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SEDAR68-DW-15

31 March 2020

Please cite this document as:

Ostrowski, Andrew D., Jennifer C. Potts, and Eric Fitzpatrick. 2020. Scamp (*Mycteroperca phenax*) age comparisons between aging labs in the Gulf of Mexico and South Atlantic. SEDAR68-DW-15. SEDAR, North Charleston, SC. 19 pp.

Scamp (*Mycteroperca phenax*) age comparisons between aging labs in the Gulf of Mexico and South Atlantic

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Abstract

To ensure aging consistency of scamp, *Mycteroperca phenax*, between labs in the Gulf of Mexico and South Atlantic, each lab read a calibration set and precision estimates were examined. Average percent error (APE), bias plots, and Evans Hoenig and Bowker symmetry tests were analyzed based on a previous working paper for red porgy (SEDAR60-WP03) and a paper by Rich McBride (2015) that analyzes the most appropriate way to look at age agreements and precision estimations. We describe the results of the calibration reads and use of ages in the assessment.

Background

Scamp, *Mycteroperca phenax*, and yellowmouth grouper, *Mycteroperca interstitialis,* complex is being assessed through Southeast Data, Assessment and Review (SEDAR) research track assessment for the entire southeast region (SEDAR 68). Scamp and yellowmouth grouper are so similar in appearance that they cannot be reliably distinguished. The preponderance of data for this assessment have been from scamp. Results from the Stock ID workshop indicate that is not enough information to reject homogeneity between the two management regions, South Atlantic (SA) and Gulf of Mexico (GOM) and should maintain the current SAFMC/GMFMC boundaries (See SEDAR 68 Stock ID Workshop Report, http://sedarweb.org/sedar-68-scamp-stock-id-process).

In order to ensure a consistency of aging between all the data providers, staff from all labs engaged in ageing Scamp met for an age workshop and established methodology for interpreting the macrostructure of the otoliths to assign ages. Following the age workshop, each lab contributed to a calibration set to be shared between readers: NOAA-NMFS Panama City Lab (NOAA-PC), the state of Florida's Fish and Wildlife Research Institute (FWRI), NOAA-NMFS Beaufort Lab (NOAA-BFT) and South Carolina Division of Natural Resources (SCDNR). The calibration set was representative of each lab's processing technique and included samples from the full age range, all months if possible, and across all sample gradients within the GOM and SA. In total, there was 400 samples in the calibration set, 200 samples from the GOM and 200 samples from the SA. Each lab was to assign ages, edge codes, and quality codes for the analysis.

Calibration set data were analyzed using average percent error (APE), age-bias plots, and Evans Hoenig and Bowker symmetry tests based on McBride (2015). All three methods are complementary and calculate precision, illustrate patterns, and evaluate bias among multiple estimations of individual samples. Based on the outcome, confidence in use of scamp ages for an assessment was evaluated.

Results

All age samples (n=400 total; n=200 from the GOM and n=200 from SA) were compared between individual reading labs: SCDNR v. FWRI, NOAA-PC v. FWRI, SCDNR v. NOAA-PC, NOAA-BFT v. FWRI, NOAA-BFT v. SCDNR, and NOAA-BFT v. NOAA-PC. APE, total agreement, agreement within one year and agreement within two years are presented in Table 1. APE ranged from 4.63 and 6.37%, direct agreement from 39.47-51.19%, agreement ±1 year 73.87-82.98% and agreement ±2 years 88.06-95.21%. Scamp are difficult to age fish, therefore, an APE of these ranges are satisfactory since acceptable APE's are 5% for other species of similar reading complexity (Campana 2001).

The bias plots between all readers showed no clear overaging or underaging bias among labs (Figs 1-12). For ages 0 – 10 years, which comprise the bulk of the age data sets, there were consistent age readings. For specimens aged 11 years or older were more highly variable (Figs. 1-12). The uncertainty in the oldest ages is not unusual as annuli can stack up and become difficult to enumerate.

The tests for symmetry indicate that the distribution of ages were significantly different between some readers, thus bias was occurring (Table 2). NOAA-PC was significantly different to NOAA-BFT and SCDNR, while NOAA-BFT was significantly different to SCDNR and SCDNR was significantly different to FWRI for the Evans Hoenig estimation. Utilizing the Bowker estimation, NOAA-PC was significantly different to SCDNR, while FWRI was significantly different to both NOAA-BFT and SCDNR. It was believed that the older ages in the calibration set were driving the results of the symmetry tests, since the age readings ranged more widely for a given sample compared to the samples aged ≤ 10 years.

The APE's improved and ranged from 4.11-6.03%, when looking at age ≤ 10, while percent agreement increased; 53.78-64.6%, 87.6-92.7%, and 97.6-99.7% for 0, ±1, ±2 years, respectively (Table 3). The bias plots showed no clear pattern of ageing error by either overaging or underaging when compared among readers (Figs 13-24). These results indicate strong precision among the ageing labs submitting data for the assessment.

The tests for symmetry were reanalyzed and indicated that there was a significant bias by FWRI to all other labs for both the Evans Hoenig and Bowker tests while SCDNR, NOAA-PC and NOAA-BFT were not significantly different to one another (Table 4). FWRI has just begun aging scamp and have the smallest data set, while the other three labs have been aging longer and have significantly larger data sets for the assessment.

Recognizing that each region (GOM v. SA) normally compares ageing precision, the calibration sets were further broken down by region specific samples and labs (NOAA-PC v. FWRI, NOAA-BFT v. SCDNR) and reanalyzed with all age samples included. APE and age agreement improved slightly between NOAA-BFT and SCDNR when compared to all samples in the calibration set, 4.24%, 54.59-95.4%, with still no significant differences in symmetry tests (Table 5). Similarly, there was little change between NOAA-PC and FWRI for APE and age agreement when compared to all samples in the calibration set. APE was 5.14%, while age agreements ranged from 49.17-88.94% with no significant differences in symmetry tests. The bias plots showed no clear pattern of ageing error by either overaging or underaging when compared among readers within a region (Figs 25-28). Samples aged ≤ 10

years had two few samples to make any valid analysis and therefore, were not included. Results indicate strong precision among the ageing labs within a region submitting data for the assessment.

Conclusion

The precision of scamp aging is high among the labs and the data provided in the assessment is of upmost quality. For the entire calibration set, APE's were low and there were no clear patterns of aging error between labs. Precision decreased in the older aged fish, however, it is not unprecedented, nor is it indicative of the whole sample set due to the low number of samples in the older age range (11+). Aging confidence is highest for ages 1-10. APE's decreased, there were still no clear patterns of aging error between labs, and the only significant symmetry differences occurred in one lab. When the results are taken as a whole, there are no outstanding issues to be concerned with and indicate our ability to age consistently among labs is high.

Literature Cited

Campana, S.E. Accuracy, precision and quality control in age determination, including a review of the useand abuse of age validation methods. J. Fish Biol. 2001, 59, 197–242.

McBride, R.S. Diagnosis of paired age agreement: a simulation of accuracy and precisions effects. ICES Journal of Marine Science, 2015, 72(7), 2149-2167.

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Tables

Table 1: Average Percent Error (%, APE) and percent agreement between labs (South Carolina (SC), Florida's Fish and Wildlife Research Institute (FWRI), NOAA-NMFS Panama City Lab (PC), and NOAA-NMFS Beaufort Lab (BFT)) for all samples in the data set.

	Age Agreement between labs-All samples					
(%)	**SCvFWRI**	**PCvFWRI**	**SCvPC**	**BFTvFWRI**	**BFTvSC**	**BFTvPC**
APE	5.38	5.28	5.72	6.13	4.63	6.37
0	44.74	51.19	47.12	40.05	50.27	39.47
±1	78.95	79.95	79.23	75.86	82.98	73.87
±2	90.48	92.09	89.76	88.06	95.21	87.47

Table 2: Evans Hoenig and Bowker Symmetry test results. Evans Hoenig results are located on the upper right of the table, Bowker results are lower left of the table. Significant differences are highlighted. South Carolina (SC), Florida's Fish and Wildlife Research Institute (FWRI), NOAA-NMFS Panama City Lab (PC), and NOAA-NMFS Beaufort Lab (BFT)

	All samples				
	PC	BFT	SC	FWRI	
PC		0.0006317	2.64E-04	0.358859	Evans Hoenig
BFT	0.073210747		0.5495266	1.05E-05	
SC	1.92E-02	0.7603332		5.54E-06	
FWRI	0.1975319	9.26E-02	4.95E-03		
	Bowker				

Table 3: Average Percent Error (%, APE) and percent agreement between labs (South Carolina (SC), Florida's Fish and Wildlife Research Institute (FWRI), NOAA-NMFS Panama City Lab (PC), and NOAA-NMFS Beaufort Lab (BFT)) for all samples aged ≤ 10 in the data set.

	Age Agreement between labs- Samples up to age 10					
(%)	**SCvFWRI**	**PCvFWRI**	**SCvPC**	**BFTvFWRI**	**BFTvSC**	**BFTvPC**
APE	4.7	5.1	5.1	5.39	4.11	6.03
0	58.3	64.61	60.47	53.78	61.11	54.13
±1	92.66	92.18	93.28	87.64	91.48	91.43
±2	98.84	98.76	97.63	97.6	98.95	99.69

Table 4: Evans Hoenig and Bowker Symmetry test results for samples aged ≤ 10 in the data set. Evans Hoenig results are located on the upper right of the table, Bowker results are lower left of the table. Significant differences are highlighted. South Carolina (SC), Florida's Fish and Wildlife Research Institute (FWRI), NOAA-NMFS Panama City Lab (PC), and NOAA-NMFS Beaufort Lab (BFT)

	Samples up to age 10				
	PC	BFT	SC	FWRI	
PC		0.1941381	0.3169234	0.0249763	Evans Hoenig
BFT	0.2991693		0.8079401	0.0011707	
SC	0.08377553	0.4646789		5.90E-04	
FWRI	0.023757941	0.0118498	1.18E-03		
	Bowker				

Table 5: Average Percent Error (%, APE), percent agreement, Evans Hoenig, and Bowker Symmetry test results between labs (South Carolina (SC), Florida's Fish and Wildlife Research Institute (FWRI), NOAA-NMFS Panama City Lab (PC), and NOAA-NMFS Beaufort Lab (BFT)) within a region for all samples from their respective regions.

	By Region-All samples	
	BFTvSC	**PCvFWRI**
APE (%)	4.24	5.141
0 (%)	54.59	49.17
±1 (%)	86.73	74.03
±2 (%)	95.4	88.94
Evans Hoenig	0.42	0.108
Bowker	0.73	0.15

Figures

Figure 1: Bias plot of NOAA-Beaufort (NOAA-BFT) ages of all samples in the calibration set compared to Florida's Fish and Wildlife Research Institute (FWRI). Sample size of each age group appears above graph.

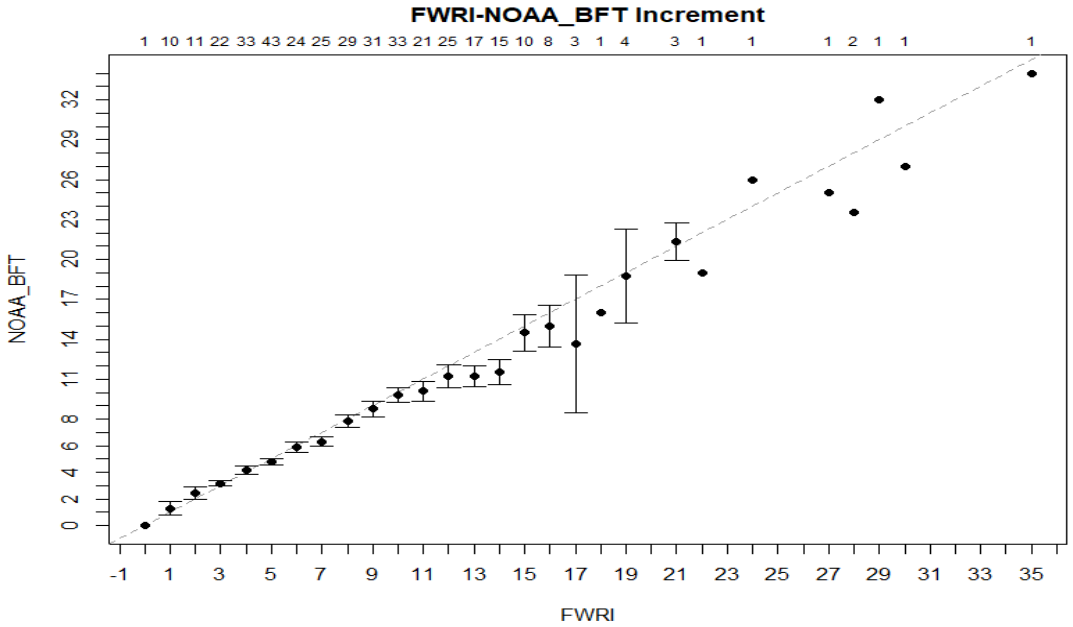

Figure 2: Bias plot of Florida's Fish and Wildlife Research Institute (FWRI) ages of all samples in the calibration set compared to NOAA-Beaufort lab (NOAA-BFT). Sample size of each age group appears above graph.

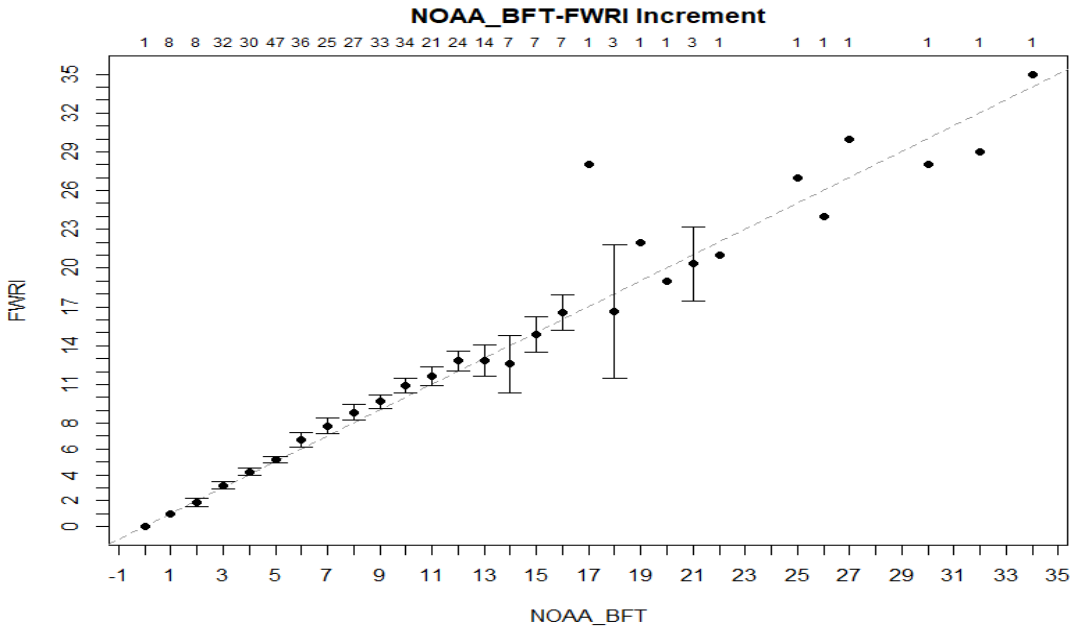

Figure 3: Bias plot of NOAA-Panama City (NOAA-PC) ages of all samples in the calibration set compared to Florida's Fish and Wildlife Research Institute (FWRI). Sample size of each age group appears above graph.

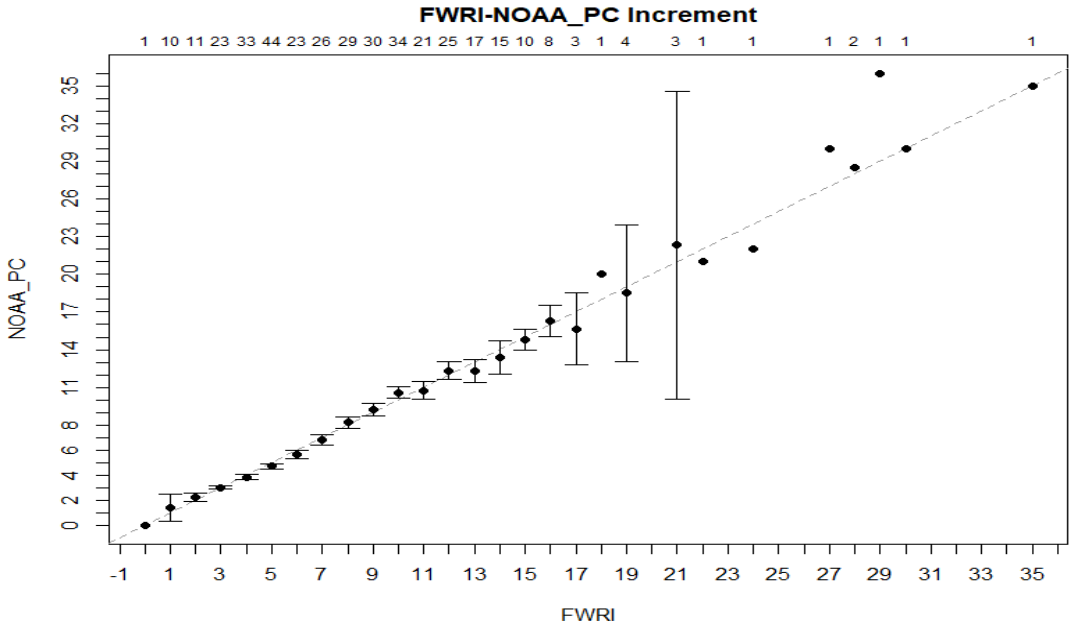

Figure 4: Bias plot of Florida's Fish and Wildlife Research Institute (FWRI) ages of all samples in the calibration set compared to NOAA-Panama City (NOAA-PC). Sample size of each age group appears above graph.

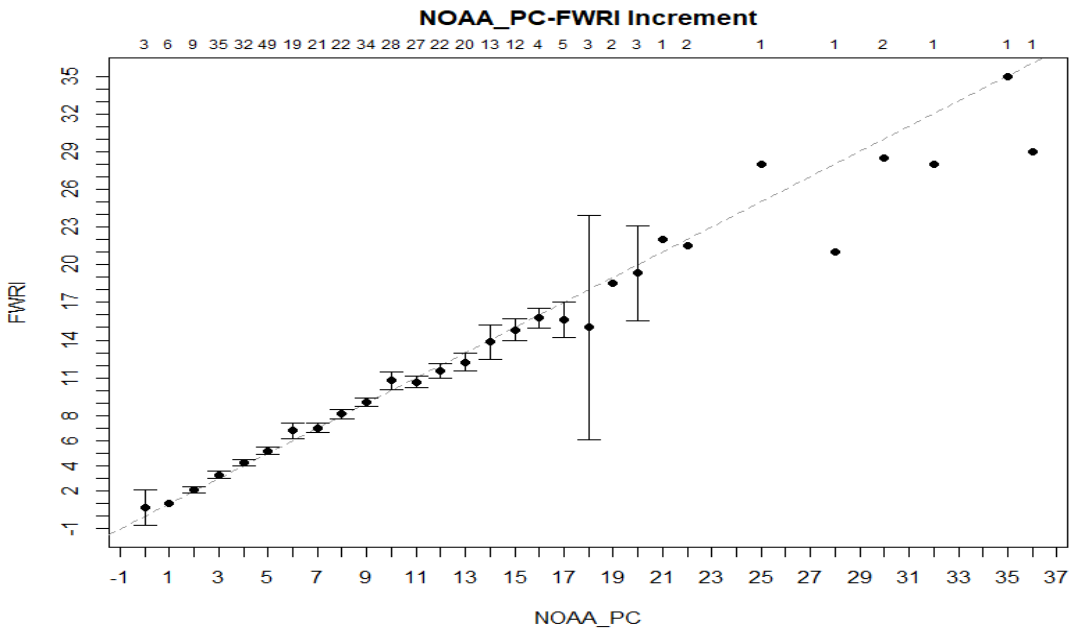

Figure 5: Bias plot of Florida's Fish and Wildlife Research Institute (FWRI) ages of all samples in the calibration set compared to South Carolina Division of Natural Resources (SCDNR). Sample size of each age group appears above graph.

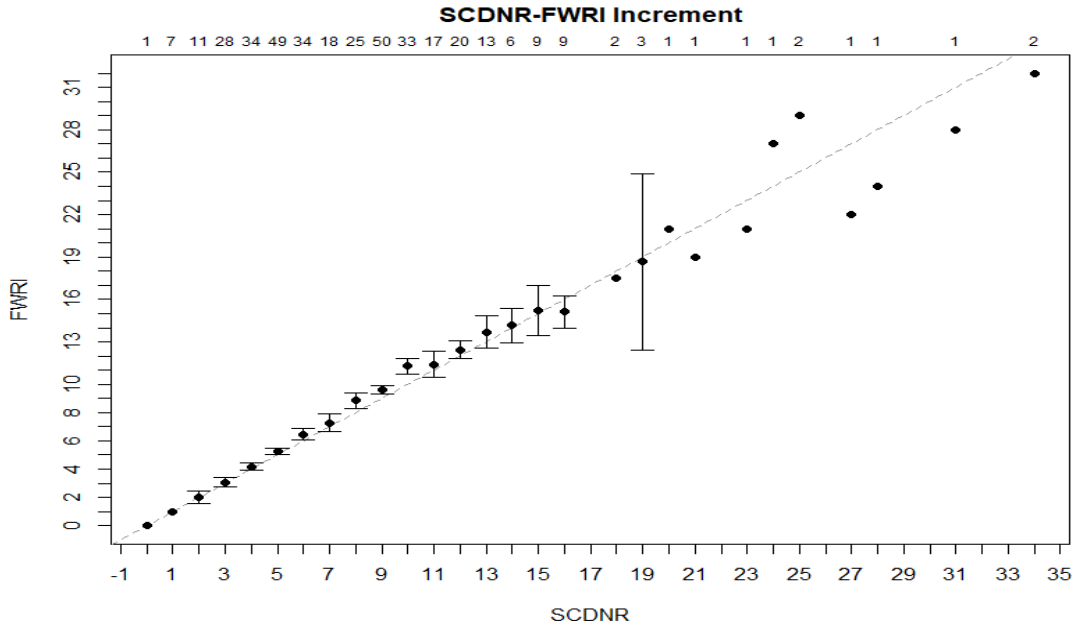

Figure 6: Bias plot of South Carolina Division of Natural Resources (SCDNR) ages of all samples in the calibration set compared to Florida's Fish and Wildlife Research Institute (FWRI). Sample size of each age group appears above graph.

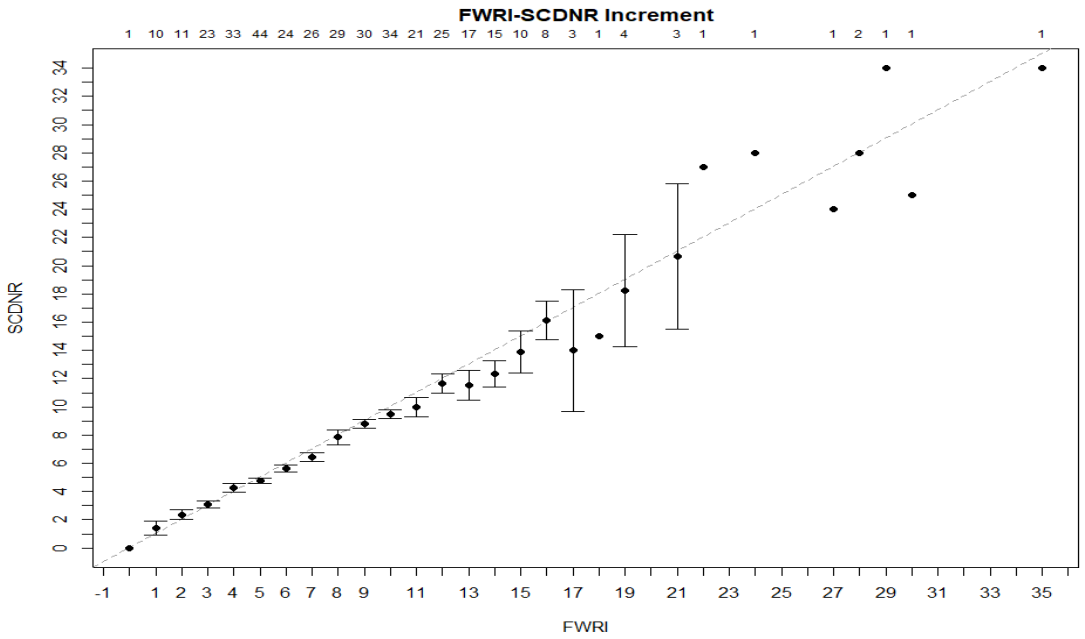

Figure 7: Bias plot of NOAA-Panama City (NOAA-PC) ages of all samples in the calibration set compared to NOAA-Beaufort (NOAA-BFT). Sample size of each age group appears above graph.

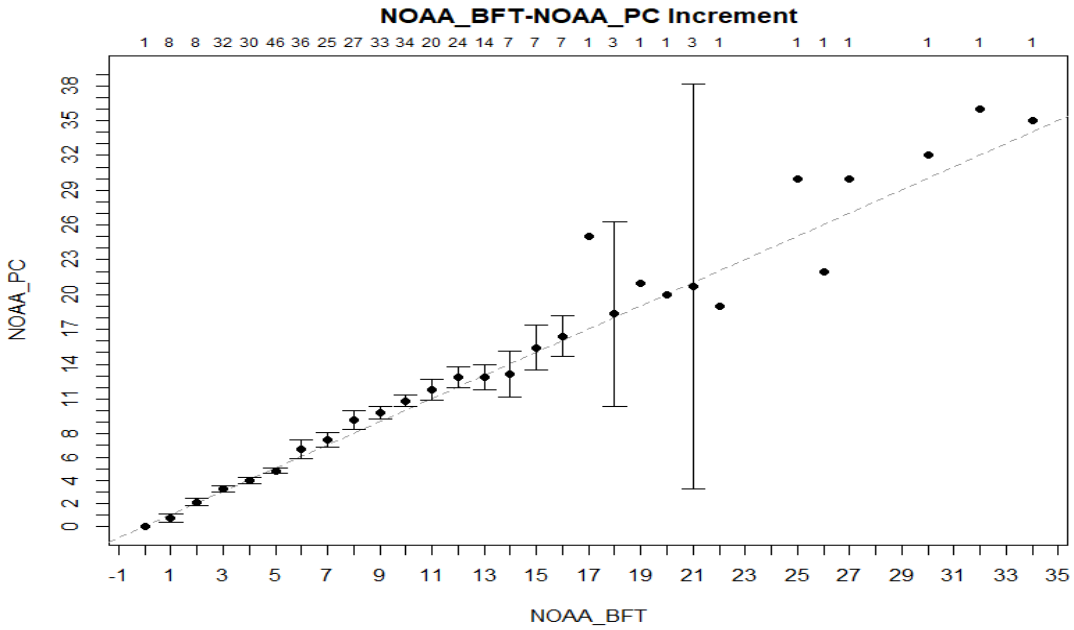

Figure 8: Bias plot of NOAA-Beaufort (NOAA-BFT) ages of all samples in the calibration set compared to NOAA-Panama City (NOAA-PC). Sample size of each age group appears above graph.

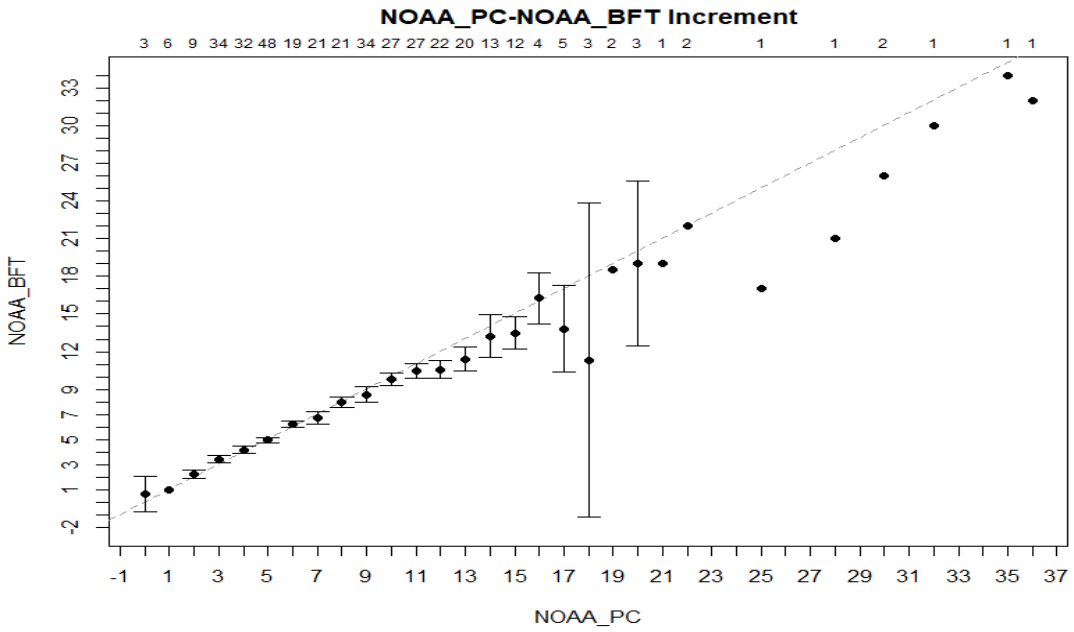

Figure 9: Bias plot of South Carolina Division of Natural Resources (SCDNR) ages of all samples in the calibration set compared to NOAA-Beaufort (NOAA-BFT). Sample size of each age group appears above graph.

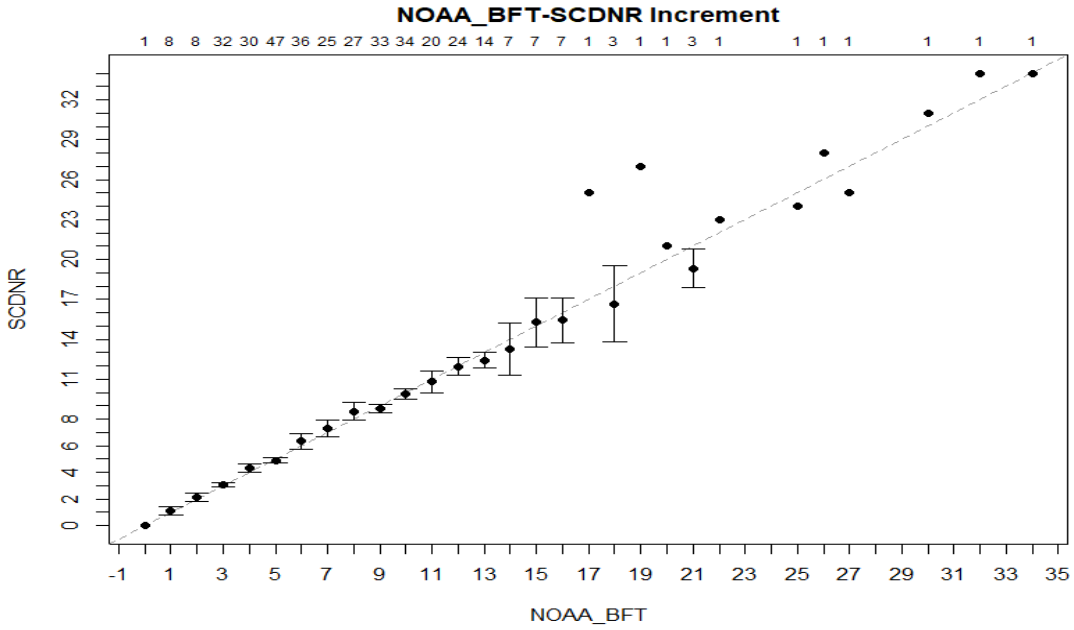

Figure 10: Bias plot of NOAA-Beaufort (NOAA-BFT) ages of all samples in the calibration set compared to South Carolina Division of Natural Resources (SCDNR). Sample size of each age group appears above graph.

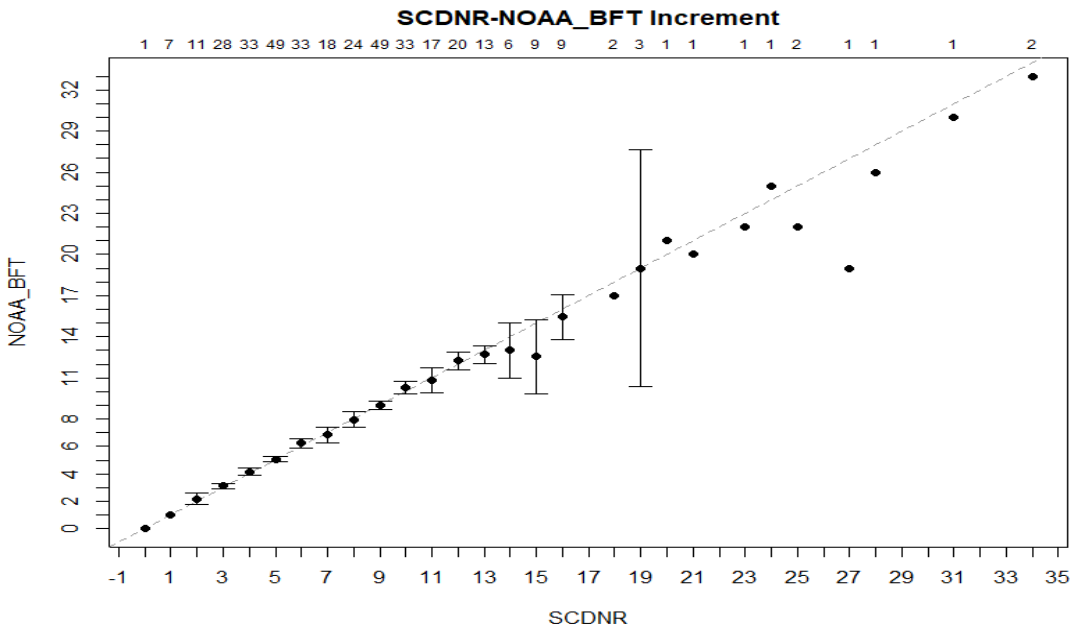

Figure 11: Bias plot of NOAA-Panama City (NOAA-PC) ages of all samples in the calibration set compared to South Carolina Division of Natural Resources (SCDNR). Sample size of each age group appears above graph.

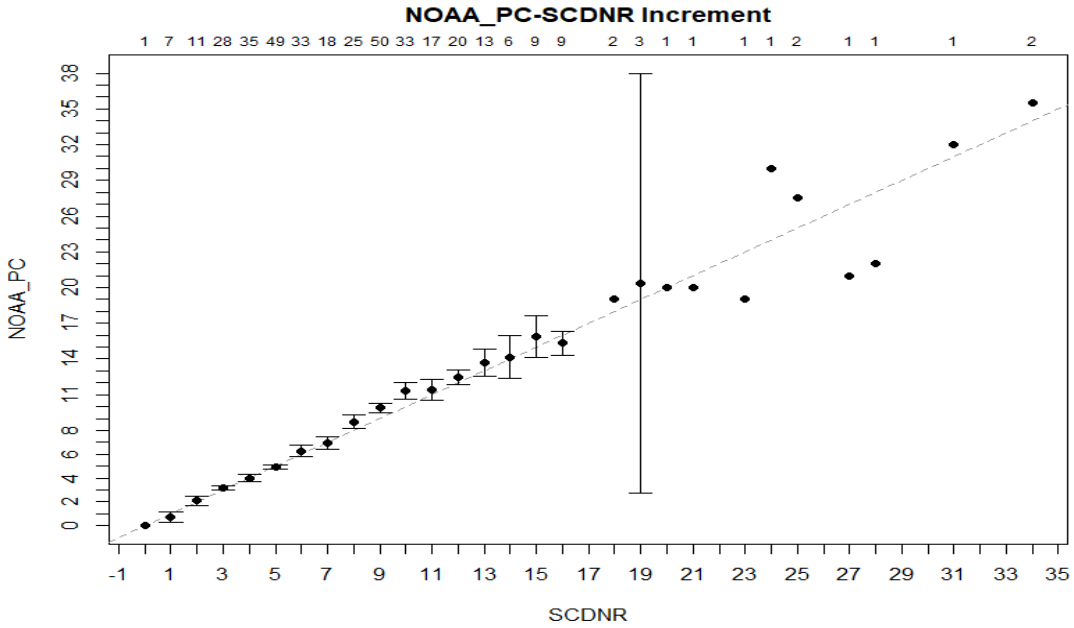

Figure 12: Bias plot of South Carolina Division of Natural Resources (SCDNR) ages of all samples in the calibration set compared to NOAA-Panama City (NOAA-PC). Sample size of each age group appears above graph.

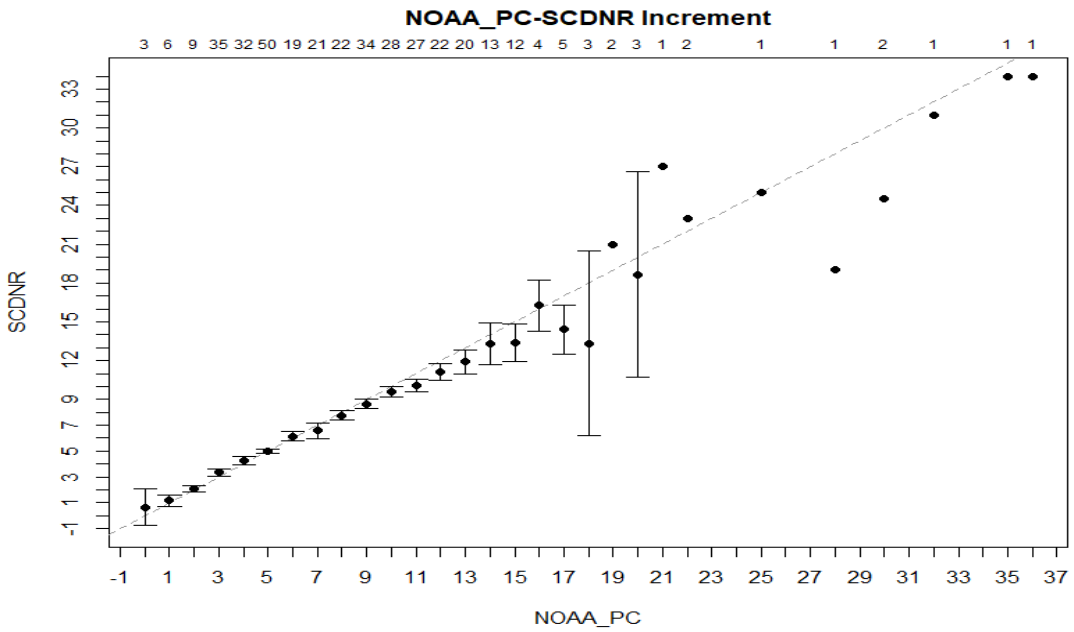

Figure 13: Bias plot of NOAA-Beaufort (NOAA-BFT) ages of all samples ≤10 in the calibration set compared to Florida's Fish and Wildlife Research Institute (FWRI). Sample size of each age group appears above graph.

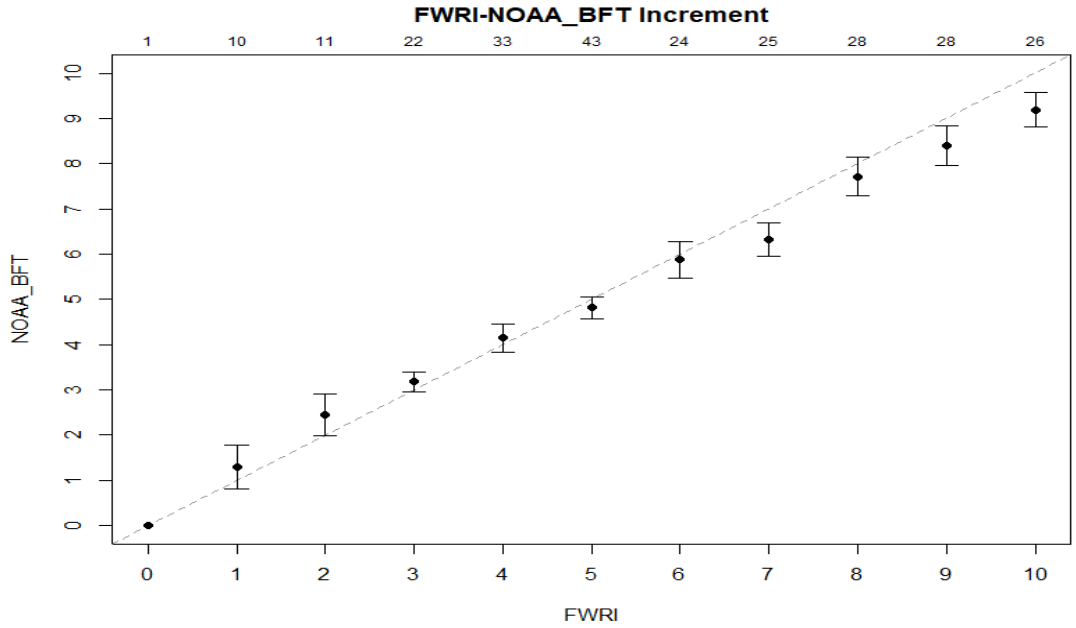

Figure 14: Bias plot of Florida's Fish and Wildlife Research Institute (FWRI) ages of all samples ≤10 in the calibration set compared to NOAA-Beaufort lab (NOAA-BFT). Sample size of each age group appears above graph.

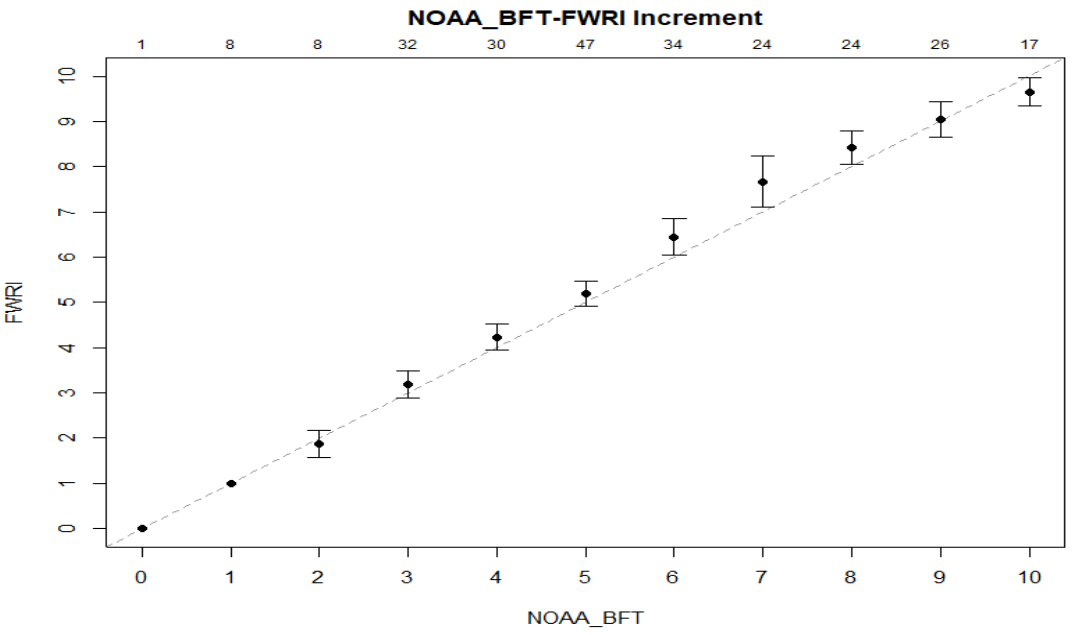

Figure 15: Bias plot of NOAA-Panama City (NOAA-PC) ages of all samples ≤10 in the calibration set compared to Florida's Fish and Wildlife Research Institute (FWRI). Sample size of each age group appears above graph.

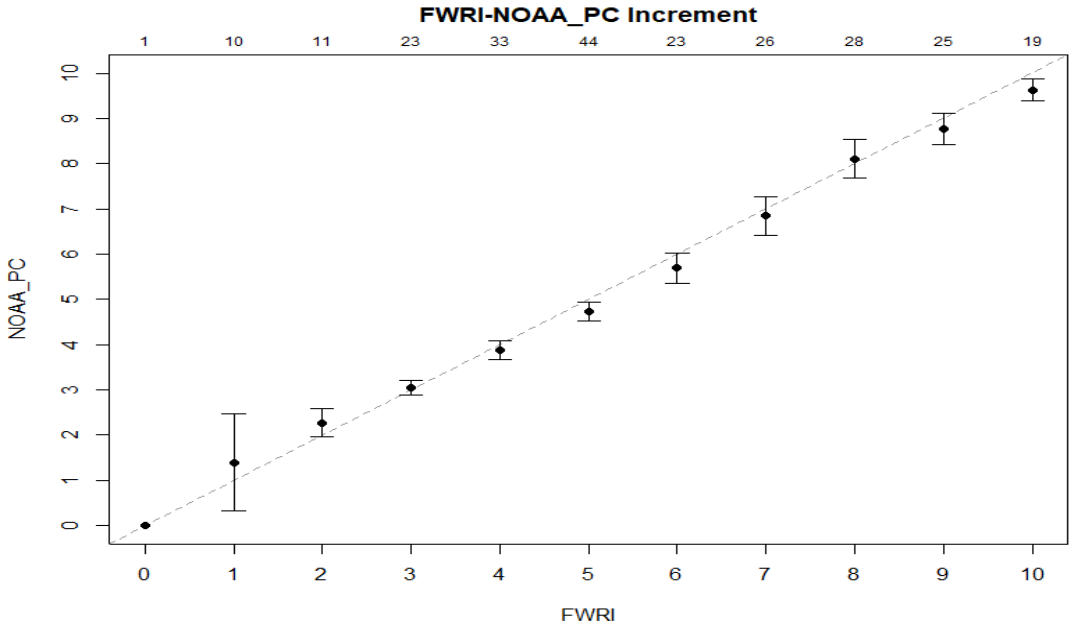

Figure 16: Bias plot of Florida's Fish and Wildlife Research Institute (FWRI) ages of all samples ≤10 in the calibration set compared to NOAA-Panama City (NOAA-PC). Sample size of each age group appears above graph.

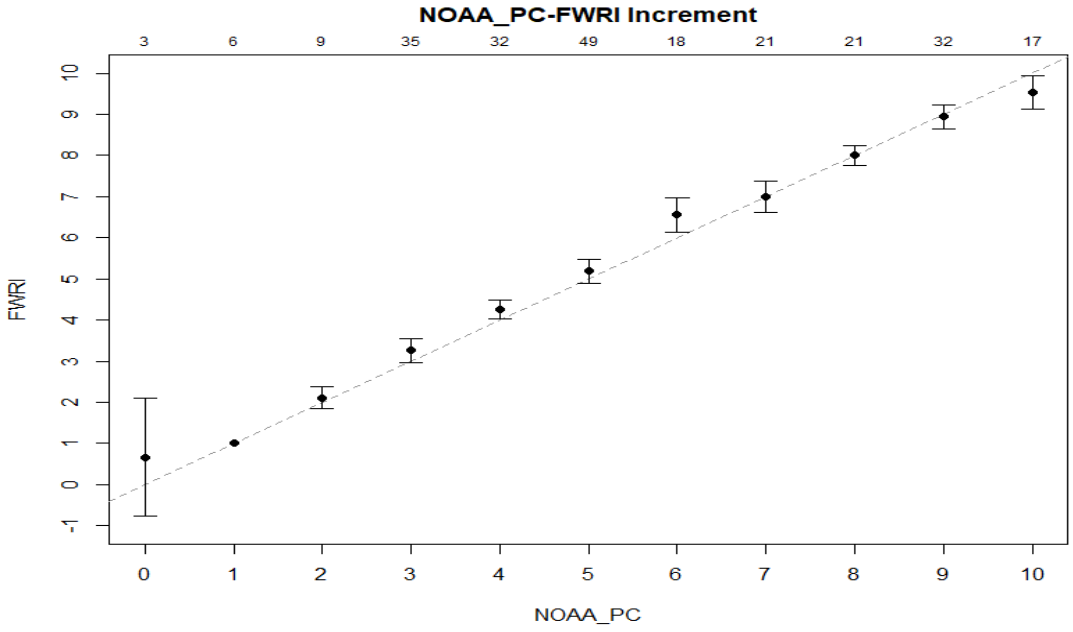

Figure 17: Bias plot of Florida's Fish and Wildlife Research Institute (FWRI) ages of all samples ≤10 in the calibration set compared to South Carolina Division of Natural Resources (SCDNR). Sample size of each age group appears above graph.

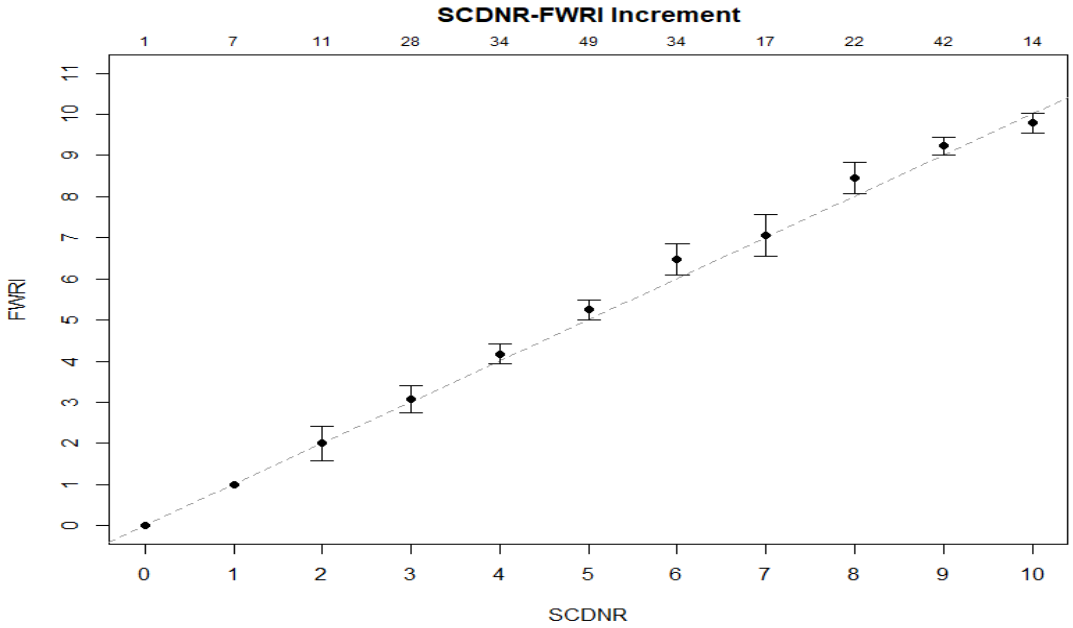

Figure 18: Bias plot of South Carolina Division of Natural Resources (SCDNR) ages of all samples ≤10 in the calibration set compared to Florida's Fish and Wildlife Research Institute (FWRI). Sample size of each age group appears above graph.

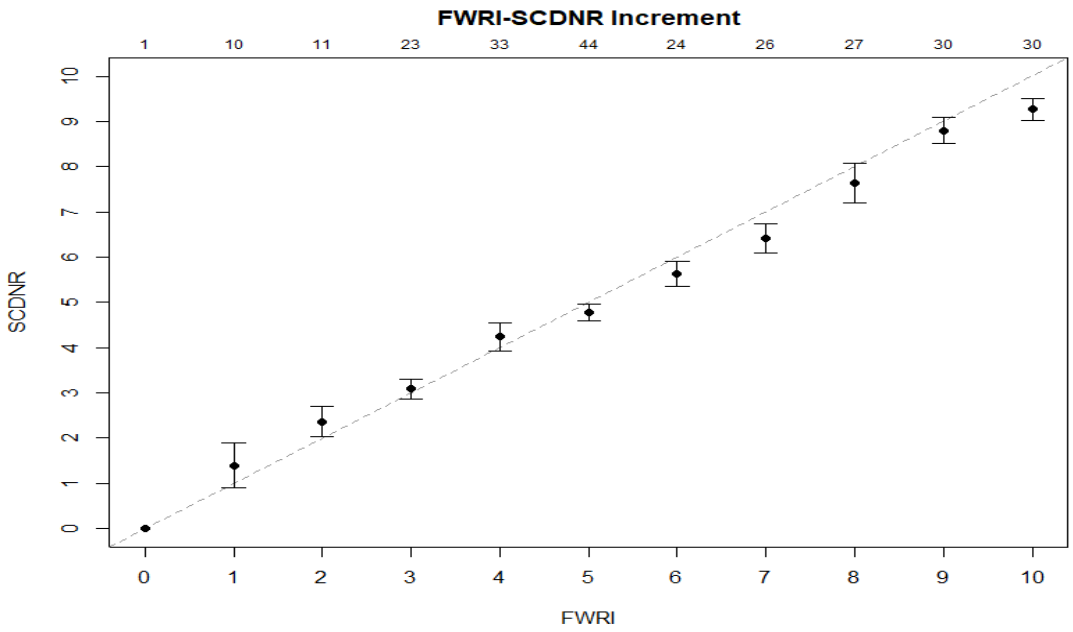

Figure 19: Bias plot of NOAA-Panama City (NOAA-PC) ages of all samples ≤10 in the calibration set compared to NOAA-Beaufort (NOAA-BFT). Sample size of each age group appears above graph.

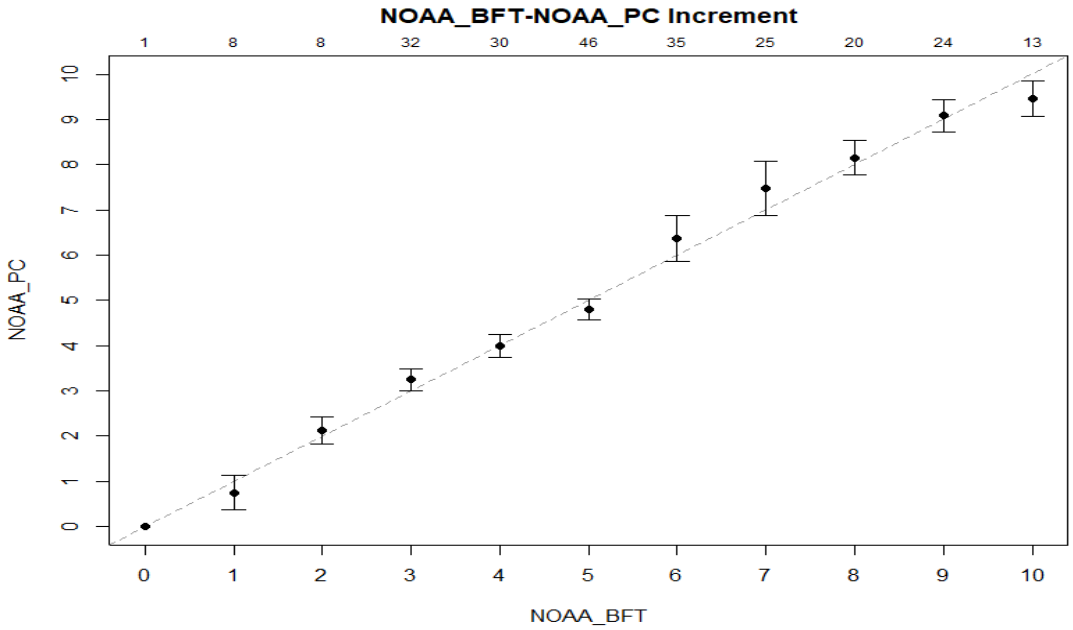

Figure 20: Bias plot of NOAA-Beaufort (NOAA-BFT) ages of all samples ≤10 in the calibration set compared to NOAA-Panama City (NOAA-PC). Sample size of each age group appears above graph.

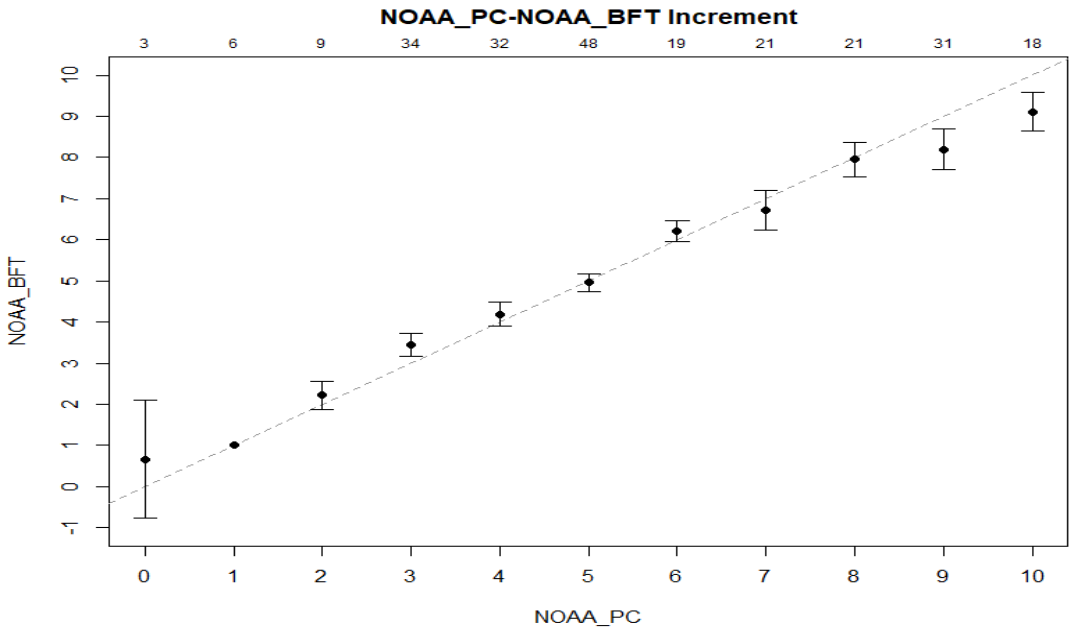

Figure 21: Bias plot of South Carolina Division of Natural Resources (SCDNR) ages of all samples ≤10 in the calibration set compared to NOAA-Beaufort (NOAA-BFT). Sample size of each age group appears above graph.

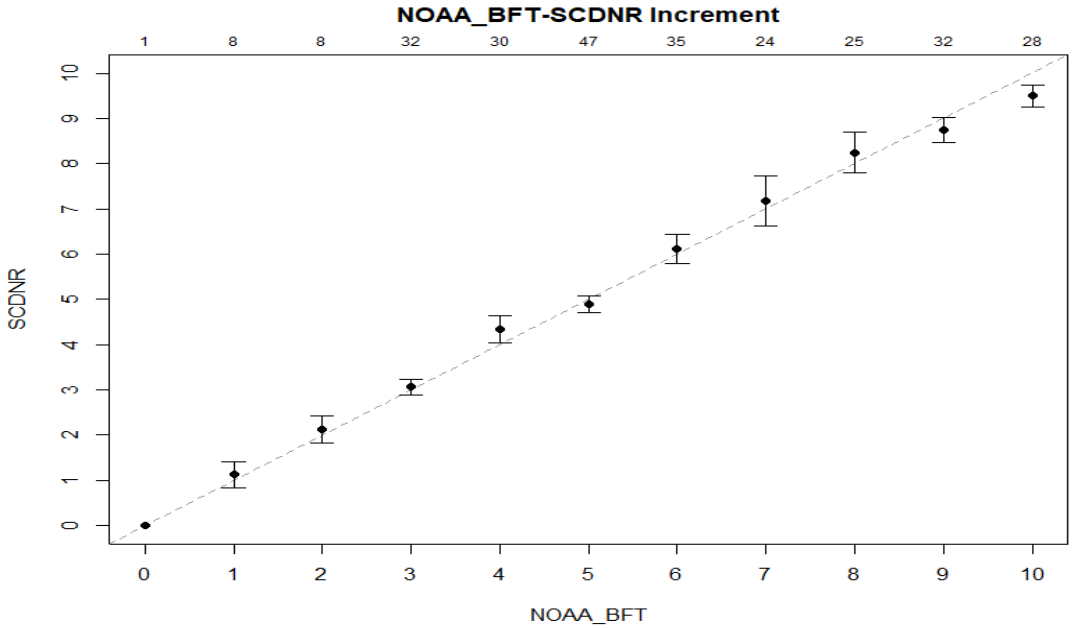

Figure 22: Bias plot of NOAA-Beaufort (NOAA-BFT) ages of all samples ≤10 in the calibration set compared to South Carolina Division of Natural Resources (SCDNR). Sample size of each age group appears above graph.

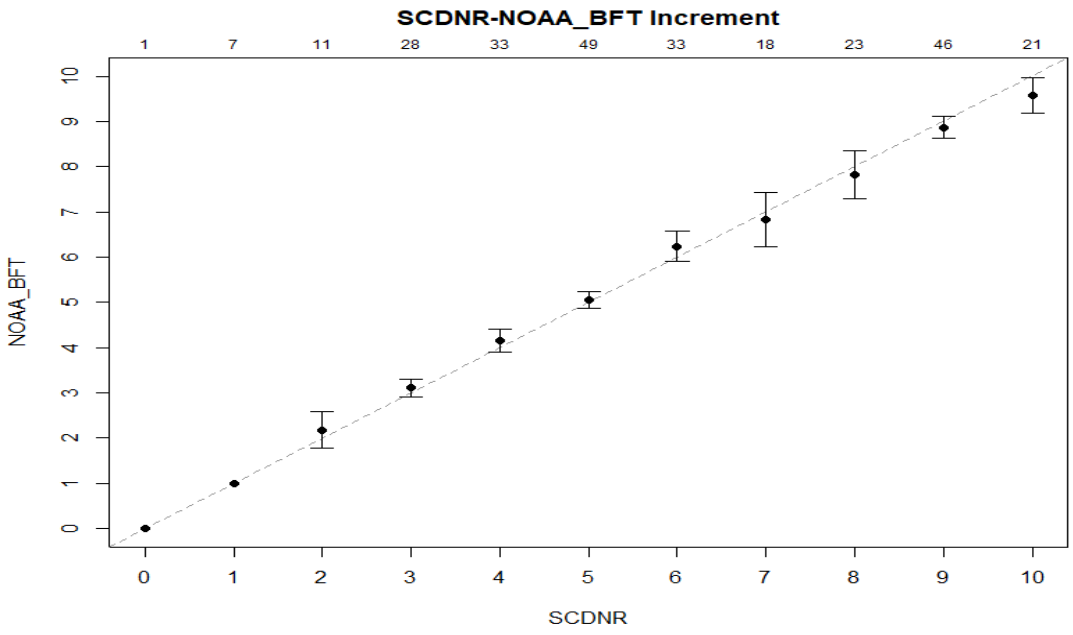

Figure 23: Bias plot of NOAA-Panama City (NOAA-PC) ages of all samples ≤10 in the calibration set compared to South Carolina Division of Natural Resources (SCDNR). Sample size of each age group appears above graph.

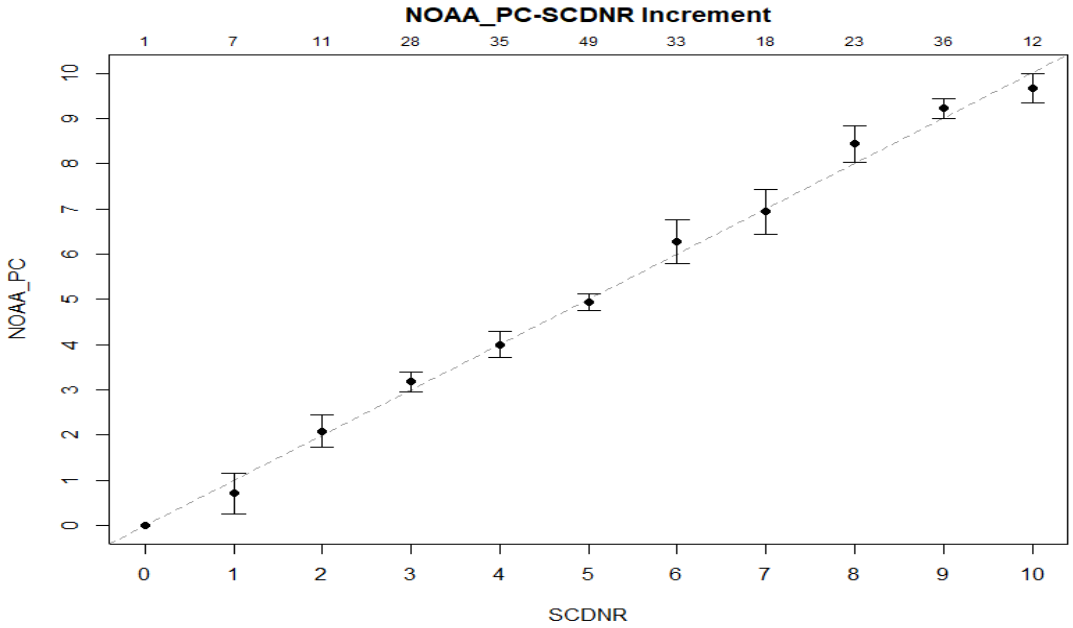

Figure 24: Bias plot of South Carolina Division of Natural Resources (SCDNR) ages of all samples ≤10 in the calibration set compared to NOAA-Panama City (NOAA-PC). Sample size of each age group appears above graph.

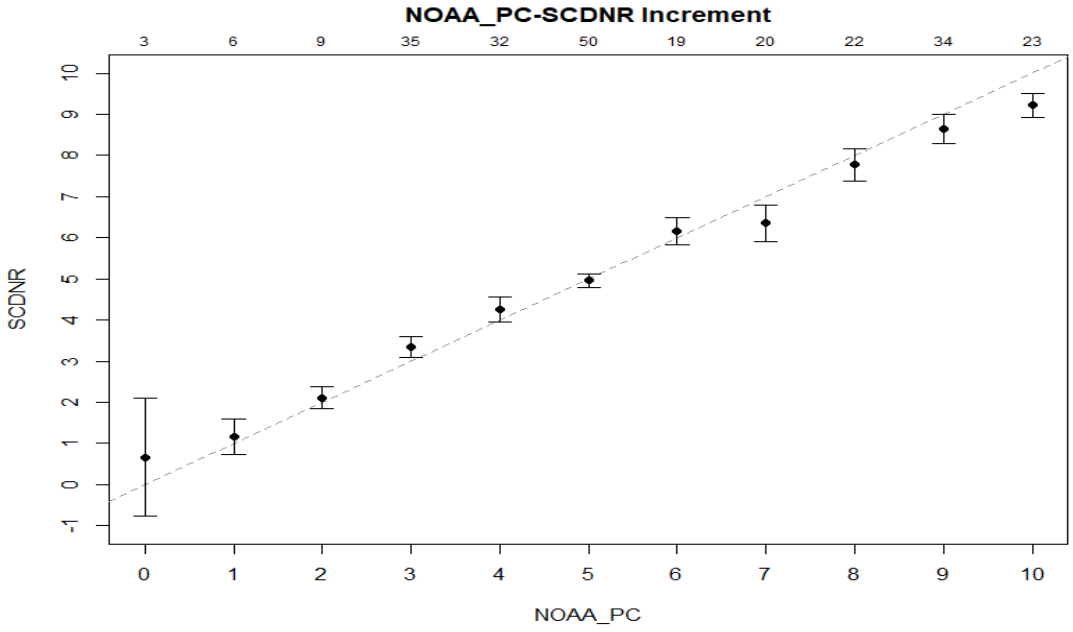

Figure 25: Bias plot of NOAA-Panama City (NOAA-PC) ages of appropriate regional samples in the calibration set compared to Florida's Fish and Wildlife Research Institute (FWRI). Sample size of each age group appears above graph.

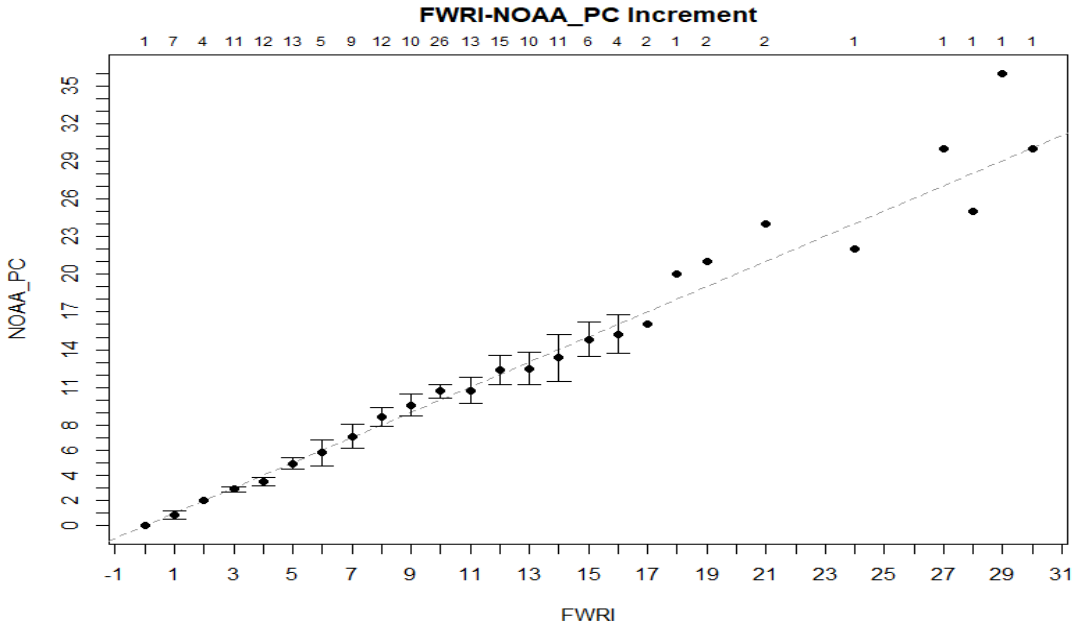

Figure 26: Bias plot of Florida's Fish and Wildlife Research Institute (FWRI) ages of appropriate regional samples in the calibration set compared to NOAA-Panama City (NOAA-PC). Sample size of each age group appears above graph.

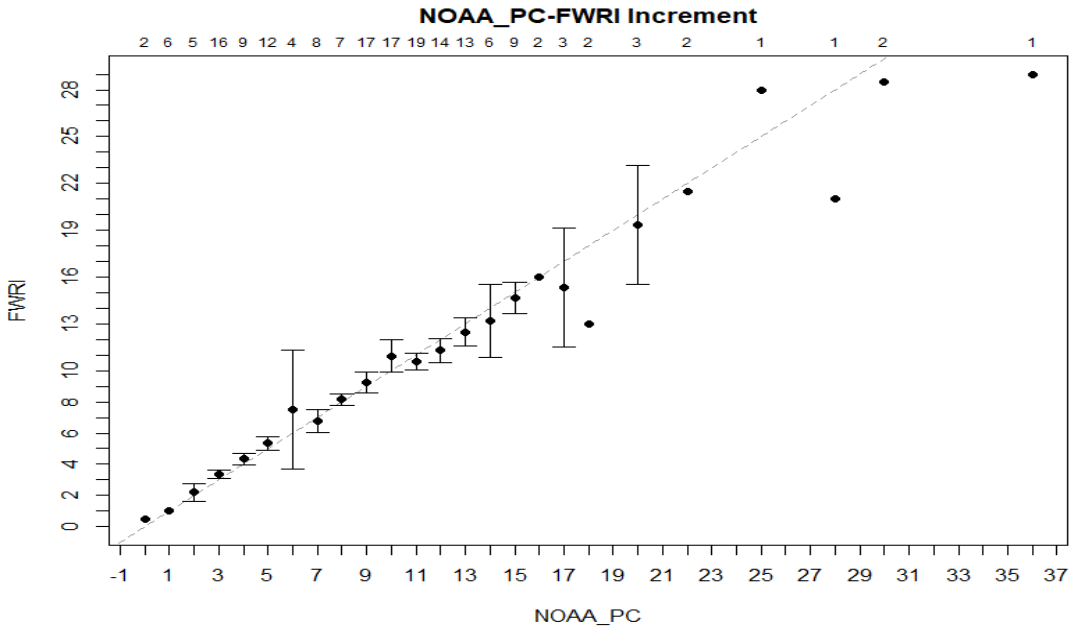

Figure 27: Bias plot of South Carolina Division of Natural Resources (SCDNR) ages of appropriate regional samples in the calibration set compared to NOAA-Beaufort (NOAA-BFT). Sample size of each age group appears above graph.

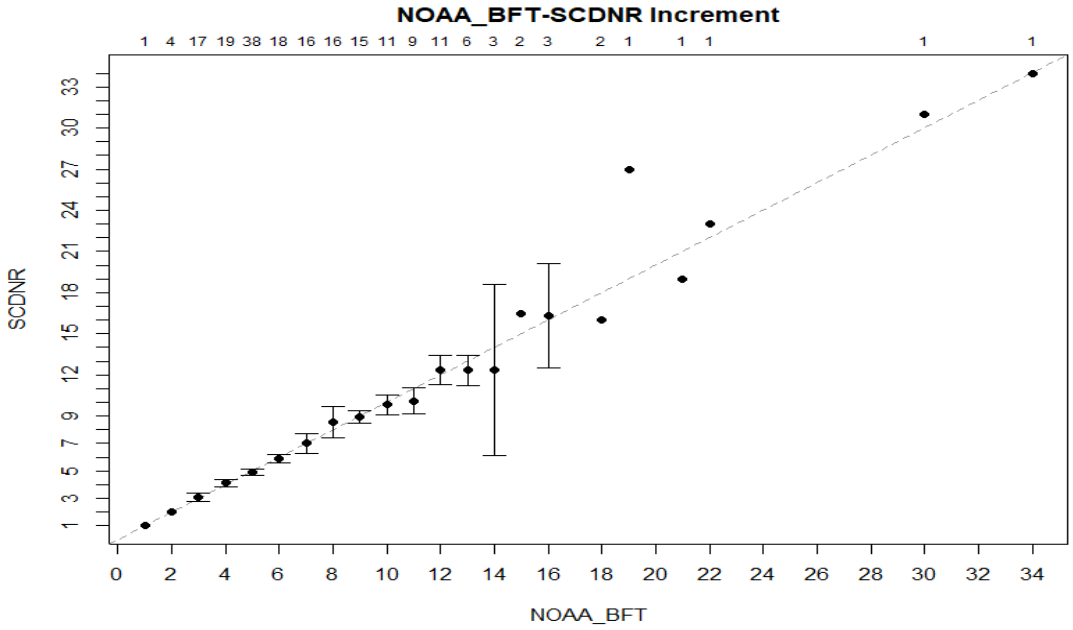

Figure 28: Bias plot of NOAA-Beaufort (NOAA-BFT) ages of appropriate regional samples in the calibration set compared to South Carolina Division of Natural Resources (SCDNR). Sample size of each age group appears above graph.