

Economic Valuation of Artificial and Natural Coral Reefs in Southeast Florida

Final Report submitted to Florida Fish and Wildlife Conservation Commission

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M. Allen and K. Wallmo



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List of Acronyms

ACS	U.S. Census Bureau's American Community Survey
CRCP	Coral Reef Conservation Program
FDEP	Florida Department of Environmental Protection
FKNMS	Florida Keys National Marine Sanctuary
FL	Florida
FWC	Florida Fish and Wildlife Conservation Commission
GLM	General Linear Model
IPA	Importance-Performance Analysis
NOAA	National Oceanic and Atmospheric Administration
SCUBA	Self Contained Underwater Breathing Apparatus
SE FL	Southeast Florida
SPCE	Stated Preference Choice Experiment
U.S.	United States
WTP	Willingness-to-Pay or Willing-to-Pay

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Executive Summary

The primary objective of this study was to estimate non-use values for changes in reef attributes and characteristics for recreational uses of the reefs and the change in value under varying reef conditions using a stated preference survey. The survey was administered in May and June of 2021 and collected data representative of residents in the Southeast Florida region, rest of Florida, and rest of the U.S. This study also examined general knowledge about coral reefs, visitation to and use of natural and artificial reefs, importance and satisfaction of reef topics, perceptions of resource conditions and threats, and beliefs about responsibility and management of reefs. These human dimensions topics are based on social science theory and research to explain and predict human decision making and behaviors, such as those related to their choices and willingness-to-pay.

This study is the second phase of a larger study on the economics of Florida's coral reefs. The first phase consisted of an Economic Impact Study of recreational fishing, SCUBA diving, and snorkeling (Wallmo et al., 2021a; 2021b). This report covers Phase 2 of the larger project. Some of the key findings are summarized below, and suggest that U.S. citizens vary in their willingness-to-pay for access to natural and artificial reefs and are influenced by their general knowledge of coral reefs and beliefs about future conditions.

Use of Natural and Artificial Reefs

About 57% of residents of the rest of Florida and 25% of out-of-state residents had visited the Southeast Florida region at least once since May of 2016, but a majority of these residents were planning to visit the region sometime in the next five years. The majority of the sample primarily participated in beach recreation and there were many who participated in boating, saltwater fishing, and diving activities (location was not specified in the survey). While these beach and water activities may or may not have occurred in Southeast Florida, these use patterns suggest the extent to which people from all over the U.S. participate in different activities and how avid of a diver, boater, or angler the general population from each region might be.

Awareness of whether any of these activities occurred in proximity to a natural or artificial reef (located in Florida or elsewhere) varied between geographies. Saltwater fishing and boating were the two activities with the highest percentage of respondents who were not sure if they took place near a reef. Diving, saltwater fishing, harvesting of marine resources, and boating more commonly occurred near natural coral reefs, but also occurred at artificial reefs or both types of reefs.

Florida residents outside of Southeast Florida counties (the Rest of Florida) were more likely to believe that *artificial reefs, in addition to natural reefs, provide fishing and diving experiences*. This was also reflected in their relatively higher use of artificial reefs for saltwater fishing and diving, compared to residents of the other two geographies. Southeast Florida residents, on the other hand, were more likely to participate in ocean activities near natural reefs.

Importance-Performance Analysis of Coral Reef Topics

Respondents were asked to rate the importance of and satisfaction with eight different coral reef topics, each on a five-point scale. The mean scores of relative importance and satisfaction with each item were plotted on a four-quadrant grid. A summary of the importance-satisfaction scores rated by residents in the three geographies are in the table below. Most of the coral reef topics were rated with high importance and relatively lower satisfaction. These topics were represented in quadrant I of the IPA grid labeled “Concentrate Here”.

Summary results from Importance-Performance Analysis:

Coral Reef Topic	Importance-Performance Scores	Geographies
(A) Existence of natural coral reefs in Southeast Florida	“Concentrate Here” High importance, Low satisfaction	All
(B) Existence of artificial reefs in Southeast Florida	“Concentrate Here” High importance, Low satisfaction	Rest of Florida Rest of U.S.
	“Keep Up the Good Work” High importance, High satisfaction	Southeast Florida
(C) Opportunities to fish at coral reefs	“Low Priority” Low importance, Low satisfaction	Rest of U.S.
	“Possible Overkill” Low importance, High satisfaction	Rest of Florida
	“Keep Up the Good Work” High importance, High satisfaction	Southeast Florida
(D) Ocean water quality in Southeast Florida	“Concentrate Here” High importance, Low satisfaction	All
(E) Coral reef education for K-12 students in the U.S.	“Concentrate Here” High importance, Low satisfaction	All
(F) Coral reef knowledge among adults in the U.S.	“Concentrate Here” High importance, Low satisfaction	All
(G) Scientific research on Florida’s coral reefs	“Concentrate Here” High importance, Low satisfaction	Rest of U.S.
	“Keep Up the Good Work” High importance, High satisfaction	Southeast Florida Rest of Florida
(H) Coral reef conservation and preservation	“Concentrate Here” High importance, Low satisfaction	All

Responsibility to Protect Coral Reefs

The ways in which people use natural and artificial reefs tend to be linked to their values, beliefs, and norms. Floridians' higher affinity for reef activities may be linked to their belief that *coral reefs are part of what makes Southeast Florida special*, suggesting a dependence on coral reefs or cultural value of coral reefs to Southeast Florida's identity. Residents of Southeast Florida counties rated threats to coral reefs as more severe compared to other geographies, with water pollution being relatively the greatest threat to coral reefs. Floridians also more strongly believed that the construction of *artificial reefs can help offset the loss of natural reefs*. The majority believed that Florida residents and people that use Southeast Florida coral reefs (for fun or for income) have some responsibility to protect coral reefs, but non-residents of Florida believed all U.S. residents had the least responsibility.

Socioeconomic Values of Natural and Artificial Reefs

Overall, respondents were generally willing to pay more to access natural coral reefs than artificial reefs. To visit a *natural reef*, out-of-state residents had a higher willingness-to-pay than residents of Florida with an average WTP estimate of \$11.79 for an entry/access fee per person per visit. Southeast Florida residents were WTP \$11.41, and residents of the rest of Florida were WTP \$11.27. To visit an *artificial reef*, Southeast Florida residents had a higher willingness-to-pay than residents of the rest of Florida and U.S., with an average WTP estimate of \$9.30. Residents of the rest of Florida and U.S. would be WTP \$8.45. Significant predictors of WTP were a) knowledge of coral reefs generally, b) beliefs about the future ocean conditions in Southeast Florida, and c) future visits in the next five years (non-residents of Florida/rest of U.S.).

Results from the stated preference choice experiment are specific to reefs in Southeast Florida, and showed how much respondents were willing-to-pay in the form of a restoration fee for changes to coral cover, the number of artificial reef sites, and visitation/congestion. Respondents from the entire sample (all geographies) were WTP \$14.92, on average, for every 1% increase in natural coral cover in SE FL, \$7.60 for every 1% increase in the number of artificial reef sites in SE FL, and \$6.23 for every 1% decrease in in congestion at a reef site in SE FL.

The choice model also provided information on the following marginal rates of substitution:

- 1.96% increase in the number of artificial reef sites needed to equal a 1% increase in natural coral cover
- 2.40% decrease in the number of visitors (congestion) needed to equal a 1% increase in the number of artificial reef sites

- 1.22% decrease in the number of visitors (congestion) needed to equal a 1% increase in natural coral cover

Introduction

The overall goal of this project was to conduct an economic valuation study of ecosystem services for recreation and tourism on the reefs of Southeast Florida, extending from the St. Lucie Inlet in Martin County through the Florida Keys in Monroe County. This project consisted of two phases: 1) an Economic Impact Study of recreational fishing, SCUBA diving, and snorkeling (Wallmo et al., 2021a; 2021b), and 2) an Economic Valuation Study of natural and artificial reefs off the Southeast Florida coast. This report covers Phase 2 of the project. The primary objective of the Phase 2 study was to estimate non-use values for changes in reef attributes and characteristics for recreational uses of the reefs and the change in value under varying reef conditions using a stated preference survey. This study also examined general knowledge about coral reefs, the importance and satisfaction with coral reefs, personal beliefs about access to reefs, and other human dimensions concepts.

The natural and artificial reefs of Southeast Florida provide benefits to those who use the reefs and to those who depend on the local economies. While many of these benefits are economic or “market” values, there are “non-market” values that should also be considered. Recreational users may benefit from ecosystems having improved characteristics. For instance, studies have suggested that snorkelers and divers consider it important to experience natural surroundings and good water quality for a satisfying recreational experience (Paterson et al., 2012; Shafer & Inglis, 2000; Williams & Polunin, 2000). It has also been suggested that there is substantial economic value associated with use at artificial reefs, which can serve as potential substitutes and thus may alleviate pressures on natural reef areas for conservation purposes (Oh et al., 2008).

Since the 1940s, more than 3,800 public artificial reefs have been placed in state and federal waters all around Florida’s coast, with about 18% of the artificial reefs deployed in Southeast Florida counties (FWC, 2021). Artificial reefs are often deployed to enhance recreational saltwater fishing and diving opportunities by increasing fish habitat, thereby generating socioeconomic benefits for coastal communities (Huth et al., 2014a; 2014b). By enhancing recreational opportunities and fish habitat, artificial reefs might also influence an increase in visitation from out-of-state individuals who have a strong interest in saltwater recreational activities, such as fishing and diving, and further contribute to economic development. There is also a value of reefs to non-reef users who may value reefs for their existence or potential for future uses.

Policy makers need to know the extent of reef use by the public and the importance of reefs to the public in order to prioritize investments that protect the reefs and provide for new artificial reefs. Ultimately, the outcomes of this project (economic impacts from Phase 1 and non-market values from Phase 2) can be used to assist in conservation management in their efforts to care for existing natural and

artificial reef systems and to formulate management strategies that are in the best interests of the residents and visitors to the Southeast Florida region.

In 2001 and 2004, economic valuation studies of natural and artificial reefs in Martin, Palm Beach, Broward, and Miami-Dade counties were completed which established use and non-use values of natural and artificial reefs in Southeast Florida (Johns et al., 2001; Johns and Sawyer, 2004). These studies provided information on the economic contribution of coral reefs to the economy of Southeast Florida that local, state, and federal coral reef managers have relied on. These numbers have become outdated and are less able to be used to justify investments in coral and artificial reef programs and efforts. This project was not a replication of the previous 2001 and 2004 studies, but provides updated economic impacts (Phase 1), non-market values, and other socioeconomic information (Phase 2/current study) that can be useful for management. The information provided on peoples' values, perceptions, and preferences for certain types of experiences can help identify management strategies that provide for satisfying recreation opportunities while continuing to protect the reef.

Methods

Sampling

The population of interest includes residents of Southeast Florida (Broward, Martin, Miami-Dade, Monroe, and Palm Beach Counties), residents of the rest of Florida, and out-of-state residents (the rest of the United States) who are 18 years of age or older. More than one-third of the state's population resides in the five Southeast Florida counties, with the top three most populous counties statewide consisting of Miami-Dade, Broward, and Palm Beach (U.S. Census Bureau, 2019). Many of the region's corals are within 1.5 km of the counties' urbanized shores, putting the residents in close proximity to these natural features. Tourists are an integral part of Florida's economy. High tourism rates, coupled with high population density near the coast, bring even more people in contact with coral reef ecosystems in the region, thereby creating more opportunities for people to derive ecosystem services from reefs, but also more opportunities for human-induced stressors to impact reefs.

Ipsos was contracted to conduct the sampling for this project. The sampling population was chosen using KnowledgePanel®, an online research panel that is representative of the entire U.S. population. Panel members are randomly recruited through probability-based sampling, and households are provided with access to the Internet and hardware if needed. Ipsos recruits panel members by using address-based sampling methods (previously Ipsos relied on random-digit dialing methods). Once household members are recruited for the panel and assigned to a study sample, they are notified by email

for survey taking, or panelists can visit their online member page for survey taking (instead of being contacted by telephone or postal mail). This allows surveys to be fielded quickly and economically. In addition, this approach reduces the burden placed on respondents, since email notification is less intrusive than telephone calls and most respondents find answering online questionnaires more interesting and engaging than being questioned by a telephone interviewer. Furthermore, respondents have the convenience to choose what day and time to complete their assigned survey.

The internet panel that participated in this survey was a demographically representative sample of the population of interest, and a sample size of approximately 1,600 completed surveys overall was desired. The sampling design obtained representation from the Southeast Florida region, State of Florida, and National level, with approximately one-third of completed surveys in each of the three regions. Please refer to Appendix III for more details about the Ipsos KnowledgePanel, sampling methodology, and weighting.

Survey Development

Ipsos developed a non-market valuation survey to estimate the value of coral reefs and artificial reefs in Southeast Florida. The final survey was developed in both English and Spanish and was designed to take no more than 15 minutes to complete (Appendix I). All survey questions were voluntary and every precaution was made to ensure there were no questions that could potentially reveal personally identifying information about the respondents. The survey was programmed into an online survey platform that was administered by Ipsos. The survey was pre-tested through 25 interviews to confirm the survey length and for quality control testing.

The first part of the survey included questions that were developed to cover a range of human dimensions topics including general knowledge of coral reefs, visitation to and use of natural and artificial reefs, importance and satisfaction of reef topics, perceptions of resource conditions and threats, and beliefs about stewardship and management of reefs. These human dimensions topics are based on social science theory and research to explain and predict human decision making and behaviors, such as those related to willingness-to-pay (WTP). The final section of the survey included two WTP questions (Q18 and Q19) to estimate the value of access to natural and artificial reefs, and a stated preference choice experiment.

Stated Preference Choice Experiment





A Stated Preference Choice Experiment (SPCE) was employed to understand the tradeoffs respondents are willing to make among different attributes associated with Florida reefs and the value of an array of policy scenarios associated with artificial and natural coral reef management. Stated

preference choice experiments are grounded in Lancasterian consumer theory (Lancaster, 1966), which specifies that utility for a good is a function of the good’s attributes. For environmental applications, the “good” is typically a non-market good (i.e., one not bought or sold in explicit markets) that is characterized by a suite of policy-relevant attributes. A range of levels is specified for each attribute, and experimental design plans are used to generate different combinations of attribute levels to describe each alternative. Including price or cost as one of the attributes allows welfare estimates (WTP) to be calculated. Survey respondents are shown choice tasks that consist of two or more alternatives and are asked to choose their most (or least) preferred alternative from the set. Alternatively, respondents may be asked to rank the alternatives. For a fully detailed explanation of the SPCE approach, see Louviere et al. (2000).

To develop the SPCE, Ipsos held focus group meetings with staff from the National Oceanic and Atmospheric Administration’s (NOAA) Coral Reef Conservation Program (CRCP) and key partners at Florida Fish and Wildlife Conservation Commission (FWC), Florida counties, and Florida Department of Environmental Protection (FDEP) to identify the policy-relevant attributes of coral reefs and levels for how each attribute may vary. Combinations of the attributes and levels were then used in a series of scenarios for the SPCE.

In the survey, respondents were shown a series of possible scenarios about the condition of the Southeast Florida coral reefs if certain actions are taken (or not taken). The scenarios were shown in pairs and respondents were asked to indicate which scenario they prefer. Each scenario described four (4) attributes shown in Table 1, which included 1) area of live coral cover, 2) the number of visitors accessing coral reefs each year, 3) the number of artificial reef locations, and 4) a fee to access coral reef areas. The description of each attribute also described the current status of that attribute.

Table 1. Description of four attributes used in scenarios for stated preference choice experiment

	Coral Cover	The amount of <i>live coral cover</i> there is relative to today. <i>Currently, there is 90% less coral cover than in the 1980s.</i>
	Visitors	The number of people that visit the coral reefs each year. Human visitors can contribute to damage and stress to coral and an increase in pollution that hurts the coral. <i>Currently, there are over 3 million visitors to Florida reefs per year.</i>
	Artificial Reefs	The number of new artificial reefs created. Artificial reefs support marine life and can help protect the coast against erosion, similar to natural reefs. Having more artificial reefs provides more options for people to visit reefs. <i>Currently, there are almost 700 artificial reefs in Southeast Florida.</i>
	Fee	A possible new fee for people to access areas with coral reefs. Each person who accesses the area would have to pay the fee on each visit. These fees would help pay for reef restoration. <i>Current access fees range from \$2 - \$15 per person.</i>

Each of the four attributes had three to five levels (i.e., values), including a “no change” condition, as shown in Table 2. The final experimental design plan consisted of 96 possible combinations of the attributes and levels (96 individual survey versions), blocked into 12 main survey versions. Each survey respondent was shown a subset of eight choice task questions in which they were asked to choose between two scenarios eight times. The choices were displayed in the same format, using the same text. In other words, the values (\$1, 20%, etc.) would be swapped out with values from Table 2.

Table 2. Description of four attributes and levels used in scenarios for stated preference choice experiment

Attribute	% change in natural reef coral coverage	% change in number of reef visitors	% change in new artificial reef locations	Access fee for natural reefs (cost per visit)
<i>N Levels</i>	4	3	4	5
Level 1	no change	no change	no change	\$0 fee per visit
Level 2	10% more live coral cover	10% fewer visitors	5% increase in artificial reef sites	\$5 fee per visit
Level 3	20% more live coral cover	15% fewer visitors	10% increase in artificial reef sites	\$10 fee per visit
Level 4	30% more live coral cover		20% increase in artificial reef sites	\$20 fee per visit
Level 5				\$30 fee per visit

Data Collection

The final survey was administered between May 18, 2021 and June 13, 2021. Members of the KnowledgePanel® sampling pool were sent a notification email inviting them to participate in the survey. The email contained a link that directed them to the survey online. Email reminders were sent to non-responders three days after the initial email. An additional reminder was sent to the remaining non-responders on Days 10 and 16 of the field-period.

Once all survey data have been collected and processed, design weights are adjusted to account for any differential nonresponse that may have occurred. Depending on the specific target population for a given study, geodemographic distributions for the corresponding population are obtained from the Current Population Survey (CPS), the U.S. Census Bureau’s American Community Survey (ACS), or in certain instances from the weighted KnowledgePanel® profile data. For this purpose, an iterative proportional fitting (raking) procedure is used to produce the final weights. In the final step, calculated weights are examined to identify and, if necessary, trim outliers at the extreme upper and lower tails of

the weight distribution. The resulting weights are then scaled to aggregate to the total sample size of all eligible respondents.

For this study, design weights for the three study-specific areas (Southeast Florida Counties, Rest of Florida, and the Rest of the United States) were computed separately to reflect their selection probabilities. These three areas were weighted separately. Demographic benchmark distributions of U.S. adults age 18 and over from the 2015-2019 ACS were used for the raking adjustment of the weights. These were based on race-ethnicity, education, household income, and language benchmarks. See Appendix III for more details on the weighting procedures and benchmark distributions.

Data Analysis

Comparisons by Geographies

Descriptive statistics were run for the entire survey sample and for each of the three regions. Frequency distributions (counts, percentages, bar graphs/histograms) were examined for normality and the extent to which the data were skewed. Statistical tests were performed to highlight statistically significant differences between residents in the Southeast Florida Counties, Rest of Florida, and the Rest of the United States. The level of significance for these tests was set at $p=.05$. Analysis of variance tests were used to test for mean (M) or average differences followed by Tukey's post-hoc tests, and Chi-square (X^2) analysis to test for differences in the distribution of nominal or ordinal variables. Scales with at least five response values and a distribution that is approximately normally distributed in the population sampled are considered continuous or interval level variables (Morgan et al., 2006; Revilla et al., 2014; Vaske, 2008). It is a common and widely accepted practice in human dimensions/social science to use these scales in parametric statistics (Baker et al. 1966; Borgatta and Bohrnstedt, 1980; Gaito, 1980; Havlicek and Peterson, 1977; Kempthorne, 1955; Vaske, 2008). Non-significant differences can also be considered real differences; however, it is left up to the reader to decide if those differences are meaningful.

Importance-Performance Analysis

Importance-Performance Analysis (IPA) is based on concepts originating in the marketing and business industries. Martilla and James (1977) used IPA to assist firms in developing business strategies. IPA compares an individual's satisfaction (performance) level with an item to the level of importance they associate with that item. Measures of importance and satisfaction are represented on a two-dimensional grid system (Figure 1). Each quadrant of the grid indicates a different level of importance and satisfaction, thus identifying what managers are doing well and what things they may need to focus

on. This tool has been used in the tourism and outdoor recreation literature as a way to help natural resource managers assess visitor concerns more accurately (e.g., Leeworthy et al., 2004; Leeworthy and Morris, 2010; Loomis et al., 2017).

In this study, IPA was used to determine which reef topics and benefits are important to people, as well as to determine the levels at which these topics and benefits perform (satisfaction). Scores falling in the upper left quadrant are relatively high on the importance scale and relatively low on the satisfaction scale (Figure 1). This quadrant is labeled “Concentrate Here.” Scores falling in the upper right quadrant are relatively high in importance and also relatively high in satisfaction, and are labeled “Keep up the Good Work”. Scores falling in the lower left quadrant are relatively low in both importance and satisfaction, and are labeled “Low Priority”. Scores in the lower right quadrant are relatively low in importance but relatively high in satisfaction, and are labeled “Possible Overkill”.

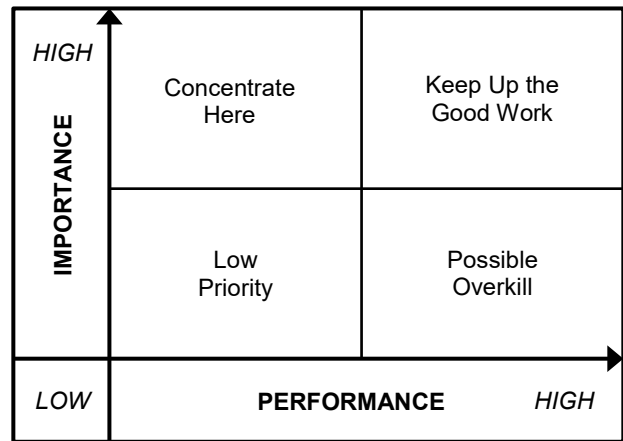


Figure 1. Importance-Performance Analysis grid

Willingness-To-Pay Estimates

To understand better what factors might affect a respondent’s WTP, we developed generalized regression models for each of the three regions. For each region, the dependent variable is the response to Q18 and Q19 (WTP for access), and the independent variables are a mix of demographic characteristics and indices constructed from questions from the survey. Table 3 shows the full set of initial variables used for preliminary models in each region.

To determine the optimal set of variables for each regional model, the SAS GLMSELECT procedure was used. This procedure performs effect selection in the framework of general linear models but somewhat mitigates the effect of selection bias and outliers that can limit stepwise regression and similar model selection techniques. The model selection goal for this application was to maximize the model prediction success and minimize the parameter variance. For a detailed explanation of the GLMSELECT procedure, see <http://facweb.cs.depaul.edu/sjost/csc423/documents/glmslect.pdf>.

Table 3. Variables used in preliminary willing-to-pay model estimation

Variable	Variable Label for Model
Knowledge of coral reefs generally.	Gen_coral_knowl
Knowledge of the difference between natural and artificial reefs.	Artificial_Natural_knowl
Knowledge of coral reefs located off the coast of Southeast Florida and the Florida Keys, in particular.	SE_coral_knowl
Knowledge of the current condition of coral reefs in Southeast Florida (including the Florida Keys).	SE_coral_cond_knowl
Number of times respondent visited Southeast Florida in the past 5 years, either on business or personal trips. <i>Not included as a question for SE county residents</i>	Past_visits
Number of times respondent stated they are likely to visit this region of Southeast Florida in the next 5 years, either business or personal trips. <i>Not included as a question for SE county residents</i>	Future_visits
Engaged in any of the following activities near a natural or artificial reef: <ul style="list-style-type: none"> • Saltwater fishing, including spearfishing • Harvesting of shellfish, lobster, octopus, seaweed, or other ocean resources • SCUBA diving, free diving, or snorkeling • Beach recreation (swimming, sunbathing, picnics, camping, beach sports, walking on the beach) • Sailing, boating, jet-skiing, waterskiing, or wakeboarding • Kayaking, surfing, standup paddle boarding, windsurfing, or kitesurfing, other 	Reef_activity
Over the next 10 years the condition of the Southeast Florida ocean environment will be somewhat to a lot worse	Future_SEFL_condition
Age	Age
Income	Income
Gender	Female
Education	Education
Household size	HHsize
Completion of the educational requirements to obtain a Boating Safety Education Identification Card.	Boatsafety

Stated Preference Choice Model

Model estimation from SPCE data (choice model) is based on random utility theory (Manski, 1977), which specifies that utility (U) for a good/alternative consists of a systematic, known component (V) and a random component (ε). The utility for the i th individual derives from alternative j – a specific bundle of attributes and their associated levels – and is expressed as U_{ij} :

$$U_{ij} = V_{ij} + \varepsilon_j, \quad [1]$$

where V_{ij} is the measurable portion of utility, and ε is the random, unobservable (from the researcher's perspective) effect. The deterministic portion of the utility of alternative j is commonly modeled as a linear function of its attributes:

$$V_{ij} = \beta X_{ij}, \quad [2]$$

where X_{ij} is a vector of attribute levels for alternative j and β is a conformable vector of attribute-specific parameters to be estimated. Substituting [2] in [1] yields:

$$U_{ij} = \beta X_{ij} + \varepsilon_j.$$

Assuming rational behavior (where individuals choose the alternative that yields the most utility to them), the probability that individual i chooses alternative j from a set of C alternatives is the probability that the utility derived from j is greater than the utility derived from any other alternative k in set C :

$$\Pr(j|C) = \Pr(U_{ij} \geq U_{ik}) \quad \forall k \in C$$

Assuming independent and identical type I extreme value distributions for the error components (Louviere et al., 2000), the probabilities take the following form:

$$\Pr(j|C) = \frac{\exp(\beta X_{ij})}{\sum_{k=1}^K \exp(\beta X_{ik})}$$

which is the well-known conditional logit model (McFadden, 1973). This model, which is commonly used to analyze SPCE data, is estimated in a straightforward way using maximum likelihood techniques.

Results

Sample Profile

The target population consisted of non-institutionalized adults age 18 and older residing in the United States, including both English and Spanish-language survey takers. The sample included 32.2% of respondents from Southeast Florida Counties, 34.1% from the remaining state of Florida, and 33.6% from the rest of the United States (all except Montana and Vermont) (Table 4). These are representative samples from each of the geographic regions but not at the county level. Of the 3,176 individuals invited to take the survey, a total of 1,635 respondents completed the survey, resulting in a 52% response rate.

The mean age of respondents was 50.6 years, and about 52.6% of respondents were female (47.4% male). The overall sample was about 56.2% white, 25.2% Hispanic, and 13.2% black. The mean and median annual household income category was \$50,000-\$74,999. About 61.2% of respondents had obtained some college education, a bachelor’s degree, or higher. Descriptive results of the entire study sample are available for survey questions Q1-Q17 in the data tables of Appendix II. The results for the geographic strata are presented in the following sections.

Table 4. Distribution of survey respondents by Southeast Florida counties, the rest of Florida, and the United States

<u>Sampling Strata</u>	<u>N</u>	<u>%</u>
(1) Southeast Florida	527	32.2
(a) Broward County	150	28.5
(b) Martin County	20	3.8
(c) Miami-Dade County	257	48.8
(d) Monroe County	4	0.8
(e) Palm Beach County	96	18.2
(2) Rest of Florida (counties outside of Southeast Florida)	558	34.1
(3) Rest of U.S. (non-residents of Florida)	550	33.6
Total number of survey respondents	1,635	100.0

Knowledge about Coral Reefs

The survey started by asking respondents how much they knew about a) the topic of coral reefs generally, b) the difference between natural and artificial reefs, c) coral reefs located off the coast of Southeast Florida and the Florida Keys, and d) the current condition of coral reefs in Southeast Florida

and the Florida Keys. Figure 2 shows the distribution of knowledge across geographies. Overall, residents of Florida typically knew more about coral reefs than out-of-state residents. A higher percentage of non-Southeast Florida residents felt they knew a “moderate amount” about the topic of coral reefs generally and the difference between natural and artificial reefs. Southeast Florida residents were more knowledgeable about the current condition of coral reefs in Southeast Florida and the Florida Keys.

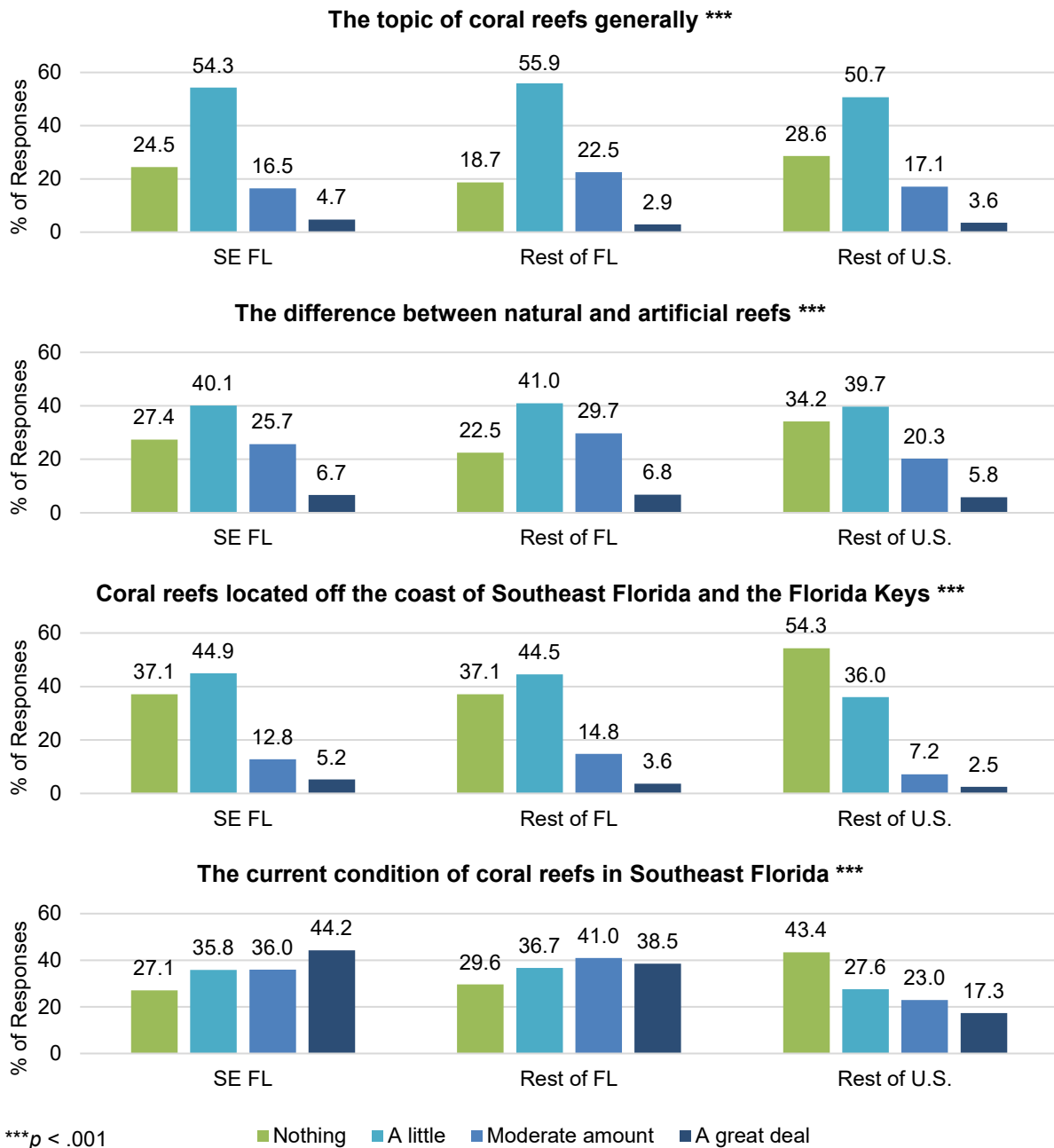


Figure 2. General knowledge about coral reefs

The survey also asked respondents to indicate if they believed statements about Florida’s reefs were 1 = definitely false, 2 = maybe false, 3 = maybe true, or 4 = definitely true. The two statements that respondents generally believed were “maybe to definitely true” were that *ocean water quality affects the condition of coral reefs* and *coral reefs protect the Southeast Florida shoreline* (Figure 3).

The largest difference between geographies was regarding the statement, *natural reefs provide fishing and diving experiences, but artificial reefs do not* ($p < .001$). On average, residents of the rest of Florida (non-Southeast Florida counties) rated this statement as closer to being “definitely false”, compared to the higher ratings by residents of Southeast Florida and the rest of the U.S. In other words, residents in non-Southeast Florida counties were more likely to believe that artificial reefs, in addition to natural reefs, provide fishing and diving experiences.

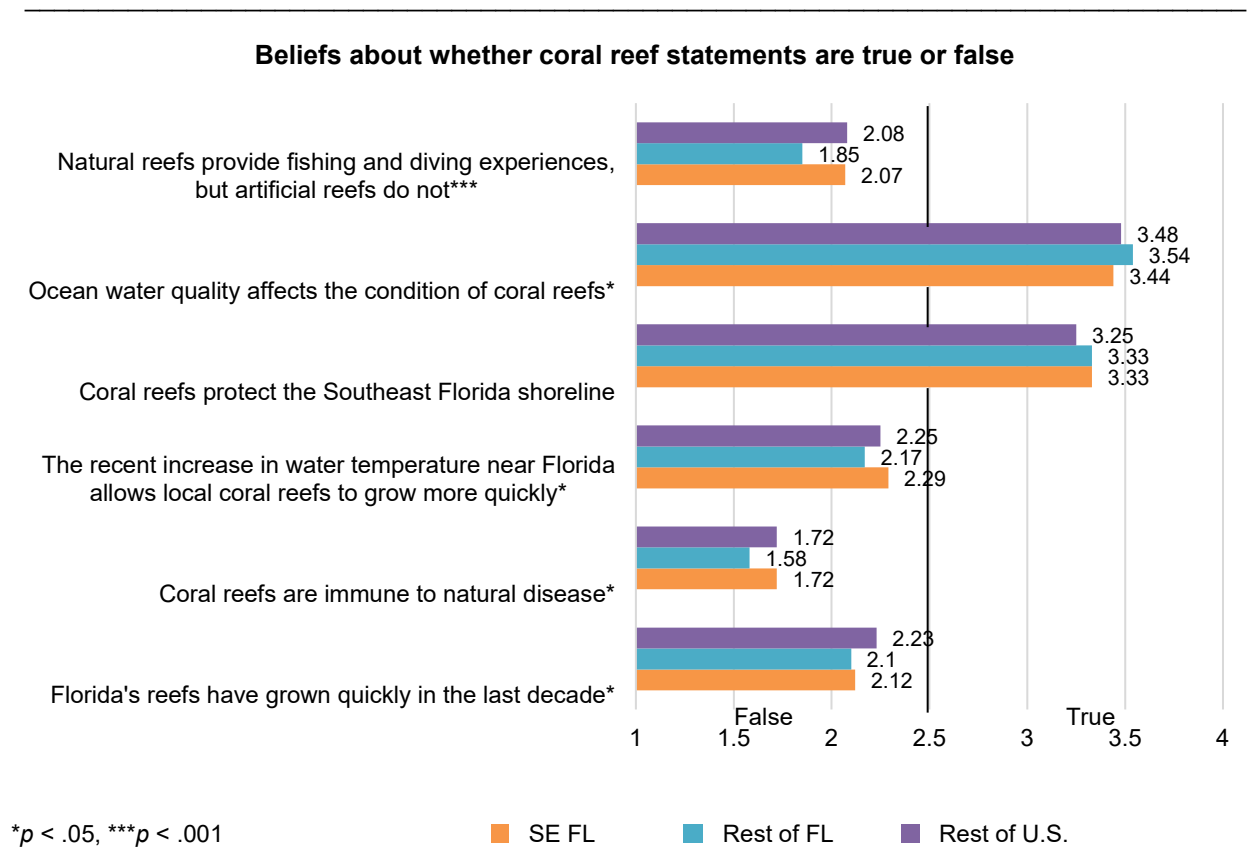


Figure 3. Beliefs about whether coral reef statements are true or false

Visitation to Natural and Artificial Reefs

Non-residents of Southeast Florida counties (Rest of Florida and Rest of U.S.) were asked about their past and future visitation to the Southeast Florida region. First, they were asked, “how many times have you visited the Southeast Florida region in the past 5 years (since May 2016), either on business or personal trips?” About 57.1% of Florida residents (outside the Southeast Florida counties) and 25.2% of out-of-state residents visited the Southeast Florida region at least once in the past five years (Figure 4). Next, they were asked, “how many times are you *likely* to visit this region of Southeast Florida in the next five years (through May 2026)?” About 76.7% of Florida residents and 52.6% of out-of-state residents said they are likely to visit the Southeast Florida region at least once in the next five years.

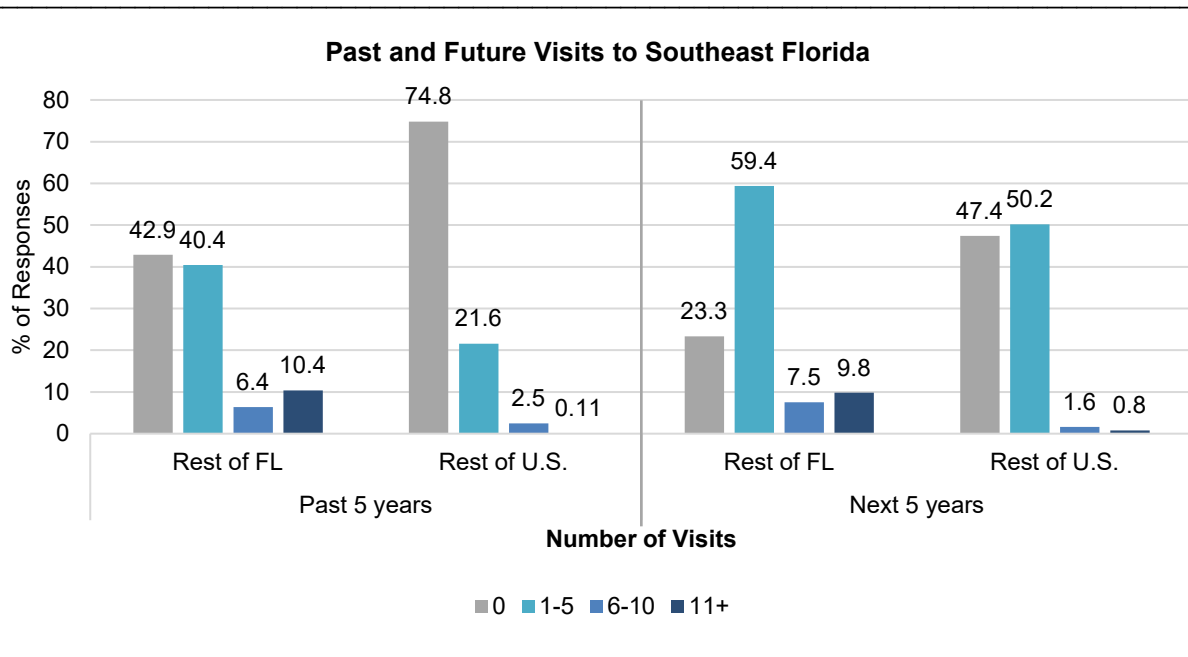


Figure 4. Number of visits to Southeast Florida in the past 5 years and the likely number of visits in the next 5 years

Participation in Water or Beach Activities

Respondents indicated which ocean activities they participated in, at any time in any location, over the past five years (since May 2016). Participation in these activities was primarily for recreational purposes, as very few respondents did any activity for work (Appendix II, Q7). There were some statistically significant differences in participation between geographic regions (Figure 5). The most common activity was *beach recreation* (including activities such as swimming, sunbathing, walking on

the beach, or other beach sports), and fewer out-of-state residents did this activity ($X^2 = 63.450, p < .001$). A significantly higher percentage of Florida residents participated in *saltwater fishing*, compared to out-of-state residents ($X^2 = 19.446, p < .001$). The least common activity among all regions was *harvesting of marine resources*.

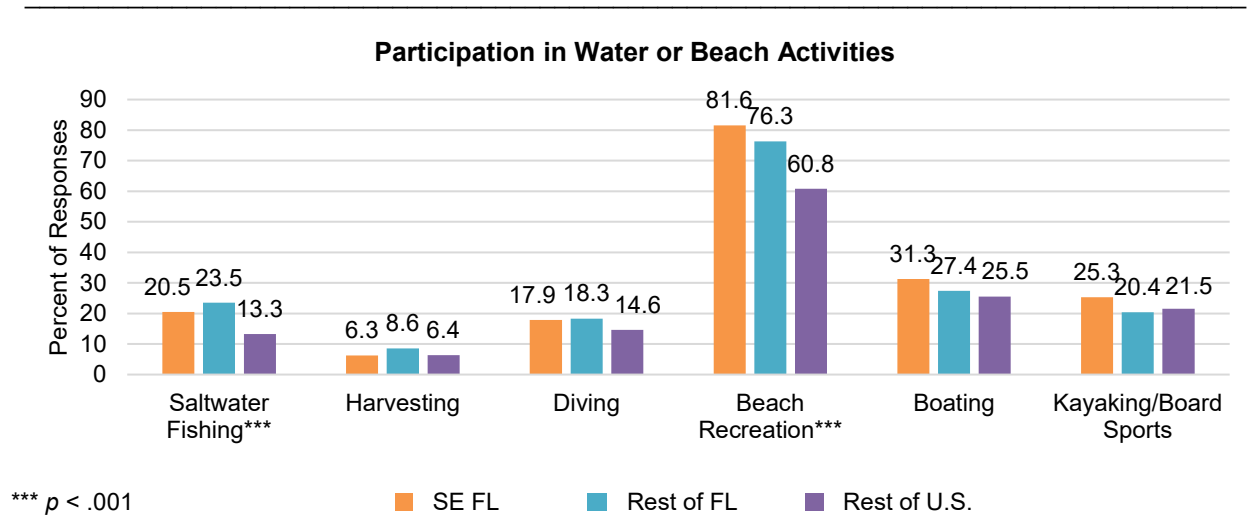


Figure 5. Participation in water or beach activities for recreation or work purposes in the past five years

Use of Natural and Artificial Reefs

For each ocean activity participated in, respondents were asked where the activity occurred by choosing one of the following options: a) took place near a *natural reef*, b) took place near an *artificial reef*, c) took place near *both types* of reefs, d) took place near a reef but I don't know if it was natural or artificial, e) did *not* take place near a reef, or f) I don't know if it took place near a reef. The survey described natural and artificial reefs as follows: Natural reefs “form over time from colonies of tiny marine animals called coral, or are rock outcrops from geological formations.” Artificial reefs are “carefully planned man-made underwater structures that mimic the characteristics of natural reefs. Artificial reefs are composed of submerged materials including concrete culverts and bridge materials, limestone boulders and steel ships.” Awareness of where saltwater fishing, harvesting of marine resources, diving/snorkeling, and boating participation occurred among geographies is presented in Figure 6 (see Appendix II for the entire sample's participation in all activities and locations).

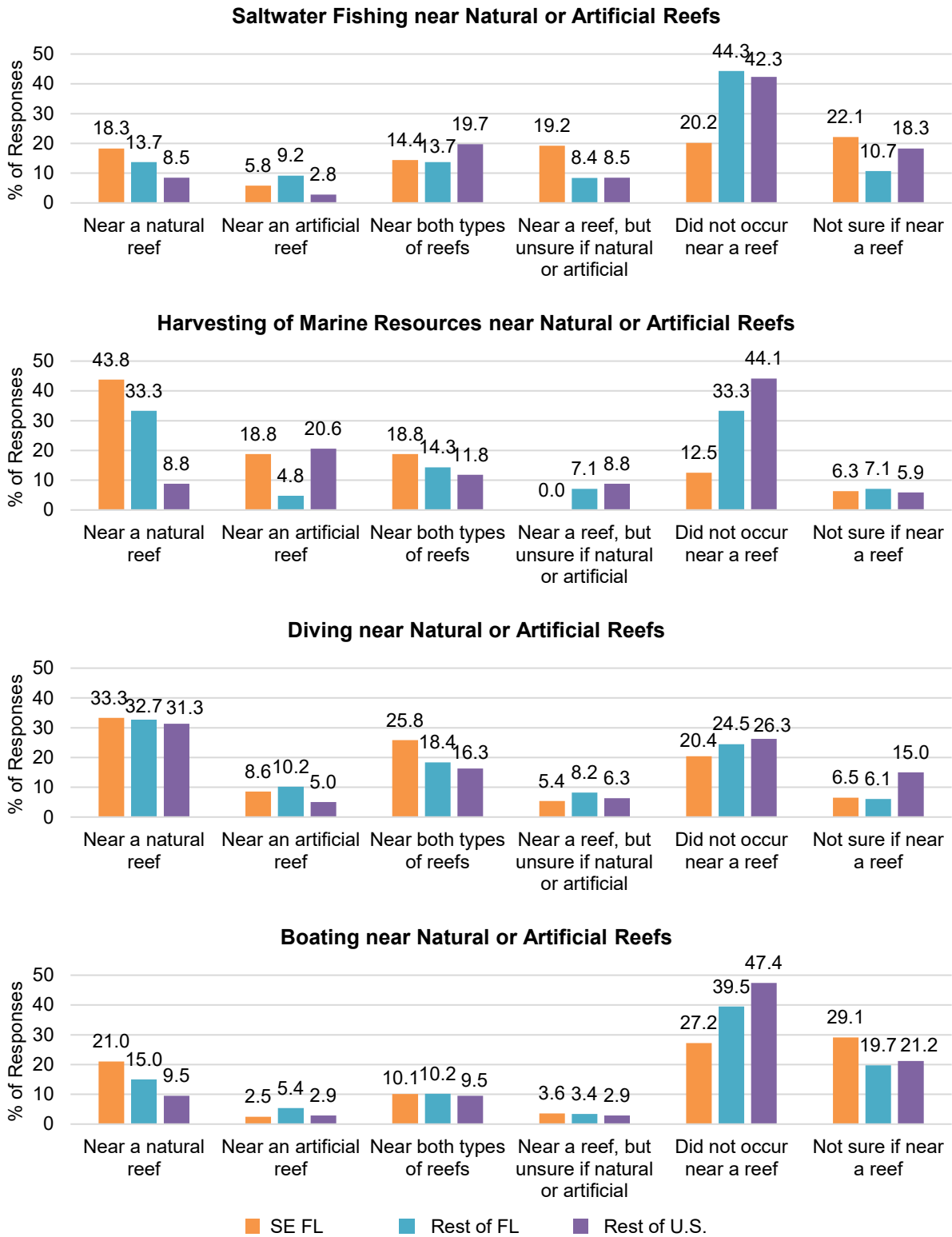


Figure 6. Saltwater fishing, harvesting of marine resources, diving/snorkeling, and boating that took place near natural or artificial reefs

Beliefs about Natural and Artificial Reefs

The survey asked respondents how much they agreed or disagreed that coral reefs are a reason why they live in or visit Southeast Florida. These ratings were on a 5-point scale of 1 = strongly disagree, 3 = neither agree or disagree, 5 = strongly agree. Residents of Southeast Florida had some disagreement or were more neutral regarding the statement, *coral reefs are one of the reasons why I live in Southeast Florida* ($M = 2.56$). Neutral ratings of agreement were also expressed by residents of the rest of Florida ($M = 2.68$) and the U.S. ($M = 2.61$) regarding the statement, *coral reefs are one of the reasons why I visit Southeast Florida*.

Respondents were also asked how much they agreed or disagreed with four statements about natural and artificial reefs (Figure 6). Residents of all geographic regions “strongly agreed” that *it is important to protect and maintain coral reefs for future generations*. Compared to the rest of the U.S., Florida residents had significantly higher agreement that *coral reefs are part of what makes Southeast Florida special* ($p < .05$), and that *the construction of artificial reefs can help offset the loss of natural reefs* ($p < .001$).

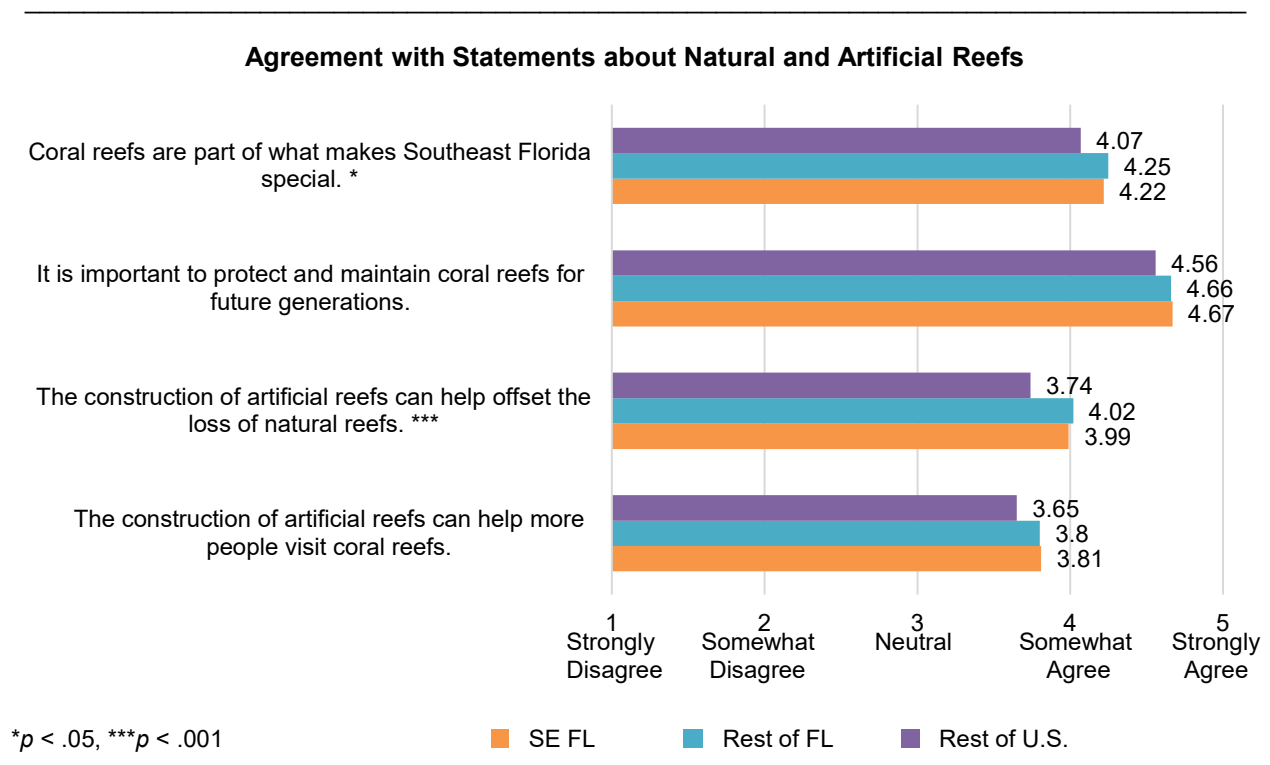


Figure 7. Mean ratings of agreement with statements about natural and artificial reefs

Importance-Satisfaction of Florida’s Reefs

The mean ratings of importance and satisfaction with eight coral reef topics were tested for geographic differences and analyzed for performance on an IPA grid. Regarding the importance of coral reef topics, overall, residents of all geographic strata rated most topics as being “moderately” to “very important” (Table 5). Residents of the entire state of Florida (Southeast Florida counties and rest of Florida strata) had similar ratings of importance for 7 out of 8 coral reef topics. Non-residents of Florida (the rest of the U.S.) had slightly lower ratings that were statistically significant ($p < .01$) for all 8 items, relative to ratings by Floridians. The most important items to residents of Southeast Florida counties, the rest of Florida, and the U.S. were *ocean water quality*, the *existence of natural coral reefs*, and *coral reef conservation and preservation*. There were statistically significant differences ($p < .001$) between each of the strata ratings on the amount of importance for *opportunities to fish at coral reefs, either for recreation or for income*, and the amount of importance decreased based on proximity of residence to Southeast Florida coral reefs. Residents of Southeast Florida counties thought fishing opportunities at coral reefs were “moderately important”, whereas residents in the rest of Florida and U.S. rated this as “a little important”.

Table 5. Mean differences in ratings of importance for Florida coral reef topics

<u>Importance</u>	<u>SE FL</u>	<u>Rest of FL</u>	<u>Rest of US</u>	<u>F-Ratio</u>	<u>p-value</u>
a. Existence of natural coral reefs in SE FL.....	<u>4.09</u>	<u>4.14</u>	3.95	4.72	.009
b. Existence of artificial reefs in SE FL.....	<u>3.68</u>	<u>3.63</u>	3.35	11.71	.000
c. Opportunities to fish at coral reefs, either for recreation or for income.....	3.12	2.88	2.70	12.71	.000
d. Ocean water quality in SE FL.....	<u>4.42</u>	<u>4.34</u>	4.11	16.29	.000
e. Coral reef education for K-12 students in U.S.	<u>3.75</u>	<u>3.67</u>	3.47	8.87	.000
f. Coral reef knowledge among adults in U.S.....	<u>3.58</u>	<u>3.49</u>	3.31	8.41	.000
g. Scientific research on Florida’s coral reefs	<u>3.97</u>	<u>4.01</u>	3.77	8.08	.000
h. Coral reef conservation and preservation	<u>4.34</u>	<u>4.26</u>	4.06	11.09	.000

Mean ratings: 1=Unimportant, 2=A little important, 3=Moderately important, 4=Very important, 5=Extremely important; means underscored by same line are not significantly different (0.05) using a Tukey post-hoc test.

Mean ratings of satisfaction with the same eight coral reef topics were also examined. Overall, residents of all geographic strata were “a little” to “moderately satisfied” with the performance of coral reef topics (Table 6). All residents of Florida were “moderately satisfied” with *the number of artificial*

reefs in Southeast Florida and *scientific research on Florida’s coral reefs*, while residents of the rest of the U.S. had significantly lower levels of satisfaction with these two topics ($p < .001$). There were significant differences between each of the three geographic regions on satisfaction with two other topics. Southeast Florida residents were “a little” to “moderately” satisfied with the *condition of natural coral reefs in Southeast Florida* and *fishing opportunities at reefs in Southeast Florida*, while residents of the rest of Florida and the U.S. each had significantly lower levels of satisfaction ($p < .001$).

Table 6. Mean differences in ratings of satisfaction with the performance of Florida coral reef topics

<u>Satisfaction</u>	<u>SE FL</u>	<u>Rest of FL</u>	<u>Rest of US</u>	<u>F-Ratio</u>	<u>p-value</u>
a. The condition of natural coral reefs in SE FL.....	2.76	2.54	2.31	11.97	.000
b. The number of artificial reefs in SE FL.....	<u>3.06</u>	<u>2.92</u>	2.68	10.51	.000
c. Fishing opportunities at reefs in SE FL.....	3.30	3.06	2.76	10.69	.000
d. Ocean water quality in SE FL.....	2.96	<u>2.48</u>	<u>2.42</u>	19.63	.000
e. Coral reef education for K-12 students in U.S. ...	2.76	<u>2.40</u>	<u>2.28</u>	25.16	.000
f. Coral reef knowledge among adults in U.S.....	2.35	<u>2.18</u>	<u>2.12</u>	3.98	.019
g. Scientific research on Florida’s coral reefs	<u>3.24</u>	<u>3.13</u>	2.87	10.97	.000
h. Coral reef conservation and preservation	2.99	<u>2.63</u>	<u>2.55</u>	15.51	.000

Mean ratings: 1=Unsatisfied, 2=A little satisfied, 3=Moderately satisfied, 4=Very satisfied, 5=Extremely satisfied; means underscored by same line are not significantly different (0.05) using a Tukey post-hoc test.

The mean ratings of importance for each item, as well as their satisfaction level with each item, were then plotted on a two-dimensional IPA grid (Figure 8). This grid illustrates how management is performing with regard to the various features and how important that feature actually is to visitors. The ideal outcome in this graphing is for all crossed items to plot into the upper right quadrant, where the items are both important to respondents and they are also satisfied with that item. The letters in the graph correspond to the eight coral reef topics of importance and satisfaction in the survey. The majority of the coral reef topics are within Quadrant II “Concentrate Here”, indicating the topics are highly important but there is lower satisfaction with the performance of these topics.

There was some variance between geographies in the performance of topics B, C, and G. For residents of Southeast Florida and the rest of Florida, the *existence of artificial reefs in Southeast Florida* (B) are of high importance but low satisfaction, indicating management may want to concentrate on this issue. Residents of the U.S. rated the existence of artificial reefs with higher performance, indicating they

are satisfied with this issue. Residents of Southeast Florida and the rest of Florida rated *scientific research on Florida's coral reefs* (G) as performing moderately well in Quadrant I, whereas residents of the rest of the U.S. rated this with lower performance in Quadrant II.

The largest difference between geographies was in ratings for *opportunities to fish at coral reefs* (C). Residents of Southeast Florida rated fishing opportunities with moderate importance and satisfaction or relatively higher priority in Quadrant I; residents of the rest of Florida rated this with slightly lower importance in Quadrant IV; and residents of the U.S. rated this with relatively the lowest amount of priority in Quadrant III. Ratings from all three geographies are “borderline”, indicating room for potential improvement in providing opportunities to fish at reefs in Southeast Florida.

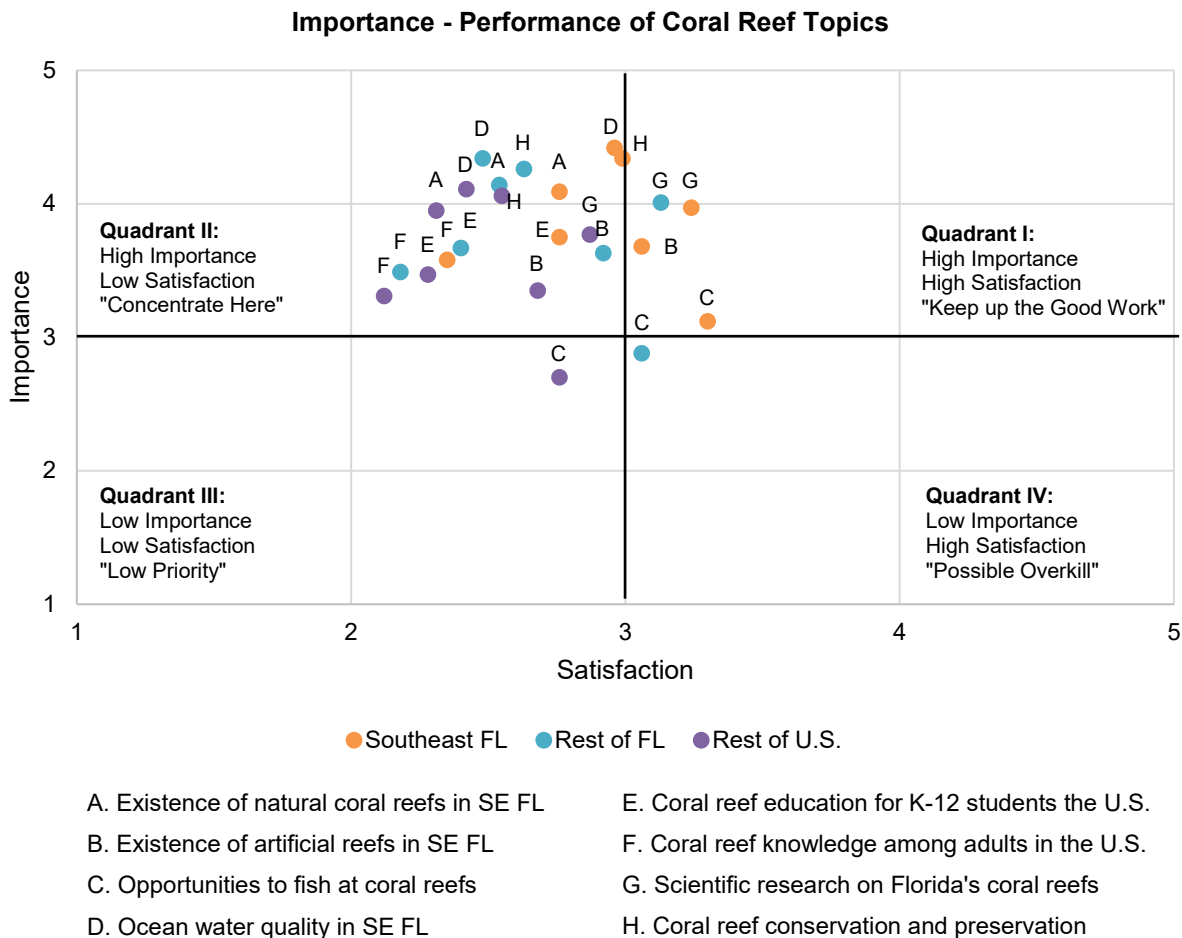
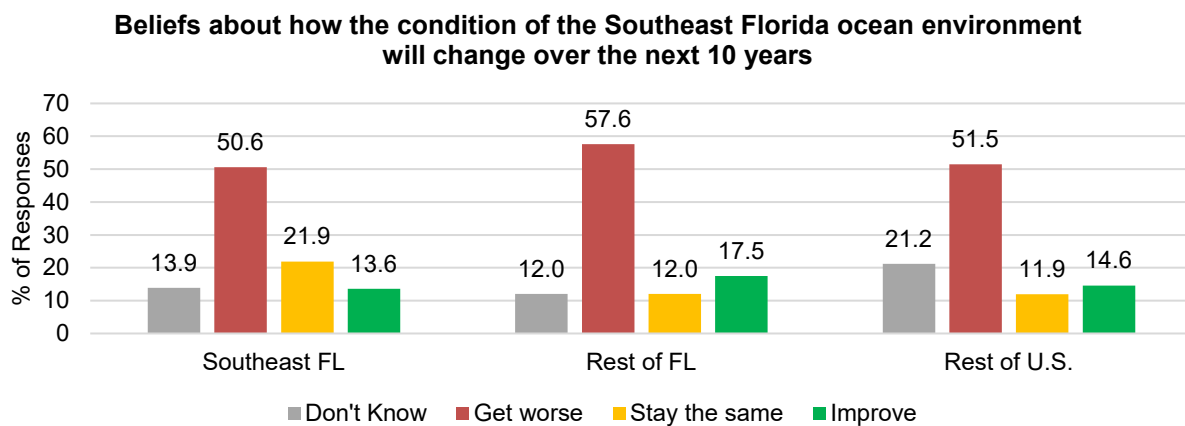


Figure 8. Importance-Performance Analysis grid illustrating the mean ratings of importance and satisfaction with eight coral reef topics; variables measured on a 5-point scale ranging from unimportant (1) to extremely important (5) and unsatisfied (1) to extremely satisfied (5)

Coral Reef Conditions and Threats

The survey asked respondents if they believed the condition of the Southeast Florida ocean environment will “get worse, stay the same, or improve” over the next 10 years. At least half of all respondents, despite geography, believed ocean conditions will “get worse” (Figure 9). Residents outside of Florida (rest of U.S.) had a higher percentage of respondents who “don’t know” how conditions will change, compared to residents within the state of Florida. More residents of Southeast Florida counties believed conditions will “stay the same”, and more residents of the Rest of Florida believed conditions will “improve” compared to residents of other geographies.



$\chi^2 = 45.786, p < .001$

Figure 9. Beliefs about how the condition of the Southeast Florida ocean environment will change over the next 10 years

Regarding the condition of coral reefs more specifically, respondents were asked to rate the severity of four threats including overfishing, climate change, water pollution, and recreation and tourism to coral reefs on a scale of 1 = no threat at all, 2 = a little of a threat, 3 = somewhat of a threat, and 4 = a great deal of a threat (Figure 10). Residents of Southeast Florida rated threats to coral reefs with higher severity, compared to ratings made by residents of the rest of Florida and U.S. Overall, the most severe threat was *water pollution*, and the least severe threat was *recreation and tourism in coral reefs*.

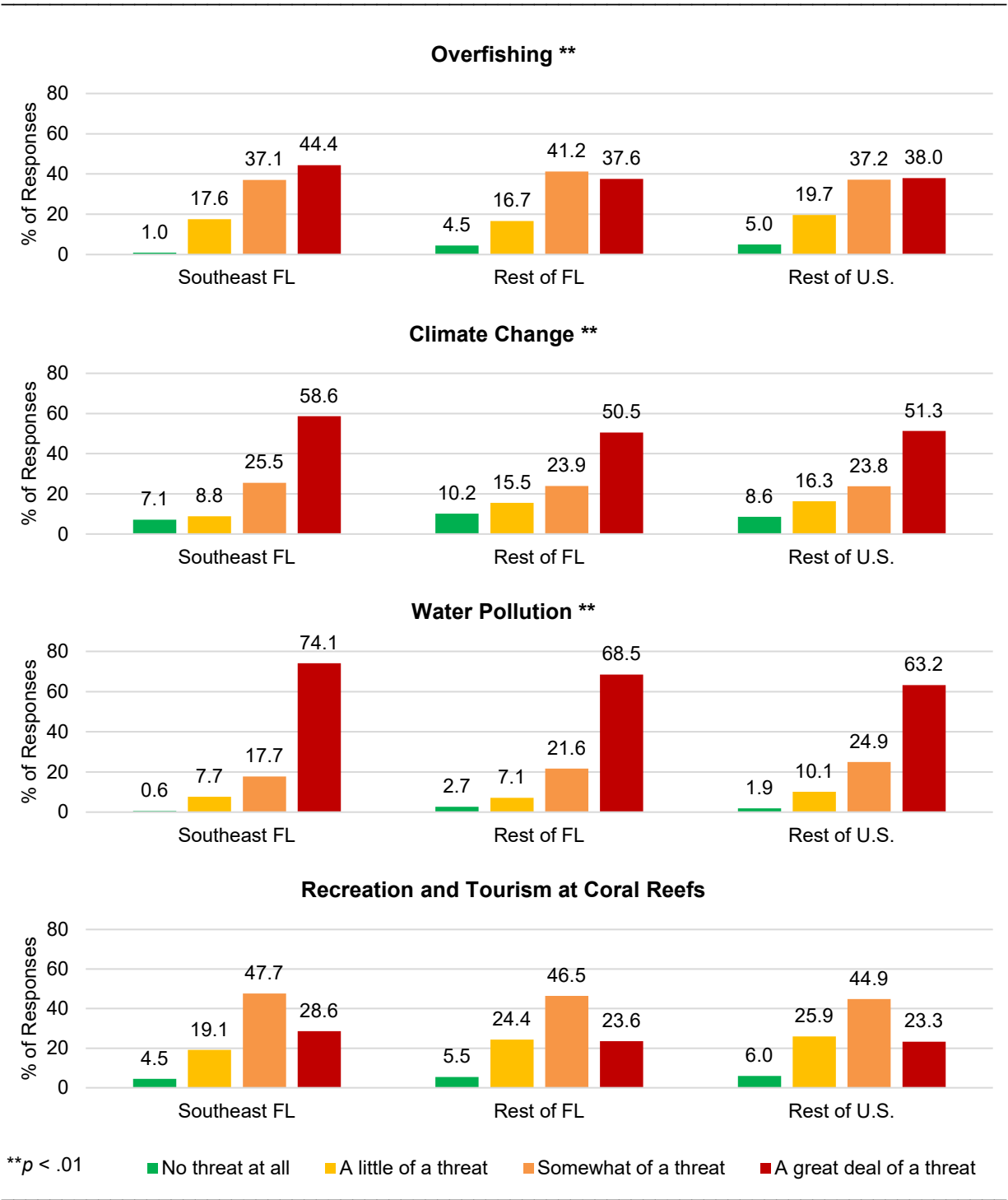


Figure 10. Beliefs about the severity of threats to coral reefs

Stewardship and Management

Responsibility to Protect Coral Reefs

The survey included a section of questions asking how much responsibility different individuals and governments have to protect coral reefs. All respondents from Southeast Florida, the rest of Florida, and U.S. believed that *local Southeast Florida residents* and *all Florida State residents* have “some responsibility” to protect coral reefs (Table 7). Respondents from outside of Florida (rest of U.S.) believed that *all U.S. residents* have “a little responsibility” or less responsibility compared to residents of Florida.

All residents, despite geographic region, believed *tourists that come to Southeast Florida* and *people that use Southeast Florida coral reefs for income* have “some to a lot” of responsibility to protect coral reefs. Residents of Southeast Florida believed that *people who use Southeast Florida coral reefs for fun* have a higher responsibility to protect coral reefs, compared to the amount of responsibility rated by the rest of Florida and U.S.

Table 7. Mean differences in ratings of responsibility of groups and organizations to protect coral reefs

<u>Responsibility of Groups and Organizations</u>	<u>SE FL</u>	<u>Rest of FL</u>	<u>Rest of US</u>	<u>F-Ratio</u>	<u>p-value</u>
a. Local Southeast Florida residents.....	<u>3.37</u>	<u>3.37</u>	<u>3.34</u>	.268	.765
b. All Florida State residents	<u>3.23</u>	<u>3.25</u>	<u>3.21</u>	.313	.731
c. All U.S. residents.....	<u>3.06</u>	<u>3.04</u>	2.82	10.97	.000
d. Tourists that come to Southeast Florida	<u>3.23</u>	<u>3.19</u>	<u>3.18</u>	.373	.689
e. People that use Southeast Florida coral reefs for fun (e.g., divers, recreational fishers)	<u>3.58</u>	<u>3.49</u>	<u>3.42</u>	5.42	.004
f. People that use Southeast Florida coral reefs for income (e.g., commercial fishers, charters).....	<u>3.64</u>	<u>3.64</u>	<u>3.57</u>	1.55	.213
g. Local Southeast Florida governments	3.67	<u>3.55</u>	<u>3.53</u>	6.43	.002
h. Florida State government.....	3.75	<u>3.60</u>	<u>3.58</u>	6.25	.002
i. U.S. Federal government	3.41	<u>3.28</u>	<u>3.23</u>	6.55	.001

Mean ratings: 1=No responsibility, 2=A little responsibility, 3=Some responsibility, 4=A lot of responsibility; means underscored by same line are not significantly different (0.05) using a Tukey post-hoc test.

There were significant differences between Southeast Florida residents and the rest of Florida and U.S. ratings of responsibility for government agencies. Southeast Florida residents believed *local*

Southeast Florida governments and the Florida State government have the highest amount of responsibility to protect coral reefs. They also rated the *U.S. Federal government* as having more responsibility.

Trust in Information from Agencies

Survey respondents were asked how much they trust information from five different management agencies if they were familiar with those agencies. Between geographies, out-of-state residents (rest of U.S.) were least familiar with each of the management agencies (Figure 11). Overall, residents of all geographies were most familiar with the *Florida Fish and Wildlife Conservation Commission* and *Florida Department of Environmental Protection*. Residents were least familiar with the *South Atlantic Fishery Management Council*.

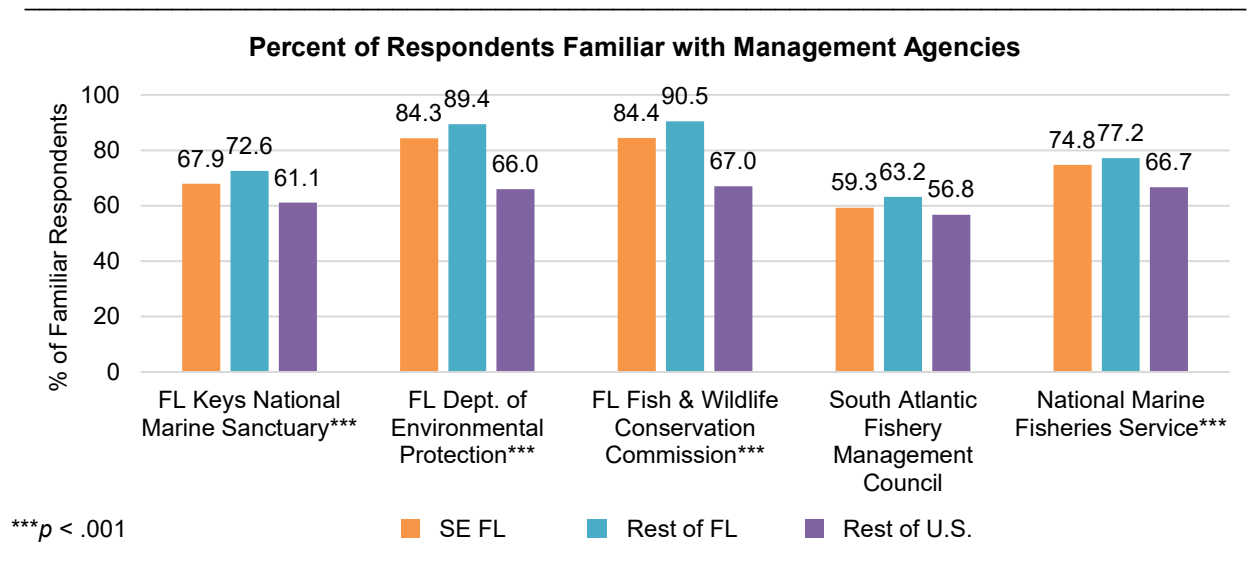


Figure 11. Percent of respondents familiar with management agencies in Florida

Of the respondents who were familiar with any of the five management agencies, trust in information from those management agencies was rated on a four-point scale of 1 = do not trust, 2 = trust a little, 3 = trust a moderate amount, and 4 = trust very much (Table 8). Residents in Southeast Florida and the rest of Florida rated the highest amount of trust in information from the *Florida Keys National Marine Sanctuary* and *Florida Fish and Wildlife Conservation Commission*. The lowest amount of trust was in information from the *South Atlantic Fishery Management Council*. Residents of the rest of the U.S. held the least amount of trust in information from each of the five management agencies.

Table 8. Mean differences in ratings of trust in information from management agencies in Florida

Trust in Information from Agencies	SE FL	Rest of FL	Rest of US	F-Ratio	p-value
a. FL Keys National Marine Sanctuary.....	<u>3.44</u>	<u>3.56</u>	3.10	17.19	.000
b. FL Dept. of Environmental Protection	<u>3.20</u>	<u>3.06</u>	2.86	13.43	.000
c. FL Fish & Wildlife Conservation Commission	<u>3.32</u>	<u>3.30</u>	3.04	14.50	.000
d. South Atlantic Fishery Management Council	<u>3.09</u>	<u>2.96</u>	2.80	8.64	.000
e. National Marine Fisheries Service	<u>3.37</u>	<u>3.23</u>	3.05	14.21	.000

Mean ratings: 1=Do not trust, 2=Trust a little, 3=Trust a moderate amount, 4=Trust very much; means underscored by same line are not significantly different (0.05) using a Tukey post-hoc test.

Personal Beliefs about Access to Coral Reefs

Survey respondents rated on a 5-point scale how much they agree or disagree with three statements regarding their personal beliefs about access to coral reefs in Southeast Florida (Figure 12). Residents of Southeast Florida had significantly more neutral ratings of agreement with the statement, *I have a right to access the coral reefs in Southeast Florida*, compared to residents in the rest of Florida and U.S. who had higher agreement with this statement ($p < .05$). Residents of all geographies somewhat agreed that *the government has a right to restrict access to the coral reefs in Southeast Florida*. Out-of-state residents (rest of U.S.) had significantly higher agreement that *local, state, and federal governments should intervene to protect Southeast Florida coral reefs from negative human impacts* ($p < .001$).

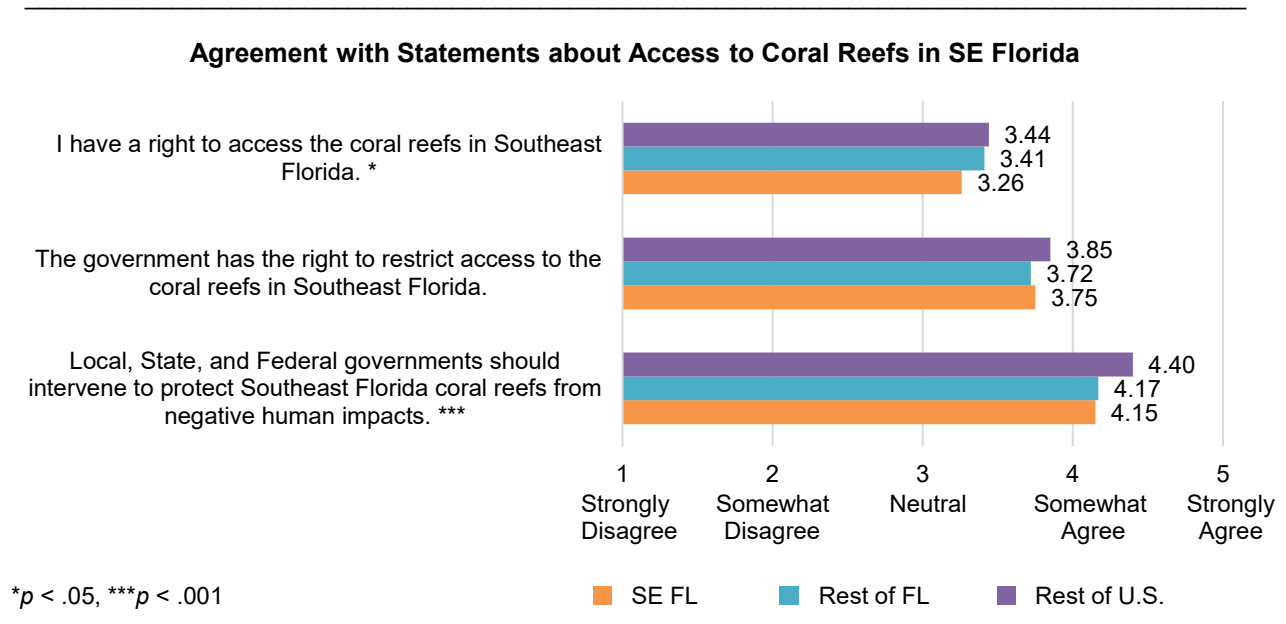


Figure 12. Mean ratings of agreement about access to coral reefs in Southeast Florida

Willingness-To-Pay for Access to Natural and Artificial Reefs

Summary statistics for responses to Q18 and Q19 give an average WTP for an entry/access fee per person per visit to a natural reef or an artificial reef (Table 9). In the survey, the fee was described as additional cost that may be charged to access a parking lot or boat marina near the reef, or added onto tickets for charter boat trips (Appendix I). For each question, respondents answered Q18 and Q19 using a sliding scale ranging from \$1 – \$50 or selecting “I would not pay a fee” to access a natural reef or an artificial reef. In general, the Rest of the U.S. would be WTP the highest amount for access to natural reefs, and SE Florida Counties would be WTP the highest amount for access to artificial reefs.

Table 9. Basic statistics with willing-to-pay mean and median, percent of respondents stating they would not pay a fee, and percent of refusals

Type of Reef	Variable	SE Florida Counties	Rest of Florida	Rest of U.S.
Natural	Mean \$ WTP (std)	11.41 (12.24)	11.27 (11.76)	11.79 (12.62)
	Median \$ WTP	10	10	10
	% of respondents stating they would not pay a fee	33.6	28.7	33.0
	% of non-responses	3.5	1.4	4.9
Artificial	Mean \$ WTP (std)	9.30 (10.69)	8.45 (10.01)	8.45 (10.60)
	Median \$ WTP	5.5	5.0	5.0
	% of respondents stating they would not pay a fee	40.0	37.0	41.5
	% of non-responses	2.9	1.2	5.2

For more precise WTP estimates and to better understand what socioeconomic factors might affect a respondent’s WTP, generalized linear regression models (GLM) were estimated for each of the three regions. WTP for access to natural and artificial reefs was estimated from the GLM models using the independent variable sample means for each geographic area (see Table 3 for preliminary list of variables used in the models). The optimal models for each region show the significant predictors of WTP in Table 10, Table 11, and Table 12.

Respondents of all three regions who have more knowledge about corals in general were more WTP for access to natural and artificial reefs. Respondents from the Rest of Florida and the Rest of the U.S. who believe the future condition of the Southeast Florida environment will become worse were also more likely to pay for access to natural and artificial reefs. The number of times out-of-state residents

(Rest of U.S.) were likely to visit Southeast Florida in the next five years had a positive effect on their WTP for access to natural reefs (Table 12). Age and boating safety education had a negative effect on WTP. Residents of Southeast Florida Counties who completed boating safety education were less likely to pay for access to natural coral reefs (an average of \$6 less) than someone who had not completed the education course (Table 10). Older respondents in Florida were also less likely to pay for access to reefs.

Table 10. Southeast Florida Counties optimal models estimating willingness-to-pay for access to natural and artificial reefs

SE FL Counties Models	Independent Variable*	Parameter Estimate	Standard Error	p-value	WTP (\$) Estimate
WTP for Natural Reef Access	Gen_coral_knowl	3.0954159	1.1152785	0.01	
	Boatsafety	-6.2184445	2.0554899	0.00	\$11.11
	Age	-0.1513932	0.0509013	0.00	
WTP for Artificial Reef Access	Gen_coral_knowl	2.8990247	0.8994225	0.00	\$9.55

*see Table 3 for full variable labels

Table 11. Rest of Florida optimal models estimating willingness-to-pay for access to natural and artificial reefs

Rest of Florida Models	Independent Variable*	Parameter Estimate	Standard Error	p-value	WTP (\$) Estimate
WTP for Natural Reef Access	Gen_coral_knowl	4.3281571	0.9130025	0.00	
	Future_SEFL_condition	5.0070372	1.2226363	0.00	\$10.98
	Age	-0.0964081	0.0389732	0.01	
WTP for Artificial Reef Access	Gen_coral_knowl	2.8990247	0.8994225	0.00	
	Future_SEFL_condition	1.5475911	0.0369555	0.01	\$8.20
	Age	-0.0907852	1.1809567	0.19	

*see Table 3 for full variable labels

Table 12. Rest of U.S. optimal models estimating willingness-to-pay for access to natural and artificial reefs

Rest of U.S. Models	Independent Variable	Parameter Estimate	Standard Error	p-value	WTP (\$) Estimate
WTP for Natural Reef Access	Gen_coral_knowl	2.1430492	0.8588635	0.01	
	Future_SEFL_condition	5.3327511	1.1354504	0.00	\$11.66
	Future visits	2.9565095	0.0490707	0.01	
WTP for Artificial Reef Access	Gen_coral_knowl	2.3566098	0.7443368	0.00	\$8.35
	Future_SEFL_condition	3.7476675	0.9624147	0.01	

*see Table 3 for full variable labels

Stated Preferences for Natural and Artificial Reef Attributes

For the SPCE, a conditional logit model was estimated for the entire dataset. The computational data requirements for this model require a larger dataset than the geographic regions discussed in the other sections of this report (Southeast Florida counties, Rest of Florida, and Rest of the U.S.). In addition, and more importantly, the experimental design plan that was employed for the SPCE was not designed to estimate models from smaller sub-samples of the data, as these smaller sub-samples may not contain the necessary number of observations from each of the 96 survey versions to represent the full main effects design. Therefore, it was necessary to use the full dataset for the choice model estimation.

The attributes in the choice model include “percent increase in natural coral cover,” “percent decrease in visitors to reef,” “percent increase in number of artificial reef sites,” and “cost.” Willingness-to-pay is calculated from model parameters following standard formulas for the measurement of compensating variation (Small and Rosen, 1981). Model results and WTP are shown in Table 13. Results follow our a priori expectation that increasing natural reef cover, increasing the number of artificial reef sites, and decreasing visitors, which can be interpreted as decreasing congestion at the site, are statistically significant and utility-enhancing. The cost constraint is negative and significant, as expected.

Table 13. Choice model results for entire survey sample

Attribute	Coefficient	Standard Error	95% Confidence Interval	WTP for 1% change in Attribute
% increase in natural coral cover	.05070**	.00173	.04731 – .05408	\$14.92
% increase in number of artificial reef sites	.02582**	.00201	.02188 – .02976	\$7.60
% decrease in visitors to reef	.02118**	.00254	.01620 – .02617	\$6.23
Cost of fee	-.00340*	.00134	-.00603 – -.00076	

* $p < .05$; ** $p < .01$

The model can be used to simulate different combinations of policy scenarios that fall between the upper and lower bounds of the attribute levels used in the experimental design. In addition, the rates at which respondents substitute among the attributes can be calculated as the attribute parameter ratios, i.e., for a given increase in natural coral cover the corresponding increase in artificial reef sites that would be needed to leave the respondent indifferent between the two changes. These marginal rates of substitution are shown in Table 14.

Table 14. Marginal rates of substitution among attributes

Marginal Rates of Substitution	%
Percent increase in number of artificial reef sites needed to equal a 1% increase in natural coral cover	1.96
Percent decrease in number of visitors needed to equal a 1% increase in number of artificial reef sites	2.40
Percent decrease in number of visitors needed to equal a 1% increase in natural coral cover	1.22

Discussion

The main goal of this study was to estimate economic values for natural and artificial reefs. This study also examined general knowledge about coral reefs, visitation to and use of natural and artificial reefs, importance and satisfaction of reef topics, perceptions of resource conditions and threats, and beliefs about stewardship and management of reefs. These human dimensions topics are based on social science theory and research to explain and predict human decision making and behaviors, such as those related to their choices and willingness-to-pay.

Comparisons between Geographies

Use of Natural and Artificial Reefs

About 57% of residents of the rest of Florida and 25% of out-of-state residents had visited the Southeast Florida region at least once since May of 2016, and a majority of these residents were planning to visit the region sometime in the next five years. While these visitation rates are not truly accurate considering the interruption of COVID-19 restrictions and other measures, they suggest that the Southeast Florida region benefits from both in-state and out-of-state visitors and is a region people want or intend to visit in the future for recreation purposes.

The majority of the sample primarily participated in beach recreation, and there were many who participated in boating, saltwater fishing, and diving activities (location was not specified in the survey). While these beach and water activities may or may not have occurred in Southeast Florida, these use patterns suggest the extent to which people from all over the U.S. participate in different activities and how avid of a diver, boater, or angler the general population from each region might be. Awareness of whether any of these activities occurred in proximity to a natural or artificial reef (located in Florida or elsewhere) varied between geographies. Saltwater fishing and boating were the two activities with the highest percentage of respondents who were not sure if they took place near a reef. Compared to other

geographies, there were more Southeast Florida residents who knew they had fished near a reef but did not know if it was natural or artificial. One possible explanation for lower levels of certainty on whether saltwater fishing or boating occurred near a reef may be due to the nature of these activities occurring above water and limited (or lack of) visibility of the type of reef that is present below. More experienced boaters and saltwater anglers may be more knowledgeable about the locations of natural and artificial reefs. There was higher certainty about diving and harvesting of marine resources taking place near a reef, particularly among Florida residents. Diving/snorkeling is an underwater activity that is more immersive with reefs where the type of reef can be more easily identified.

Florida residents outside of Southeast Florida counties (the Rest of Florida) were more likely to believe that *artificial reefs, in addition to natural reefs, provide fishing and diving experiences*. This was also reflected in their relatively higher use of artificial reefs for saltwater fishing and diving, compared to residents of the other two geographies. One possible explanation may be that the Florida counties outside of the Southeast region are not all located in close proximity to Florida's coral reef tract but have more access to recreation opportunities at artificial reefs deployed throughout Florida's coasts. Southeast Florida residents, on the other hand, were more likely to participate in ocean activities near natural reefs. While natural reefs received higher use overall, there was a decent amount of participation in activities that occurred near both types of reefs. For example, 33% of Southeast Florida residents went diving near a natural reef, while 26% went diving at both types of reefs. The use of both natural and artificial reefs suggests the importance of access to different types of reefs for recreation opportunities.

Importance-Satisfaction of Reefs

The importance placed on the coral reef topics is one way to describe social values of reefs, and satisfaction is a way to describe how much those benefits are being provided. The IPA showed the importance and satisfaction with eight coral reef topics, and several differences emerged between geographies. Residents of Southeast Florida and the rest of Florida generally rated each topic with higher importance compared to residents of the rest of the U.S., but their satisfaction scores varied. The *condition of natural coral reefs* in Southeast Florida was rated with high importance but lower satisfaction, suggesting this is a priority issue. Related to the condition of natural reefs were high priorities for ocean water quality and coral reef conservation (also rated with high importance but relatively low satisfaction). The *existence of artificial reefs* in Southeast Florida was also very important to Florida residents. Satisfaction with the number of artificial reefs was slightly higher than the score for natural reefs, and has the potential to shift in performance depending on whether artificial reefs are maintained or if additional sites are created.

Responsibility to Protect Coral Reefs

The ways in which people use natural and artificial reefs tend to be linked to their values, beliefs, and norms. Floridians' higher affinity for reef activities may be linked to their belief that "coral reefs are part of what makes Southeast Florida special", suggesting a dependence on coral reefs or *cultural value of coral reefs* to Southeast Florida's identity. As such, Florida residents may be more motivated to want to conserve coral reefs for this purpose. People are more likely to feel obligated to act in favor of a healthy ocean when they feel responsible and are aware of the negative impacts of human actions on the marine environment (Engel et al., 2020).

Florida residents were more knowledgeable about coral reefs compared to the rest of the U.S. About 53% of all residents, despite geography, believed the condition of the Southeast Florida ocean environment will get worse over the next ten years, but out-of-state residents had a higher percentage of those who did not know how conditions will change. To some extent, all residents were aware of threats to coral reefs. Residents of Southeast Florida counties rated these threats as more severe, with water pollution being relatively the greatest threat to coral reefs. Floridians also more strongly believed that the construction of *artificial reefs can help offset the loss of natural reefs*. Floridians may be more invested in maintaining reef resources compared to out-of-state residents. Targeted messaging and outreach may focus on increasing problem awareness and communicating the benefits of natural and artificial reefs to out-of-state visitors, as one first needs to be cognizant of the problems impacting the ocean to feel responsible for it.

The majority believed that Florida residents and people that use Southeast Florida coral reefs (for fun or for income) have some responsibility to protect coral reefs, but non-residents of Florida believed all U.S. residents had the least responsibility. Out-of-state residents more strongly believed that local, state, and federal governments should intervene to protect Southeast Florida coral reefs from negative human impacts. This has implications on management of non-residents and tourists visiting Southeast Florida and how they interact with coral reef environments. Emphasizing a sense of care and concern for coral reef ecosystems can promote obligations to act, and ultimately, marine stewardship (Nassauer, 2011).

Socioeconomic Values of Natural and Artificial Reefs

Overall, respondents were generally willing to pay more to access natural coral reefs than artificial reefs. To visit a *natural reef*, out-of-state residents had a higher willingness-to-pay than residents of Florida with an average WTP estimate of \$11.79 for an entry/access fee per person per visit. Southeast Florida residents were WTP \$11.41, and residents of the rest of Florida were WTP \$11.27. To visit an *artificial reef*, Southeast Florida residents had a higher willingness-to-pay than residents of the rest of

Florida and U.S., with an average WTP estimate of \$9.30. Residents of the rest of Florida and U.S. would be WTP \$8.45. Generally, results are consistent with the idea that natural reefs are preferred to artificial reefs.

The generalized regression models provided more precise estimates for each region based on significant predictors of a respondent's WTP. General *knowledge about coral reefs* and beliefs about *future conditions of the ocean environment in Southeast Florida* were common predictors of each region's WTP for access to either natural coral reefs or artificial reefs. These findings are consistent with arguments by Stern et al. (1995) that perceptions and beliefs have a strong impact on intentions, such as WTP. This also reinforces the importance of communication and outreach about Florida's natural and artificial reefs at local, state, and national levels. The more people know about reefs and how conditions are changing, the more likely they are willing to pay for restoration in order to access reefs. But there are additional factors that come into play.

For out-of-state residents, the *number of times they were likely to visit Southeast Florida in the next five years* had a positive effect on their WTP for access to natural reefs. This may indicate that coral reefs in Southeast Florida have "option value", which is value that captures the potential for non-residents to be able to visit a reef in the future. This may also partially explain the high WTP value relative to the WTP values of other geographies, and shows the added value of reefs to U.S. citizens nationwide.

Age and boating safety education had a negative effect on WTP. Older residents of Florida (including Southeast Florida counties) were less likely than younger residents to pay for access to natural coral reefs. Residents of Southeast Florida counties who completed boating safety education were less likely to pay for access to natural coral reefs (an average of \$6 less) than someone who had not completed the education course. The survey described the fee as a cost that "may be charged to access a parking lot or boat marina near the reef, or added onto tickets for charter boat trips". But boaters would not necessarily be paying for entry into a natural coral reef, unless for instance, the access fee would be for using a mooring buoy near a coral reef. There may also be underlying factors regarding boating activities at coral reefs.

Results from the stated preference choice experiment showed how much respondents were willing-to-pay for a restoration fee contingent upon varying levels of coral cover, artificial reef sites, and visitation/congestion. Results found that respondents were WTP \$14.92 for every 1% increase in natural coral cover, \$7.60 for every 1% increase in the number of artificial reef sites, and \$6.23 for every 1% decrease in in congestion at a reef site. These results further suggest higher preferences for natural coral reefs but indicate the potential for artificial reefs as alternative site destinations or substitutes.

The implications may be particularly important to issues regarding reef uses, visitation rates, and carrying capacity at reef sites. Natural and artificial reefs as substitute goods may help distribute activity

use and pressure. For instance, artificial reefs adjacent to an existing natural reef system may act as a substitute good and shift diving activity away from natural reefs (Leeworthy, et al., 2006). On the other hand, they may be complementary, as an enhanced artificial reef system may attract more divers to the area, and in turn, lead to more dives on natural reefs.

Limitations and Future Research

Limitations of the sample

The sample obtained from KnowledgePanel allowed for information to be collected from a general population of residents in the Southeast Florida region, the rest of Florida, and the rest of the U.S. (which include tourists and potential visitors in the future). However, the panel did not allow for representation at the Southeast Florida county level, which was originally desired. Due to the nature of the panel sample, the survey results reflect a more “general” population of U.S. residents, which may partially explain the high participation in beach recreation and lower participation in reef activities such as diving. Sampling from a more targeted population of reef user groups would provide a better understanding of natural and artificial reef values. Since knowledge of coral reefs was a significant predictor of WTP in this study, specific reef user groups may have more experience in reefs that contribute to their knowledge and beliefs, and ultimately their WTP for reef restoration or additional artificial reef sites.

Limitations of the value estimates from the SPCE

It should be noted that due to several resource constraints, the stated preference choice experiment survey did not adhere to all of the best practice recommendations outlined in Johnston et al. (2017). In particular, there was limited qualitative research in the survey development and the choice task question did not contain an explicit “opt out” option, forcing respondents to choose a profile or skip the question. This limits the robustness of the willingness-to-pay estimates derived from the stated preference choice experiment. The estimates are still informative but caution should be taken in how the values are intended to be used.

Future Analysis and Studies

The survey results provide a rich source for deeper analysis of relationship questions regarding natural and artificial reefs. Many additional analyses using the data are possible. For example, an examination of user subgroups based on activity. Respondents who participate in saltwater fishing or diving may have different perceptions and WTP than non-reef users. Questions about natural and artificial reefs might also be correlated with the respondent’s geographic location. Further studies could examine

how economic values placed on ecosystems and their services are affected by physical proximity to the coastline and reefs. It has been suggested that the boundary between use and non-use values is affected by site proximity and anticipated increases in resource quality, potentially turning non-users into expected resource users (Bateman et al., 2006). Finally, natural and artificial reefs provide a variety of ecosystem services, in addition to recreation and tourism, that have value. Future studies may want to take on a more comprehensive valuation of Florida's reefs. NOAA CRCP will be conducting this type of valuation study that should be useful to local and state management partners. Replication of these studies would also allow for updated values to be provided on a regular basis, or for economic monitoring to occur.

Conclusion

This project examined non-market values of natural and artificial reefs and complements the Phase 1 economic impact studies of recreational fishing, SCUBA diving, and snorkeling (Wallmo et al., 2021a, 2021b). The survey results suggest that reefs provide a variety of ecosystem services and benefits, both social and economic. Explicitly accounting for these benefits, using a range of economic and non-economic metrics, can reveal hidden benefits that are not typically measured by market forces or considered in management deliberations. Understanding the variety of socioeconomic benefits can also result in improved decisions that most readily reflect the true value of natural and artificial reef systems to society. This project was not able to replicate the original Johns et al. (2001) study. Rather, a stated preference choice experiment allowed for the valuation of individual attributes associated with reefs, including live coral cover, number of artificial reefs, visitation, and an access fee that would go to restoration. Overall findings suggest that respondents prefer natural coral reefs over artificial reefs, but artificial reefs may be acceptable substitutes. Knowledge about coral reefs and beliefs about future conditions had a positive effect on respondents' willingness-to-pay for access to either natural or artificial reefs. Natural and artificial reefs provide benefits to residents of Southeast Florida, the state of Florida, and out-of-state visitors, including visitors who plan to visit the region in the future.

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Appendix I. Survey Instrument

Main Questionnaire (including screener, if applicable)

Programming Notes:

- Code all refusals as -1.
- Use default instruction text for each question type unless otherwise specified.
- Allow respondents to go back/forward
- **HIGHLIGHTED TEXT:** Confirm that text is correct just prior to launch (e.g., dates).
- Do not prompt on all questions. (Remove this instruction if sample is all opt-in, client list sample, or otherwise not KP.)

Consent and screening

Base: All respondents

CONSENT [S, Prompt once]

We're conducting a survey study, in collaboration with the Florida Fish and Wildlife Conservation Commission, to understand your opinions about Florida's coral reefs and artificial reefs. The survey will take about 15 minutes.

You do not have to answer any questions you do not wish to answer, and you may quit the survey at any time. All your responses will remain anonymous and confidential.

Do you wish to continue to the survey?

1. Yes
2. No

Terminate if CONSENT=2 "No" or "Refused"

Base: Qualified respondents

Double prompt

Q1 [DROPDOWN, PROMPT ONCE]

In which US state or territory do you currently live?

- | | | |
|--------------------------|-------------------|--------------------|
| 63. Alabama | 32. Indiana | 88. Nevada |
| 94. Alaska | 42. Iowa | 12. New Hampshire |
| 86. Arizona | 47. Kansas | 22. New Jersey |
| 71. Arkansas | 61. Kentucky | 85. New Mexico |
| 93. California | 72. Louisiana | 21. New York |
| 84. Colorado | 11. Maine | 56. North Carolina |
| 16. Connecticut | 52. Maryland | 44. North Dakota |
| 51. Delaware | 14. Massachusetts | 31. Ohio |
| 53. District of Columbia | 34. Michigan | 73. Oklahoma |
| 59. Florida | 41. Minnesota | 92. Oregon |
| 58. Georgia | 64. Mississippi | 23. Pennsylvania |
| 95. Hawaii | 43. Missouri | 15. Rhode Island |
| 82. Idaho | 81. Montana | 57. South Carolina |
| 33. Illinois | 46. Nebraska | 45. South Dakota |

62. Tennessee
74. Texas
87. Utah

13. Vermont
54. Virginia
91. Washington

55. West Virginia
35. Wisconsin
83. Wyoming

[Exclude this option from Dropdown list]

97. I do not live in the US [S]

Assign numeric codes but show full state names in alphabetic order.

Terminate if "I do not live in the US" is selected OR Refused

Create data-only variable: DOV_STATE

If Q1=FLORIDA, DOV_STATE =1 "FLORIDA"

If Q1 NE FLORIDA, DOV_STATE=2 "OTHER US"

State Confirmation :

If Q1=PPSTATE, CONTINUE TO Q2 and punch DOV_MSACAT FROM PPMSACAT

If Q1 does not = PPSTATE, ASK QZIP

Base: xppmasact does not =Q1

Prompt once

QZIP [Q]:

What is the ZIP Code where you live?

SCRIPTER: min.=00000, max.=99999; require a 5-digit response.

Scripting please use QZIP to create updated DOV_MSACAT value (combined with data from xppmasact when ppstate =Q1) from look-up.

Base: Q1 = 59 "Florida"

Q2 [DROPDOWN, PROMPT ONCE]

In which county do you reside?

1. Alachua County

2. Baker County

3. Bay County

4. Bradford County

5. Brevard County

6. Broward County

7. Calhoun County

8. Charlotte County

9. Citrus County

10. Clay County

11. Collier County

12. Columbia County

13. DeSoto County

14. Dixie County

15. Duval County

16. Escambia County

17. Flagler County

18. Franklin County

19. Gadsden County

20. Gilchrist County

21. Glades County

22. Gulf County

23. Hamilton County

24. Hardee County

25. Hendry County

26. Hernando County

27. Highlands County

28. Hillsborough County

29. Holmes County

30. Indian River County

31. Jackson County

32. Jefferson County

33. Lafayette County

34. Lake County

35. Lee County

36. Leon County

37. Levy County

38. Liberty County

39. Madison County

40. Manatee County

41. Marion County

42. Martin County

43. Miami-Dade County

44. Monroe County

45. Nassau County

46. Okaloosa County

47. Okeechobee County

48. Orange County

- 49. Osceola County
- 50. Palm Beach County
- 51. Pasco County
- 52. Pinellas County
- 53. Polk County
- 54. Putnam County
- 55. Santa Rosa County

- 56. Sarasota County
- 57. Seminole County
- 58. St. Johns County
- 59. St. Lucie County
- 60. Sumter County
- 61. Suwannee County
- 62. Taylor County

- 63. Union County
- 64. Volusia County
- 65. Wakulla County
- 66. Walton County
- 67. Washington County

[Exclude this option from Dropdown list]

97. I don't know **[S]**

Create data-only variable: DOV_COUNTY

If Q2= BROWARD, MARTIN, MIAMI-DADE, MONROE, OR PALM BEACH, DOV_COUNTY=1 "SE FLORIDA"

If Q2 NE BROWARD, MARTIN, MIAMI-DADE, MONROE, OR PALM BEACH, DOV_COUNTY=2 "OTHER FLORIDA"

Base: Qualified respondents

Q3 [S, Banked Grid]

We're going to ask you some questions about coral reefs. How much do you feel you know about...

Randomize and record the order of statements

Statements in rows:

- a. the topic of coral reefs generally?
- b. the difference between natural and artificial reefs?
- c. coral reefs located off the coast of Southeast Florida and the Florida Keys, in particular?
- d. the current condition of coral reefs in Southeast Florida (including the Florida Keys)?

Answers in columns:

- 1. Nothing
- 2. A little
- 3. Moderate amount
- 4. A great deal

Base: Qualified respondents

Q4 [S, Banked Grid]

To the best of your knowledge, which of the following statements about Florida's reefs are true and which are false?

Rotate and record the order of statements

Statements in rows:

- a. Florida's coral reefs have grown quickly in the last decades.
- b. Coral reefs are immune to natural disease.

- c. The recent increase in water temperature near Florida allows local coral reefs to grow more quickly.
- d. Coral reefs protect the Southeast Florida shoreline.
- e. Ocean water quality affects the condition of coral reefs.
- f. Artificial reefs provide fishing and diving experiences that are not available at natural reefs.

Answers in columns:

- 1. Definitely false
- 2. Maybe false
- 3. Maybe true
- 4. Definitely true

Create data-only variable: DOV_ACCURACY_Q4A

If Q4A= 1 OR 2, DOV_ACCURACY_Q4A=1 "ACCURATE"
If Q4A= 3 OR 4, DOV_ACCURACY_Q4A=2 "INACCURATE"

If respondent doesn't fall under any of the above buckets, please set the DOV_ACCURACY_Q4A as missing/refused.

Create data-only variable: DOV_ACCURACY_Q4B

If Q4B= 1 OR 2, DOV_ACCURACY_Q4B=1 "ACCURATE"
If Q4B= 3 OR 4, DOV_ACCURACY_Q4B=2 "INACCURATE"

If respondent doesn't fall under any of the above buckets, please set the DOV_ACCURACY_Q4B as missing/refused.

Create data-only variable: DOV_ACCURACY_Q4C

If Q4C= 1 OR 2, DOV_ACCURACY_Q4C=1 "ACCURATE"
If Q4C= 3 OR 4, DOV_ACCURACY_Q4C=2 "INACCURATE"

If respondent doesn't fall under any of the above buckets, please set the DOV_ACCURACY_Q4C as missing/refused.

Create data-only variable: DOV_ACCURACY_Q4D

If Q4D= 3 OR 4, DOV_ACCURACY_Q4D=1 "ACCURATE"
If Q4D= 1 OR 2, DOV_ACCURACY_Q4D=2 "INACCURATE"

If respondent doesn't fall under any of the above buckets, please set the DOV_ACCURACY_Q4D as missing/refused.

Create data-only variable: DOV_ACCURACY_Q4E

If Q4E= 3 OR 4, DOV_ACCURACY_Q4E=1 "ACCURATE"
If Q4E= 1 OR 2, DOV_ACCURACY_Q4E=2 "INACCURATE"

If respondent doesn't fall under any of the above buckets, please set the DOV_ACCURACY_Q4E as missing/refused.

Create data-only variable: DOV_ACCURACY_Q4F

If Q4F= 3 OR 4, DOV_ACCURACY_Q4F=1 "ACCURATE"
If Q4F= 1 OR 2, DOV_ACCURACY_Q4F=2 "INACCURATE"

If respondent doesn't fall under any of the above buckets, please set the DOV_ACCURACY_Q4F as missing/refused.

Base: Qualified respondents

DISP1 [DISPLAY]

The next couple questions are about the Southeast region of Florida, shown below. This region encompasses Martin, Palm Beach, Broward, Miami-Dade, and Monroe Counties.

[DISPLAY IMAGE]



[Scripter: Please enable Back button for Q6 through Q9]

Base: DOV_COUNTY=2 "Other Florida" or DOV_STATE=2 "Other US"

Q5 [S]

How many times have you visited this region of Southeast Florida in the past **5** years, either on business or personal trips? (since May 2016).

1. 0
2. 1-5
3. 6-10
4. 11-15
5. 16+

Base: DOV_COUNTY=2 "Other Florida" or DOV_STATE=2 "Other US"

Q6 [S]

How many times are you **likely** to visit this region of Southeast Florida in the next **5** years (through May 2026)? Select the number of likely trips, either business or personal trips. Your best guess is fine.

1. 0
2. 1-5
3. 6-10
4. 11-15
5. 16+

Base: Qualified respondents

Q7 [M, Banked Grid]

Now, thinking about the past **5** years (since May 2016), have you engaged in any of the following water or beach activities **at any time in any location (in Florida or elsewhere)? Tell us which activities you engaged in for recreation or fun OR for work or as a source of income (select both if applicable).**

*If column 3 is selected, do not allow another column to be selected.
Allow any combo of columns 1 or 2 selections (either, both)*

Double prompt for each row: "Select at least one answer for each row."

Randomize and record the order of statements

Statements in rows:

- a. Saltwater fishing, including spearfishing
- b. Harvesting of shellfish, lobster, octopus, seaweed, or marine life other than fish
- c. SCUBA diving, free diving, or snorkeling
- d. Beach recreation (swimming, sunbathing, picnics, camping, beach sports, walking on the beach)
- e. Sailing, boating, jet-skiing, waterskiing, or wakeboarding
- f. Kayaking, surfing, standup paddle boarding, windsurfing, or kitesurfing
- g. Other: *Please specify* **[MEDIUM TEXT BOX]**

Answers in columns:

1. Recreation/ fun
2. Work/ source of income
3. Didn't do this activity [S]

Base: Qualified respondents

Q8 [S]

Have you ever completed the educational requirements to obtain a Boating Safety Education Identification Card and to operate a boat in Florida?

1. Yes
2. No
3. I don't know

Base: Qualified respondents

DISP2 [DISPLAY]

Now we'll ask you some questions about Florida's reefs.

Florida's reefs are large underwater formations. There are both **natural reefs** and **artificial reefs**.

Natural reefs form over time from colonies of tiny marine animals called coral, or are rock outcrops from geological formations.

Artificial reefs are carefully planned man-made underwater structures that mimic the characteristics of natural reefs. Artificial reefs are composed of submerged materials including concrete culverts and bridge materials, limestone boulders and steel ships.

Both natural and artificial reefs are found all over the world's oceans.

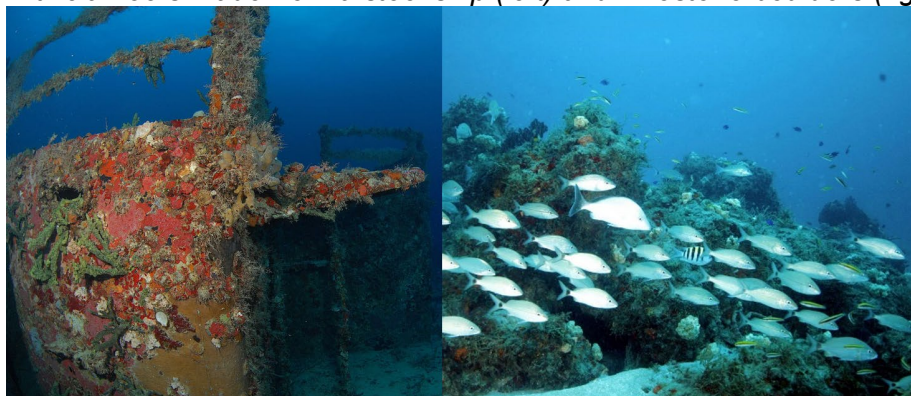
The next page has pictures of **natural** and **artificial** coral reefs.

[DISPLAY ON NEXT SCREEN]

Natural coral reef



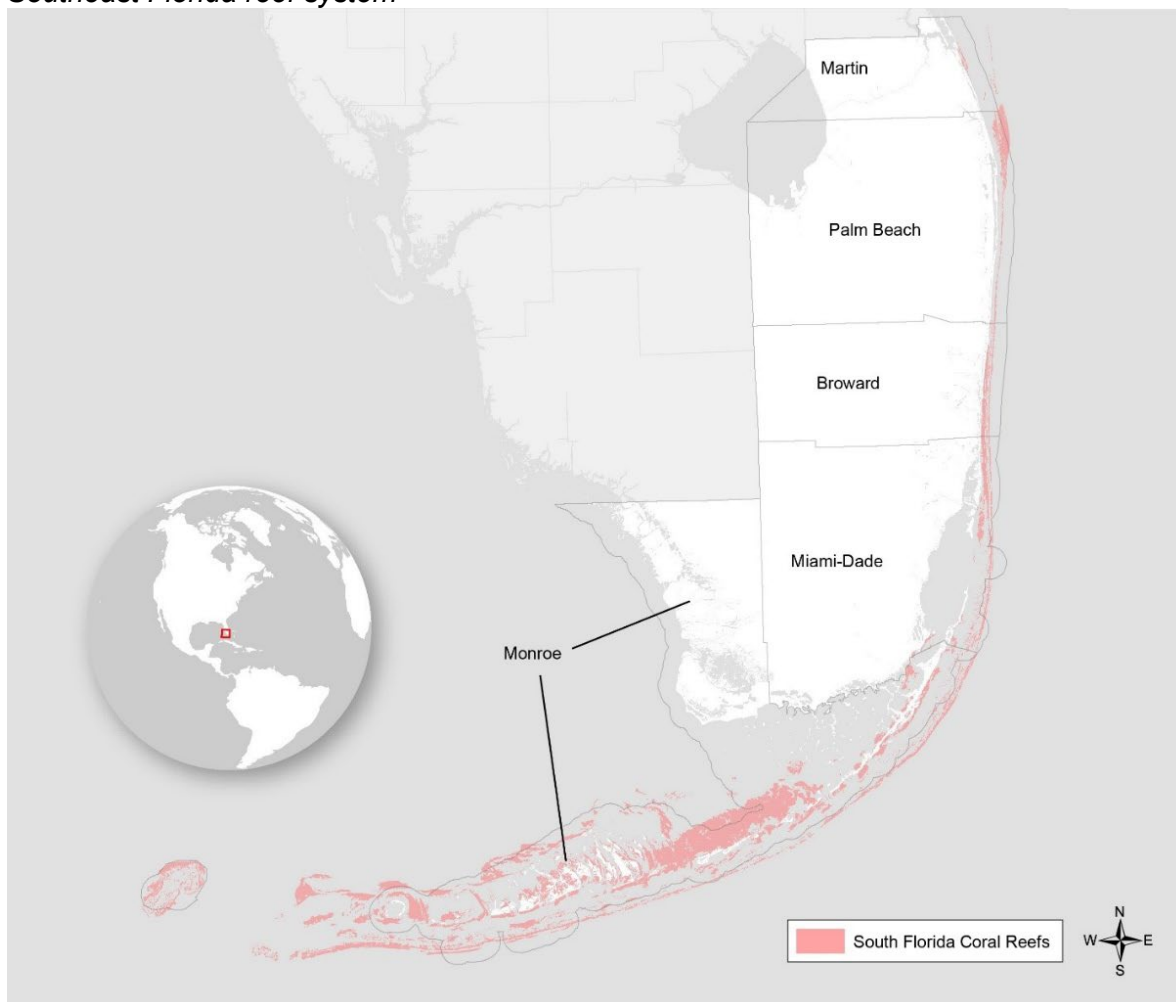
Artificial reefs made from a steel ship (left) and limestone boulders (right).



[DISPLAY ON NEXT SCREEN]

The Florida Reef Tract is the 3rd largest coral barrier reef system in the world. It consists of 350 miles of reefs off the coast of Southeast Florida and the Florida Keys.

Southeast Florida reef system



Base: If any activities selected in Q7, either as “fun/recreation” or “work/source of income” [Q7a-Q7g=1 OR 2]

Q9 [S, Accordion Grid]

We'll show you the activities you've engaged in over the past **5** years. Did these activities **ever** take place near a coral reef? Please indicate whether the activity ever took place near a natural coral reef, near an artificial reef, or near both.

Choose one response for each activity.

Show only the activities selected in Q7, either as “fun/recreation” or “work/source of income”

Statements in rows:

- a. Saltwater fishing, including spearfishing
- b. Harvesting of shellfish, lobster, octopus, seaweed, or other ocean resources
- c. SCUBA diving, free diving, or snorkeling
- d. Beach recreation (swimming, sunbathing, picnics, camping, beach sports, walking on the beach)
- e. Sailing, boating, jet-skiing, waterskiing, or wakeboarding
- f. Kayaking, surfing, standup paddle boarding, windsurfing, or kitesurfing
- g. Other

Answers in columns:

- 1. Took place near a **natural reef**
- 2. Took place near an **artificial reef**
- 3. Took place near **both types** of reefs
- 4. Took place near a reef, but I don't know if it was natural or artificial
- 5. Did **not** take place near a reef
- 6. I don't know if it took place near a reef

Base: Qualified respondents

Q10 [S, Banked Grid]

Now, please tell us whether you agree or disagree with these statements about Florida's reefs:

Randomize and record the order of statements

Statements in rows:

- a. Coral reefs are part of what makes Southeast Florida special.
- b. **[SHOW IF DOV_COUNTY=1 'SE FLORIDA']** Coral reefs are one of the reasons why I live in Southeast Florida.
- c. **[SHOW IF (DOV_COUNTY=2 "Other Florida" OR DOV_STATE=2 "Other US") AND Q5 > 1]** Coral reefs are one of the reasons why I visit Southeast Florida.
- d. It is important to protect and maintain coral reefs for future generations.
- e. The construction of artificial reefs can help offset the loss of natural reefs.
- f. The construction of artificial reefs can help more people visit coral reefs.

Answers in columns:

1. Strongly disagree
2. Somewhat disagree
3. Neither agree nor disagree
4. Somewhat agree
5. Strongly agree

Base: Qualified respondents

Q11 [S, Banked Grid]

Next, we'll list some topics and issues related to coral reefs. Please tell us how **important** each of these topics and issues are to you:

Randomize and record the order of statements

Statements in rows:

- a. Existence of natural coral reefs in Southeast Florida
- b. Existence of artificial reefs in Southeast Florida
- c. Opportunities to fish at coral reefs, either for recreation or for income
- d. Ocean water quality in Southeast Florida
- e. Coral reef education for K-12 students in the US
- f. Coral reef knowledge among adults in the US
- g. Scientific research on Florida's reefs
- h. Coral reef conservation and preservation

Answers in columns:

1. Unimportant
2. A little important
3. Moderately important
4. Very Important
5. Extremely important
6. I don't know

Base: Qualified respondents

Q12 [S, Banked Grid]

Now we'll show you the same reef-related issues. Please tell us how **satisfied** you are with each.

Keep the order of statements same as Q11

Statements in rows:

- a. The condition of natural coral reefs in Southeast Florida
- b. The number of artificial reefs in Southeast Florida
- c. Fishing opportunities at reefs of Southeast Florida
- d. Ocean water quality in Southeast Florida
- e. Coral reef education for K-12 students in the US
- f. Coral reef knowledge among US adults

- g. Scientific research on coral reefs
- h. Coral reef conservation and preservation

Answers in columns:

- 1. Unsatisfied
- 2. A little satisfied
- 3. Moderately satisfied
- 4. Very satisfied
- 5. Extremely satisfied
- 6. I don't know

Base: Qualified respondents

Q13 [S]

Over the next 10 years, do you think the condition of the Southeast Florida ocean environment will get worse, stay the same, or improve?

- 1. Get a lot worse
- 2. Get somewhat worse
- 3. Stay the same
- 4. Improve somewhat
- 5. Improve a lot
- 6. Don't know

Base: Qualified respondents

Q14 [S, Banked Grid]

How much of a threat do you think the following factors are to coral reefs?

Randomize and record the order of statements

Statements in rows:

- a. Overfishing
- b. Climate change
- c. Water pollution
- d. Recreation and tourism at coral reefs

Answers in columns:

- 1. No threat at all
- 2. A little of a threat
- 3. Somewhat of a threat
- 4. A great deal of a threat

Base: Qualified respondents

Q15 [S, Banked Grid]

How much responsibility do each of the following groups and organizations have in protecting Southeast Florida coral reefs?

Randomize and record the order of statements

Statements in rows:

- a. Local Southeast Florida residents
- b. Tourists that come to Southeast Florida
- c. All Florida state residents
- d. US residents
- e. People that use Southeast Florida coral reefs for fun (e.g., boaters, divers, recreational fishers)
- f. People that use Southeast Florida coral reefs for income (e.g., commercial fishers, boat tour companies)
- g. Local Southeast Florida governments
- h. Florida state government
- i. US federal government

Answers in columns:

- 1. No responsibility
- 2. A little responsibility
- 3. Some responsibility
- 4. A lot of responsibility

Base: Qualified respondents

Q16 [S, Banked Grid]

How much do you *trust* information from the following agencies?

Randomize and record the order of statements

Statements in rows:

- a. Florida Keys National Marine Sanctuary
- b. Florida Department of Environmental Protection
- c. Florida Fish and Wildlife Conservation Commission
- d. South Atlantic Fishery Management Council
- e. NOAA National Marine Fisheries Service

Answers in columns:

- 1. Do not trust
- 2. Trust a little
- 3. Trust a moderate amount
- 4. Trust very much
- 5. I don't know this agency

Base: Qualified respondents

Q17 [S, Banked Grid]

Now we'll show you statements about personal beliefs. Please tell us whether you agree or disagree with these statements.

Randomize and record the order of statements

Statements in rows:

- a. Climate change is a serious threat to Southeast Florida.
- b. I have a right to access the coral reefs in Southeast Florida.
- c. The government has the right to restrict access to the coral reefs in Southeast Florida.
- d. Local, State, and federal governments should intervene to protect Southeast Florida coral reefs from negative human impacts.

Answers in columns:

- 1. Strongly disagree
- 2. Somewhat disagree
- 3. Neither agree nor disagree
- 4. Somewhat agree
- 5. Strongly agree

ROTATE ORDER OF Q18 AND Q19 and Capture in DOV_Q18_Q19

Base: Qualified respondents

Q18 [RS with range \$1-\$50]

How much would you be willing to pay, if anything, as an entry/access fee per person per visit to a NATURAL reef? The fee may be charged to access a parking lot or boat marina near the reef, or added onto tickets for charter boat trips.

Slider selector ranging from \$1 to \$50

97. I would not pay a fee to access a natural reef. **[S]**

Base: Qualified respondents

Q19 [RS with range \$1-\$50]

How much would you be willing to pay, if anything, as an entry/access fee per person per visit to an ARTIFICIAL reef? The fee may be charged to access a parking or boat marina near the reef, or added onto tickets for charter boat trips.

Slider selector ranging from \$1 to \$50

97. I would not pay a fee to access an artificial reef. **[S]**

Base: Qualified respondents

DISP3 [DISPLAY]

Coral cover in Southeast Florida has declined greatly. Coral cover of some of the reefs has decreased by over 90% in the last few decades. Living corals will continue to decline without intervention, but it's possible to restore some of the corals and maintain the reef ecosystem if certain actions are taken.

We'll show you some possible scenarios about the condition of the Southeast Florida coral reefs if certain actions are taken (or not taken). The scenarios will be shown in pairs, and we would like you to tell us which scenario you prefer. Each scenario will describe four factors:



Fee

A possible new fee for people to access areas with coral reefs. Each person who accesses the area would have to pay the fee on each visit. These fees would help pay for reef restoration.

Current access fees range from \$2 - \$15 per person.



Visitors

The number of people that visit the coral reefs each year. Human visitors can contribute to damage and stress to coral and an increase in pollution that hurts the coral.

Currently, there are over 3 million visitors to Florida reefs per year.



Artificial reefs

The number of new artificial reefs created. Artificial reefs support marine life and can help restore reef ecosystem processes, similar to natural reefs. Having more artificial reefs provides more options for people to visit reef habitats to experience Florida's reefs.

Currently, there are almost 700 artificial reefs in Southeast Florida.



Coral cover

The amount of *live coral cover* there is relative to today.

Currently, there is 90% less coral cover than in the 1980s.

Base: Qualified respondents

Q20 [S]

For the next set of questions, please tell us which of the two scenarios you prefer.

[SEE ATTACHMENT *Coral Reef Survey Conjoint Trials.xlsx*]

There are four (4) attributes (area of live coral cover, number of visitors accessing the coral reefs, number of artificial reef locations, and access fee for natural coral reefs) with 3-5 levels (i.e., values) each, as shown in the table below. There are 48 possible combinations of the attributes and 1,128 possible choice pairs.

Each participant would be shown a subset of 8 choices, in other words, they would be asked to choose between two scenarios 8 times. There are 12 sets of 8 choices. One of the 12 sets which will be randomly assigned to each participant.

The choices would be displayed in the same format as in the example above, using the same text. In other words, the values (\$1, 20%, etc.) would be swapped out with values from the table below.

Attribute	1. Natural reef coral coverage (% change)	2. Number of reef visitors	3. New artificial reef locations	4. Access fee for natural reefs (cost per visit)
<i>N Levels</i>	4	3	4	5
Level 1	no change	no change	no change	\$0 fee per visit
Level 2	10% more coral cover	10% fewer visitors	5% increase in artificial reef sites	\$5 fee per visit
Level 3	20% more natural coral cover	15% fewer visitors	10% increase in artificial reef sites	\$10 fee per visit
Level 4	30% more natural coral cover		20% increase in artificial reef sites	\$20 fee per visit
Level 5				\$30 fee per visit

Example layout:


Option A

Access fee: \$0 fee per visit

Visitors: no change

New artificial reefs: no change

Natural coral: no change




Option B

Access fee: \$5 fee per visit

Visitors: 10% fewer visitors

New artificial reefs: 5% increase in artificial reef sites

Natural coral: 10% more natural coral cover



Additionally, should the 8 pairs of scenarios be randomly selected of the 12? Yes, but to clarify further - there are 12 sets of 8 pairs in the lookup table (Set 1, Set 2... Set 12). Each person should be randomly assigned a set (Participant 1 -> Set 3, Participant 2 -> Set 10, ...).

- To the extent possible, please ensure that the number of participants assigned to each of the 12 sets is ~ equal.
- If possible, please randomize the order of the 8 pairs within the set for each participant. e.g., the order of the 8 pairs for Set 1 might be 4-2-5-1-7-2-8-3 for one person and 8-3-4-2-6-5-1-3 for another person.

Any randomization within each scenario pair? As in, whether Option A/B goes on the left/right? If that's easy, yes, please. And of course, we need to record the order. It could be coded

something like [12, 12, 21, 21, 12...], where each 12/21 pair tells us the option order. But this randomization is **not** a high priority, so if it takes a lot of resources, just show them in order they show up in the lookup table.

Q21 [Checkbox]

Thank you for completing this survey! Your input will be used to guide decisions about caring for Southeast Florida reefs. If you would like to receive a copy of our study findings, please check the box below. A study report will be emailed to the address associated with your KnowledgePanel® account.

Yes, please send me the study report by email.

Show KP closing question QF1

Appendix II. Survey Data Tables for Entire Study Sample

Q1. In which U.S. state or territory do you currently live?

<u>U.S. state or territory</u>	<u>n</u>	<u>%</u>	<u>Total N</u>	<u>Total %</u>	<u>U.S. state or territory</u>	<u>n</u>	<u>%</u>	<u>Total N</u>	<u>Total %</u>
Alabama	5	0.3	5	0.3	Nevada.....	4	0.2	1,361	83.1
Alaska.....	1	0.0	6	0.3	New Hampshire	3	0.2	1,364	83.3
Arizona	17	1.0	23	1.3	New Jersey	17	1.0	1,381	84.3
Arkansas	6	0.3	29	1.6	New Mexico	4	0.2	1,385	84.5
California	71	4.4	100	6.0	New York	37	2.3	1,422	86.8
Colorado.....	13	0.8	113	6.8	North Carolina.....	22	1.3	1,444	88.1
Connecticut	4	0.2	117	7.0	North Dakota.....	1	0.0	1,445	88.1
Delaware	3	0.2	120	7.2	Ohio	26	1.6	1,471	89.7
District of Columbia	3	0.2	123	7.4	Oklahoma.....	4	0.3	1,475	90.0
Florida	1,085	66.4	1,208	73.8	Oregon	8	0.5	1,483	90.5
Georgia.....	18	1.1	1,226	74.9	Pennsylvania.....	27	1.7	1,510	92.2
Hawaii.....	1	0.1	1,227	75.0	Rhode Island.....	1	0.0	1,511	92.2
Idaho	2	0.1	1,229	75.1	South Carolina	13	0.8	1,524	93.0
Illinois	22	1.3	1,251	76.4	South Dakota	2	0.1	1,526	93.1
Indiana.....	13	0.8	1,264	77.2	Tennessee	15	0.9	1,541	94.0
Iowa.....	3	0.2	1,267	77.4	Texas	40	2.4	1,581	96.4
Kansas	5	0.3	1,272	77.7	Utah	5	0.3	1,586	96.7
Kentucky.....	9	0.6	1,281	78.3	Vermont	0	0.0	1,586	96.7
Louisiana	4	0.2	1,285	78.5	Virginia	17	1.1	1,603	97.8
Maine.....	4	0.2	1,289	78.7	Washington	13	0.8	1,616	98.6
Maryland.....	15	0.9	1,304	79.6	West Virginia.....	4	0.3	1,620	98.9
Massachusetts	11	0.7	1,315	80.3	Wisconsin.....	14	1.0	1,634	99.9
Michigan	17	1.0	1,332	81.3	Wyoming	1	0.1	1,635	100.0
Minnesota.....	5	0.3	1,337	81.6					
Mississippi.....	5	0.3	1,342	81.9					
Missouri	11	0.7	1,353	82.6					
Montana	0	0.0	1,353	82.6					
Nebraska.....	4	0.3	1,357	82.9					

Q2. In which county do you reside? (Q1 = Florida)

<u>Florida County</u>	<u>n</u>	<u>%</u>	<u>Total N</u>	<u>Total %</u>	<u>Florida County</u>	<u>n</u>	<u>%</u>	<u>Total N</u>	<u>Total %</u>
Refused	11	1.0	11	1.0	Manatee	13	1.2	452	41.4
Alachua	10	0.9	21	1.9	Marion	20	1.9	472	43.3
Bay	2	0.2	23	2.1	Martin	20	1.8	492	45.1
Bradford.....	1	0.1	24	2.2	Miami-Dade.....	227	20.0	719	66.1
Brevard.....	29	2.6	53	4.8	Monroe.....	2	0.2	721	66.3
Broward	150	13.8	203	18.6	Nassau.....	1	0.1	722	66.4
Charlotte.....	12	1.1	215	19.7	Okaloosa.....	11	1.0	733	67.4
Citrus	7	0.7	222	20.4	Okeechobee.....	0	0.0	733	67.4
Clay	8	0.7	230	21.1	Orange	54	4.9	787	72.3
Collier	8	0.8	238	21.8	Osceola.....	10	0.9	797	73.3
Columbia	1	0.1	239	21.9	Palm Beach.....	128	11.8	925	85.1
DeSoto	1	0.1	240	22.0	Pasco	23	2.1	948	87.2
Duval	29	2.6	269	24.6	Pinellas	35	3.3	983	90.5
Escambia.....	14	1.3	283	25.9	Polk	27	2.5	1,010	93.0
Flagler	6	0.6	289	26.5	Putnam.....	1	0.1	1,011	93.1
Franklin.....	0	0.0	289	26.5	Santa Rosa	2	0.2	1,013	93.3
Glades	5	0.5	294	27.0	Sarasota.....	8	0.7	1,021	94.1
Gulf.....	1	0.1	295	27.1	Seminole	16	1.5	1,037	95.6
Hardee.....	1	0.1	296	27.1	St. Johns	9	0.8	1,046	96.4
Hernando.....	4	0.4	300	27.5	St. Lucie	22	2.0	1,068	98.4
Highlands	2	0.2	302	27.7	Sumter	4	0.4	1,072	98.8
Hillsborough	51	4.7	353	32.4	Suwannee	2	0.2	1,074	99.0
Holmes	4	0.4	357	32.7	Union.....	1	0.1	1,075	99.0
Indian River	5	0.4	362	33.2	Volusia	9	0.9	1,084	99.9
Jackson	2	0.2	364	33.4	Wakulla	1	0.1	1,085	100.0
Jefferson.....	1	0.1	365	33.4					
Lake.....	21	2.0	386	35.4					
Lee	24	2.2	410	37.6					
Leon	20	1.8	430	39.4					
Levy.....	2	0.2	432	39.6					
Madison.....	7	0.6	439	40.2					

Q3. We're going to ask you some questions about coral reefs. How much do you feel you know about:

Knowledge about coral reefs	Nothing		A little		Moderate amount		A great deal		Total N
	n	%	n	%	n	%	n	%	
a. The topic of coral reefs generally.....	389	23.9	873	53.6	305	18.8	60	3.7	1,627
b. The difference between natural and artificial reefs	456	28.0	655	40.3	410	25.2	105	6.5	1,626
c. Coral reefs located off the coast of Southeast Florida and the Florida Keys, in particular	697	42.9	678	41.7	188	11.6	61	3.8	1,624
d. The current condition of coral reefs in Southeast Florida	724	44.6	646	39.8	200	12.3	52	3.2	1,622

1=Nothing, 2=A little, 3=Moderate amount, 4=A great deal

Q4. To the best of your knowledge, which of the following statements about Florida's reefs are true and which are false?

Statements	Definitely false		Maybe false		Maybe true		Definitely true		Mean
	n	%	n	%	n	%	n	%	
a. Florida's coral reefs have grown quickly in the past decades...	334	21.1	725	45.8	481	30.1	44	2.8	2.15
b. Coral reefs are immune to natural disease	808	49.4	533	33.6	213	13.4	36	2.2	1.67
c. The recent increase in water temperature near Florida allows local coral reefs to grow more quickly.....	315	20.0	626	39.6	586	37.1	52	3.3	2.24
d. Coral reefs protect the Southeast Florida shoreline.	29	1.8	100	6.3	814	51.5	638	40.4	3.30
e. Ocean water quality affects the condition of coral reefs	31	1.9	84	5.3	557	34.9	923	57.9	3.49
f. Natural reefs provide fishing and diving experiences but artificial reefs do not	537	33.8	594	37.4	383	24.1	74	4.6	2.00

1=Definitely false, 2=Maybe false, 3=Maybe true, 4=Definitely true

Q5. How many times have you visited this region of Southeast Florida in the past 5 years, either on business or personal trips? (since May 2016).

<u>Number of visits</u>	<u>n</u>	<u>%</u>	<u>Total N</u>	<u>Total %</u>
0	646	58.8	646	58.8
1-5	341	31.0	987	89.8
6-10	49	4.4	1,036	94.2
11-15	21	1.9	1,057	96.1
16+	42	3.9	1,099	100.0

Q6. How many times are you *likely* to visit this region of Southeast Florida in the past 5 years (through May 2016)? Select the number of likely trips, either business or personal trips. Your best guess is fine.

<u>Number of visits</u>	<u>n</u>	<u>%</u>	<u>Total N</u>	<u>Total %</u>
0	388	35.3	388	35.3
1-5	603	54.8	991	90.1
6-10	50	4.6	1,041	94.7
11-15	21	2.0	1,062	96.6
16+	37	3.4	1,099	100.0

Q7. Now, thinking about the past 5 years (since May 2016), have you engaged in any of the following water or beach activities at any time in any location (in Florida or elsewhere)? Tell us which activities you engaged in for recreation or fun OR for work or as a source of income (select both if applicable).

Activity engaged in	For recreation/fun		For work/income		Didn't do activity		Total N
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	
a. Saltwater fishing, including spearfishing	302	18.6	9	0.5	1,316	80.9	1,627
b. Harvesting of shellfish, lobster, octopus, seaweed, or marine life other than fish	106	6.5	11	0.7	1,511	92.8	1,628
c. SCUBA diving, free diving, or snorkeling	270	16.6	5	0.3	1,352	83.1	1,627
d. Beach recreation (swimming, sunbathing, picnics, camping, beach sports, walking on the beach).....	1,170	71.9	15	0.9	443	27.2	1,628
e. Sailing, boating, jet-skiing, waterskiing, or wakeboarding	448	27.5	8	0.5	1,172	72.0	1,628
f. Kayaking, surfing, standup paddle boarding, windsurfing, or kitesurfing.....	355	21.8	8	0.5	1,264	77.7	1,626
g. Other:	183	11.3	10	0.6	1,433	88.1	1,626

Q8. Have you ever completed the educational requirements to obtain a Boating Safety Education Identification Card and to operate a boat in Florida?

	<i>n</i>	%	Total N	Total %
Yes	104	6.4	104	6.4
No.....	1,498	92.0	1,602	98.5
I don't know	25	1.5	1,627	100.0

Q9. We'll show you the activities you've engaged in over the past 5 years. Did these activities ever take place near a coral reef? Please indicate whether the activity ever took place near a natural coral reef, near an artificial reef, or near both.

Activity engaged in	Took place near a natural reef		Took place near an artificial reef		Took place near both types of reefs		Don't know if artificial or natural		Did not take place near a reef		Not sure if took place near a reef		Total N
	n	%	n	%	n	%	n	%	n	%	n	%	
a. Saltwater fishing.....	43	14.1	21	6.8	46	15.2	37	12.1	109	35.6	50	16.2	306
b. Harvesting of marine resources.....	31	28.1	16	14.3	16	14.8	6	5.9	33	30.2	7	6.8	109
c. SCUBA diving, free diving, snorkeling.....	88	32.7	21	7.8	54	20.3	18	6.6	64	23.8	24	8.8	269
d. Beach recreation.....	153	13.1	30	2.6	70	5.9	85	7.2	534	45.6	300	25.6	1,172
e. Boating.....	67	15.1	17	3.8	44	10.0	45	10.1	167	37.7	104	23.4	443
f. Board sports.....	48	13.4	11	3.2	31	8.7	30	8.4	188	52.9	48	13.5	357
g. Other:.....	43	22.1	8	4.3	13	6.8	9	4.8	77	39.8	40	20.6	193

Q10. Now, please tell us whether you agree or disagree with these statements about Florida's reefs:

Statements	Strongly Disagree		Somewhat Disagree		Neither		Somewhat Agree		Strongly Agree		Mean
	n	%	n	%	n	%	n	%	n	%	
a. Coral reefs are part of what makes SE FL special.....	14	0.9	32	2.0	301	18.8	563	35.1	694	43.3	4.18
b. Coral reefs are one of the reasons why I live in SE FL.	147	28.5	40	7.9	246	47.8	53	10.3	28	5.5	2.56
c. Coral reefs are one of the reasons why I visit SE FL.....	95	21.1	63	14.0	204	45.2	61	13.5	28	6.2	2.70
d. It is important to protect and maintain coral reefs for future generations.....	14	0.9	18	1.1	123	7.7	238	14.8	1,212	75.5	4.63
e. The construction of artificial reefs can help offset the loss of natural reefs.....	35	2.2	89	5.6	305	19.1	717	44.9	450	28.2	3.91
f. The construction of artificial reefs can help more people visit coral reefs.....	41	2.6	65	4.0	505	31.6	627	39.2	361	22.6	3.75

1=Strongly disagree, 2=Somewhat disagree, 3=Neither agree nor disagree, 4=Somewhat agree, 5=Strongly agree

Q11. Next, we'll list some topics and issues related to coral reefs. Please tell us how important each of these topics/issues are to you:

	<u>Unimportant</u>		<u>A little Important</u>		<u>Moderately Important</u>		<u>Very Important</u>		<u>Extremely Important</u>		<i>Mean</i>
	<i>n</i>	<i>%</i>	<i>n</i>	<i>%</i>	<i>n</i>	<i>%</i>	<i>n</i>	<i>%</i>	<i>n</i>	<i>%</i>	
a. Existence of natural coral reefs in SE FL.....	23	1.5	120	7.9	230	15.3	496	32.9	638	42.3	4.07
b. Existence of artificial reefs in SE FL	66	4.6	211	14.5	365	25.1	469	32.3	342	23.5	3.56
c. Opportunities to fish at coral reefs	275	19.4	260	18.3	389	27.4	318	22.4	176	12.4	2.90
d. Ocean water quality in SE FL	20	1.3	63	4.1	164	10.8	482	31.7	791	52.0	4.29
e. Coral reef education for K-12 students in the U.S.	54	3.6	198	13.2	379	25.2	486	32.4	383	25.6	3.63
f. Coral reef knowledge among adults in the U.S.	54	3.6	230	15.4	451	30.1	502	33.6	260	17.4	3.46
g. Scientific research on Florida's reefs	32	2.1	116	7.7	303	20.1	543	36.0	514	34.0	3.92
h. Coral reef conservation and preservation	19	1.3	81	5.3	199	13.1	466	30.7	750	49.5	4.22

1=Unimportant, 2=A little important, 3=Moderately important, 4=Very important, 5=Extremely important

Q12. Now we'll show you the same reef-related issues. Please tell us how satisfied you are with each.

	<u>Unsatisfied</u>		<u>A little Satisfied</u>		<u>Moderately Satisfied</u>		<u>Very Satisfied</u>		<u>Extremely Satisfied</u>		<i>Mean</i>
	<i>n</i>	<i>%</i>	<i>n</i>	<i>%</i>	<i>n</i>	<i>%</i>	<i>n</i>	<i>%</i>	<i>n</i>	<i>%</i>	
a. The condition of natural coral reefs in SE FL.....	252	24.4	229	22.1	364	35.2	117	11.3	73	7.1	2.55
b. The number of artificial reefs in SE FL.....	70	7.9	214	24.0	399	44.7	152	17.0	57	6.4	2.90
c. Fishing opportunities at reefs in SE FL	56	6.6	162	19.3	374	44.5	174	20.6	75	8.9	3.06
d. Ocean water quality in SE FL	242	21.0	276	24.0	383	33.2	165	14.3	85	7.4	2.63
e. Coral reef education for K-12 students in the U.S.	250	24.0	317	30.5	279	26.8	109	10.5	85	8.2	2.48
f. Coral reef knowledge among adults in the U.S.	375	33.3	327	29.1	292	25.9	70	6.2	63	5.6	2.22
g. Scientific research on Florida's reefs	74	7.2	171	16.7	482	46.9	192	18.7	108	10.5	3.09
h. Coral reef conservation and preservation	187	16.6	271	24.1	426	37.9	142	12.6	98	8.7	2.73

1=Unsatisfied, 2=A little satisfied, 3=Moderately satisfied, 4=Very satisfied, 5=Extremely satisfied

Q13. Over the next 10 years, do you think the condition of the Southeast Florida ocean environment will get worse, stay the same, or improve?

	<u>n</u>	<u>%</u>	<u>Total N</u>	<u>Total %</u>
Get a lot worse	244	15.0	244	15.0
Get somewhat worse	627	38.6	871	53.6
Stay the same	248	15.3	1,119	68.9
Improve somewhat.....	217	13.4	1,146	82.2
Improve a lot	32	2.0	1,178	84.2
Don't know.....	257	15.8	1,435	100.0

Q14. How much of a threat do you think the following factors are to coral reefs?

<u>Threats</u>	<u>No threat at all</u>		<u>A little of a threat</u>		<u>Somewhat of a threat</u>		<u>A great deal of a threat</u>		<u>Total N</u>
	<u>n</u>	<u>%</u>	<u>n</u>	<u>%</u>	<u>n</u>	<u>%</u>	<u>n</u>	<u>%</u>	
a. Overfishing	56	3.5	287	18.0	614	38.6	636	39.9	1,593
b. Climate change	138	8.6	217	13.7	388	24.4	849	53.3	1,592
c. Water pollution	29	1.8	132	8.3	342	21.4	1,092	68.5	1,595
d. Recreation and tourism at coral reefs	84	5.3	371	23.3	738	46.4	399	25.1	1,592

1=No threat at all, 2=A little of a threat, 3=Somewhat of a threat, 4=A great deal of a threat

Q15. How much responsibility do each of the following groups and organizations have in protecting Southeast Florida coral reefs?

Groups and organizations	No responsibility		A little responsibility		Some responsibility		A lot of responsibility		Mean
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	
a. Local Southeast Florida residents.....	36	2.3	158	10.0	587	37.2	795	50.5	3.36
b. Tourists that come to Southeast Florida	70	4.4	220	14.1	604	38.6	671	42.9	3.20
c. All Florida state residents	48	3.0	234	14.8	609	38.5	691	43.7	3.23
d. U.S. residents.....	95	6.0	357	22.8	606	38.7	508	32.4	2.98
e. People that use Southeast Florida coral reefs for fun	41	2.6	120	7.6	434	27.5	981	62.2	3.49
f. People that use Southeast Florida coral reefs for income	25	1.6	109	6.9	313	19.8	1,131	71.7	3.62
g. Local Southeast Florida governments	24	1.5	102	6.5	379	24.0	1,070	68.0	3.58
h. Florida state government	26	1.6	92	5.8	319	20.3	1,133	72.2	3.63
i. U.S. federal government	51	3.3	201	12.7	540	34.3	783	49.7	3.30

1=No responsibility, 2=A little responsibility, 3=Some responsibility, 4=A lot of responsibility

Q16. How much do you trust information from the following agencies?

Agencies	Do not trust		Trust a little		Moderate amount		Trust very much		I don't know this agency		Mean*
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	
a. Florida Keys National Marine Sanctuary.....	31	1.9	128	8.0	398	25.0	522	32.9	511	32.1	3.31
b. Florida Department of Environmental Protection.....	76	4.8	223	14.1	534	33.6	436	27.4	319	20.1	3.05
c. Florida Fish and Wildlife Conservation Commission.....	39	2.5	166	10.4	530	33.4	545	34.3	307	19.4	3.24
d. South Atlantic Fishery Management Council.....	46	2.9	203	12.8	450	29.3	250	15.8	638	40.2	2.95
e. NOAA National Marine Fisheries Service.....	41	2.6	156	9.8	461	29.0	502	31.6	431	27.1	3.23

1=Do not trust, 2=Trust a little, 3=Trust a moderate amount, 4=Trust very much, 5=Trust very much, 6=I don't know this agency

*Mean does not include "6=I don't know this agency" responses

Q17. Now we'll show you statements about personal beliefs. Please tell us whether you agree or disagree with these statements.

	<u>Strongly Disagree</u>		<u>Somewhat Disagree</u>		<u>Neither</u>		<u>Somewhat Agree</u>		<u>Strongly Agree</u>		<i>Mean</i>
	<i>n</i>	<i>%</i>	<i>n</i>	<i>%</i>	<i>n</i>	<i>%</i>	<i>n</i>	<i>%</i>	<i>n</i>	<i>%</i>	
a. Climate change is a serious threat to SE FL.....	86	5.4	94	5.9	325	20.4	327	20.5	760	47.7	3.99
b. I have a right to access the coral reefs in SE FL	51	3.2	178	11.2	674	42.4	502	31.6	184	11.6	3.37
c. The government has the right to restrict access to the coral reefs in SE FL.....	64	4.1	130	8.2	357	22.6	582	36.8	449	28.3	3.77
d. Local, state, and federal governments should intervene to protect SE FL coral reefs from negative human impacts	20	1.2	50	3.1	246	15.5	493	31.0	783	49.2	4.24

1=Strongly disagree, 2=Somewhat disagree, 3=Neither agree nor disagree, 4=Somewhat agree, 5=Strongly agree

Appendix III. Ipsos KnowledgePanel® Methodology

Introduction

Ipsos is passionate about social science, health, and public policy research. We collaborate closely with our client throughout the research process, while applying rigor in every step. We specialize in innovative online research that consistently gives leaders in academia, government, and business the confidence to make important decisions. Ipsos delivers affordable, statistically valid online research through KnowledgePanel® and leverages a variety of other assets, such as world-class advanced analytics, an industry-leading physician panel, an innovative platform for measuring online ad effectiveness, and a research-ready behavioral database of frequent supermarket and drug store shoppers.

KnowledgePanel is the first and largest online research panel that is representative of the entire U.S. population. Panel members are randomly recruited through probability-based sampling, and households are provided with access to the Internet and hardware if needed. Ipsos recruits panel members by using address-based sampling (ABS) methods (previously Ipsos relied on random-digit dialing [RDD] methods). Once household members are recruited for the panel and assigned to a study sample, they are notified by email for survey taking, or panelists can visit their online member page for survey taking (instead of being contacted by telephone or postal mail). This allows surveys to be fielded quickly and economically. In addition, this approach reduces the burden placed on respondents, since email notification is less intrusive than telephone calls and most respondents find answering online questionnaires more interesting and engaging than being questioned by a telephone interviewer. Furthermore, respondents have the convenience to choose what day and time to complete their assigned survey.

Ipsos Public Affairs

Ipsos Public Affairs has a strong tradition in working with sophisticated academic, government, and commercial researchers to provide high quality research, samples, and analyses. The larger Ipsos offers the fundamental knowledge for governmental agencies, academics, industries, industry, retailers, services companies and the media need to provide exceptional quality in research to make effective decisions. It delivers a comprehensive range of information and consultancy services. Ipsos is one of the leading survey research organizations worldwide, operating in 90 countries with over 16,000 employees.

For further information, visit our website: www.ipsos.com.

KnowledgePanel Methodology

KnowledgePanel is the largest online panel that relies on probability-based sampling techniques for recruitment; hence, it is the largest national sampling frame from which fully representative samples can be generated to produce statistically valid inferences for study populations. Our panel provides samples with the highest level of representativeness available in online research for measurement of public opinions, attitudes, and behaviors. The panel was first developed in 1999 by Knowledge Networks, an Ipsos company. Panel members are randomly selected so that survey results can properly represent the U.S. population with a measurable level of accuracy, features that are not obtainable from nonprobability or opt-in online panels (for comparisons of results from probability versus nonprobability methods, see MacInnis et al., 2018¹ and Yeager et al., 2011²).

KnowledgePanel's recruitment process was originally based exclusively on a national RDD sampling methodology. In 2009, in light of the growing proportion of cellphone-only households, Ipsos migrated to an ABS recruitment methodology via the U.S. Postal Service's Delivery Sequence File (DSF). ABS not only improves population coverage, but also provides amore effective means for recruiting hard-to-reach individuals, such as young adults and minorities. Households without Internet connection are provided with a web-enabled device and free internet service.

After initially accepting the invitation to join the panel, participants are asked to complete a short demographic survey (the initial Core Profile Survey); answers to this survey allow efficient panel sampling and weighting for future surveys. Upon completing the Core Profile Survey, participants become active panel members. All panel members are provided privacy and confidentiality protections.

ABS Recruitment

We use probability-based sampling methods for recruiting new members to join KnowledgePanel. For this purpose, we rely on the latest version of the Delivery Sequence File (DSF) from the USPS to select address-based samples that are nationally representative of all households. By taking advantage of a host

¹ MacInnis, B., Krosnick, J., Ho, A., and M. Cho. 2018. The Accuracy of Measurements with Probability and Nonprobability Survey Samples: Replication and Extension. *Public Opinion Quarterly*, Winter 2018.

² Yeager, D., Krosnick, J., Chang, L., Javitz, H., Levendusky, M., Simper, A. and R. Wang. 2011. Comparing the Accuracy of RDD Telephone Surveys and Internet Surveys Conducted With Probability and Non-Probability Samples. *Public Opinion Quarterly*, Winter 2011.

of ancillary data that are appended to each address, we use stratified random sampling to ensure the geodemographic composition of our panel members mimic those of the adult population in the U.S.³

Adults from sampled households are invited to join KnowledgePanel through a series of mailings, including an initial invitation letter, a reminder postcard, and a subsequent follow-up letter. Moreover, telephone refusal-conversion calls are made to nonresponding households for which a telephone number could be matched to a physical address. Invited households can join the panel by:

- Completing and mailing back a paper form in a postage-paid envelope
- Calling a toll-free hotline phone number maintained by Ipsos
- Going to a designated Ipsos website and completing the recruitment form online

KnowledgePanel LatinoSM Recruitment

In 2008, KnowledgePanel LatinoSM was developed to provide researchers with the capability to conduct representative online surveys with United States Hispanics, including both English and Spanish-dominant Hispanics. With the advent of KnowledgePanel Latino, the first United States Online panel representative of Hispanics was established to include those without Internet access and those who only speak Spanish. Hispanic members recruited through our traditional ABS sampling methodology described above are supplemented with recruitment using a custom dual-frame RDD sampling methodology targeting telephone exchanges associated with census blocks that have a 65% or greater Latino population density (this density level covers just over 50% of the United States Hispanic population). Moreover, cellular numbers from rate centers with high concentration of Hispanics are also used to improve the representation of samples. With this telephone recruitment, households are screened in the Spanish language to only recruit those homes where Spanish is spoken at least half the time.

Household Member Recruitment

During the initial recruitment survey, all household members are enumerated. Following enumeration, attempts are made to recruit every household member who is at least 13 years old to participate in KnowledgePanel surveys. For household members aged 13 to 17, consent is collected from the parents or the legal guardian during the initial recruitment interview. No direct communication with teenagers is attempted before obtaining parental consent.

³ Fahimi, M. and D. Kulp. 2009. Address-Based Sampling – Alternatives for Surveys That Require Contacts with Representative Samples of Households. Quirk's Marketing Research Review, May 2009.

Survey Sampling from KnowledgePanel

Once panel members are recruited and profiled by completing our Core Profile Survey, they become eligible for selection for client surveys. Typically, specific survey samples are based on the equal probability selection method (EPSEM) for general population surveys. Customized stratified random sampling based on “profile” data can also be implemented as required by the study design. Profile data can also be used when a survey calls for pre-screening—that is, members are drawn from a subsample of the panel, such as females, Republicans, grocery shoppers, etc. (This can reduce screening costs, particularly for rare subgroups.) In such cases, we take care to ensure that all subsequent survey samples drawn that week are selected in such a way as to result in a sample that remains representative of the panel distributions. While surveys can be conducted with these teens directly, in most instances, teen surveys are conducted by first selecting a sample of active members who are parents. This parent route alternative makes it possible to reach a larger sample of teens.

Survey Administration

Once assigned to a survey, members receive a notification email letting them know there is a new survey available for them to complete. This email notification contains a link that sends them to the survey. No login name or password is required. The field period depends on the client’s needs and can range anywhere from a few hours to several weeks.

Typically, after three days, automatic email reminders are sent to all non-responding panel members in the sample. Additional email reminders are sent or custom reminder schedules are set up as needed. To assist panel members with their survey taking, each individual has a personalized member portal listing all assigned surveys that have yet to be completed.

Ipsos also operates an ongoing modest incentive program to encourage participation and create member loyalty. The incentive program includes special raffles and sweepstakes with both cash rewards and other prizes to be won. Typically, we assign panel members no more than one survey per week. On average, panel members complete two to three surveys per month with durations of 10 to 15 minutes per survey. An additional incentive is usually provided for longer surveys.

Response Rates

As a member of the American Association of Public Opinion Research (AAPOR), Ipsos follows the AAPOR standards for response rate reporting. While the AAPOR standards were established for single

survey administrations and not for multi-stage panel surveys, we use the Callegaro-DiSogra (2008)⁴ algorithms for calculating KnowledgePanel survey response rates. Generally, the KnowledgePanel survey completion rate is about 60%, with minor variations due to survey length, topic, sample specifications, and other fielding characteristics. In contrast, virtually all surveys that employ nonprobability online panels typically achieve survey completion rates in the low single digits. This means that – aside from the fact that nonprobability panels are inherently not representative of any known populations – the effective size of KnowledgePanel (55,000 panel members × 0.60 completion rate = 33,000 respondents) would be equivalent to a nonprobability panel with 1,650,000 members that on average secures completion rates close to 2% (1,650,000 panel members × 0.02 = 33,000 respondents).

Sample Weighting

As detailed above, significant resources and infrastructure are devoted to the recruitment process for KnowledgePanel so that our active panel members can properly represent the adult population of the U.S. This representation is achieved not only with respect to a broad set of geodemographic indicators, but also for hard-to-reach adults (such as those without Internet access or Spanish-language-dominant Hispanics) who are recruited in proper proportions. Consequently, the raw distribution of KnowledgePanel mirrors that of the U.S. adults fairly closely, barring occasional disparities that may emerge for certain subgroups due to differential attrition.

For selection of general population samples from KnowledgePanel, a patented methodology has been developed that ensures all samples behave as EPSEM samples. Briefly, this methodology starts by weighting the pool of active members to the geodemographic benchmarks secured from the latest March supplement of the U.S. Census Bureau’s Current Population Survey (CPS) along several dimensions. Using the resulting weights as measures of size, a probability-proportional-to-size (PPS) procedure is used to select study specific samples. It is the application of this PPS methodology with the imposed size measures that produces fully self-weighting samples from KnowledgePanel, for which each sample member can carry a design weight of unity. Moreover, in instances where a study design requires any form of oversampling of certain subgroups, such departures from an EPSEM design are accounted for by adjusting the design weights in reference to the CPS benchmarks for the population of interest.

The geodemographic benchmarks used to weight the active panel members for computation of size measures include:

⁴ Callegaro, M. and C. DiSogra. 2008. Computing Response Metrics for Online Panels. *Public Opinion Quarterly*, Vol. 72, No. 5.

- Gender (Male/Female)
- Age (18–29, 30–44, 45–59, and 60+)
- Race/Hispanic ethnicity (White/Non-Hispanic, Black/Non-Hispanic, Other/Non-Hispanic, 2+ Races/Non-Hispanic, Hispanic)
- Education (Less than High School, High School, Some College, Bachelor and beyond)
- Census Region (Northeast, Midwest, South, West)
- Household income (under \$10k, \$10K to <\$25k, \$25K to <\$50k, \$50K to <\$75k, \$75K to <\$100k, \$100K to <\$150k, and \$150K+)
- Home ownership status (Own, Rent/Other)
- Metropolitan Area (Yes, No)
- Hispanic Origin (Mexican, Puerto Rican, Cuban, Other, Non-Hispanic)

Study-Specific Post-Stratification Weights

Once all survey data have been collected and processed, design weights are adjusted to account for any differential nonresponse that may have occurred. Depending on the specific target population for a given study, geodemographic distributions for the corresponding population are obtained from the CPS, the U.S. Census Bureau’s American Community Survey (ACS), or in certain instances from the weighted KnowledgePanel profile data. For this purpose, an iterative proportional fitting (raking) procedure is used to produce the final weights. In the final step, calculated weights are examined to identify and, if necessary, trim outliers at the extreme upper and lower tails of the weight distribution. The resulting weights are then scaled to aggregate to the total sample size of all eligible respondents.

For this study, design weights for the three study-specific areas (Southeast Florida, remaining Florida, and the rest of the United States) were computed separately to reflect their selection probabilities. These three areas were weighted separately. The following benchmark distributions of U.S. adults age 18 and over from the 2015-2019 American Community Survey (ACS) were used for the raking adjustment of the weights.

Area 1: Southeast of FL Region

- Gender (Male, Female) by Age (18-34, 35-44, 45-59, 60-69,70+)
- Race-Ethnicity (White/Non-Hispanic, Black/Non-Hispanic, Other or 2+ Races/Non-Hispanic, Hispanic)
- Education (Less than High School or High School, Some College, Bachelor or higher)

- Household Income (Under \$25K, \$25K-\$49,999, \$50K-\$74,999, \$75K-\$99,999, \$100K-\$149,999, \$150K and Over)
- Language Proficiency (English Proficient Hispanic, Bilingual Hispanic, Spanish Proficient Hispanic, Non-Hispanic)

Area 2: Remaining FL Region

- Gender (Male, Female) by Age (18-34, 35-44, 45-59, 60-69,70+)
- Race-Ethnicity (White/Non-Hispanic, Black/Non-Hispanic, Other or 2+ Races/Non-Hispanic, Hispanic)
- Education (Less than High School, High School, Some College, Bachelor or Higher)
- Household Income (Under \$25K, \$25K-\$49,999, \$50K-\$74,999, \$75K-\$99,999, \$100K-\$149,999, \$150K and Over)
- Language Proficiency (Non Bilingual Hispanic, Bilingual Hispanic, Non-Hispanic)

Area 3: Remaining United States Region

- Gender (Male, Female) by Age (18-34, 35-44, 45-59, 60-69,70+)
- Race-Ethnicity (White/Non-Hispanic, Black/Non-Hispanic, Other/Non-Hispanic, Hispanic, 2+ Races/Non-Hispanic)
- Education (Less than High School, High School, Some College, Bachelor or Higher)
- Census Region (Northeast, Midwest, South, and West)
- Household Income (Under \$25K, \$25K-\$49,999, \$50K-\$74,999, \$75K-\$99,999, \$100K-\$149,999, \$150K and Over)
- Language Proficiency (Non Bilingual Hispanic, Bilingual Hispanic, Non-Hispanic)

The resulting weights were trimmed and scaled to sum to the un-weighted sample size of each area (labeled as weight, n=1635).

Trimming:

SE FL Counties: (2.85%, 97.15%)

Rest of FL: (0%, 99.46%)

Rest of U.S.: None

Design Effect:

SE FL Counties: 2.6905

Rest of FL: 1.6417

Rest of U.S.: 1.2639

Range on Weights:

Analysis Variable: weight										
Three_Level_Area	N Obs	N	Minimum	Maximum	Mean	Median	Coeff of Variation	1st Pctl	99th Pctl	Sum
SE FL Counties	527	527	0.041	5.820	1.000	0.505	130.020	0.041	5.820	527.000
Rest of FL	558	558	0.296	5.241	1.000	0.784	80.108	0.296	4.917	558.000
Rest of U.S.	550	550	0.225	3.695	1.000	0.860	51.371	0.277	3.059	550.000