Allocation Analysis of the Gulf of Mexico Gag and Red Grouper Fisheries

Prepared for:
Coastal Conservation Association

By:
Brad Gentner
Principal
Gentner Consulting Group

Table of Contents

Executive Summary

Grouper stocks are harvested by competing user groups and competition is increasing due to coastal population increases, falling total allowable catches (TAC) and changes in management regimes.

- TACs have been decreasing over the last few years due to stock concerns
- Coastal populations have been increasing
- Recreational effort has been increasing slightly
- Increasing use of rights based fishery management increases the need for allocation analysis before initial allocations are made
- Current management allows the allocation to creep between fisheries based on which sector catches the fish first

This report uses economics to analyze grouper allocations in the Gulf of Mexico. Economic value is the appropriate metric for examining allocations. Economic value includes those values accruing to commercial fishermen, for-hire recreational businesses, consumers, and recreational anglers. While total economic value is important, examining marginal willingness to pay (MWTP) using the equimarginal principle is the most appropriate way to estimate the allocation that maximizes value for all of society. The National Marine Fisheries Service uses the site choice random utility model as its standard model for estimating recreational marginal values. This paper estimates a site choice random utility model for grouper and compares the marginal willingness to pay estimates from this analysis to other analyses available in the literature.

- This study establishes the MWTP for gag grouper at $13.58/pound and red grouper at $13.51/pound.
- Haab et al (2008) find MWTP for grouper to fall between $5.15 and $58.78 per pound
- Gentner (2004) find gag grouper MWTP to be $19.37/pound and $19.27/pound for red grouper.
- Carter et al (2008) find current commercial MWTP for red grouper to be $1.25/pound with a range of $3.72/pound for a 0% allocation to $0.53/pound for a 100% allocation.
- Using the equimarginal principle, all recreational estimates of MWTP, with the exception of Carter et al (2008), are higher than commercial MWTP.
- The equimarginal principle indicates that societal value for gag grouper and red grouper is maximized with a 100% allocation to the recreational sector.
- Using Gentner (2004), quality increases for increase in allocation would exceed effort increases. This important result suggests that for a given change in an allocation there would be an increase in angling quality.

Economic impacts, while not appropriate for deciding allocations alone, provide important context on the distributional impacts of an allocation policy. The current total economic impacts for the commercial and recreational sectors are estimated below.

- Recreational gag grouper fishing generates $107 million in value added, $60.8 million in income and supports 1,523 jobs.
- Commercial gag grouper fishing generates $16 million in value added, $7.7 in income, and supports 322 jobs.

- Recreational red grouper fishing generates $35.2 million in value added, $20 million in income, and supports 501 jobs.
- Commercial red grouper fishing generates $49 million in value added, $23.7 million in income, and supports 988 jobs.
- The majority of the economic impacts in the commercial sector in both fisheries occur in the retail and restaurant sectors generating 51% of the jobs, 55% of the value added, and 30% of the income.
- It is likely that retail and restaurant sectors would experience very few losses with a 100% recreational allocation as consumers will readily substitute imported product or other fish species.

This report concludes that a 100% allocation to the recreational sector would maximize economic value to society. This report does not examine social impacts beyond the distributional information provided by the limited economic impact analysis. This analysis, like many, does not include an analysis of values accruing to the consumer sector nor the for-hire sector. Because consumers readily substitute for imports or other species, it is likely that including consumer values would do little to change this conclusion. If for-hire values were included, they would bolster the 100% allocation conclusion.

Introduction

Grouper stocks are harvested by competing user groups and the competition between those groups is intensifying as total allowable catches (TAC) are reduced for stock rebuilding. Additionally, in the Gulf of Mexico (GoM), the commercial red snapper fishery is under a rights based management regime and rights based management is currently being proposed for the grouper fishery. Historically in the United States (US), rights based systems have barred non-commercial interest from acquiring quota. If this prohibition continues, denying recreational anglers the ability to change allocation using market forces, changing allocations after a commercial rights based system has been imposed will likely become more difficult as the commercial fishery becomes rationalized. Therefore, it is very important to set the allocation correctly when implementing the initial allocation of the commercial rights.

As a result of this increasing pressure, the Gulf of Mexico Fishery Management Council (GMFMC) is developing guidelines for examining allocations between sectors. The reauthorization of Magnuson/Stevens includes language regarding the use of economic value in allocating stocks between sectors, and economic theory dictates the use of economic value when making allocation decisions.

The purpose of this report is to examine reallocation of the red and gag grouper fisheries using economic value as a metric. The report includes a brief discussion about the use of economics in the allocation of resources followed by a discussion of history of the allocations in these two fisheries along with recreational effort and catch trends. Next, estimates for recreational values for gag and red grouper in the GoM are estimated using a site choice random utility model, specified using the 2006 Marine Recreational Fisheries Statistical Survey (MRFSS) economic add-on survey data. Additionally, these estimates are compared to other recreational and commercial value estimates of gag and red grouper from the existing literature. Commercial value estimates were not generated in this analysis as the data needed to estimate commercial values is not publicly available. Instead, commercial value estimates have been taken from the literature. The analysis conducted herein suggests that allocation should be moved to the recreational sector, and a 100% recreational allocation maximizes benefits to society across both gag and red grouper fisheries.

A reallocation to the recreational sector of the entire total allowable catch may potentially create significant social impacts. While this analysis does not include a complete examination of social impacts, commercial and recreational economic impacts are estimated and used to discuss the potential distributional effects of a reallocation policy.

Economics of Allocation

Broadly defined, economists use two different metrics to examine the implications of policy decisions on society: economic value and economic impacts. The first, economic value, also known as economic benefit or welfare, monetizes the value society places on resources or activities. Economic value should be the metric used to decide between one course of action and another (Freeman 1993, Edwards 1990, and others).

The second, economic impacts, examines the flow of expenditures on fishery resource activities and products as that spending moves through a community. While economic impact measures should not be used to choose a course of action, they can be used to examine what particular sectors in the economy are hurt or helped by a particular policy and to what degree. Economic impact analysis examines the distribution of value changes identified when comparing benefits, making both types of analysis complementary.

Very few allocation studies have been conducted for saltwater recreational fishing. Kirkley, et al. (2000) conducted a study for striped bass allocation in Virginia. Carter, Agar, and Waters, 2008, conducted an allocation analysis for the red grouper fishery in the GoM. Their analysis will be discussed at greater length below. Edwards (1990) developed a guide for the allocation of fishery resources and this discussion follows his framework.

For both the recreational and commercial sectors, total value is the sum of consumer and producer surplus. Producer surplus is measured by examining the supply curves for commercial producers of seafood, including harvesters, processors, wholesalers, and distributors, as well as the supply curves for for-hire recreational service providers. Essentially, producer surplus is the difference between the cost of producing the good and the dollar value generated by the sale of the good. Consumer surplus is measured by examining the demand for goods at the consumer level including the demand for fish at markets and restaurants and the demand for recreational fishing trips. Consumer surplus is the difference between the amount society would be willing to pay for the good in question and what consumers actually paid for the good in the marketplace.

For the recreational sector, total value or net benefits is the sum of the consumer surplus from recreational fishing participants and producer surplus from for-hire charter and head boat operators. For the commercial sector, total value is the sum of consumer surplus from the purchase of seafood products in markets and restaurants and the producer surplus from harvesters, processors, wholesalers, and distributors of those fishery products.

Value is not static across all allocations, and, as any consumer obtains more of a good, the marginal value of obtaining the next unit of that good falls. That is, there are diminishing returns to additional consumption of any good and this is a fundamental tenet of consumer demand, which has important implications for allocation decisions. A similar tenet exists for producers, but does not always hold depending on the character of the industry. As a result, it is important to examine the schedule of these marginal values in each sector. Societal benefits are maximized at the allocation where commercial sector marginal value is equal to the marginal value from the recreational sector. This is known in economics as the equimarginal principle.

Estimating consumer surplus entails estimating demand curves for both the angling experience and for consumer purchases of seafood. On the recreational side of the equation, estimating consumer surplus involves specialized surveys of anglers. The National Marine Fisheries Service (NMFS) periodically collects the data necessary to estimate site choice recreational demand models. NMFS has spent considerable time and effort developing site choice models[1]

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[1] A partial list of the research in recreational site choice models conducted or sponsored by NMFS or using Marine Recreational Fisheries Statistical Survey data include: Gautam and Steinback (1998); Gentner (2007); Gentner and Lowther (2002); Gillig, Woodward, Ozuna, T., and Griffin (2000); Haab, Hicks, Schnier, and Whitehead (2008);

and, currently, site choice models are the agency's preferred recreational valuation technique.[2] On the seafood consumer side, data on the prices and quantities of seafood purchased in markets and restaurants is needed. Unfortunately this type of data rarely exists.

Estimating producer surplus requires data on the costs and earnings of all the various businesses involved in the production and sale of seafood or recreational services. Very little of this type of information exists, making the calculation of producer surplus difficult at best and impossible at worst.

In summary, the equimarginal principle is the preferred method to examine allocations. Often, it is difficult to develop a complete schedule of marginal values across all possible allocations. In this case, it is appropriate to examine total value, recognizing, however, that total value may not take diminishing marginal returns into account.

Trends in the Recreational Fishery

Groupers are a popular recreational target species for both private anglers and for-hire vessel patrons. The majority of all grouper trips, for both gag and red grouper occur in Florida, with a small number of trips occurring in Alabama and other states. As a result, the analysis of the value of gag and red grouper harvest is confined to trips taken in Florida as there is insufficient data on trips occurring in other states for the modeling technique employed in this paper (GMFMC 2008). Directed effort estimates are very important for this analysis as they are used in the expansion of marginal value estimates to total value estimates and the expansion and prediction of economic impact estimates later in this analysis.

Table 1 details the history of the allocation of both gag and red grouper in the Gulf of Mexico since 1986. In 2006, the total gag grouper total allowable catch (TAC) was 3.27 million pounds split with 59% allocated to the recreational sector and 41% allocated to the commercial sector. In the gag grouper fishery, the allocation has crept towards the commercial sector since 1986, but has been relatively stable in the last few years. For red grouper, the TAC in 2006 was 6.15 million pounds split 16% recreational and 84% commercial. In the red grouper fishery, there has been significant creep towards the commercial fisher since 1986, with a significant recreational loss of allocation over the last few years leading up to 2006.

Directed effort is an important part of this analysis and can be defined by either target trips, catch trips, or a combination of the two measures. Target trips include those trips where the angler indicated a targeting decision for gag grouper, but did not harvest any grouper. Catch trips are all trips, regardless of target, where gag grouper were caught. For the purposes of this report, total directed effort is the sum of target trips and catch trips, following the conventions of the American Fisheries Society. It is important to note, however, that these directed effort estimates are not additive across species as anglers on a targeted trip for one species may indicated multiple target species in the intercept survey or may have caught another species during their

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Haab, Whitehead, and McConnell (2003); Haab and Hicks (1999); Haab and Whitehead (1999); Hicks, Gautam, Steinback, and Thunberg (1999); and Hindsley, Landry, and Gentner (2008).

[2] See the Center for Independent Experts evaluation of NMFS' recreational economic program. Center for Independent Experts. (CIE 2006).

trip. An example for this analysis includes an angler that listed gag grouper as her primary target while only catching red grouper. This angler's effort then becomes part of the target effort for gag grouper and the catch effort for only red grouper. It is impossible to eliminate this potential double counting.

Table 1. Annual Allocations of Gag and Red Grouper, 1986-2006 (GMFMC, 2008).

Year	Gag Grouper		Red Grouper	
	Percent Recreational	Percent Commercial	Percent Recreational	Percent Commercial
1986	68%	32%	28%	72%
1987	61%	39%	18%	82%
1988	75%	25%	35%	65%
1989	58%	42%	28%	72%
1990	41%	59%	20%	80%
1991	64%	36%	26%	74%
1992	57%	43%	37%	63%
1993	60%	40%	25%	75%
1994	55%	45%	28%	72%
1995	62%	38%	28%	72%
1996	60%	40%	17%	83%
1997	62%	38%	12%	88%
1998	58%	42%	16%	84%
1999	64%	36%	18%	82%
2000	69%	31%	27%	73%
2001	56%	44%	19%	81%
2002	60%	40%	22%	78%
2003	59%	41%	22%	78%
2004	63%	37%	34%	66%
2005	59%	41%	23%	77%
2006	59%	41%	16%	84%

Because of this double counting problem, all aggregated values in this report are calculated by converting marginal value estimates denominated by numbers of fish and converting them to weight by dividing by the current average harvest weight per fish. This issue again points to the need to use the equimarginal principle as it does not require arbitrary decisions regarding aggregating values to total value estimates.

Figure 1 details the trends in directed effort in the gag grouper fishery. All directed effort data has been taken from the final Amendment 30b (GMFMC 2008). Target trips for gag have been on the rise since 2002, but dropped between 2005 and 2006 to 469,625 target trips, a drop of more than 75,000 trips. Catch trips rose until 2004, but then fell precipitously from 2004 until 2006 to 821,487 trips. Since 2004, catch trips have fallen by 466,000 trips. In total in 2006, gag grouper anglers took 1.3 million trips targeting and/or catching gag grouper, a drop from the previous year of 387,000 trips. While not detailed in Figure 1, the majority (80%) of the 2006 trips were in the private/rental boat mode and 10% where in the for-hire mode. The remaining 10% were in the shore mode.

Figure 1. Gag Grouper Directed Effort, 2002 – 2006.

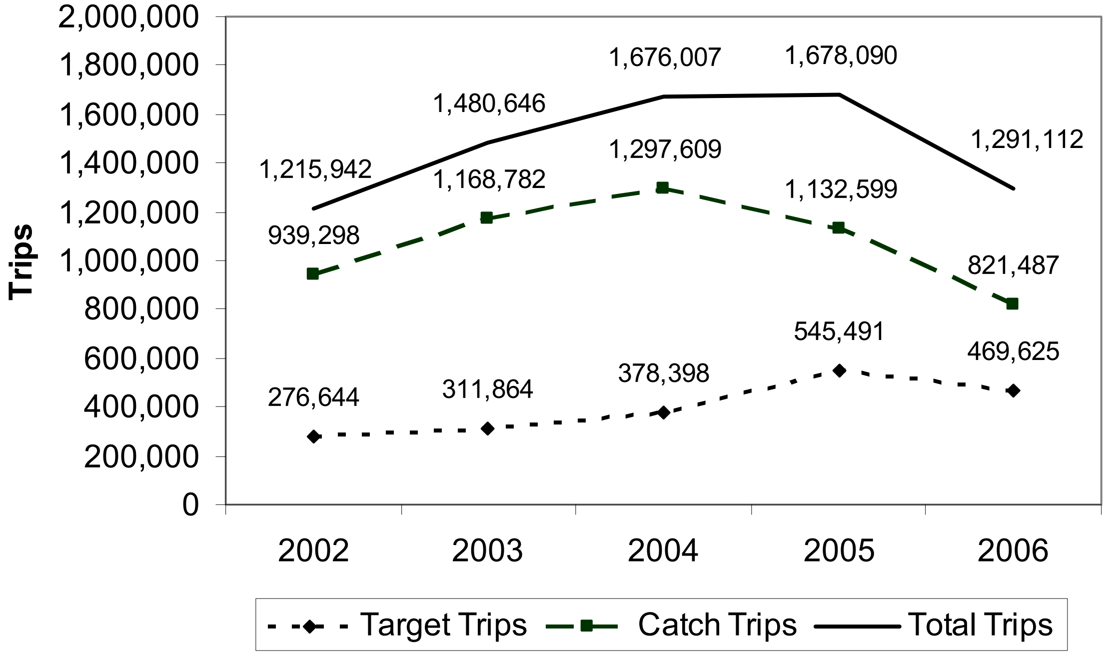


Figure 2. Red Grouper Directed Effort, 2002 – 2006.

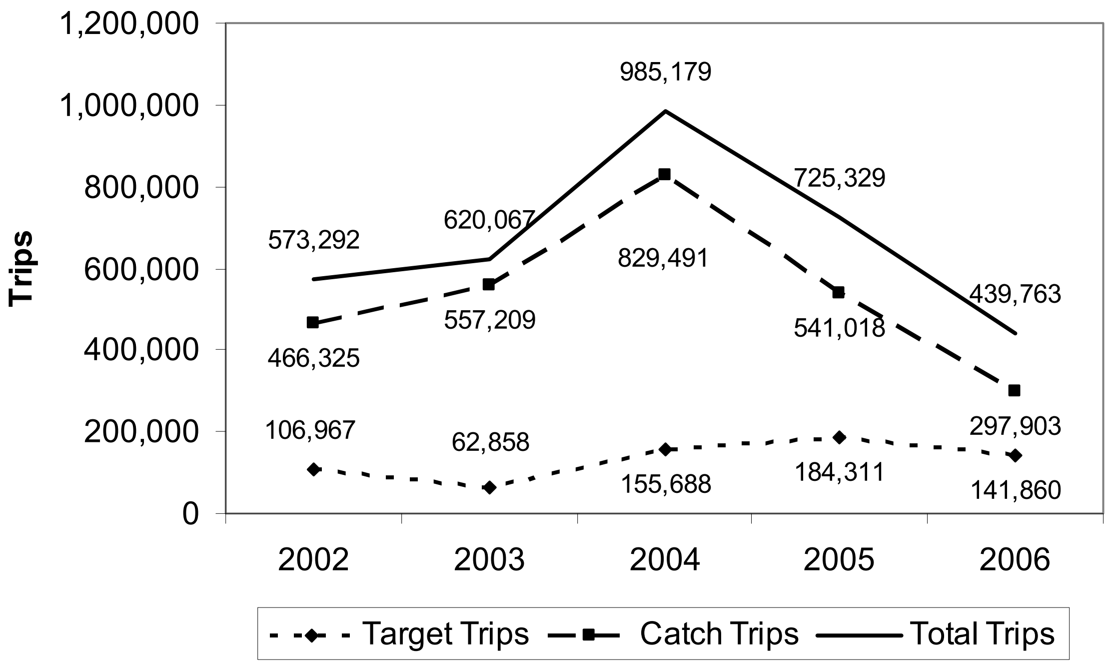
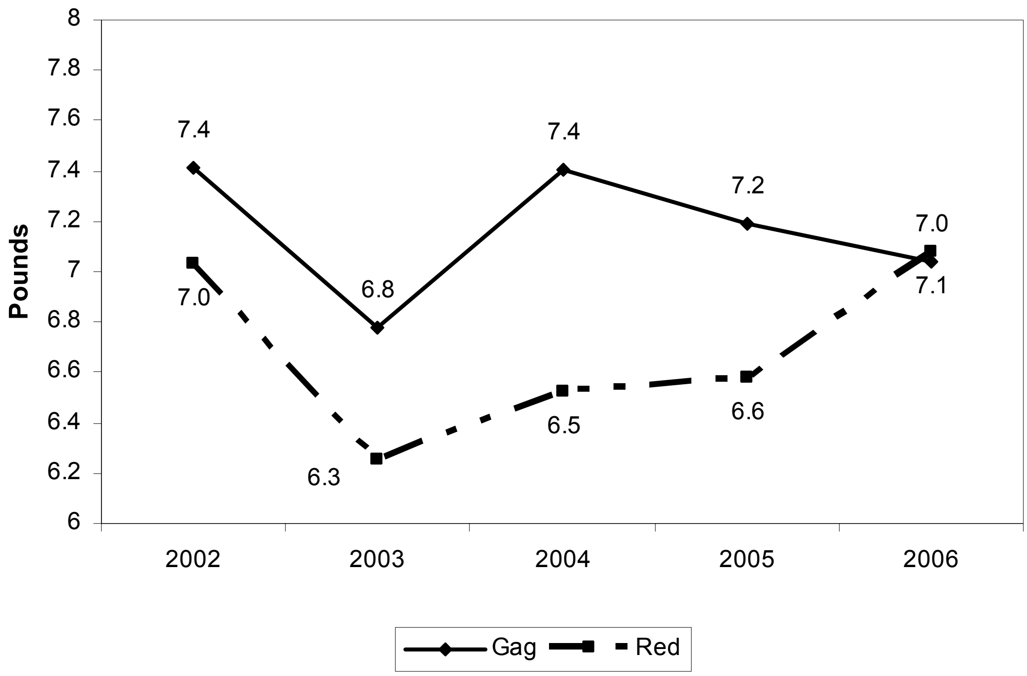


Figure 2 displays the directed effort in the red grouper fishery over the same time period. Target trips for red grouper have been fairly flat over this time period with a moderate increasing trend. In 2006, target effort was 141,860 trips, a drop of more than 40,000 trips since 2005. Catch effort, on the other hand, has declined considerably in recent years. In 2006, catch effort was

297,903 trips, a drop of more than 240,000 trips. Total effort in 2006 was 439,763 trips dominated by the private rental mode with 81% of those trips. The for-hire mode was responsible for 15% of the 2006 trips with the balance (4%) made up of catch effort trips in the shore mode.

To use the equimarginal principle, angler harvest needs to be denominated in pounds. For reasons to be discussed below, it is difficult to estimated site choice models using harvested pounds directly, so the following estimates will be used to convert numbers of fish to pounds of fish after model estimation. Figure 3 displays the trends in weight per harvested fish from the MRFSS data (NMFS 2008). During the 2002 to 2006 period, gag grouper weight per fish has been falling to just over 7 pounds per fish in 2006. Over the same period, the red grouper weight per harvested fish has slightly increased since 2002 to just over 7 pounds per fish.

Figure 3. Average Weight per Grouper, 2002 – 2006.



Recreational Valuation Methodology

Site choice random utility models (RUM) rely on observed data on recreational site choices. The observed data for this study comes from the 2006 MRFSS intercept survey. In this section, the RUM model is specified and the data manipulation process necessary to run a RUM for groupers using the MRFSS angler data is presented.

This report relies on data from the National Marine Fisheries Service's MRFSS. Since 1994, NMFS has used the MRFSS to gather the travel cost data necessary to estimate the value of access and the value of changes in catch rates. NMFS has invested significant time and money developing the site choice methodology and has deemed it the most appropriate method for estimating recreational values (Center for Independent Experts 2006)

The MRFSS consists of two independent and complementary surveys: a field intercept survey and a random digit dial (RDD) survey of coastal households. The intercept survey is a creel survey used to estimate mean catch-per-trip by species across several strata including fishing wave (2-month period), fishing mode (shore, private or rental boat, or for-hire fishing vessel), and state. Data elements collected during the base part of the intercept survey include state, county, zip code of residence, hours fished, primary area fished, target species, gear used, and days fished in the last two and 12 months. The creel portion of the survey collects length and weight of all fish species retained by the angler and the species and disposition of all catch not retained by the angler.

Because the MRFSS constitutes the best nationwide sample frame for marine recreational angling and offers considerable savings over implementing a new program, economic data collection is added-on to the MRFSS effort. During January through December of 2006, an intercept add-on survey was conducted to obtain data on angler trip expenditures. Upon completion of the base MRFSS survey in 2006, anglers were asked to complete a short add-on questionnaire. The intercept add-on survey was designed to collect the minimum data necessary to estimate RUM's of anglers' site choice decisions.

Nested Logit

RUMs use all of the substitute recreational sites facing an angler to value attributes of the site chosen by an angler. In this case, grouper harvest rates will be valued. NMFS has sponsored a good deal of research into RUMs of recreational site choice to value site closures and angling quality (see footnote 1). The majority of this work has involved specifying nested logit models of recreational site choice using expected catch or harvest rates as the measure of angling quality. The following analysis is patterned after previous NMFS RUM specifications as closely as possible given the data limitations described below. The nested structure was chosen because failing to account for substitution between modes has potentially large impacts on marginal willingness to pay (MWTP) estimates for harvest. In particular, selecting the conditional logit over the nested logit typically induces an upward bias in MWTP (Haab et al 2008). The appropriateness of the nested specification was also tested, and, with this particular data set, it was deemed more appropriate (see Table 4).

The specification of the nested logit model for recreational choices has been adapted from Haab and McConnell (2003). Angler utility is specified as:

$$u_{jk} = v_{jk} + \varepsilon_{jk}$$

where v_{jk} is an angler's indirect utility and ε_{jk} is a random error term for site j in mode k. For this report, it is assumed that the decision to fish for grouper is made outside of the model. Due to data limitations, it was impossible to estimate models for either gag or red grouper independently, so the model was specified using all grouper species. Subsequent to the choice to participate in grouper fishing, the angler is assumed to make a fishing mode choice, between either the private/rental boat or for-hire mode, and then a site choice conditioned on the mode choice. The upper level nesting structure includes the choice of fishing mode across for-hire fishing and fishing from the private/rental boat mode. There were only a handful of shore fishing observations in the data, which is too few to include as a separate nest. In this case, the global site list includes only the 30 Florida sites used in Haab et al (2000) due to data limitations.

An angler chooses a fishing site from the set of all alternative sites and fishing mode combinations, if the utility of visiting that site in that mode is greater than the utility of visiting any other site in any other mode in the global choice set.

$$u_{jk} \geq u_{j'k'} \forall j', k'$$

Furthermore, grouper angler indirect utility is specified by:

$$v(y - c_{jk}, q_{jk}, s_k) = -\beta_y c_{jk} + q_{jk}\beta + s_k \gamma$$

where y is income, c_{jk} is the cost of traveling to the site, q_{jk} is a vector of quality attributes that vary by site and mode choice, and s_k is a set of attributes that vary only by mode choice. Since income is an additive constant across all sites combinations in the choice set, it falls out of the nested logit probability. Following Haab et al (2000), the vector q contains travel cost, the log of the number of MRFSS intercept sites aggregated into the sites used in this model, and the expected keep rate. The keep rate was used to model mortality and not total catch. The keep rate includes observed catch, as well as self reported mortality not seen by a MRFSS interviewer. It does not include any mortality of released fish unless the fish was dead before release. This measure most closely approximates commercial mortality. The vector, s, contains one variable which takes the value of one if the angler was fishing in the for-hire mode during wave 3.

The nested logit probability is:

$$\Pr(j,k) = \frac{\exp\left(\dfrac{\alpha_k + v_{jk}}{\theta_k}\right)\left[\sum_{l=1}^{J_k} \exp\left(\dfrac{\alpha_k + v_{lk}}{\theta_k}\right)\right]^{\theta_k - 1}}{\sum_{m=1}^{K}\left[\sum_{l=1}^{J_m} \exp\left(\dfrac{\alpha_m + v_{lm}}{\theta_m}\right)\right]^{\theta_m}}$$

where K is the total number of upper level nests, J_k is number of lower level sites for upper level k, m = (1,….,J), l = (1,….,K), α_k is the location parameter, and θ_k is the inclusive value parameter. This study is concerned with estimating the marginal net benefits of grouper harvest. The appropriate benefit metric in this case is compensating variation (CV) (Haab and McConnell, 2003). Within the nested logit model, indirect utility is specified as:

$$V(c,q,s,y) = \ln\left(\sum_{m=1}^{K} a_m \left[\sum_{l=1}^{J_m} \exp\left(\frac{v(y - c_{lm}, q_{lm}, s_m)}{\theta_m}\right)\right]^{\theta_m}\right)$$

CV is calculated by differencing the indirect utility before an allocation change to the indirect utility after an allocation change and is represented by:

$$V(c,q,s,y) = V(c^*,q^*,s^*,y-WTP)$$

where the star (*) denotes the changed indirect utility attributes. If V(*) >V(original) then CV is greater than zero. For quality changes that are the same for all sites, such as an allocation change, the CV calculation collapses to:

$$WTP = \frac{\Delta ekarate(\beta_{ekarate})}{\beta_{travelc}}$$

or the change in the expected keep rate times the parameter estimate for expected keep rate divided by the parameter estimate for travel cost. Please see Haab and McConnell (2003) for further details of this specification and the mechanics of the CV calculation. For the remainder of this report CV will be referred to as marginal willingness to pay (MWTP).

Data Manipulation

During the 2006 MRFSS intercept add-on survey, 424 anglers caught grouper, were on single day trips primarily for fishing, finished the intercept add-on containing the necessary variables, and gave the interviewer a home zip code necessary for travel cost calculation. Table 2 contains the descriptive statistics for the variables used in this analysis. By wave, 14.4% of all anglers were intercepted in wave 1, 15.3% were intercepted in wave 2, 16.0% were intercepted in wave 3, 10.6% were intercepted in wave 4, 15.3% were intercepted in wave 5, and 28.3% were intercepted in wave 6, the most popular fishing wave in the data. By fishing mode, 15% were in the for-hire mode and 85% were intercepted in the private rental mode.

Travel cost is simply the round trip travel distance multiplied by the current federal government travel reimbursement rate of $0.585/mile. The opportunity cost of time was calculated by taking the travel time (calculated miles/40 mph average travel speed) and multiplying it by one-third the wage rate. Wage rates were calculated by taking median household income by zip code and dividing it by 2,000 work hours per year (U.S. Census Bureau, 2002). MWTP based on the opportunity cost of time calculated using U.S. Census income estimates likely represent an upper bound when compared to the typical opportunity cost of time calculation from Hicks et al (1999), Haab et al (2000), and Haab et al (2008). The variable used to describe mode choice in the upper level nest was created by crossing participation in the for-hire mode with a wave 3 participation dummy.

Following Hicks et al (1999), a keep rate matrix for all sites by mode was developed by taking the five year average keep at each site by mode. These matrices contain many zero values that may indicate the site is not used as a grouper site or that may indicate that grouper has never been encountered by MRFSS interviewers at the site. Zeros were replaced using the nearest neighboring site in the same mode, if replacement was deemed appropriate based on examination of the harvest data and the site's location. Table 2 contains the descriptive statistics for all variables used in the modeling.

Table 2. Descriptive Statistics for All Variables.

Variable Name	Description	Mean	Standard Error	Lower Confidence Limit	Upper Confidence Limit
pr	Private/Rental Mode Dummy	0.85	0.02	0.81	0.88
charter	Charter Mode Dummy	0.15	0.02	0.12	0.19
ffdays2	Two Month Avidity	5.00	0.31	4.39	5.61
travel_opp	Calculated Travel Cost	$48.48	$6.52	$35.67	$61.30
lnm	Log of # of Aggregated Sites	3.12	0.04	3.04	3.19
ekarate	Expected Harvest	0.81	0.00	0.80	0.82
charter3	Charter Crossed with Wave3	2.12%	0.01	0.75%	3.50%
wave2	Intercepted in Wave 2	15.33%	0.02	11.89%	18.77%
wave3	Intercepted in Wave 3	16.04%	0.02	12.53%	19.54%
wave4	Intercepted in Wave 4	10.61%	0.01	7.67%	13.56%
wave5	Intercepted in Wave 5	15.33%	0.02	11.89%	18.77%
wave6	Intercepted in Wave 6	28.30%	0.02	24.00%	32.61%

Expected Keep Rates

To conform to current theories on the calculation of welfare effects stemming from quality changes, expected keep rates, (rather than historic keep rates), were used as the quality variable in the nested logit model. Typically, a poisson regression is used to estimate expected keep rates. However, if over-dispersion is found in the data the zero alter poission (ZAP) or the negative binomial models are more appropriate. Initial runs using a poisson indicated over-dispersion in the data so both ZAP models and negative binomial models were estimated. The negative binomial model performed far better than the ZAP and was used here for expected keep rates. The specification of the negative binomial is:

$$\Pr(x_i) = \frac{\Gamma\left(x_i + \frac{1}{\alpha}\right)}{\Gamma(x_i + 1)\Gamma\left(\frac{1}{\alpha}\right)} \left(\frac{\frac{1}{\alpha}}{\frac{1}{\alpha} + \lambda_i}\right)^{\frac{1}{\alpha}} \left(\frac{\lambda_i}{\frac{1}{\alpha} + \lambda_i}\right)^{x_i}$$

where $\lambda_i = \exp(z_i \beta)$, x_i equals harvest of individual i on the intercepted trip, and z_i contains variables describing the site and the individual including a constant term, five year average harvest rate in numbers of fish, two month fishing avidity (the number of trips taken in the previous two months), for-hire mode participation dummy, and a wave 5 participation dummy. In previous studies (Hicks et al 1999, and Haab et al 2000), years of fishing experience was used to describe angler experience. This variable was not collected in the 2006 add-on, so two month fishing avidity was used as a proxy for fishing experience.

Table 3 contains the parameter estimates from the negative binomial expected keep model. All variables were significant at the 90% level except hours fished. All parameter estimates are significantly different from zero. The value of tau, the over-dispersion parameter is 3.84 and significant indicating that over-dispersion was indeed a problem in this data set that was corrected using the negative binomial specification. All parameters had a positive and significant impact on the expected keep rate except for wave5, which had a negative impact on expected keep. The parameters from this model were used construct the expected keep rates for all potential site choices in the model.

Table 3. Negative Binomial Expected Keep Rate Model Results.

Variable	Parameter Estimate	Standard Error	T-ratio	P-value
constant	-3.4201	0.3609	-9.4760	0.0000
karate	3.2079	0.7133	4.4970	0.0000
ffdays2	0.0462	0.0231	2.0028	0.0452
charter	1.3107	0.7772	1.6865	0.0917
wave5	-1.2965	0.6713	-1.9313	0.0535
Tau	3.8429	1.4470	2.6558	0.0079

For the purposes of this analysis, it would have been ideal to use weight of grouper harvested instead of numbers of grouper harvested. However, harvest in this analysis is defined as harvest measured and weighed by a MRFSS interviewer plus harvest consumed or disposed of at sea. While several methods were explored to assign weights to the unobserved catch, none proved satisfactory. Instead MWTP estimates for keep rates in numbers of grouper were converted to weight based measures using the average weight of grouper from Figure 3.

Results

Table 4 includes the results of the nested RUM estimation. Full information maximum likelihood estimation was conducted using SAS PROC MDC (SAS 2003). Overall, all parameters were significant at the 95% level with the exception of the upper level nest variable indicating for-hire anglers fishing in wave 3, and it was significant at the 90% level. The model performed well with a McFadden's R of 0.6271 and a Cragg-Uhler statistic of 0.9950. The travel cost parameter was negative, as expected, suggesting that anglers prefer sites with lower travel cost. The site aggregation parameter was positive suggesting that anglers prefer aggregated sites containing a larger number of individual MRFSS sites. The parameter on expected harvest was also positive suggesting that anglers prefer more catch to less. Finally, a test of the appropriateness of the nested model over the conditional logit model suggests that the nested model is indeed appropriate.

Estimates of Marginal Values of Grouper

Table 5 contains the MWTP for this study and several other NMFS sponsored studies for comparison. The MWTP estimates from this model are displayed in the first three rows. Using the analysis presented above, the MWTP for one grouper was $95.59 in 2006. Using the average weights from Figure 3, this translates into a MWTP per pound of $13.58 for gag and $13.51 for red grouper. Expanding these marginal values to the total economic value of grouper harvest in 2006 yields $26.4 million for the gag grouper fishery and $13.6 million for the red grouper fishery.

Table 4. Nested Model Parameter Estimates

Parameter	Estimate	Standard Error	P-Value
Lower Level Nest			
travel_opp	-0.0384	0.0020	<.0001
lnm	0.5608	0.0855	<.0001
ekarate	3.6735	0.5194	<.0001
Upper Level Nest			
charter3	-0.7002	0.3811	0.0662
Inclusive Value Parameters			
Charter Mode	0.0100	*	
Private/Rental Mode	0.3190	0.0384	
Model Fit			
Log Likelihood	-662.4747		
McFadden's R	0.6271		
Cragg-Uhler	0.9950		
IIA Test	89.7469		<.0001

*Restricted parameter. Likelihood ratio test fails to reject restriction

Table 5. Mean Willingness to Pay for Grouper, 2006.

Model	Compensating Variation, 2006 Dollars	Mean	Total Value
Model in This Report: Grouper Nested Logit	One Grouper	$95.59	---
	One Pound Gag Grouper	$13.58	$26,439,769
	One Pound Red Grouper	$13.51	$13,642,039
Haab et al, 2008	One Grouper	$122.96	---
	One Pound Gag Grouper	$17.27	$33,616,777
	One Pound Red Grouper	$18.34	$18,527,896
Gentner, 2004	One Grouper	$136.36	---
	One Pound Gag Grouper	$19.37	$37,713,831
	One Pound Red Grouper	$19.27	$19,459,079
Carter et al, 2008	One Grouper	---	---
	One Pound Gag Grouper	---	
	One Pound Red Grouper*	$1.33	$1,698,129.73

NMFS has invested considerable time and funds estimating MWTP for various species using a variety of methodologies. The vast majority of this work has focused on RUMs of recreational choice using either revealed preference data or stated preference data. Most recently, the Marine Fisheries Initiative (MARFIN) funded Haab, Hicks, Schnier, and Whitehead to explore the impacts of angler heterogeneity on MWTP estimates derived from site choice RUMs (Haab et al 2008). They focused on single species models for popular Gulf and South Atlantic species including grouper. For each species they specified the typical conditional and nested logits as well as expanding their analysis to a new class of models including random parameters logit and finite mixture models, both still based on the RUM framework, in an attempt to incorporate angler heterogeneity.

The Haab et al (2008) models used data from the 2000 MRFSS intercept add-on survey. They calculated travel cost to include the opportunity cost of time for those unable to take time off work with pay to participate and they used $0.30/mile for their calculations. In addition, they also added the average charter fee from Gentner et al (2001). Otherwise, they followed the standard data creation steps outlined in this paper.

MWTP estimates for grouper ranged from $34.50 to $393.98 per fish across all the various specifications used in their analysis. All values have been converted to 2006 dollars using the consumer price index. Using weight conversion factors from 2000, this represents a range of $4.85/pound to $55.33/pound for gag and $5.15 to $58.78/pound for red grouper. The MWTP numbers from their report displayed in Table 5 are from the finite mixture model that accounts for angler heterogeneity and was particularly well behaved. Using these estimates, the total economic benefits from the gag grouper fishery are $33.6 million and $18.5 million from the red grouper fishery.

Several results are worth noting beyond the MWTP estimates. Haab et al’s (2008) primary goal was to explore new methods and not directed policy application. As a result, it produced a wide range of values. However, the results derived support the values found in this analysis. Also, they found that aggregating across differing species, as in Carter et al (2008), adds biases when trying to examine single species policies such as allocation.

In 2003, NMFS explored a new methodology, the stated preference choice experiment, to examine angler choices of recreational fishing trips. This method presents anglers with a series of hypothetical fishing trips that vary in trip attributes through a mail survey. The data are analyzed using a RUM in much the same way that the revealed preference data was analyzed above.

Gentner (2004) details the analysis of this data, and, while not calculated in the paper, it is possible to calculate the MWTP for grouper harvest using the parameters in the paper. Using the policy outcome model, the MWTP for on grouper is $136.36 in 2006 dollars. This translates into a MWTP for gag harvest of $19.37/pound and $19.27/pound for red grouper. When looking at total economic benefits, these estimates generate $37.7 million in gag benefits and $19.5 million in red grouper benefits.

An added advantage of stated preference choice experiments is the ability to predict effort changes stemming from changes in fishing trip attributes. The model generates an elasticity measure for grouper harvest of 0.114 which means that if harvest goes up one unit, effort will rise by 11.4%. This information will be used below to discuss possible economic impact consequences of various allocation scenarios. Both valuation and effort predictions from this model were used in the red snapper fishery management plan amendment 27 (GMFMC 2007).

Finally, Carter, Agar, and Waters (2008) estimated both commercial and recreational MWTP estimates in the red grouper fishery in their examination of red grouper allocation. They used commercial and recreational data from 2003 for data availability reasons and because there were major regulatory changes for both commercial and recreational anglers after 2003.

On the commercial side, Carter et al (2008), estimated profit functions for multi-product firms in a mixed species fishery. Their commercial analysis resulted in a MWTP for red grouper in the commercial sector of $1.25/pound in 2006 dollars. In the multi-species reef fishery many trips do not harvest grouper. In order to include these zero grouper trips Carter et al (2008) used a harvest of 0.1 pounds to replace the zero grouper harvest levels. This substitution likely introduces an upward bias in the commercial MWTP estimate. Their paper also used a simulation approach to estimate the MWTP for red grouper across a range of allocation scenarios. From this simulation the maximum amount the commercial sector is willing to pay for additional allocation was $3.72 in 2006 dollars.

Carter et al (2008) attempted to estimate a consumer demand model for red grouper and met with little success. As a result, red grouper consumer MWTP was not included in their analysis. This is a common problem for consumer demand models as adequate data at the consumer level does not exist. It is, however, possible to estimate consumer surplus measures using landings data as in Park et al (2004). No attempt was made by Carter et al to estimate consumer surplus values using landings data.

Carter et al (2008) also estimated a recreational demand model. They did not estimate a recreational site choice model, but instead selected a hedonic price model, a first for NMFS. Hedonic models use the price of a good traded in the market and in this case they used charter trip prices. Hedonic modeling assumes that the good in question is composed of many attributes and in this case those attributes include the harvest of fish. As such, the value of harvest is reflected in the charter price and econometric methods can be used to extract the portion of the total price attributable to harvest. Due to data limitations, the model was estimated using all species of fish harvested by recreational anglers on charter trips. The point estimate for MWTP for all species of fish was found to be $1.33 in 2006 dollars. This estimate was then applied to red grouper. As with the RUM's discussed in this paper, they were unable to trace out the benefit function for recreational fishing. No attempt was made in Carter et al (2008) to estimate the MWTP for grouper from the for-hire sector.

Economic Impacts

While allocation decisions should be made by using the equimarginal principle or total economic value as the primary factor, there are other factors that can be examined such as economic impacts. Economic impacts help to examine distributional issues that may arise with any reallocation (Kirkley et al 2000; Edwards 1990). Table 6 and Table 7 detail the current economic impacts generated by trip expenditures in the recreational sector. These estimates were generated using the 2006 MRFSS economic add-on following Gentner and Steinback (2008). This data was used to calculate grouper specific trip expenditures of $64.51 per person per trip. Using the gag grouper total directed effort, gag grouper fishing generates $83.3 million in total trip expenditures. The gag grouper fishery generates 1,513 jobs, $107 million in value added (or contribution to gross domestic product), and $60.8 million in personal income. Because there is less directed effort in the red grouper fishery, total trip expenditures are lower at $27.6 million dollars which supports 501 jobs, $35.2 million in value added and $20 million in person income.

Table 6. Recreational Gag Grouper Trip Expenditures and Economic Impacts.

Expenditure Category	Expenditures		Impacts		
	Mean	Total	Value Added	Income	Jobs
Private Transportation	$6.83	$8,822,574	$9,945,171	$5,433,043	112
Groceries	$6.91	$8,927,613	$12,350,674	$7,129,302	165
Restaurant	$1.75	$2,257,595	$2,217,091	$1,320,858	32
Lodging	$0.24	$313,754	$460,412	$283,495	10
Public Transportation	$0.02	$19,520	$28,668	$16,424	0
Boat Fuel	$20.80	$26,855,719	$30,272,881	$16,538,085	341
Boat Rental	$0.04	$52,755	$77,446	$44,770	1
Charter Fees	$19.54	$25,229,902	$37,037,688	$21,411,177	627
Crew Tips	$0.27	$342,445	$502,706	$290,624	9
Bait	$3.86	$4,986,667	$7,305,711	$4,285,077	116
Ice	$1.01	$1,299,443	$1,023,558	$683,218	20
Fishing Tackle	$2.70	$3,488,977	$4,799,861	$2,827,366	62
Parking	$0.48	$620,049	$910,265	$526,225	15
Souvenirs	$0.06	$78,249	$51,536	$33,197	1
TOTAL	**$64.51**	**$83,295,263**	**$106,983,668**	**$60,822,860**	**1,513**

Table 7. Recreational Red Grouper Trip Expenditures and Economic Impacts.

Expenditure Category	Expenditures		Impacts		
	Mean	Total	Value Added	Income	Jobs
Private Transportation	$6.83	$3,005,039	$3,387,404	$1,850,538	38
Groceries	$6.91	$3,040,816	$4,206,738	$2,428,297	56
Restaurant	$1.75	$768,955	$755,159	$449,895	11
Lodging	$0.24	$106,867	$156,820	$96,561	3
Public Transportation	$0.02	$6,649	$9,765	$5,594	0
Boat Fuel	$20.80	$9,147,271	$10,311,184	$5,633,003	116
Boat Rental	$0.04	$17,969	$26,379	$15,249	0
Charter Fees	$19.54	$8,593,505	$12,615,331	$7,292,817	214
Crew Tips	$0.27	$116,640	$171,226	$98,989	3
Bait	$3.86	$1,698,498	$2,488,383	$1,459,531	40
Ice	$1.01	$442,601	$348,632	$232,710	7
Fishing Tackle	$2.70	$211,194	$310,043	$179,237	5
Parking	$0.48	$442,601	$348,632	$232,710	7
Souvenirs	$0.06	$26,652	$17,553	$11,307	0
TOTAL	**$64.51**	**$27,625,256**	**$35,153,248**	**$19,986,436**	**501**

For the recreational sector, durable good purchases attributable to grouper fishing, such as fishing rods, tackle, boats, homes, and vehicles were not included in the analysis. Durable good purchases are generally left out of individual species policy discussions because recreational anglers buy gear that could be used in multiple fisheries. It is impossible to apportion durable good expenditures attributable only to grouper fishing. Durable good expenditures were also left out of the analysis below because very little can be said about what will happen when allocations change. While it is possible that some anglers only fish for grouper and would no longer fish if recreational allocation fell, it is more likely that they would continue to fish in other fisheries. While increasing recreational allocations might induce non-anglers to take up the sport and purchase durable goods, it is beyond the scope of this analysis to examine the participation decision. If changes in durable good purchases could be estimated specific to grouper, they would increase the economic impact of recreational grouper fishing. That said, total durable good expenditures and impacts are detailed in Table 8. Across the entire GoM, including all of Florida, and across all fisheries, durable good expenditures total $21.2 billion and generate $9.5 billion in value added, $6.2 billion in income, and support 167,056 jobs. While it is impossible to determine how durable expenditures would change as allocations change, grouper fishing stimulates considerable economic activity beyond trip expenditures.

Table 8. Durable Good Expenditures and Economic Impacts (Gentner and Steinback, 2008).

State	Durable Expenditures in Thousands of $	Value Added in Thousands of $	Income in Thousands of $	Employment
Alabama	$516,924	$229,176	$151,731	4,430
East Florida	$7,247,064	$3,028,210	$1,965,660	50,359
West Florida	$8,134,905	$3,611,142	$2,390,400	64,330
Louisiana	$2,553,535	$995,965	$665,113	22,702
Mississippi	$506,750	$177,885	$117,283	3,514
Texas	$2,270,369	$1,422,290	$911,226	21,720
Total	$21,229,549	$9,464,668	$6,201,413	167,056

On the commercial side, price per pound for each species was taken from FUS (2006) and used to establish total landed value. To capture the impact of this harvest on the harvester, dealer, processor, and wholesale sectors, the NMFS Fisheries Input/Output Model was used to estimate the economic impacts generated by harvesting, processing, and wholesaling sectors (Kirkley et al 2004). To capture the retail trade in these two grouper species, the value added table from the 2006 Fisheries of the United States was used to calculate the amount of each species purchased at restaurants and retail markets and the markup percentages within that model were used to estimate total consumer expenditures on gag and red grouper. An IMPLAN model was then constructed to estimate the economic impact those expenditures were run through IMPLAN software to estimate the impacts from the retail sector (IMPLAN 2000). Table 9 contains the commercial economic impact estimates.

Commercial fishing for gag grouper generates $16 million in value added, $7.7 million in income and supports 322 jobs, far fewer than the recreational gag grouper fishery. Commercial fishing for red grouper generates $49 million in value added, $23.7 million in income, and supports 988 jobs, which is more than the recreational fishery. Both commercial fisheries generate $64.9 million in value added, $31.4 million in income, and support 1,310 jobs. The majority of these impacts however are generated by the retail and restaurants sectors. The retail trade from grocery stores and other retail outlets generate $2.2 million in value added, $316,000 in income and support 22 jobs. The restaurant sector, however, is larger than all the harvesting and processing sectors combined generating $33.7 million in value added, $9.1 million in income, and supporting 642 jobs.

It is unlikely that the economic impacts of retail and restaurant trade would fall with falling commercial allocations of gag grouper or red grouper. Asche et al (2005) summarizes the results of many research projects looking at seafood demand and the majority of this work indicates that consumers readily substitute other species in the face of price changes. Changes in allocation away from the commercial sector would be met with higher consumer prices unless the demand could be met by imports. If prices rose, consumers would switch to imports or other species. Additionally, Park et al (2004) used commercial landings to estimate consumer demand for grouper in the U.S. and found consumers would substitute other species or imports readily. As a result, restaurants and retail outlets would still provide the same amount of fish, albeit different kinds of fish, in the face of reduced commercial allocations. When looking at only the harvester, processors, and dealers, gag grouper supports only $6.7 million in value added, $5.8 million in income, and supports only 159 jobs while red grouper generates $20.9 million in value added, $17.9 million in income and supports only 487 jobs. In contrast, recreational gag grouper fishing generates $107 million in value added, $60.8 million in personal income, and supports 1,513 jobs while red grouper fishing generates $35.2 million in value added, $20 million in person income, and supports 501 jobs.

Table 9. Economic Impacts of Commercial Red and Gag Grouper Harvest.

Sector	Gag Grouper	Red Grouper	Total Gag and Red Grouper
Harvesters			
Employment impacts (FTE jobs)	74	226	300
Income Impacts (000 of 2006$)	$2,299	$7,056	$9,355
Value Added (000 of 2006 $)	$3,062	$9,401	$12,462
Primary dealers/processors			
Employment impacts (FTE jobs)	41	125	165
Income Impacts (000 of 2003$)	$1,759	$5,402	$7,162
Value Added (000 of 2006 $)	$2,187	$6,714	$8,901
Secondary wholesalers/distributors			
Employment impacts (FTE jobs)	44	136	181
Income Impacts (000 of 2003$)	$1,341	$4,116	$5,457
Value Added (000 of 2006 $)	$1,900	$5,834	$7,734
Retail			
Employment impacts (FTE jobs)	5	17	22
Income Impacts (000 of 2003$)	$77.78	$238.22	$316.00
Value Added (000 of 2006 $)	$533.88	$1,638.68	$2,172.56
Restaurants			
Employment impacts (FTE jobs)	158	484	642
Income Impacts (000 of 2003$)	$2,241.53	$6,874.41	$9,115.95
Value Added (000 of 2006 $)	$8,270.25	$25,384.54	$33,654.79
Harvesters and seafood industry			
Employment impacts (FTE jobs)	322	988	1,310
Income Impacts (000 of 2003$)	$7,719	$23,687	$31,406
Value Added (000 of 2006 $)	$15,953	$48,972	$64,925

Similar arguments could also be made for recreational fishing. Economic theory suggests that consumers spend a fixed proportion of their income on leisure activities and if one recreational activity were to no longer be available, they would continue to spend that same proportion of their income on another recreational activity. Recreational anglers are also capable of fishing for many different species or even participating in other recreational activities. While some anglers might quit fishing altogether if allocations were changed in favor of the commercial sector, many would continue to fish for another species. To a large degree, this is why value should be used instead of economic impacts to make allocation decisions.

Using the elasticity estimate from Gentner (2004), changes in recreational effort were estimated for a variety of allocation scenarios. Table 10 and Table 11 display the results of this analysis for gag and red grouper respectively. Since the elasticity is small, the increases in effort are relatively moderate. Caution is warranted in interpreting theses estimates as allocations move farther away from the status quo. This analysis also assumes that recreational expenditures would not change as allocations change, which is probably a safe assumption for relatively small changes in allocations.

Table 10. Recreational Economic Impacts Across Various Gag Grouper Allocation Scenarios.

	Allocation Scenario		Recreational Impacts	
Change	Recreational Share	Commercial Share	Value Added (1000's of $'s)	Employment
2006 Status Quo	59%	41%	$106,984	1,513
Recreational +5%	64%	36%	$109,137	1,535
Recreational +25%	84%	16%	$109,586	1,555
Recreational +35%	94%	6%	$109,743	1,565
Recreational 100%	100%	0%	$109,946	1,571
Commercial +5%	54%	46%	$104,830	1,490
Commercial +25%	34%	66%	$104,381	1,470
Commercial +40%	19%	81%	$104,044	1,455
Commercial 100%	0%	100%	$0	0

A 100% allocation to the recreational gag grouper sector would generate an additional $3 million in value added and support 58 additional jobs. Because gag grouper allocations are currently closer to 100% relative to red grouper, the changes in effort implied in Table 10 are relatively small. If the recreational sector received 100% of the gag grouper TAC, Gentner (2004) predicts only 4.42% more trips for a 41% increase in the quota. This suggests that harvest rates would likely increase as the available harvest is increasing faster than effort.

Table 11. Recreational Economic Impacts Across Various Red Grouper Allocation Scenarios.

	Allocation Scenario		Recreational Impacts	
Change	Recreational Share	Commercial Share	Value Added (1000's of $'s)	Employment
2006 Status Quo	16%	84%	$36,439	515
Recreational +5%	21%	79%	$37,345	537
Recreational +25%	41%	59%	$38,184	558
Recreational +50%	66%	34%	$39,233	583
Recreational 100%	100%	0%	$40,660	618
Commercial +5%	11%	89%	$35,534	493
Commercial 100%	0%	100%	$0	0

Conversely, since the red grouper allocations are farther from 100% than gag grouper, the changes in effort implied in Table 11 are higher relative to gag grouper. A 100% allocation to the recreational red grouper sector would generate an additional $4.2 million in value added and support 103 additional jobs. Overall, a move to a 100% allocation in the red grouper fishery would only increase effort 22.7% for an 84% increase in allocation. Again, this result still leaves room for a quality improvement in red grouper harvest.

Several caveats to the results in Tables 10 and 11 are in order. First, the effort increases from Gentner (2004) only apply to anglers that are currently participating in recreational fishing and do not include any increases in effort from current non-anglers that may be induced to participate in grouper fishing as fishing quality increases. As a result, one could argue that the estimates provided in Tables 10 and 11 are therefore lower bounds on the potential increases in effort, expenditures, and economic impacts. Given the current MRFSS economic data, it is not possible to estimate how many more trips would be taken by members of the general population that aren't currently recreational anglers. Second, the analysis assumes that trip expenditure estimates would not change as allocations changed. If more of the increases in effort occurred in the for-hire mode, trip expenditures on average would increase. On the other hand, if grouper became easier to catch as allocations increased, search time and therefore fuel costs would decrease, lowering trip expenditures and the subsequent impacts. No attempt was made to examine potential changes in trip expenditures. Finally, directed effort estimates are not additive for reasons discussed in the directed effort section above. As a result, one cannot add the estimates from Tables 6 and 7 nor Tables 10 and 11 together to get the total economic impacts for both species.

It is beyond the scope of this analysis to examine changes in commercial sector economic impacts. To perform such an analysis, estimates of gag grouper and red grouper dockside prices would be needed for various levels of landings. As allocations fall, dockside prices would increase partially ameliorating the impact of the fall in allocation. Conversely, as allocations increased dockside prices would likely fall, dampening an increase in commercial economic impacts.

Discussion

It is very difficult to establish MWTP functions for recreational fisheries and no attempt was made in this analysis to generate those. However if one assumes the angler benefit function has a horizontal slope, as in Carter et al (2008), all point estimates of MWTP, outside of the Carter et al (2008) estimate, are higher than the highest MWTP estimated in Carter et al (2008) for the commercial fishery. For instance, the lowest per pound MWTP for red grouper from Haab et al (2008) is $5.15, a full $1.43 higher than the commercial MWTP of $3.72 which coincides with a 100% recreational allocation. This result suggests that total societal value would be maximized with a 100% allocation to the recreational sector. While Carter et al (2008) did not estimate a gag grouper MWTP for either the commercial or recreational sectors, it is likely that the commercial gag MWTP would be similar. If the gag grouper commercial MWTP schedule were similar, it would also recommend a 100% allocation to the recreational sector.

Using the MWTP estimated in this paper of $13.51, current red grouper angler total economic value is $13.6 million and would be $83 million dollars under a 100% allocation to the recreational sector. Current commercial value in the red grouper fishery is $6.4 million and under a 100% allocation to the commercial sector, that value rises to $10.2 million dollars using estimates from Carter et al (2008).

There are several caveats to the analysis presented here. First, consumer MTWP values were not calculated in this study or in any of the other studies presented here. It is likely that these values would be low given the highly price elastic nature of consumer demand for seafood (Asche et al 2005; Park et al 2004). Balancing the lack of consumer MWTP is the lack of MWTP estimates from the for-hire sector. None of the analyses examined here estimated for-hire values for the commercial providers of recreational services as adequate data on this industry does not exist. It is likely that the MWTP estimates from the for-hire sector would be at least as high as the consumer MWTP suggesting that the omission of these two values would not change the conclusions presented here. If anything, the inclusion of for-hire MWTP estimates would further bolster the 100% recreational allocation conclusion.

Finally, because of the diminishing marginal returns principle, the recreational MWTP should decrease as the amount of harvest increases. Because effort in both of these fisheries is quite high, the marginal increase in harvest, even for a large increase in quota, is relatively small. For example, in the red grouper fishery a 100% allocation would increase harvest per trip by 11.75 pounds or, using the current average weight per red grouper, only 1.7 red grouper. In the case of red grouper, 1.7 fish increase is a slight increase suggesting that the MWTP for that next 0.7 fish would be only slight lower. For gag grouper the increase is even smaller. At a 100% allocation, the average harvest weight increase per trip would be slightly more than one pound and less than a single fish increase. In the case of gag grouper, MWTP at a 100% recreational allocation would not be lower than the estimates presented here.

There are other factors to consider when changing allocations including distributional concerns, equity, and other social factors (Kirkley et al, 2000; Edwards, 1990). With a 100% allocation to the recreational sector across either of these two grouper species, there would be negative impacts on the commercial sector, more for red grouper than for gag grouper. From the economic impact analysis, it is clear both the recreational and commercial sectors generate significant economic impact. It is difficult, however, to draw conclusions from limited economic impact analysis conducted here. Instead, this information is useful in providing context about potential distributional effects of any reallocation policy. On the commercial side, it is very unlikely that all the economic impacts supported by commercial activity would be lost with a 100% allocation to the recreational sector. Additionally, with a 100% allocation to the recreational sector, more value added, income, and jobs would be supported in industries that support recreational fishing. It is not possible from this analysis to know if the recreational economic impact gains would outweigh any commercial losses. The converse is equally true for a 100% allocation to the commercial sector.

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