# Atlantic States Marine Fisheries Commission

## *Summary of the 2020-2021 Tautog Ageing Sample Exchange*

September 2021

*Vision: Sustainably Managing Atlantic Coastal Fisheries*

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## Acknowledgements

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The ASMFC would also like to note that this exchange was delayed due to the COVID-19 pandemic which posed many challenges. The tautog agers worked creatively and with determination to complete the exchange during the pandemic, sometimes bringing the laboratory equipment home or rescheduling when the samples were held up in the mail for a month. The ASMFC thanks them for their resilience and dedication to their work through challenging times.

## Background and Statement of Problem

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

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

Since the publication of Elzey and Trull (2016), there has been increased interest in the use of pelvic spines for ageing tautog. At a September 2018 Tautog Technical Committee (TC) meeting, the TC tasked tautog agers along the Atlantic coast to evaluate various ageing structures, including spines, for use in providing ages to a stock assessment.

Agers from Massachusetts through Virginia met via conference call in April, 2019, to discuss hard part data collection along the coast, training needs on new methods, and how to proceed with the task from the TC for evaluating various structures. On the call it was decided that a workshop should be held to evaluate ageing structures as a group and then an exchange should follow.

The in-person ageing workshop took place in December, 2019, at the Massachusetts Division of Marine Fisheries facility in Gloucester. Participants aged tautog opercula, spines, sectioned otoliths, and whole otoliths and ageing precision was evaluated using average percent error (APE). An exchange set was compiled using opercula, spines, and sectioned otoliths and began to be circulated to the agers in February, 2020. Three laboratories completed the ageing exercise before the onset of the COVID-19 pandemic, when many ageing labs were no longer accessible to employees due to the shut-down. As people were allowed to schedule time in their ageing labs or shift work to their homes, the exchange was resumed in December, 2020. Delays in shipping due through the United States Postal Service over the holidays posed another challenge to the project, but the final lab completed ageing in July, 2021. Tautog agers met on August 11$^{th}$, 2021, via conference call to review the results of the exchange and make recommendations to the TC.

## Exchange Objectives

The objectives of the 2020-2021 tautog ageing structure exchange were to:

1. Review methods used by individual labs or agencies along the Atlantic coast to prepare and read otoliths, operculum, pelvic spines

2. Determine the precision and bias of age reading data between different readers and labs or agencies along the coast by ageing structure
3. Develop ageing protocol and make recommendations

## Agency & Lab Ageing Information

Several ageing laboratories from Massachusetts to Virginia provided samples for the sample exchange. Below is a brief summary from each lab about how samples were collected, processed, and read.

### *Massachusetts Division of Marine Fisheries (MA DMF)*

MA DMF tautog otoliths and operculum are collected from several sources; cooperation from commercial fisherman, within division fish potting, and cooperation with several recreational anglers. Opercula have been collected since 1995 and otoliths have been collected since 2012. Otolith and pelvic spine samples have been collected from our ventless lobster trap survey since 2015 as well as from a tautog rod and reel survey since 2016. Opercula are boiled and brushed clean before being dried and aged without magnification. Otoliths are baked, sectioned and aged with transmitted light under a compound microscope. Tautog pelvic fin spines have been collected from primarily recreational sources since 2014. Spines are boiled for 1-2 minutes, brushed clean with a small brush then allowed to air dry for at least 48 hours. The spines are embedded in epoxy and 0.75 mm sections are cut. Three successive sections are removed starting just above the condyle.

### *Rhode Island Division of Marine Fisheries (RI DMF)*

Opercula have been the primary ageing structure collected by RI DMF since 1987, primarily from donated recreational carcasses. The annual target number of samples is 200 per the requirements of Addendum III to the Fishery Management Plan for Tautog. A subsample of otoliths has also been collected since 2012 following the recommendations of the 2012 Tautog Ageing Workshop. Additionally, in 2017, following the findings of Elzey and Trull (2017), RI DMF began collecting tautog pelvic spines for ageing.

Operculum are processed for ageing by removing them from fish racks and subsequently boiling the structures to remove all flesh and tissue. Ageing of opercula is conducted by holding the structure up to fluorescent lighting and counting the annuli. Otoliths are collected through dissection and thoroughly dried and stored in glass vials for processing. When ready to be processed, otoliths are embedded in epoxy resin, sectioned, mounted on microscope slides, and aged with a microscope. Pelvic spines are collected and processed following the protocol identified by Elzey and Trull (2017).

All structures are 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. RI DMF is currently training a second ager and plans to have both readers conduct full reads of all samples going forward. Additionally, RI DMF plans to focus on collecting, processing, and ageing a single structure going forward. RI DMF will follow any recommendation that comes from this workshop and the Tautog Technical Committee with regards to which structure should be used as the primary structure for ageing tautog going forward.

### *Connecticut Department of Energy and Environmental Protection (CT DEEP)*

Since 1984, Tautog operculum have been collected during both the spring and fall from the Long Island Sound Trawl Survey. Opercula are the primary collected aging structure, however a subsample of

otoliths has also been collected since 2012 following recommendations of the Tautog aging workshop held that year. In addition to the two aging structures already being collected pelvic spines have also been collected since the fall of 2017. At this time, otoliths and spines are being archived. The annual target number of samples is 200 per the requirements of Addendum III to the Fishery Management Plan for Tautog. Currently, age data exist from 1984 to 2016 with little exception. Opercula are boiled and brushed clean before being dried and aged using a micro projector without magnification.

*New York State Department of Environmental Conservation (NY DEC)*

Fishery dependent tautog samples are primarily obtained by collecting fish racks from commercial markets and party boats. 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, the gonads are observed to determine the sex of the fish, and the opercula bone and the pectoral spines are removed and frozen until further processing. Otoliths are removed from as many of these fish as possible.

Previously frozen opercular and spine samples are thawed and boiled for 2 minutes and the flesh is gently removed from the structure. The opercular bones are allowed to air dry overnight and are then read without magnification using overhead lighting. Spines and otoliths are cleaned, embedded in an epoxy resin, sectioned and read with transmitted light under a compound microscope. Aged samples are available from 1993 to the present.

*New Jersey Division of Fish and Wildlife (NJ DFW)*

NJDFW sampling for tautog was initiated in 1993. Currently samples are primarily collected from Party/ Charter boats and Commercial vessels. Fishery Independent samples are also occasionally collected aboard the NJDFW Ocean Trawl Survey when caught. Racks are collected from fishery dependent vessels, where lengths are recorded, sex is determined when available, opercula are removed, and a subset of 50 paired otoliths are collected. The opercula are prepared through the boiling process, dried, and aged at the Nacote Creek Research lab under a magnisight machine by a single staff member.

*Maryland Department of Natural Resources (MD DNR)*

The department has been collecting tautog biological samples since 1996. We have 5,089 tautog ages from operculum 1996-2018. From 1996-2009, age structures were collected from the commercial pot fishery and by spear fishing. From 2010-2018, age structures were collected on board hook and line charter vessels, with minor collections from the commercial pot fishery in 2011 and 2012. In 2018 the department began a minor shift toward a recreational rack program, and in 2019 the majority of the samples were collected by a charter boat rack program with minor sampling on board the charter boats. The goal is to randomly sample the range of length groups that represent the catch of the recreational fishery. Maryland is a *de minimis* state with a very small commercial fishery. Each fish is measured (mm total length) and weighed (kg), using the digital scale (unless it was from the rack program; 2018-2019). The gonads are observed to determine the sex of the fish. These data are recorded on each scale envelope. Opercula are removed and placed in the envelope(s). Paired fish heads are tagged with a tuna or yellow perch tag and that tag number is recorded on the opercula envelope(s). Heads are frozen and the goal is to have 50 paired samples within 10 mm length groups that represent the fishery.

Paired fish weight on hand is 5,047 fish, however, weights are not available using the rack collection method. Sex data has been available from the rack program as the gonads typically present. The

department has been collecting paired otoliths since 2011 but does not age those structures. We have collected over 200 opercula for the 2019 calendar year; those ages will be available in 2020. The department began collecting pelvic spines in 2018, however, the majority are not paired with another structure, except those provided to the ASMFC ageing workshop. Those spines were processed by the Massachusetts Division of Marine Fisheries. DNA was collected for scientists at VIMS in 2014

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. Two readers age all the opercula; a third reader resolves disagreement.

*Virginia Institute of Marine Science (VIMS)*

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. Opercula are boiled clean and dried prior to reading. Otoliths are processed by a slow speed saw and a transverse section removed to be mounted to a glass slide with Crystal Bond, polished to approximately 0.3mm thickness and covered over again with Crystal Bond. Spines have been processed using a similar method to MA DMF with the exception of using Crystal Bond instead of epoxy. A total of 457 Tautog have been aged by the two surveys (CM 50, NM 407). To date VIMS tautog data has not been requested but not used in assessments due to the low number of samples across the surveys time series. There are three readers at VIMS and the mode age for each sample is provided as the final age. If there is no mode from the initial read, the readers reread the sample and if there is still no mtode, they examine the sample together and come to a consensus age. If a consensus age cannot be determined the sample is discarded. Very few samples are discarded. Precision tests are preformed within each reader (multiple reads of the same sample) and between readers. VIMS uses similar precision and symmetry tests to the NEFSC.

*Virginia Marine Resources Commission (VMRC)*

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

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

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

A symmetry test (Hoenig et al. 1995) and coefficient of variation (CV) analysis are used to detect any systematic difference and precision on age readings, respectively, within the reader, for the following comparisons: 1) in the current year and 2) time series bias between the current and previous years; 3) between opercula and otoliths ages.

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

- Otolith Preparation Protocol
https://www.odu.edu/content/dam/odu/offices/center-for-quantitative-fisheries/docs/tautogotolith-preparation-protocol.pdf
- Otolith Ageing Protocol
https://www.odu.edu/content/dam/odu/offices/center-for-quantitative-fisheries/docs/tautogotolith-ageing-protocol.pdf
- Operculum Preparation Protocol
https://www.odu.edu/content/dam/odu/offices/center-for-quantitative-fisheries/docs/tautogoperculum-prep.pdf

## Hard Part Exchange

### *Sample exchange set description*

Agencies and labs were asked to supply paired samples of opercula, sectioned otoliths, and pelvic spines that were collected throughout the year representing various lengths, ages, sexes, and collections sites in their respective regions. Scott Elzey (MA DMF) organized the exchange set from the submitted samples for a total of 64 complete paired samples of all three hard parts and an additional 11 of paired opercula and spine samples because MD DNR does not process sectioned otoliths for tautog (Table 1). Samples were randomized so participants did not know which paired samples were from the same fish. Samples in the exchange set ranged in the month the fish was captured (Figure 1) and the length of the tautog by sex (Figure 2).

### *State and lab participation*

Nine laboratories participated in the tautog sample exchange, see Table 2 for the order the labs received the exchange set. The number of readers participating in the exchange for each lab was one (MA DMF, RI DMF, CT DEEP, MD DNR, VIMS), two (DE DFW, NJ DFW, VMRC), or three (NY DEC), although NY DEC and VMRC provided consensus ages which were used in the analysis. All agers provided annulus count, margin code, and final age for all samples with the exceptions of some unreadable samples as determined by the individual ager and sectioned otoliths which were not aged by MD DNR. Each reader was treated independently in the analysis, except for NY DEC and VMRC which provided consensus ages for the multiple readers.

Each lab provided its experience level with each ageing structure for tautog using 0 (no experience), 1 (limited experience), 2 (some experience), or 3 (very experienced; Table 3). Agers who attended the in-person workshop preceding the exchange participated in a training on preparing and reading ages on spines and therefore scored spines as a “1” for experience. The agers noted that due to the delays in the

exchange schedule because of the pandemic, there was an extended period of time between the training and receiving the exchange for some of the labs.

## Methods

Agreement between readers and between labs was evaluated to provide information on ageing error. Exact agreement was tested using Bowker's test of symmetry around the diagonal 1:1 line (Evans and Hoenig 1998) where a significant p-value (<0.05) indicates systematic bias between the age readings. Without knowing the true age of the fish, this test does not identify which reader is more accurate, but rather identifies whether there are differences or not. Mean coefficient of variation (CV), percent of exact agreement between readers, and percent agreement within one year was also calculated for each lab and reader to provide a measure of precision. While this does not serve as a proxy for accuracy, it does indicate the level of ease for assigning an age to that ageing structure, the reproducibility of the age, or the skill level of the readers. Generally, CVs of 5% serve as a reference point for determining precision, where greater values would indicate ageing imprecision (Campana 2001). The tautog agers agreed to revise the reference value so that acceptable CVs were those less than 10% for this exercise due to the challenging nature of ageing the species.

Following the exchange, the agers agreed to remove some samples from the analysis due to unreadability. If two or more independent agers noted that the sample was unreadable, processed incorrectly, or broken, the sample was removed from the analyses. For opercula, samples #19, 29, 30, 34, 42, and 47 were removed from the analysis. Several readers reported that #19 appeared to have two opercula in the sample envelop from two different fish. For otoliths, samples #2, 6, 17, 38, and 57 were removed from the analysis. For spines, samples #20, 21, and 40 were removed from the analysis. The agers noted that the spine samples had the fewest categorized as "unreadable."

## Results

*Opercula Samples*

Sample size, Bowker's p-values, CVs (%), exact agreement (%), and agreement within one year (%) were calculated for all readers in all labs for the opercula samples. Sample size varied from 67 to 69 samples because readers did not provide ages for all samples and 6 opercula samples were removed from the analysis due to unreadability (Table 4). Of the 55 comparisons made, 10 had significant p-values which indicated systematic bias between the readers and labs (Table 5). CVs ranged from 3-16% (average of 10%), with 29 being greater than or equal to 10%, indicating some lack of precision (Table 6). Exact agreement between readers ranged from 25-67% (average of 40%; Table 7) and agreement within one year ranged from 60-99% (average of 81%; Table 8).

*Sectioned Otolith Samples*

Sample size, Bowker's p-values, CVs (%), exact agreement (%), and agreement within one year (%) were calculated for all readers in all labs for the sectioned otolith samples. Sample size varied from 58 to 59 samples because readers did not provide ages for all samples, MD DNR did not age the sectioned otolith samples, and 5 otoliths were removed from the analysis due to unreadability (Table 9). Of the 45 comparisons made, 8 had significant p-values which indicated some systematic bias between the

readers and labs (Table 10). CVs ranged from 1-14% (average of 9%), with 26 being less than the reference value of 10% (Table 11). Exact agreement between readers ranged from 29-88% (average of 52%; Table 12) and agreement within one year ranged from 71-100 (average of 89%; Table 13).

### *Pelvic Spine Samples*

Sample size, Bowker's p-values, CVs (%), exact agreement (%), and agreement within one year (%) were calculated for all readers in all labs for the pelvic samples. Sample size varied from 71 to 72 samples because readers did not provide ages for all samples and 3 samples were removed from the analysis due to unreadability (Table 14). Of the 55 comparisons made, 25 had significant p-values which indicated systematic bias between the readers and labs (Table 15). CVs ranged from 6-20% (average of 11%), with 30 values being greater than or equal to 10%, indicating some imprecision (Table 16). Exact agreement between readers ranged from 13-63% (average of 40%; Table 17) and agreement within one year ranged from 56-96% (average of 82%; Table 18).

### *Comparison between Paired Opercula and Sectioned Otoliths*

There were 64 paired opercula and sectioned otolith samples in the exchange, although not all readers aged all samples and some unreadable samples were removed from the analysis. Sample size, Bowker's p-values, CVs, exact agreement, and agreement within one year were used to evaluate bias and precision in age readings between paired opercula and sectioned otolith samples (Table 19). These tests identified imprecision (CVs > 10%) for 7 of the 10 readers but no systematic bias between sets of age determination (Bowker's $p > 0.05$). Exact agreement varied from 25-42% with an average of 32% for all 10 readers. Agreement within one year varied from 70-87% with an average of 76%. Without a validated ageing method, these tests cannot indicate which structure provides more accurate ages, only that imprecision was detected. Reader age frequency and bias plots can be found in Figure 3-Figure 12. Generally, at younger ages, opercula were aged as older than sectioned otoliths.

### *Comparison between Paired Opercula and Pelvic Spines*

There were 75 paired opercula and pelvic spine samples in the exchange, although not all readers aged all samples and some unreadable samples were removed from the analysis. Sample size, Bowker's p-values, CVs, exact agreement, and agreement within one year were used to evaluate bias and precision in age readings between paired opercula and spine samples (Table 21). These tests identified imprecision (CVs > 10%) for 8 out of 11 readers and some systematic bias between sets of age determination (Bowker's $p < 0.05$). Exact agreement varied from 27-53% with an average of 38% for all 11 readers. Agreement within one year varied from 61-91%% with an average of 78%. Without a validated ageing method, these tests cannot indicate which structure provides more accurate ages, only that bias and imprecision were detected. Reader age frequency and bias plots can be found in Figure 13-Figure 23. Generally, at younger ages, opercula were aged younger than spines but at older ages, spines were aged younger than opercula.

### *Comparison between Paired Pelvic Spines and Sectioned Otoliths*

There were 64 paired opercula and sectioned otolith samples in the exchange, although not all readers aged all samples and some unreadable samples were removed from the analysis. Sample size, Bowker's p-values, CVs, exact agreement, and agreement within one year were used to evaluate bias and precision in age readings between paired opercula and sectioned otolith samples (Table 21). These tests identified imprecision (CVs > 10%) for 7 out of 10 readers and some systematic bias between sets of age determination (Bowker's $p > 0.05$). Exact agreement varied from 18-51% with an average of 40% for all

10 readers. Agreement within one year varied from 63-86% with an average of 78%. Without a validated ageing method, these tests cannot indicate which structure provides more accurate ages, only that bias and imprecision were detected. Reader age frequency and bias plots can be found in Figure 24-Figure 33. There were no consistent patterns in over- or under-ageing between the structures.

## Discussion

The tautog readers agreed that given the limited experience most readers had with ageing spines (Table 3), the results were encouraging and this method should be approved as an acceptable structure for ageing tautog. The tautog agers advise the TC to use ages from spines if the agency supplying the ages have demonstrated that the spine ages are consistent with the ages provided from either opercula or otoliths. The agers recommend that agencies or ageing labs that are interested in switching to spine ages collect paired samples with otoliths and/or opercula for at least one year. During that year, multiple ageing structures should be prepared and aged to gain experience and exhibit consistent ages between structures.

Agers noted that it was challenging reading the spine samples so long after the training workshop took place in 2019, although the delay was unavoidable due to COVID restrictions. However, the readers agreed the results for spines was fairly consistent with the other ageing structures (Table 22) despite the limited experience of most of the participants. Readers acknowledged that it was challenging to identify the first annulus on the spines, while noting that was also a challenge for opercula. It was also noted that a lot of the age discrepancy happens at older ages (>12) and the stock assessment uses a 12 plus age group.

Recommendations:

- Providing tautog ages to the TC or stock assessment subcommittee using spines is acceptable, although agencies/labs should collect paired samples for at least a year to establish methods and show consistency between structure's ages
- The exchange set will be maintained by ASMFC as a training set that can be available to labs or agencies to borrow
- Scott Elzey will develop a document or powerpoint with photos or a YouTube video on how to prepare tautog spine samples for age readings to be used as a training tool
- A compound scope, if available, should be used for reading spines

# References

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# Tables

**Table 1. Description of samples in the exchange including number of paired samples from each laboratory/state agency, sex of the samples as female (F), male (M), or unknown (U), length range of the tautog the sample was collected from, and month the samples were collected. *One paired sample includes an operculum, sectioned otolith, and pelvic spine collected from the same tautog with the exception of the 12 samples from MD DNR which are only a paired operculum and spine.**

| Lab/Agency | Paired Samples (number) | Sex (number) | Length Range (mm) | Collection Month Range |
|---|---|---|---|---|
| MA DMF | 8 | F (3), M (4), U (1) | 52-453 | 5-9 |
| RI DMF | 9 | F (5), M (4) | 305-806 | 4-11 |
| CT DEEP | 9 | F (6), M (3) | 140-537 | 4-9 |
| NY DEC | 9 | F (1), M (7), U (1) | 347-479 | 10-11 |
| NJ DFW | 9 | F (5), M (4) | 290-612 | 1-4 |
| MD DNR | 12* | F (6), M (6) | 425-690 | 11-12 |
| VIMS | 10 | U (10) | 200-450 | 10 |
| VMRC | 9 | F (5), M (4) | 295-525 | 4 |

**Table 2. The order and month that the laboratories/agencies aged the tautog exchange set. The exchange set was sent to NY DEC in March, 2020, but was not aged until December that year due to COVID restrictions.**

| Lab/Agency | Date Aged |
|---|---|
| MA DMF | February, 2020 |
| MD DNR | February, 2020 |
| VIMS | March, 2020 |
| NY DEC | December, 2020 |
| CT DEEP | January, 2021 |
| DE DFW | February, 2021 |
| RI DMF | March, 2021 |
| NJ DFW | April, 2021 |
| VMRC | May, 2021 |

**Table 3. The experience level with each ageing structure for the agers who participated in the exchange. Agers used a 0-3 scale where 0 indicated no experience, 1 indicated limited experience, 2 indicated some experience, or 3 indicated a lot of experience with the structure.**

| | Experience Level | | |
|---|---|---|---|
| **Ager** | **Opercula** | **Otolith** | **Spine** |
| MA | 3 | 3 | 3 |
| RI | 3 | 3 | 1 |
| CT | 3 | 2 | 1 |
| NY | 3 | 2 | 1 |
| NJ1 | 2 | 2 | 1 |
| NJ2 | 3 | 0 | 0 |
| DE1 | 3 | 1 | 1 |
| DE2 | 2 | 1 | 0 |
| MD | 3 | 1 | 1 |
| VIMS | 3 | 3 | 1 |
| VMRC | 3 | 3 | 1 |

**Table 4. Sample size of the opercula samples in the tautog exchange by reader. There were 75 opercula samples in the exchange but not all readers aged all samples and six samples were eliminated from analysis due to unreadability.**

| | **MA** | **RI** | **CT** | **NY** | **NJ1** | **NJ2** | **DE1** | **DE2** | **MD** | **VIMS** | **VMRC** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **MA** | 69 | | | | | | | | | | |
| **RI** | 67 | 67 | | | | | | | | | |
| **CT** | 69 | 67 | 69 | | | | | | | | |
| **NY** | 69 | 67 | 69 | 69 | | | | | | | |
| **NJ1** | 69 | 67 | 69 | 69 | 69 | | | | | | |
| **NJ2** | 69 | 67 | 69 | 69 | 69 | 69 | | | | | |
| **DE1** | 69 | 67 | 69 | 69 | 69 | 69 | 69 | | | | |
| **DE2** | 69 | 67 | 69 | 69 | 69 | 69 | 69 | 69 | | | |
| **MD** | 69 | 67 | 69 | 69 | 69 | 69 | 69 | 69 | 69 | | |
| **VIMS** | 69 | 67 | 69 | 69 | 69 | 69 | 69 | 69 | 69 | 69 | |
| **VMRC** | 69 | 67 | 69 | 69 | 69 | 69 | 69 | 69 | 69 | 69 | 69 |

**Table 5. Symmetry test p-values for the tautog opercula comparisons using Bowker's test. Significant p-values (α<0.05) are shown with an asterisks and indicate systematic bias between the readers and labs.**

| | MA | RI | CT | NY | NJ1 | NJ2 | DE1 | DE2 | MD | VIMS | VMRC |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **MA** | | | | | | | | | | | |
| **RI** | 0.015* | | | | | | | | | | |
| **CT** | 0.267 | 0.021* | | | | | | | | | |
| **NY** | 0.037* | 0.396 | 0.068 | | | | | | | | |
| **NJ1** | 0.000* | 0.462 | 0.002* | 0.462 | | | | | | | |
| **NJ2** | 0.127 | 0.300 | 0.116 | 0.555 | 0.140 | | | | | | |
| **DE1** | 0.023* | 0.306 | 0.195 | 0.096 | 0.131 | 0.269 | | | | | |
| **DE2** | 0.140 | 0.260 | 0.256 | 0.119 | 0.077 | 0.250 | 0.077 | | | | |
| **MD** | 0.323 | 0.149 | 0.269 | 0.060 | 0.005* | 0.228 | 0.173 | 0.752 | | | |
| **VIMS** | 0.448 | 0.159 | 0.283 | 0.034* | 0.001* | 0.339 | 0.125 | 0.527 | 0.356 | | |
| **VMRC** | 0.149 | 0.272 | 0.096 | 0.217 | 0.005* | 0.266 | 0.536 | 0.268 | 0.229 | 0.055 | |

**Table 6. Mean coefficients of variation (CVs) between readers for tautog opercula samples. CVs greater than or equal to 10% indicate ageing imprecision between readers.**

| | MA | RI | CT | NY | NJ1 | NJ2 | DE1 | DE2 | MD | VIMS | VMRC |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **MA** | | | | | | | | | | | |
| **RI** | 8 | | | | | | | | | | |
| **CT** | 6 | 9 | | | | | | | | | |
| **NY** | 12 | 14 | 13 | | | | | | | | |
| **NJ1** | 8 | 13 | 11 | 14 | | | | | | | |
| **NJ2** | 12 | 16 | 11 | 15 | 12 | | | | | | |
| **DE1** | 10 | 10 | 12 | 15 | 13 | 12 | | | | | |
| **DE2** | 9 | 10 | 11 | 14 | 13 | 12 | 3 | | | | |
| **MD** | 7 | 10 | 9 | 11 | 10 | 12 | 8 | 8 | | | |
| **VIMS** | 7 | 11 | 8 | 12 | 10 | 14 | 10 | 10 | 7 | | |
| **VMRC** | 8 | 11 | 9 | 14 | 8 | 10 | 8 | 9 | 9 | 8 | |

**Table 7.** Percent exact agreement between readers for the tautog opercula samples. Color scale indicates level of agreement where green is highest agreement and red is the lowest agreement.

| | MA | RI | CT | NY | NJ1 | NJ2 | DE1 | DE2 | MD | VIMS | VMRC |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **MA** | | | | | | | | | | | |
| **RI** | 46 | | | | | | | | | | |
| **CT** | 51 | 45 | | | | | | | | | |
| **NY** | 33 | 30 | 25 | | | | | | | | |
| **NJ1** | 55 | 43 | 39 | 42 | | | | | | | |
| **NJ2** | 30 | 25 | 39 | 32 | 38 | | | | | | |
| **DE1** | 29 | 39 | 32 | 26 | 36 | 41 | | | | | |
| **DE2** | 39 | 37 | 33 | 29 | 32 | 39 | 67 | | | | |
| **MD** | 46 | 43 | 38 | 39 | 49 | 38 | 43 | 39 | | | |
| **VIMS** | 43 | 33 | 41 | 41 | 52 | 33 | 41 | 42 | 45 | | |
| **VMRC** | 48 | 43 | 51 | 28 | 59 | 48 | 46 | 45 | 45 | 49 | |

**Table 8.** Percent agreement within one year between readers for the tautog opercula samples. Color scale indicates level of agreement where green is highest agreement and red is the lowest agreement.

| | MA | RI | CT | NY | NJ1 | NJ2 | DE1 | DE2 | MD | VIMS | VMRC |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **MA** | | | | | | | | | | | |
| **RI** | 87 | | | | | | | | | | |
| **CT** | 91 | 81 | | | | | | | | | |
| **NY** | 83 | 67 | 81 | | | | | | | | |
| **NJ1** | 90 | 78 | 86 | 75 | | | | | | | |
| **NJ2** | 74 | 60 | 80 | 72 | 84 | | | | | | |
| **DE1** | 80 | 81 | 70 | 80 | 80 | 75 | | | | | |
| **DE2** | 86 | 85 | 78 | 78 | 81 | 74 | 99 | | | | |
| **MD** | 86 | 76 | 81 | 80 | 80 | 72 | 80 | 83 | | | |
| **VIMS** | 93 | 82 | 86 | 86 | 84 | 68 | 81 | 81 | 90 | | |
| **VMRC** | 84 | 73 | 83 | 72 | 88 | 83 | 83 | 83 | 80 | 83 | |

**Table 9. Sample size of the sectioned otolith samples in the tautog exchange by reader. There were 64 otolith samples in the exchange but not all readers aged all samples and 5 samples were removed from the analysis due to unreadability. The reader in Maryland did not age the otolith samples.**

| | MA | RI | CT | NY | NJ1 | NJ2 | DE1 | DE2 | VIMS | VMRC |
|---|---|---|---|---|---|---|---|---|---|---|
| **MA** | 58 | | | | | | | | | |
| **RI** | 58 | 58 | | | | | | | | |
| **CT** | 58 | 58 | 59 | | | | | | | |
| **NY** | 58 | 58 | 59 | 59 | | | | | | |
| **NJ1** | 58 | 58 | 59 | 59 | 59 | | | | | |
| **NJ2** | 58 | 58 | 59 | 59 | 59 | 59 | | | | |
| **DE1** | 58 | 58 | 59 | 59 | 59 | 59 | 59 | | | |
| **DE2** | 58 | 58 | 59 | 59 | 59 | 59 | 59 | 59 | | |
| **VIMS** | 58 | 58 | 59 | 59 | 59 | 59 | 59 | 59 | 59 | |
| **VMRC** | 58 | 58 | 59 | 59 | 59 | 59 | 59 | 59 | 59 | 59 |

**Table 10. Symmetry test p-values for the tautog sectioned otolith comparisons using Bowker's test. Significant p-values ($\alpha<0.05$) are shown with an asterisks and indicate systematic bias between the readers and labs. The reader in Maryland did not age the otolith samples.**

| | MA | RI | CT | NY | NJ1 | NJ2 | DE1 | DE2 | VIMS | VMRC |
|---|---|---|---|---|---|---|---|---|---|---|
| **MA** | | | | | | | | | | |
| **RI** | 0.342 | | | | | | | | | |
| **CT** | 0.057 | 0.081 | | | | | | | | |
| **NY** | 0.501 | 0.358 | 0.074 | | | | | | | |
| **NJ1** | 0.023* | 0.038* | 0.744 | 0.084 | | | | | | |
| **NJ2** | 0.020* | 0.026* | 0.397 | 0.019* | 0.090 | | | | | |
| **DE1** | 0.087 | 0.042* | 0.500 | 0.199 | 0.161 | 0.251 | | | | |
| **DE2** | 0.082 | 0.089 | 0.092 | 0.110 | 0.039* | 0.360 | 0.264 | | | |
| **VIMS** | 0.265 | 0.191 | 0.348 | 0.350 | 0.127 | 0.054 | 0.229 | 0.229 | | |
| **VMRC** | 0.293 | 0.416 | 0.196 | 0.173 | 0.111 | 0.045* | 0.084 | 0.063 | 0.172 | |

**Table 11.** Mean coefficients of variation (CVs) between readers for tautog sectioned otolith samples. CVs greater than or equal to 10% indicate ageing imprecision between readers. The reader in Maryland did not age the otolith samples.

| | MA | RI | CT | NY | NJ1 | NJ2 | DE1 | DE2 | VIMS | VMRC |
|---|---|---|---|---|---|---|---|---|---|---|
| **MA** | | | | | | | | | | |
| **RI** | 1 | | | | | | | | | |
| **CT** | 12 | 12 | | | | | | | | |
| **NY** | 5 | 4 | 10 | | | | | | | |
| **NJ1** | 5 | 4 | 13 | 7 | | | | | | |
| **NJ2** | 11 | 11 | 14 | 14 | 9 | | | | | |
| **DE1** | 12 | 12 | 14 | 9 | 11 | 14 | | | | |
| **DE2** | 9 | 9 | 14 | 11 | 8 | 11 | 9 | | | |
| **VIMS** | 6 | 6 | 11 | 4 | 8 | 13 | 8 | 10 | | |
| **VMRC** | 2 | 1 | 12 | 4 | 5 | 10 | 11 | 8 | 6 | |

**Table 12.** Percent exact agreement between readers for the tautog sectioned otolith samples. Color scale indicates level of agreement where green is highest agreement and red is the lowest agreement. The reader in Maryland did not age the otolith samples.

| | MA | RI | CT | NY | NJ1 | NJ2 | DE1 | DE2 | VIMS | VMRC |
|---|---|---|---|---|---|---|---|---|---|---|
| **MA** | | | | | | | | | | |
| **RI** | 88 | | | | | | | | | |
| **CT** | 38 | 41 | | | | | | | | |
| **NY** | 79 | 84 | 44 | | | | | | | |
| **NJ1** | 59 | 66 | 37 | 63 | | | | | | |
| **NJ2** | 33 | 34 | 36 | 29 | 39 | | | | | |
| **DE1** | 43 | 43 | 31 | 42 | 47 | 42 | | | | |
| **DE2** | 50 | 45 | 34 | 46 | 49 | 32 | 49 | | | |
| **VIMS** | 76 | 72 | 32 | 73 | 59 | 31 | 51 | 51 | | |
| **VMRC** | 83 | 84 | 44 | 76 | 61 | 39 | 49 | 44 | 73 | |

**Table 13.** Percent agreement within one year between readers for the tautog sectioned otolith samples. Color scale indicates level of agreement where green is highest agreement and red is the lowest agreement. The reader in Maryland did not age the otolith samples.

| | MA | RI | CT | NY | NJ1 | NJ2 | DE1 | DE2 | VIMS | VMRC |
|---|---|---|---|---|---|---|---|---|---|---|
| **MA** | | | | | | | | | | |
| **RI** | 100 | | | | | | | | | |
| **CT** | 86 | 83 | | | | | | | | |
| **NY** | 98 | 98 | 81 | | | | | | | |
| **NJ1** | 98 | 97 | 83 | 93 | | | | | | |
| **NJ2** | 81 | 83 | 80 | 81 | 92 | | | | | |
| **DE1** | 88 | 90 | 71 | 88 | 90 | 83 | | | | |
| **DE2** | 84 | 84 | 76 | 85 | 90 | 80 | 95 | | | |
| **VIMS** | 95 | 97 | 83 | 93 | 95 | 86 | 90 | 86 | | |
| **VMRC** | 98 | 98 | 85 | 100 | 98 | 83 | 90 | 86 | 97 | |

**Table 14.** Sample size of the pelvic spine samples in the tautog exchange by reader. There were 75 spine samples in the exchange but not all readers aged all samples and 3 spine samples were removed from the analysis due to unreadability.

| | MA | RI | CT | NY | NJ1 | NJ2 | DE1 | DE2 | MD | VIMS | VMRC |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **MA** | 72 | | | | | | | | | | |
| **RI** | 72 | 72 | | | | | | | | | |
| **CT** | 72 | 72 | 72 | | | | | | | | |
| **NY** | 72 | 72 | 72 | 72 | | | | | | | |
| **NJ1** | 71 | 71 | 71 | 71 | 71 | | | | | | |
| **NJ2** | 72 | 72 | 72 | 72 | 71 | 72 | | | | | |
| **DE1** | 72 | 72 | 72 | 72 | 71 | 72 | 72 | | | | |
| **DE2** | 72 | 72 | 72 | 72 | 71 | 72 | 72 | 72 | | | |
| **MD** | 72 | 72 | 72 | 72 | 71 | 72 | 72 | 72 | 72 | | |
| **VIMS** | 72 | 72 | 72 | 72 | 71 | 72 | 72 | 72 | 72 | 72 | |
| **VMRC** | 72 | 72 | 72 | 72 | 71 | 72 | 72 | 72 | 72 | 72 | 72 |

**Table 15. Symmetry test p-values for the tautog pelvic spine comparisons using Bowker's test. Significant p-values (α<0.05) are shown with an asterisks and indicate systematic bias between the readers and labs.**

| | MA | RI | CT | NY | NJ1 | NJ2 | DE1 | DE2 | MD | VIMS | VMRC |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **MA** | | | | | | | | | | | |
| **RI** | 0.006* | | | | | | | | | | |
| **CT** | 0.046* | 0.001* | | | | | | | | | |
| **NY** | 0.522 | 0.000* | 0.057 | | | | | | | | |
| **NJ1** | 0.016* | 0.226 | 0.000* | 0.009* | | | | | | | |
| **NJ2** | 0.195 | 0.017* | 0.248 | 0.532 | 0.019* | | | | | | |
| **DE1** | 0.240 | 0.074 | 0.001* | 0.152 | 0.453 | 0.096 | | | | | |
| **DE2** | 0.388 | 0.005* | 0.028* | 0.420 | 0.021* | 0.458 | 0.091 | | | | |
| **MD** | 0.423 | 0.002* | 0.192 | 0.326 | 0.002* | 0.457 | 0.027* | 0.579 | | | |
| **VIMS** | 0.016* | 0.780 | 0.000* | 0.005* | 0.410 | 0.028* | 0.258 | 0.035* | 0.010* | | |
| **VMRC** | 0.554 | 0.001* | 0.050 | 0.512 | 0.028* | 0.491 | 0.144 | 0.400 | 0.167 | 0.012* | |

**Table 16. Mean coefficients of variation (CVs) between readers for tautog pelvic spine samples. CVs greater than or equal to 10% indicate ageing imprecision between readers.**

| | MA | RI | CT | NY | NJ1 | NJ2 | DE1 | DE2 | MD | VIMS | VMRC |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **MA** | | | | | | | | | | | |
| **RI** | 6 | | | | | | | | | | |
| **CT** | 14 | 12 | | | | | | | | | |
| **NY** | 9 | 7 | 9 | | | | | | | | |
| **NJ1** | 9 | 6 | 10 | 9 | | | | | | | |
| **NJ2** | 14 | 13 | 12 | 10 | 12 | | | | | | |
| **DE1** | 11 | 9 | 9 | 11 | 7 | 14 | | | | | |
| **DE2** | 16 | 15 | 12 | 16 | 10 | 17 | 8 | | | | |
| **MD** | 19 | 17 | 16 | 19 | 14 | 20 | 11 | 10 | | | |
| **VIMS** | 6 | 6 | 10 | 8 | 7 | 13 | 7 | 12 | 15 | | |
| **VMRC** | 7 | 6 | 10 | 7 | 7 | 12 | 9 | 14 | 18 | 7 | |

**Table 17. Percent exact agreement between readers for the tautog pelvic spine samples. Color scale indicates level of agreement where green is highest agreement and red is the lowest agreement.**

| | MA | RI | CT | NY | NJ1 | NJ2 | DE1 | DE2 | MD | VIMS | VMRC |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **MA** | | | | | | | | | | | |
| **RI** | 53 | | | | | | | | | | |
| **CT** | 32 | 44 | | | | | | | | | |
| **NY** | 50 | 61 | 44 | | | | | | | | |
| **NJ1** | 48 | 62 | 51 | 54 | | | | | | | |
| **NJ2** | 29 | 32 | 28 | 33 | 37 | | | | | | |
| **DE1** | 31 | 46 | 57 | 43 | 52 | 28 | | | | | |
| **DE2** | 21 | 28 | 47 | 29 | 41 | 24 | 46 | | | | |
| **MD** | 13 | 13 | 28 | 15 | 23 | 19 | 36 | 43 | | | |
| **VIMS** | 47 | 53 | 47 | 53 | 54 | 38 | 53 | 33 | 22 | | |
| **VMRC** | 54 | 58 | 50 | 63 | 58 | 38 | 49 | 28 | 13 | 53 | |

**Table 18. Percent agreement within one year between readers for the tautog pelvic spine samples. Color scale indicates level of agreement where green is highest agreement and red is the lowest agreement.**

| | MA | RI | CT | NY | NJ1 | NJ2 | DE1 | DE2 | MD | VIMS | VMRC |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **MA** | | | | | | | | | | | |
| **RI** | 90 | | | | | | | | | | |
| **CT** | 74 | 74 | | | | | | | | | |
| **NY** | 90 | 92 | 82 | | | | | | | | |
| **NJ1** | 82 | 83 | 89 | 86 | | | | | | | |
| **NJ2** | 82 | 85 | 86 | 89 | 86 | | | | | | |
| **DE1** | 83 | 79 | 88 | 86 | 90 | 86 | | | | | |
| **DE2** | 69 | 67 | 85 | 68 | 86 | 74 | 86 | | | | |
| **MD** | 56 | 63 | 76 | 65 | 77 | 61 | 82 | 88 | | | |
| **VIMS** | 90 | 85 | 90 | 93 | 90 | 88 | 85 | 79 | 74 | | |
| **VMRC** | 86 | 92 | 82 | 96 | 85 | 86 | 86 | 72 | 63 | 90 | |

**Table 19.** **Sample size, Bowker's p-value, mean CV, exact agreement, and agreement within one year for paired tautog opercula and sectioned otolith samples. Significant p-values (<0.05) are indicated with an asterisk. Color scale for CVs is green for low CVs and red for high CVs. Agreement color scale indicates level of agreement where green is the highest and red is the lowest agreement. Labs with multiple readers are denoted with numbers.**

| Lab/ Agency | n | Bowker's p-value | CV (%) | Exact Agreement (%) | Agreement within 1 yr (%) |
|---|---|---|---|---|---|
| MA DMF | 53 | 0.402 | 9 | 42 | 83 |
| RI DMF | 50 | 0.480 | 13 | 26 | 72 |
| CT DEEP | 53 | 0.119 | 16 | 26 | 70 |
| NY DEC | 53 | 0.368 | 12 | 30 | 74 |
| NJ DFW 1 | 53 | 0.375 | 9 | 42 | 83 |
| NJ DFW 2 | 53 | 0.206 | 16 | 25 | 72 |
| DE DFW 1 | 53 | 0.648 | 15 | 32 | 72 |
| DE DFW 2 | 53 | 0.552 | 12 | 36 | 72 |
| MD DNR | Did not age sectioned otoliths | | | | |
| VIMS | 53 | 0.297 | 14 | 28 | 79 |
| VMRC | 53 | 0.128 | 9 | 34 | 87 |

**Table 20.** Sample size, Bowker's p-value, mean CV, exact agreement, and agreement within one year for paired tautog opercula and pelvic spine samples. Significant p-values (<0.05) are indicated with an asterisk. Color scale for CVs is green for low CVs and red for high CVs. Agreement color scale indicates level of agreement where green is the highest and red is the lowest agreement. Labs with multiple readers are denoted with numbers.

| Lab/ Agency | n | Bowker's p-value | CV (%) | Exact Agreement (%) | Agreement within 1 yr (%) |
|---|---|---|---|---|---|
| MA DMF | 66 | 0.025 * | 7 | 50 | 91 |
| RI DMF | 64 | 0.102 | 15 | 27 | 73 |
| CT DEEP | 66 | 0.014 * | 14 | 35 | 76 |
| NY DEC | 66 | 0.370 | 12 | 29 | 77 |
| NJ DFW 1 | 65 | 0.006 * | 11 | 48 | 86 |
| NJ DFW 2 | 66 | 0.194 | 17 | 29 | 76 |
| DE DFW 1 | 66 | 0.215 | 9 | 41 | 77 |
| DE DFW 2 | 66 | 0.317 | 13 | 39 | 73 |
| MD DNR | 66 | 0.287 | 15 | 35 | 61 |
| VIMS | 66 | 0.510 | 7 | 53 | 88 |
| VMRC | 66 | 0.504 | 12 | 36 | 79 |

**Table 21.** **Sample size, Bowker's p-value, mean CV, exact agreement, and agreement within one year for paired tautog sectioned otoliths and pelvic spine samples. Significant p-values (<0.05) are indicated with an asterisk. Color scale for CVs is green for low CVs and red for high CVs. Agreement color scale indicates level of agreement where green is the highest and red is the lowest agreement. Labs with multiple readers are denoted with numbers.**

| Lab/ Agency | n | Bowker's p-value | CV (%) | Exact Agreement (%) | Agreement within 1 yr (%) |
|---|---|---|---|---|---|
| MA DMF | 57 | 0.006 * | 9 | 51 | 86 |
| RI DMF | 56 | 0.410 | 10 | 50 | 80 |
| CT DEEP | 57 | 0.368 | 15 | 37 | 68 |
| NY DEC | 57 | 0.621 | 10 | 46 | 79 |
| NJ DFW 1 | 56 | 0.276 | 9 | 46 | 86 |
| NJ DFW 2 | 57 | 0.363 | 21 | 18 | 63 |
| DE DFW 1 | 57 | 0.300 | 14 | 37 | 79 |
| DE DFW 2 | 57 | 0.319 | 13 | 30 | 79 |
| MD DNR | Did not age sectioned otoliths | | | | |
| VIMS | 57 | 0.214 | 13 | 42 | 84 |
| VMRC | 57 | 0.034 * | 9 | 54 | 82 |

**Table 22. Summary table comparing the three ageing structures.**

| | | Ageing Structure | | |
|---|---|---|---|---|
| | | **Opercula** | **Otolith** | **Spine** |
| **Sample Size per Reader** | min | 67 | 58 | 71 |
| | max | 69 | 59 | 72 |
| | average | 69 | 59 | 72 |
| **Number of Comparisons Between Readers** | number | 55 | 45 | 55 |
| ***p*-value** | average | 0.209 | 0.188 | 0.186 |
| | # significant | 10 | 8 | 25 |
| **CVs** | min | 3% | 1% | 6% |
| | max | 16% | 14% | 20% |
| | average | 10% | 9% | 11% |
| | # of CVs <10% | 26 | 26 | 25 |
| **Exact Agreement** | min | 25% | 29% | 13% |
| | max | 67% | 88% | 63% |
| | average | 40% | 52% | 40% |
| **Agreement Within 1 Year** | min | 60% | 71% | 56% |
| | max | 99% | 100% | 96% |
| | average | 81% | 89% | 82% |

## Figures

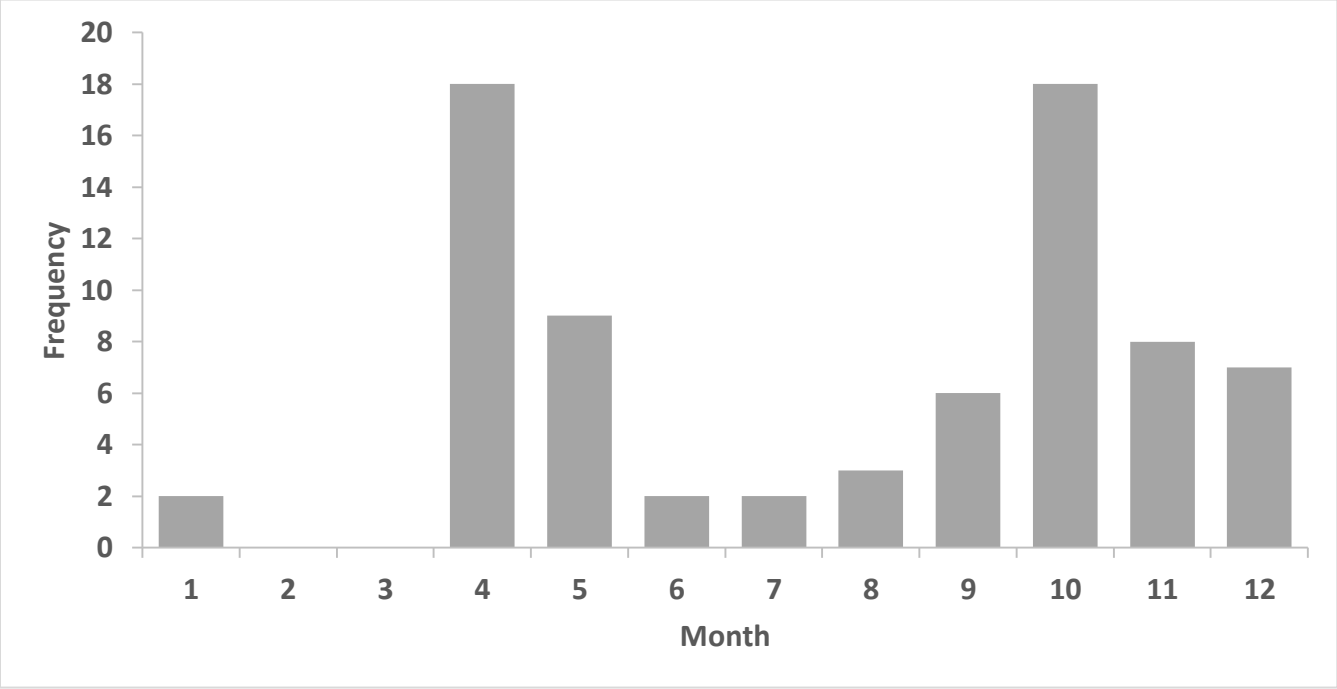


**Figure 1** **Number of samples collected by month in the exchange set.**

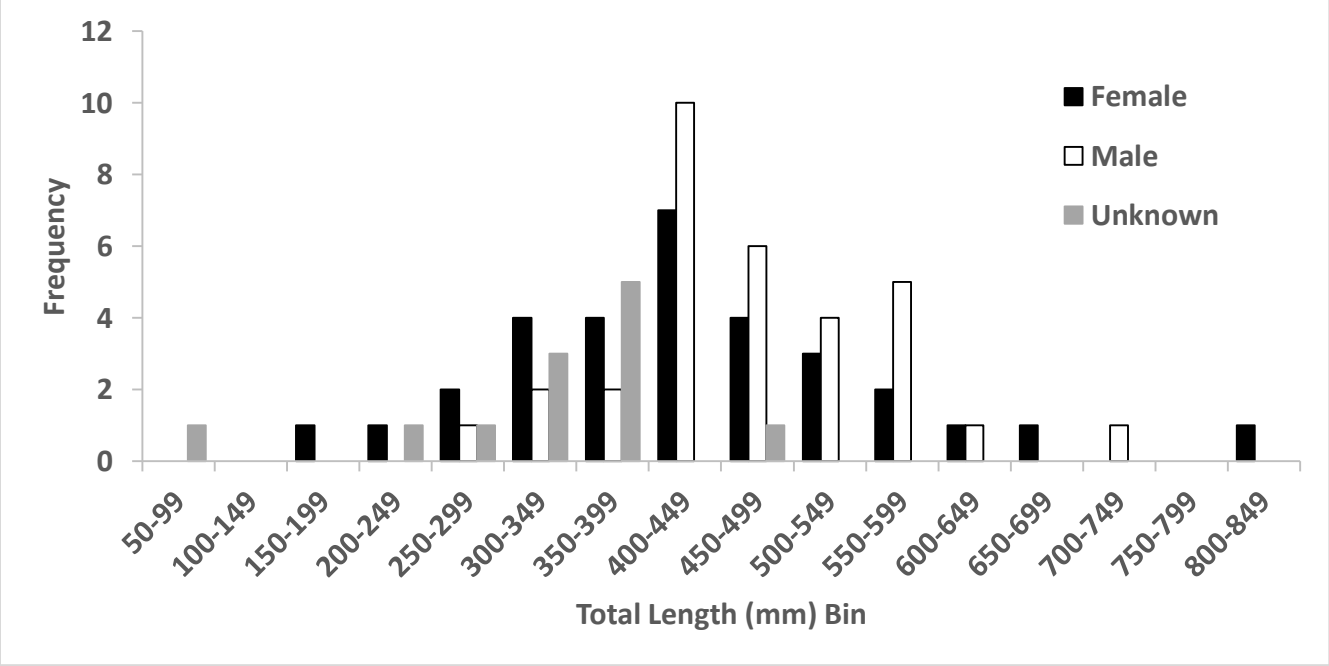


**Figure 2** **Length frequency of tautog in the hard part exchange by sex.**

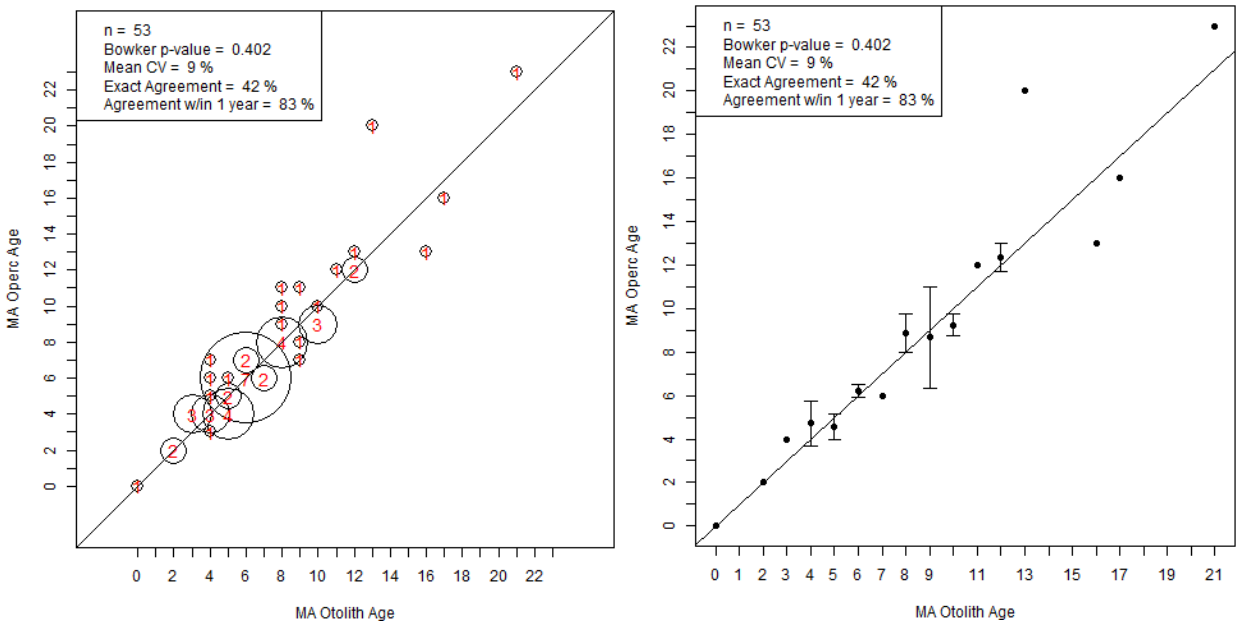


**Figure 3** **Age frequency (left) and age bias (right) plots for MA tautog opercula and sectioned otolith age determinations. Error bars in the age bias plots are 95% confidence intervals.**

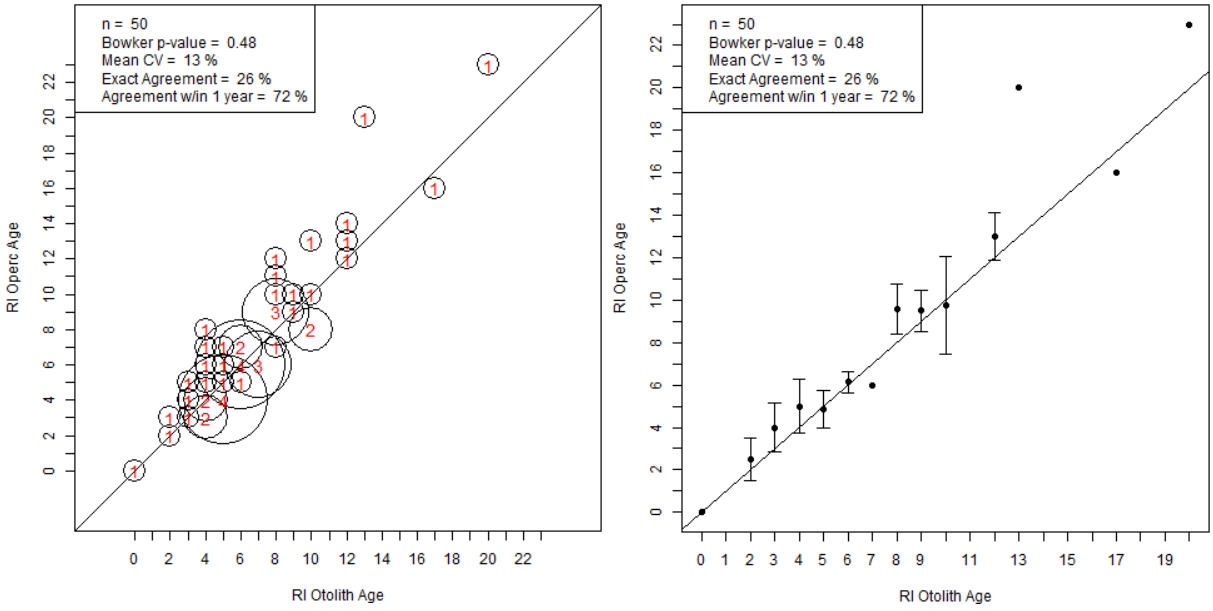


**Figure 4** **Age frequency (left) and age bias (right) plots for RI tautog opercula and sectioned otolith age determinations. Error bars in the age bias plots are 95% confidence intervals.**

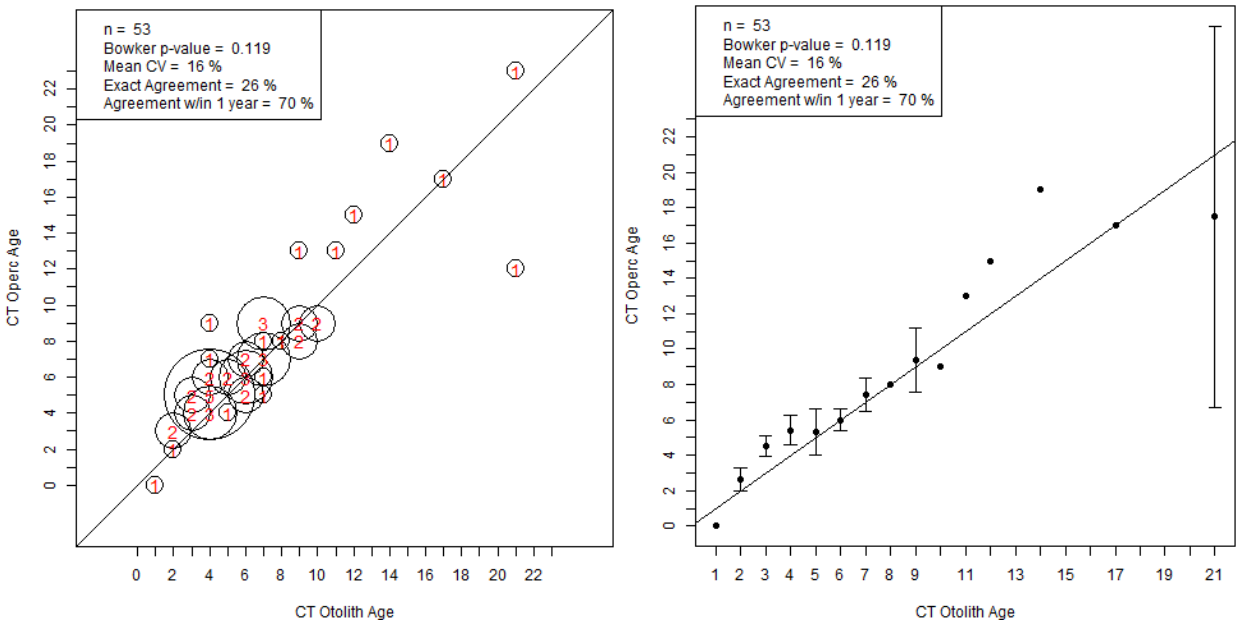


**Figure 5** **Age frequency (left) and age bias (right) plots for CT tautog opercula and sectioned otolith age determinations. Error bars in the age bias plots are 95% confidence intervals.**

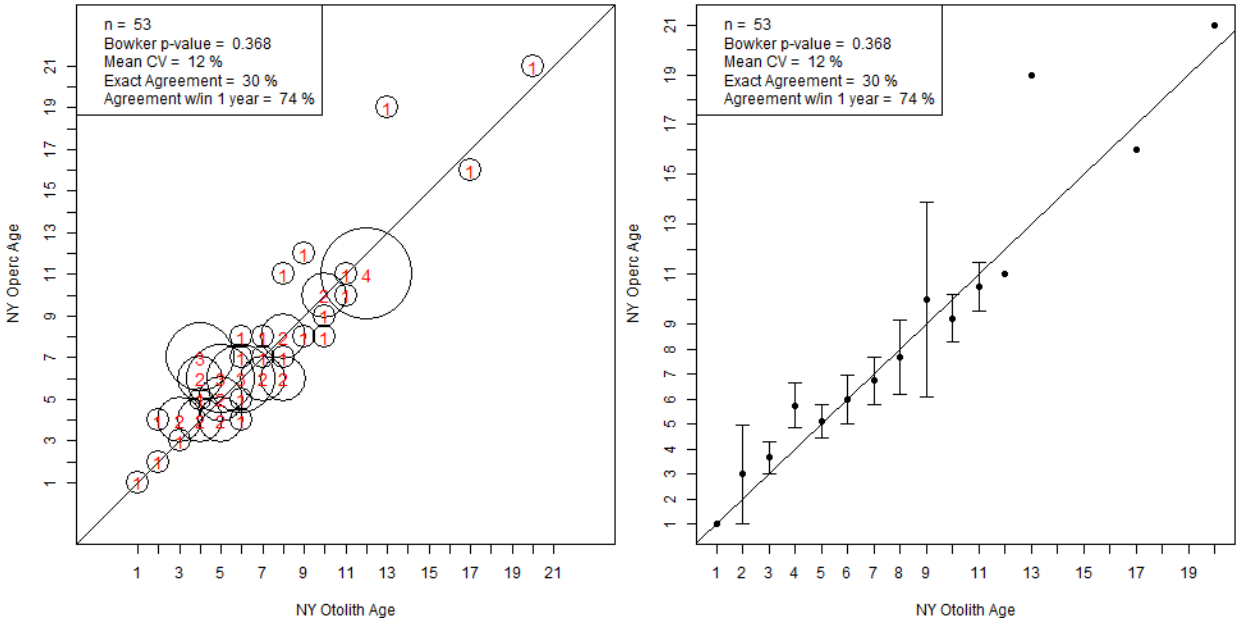


**Figure 6** **Age frequency (left) and age bias (right) plots for NY tautog opercula and sectioned otolith age determinations. Error bars in the age bias plots are 95% confidence intervals.**

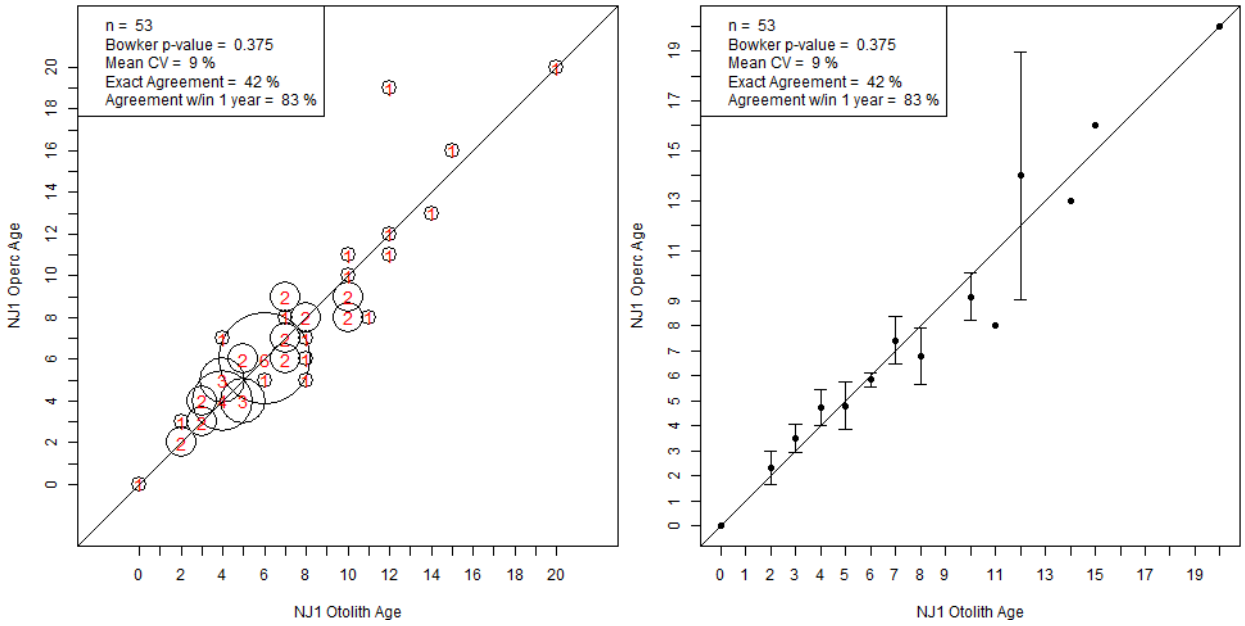


**Figure 7** **Age frequency (left) and age bias (right) plots for NJ1 tautog opercula and sectioned otolith age determinations. Error bars in the age bias plots are 95% confidence intervals.**

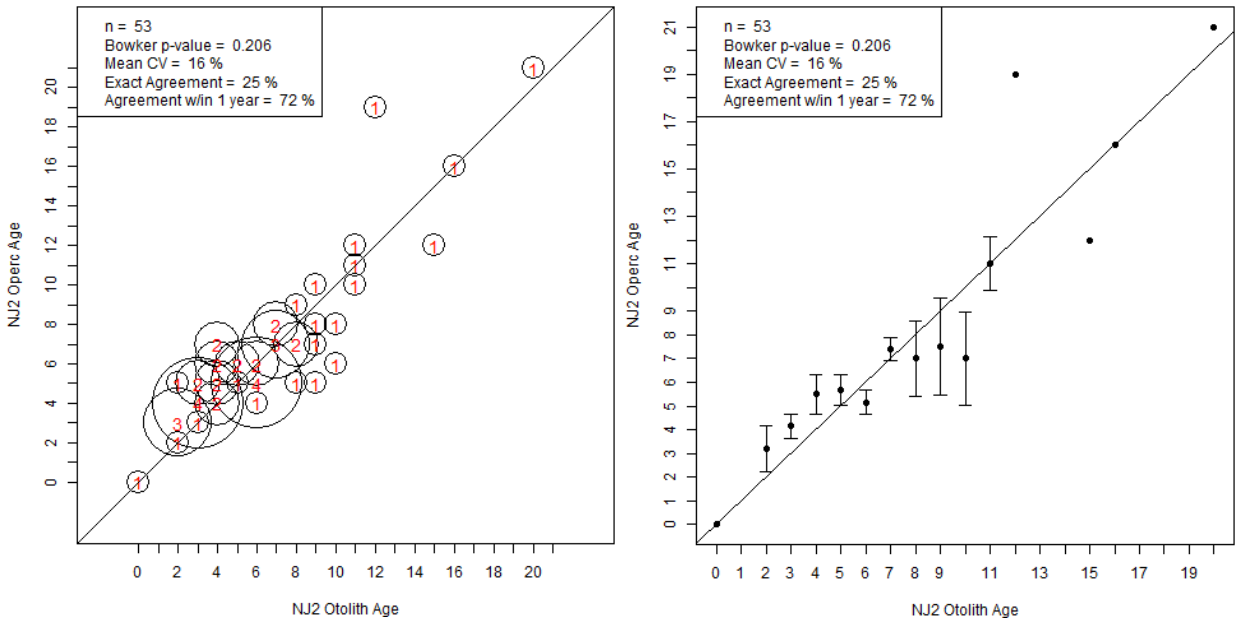


**Figure 8** **Age frequency (left) and age bias (right) plots for NJ2 tautog opercula and sectioned otolith age determinations. Error bars in the age bias plots are 95% confidence intervals.**

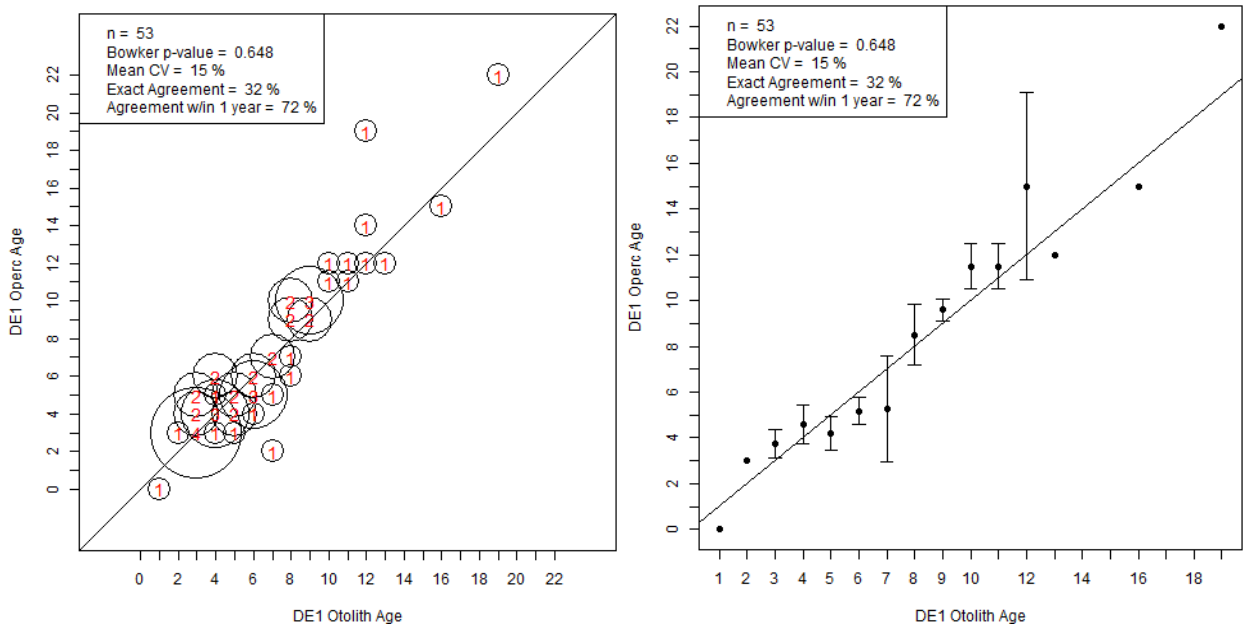


**Figure 9** **Age frequency (left) and age bias (right) plots for DE1 tautog opercula and sectioned otolith age determinations. Error bars in the age bias plots are 95% confidence intervals.**

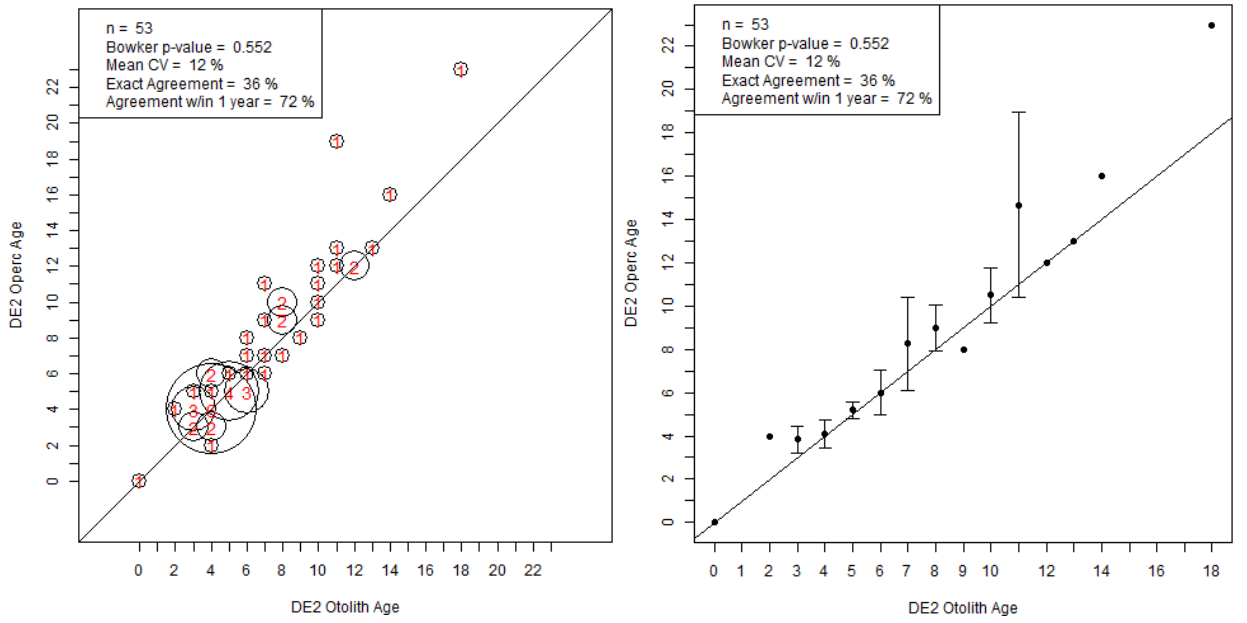


**Figure 10** **Age frequency (left) and age bias (right) plots for DE2 tautog opercula and sectioned otolith age determinations. Error bars in the age bias plots are 95% confidence intervals.**

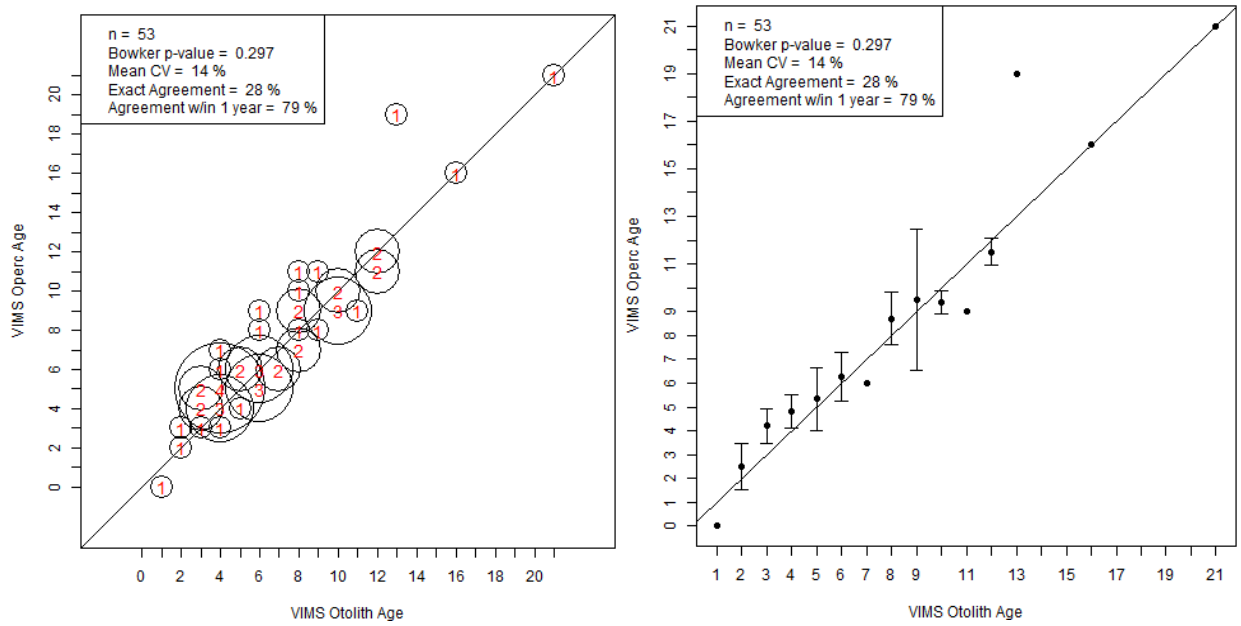


**Figure 11** **Age frequency (left) and age bias (right) plots for VIMS tautog opercula and sectioned otolith age determinations. Error bars in the age bias plots are 95% confidence intervals.**

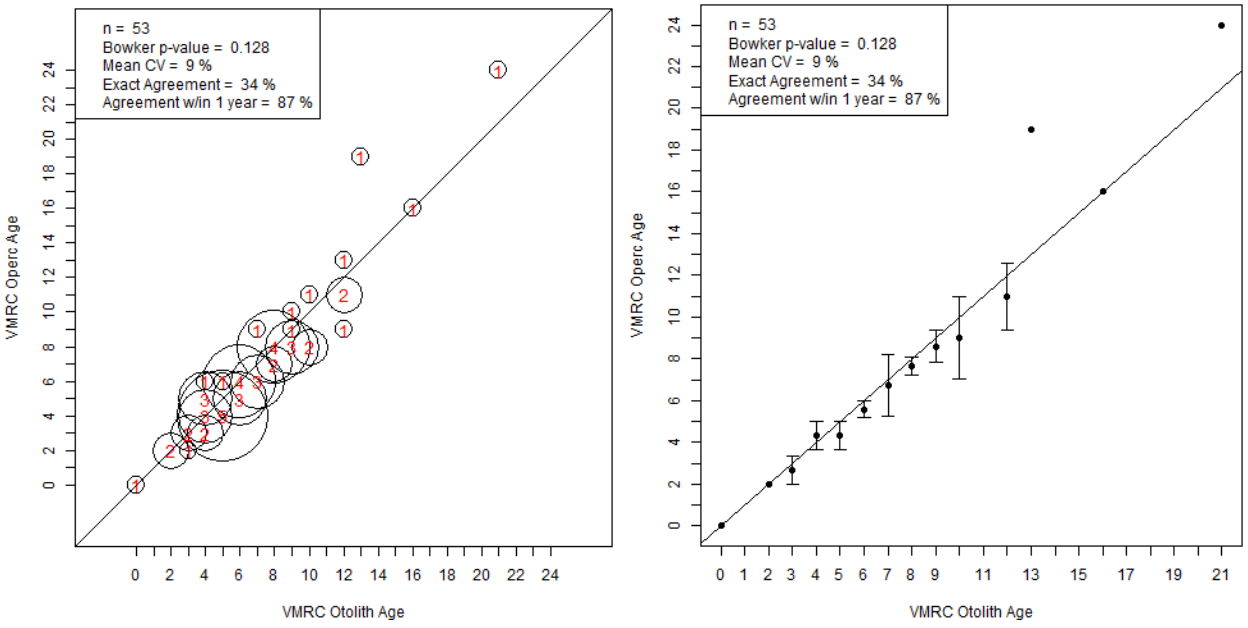


**Figure 12** **Age frequency (left) and age bias (right) plots for VMRC tautog opercula and sectioned otolith age determinations. Error bars in the age bias plots are 95% confidence intervals.**

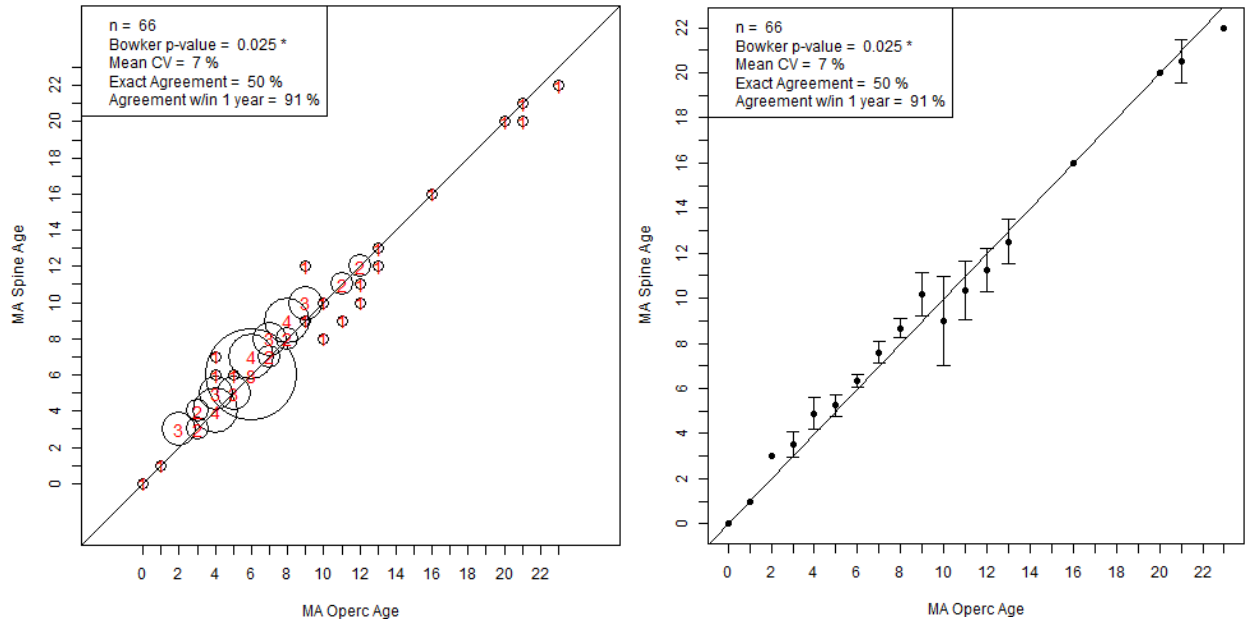


**Figure 13** **Age frequency (left) and age bias (right) plots for MA tautog opercula and pelvic spine age determinations. Error bars in the age bias plots are 95% confidence intervals.**

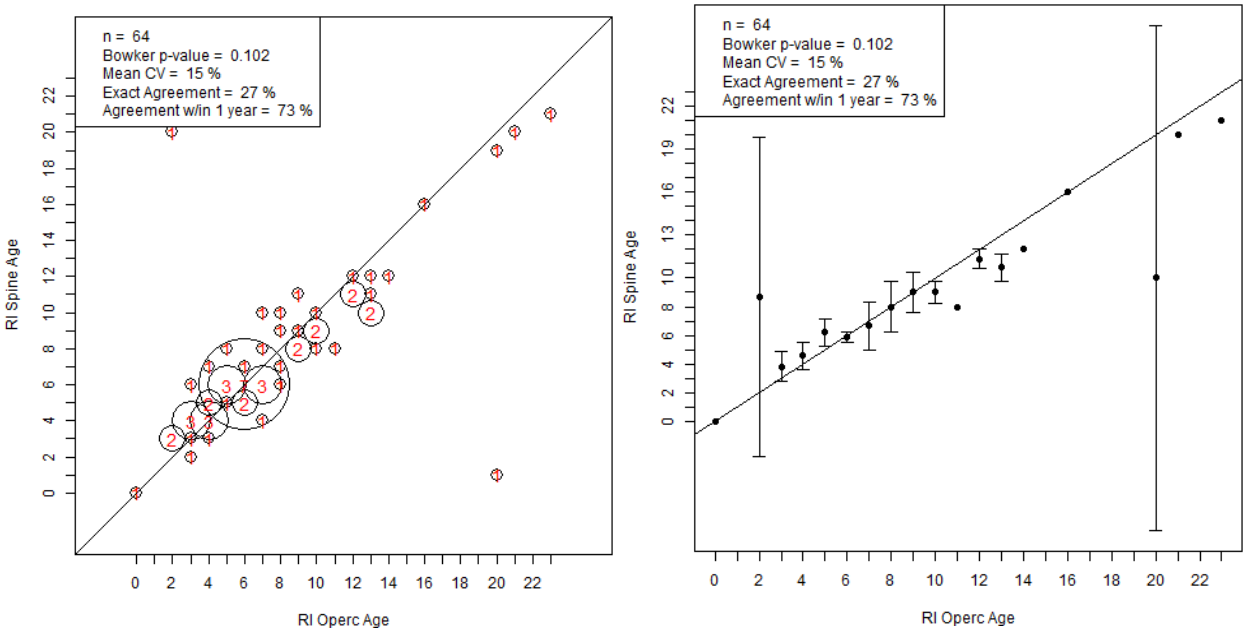


**Figure 14** **Age frequency (left) and age bias (right) plots for RI tautog opercula and pelvic spine age determinations. Error bars in the age bias plots are 95% confidence intervals.**

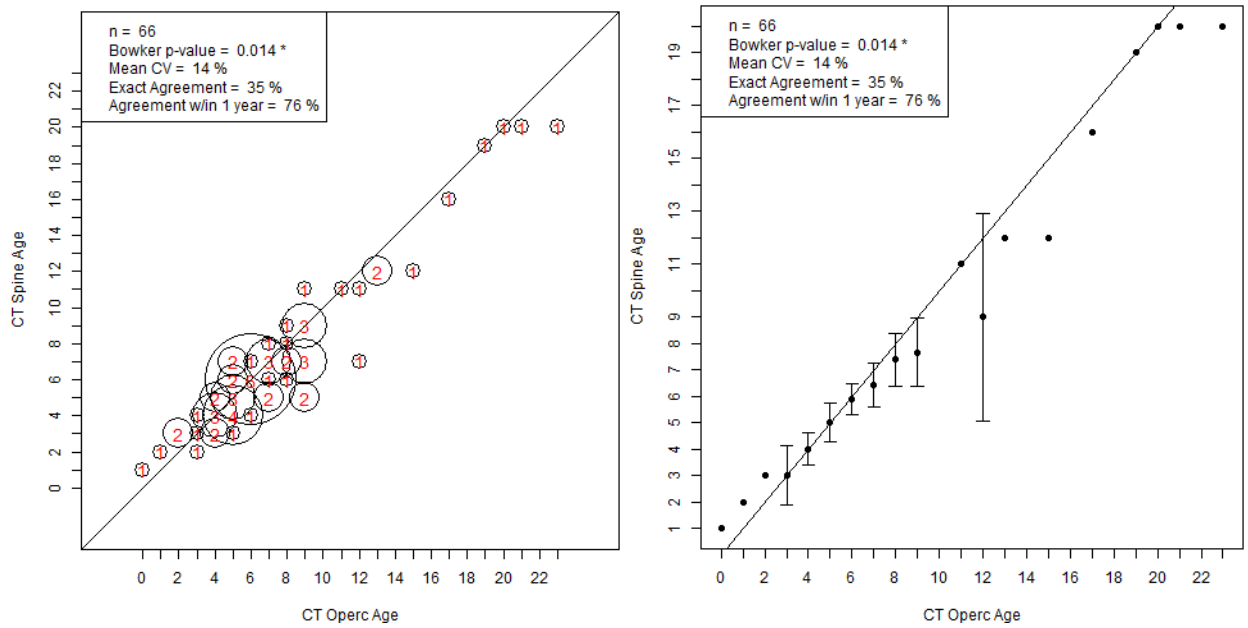


**Figure 15** **Age frequency (left) and age bias (right) plots for CT tautog opercula and pelvic spine age determinations. Error bars in the age bias plots are 95% confidence intervals.**

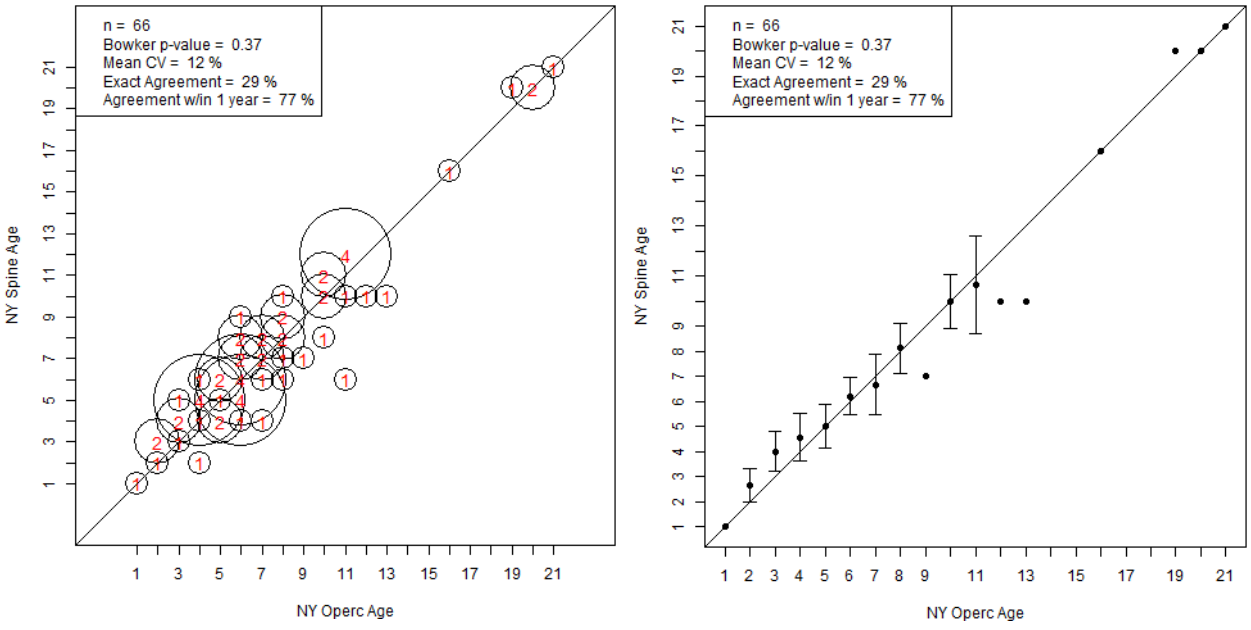


**Figure 16** **Age frequency (left) and age bias (right) plots for NY tautog opercula and pelvic spine age determinations. Error bars in the age bias plots are 95% confidence intervals.**

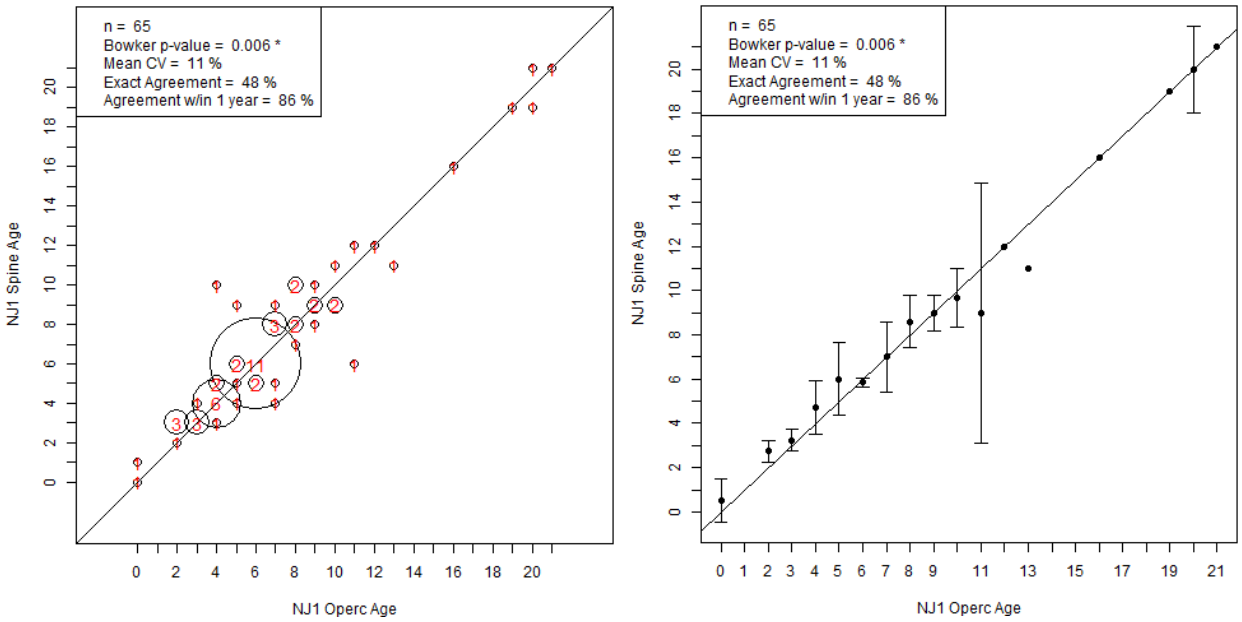


**Figure 17** **Age frequency (left) and age bias (right) plots for NJ1 tautog opercula and pelvic spine age determinations. Error bars in the age bias plots are 95% confidence intervals.**

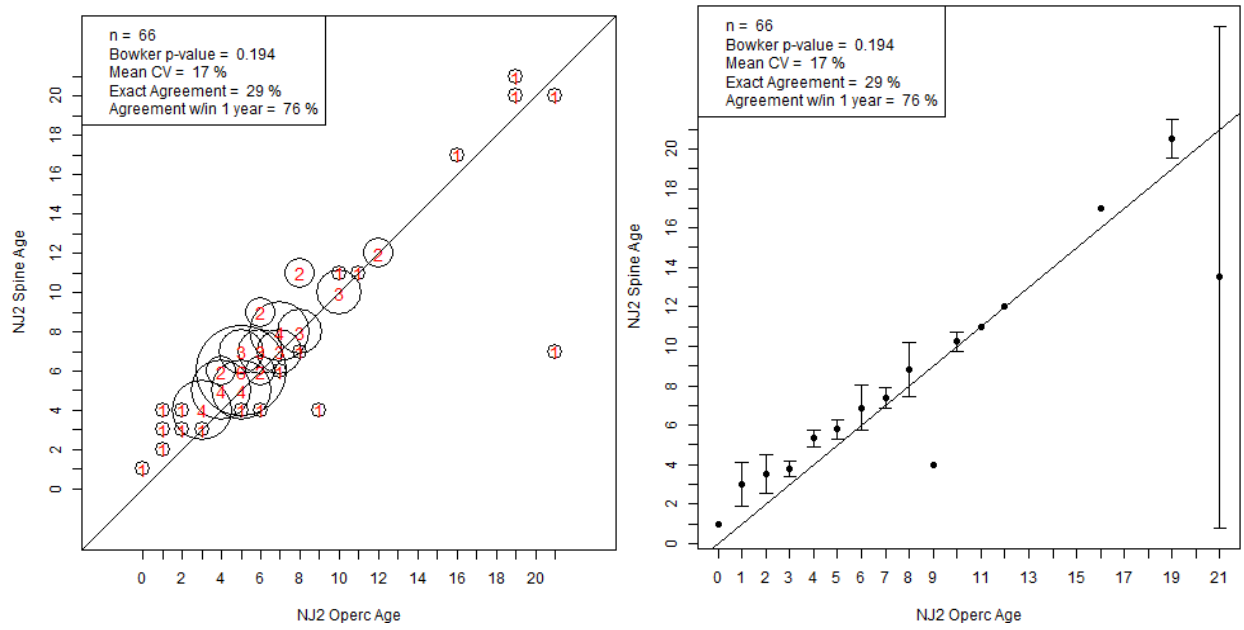


**Figure 18** **Age frequency (left) and age bias (right) plots for NJ2 tautog opercula and pelvic spine age determinations. Error bars in the age bias plots are 95% confidence intervals.**

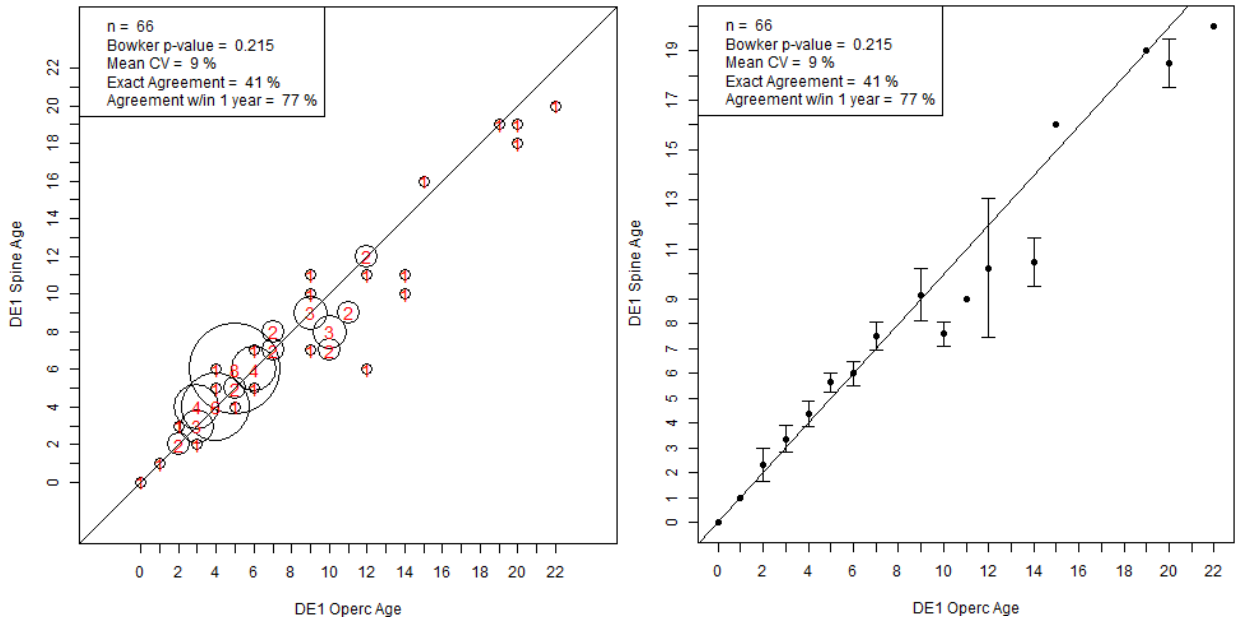


**Figure 19** **Age frequency (left) and age bias (right) plots for DE1 tautog opercula and pelvic spine age determinations. Error bars in the age bias plots are 95% confidence intervals.**

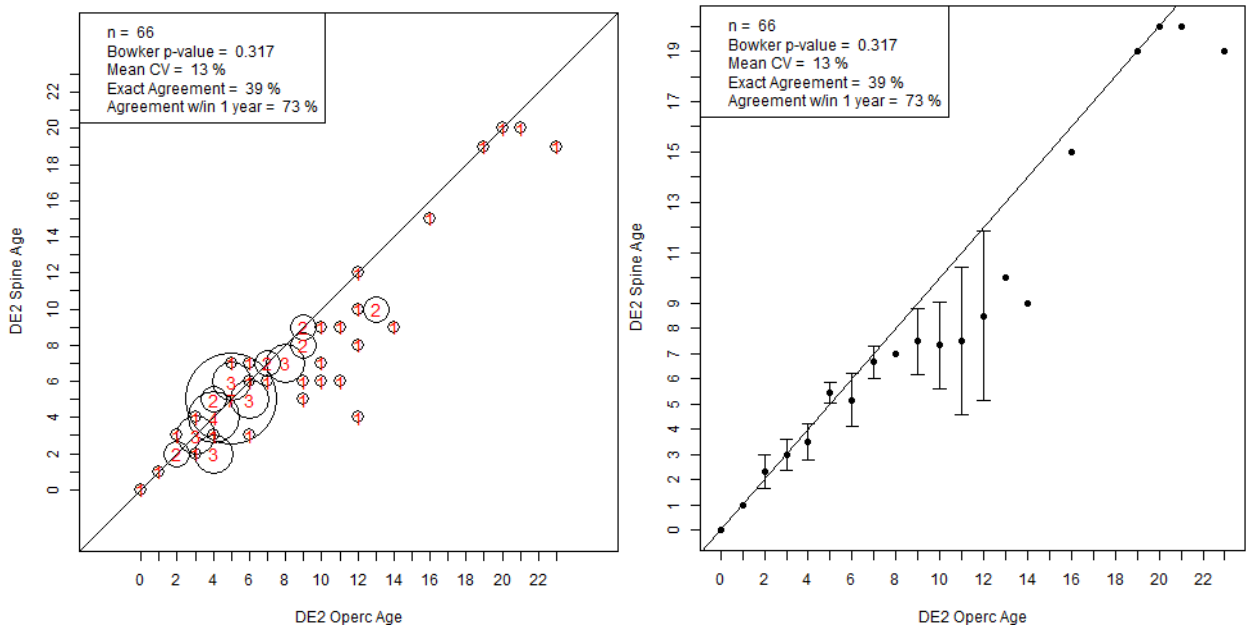


**Figure 20** **Age frequency (left) and age bias (right) plots for DE2 tautog opercula and pelvic spine age determinations. Error bars in the age bias plots are 95% confidence intervals.**

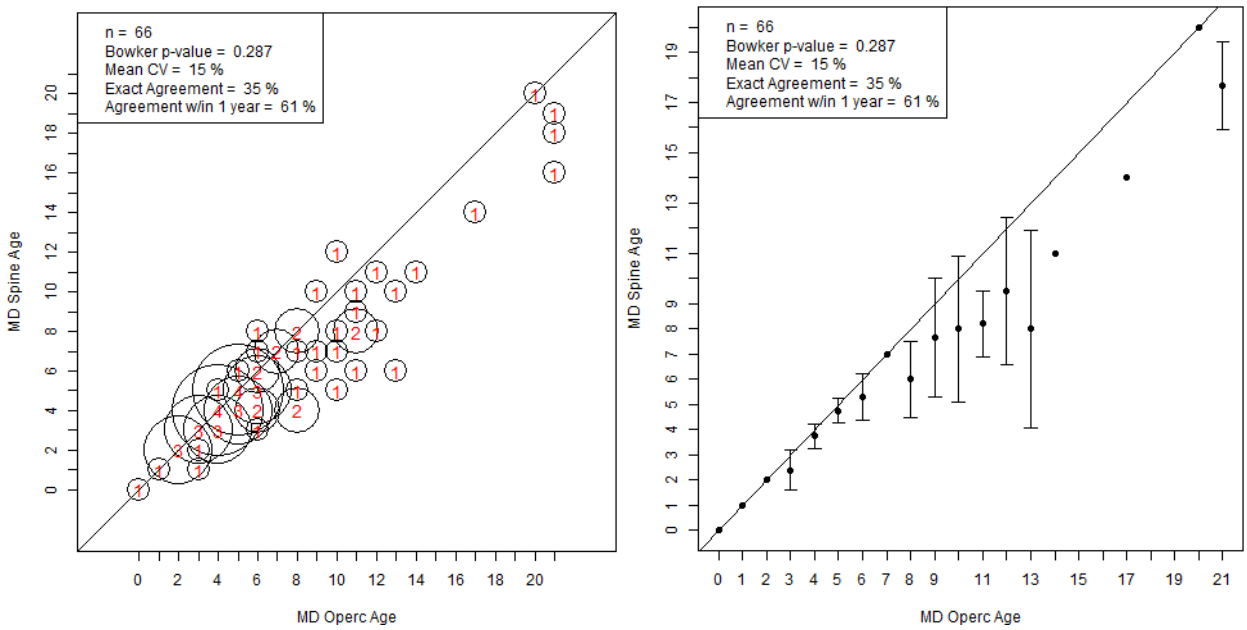


**Figure 21** **Age frequency (left) and age bias (right) plots for MD tautog opercula and pelvic spine age determinations. Error bars in the age bias plots are 95% confidence intervals.**

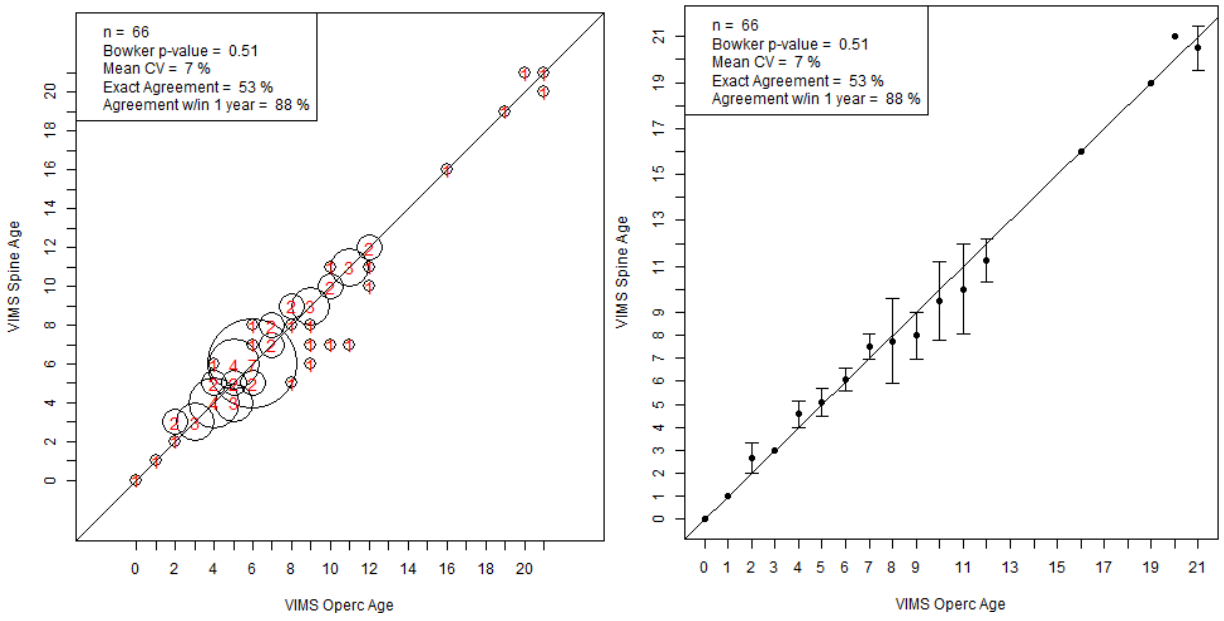


**Figure 22** **Age frequency (left) and age bias (right) plots for VIMS tautog opercula and pelvic spine age determinations. Error bars in the age bias plots are 95% confidence intervals.**

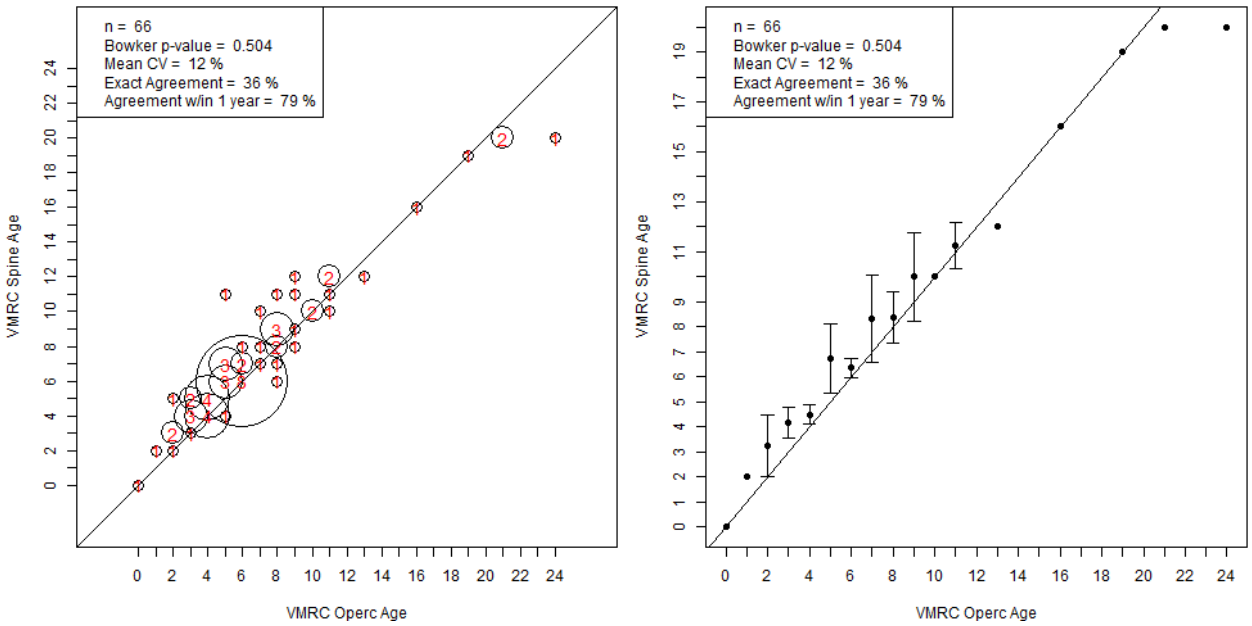


**Figure 23** **Age frequency (left) and age bias (right) plots for VMRC tautog opercula and pelvic spine age determinations. Error bars in the age bias plots are 95% confidence intervals.**

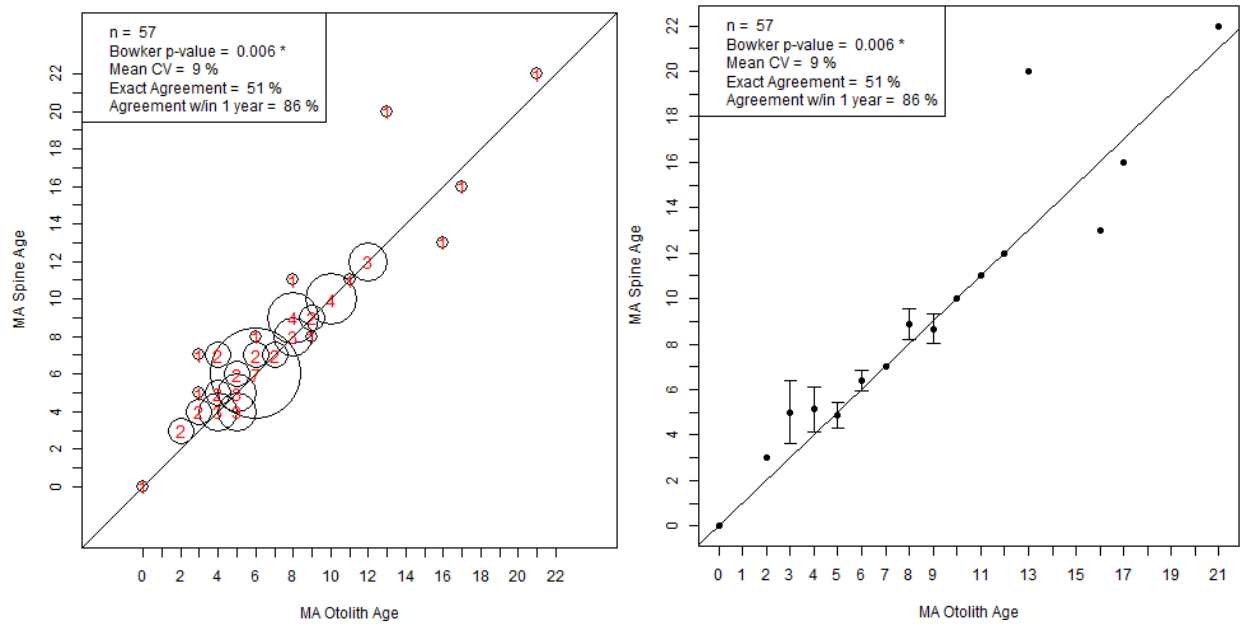


**Figure 24** **Age frequency (left) and age bias (right) plots for MA tautog sectioned otoliths and pelvic spine age determinations. Error bars in the age bias plots are 95% confidence intervals.**

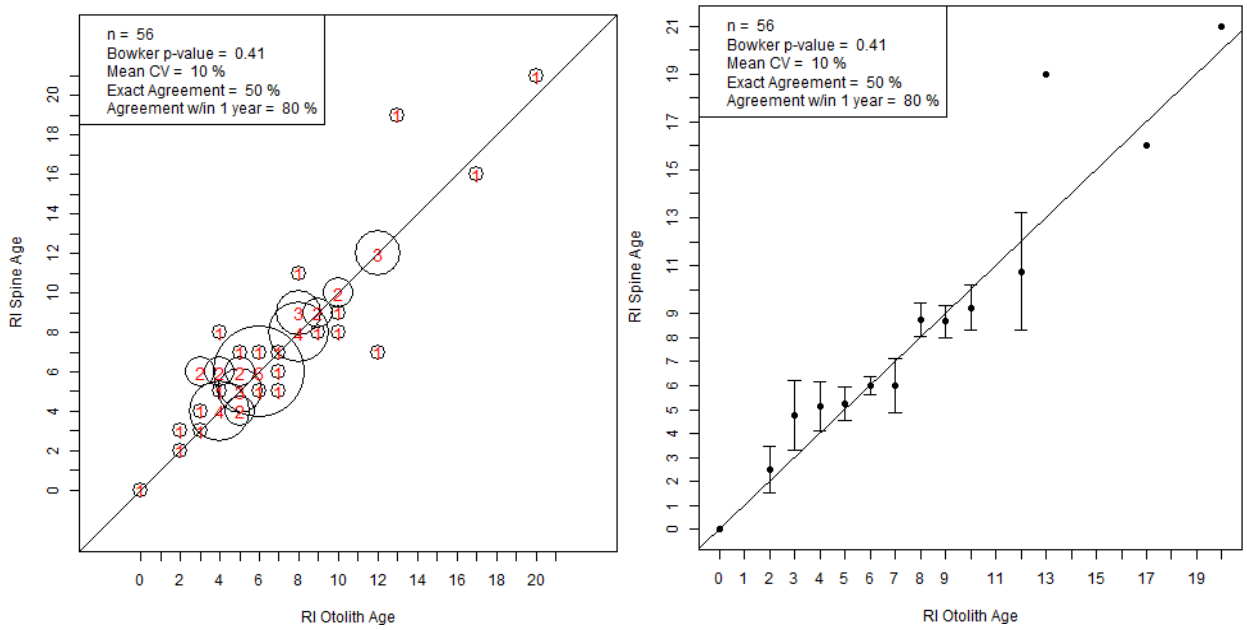


**Figure 25** **Age frequency (left) and age bias (right) plots for RI tautog sectioned otoliths and pelvic spine age determinations. Error bars in the age bias plots are 95% confidence intervals.**

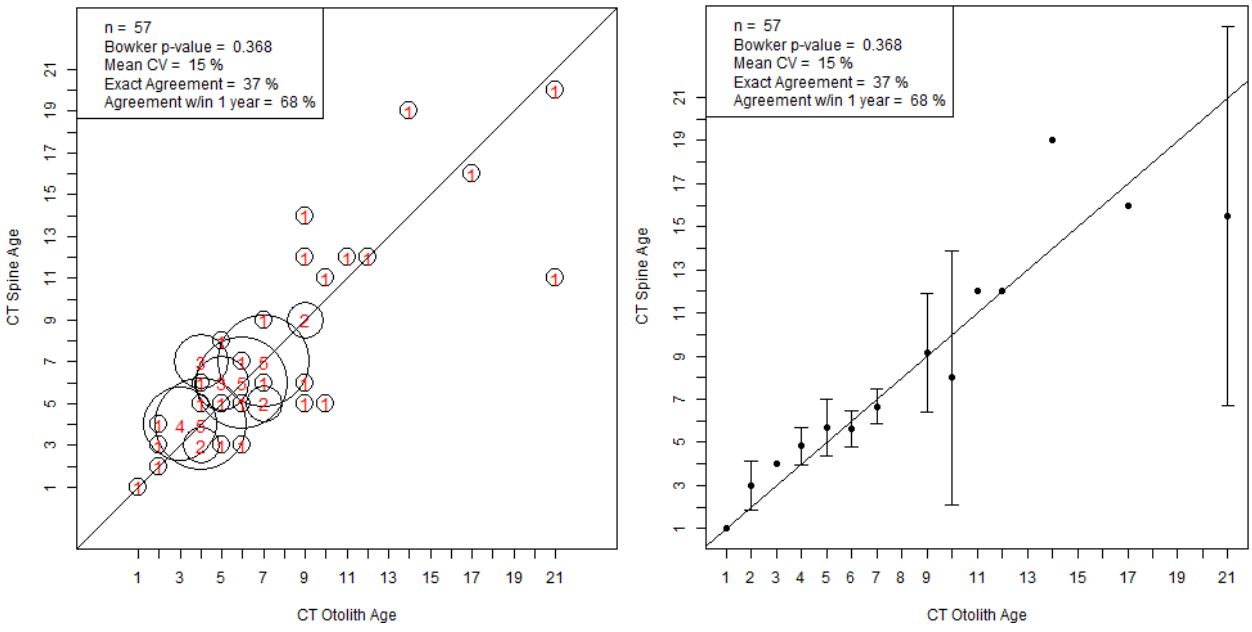


**Figure 26** **Age frequency (left) and age bias (right) plots for CT tautog sectioned otoliths and pelvic spine age determinations. Error bars in the age bias plots are 95% confidence intervals.**

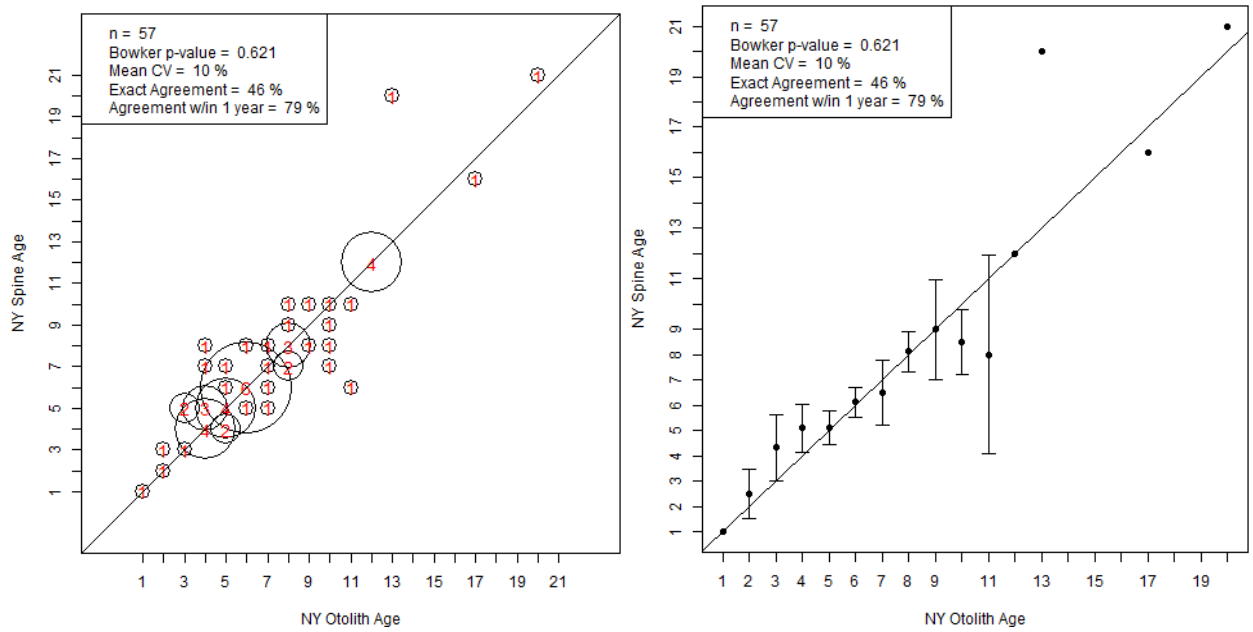


**Figure 27** **Age frequency (left) and age bias (right) plots for NY tautog sectioned otoliths and pelvic spine age determinations. Error bars in the age bias plots are 95% confidence intervals.**

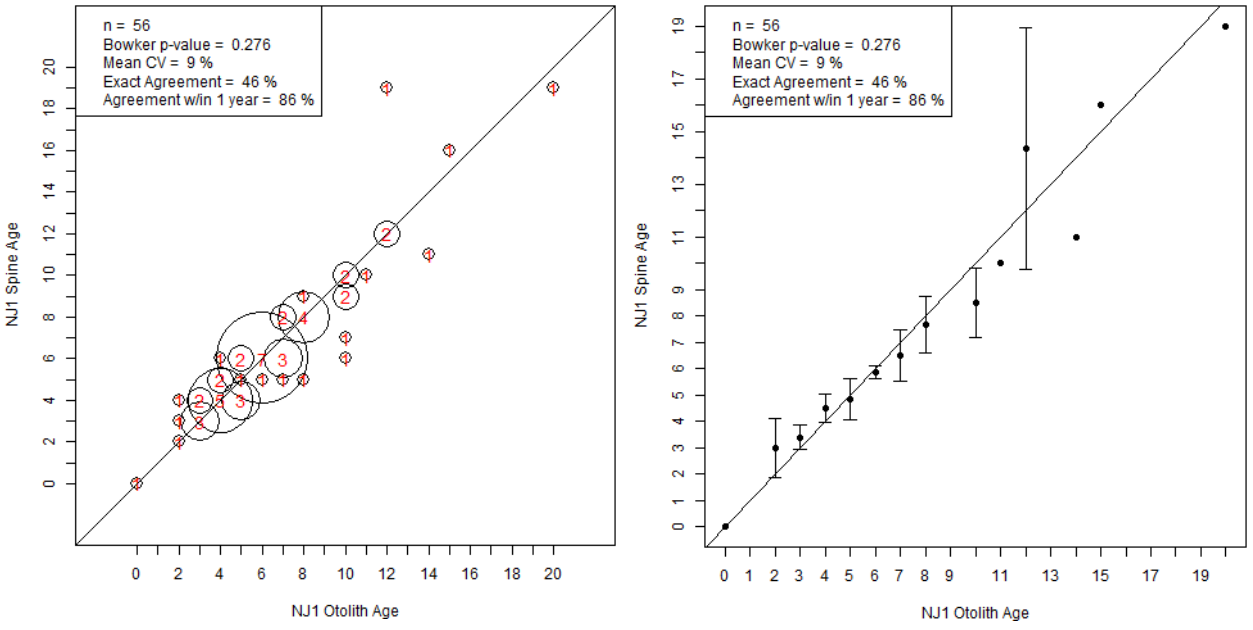


**Figure 28** **Age frequency (left) and age bias (right) plots for NJ1 tautog sectioned otoliths and pelvic spine age determinations. Error bars in the age bias plots are 95% confidence intervals.**

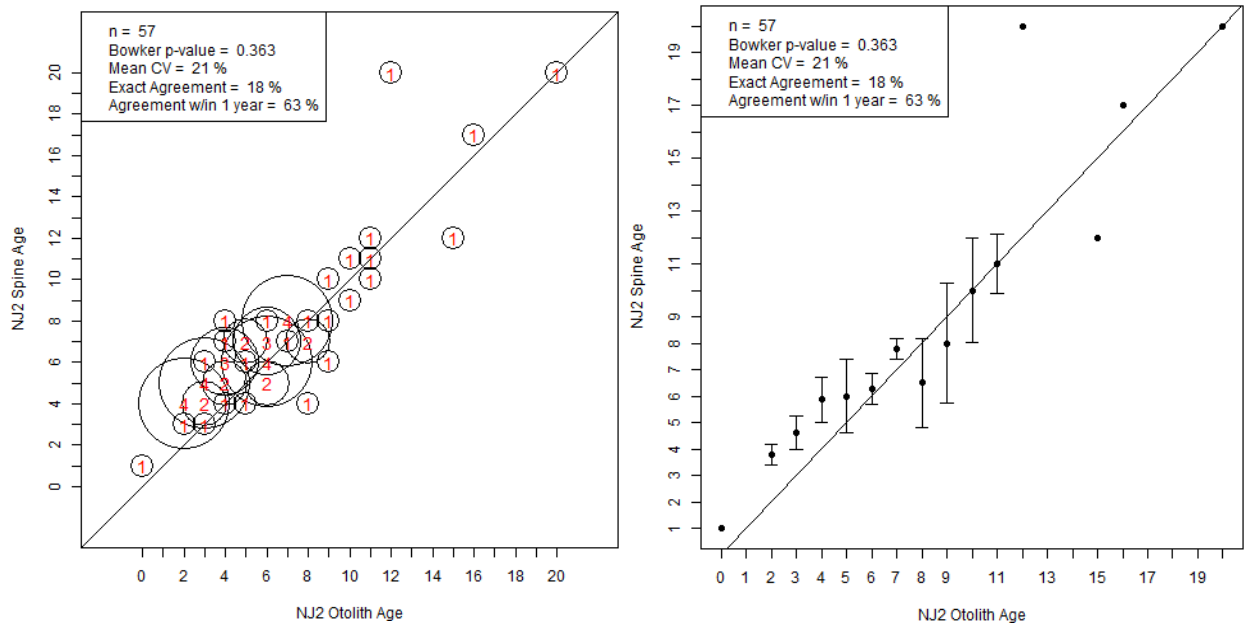


**Figure 29** **Age frequency (left) and age bias (right) plots for NJ2 tautog sectioned otoliths and pelvic spine age determinations. Error bars in the age bias plots are 95% confidence intervals.**

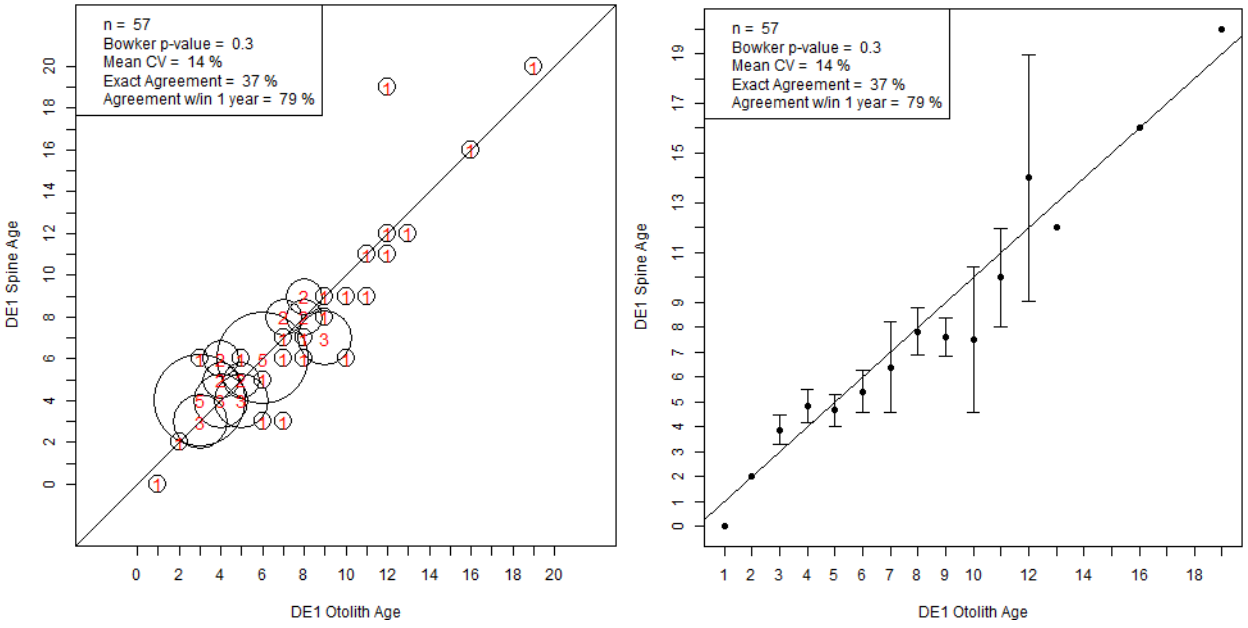


**Figure 30** **Age frequency (left) and age bias (right) plots for DE1 tautog sectioned otoliths and pelvic spine age determinations. Error bars in the age bias plots are 95% confidence intervals.**

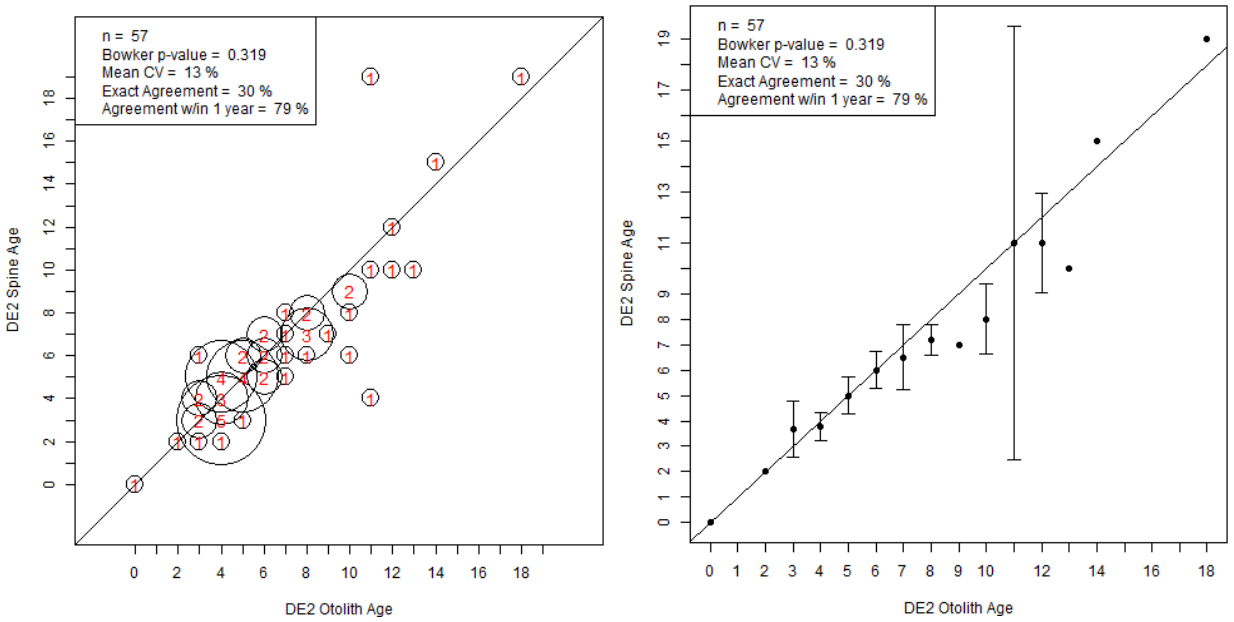


**Figure 31** **Age frequency (left) and age bias (right) plots for DE2 tautog sectioned otoliths and pelvic spine age determinations. Error bars in the age bias plots are 95% confidence intervals.**

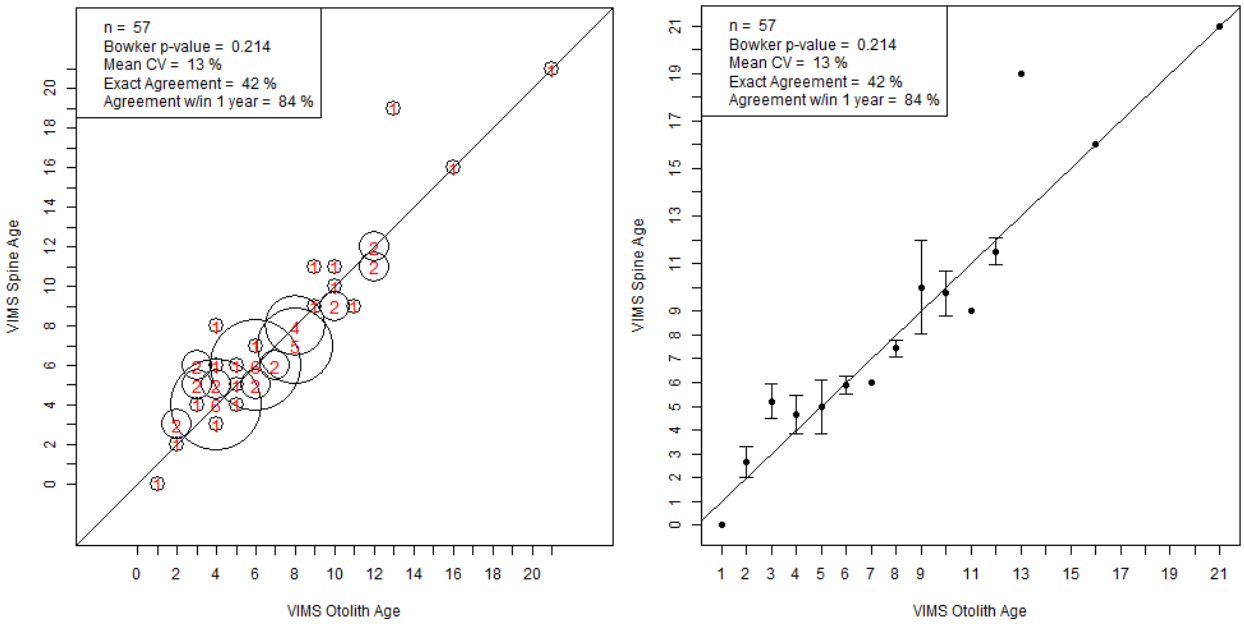


**Figure 32** **Age frequency (left) and age bias (right) plots for VIMS tautog sectioned otoliths and pelvic spine age determinations. Error bars in the age bias plots are 95% confidence intervals.**

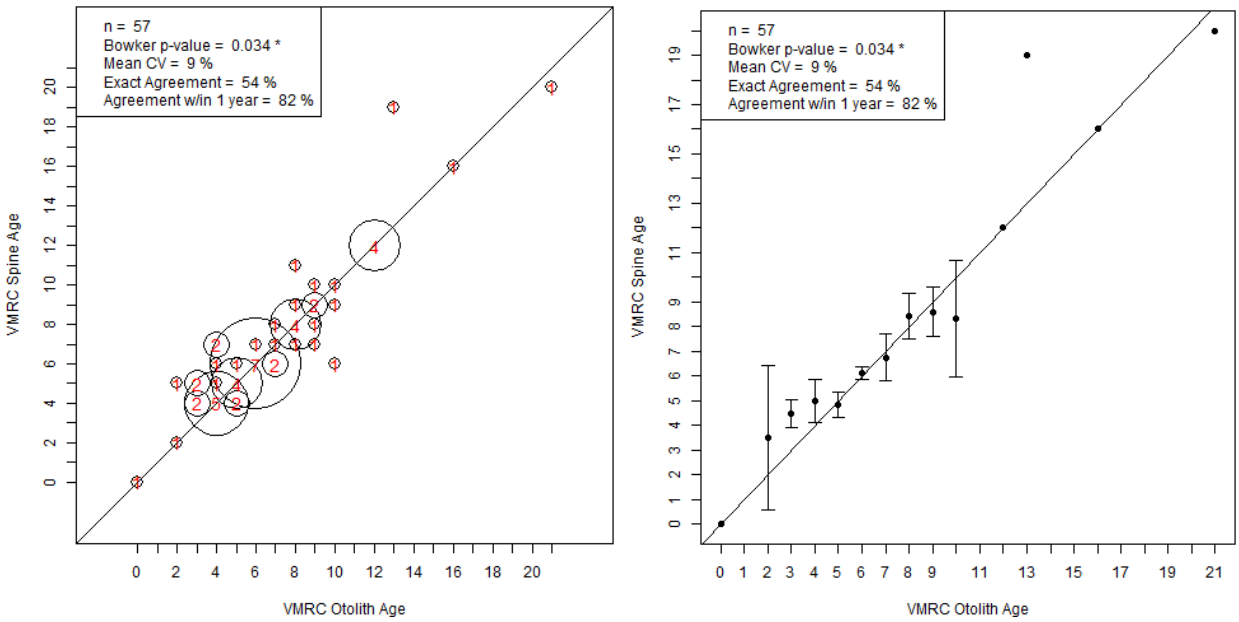


**Figure 33 Age frequency (left) and age bias (right) plots for VMRC tautog sectioned otoliths and pelvic spine age determinations. Error bars in the age bias plots are 95% confidence intervals.**

# Appendix: Sample Photos

Exchange set sample pictures are organized in paired samples of opercula, sectioned otoliths, and pelvic spines. Not all samples in the exchange were photographed. The workshop sample ID has also been provided in parentheses for each picture since the sample ID numbers were reassigned for the exchange set.

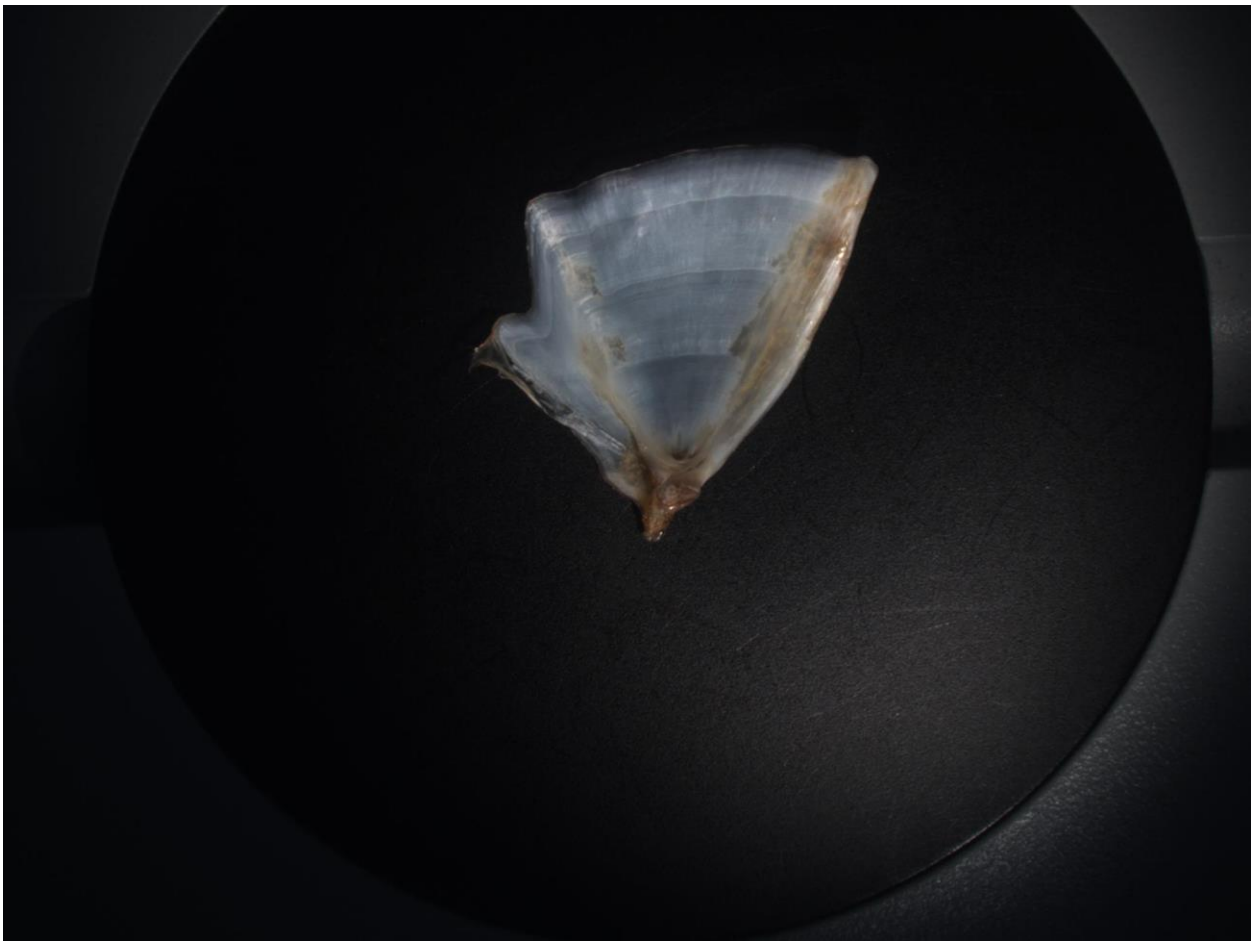

**Figure 1. Operculum sample #1. This is a paired sample with sectioned otolith #21 and pelvic spine #57. This sample was collected from a 352 mm long male tautog which was captured in May, 2019, by MA DMF in their state waters. Participants in the exchange aged this sample from an age 4 to 6, with a mode of age 5. (Workshop #025OP)**

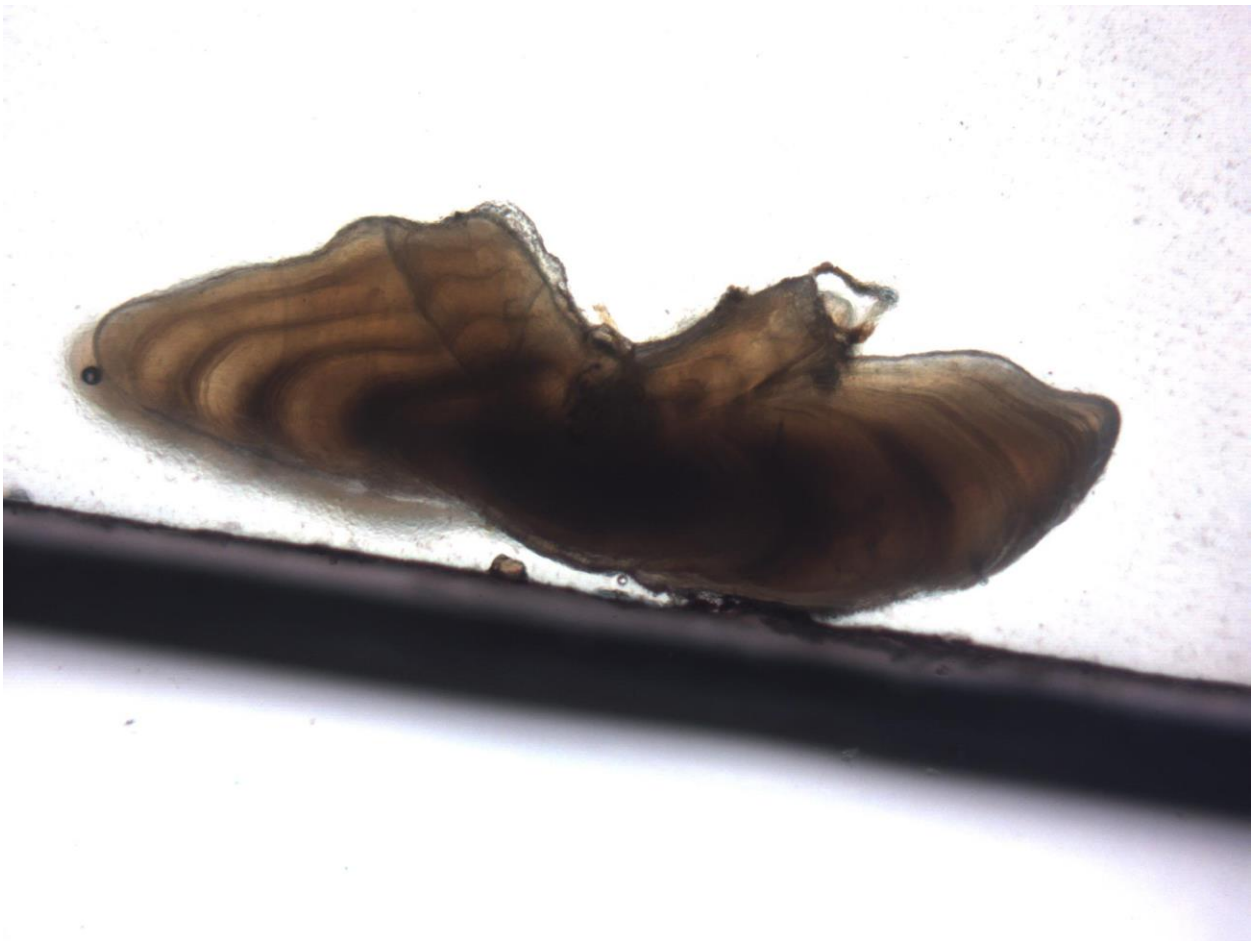

**Figure 2. Sectioned otolith sample #21. This is a paired sample with operculum #1 and pelvic spine #57. This sample was collected from a 352 mm long male tautog which was captured in May, 2019, by MA DMF in their state waters. Participants in the exchange aged this sample from an age 4 to 5, with a mode of age 5. (Workshop #008SO)**

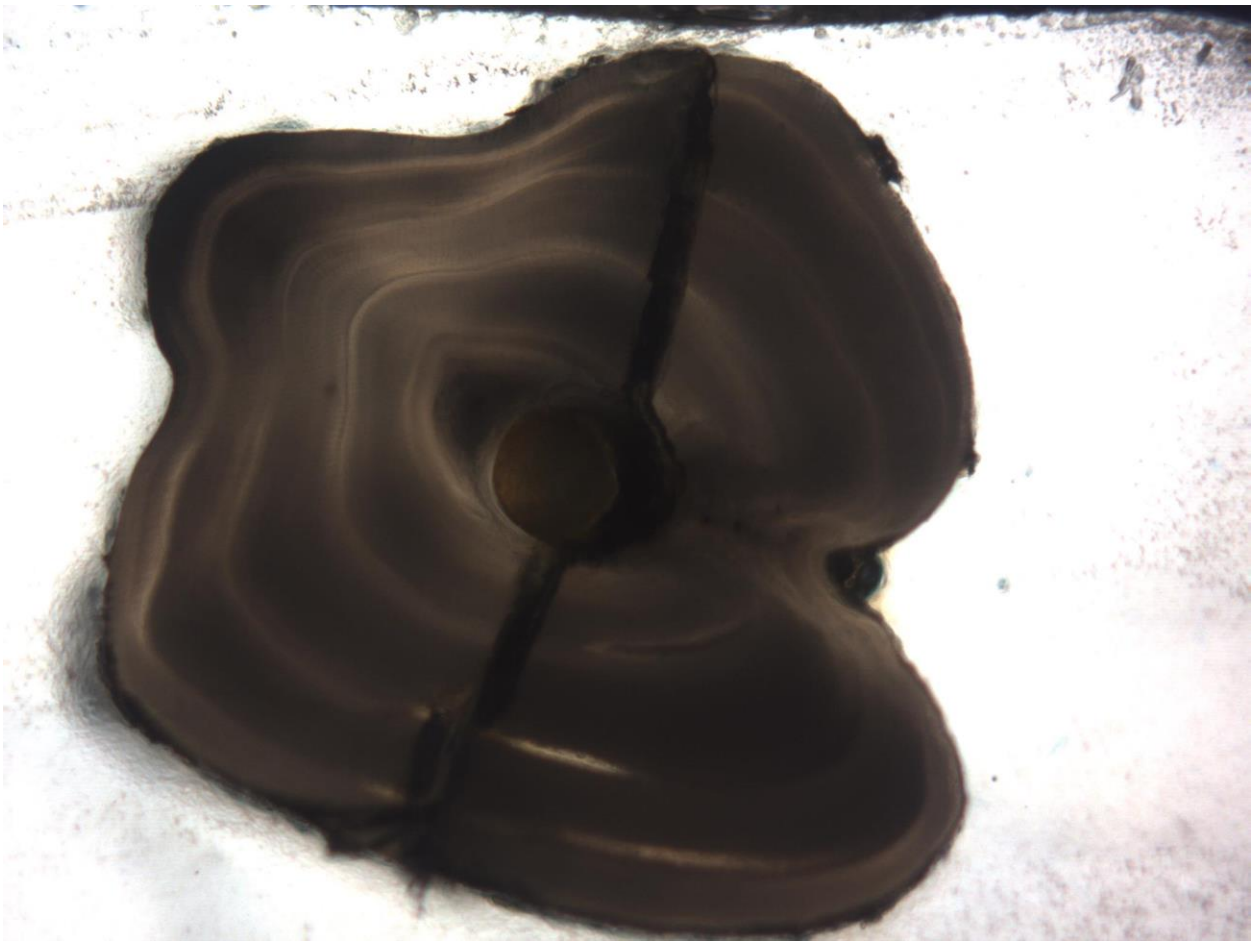

**Figure 3. Pelvic spine sample #57. This is a paired sample with operculum #1 and sectioned otolith #21. This sample was collected from a 352 mm long male tautog which was captured in May, 2019, by MA DMF in their state waters. Participants in the exchange aged this sample from an age 4 to 6, with a mode of age 5. (Workshop #010PS)**

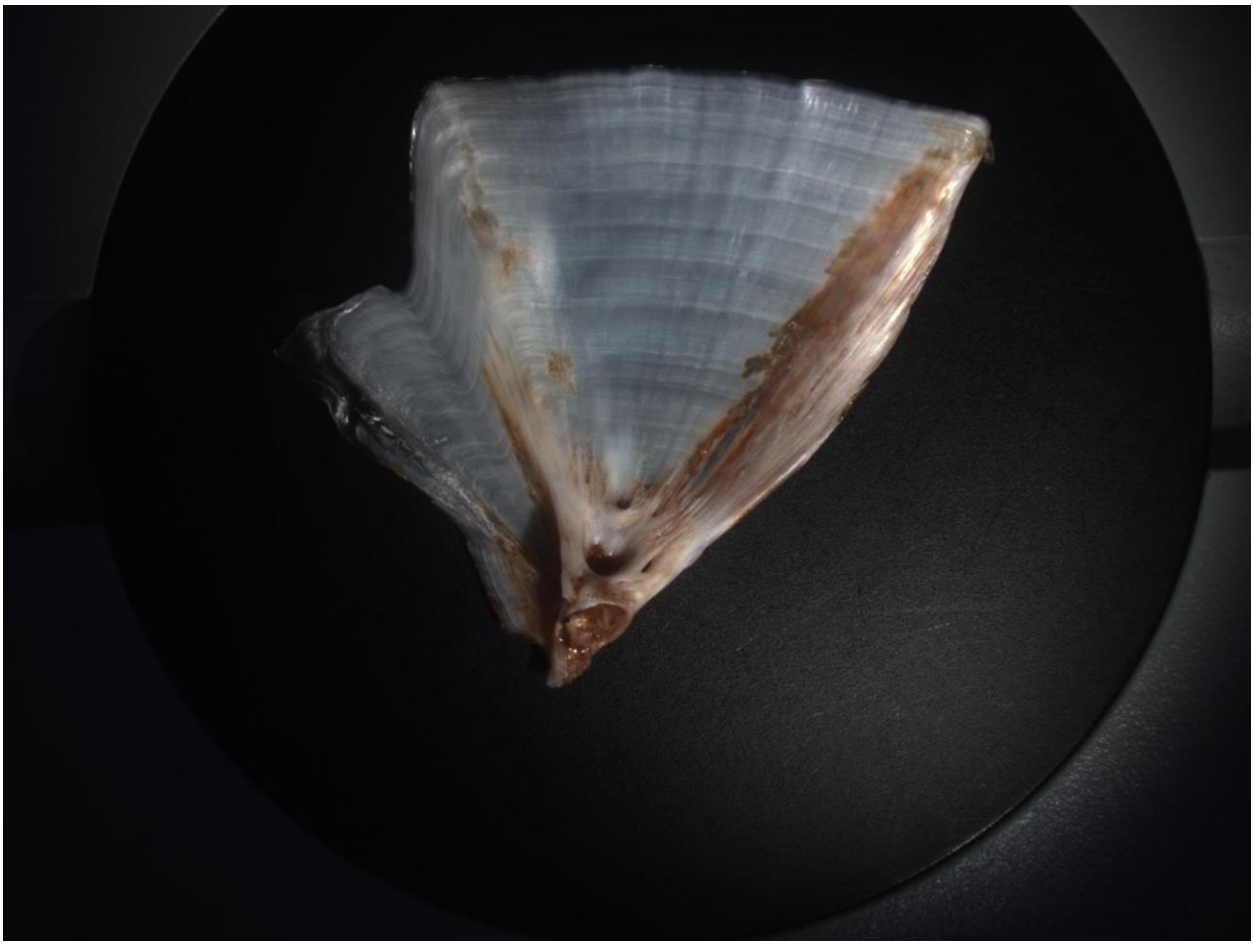

**Figure 4. Operculum sample #3. This is a paired sample with sectioned otolith #54 and pelvic spine #73. This sample was collected from a 543 mm long tautog which was captured in December, 2018, by MD DNR in their state waters. Participants in the exchange aged this sample from an age 11 to 15, with a mode of age 11. (Workshop #028OP)**

**Figure 5. Sectioned otolith sample #54. This is a paired sample with operculum #3 and pelvic spine #73. This sample was collected from a 543 mm long tautog which was captured in December, 2018, by MD DNR in their state waters. Participants in the exchange aged this sample from an age 11 to 12, with a mode of age 12. (Workshop #028SO)**

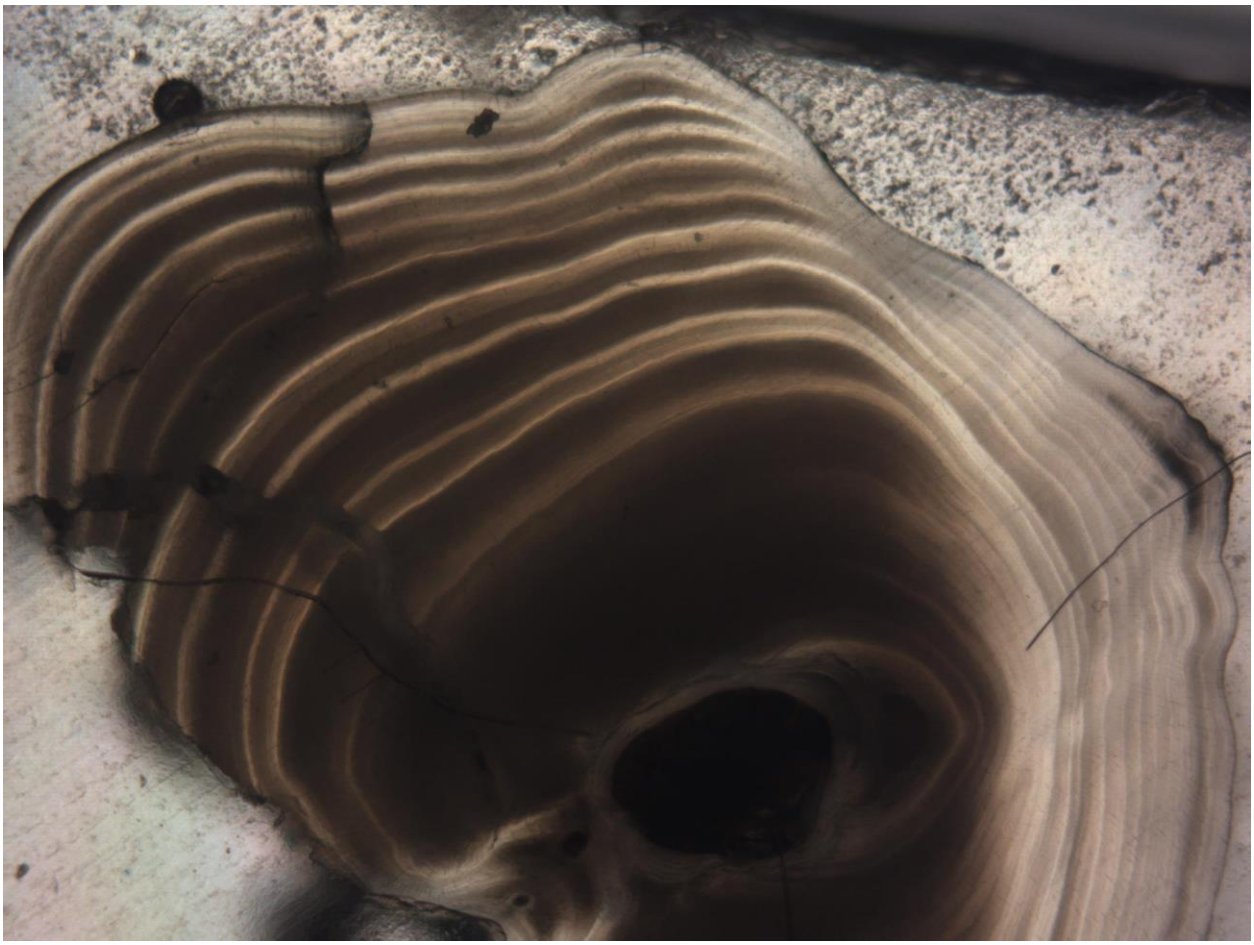

**Figure 6. Pelvic spine sample #73. This is a paired sample with operculum #3 and sectioned otolith #54. This sample was collected from a 543 mm long tautog which was captured in December, 2018, by MD DNR in their state waters. Participants in the exchange aged this sample from an age 11 to 12, with a mode of age 12. (Workshop #042PS)**

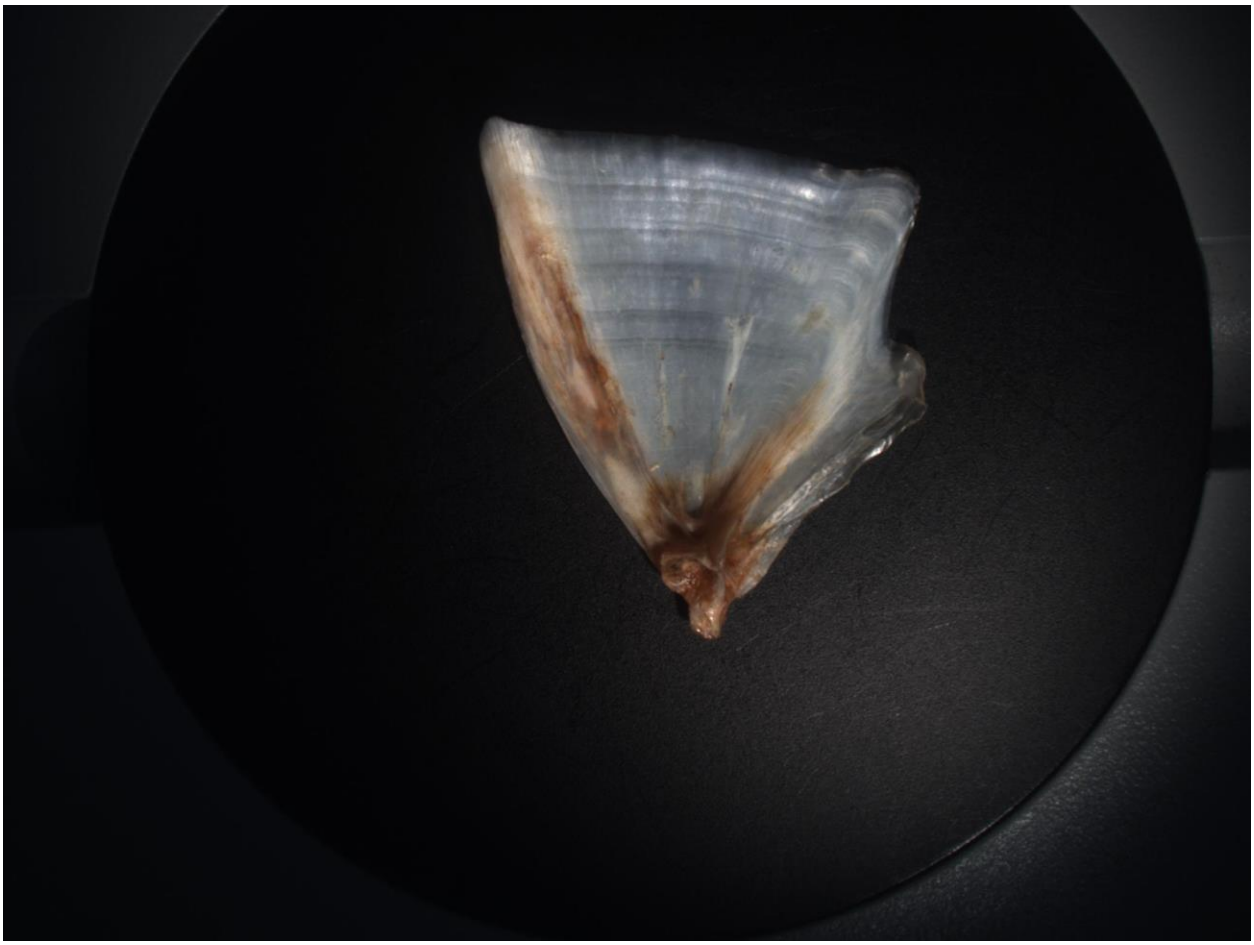

**Figure 7. Operculum sample #6. This is a paired sample with sectioned otolith #18 and pelvic spine #46. This sample was collected from a 440 mm long male tautog which was captured in December, 2018, by MD DNR in their state waters. Participants in the exchange aged this sample from an age 5 to 9, with a mode of age 7. (Workshop #018OP)**

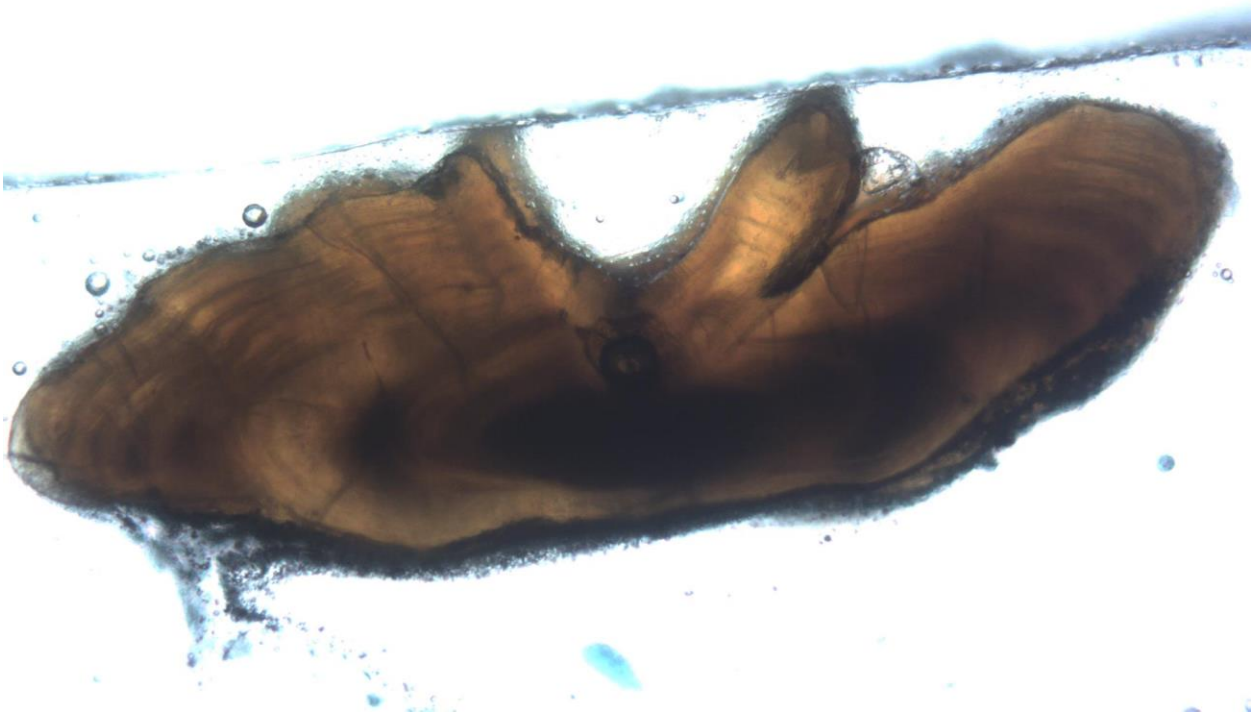

**Figure 8. Sectioned otolith sample #18. This is a paired sample with operculum #6 and pelvic spine #46. This sample was collected from a 440 mm long male tautog which was captured in December, 2018, by MD DNR in their state waters. Participants in the exchange aged this sample from an age 6 to 7, with a mode of age 6. (Workshop #037SO)**

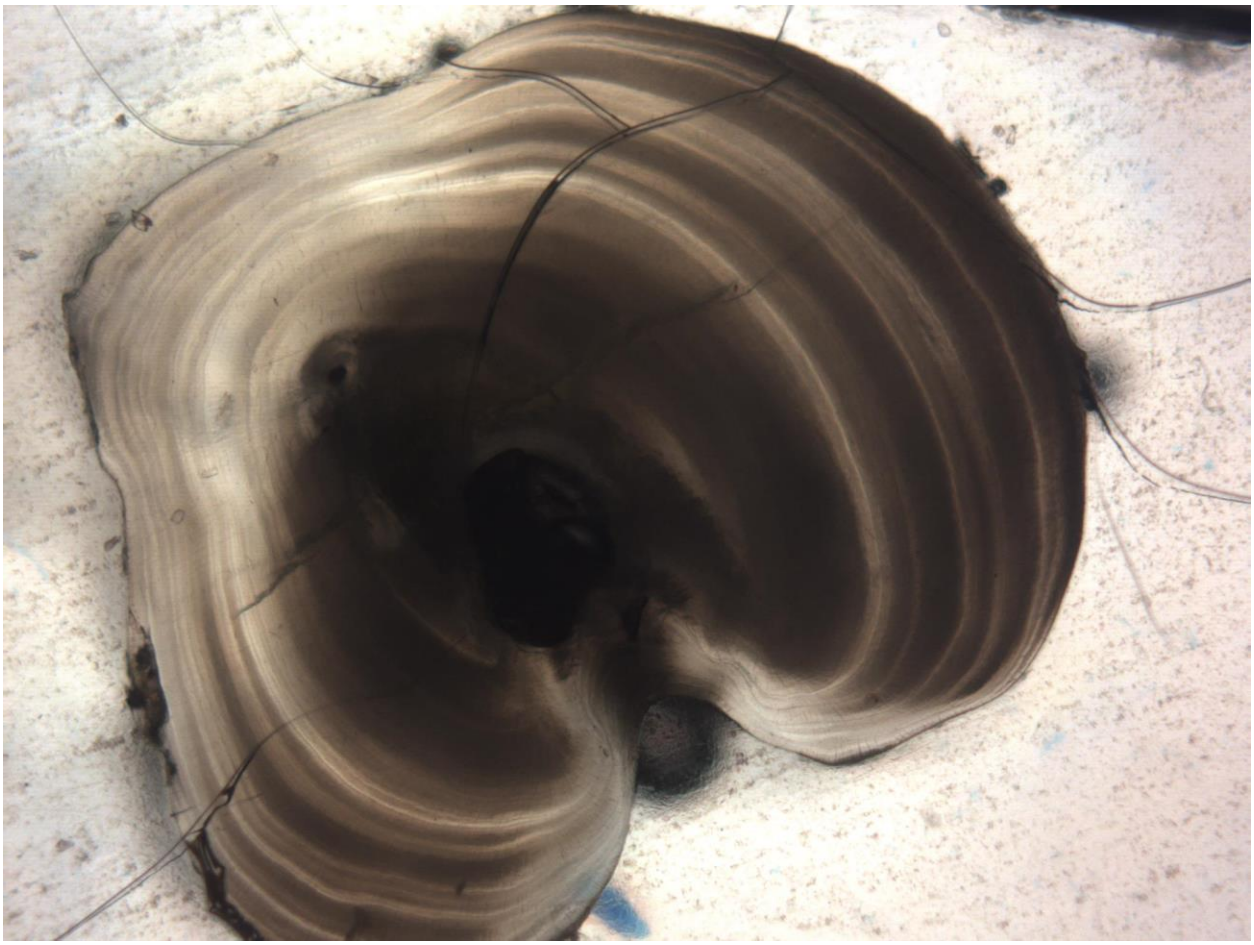

**Figure 9. Pelvic spine sample #46. This is a paired sample with operculum #6 and sectioned otolith #18. This sample was collected from a 440 mm long male tautog which was captured in December, 2018, by MD DNR in their state waters. Participants in the exchange aged this sample from an age 4 to 7, with a mode of age 7. (Workshop #014PS)**

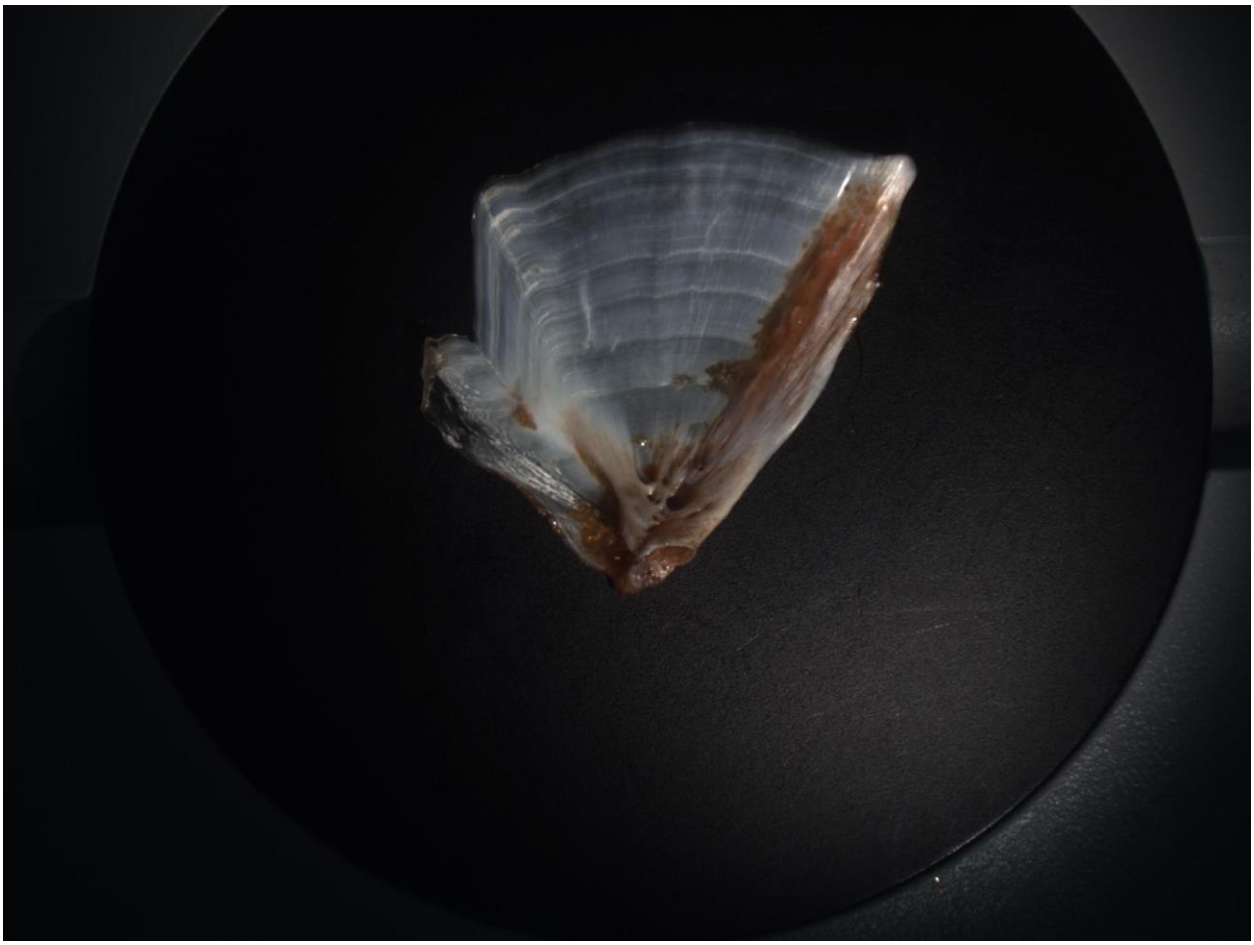

**Figure 10. Operculum sample #7. This is a paired sample with sectioned otolith #9 and pelvic spine #12. This sample was collected from a 442 mm long female tautog which was captured in November, 2018, by MD DNR in their state waters. Participants in the exchange aged this sample from an age 7 to 9, with a mode of age 8. (Workshop #037OP)**

**Figure 11. Sectioned otolith #9 sample. This is a paired sample with operculum #7 and pelvic spine #12. This sample was collected from a 442 mm long female tautog which was captured in November, 2018, by MD DNR in their state waters. Participants in the exchange aged this sample from an age 7 to 9, with a mode of age 9. (Workshop #039SO)**

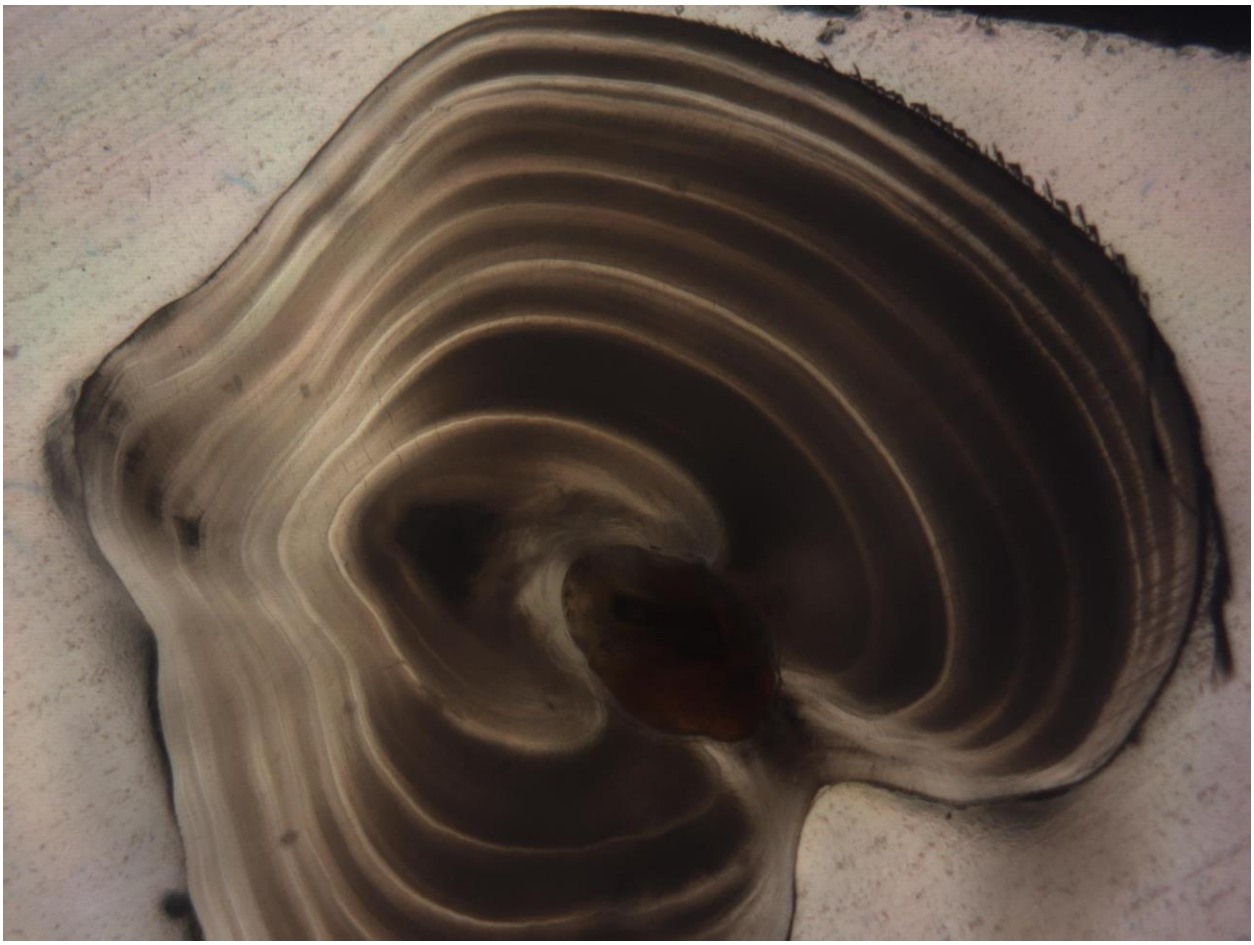

**Figure 12. Pelvic spine sample #12. This is a paired sample with operculum #7 and sectioned otolith #9. This sample was collected from a 442 mm long female tautog which was captured in November, 2018, by MD DNR in their state waters. Participants in the exchange aged this sample from an age 7 to 9, with a mode of age 8. (Workshop #038PS)**

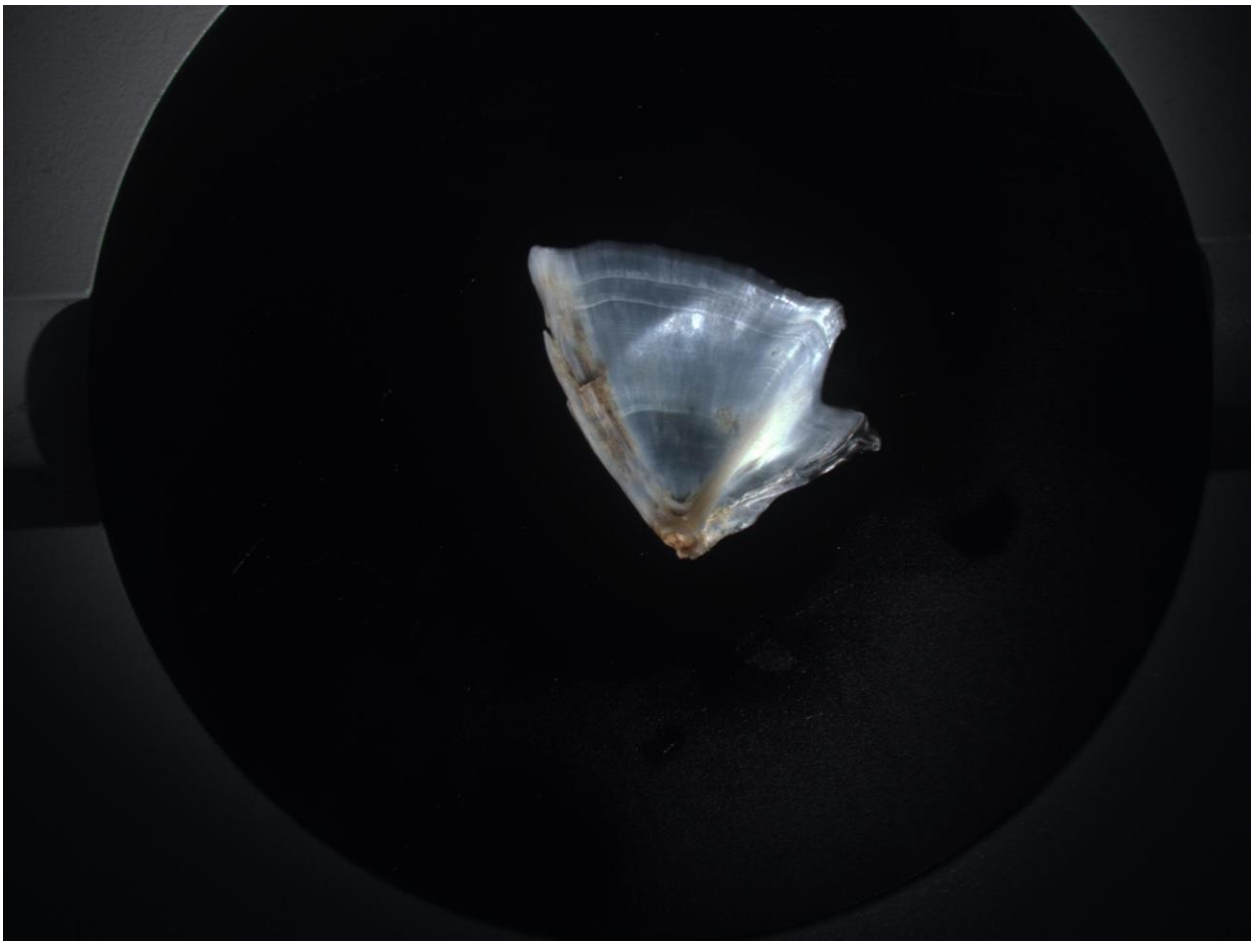

**Figure 13. Operculum sample #8. This is a paired sample with sectioned otolith #19 and pelvic spine #27. This sample was collected from a 320 mm long female tautog which was captured in September, 2019, by RI DEM in their state waters. Participants in the exchange aged this sample from an age 3 to 4, with a mode of age 3. (Workshop #004OP)**

**Figure 14. Sectioned otolith sample #19. This is a paired sample with operculum #8 and pelvic spine #27. This sample was collected from a 320 mm long female tautog which was captured in September, 2019, by RI DEM in their state waters. Participants in the exchange aged this sample from an age 3 to 4, with a mode of age 4. (Workshop #015SO)**

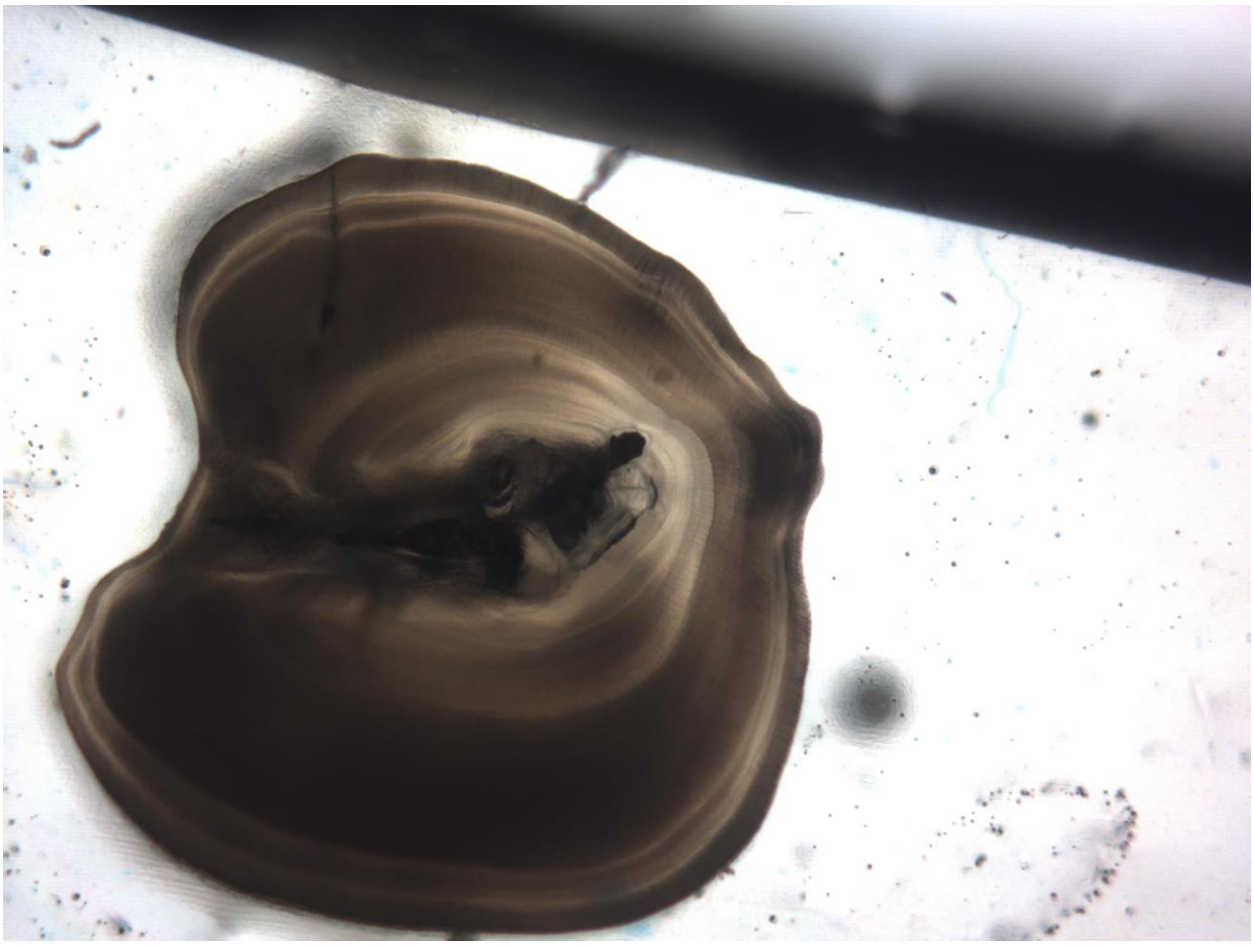

**Figure 15. Pelvic spine sample #27. This is a paired sample with operculum #8 and sectioned otolith #19. This sample was collected from a 320 mm long female tautog which was captured in September, 2019, by RI DEM in their state waters. Participants in the exchange aged this sample from an age 3 to 5, with a mode of age 3. (Workshop #033PS)**

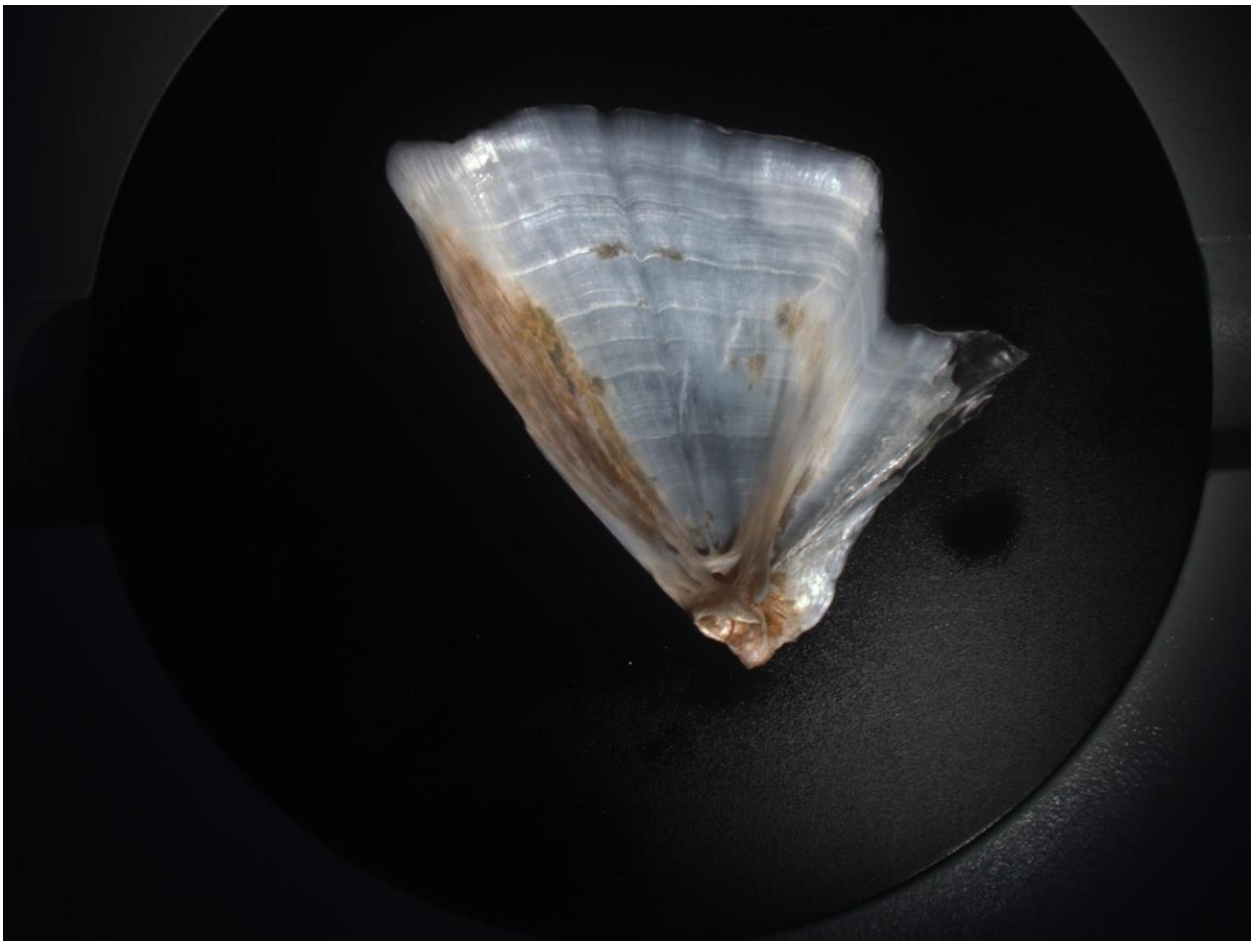

**Figure 16. Operculum sample #10. This is a paired sample with sectioned otolith #55 and pelvic spine #4. This sample was collected from a 480 mm long male tautog which was captured in April, 2019, by RI DEM in their state waters. Participants in the exchange aged this sample from an age 8 to 10, with a mode of age 8. (Workshop #017OP)**

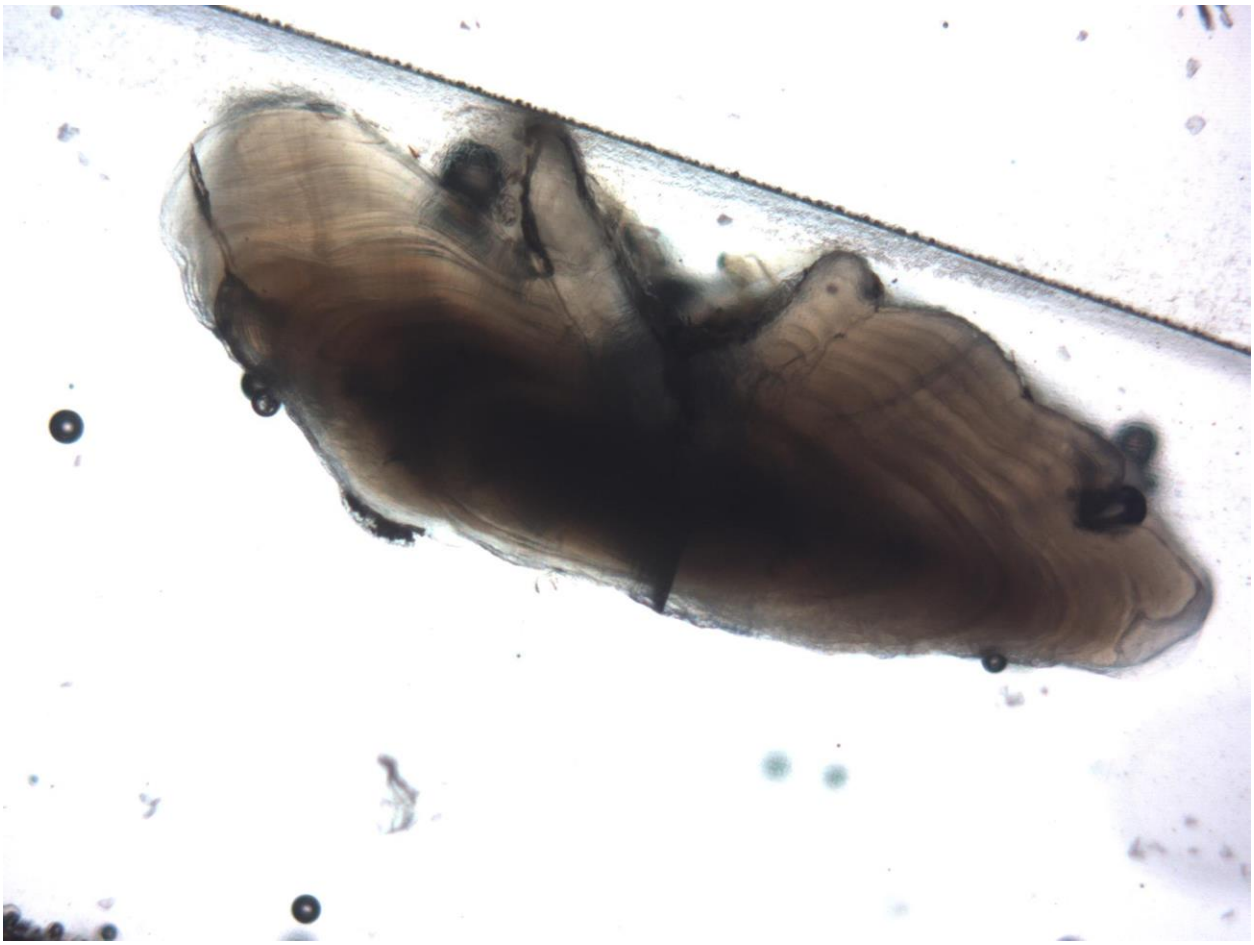

**Figure 17. Sectioned otolith sample #55. This is a paired sample with operculum #10 and pelvic spine #4. This sample was collected from a 480 mm long male tautog which was captured in April, 2019, by RI DEM in their state waters. Participants in the exchange aged this sample from an age 7 to 8, with a mode of age 8. (Workshop #005SO)**

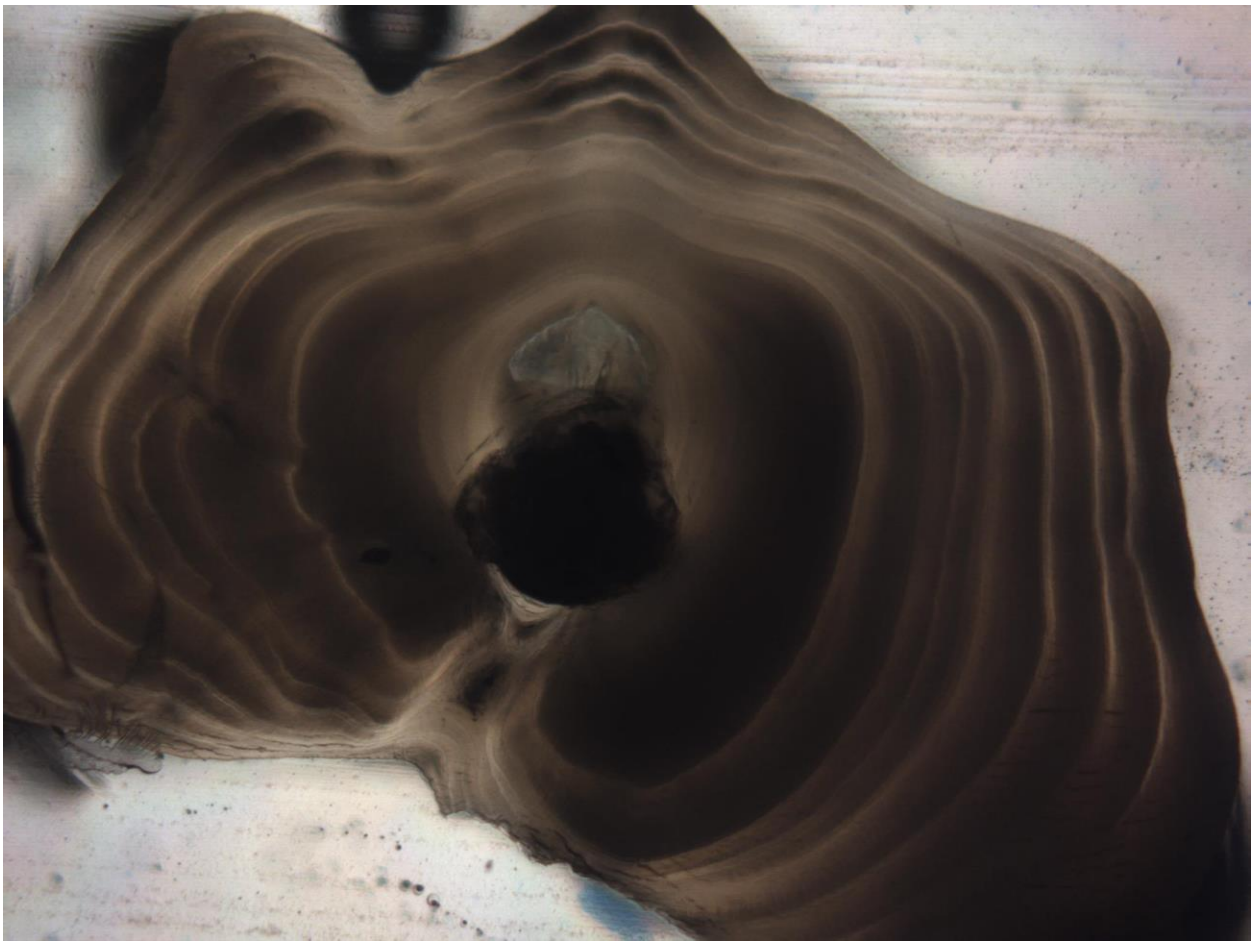

**Figure 18. Pelvic spine sample #4. This is a paired sample with operculum #10 and sectioned otolith #55. This sample was collected from a 480 mm long male tautog which was captured in April, 2019, by RI DEM in their state waters. Participants in the exchange aged this sample from an age 7 to 9, with a mode of age 9. (Workshop #029PS)**

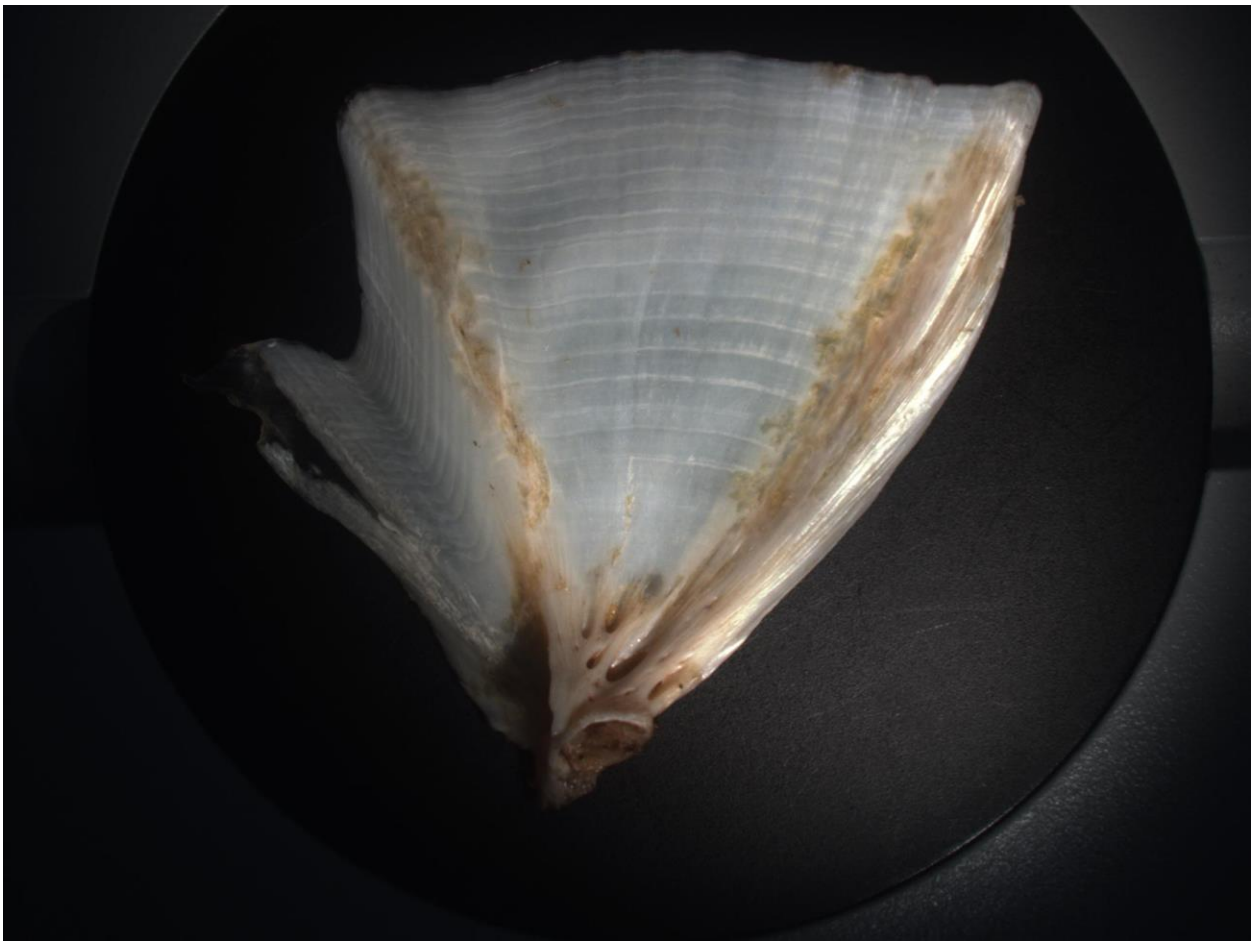

**Figure 19. Operculum sample #12. This is a paired sample with pelvic spine #69 (no paired otolith sample). This sample was collected from a 640 mm long female tautog which was captured in December, 2018, by MD DNR in their state waters. Participants in the exchange aged this sample from an age 20 to 21, with a mode of age 21. (Workshop #042OP)**

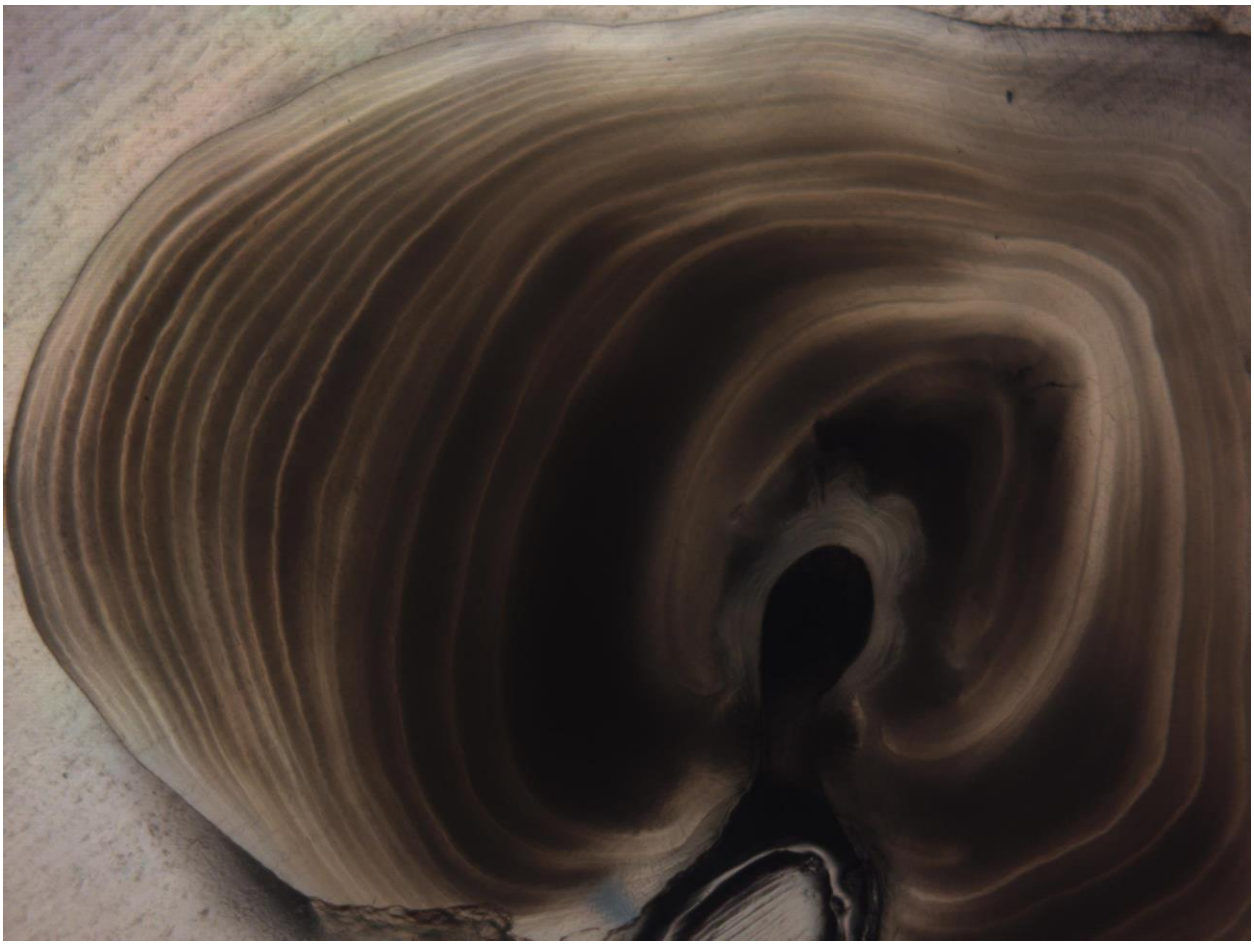

**Figure 20. Pelvic spine sample #69. This is a paired sample with operculum #12 (no paired otolith sample). This sample was collected from a 640 mm long female tautog which was captured in December, 2018, by MD DNR in their state waters. Participants in the exchange aged this sample from an age 7 to 21, with a mode of age 20. (Workshop #039PS)**

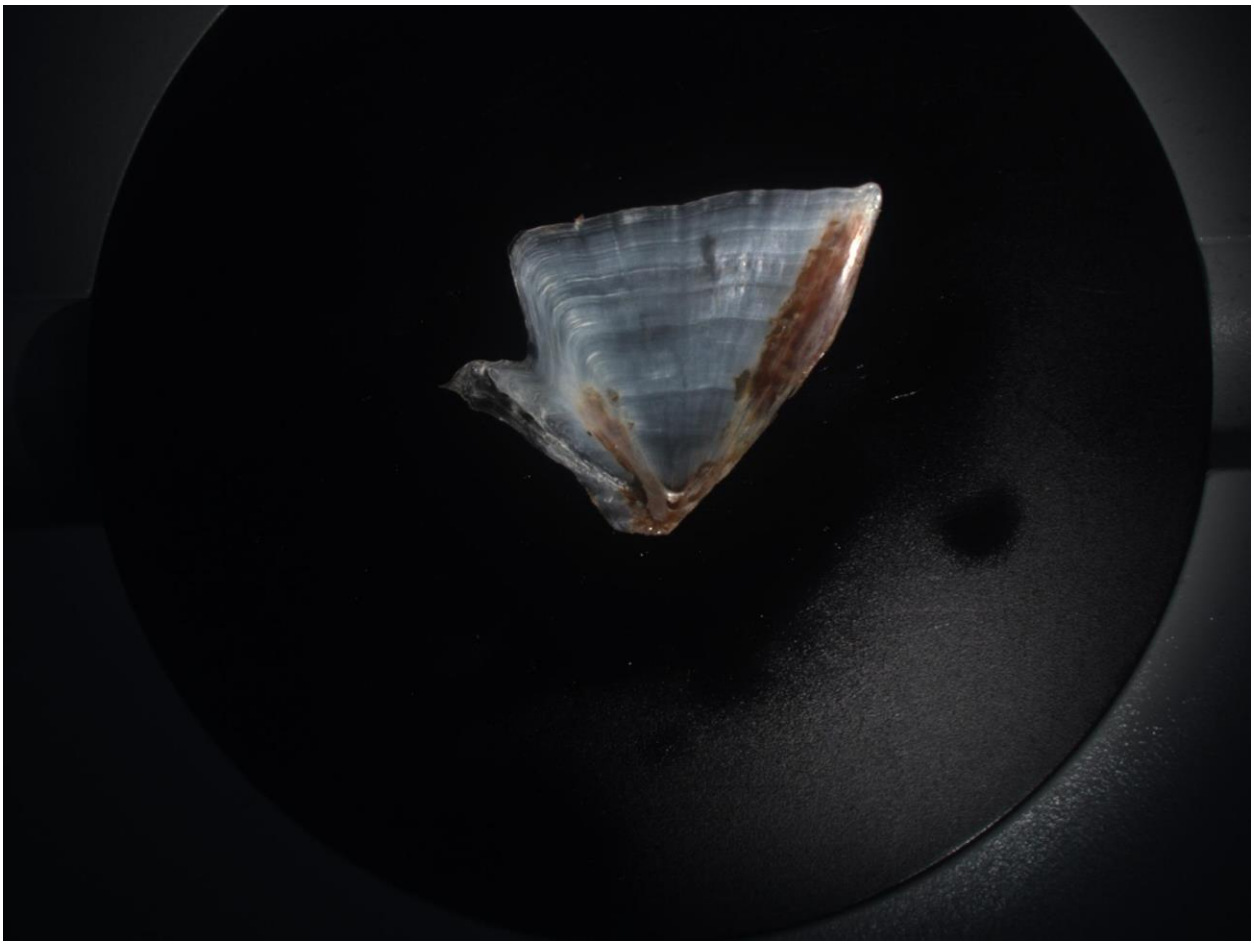

**Figure 21. Operculum sample #14. This is a paired sample with sectioned otolith #57 and pelvic spine #52. Sample was from a tautog that was 325 mm long. This tautog was captured in October 2017 in New Jersey waters by VIMS. Participants in the exchange aged this sample from an age 5 to 8, with a mode of age 6. (Workshop #015OP)**

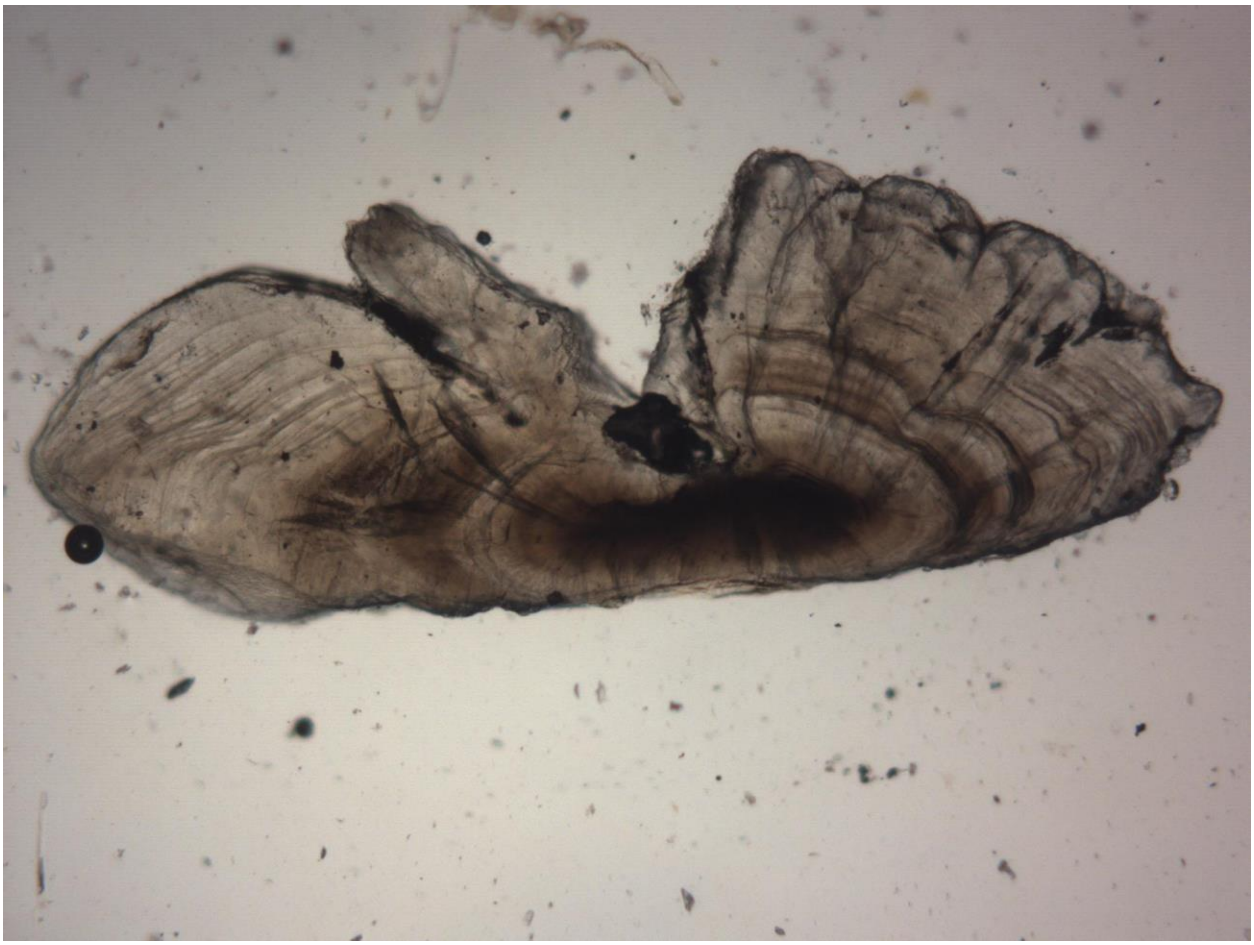

**Figure 22. Sectioned otolith sample #57. This is a paired sample with operculum #14 and pelvic spine #52. Sample was from a tautog that was 325 mm long. This tautog was captured in October 2017 in New Jersey waters by VIMS. Participants in the exchange aged this sample from an age 6 to 9, with a mode of age 8. Sample was removed from the analysis due to unreadability. (Workshop #032SO)**

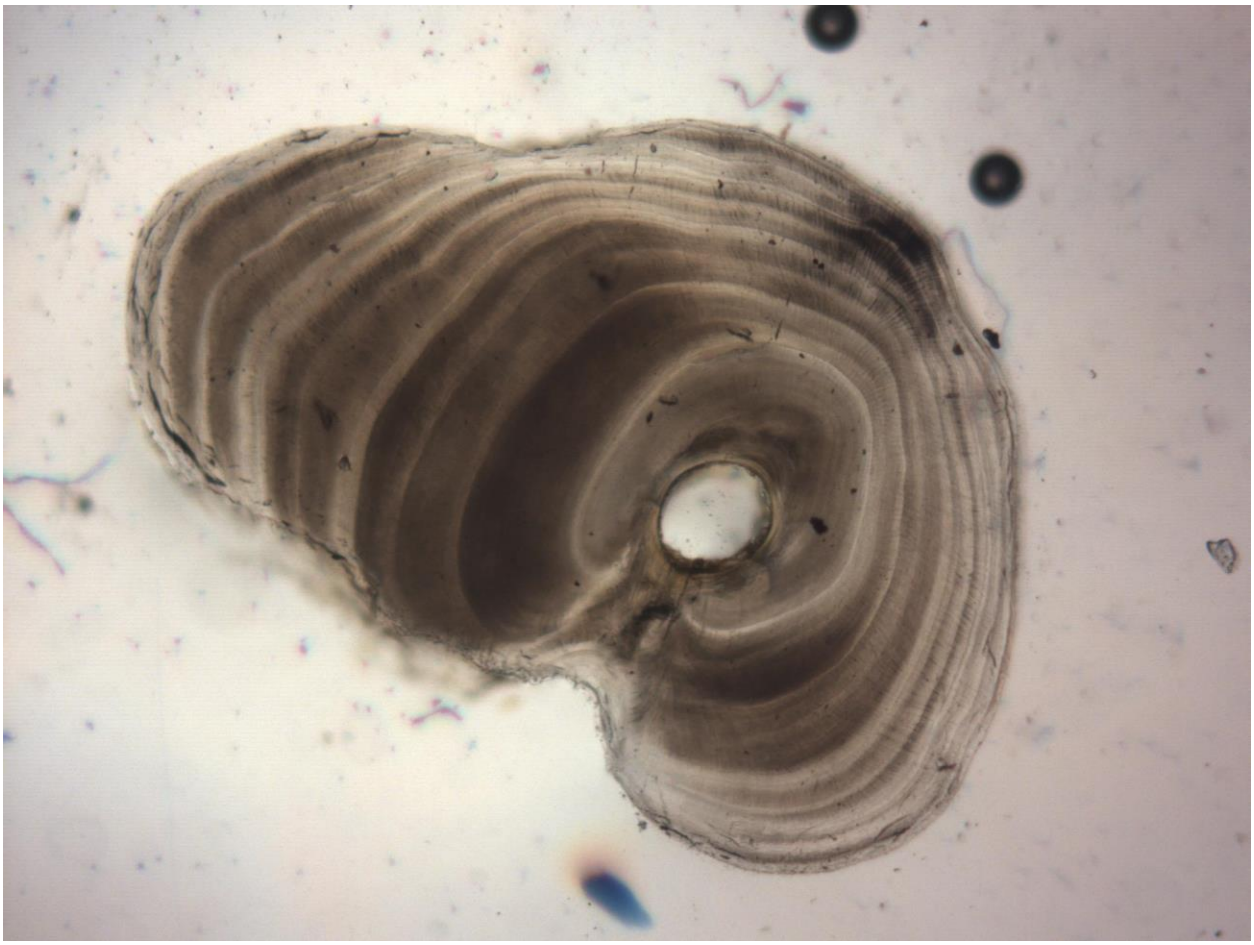

**Figure 23. Pelvic spine sample #52. This is a paired sample with operculum #14 and sectioned otolith #57. Sample was from a tautog that was 325 mm long. This tautog was captured in October 2017 in New Jersey waters by VIMS. Participants in the exchange aged this sample from an age 7 to 11, with a mode of age 8. (Workshop #037PS)**

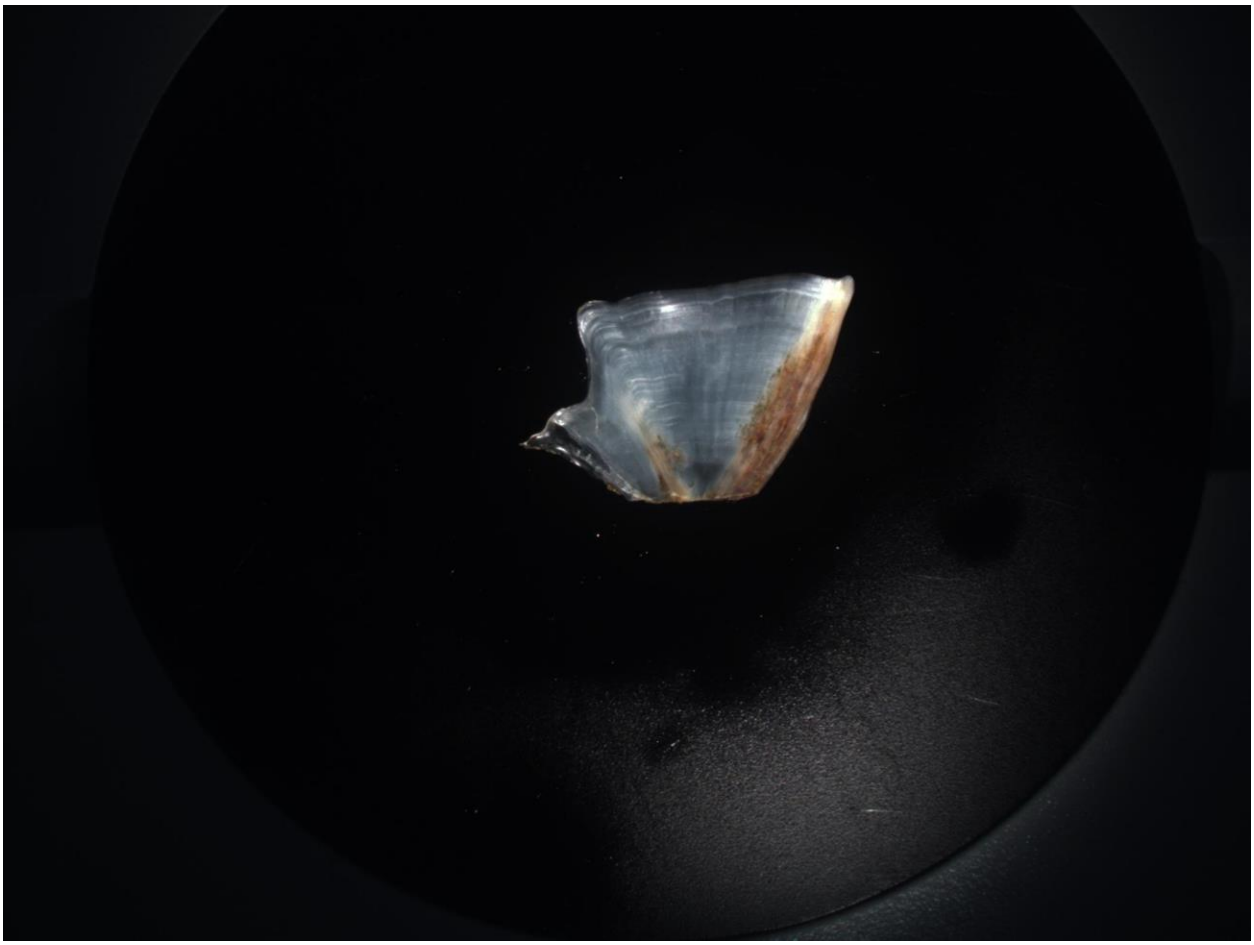

**Figure 24. Operculum sample #19. This is a paired sample with sectioned otolith #16 and pelvic spine #72. Sample was from a tautog that was 275 mm long. This tautog was captured in October 2017 in New Jersey waters by VIMS. Participants in the exchange aged this sample from an age 2 to 3, with a mode of age 2. This sample was removed from the analysis because participants suspected that there were opercula from multiple fish in the sample envelope. (Workshop #012OP)**

**Figure 25. Sectioned otolith sample #16. This is a paired sample with operculum #19 and pelvic spine #72. Sample was from a tautog that was 275 mm long. This tautog was captured in October 2017 in New Jersey waters by VIMS. Participants in the exchange aged this sample from an age 3 to 6, with a mode of age 2. (Workshop #004SO)**

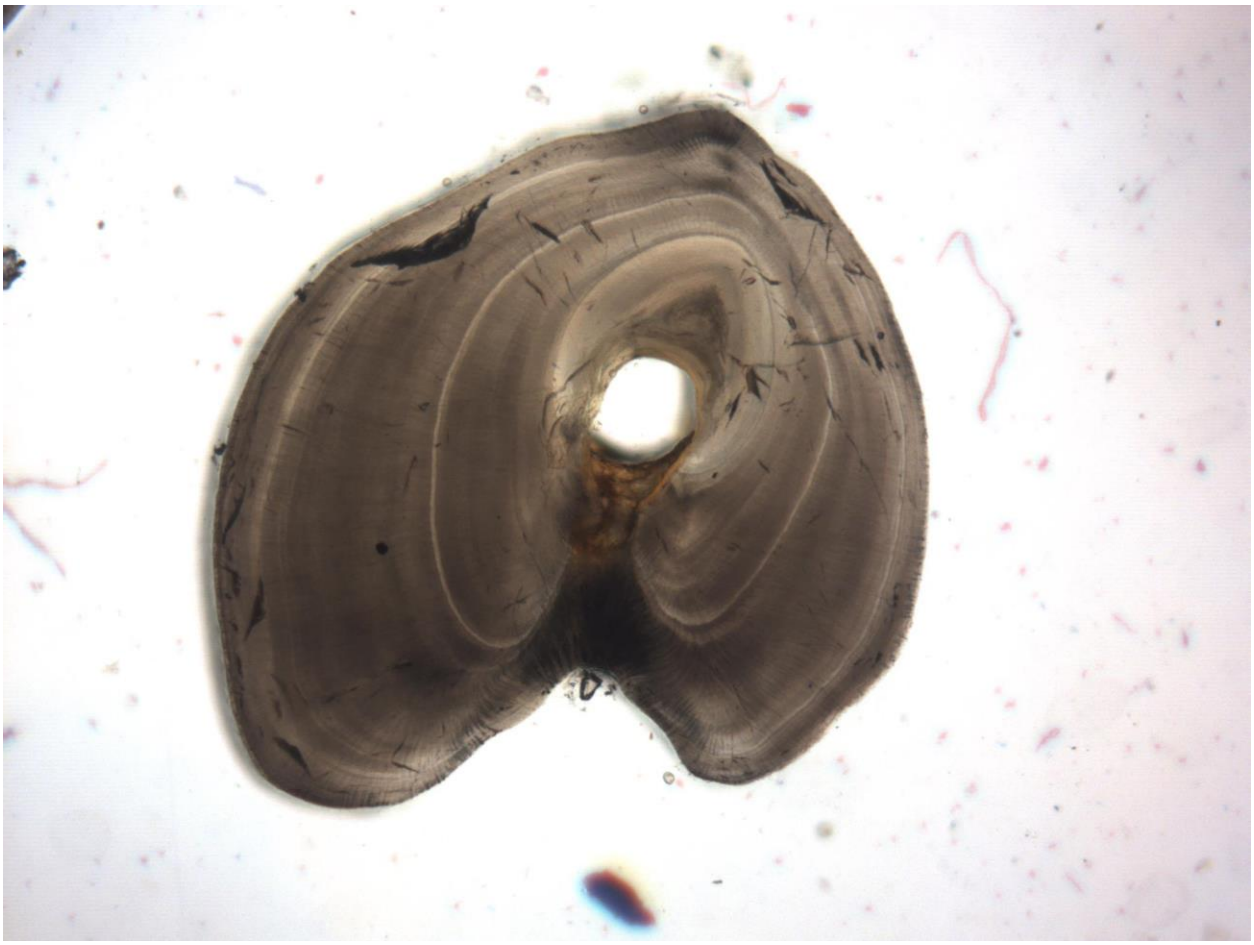

**Figure 26. Pelvic spine sample #72. This is a paired sample with operculum #19 and sectioned otolith #16. Sample was from a tautog that was 275 mm long. This tautog was captured in October 2017 in New Jersey waters by VIMS. Participants in the exchange aged this sample from an age 2 to 4, with a mode of age 3. (Workshop #023PS)**

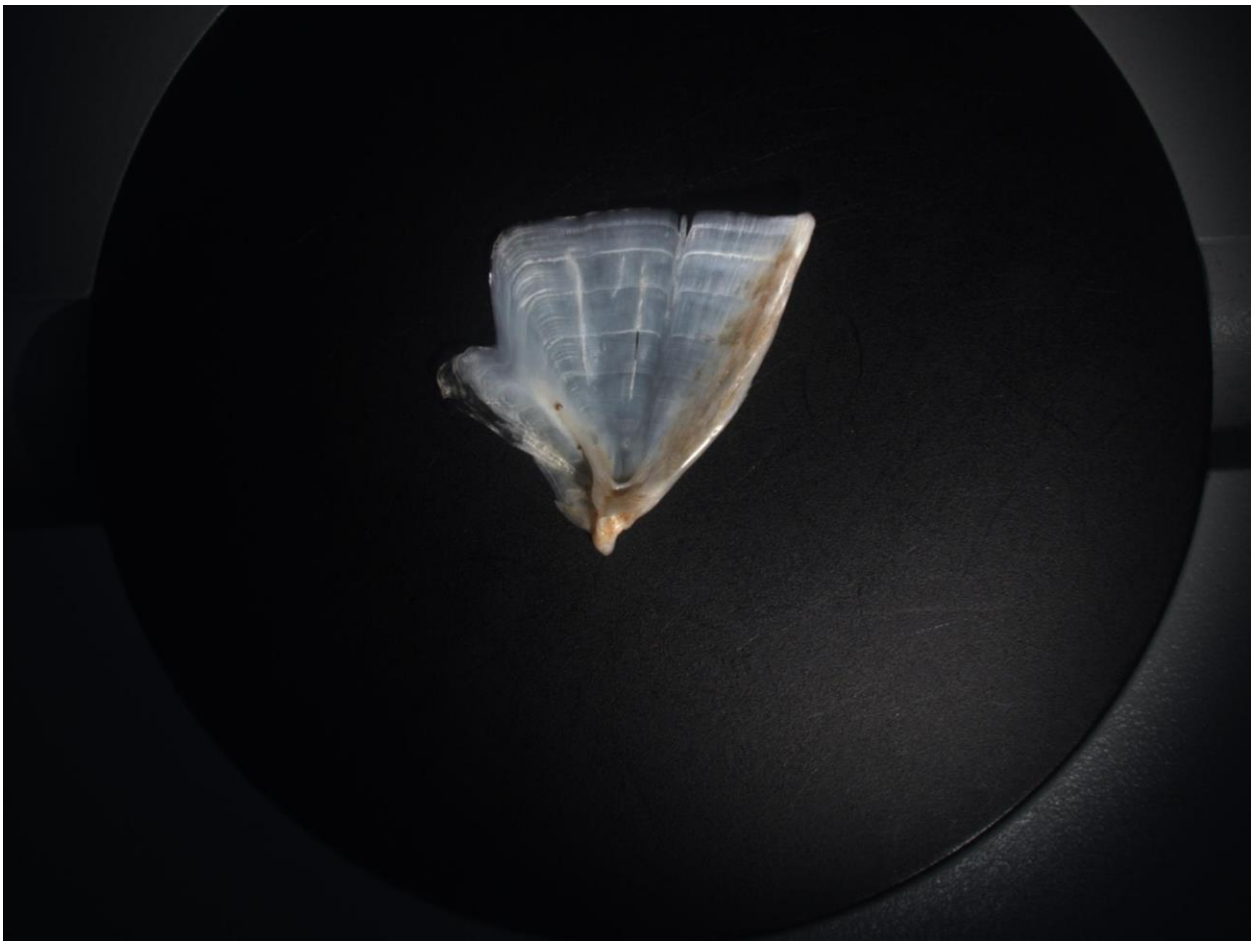

**Figure 27. Operculum sample #21. This is a paired sample with sectioned otolith #62 and pelvic spine #61. This sample was collected from a 313 mm long female tautog which was captured in August, 2019, by RI DEM in their state waters. Participants in the exchange aged this sample from an age 5 to 7, with a mode of age 6. (Workshop #035OP)**

**Figure 28. Sectioned otolith sample #62. This is a paired sample with operculum #21 and pelvic spine #61. This sample was collected from a 313 mm long female tautog which was captured in August, 2019, by RI DEM in their state waters. Participants in the exchange aged this sample from an age 4 to 6, with a mode of age 5. (Workshop #017SO)**

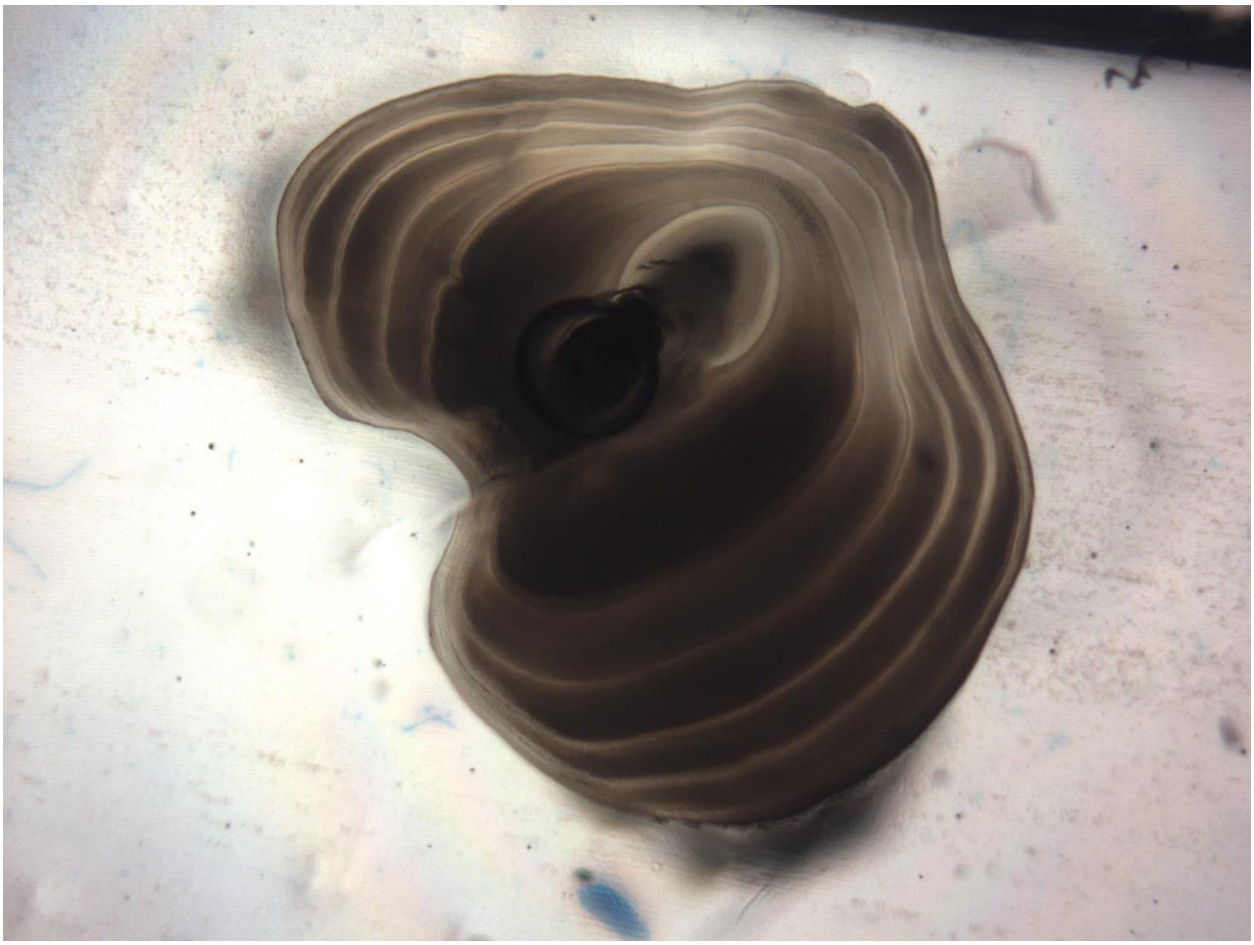

**Figure 29. Pelvic spine sample #61. This is a paired sample with sectioned otolith sample #62 and operculum #21. This sample was collected from a 313 mm long female tautog which was captured in August, 2019, by RI DEM in their state waters. Participants in the exchange aged this sample from an age 5 to 7, with a mode of age 6. (Workshop #001PS)**

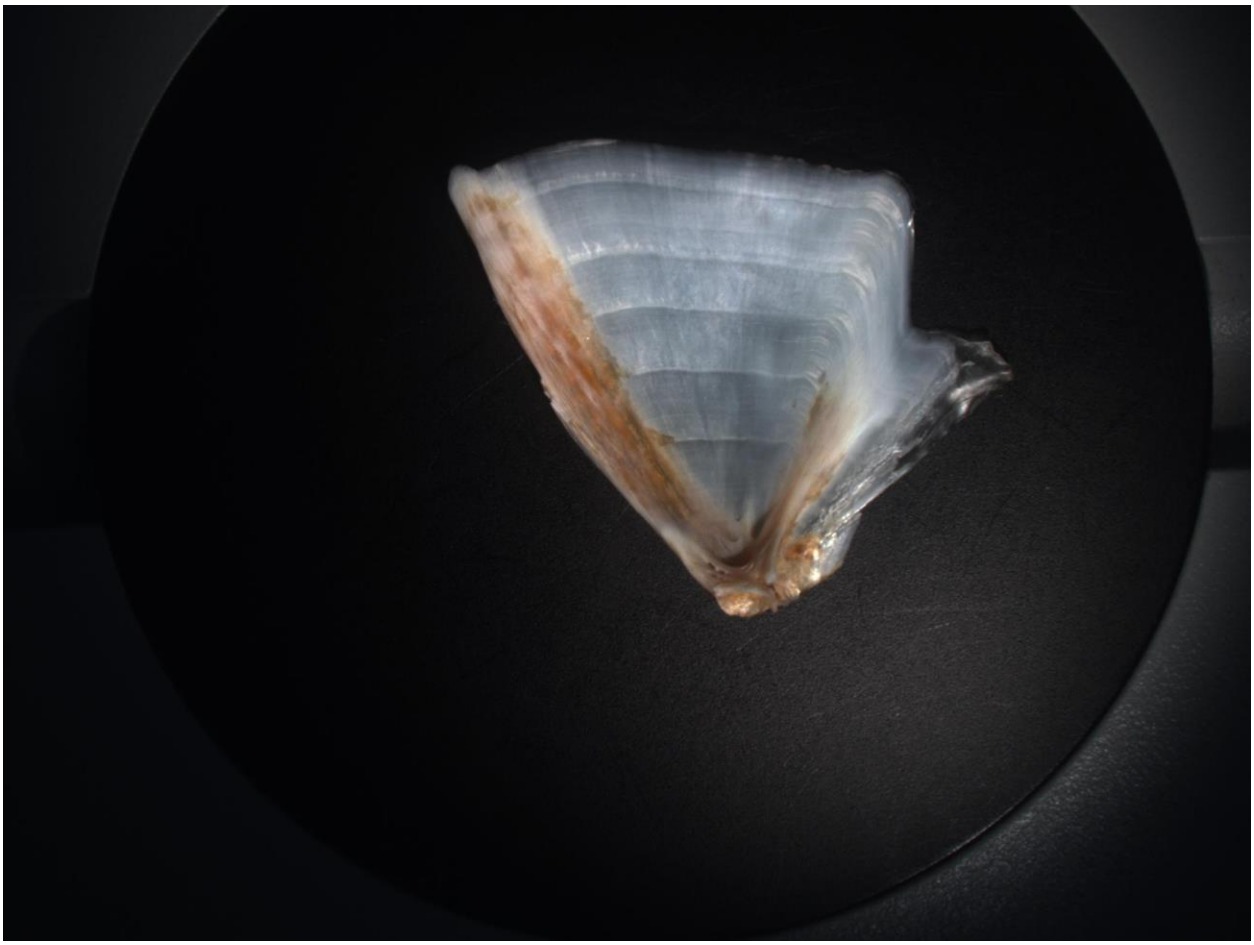

**Figure 30. Operculum sample #23. This is a paired sample with sectioned otolith #52 and pelvic spine #36. This sample was collected from a 450 mm long male tautog which was captured in November, 2018, by RI DEM in their state waters. Participants in the exchange aged this sample from an age 5 to 8, with a mode of age 6. (Workshop #024OP)**

**Figure 31. Sectioned otolith sample #52. This is a paired sample with operculum #23 and pelvic spine #36. This sample was collected from a 450 mm long male tautog which was captured in November, 2018, by RI DEM in their state waters. All participants aged this sample as 6 years-old. (Workshop #016SO)**

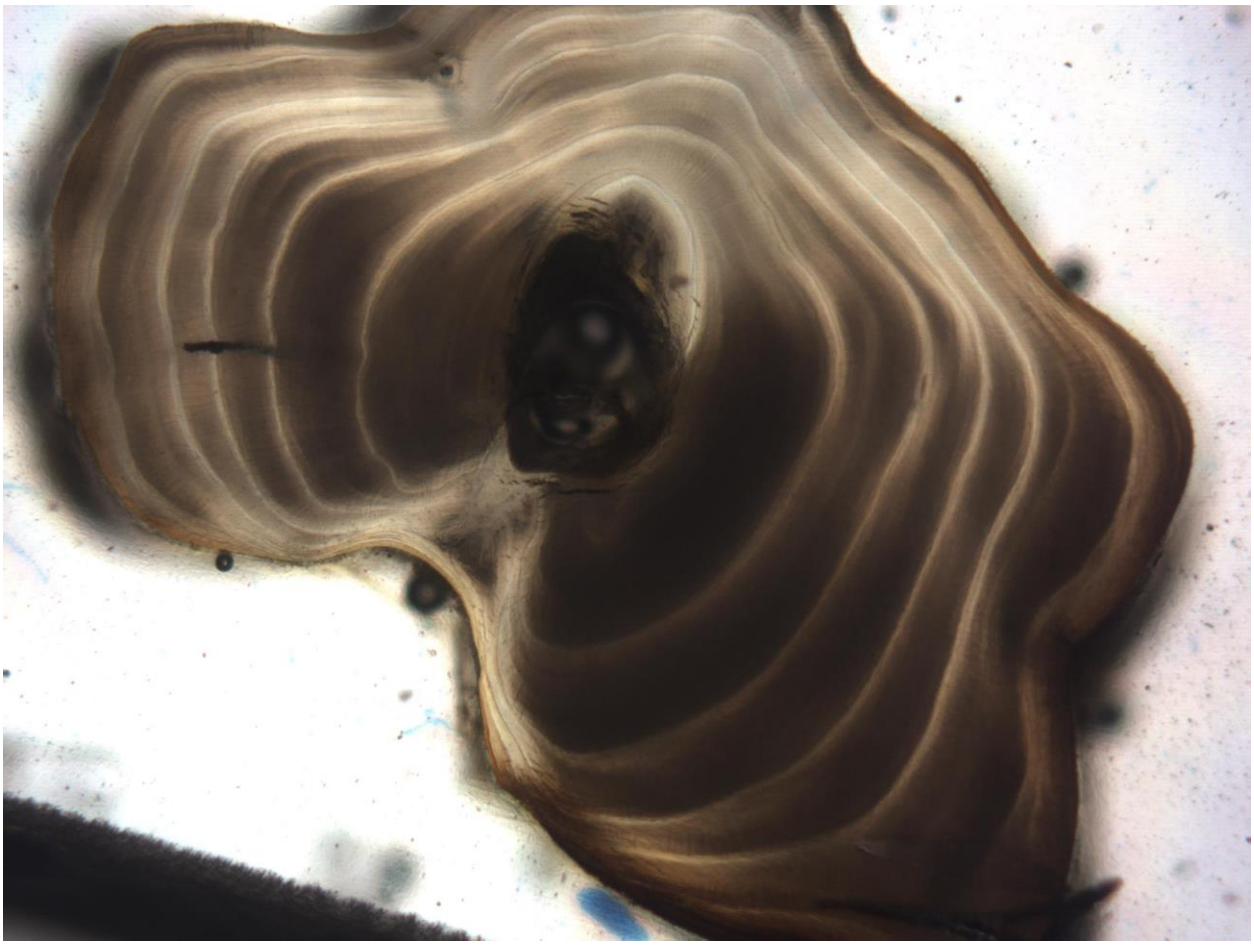

**Figure 32. Pelvic spine sample #36. This is a paired sample with sectioned otolith #52 and operculum #23. This sample was collected from a 450 mm long male tautog which was captured in November, 2018, by RI DEM in their state waters. Participants in the exchange aged this sample from an age 5 to 7, with a mode of age 6. (Workshop #035PS)**

**Figure 33. Operculum sample #26. This is a paired sample with sectioned otolith #20 and pelvic spine #31. This sample was collected from a 52 mm long tautog which was captured in September, 2018, by MA DMF in their state waters. Participants in the exchange aged this sample from an age 0 to 1, with a mode of age 0. (Workshop #020OP)**

**Figure 34. Sectioned otolith sample #20. This is a paired sample with operculum #26 and pelvic spine #31. This sample was collected from a 52 mm long tautog which was captured in September, 2018, by MA DMF in their state waters. Participants in the exchange aged this sample from an age 0 to 1, with a mode of age 0. (Workshop #027SO)**

**Figure 35. Pelvic spine sample #31. This is a paired sample with operculum #26 and sectioned otolith #20. This sample was collected from a 52 mm long tautog which was captured in September, 2018, by MA DMF in their state waters. Participants in the exchange aged this sample from an age 0 to 1, with a mode of age 0. (Workshop #009PS)**

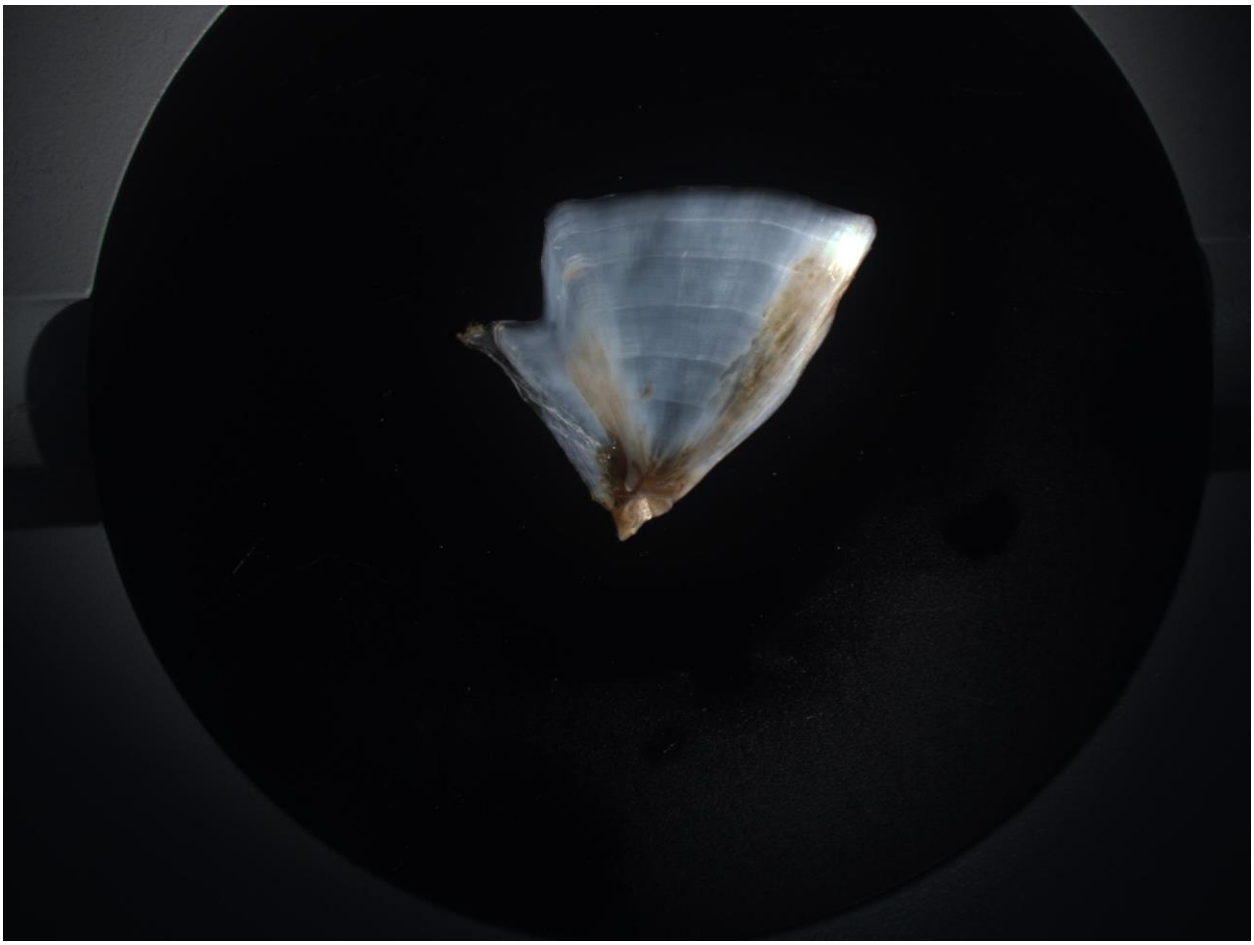

**Figure 36. Operculum sample #27. This is a paired sample with sectioned otolith #58 and pelvic spine #37. This sample was collected from a 337 mm long female tautog which was captured in May, 2019, by MA DMF in their state waters. Participants in the exchange aged this sample from an age 5 to 6, with a mode of age 6. (Workshop #006OP)**

**Figure 37. Sectioned otolith sample #58. This is a paired sample with operculum #27 and pelvic spine #37. This sample was collected from a 337 mm long female tautog which was captured in May, 2019, by MA DMF in their state waters. Participants in the exchange aged this sample from an age 6 to 7, with a mode of age 7. (Workshop #034SO)**

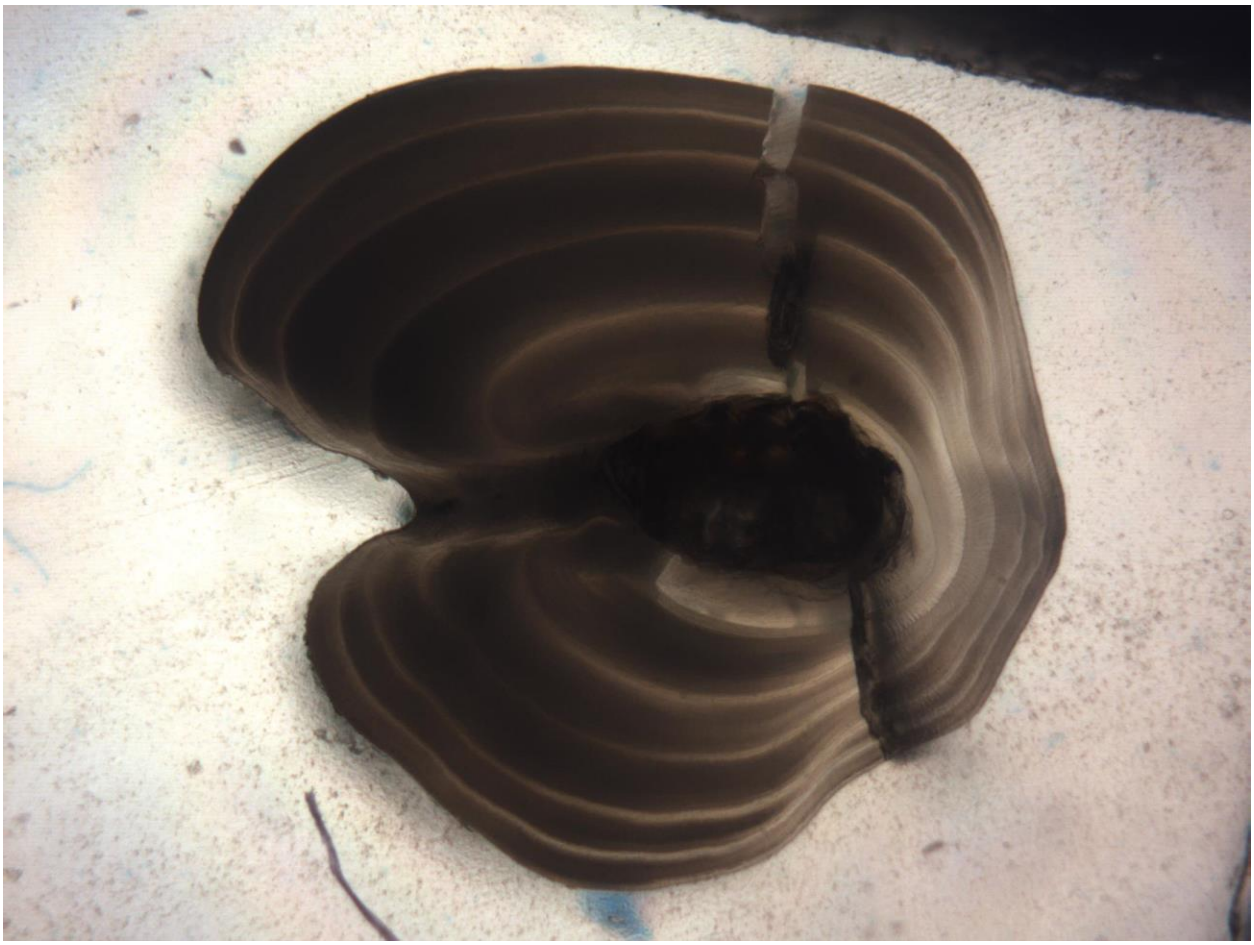

**Figure 38. Pelvic spine sample #37. This is a paired sample with operculum #27 and sectioned otolith #58. This sample was collected from a 337 mm long female tautog which was captured in May, 2019, by MA DMF in their state waters. Participants in the exchange aged this sample from an age 5 to 7, with a mode of age 6. (Workshop #024PS)**

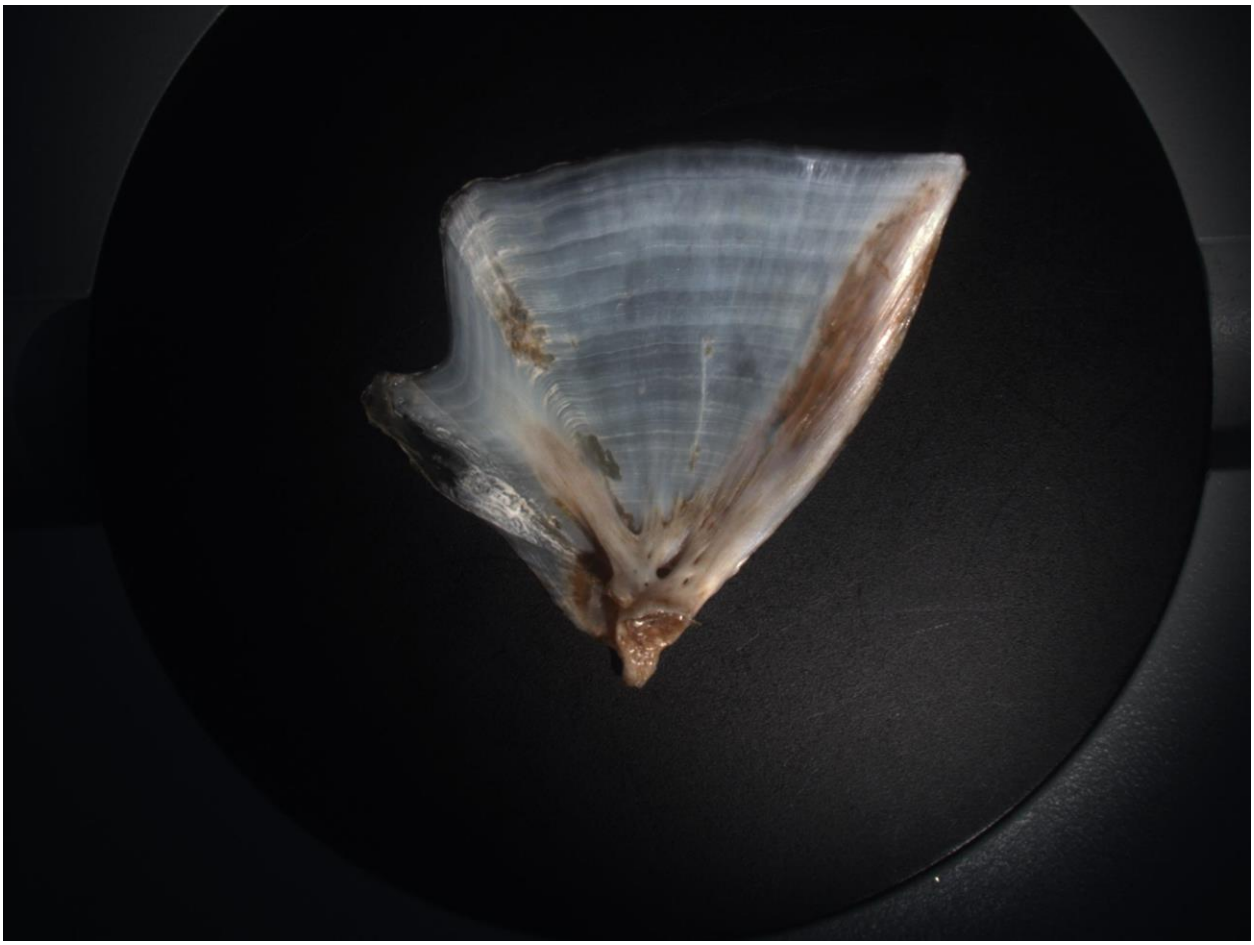

**Figure 39. Operculum sample #28. This is a paired sample with sectioned otolith #25 and pelvic spine #55. This sample was collected from a 497 mm long female tautog which was captured in November, 2018, by MD DNR in their state waters. Participants in the exchange aged this sample from an age 10 to 13, with a mode of age 10. (Workshop #039OP)**

**Figure 40. Sectioned otolith sample #25. This is a paired sample with pelvic spine #55 and operculum #28. This sample was collected from a 497 mm long female tautog which was captured in November, 2018, by MD DNR in their state waters. Participants in the exchange aged this sample from an age 9 to 10, with a mode of age 9. (Workshop #019SO)**

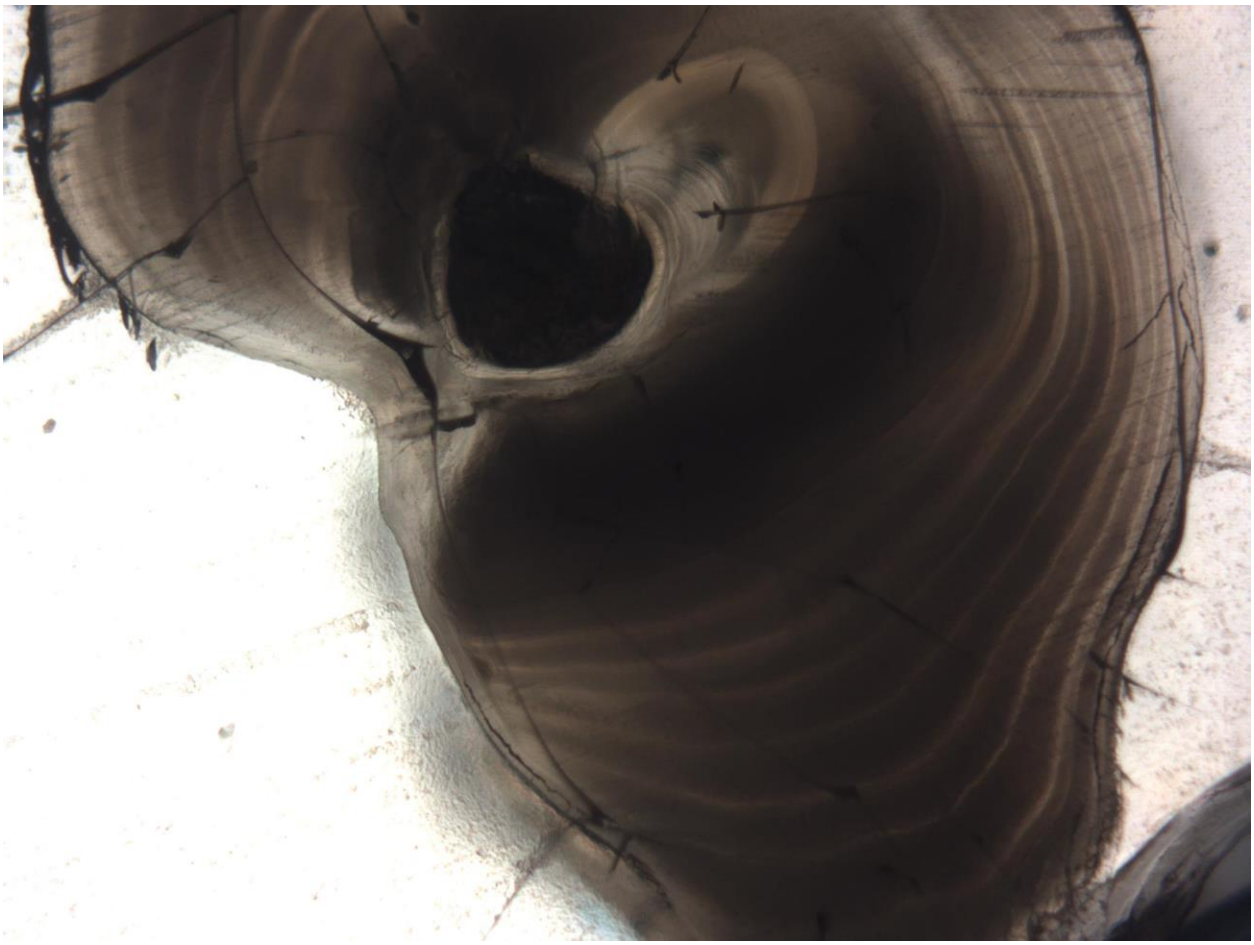

**Figure 41. Pelvic spine sample #55. This is a paired sample with sectioned otolith #25 and operculum #28. This sample was collected from a 497 mm long female tautog which was captured in November, 2018, by MD DNR in their state waters. Participants in the exchange aged this sample from an age 8 to 12, with a mode of age 9. (Workshop #018SP)**

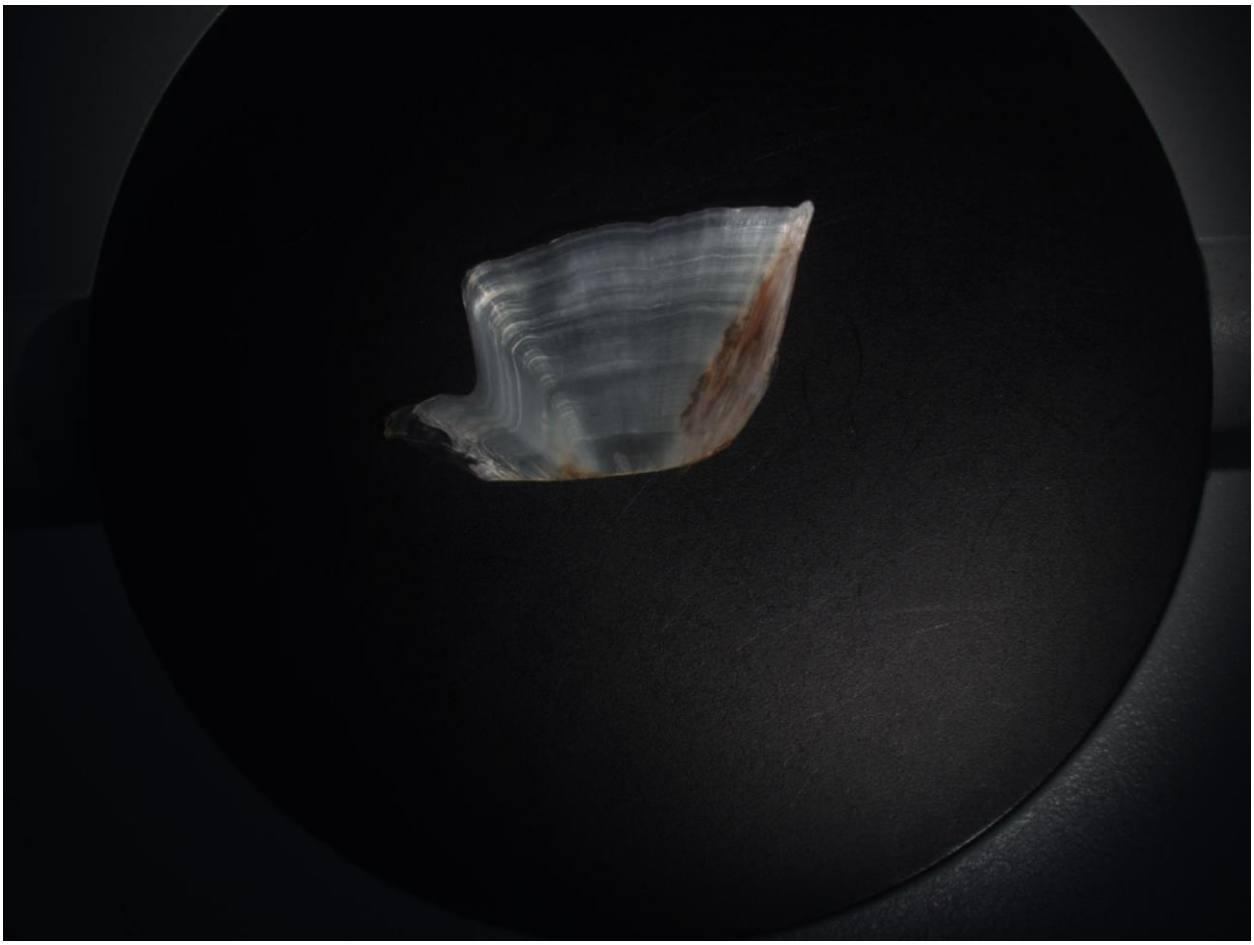

**Figure 42. Operculum sample #29. This is a paired sample with sectioned otolith #61 and pelvic spine #67. Sample was from a tautog that was 335 mm long. This tautog was captured in October 2017 in Maryland waters by VIMS. Participants in the exchange aged this sample from an age 5 to 8, with a mode of age 7. Sample was removed from the analysis due to unreadability. (Workshop #043OP)**

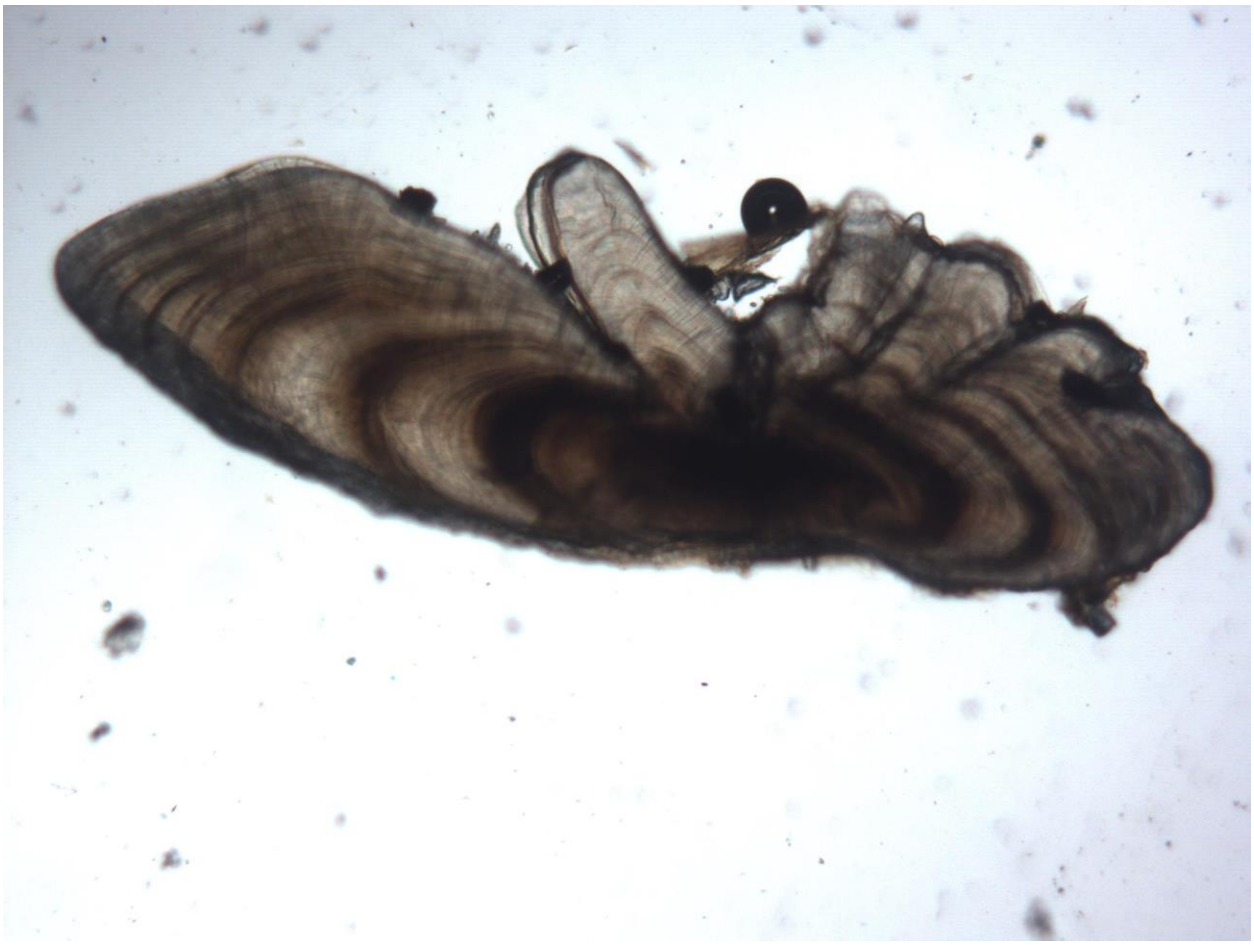

**Figure 43. Sectioned otolith sample #61. This is a paired sample with operculum #29 and pelvic spine #67. Sample was from a tautog that was 335 mm long. This tautog was captured in October 2017 in Maryland waters by VIMS. Participants in the exchange aged this sample from an age 6 to 9, with a mode of age 8. (Workshop #013SO)**

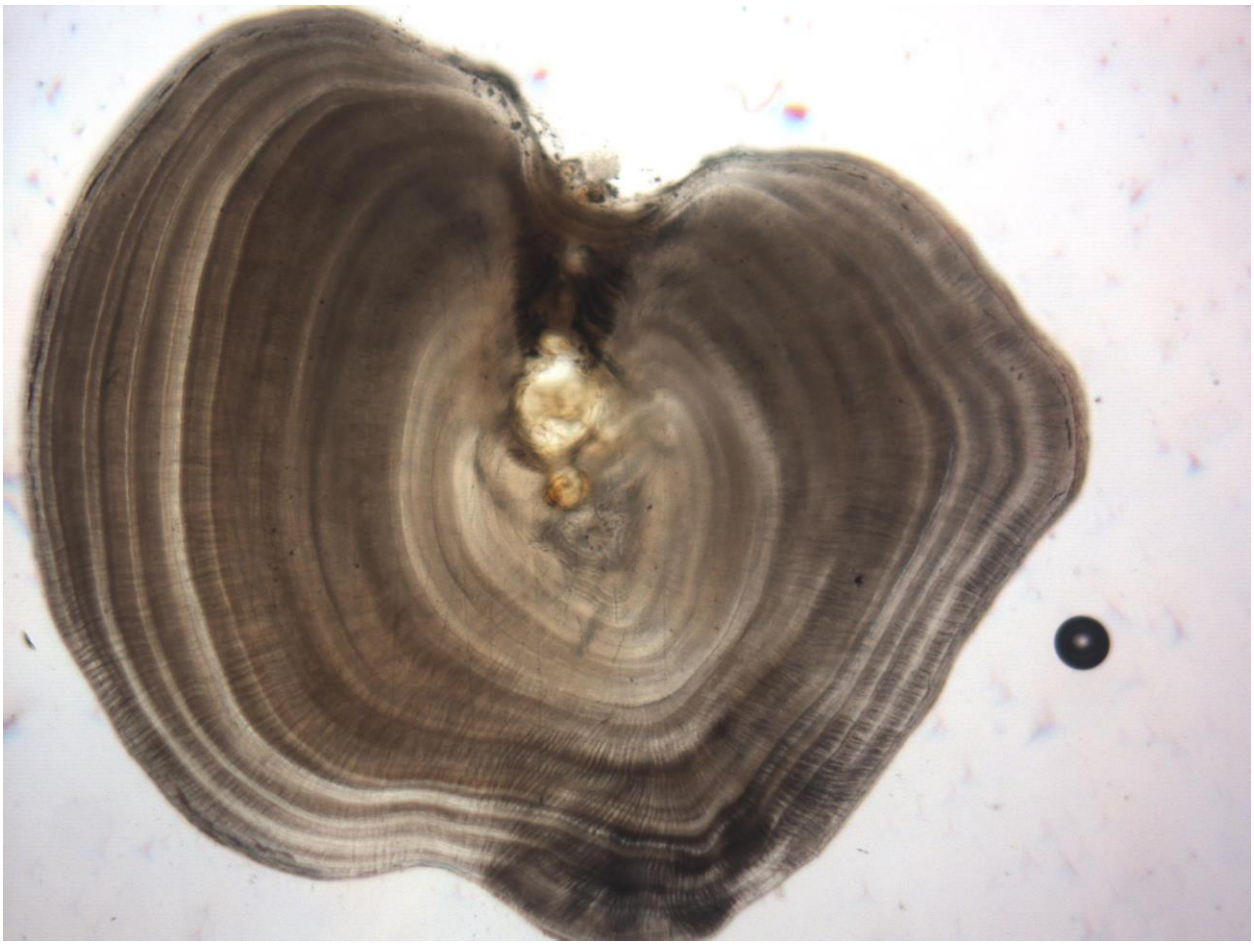

**Figure 44. Pelvic spine sample #67. This is a paired sample with operculum #29 and sectioned otoliths #61. Sample was from a tautog that was 335 mm long. This tautog was captured in October 2017 in Maryland waters by VIMS. Participants in the exchange aged this sample from an age 6 to 14, with a mode of age 7. (Workshop #005PS)**

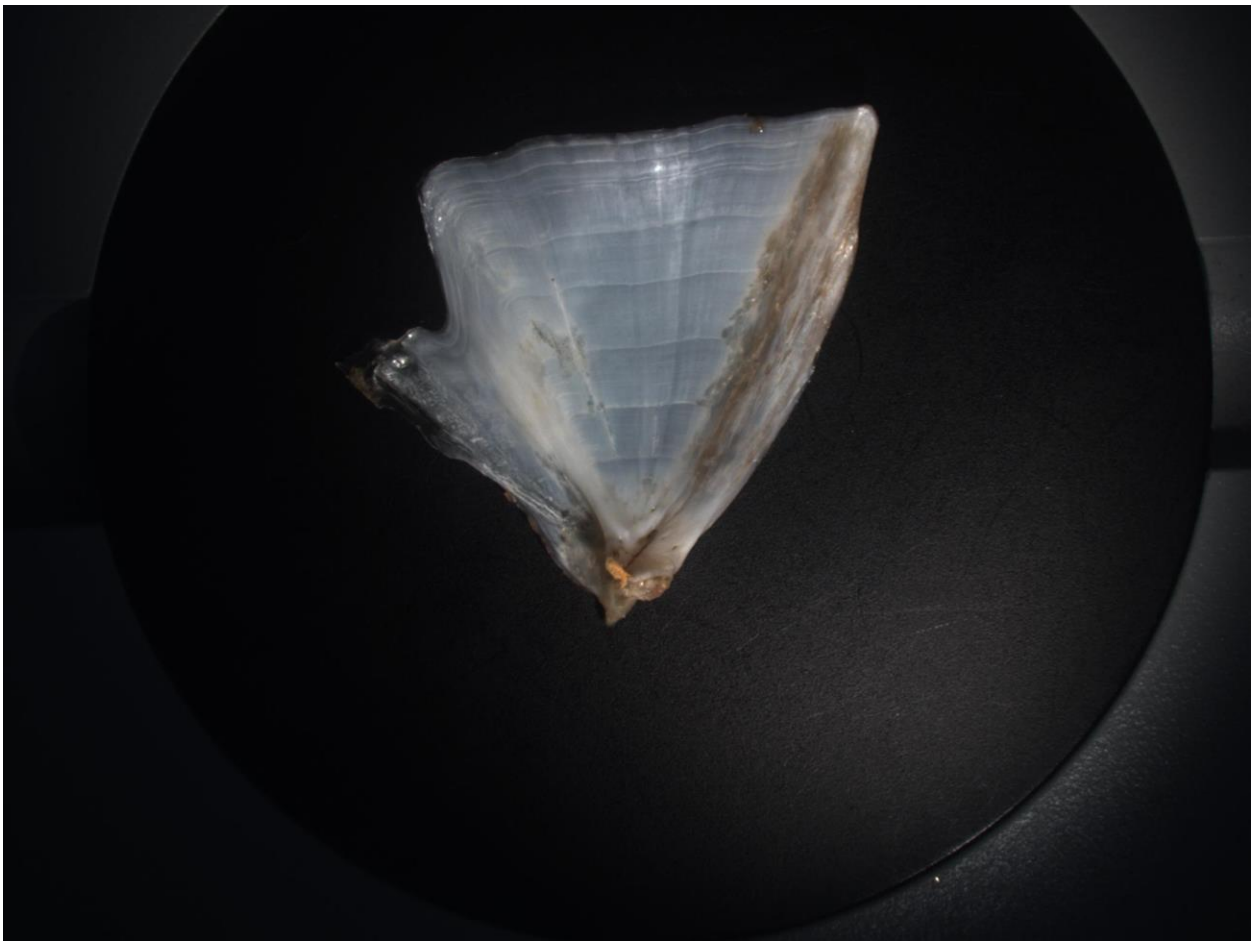

**Figure 45. Operculum sample #31. This is a paired sample with sectioned otolith #8 and pelvic spine #17. This sample was collected from a 453 mm long male tautog which was captured in May, 2019, by MA DMF in their state waters. Participants in the exchange aged this sample from an age 8 to 9, with a mode of age 9. (Workshop #038OP)**

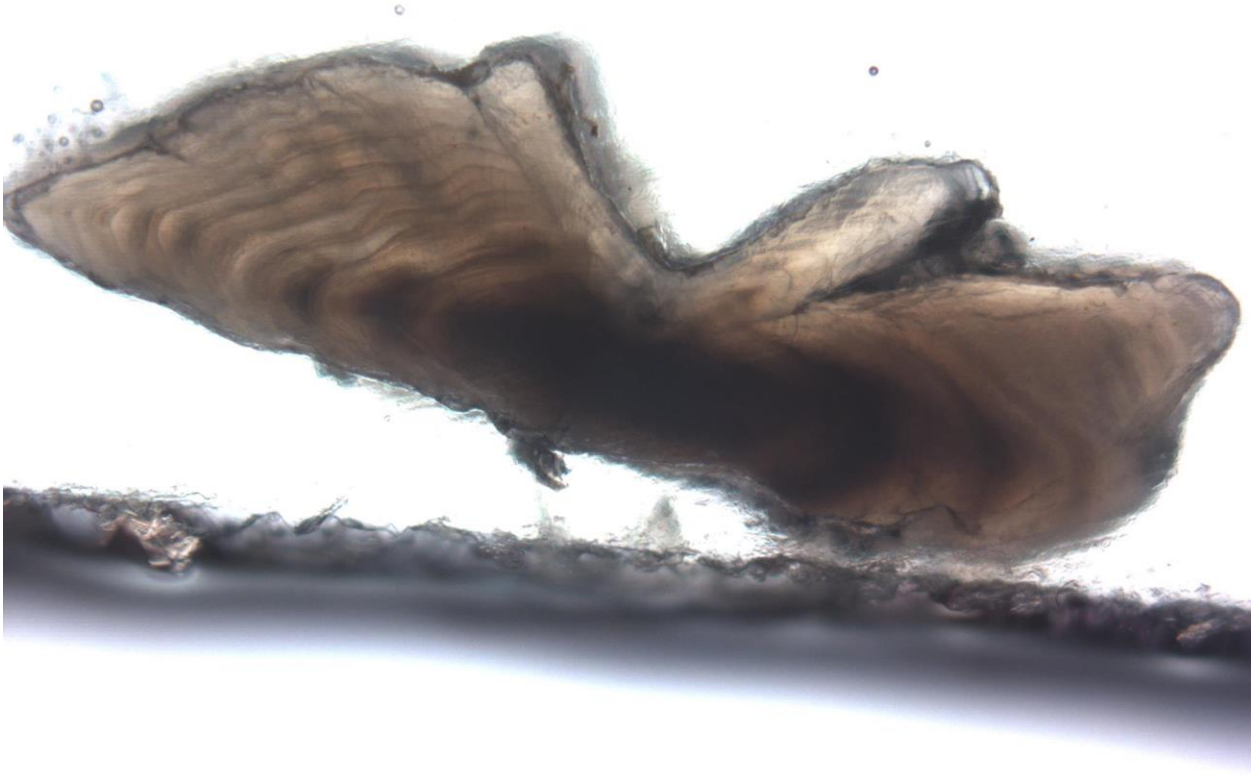

**Figure 46. Sectioned otolith sample #8. This is a paired sample with operculum #31 and pelvic spine #17. This sample was collected from a 453 mm long male tautog which was captured in May, 2019, by MA DMF in their state waters. Participants in the exchange aged this sample from an age 7 to 10, with a mode of age 10. (Workshop #023SO)**

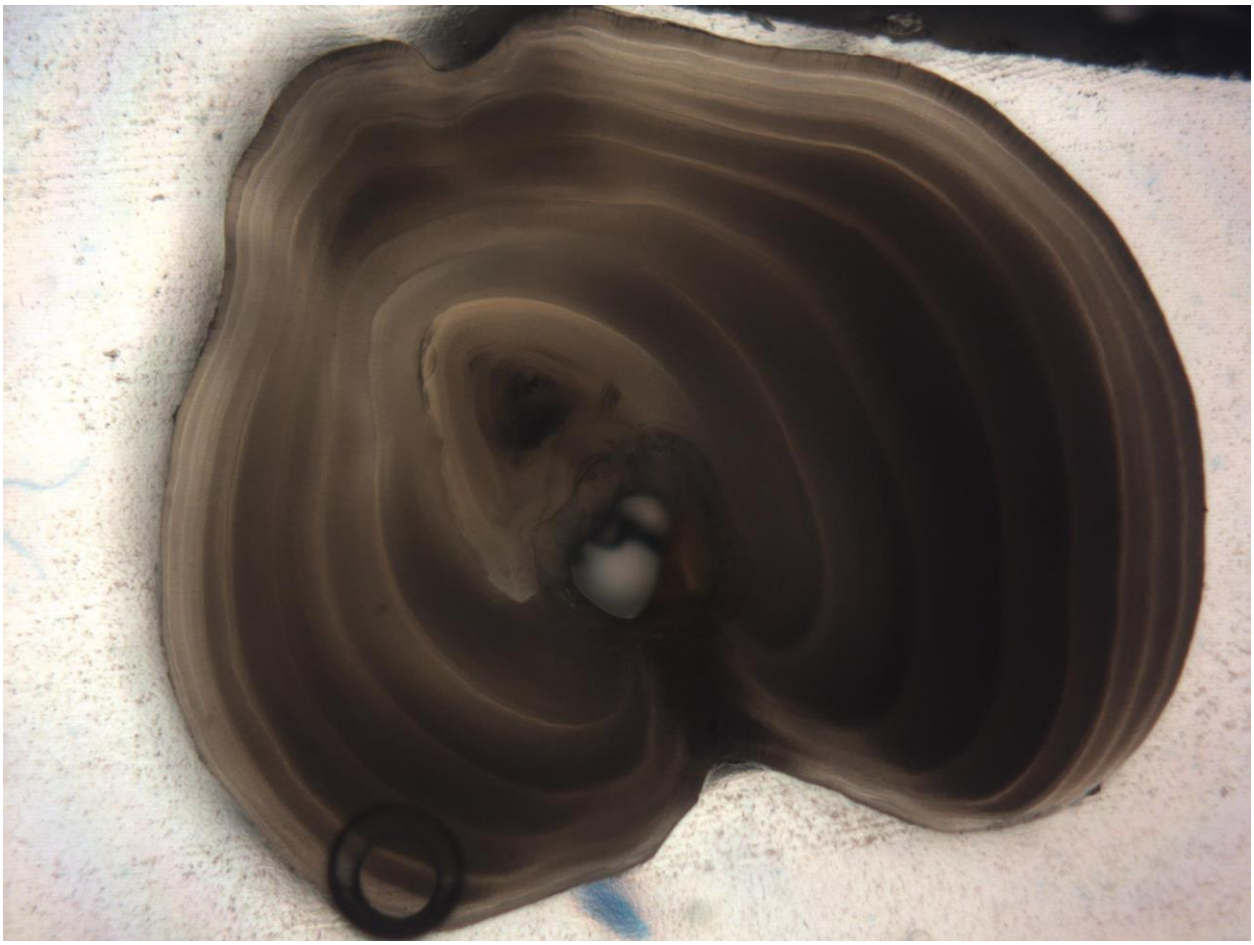

**Figure 47. Pelvic spine sample #17. This is a paired sample with operculum #31 and sectioned otolith #8. This sample was collected from a 453 mm long male tautog which was captured in May, 2019, by MA DMF in their state waters. Participants in the exchange aged this sample from an age 8 to 10, with a mode of age 9. (Workshop #040PS)**

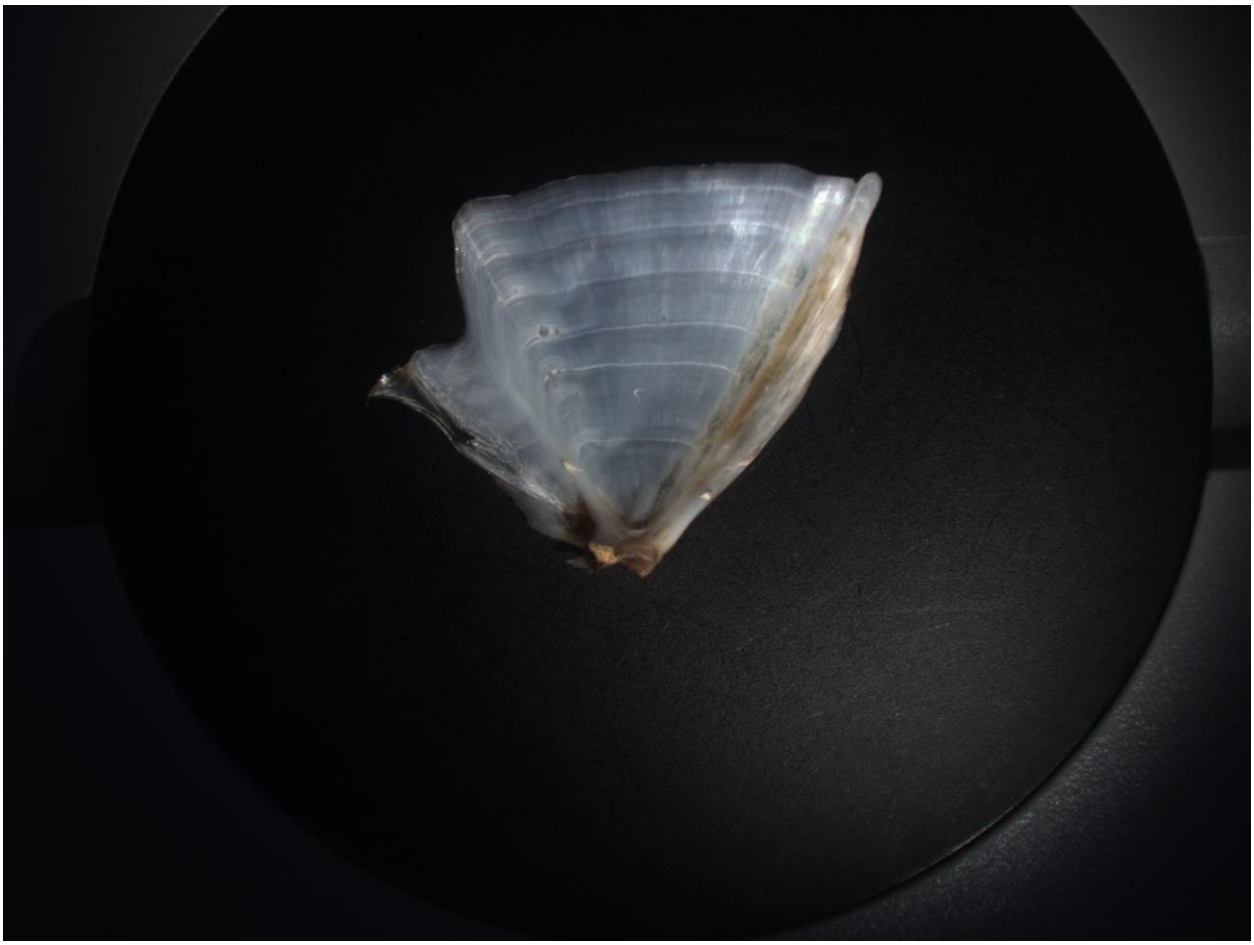

**Figure 48. Operculum sample #33. This is a paired sample with sectioned otolith #4 and pelvic spine #63. This sample was collected from a 411 mm long male tautog which was captured in May, 2019, by MA DMF in their state waters. Participants in the exchange aged this sample from an age 7 to 8, with a mode of age 7. (Workshop #027OP)**

**Figure 49. Sectioned otolith sample #4. This is a paired sample with operculum #33 and pelvic spine #63. This sample was collected from a 411 mm long male tautog which was captured in May, 2019, by MA DMF in their state waters. Participants in the exchange aged this sample from an age 7 to 8, with a mode of age 7. (Workshop #038SO)**

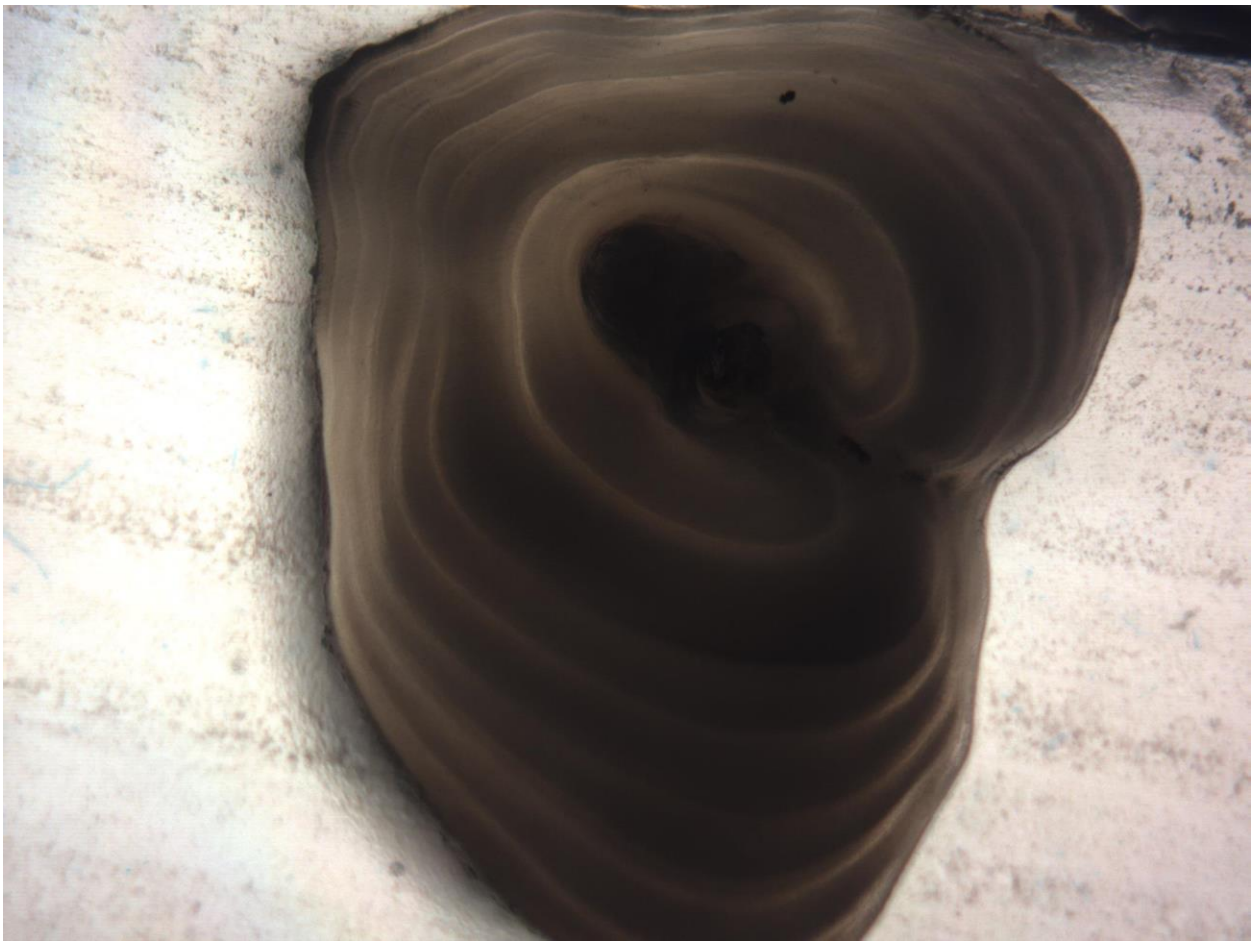

**Figure 50. Pelvic spine sample #63. This is a paired sample with operculum #33 and sectioned otolith #4. This sample was collected from a 411 mm long male tautog which was captured in May, 2019, by MA DMF in their state waters. Participants in the exchange aged this sample from an age 7 to 8, with a mode of age 8. (Workshop #041PS)**

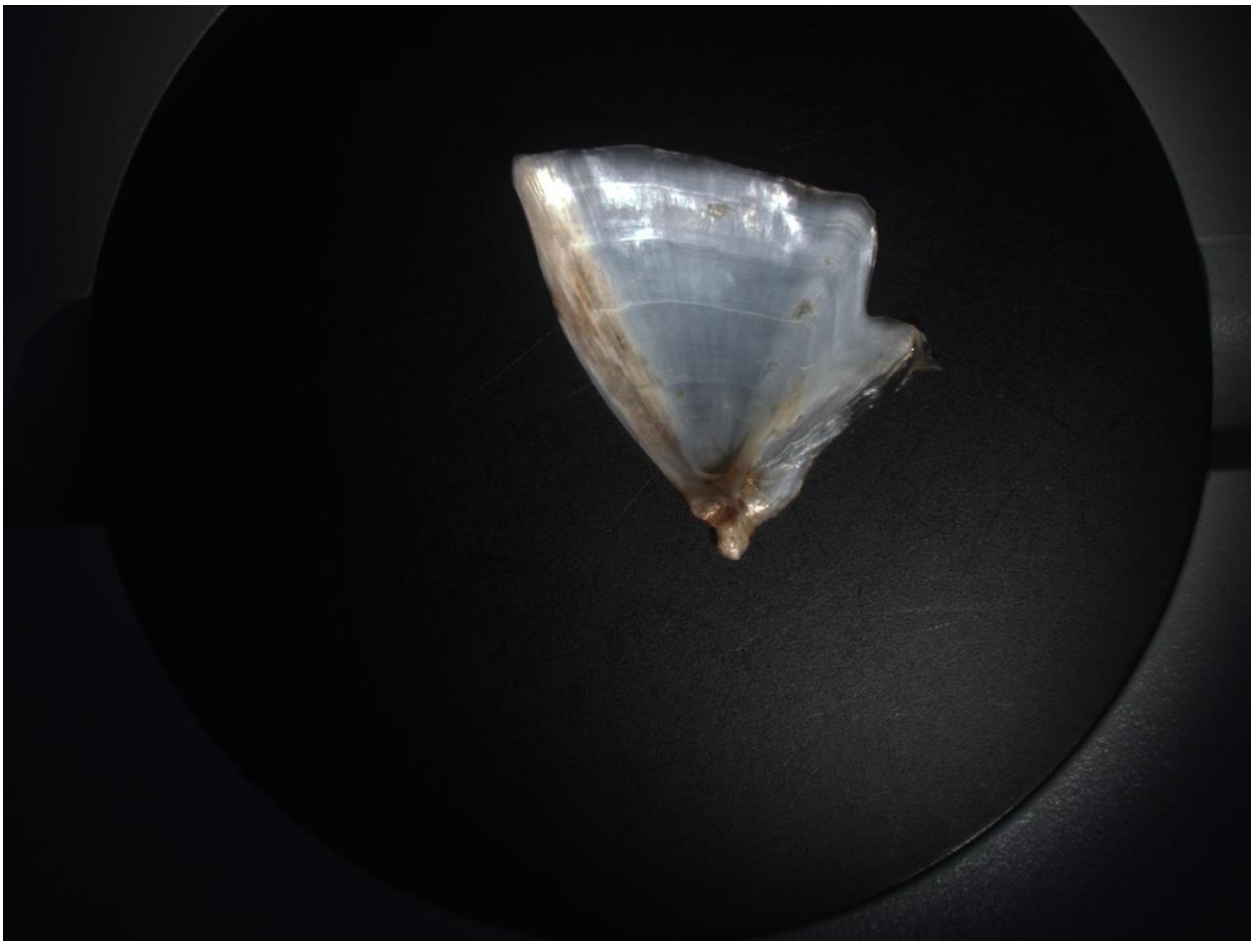

**Figure 51. Operculum sample #36. This is a paired sample with sectioned otolith #35 and pelvic spine #62. This sample was collected from a 361 mm long female tautog which was captured in May, 2019, by MA DMF in their state waters. Participants in the exchange aged this sample from an age 5 to 7, with a mode of age 5. (Workshop #030OP)**

**Figure 52. Sectioned otolith sample #35. This is a paired sample with operculum #36 and pelvic spine #62. This sample was collected from a 361 mm long female tautog which was captured in May, 2019, by MA DMF in their state waters. Participants in the exchange aged this sample from an age 5 to 7, with a mode of age 6. (Workshop #041SO)**

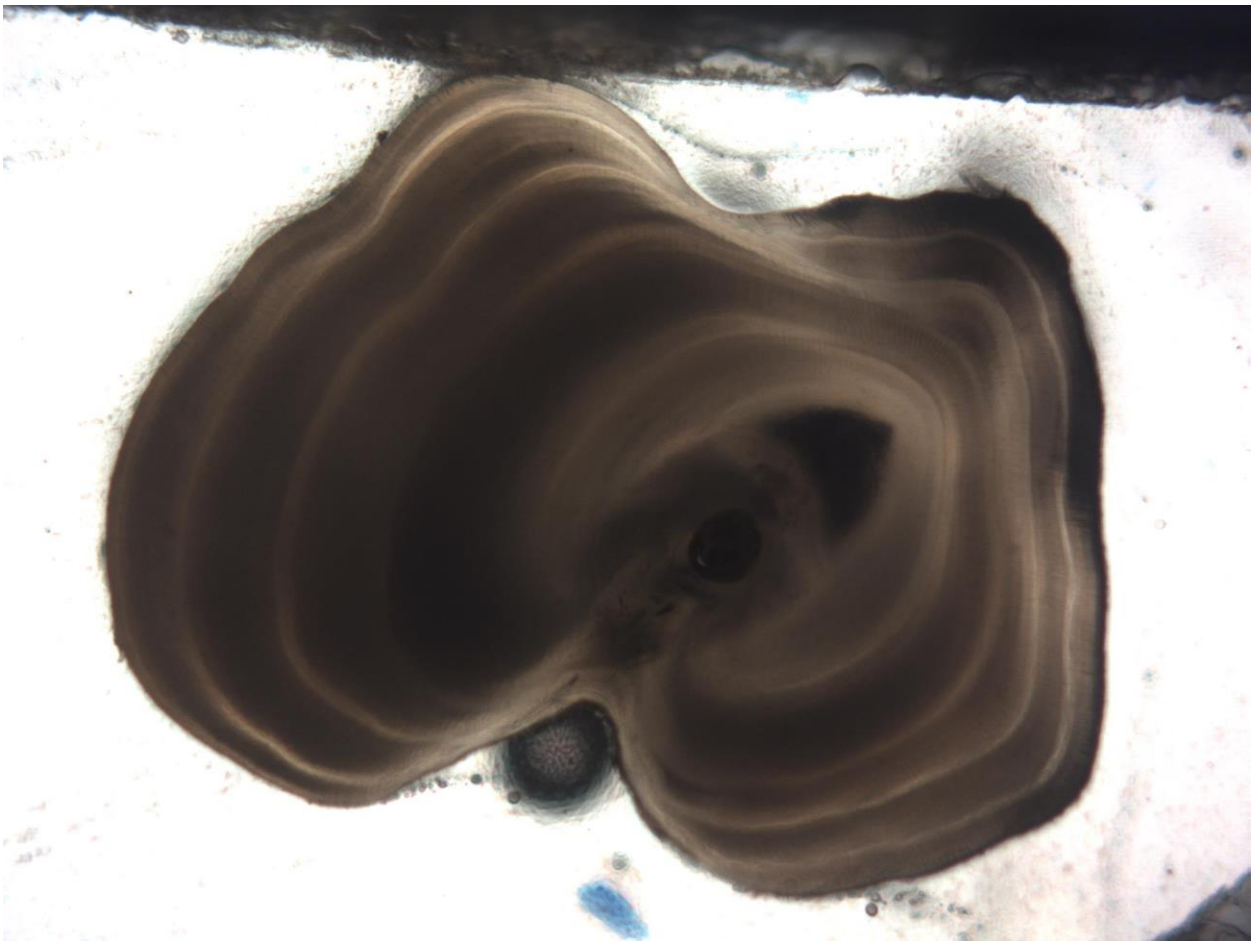

**Figure 53. Pelvic spine sample #62. This is a paired sample with operculum #36 and sectioned otolith #35. This sample was collected from a 361 mm long female tautog which was captured in May, 2019, by MA DMF in their state waters. Participants in the exchange aged this sample from an age 5 to 6, with a mode of age 6. (Workshop #011PS)**

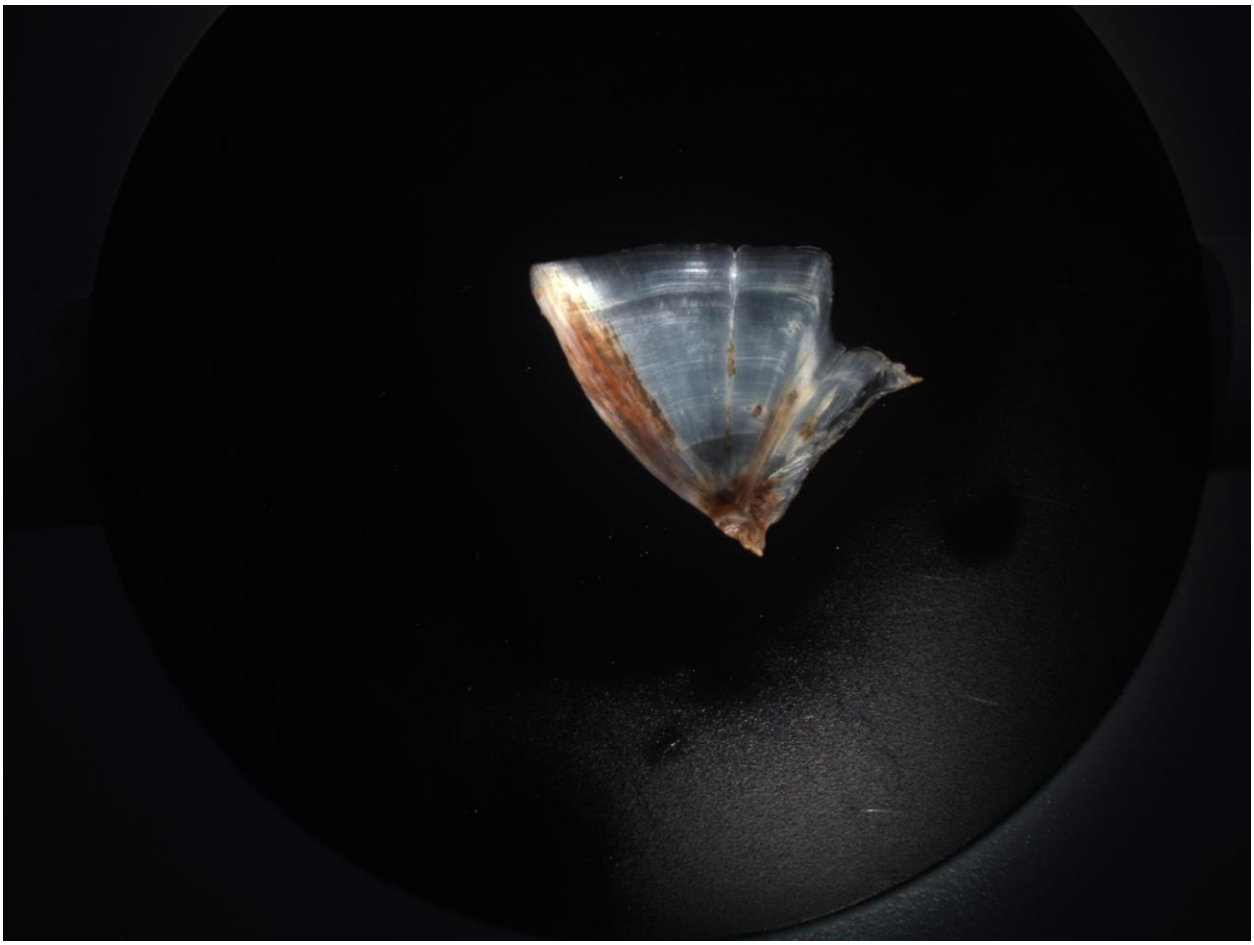

**Figure 54. Operculum sample #40. This is a paired sample with sectioned otolith #28 and pelvic spine #26. Sample was from a tautog that was 300 mm long. This tautog was captured in October 2017 in New York waters by VIMS. Participants in the exchange aged this sample from an age 2 to 4, with a mode of age 3. (Workshop #010OP)**

**Figure 55. Sectioned otolith sample #28. This is a paired sample with operculum #40 and pelvic spine #26. Sample was from a tautog that was 300 mm long. This tautog was captured in October 2017 in New York waters by VIMS. All participants in the exchange aged this sample as an age 2. (Workshop #031SO)**

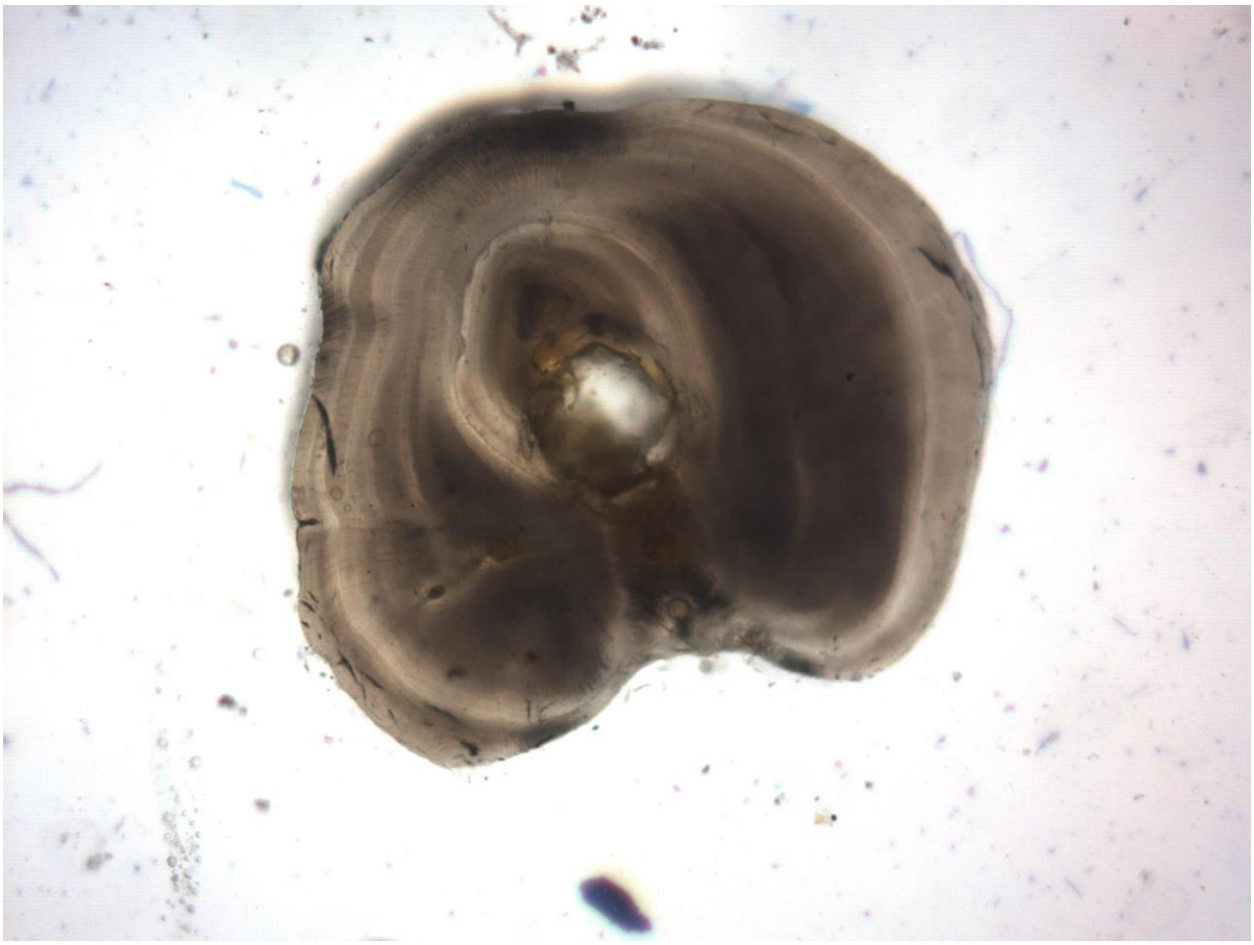

**Figure 56. Pelvic spine sample #26. This is a paired sample with sectioned otolith #28 and operculum #40. Sample was from a tautog that was 300 mm long. This tautog was captured in October 2017 in New York waters by VIMS. Participants in the exchange aged this sample from an age 1 to 4, with a mode of age 2. (Workshop #004PS)**

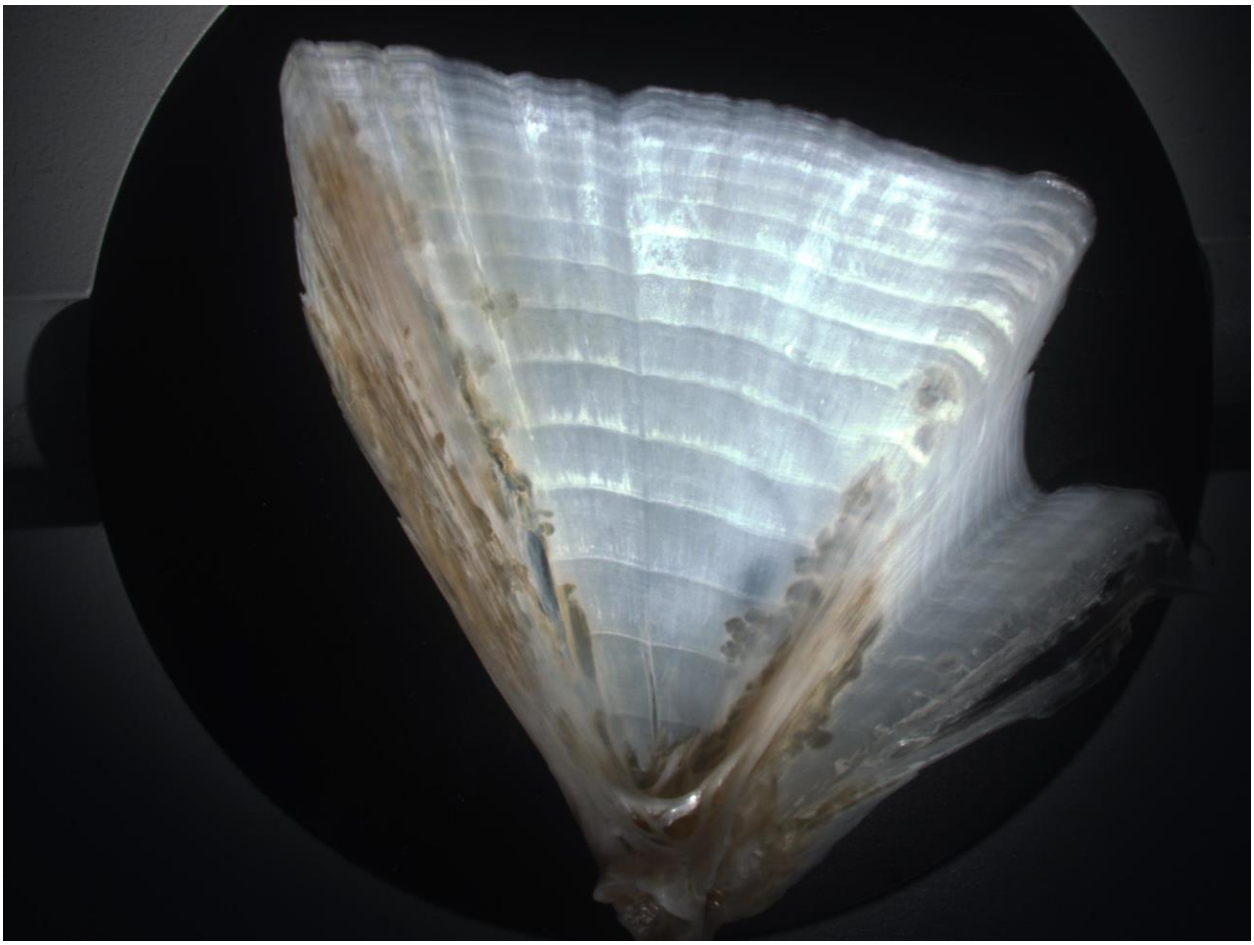

**Figure 57. Operculum sample #41. This is a paired sample with sectioned otolith #36 and pelvic spine #5. This sample was collected from an 806 mm long female tautog which was captured in August, 2019, by RI DEM in their state waters. Participants in the exchange aged this sample from an age 15 to 17, with a mode of age 16. (Workshop #005OP)**

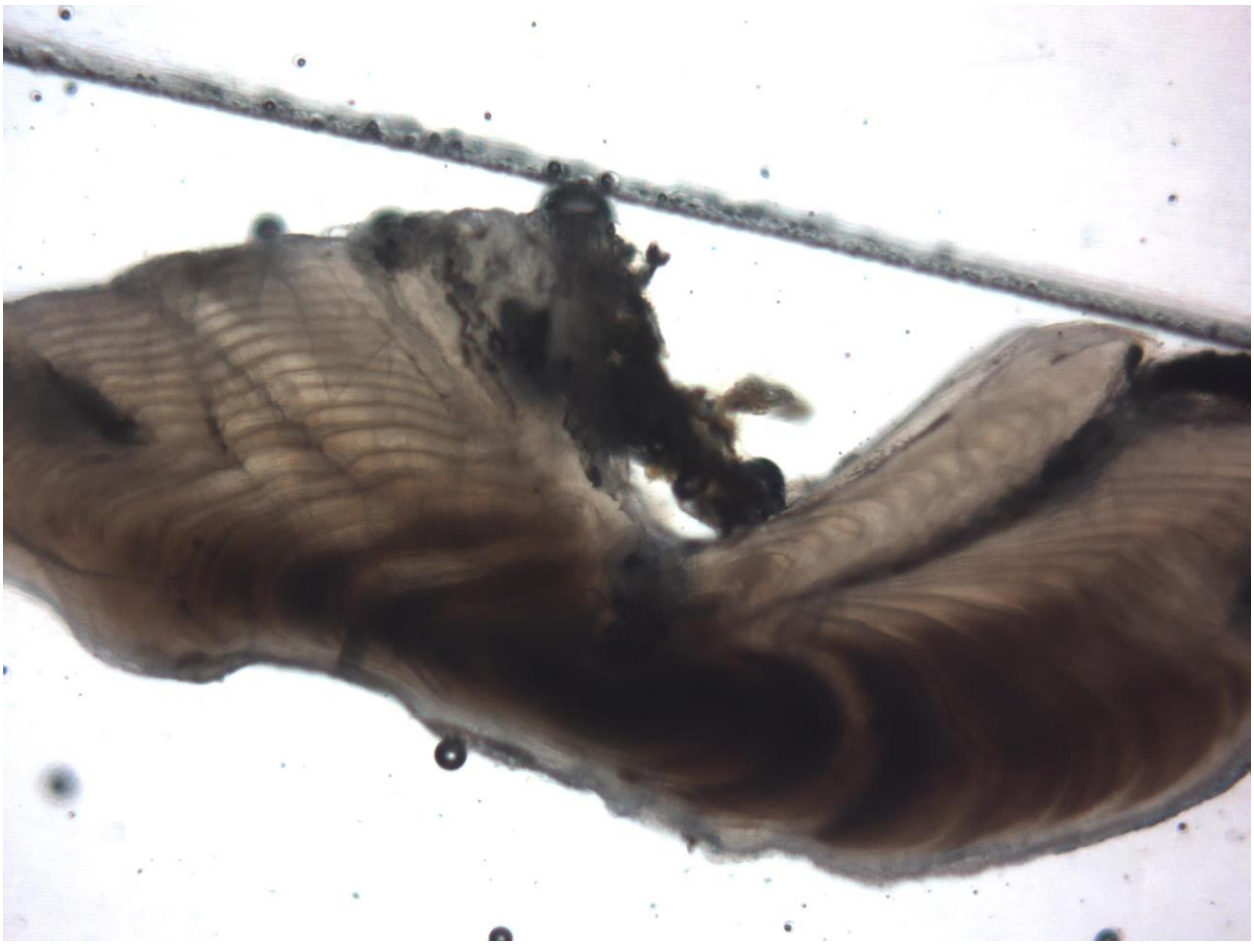

**Figure 58. Sectioned otolith sample #36. This is a paired sample with operculum #41 and pelvic spine #5. This sample was collected from an 806 mm long female tautog which was captured in August, 2019, by RI DEM in their state waters. Participants in the exchange aged this sample from an age 14 to 17, with a mode of age 17. (Workshop #022SO)**

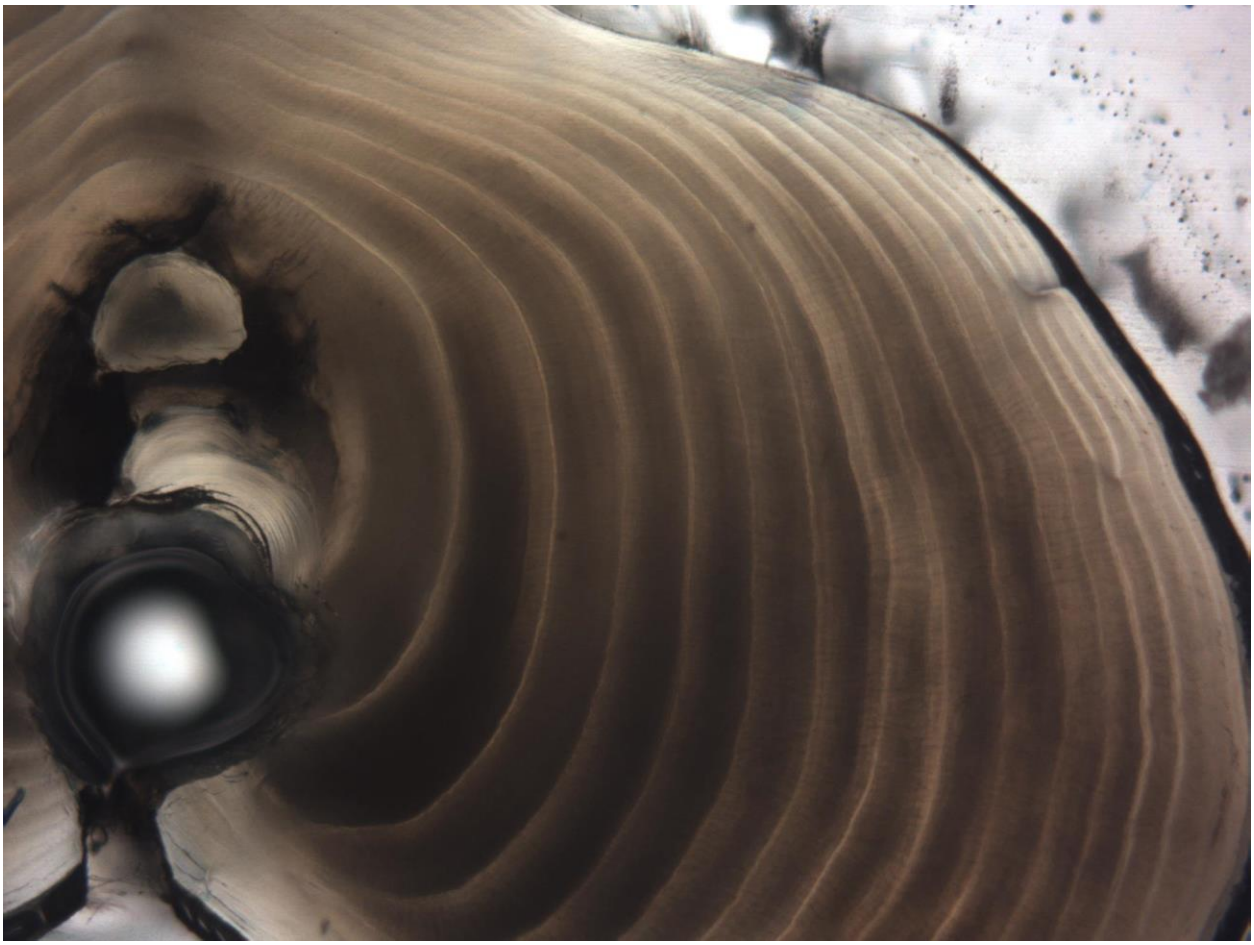

**Figure 59. Pelvic spine sample #5. This is a paired sample with operculum #41 and sectioned otolith #36. This sample was collected from an 806 mm long female tautog which was captured in August, 2019, by RI DEM in their state waters. Participants in the exchange aged this sample from an age 14 to 17, with a mode of age 16. (Workshop #036PS)**

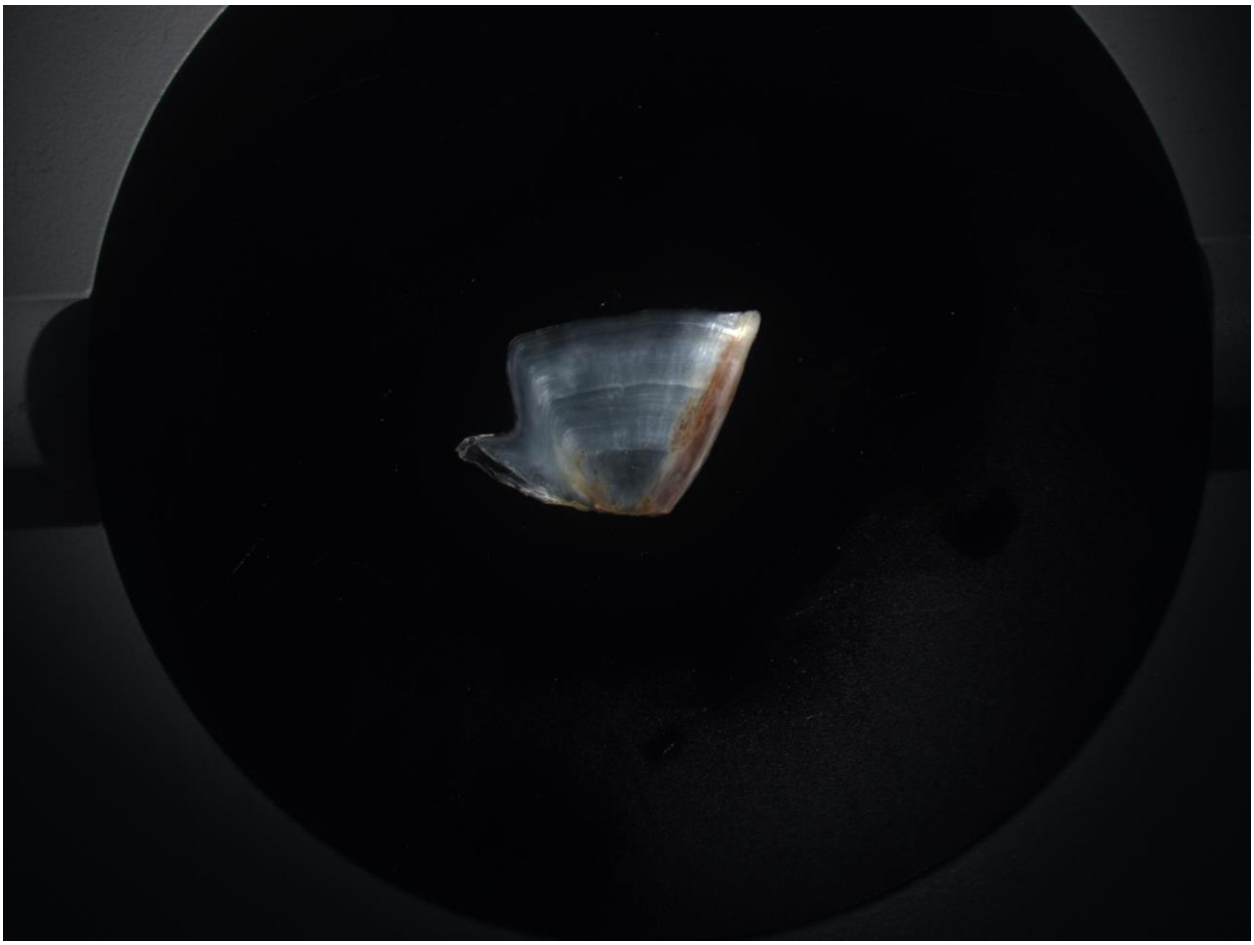

**Figure 60. Operculum sample #42. This is a paired sample with sectioned otolith #7 and pelvic spine #66. Sample was from a tautog that was 250 mm long. This tautog was captured in October 2017 in New Jersey waters by VIMS. Participants in the exchange aged this sample from an age 2 to 3, with a mode of age 3. Sample was removed from the analysis due to unreadability. (Workshop #003OP)**

**Figure 61. Sectioned otolith sample #7. This is a paired sample with operculum #42 and pelvic spine #66. Sample was from a tautog that was 250 mm long. This tautog was captured in October 2017 in New Jersey waters by VIMS. Participants in the exchange aged this sample from an age 2 to 6, with a mode of age 3. (Workshop #002SO)**

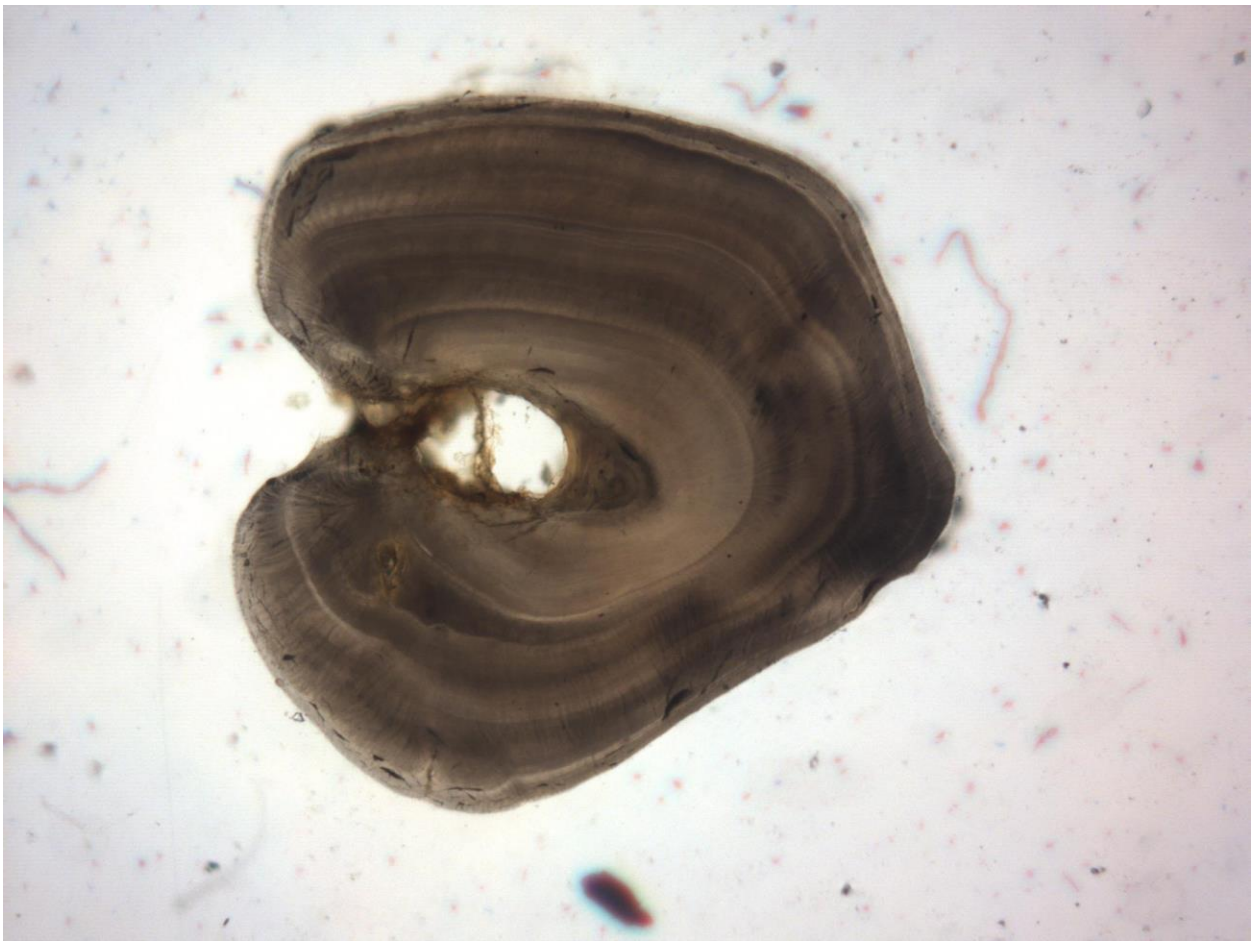

**Figure 62. Pelvic spine sample #66. This is a paired sample with operculum #42 and sectioned otolith #7. Sample was from a tautog that was 250 mm long. This tautog was captured in October 2017 in New Jersey waters by VIMS. Participants in the exchange aged this sample from an age 3 to 5, with a mode of age 4. (Workshop #002PS)**

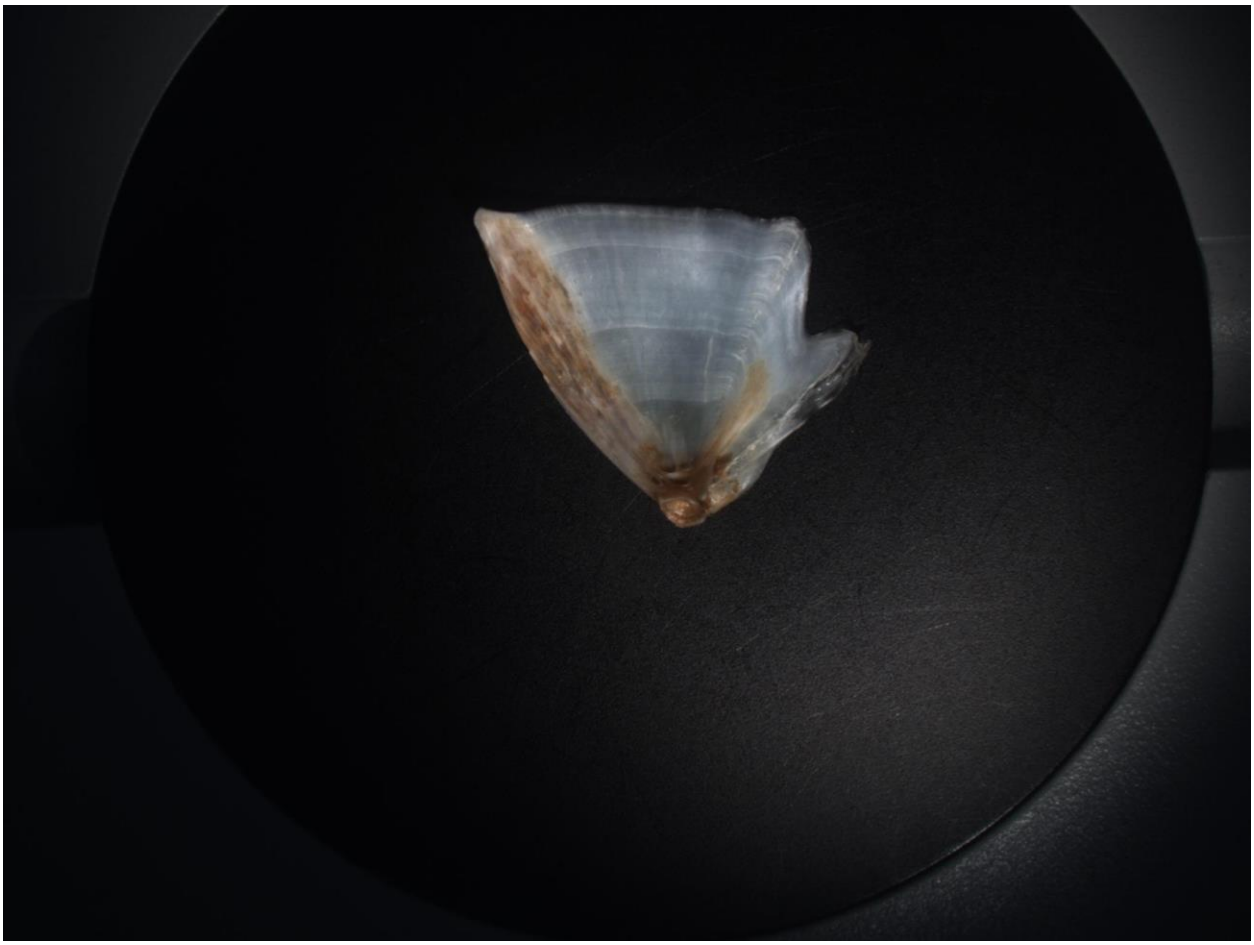

**Figure 63. Operculum sample #44. This is a paired sample with sectioned otolith #41 and pelvic spine #75. This sample was collected from a 305 mm long male tautog which was captured in July, 2019, by RI DEM in their state waters. All participants in the exchange aged this sample as an age 4. (Workshop #021OP)**

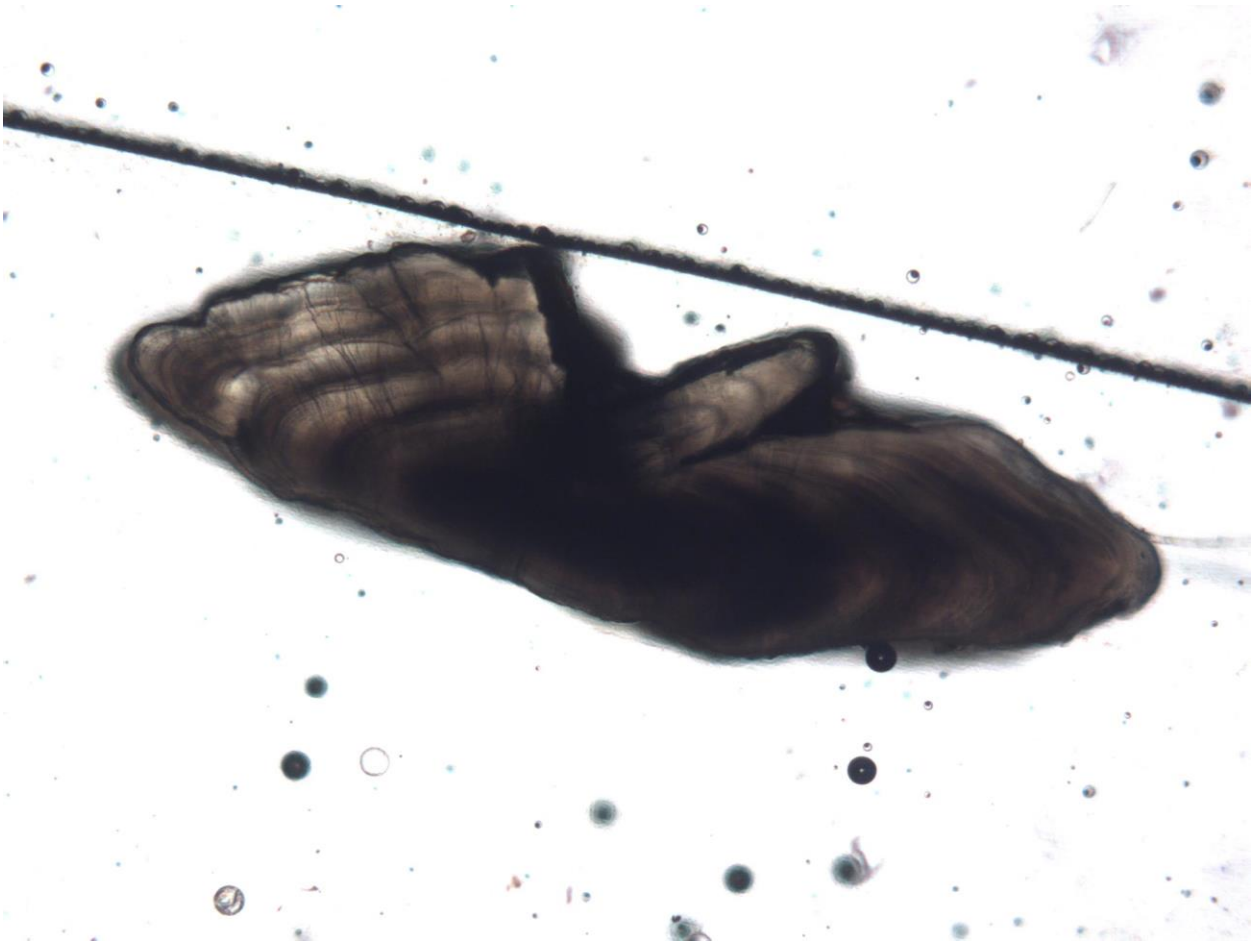

**Figure 64. Sectioned otolith sample #41. This is a paired sample with operculum #44 and pelvic spine #75. This sample was collected from a 305 mm long male tautog which was captured in July, 2019, by RI DEM in their state waters. Participants in the exchange aged this sample from an age 3 to 5, with a mode of age 5. (Workshop #003SO)**

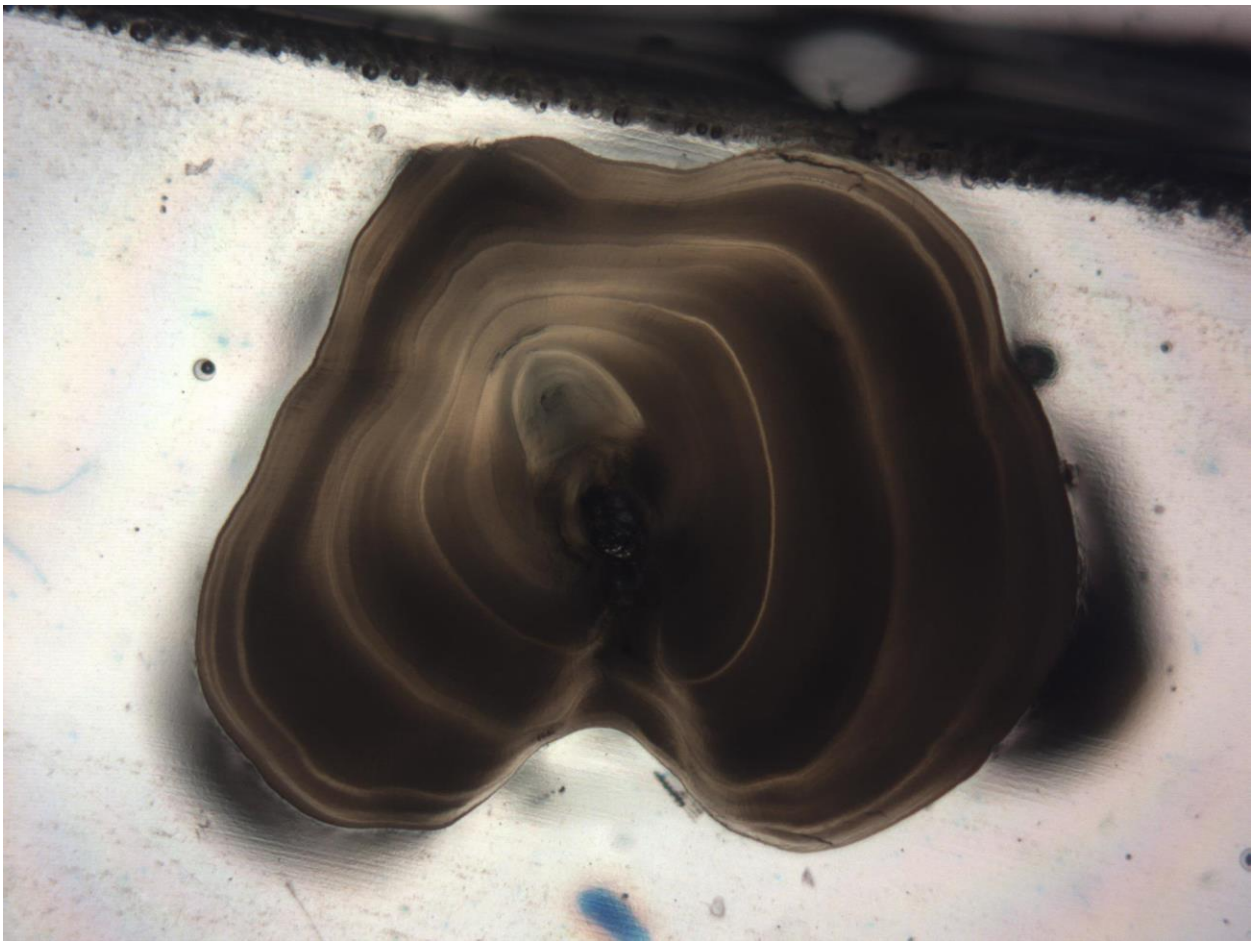

**Figure 65. Pelvic spine sample #75. This is a paired sample with operculum #44 and sectioned otolith #41. This sample was collected from a 305 mm long male tautog which was captured in July, 2019, by RI DEM in their state waters. Participants in the exchange aged this sample from an age 4 to 7, with a mode of age 5. (Workshop #028PS)**

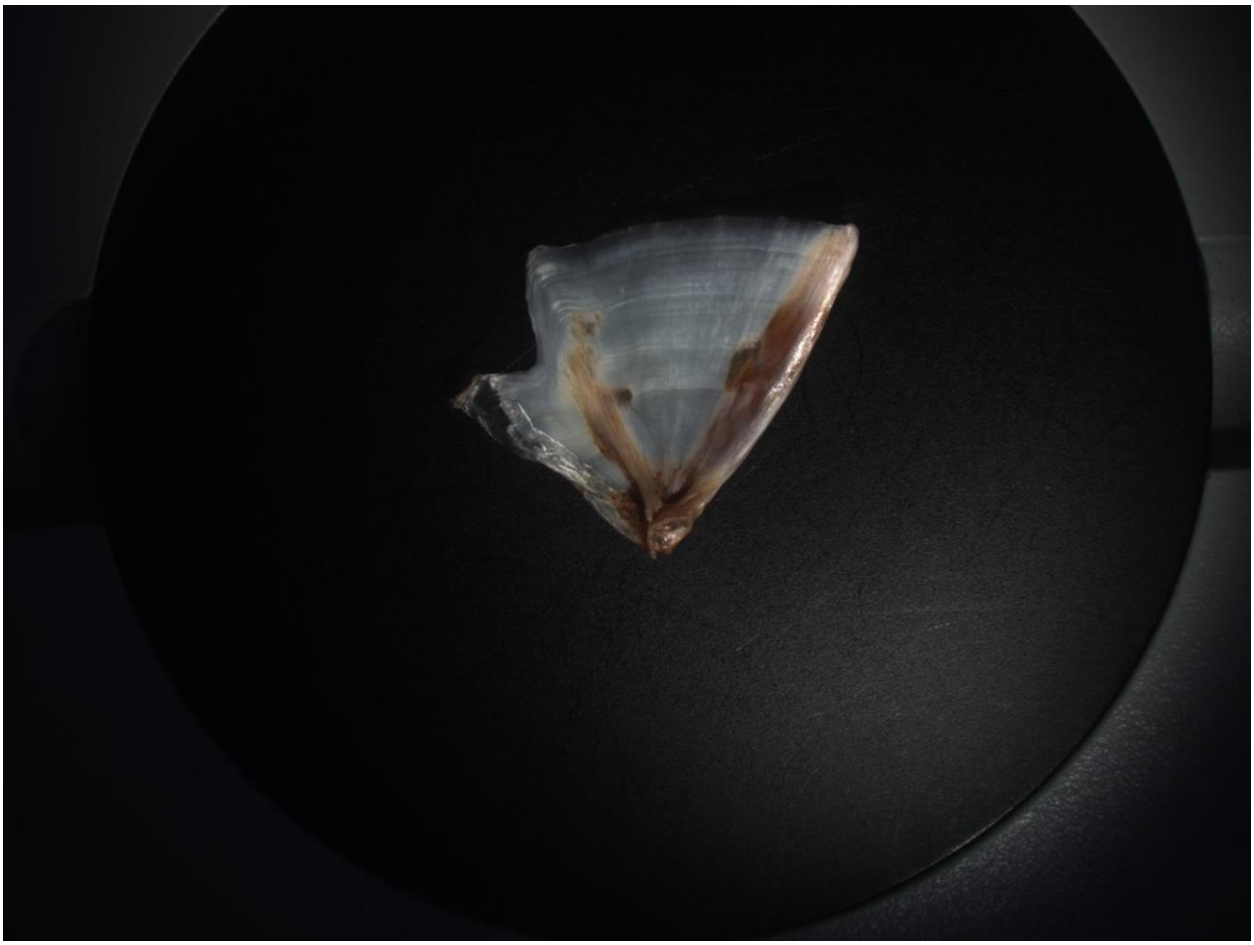

**Figure 66. Operculum sample #49. This is a paired sample with sectioned otolith #42 and pelvic spine #21. Sample was from a tautog that was 330 mm long. This tautog was captured in October 2017 in New York waters by VIMS. Participants in the exchange aged this sample from an age 2 to 4, with a mode of age 4. (Workshop #019OP)**

**Figure 67. Sectioned otolith sample #42. This is a paired sample with operculum #49 and pelvic spine #21. Sample was from a tautog that was 330 mm long. This tautog was captured in October 2017 in New York waters by VIMS. Participants in the exchange aged this sample from an age 2 to 3, with a mode of age 3. (Workshop #010SO)**

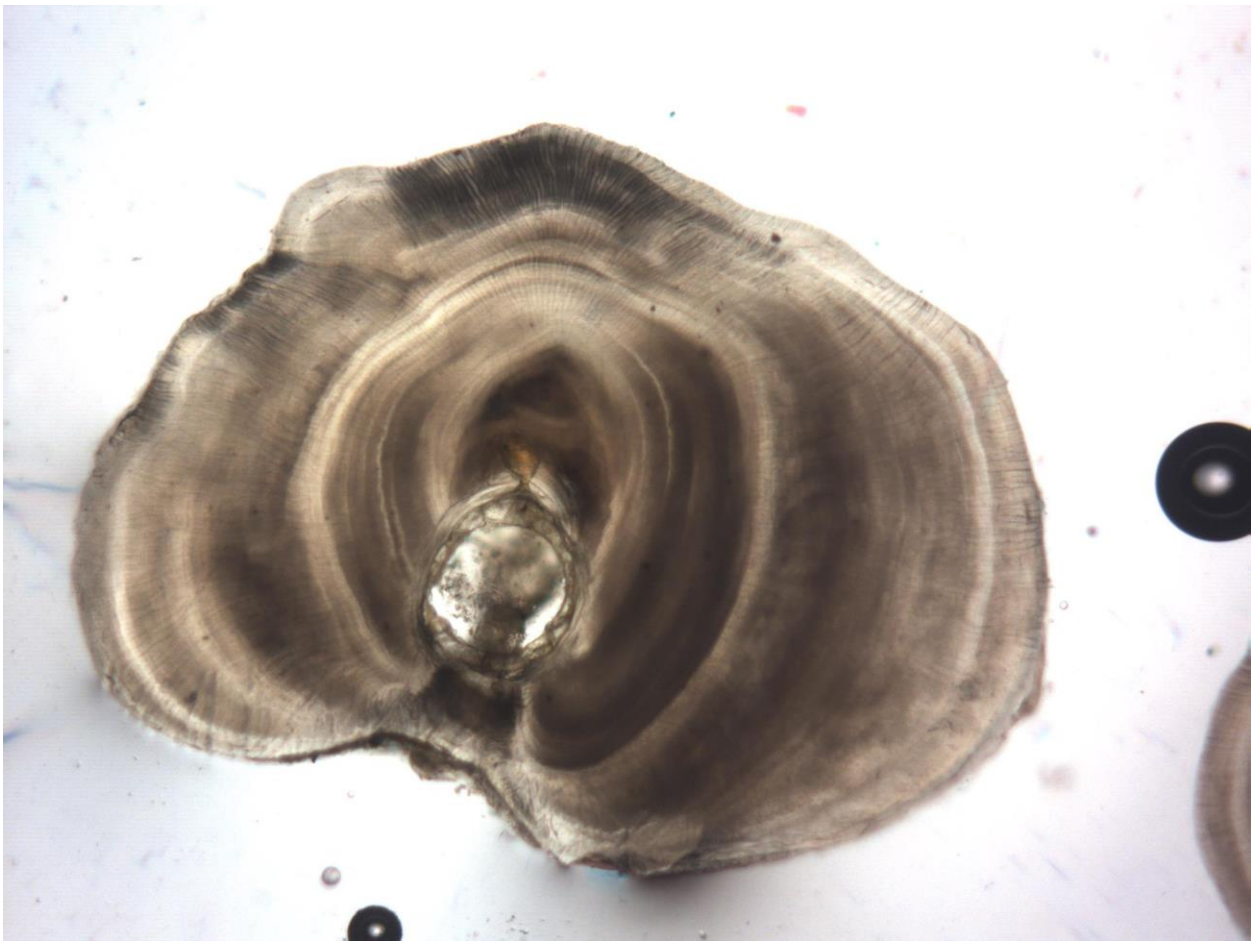

**Figure 68. Pelvic spine sample #21. This is a paired sample with operculum #49 and sectioned otolith #42. Sample was from a tautog that was 330 mm long. This tautog was captured in October 2017 in New York waters by VIMS. Participants in the exchange aged this sample from an age 2 to 5, with a mode of age 4. Sample was removed from the analysis due to unreadability. (Workshop #032PS)**

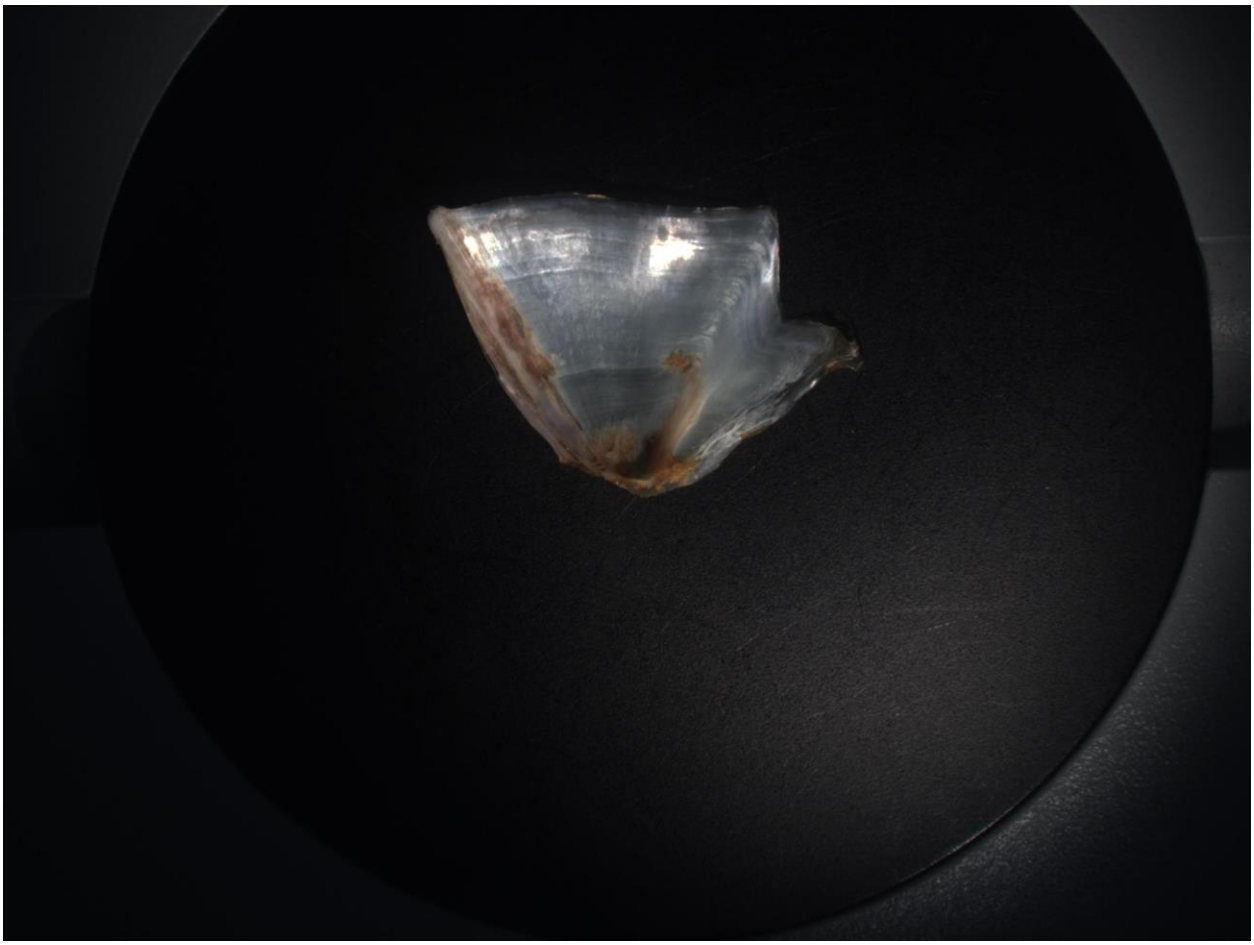

**Figure 69. Operculum sample #50. This is a paired sample with sectioned otolith #37 and pelvic spine #10. Sample was from a tautog that was 310 mm long. This tautog was captured in October 2017 in New Jersey waters by VIMS. Participants in the exchange aged this sample from an age 4 to 6, with a mode of age 5. (Workshop #032OP)**

**Figure 70. Sectioned otolith sample #37. This is a paired sample with operculum #50 and pelvic spine #10. Sample was from a tautog that was 310 mm long. This tautog was captured in October 2017 in New Jersey waters by VIMS. Participants in the exchange aged this sample from an age 5 to 6, with a mode of age 6. (Workshop #018SO)**

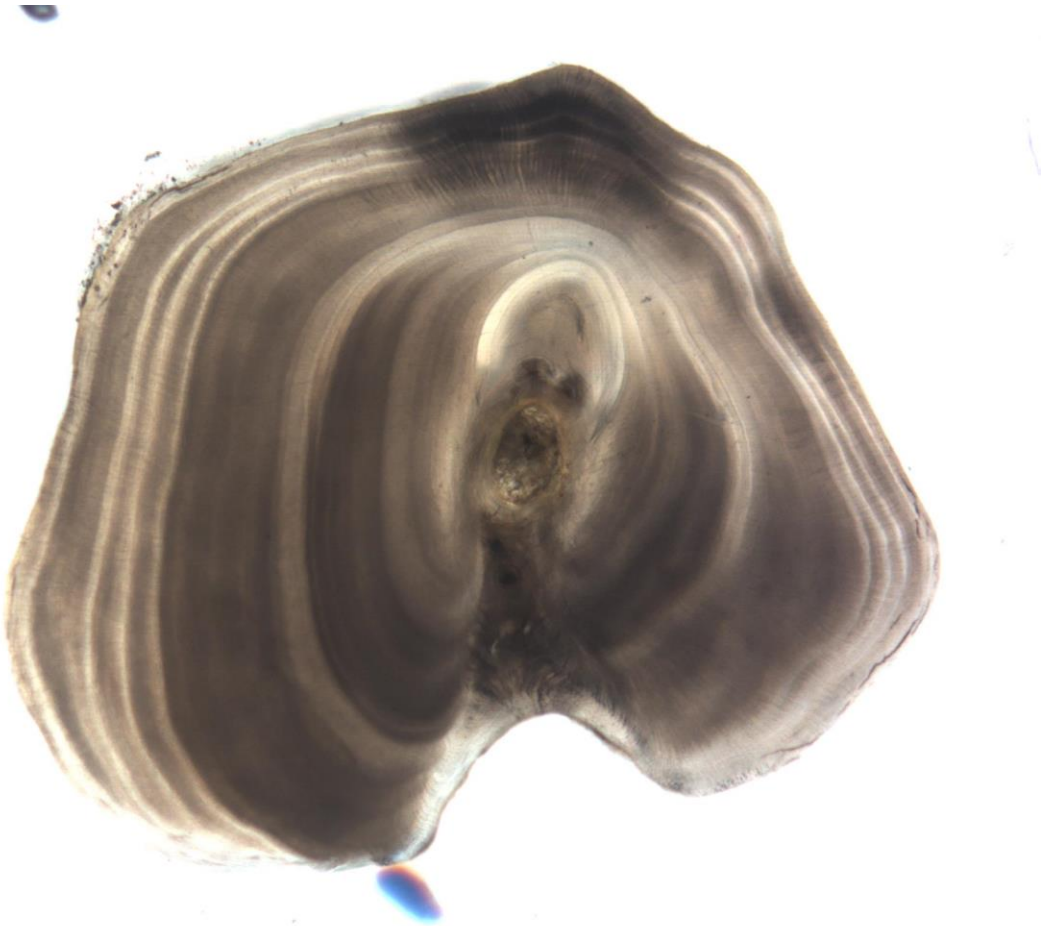

**Figure 71. Pelvic spine sample #10. This is a paired sample with operculum #50 and sectioned otolith #37. Sample was from a tautog that was 310 mm long. This tautog was captured in October 2017 in New Jersey waters by VIMS. Participants in the exchange aged this sample from an age 5 to 6, with a mode of age 6. (Workshop #019PS)**

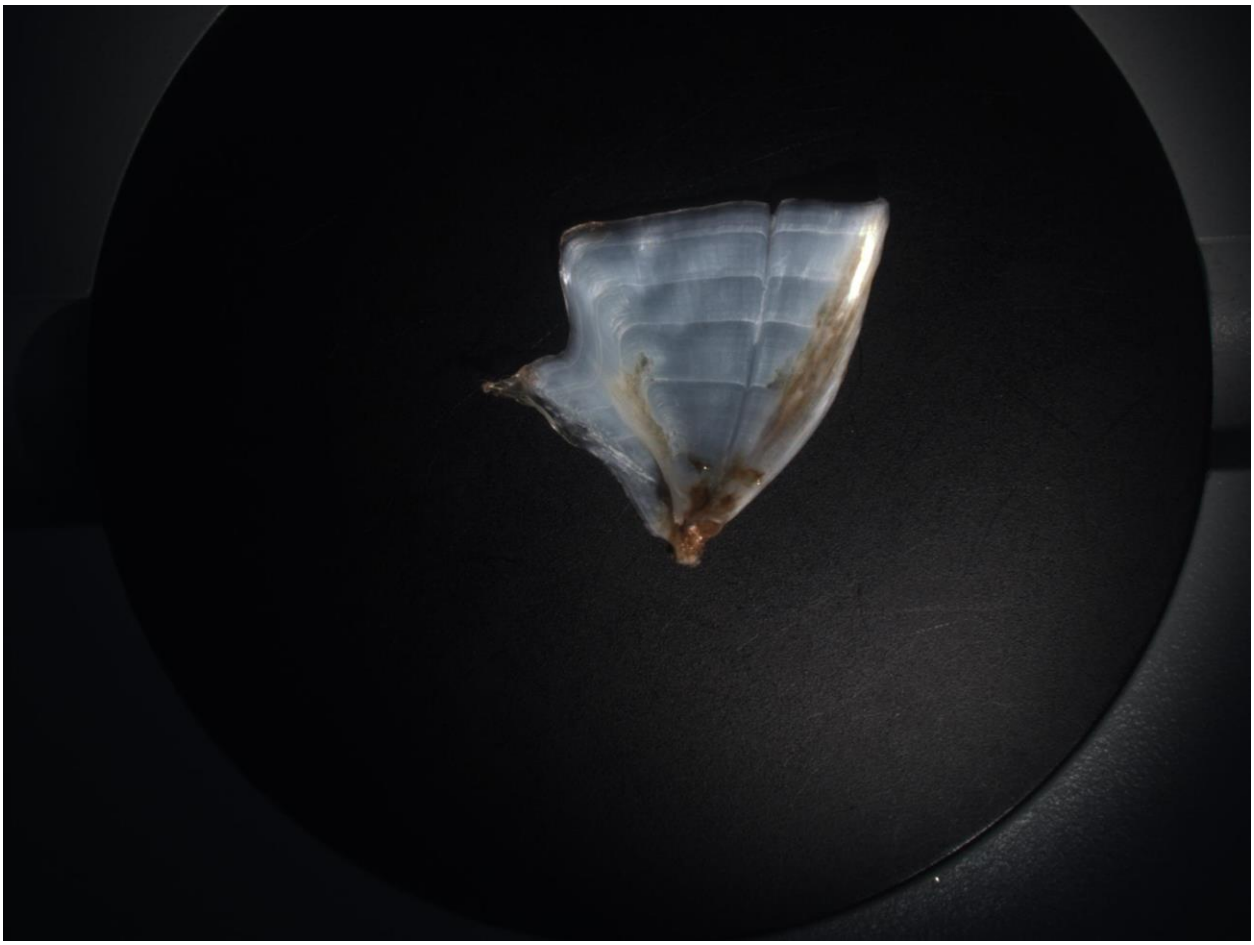

**Figure 72. Operculum sample #51. This is a paired sample with sectioned otolith #39 and pelvic spine #35. This sample was collected from a 328 mm long female tautog which was captured in May, 2019, by MA DMF in their state waters. Participants in the exchange aged this sample from an age 5 to 6, with a mode of age 6. (Workshop #040OP)**

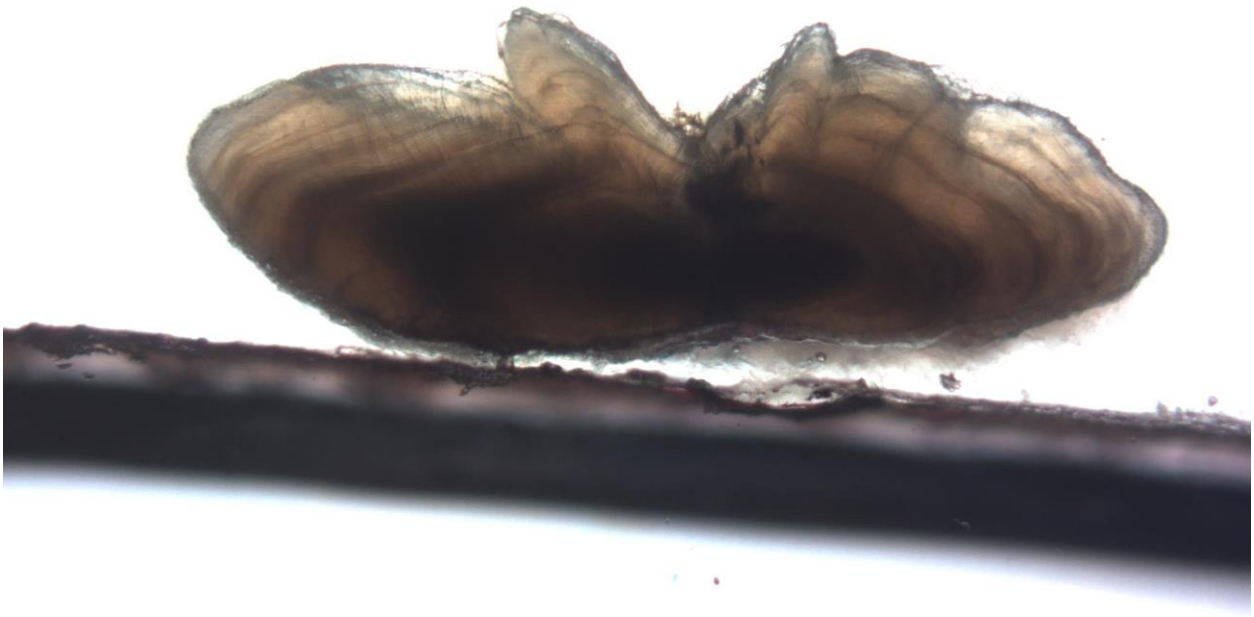

**Figure 73. Sectioned otolith sample #39. This is a paired sample with operculum #51 and pelvic spine #35. This sample was collected from a 328 mm long female tautog which was captured in May, 2019, by MA DMF in their state waters. Participants in the exchange aged this sample from an age 3 to 6, with a mode of age 5. (Workshop #040SO)**

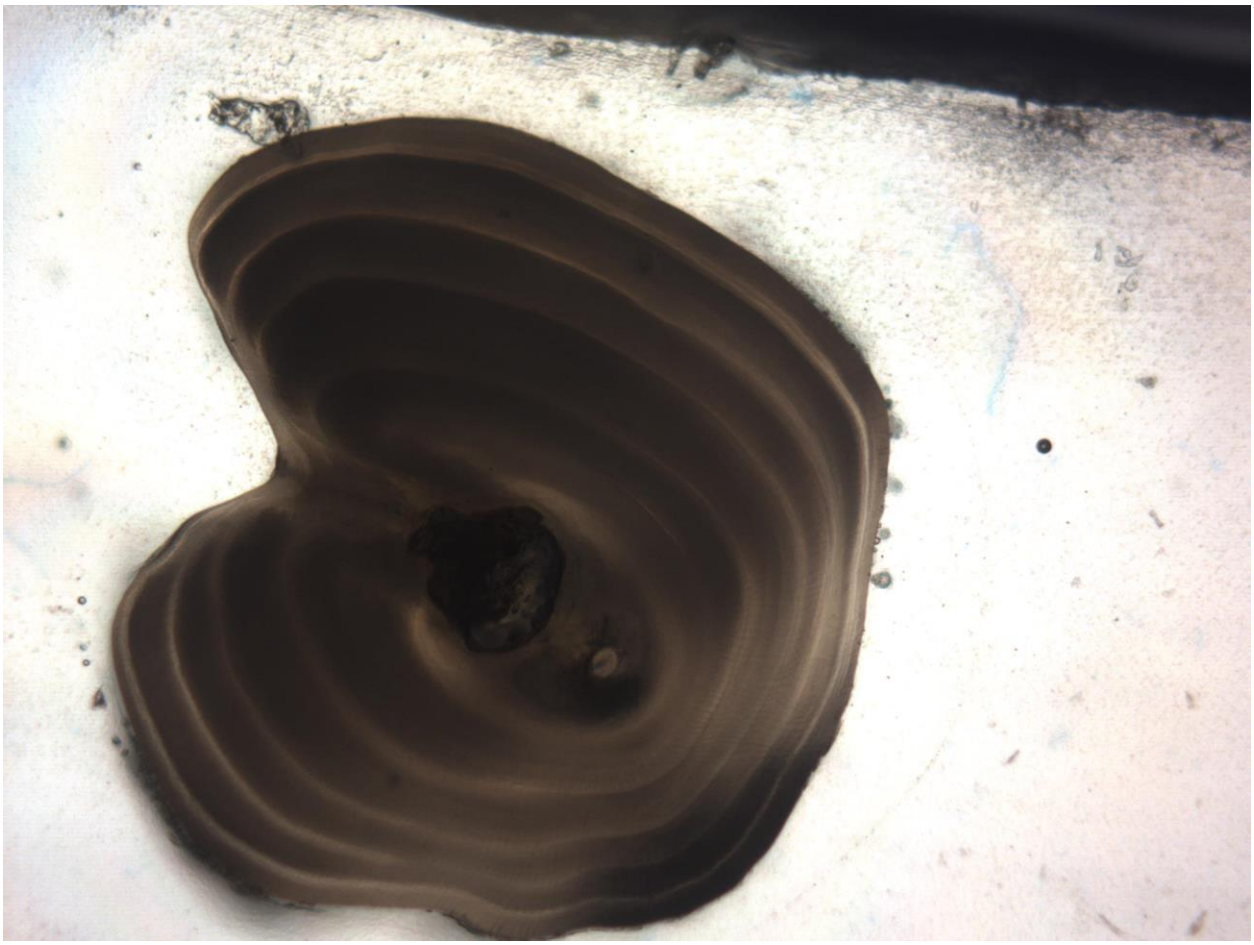

**Figure 74. Pelvic spine sample #35. This is a paired sample with operculum #51 and sectioned otolith #39. This sample was collected from a 328 mm long female tautog which was captured in May, 2019, by MA DMF in their state waters. Participants in the exchange aged this sample from an age 5 to 6, with a mode of age 6. (Workshop #030PS)**

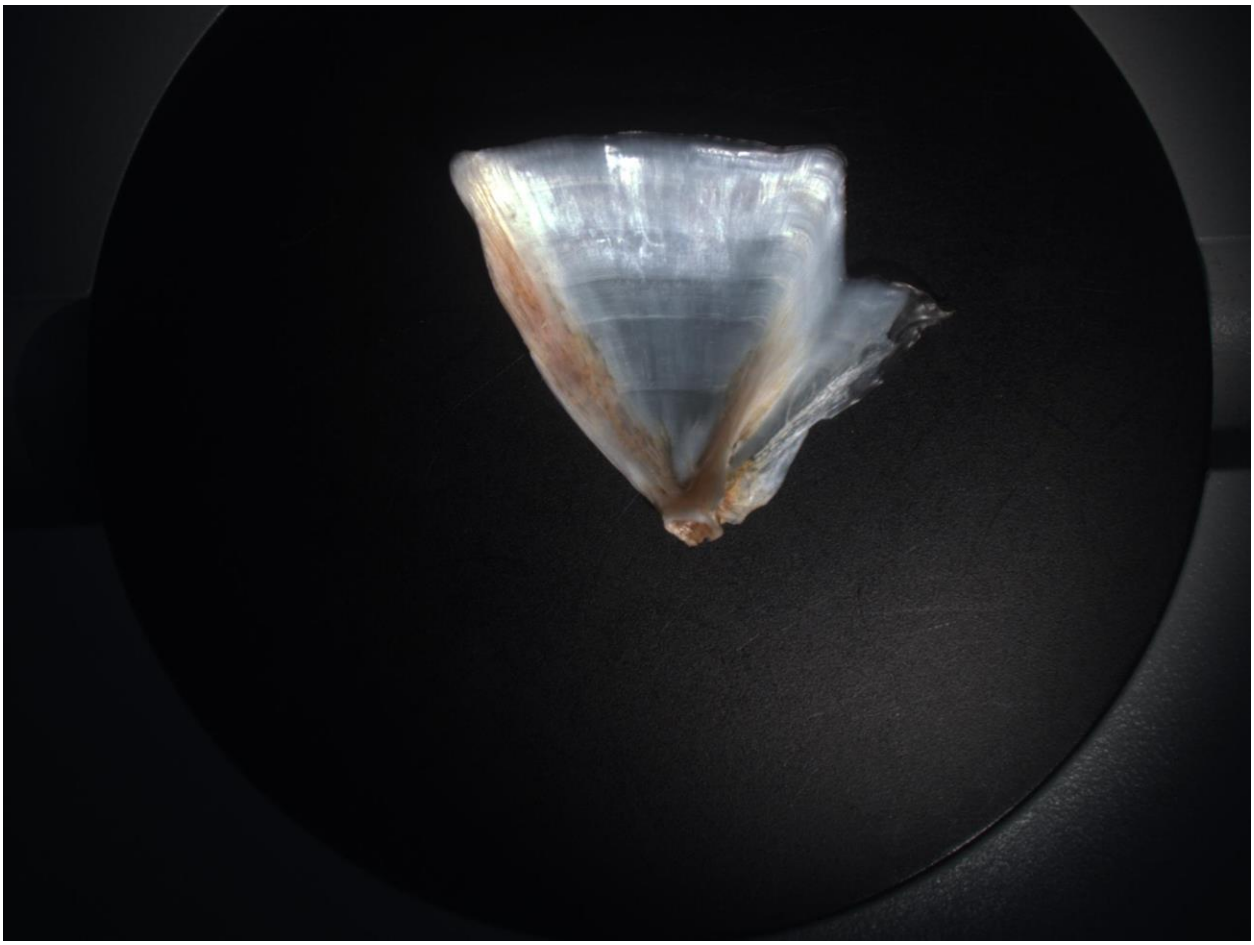

**Figure 75. Operculum sample #53. This is a paired sample with sectioned otolith #63 and pelvic spine #2. This sample was collected from a 398 mm long female tautog which was captured in November, 2018, by RI DEM in their state waters. Participants in the exchange aged this sample from an age 5 to 6, with a mode of age 5. (Workshop #033OP)**

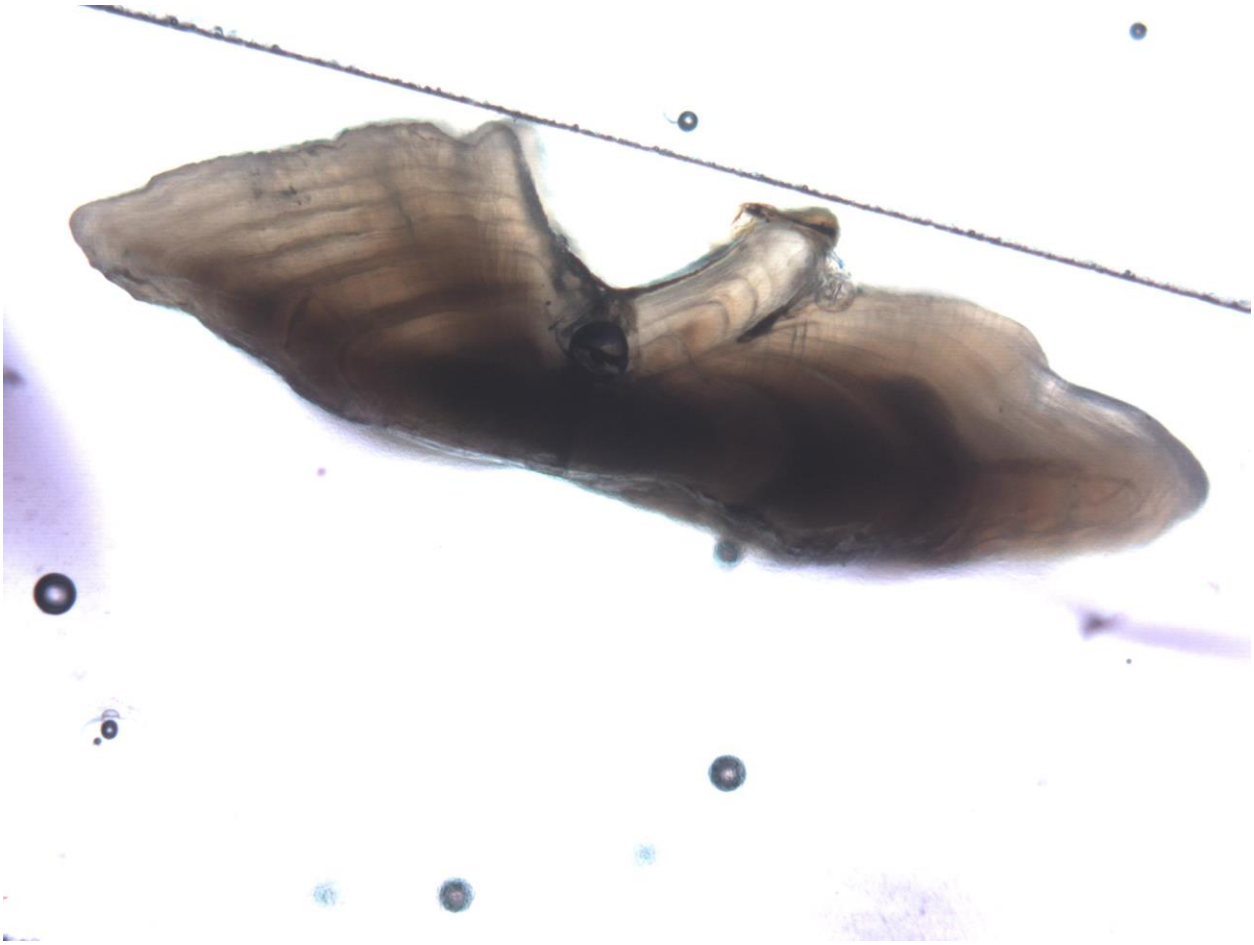

**Figure 76. Sectioned otolith sample #63. This is a paired sample with operculum #53 and pelvic spine #2. This sample was collected from a 398 mm long female tautog which was captured in November, 2018, by RI DEM in their state waters. Participants in the exchange aged this sample from an age 5 to 7, with a mode of age 6. (Workshop #025SO)**

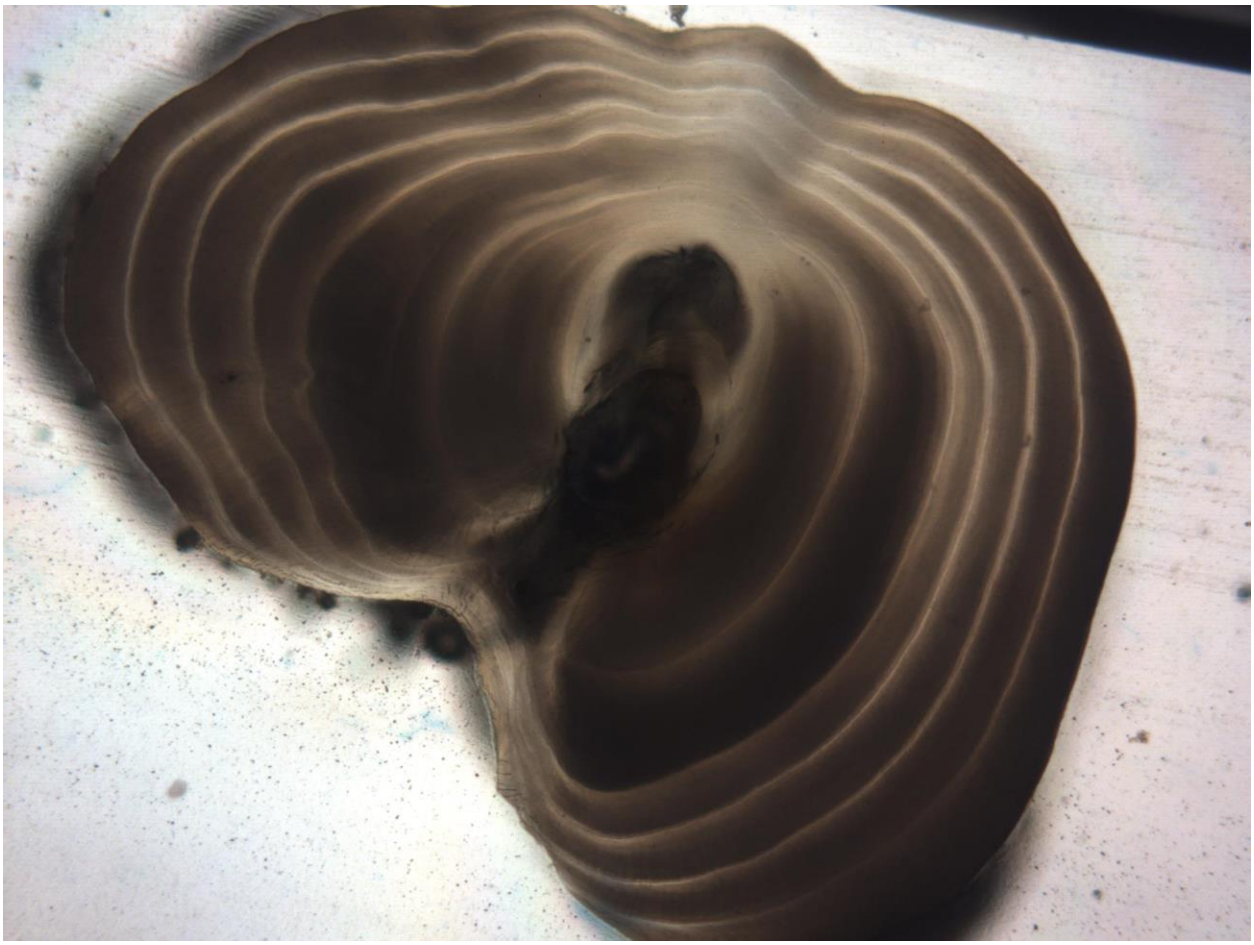

**Figure 77. Pelvic spine sample #2. This is a paired sample with operculum #53 and sectioned otolith #63. This sample was collected from a 398 mm long female tautog which was captured in November, 2018, by RI DEM in their state waters. Participants in the exchange aged this sample from an age 5 to 7, with a mode of age 6. (Workshop #006PS)**

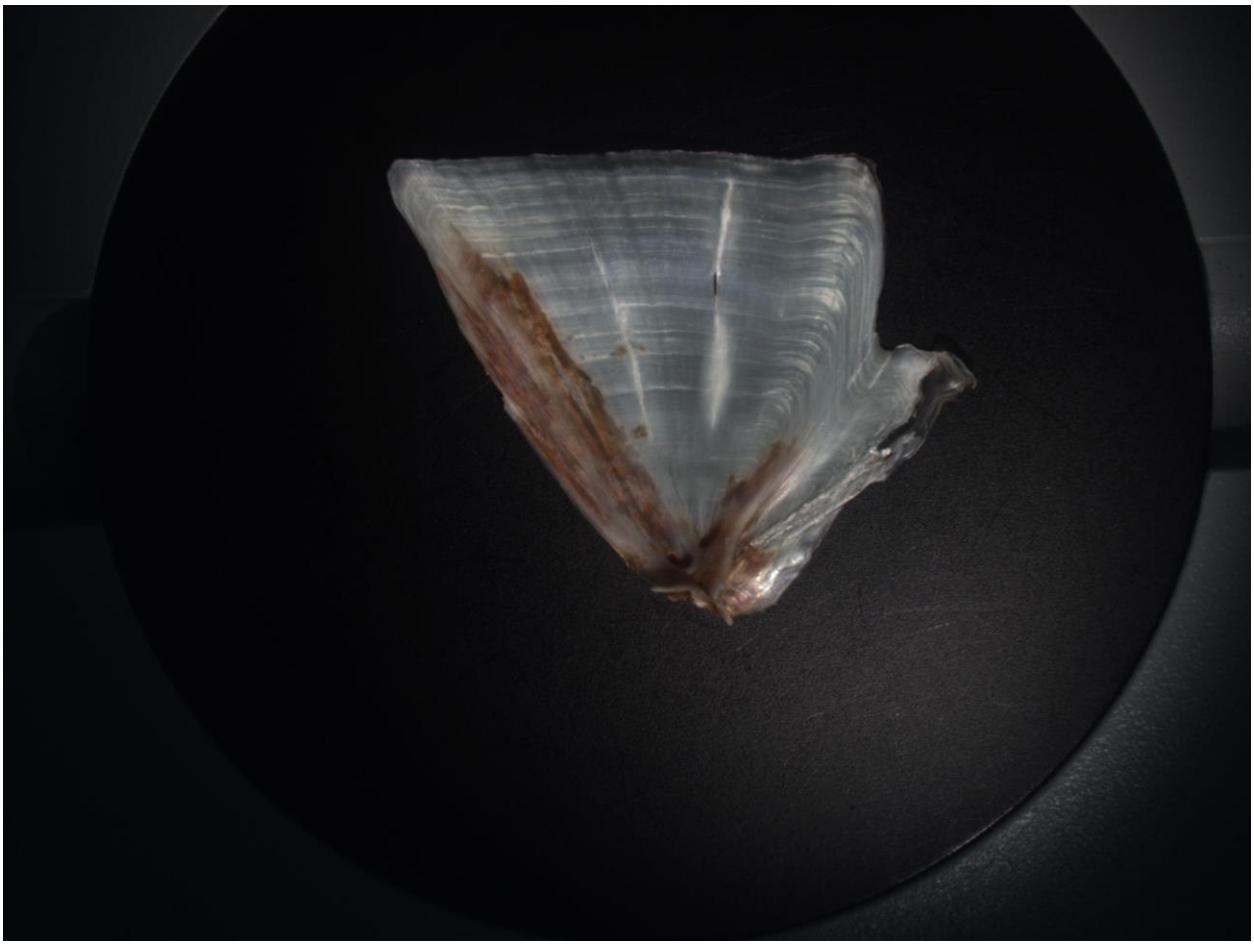

**Figure 78. Operculum sample #56. This is a paired sample with sectioned otolith #64 and pelvic spine #23. Sample was from a tautog that was 450 mm long. This tautog was captured in October 2017 in Delaware waters by VIMS. Participants in the exchange aged this sample from an age 11 to 13, with a mode of age 13. (Workshop #026OP)**

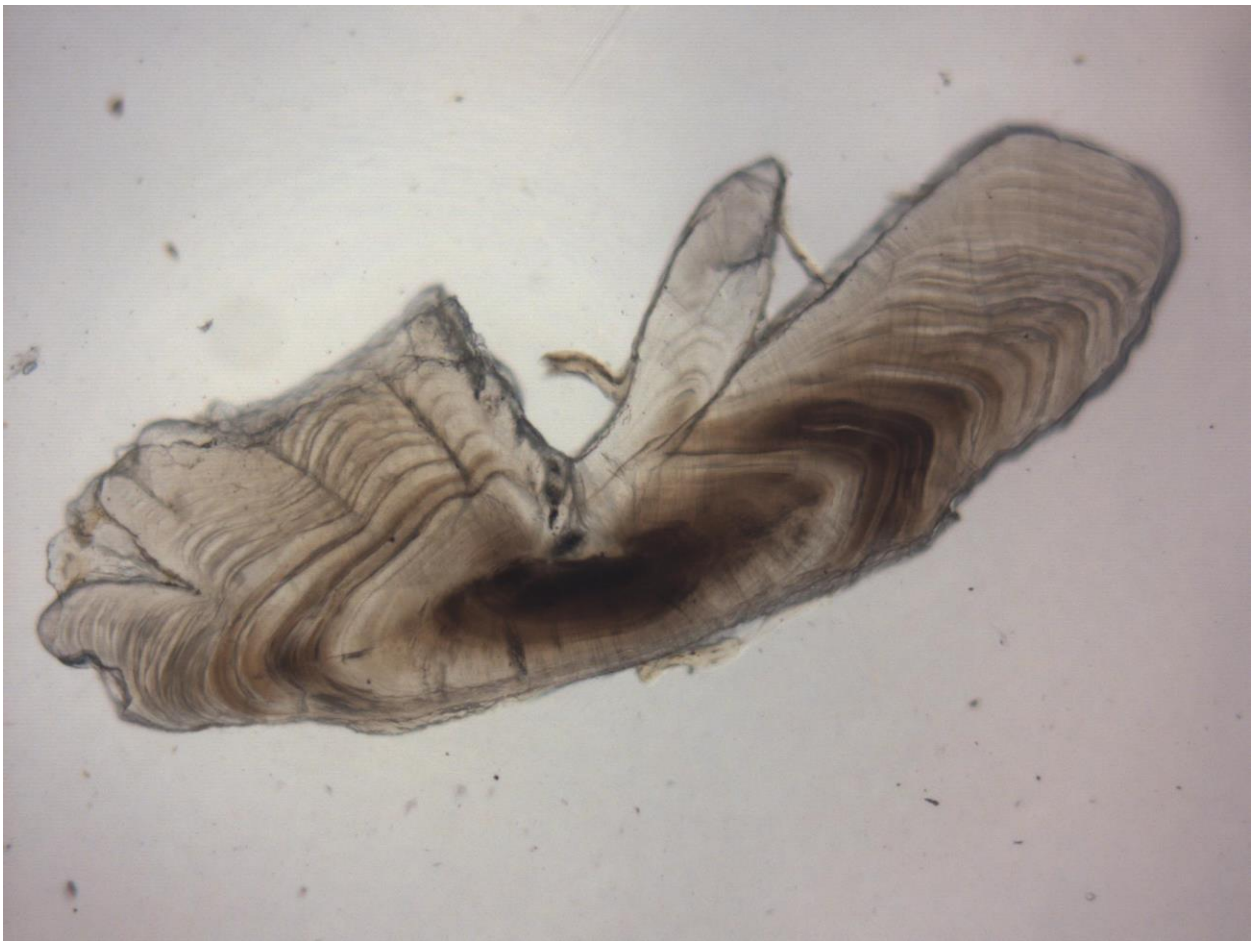

**Figure 79. Sectioned otolith sample #64. This is a paired sample with operculum #56 and pelvic spine #23. Sample was from a tautog that was 450 mm long. This tautog was captured in October 2017 in Delaware waters by VIMS. Participants in the exchange aged this sample from an age 12 to 21, with a mode of age 12. (Workshop #021SO)**

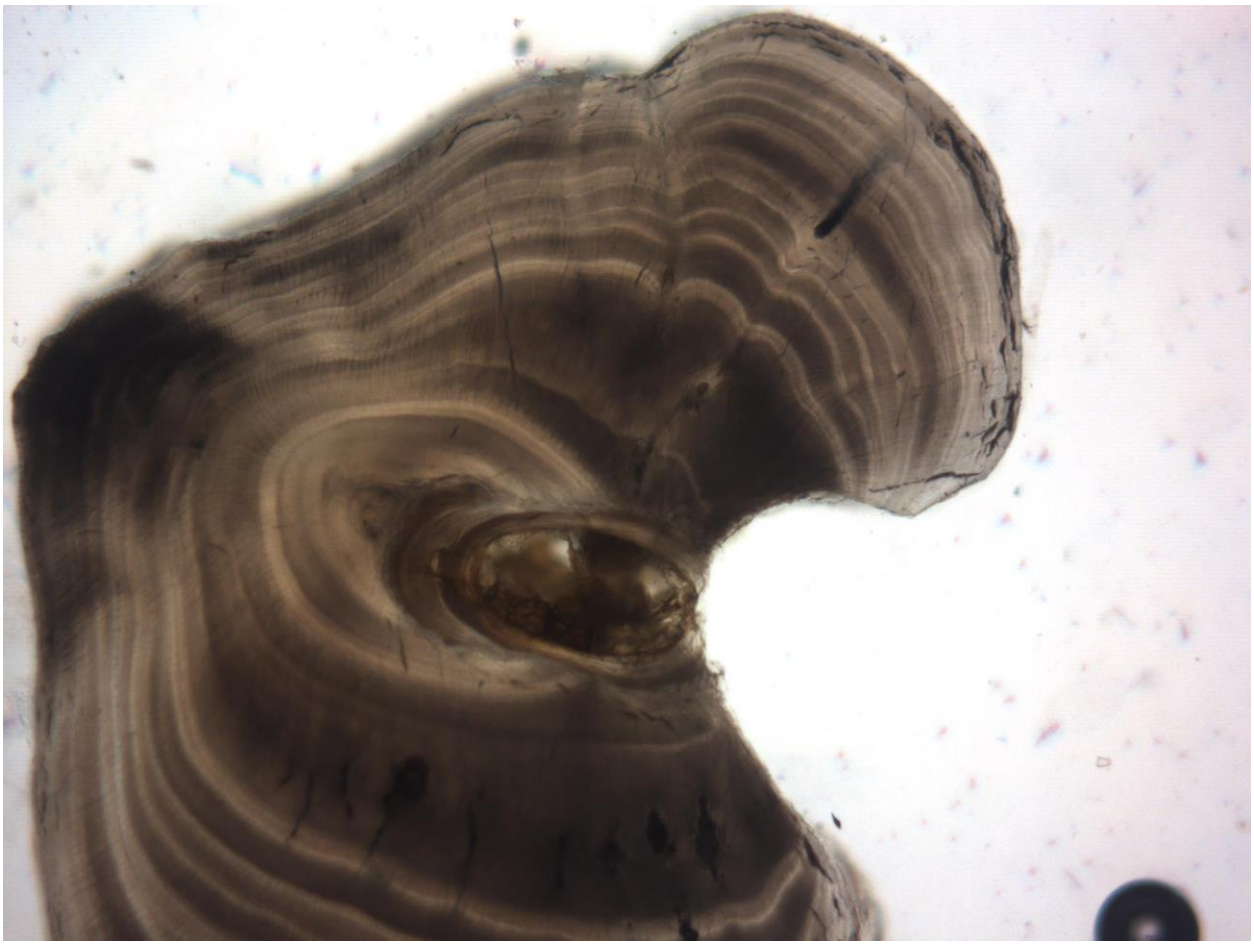

**Figure 80. Pelvic spine sample #23. This is a paired sample with operculum #56 and sectioned otolith #64. Sample was from a tautog that was 450 mm long. This tautog was captured in October 2017 in Delaware waters by VIMS. Participants in the exchange aged this sample from an age 10 to 13, with a mode of age 12. (Workshop #013PS)**

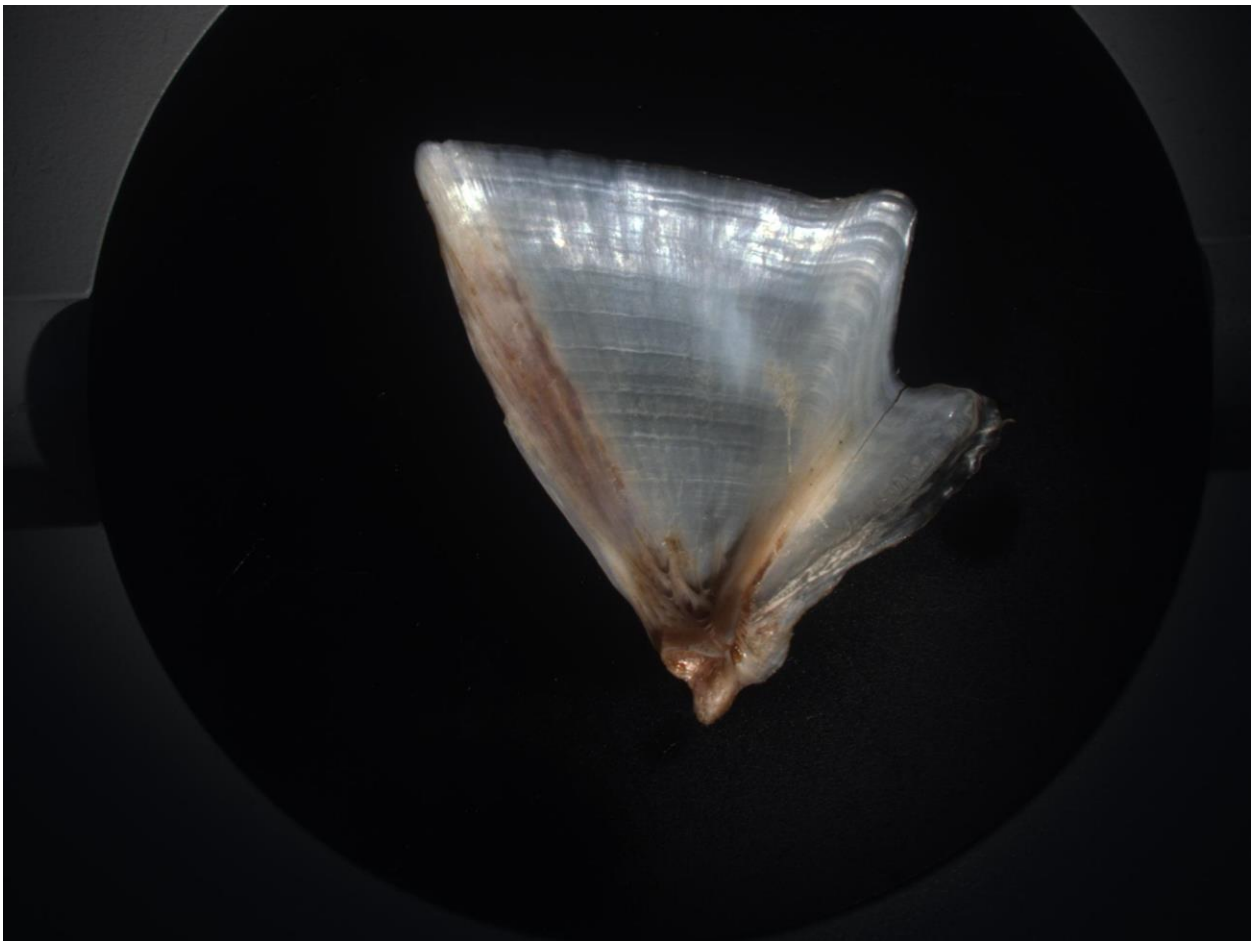

**Figure 81. Operculum sample #58. This is a paired sample with sectioned otolith #38 and pelvic spine #51. This sample was collected from a 514 mm long female tautog which was captured in December, 2018, by MD DNR in their state waters. Participants in the exchange aged this sample from an age 10 to 14, with a mode of age 12. (Workshop #009OP)**

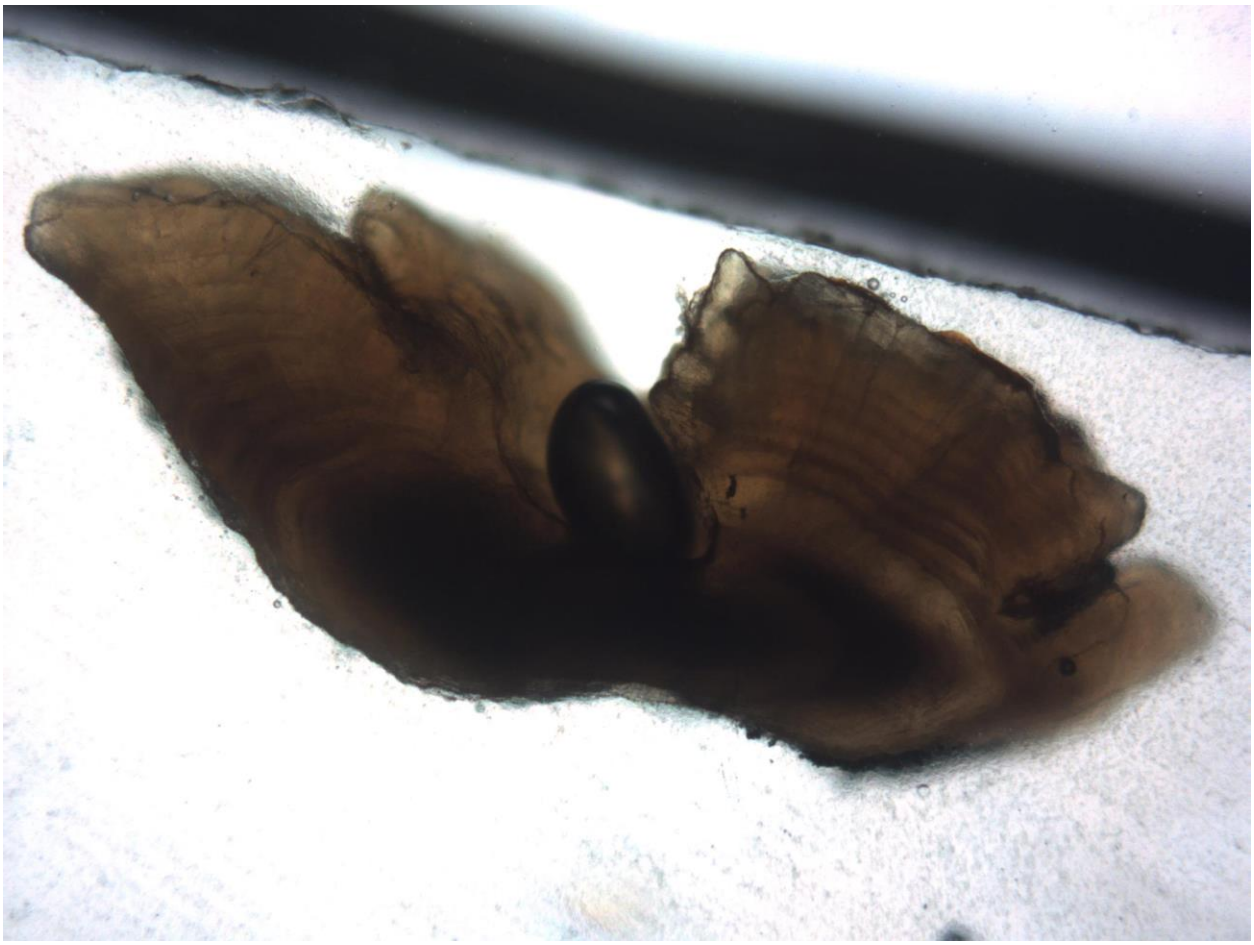

**Figure 82. Sectioned otolith sample #38. This is a paired sample with pelvic spine #51 and operculum #58. This sample was collected from a 514 mm long female tautog which was captured in December, 2018, by MD DNR in their state waters. Participants in the exchange aged this sample from an age 8 to 11, with a mode of age 9. Sample was removed from the analysis due to unreadability. (Workshop #001SO)**

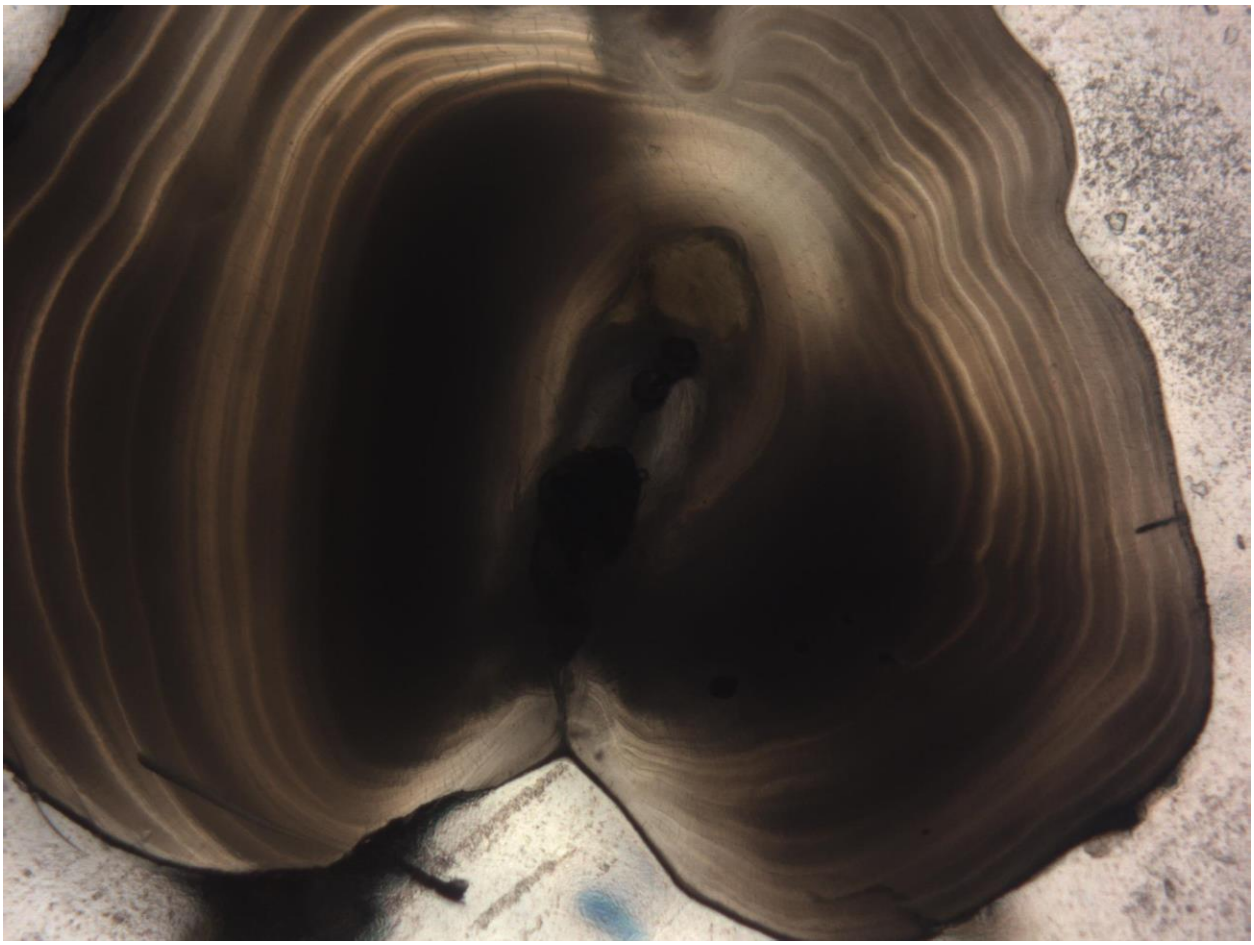

**Figure 83. Pelvic spine sample #51. This is a paired sample with sectioned otolith #38 and operculum #58. This sample was collected from a 514 mm long female tautog which was captured in December, 2018, by MD DNR in their state waters. Participants in the exchange aged this sample from an age 7 to 11, with a mode of age 10. (Workshop #031PS)**

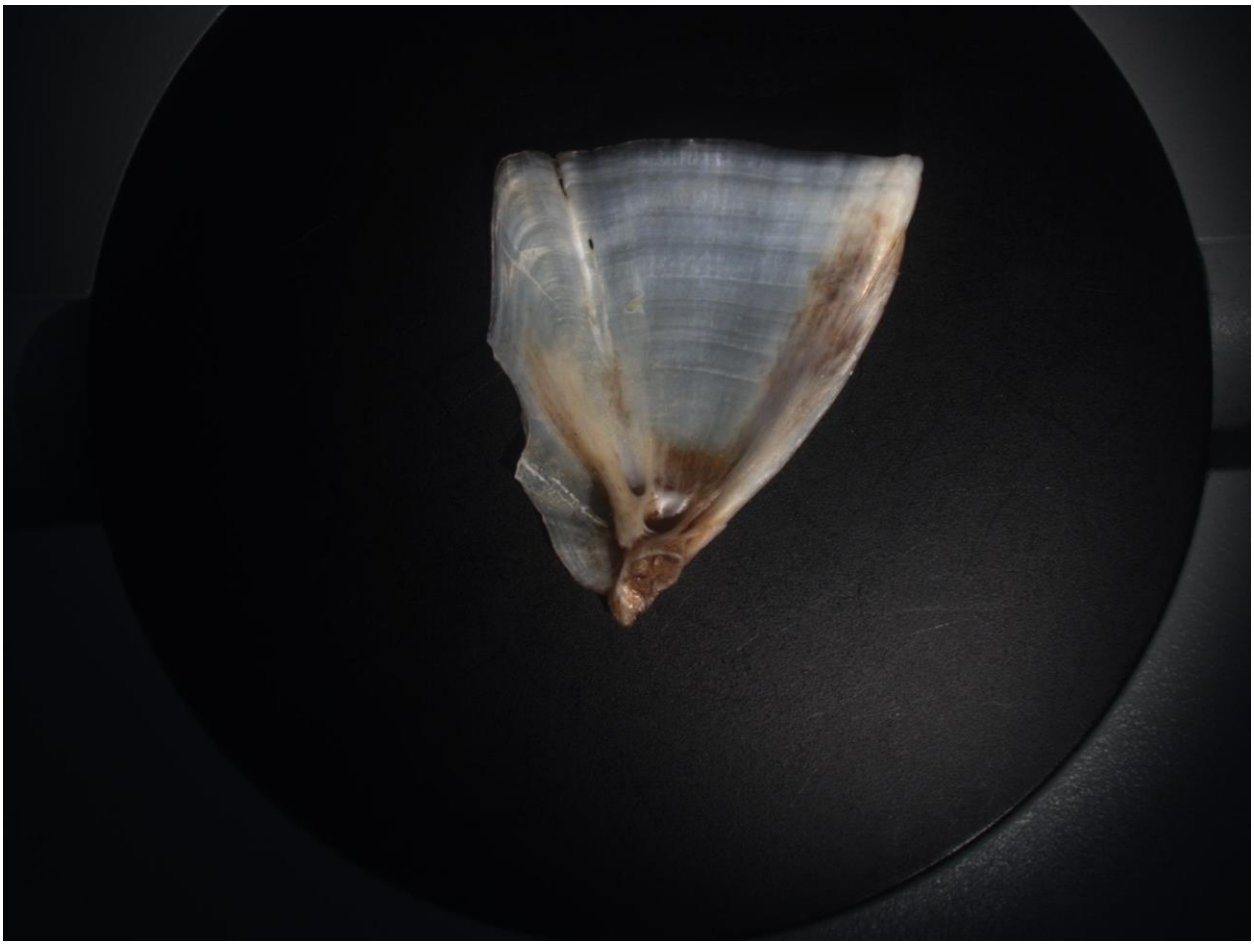

**Figure 84. Operculum sample #59. This is a paired sample with sectioned otolith #26 and pelvic spine #54. This sample was collected from a 447 mm long female tautog which was captured in December, 2018, by MD DNR in their state waters. Participants in the exchange aged this sample from an age 6 to 11, with a mode of age 8. (Workshop #036OP)**

**Figure 85. Sectioned otolith sample #26. This is a paired sample with operculum #59 and pelvic spine #54. This sample was collected from a 447 mm long female tautog which was captured in December, 2018, by MD DNR in their state waters. Participants in the exchange aged this sample from an age 9 to 10, with a mode of age 10. (Workshop #036SO)**

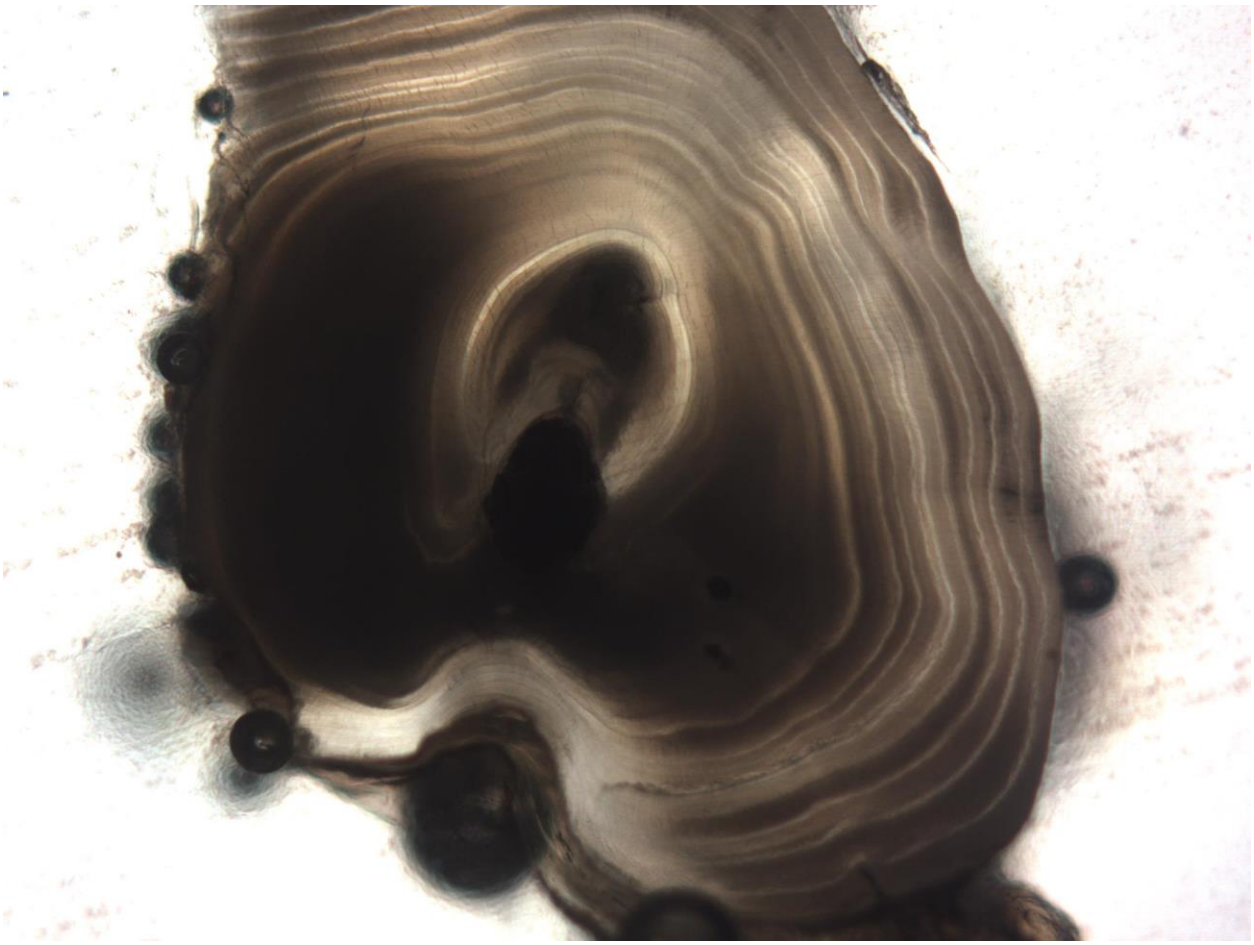

**Figure 86. Pelvic spine sample #54. This is a paired sample with operculum #59 and sectioned otolith #26. This sample was collected from a 447 mm long female tautog which was captured in December, 2018, by MD DNR in their state waters. Participants in the exchange aged this sample from an age 8 to 10, with a mode of age 9. (Workshop #020PS)**

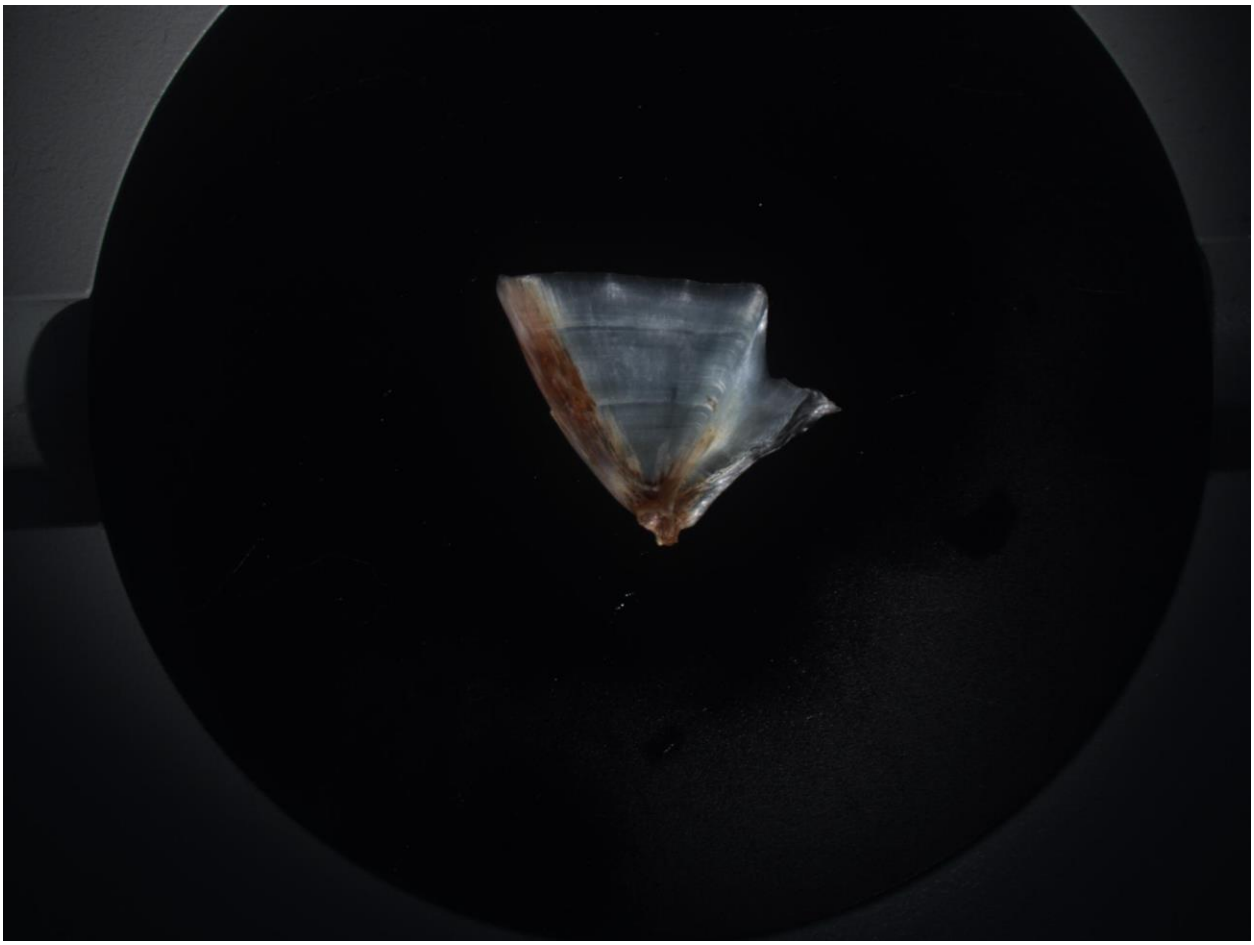

**Figure 87. Operculum sample #61. This is a paired sample with sectioned otolith #13 and pelvic spine #64. Sample was from a tautog that was 200 mm long. This tautog was captured in October 2017 in New Jersey waters by VIMS. All participants aged this sample as a 2-year-old during the sample exchange. (Workshop 001OP)**

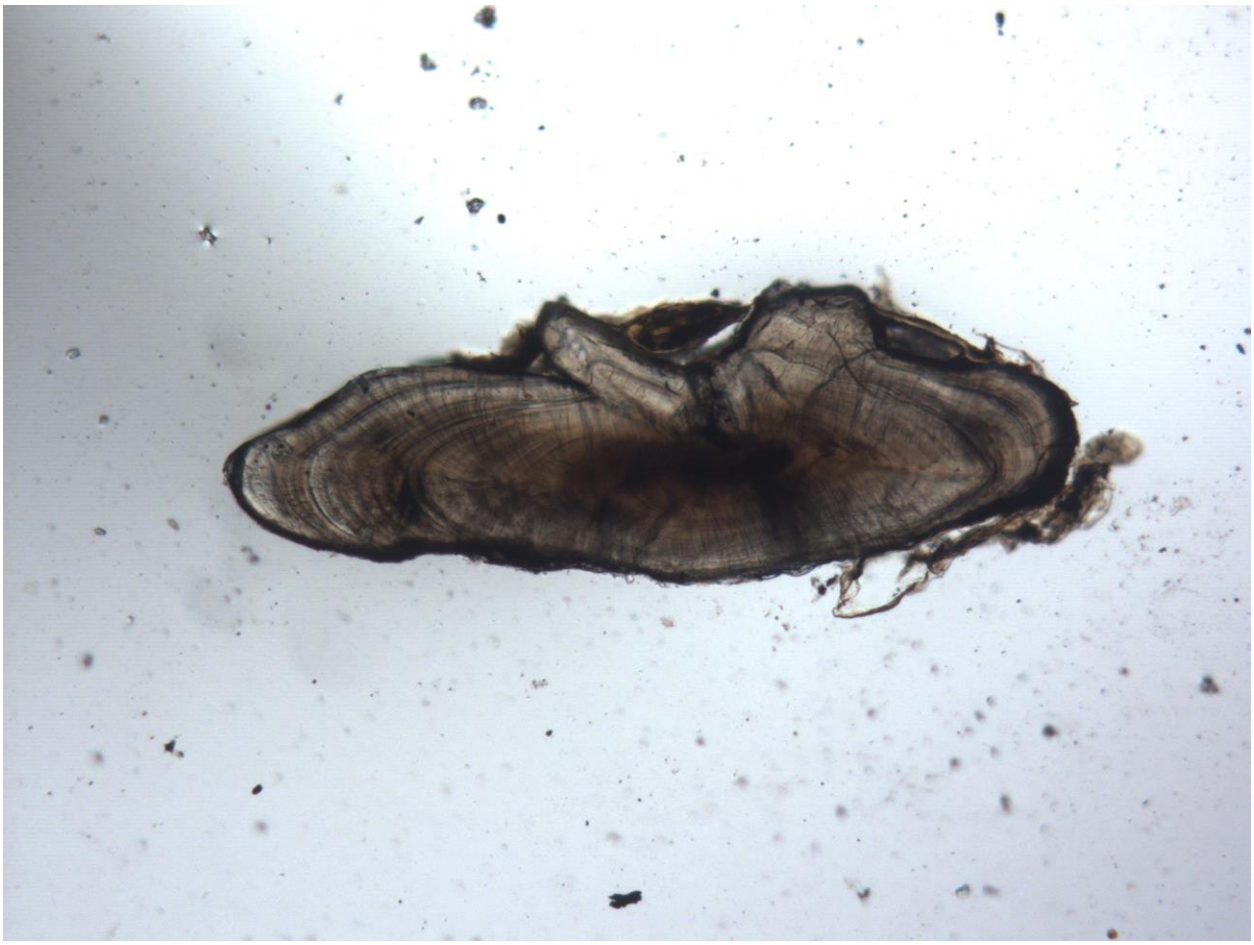

**Figure 88. Sectioned otolith sample #13. This is a paired sample with pelvic spine #64 and operculum #61. Sample was from a tautog that was 200 mm long. This tautog was captured in October 2017 in New Jersey waters by VIMS. Participants in the exchange aged this sample from an age 2 to 7, with a mode of age 2. (Workshop 012SO)**

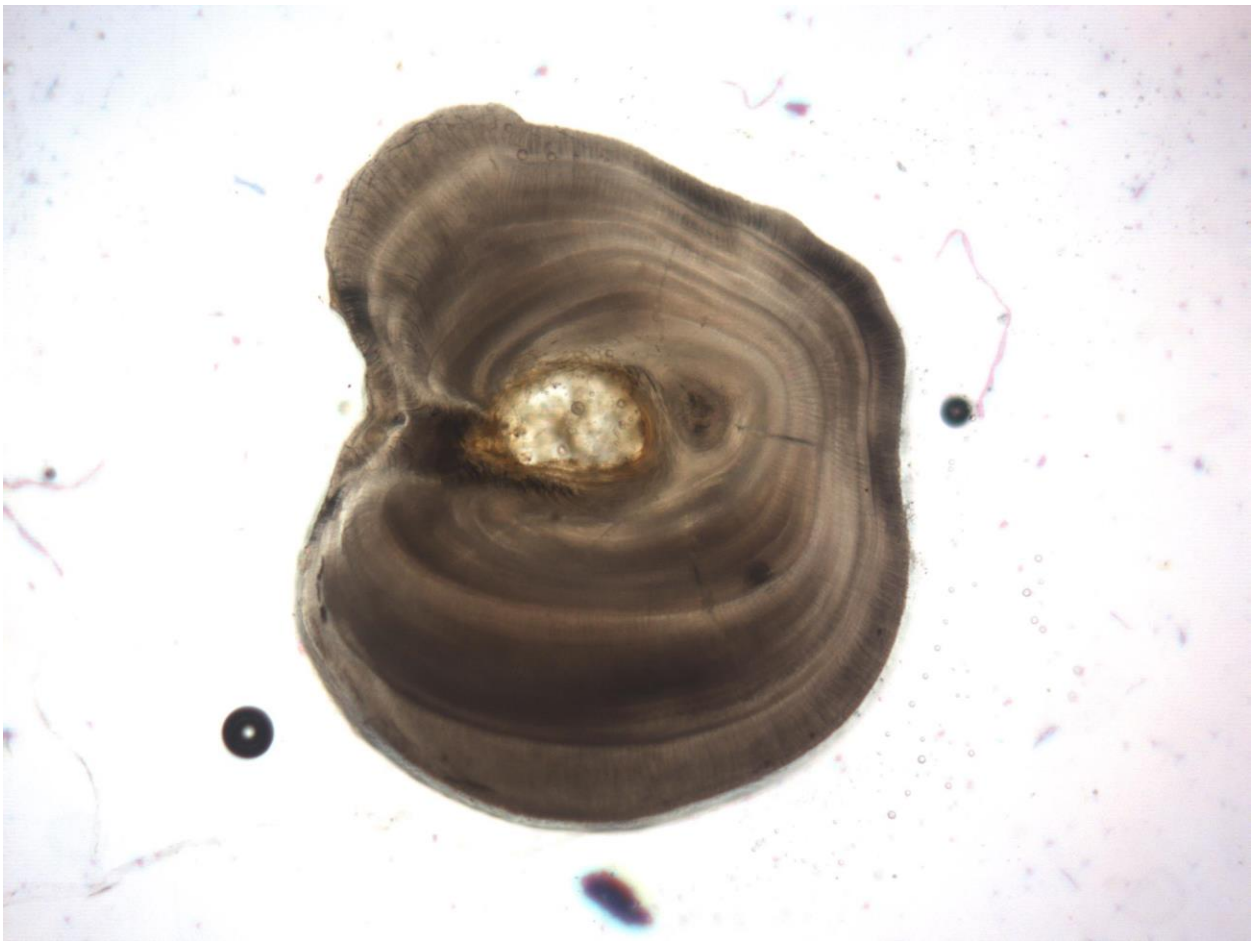

**Figure 89. Pelvic spine sample #64. This is a paired sample with sectioned otolith #13 and operculum #61. Sample was from a tautog that was 200 mm long. This tautog was captured in October 2017 in New Jersey waters by VIMS. Participants in the exchange aged this sample from an age 2 to 5, with a mode of age 3. (Workshop 043PS)**

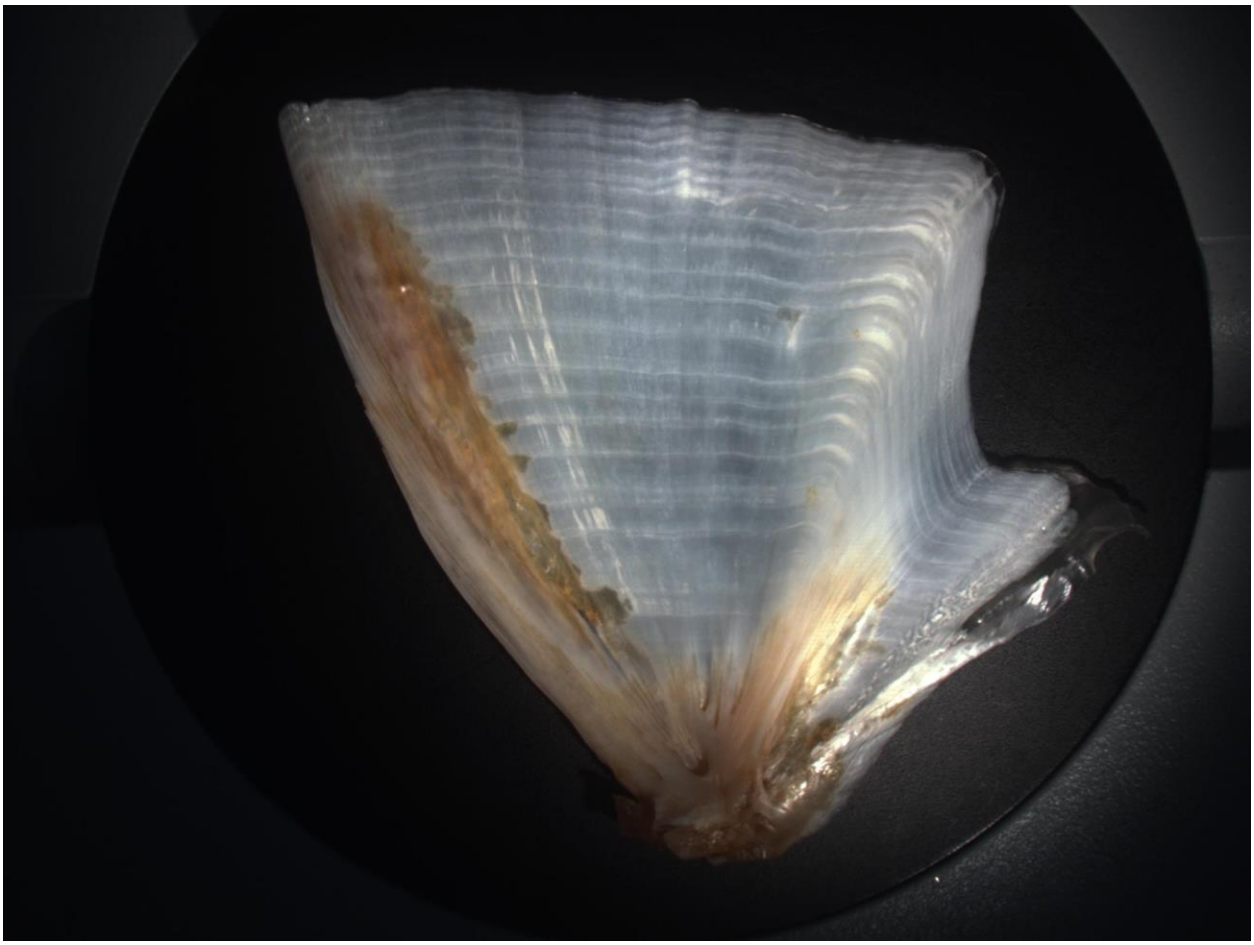

**Figure 90. Operculum sample #67. This is a paired sample with pelvic spine #41 (no paired otolith sample). This sample was collected from a 690 mm long male tautog which was captured in December, 2018, by MD DNR in their state waters. Participants in the exchange aged this sample from an age 19 to 21, with a mode of age 21. (Workshop #041OP)**

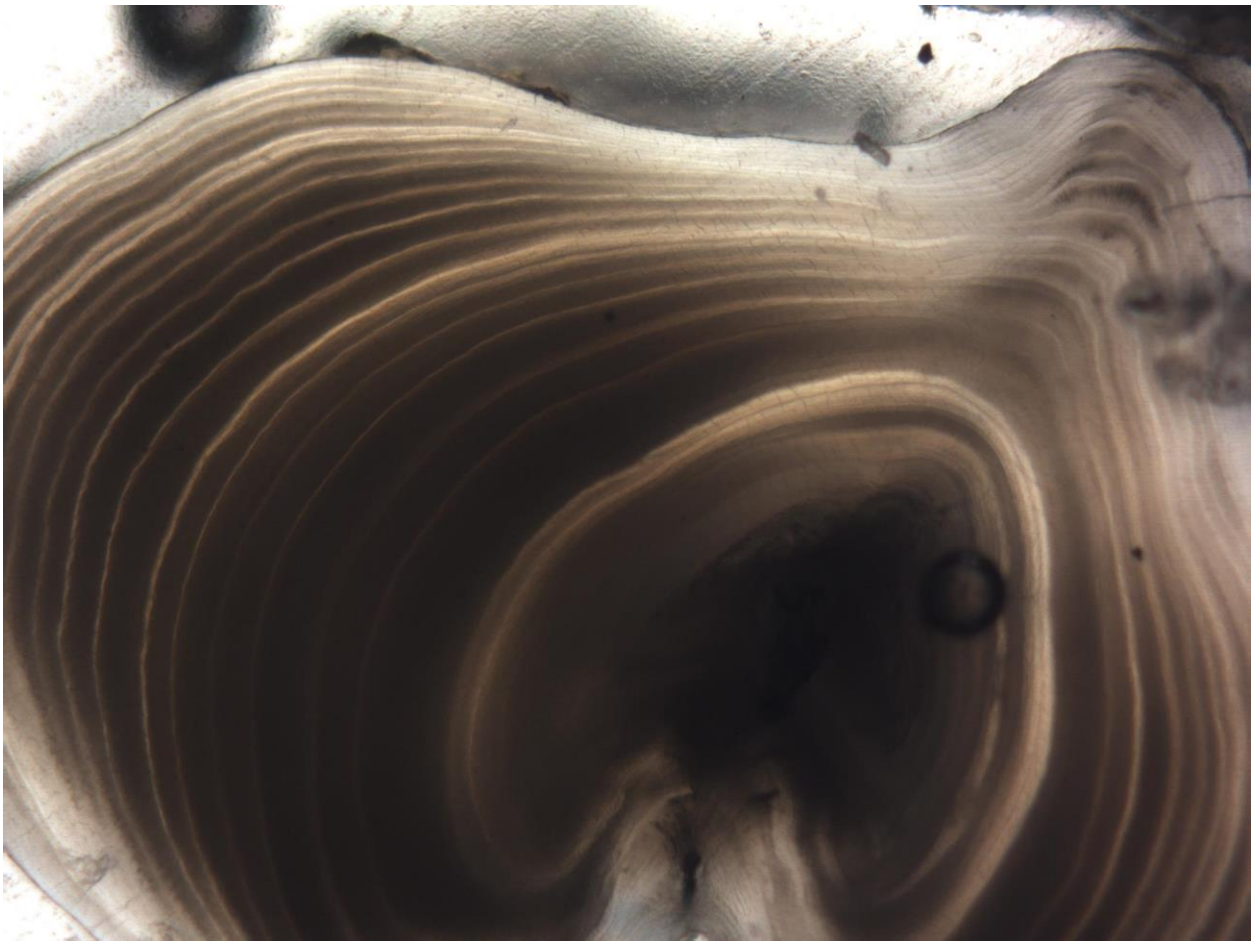

**Figure 91. Pelvic spine sample #41. This is a paired sample with operculum #67 (no paired otolith sample). This sample was collected from a 690 mm long male tautog which was captured in December, 2018, by MD DNR in their state waters. Participants in the exchange aged this sample from an age 18 to 21, with a mode of age 20. (Workshop #021PS)**

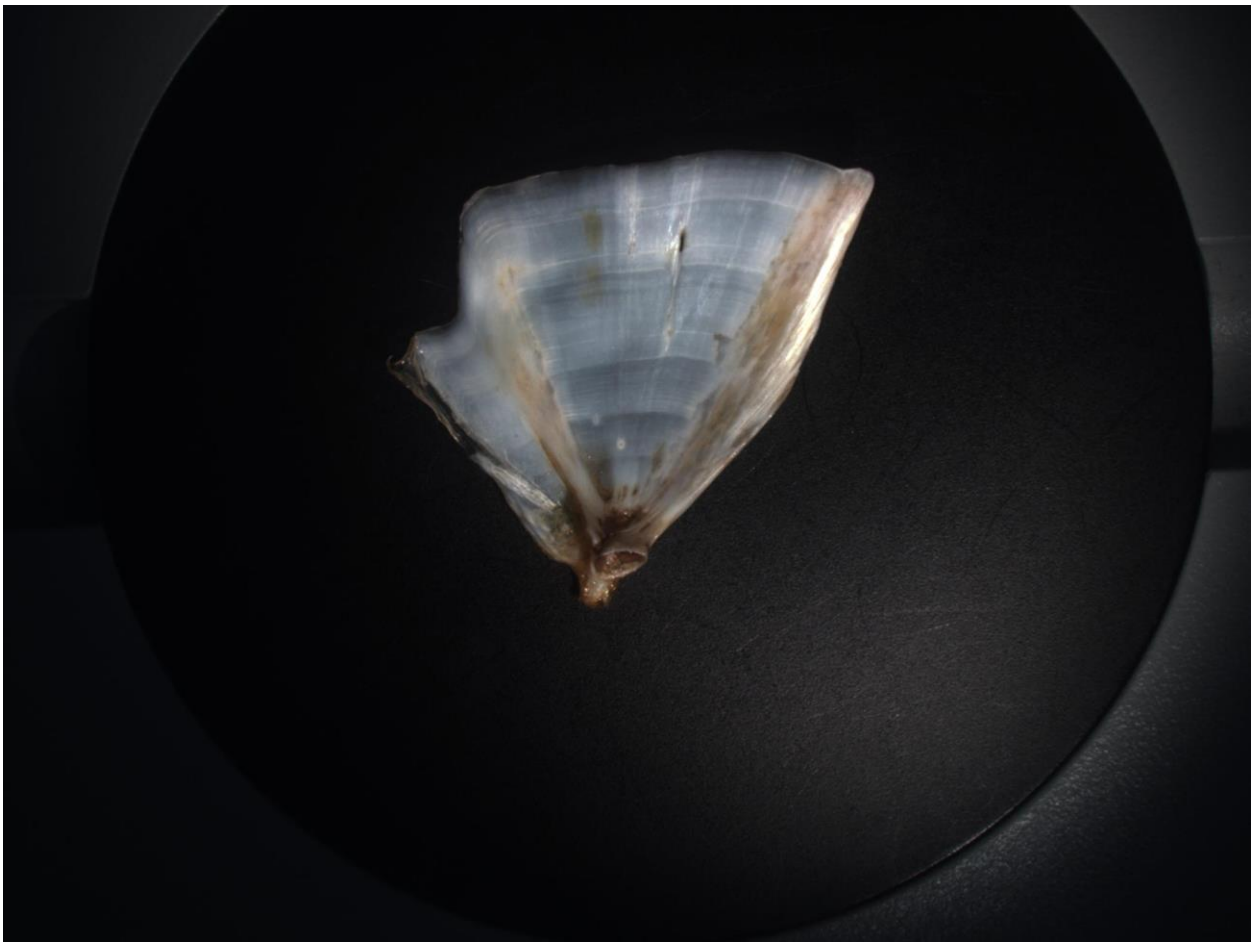

**Figure 92. Operculum sample #68. This is a paired sample with sectioned otolith #45 and pelvic spine #59. This sample was collected from a 391 mm long male tautog which was captured in May, 2019, by MA DMF in their state waters. Participants in the exchange aged this sample from an age 5 to 8, with a mode of age 6. (Workshop #031OP)**

**Figure 93. Sectioned otolith sample #45. This is a paired sample with operculum #68 and pelvic spine #59. This sample was collected from a 391 mm long male tautog which was captured in May, 2019, by MA DMF in their state waters. Participants in the exchange aged this sample from an age 6 to 7, with a mode of age 7. (Workshop #020SO)**

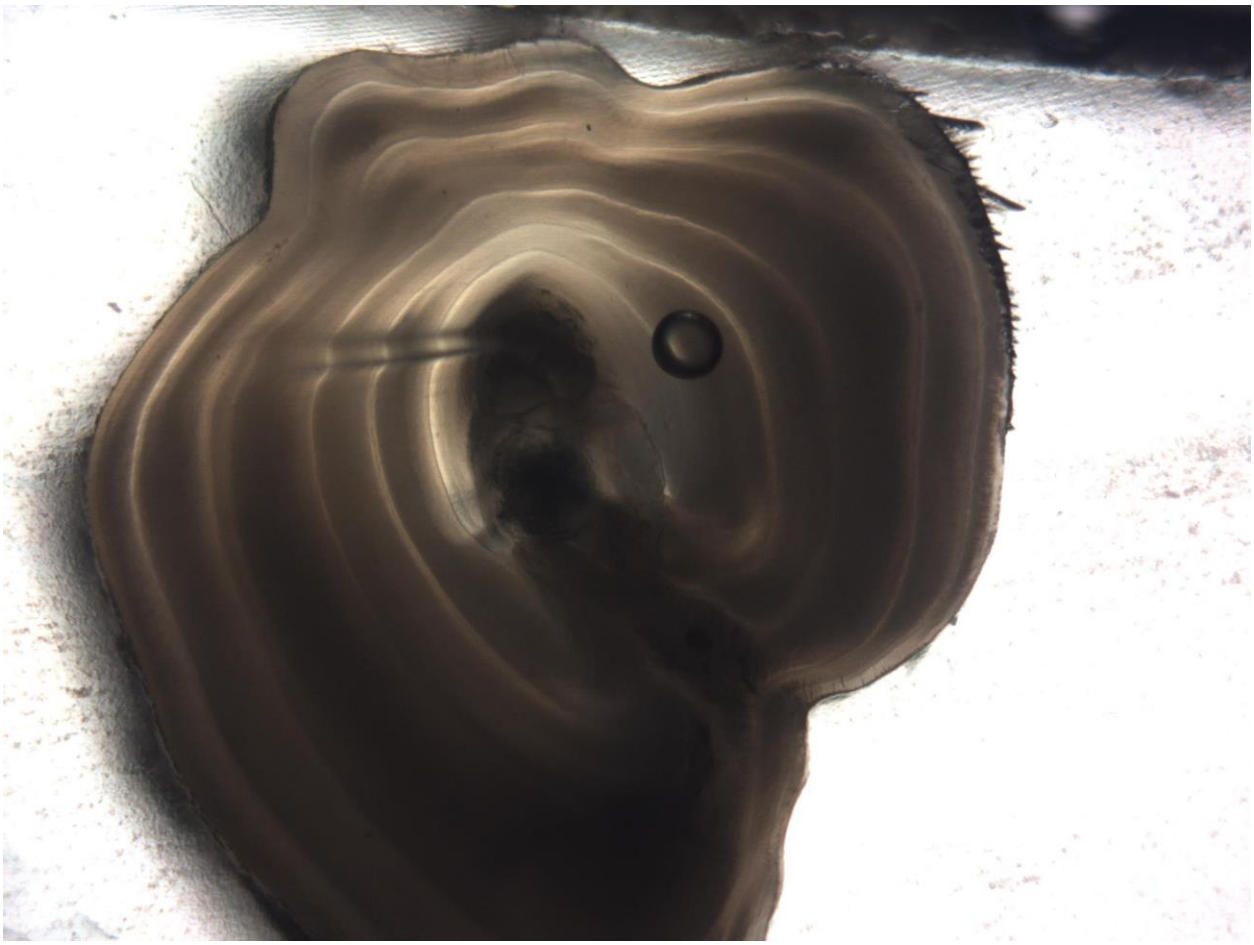

**Figure 94. Pelvic spine sample #59. This is a paired sample with operculum #68 and sectioned otolith #45. This sample was collected from a 391 mm long male tautog which was captured in May, 2019, by MA DMF in their state waters. Participants in the exchange aged this sample from an age 5 to 7, with a mode of age 6. (Workshop #008PS)**

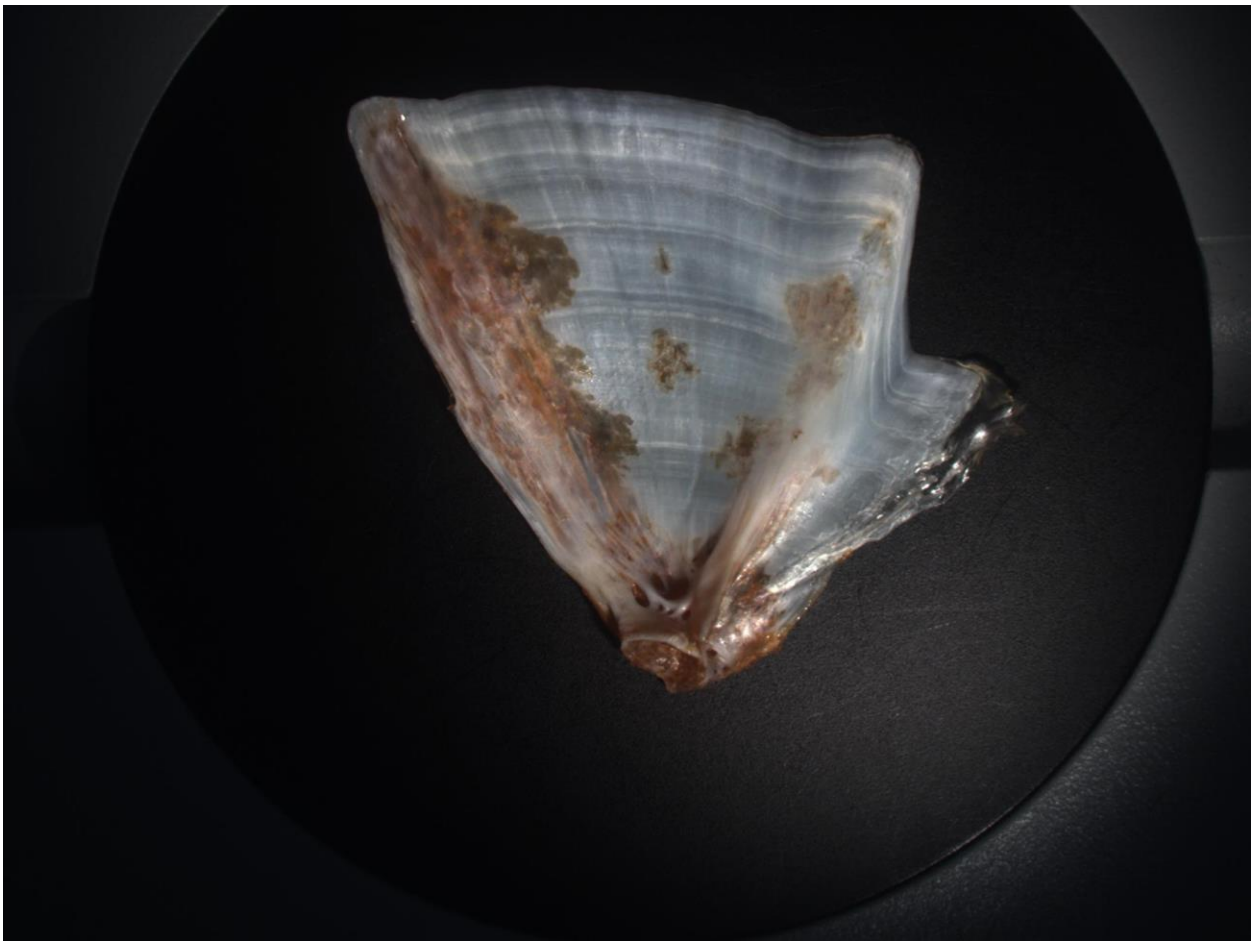

**Figure 95. Operculum sample #69. This is a paired sample with sectioned otolith #24 and pelvic spine #22. This sample was collected from a 574 mm long male tautog which was captured in December, 2018, by MD DNR in their state waters. Participants in the exchange aged this sample from an age 6 to 11, with a mode of age 11. (Workshop #022OP)**

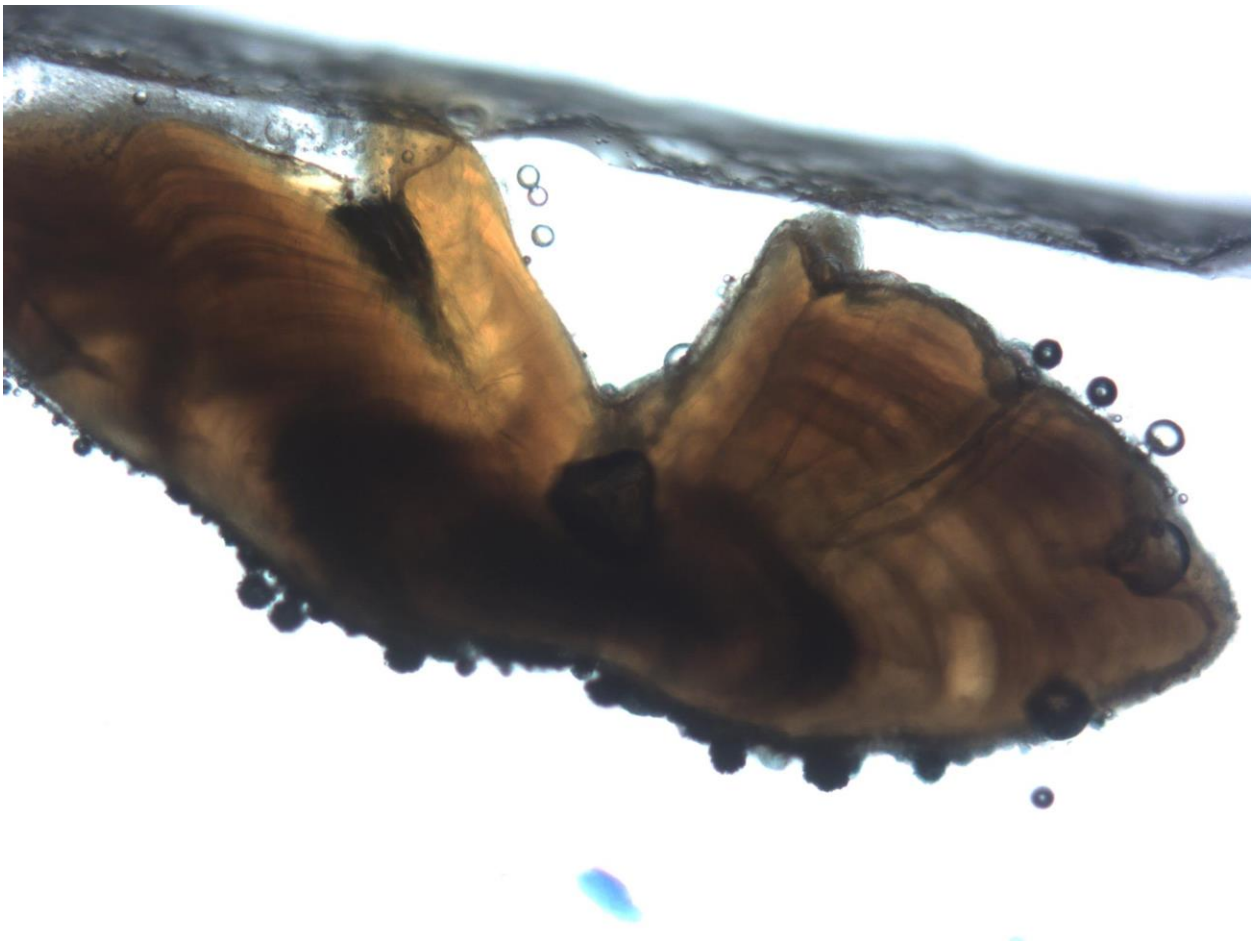

**Figure 96. Sectioned otolith sample #24. This is a paired sample with operculum #69 and pelvic spine #22. This sample was collected from a 574 mm long male tautog which was captured in December, 2018, by MD DNR in their state waters. Participants in the exchange aged this sample from an age 7 to 10, with a mode of age 8. (Workshop #006SO)**

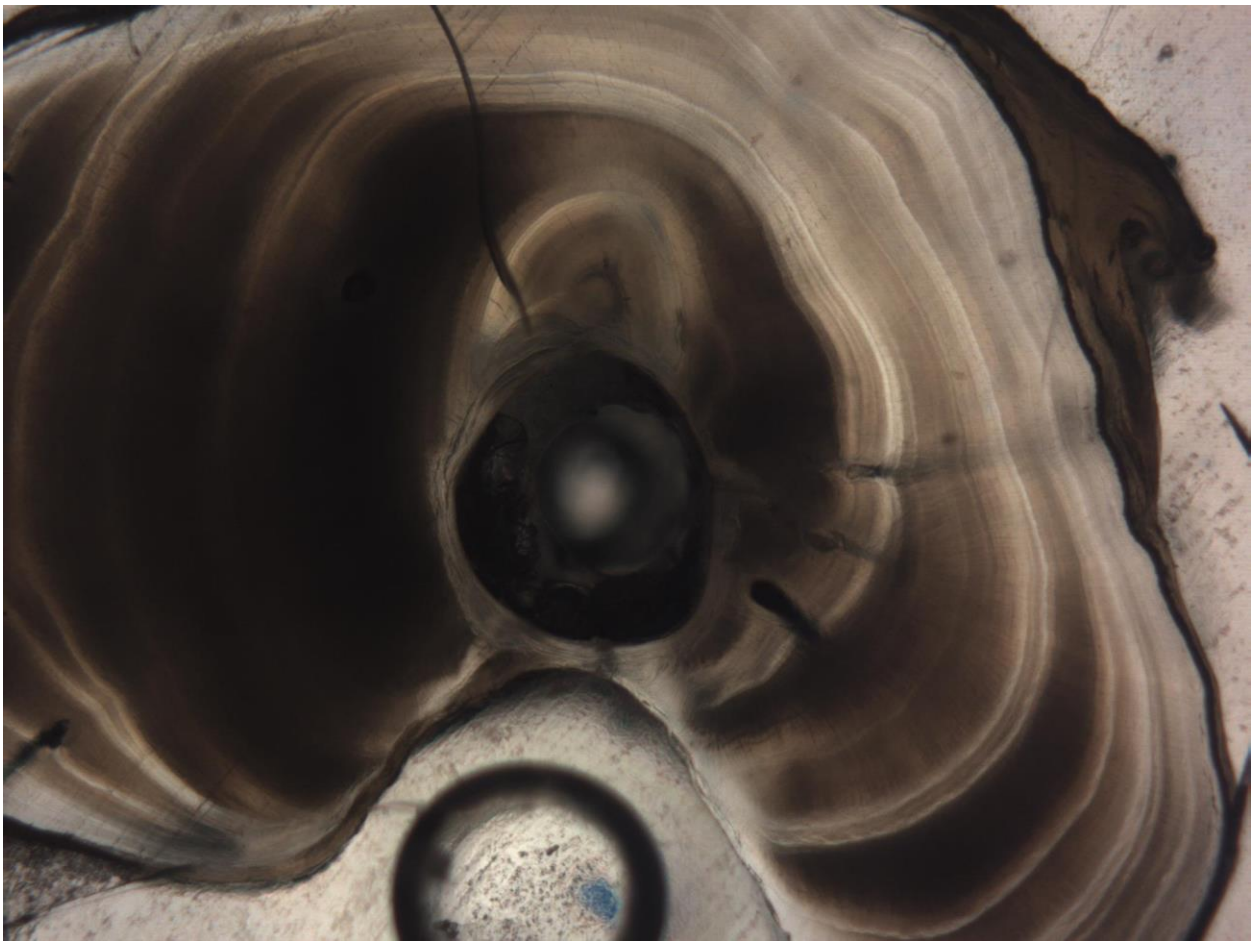

**Figure 97. Pelvic spine sample #22. This is a paired sample with operculum #69 and sectioned otolith #24. This sample was collected from a 574 mm long male tautog which was captured in December, 2018, by MD DNR in their state waters. Participants in the exchange aged this sample from an age 5 to 10, with a mode of age 7. (Workshop #007PS)**

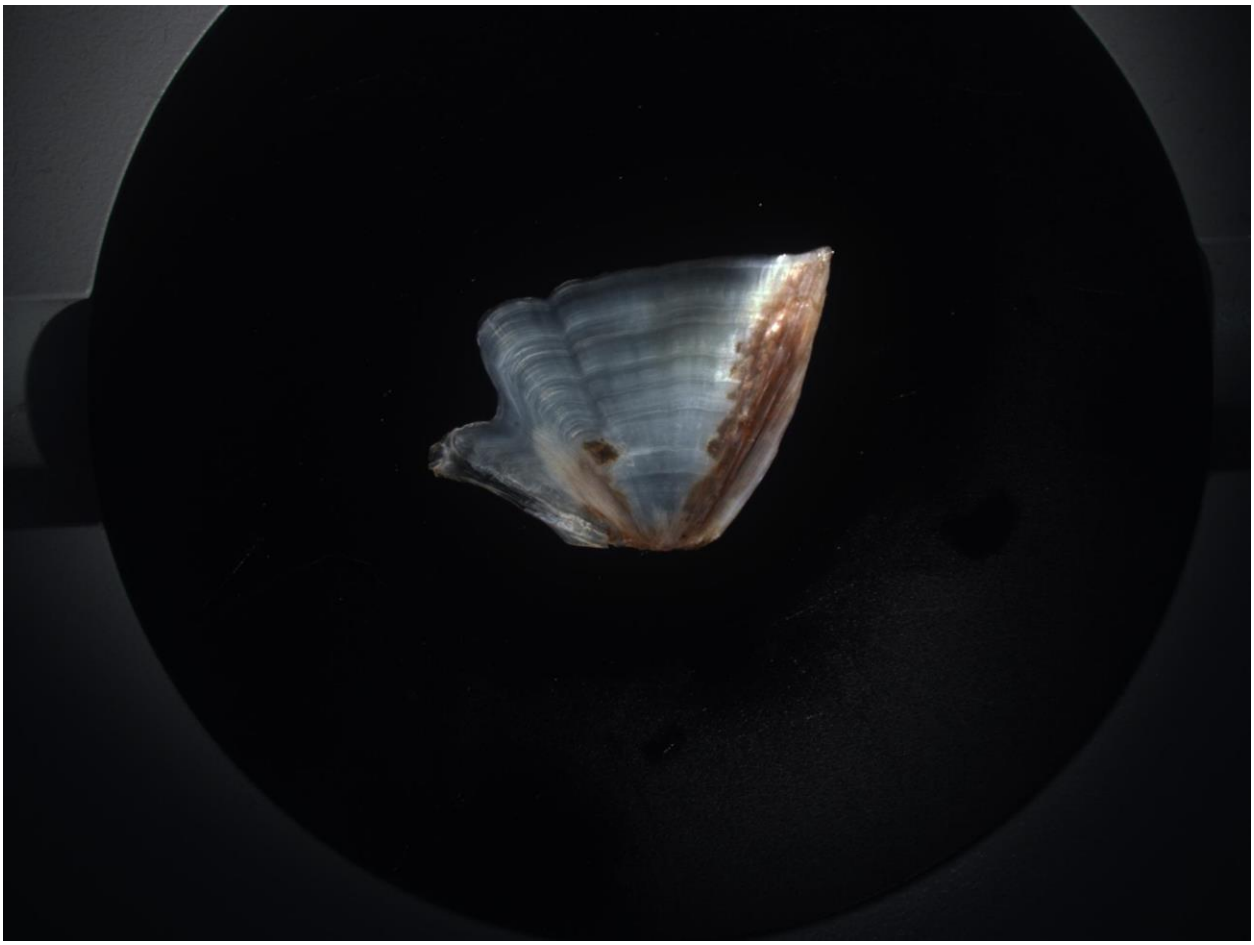

**Figure 98. Operculum sample #70. This is a paired sample with sectioned otolith #23 and pelvic spine #34. Sample was from a tautog that was 340 mm long. This tautog was captured in October 2017 in New Jersey waters by VIMS. Participants in the exchange aged this sample from an age 5 to 9, with a mode of age 8. (Workshop 002OP)**

**Figure 99. Sectioned otolith sample #23. This is a paired sample with operculum #70 and pelvic spine #34. Sample was from a tautog that was 340 mm long. This tautog was captured in October 2017 in New Jersey waters by VIMS. Participants in the exchange aged this sample from an age 6 to 9, with a mode of age 8. (Workshop 011SO)**

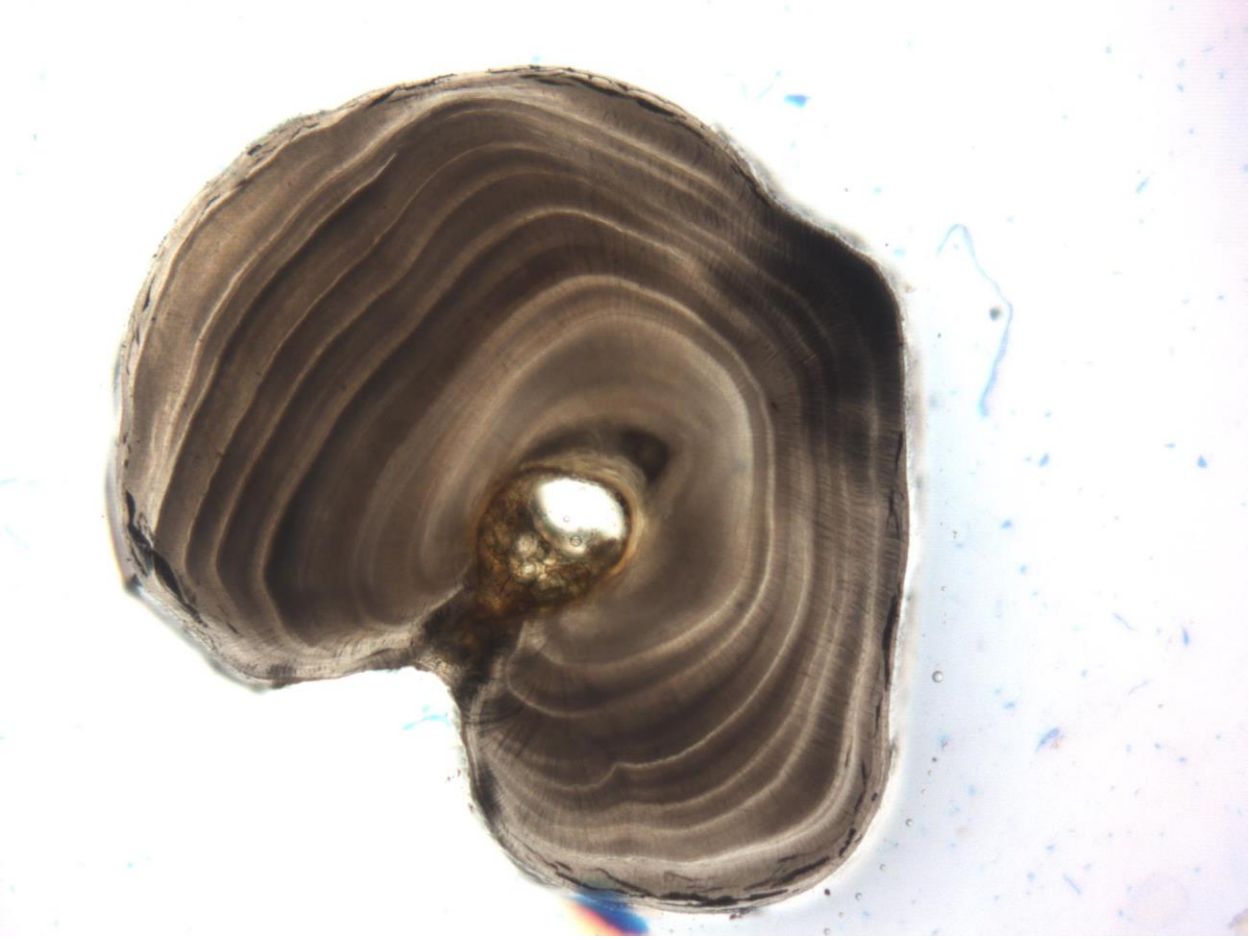

**Figure 100. Pelvic spine sample #34. This is a paired sample with sectioned otolith #23 and operculum #70. Sample was from a tautog that was 340 mm long. This tautog was captured in October 2017 in New Jersey waters by VIMS. Participants in the exchange aged this sample from an age 7 to 9, with a mode of age 7. (Workshop 017PS)**

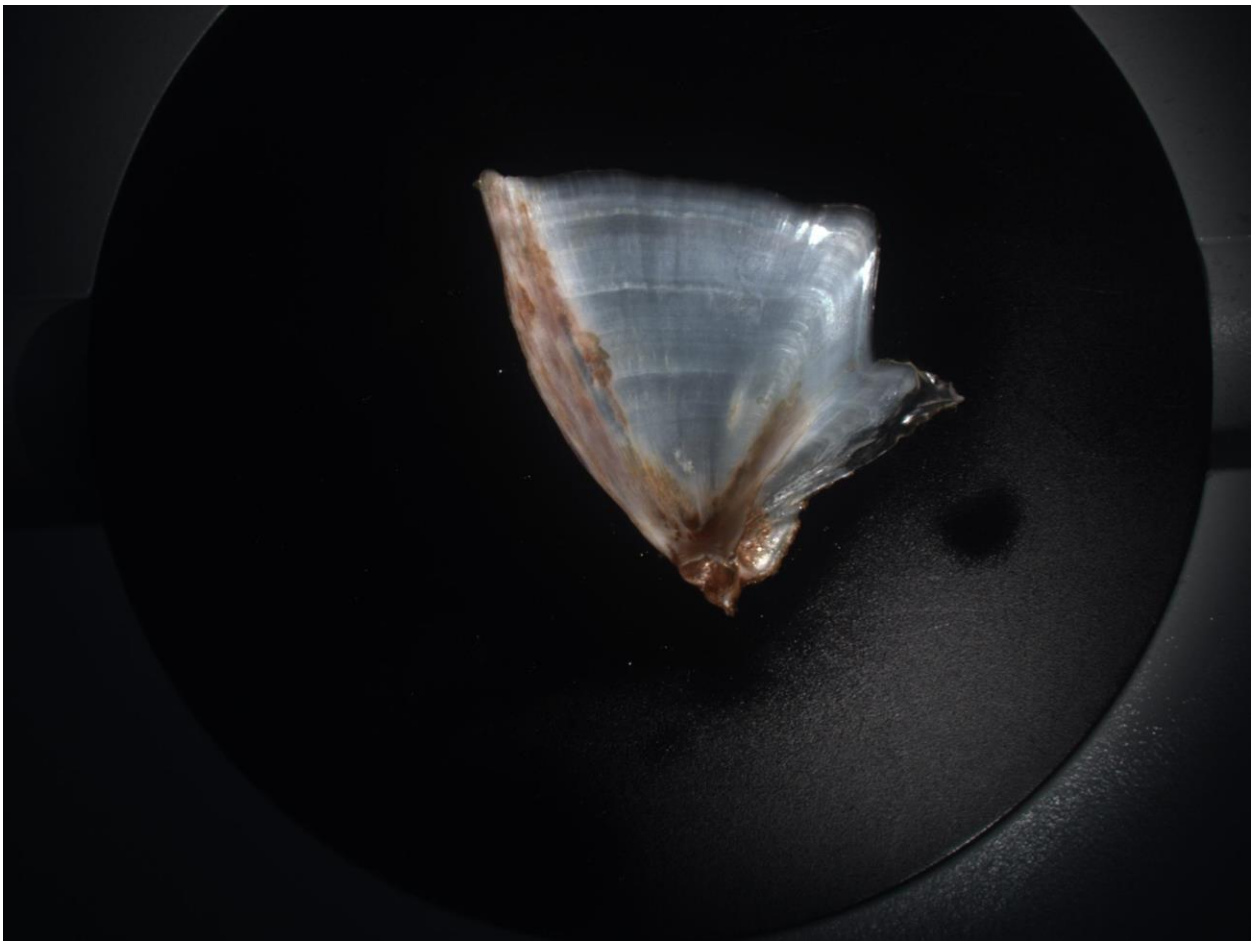

**Figure 101. Operculum sample #71. This is a paired sample with sectioned otolith #5 and pelvic spine #29. This sample was collected from a 425 mm long male tautog which was captured in November, 2018, by MD DNR in their state waters. Participants in the exchange aged this sample from an age 3 to 7, with a mode of age 4. (Workshop #016OP)**

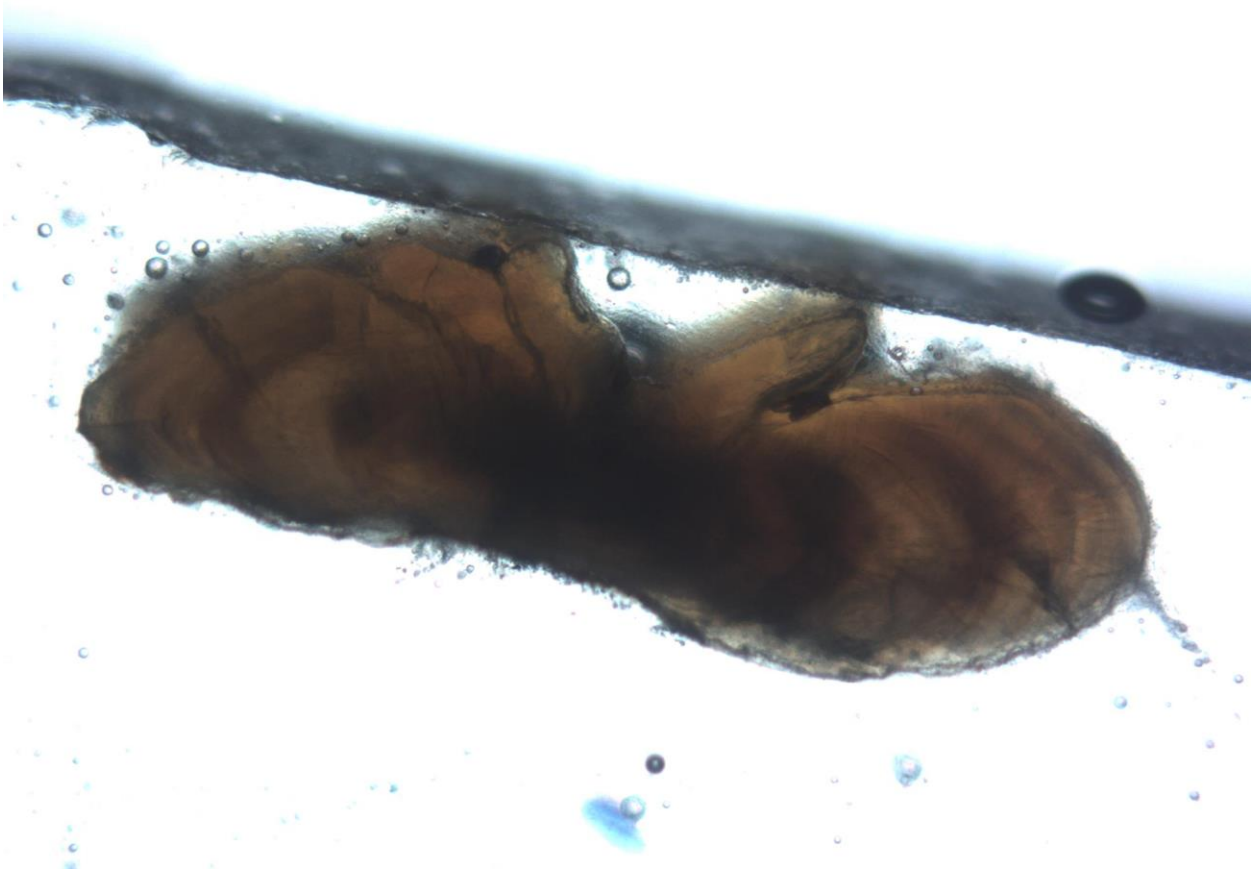

**Figure 102. Sectioned otolith sample #5. This is a paired sample with operculum #71 and pelvic spine #29. This sample was collected from a 425 mm long male tautog which was captured in November, 2018, by MD DNR in their state waters. Participants in the exchange aged this sample from an age 3 to 4, with a mode of age 4. (Workshop #009SO)**

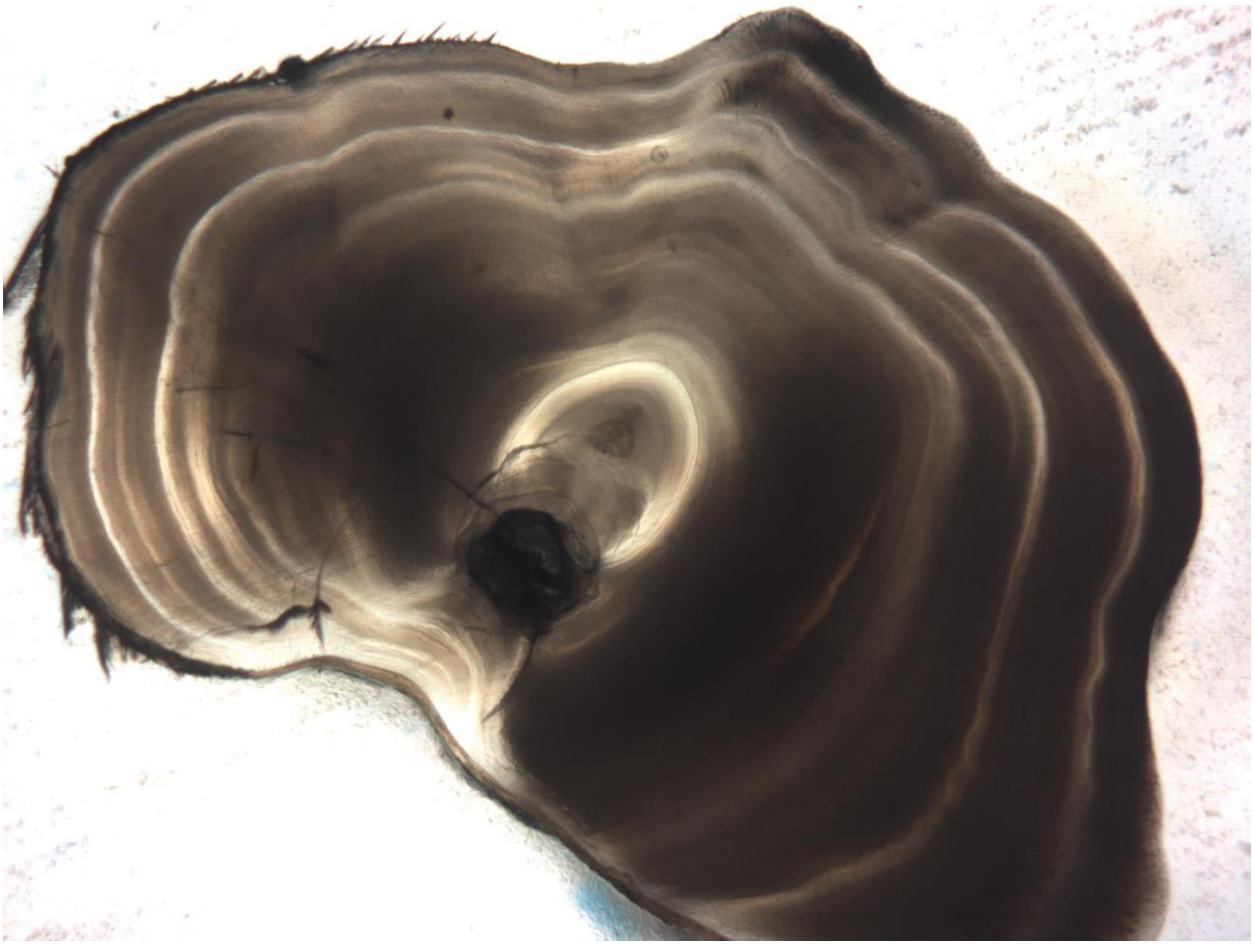

**Figure 103. Pelvic spine sample #29. This is a paired sample with sectioned otolith #5 and operculum #71. This sample was collected from a 425 mm long male tautog which was captured in November, 2018, by MD DNR in their state waters. Participants in the exchange aged this sample from an age 3 to 5, with a mode of age 4. (Workshop #022PS)**

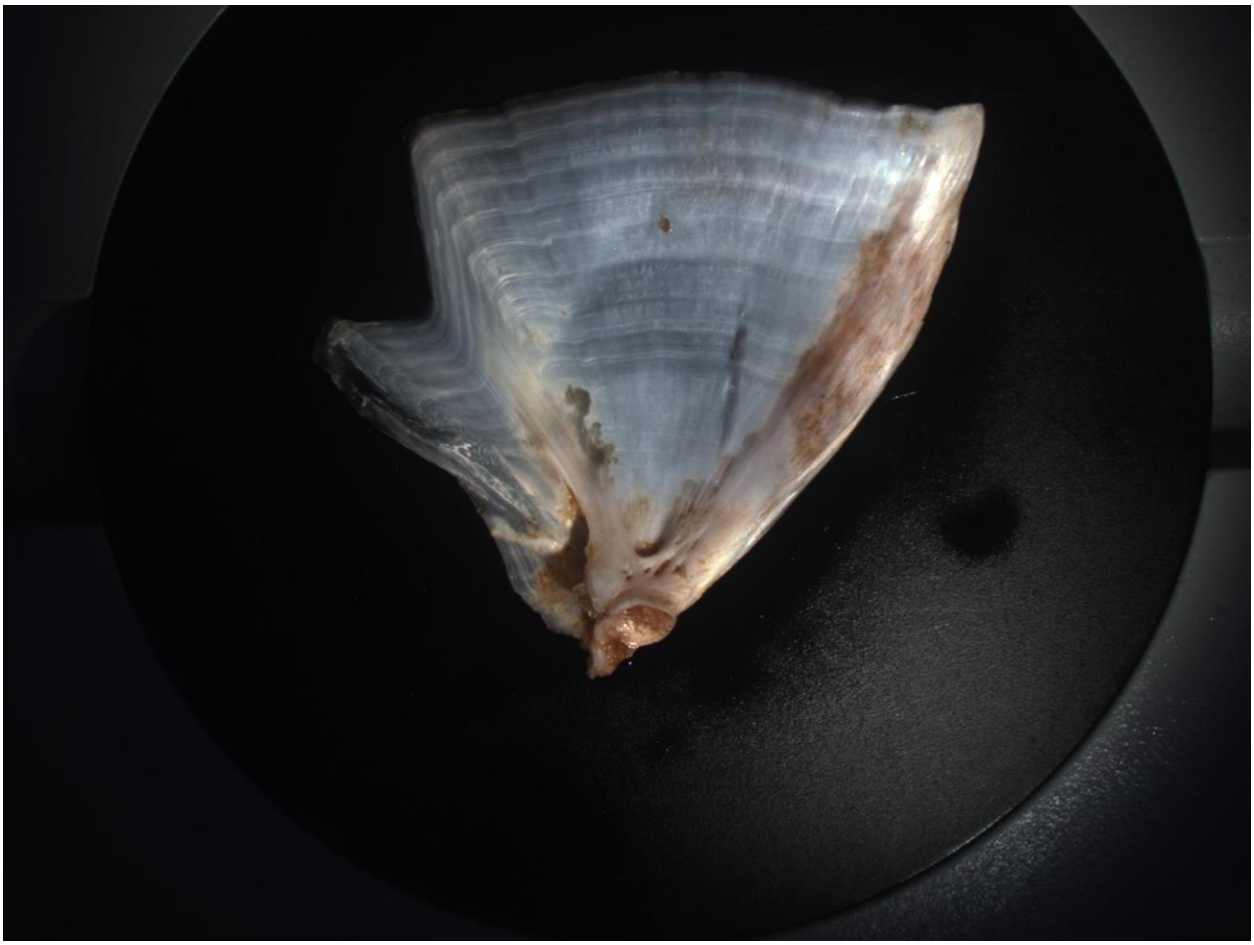

**Figure 104. Operculum sample #72. This is a paired sample with sectioned otolith #31 and pelvic spine #19. This sample was collected from a 561 mm long male tautog which was captured in November, 2018, by MD DNR in their state waters. Participants in the exchange aged this sample from an age 9 to 13, with a mode of age 10. (Workshop #013OP)**

**Figure 105. Sectioned otolith sample #31. This is a paired sample with operculum #72 and pelvic spine #19. This sample was collected from a 561 mm long male tautog which was captured in November, 2018, by MD DNR in their state waters. Participants in the exchange aged this sample from an age 9 to 11, with a mode of age 10. (Workshop #014SO)**

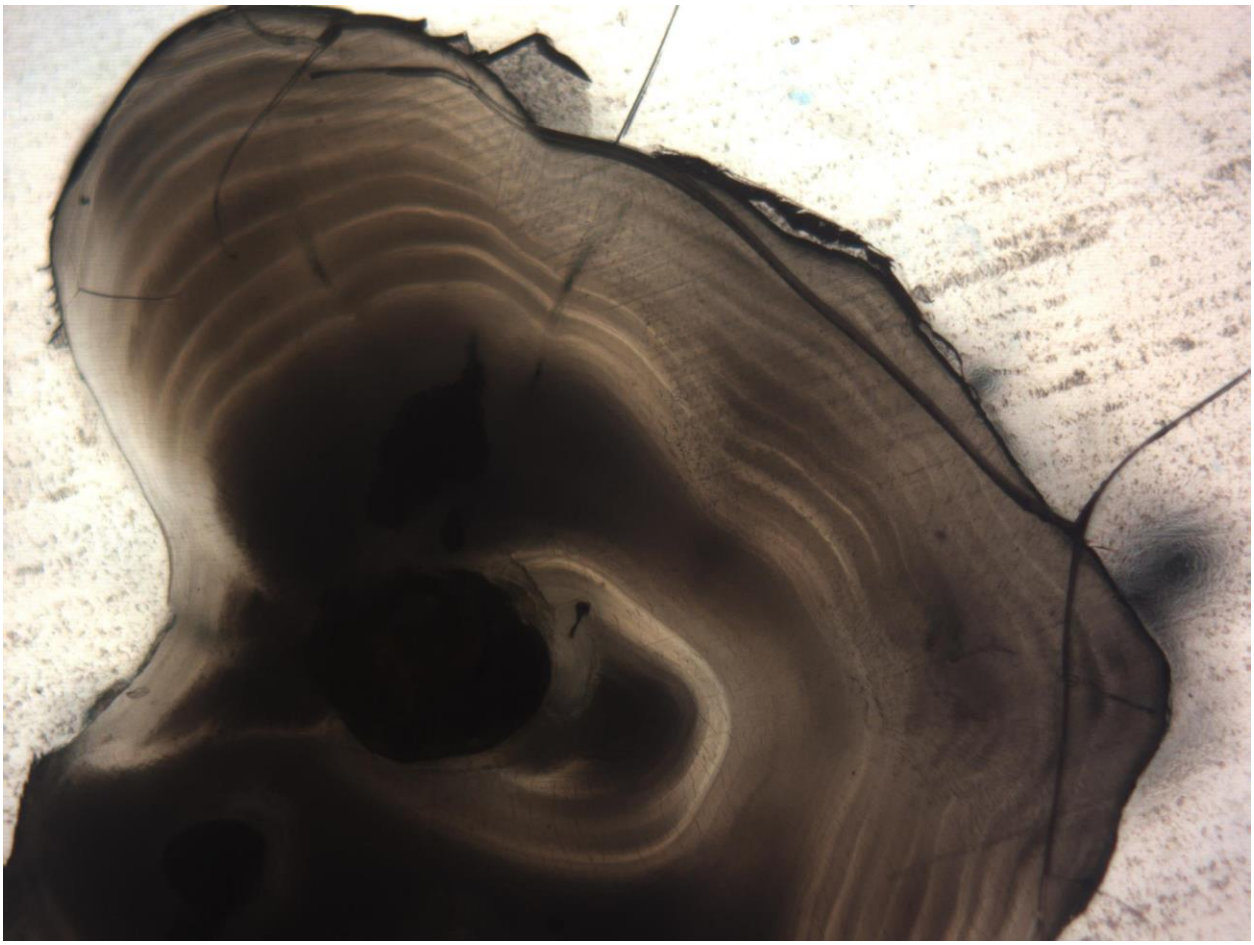

**Figure 106. Pelvic spine sample #19. This is a paired sample with operculum #72 and sectioned otolith #31. This sample was collected from a 561 mm long male tautog which was captured in November, 2018, by MD DNR in their state waters. Participants in the exchange aged this sample from an age 5 to 11, with a mode of age 10. (Workshop #003PS)**

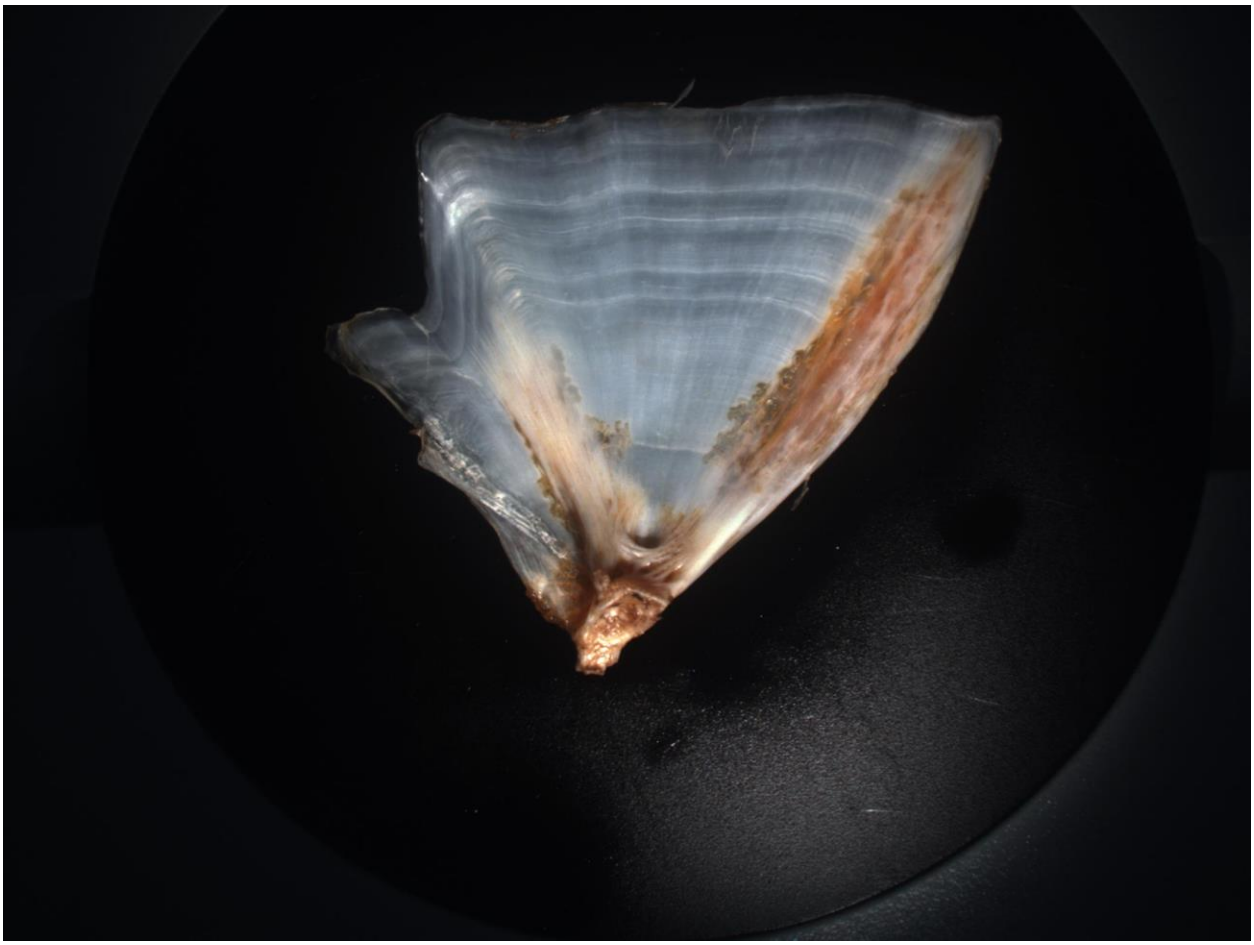

**Figure 107. Operculum sample #73. This is a paired sample with sectioned otolith #22 and pelvic spine #20. This sample was collected from a 554 mm long male tautog which was captured in November, 2018, by MD DNR in their state waters. Participants in the exchange aged this sample from an age 7 to 10, with a mode of age 8. (Workshop #011OP)**

**Figure 108. Sectioned otolith samples #22. This is a paired sample with operculum #73 and pelvic spine #20. This sample was collected from a 554 mm long male tautog which was captured in November, 2018, by MD DNR in their state waters. Participants in the exchange aged this sample from an age 7 to 10, with a mode of age 8. (Workshop #030SO)**

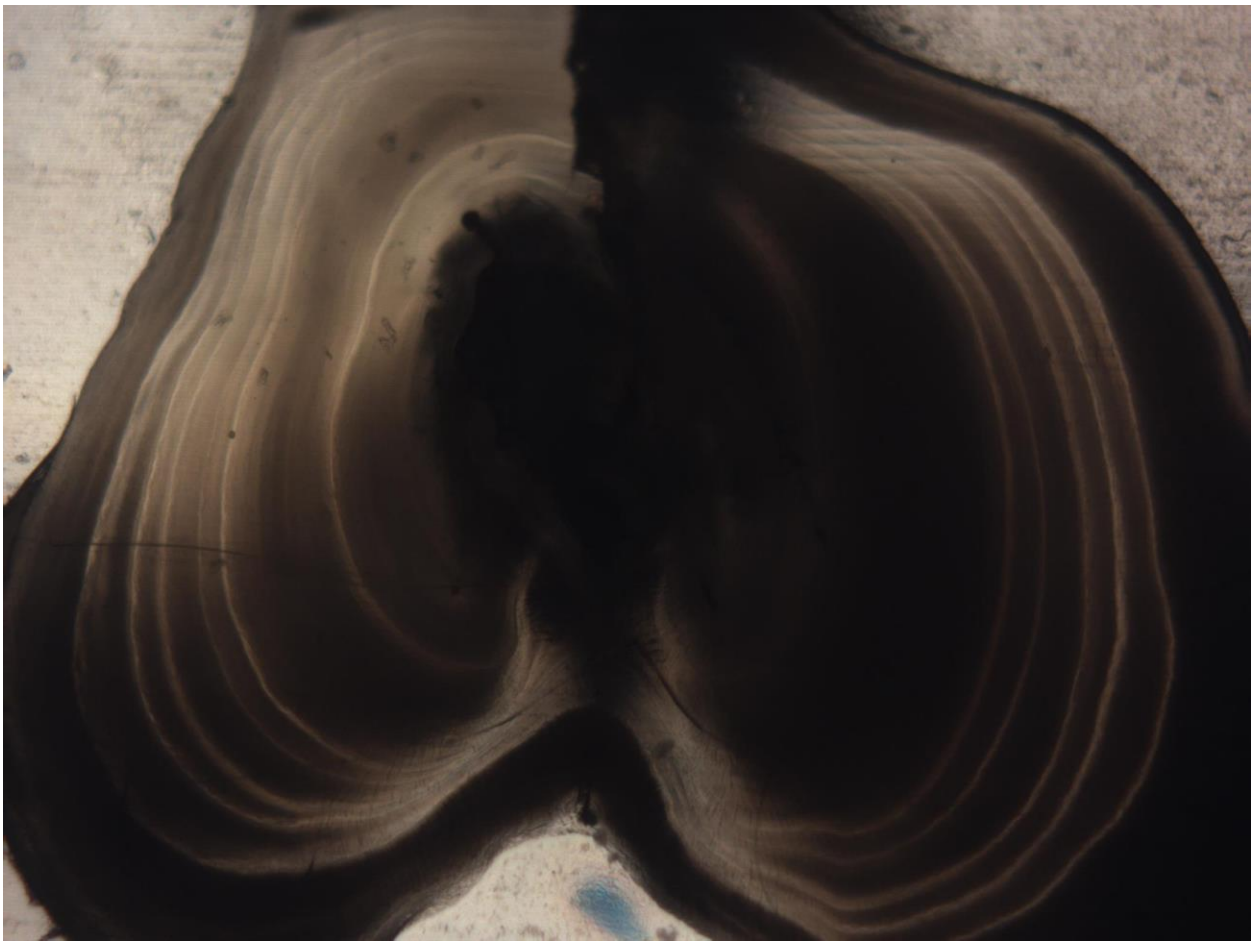

**Figure 109. Pelvic spine sample #20. This is a paired sample with operculum #73 and sectioned otolith #22. This sample was collected from a 554 mm long male tautog which was captured in November, 2018, by MD DNR in their state waters. Participants in the exchange aged this sample from an age 6 to 8, with a mode of age 7. Sample was removed from the analysis due to unreadability. (Workshop #027PS)**

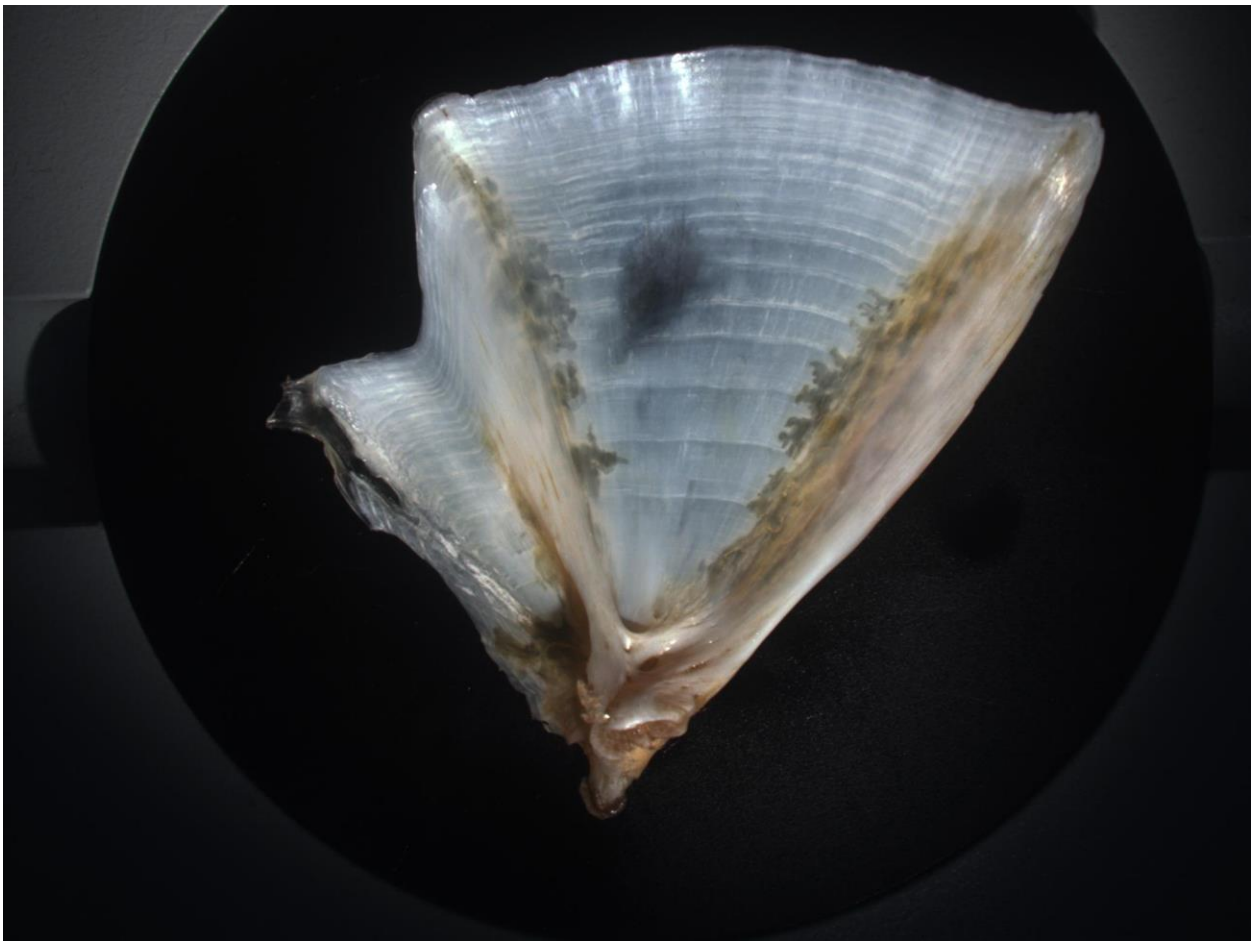

**Figure 110. Operculum sample #74. This is a paired sample with sectioned otolith #43 and pelvic spine #39. This sample was collected from a 617 mm long female tautog which was captured in August, 2019, by RI DEM in their state waters. Participants in the exchange aged this sample from an age 19 to 20, with a mode of age 19. (Workshop #008OP)**

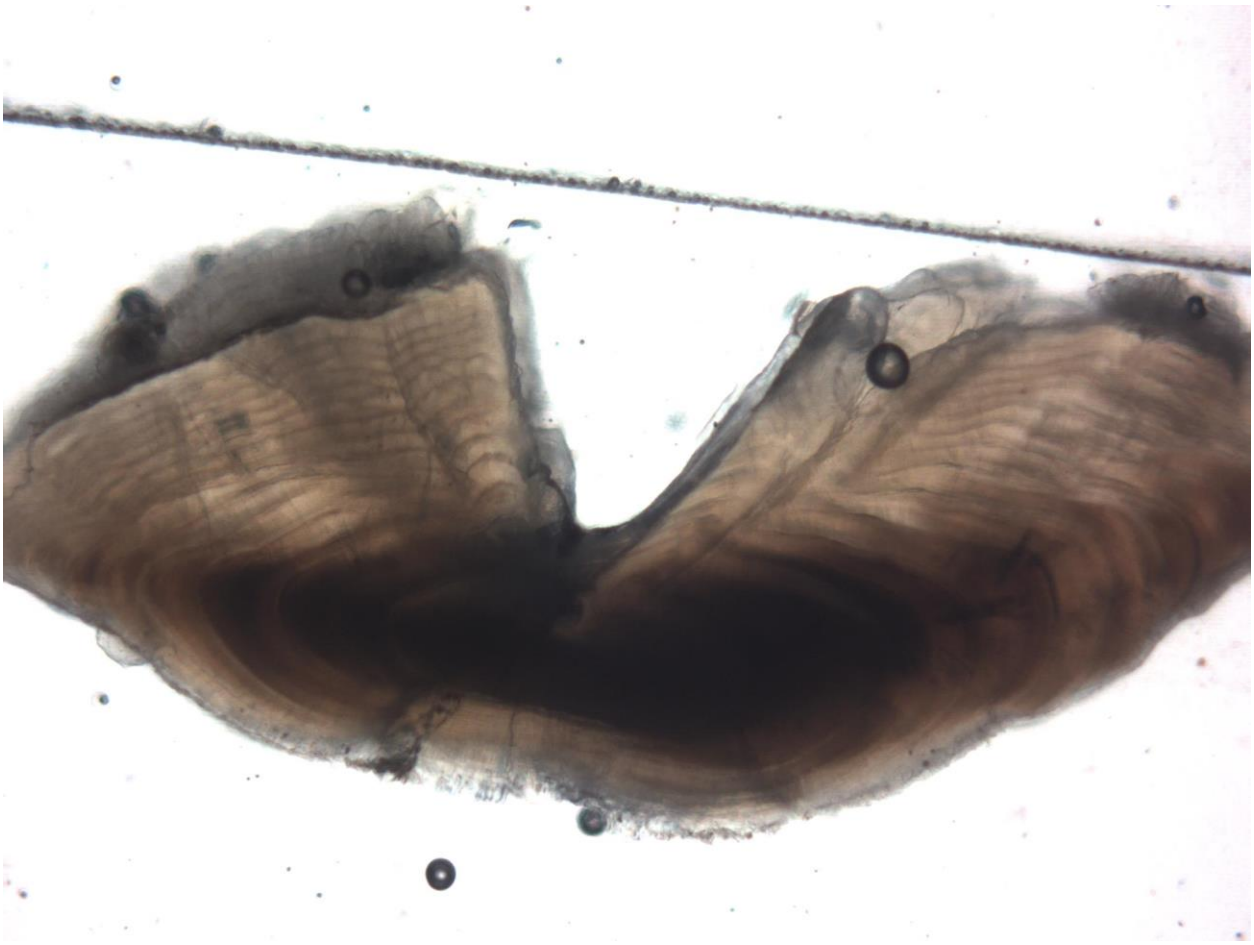

**Figure 111. Sectioned otolith sample #43. This is a paired sample with operculum #74 and pelvic spine #39. This sample was collected from a 617 mm long female tautog which was captured in August, 2019, by RI DEM in their state waters. Participants in the exchange aged this sample from an age 11 to 14, with a mode of age 13. (Workshop #033SO)**

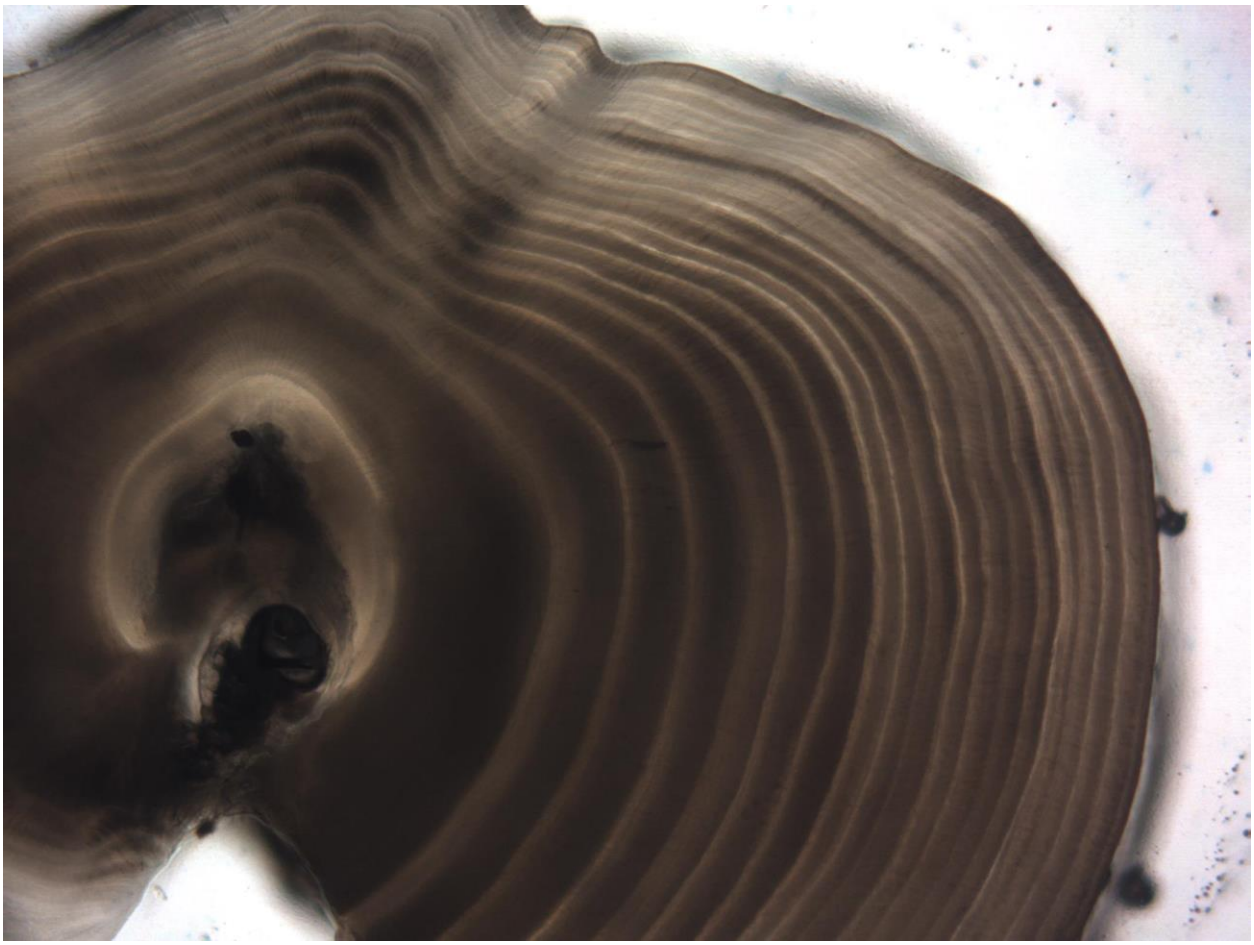

**Figure 112. Pelvic spine sample #39. This is a paired sample with operculum #74 and sectioned otolith #43. This sample was collected from a 617 mm long female tautog which was captured in August, 2019, by RI DEM in their state waters. Participants in the exchange aged this sample from an age 19 to 20, with a mode of age 19. (Workshop #034PS)**

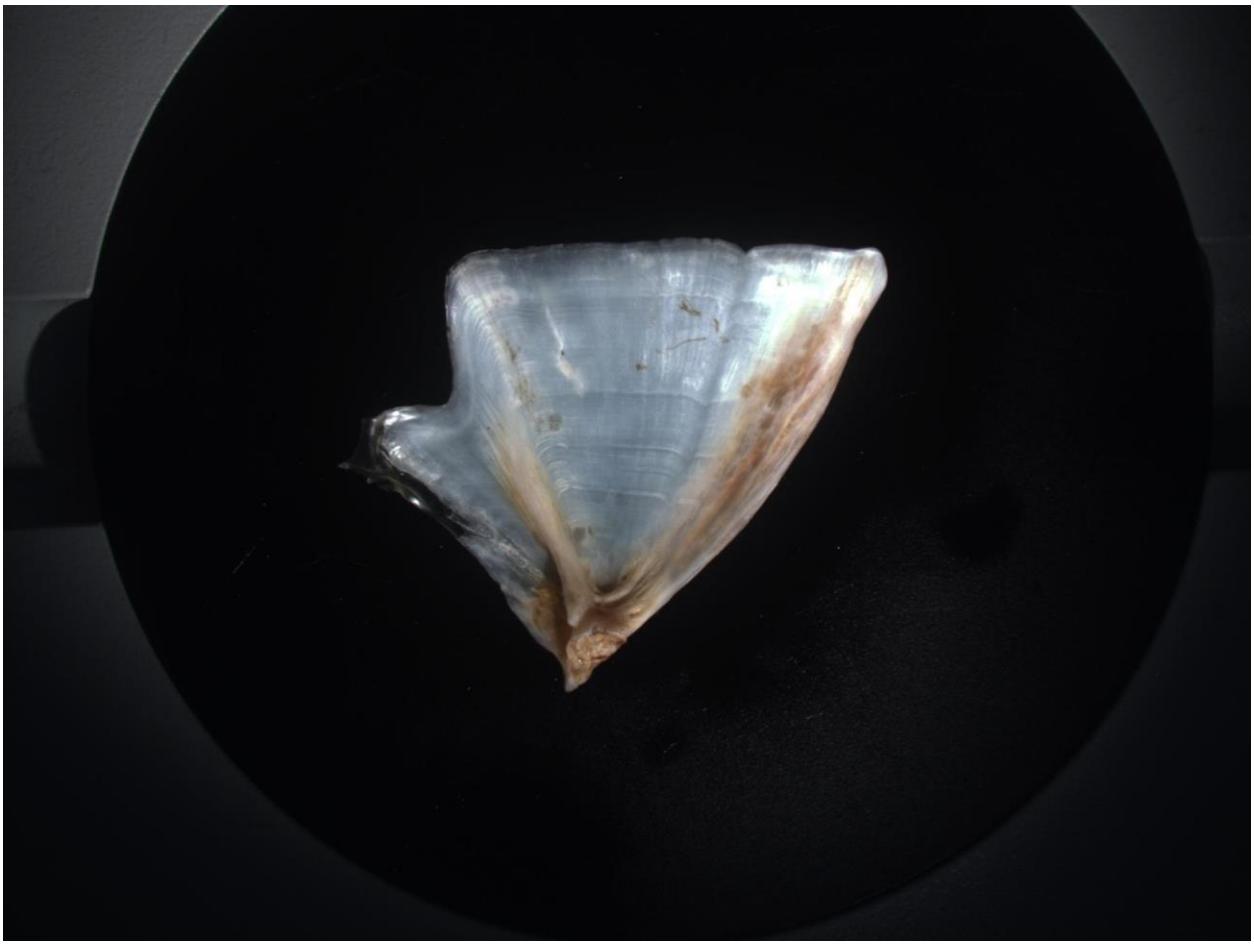

**Figure 113. Operculum sample #75. This is a paired sample with sectioned otolith #3 and pelvic spine #53. This sample was collected from a 414 mm long male tautog which was captured in July, 2019, by RI DEM in their state waters. Participants in the exchange aged this sample from an age 5 to 7, with a mode of age 6. (Workshop #007OP)**

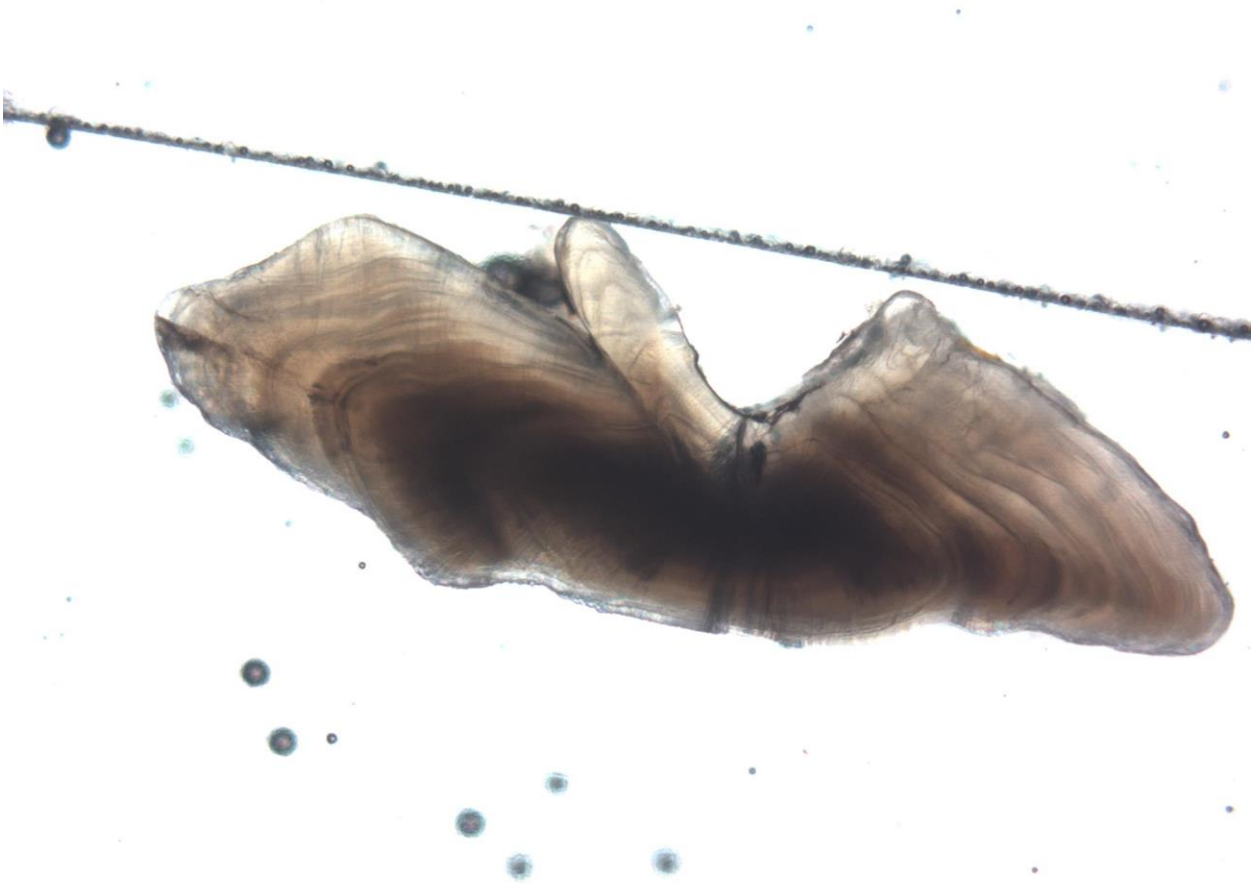

**Figure 114. Sectioned otolith sample #3. This is a paired sample with operculum #75 and pelvic spine #53. This sample was collected from a 414 mm long male tautog which was captured in July, 2019, by RI DEM in their state waters. Participants in the exchange aged this sample from an age 4 to 6, with a mode of age 6. (Workshop #029SO)**

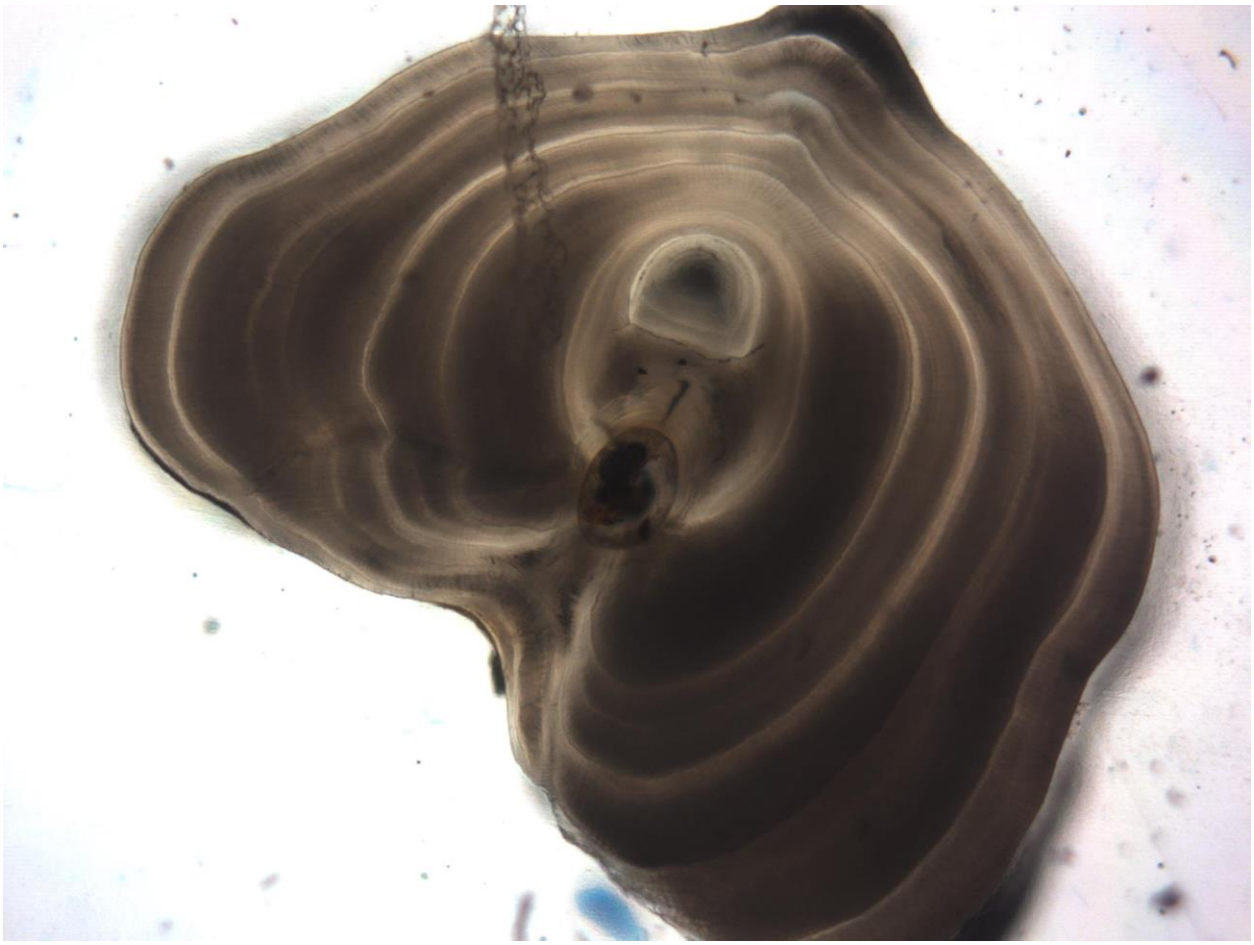

**Figure 115. Pelvic spine sample #53. This is a paired sample with sectioned otolith #3 and operculum #75. This sample was collected from a 414 mm long male tautog which was captured in July, 2019, by RI DEM in their state waters. Participants in the exchange aged this sample from an age 5 to 7, with a mode of age 6. (Workshop #016PS)**