Appendix N

Methodology and Assumptions in Estimating the Economic Effects of the South Atlantic Snapper Grouper Amendment 17A on the Recreational Sector

Antonio Lamberte, NMFS SERO

January 2010

1.0 Introduction

The South Atlantic Fishery Management Council has developed Snapper Grouper Amendment 17A to reduce the fishing mortality of red snapper. Several red snapper management measures have been considered to achieve the desired fishing mortality reduction, inclusive of discard mortality. **Alternative 1** is the no action alternative. **Alternative 2** would prohibit harvest, retention, and possession red snapper in the South Atlantic EEZ year round. **Alternatives 3A, 3B, 3C,** and **3D** would add to **Alternative 2** a year-round prohibition of harvest, retention, and possession of any species in the snapper grouper fishery management unit in an area corresponding to commercial logbook grids 2880, 2980, 3080 and 3180. These four alternatives differ only in the depth restriction -- all depths for **Alternative 3A**, from 66 feet to 240 feet for **Alternative 3B**, from 98 feet to 240 feet for **Alternative 3C**, and from 98 feet to 300 feet for **Alternative 3D**. **Alternatives 4A, 4B, 4C,** and **4D** would add to **Alternative 2** a year-round prohibition of harvest, retention, and possession of any species in the snapper grouper fishery management unit in an area corresponding to commercial logbook grids 2880, 2980, 3080, 3180, 3179, 3278, and 3279. These four alternatives differ only in the depth restriction -- all depths for **Alternative 4A**, from 66 feet to 240 feet for **Alternative 4B**, from 98 feet to 240 feet for **Alternative 4C**, and from 98 feet to 300 feet for **Alternative 4D**. **Alternative 5** would allow fishing for black sea bass in the closed areas using black sea bass pots with endorsements. **Alternative 6** would allow bottom longline fishing for snapper grouper, except red snapper, in the closed areas beyond 50 fathoms. **Alternative 7** would allow fishing for snapper grouper, except red snapper, in the closed areas using spearfishing gear. **Alternative 8**, and its various sub-alternatives, would address the issue of vessels transiting through the closed areas.

This appendix focuses on estimating the economic effects of **Alternatives 2, 3A, 3B, 3C, 3D, 4A, 4B, 4C,** and **4D**. **Alternatives 5, 6,** and **7** are not standalone measures and would be combined with any of the previous alternatives. In terms of economic effects, they would tend to mitigate the effects of previous alternatives on the commercial sector. **Alternative 8,** which affects both commercial and recreational vessels, would mainly define conditions for allowing vessels to transit the closed areas without being subject to penalty. In terms of economic effects, this alternative would tend to reduce travel costs as vessels would not have to go around the closed areas when traveling to and from port or open fishing areas.

The procedure for calculating the economic effects of these alternatives on the recreational sector involves estimating the expected changes in consumer surplus (CS) to anglers and net operating revenues (NOR) to for-hire vessels. This procedure follows the method employed in previous snapper grouper plan amendments (Amendments 15A and 16) and the red snapper interim rule (NMFS 2008b). It also draws upon the general method used in the economic analysis for the red

snapper fishery closure in the Gulf of Mexico (NMFS 2008a). Data, averaged over the years 2005-2008, were used in estimating the economic effects of this amendment. The period 2005-2008 was chosen per agreement among the members of the Interdisciplinary Planning Team. In this document, the economic values are in 2009 dollars.

2.0 Method for Estimating the Expected Economic Effects

The expected change in CS was estimated using the following equation:

(1) $$\Delta(CS)_{i,j,k} = \Delta(TTRIP)_{i,j,k} \times (CS)_{0,0,0} \times (FISH)_{i,j,k}$$

where $\Delta(CS)_{i,j,k}$ is the change in consumer surplus for species *i* (red snapper, snapper grouper) in area *j* (Northeast Florida/Georgia, Southeast Florida, South Carolina, North Carolina) using fishing mode *k* (charterboat, headboat, private). $\Delta(TTRIP)_{i,j,k}$ is the change in target trips per angler for species *i* in area *j* using fishing mode *k*. $(CS)_{0,0,0}$ is consumer surplus of keeping (landing) one fish per angler target trips. $(FISH)_{i,j,k}$ is the average fish kept per angler, per targeted trip of species *i* in area *j* using fishing mode *k*. It may be noted that TTRIP and FISH are 2005-2008 averages.

CS in the present case is the net benefit an angler derives from an additional fish kept on a fishing trip and is equivalent to the difference between the monetized benefit an angler receives and the actual cost. This value is the appropriate measure of economic effects on recreational anglers as a result of changes in fishing regulations. For the current analysis, the CS of keeping one fish per angler trip was assumed constant across species, areas, and modes (thus, the notation $CS_{0,0,0}$). Further, this value was assumed to remain constant and unaffected by changes in target trips resulting from changes in regulations.

The expected change in for-hire NOR was estimated using the following equation:

(2) $$\Delta(NOR)_{i,j,k} = \Delta(TTRIP)_{i,j,k} \times (NOR)_{0,0,k}$$

where $\Delta(NOR)_{i,j,k}$ is the change in net operating revenues for species *i* (red snapper, snapper grouper) in area *j* (Northeast Florida/Georgia, Southeast Florida, South Carolina, North Carolina) using fishing mode *k* (charterboat, headboat). $\Delta(TTRIP)_{i,j,k}$ is the change in target trip per angler for species *i* in area *j* using fishing mode *k*. $(NOR)_{0,0,k}$ is the baseline net operating revenue per angler target trip using mode *k* (charterboat, headboat).

NOR is the net operating revenue, expressed on a per angler basis, a charterboat or headboat derives from a fishing trip. NOR was calculated as revenue minus the costs for fuel, ice, bait, and other supplies. Producer surplus is the appropriate measure of economic effects on for-hire operations as a result of changes in fishing regulations. Estimates of the average producer surplus for for-hire operations are not available, and this analysis used NOR as a proxy value. In the current analysis, NOR per angler trip was assumed constant across species and areas but not across modes (thus, the notation $NOR_{0,0,k}$). In addition, this value was assumed to be invariant to changes in the number of angler target trips.

In assessing the economic effects of each alternative, the change in target trips [$\Delta(TTRIP)_{i,j,k}$] was first estimated, followed by the use of equation (1) to generate the expected change in CS and equation (2) to generate the expected change in NOR. For **Alternative 2**, the change in target trips was estimated by assuming cancellation of all red snapper target trips. This approach would overestimate the economic effects of **Alternative 2** if anglers continued fishing but shifted their effort to target other species. For **Alternatives 3A, 3B, 3C, 3D, 4A, 4B, 4C,** and **4D**, the change in target trips was estimated by assuming cancellation of all red snapper target trips (as in **Alternative 2**) and cancellation of all snapper grouper trips made in the areas where fishing would be prohibited. This approach would also overestimate the economic effects of these alternatives if anglers chose to continue fishing for these species in other open areas or target new species in the areas where fishing for red snapper and other snapper grouper species would be prohibited.

3.0 Data, Parameters, and Assumptions

The basic parameters used in estimating the economic effects of Amendment 17A were recreational angler target effort, angler consumer surplus, average fish kept per angler trip, and for-hire vessel net operating revenues.

3.1 Headboat Angler Target Trips

The headboat data does not contain information collected at the angler level, nor does it collect target intent information. Therefore, an alternative approach was used to estimate angler target effort. Since the 1980s, NMFS (Beaufort) has conducted surveys of the headboat sector and has generated a measure of fishing effort in terms of angler days. The method of deriving total angler days from survey reports is a complex process. Here is a brief description of the process from the "Review of Headboat Survey, Questions and Answers" (NMFS 2004):

> *"First, reported effort is calculated from catch records. The term "reported" refers to data actually provided by the vessel personnel in the form of catch records. Data on effort are provided as number of anglers on a given trip. Numbers of anglers are standardized, depending on the type of trip (length in hours), by converting number of anglers to "angler days" (e.g., 40 anglers on a half-day trip would yield 40 * 0.5 = 20 angler days). Angler days are summed by month for individual vessels. Port agents enter the reported anglers from catch records on an internal worksheet called a headboat activity report (HAR). The reported anglers are converted to angler days and totaled. The monthly total of angler days is referred to as catch record angler days (CRADs). We then take every piece of information recorded on the HAR for that vessel for that month and use them to calculate estimated angler days, or EADs. This is the adjustment for non-reporting. This expansion to arrive at estimated angler days is often complex and usually labor intensive. If there is complete reporting by vessel personnel, i.e., a catch record submitted for every trip made, then CRAD=EAD and the process is simple. More often that not, however, there are varying degrees of incompleteness of reporting. The usual estimation procedure involves using sampler observations of activity and developing an adjustment ratio to expand the reported observations."*

The EADs noted above are for all headboat activities and are not broken down into EADs for specific species. In the current analysis, all headboat angler days (EADs) were assumed to be

target angler trips for snapper grouper species. This assumption is expected to overestimate snapper grouper target trips, because some headboat anglers may not target any species while others target species other than snapper grouper (e.g., mackerel, dolphin).

In estimating red snapper target trips, the following formula was used:

$$(3) \qquad (TTRED)_j = \{\frac{CRAD_{RED}}{CRAD_{SG}}\}_j \times (EAD)_j$$

where $(TTRED)_j$ is angler target trips for red snapper in area *j* (Northeast Florida/Georgia, Southeast Florida, South Carolina, North Carolina). $(CRAD_{RED})_j$ is red snapper angler days in area *j* calculated from the catch records. $(CRAD_{SG})_j$ is the snapper grouper angler days in area *j* calculated from the catch records, and $(EAD)_j$ is the estimated angler days in area *j*.

To derive angler target trips in the various logbook grids included under **Alternatives 3A** through **4D**, the following formula was used:

$$(4) \qquad (TTSG)_j = \{\frac{CRADSG_{GRID}}{CRAD_{SG}}\}_j \times (EAD)_j$$

where $(TTSG)_j$ is snapper grouper target trip in the subject grids in area *j* (Northeast Florida/Georgia, Southeast Florida, South Carolina, North Carolina). $(CRADSG_{GRID})_j$ is snapper grouper angler days in the subject grids in area *j* calculated from the catch records. $(CRAD_{SG})_j$ is the snapper grouper angler days in area *j* calculated from the catch records, and $(EAD)_j$ is the estimated angler days in area *j*.

Several data sets were explored to extract bathymetric information of red snapper catches (see NMFS 2009d). Due to limitations on available bathymetric information from other sources, the commercial logbook data was relied upon to determine red snapper removals from the various depths in the subject statistical areas. For the current purpose of assigning headboat angler trips to various depths within each of the statistical grids proposed to be closed to snapper grouper fishing, information from the commercial logbook data was used. Several limitations of using this information were noted in NMFS (2009d), and are deemed also relevant here in assigning headboat angler trips by depth.

In 2005-2008, a total of 5,596 commercial vessel trips catching no red snapper were made in statistical grids 2880, 2980, 3080, 3180, 3179, 3278, and 3279. Of these trips, 2,251 had complete depth information. Using only those trips with complete depth information, the following table was constructed, showing the distribution of trips by depth within each grid. This information was used to assign headboat angler trips to the various depths in each grid.

Table A.1. Percent distribution of commercial vessel trips within each of the seven statistical grids, by depth, 2005-2008.

Statistical Grid	66-240 feet	98-240 feet	98-300 feet
2880	98%	85%	86%
2980	91%	88%	88%

3080	97%	97%	97%
3180	98%	98%	100%
3278	88%	88%	89%
3279	89%	88%	88%
2880	98%	85%	86%

Basic data provided by Dr. Jim Waters.

Estimates of the various types of headboat target trips are provided in Table A.2. Table footnotes explain the various acronyms for trips. For purposes of estimating the economic effects, the affected target trips used were TTRED for **Alternative 2** and the sum of TTRED and corresponding TTSG for the rest of the alternatives. For example, in estimating the economic effects of **Alternative 3A**, the sum of TTRED and $TTSG_{3A}$ was used as the affected target trips.

Table A.2. Average headboat angler target trips, by area, 2005-2008.

TRIP TYPE	FL_NE/GA	FL_SE	SC	NC	TOTAL
EAD	51,183	106,225	49,532	25,823	232,763
$CRAD_{SG}$	47,377	35,604	41,976	15,987	140,943
TTRED	41,479	7,170	4,658	2,382	55,690
$TTSG_{3A}$	8,862	0	0	0	8,862
$TTSG_{3B}$	8,455	0	0	0	8,455
$TTSG_{3C}$	7,664	0	0	0	7,664
$TTSG_{3D}$	7,718	0	0	0	7,718
$TTSG_{4A}$	8,862	0	6,296	0	15,159
$TTSG_{4B}$	8,455	0	5,572	0	14,027
$TTSG_{4C}$	7,664	0	5,538	0	13,202
$TTSG_{4D}$	7,718	0	5,555	0	13,273

EAD = estimated angler days.
CRADSG = snapper grouper angler days calculated from the catch records.
TTRED = red snapper target angler trips.
$TTSG_{3A}$ = snapper grouper target angler trips in grids and depths under Alternative 3A.
$TTSG_{3B}$ = snapper grouper target angler trips in grids and depths under Alternative 3B.
$TTSG_{3C}$ = snapper grouper target angler trips in grids and depths under Alternative 3C.
$TTSG_{3D}$ = snapper grouper target angler trips in grids and depths under Alternative 3D.
$TTSG_{4A}$ = snapper grouper target angler trips in grids and depths under Alternative 4A.
$TTSG_{4B}$ = snapper grouper target angler trips in grids and depths under Alternative 4B.
$TTSG_{4C}$ = snapper grouper target angler trips in grids and depths under Alternative 4C.
$TTSG_{4D}$ = snapper grouper target angler trips in grids and depths under Alternative 4D.

3.2 Charterboat and Private Angler Target Trips

The number of red snapper and all snapper grouper species target trips is calculated using the methods described in Holiman (1996), as modified by SEFSC and SERO staff. Target trips, by fishing mode, in both EEZ and state waters were calculated for each of the four states in the South Atlantic. Total target trips for Florida were partitioned into Northeast Florida and Southeast Florida using the estimated ratio of red snapper landings between the two areas as reported in SERO-LAPP-2009-05 (NMFS 2009c). This partitioning assumes red snapper and

snapper grouper target trips are directly proportional to red snapper landings. In the absence of information on species targeting by grid, assignment of snapper grouper target trips to the various grids was done using the proportion of headboat angler trips in the various grids. This assignment assumes that charter and private target trips were taken in about the same areas as headboat trips. This approach is analogous to the one used in assigning MRFSS removals of red snapper from the various logbook grids (see NMFS 2009c). Within each grid, charter and private target trips were assigned by depth in the same way headboat angler trips were distributed by depth. This approach is analogous to the one used in assigning MRFSS removals of red snapper by depth (see NMFS 2009d).

Table A.3 presents the estimated average charter and private target trips for the period 2005-2008. Table footnotes explain the various acronyms for trips. In estimating the expected economic effects, the affected target trips used were TTRED for **Alternative 2** and the sum of TTRED and relevant TTSG for the other alternatives. For example, in estimating the economic effects of **Alternative 4A**, the sum of TTRED and $TTSG_{4A}$ was used as the affected target trips.

Table A.3. Average target trips for snapper grouper and red snapper, by area, by mode, 2005-2008.

	FL_NE/GA		FL_SE		SC		NC		TOTAL	
	Charter	Private	Charter	Private	Charter	Private	Charter	Private	Charter	Private
TTRED	3,231	33,792	530	6,242	301	2,971	0	0	4,062	43,005
$TTSG_{3A}$	1,984	12,192	0	0	0	0	0	0	1,984	12,192
$TTSG_{3B}$	1,893	11,632	0	0	0	0	0	0	1,893	11,632
$TTSG_{3C}$	1,716	10,546	0	0	0	0	0	0	1,716	10,546
$TTSG_{3D}$	1,728	10,622	0	0	0	0	0	0	1,728	10,622
$TTSG_{4A}$	1,984	12,192	0	0	505	2,817	0	0	2,489	15,008
$TTSG_{4B}$	1,893	11,632	0	0	447	2,493	0	0	2,340	14,125
$TTSG_{4C}$	1,716	10,546	0	0	444	2,477	0	0	2,160	13,024
$TTSG_{4D}$	1,728	10,622	0	0	446	2,485	0	0	2,174	13,107

TTRED = red snapper target angler trips.
$TTSG_{3A}$ = snapper grouper target angler trips in grids and depths under Alternative 3A.
$TTSG_{3B}$ = snapper grouper target angler trips in grids and depths under Alternative 3B.
$TTSG_{3C}$ = snapper grouper target angler trips in grids and depths under Alternative 3C.
$TTSG_{3D}$ = snapper grouper target angler trips in grids and depths under Alternative 3D.
$TTSG_{4A}$ = snapper grouper target angler trips in grids and depths under Alternative 4A.
$TTSG_{4B}$ = snapper grouper target angler trips in grids and depths under Alternative 4B.
$TTSG_{4C}$ = snapper grouper target angler trips in grids and depths under Alternative 4C.
$TTSG_{4D}$ = snapper grouper target angler trips in grids and depths under Alternative 4D.

3.3 Average Fish Landed

Table A.4 presents the 2005-2008 average fish landed per angler target trip by geographic area and fishing mode. These numbers were derived by assigning all landed fish to target trips, that is, total landed fish divided by total target trips by area and fishing mode. In areas and modes where landed fish far exceeded the number of target trips, the averages would be relatively high. Conversely, where the number of target trips far exceeded the number of fish landed, the

averages would be relatively low. In the absence of charter and private target trips for red snapper in North Carolina, the corresponding average fish landed was set to zero. To some extent, this method of assigning all landed fish to target trips would mitigate the potential overestimation of changes in CS due to overestimation of target trips, particularly for headboats.

Table A.4. Average red snapper and snapper grouper landed per angler target trip, by area, by mode, 2005-2008.

	Charterboat		Headboat		Private	
	Red Snapper	Snapper Grouper	Red Snapper	Snapper Grouper	Red Snapper	Snapper Grouper
FL-NE/GA	3.5	9.6	0.2	2.6	0.8	6.3
FL-SE	3.5	9.6	0.1	3.8	0.8	6.3
SC	1.0	12.7	0.3	6.1	0.4	3.3
NC	0.0	49.7	0.0	9.0	0.0	5.7

3.4 Consumer Surplus and Net Operating Revenues

Estimates of recreational CS and for-hire NOR were derived by the SEFSC based on several studies (NMFS 2009a). For the current amendment, a CS value of $80, charter NOR value of $128, and headboat NOR value of $68 were chosen because these are based on a more recent study using data collected from a South Atlantic state (Dumas et al. 2009). These values are expressed in 2009 dollars.

4.0 Results

Estimates of the expected changes in consumer surplus and net operating revenues are presented in Tables A.5-A.14. Estimates of the economic effects of **Alternative 2** involved the direct applications of equations 1 and 2 above. The economic effects of the other alternatives were estimated as a two-step process. First, the changes in CS and NOR for snapper grouper target trips in the subject grids and depths were estimated using equations 1 and 2. Second, the resulting numbers were added to the estimated changes in CS and NOR due to Alternative 2.

Table A.5. Economic effects of Alternative 2, in 2009 dollars.

	Charterboat	Headboat	Private	Total
Northeast Florida/Georgia				
CS	904,548	663,664	2,162,682	3,730,893
NOR	413,508	2,820,571		3,234,078
Total	1,318,056	3,484,235	2,162,682	6,964,972
Southeast Florida				
CS	148,462	54,578	419,513	622,552
NOR	67,868	487,576		555,444
Total	216,330	542,153	419,513	1,177,996
South Carolina				
CS	23,560	126,342	93,840	243,742
NOR	38,560	316,766		355,326
Total	62,120	443,108	93,840	599,068

North Carolina				
CS	0	6,702	0	6,702
NOR	0	161,989		161,989
Total	0	168,691	0	168,691

CS = consumer surplus.
NOR = Net operating revenue.

Table A.6. Economic effects of Alternative 3A, in 2009 dollars.

	Charterboat	Headboat	Private	Total
Northeast Florida/Georgia				
CS	2,428,190	2,507,009	8,307,352	13,242,550
NOR	667,448	3,423,203		4,090,651
Total	3,095,638	5,930,212	8,307,352	17,333,201
Southeast Florida				
CS	148,462	54,578	419,513	622,552
NOR	67,868	487,576		555,444
Total	216,330	542,153	419,513	1,177,996
South Carolina				
CS	23,560	126,342	93,840	243,742
NOR	38,560	316,766		355,326
Total	62,120	443,108	93,840	599,068
North Carolina				
CS	0	6,702	0	6,702
NOR	0	161,989		161,989
Total	0	168,691	0	168,691

CS = consumer surplus.
NOR = Net operating revenue.

Table A.7. Economic effects of Alternative 3B, in 2009 dollars.

	Charterboat	Headboat	Private	Total
Northeast Florida/Georgia				
CS	2,358,390	2,422,316	8,025,388	12,806,094
NOR	655,815	3,395,515		4,051,329
Total	3,014,205	5,817,830	8,025,388	16,857,423
Southeast Florida				
CS	148,462	54,578	419,513	622,552
NOR	67,868	487,576		555,444
Total	216,330	542,153	419,513	1,177,996
South Carolina				
CS	23,560	126,342	93,840	243,742
NOR	38,560	316,766		355,326
Total	62,120	443,108	93,840	599,068
North Carolina				
CS	0	6,702	0	6,702

NOR	0	161,989		161,989
Total	0	168,691	0	168,691

CS = consumer surplus.
NOR = Net operating revenue.

Table A.8. Economic effects of Alternative 3C, in 2009 dollars.

	Charterboat	Headboat	Private	Total
Northeast Florida/Georgia				
CS	2,222,476	2,257,712	7,477,923	11,958,111
NOR	633,162	3,341,702		3,974,864
Total	2,855,638	5,599,414	7,477,923	15,932,975
Southeast Florida				
CS	148,462	54,578	419,513	622,552
NOR	67,868	487,576		555,444
Total	216,330	542,153	419,513	1,177,996
South Carolina				
CS	23,560	126,342	93,840	243,742
NOR	38,560	316,766		355,326
Total	62,120	443,108	93,840	599,068
North Carolina				
CS	0	6,702	0	6,702
NOR	0	161,989		161,989
Total	0	168,691	0	168,691

CS = consumer surplus.
NOR = Net operating revenue.

Table A.9. Economic effects of Alternative 3D, in 2009 dollars.

	Charterboat	Headboat	Private	Total
Northeast Florida/Georgia				
CS	2,231,794	2,269,089	7,516,041	12,016,924
NOR	634,715	3,345,421		3,980,137
Total	2,866,509	5,614,511	7,516,041	15,997,061
Southeast Florida				
CS	148,462	54,578	419,513	622,552
NOR	67,868	487,576		555,444
Total	216,330	542,153	419,513	1,177,996
South Carolina				
CS	23,560	126,342	93,840	243,742
NOR	38,560	316,766		355,326
Total	62,120	443,108	93,840	599,068
North Carolina				
CS	0	6,702	0	6,702
NOR	0	161,989		161,989
Total	0	168,691	0	168,691

CS = consumer surplus.

NOR = Net operating revenue.

Table A.10. Economic effects of Alternative 4A, in 2009 dollars.

	Charterboat	Headboat	Private	Total
Northeast Florida/Georgia				
CS	2,428,190	2,507,009	8,307,352	13,242,550
NOR	667,448	3,423,203		4,090,651
Total	3,095,638	5,930,212	8,307,352	17,333,201
Southeast Florida				
CS	148,462	54,578	419,513	622,552
NOR	67,868	487,576		555,444
Total	216,330	542,153	419,513	1,177,996
South Carolina				
CS	537,839	3,199,953	848,174	4,585,965
NOR	103,231	744,925		848,156
Total	641,069	3,944,878	848,174	5,434,121
North Carolina				
CS	0	6,702	0	6,702
NOR	0	161,989		161,989
Total	0	168,691	0	168,691

CS = consumer surplus.
NOR = Net operating revenue.

Table A.11. Economic effects of Alternative 4B, in 2009 dollars.

	Charterboat	Headboat	Private	Total
Northeast Florida/Georgia				
CS	2,358,390	2,422,316	8,025,388	12,806,094
NOR	655,815	3,395,515		4,051,329
Total	3,014,205	5,817,830	8,025,388	16,857,423
Southeast Florida				
CS	148,462	54,578	419,513	622,552
NOR	67,868	487,576		555,444
Total	216,330	542,153	419,513	1,177,996
South Carolina				
CS	478,680	2,846,388	761,401	4,086,469
NOR	95,791	695,673		791,465
Total	574,471	3,542,061	761,401	4,877,934
North Carolina				
CS	0	6,702	0	6,702
NOR	0	161,989		161,989
Total	0	168,691	0	168,691

CS = consumer surplus.
NOR = Net operating revenue.

Table A.12. Economic effects of Alternative 4C, in 2009 dollars.

	Charterboat	Headboat	Private	Total
Northeast Florida/Georgia				
CS	2,222,476	2,257,712	7,477,923	11,958,111
NOR	633,162	3,341,702		3,974,864
Total	2,855,638	5,599,414	7,477,923	15,932,975
Southeast Florida				
CS	148,462	54,578	419,513	622,552
NOR	67,868	487,576		555,444
Total	216,330	542,153	419,513	1,177,996
South Carolina				
CS	475,902	2,829,786	757,326	4,063,014
NOR	95,442	693,361		788,803
Total	571,344	3,523,146	757,326	4,851,817
North Carolina				
CS	0	6,702	0	6,702
NOR	0	161,989		161,989
Total	0	168,691	0	168,691

CS = consumer surplus.
NOR = Net operating revenue.

Table A.13. Economic effects of Alternative 4D, in 2009 dollars.

	Charterboat	Headboat	Private	Total
Northeast Florida/Georgia				
CS	2,231,794	2,269,089	7,516,041	12,016,924
NOR	634,715	3,345,421		3,980,137
Total	2,866,509	5,614,511	7,516,041	15,997,061
Southeast Florida				
CS	148,462	54,578	419,513	622,552
NOR	67,868	487,576		555,444
Total	216,330	542,153	419,513	1,177,996
South Carolina				
CS	477,273	2,837,981	759,338	4,074,592
NOR	95,615	694,502		790,117
Total	572,888	3,532,483	759,338	4,864,708
North Carolina				
CS	0	6,702	0	6,702
NOR	0	161,989		161,989
Total	0	168,691	0	168,691

CS = consumer surplus.
NOR = Net operating revenue.

Table A.14. Summary of economic effects, in 2009 dollars.

		FL_NE/GA	FL_SE	SC	NC	TOTAL
ALT. 2	CS	3,730,893	622,552	243,742	6,702	4,603,890
	NOR	3,234,078	555,444	355,326	161,989	4,306,837
	TOTAL	6,964,972	1,177,996	599,068	168,691	8,910,728
ALT. 3A	CS	13,242,550	622,552	243,742	6,702	14,115,547
	NOR	4,090,651	555,444	355,326	161,989	5,163,410
	TOTAL	17,333,201	1,177,996	599,068	168,691	19,278,957
ALT. 3B	CS	12,806,094	622,552	243,742	6,702	13,679,090
	NOR	4,051,329	555,444	355,326	161,989	5,124,088
	TOTAL	16,857,423	1,177,996	599,068	168,691	18,803,179
ALT. 3C	CS	11,958,111	622,552	243,742	6,702	12,831,108
	NOR	3,974,864	555,444	355,326	161,989	5,047,623
	TOTAL	15,932,975	1,177,996	599,068	168,691	17,878,731
ALT. 3D	CS	12,016,924	622,552	243,742	6,702	12,889,921
	NOR	3,980,137	555,444	355,326	161,989	5,052,896
	TOTAL	15,997,061	1,177,996	599,068	168,691	17,942,817
ALT. 4A	CS	13,242,550	622,552	4,585,965	6,702	18,457,770
	NOR	4,090,651	555,444	848,156	161,989	5,656,239
	TOTAL	17,333,201	1,177,996	5,434,121	168,691	24,114,009
ALT. 4B	CS	12,806,094	622,552	4,086,469	6,702	17,521,817
	NOR	4,051,329	555,444	791,465	161,989	5,560,227
	TOTAL	16,857,423	1,177,996	4,877,934	168,691	23,082,044
ALT. 4C	CS	11,958,111	622,552	4,063,014	6,702	16,650,380
	NOR	3,974,864	555,444	788,803	161,989	5,481,100
	TOTAL	15,932,975	1,177,996	4,851,817	168,691	22,131,480
ALT. 4D	CS	12,016,924	622,552	4,074,592	6,702	16,720,771
	NOR	3,980,137	555,444	790,117	161,989	5,487,686
	TOTAL	15,997,061	1,177,996	4,864,708	168,691	22,208,457

CS = consumer surplus.
NOR = Net operating revenue.

5.0 Discussion and Caveats

The following provides some discussion and caveats on the model and assumptions, in addition to those already noted in the preceding section. These are not listed in any implied order of importance.

a. MRFSS target trips – there are several potential measures of effort and thus of trips potentially affected by this amendment. Effort may be measured, generally in ascending magnitude, as target trips, harvest trips, catch trips, and directed trips. Target trips are those trips for which the angler stated a specific primary or secondary target species. Harvest trips are those trips for which the recreational catch was comprised of Types A or B1 fish. Type A refers to fish that were caught, landed whole, and available for identification and enumeration by the interviewers. Type B1 refers to fish that were caught and filleted, released dead, given away, or disposed of in some way other than being landed or released alive. Catch trips are those trips which caught the species and for which the recreational catch was comprised of Types A, B1, and B2 fish. Type B2 refers to fish caught and released alive. Directed trips are a combination of two or more of the other trips noted above but are generally a combination of target and catch trips. The use of target trips in estimating economic effects is premised on the contention that these trips are closely related to recreational angler expectations and thereby carries more information generally embodied in angler demand functions (demand studies, and the estimated values they produce, generally are based on target trips). The other types of trip, particularly the directed trips, may also be relevant for economic analysis since they embody both intent and the fact that anglers caught the species of interest. The use of target trips may not fully capture the economic effects of this amendment. However, the use of other types of trips (i.e., non-target trips) would probably result in lower estimates of the value per trip or per fish as someone less interested in catching a particular species would be expected to value that species less.

   Another issue with MRFSS target trips pertains to estimating the number of target trips by grid and depth. Effort by grid and depth is not directly available in the recreational data. Instead, target trips by grid and depth were derived using the same ratio of snapper grouper trips in each grid and depth assigned to headboat trips. The possible differences in fishing areas and depths between headboats and charterboats as well as between headboats and private boats would introduce bias of unknown magnitude into the estimates of MRFSS target trips by grid and depth. It is likely, however, that this bias would not significantly alter the ranking of alternatives or the distribution of economic effects by area.

b. Headboat target trips – unlike MRFSS, the headboat survey does not collect target intent information. Target trips (TTRED and TTSG) were derived using equations (3) and (4). Vital to the derivation of TTRED are three terms: EAD, $CRAD_{red}$, and $CRAD_{sg}$. NMFS (Beaufort) derived EAD by adjusting CRAD for missing information. CRAD was calculated from the catch records by adding up all angler days per trip, and angler days per trip were calculated by multiplying the number of anglers per trip by the length of the trip. The length of the trip was normalized to 12 hours as one angler day. For the current analysis, CRAD is identical to $CRAD_{sg}$. A similar approach was used here to calculate $CRAD_{red}$ by including only those trips with catches of red snapper. For most trips, the number of anglers far exceeded the number of red snapper caught, resulting in relatively low average red snapper per angler. This method of calculation assumed that all anglers in a trip with catches of

red snapper would be uniformly affected by the red snapper ban proposed in this amendment. To the extent that some anglers did not expect to catch red snapper, this method of calculation would overestimate the number of angler days (trips) affected by the red snapper ban. Overestimation of affected target trips would also result if anglers who normally catch or expect to catch red snapper chose some other species to target. Other methods of calculating $CRAD_{red}$ also exist. For one method, the number of anglers per trip could be restricted to equal the number of red snapper caught in that particular trip. Another method would be to include only those trips showing an average catch of at least one, or some other level, of red snapper per angler. These and other possible methods would also be accompanied by their own implicit assumptions. For example, restricting the number of anglers to the number of red snapper caught would assume a zero value of the opportunity to catch red snapper afforded to the uncounted anglers. These other methods were not explored in this analysis.

The estimation of $CRADSG_{grid}$ utilized three important terms: EAD, $CRAD_{sg}$, and $CRADSG_{grid}$. The first two terms are similar to those used to calculate TTRED. $CRADSG_{grid}$ was estimated in the same way as $CRAD_{red}$ but this time only trips assigned to the subject grids were included. Catch records reported by headboat operators contain grid information, but not all reported trips contain this information. No adjustments were made for trips with missing grid information, and only trips with grid information were included in estimating $CRADSG_{grid.}$ This approach would likely underestimate, to an unknown extent, the number of trips actually taken in those various grids.

Another issue relates to the assignment of headboat angler trips by depth. In the absence of depth information in headboat trip reports, depth information from logbook reports of commercial vessels was used. It is likely commercial vessels fish for various snapper grouper species in depths different from headboats. This would introduce bias of unknown magnitude to the assignment of headboat angler trips by depth, and in turn would affect the estimation of economic effects from the fishing closure of various grids and depths.

c. Average fish landed – considering the various types of trips discussed above, there is no one-to-one correspondence between landed fish and target trips. Some species of fish are landed without being targeted and some target trips do not catch the targeted species. Under the methodology of assigning economic values to target trips only and of putting an economic value to each fish landed, the derivation of average fish per angler target trip resulted in very low numbers in some cases and very high numbers in others. To some extent, this approach would compensate for over- and under-estimation of target trips in calculating the changes in CS due to the various alternatives. Since the methodology was consistently applied across all alternatives, the ranking of alternatives would not be affected.

d. Consumer surplus (CS) – a value of $80 (2009 dollars) per fish, per angler, per trip was used for this amendment. This value is for a snapper grouper trip and is derived from a study conducted in North Carolina (Dumas et al. 2009). Other estimates are

provided by other studies, some higher and others lower. The value used was chosen because it was derived from a study using more recent data collected from a state in the South Atlantic. The chosen value is comparable to the values used in earlier amendments and is also close, on average, to the value generated in a recent study re-analyzing earlier survey data. It should be noted that the use of a constant value of consumer surplus across all areas and fishing modes does not take into account possible differences in valuation across areas and modes. In addition, the value used is based on an estimate of a unit increase in targeted catch and keep and, thus, may not fully reflect the CS loss when the entire red snapper fishery is closed, or certain areas are closed to snapper grouper fishing. However, because the value and methodology was used consistently across all alternatives, the ability to rank alternatives should not be affected.

e. Net operating revenue (NOR) – The values of $128 and $68, respectively, for charter and headboat NOR per angler trip were used in this amendment. Other estimates are provided by other studies, some higher and others lower. The NOR values used were chosen because they were derived from a study using more recent data collected from a state in the South Atlantic (Dumas et al. 2009). The values used are comparable to the values used in earlier amendments as well as to the values from other studies. In addition, the use of these values as opposed to other values should not affect the ranking of alternatives and the relative distribution of changes in NOR. However, it is noted that the use of these values does not take into account differences in charter and headboat operations by area.

f. Economic effects – the economic effects of the fishing ban on red snapper in the EEZ and snapper grouper in certain grids were estimated under the assumption that the affected trips would be cancelled. This assumption would rule out the possibility that anglers may opt to target other species in the affected areas or snapper grouper species in areas that remain open. This assumption, however, should not alter the ranking of alternatives or the distribution of economic effects by area, unless the likelihood of these behaviors differs by alternative.

g. Period of analysis – although the proposed alternatives would establish management measures that would remain in effect for a number of years until lifted or replaced by other management measures, the estimated economic effects of the alternative prohibitions represent single year, annual effects. As such, they would be expected to re-occur in each subsequent year. However, as the measures remain in effect, anglers and fishing businesses would be expected to adapt to these measures, with anglers learning to target alternative species in the open areas and for-hire operations developing new services or different for-hire experiences to offer, thereby reducing the adverse effects in subsequent years. However, it is noted that some anglers may elect to substitute completely different recreational activities and some fishing businesses may not be able to adequately adapt to the new regulations and survive as viable business operations.

h. Effects of recent and pending amendments – several amendments have been recently implemented or are in the process of being implemented. The effects of these

amendments are not explicitly considered in estimating the economic effects of this current amendment. The overall economic effects of this amendment may be less than described if the effects of these other amendments reduce the baseline of the fishery from that used in this analysis. While such would not affect the cumulative effect of all these amendments, the incremental effect of this amendment would be reduced.

6.0 Sensitivity Analysis

The Scientific and Statistical Committee (SSC) of the South Atlantic Council suggested the following alternatives to improve the analysis of economic effects on the recreational sector (SSC 2009):

a. The analysis could value the loss of recreational harvest by attaching economic value of one fish harvest to proposed reductions in harvest. The value of one fish harvest should be obtained from a behavioral model that incorporates species-substitution opportunities.
b. The analysis could value the loss of target trips by attaching economic value of lost trip taking opportunities to the lost trips. The value of lost trip taking opportunities should be obtained from a behavioral model that incorporates substitution opportunities.
c. The analysis could conduct sensitivity analysis around the assumptions that likely result in overestimates of economic effects. For example, considering the second point above, an analysis that cancels 75%, 50%, and 25%, in addition to 100%, of target trips would highlight the sensitivity of results to the assumption.

The SSC recommended pursuing the third alternative. To some extent, the analysis already took account of the first suggestion. The CS value used in estimating changes in CS was derived from a behavioral model; however, the CS value generated was expressed as an average value per fish. For this reason, the average number of fish harvested per angler trip was used in equation (1) above to account for changes in CS when anglers harvested other than 1 fish. This approach, nevertheless, would not directly account for species substitution.

In pursuing the third alternative, two sets of sensitivity analyses were conducted. The first set considered various levels of trip cancellation. The second set also considered various levels of trip cancellation and, in addition, assumed the average number of snapper grouper harvest per angler trip was the same as the average number of red snapper harvest per angler trip. The second analysis was conducted because the estimated economic effects from the area closures were dominated by changes in CS. The tables below show only the overall results per alternative, and this is deemed adequate for the current purpose.

Table A.15 presents the analysis under various assumed level of trip cancellations. The estimates show relatively substantial differences in the estimates of economic effects under different assumptions of trip cancellation. It is possible the proposed regulations would severely limit the opportunities for recreational fishing, particularly for for-hire vessels, given current economic conditions and recently implemented regulations affecting the snapper grouper fishery. In a sense, this would support a higher level of trip cancellation. Over time, however, as

economic conditions improve and anglers as well as for-hire operators adjust to the regulations, fishing activities may return to their higher levels. It is possible then that trip cancellations may be high in the short-term but increase over time. One other feature in the tabulated estimates is that, for a given level of trip cancellation, the area closures, in addition to the red snapper fishing ban, would still result in relatively larger reductions in economic values when compared with the alternative that would only close the red snapper fishery. This issue is partly addressed in the second set of sensitivity analysis.

Table A.16 shows the overall economic effects of each alternative when assuming the average number of snapper grouper per angler trip fish harvested for snapper grouper to be the same as that for red snapper. For each mode and area, the estimated average number of snapper grouper harvest per trip far exceeded the corresponding average for red snapper. Largely because of this higher average number of snapper grouper harvest, the area closures were estimated to result in relatively substantial reductions in CS despite affecting fewer trips than the red snapper fishing ban. This analysis was conducted without implying that, in actuality, the average number of red snapper harvest per trip would be equal to or higher than the corresponding average for snapper grouper.

The results in Table A.16 still show the same pattern as those in Table A.15. This time, however, the introduction of area closures would not result in very large reductions in CS and in total economic values under each level of trip cancellation. For example, under the assumption of 100% trip cancellation, total economic effects would increase from $8.9 million under **Alternative 2** to $19.3 million under **Alternative 3A** (Table A.15). As shown in Table A.16, the corresponding economic effects would increase from $8.9 million to $11.2 million – the increase would still be substantial but not by a very large margin. It appears that the estimated changes in CS and total economic values are quite sensitive to the average number of fish used.

Table A.15. Summary of economic effects under different levels of trip cancellation, in 2009 dollars.

		Percent of Trips Cancelled			
		100%	75%	50%	25%
ALT. 2	CS	4,603,890	3,452,918	2,301,945	1,150,973
	NOR	4,306,837	3,230,128	2,153,419	1,076,709
	TOTAL	8,910,728	6,683,046	4,455,364	2,227,682
ALT. 3A	CS	14,115,547	10,586,660	7,057,774	3,528,887
	NOR	5,163,410	3,872,557	2,581,705	1,290,852
	TOTAL	19,278,957	14,459,218	9,639,478	4,819,739
ALT. 3B	CS	13,679,090	10,259,318	6,839,545	3,419,773
	NOR	5,124,088	3,843,066	2,562,044	1,281,022
	TOTAL	18,803,179	14,102,384	9,401,589	4,700,795
ALT. 3C	CS	12,831,108	9,623,331	6,415,554	3,207,777
	NOR	5,047,623	3,785,717	2,523,812	1,261,906
	TOTAL	17,878,731	13,409,048	8,939,365	4,469,683

ALT. 3D	CS	12,889,921	9,667,441	6,444,960	3,222,480
	NOR	5,052,896	3,789,672	2,526,448	1,263,224
	TOTAL	17,942,817	13,457,112	8,971,408	4,485,704
ALT. 4A	CS	18,457,770	13,843,327	9,228,885	4,614,442
	NOR	5,656,239	4,242,180	2,828,120	1,414,060
	TOTAL	24,114,009	18,085,507	12,057,005	6,028,502
ALT. 4B	CS	17,521,817	13,141,363	8,760,909	4,380,454
	NOR	5,560,227	4,170,170	2,780,113	1,390,057
	TOTAL	23,082,044	17,311,533	11,541,022	5,770,511
ALT. 4C	CS	16,650,380	12,487,785	8,325,190	4,162,595
	NOR	5,481,100	4,110,825	2,740,550	1,370,275
	TOTAL	22,131,480	16,598,610	11,065,740	5,532,870
ALT. 4D	CS	16,720,771	12,540,578	8,360,385	4,180,193
	NOR	5,487,686	4,115,765	2,743,843	1,371,922
	TOTAL	22,208,457	16,656,343	11,104,228	5,552,114

CS = consumer surplus.
NOR = Net operating revenue.

Table A.16. Summary of economic effects under different levels of trip cancellation and assuming the same average number of fish harvested for red snapper and snapper grouper, in 2009 dollars.

		Percent of Trips Cancelled			
		100%	75%	50%	25%
ALT. 2	CS	4,603,890	3,452,918	2,301,945	1,150,973
	NOR	4,306,837	3,230,128	2,153,419	1,076,709
	TOTAL	8,910,728	6,683,046	4,455,364	2,227,682
ALT. 3A	CS	6,081,456	4,561,092	3,040,728	1,520,364
	NOR	5,163,410	3,872,557	2,581,705	1,290,852
	TOTAL	11,244,866	8,433,649	5,622,433	2,811,216
ALT. 3B	CS	6,013,688	4,510,266	3,006,844	1,503,422
	NOR	5,124,088	3,843,066	2,562,044	1,281,022
	TOTAL	11,137,777	8,353,333	5,568,888	2,784,444
ALT. 3C	CS	5,881,955	4,411,466	2,940,978	1,470,489
	NOR	5,047,623	3,785,717	2,523,812	1,261,906
	TOTAL	10,929,578	8,197,184	5,464,789	2,732,395
	CS	5,891,068	4,418,301	2,945,534	1,472,767

ALT. 3D	NOR	5,052,896	3,789,672	2,526,448	1,263,224
	TOTAL	10,943,964	8,207,973	5,471,982	2,735,991
ALT. 4A	CS	6,380,711	4,785,533	3,190,356	1,595,178
	NOR	5,656,239	4,242,180	2,828,120	1,414,060
	TOTAL	12,036,951	9,027,713	6,018,475	3,009,238
ALT. 4B	CS	6,278,520	4,708,890	3,139,260	1,569,630
	NOR	5,560,227	4,170,170	2,780,113	1,390,057
	TOTAL	11,838,746	8,879,060	5,919,373	2,959,687
ALT. 4C	CS	6,145,170	4,608,877	3,072,585	1,536,292
	NOR	5,481,100	4,110,825	2,740,550	1,370,275
	TOTAL	11,626,269	8,719,702	5,813,135	2,906,567
ALT. 4D	CS	6,155,081	4,616,310	3,077,540	1,538,770
	NOR	5,487,686	4,115,765	2,743,843	1,371,922
	TOTAL	11,642,767	8,732,075	5,821,383	2,910,692

CS = consumer surplus.
NOR = Net operating revenue.

References

Dumas, C.F., J.C. Whitehead, C.E. Landry, and J.H. Herstine. 2009. "Economic Impacts and Recreation Value of the North Carolina For-Hire Fishing Fleet." North Carolina Sea Grant FRG Grant Report 07-FEG-05.

NMFS (National Marine Fisheries Service). 2009a. "Response to the 7/10/09 Data Request for Amendment 17a to the Snapper Grouper Fishery Management Plan of the South Atlantic." 4 p.

NMFS (National Marine Fisheries Service). 2009b. "Economic Value of Angler Catch and Keep in the Southeast United States: Evidence from a Choice Experiment." NOAA SEFSC SSRG.

NMFS (National Marine Fisheries Service). 2009c. "Evaluating the Effects of Amendment 16 and Amendment 17A Regulations on Red Snapper Removals by South Atlantic Recreational Private and Charterboat Fisheries." SERO-LAPP-2009-05.

NMFS (National Marine Fisheries Service). 2009d. "Evaluating the Effects of Amendment 16 and Amendment 17A Regulations on Red Snapper Removals by South Atlantic Recreational Private and Charterboat Fisheries." SERO-LAPP-2009-07.

NMFS (National Marine Fisheries Service). 2008a. "Analysis of the Expected Economic Effects of the August 5 Closure of the 2008 Red Snapper Recreational Fishery in the Federal Waters of the Gulf of Mexico." NOAA SEFSC SSRG.

NMFS (National Marine Fisheries Service). 2008b. "Interim Rule to Reduce Overfishing of Red Snapper in the South Atlantic." NOAA SERO.

NMFS (National Marine Fisheries Service). 2004. "Review of Headboat Survey, Questions and Answers." NOAA SEFSC-BEAUFORT.

SSC (Scientific and Statistical Committee). 2009. "SSC Consensus Statements and Report for the December 2009 Meeting." Atlantic Beach, NC.