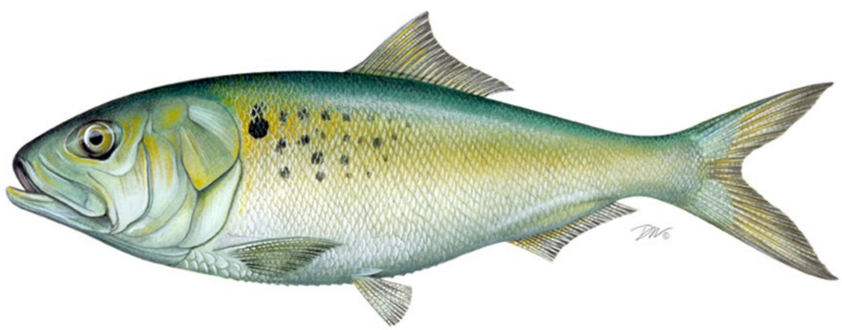
Atlantic States Marine Fisheries Commission

Summary of the 2023 Atlantic Menhaden Ageing Workshop



November 2023

Vision: Sustainably Managing Atlantic Coastal Fisheries

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Acknowledgements

The Atlantic States Marine Fisheries Commission would like to thank those who participated in the workshop: Lisa Pinkham (ME), Scott Elzey (MA), Nicole Lengyel Costa (RI), Kelli Mosca (CT), Caitlin Craig (NY), Jamie Darrow (NJ), Audrey Ostroski (DE), Katherine Messer (MD), Jameson Gregg (VIMS), Hank Liao (VMRC), Sara Pace (NC), Amanda Rezek (NOAA), Jessica Branscome (NOAA), and Jonathan Tucker (SC). An extra thank you to Katherine, Jessica, and Amanda for preparing the samples and to Amanda and the Beaufort Lab for hosting the workshop. Kristen Anstead (ASMFC) coordinated the workshop and produced this report.

Background and Statement of Problem

In 1955, the NOAA Laboratory in Beaufort, North Carolina, began monitoring the Atlantic menhaden purse-seine fishery for size and age composition of the catch (June and Reintjes 1959). Scales were selected as the ageing tool of choice for Atlantic menhaden due to ease of processing and reading and an age validation study confirming reliable age marks on scales (June and Roithmayer 1960). During the early decades of the Menhaden Program at the NOAA Beaufort Laboratory, scales from individual menhaden specimens were read multiple times by several readers. Since the early 1970s, only a single reader was retained on staff to age menhaden scales. The Beaufort Lab still ages all reduction fishery samples.

In response to an identified need for more biological sampling (i.e., length and age data) by the Atlantic Menhaden Advisory and Technical Committees (TC), Amendment 2 to the Interstate Fishery Management Plan for Atlantic Menhaden (ASMFC 2012) has required jurisdictions from NC to ME to collect biological samples proportional to bait landings since 2013. State agencies also collect scales and otoliths from their fishery-independent programs.

To address future plans for states to age Atlantic menhaden scales from the bait fishery and the research recommendation to conduct an ageing workshop, the ASMFC organized and held a workshop in 2015 (ASMFC 2015). An exchange of scale samples took place and was followed with an in-person workshop to discuss the results. Despite the fact that most participating agers were new to ageing Atlantic menhaden or had never aged the species, agreement between readers was, on average, 73% and increased to 95% within one year. False annuli, poor storage of samples, and damaged scales were common issues identified at the workshop.

Atlantic menhaden scales were also examined at ASMFC's 2017 and 2018 Quality Assurance/Quality Control Fish Ageing Workshops (ASMFC 2017, 2018). Average percent error between agers along the Atlantic coast was 15% in 2017 and 13% in 2018, although many readers had no previous experience ageing Atlantic menhaden.

Since Amendment 2 (ASMFC 2012), the Beaufort Lab has been ageing the bait samples in addition to the reduction samples for the stock assessments (2015, 2017, 2020, 2022, and anticipated 2025). The states aged some of the fishery-independent samples, although those were not used in any of the assessments. The workload of ageing both the reduction and bait samples is unsustainable and thus the TC recommended *another* ageing workshop to establish ageing protocols so the states could begin ageing their own bait and fishery-independent samples for future stock assessments. Agers from Maine through South Carolina met via conference call in December, 2022, to review the results of the 2015 Atlantic menhaden ageing workshop, establish goals of the 2023 workshop, and discuss the availability of paired samples. On the call it was decided that a workshop should be held to evaluate ageing structures, including scales and whole otoliths, and protocols as a group and then an exchange should follow. After the exchange, the agers will review the analysis and results and make recommendations to the TC.

Workshop Objectives and Goals

Atlantic menhaden agers met at the Beaufort Lab in North Carolina on November 14-15, 2023, for the Atlantic menhaden ageing workshop.

The objectives of the workshop were to (1) investigate age determinations in groups for scales and whole otoliths, (2) review preliminary results (average percent error between groups by structure), (3) review samples with high disagreement, and (4) plan for the exchange to follow.

Workshop Sample Evaluation

Unpaired scales and paired scales and whole otoliths from Massachusetts, Rhode Island, New York, Maryland, Delaware, Virginia Institute of Marine Science (VIMS), North Carolina, and the NOAA Beaufort ageing labs were provided for the workshop. The workshop sample set was comprised of 76 scales and 65 whole otoliths where all 65 of the whole otoliths were paired with a scale. Samples represented fork lengths from 90-314 mm (Figure 1) and were collected from various state waters (Figure 2) throughout the year (Figure 3).

On the first day of the workshop, Amanda Rezek (NOAA Beaufort) gave an overview of the menhaden program and scale ageing protocol. Katie Messer (MD) reviewed otolith ageing protocols and Genny Nesslage (UMCES Chesapeake Biological Laboratory) presented via webinar on the results of an ageing project from the 2022 cooperative Atlantic menhaden winter survey. Following the presentations, participants split into three groups and rotated through stations that included scale and whole otolith samples. Only catch date was provided for the age readings. The groups provided a consensus age for each sample. On the second day, the group met as a whole to review average percent error (APE) between groups by structure, differences in age between paired scales and whole otoliths, and individual samples with high disagreement to make age determinations. At the end of the workshop, participants discussed how to proceed with the exchange.

Discussion

Ageing precision between groups for consensus ages were evaluated using APE. Not all groups aged all samples at the workshop, so APE was calculated for each sample if at least two out of the three groups aged it. Of the 76 scale samples, 31 were aged by at least two groups. Of the 65 whole otolith samples, 40 were aged by all groups. APE by sample was averaged to compare between structures (Table 1-Table 2). The average APEs by structure (and range of APEs) were: scales 14.8% (0-67%) and otoliths 10.0% (0-38%).

Participants also reviewed group age comparisons for paired scale and otolith samples. The sample sizes were low for paired samples aged at the workshop due to time limitations and more complete results will be provided after the exchange. 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 hard part is more accurate, but rather identifies whether there are differences or not. Mean coefficient of variation (CV), percent of exact agreement between paired samples, and percent agreement within one year was also calculated 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 or the reproducibility of the age. Generally, CVs of 5% serve as a reference point for determining precision, where greater values indicate ageing imprecision (Campana 2001) and can also indicate the structures are hard to interpret or agers need more training (Morison et al. 1998). One of out of three groups had a significant p-value, indicating some bias between the age readings (Figure 4-Figure 6). For all three groups, the mean CVs were greater than 5%. Exact agreement between paired scales and otoliths ranged from 52-53% and agreement within one year ranged from 92-100%. In general, the scale was aged as older than the whole otolith.

The participants of the workshop reviewed some samples as a group to count annuli together and determine consensus ages for samples with high disagreement. The group noted that the scales with the highest disagreement between groups were provided by New York (e.g., scales # 12, 23, 29, 42) and hypothesized that there might be a collection or storage issue since the scales looked dirty. The agers agreed that the exchange should collect information on processing and cleaning scales so methods can be compared for readability. Additionally, agers should provide information about what equipment they use to age scales (scope or microfiche).

There was some disagreement among agers about considering spacing between annuli on a scale. Agers reviewed the guidance from the 2015 workshop for counting rings:

> *Only count rings that can be identified as continuous around the anterior and lateral fields. If a ring is difficult to see, distances between previous annuli can be used for guidance in identifying true annuli. The distance between two annuli should be approximately half the distance between the previous two annuli.*

Agers still agreed with this statement and noted that spacing should be used as guidance when one is questioning an annuli and clear annuli should still be counted regardless of spacing unless the annulus is composed of a band of close rings. Similarly, agers should consider all information (e.g., spacing, birthday, collection month) when ageing a sample.

A full sample exchange will follow and more thorough analysis comparing readers and paired samples will be completed and reviewed then.

Exchange Details

Workshop participants agreed to age the complete workshop set (76 scales and 65 whole otoliths) for the exchange since not all samples were aged at the workshop due to time limitations. Each lab will have two weeks to age the exchange set (Table 3) and will begin in December 2023 and will run through July 2024. When the exchange is completed, results will be analyzed and provided to the group on a conference call. Recommendations to the TC will be made at that time.

The goals of the Atlantic menhaden ageing structure exchange are to:

- *Establish methods to prepare and read otoliths and/or scales*
- *Determine the precision and bias of age reading data between different readers and labs or agencies along the coast*

- *Make recommendations to improve and standardize ageing practices*
- *Move bait sample ageing from the Beaufort Lab to the states*

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Tables and Figures

Table 1. **Ageing worksheet for Atlantic menhaden scales with the sample number, lab providing the sample, catch date of the sample, workshop group (#1-3) annulus counts, margin codes (scored from 1 to 4), and final age (highlighted in green), as well as average age (X) and average percent error (APE) values between groups. APEs were calculated if at least two groups aged the sample.**

Sample #	Lab	Catch date	1			2			3			X	APE	
3	RI	1/12/2021	3	3	4	5		5	4	2	5	5	10%	
5	MD	6/14/2017	3	3	4	3	2	3	3	3	4	4	12%	
6	NY	6/2/2021	3	2	3	3	3	3	4	1	4	3	13%	
7	DE	12/1/2016	0	3	0	0	0	0	0	3	0	0	0%	
9	MA	6/15/2021	3	1	3	5	4	6	4	1	4	4	26%	
12	NY	5/3/2022	3	1	3	2	2	2	3	3	4	3	22%	
13	MD	6/22/2017	4	1	4	3	1	3	4	1	4	4	12%	
15	NC	1/16/2023	2	1	2	2	1	3	2	3	3	3	17%	
17	VA	5/22/1995	2	1	2	3	1	3	2	2	2	2	19%	
19	NY	4/30/2022	2	3	3	2	3	3	3	1	3	3	0%	
20	MD	6/28/2017	4	1	4	3	1	3	4	1	4	4	12%	
23	NY	5/12/2016	0	4	1	0	0	0	2	1	2	1	67%	
24	MD	6/28/2017	3	2	3	3	2	3	3	2	3	3	0%	
25	DE	12/2/2016	3	2	3	4	1	4	4	2	4	4	12%	
26	MA	6/15/2021	5	3	6	6	2	6	4	2	4	5	17%	
28	MD	6/28/2017	3	1	3	3	0	3	3	2	3	3	0%	
29	NY	2/26/2022	0	2	1	0	1	0	0	3	1	1	67%	
35	MD	7/16/2018	4	1	4	4	2	4	4	2	4	4	0%	
38	NY	8/27/2021	3	2	3	3	1	3	3	2	3	3	0%	
40	MD	7/5/2017	4	1	4	4	4	4	4	2	4	4	0%	
41	NC	1/16/2023	2	4	3	2	2	3	3	2	4	3	13%	
42	NY	5/12/2016	0	3	1	0	0	0	1	3	2	1	67%	
44	MD	7/5/2017	4	1	4	3	2	3	5	2	5	4	17%	
46	MD	7/5/2017	3	4	4	3	2	3				4	14%	
50	MD	7/12/2017	2	2	2	2	2	2				2	0%	
53	VA	12/13/1995	0	3	0	0	0	0				0	0%	
87	DE	5/17/2017	3	1	3	4	1	4				4	14%	
89	NC	1/16/2023	4	2	4	2	4	3				4	14%	
90	RI	5/18/2023	3	3	4	3	2	3				4	14%	
92	NC	1/12/2023	3	4	4	4	1	4				4	0%	Average APE
93	NJ	10/30/2016	2	3	2	2	2	2				2	0%	14.8%

Table 2. **Ageing worksheet for Atlantic menhaden whole otoliths with the sample number, lab providing the sample, catch date of the sample, workshop group (#1-3) annulus counts, margin codes (scored from 1 to 4), and final age (highlighted in green), as well as average age (X) and average percent error (APE) values between groups. APEs were calculated if at least two groups aged the sample.**

Sample #	Lab	Catch date	1			2			3			X	APE	
162	NY	6/2/2021	2	3	3	2	4	3	3	1	3	3	0%	
163	DE	12/1/2016	0	3	0	0	0	0	0	4	0	0	0%	
164	NY	5/3/2022	2	4	3	2	4	3	2	4	3	3	0%	
165	MD	6/22/2017	3	2	3	3	2	3	3	4	4	3	13%	
166	VA	5/22/1995	1	4	2	1	4	2	1	4	2	2	0%	
167	NY	4/30/2022	1	4	2	2	4	3	2	4	3	3	17%	
168	MD	6/28/2017	3	4	4	4	1	4	3	4	4	4	0%	
169	NY	5/12/2016	0	4	1	1	4	2	1	4	2	2	27%	
170	MD	6/28/2017	3	1	3	2	4	3	3	2	3	3	0%	
171	DE	12/2/2016	5	3	5	3	2	3	3	2	3	4	24%	
172	MD	6/28/2017	2	2	2	2	4	3	3	1	3	3	17%	
173	MD	7/16/2018	3	2	3	3	2	3	3	2	3	3	0%	
174	NY	8/27/2021	3	2	3	3	4	3	2	3	2	3	17%	
175	MD	7/5/2017	3	2	3	3	2	3	3	1	3	3	0%	
176	NC	1/16/2023	2	3	3	2	2	3	2	4	3	3	0%	
177	NY	5/12/2016	1	1	1	1	1	1	1	2	1	1	0%	
178	MD	7/5/2017	5	1	5	3	2	3	5	1	5	4	21%	
179	MD	7/5/2017	3	1	3	2	4	3	4	1	4	3	13%	
180	MD	7/12/2017	2	1	2	1	4	2	2	1	2	2	0%	
181	VA	12/13/1995	0	3	0	0	4	0	0	3	0	0	0%	
194	DE	5/17/2017	2	4	3	2	4	2	2	4	3	3	17%	
195	NC	1/16/2023	1	4	2	1	3	2	1	3	2	2	0%	
196	RI	5/18/2023	2	4	3	2	4	3	2	3	3	3	0%	
197	NC	1/12/2023	2	4	3	2	4	3	2	3	3	3	0%	
198	NJ	10/30/2016	11	3	1	1	3	1	1	2	1	1	0%	
199	MD	6/14/2018	1	4	2	3	2	3	4	4	5	3	33%	
200	MD	6/18/2018	1	4	2	1	4	2	2	1	2	2	0%	
201	NC	12/20/2022	4	3	4	4	4	4	4	3	4	4	0%	
202	DE	6/12/2017	1	2	1	2	4	3	2	1	2	2	33%	
203	MD	6/27/2018	4	3	4	5	1	5	4	4	5	5	10%	
204	NC	1/8/2023	1	3	2	2	3	3	1	3	2	2	19%	
205	VA	10/31/2016	2	4	2	3	1	3	2	2	2	2	19%	
206	RI	7/20/2021	3	1	3	3	1	3	2	2	2	3	17%	
207	MD	7/27/2018	2	3	2	2	4	2	3	1	3	2	19%	
208	NC	1/11/2023	1	4	2	1	3	2	1	3	2	2	0%	
209	NY	10/18/2016	3	4	3	5	4	5	4	2	4	4	17%	
210	RI	9/15/2021	1	3	1	3	2	3	3	2	3	2	38%	
211	NJ	2/15/1995	3	4	4	3	4	4	3	4	4	4	0%	
212	MD	7/30/2018	3	2	3	4	1	4	4	1	4	4	12%	Average APE
213	NC	1/11/2023	1	4	2	2	3	3	2	4	3	3	17%	10.0%

Table 3. Schedule of the Atlantic menhaden sample exchange. Unassigned weeks will be used if the exchange gets behind schedule.

Date	Ageing Lab
December 4-15, 2023	MA DMF
December 18, 2023 – January 5, 2024	DE DFW
January 8-19, 2024	RI DMF
January 22 – February 2, 2024	CT DEEP
February 5-16, 2024	VIMS
February 19-23, 2024	
February 26 – March 8, 2024	SC DNR
March 11-29, 2024	
April 1-12, 2024	NYS DEC
April 15-26, 2024	ME DMR
April 29 – May 3, 2024	
May 6-17, 2024	NJ FW
May 20-31, 2024	
June 3-14, 2024	VMRC
June 17-28, 2024	NC DMF
July 1-12, 2024	MD DNR
July 15-26, 2024	NOAA Beaufort

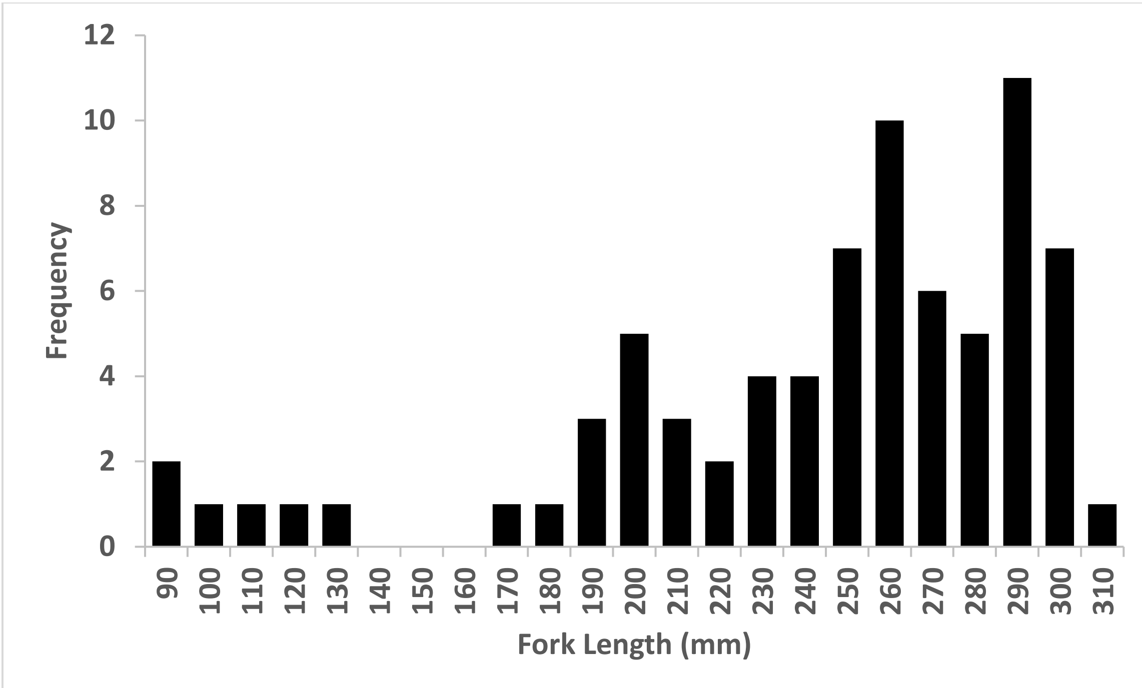

Figure 1. Length frequency of Atlantic menhaden in the workshop set.

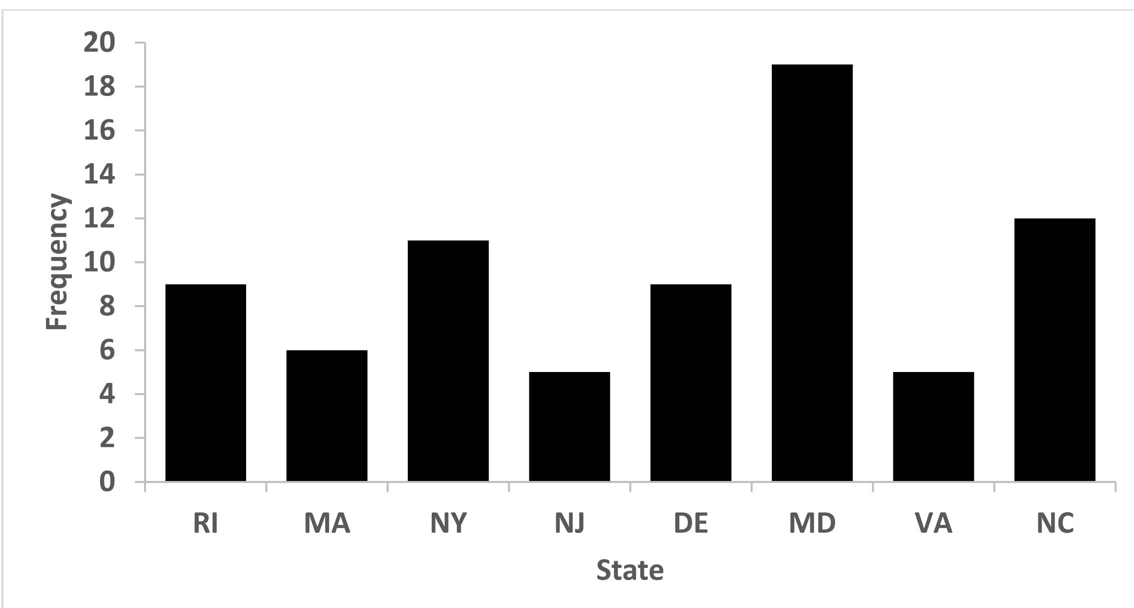

Figure 2. Number of samples collected in state waters in the workshop set.

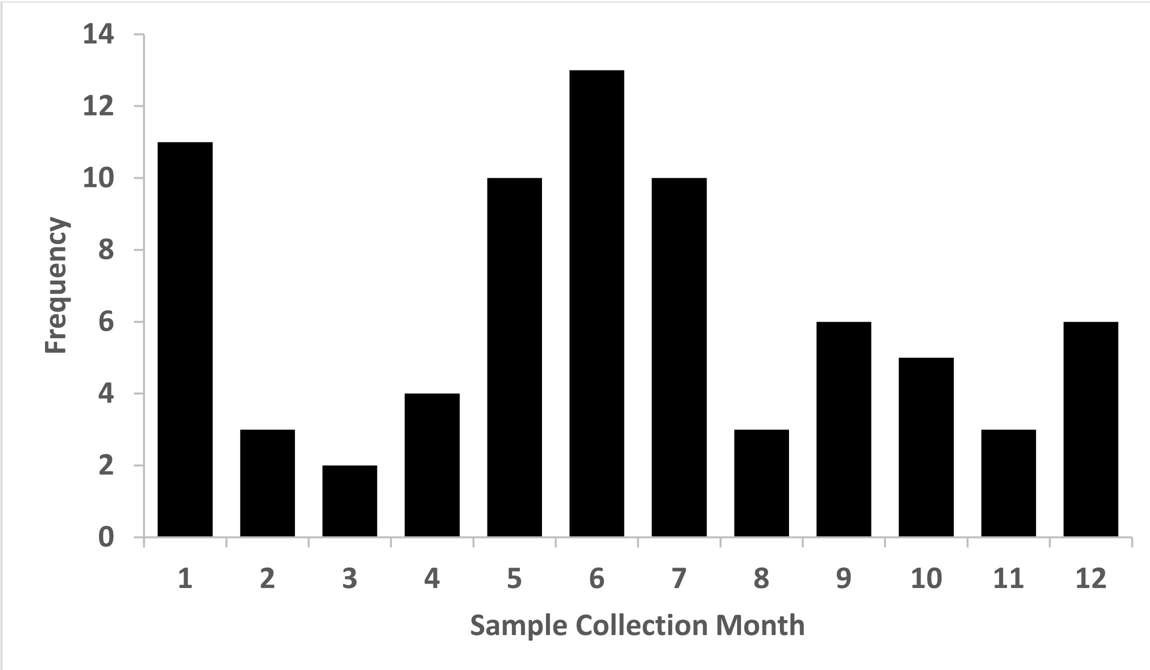

Figure 3. Number of samples collected by month in the workshop set.

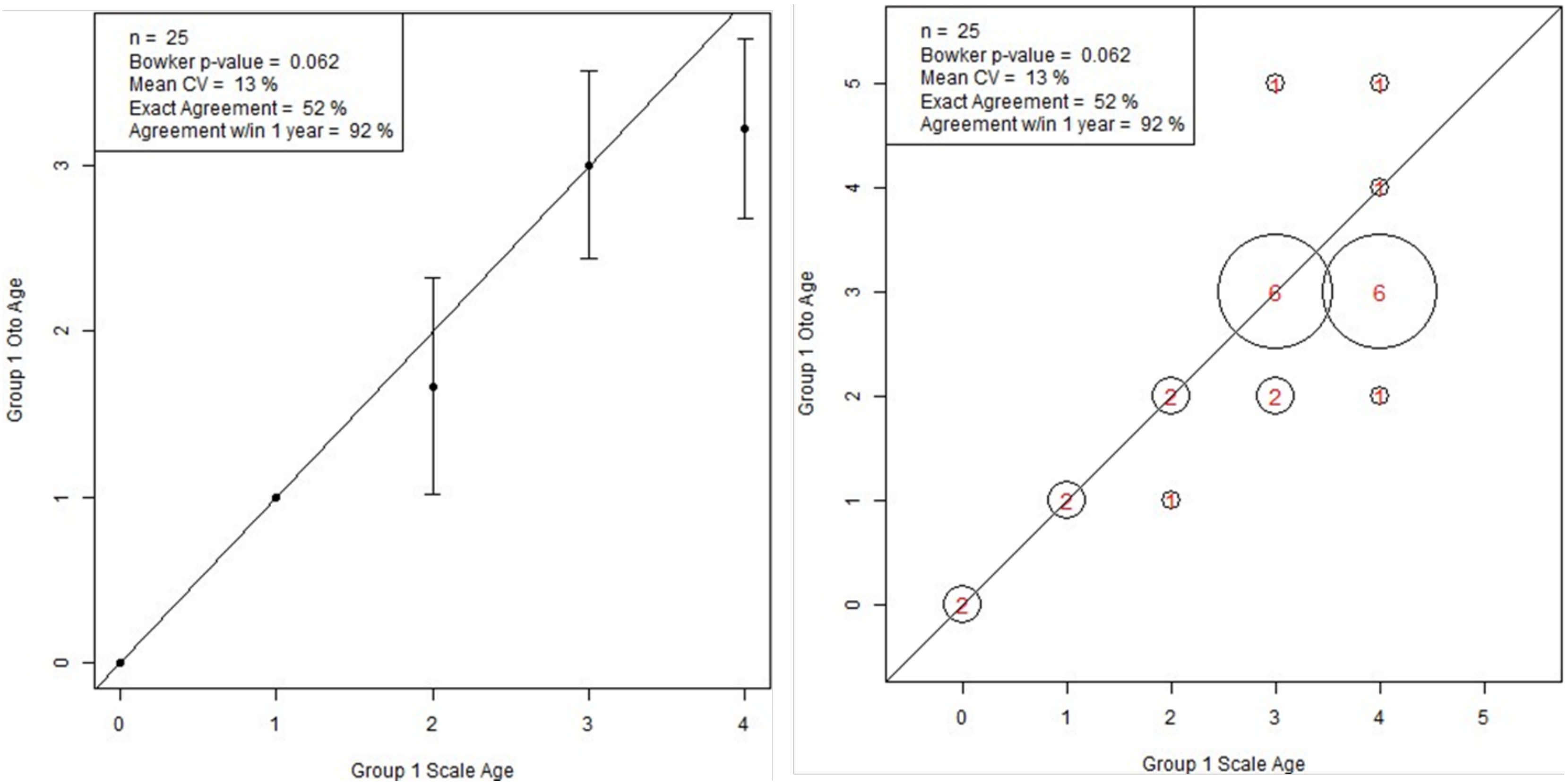

Figure 4. **Age bias (left) and age frequency (right) plots for group 1's scale and otolith age determinations. Error bars in the age bias plots are 95% confidence intervals.**

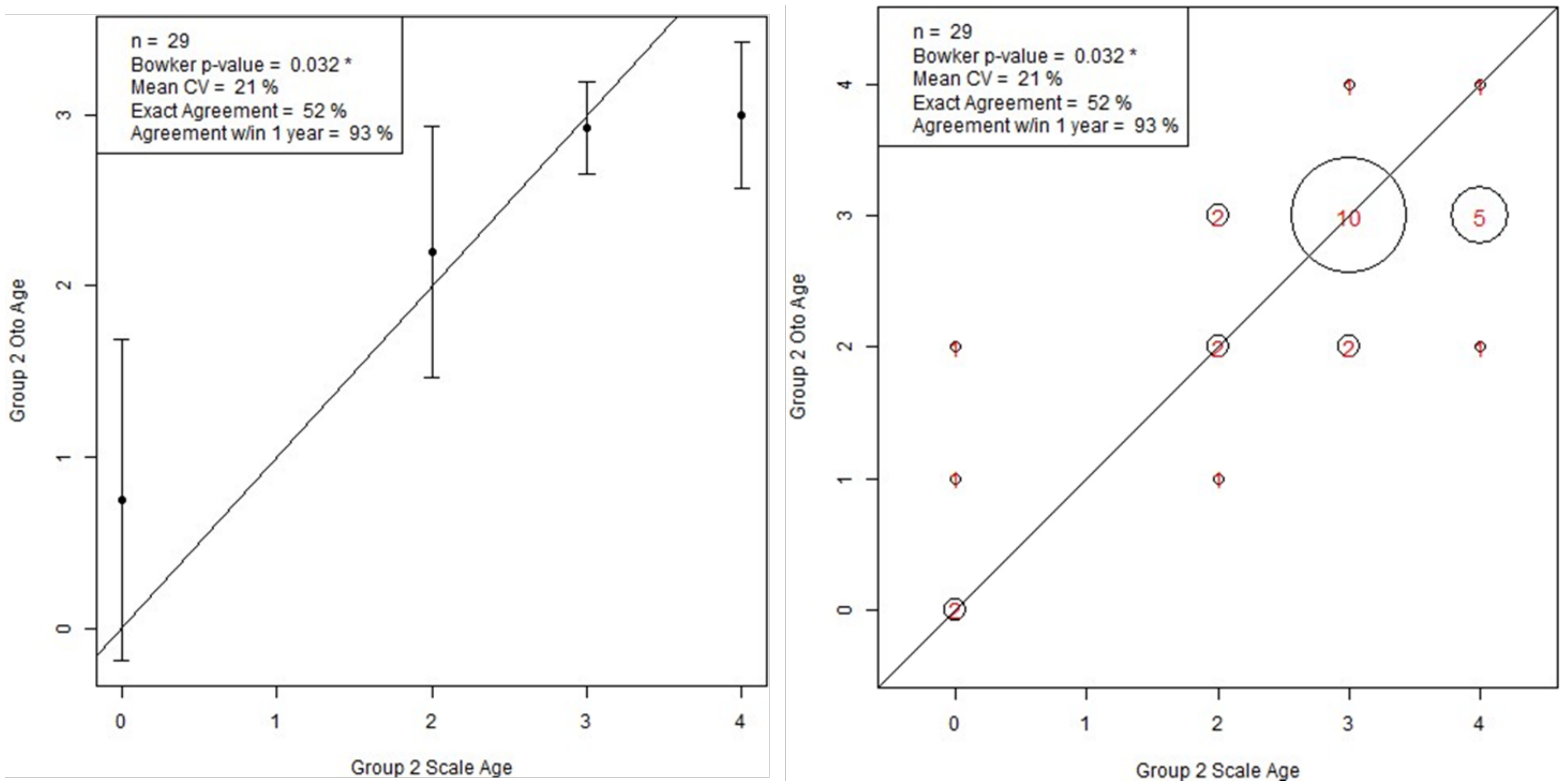

Figure 5. **Age bias (left) and age frequency (right) plots for group 2's scale and otolith age determinations. Error bars in the age bias plots are 95% confidence intervals.**

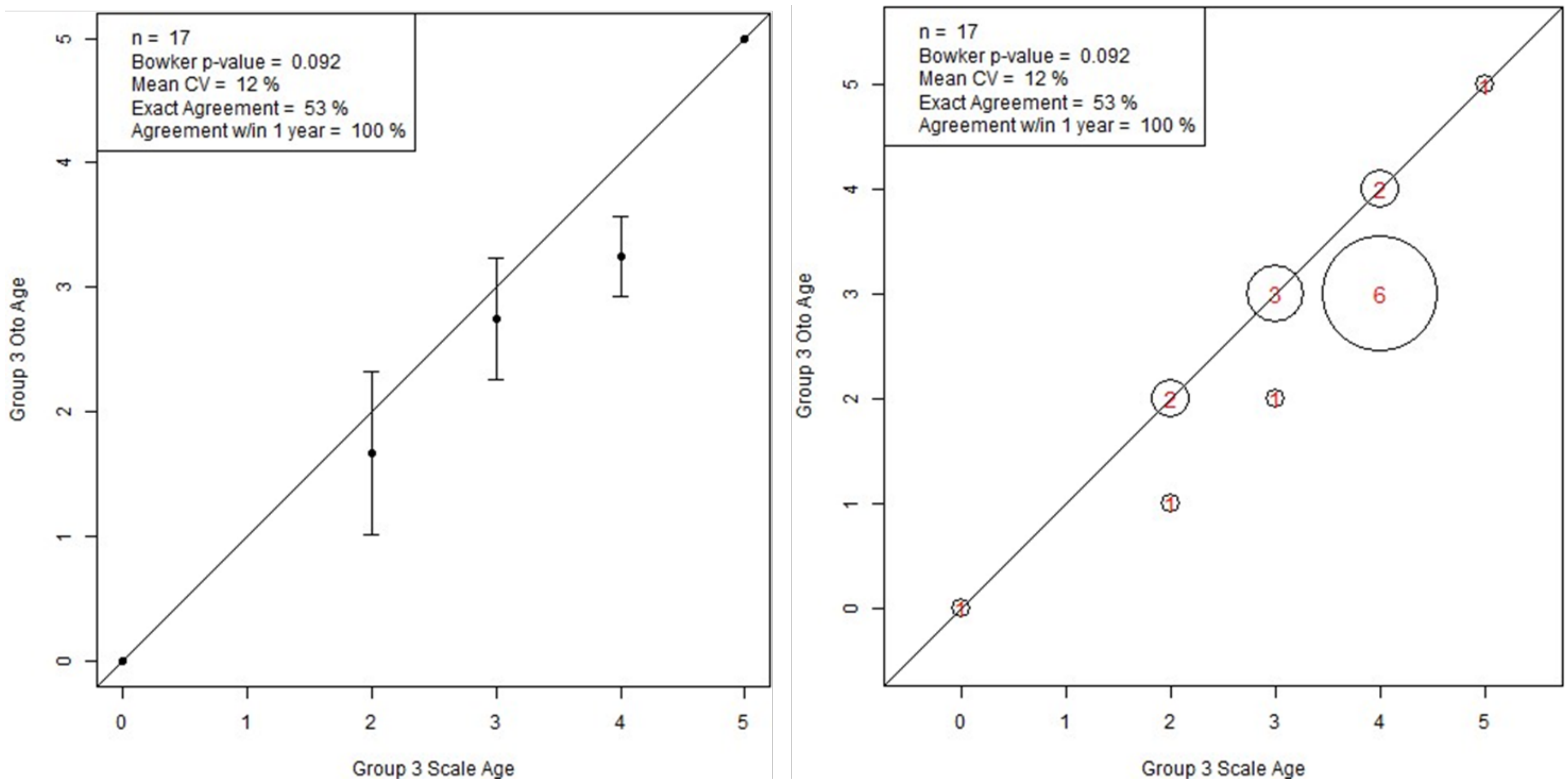

Figure 6. **Age bias (left) and age frequency (right) plots for group 3's scale and otolith age determinations. Error bars in the age bias plots are 95% confidence intervals.**