	MA	14	8/3/2018	12	2	12	12	2	12	11	2	11	10	4	10			14	12	9%
11	RI	3	1/25/2018	2	4	3	1	4	2	2	4	3	2	4	3	2		3	3	11%
12	VIMS	16+	3/21/2018	16	1	16	12	4	13	11	4	12	11	4	12	14		15	14	11%
13	DE	1	12/3/2018	2	4	2	3	4	3	1	3	1	1	4	1	1		1	2	45%
14	VIMS	7	3/19/2018	7	1	7	6	4	7	6	4	7	6	4	7	6		7	7	0%
15	RI	4	5/21/2018	3	4	4	2	4	3	3	4	4	4	2	4	3		3	4	13%
16	SCDNR	1	12/18/2014	1	4	1	1	4	1	1	3	1	1	4	1	1	4	1	1	0%
17	DE	6	3/19/2018	7	4	8	7	3	8	7	3	8	7	4	8	6	2	6	8	8%
18	VIMS	7	3/19/2018	6	4	7	6	4	7	6	4	7	6	4	7	6	4	7	7	0%
19	MA	9	9/15/2014	9	3	9	9	2	9	9	3	9	9	2	9	9	3	9	9	0%
20	SCDNR	1	4/8/2014	1	1	1	1	1	1	1	1	1	0	4	1	1	1	1	1	0%
21	VIMS	3	6/1/2014	3	1	3	3	2	3	3	1	3	3	1	3	3	2	3	3	0%
22	VIMS	19	3/21/2018	17	4	18	18	4	19	18	4	19	17	4	18	19	4	20	19	3%
23	MA	8	10/13/2018	8	3	8	7	4	7	8	2	8	9	2	9	8	3	8	8	5%
24	RI	4	5/21/2018	3	4	4	4	1	4	3	4	4	3	4	4	3	3	4	4	0%
25	MA	11	7/3/2014	10	1	10	9	3	9	10	4	11	10	3	10	10	4	11	10	6%
26	DE	1	12/3/2018	1	3	1	1	4	1	1	4	1	1	4	1	1	4	1	1	0%
27	RI	3	1/25/2018	2	4	3	3	1	3	2	3	3	2	3	3	2	3	3	3	0%
28	ODU	4	3/9/2015	3	4	4	3	4	4	3	3	4	3	4	4	3	4	4	4	0%
29	ODU	25	3/4/2015	24	4	25	24	1	24	22	3	23	25	4	26	24	4	25	25	4%
30	MA	15	8/3/2018	15	2	15	15	3	15	15	2	15	14	3	14	15	1	15	15	2%

Average APE	7%
Scale APE	12%
Otolith APE	2%

Table 9. Symmetry test p-values for inter-lab age comparisons using Bowker's test and CVs (%) for striped bass scales (a) and otoliths (b). P-values appear above the shaded diagonal line and CVs are below. CVs > 5% are highlighted.

(a)

	MA	NEFSC	RI	NY	NJ	DE	MD	VIMS	ODU
MA		0.29	0.34	1.00	0.42	0.42	0.17	0.45	0.26
NEFSC	7		0.45	0.29	0.42	0.42	0.34	0.38	0.33
RI	5	10		0.34	0.45	0.45	0.36	0.53	0.45
NY	0	7	5		0.42	0.42	0.17	0.45	0.26
NJ	10	3	12	10		1.00	0.31	0.50	0.41
DE	10	3	12	10	0		0.31	0.50	0.41
MD	7	9	8	7	11	11		0.53	0.32
VIMS	15	16	15	15	18	18	18		0.44
ODU	8	8	9	8	9	9	1	19	

(b)

	MA	NEFSC	RI	NJ	DE	MD	VIMS	ODU
MA		0.32	0.32	1.00	0.37	0.54	0.42	0.54
NEFSC	1		1.00	0.32	0.61	0.54	0.42	0.54
RI	2	1		0.32	0.61	0.54	0.42	0.54
NJ	1	1	1		0.37	0.54	0.42	0.54
DE	6	6	6	5		0.44	0.43	0.44
MD	2	3	3	2	8		0.54	1.00
VIMS	2	2	3	1	7	3		0.54
ODU	2	3	3	2	8	0	3	

Table 10. **Percent exact agreement (below the shaded diagonal line) and agreement within one year (above the shaded diagonal line) between readers for striped bass scales (a) and otoliths (b).**

(a)

	MA	**NEFSC**	**RI**	**NY**	**NJ**	**DE**	**MD**	**VIMS**	**ODU**
MA		93	100	100	80	80	73	80	73
NEFSC	53		87	93	93	93	87	60	87
RI	60	47		100	67	67	80	73	80
NY	100	53	60		80	80	73	80	73
NJ	40	80	40	40		100	80	60	87
DE	40	80	40	40	100		80	60	87
MD	53	40	53	53	33	33		60	100
VIMS	33	20	20	33	20	20	27		47
ODU	40	53	40	40	40	40	87	27	

(b)

	MA	**NEFSC**	**RI**	**NJ**	**DE**	**MD**	**VIMS**	**ODU**
MA		100	93	100	87	87	93	87
NEFSC	73		93	100	93	87	93	87
RI	67	87		93	93	87	87	87
NJ	80	93	80		93	87	100	87
DE	67	73	67	80		80	93	80
MD	80	67	60	73	73		87	100
VIMS	80	80	67	80	60	67		87
ODU	80	67	60	73	73	100	67	

Table 11. Ageing worksheet for summer flounder at the workshop with the sample number, lab providing the sample and their assigned age, catch date of the sample, workshop group annulus counts, margin codes (scored from 1 to 4), and final age as well as average percent error (APE) values between groups. Samples #1-14 are otoliths and #15-20 are scales. Paired samples included #s 4 & 19, 7 & 16, and 11 & 17.

Sample #	Lab	Age	Catch date	Group 1			Group 2			Group 3			Group 4			Group 5			Average Age	APE
				Annulus count	Margin code	Final age	Annulus count	Margin code	Final age	Annulus count	Margin code	Final age	Annulus count	Margin code	Final age	Annulus count	Margin code	Final age		
1	ODU	5	3/17/2015	4	4	5	4	4	5	4	4	5	4	4	5	4	4	5	5	0%
2	NCDMF	3	2/3/2014	2	4	3	2	4	3	2	3	3	2	3	3	2	4	3	3	0%
3	VIMS	0	10/12/2015	0	4	0	0	4	0	0	3	0	0	3	0	0	4	0	0	0%
4	ODU	11	3/21/2015	10	4	11	11	4	12	10	4	11	10	4	11	11	3	12	11	4%
5	NCDMF	7	2/26/2014	6	4	7	6	4	7	6	4	7	6	4	7	6	4	7	7	0%
6	VIMS	2	5/22/2015	1	4	2	1	4	2	1	4	2	1	4	2	1	4	2	2	0%
7	ODU	3	3/17/2015	2	4	3	2	4	3	2	3	3	2	4	3	2	4	3	3	0%
8	VIMS	4	10/10/2015	4	2	4	4	3	4	4	3	4	4	2	4	4	3	4	4	0%
9	NCDMF	2	12/5/2013	2	3	2	2	4	2	2	3	2	2	3	2	2	4	2	2	0%
10	ODU	7	7/21/2015	7	2	7	7	1	7	6	2	6	7	2	7	7	2	7	7	5%
11	ODU	1	11/20/2015	1	3	1	1	4	1	2	3	2	2	3	2	1	4	1	1	34%
12	VIMS	6	10/24/2015	7	2	7	7	3	7	7	2	7	7	3	7	7	3	7	7	0%
13	NCDMF	11	2/3/2014	10	4	11	11	4	12	11	4	12	11	3	12	11	4	12	12	3%
14	VIMS	9	5/16/2015	9	1	9	9	1	9	8	4	9	8	4	9	8	4	9	9	0%
15	RI	5	7/3/2015	4	3	4	4	3	4	4	3	4	4	4	5	5	1	5	4	11%
16	ODU	3	3/17/2015	2		2	3	4	4	3	1	3	1	4	2	3	2	3	3	23%
17	ODU	1	11/20/2015	1	4	1	1	4	1	1	3	1	1	4	1	1	4	1	1	0%
18	RI	2	9/18/2015	1	4	1	1	4	1	1	3	1	1	3	1	1	4	1	1	0%
19	ODU	11	3/17/2015	8	4	9	9	4	10	9	3	10	10	3	11	9	4	10	10	4%
20	RI	4	7/3/2015	1	4	2	5	1	5	2	2	2	1	4	2	3	1	3	3	34%
																			Average APE	6%
																			Otolith APE	3%
																			Scale APE	12%

Table 12. Symmetry test p-values for inter-lab age comparisons using Bowker's test and CVs (%) for summer flounder otoliths (a) and scales (b). P-values appear above the shaded diagonal line and CVs are below. There were two readers from CT. CVs > 5% are highlighted.

(a)

	NEFSC	RI	CT	CT	DE	VIMS	ODU	NC	SC
NEFSC		0.14	0.14	0.14	1	1	1	1	0.139
RI	4		1	1	0.14	0.14	0.14	0.14	1
CT	4	0		1	0.14	0.14	0.14	0.14	1
CT	4	0	0		0.14	0.14	0.14	0.14	1
DE	0	4	4	0		1	1	1	0.14
VIMS	1	4	4	4	1		1	1	0.14
ODU	1	4	4	4	1	0		1	0.14
NC	1	4	4	4	1	0	0		0.14
SC	4	0	0	0	4	4	4	4	

(b)

	NEFSC	RI	CT	CT	DE	VIMS	ODU	NC	SC
NEFSC		0.50	0.50	0.50	1.00	0.31	0.50	0.31	0.50
RI	29		1	1	0.50	1	1	1	1
CT	29	0		1	0.50	1	1	1	1
CT	29	0	0		0.50	1	1	1	1
DE	5	33	33	33		0.31	0.50	0.31	0.50
VIMS	33	22	22	22	28		1	1	1
ODU	32	11	11	11	27	12		1	1
NC	33	22	22	22	28	0	12		1
SC	29	0	0	0	33	22	11	22	

Table 13. **Percent exact agreement (below the shaded diagonal line) and agreement within one year (above the shaded diagonal line) between readers for summer flounder otoliths (a) and scales (b). There were two readers from CT.**

(a)

	NEFSC	RI	CT	CT	DE	VIMS	ODU	NC	SC
NEFSC		100	100	100	100	100	100	100	100
RI	86		100	100	100	100	100	100	100
CT	86	100		100	100	100	100	100	100
CT	86	100	100		100	100	100	100	100
DE	100	86	86	86		100	100	100	100
VIMS	86	86	86	86	86		100	100	100
ODU	86	86	86	86	86	100		100	100
NC	86	86	86	86	86	100	100		100
SC	86	100	100	100	86	86	86	86	

(b)

	NEFSC	RI	CT	CT	DE	VIMS	ODU	NC	SC
NEFSC		67	67	67	100	67	83	67	67
RI	50		100	100	67	67	100	67	100
CT	50	100		100	67	67	100	67	100
CT	50	100	100		67	67	100	67	100
DE	83	33	33	33		83	83	83	67
VIMS	50	33	33	33	50		83	100	67
ODU	33	50	50	50	50	50		83	100
NC	50	33	33	33	50	100	50		67
SC	50	100	100	100	33	33	50	33	

Table 14. Ageing worksheet for tautog at the workshop with the sample number, lab providing the sample and their assigned age, catch date of the sample, workshop group annulus counts, margin codes, and final age as well as average percent error (APE) values between groups. Samples #1-28 are opercula, #29-36 are otoliths, and #37-42 are pelvic spines. Paired samples include #s 25 & 32 & 42, 23 & 33 & 41, 19 & 31 & 40, 4 & 35 & 39, 11 & 29 & 38, 2 & 34 & 37, 7 & 36, and 14 & 30. [Table on next page.]

Sample #	Lab	Age	Catch date	Group 1			Group 2			Group 3			Group 4			Group 5			Average Age	APE
				Annulus count	Margin code	Final age	Annulus count	Margin code	Final age	Annulus count	Margin code	Final age	Annulus count	Margin code	Final age	Annulus count	Margin code	Final age		
1	VIMS	2	10/1/2017	2	+	2	2	3	2	3	4	3	2	3	2	2	3	2	2	15%
2	DE	8	12/13/2018	8	+	8	7	4	7	8	3	8	8	4	8	9	4	9	8	5%
3	RI	3	9/8/2015	2	+	2	2	3	2	2	3	2	2	3	2	2	2	2	2	0%
4	VIMS	1	10/4/2017	5	+	5	4	3	4	3	3	3	6	3	6	6	3	6	5	22%
5	MA	12	11/6/2015	11	+	11	11	4	11	11	3	11	12	3	12	11	4	11	11	3%
6	RI	2	9/8/2015	2	+	2	2	3	2	1	4	1	2	3	2	2	4	2	2	18%
7	RI	5	11/28/2017	4	+	4	4	4	4	5	4	5	5	1	5	5	1	5	5	10%
8	MD	19	2/20/2014	16	+	17	18	2	18	18	3	19	18	1	18	18	4	19	18	4%
9	NY	7	5/19/2015	6	+	7	7	4	8	7	4	8	7	4	8	7	4	8	8	4%
10	NY	8	6/14/2015	6	+	7	8	1	8	7	2	7	6	2	6	8	1	8	7	9%
11	MA	11	5/31/2018	8	+	9	10	1	10	10	4	11	10	4	11	10	4	11	10	7%
12	MD	6	12/6/2014			6	6	4	6	6	3	6	6	3	6	6	4	6	6	0%
13	ODU	6	4/25/2014	5	+	6	6	1	6	6	3	7	6	4	7	5	4	6	6	8%
14	RI	4	11/28/2017	4	+	4	4	4	4	4	3	4	4	4	4	4	4	4	4	0%
15	MD	3	12/16/2014	3	+	3	4	3	4	3	2	3	3	2	3	4	4	4	3	14%
16	ODU	3	11/22/2014	4	+	4	5	3	5	5	4	5	5	3	5	4	2	4	5	10%
17	MA	6	10/31/2015	5	+	5	6	2	6	6	3	6	5	3	5	6	4	6	6	9%
18	MA	9	11/6/2015	9	+	9	8	4	8	9	3	9	8	4	8	9	3	9	9	6%
19	DE	5	11/18/2018	4	+	4	4	4	4	5	3	5	6	3	6	5	3	5	5	13%
20	NJ	5	1/10/2012	3	+	4	4	4	5	4	4	5	4	3	5	4	4	5	5	7%
21	DE	8	11/18/2018	6	+	6	8	4	8	8	3	8	9	3	9	10	4	10	8	13%
22	ODU	17	4/27/2014	16	+	17	18	2	18	15	3	16	19	3	20	18	1	18	18	6%
23	MA	2	7/5/2016	1	1	1	1	2	1	2	2	2	1	2	1	1	1	1	1	27%
24	VIMS	4	10/6/2011	5	+	5	5	4	5	5	4	5	5	3	5	5	2	5	5	0%
25	VIMS	3	10/1/2017	3	+	3	3	3	3	4	4	4	4	3	4	3	4	3	3	14%
26	MD	28	2/20/2014	26	1	26	27	4	28	28	3	29	28	3	29	28	1	28	28	3%
27	NJ	9	1/11/2012	8	+	9	9	4	10	10	4	11	10	2	10	9	4	10	10	4%
28	NY	10	11/19/2015	8	1	8	7	4	7	8	3	8	7	2	7	10	3	10	8	10%
29	MA	11	5/31/2018	10	2	10	11	2	11	10	4	11	10	1	10	10	4	11	11	5%
30	RI	4	11/28/2017	4	3	4	4	3	4	4	3	4	4	3	4	4	4	4	4	0%
31	DE	3	11/18/2018	3	3	3	3	4	3	3	3	3	3	3	3	3	3	3	3	0%
32	VIMS	3	10/1/2017	3	3	3	3	3	3	3	3	3	3	3	3	3	4	3	3	0%
33	MA	2	7/5/2016	1	4	2	2	2	2	2	1	2	2	1	2	2	1	2	2	0%
34	DE	8	12/13/2018	8	4	8	8	4	8	10	3	10	8	3	8	10	4	10	9	11%
35	VIMS	1	10/4/2017	1	4	1	1	4	1	1	4	1	1	4	1	1	4	1	1	0%
36	RI	5	11/28/2017	5	2	5	5	2	5	4	4	4	5	2	5	5	3	5	5	7%
37	DE	8	12/13/2018	8	4	8	8	4	8	10	4	10	9	1	9	9	4	9	9	7%
38	MA	11	5/31/2018	9	1	9	11	1	11	10	4	11	11	1	11	9	3	10	10	7%
39	VIMS	1	10/4/2017	1	2	1	1	3	1	2	4	2	2	3	2	2	3	2	2	30%
40	DE	4	11/18/2018	4	3	4	4	3	4	5	4	5	4	3	4	5	4	5	4	11%
41	MA	2	7/5/2016	1	1	1	2	2	2	2	1	2	2	1	2	2	2	2	2	18%
42	VIMS	3	10/1/2017	3	3	3	3	3	3	3	4	3	4	2	4	3	4	3	3	10%

Average APE	8%
Opercle APE	9%
Otolith APE	3%
Spine APE	14%

Table 15. 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 under. There were two readers from CT. CVs > 5% are highlighted.

(a)

	MA	RI	CT	CT	MD	VIMS	ODU
MA		0.79	0.59	0.63	0.36	0.47	0.68
RI	10		0.65	0.74	0.53	0.53	0.62
CT	10	5		0.56	0.31	0.63	0.65
CT	8	2	5		0.45	0.42	0.53
MD	10	5	8	5		0.29	0.08
VIMS	11	8	8	7	7		0.50
ODU	11	6	9	5	1	6	

(b)

	MA	RI	CT	CT	MD	VIMS	ODU
MA		0.39	0.39	0.39	0.26	0.39	0.39
RI	5		1.00	1.00	0.32	1.00	1.00
CT	5	0		1.00	0.32	1.00	1.00
CT	5	0	0		0.32	1.00	1.00
MD	8	9	9	9		0.32	0.32
VIMS	4	1	1	1	8		1.00
ODU	2	3	3	3	6	2	

(c)

	MA	RI	CT	CT	MD	VIMS	ODU
MA		0.39	0.37	0.39	1.00	0.42	1.00
RI	7		0.29	1.00	0.39	0.42	0.39
CT	15	8		0.29	0.37	0.39	0.37
CT	7	0	8		0.39	0.42	0.39
MD	2	7	15	7		0.42	1.00
VIMS	13	13	5	13	13		0.42
ODU	2	7	15	7	0	13	

Table 16. 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	CT	MD	VIMS	ODU
MA		93	86	93	86	93	86
RI	50		96	100	96	89	96
CT	46	54		100	82	93	82
CT	57	75	54		96	93	96
MD	54	54	43	54		82	100
VIMS	36	43	61	50	54		82
ODU	50	54	36	54	93	57	

(b)

	MA	RI	CT	CT	MD	VIMS	ODU
MA		88	88	88	100	88	100
RI	63		100	100	88	100	88
CT	63	100		100	88	100	88
CT	63	100	100		88	100	88
MD	75	63	63	63		88	100
VIMS	75	88	88	88	75		88
ODU	88	75	75	75	88	88	

(c)

	MA	RI	CT	CT	MD	VIMS	ODU
MA		100	100	100	100	83	100
RI	50		100	100	100	100	100
CT	33	83		100	100	100	100
CT	50	100	83		100	100	100
MD	67	50	33	50		100	100
VIMS	50	50	67	50	33		100
ODU	67	50	33	50	100	33	

Table 17. Ageing worksheet for winter flounder at the workshop with the sample number, lab providing the sample and their assigned age, catch date of the sample, workshop group annulus counts, margin codes (scored from 1 to 4), and final age as well as average percent error (APE) values between groups. Samples #1-15 are otoliths and samples 16-20 are scales.

Sample #	Lab	Age	Catch date	Group 1			Group 2			Group 3			Group 4			Group 5			Average Age	APE
				Annulus count	Margin code	Final age	Annulus count	Margin code	Final age	Annulus count	Margin code	Final age	Annulus count	Margin code	Final age	Annulus count	Margin code	Final age		
1	VIMS	3	10/9/2015	3	3	3	3	3	3	3	3	3	3	2	3	3	3	3	3	0%
2	NY	7	3/21/2002	6	4	7	7	1	7	6	4	7	6	4	7	6	4	7	7	0%
3	MA	10	5/14/2013	9	4	10	9	4	10	9	4	10	9	4	10	9	4	10	10	0%
4	VIMS	3	10/8/2015	3	2	3	3	2	3	2	3	2	3	2	3	3	2	3	3	11%
5	NY	6	4/30/2002	5	4	6	5	4	6	5	4	6	5	4	6	5	3	6	6	0%
6	VIMS	5	10/8/2015	5	3	5	5	2	5	5	2	5	5	2	5	5	2	5	5	0%
7	NY	6	3/24/2003	5	4	6	5	4	6	5	3	6	5	3	6	5	4	6	6	0%
8	VIMS	7	10/8/2015	7	2	7	7	2	7	8	2	8	7	2	7	7	2	7	7	4%
9	VIMS	11	5/21/2015	10	4	11	10	4	11	10	4	11	10	4	11	10	3	11	11	0%
10	MA	2	5/9/2013	1	4	2	1	4	2	1	4	2	1	4	2	2	1	2	2	0%
11	NY	4	4/3/2003	3	4	4	3	4	4	3	4	4	3	3	4	3	4	4	4	0%
12	MA	8	5/8/2013	7	4	8	7	4	8	6	4	7	7	4	8	7	4	8	8	4%
13	MA	5	5/7/2013	4	4	5	4	4	5	4	4	5	4	4	5	4	4	5	5	0%
14	VIMS	12	5/17/2015	12	2	12	12	2	12	12	4	13	12	3	13	12	4	13	13	4%
15	MA	7	5/6/2013	6	4	7	6	4	7	6	4	7	6	4	7	6	4	7	7	0%
16	RI	3	8/20/2015	2	4	2	2	2	2	1	3	1	2	2	2	2	2	2	2	18%
17	RI	3	5/19/2015	2	4	3	3	1	3	1	4	2	2	2	2	2	2	2	2	20%
18	RI	2	5/21/2015	2	4	3	4	1	4	2	4	3	1	4	2	1	4	2	3	23%
19	RI	2	5/21/2015	1	4	2	3	1	3	1	4	2	1	2	1	1	1	1	2	36%
20	RI	3	5/20/2015	1	4	2	3	1	3	1	4	2	1	2	1	1	1	1	2	36%
																			Average APE	8%
																			Otolith APE	2%
																			Scale APE	26%

Table 18. **Symmetry test p-values for inter-lab age comparisons using Bowker's test and CVs (%) for winter flounder otoliths (a) and scales (b). P-values appear above the shaded diagonal line and CVs are below. There were two readers from CT. CVs > 5% are highlighted.**

(a)

	MA	NEFSC	RI	CT	CT	VIMS	SC
MA		0.61	0.61	0.61	0.61	0.61	0.61
NEFSC	4		1	1	1	1	1
RI	3	0		1	1	1	1
CT	4	0	0		1	1	1
CT	3	0	0	0		1	1
VIMS	4	0	0	0	0		1
SC	3	0	0	0	0	0	

(b)

	NEFSC	RI	CT	CT	SC
NEFSC		0.32	0.32	0.32	0.32
RI	30		1	1	1
CT	30	0		1	1
CT	30	0	0		1
SC	30	0	0	0	

Table 19. Percent exact agreement (below the shaded diagonal line) and agreement within one year (above the shaded diagonal line) between readers for winter flounder otoliths (a) and scales (b). There were two readers from CT.

(a)

	MA	NEFSC	RI	CT	CT	VIMS	SC
MA		100	100	100	100	100	100
NEFSC	73		100	100	100	100	100
RI	80	93		100	100	100	100
CT	73	100	93		100	100	100
CT	80	93	100	93		100	100
VIMS	73	100	93	100	93		100
SC	80	93	100	93	100	93	

(b)

	NEFSC	RI	CT	CT	SC
NEFSC		100	100	100	100
RI	20		100	100	100
CT	20	100		100	100
CT	20	100	100		100
SC	20	100	100	100	

Figures

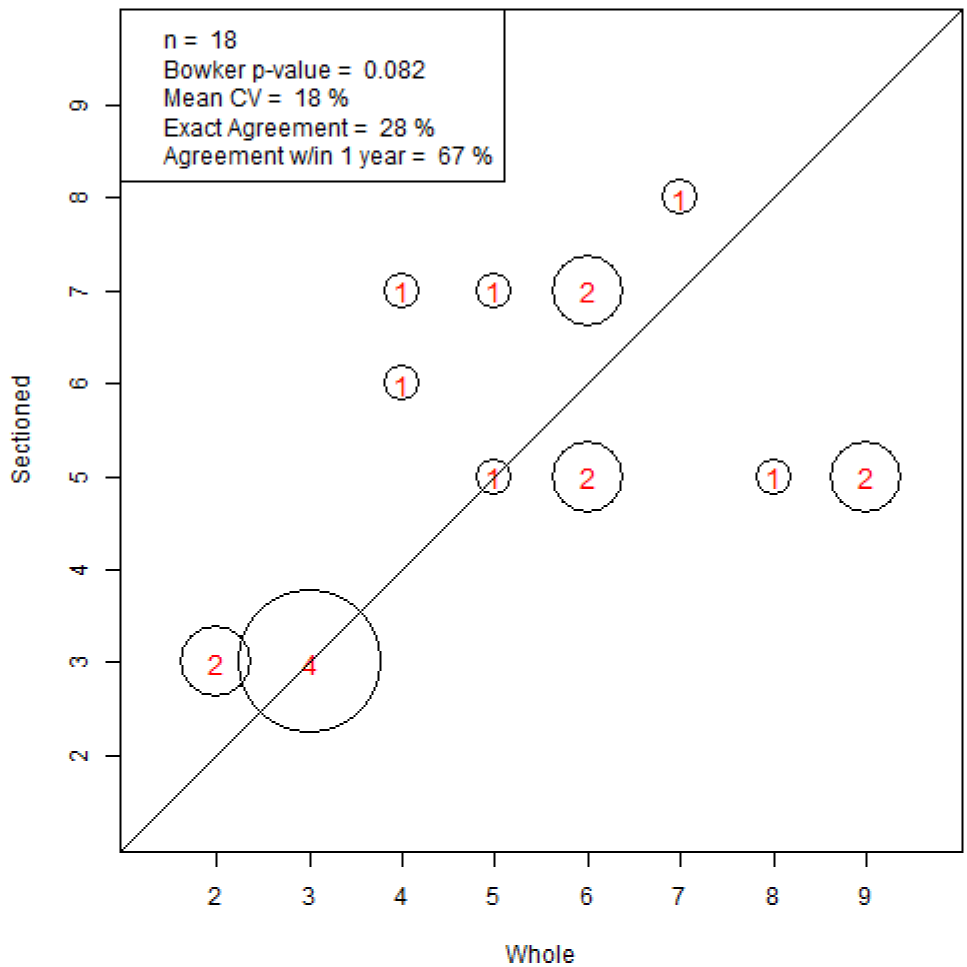


Figure 1. Age frequency comparison for American eel paired sectioned and whole otolith samples. Circles are proportional to number of observations.

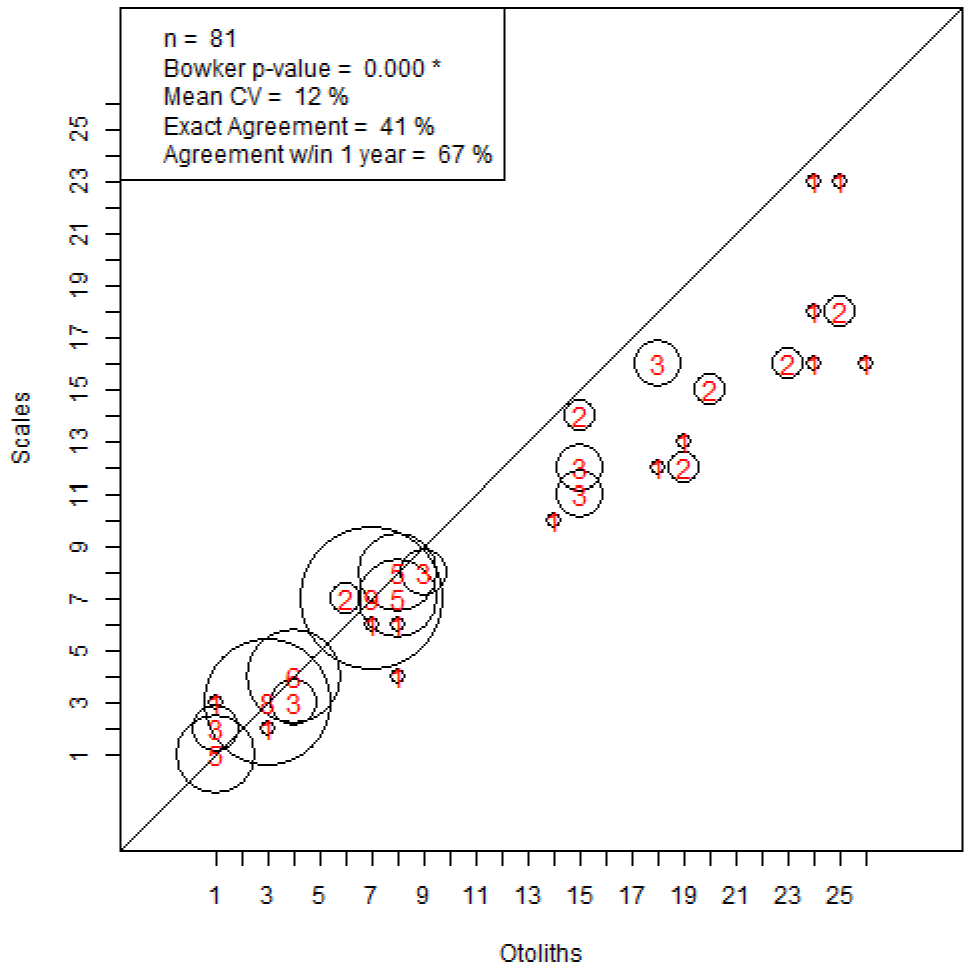


Figure 2. Age frequency comparison for striped bass paired scale and otolith samples. Circles are proportional to number of observations.

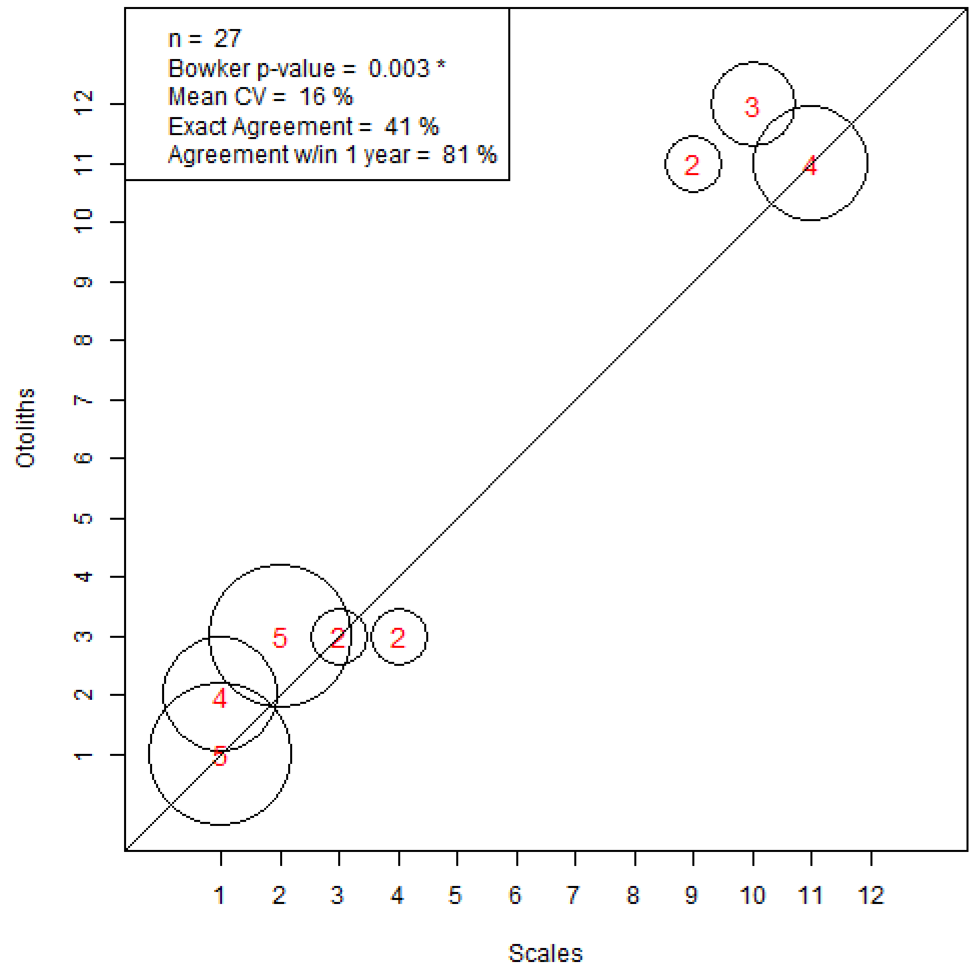


Figure 3. Age frequency comparison for summer flounder paired scale and otolith samples. Circles are proportional to number of observations.

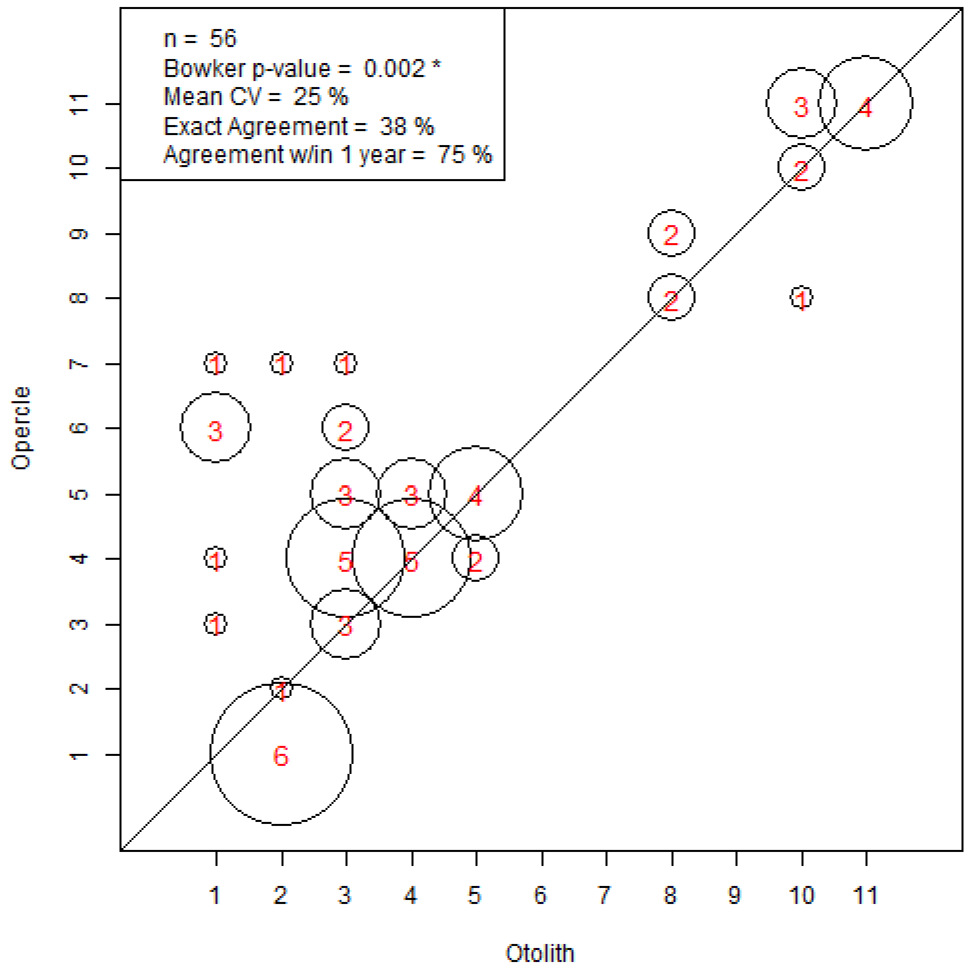


Figure 4. **Age frequency comparison for tautog paired opercula and otolith samples. Circles are proportional to number of observations.**

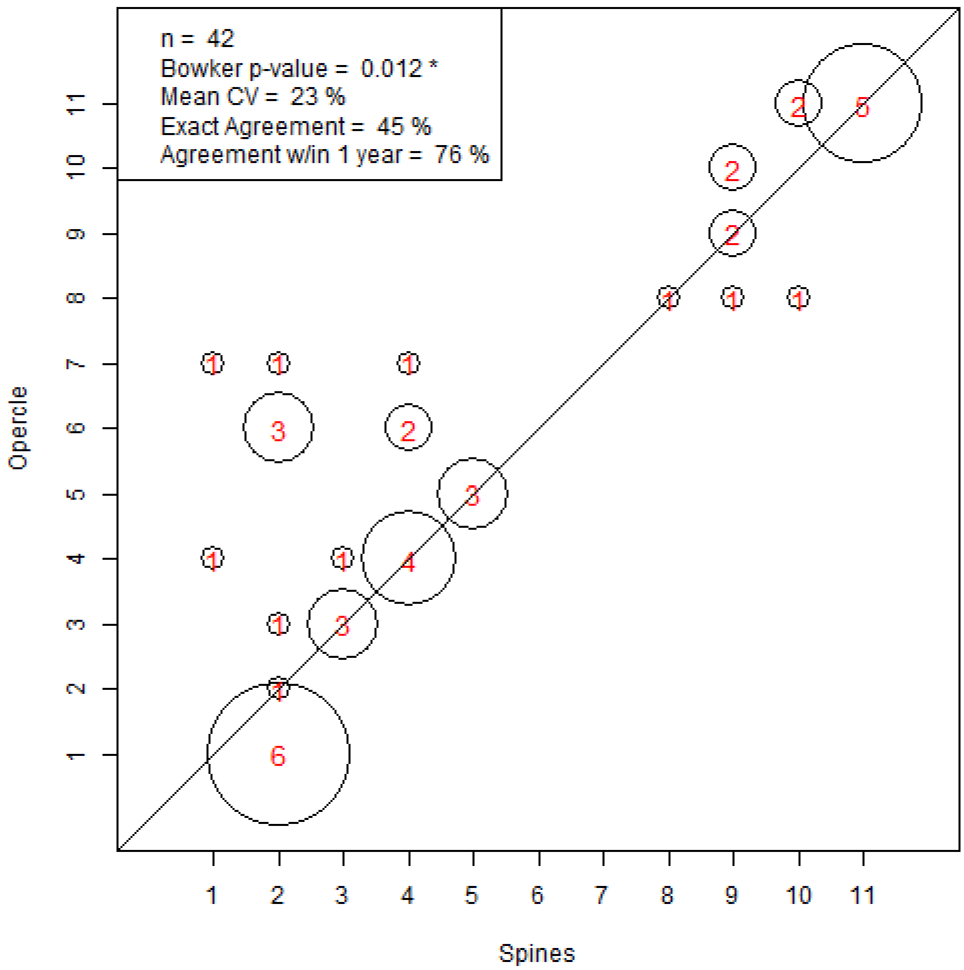


Figure 5. Age frequency comparison for tautog paired opercula and pelvic spine samples. Circles are proportional to number of observations.

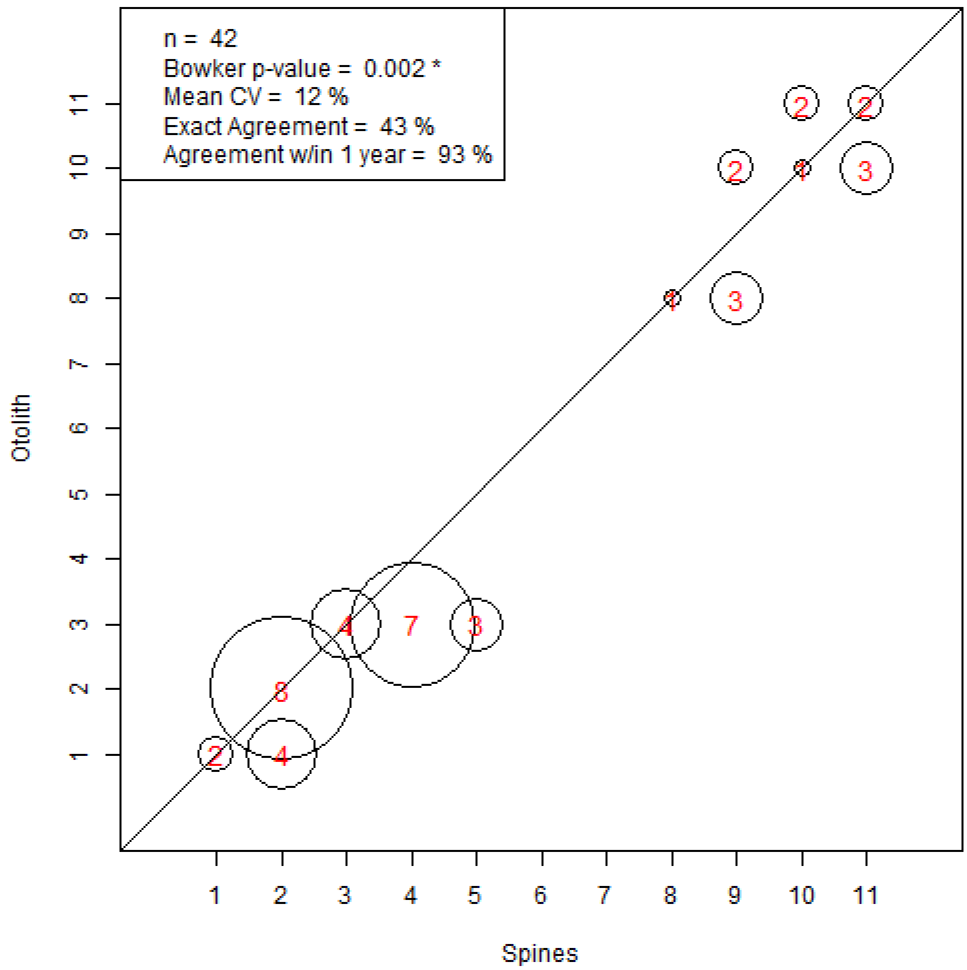


Figure 6. Age frequency comparison for tautog paired otolith and pelvic spine samples. Circles are proportional to number of observations.

Appendix A: Agenda

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

Wednesday, March 20th, 2019 – 9:00 a.m. to 5:00 p.m.
Thursday, March 21st, 2019 – 9:00 a.m. to ~3:00 p.m.

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

Agenda

Wednesday, March 20th

1. Call to Order/Introductions
2. Conduct Hard Part Readings Exercise for Striped Bass, Winter Flounder, Summer Flounder, American Eel, Tautog, and Atlantic Croaker

Thursday, March 21st

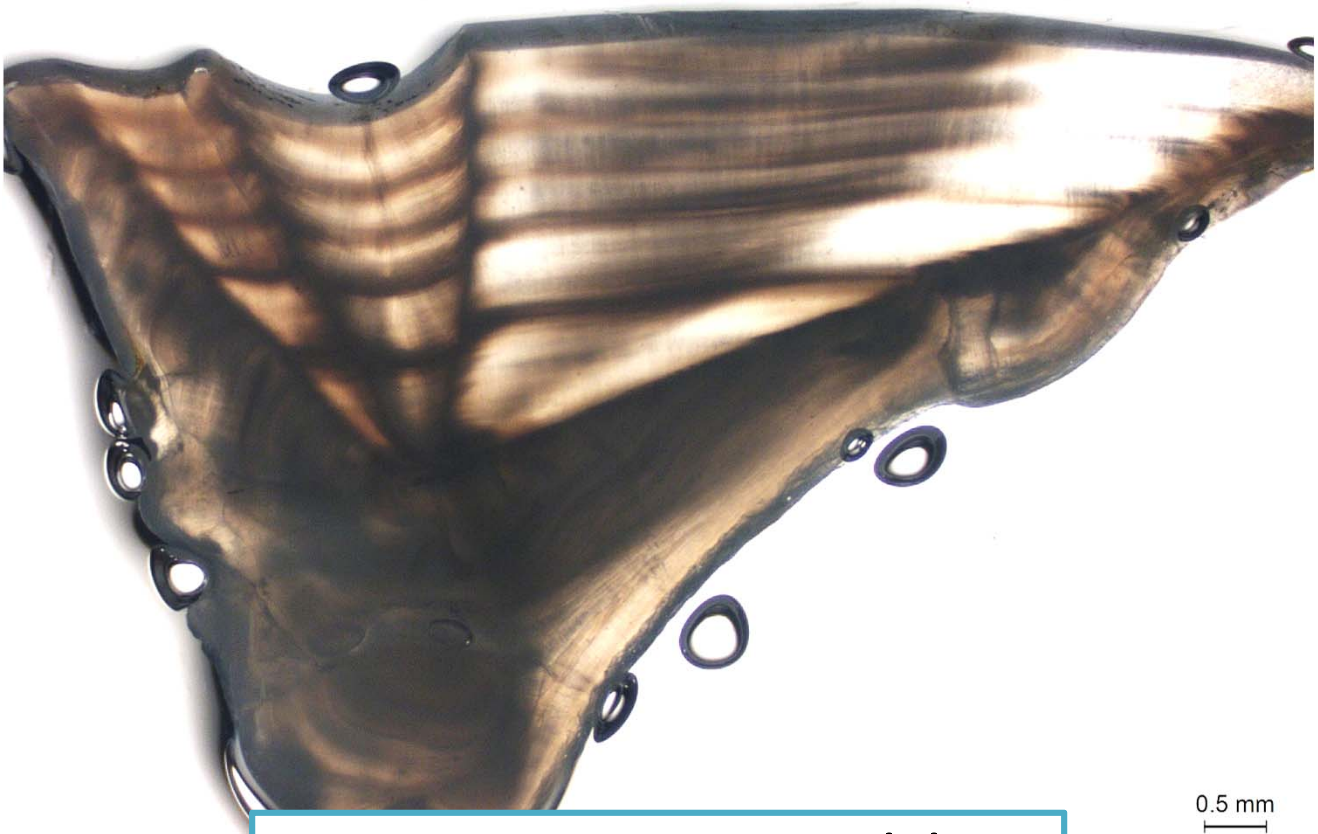
3. Review and Comparison of Otolith Reading Exercise by Groups and by States
4. Discussion and Review of Issues and Differences Encountered during Reading Exercise
5. Make Recommendations
6. Other Business

Adjourn

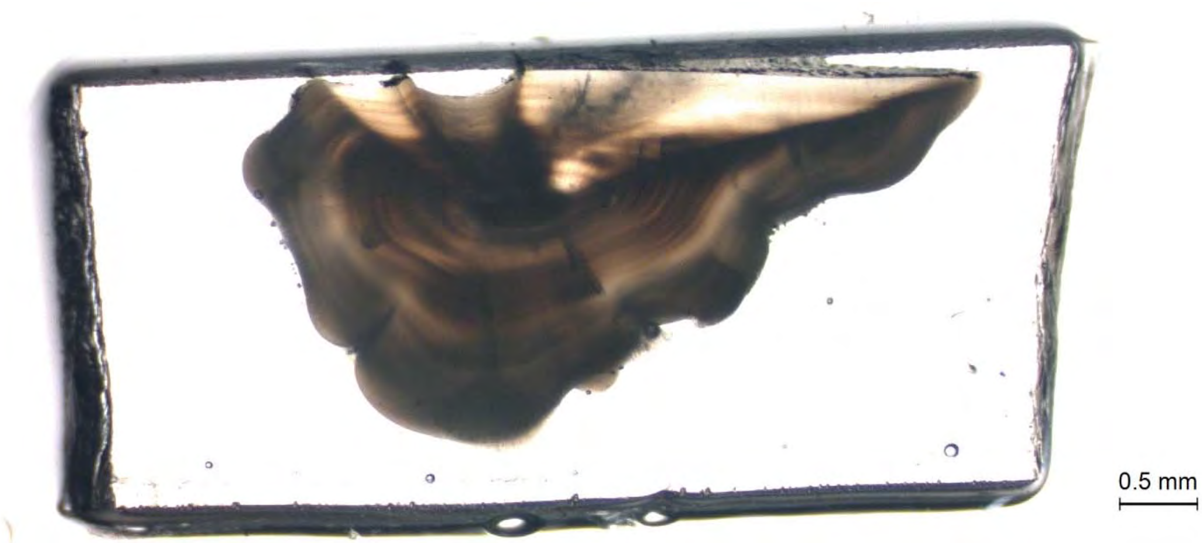
Appendix B: Sample Images

Atlantic Croaker 1 9/23/2014

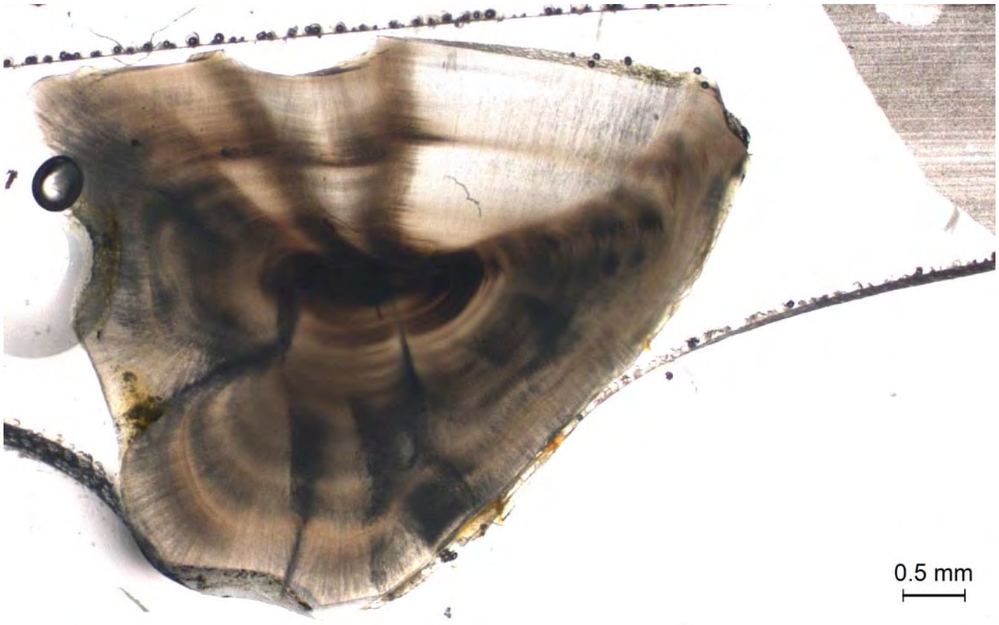
Atlantic Croaker 2 10/1/2012



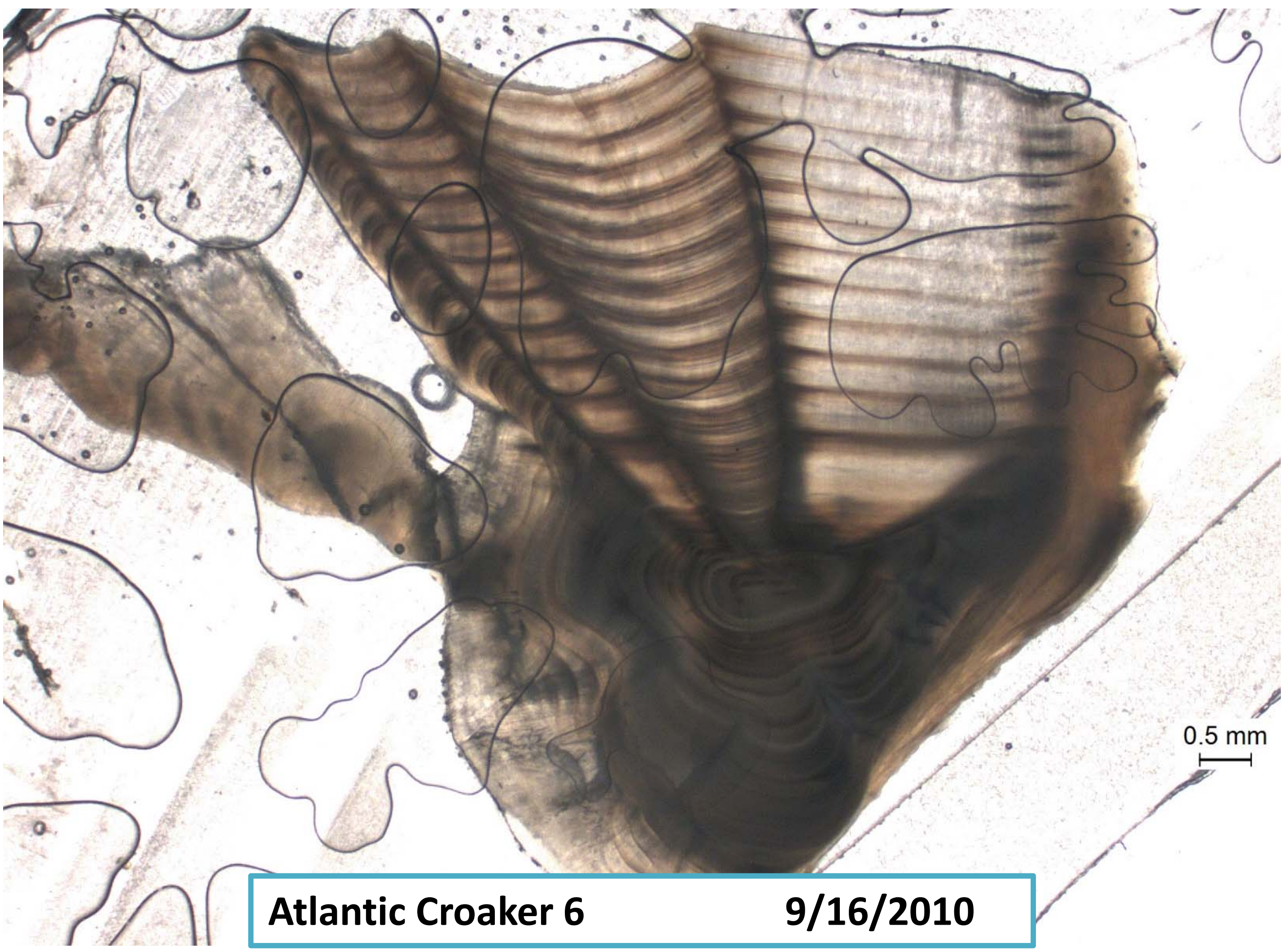
Atlantic Croaker 3 7/1/2014



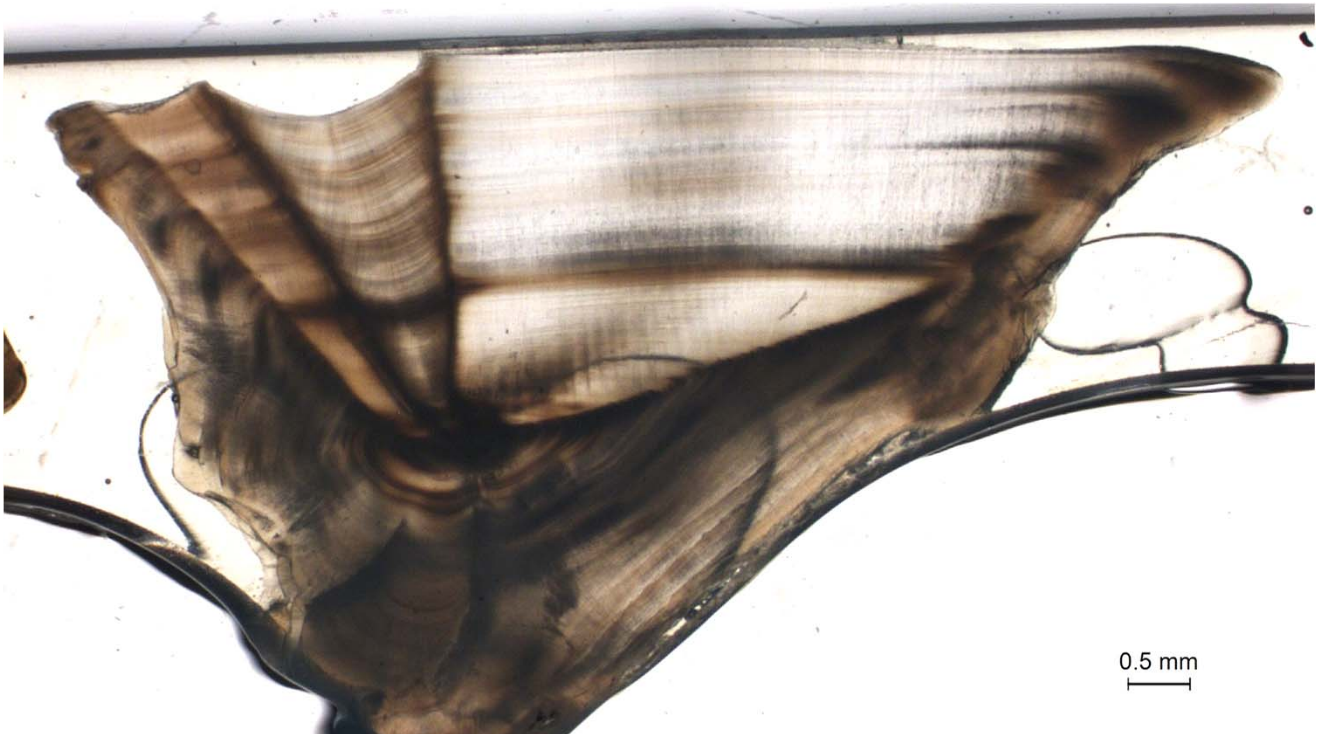
Atlantic Croaker 4 5/15/2012



Atlantic Croaker 5 5/14/2014



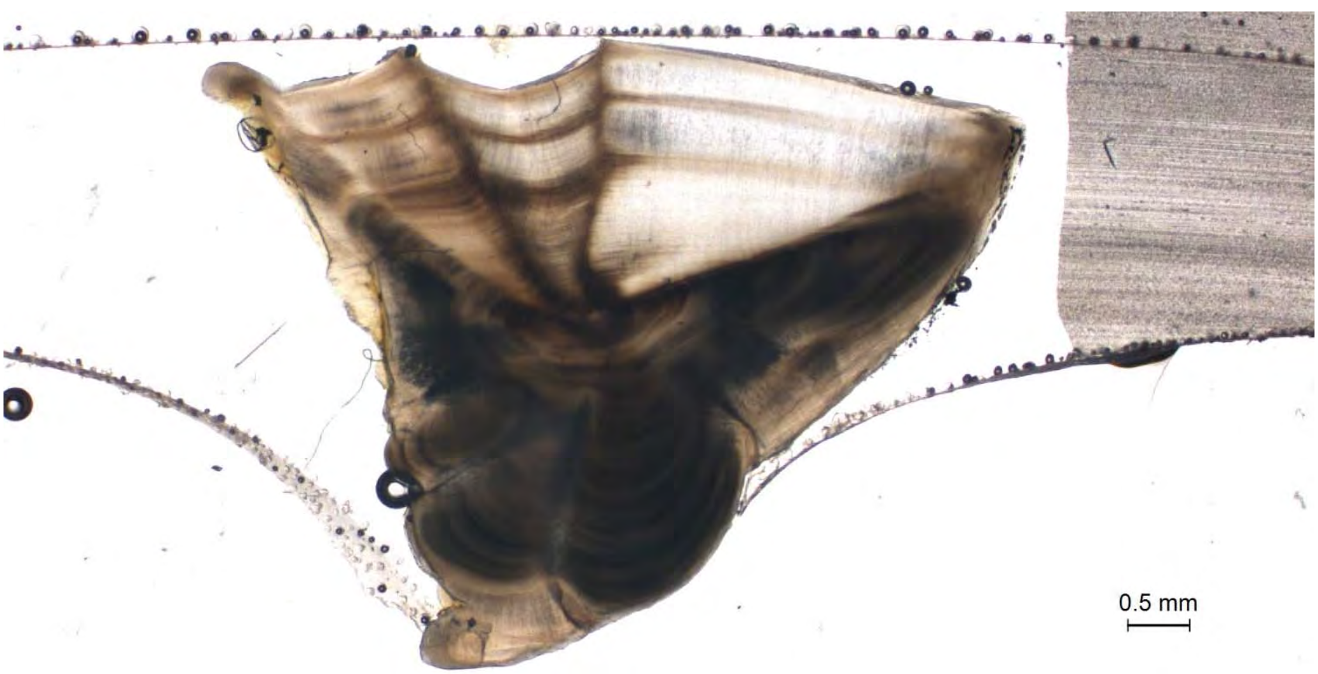
Atlantic Croaker 6 9/16/2010



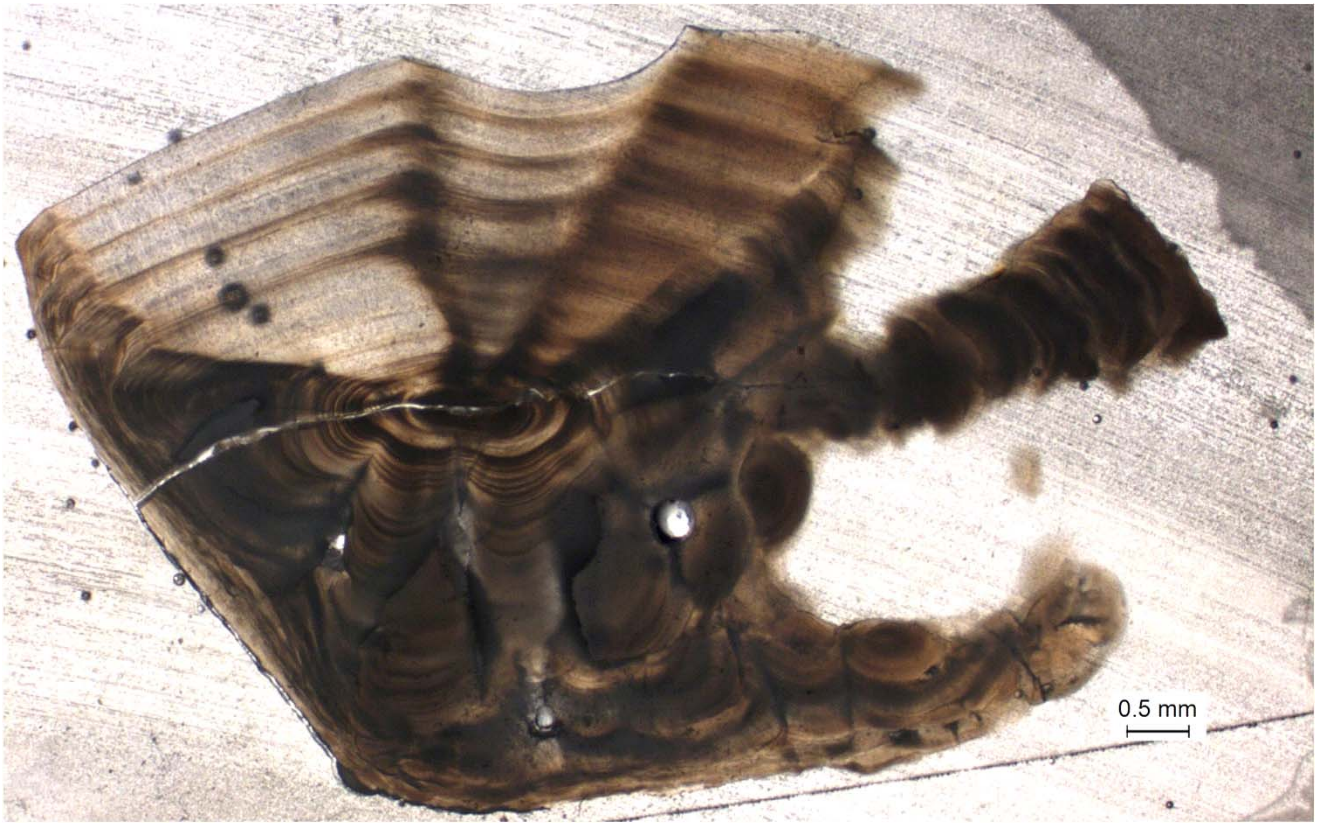
Atlantic Croaker 7 6/29/2011

Atlantic Croaker 8 5/10/2014

Atlantic Croaker 9 4/21/2014

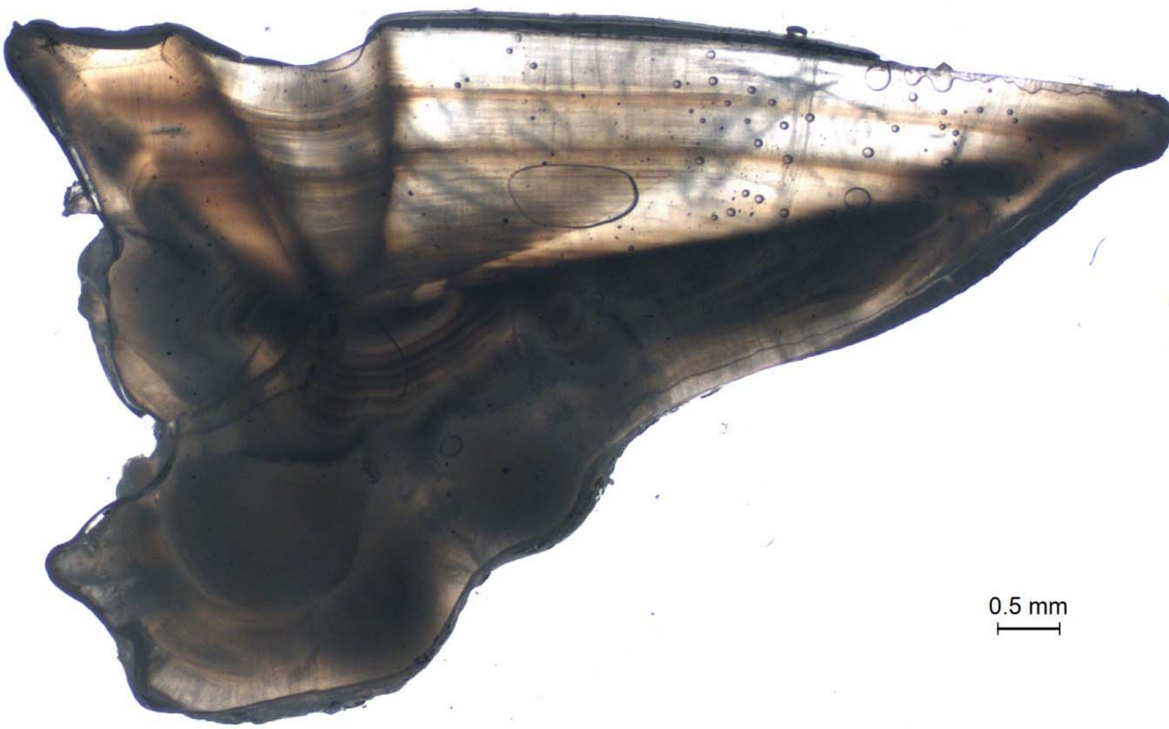


Atlantic Croaker 10 5/14/2014



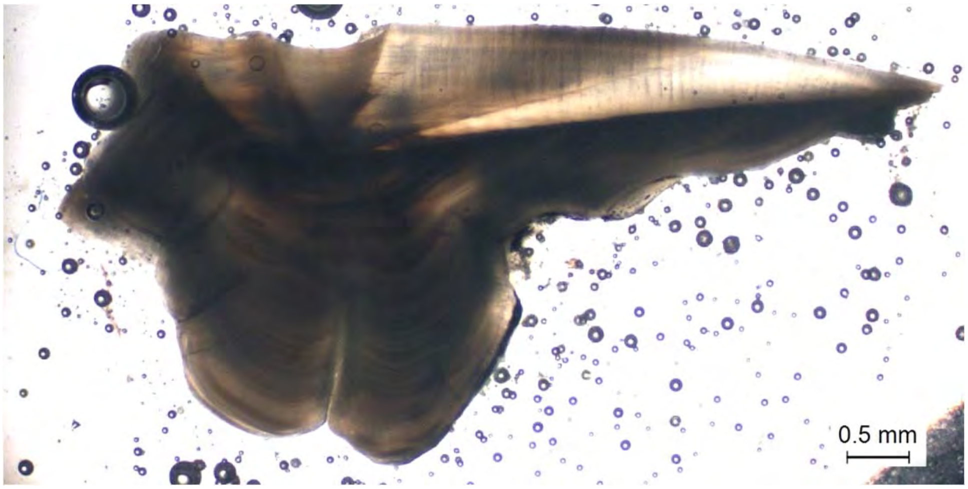
Atlantic Croaker 11 10/3/2006

Atlantic Croaker 12 3/26/2013

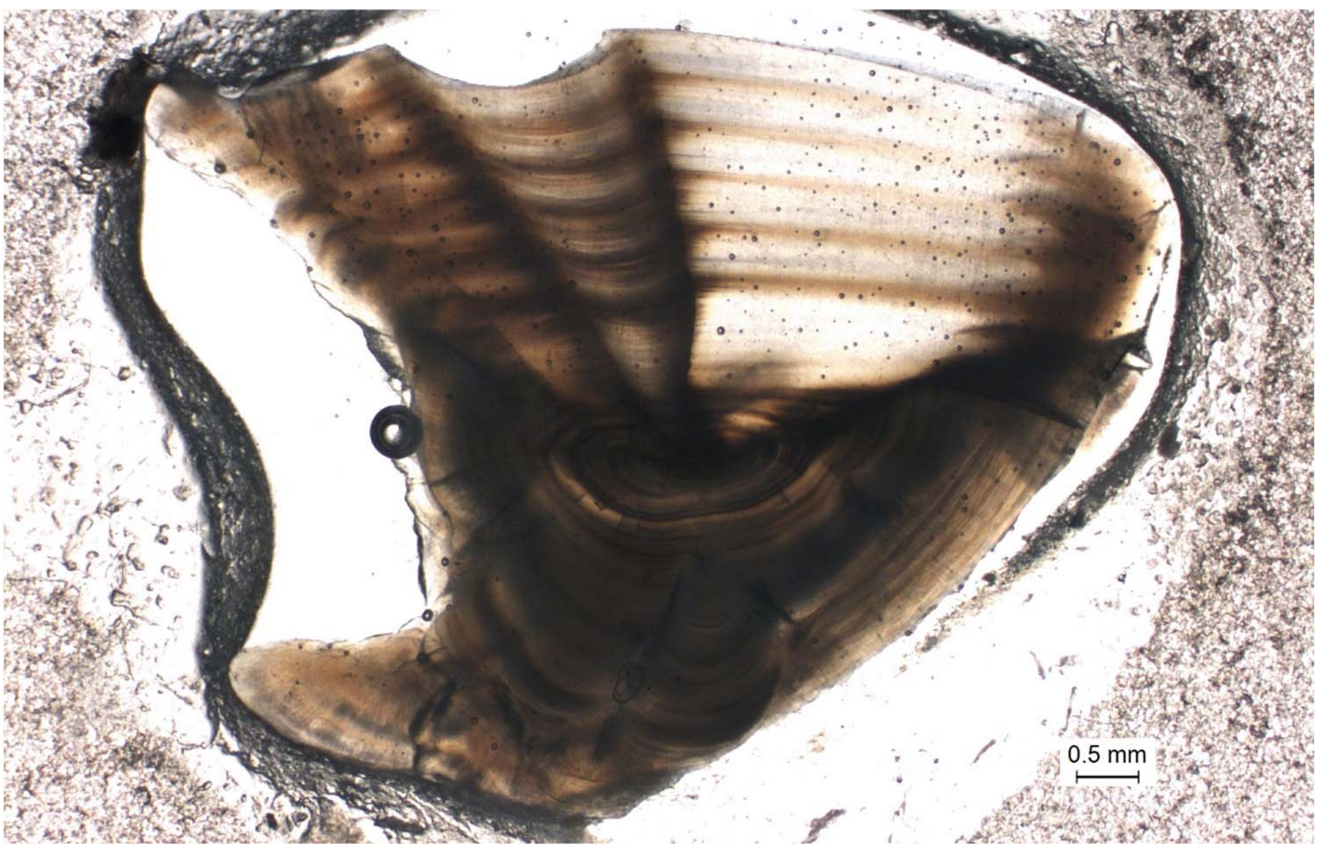


Atlantic Croaker 13 9/15/2015

Atlantic Croaker 14 8/18/2014

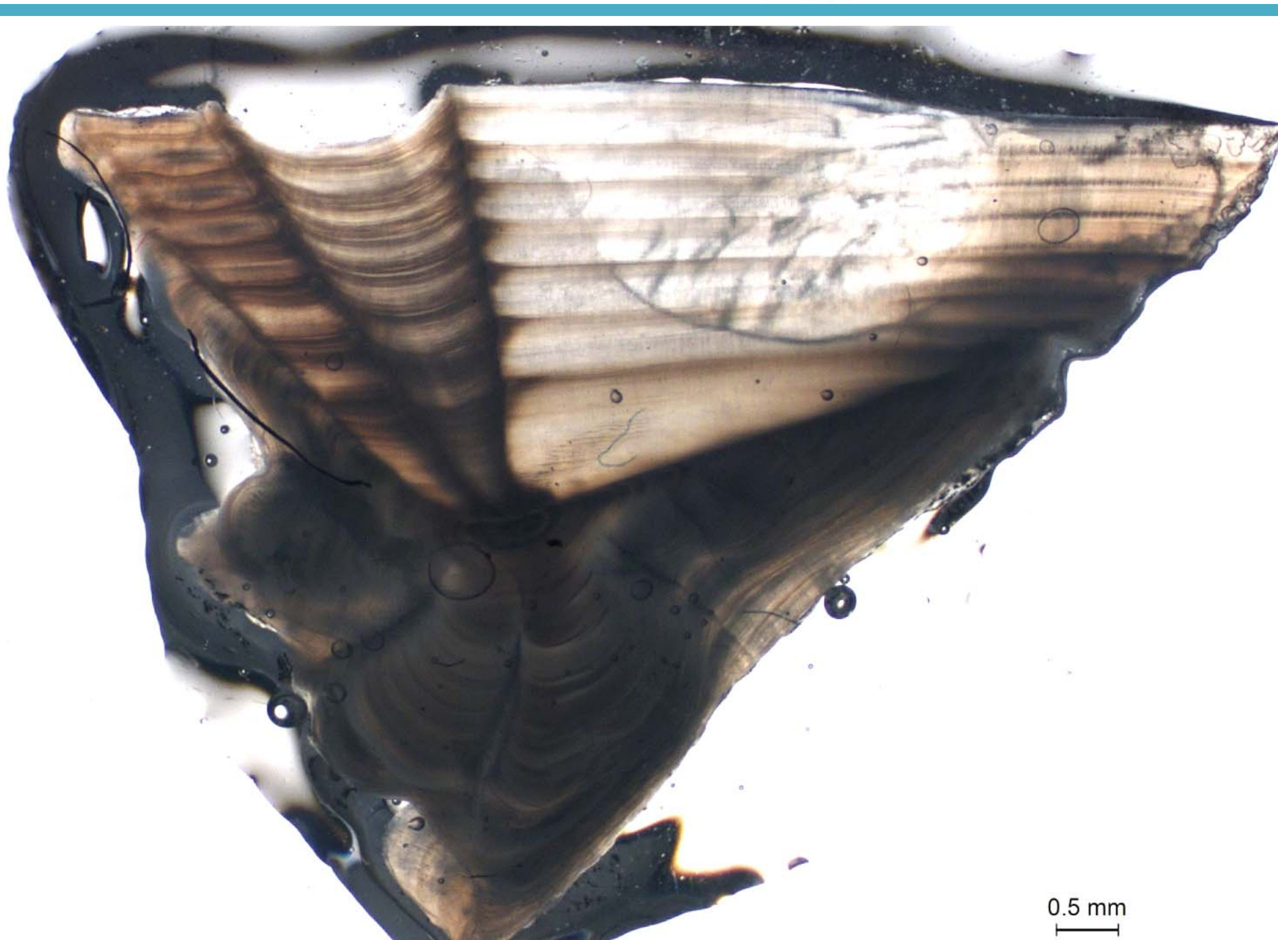


Atlantic Croaker 15 11/5/2014

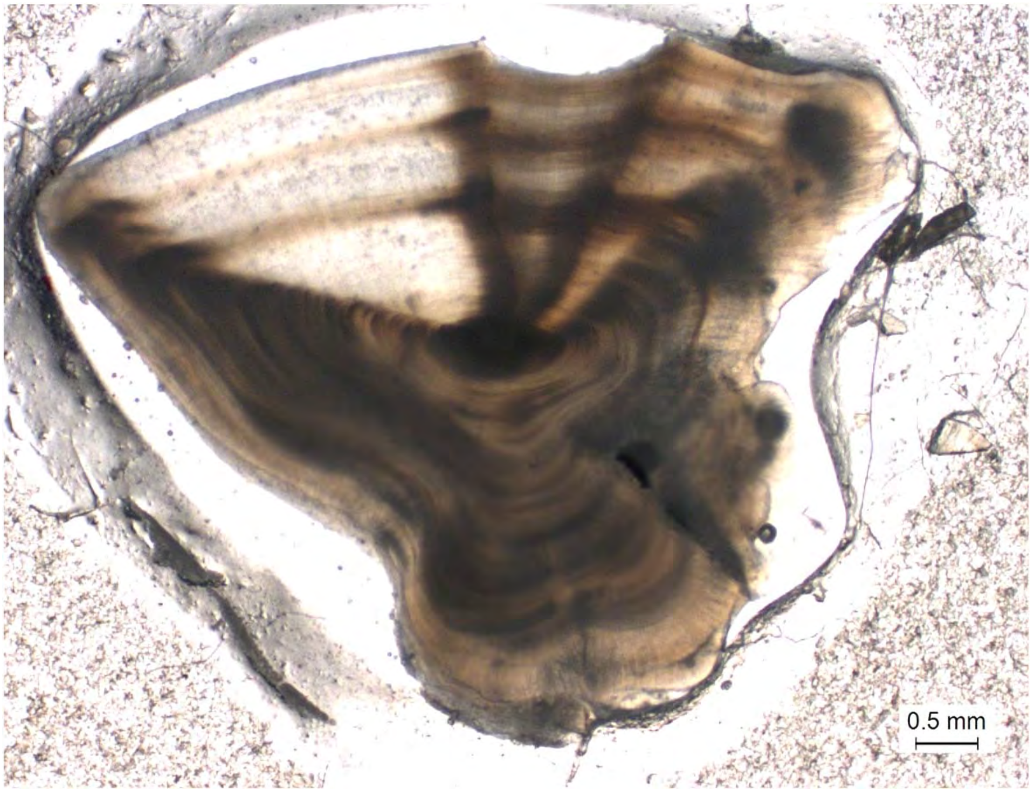


Atlantic Croaker 16 3/26/2013

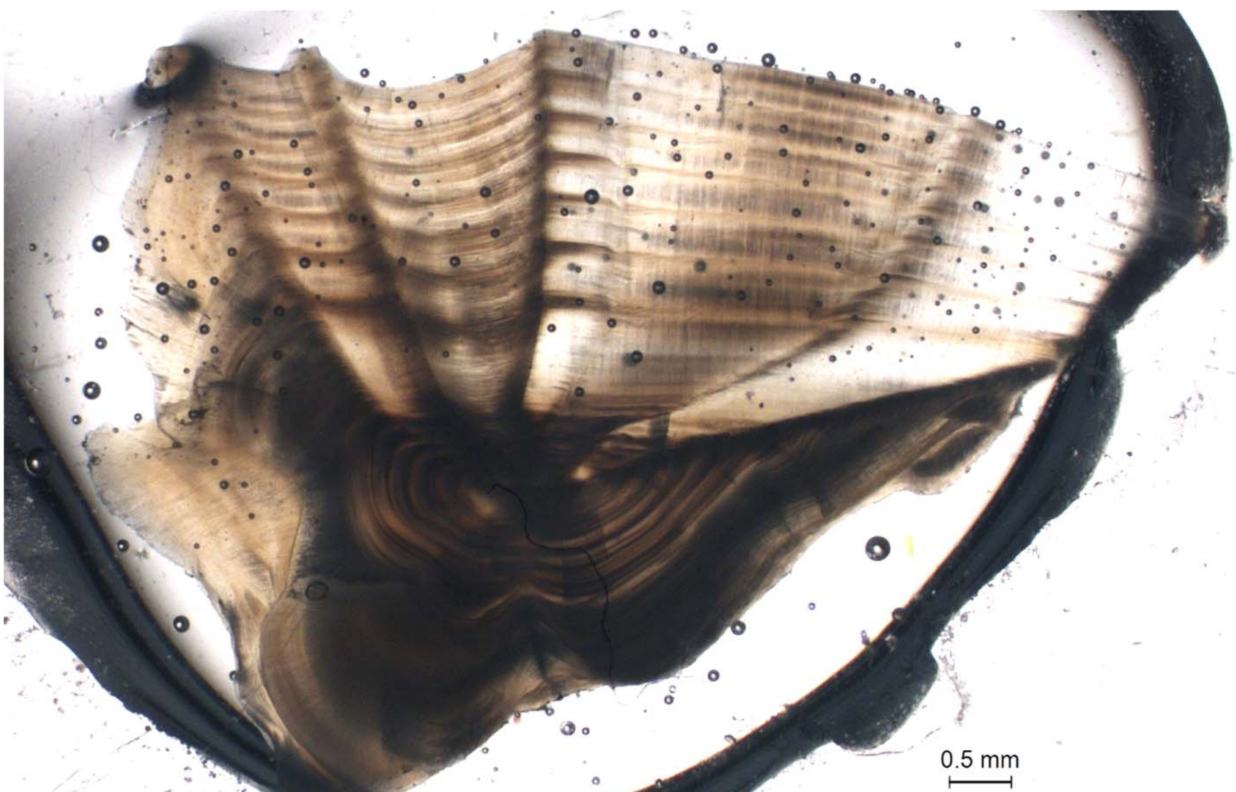
Atlantic Croaker 17 **9/15/2015**



Atlantic Croaker 18 **8/17/2015**



Atlantic Croaker 19 6/13/2013

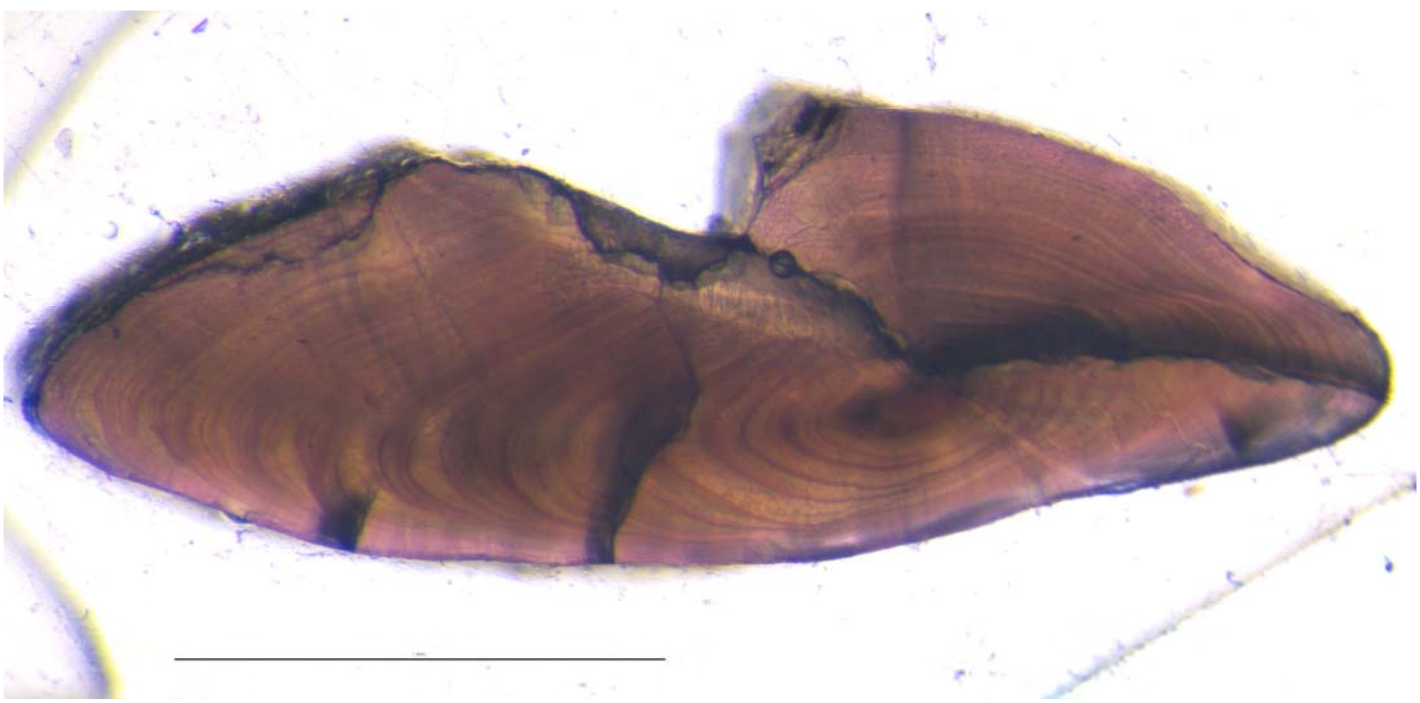


Atlantic Croaker 20 4/26/2014

American Eel 1 11/16/2016

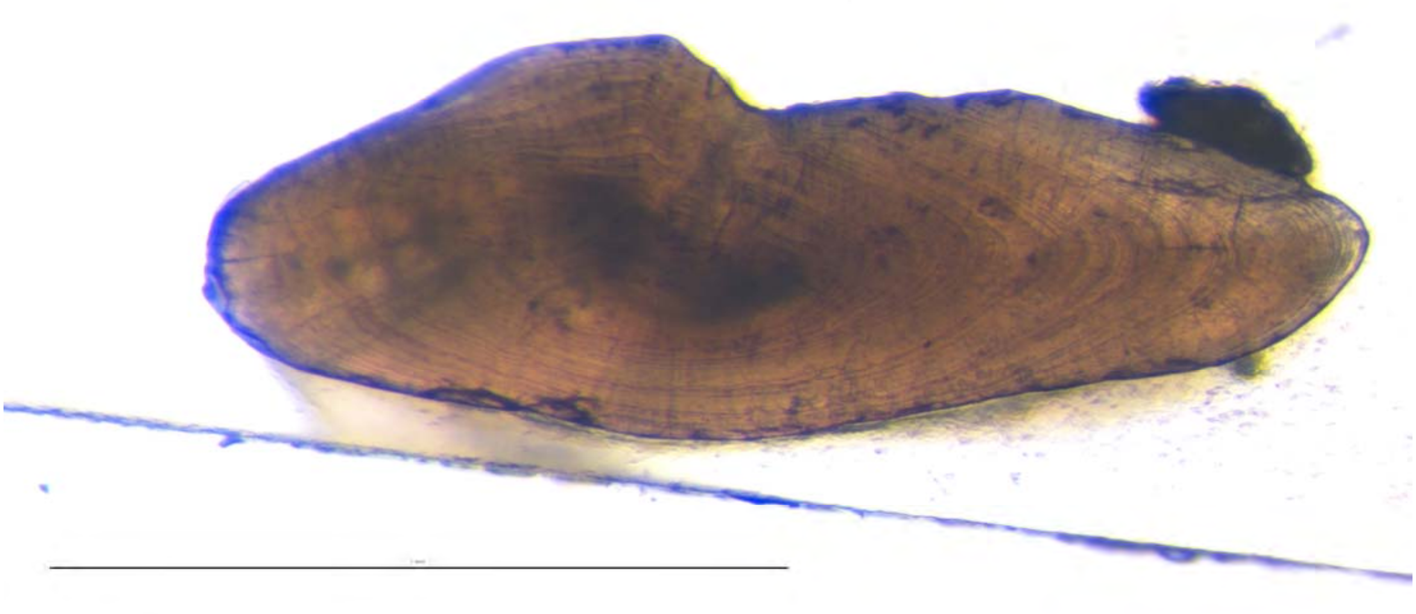
American Eel 2 10/28/2015

American Eel 3 11/5/2014

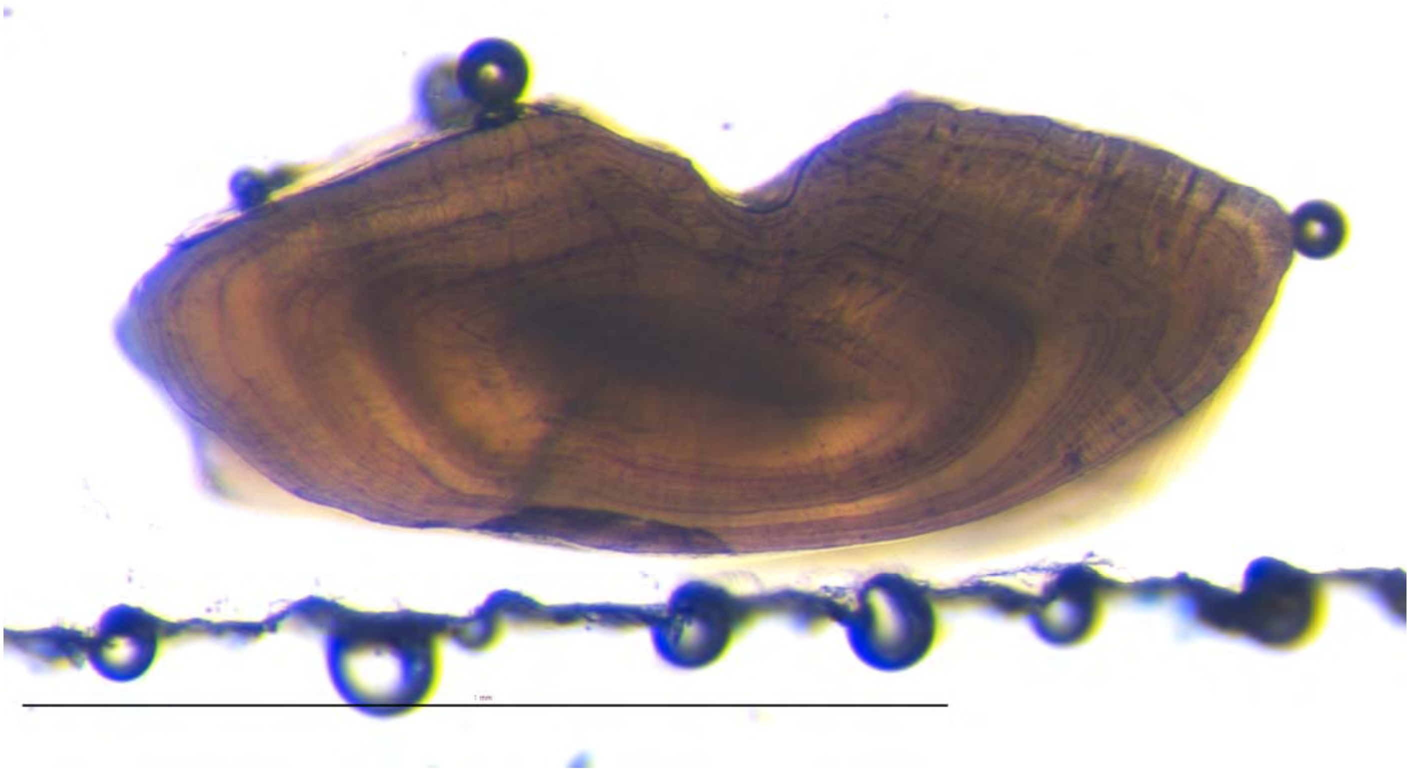


American Eel 4 9/16/2016

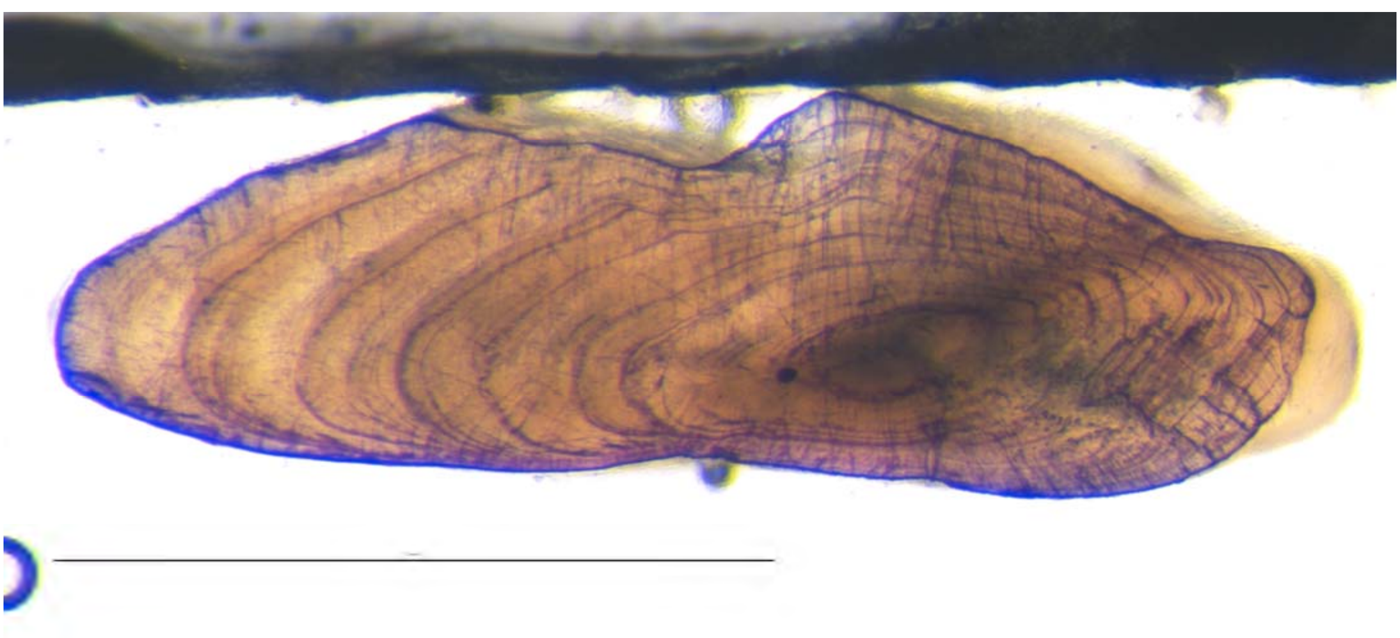
American Eel 5 11/5/2014



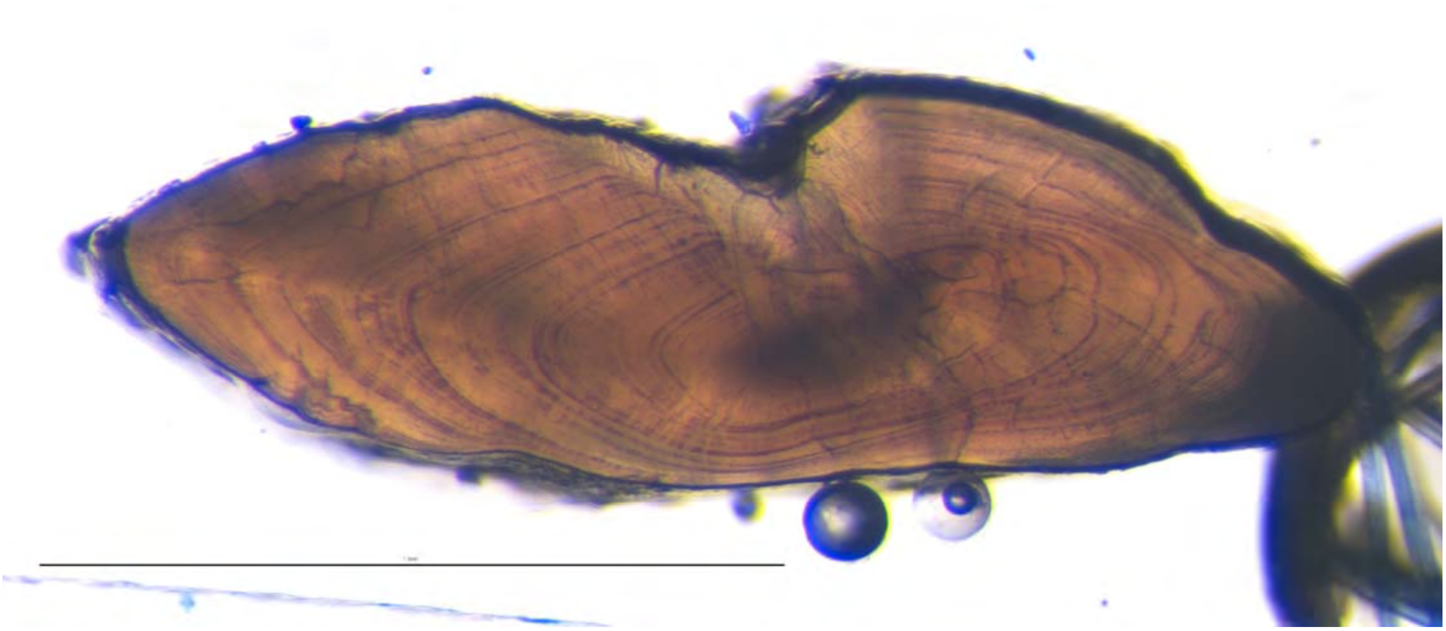
American Eel 6 6/28/2012



American Eel 7 9/11/2012



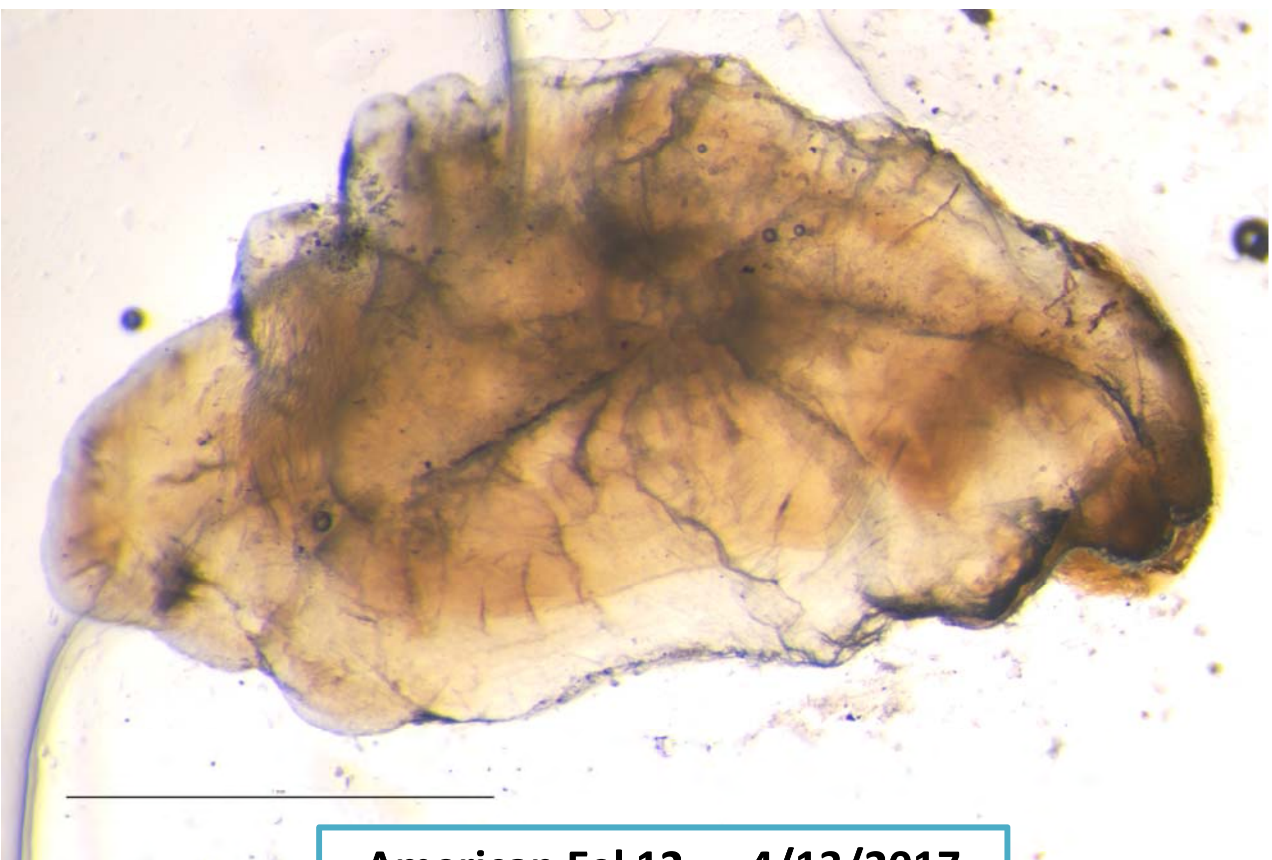
American Eel 8 (no date)



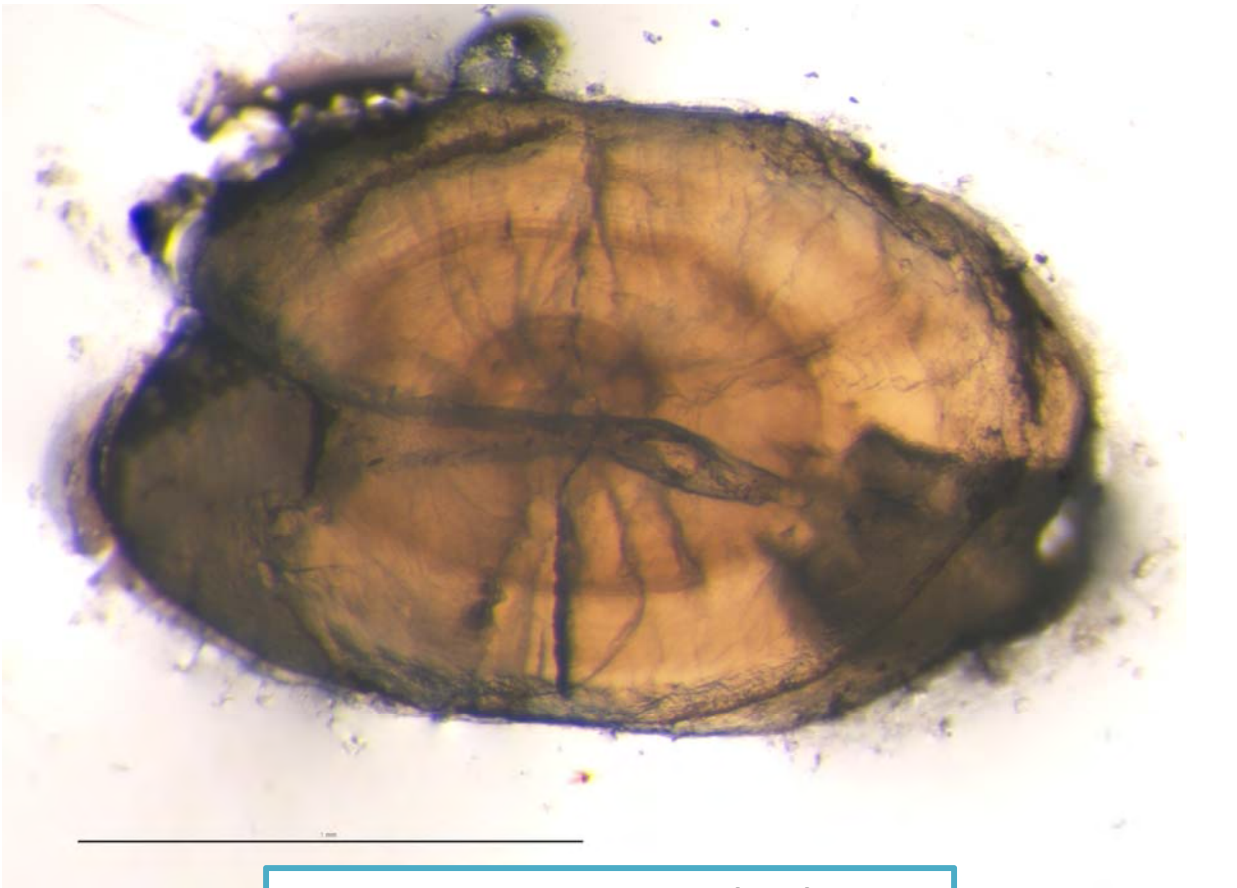
American Eel 9 10/2/2012

American Eel 10 3/10/2015

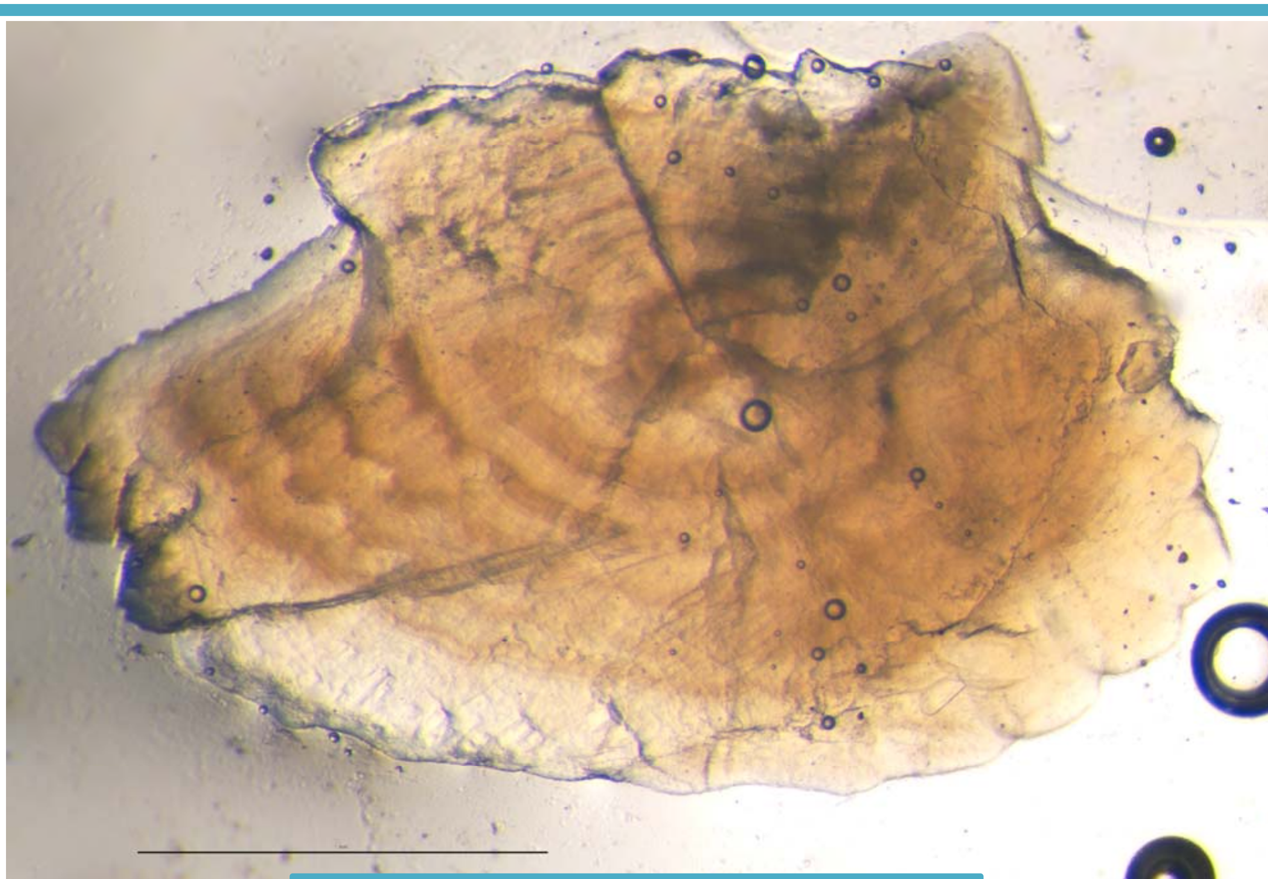
American Eel 11 6/28/2012



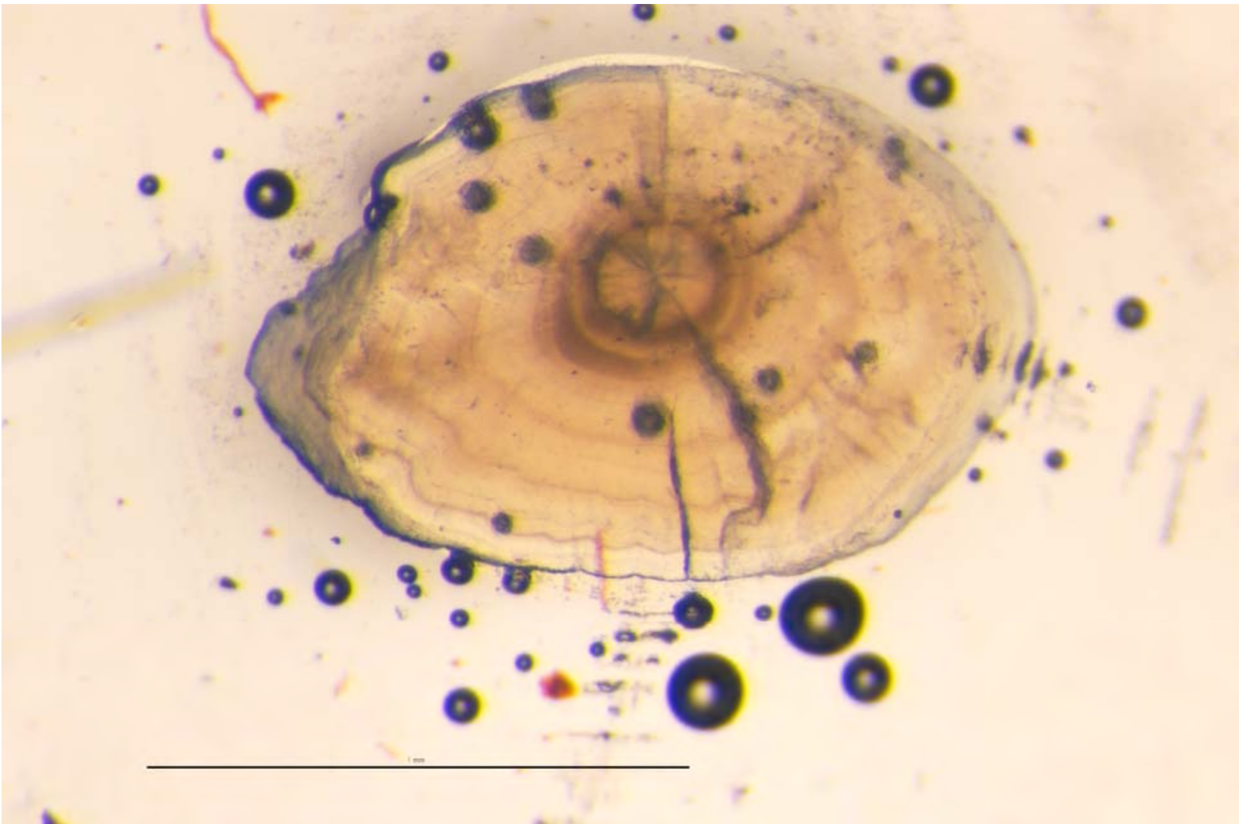
American Eel 12 4/13/2017



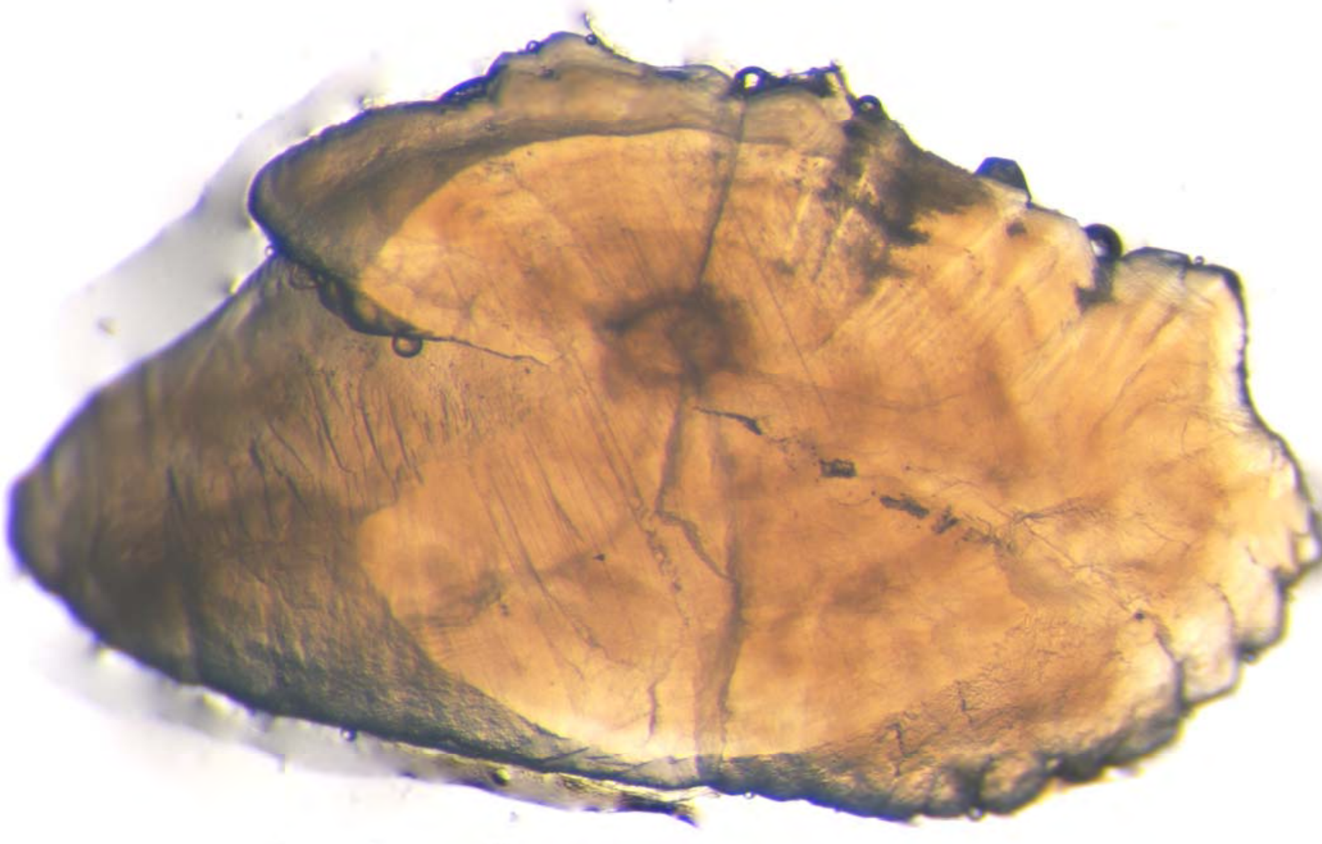
American Eel 13 9/11/2012



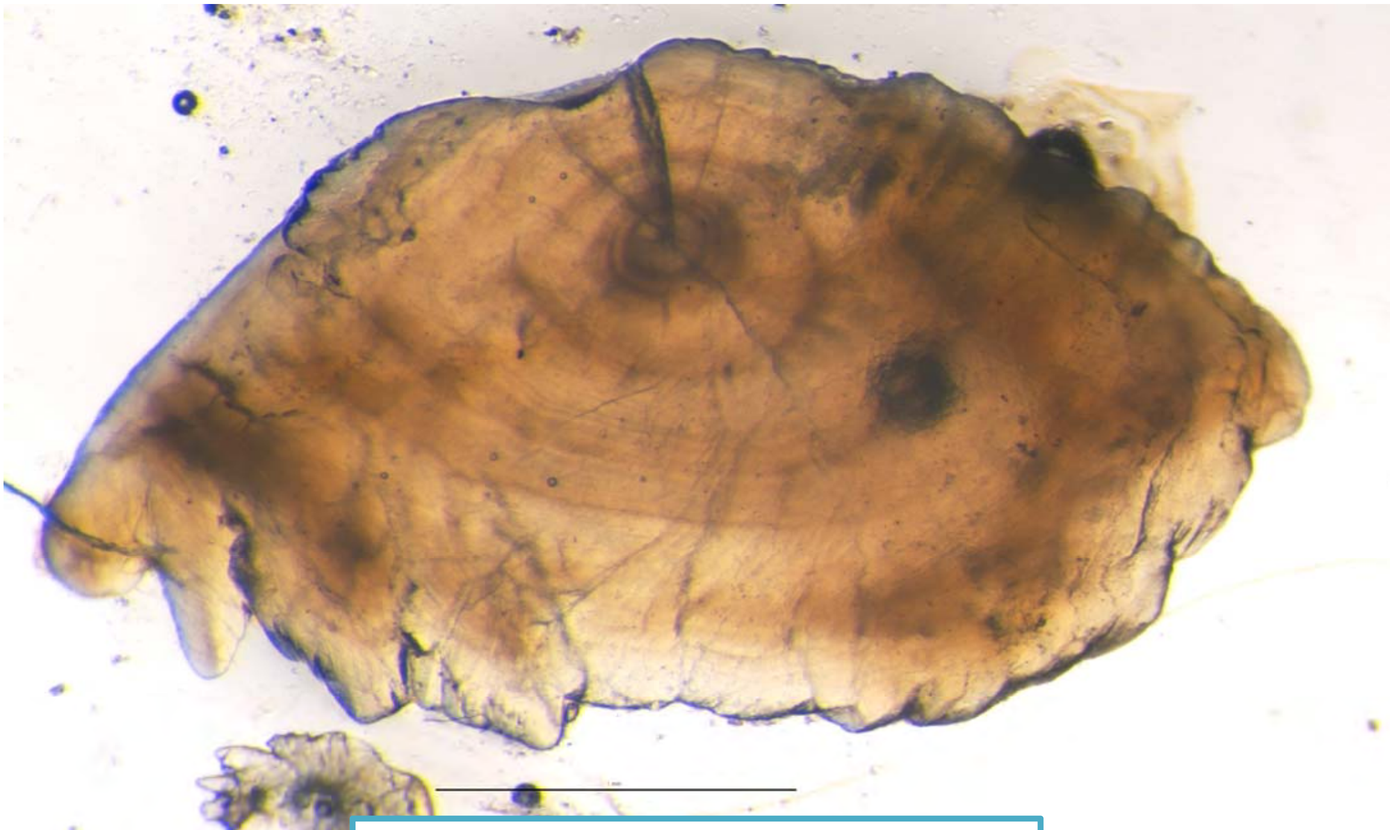
American Eel 14 4/25/2017



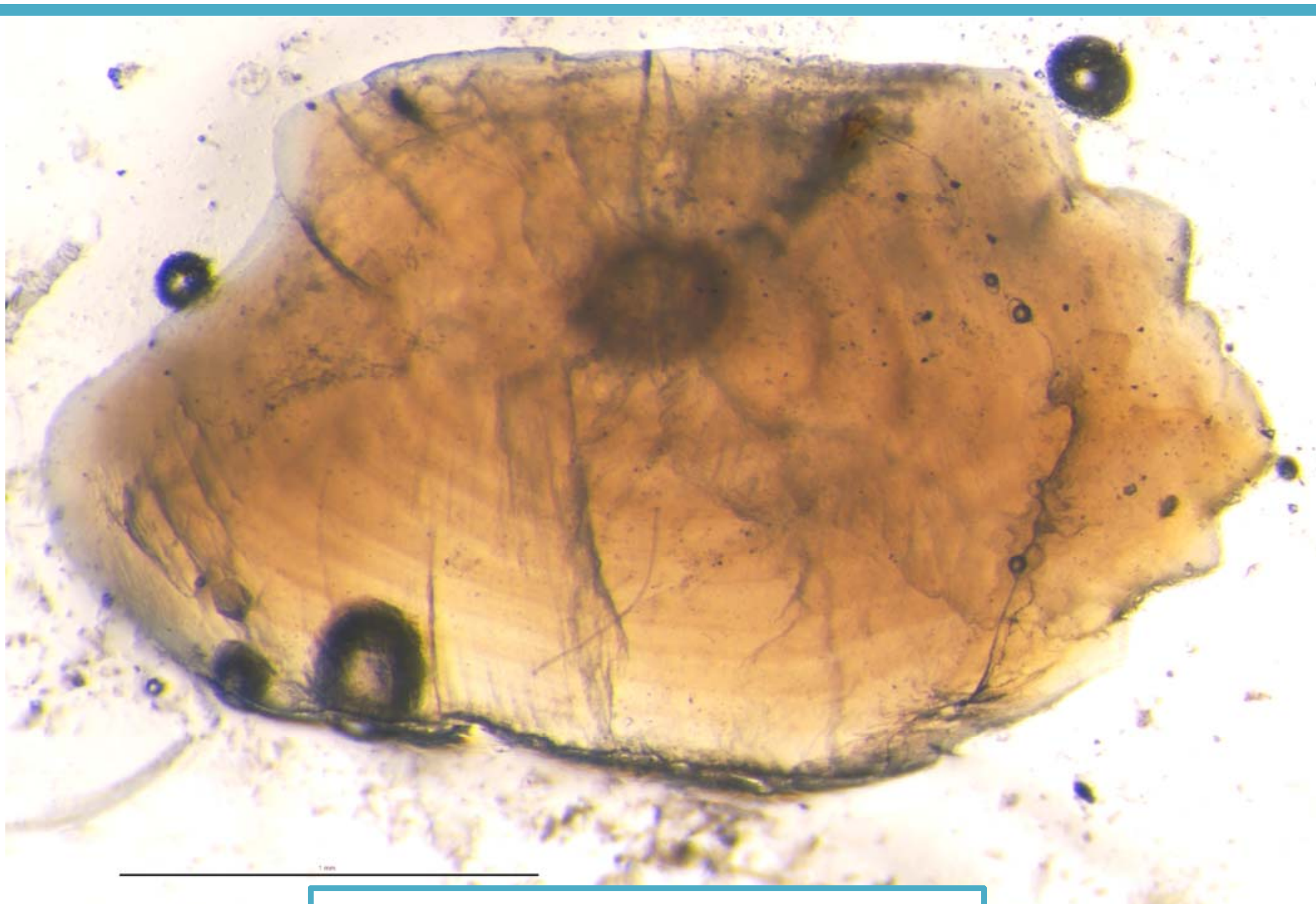
American Eel 15 8/14/2017



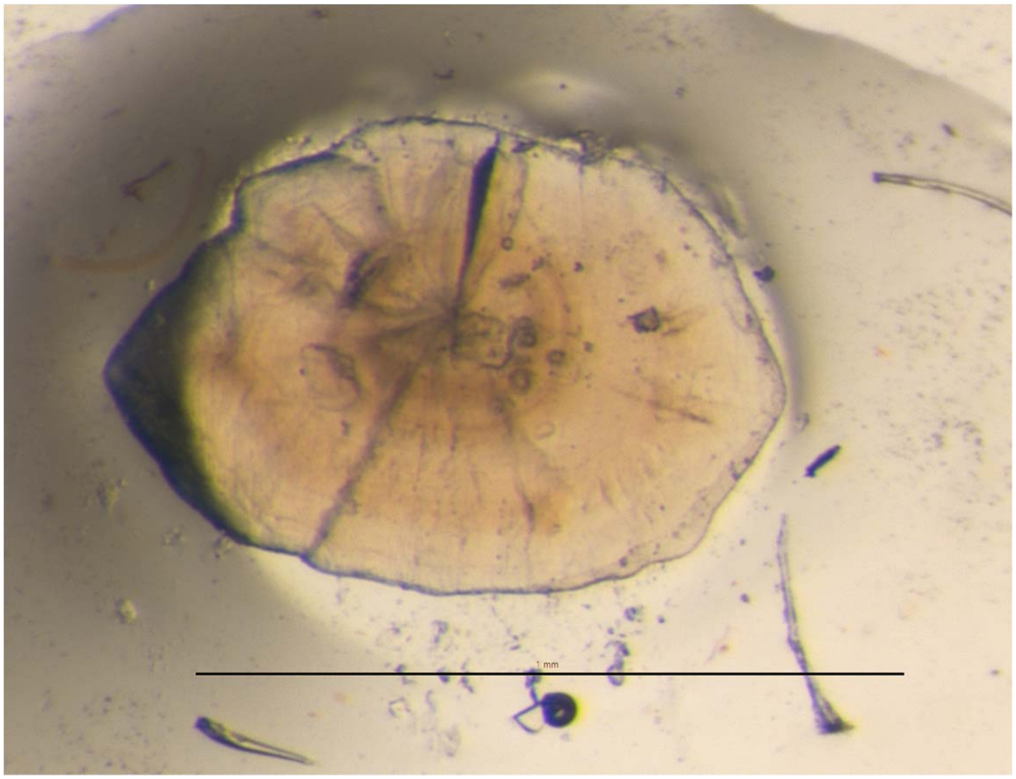
American Eel 16 10/2/2012



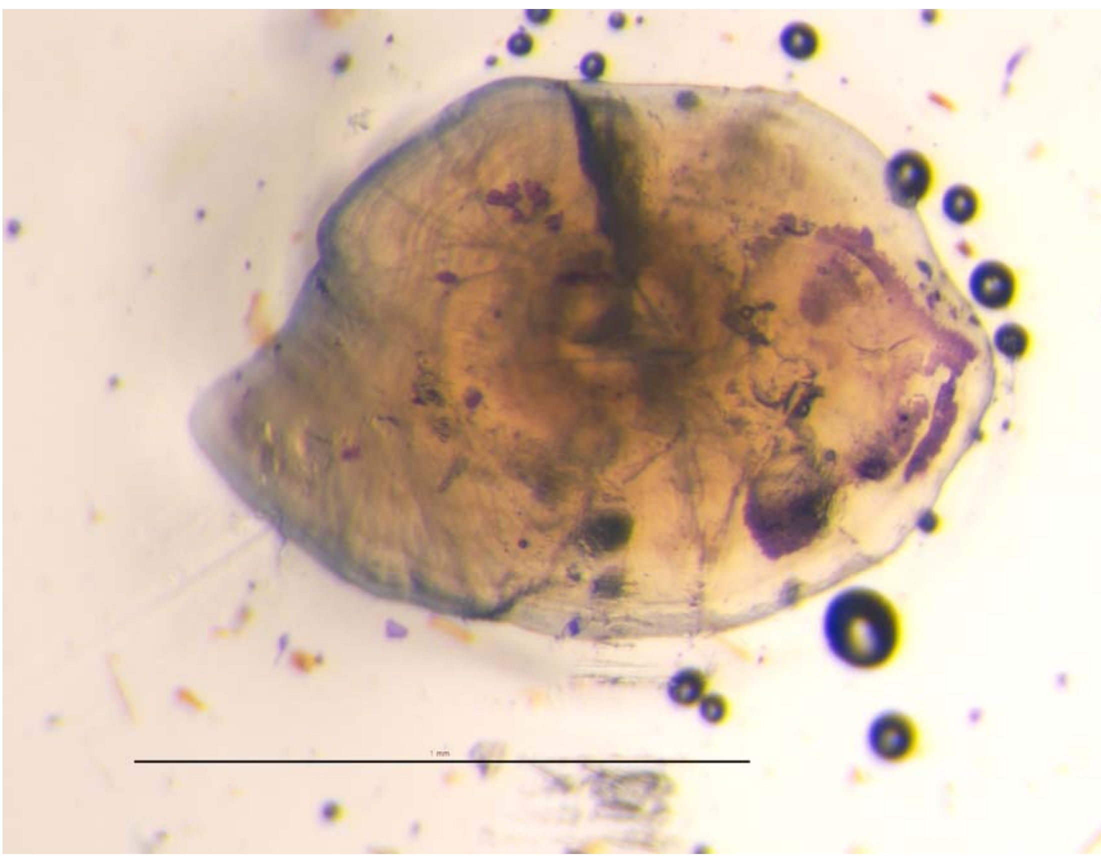
American Eel 17 4/13/2017



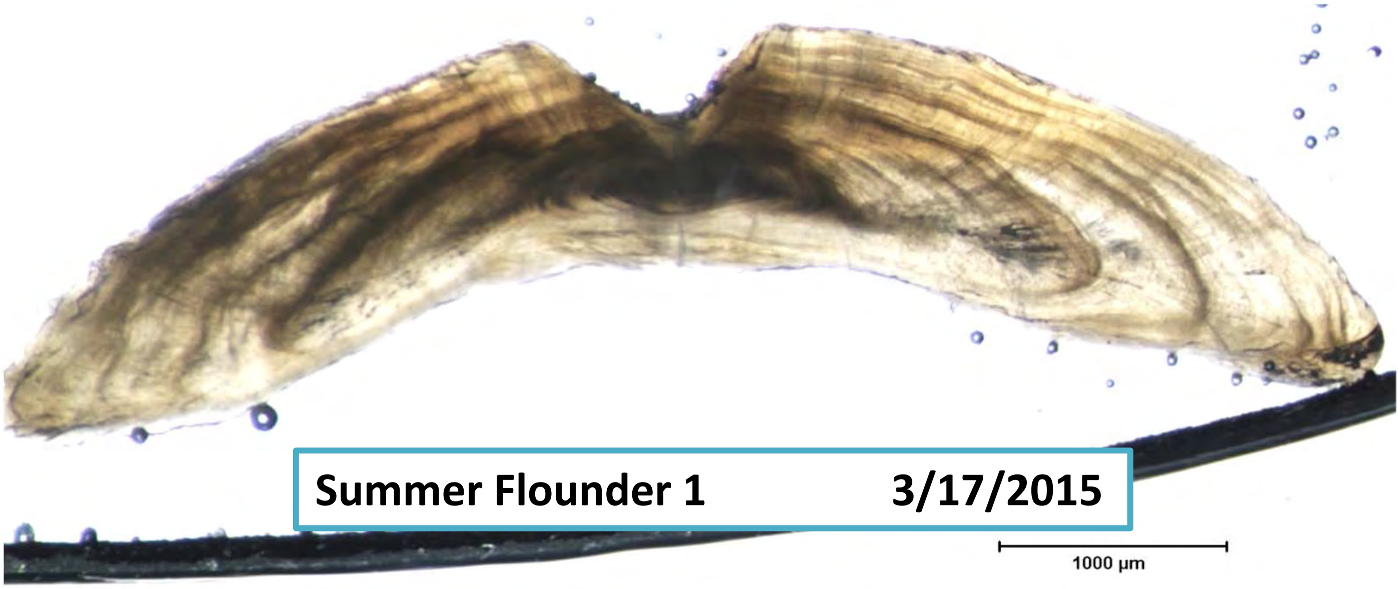
American Eel 18 5/17/2017



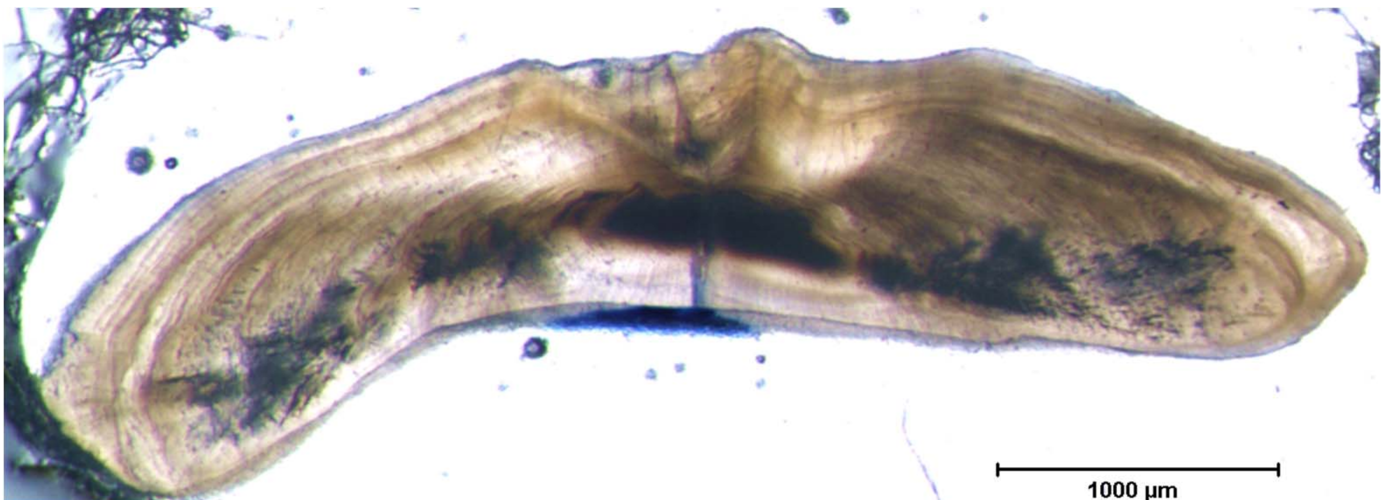
American Eel 19 7/17/2017



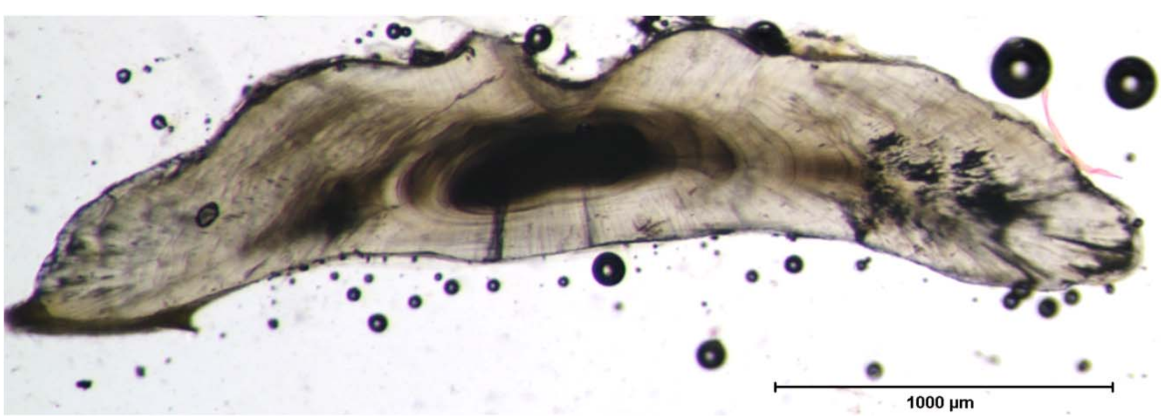
American Eel 20 8/14/2017



Summer Flounder 1 3/17/2015

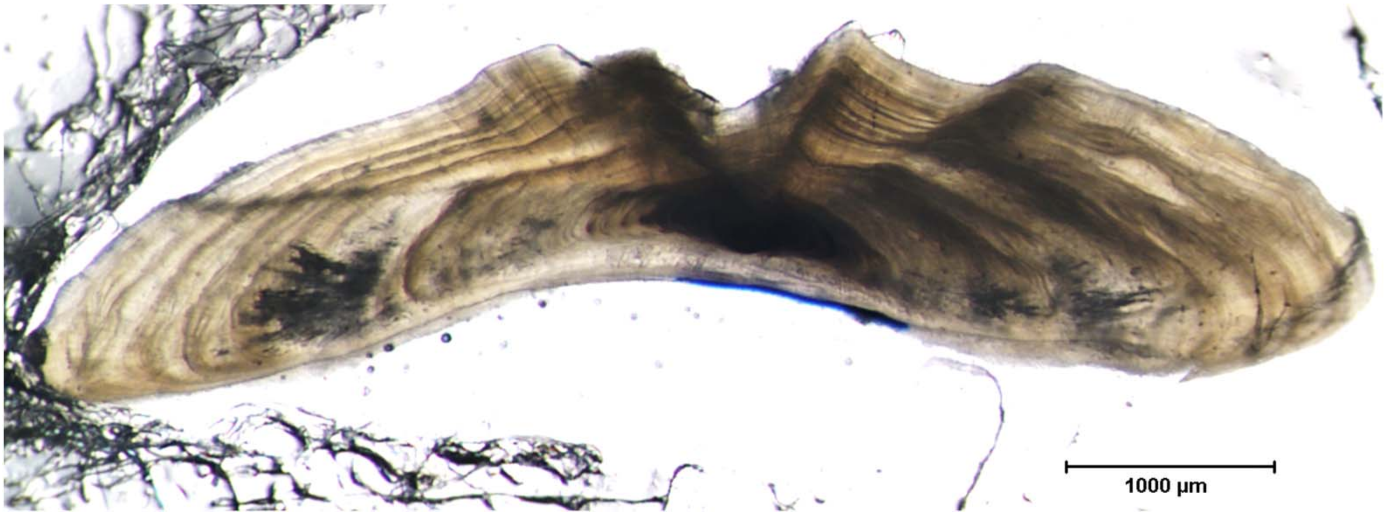


Summer Flounder 2 2/3/2014

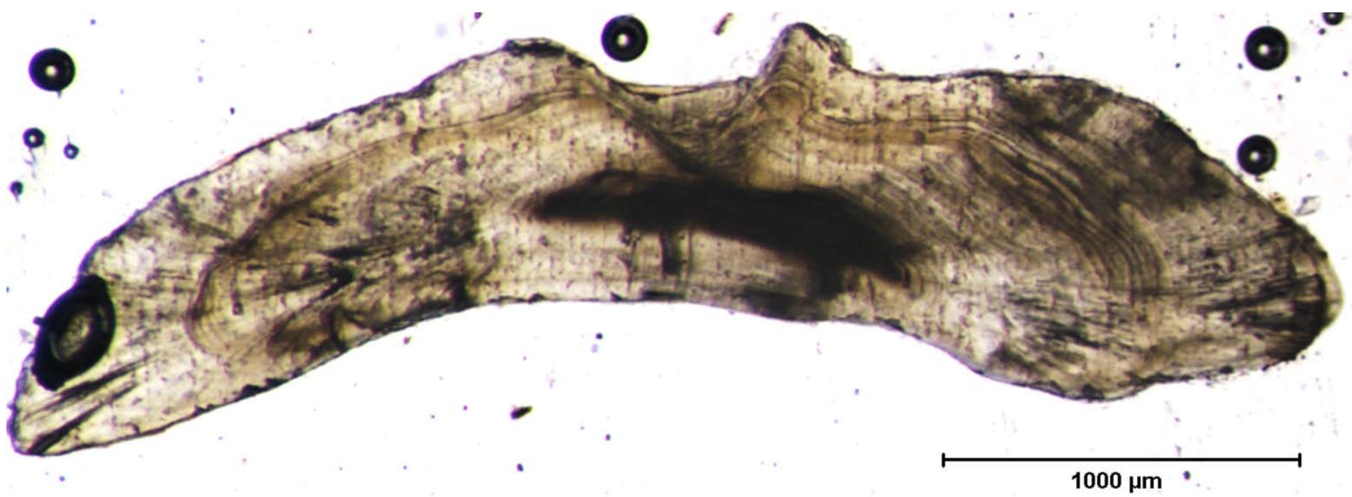


Summer Flounder 3 10/12/2015

Summer Flounder 4 3/21/2015

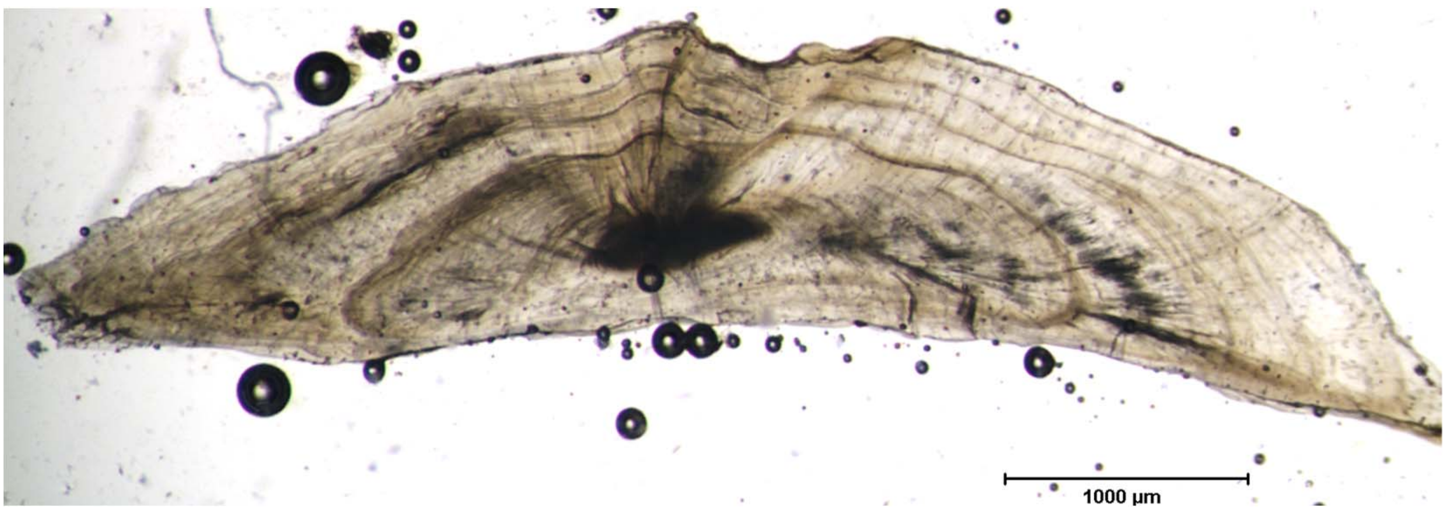


Summer Flounder 5 2/26/2014

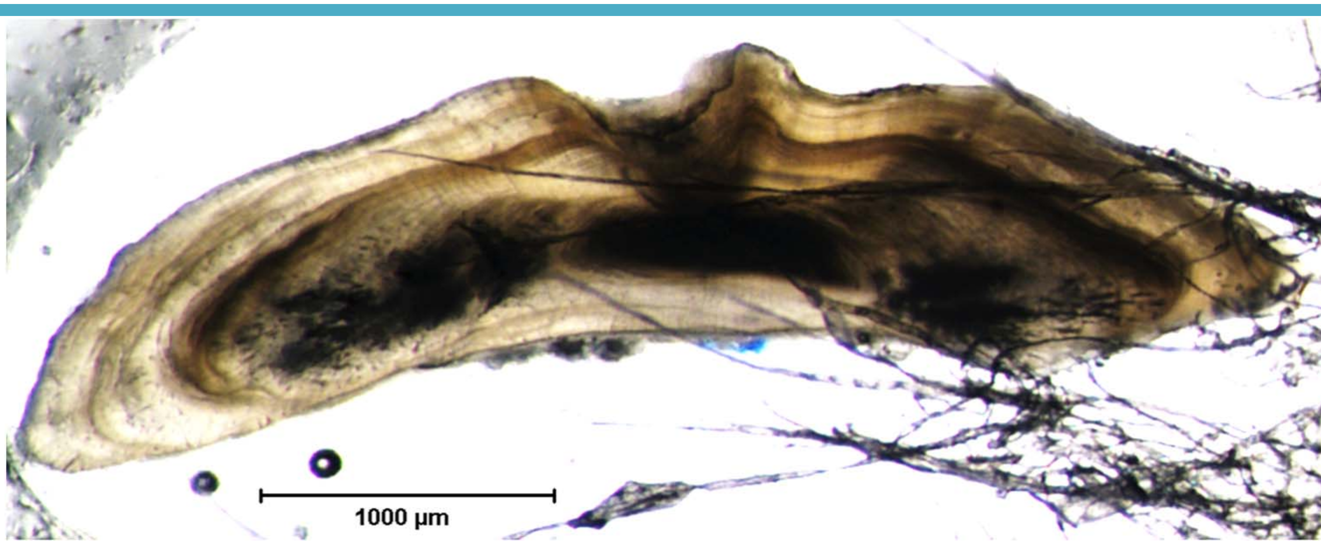


Summer Flounder 6 5/22/2015

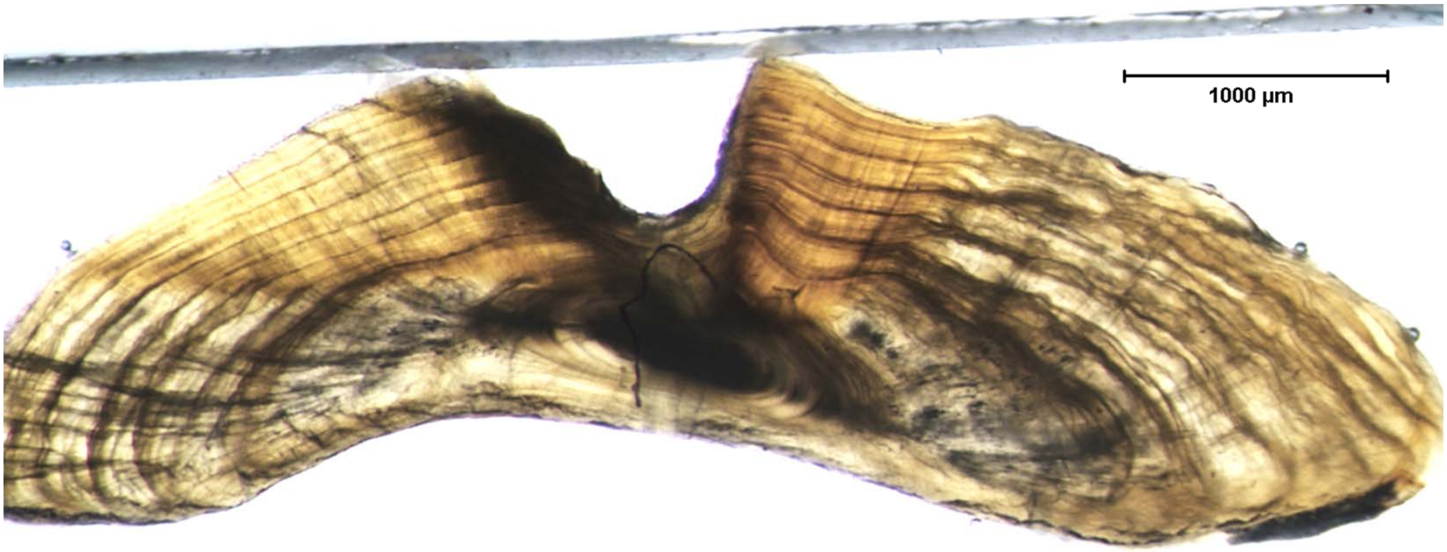
Summer Flounder 7 3/17/2015



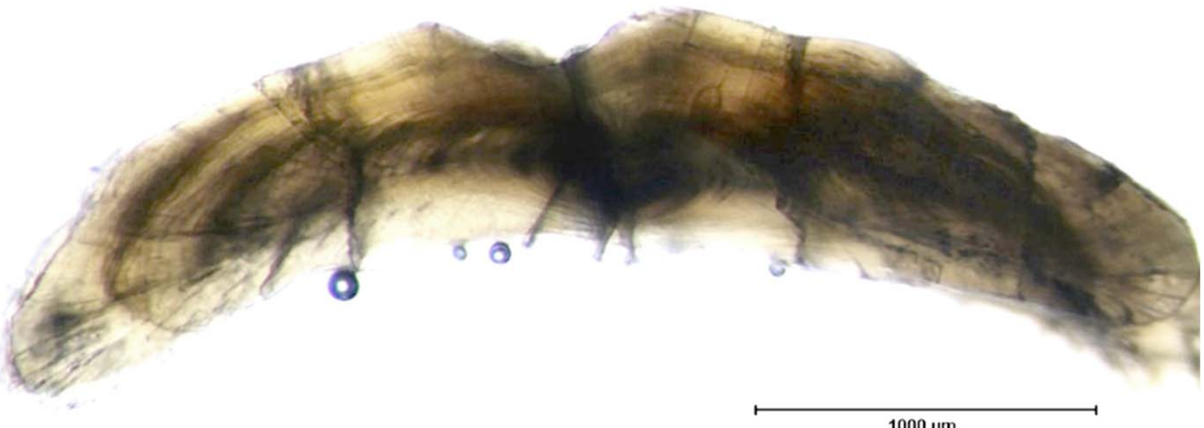
Summer Flounder 8 10/10/2015



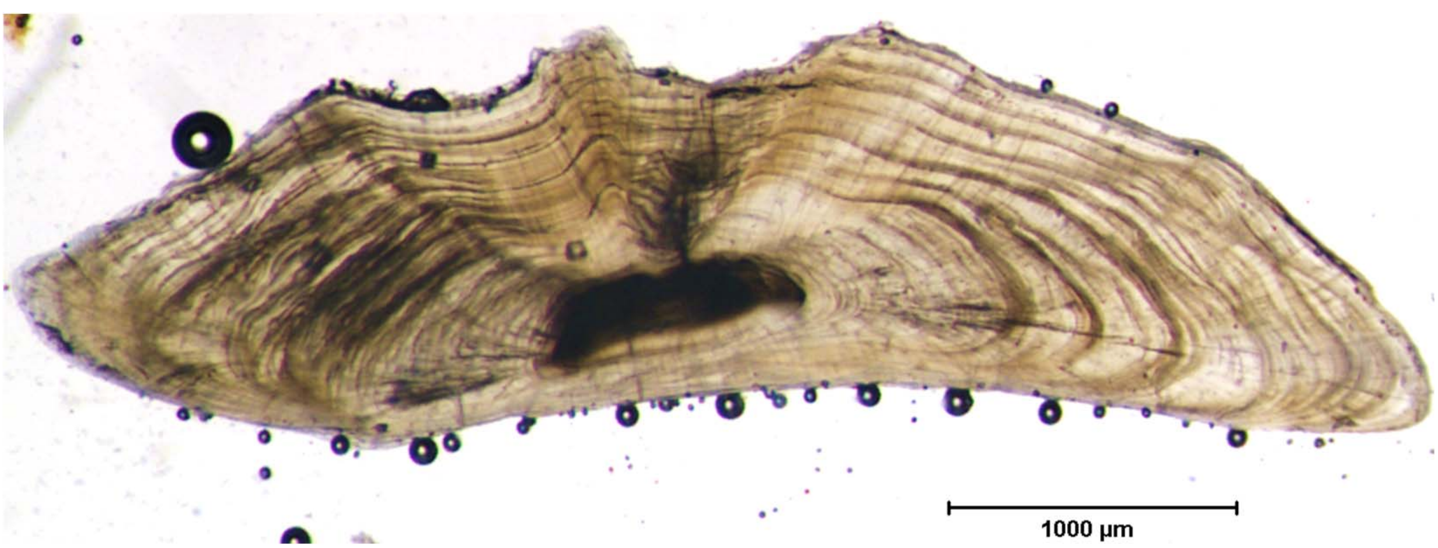
Summer Flounder 9 12/5/2013



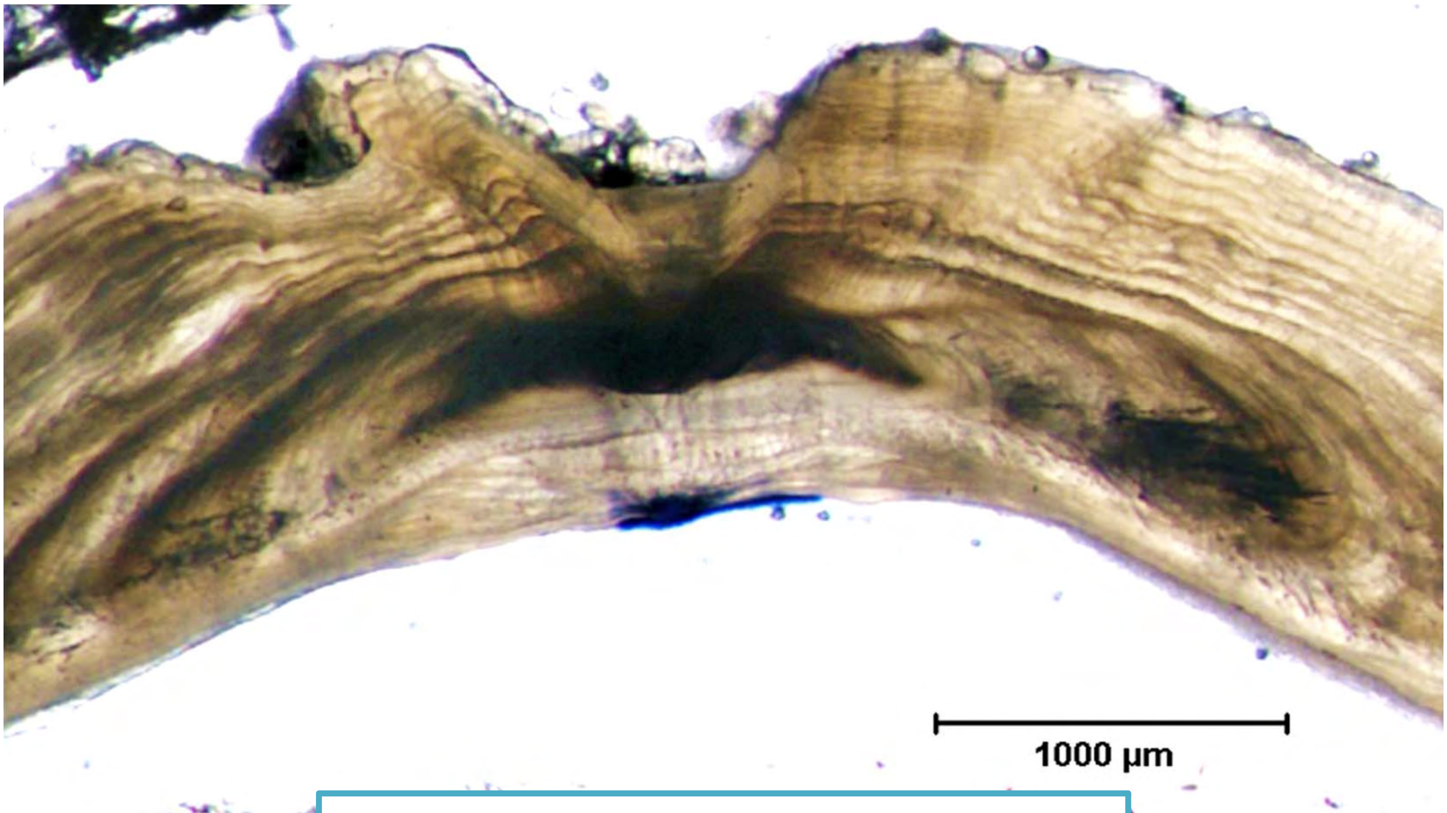
Summer Flounder 10 7/21/2015



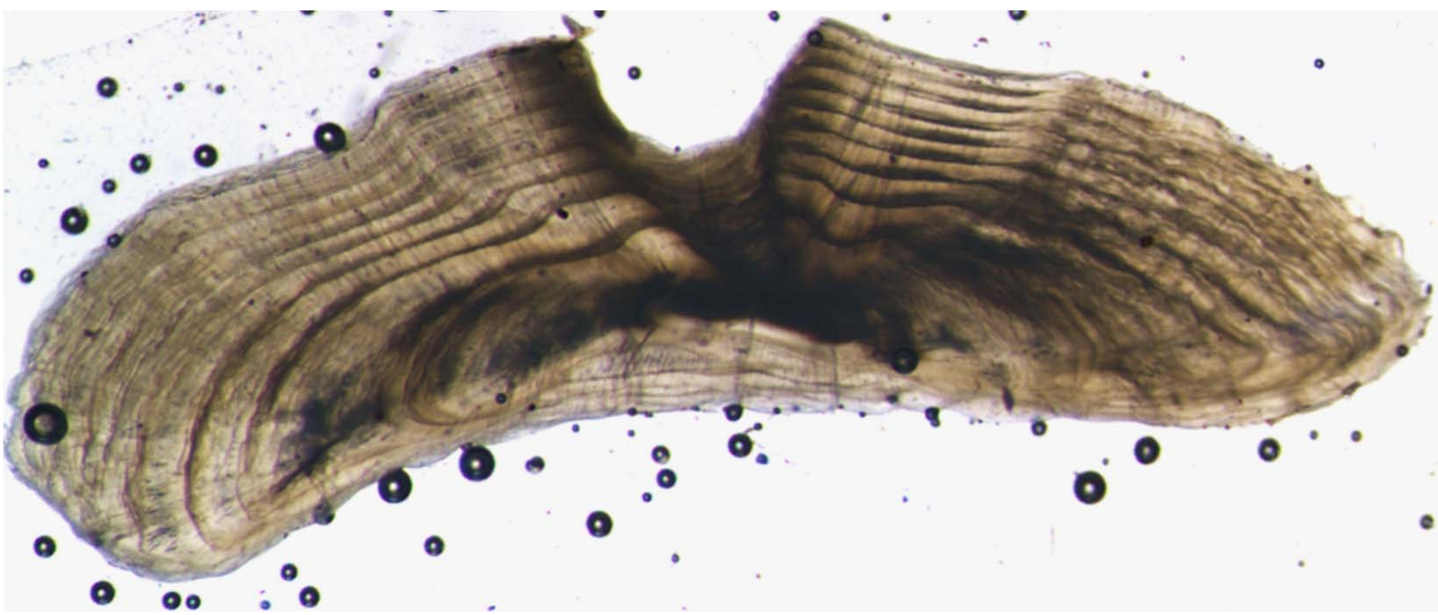
Summer Flounder 11 11/20/2015



Summer Flounder 12 10/24/2015



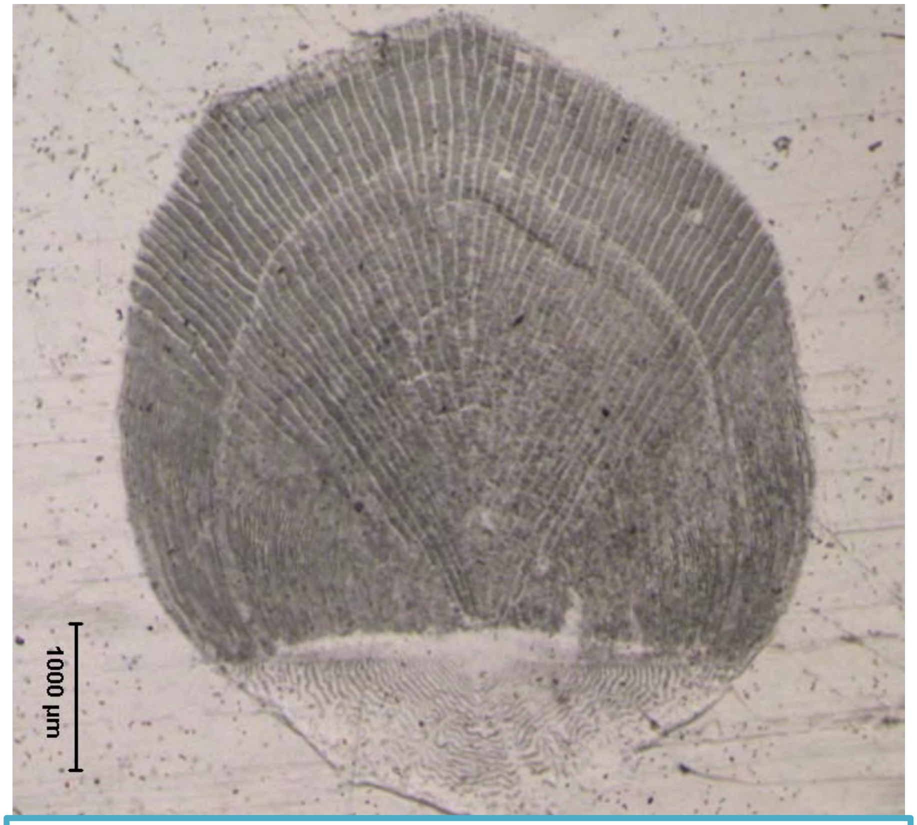
Summer Flounder 13 2/3/2014



Summer Flounder 14 5/16/2015

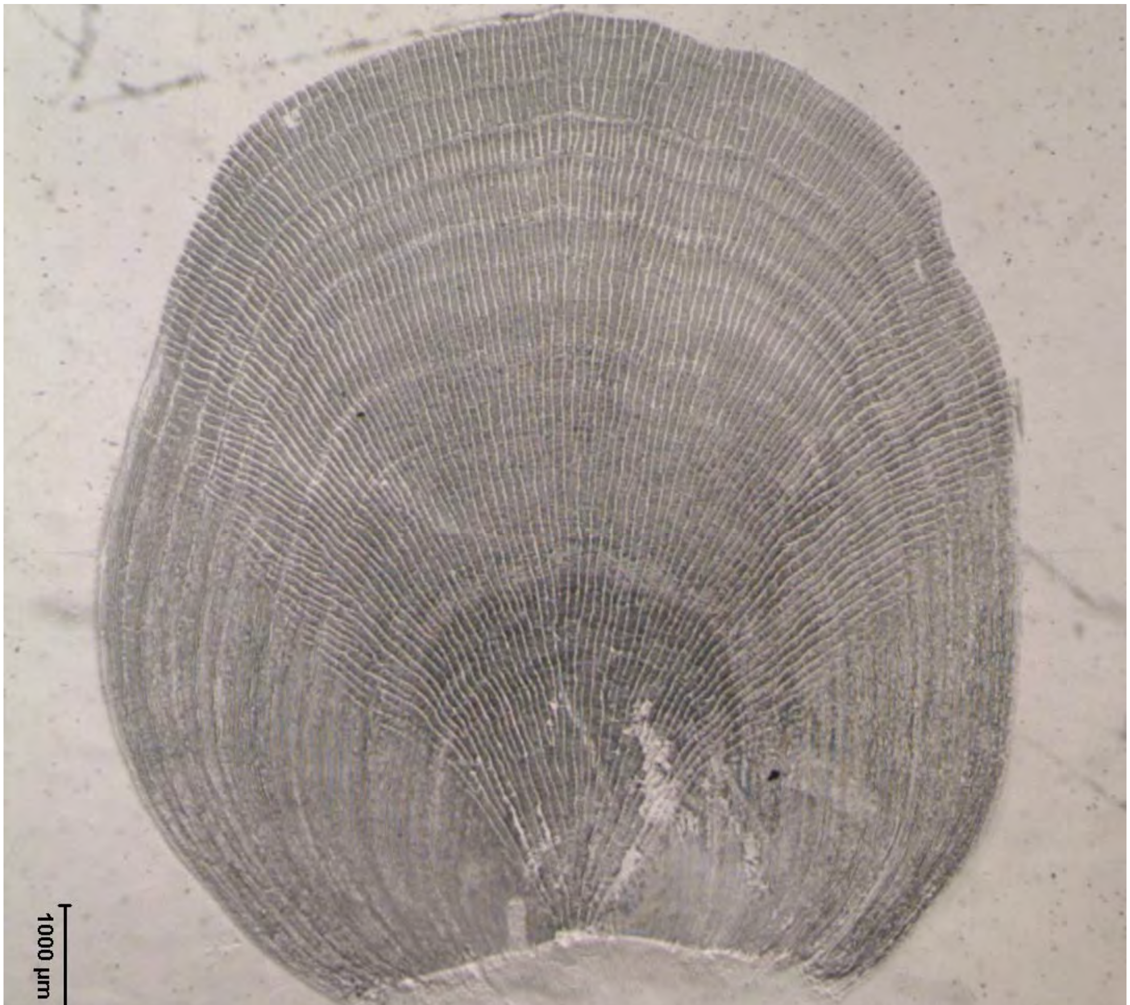
Summer Flounder 15 7/3/2015

Summer Flounder 16 3/17/2015

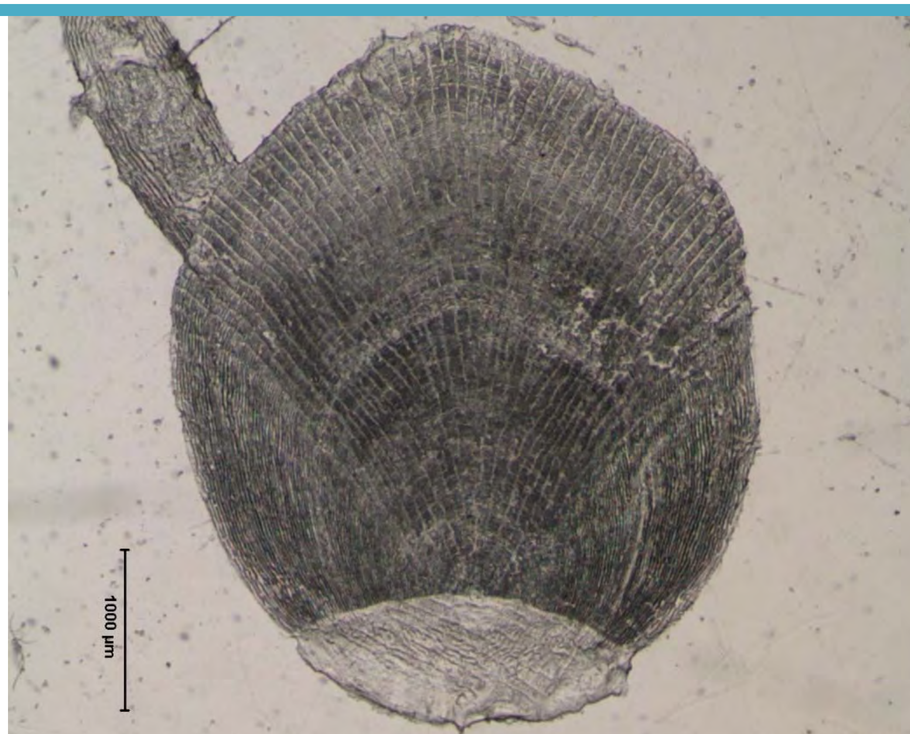


Summer Flounder 17 11/20/2015

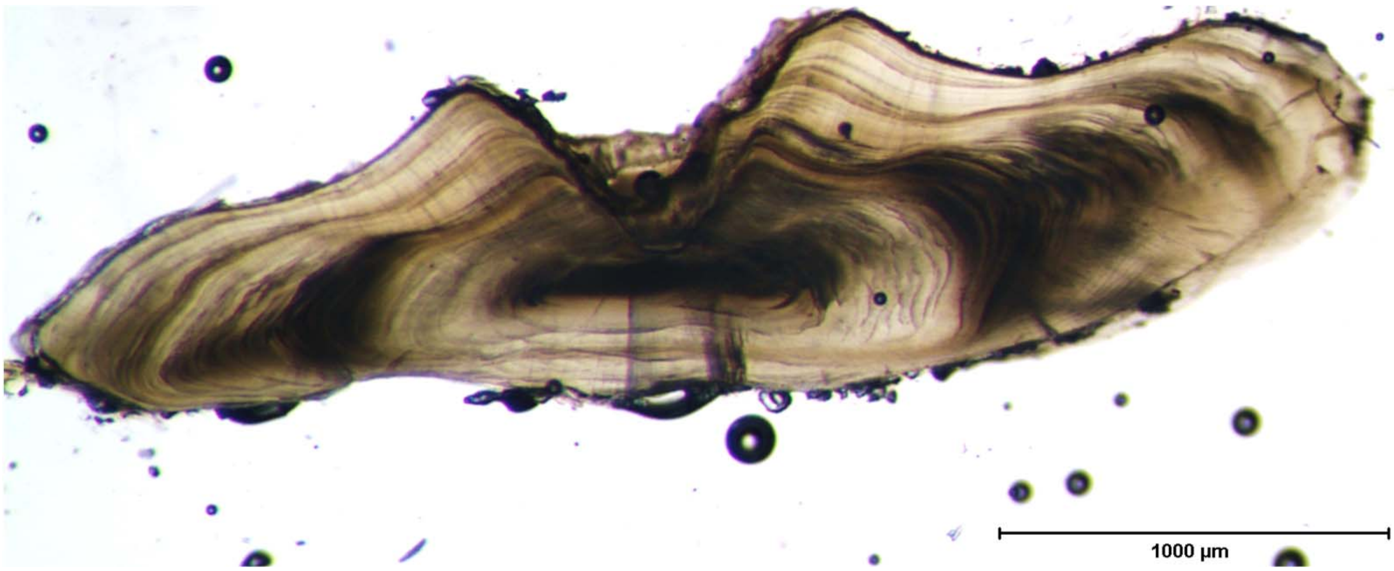
Summer Flounder 18 9/18/2015



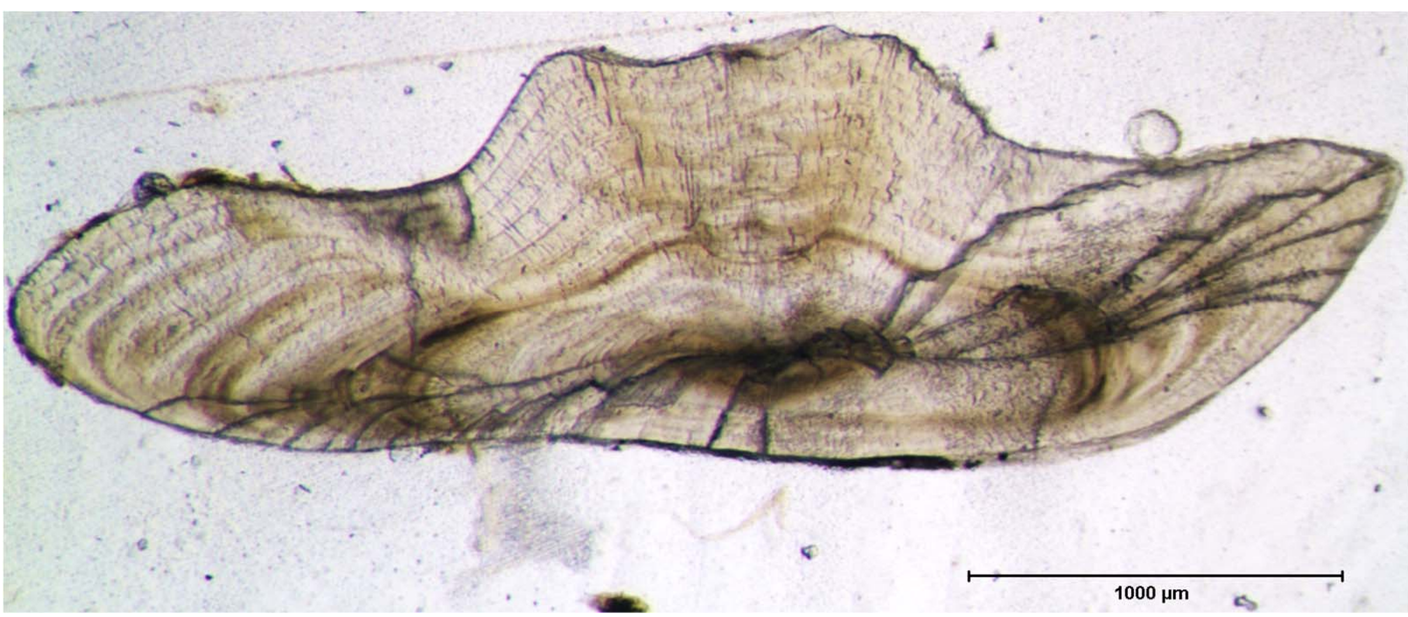
Summer Flounder 19 **3/17/2015**



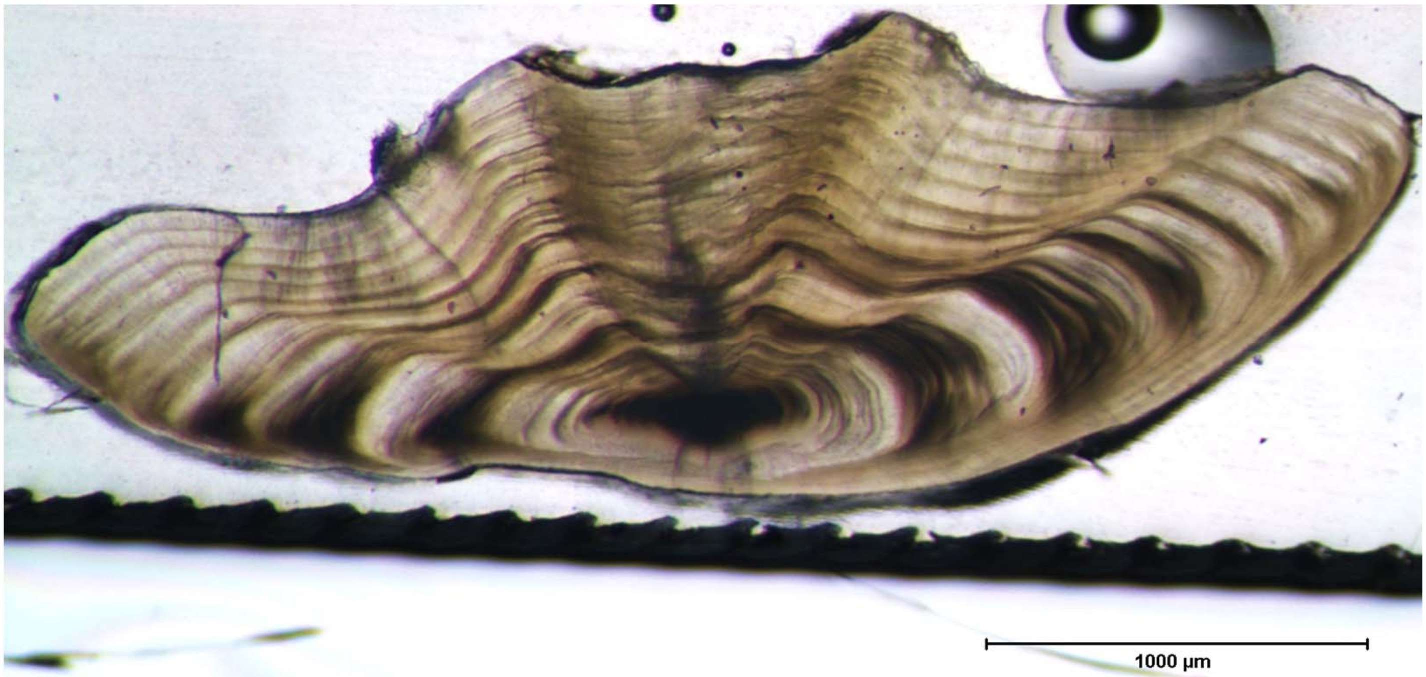
Summer Flounder 20 **7/3/2015**



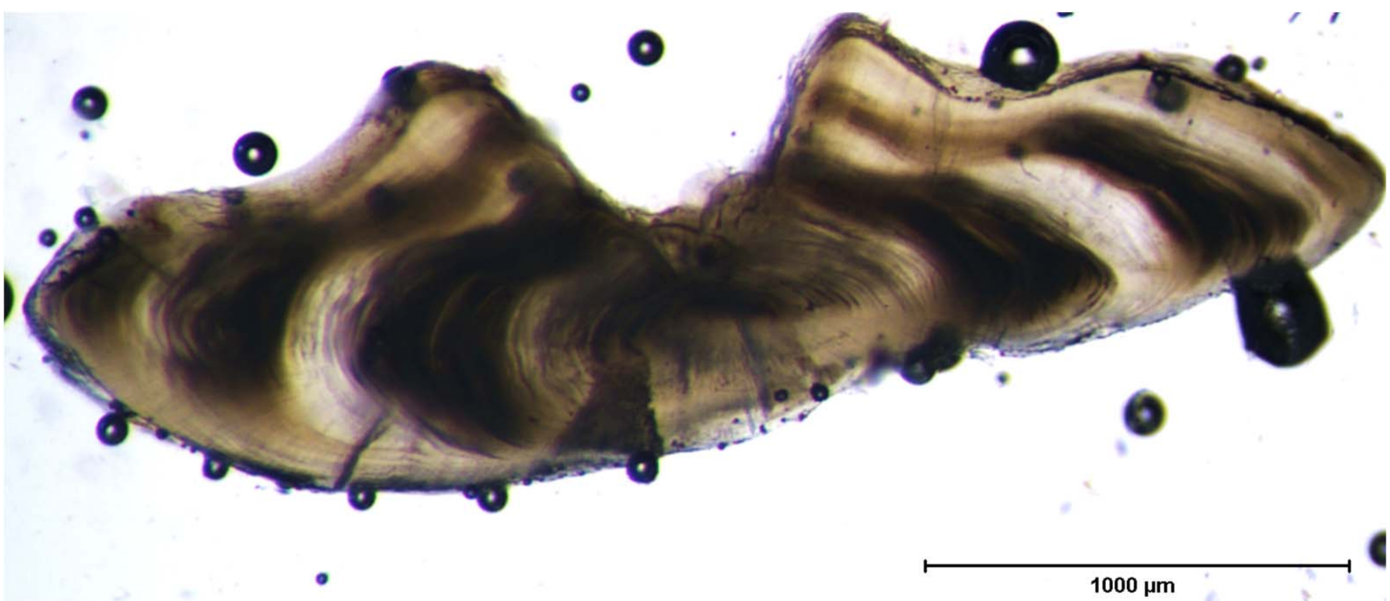
Winter Flounder 1 10/9/2015



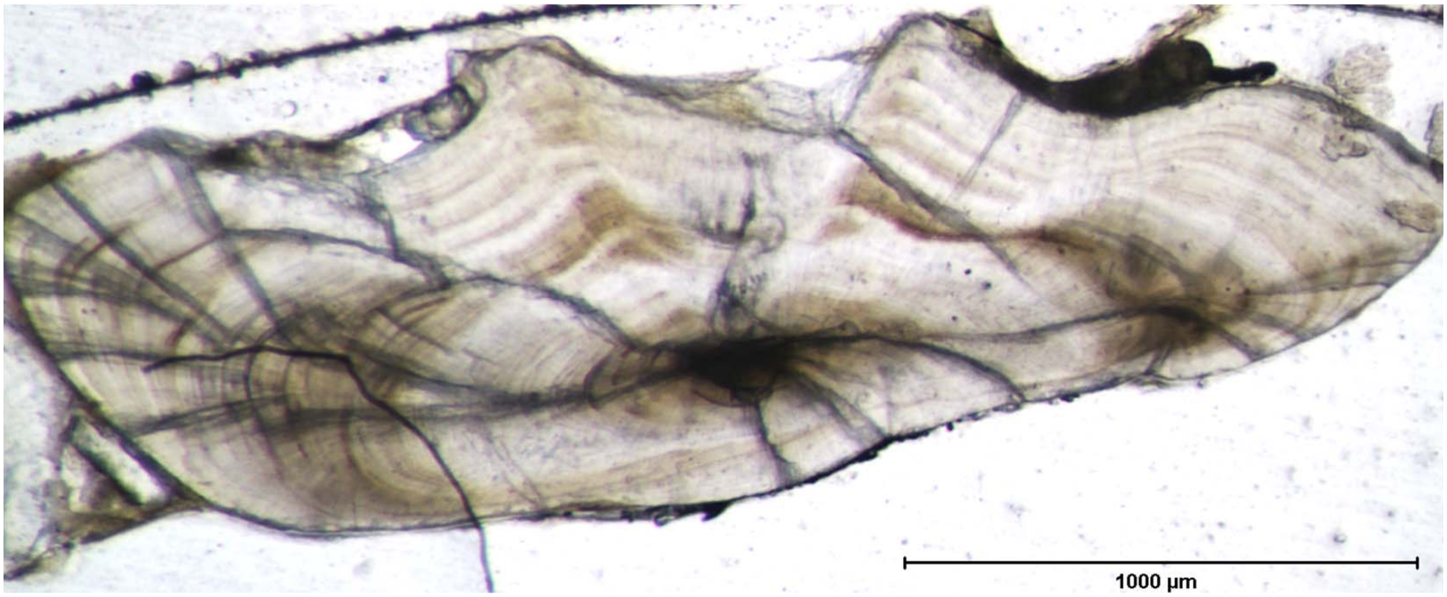
Winter Flounder 2 3/21/2002



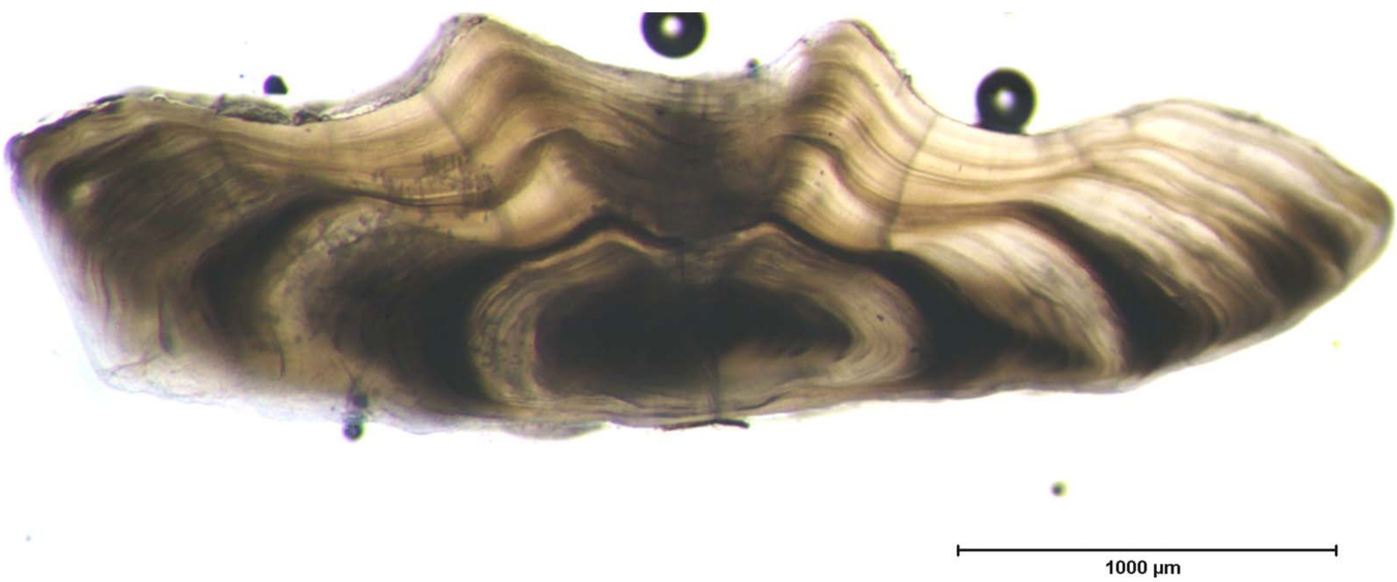
Winter Flounder 3 5/14/2013



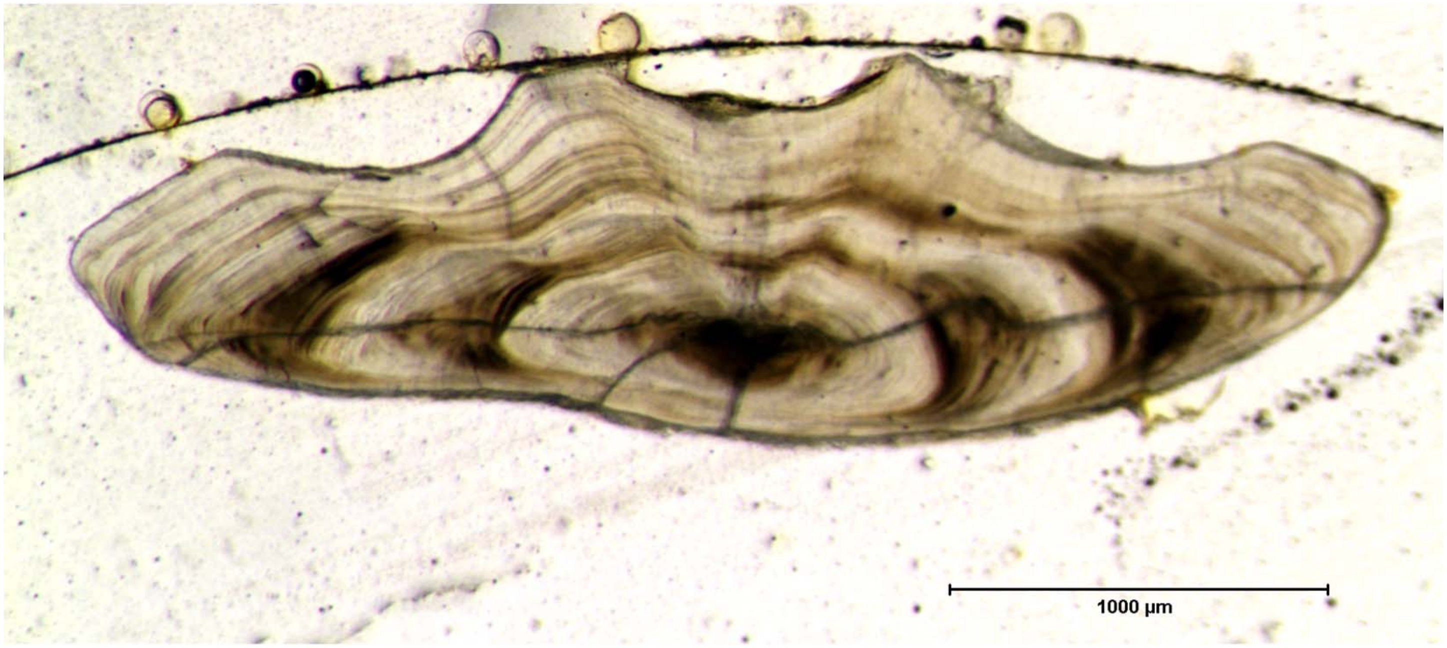
Winter Flounder 4 10/8/2015



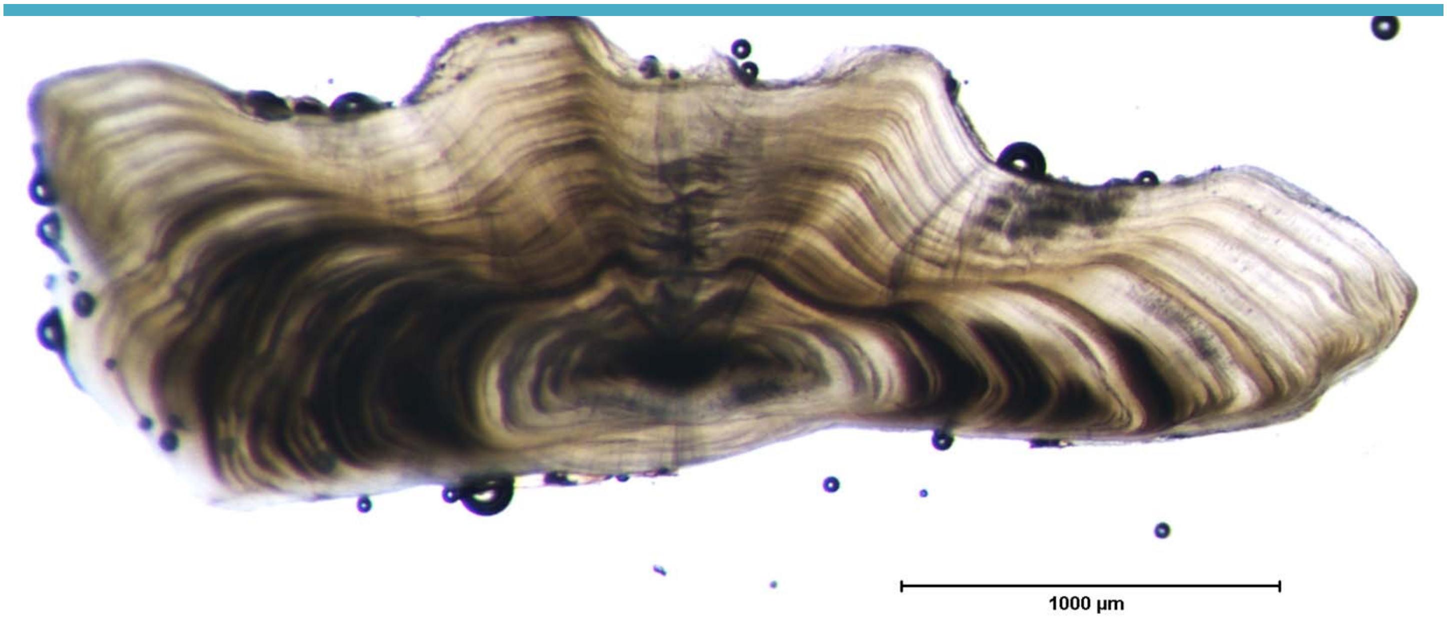
Winter Flounder 5 4/30/2002



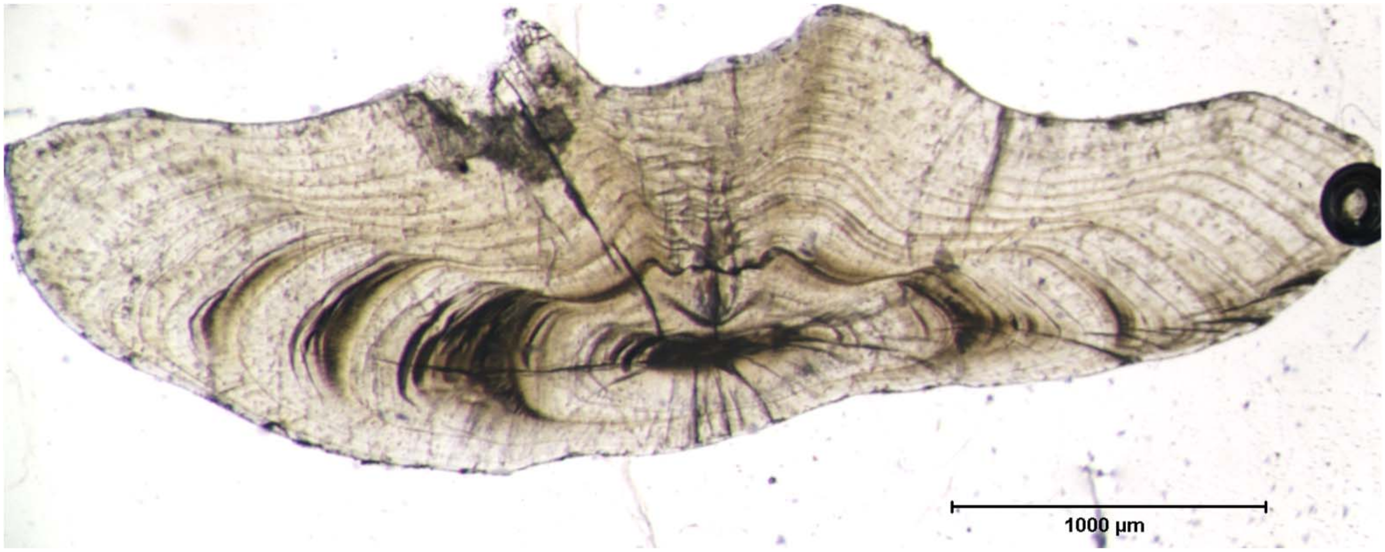
Winter Flounder 6 10/8/2015



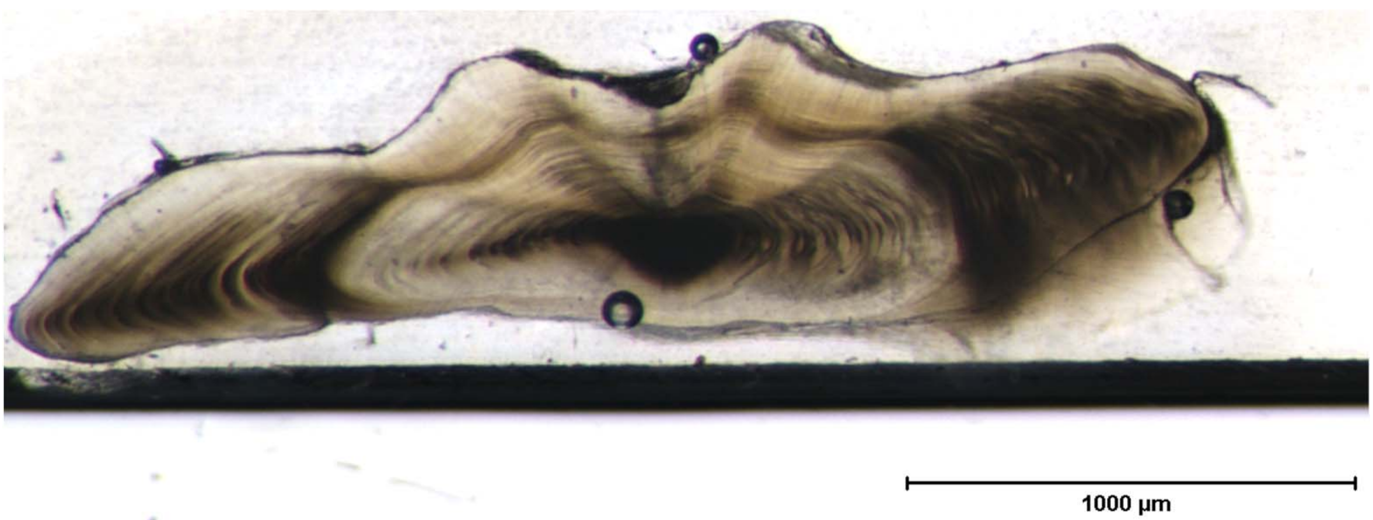
Winter Flounder 7 3/24/2003



Winter Flounder 8 10/8/2015

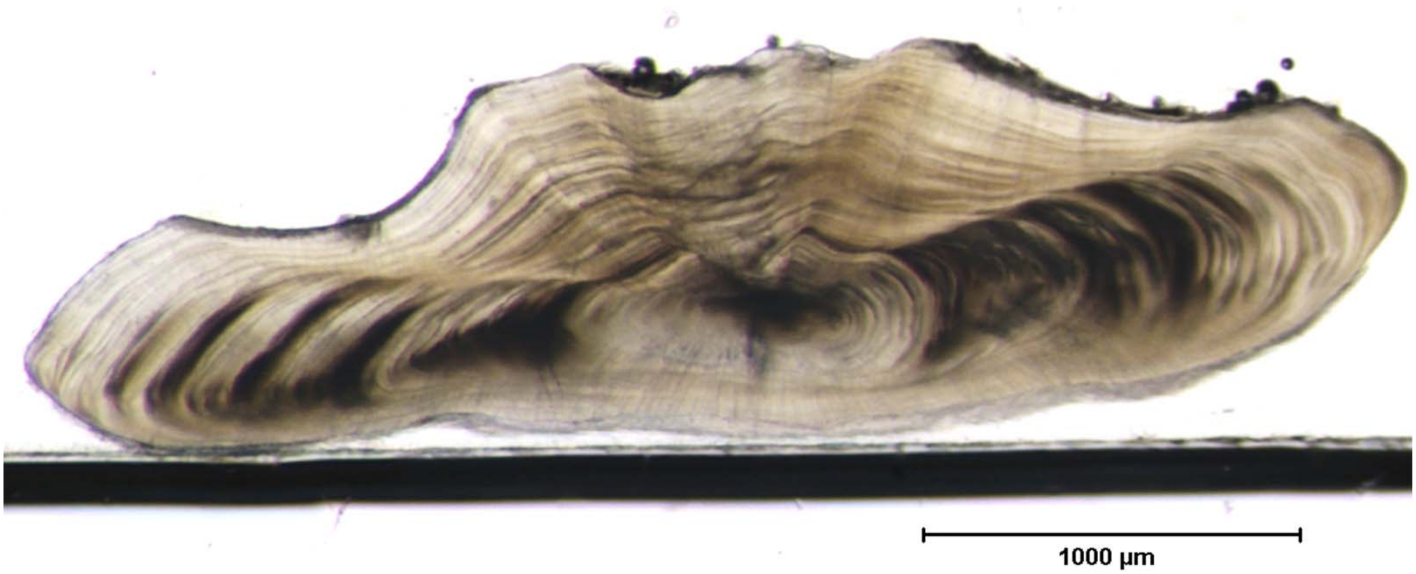


Winter Flounder 9 5/21/2015

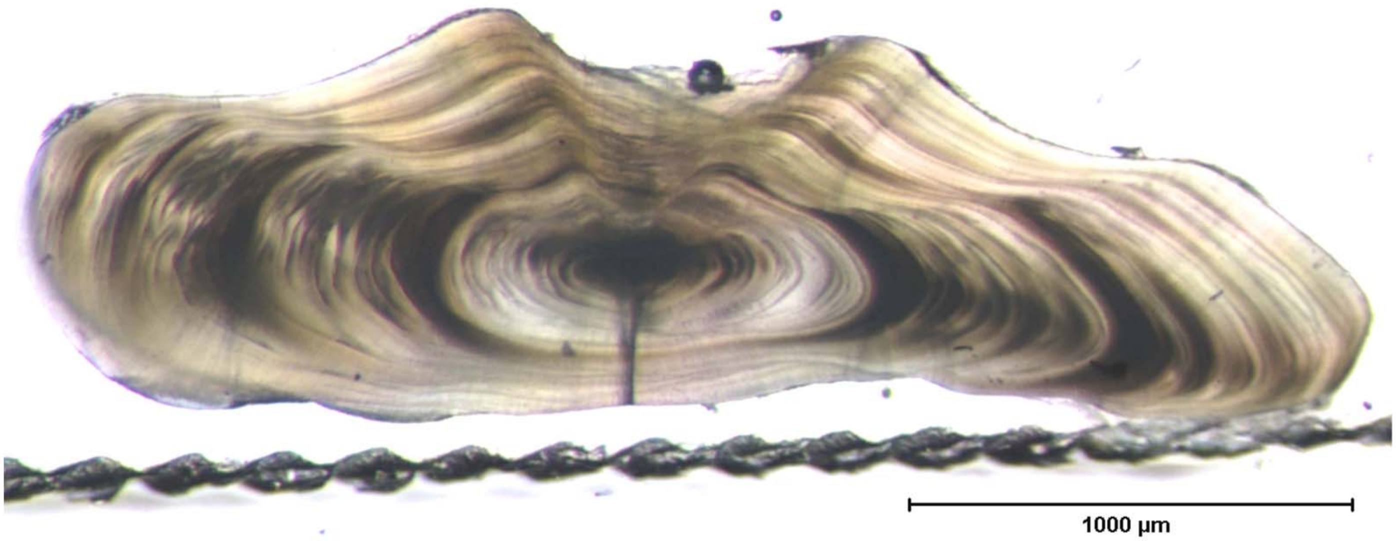


Winter Flounder 10 5/9/2013

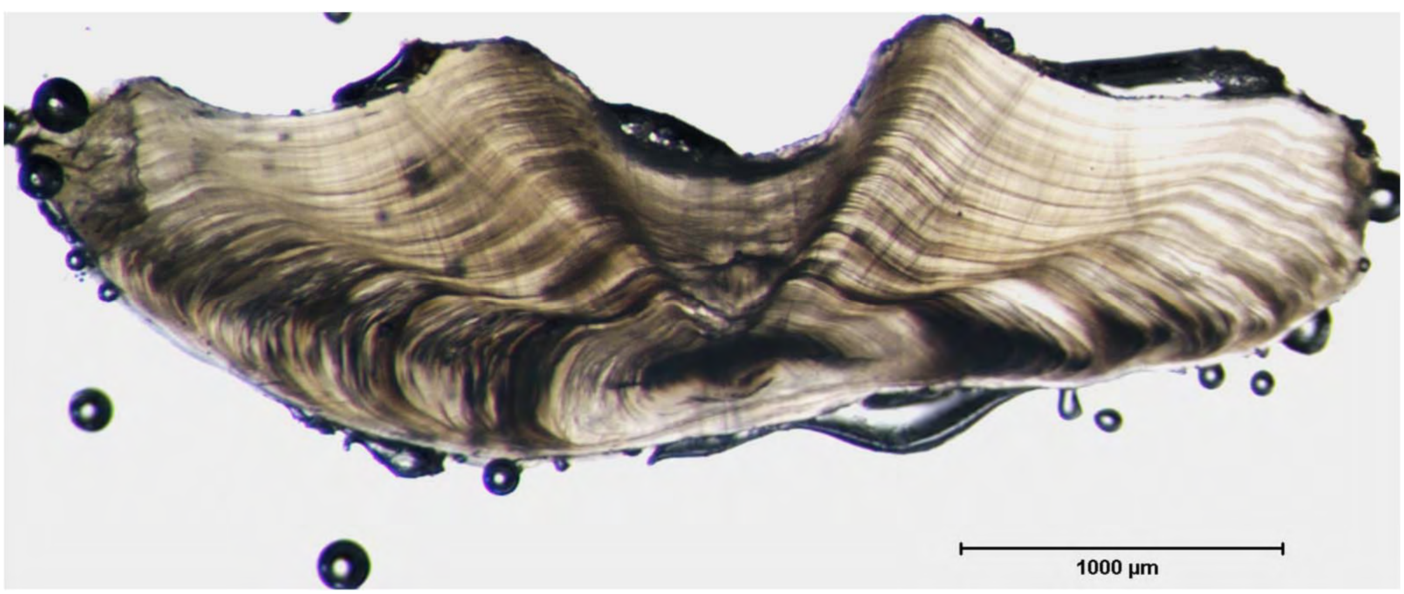
Winter Flounder 11 4/3/2003



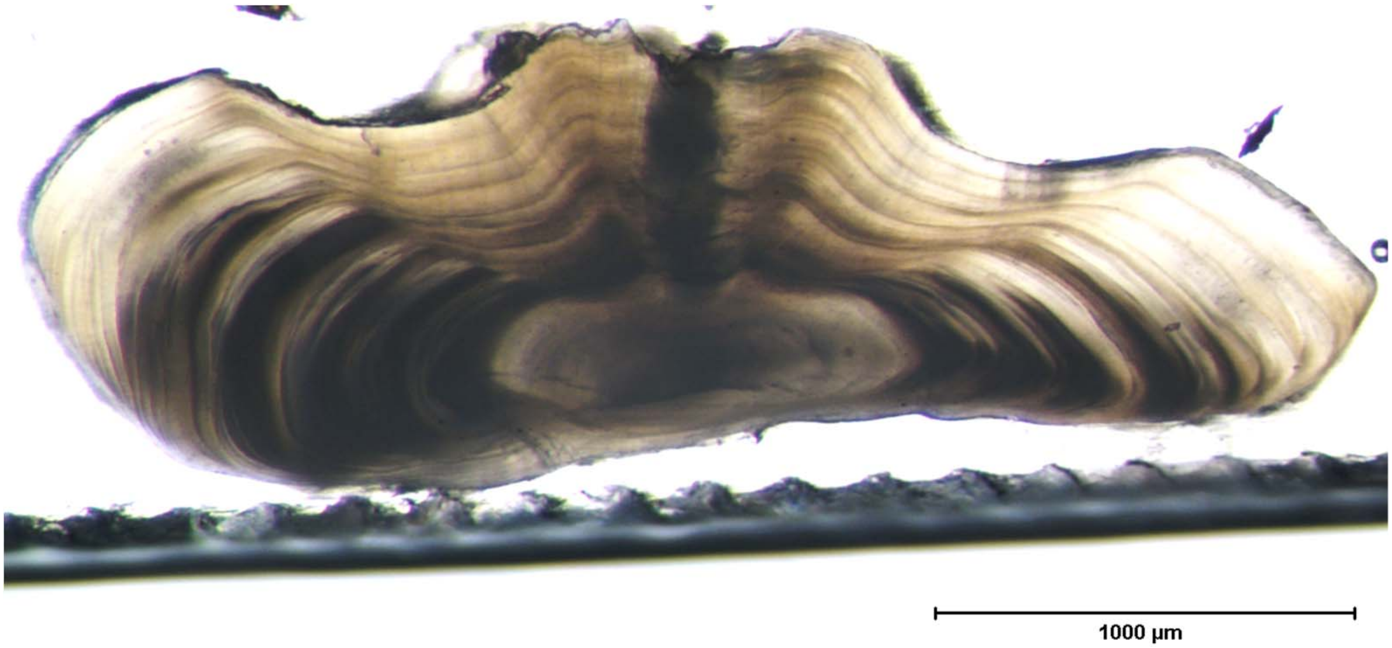
Winter Flounder 12 5/8/2013



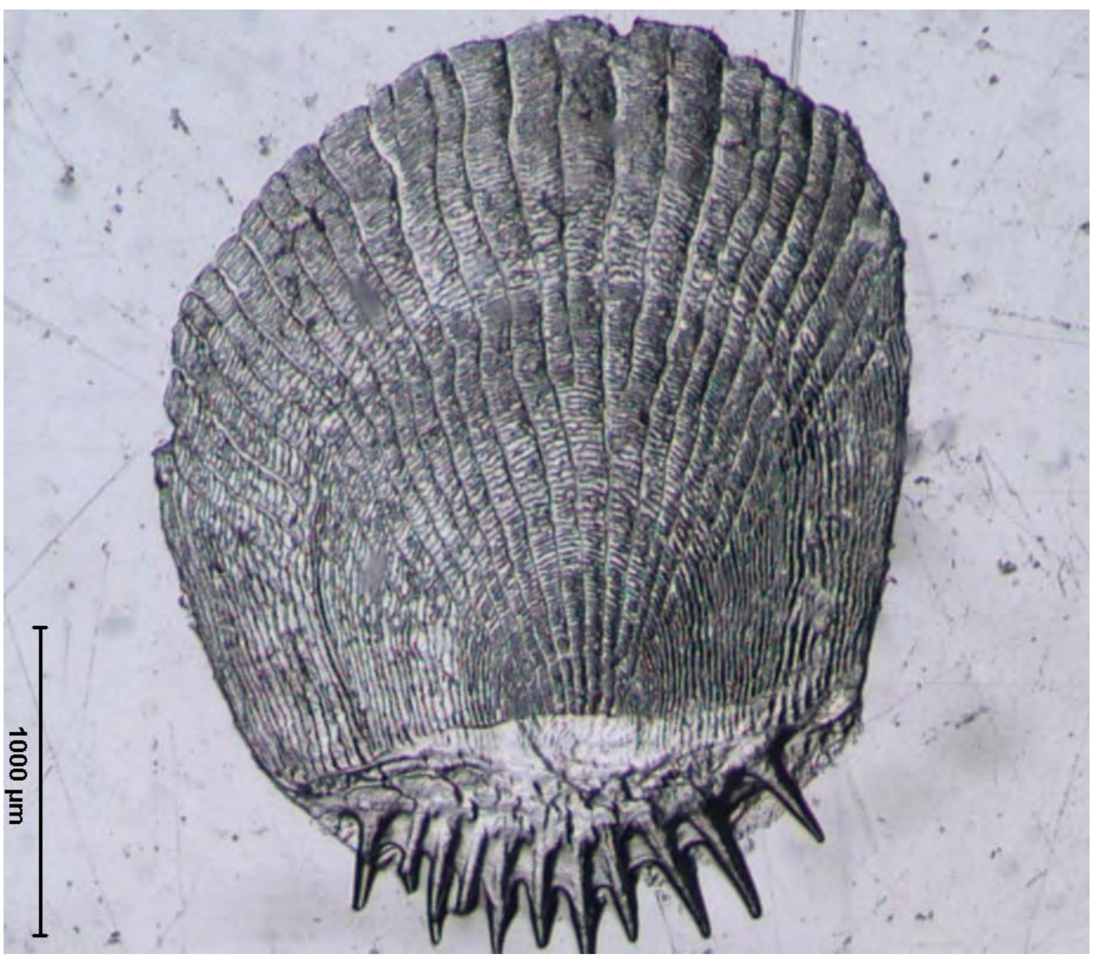
Winter Flounder 13 5/7/2013



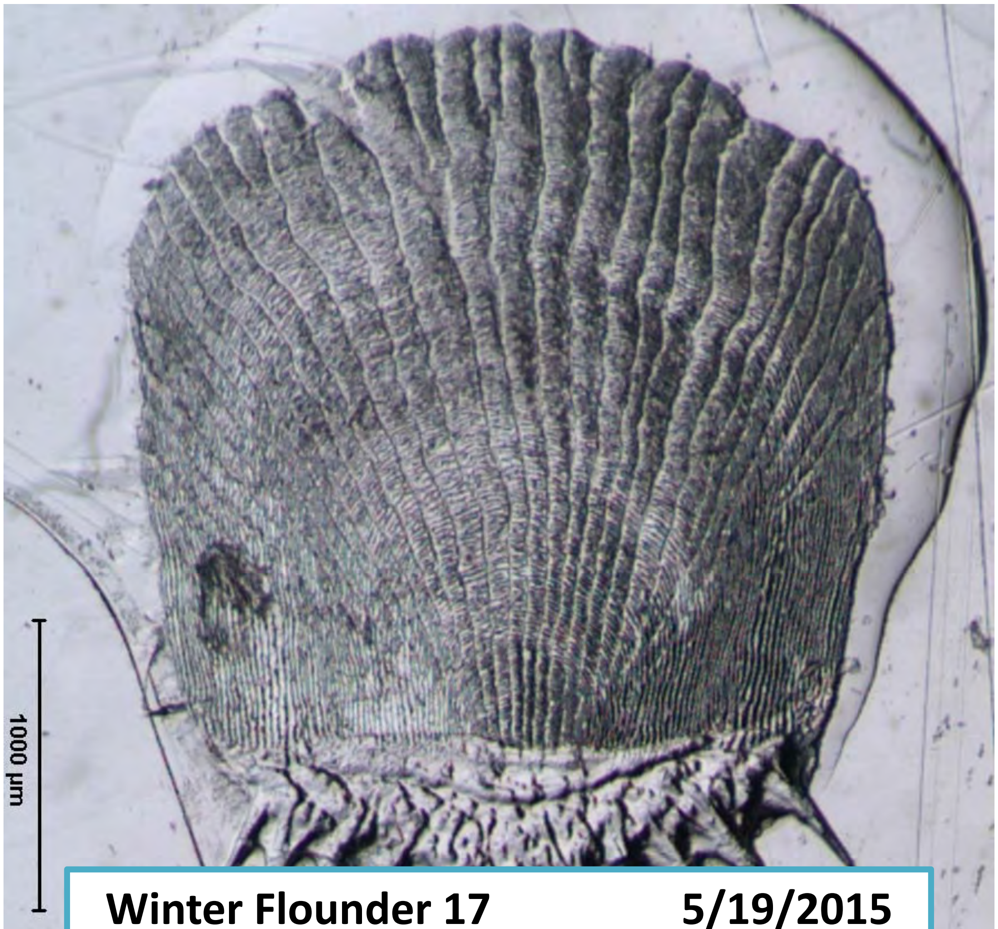
Winter Flounder 14 5/17/2015



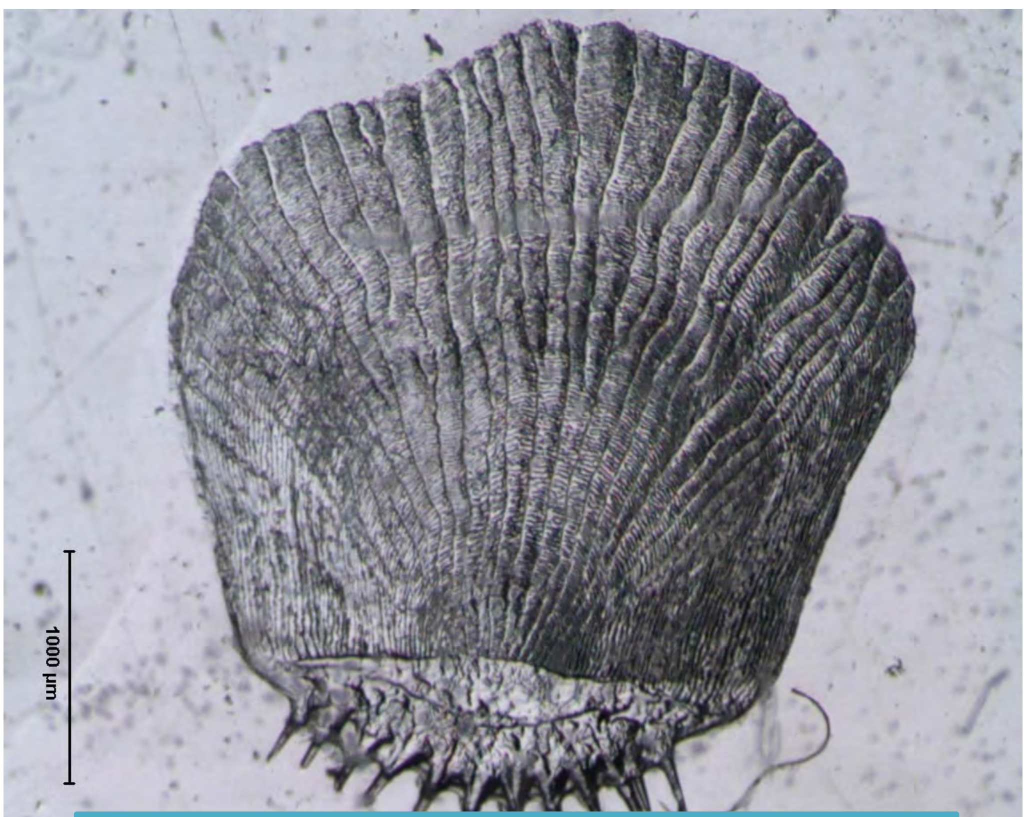
Winter Flounder 15 5/6/2013



Winter Flounder 16 8/20/2015

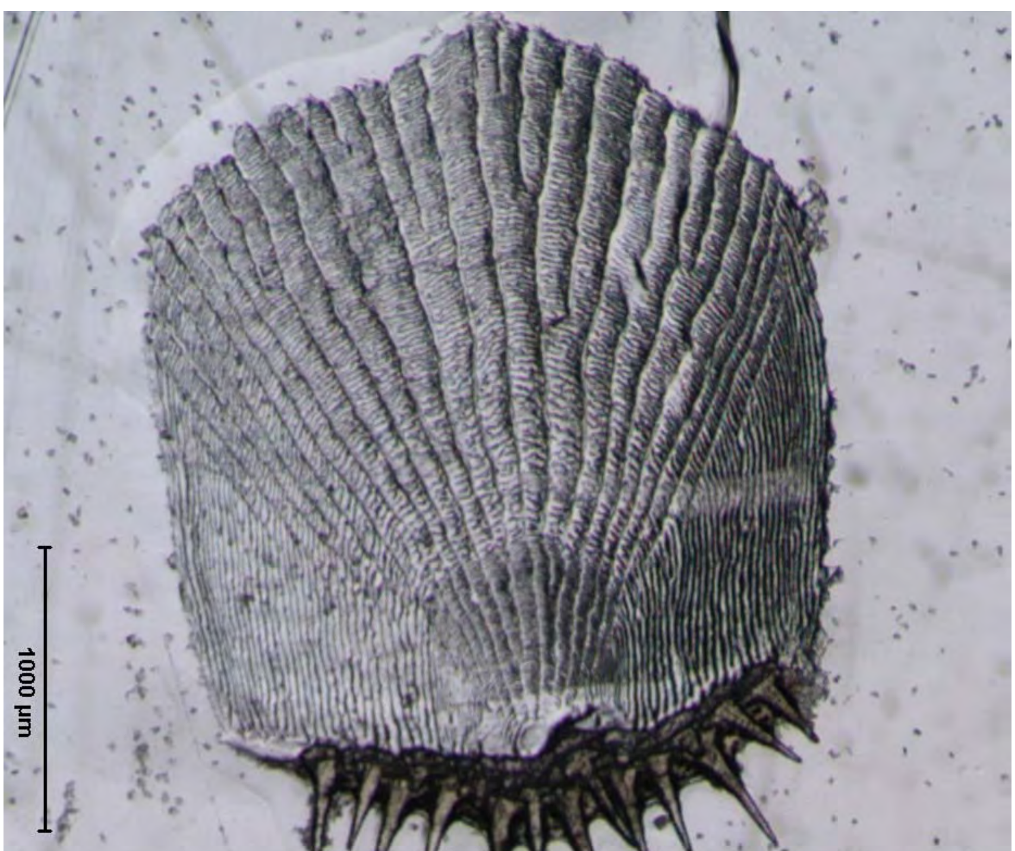


Winter Flounder 17 **5/19/2015**



Winter Flounder 18 **5/21/2015**

Winter Flounder 19 5/21/2015



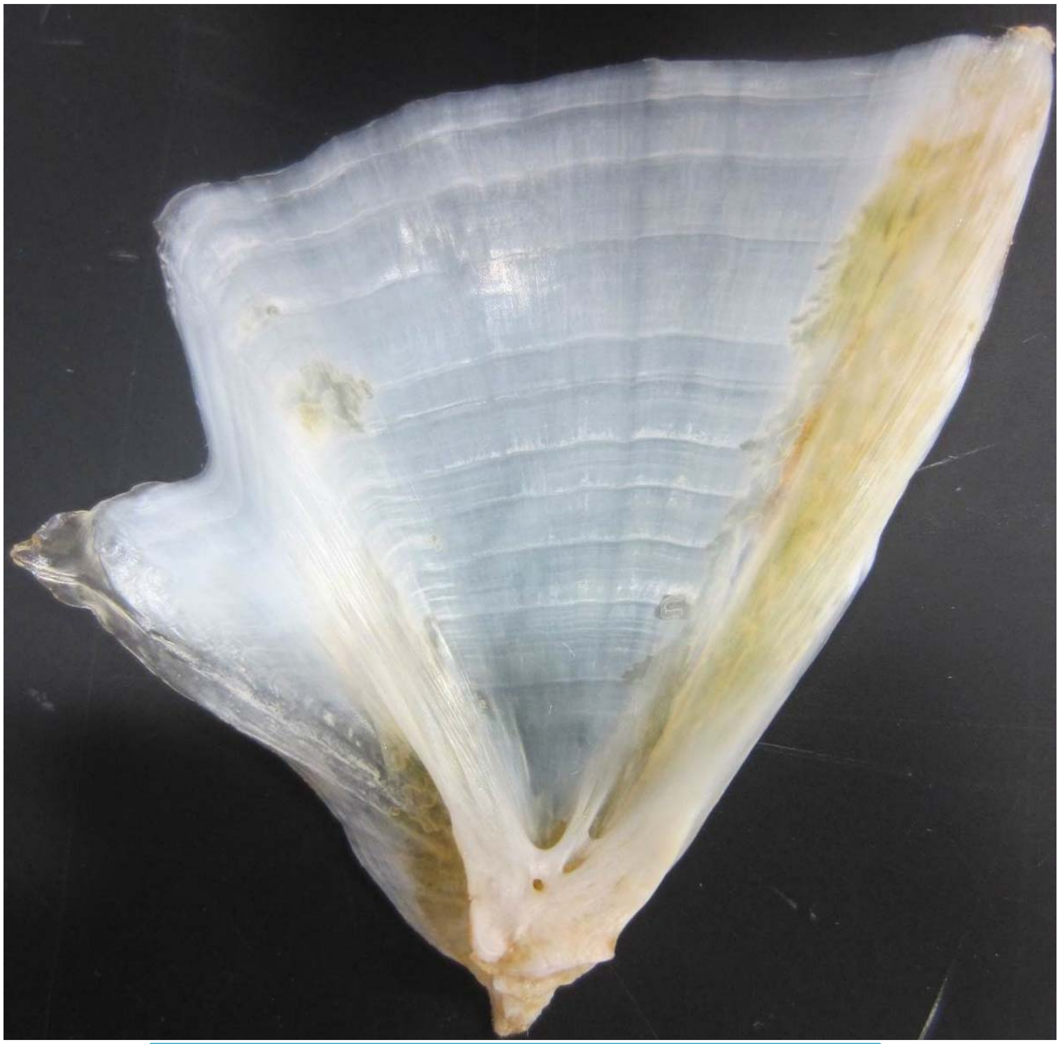
Winter Flounder 20 5/20/2015

Tautog 1 10/2017

Tautog 2 12/13/2018

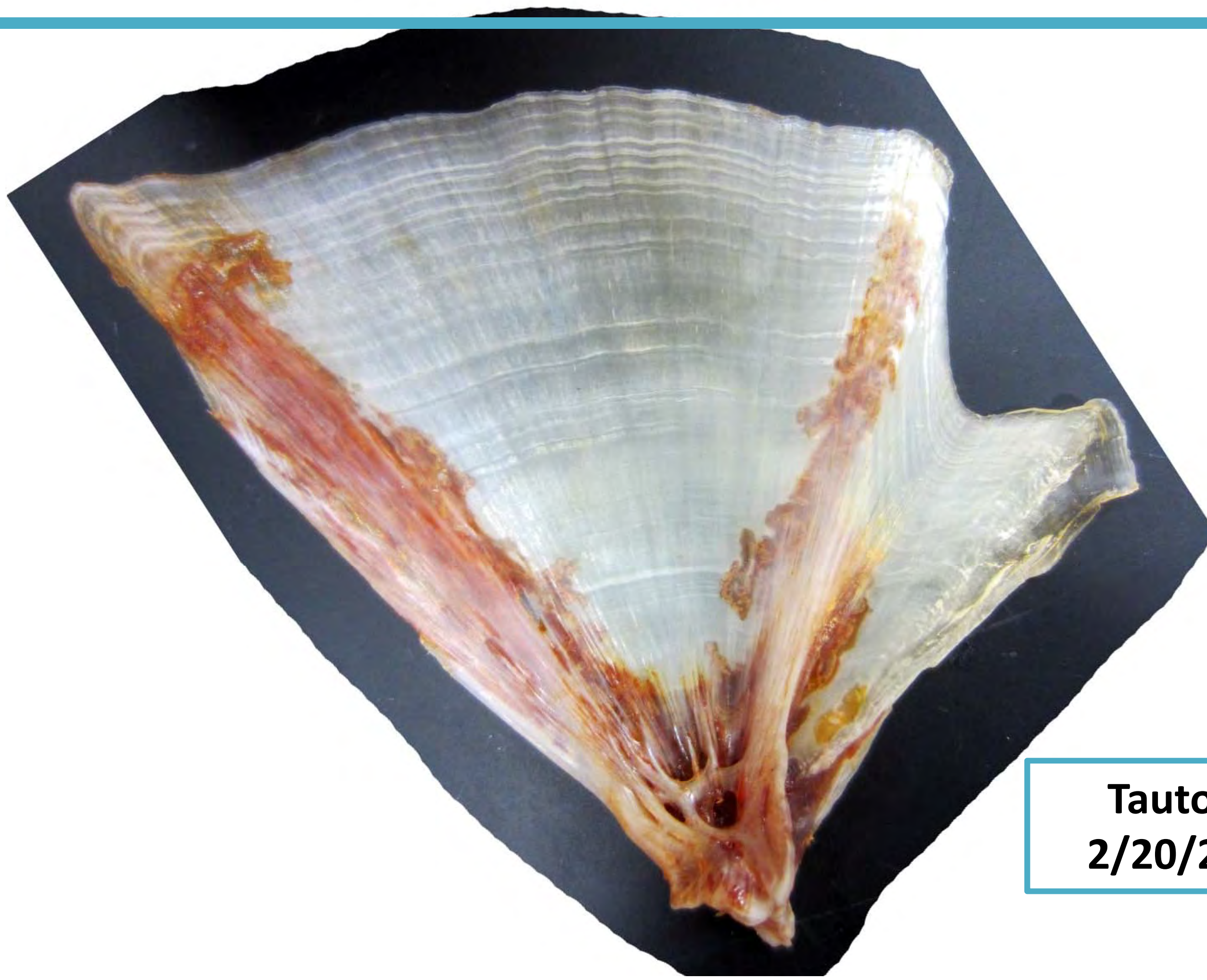
Tautog 3 9/8/2015

Tautog 4 10/2017



Tautog 5 11/6/2015

Tautog 6 9/8/2015

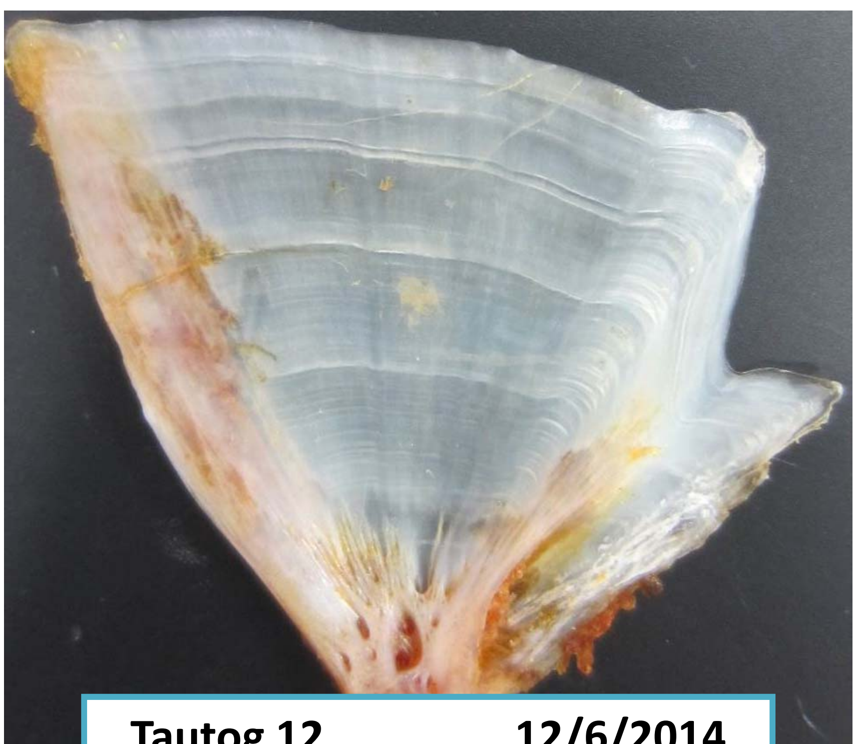


Tautog 8
2/20/2014

Tautog 9
5/19/2015

Tautog 10
6/14/2015

Tautog 11 5/31/2018



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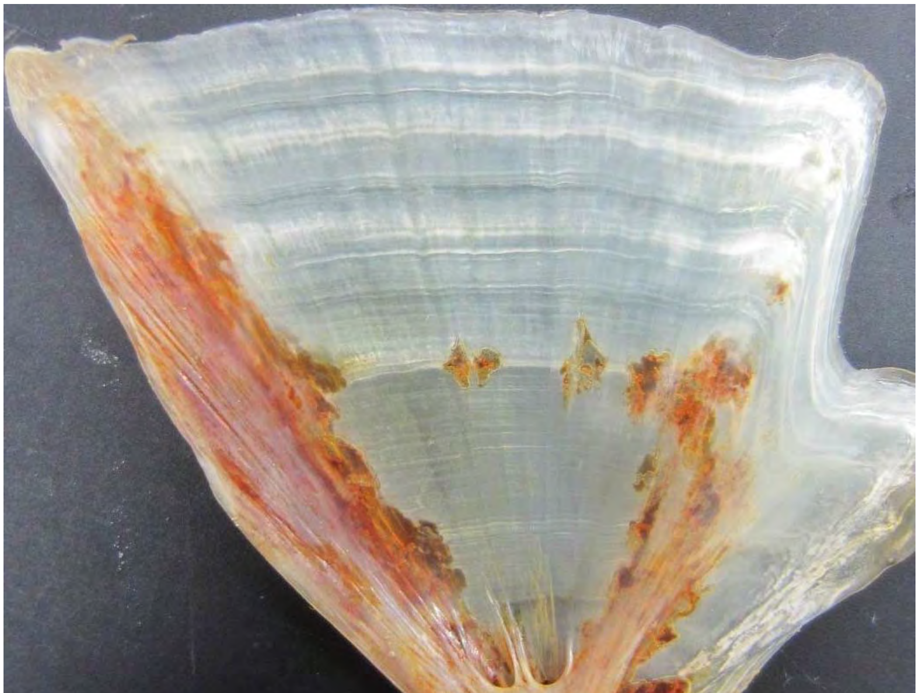

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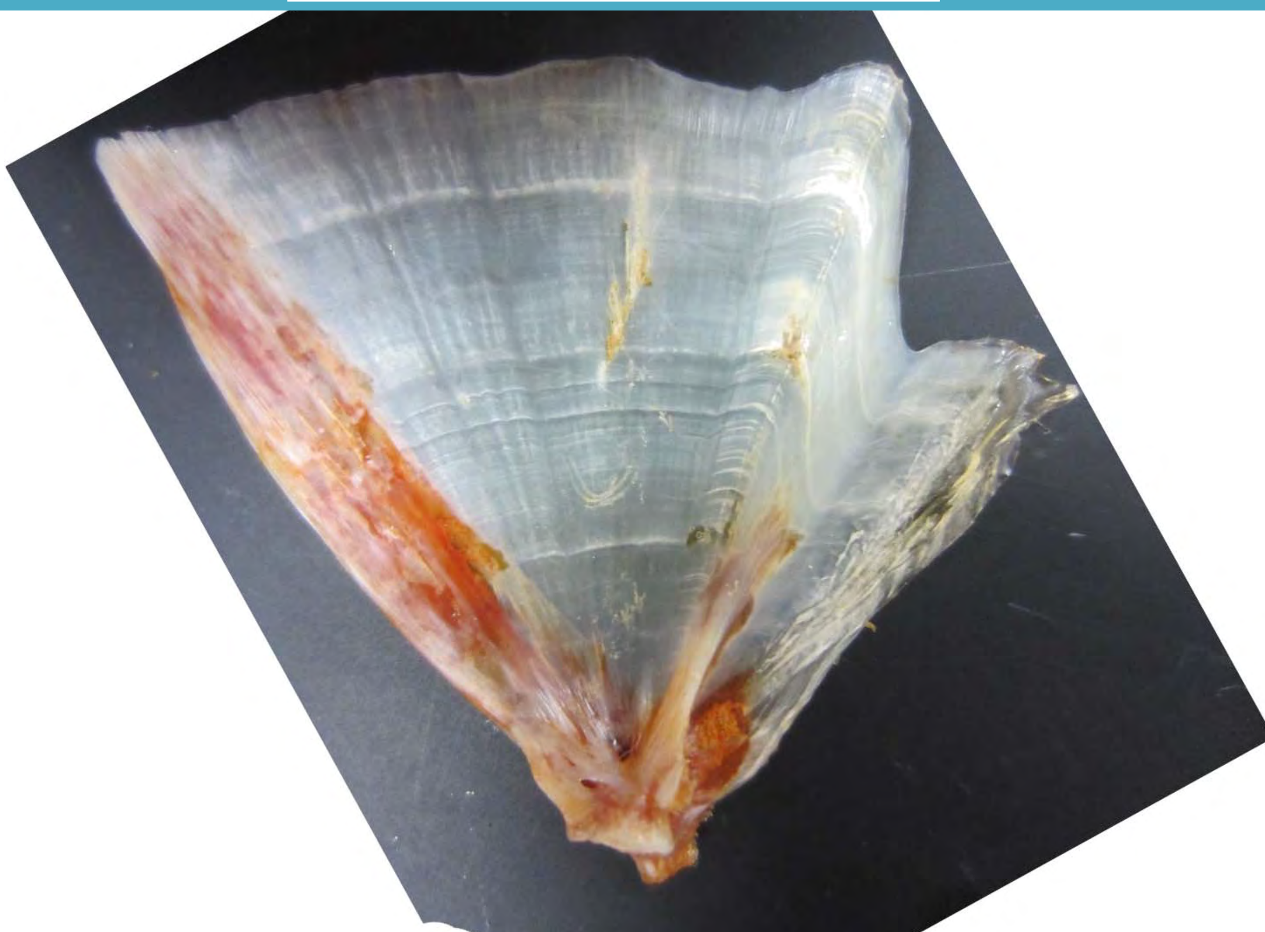
Tautog 14 11/28/2017

Tautog 15 12/16/2014



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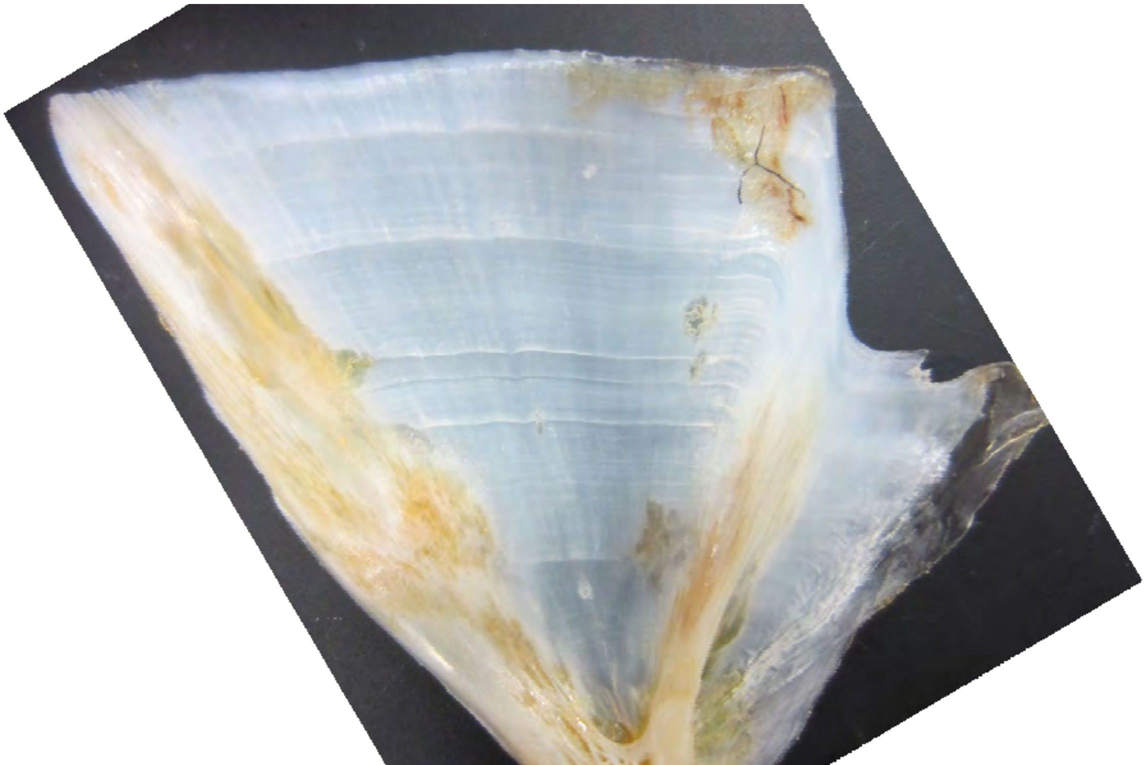

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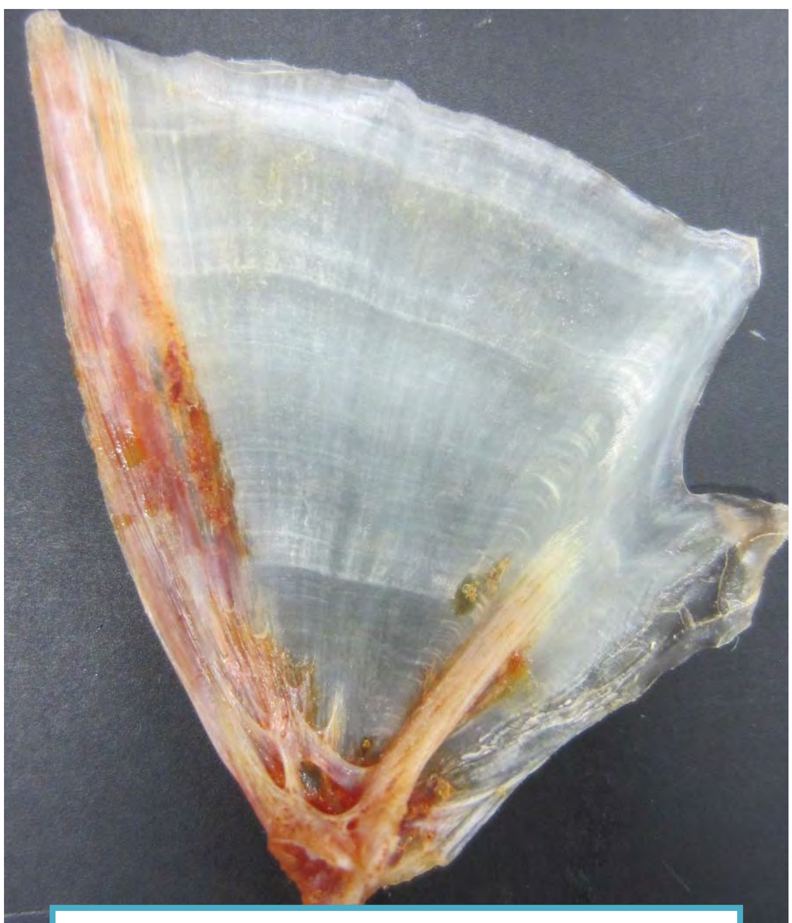
Tautog 18 11/6/2015

Tautog 19 11/18/2018



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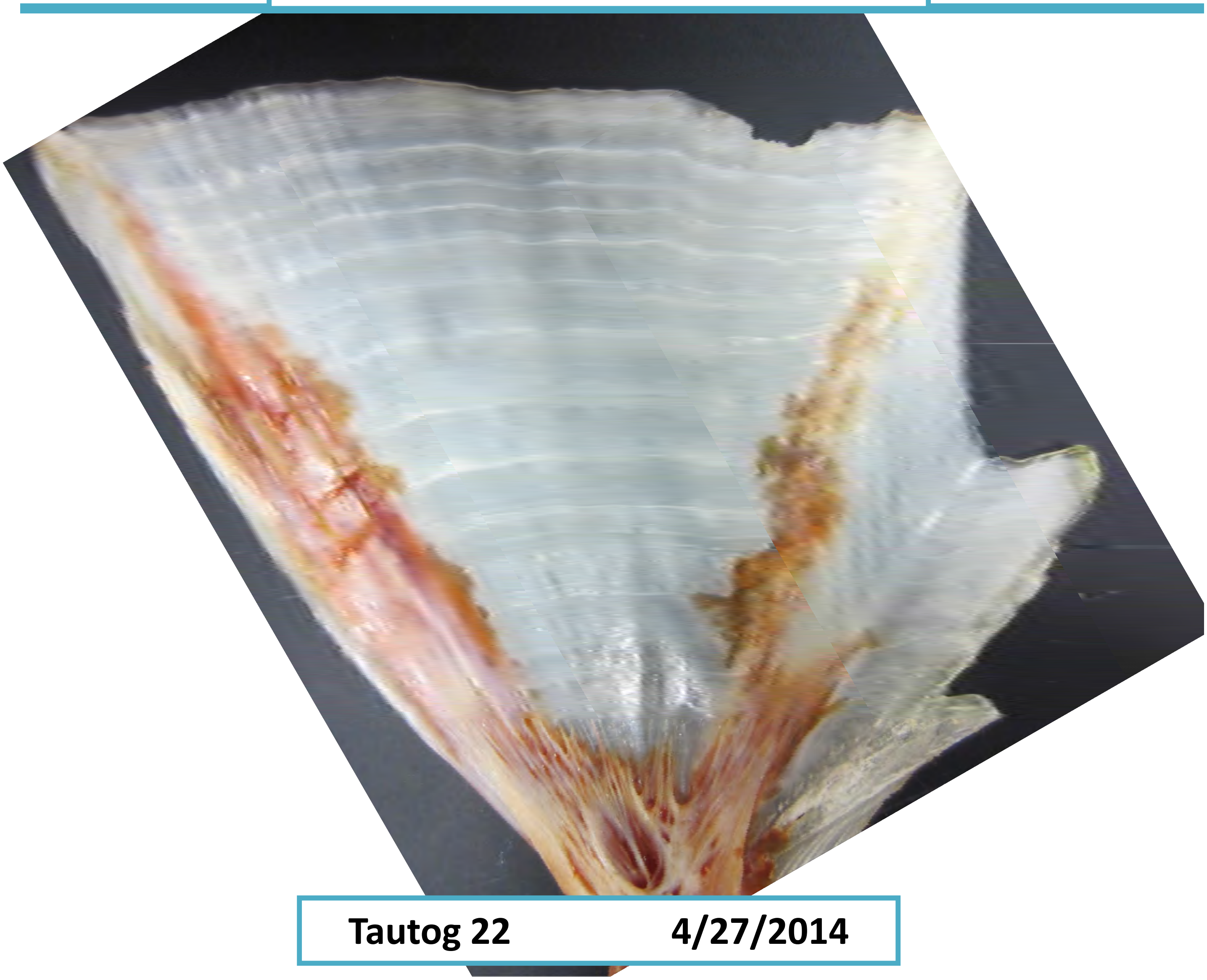
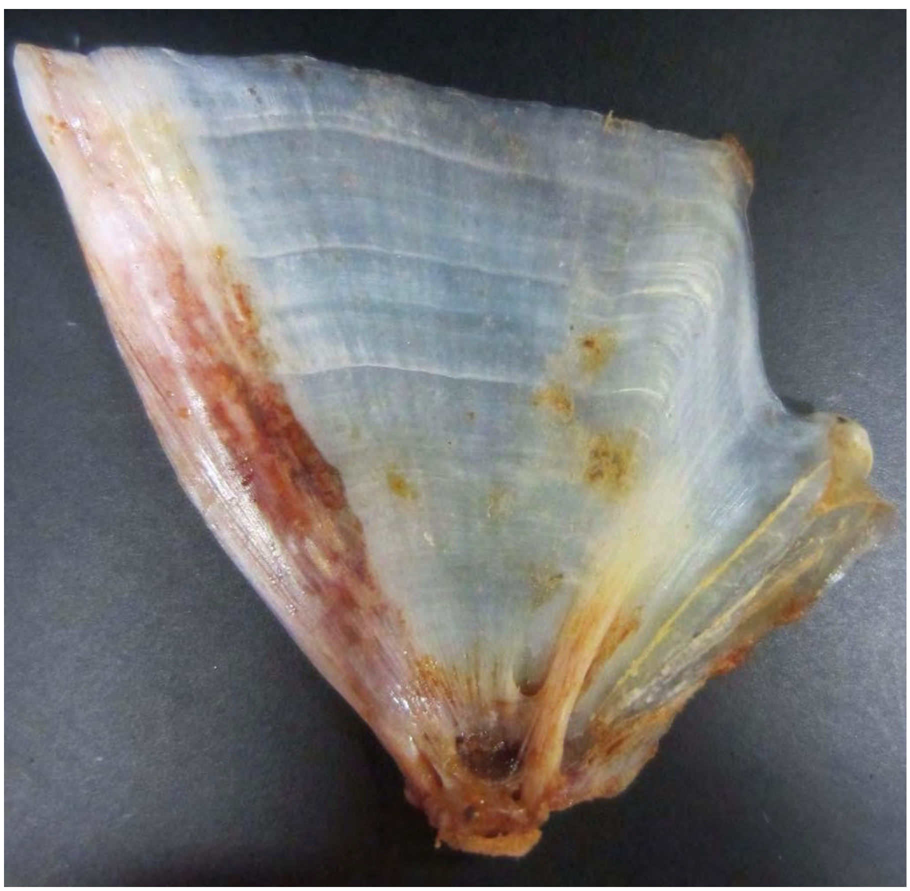


Tautog 22 4/27/2014

Tautog 23 7/5/2016



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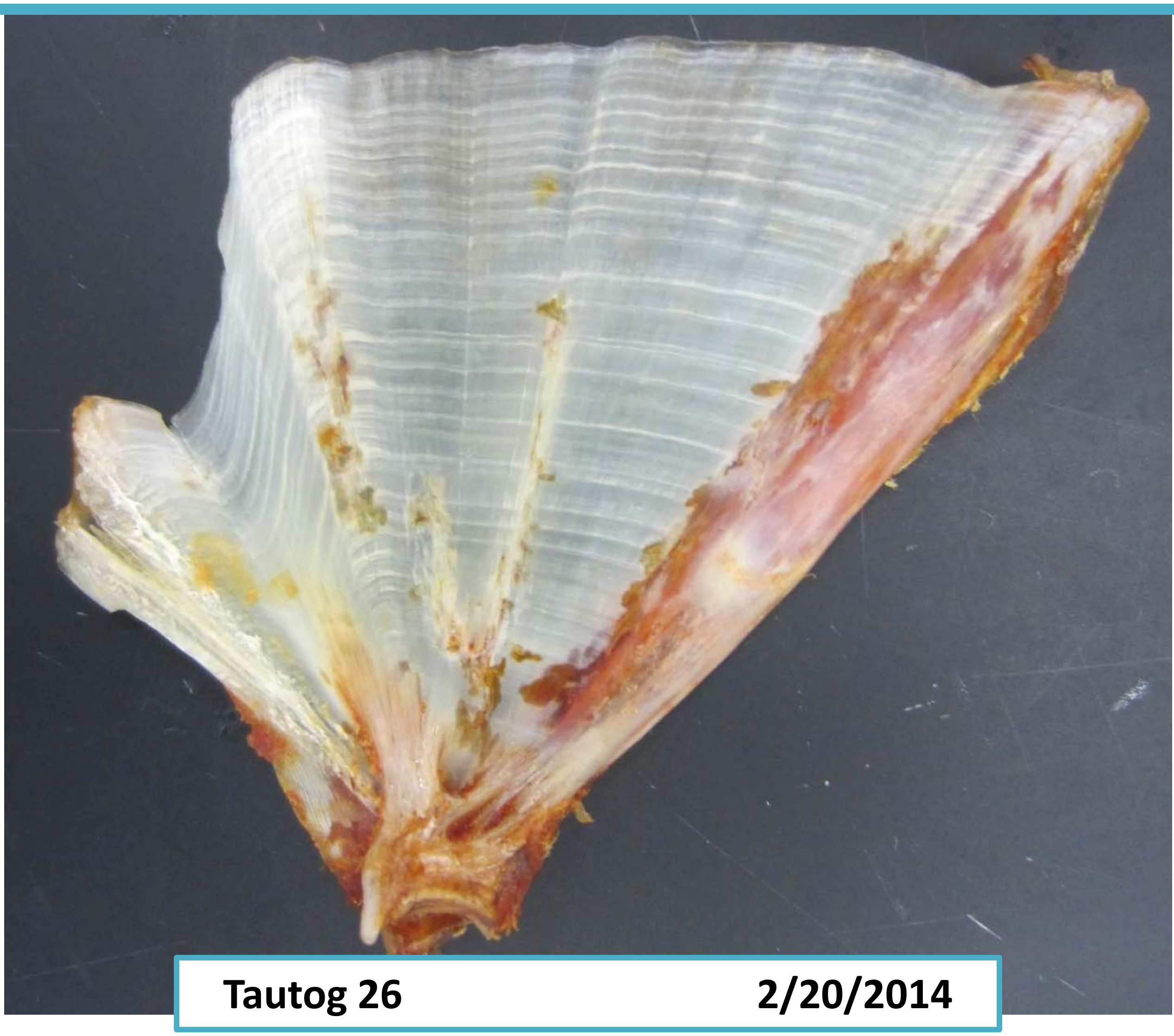

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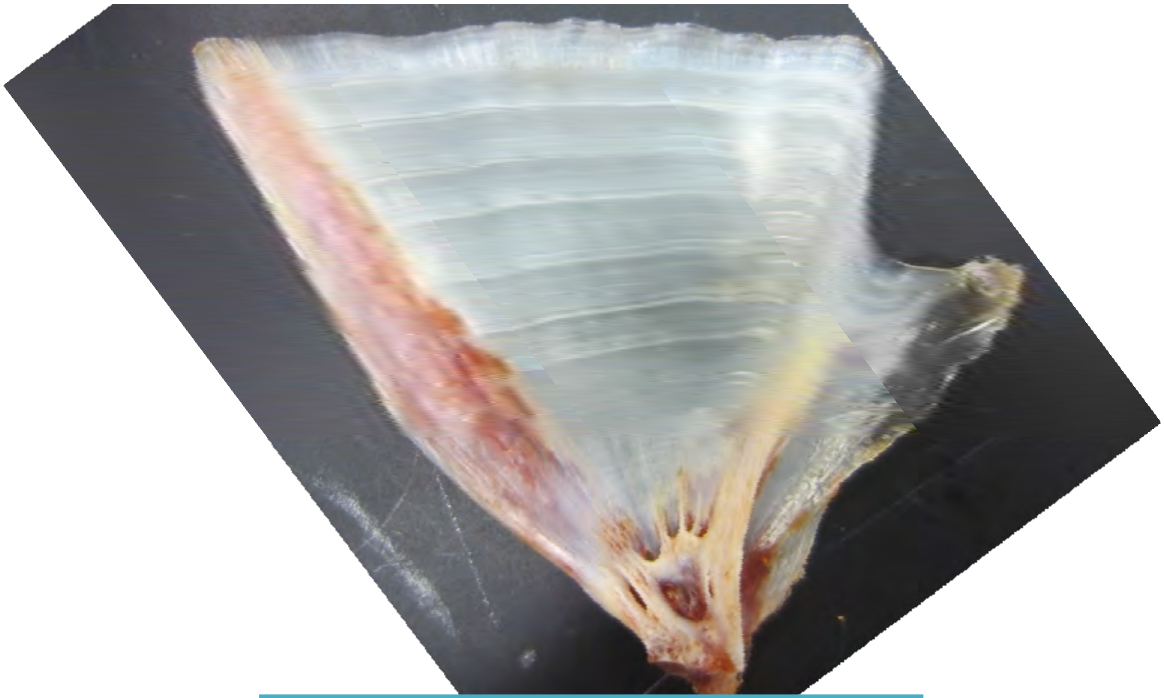

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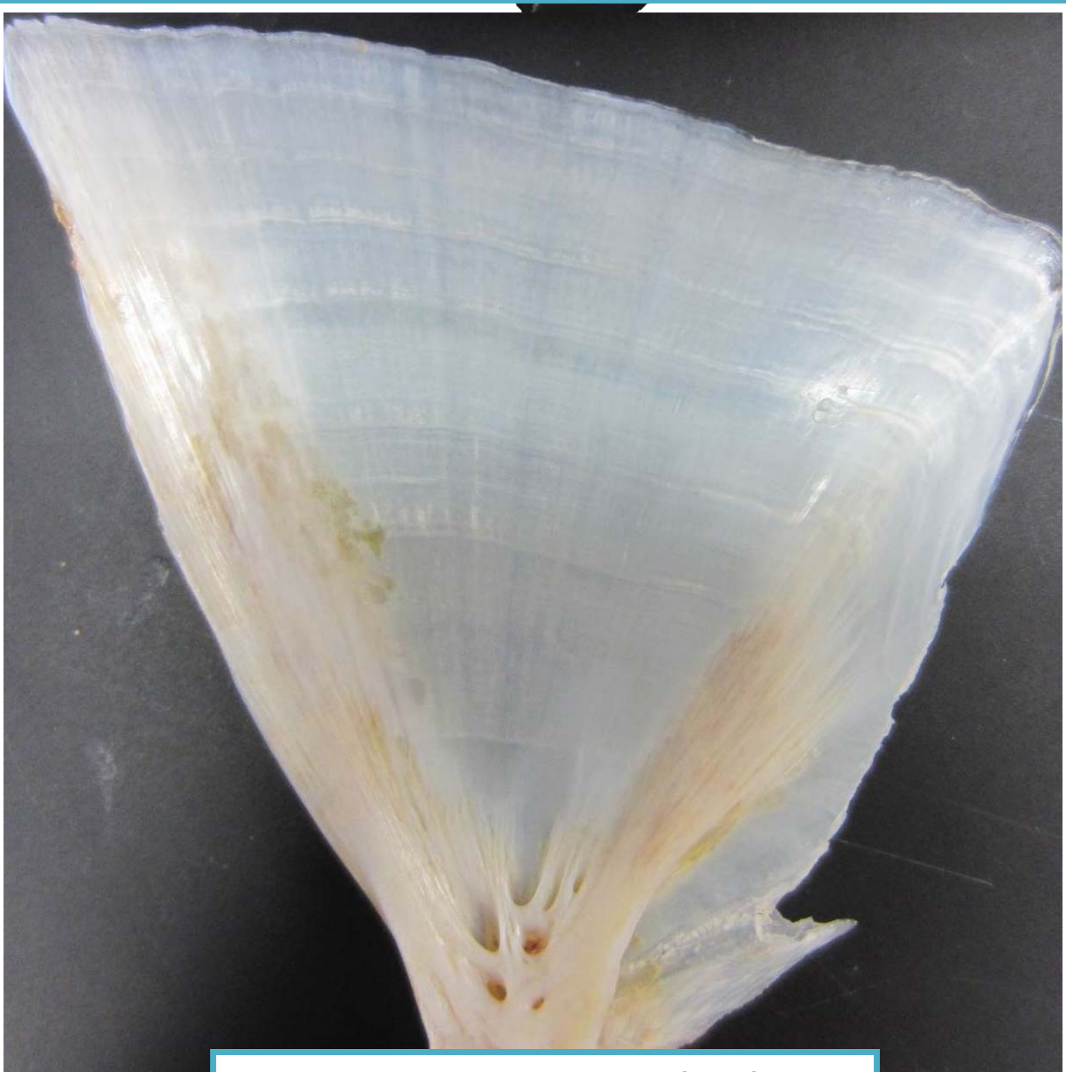

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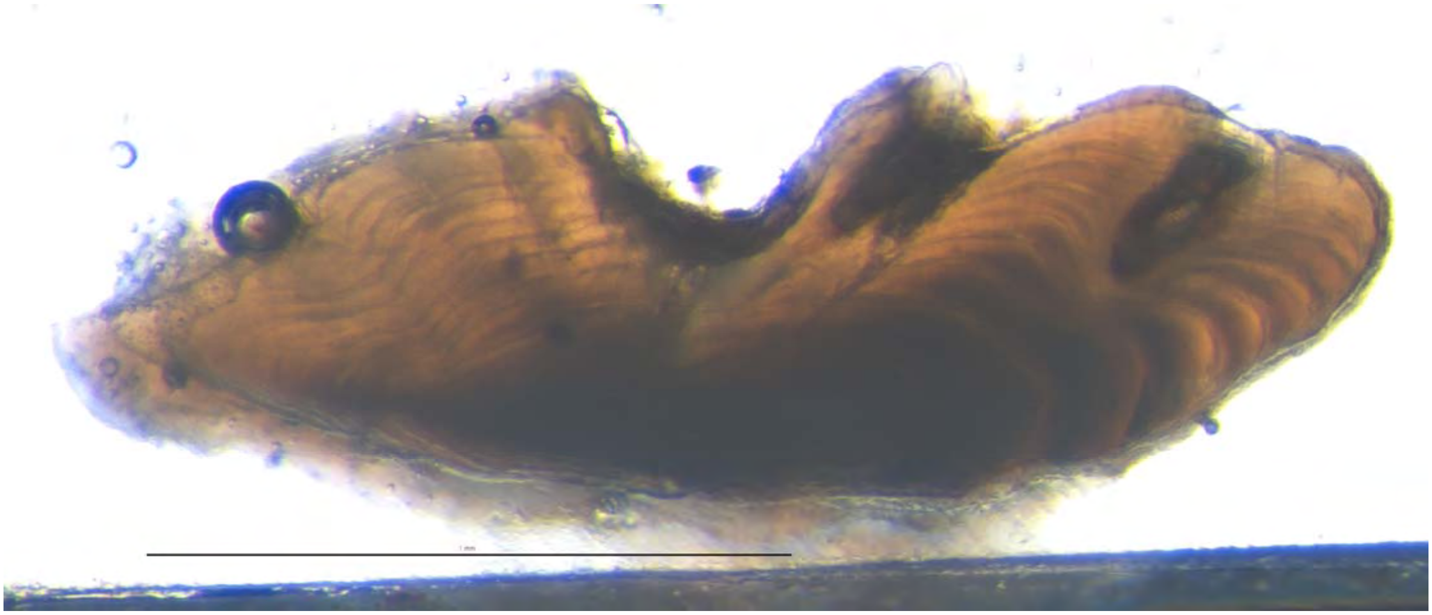

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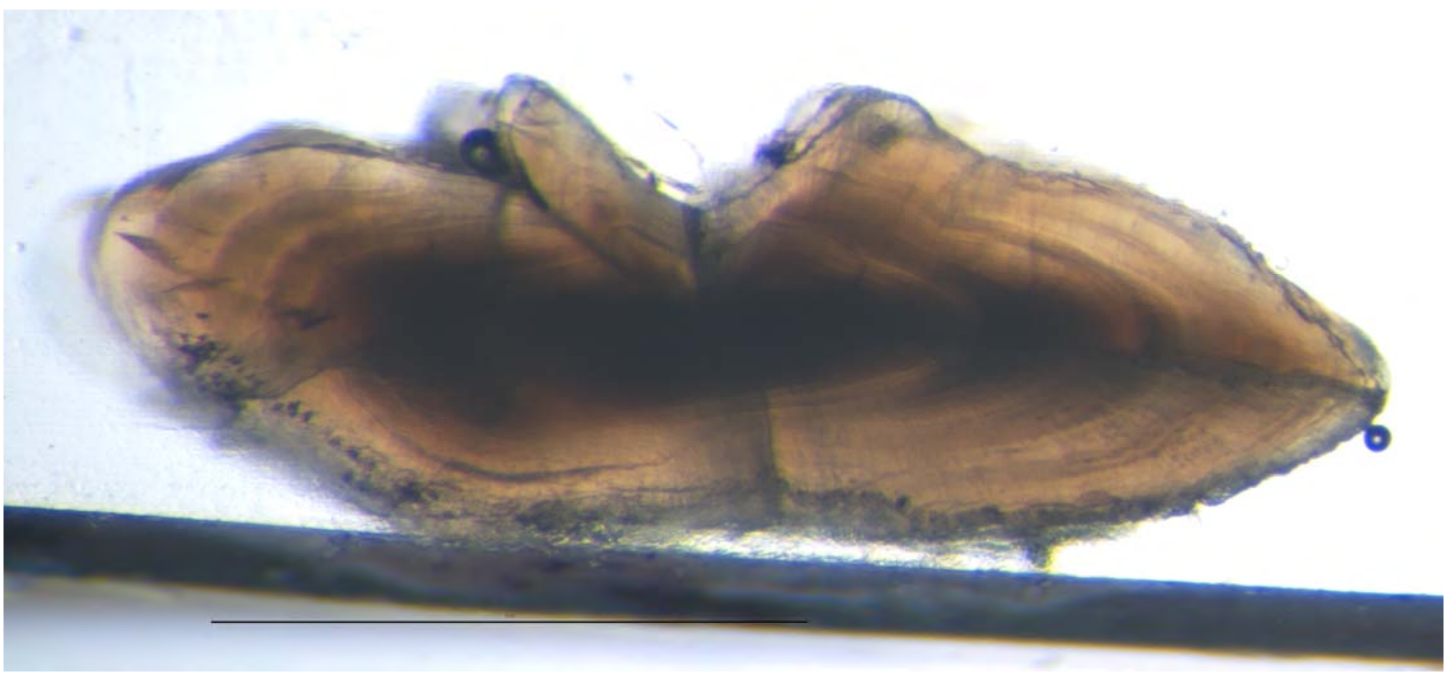

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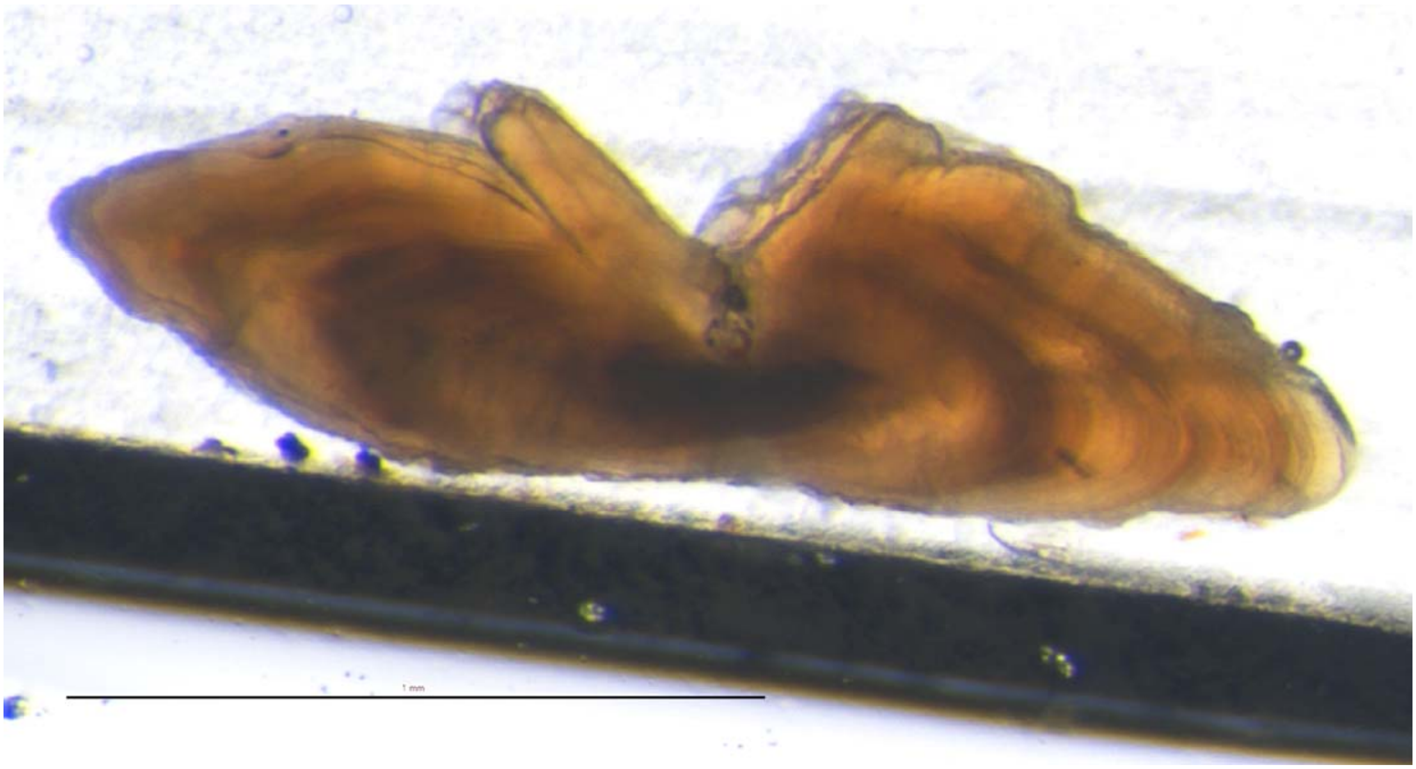

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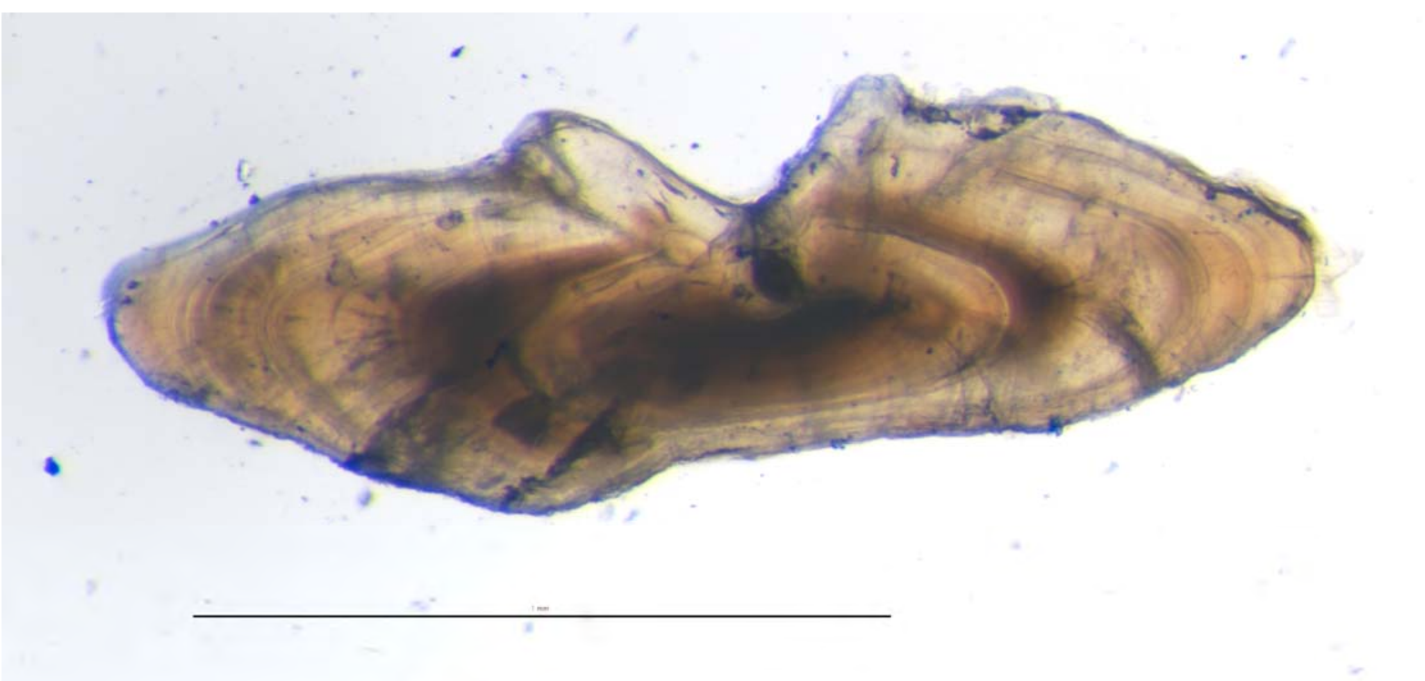

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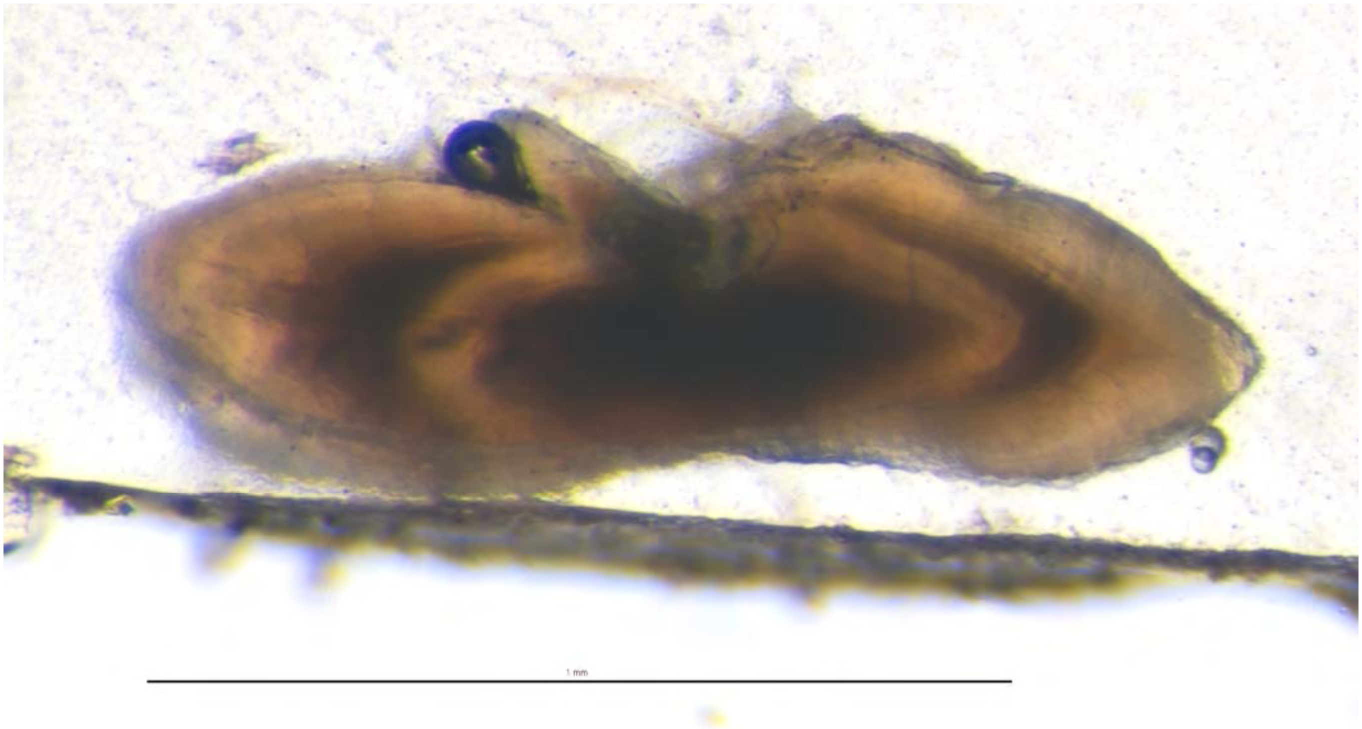

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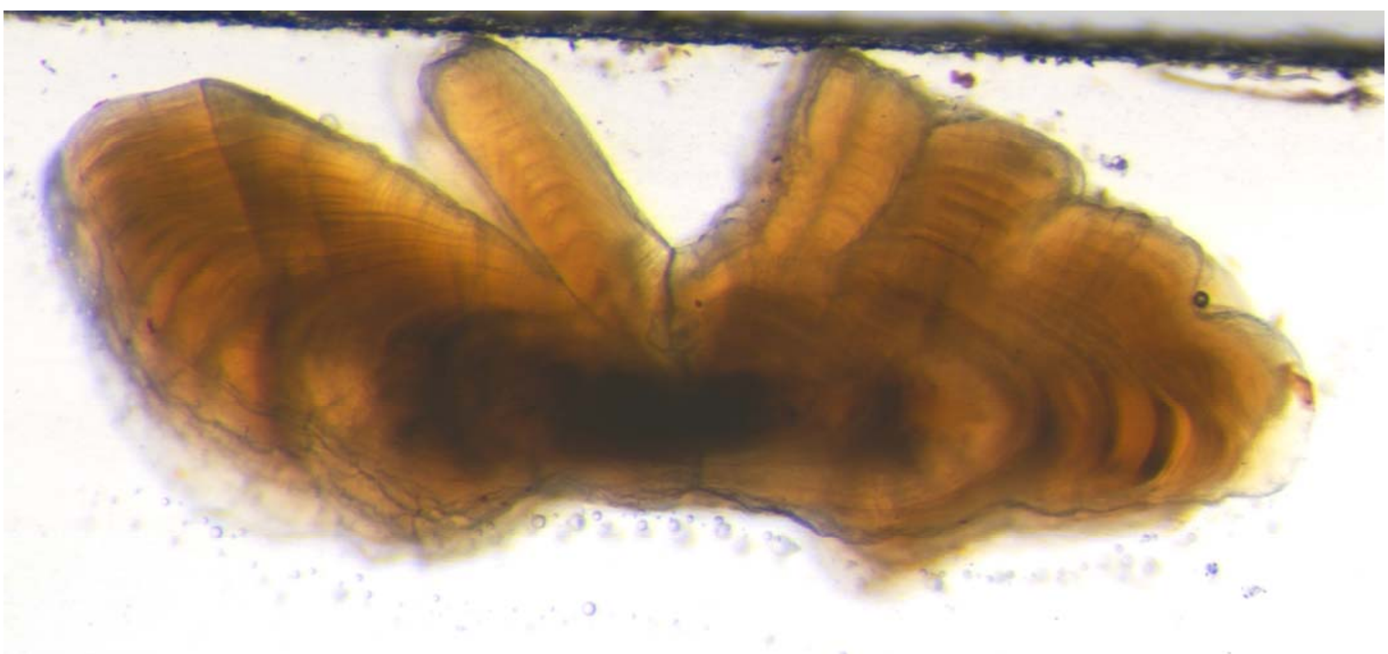

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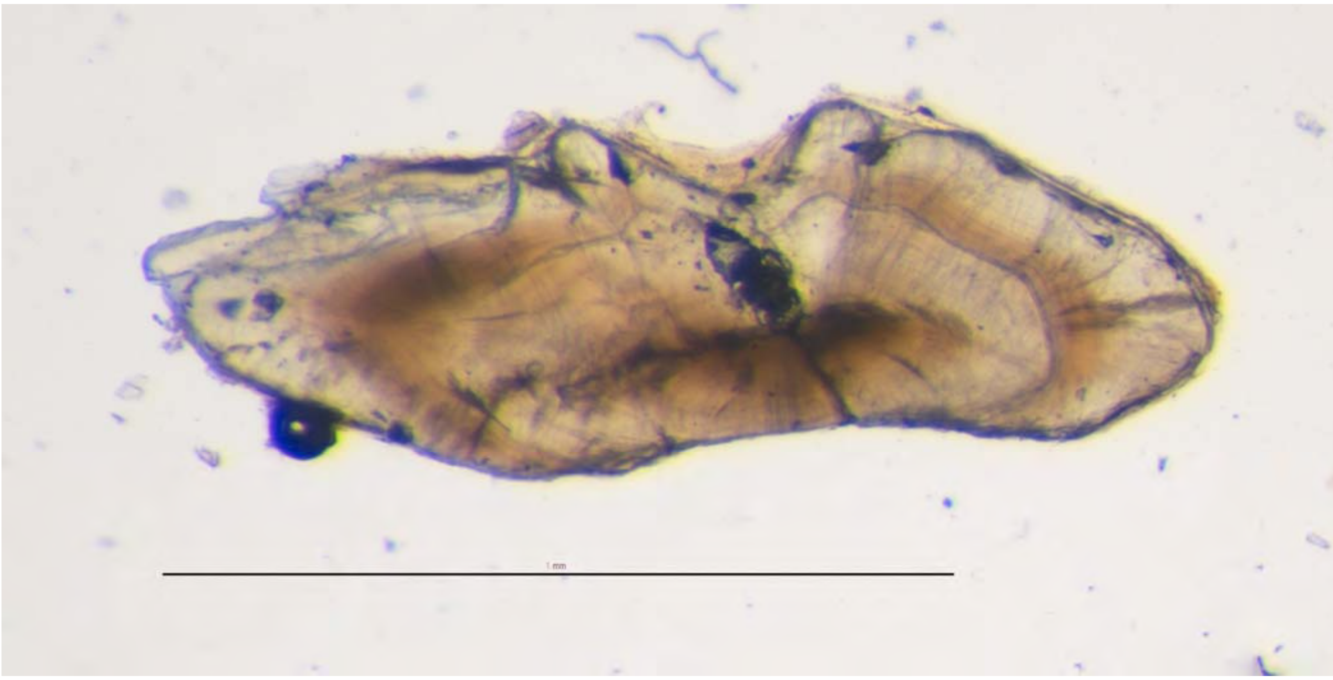
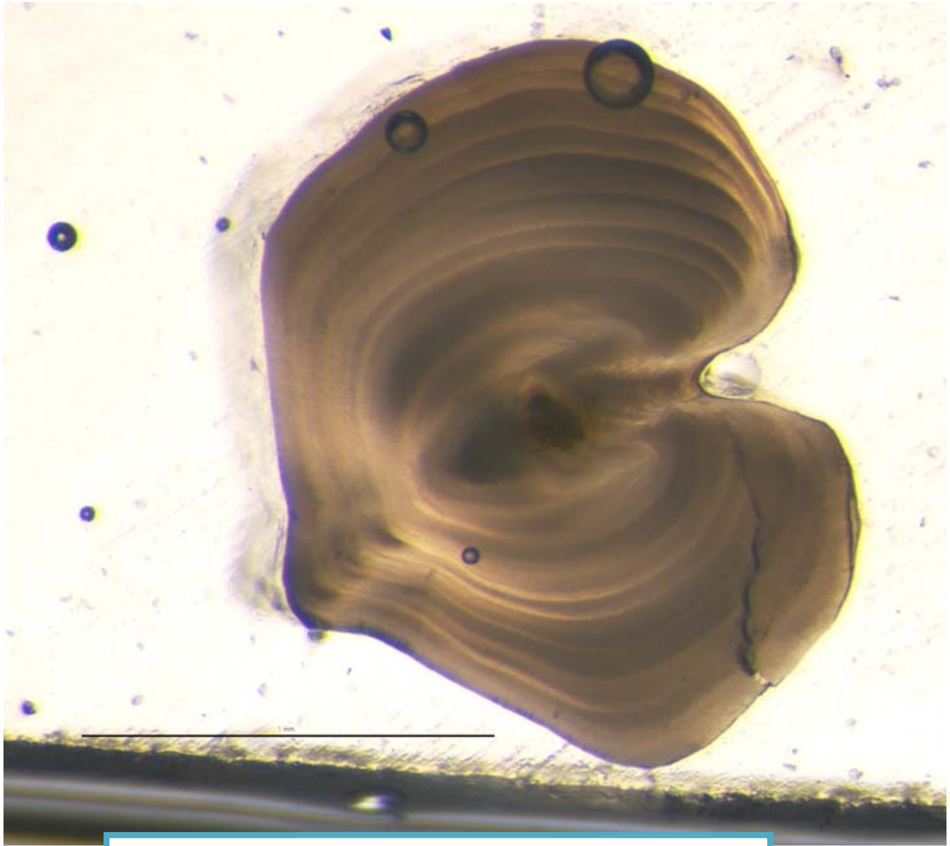


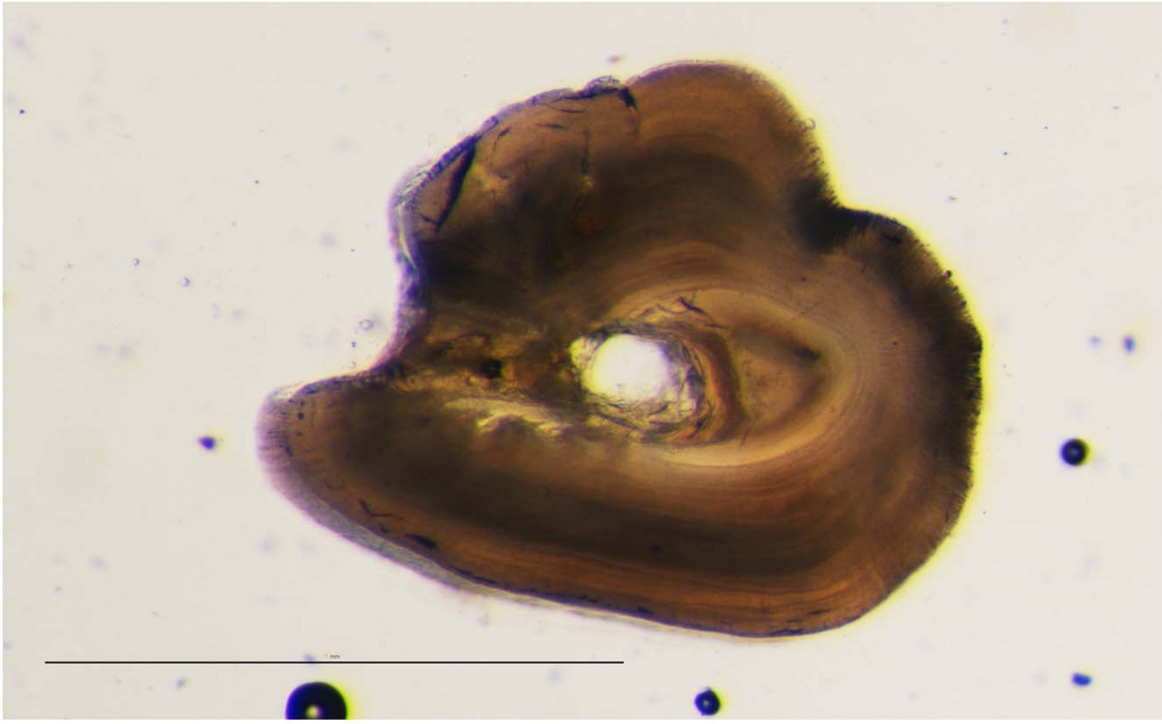
Tautog 35 10/2017

Tautog 36 11/28/2017

Tautog 37 12/13/2018



Tautog 38 5/31/2018



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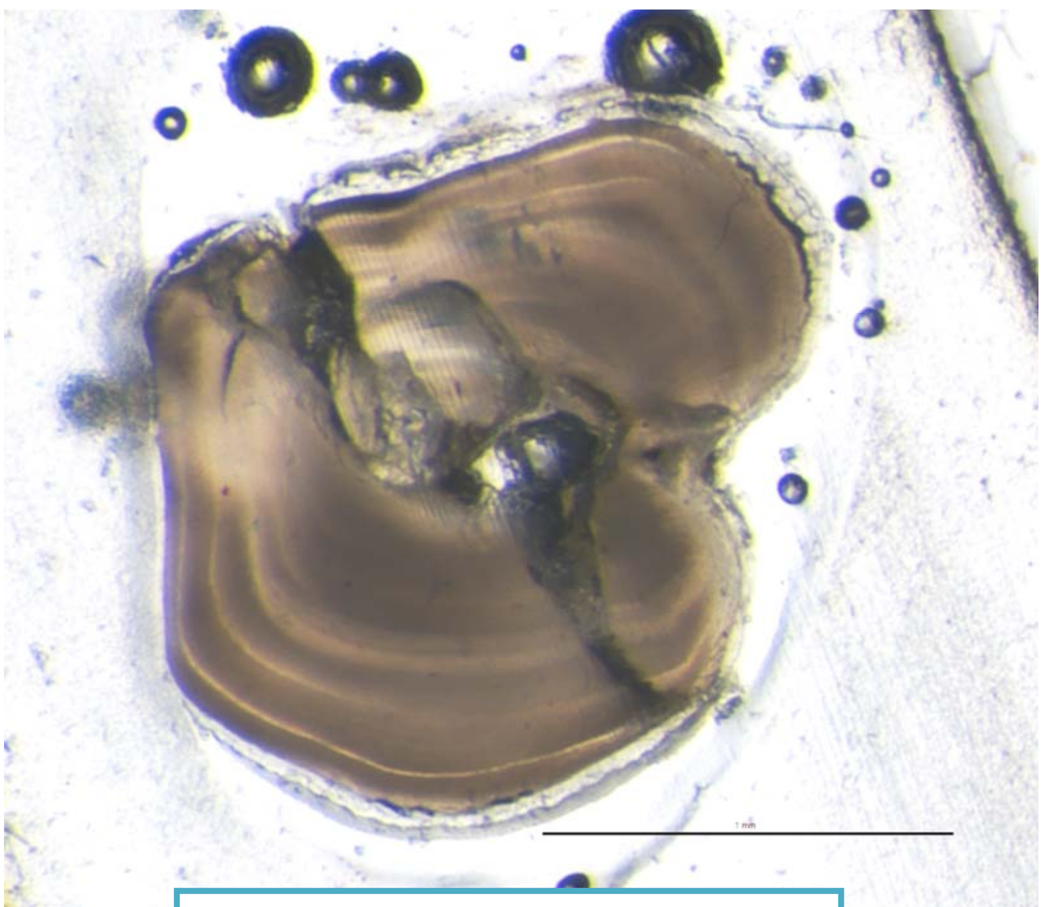

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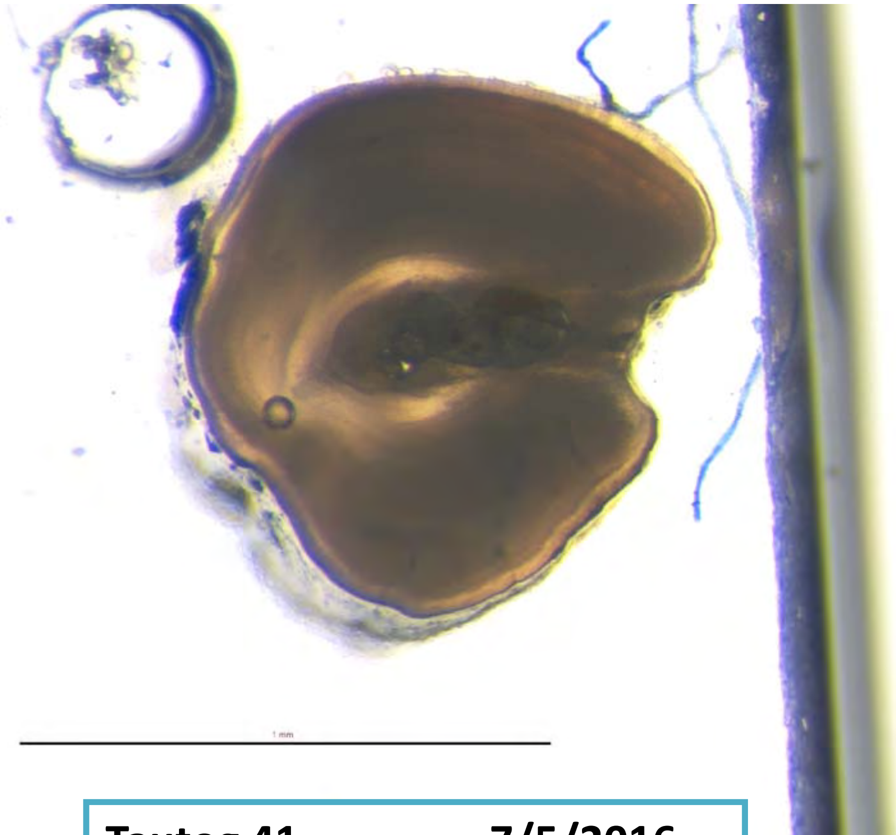

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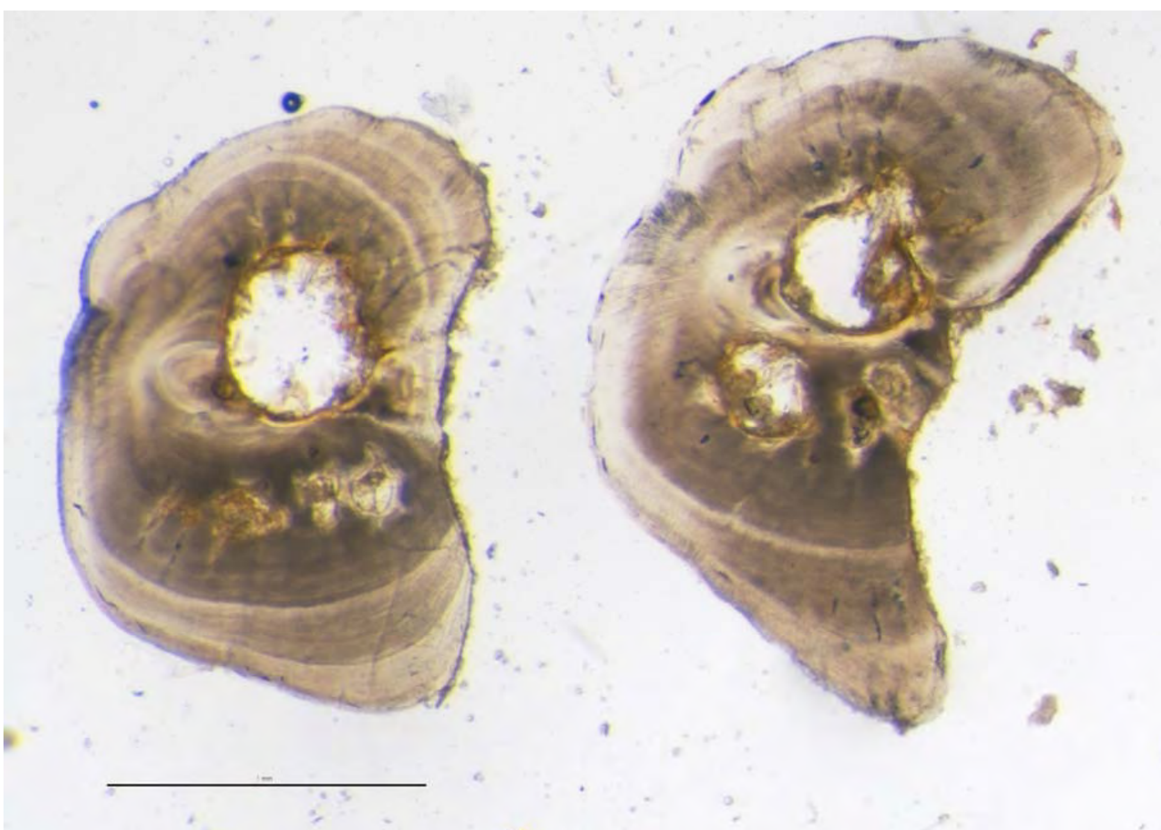

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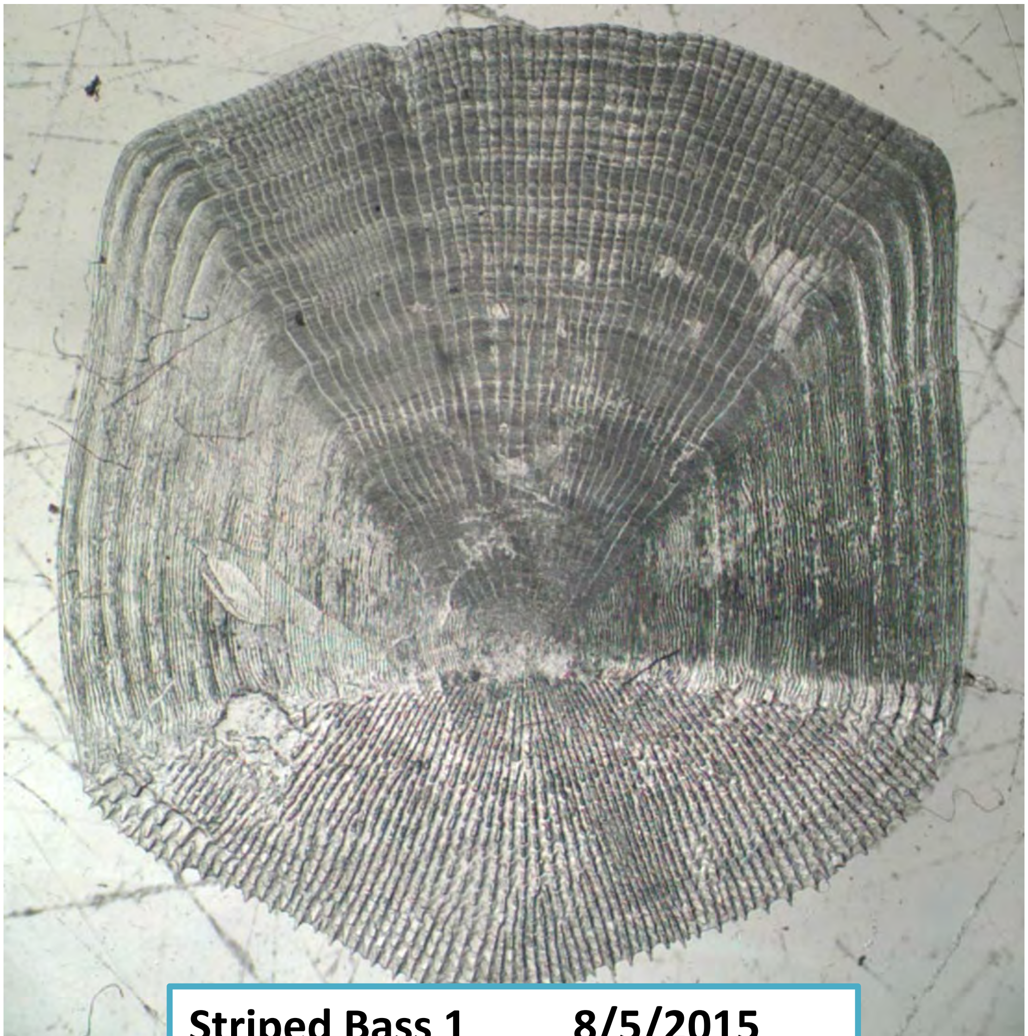
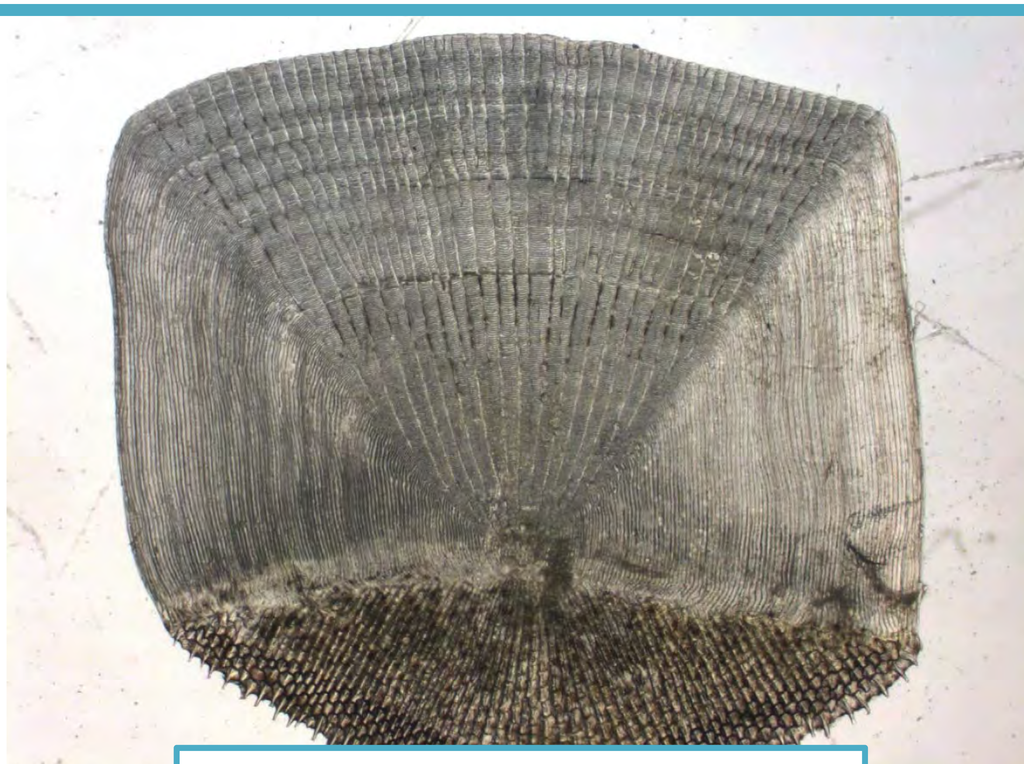
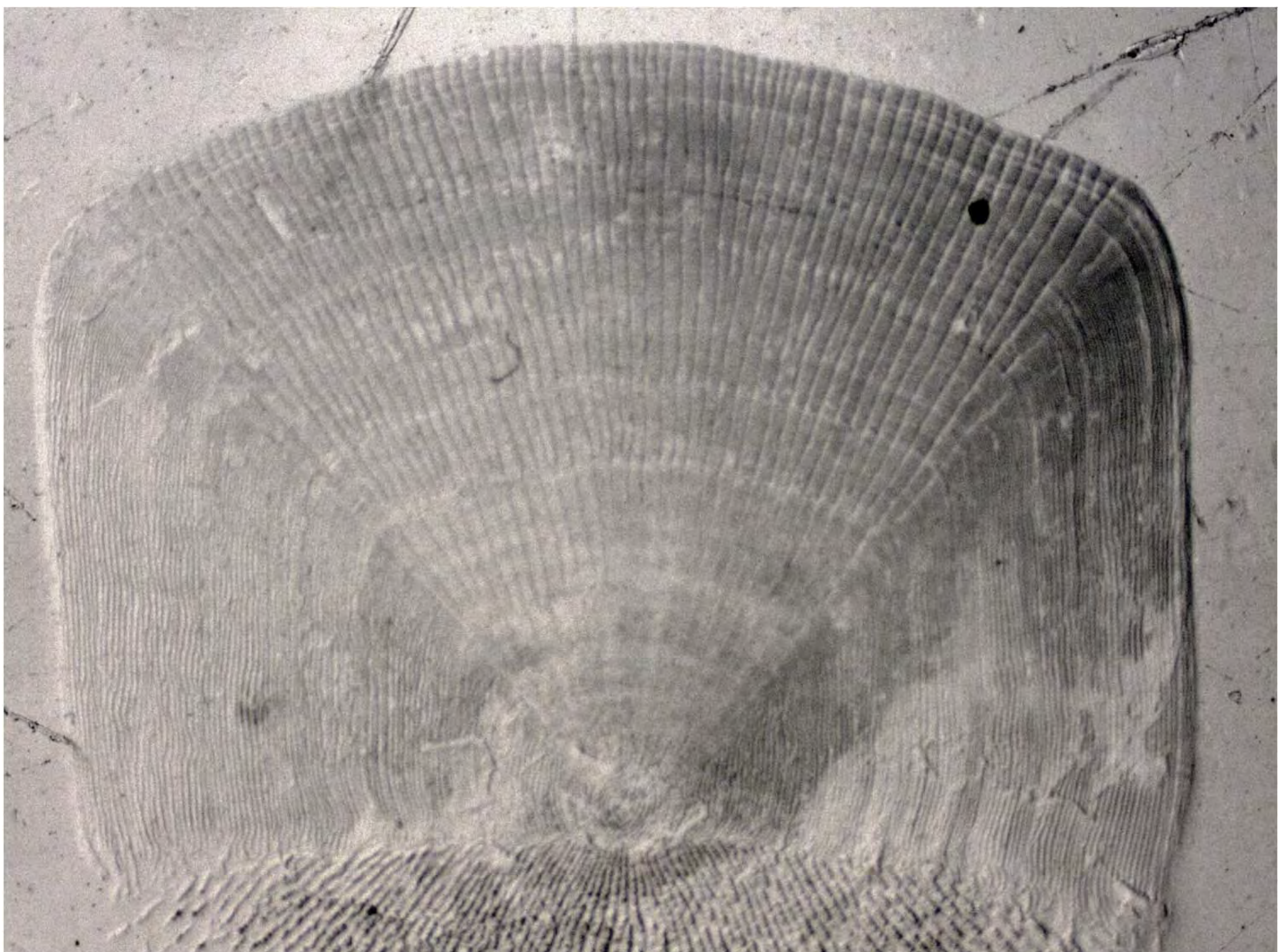


Striped Bass 1 8/5/2015

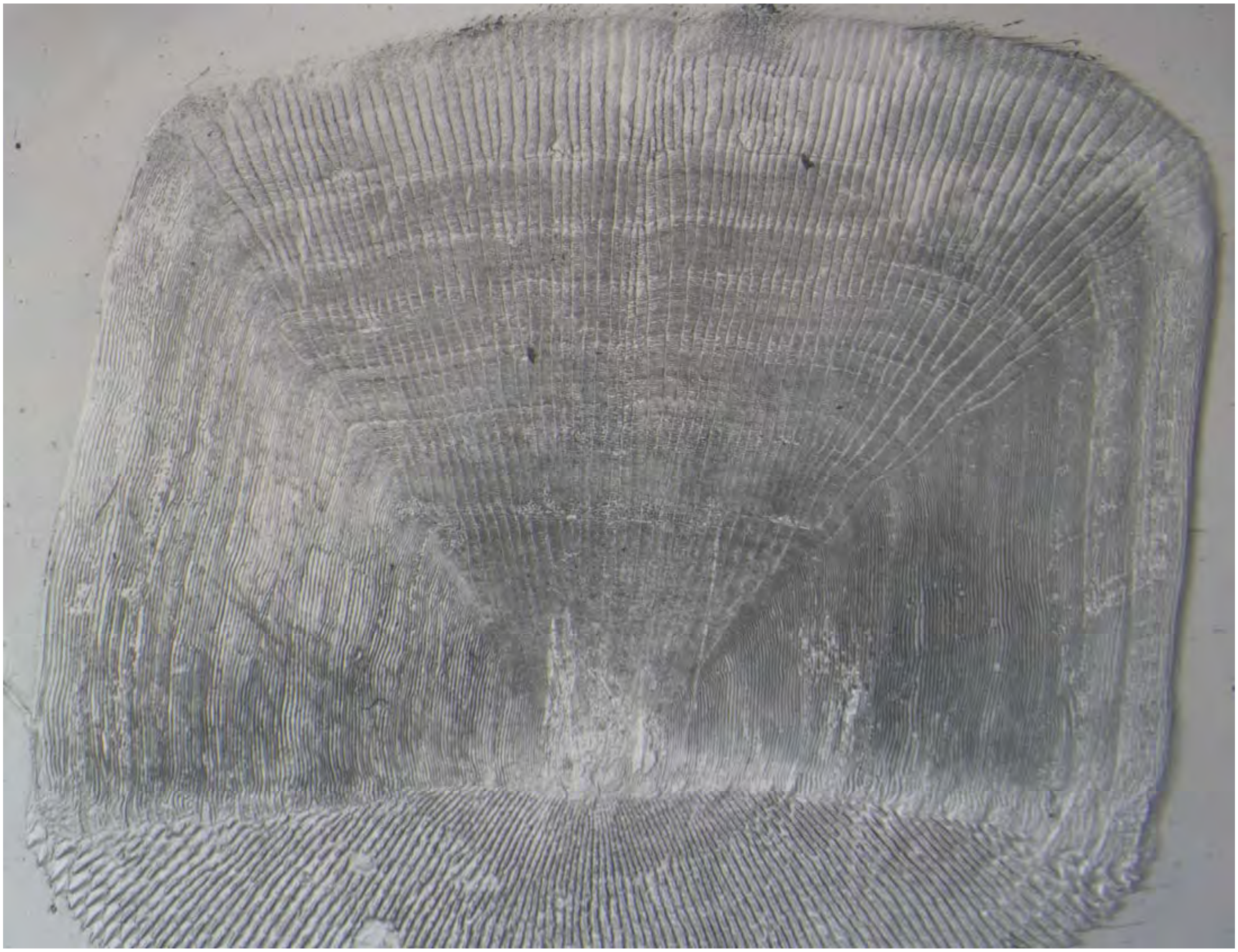


Striped Bass 2 7/15/2015

Striped Bass 3 7/1/2015

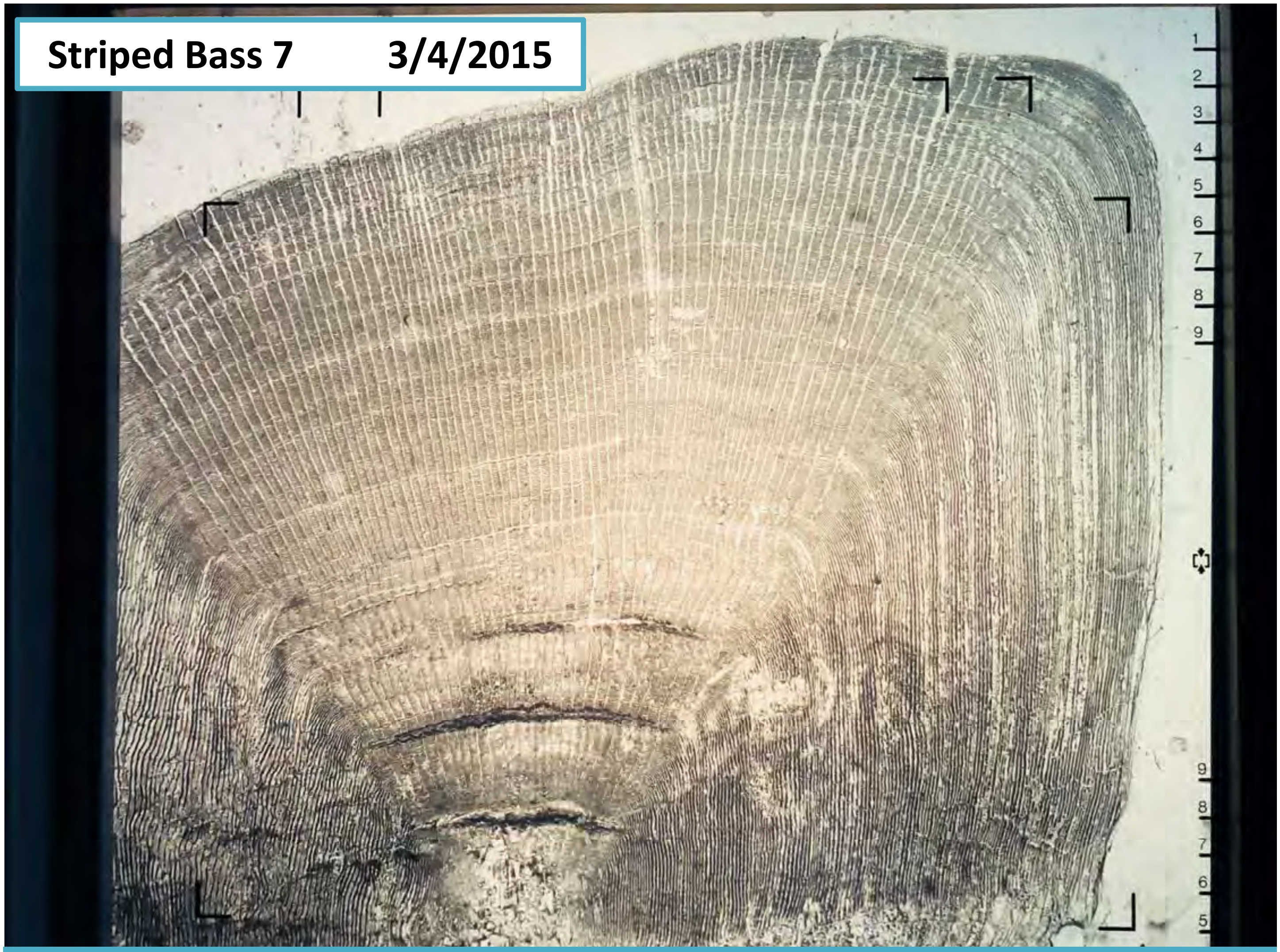


Striped Bass 4 3/28/1996



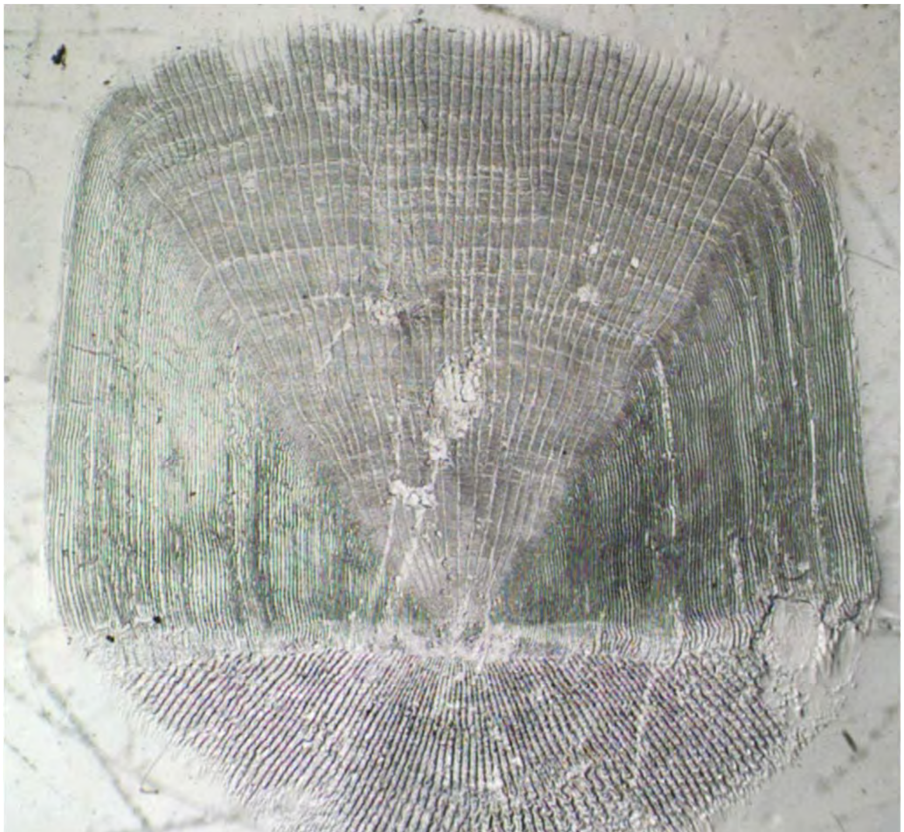
Striped Bass 5 10/13/2018

Striped Bass 6 6/20/2012

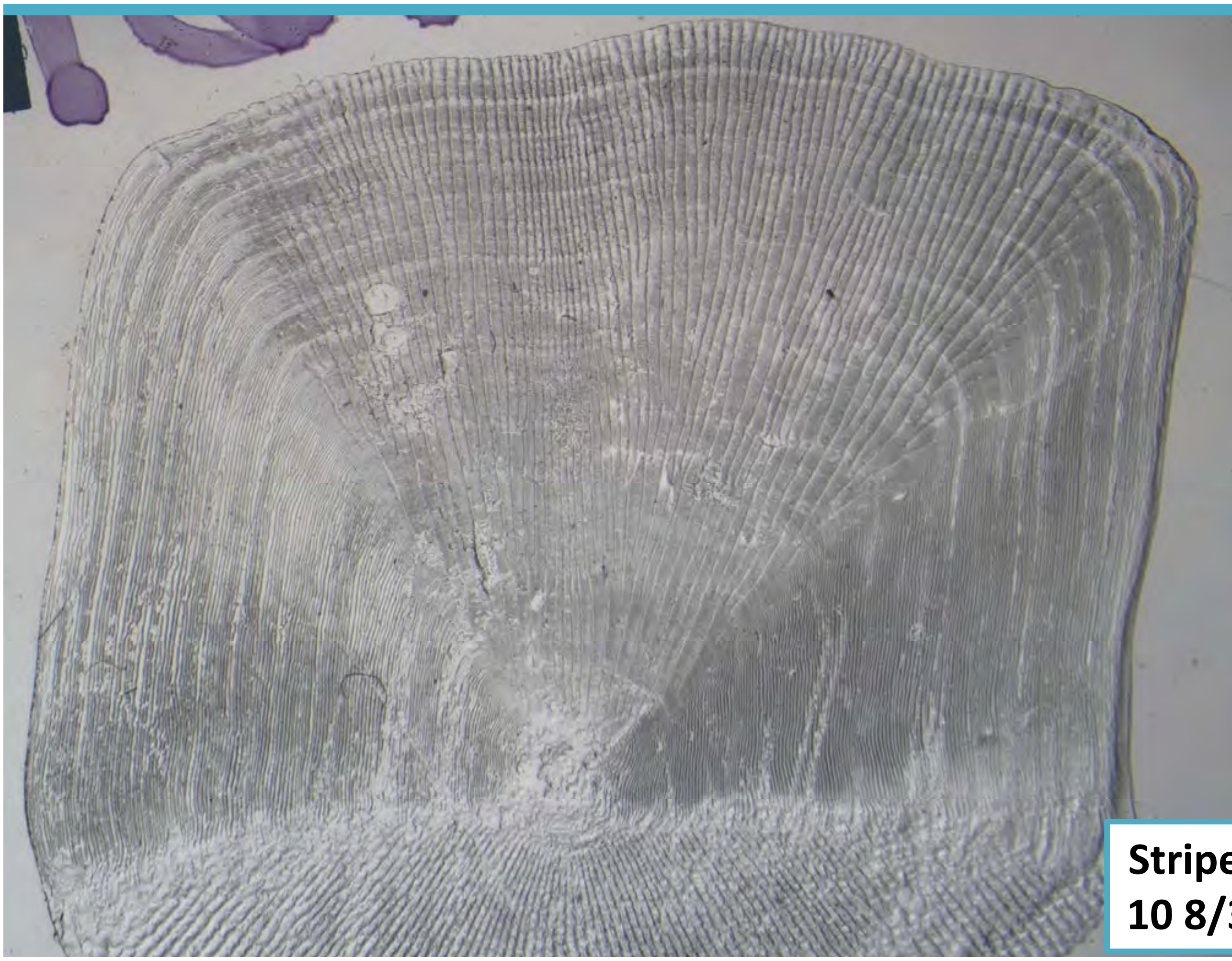


Striped Bass 7 3/4/2015

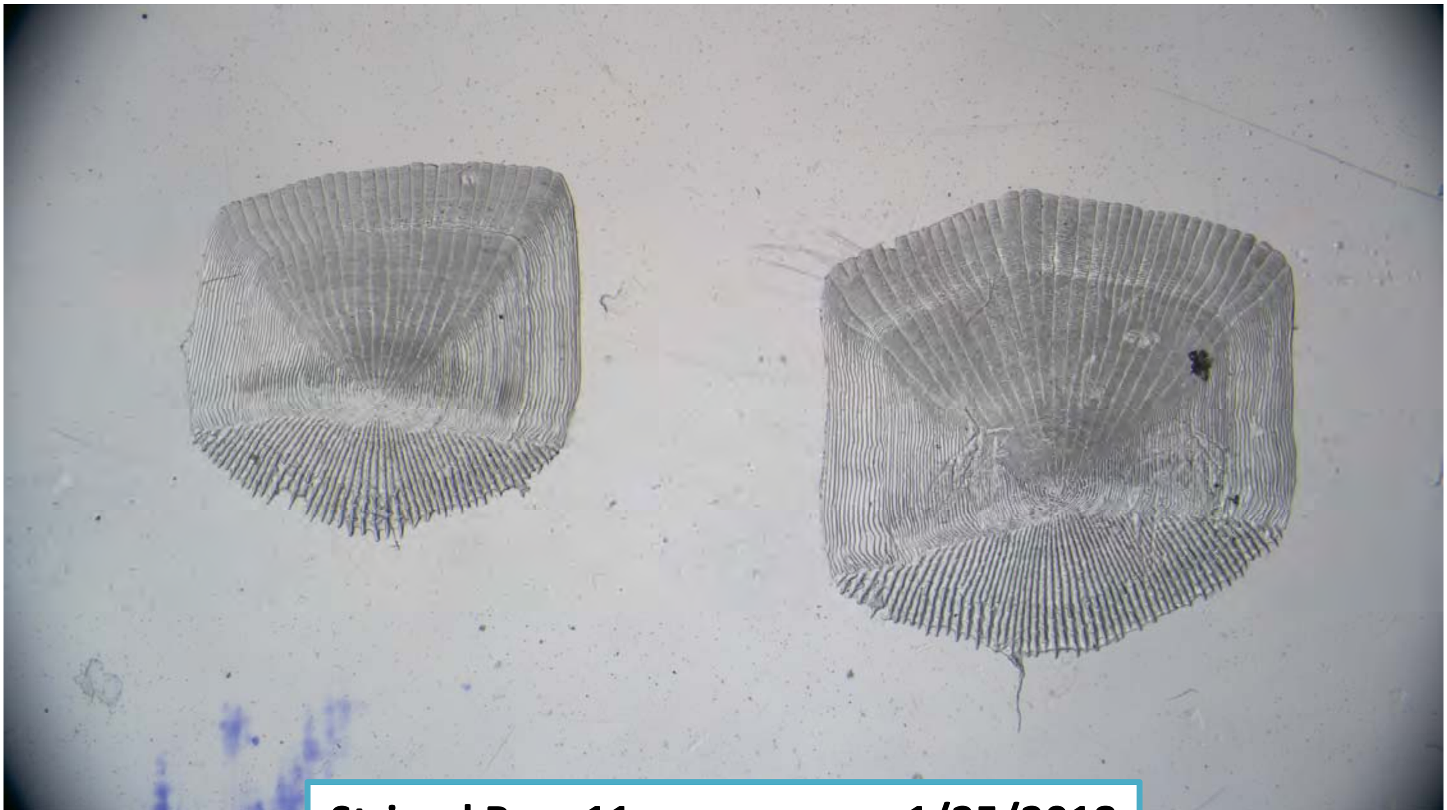
Striped Bass 8 3/19/2018



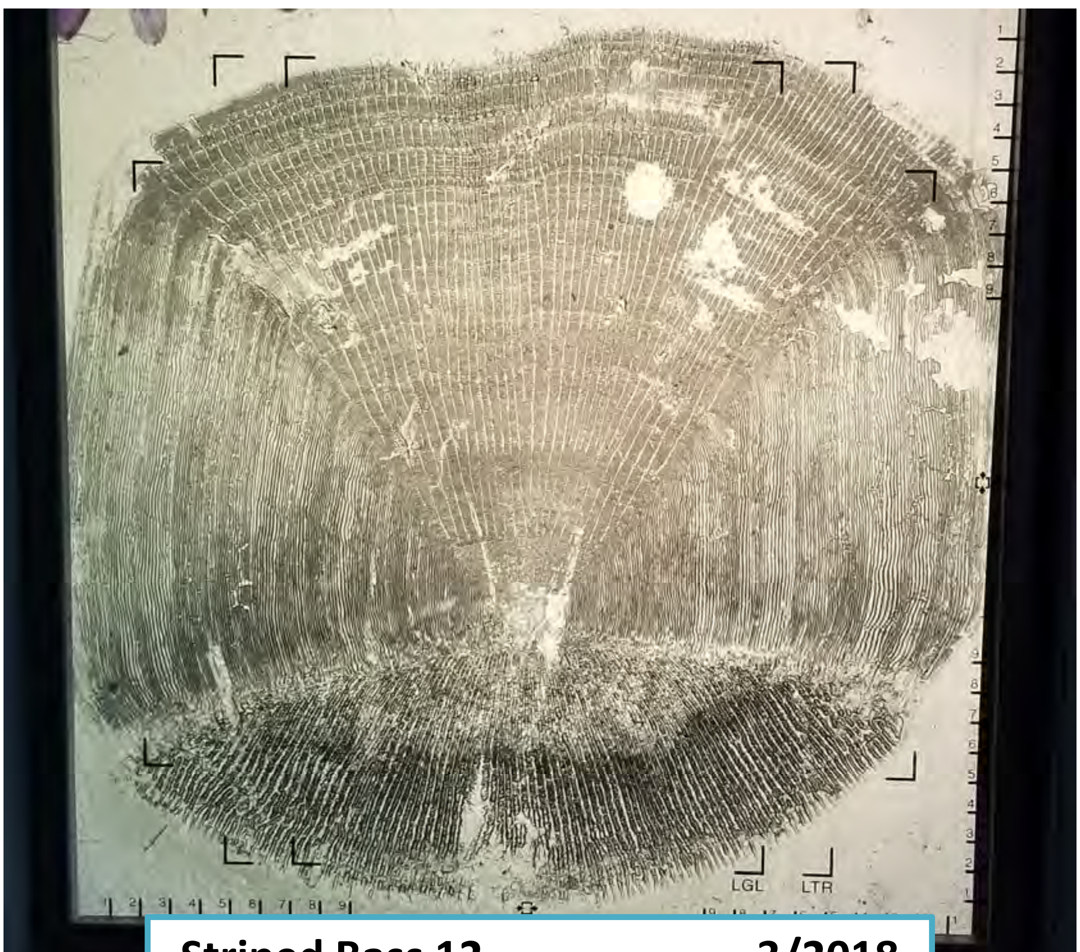
Striped Bass 9 4/21/2012



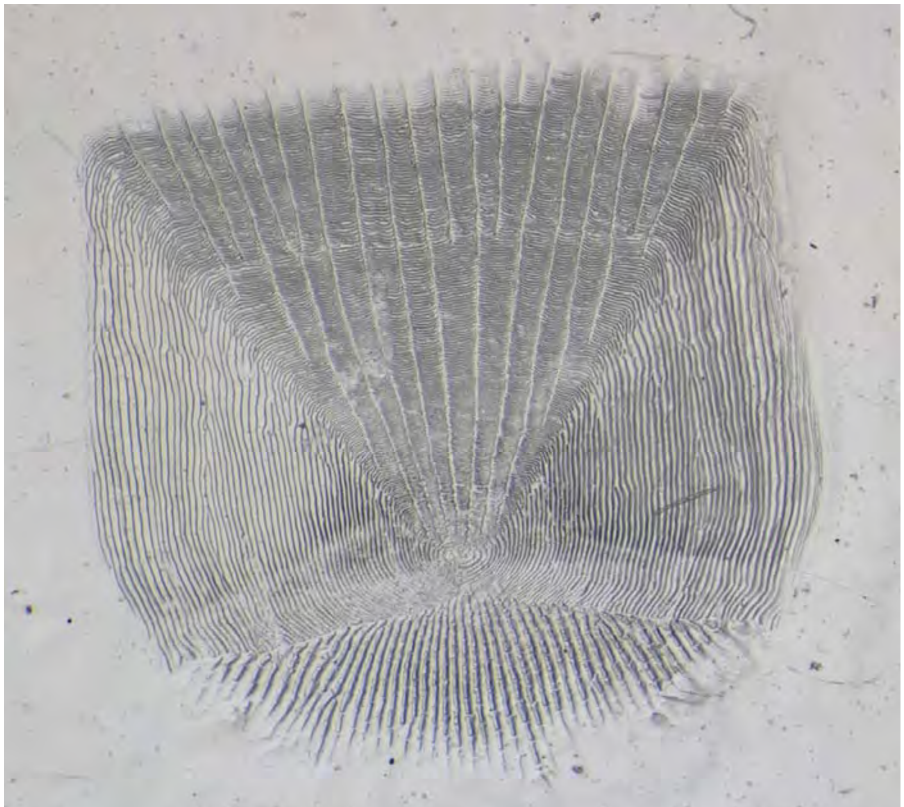
Striped Bass 10 8/3/2018



Striped Bass 11 1/25/2018

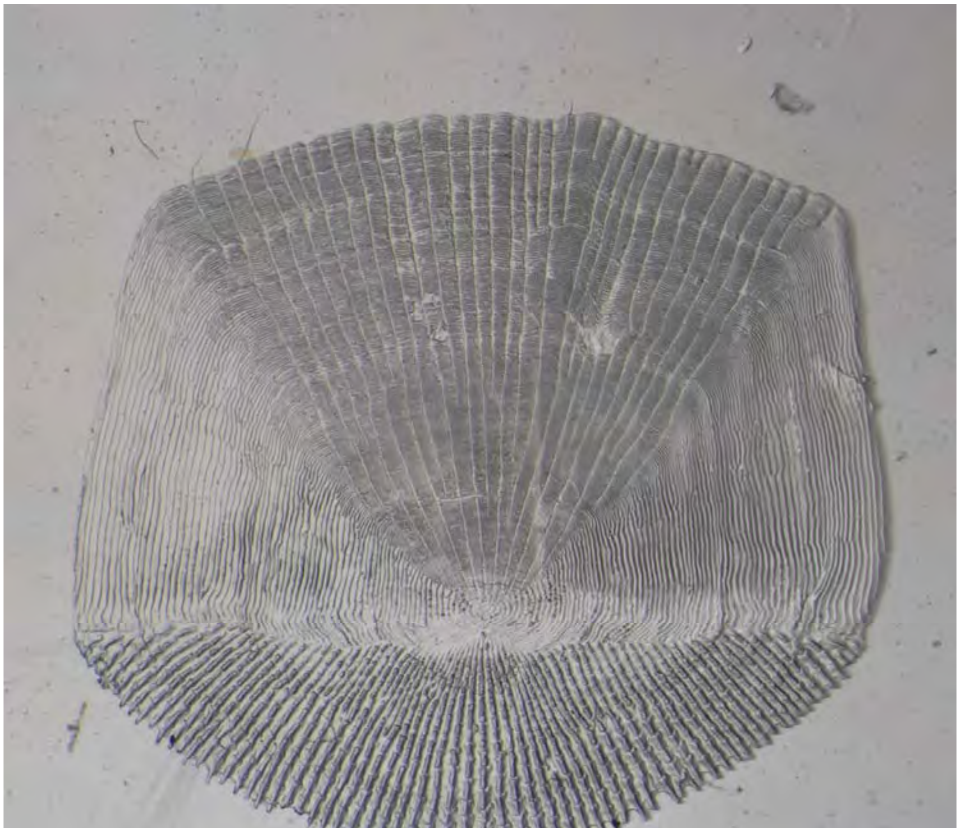


Striped Bass 12 3/2018



Striped Bass 13 12/3/2018

Striped Bass 14 3/2018



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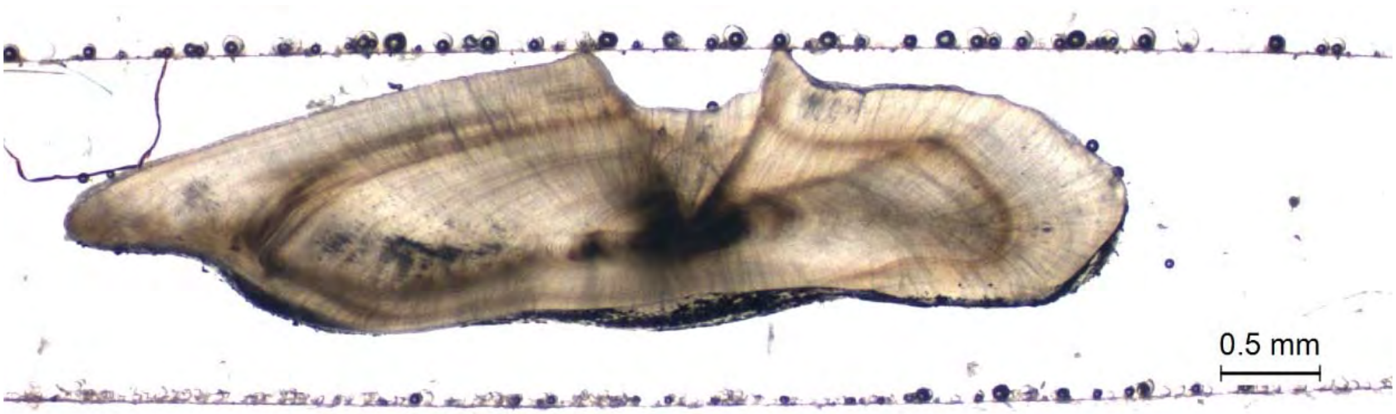
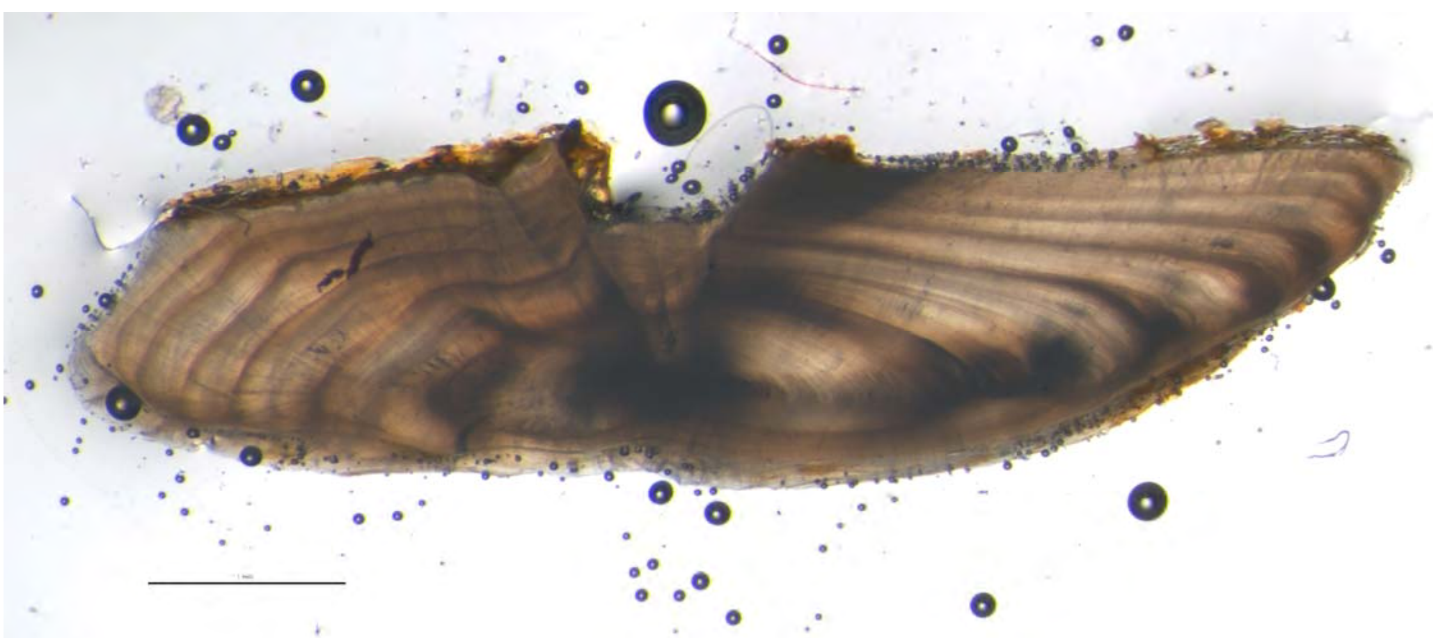
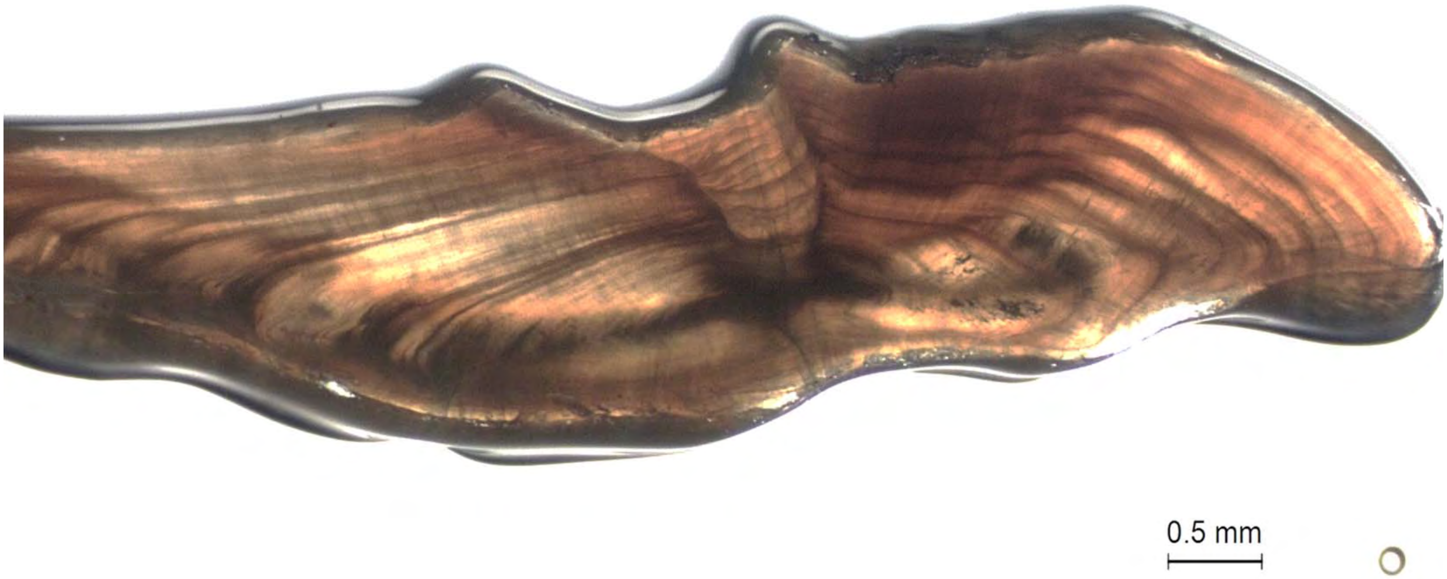


Striped Bass 16 12/18/2014

Striped Bass 17 **3/19/2018**

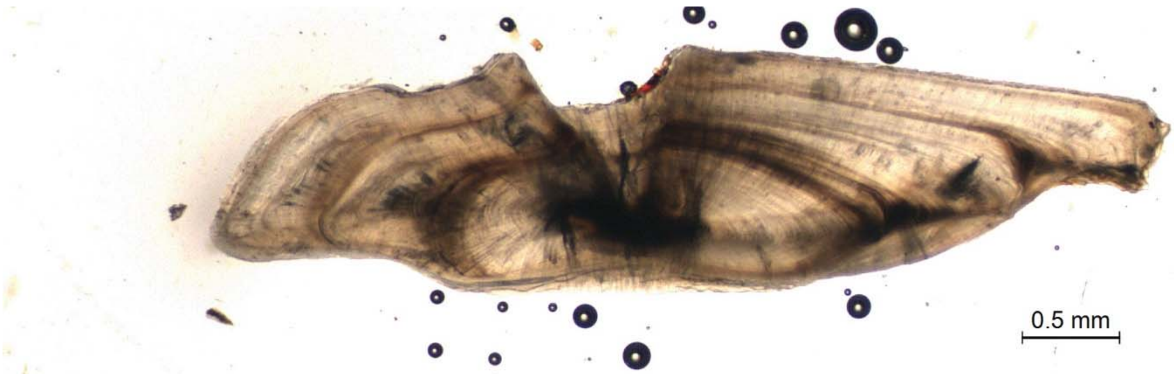


Striped Bass 18 **3/2018**



Striped Bass 19 9/15/2014

Striped Bass 20 4/8/2014



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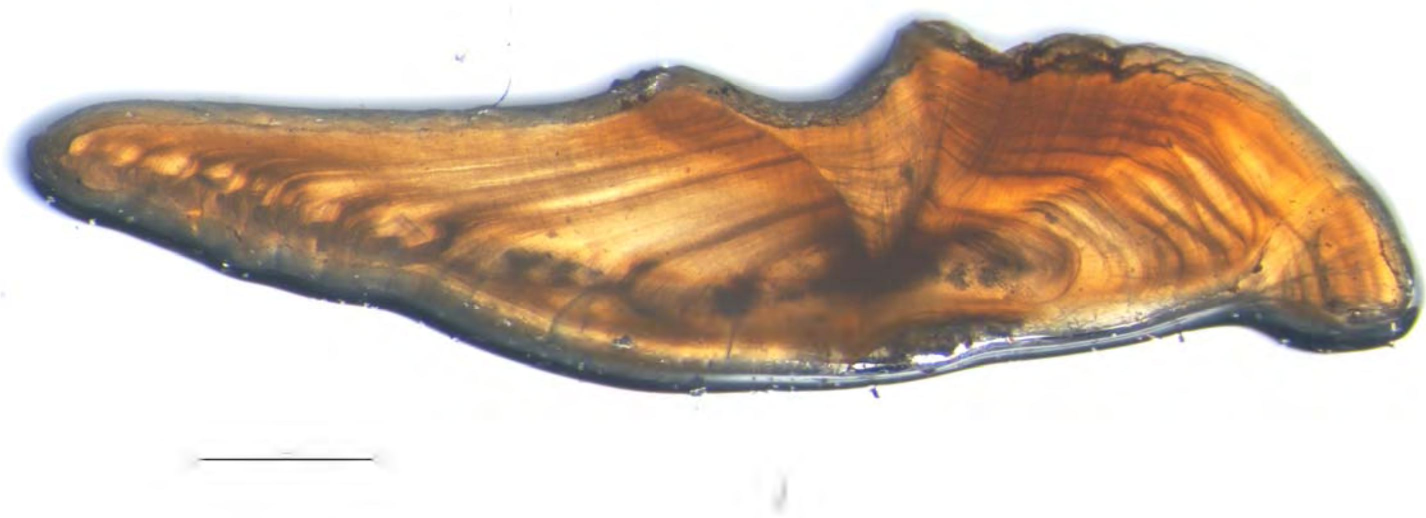
Striped Bass 22 3/2018



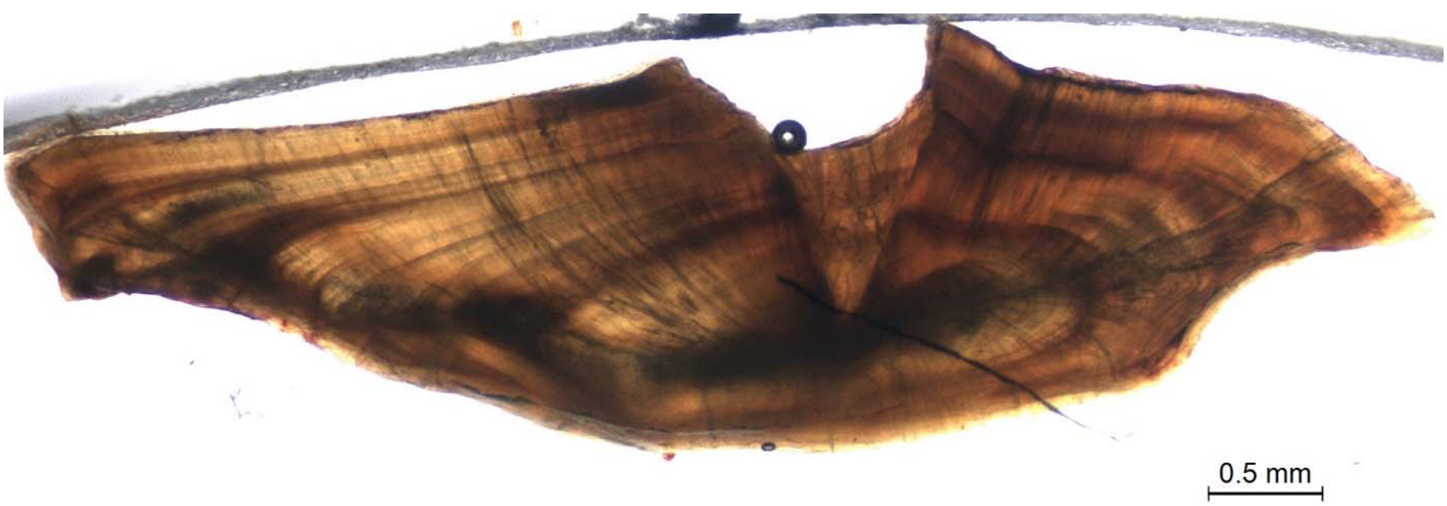
Striped Bass 23 10/13/2018

Striped Bass 24 5/21/2018

Striped Bass 25 7/3/2014

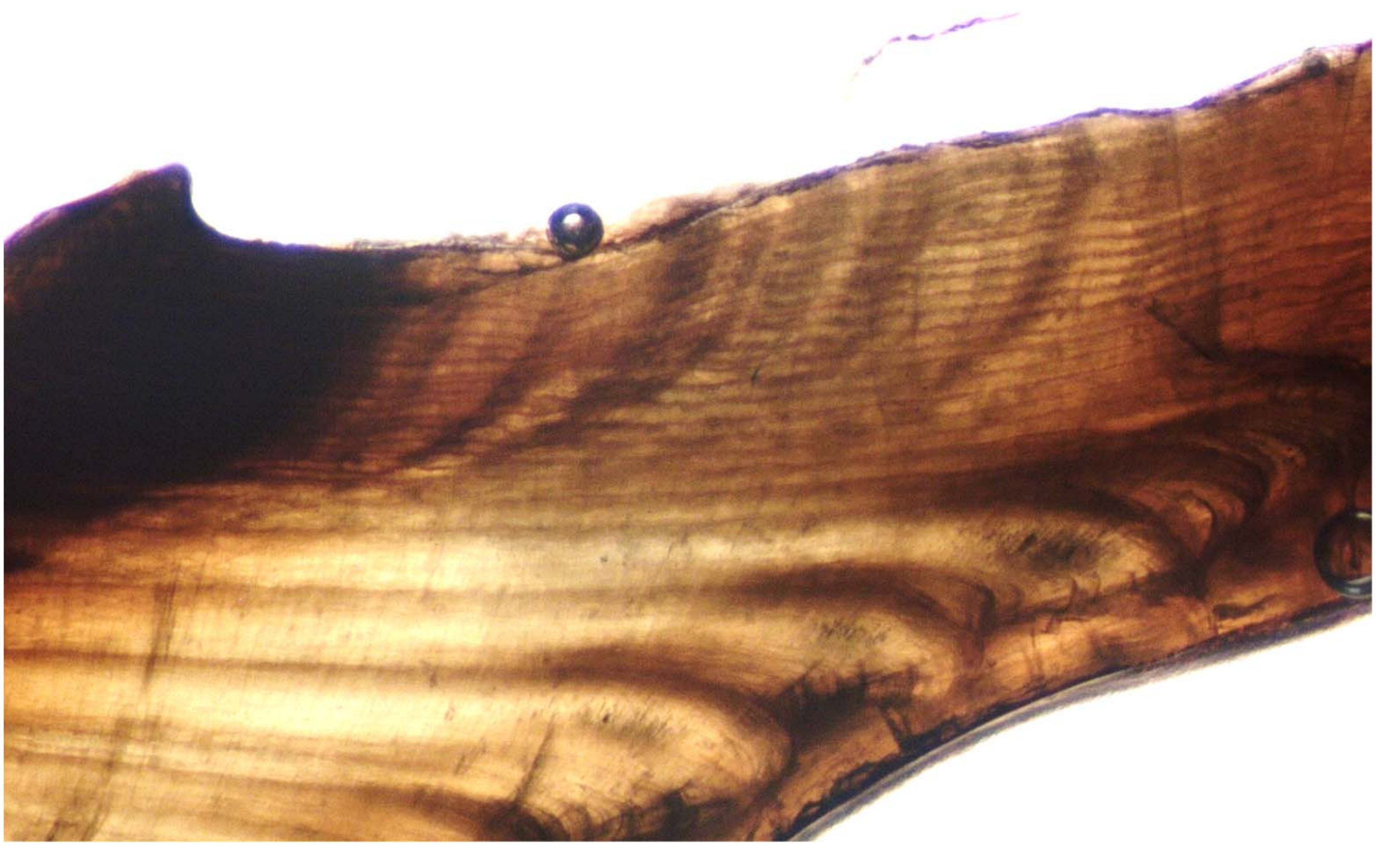
Striped Bass 26 12/3/2018

Striped Bass 27 1/25/2018



Striped Bass 28 3/9/2015

Striped Bass 29 3/4/2015



Striped Bass 30 8/3/2018