Update of Red Porgy, *Pagrus pagrus*, Reproductive Life History from the MARMAP/SERFS program.

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Addendum added: 10 January 2020

** Addendum added to reflect changes made during the SEDAR assessment process. The final female maturity recommendation is found on Page 21. **

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Introduction

The Red Porgy, *Pagrus pagrus*, is a protogynous sparid distributed throughout the Atlantic Ocean and Mediterranean Sea, in depths from 18 to 280 m (Manooch and Hassler 1978; Vassilopoulou and Papaconstantinou 1992). Along the Atlantic coast of the southeastern U.S., Red Porgy inhabit reefs (live bottom *sensu* Struhsaker 1969) on the middle to outer continental shelf and shelf-break (Grimes et al. 1982). Red Porgy in the northwestern Atlantic are thought to constitute a single stock (Manooch and Huntsman 1977) but are separate from those in the northeastern and southwestern Atlantic (Ball et al. 2003). Red Porgy are winter spawners, with the peak of spawning season being January through March (Farmer et al. 2017). Notable plasticity in the growth as well as reproductive parameters, such as size and age at female maturity and size and age at transition, has been documented (Harris and McGovern 1997; SEDAR-1 Update 2012).

Landings of Red Porgy in the commercial fishery off the Atlantic coast peaked in 1982 and were at a minimum in 2000 due to a 1-year moratorium that started in September 2009 (SEDAR-1 Update 2006). A variety of regulations have been implemented since the moratorium. Landings from 2007 through 2017 have been relatively consistent, averaging 116,200 lb in North Carolina through Georgia (Pers. comm., NOAA Fisheries, data queried 16 October 2019, www.fisheries.noaa.gov/topic/resources-fishing#commercial-fishing). The total allowable catch (TAC) has been split equally between the commercial and recreational sectors since February 2010. Recreational landings initially dominated the total landings of Red Porgy, averaging almost 90% during 1972–1975 (SEDAR-1 Update 2006). Annual landings decreased to approximately 25% of the total landings during 1982-1998 (SEDAR-1 Update 2006), and have averaged 45% since 2010 (Pers. comm., National Marine Fisheries Service (NMFS), Fisheries Statistics Division, data queried 21 October 2019, www.fisheries.noaa.gov/topic/resources-fishing#recreational-fishing). In 2006, the stock off the Atlantic coast was assessed to be overfished, but not undergoing overfishing (SEDAR Update, 2006). The most recent stock assessment took place in 2012 and showed no change in the stock status – the stock is overfished but not undergoing overfishing (SEDAR-1 Update 2012).

Since 1972, The Marine Resources Monitoring, Assessment and Prediction program (MARMAP) has conducted fishery-independent and fishery-dependent research on reef fish species off the continental shelf and shelf edge between Cape Hatteras, North Carolina, and St. Lucie Inlet, Florida. In 2008, with a first field season in 2009, the SouthEast Area Monitoring and Assessment Program, South Atlantic Region (SEAMAP-SA) provided supplemental funding to expand the geographical sampling coverage of the MARMAP fishery-independent chevron trap survey. In 2010, the Southeast Fishery-Independent Survey (SEFIS), located at the Southeast Fisheries Science Center in Beaufort, NC, further expanded the geographical coverage of the reef fish survey and video cameras were added to the trap to provide additional information. Collectively, these three surveys to monitor reef fish are now referred to as the SouthEast Reef Fish Survey (SERFS).

Although fishery-independent catch-per-unit-effort data from the chevron video trap survey indicate an increase in relative abundance of Red Porgy in the early to mid-2000s (Bubley and Smart 2019), data from 2008-2017 are mostly near historical low values. Since reproductive parameters were last provided for an assessment (SEDAR-1 Update, 2012), three additional years (2012, 2014, and 2016) of samples collected by SERFS have been evaluated, with the latter two years representing the largest sample sizes in the history of the chevron video trap survey conducted by SERFS.

Objective

The purpose of the present study is to provide current estimates of reproductive parameters (i.e., age at maturity and age at sex transition) for an on-going Standard Assessment. The analyses were conducted on data from the period 2012-2016. In both analyses, the reproductive parameter was related to two definitions of age (increment count and calendar age). In addition to the current estimates, this report presents prior period-specific estimates of the parameters based on primarily fishery-independent data collected during 1979-2011. Data presented in this report are based on a query of the combined MARMAP/SERFS database on November 21, 2018.

Methods

Survey Design and Gear

(see MARMAP 2009 and Smart et al. 2015 for full description of MARMAP/SERFS survey design and gear)

<u>Sampling area</u> - chevron video trap

- Cape Hatteras, NC, to St. Lucie Inlet, FL
  - General increase in sampling intensity (# of annual chevron trap deployments) through time
  - Gradual shift regarding the spatial coverage of samples through time (Bubley and Smart 2019)
    - Sampling south of 30^{o} N started in 1997
    - Sampling between Cape Lookout and Cape Hatteras started in 2012
- Sampling depths range from 9 to 109 m
  - Generally less than 100 m

<u>Sampling season</u> - chevron video trap

- May through September
  - Limited earlier and later sampling in some years

<u>Survey Design</u> - chevron video trap

- Simple random sample survey design
  - Annually, randomly selected stations from a chevron video trap universe of confirmed live-bottom and/or hard-bottom habitat stations
  - No two stations are randomly selected that are closer than 200 m from each other
    - Minimum distance is typically closer to 400 m

<u>Primary Sampling Gear</u> – Chevron video trap
(see Collins 1990 for description with additional details)

- Arrowhead shaped, with a total interior volume of 0.91 m^3
- Constructed of 35 x 35 mm square mesh plastic-coated wire with a single entrance funnel ("horse neck")
- Baited with a combination of whole or cut clupeids (*Brevoortia* or *Alosa* spp., family Clupeidae), with *Brevoortia* spp. most often used
  - Four whole clupeids on each of four stringers suspended within the trap
  - Approximately 8 clupeids placed loose in the trap

- Soak time of approximately 90 minutes
- Sampling with this gear started in 1988 but data from 1988 and 1989 considered preliminary

Data Filtering/Inclusion

- Projects coordinated by MARMAP/SERFS (Table 1)
  - P05/T59/T60 – MARMAP/SEAMAP-SA/SEFIS
  - P50 – Port Sampling (Fishery-Dependent)
- Gear (Table 2)
  - 043 – Hook-and-line (rod and reel; snapper reel)
  - 053 - Blackfish trap
  - 074 - Florida Antillean trap
  - 324 - Chevron trap

Summary tables were generated for fish collected and processing for life history samples per project and gear type by year (Tables 1 and 2). Data analyses were performed using Statistical Analysis System (SAS) software (SAS Institute 1989).

<u>Reproductive data</u>

Following specimen capture and dissection, the posterior portion of the gonads was fixed for 14 days in a 10-11% seawater–formalin solution buffered with marble chips and then transferred to 50% isopropanol for 7–14 days. Reproductive tissue was processed in automated tissue processors and blocked in paraffin. Three transverse sections (6–8 um thick) were cut from each sample with a rotary microtome, mounted on glass slides, stained with double-strength Gill hematoxylin, and counterstained with eosin-y.

Sections were viewed under a compound microscope (20 to 400X) by two readers without knowledge of specimen length, specimen age, and date/location of capture. The readers independently determined sex and reproductive phase using histological criteria (Table 3) described by Harris and McGovern (1997) and Harris et al. (2004); terminology follows a recent review by Brown-Peterson et al. (2011). If the assessments differed between readers, the section was viewed jointly by the readers. If disagreement on sex and/or reproductive phase persisted, the specimen was eliminated from reproductive analyses. To ensure that females were correctly assigned to the immature and regenerating categories, the length frequency histogram of females that were definitely mature (i.e., were developing, spawning capable, or regressing) was compared with the histograms for females assessed as immature and regenerating/early developing. Early developing ovaries exhibited the presence of cortical alveolar oocytes (CAO). Females of uncertain maturity were excluded from all reproductive analyses (Wyanski et al., 2000).

Specimens with developing, spawning, regressing, or regenerating gonads were considered sexually mature (Brown-Peterson et al. 2011). For females, this definition of maturity included specimens with oocyte development at or beyond the cortical alveolar stage. To estimate age at 50% maturity (A50), the PROBIT procedure (SAS Institute, Inc., 1990) was used. The LOGISTIC procedure was used to determine which model (Gompit, Logit, or Probit) provided the best fit to maturity data. The selected model had the lowest Akaike information criterion (AIC; Akaike, 1973).

Juvenile females were excluded from sex ratio analyses to restrict data to the adult population (Coleman et al., 1996), and adult specimens undergoing sex transition (female to male) were considered males because these specimens would likely have spawned as males in the next spawning season (Sadovy and Shapiro, 1987). The small percentage of juvenile females undergoing sex transition was also excluded to improve model fit and for consistency with all previous SEDAR Red Porgy assessments.

- Data filtering to include only adults of known sex fish
  - Exclude fish with unknown sex (Sex = 9) or with germ cells that were undifferentiated (Sex = 0)
  - Exclude juvenile females undergoing sex transition (Sex=8)
  - Exclude fish with an unknown reproductive phase (Mat = 9) or the gonads were inactive and a reproductive phase could not be assessed (Mat = 0)

Age at maturity was estimated for 9 periods that were defined by sampling gear and in some cases changes in management regulations during a period. Given the high degree of plasticity in life history characteristics exhibited by Red Porgy, especially growth rate and age at maturity, the length of periods was restricted to 4-5 years.

- 1979-1983: blackfish trap, Florida Antillean trap, and hook-and-line (rod and reel; snapper reel)
- 1984-1987: blackfish trap, Florida Antillean trap, and hook-and-line (rod and reel; snapper reel)
- 1988-1989: chevron trap, preliminary data (see Smart et al., 2015)
- 1990-1994: chevron trap; 1 Jan 1992 – commercial gear restrictions, 12” TL size limit
- 1995-1998: chevron trap
- 1999-2002: chevron trap; 24 Feb 1999 – 14” size limit, bag limit of 5 per person per day, no harvest in Mar and Apr; Sep 1999 to Aug 2000 – moratorium; 22 Sep 2000 – no harvest in Jan through Apr, 50 lb commercial trip limit, bag limit of 1 per person per day
- 2003-2006: chevron trap
- 2007-2011: chevron trap; 23 Oct 2006 – commercial quota implemented, commercial trip limit shifted to 120 fish, bag limit of 3 per person per day/trip; 15 Feb 2010 – commercial quota increases, recreational quota established, 50% allocation to each sector
- 2012-2016: chevron trap

Sex ratio at age was estimated for two periods defined by gear type, and for periods combined for consistency with the methodology of the previous assessment (SEDAR-1 Update, 2012).

- 1979-1987: blackfish trap, Florida Antillean trap, and hook-and-line (rod and reel; snapper reel)
- 1988-2016: chevron trap

Results

Reproduction

Correct assignment of female Red Porgy collected during 2012-2016 to the immature and regenerating/CAO categories is indicated by the near-overlap in the length histograms for definitely mature (i.e., developing, spawning capable, or regressing) and regenerating/CAO specimens, and by the modest overlap in the histograms for immature and regenerating/CAO specimens (Fig. 1A). The 128 specimens categorized as being of uncertain maturity were similar in size to the immature females (Fig. 1B), which confirmed the expectation that it would be more difficult to assess reproductive phase in inactive females with smaller (vs. larger) gonads. We also noted evidence of juvenile sex transition (i.e., female to male) in 3% (36 of 1393) of all females undergoing transition (Fig. 2).

The LOGISTIC procedure determined that the Logit link produced the lowest AIC value for 6 of 9 periods in the analysis of calendar age at maturity. Therefore, the PROBIT procedure was used to apply the Logit model to data from each period for temporal consistency. The analysis of increment count at maturity revealed a similar pattern, as the Logit link produced the lowest AIC value for 7 of 9 periods. In both analyses, the age at 50% maturity increased from age 1 in the early to mid-1980s to age 2 in the late 1980s through early 2000s, with a return to the historical value of age 1 in all periods since the mid-2000s (Tables 4 and 5).

In the analyses of sex ratio at age (calendar age and increment count), the LOGISTIC procedure determined that the Logit link produced the lowest AIC value for the dataset of specimens collected with chevron traps during 1988-2016. These specimens from chevron traps were numerically dominant (83%) in the overall dataset that combined data from chevron traps and data collected with other gear types during 1979-1987 (Table 6). Therefore, the Logit model was used in the PROBIT procedure to estimate sex ratio at age from both periods for temporal consistency. In both analyses (i.e., calendar age and increment count), the estimate of age at 50% male based on specimens collected in 1979-1987 with blackfish traps, Florida Antillean traps, and hook-and-line was around age 5 compared to age 3 for specimens collected with chevron traps in 1988-2016. Differences in gear selectivity or sample collection date or a combination of both are likely the cause of the differing estimates.

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Table 1. The annual number of Red Porgy collected by MARMAP/SERFS available for reproduction analyses based on project. See Methods for project code descriptions.

Year	P05	P50	T59	T60	Total
1978	336	136			472
1979	373				373
1980	860	7			867
1981	645	167			812
1982	748	77			825
1983	1130	25			1155
1984	653				653
1985	400				400
1986	414				414
1987	706				706
1988	4				4
1989	412				412
1990	491				491
1991	515				515
1992	493				493
1993	533				533
1994	984	78			1062
1995	637				637
1996	987				987
1997	632	581			1213
1998	720	219			939
1999	471				471
2000	554	422			976
2001	759	281			1040
2002	566				566
2003	478				478
2004	1008				1008
2005	995				995
2006	724				724
2007	1074				1074
2008	438				438
2009	511				511
2010	518		19	150	687
2011	582		25	335	942
2012	976		6	707	1689
2013	88				88
2014	1369		76	414	1859
2016	862		3	1051	1916
Total	**24646**	**1993**	**129**	**2657**	**29425**

Table 2. The annual number of Red Porgy collected by MARMAP/SERFS available for reproduction analyses based on gear type. See Methods for gear code descriptions.

Year	043	053	074	324	Total
1978	134	3			
1979	144	192			
1980	560	249	12		
1981	369	207	196		
1982	325	128	292		
1983	170	204	766		
1984	133	131	384		
1985	45	241	92		
1986	29	235	146		
1987	45	120	531		
1988			1	3	
1989	188	21	21	182	
1990	24			466	
1991	25			490	
1992				493	
1993	35			489	
1994	89			973	
1995	9			628	
1996				983	
1997	601			612	
1998	223			716	
1999	29			424	
2000	444			528	
2001	342			698	
2002				562	
2003				472	
2004				1001	
2005	631			975	
2006	965			715	
2007	416			1053	
2008				418	
2009				412	
2010				649	
2011				914	
2012				1682	
2013				88	
2014	139			1858	
2015					
2016				1907	
Total	**6114**	**1731**	**2441**	**20391**	**30677**

Table 3. Histological criteria used to determine reproductive state in Red Porgy (modified from Wallace and Selman (1981); Hunter and Macewicz (1985); Wenner et al. (1986); West (1990); Brown-Peterson et al. (2011).

Reproductive Stage	Male	Female
1-Immature	Small transverse section compared to resting male; spermatogonia & little or no spermatocyte development	Oogonia & primary growth oocytes only (< 60 m), no evidence of atresia. Relative to regenerating female, area of transverse section of ovary is smaller, lamellae lack muscle and connective tissue bundles are not as elongate, oogonia are abundant along margin of lamellae, ovarian wall is thinner. See below
2-Developing	Development of cysts containing primary and secondary spermatocytes through some accumulation of spermatozoa in lobular lumina and ducts.	See below (2B, 2C, 2D, 2E, 2F, & 2G)
3-Spawning capable	Predominance of spermatozoa in lobules and ducts; little or no occurrence of spermatogenesis.	Completion of yolk coalescence and hydration in most-advanced oocytes
4-Regressing	No spermatogenesis; some residual spermatozoa in shrunken lobules or ducts.	More than 50% of vitellogenic oocytes undergoing alpha or beta atresia.
5-Regenerating	Large transverse section compared to immature male; little or no spermatocyte development; empty lobules and ducts; some recrudescence (spermatagonia through primary spermatocytes) possible at end of stage.	Oogonia & primary growth oocytes only (> 60 m), traces of all stages of atresia. Relative to immature female, area of transverse section of ovary is larger, lamellae more elongate, oogonia are less abundant along margin of lamellae, bundles of connective and muscle tissue present, ovarian wall is thicker.
2B-Developing, recent spawn (POC)		Vitellogenic oocytes predominant and POCs (postovulatory complex) <24 h old (sensu Hunter and Macewicz 1985).
2C-Developing, recent spawn (POC)		Vitellogenic oocytes predominant and POCs 24-48 h old (sensu Hunter and Macewicz 1985).
2D-Developing, recent spawn (POC)		Vitellogenic oocytes predominant and POCs >48 h old (sensu Hunter and Macewicz 1985)
2E-Early developing, cortical alveolar (CAO)		Most-advanced oocytes in cortical-alveolar stage. Cortical alveoli form in peripheral cytoplasm. Oil droplets form around nucleus.
2F-Developing, vitellogenesis		Most-advanced oocytes in yolk-granule or yolk-globule stage.
2G-Oocyte maturation		Most-advanced oocytes in migratory-nucleus step. Partial coalescence of yolk globules. Nucleus has moved away from center of cell, being replaced by coalescing oil droplets. By the time of ovulation, one large oil droplet is present.

Table 4. Period-specific parameters of the calendar age at maturity ogive for female Red Porgy and an estimate of age at 50% maturity (A_{50}). Specimens from 1979-1987 were collected with blackfish traps, Florida Antillean traps, and hook-and-line (rod and reel; snapper reel), whereas specimens from 1988-2016 were collected with chevron traps. The Logit model in the analysis utilized the cumulative logistic distribution function. a = intercept, b = slope, CI = confidence interval

Age variable	Period	N	a (SE)	b (SE)	A_{50}	Lower 95% CI	Upper 95% CI
Calendar age	1979-1983	923	-1.393 (0.295)	1.403 (0.144)	0.99	0.71	1.20
Calendar age	1984-1987	1260	-1.191 (0.209)	1.244 (0.108)	0.96	0.74	1.12
Calendar age	1988-1989	54	-5.457 (1.416)	2.186 (0.620)	2.50	2.14	3.12
Calendar age	1990-1994	762	-4.197 (1.196)	2.020 (0.544)	2.08	1.54	2.61
Calendar age	1995-1998	1321	-3.884 (0.376)	1.599 (0.157)	2.43	2.25	2.63
Calendar age	1999-2002	844	-3.014 (0.250)	1.484 (0.108)	2.03	1.92	2.15
Calendar age	2003-2006	1033	-2.135 (0.456)	1.715 (0.232)	1.25	0.88	1.49
Calendar age	2007-2011	1396	-2.293 (0.526)	2.185 (0.314)	1.05	0.67	1.28
Calendar age	2012-2016	1635	-3.382 (0.761)	2.507 (0.417)	1.35	0.98	1.50

Table 5. Period-specific parameters of the age (increment count) at maturity ogive for female Red Porgy and an estimate of age at 50% maturity (A_{50}). Specimens from 1979-1987 were collected with blackfish traps, Florida Antillean traps, and hook-and-line (rod and reel; snapper reel), whereas specimens from 1988-2016 were collected with chevron traps. The Logit model in the analysis utilized the cumulative logistic distribution function. a = intercept, b = slope, CI = confidence interval

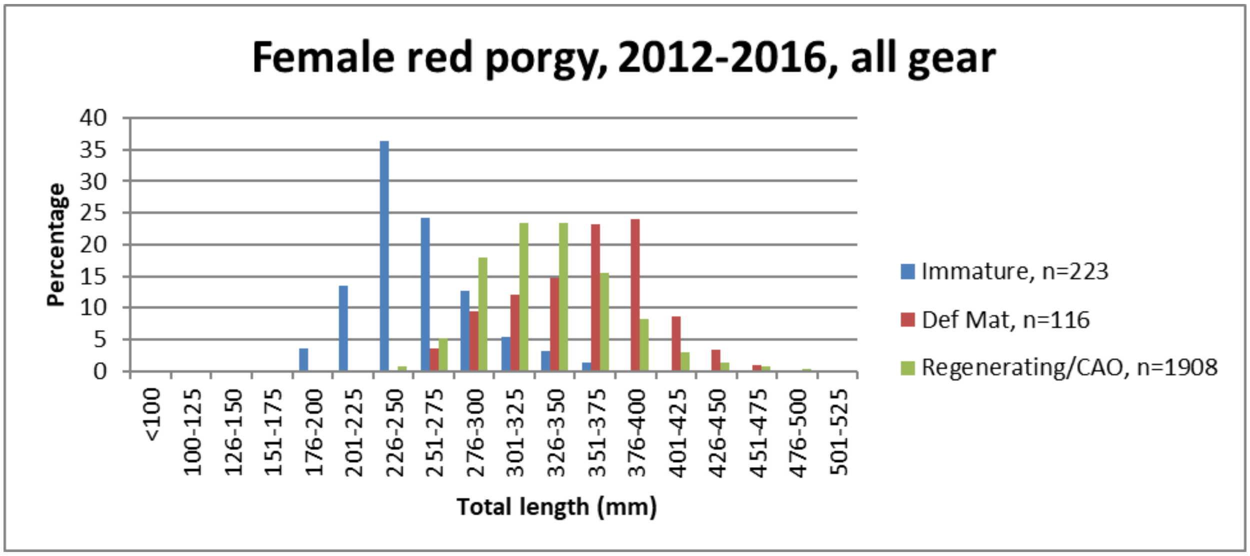
Age variable	Period	N	a (SE)	b (SE)	A_{50}	Lower 95% CI	Upper 95% CI
Increment count	1979-1983	923	-2.781 (0.345)	2.329 (0.198)	1.19	1.06	1.30
Increment count	1984-1987	1260	-2.625 (0.430)	2.733 (0.351)	0.96	0.79	1.09
Increment count	1988-1989	54	-6.768 (2.036)	3.127 (1.009)	2.16	1.90	2.68
Increment count	1990-1994	762	-4.611 (2.283)	2.562 (1.210)	1.80	n/a	n/a
Increment count	1995-1998	1323	-3.917 (0.662)	1.790 (0.307)	2.19	1.87	2.57
Increment count	1999-2002	844	-3.096 (0.246)	1.688 (0.120)	1.83	1.72	1.95
Increment count	2003-2006	1035	-2.065 (0.644)	1.846 (0.365)	1.12	0.56	1.43
Increment count	2007-2011	1397	-1.713 (0.443)	2.088 (0.302)	0.82	0.44	1.05
Increment count	2012-2016	1635	-3.575 (0.828)	2.831 (0.503)	1.26	0.92	1.50

Table 6. Period-specific parameters of the ogives for proportion male at calendar age and increment count in female Red Porgy, including estimates of age at 50% (A_{50}) male. Specimens undergoing sex change from female to male were considered males. Specimens from 1979-1987 were collected with blackfish traps, Florida Antillean traps, and hook-and-line (rod and reel; snapper reel), whereas specimens from 1988-2016 were collected with chevron traps. The Logit model in the analysis utilized the cumulative logistic distribution function. a = intercept, b = slope, CI = confidence interval

Age variable	Period	N	a (SE)	b (SE)	A50	Lower 95% CI	Upper 95% CI
Calendar age	1979-1987	2679	-1.660 (0.098)	0.304 (0.028)	5.47	5.04	6.04
Calendar age	1988-2016	13,403	-2.118 (0.098)	0.644 (0.025)	3.29	3.17	3.40
Calendar age	1979-2016	16,082	-2.125 (0.073)	0.617 (0.019)	3.45	3.35	3.54
Increment count	1979-1987	2679	-1.718 (0.097)	0.349 (0.030)	4.93	4.57	5.40
Increment count	1988-2016	13,441	-2.047 (0.107)	0.662 (0.028)	3.09	2.96	3.22
Increment count	1979-2016	16,120	-2.084 (0.080)	0.642 (0.022)	3.24	3.14	3.34

Figure 1. Comparisons of length frequencies of female Red Porgy of differing maturity status sampled off the southeastern U.S. Atlantic coast, 2012–2016. Gonad tissue was examined histologically and categorized as immature, definitely mature (Def Mat: developing, spawning capable, or regressing), inactive mature (regenerating/CAO), or uncertain maturity. CAO = presence of cortical alveolar oocytes.

A)



B)

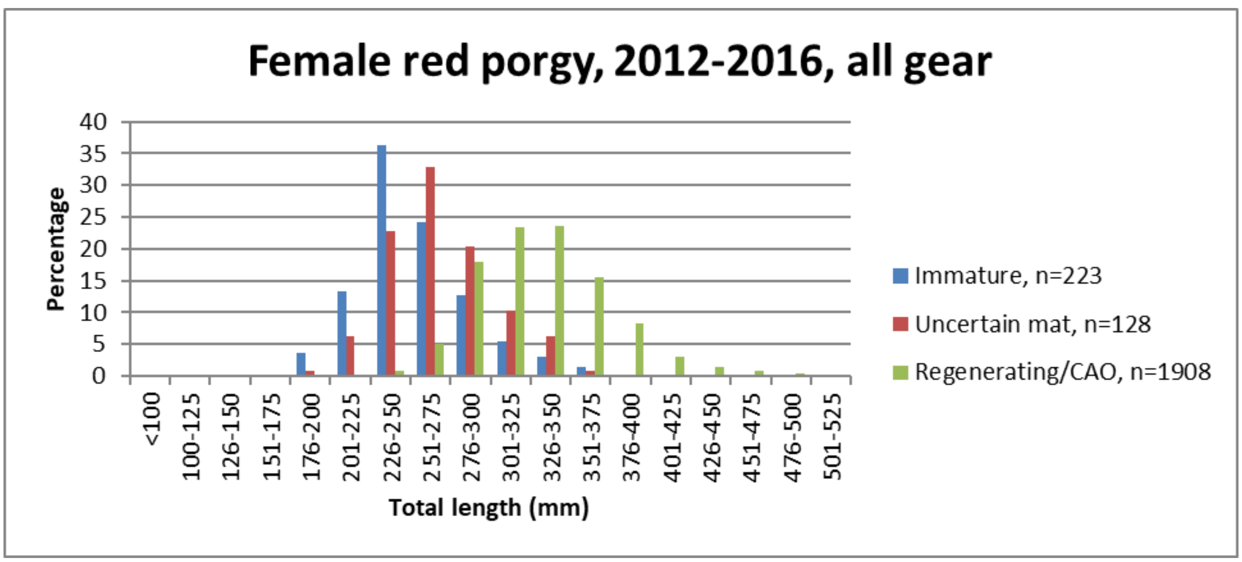
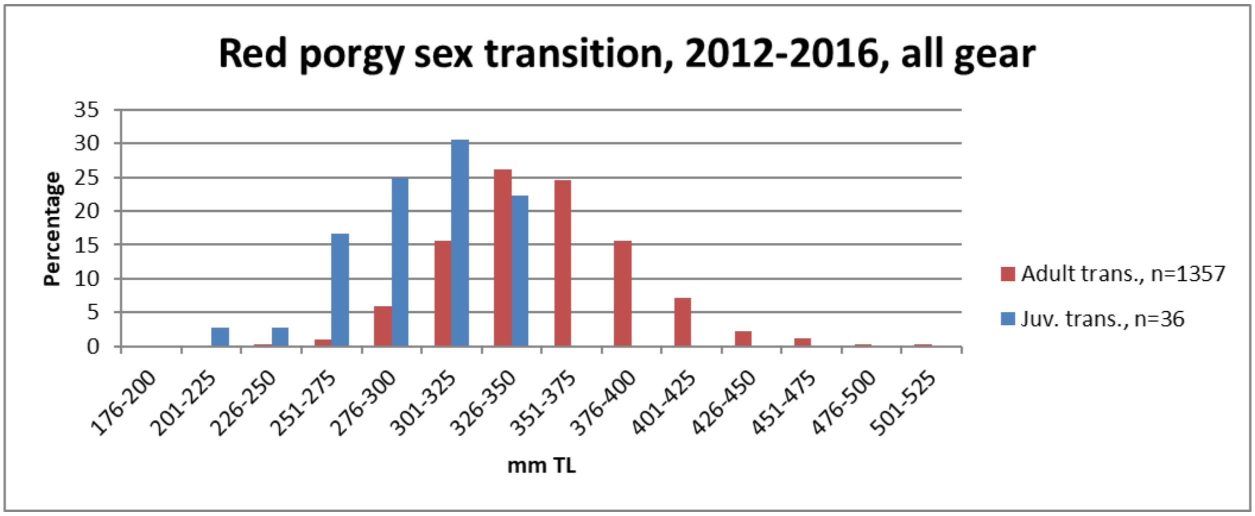


Figure 2. A comparison of length frequencies of juvenile (in blue) and adult (in red) female Red Porgy sampled off the southeastern U.S. Atlantic coast, 2012–2016, that were undergoing sex transition.



Addendum

Addendum added January 10, 2020 to reflect changes made during the assessment process.

The final female maturity recommendation is found in the addendum on Page 21.

Table 4 - Updated. Period-specific parameters of the calendar age at maturity ogive for female Red Porgy and an estimate of age at 50% maturity (A_{50}). Specimens from 1979-1987 were collected with blackfish traps, Florida Antillean traps, and hook-and-line (rod and reel; snapper reel), whereas specimens from 1988-2016 were collected with chevron traps. The Logit model in the analysis utilized the cumulative logistic distribution function. a = intercept, b = slope, CI = confidence interval

Age variable	Period	N	a (SE)	b (SE)	A_{50}	Lower 95% CI	Upper 95% CI
Calendar age	1979-1983	923	-1.393 (0.295)	1.403 (0.144)	0.99	0.71	1.20
Calendar age	1984-1987	1260	-1.191 (0.209)	1.244 (0.108)	0.96	0.74	1.12
Calendar age	1988-1989	54	-5.457 (1.416)	2.186 (0.620)	2.50	2.14	3.12
Calendar age	1990-1994	762	-4.197 (1.196)	2.020 (0.544)	2.08	1.54	2.61
Calendar age	1995-1998	1321	-3.884 (0.376)	1.599 (0.157)	2.43	2.25	2.63
Calendar age	1999-2002	844	-3.014 (0.250)	1.484 (0.108)	2.03	1.92	2.15
Calendar age	2003-2006	1033	-2.135 (0.456)	1.715 (0.232)	1.25	0.88	1.49
Calendar age	2007-2011	1396	-2.293 (0.526)	2.185 (0.314)	1.05	0.67	1.28
Calendar age	2012-2016	1635	-3.382 (0.761)	2.507 (0.417)	1.35	0.98	1.50
Calendar age	**1979-2016**	**9174**	**-2.445 (0.154)**	**1.619 (0.075)**	**1.51**	**1.42**	**1.59**

Table 5 - Updated. Period-specific parameters of the age (increment count) at maturity ogive for female Red Porgy and an estimate of age at 50% maturity (A_{50}). Specimens from 1979-1987 were collected with blackfish traps, Florida Antillean traps, and hook-and-line (rod and reel; snapper reel), whereas specimens from 1988-2016 were collected with chevron traps. The Logit model in the analysis utilized the cumulative logistic distribution function. a = intercept, b = slope, CI = confidence interval

Age variable	Period	N	a (SE)	b (SE)	A_{50}	Lower 95% CI	Upper 95% CI
Increment count	1979-1983	923	-2.781 (0.345)	2.329 (0.198)	1.19	1.06	1.30
Increment count	1984-1987	1260	-2.625 (0.430)	2.733 (0.351)	0.96	0.79	1.09
Increment count	1988-1989	54	-6.768 (2.036)	3.127 (1.009)	2.16	1.90	2.68
Increment count	1990-1994	762	-4.611 (2.283)	2.562 (1.210)	1.80	n/a	n/a
Increment count	1995-1998	1323	-3.917 (0.662)	1.790 (0.307)	2.19	1.87	2.57
Increment count	1999-2002	844	-3.096 (0.246)	1.688 (0.120)	1.83	1.72	1.95
Increment count	2003-2006	1035	-2.065 (0.644)	1.846 (0.365)	1.12	0.56	1.43
Increment count	2007-2011	1397	-1.713 (0.443)	2.088 (0.302)	0.82	0.44	1.05
Increment count	2012-2016	1635	-3.575 (0.828)	2.831 (0.503)	1.26	0.92	1.50
Increment count	**1979-2016**	**9179**	**-2.551 (0.282)**	**1.904 (0.162)**	**1.34**	**1.19**	**1.47**

Table 7. Comparisons of period-specific ogives for calendar age (yr) at maturity in female Red Porgy based on data from fishery-independent sampling by SERFS. Specimens from 1979-1987 were collected with blackfish traps, Florida Antillean traps, and hook-and-line (rod and reel; snapper reel), whereas specimens from 1990-2016 were collected with chevron traps. The Logit model in the analysis utilized the cumulative logistic distribution function.

Gear	N	Period			
			1979-1987	1990-2002	2003-2016
SR, FLT, BFT	2183	1979-1987	.	< 0.001	0.067
Chevron	2927	1990-2002	< 0.001	.	< 0.001
Chevron	4064	2003-2016	0.067	< 0.001	.
Total	9174				

SR = Snapper reel
FLT = Florida trap
BFT = Blackfish trap

Probit analysis: mature = period, calendar age
Cumulative distribution: logistic

SEDAR60-WP02 ADDENDUM

Background:

The assessment team expressed concern at the SEDAR 60 Red Porgy in-person Workshop (December 2019) about using period-specific estimates of life history parameters in the model for only female maturity, as was done in the 2006 and 2012 assessments. It is possible that other parameters such as growth and sex ratio also exhibit the plasticity seen in female maturity, which could affect these maturity estimates. In addition, a panel member asked if the period-specific maturity ogives are statistically different.

To address the question of statistical significance, female maturity data from SERFS fishery-independent sampling were grouped into three periods (1979-1987, 1990-2002, and 2003-2016), with the latter two periods representing data from chevron traps. Maturity ogives for the three periods were compared using a Probit analysis with the logistic distribution function. The results showed that the proportion of mature females at calendar age decreased significantly ($P < 0.001$) between the early and middle periods and then increased significantly ($P < 0.001$) between the middle and latter periods, with the differences in maturity ogives for the early and latter periods not being statistically significant ($P=0.067$; Table 7 in addendum of SEDAR60-WP02).

Recommendation:

Although there is statistical evidence for the use of period-specific maturity ogives, the consensus of the workshop panel was to shift to an overall (1979-2016) maturity ogive in the model until temporal trends in other life history parameters can be investigated. Parameter estimates for the overall ogive are presented in the updates of Tables 4 and 5 (addendum of SEDAR60-WP02).