

Draft Report (2/12/2026) for SAFMC SEP

Snapper-Grouper Management Strategy Evaluation: Recreational Angler Attitudes and Preferences

Draft Report on the Recreational Angler Survey

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Executive Summary

The goal of the survey was to provide information about stakeholder preferences for general and specific regulations useful for informing management of South Atlantic reef fish recreational fisheries. The survey was developed in a stated preference frame with a discrete choice experiment as the primary mechanisms for understanding preferences and trade-offs among management options. The survey also included stated preference questions about general trade-offs, and novel management strategies. General trade-off questions focused on respondents attitudes towards fishing regulations and conditions under which they would find additional restrictions acceptable, while the novel management strategies asked respondents about options that may be further from implementation, including harvest tags, spatial management (large target/harvest closures and dedicated fishing areas), and education requirements for reef fishing (roughly following the concept of hunter safety requirements). The survey was implemented via a panel to match the spatial extent of South Atlantic waters and minimize avidity bias in response rate. Over 7,889 responses were received with 1,967 deemed useful for analyses, with a robust qualifying question routine used to ensure most respondents did in fact reef fish in the South Atlantic in recent years. Analyzed respondents (hereafter 'respondents') were generally male and older, though there was a higher proportion of female respondents (near 40%) than is likely to occur in the fishery (panel respondents generally skew female). Respondents overwhelmingly considered themselves recreational fishers who predominately cared most about reef fishing, which they most often did from private vessels and most often targeted red snapper. The alignment of these descriptions with expectations of South Atlantic recreational reef fisher demographics seem to indicate generally the panel-based survey results were reasonable.

Respondents overall agreed with fish-population-needs for recreational reef fishing regulations in general, and most respondents indicated stricter regulations would be acceptable if they improved fishing. Most respondents cared more about red snapper management than gag, and the DCE analyses (mixed logit model) were considered more robust for red snapper (driven largely by the greater sample size for red snapper). The model results suggested overall respondents wanted a longer harvest season than the status quo (2 days for red snapper) and disliked¹ a fee-based permit, but preferred 3- and 6-month targeting closures over no targeting closures, and that respondents did not care about aggregate bag limits. Respondents overall had quite positive perceptions of the novel management strategies, with nearly 70% of respondents liking (a lot or somewhat) spatial management and education requirements. The overall analysis indicates most respondents would accept or even prefer stricter harvest regulations, especially for red snapper, and were open to the novel options described here.

The respondent preferences indicated heterogeneity, however. Subsequent latent class analyses suggested that red snapper respondents could be broken into three classes– (42.2%) “harvest-oriented” Class 1 that preferred longer seasons and resist effort restricting rules like target closures and mandatory stopping, and a slightly smaller (33.2%) “conservation-oriented”

¹ “Disliked” here should be interpreted as a negative utility associated with increasing fees

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Class 2 that preferred more restrictive red snapper regulations and were least likely to opt out of the options, and a (24.5%) “flexible pragmatists” Class 3 which had a balanced preference for regulations, but were the most likely to opt out of the options and prefer the status quo.

Overall, the survey results suggest that even among anglers who indicate that they care about reef fishing and specifically red snapper, there are two groups (consisting of over 55 percent of the sample for red snapper) that are generally very open to additional restrictions, and there is one group that mostly dislikes any additional regulations. One interpretation of this would be that there are some (especially red snapper) anglers who would not want stricter regulations under any circumstances or think they are warranted, while overall most of the (even red snapper) fishers would accept or even prefer additional regulations, including targeting closures and novel options like spatial management and education requirements.

The results appear most reliable for red snapper and less so for gag grouper. The survey design, demographics, and red snapper DCE analyses lend confidence that the survey results are reflective of reef and especially red snapper anglers, while the class-based differences in preferences, attitudes, and willingness to opt-out of the red snapper fishery is compatible with the idea that some sub-groups could be more or less willing to accept stricter regulations. It is likely important to frame the survey results carefully to avoid suggesting that the average responses (general favorability towards stricter regulations including targeting closures and spatial management) represent all respondents, much less all fishers. As with all stated preference and especially SPCE or DCE instruments, the results are subject to potential hypothetical biases or limitations. That is, respondents to our survey were indicating their preferences and potential hypothetical behavior under a range of options not currently implemented.

Draft Report (2/12/2026) for SAFMC SEP

TABLE OF CONTENTS

Executive Summary	2
1 Goals and Objectives	5
2 Conceptual Approach and Survey Design	5
3 Detailed Descriptions of Survey Parts.....	6
3.1 <i>Informed Consent and qualifying questions</i>	7
3.2 <i>Fishing experience and behavior questions</i>	7
3.3 <i>General trade-off questions</i>	7
3.4 <i>Discrete choice questions</i>	8
3.5 <i>Novel management questions</i>	11
3.6 <i>Demographic questions</i>	12
4 Survey Distribution	12
5 Analyses	13
5.1 <i>Implementation, responses, and general demographics results</i>	13
5.2 <i>General trade-off questions results</i>	15
5.3 <i>DCE questions results</i>	17
5.4 <i>Latent class analyses- Red Snapper</i>	20
5.5 <i>Latent class analyses- Gag Grouper</i>	24
5.6 <i>Novel management strategies</i>	28
5.7 <i>Trip dynamics</i>	30
6 Study Limitations	31
7 Conclusions	31

Draft Report (2/12/2026) for SAFMC SEP

1 Goals and Objectives

The goal of the survey was to provide information useful for informing management of South Atlantic reef fish recreational fisheries. Specifically, South Atlantic recreational reef fish angler (hereafter, “angler”) stated preferences and planned behaviors were described with respect to fisheries management regulations. There were four objectives for the survey:

1. Describe angler demographic information.
2. Estimate angler attitudes towards restrictive fisheries regulations in general.
3. Quantitatively describe anglers’ relative preference for specific attributes of management regulations, such as harvest season length, reef fish aggregate bags, etc., including consideration of angler preference heterogeneity.
4. Describe angler opinions regarding novel management options.

2 Conceptual Approach and Survey Design

The survey constitutes a “stated” measurement of angler preferences and planned behaviors. Stated measures rely on respondents (here anglers) saying or “stating” their preferences and potentially, future behaviors. Stated approaches are separated from “revealed” analyses that describe observed behaviors to infer preferences. Stated approaches are common in research and routinely incorporated into management decision-making. Stated preference approaches are flexible and permit asking about perception and behaviors, including responses to future or alternative conditions that differ from current conditions, but their primary limitation is that respondent’s statements of how they would act can differ from how they might act in real-world situations (sometimes referred to as hypothetical bias). Given the overall objective of the project of assessing angler preferences for and possible behavioral responses to different or novel management actions, a stated preference approach is warranted.

The survey approach is intended to guide respondents through a series of questions that encourage them to think about the recreational reef fisheries in the South Atlantic, its management, and possible trade-offs between regulations and fishing opportunities. The survey focused particularly on trade-offs associated with regulatory recreational fisheries management but asked additional questions to provide additional context regarding how trade-offs might be interpreted differently among different anglers.

The stated-preference survey instrument was designed around a discrete choice experiment (DCE). DCE’s ask respondents to select between two or more options that are differentiated by specific levels of multiple attributes. Respondent selections of options differentiated by different levels of multiple attributes produced data that permit quantitative evaluation of the importance of the attributes in determining the respondents’ choice. DCE applications are relatively common in fisheries, where they are often used to assess possible fisher responses to yet-unimplemented management strategies. This is considered their strength, as no revealed preference analyses or empirical counterfactual-based difference-in-difference approaches can be applied to study management actions that are not yet implemented. The acknowledged limitation of DCE is that the options are hypothetical, and it is

Draft Report (2/12/2026) for SAFMC SEP

possible that respondents may make real-world choices that differ from how they state they would in a DCE.

The survey included five different types of questions:

- Fishing experience questions that asked about past reef fishing behaviors including locations (states), modes (private vs. for-hire), intensity (quantity of trips taken), and targets (species). We also directly asked about the importance of recreational reef fishing in the South Atlantic to respondents lives. This information is commonly collected to (i) help describe fishers, (ii) consider possible behavior-based heterogeneity (e.g., per avidity, target species, modes), and (iii) indicate if there may be groups that are not well represented in the survey results. However, we limited the number of questions asked in this section (owing to overall survey length concerns) and so these questions are not likely suitable for developing centrality-to-lifestyle scales that could be compared to broadly different fisheries.
- General trade-off attitude questions that asked about anglers' perception of the importance and effect of restrictive regulations on fish populations and fishing experiences. These were simple stated-preference questions (not choice experiments) and included questions explicitly asking under what conditions more restrictive harvest regulations would be acceptable. These questions can help provide some indication of overall attitudes towards management, and may contextualize choice experiment results. It is possible that in some fisheries and potentially the South Atlantic reef fishery, anglers could oppose regulations for multiple and potentially different reasons—for example, because (i) they thought regulations were unnecessary (i.e., anglers believing fish populations are “fine”), (ii) they thought the specific regulations would not be effective, or (iii) they disliked the proposed regulations. Understanding the overall attitudes towards regulations and trade-offs between regulations and potential fishery quality may help provide context regarding these reasons
- Choice and future behavior questions using a discrete choice approach to ask anglers which of two hypothetical future management options they would prefer. These questions constituted the majority of the survey and were used to assess preference for specific management options. Attributes and levels were selected based on working group and Council staff input.
- Novel management questions that presented and asked respondents about more “out of the box” options that were not well suited for inclusion in the discrete choice experiments but have theoretical and or literature-based support for potentially addressing recreational fishing trade-off questions. These questions may be used to consider relative support for future work.
- Demographic questions that asked about respondents age, sex, income, state residency, etc. This information is commonly used to assess heterogeneity of respondents.

[3 Detailed Descriptions of Survey Parts](#)

Though the full survey will be appended to the final report, we describe the parts of the survey here in a way that should provide general understanding of the instrument content, flow, and intent useful for the interpretation of the results.

Draft Report (2/12/2026) for SAFMC SEP

3.1 Informed Consent and qualifying questions

These front-end questions included required language to ensure respondents are 18 years of age or older, have experience that makes them appropriate for the survey topic (South Atlantic Reef Fish anglers), understand any possible risks and or benefits of taking the survey, and understand the background and motivation for the survey. These are generally standard components of research-management surveys. One less common approach that we used here was how we handled the “qualifying question” which attempted to ensure the respondents had experience as recreational reef fishers in the South Atlantic. Respondents were asked to indicate any of the outdoor activities that they had participated in within the last 2 years in the South Atlantic, including options like recreational kayaking, recreational reef fishing and recreational marine ice fishing was another. Recreational marine ice fishing is not common anywhere in the continental US and is wholly impossible in the South Atlantic, and this question was asked before respondents saw any information regarding the purpose or topic of the study. Only respondents who selected recreational reef fishing, but not recreational marine ice fishing were forwarded to the rest of the survey. This design was intended to select respondents who had in fact recreationally reef-fished, and who were not simply selecting all options (since that would include selecting knew something about recreational reef fishing in the South Atlantic. This qualifying question was only used with the panel distribution (described below) and was omitted from the email-based distribution.

3.2 Fishing experience and behavior questions

This section included a series of questions that could be used to describe broad behavior-based angler types. It included questions about fisher self-identity (e.g., recreational vs. for-hire), type of fishing most important to them (e.g., reef vs. inshore), intensity of fishing (trips in the last 12 months), and common fishing modes (shore, private vessel, for-hire) and targeted reef species. These questions can be used to help verify the representativeness of the survey to overall recreational fishing population and the responses can be used individually via grouping procedures as covariates in analyses of other components of the survey (e.g. DCE analyses).

3.3 General trade-off questions

This brief section has two types of questions. The first were a series of likert-scale questions asking respondents to agree or disagree with statements about how recreational fishing regulations affected reef fish populations and conditional preferences for more or less restrictive regulations (e.g., “I would rather have less restrictive regulations now even if it made it harder to catch keeper sized reef fish”, or “I would rather have more restrictive regulations for the next 2 years if it led to better fishing over the next 10 years”). The second question directly asked under what conditions would respondents find stricter regulations acceptable, with conditions being based on fishing experiences (catch number, catch size, distance traveled on water, and opt-outs such as none of the above). These questions may be analyzed directly to inform management of how anglers (or groups of anglers) feel about stricter regulations. This is especially critical as managers may well receive feedback disproportionately from certain

Draft Report (2/12/2026) for SAFMC SEP

groups of anglers, and it is useful to consider the extent to which such feedback represents the overall angler population. To that point, the responses to these questions from the email survey (see section 4. Implementation) could represent a skewed or biased perspective, given evidence that typically such no-compensation email surveys are more often answered by more avid and/or invested anglers. Answers to these questions may also be useful as covariates in subsequent analyses.

3.4 Discrete choice questions

The project focused on two reef species—gag grouper and red snapper. The availability, techniques, regulations, and trip-related experiences (e.g., catch rate, size, travel distance, etc.) could vary across species and spatial regions over which the survey was implemented. The selection of gag and red snapper was based on the expectation (as informed by MRIP targeting data- and working-group feedback) that these two species were the most common or “sought after” targets throughout much of the range—especially if that range were weighted by trips taken. Further, the multi-management zones and historical/current regulations of black sea bass might render some of the attributes well-suited for red snapper and gag grouper inconsequential or nonsensical for black sea bass (e.g., long-history of minimal or no closed harvest season, and different black sea bass regulations based on spatial zone of waters adjacent to North Carolina). Even excluding black sea bass, reasonable levels of the important attributes (especially harvest season duration) would differ between red snapper and gag grouper, with the recent/current red snapper harvest season being 2 days and the gag seasons being 57). To account for this, a gag grouper and red snapper version of the DCE (and novel management questions) were developed. All respondents were asked to select which of these two species they cared most about, and this question directed respondents towards the appropriate survey version.

Each species-specific DCE included instructions of the choice-question process, detailed description of the attributes considered, and attention/understanding check questions. The attributes are described below with a brief justification for their inclusion:

- Harvest season: The duration of the harvest season (number of days which harvest of a species is allowed) was expected to be one of the most important attributes to anglers based on public feedback. It was expected that respondents would show preference for longer harvest seasons.
- Reef fish targeting closure: Regulations restricting targeting reef or bottom fish have not been implemented in the South Atlantic recently but remain in discussion because of their potential to limit total mortality by decreasing discard mortality. It was expected that respondents would dislike any non-zero level of targeting closure.
- Reef fish aggregate bag limits: This is the concept that a multi-species bag limit might be applied that could somehow be more sustainable and might obviate less-liked options like shorter harvest seasons or targeting closures. This attribute was retained for the choice experiments based on Council recommendations. It is complicated by the fact that separate grouper- and snapper-family aggregate bags already exist in the South Atlantic (3 for grouper, 10 for snapper), and was defined in the choice experiments more broadly as applying to all reef fish (including snapper, grouper, grunt, sea bass,

Draft Report (2/12/2026) for SAFMC SEP

etc.) but would not alter extant species-specific bag limits. Discussions with SAFMC partners and unpublished research suggested that aggregate bag limits alone might not be expected to reduce harvest much under current angler behavior, but there is little (no?) literature describing how these specific multi-species limits might be perceived by anglers.

- Mandatory stopping rule: This attribute described a yet-unimplemented rule that fishing must stop if species and/or aggregate bags were reached. It is possible that such an approach could increase the efficacy of aggregate bags or other measures. There are few if any precedents for such a rule in US marine recreational fisheries.
- South Atlantic Reef Fish Permit: This attribute described a hypothetical permit that would need to be purchased for targeting reef fish in federal South Atlantic waters. It serves as a “payment vehicle” for the DCE, an analyses check (cost components are expected to have negative betas with respect to selection), and allows connecting the other attributes to a monetary metric. It was included primarily for these reasons and was not recommended by SAFMC Council nor the working group.

Respondents were given three choice sets, each one asking them to choose between Option 1 and Option 2. Each option contained a combination of different levels of each attribute. The combinations were selected following a D-efficient design to ensure optimality for analyses—essentially ensuring attributes levels were sufficiently concentrated across choice sets. Any combinations that were nonsensical or would be clearly dominating/dominated with respect to other choices (e.g., the most lenient levels of all attributes, or the most restrictive) were removed. The choice sets were broken into 10 blocks, such that each respondent received one block consisting of three choice set questions. This follows standard DCE methodology. A departure from common DCE approaches, especially for more economic analyses, is that we did not include the status quo (current levels of all attributes) as a separate choice. That is each of Option 1 and Option 2 were composed of varying levels of each attribute, and there was no fixed Option 3 that that represented the status quo levels. The reason for this was that the status quo management for gag grouper is likely not biologically sustainable (e.g., a 57-day harvest season combined with the status-quo levels of the other attributes) may not prevent overfishing of the stock. Yet at the same time this status quo would likely dominate the other choices—i.e., we thought it would likely be chosen over the varied Option 1 and Option 2, each of which would by definition contain more restrictions. For red snapper, the status quo is arguably not socioeconomically sustainable, as the current 2-day harvest season is thought to have caused substantial dissatisfaction and loss of option value. In both cases, the socioecological system is likely to not be at equilibrium, and so the provision of the status quo would likely impair learning from the varied Option 1 and Option 2. We did include the status quo levels (e.g., 2-day harvest season for red snapper, 57-day harvest season for gag) within Option 1 and 2. An explicit opt-out was included as a “third” choice. Respondents could select Option 1, Option 2, or indicate “I would choose to not fish for Red Snapper/Gag Grouper under either option”. While some DCE’s consider status quo and opt-outs synonymous, in this context they represent different types of decisions (preference vs. planned behavior). The opt-out is considered in analyses but ought not to be considered as the status quo. Detailed information of the attributes and levels are provided below for each gag and red snapper.

Draft Report (2/12/2026) for SAFMC SEP

Table 1. Gag choice experiment attributes and levels

Attributes	Description	Levels
Gag Harvest Season	Days during which harvest of gag grouper is allowed in federal waters. The harvest season for gag grouper was 57 days in 2025.	Shorter: 29 days Medium: 57 days (current season) Longer: 114 days
Reef Fish Targeting Closure	Days when targeting reef fish is prohibited, sometimes called "bottom fishing closures." None are currently implemented in South Atlantic waters.	None: No closures 3 months: Targeting closure 6 months: Targeting closure
Reef Fish Aggregate Bags	Limits on total reef fish kept per day. Current limits are by species and family (e.g., 1 gag, 3 grouper). This Reef Fish Aggregate Bag would limit the total of all reef fish combined.	Unlimited (current; 1 gag) 5 reef fish (1 gag) 7 reef fish (1 gag) 10 reef fish (1 gag) 15 reef fish (1 gag)
Mandatory Stopping Rule	Anglers must stop fishing once daily bag limits (species or aggregate) are reached. Currently no mandatory stopping rules exist.	Yes: Implemented No: Not implemented
South Atlantic Reef Fish Permit	Permit to reef fish in federal waters. Funds would support enforcement. Currently only Florida requires a (free) reef fish permit.	\$0: Current \$50 \$100 \$150

Table 2. Red Snapper (RS) choice experiment attributes and levels

Regulations	Description	Levels
Red Snapper Harvest Season	Days during which harvest of Red Snapper is allowed in federal waters. The harvest season for Red Snapper was 2 days in 2025.	Shorter: 2 days (current season) Medium: 15 days Longer: 60 days
Reef Fish Targeting Closure	Days when targeting reef fish is prohibited, sometimes called "bottom fishing closures." None are currently implemented in South Atlantic waters.	None: No closure (current) 3 month closure 6 months closure
Reef Fish Aggregate Bags	Limits on total reef fish kept per day. Current limits are by species and family (e.g., 1 Red Snapper, 10 snapper). This Reef Fish Aggregate Bag would limit the total of all reef fish combined, but would not change the species or family limits.	Unlimited (current; 1 RS) 5 reef fish (1 RS) 7 reef fish (1 RS) 10 reef fish (1 RS) 15 reef fish (1 RS)
Mandatory Stopping Rule	Anglers must stop fishing once daily bag limits (species or aggregate) are reached. Currently no mandatory stopping rules exist.	Yes: Implemented No: Not implemented (current)
South Atlantic Reef Fish Permit	Permit to reef fish in federal waters. Funds would support enforcement. Currently only Florida requires a (free) reef fish permit.	\$0: Current \$50 \$100 \$150

Draft Report (2/12/2026) for SAFMC SEP

3.5 Novel management questions

There were three novel management strategies considered. Their details and reason for their inclusion are summarized below.

- Harvest tags: tags that must be attached to individual fish harvested. The harvest tag questions specified the number of tags would be determined by the recommended catch levels (and so would vary season to season), the allocation of tags would be determined via lottery, and that there would be no cost for tags. Respondents were told that implementation of harvest tags would coincide with cessation of closed harvest, bag, and size limits, as catch would be directly controlled. Harvest tags have been suggested as an alternative approach to more successfully control fishing-related mortality without the option-value losses associated with short harvest seasons. Major uncertainties associated with harvest tags involve their logistic implementation and enforcement, as well as behavioral responses of anglers—specifically how harvest tags would affect overall effort. This may well differ stock-to-stock and could change over time as norms and/or motivations for fishing may shift.
- Spatial closures management: A system in which large proportions of federal waters would be closed to targeting and harvest for much of the year, but also a similarly large proportion of waters would be open to harvest year-round. Respondents were told that 50% of waters would be closed to targeting and harvest for 9 months of the year (open the remaining 3 months), that 50% of waters would be open year-round, and that which waters were closed would rotate over time. This approach would ensure that some areas would always be open to some harvest, but that other areas would be essentially protected. Advantages of such an approach include preventing seasonal disruption to fishing-based economies that could be adversely affected by prolonged targeting closures, while still providing the fishing-related-mortality-decreases in certain spatiotemporal zones.
- Reef fishing education requirement: This alternative suggested that anglers would need to obtain an education-based endorsement to target reef fish and is based roughly on the concept of a hunter safety card. Respondents were told that the course would teach best practices regarding catching, releasing, and harvesting reef fish to encourage ethical on-water fishing behavior, and that it would require 8 hours of online class, one in-person meeting, and a small fee (\$25) to defray costs associated with implementation. This justification for such an inclusion is based on the reality that recreational fishing-related mortality can only be decreased by diminished effort, catchability, or possibly discard mortality rate (though Shertzer et al. 2024 suggested effort reductions would likely be much more successful than changes in discard mortality rate). An education requirement might decrease overall effort while still allowing access (option value) individuals to whom fishing is most valuable, while potentially also diminishing discard mortality rate).

Questions about novel management strategies included respondent opinion (like/dislike) and preference for the novel strategy to any of the restrictive levels of the DCE

Draft Report (2/12/2026) for SAFMC SEP

attributes. All novel strategies were clearly described as hypothetical options that did have some scientific support. This was done to limit respondent concern (i.e., fear of immediate implementation of a novel approach that they may not agree with), while still indicating that the options were reasonable to consider.

3.6 Demographic questions

Respondents were asked at the end of the survey to indicate their sex, age and income (binned categories for each), and state and county of residence. These data from these questions may be used as covariates and to interpret classes describing preference heterogeneity. Respondents were also asked an open-ended question at the end of the survey.

4 Survey Distribution

The primary distribution approach was via a panel implemented via Dynata using the Qualtrics interface. Panel distribution typically and in this case refers to a third-party entity (here Dynata) finding respondents according to designer-specified strata. Respondents are provided some financial incentive by the third-party, and designers typically pay per response. A panel approach was used for several reasons. First, publicly available contact information of marine recreational fishers in North Carolina, South Carolina, and Georgia was not available. Contact information was available for Florida, as this information is considered public record and provided online. This precluded email or efficient mail-based surveys outside of Florida. Second, recent response rates for email-based surveys have been low and decreasing below levels traditionally considered necessary (e.g., 5%) for informing management. Panel-based surveys can also alleviate logistic concerns associated with compensating individuals by the designers. A possible limitation of panel-based surveys is that the financial incentive may encourage those lacking expertise, experience, or true opinions to complete the survey. This concern was addressed via the qualifying question described in 3.1, as well as multiple attention/understanding checks throughout the survey.

In addition, an alternative, email-based distribution was implemented for Florida. An identical survey (except for an altered qualifying question) was developed in Qualtrics for online implementation. Contact information was provided via public record of those who purchased a saltwater Florida fishing license. This pool was restricted to those who had currently had a Florida State Reef Fish Permit, a free permit required to target reef fish in Florida waters. The Reef Fish pool was further restricted to only those individuals whose address was listed in an eastern Florida county, to target people to whom the South Atlantic survey would be more relevant. The resulting pool was subsampled at approximately a 70% inclusion rate to randomly select ~100,000 individuals, which was hoped to yield 2-3,000 responses assuming the anticipated 2-3% response rate. The email survey is considered as a sensitivity analysis for the primary product, the panel-based survey. The analysis of the email data is ongoing and results are not included in this draft report.

Draft Report (2/12/2026) for SAFMC SEP

5 Analyses

Analyses to date are described below. Final analyses to include additional samples and for publication is ongoing and will be updated as available. All analyses here describe the panel data. The panel data are considered the primary data for this project, as they were sampled across the spatial range of the project and avoid some of the avidity bias issues expected in email data.

The data were analyzed separately for gag and red snapper. As is described in detail below, the respondents selected red snapper (82.5%) much more than gag (17.5%) as the reef fish whose management they cared more about. Both species were analyzed via mixed logit models, which allows for preference heterogeneity—the concept that different respondents have different preferences. Preference heterogeneity can be explored via post-hoc latent class analyses which help understand different “groups” of respondents based on their expressed preferences. The larger sample size for red snapper permitted the latent class analyses, but it was not considered reliably converged at the current gag sample size. This explains why some of the results described below (e.g., 5.2 General Trade-off questions) describe only a single mean response for gag and provide class-specific means for red snapper. Summarily, red snapper Class 1 was a smaller (43.1% of red snapper respondents) class that appeared more amenable to restrictions and perhaps more casual red snapper anglers, whereas Class 2 was a larger (56.9%) group that seemed to prefer the most lenient regulations. Additional details of the latent class analyses are described in section 5.4.

5.1 Implementation, responses, and general demographics results

The panel survey was implemented through Dynata from November 21 through January 2025. A total of 1,976 surveys were analyzed (after 5,922 were removed owing to incompleteness).

5.1.1 General demographics

Demographic information about respondents is provided in Table 3. Respondents were mostly male (61%) although it is possible that females are overrepresented in panel data. That is, it is possible that females are more likely to agree to take panel surveys than males, and that the proportion of female respondents was greater than the proportion of female South Atlantic recreational reef fishers. The majority of the respondents (74.9%) reported household income <\$100,000 and most (74.8%) were under 55 years of age. Respondents were more often from Florida (43.8% of respondents) than other states, and most respondents (82.6%) said they cared more about red snapper management than gag grouper.

Draft Report (2/12/2026) for SAFMC SEP

Table 3. Demographic information for panel survey respondents.

Variable & Category	Count	%
<u>Gender</u>		
Female	778	40.1
Male	1,158	59.7
Non-binary/Other	3	0.2
<u>Income</u>		
Less than \$25,000	207	10.7
\$25,000-\$49,999	503	25.9
\$50,000-\$99,999	752	38.8
\$100,000-\$199,999	397	20.5
\$200,000 or more	69	3.6
Prefer not to say	11	0.6
<u>Age</u>		
18-34 years	532	27.4
35-64 years	1,198	61.8
Over 65 years old	165	8.5
Prefer not to say	44	2.3
<u>State Resident</u>		
Florida	789	40.8
Georgia	400	20.7
South Carolina	312	16.1
North Carolina	432	22.3
<u>Species Care About Most</u>		
Gag	288	14.6
Red Snapper	1,679	85.4

5.1.2 Fishery demographics

Respondents overwhelmingly identified as recreational fishers (92.2%). Most indicated that marine reef fishing (57.0%) was the type of South Atlantic recreational fishing that was most important to them, followed by inshore marine fishing (35.1%). Most (81.1%) agreed or strongly agreed that recreational reef fishing was an important part of their life. Nearly half indicated the most common way they reef fished in the South Atlantic was from a private or rental vessel (49.7%), with the other common modes being shore-based (32.6%) and for-hire (16.9%). The shore-based proportion is interesting. It may include respondents who have unclear or variable definitions of reef fishing, but it also may include individuals who fish for some reef species (e.g., black sea bass, mangrove snapper, etc.) from jetties or other shore-based structures.

Red snapper was the species that the most respondents indicated they had targeted in the last 12 months, followed by other groupers, black seabass, and other snappers (Fig. 1). Interestingly, gag was selected by <20% of respondents, at a similar level to amberjack species.

Draft Report (2/12/2026) for SAFMC SEP

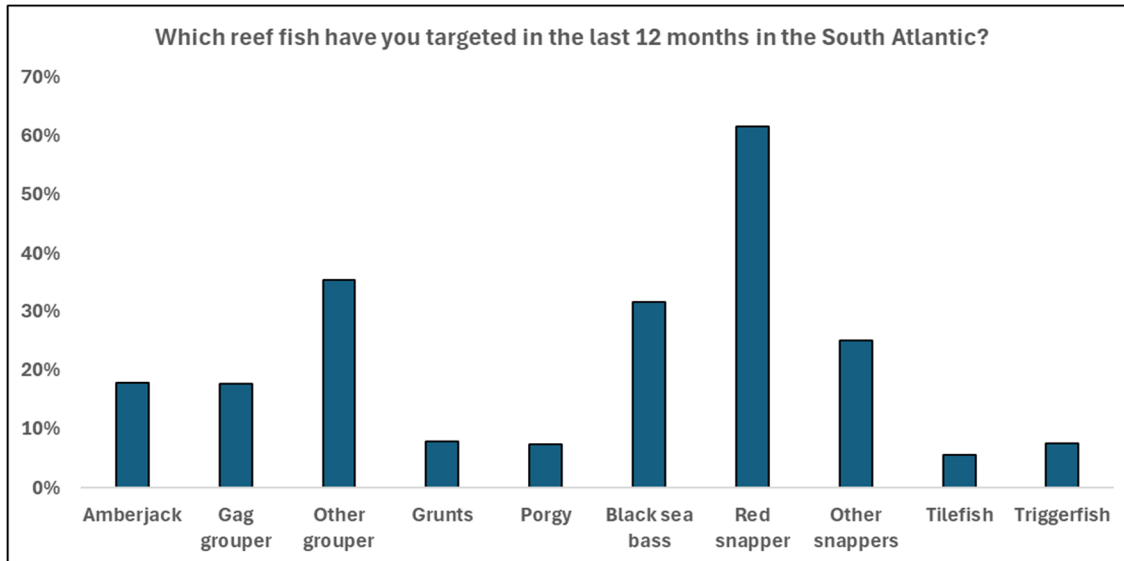


Figure 1. Frequency of responses by species of South Atlantic reef fish. Respondents were asked to select all species that they had targeted in the last 12 months.

5.1.3 Analyses overview with respect to class

The survey design asked respondents which of the management of gag or red snapper respondents cared more about. This allowed analyses of many questions by species. The larger sample of red snapper allowed for definition of “classes” of anglers—post-hoc groupings based on heterogeneity in the preferences expressed during the DCE questions. Class definition and analyses (assessment of what components contributed towards assignment to a class) occurs after the DCE results, but classification (grouping into one class or another) occurs at the scale of the individual respondent. This allows for description of other survey questions by class. However, the relatively low number of gag responses precluded class analyses of gag data. Therefore, class-specific responses are shown for some components of the survey below, but are only available for red snapper respondents. Details of the classification approaches and results are described in 5.4.

5.2 General trade-off questions results

The general trade-off questions were asked via a block of Likert scale (agree-disagree), followed by a single “select all that apply” multiple choice question directly asking under what conditions would stricter regulations be acceptable. Responses differed substantially between gag (N=193) and red snapper (N=915), with red snapper responses generally showing average responses that indicated respondents believed regulations were necessary, that stricter regulations would increase fish populations, and that they would prefer stricter regulations now if it led to greater catch in the future (Table 4).

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Table 4. Respondents' opinions about recreational reef management in the South Atlantic based on the reef fish they cared most about (either gag [N=193] or red snapper [N=915]).

Question	Gag grouper respondent mean (Std Dev)	Red snapper respondent mean (Std Dev)
Regulations are necessary to prevent overfishing reef fish populations	4.11 (1.01)	4.12 (1.02)
Stricter reef fish regulations would lead to increased reef fish populations	3.68 (1.04)	3.82 (1.00)
I would rather have less restrictive regulations now, even if they led to it being harder to catch keeper sized reef fish in the next 10 years	3.82 (1.02)	2.74 (1.21)
I would rather have more restrictive regulations in the next 2 years if it led to better reef fishing in the next 10 years	2.58 (1.16)	3.81 (1.01)

Respondents generally thought stricter regulations would be acceptable if they led to improved fishing experiences, although their responses indicated catch-related aspects were more important than travel cost ones. The majority of respondents (55-61%) indicated that stricter regulations would be acceptable for reef fish if they led to catching more or larger reef fish. Slightly less than half (41-47%) would accept stricter regulations if it led to shorter on-water travel distance. Respondents' assertion that stricter regulations would not lead to any such benefits for red snapper differed substantially between classes (8.2% Class 1, 23.4% Class 2).

Table 5 Conditions under which respondents would consider stricter regulations acceptable for gag (N=288), red snapper entire sample (N=1,679), and red snapper Class 1 (N=709), Class 2 (N=558) and Class 3 (N =412)

Stricter regulations would be acceptable if they lead me to.... (Check all that apply)	Gag (%)	Red snapper all sample (%)	Red Snapper Class 1 (%)	Red Snapper Class 2 (%)	Red Snapper Class 3 (%)
Catching more reef fish per trip	61.1	56.0	57.6	57.3	43.1
Catching larger reef fish	57.6	58.1	60.1	58.8	45.8
Needing to travel shorter distances on the water	44.4	45.9	46.6	45.8	42.7
I don't believe stricter regulations would lead to any of these	9.4	9.0	7.7	8.0	17.8

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The panel responses to the general trade-off questions suggest respondents generally accepted the need for regulations and that most would accept stricter regulations if they saw catch-related benefits. Caution should be applied to the interpretation of these results for several reasons, include (i) heterogeneity of red snapper respondents suggest many anglers would not find stricter regulations acceptable even if most would, (ii) these more general trade-off questions may describe overall attitudes, and it cannot be known what exactly respondents “had in mind” when they consider what “stricter regulations” would look like, and (iii) stricter regulations are imposed on the individual level, while the benefits are distributed across the fishing population in any open access fishery, which means it may be difficult if not almost impossible for individual anglers to recognize catch-related improvements from stricter regulations, especially depending on how dynamic targeting and effort is (i.e., latent effort that increases following regulation-induced population and catch improvements would be expected to subsequently diminish those catches to equilibrium levels).

5.3 DCE questions results

The DCE data are analyzed via logit models. Logit analyses of choice data essentially describes the quantitative effects of the options respondents faced on the choice they made. Specifically these analyses allow for the estimation of coefficients that describe the magnitude and direction of effects of specific attribute levels on the choice. For most choice experiences, the attributes and levels are considered as factors or discrete levels—with the general exception of the payment vehicle (variable linked to cost). This implicitly considers that respondents may have non-linear utility between attribute levels—i.e., a harvest season of 10 days may be more than twice as valuable as one of 5 days. The coefficients should be interpreted relative to a “baseline” level, in this case the first level of the attribute (analogous to an effects parameterization of a categorical variable in a GLM). Positive coefficients indicate the attribute level increased probability of the respondent selecting the choice option featuring it, relative to the baseline level. For example, in Table 6 below, the 0.358 coefficient for 3-month target closure indicated respondents were more likely to select an option including the 3-month target closure level than they were an option with the baseline (here, status quo of zero day targeting closure). Coefficients that were not statistically significant suggest they were not meaningful contributions to respondent choice.

Both gag and red snapper data were analyzed via mixed logit models. Mixed logit models are currently one of the most common approaches for analyzing choice data, and allow for more flexibility than the conditional logit. Mixed logit models account for preference heterogeneity—essentially allowing for variation in individual “taste” of the chooser. The “mixed” of mixed logit refers to allowing the random effects (coefficients) of individuals to be selected from any distribution as opposed to imposing one, such as the normal distribution with a probit model. The heterogeneity of the preferences—in what ways they varied and those groups or “classes” of respondents differed in terms of both their preferences and any other characteristics—can be further explored via latent class analyses (described in section 5.4).

The results indicate the red snapper mixed logit model performed generally well. This is

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assessed by the statistical significance of most of the parameters and the negative Permit coefficient (Table 6). The latter aligns with general economic theory, since the Permit attribute was a cost (a hypothetical reef fish permit costing \$0, \$50, or \$100) and represented the payment vehicle in our survey. The dollar unit of the Permit question allows willingness to pay (WTP) to be calculated for the other coefficients—this essentially rescales the coefficients into terms that some consider more intuitive (e.g., average respondents would be willing to pay \$91 to receive a 15-day red snapper harvest season compared to the 2-day red snapper harvest season baseline).

There are several important key results in the red snapper DCE. The first is that overall respondents preferred longer harvest seasons and target closures. The former is expected given recent opinions expressed; the latter may be surprising. The statistical significance of the positive coefficient for both the 3-month and 6-month target closures, combined with the general agreement of other coefficients with current understanding (negative coefficient for Permit, positive for longer harvest seasons) seems to suggest respondent preference for target closures is believable.

Second, respondents did not seem to base their choices much on aggregate bag levels (here 5- and 7-reef fish aggregate bags were pooled, as were 10- and 15-reef fish aggregate bags) or for stopping rules. The lack of significance of aggregate bags, even when pooled for smaller and larger sizes, could have several explanations. Perhaps respondents struggled to understand the concept of an aggregate bag (although the survey did include a practice question testing this). It may also be that the existence of grouper- and snapper-specific aggregate bags, along with gag and red snapper bag limits, limited the interest in this option. Previous unpublished analysis from the SAFMC staff suggest that aggregate bags would not often limit the harvest of most South Atlantic reef fish trips (and therefore would not often reduce overall harvest) seem to correspond with the interpretation that respondents did not care much about aggregate bag limits. The non-significant of the stopping rule has a similar interpretation. It may be that respondents were unsure how this would actually be implemented and enforced successfully on the water, and/or thought that it would not often require a behavioral alteration (e.g., perhaps many anglers rarely find themselves on trips in which all the reef fish harvest options have been filled and they still wish to keep fishing). Finally, the negative coefficient for the ASC_OptOut refers to the "Alternative Specific Constant", in this case the opt-out ("I would choose to not fish for red snapper under either option"). The negative and statistically significant value of this coefficient suggests red snapper respondents preferred not to opt out of the fishery as a group—i.e., they are more likely to choose Option A or Option B than not fishing due to management changes.

The overall results of the red snapper DCE suggest respondents overall were open to and even preferring some additional restrictions (target closures more so than aggregate bags), though they also wanted longer harvest seasons.

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Table 6. Red snapper mixed logit model results

Choice	Coefficient	Mean WTP (\$)	Std. Error	95% CI High	95% CI Low
Permit	-0.005***	--	0.007	-0.006	-0.003
Harvest Season – 15 day	0.407***	\$89.11	0.064	0.280	0.533
Harvest Season – 30 day	0.596***	\$130.59	0.080	0.434	0.752
Target Closure – 3 month	0.473***	\$103.65	0.083	0.310	0.636
Target Closure – 6 month	0.373***	\$81.65	0.080	0.216	0.529
Agg Bag – 5 to 7	0.008	\$1.76	0.083	-0.155	0.171
Agg Bag – 10 to 15	0.119	\$26.20	0.081	-0.038	0.277
Mandatory Stopping – Yes	0.079	\$17.37	0.065	-0.048	0.207
Optout	-1.508***	\$330.45	0.112	-1.727	-1.288
<i>Standard Deviation</i>					
Permit	0.012***		0.001	0.010	0.014
Harvest Season – 15 day	0.528***		0.161	0.211	0.844
Harvest Season – 30 day	1.052***		0.173	0.713	1.392
Target Closure – 3 month	0.728***		0.150	0.435	1.022
Target Closure – 6 month	0.718***		0.163	0.399	1.038
Agg Bag – 5 to 7	0.630**		0.211	0.216	1.044
Agg Bag – 10 to 15	-0.850***		0.144	-1.132	-0.568
Mandatory Stopping – Yes	0.808***		0.111	0.590	1.026

The gag-specific DCE mixed logit model did converge but produced some estimates suggesting additional data might improve the reliability of the results (Table 7). The payment vehicle Permit coefficient is statistically significant and negative, but the only other parameters that were so included the 3-month target closure and the stopping rule coefficients. The high and often statistically significant standard deviations of the coefficients further indicate caution is warranted when translating the gag respondent results to overall preferences.

There were also several differences between this model and the red snapper. The baseline gag Harvest season was a shorter season (29 days) than the current (57 days), though the lack of significance of either the 57-day or 114-day season should limit inferring much from these values. Finally, the gag model performed better with a different parameterization of the alternative specific constant. Here parameters for the Option 1 (A) and Option 2 (B) are estimated, and their positive, statistically significant values suggest again that respondents were more likely to select a management option than indicate they would not fish for gag under either option.

The overall results of gag indicate less clear respondent preferences for altered management regulations and are consistent with some sample size concerns. While ongoing sample collection may alleviate concerns, the panel respondents were not (and likely could not be in a cost-efficient manner) stratified for preferred species (gag or red snapper). Further analyses could consider simplifications to the model, but the possibility that respondents were generally less opinionated regarding gag regulations should also be considered.

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Table 7. Gag Grouper mixed logit results

Attribute	Coefficient	Mean WTP (\$)	Std. Error	95% CI High	95% CI Low
Permit	-0.004*	–	0.002	-0.007	-0.000
Harvest Season_57 days	0.136	38.20	0.148	-0.155	0.427
Harvest Season_114 days	0.044	12.20	0.181	-0.312	0.399
Target Closure_3 month	0.176	49.50	0.172	-0.160	0.513
Target Closure_6 month	-0.091	-25.6	0.164	-0.412	0.230
Agg Bag_ 5 and 7	0.172	48.40	0.215	-0.249	0.593
Agg Bag_ 10 and 15	0.269	75.60	0.203	-0.129	0.667
Stopping Rule_Yes	0.197	55.50	0.157	-0.110	0.505
ASC_Optout	-1.78***		0.260	-2.29	-1.27
<i>Standard Deviation</i>					
Permit	0.015***		0.002	0.010	0.020
Harvest Season_57 days	0.802**		0.277	0.258	1.346
Harvest Season_114 days	0.865		0.462	-0.040	1.770
Target Closure_3 month	0.628		0.402	-0.160	1.417
Target Closure_6 month	-0.524		0.465	-1.436	0.388
Agg Bag_ 5 and 7	1.339***		0.216	0.917	1.761
Agg Bag_ 10 and 15	0.105		0.434	-0.746	0.955
Stopping Rule_Yes	-0.437		0.278	-0.982	0.108
ASC_Optout					
N	287				
LR Chi2(8)	63.28				
Prob > chi2	0.000				
Halton draws	500				
Log likelihood	-794.13				

5.4 Latent class analyses- Red Snapper

It can be important and informative to interpret the preference heterogeneity that the mixed logit choice models describe. This is often completed with latent class analyses. Latent class analyses were performed for red snapper and gag grouper. The latent class logit analyses were based on the stated attribute and level preference—that is, the information about the attribute levels that corresponded to the options selected (or if instead the respondent opted out) was used to develop classes and allows assessment of how specific attribute levels contributed to classification. The number of classes specified was based on the information criteria (BIC) and, critically, a reasonable interpretation of the classes produced (Table 8).

Latent class analysis identified three significantly different respondent groups. A “harvest-oriented” class (Class 1: 42.2% of red snapper respondents) generally preferred more conservative management than the status quo but was not likely to opt out of the options, which could be due to a strong preference for increased harvest season lengths. A “conservation-oriented” class (Class 2: 33.2%) tended to prefer the most liberal harvest regulations presented and was very unlikely to opt out. A “flexible pragmatists” class (Class 3: 24.5%) exhibited balanced support for some harvest restrictions with avoidance of most of the stringent management scenarios and was more likely to opt out. These differences are illustrated in Table 9 which shows class utilities (how the levels of attributes corresponded to selected preferences by class). Note that Class 2 indicated preference against targeting closures, a stopping rule, and a low aggregate bag, as well as indicating a strong preference to not opt out (stop fishing for red snapper). Class 1 was willing to not fish for red snapper and

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tended to favor more restrictive harvest (even preferring a medium-length season over a long season). In contrast, Class 3 exhibited more moderate and mixed preferences across attributes, showing support for seasonal extensions and some targeting closures, while being less strongly opposed to aggregate bag limits and management controls than Class 2.

Table 8. Estimation of the number of classes to consider

Model	Log-Likelihood	Parameters (df)	AIC	BIC	Class Shares
2 class	-4,625.9	19	9,289.8	9,434.6	C1: 59.5%
					C2: 40.5%
3 class	-4,608.95	29	9,275.9	9,496.9	C1: 42.2%
					C2: 33.2%
					C3: 24.5%
4 class	-4,604.18	39	9,286.4	9,583.6	C1: 15.6%
					C2: 30.1%
					C3: 24.3%
					C4: 29.9%

Table 9. Red snapper latent class-specific utilities

Variable	Class 1	Class 2	Class 3
Permit Fee	-0.012	-0.011	0.000
Harvest Season (Medium)	3.081	-1.642	0.686
Harvest Season (Long)	4.441	-2.313	0.117
Targeting Closure: 3 Months	-0.384	0.447	1.057
Targeting Closure: 6 Months	-2.849	1.881	1.892
Aggregate Bag Limit: Low	-0.451	-1.626	1.309
Aggregate Bag Limit: High	1.377	-2.069	-0.165
Stopping Rule (Mandatory Stop After Bag)	-1.059	0.964	0.232
ASC3 (Opt Out)	-2.471	-38.060	1.890
Class Share	42.2%	33.2%	24.5%

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The classes were relatively even with respect to demographic variables (Table 10). Class 2 contained slightly higher proportions of male respondents, while Class 3 contained a somewhat higher proportion of female respondents. Age distributions were similar across classes, with the majority of respondents in all three classes falling within the age 35–64 category. Income distributions were also broadly comparable, although Class 1 tended to have slightly higher representation in the upper income categories (\$100,000 and above) relative to Classes 2 and 3. Respondents were primarily residents of Florida, Georgia, North Carolina, and South Carolina across all classes, with only modest differences in state representation.

Table 10. Descriptive demographics of red snapper classes

Variable & Category	Class 1 Count	Class 1 %	Class 2 Count	Class 2 %	Class 3 Count	Class 3 %	χ^2	df
Gender							60.4***	4
Female	300	39.2	297	41.2	83	48.7		
Male	464	60.1	422	58.7	87	50.9		
Non-binary	9	0.5	3	0.05	6	0.4		
Income							142.2***	10
Less than \$25,000	72	41.8	72	42.0	28	16.2		
\$25,000-\$49,999	198	45.4	189	43.3	49	11.4		
\$50,000-\$99,999	296	45.9	294	45.4	56	8.7		
\$100,000-\$199,999	161	49.0	137	41.7	30	9.2		
\$200,000 or more	32	53.6	23	38.8	4	7.7		
Prefer not to say	6	44.4	2	25.9	2	29.6		
Age							35.1***	6
18-34 years	210	46.0	203	44.5	43	9.5		
35-64 years	467	45.9	445	43.8	104	10.3		
65 years and older	71	50.0	53	37.8	17	12.2		
Prefer not to say	16	41.9	16	41.9	6	16.2		
State Resident							31.9***	8
Florida	297	46.7	277	43.6	61	9.7		
Georgia	160	44.6	164	45.7	34	9.6		
South Carolina	135	47.9	116	41.4	30	10.8		
North Carolina	169	45.4	158	42.6	44	12.0		

The classes of red snapper respondents were remarkably similar with respect to the likert-scale block of general trade-off questions (Table 11). Both classes most agreed with the statement that regulations were necessary to prevent overfishing, and least agreed with the statement that they would rather have less restrictions now if it led to smaller regulations in the future.

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Table 11. Responses to general fishing regulation/trade-off questions by class (red snapper anglers only)

Question	All red snapper (Std Dev)	Red snapper Class 1 (Std Dev)	Red snapper Class 2 (Std Dev)
Regulations are necessary to prevent overfishing reef fish populations	4.12 (1.02)	4.14 (1.02)	4.17 (0.99)
Stricter reef fish regulations would lead to increased reef fish populations	3.82 (1.00)	3.82 (1.01)	3.88 (0.97)
I would rather have less restrictive regulations now, even if they led to it being harder to catch keeper sized reef fish in the next 10 years	2.74 (1.21)	2.74 (1.21)	2.73 (1.24)
I would rather have more restrictive regulations in the next 2 years if it led to better reef fishing in the next 10 years	3.81 (1.01)	3.85 (1.01)	3.84 (1.00)

The greatest difference between classes seemed to occur in how they responded to the general regulation/trade-off question asking under what conditions stricter regulations would be acceptable (Table 12). The slightly smaller, “regulation tolerant” Class 1 found regulations acceptable at greater proportions than the slightly larger, “restriction adverse” Class 2. Class 2 respondents were approximately 4 times more likely to indicate none of the above (more fish, larger fish, shorter on water travel distances) would make stricter regulations acceptable, and that they didn’t believe stricter regulations would lead to any of these—although the overall proportions of respondents holding these views were in the clear minority, even of only Class 2.

Overall, the latent class analyses were especially insightful. It suggests that red snapper respondents could fall into two categories. The first category (Class 1) was more accepting and even preferred stricter regulations, and the second category (Class 2) disliked any stricter regulations and was more likely to believe they would not be effective, even while most believed regulations were necessary. The classes did not differ much at all by sex, income, or age (Class 2 was slightly older and more male) but also were nearly identical with respect to reef fishing trips per year. There were two main differences between the classes. First, the “restriction adverse” class was less likely to accept stricter regulations even if it improved fishing experiences, and more likely to think stricter regulations would not lead to these improvements. Second, the restriction adverse Class 2 was less likely to opt out of red snapper fishing. A summary of the results is that a meaningful (~57%) proportion of the red snapper respondents generally though regulations in general for reef fish were necessary and would like

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larger fish populations if regulations could deliver them (Table 11), but were less likely to accept stricter regulations in part because they did not believe the stricter regulations would lead to better fishing (Table 12), and disliked the specific stricter regulations explored in the DCE (e.g., targeting closures, stopping rules). Further, some minority of the red snapper respondents (probably around 20% based on differences by class in Tables 11 and 12) don't believe there is a need for stricter red snapper regulations. One interpretation of this is that there is some group of red snapper respondents who are dedicated red snapper fishers and would dislike any stricter regulations, even though the overall respondents would accept or even prefer them. The implication is any restrictions would face some pushback but that most reef fish anglers would be accepting or even preferring them. This interpretation and implication obviously depends upon the extent to which the survey results are representative of red snapper and reef fishers in the South Atlantic. The panel distribution of the survey, as well as the specific qualifying questions used should provide reasonable representativeness, and the similarity in the trips per last 12 months does assure against clear differences between very casual anglers and more avid ones.

Table 12. Conditions under which respondents would find stricter regulations acceptable by class, red snapper data only.

Stricter regulations would be acceptable if they lead me to.... (Check all that apply)	Sample (%)	Class 1 (%)	Class 2 (%)	Class 3 (%)
Catching more reef fish per trip	56.0	57.6	57.3	43.1
Catching larger reef fish	58.1	60.1	58.8	45.8
Needing to travel shorter distances on the water	45.9	46.6	45.8	42.7
I don't believe stricter regulations would lead to any of these	8.9	7.7	8.0	17.8

5.5 Latent class analyses- Gag Grouper

As with red snapper, it can be important and informative to interpret the preference heterogeneity that the mixed logit choice models describe, which is often accomplished with latent class analyses. A latent class logit analysis was conducted for gag grouper based on the stated attribute- and level-preference data—that is, the information about the attribute levels that corresponded to the options selected (or if instead the respondent opted out) was used to develop classes and to assess how specific attribute levels contributed to class membership. The number of classes specified was based on the information criteria (BIC) and a reasonable interpretation of the classes produced (Table 13). A three-class solution provided the best balance between model fit and interpretability for gag grouper, while a four-class model did not converge.

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Table 13. Estimation of the number of classes to consider

Model	Log-Likelihood	Parameters (df)	AIC	BIC	Class Shares
2 class	-772.73	19	1,583.5	1,694.8	C1: 13.0% C2: 87.0%
3 class	-759.26	29	1,576.5	1,746.4	C1: 18.7% C2: 13.6% C3: 67.7%
4 class	No convergence achieved				

Latent class analysis identified three significantly different respondent groups for gag grouper. A smaller “harvest-restrictive” class (Class 1: 18.7% of gag grouper respondents) generally preferred more conservative management than the status quo, including strong support for low aggregate bag limits and mandatory stopping rules, and was very unlikely to opt out of fishing for gag grouper. A second small class (Class 2: 13.6%) tended to prefer more liberal harvest regulations, including longer seasons and fewer management constraints, and was also unlikely to opt out. A large “flexible pragmatists” class (Class 3: 67.7%) exhibited more moderate preferences across attributes, showing support for some seasonal extensions and aggregate bag flexibility, while displaying a comparatively greater willingness to opt out of fishing relative to the other two classes. These differences are illustrated in Table 14, which presents class utilities describing how attribute levels corresponded to selected preferences by class.

Class 1 exhibited strong positive preferences for a low aggregate bag limit and a mandatory stopping rule, and negative preferences for medium and long seasons and short targeting closures, indicating a generally conservation-oriented management perspective. Class 2 showed positive preferences for a long season and a stopping rule, but negative preferences for a low aggregate bag limit and high permit fees, consistent with a harvest-oriented orientation. In contrast, Class 3 displayed smaller-magnitude and mixed coefficients across most attributes, suggesting weaker and more flexible preferences, along with a negative opt-out constant that was smaller in magnitude than Class 1 but larger than Class 2, indicating an intermediate willingness to choose the opt-out option.

Table 14. Gag Grouper latent class-specific utilities

Variable	Class 1	Class 2	Class 3
Permit Fee	-0.096	-0.005	0.002
Harvest Season (Medium)	-0.588	-0.030	0.268
Harvest Season (Long)	-1.363	0.887	0.080
Targeting Closure: 3 Months	-1.772	0.548	0.064
Targeting Closure: 6 Months	1.387	0.197	0.001
Aggregate Bag Limit: Low	2.572	-1.017	0.057
Aggregate Bag Limit: High	0.439	-0.053	0.330
Stopping Rule (Mandatory Stop After Bag)	3.657	1.177	-0.150
ASC3 (Opt Out)	-10.587	1.415	-2.214
Class Share	18.7%	13.6%	67.7%

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The classes were relatively even with respect to most demographic variables (Table 15). Class 3 contained a higher proportion of male respondents, while Classes 1 and 2 contained somewhat higher proportions of female respondents. Age distributions were similar across classes, although younger respondents (18–34) were slightly more represented in Class 3. Income distributions were broadly comparable, with Class 3 exhibiting higher representation across middle- and upper-income categories. Respondents in all classes were primarily residents of Florida, Georgia, South Carolina, and North Carolina, with only modest differences in state representation. Overall, demographic characteristics did not strongly differentiate classes, suggesting that observed preference heterogeneity is driven more by management attitudes than by socio-demographic factors.

Table 15. Descriptive demographics of gag grouper classes

Variable & Category	Class 1 Count	Class 1 %	Class 2 Count	Class 2 %	Class 3 Count	Class 3 %	χ^2	df
Gender							5.1098	4
Female	21	21.7	18	18.6	58	59.8		
Male	41	22.2	18	9.7	126	68.1		
Non-binary	0	0.0	0	0.0	1	0.1		
Income							13.3492	
Less than \$25,000	12	35.3	6	17.7	16	47.1		
\$25,000-\$49,999	16	24.2	10	15.2	40	60.6		
\$50,000-\$99,999	20	19.1	12	11.4	73	69.5		
\$100,000-\$199,999	11	16.2	6	8.8	51	75.0		
\$200,000 or more	3	37.5	1	12.5	4	50.0		
Prefer not to say	0	0.0	1	50.0	1	50.0		
Age							12.9112*	6
18-34 years	16	21.6	11	14.9	47	63.5		
25-64 years	39	21.6	18	9.9	124	68.5		
65 years or older	6	26.1	4	17.4	13	56.5		
Prefer not to say	1	20.0	3	60.0	1	20.0		
State Resident							4.5660	6
Florida	33	21.6	16	10.5	104	68.0		
Georgia	11	27.5	4	10.0	25	62.5		
South Carolina	6	20.0	4	13.3	20	66.7		
North Carolina	12	20.0	12	20.0	36	60.0		

The classes of gag grouper respondents were also highly similar with respect to the Likert-scale block of general regulation and trade-off questions (Table 16). Across all classes, respondents most strongly agreed that regulations are necessary to prevent overfishing and generally agreed that stricter regulations would lead to increased reef fish populations. All classes expressed relatively low agreement with the statement that they would prefer less restrictive regulations now even if it led to poorer fishing in the future, and relatively high agreement that

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more restrictive regulations in the short term would be acceptable if they led to better fishing in the long term.

Table 16. Responses to general fishing regulation/trade-off questions by class (gag anglers only)

Question	All gag (Std Dev)	Gag Class 1 (Std Dev)	Gag Class 2 (Std Dev)	Gag Class 3 (Std Dev)
Regulations are necessary to prevent overfishing reef fish populations	4.11 (1.01)	4.14 (1.01)	3.67 (1.20)	4.18 (0.95)
Stricter reef fish regulations would lead to increased reef fish populations	3.68 (1.04)	3.83 (0.96)	2.97 (1.18)	3.76 (1.00)
I would rather have less restrictive regulations now, even if they led to it being harder to catch keeper sized reef fish in the next 10 years	2.58 (1.16)	2.40 (1.07)	2.56 (1.11)	2.65 (1.20)
I would rather have more restrictive regulations in the next 2 years if it led to better reef fishing in the next 10 years	3.82 (1.02)	3.98 (0.91)	3.31 (1.13)	3.86 (1.01)

The greatest difference between classes appeared in responses to the question regarding conditions under which stricter regulations would be acceptable (Table 17). Class 2 was less likely than Classes 1 and 3 to indicate that stricter regulations would be acceptable if they led to catching more or larger fish, and slightly more likely to indicate that they did not believe stricter regulations would lead to any of these outcomes. However, overall proportions of respondents holding these views remained in the minority across all classes.

Table 17. Conditions under which respondents would find stricter regulations acceptable by class, for gag grouper data only.

Stricter regulations would be acceptable if they lead me to.... (Check all that apply)	General Sample (%)	Class 1 (%)	Class 2 (%)	Class 3 (%)
Catching more reef fish per trip	61.1	61.9	36.1	65.6
Catching larger reef fish	57.6	58.7	38.9	60.9
Needing to travel shorter distances on the water	44.4	44.4	38.9	45.5
I don't believe stricter regulations would lead to any of these	9.4	9.5	13.9	8.5

Draft Report (2/12/2026) for SAFMC SEP

5.6 Novel management strategies

Respondents generally like each of the novel management strategies (harvest tag, spatial management, education requirements) that the survey asked about—with about 50-70% of respondents indicating that they liked (a lot, somewhat) each of the novel options across gag and red snapper respondents (Figs. 2 and 3). This is notable because only about 10-20% of the respondents indicated that they disliked these strategies (a lot or somewhat), with the remainder indicating they neither liked nor disliked. Spatial management (large targeting closures for most of the year with large areas open to harvest year-round) had the greatest support, with nearly 70% of respondents indicating that liked this option “somewhat” or “a lot”- consistent across gag and red snapper.

Figure 2. Like/dislike for novel management options, red snapper respondents

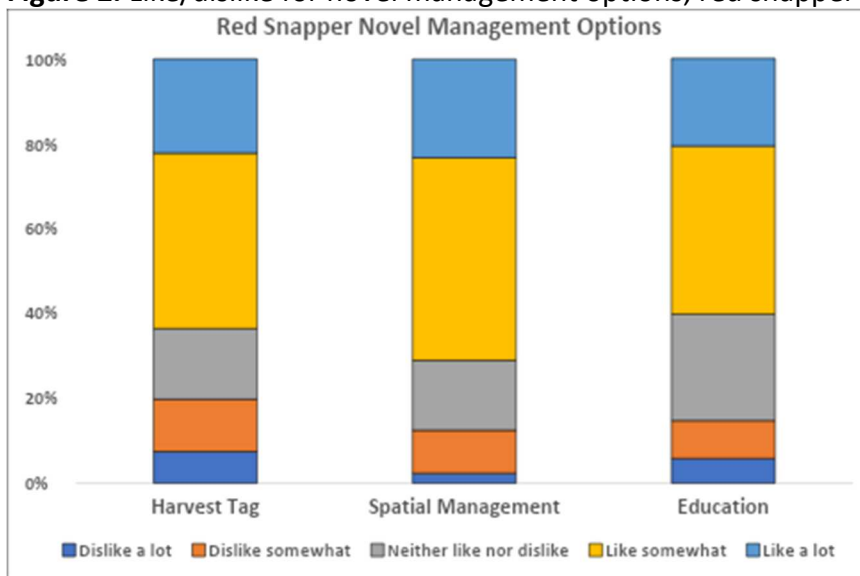
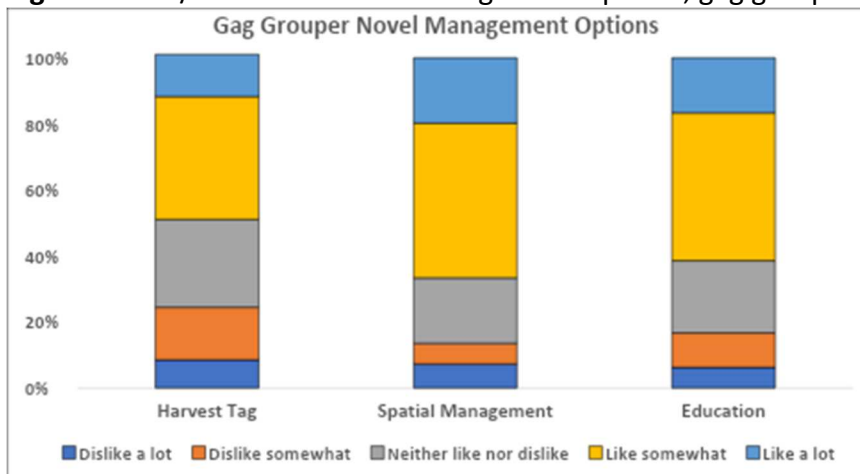


Figure 3. Like/dislike for novel management options, gag grouper respondents



Draft Report (2/12/2026) for SAFMC SEP

When asked which if any of the regulations from the DCE respondents preferred the novel strategy they were asked about over, most indicated at least one option (Table 18-19) there was no DCE regulations (shorter harvest season, targeting closure, aggregate bag, stopping rule, or reef fish permit) that the majority of the respondents preferred any of the novel strategies to. However, the “standard” (DCE-asked) strategy that a novel strategy was most often preferred over were the aggregate bags, with around 40% of respondents preferring any of the novel strategies of these. This analysis is most useful for providing context. The type of question used here (would you prefer the novel strategy over any of the following) is not as robust a comparison as the DCE. It is possible that respondents in general are less likely to say they “dislike” a new idea (like the novel strategy) and also might generally be less likely to say they’d prefer a novel strategy to the options that were presented as more “standard” options in the DCE. Likely the best interpretation of these questions is that the novel strategies considered were liked overall—very few respondents indicated these were “hard no’s”, and should not be considered “non starters” from a stakeholder perception perspective. These questions suggest these novel options, some of which have potential, at least theoretically, for addressing socioeconomic and ecological constraints, are worth considering further. These responses also lend support for the lack of preference for aggregate bags shown in the DCEs, specifically for red snapper.

Table 18 Red snapper novel management preferences. Novel options are shown in columns and the “standard” options asked about for the DCE are shown in rows. The proportions indicated the proportion of total respondents that indicated they preferred the given novel option over the given standard option. For example, 19% of respondents indicated they preferred a harvest tag over a shorter harvest season.

“Standard” Option in DCE	Novel Option		
	Harvest Tag	Spatial Management	Education
Shorter Harvest Season	19%	18%	19%
Targeting Closure	20%	22%	18%
Reef Fish Aggregate Bag	27%	25%	25%
Mandatory Stopping Rule	17%	16%	18%
South Atlantic Reef Fish Permit	18%	19%	21%

Draft Report (2/12/2026) for SAFMC SEP

Table 19 Gag novel management preferences. Novel options are shown in columns and the “standard” options asked about for the DCE are shown in rows. The proportions indicated the proportion of total respondents that indicated they preferred the given novel option over the given standard option. For example, 22% of respondents indicated they preferred a harvest tag over a shorter harvest season.

“Standard” Option in DCE	Novel Option		
	Harvest Tag	Spatial Management	Education
Shorter Harvest Season	22%	15%	21%
Targeting Closure	20%	18%	20%
Reef Fish Aggregate Bag	21%	25%	21%
Mandatory Stopping Rule	21%	22%	20%
South Atlantic Reef Fish Permit	16%	20%	18%

5.7 Trip dynamics

Part of the DCE question (Section 5.3) included follow-up questions of how the respondents’ trips would change under the management option that they selected. Analyses of these questions are ongoing and not straightforward, as the selections are conditional on the management option selected. Summary statistics are described in Table 14. These statistics are summarized across all blocks of the survey, which means that they are pooled across the attribute levels asked. One of the key attributes, harvest season length, was described differently, even in relative terms, for red snapper than for gag. Red snapper harvest season levels did not include an option for a shorter season than the status quo, given that the current season was only two days. Gag harvest season levels included both a shorter (29-day season) and a longer (114-day season) than the current 57-day season. This may help explain why 85.2% of the red snapper respondents indicated that the number of red snapper trips they thought they would take would stay the same or increase under the management selected, compared to 75.6% of gag respondents. There are also considerations for how the trip questions should be interpreted, given that future planned behavior (the number of trips one would take under a hypothetical management scenario selected) may require a different cognitive response than the option preference questions posed in the DCE. Further analyses are required to consider the relative effect of specific regulations on planned future trips.

Draft Report (2/12/2026) for SAFMC SEP

Table 20. Average frequency of stated trip responses to preferred management options in the DCE for red snapper and gag grouper.

Trip response	Red Snapper	Gag Grouper
Stop or decrease a lot	11%	12%
Decrease a little	6%	11%
Stay the same	38%	40%
Increase a little	32%	25%
Increase a lot	13%	12%

6 Study Limitations

There are several limitations to our study. First, we asked respondents about their intended behaviors, and we did not measure actual behaviors in response to changes in red snapper management. Thus, our results may be subject to hypothetical bias, a known limitation of DCE-based studies. This bias refers to the potential for differences between how respondents say they would act and how they would actually act. Sometimes hypothetical bias is expected to result in inflated WTP estimates. In our study, we consider especially the responses of how fishing effort might change under the yet-unimplemented management selections to be especially uncertain, as fishers may hesitate to indicate that they would fish less in the future. Second, we did not test for policy consequentiality in our choice experiments, that is, whether respondents believed that their survey responses would impact policy design and implementation. The concern here is that respondents may attempt to give answers that they believe will most likely result in outcomes they prefer, as opposed to giving answers that more accurately reflect their future behavior or true preferences. Finally, we did not test for scale heterogeneity (i.e., differences in scale across choice tasks or respondents).

7 Conclusions

Respondents overall agreed with fish-population-needs for recreational reef fishing regulations in general, and most respondents indicated stricter regulations would be acceptable if they improved fishing. Most respondents cared more about red snapper management than gag, and the DCE analyses (mixed logit model) were considered more robust for red snapper. The model results suggested that overall respondents wanted a longer harvest season than the status quo (2 days for red snapper) and disliked a fee-based permit but actually preferred 3- and 6-month targeting closures over no targeting closures, and that respondents did not care about aggregate bag limits. Respondents overall had quite positive perceptions of the novel

Draft Report (2/12/2026) for SAFMC SEP

management strategies, with nearly 70% of respondents liking (a lot or somewhat) spatial management and education requirements. The overall analysis indicates most respondents would accept or even prefer stricter harvest regulations, especially for red snapper, and were open to the novel options described here.

The respondent preferences indicated heterogeneity, however. Subsequent latent class analyses suggested that red snapper respondents could be broken into three classes– (42.2%) “harvest-oriented” Class 1 that preferred longer seasons and resist effort restricting rules like target closures and mandatory stopping, a slightly smaller (33.2%) “conservation-oriented” Class 2 that preferred more restrictive red snapper regulations and were least likely to opt out of the options, and a (24.5%) “flexible pragmatists” Class 3 which had a balanced preference for regulations, but were the most likely to opt out of the options and prefer the status quo.

Overall, the survey results suggest that even among anglers who indicate that they care about reef fishing and specifically red snapper, there are two groups (consisting of over 55 percent of the sample for red snapper) that are generally very open to additional restrictions, and there is one group that mostly dislikes any additional regulations. One interpretation of this would be that there are some (especially red snapper) anglers who would not want stricter regulations under any circumstances or think they are warranted, while overall most of the (even red snapper) fishers would accept or even prefer additional regulations, including targeting closures and novel options like spatial management and education requirements.

The results appear most reliable for red snapper and less so for gag grouper. The survey design, demographics, and red snapper DCE analyses lend confidence that the survey results are reflective of reef and especially red snapper anglers, while the class-based differences in preferences, attitudes, and willingness to opt-out of the red snapper fishery is compatible with the idea that some sub-groups could be more or less willing to accept stricter regulations. It is likely important to frame the survey results carefully to avoid suggesting that the average responses (general favorability towards stricter regulations including targeting closures and spatial management) represent all respondents, much less fishers.