Changes to NMFS age readings of U.S. South Atlantic Red Porgy (*Pagrus pagrus*)

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SEDAR60-WP03

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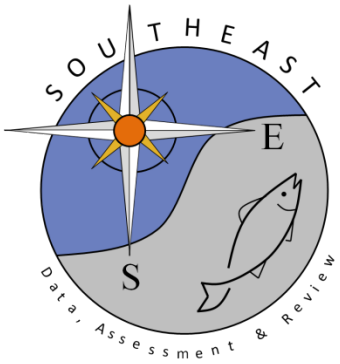

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Abstract

All Red Porgy age samples previously submitted to SEDAR01, 2006 update to SEDAR01, and 2012 update to SEDAR01 available at NMFS Beaufort Laboratory were re-aged based on the results of a recent age validation study. Otolith processing methodology and criteria for interpreting the growth zones on the otoliths was set and shared with SCDNR, the other laboratory submitting Red Porgy age data stock assessments. We describe in detail the changes to the age readings and illustrate the effect on the age frequencies over time.

Background

The age readings of Red Porgy, *Pagrus pagrus*, from the Southeastern U.S. Atlantic has been contentious since SEDAR01 in 2002. Laboratories engaged in ageing Red Porgy have used different methods of processing the sagittal otoliths, the preferred age structure, and used different methods of interpretation of the annual pattern of translucent and opaque zone formation. As a result of these issues, an age validation study was attempted by National Marine Fisheries Service (NMFS) Beaufort Laboratory in 2005-2006. The study encountered many obstacles and was not completed. In 2015, a three-year age validation project was funded through a MARFIN grant. The project was successful in validating the formation of the first annulus and the subsequent annual deposition of growth zones on adult fish. Based on the results of this study, otolith processing methodology and criteria for the reading of the annual growth zones was established and shared with South Carolina Department of Natural Resources (SCDNR), the other laboratory submitting age data for SEDAR-60.

Due to the results of the age validation study, the Red Porgy age data from NMFS for SEDAR-01, 2006 Update to SEDAR01 and 2012 Update to SEDAR01 have changed. The primary change in the age readings was based on the formation of the first annulus, or opaque zone. Approximately 45% of the fish exhibit a late summer/early fall check mark in their first year, which should not be counted as an annulus. A minimum measurement criteria from the core area to the outside edge of the first annulus was used to identify the first annulus. After the formation of the first, true annulus, each subsequent distinct opaque zone that was continuous from the sulcal groove around the transverse portion of the otolith section should be counted as one year. This criteria had a lesser impact on the overall age readings.

Along with the changes in the age data due to the methodology for reading the samples, the numbers of samples available for the assessment have changed for various reasons. Some of the historic samples were lost due to breakage, compromised storage location, or otolith sections rendered unreadable due to a chemical process. With the advent of more readily access to the original submitted

electronic data for each sample, rather than relying on hard copy data sheets and data recorded on sample envelopes, some sample data could not be reconciled. Thus, the samples were deemed unusable. In the case of fishery-dependent samples, we also verified the survey source and fishing mode of the samples and the sampling methodology (e.g., random or biased). Some samples used in past assessments, but now determined to be from a biased collection, could not be used to characterize the fishery. Those samples could be used for population level parameters such as growth models. The issues with the data reconciliation had the largest effect on the samples collected prior to 2004.

This report will focus primarily on the comparison of the original age data to the newly re-aged sample data. The data analyses will be based on increment counts, because that is what went into the previous Red Porgy stock assessments and will be used in SEDAR60. Because there have been changes in the staff who read the samples for the different stock assessments, as well as subtle changes to the sample processing methodology and microscopes used for viewing the otolith sections, data unique to each of the past Red Porgy stock assessments will be analyzed separately. The data sets will be SEDAR01, 2006 Updated to SEDAR01, and 2012 Update to SEDAR01.

SEDAR-01

Age data submitted from National Marine Fisheries Service's Beaufort Laboratory (NMFS) for SEDAR01 was from a published study (Potts and Manooch, 2002). The study included samples collected from the recreational Headboat fishery (1989 – 1998)and commercial fishery (1997 – 1998) operating in the US South Atlantic. SCDNR contributed some fishery-independent samples to cover the size range of fish below the regulatory minimum size limit. A total of 631 samples were aged. The otolith samples were sectioned and mounted on glass slides for viewing. To enhance the growth zones, clove oil was applied to the sections when reading them, and then wiped off before storing the slides. Clove oil is slightly acidic, and has the potential to erode the otolith sections, or clear, them over time. This phenomenon made re-reading some of the samples difficult or impossible. In addition, some of the slides were damaged during transition from one storage location to another. In all, 215 samples were available for re-reading.

Two main differences in age readings were noted during the re-reading process. The main difference in the age readings was due to the identification of the true, first annulus. For fish originally aged 2 – 6 years were on average 0.77 years younger with the new ageing (Figure 1). The second difference noted was the interpretation of the opaque zones as annuli or check marks. The original data set included comments that noted "double rings". When re-reading the samples, the opaque zones were continuous around the circumference of the otolith section. Based on the age validation study results, those opaque zones should be counted. This difference primarily affected fish originally aged 7 – 9 years. They are now aged as high as 15 years, but averaged 1.2 years older (Figure 1).

With the change in age readings, the nominal age frequency has changed as well. The modal age has shifted to one year younger, from age-2 to age-1 (Figure 2). The Breusch-Pagan test (heteroscedasticity) revealed a significant difference ($p<0.001$) in the overall shape of the age-frequencies (Breusch and Pagan, 1979). The percent agreement between the original readings and the new readings was 21.6% suggesting that a larger than expected change in the age readings occurred. Due to the age validation study, we feel more confidence in the new readings.

2006 Update to SEDAR-01

For the 2006 update assessment to SEDAR01, a new set of age samples were appended to the SEDAR01 data set. These data included historical Southeast Region Headboat Survey samples back to 1979 and samples from new sources. Expanded commercial fishery collections and other recreational fishery sampling (e.g., charter boat and private boat) accounted for the new sources of samples. A different person read the new set of samples, but did not re-read the previous set. Also, the new samples were sectioned and adhered to glass slides with a clear mounting medium applied to the tops of the sections to aid in enhancing the growth zones. This process eliminated the issues with using clove oil. Overall, the samples were in much better shape for re-reading than the ones used in SEDAR-01.

The data for the new set of ages submitted to the update assessment revealed a consistent pattern of ageing error. The primary difference in the original age readings compared to the new readings was due to the interpretation of the first annulus. After age-1 fish, average difference in readings was 0.76 years younger for all ages, 2 – 17 years (Figure 3).

As with the previous age data set for SEDAR01, the nominal age frequency for the new set of samples has changed. The modal age shifted from age-4 to age-3 (Figure 4). Again, the Breusch-Pagan test revealed significant heteroscedasticity ($p = 0.0158$). Beyond the shift of the age-frequency by 1 year, the biggest change occurred in ages < 4-years. When aging many reef fish species, the growth zones on the otolith of the youngest fish are some of the more difficult to interpret. The age validation study provided a more clear criteria for enumerating the annuli. Thus, the expectation was to see more difference in the youngest fish.

2012 Update to SEDAR-01

For the 2012 update assessment to SEDAR01, age data collected from 2005 to 2012 were appended to the input data. These new samples were collected primarily from the commercial fishery (94%). Yet another person was the age reader for this set. This set of samples were read after an age validation study was attempted in 2005-2006. Though that study was not completed, there was a suggestion that red porgy formed a check mark on the otolith that was within its first year, but was not the first annulus. Armed with this information, the age reader made an assumption to generally disregard the first continuous opaque zone, whether it was the true first annulus or the check mark. These samples were processed in the same manner as the set for the 2006 update assessment. The samples were in good shape and could be re-read with little problems.

The new set of samples for the 2012 assessment revealed a consistent pattern of ageing error, but different from the previous two sets. Instead of the issue of over-aging, this set were determined to be under-aged by an average of 0.56 years for ages 1 – 13 (Figure 5). The original age reader also had a tendency to under-age the oldest fish by 4 years on average (maximum difference was 8 years). This pattern was similar to the one seen by the original age reader of the first SEDAR01 assessment.

Another difference with this set of age data was in the age frequencies. The previous two sets of age data revealed a definitive shift in the modal age. In the case of this data set, the modal age stayed the same (Figure 6). More subtle shifts in the age-frequency were noted. The Bruesch-Pagan test

revealed significant heteroscedasticity in the age frequencies ($p<0.001$). In the original age data, the fish were under-aged and the amount of under-ageing was higher for the oldest fish.

Conclusion

We have more confidence in the newly recorded age data for SEDAR60. The age validation study for red porgy was successful in identifying first annulus and the periodicity of the opaque zone deposition on the otoliths. The results of the study were shared with other researchers, who agreed with the validation of the opaque zones as annuli. The current age-readers at NMFS were trained and vetted through the use of a calibration set of otolith sections. In addition, during the reading process, the age-readers would exchange samples to ensure consistency in readings. A few samples of the oldest fish were exchanged with SCDNR to verify readings, for which they were. The complete age data set for SEDAR60 from NMFS is more consistent through time and should be consistent with the data set submitted by SCDNR.

Literature Cited

Potts, J. C., and C. S. Manooch III. 2002. Estimated ages of red porgy (*Pagrus pagrus*) from fishery-dependent and fishery-independent data and a comparison of growth parameters. Fish. Bull. 100:81 – 89.

Breusch, T. S., and A. R. Pagan. 1979. A Simple Test for Heteroscedasticity and Random Coefficient Variation. Econometrica 47:1287–1294.

Figures

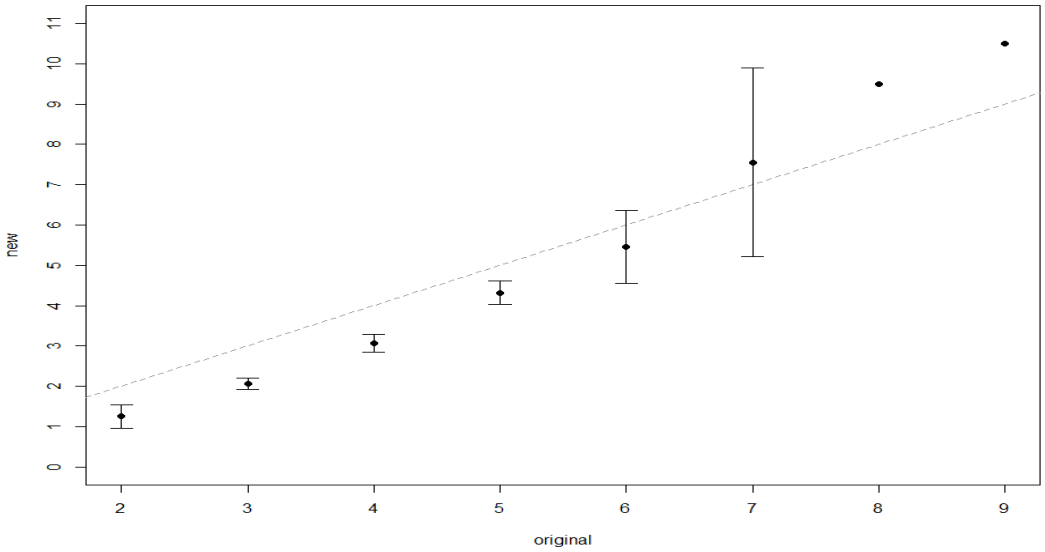

Figure 1. Bias plot of the original South Atlantic Red Porgy age data submitted to SEDAR01 compared to the new age readings based on an age validation study. The 1:1 line is the original data. The error bars represent the 95% confidence intervals about the average age readings.

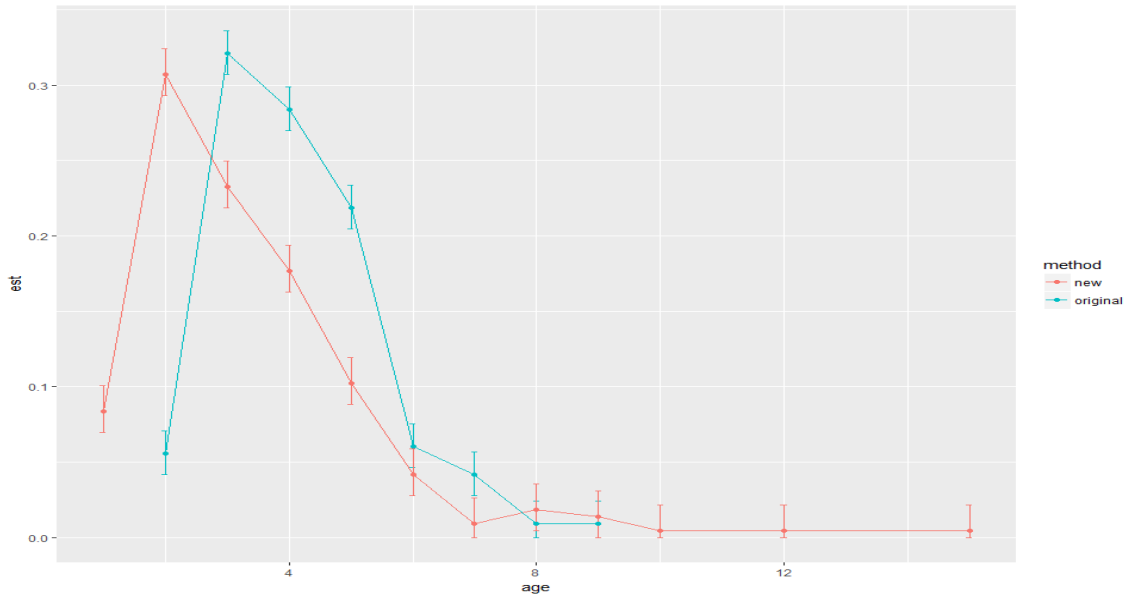

Figure 2. Comparison of nominal age frequencies of SEDAR01South Atlantic Red Porgy age data between original data and new age readings. Error bars represent 95% confidence intervals.

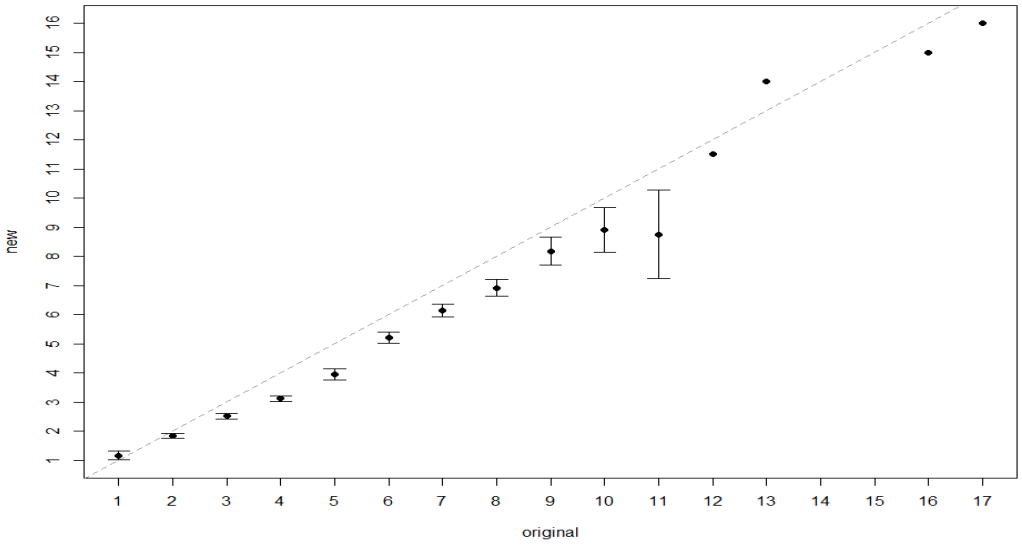

Figure 3. Bias plot of the additional South Atlantic Red Porgy age data submitted to the 2006 Update assessment of SEDAR01. The original data, represented by the 1:1 line, were compared to the new age readings based on an age validation study. The error bars represent the 95% confidence intervals about the new age readings.

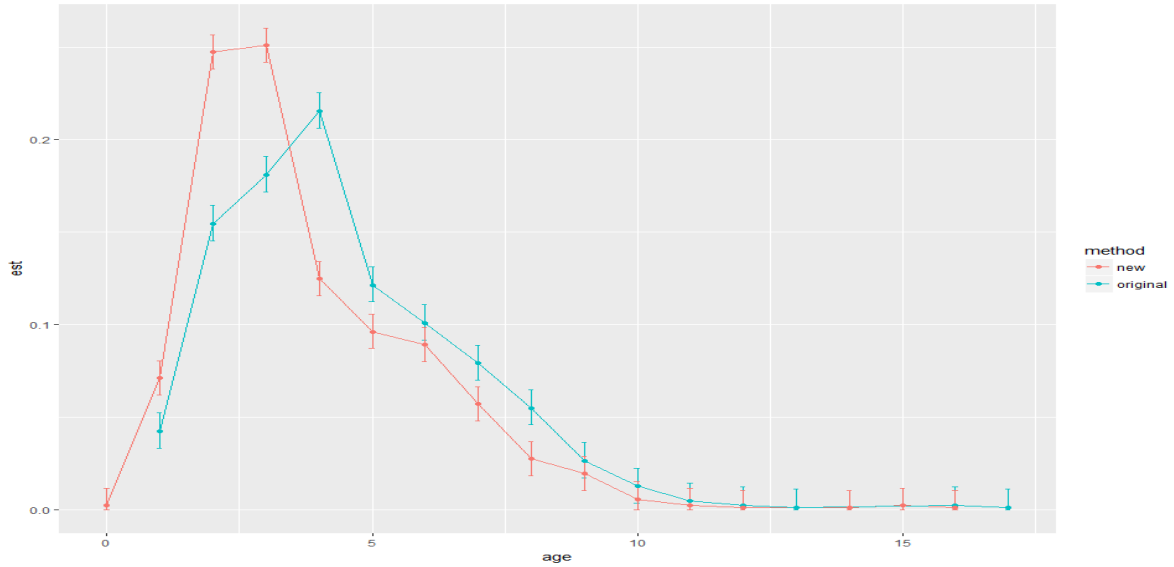

Figure 4. Comparison of nominal age frequencies of additional age data submitted to the 2006 update to SEDAR01 South Atlantic Red Porgy between original data and new age readings. Error bars represent 95% confidence intervals.

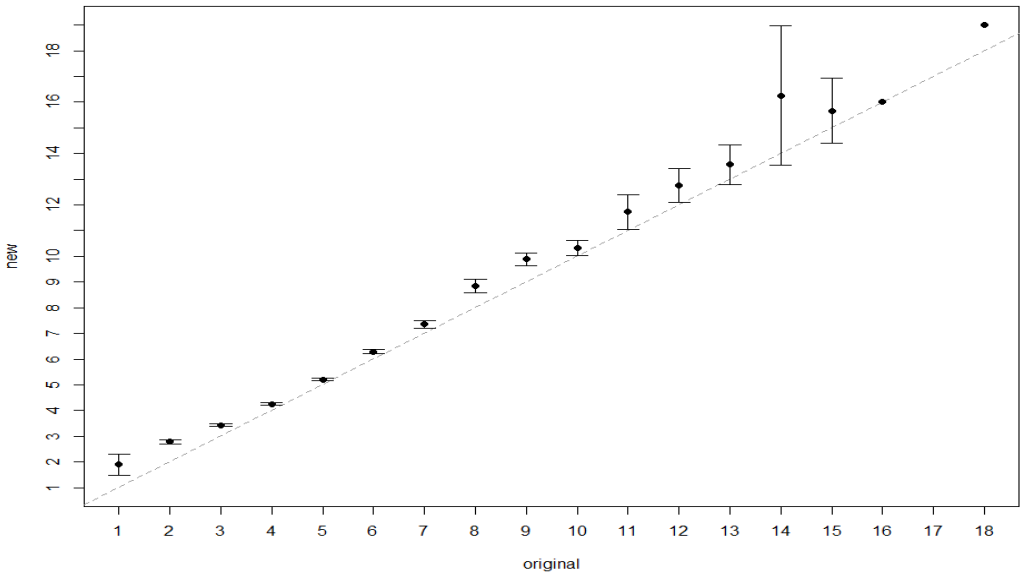

Figure 5. Bias plot of the additional South Atlantic Red Porgy age data submitted to the 2012 Update assessment of SEDAR01. The original data, represented by the 1:1 line, were compared to the new age readings based on an age validation study. The error bars represent the 95% confidence intervals about the new age readings.

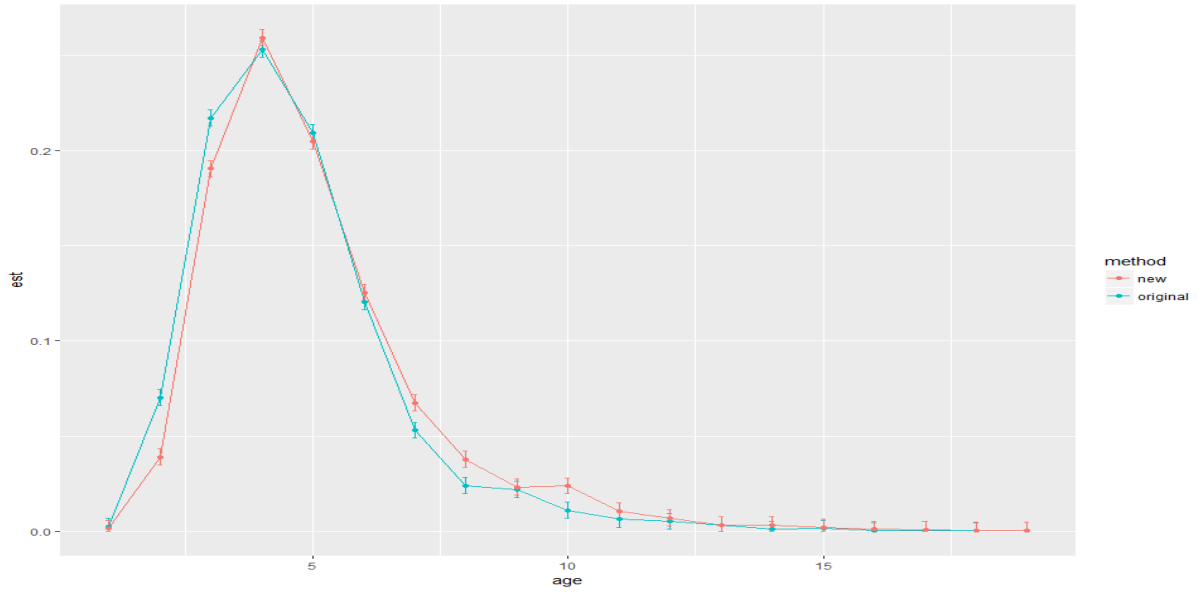

Figure 6. Comparison of nominal age frequencies of additional age data submitted to the 2012 update assessment of SEDAR01 South Atlantic Red Porgy between original data and new age readings. Error bars represent 95% confidence intervals.