An Update to Gag Grouper (*Mycteroperca microlepis*) Calendar Age Calculations

Andrew D. Ostrowski, C. Michelle Willis, Keilin Gamboa-Salazar, and Margaret W. Finch

SEDAR71-WP01

Received: 10/22/2020

Please cite this document as:

Ostrowski Andrew D., C. Michelle Willis, Keilin Gamboa-Salazar, and Margaret W. Finch. 2020. An Update to Gag Grouper (*Mycteroperca microlepis*) Calendar Age Calculations. SEDAR71-WP01. SEDAR, North Charleston, SC. 16 pp.

An Update to Gag Grouper (*Mycteroperca microlepis*) Calendar Age Calculations

Andrew D. Ostrowski[1], C. Michelle Willis[2], Keilin Gamboa-Salazar[2], and Margaret W. Finch[2]

1. NMFS Southeast Fisheries Science Center

101 Pivers Island Road, Beaufort, NC 28516

2. South Carolina Department of Natural Resources

Marine Resources Division MARMAP

217 Fort Johnson Road, Charleston, SC 29412

SEDAR 71-WP01
MARMAP/SEAMAP-SA Reef Fish Survey Technical Report #2020-06

Abstract

Calendar ages are utilized in the life history data provided to Southeast Data, Assessment, and Review (SEDAR) assessments to evaluate year class strength of species more accurately. A calendar age estimation is calculated based on time of capture and the relative size of the marginal translucent zone of the sample (i.e., edge code). It is important that edge codes are analyzed periodically to determine the time period of greatest and lowest increment deposition, and therefore appropriately assign the month range for which calendar age should be based. This working paper analyzes the edge codes assigned by the readers from the two main data providers, South Carolina Department of Natural Resources (SCDNR) and NOAA Beaufort Lab (NOAA) for the upcoming SEDAR assessment of Gag. Both labs observed similar patterns for current readers; mainly an increase in edge codes 1 and 2 counts from March to August, and a decrease in edge code 4 counts during the summer months, followed by increases in of edge codes 3 and 4 in winter. SCDNR shows this trend for all readers across the complete aging data set. These results show that bumping criteria to calculate calendar age for Gag should be for samples with an edge code 3 or 4 and captured between January 1 and August 31. More accurate calendar age estimates should lead to clearer, stronger year-class patterns for the assessment.

Background

Life history data including age, growth, reproduction, longevity, and natural mortality are vital to age-based stock assessment models. Since the inception of SEDAR, a great emphasis has been placed on increasing the amount of age data used in assessment models. Age data are obtained by examining fish hard parts such as otoliths, scales, or spines and are inferred by annual growth patterns that form within those structures, called annuli or increment counts, with each one being a combination of an opaque and translucent zone. These increment counts do not always accurately estimate the population age because they do not account for time of capture in relation to timing of increment deposition, an important factor in determining if the fish has spent more time alive than suggested by just the increment counts. Furthermore, temporal, ecological, and physiological factors may play a part in increment deposition rates making periodic examination of otolith translucent zones worthwhile (Stevenson & Campana, 1992). An age determination using increment count could bias year class strength, spawning determination, and other important factors in the assessment model to a younger age.

To account for these concerns, calendar ages have been used to more accurately predict age assignments (SEDAR 53, 58, 59). Calendar ages are calculated based on edge code, or the width of the marginal translucent zone, and time of capture. These two factors determine if a year is added to an increment count to yield calendar age, or if the increment count equals the calendar age (i.e. bumping criteria). Date of capture is objective, whereas the edge code is subjectively assigned by the reader based on the amount of translucent zone (or new growth) present after the last opaque zone (Table 1). To reduce bias associated with reader subjectivity, agers read a training set and multiple calibration sets from regional aging labs in advance of production aging. A narrow edge margin (Code 1 or 2) indicates the fish likely deposited a new opaque zone recently, whereas a wide edge margin (Code 3 or 4) indicates the fish is likely to deposit a new opaque zone in the coming months.

The purpose of this working paper is to analyze the edge codes assigned by current age readers of Gag from SCDNR and NOAA to assign bumping criteria for the current SEDAR assessment.

Methods

Each lab read their samples in preparation for the upcoming assessment. Gag was the first species for which an Age Workshop was held (Reichert et. al, 2005), where various aging labs across the region met to discuss methods and interpretation of Gag otoliths. One method established for consistency between aging labs is whole versus sectioned otoliths for aging. All samples are aged whole at both labs using a dissecting microscope (20-40x power) with transmitted light. If a sample is deemed difficult to age and/or older than or equal 7 years (SCDNR) or 8-10 (NOAA), it is sectioned on a Buehler Low-speed Isomet saw and reread. For both labs, the subsequent sectioned read is used in the assessment. This procedure was based on an age workshop that was held at the SCNDR Marine Resources Research Institute (Charleston, SC) September 21-22, 2005 (Reichert et. al, 2005) in preparation of SEDAR 10.

The Beaufort lab has one reader who reads all contemporary samples after reading a calibration set and analyzing bias and average percent error (APE). SCDNR has two readers that read samples independently after reading a training and calibration set and analyzing bias and APE as well. Otolith reads are “blind,” where readers have no knowledge of date of capture, gear used for capture, size of fish, etc. Together, the readers re-age samples that disagree on increment count and/or edge code and come to a consensus increment count and edge code, which are the final data provided to SEDAR.

Here, edge codes produced by each lab were plotted by month, and the patterns seen for each edge code were analyzed for each reader. For the SCDNR lab, bias plots were generated using the FSA package in R (R Core Team 2013; Ogle *et al.* 2020) to compare the most recent reads produced by current readers, and the APE value was computed.

Results

The current Beaufort age reader is responsible for 75% of the total age readings in their data set (Table 2), therefore, it is important that edge code analysis be reassessed. For whole and sectioned otoliths, the counts of edge code 1 assignments are lowest in the early months of the year, followed by a rapid increase in May through July (Table 3A and 3B; Figure 1A and 1B), which follows peak spawning for Gag (SEDAR 10). Counts of edge code 2 increased starting in July and continuing until October for whole otoliths (Table 3A), as expected due to the otolith growth. The differences in edge code 2 counts between sectioned and whole otoliths were most likely due to the difficulty of edge assignment in older fish, because of the closer spacing of annuli as fish age. The highest counts of edge codes 3 and 4 are during the months following peak spawning activity, followed by a decrease throughout the summer as the counts of edge codes 1 and 2 increase for both whole and sectioned otoliths (Figure 1). These samples with edge codes 3 and 4 were likely born later in the spawning season, and based on proper criteria, would be bumped up by a year into a different cohort. Based on these results, the bumping criteria for the current Beaufort age reader should be to advance increment count of samples with an edge code of 3 or 4 with dates of capture between January 1st and August 31st.

The current readers for SCDNR provided increment counts and edge codes for 19% of the total reads in the dataset provided (Table 4). Whole reads for both readers show a similar pattern to Beaufort, with edge code 1 increasing from April to a peak in July, and edge code 2 increasing from June through July (Table 5A). This pattern can be seen in sectioned otolith reads as well, particularly with edge code 1 (Table 5B). When SCDNR increment counts and edge codes are examined for the complete dataset (both historical and current readers), the pattern continues (Table 8; Figure 2C). Similar to Beaufort, whole reads show a decrease in the counts of edge code 4 through the summer months, concurrent with the increase in edge code 1 (Figure 2). For fish captured in August, both current and historical readers observed the least amount of edges with code 4, followed by a jump in edge codes of 2 in September. It is important to note that even though total sample sizes are larger in the summer and fall months, the patterns that have been described for both labs are also observed when percentages of each edge code are calculated for each month (Tables 6 and 7). Like Beaufort, variances in edge code assignments are often due to the difficulty in determining edge size in older fish.

In a similar way, bias plots comparing the increment counts assigned by SCDNR's current readers show greater variability between readers in the older fish (Figure 3), due not only to greater difficulty in ageing these, but perhaps also because of lower sample sizes in these ages. Nonetheless, these bias plots depict a high percentage of agreement (81.3%) and yield a low APE (2.41; Figure 3). Thus, due to the similar patterns observed between the Beaufort and SCDNR lab, and the high confidence in the most recent reads, it is recommended that bumping criteria be established as stated above.

Conclusion

The last time Gag edge code was analyzed by reader was for SEDAR 10 (Reichert *et al*. 2005), with readers who are no longer primary readers at their respective labs, although at least one previous SCDNR reader is still available to provide guidance and support for current Gag readers, as needed. The reported bumping criteria for SEDAR 10 was for edge codes 3 or 4 for samples collected between January 1 and June 30. Based on the analysis of the ages assigned by current readers, it appears more suitable to bump samples collected between January 1 and August 31 with a wide margin (edge code 3 or 4) for this assessment. Due to the large volume of ages by the current Beaufort reader, in combination with SCDNR's analyses of edge codes across the entire age dataset, these differences in bumping criteria could have large impacts on correct calendar age assignments and subsequent documentation of year class strength.

Literature Cited

Ogle, D.H., P. Wheeler, and A. Dinno. 2020. FSA: Fisheries Stock Analysis. R package version 0.8.30, https://github.com/droglrenc/FSA**.**

R Core Team. 2013. R: a language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. Available online at: https://www.r-project.org/

Reichert, M., G. Fitzhugh, J. and Potts. 2005. Report of gag (*Mycteroperca microlepis*) age workshop. SEDAR10-DW13. SEDAR, North Charleston, SC. 9 pp.

SEDAR. 2005. SEDAR10 South Atlantic Gag Grouper Stock Assessment Report 1. SEDAR, North Charleston, SC. 485 pp. Available online at: http://sedarweb.org/sedar-10

SEDAR. 2017. SEDAR 53 – South Atlantic Red Grouper Assessment Report. SEDAR, North Charleston SC. 159 pp. Available online at: http://sedarweb.org/sedar-53

SEDAR. 2020. SEDAR 58 – Atlantic Cobia Stock Assessment Report. SEDAR, North Charleston SC. 500 pp. Available online at: http://sedarweb.org/sedar-58

SEDAR. 2020. SEDAR – South Atlantic Greater Amberjack Stock Assessment Report. SEDAR, North Charleston SC. 142 pp. Available online at: http://sedarweb.org/sedar-59

Stevenson, D.K., and S.E. Campana. 1992. Otolith Microstucture Examination and Analysis. Canadian Special Publication of Fisheries and Aquatic Sciences 117. DOI: 10.13140/RG.2.2.22258.61127

Tables

Table 1. Readability and edge codes used by MARMAP

EDGE TYPE

Code	Description
1	Opaque zone on the edge.
2	Narrow translucent zone on edge; Width less than about 30% of previous increment
3	Medium translucent zone on edge; Width about 30-60% of previous increment
4	Wide translucent zone on edge; Width more than about 60% of previous increment

Table 2. Count and percentages of samples read by Beaufort's current reader compared to previous readers

Readers	Number of samples read	Percentage
Current reader	11621	75.25
Previous readers	3822	24.75
Total	**15443**	**100**

Table 3. Current Beaufort Reader's whole (A) and sectioned (B) otolith edge codes by month and edge code type

A

	Edge type				
Month	**1**	**2**	**3**	**4**	**Total**
1	37	82	49	71	239
2	44	87	96	63	290
3	11	24	35	13	83
4	25	14	31	32	102
5	305	299	433	655	1692
6	327	277	288	549	1441
7	286	309	229	453	1277
8	255	327	146	287	1015
9	242	331	155	175	903
10	285	508	345	335	1473
11	186	307	240	181	914
12	111	223	191	159	684
Total	**2114**	**2788**	**2238**	**2973**	**10113**

B	Edge type				
Month	**1**	**2**	**3**	**4**	**Total**
1	2	10	22	41	75
2	6	20	24	37	87
3	1	2	3	2	8
4		2	1	6	9
5	16	52	79	113	260
6	17	44	56	99	216
7	11	37	29	62	139
8	17	43	27	42	129
9	7	30	23	28	88
10	13	47	39	56	155
11	12	38	29	43	122
12	25	46	46	53	170
Total	**127**	**371**	**378**	**582**	**1458**

Table 4. Count and percentages of samples read by SCDNR's current readers compared to previous readers

SCDNR Readers	Number of samples read	Percentage
Current readers	1150	18.83
Previous readers	4957	81.17
Total	**6107**	**100.00**

5. Current SCDNR readers' whole (A) and sectioned (B) otolith edge codes by month and edge code type. Both SCDNR readers read the same number of whole and sectioned otoliths.

A	**Edge Type**				
Month	**1**	**2**	**3**	**4**	**Total**
1	1	2	1	7	11
2		2	5	8	15
3	5		1	12	18
4	20	3	7	41	71
5	40	6	4	23	73
6	37	30	5	13	85
7	53	96	7	8	164
8	9	24	12	3	48
9	2	2	15	4	23
10	6	12	14	1	33
11	3	6	7	1	17
12		6	7	5	18
Total	176	189	85	126	576

B	**Edge Type**				
Month	**1**	**2**	**3**	**4**	**Total**
1	3	2	1	3	9
2		1	5	5	11
3	8	6	8	14	36
4	19	7	9	22	57
5	39	7	15	35	96
6	11	2	3	10	26
7	13	9	3	13	38
8	7	2	3	1	13
9	10	45	18	3	76
10	19	23	6	8	56
11	2	1	2	1	6
12	6	14	10	16	46
Total	137	119	83	131	470

Table 6. Percentage of total for current Beaufort Reader's whole (A) and sectioned (B) otolith edge codes by month and edge code type.

A	Edge type				
Month	**1**	**2**	**3**	**4**	**Total**
1	15.5	34.3	20.5	29.7	100
2	15.2	30.0	33.1	21.7	100
3	13.3	28.9	42.2	15.7	100
4	24.5	13.7	30.4	31.4	100
5	18.0	17.7	25.6	38.7	100
6	22.7	19.2	20.0	38.1	100
7	22.4	24.2	17.9	35.5	100
8	25.1	32.2	14.4	28.3	100
9	26.8	36.7	17.2	19.4	100
10	19.3	34.5	23.4	22.7	100
11	20.4	33.6	26.3	19.8	100
12	16.2	32.6	27.9	23.2	100

B	Edge type				
Month	**1**	**2**	**3**	**4**	**Total**
1	2.7	13.3	29.3	54.7	100
2	6.9	23.0	27.6	42.5	100
3	12.5	25.0	37.5	25.0	100
4	0.0	22.2	11.1	66.7	100
5	6.2	20.0	30.4	43.5	100
6	7.9	20.4	25.9	45.8	100
7	7.9	26.6	20.9	44.6	100
8	13.2	33.3	20.9	32.6	100
9	8.0	34.1	26.1	31.8	100
10	8.4	30.3	25.2	36.1	100
11	9.8	31.1	23.8	35.2	100
12	14.7	27.1	27.1	31.2	100

Table 7. Percentage of total for current SCDNR readers' whole (A) and sectioned (B) otolith edge codes by month and edge code type.

A	Edge Type				
Month	**1**	**2**	**3**	**4**	**Total**
1	9.1	18.2	9.1	63.6	100
2		13.3	33.3	53.3	100
3	27.8		5.6	66.7	100
4	28.2	4.2	9.9	57.7	100
5	54.8	8.2	5.5	31.5	100
6	43.5	35.3	5.9	15.3	100
7	32.3	58.5	4.3	4.9	100
8	18.8	50.0	25.0	6.3	100
9	8.7	8.7	65.2	17.4	100
10	18.2	36.4	42.4	3.0	100
11	17.6	35.3	41.2	5.9	100
12		33.3	38.9	27.8	100

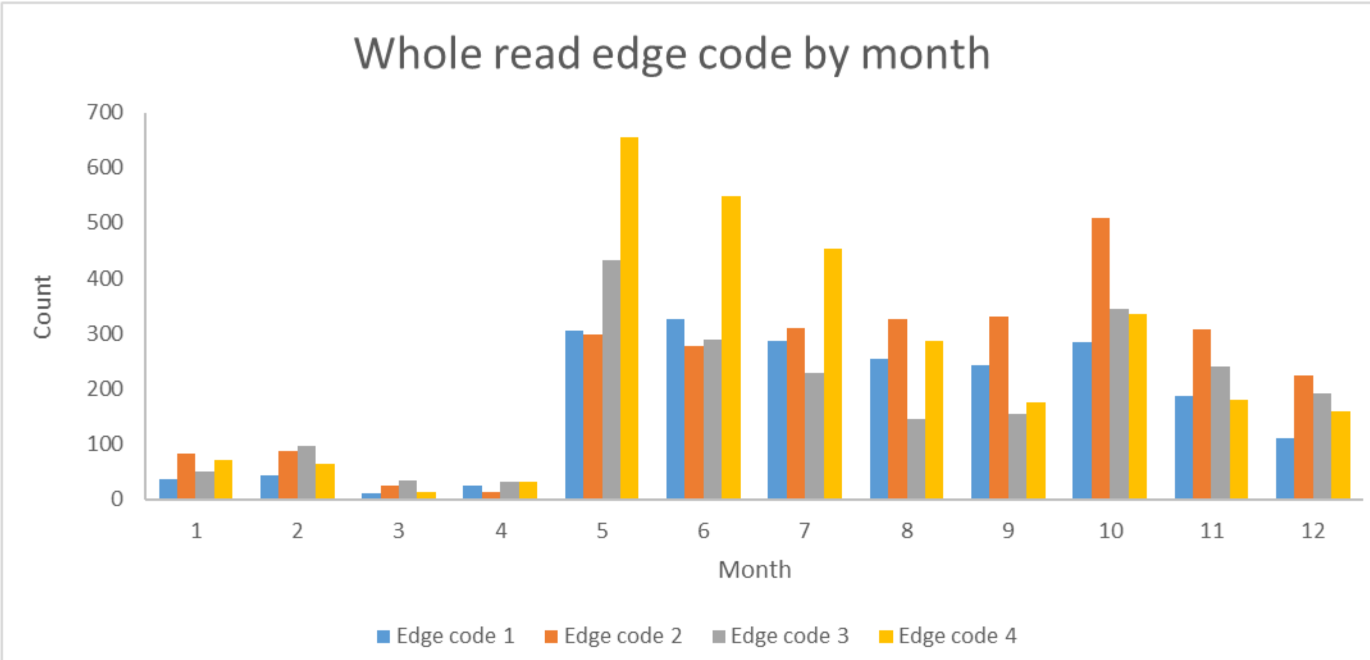
B	Edge Type				
Month	**1**	**2**	**3**	**4**	**Total**
1	33.3	22.2	11.1	33.3	100
2	0.0	9.1	45.5	45.5	100
3	22.2	16.7	22.2	38.9	100
4	33.3	12.3	15.8	38.6	100
5	40.6	7.3	15.6	36.5	100
6	42.3	7.7	11.5	38.5	100
7	34.2	23.7	7.9	34.2	100
8	53.8	15.4	23.1	7.7	100
9	13.2	59.2	23.7	3.9	100
10	33.9	41.1	10.7	14.3	100
11	33.3	16.7	33.3	16.7	100
12	13.0	30.4	21.7	34.8	100

Table 8. Edge count and proportion of narrow (edge type 1 or 2) and wide (edge type 3 or 4) translucent zones for complete SCDNR dataset (both historical and current readers). Whole and sectioned reads are combined in this table.

Month	Narrow Edge Count	Narrow Edge Proportion	Wide Edge Count	Wide Edge Proportion	Total Average of Edge Type	Total Count of Edge Type
1	22	0.07	314	0.93	3.67	336
2	20	0.05	390	0.95	3.72	410
3	34	0.05	598	0.95	3.73	632
4	96	0.13	622	0.87	3.48	718
5	109	0.28	278	0.72	3.09	387
6	94	0.36	164	0.64	2.91	258
7	202	0.59	138	0.41	2.49	340
8	102	0.58	73	0.42	2.43	175
9	74	0.49	76	0.51	2.65	150
10	89	0.54	76	0.46	2.44	165
11	28	0.22	99	0.78	3.24	127
12	30	0.22	105	0.78	3.3	135

Figures

Figure 1. Current Beaufort Reader's whole and sectioned otolith edge codes by month and edge code type



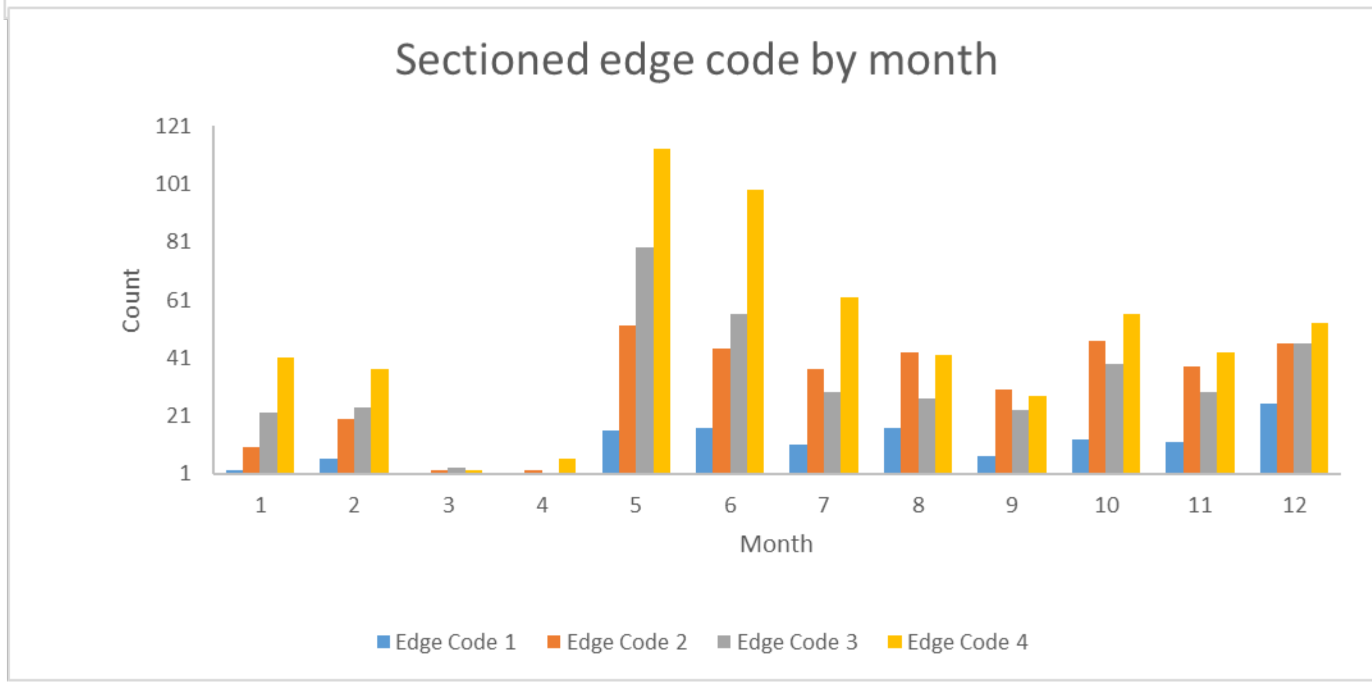
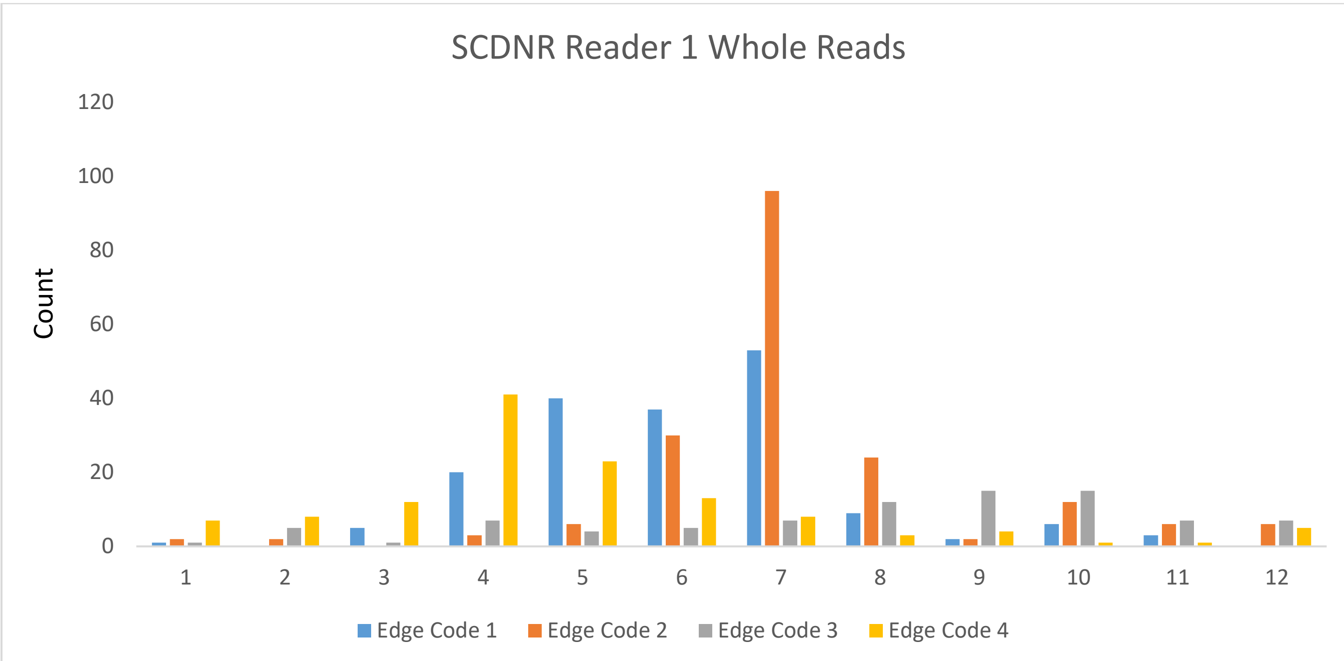
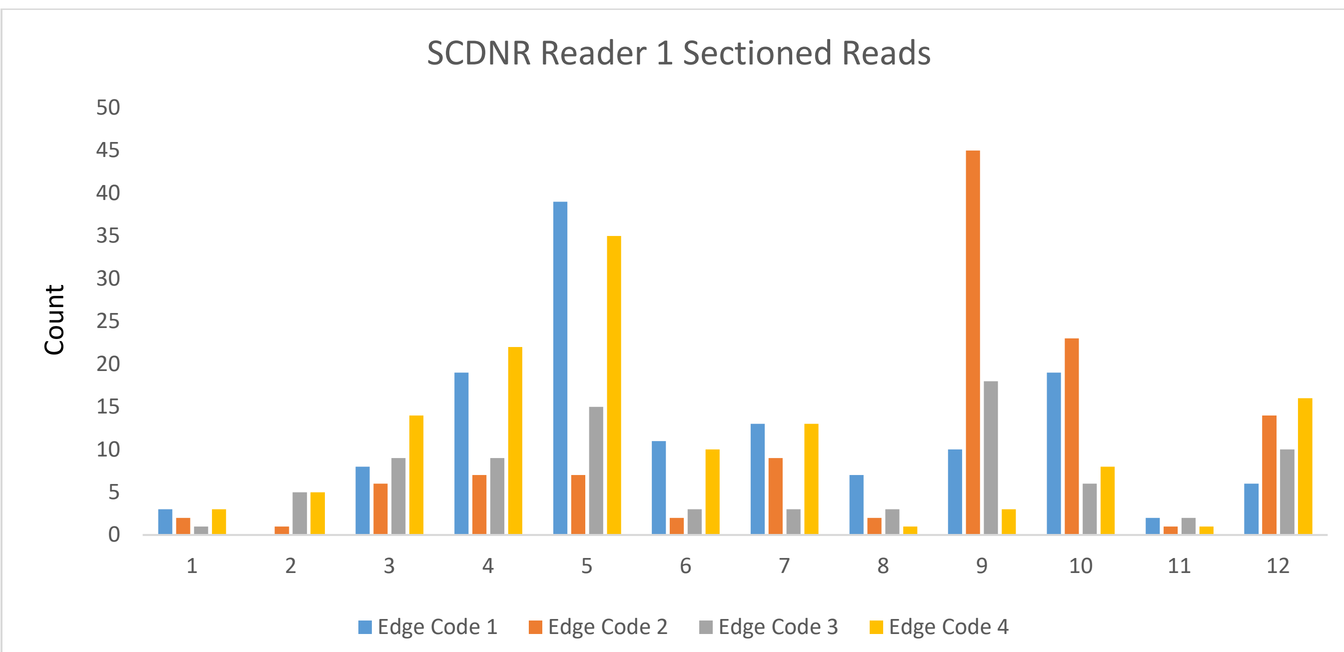


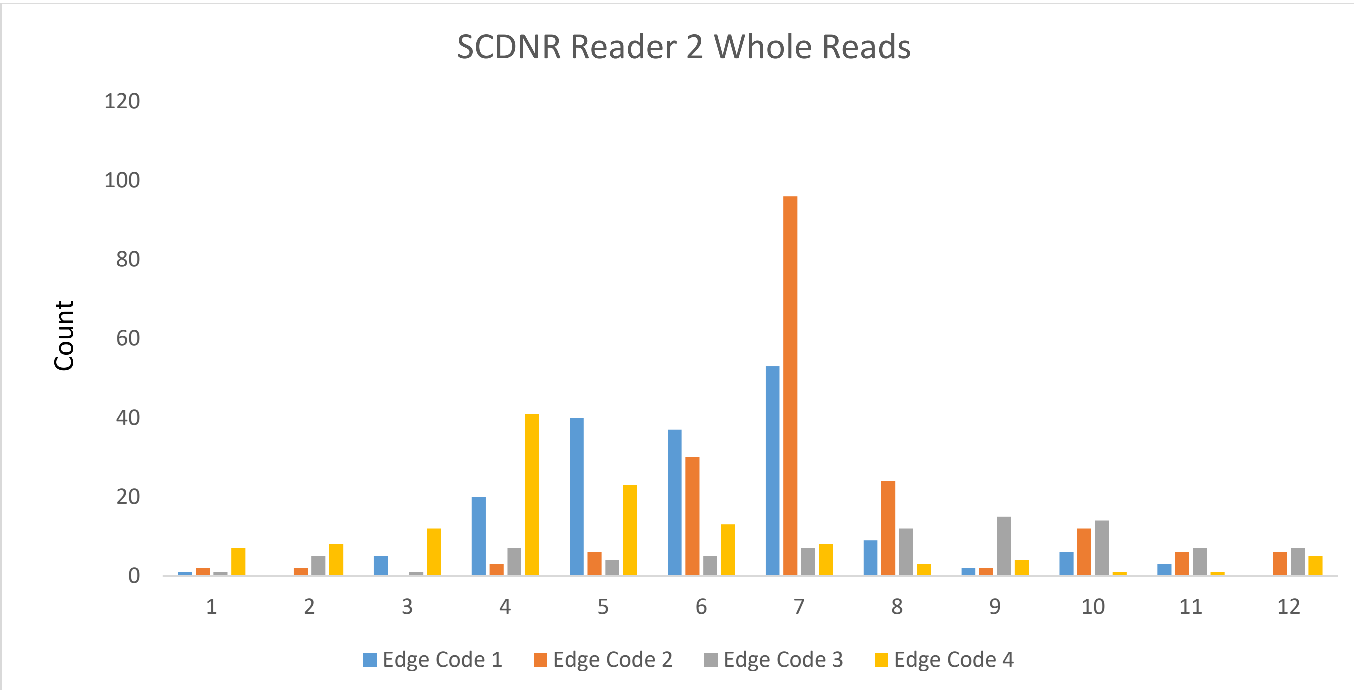
Figure 2. SCDNR whole and sectioned counts of aged samples by month and edge code type for current Reader 1 (A) and Reader 2 (B). Combined whole and sectioned counts of aged samples by month and edge code type for historical and current readers (C).

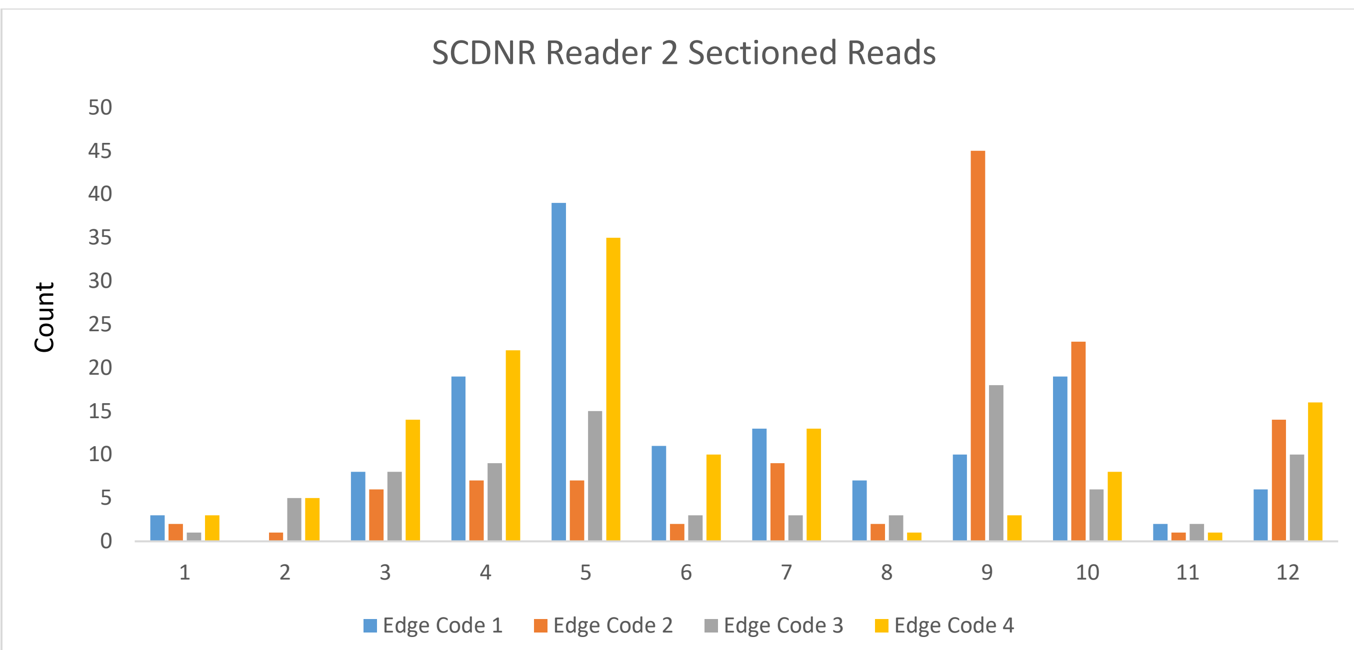
A





B


SCDNR Reader 2 Whole Reads
Count
0
20
40
60
80
100
120
1
2
3
4
5
6
7
8
9
10
11
12
Edge Code 1
Edge Code 2
Edge Code 3
Edge Code 4


SCDNR Reader 2 Sectioned Reads
Count
0
5
10
15
20
25
30
35
40
45
50
1
2
3
4
5
6
7
8
9
10
11
12
Edge Code 1
Edge Code 2
Edge Code 3
Edge Code 4

C

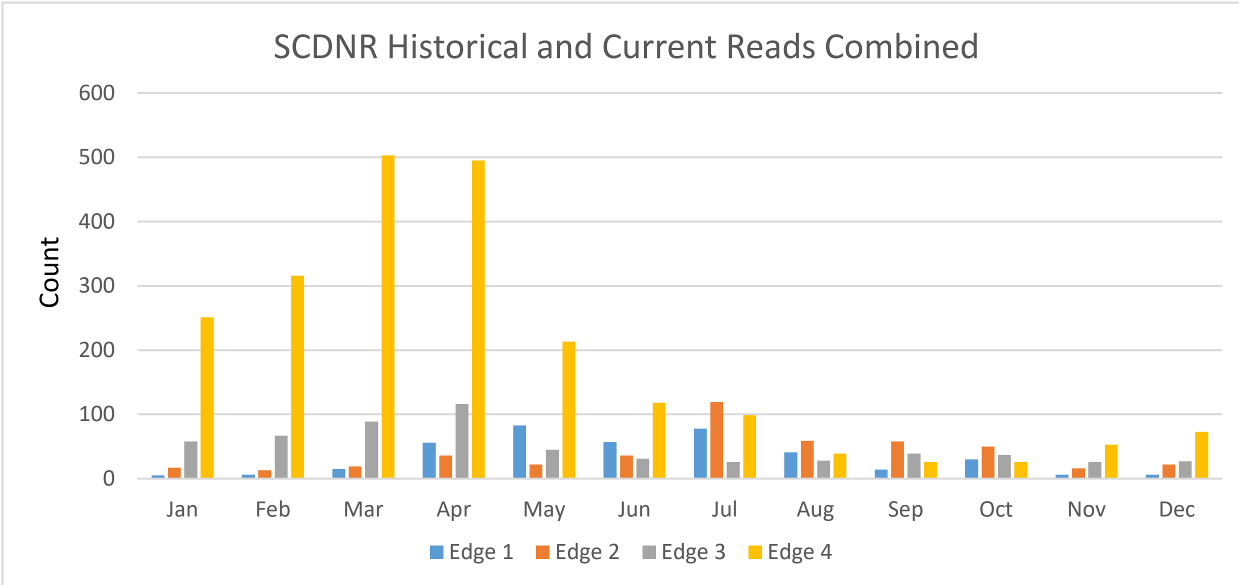
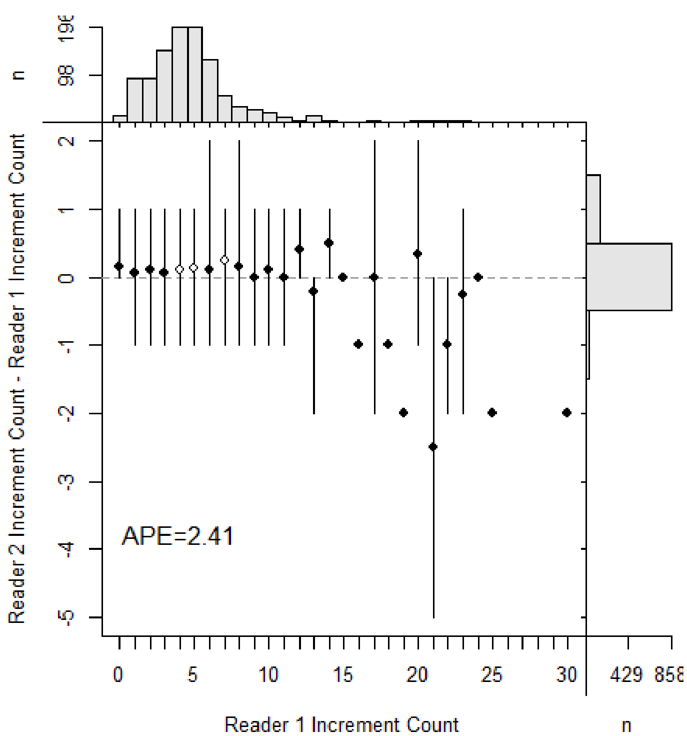
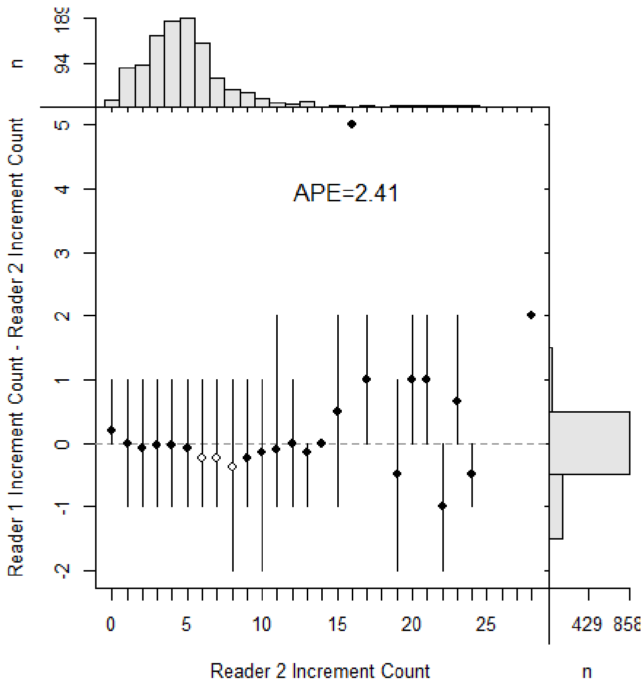


Figure 3. Bias plots comparing increment count reads for current SCDNR's readers, showing APE value.

A



B



n
94
189
APE=2.41
Reader 1 Increment Count - Reader 2 Increment Count
5
4
3
2
1
0
-1
-2
0
5
10
15
20
25
429
858
Reader 2 Increment Count
n