Economic Analysis of Possible Annual Catch Targets for the Commercial Snapper-Grouper Fishery

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Introduction

The Magnuson-Stevens Reauthorization Act of 2006 mandated that fishery management councils specify annual catch limits (ACLs) to end overfishing of managed species in their jurisdictions. In response to this mandate, the South Atlantic Council is preparing Amendment 17 to its snapper-grouper management plan to specify catch limits for 10 species in the management unit for which overfishing is occurring. These species are gag (*Mycteroperca microlepis*), black grouper (*M. bonaci*), red grouper (*Epinephelus morio*), snowy grouper (*E. niveatus*), speckled hind (*E. drummondhayi*), warsaw grouper (*E. nigritus*), tilefish (*Lopholatilus chamaeleonticeps*), vermilion snapper (*Rhomboplites aurorubens*), black sea bass (*Centropristis striata*) and red snapper (*Lutjanus campechanus*).

This report describes the results of a simulation model that calculated the expected economic effects of possible catch limits for the commercial fishery from North Carolina through the Atlantic side of the Florida Keys. These results are preliminary and likely will change as the proposed management alternatives and the simulation model evolve during the development of Amendment 17.

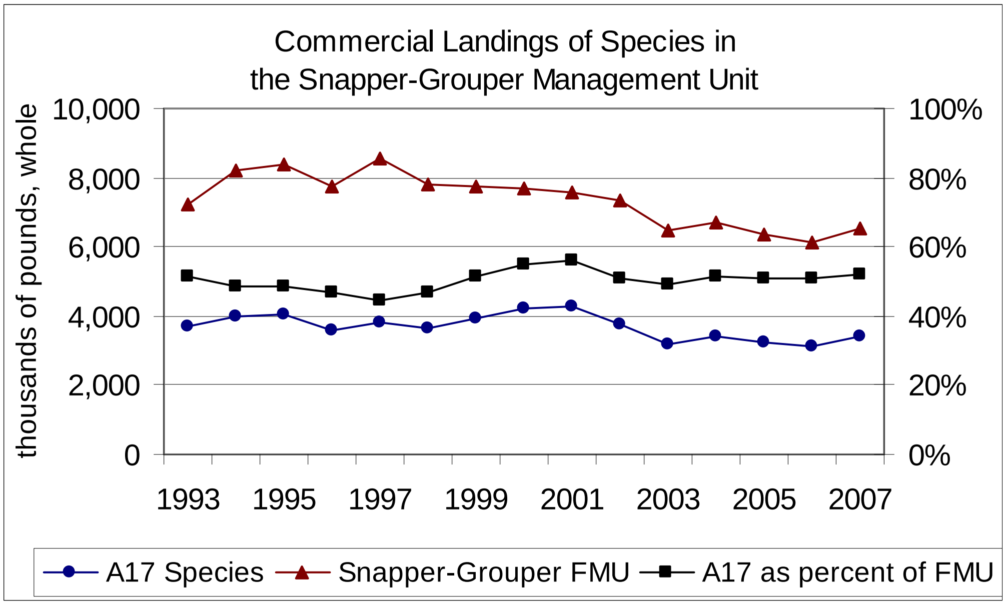
Historical Context

The snapper-grouper fishery consists of commercial and recreational sectors that harvest a variety of bottom dwelling snappers, groupers, sea basses, tilefishes, porgies, grunts, triggerfishes, jacks and wrasses. Many of these species inhabit reef outcroppings and reef-like structures that can be found by commercial and recreational fishermen with relatively inexpensive global positioning systems, which contributes to their vulnerability to overfishing.

Commercial fishermen are required to obtain permits to fish in federal waters for species in the snapper-grouper management unit, and all permit holders are required to submit logbook reports about their trips and catches in the snapper-grouper fishery. Logbook data are available for the 15-year time series encompassing 1993-2007. During this period, permit holders have reported landings in the snapper-grouper fishery that ranged from a peak of 8.5 million pounds worth $14.1 million in 1997 to a low of 6.1 million pounds worth $13.1 million in 2006 (Figure 1).

The ten species addressed in Amendment 17 represent an important part of the total commercial snapper-grouper fishery, and contributed between 45 percent and 55 percent of total snapper-grouper landings from 1993-2007 (Figure 1). Commercial landings of these 10 species remained relatively constant at approximately 3.9 million pounds per year between 1993 and 2001. Landings declined between 2001 and 2003 and then remained relatively constant at nearly 3.3 million pounds and 51 percent of total snapper-grouper landings between 2003 and 2007.

Figure 1. Commercial landings for the 10 species addressed in Amendment 17 compared to commercial landings for all species in the snapper-grouper fishery management unit (FMU).

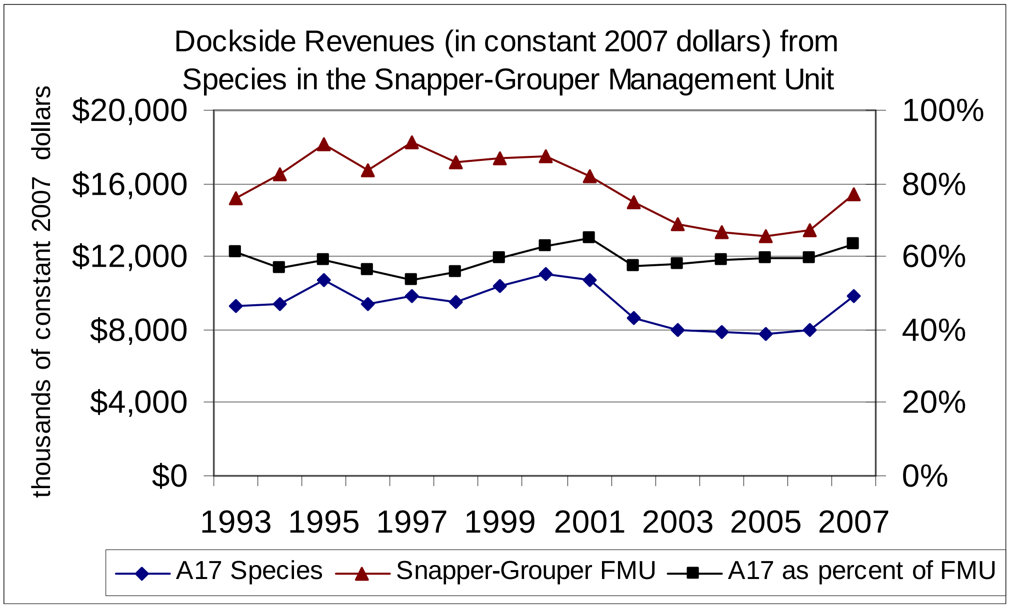


Source: NOAA Fisheries, Southeast Fisheries Science Center logbook database as of September 22, 2008.

These ten species represent an even larger portion of dockside revenues, and contributed between 54 percent and 65 percent of total snapper-grouper revenues from 1993-2007 (Figure 2).[1] Dockside revenues increased between 1993 and 2001, declined in 2002 and remained relatively stable until 2006, and then increased in 2007 to their highest level during the 1993-2007 period. However, after adjusting for inflation by using the consumer price index for all urban consumers, the adjusted dockside revenues in 2007 remained lower than in 1995 and 1999-2001 (Figure 2). Dockside revenues for the 10 species in Amendment 17 averaged 59 percent of total dockside revenues from all species in the snapper-grouper management unit from 1993-2007.

[1] Dockside revenues were calculated by multiplying landings per trip from the logbook database by average monthly prices for each species from the Accumulated Landings System maintained by NOAA Fisheries, Southeast Fisheries Science Center.

Figure 2. Dockside revenues in constant 2007 dollars for the 10 species addressed in Amendment 17 compared to dockside revenues for all species in the snapper-grouper fishery management unit (FMU). Constant 2007 dollars were calculated by adjusting dockside revenues for inflation as measured by the consumer price index for all urban consumers, given a 2007 base period.



Source: NOAA Fisheries, Southeast Fisheries Science Center logbook database as of September 22, 2008.

Possible Annual Catch Targets

Council staff provided two sets of possible annual catch targets (ACT) to be evaluated (Table 1). For each species, high and low values for the annual catch target were established according to the following criteria. For the commercial sector, the high (*i.e.*, liberal) value was calculated as 90% of the commercial allocation of allowable biological catch (ABC), and the low (*i.e.*, conservative) value was calculated as 64% of the commercial allocation.[2] The allowable biological catches were defined by the Council's Scientific and Statistical Committee. Commercial shares were defined in Amendment 15B as 68% for vermilion snapper, 51% for gag, and 95% for snowy grouper, and in Amendment 13C as 43% for black sea bass. If implemented by Amendment 17, allocation alternative 4[3] would result in commercial shares for the remaining species as

[2] For the liberal scenario, ACL=Sc*ABC, and ACT=Sc*0.9*ACL. For the conservative scenario, ACL=Sc*0.8*ABC, and ACT=Sc*0.8*ACL. ABC=Allowable Biological Catch; Sc=commercial share of ABC; ACL=Annual Catch Limit; and ACT=Annual Catch Target.

[3] Commercial shares are based on the sector allocations that would result from allocation alternative 4 in Amendment 17, where sector allocation is calculated as 0.5 * (average annual catches from 1986-2007) + 0.5 * (average annual catches from 2005-2007) (personal communication from Richard Devictor, Council staff).

45% for black grouper, 48% for red grouper, 94% for (golden) tilefish, and 28% for red snapper. The allowable biological catches are zero for speckled hind and warsaw grouper, and hence no catch targets are specified. The commercial allocations and annual catch targets in Table 1 are preliminary and subject to change as Amendment 17 is developed.

Table 1. Allowable biological catches (ABC) and possible annual catch targets (ACT) for the commercial fishing sector for ten species in the snapper-grouper management unit. Units are pounds, whole weights. Tabled entries were provided by Richard Devictor, Council staff.

Species	ABC (pounds)	Allocation to Commercial Sector	Conservative ACT (Commercial)	Liberal ACT (Commercial)
Vermilion snapper	628,459	427,352	273,505	384,617
Gag	818,920	417,649	267,295	375,884
Black grouper	187,697	84,464	54.057	76,017
Red grouper	704,893	338,349	216,543	304,514
Snowy grouper	102,960	97,812	62,600	88,031
Speckled hind	0	0	0	0
Warsaw grouper	0	0	0	0
(Golden) tilefish	326,554	306,960	196,455	276,265
Black sea bass	847,000	364,210	233,094	327,789
Red snapper	42,000	11,760	7,526	10,584

The possible catch targets are well-below historical landings for most of the 10 species in Amendment 17, although landings in recent years also have been below their historical averages. A comparison of annual catch targets and historical landings for individual species is presented in Appendix A.

Method of Analysis

A simulation model was developed for Amendment 13C to analyze the short-term economic effects of management alternatives proposed for the commercial harvesting sector of the snapper-grouper fishery. The model was revised and used for the economic analysis of proposed alternatives in Amendment 15A, was modified for Amendment 16, and has been updated again for Amendment 17. A detailed description of the model, including a discussion of its strengths and weaknesses, was prepared for Amendment 16 and is reproduced in this report as Appendix B. A brief synopsis of the model appears in the following paragraphs.

The model uses logbook trip reports to simulate the short-term economic effects of proposed management alternatives. The general method of analysis is to hypothetically impose proposed regulations on individual fishing trips as reported to the logbook database. Each reported trip is examined with regard to a combination of proposed rules for all species, and the effects of the rules on trip catches, revenues and costs are calculated.

The simulated fishing incomes net of trip costs for specific combinations of management alternatives are compared to the no-action alternative to estimate the expected economic effects of the proposed alternatives for commercial fishermen. The no-action alternative is simulated as the status quo fishery without the proposed combination of rules. The difference between net operating revenues with rule-combination *a* and net operating revenues for the status quo fishery is interpreted as the expected economic effect that would result if combination *a* were implemented.

Application to Amendment 17

The possible annual catch targets were treated as commercial quotas in the simulation analysis of Amendment 17. Fishing was assumed to proceed with existing seasonal closures, trip limits, minimum size limits and other regulations until the commercial quota was filled, at which time the fishery for that species was closed for the remainder of its fishing year. All fishing years began on January 1 except for the fishing year for black sea bass, which began on June 1. Logbook data for the five year period 2003-2007 were used to simulate the fishery with the possible annual catch targets.

Commercial quotas defined by the catch targets for the ten species addressed in Amendment 17 were hypothetically imposed on the commercial fishery. The ten quotas were evaluated simultaneously to account for potential joint effects on the fishery because most trips land more than one species. This report considered two combinations of annual catch targets for Amendment 17. One combination considered the possible high catch targets for all 10 species, whereas the second combination considered the low catch targets for all 10 species.

The regulatory conditions that characterize the status quo fishery to be compared with the simulated outcomes for Amendment 17 depend on the regulations to be implemented by Amendment 16, which is being developed with management alternatives for gag and vermilion snapper. While a preferred commercial quota has been identified for gag, the final quota for vermilion snapper has not been determined. To accommodate this uncertainty, three management scenarios were simulated in addition to the two combinations of high and low catch targets that characterize Amendment 17. The first scenario characterizes the no-action alternatives for Amendment 16. The second scenario includes the proposed quota of 353,940 pounds, gutted weight, for gag and a quota of 385,000 pounds, gutted weight, for vermilion snapper. After adjustment for post-quota bycatch mortality, the effective quota for gag is 352,940 pounds, gutted weight, and for vermilion snapper is 324,000 pounds, gutted weight. The third scenario is characterized by the same quota for gag and a quota of 647,690 pounds for vermilion snapper. After adjusting for post-quota bycatch mortality, the effective quota for vermilion snapper is 612,690 pounds, gutted weight. Other commercial quotas have been proposed for vermilion snapper in Amendment 16, but these two were considered sufficient for this analysis given the preliminary status of Amendment 17. The regulatory scenarios that were simulated for this analysis are summarized in Table 2.

Table 2. Model names and descriptions of regulatory conditions that were simulated for the analysis of annual catch targets.

Model	Description
A16_NO ACTION	Regulatory conditions prior to implementation of Amendment 16
A16_VS30	Regulatory conditions given proposed quotas of 352,940 lbs (approx. 416,500 lbs whole weight) for gag and 612,690 lbs (approx. 680,100 lbs whole weight) for vermilion snapper, after adjustment for post-quota bycatch mortality.
A16_VS58	Regulatory conditions given proposed quotas of 352,940 lbs (approx. 416,500 lbs whole weight) for gag and 324,000 lbs (approx. 359,600 lbs whole weight) for vermilion snapper, after adjustment for post-quota bycatch mortality.
A17_LIBERAL	Regulatory conditions given high (*i.e.*, liberal) annual catch targets for all 10 species addressed by Amendment 17. Catch targets are not adjusted for post-quota bycatch mortality.
A17_CONSERVATIVE	Regulatory conditions given low (*i.e.*, conservative) annual catch targets for all 10 species in Amendment 17. Catch targets are not adjusted for post-quota bycatch mortality.

Finally, the simulation model was run for one year in this analysis. In principle, the model should simulate the fishery over several years to calculate the longer-term benefits and/or costs associated with managing and rebuilding fish stocks. In fact, the concepts of annual catch limits and annual catch targets were devised to accommodate uncertainty in the ability to predict the recovery of fish populations over time. This uncertainty has not been programmed into the simulation model.

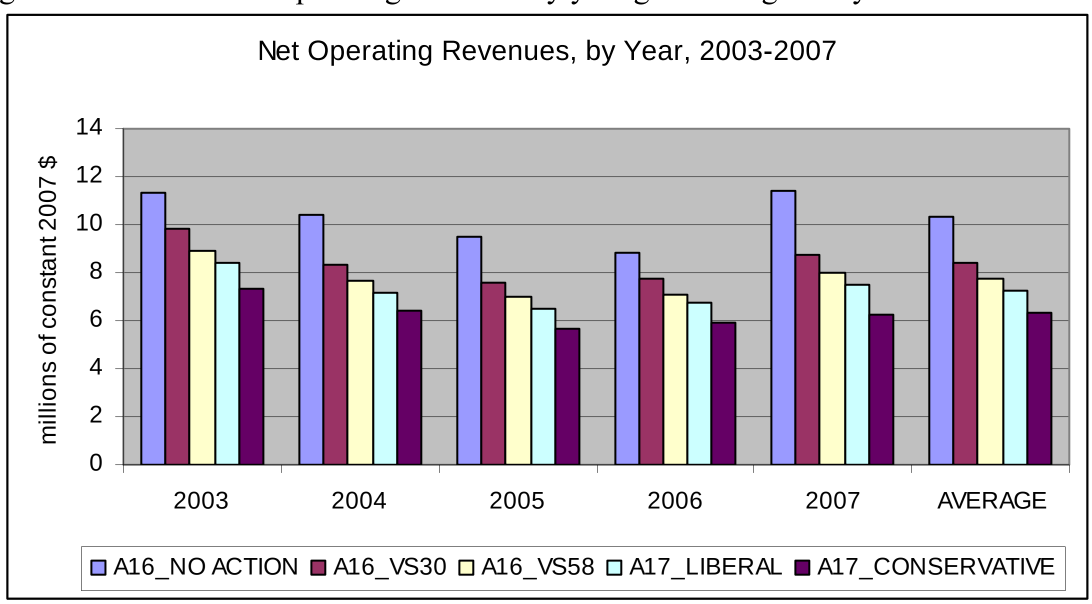
Results

On average from 2003-2007, 890 vessels made 14,665 trips that landed a total of 6.4 million pounds of species in the snapper-grouper management unit. Within this group, an average of 633 vessels made 6,942 trips that landed a total of 3.3 million pounds of the species to be addressed in Amendment 17. An average of 253 vessels made 2,230 trips that landed vermilion snapper; 310 vessels made 2,665 trips that landed gag; 247 vessels made 1,214 trips that landed black grouper; 402 vessels made 2,725 trips that landed red grouper; 160 vessels made 1,057 trips that landed snowy grouper; 64 vessels made 402 trips that landed (golden) tilefish; 237 vessels made 2,157 trips that landed black sea bass; and 220 vessels made 1,385 trips that landed red snapper. These totals reflect vessels that submitted trip reports to the logbook database and do not include vessels without federal permits that were not required to submit trip reports.

Given regulatory conditions without Amendments 16 or 17, the simulation model predicted that commercial fishermen would earn an average of approximately $10.3 million per year after deducting routine trip costs such as fuel, bait, ice, food and other supplies, but before accounting for fixed costs (Figure 3). This estimate represents income to boat owners, captains and crew members for their labor, plus income to boat owners to pay fixed costs and earn a return to capital invested in boat and equipment.

Figure 3 is interpreted as follows. The simulation model uses information from the recent past as a predictor of the near future. If environmental and biological conditions in the near future most closely resemble conditions that existed in 2007, for example, then the simulation model predicts that fishermen would earn $11.4 million without the regulatory constraints that would be implemented with Amendments 16 and 17. However, if environmental conditions in the near future most closely resemble conditions that existed in 2006, then the model predicts that fishermen would earn $8.9 million. Because the future is unknown and because environmental conditions vary over time, we do not know which year is the best predictor of the near future. Therefore, the 5-year average of $10.3 million is used as the expected predictor of the near future. During the 2003-2007 period, hindsight suggests that conditions in 2003 and 2007 yielded above average economic outcomes, conditions in 2004 yielded about average economic outcomes, and conditions in 2005 and 2006 yielded below average economic outcomes (Figure 3).

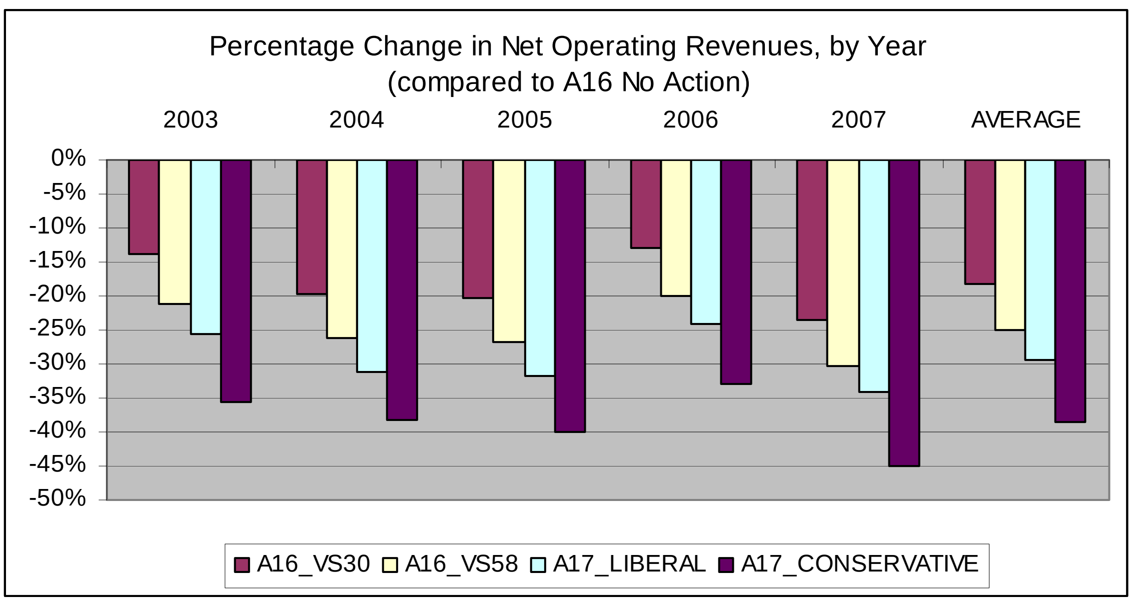
Figure 3. Predicted net operating revenues by year given 5 regulatory scenarios.



The additional regulations considered in Amendments 16 and 17 would reduce net operating returns to commercial fishermen. Figures 3 and 4 indicate that the expected reductions would be greatest if conditions in the near future most closely resemble conditions in 2007, and would be the smallest if conditions most closely resemble 2006. This result illustrates the commonsense notion that a given set of regulations will be more constraining when environmental and biological conditions are conducive to large catches, and will be less constraining when conditions are likely to yield small catches.

On average, the simulation model predicted that the management scenarios for Amendment 16 would reduce net operating revenues by 18% for model A16_VS30 and 25% for model A16_VS58 compared to regulatory conditions without Amendments 16 and 17, as defined by model A16_NO ACTION, and that the catch targets that could be implemented by Amendment 17 would reduce net operating revenues by 30% for model A17_LIBERAL and 39% for model A17_CONSERVATIVE (Figure 4). Therefore, the high catch targets would reduce net operating revenues by an additional 12% (=30% - 18%) when compared to Amendment 16 with the higher quotas for gag and vermilion snapper. The high catch targets would reduce net operating revenues by an additional 5% (=30% - 25%) when compared to Amendment 16 with the lower quotas for gag and vermilion snapper. Similarly, the low catch targets would reduce net operating revenues by an additional 21% (=30% - 18%) compared to Amendment 16 with the higher quotas for gag and vermilion snapper, and by an additional 14% (=30% - 25%) when compared to Amendment 16 with lower quotas for gag and vermilion snapper.

Figure 4. Predicted percentage changes in net operating revenues, by year given 5 regulatory scenarios.



Trips reported to the logbook database were classified by gear. On average from 2003-2007, 546 vessels made 5,132 trips with vertical hook-and-line gear and landed 2.27 million pounds, whole weight, of species in Amendment 17; 61 vessels made 575 trips with dive gear and landed 0.14 million pounds of species in Amendment 17; 50 vessels made 686 trips with fish pots and landed 0.48 million pounds of species in Amendment 17; 25 vessels made 232 trips with bottom longlines and landed 0.36 million pounds of species in Amendment 17; 88 vessels made 253 trips with trolling lines and landed 0.18 million pounds of species in Amendment 17; and 18 vessels made 64 trips with other gears, such as cast nets or gill nets, and landed 0.06 million pounds of species in Amendment 17.

Figure 5 illustrates that most fishing activities in the commercial snapper-grouper fishery use vertically suspended hook-and-line gear. Therefore, the magnitude of losses in net operating revenues associated with Amendments 16 and 17 would be incurred primarily by fishermen with vertical line gear. However, the predicted losses when expressed as percentages of baseline net operating revenues for fishermen with dive gear, longlines and fish pots could be substantial for some regulatory scenarios (Figure 6). Fishermen with dive gear potentially would be affected by restrictions on the harvest of groupers. Fishermen with fish pots potentially would be affected primarily by the low catch target for black sea bass. Fishermen with bottom longlines potentially would be affected primarily by both high and low catch targets for tilefish and snowy grouper.

Figure 5. Predicted net operating revenues, by gear given 5 regulatory scenarios.

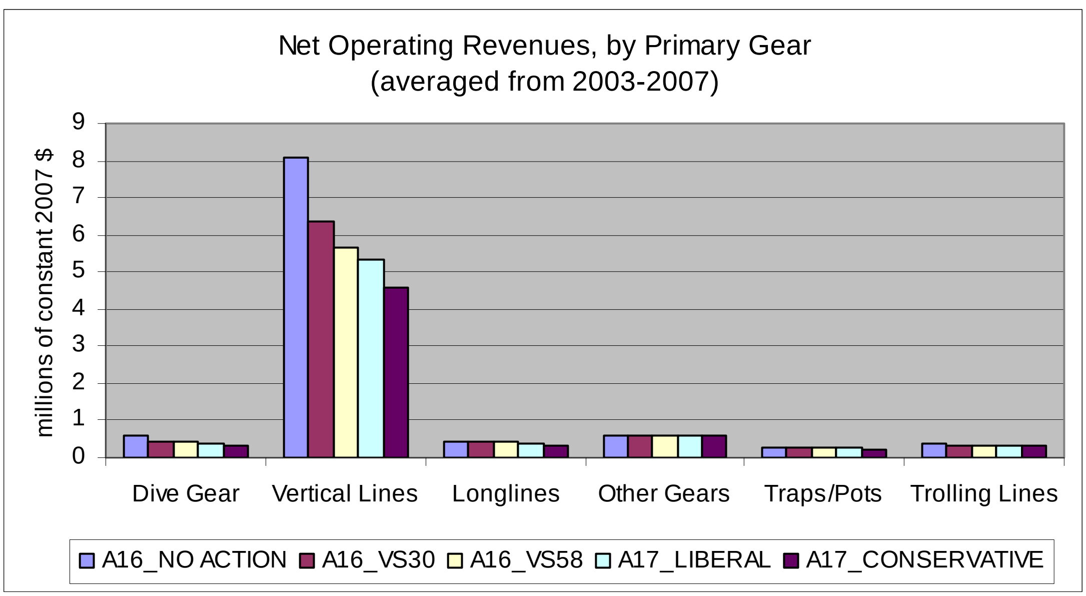
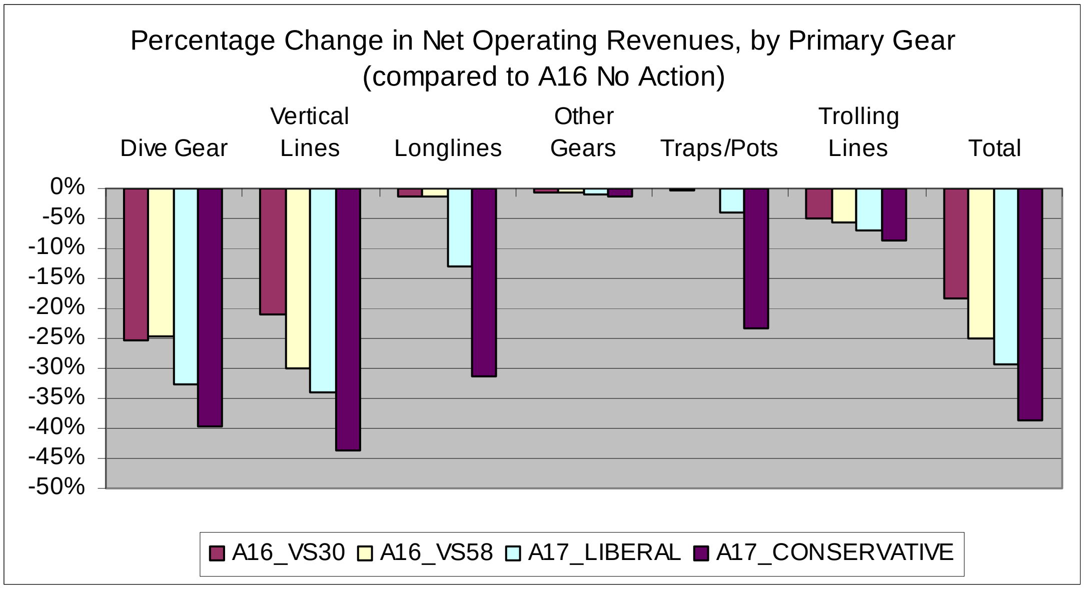


Figure 6. Predicted percentage changes in net operating revenues, by gear given 5 regulatory scenarios.



Trips reported to the logbook database also were classified according to the location of fishing activity. Regions were defined as North Carolina, South Carolina, Georgia and northeast Florida including Nassau, Duval and St. Johns Counties, central and southeast Florida from Flagler through Miami-Dade Counties, and the Atlantic side of the Florida Keys in Monroe County. On average from 2003-2007, 147 vessels made 2,405 trips in North Carolina and landed 1.26 million pounds, whole weight, of species in Amendment 17; 64 vessels made 910 trips in South Carolina and landed 1.0 million pounds of species in Amendment 17; 44 vessels made 468 trips in Georgia and northeast Florida and landed 0.47 million pounds of species in Amendment 17; 169 vessels made 1,356 trips in central and southeast Florida and landed 0.39 million pounds of species in Amendment 17; and 230 vessels made 1,804 trips in the Florida Keys and landed 0.16 million pounds of species in Amendment 17.

Figure 7 indicates that the 5-year average of net operating revenues earned without management actions proposed in Amendments 16 and 17 are about equal for South Carolina, central and southeast Florida, and the Florida Keys. In aggregate (and not necessarily individually), fishermen in North Carolina earned slightly more net operating revenues, while fishermen in Georgia and northeast Florida earned slightly less.

Figures 7 and 8 indicate that the incidence of possible management actions in Amendments 16 and 17 primarily would affect fishermen in North Carolina, South Carolina, and Georgia and northeast Florida. This result occurs because the species to be managed in Amendments 16 and 17 primarily exist in these areas. Except for (golden) tilefish, fishermen in central and southeast Florida tend to land other species, such as in the jacks family, in the snapper-grouper fishery. Fishermen in the Florida Keys also tend to land other species, such as yellowtail snapper, in the snapper-grouper fishery.

Figure 8 indicates that Amendment 16 with high quotas for gag and vermilion snapper could reduce net operating revenues by an average of 20% in North Carolina, and 30% in South Carolina and Georgia and northeast Florida. Amendment 16 with low quotas for gag and vermilion snapper could reduce net operating revenues by 34% in North Carolina, 40% in South Carolina, and 45% in Georgia and northeast Florida. Amendment 17 with high catch targets could reduce net operating revenues by an average of 37% in North Carolina, 45% in South Carolina, and 55% in Georgia and northeast Florida. Finally, Amendment 17 with low catch targets could reduce net operating revenues by an average of 50% in North Carolina, 60% in South Carolina, and 65% in Georgia and northeast Florida.

Figure 7. Predicted net operating revenues, by location of fishing activity given 5 regulatory scenarios.

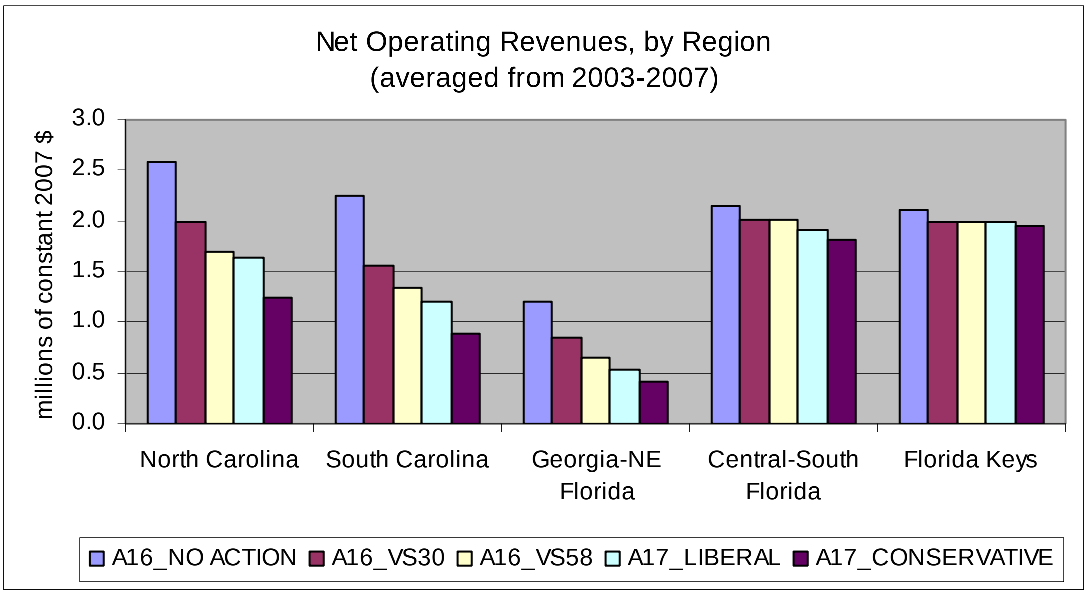
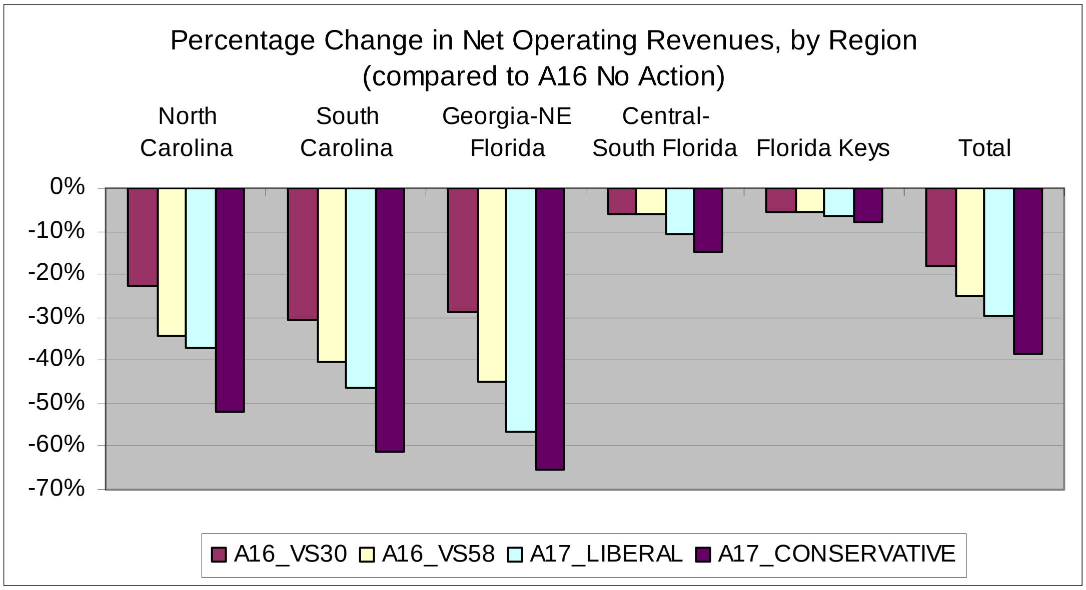


Figure 8. Predicted percentage changes in net operating revenues, by location of fishing activity given 5 regulatory scenarios.



The expected reductions in net operating revenues associated with Amendments 16 and 17 could lead to additional losses in terms of reduced economic activity in local communities and surrounding regions as lower incomes for fishermen cause their consumer and business spending to contract. Normally in a smoothly running economy, these regional economic impacts are not expected to be large because the commercial fishing sector is not a major source of employment and income in many communities. Fuel not sold to fishermen, for example, probably could be sold elsewhere. And fishermen who leave the fishery probably would find employment elsewhere. However, the economy currently is not running smoothly. Suppliers of fishing inputs may not find other buyers as quickly, and opportunities for fishermen to find other employment quickly are not certain. Hence, there could be a reduction in local and regional economic activity associated with implementation of Amendments 16 and 17. The simulation model described in this report focuses on the direct economic effects of proposed management actions on the commercial fishing sector and does not account for potential indirect effects on local and regional economies.

Summary

This report described the results of a simulation model that calculated the expected economic effects of possible catch limits to be defined by Amendment 17 for the commercial snapper-grouper fishery. Five management scenarios were simulated. The baseline scenario assumed management conditions without Amendments 16 or 17. Because Amendment 16 is still being developed, two scenarios were simulated, one with a higher quota for vermilion snapper and the other with a lower quota. Two management scenarios were simulated for the catch limits to be defined in Amendment 17, one with higher catch limits and the other with lower catch limits.

The analysis suggests that the possible catch limits could reduce net operating revenues for commercial fishermen by an overall average of approximately 30% for the management scenario with high catch limits and by nearly 40% for the scenario with low catch limits. The costs associated with these management scenarios would be borne primarily by fishermen who use vertical line gear and by fishermen in North Carolina, South Carolina, and Georgia and northeast Florida.

These results are preliminary and likely will change as the proposed management alternatives and the simulation model evolve during the development of Amendments 16 and 17.

Appendix A

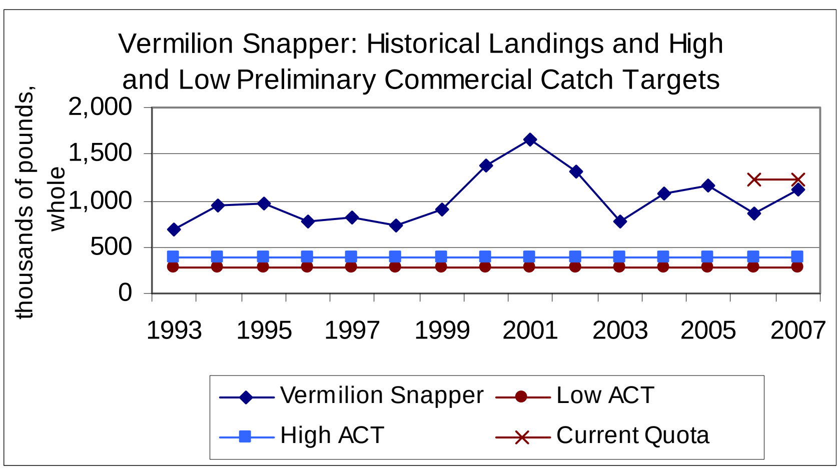
Comparison of Annual Catch Targets with Historical Landings for the Commercial Snapper-Grouper Fishery, by Species

Vermilion Snapper

Commercial fishermen landed an average of slightly less than 1.0 million pounds, whole weight, of vermilion snapper between 2003 and 2007. Therefore, the possible high catch target of 384,617 pounds is 60% smaller than average annual landings from 2003-2007, and the low catch target of 273,505 pounds is 70% smaller (Figure A1). Landings of vermilion snapper peaked in 2001 at 1.6 million pounds, whole weight.

The commercial fishery for vermilion snapper is managed with a 12 inch minimum size limit that was implemented by Amendment 1 in 1992. Amendment 13C implemented a 1.2 million pound (1.1 million pounds, gutted weight) quota in 2006. Amendment 16 is being developed and could reduce the quota for vermilion snapper by up to 60%. Hence, the net effect of Amendment 17 depends on the outcome of Amendment 16.

Figure A1. Comparison of possible annual catch targets for vermilion snapper with historical landings from 1993-2007.



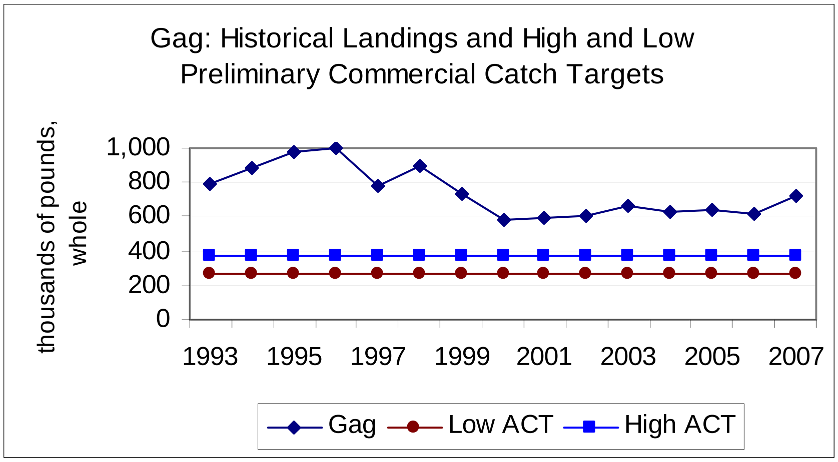
Source: NOAA Fisheries, Southeast Fisheries Science Center logbook database as of September 22, 2008.

Gag

Commercial landings of gag peaked in 1995 and 1996 and then declined through 2000 (Figure A2). At the end of February 1999, Amendment 9 implemented a 24 inch minimum size limit for gag and closed the commercial fishery for gag during the months of March and April. Landings of gag were relatively stable at approximately 630,000 pounds, whole weight, per year between 2000 and 2007.

The net effect of Amendment 17 depends on the outcome of Amendment 16.
Amendment 16 is being developed and could close the fishery for gag from January through April and implement a quota of 353,940 pounds, gutted weight, or approximately 417,600 pounds, whole weight. The possible high value of 375,884 pounds for the annual catch limit is 10% smaller than the proposed quota in Amendment 16 and 40% smaller than average annual landings from 2000-2007, while the low annual catch limit of 267,295 pounds is 36% smaller than the proposed quota and 57% smaller than average landings.

Figure A2. Comparison of possible annual catch targets for gag with historical landings from 1993-2007.



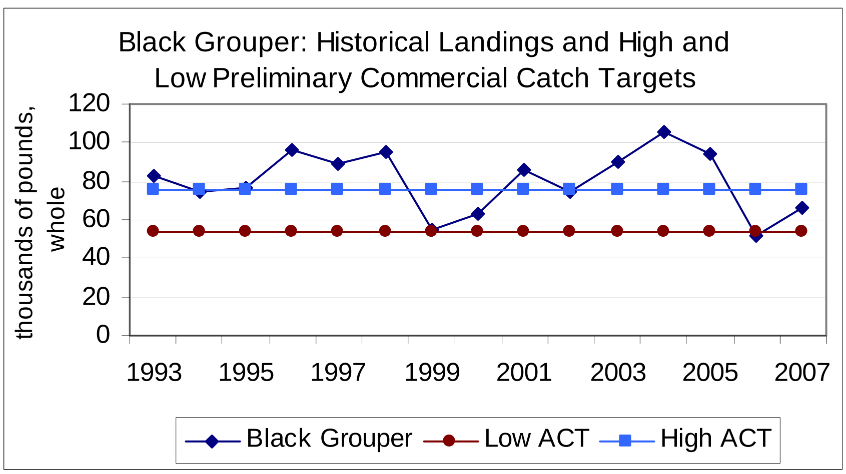
Source: NOAA Fisheries, Southeast Fisheries Science Center logbook database as of September 22, 2008.

Black Grouper

Commercial landings of black grouper ranged from 51,000 pounds, whole weight, in 2006 to 105,000 pounds in 2004, with a 5-year average of 81,400 pounds from 2003-2007 (Figure A3). These figures are approximations because logbook data were adjusted in an attempt to account for potential species misidentification of gag for black grouper. Black grouper is primarily a southern species and fishermen sometimes use the term 'black grouper' as a common name for gag. Therefore, the landings of black grouper that fishermen reported on their logbooks from North Carolina through St. Johns County, Florida, were considered to be gag in this analysis. Based on this adjustment, the possible high catch target of 76, 017 pounds is only 6% smaller than average landings from 2003-2007, while the low catch limit of 54,057 pounds is 33% smaller.

Management tools for black grouper include a 24 inch minimum size limit and a seasonal closure during March and April that were implemented in 1999 by Amendment 9. Also, Amendment 16 is being developed and includes a proposal to extend the seasonal closure to include January through April. In addition, Amendment 16 would close the commercial fishery for black grouper when the quota for gag is filled. Hence, the net effect of Amendment 17 depends on the outcome of Amendment 16.

Figure A3. Comparison of possible annual catch targets for black grouper with historical landings from 1993-2007.



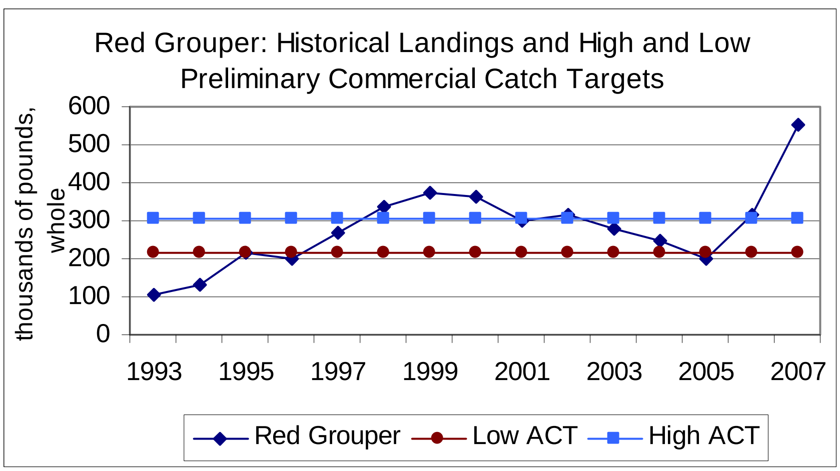
Source: NOAA Fisheries, Southeast Fisheries Science Center logbook database as of September 22, 2008.

Red Grouper

Commercial landings of red grouper increased from approximately 100,000 pounds, whole weight, in 1993 to 370,000 pounds in 1999 and then declined through 2005 (Figure A4). The sharp increase in landings from 200,000 pounds in 2005 to 550,000 pounds in 2007 might reflect an adjustment by fishermen to regulations on other species that were imposed in 2006 by Amendment 13C. The possible high catch target of 304,514 pounds is approximately equal to the 5-year average annual landings from 2003-2007 of 319,000 pounds, but is 45% smaller than landings recorded in 2007. The low catch target of 216,543 pounds is 32% smaller than the 5-year average landings and 60% smaller than landings in 2007.

Regulations for red grouper include a 12 inch minimum size limit that was implemented in 1983 by the original fishery management plan. Also, Amendment 16 is being developed and includes a proposal to close the commercial fishery for red grouper from January through April. In addition, Amendment 16 would close the commercial fishery for red grouper when the quota for gag is filled. The net effect of Amendment 17 depends on the outcome of Amendment 16.

Figure A4. Comparison of possible annual catch targets for red grouper with historical landings from 1993-2007.

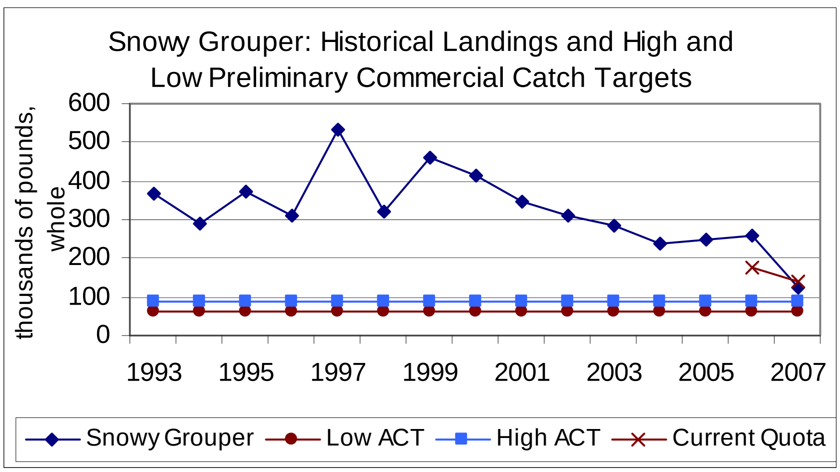


Source: NOAA Fisheries, Southeast Fisheries Science Center logbook database as of September 22, 2008.

Snowy Grouper

Commercial landings of snowy grouper peaked at 530,000 pounds, whole weight, in 1997, and have declined almost steadily since 1999 (Figure A5). Commercial quotas and trip limits were implemented in mid-1994 by Amendment 3. Tighter controls were implemented in late 2006 by Amendment 13C, which specified trip limits of 275 pounds, gutted weight, in 2006, 175 pounds in 2007, and 100 pounds in 2008 and thereafter until changed. The commercial quota was specified as 151,000 pounds gutted weight in 2006, 118,000 pounds in 2007, and 84,000 pounds in 2008 (approximately 99,000 pounds whole weight) and thereafter until changed. Therefore, the possible high annual catch target of 88,031 pounds, whole weight, is about 10% smaller than the current quota, and the low catch target of 62,600 pounds is 36% smaller.

Figure A5. Comparison of possible annual catch targets for snowy grouper with historical landings from 1993-2007.



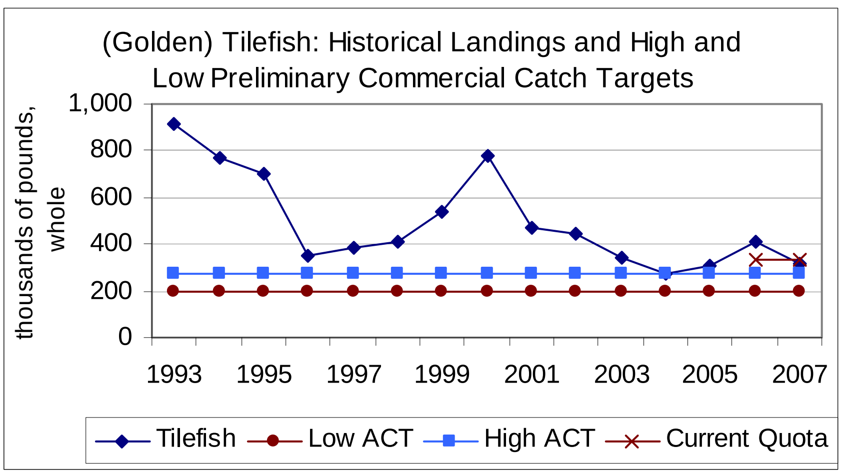
Source: NOAA Fisheries, Southeast Fisheries Science Center logbook database as of September 22, 2008.

(Golden) Tilefish

Commercial landings of (golden) tilefish have fluctuated widely (Figure A6). Within the 1993-2007 study period, landings declined from more than 900,000 pounds (whole weight) in 1993 to 350,000 pounds in 1996, and up to 775,000 pounds in 2000 before declining to an average of 330,000 pounds per year from 2003-2007.

A commercial quota and trip limit were first implemented in 1994 by Amendment 3. More restrictive management was implemented in late 2006 by Amendment 13C, including a commercial quota of 295,000 pounds gutted weight (approximately 331,000 pounds whole weight) and a trip limit that changed from 4000 pounds (gutted weight) to 300 pounds if 75 percent of the quota was filled by September 1. The possible high annual catch target of 276,265 pounds (whole weight) is approximately 16% smaller than the current quota, while the low catch target of 196,455 pounds is 40% smaller.

Figure A6. Comparison of possible annual catch targets for (golden) tilefish with historical landings from 1993-2007.



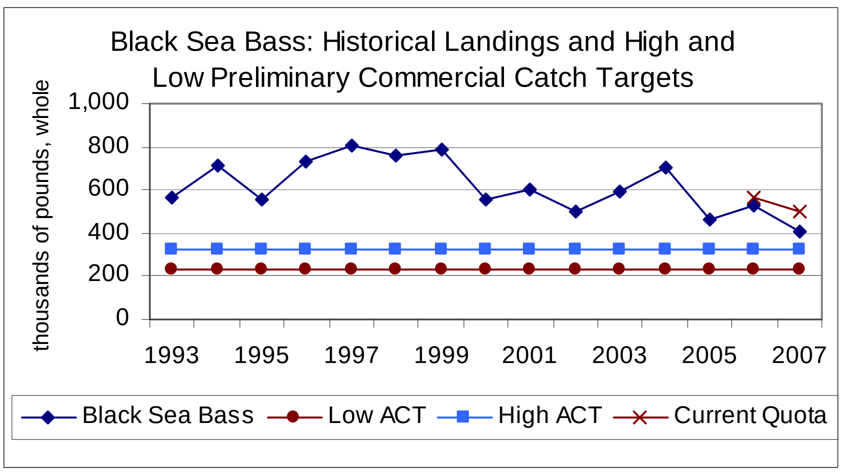
Source: NOAA Fisheries, Southeast Fisheries Science Center logbook database as of September 22, 2008.

Black Sea Bass

Commercial landings of black sea bass averaged almost 800,000 pounds (whole weight) from 1997 to 1999 (Figure A7). Landings generally declined since then to about 410,000 pounds in 2007.

Management measures for black sea bass include an 8 inch minimum size limit that was implemented in 1983 by the original fishery management plan and increased to 10 inches by Amendment 9 in 1999. More recently, Amendment 13C specified a fishing year from June 1 though May 31, and implemented a commercial quota of 477,000 pounds, gutted weight, for the 2006 fishing year, 423,000 pounds for the 2007 fishing year, and 309,000 pounds (approximately 364,000 pounds whole weight) for the fishing year that began in June 2008. Therefore, the possible high annual catch target of 327,789 pounds, whole weight, is about 10% smaller than the current quota, and the low catch target of 233,094 pounds is 36% smaller.

Figure A7. Comparison of possible annual catch targets for black sea bass with historical landings from 1993-2007.

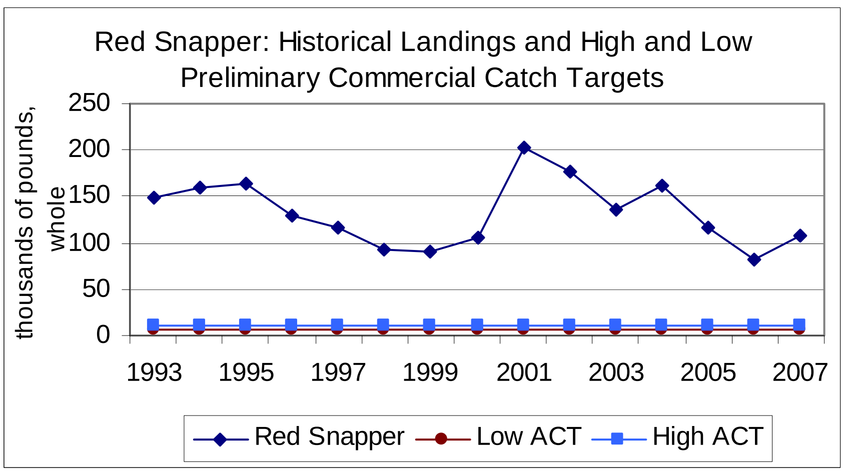


Source: NOAA Fisheries, Southeast Fisheries Science Center logbook database as of September 22, 2008.

Red Snapper

The commercial fishery for red snapper exhibited two periods of generally declining landings: from 1995 through 1999, and from 2001 through 2006 (Figure A8). Fishermen landed an average of approximately 102,000 pounds, whole weight, annually between 2005 and 2007. Therefore, the possible high annual catch target of 10,584 pounds, whole weight, is approximately 89% smaller than average landings from 2005-2007, and the low catch target of 7,526 pounds is 92% smaller. Red snapper was declared recently to be severely overfished; hence the relatively low values for the possible catch targets. Previous regulations for red snapper include a 12 inch minimum size limit that was implemented in 1983 by the original fishery management plan. The size limit was increased to 20 inches in 1992 by Amendment 1.

Figure A8. Comparison of possible annual catch targets for red snapper with historical landings from 1993-2007.



Source: NOAA Fisheries, Southeast Fisheries Science Center logbook database as of September 22, 2008.

Appendix B

An Economic Model to Analyze Management Alternatives Proposed for the Commercial Fishery in Amendment 16 to the Atlantic Snapper-Grouper Fishery Management Plan

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An Economic Model to Analyze Management Alternatives Proposed for the Commercial Fishery in Amendment 16 to the Atlantic Snapper-Grouper Fishery Management Plan

Abstract: *This report documents the economic model developed to analyze management alternatives proposed in Amendment 16 for the commercial snapper-grouper fishery in federal waters from North Carolina through the Florida Keys. The model uses trip-level data to simulate the effects of proposed management alternatives for vermilion snapper* (*Rhomboplites aurorubens) and gag* (*Mycteroperca microlepis*).

Introduction

The National Marine Fisheries Service found that the gag *(Mycteroperca microlepis)* resource along the U.S. south Atlantic coast is overfished and that additional management is required to rebuild the population to biologically acceptable levels. In addition, overfishing was found for the vermilion snapper (*Rhomboplites aurorubens*) resource and that reductions in fishing mortality are required to prevent the resource from declining below biologically acceptable levels. As a result, the South Atlantic Fishery Management Council prepared Amendment 16 to its Snapper-Grouper Fishery Management Plan to specify biological benchmarks and rebuilding plans for the management of gag, and to reduce fishing mortality for vermilion snapper to end overfishing. Amendment 16 considers a wide range of management alternatives for the commercial and recreational fisheries. This report describes the economic model developed to analyze management alternatives proposed in Amendment 16 for the commercial snapper-grouper fishery in federal waters from North Carolina through the Florida Keys.

Method of Analysis

Commercial fishermen in the Atlantic snapper-grouper fishery are required to submit logbook trip reports within 7 days of the completion of each trip. The general method of analysis in the model was to hypothetically impose proposed regulations on individual fishing trips as reported to the logbook database. Each reported trip was examined with regard to a combination of rules proposed in Amendment 16, and the effects of the rules on trip catches, revenues and costs were calculated. A six-year average was used to estimate the expected effects of proposed regulations so that anomalies that may have affected fishing success in any one year would be averaged out. Logbook data for the six year period, 2001-2006, were used to simulate the fishery with the proposed management alternatives for Amendment 16.

Logbook trip reports include information about landings by species, but do not include information about trip revenues. Therefore, average monthly prices were calculated from the NMFS Accumulated Landings System and merged with logbook trip reports by year, month, species and state. Trip revenues for each species were calculated as the product of average monthly prices and reported pounds per trip.

Information about trip costs was obtained from a sample of snapper-grouper boats that was required to report trip costs in 2002-2003 in conjunction with their normal logbook reporting requirements. Data that were collected included their costs per trip for major variable inputs such as fuel, bait, ice, food and other disposable supplies. Trip costs were estimated for each major gear type as a function of pounds landed, days per trip away from port, crew size and other trip characteristics, with the explanatory variables chosen to match the types of information reported for each trip in the logbook database (Perruso and Waters 2005).[4] Then, the estimated coefficients from the trip cost equations were used to calculate expected trip costs for each trip in the logbook database for 2001-2006. The expected trip costs were adjusted to constant 2005 dollars with the producer price index for #2 diesel fuel.[5]

Net operating revenues for trip j in year t were calculated as trip revenues from all species s, $TR_{j,t} = \sum R_{s,j,t}$, minus predicted trip costs, $TC_{j,t}$, which include fuel, oil, bait, ice, and other supplies, and exclude fixed costs and labor costs. Fixed costs were not deducted because data are not available with which to determine the fraction of each boat's fixed costs that should be allocated to species in Amendment 16 relative to its other fishing activities. Therefore, net operating revenues represent the return to fixed factors of production, labor (including crew) and boat owner. Net operating revenues were adjusted to constant 2005 dollars with the consumer price index for all items and all urban consumers.[6]

Fishermen were presumed willing to embark on a trip if net operating revenues exceeded an opportunity cost of labor defined as $50 per person per day fished in 2005. Opportunity cost does not measure actual payments to labor. Rather, it is used in the model as a proxy for the unknown minimum amount that fishermen would be willing to accept for each trip, and is used in the model to determine if trips are still worth taking after accounting for the effects of regulation. The proxy value of $50 per person per day

[4] Perruso, Lawrence A., and James R. Waters. 2005. Trip level cost function estimation for the south Atlantic snapper-grouper commercial fishery. Social Science Research Group Working Paper SEFSC SSRG 9, National Marine Fisheries Service, Southeast Fisheries Science Center, 75 Virginia Beach Drive, Miami FL 33149.

[5] The producer price index for #2 diesel fuel can be found at http://data.bls.gov. See series WPU057303.

[6] The consumer price index for all urban consumers can be found at http://data.bls.gov. See series CUUR0000SAO, which was adjusted to a 2005 base period for this study.

fished is slightly more than the current minimum wage rate of \$5.85 per hour for an 8-hour work day, which is the minimum that could be earned in less risky land-based employments. Opportunity cost was adjusted annually for changes in the cost of living between 2001 and 2006 with the consumer price index for all items and all urban consumers and a base year of 2005.

If trip revenues exceeded trip costs plus opportunity cost after accounting for the likely effects of proposed restrictions on trip-level harvests, then short-term economic losses were measured as the resulting reduction in trip revenues. Conversely, if the combination of proposed alternatives would cause trip revenues to fall below the sum of trip costs and opportunity cost, then the trip was recorded as not taken, and losses were measured as a reduction in net operating revenues, which included the loss in revenues from all species minus the savings of trip costs not incurred.

Net operating revenues for the combination of proposed rules denoted by *a* in rebuilding year *t*, $NOR_{a,t}$, were totaled for all trips within each logbook year, *k*, from 2001-2006, with annual totals averaged across all six years.

$$NOR_{a,t} = \frac{\sum_{k=2001}^{k=2006} \sum_{j=trips} (TR_{a,j,k} - TC_{a,j,k})}{6}$$

The six-year average is interpreted as the expected annual economic effect of the proposed combination of rules on industry net operating revenues in rebuilding year *t*, $NOR_{a,t}$. Each analysis was conducted for a single rebuilding year, $t = 2009$.

This approach is interpreted as follows. If 2009 is similar to fishing conditions that existed in 2006, then the analysis of proposed regulations with logbook data from

2006 would represent the predicted outcome of proposed regulations for 2009. However, if 2009 turns out to be similar to fishing conditions that existed in 2001, then the analysis of proposed regulations with data from 2001 would represent the predicted outcome for 2009. We do not know exactly what conditions will prevail in 2009; therefore we construct an average predicted outcome based on the six most recent years for which data are available.

The predicted outcome for rule-combination *a* is compared to the predicted outcome for no-action (*i.e.*, no additional management) to determine if the proposed alternatives are expected to generate net benefits or losses to commercial fishermen. The fishery without additional management was evaluated by simulating the effects of rules recently implemented by Snapper-Grouper Amendment 13C and rules to be implemented by Snapper-Grouper Amendment 15A with the historical logbook data from 2001-2006. Net benefits are expected to accrue to the fishery if the predicted outcome for rule combination *a* exceeds the predicted outcome without additional regulation. A net loss would accrue if the predicted outcome for rule combination *a* is less than the predicted outcome for no additional management. Because the analysis is short-term for rebuilding year 2009 only, we expect it to estimate the short-term losses associated with implementation of rules proposed in Amendment 16.

Method of Modeling Management Alternatives

This section describes the method of modeling the effects of management actions on the commercial snapper-grouper fishery. Management alternatives proposed in Amendment 16 or that have been implemented or proposed by Amendments 13C and

15A include minimum size limits, limits on catch per trip, seasonal closures, quotas, and limits on the numbers of black sea bass pots fished per trip. Each type of regulation was modeled by restricting the ability to catch and/or keep fish that were reported on logbook trip reports.

Minimum size limits:

Larger minimum size limits were modeled by assuming that an additional (when compared to the status quo) percentage, ρ_s^{msl}, of species s on each trip are undersized and must be culled from the catch and discarded.

$$q_{s,j,t} = h_{s,j,t}(1-\rho_s^{msl})$$

Variable $h_{s,j,t}$ represents quantity of species s caught on trip j in year t, and $q_{s,j,t}$ denotes quantity kept after accounting for the effects of the larger minimum size limit. Each trip is assumed to catch the same quantity of species s as without the size limit, but that undersized fish would be discarded and subject to release mortality. Revenues for species s on trip j, $R_{s,j,t} = p_{s,j,t}\ q_{s,j,t}$, are based on quantities kept, $q_{s,j,t}$, and price per pound, $p_{s,j,t}$. The harvest of other species on trip j, $h_{sp,j,t}$ for $sp \neq s$, is assumed not to be affected by the proposed minimum size limit for species s. If trip revenues exceeded trip costs after accounting for the proposed minimum size limit and other jointly-proposed rules, then the expected losses for trip j due to a minimum size limit were calculated as a reduction in trip revenues for species s, $p_{s,j,t}\ (q_{s,j,t} - h_{s,j,t})$. However, if the trip became unprofitable with the proposed combination of rules, then losses were measured as a reduction in net operating revenues, which included the loss in revenues from all species minus the savings of trip costs not incurred because the trip would not be taken, $\sum_s p_{s,j,t} h_{s,j,t} - TC_{j,t}$.

In the simulation model, trip costs are a function of total catch, including discards, and are not changed by the minimum size limit. Data were not available with which to estimate the potential additional costs of culling and discarding undersized fish.

The percentages that define the additional undersized fish associated with each proposed minimum size limit were held constant throughout the analysis and regardless of the alternatives proposed for other species in the fishery. When effective biologically, minimum size limits gradually change the age and size distribution of the resource and the percentage of undersized fish landed. However, this analysis does not include a biological component with which to endogenously determine changes in the proportion of undersized fish that would be landed each year.

These percentages refer to numbers of fish smaller than the proposed minimum size limits. However, the simulation model works with quantities of each species landed as reported on logbook trips rather than numbers of fish. Hence, this method of simulating the effect of minimum size limits is an approximation for the preferred method that would use numbers of fish, and is likely to overestimate the effect of the minimum size limit when the average weight per fish for species *s* exceeds 1 pound.

Mesh regulations for black sea bass pots:

Mesh regulations were implemented in Amendment 13C and affect the proportion of small fish that would be retained by fish pots. Hence, they were modeled in a similar way as minimum size limits by specifying the additional percentage, ρ^{mesh}, of fish on each trip that would be too small to be retained in fish pots. The primary difference between mesh regulations and minimum size limits is that mesh regulations affect catches and revenues from all species caught in pots, whereas the effects of minimum size limits are specific to species *s*. Although black sea bass constitute the bulk of catches in fish pots, mesh regulations are modeled to reduce the catch of all species that were landed with fish pots.

$$q_{s,j,t} = h_{s,j,t}(1-\rho^{mesh}) \qquad for\ all\ s$$

If trip revenues exceeded trip costs after accounting for larger mesh and other jointly-proposed rules, then losses were measured as a reduction in trip revenues for all species caught on trip *j* in year *t*, $\sum p_{s,j,t}\ (q_{s,j,t} - h_{s,j,t})$. Fish that would not be retained due to the larger mesh were assumed to have never been caught, and hence would not be subject to release mortality. Therefore, trip costs could change due to implementation of mesh regulations if empirical evidence suggests that trip costs are a function of total quantity harvested.

Some combinations of management alternatives would implement larger mesh regulations and larger minimum size limits. Since mesh regulations and minimum size limits both act to reduce the catch of smaller fish, the combined percentage, ρ_s^C, of species *s* that would be lost due to mesh and size limit regulations would be the greater of the two effects.

$$\rho_s^C = \max[\rho_s^{msl},\ \rho^{mesh}]$$

where ρ^{mesh} pertains to all species caught with pot gear on trip *j* and ρ_s^{msl} pertains only to species *s* for which the minimum size limit applies. The combined effects of mesh regulations and minimum size limits were modeled as:

$$q_{s,j,t} = h_{s,j,t}\,(1 - \rho_s^C)$$

Variable $\rho^{mesh} > 0$ only for pot gear. Otherwise, $\rho^{mesh} = 0$, and $\rho_s{}^C = \rho_s{}^{msl}$. If neither minimum size limits nor mesh regulations are proposed, then $\rho_s{}^C = 0$.

Limit on number of pots fished per trip:

A limit on the number of pots that may be fished per trip is modeled by restricting the number of pots to the pot limit, and reducing catch per trip proportionally. If $P_{j,t}$ denotes the number of pots reported for trip j in year t, and PL represents the pot limit, then

$$q_{s,j,t} = h_{s,j,t}\,\frac{PL}{P_{j,t}} \qquad \text{for } P_{j,t} > PL$$

$$q_{s,j,t} = h_{s,j,t} \qquad \text{for } P_{j,t} \le PL$$

Pot limits affect the ability to catch fish of all species on trips using pots. Hence, potential reductions in catch due to pot limits are considered in the model to occur prior to the effects of other kinds of management rules, such as minimum size limits and trip limits, that restrict the ability of fishermen to keep their catches.

Trip limits:

Trip limits for species s impose a maximum allowable catch per trip, and trips with catches of species s in excess of the trip limit, TL_s, were modeled by restricting their catches to the trip limit. Some management actions combine trip limits and minimum size limits and/or mesh regulations. In this event, the simulation model reduced catches according to the percentage, $\rho_s{}^C$, of undersized fish on trip j before determining if the trip limit would be restrictive.

$$q_{s,j,t} = TL_s \qquad when\ h_{s,j,t}(1-\rho_s^C) \geq TL_s$$

Losses attributable to the trip limit were measured as the value of the difference between catches for species *s* that would have occurred with and without the trip limit, $p_{s,j,t}\ [TL_s - h_{s,j,t}\ (1 - \rho_s^C)]$. Please note that losses due to the trip limit would be equal to the difference between the trip limit and reported catches, $p_{s,j,t}\ [TL_s - h_{s,j,t}]$, only when there were no proposed minimum size limits or mesh regulations. The portion of the overall loss measured by $[p_{s,j,t}\ h_{s,j,t}\ \rho_s^C]$ is attributable to the minimum size limit and/or mesh regulation rather than the trip limit. The quantity of species *s* in excess of the trip limit, after accounting for the effects of minimum size limits and mesh regulations, is assumed to have been caught, discarded, and subject to release mortality because the trip would continue in search of other species. In this event, trip costs would not change due to implementation of trip limits.

Trips with catches less than the trip limit, after accounting for the effects of minimum size limits and mesh regulations, would not incur additional losses due to the trip limit.

$$q_{s,j,t} = h_{s,j,t}(1-\rho_s^C) \qquad when\ h_{s,j,t}(1-\rho_s^C) < TL_s$$

The simulation model includes a behavioral assumption about the effect of trip limits on the duration of trips and the cost of fishing. Trips are modeled to terminate after the trip limit is filled if the regulated species is the primary source of revenue on the trip. In this event, trip costs are reduced due to the shorter trip duration and smaller quantity harvested. However, if the regulated species is not the primary source of revenue, then the trip is modeled to continue even if the trip limit is filled. In this event, fish caught in excess of the trip limit are presumed to be caught and discarded. Trip costs would not change.

Trip limits create an incentive for fishermen to take shorter, but more frequent fishing trips. However, this behavioral response has not been modeled for this analysis.

Seasonal closures:

Seasonal closures for species s were modeled by defining variable $open_s = 0$ when the season is closed for species s and $open_s = 1$ when it is open, and then multiplying by the reported catch of species s on trip j. Therefore, catch of species s would be affected by a seasonal closure policy only during the closed season; *i.e.*, $q_{s,j,t} = 0$ only when $open_s = 0$.

$$\begin{aligned} q_{s,j,t} &= h_{s,j,t}(1-\rho_s^C)\ open_s && when\ h_{s,j,t}(1-\rho_s^C) < TL_s \\ q_{s,j,t} &= TL_s\ open_s && when\ h_{s,j,t}(1-\rho_s^C) \geq TL_s \end{aligned}$$

Seasonal closures create an incentive for boats to re-schedule trips to minimize the likely effect of the closure. However, the model does not accommodate this type of behavioral adaptation to regulation. Logbook data record the month and day landed for each reported trip, and the duration of each trip so that start dates could be calculated. The model uses landed date to identify the trips that would be subject to the closure.

Quotas:

Fishery-wide quotas were modeled in a similar way as seasonal closures. The primary difference between seasonal closures and quotas is that seasonal closures have fixed beginning and ending dates, whereas quotas may or may not result in fishery closures. When quotas are filled, the closure dates vary annually depending on the speed at which the fishery lands its quota for species *s*. The closure extends through the end of the fishing year once the quota is filled.

The equations that describe the short-term economic effects of quotas are the same as already presented for seasonal closures. The model sets variable $open_s = 0$ to reflect a no-harvest rule resulting from seasonal closures or fishery closures after the quota is filled. Otherwise, it sets $open_s = 1$ to indicate that the fishery for species *s* is open and that trips are unaffected by either quota or seasonal closure.

The model compares the accumulated fishery landings of species *s* with its quota to determine if and when the fishery would be closed. This is accomplished by sorting logbook trip reports by year, month and day landed, and then performing a chronological trip-by-trip accumulation of landings that likely would occur given the selected combination of proposed management alternatives. The model sets $open_s = 1$ at the beginning of each fishing year, and sets $open_s = 0$ as soon as accumulated landings exceed the quota for species *s*.

Quotas tend to promote a race for fish as fishermen compete to maximize their shares of the overall catch before the fishery is closed. The model does not include the possibility that fishermen might accelerate their trips in anticipation of a fishery closure, or that dockside prices might fall if market gluts occur due to the accelerated harvesting activity. More work is needed on these issues since they are two of the primary outcomes of quota management.

Discussion of Model Strengths and Weaknesses

The logbook data used in this analysis reflect the full range of harvesting activities and outcomes for trips in the commercial snapper-grouper fishery, from targeted to incidental capture of various species, and included differences in species composition and fishing activities by area, gear, duration of trip, crew size, good luck and bad luck, and so forth. In this sense, this analysis is more realistic than conventional bioeconomic models, which specify homogeneous fishing activity within a few discrete fishing classes defined by vessel size, gear type, area fished, or scale of operation.

The use of logbook data to simulate the effects of proposed management actions is most appropriate in the short-term because logbooks report actual fishing behavior during a recent period of time. This type of simulation analysis assumes that fishing conditions in the near-future will be similar to conditions in the recent past, and that annual variations in model outcomes are associated with short-term anomalies rather than long-term trends in economic, biological, or environmental conditions.

The use of logbook data becomes less reliable for longer-term analyses because fishing effort and catch rates may change in response to changes in economic, regulatory and environmental conditions. Dockside fish prices, fuel prices and other input costs, the abundance of fish, regulation and other factors may change over time, and all interact to determine the profitability of fishing. Regulation tends to reduce the profitability of fishing, at least initially when first implemented, and fishing effort in the snapper-grouper fishery may decline if some trips switch to other species such as king mackerel. This analysis accounts for behavioral response by eliminating the currently observed trips that likely would become unprofitable given the proposed restrictions on the harvest and retention of vermilion snapper, gag snowy grouper, tilefish, black sea bass and red porgy. However, the simulation model does not account for more complex behavioral responses such as a redirection of fishing effort among different types of fishing as fishermen react to minimize the adverse effects of management. Conversely, fishing effort in the snapper-grouper fishery may increase over time if proposed regulations are successful in increasing the long-term abundance of economically important species. This analysis does not account for potential changes in fishing effort over time, and additional econometric analysis is needed to model this type of behavioral response to changes in resource abundance and regulation.

The outlook for future economic conditions in the commercial fishery has deteriorated, which may lead to reductions in fishing effort, landings and net revenues to boat owners, captains and crews that are independent of regulations proposed in Amendment 16. Fuel prices have increased since 2001, which makes fishing trips more costly and less profitable. In addition, increased commercial and residential development along the coast have increased land prices, reduced the availability of docking space and increased the costs of dockage. Higher ownership and operating costs for vessel owners and dockside fish buyers could lead to a long-term decline in commercial fishery landings with or without regulations proposed in Amendment 16. These declines would not be attributable to the implementation of Amendment 16.