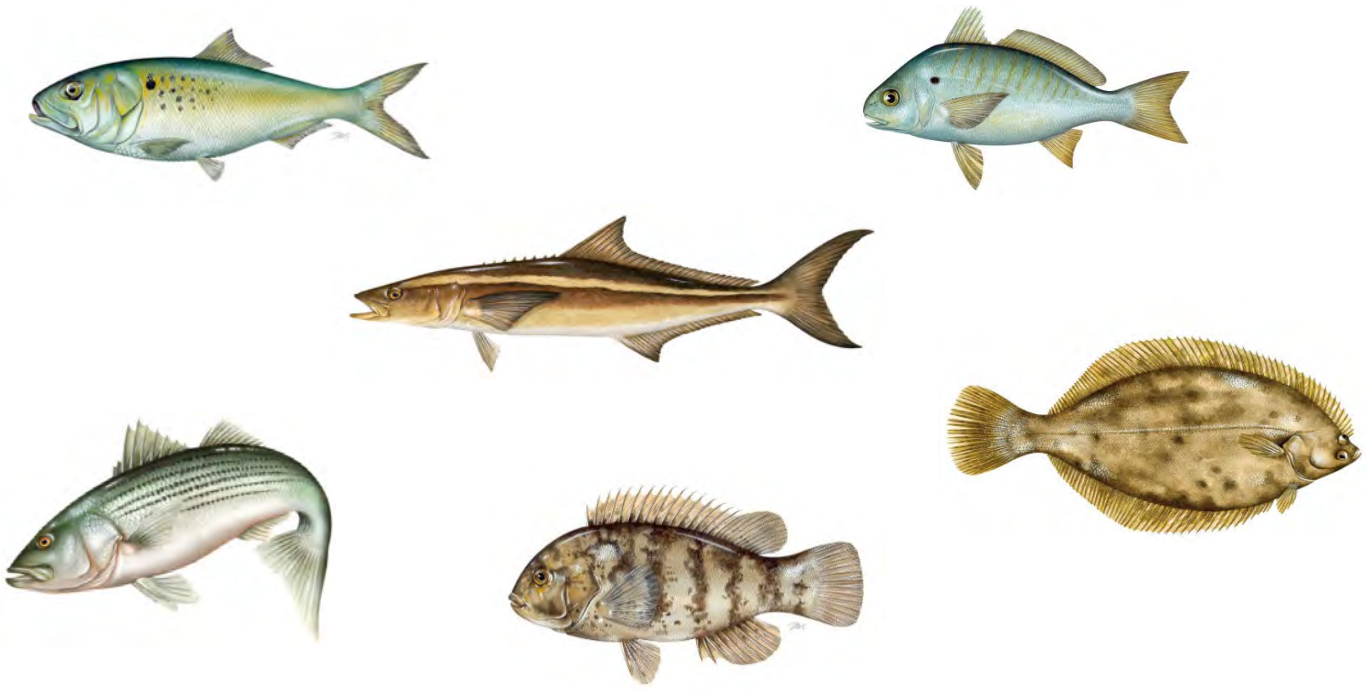
Atlantic States Marine Fisheries Commission

Report of the Quality Assurance/Quality Control Fish Ageing Workshop



St. Petersburg, Florida
April 8-9, 2026

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: Scott Elzey (MA DMF), Eric Robillard (NEFSC), Nicole Lengyel Costa (RI DMF), David Ellis (CT DEEP), Zach Shuller (NY DEC), Jamie Darrow (NJ DW), Alexandria Hoffman (DE DFW), Miranda Rosen (MD DNR), Melanie Chattin (VIMS), Hongsheng Liao (VMRC), Sara Pace (NC DMF), Jessica Branscome (SEFSC), Amanda Rezek (SEFSC), Jonathan Tucker (SC DNR), Donna McDowell (GA DNR), and Jessica Carroll (FL FWC). A special thanks to Jessica Carroll, Kristin Cook, Kiley Gray, and Brittany Bottom with FL FWC for hosting, preparing the samples, and leading the group through the workshop. The Commission also thanks Jessica Carroll for coordinating the workshop and Samara Nehemiah (ASMFC) for coordinating the workshop and preparing this report.

Statement of Problem

Many of the stock assessments for fish species managed by the Atlantic States Marine Fisheries Commission (ASMFC) have identified the collection of ageing hard parts, development of sample processing and reading protocols, and regular sample exchanges as research priorities. Several species managed by the ASMFC have had their own ageing structure exchange and workshop to address this. However, there is a continued need for a quality assurance/quality control (QA/QC) workshop because any gradual decline in ageing accuracy could have detrimental effects on stock assessments and consistency should be monitored over time (Campana 2001). Following the Gulf States Marine Fisheries Commission (GSMFC) protocol to hold annual QA/QC workshops for its participating members, the ASMFC made an annual QA/QC fish ageing workshop a research priority. Since 2016, a QA/QC Fish Ageing Workshop has been held, with the exception of the pandemic years of 2020-2022, to provide a regular check-in for species that have had their own ageing workshop, use age data in their assessments, or are assessed with an age-structured model.

The full QA/QC sample collection contains approximately 20 samples from each of the following species: Atlantic croaker *(Micropogonias undulatus)*, Atlantic menhaden *(Brevoortia tyrannus)*, Atlantic striped bass *(Morone saxatilis)*, American eel *(Anguilla rostrata)*, black drum *(Pogonias cromis)*, black sea bass *(Centropristis striata)*, bluefish *(Pomatomus saltatrix)*, cobia *(Rachycentron canadum)*, red drum *(Sciaenops ocellatus)*, scup *(Stenotomus chrysops)*, spot *(Leiostomus xanthurus)*, summer flounder *(Paralichthys dentatus)*, tautog *(Tautoga onitis)*, weakfish *(Cynoscion regalis)*, and winter flounder *(Pseudopleuronectes americanus)*. Samples were provided by various ageing labs and programs along the Atlantic coast and each collection program, sample preparation, and age determination method by species and lab are described in Appendix B: State Sample Collection, Preparation, and Ageing Methodology.

The workshop previously evaluated 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. Similarly, American eel was added to the collection in 2019 following its own ageing workshop but agers did not recommend maintaining this species in the QA/QC collection because few agers at the workshop age American eel, ages are not used in the stock assessment, and sample appearance varies widely by collection area.

Samples in the QA/QC collection include scales, whole otoliths, sectioned otoliths, spines, and/or opercula depending on the species and which hard part is used to provide ages to the ASMFC during stock assessments. The Ageing Committee decided to rotate species every few years so that more species could be included in the workshop. Atlantic menhaden, cobia, spot, striped bass, tautog, and winter flounder were identified as species to evaluate for the 2026 QA/QC workshop which took place from April 8-9th at the Florida Fish and Wildlife Research Institute (FL FWRI) in St. Petersburg, FL (Appendix A: Agenda).

Workshop Objectives

The objectives of the 2026 workshop were to:

(1) Age samples collected and prepared from labs along the Atlantic coast for Atlantic menhaden, cobia, spot, striped bass, tautog, and winter flounder.
(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.

Workshop Proceedings and Methods

Workshop participants met on Wednesday, April 8th, in a conference room at the FL FWRI building in St. Petersburg to go over the goals of the workshop, agenda, and to make introductions (Appendix A: Agenda). Jessica Carroll and the staff at Florida's Fish and Wildlife Conservation (FL FWC) Commission including Kristin Cook, Kiley Gray, and Brittany Bottom set up stations ahead of the workshop for the hard part reading exercise. Participants broke into four groups, each led by a FL FWC employee, and began ageing the structures at each station (Appendix C: Sample Photos). 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. Participants were able to identify their ageing experience for each species or hard part as None (no experience ageing this species), Minimal (some instruction in ageing or have aged a few individuals during trainings or workshops), Some (two or more years ageing this species), and Experienced (I am confident ageing this species and train others to age this species). Only individuals that noted their experience level as Some or Experienced were included in analysis between labs. However, all groups were considered in the analysis, regardless of accumulative experience within groups.

For each of the six species, every member of the group aged the samples (n=20-40 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 (GSMFC 2020). 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 month 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 Evans-Hoenig test of symmetry around the diagonal 1:1 line (Evans and Hoenig 1998) where a significant p-value (<0.05) indicates systematic bias between the age readings. Without knowing the true age of the fish, this test does not identify which reader is more accurate but rather identifies whether there are differences or not. Mean coefficient of variation (CV), percent of exact agreement between readers, and percent agreement within one year was also calculated for each lab and reader to provide a measure of precision. While this does not serve as a proxy for accuracy, it does indicate the level of ease for assigning an age to that ageing structure, the reproducibility of the age, or the skill level of the readers. Generally, CVs of 5% serve as a reference point for determining precision, where greater values indicate ageing imprecision (Campana 2001).

Workshop Results

On April 9th, the attendees of the workshop met to go over the APE for each species and results from individual age readers, revisit samples with high disagreement, and make recommendations for following workshops or coastwide ageing (Appendix A: Agenda). The APE varied by species throughout the years of the workshop (Table 2). Discussion and results for each species follows and sample images are available in Appendix C: Sample Photos.

I. Atlantic Menhaden

The ASMFC completed a paired sample exchange for Atlantic menhaden in 2025 which indicated poor agreement between scales, otolith and paired samples (ASMFC 2025b). Following the exchange, the QA/QC set was replenished with both scale and otolith samples. Additionally, the annuli deposition timeline was updated by the Southeast Fisheries Science Center (SEFSC) to include the stock assessment assumed birthdate of March 1 (Figure 1). The 2026 QA/QC workshop included 21 scales, 3 sectioned otoliths, and 11 whole otoliths, with 14 scales having a paired section or whole otolith sample. Both agers from the SEFSC were experienced ageing menhaden samples, and agers from the Massachusetts Division of Marine Fisheries (MA DMF), New York Department of Environmental Conservation (NY DEC), and the Virginia Institute of Marine Science (VIMS) had some experience with ageing menhaden. However, VIMS did not have experience ageing sectioned otoliths and were not included in analysis for that structure.

Atlantic menhaden had some of the highest APEs of all the species aged at the 2026 workshop, though the overall APE was the lowest it has been since 2016. Sectioned otoliths had the highest overall APE (>15%; Table 2), although the sample size was small (n=3). Scales had higher APE than otoliths (Table 3). The Evans-Hoenig test of symmetry indicated bias between labs for scales (Table 4) but there was relatively good agreement within one-year (Table 5). Sectioned

otoliths had high CVs between labs (Table 6) and 100% agreement within one-year (Table 7). Whole otoliths indicated imprecision between labs, some of which was statistically significant (Table 8). Additionally, exact agreement was low for this structure between some labs (range 36%-100%; Table 9). Comparison of paired ages between scales and whole otoliths suggested that there was not statistically significant bias between structures, although CVs were relatively high (11%), and these structures had 98% agreement within one-year (Figure 2). Bias between sectioned and whole otoliths were not compared due to the low sample size.

The group discussed differences and difficulty in identifying the first ring on scale structures. Additionally, the group had differences when labs decided to bump ages up in the spring months. Atlantic menhaden have a protracted spawning period along the Atlantic coast (Figure 1, Latour et al. 2023). Labs noted the potential for fish further north to have a longer period of annulus deposition in the spring, with varying growth. Specifically, the rule of June 1st as a cut off for bumping ages with marginal growth (e.g., ½ growth of the previous rings; Figure 1) was seen as too rigid of a rule for the northern states. This would be similar to a margin code of 3 or greater, though many states do not use margin codes when ageing samples outside of the QA/QC workshop. Therefore, the group recommended that states should collect data on marginal increment throughout the year in their region to understand if growth and ring deposition differs regionally.

Further, the group discussed progress and results from the Atlantic menhaden age exchange conducted across labs between 2024 and 2025. Due to poor agreement, labs agreed to work with neighboring states to gain practice ageing Atlantic menhaden and to improve agreement (ASMFC 2025). The group at the 2026 QA/QC also noted that exchange set samples did not hold up during the shipping process between labs and recommended mounting samples more securely such as using a more rigid structure, such as Blackwell trays, and to use Flo-texx to mount otolith samples or acetate pressings for scales.

II. Cobia

The cobia samples evaluated at the 2026 workshop consisted of 20 otolith samples. The timeline of annulus deposition and assumed birthdate are provided in Figure 3. Cobia otoliths had the lowest APE of any structure evaluated at this year's workshop (4.39%) which was similar to APE from the 2023 and 2024 workshops (Table 2). However, group 3 collectively had one ager with minimal experience ageing cobia, and the other three members had no experience. Agers from the Virginia Marine Resource Commission (VMRC), North Carolina Division of Marine Fishers (NC DMF), the Florida Fish and Wildlife Conservation Commission (FL FWC) and the Southeast Fisheries Science Center (SEFSC) had experience ageing cobia otolith. CVs were greater than 5% for some labs indicating some bias, but this was not statistically significant for any lab (Table 11). Exact agreement was at least 65% for all labs and agreement within a year was greater than 95% for all labs (Table 12).

The group noted that sample 18 caused disagreement between labs, likely due to a processing error. The group was unsure what to count as the first ring for this sample. Due to uncertainty with this sample, the group recommended this sample be removed from the collection and swapped with another sample next year.

III. Spot

The spot samples evaluated included 18 sectioned otoliths and 12 whole otoliths, for a total of 30 samples. The timeline of annulus deposition and assumed birthdate are provided in Figure 4. Twelve sections and whole otoliths were paired samples. The overall APE was 9.56% which was higher than the 2024 APE estimate (Table 13). However, the overall APE was driven by the whole otolith APE (22.12%), which was significantly higher than the sectioned otolith APE (1.19%). Labs that had experience with sectioned otoliths included Delaware Division of Fish and Wildlife (DE DFW), VMRC, the Virginia Institute of Marine Science (VIMS), South Carolina Department of Natural Resources (SC DNR), the SEFSC, and FL FWC. The DE DFW, VIMS, NC DMF, SC DNR, and FL FWC indicated experience ageing whole otoliths. Sectioned otoliths had no CVs that were greater than 5% or p-values less than 0.05, suggesting unbiased and precise ages (Table 14), and all labs had at least 94% exact agreement with other labs (Table 15). All but one intralab CVs for whole otoliths were greater than 5%, suggesting biased ages (0) and exact agreement ranged from 67% to 100% (Table 17). Comparison of ages between whole and sectioned otoliths suggested significant statistical bias between structures, where whole otoliths tended to be aged older (Figure 5).

The group discussed the difficulty of identifying the first annulus due to the presence of a ‘starburst’ pattern on whole otoliths. Labs noted that the starburst will extend beyond a check (false ring), and that rings within the starburst should not be counted. Some labs noted that they were counting the check as the first annulus, likely causing disagreement between groups and labs. Further, some labs noted that they intentionally sent tricky samples for the QA/QC collection. NC DMF and VIMS routinely age whole otoliths and will connect outside of the QA/QC to make sure they are on the same page when it comes to ageing whole otoliths. Additionally, NC suggested they can submit more samples for the QA/QC collection.

IV. Striped Bass

Striped bass samples considered for the 2026 workshop included 20 scales and 20 otoliths, for a total of 40 samples. The timeline of annulus deposition and assumed birthdate are provided in Figure 6. 15 scales and otolith samples were paired. Overall, average APE was 4.87%, which was lower than the 2024 and 2025 APEs (Table 2). However, scales had a higher APE (7.86%) compared to otoliths (1.88%). MA DMF, Rhode Island Department of Environmental Management (RI DEM), the NY DEC, the New Jersey Division of Fish and Wildlife (NJ DFW), DE DFW, VMRC and a reader with SEFSC had experience ageing striped bass scales. In addition to the labs with experience ageing scales, MA DMF, VIMS, and NC DMF had experience with ageing striped bass otoliths. For striped bass scales, many labs had CVs >5% and a few labs had p-values <0.05, suggesting significant bias between labs (Table 19). Exact agreement of scales

ranged from 20% to 100% (Table 20). For striped bass otoliths, few labs had CVs >5% between labs and no p-values were <0.05, suggesting unbiased otolith ages between labs (0). Exact agreement of otolith ranged from 60%-100%, with all labs having 100% agreement within one-year (Table 22). Paired scale and otolith samples did not have a strong statistical bias and had an overall exact agreement of 58% (Figure 7).

The group discussed the spacing to the first ring and other growth considerations. One lab noted that the 1st ring should be within 30-50 mm of the core when using a 29mm lens on an EYECOM 3000 microfiche reader. This distance was determined by measuring the distance from the focus to the first annulus on a reference set of scale samples of known ages. Additionally, the group noted that there is often a check after age 2, which is likely due to fast growth at this age. Overall, the group noted that the QA/QC collection primarily consists of fish younger than age-9. However, the stock assessment has a plus group of age-15 (ASMFC 2024). Therefore, the QA/QC should be updated to include samples over age-9.

V. Tautog

The tautog samples evaluated for this workshop included 14 otoliths, 13 operculum, and 13 spines, for a total of 40 samples. The timeline of annulus deposition and assumed birthdate are provided in Figure 8. Average APE for the 2026 workshop was 6.11% which was slightly lower than the 2025 APE, but slightly higher than the 2024 APE (Table 2). Tautog spines had the highest APE (7.56%), followed by operculum (6.26%), then otolith (4.61%; Table 23). MA DMF, RI DEM, CT DEEP, NJ DFW, DE DFW, VMRC, and one reader from the SEFSC indicated experience ageing tautog operculum, spines, and otoliths. Additionally, VIMS had experience ageing otoliths for tautog. Most labs had CVs less than 5%, with few CVs above 5% (Table 24). Percent agreement of tautog otolith ages between labs varied but ranged from 43% and 100% (Table 25). Tautog opercles had higher CVs than otoliths, indicating higher bias between labs (0), and had low exact agreement ranging from 23% to 100% (Table 27). Tautog spines also had high CVs between labs (0), but exact agreement was improved from opercles (Table 29).

Tautog paired structures suggested relatively poor agreement, regardless of ageing structure. Tautog otolith and operculum did not have statistically significant bias, but relatively low agreement with 40% exact agreement and 68% agreement within one-year (Figure 9). Comparison of paired spines and operculum suggest that there was statistically significant bias between structures, where spines tended to be aged older for certain age classes (Figure 10). Finally, comparisons between spines and otoliths also suggest there was statistically significant bias between structures, where spines were aged younger for samples above 11-years old (Figure 11).

The group noted that growth is highly variable between individuals, but bumping between labs and groups could highlight the bias between ages. For example, group 4 noted that they tended to bump tautog that were captured in July (Figure 8). However, there are limited samples collected in the summer so there are limited opportunities to age these summer fish with different growth patterns. The group also noted that there were differences in how state

prepared spines on the slide. One lab noted that they arrange spine sections closer to the body of the fish to further away from left to right on the slide, but it is unclear how other labs processed those samples for this collection. Because some spine samples do not show clear views of the rings and readers may use multiple spine sections to get an annuli count, labs should take caution in how spines are processed. For ageing operculum, the group noted that looking towards the 'elbow' may provide a clearer read.

Similarly, states have begun to transition away from operculum and have prioritized ageing spines (ASMFC 2025b), which was recommended in previous QA/QC workshops (ASMFC 2021, 2012). Currently, the tautog assessment considers 4 regional stock assessments with geographical similarities (ASMFC 2025b). The 2025 update suggested that states should continue to evaluate agreement and bias between tautog structures as they transition to new ageing structures before the next benchmark assessment which will likely be in 2028 (ASMFC 2025c). However, the group noted that some agers and field biologists are unclear of the FMP requirements and research recommendations when it comes to ageing species, including tautog. Therefore, the group recommended that ASMFC develop an ageing requirement document, with information on stock assessment requirements and research needs, so that agers are more familiar with the necessary ageing requirements for each species.

VI. Winter Flounder

Winter flounder samples evaluated in this year's workshop included 20 sectioned otoliths, and 20 whole otoliths, with a total of 40 samples. The timeline of annulus deposition and assumed birthdate are provided in Figure 12. Average APE was high compared to other species (9.65%) and was higher than all previous QA/QC workshops (Table 2, Table 30). However, this trend was driven by the APE of whole otoliths, which was the highest of any structure evaluated this year (16.84%). Labs that had experience ageing sectioned otoliths included MA DMF, the Northeast Fisheries Science Center (NEFSC), RI DEM, CT DEEP, and VIMS. Only MA DMF, NEFSC, and CT DEEP had experience ageing whole otoliths. However, only MA DMF and NEFSC were identified as experienced agers. For sectioned otolith, all CVs were 5% or less (Table 31), and exact agreement between labs were all greater than 65% (Table 32). CVs for whole otolith were very high, but not statistically significant (Table 33,32), and exact agreement ranged from 35%-65% (0). Paired whole and sectioned samples suggest some bias, though not statistically significant, where sectioned otoliths were aged older than whole otoliths for most ages (Figure 13).

Previous workshops suggested that otolith samples from age-5 and older should be sectioned (ASMFC 2012a). The group noted that overall ageing whole otoliths is not recommended but has been done historically (NJ DEM, MA DMF). Both CT and NEFSC still age whole otolith for smaller fish, including age 4 and younger (CT DEEP) and for fish <20 cm (NEFSC). There was some disagreement between labs on when to bump depending on capture date and growth. Because MA DMF and NEFSC routinely age winter flounder and have experience with whole sections, the group recommended that those labs do an exchange in order to compare ages and

evaluate bias and agreement between samples. Additionally, this exchange should focus on criteria for bumping ages.

The group also suggested adding more paired samples to the collection. Because NJ provided both otoliths for the QA/QC collection, NJ can section one of the pairs so that the QA/QC can evaluate more paired samples next year. Additionally, the group recommended removing winter flounder paired samples for large fish from the collection in order to focus the comparison of paired structures on smaller individuals.

Workshop Recommendations

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

- Atlantic menhaden paired structures (scales and otoliths), tautog (spine, operculum, and otoliths), winter flounder paired samples (sectioned otolith and whole otolith), scup (scales and otoliths), bluefish, summer flounder, and black sea bass will be included at the 2027 QA/QC Fish Ageing Workshop.

- For winter flounder, the group should focus on smaller individuals as labs have transitioned to sectioning smaller winter flounder over time. The sample set will need to be replenished to include paired samples of smaller fish.

- For spot, NC and VIMS will work together to make sure they are on the same page ageing whole otoliths and identifying the first ring.

- For Atlantic menhaden, an exchange should be repeated to ensure samples are protected during shipping. Samples should be mounted more securely, including mounting samples on black well trays or with a medium such as Flo-texx.

- For Atlantic menhaden, states should explore whether there may be a difference in marginal increments by region.

- For tautog, DE will start to collect spines to compare age agreement between operculum and spines.

- For cobia, sample 18 should be replaced with a better sample.

- The ASMFC should develop a document that describes ageing requirements for each species and state, stock assessment age considerations, and research needs for ageing structures.

Tables

Table 1. Species included in the QA/QC reference collection along with the model used in the stock assessment and the age of the plus-group used in the model. If the species has had its own ageing workshop, it is indicated in the last column of the table. Shaded rows indicate the species examined during the 2025 QA/QC Workshop.

Species	Model	Age Plus Group	Source	Ageing Workshop
American eel	Trend analyses	N/A	ASMFC 2023	2017
Atlantic croaker	Trend analyses	N/A	ASMFC 2025c	2008
Atlantic menhaden	Statistical catch-at-age model (BAM)	6+	ASMFC 2025d	2023
Black drum	Age-structured production model (JABBA-Select)	N/A	ASMFC 2023b	
Black sea bass	Statistical catch-at-age model (Mid-Atlantic Stock: ASAP, South Atlantic Stock: BAM)	8+	NEFSC 2025; SEDAR 76 (SEDAR 2023)	2013
Bluefish	Statistical catch-at-age model (ASAP)	6+	NEFSC 2025b	2011
Cobia	Statistical catch-at-age model (BAM)	12+	SEDAR 58 (SEDAR 2020)	
Red drum	Statistical catch-at-age model (SS3)	7+	ASMFC 2024b	2008
Scup	Statistical catch-at-age model (ASAP)	7+	NEFSC 2025c	1979, 2014
Striped bass	Statistical catch-at-age model	15+	ASMFC 2024a	2003
Spot	Trend analysis	N/A	ASMFC 2025e	
Summer flounder	Statistical catch-at-age model (ASAP)	7+	NEFSC 2025d	2014
Tautog	Statistical catch-at-age model (ASAP)	12+	ASMFC 2025b	2012, 2021
Weakfish	Statistical catch-at-age model	6+	ASMFC 2025f	
Winter flounder	Swept-area (Gulf of Maine Stock); Statistical catch-at-age model (ASAP; S. New England/MA Stock)	7+	NEFSC 2025e	2012

Table 2. The ageing structure with sample size in parentheses and average percent error (APE) between the four ageing groups for each species aged at the annual QA/QC Fish Ageing Workshops.

Species	Ageing structure (sample size)	2016	2017	2018	2019	2023	2024	2025	2026
Alewife	scales (5), otoliths (5)	13.23%	-------	-------	-------	-------	-------	-------	-------
American Eel	otoliths (20)	-------	-------	-------	10.37%	-----	-------	-------	-------
Atlantic Croaker	otoliths (20)	7.76%	10.57%	-------	0.62%	-------	3.03%	-------	-------
Atlantic Menhaden	scales (21), otoliths (10 whole, 3 sectioned)	-------	15.42%	13.45%	-------	-------	-------	15.90%	10.36%
Black Drum	otoliths (20)	-------	-------	-------	-------	-------	3.41%	-------	-------
Black Sea Bass	otoliths (10 sectioned, 10 whole)	3.67%	------	12.71%	-------	7.55%	7.06	5.58	-------
Bluefish	otoliths (20)	23.06%	25.60%	17.69%	-------	5.78%	2.95%	-------	-------
Cobia	otoliths (20)	-------	-------	-------	-------	4.35%	4.87%	-------	4.39%
Red Drum	otoliths (20)	-------	-------	26.77%	-------	0.31%	-------	0.00%	-------
Scup	otoliths (14), scales (6)	-------	-------	11.60%	-------	5.32%	8.25%	-------	-------
Spot	otoliths (18 section, 12 whole)	-------	-------	-------	-------	-------	4.56%	-------	9.56%
Striped bass	scales (20), otoliths (20)	4.96%	------	7.54%	5.90%	-------	11.50%	8.18%	4.87%
Summer Flounder	scales (6), otoliths (14)	-------	3.63%	-------	6.85%	-------	2.37%	-------	-------
Tautog	opercula (13), pelvic spine (13), otoliths (14)	6.09%	10.89%	11.28%	8.17%	9.55%	5.48%	7.89%	6.11%
Weakfish	otoliths (20)	-------	-------	-------	-------	0.00%	-------	-------	-------
Winter Flounder	otoliths (20 sectioned, 20 whole)	-------	4.41%	-------	7.78%	-------	7.75%	7.76%	9.65%

Table 3. Ageing worksheet for Atlantic menhaden at the workshop with the sample number, lab providing the sample, ageing structure, catch month 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 #1-21 are scales, samples #22-24 are sectioned otoliths, and samples #25-35 are whole otoliths.

Sample	Lab	Structure	Catch date	Group1			Group2			Group3			Group4			Average Age	APE
1	RI	Scale	5/27/2014	3	1	3	3	2	3	3	2	3	2	3	3	3	0%
2	MD	Scale	6/1/2016	4	2	4	4	2	4	4	1	4	4	1	4	4	0%
3	RI	Scale	6/2/2017	3	2	3	4	2	4	3	2	3	2	2	2	3	17%
4	NCDMF	Scale	3/20/2014	4	3	5	3	2	3	4	1	4	3	4	4	4	13%
5	MA	Scale	5/27/2025	3	2	3	3	2	3	3	2	3	3	3	4	3.25	12%
6	MA	Scale	5/21/2025	3	2	3	3	2	3	3	2	3	3	2	3	3	0%
7	MA	Scale	5/21/2025	5	1	5	4	3	5	5	1	5	5	1	5	5	0%
8	RI	Scale	5/12/2017	2	4	3	3	2	3	3	1	3	3	1	3	3	0%
9	NCDMF	Scale	1/6/2014	1	4	1	1	3	1	1	3	1	1	3	2	1.25	30%
10	MA	Scale	5/19/2025	4	1	4	3	1	3	4	1	4	5	1	5	4	13%
11	MD	Scale	7/5/2016	4	2	4	3	2	3	5	2	5	4	1	4	4	13%
12	MA	Scale	5/27/2025	3	4	4	3	2	3	3	2	3	3	3	4	3.5	14%
13	MA	Scale	5/21/2025	3	2	3	3	2	3	3	2	3	3	2	3	3	0%
14	MA	Scale	5/19/2025	3	4	4	3	4	4	4	1	4	3	3	4	4	0%
15	MA	Scale	5/21/2025	3	1	3	2	4	3	3	2	3	3	4	4	3.25	12%
16	RI	Scale	5/13/2017	0	4	1	1	2	1	1	3	2	1	3	2	1.5	33%
17	MD	Scale	9/8/2016	1	3	1	2	4	2	1	4	1	1	3	1	1.25	30%
18	NCDMF	Scale	10/26/2016	2	2	2	2	3	2	2	2	2	2	2	2	2	0%
19	MA	Scale	5/21/2025	3	2	3	3	2	3	3	2	3	3	1	3	3	0%
20	MA	Scale	5/19/2025	3	4	4	3	4	4	3	2	3	3	2	3	3.5	14%
21	MA	Scale	5/21/2025	3	3	4	3	2	3	3	2	3	5	1	5	3.75	20%
22	RI	Section	5/13/2017	3	2	3	3	4	4	3	2	3	3	2	3	3.25	12%
23	RI	Section	5/12/2017	3	2	3	5	1	5	2	2	2	2	3	3	3.25	27%
24	RI	Section	6/2/2017	5	1	5	3	4	4	5	3	5	4	4	5	4.75	8%
25	MA	Whole	5/21/2025	2	4	3	2	4	3	4	1	4	4	3	4	3.5	14%
26	MA	Whole	5/19/2025	2	4	3	3	4	4	3	4	4	3	4	4	3.75	10%
27	MA	Whole	5/19/2025	3	4	4	3	4	4	3	3	4	3	1	3	3.75	10%
28	MA	Whole	5/27/2025	2	4	3	3	4	4	3	3	4	3	4	4	3.75	10%
29	MA	Whole	5/21/2025	2	4	3	2	4	3	3	1	3	3	1	3	3	0%
30	MA	Whole	5/21/2025	3	4	4	3	4	4	6	1	6	5	1	5	4.75	16%

Sample	Lab	Structure	Catch date	Group1			Group2			Group3			Group4			Average Age	APE
31	MA	Whole	5/21/2025	2	4	3	2	4	3	3	1	3	3	1	3	3	0%
32	MA	Whole	5/21/2025	2	4	3	4	2	4	3	2	3	3	1	3	3.25	12%
33	MA	Whole	5/21/2025	4	1	4	4	4	5	4	1	4	5	1	5	4.5	11%
34	MA	Whole	5/27/2025	3	2	3	3	4	4	4	1	4	3	1	3	3.5	14%
35	MA	Whole	5/19/2025	2	4	3	2	4	3	2	3	3	3	1	3	3	0%

Average APE	10.36%
Scale APE	10.44%
Section APE	15.45%
Whole APE	8.82%

Table 4. Symmetry test p-values for inter-lab age comparisons using Evans-Hoenig test of symmetry and CVs (%) for Atlantic menhaden scales. P-values appear above the shaded diagonal line and CVs are below. Significant p-values (p<0.05) and CVs higher than 5% are highlighted in yellow.

Lab	MA	NY	VIMS	SEFSC1	SEFSC2
MA		0.32	1.00	0.26	0.43
NY	1		0.32	0.48	0.56
VIMS	0	1		0.26	0.43
SEFSC1	8	9	8		0.55
SEFSC2	9	10	9	9	

Table 5. Percent exact agreement (below the shaded diagonal line) and agreement within one year (above the shaded diagonal line) between readers for Atlantic menhaden scales.

Lab	MA	NY	VIMS	SEFSC1	SEFSC2
MA		100	100	100	95
NY	95		100	100	95
VIMS	100	95		100	95
SEFSC1	67	62	67		95
SEFSC2	67	62	67	71	

Table 6. Symmetry test p-values for inter-lab age comparisons using Evans-Hoenig test of symmetry and CVs (%) for Atlantic menhaden sectioned otoliths. P-values appear above the shaded diagonal line and CVs are below. Significant p-values (p<0.05) and CVs higher than 5% are highlighted in yellow.

Lab	MA	NY	SEFSC1	SEFSC2
MA		1	0.32	0.61
NY	0		0.32	0.61
SEFSC1	9	9		0.61
SEFSC2	24	24	32	

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

Lab	MA	NY	SEFSC1	SEFSC2
MA		100	100	100
NY	100		100	100
SEFSC1	67	67		100
SEFSC2	0	0	0	

Table 8. Symmetry test p-values for inter-lab age comparisons using Evans-Hoenig test of symmetry and CVs (%) for Atlantic menhaden whole otoliths. P-values appear above the shaded diagonal line and CVs are below. Significant p-values (p<0.05) and CVs higher than 5% are highlighted in yellow.

Lab	MA	NY	SEFSC1	SEFSC2
MA		1	0.51	0.03
NY	0		0.51	0.03
SEFSC1	8	8		0.16
SEFSC2	9	9	13	

Table 9. Percent exact agreement (below the shaded diagonal line) and agreement within one year (above the shaded diagonal line) between readers for Atlantic menhaden whole otoliths.

Lab	MA	NY	SEFSC1	SEFSC2
MA		100	100	100
NY	100		100	100
SEFSC1	64	64		91
SEFSC2	55	55	36	

Table 10. Ageing worksheet for cobia at the workshop with the sample number, lab providing the sample, ageing structure, catch month 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.

Species	Sample	Lab	Structure	Catch date	Group1			Group2			Group3			Group4			Average Age	APE
Cobia	1	VMRC	Otolith	7/9/2018	3	1	3	3	1	3	3	2	3	3	1	3	3	0%
Cobia	2	VMRC	Otolith	9/2/2018	8	2	8	8	3	8	8	2	8	8	2	8	8	0%
Cobia	3	FWRI	Otolith	10/8/2021	3	3	3	3	3	3	4	3	4	3	2	3	3.25	12%
Cobia	4	VIMS	Otolith	9/1/2012	4	3	4	4	2	4	5	2	5	4	2	4	4.25	9%
Cobia	5	SCDNR	Otolith	6/11/2016	4	1	4	4	1	4	5	1	5	4	1	4	4.25	9%
Cobia	6	FWRI	Otolith	10/11/2021	5	3	5	5	3	5	5	2	5	5	2	5	5	0%
Cobia	7	FWRI	Otolith	10/8/2021	4	3	4	4	2	4	5	2	5	4	2	4	4.25	9%
Cobia	8	VMRC	Otolith	6/1/2018	7	1	7	5	4	6	7	1	7	7	1	7	6.75	6%
Cobia	9	SCDNR	Otolith	5/24/2016	7	1	7	6	4	7	7	1	7	6	1	6	6.75	6%
Cobia	10	SCDNR	Otolith	5/26/2016	8	4	9	8	4	9	12	1	12	8	4	9	9.75	12%
Cobia	11	SCDNR	Otolith	5/17/2016	7	4	8	7	4	8	8	4	9	6	4	7	8	6%
Cobia	12	VMRC	Otolith	7/16/2022	8	1	8	8	1	8	9	1	9	8	1	8	8.25	5%
Cobia	13	VMRC	Otolith	7/8/2022	3	1	3	3	1	3	3	1	3	3	1	3	3	0%
Cobia	14	VIMS	Otolith	5/1/2019	3	1	3	3	1	3	3	2	3	2	4	3	3	0%
Cobia	15	SCDNR	Otolith	6/9/2016	9	1	9	10	1	10	10	1	10	9	1	9	9.5	5%
Cobia	16	FWRI	Otolith	3/15/2021	1	4	2	2	1	2	2	1	2	1	4	2	2	0%
Cobia	17	VMRC	Otolith	8/11/2018	11	2	11	11	1	11	11	2	11	11	1	11	11	0%
Cobia	18	VMRC	Otolith	6/16/2018	4	1	4	4	4	5	5	1	5	4	1	4	4.5	11%
Cobia	19	VIMS	Otolith	9/1/2017	2	3	2	2	3	2	2	3	2	2	2	2	2	0%
Cobia	20	FWRI	Otolith	2/26/2021	1	4	2	2	1	2	2	1	2	2	1	2	2	0%
																	Average APE	4.39%

Table 11. Symmetry test p-values for inter-lab age comparisons using Evans-Hoenig test of symmetry and CVs (%) for cobia otoliths. P-values appear above the shaded diagonal line and CVs are below. Significant p-values (p<0.05) and CVs higher than 5% are highlighted in yellow.

Lab	VMRC	NC	SEFSC2	FL
VMRC		0.1	0.56	0.61
NC	4		0.06	0.37
SEFSC2	2	5		0.39
FL	10	8	10	

Table 12. Percent exact agreement (below the shaded diagonal line) and agreement within one year (above the shaded diagonal line) between readers for cobia otoliths.

Lab	VMRC	NC	SEFSC2	FL
VMRC		100	100	95
NC	70		100	95
SEFSC2	85	65		95
FL	70	80	70	

Table 13. Ageing worksheet for spot at the workshop with the sample number, lab providing the sample, ageing structure, catch month 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 #1-18 are sectioned otoliths and samples #19-30 are whole otoliths.

Species	Sample	Lab	Structure	Catch date	Group1			Group2			Group3			Group4			Average Age	APE
Spot	1	VIMS	Section	7/2/2003	5	1	5	5	1	5	5	2	5	5	1	5	5	0%
Spot	2	VIMS	Section	10/21/2025	1	2	1	1	3	1	1	3	1	1	2	1	1	0%
Spot	3	FL	Section	12/19/2016	4	4	4	4	1	4	4	4	4	4	4	4	4	0%
Spot	4	VIMS	Section	10/2/2025	1	3	1	1	4	1	1	4	1	1	3	1	1	0%
Spot	5	SCDNR	Section	1/4/2022	0	4	1	0	4	1	0	4	1	0	3	1	1	0%
Spot	6	SCDNR	Section	9/12/2022	1	3	1	1	4	1	1	4	1	1	3	1	1	0%
Spot	7	FL	Section	7/21/2021	2	1	2	2	2	2	2	2	2	2	2	2	2	0%
Spot	8	VIMS	Section	9/2/2021	2	2	2	2	3	2	1	3	1	2	2	2	1.75	21%
Spot	9	VIMS	Section	9/4/2019	0	3	0	0	4	0	0	3	0	0	2	0	0	0%
Spot	10	SCDNR	Section	9/26/2022	3	3	3	3	4	3	3	3	3	3	3	3	3	0%
Spot	11	VIMS	Section	11/13/2016	0	4	0	0	4	0	0	3	0	0	3	0	0	0%
Spot	12	VIMS	Section	9/14/2002	3	2	3	3	2	3	3	3	3	3	3	3	3	0%
Spot	13	VIMS	Section	9/2/2021	1	2	1	1	3	1	1	3	1	1	2	1	1	0%
Spot	14	FL	Section	7/21/2021	3	2	3	3	2	3	3	2	3	3	2	3	3	0%
Spot	15	VIMS	Section	5/6/2014	2	4	3	2	4	3	2	4	3	2	3	3	3	0%
Spot	16	VIMS	Section	10/22/2025	2	4	2	2	4	2	2	3	2	2	3	2	2	0%
Spot	17	VIMS	Section	10/1/2025	2	4	2	2	4	2	2	3	2	2	3	2	2	0%
Spot	18	VIMS	Section	10/11/2017	0	4	0	0	4	0	0	3	0	0	3	0	0	0%
Spot	19	VIMS	Whole	5/6/2014	2	4	3	2	3	3	2	2	2	2	3	3	2.75	14%
Spot	20	VIMS	Whole	9/4/2019	0	3	0	0	4	0	0	3	0	0	0	0	0	0%
Spot	21	VIMS	Whole	10/1/2025	2	3	2	2	4	2	2	3	2	2	3	2	2	0%
Spot	22	VIMS	Whole	10/2/2025	2	3	2	3	2	3	2	4	2	3	2	3	2.5	20%
Spot	23	VIMS	Whole	10/22/2025	2	4	2	2	4	2	4	4	4	1	3	1	2.25	39%
Spot	24	VIMS	Whole	11/13/2016	0	4	0	0	4	0	0	4	0	0	3	0	0	0%

Species	Sample	Lab	Structure	Catch date	Group1			Group2			Group3			Group4			Average Age	APE
Spot	25	VIMS	Whole	9/2/2021	2	4	2	2	4	2	2	3	2	1	3	1	1.75	21%
Spot	26	VIMS	Whole	10/11/2017	0	4	0	1	2	1	0	3	0	0	3	0	0.25	150%
Spot	27	VIMS	Whole	10/21/2025	2	3	2	2	4	2	2	3	2	1	3	1	1.75	21%
Spot	28	VIMS	Whole	9/2/2021	1	3	1	1	3	1	1	3	1	1	3	1	1	0%
Spot	29	VIMS	Whole	7/2/2003	5	1	5	5	1	5	4	4	5	5	1	5	5	0%
Spot	30	VIMS	Whole	9/14/2002	3	3	3	3	2	3	3	2	3	3	2	3	3	0%
																	Average APE	9.56%
																	Section APE	1.19%
																	Whole APE	22.12%

Table 14. Symmetry test p-values for inter-lab age comparisons using Evans-Hoenig test of symmetry and CVs (%) for spot sectioned otoliths. P-values appear above the shaded diagonal line and CVs are below. There were no significant p-values (p<0.05) or CVs greater than 5%.

Lab	DE	VMRC	VIMS	SEFSC2	SC	FL
DE		0.32	0.32	0.32	1.00	0.32
VMRC	3		1.00	1.00	0.32	1.00
VIMS	3	0		1.00	0.32	1.00
SEFSC2	3	0	0		0.32	1.00
SC	0	3	3	3		0.32
FL	3	0	0	0	3	

Table 15. Percent exact agreement (below the shaded diagonal line) and agreement within one year (above the shaded diagonal line) between readers for spot sectioned otoliths.

Lab	DE	VMRC	VIMS	SEFSC2	SC	FL
DE		100	100	100	100	100
VMRC	94		100	100	100	100
VIMS	94	100		100	100	100
SEFSC2	94	100	100		100	100
SC	100	94	94	94		100
FL	94	100	100	100	94	

Table 16. Symmetry test p-values for inter-lab age comparisons using Evans-Hoenig test of symmetry and CVs (%) for spot whole otoliths. P-values appear above the shaded diagonal line and CVs are below. Significant p-values (p<0.05) and CVs higher than 5% are highlighted in yellow.

Lab	DE	VIMS	NC	SC	FL
DE		0.61	0.61	1.00	0.37
VIMS	18		0.37	0.61	0.32
NC	20	26		0.61	0.32
SC	0	18	20		0.37
FL	6	12	14	6	

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

Lab	DE	VIMS	NC	SC	FL
DE		92	92	100	92
VIMS	75		92	92	92
NC	58	58		100	100
SC	100	75	58		92
FL	83	92	67	83	

Table 18. Ageing worksheet for striped bass at the workshop with the sample number, lab providing the sample, ageing structure, catch month 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 #1-20 are scales and samples #20-40 are otoliths.

Species	Sample	Lab	Structure	Catch date	Group1			Group2			Group3			Group4			Average Age	APE
Striped bass	1	RI	Scale	8/5/2015	9	4	9	11	2	11	9	1	9	10	1	10	9.75	8%
Striped bass	2	NY	Scale	7/15/2015	5	2	5	5	3	5	7	2	7	5	2	5	5.5	14%
Striped bass	3	NY	Scale	7/1/2015	4	2	4	4	3	4	3	2	3	4	2	4	3.75	10%
Striped bass	4	MA	Scale	6/17/2024	7	1	7	8	1	8	7	1	7	6	4	7	7.25	5%
Striped bass	5	MA	Scale	7/23/2024	5	2	5	6	2	6	5	2	5	5	1	5	5.25	7%
Striped bass	6	ME	Scale	6/20/2012	2	1	2	2	1	2	2	2	2	2	1	2	2	0%
Striped bass	7	RI	Scale	2/24/2022	2	4	3	2	4	3	1	4	2	1	3	2	2.5	20%
Striped bass	8	MA	Scale	7/1/2024	9	2	9	10	1	10	8	2	8	8	2	8	8.75	9%
Striped bass	9	VA	Scale	7/6/2021	6	2	6	6	2	6	6	2	6	6	1	6	6	0%
Striped bass	10	MA	Scale	8/3/2018	14	1	14	14	1	14	13	1	13	14	2	14	13.75	3%
Striped bass	11	RI	Scale	1/25/2018	3	2	3	2	4	3	2	4	3	2	3	3	3	0%
Striped bass	12	RI	Scale	2/6/2023	2	4	3	3	4	4	3	2	3	3	4	4	3.5	14%
Striped bass	13	DE	Scale	12/3/2018	1	4	1	1	4	1	1	4	1	1	3	1	1	0%
Striped bass	14	VIMS	Scale	3/19/2018	4	4	5	6	4	7	5	4	6	5	3	6	6	8%
Striped bass	15	RI	Scale	5/21/2018	3	4	4	3	4	4	3	1	3	3	1	3	3.5	14%
Striped bass	16	MA	Scale	7/18/2024	7	2	7	7	2	7	6	2	6	6	2	6	6.5	8%
Striped bass	17	MA	Scale	7/8/2024	9	1	9	8	1	8	10	1	10	9	1	9	9	6%
Striped bass	18	RI	Scale	1/20/2023	4	3	5	4	3	5	4	2	4	3	3	4	4.5	11%
Striped bass	19	MA	Scale	7/1/2024	6	1	6	7	1	7	5	1	5	5	1	5	5.75	13%
Striped bass	20	MA	Scale	9/1/2024	5	3	5	5	3	5	5	1	5	4	1	4	4.75	8%
Striped bass	21	MA	Otolith	7/1/2024	6	1	6	6	1	6	6	1	6	6	1	6	6	0%
Striped bass	22	MA	Otolith	9/15/2014	9	2	9	8	3	8	9	3	9	9	3	9	8.75	4%
Striped bass	23	SC	Otolith	12/18/2014	1	4	1	1	4	1	1	4	1	1	4	1	1	0%
Striped bass	24	RI	Otolith	5/21/2018	3	4	4	3	3	4	3	3	4	3	3	4	4	0%
Striped bass	25	MA	Otolith	7/3/2014	10	4	11	11	1	11	9	2	9	10	1	10	10.25	7%
Striped bass	26	DE	Otolith	12/3/2018	1	4	1	1	4	1	1	4	1	1	4	1	1	0%

Species	Sample	Lab	Structure	Catch date	Group1			Group2			Group3			Group4			Average Age	APE
Striped bass	27	RI	Otolith	1/25/2018	2	4	3	2	3	3	2	3	3	2	3	3	3	0%
Striped bass	28	VA	Otolith	7/6/2021	7	1	7	7	1	7	7	1	7	7	1	7	7	0%
Striped bass	29	MA	Otolith	6/17/2024	7	4	8	7	4	8	7	2	7	7	4	8	7.75	5%
Striped bass	30	MA	Otolith	7/23/2024	6	1	6	6	1	6	6	1	6	6	1	6	6	0%
Striped bass	31	RI	Otolith	1/20/2023	4	3	5	5	1	5	4	3	5	4	4	5	5	0%
Striped bass	32	MA	Otolith	7/18/2024	7	1	7	7	1	7	6	4	7	6	4	7	7	0%
Striped bass	33	SC	Otolith	4/8/2014	0	4	1	1	1	1	0	4	1	1	1	1	1	0%
Striped bass	34	RI	Otolith	2/24/2022	2	4	3	3	1	3	3	1	3	2	4	3	3	0%
Striped bass	35	MA	Otolith	7/8/2024	8	4	9	9	1	9	9	3	9	8	3	9	9	0%
Striped bass	36	MA	Otolith	9/1/2024	4	3	4	4	4	4	5	2	5	5	1	5	4.5	11%
Striped bass	37	VIMS	Otolith	6/1/2014	3	2	3	3	1	3	3	2	3	3	1	3	3	0%
Striped bass	38	VIMS	Otolith	3/19/2018	6	4	7	6	4	7	7	1	7	6	4	7	7	0%
Striped bass	39	MA	Otolith	7/1/2024	8	4	9	9	1	9	9	1	9	9	1	9	9	0%
Striped bass	40	RI	Otolith	2/6/2023	3	4	4	3	4	4	3	3	3	3	4	4	3.75	10%
																	Average APE	4.87%
																	Scale APE	7.86%
																	Otolith APE	1.88%

Table 19. Symmetry test p-values for inter-lab age comparisons using Evans-Hoenig test of symmetry and CVs (%) for striped bass scales. P-values appear above the shaded diagonal line and CVs are below. Significant p-values (p<0.05) and CVs higher than 5% are highlighted in yellow.

Lab	MA	RI	NY	NJ	DE	VMRC	SEFSC2
MA		0.1	0.16	0.10	0.17	0.12	0.10
RI	5		0.04	1.00	0.00	0.37	1.00
NY	2	7		0.04	0.19	0.06	0.04
NJ	5	0	7		0.00	0.37	1.00
DE	12	16	12	16		0.01	0.00
VMRC	7	2	9	2	16		0.37
SEFSC2	5	0	7	0	16	2	

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

Lab	MA	RI	NY	NJ	DE	VMRC	SEFSC2
MA		100	100	100	95	100	100
RI	60		90	100	80	100	100
NY	90	50		100	95	100	100
NJ	60	100	50		80	100	100
DE	40	20	45	20		90	90
VMRC	50	90	40	90	20		95
SEFSC2	60	100	50	100	20	90	

Table 21. Symmetry test p-values for inter-lab age comparisons using Evans-Hoenig test of symmetry and CVs (%) for striped bass otoliths. P-values appear above the shaded diagonal line and CVs are below. Significant p-values (p<0.05) and CVs higher than 5% are highlighted in yellow.

Lab	MA	RI	NY	NJ	DE	VMRC	VIMS	NC	SEFSC2
MA		0.32	1.00	0.32	0.26	0.32	1.00	1.00	0.32
RI	0		0.32	1.00	0.48	1.00	0.32	0.56	1.00
NY	0	0		0.32	0.26	0.32	1.00	1.00	0.32
NJ	0	0	0		0.48	1.00	0.32	0.56	1.00
DE	5	6	5	6		0.48	0.26	0.18	0.48
VMRC	0	0	0	0	6		0.32	0.56	1.00
VIMS	0	0	0	0	5	0		1.00	0.32
NC	1	2	1	2	4	2	1		0.56
SEFSC2	0	0	0	0	6	0	0	2	

Table 22. Percent exact agreement (below the shaded diagonal line) and agreement within one year (above the shaded diagonal line) between readers for striped bass otoliths.

Lab	MA	RI	NY	NJ	DE	VMRC	VIMS	NC	SEFSC2
MA		100	100	100	100	100	100	100	100
RI	95		100	100	100	100	100	100	100
NY	100	95		100	100	100	100	100	100
NJ	95	100	95		100	100	100	100	100
DE	65	60	65	60		100	100	100	100
VMRC	95	100	95	100	60		100	100	100
VIMS	100	95	100	95	65	95		100	100
NC	90	85	90	85	75	85	90		100
SEFSC2	95	100	95	100	60	100	95	85	

Table 23. Ageing worksheet for tautog at the workshop with the sample number, lab providing the sample, ageing structure, catch date of the sample, workshop group annulus counts, margin codes (scored from 1 to 4), and final age as well as average percent error (APE) values between groups. Samples #1-14 are otoliths, samples #15-27 are operculum, and samples #28-40 are spines.

Species	Sample	Lab	Structure	Catch date	Group1			Group2			Group3			Group4			Average Age	APE
Tautog	1	VIMS	Otolith	10/5/2017	2	3	2	2	3	2	2	2	2	2	2	2	2	0%
Tautog	2	RI	Otolith	10/24/2022	8	3	8	8	3	8	8	2	8	8	3	8	8	0%
Tautog	3	RI	Otolith	11/20/2019	17	3	17	20	3	20	18	2	18	19	1	19	18.5	5%
Tautog	4	DE	Otolith	11/18/2018	3	4	3	4	3	4	4	3	4	4	2	4	3.75	10%
Tautog	5	MA	Otolith	9/14/2025	3	2	3	3	3	3	3	3	3	3	2	3	3	0%
Tautog	6	RI	Otolith	11/20/2019	12	3	12	12	4	12	11	2	11	11	2	11	11.5	4%
Tautog	7	VMRC	Otolith	3/5/2022	19	4	20	20	4	21	21	3	22	21	4	22	21.25	4%
Tautog	8	DE	Otolith	11/18/2018	9	4	9	9	3	9	7	4	7	8	3	8	8.25	9%
Tautog	9	MA	Otolith	7/24/2025	10	4	11	9	2	9	9	1	9	10	3	11	10	10%
Tautog	10	RI	Otolith	11/4/2022	15	3	15	16	2	16	15	3	15	16	2	16	15.5	3%
Tautog	11	MA	Otolith	9/2/2025	5	3	5	4	3	4	4	2	4	5	2	5	4.5	11%
Tautog	12	MA	Otolith	7/24/2025	3	4	4	5	1	5	5	2	5	4	3	5	4.75	8%
Tautog	13	RI	Otolith	11/2/2022	4	3	4	4	2	4	4	2	4	4	2	4	4	0%
Tautog	14	MA	Otolith	7/29/2025	6	4	7	7	1	7	7	1	7	6	3	7	7	0%
Tautog	15	MA	Opercle	7/24/2025	11	1	11	11	1	11	10	1	10	10	1	10	10.5	5%
Tautog	16	RI	Opercle	11/2/2022	4	3	4	3	4	3	4	2	4	3	3	3	3.5	14%
Tautog	17	MA	Opercle	9/2/2025	5	3	5	6	3	6	5	2	5	6	2	6	5.5	9%
Tautog	18	MA	Opercle	7/24/2025	5	4	6	6	4	7	5	3	6	5	4	6	6.25	6%
Tautog	19	RI	Opercle	11/20/2019	18	4	18	20	2	20	18	2	18	19	1	19	18.75	4%
Tautog	20	RI	Opercle	11/5/2022	14	2	14	13	2	13	14	2	14	13	1	13	13.5	4%
Tautog	21	DE	Opercle	11/18/2018	7	3	7	7	3	7	9	2	9	9	2	9	8	13%
Tautog	22	DE	Opercle	11/18/2018	4	3	4	4	3	4	4	2	4	3	2	3	3.75	10%
Tautog	23	RI	Opercle	11/20/2019	11	3	11	12	4	12	12	3	12	12	2	12	11.75	3%
Tautog	24	VMRC	Opercle	3/5/2022	19	4	20	20	4	21	16	4	17	22	3	23	20.25	9%
Tautog	25	VIMS	Opercle	10/5/2017	2	3	2	2	1	2	2	2	2	2	2	2	2	0%

Species	Sample	Lab	Structure	Catch date	Group1			Group2			Group3			Group4			Average Age	APE
Tautog	26	MA	Opercle	7/29/2025	6	1	6	7	3	7	7	2	7	7	1	7	6.75	6%
Tautog	27	RI	Opercle	10/24/2022	7	3	7	7	4	7	7	2	7	7	2	7	7	0%
Tautog	28	RI	Spine	10/24/2022	8	4	8	8	4	8	8	1	8	8	3	8	8	0%
Tautog	29	RI	Spine	11/20/2019	18	3	18	19	4	19	18	2	18	19	1	19	18.5	3%
Tautog	30	MA	Spine	7/24/2025	10	3	11	11	1	11	11	1	11	11	1	11	11	0%
Tautog	31	MA	Spine	7/24/2025	5	1	5	5	1	5	5	2	5	5	1	5	5	0%
Tautog	32	DE	Spine	11/18/2018	9	4	9	7	2	7	10	2	10	10	3	10	9	11%
Tautog	33	DE	Spine	11/18/2018	3	4	3	3	4	3	4	1	4	4	3	4	3.5	14%
Tautog	34	RI	Spine	11/3/2022	14	2	14	13	3	13	12	1	12	13	2	13	13	4%
Tautog	35	MA	Spine	9/2/2025	5	3	5	6	3	6	5	2	5	5	2	5	5.25	7%
Tautog	36	VMRC	Spine	3/5/2022	19	4	20	22	4	23	10	2	10	8	3	9	15.5	39%
Tautog	37	MA	Spine	7/29/2025	6	4	7	7	1	7	6	4	7	6	1	6	6.75	6%
Tautog	38	RI	Spine	11/2/2022	4	3	4	4	3	4	4	4	4	4	2	4	4	0%
Tautog	39	MA	Spine	9/14/2025	3	3	3	4	2	4	3	3	3	3	2	3	3.25	12%
Tautog	40	RI	Spine	11/20/2019	11	4	11	12	4	12	11	2	11	11	2	11	11.25	3%
																	Average APE	6.11%
																	Otolith APE	4.61%
																	Opercles APE	6.29%
																	Spine APE	8%

Table 24. Symmetry test p-values for inter-lab age comparisons using Evans-Hoenig test of symmetry and CVs (%) for tautog otoliths. P-values appear above the shaded diagonal line and CVs are below. Significant p-values (p<0.05) and CVs higher than 5% are highlighted in yellow.

Lab	MA	RI	CT	NJ	DE	VMRC	VIMS	SEFSC2
MA		0.28	0.26	0.28	0.77	0.25	1.00	0.28
RI	6		0.14	1.00	0.31	0.32	0.28	1.00
CT	7	3		0.14	0.32	0.51	0.26	0.14
NJ	7	0	3		0.31	0.32	0.28	1.00
DE	7	3	0	3		0.61	0.77	0.31
VMRC	5	1	2	1	3		0.25	0.32
VIMS	0	6	7	7	7	5		0.28
SEFSC2	6	0	3	0	3	1	6	

Table 25. Percent exact agreement (below the shaded diagonal line) and agreement within one year (above the shaded diagonal line) between readers for tautog otoliths.

Lab	MA	RI	CT	NJ	DE	VMRC	VIMS	SEFSC2
MA		93	86	92	86	93	100	93
RI	50		86	100	86	93	93	100
CT	43	71		100	100	100	100	100
NJ	46	100	69		85	92	92	100
DE	43	64	93	62		100	93	100
VMRC	57	93	71	92	64		100	100
VIMS	100	50	43	46	43	57		93
SEFSC2	50	100	71	100	64	93	50	

Table 26. Symmetry test p-values for inter-lab age comparisons using Evans-Hoenig test of symmetry and CVs (%) for tautog opercles. P-values appear above the shaded diagonal line and CVs are below. Significant p-values (p<0.05) and CVs higher than 5% are highlighted in yellow.

Lab	MA	RI	CT	NJ	DE	VMRC	SEFSC2
MA		0.55	0.57	0.43	0.57	1.00	0.43
RI	5		0.67	0.32	0.67	0.22	0.32
CT	5	9		0.72	1.00	0.75	0.72
NJ	6	1	8		0.72	0.16	1.00
DE	5	9	0	8		0.75	0.72
VMRC	9	5	13	5	13		0.16
SEFSC2	6	1	8	0	8	5	

Table 27. Percent exact agreement (below the shaded diagonal line) and agreement within one year (above the shaded diagonal line) between readers for tautog opercles.

Lab	MA	RI	CT	NJ	DE	VMRC	SEFSC2
MA		100	92	100	92	92	100
RI	54		77	100	77	85	100
CT	54	31		92	100	77	92
NJ	46	92	38		77	85	100
DE	54	31	100	38		77	92
VMRC	38	77	23	85	23		100
SEFSC2	46	92	38	100	38	85	

Table 28. Symmetry test p-values for inter-lab age comparisons using Evans-Hoenig test of symmetry and CVs (%) for tautog spines. P-values appear above the shaded diagonal line and CVs are below. Significant p-values (p<0.05) and CVs higher than 5% are highlighted in yellow.

Lab	MA	RI	CT	NJ	DE	VMRC	SEFSC2
MA		0.25	0.37	0.25	0.17	0.28	0.28
RI	4		0.43	1.00	0.43	0.32	0.32
CT	4	6		0.43	0.32	0.28	0.28
NJ	4	0	6		0.43	0.32	0.32
DE	7	10	3	10		0.28	0.28
VMRC	6	1	8	1	11		1.00
SEFSC2	6	1	8	1	11	0	

Table 29. Percent exact agreement (below the shaded diagonal line) and agreement within one year (above the shaded diagonal line) between readers for tautog spines.

Lab	MA	RI	CT	NJ	DE	VMRC	SEFSC2
MA		100	92	100	85	92	92
RI	54		92	100	92	92	92
CT	62	46		100	92	92	92
NJ	54	100	46		92	92	92
DE	62	46	92	46		92	92
VMRC	46	92	46	92	46		100
SEFSC2	46	92	46	92	46	100	

Table 30. Ageing worksheet for winter flounder at the workshop with the sample number, lab providing the sample, ageing structure, catch date of the sample, workshop group annulus counts, margin codes (scored from 1 to 4), and final age as well as average percent error (APE) values between groups. Samples #1-20 are sectioned otolith and samples #21-40 are whole otoliths.

Species	Sample	Lab	Structure	Catch date	Group1			Group2			Group3			Group4			Average Age	APE
W. flounder	1	VIMS	Section	10/9/2015	3	2	3	3	2	3	3	2	3	3	2	3	3	0%
W. flounder	2	NY	Section	3/21/2002	6	4	7	7	1	7	6	4	7	6	3	7	7	0%
W. flounder	3	MA	Section	9/16/2024	5	3	5	5	3	5	6	3	6	6	1	6	5.5	9%
W. flounder	4	VIMS	Section	10/8/2015	3	3	3	3	2	3	3	3	3	3	2	3	3	0%
W. flounder	5	NY	Section	4/30/2002	5	4	6	5	4	6	5	4	6	5	4	6	6	0%
W. flounder	6	VIMS	Section	10/8/2015	5	2	5	5	2	5	5	3	5	5	1	5	5	0%
W. flounder	7	NY	Section	3/24/2003	5	4	6	5	4	6	5	4	6	5	4	6	6	0%
W. flounder	8	VIMS	Section	10/8/2015	7	3	7	7	2	7	7	4	7	7	1	7	7	0%
W. flounder	9	VIMS	Section	5/21/2015	10	4	11	10	4	11	10	4	11	10	4	11	11	0%
W. flounder	10	MA	Section	9/18/2024	6	3	6	6	3	6	6	3	6	7	1	7	6.25	6%
W. flounder	11	NY	Section	4/3/2003	3	4	4	3	4	4	3	4	4	3	4	4	4	0%
W. flounder	12	MA	Section	9/30/2024	4	2	4	4	2	4	4	2	4	4	2	4	4	0%
W. flounder	13	MA	Section	10/1/2024	4	2	4	4	4	4	5	1	5	5	1	5	4.5	11%
W. flounder	14	VIMS	Section	5/17/2015	12	4	13	12	1	12	11	4	12	12	1	12	12.25	3%
W. flounder	15	VIMS	Section	5/21/2015	4	4	5	4	4	5	4	4	5	4	3	5	5	0%
W. flounder	16	MA	Section	9/17/2024	3	3	3	4	2	4	4	2	4	4	2	4	3.75	10%
W. flounder	17	MA	Section	9/18/2024	5	2	5	5	1	5	5	3	5	5	1	5	5	0%
W. flounder	18	MA	Section	10/1/2024	7	2	7	7	1	7	7	2	7	7	1	7	7	0%
W. flounder	19	MA	Section	9/28/2024	3	3	3	3	2	3	3	2	3	3	2	3	3	0%
W. flounder	20	MA	Section	9/16/2024	3	3	3	4	2	4	4	2	4	4	1	4	3.75	10%
W. flounder	21	MA	Whole	9/18/2024	4	3	4	4	3	4	4	3	4	4	1	4	4	0%
W. flounder	22	NJ	Whole	5/22/1995	1	1	1	1	2	1	1	2	1	1	3	2	1.25	30%
W. flounder	23	NJ	Whole	4/29/1996	1	1	1	1	1	1	1	2	1	1	3	2	1.25	30%
W. flounder	24	MA	Whole	9/16/2024	3	3	3	3	4	3	3	3	3	3	3	3	3	0%

Species	Sample	Lab	Structure	Catch date	Group1			Group2			Group3			Group4			Average Age	APE
W. flounder	25	NJ	Whole	3/25/1997	1	1	1	1	1	1	1	2	1	1	3	2	1.25	30%
W. flounder	26	NJ	Whole	5/19/1997	1	1	1	2	2	2	2	1	2	2	1	2	1.75	21%
W. flounder	27	MA	Whole	9/30/2024	5	2	5	5	3	5	5	2	5	5	2	5	5	0%
W. flounder	28	NJ	Whole	5/19/1997	1	1	1	2	2	2	2	2	2	2	1	2	1.75	21%
W. flounder	29	MA	Whole	10/1/2024	7	3	7	7	3	7	7	1	7	7	1	7	7	0%
W. flounder	30	NJ	Whole	5/6/1998	1	1	1	1	1	1	2	1	2	2	1	2	1.5	33%
W. flounder	31	NJ	Whole	5/22/1995	1	1	1	1	1	1	2	1	2	2	1	2	1.5	33%
W. flounder	32	MA	Whole	9/17/2024	4	2	4	2	4	2	2	3	2	3	2	3	2.75	27%
W. flounder	33	NJ	Whole	10/20/2022	1	2	1	1	2	1	1	2	1	3	3	3	1.5	50%
W. flounder	34	NJ	Whole	6/1/2023	3	1	3	2	2	2	4	1	4	4	1	4	3.25	23%
W. flounder	35	MA	Whole	9/18/2024	6	3	6	6	3	6	6	2	6	6	4	6	6	0%
W. flounder	36	MA	Whole	9/28/2024	4	2	4	3	2	3	3	2	3	3	1	3	3.25	12%
W. flounder	37	NJ	Whole	4/3/1997	1	1	1	0	4	1	1	2	1	1	1	1	1	0%
W. flounder	38	MA	Whole	9/16/2024	5	3	5	4	3	4	5	2	5	4	4	4	4.5	11%
W. flounder	39	MA	Whole	10/1/2024	4	3	4	3	3	3	4	2	4	3	3	3	3.5	14%
W. flounder	40	NJ	Whole	8/28/2022	5	3	5	5	2	5	5	2	5	5	3	5	5	0%
																	Average APE	9.65%
																	Sectioned Otolith APE	2.46%
																	Whole Otolith APE	16.84%

Table 31. Symmetry test p-values for inter-lab age comparisons using Evans-Hoenig test of symmetry and CVs (%) for winter flounder sectioned otoliths. P-values appear above the shaded diagonal line and CVs are below. Significant p-values (p<0.05) and CVs higher than 5% are highlighted in yellow.

Lab	MA	NEFSC	RI	CT	VIMS
MA		0.1	0.56	0.03	1.00
NEFSC	4		0.08	1.00	0.10
RI	2	2		0.18	0.56
CT	5	1	3		0.03
VIMS	0	4	2	5	

Table 32. Percent exact agreement (below the shaded diagonal line) and agreement within one year (above the shaded diagonal line) between readers for winter flounder sectioned otoliths.

Lab	MA	NEFSC	RI	CT	VIMS
MA		100	100	95	100
NEFSC	70		100	100	100
RI	85	85		100	100
CT	65	90	75		100
VIMS	100	70	85	65	

Table 33. Symmetry test p-values for inter-lab age comparisons using Evans-Hoenig test of symmetry and CVs (%) for winter flounder whole otoliths. P-values appear above the shaded diagonal line and CVs are below. Significant p-values (p<0.05) and CVs higher than 5% are highlighted in yellow.

Lab	MA	NEFSC	CT
MA		0.31	0.41
NEFSC	25		0.56
CT	15	15	

Table 34. Percent exact agreement (below the shaded diagonal line) and agreement within one year (above the shaded diagonal line) between readers for winter flounder whole otoliths.

Lab	MA	NEFSC	CT
MA		100	95
NEFSC	35		95
CT	65	60	

Figures

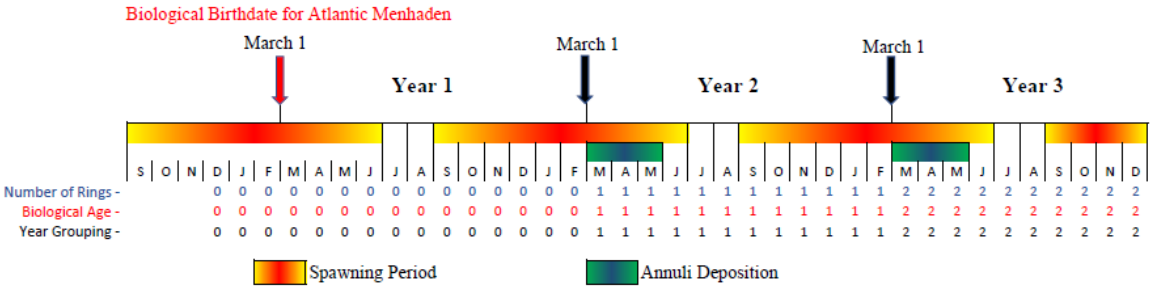

Figure 1. Timeline showing spawning period and annuli deposition ranges for Atlantic menhaden. Source: SEFSC 2025.

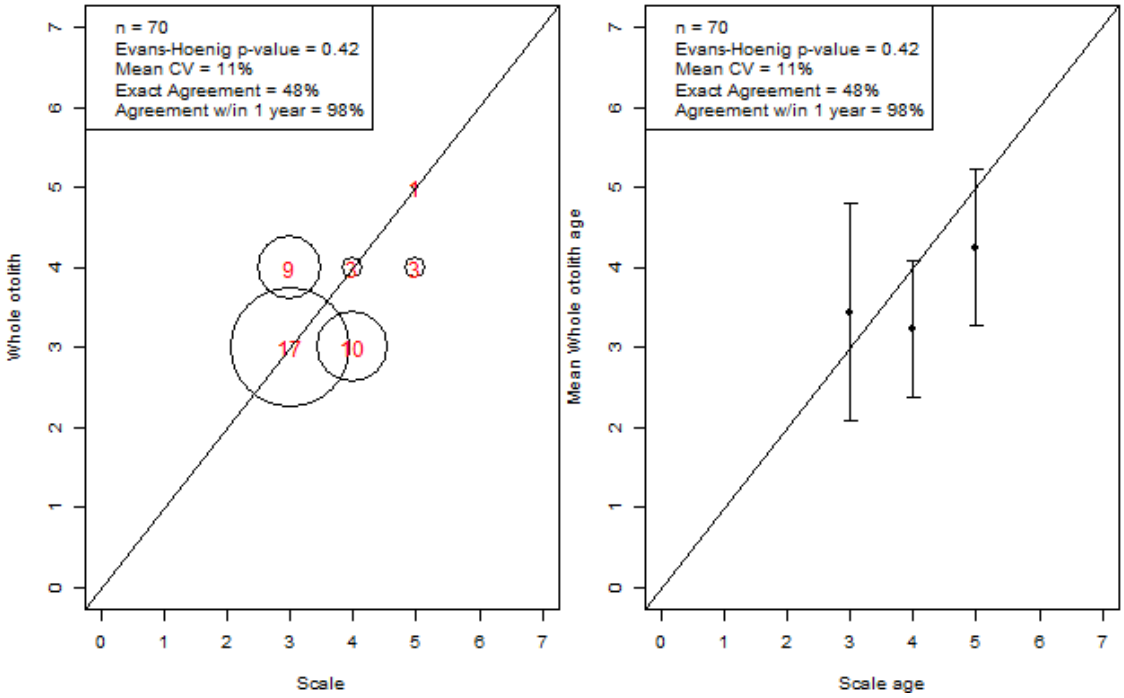

Figure 2. Age frequency (left) and age bias (right) plots for Atlantic menhaden paired scale and whole otolith samples. Circles are proportional to number of observations.

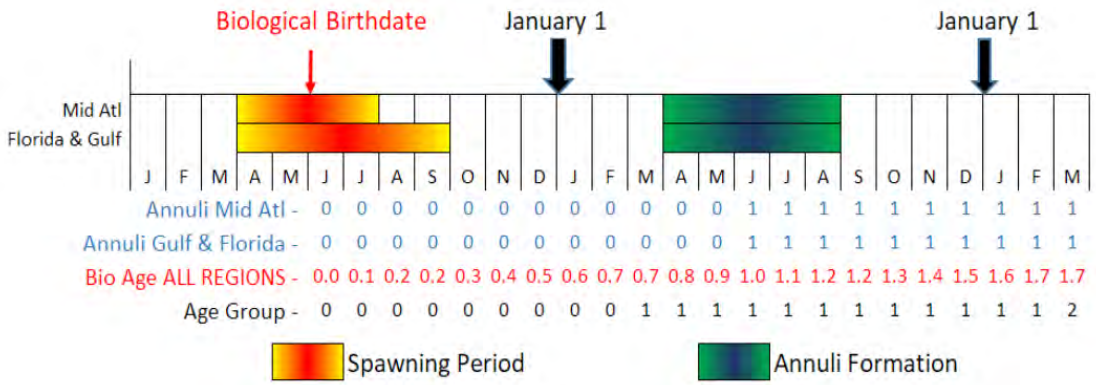

Figure 3. Timeline showing spawning period and annuli deposition ranges for cobia (GSMFC 2020).

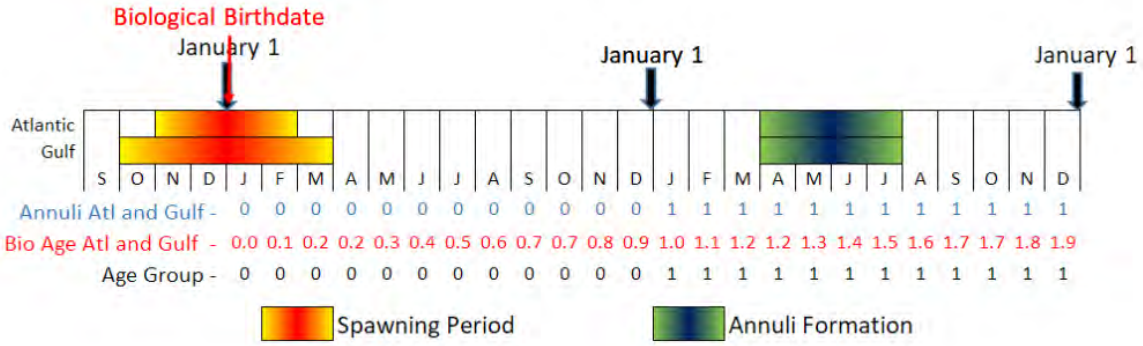

Figure 4. Timeline showing spawning period and annuli deposition ranges for spot (GSMFC 2020).

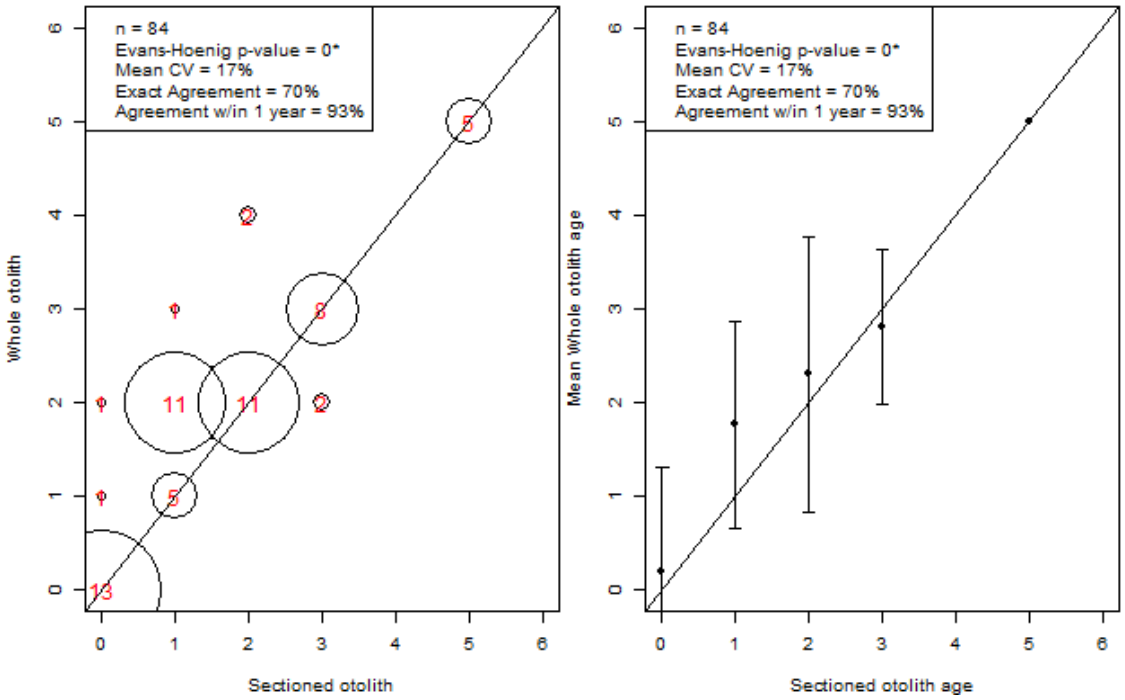

Figure 5. Age frequency (left) and age bias (right) plots for spot paired sectioned otolith and whole otolith samples. Circles are proportional to number of observations.

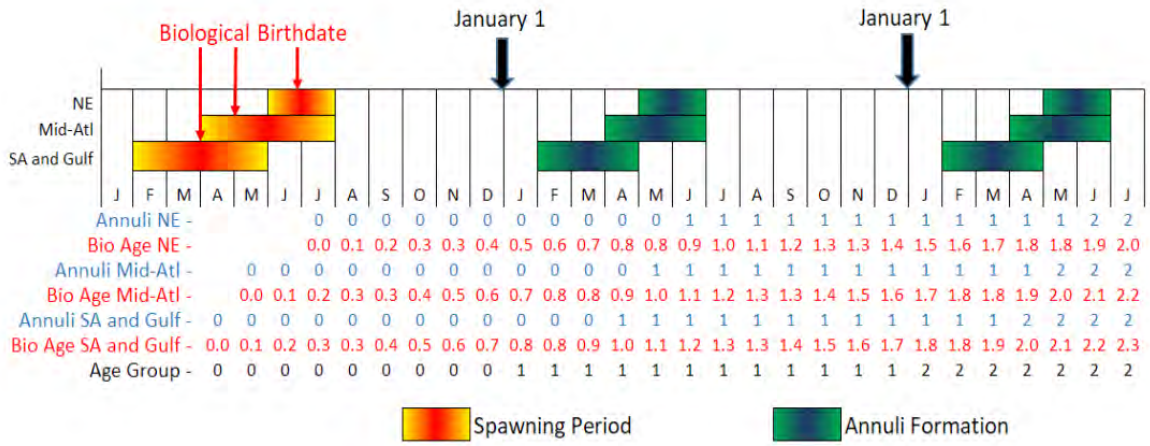

Figure 6. Timeline showing spawning period and annuli deposition ranges for striped bass from New England to the Gulf of Mexico (GSMFC 2020).

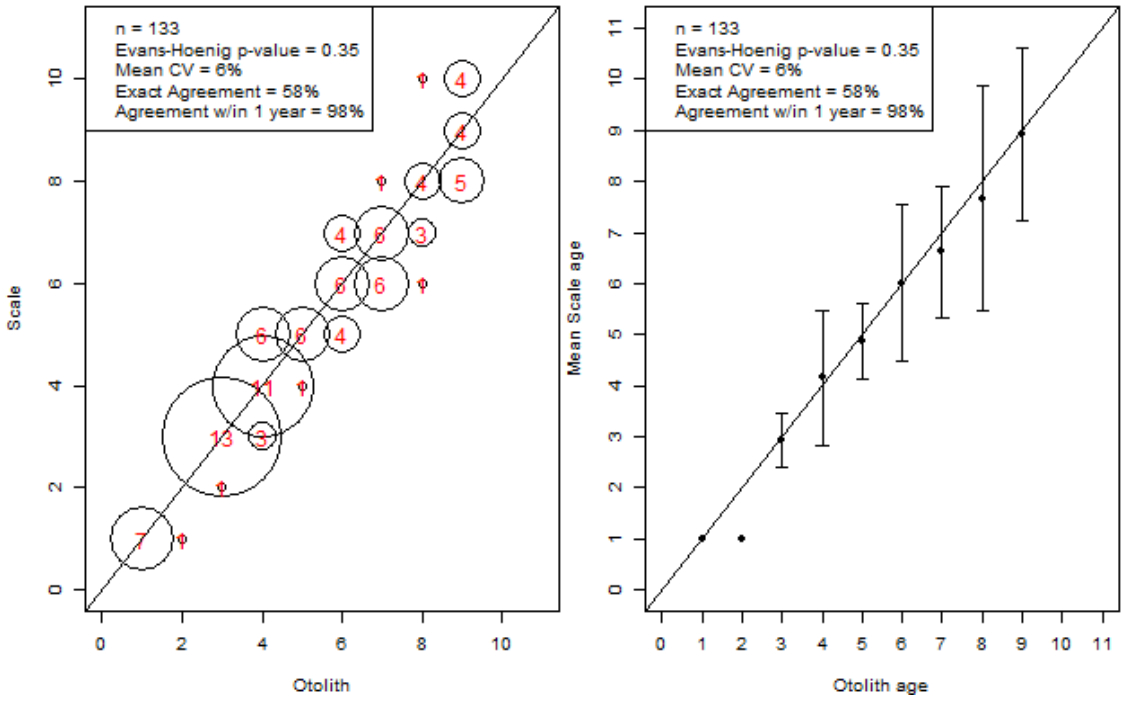

Figure 7. Age frequency (left) and age bias (right) plots for striped bass paired otolith and scale samples. Circles are proportional to number of observations.

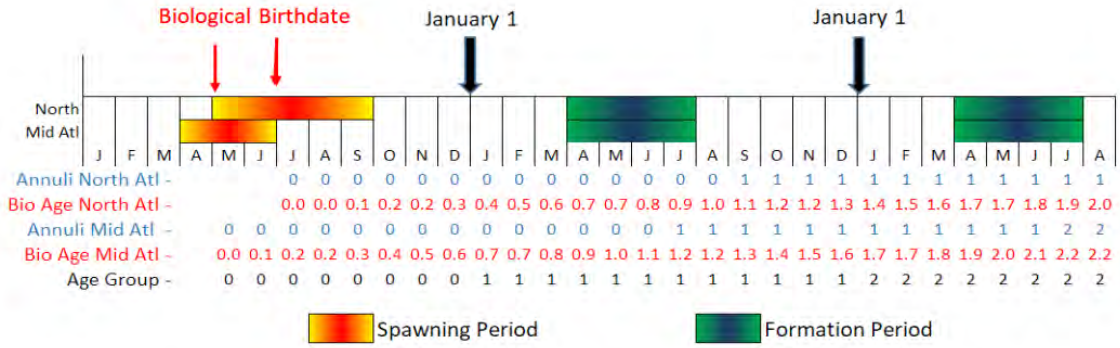

Figure 8. Timeline showing spawning period and annuli deposition ranges for tautog (GSMFC 2020).

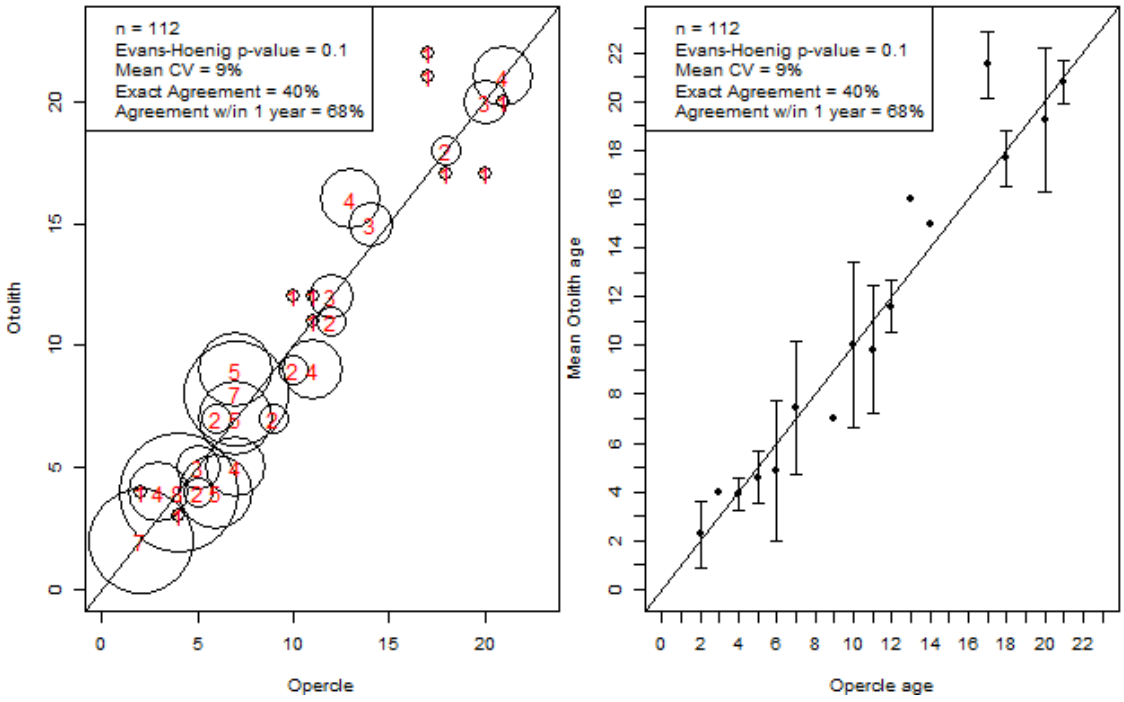

Figure 9. Age frequency (left) and age bias (right) plots for tautog paired opercle and otolith samples. Circles are proportional to number of observations.

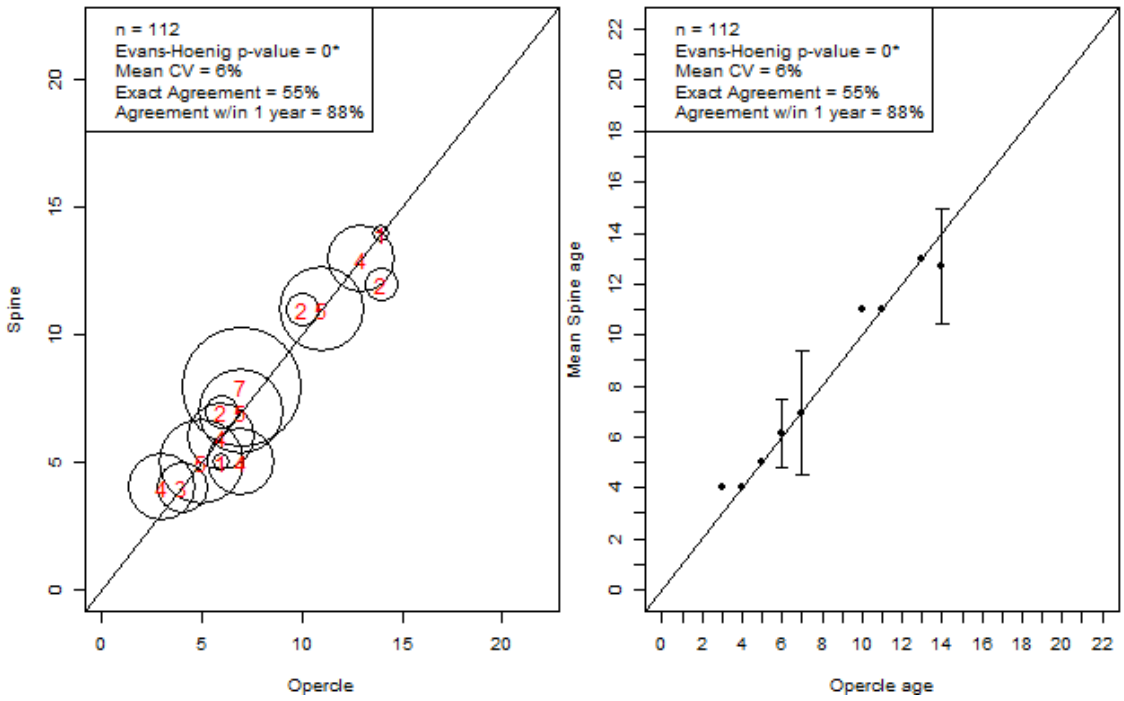

Figure 10. Age frequency (left) and age bias (right) plots for tautog paired opercle and spine samples. Circles are proportional to number of observations.

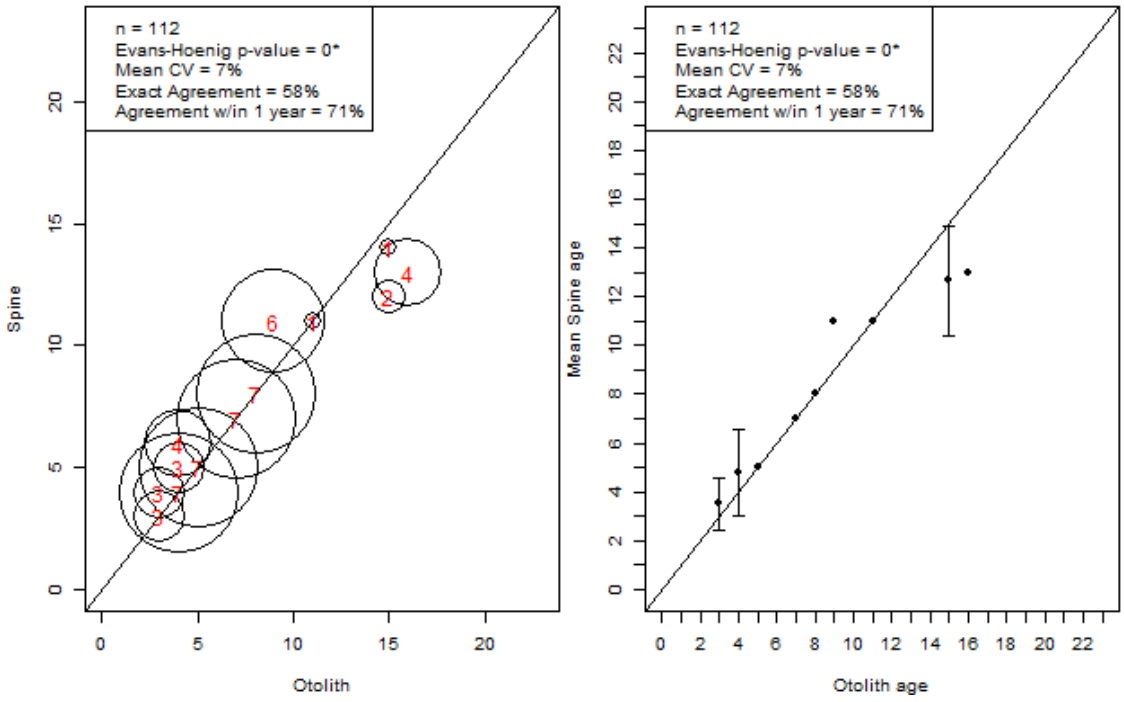

Figure 11. Age frequency (left) and age bias (right) plots for tautog paired otolith and spine samples. Circles are proportional to number of observations.

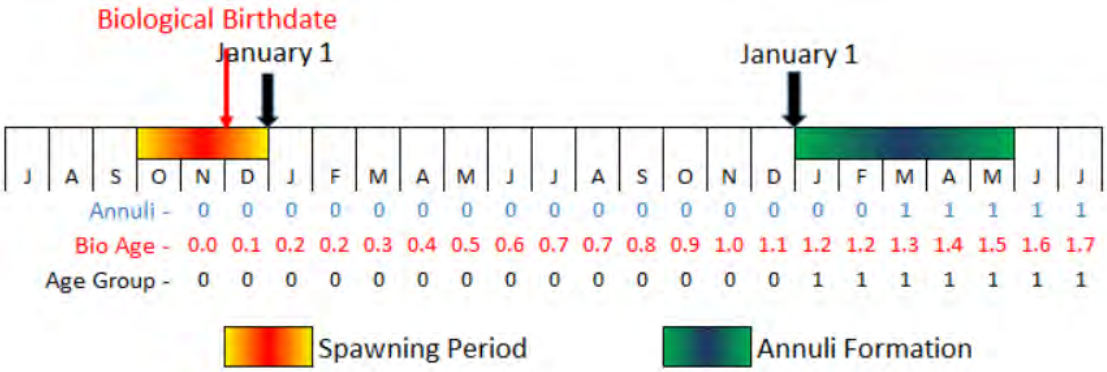

Figure 12. Timeline showing spawning period and annuli deposition ranges for winter flounder (GSMFC 2020).

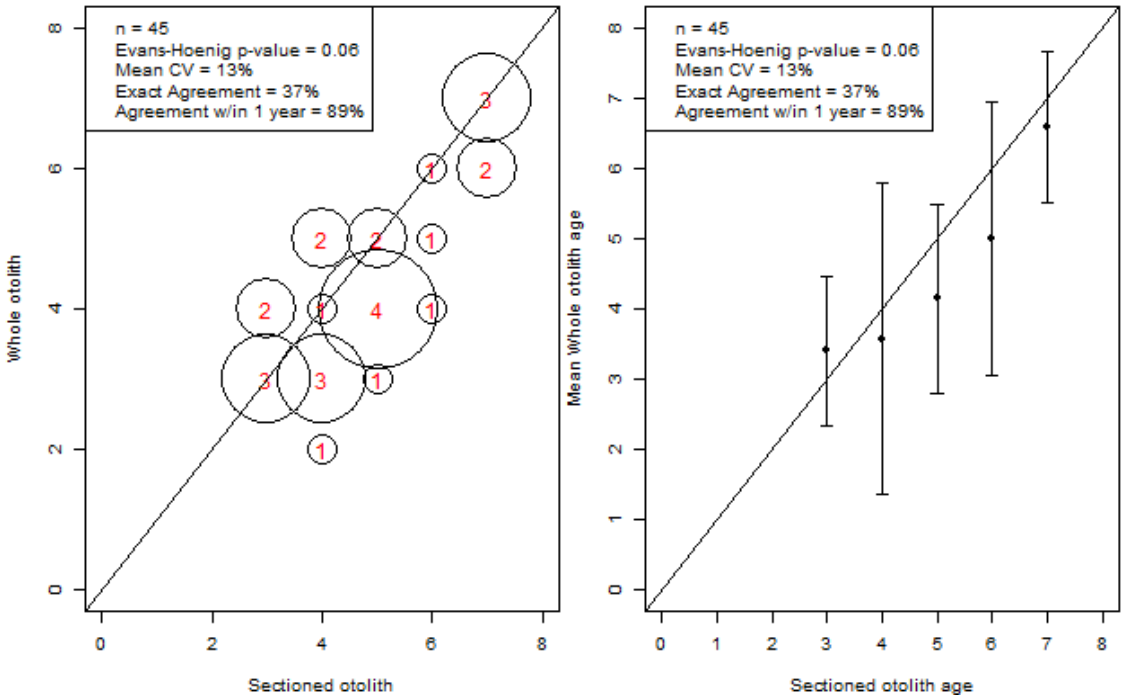

Figure 13. Age frequency (left) and age bias (right) plots for winter flounder paired sectioned otolith and whole otolith samples. Circles are proportional to number of observations.

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Appendix A: Agenda

Atlantic States Marine Fisheries Commission

2026 QA/QC Fish Ageing Workshop

April 8-9, 2026

100 8th Ave SE, St Petersburg, FL 33701

DRAFT AGENDA

Wednesday, April 8

- Welcome and introductions 9:00 a.m.
- Conduct age readings for 2026 species 9:30 a.m.
    - Atlantic menhaden (paired scale and otolith samples)
    - Cobia (otoliths)
    - Spot (whole and sectioned otoliths)
    - Striped bass (paired scale and otolith samples)
    - Tautog (paired opercula, otolith, and fin spine samples)
    - Winter flounder (paired whole and sectioned otoliths)
- Adjourn for day 5:00 p.m.

Thursday, April 9

- Review comparison of ages by groups 9:00 a.m.
- Discussion of issues and differences encountered 10:00 a.m.
- Make recommendations 11:00 a.m.
- Other Business 11:30 a.m.
- Adjourn 12:00 p.m.

Appendix B: State Sample Collection, Preparation, and Ageing Methodology

I. Atlantic Menhaden

Maine Department of Marine Resources (ME DMR)

ME DMR currently collects fish samples from the menhaden bait fishery. We collect 15 fish per sample and they are stored in labeled boxes and placed in the freezer until we can process them. We collect 15 in case there are damaged scales. It assures we can get 10 good fish. Samples are placed in lukewarm water to thaw and process. To process a sample; we document the length and the weight, remove a patch of scales and place them in a vial with water, remove the otolith and place in a tray. Otoliths are then put in a vial and stored in a labeled coin envelope. Scales are dried on a paper towel and placed on glass slides and labeled with the sample information and stored in a coin envelope.

I have been ageing herring otoliths since 1996. I started ageing menhaden in 2021. Most of my experience is from the workshop as I am self taught. At this time I am the only menhaden ager. I digitize the otoliths and scales as a tiff file. I go back later and age them and annotate them. I have all ages saved with notations. Once everything is digitized, I send my samples to Amanda in Beaufort.

MA DMF

MA DMF currently collects scale samples from menhaden captured primarily in the purse sein bait fishery. Scales are stored dry in coin envelopes. Scales are then cleaned with a pancreatin solution in an ultrasonic bath prior to being patted dry on a paper towel and sandwiched between two glass slides. Prepared samples are currently being sent to the NMFS lab in Beaufort for ageing. Otolith collections commenced in 2023. 2025 marked the first year that MA DMF aged both the scales and otoliths before sending the scales to Beaufort. Menhaden ageing experience within MA DMF is limited to the ASMFC QA/QC workshops and the menhaden ageing workshops. Scales aged for the exchange were read through a microfiche reader. Otoliths were examined through a stereo microscope with reflected light on a black background.

RI DEM

Scale samples and otoliths are currently collected from fishery-dependent sampling of bait fisheries with supplementary fishery-independent samples collected from the RIDEM DMF

Trawl Survey. The annual sample size target is 100 samples which is typically sufficient to satisfy the ASMFC requirement of one 10-fish sample per 300 metric tons landed. After removal, scales are initially stored dry in coin envelopes until they can be processed in the laboratory. When processed, scales are lightly cleaned with a gentle cleanser and water, dried on paper towels, and pressed between two microscope slides. Fishery-dependent samples are currently shipped to the NOAA-Beaufort Lab where they are aged, and archived. Otoliths are stored in glass vials and not currently aged.

Menhaden ageing experience is limited to two ASMFC workshops in 2015 and 2023. For the 2023 workshop, states participated in a hard parts exchange. For that exchange, scales were read on a microfiche and otoliths were read on a stereo microscope with reflected light. As of 2026, RI will begin ageing menhaden scales following the NOAA Beaufort protocol as recommended by the ASMFC TC. RI will send samples to Beaufort after aging and, if time and resources allow, Beaufort staff will age a sub-sample of RI fish to allow for comparisons between agers.

CT DEEP

Prior to 2024, Menhaden scale samples were only collected from the Long Island Sound Trawl Survey (LISTS) if there were more than 10 menhaden caught in a particular tow. Scale samples were taken from a random 10 fish and the rest were measured. This procedure was done to emulate the sampling protocol from the fishery dependent sampling. Starting in 2024 scales were taken no matter the number of fish, from subsamples of menhaden, stratified by length group, to better represent the full range of sizes caught by LISTS. Individual weights were taken from menhaden being sampled starting in 2024. Scales were removed from about mid-body, below insertion of the dorsal fin. Before the sample was taken, slime was removed from the scales using a blunt knife, and the knife was rinsed between fish to prevent cross-contamination between samples. Scales were stored in coin envelopes until lab processing.

In the lab, scales were removed from the envelope and placed in a small beaker with water and a drop of dish soap. The beaker was placed in an ultrasonic cleaner and allowed to soak with the cleaner running for a few minutes. Scales are examined, looking for signs of regeneration. If the scale did not look regenerated, it was scrubbed using a toothbrush to remove and excess slime or skin. The scale was then dipped in freshwater, blotted dry on a paper towel and placed on a slide for mounting. This process was repeated until there are 6-10 scales on the slide (depending on the size of the scales). A top slide was put on top on the scales and affixed together with two pieces of clear tape and then labeled with the sample number, date and fish ID number. The mounted scales were placed back in the envelope, along with the unused scales and cataloged by sample number and fish ID number.

Menhaden scales were aged using a microfiche, either a COM 200 or aperture card 6000). Annuli were defined as compression in the normal pattern of circuli that can be seen over the anterior field with continuous cutting over into the lateral fields. Annuli measurements are not currently taken on the scales. Previously, all scales were read blind by a single reader and assigned a confidence rating from 1-4 (1 being the best samples with little opinion on a different age estimate and 4 being unreadable). All samples with a confidence of 3 and a subsample of confidence of 2 samples would be re-read by the original reader. Starting in 2023 menhaden were blind read by either two separate readers or aged twice by a single reader. The two reads were compared for ACV, percent agreement and bias using statistical tests of symmetry (McNamar, Evans & Hoenig and Bowker's all using the FSA package in R). Any samples not in agreement were read blind again by the lead biologist for menhaden. The current lead biologist for ageing menhaden is Kelli Mosca, who has been ageing menhaden since 2022 and has had experience ageing shad since 2018.

NY DEC

NY DEC currently collects Atlantic menhaden scale samples through our agency run fisheries dependent sampling program. Menhaden scales typically come from fish that have been sampled at local bait shops. These fish are caught primarily using cast nets or small bait seines. Additionally, and when available, menhaden scale samples are collected portside, directly from larger inshore seining operations. The Nearshore Trawl Survey, conducted by Stony Brook University, also collects scale and otolith samples that they provide to NY DEC. Both scales and otoliths are stored in coin envelopes. Prior to 2024, scales were cleaned by soaking them for several hours in a diluted dish soap solution. After soaking, material on the scale was removed using a paper towel. The scales were then dried and pressed between two glass slides. Feedback from the 2023 menhaden ageing workshop indicated that NY's methodology for cleaning the scale samples should be modified as the samples were difficult to read. Scales are now cleaned with a pancreatin solution and run through an ultrasonic machine to better remove debris. Prepared samples are currently being sent to the NMFS lab in Beaufort for ageing. Menhaden ageing experience at NY DEC is limited to menhaden ageing workshops. Scales aged for this recent exchange were read through a microfiche and otoliths were examined through a stereo microscope. There was only one reader for the scales and otoliths during this exchange.

NJ DFW

Scale samples are currently collected from fishery-dependent sampling of commercial bait fisheries (purse seines and occasional paired trawls and gillnets). Samples are processed according to NOAA-Beaufort Atlantic Menhaden: Port Sampling and Scale Processing Protocols (Appendix A) before having been sent to the NOAA Beaufort Lab for ageing. Age samples are not currently collected from fishery-independent sampling. Due to NOAA ageing NJ's samples, NJ agers have minimal experience with ageing menhaden outside of the 2024 workshop. NJ has begun ageing their samples for 2024 survey year to present.

DE DFW

Fisheries staff pick up a 10-fish commercial Atlantic menhaden sample at the port and bring it back to the lab for processing. This usually occurs in the spring. Occasionally, a second set of 10 fish can be obtained in the fall. It all depends on availability of the samples. The fish arrive at the lab fresh, never frozen. Scales are taken from the side of the fish and just below the dorsal fin. Once removed from the fish, scales are placed in an envelope labeled with a fish identification number (beginning with a "C" to identify it as a commercial sample), date collected/processed (happens on the same day), location collected, gear type, fork length, and weight. Scales are then gently cleaned using warm water, Dawn dish soap, and a toothbrush. Scales are laid on a strip of paper labeled with their fish identification number to dry before being pressed between two slides. The slides are then secured together with Scotch tape and labeled with the species name and fish identification number (e.g. ATL MEN C-03001). Once pressed between slides, the scales are read on a microfiche. Scales are read blind (i.e. without the reader knowing any length or weight data and only using capture date once annuli are counted and a margin code is assigned) by two or more readers. The readers compare their ages, and a final age is agreed upon. The first ager has been ageing menhaden scales since 2021. A second ager just start ageing menhaden in November 2023.

MD DNR

<u>Dependent Sampling (Pound nets)</u>

Each week, MD fisheries biologists collect 25 scale samples from Atlantic menhaden. The samples are taken with a clean, blunt knife from the fish; below the dorsal fin and above the lateral line. Ample scales are taken to ensure there are enough scales for processing. The fish are chosen at random; however, healthy, undamaged fish are selected. The scales are placed in a coin envelope with the location and fish data and identification written on it. These samples are then brought back to the office to be processed later that week.

Independent Sampling (Gill nets)

Each week, MD fisheries biologists collect 10 scale and otolith samples from Atlantic menhaden. The first 5 fish in each of the first 2 mesh sizes are chosen at random; however, healthy undamaged fish are selected. The menhaden are placed in a cooler and brought back to the lab for processing. Back at the lab, biological data and samples are collected. The scale samples are taken in the same process and location as the dependent samples. Then both the otoliths are removed by cutting open the head and pulling out the otoliths with forceps and placing them in a vial.

Scale Sample Process

Each week, the samples that were collected are processed. The scales are removed from the envelope, and the best 4 to 8 scales without regeneration are chosen to be cleaned and mounted. The scales are placed in a warm water and dawn soap bath for 1 min, then rinsed in clean warm water. Next, they are rubbed on a paper towel with the biologist's fingertip until clean. The scales are placed on a slide, all with the same orientation on the slide. Another slide is placed on top, and the two slides are secured with tape. During aging, the samples without 2 readable scales are remounted in this same process. If a sample has all regenerated scales, it is not used in aging. The scales are then aged by two MD biologists with a microfiche reader.

Otolith Sample Process

Atlantic menhaden otoliths are read whole, so they are removed from their vial and placed in a reading tray. Either water or light mineral oil is placed on the otolith to submerge it. After the otolith is aged with a compound microscope, it is cleaned and dried and placed back in its vial.

VMRC

VMRC continued to compare different methods on ageing menhaden using a larger sample size (159 fish) collected in 2024 than in 2023 (45 fish). The results can be found in Appendix of the 2024 Annual Report (https://www.mrc.virginia.gov/ageing-lab/Reports/VMRC_2024_Ageing_and_Growth_Report.pdf).

VIMS

Sample collection

Atlantic Menhaden is a “Priority” species for its two major fisheries-independent trawl surveys, NEAMAP and ChesMMAP. Priority species means that length, weight, sex, maturity, stomach, and otoliths are collected for 5 individuals from each length bin on each tow. Paired otolith and scale samples were collected from the NEAMAP fisheries-independent trawl survey from 2016-2018. As otoliths are the preferred hard part for ageing, otoliths have been collected and aged

since 2008 to present. Additionally, smaller grant funded projects and collaborations have 53 paired scales and otoliths in 2018-2019 and again in 2022-2023. The total number of whole otoliths have been aged from the NEAMAP and ChesMMAP Trawl Surveys to date is 5,797 (NM 2,575, CM 3,222).

Scales

Paired Atlantic Menhaden scales and otolith samples will be removed from specimens at sea. Approximately 30-50 scales will be removed from each specimen. After collection, these scales are properly labeled and stored in capped vials in the freezer for later cleaning and processing in the laboratory. By freezing the scales rather than drying them, the scales will less likely be damaged. At the laboratory the scales will be thawed and lightly scrubbed in a soap and water solution to remove any debris and excess slime. Six of the best scales will be selected, thoroughly dried and pressed between two glass microscope slides with the sides of the slides taped closed on the ends. Due to variations in the scales, six samples are selected to provide the most accurate age for each specimen. Scale sample slides are preferably read using a microfiche reader. If no microfiche is available, then a stereo dissecting scope with transmitted light will suffice. Additionally, if the stereo microscope has imaging capabilities, larger images can be displayed to mimic the microfiche with sufficient lighting. Scales and otoliths will be read independently of each other but will later be compared across both of these ageing structures.

Whole Otoliths

The whole head of each menhaden sample will be removed with a serrated knife behind the operculum, labeled and frozen in storage bags to later have their delicate otoliths removed back at the laboratory. Due to size and fragile nature of menhaden otoliths, careful extraction can more easily occur at the stable laboratory setting. After otolith extraction, samples are dried and stored in small vials. Otoliths are read whole in a petri dish full of water or ethanol (Ethanol dries quickly and samples can be sealed back in storage vials more quickly), under a stereo dissecting microscope with transmitted light for the best contrast. Depending on the clarity and size of the otolith 25x zoom should be used with the otolith viewed in a watch glass full of 70% EtOH. This will assure no “clearing” (loss of visible annuli) will occur if the otoliths are dried, then stored. Wet stored otoliths straight from the otic cavity, read in water or read in ethanol can cause clearing if sealed in a vial before drying. Sometimes a combination of reflected and transmitted light is necessary to distinguish annuli separation and boundaries. The core of the otolith will appear as a circular, hollow shape in the center of the otolith. The core has a dark/opaque outline. This outline will be called the core boundary. The core boundary extends away from the core slightly up both the rostrum (long point) and antirostrum (“thumb”) of each otolith.

The first annulus is often a thicker, darker band. Establishing the first annulus is critical to proper age assignment. The first annulus will often not have a lot of separation from the core boundary. The clearest separation to identifying the first annulus will occur on the rostrum. Similar to the first annulus, any of the additional annuli will be best identified on the rostrum of the otolith. Starting with the first annulus, the annuli will gradually get thinner and lighter as the fish grows older. The best and clearest annuli can be traced all the way around the otolith. More difficult annuli can be checked by observing annuli on both the rostrum and antirostrum. Annuli are often less visible on the antirostrum, however the annuli often morphometrically visible by raised bumps along the inner edge of the antirostrum. Additionally, these raised bumps can be seen as layers of the otolith (like a typographical map). These layers can be traced to individual annuli around the otolith and are usually most visible on fish exhibiting more than one annuli.

There are three readers at VIMS and the mode age for each sample (both scales and otoliths) 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 performed within each reader (multiple reads of the same sample) and between readers. VIMS uses similar precision and symmetry tests to the NEFSC.

NC DMF

NCDMF collects Atlantic menhaden samples from fishery-dependent sampling of the commercial bait fishery. This is comprised of a 10 fish representative sample from each catch. The side of the fish is wiped off with a rag or towel to get rid of any dirt or excess slime before taking a scale sample. Samples are collected with the dull edge of a scallop knife or similar instrument (collecting at least 20-30+ scales). The scales are placed in a coin envelope and dried to prevent mold growth. Depending on the size of the scales, 6-8 scales are selected and placed between two glass microscope slides (25x75x1 mm in size). The edges of the two glass slides are taped to secure the scales. The left side of the slide is labeled with the species name, date, fork length (mm), and sequence number and line number that NCDMF uses to link the sample back to its biological data. Age structures for the exchange were read on a microscope.

NOAA Southeast Fisheries Science Center (SEFSC) Beaufort

Atlantic menhaden scale samples have been collected from fishery-dependent sampling (purse-seine nets) from reduction fisheries since 1955. Samples may be fresh or frozen and have been

collected by one port sampler in Reedville, VA and are processed and mounted according to NOAA's sampling protocol before being sent to the Lab for ageing. Scales are removed from the lateral line below the insertion of the dorsal fin and soaked in soapy water. They are cleaned between two fingers before being mounted concave down (~10 scales) between microscope slides. In 2023 the reduction sampling protocol changed to collect 5 fish/collection instead of 10. In 2024, the port sampler retired with VMRC to collect and mount reduction samples in the future. Scale samples from bait fisheries are collected by eleven state sampling programs with different protocols and are sent mounted to the Lab for ageing. The Lab currently ages an average of 1,000 scale samples from the reduction fishery and 1,800 samples from bait fisheries yearly. Otoliths are only received and aged for comparison studies.

An Olympus stereo microscope and monitor are used to view all samples for age determination using the Lab's ageing protocol. A digital image and annuli measurements are taken from the "best" scale using the imaging software cellSens. Scales: Mounted, 2x magnification, 0.5x objective, transmitted light, scope. Otoliths: Whole in watch glass with 70% alcohol, patted dry and dried overnight in vial with lid open, 6.3x magnification, 0.5x objective, transmitted light, scope or reflective light on dark background. Readability, annuli counts and edge codes are not recorded but a final age is entered in a database, taking edge growth and capture date into consideration. One ager has provided all ages until 2024, when an additional ager was added. Single reader ages are used in production but consensus ages were determined for this comparison study. The primary ager has been ageing scales for nine years, with limited otolith ageing. Ager 2 has extensive otolith ageing of other species and 1 year of menhaden scale ageing experience.

SC DNR

South Carolina is at the southern end of the menhaden range, and with no commercial landings there are no samples currently taken to meet any age reporting requirements. Therefore, menhaden ageing experience is limited to ASMFC ageing workshops. No samples were sent for the exchange set. Scales were read through a stereo microscope with transmitted light. The otoliths were read through the same microscope, but with reflected light. Ages were assigned by a single reader.

II. Cobia

VIMS

Cobia is "Priority" species for the NEAMAP and ChesMMAP surveys. Length, weight, sex, maturity, stomachs for diet analysis, and otoliths are collected from 5 specimens from each length bin from each tow. Otoliths have been sectioned for the best results and accuracy with ageing. Despite lower encounters with this species, the surveys maintain cobia as a priority

species and provide data when applicable for assessment needs. Otoliths are sectioned and wet-sanded to a thinner width. Annulus counts are adjusted to reflect the timing of sample collection relative to ring formation. Age is assigned as the mode of three independent readings. There are three readers at VIMS and the mode age for each sample is provided as the final age. If there is no mode from the initial read, the readers reread the sample and if there is still no mode, they examine the sample together and come to a consensus age. If a consensus age cannot be determined the sample is discarded. Very few samples are discarded. Precision tests are performed within each reader (multiple reads of the same sample) and between readers. VIMS uses similar precision and symmetry tests to the NEFSC.

VMRC

VMRC obtains cobia otoliths from the recreational catch and have been collected by VMRC since 1999. All samples are processed for ageing. The left or right sagittal otolith is randomly selected and sectioned using the epoxy resin method described in detail in Protocol of Preparation of Otolith Transverse Cross-Sections for Age Estimation. The VMRC Ageing Lab uses sectioned otoliths to age cobia. Each section is read under transmitted light using a polarizing filter. Cobia are assigned a January 1st birthdate by convention. In addition to recording the number of annuli, the margin or the growth width after the last annulus is coded from 1 to 4. Each section is aged by two readers. If the first readings disagree, the readers re-age the fish together. If a consensus cannot be reached, the sample is excluded from further analysis and, if available, another sample from the same length bin replaces it. Each year, readers revisit a reference collection of samples from 2000 to increase consistency across years.

The following are links to the preparation and ageing protocols for cobia.
Otolith Preparation Protocol https://www.mrc.virginia.gov/ageing-lab/Preparation-of-Otolith-Thin-Sections-for-Age-Estimation.pdf

NC DMF

NC DMF has collected cobia otoliths since 2008. Most cobia otoliths are collected from the recreational fishery through the Carcass Collection Program, and samples are also collected through independent gill net sampling programs as well as commercial fish house sampling programs. Left otoliths (right otoliths if the left otolith was damaged or missing) are embedded in epoxy resin, sectioned on an IsoMet Low Speed Saw between two 3” blades using a 0.5 mm spacer, mounted on a slide with Crystal Bond, and top coated with Shandon Mount. Sections are read under a microscope using transmitted light. Cobia are assigned a January 1st birthdate. To ensure fish are assigned to the correct cohort, samples with a margin code (coded from 1-4) of 3 or 4 are assigned an age equal to the annuli count plus one (“bumped”) from January through August. Two independent readers age each sample and record the final age, margin

code, and whether the age was bumped. A third reader will age any disagreements. If 2 readers assign the sample the same age, that age is used for analysis. If a sample is assigned 3 different ages, the Age Lab Biologist and the species lead re-age the fish together to see if an age can be agreed on; if not, the sample is excluded.

FL FWC
Cobia otoliths are collected from both fishery-independent monitoring surveys and occasional fishery-dependent sources, as well as targeted collections for a reproductive study from 2022-2024. Typical collections average 20 samples annually, but the reproductive study collected 615 samples across the sampling timeframe. Cobia otoliths are embedded in a plastic resin, mounted on card stock with hot glue, and thin sectioned using a Buehler low-speed saw equipped with four blades; processing yields three transverse sections of the otolith core. The sections are aged with transmitted light, by two independent readers, using a stereo microscope. The readers record annuli count and margin code (1 - 4) without knowledge of the size of fish. Ages are determined using annulus count and margin code at date of capture

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.

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 and otoliths are collected from a subset of commercially sampled fish to augment the structure comparisons from our rack collections. Scales are impressed in acetate using a heated press and aged by examining impressions on a microfiche projector. Otoliths are cross-sectioned, baked and read with transmitted light on a compound microscope.

RI DEM

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 IsoMetTM slow speed saw. Thin sections are then mounted onto microscope slides with Flo-TexxTM and aged with a Leica stereo microscope. All samples are currently aged annually by a single reader. A second read is conducted by the same reader on at least 10% of the samples to obtain precision estimates.

NY DEC

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

NJ DFW

Striped bass scale samples have been collected regularly during several fishery independent surveys since 1989 including but not limited to the Striped Bass Tagging Survey in Delaware Bay, the Ocean Trawl Survey along the New Jersey 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 and 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, US 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 two biologists looked at each scale sample to arrive at an agreed age, if they did not agree a third biologist views them, if no agreement then a fourth 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.

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 performed within each reader (multiple reads of the same sample) and between readers. VIMS uses similar precision and symmetry tests to the NEFSC. 63

VMRC

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. Some 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. Otoliths samples are cleaned and baked in a Thermolyne 1400 furnace. After baking, both otoliths from each fish are embedded in epoxy resin and sectioned. 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 https://www.mrc.virginia.gov/ageing-lab/Preparation-of-Otolith-Thin-Sections-for-Age-Estimation.pdf
Scale Preparation Protocol https://www.mrc.virginia.gov/ageing-lab/Preparation-of-Scale-Impressions-for-Age-Estimation.pdf

NC DMF

The DMF Age Lab ages striped bass collected from the Central Southern Management Area (CSMA). Otoliths have been collected since 2014. Samples are collected through independent programs including gill net, trawl, and seine net surveys. When the fishery is open, fishery dependent samples are also collected through commercial fish house sampling and the recreational Carcass collection Program. Left otoliths (right otoliths if the left otolith was damaged or missing) are sectioned on a Hilquist Thin Sectioning Machine to a thickness of 0.5 mm, mounted to a slide with Loctite, and top coated with Shandon-Mount. Sections are read under a microscope using transmitted light. Striped bass are assigned a January 1st birthdate. To ensure fish are assigned to the correct cohort, samples with a margin code (coded from 1-4) of 3 or 4 are assigned an age equal to the annuli count plus one ("bumped") from January through May. Two independent readers age each sample and record the final age, margin code, and whether the age was bumped. A third reader will age any disagreements. If 2 readers assign the sample the same age, that age is used for analysis. If a sample is assigned 3 different ages, the Age Lab Biologist and the species lead re-age the fish together to see if an age can be agreed on; if not, the sample is excluded.

SC DNR

Striped bass have been aged in South Carolina since the 1950s 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 64 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. Spot

MD DNR

A subsample of spot was retained based on a yearly length bins and brought back to the lab for processing from the onboard sampling effort. Otoliths were taken and individual weights (grams), TL (millimeters) and sex were determined from subsampled. All spot otoliths were processed and aged by two project biologists. The left otolith from each specimen was mounted to a glass slide for sectioning. If the left otolith was damaged or missing, the right otolith was substituted. Otoliths were mounted to a glass slide using Crystalbond® 509 and sectioned with a Buehler IsoMet® low speed saw using two blades separated by a 0.4 mm spacer. Allied High Tech Products Inc. impregnated diamond metal bonded, high concentration cutting blades, measuring 102 mm in diameter and 0.31 mm thick (model number 60-20070) 64 were used. The core of the otolith was determined, and the cut was made. When the otolith is

held up to a light the opaque area is determined to be the core. The 0.4 mm sections were then mounted on microscope slides and viewed under a microscope at five to six power 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.

VMRC

The VMRC Biological Sampling Program has collected Spot otoliths with their biological information since 1988, and the VMRC Ageing Lab process and age the otoliths. 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 sectioned using the epoxy resin method described in detail in Protocol of Preparation of Otolith Transverse Cross-Sections for Age Estimation. 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. Spot 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 (May to July), 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 Spot.
Otolith Preparation Protocol https://www.mrc.virginia.gov/ageing-lab/Preparation-of-Otolith-Thin-Sections-for-Age-Estimation.pdf

NC DMF

Spot otoliths have been collected since 1995 from fishery independent programs such as gill net, trawl, and seine net surveys, as well as fishery dependent commercial fish house programs. Whole spot otoliths are placed in water in a container with a black background and aged using a microscope with reflected light. Spot are assigned a January 1st birthdate. To ensure fish are assigned to the correct cohort, samples with a margin code (coded from 1-4) of 3 or 4 are assigned an age equal to the annuli count plus one ("bumped") from January through July. Two independent readers age each sample and record the final age, margin code, and whether the age was bumped. A third reader will age any disagreements. If 2 readers assign the sample the same age, that age is used for analysis. If a sample is assigned 3 different ages, the Age Lab Biologist and the species lead re-age the fish together to see if an age can be agreed on; if not, the sample is excluded.

SC DNR

Spot were not historically aged in SC, but starting in 2010 an effort was made to look at life history of the species. Otolith samples are mostly taken from a fishery-independent trammel net survey but have also been taken from near-shore trawls and fishery-dependent angler 65 interactions. Otoliths are embedded in epoxy resin and sectioned using a low-speed saw, then mounted to a microscope slide with Cytoseal medium. Slides are looked at by two independent readers who record annuli count. If any disagreements occur, both readers look at the section together and come to a consensus or the sample is excluded from analysis. Ages are then assigned based on date of capture and margin code with annulus deposition being April to June.

FL FWRI

Spot otoliths are collected from both fishery-independent monitoring surveys as well as fishery-dependent sources, but collections are typically incidental and average less than 10 samples annually. Spot otoliths are embedded in a plastic resin, mounted on card stock with hot glue, and thin sectioned using a Buehler low-speed saw equipped with four blades; processing yields three transverse sections of the otolith core. The sections are aged with transmitted light, by two independent readers, using a stereo microscope. The readers record annuli count and margin code (1 - 4) without knowledge of the size of fish. Ages are determined using annulus count and margin code at date of capture.

V. Tautog

MA DMF

Tautog age structures are collected from a variety of sources including fish pots, ventless lobster traps, trawl survey and rod and reel. Opercula collections began in 1995 and ceased in 2019. Otoliths have been collected since 2012. Otolith and pelvic spine samples have been collected from our ventless lobster trap survey since 2015 as well as from a tautog rod and reel survey (2016-2018). Opercula are boiled and brushed clean before being dried and aged without magnification. Otoliths are baked, sectioned and aged with transmitted light under a compound microscope. Tautog pelvic fin spines have been collected since 2014 with sources of spines increasing over time. Spines are boiled for 1-2 minutes, brushed clean with a small brush then allowed to air dry for at least 48 hours. The spines are embedded in epoxy and 0.75 mm sections are cut. Three successive sections are removed starting just above the condyle. Sections are affixed to a slide with a liquid coverslip and aged through a compound microscope with transmitted light.

RI DEM

Opercula have been collected by RI DEM since 1987, primarily from donated recreational carcasses. The annual target number of samples is 200 per the requirements of Addendum III to the FMP for Tautog. Sample collection has primarily included operculum; however, otoliths have also been collected since 2012 following the recommendations of the 2012 Tautog Ageing Workshop (ASMFC 2012). Additionally, in 2017, RI DEM began collecting tautog pelvic spines for ageing. Following the recommendations of the 2023 QA/QC workshop, RIDEM conducted one year of paired otolith/spine age readings in 2022, and in 2023, RIDEM fully transitioned to collecting and ageing spines as the primary ageing structure. Collection and processing will follow (Elzey and Trull 2016). All samples are currently aged annually by a single reader. A second read is conducted by the same reader on at least 10% of the samples for each structure to obtain precision estimates.

NY DEC

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

NJ DFW

Sampling for tautog was initiated in 2007, collecting samples primarily from commercial and party/ charter vessels. Currently, NJ collects its samples primarily from fishery-dependent party/charter vessels and supplements sample for outside the recreational catch limits with fishery-independent sources, the NJ FW Ocean Trawl Survey and NJ's Artificial Reef Ventless Trap Survey. Racks are collected from fishery-dependent vessels, where lengths and sex are recorded, and opercula are removed. The opercula were processed and aged at the Nacote Creek Research lab, where they were viewed using transmitted and reflected light. In 2023 NJ began to collect and age otoliths. The otoliths were sectioned and mounted to slides and aged using transmitted light under a microscope.

MD DNR

Maryland has collected tautog opercula for ageing since 1996. The current FMP requires that each state collect 200 opercula and 50 otolith samples per year. Tautog have been collected by hook and line, commercial fish pots and on rare occasion spearfishing. Juvenile tautog have also

been collected by seining eel grass beds in 2015 which provided samples of the smallest length groups in the population. The most productive method is hook and line with a partnering professional charter boat.

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

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

VIMS

Tautog are collected for both NEAMAP and ChesMMAP surveys and additionally is considered a "Priority" species for NEAMAP, meaning that length, weight, sex, maturity state, stomach, and otoliths are collected for 5 individuals from each length bin on each tow. VIMS uses sectioned otoliths, pelvic spines, and opercula for age determination. Both opercula and otoliths have been collected since 2010 as per comparison purposes due to the low number of encounters by each survey over their time series. Additionally, paired pelvic spines have been collected since 2017. Prior to 2010 only opercula were collected. To date, VIMS tautog data has not been 66 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 performed within each reader (multiple reads of the same sample) and between readers. VIMS uses similar precision and symmetry tests to the NEFSC.

VMRC

VMRC obtains tautog otoliths, operculum, and pelvic fin spines from the commercial and recreational catch. Tautog have been collected as part of VMRC's Biological Sampling Program since 1998. All samples are processed for ageing. Operculum and pelvic fin spines are removed and frozen until prepared for age reading. Thawed samples are boiled 5-6 minutes to loosen attached tissue. When the sample is removed from the water, skin and tissue are removed. Clean opercula are read using transmitted light, usually from a window or overhead light. Pelvic fin spines are allowed to air dry for at least 24hrs after cleaning. Then they are embedded in epoxy resin and sectioned. Otoliths samples are cleaned and baked in a Thermolyne TM 1400 furnace. After baking, both otoliths from each fish 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.
Preparation Protocols Otolith https://www.mrc.virginia.gov/ageing-lab/Preparation-of-Otolith-Thin-Sections-for-Age-Estimation.pdf
Operculum https://mrc.virginia.gov/ageing-lab/Tautog-Operculum-Preparation-Protocol.pdf

VI. Winter flounder

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 have typically been read whole with reflected light. Samples assigned an age of 5 or older were then thin sectioned and read either with a stereoscope using reflected light or with a compound microscope with transmitted light. Beginning in 2022 all otoliths are being sectioned prior to being aged as described previously.

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 Leica stereo 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 IsometTM low-speed saw and read on a compound microscope with transmitted light.

NEFSC

Winter flounder otoliths are sourced from the NEFSC bottom trawl survey and port sampling programs. Age determination for winter flounder has been conducted at the NEFSC Age and Growth Laboratory since 1971. From 1971 to 2005, age estimation was performed using scales. A comparison of the two calcified structures (scales and otoliths) was conducted on the same individuals from 2005 to 2014. The comparison demonstrated that otoliths yield more accurate and precise age estimates; consequently, scale-based age determination was discontinued in the fall of 2014. Currently, all otolith samples from fish smaller than 20 cm total length (TL) are analyzed whole using a stereoscope reflected light. Otoliths from all other samples are processed via thin-sectioning and examined with a stereoscope using transmitted light.

NJ DFW

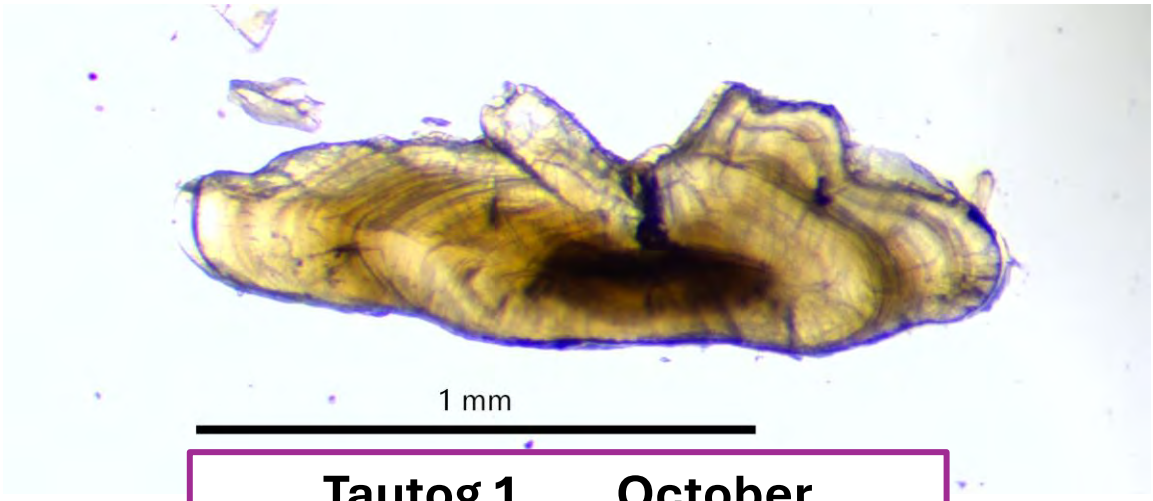
Sampling for winter flounder began in 1993 for New Jersey. Winter flounder otoliths are collected during the April Ocean Trawl Survey due to higher occurrences from the fish leaving the estuaries after spawning. From 1995-2005, we had a spawning survey of winter flounder in some of our northern estuaries, 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 IsometTM saws. The sections are then read by two individual readers, and discrepancies are then read by a tie breaker.

VIMS

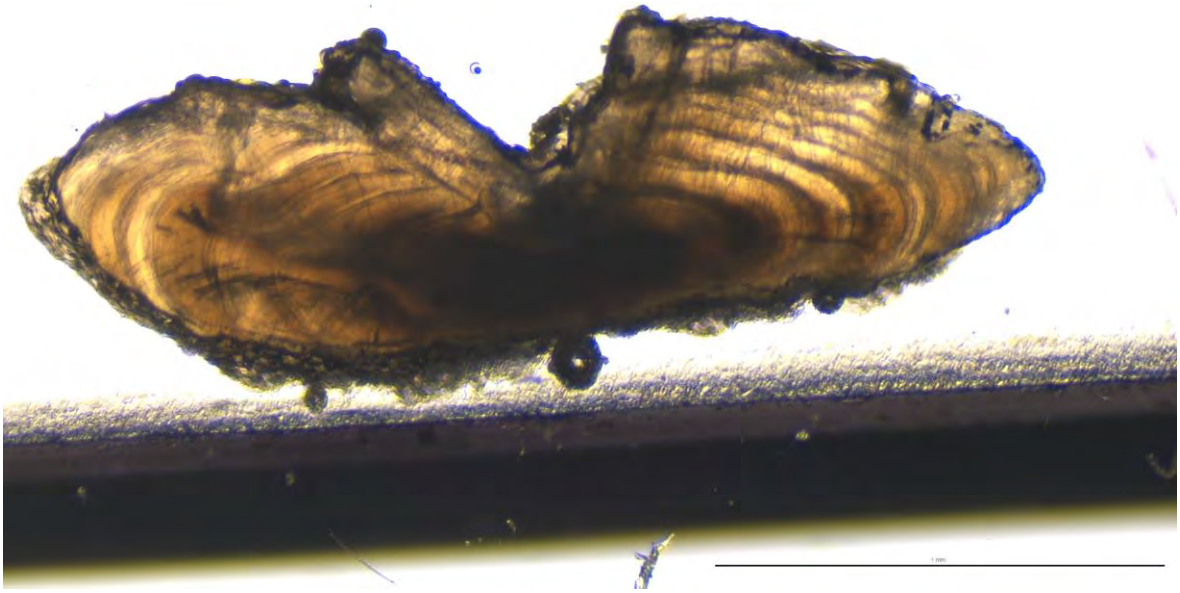
Winter flounder is a “Priority” species for NEAMAP, meaning that length, weight, sex, maturity state, stomach, and otoliths are collected for five individuals from each length bin on each tow. VIMS uses sectioned otoliths to age winter flounder. Otoliths are sectioned using a method similar to VMRC’s. 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. 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 68 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 performed within each reader (multiple reads of the same sample) and between readers. VIMS uses similar precision and symmetry tests to the NEFSC.

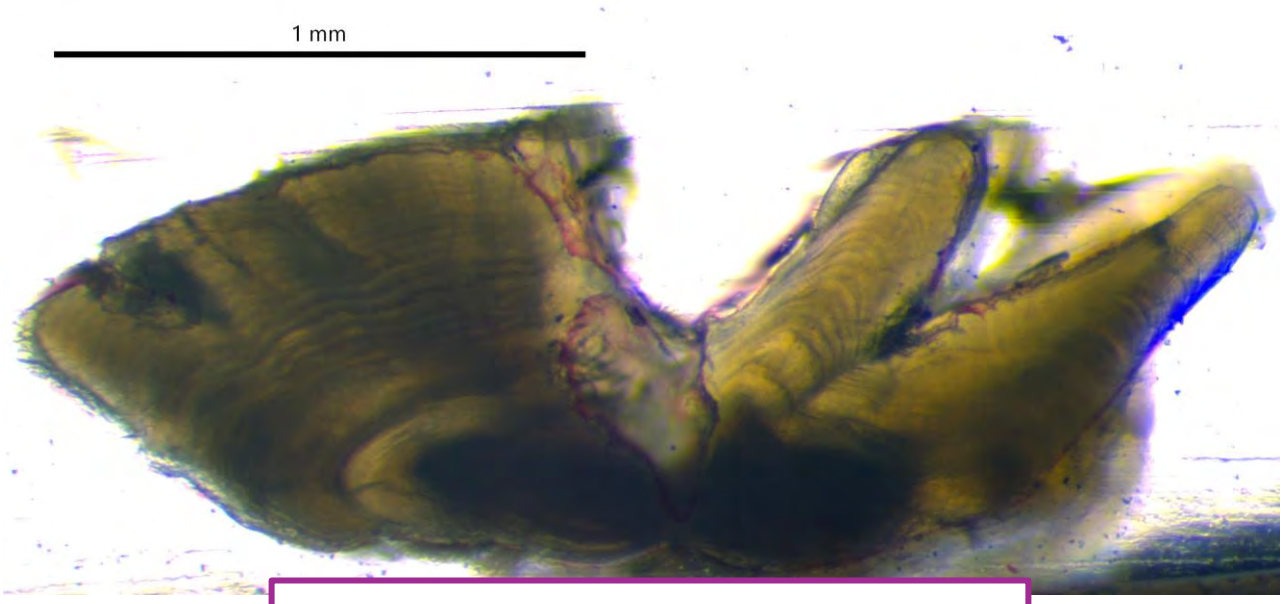
Appendix C: Sample Photos



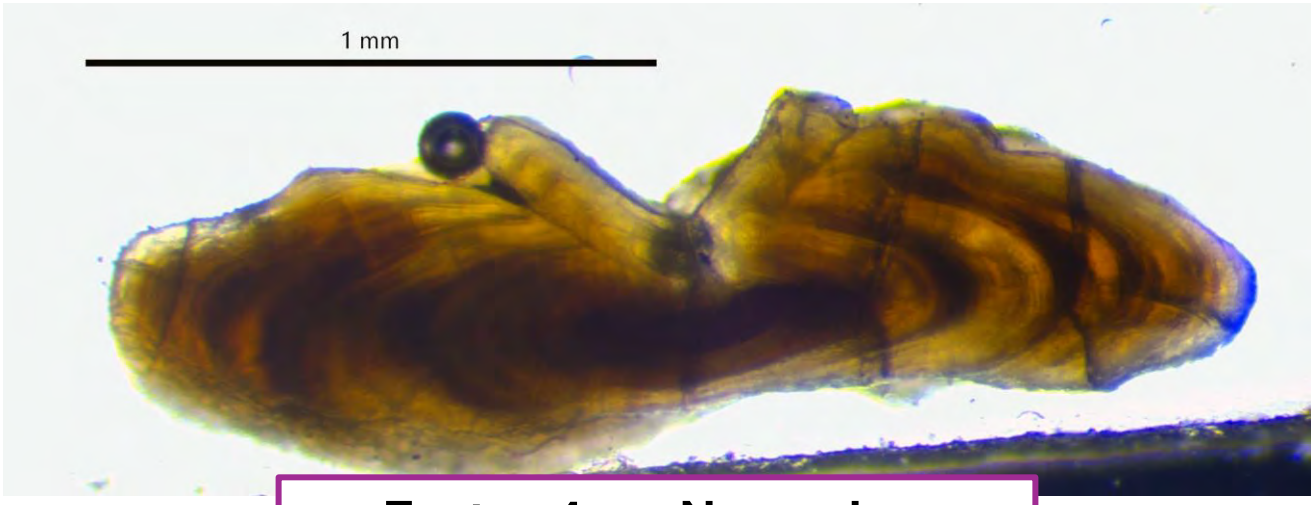
Tautog 1 October



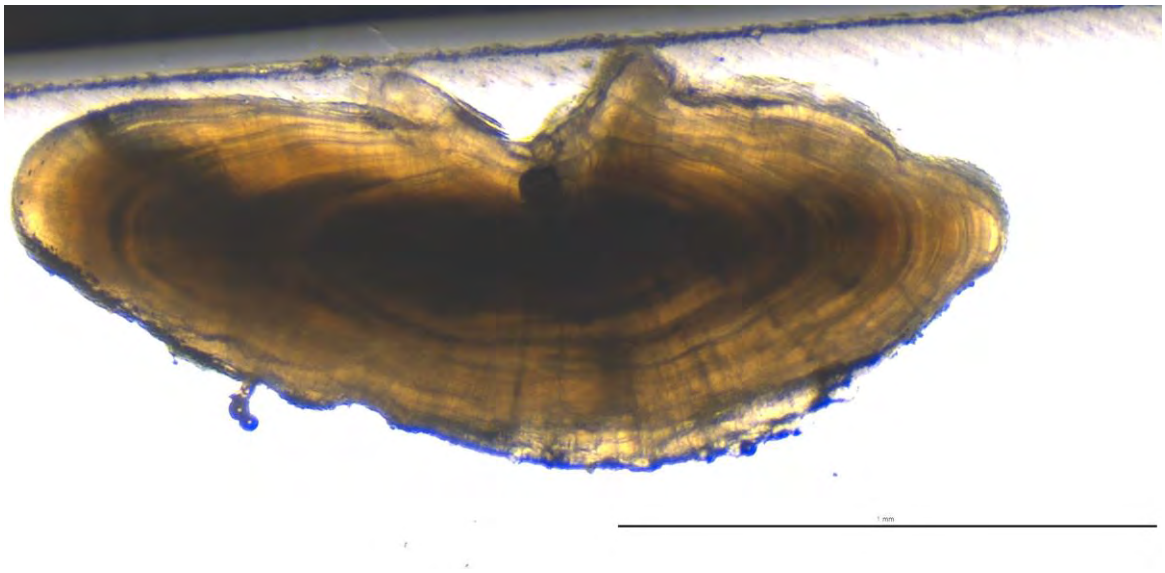
Tautog 2 October



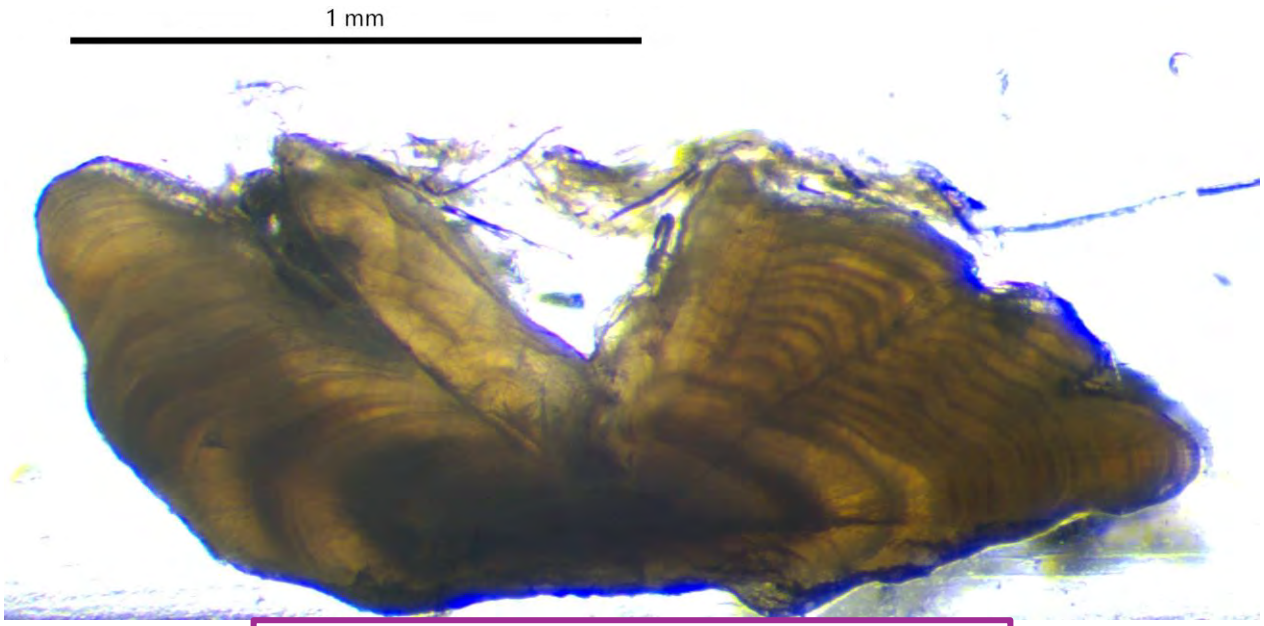
Tautog 3 November



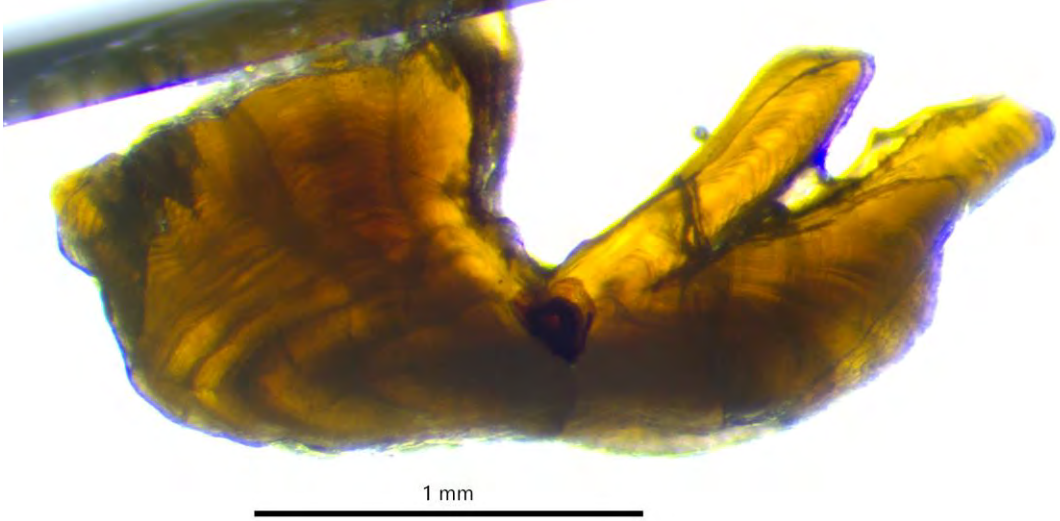
Tautog 4 November



Tautog 5 September



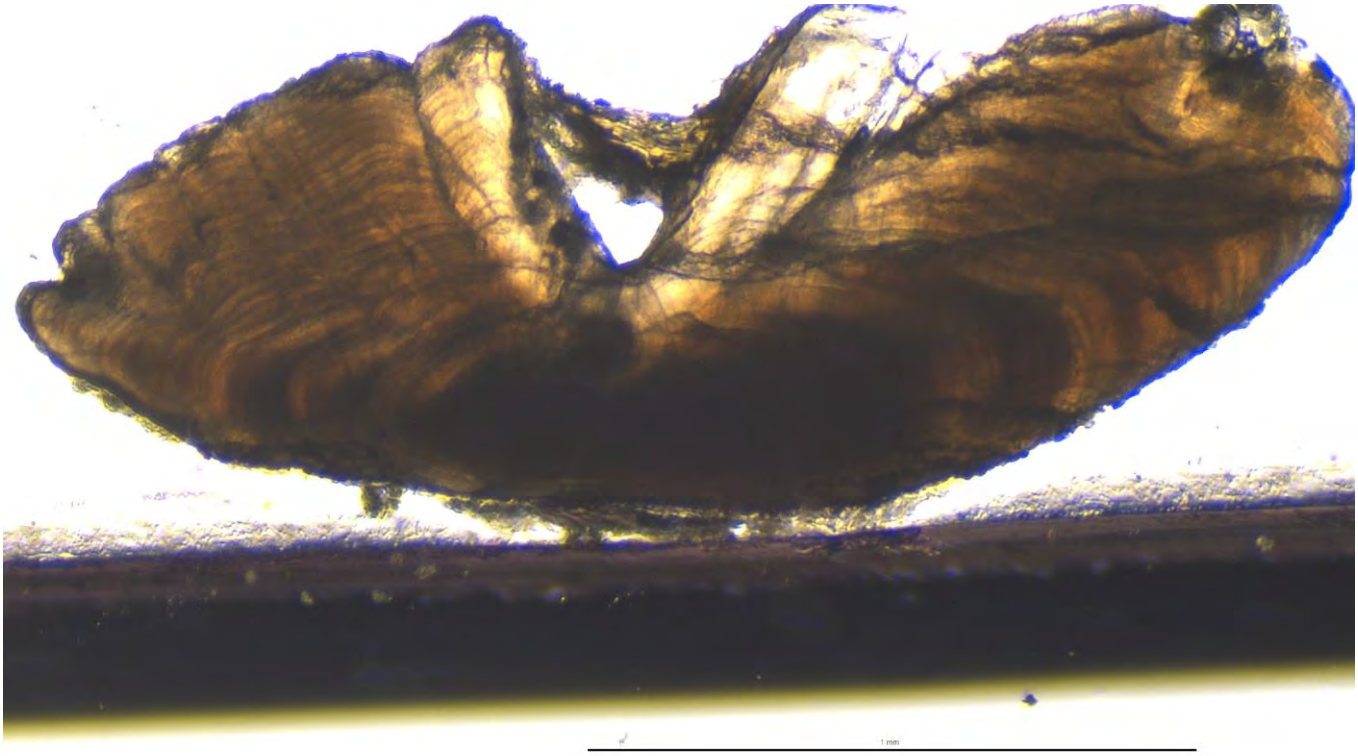
Tautog 6 November



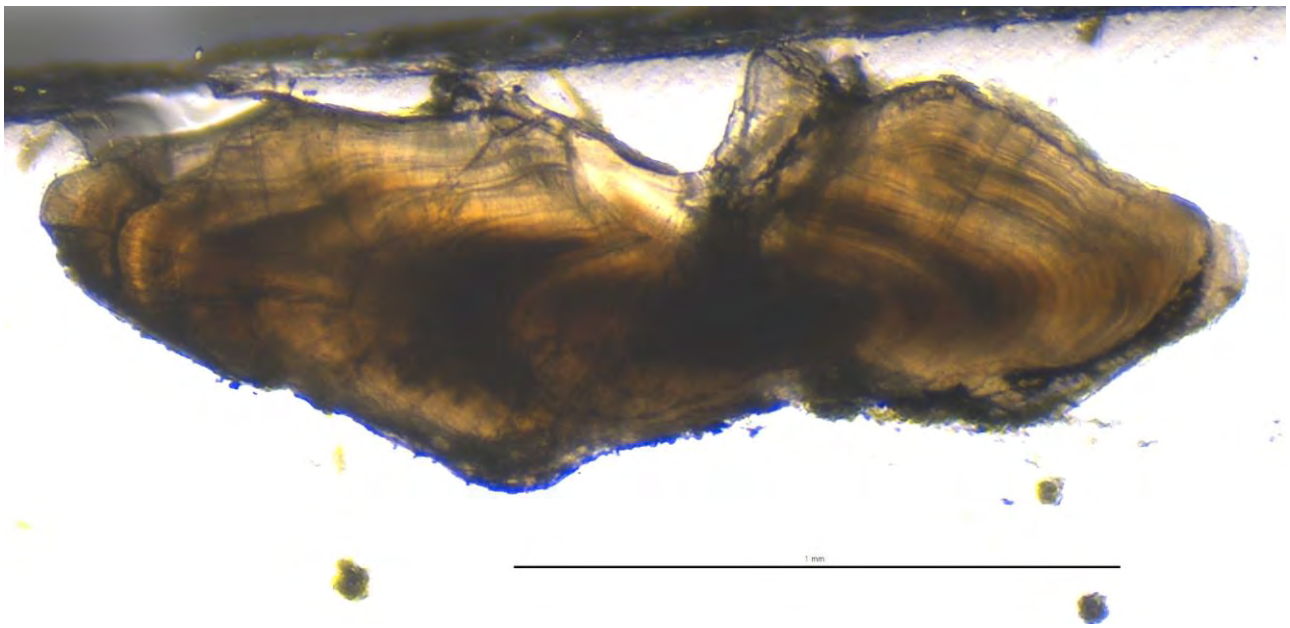
Tautog 7 March

Tautog 8 November

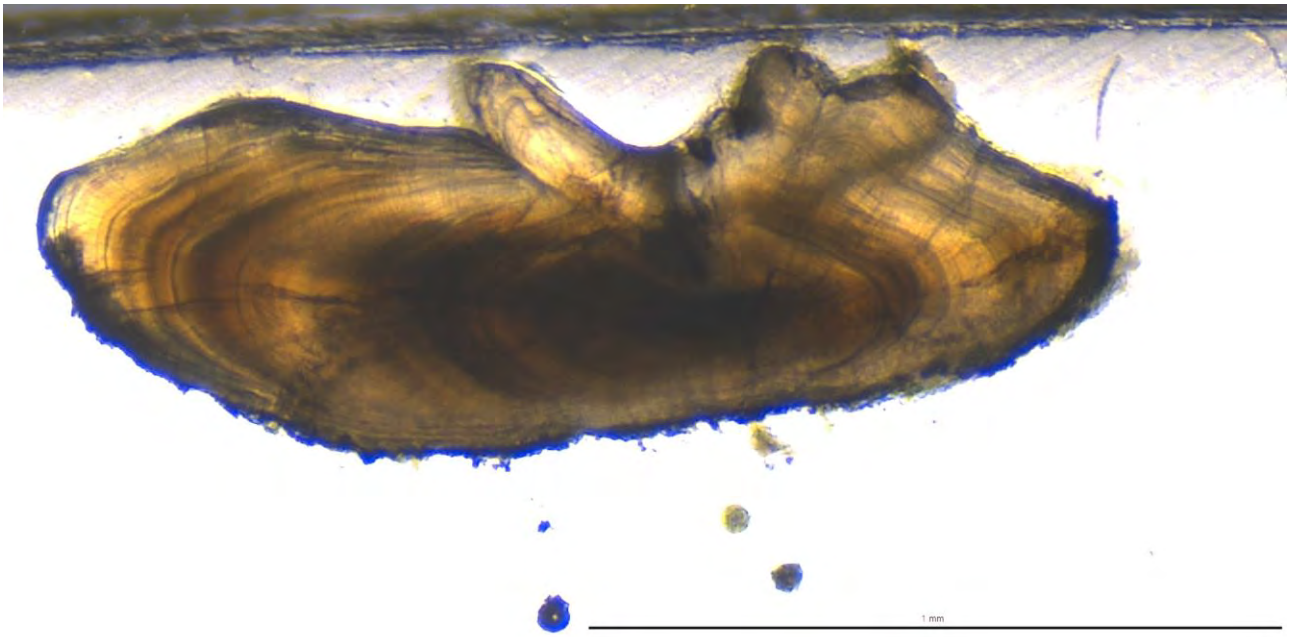
Tautog 9 July



Tautog 10 November



Tautog 11 September



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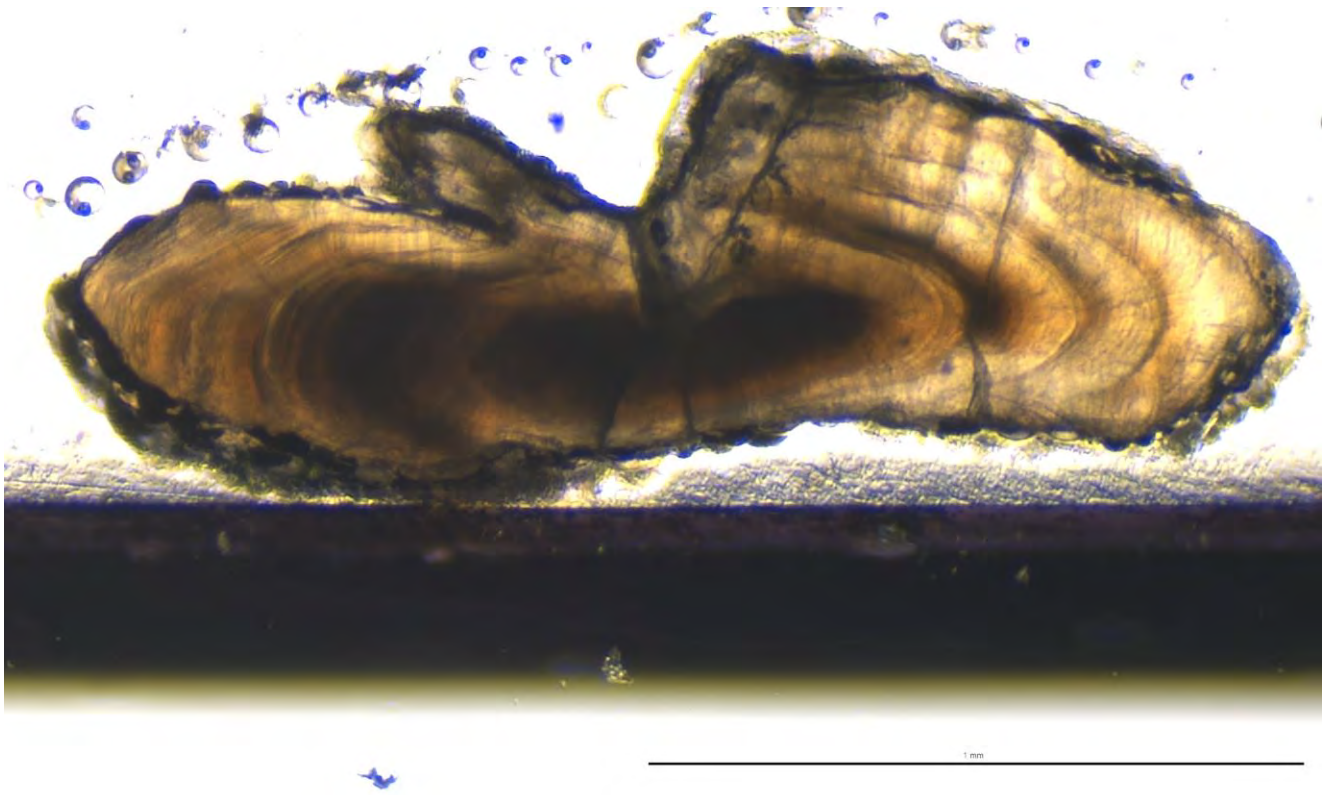

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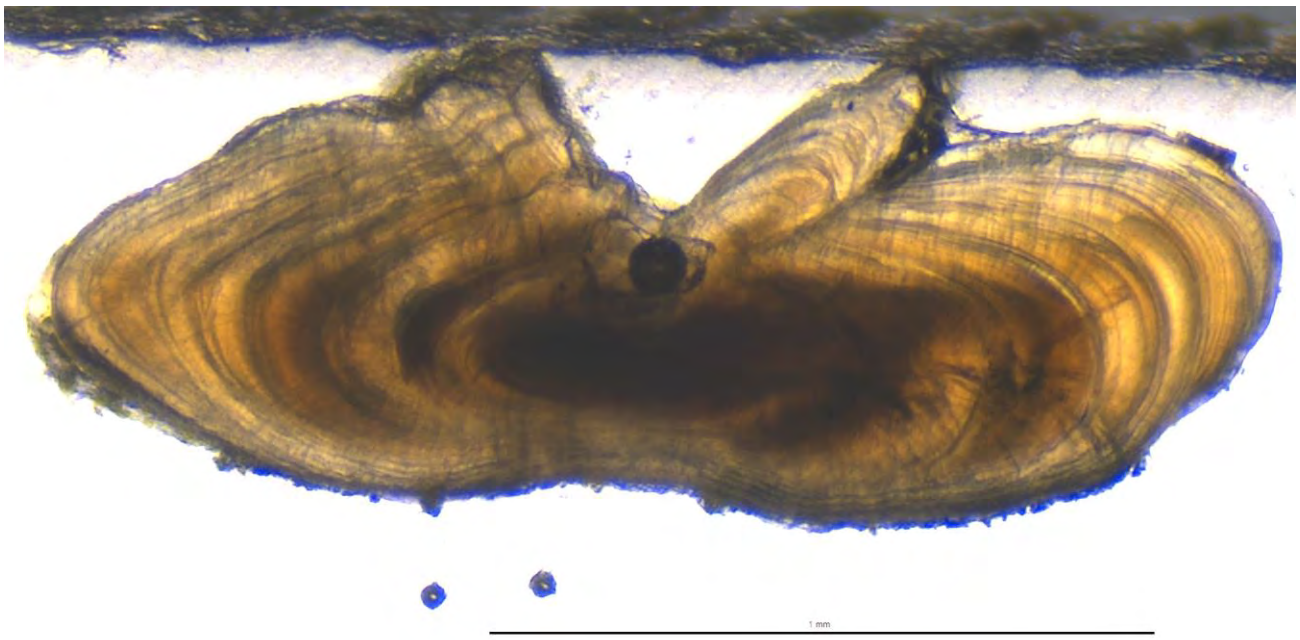


Tautog 14 July

Tautog 15 July

Tautog 16 November

Tautog 17 September

Tautog 18 July

Tautog 19 November

Tautog 20 November

Tautog 21 November

Tautog 22 November

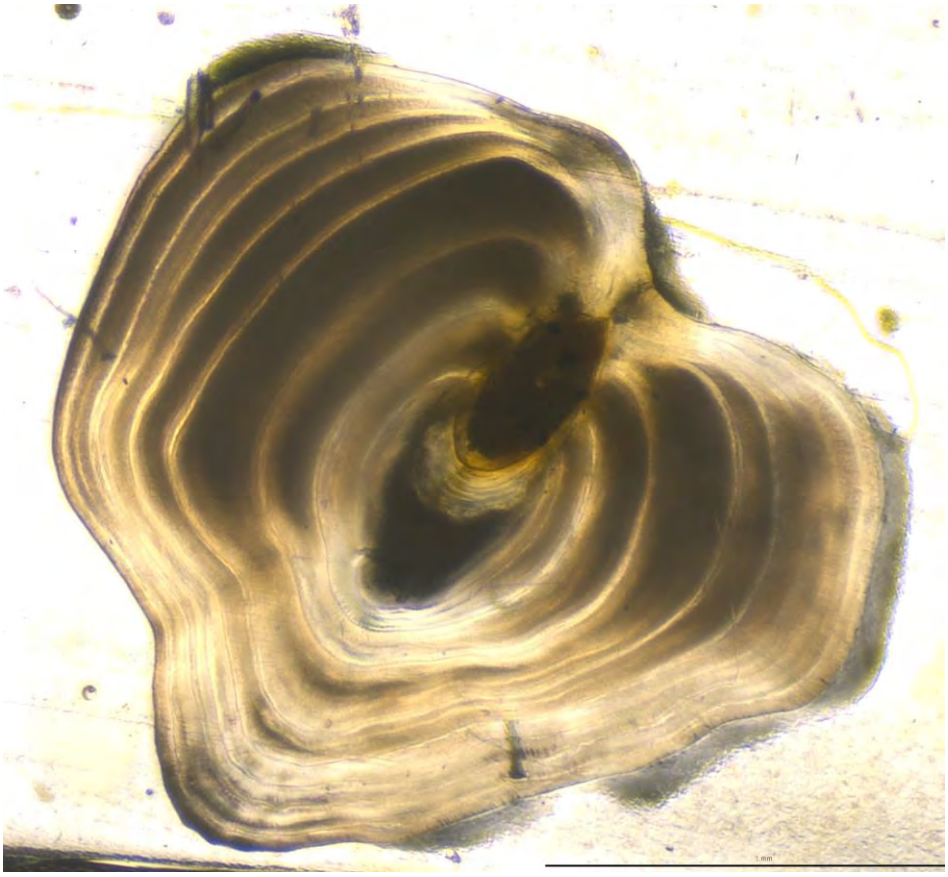
Tautog 23 November

Tautog 24 March

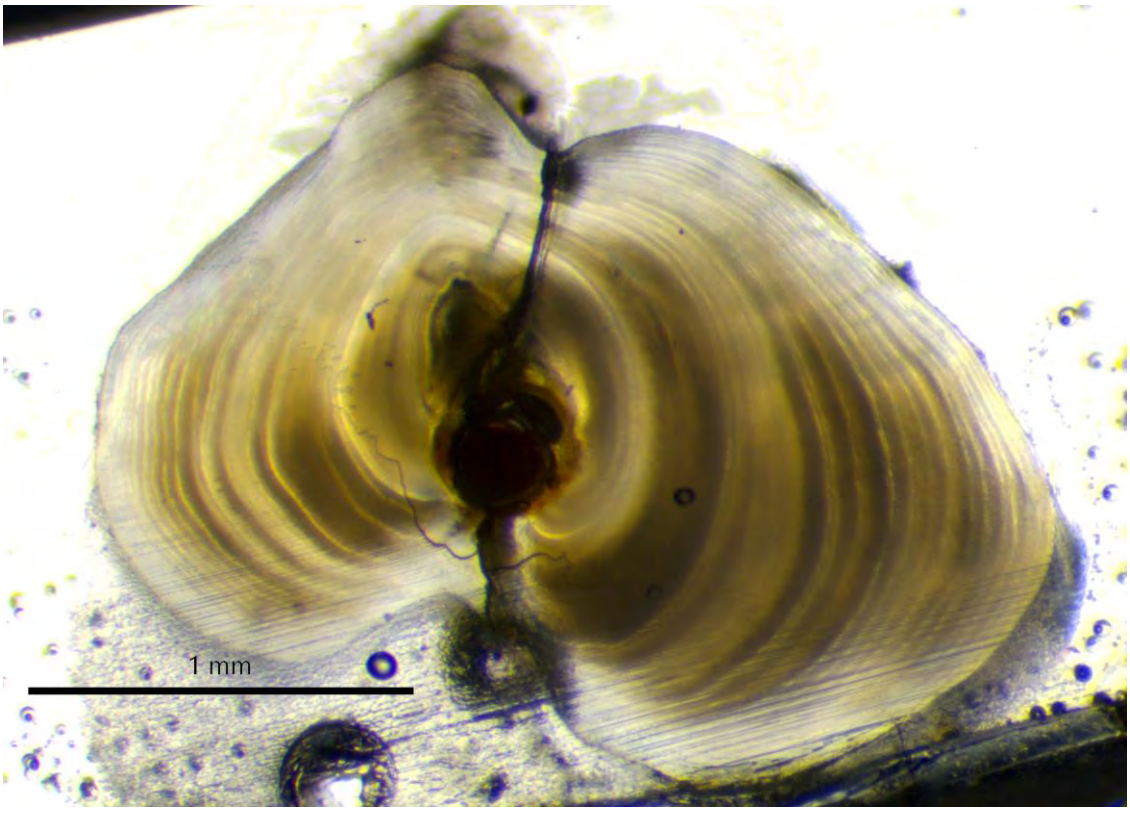
Tautog 25 October

Tautog 26
July

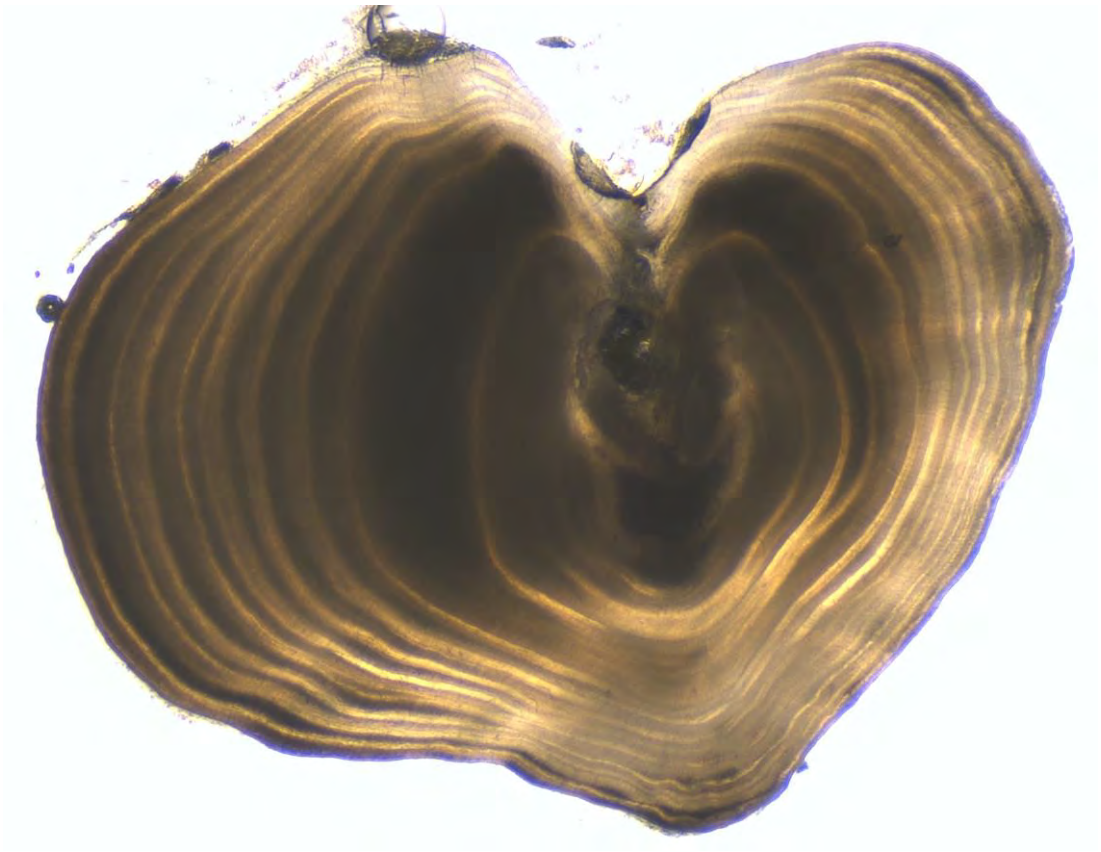
Tautog 27
October



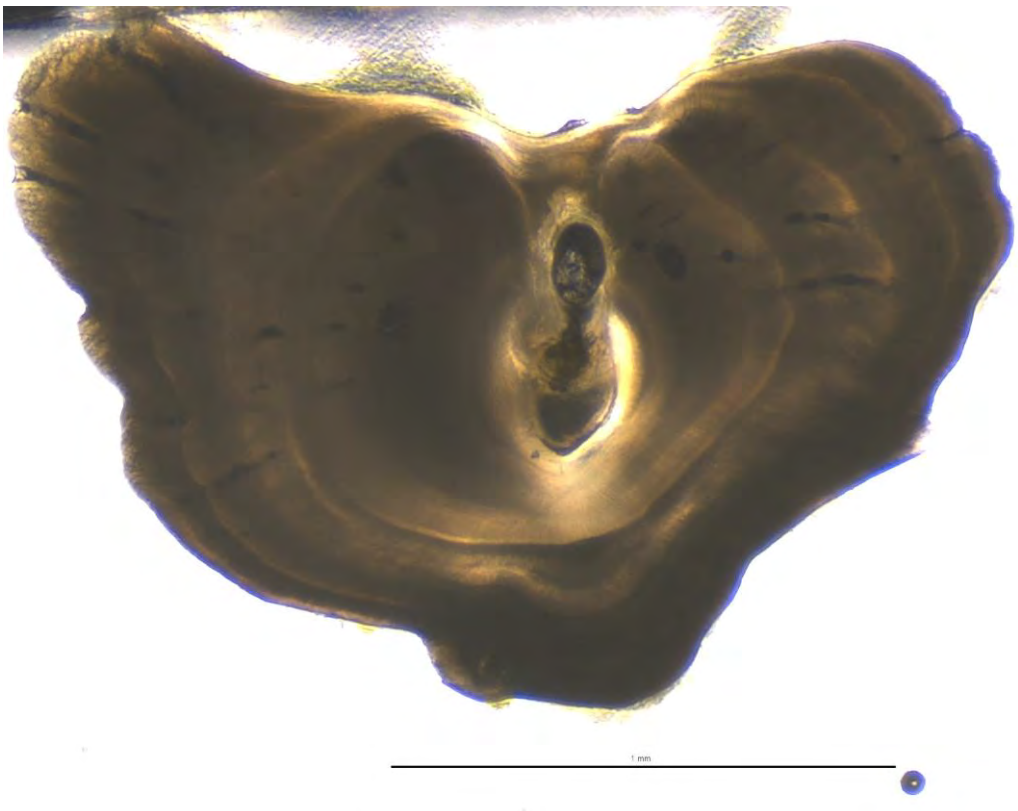
Tautog 28 October



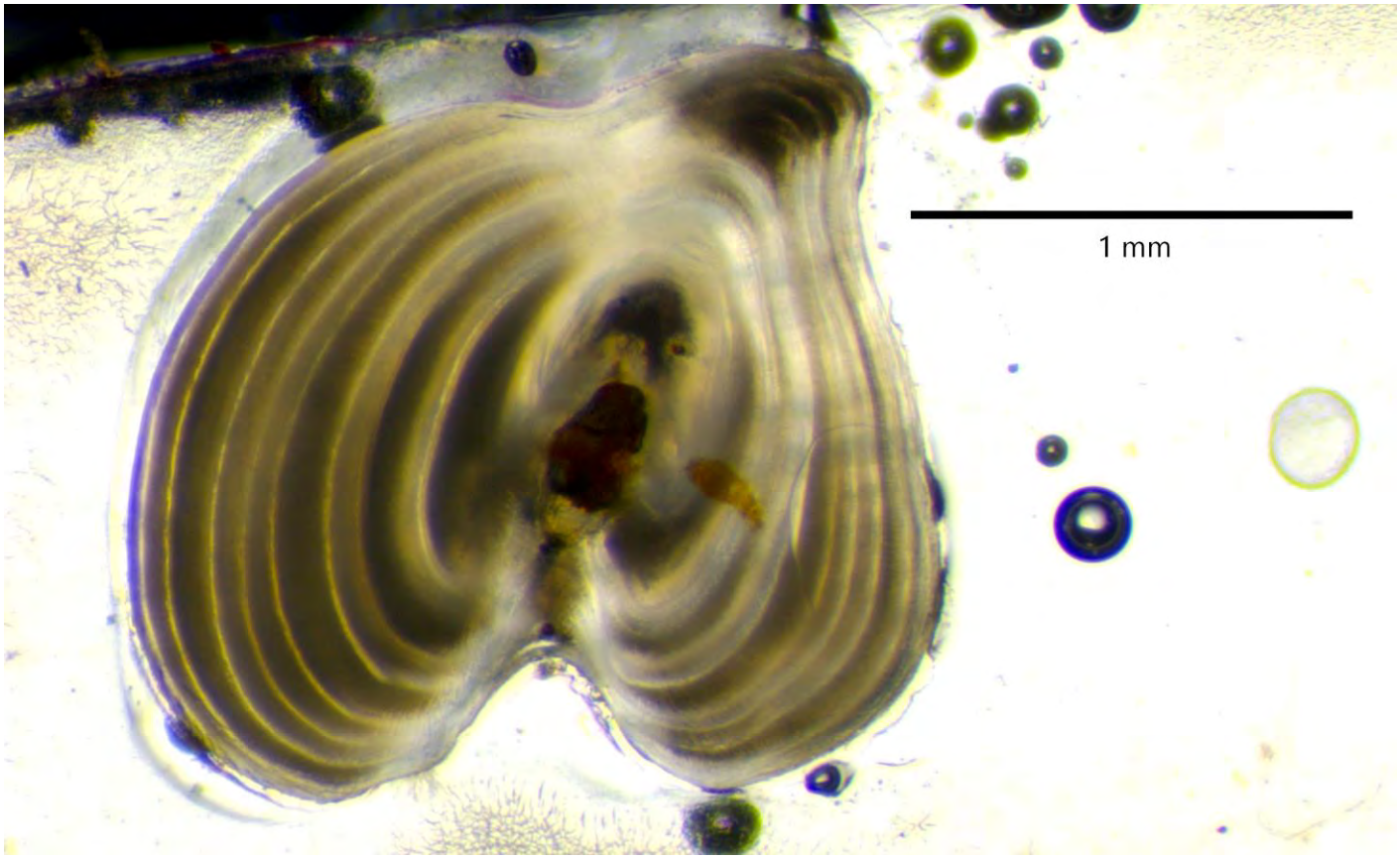
Tautog 29 November



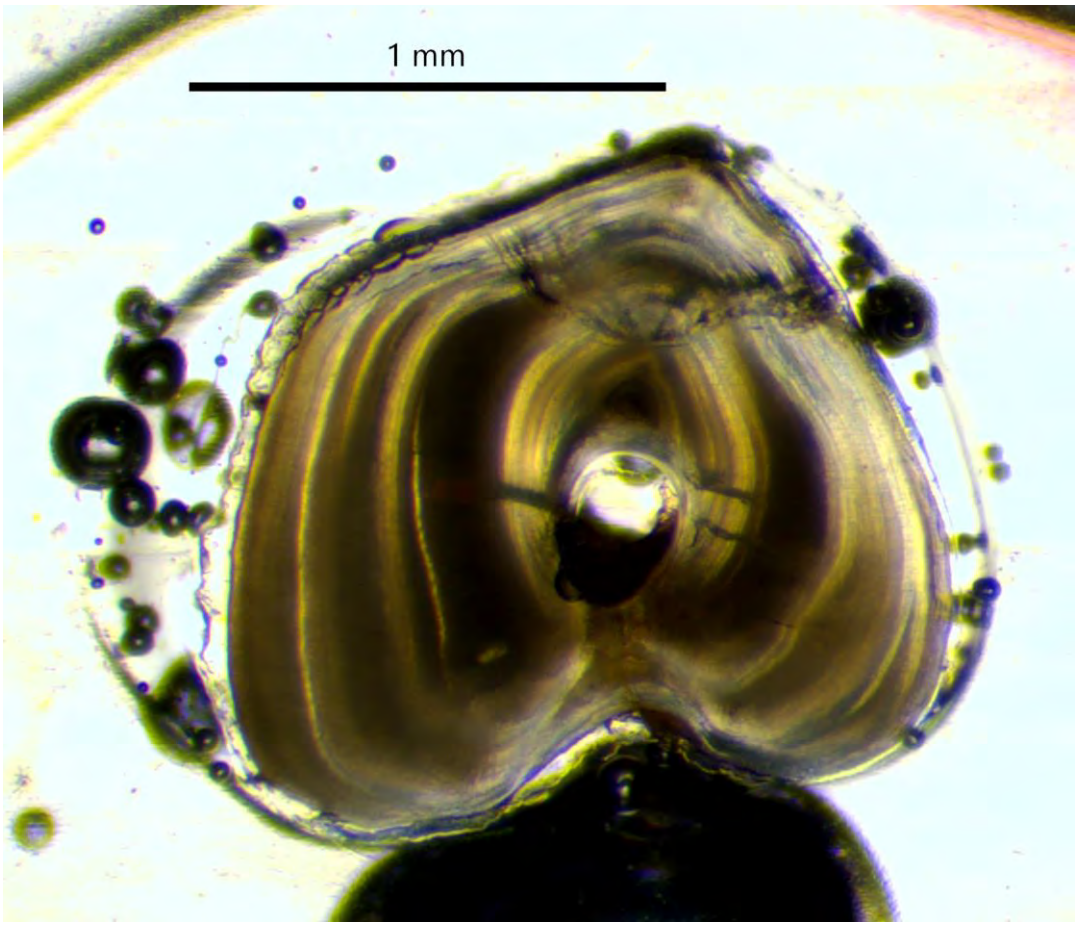
Tautog 30 July



Tautog 31 July



Tautog 32 November



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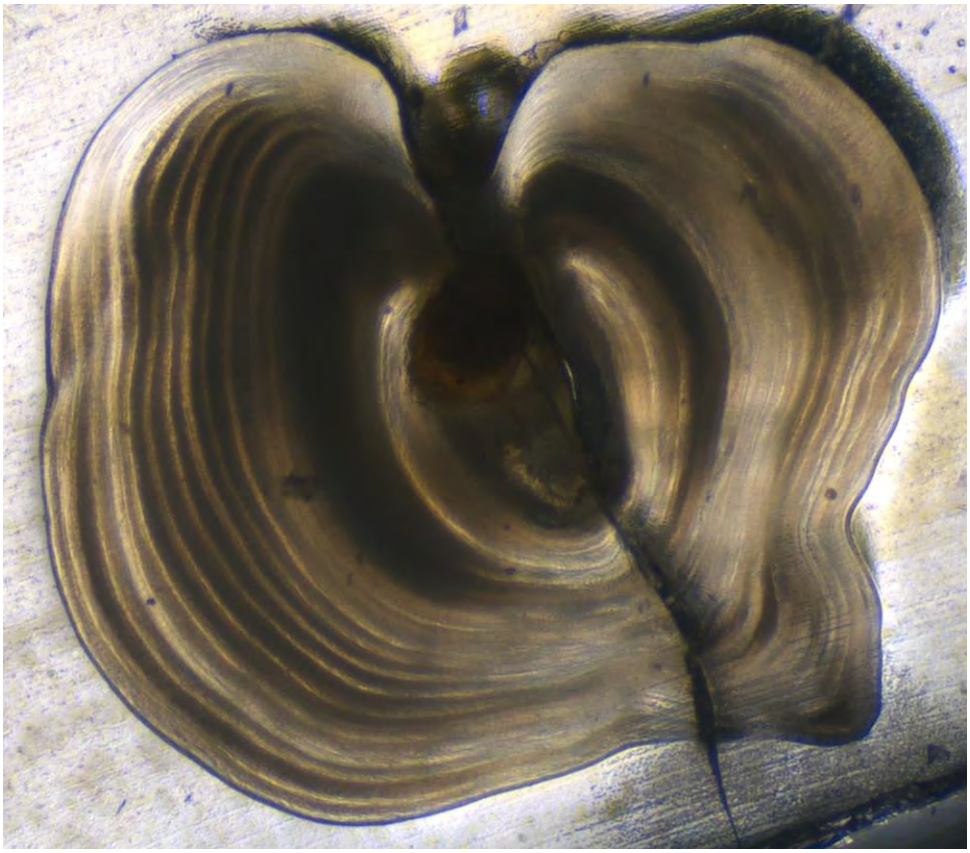
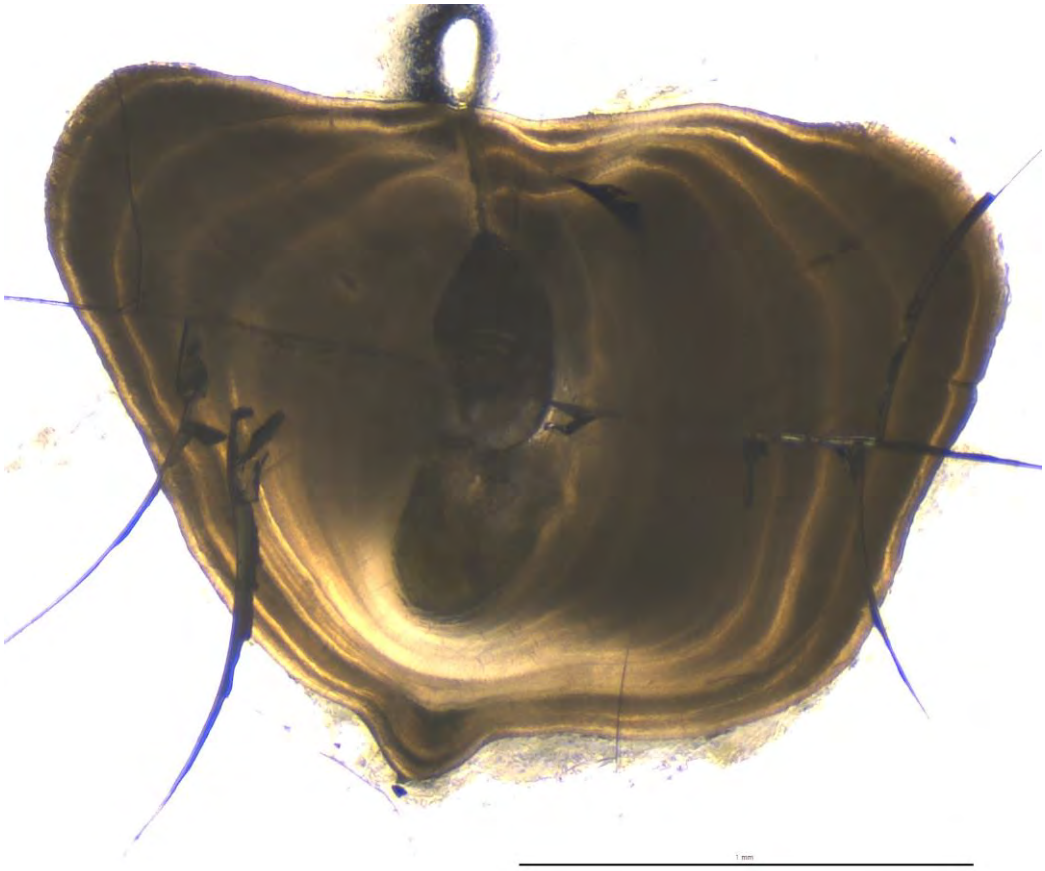
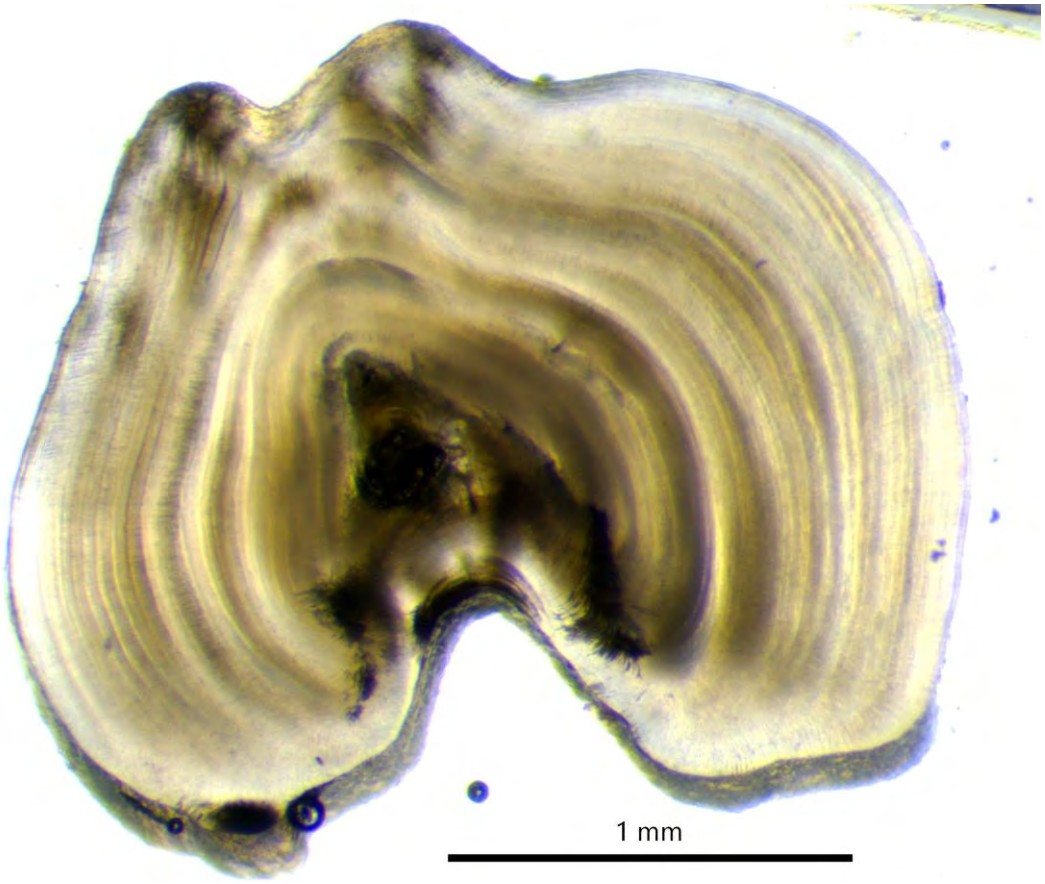


Tautog 34 November

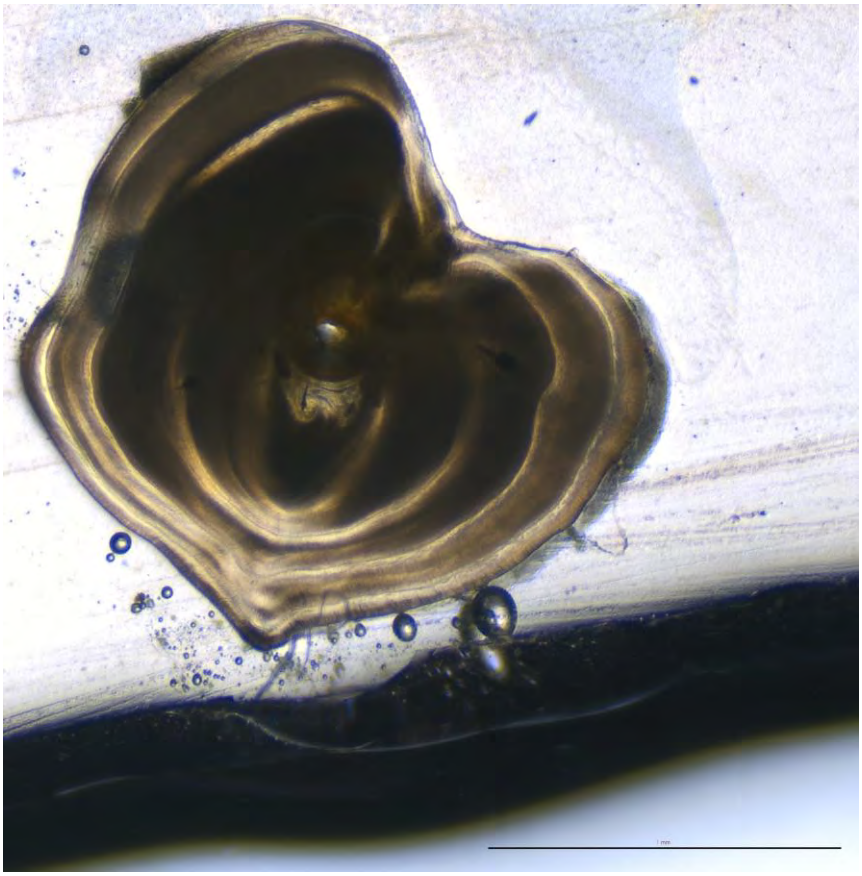


Tautog 35 September

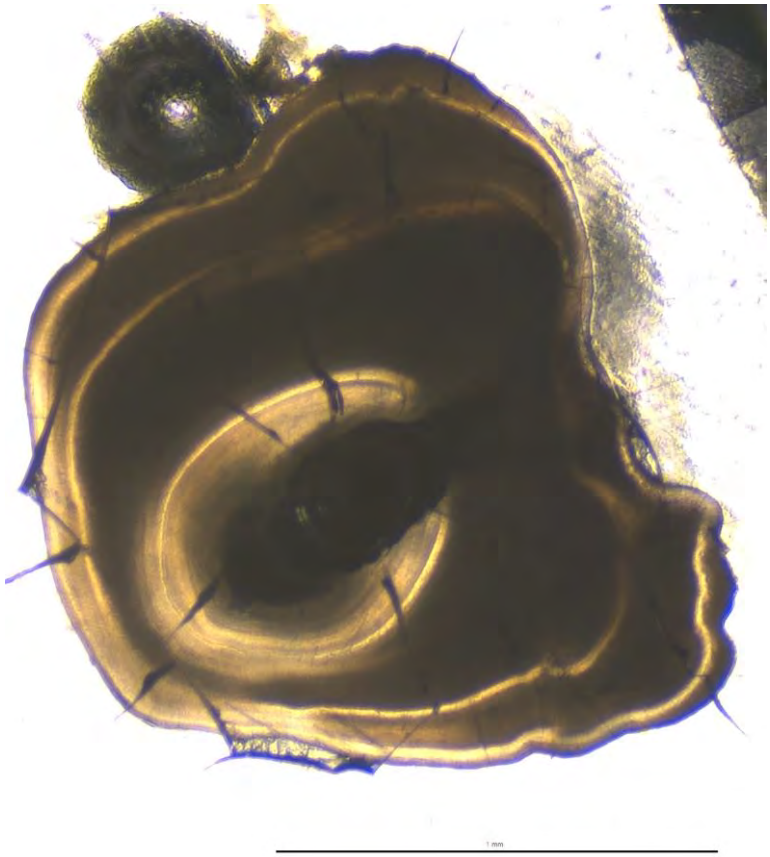


Tautog 36 March

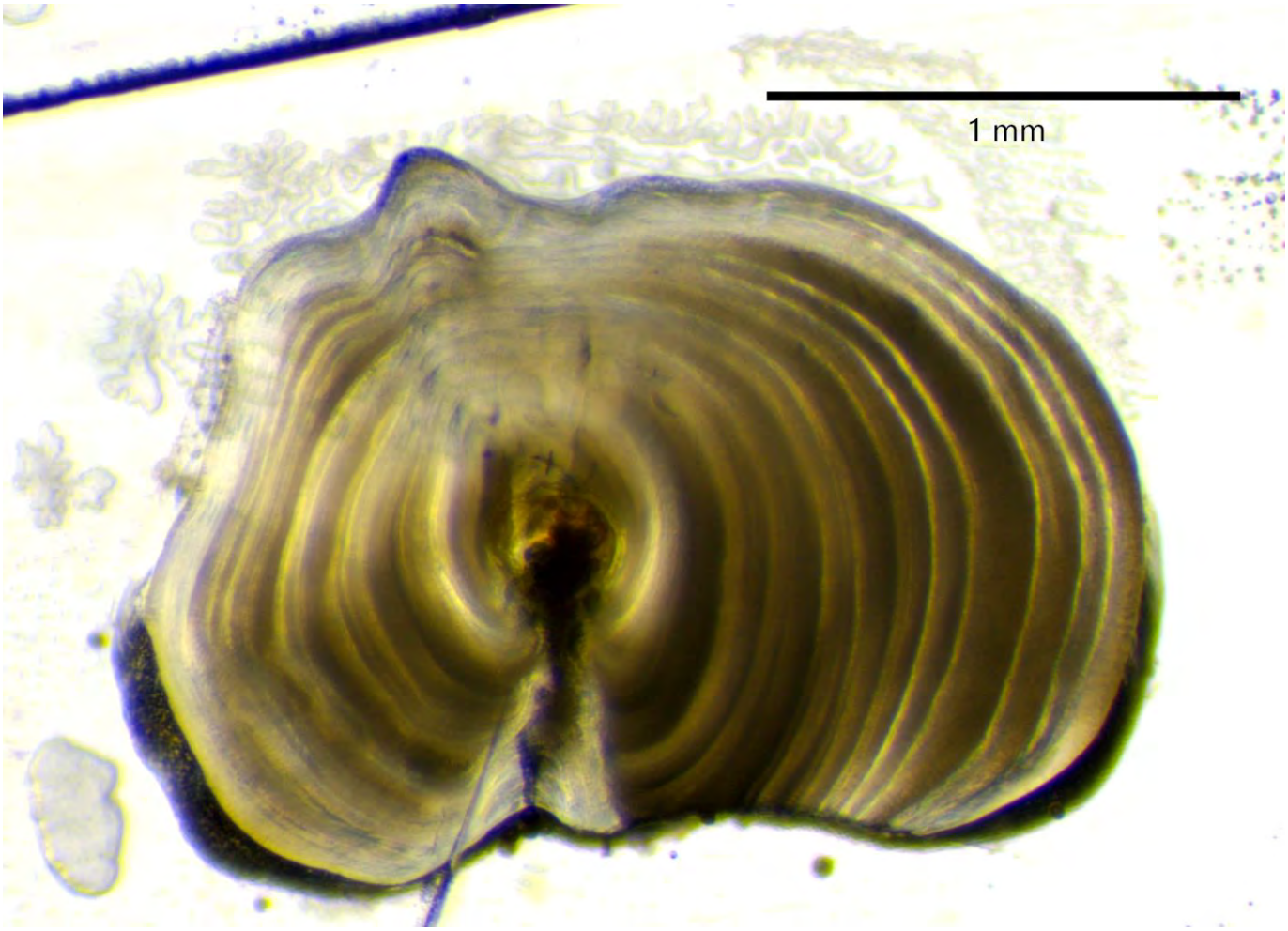
Tautog 37 July



Tautog 38 November



Tautog 39 September



Tautog 40 November

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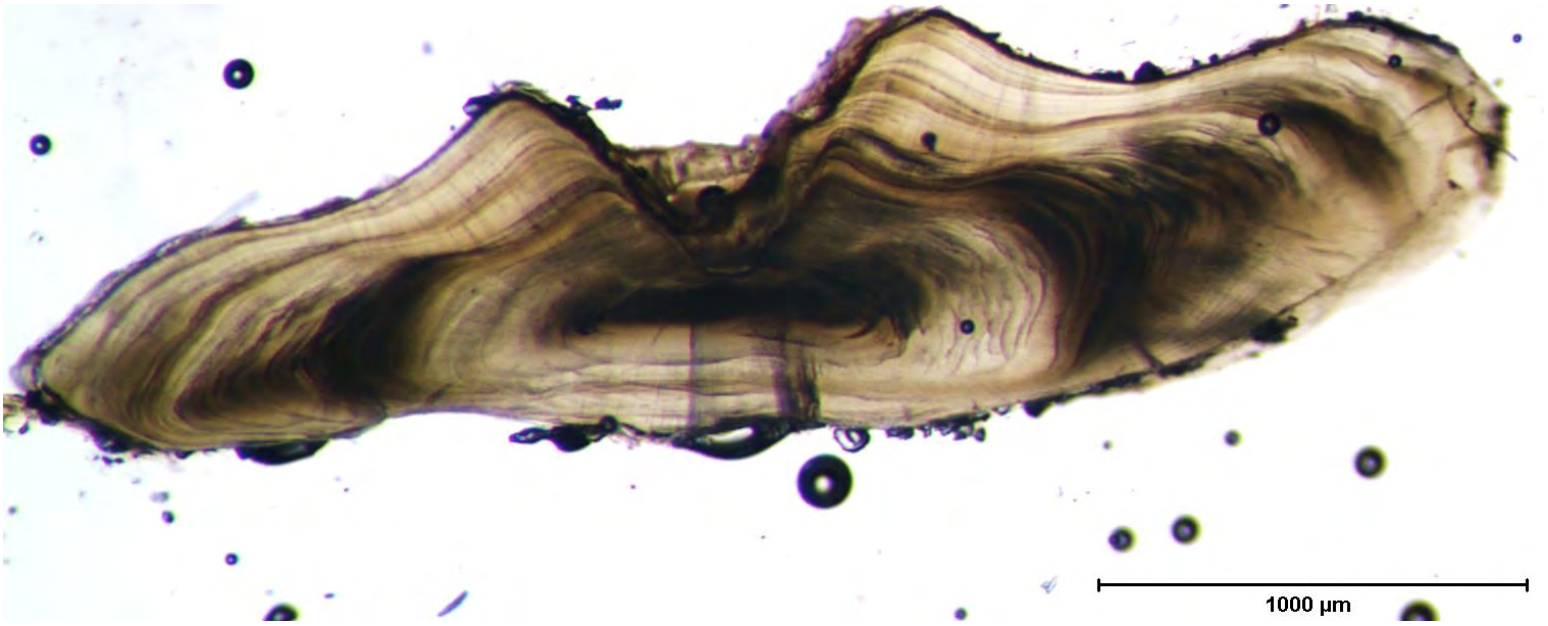
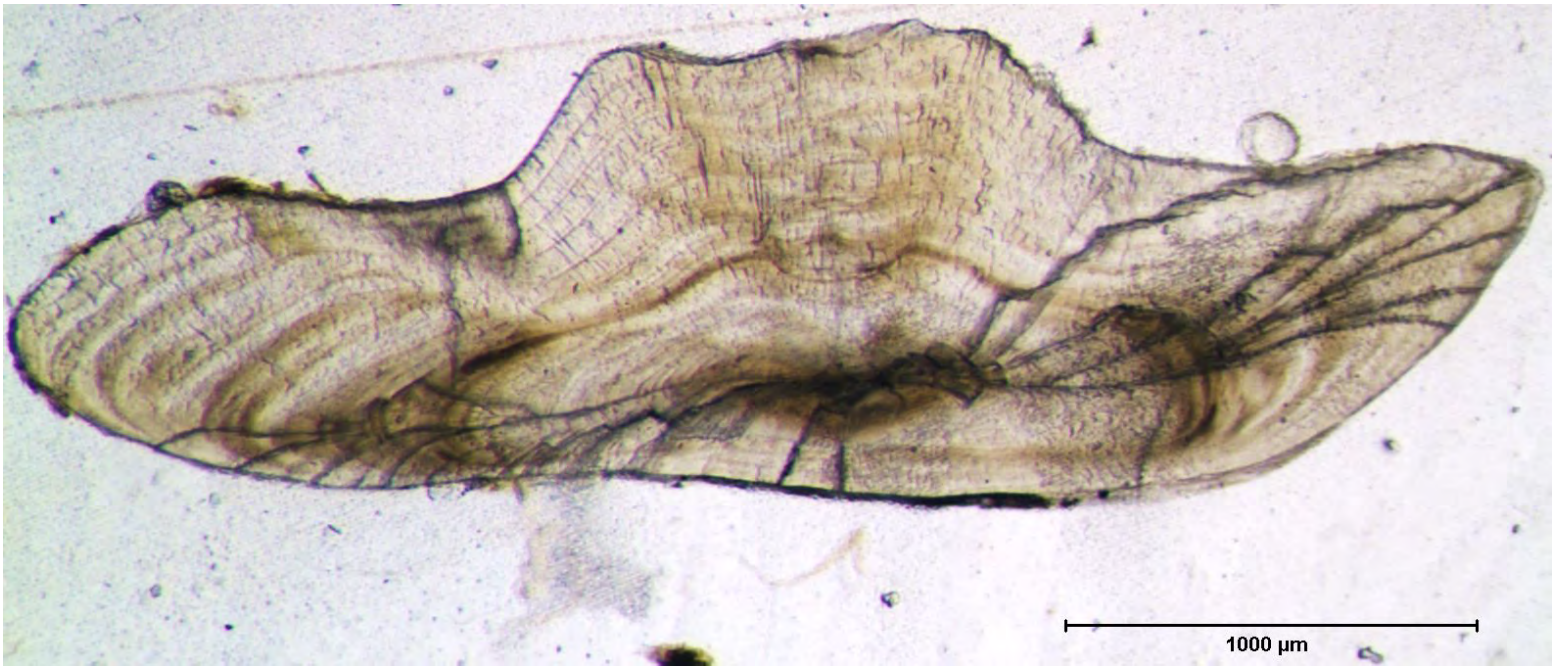
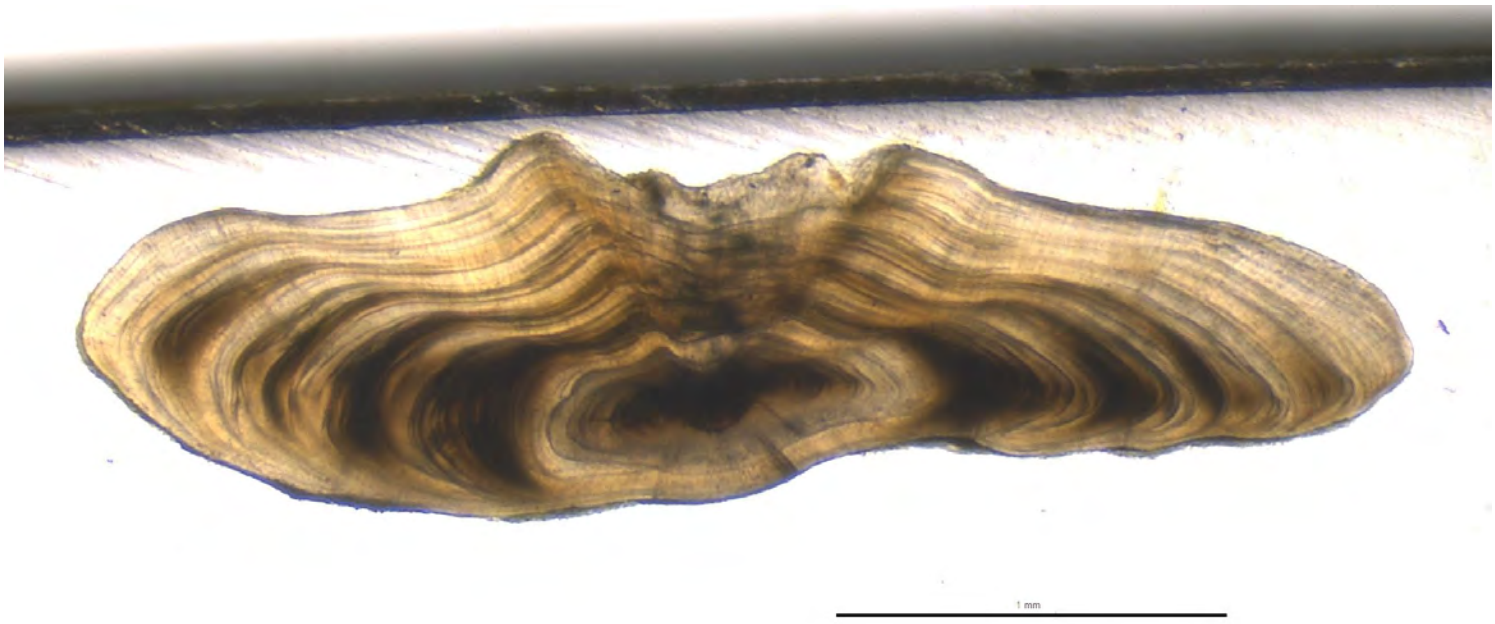


Winter Flounder 1 October

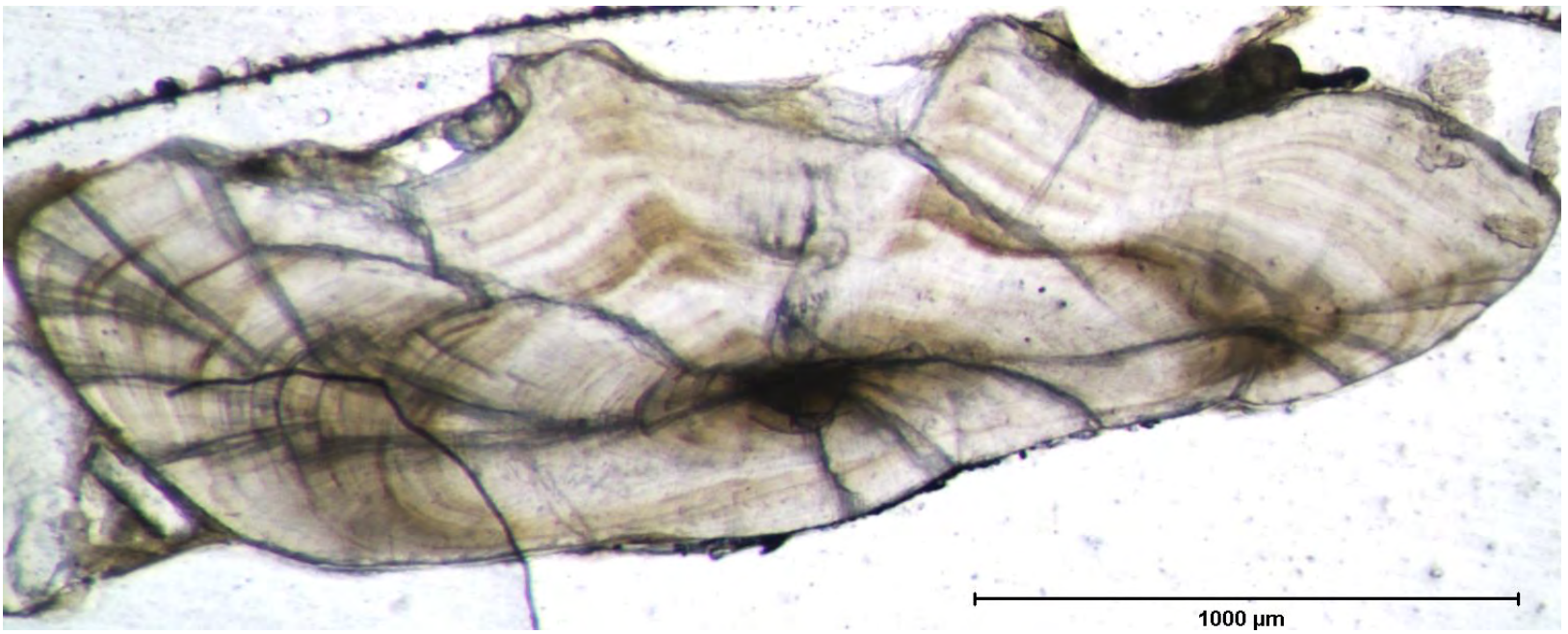


Winter Flounder 2 March

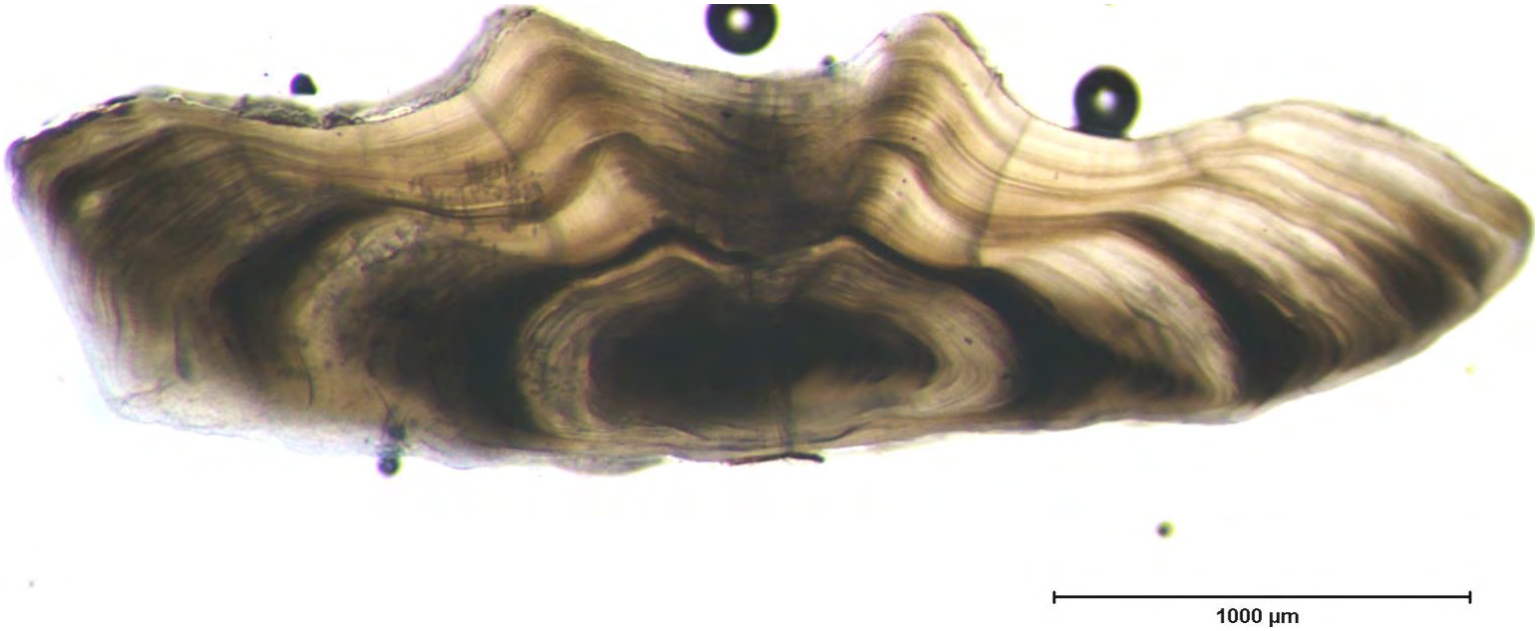


Winter Flounder 3 **September**

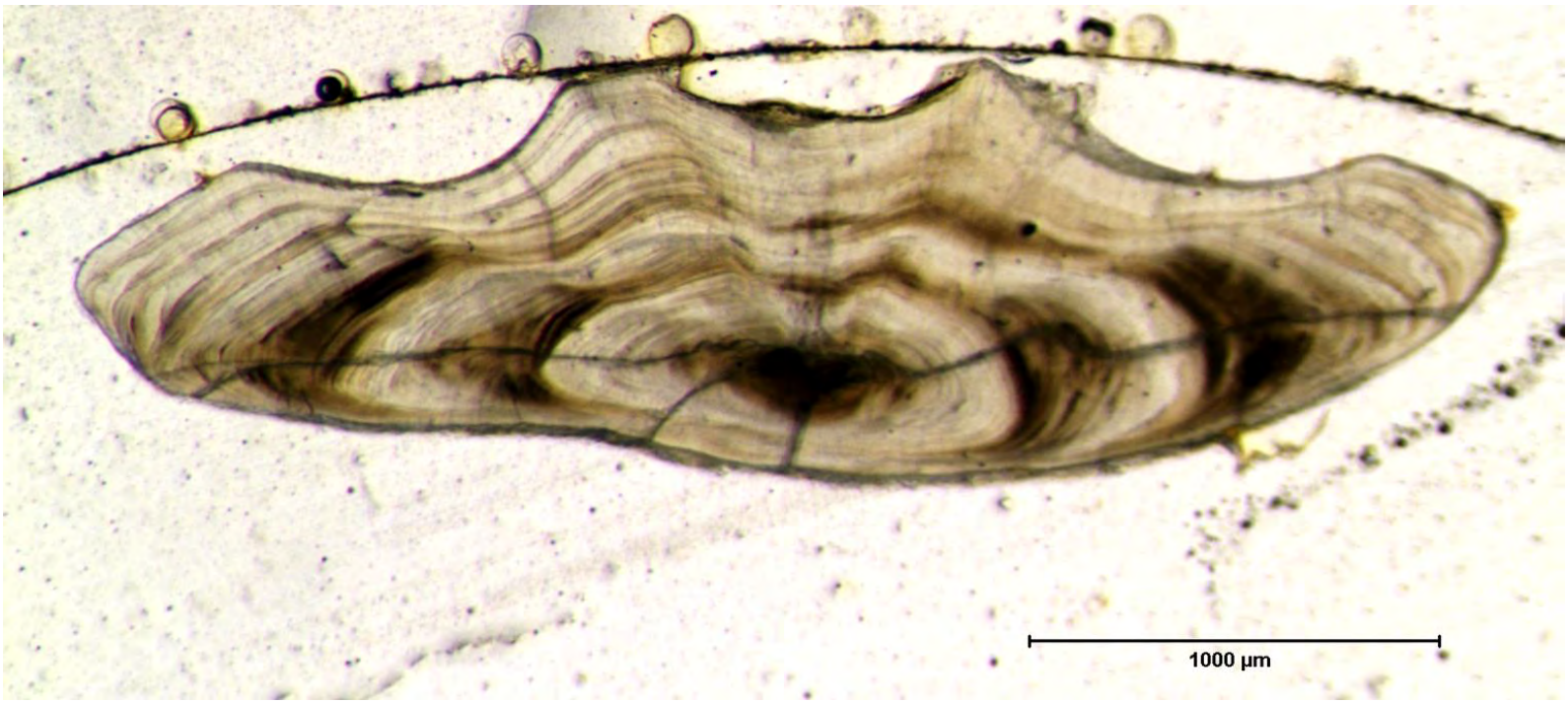
Winter Flounder 4 **October**



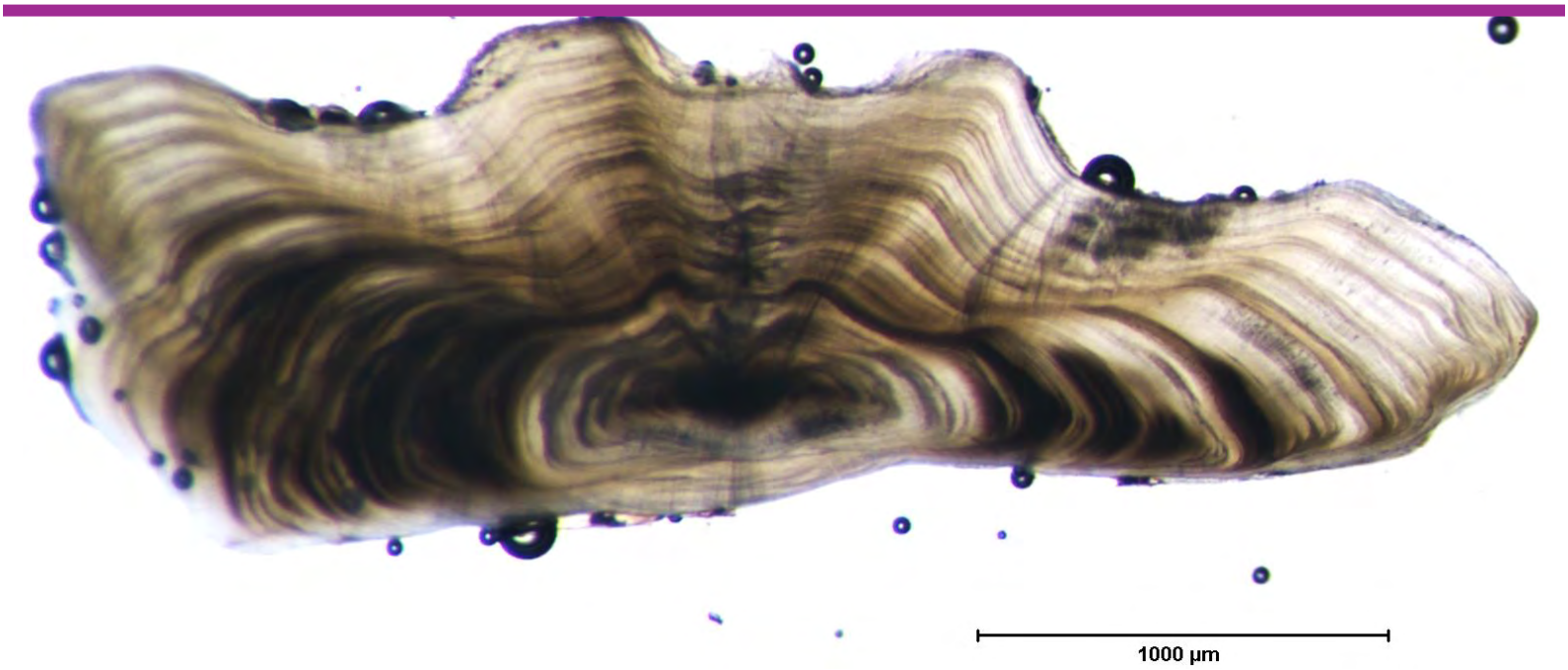
Winter Flounder 5 April



Winter Flounder 6 October

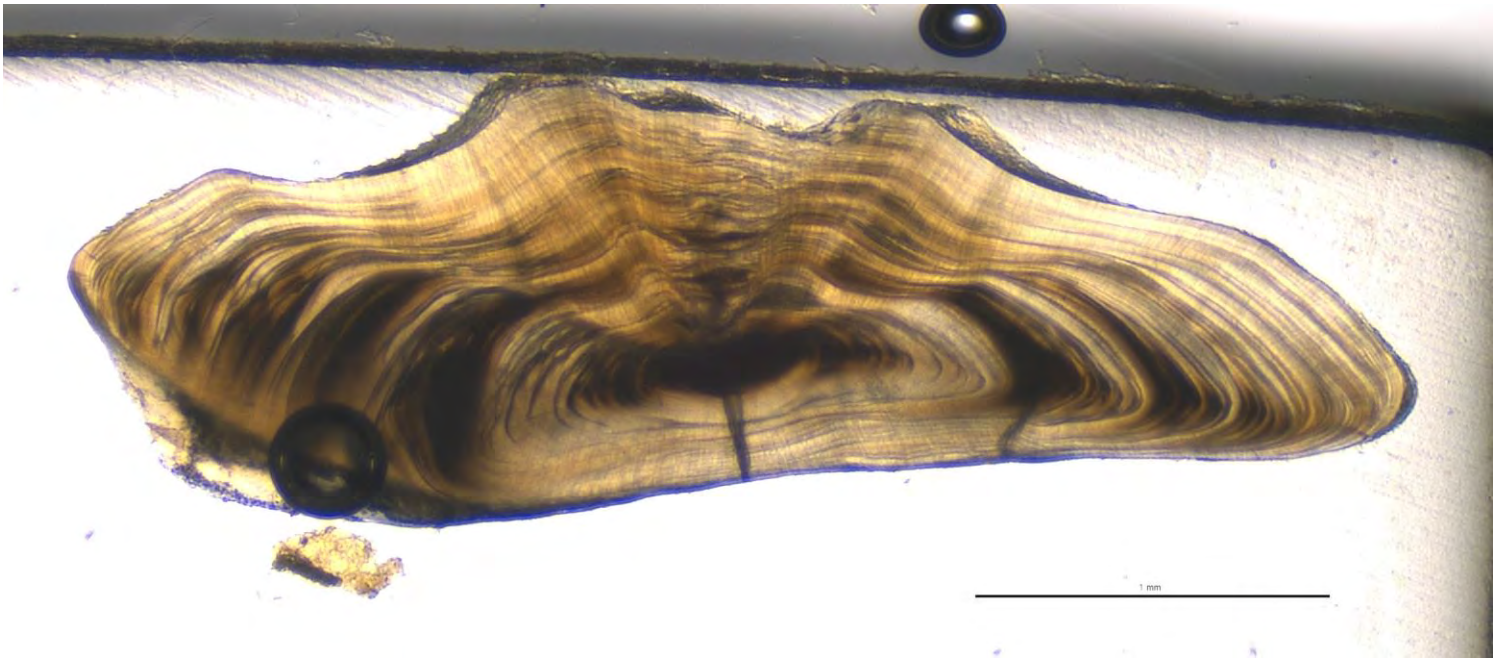


Winter Flounder 7 March

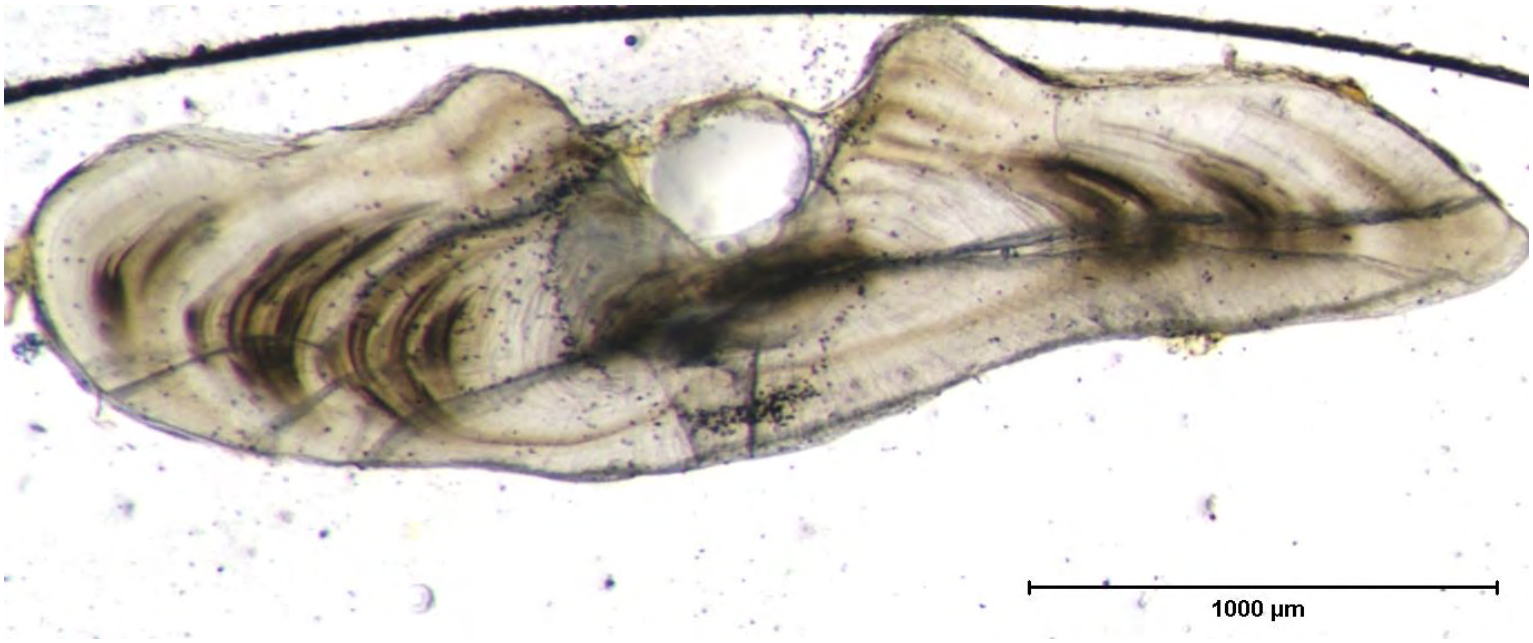


Winter Flounder 8 October

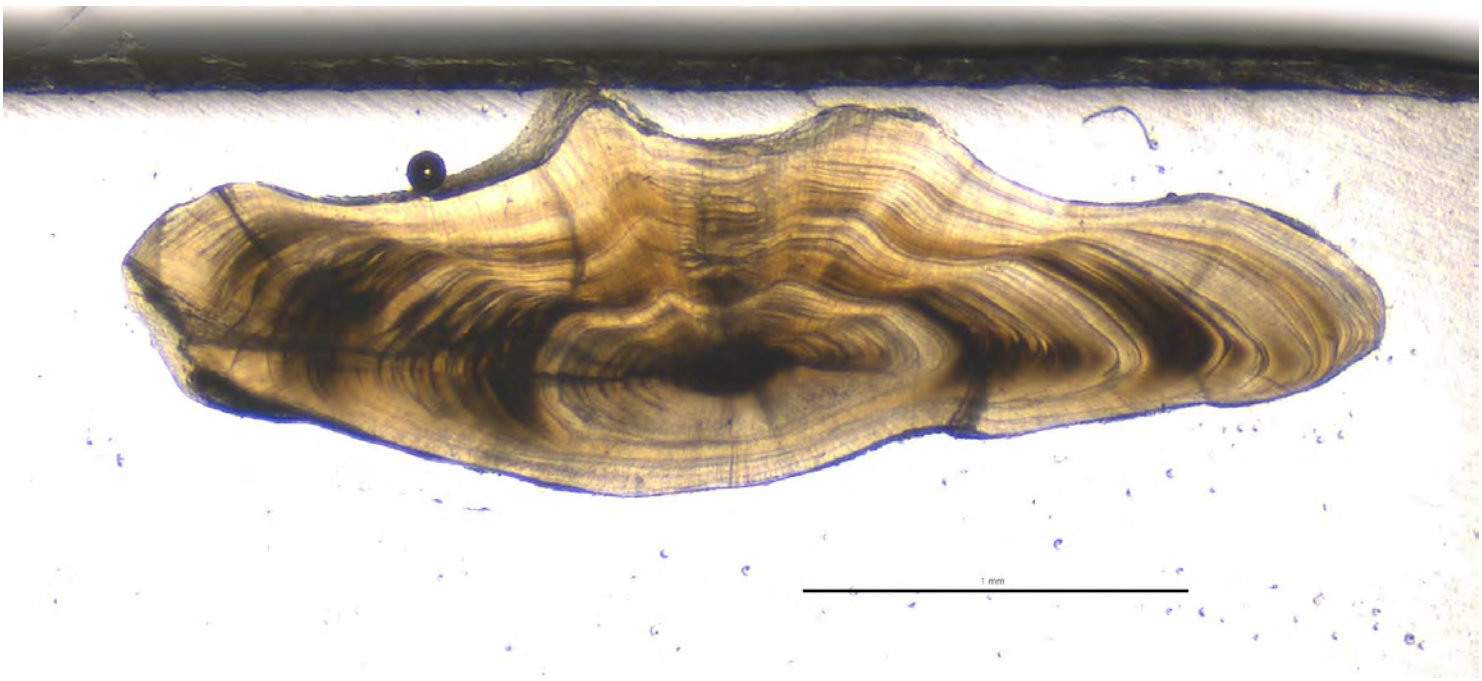
Winter Flounder 9 May



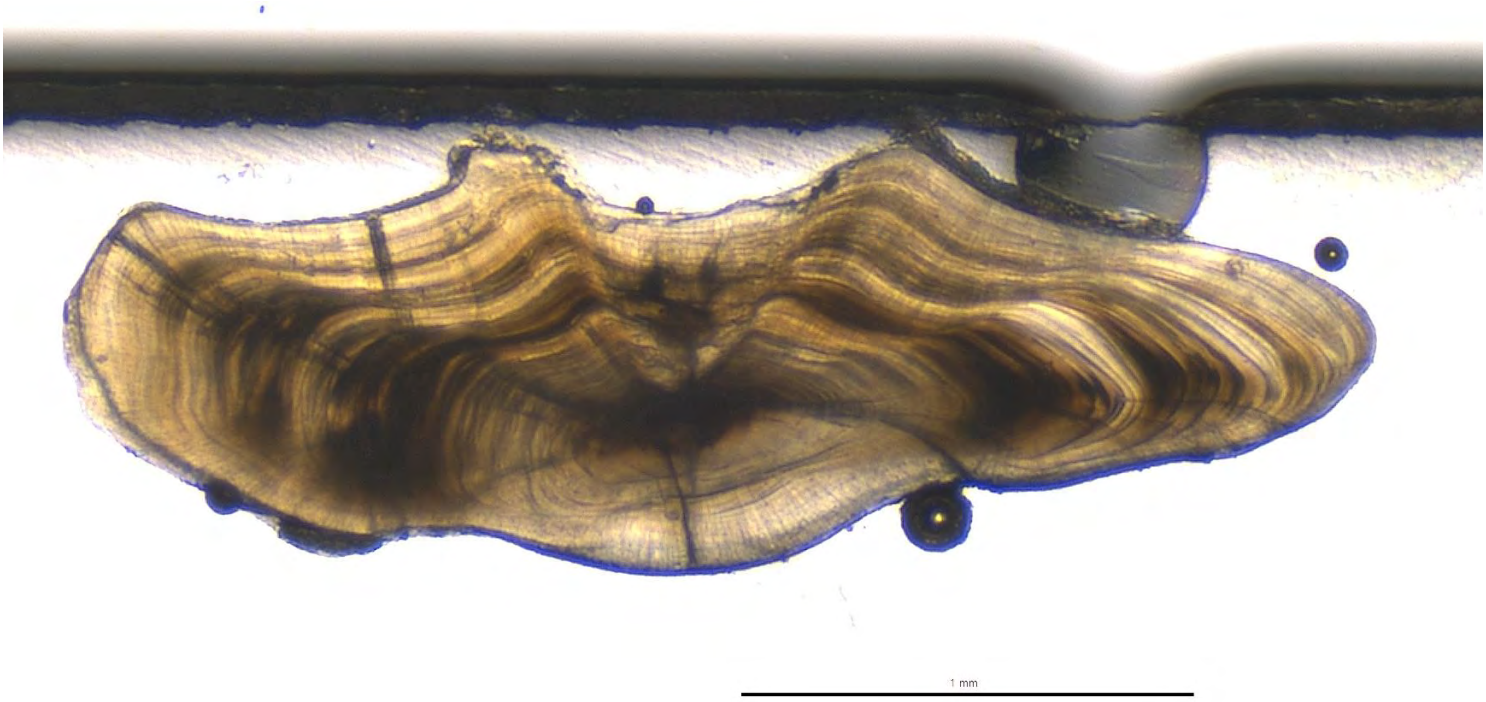
Winter Flounder 10 September



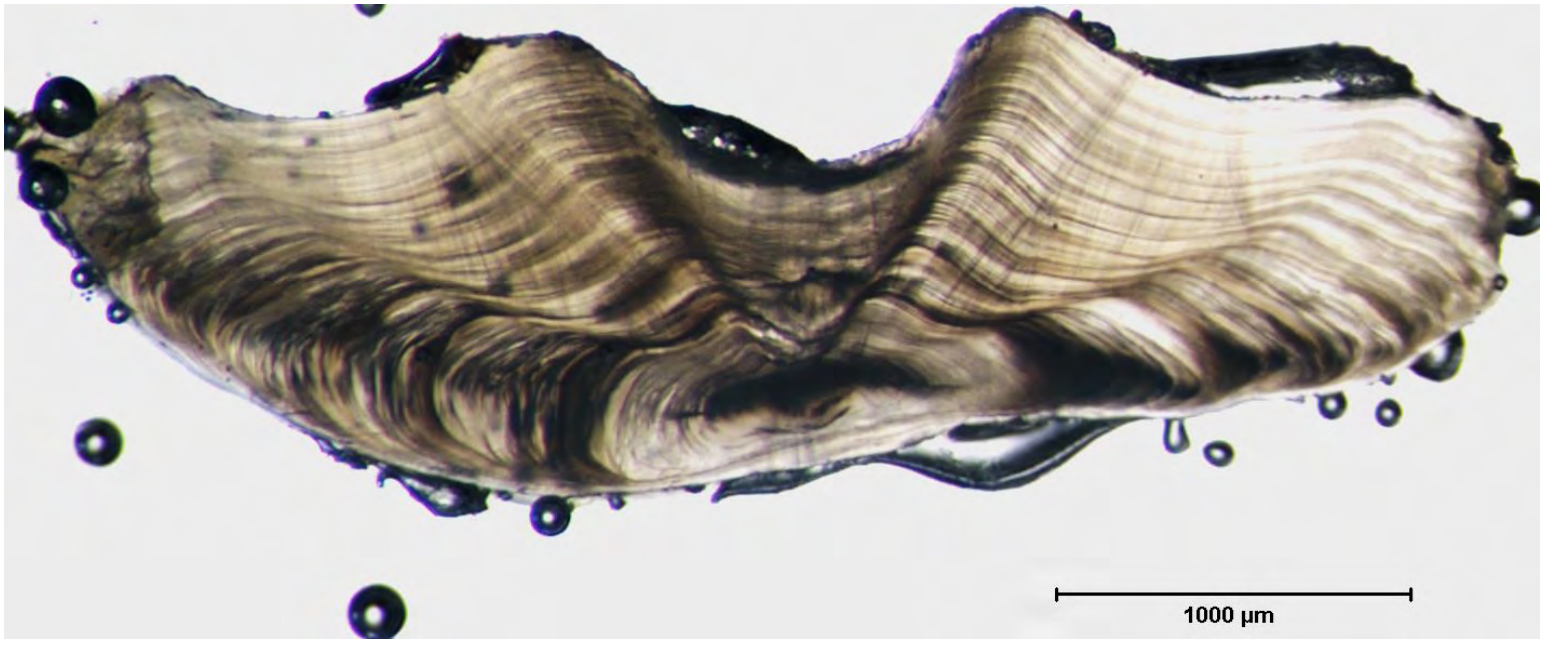
Winter Flounder 11 April



Winter Flounder 12 September

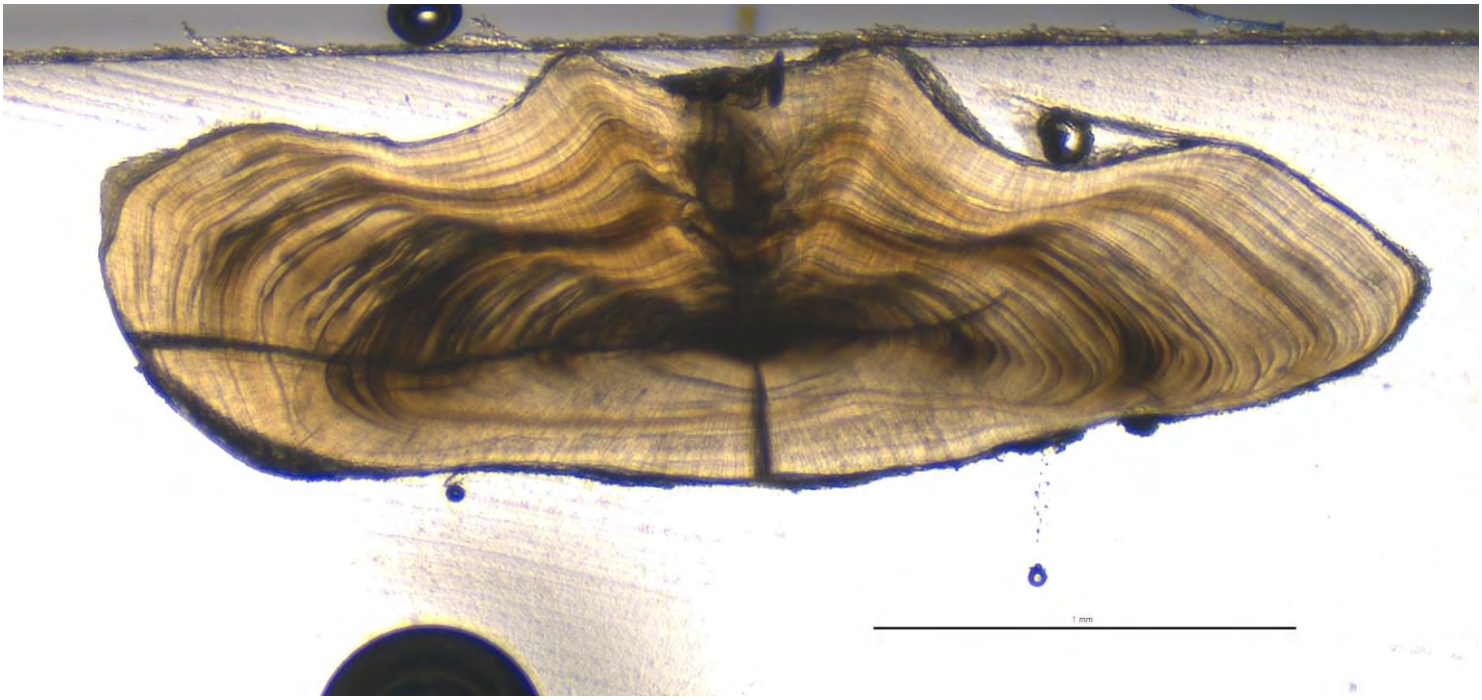


Winter Flounder 13 October

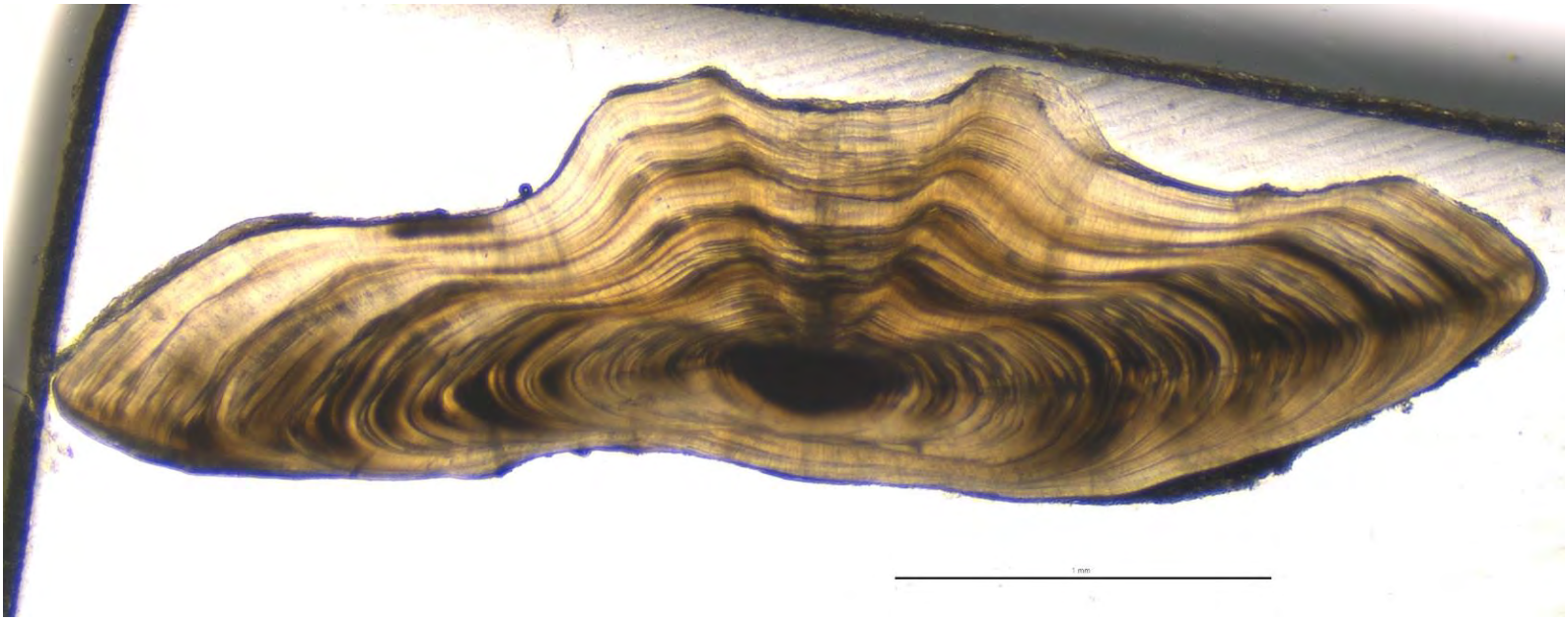


Winter Flounder 14 May

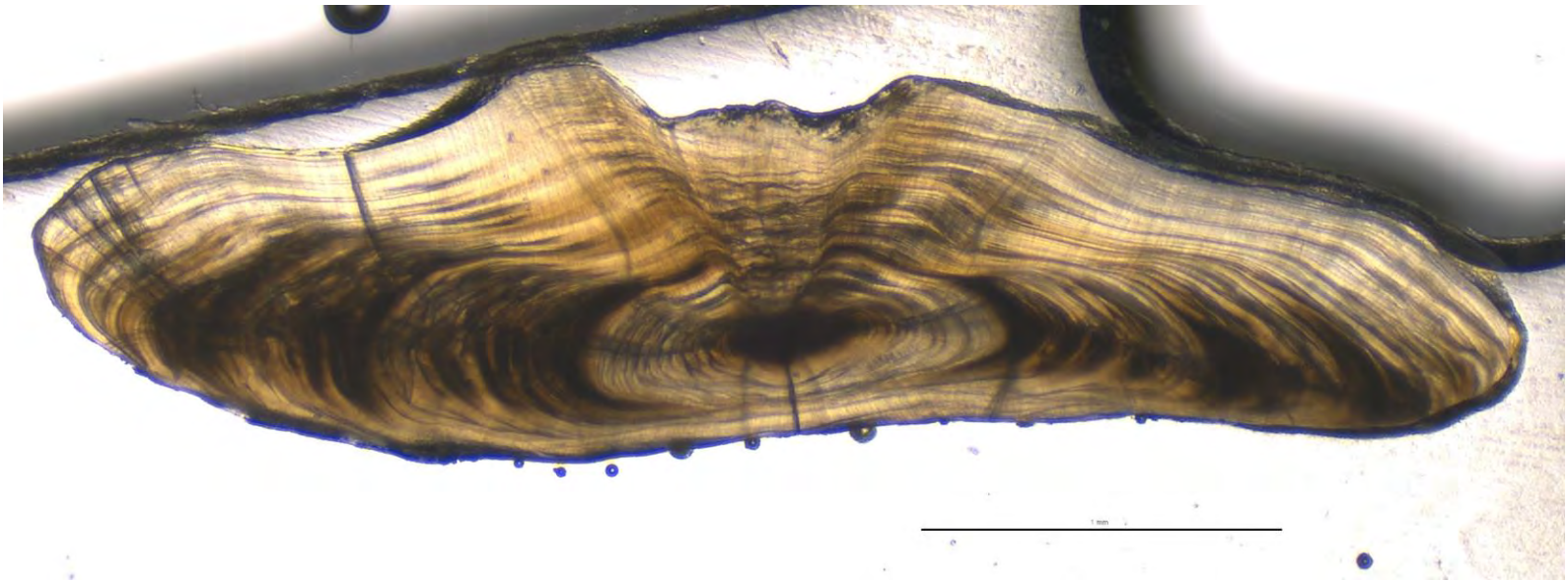
Winter Flounder 15 May



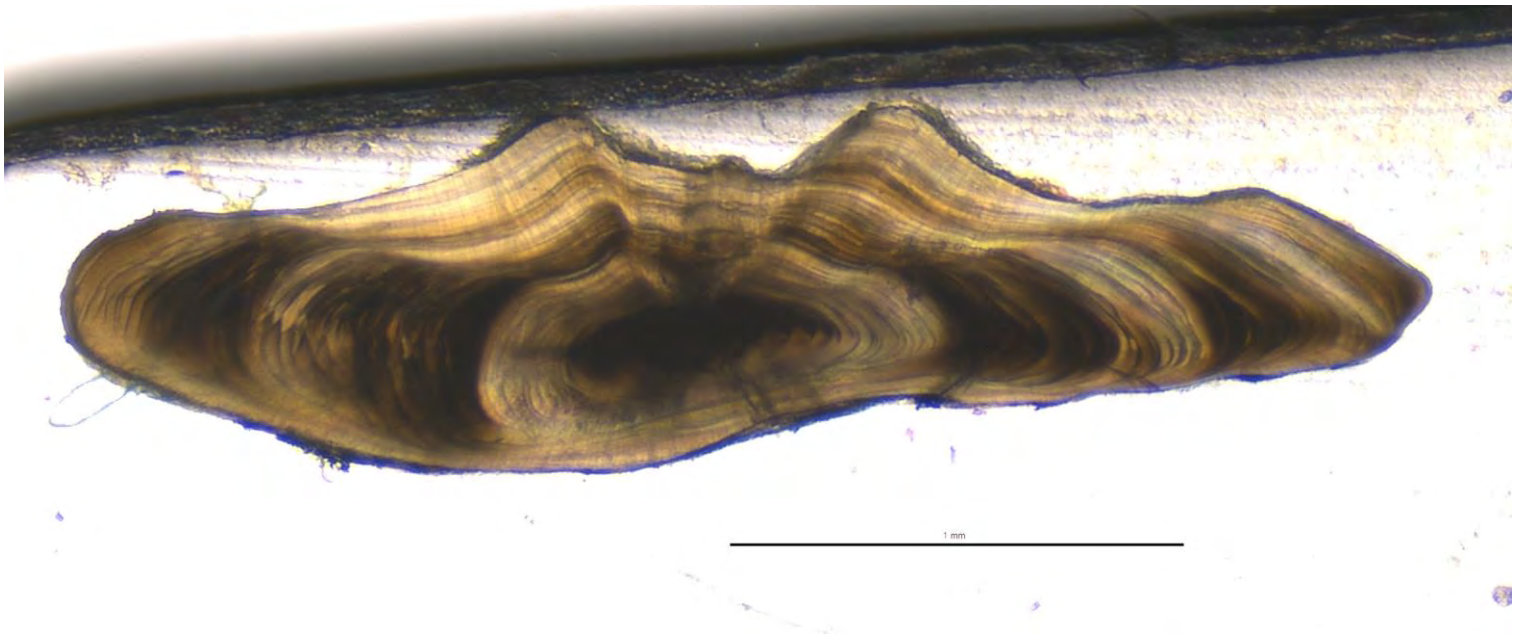
Winter Flounder 16 September



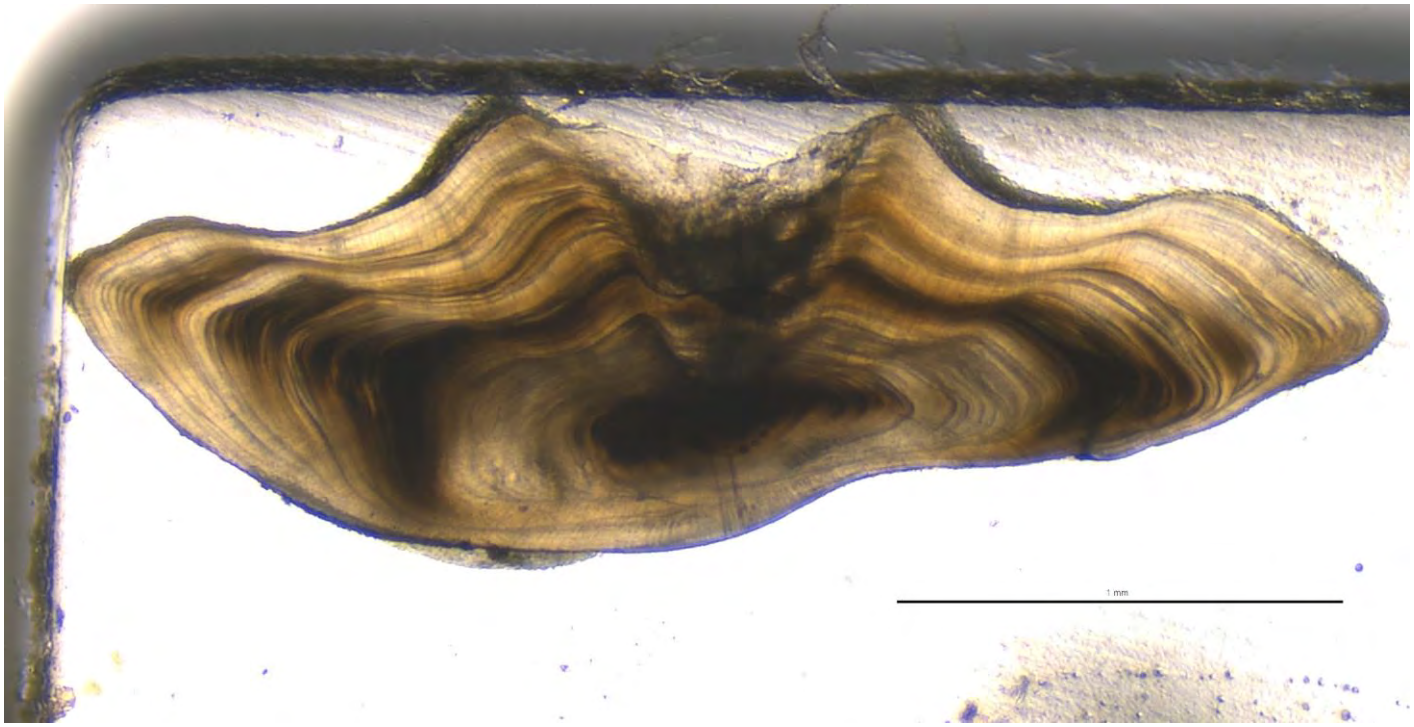
Winter Flounder 17 September



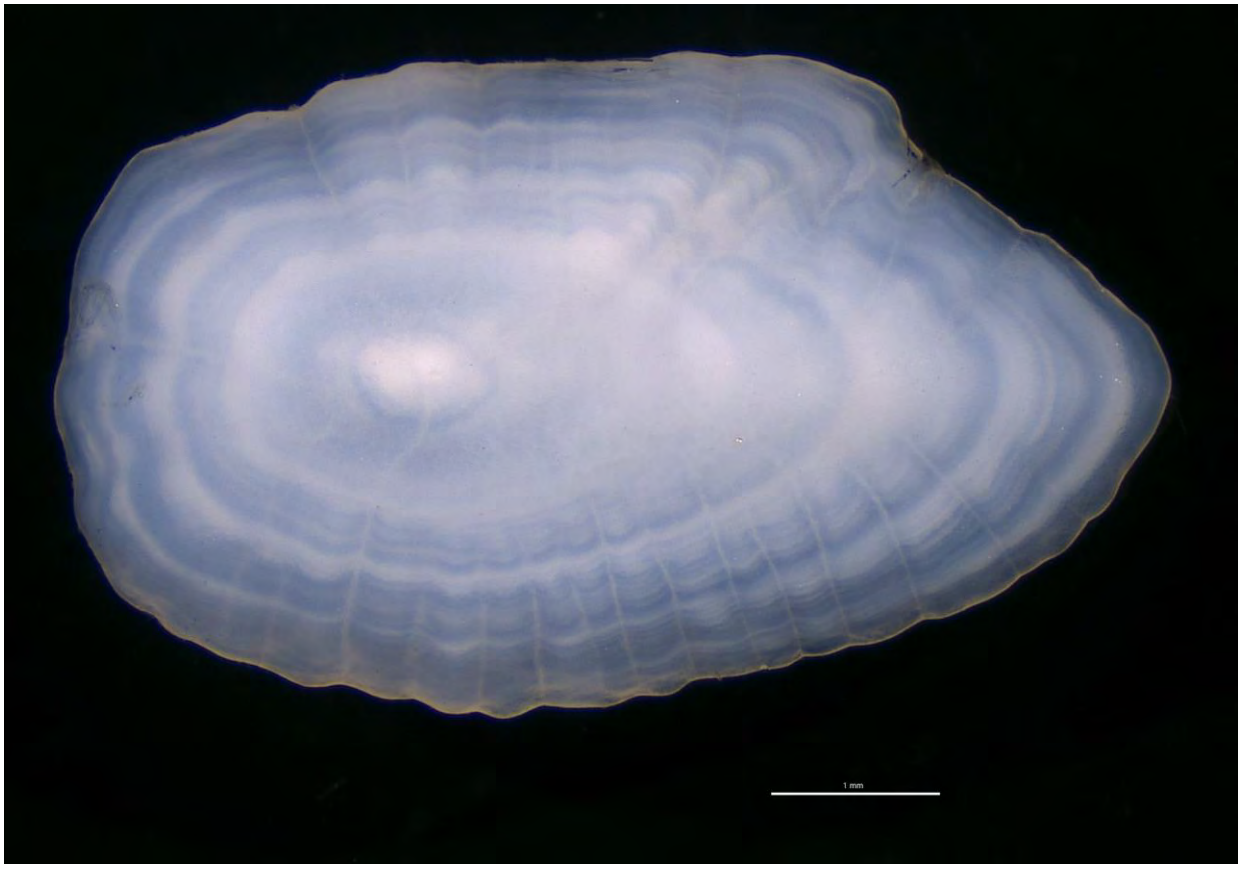
Winter Flounder 18 October



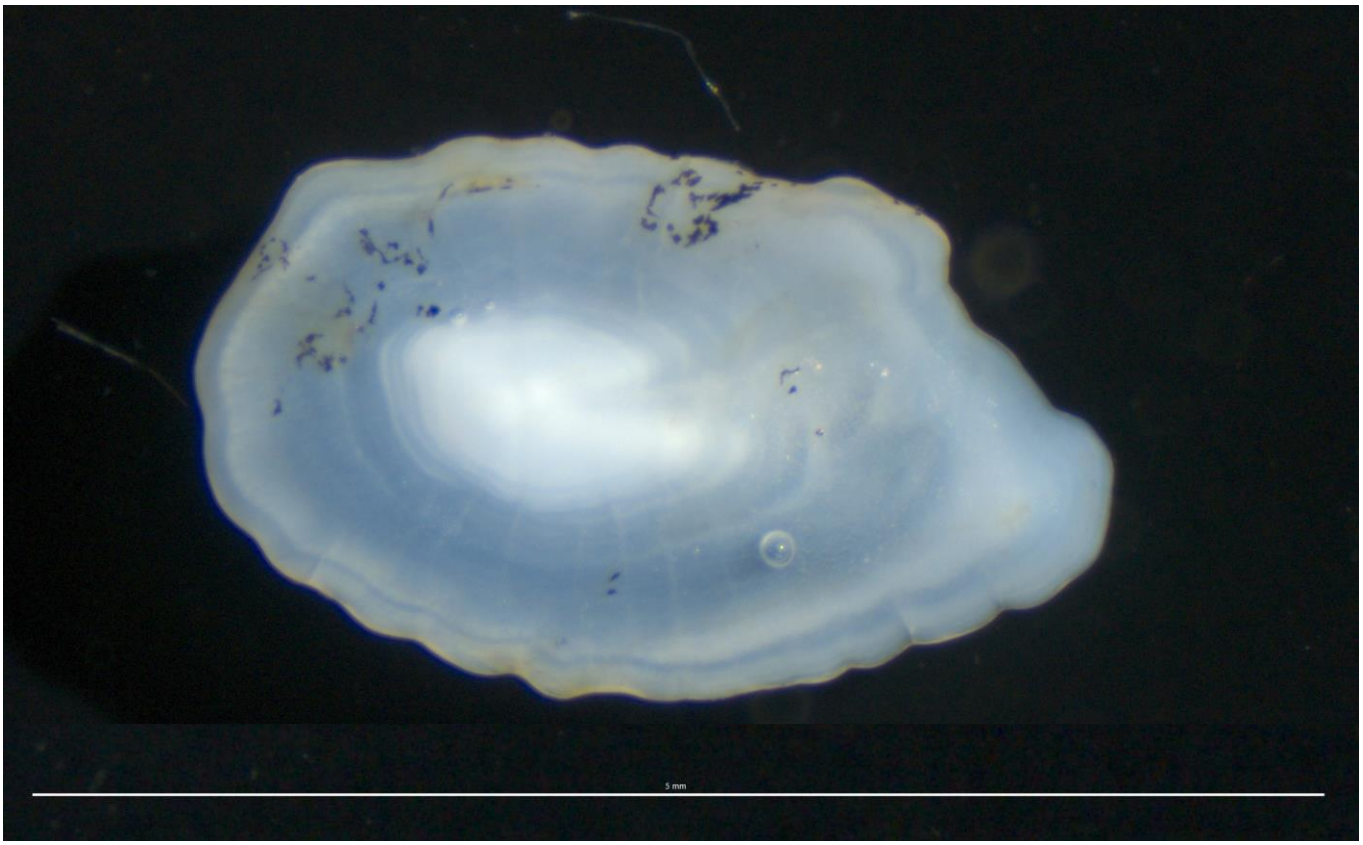
Winter Flounder 19 September



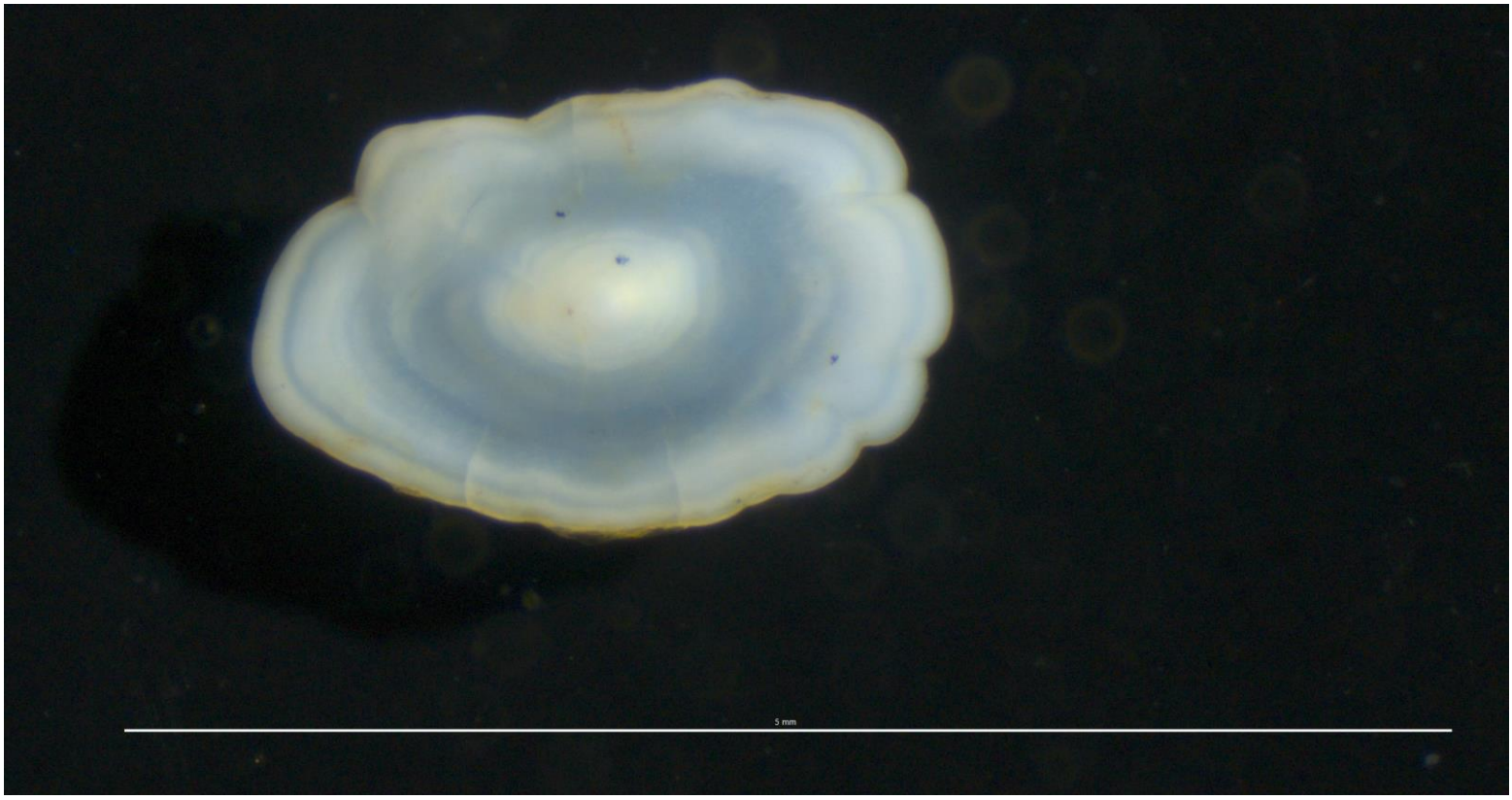
Winter Flounder 20 September



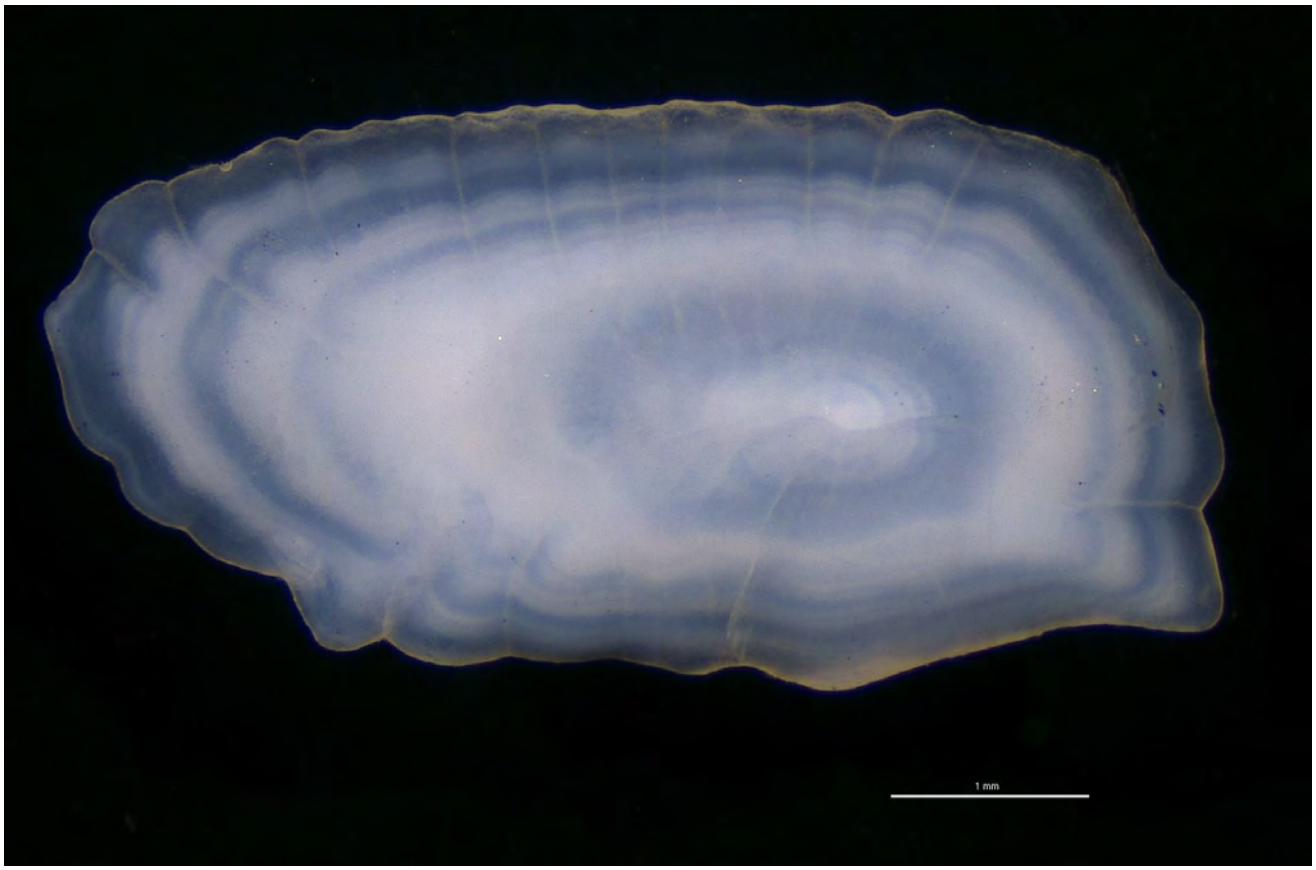
Winter Flounder 21 September



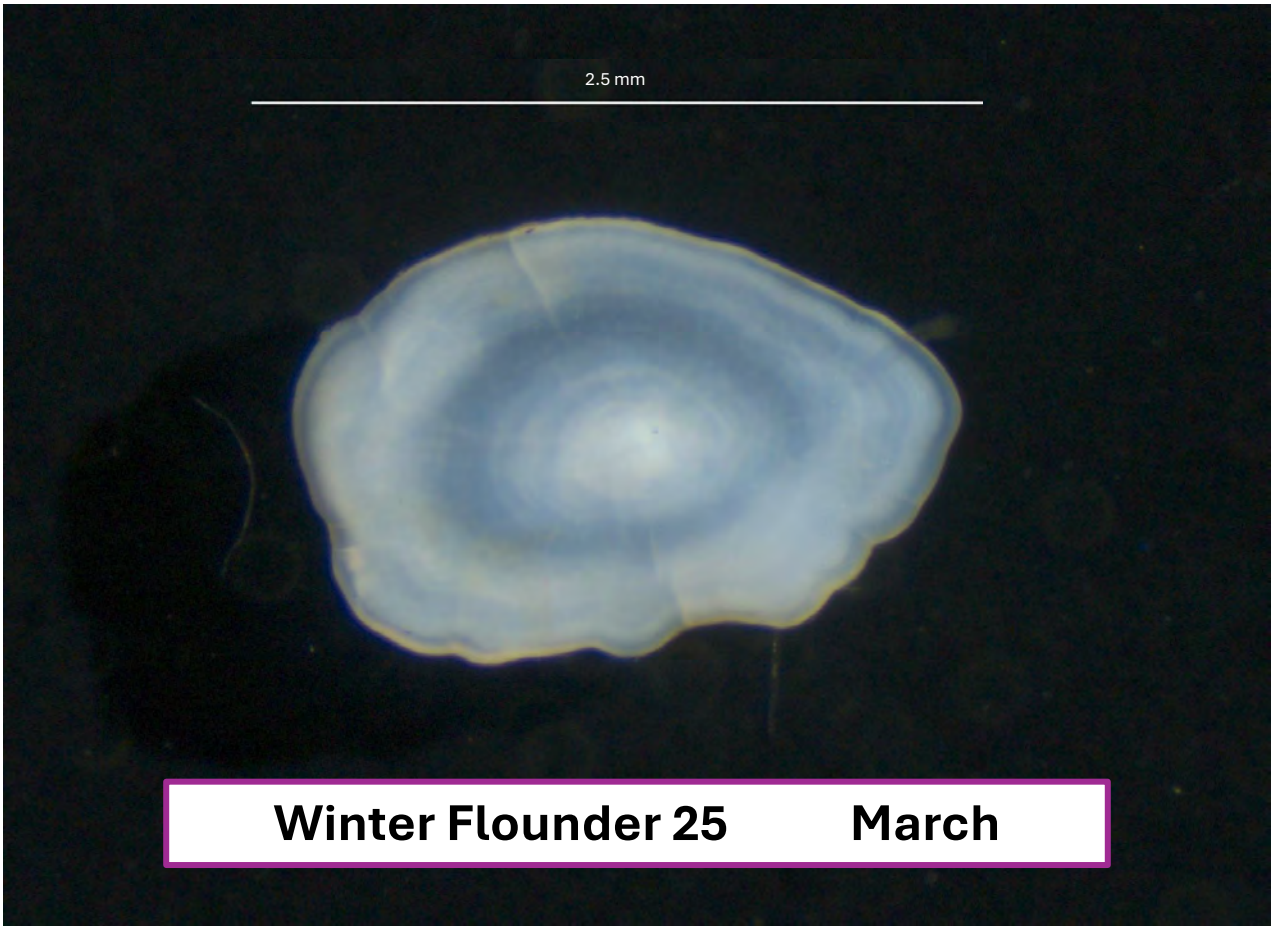
Winter Flounder 22 May

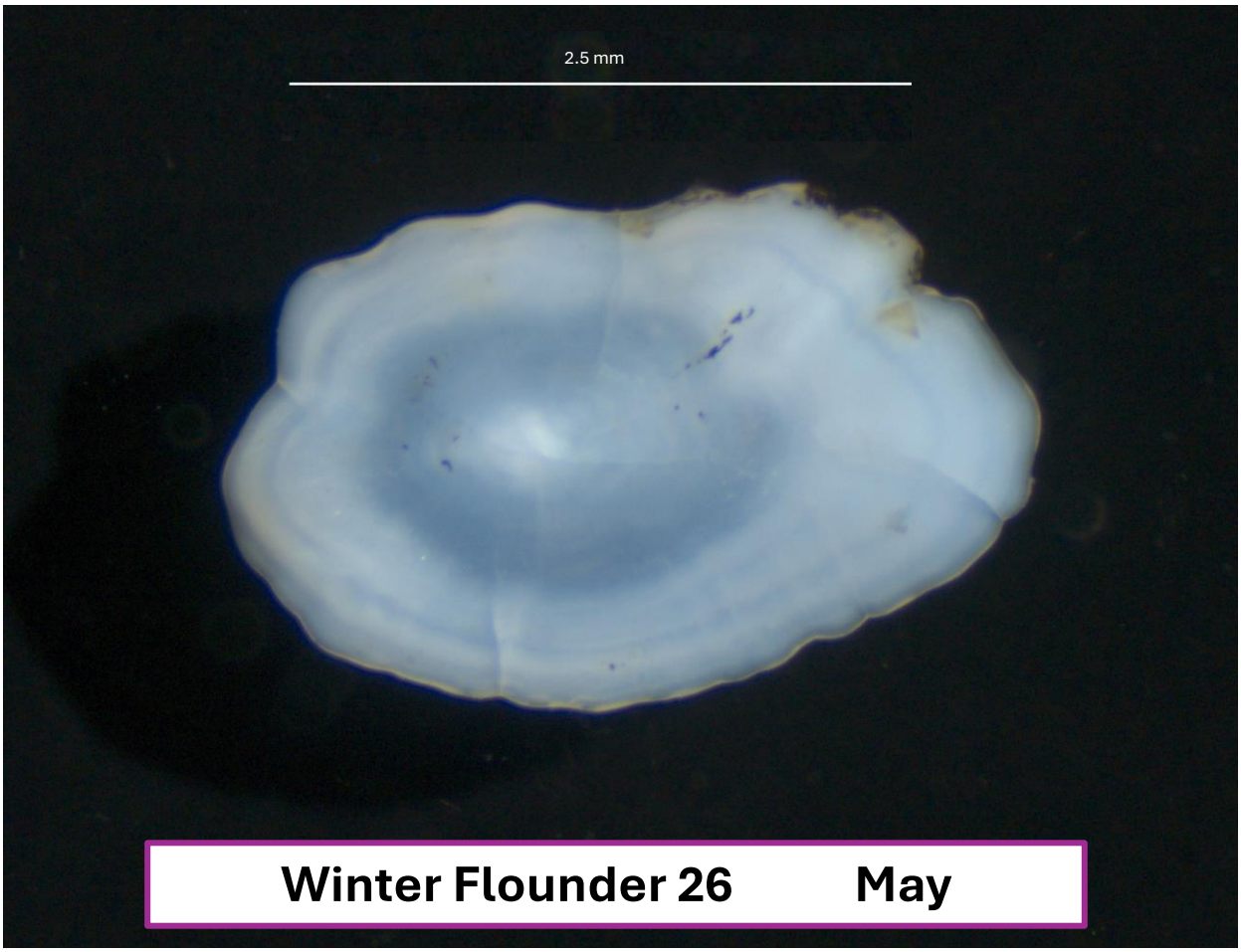


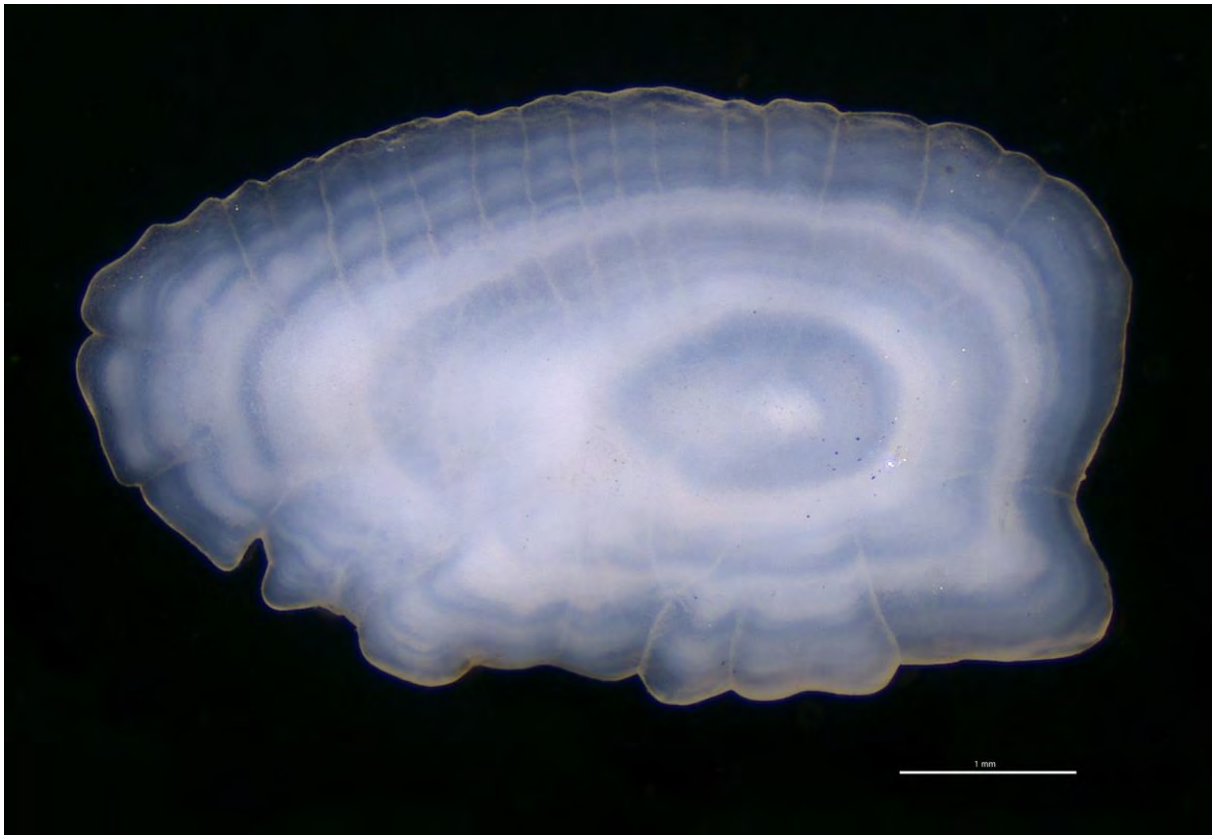
Winter Flounder 23 April



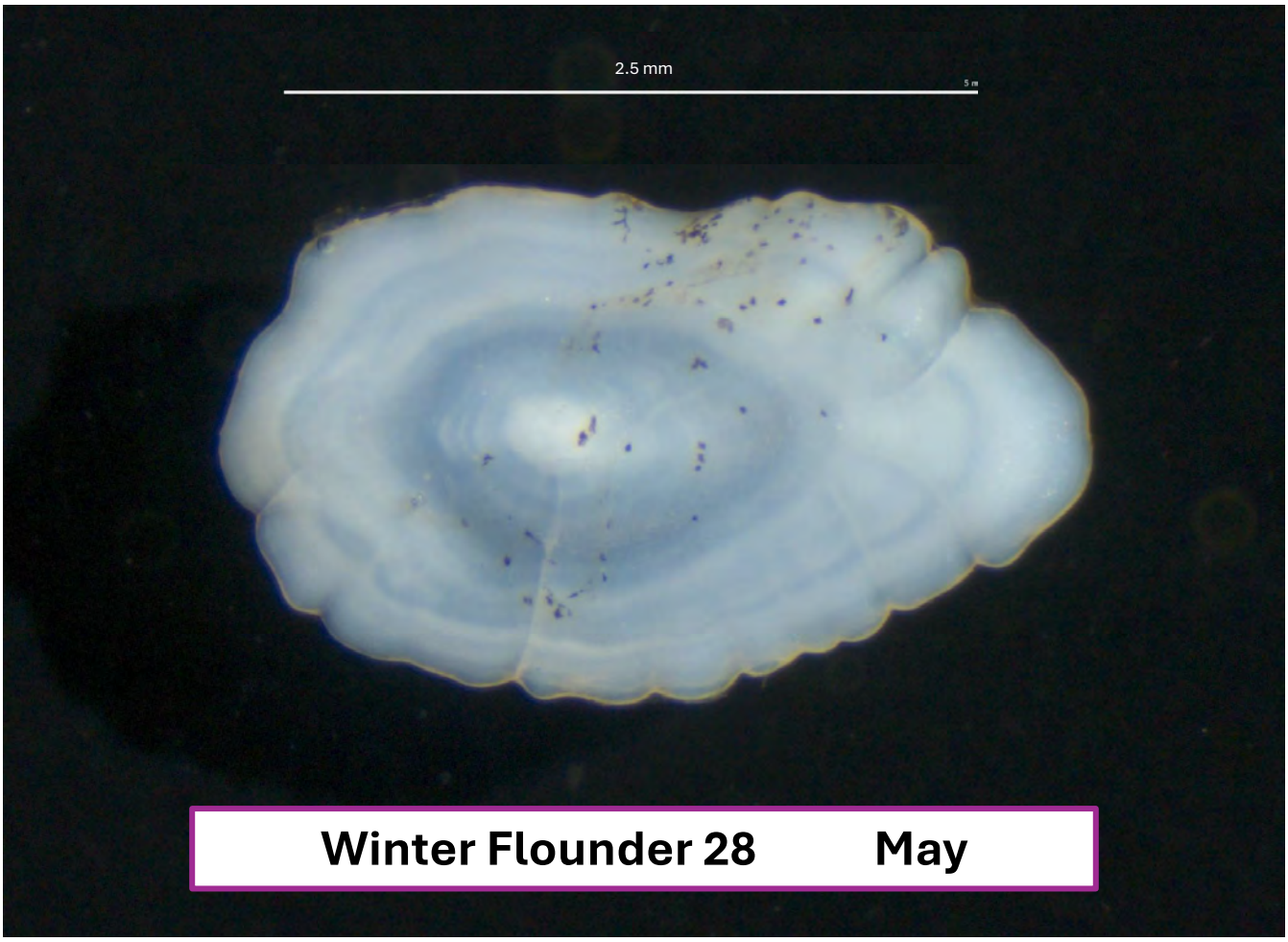
Winter Flounder 24 September


2.5 mm
Winter Flounder 25 March

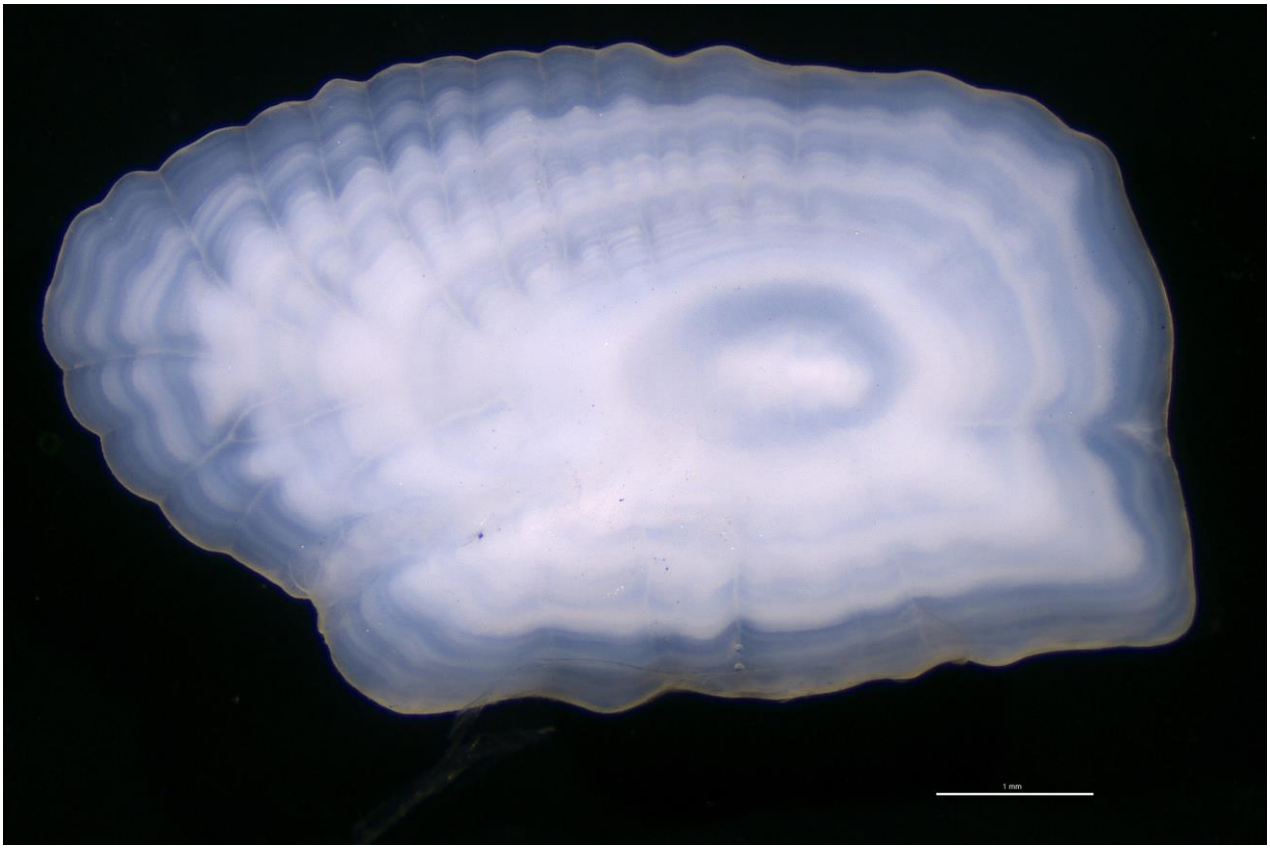

2.5 mm
Winter Flounder 26 May



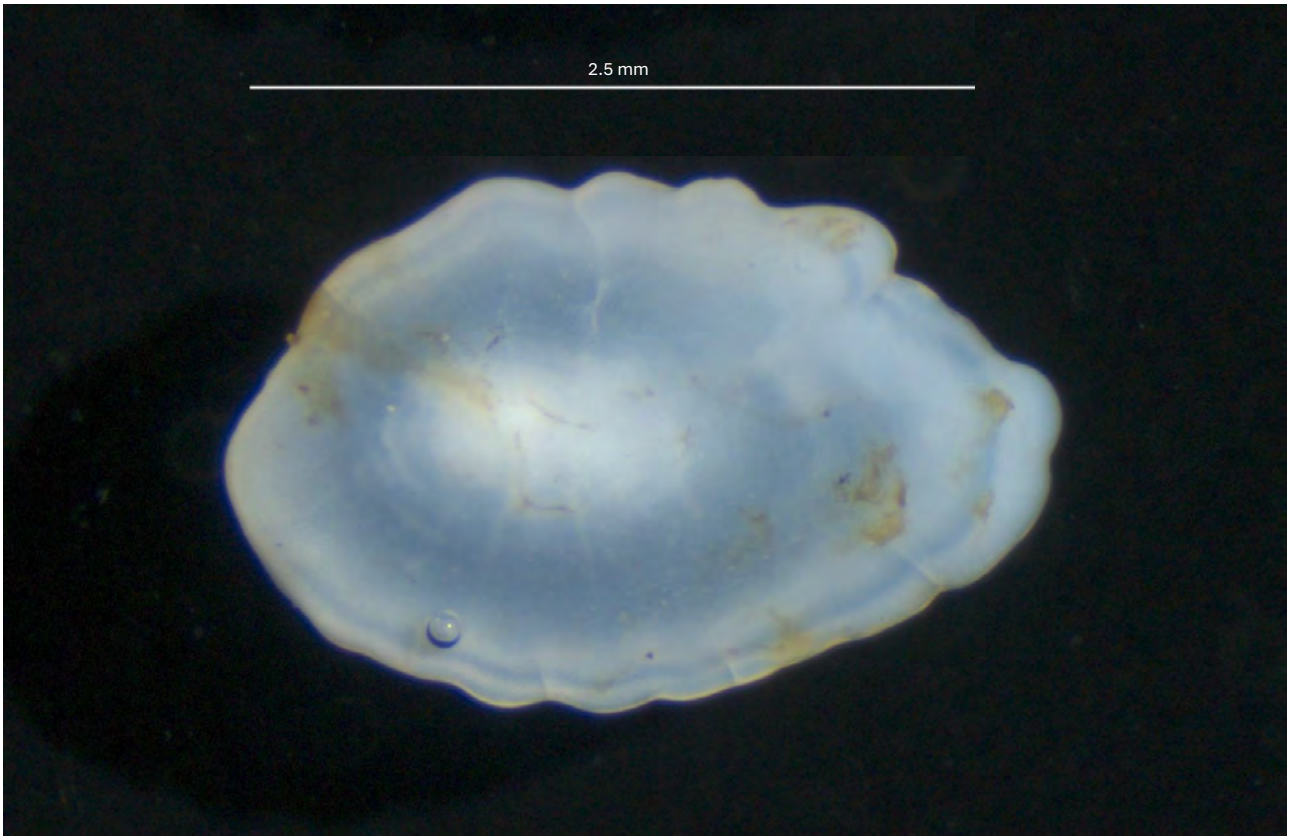
Winter Flounder 27 September



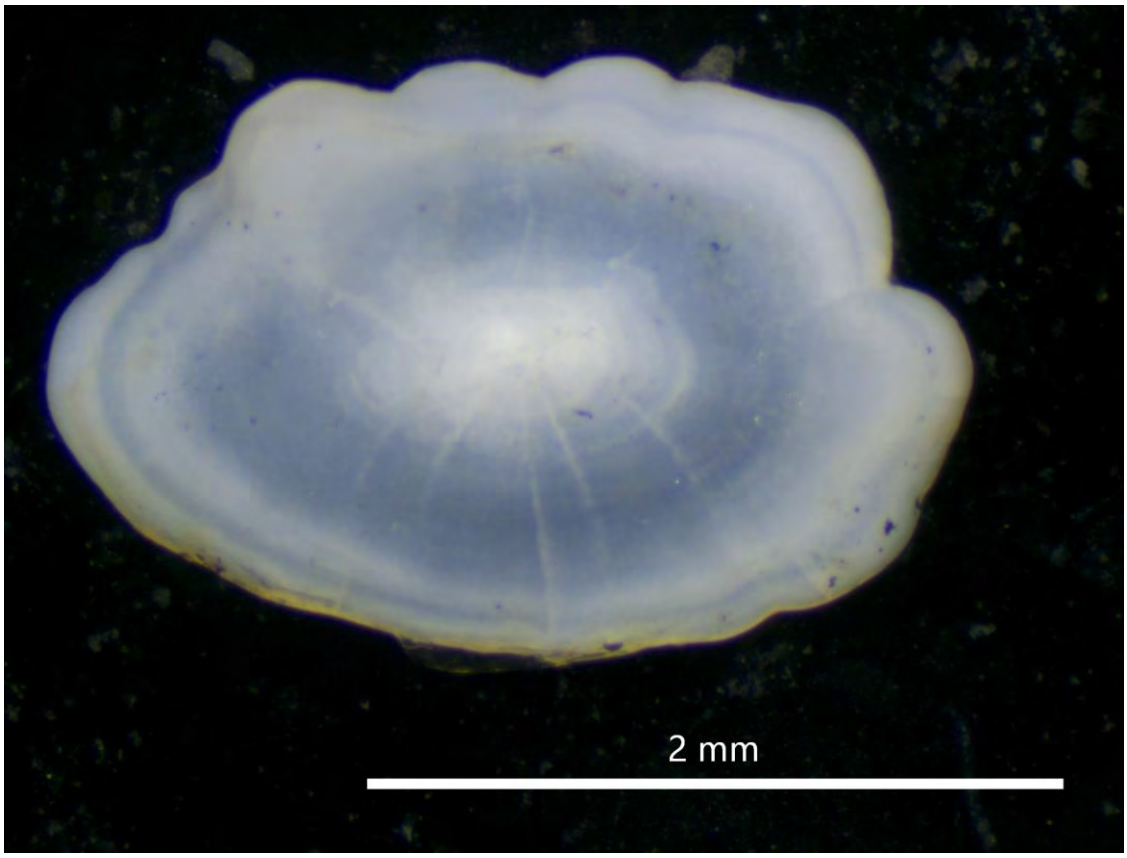
Winter Flounder 28 May



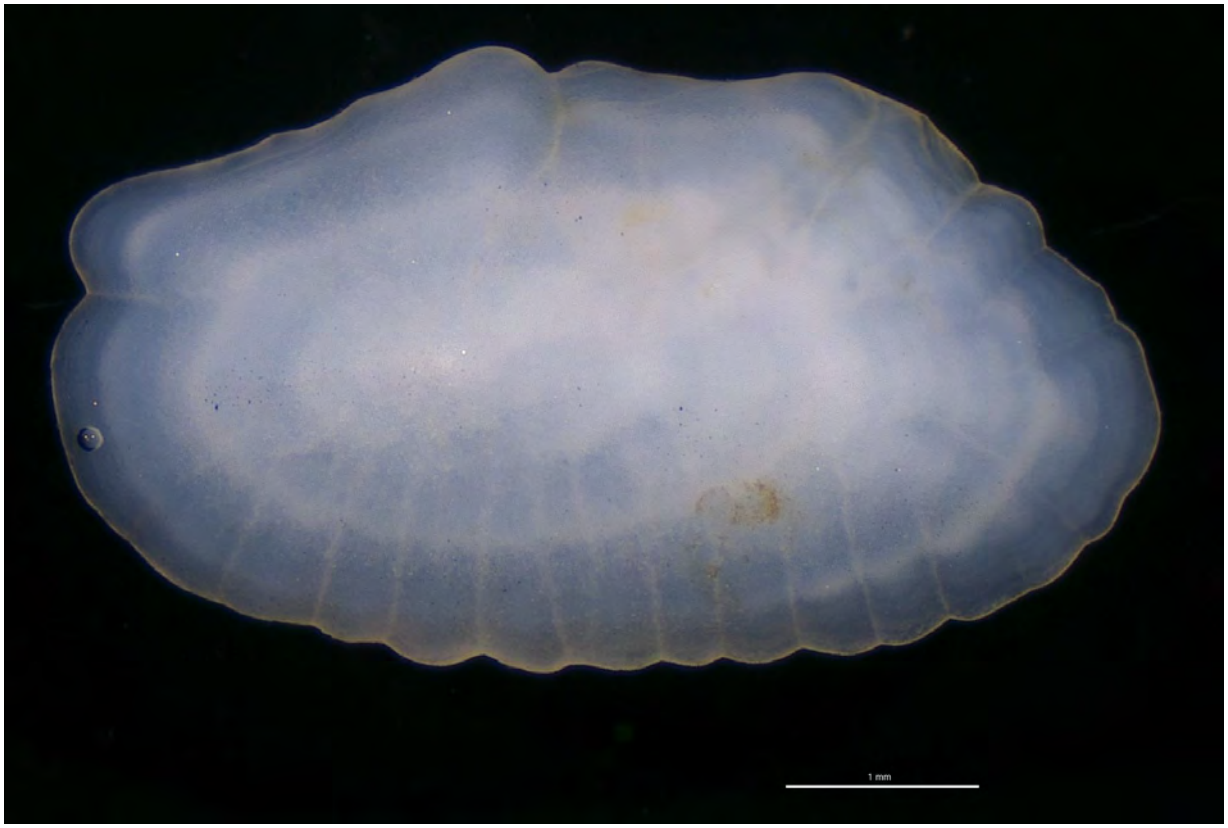
Winter Flounder 29 October



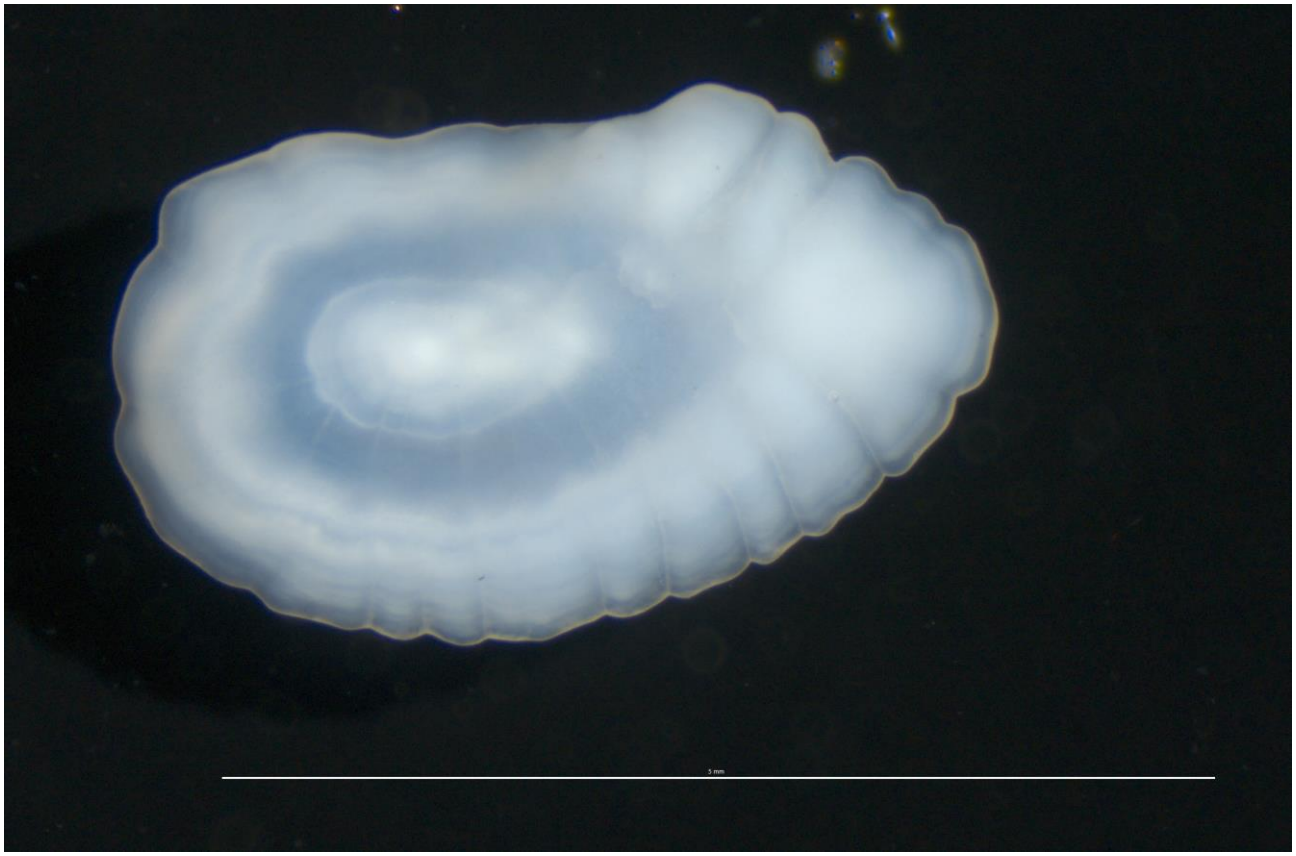
Winter Flounder 30 May



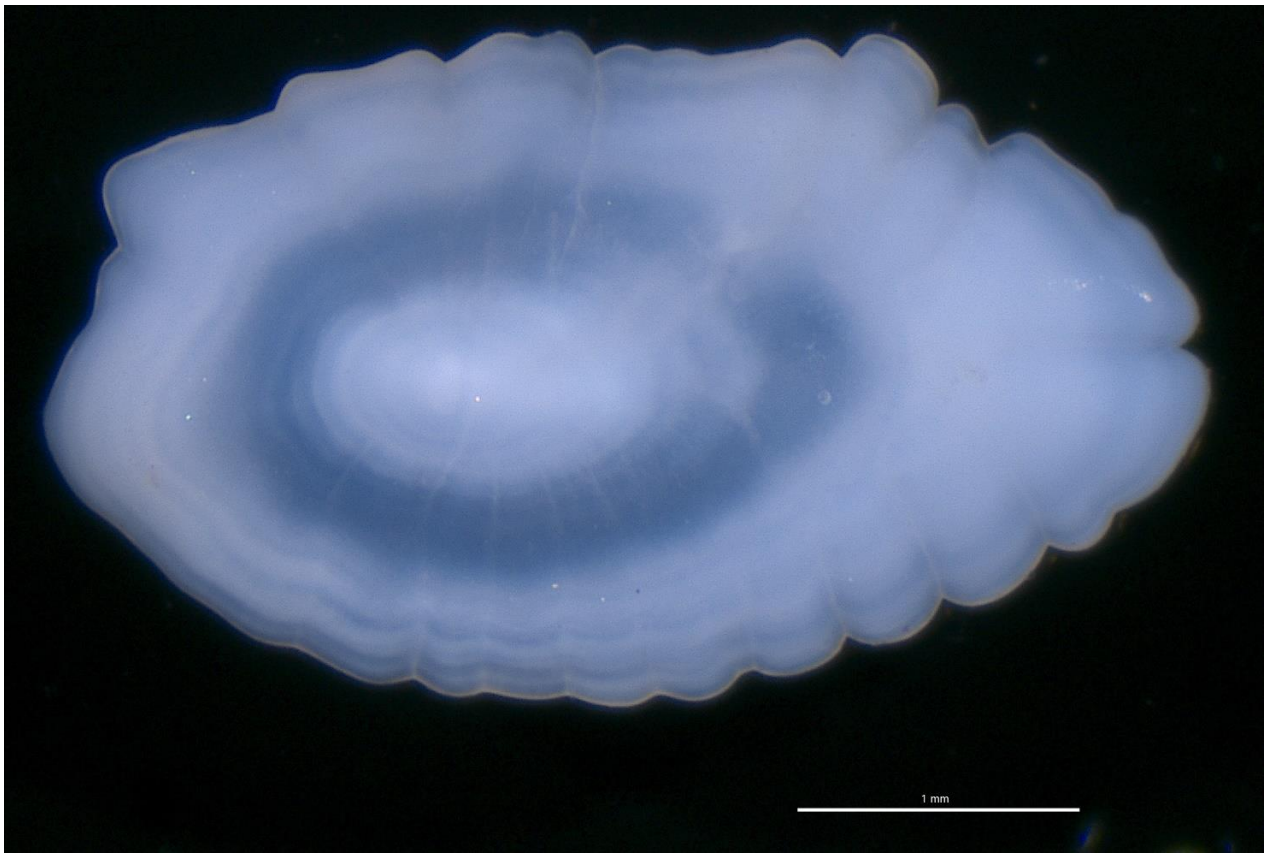
Winter Flounder 31 May



Winter Flounder 32 September

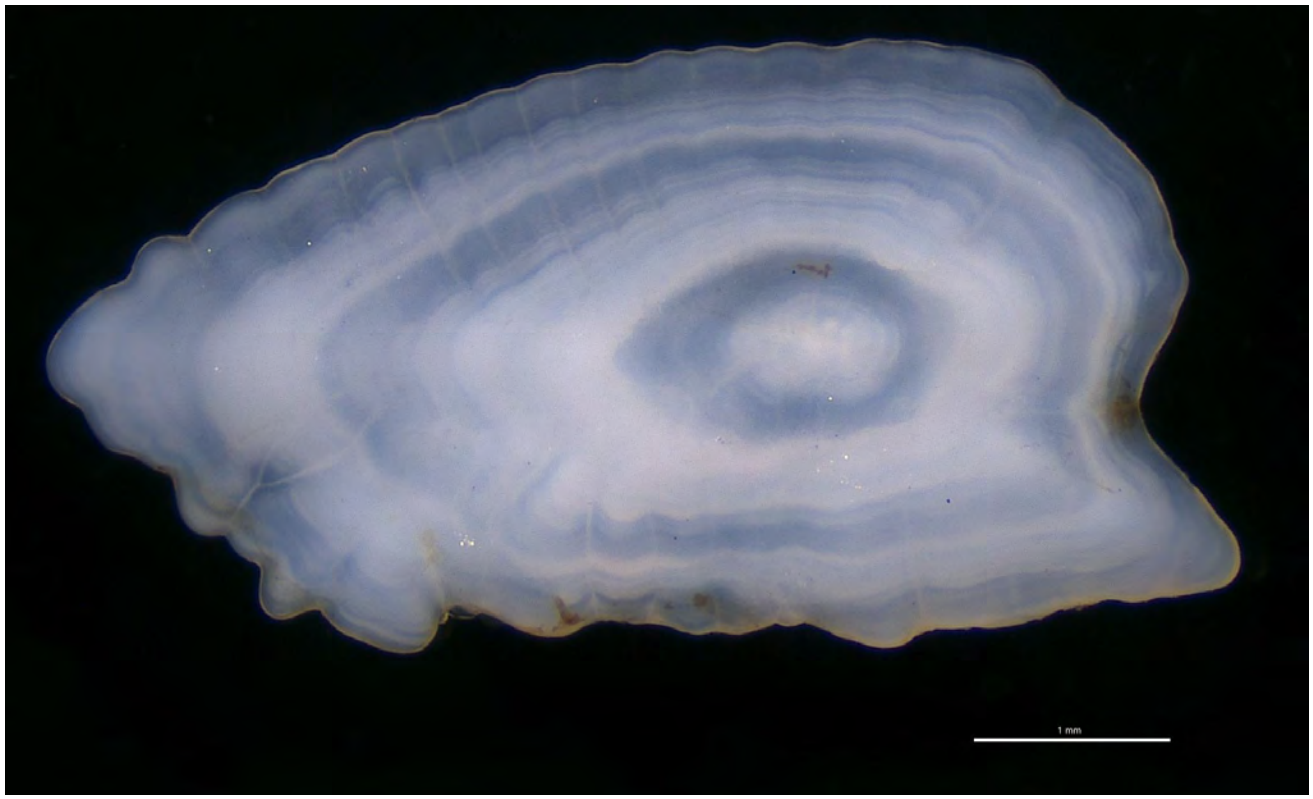


Winter Flounder 33 October

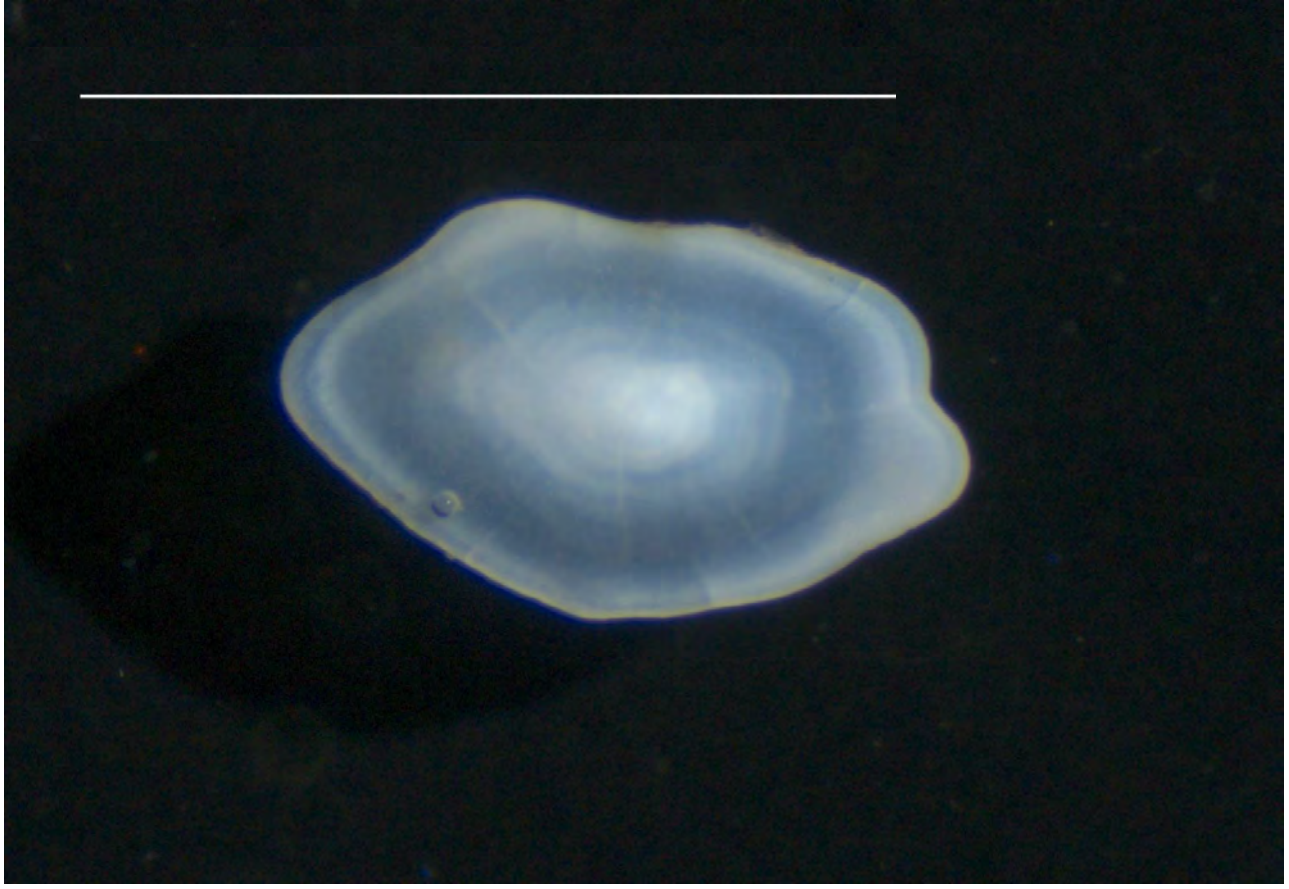


Winter Flounder 34 June

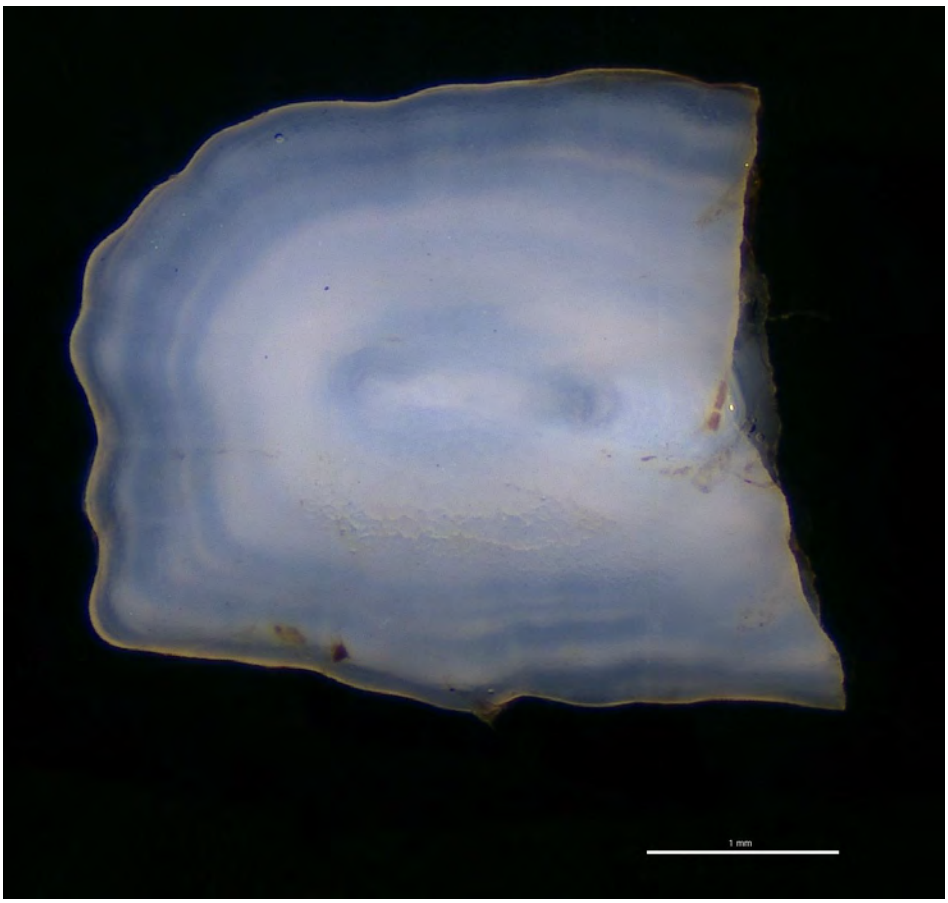
Winter Flounder 35 September



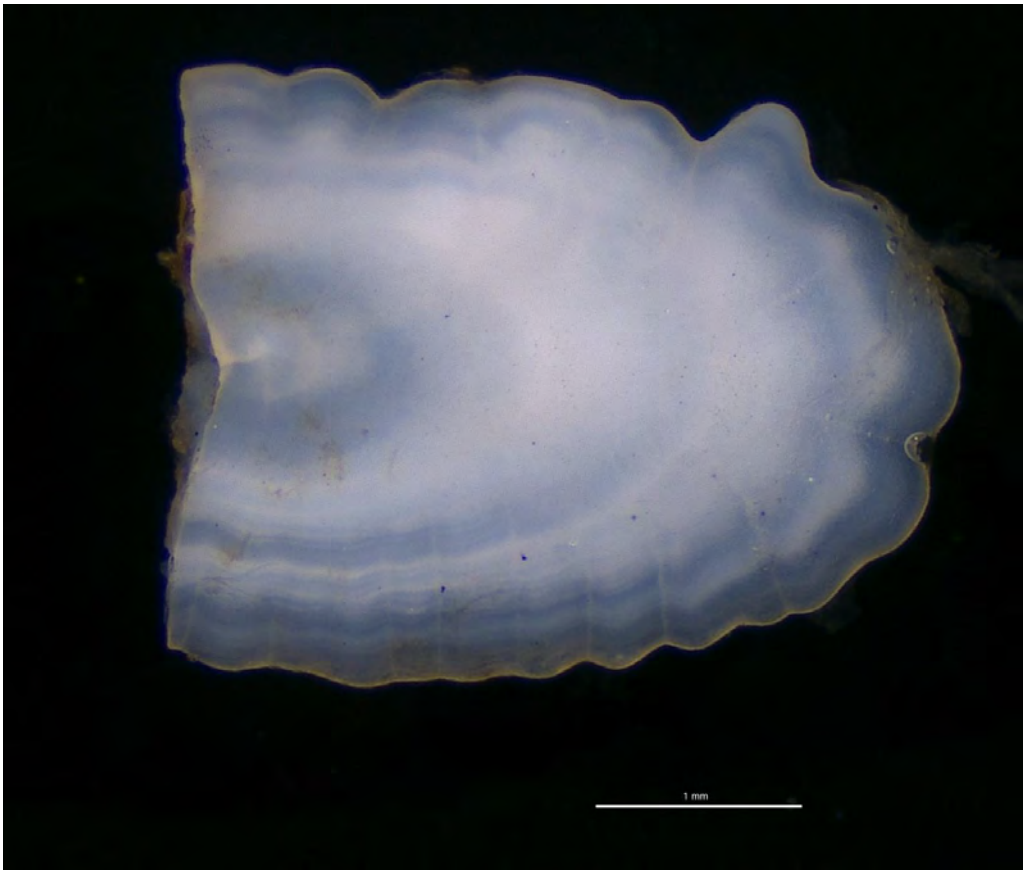
Winter Flounder 36 September



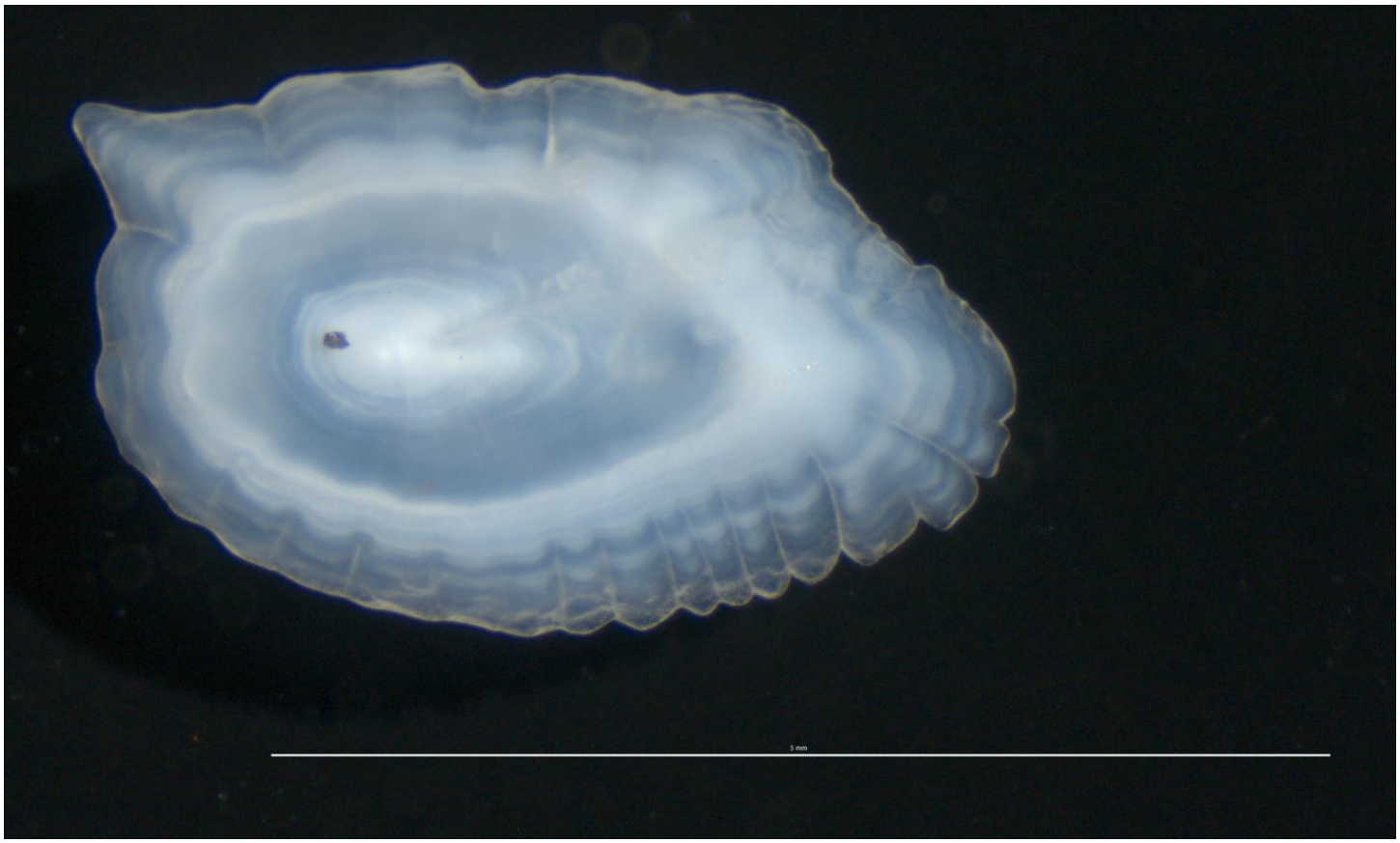
Winter Flounder 37 April



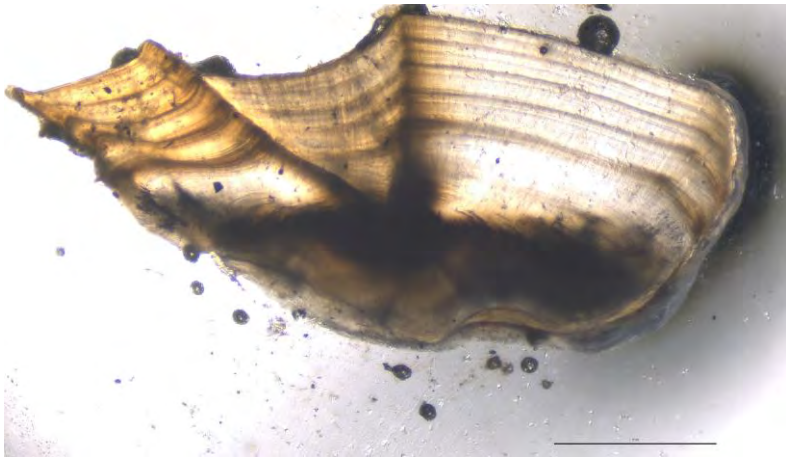
Winter Flounder 38 September



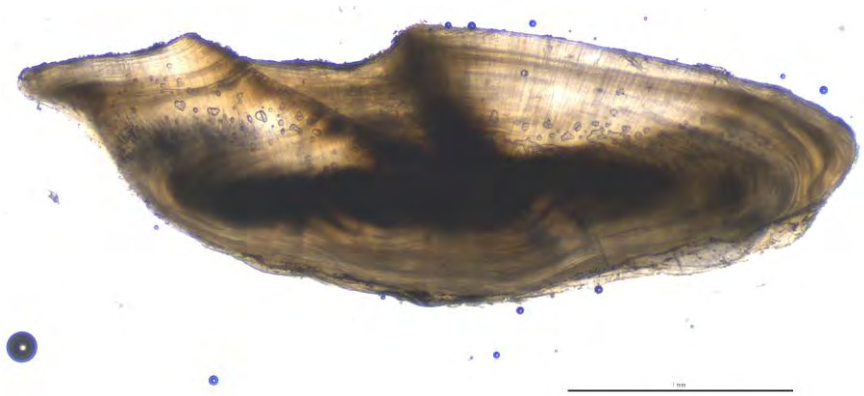
Winter Flounder 39 October



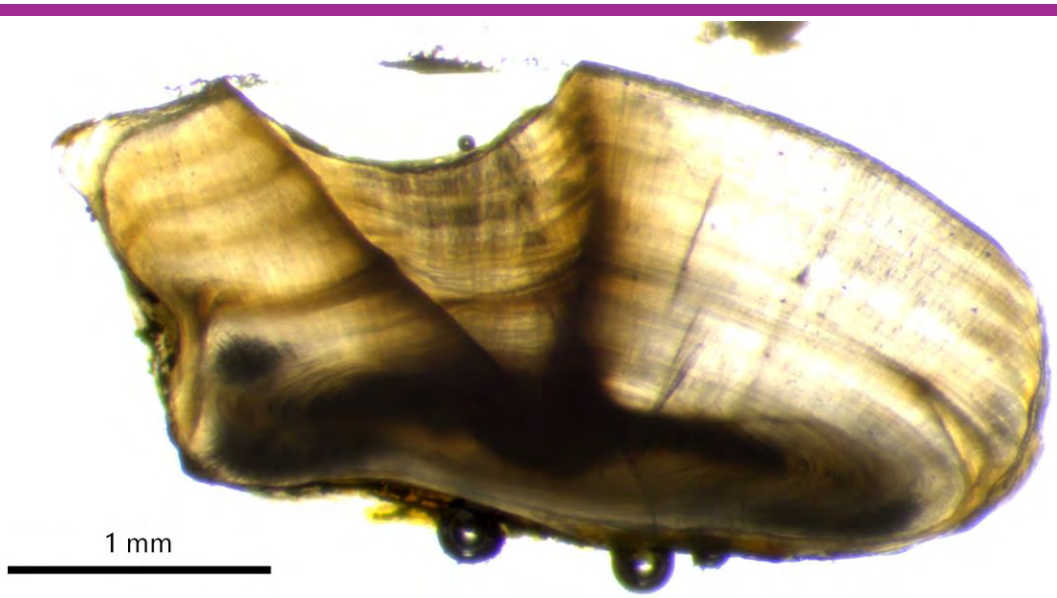
Winter Flounder 40 August



Spot 1 July

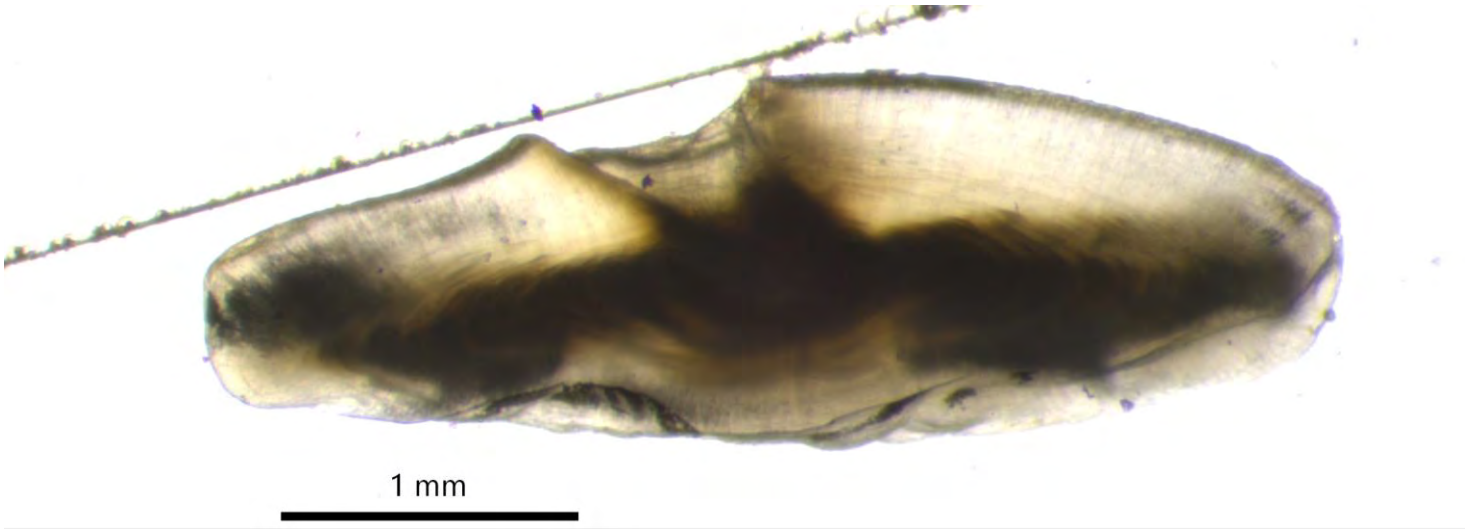


Spot 2 October



Spot 3 December

Spot 4 October



Spot 5 January

Spot 6 September

Spot 7 July

Spot 8 September

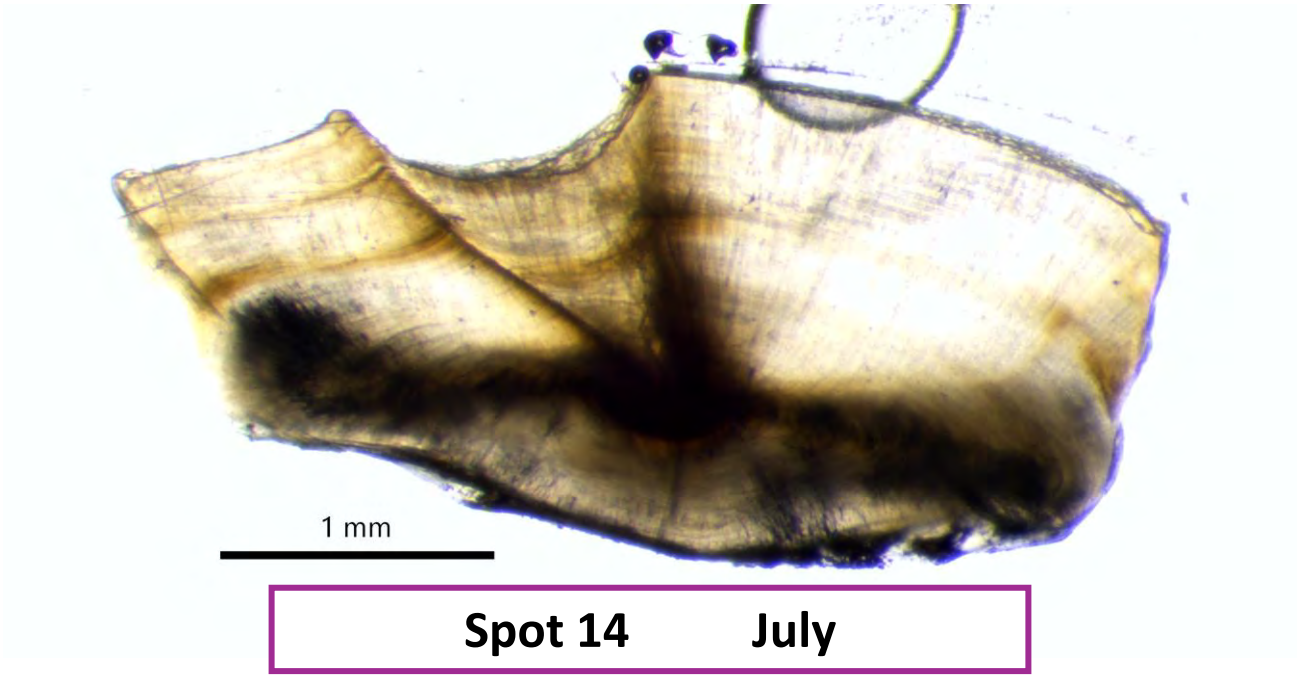
Spot 9 October

Spot 10 September

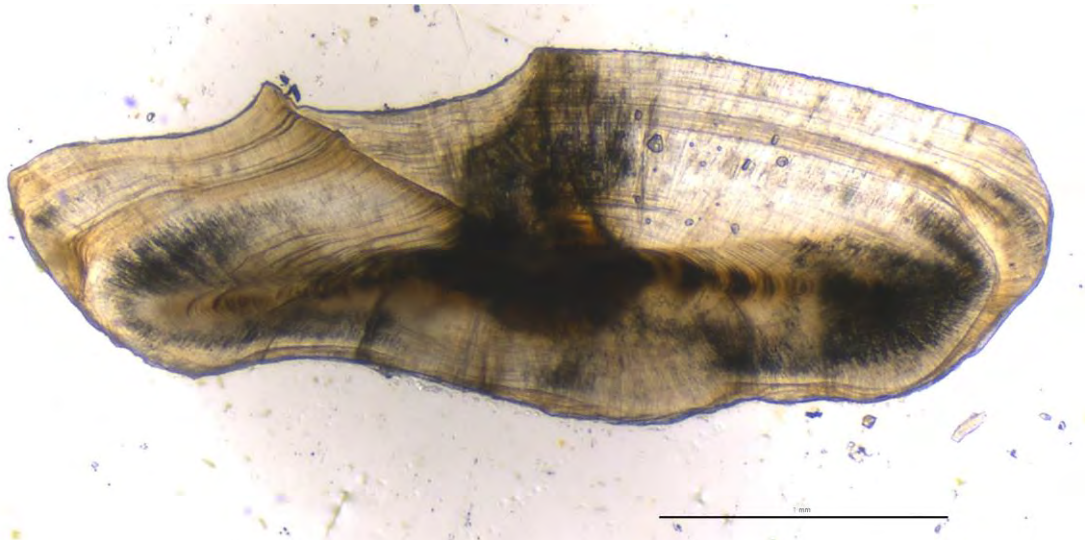
Spot 11 November

Spot 12 September

Spot 13 September



Spot 14 July

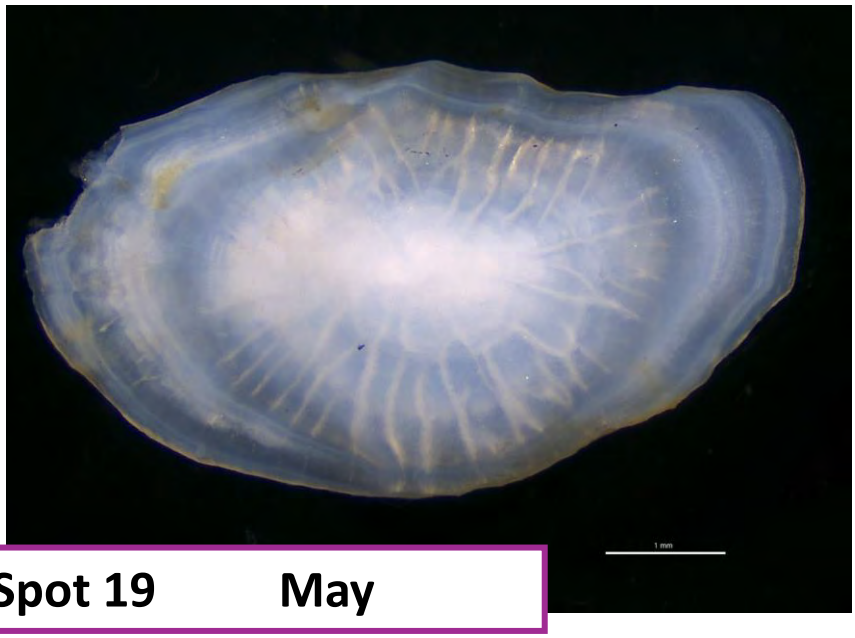


Spot 15 May

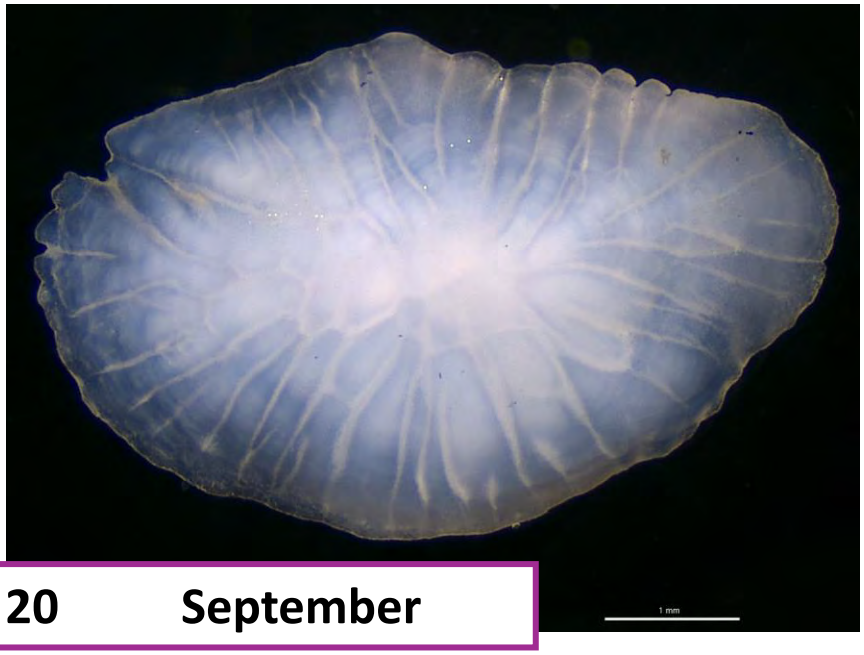
Spot 16 October

Spot 17 October

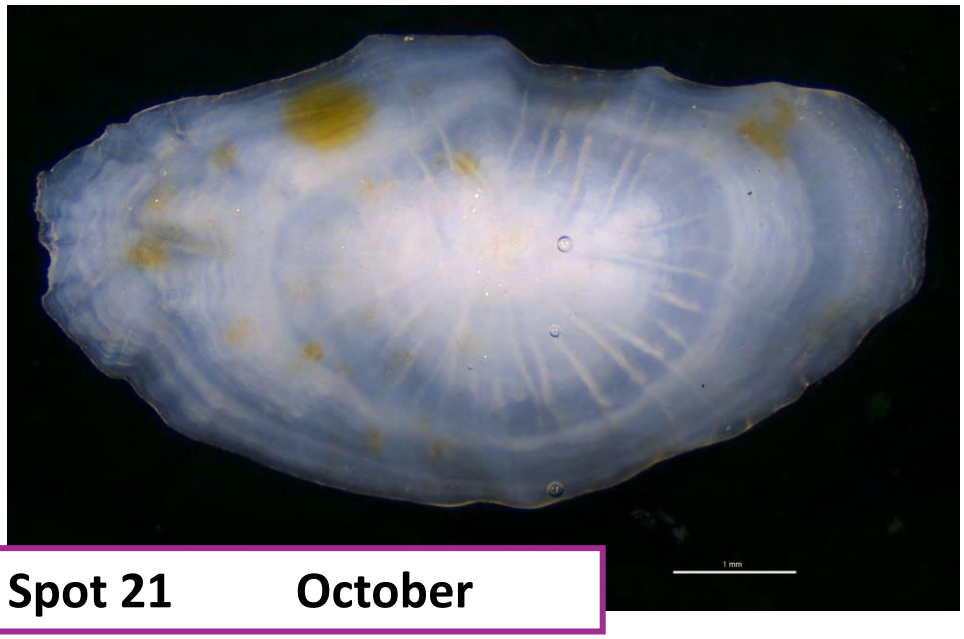
Spot 18 October



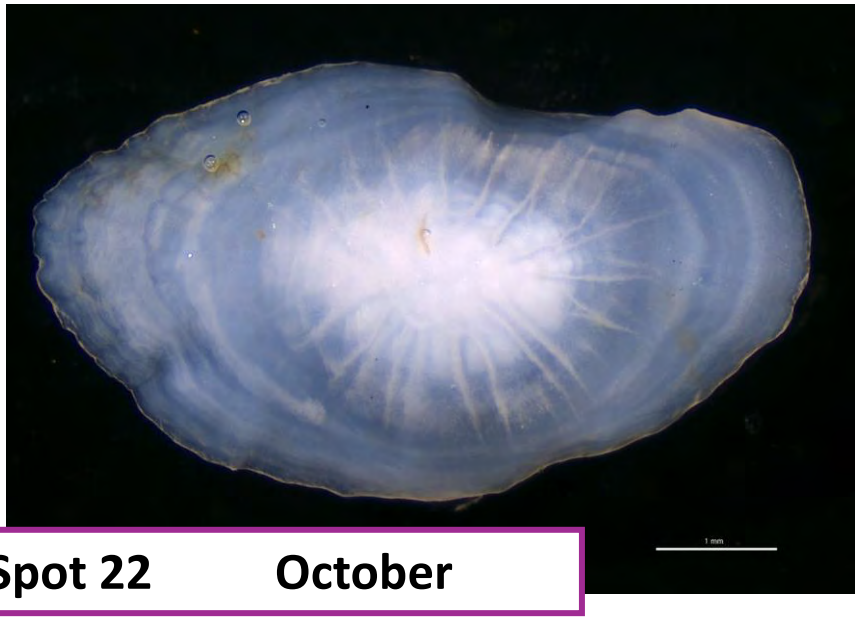
Spot 19 May



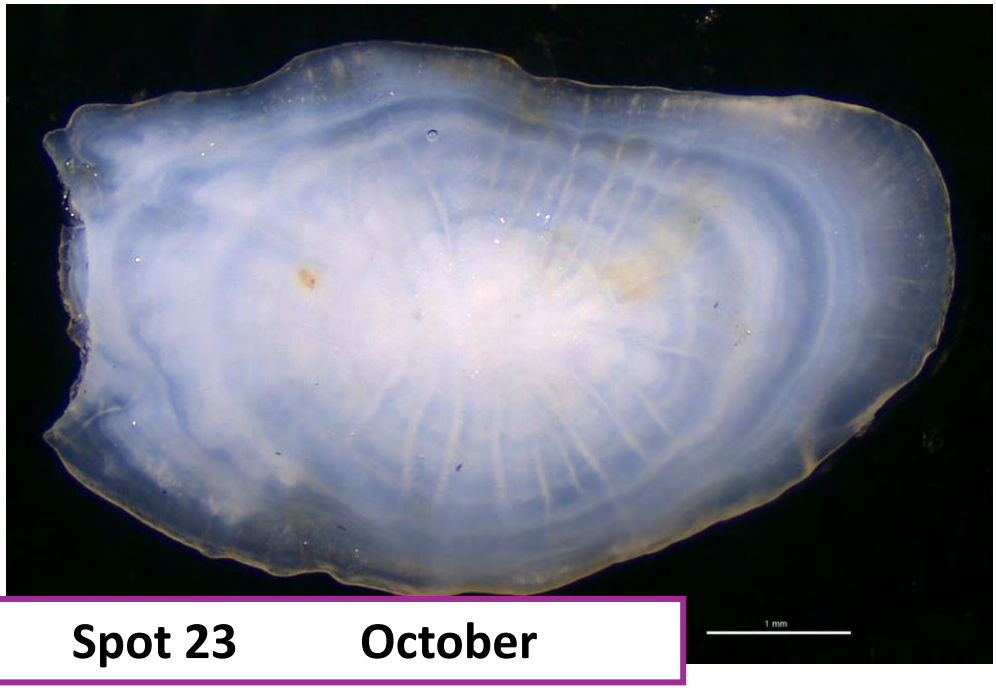
Spot 20 September



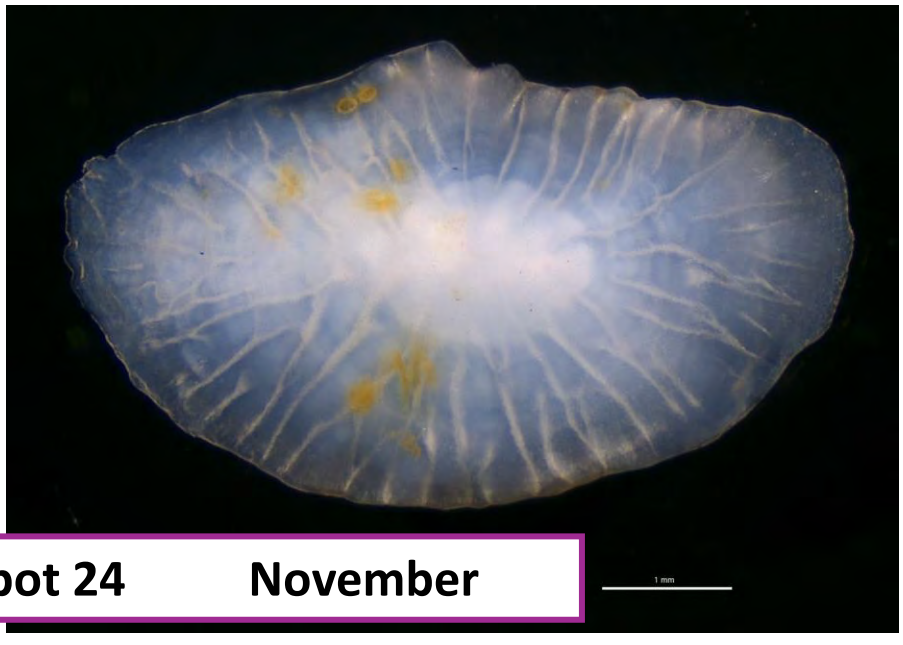
Spot 21 October



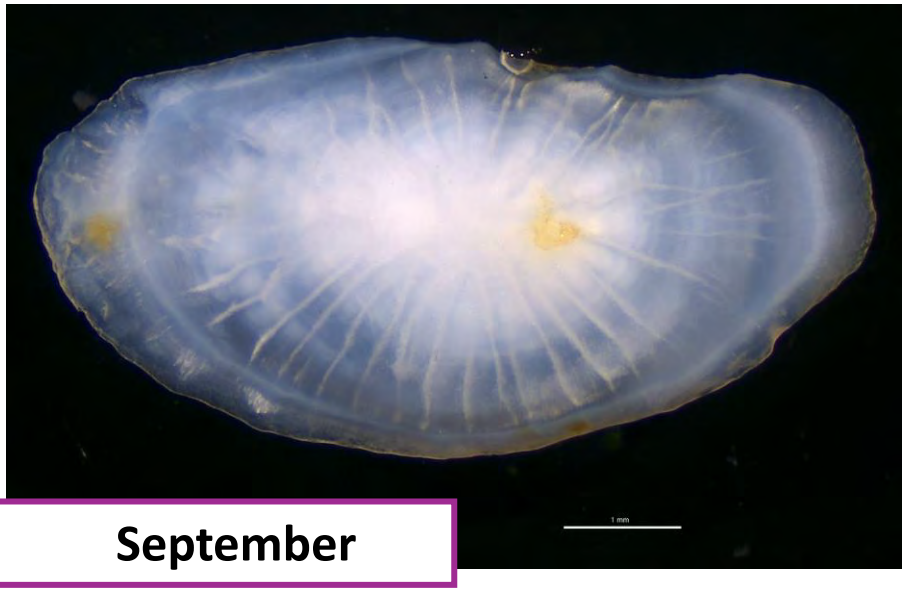
Spot 22 October



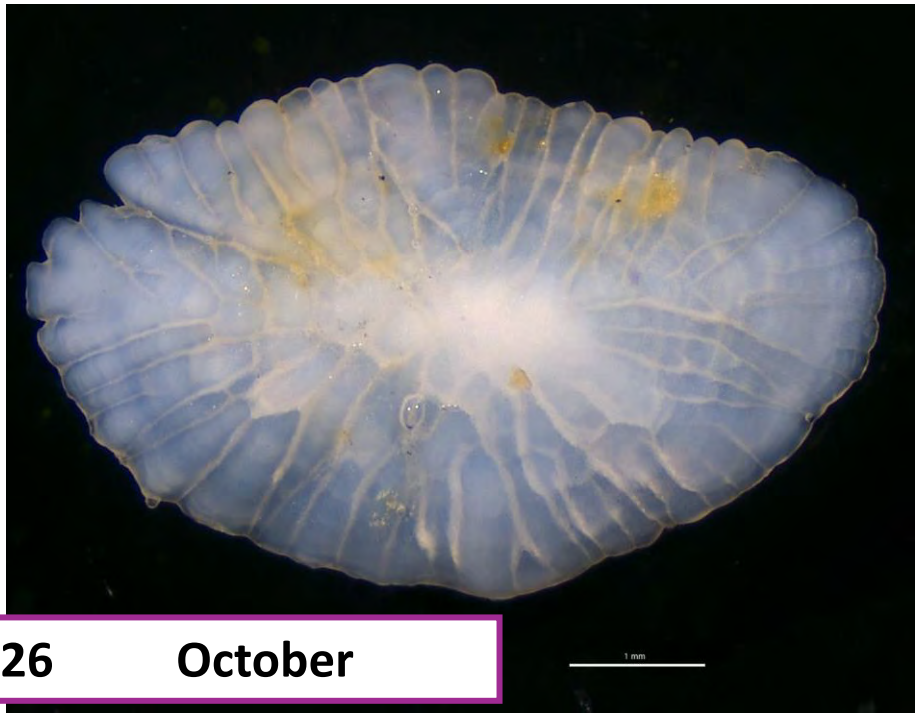
Spot 23 October



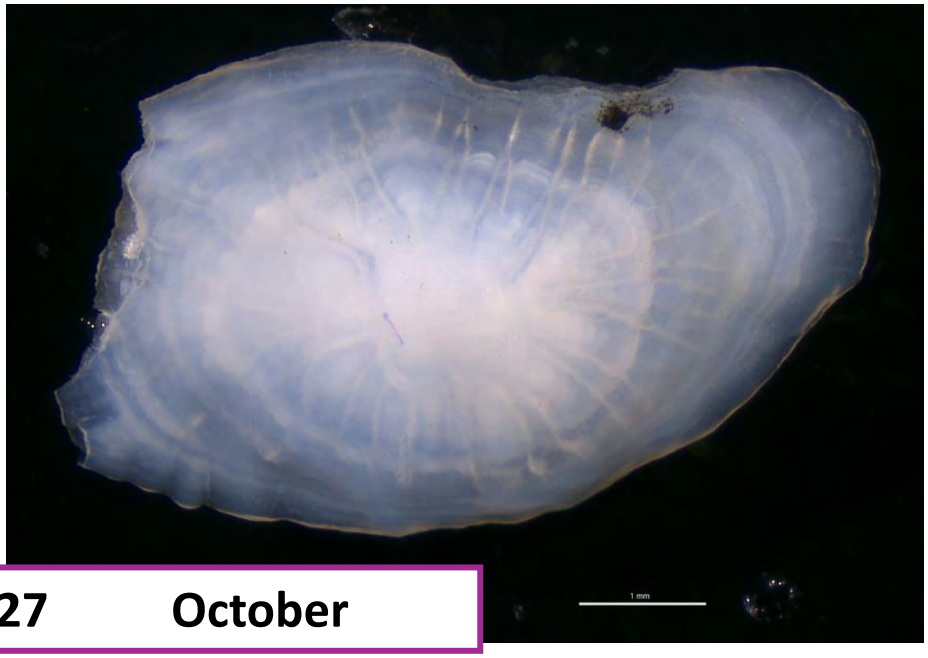
Spot 24 November



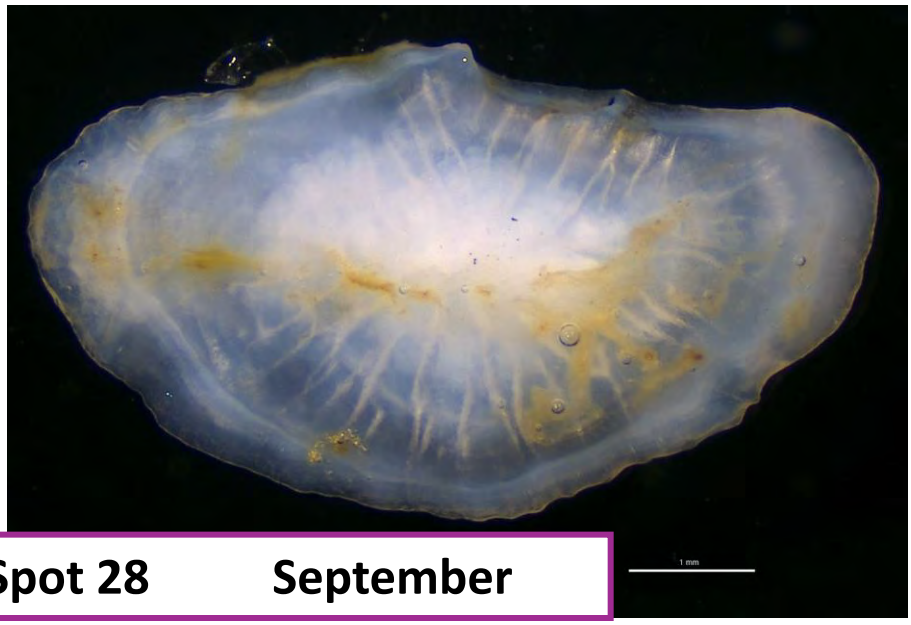
Spot 25 September



Spot 26 October

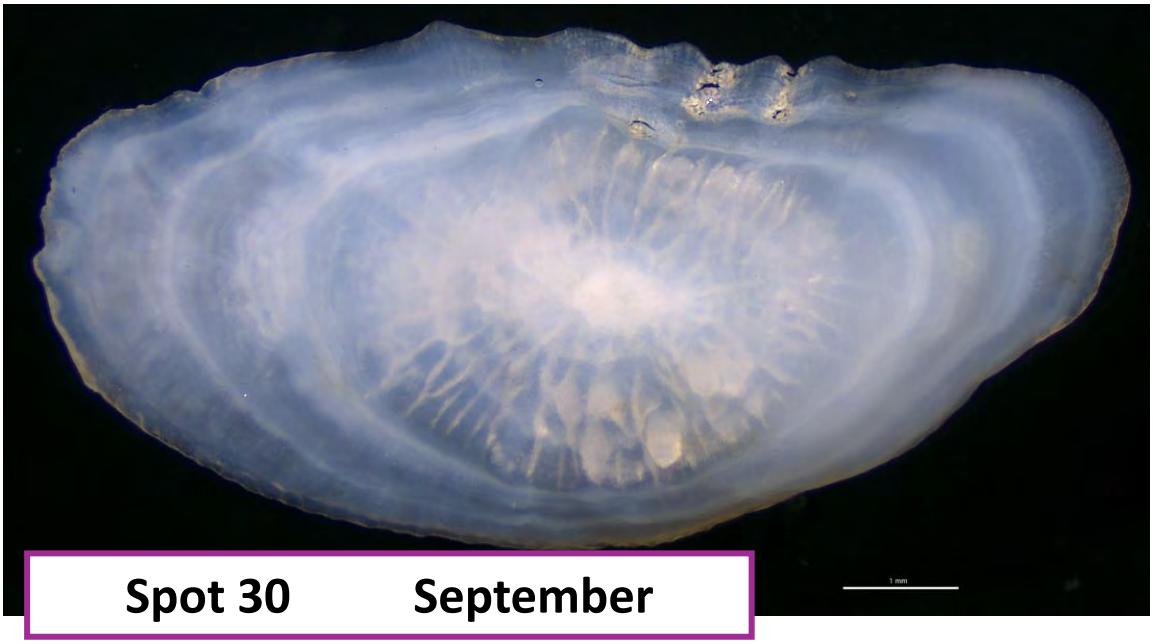


Spot 27 October

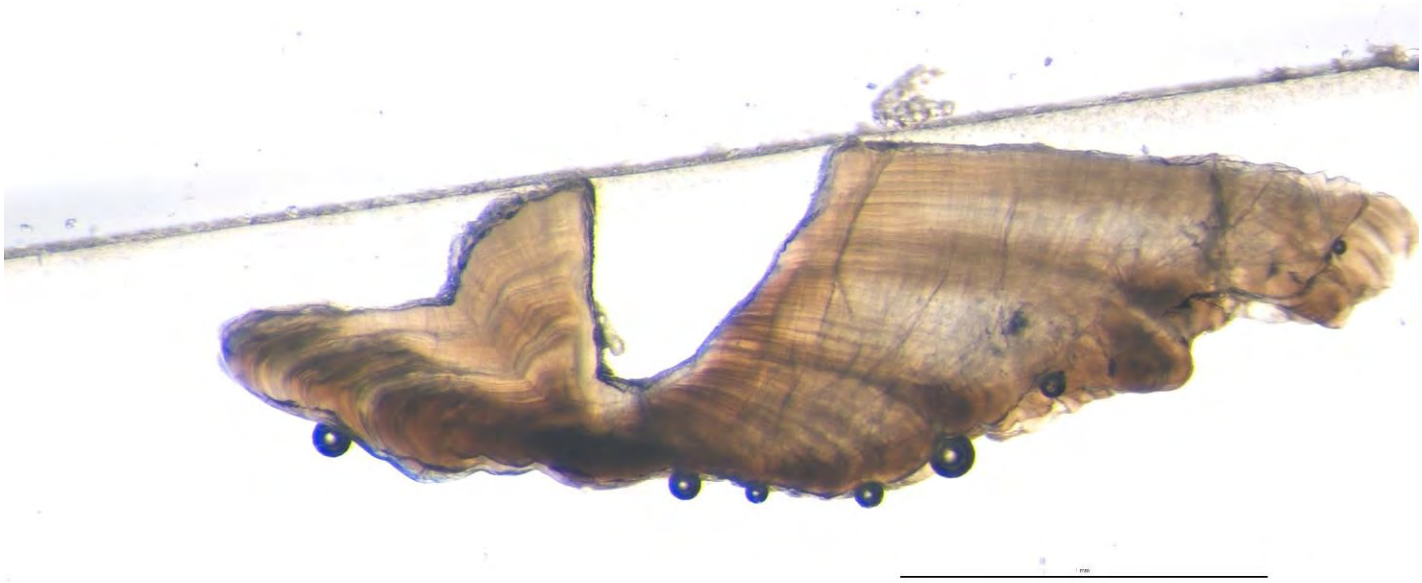


Spot 28 September

Spot 29 July



Spot 30 September

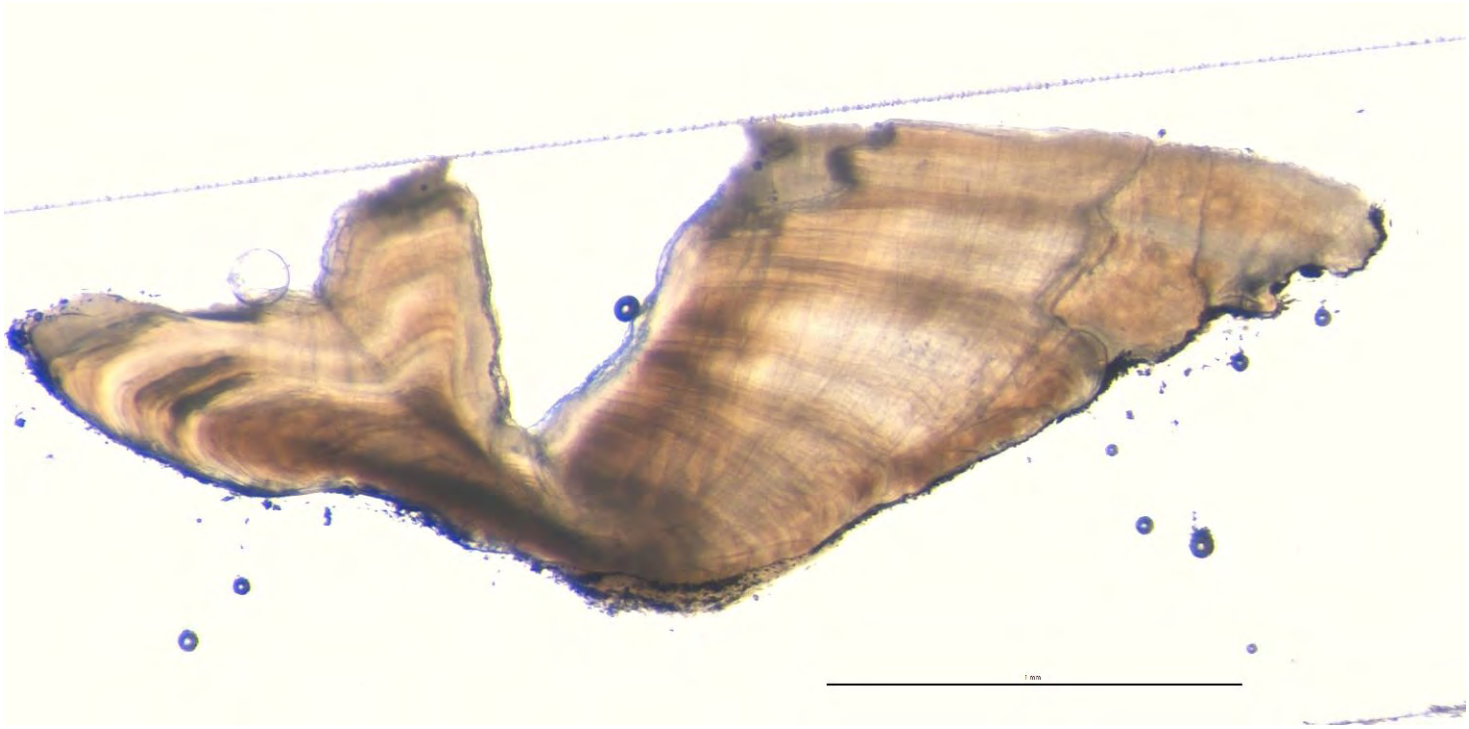


Cobia 1 July

Cobia 2 September

Cobia 3 October

Cobia 4 September

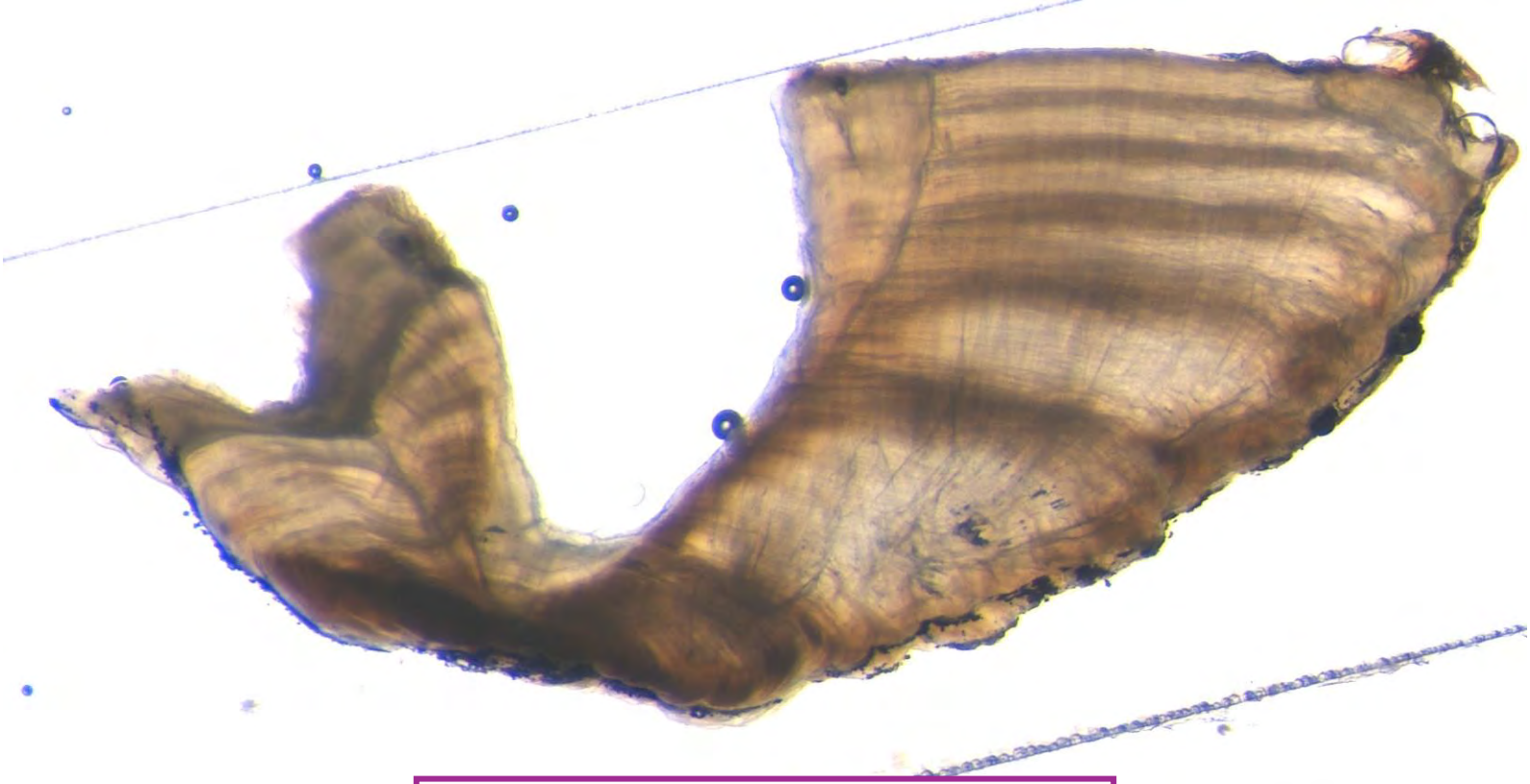


Cobia 5 June

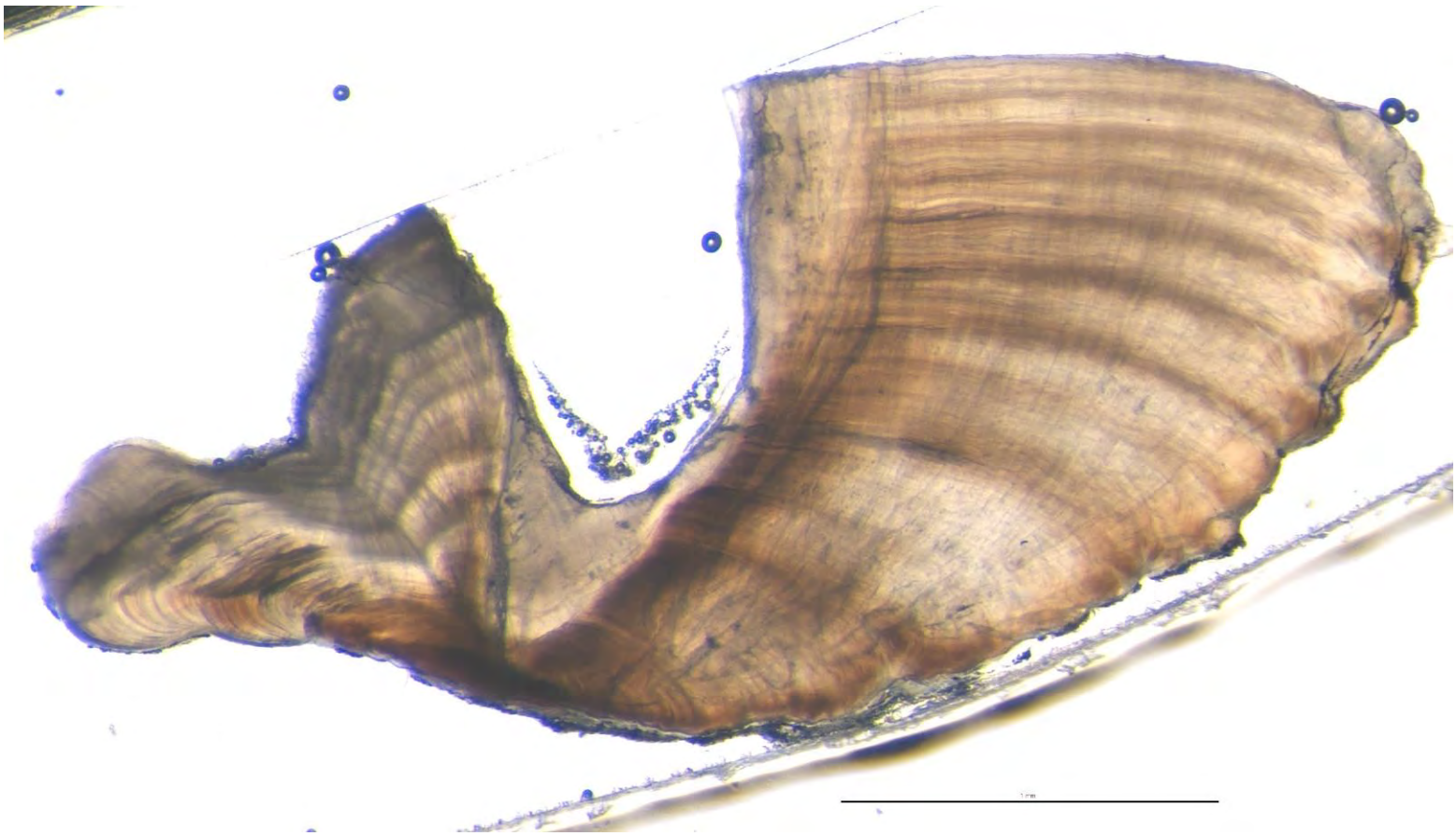
Cobia 6 October

Cobia 7 October

Cobia 8 June

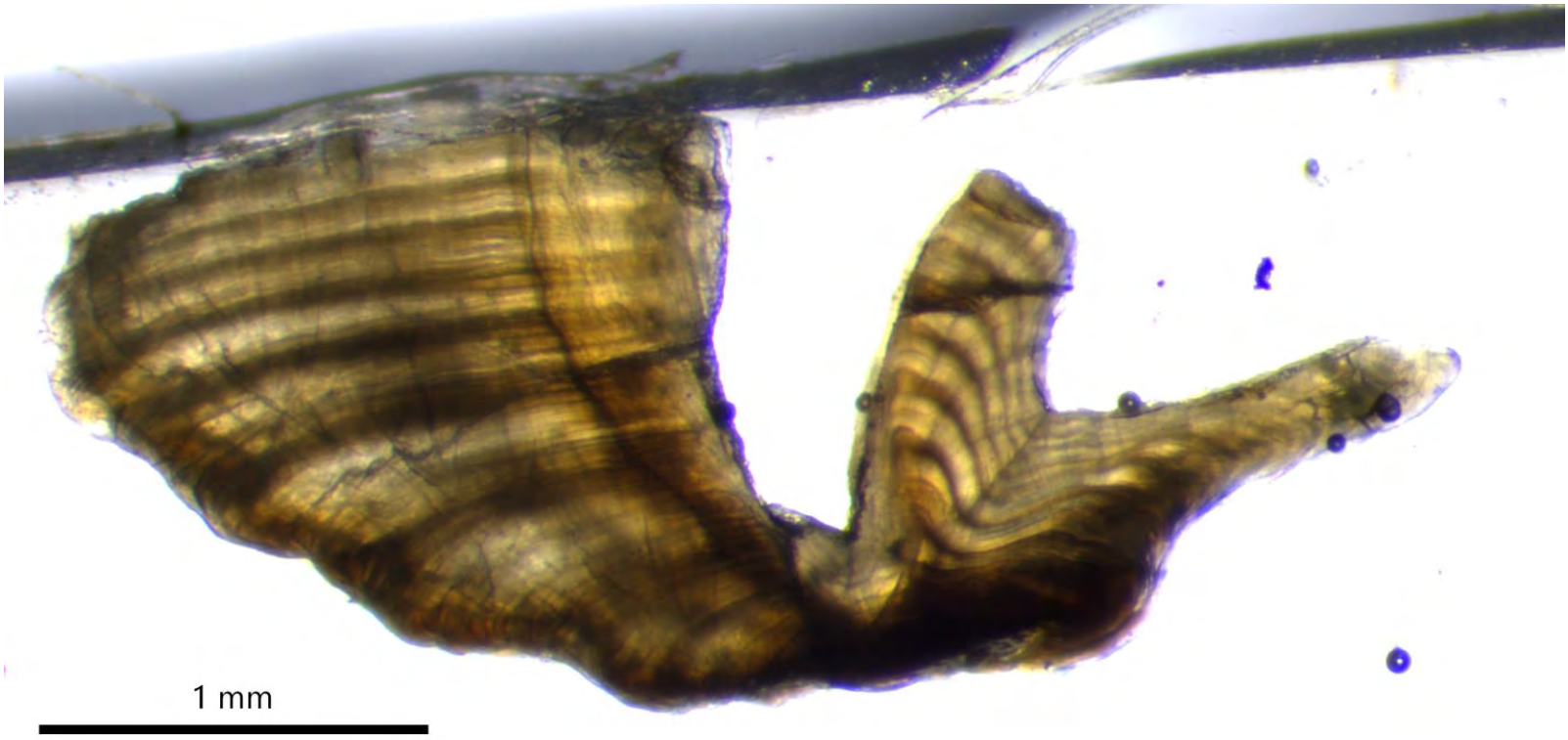


Cobia 9 May



Cobia 10 May

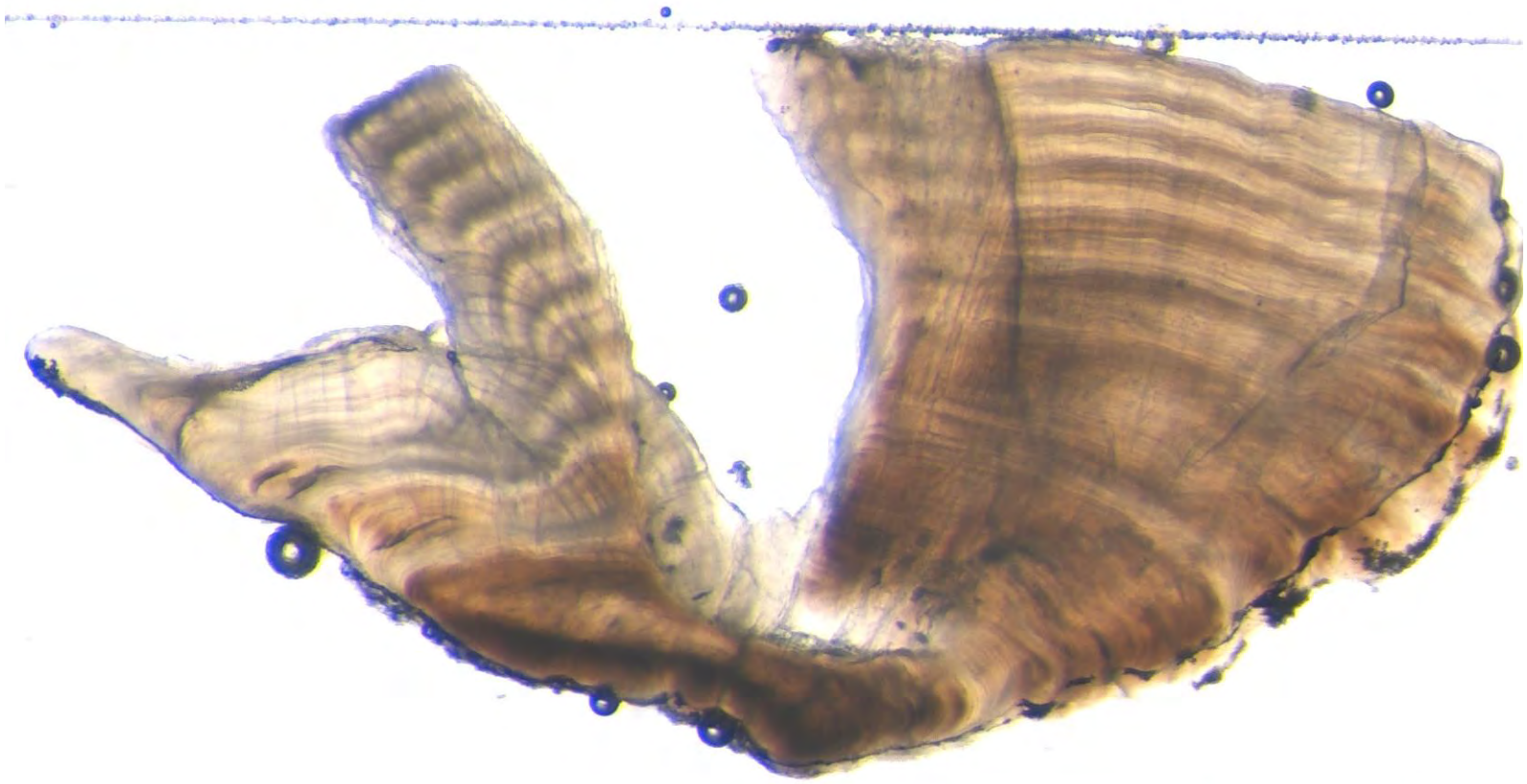
Cobia 11 May



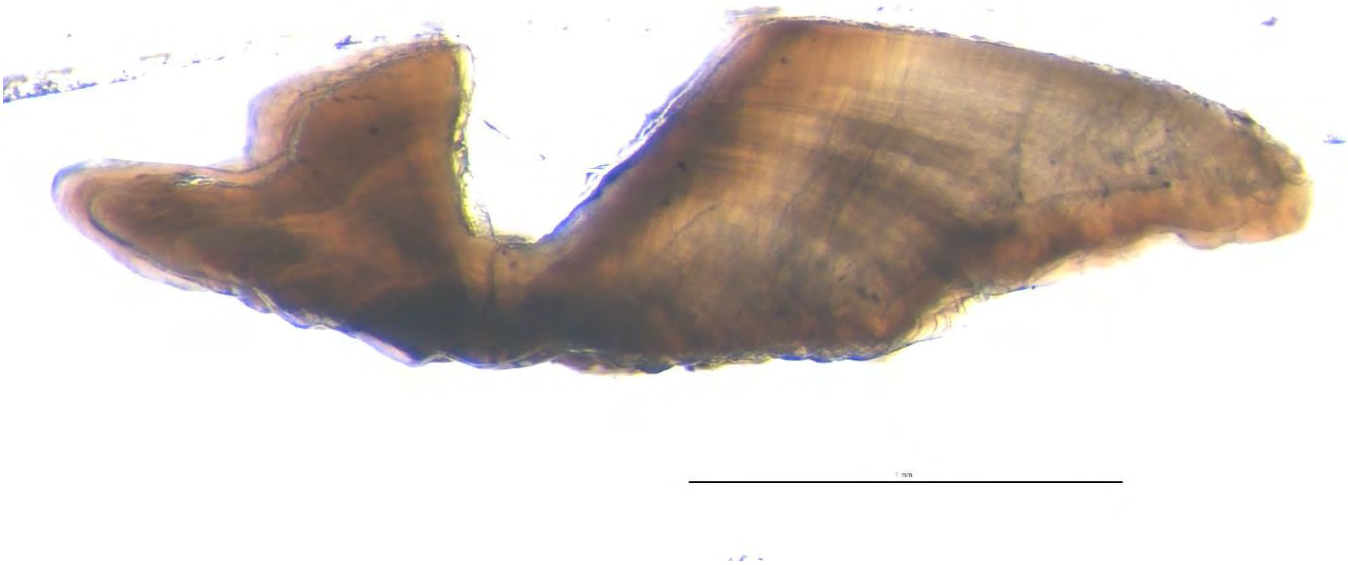
Cobia 12 July

Cobia 13 July

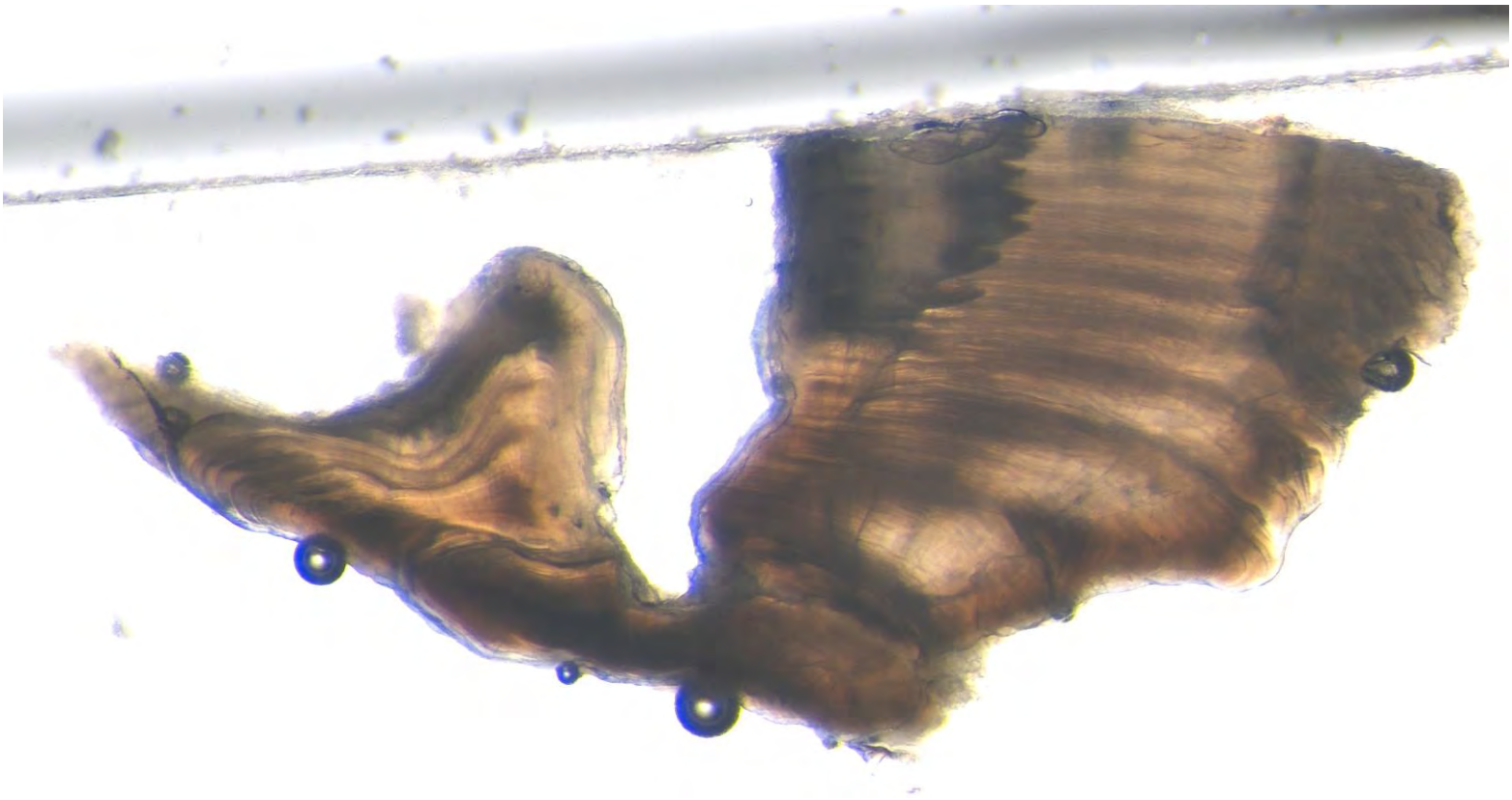
Cobia 14 May



Cobia 15 June

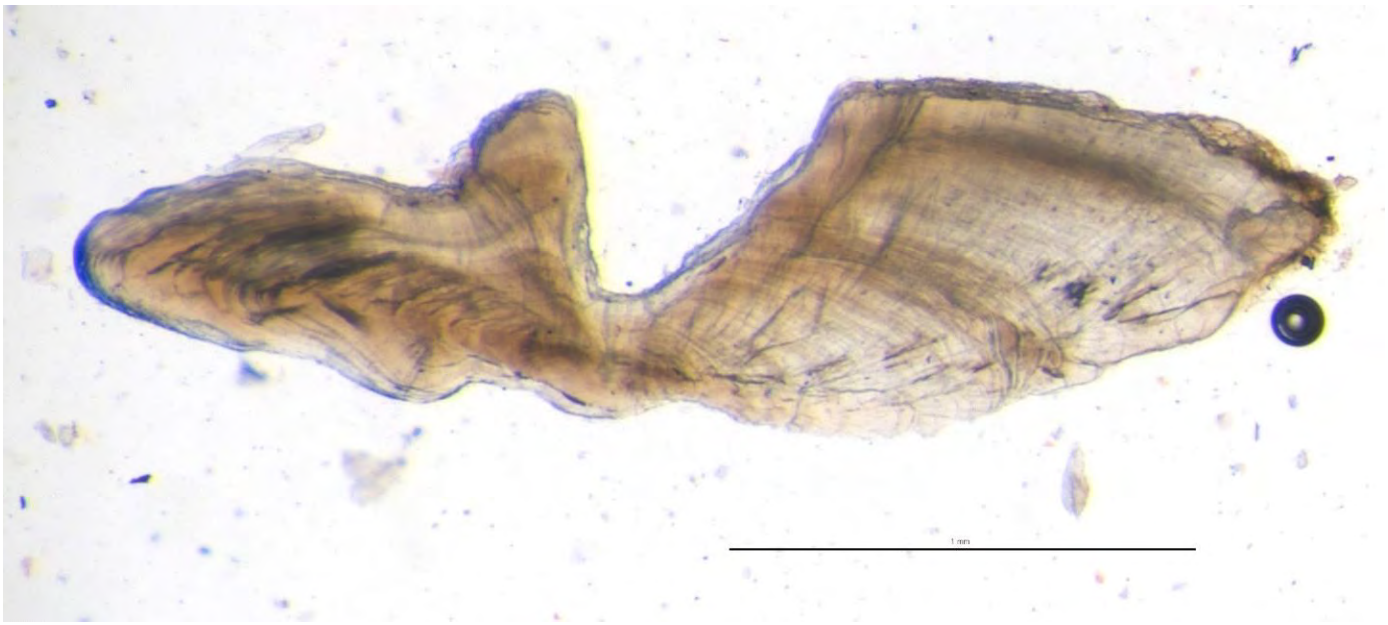


Cobia 16 March



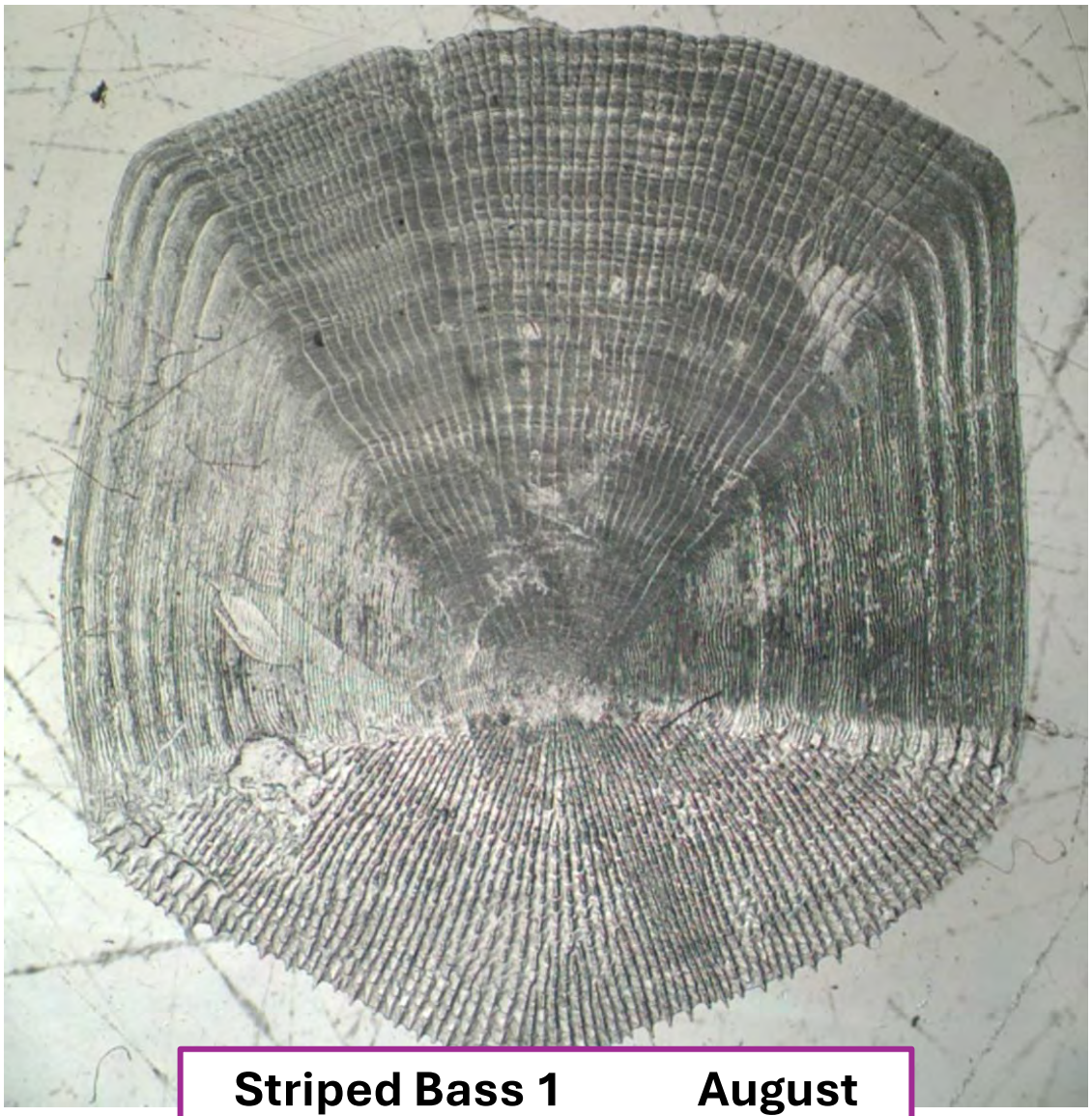
Cobia 17 August

Cobia 18 June



Cobia 19 September

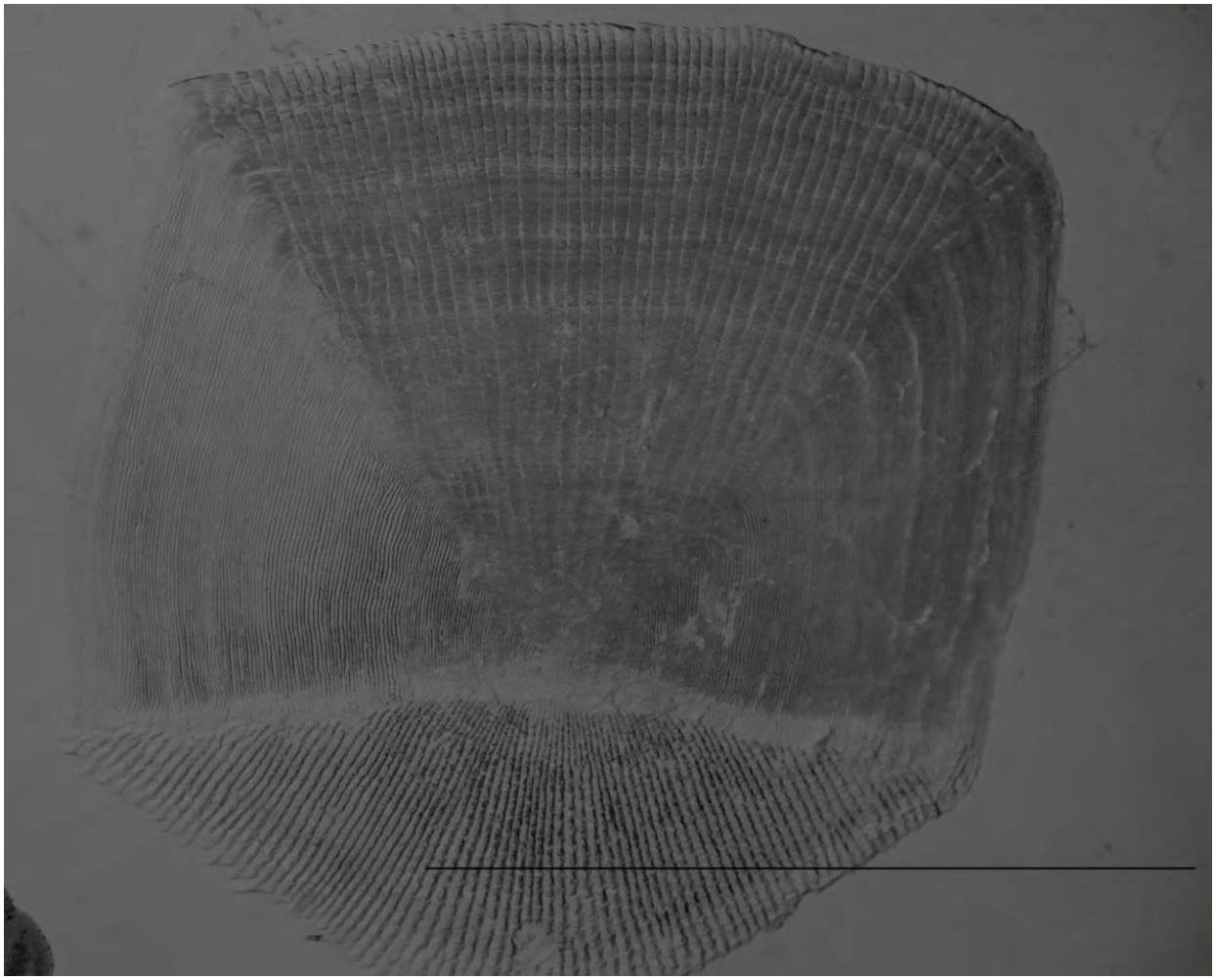
Cobia 20 February



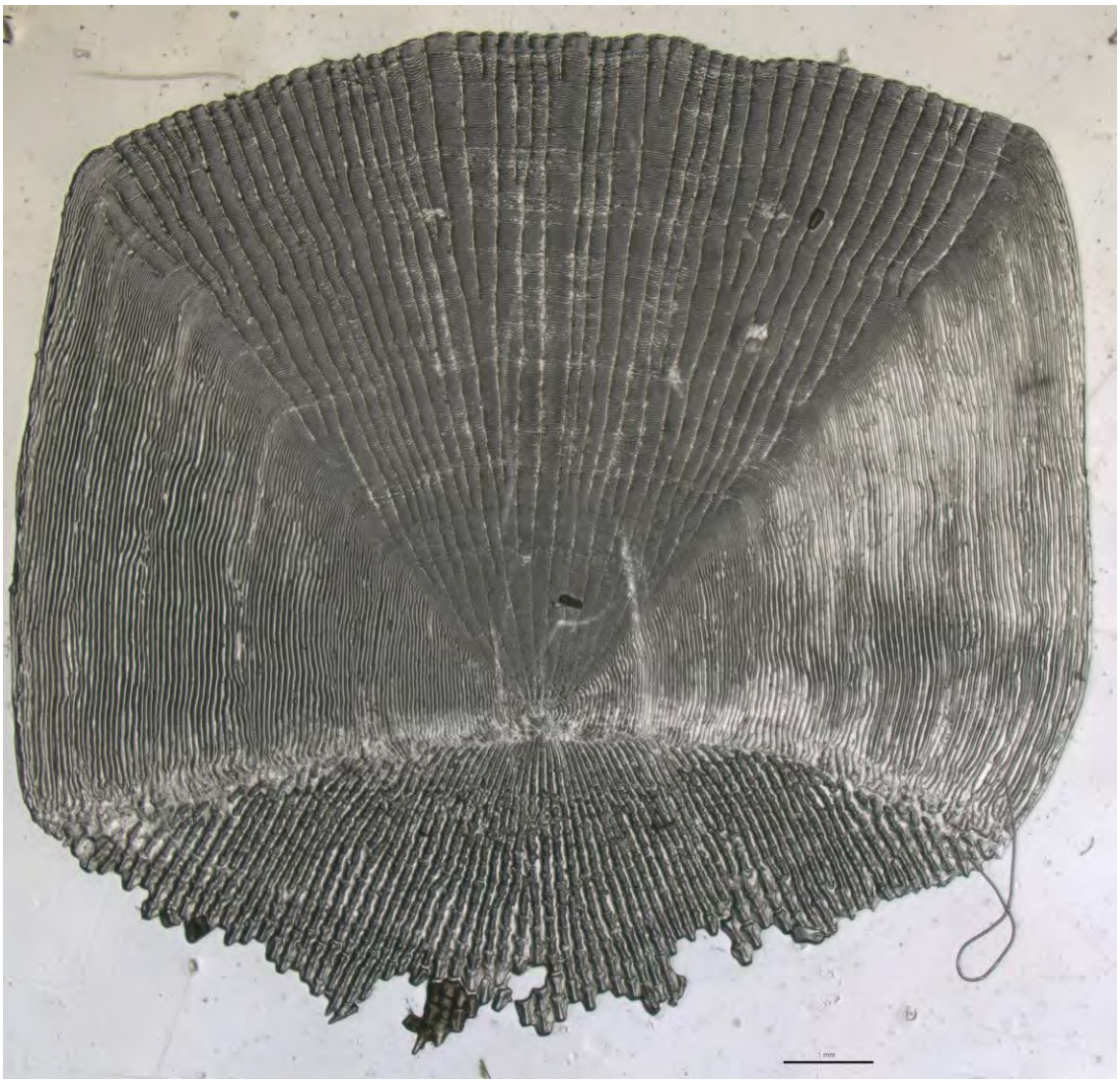
Striped Bass 1 August

Striped Bass 2 July

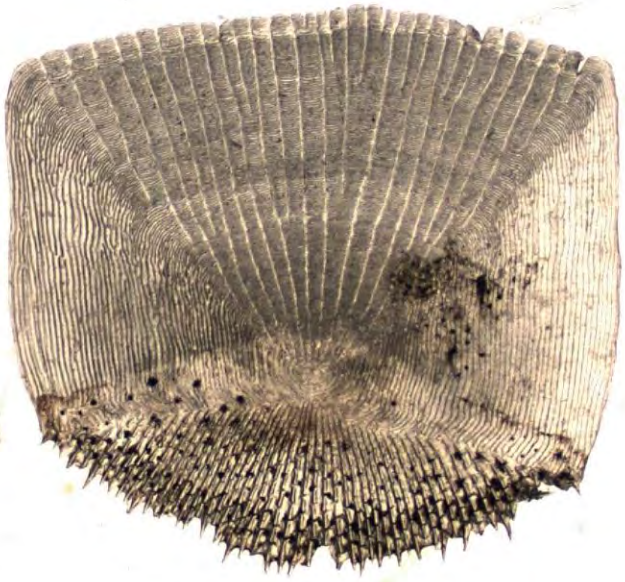
Striped Bass 3 July



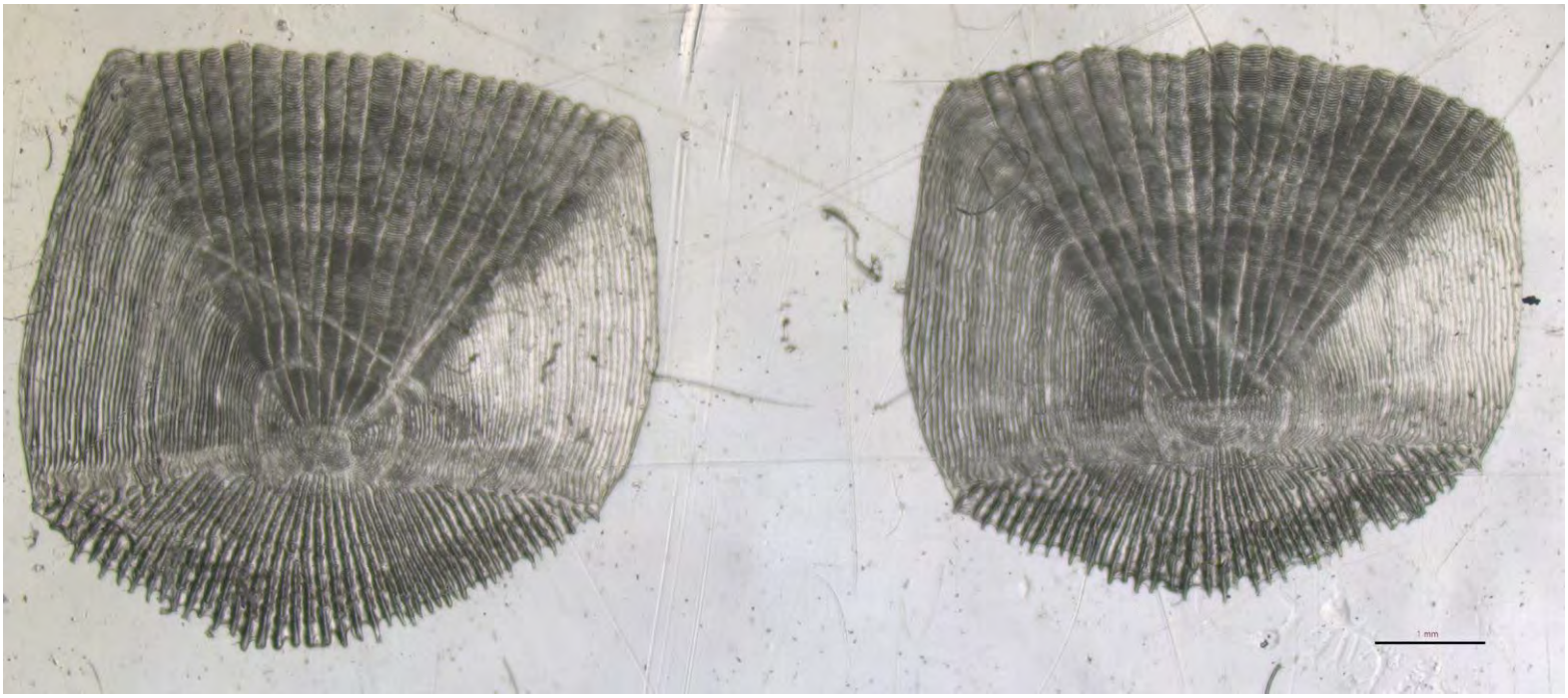
Striped Bass 4 June



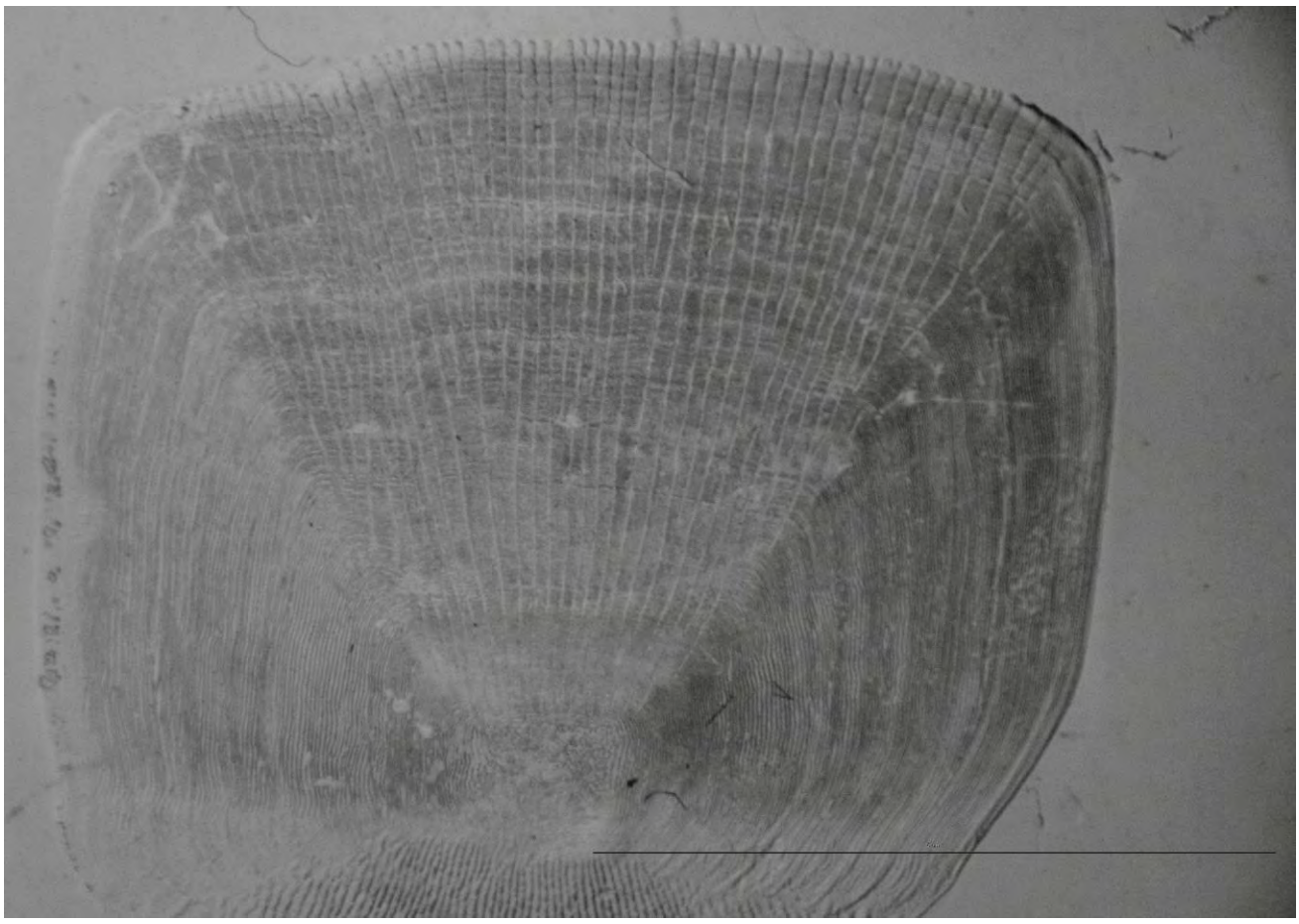
Striped Bass 5 July



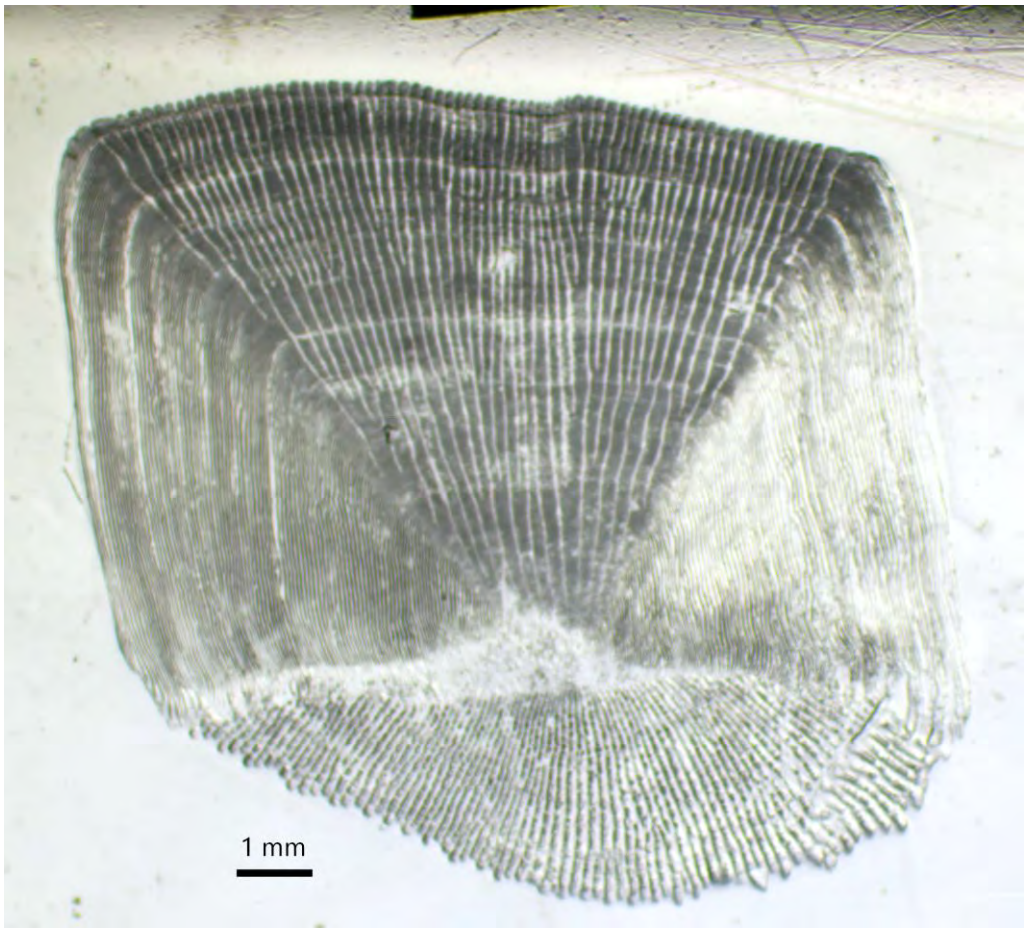
Striped Bass 6 June



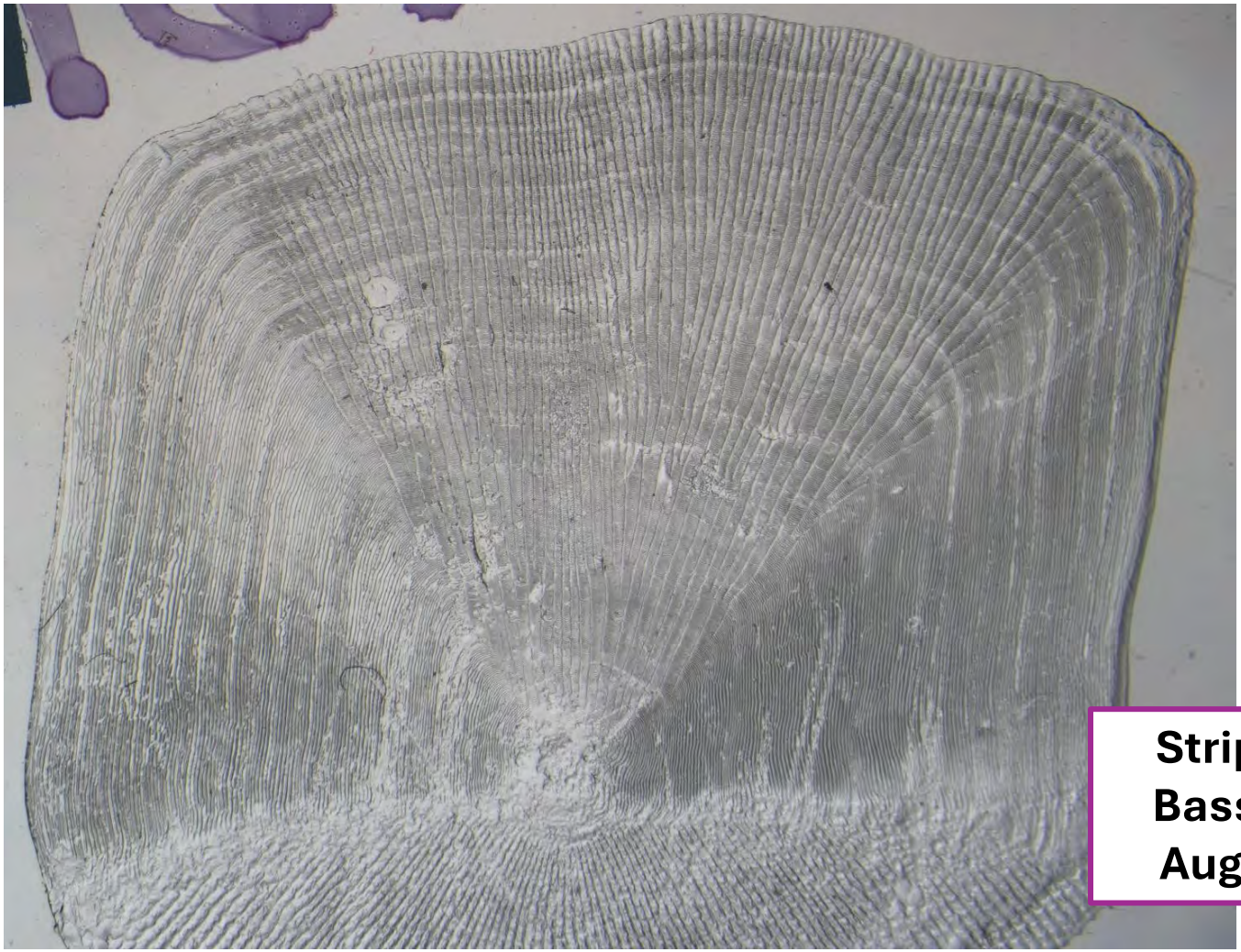
Striped Bass 7 February



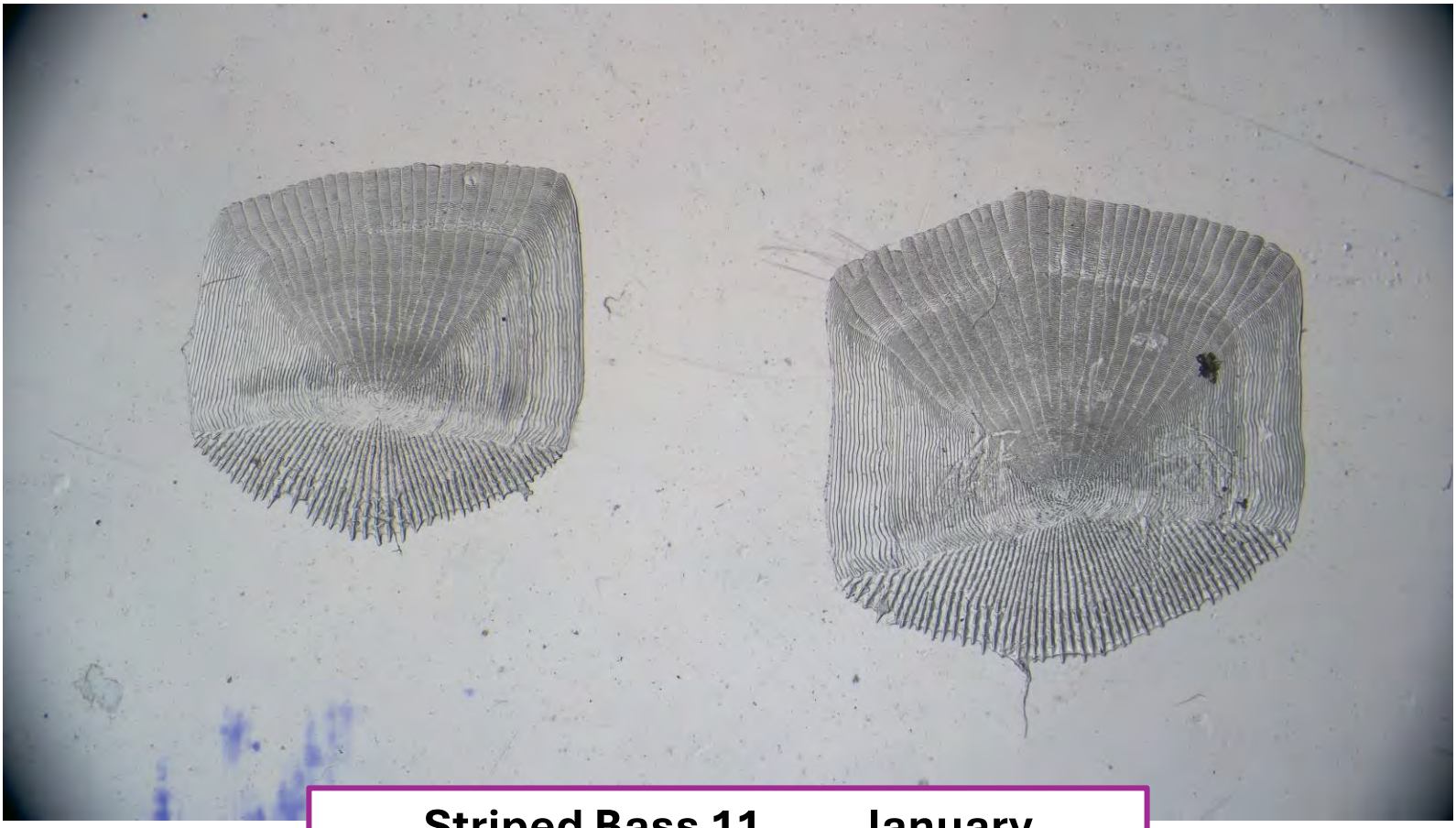
Striped Bass 8 July



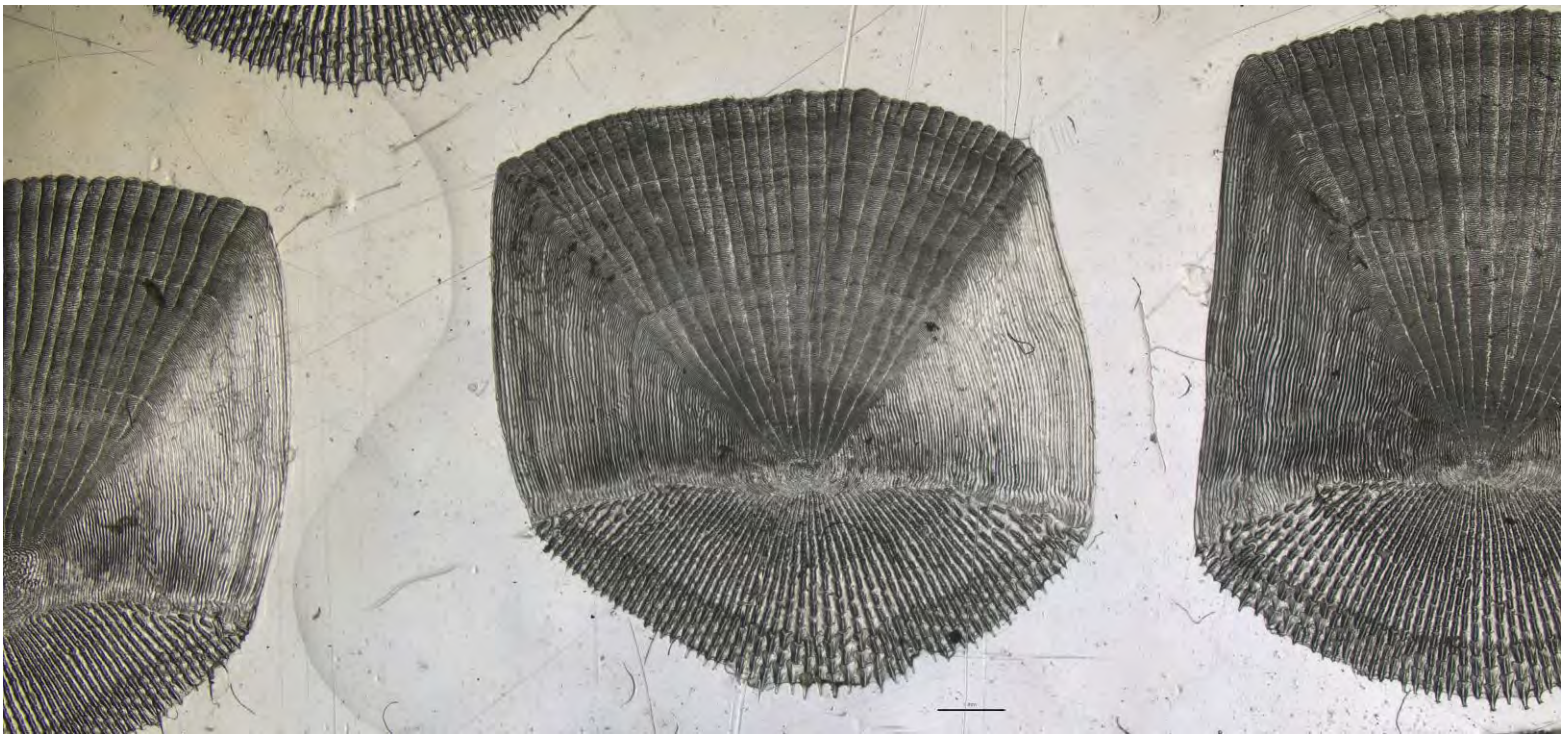
Striped Bass 9 July



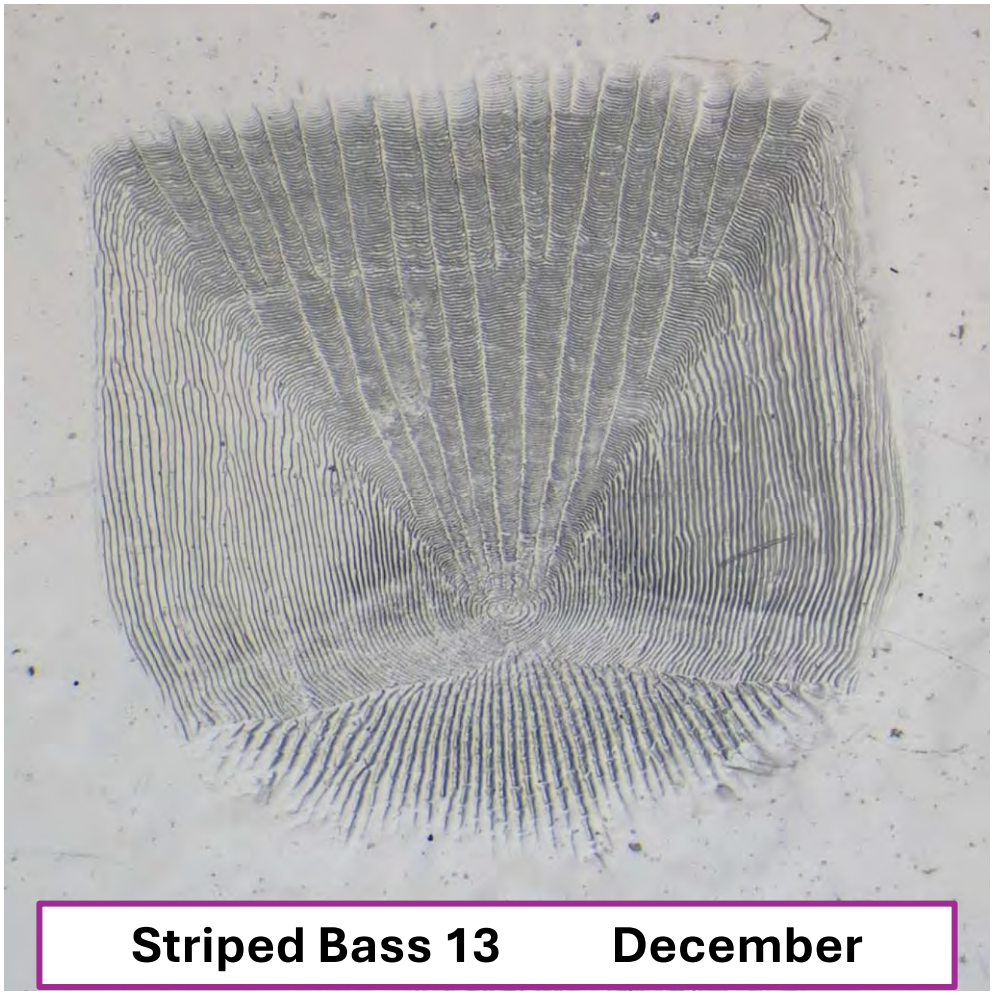
Striped Bass 10 August



Striped Bass 11 January



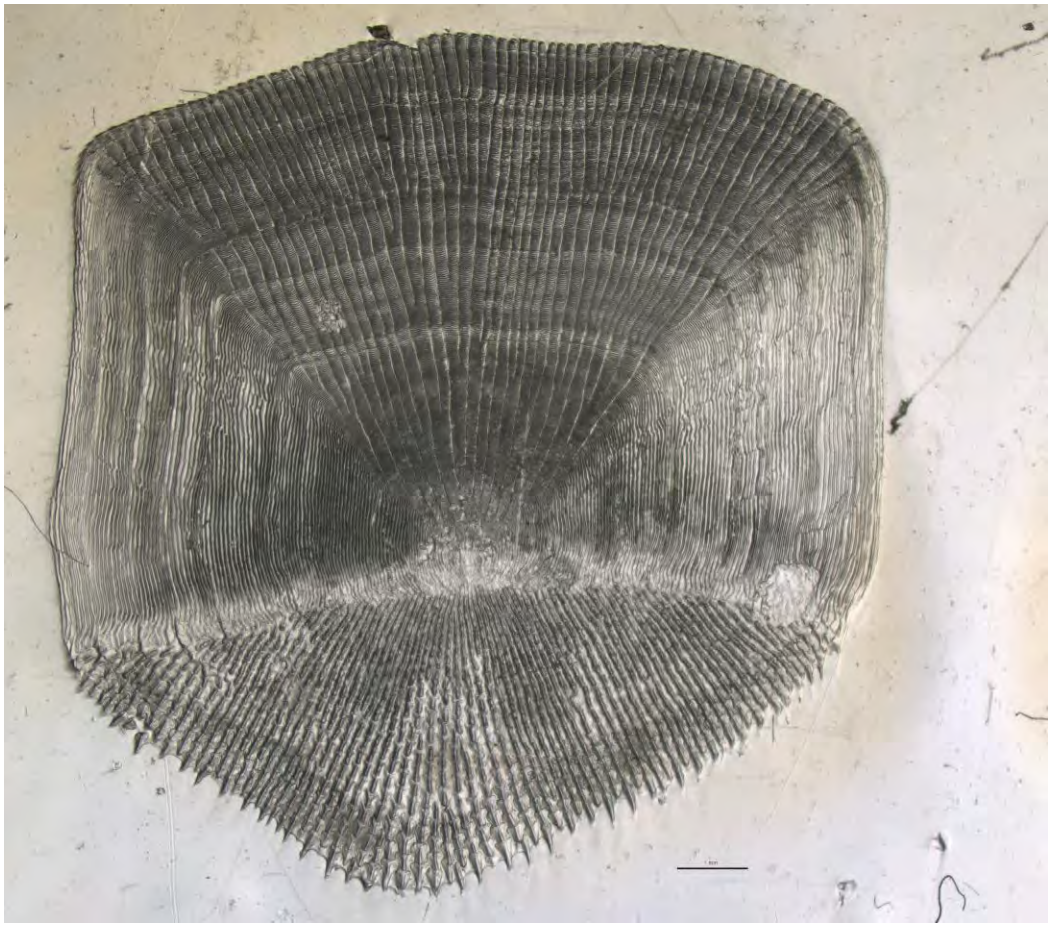
Striped Bass 12 February



Striped Bass 13 December

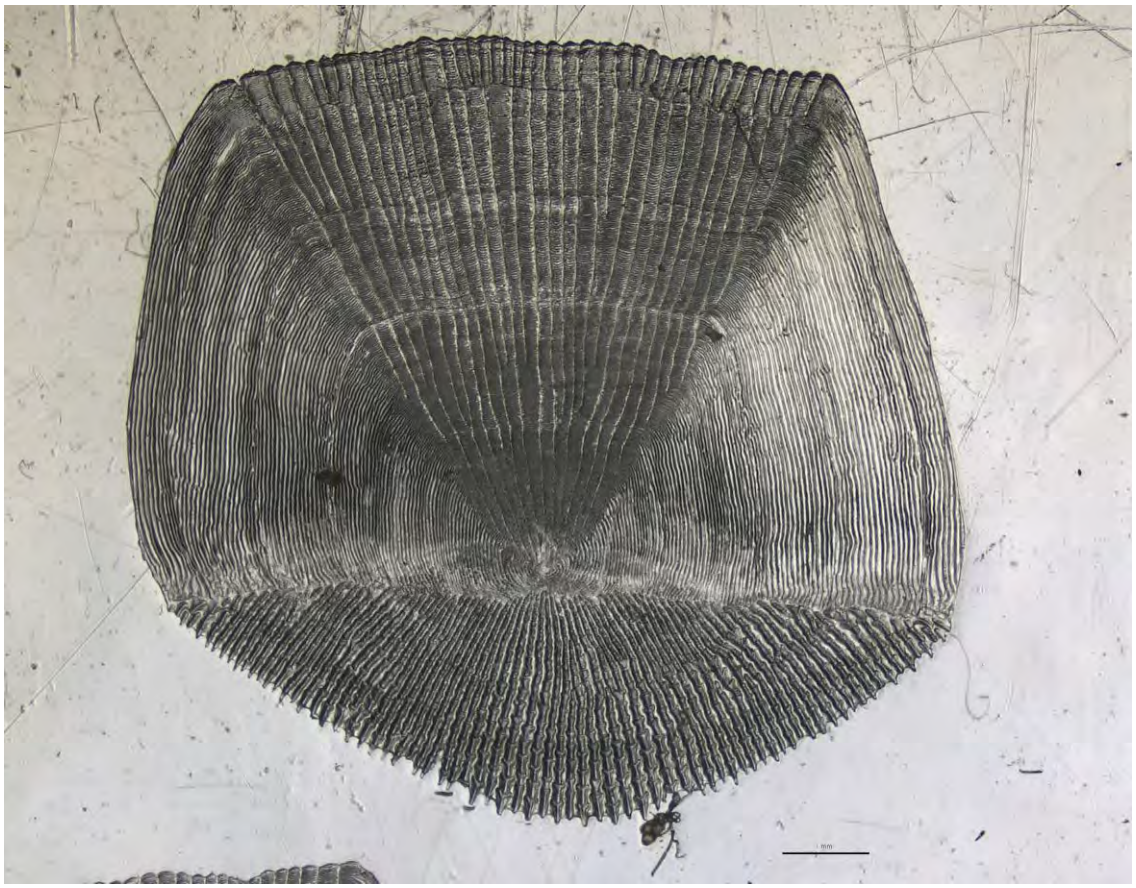
Striped Bass 14 March

Striped Bass 15 May

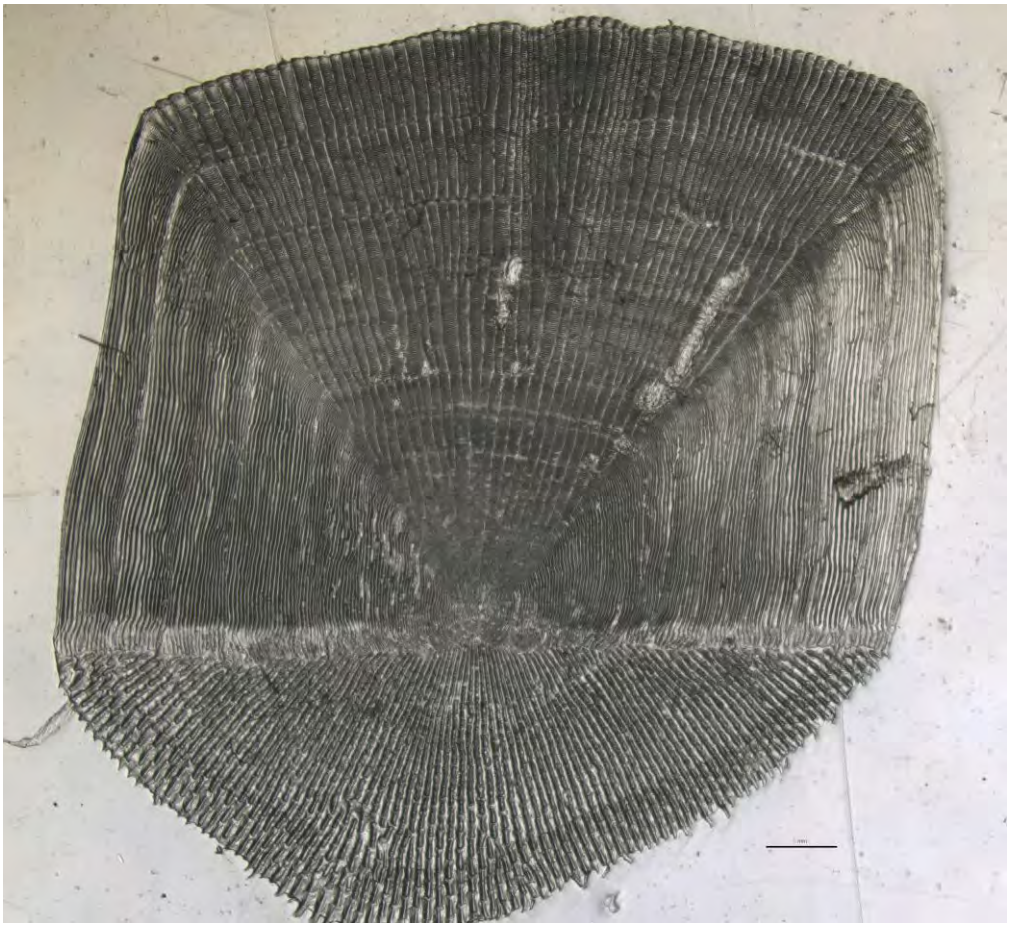


Striped Bass 16 July

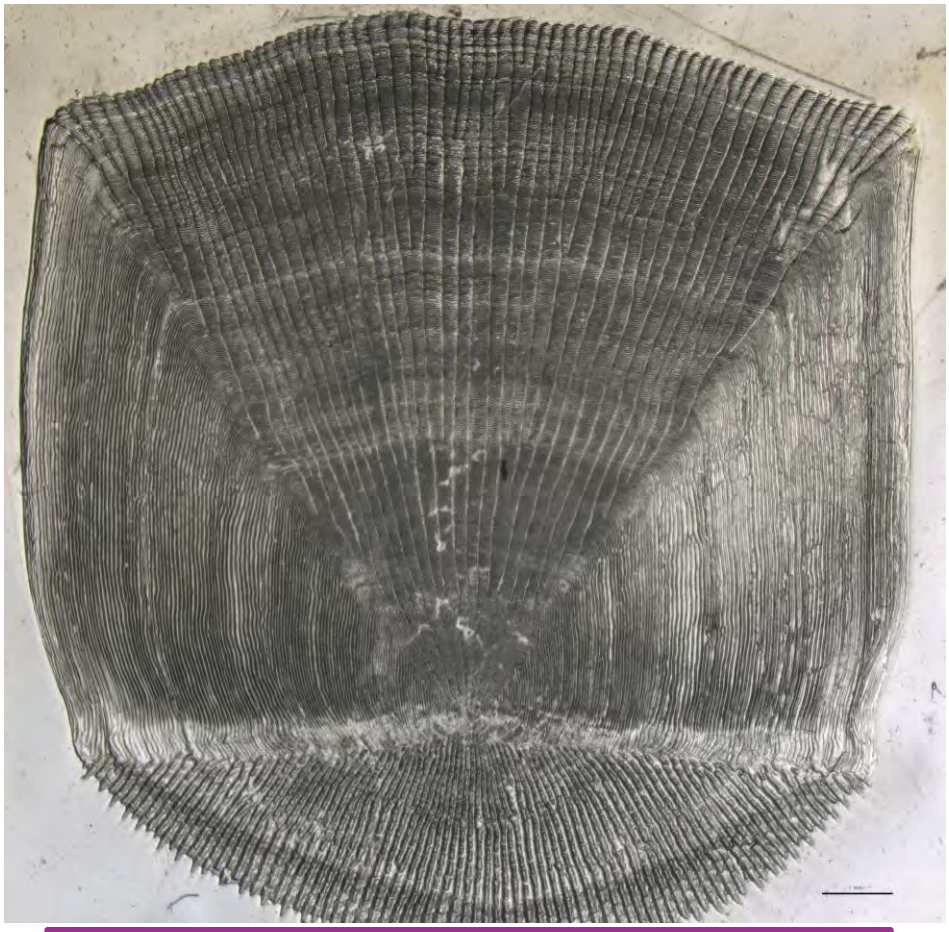
Striped Bass 17 July



Striped Bass 18 January

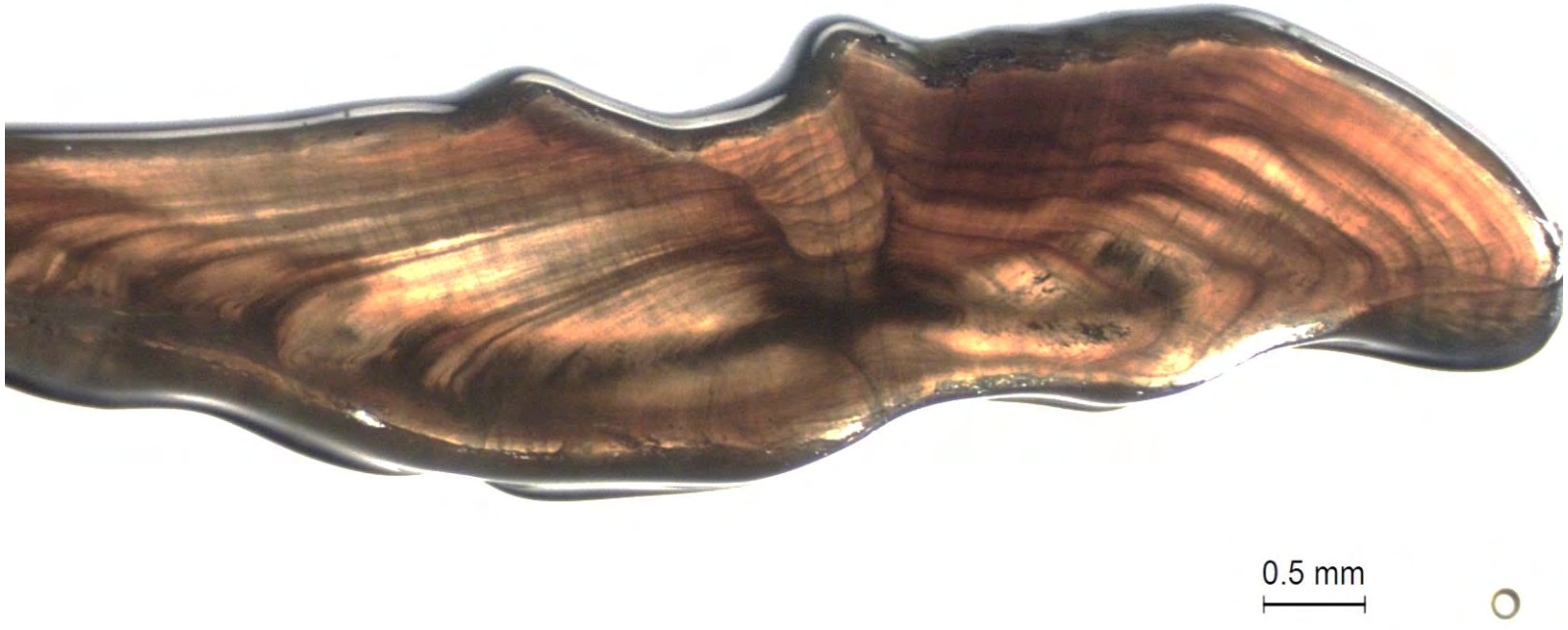


Striped Bass 19 July

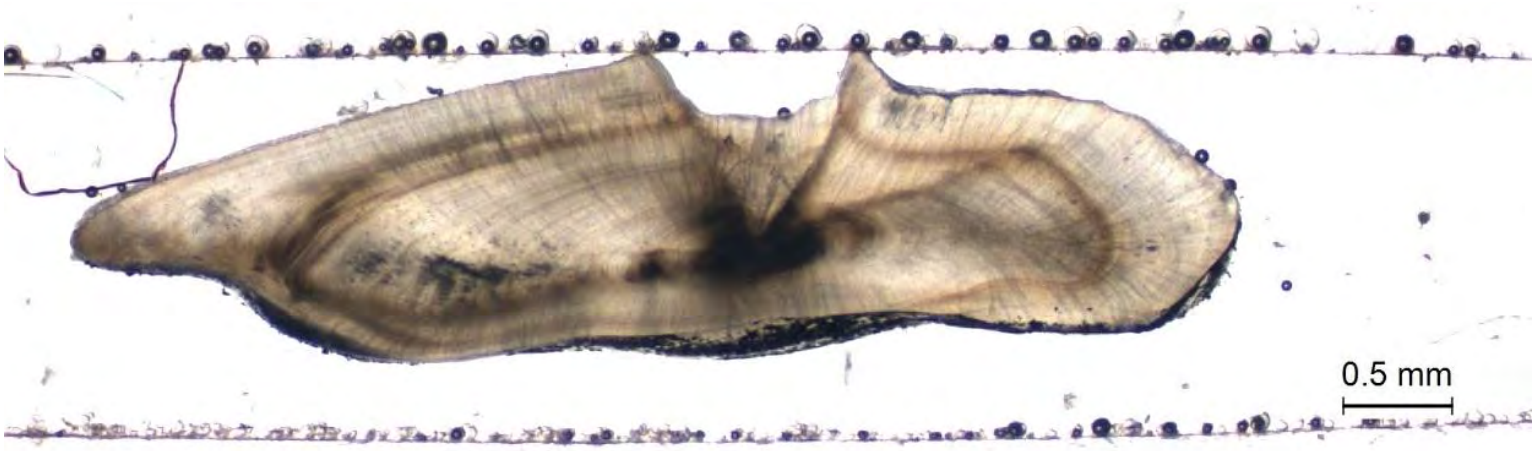


Striped Bass 20 September

Striped Bass 21 July



Striped Bass 22 September

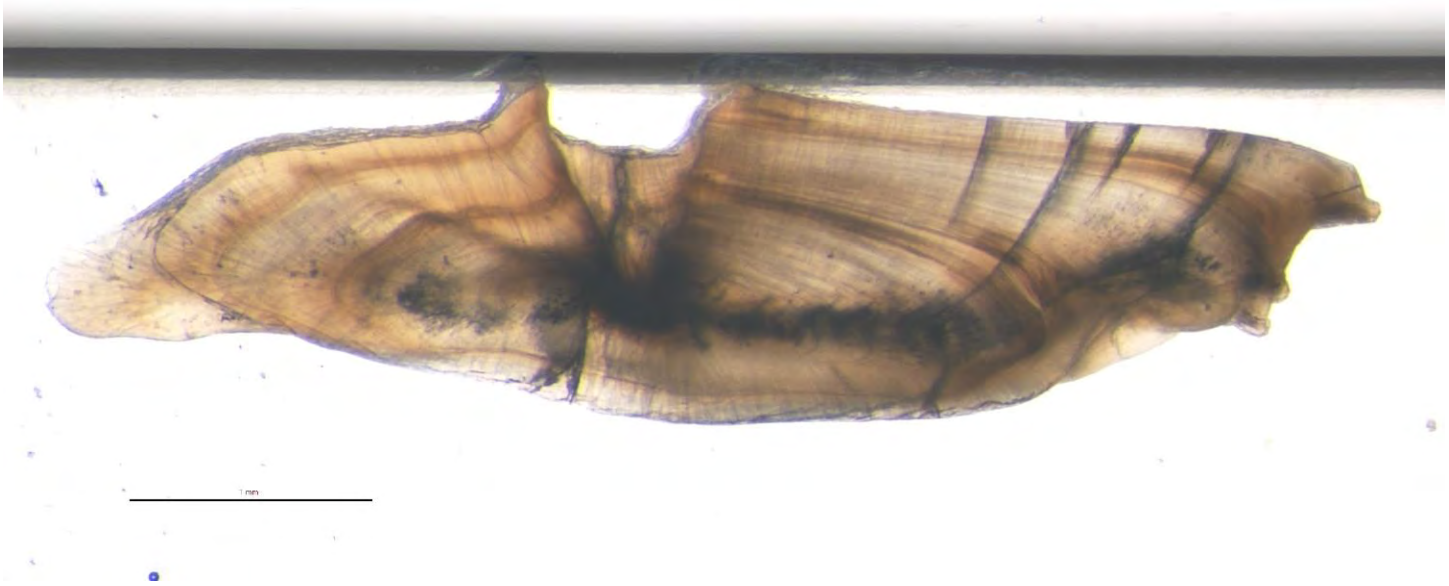


Striped Bass 23 December

Striped Bass 24 May

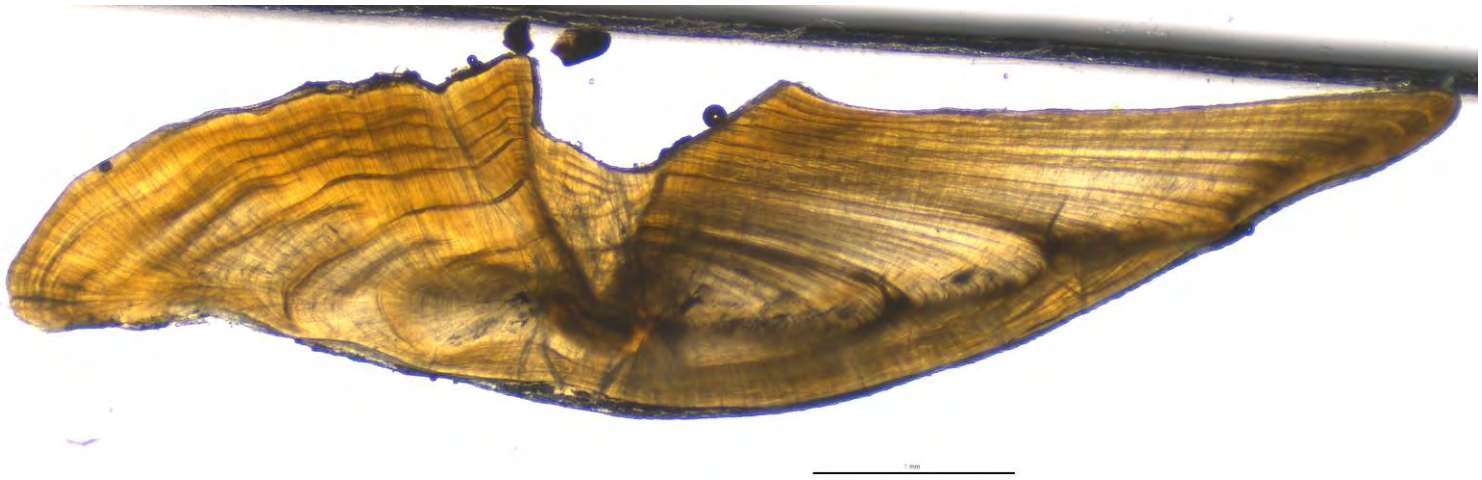
Striped Bass 25 July

Striped Bass 26 December



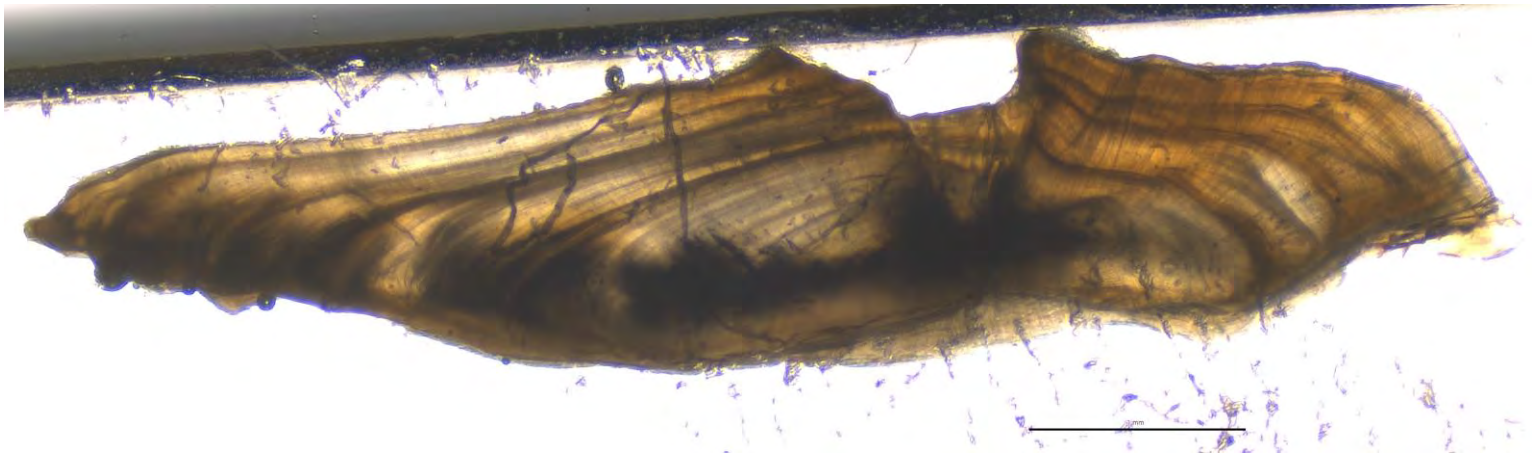
Striped Bass 27 January

Striped Bass 28 July

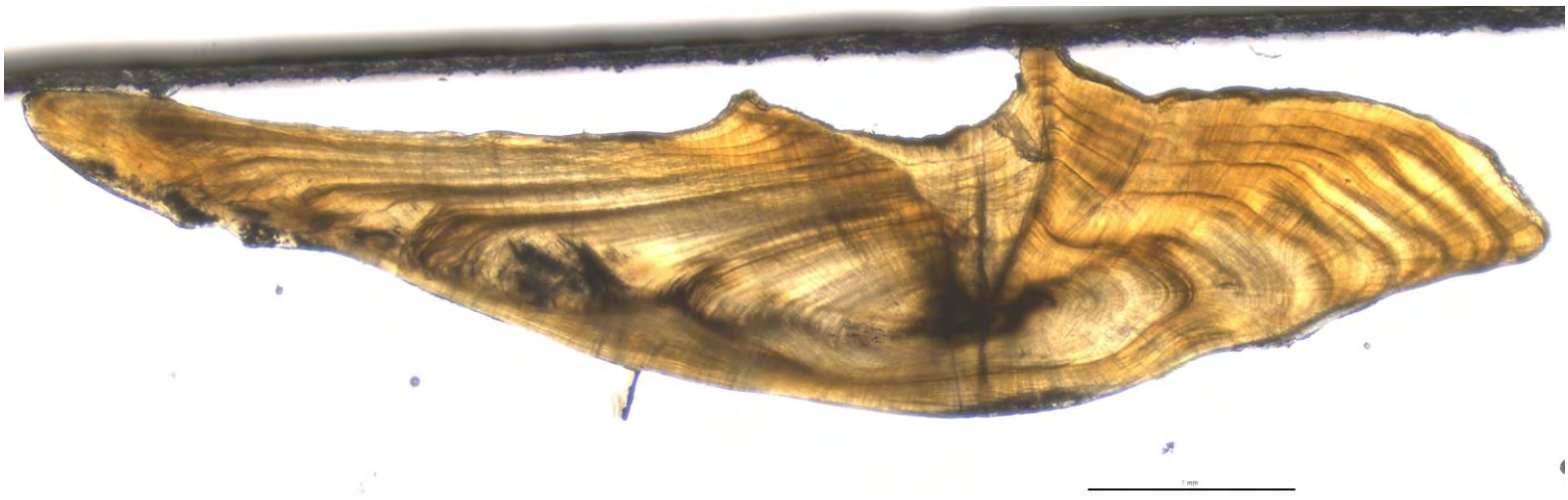


Striped Bass 29 June

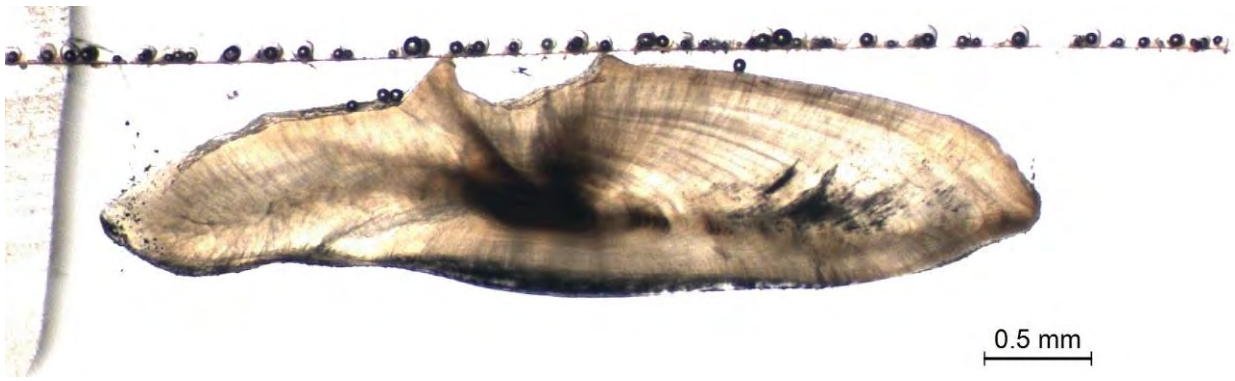
Striped Bass 30 July



Striped Bass 31 January



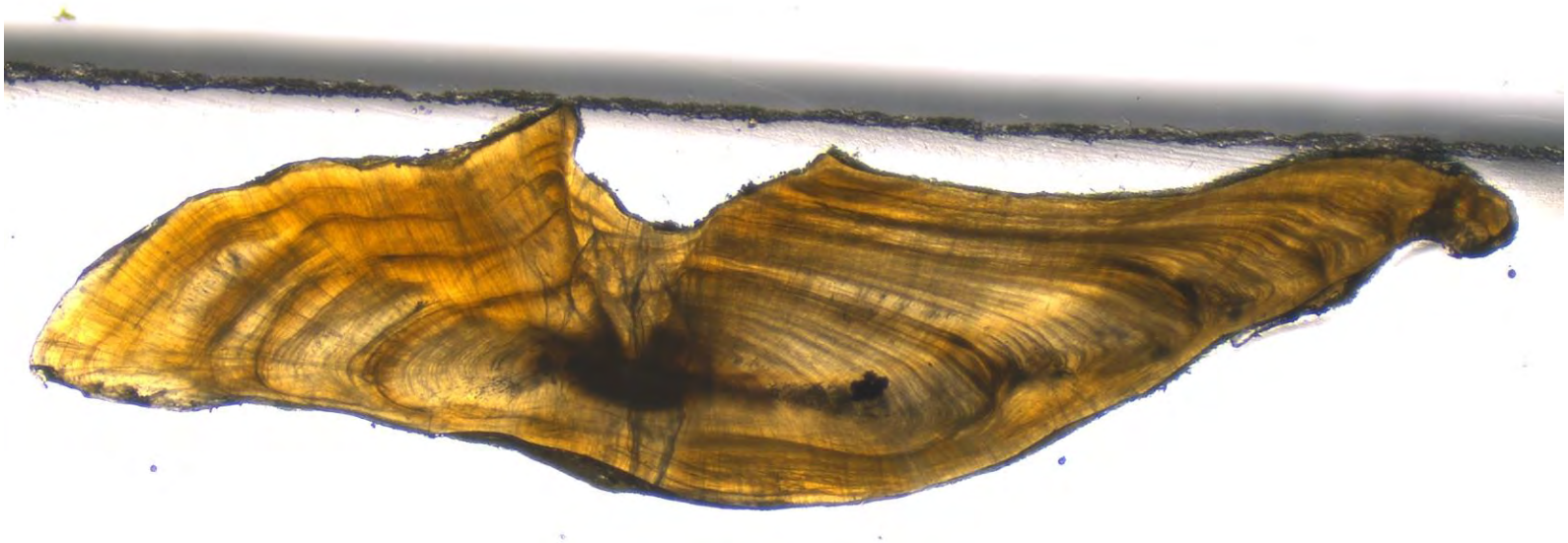
Striped Bass 32 July



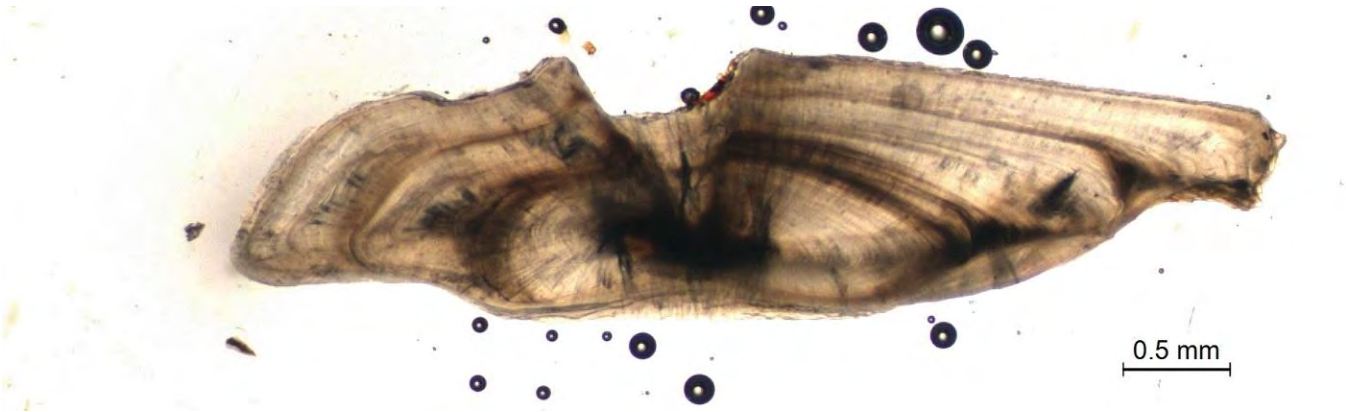
Striped Bass 33 April

Striped Bass 34 February

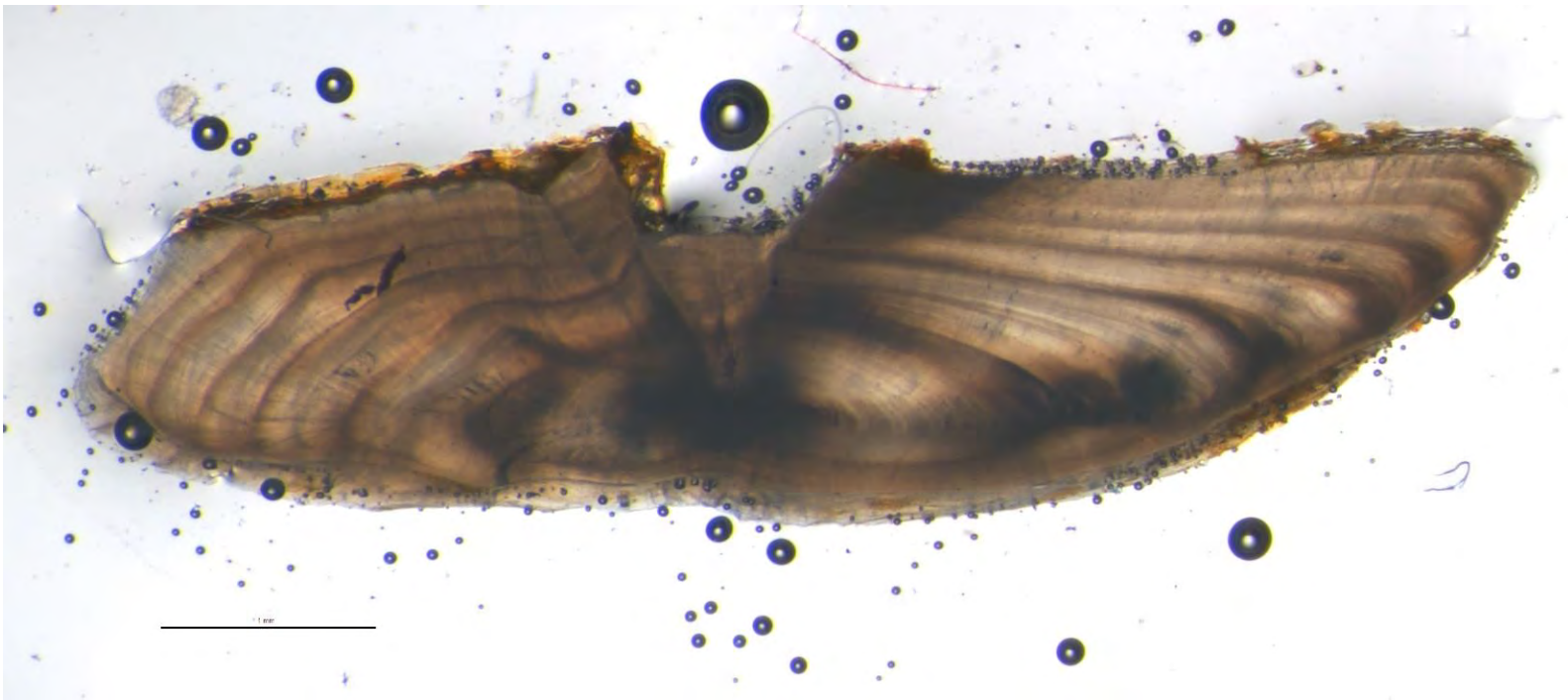
Striped Bass 35 July



Striped Bass 36 September

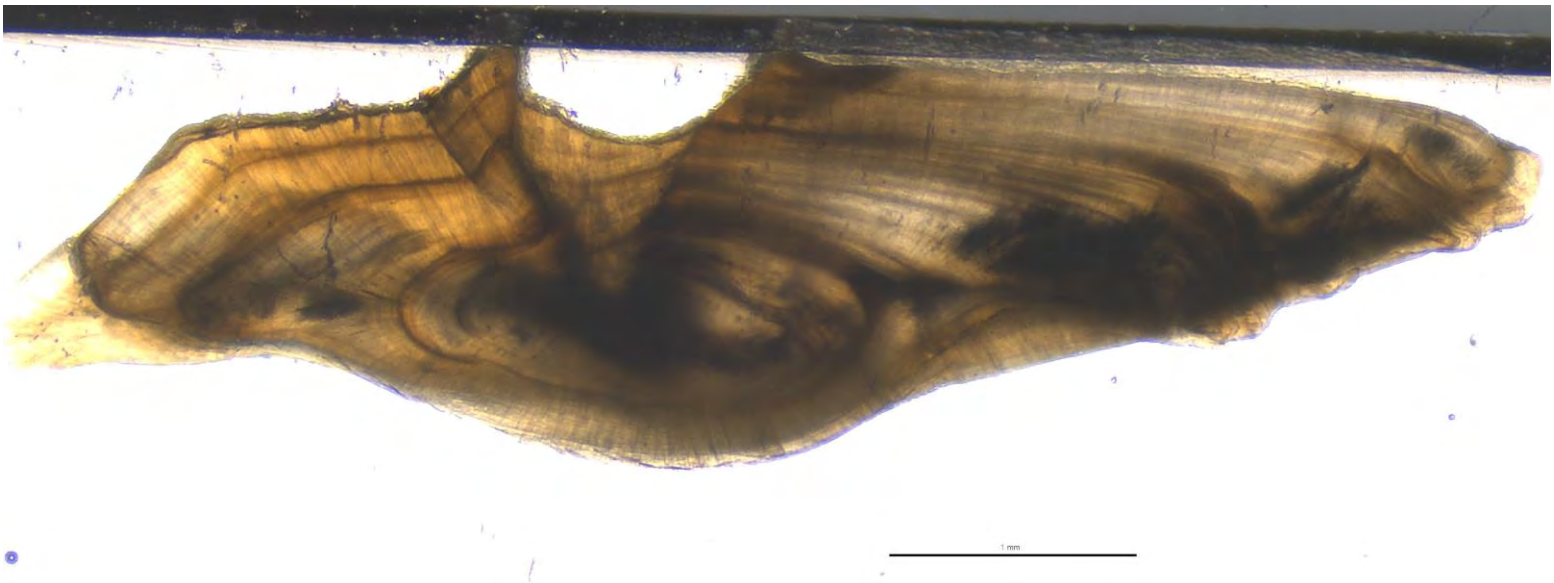


Striped Bass 37 June

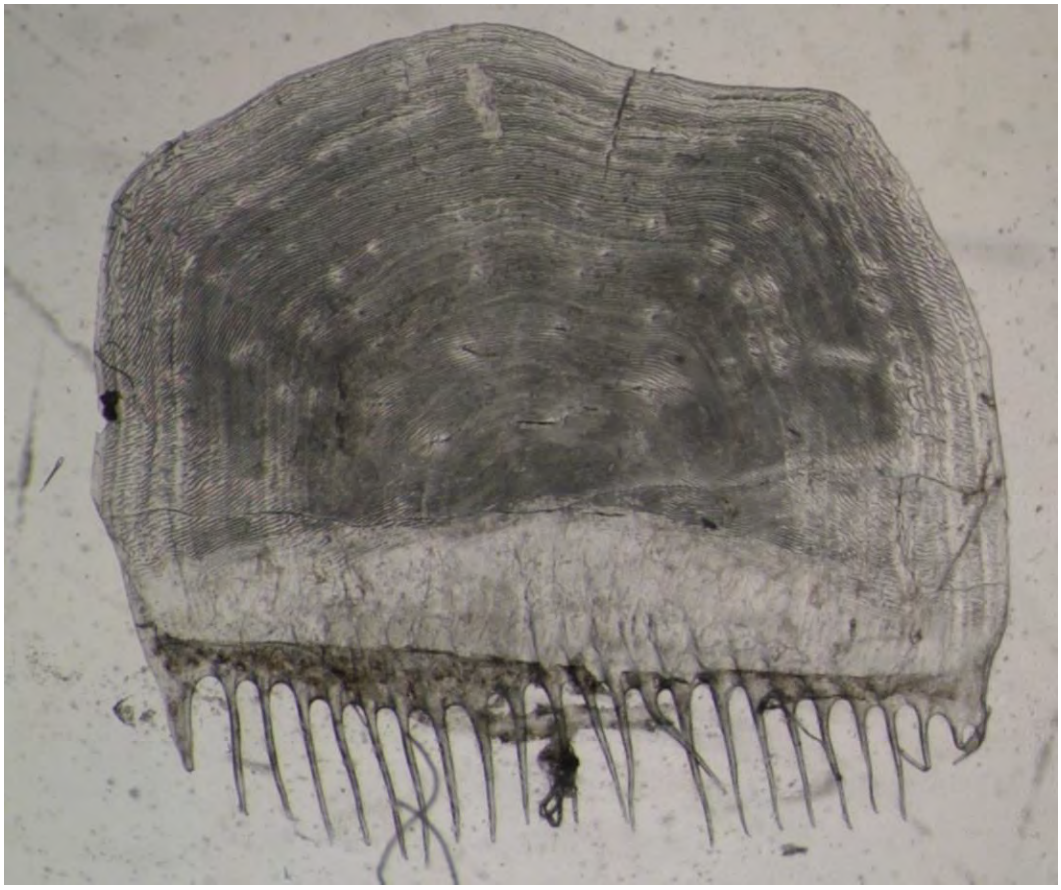


Striped Bass 38 March

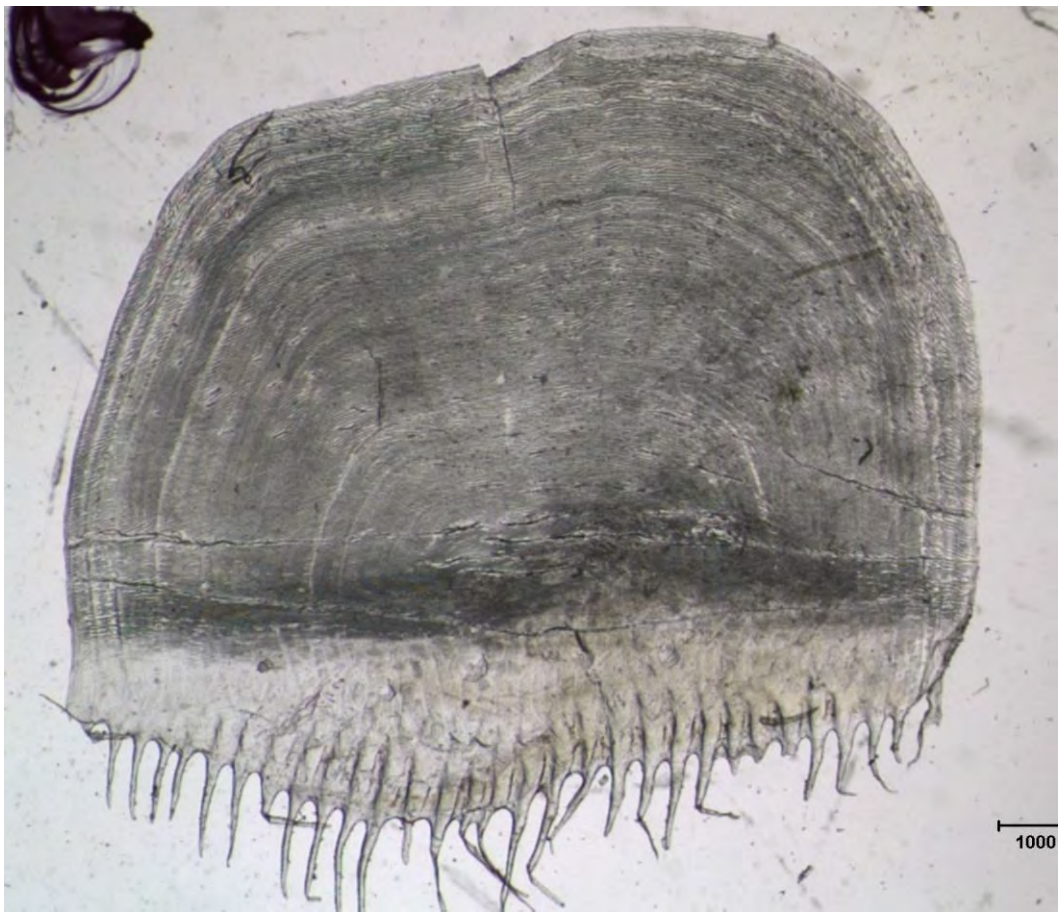
Striped Bass 39 July



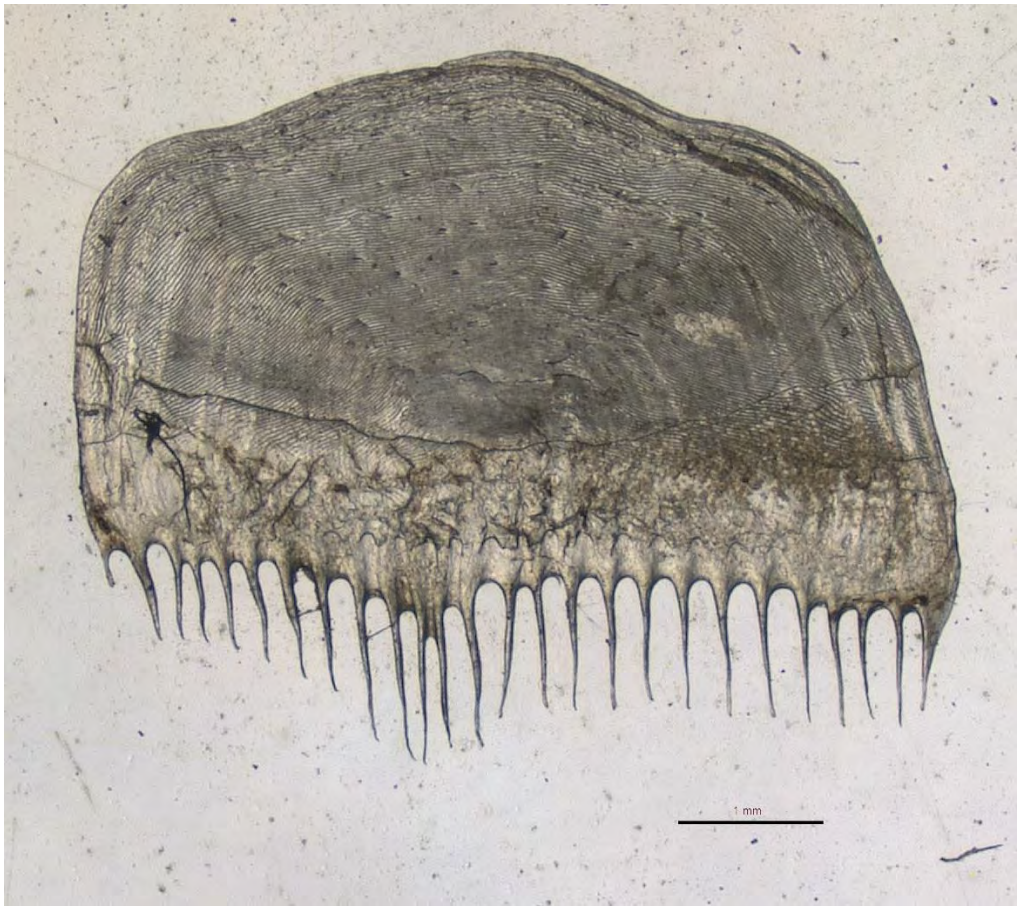
Striped Bass 40 February



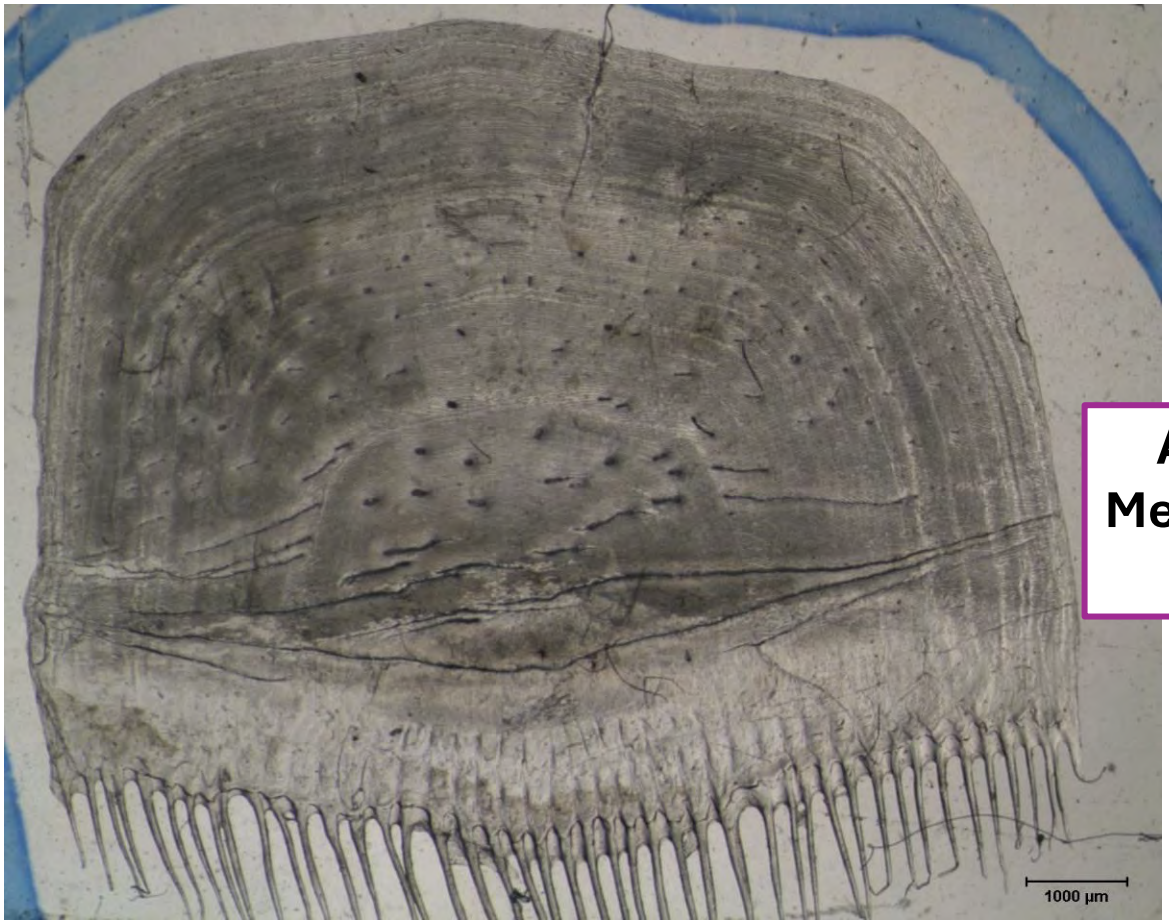
Atlantic Menhaden 1 May



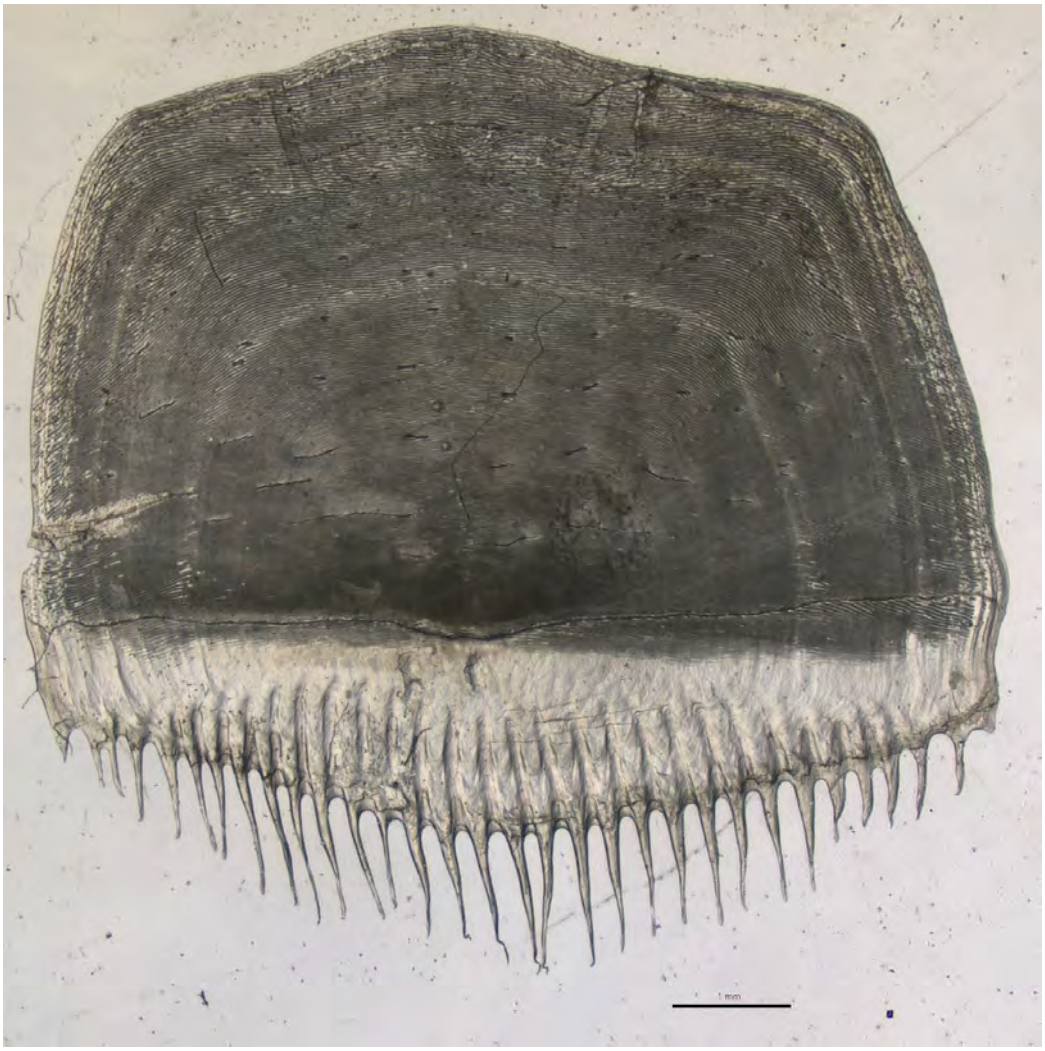
Atlantic Menhaden 2 June



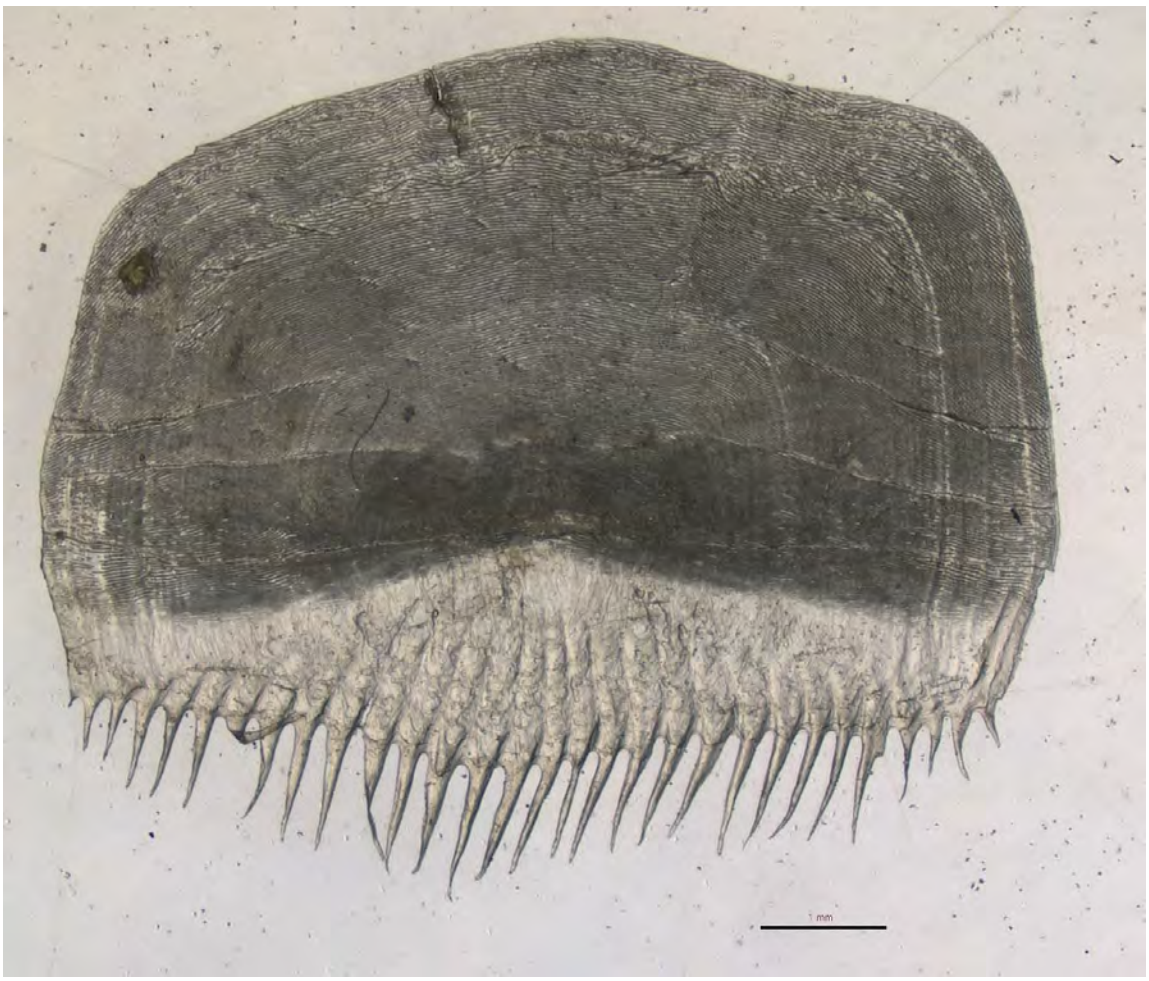
Atlantic Menhaden 3 June



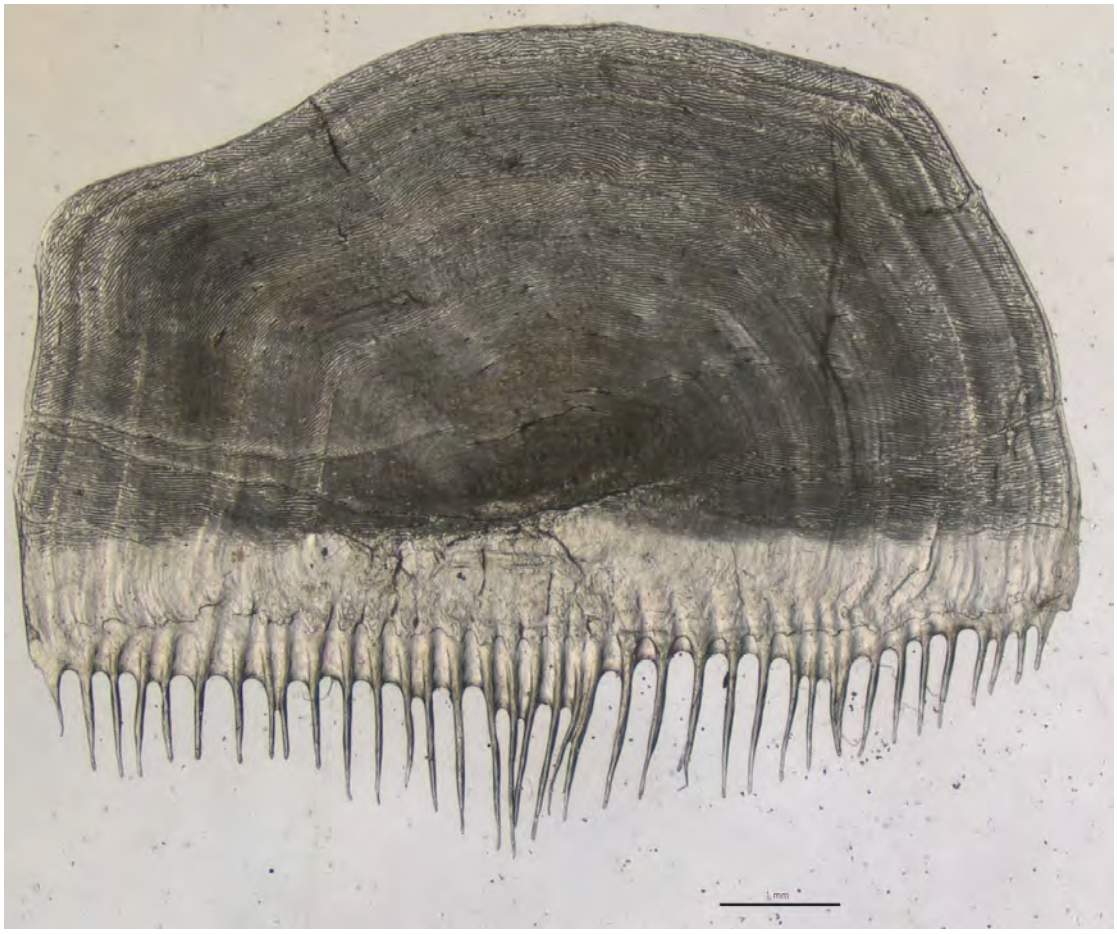
Atlantic Menhaden 4 March



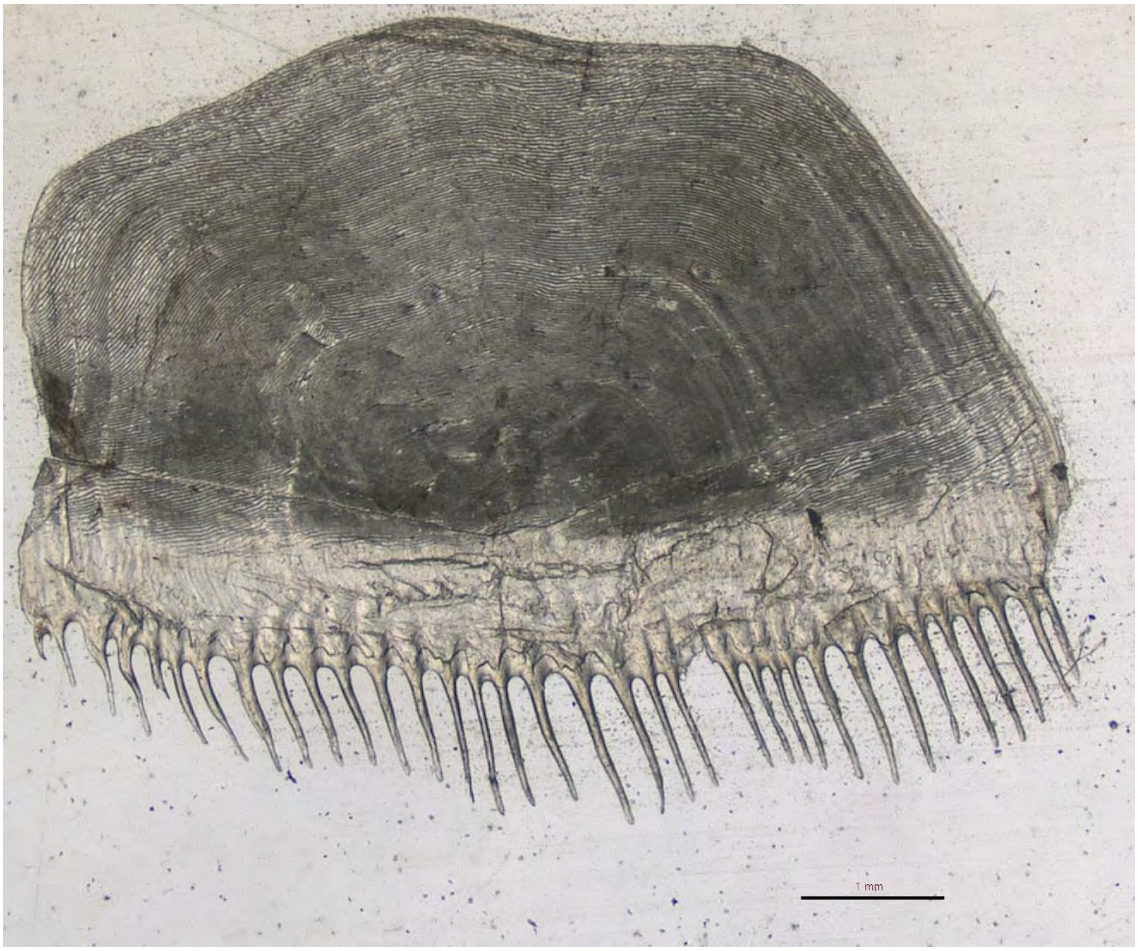
Atlantic Menhaden 5 May



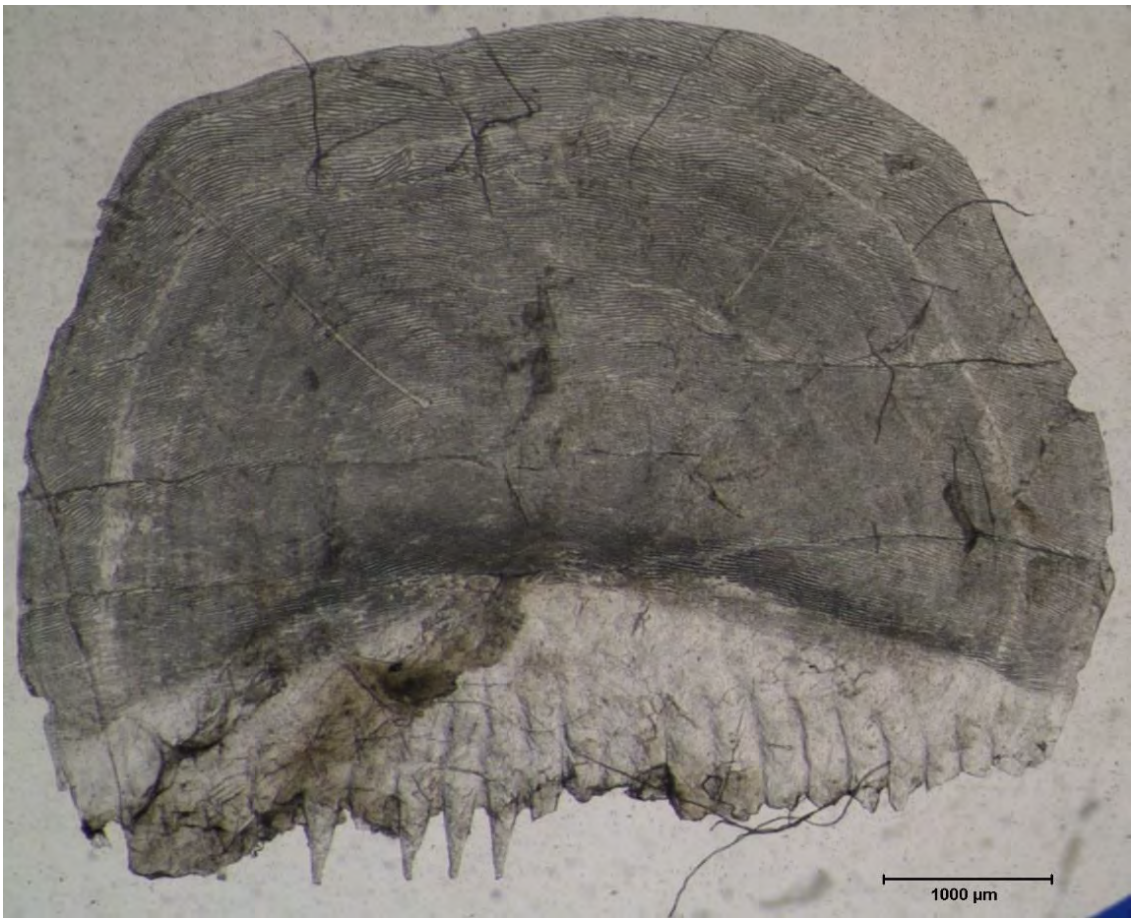
Atlantic Menhaden 6 May



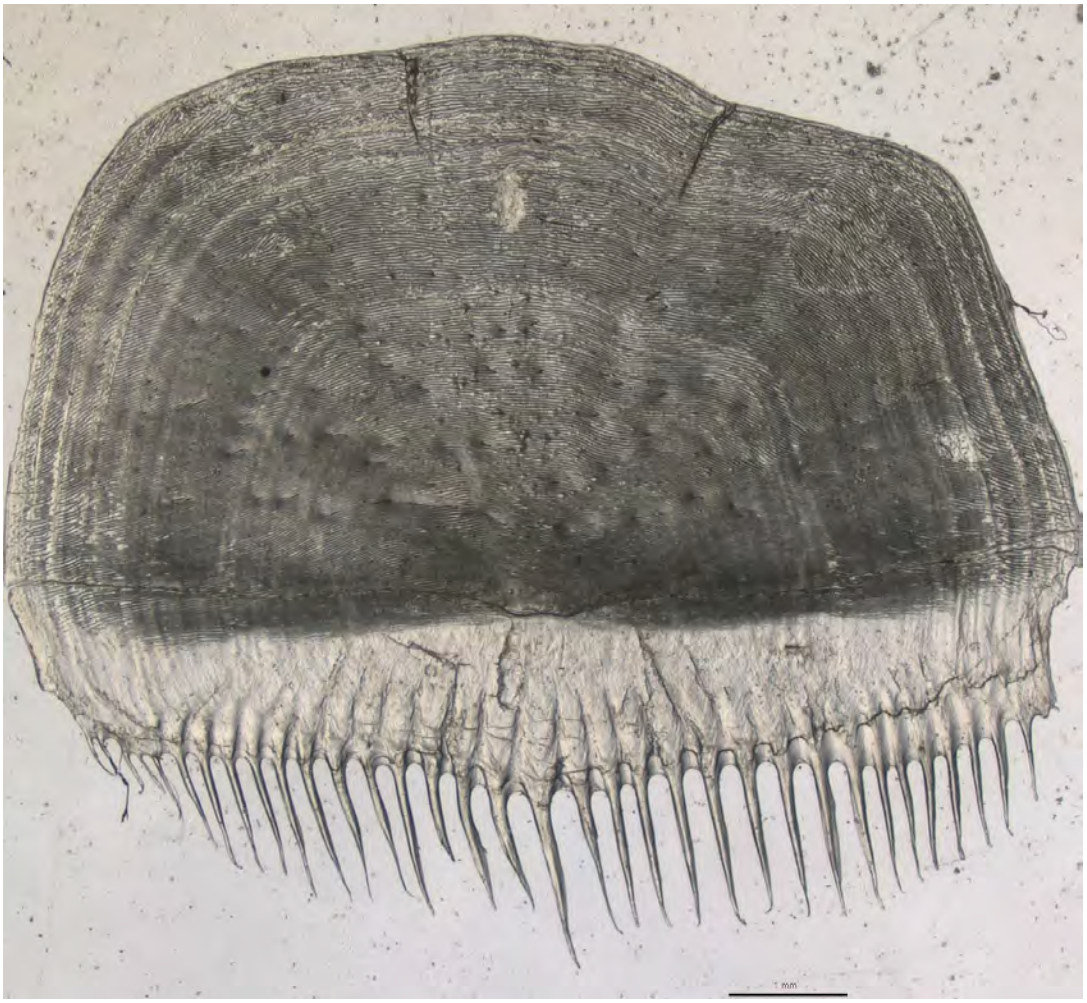
Atlantic Menhaden 7 May



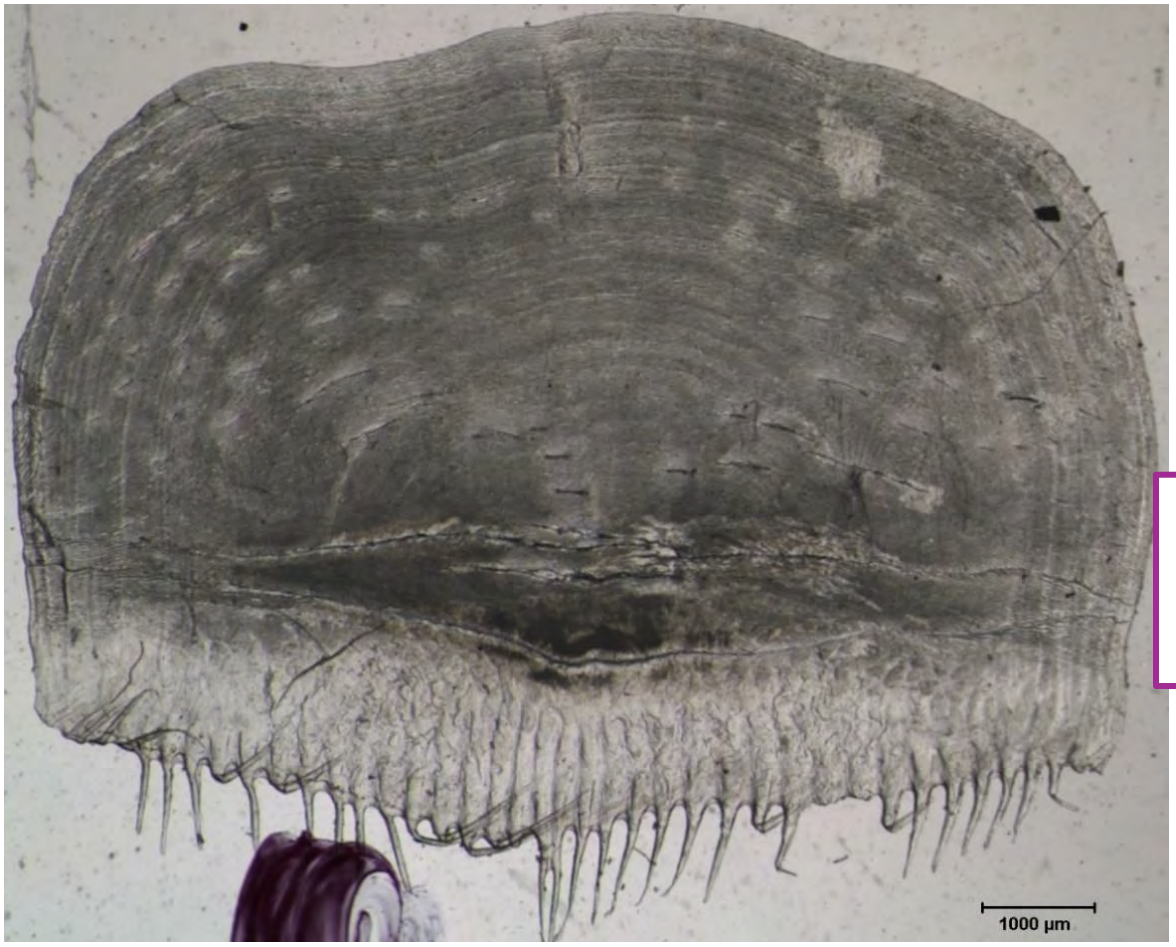
Atlantic Menhaden 8 May



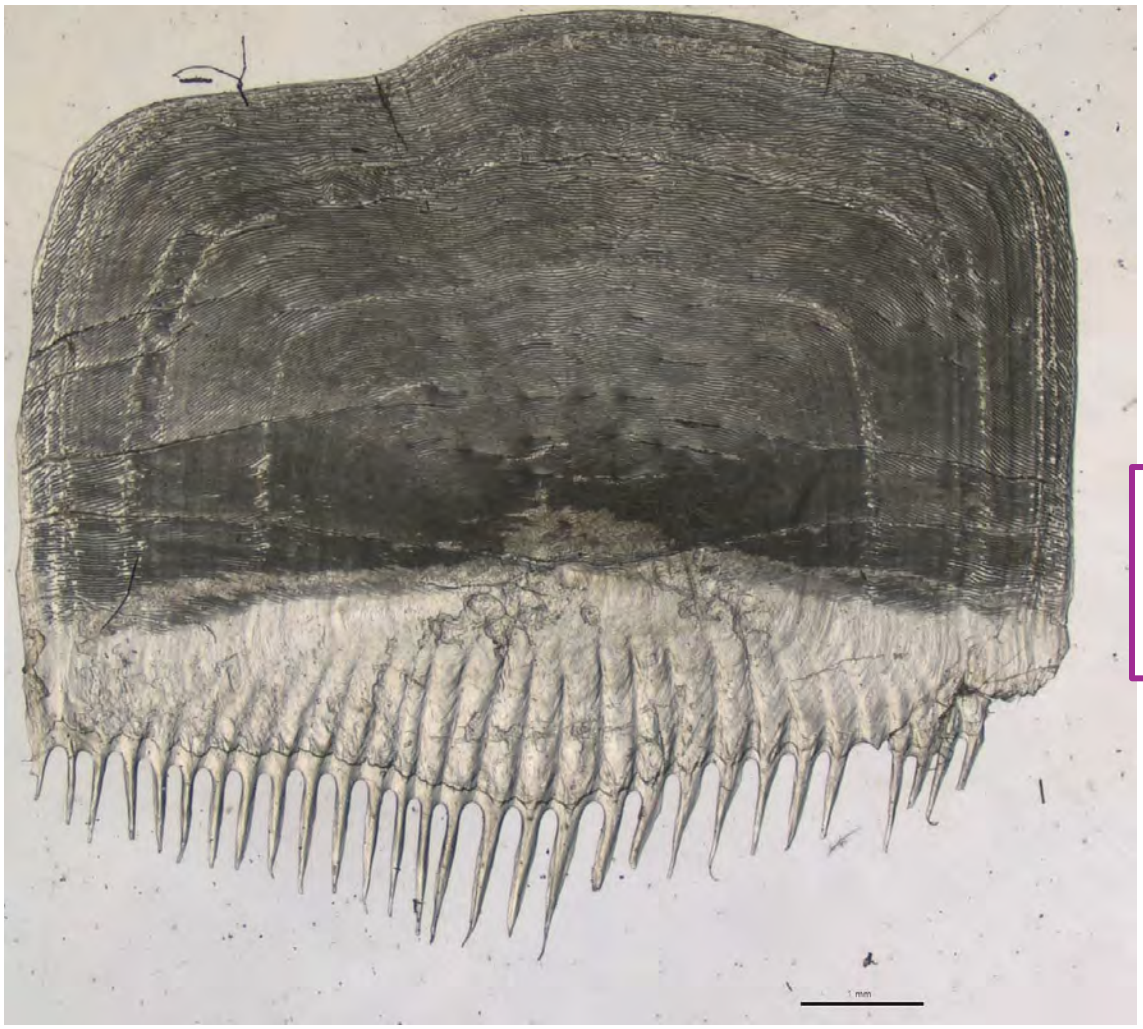
Atlantic Menhaden 9 January



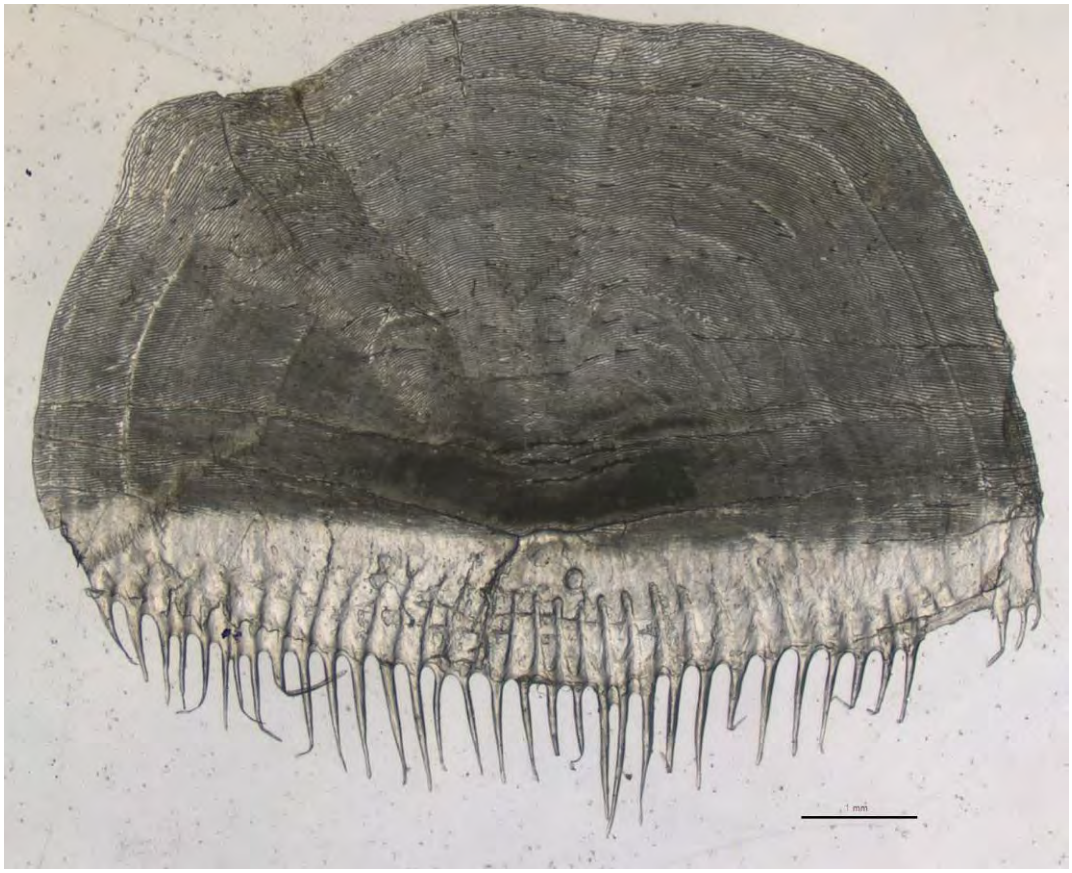
Atlantic Menhaden 10 May



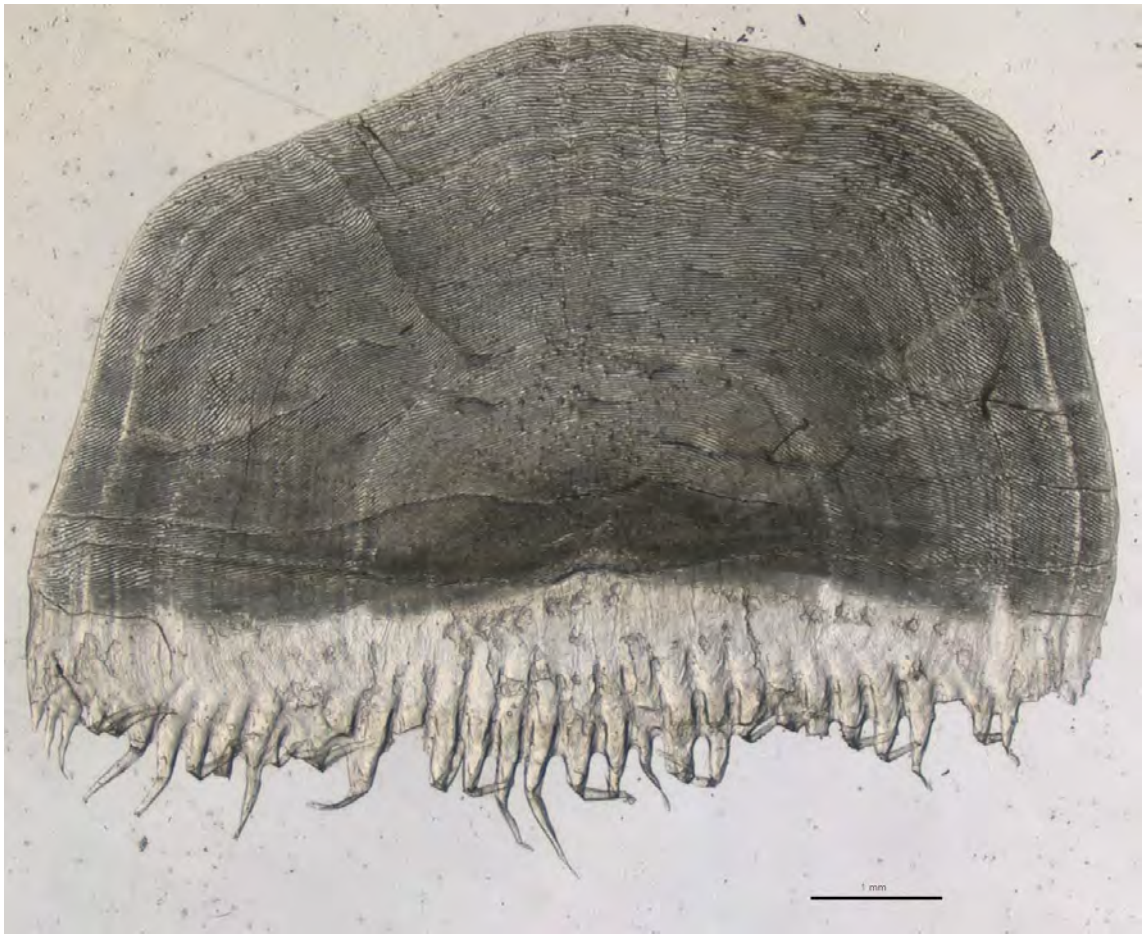
Atlantic Menhaden 11 July



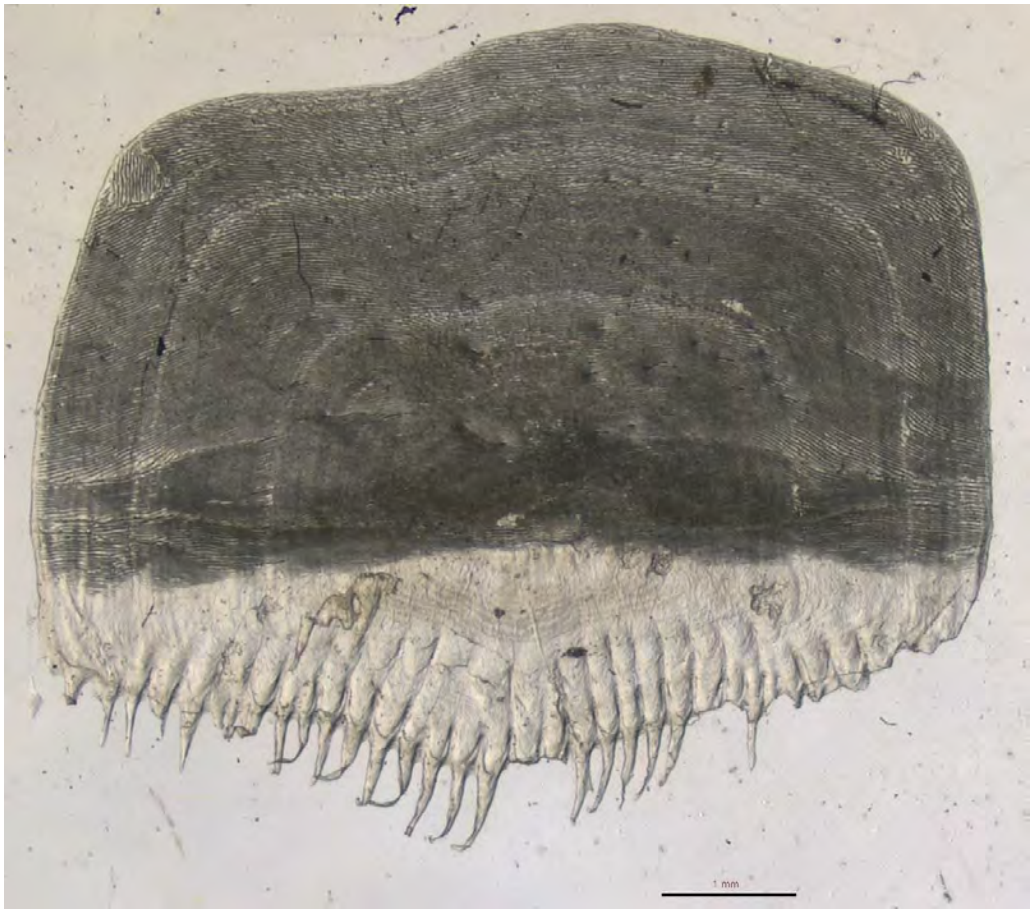
Atlantic Menhaden 12 May



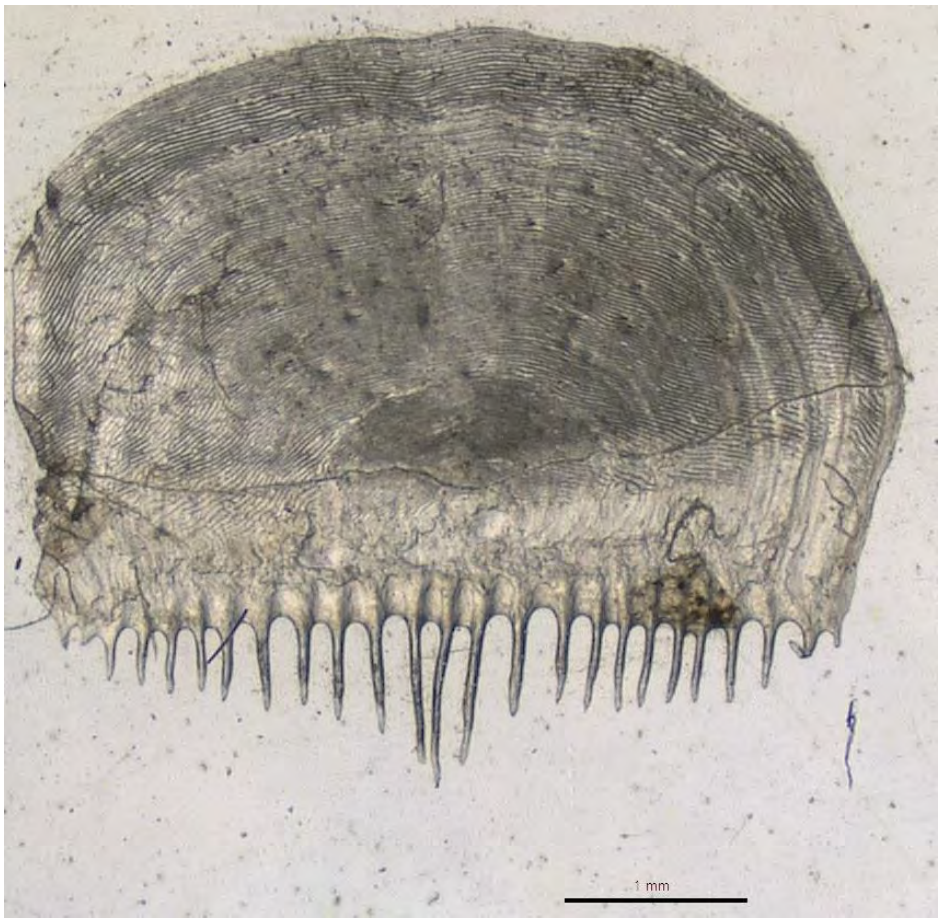
Atlantic Menhaden 13 May



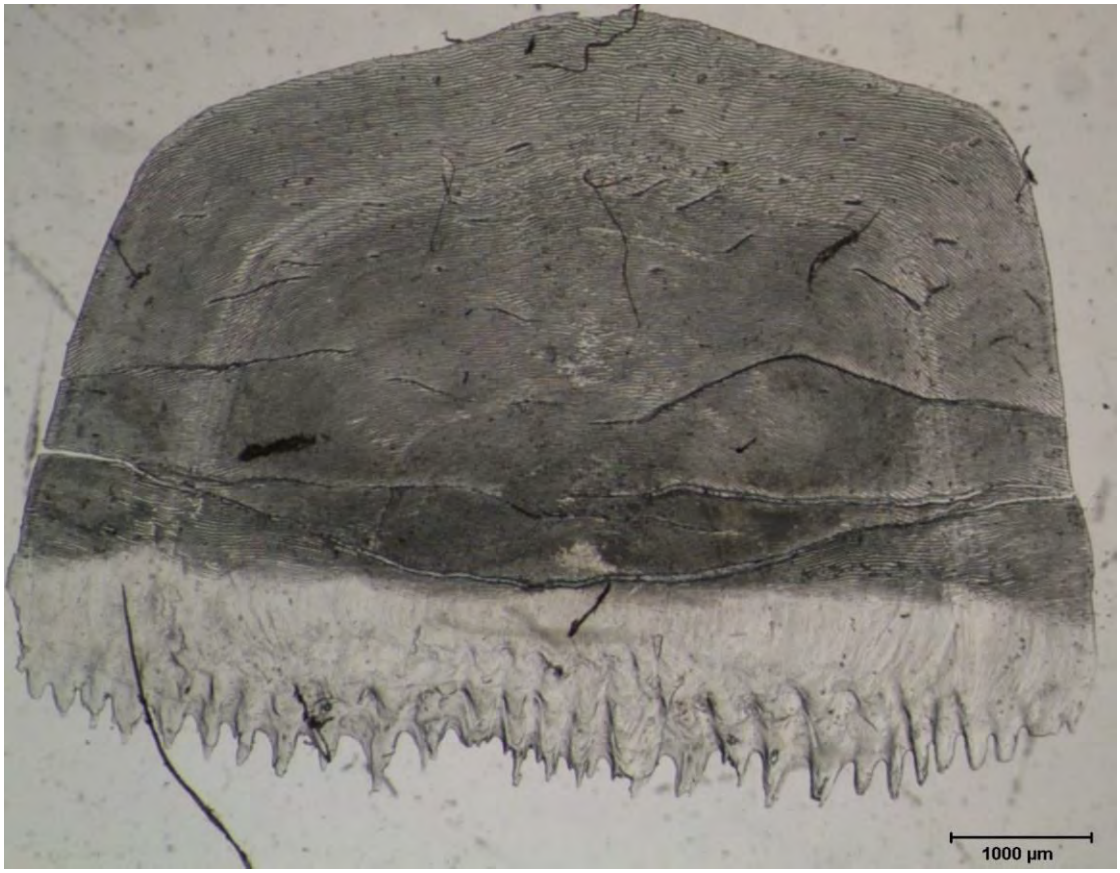
Atlantic Menhaden 14 May



Atlantic Menhaden 15 May



Atlantic Menhaden 16 May



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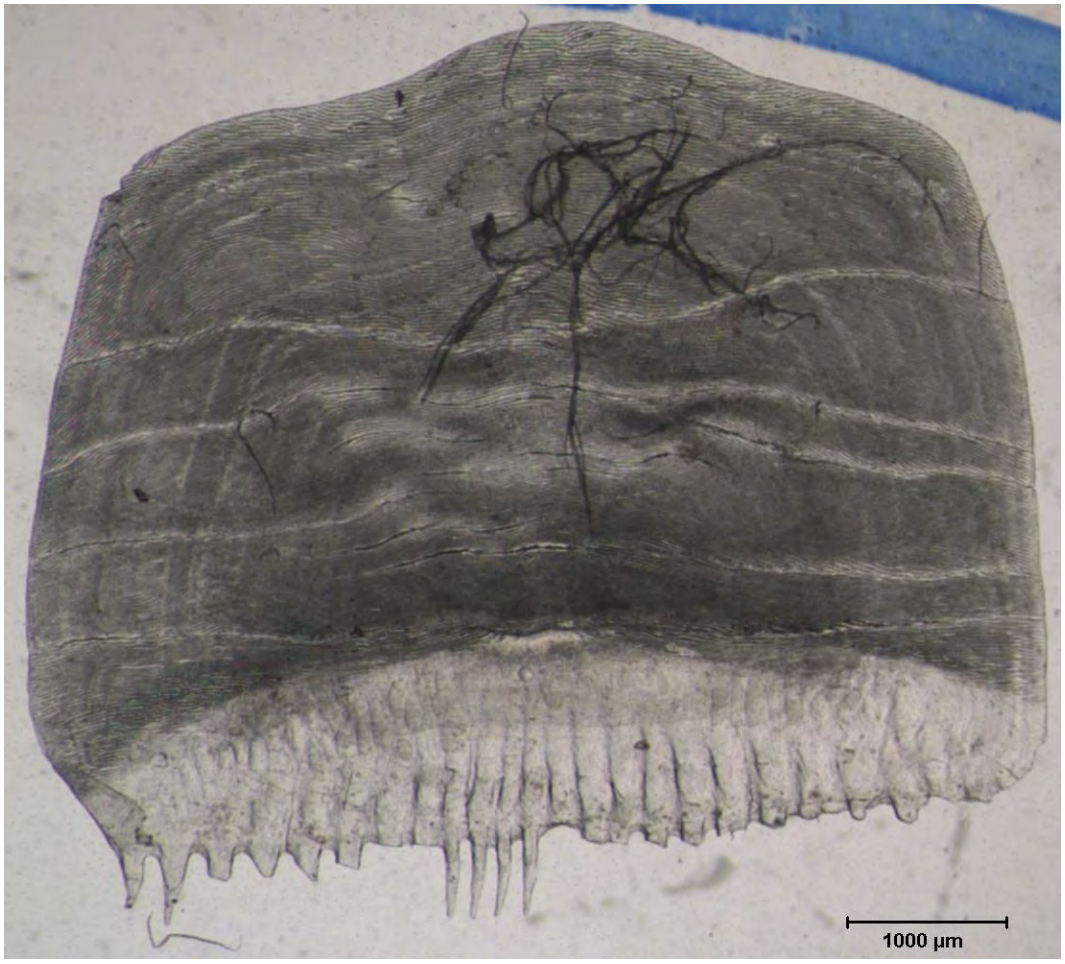

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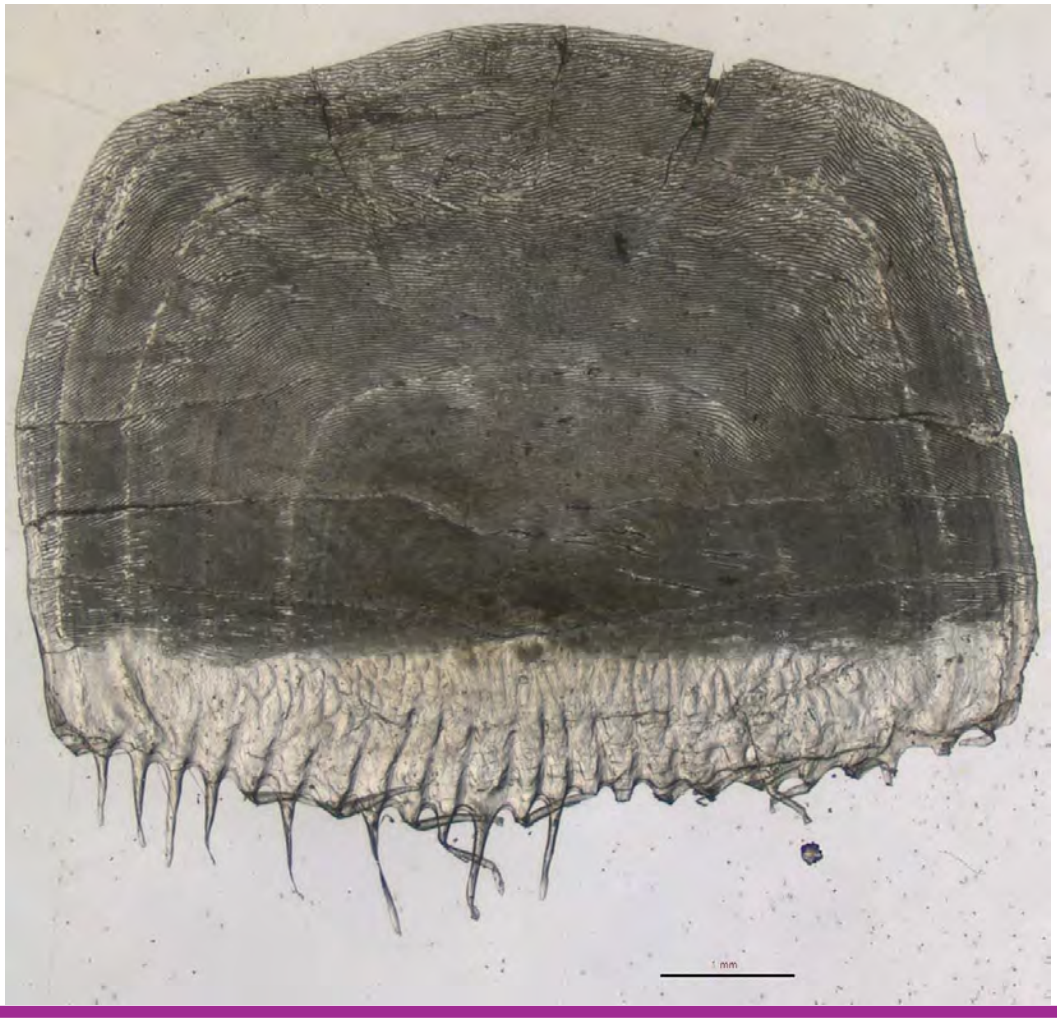

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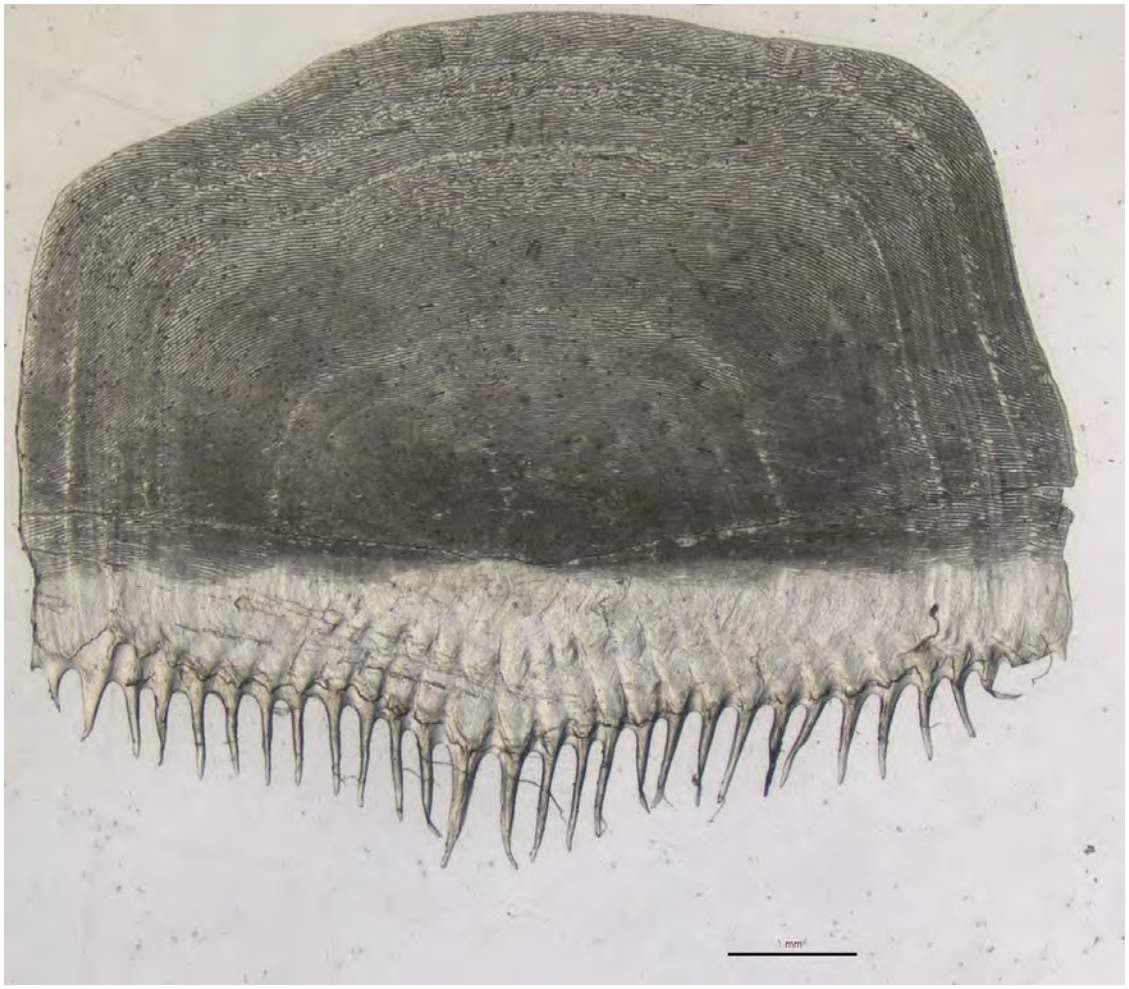

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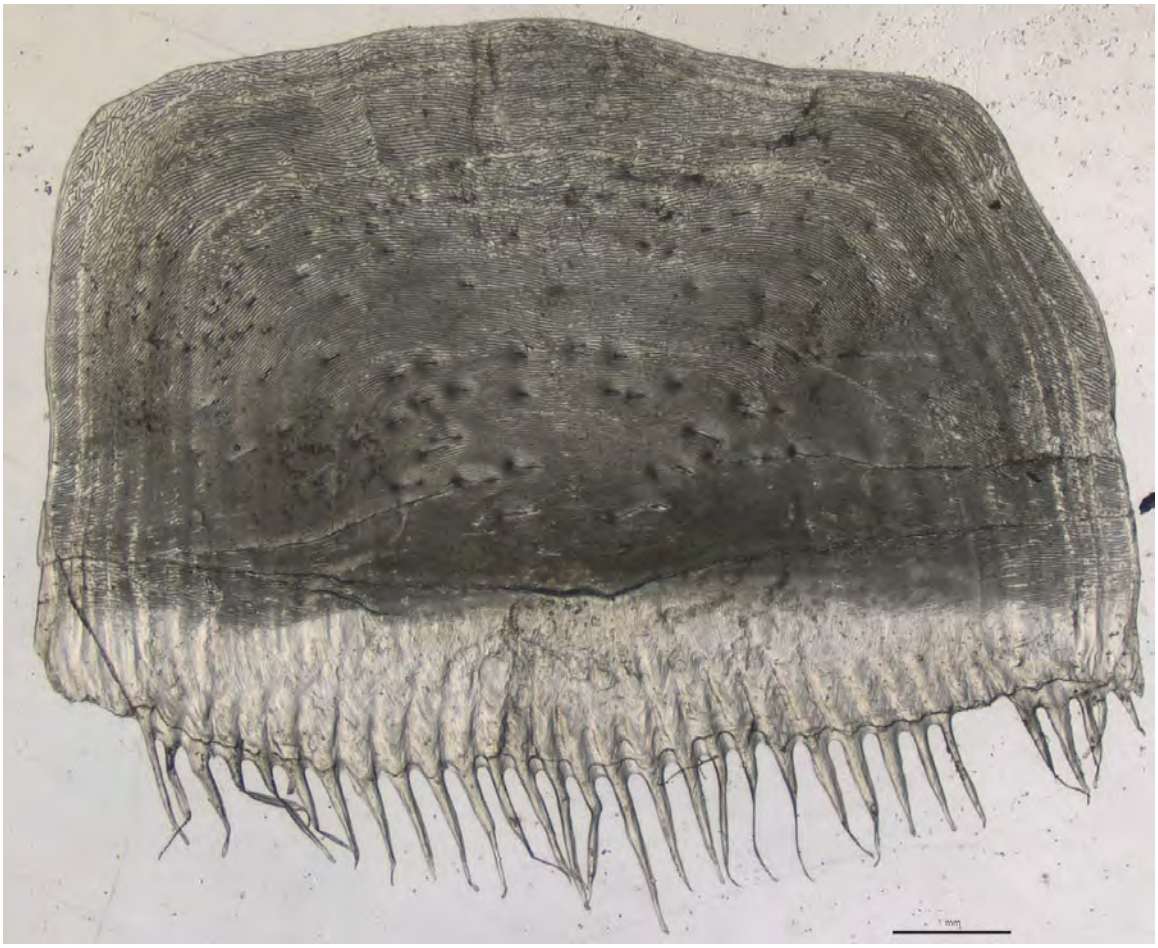

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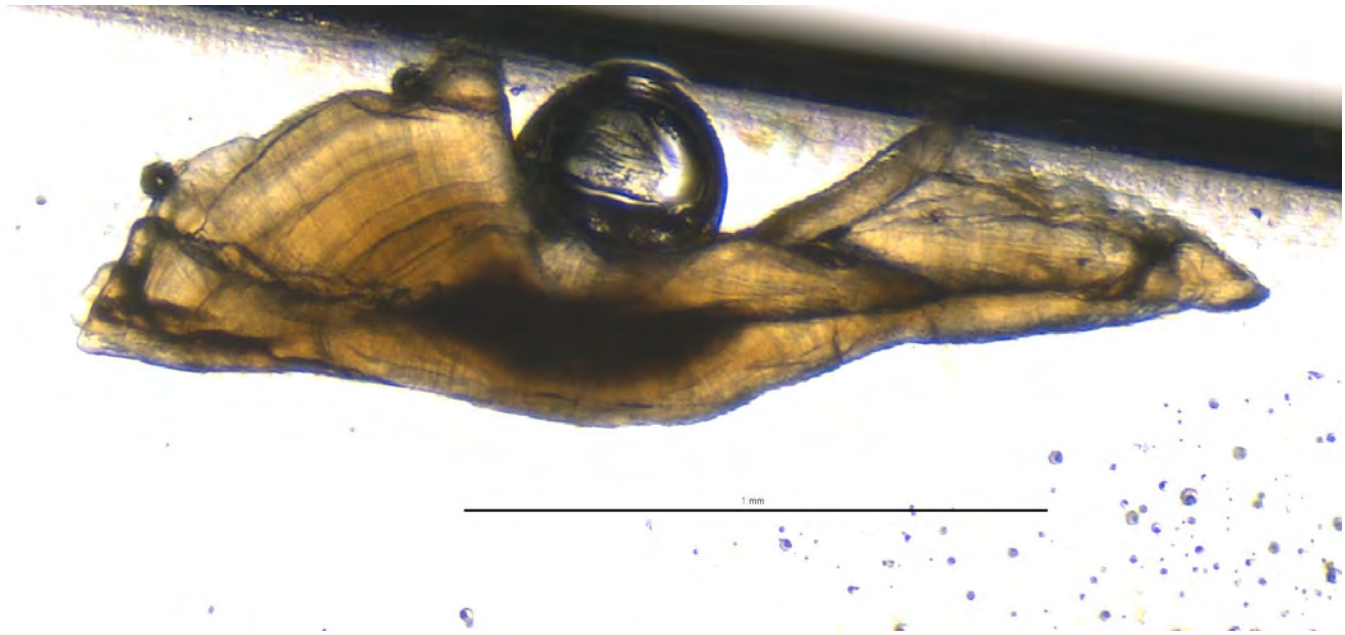
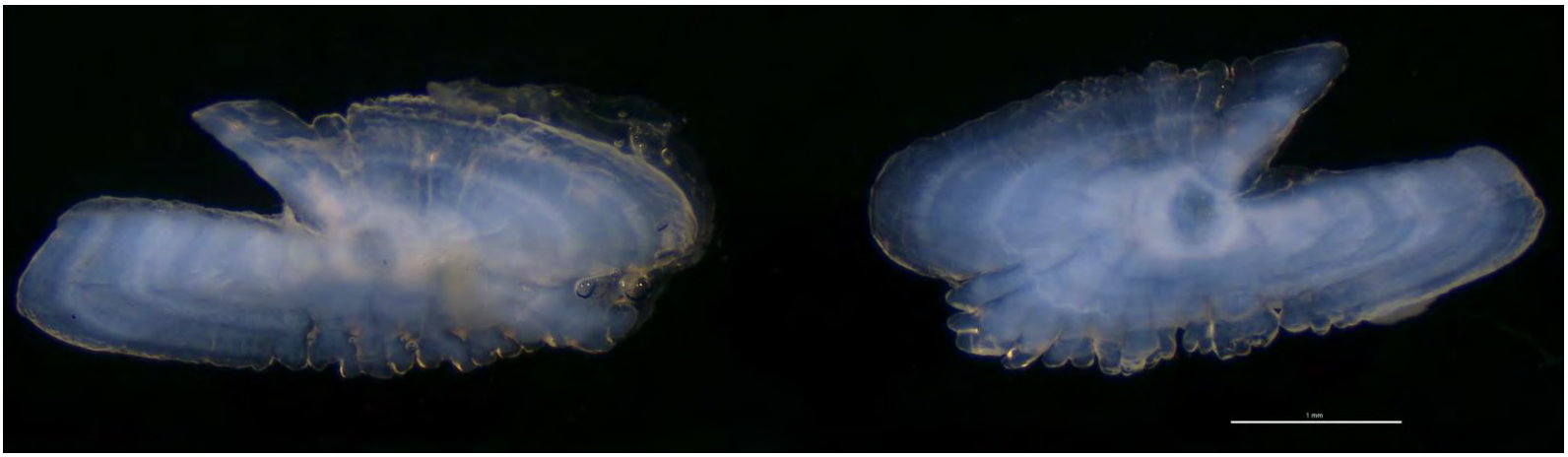


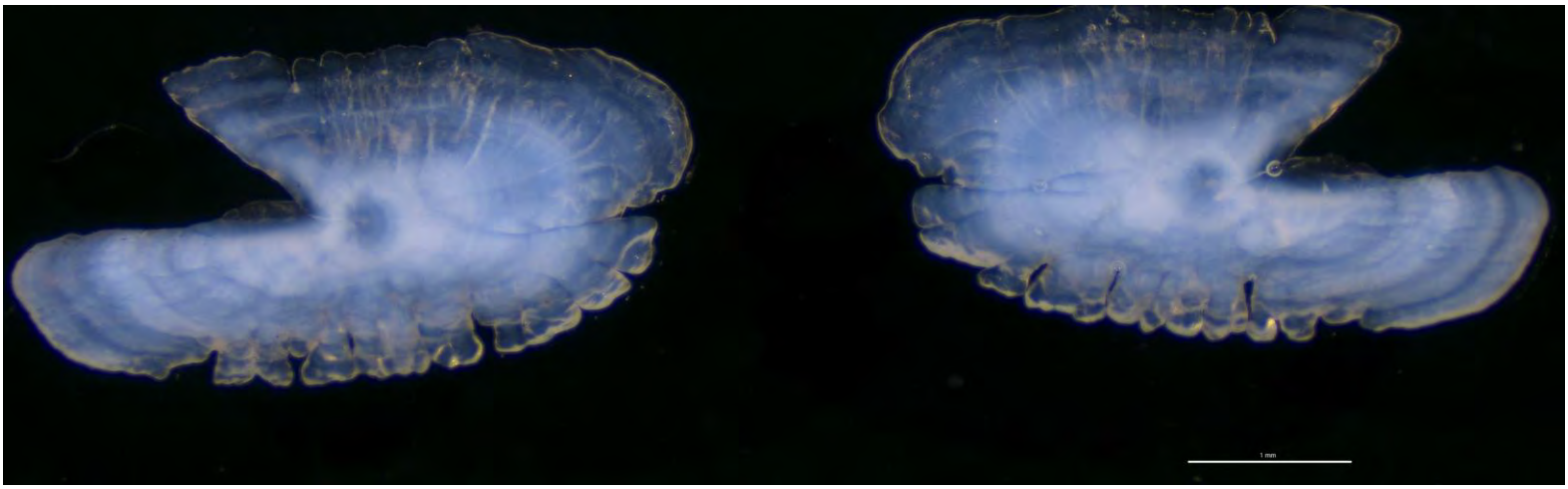
Atlantic Menhaden 22 May

Atlantic Menhaden 23 May

Atlantic Menhaden 24 June



Atlantic Menhaden 25 May



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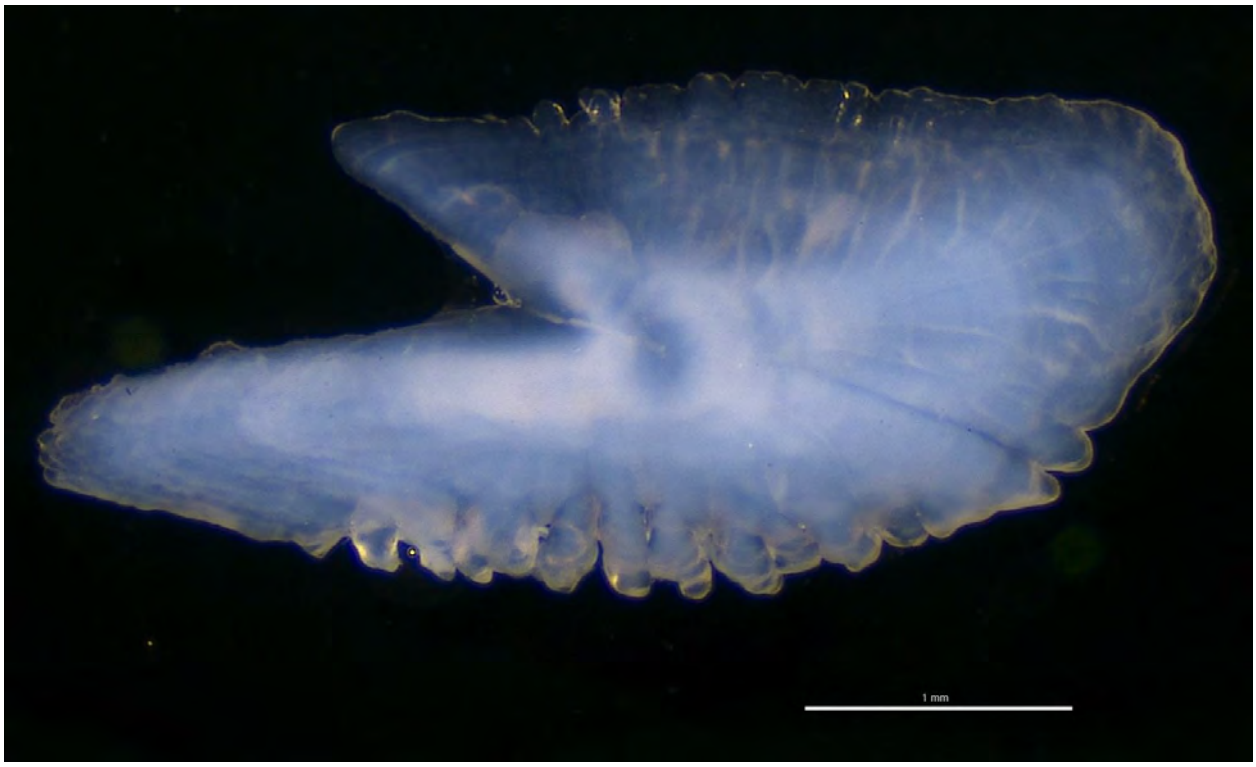

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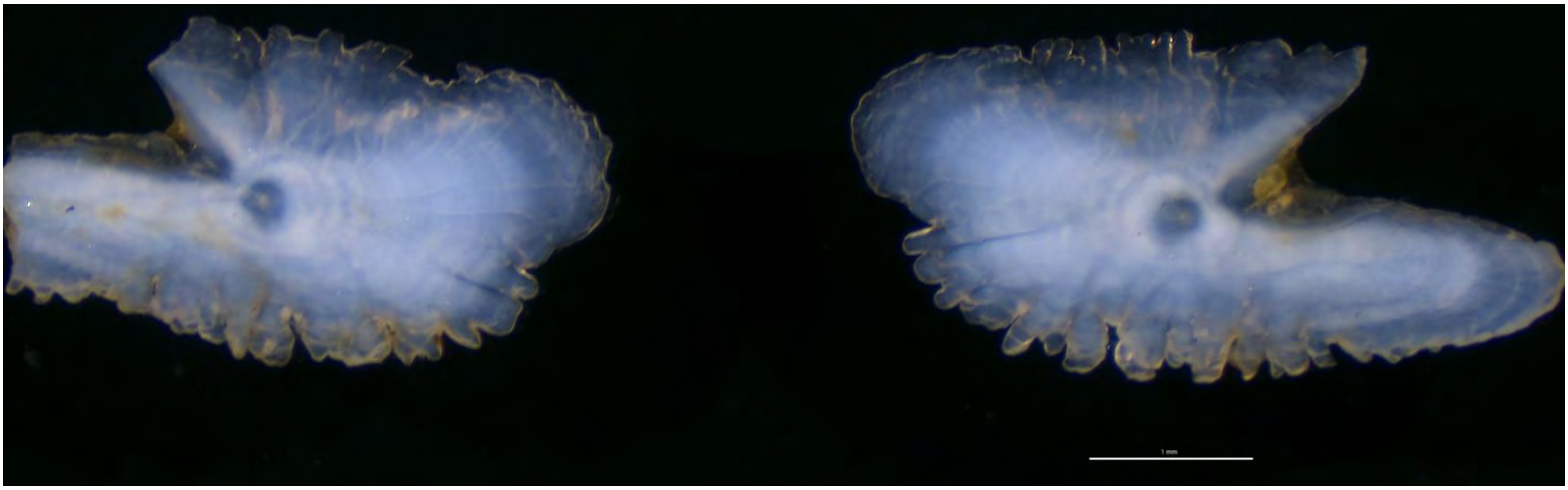

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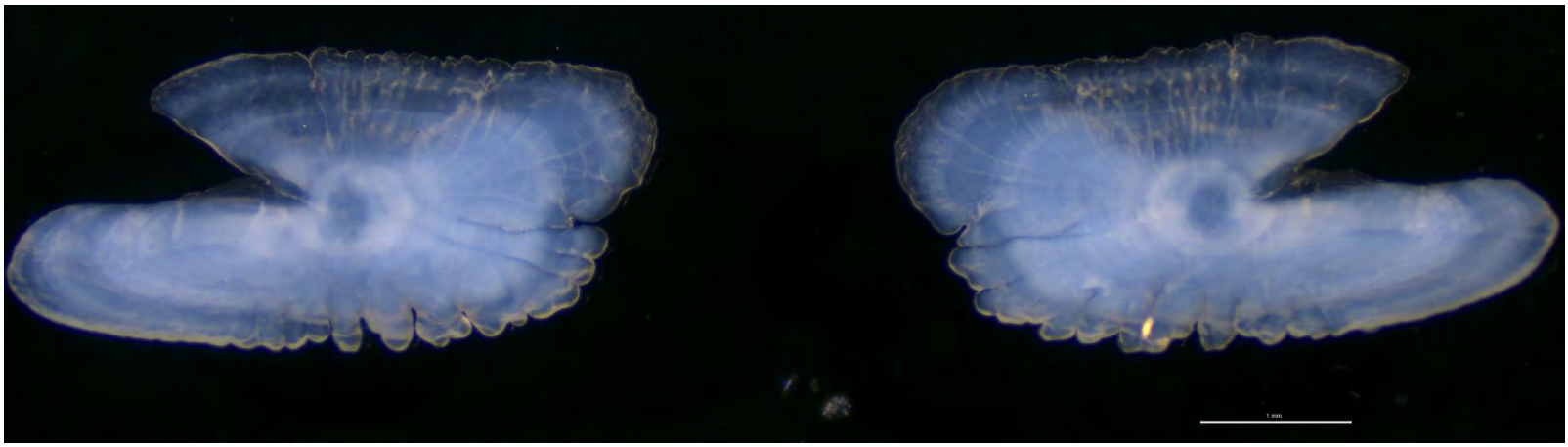

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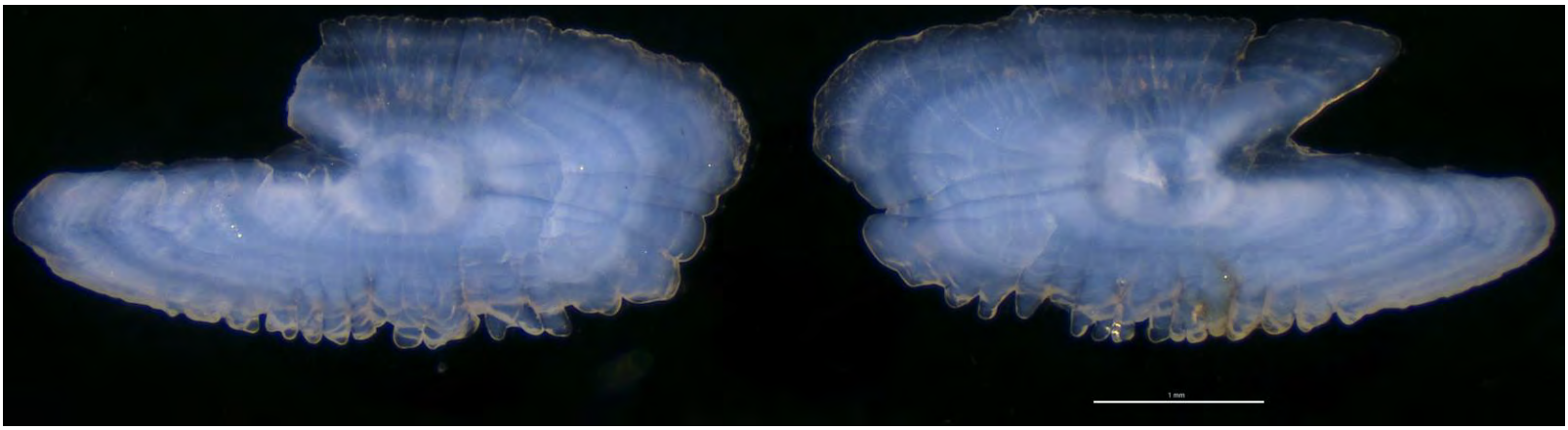

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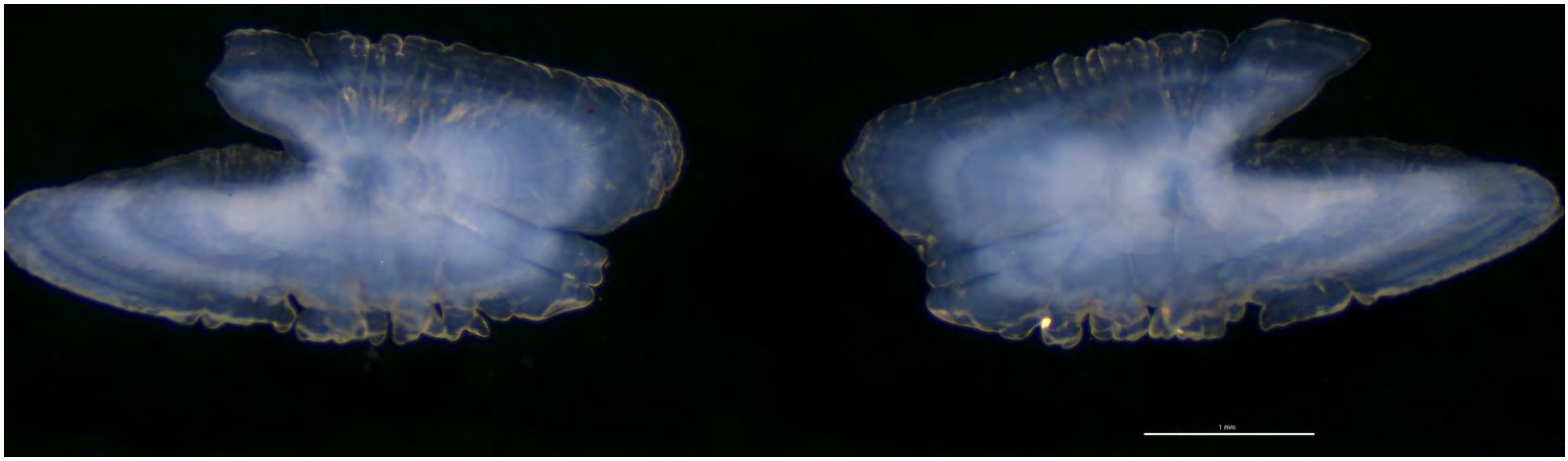

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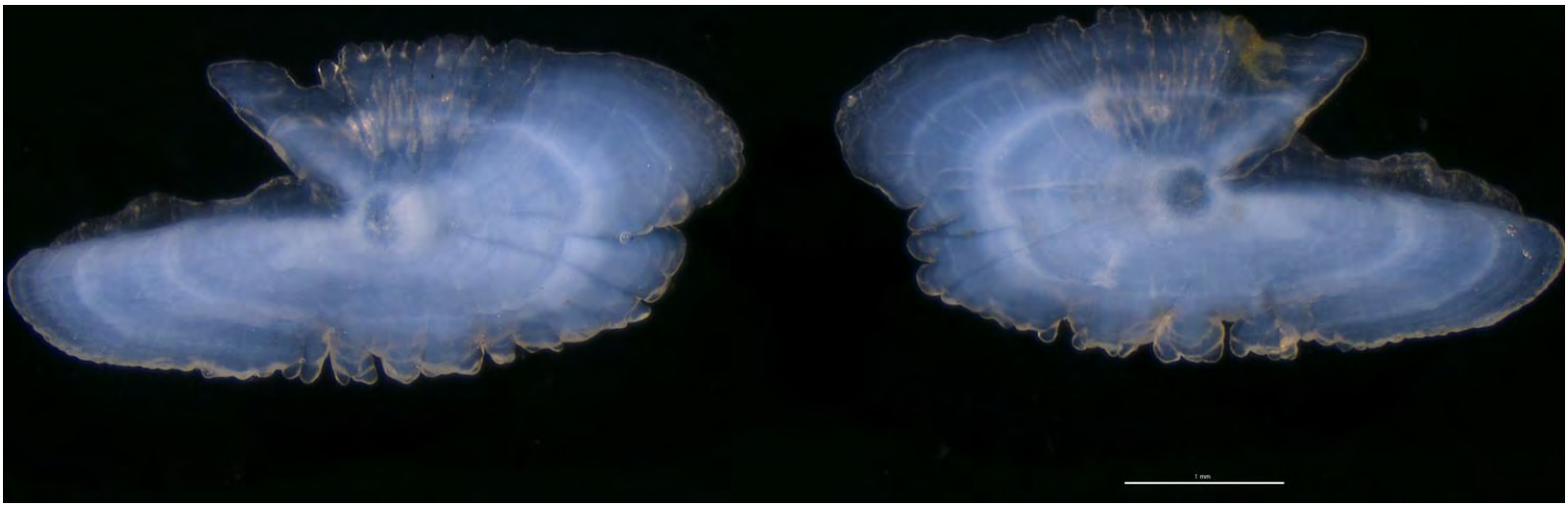

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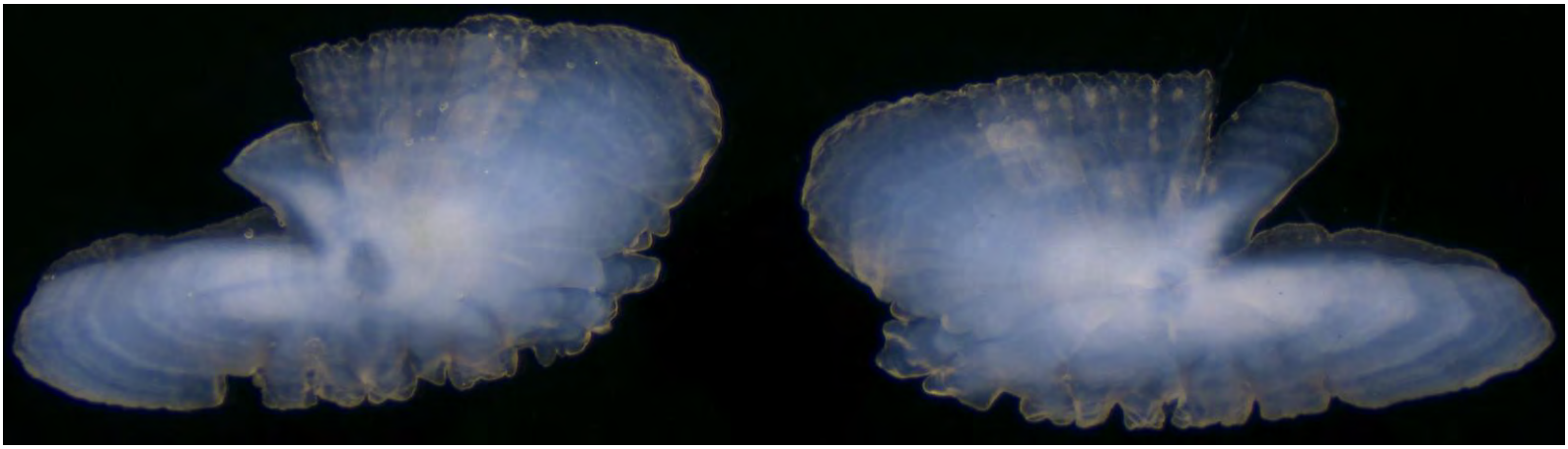

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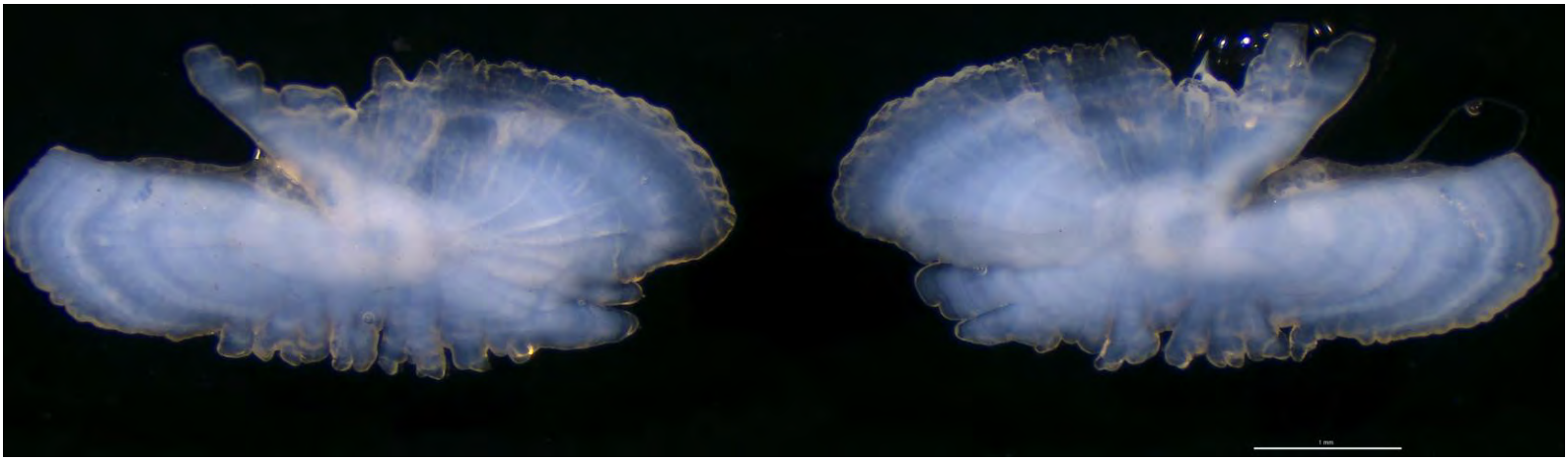

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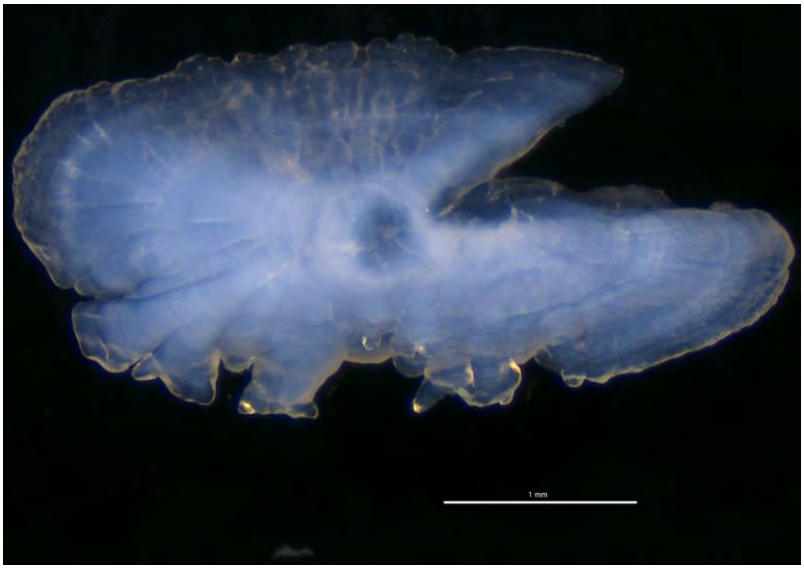

Atlantic Menhaden 35 May

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