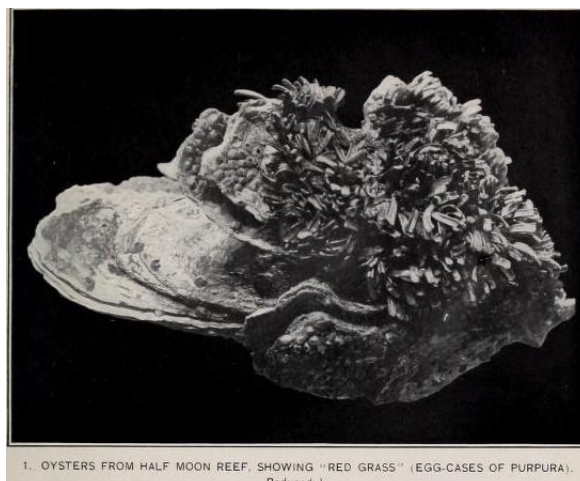


The Half Moon Reef Restoration: A Socioeconomic Evaluation

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Cover image adapted from Moore (1907).

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1 Executive summary

This is the final report for TNC project 2015GOMTXAM_001, *Angler Attitudes Toward the Half Moon Reef Restoration*. This report contains data and analysis from the project, focusing on the most relevant and interesting results. The project was a collaboration between The Nature Conservancy and Texas Sea Grant College Program. The Nature Conservancy staff on this project includes:

- Christine Shepard, Ph.D., Director of Science, Gulf of Mexico Program, The Nature Conservancy
- Mark Dumesnil, Associate Director of Coastal Restoration, Texas Chapter, The Nature Conservancy
- Bryan DeAngelis, North America Coastal Habitat Restoration Coordinator, The Nature Conservancy
- Jeff DeQuattro Director of Restoration, Gulf of Mexico, The Nature Conservancy

Texas Sea Grant College Program staff on this project includes:

- Stuart Carlton, Ph.D., principal investigator. Dr. Carlton is Texas Sea Grant's Healthy Coastal Ecosystems and Social Science Specialist. He oversaw the project on Texas Sea Grant's side and was responsible for the angler awareness, attitudes, and satisfaction component of the project.
- Andrew Ropicki, Ph.D., co-principal investigator. Dr. Ropicki is an Assistant Professor and Marine Economics Extension Specialist with the Texas A&M Department of Agricultural Economics and Texas Sea Grant. He was responsible for the economic impact analysis.
- Bill Balboa, co-principal investigator. Mr. Balboa is an Extension Agent with Texas Sea Grant and the Texas A&M Agrilife Extension Service. He oversaw the in-person survey administration and helped to design the in-person and online surveys.

1.1 Project background

Half Moon Reef is an historical oyster reef in Matagorda Bay, Texas. The original reef was large, measuring as much as 494 acres in 1905 (Moore, 1907). However, by the late 20th century, the Reef had essentially disappeared due to a combination of dredging, harvesting, and water flow changes. The Nature Conservancy oversaw a project to restore Half Moon Reef, completing construction of a 54-acre, 3-dimensional and segmented,

sub-tidal oyster reef in spring of 2014. The project's substantial vertical height above the bay bottom and other beneficial design features have resulted in a successful estuarine habitat restoration project that is unique along the Texas Gulf Coast. In the two years post-construction, the reef has exhibited extraordinary productivity and growth of live oysters and has resulted in a substantial increase in marine biodiversity and productivity in comparison to open bay bottom habitats. Though the restoration appears to be an ecological success, its impact on anglers has not been studied.

To that end, we performed a mixed-mode evaluation of social dimensions of the Half Moon Reef restoration project. Specifically, we administered three surveys: an in-person angler intercept survey, an online survey of anglers, and an online survey of guides to investigate:

1. Angler awareness of the Half Moon Reef restoration
2. Angler use of and satisfaction with the Half Moon Reef restoration
3. Demographics and motivations of Half Moon Reef anglers
4. The economic impact of the Half Moon Reef restoration.

In this Executive Summary, we briefly review the project background and the main findings of the evaluation.

1.2 Angler awareness of the Half Moon Reef restoration

Awareness of the Half Moon Reef restoration project was relatively high given the relative recency of the construction. Approximately 44.6% of the in-person survey respondents reported that they had heard of the reef. Among those who said that they had heard of Half Moon Reef, familiarity with the Half Moon Reef restoration project was moderate. Only 13% of the online survey respondents who had heard of Half Moon Reef reported that they were "Extremely familiar" with the project. All of those who were extremely familiar were also Half Moon Reef anglers (Table 1). These two facts suggest that there is room for additional outreach before the Half Moon Reef message is saturated among anglers: most of the angling public is not fully aware of Half Moon Reef or The Nature Conservancy's role in the project.

Table 1: Familiarity with Half Moon Reef

Answer	Overall %	Half Moon anglers %	Other anglers %
Extremely familiar	13.3	38.1	0
Somewhat familiar	60.0	61.9	59.0
Not at all familiar	26.7	0	41.0

1.3 Angler use of and satisfaction with the Half Moon Reef restoration

Approximately 4.4% of the in-person respondents reported that they had fished at Half Moon Reef on the day they were surveyed. Half Moon Reef is extremely popular with the guides we surveyed, as well. All of the guides surveyed reported that they took customers to Half Moon Reef and they responded that, on average, 25% of their charter trips involved fishing at Half Moon Reef.

Overall, anglers found Half Moon Reef to be a satisfying place to fish, in some ways more so than Matagorda Bay as a whole. Approximately, 94.4% of Half Moon Reef anglers reported that Half Moon Reef offers a more satisfying experience than other fishing locations. Additionally, anglers returning from Half Moon Reef trips reported higher overall satisfaction (mean rating of 8.2 on a 10 point scale) than did anglers returning from trips to other Matagorda Bay locations (7.9/10). It is worth noting, however, that the difference in overall satisfaction was not statistically significant (Wilcoxon rank sum $p = 0.5$).

Half Moon Reef anglers agreed that the fishing was excellent at Half Moon Reef (mean score 3.95 on a 5-point scale), rating it higher than Matagorda Bay anglers rated Matagorda Bay (3.79), though the difference was not statistically significant (Wilcoxon signed rank $p = 0.65$). The guides also agreed that the fishing is excellent at Half Moon Reef (mean score 4.18/5).

In short, **Half Moon Reef appears to be an above-average to excellent fishing spot in Matagorda Bay.** Anglers and guides agree that the fishing at Half Moon Reef is excellent, perhaps among the best in Matagorda Bay, and rate the overall experience as being at least as satisfying, if not more satisfying, than the rest of Matagorda Bay. Anglers appear to be willing to change their trip plans to try Half Moon Reef, and those who do are rarely dissatisfied with the trip. Half Moon Reef shares many of these good characteristics with Matagorda Bay in general, though anglers rate Half Moon Reef as an easier place to fish than Matagorda Bay in general and may catch more fish there, as well.

Guides' relationship with Half Moon Reef is more nuanced. They believe that Half Moon Reef is an excellent place to fish and take many of their charter customers to Half Moon Reef, but don't agree that it is among the best places to fish in the area. However, they also don't agree that Half Moon Reef is "Just OK compared to other places". These fuzzy, quasi-contradictory attitudes seem to indicate that guides believe Half Moon Reef is an excellent place to take charter clients but may not believe it is among the best places to fish in the area. One possible explanation for these quasi-contradictory attitudes is that guides' goals when taking charter clients to Half Moon Reef are different from when they take personal trips.

1.4 Demographics and motivations of Half Moon Reef anglers

The overall age of our respondents was 50.7 years. Half Moon Reef anglers were older than the other respondents (55 vs. 48.6 years, though the difference was not statistically significant). They were also significantly more likely to be on a guided trip (20% of Half Moon Reef trips were guided vs. 2.9% for the rest of Matagorda Bay). Half Moon Reef anglers who were not on a guided trip were significantly more avid than the average Matagorda Bay angler. Approximately 67% of Half Moon Reef anglers took an above-median number of fishing trips per year, compared with 20.5% of general Matagorda Bay anglers. In short, these demographic data indicate that Half Moon Reef anglers are more likely than other anglers to be “in the know”, either because they fish the area a lot or because they are professional guides.

That said, Half Moon Reef anglers are motivated to fish by the same factors that motivate general Matagorda Bay anglers: being in nature is the most important, followed by a cluster of food/social/fun motivations, with trophy fishing being the least important motivation. However, trophy fishing was significantly less important to Half Moon Reef anglers than to other Matagorda Bay anglers.

1.5 The economic impact of the Half Moon Reef restoration

Analysis was performed to calculate the economic impacts created by increased recreational fishing trips taken to Matagorda Bay due to the Half Moon Reef restoration. The economic impacts of increased recreational fishing trips to Matagorda Bay due to the Half Moon Reef restoration project were calculated for both: 1) private boat (non-guided) fishing trips, and 2) charter (guided) fishing trips. The economic impacts calculated included employment, labor income, value-added, and output. Employment measures the number of jobs created by the additional recreational fishing. Labor income measures the wages paid to those employed due to the increase in recreational fishing. Value-added measures the increase in Texas GDP due to the spending of recreational fishers on additional fishing trips taken to Matagorda Bay due to the restoration project. Output measures the value of goods and services purchased as a result of increased recreational fishing in Matagorda Bay. The difference between value-added and output is that value added accounts for the value of intermediate goods and services purchased (value-added = sale price of final goods and services – value of intermediate goods and services consumed in the creation of final goods and services) while output does not (output = sale price of final goods and services).

State level economic impacts associated with private vessel and charter/guided trips

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were calculated. Three different data sources were used in the calculations. The in-person interviews and online guide surveys, conducted as part of this research, were used to estimate angler behavioral changes (increased recreational fishing trips) due to the restoration project. Texas Parks and Wildlife Department (TPWD) creel survey estimates of total annual recreational fishing trips to Matagorda Bay (both private boat and charter trips) were combined with survey data to estimate the total number of recreational fishing trips to Matagorda Bay that were due to the reef restoration project. Per angler economic impacts were calculated using estimates from a NOAA Technical Memorandum entitled "The Economic Contribution of Marine Angler Expenditures in the United States, 2011" (Lovell, Steinback, and Hilger 2013) updated to reflect 2015 spending values by economists from the Texas A&M Department of Agricultural Economics. Finally, total economic impacts were calculated as the product of per angler impacts and total recreational fishing trips due to the Half Moon Reef restoration project. The analysis indicated that increased recreational fishing (private and charter fishing trips) led to the following estimated economic impacts during the twelve months prior to the survey:

- 12 jobs
- \$465,000 in annual labor income
- \$691,000 in value-added
- \$1,273,000 in output

1.6 Conclusion: Key Findings

In sum, Half Moon Reef appears to be an excellent contribution to the Matagorda Bay fishery. Recreational anglers and guides are very satisfied with the existing restoration and believe that we need more projects like this. The key findings are as follows:

1. On average, both guides and anglers agree that the fishing at Half Moon Reef is excellent.
2. On average, both guides and anglers strongly agree that the Texas coast needs more restoration projects like Half Moon Reef and agree that environmental restoration projects like Half Moon Reef are critical to the future of the Texas coast.
3. The annual economic impacts from the recreational fishing industry due to the reef restoration include an additional \$691,000 to Texas' GDP and \$1.273 million in economic activity.

2 Introduction

This report is a draft of the final report for TNC project 2015GOMTXAM_001, *Angler Attitudes Toward the Half Moon Reef Restoration*. This report contains data and analysis from the project, focusing on the most relevant and interesting results. The full survey findings were included in the data report submitted on February 16, 2016, incorporated here by reference.

2.1 Project background

Half Moon Reef is an historical oyster reef in Matagorda Bay, Texas. The original reef was large, measuring as much as 494 acres in 1905 (Moore, 1907). However, by the late 20th century, the Reef had essentially disappeared due to a combination of dredging, harvesting, and water flow changes. The Nature Conservancy oversaw a project to restore Half Moon Reef, completing construction of a 54-acre, 3-dimensional and segmented, sub-tidal oyster reef in spring of 2014. The project's substantial vertical height above the bay bottom and other beneficial design features have resulted in a successful estuarine habitat restoration project that is unique along the Texas Gulf Coast. In the two years post-construction, the reef has exhibited extraordinary productivity and growth of live oysters and has resulted in a substantial increase in marine biodiversity and productivity in comparison to open bay bottom habitats. Though the reef restoration appears to be an ecological success, its impact of the restoration on anglers has not been studied.

To that end, we performed a mixed-mode evaluation of social dimensions of the Half Moon Reef restoration project. Specifically, we administered three surveys: an in-person angler intercept survey, an online survey of anglers, and an online survey of guides to investigate:

1. Angler awareness of the Half Moon Reef restoration
2. Angler use of and satisfaction with the Half Moon Reef restoration
3. Demographics and motivations of Half Moon Reef anglers
4. The economic impact of the Half Moon Reef restoration.

3 Methods

In order to fully address these research questions, we designed and conducted three surveys: an in-person angler intercept survey (which provided data for all four research questions), an online survey of anglers (which provided data for research questions 1–3), and

3. Methods

an online survey of guides (which provided data for all four research questions). By using three surveys targeting two different audiences (recreational anglers and guides) in two different survey modes (in-person and online), we were able to more fully explore the research questions than we would have by using only a single survey mode or targeting only one audience. Each of the survey methods is briefly described below.

3.1 Angler intercept survey

The angler intercept survey was designed to sample all anglers who fished Matagorda Bay, regardless of whether or not they fished Half Moon Reef. The survey was administered over 14 trips between August and December, 2015. The trips were split between two ramps: Matagorda Harbor and Palacios, the two primary launch sites for Half Moon Reef anglers.

Surveys were coordinated with Texas Parks and Wildlife so both teams would not be surveying the same dock simultaneously. Weather was also taken into consideration for this effort, as Matagorda Harbor is more protected and offers a wider range of fishing locations than Palacios. Survey dates and locations were set to maximize interview opportunities based on: 1) preferential angler use of boat ramps to access the restoration site, 2) weather and wind speed 3) avoidance of conflicts with TPWD routine creel survey activities at the same sites. The majority of angling activity generally occurred Thursday, Friday, weekends, and holidays. "Good weather" days were defined as days without rain and sustained wind speeds < 15mph and conflicts with TPWD surveys were avoided by coordinating our survey schedules with regional TPWD staff.

During each survey administration, technicians remained at the ramp for a minimum of 8 hours. As boats returned to the marina, one angler from each boat was approached and asked to participate in the survey. If there were multiple fishermen from different counties, attempts were made to interview individual fishermen. If the angler was a fishing guide, emails were requested and no further information was collected. If multiple anglers were encountered, one member of the party was chosen at random to be interviewed. Refusal to participate in the interview was noted and the interview terminated. Efforts were made to prevent interviewing anglers more than once during the survey period. Prior to each interview the selected angler was asked if they had previously participated in the interviews – if the answer was affirmative, the interview was terminated and another member of the angling party interviewed. For-hire or guided parties were not surveyed. Contact information was collected for each guide for subsequent use in the online guide survey.

The specific questions for the intercept survey are listed in Tables 1–10 of the Data Report.

3.2 Online angler survey

We also conducted an online angler survey to supplement the in-person intercept surveys. The online survey allowed us to explore questions about Half Moon Reef and fishing in greater depth, asking questions that require more time and consideration than would be appropriate in an in-person survey of people returning from a fishing trip.

During the intercept survey, 178 anglers agreed to provide their email address to participate in the online survey. The online survey was conducted between December, 2015 and January, 2016. The respondents were sent notification emails and multiple waves of reminders, following standard survey administration best practices (Dillman et al., 2008). A total of 73 respondents completed the survey, a 41% response rate. This is a good response rate for an online survey and the respondents to the online survey appear to have similar demographic characteristics to the respondents to the in-person survey, indicating that the sample is reasonably representative. However, because sub-dividing 73 respondents into groups limits our statistical power, some of the comparisons are difficult to make.

The specific questions from the online survey can be found in Tables 11–74 of the Data Report.

3.3 Online guide survey

We surveyed guides separately to help us fully understand the economic impact of the Half Moon Reef restoration and how the restoration is influencing guides' business. Technicians collected contact information from 28 guides working in the Matagorda Bay area. This represents the large majority (~80%) of the guides who launch from Matagorda Harbor or Palacios, though there may be other guides who launch from other ramps. The guide survey was administered between December, 2015 and January, 2016, using the same multiple-wave format as the online angler survey. A total of 20 guides responded, a 71% response rate.

The specific questions from the guide survey can be found in Tables 72–89 of the Data Report.

4 Results and discussion

Here, the results and discussion are presented by research question, integrating the different surveys as needed.

4.1 Angler awareness of the Half Moon Reef restoration

Awareness of the Half Moon Reef restoration project was relatively high given the recency of the construction. Approximately 44.6% of the in-person survey respondents reported that they had heard of the reef. Even accounting for some social desirability bias (that is, the subconscious tendency to answer in the positive to please the interviewer), the results indicate relatively widespread awareness of the project. Figure 1 illustrates the proportion of interviewed anglers who had heard of the Reef by county.

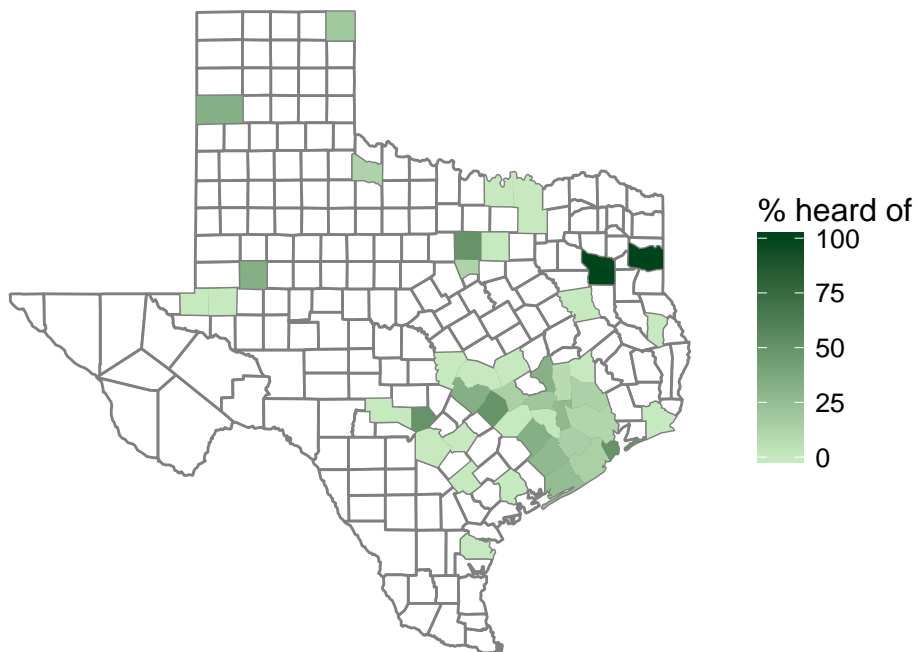


Figure 1: Proportion of interviewed anglers who have heard of Half Moon Reef

Among those who said that they had heard of Half Moon Reef, familiarity with the Half Moon Reef restoration project was moderate. Only 13% of the online survey respondents who had heard of Half Moon Reef reported that they were “Extremely familiar” with the project. All of those who were extremely familiar were also Half Moon Reef anglers (Table 2).

Table 2: Familiarity with Half Moon Reef

Answer	Overall %	Half Moon anglers %	Other anglers %
Extremely familiar	13.3	38.1	0

Answer	Overall %	Half Moon anglers %	Other anglers %
Somewhat familiar	60.0	61.9	59.0
Not at all familiar	26.7	0	41.0

Though awareness of the reef is *relatively* high, most anglers still haven't heard of the Half Moon Reef restoration project. Even those who had heard of it only had moderate familiarity with the project. These two facts suggest that there is room for additional outreach before the Half Moon Reef message is saturated among anglers. Most of the angling public is not fully aware of Half Moon Reef or The Nature Conservancy's role in the project.

4.2 Angler use of and satisfaction with the Half Moon Reef restoration

Much of this section contains comparisons between Half Moon Reef, specifically and Matagorda Bay, generally. We report p-values and statistical significance where possible, though the relatively small number of anglers who fish at Half Moon Reef limits our statistical power and makes it hard to draw statistically significant conclusions. That said, comparisons between Half Moon Reef and Matagorda Bay are informative because they allow us to see areas where Half Moon Reef improves upon Matagorda Bay. After all, it's one thing if Half Moon Reef offers an additional average place to fish within Matagorda Bay. It's quite another if Half Moon Reef is a fishing spot that is above average in some way.

Since many of the in-person survey questions asked about anglers' attitudes toward the trip they just completed, we asked anglers whether they had fished Half Moon Reef that day. We can use the proportion of Half Moon Reef anglers on a given day to extrapolate to the full season as necessary. Approximately 4.4% of the in-person respondents reported that they had fished at Half Moon Reef on the day they were surveyed. Figure 2 visualizes the proportion of in-person anglers from different counties, though not all anglers reported their counties. Half Moon Reef is extremely popular with the guides we surveyed, as well. All of the guides surveyed reported that they took customers to Half Moon Reef and they responded that, on average, 25% of their charter trips involved fishing at Half Moon Reef.

The Half Moon Reef restoration appears to be influencing whether or not people are choosing to fish in Matagorda Bay. Of the anglers interviewed in-person, 6% responded that their knowledge of or experience fishing Half Moon Reef was a factor in their choice

4. Results and discussion

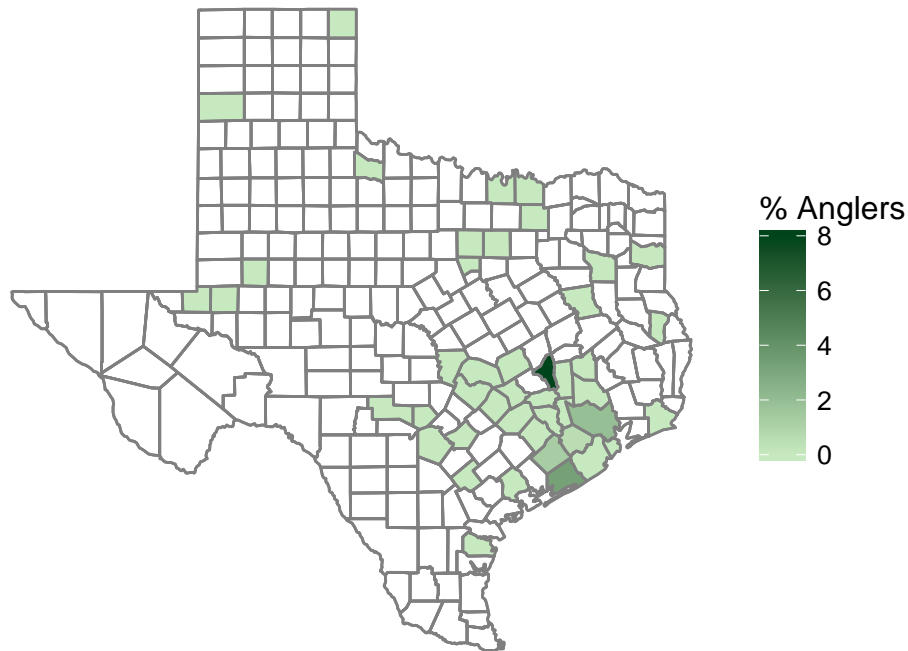


Figure 2: Proportion of anglers who have fished at Half Moon Reef

to fish in Matagorda Bay at some point since the restoration. Similarly, approximately 5.6% of anglers responded that they had changed their fishing destination to Matagorda Bay at least once as a result of the restoration. In some ways, this result is as important as any specific satisfaction item: anglers are willing to change behavior to try Half Moon Reef.

Overall, anglers found Half Moon Reef to be a satisfying place to fish, perhaps even more-so than Matagorda Bay as a whole. Approximately, 94.4% of anglers returning from a Half Moon Reef fishing trip reported that Half Moon Reef offers a more satisfying experience than other fishing locations. While it is not surprising that people who chose to fish Half Moon Reef felt like it offered a more satisfying experience (otherwise they would have chosen to fish somewhere else), anglers returning from Half Moon Reef trips reported higher overall satisfaction (mean rating of 8.2 on a 10 point scale) than did anglers returning from other trips (7.9/10), as well. It is worth noting, however, that the difference in overall satisfaction was not statistically significant (Wilcoxon rank sum $p = 0.5$).

Interestingly, none of the Half Moon Reef anglers reported being dissatisfied with their trip (Figure 3). One potential explanation for the lack of dissatisfaction is that Half Moon Reef is reputedly a place to catch larger numbers of fish. We found that this was true: Half

Moon Reef anglers reported catching more fish (5 fish per trip) than did other anglers (3.7 fish). However, the difference was not significant (Wilcoxon rank sum $p = 0.324$) and the number of fish caught was not significantly correlated with overall satisfaction. We delve into angler motivations later in this report.

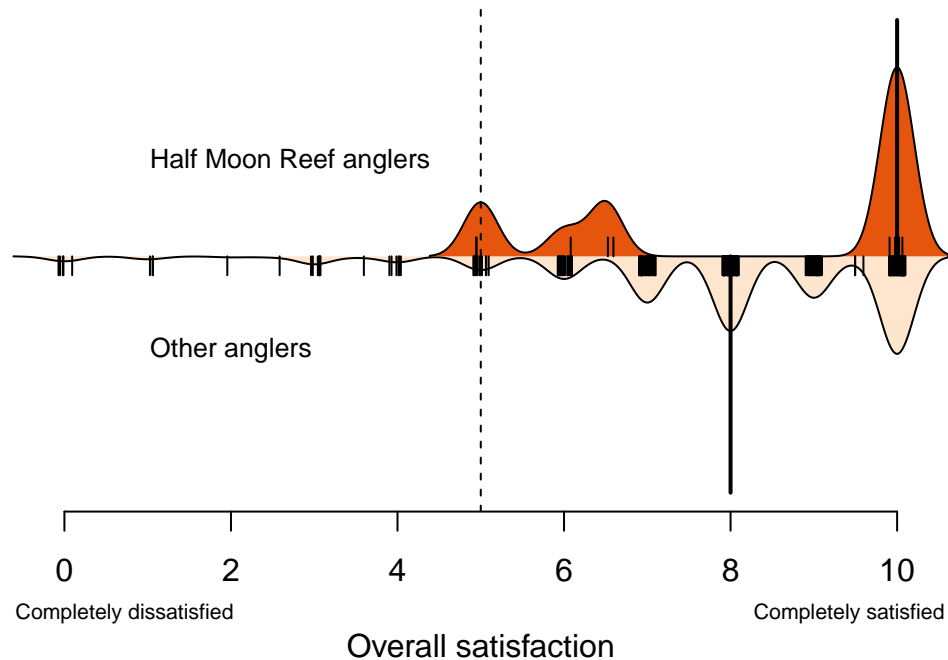


Figure 3: Distribution of overall satisfaction, Half Moon Reef vs. other anglers

The results of the online survey give further evidence of positive attitudes toward Half Moon Reef. We asked a series of satisfaction questions to all of the survey participants. Those who had indicated that they had fished Half Moon Reef in the last year were asked about Half Moon Reef. Those who indicated they had not fished Half Moon Reef in the last year were asked the same set of questions about Matagorda Bay.

Half Moon Reef anglers agreed that the fishing was excellent at Half Moon Reef (mean score 3.95 on a 5-point scale from strongly disagree to strongly agree), rating it higher than Matagorda Bay anglers rated Matagorda Bay (3.79), though the difference was not statistically significant (Wilcoxon signed rank $p = 0.65$). The guides also agreed that the fishing is excellent at Half Moon Reef (mean score 4.18/5).

How does the “excellent” fishing compare to the rest of Matagorda Bay? Half Moon Reef anglers slightly agreed that the fishing at Half Moon Reef is among the best in Matagorda

4. Results and discussion

Bay (3.25/5), which was significantly lower than general Matagorda Bay anglers rated Matagorda Bay compared to the rest of the area (3.69/5; $p = 0.03$; Figure 4). It must be noted that this is not quite an apples-to-apples comparison because Half Moon anglers were comparing Half Moon Reef to Matagorda Bay, and Matagorda Bay anglers were comparing Matagorda Bay to the rest of the region.

The guides also slightly agreed that Half Moon Reef is some of the best fishing in Matagorda Bay (3.76/5, with 1 being “strongly disagree” and 5 being “strongly agree”). This is surprising given that the guides overall agree that Half Moon Reef offers excellent fishing and given that the guides take a large percentage of their charter clients there. While our data doesn’t offer a direct explanation for this apparent discrepancy, the answer probably has to do with differential expectations: the guides are looking for something different when they personally fish than they are when they are running a charter.

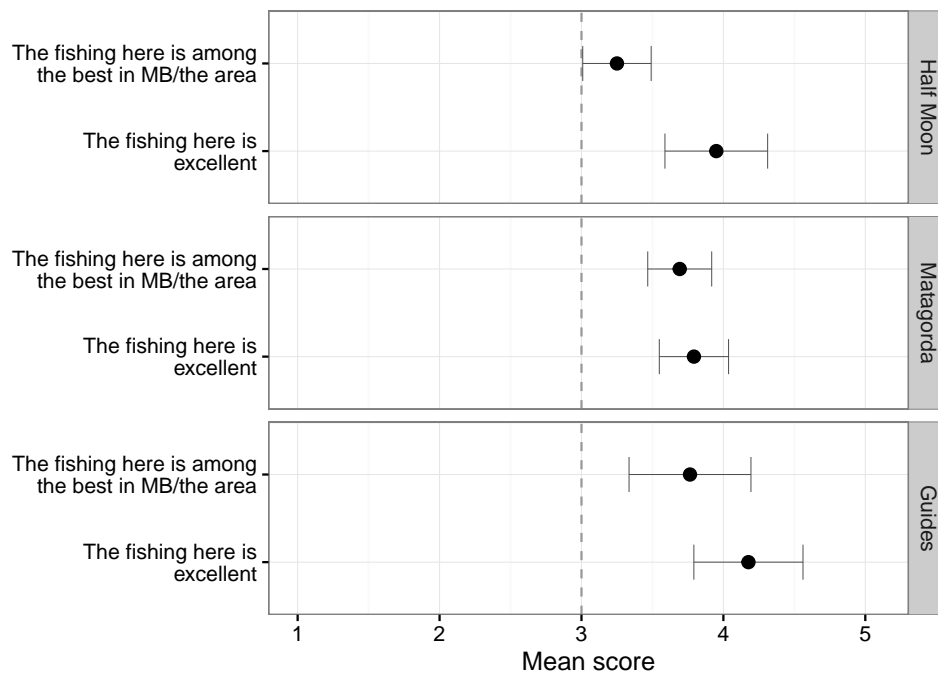


Figure 4: Fishing quality, Half Moon Reef vs. Matagorda Bay anglers

We also asked a series of questions about the aesthetics of Half Moon Reef and Matagorda Bay (Figure 5). These questions allowed us to more fully examine angler perceptions of Half Moon Reef. Half Moon Reef anglers agreed that Half Moon Reef is a pleasant

place to fish (average score of 3.9 on a 5-point strongly disagree–strongly agree scale), slightly (but not significantly) lower than Matagorda Bay anglers rated Matagorda Bay (4.23 on the same scale). Respondents very slightly agreed that Half Moon Reef is “too crowded” and is “just okay compared to other places”, though neither of these were significantly different from the neutral “Neither agree nor disagree” choice. Finally, Half Moon Reef anglers agreed significantly less strongly than did Matagorda Bay anglers that HMR/Matagorda Bay “is an attractive place to fish” (3.65 vs. 4.06; $p = 0.03$).

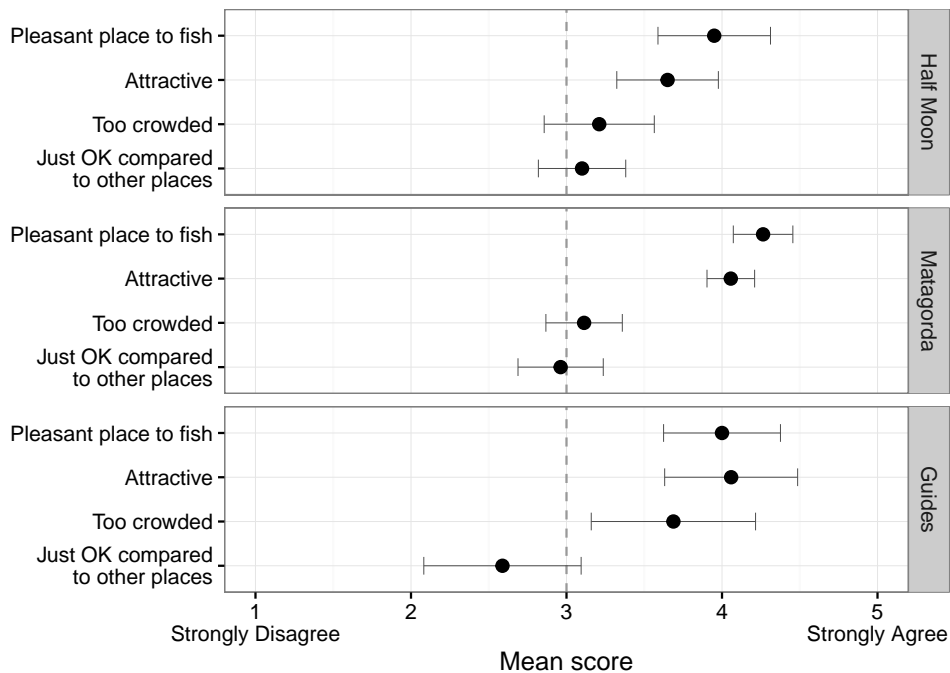


Figure 5: Aesthetic ratings, online survey of Half Moon Reef vs. other locations

We also used a series of semantic differential questions to ascertain respondents’ opinions of the experience of fishing at Half Moon Reef. In these questions, respondents were presented with a series of opposing adjective pairs (stressful-relaxing, ugly-beautiful, noisy-peaceful, etc.) and were asked to rate fishing at Half Moon Reef (or Matagorda Bay) on a 7-point scale for each adjective pair, with 1 indicating agreeing with the first (negative) adjective and 7 indicating agreeing with the second (positive) adjective. Among the anglers, all of the ratings for both Half Moon Reef and Matagorda Bay were positive. The only statistically significant difference in the ratings between the two is for the Difficult-Easy adjective pair, with Half Moon Reef being rated as significantly easier to fish than the rest of Matagorda Bay ($p = 0.02$; Figure 6).

4. Results and discussion

The guides were asked the semantic differential questions about Half Moon Reef rather than Matagorda Bay. Like the anglers, all of the guides' ratings were positive. However, the small sample of guides makes meaningful statistical comparisons impossible.

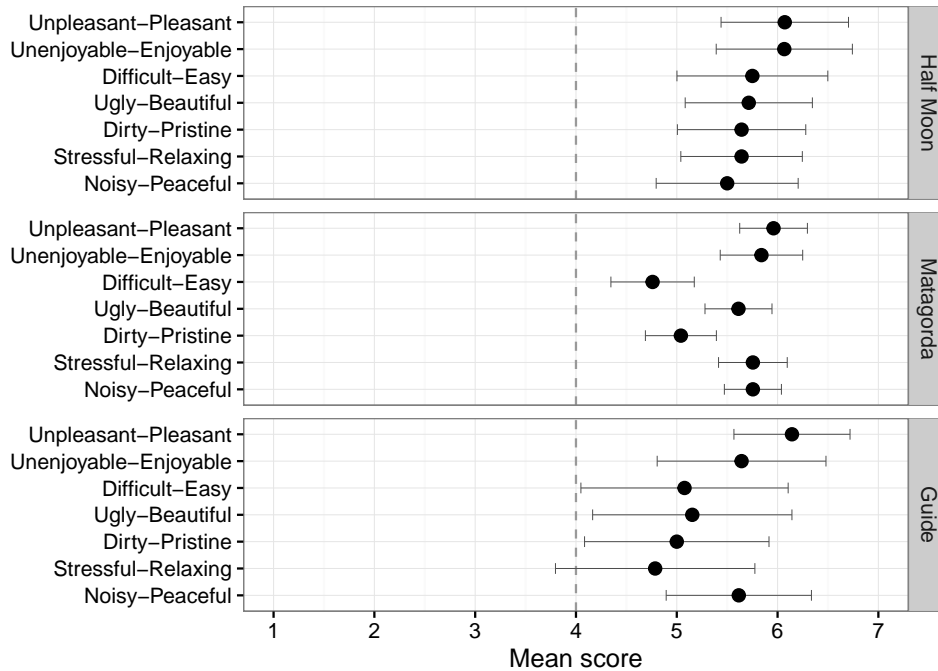


Figure 6: Semantic differential questions, online survey of Half Moon Reef vs. other locations

Summary: angler satisfaction

In short, **Half Moon Reef appears to be an above-average to excellent fishing spot in Matagorda Bay.** Anglers and guides agree that the fishing at Half Moon Reef is excellent, perhaps among the best in Matagorda Bay, and rate the overall experience as being at least as satisfying, if not more satisfying, than the rest of Matagorda Bay. Anglers appear to be willing to change their trip plans to try Half Moon Reef, and those who do are rarely dissatisfied with the trip. Half Moon Reef shares many of these positive characteristics with Matagorda Bay in general, though anglers rate Half Moon Reef as an easier place to fish than Matagorda Bay in general and may catch more fish there, as well.

Guides' relationship with Half Moon Reef is more nuanced. They believe that Half Moon Reef is an excellent place to fish and take many of their charter customers to Half Moon Reef, but don't agree that it is among the best places to fish in the area. However, they also don't agree that Half Moon Reef is "Just OK compared to other places". These

fuzzy, quasi-contradictory attitudes seem to indicate that guides believe Half Moon Reef is an excellent place to take charter clients but may not believe it is among the best places to fish in the area. Perhaps guides' goals when taking charter clients to Half Moon Reef are different from when they take personal trips.

4.3 Demographics and motivations of Half Moon Reef anglers

The surveys suggest that there are differences between anglers who fish Half Moon Reef and those who do not. In this section, we explore these differences.

Demographics

The overall age of our respondents was 50.7 years. Half Moon Reef anglers were older than the other respondents (55 vs. 48.6 years), though the difference was not statistically significant ($p = 0.14$).

Trip type: guided or self-directed?

In the in-person survey, anglers who fished Half Moon Reef were significantly more likely to be on a guided trip than were anglers who did not fish Half Moon Reef, with (20% of Half Moon Reef trips being guided vs. 2.9% for the rest of Matagorda Bay (Fisher's exact test $p = 0.01$). These findings underscore how popular Half Moon Reef is with guides.

Angler avidity

For the online surveys, we divided the anglers into two separate groups: *avid* anglers and *non-avid* anglers. Avid anglers are defined as those who took an above-median number of fishing trips and non-avid anglers are those who fished either at or below the median amount. Half Moon Reef anglers were much more likely to be avid than were Matagorda Bay anglers. Approximately 66.7% of Half Moon Reef anglers were avid, compared with 20.5% of general Matagorda Bay anglers (Fisher's exact test $p = 0.001$).

Motivations

Past research (e.g., Fedler and Ditton 1994; Beardmore et al., 2011) has shown that anglers are motivated to fish for a variety of reasons beyond the simple desire to catch fish for food or land a trophy fish. Using questions adapted from Sutton (2007), we asked online survey participants to rate their reasons for fishing on a scale of 1 to 5, with 1 meaning they strongly disagreed with a given motivation for fishing and 5 meaning they strongly agreed with a motivation. The specific question wordings and averages for the motivation questions can be found in Tables 39–60 of the Data Report. For the purposes of this analysis, the motivations were grouped into five categories:

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1. **Nature** motivations include the desire to experience unpolluted natural surroundings, be outdoors, or be close to nature.
2. **Fun** motivations include the desire to relax, have thrills, and experience new or different things.
3. **Social** motivations include the desire to be with family, friends, and others who enjoy the same things that the respondent does.
4. **Food** motivations include the desire to catch fish for food.
5. **Trophy** motivations include the desire to catch trophy-sized fish.

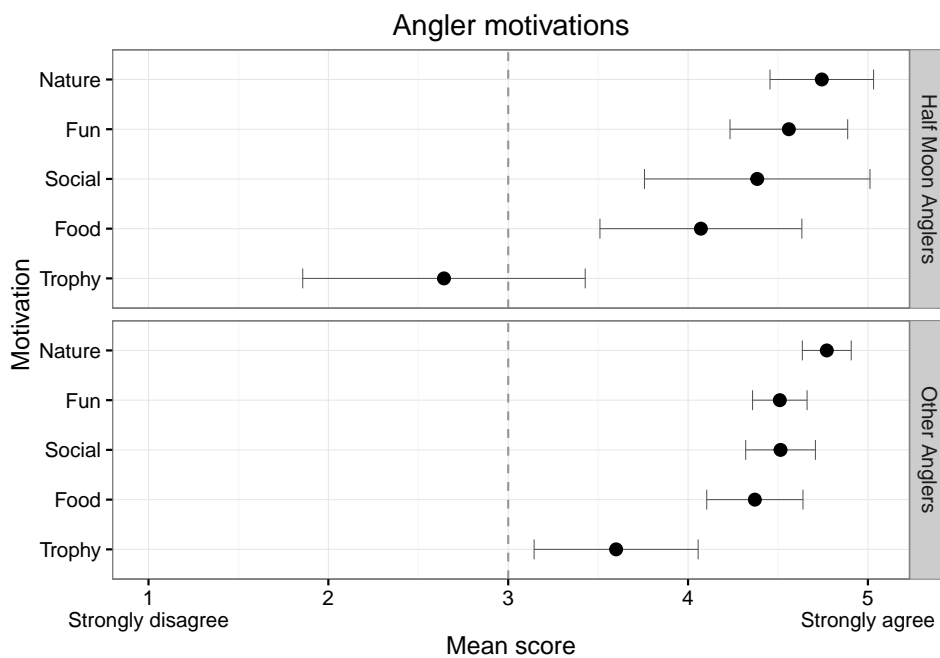


Figure 7: Motivations for Half Moon Reef vs. other anglers

The motivations for Half Moon Reef and other anglers are visualized in Figure 7. The relative importance of each motivation is approximately the same for Half Moon Reef and other Matagorda Bay anglers: being in nature is the most important, followed by the cluster of food/social/fun motivations, with trophy fishing being the least important motivation. However, trophy fishing was significantly less important to Half Moon Reef anglers than to other Matagorda Bay anglers. (Wilcoxon rank sum $p = 0.04$).

Sense of place

As people use an area over time, they tend to develop a "sense of place" associated with

that area. Sense of place can be a critical determinant of how strongly people are attached to an area. Prior research (e.g., Buijs et al. 2009) shows that people who have a stronger sense of place are more likely to support work to restore or preserve the area. We measured three components of sense of place in the online survey¹:

- **Place attachment** measures the emotional bond between a person and a place. Does the person feel happy at the place? Is it among their favorite places to be? Does the person miss the place when they are not there?
- **Place identity** measures the extent to which someone sees themselves in a place. Does it reflect the type of person they are? To what extent do people feel they can really be themselves in the place?
- **Place dependence** measures how much someone relies on a place for their recreation needs. Is the place the best place for that person to recreate in their preferred manner? Can the person do the things they enjoy most there?

Given the fact that the Half Moon Reef restoration is new, we would expect anglers to have limited sense of place toward Half Moon Reef. The results confirm this expectation: the average response to each of the place attachment, place identity, and place dependence indicated slight disagreement, though the responses were not significantly different from neutral (Figure 8).

Unsurprisingly, Matagorda Bay anglers' sense of place was significantly stronger than Half Moon Reef anglers' was. Over time, we would expect to see Half Moon Reef anglers' sense of place toward Half Moon Reef increase, perhaps approaching people's attachment to the overall Bay. Changes in sense of place might be worth tracking over time because there's a strong relationship between the sense of place constructs and intention to fish Matagorda Bay in the future (Figure 9). In other words, those who feel more strongly attached with, identify more strongly with, and/or depend more strongly on Matagorda Bay are more likely to fish there more often. This presumably would be the case with Half Moon Reef, as well. Do anglers who fish there develop a stronger sense of place over time? If so, does it lead to them taking a larger percentage of their trips to Half Moon Reef and/or more strongly supporting these sorts of projects in the future. These results suggest that the answer to all of those questions is likely to be yes, but only time will tell.

For the sake of comparison, we also asked guides the sense of place questions about Matagorda Bay (**not** Half Moon Reef). Guides' place identity and place attachment were essentially identical to the other anglers, but their place dependence was lower. This reveals something interesting about the guides: they may depend on Matagorda Bay for

¹The full suite of sense of place questions can be found in Table 24 of the Data Report.

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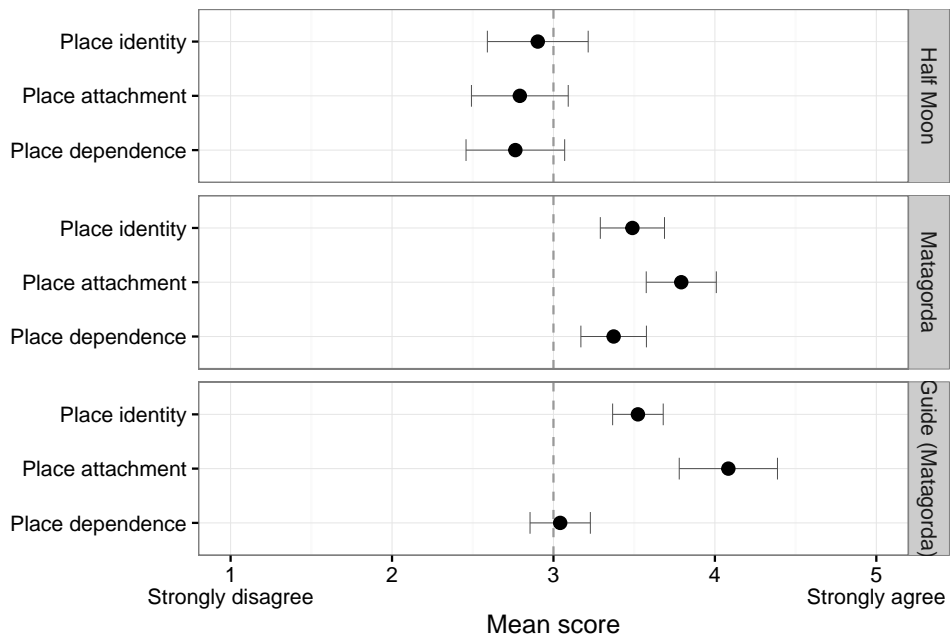


Figure 8: Sense of place variables for Half Moon Reef and Matagorda Bay anglers

their business, but these results suggest that they do not depend on it for their recreation needs.

Conservation practices

We asked online participants about a series of fishing-related conservation practices, including:

- Using circle hooks
- Disposing of used fishing line appropriately
- Catch-and-release fishing
- Using barbless hooks
- Using artificial bait to avoid deep-hooking
- Observing size limits
- Observing bag limits

For each practice, we asked respondents to rate (1) the importance of performing the conservation actions for conserving fish populations in the area (5-point scale from very unimportant to very important) and (2) the frequency with which they perform the conservation actions (5-point scale from none of the time to all of the time). We would expect

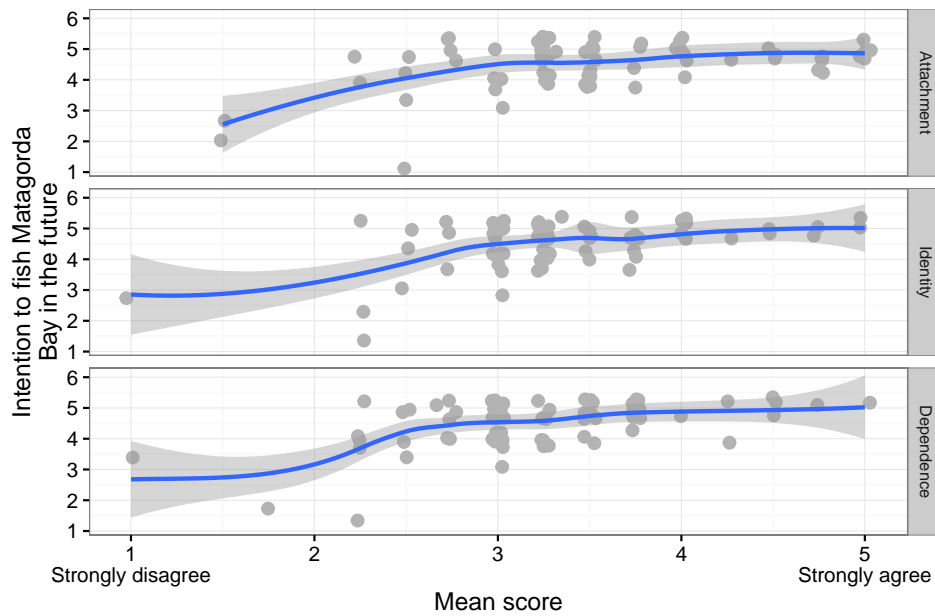


Figure 9: Sense of place and intention to fish Matagorda Bay in the future

their to be a strong relationship between the perceived importance of a given practice and how frequently anglers performed the practice. The results bore this out (correlation = 0.37; Figure 10). There were no statistically significant differences between Half Moon Reef and Matagorda Bay anglers in either the perceived importance or the frequency of performing of different practices.

Support for management actions

We asked online survey participants a series of questions about their support for different potential management actions, including:

- Protecting existing fish habitats
- Restoring degraded fish habitats
- Limiting the total number of fish you can keep
- Manage some species as catch-and-release only
- Increase the recreational harvest limit by decreasing the commercial harvest limit
- Establishing size limits on the fish you can catch

The respondents were asked to rate these management strategies on a scale of 1 (not at all important) to 5 (very important). Overall, both Matagorda Bay and Half Moon Reef

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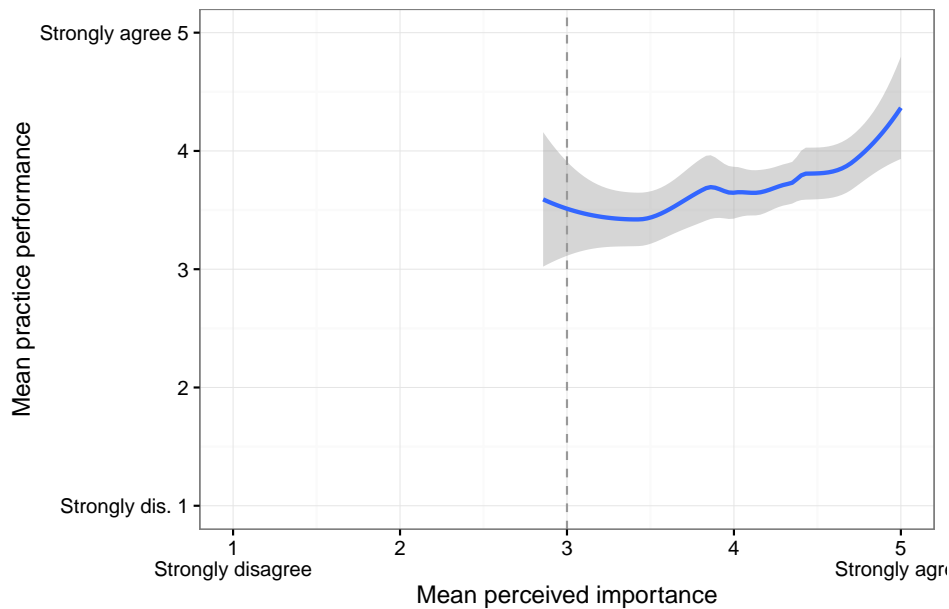


Figure 10: Relationship between mean perceived importance of a conservation practice and the mean frequency with which anglers perform the practice

anglers thought that protecting and restoring habitats were the most important of the potential management actions, followed by establishing size limits, bag limits, and decreasing the commercial catch, with catch-and-release only fisheries representing the least-supported management strategies. However, even the least-supported strategies were rated as somewhat important, indicating broad support for fisheries management. There were no significant differences between Half Moon Reef and Matagorda Bay anglers in support for different management strategies (Figure 11).

One explanation for the preference of protecting or restoring habitats as a management action is that neither of them requires any direct sacrifice on the part of the anglers. Size or bag limits, for example, impinge on an anglers' ability to take home fish. Habitat protection and restoration do not affect an angler's ability to take home fish. Instead, habitat protection and restoration may actually increase an angler's ability to take home fish by increasing the number of places to fish and/or raising overall fish stock levels. This is a key advantage of habitat protection and restoration as management choices, an advantage that anglers seem to be attuned to. But regardless of the reasons underlying the support, these results suggest that anglers might generally support projects like the Half Moon Reef restoration in the future, although our questions don't take the economic

4.3. Demographics & motivations

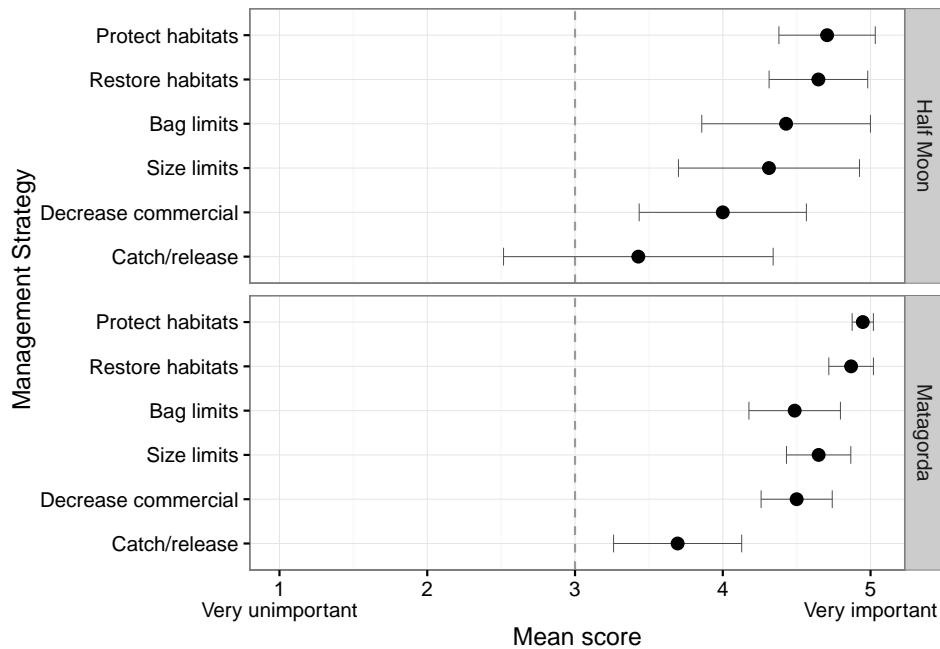


Figure 11: Support for management strategies, Half Moon Reef vs. Matagorda Bay anglers

price of different management actions into account.

Summary: angler characteristics

The demographics, avidity, and trip-type data reveal that **Half Moon Reef anglers are different from the general Matagorda Bay angling population**: they tend to be older (and presumably more experienced) and either more avid or on a guided trip (presumably led by an expert guide). This sounds like a group of relatively elite anglers, but they did not rate themselves as such. In the online survey, Half Moon Reef anglers were neutral about the statement that “Most of the anglers at Half Moon Reef are above-average” (average response 2.95 on a 5-point scale). By comparison, those who fished in Matagorda Bay slightly agreed with the statement that “Most of the anglers at Matagorda Bay are above-average” (3.4; $p = 0.02$). While the reason for this discrepancy is not immediately clear, one possible explanation is that respondents noticed the relatively high proportion of guided trips to Half Moon Reef and rate guided anglers as below average.

Why are Half Moon Reef and non-Half Moon Reef anglers different? The reasons are not clear from the data. It may be that older, more experienced, and more avid anglers are more likely to be aware of Half Moon Reef because they are more plugged-in to the angling community and changes to Matagorda Bay. Alternately, older/more avid

4. Results and discussion

anglers might be more excited to try fishing a new place after a lifetime of fishing in the same areas. It may be that Half Moon Reef fishing is following an innovation curve like the one described in the Diffusion of Innovations theory (Rogers 2010): a certain proportion of the population is more likely to be innovators or early adopters of innovations, and other people will follow the early adopters' lead over time. If this is the case, then the characteristics of Half Moon Reef anglers should change over time to be more like the average Matagorda Bay angler. Our data isn't fine-scale enough to test these or other hypotheses, but future work might explore them.

4.4 The economic impact of the Half Moon Reef restoration

The economic impacts of increased recreational fishing trips to Matagorda Bay due to the Half Moon Reef restoration project were calculated for both: 1) private boat (non-guided) fishing trips, and 2) charter (guided) fishing trips. Three different data sources were used in the calculations. The in-person interviews and online guide surveys, conducted as part of this research, were used to estimate angler behavioral changes (increased recreational fishing trips) due to the restoration project. Texas Parks and Wildlife Department (TPWD) creel survey estimates of total annual recreational fishing trips to Matagorda Bay (both private boat and charter trips) were combined with survey data to estimate the total number of recreational fishing trips to Matagorda Bay that were due to the reef restoration project. Per trip economic impacts were calculated using estimates from a NOAA Technical Memorandum entitled "The Economic Contribution of Marine Angler Expenditures in the United States, 2011" (Lovell, Steinback, and Hilger 2013) updated to reflect 2015 spending values by economists from the Texas A&M Department of Agricultural Economics. Finally, total economic impacts were calculated as the product of per angler impacts and total recreational fishing trips due to the Half Moon Reef restoration project. The remainder of this section will provide details on the data used in the analysis, the calculation of economic impacts, and the results of the economic impact analysis.

In person interview data

The economic impact analysis questions that were part of the in-person interviews were designed to determine how the reef restoration impacted private boat angler fishing behavior; namely, did anglers take additional fishing trips to Matagorda Bay because of the restoration project? The survey questions were designed to capture both how fishing trips to Matagorda Bay were impacted during the past 12 months and how anglers expected it to impact fishing trips over the next 12 months. The goal behind asking about both past behavior and expected future behavior was to examine the possibility that as awareness of the restoration and its impacts on fishing opportunities grows; economic impacts of the project could intensify through time. Respondents were also asked if addi-

tional trips to Matagorda Bay over the past 12 months were unplanned trips or diverted trips. Diverted trips are trips that were planned for a different fishing spot (another body of water) but were redirected to Matagorda Bay, unplanned trips were simply additional trips taken by anglers (not previously planned for another location) due to improved fishing associated with Half Moon Reef. With regards to future trips respondents were only asked about unplanned trips.

The survey data used in the analysis included only responses from private boat anglers on vessels that had not been previously surveyed. By not using responses from anglers fishing from vessels surveyed on a previous outing we limited the likelihood of double counting a respondent. Four hundred anglers (after removing duplicate vessels) took part in the in-person interviews and 357 of them (89%) fished from private vessels.

Respondents were first asked about their fishing at Matagorda Bay during the last 12 months. Approximately 98% of private boat anglers (349 of 357) provided information on their fishing at Matagorda Bay during the previous 12 months. The data is summarized in Table 3 below. There was a wide range in trips taken (1 to 301)² with the average respondent taking approximately 25 trips, however it is worth noting the median value is around 12 trips. Respondents were then asked whether they were aware of the Half Moon Reef restoration project, 43.4% of respondents were aware of the restoration³. The trip information for those anglers aware of the reef restoration project are presented below in Table 4, as the data indicates this was comprised of more avid anglers than the general survey population. While those aware of the restoration only accounted for 43.4% of survey respondents they accounted for 62.5% of trips taken during the past 12 months.

Table 3: Summary of Private Vessel Respondent Matagorda Bay Fishing (Past 12 Months)

Range	1 to 301 trips
Avg # of trips	24.6
Modal # of trips	2
Median # of trips	~12
Total trips	8,586

²Some respondents indicated they took no trips in the past 12 months, these respondents were obviously not counting the trip they just finished prior to the interview. Because of this, an additional trip was added to each respondent to account for the current trip (it was assumed they were not including it). As a result, economic impact estimates are expected to be conservative since percentage of impacted trips is assumed lower for fishers that included the just completed trip in their number of trips taken during the past 12 months.

³This percentage is slightly different from the number presented earlier in the report (44.6%) due to the focus on private boat anglers and removal of responses from previously surveyed vessels.

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Table 4: Summary of Matagorda Bay Fishing by Private Vessel Respondents Aware of Reef Restoration (Past 12 Months)

Range	2 to 301 trips
Avg # of trips	35.7
Modal # of trips	21
Median # of trips	21
Total trips	5,362

It was assumed that awareness of the reef restoration project was necessary for anglers to have changed their fishing behavior due to the restoration project⁴. Those that indicated they were aware of the restoration project were asked a series of questions to determine how many of their previous trips were either unplanned or diverted trips due to the effects of the restoration, and how many of their trips planned for the next 12 months they attributed to the restoration project. Some respondents simply indicated whether they had taken diverted/unplanned trips, or were planning additional trips in the coming year, due to the restoration and did not provide an estimate of the number of impacted trips. Those respondents were assumed to have had restoration induced trips (unplanned/diverted and future trips due to the restoration) equal, in terms of percentage of all trips taken by the individual, to those respondents that provided estimated numbers of impacted trips. Results were broken down by state of residence for the purposes of calculating economic impacts.

The estimates of unplanned/diverted past trips and expected impacted future trips by the reef restoration are presented in Table 5. As the table shows very few respondents indicated that they diverted trips to Matagorda Bay due to the reef restoration, most trips due to the reef restoration were unplanned additional trips. The table presents data on both trips impacted and percentage of anglers that took impacted trips. In addition, the table breaks down percentage of impacted trips for both: 1) those respondents aware of the reef restoration project, and 2) all respondents. The key measures from the table used in the calculation of economic impacts are: 1) percentage of trips unplanned (all), 2) percentage of trips diverted (all), and 3) percentage of trips planned due to the restoration (all).

Online Guide Survey Data

The online survey of Matagorda Bay fishing guides was used to determine the impacts

⁴While it is possible that some fishers may have been unaware of the reef restoration but changed their fishing behavior based on fishing results (more success fishing at Half Moon Reef), this seemed unlikely given the large amount of press coverage the restoration received. Again, results may be considered conservative estimates since this assumption could lead to unaccounted for impacted trips

Table 5: Estimated Private Vessel Trip Impacts of the Half Moon Reef Restoration

Texans Previous 12 Months (n=341):	
Estimated total unplanned trips	222
% aware of the restoration that took unplanned trips	17.93%
% that took unplanned trips (all)	7.62%
% of aware trips taken that were unplanned	4.17%
% of trips unplanned (all)	2.68%
Estimated total diverted trips	36
% aware of restoration that took diverted trips	17.24%
% that took diverted trips (all)	7.33%
% of aware trips taken that were diverted	0.68%
% of trips diverted (all)	0.43%
Texans Next 12 Months (n=335):	
Estimated total planned trips due to the restoration	252
% aware of restoration that have planned trips due to the restoration	19.42%
% that have planned trips due to the restoration (all)	8.54%
% of aware trips planned due to the restoration	4.97%
% of trips planned due to the restoration (all)	2.71%
Non-Texans Previous 12 Months (n=10):*	
Estimated total unplanned trips	5
% aware of restoration that took unplanned trips	20.00%
% that took unplanned trips (all)	10.00%
% of aware trips taken that were unplanned	12.20%
% of trips unplanned (all)	9.26%
Non-Texans Next 12 Months (n=10):	
Estimated total planned trips due to the restoration	6
% aware of restoration that have planned trips due to the restoration	20.00%
% that have planned trips due to the restoration (all)	10.00%
% of aware trips planned due to the restoration	6.12%
% of trips planned due to the restoration (all)	8.11%

*None of the non-resident respondents indicated they diverted trips from other locations to Matagorda Bay due to the reef restoration

4. Results and discussion

of the reef restoration on charter fishing trips in Matagorda Bay. While in-person interview data from charter anglers could have been used to estimate the impacts of the reef restoration on charter fishing in Matagorda Bay, the online guide survey was used because guides, as proprietors of their own businesses with a vested interest in the fishery, were assumed to be better suited to evaluate the impacts of the reef restoration on their businesses. To determine the effects of the reef restoration project on charter fishing in Matagorda Bay, fishing guides were asked to estimate the size of their business (average number of annual trips led) before and after the restoration and whether they felt any increase in fishing trips was due to the restoration⁵.

In all, 36 guides responded to the survey. Seventy-seven percent of guides indicated they take charter clients to Half Moon Reef; among those guides that fish at Half Moon Reef approximately 26% of their charter trips involve fishing at Half Moon Reef. Table 6 provides estimates of how the restoration project has impacted survey respondent fishing behaviors. As Table 6 shows, charter trips were impacted to a greater extent than private vessel trips (10.5% increase in trips due to the restoration of Half Moon Reef). The data also shows that the guides believed there was a sizable increase in charter trips following the restoration (approximately 1/3 of the total increase) that were not attributable to the restoration project. This increase could be due to any of a number of factors (improved economic conditions leading to more spending on recreational fishing, increased interest in recreational fishing, etc.).

Table 6: Estimated Charter Fishing Impacts of the Half Moon Reef Restoration

	# of Trips	% Increase
Estimated average annual trips before the restoration	2558	
Estimated increase in annual trips after the restoration	381	14.9%
Estimated increase due to the reef restoration	268	10.5%

Texas Parks and Wildlife Creel Survey Data

The TPWD contacts anglers through annual creel surveys to gather information on fishing effort by bay system and fishing type (bay/gulf, private vessel/charter, and resident/non-resident). Creel surveys are conducted throughout the year on randomly selected weekdays and weekends at boat-ramps and wet-slip sites. The sites are surveyed in proportion to their fishing pressure, with more active locations being surveyed more frequently

⁵Data was collected on impacts related to both half-day and full-day trips (the two standard trip durations offered in the fishery) with the hopes of performing a more thorough economic impact analysis; however, the NOAA fisheries data on fishing trip expenditures did not differentiate between the two trip types (half and full day) so further analysis was not possible.

in an effort to generate realistic estimates of fishing effort by geographic location (<http://tpwd.texas.gov/fishboat/fish/didyouknow/creel.phtml>).

For the purposes of this analysis, TPWD estimated annual Matagorda Bay fishing effort is used to extrapolate total (population level) restoration impacted fishing trips from our survey sample estimates. The analysis assumes that our surveys were administered to representative samples of all Matagorda Bay recreational anglers. Table 7 provides the TPWD's 2015 estimate of recreational fishing effort in Matagorda Bay.

Table 7: Estimated Total Annual Recreational Fishing Trips to Matagorda Bay

Trip Type	# of Resident Trips	# of Non-Resident Trips	Total Trips
Private Vessel	87,458	930	88,388
Charter Vessel	13,518	408	13,926

Per Trip Economic Impact Estimates

Calculation of the economic impacts associated with increase recreational fishing due to the reef restoration project required estimates of average per angler trip expenditures. Anglers generate impacts by purchasing goods and services (gas, groceries, lodging, charter fees, etc.) during their fishing trips. These trip expenditures are the direct economic activity associated with recreational fishing in Matagorda Bay that generate economic impacts.

Trip expenditure surveys are usually very costly and time-consuming as they require a great deal of information be gathered from fishers. Fortunately, every five years NOAA Fisheries conducts national surveys, with data summarized at the state level, of marine recreational fishers gathering data on recreational fishing trip expenditures⁶; the most recent survey was conducted in 2011 (Lovell, Steinback, and Hilger 2013). The NOAA Fisheries survey is a large undertaking; 1,025 of the 5,820 surveys mailed to Texas fishers were completed and returned to NOAA Fisheries (17.6% response rate)⁷. The trip expenditures serve as inputs into an input-output model which measures the interdependency of industries in an economy, and based on calculations of interdependency determine

⁶The survey also collects data on durable goods purchases related to marine recreational fishing (tackle, fishing rods, clothing, boats, camping equipment, etc.) and calculates economic impacts associated with these purchases as well. Economic impacts associated with durable goods spending were not included in this analysis because determining the portion of these purchases due to the reef restoration project is beyond the scope of this project.

⁷Completed surveys numbers include surveys that were missing some responses. In addition to Texas surveys, data was gathered on non-residents from surveys sent to other states where residents indicated they fished in Texas.

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how spending in one area of the economy (recreational fishing) impacts economic activity in other sectors of the economy or more broadly the general economy for a region (city, county, state, or federal) (Miller and Blair, 2009). The specific input-output model software employed for this analysis, and by NOAA fisheries in their calculations, is IMPLAN (IMPLAN Group LLC. 2015).

The NOAA Fisheries expenditure survey asks fishers about spending on their most recent fishing trip and to report what they personally spent on themselves or others and to not include any money that was spent on them by others (Lovell, Steinback, and Hilger 2013). Gathering data in this manner ensures that NOAA Fisheries is collecting per person expenses and not per angling party expenses. While the NOAA Fisheries Report presents average angler expenditures for all marine recreational fishing in Texas, we assume that Matagorda Bay trips are similar, in terms of trip expenditures, to the average Texas recreational marine fishing trip. Given that the last NOAA Fisheries survey was completed in 2011, trip expenditures were updated to 2015 values to account for inflation and price fluctuations. Inflation was calculated using the CPI with prices increasing approximately 5.5%; however, a 36% drop in fuel costs from 2011 to 2015 offset the impacts of inflation on trip expenditures. Trip level expenditures from the original NOAA Fisheries report (Lovell, Steinback, and Hilger 2013) and updated 2015 values are shown in Table 8. As the table shows, charter expenditures are significantly higher due to charter fees⁸.

Once average trip expenditures are calculated they serve as inputs for the IMPLAN input-output modeling program. Each type of trip expenditure (auto fuel, bait, ice, etc.,) is included in an IMPLAN sector that matches the type of business activity it represents, and the economic impacts associated with spending in each sector are calculated. The IMPLAN economic sectors used in our analysis are presented in Table 9. After the trip level expenditures have been calculated and included in appropriate IMPLAN sectors, the model is run to determine the economic impacts of an average individual's recreational fishing trip. Four different types of economic impact measures were calculated: employment, labor-income, value-added, and output. Employment measures the number of jobs created by the additional recreational fishing. Labor income measures the wages paid to those employed due to the increase in recreational fishing. Value-added measures the increase in Texas GDP due to the spending of recreational fishers on additional fishing trips taken to Matagorda Bay due to the restoration project. Output measures the value of goods and services purchased as a result of increased recreational fishing in Matagorda Bay⁹.

⁸This difference is probably offset by durable goods expenditures by private vessel owners (boat purchases) that are not captured in trip level expenditures.

⁹The difference between value-added and output is in how each metric accounts for intermediate inputs related to goods and services. Intermediate inputs include energy, materials, and purchased services

4.4. Economic impacts

Table 8: Individual Level Trip Expenditures

Expense Category:	Private Vessel Per Individual Expenditures				Charter Vessel Average Expenditure			
	2011		2015		2011		2015	
	Resident	Non-Resident	Resident	Non-Resident	Resident	Non-Resident	Resident	Non-Resident
Auto Fuel	\$46.06	\$36.93	\$29.65	\$23.78	\$54.94	\$85.63	\$35.37	\$55.13
Auto Rental	\$0.00	\$14.27	\$0.00	\$15.05	\$0.00	\$22.57	\$0.00	\$23.81
Bait	\$13.60	\$10.20	\$14.35	\$10.76	\$4.26	\$2.55	\$4.49	\$2.69
Boat Fuel	\$32.99	\$16.11	\$21.24	\$10.37	\$0.00	\$0.00	\$0.00	\$0.00
Boat Rental	\$1.98	\$0.66	\$2.09	\$0.70	\$6.72	\$5.89	\$7.09	\$6.21
Charter Fees	\$0.00	\$0.00	\$0.00	\$0.00	\$205.77	\$152.20	\$217.09	\$160.57
Crew Tips	\$0.00	\$0.00	\$0.00	\$0.00	\$13.86	\$19.65	\$14.62	\$20.73
Fish Processing	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.29	\$0.00	\$0.31
Food from Grocery Stores	\$32.74	\$15.64	\$34.54	\$16.50	\$34.16	\$27.89	\$36.04	\$29.42
Food from Restaurants	\$23.84	\$28.68	\$25.15	\$30.26	\$37.31	\$30.41	\$39.36	\$32.08
Gifts & Souvenirs	\$1.70	\$8.94	\$1.79	\$9.43	\$8.13	\$24.83	\$8.58	\$26.20
Ice	\$4.19	\$3.17	\$4.42	\$3.34	\$5.45	\$2.42	\$5.75	\$2.55
Lodging	\$22.35	\$21.35	\$23.58	\$22.52	\$38.56	\$67.44	\$40.68	\$71.14
Parking & Site Access	\$1.68	\$1.59	\$1.77	\$1.68	\$0.58	\$4.64	\$0.61	\$4.90
Public Transportation	\$0.00	\$21.37	\$0.00	\$22.55	\$0.00	\$13.55	\$0.00	\$14.30
Tournament Fees	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Total	\$181.13	\$178.91	\$158.59	\$166.94	\$409.74	\$459.96	\$409.69	\$450.05

Notes on 2015 Numbers

1. Used US EIA website to calculate fuel costs (2011: \$3.372/gallon, 2015: \$2.171/gallon)
2. All other values were inflated using CPI Calculator (5.5% Inflation from 2011 to 2015).

For each impact measure three different types of effects are calculated: direct, indirect, and induced. Direct effects are those created by the actual purchases of goods and services made by recreational anglers (bait, ice, fuel, etc.). Indirect effects measure inter-industry transactions impacts. An example would include increased recreational fishing leading to more bait purchases at bait shops, this increase in demand would lead to more business for bait suppliers (an indirect effect). Induced effects result from employees of directly and indirectly affected industries purchasing goods and services in the regional economy. The individual level per-trip economic impacts are presented in Table 10.

Calculation of Economic Impacts

used in production of a good or service. Output simply measures the gross revenue associated with the sale of a good or service. Value-added measures the net value of a good service after accounting for any intermediate inputs used in creating the good or service (value-added = output – intermediate inputs). As an example, consider a woodworker purchasing \$200 worth of lumber from a sawmill and using it to build a table it sells for \$500. The output measure associated with the sale of the table would be \$500; while the value-added measure would be \$300 after subtracting the value of the lumber.

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Table 9: IMPLAN sectors used

Expense Category:	IMPLAN Sectors	IMPLAN Sector Descriptions
Auto Fuel	402	Retail - Gasoline Stores
Auto Rental	442	Automotive Equipment Rental & Leasing
Bait	404	Retail - Sporting Goods
Boat Fuel	402	Retail - Gasoline Stores
Boat Rental	443	General and Consumer Goods Rental
Charter Fees	414	Scenic and sightseeing transportation
Crew Tips	414	Scenic and sightseeing transportation
Fish Processing	93	Seafood Product Preparation & Packaging
Food from Grocery Stores	400	Retail - Food & Beverage Stores
Food from Restaurants	501	Full Service Restaurants
Gifts & Souvenirs	406	Retail - Miscellaneous
Ice	402	Retail - Gasoline Stores
Lodging - Hotels and Motels	499	Hotels and Motels
Lodging - Other	500	Other Accommodation
Parking & Site Access	512	Other Personal Services - Parking
Public Transportation	408	Air Transportation

Total economic impacts derived from increased recreational fishing in Matagorda Bay due to the restoration project were calculated as the product of: 1) the percentage increase in survey respondent fishing trips due to the reef restoration project (Sample % Increase), 2) the TPWD estimates of total recreational fishing in Matagorda Bay (TPWD Estimates), and 3) the individual level economic impacts of trip expenditures (Economic Impacts). Separate impacts were calculated for private vessel and charter fishers, with each broken down by residency status. In addition, private vessel impacts were calculated for both unplanned and diverted trips during the past 12 months and trips planned during the next 12 months due to the restoration.

$$\text{Total Economic Impacts} = \text{Sample \% Increase} * \text{TPWD Estimates} * \text{Economic Impacts}$$

Results

The total economic impacts are presented in Tables 11—14. These impacts are measured at the state level due to data limitations¹⁰.

¹⁰The expenditure data from the NOAA Fisheries survey does not include information on where the expenditures were made. In the calculation of economic impacts all expenditures are assumed to have taken place in Texas. While this assumption may not hold for non-residents the impact of the assumption is limited as non-residents make up less than 3% of all Matagorda Bay recreational fishers per the TPWD creel survey. Although it is impossible to calculate the county/regional level impacts of the restoration project given the data used, it is safe to assume that some of the expenditures, and associated impacts, took place in the

Table 10: Trip Expenditure Economic Impacts Per Individual

Private Boat - Resident				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	0.0011	\$31	\$45	\$75
Indirect Effect	0.0002	\$10	\$18	\$32
Induced Effect	0.0003	\$12	\$21	\$37
Total Effect	0.0016	\$53	\$84	\$144

Private Boat - Non Resident				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	0.0013	\$40	\$63	\$110
Indirect Effect	0.0003	\$14	\$26	\$48
Induced Effect	0.0003	\$16	\$28	\$48
Total Effect	0.0019	\$70	\$117	\$207

For-Hire Resident				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	0.0034	\$131	\$165	\$340
Indirect Effect	0.0012	\$65	\$102	\$180
Induced Effect	0.0012	\$57	\$99	\$174
Total Effect	0.0058	\$253	\$366	\$694

For-Hire Non Resident				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	0.0036	\$135	\$187	\$362
Indirect Effect	0.0012	\$64	\$102	\$181
Induced Effect	0.0012	\$58	\$101	\$177
Total Effect	0.006	\$256	\$390	\$719

4. Results and discussion

Table 11: Private Vessel Unplanned Trip Impacts (Previous 12 Months)

Private Vessel - Resident				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	2.58	\$72,700	\$105,500	\$175,800
Indirect Effect	0.47	\$23,400	\$42,200	\$75,000
Induced Effect	0.7	\$28,100	\$49,200	\$86,700
Total Effect	3.75	\$124,200	\$196,900	\$337,500

Private Vessel - Non Resident				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	0.11	\$3,400	\$5,400	\$9,500
Indirect Effect	0.03	\$1,200	\$2,200	\$4,100
Induced Effect	0.03	\$1,400	\$2,400	\$4,100
Total Effect	0.17	\$6,000	\$10,000	\$17,700

All - Unplanned Private Vessel Trips Due to Restoration				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	2.69	\$76,100	\$110,900	\$185,300
Indirect Effect	0.49	\$24,600	\$44,400	\$79,100
Induced Effect	0.73	\$29,500	\$51,600	\$90,800
Total Effect	3.91	\$130,200	\$206,900	\$355,200

*All dollar values are rounded to the nearest hundred.

The total impacts (private and charter vessels including both resident and non-resident trips) for the past 12 months are presented in Table 14. The table presents economic impacts with, and without, diverted trips. Since the economic impacts are state-level impacts and most diverted trips were probably diverted from another Texas fishing site (not out of state) it is likely these are not additional state-level impacts associated with the restoration project. However, given that some of the trip expenditures and associated impacts are likely to be concentrated in the communities directly around Matagorda Bay it stands to reason that some of the impacts of diverted trips shifted towards Matagorda Bay communities; as such, both numbers are relevant¹¹. As the table indicates, this anal-

communities surrounding Matagorda Bay.

¹¹Adding the diverted trips to the unplanned trips puts a ceiling on the total economic impacts to the Matagorda Bay region. Since most diverted trips were probably diverted from another Texas fishing locale the spending associated with the trip does not represent an economic impact to Texas due to the reef restora-

Table 12: Private Vessel Diverted Trip Impacts (Previous 12 Months)

Private Vessel - Resident				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	0.41	\$11,700	\$16,900	\$28,200
Indirect Effect	0.08	\$3,800	\$6,800	\$12,000
Induced Effect	0.11	\$4,500	\$7,900	\$13,900
Total Effect	0.6	\$20,000	\$31,600	\$54,100

Private Vessel - Non Resident				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	0	\$0	\$0	\$0
Indirect Effect	0	\$0	\$0	\$0
Induced Effect	0	\$0	\$0	\$0
Total Effect	0	\$0	\$0	\$0

All - Unplanned Private Vessel Trips Due to Restoration				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	0.41	\$11,700	\$16,900	\$28,200
Indirect Effect	0.08	\$3,800	\$6,800	\$12,000
Induced Effect	0.11	\$4,500	\$7,900	\$13,900
Total Effect	0.6	\$20,000	\$31,600	\$54,100

* All dollar values are rounded to the nearest hundred.

ysis found that the annual economic impacts associated with increased recreational fishing in Matagorda Bay due to the Half Moon Reef Restoration Project are substantial. This analysis found annual value-added impacts of approximately \$700,000 and output im-

tion. However, some of the spending on these diverted trips would be expected to occur around Matagorda Bay when it would have been spent elsewhere (another part of the State) if not diverted. The ceiling created is a high one and includes a number of assumptions. First, it would assume that all expenditures associated with diverted trips occurred in the Matagorda Bay region. In addition, since the impacts are calculated at the state level the ceiling would assume no leakage of indirect and induced impacts. This would imply that all secondary transactions leading to indirect and induced impacts occurred in the Matagorda Bay region. These restrictive assumptions are unlikely to be realistic, in reality it is safe to assume that some amount of the diverted trip impacts represent economic impacts on Matagorda Bay communities due to the reef restoration; however, determining the percentage is beyond the scope of the current study.

5. Recommendations

Table 13: Private Vessel Planned Trips Due to Restoration (Next 12 Months)

Private Vessel - Resident				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	2.61	\$73,500	\$106,700	\$177,800
Indirect Effect	0.47	\$23,700	\$42,700	\$75,800
Induced Effect	0.71	\$28,400	\$49,800	\$87,700
Total Effect	3.79	\$125,600	\$199,200	\$341,300

Private Vessel - Non Resident				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	0.07	\$2,300	\$3,600	\$6,300
Indirect Effect	0.02	\$800	\$1,500	\$2,700
Induced Effect	0.02	\$900	\$1,600	\$2,700
Total Effect	0.11	\$4,000	\$6,700	\$11,700

All Private Vessel Planned Trips Due to Restoration				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	2.68	\$75,800	\$110,300	\$184,100
Indirect Effect	0.49	\$24,500	\$44,200	\$78,500
Induced Effect	0.73	\$29,300	\$51,400	\$90,400
Total Effect	3.9	\$129,600	\$205,900	\$353,000

* All dollar values are rounded to the nearest hundred.

pacts of approximately \$1.3 million.

5 Recommendations & follow-ups

From an angler satisfaction and economic impact standpoint, the Half Moon Reef restoration appears to be a success story. As such, we have few recommendations on how to improve. There is a chance to continue outreach related to the reef, sharing the biological and sociological success to The Nature Conservancy (and potentially Texas Sea Grant) stakeholders. Angler awareness of the reef is bound to continue to improve. This might be worth tracking over time: will the economic impact actually increase as more people become aware of the Reef restoration? Or will angler satisfaction, and number of trips, decrease as the reef gets over-crowded? These are open questions that might be worth studying in the future.

Table 14: Charter Vessel Impacts Due to Restoration (Past 12 Months)

For-Hire Resident				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	4.36	\$167,900	\$211,500	\$435,900
Indirect Effect	1.54	\$83,300	\$130,800	\$230,800
Induced Effect	1.54	\$73,100	\$126,900	\$223,100
Total Effect	7.44	\$324,300	\$469,200	\$889,800

For-Hire Non Resident				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	0.14	\$5,200	\$7,200	\$14,000
Indirect Effect	0.05	\$2,500	\$3,900	\$7,000
Induced Effect	0.05	\$2,200	\$3,900	\$6,800
Total Effect	0.24	\$9,900	\$15,000	\$27,800

All - Guided Trips Due to Restoration				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	4.5	\$173,100	\$218,700	\$449,900
Indirect Effect	1.58	\$85,800	\$134,700	\$237,800
Induced Effect	1.58	\$75,300	\$130,800	\$229,900
Total Effect	7.66	\$334,200	\$484,200	\$917,600

* All dollar values are rounded to the nearest hundred.

Additionally, the contribution of Half Moon Reef in people's sense of place might be worth additional study over time. While sense of place seems esoteric (indeed, we almost left it out of this report), it is a measure of people's quality of life. If Half Moon Reef contributes to an increase in sense of place, that means it is measurably increasing the quality of people's lives. That would be pretty powerful.

5.1 Recommendations on the evaluation process

Based on our experience with this project, we have several recommendations for future evaluation projects. These would apply to Half Moon Reef and to other, similar evaluations.

The strongest aspect of this project is that it was an innovative, mixed-mode, multidisciplinary social science evaluation of a reef restoration. Many evaluations look at either

5. Recommendations

Table 15: Total Economic Impacts (All Vessels – Previous 12 Months)

All New Trips (Private and Guided)				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	7.19	\$249,300	\$329,700	\$635,100
Indirect Effect	2.08	\$110,400	\$179,100	\$316,900
Induced Effect	2.31	\$104,800	\$182,500	\$320,800
Total Effect	11.58	\$464,500	\$691,300	\$1,272,800

All Additional Trips (Private and Guided) (Includes Diverted Trips)				
Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	7.6	\$260,900	\$346,600	\$663,300
Indirect Effect	2.15	\$114,200	\$185,900	\$328,900
Induced Effect	2.43	\$109,300	\$190,400	\$334,700
Total Effect	12.18	\$484,400	\$722,900	\$1,326,900

* All dollar values are rounded to the nearest hundred.

angler satisfaction or economic impact, or do a half-measure job of analyzing each. In this evaluation, we used multiple survey modes to do a more complete evaluation. This gives you a much more nuanced understanding of the social impact of Half Moon Reef. Future projects should continue to take this approach; we feel it is far superior to a more pared-down evaluation.

The biggest areas for improvement are related to the project startup process. Red tape, bureaucratic delays, and contractual negotiations (on the part of both The Nature Conservancy and Texas A&M) caused the project to get a very late start. This caused us to miss the first part of the high-use season for Half Moon Reef and shortened our survey window. A longer window would have allowed us to survey more people and increase our statistical power, making for better comparisons. That said, delays of these sort are not surprising for a new contractor-contractee relationship.

In terms of which surveys and survey questions were effective, the questions related to angler use, satisfaction, and demographics were critical in establishing the impact of the reef. Some of the softer questions (sense of place, etc.) were less immediately important, but do help to paint a more complete picture. In addition, they may allow us to answer applied research questions in future research, which can help drive theory and practice forward. That said, the softer questions could be replaced with other questions in the future, either to elicit more information or to take different evaluative approaches.

Having a mixed-mode survey is important because it allows us to vary the questions

based on the survey mode. In-person intercept surveys are necessarily short, providing valuable data in limited quantities. Supplementing with online followups allowed us to ask more probing, detailed questions. If more funding were available, adding a qualitative research component would significantly improve our understanding of satisfaction with the Half Moon Reef restoration and allow us to delve further into stakeholders' attitudes.

However, the online surveys were limited to people who gave us their email address. This meant guides and people who were fishing at Half Moon Reef and volunteered their address. It would be nice to supplement what we did with either a general population survey (about \$15-20 per response for a mail survey) or with additional surveys of targeted groups such as CCA members.

6 Unedited comments about Half Moon Reef

We asked survey respondents if they had any additional comments about Half Moon Reef. Here, we print the comments in unedited form.

6.1 Angler comments

What follows are unedited, unfiltered comments about Half Moon Reef from respondents to the online angler surveys.

- I haven't fished Half Moon Reef but think it is a very import project in West bay. We wade fish East and West bay year round using artificial lures exclusively. I'm 45 and have been fishing Matagorda since I was 5-6 years old. This last year has been one of the best we have had on numbers of trout and reds and also on big trout 27"+. I think that the timely spring summer rains and the 5 trout limit both have a lot to do with this.
No
- love the fishing and area!
- Too many fishing guides. At least farmers take care of and put back to the land. Fishing guides just take. They are able to take overwhelming amounts of fish for their customers with no consideration of limits. Why can one guide have the privilege of taking multiple limits a day for his clients. Look.at what happened to East Mat. The fishing guides left for lack.of fish. They caught them all. Did they do anything to reinvest what they made? / So if we want to work on something. Work on tighter guidelines for guides.

6. Angler comments

- It was a well done restoration project. / I primarily wade fish with artificials so i have only been to Half Moon a few times when taking kids fishing.
- Maybe create a project along south Shore line of either bay. You should receive alot more feed back since that shoreline offers alot more wind protection, which creates fishable waters. Research would be at a faster pace at certain goals you may be targeting
- This is my first trip to Matagorda Bay in 55 years. The Colorado River had the bay so muddy it made it almost impossible to catch fish. I enjoyed the trip. On this trip was the first time i heard of the Half Moon Reef. I was excited to hear about it. I fish a similar reef at the mouth of Keller Bay and it holds a lot of fish and has helped to clean the bay system.
- I'm all for Half Moon Reef but don't care to fish it
- Love it and will continue to go as time allows.
- I think half moon project was a great use of resources. I also like the lower trout limit. Habitat and conservation will improve the numbers and size of the trout.
- The flounder regulations have made a noticeable improvement. My wife and I are catching more and better flounder. The new 5 trout limit will do the same thing in our opinion and we are looking forward to seeing improvements in the trout populations in the coming years. The rains we have received in the watersheds namely the Colorado River watershed this year should help the ecosystem in West Matagorda Bay tremendously. I also read where a large number of trout fingerlings were restocked in West Matagorda Bay this year. / / We run a shallow water flats boat so it has to be fairly calm winds for us to fish Half Moon Reef. Friends of ours have been fishing there more as of late and the word from them has been positive.
- I look forward to fishing it for the first time this spring. i have heard good things about it from fishing guides Tommy Countz and Rob Cummins. I will most likely go there for the first time with a guide or one of my friends that has fished it previously
- I mostly fish East Matagorda Bay. Until recently I fished generally offshore / East Bay is much closer however, I plan to start going to Half Moon Reef again soon. Thank you for your work on this project. I'll bet it attracts lot's of fish.
- I'm glad to see such an important resource planned and placed in the bay system. It is a good investment for the ecosystem and the people who use it. Thank you...

- I would like to see some grass planting projects on the south shoreline of West Mati closer to the river and East Mati (Edlebach Flats) /
- I only wade fish, so I have never fished Half Moon
- Needs to be more monitoring of guide catches, many illegal sizes brought to the cleaning tables.
- Fish On
- I wish the bait camps would take care of the public, (when it comes buying bait) like they take care of the guides.
- I think Matagorda has the nicest facilities for the fisherman on the coast.

6.2 Guide comments

What follows are unedited, unfiltered comments about Half Moon Reef from respondents to the online guide surveys.

- Need more reefs built
- Great Project!!
- Just another spot to fish
- We could use at least one or two more...It gets crazy out there in the summer time...Too many boats at one time. But it definitely holds the trout.
- This has turned out to be a great project that worked. I would like to see more projects like this for the entire gulf coast. This just shows there are plenty of fish, they are easier to catch around reefs like Half Moon.
- No not really just build more please
- You have to be careful on the east end of the reef because it shallow enough that you can hit it as has happened to several fishermen.
- The reef is excellent, much needed habitat that the bay's need more of.
- We live fishing it. It gives us another option

7. References

- Wind direction, speed of wind , water clarity and tidal movement, determine when and how to fish this reef...only draw back is the jagged rocks that stick up near the surface and can be hit by boats/motors that are unmarked.....
- Needs to be marked much better than it is now.....lots of dangerous rocks and rookie boat owners have trouble navigating it.....
- At certain times of the year Half Moon Reef pays off very well.

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