Ageing error matrices for SEDAR33: gag grouper and greater amberjack

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SEDAR33-AW22

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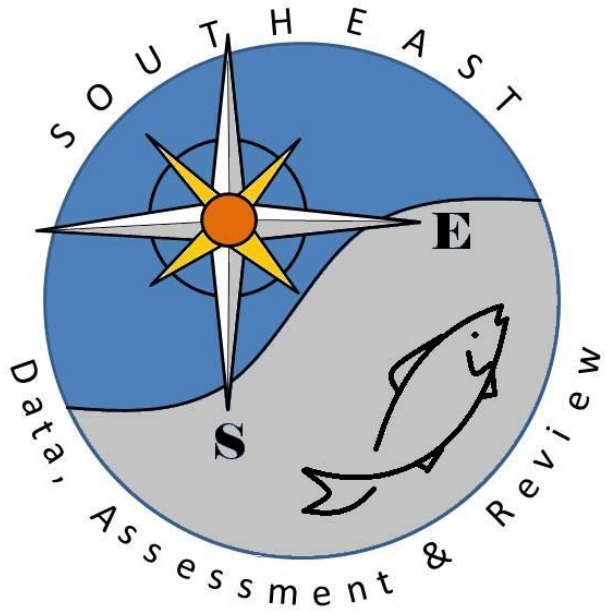

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Introduction

Determining sustainability in fish stocks relies on estimates of growth, age at maturity, longevity, natural mortality, and recruitment variability; all of which rely on an accurate estimate of age. In situations where age estimates are both imprecise and biased, an ageing error matrix can be incorporated into the modeling process (Methot 2000, 2009; Punt et al., 2008; Gertseva and Cope, 2011; Candy et al., 2012). It is recommended that a reference collection of known ages be routinely read by multiple readers from multiple ageing facilities to fully capture the imprecision and bias associated with traditional ageing estimations into the ageing error matrix. The reference collection needs to include samples that fully represent the range of ages (especially the older fish) and with sufficient sample sizes per age class to enable appropriate statistical analysis (Campana, 2001; Punt et al., 2008). The objectives of this report are to describe the reference collections used for calculating the ageing error matrices for gag grouper and greater amberjack and to provide the results of multiple ageing facilities and multiple readers variation.

Methods

Reference Collections

Gag Grouper

The gag grouper reference collection is composed of mostly whole sagittal otoliths (n=187) and a few thin sectioned sagittal otoliths (n=16). Otoliths were selected from the commercial (70%) and recreational sector (23%), as well as fishery independent surveys (6%). Gag otoliths were selected from a wide range of lengths (460-1300 mm FL) (Figure 1a) and ages (1-25 yr) (Figure 1b). A majority of the gag otoliths were collected from the west Florida shelf (92%). Gag grouper have mainly been aged by multiple readers (6) from the NMFS Panama City Laboratory (1979-2012) (Table 1). In more recent years (2006-2012), the Florida Fish and Wildlife Research Institute (FWRI) provided additional ages.

Greater Amberjack

Greater amberjack are aged using thin sectioned sagittal otoliths. The reference collection samples were randomly chosen from all available sections from the University of Florida and were randomly drawn to represent similar age proportions as observed in the fisheries with all gears combined (n=100). Otoliths were selected from greater amberjack from a wide range of lengths (500-1100 mm FL) and ages (1-8 yr) (Figure 2). Three ageing facilities contributed ages to SEDAR33. The University of Florida, Fisheries and Aquatic Sciences provided a majority of the ages (1980-2008) and the National Marine Fisheries Service, Panama

City Laboratory, and Louisiana Department of Wildlife and Fisheries provided ages in the more recent years (2009-2012) (Table 2).

Calculating Ageing Error

By including ageing error in the model process, the imprecision and bias associated with having multiple readers providing ages can be taken into consideration. Ageing error was estimated by calculating the standard deviation at age between pairs of readers or ageing facilities. For some years, more than 2 readers or ageing facilities provided ages and for these time periods an average standard deviation age among pairs of readers was calculated.

Results and Discussion

Gag Grouper

Calculating an overall ageing error matrix for gag grouper was difficult given the number of individual readers over time, the multiple ageing facilities, and the fact that not all otolith readers read the entire reference collection. The reference collection for gag grouper was created with gag collected in 2000, prior to this year ageing error was calculated using a proportion of the fish aged by both readers from a corresponding time period (e.g., 1979-1990, 200 gag collected in 1979-1980; 1991-1995, 800 gag collected in 1996). In addition, final reads of the reference collection for reader D. Fable were not completed; instead ageing error was calculated between D. Fable and G. Fitzhugh using 370 fish collected in 2009. In 2006, the Florida Fish and Wildlife Research Institute (FWRI) began to provide ages for gag collected in state fishery independent surveys. This ageing facility used thin sectioned otoliths to interpret age for gag, even though the standard is to use whole sagittal otoliths. Reader agreement and subsequent ageing error matrix between FWRI and G. Fitzhugh was based on 100 samples from the reference collection and 100 samples from FWRI (2006) (Figure 3a). For the years FWRI provided ages, the overall average ageing error was based on the 100 samples interpreted by all readers for those years (2007-2008, 2009-2012)(Figure 3a). There were similarities and low variability in the ageing error calculated per time period (based on different primary readers) for ages 2-8 (Figure 3a). The overall average ageing error does provide a good indication of imprecision for all years for ages 2-8 (Figure 3b).

Greater Amberjack

Ageing error was calculated between each pair of ageing facilities and an average ageing error among pairs of ageing facilities was calculated to estimate an overall average ageing error matrix (Figure 4a). Ageing error increased with age for each pair-wise comparison. Although not all ageing facilities aged greater amberjack for all years, the overall average ageing error does provide a good indication of imprecision for all years for ages 2-6 (Figure 4b).

Literature Cited

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Table 1. Multiple readers contributed gag grouper ages to SEDAR33. Listed are the percentages of age contribution by reader and by year (1979-2012). NMFS PC – National Marine Fisheries Service, Panama City Laboratory; FWRI – Florida Fish and Wildlife Research Institute

Year	A. Johnson NMFS PC	C. Gardner NMFS PC	G. Fitzhugh NMFS PC	B. Fable NMFS PC	L. Goetz NMFS PC	D. Fable NMFS PC	E. Crow NMFS PC	FWRI
1979-1990	55%	45%						
1991	72%		28%					
1992	67%		33%					
1993	85%		15%					
1994	84%		16%					
1995	83%		17%					
1996			100%					
1997			100%					
1998			40%	60%				
1999			100%					
2000			100%					
2001			100%					
2002				100%				
2003			100%					
2004			100%					
2005				80%			20%	
2006			97%					3%
2007			21%		75%			4%
2008			29%		51%		14%	7%
2009			4%			86%		11%
2010			5%			72%	10%	12%
2011			4%			40%	53%	4%
2012			2%				93%	5%

Table 2. Multiple ageing facilities contributed greater amberjack ages to SEDAR33. Listed are the percentages of age contribution by ageing facility and by year (1980-2012). UF - University of Florida, Fisheries and Aquatic Sciences, Gainesville, FL; LADWF - Louisiana Department of Wildlife and Fisheries, Baton Rouge, LA; NMFS PC - National Marine Fisheries Service, Panama City Laboratory.

Year	UF	LADWF	NMFS PC
1980	100%		
1981	100%		
1989	100%		
1990	100%		
1991	100%		
1992	100%		
1993	100%		
1994	100%		
1995	100%		
1996	100%		
1997	91%	9%	
1998	100%		
1999	100%		
2000	100%		
2001	100%		
2002	81%		19%
2003	89%		11%
2004	100%		
2005	100%		
2006	100%		
2007	99%		1%
2008	95%		5%
2009		41%	59%
2010		73%	27%
2011		69%	31%
2012		78%	22%

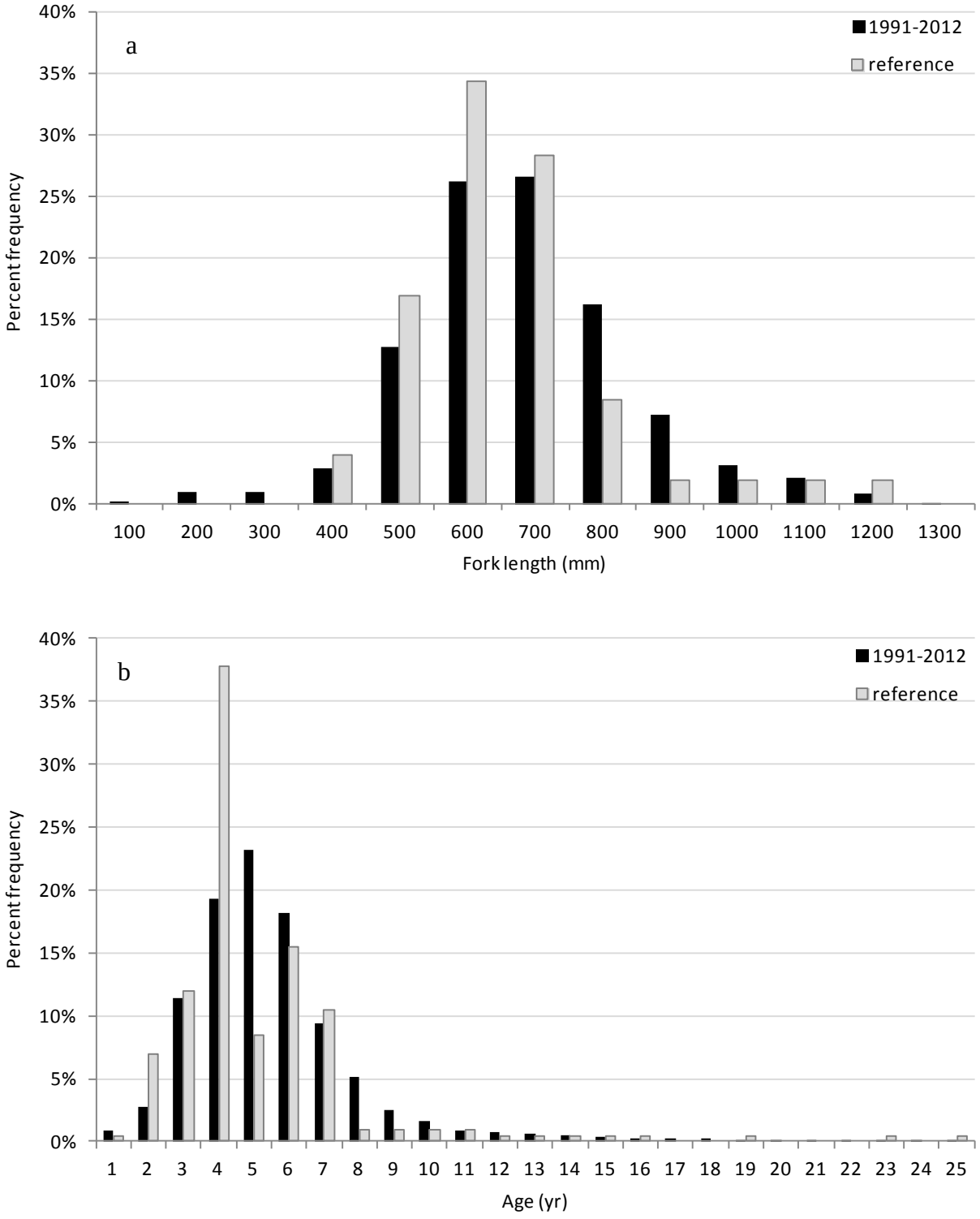

Figure 1. Comparison of the (a) length and (b) age frequency between the gag grouper reference collection samples versus all the data used in SEDAR33.

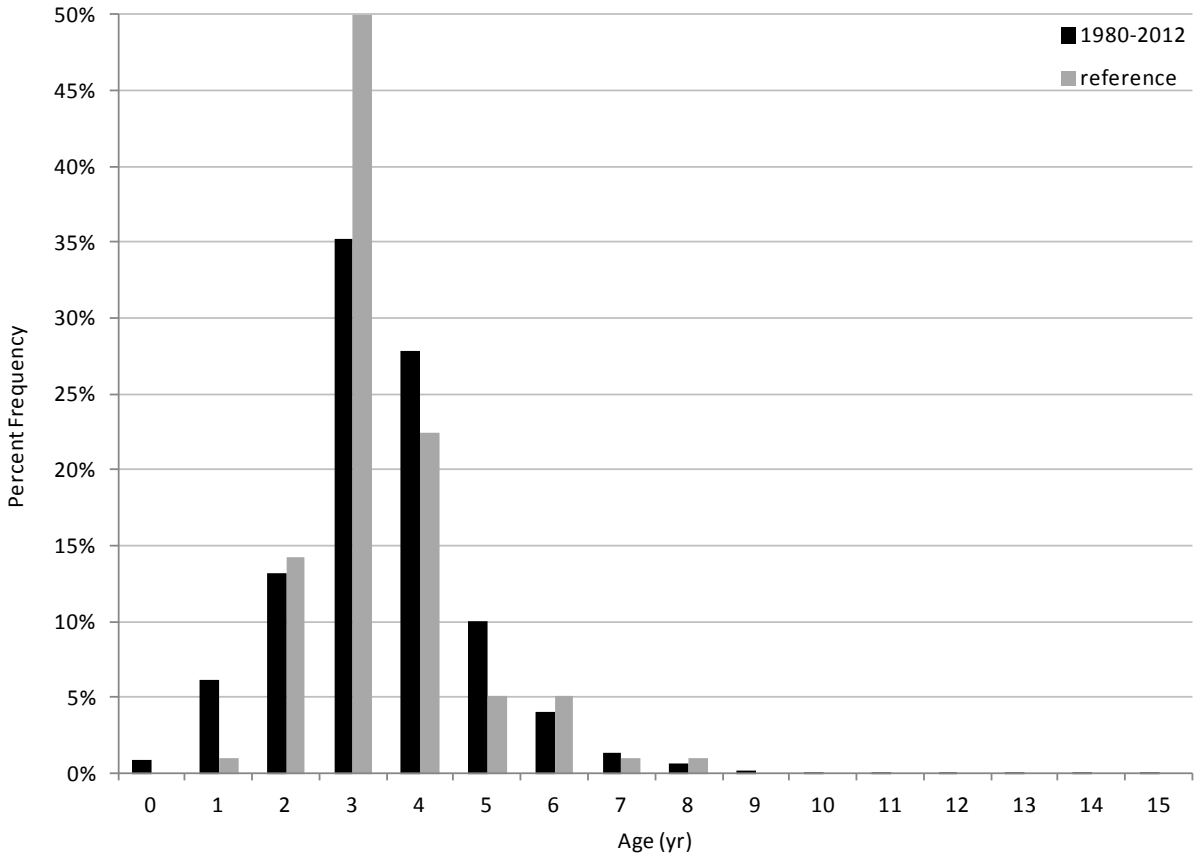

Figure 2. Comparison of the age frequency between the greater amberjack reference collection samples versus all the data used in SEDAR33.

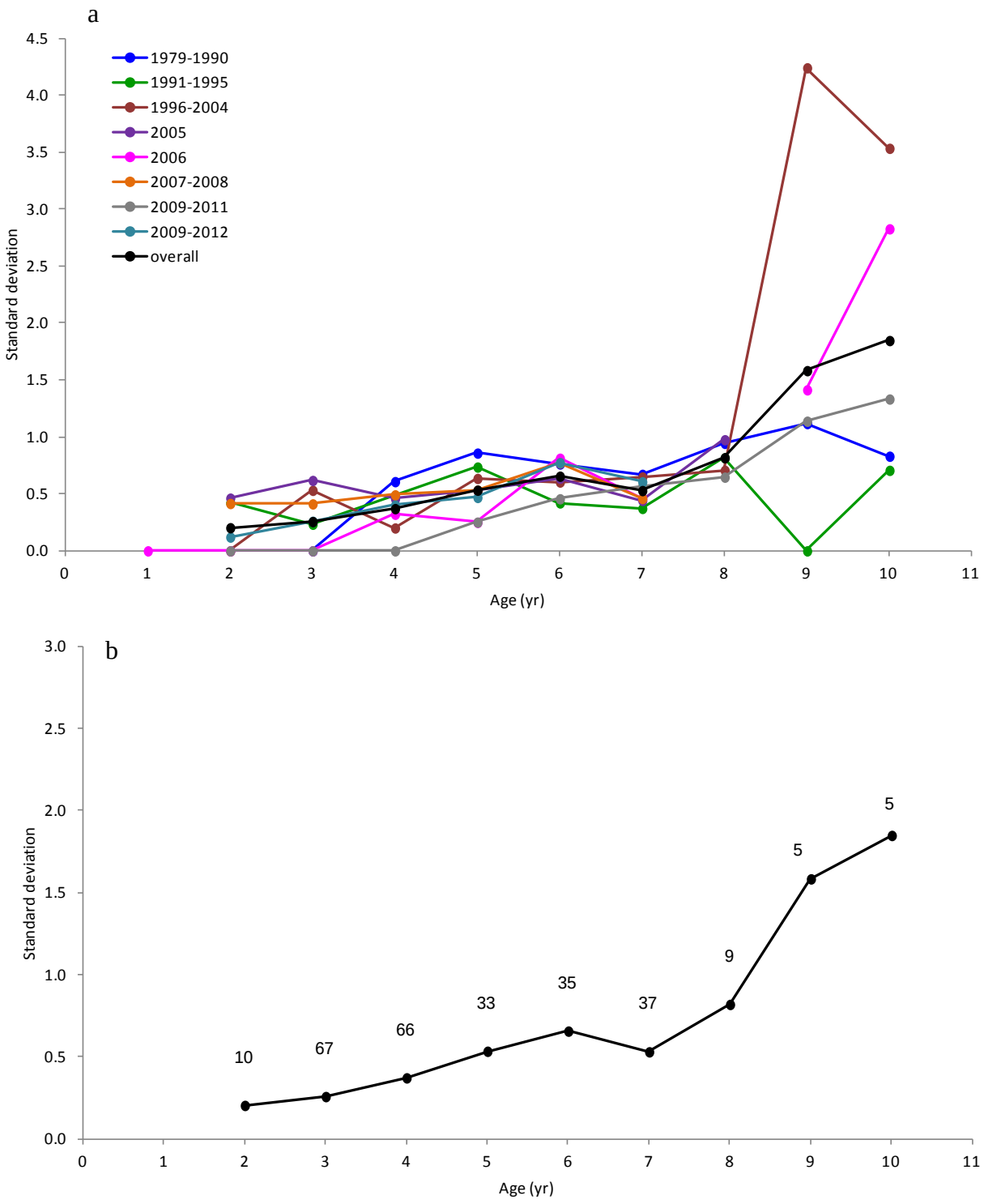

Figure 3. Standard deviation by age for gag grouper by (a) particular time periods that reflect changes in primary reader and (b) overall average for all time periods and readers/ageing facilities (sample sizes above data points).

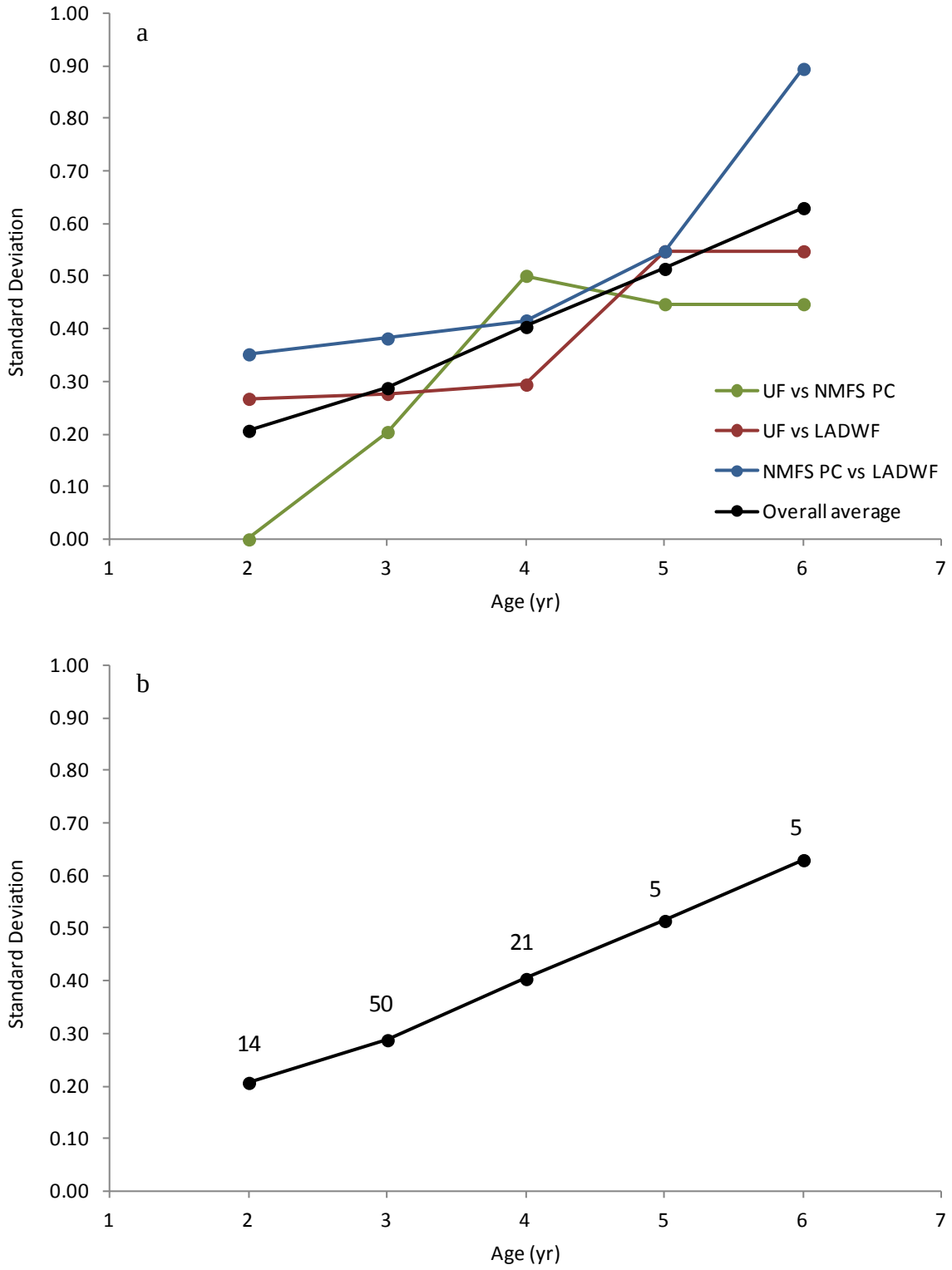

Figure 4. Standard deviation by age for greater amberjack by (a) pairs of ageing facilities (see Table 2 for abbreviations) and (b) overall average for all time periods and ageing facilities (sample sizes above data points).