NOTE: The following is an excerpt from the impacts analysis for Snapper Grouper AM 27 (Commercial Visioning). This summarized version of the document is being provided as background on the analysis and model results. For comparison purposes, the analysis for Action 1 (establish a commercial split season for blueline tilefish) is included to provide an example of a circumstance where the SARIMA and "Last 3" models align as far as projected closure dates (**Table 3**). The analysis of Action 4 (Establish a commercial split season for red porgy) is an example of divergent results for the two models used (**Table 11**), with the "Last 3" projecting harvest closures under many of the alternatives after the ACL is met while the SARIMA model does not project the ACL to be met using the projected mean values, and therefore no commercial harvest closures are expected. The divergent results such as this are at the crux of the request from the IPT for the SEP and SSC to provide guidance on the appropriate model results to use for the biological, economic, and social effects. At their October meeting, the SSC discussed the preliminary results from both models and recommended using the results from the "Last 3" model instead of the SARIMA model. Despite this recommendation, the SSC did have some questions on the SARIMA model that could not be answered during the meeting, as the analyst was not available. Also, analyses have been revised and more analyses have been completed since the October 2017 SSC meeting. As such, the SSC will be discussing this topic again at their upcoming meeting in May 2018.

"Impacts of proposed alternatives in South Atlantic Regulatory Amendment 27: Commercial Visioning Blueprint

LAPP/DM Branch
Southeast Regional Office
NOAA Fisheries Service

Introduction

The South Atlantic Fishery Management Council (Council) manages Snapper-Grouper stocks in federal waters from the Florida Keys to the Virginia/North Carolina border. In Vision Blueprint Commercial Regulatory Amendment 27 for the Snapper Grouper Fishery of the South Atlantic Region (Reg-27), the Council has proposed modifications of commercial regulations such as fishing seasons, trip limits, seasonal closures, and size limits for species in the snapper grouper fishery. These proposed management measures are intended to lengthen commercial fishing seasons, minimize discard mortality, to improve compliance, and aid in enforcement of regulations in the South Atlantic region. This document evaluates the impacts of proposed alternatives in Reg-27 and provides analytical support for the Council's decision-making process.

Methods & Results

For most actions, landings were expressed as daily catch rates by month, based on open federal days, and two catch rate projection models were developed: (1) based on the last three years of data (2014-2016; "Last 3"), and (2) a seasonal auto-regressive integrated moving average (SARIMA) model. In the "Last 3" model, the mean and standard deviation of the last three years of data were used to generate monthly mean and 95% confidence interval projection estimates for daily catch rates, which were subsequently expanded into estimates of monthly landings by multiplying by the number of days in each month. In a SARIMA(p,d,q)x(P,D,Q)

model (Box et al. 2013), the autoregressive component (p) represents the lingering effects of previous observations, the integrated component (d) represents temporal trends, and the moving average component (q) represents lingering effects of previous random shocks (or error). The SARIMA models were implemented using Proc ARIMA in SAS version 9.2 (SAS Institute). Following Farmer & Froeschke (2015), all possible combinations of single-difference SARIMA models for landings per day by wave were considered (**Table S-1**). A single-difference SARIMA model only considers a maximum of one differencing term in the annual and one differencing term in the seasonal component. Differencing terms considered were annual and monthly. All SARIMA models were fit using conditional least squares. Stationarity tests were used to guide differencing selection. Final SARIMA model selection was guided by the examination of autocorrelations, inverse autocorrelations, partial autocorrelations, cross-correlations, residual diagnostics, and AIC.

The Last 3 approach is a simple average and highly sensitive to recent trends. The SARIMA approach is more statistically robust, with the final model selected with the combination of seasonal and interannual trends that best fits the data. The SARIMA model approach is sensitive to recent trends, captures long term trends, and has been shown to provide superior fits to catch trends as compared to recent year's data approaches (Farmer & Froeschke 2015). When alternative projection modeling approaches provide very different mean estimates of catch rates and closure dates, this should be interpreted as an indication that historical data are not very informative of future trends. When different modeling approaches provide reasonably close estimates of catch rates and closure dates but confidence limits are wide, this should be interpreted as high variability within the historical data. Both modeling approaches were retained for projections to provide the Council information regarding the uncertainty in the projected closure dates. Most of the species under consideration in Reg-27 are indirectly harvested during trips targeting other stocks; for this reason, uncertainty in the historical data is often high. Similarly, actions involving targeted species often require extrapolation of catch rates to periods that have been subject to recent closures or a complex management history, further contributing to uncertainty.

Action 1. Establish a commercial split season for blueline tilefish

- **Alternative 1 (No Action)**. The commercial fishing year for blueline tilefish in the South Atlantic EEZ is from January 1 to December 31.
- **Alternative 2.** Specify two commercial fishing seasons for blueline tilefish. Allocate the blueline tilefish commercial ACL into two quotas: 40% to the period January 1 through June 30 and 60% to the period July 1 through December 31. Any remaining quota from Season One would transfer to Season Two. Any remaining quota from Season Two would not be carried forward.
    - **Sub-alternative 2a.** Season 1 trip limit = 100 pounds lbs gw, Season 2 trip limit = 300 pounds lbs gw.
    - **Sub-alternative 2b.** Season 1 trip limit = 150 pounds lbs gw, Season 2 trip limit = 300 pounds lbs gw.
- **Alternative 3.** Modify the commercial trip limit for blueline tilefish:

- **Sub-alternative 3a**. 100 lbs gw from January 1 through April 30 and 300 lbs gw from May 1 through December 31
- **Sub-alternative 3b**. 150 lbs gw from January 1 through April 30 and 300 lbs gw from May 1 through December 31
- **Sub-alternative 3c.** 100 lbs gw from January 1 through June 30 and 300 lbs gw from July 1 through December 31.

Average monthly commercial landings for blueline tilefish by state from 2004-2013 are provided in **Figure 1**. The percentage of annual blueline tilefish landings from each state from 2002-2016 is provided in **Figure 2**. Due to recent quota closures (**Table 1**), data were not available from recent years to inform Season 2 landings. The Council may want to consider moving this action to blueline tilefish amendment (Amendment 38) given the pending completion in June 2018 of the SEDAR 50 stock assessment, which may provide updated stock status and ABC recommendations. Also, blueline tilefish management has been very dynamic over the past few years, with many regulatory changes including a prohibition of harvest beyond 240 fathoms in 2011. The input data available for forecasting future landings have consequently been affected, which has implications for the reliability of analyses. In general, the most recent year is probably the best available predictor of future trends.

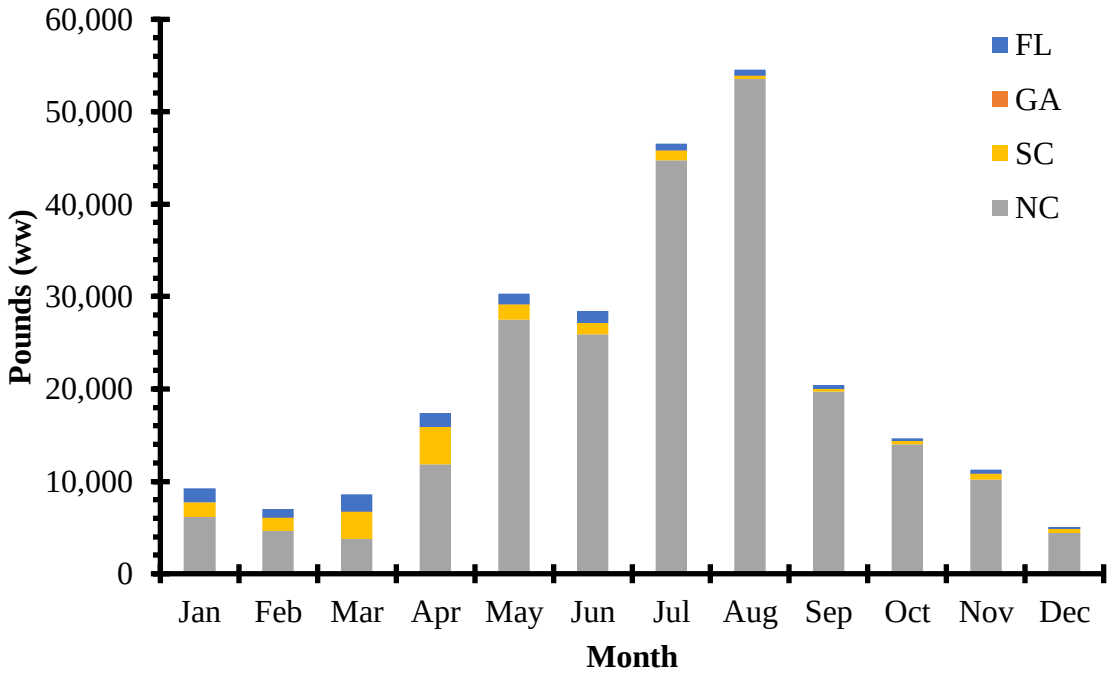

Figure 1. The average monthly South Atlantic blueline tilefish landings by state from 2004-2013 in pounds whole weight. The years 2014-2016 were excluded due to closures. Source: Southeast Fisheries Science Center commercial (5/2/2017) ACL dataset.

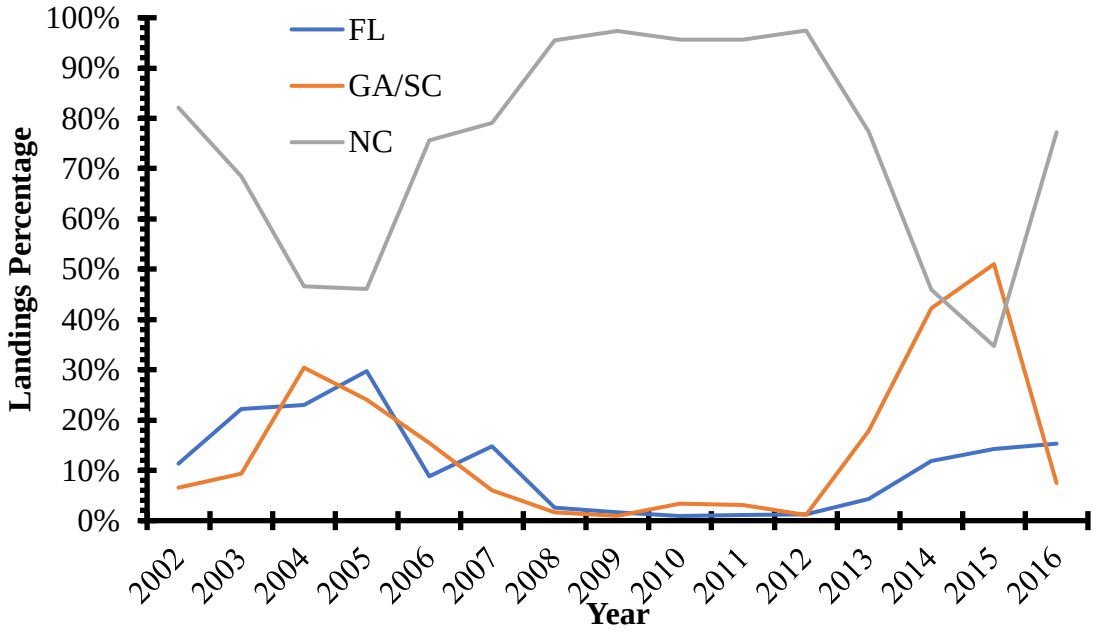

Figure 2. The percentage of annual South Atlantic blueline tilefish landings by state from 2002-2016. Georgia and South Carolina were combined due to confidentiality concerns. Source: Southeast Fisheries Science Center commercial (5/2/2017) ACL dataset.

Table 1. Blueline tilefish recent landings and quota closures.

Fishing Year	Current Landings	ACL	%ACL	Closure Date
2017	85,629	87,521	97.84	7/18/17; Reopened 10/24/17-11/1/17
2016	101,043	87,521	115.45	6/1/16; reopened 7/13/16, closed 8/30/16
2015	78,802	17,841	441.69	4/7/2015
2014	143,942	112,207	128.28	6/23/2014
2013	309,411	376,469	82.19	
2012	378,667	343,869	110.12	9/8/2012

Source: SERO ACL Monitoring Webpage.

Trip limit impacts were simulated by modifying and re-summarizing landings from commercial logbook trip records (SEFSC commercial logbook data, accessed April 2017). Total monthly landings 2006-2016 were compared between modified (500, 400, 300, 250, 200, 150, and 100-lb gw trip limit) and unmodified trip records. Monthly scalars were applied to projected landings data for the alternatives listed above. Monthly trip limit scalars on projected catches were determined using the last three fully open years without a trip limit in place within this range (**Table 2**). All trip limit scalars were based on a 300-lb trip limit baseline, with landings from Mar 2015-June 2016 scaled up from the 100-lb trip limit that was in place at that time. To predict baseline 2018 landings for Alternative 1, monthly commercial landings data for 1997-2016 was obtained from the NOAA Southeast Fisheries Science Center (SEFSC) annual catch limit (ACL) commercial database (accessed May 2017). Input data was evaluated from 1997 onward because species identification has improved through time. Landings under a back-

calculated 300-lb trip limit were converted to daily catch rates by month, which considered the number of open days during months with quota closures or seasonal restrictions on harvest. Landings were projected using the Last 3 and SARIMA methods described above. Commercial discards were estimated by month using the SEFSC Commercial Logbook and Supplemental Discard Logbook (accessed May 2017) to develop a discard rate in numbers of fish per unit effort, by species, gear, and region, and expand that rate to the total effort in the fishery by gear and region.

Table 2. Projected blueline tilefish commercial trip limit scalars, by month, based on most recent three years without a quota closure.

Month	500-lb	400-lb	300-lb	250-lb	200-lb	150-lb	100-lb	Years
1	130%	116%	100%	90%	79%	66%	51%	2013-2015
2	125%	113%	100%	92%	82%	70%	56%	2013-2015
3	138%	120%	100%	89%	76%	63%	48%	2012*-2014
4	137%	120%	100%	89%	78%	65%	51%	2012*-2014
5	139%	120%	100%	89%	78%	65%	52%	2012-2014
6	139%	120%	100%	90%	79%	67%	53%	2012*-2014
7	146%	123%	100%	88%	75%	62%	47%	2011-2013
8	146%	124%	100%	87%	74%	60%	45%	2011-2013
9	151%	126%	100%	87%	73%	58%	42%	2010, 2011, 2013
10	149%	125%	100%	87%	73%	58%	43%	2010, 2011*, 2013*
11	149%	125%	100%	87%	73%	58%	43%	2010*, 2011*, 2013*
12	148%	125%	100%	87%	73%	59%	44%	2010*, 2011*, 2013*

*Some months aggregated to achieve sample size of n>30.

The final selected model was a ARIMA(1,0,0)X(0,1,1)s with R^2=0.53 (**Figure 3**). Projected mean and 95% confidence intervals for daily catch rates were expanded into estimates of monthly landings by multiplying by the number of days in each month. Peak blueline tilefish landings were projected for August, followed by July (**Figure 4**). Projections using the Last 3 model anticipated 50% of the ACL would be reached in April (95% CI: Mar-June). SARIMA projections estimated 50% of the ACL would be reached in May (95% CI: Jan-Dec). Projected season lengths under Alternatives 1-3 are provided in **Table 3**. Due to recent dynamic changes in the fishery and challenges accounting for the imposition of a 300-lb trip limit in July 2016, there is substantial uncertainty in these projections. Expanded estimates of commercial discards for blueline tilefish from the SEFSC Supplemental Commercial Discard Logbook (accessed May 2017) are provided in **Figure S-1**.

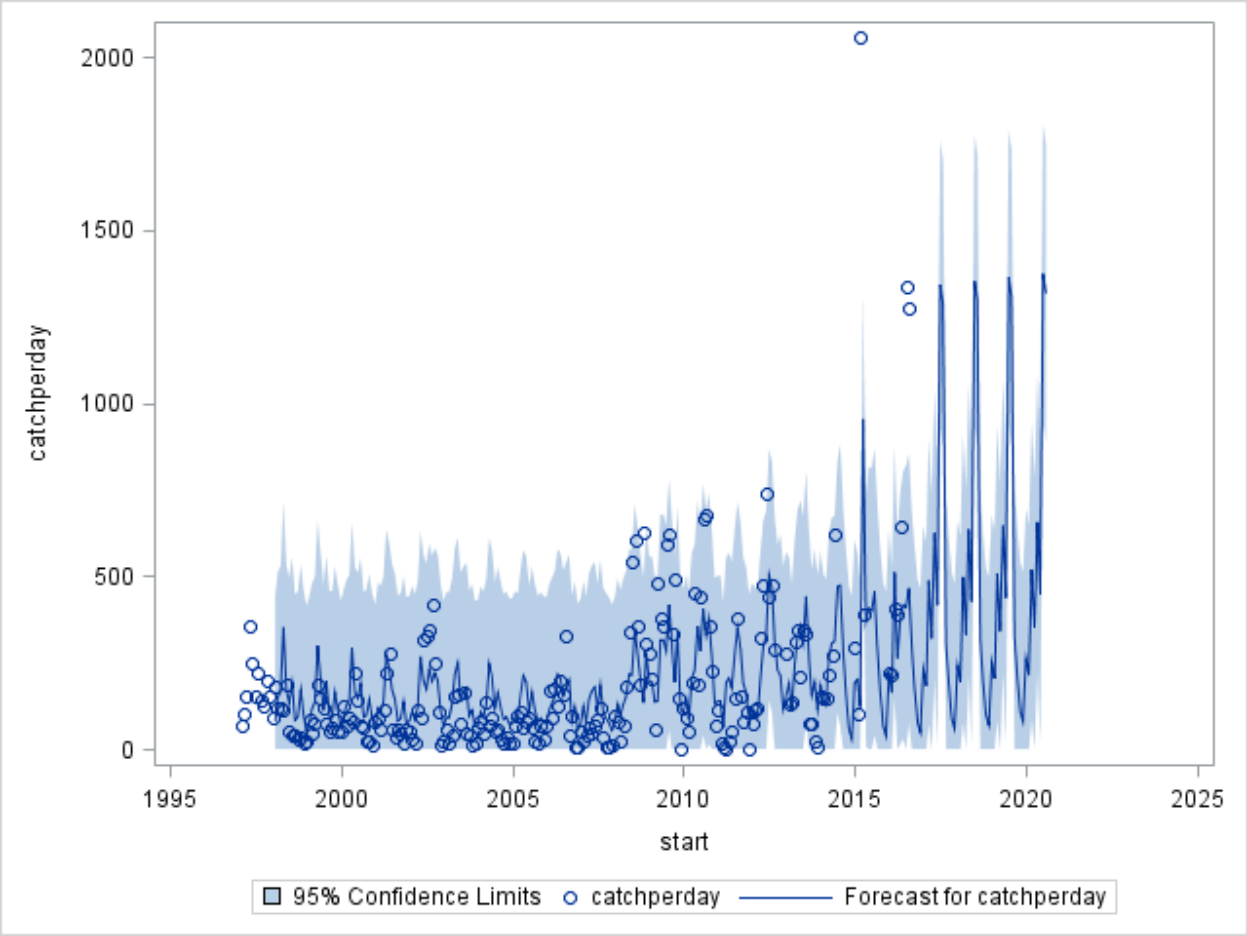

Figure 3. Final SARIMA model fit for blueline tilefish monthly commercial landings (lb ww) per open day.

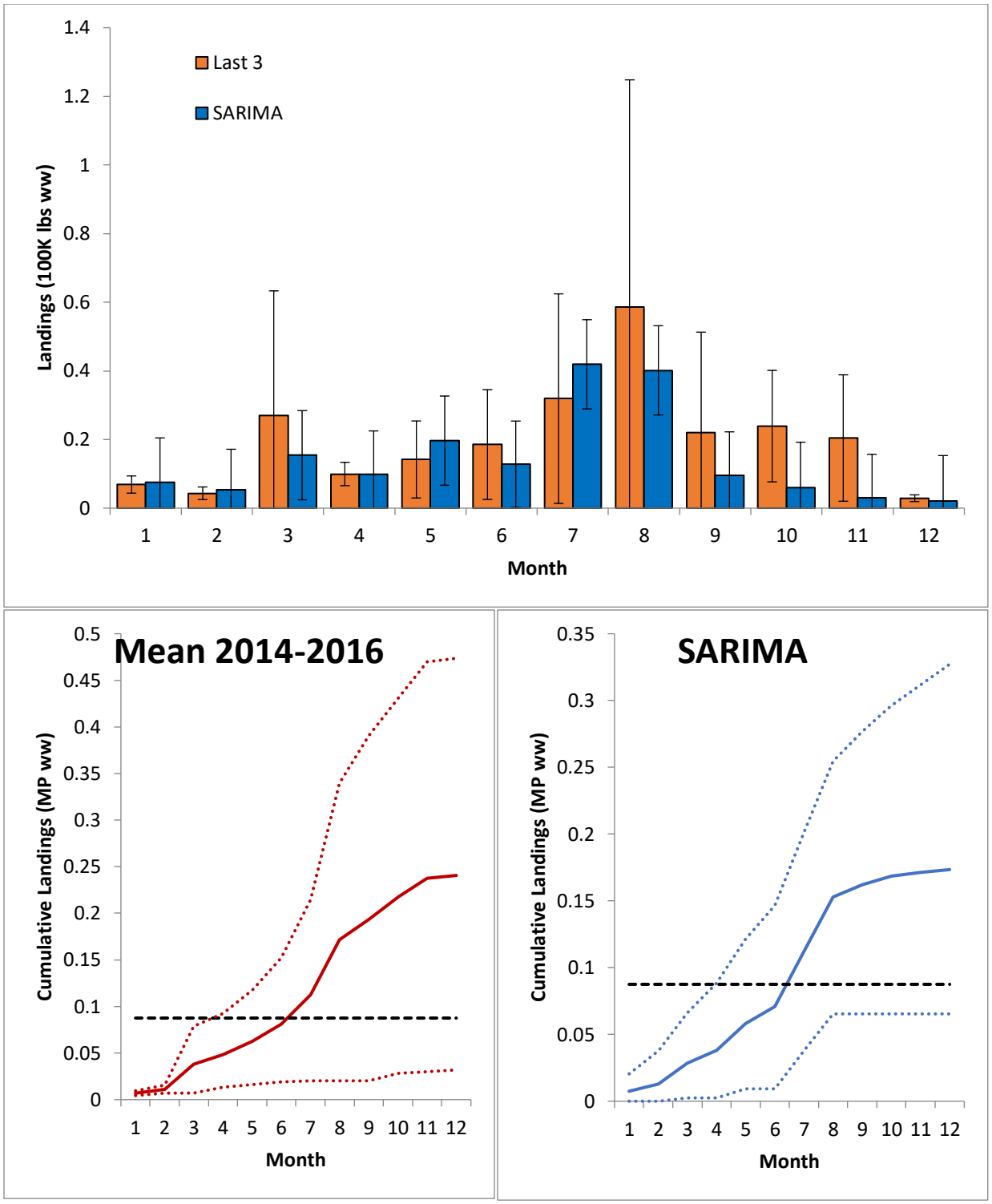

Figure 4. Blueline tilefish projected commercial landings (MP: million pounds, whole weight) by month (top) and mean (solid line) and 95% confidence limits (dotted lines) estimates for cumulative landings relative to ACL (bottom) for two projection models: Mean of last 3 years (2014-2016) and SARIMA.

Table 3. Projected mean and 95% lower and upper (L95, U95) confidence limits quota closure dates for blueline tilefish under different alternatives proposed for Action 1. Blanks denote no projected quota closure.

		Mean 2014-2016			SARIMA		
Alternative	**Season**	**L95**	**MEAN**	**U95**	**L95**	**MEAN**	**U95**
Alt 1	Jan-Dec		7-Jul	22-Apr		13-Jul	2-May
Alt 2a	Jan-June		12-Jun	28-Mar		25-Jun	7-Apr
	July-Dec		11-Aug	27-Jul		9-Aug	30-Jul
Alt 2b	Jan-June		14-May	20-Mar		25-May	19-Mar
	July-Dec		11-Aug	27-Jul		9-Aug	30-Jul
Alt 3a	Jan-Dec		30-Jul	16-Jun		27-Jul	14-Jun
Alt 3b	Jan-Dec		24-Jul	4-Jun		23-Jul	30-May
OLD Alt 3c*	Jan-Dec		20-Jul	9-Jun		18-Jul	5-Jun
NEW Alt 3c	Jan-Dec		8-Aug	6-Jul		8-Aug	8-Jul

***considered but rejected*

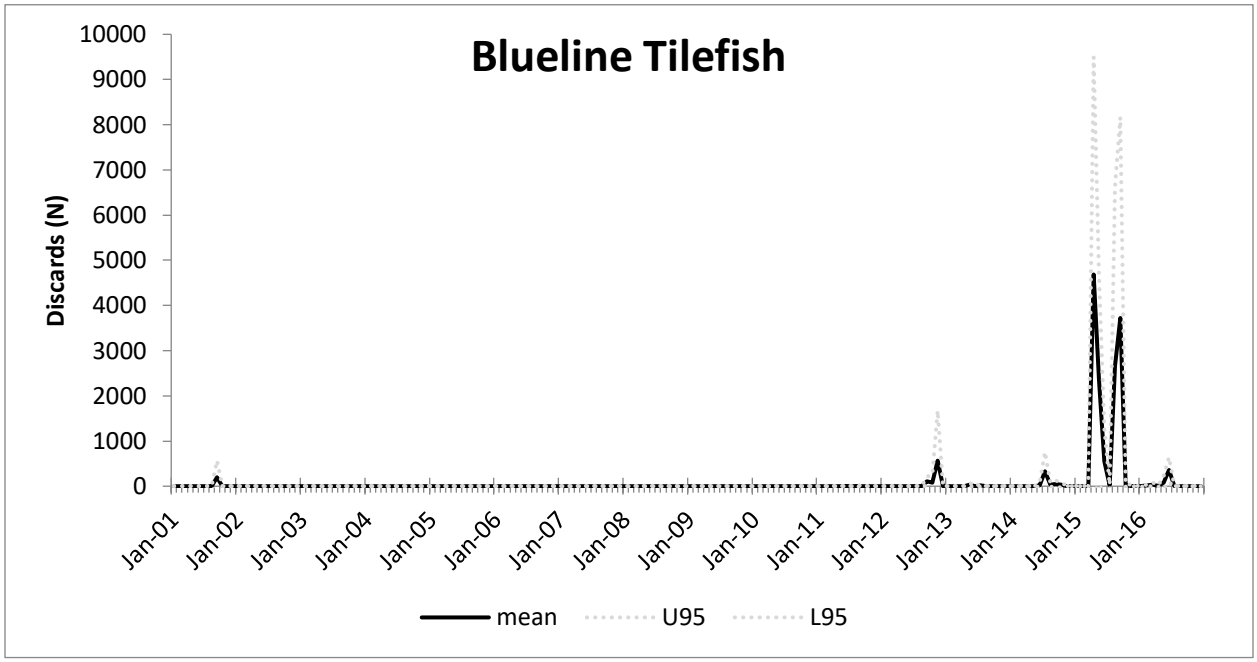

Figure S-1. Blueline tilefish expanded monthly commercial discard estimates (numbers of fish) from the SEFSC Supplemental Commercial Discard Logbook (accessed May 2017). Black line denotes mean, dotted lines denote 95% confidence limits for estimate.

Action 4. Establish a commercial split season for red porgy

- **Alternative 1 (No Action).** The commercial fishing year for red porgy in the South Atlantic exclusive economic zone is from January 1 to December 31. During January 1 through April 30 each year, no person may sell or purchase red porgy harvested from the South Atlantic exclusive economic zone, and the harvest and possession limit is three per person per day or three per person per trip, whichever is more restrictive. From May 1 through December 31 each year, the trip limit for red porgy is 120 fish.
- **Alternative 2.** Specify two commercial fishing seasons for red porgy. Allocate the commercial red porgy annual catch limit into two quotas: 30% to the period January 1 through April 30 and 70% to the period May 1 through December 31. Any remaining quota from Season 1 would transfer to Season 2. Any remaining quota from Season 2 would not be carried forward. Remove the sale and purchase prohibition during January 1 to April 30 each year. Retain the commercial trip limit of 120 fish from May 1 through December 31 and specify a commercial trip limit from January 1 through April 30 of:
    - **Sub-alternative 2a.** 30 fish
    - **Sub-alternative 2b.** 45 fish
    - **Sub-alternative 2c.** 60 fish
- **Alternative 3.** Specify two commercial fishing seasons for red porgy. Allocate the commercial red porgy ACL into two quotas: 50% to the period January 1 through April 30 and 50% to the period May 1 through December 31. Any remaining quota from Season 1 would transfer to Season 2. Any remaining quota from Season 2 would not be carried forward. Remove the sale and purchase prohibition during January 1 to April 30 each year. Retain the commercial trip limit of 120 fish from May 1 through December 31 and specify a commercial trip limit from January 1 through April 30 of:
    - **Sub-alternative 3a.** 30 fish
    - **Sub-alternative 3b.** 45 fish
    - **Sub-alternative 3c.** 60 fish
- **Alternative 4.** Remove the harvest and possession restrictions, and sale and purchase prohibition for red porgy from the South Atlantic during January 1 to April 30 each year. Specify a commercial trip limit of 120 fish from January 1 through December 31.

Average monthly commercial landings for red porgy by state from 2005-2012 and 2014-2016 are provided in **Figure 13**. The year 2013 was excluded due to a closure. The percentage of annual red porgy landings from each state from 2002-2016 is provided in **Figure 14**. It was difficult to this evaluate alternative given the unspecified percentages. Similar to blueline tilefish (see Action 1, above), commercial landings data were converted to daily catch rates within months for 1997-2016. There has only been one recent quota closure for red porgy (**Table 9**). Two projection models were fit to the data: (1) mean catch rates 2014-2016 ("Last 3") and (2) a SARIMA model. For the Last 3 model, landings in the event of a Jan-Apr opening of the fishery were extrapolated from mean 2014-2016 May landings using the mean ratio of May landings to Jan-Apr landings 1986-1999 (the final year the fishery was open Jan-Apr). Final SARIMA model selection was guided by the examination of autocorrelations, inverse autocorrelations, partial autocorrelations, cross-correlations, residual diagnostics, and AIC. In the SARIMA model, Jan-Apr catch rates were left blank 2000-present, allowing the model to freely estimate these parameters from the input time series. The final selected model was a ARIMA(1,1,0)X(0,1,1)s with R^2=0.89 (**Figure 15**).

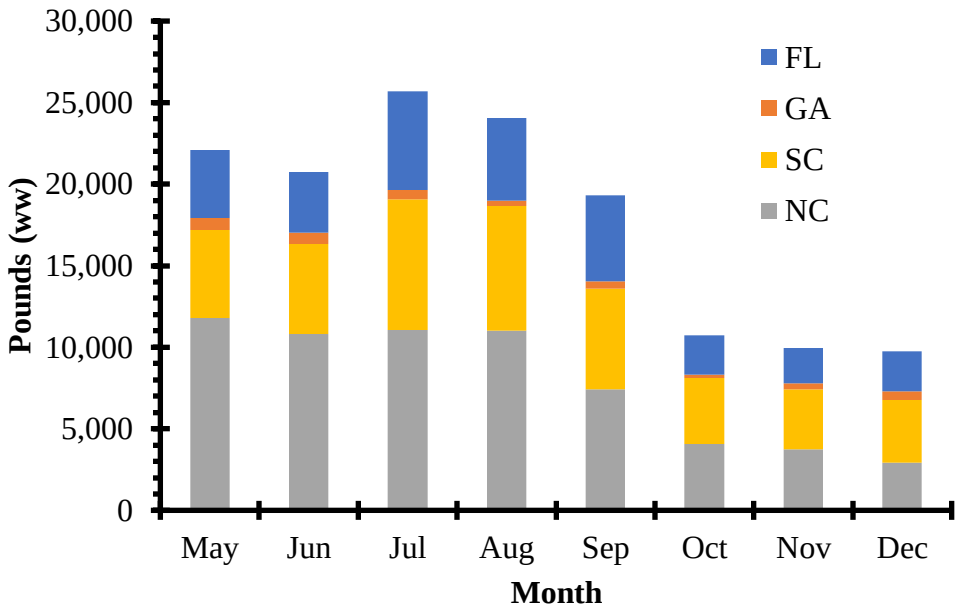

Figure 13. The average monthly South Atlantic red porgy landings by state from 2005-2012 and 2014-2016 in pounds whole weight. The year 2013 was excluded due to a closure. Data from the months of January to April was not available due to the seasonal closure in place since 2000. Source: Southeast Fisheries Science Center commercial (5/2/2017) ACL dataset.

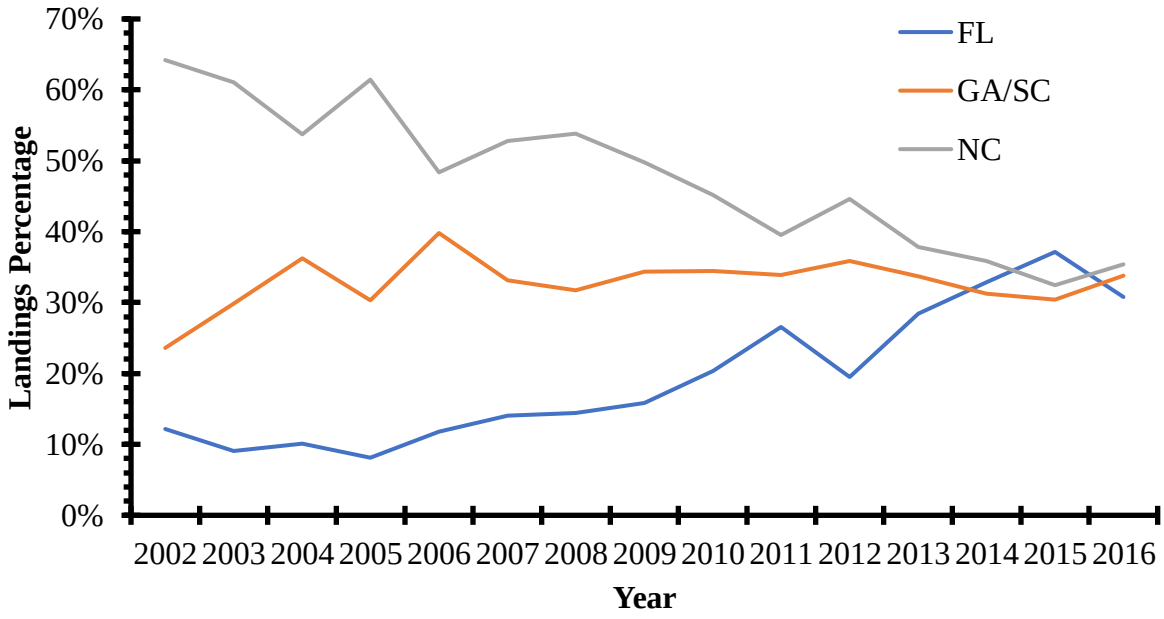

Figure 14. The percentage of annual South Atlantic red porgy landings by state from 2002-2016. Georgia and South Carolina were combined due to confidentiality concerns. Source: Southeast Fisheries Science Center commercial (5/2/2017) ACL dataset.

Table 9. Red porgy recent landings and quota closures.

Year	Landings	ACL	Units	%ACL	Closure
2016	120,104	164,000	ww	73.23	
2015	146,056	164,000	ww	89.06	
2014	155,546	154,500	ww	100.68	
2013	163,337	153,000	gw	106.76	12/02/13
2012	155,743	190,050	gw	81.95	
2011	195,215	190,050	gw	102.72	
2010	152,743	190,050	gw	80.37	
2009	158,219	190,050	gw	83.25	
2008	165,365	127,000	gw	130.21	
2007	136,382	127,000	gw	107.39	
2006	80,293	127,000	gw	63.22	
2005	46,844	None	gw		
2004	47,848	None	gw		

Source: SERO ACL Monitoring Webpage.

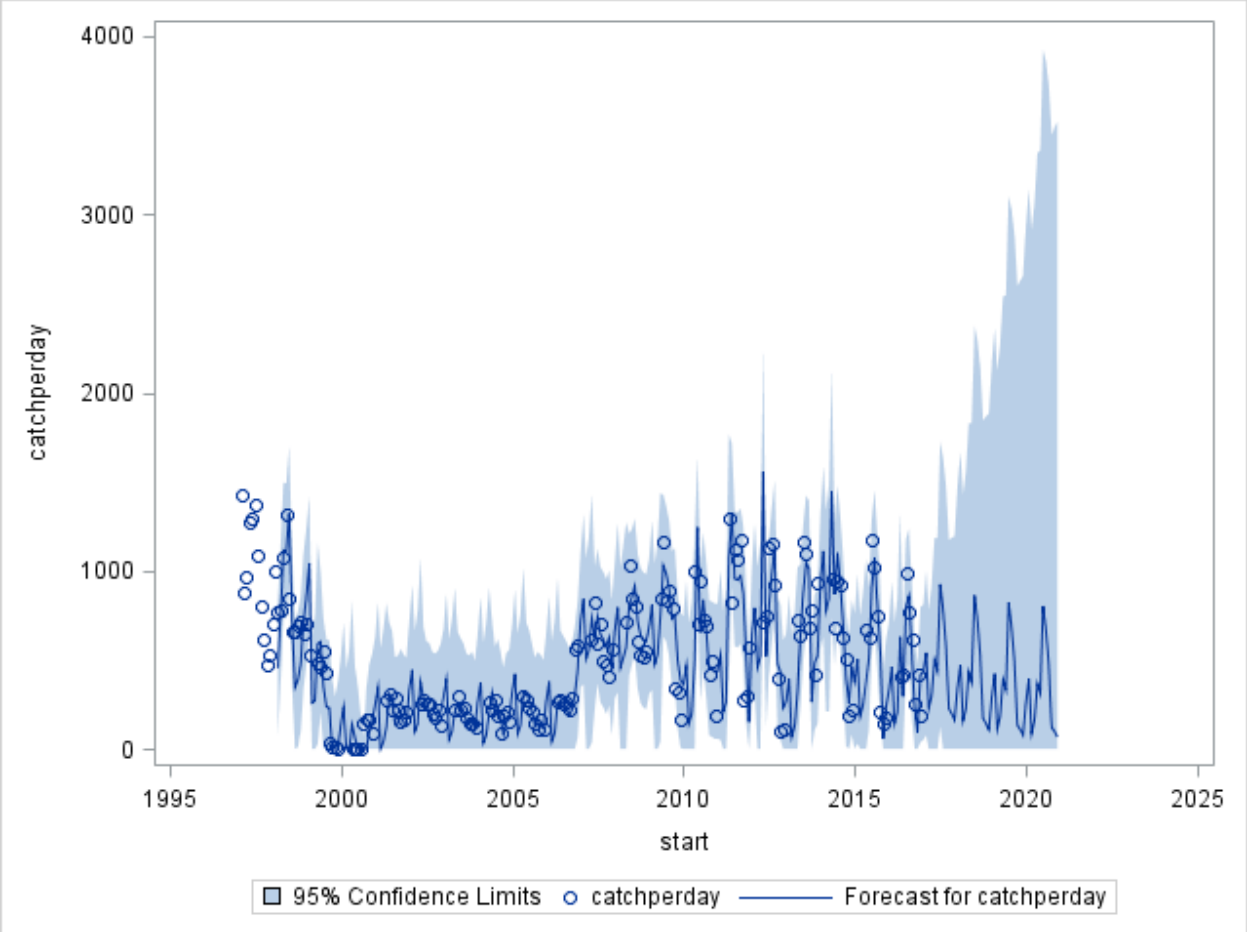

Figure 15. Final SARIMA model fit for red porgy monthly commercial landings (lb ww) per open day.

With a Jan-Apr closure, 50% of the ACL is projected to be caught by August (95% CI: July-Sept) or Sept (95% CI: June-No Closure) by the Last 3 and SARIMA models, respectively (**Figure 16: left**). Between Jan-June 30, 38,247 lb ww (95% CI: 23,862-52,632 lb ww) to 24,646 lb ww (95% CI: 0-111,485 lb ww) is projected to be caught by the Last 3 and SARIMA models, respectively.

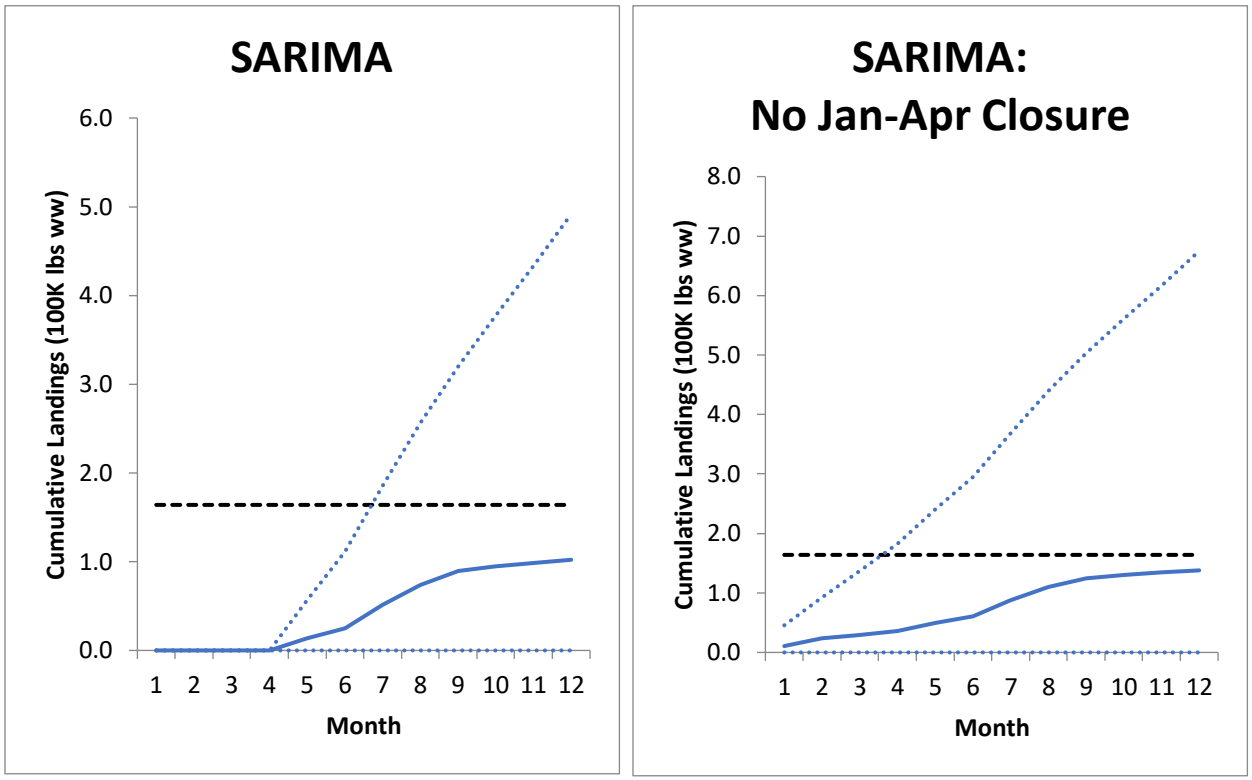

Figure 16. Mean (solid line) and 95% confidence limits (dotted lines) for Red porgy projected cumulative landings relative to ACL, with and without Jan-Apr closure, for two projection models: Mean of last 3 years (2014-2016) and SARIMA.

Without a Jan-Apr closure, 50% of the ACL is projected to be caught by May (95% CI: Apr-July) or July (95% CI: Feb-Dec 31) by the Last 3 and SARIMA models, respectively (**Figure 16: right**). Between Jan-June 30, 110,456 lb (95% CI: 63,041-157,871 lb ww) to 60,393 lb ww (95% CI: 0-294,705 lb ww) is projected to be caught by the Last 3 and SARIMA models, respectively. The wide confidence intervals for these projections indicate the substantial uncertainty in the predictions, especially for the impacts of removing the Jan-Apr closure, which has been in place since 2000.

Expanded estimates of commercial discards for red porgy from the SEFSC Supplemental Commercial Discard Logbook (accessed May 2017) are provided in **Figure S-2**.

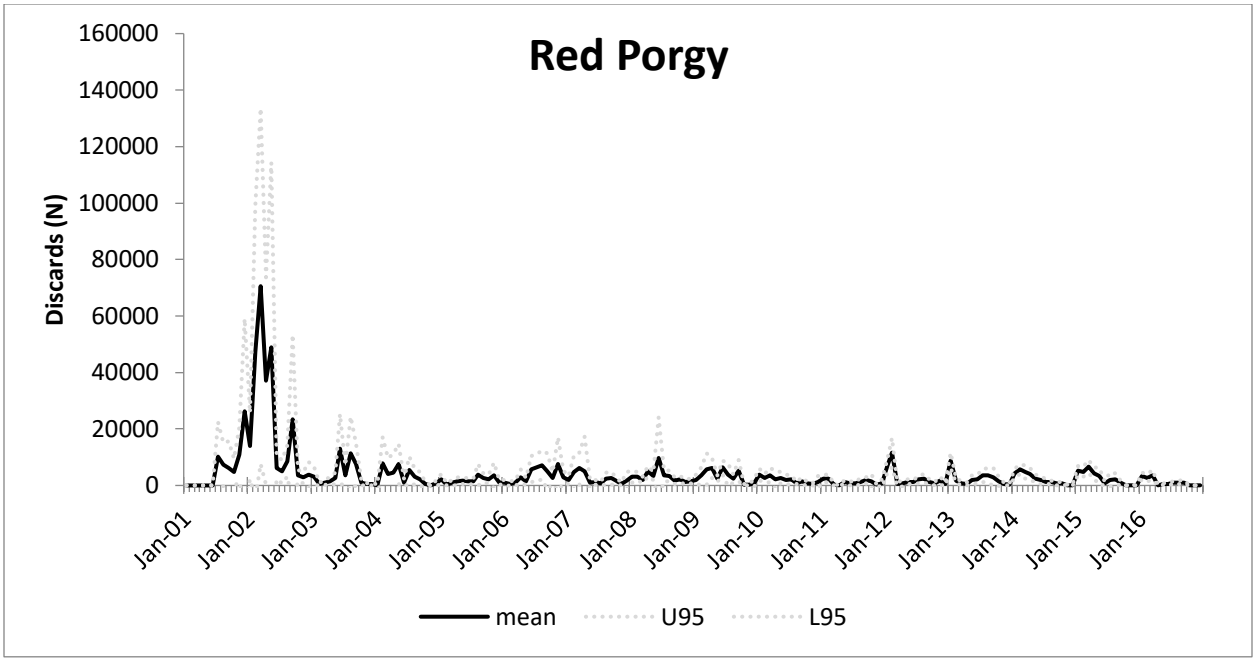

Figure S-2. Red porgy expanded monthly commercial discard estimates (numbers of fish) from the SEFSC Supplemental Commercial Discard Logbook (accessed May 2017). Black line denotes mean, dotted lines denote 95% confidence limits for estimate.

The Commercial Logbook provides landings at the trip-level in pounds, but the proposed red porgy trip limits are in numbers of fish. Commercial Trip Interview Program (TIP, accessed Oct 2017) data was used to evaluate the potential impacts of the various proposed trip limit alternatives. The TIP data is not a comprehensive sample of the fish landed on a given trip, and thus cannot be directly used for determination of trip limit impacts. Annual mean landed weight from representative samples from commercial trips intercepted by the TIP were used to estimate the number of fish landed in Commercial Logbook reported trips. Data were stratified by state for 1995-2005, and Florida and Georgia data were pooled for 2006-2016 because Georgia TIP data were very limited (n=1) from 2006-2016. Florida and Georgia data were more highly correlated than Georgia and South Carolina data during the 1995-2005 period (83.6% vs. 80.9%). Mean weights (pounds whole weight) were determined from TIP data using measured weights when available in either round (whole) weight or gutted weight with head on, using a conversion factor of 1.04 for gutted to whole weight. When measured weights were unavailable, meristic conversions were used to convert measured length (total, standard, or fork length) to total length in mm, and then to convert total length to whole weight in pounds using conversion factors found in Table 1 of SEDAR-1 Update (2006). These conversions were not updated by SEDAR-1 Update (2012), the most recent red porgy stock assessment. Numbers caught on Commercial Logbook trips were computed by dividing the reported landings in pounds whole weight by the annual mean weight from the TIP data by state and by year (**Figure 17**). Estimated reductions from projected landings for various trip limits are shown in **Table 10**. Projected quota closure dates are shown in **Table 11**. Projected cumulative landings trends are shown in **Figure 18**.

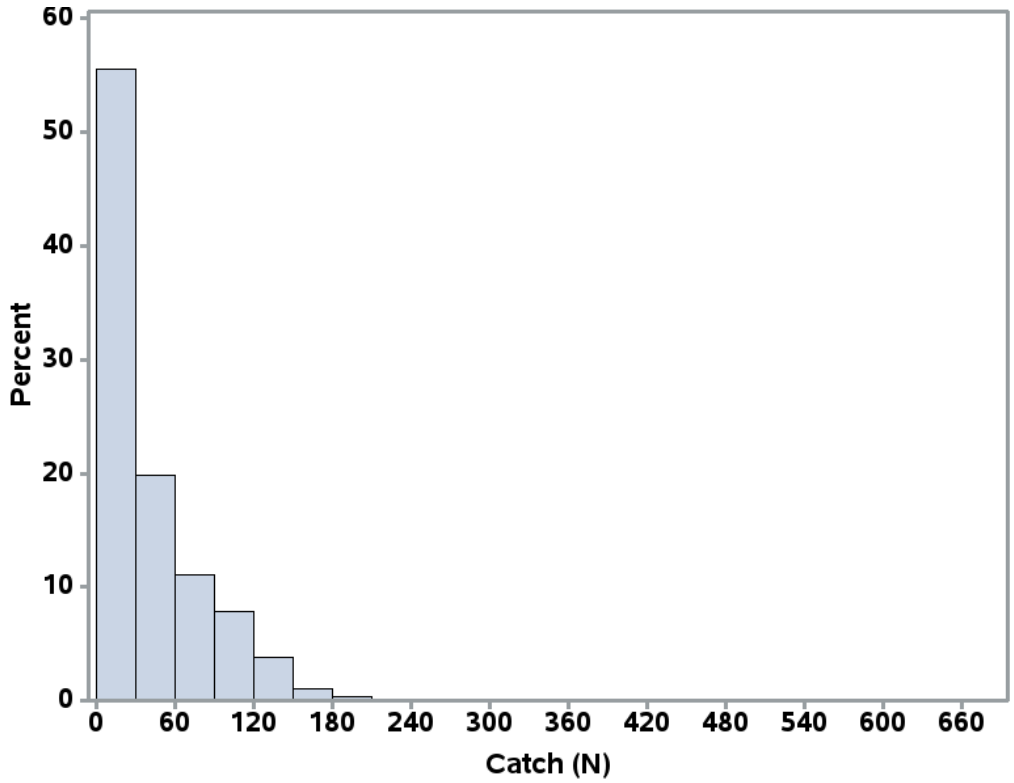

Figure 17. Histogram of estimated number of red porgy caught per trip based on Commercial Logbook reported landings in pounds whole weight divided by mean weights for red porgy intercepted by the Trip Interview Program, by state and year, 2006-2016.

Table 10. Mean weight of landed red porgy intercepted on commercial trips by the Trip Interview Program. Note FL and GA 2006-2016 have been pooled due to low sample sizes off GA.

Year	FL	GA	SC	NC
1995	1.93	1.49	1.60	1.84
1996	1.92	1.42	1.60	1.76
1997	1.89	1.49	1.65	1.77
1998	1.86	1.34	1.56	1.59
1999	1.82	1.83	1.74	2.06
2000	1.97	2.01	2.25	1.91
2001	2.21	1.88	2.19	2.03
2002	1.95	2.14	2.18	2.24
2003	2.26	2.21	2.19	2.09
2004	2.67	2.49	2.12	2.14
2005	2.57	2.76	2.13	2.17
2006	2.38		2.14	1.68
2007	2.70		2.07	1.82
2008	2.66		2.20	1.78
2009	3.45		2.09	1.69
2010	5.05		2.15	1.86

2011	5.26	2.31	1.82
2012	4.69	2.33	1.72
2013	4.24	2.13	1.66
2014	2.42	2.06	1.85
2015	2.10	2.24	1.76
2016	2.07	2.16	1.91

Table 11. Projected mean and 95% lower and upper (L95, U95) confidence limits for quota closure dates for red porgy under different alternatives proposed for Action 4. Blank cells denote no anticipated quota closure.

		MEAN 2014-2016			**SARIMA**		
Alternative	**Season**	L95	**MEAN**	U95	L95	**MEAN**	U95
Alt 1	Jan-Dec			11-Nov			23-Jul
Alt 2a	Jan-Apr			29-Apr			8-Mar
	May-Dec		**6-Nov**	25-Aug			2-Jul
Alt 2b	Jan-Apr			3-Apr			20-Feb
	May-Dec		**2-Oct**	25-Aug			2-Jul
Alt 2c	Jan-Apr		**22-Apr**	20-Mar			13-Feb
	May-Dec		**25-Sep**	25-Aug			2-Jul
Alt 3a	Jan-Apr						24-Apr
	May-Dec		**6-Nov**	24-Aug			15-Jun
Alt 3b	Jan-Apr						28-Mar
	May-Dec		**2-Oct**	9-Aug			15-Jun
Alt 3c	Jan-Apr						13-Mar
	May-Dec		**19-Sep**	29-Jul			15-Jun
Alt 4	Jan-Dec		**24-Aug**	6-Jul			18-Apr

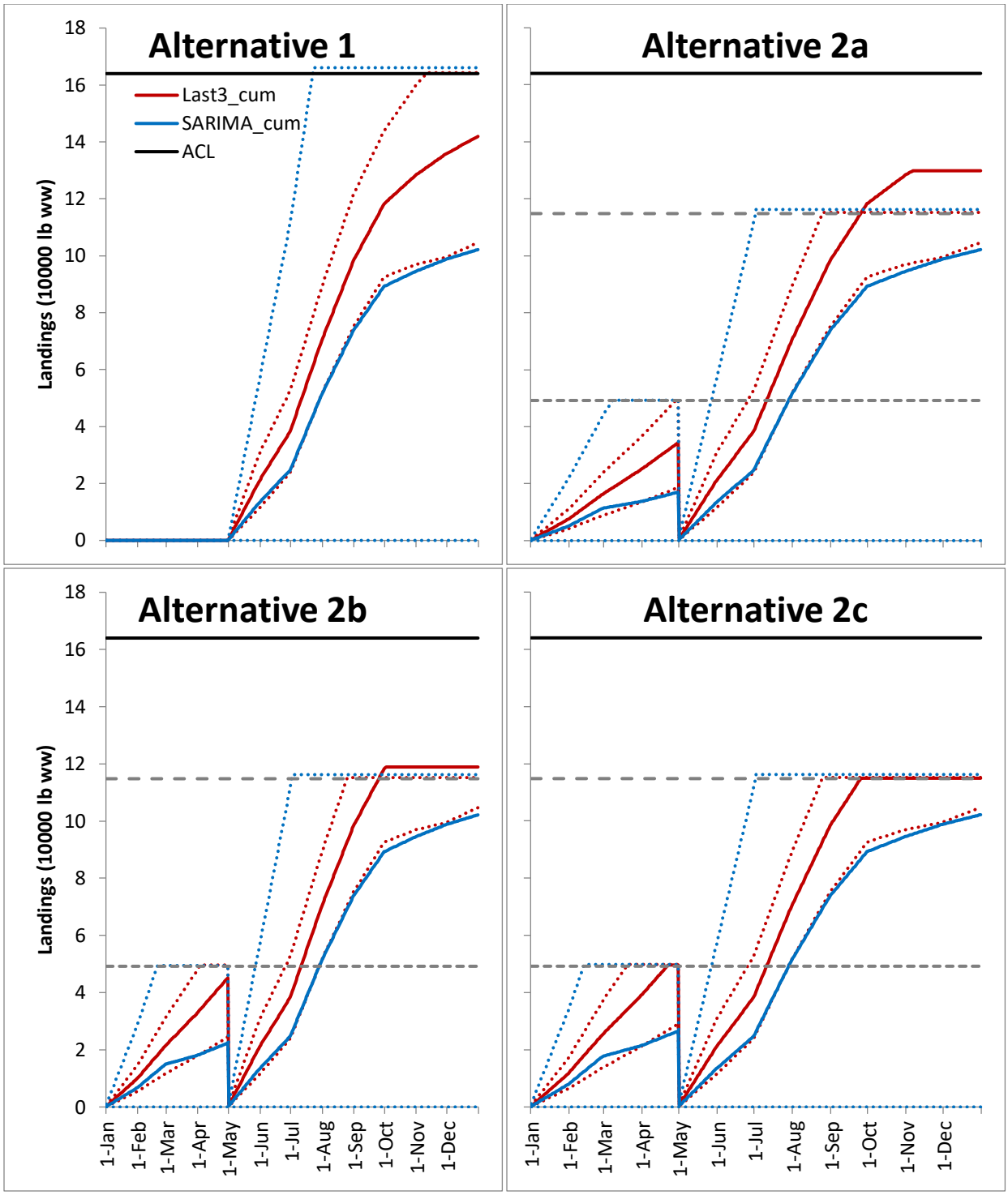

Figure 18. Mean (solid line) and 95% confidence limits (dotted lines) for red porgy projected cumulative landings relative to ACL under two projection models: Mean of last 3 years (2014-2016; red) and SARIMA (blue) relative to ACL (black) and seasonal quotas of 30%, 50%, and 70% of the ACL (gray)."