



Recreational diver willingness to pay for goliath grouper encounters during the months of their spawning aggregation off eastern Florida, USA



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ABSTRACT

Recently, fisheries managers have been faced with high uncertainty about Atlantic goliath grouper (*Epinephelus itajara*) stock status, especially due to the lack of fishery-dependent data since the harvest moratorium in 1990. Regardless of this uncertainty, the angling community has been pressuring fishery managers to open the goliath grouper to recreational take, while the diving community has been pressuring managers to keep the fishery closed due to the touted ecotourism value of the spawning aggregations. A previous study estimated that resident anglers in Florida who wanted the fishery open were willing to pay between US\$34 and US\$79 to harvest a goliath grouper. Using a survey instrument with choice experiments, the present study estimated that divers ($n = 1537$) off eastern Florida would be willing to pay approximately US\$103 for a dive trip with one goliath grouper encounter during the months of their spawning aggregation (August–October), and US\$202 if there are 40 goliath grouper (such as is common on a many spawning aggregation sites). Results suggested that divers coming from outside of Florida were willing to pay higher rates for dive trips with goliath grouper encounters; and at spawning aggregations sites, willingness to pay was estimated around US\$336 for these non-Florida divers. Based on life-history traits of goliath grouper and the high value of their spawning aggregation sites, we suggest any changes in goliath grouper policy that would negatively impact spawning aggregation numbers be made with caution.

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1. Introduction

State (Florida) and US federal fishery managers are faced with uncertainty regarding Atlantic goliath grouper, *Epinephelus itajara* (Lichtenstein, 1822), a species protected from recreational or commercial harvest since implementation of a 1990 moratorium and considered critically endangered by the International Union for the Conservation of Nature (IUCN, 2015). At the same time, fishery managers are under pressure from some stakeholder groups to remove the decades-old moratorium, citing anecdotal accounts of recovery. While there still remains uncertainty as to the goliath grouper stock status and age structure (Cass-Calay and Schmidt, 2009), some anglers have voiced concerns that goliath grouper are negatively affecting other reef fish populations, that there are

too many of them, and that their populations need to be thinned (Frias-Torres, 2013; Shideler et al., 2015). A recent study by Shideler et al. (2015) investigated recreational angler motivations and willingness to pay to harvest a goliath grouper. That study found recreational anglers who wanted the fishery open also believed that there are “too many goliath grouper,” and that their mean willingness to pay for a goliath grouper harvest tag in a theoretical healthy fishery was estimated to be between \$34 and \$79. It was suggested that additional studies are needed to examine other stakeholder groups’ willingness to pay for goliath grouper to stay in the water. In fact, while anglers have been pressuring policy makers and managers to open the goliath grouper to recreational take, the recreational dive industry has been lobbying the managers to keep the fishery closed, and has indicated growing interest in goliath grouper for non-consumptive direct use (Harrington et al., 2009).

In the last stock assessment conducted in 2010, it was suggested that any potential consumptive fishery would be relatively small because of current stock uncertainty. Given the small potential

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fishery and mean angler willingness to pay, “there may be greater long-term economic benefit to development of sustainable non-consumptive eco-tourism venues than would be possible from a consumptive fishery” (SEDAR 23, 2011). However, this remains unknown, largely due to the lack of data for non-consumptive uses. Studies have examined recreational diver willingness to pay in the Caribbean region, with many focusing on biodiversity (e.g., Beaumont et al., 2008; Nijkamp et al., 2008; Schuhmann et al., 2013a). However, Heyman et al. (2010) suggested that dive ecotourism at Nassau grouper (*Epinephelus striatus*) spawning areas may represent an economically attractive alternative to fishing, and Rudd and Tupper (2002) found that market shares for dive trips increased significantly for sites with increased size and abundance for Nassau grouper in the Turks and Caicos, but it was unknown whether this also applies to goliath grouper off Florida.

The goal of the present study was to attain the best-estimated recreational diver willingness to pay for goliath grouper encounters during the months of their spawning aggregation using a choice experiment valuation approach. This will allow policy makers to compare these welfare measures to those derived for recreational anglers in Shideler et al. (2015) to evaluate the socio-economic impacts of any changes in goliath grouper policy.

2. Methods

A comprehensive list of dive charters on the eastern coast of Florida was compiled conducting extensive online searches; in total, 30 dive charters were identified. We restricted our search to the east coast because goliath grouper spawning aggregation sites there are more widely advertised; and due to the nature of the extensive shelf off western Florida, many dive charter do not exclusively target western spawning aggregation sites. Eighteen dive shops were strategically contacted (representing dive charters from various regions along the east coast of Florida), ranging from the Florida Keys to Jacksonville. Dive shops were contacted with information about the study, either by phone or by email (email if dive shops did not answer telephone). Initially, 10 dive shops agreed to participate in the study; however, as word spread among dive shops, interest grew and an additional three dive shops were identified and included in the project. The southern-most dive shop was located in Pompano Beach, Florida, and the northern-most dive shop is located in Jupiter, Florida. Distance between the southern-most and northern-most dive shop is approximately 50 miles.

2.1. Survey instrument and choice experiment design

A diver survey was created following recommendation of Dillman (2007). In addition to demographic variables, survey participants were asked about the expenditures for diving, and familiarity with goliath grouper and the present “controversy” (see Shideler et al., 2015). The choice experiment design approach is a carefully-designed choice task that helps reveal factors that influence decisions. Additionally, consumer surplus can be calculated by summing marginal values of attribute levels (Hanley et al., 1998).

For the present study, four attributes were selected based on specific research questions as well as on previous studies in the Caribbean region that identified important issues to recreational divers (i.e., diver crowding; Rudd and Tupper, 2002; Schuhmann et al., 2013a,b). Each attribute had four levels (Table 1), and a fractional-factorial survey design was employed to select an optimal set of 32 combinations of attributes from the full 256 available combinations, which were selected and paired (for a total of 16 choice experiments, see Fig. 1 for example of a choice experiment) using the rotation design function in the support CEs package in R (Aizaki, 2012; Aizaki et al., 2015). The 16 choice

experiments were blocked into four survey versions to reduce survey participant fatigue. Forty surveys (10 of each version) were used in two pilot studies at a participating dive shop in Jupiter (total pilot $n = 80$, 20 of each version). Responses were used to improve the survey design. In total, 10,000 final surveys were printed (four versions of the survey, each with 2500 copies), and were sequentially shuffled, divided haphazardly into 13 packages, and delivered to dive charters on July 31, 2015. Charters were instructed to begin distributing surveys August 1 and end on October 31, 2015. Included with the delivery was a pre-paid and pre-labeled shipping box.

2.2. Model estimation

Multinomial logistic regression was used to estimate recreational divers’ willingness to pay for levels associated with the various attributes. Coefficient estimates were used to compare relative importance of the attributes. The foundation for our analysis has its roots in Lancaster’s characteristic theory of value and random utility theory (McFadden, 1973; Manski, 1977; Hanley et al., 1998). Following random utility theory, we assume that utility for any option is derived from the attributes that make up that option. Based on McFadden (1973) and Hanley et al. (1998), we used the following relationships to investigate our data:

$$U_{in} = V_{in} + \varepsilon_{in} \quad (1)$$

where the utility (U) for any individual (n) from a specific alternative (i) comprises a deterministic component (V) and a random component (ε). If one of the deterministic components is price, then willingness to pay (WTP) can be calculated with the following relationship:

$$WTP = -\beta_A/\beta_P \quad (2)$$

Where β_A is the estimated coefficient of a particular attribute level and β_P is the estimated coefficient of price.

For more information on random utility models, see McFadden (1973), Manski (1977), Adamowicz et al. (1994), Hanley et al. (1998), and Schuhmann et al. (2013a).

2.3. Logistic regression models

The particular model we chose to estimate consumer utility values (based on Equation (1)) was a conditional logistic regression (CL), which treats the coefficients of each attribute as fixed parameters using a maximum-likelihood approach (following Aizaki et al., 2015). All model estimation was conducted using the “survival” package (Therneau and Grambsch, 2000; Therneau, 2015) in R statistical environment (R Core Team., 2015) using the front-end package “clogit” (Aizaki, 2012). We opted to specify three models: (1) a full model of all divers; (2) a model of divers indicating Florida residence; and (3) a model of divers indicating residence outside of Florida. This approach allowed us to make inferences about divers generally, but also allowed us to compare residents with visitors. This approach also afforded us the ability to compare results of the present study with Shideler et al. (2015), who surveyed only Florida resident recreational anglers. Preference heterogeneity was examined by interacting attributes of the individuals with goliath grouper encounters (treated as ordinal data for interactions) in the choice experiments. Attributes of the individuals found not to significantly relate to goliath grouper encounters were removed from the model in a reverse stepwise method. To test whether there was a difference in the levels of attributes (e.g., are divers simply willing to pay to see a goliath grouper or is there a difference in

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