Estimating the Economic Value and Economic Contribution of the Crab Bank Seabird Sanctuary

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The views expressed herein are those of the authors and not necessarily those of Audubon South Carolina, the National Audubon Society, Inc., and the National Fish and Wildlife Foundation.

This study is dedicated to the memory of Philip P. Maier, Director of the Marine Resources Division, South Carolina Department of Natural Resources, who passed away on December 7, 2021.

Executive Summary

The Crab Bank Seabird Sanctuary (CBSS) is a dedicated Heritage Trust Property and a Seabird Sanctuary owned and managed by the South Carolina Department of Natural Resources (SCDNR). It is located in the Charleston Harbor, near the mouth of Shem Creek in Mount Pleasant, SC. Crab Bank supported 5000 bird nests in a typical summer.

By the end of 2018, wind and waves eroded this unique habitat to a tiny fraction of its original size. The US Army Corps of Engineers began restoring Crab Bank in September 2021 and completed restoration in November 2021. Our study demonstrated that this 32 to 40-acre island has the potential to generate use (e.g., wildlife watching, etc.) and non-use economic benefits as well as annually generating market oriented economic contributions such as jobs and income in the SC Tri-County regional economy.

To estimate the use and nonuse values of the restored Crab Bank we survey South Carolina residents using an online panel survey mode. The survey also asks questions about hypothetical recreation and donation behavior in different restoration scenarios. Recreation questions address past use of Crab Bank. Future recreation behavior questions are asked under status quo and restoration scenarios.

- Several willingness to donate estimates are developed. The willingness to donate estimates vary depending on how standard known biases in contingent valuation research are treated. Mean willingness to donate when the problem of hypothetical bias is ignored ranges from $65 to $140 per household. When hypothetical bias is treated with a certainty recode approach, mean willingness to donate ranges from $0 to $97. When the “fat tails” problem is addressed, mean willingness to donate estimates are $63 when hypothetical bias is ignored and $38 when it is treated.
- A recreation demand model for Crab Bank visits is also estimated. We find that as travel costs increase the number of visits decrease and as income increases the number of visits increase. The model finds that respondents expect to take more visits in 2022 and Crab Bank restoration leads to an increase in the desirability of Crab Bank as a destination. This suggests a significant increase in recreational use value from the restoration of Crab Bank and lends validity to the willingness to donate estimates.
- We aggregated the willingness to donate responses over the South Carolina household population. The aggregate benefit estimates of a restored Crab Bank ranged from a minimum of $15 million when we adopt the most conservative assumptions up to a maximum of $60 million. The lower estimate is almost four times greater than the expected cost of Crab Bank restoration. A sensitivity analysis suggests that, even with very conservative assumptions, the probability that the benefits of Crab Bank restoration are less than the cost is only 23%. The analysis indicates that the benefits of restoration exceed the costs to South Carolina residents making restoration an efficient policy.

We also characterized the pre-restoration economic contributions (e.g., sales, jobs, income, etc.) to the SC Tri-County regional economy for typical CBSS recreational user expenditures on non-consumptive and consumptive activities associated with recreational use. These CBSS

recreational user expenditure effects on the SC Tri-County regional economy were approximated using an input-output (I-O) economic model, IMPLAN.

- There is no basic usage (e.g., estimated number of monthly visitors, etc.) or other related activity monitoring program for the Crab Bank area that could have been used for approximating its SC Tri-County economic contribution or other economic use metrics. Consequently, estimates of CBSS related use expenditures and other information needed were mainly based on secondary data sources as well as professional judgment.
- The combined total annual SC Tri-County estimated output contribution effects of outfitter ecotourism services, recreational fishing, shrimping and paddle club activities associated with the CBSS was about $5.18 million in 2019 dollars. These annual total economic contribution effects included supporting over 54 jobs (full time and part time) and generating about $1.65 million in labor income (i.e., salaried employee wages and proprietor income). The total annual contribution effects associated with these activities also generated a SC Tri-County Gross Regional Product (total value added) of about $2.67 million.

In summary, our study estimated the use and non-use economic values of restoring the CBSS and characterized its baseline economic contribution to the SC Tri-County economy. A key finding is that the CBSS's aggregate economic value is greater than the expected restoration cost. Our findings also support the continued need for the economic analysis of habitat restoration, enhancement and similar federal projects.

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Introduction

The Crab Bank Seabird Sanctuary (CBSS) is a dedicated Heritage Trust Property and a Seabird Sanctuary owned and managed by the South Carolina Department of Natural Resources (SCDNR). It is located in the Charleston Harbor, near the mouth of Shem Creek in Mount Pleasant, SC (Riggin 2018). Crab Bank supported nesting brown pelicans, royal terns, black skimmers, gull-billed terns, sandwich terns, laughing gulls, American oystercatchers, and willets. In a typical summer, Crab Bank hosted 5000 bird nests. However, wind and waves eroded this unique habitat. Created in the 1950s from sand dredged from the harbor, Crab Bank had eroded to a tiny fraction of its original size by the end of 2018. Moreover, in 2017, Hurricane Irma washed away most of the remaining high ground, then after one last storm paired with a high tide, any opportunity for nesting birds was eliminated in 2018.

The remedy for this situation was to restore the Crab Bank area using selected dredge sands that became available when the US Army Corps of Engineers (USACE) dredged the Charleston Harbor in 2019-2022 to meet the needs of larger ships. The restoration started in September 2021 and was completed in November 2021 (see Figure 1). The preliminary estimated acreage for the restored Crab Bank is about 32 to 40 acres above the high tide line (N. Schillerstrom, personal communication, December 15, 2021), which will be ample area for high-ground nesting habitat. The USACE also estimated that it will take at least 50 years, half a century, for Crab Bank to erode back to a half-acre in size — sufficient time to hatch tens of thousands of young birds. While the work of restoring Crab Bank was originally estimated by the U.S. Army Corps of Engineers to cost about $4 million, the actual cost was $377,000 because of some special circumstances. With the U.S. Army Corps of Engineers covering 65% of that total cost, donations and grant money in the amount of $132,000 were secured to fully fund the project.

This 40-acre area has the potential to generate use (e.g., wildlife watching, etc.) and non-use economic benefits as well as generating market oriented economic contributions such as jobs and income in the Charleston–North Charleston, SC Metropolitan Statistical Area (hereafter the "SC Tri-County economy", a metro area comprising Berkeley, Charleston and Dorchester counties). The purpose of this report is to estimate the economic value and economic contribution of the CBSS to the state of South Carolina (SC) and, in particular, the SC Tri-County economy.

Economists have developed various economic analysis approaches or techniques for estimating the economic value of restoration of natural habitats such as the CBSS. In general, these include revealed preference (e.g., avoided cost, hedonic price and travel cost) and stated preference (e.g., contingent valuation methods) and benefit transfer methods. While each has limitations, we use stated preference methods because they are capable of capturing the total economic value held by the South Carolina population for the CBSS resource. Total economic value contains use values (e.g., outdoor recreation) and nonuse values. Users of the CBSS resource include those in the tourism sector of the economy. Nonusers are those who might value the CBSS resource but never visit the site. Nonuse values are those motivated by ecological integrity, altruism and bequests to future generations.

We also estimate the economic contribution (e.g., sales, jobs, income, etc.) of CBSS associated activities to the SC Tri-County economy. As Watson *et al.*, (2007) noted, economic contribution can be defined as "the gross changes in a region's existing economy that can be attributed to a given industry, event, or policy." In this case, it includes economic activities associated with the CBSS such as bird and other wildlife watching as well as nature education trips. Moreover, unlike economic impact analysis, economic contribution analysis (ECA) is indifferent about whether the consumer (e.g., bird watching participant) is a resident or a non-resident tourist relative to the defined study area. In other words, an ECA provides critical insight into the gross economic contribution or importance of economic activities for a given study region. This study establishes a baseline of economic activities related to the CBSS and associated industry sectors (e.g., nature-based tourism outfitters, lodging, etc.). This baseline can then be used to monitor changes in local economic contribution effects after CBSS restoration.

Economic Value

The concept of economic value is based on consumer demand theory. With a market good, such as pizza or a car, economic value is the difference between what a consumer is willing to pay and the market price. With a nonmarket good, such as a natural resource like Crab Bank, there is no market price so economic values (both use and nonuse) are captured in the willingness to pay for the resource. Since there are no markets to reveal willingness to pay, economists use nonmarket valuation methods such as contingent valuation to estimate hypothetical willingness to pay statements.

To estimate the use and nonuse values we survey South Carolina residents using an online panel survey mode. The survey contains contingent valuation method questions to value the restoration of Crab Bank (Haab, et al. 2020). These are in the form of repeated dichotomous choice scenarios (see, e.g., Giguere, Moore and Whitehead 2020). These questions present various restoration scenarios for Crab Bank along with an individual cost for the restoration scenario (e.g., a voluntary contribution). Respondents are asked whether they would make the donation in that situation. These data are used to estimate the total value, including use and nonuse value, of Crab Bank restoration.

The survey also asks questions about hypothetical recreation and donation behavior in different restoration scenarios. The recreation questions address past use of Crab Bank to establish a baseline. Future recreation behavior questions are asked under status quo and restoration scenarios. With these questions we estimate recreation demand models which allow estimation of the use value of Crab Bank under various management scenarios.

Survey Description and Data

An online survey was developed with the Qualtrics platform (see Appendix A). We purchased a sample of South Carolina residents from Dynata (dynata.com), a market research company that was formed by merger between Research Now and Survey Sampling International in 2017. Dynata provides opt-in survey samples for academic research which have been found to yield similar results to more traditional survey modes (Lindhjem and Navrud 2011). A survey was developed during 2021 before restoration of Crab Bank and pretested with over 200 SC residents. A number of changes were made to the survey based on the pretest results and the final survey version was fielded in July 2021.

Dynata survey participants initially saw the informed consent screen. The survey was determined to be exempt from Appalachian State University Institutional Review Board oversight due to the lack of sensitive or risky questions. Researcher contact information was provided but no questions about the research product were received.

One-thousand two-hundred eighty-four Dynata panelists completed the survey. We initially asked panelists about their state of residence, categorical age (e.g., between 18 and 24) and zip code. In order to increase data quality we deleted anyone who answered that they did not live in SC, provided an age that did not match with their birth year (asked at the end of the survey) and provided a non-SC zip code. Seventy respondents lived outside of SC and seven other panelists did not provide a reliable age, zip code or both. Once these respondents were deleted from the data, 1207 SC residents qualified for the survey. A summary of these data is presented in Appendix B.

The survey began with some informational text describing the history of CBSS, the future restoration plans, a map and photographs. Only 22% of the sample knew anything about Crab Bank before the survey. Respondents were presented information about Crab Bank nesting habitat and asked about their concern about Crab Bank erosion and importance of Crab Bank for nesting habitat. Thirty-five percent were very concerned about Crab Bank erosion, 50% were somewhat concerned and 15% were not concerned. Forty-six percent felt that nesting habitat was very important and 40% felt that it was somewhat important. Respondents were then described how Crab Bank supports the “local nature-based tourism economy” and asked about its importance. Thirty-five percent felt that Crab Bank was very important and 44% felt that it was somewhat important for tourism.

Recreational use

Following this introduction, we asked about recreational use of Crab Bank. Seventeen percent of survey respondents had used Crab Bank for recreational purposes in the past (7% did not know if they had). Ten percent of all respondents who had participated in Crab Bank recreation in the past indicated that they had accessed the “Crab Bank/Shem Creek area” using their own boat and 10% using other boats (e.g., rental). Eight percent had viewed the Crab Bank/Shem Creek area from Shem Creek without a boat and 7% had viewed without a boat but not from Shem Creek.

Respondents were asked for the number of times that they had used or viewed the Crab Bank/Shem Creek area during 2020. One hundred and sixty-two respondents, 13% of the sample, indicated a positive number with one visit being the mode. One-hundred forty-seven respondents indicated that the Covid-19 pandemic had affected their visitation and most of these indicate that visits had decreased in 2020. One hundred and ninety-two respondents, 16% of the sample, indicated that they would visit the Crab Bank/Shem Creek area in 2021.

Crab Bank restoration

Respondents were then described the restoration of 28 acres of Crab Bank by the U.S. Army Corps of Engineers with funding from corporate and individual citizen donations. Eighty-four percent of respondents support restoration and 83% support the use of donations. Respondents are then told that the same factors that caused erosion in the past would continue to cause erosion in the future and that a maintenance plan with periodic renourishment could maintain the size of Crab Bank at 28 acres. Eighty-one percent of respondents support a maintenance plan.

Respondents are then presented with estimates of the expected total cost of the maintenance plan and the cost per SC household, $2. The expected household cost is based on the published cost of $4 million for restoration and about 2 million SC households. Respondents are asked if they would be willing to make a one-time donation of $2, in 2022, to a hypothetical Crab Bank Maintenance Fund to maintain Crab Bank. Fifty-percent of respondents answered yes, 23% answered no and 27% answered don't know. Those who answer no or don't know are asked why. Thirty-seven percent of those who answer no or don't know state that they do not have enough money, 31% state that it is because they never visit the Crab Bank/Shem Creek area, 9% do not think Crab Bank erosion is a very important problem, 26% just do not like hypothetical questions and 11% state that there is some other reason.

Donation Scenarios

Respondents who answered that they would donate $2 proceed to the next section of the questionnaire where they encounter additional hypothetical donation scenarios and questions. The next two questions are preceded by a statement that there is some scientific uncertainty about the impacts of a restored Crab Bank. Respondents are told that Crab Bank restoration could provide protection from shoreline erosion for as many as 100 Mount Pleasant houses and that Crab Bank could host between 2000 and 5000 bird nests. Sixty-two percent of respondents feel that protecting homes is very important and 31% think that it is somewhat important. Eighty percent of respondents feel that providing nesting habitat is very important and 20% think that it is somewhat important (only one respondent felt that bird nests is not important).

Next, respondents are told that there is uncertainty about how many SC households would donate to the Crab Bank Maintenance Fund. They are told that the average donation amount would need to be higher if not every SC household donates. Forty-seven percent are very concerned that not every SC household would donate and 46% are somewhat concerned.

Following these introductory questions respondents are presented with specific instructions about the hypothetical donation scenarios. Respondents are told that, due to scientific uncertainty, the number of homes protected will range from 10 to 100, the number of bird nests at Crab Bank will range from 2000 to 5000 and the average one-time donation needed to maintain Crab Bank for 50 years will range from $2 to $1000 (if 1 out of every 500 SC households donates). Sixty-seven percent of respondents stated that they read the instructions very closely and 29% said that they read the instructions somewhat closely.

With donation payment mechanisms researchers have found that it is important to provide information about what happens if the money raised is (a) not enough to fund the program or (b) more than enough to fund the program in order to minimizing free-riding and other strategic behaviors (Groothuis and Whitehead 2009). We present information about different ways that these situations could be handled and ask respondents to indicate which way they like best. Then we include these proposals as another attribute in the hypothetical donation scenarios.

If the money raised is more than $4 million, 50% of respondents preferred that the additional money would be kept in a state fund dedicated to coastal birds, 38% preferred that the additional money would go toward scientific monitoring and environmental stewardship of Crab Bank and 12% preferred that the additional money is returned to households that donate. If the money raised is less than $4 million 86% prefer that all donations would be used to maintain Crab Bank but for less than 50 years and 14% preferred that all donations would be returned to households.

Respondents are then told that they will be presented with “various combinations of the impact and future funding of Crab Bank maintenance.” Respondents are presented with text saying that, while the scenarios are hypothetical, the results of the study will be shared with state government and non-governmental organizations that will make decisions about Crab Bank in the future to emphasize the consequentiality of the answers to the hypothetical donation questions (Carson and Groves 2007).

Respondents answer donation questions from four of six randomly assigned and randomly ordered scenarios that vary depending on what is done with money that is collected over or under the $4 million target (Table 1). In each scenario (see Figure 2), respondents are provided with specific information about the number of homes that would be protected, the number of bird nests in a typical summer and what happens when more or less than $4 million dollars is raised. There were 10 levels of the homes attribute with number of homes randomly varied from 10 to 100. There were four levels of the nest attribute: 2000, 3000, 4000, and 5000. Then respondents are asked if they would be willing to make a specific one-time donation in 2022 to the Crab Bank Maintenance Fund. One of 30 donation amounts was presented in each question with the range from $10 to $300 in increments of $10. The upper amount was chosen based on analysis of the pretest data where the upper amount ranged to $1000.

The yes responses (i.e., willingness to donate) do not vary much, from 31% to 35%, across the six choice questions (Table 2). The no responses vary a bit more, from 36% to 45%. These responses suggest that about one-third of the sample of those willing to donate $2 are willing to donate even more. Following each of the six choice questions, respondents who are willing to donate more than $2 are asked how sure they are that they would make the donation in the scenario. The percentage of respondents who are very sure ranges from 60% to 69% across the six choice questions with almost all other respondents being somewhat sure that they would actually make the donation. Respondents who answer “very sure” to a certainty follow-up question are those most likely to actually pay when placed in the real situation (Penn and Hu 2018).

Ex-post recreation

Following the choice questions respondents are asked to predict about how many times they think they would use and/or view the Crab Bank/Shem Creek area during 2022 after it was fully restored to 28 acres. Of the 607 respondents who would be willing to donate $2, 64% stated that they would make at least one Crab Bank visit. Twenty-four percent would make one visit, 16% would make two visits, 9% would make three visits and the remainder indicate they would make between five and 10 or more visits.

Respondents are told that there are plans for a “Pelicam” where anyone can watch the birds at Crab Bank from a computer or other device. Sixty-four percent of those willing to donate $2 state that they would use the Pelicam and 31% of these say that they would use the Pelicam very often and 44% would use it sometimes.

Debriefing questions

Those respondents who are willing to pay $2 are then asked standard contingent valuation debriefing questions. Ninety-five percent state that they strongly agree or somewhat agree with a statement that they understood all of the information presented to them about the hypothetical situations. Seventy-three percent strongly or somewhat agree with the statement that they have confidence in the ability of the government to manage Crab Bank. Eighty-three percent believe that the survey is consequential (Carson and Groves 2007). Eighty-three percent strongly agree or somewhat agree with the statement “I believe the results of this survey could affect decisions about Crab Bank” and 88% strongly or somewhat agree with the statement “I believe the results of this survey will be shared with decision makers”.

Attribute non-attendance is an issue in stated preference studies where survey respondents do not pay complete attention to the variation in the level of choice attributes presented (Lew and Whitehead 2020). We asked respondents to state how much attention they paid to each of the attributes. Forty-three percent of respondents paid a lot of attention to the number of homes protected from erosion, 39% paid some attention and the remainder said they did not pay much attention to the attribute (i.e., not much, none). Sixty-four percent paid a lot of attention to the number of bird nests and 29% paid some attention. Fifty-seven percent paid a lot of attention to what happens if more than $4 million is raised and 32% paid some attention. Fifty-five percent paid a lot of attention to what happens if less than $4 million is raised and 34% paid some attention. Seventy-one percent paid a lot of attention to the donation amount and 21% paid some attention.

Socioeconomic Questions

At the beginning of the survey respondents are asked about their age and to which gender they most closely identify. Thirty-six percent of respondents are between the ages of 25 and 44, 28% are 65 and older, 26% are 45 to 64 and 9% are 18 to 24. At the end of the survey questionnaire respondents were asked several socioeconomic questions. Respondent age is measured as equal to 2021 minus the stated birth year. Respondent age ranges from 18 to 101 with a median age of

48 and a mean age of 50. Only 4 respondents preferred to not answer the birth year question. Thirty-six percent are male, 63% are female, 3 respondents are non-binary or a third gender and 7 respondents prefer not to say.

At the end of the survey respondents are asked if they are now married, widowed, divorced, separated or never married. Fifty-two percent of respondents are married, 6% widowed, 11% divorced, 3% separated and 26% never married. Three percent of respondents indicated that they preferred not to answer the question.

Respondents are asked about the highest level of school or degree that they have completed. Twenty-three percent of respondents hold a four-year college degree, 23% hold a college degree, 22% have some college but no degree, 13% have a two-year college degree, 10.5% have a masters degree, 4% have less than a high school degree, 2% have a professional degree (e.g., JD, MD) and 1% has a doctoral degree. One percent of respondents prefer not to answer the education question.

Survey respondents are asked to choose one or more races that they consider themselves to be. The sample of respondents is comprised of 78% who consider themselves to be white, 17% who consider themselves to be black or African American, 2% American Indian or an Alaska Native, 2% Native Hawaiian or Pacific Islander, and 1% Asian. Three percent consider themselves to be some other race and 2% prefer not to answer. In a follow-up question, 3% consider themselves to be Spanish, Hispanic or Latino.

Respondents are asked to choose a statement that describes their current employment status. Thirty-eight percent are working as a paid employee and 8% are self-employed. The rest of the sample is not working. Thirty-percent are retired, 8% are looking for work, 6% are disabled, 2% are on a temporary layoff and 7% are not working for some other reason. Two percent of the sample prefer not to answer the question.

Respondents are then asked to report their 2020 household income before taxes. There are 12 categories of income with 12% of respondents earning between $30 thousand and $40 thousand, 11% earning between $20 thousand and $30 thousand and 10% earning between $100 thousand and $150 thousand. Less than 10% are represented in the other nine categories. Eight percent of respondents preferred not to answer.

The final two questions concerned politics. Seventy-five percent of all respondents voted in the last election. Thirty-seven percent consider themselves to be Republican, 29% Democrat, and 22% Independent. Seven percent have no party preference, 1% are members of some other party and 4% preferred not to answer the question.

Data Summary

In order to develop a “complete case” sample for analysis we delete those respondents who prefer not to answer demographic questions. This leaves a sample size of 1109 respondents.

According to the US Census Bureau (https://www.census.gov/quickfacts/SC), 23% of SC adults are 65 and older, 52% are female, 69% are white and 27% are black or African American (Table 3). Of those aged 25 and older, 88% are high school graduates and 28% have a four-year college degree. The median household income is $53,199. In our sample, 29% of SC adults are 65 and older, 64% are female, 78% are white and 17% are black or African American. Of those aged 25 and older, 96% are high school graduates and 40% have a four-year college degree. The median household income is between $40 thousand and $50 thousand. Therefore, our sample is older, more female, more likely to be white with more education and less household income than the population. In order to make our sample more representative of the population, we weight the responses on gender and age and statistically test other variables to determine if survey responses vary systematically.[1]

Geographically, the sample is from each of the four regions of SC (see www.sc.gov). Twenty percent of the population is from the Low Country Region, 20% is from the PeeDee Region, 30% is from the Midlands Region and 30% is from the Upstate Region. This compares favorably to the population where 23% of the population is from the Low Country Region, 18% is from the PeeDee Region, 29% is from the Midlands Region and 30% is from the Upstate Region We use Google Maps to estimate driving distances from the respondents' home zip code to Mt. Pleasant, SC. The mean distance is 141 miles with a median of 136 miles and a range of 0 to 262 miles.

<u>Willingness to donate modelling results</u>

Given the number of questions asked in the survey there is a variety of statistical analyses that can be conducted. We focus our attention on the analyses that directly pertain to the purpose of the report – estimating the economic value of Crab Bank Seabird Sanctuary.

We first assess the determinants of whether respondents are willing to donate $2. In Table 4 we present ordinary least squares regression models of the probability that respondents will donate (i.e., linear probability model). We use the linear probability model to facilitate intuitive interpretation of the coefficients as the change in the probability of belonging to the valuation sample.[2] In the unweighted model we find that distance from Mt. Pleasant and SC regional residence does not affect the probability. The socioeconomic variables that matter are race, education and income. Respondents who are Black or African American have a 11.6% lower rate of donation relative to those who are White. Those with a four-year college degree have a 5.8% higher chance of donation. Each $10 thousand dollar increase in income increases the probability of a donation by 13.6%. The weighted model is similar but additional coefficients are statistically different from zero. We find that distance from Mt. Pleasant has a negative effect on the

[1] Population frequencies for 2019 are from the US Census (https://www.census.gov/data/tables/time-series/demo/popest/2010s-state-detail.html).

[2] Note that the marginal effects from a logistic regression would achieve the same objective.

probability. Each 100 miles away reduces the probability by 7.9.

We next estimate logistic regression models of the willingness to donate more than $2. The sample is comprised of 579 of the 1109 survey respondents who are willing to donate $2. The data summary for the socioeconomic variables for this subsample is presented in Table 5. The donation scenario variable descriptions are presented in Table 6. Each respondent answers four randomly assigned and ordered choice questions so the sample is treated as a quasi-panel (i.e., cross-section time-series). In addition to the socioeconomic variables (Table 5), the models include variables that take account of the variation in the number of homes protected and bird nests supported by Crab Bank as well as controls for scenarios where the money raised is greater than or less than $4 million (Table 7). The mean number of homes protected ranges from 53.7 to 56.2 across the six scenarios. The mean number of nests ranges from 3423 to 3546. The mean donation amount ranges from $150.2 to $160.5. The respondents who are willing to donate the suggested amount is 34.3% and 22.5% are very sure that they would actually donate.

The distribution of the willingness to donate responses over the dollar amounts is presented in Table 8. In general, as the dollar amount increases the percentage of yes (and yes, very sure) responses declines. In a simple linear regression accounting for the panel nature of the data with fixed effects, each $10 increase in the dollar amount leads to a 1.67% decrease in the percentage of yes responses. But, as is clear from Figure 3, the pattern of responses is non-linear with eleven instances where the percentage of yes responses increases with a $10 increase in the dollar amount (i.e., non-monotonicity). Non-monotonicies can be due to small sample sizes or irrationality on the part of the respondent. Also, there is a flat portion of the curve in Figure 3 from the $210 to $300 donation amounts. This is known as the “fat tails” problem which may result from “yea-saying” respondents. Yea saying results when respondents will answer in the affirmative to a willingness to pay question regardless of the scenario. The non-monotonicity and fat tails problems have the potential to bias average willingness to donate responses and increase the standard error of the estimates. We will return to an investigation of these issues below.

We first estimate unweighted and weighted models including all experimental and socioeconomic variables (Table 9). The standard errors are clustered at the individual level to take account of the fact that the donation answers from respondents are not independent across the four questions answered. In both models we find that only the donation amount, the number of nests, and dummy variables for respondents 65 and older and female respondents have coefficients that are statistically different from zero. Respondents are sensitive to the requested donation amount. As the donation amount increases the likelihood that the respondent would pay decreases. As the number of nests supported increases the likelihood that the respondent would pay increases. Both of these results are predicted by economic theory. The unweighted and weighted coefficient estimates are similar. This result should be kept in mind below when we estimate more complex logit models that preclude using the sampling weights. Further, similar results are found when the dependent variable is recoded to a “no” (will not donate) answer when the respondent is not very sure of their answer (note: these results are available upon request).

As described in the survey questionnaire section of this report, some respondents do not pay full attention to all of the attributes of a choice question. We asked respondents “stated attribute non-attendance" questions and many reported that they did not pay "a lot" of attention to the attributes. Attribute non-attendance can lead to biased and statistically insignificant coefficient estimates (Giguere et al. 2020). In order to assess the effect of attribute non-attendance on our results we estimate a latent class logistic regression model. Latent class models estimate two or more vectors of coefficients. Each vector represents a class, or type, of respondent. The model also estimates the probability that any respondent belongs to each class.

In the latent class logit model we drop all socioeconomic variables except for age, gender and income (due to its theoretical importance in a donation model) because these models sometimes have a difficult time estimating different coefficient vectors as the number of variables increase (Table 10). The model finds two classes with the probability of belonging to class 1 equal to 58.4% and the probability of belonging to class 2 equal to 41.6%. In both classes, the coefficient on the dollar amount is negative and statistically significant but only in class 2 is there a statistically significant coefficient on one of the quality attributes with the coefficient on the number of nests being statistically different from zero[3]. In both classes older respondents and females are less likely to be willing to donate. In both classes the probability of a donation increases with income.

Willingness to donate estimates

Willingness to donate estimates are developed with simple models that include only the dollar amount as a regressor. The use of simple models eases the burden of calculation, generates the equivalent estimates and can be interpreted as estimating willingness to donate at the means of the attributes (Table 7). Simple logistic regression models are presented in Table 11. The first uses the willingness to donate as the dependent variable (yes) and the second adjusts willingness to donate for those who are very sure that they would actually pay (yes very sure). The latter is considered to be an estimate corrected for "hypothetical bias" (Penn and Hu 2018). In both models the coefficient on the dollar amount is negative and statistically significant. In the "yes very sure" model the constant is negative and statistically different from zero. This occurs when the percentage of yes responses is below 50% at the lowest dollar amount. The model without the hypothetical bias correction outperforms the other statistically with higher model χ^2 and pseudo-R^2 values.

We also estimate and present logistic models with the log-linear functional form and linear probability models. The log-linear functional form often outperforms the linear and that is the case with these data. The linear probability model provides more intuitive results. The constant in the basic model (yes) suggests that the probability of a donation is 64% if the requested amount is $0 and decreases by 1.7% with each $10 increase. The maximum donation is estimated to be $382. In the model with the dependent variable recoded for certainty (yes very sure) The constant in the basic model suggests that the probability of a donation is 43% if the

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[3] In a another two-class model with the attributes measured in logs (for ease of calculation of elasticity), the scope elasticity in class 2 is 0.40 (Whitehead 2016).

requested amount is $0 and decreases by 1.1% with each $10 increase. The maximum donation is estimated to be $382.

In order to assess the extent of the "fat tails" problem we estimate a simple latent class model. The four-class model fits the data best with the raw data, relative to two and three-class models according the AIC statistic (Table 12). The fitted bid curves with the probability of a yes response plotted against the suggested donation amount for each class are presented in Figure 4. The dominant class is class 1 with a probability that a respondent belongs equal to 35%. The bid curve shows that the probability of a yes response is 85% at a donation of zero and falls steeply to near 0% when the donation amount is $100[4]. There is a 22% probability of belonging to class 2 where the probability of a yes response is 89% at a $0 donation and falls slowly to 19% at a donation of $300. The donation at which the probability of a yes response is near zero is $960 for class 2. There is a 22% probability that a respondent will belong to class 4. The bid curve for class 4 looks similar to that of class 1 but indicates a larger willingness to pay. The probability of a yes response at a donation of $0 is 99.7% and falls to near zero at $190.

There is a 19% probability that a respondent belongs to class 3. In this class the probability of a yes response is 98% regardless of the dollar amount. In an initial model, the coefficient on the dollar amount variable is positive and statistically insignificant. We constrain this coefficient to be equal to zero and re-estimate the model with the attribute non-attendance interpretation (Koetse 2017). This constraint is supported statistically by a likelihood ratio test. In other words, we assert that there is a 19% probability that a respondent will ignore the suggested donation amount and answer yes, signaling support for restoration of Crab Bank. There is a coincidence of the 19% estimated probability from class 3 and the average percentage of yes responses in the raw data of 14% over the bid range $210 to $300. We interpret class 3 as capturing the extent of yea saying bias and adjust for this in our estimates of the willingness to donate.

We also estimate a four-class model with the dependent variable recoded for hypothetical bias (Table 13). In this model we find three classes with theoretically correct signs on the dollar amount variable but the fourth class has a positive coefficient on the dollar amount. This indicates that once the dependent variable is recoded, there is a 12% chance that respondents are more likely to donate with a higher amount. This suggests some irrationality by that class of respondents who exhibit yea-saying behavior and fat tails. Constraining this coefficient to zero is not supported by a likelihood ratio test.

Willingness to donate (WTD) estimates are developed using the formulas from Hanemann (1984, 1989). The mean WTD is the negative of the ratio of the logit constant and the coefficient on the dollar amount. This estimate allows for negative WTD values. If the negative portion of the WTD distribution is truncated (i.e., set equal to zero) then the truncated mean WTD estimate results. In addition, we have estimated a logistic regression model similar to those in Table 10 but with the log-linear functional form. This results in the median WTD estimate (Hanemann

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[4] "Near zero" is defined as four zero digits to the right of the decimal.

1984). Finally, we have also estimated a linear probability model with the WTD estimate equal to the area of the triangle formed by the vertical and horizontal intercepts of the estimated line.

The variety of WTD estimates is presented in Table 14. The mean willingness to donate from the linear functional form of the logistic regression model is $84 [95% confidence interval is $65, $102]. When we recode the uncertain yes responses to no responses the willingness to donate estimate is -$31 [-$71, $8] and not statistically different from zero. These two estimates include the negative portion of the distribution. It is not clear whether survey respondents would hold negative values for restoration of Crab Bank (i.e., restoration of Crab Bank would make people worse off) so an alternative estimate is the truncated mean. The truncated mean willingness to donate in the baseline model is $140 [$125, $155] and $97 [$82, $112] in the adjusted model. The truncated mean estimates are statistically different than the untruncated mean estimates. The difference between the base (yes) and uncertainty adjusted (yes very sure) estimates suggests that an adjustment for hypothetical bias is a 44% reduction in baseline WTD.

The median willingness to donate estimates are developed from the log-linear logistic regression model. The median willingness to donate for the baseline model is $65 [$54, $77] and $20 [$12, $27] with the hypothetical bias correction. The linear mean willingness to donate, estimated from the linear regression model, is $122 [$111, $134] in the baseline model and $81 [$71, $92] in the adjusted model. These estimates are conceptually similar to the truncated mean WTD from the linear logistic model and are not statistically different.

Willingness to donate estimates, both truncated and untruncated, can be developed from each class of the latent class logit model in the same way as from binary logit models. By capturing the respondent heterogeneity across class there is little difference between the truncated and untruncated mean estimates. The mean WTD in class one is $16 [$10, $21] and the truncated mean is $17 which is not statistically different. In class 2, the mean WTD is $178 [$142, $215]. Given that the bid curve crosses the vertical axis at a probability of 0.89 and the trajectory is flat there is a greater negative area in the second quadrant relative to the other classes. The truncated WTD is $188 [$152, $224] which is statistically different from the untruncated WTD. The mean WTD in class four is $74 [$64, $84] and the truncated mean is also $74 with only a $0.04 difference. The third class WTD is undefined.

These estimates can be combined into a single estimate by weighting each class WTD estimate by the class probability and ignoring the non-attending class three. The weighted mean WTD estimate is $63 [$50, $76] and the truncated mean is $66 [$53, $79]. The $3 difference is statistically different from zero. From the latent class logistic regression model with recoded yes responses, the mean WTD is $38 [$26, $50] when negative values are allowed and $47 [$30, $63] when the distribution is truncated at zero. We interpret this estimate as including a correction for the bias from the fat tail of the WTD distribution.

Comparing the willingness to donate across the binary and latent class logit models provides an estimate of the upward bias of yea-saying behavior that results in a bid curve with a fat tail appearance. Considering the mean WTD estimates, the yea-saying behavior results in an upward bias of 33% $((83.65 - 62.80)/62.80)$. In the model adjusted for certainty, the mean WTD estimate is negative, which results from the downward bias in the vertical intercept of the bid curve caused by the yea-saying behavior. Considering the truncated mean WTP estimates, the yea-saying behavior results in an upward bias of 114% $((140.18 - 65.55)/65.55))$. In the model adjusted for certainty yea-saying behavior results in an upward bias of 109% $((97.25 - 46.52)/46.52))$. It is clear that yea-saying bias can be substantial and it is important to take it into account in order to avoid overestimating environmental benefits.

Recreation behavior

A summary of the visitation data is presented in Table 15. Ten percent of the sample stated that they have visited Crab Bank in 2020 and the mean number of visits is 3.1. Eleven percent intended to visit Crab Bank in 2021 and the mean number of visits is 3.5. After restoration in 2022, 34% of the sample intended to visit Crab Bank and the mean number of trips is 2.7. We estimate a recreation demand model to determine if these recreational visit estimates are valid measures of use and to gain an understanding of the increased value created by Crab Bank (see Whitehead et al. 2008 for a similar study).

In a recreation demand model the travel cost of site access is assumed to be an implicit price of the trip. The standard construction of a travel cost variable is $TC = (c \times 2 \times d_i) + \left(\gamma \times w_i \times \frac{2 \times d_i}{mph}\right)$. The first term is the money cost per mile. The cost per mile, $c = \$0.2021$, is obtained from AAA and only includes variable costs (e.g., gas and oil, tires). Round trip distance, d_i where *i* is the individuals in the sample, is computed from Google maps from the respondent's zip code to the zip code of Mt. Pleasant. The opportunity cost of time, γ, is set to be one-third of the wage rate as is standard in the literature. The wage rate, w_i, is the household income divided by 2000 working hours (i.e., 50 weeks per year × 40 hours per week). Time spent traveling is the round-trip distance divided by the average miles per hour, *mph*, which is assumed to be 60. The round-trip travel cost for the truncated sample of those who are willing to donate $2 is $103.

The recreation demand model is estimated with the full sample, including those who do not take trips (Table 16). The model is set up as a panel with two or three observations for each respondent. Respondents who are not willing to donate $2 are not asked the 2020 visits question. Since recreational visits are integers it is common in the recreation demand literature to estimate a "count data" model (e.g., Poisson, negative binomial). We estimate the negative binomial form to capture the overdispersion of the data (i.e.., the mean and standard deviation of visits are not equal) but the Poisson form provides similar results. The recreation demand model is specified with random effects to account for the panel nature of the data.

The empirical results suggest that survey respondents are exhibiting demand behavior with a negative coefficient on the travel cost variable and a positive coefficient on the income variable. In other words, as travel costs increase the number of visits decrease and as income increases the number of visits increase. The coefficient on visits in 2021 is positive and statistically significant indicating that respondents expected to take more visits in 2021 than 2020. This is consistent with the survey question where respondents were asked how the Covid-19 pandemic affected the number of times they viewed or visited Crab Bank. Seventy-nine percent of those who said the number of visits had been affected indicated that Covid-19 decreased visits. The coefficient on visits in 2022 is positive and statistically significant indicating that respondents expected to take more visits in 2022 than 2020 (and 2021). This indicates that Crab Bank restoration leads to an increase in the desirability of Crab Bank as a destination.

The consumer surplus per visit can be estimated from this model as the negative inverse of the coefficient on the travel cost variable. Conceptually, consumer surplus per visit is the difference between the willingness to pay for the visit and the amount that must actually be paid for the visit. The consumer surplus per visit estimate is $278 [$129, $428] which indicates significant value. Note, however, that the consumer surplus per visit estimate is biased upwards because of the lack of substitute prices in the model and lack of controls for overnight and multipurpose trips. The coefficient on the year 2022 trips with Crab Bank restoration indicates that the increase in consumer surplus per trip is $344 [$159, $528], a 123% increase. Even considering the upward bias in the consumer surplus estimates, this suggests a significant increase in recreational use value from the restoration of Crab Bank and lends validity to the willingness to donate estimates.

<u>Aggregate benefits</u>

A number of willingness to donate estimates are presented due to the hypothetical nature of the exercise. In this research context, it is never clear which willingness to donate estimate would most closely mirror the true willingness to donate -- that which would arise from real behavior in the actual situation described in the survey. Given this situation it is appropriate to present the full range of willingness to donate estimates and conduct a sensitivity analysis to determine the most likely outcomes. For this analysis we consider the best WTD estimates to be those estimated without the bias caused by yea-saying behavior. The best case WTD is the estimate that assumes responses are not engaged in hypothetical bias behavior, $63 per household. We consider our base case estimate to be that assuming that respondents do overstate their willingness to donate and include only those who are very sure they would make the donation. The base case WTD estimate is $38 per household. The worst case WTD estimate is considered to be $2 since all respondents who engaged in the valuation exercise stated that they would pay this amount at least once.

Black or African American residents are underrepresented in the sample and these respondents are less likely to donate. If the sample was representative on race, the number of respondents in the donation sample would be lower. The population is 27% black while the sample is 17% black. Since respondents who are Black or African American have a 11.8% lower rate of donation the effect on the sample size of those who will donate is about 1.2% ($11.8 \times (0.27 - 0.17) = 1.18$) higher than it would be if the sample was more representative. Considering high school graduates and using similar math, the number of respondents willing to donate $2 is 1.1% higher than if the sample was more representative. Considering college graduates, the sample is 0.9% higher. On the other hand, the sample has lower median income than the population. The model predicts that the percentage of SC residents that would donate is 1.1% lower than if the sample was representative. Instead of aggregative over 52% of the SC population, we will aggregate over 50% of the population (note: $52.2 - 1.2 - 1.1 - 0.9 + 1.1 = 50.1$).

We also adjust the aggregation rule downward to include only those respondents who answered the questions rationally according to the scope test. In the two-class latent class model (Table 10) there is a 42% chance that respondents would belong to this rational class. By aggregating only over 42% of the sample that would donate at least $2 we may be applying an overly conservative rule. It is likely that a good number of the respondents in the non-attending to scope class is also in the non-attending to cost (i.e., yea saying) class that we have already eliminated.

A summary of the aggregate benefit calculations is presented in Table 17. The number of SC households, almost 2 million, is from the US Census. We apply the probability that a household would donate, 50.1%, estimated from the survey. For our low aggregate benefit we only consider those who would respond rationally to the scope of the environmental improvement, 42%. For our high estimate we consider all responses as valid. The low willingness to donate is the estimate adjusted for fat tails and hypothetical bias, $38. The high estimate is only adjusted for fat tails, $63. Taking the product of the willingness to donate estimate and the valid, donating SC households leads to a range of benefit estimates of $15 million to $60 million. The lower estimate is almost four times greater than the expected cost of Crab Bank restoration. This suggests that the benefits of restoration exceed the costs to SC residents making restoration an efficient policy.

We have attempted to apply conservative decision rules to the aggregate benefit estimate calculation above. But, further sensitivity analysis is warranted given that we use stated preference valuation methods to forecast the future value of Crab Bank. We assume that the willingness to donate is drawn from a uniform distribution with a range from $2 to $68, $WTD \sim U[2{,}68]$, and the number of households that would be willing to donate is drawn from a uniform distribution that ranges from zero to 1.9 million, $N \sim U[0{,}1.922]$. We take 1000 random draws from these distributions and calculate the net benefit for each draw: $NB = WTD \times N - C$. Assuming a constant cost of $4 million, the net benefits range from -$4 million to $55 million. Under these assumptions the probability that the net benefits are negative is 23%.

Economic Contribution

To estimate the baseline 2019 economic contribution of the Crab Bank Sanctuary (CBSS) to the SC Tri-County economy and its communities, total annual category expenditures (e.g., SC Tri-County Area outfitter related sales) that were considered attributable to the CBSS were approximated. (Due to the pandemic, it was assumed that 2020 would be an atypical year for establishing an annual baseline so 2019 was used as the baseline year.) This involved a multi-method approach that included a thorough review of secondary documents, appropriate data sets, selected semi-structured phone interviews of SC coastal nature-based tourism businesses, other organizations as well as recreational participants and other stakeholders.

Modeling Economic Contribution Effects and Input-Output Analysis

Outdoor recreation activities, including both consumptive (e.g., recreational fishing, hunting) and non-consumptive (e.g., bird watching, kayaking) economic activities, can trigger initial expenditures by participants within a region. However, only the estimated expenditure amounts that initially remain in the study region, the SC Tri-county economy, were considered and defined as the direct economic effects. More importantly, these "retained" expenditures can have significant secondary economic effects; this phenomenon that circulates the economic effects of money in the regional economy is referred to as the multiplier effect. That is, initial expenditures can influence other economic sectors in a region, creating several additional rounds or cycles of economic activity. Starting with the direct effects derived from expenditures retained in the region, the multiplier effect has two components: 1) indirect economic effects resulting from subsequent spending by supporting businesses, and 2) induced economic effects stemming from local employees who receive wages and then, in turn, spend these wages on other businesses in the local economy.

For example, expenditures associated with Crab Bank use such as birdwatching will ripple through the regional SC Tri-County economy causing additional rounds of expenditures by SC businesses that provide supporting goods and services. In this situation, the direct economic effects would originate from consumers that paid SC outfitter Crab Bank tour fees and then perhaps dined at a Mount Pleasant, SC, restaurant to chat about their Crab Bank area viewing and/or an on-site visit. Indirect economic effects would include an outfitter contracting a local vendor to service their equipment, and the induced economic effects would include any of the workers at these businesses who receive wages, who then spend their own money at other local stores and shops (e.g., grocery, restaurant). Thus, the total economic effects of these Crab Bank related use expenditures are the sum of the direct economic effects plus the quantifiable effects of indirect and induced economic effects of Crab Bank related use expenditures in the study region.

To approximate how these spending effects ripple throughout a region an input-output (I-O) models and I-O analysis is a method frequently utilized to approximate economic "ripple" effects of expenditures on an industry and/or economic sectors (e.g., lodging, restaurants, outfitter services, etc.). By using multipliers that quantify inter-industry linkages, an I-O model can estimate the cascading total economic effects of initial expenditures such as apparent Crab Bank user (consumer) related spending on an entire region's total household income, employment, value added and other related economic variables (Miller & Blair, 2009). Using an online I-O software, IMPLAN Version 6 (IMPLAN, 2021a), a regional I-O model was employed that had computed sector multipliers specific to the SC Tri-County regional economy. IMPLAN was employed because it is an extensively used software in the U.S. for both EIA and ECA purposes.

<u>Economic Impact Analysis vs. Economic Contribution Analysis</u>

The distinction made between ECA and EIA, as there has been some misapplication of these terms as synonymous, is important to this study. Both of these involve I-O modeling but their measurement reflects "distinctly different metrics…" (Watson et al., 2007). To clarify, ECA economic contribution focuses on the gross changes in a region's existing economy, i.e., the status quo, that can be attributed to a given event, industry or policy, e.g., the pre-restoration regional economic effects of the Crab Bank, while EIA methodology focuses on ex ante, "what if," estimation of the net effects of an economic activity associated with an event, industry and/or policy changes in an existing regional economy (Watson et al., 2007). For a general review of Input-Output (I-O) analyses and further discussion of the differences between ECA and EIA approaches see Parajuli et al. (2019). It is also critical that ECA and EIA, market-oriented analysis methods based solely on using input-output models, are not be confused with other economic analysis methodologies that include estimating non-market economic values such as willingness to pay for nature-based recreation opportunities or restoring a habitat such as the Crab Bank that were the focus of our economic value analysis.

Economic Contribution Analysis Methodology

The economic contribution analysis (ECA) was based on using IMPLAN's compiled data sets that had 413 IMPLAN sectors that characterized the 2018 SC Tri-County economy using 413 IMPLAN sectors (Table 18). The 2018 highlights of the SC Tri-County economy data included that generating a Gross Regional Product (GRP) of about $44.2 billion and $23.4 billion of employee compensation that supported nearly 490,000 jobs (Table 18). As an update, it should be noted that Leisure and Hospitality industry sectors and as well as sectors dependent on military related spending are still important components of the SC Tri-County economy, but the transition toward a much more diverse economy has continued and includes information technology, manufacturing and other sectors. However, during the 2019-20 pandemic induced recession some SC Tri-County sectors had major losses, but progress toward a healthy recovery has continued. Of course, the Leisure and Hospitality sectors had the highest losses; then again, these sectors have continued toward a recovery.

Approximating Crab Bank Related Use Expenditures

The ECA of the sing IMPLAN required approximating category expenditures for two types of activities that were associated with the CBSS economic use: 1) non-consumptive use activities, e.g., guided ("for-hire") ecotours, etc., that usually involved motorized and non-motorized water craft including rentals[5] that were related to viewing and/or visiting the Crab Bank area; and 2) consumptive fishing and shrimping activities that occurred in the Crab Bank area. Possibility significant Crab Bank related economic use activities that were no part of our ECA included for-hire (guided) recreational fishing trips as well as ecotourism-oriented group trips such as bus tours that involved viewing and/or photographing the Crab Bank area from Charleston Harbor locations such as Shem Creek in Mt. Pleasant, SC.

The above Crab Bank area consumptive and non-consumptive recreational activities are not unusual for a protected area. However, unlike some protected area sites such as US National Wildlife Refuges (e.g., Cullinane Thomas et. al, 2018), there were no basic recreational usage

[5] Based on Cauthen (2020) and other sources, it was generally assumed that use of non-motorized watercraft rentals offered by SC Tri-County outfitters mainly included activities related to viewing and/or on-site visiting the Crab Bank area. It is possible that some rentals were also used for consumptive activities related to the Crab Bank area such as shell/fossil collecting and/or recreational kayak fishing.

(e.g., estimated the number of monthly visitors, etc.) and/or other related activity monitoring program data available for the Crab Bank area that could have been used for approximating its SC Tri-County economic contribution or other CBSS use related metrics.

Since IMPLAN's ECA requires expenditure data, Crab Bank use related expenditures had to be approximated based on the secondary data sources that included employing various ad-hoc estimation procedures as well as professional judgment. Also, the highest estimated category expenditure totals related to the Crab Bank area economic activities were sourced from Cauthen's (2020) report that approximated 2018 consumer annual spending on SC Tri-County outfitter for-hire services. Therefore, this set the precedent of trying to select secondary expenditure data sources that were near or based on 2018 dollars (i.e., 2018 consumer purchases). The following summarizes how Crab Bank related activity expenditure data used for the economic contribution analysis was derived:

Outfitter Ecotourism Service, i.e., for-hire paddle ecotours, motor ecotours and watercraft renting:

- Total (aggregated) 2018 annual estimated SC Tri-County outfitter sales, i.e., "Estimated Revenues, Lower," associated with the Crab Bank guide services for motorized and non-motorized tours as well as paddle watercraft rental sales as reported by Cauthen (2020) were used to characterize annual expenditures margined as output dollars on these services (see "Outfitter Fees" category totals in Table 19 for paddle tours and motor tours.). [6]
- In addition, using secondary data related to outdoor recreation spending (e.g., Bertone-Riggs, 2015, etc.) and professional judgment, estimated 2018 annual aggregate category expenditures such as "Auto Fuel," "Lodging" and "Restaurant – Full Service," by these outfitter clients were approximated as simple ratios of the category totals for SC Tri-County outfitter Paddle Tours and Motor Tours reported by Cauthen (2020) (Table 19).

Recreational Fishing:

- Total 2018 annual usage data (e.g., total number of boat fishing trips & average angler per boat trip, etc.) and related expenditures for recreational fishing associated with the Crab Bank area were approximated based on angler interviewers and used to conservatively estimate annual average category private angler expenditure per boat based on SC data adapted from Lovell, et al. (2020). Total category expenditures were then approximated (extrapolated) by multiplying the 2018 estimated total number of fishing boat trips, 1,200, related to using the Crab Bank area by the category averages per

[6] Cauthen (2020) used simple algorithms and various assumptions to estimate 2018 outfitter gross revenues (sales) that included activities for coastal destinations including the Crab Bank area. Cauthen (2020) is commended for attempting to approximate these data as part of his internship study.

boat trip (Table 19).

Recreational Shrimping:

- Total 2018 annual expenditures for shrimp baiting activities within the Crab Bank area were approximated based on recreational shrimper interviewers and by assuming that shrimping expenditures when controlled for estimated average number of shrimpers per boat trip as well as bait and ice trip costs were similar to SC private angler fishing trip spending as adapted from Lovell, et al. (2020). When approximating 2018 annual average category per boat expenditures for Crab Bank "deep-hole" shrimping[7] activities, spending data was also adapted from Lovell, et al. (2020) and adjusted for the average number of participants per boat trip with bait expenses excluded. Category totals were then approximated by multiplying the 2018 estimated total number of shrimping boat trips, 1,720, weighted for deep-hole vs shrimp baiting based on interviews and professional judgment (Table 19).

Paddle Club Group Activities (e.g., meetups, etc.)

- Based on Charleston area internet paddle club membership count data[8] (Paddle SC, 2021) and participant interviews, average category expenditures in 2018 dollars per boat or participant associated with individual club trips were approximated using data adapted from Lindberg and Bertone-Riggs (2015) and Beedle (2008). Using estimated average category totals per boat, usually one person per kayak (Table 19), these paddle club averages were then extrapolated to annual category totals based on the provisional assumption that SC Tri County club members and their guests participated in 1,490 boat trips associated with the Crab Bank area during 2018.

<u>IMPLAN Economic Contribution Procedures</u>

The approximated sub-totals for the above Crab Bank related use activities were then allocated ("sectored") to each appropriate industry sector using IMPLAN Activity templates (Table 20). IMPLAN related methodological literature (e.g., Kosaka & Steinback, 2018), IMPLAN industry sector descriptions, and other sources such as Cullinane Thomas, et. al (2017) as well as professional judgment were used to allocate these Crab Bank related expenditure values to the appropriate IMPLAN sectors. As needed when using an I-O model, all expenditure values

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[7] "Deep-hole" shrimping involves using a specialized cast net to target shrimp commonly found at depths greater than 15 feet without using a bait attractant (Cope, 2022).

[8] SC Tri-County outfitter non-motorized watercraft rental sales, mainly kayaks, associated with the Crab Bank were included in the outfitter ECA. Therefore, to minimize possible double-counting of Crab Bank use related rental sales by SC Tri-County outfitters, the estimate of paddle club trips was adjusted to only include the approximated number of club members that most likely used their own or a borrowed watercraft (ACA, 2019), not a rental, for Crab Bank area use activities.

associated with a given producing sector were also converted into manufacturer or producer values using IMPLAN default settings. As previously indicated, this included converting approximated retail expenditures by Crab Bank users (consumers) into appropriate producer values using IMPLAN default retail margin settings.

These subtotals included user spending on outfitter tours and/or rental fees associated with the Crab Bank as well as other estimated trip expenses assumed to have been related to viewing, visiting and/or consumptive uses (e.g., shrimping, etc.) of the Crab Bank area. Based on outfitter recommendations, economic contribution output and other dollar metrics generated by IMPLAN's ECA were converted from 2018 dollars to 2019 dollars using IMPLAN deflators. Thus, a relatively conservative reference point ("benchmark") was established for typifying the pre-restoration annual economic contribution effects related to the Crab Bank area.

Crab Bank Economic Contribution Analysis Results

DISCLAIMER: The economic contribution aggregates associated with selected Crab Bank activities that were estimated in this study were based on a limited number of stakeholder interviews and/or secondary data sources. Thus, these estimated economic aggregates are only intended to typify output and other economic contribution metrics (e.g., employment, value added, etc.) related to SC Tri-County business services and products (e.g., for-hire paddle tours, kayak rentals, food & beverage purchase, etc.) that could have been associated with viewing, visiting and/or other selected use activities related to the Crab Bank area.

The estimated annual baseline (pre-restoration) economic contribution for SC Tri-County ecotourism outfitter services (Table 21) and other selected use activities (Table 22) considered to be attributable to the Crab Bank area were estimated and summarized (Table 23). These direct, indirect and induced economic contribution effects for the SC Tri-County economy were based on estimated Crab Bank use expenditures that were assumed to have been attributable to major Crab Bank activities before restoration. The combined SC Tri-County total estimated direct output contribution effects of outfitter ecotourism services, recreational fishing, shrimping and paddle club activities (Table 23) were about $3.03 million (in 2019 dollars).[9] The combined total economic contribution output effects, approximately $5.18 million, supported an estimated total number of 54.4 jobs (full time and part time) and generated about $1.65 million in labor income (i.e., salaried employee wages and proprietor income) (Table 23).

The approximated combined total contribution effects of these activities also generated a SC Tri-County Gross Regional Product (total value added), a subcomponent of the total output effect, of about $2.67 million (Table 23). Using IMPLAN, it was also estimated that the total 2019 local and SC state taxes related to the SC Tri-County economic contribution effects of the Crab Bank

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[9] It should be noted that these direct effect outputs represent sales that were initially retained in the SC Tri-County economy and should not be confused with gross sales related to Crab Bank industry sectors.

including tax induced effects were about $178,400 and $143,600, respectively.

When evaluating overall ECA results, a simple and useful regional economic analysis comparative evaluation metric includes comparing IMPLAN derived Type Social Accounting Matrix (SAM) economic contribution output multipliers to other regional ECA studies that also used I-O models, herein called a “SAM ECA output multiplier.” SAM total economic multipliers in general, represent the size of estimated total economic effects as a ratio of total effects output to direct effects with total effects including indirect and induced effects stemming from an economic activity (e.g., Crab Bank related economic activities) in a region due to household spending of earned income linked to the direct or indirect effect of resident and nonresident consumer spending. IMPLAN’s multipliers also include induced effects resulting from local/state/federal government spending. However, ECA SAM total output multipliers and other ECA SAM multipliers are not comparable to EIA derived SAM total output multipliers even if the same exact regional data, participant spending patterns and related sectoring were used. This is due to the ECA related constraints that were applied to the I-O model’s feedback linkages (i.e., indirect and induced effects) in the study area so that economic contribution effects would not be overestimated by double-counting secondary effects (Parajuli et al., 2019).

A state level 2011 SAM ECA output multiplier for SC wildlife watching expenditures estimated by Poudel et al. (2017), 1.77, was slightly larger than the 2019 ECA output multiplier, 1.71, estimated for apparent Crab Bank area related activities in this study. Possible factors contributing to the relatively lower multiplier in our study while perhaps not being significantly different include the use of different IMPLAN sectoring approaches and the size of the study region economies. The size of the study region economy can be especially important because generally the larger the regional economy, the higher will be the associated total multipliers, other factors being equal, thus a higher potential for “recirculating” participant expenditures more often in the larger region (Watson et al., 2007).

<u>Limitations and Recommendations</u>

The ecological importance and biodiversity significance of the CBSS has been well documented (e.g., National Audubon Society [NAS], 2022). This study provided new important public policy information by estimating the non-market economic benefits of the CBSS and characterizing the its baseline SC Tri-County economic contribution metrics. Nevertheless, this study’s scope did not include considering other possible socioeconomic benefits related to the CBSS. A list of these important CBSS socioeconomic benefits would include the following:

- ✓ Fostering local community links with their cultural and natural heritage
- ✓ Generally nurturing local, regional and national support for funding conservation programs
- ✓ Providing a site for environmental education activities that advances localized conservation awareness
- ✓ Providing a site that largely reinforces positive social “connectivity” with the environment and
- ✓ Generally improving human health and well-being for active and passive users.

We recognize that protecting and monitoring ground-nesting seabirds and shorebirds are the highest priority uses for the limited funding, volunteer and other resources available for managing the Crab Bank. Yet, we believe it is apparent that one of the important limitations to estimating the Crab Bank's recreational non-market use value and economic contribution includes the lack of a basic Crab Bank usage monitoring program such as using non-interviewing methods (e.g., using random visual counting methods) to approximate the weekly number of individuals that visited and/or used the Crab Bank area. Consequently, our SC Tri-County economic contribution analysis was challenged by dependency on various secondary sources and the related need to use ad-hoc methods for estimating Crab Bank basic usage metrics. Also, for a coastal economy with major tourism dependent economic sectors, there was a paucity of basic cross-sectional data regarding Crab Bank participants such as residency, accommodation arrangements and reason(s) an individual choose to visit and/or use (e.g., collect shells, etc.). These types of data are especially important for informing nature-based tourism marketing, management and related public policy.

However, we are not currently aware of any plans to implement a recreational usage monitoring program for the Crab Bank that could provide a pragmatic multi-purpose data source for approximating various economic benefits that will be generated by this unique publicly accessible protected area. For example, Shaw and Dundas (2021) recommend that management plans for restored areas should include implementing recreational usage monitoring because among other considerations these data when coupled with benefit transfer methods can be especially useful in estimating the non-market benefits of a restoration project over time. Specifically, our recreation demand analysis results are consistent with the need to consider implementing a pragmatic choice type experiment methodology approach that would include periodically asking non-resident SC Tri-County Crab Bank visitors if they would still take the trip if it cost more and if the Crab Bank was not there. This approach, among other considerations, would allow estimating the non-market economic use value as a Crab Bank trip attribute, not as the sole purpose of the trip.

In addition, if recreational usage data were routinely collected, it could be combined with user expenditure pattern estimates derived from secondary and/or primary data sources for annually informing stakeholders about the post-restoration economic contribution of the Crab Bank. Recreational usage data might also be useful for the trend analysis of human disturbances effects on Crab Bank shorebirds as well as the related policy-oriented socioeconomic dimensions of laws and policies in place to help minimize human disturbances.

IMPLAN, a static economic impact model, was a critical tool in this study. While IMPLAN is on to the most widely used model for estimating and analyzing regional economic impacts and contributions, some of its limitations should be considered. First, as previously discussed it is possible that their 2020 data due to the uniqueness of pandemic related effects "…does not accurately reflect the economic conditions…" (IMPLAN, 2021b). This type of economic environment still should be considered when using a static, I-O model given uncertainty surrounding the evolving local, regional and national economies. There are also a number of theoretical limitations when using a static input-output model as well as issues with verifying its estimates. In addition, IMPLAN does not recommend using their data for ECA or EIA analysis purposes five years beyond the data set year; 2018 for the IMPLAN version used in this study. Regardless, IMPLAN is still among the most cost-effective static economic impact model software and met our need of providing economic contribution approximations congruent with our study's scope and resources.

Conclusions

In this report we have estimated the use and non-use values of renourishment of the CBSS and estimated category expenditure and usage patterns of economic activities associated with the CBSS area and baseline economic contribution for the Tri-County Area related to the CBSS. The key finding is that there is substantial value generate by restoration of Crab Bank. The benefit of a restored Crab Bank ranges from a minimum of $15 million when we adopt the most conservative assumptions up to a maximum of $60 million. The lower estimate is almost four times greater than the expected cost of Crab Bank restoration. This suggests that the benefits of restoration exceed the costs to SC residents making restoration an efficient policy.

The economic valuation and contribution analysis findings allow private and public-sector stakeholders to have an improved and informed conversation on the economic significance of the CBSS area. In addition, the study methodology and findings are supportive of the continued need for the economic analysis of habitat restoration, enhancement and similar types of projects across federal programs. The findings also help inform nature-based tourism marketing, management and related public policy.

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Table 1. "Provision point" donation scenarios

Scenario	More than $4 million is raised	Less than $4 million is raised
1	Additional money is returned	All of the money is returned
2	Additional money is used for science	All of the money is returned
3	Additional money is used for conservation	All of the money is returned
4	Additional money is returned	Less than 50 years maintenance
5	Additional money is used for science	Less than 50 years maintenance
6	Additional money is used for conservation	Less than 50 years maintenance

Table 2. Willingness to donate

Scenario	Sample size	% Yes	% No	% I don't know
1	397	33	39	28
2	411	35	36	29
3	381	31	45	24
4	402	34	38	28
5	410	33	38	29
6	427	34	39	27

Table 3. Population and Sample Socioeconomic Characteristics

Characteristic	Population	Sample
Midlands Region	29%	30%
PeeDee Region	18%	20%
Upstate Region	30%	30%
Low Country Region	23%	20%
Age 65 and older	23%	29%
Female	52%	64%
White	69%	78%
Black or African American	27%	17%
High school graduate (age 25+)	88%	96%
College graduate (age 25+)	28%	40%
Median household income	$53,199	$45,000
Sample size		1109

Table 4. Linear probability model: Determinants of willingness to donate $2

	Coefficient	Standard Error	t-value	Coefficient	Standard Error	t-value
Intercept	0.4795	0.1039	4.61	0.4630	0.1001	4.63
Distance	-0.0008	0.0005	-1.59	-0.0008	0.0005	-1.65
Midlands	0.0530	0.0641	0.83	0.0481	0.0629	0.76
PeeDee	0.0590	0.0544	1.08	0.0585	0.0542	1.08
Upstate	0.0877	0.0890	0.98	0.0727	0.0882	0.82
Age65	-0.0454	0.0341	-1.33	-0.0432	0.0353	-1.23
Female	-0.0068	0.0319	-0.21	-0.0214	0.0300	-0.71
White	-0.0527	0.0620	-0.85	-0.0768	0.0623	-1.23
Black	-0.1156	0.0676	-1.71	-0.1181	0.0675	-1.75
High School	0.0747	0.0754	0.99	0.1418	0.0717	1.98
Bachelors	0.0578	0.0346	1.67	0.0766	0.0349	2.19
Income	0.0014	0.0004	3.43	0.0013	0.0004	3.34
F value	3.46			4.75		
R^2	0.0335			0.0454		
Sample size	1109			1109		
Weighted	No			Yes		

Note: Standard errors are clustered on the respondent.

Table 5. Data summary of subsample of respondents willing to donate $2

Variable	Mean	Minimum	Maximum
Distance from Mt. Pleasant, SC	136.853	0	261.65
Midlands Region resident	0.283	0	1
PeeDee Region resident	0.209	0	1
Upstate Region resident	0.295	0	1
Low Country Region resident	0.212	0	1
Age 65 and older	0.295	0	1
Female	0.604	0	1
White	0.803	0	1
Black or African American	0.145	0	1
High school graduate	0.969	0	1
College graduate	0.432	0	1
Median household income (in thousands)	65.035	5	155
Sample size	579		

Table 6. Donation scenario variables

Variable	Label
Yes	Would donate $A
Yes very sure	Is "very sure" would donate $A in a real situation
Amount	Donation amount ($A)
Homes	Number of homes protected (in thousands)
Nests	Number of seabird nests protected
Return1	Extra donations: returned
Science	Extra donations: used for science
Conserve	Extra donations: used for conservation
Return2	Not enough donations: returned
LT50YRS	Not enough donations: Crab Bank is maintained for less than 50 years

Table 7. Data summary of donation scenario variables

	Attribute means by donation question number					
Variable	1	2	3	4	5	6
Yes	34%	36%	31%	35%	33%	35%
Yes very sure	22%	22%	22%	23%	21%	5%
Amount	157	153	158	152	152	150
Homes	56	56	52	55	54	55
Nests	3.56	3.53	3.49	3.47	3.52	3.47
Return1	1	0	0	1	0	0
Science	0	1	0	0	1	0
Conserve	0	0	1	0	0	1
Return2	1	1	1	0	0	0
LT50YRS	0	0	0	1	1	1
Sample size	380	392	362	384	391	407

Table 8. Donation responses by dollar amount

Amount	% Yes	% Yes very sure	Sample size
10	81.1	56.8	74
20	71.4	50.0	70
30	65.1	44.2	86
40	53.0	36.4	66
50	57.3	31.5	89
60	55.4	37.8	74
70	43.8	31.3	80
80	40.5	26.6	79
90	40.0	25.9	85
100	40.7	27.2	81
110	32.9	19.0	79
120	27.3	15.6	77
130	25.0	20.8	72
140	24.7	13.5	89
150	26.8	14.6	82
160	31.3	17.5	80
170	21.4	17.1	70
180	28.6	17.9	84
190	21.8	13.8	87
200	40.3	25.4	67
210	15.3	9.70	72
220	17.5	8.80	57
230	28.2	19.2	78
240	18.6	16.3	86
250	21.7	11.7	60
260	21.2	14.1	85
270	22.4	17.9	67
280	19.5	9.8	82
290	15.0	11.3	80
300	19.2	14.1	78

Table 9. Logistic regression model: Determinants of willingness to donate > $2 (Yes)

	Coefficient	Standard Error	t-value	Coefficient	Standard Error	t-value
Constant	1.6501	0.6085	2.71	1.6237	0.6204	2.62
Amount	-0.0092	0.0007	-12.63	-0.0086	0.0007	-12.67
Homes	0.0009	0.0017	0.53	0.0005	0.0016	0.28
Nests	0.0700	0.0423	1.65	0.0672	0.0403	1.67
Science	-0.0186	0.1009	-0.18	-0.0995	0.0970	-1.03
Conserve	-0.0837	0.1045	-0.8	-0.1120	0.1003	-1.12
LT50YRS	-0.0238	0.0825	-0.29	-0.0453	0.0794	-0.57
Distance	-0.0026	0.0025	-1.06	-0.0013	0.0024	-0.54
Midlands	0.4698	0.3449	1.36	0.5067	0.3140	1.61
PeeDee	0.2201	0.2879	0.76	0.2747	0.2746	1.00
Upstate	0.7696	0.4769	1.61	0.6147	0.4551	1.35
Age65	-1.2208	0.1853	-6.59	-1.1698	0.2068	-5.66
Female	-0.7889	0.1641	-4.81	-0.8519	0.1559	-5.47
White	-0.2573	0.3318	-0.78	-0.3908	0.3195	-1.22
Black	0.2473	0.3579	0.69	0.1649	0.3365	0.49
High School	-0.5194	0.4014	-1.29	-0.5251	0.4432	-1.18
Bachelors	0.0552	0.1722	0.32	0.2518	0.1708	1.47
Income	0.0021	0.0020	1.06	0.0014	0.0020	0.74
Model χ^2	455.57			474.56		
Pseudo R^2	0.1529			0.1539		
Sample size	579			579		
Time periods	4			4		
Weighted	No			Yes		

Note: Standard errors are clustered on the respondent.

Table 10. Latent class logistic regression model: Determinants of willingness to donate > $2 (Yes)

	Class 1			Class 2		
	Coefficient	Standard Error	t value	Coefficient	Standard Error	t value
Constant	0.9493	0.5824	1.63	2.3778	0.5131	4.63
Amount	-0.0342	0.0034	-10.19	-0.0104	0.0013	-8.27
Homes	-0.0002	0.0040	-0.04	0.0037	0.0033	1.10
Nest	-0.0731	0.1042	-0.70	0.1790	0.0867	2.07
Science	-0.0697	0.2826	-0.25	-0.3174	0.2330	-1.36
Conserve	-0.1975	0.2778	-0.71	-0.0985	0.2356	-0.42
LT50YRS	-0.2215	0.2308	-0.96	0.0997	0.1891	0.53
Age65	-0.5989	0.2852	-2.10	-1.8226	0.3241	-5.62
Female	-0.1000	0.2445	-0.41	-0.9554	0.2257	-4.23
Income	0.0113	0.0029	3.83	0.0111	0.0030	3.76
Class probability	0.5836	0.02476	23.57	0.4164	0.02476	16.82
Model χ^2	627.84					
Pseudo R^2	0.237					
Sample size	579					
Time periods	4					
Weighted	Yes					

Table 11. Simple models: Willingness to donate > $2 (Yes, Yes sure)

	Yes			Yes very sure		
	Logistic Regression - linear					
	Coefficient	Standard Error	t value	Coefficient	Standard Error	t value
Constant	0.6312	0.09848	6.41	-0.19403	0.10841	-1.79
Amount	-0.00755	0.00060	-12.66	-0.00618	0.0007	-8.79
Model χ^2	209.10			115.27		
Pseudo R^2	0.0678			0.0438		
	Logistic Regression – log-linear					
	Coefficient	Standard Error	t value	Coefficient	Standard Error	t value
Constant	3.4799	0.3001	11.60	1.8761	0.2909	6.45
Ln(Amount)	-0.8325	0.0629	-13.23	-0.6288	0.0631	-9.96
Model χ^2	239.31			130.47		
Pseudo R^2	0.0776			0.0496		
	Linear Regression (OLS)					
	Coefficient	Standard Error	t value	Coefficient	Standard Error	t value
Constant	0.6393	0.0236	27.13	0.4260	0.0241	17.64
Amount	-0.0017	0.0001	-14.61	-0.0011	0.0001	-9.66
F value	221.6			118.0		
R^2	0.0874			0.0485		
Sample size	579			579		
Time periods	4			4		
Weights	Yes			Yes		

Note: Standard errors are clustered on the respondent.

Table 12. Simple latent class logistic regression model: Willingness to donate > $2 (Yes)

	Class 1			Class 2		
	Coefficient	Standard Error	t value	Coefficient	Standard Error	t value
Constant	1.7028	0.6097	2.79	2.1143	0.3086	6.85
Amount	-0.1070	0.0311	-3.44	-0.0119	0.0018	-6.73
Class probability	0.3535			0.2276		
	Class 3			Class 4		
	Coefficient	Standard Error	t value	Coefficient	Standard Error	t value
Constant	4.0831	0.8068	5.06	5.6796	1.7774	3.2
Amount	0[a]			-0.0767	0.0227	-3.38
Class probability	0.1950			0.2240		
Model χ^2	845.57					
Pseudo R^2	0.2942					
Sample size	579					
Time periods	4					
Weights	Yes					

Note: The coefficient on the amount variable is constrained to zero. This is supported by the likelihood ratio test where the restriction is not rejected (χ^2 = 0.074 [1 df]).

Table 13. Simple latent class logistic regression model: Willingness to donate > $2 (Yes very sure)

	Class 1			Class 2		
	Coefficient	Standard Error	t value	Coefficient	Standard Error	t value
Constant	0.3641	0.5383	0.68	5.0867	1.3622	3.73
Amount	-0.0871	0.03118	-2.79	-0.0602	0.0177	-3.40
Class probability	0.5517	0.0363	15.22	0.1766	0.0339	5.20
	Class 3			Class 4		
	Coefficient	Standard Error	t value	Coefficient	Standard Error	t value
Constant	1.1320	0.5155	2.20	0.6106	0.7410	0.082
Amount	-0.0066	0.0031	-2.16	0.0392	0.0178	2.20
Class probability	0.1505	0.0259	5.81	0.1212	0.0161	7.55
Model χ^2	755. 60					
Pseudo R^2	0.3005					
Sample size	579					
Time periods	4					
Weights	Yes					

Note: The coefficient on the amount variable is constrained to zero. This is not supported by the likelihood ratio test but the unconstrained coefficient is positive and statistically different from zero.

Table 14. Willingness to donate (WTD) estimates

	Yes			Yes very sure		
	WTD	Standard Error	t value	WTD	Standard Error	t value
Mean[a]	83.65	9.51	8.79	-31.41	20.29	-1.55
Zero Truncated Mean[a]	140.18	7.75	18.09	97.25	7.63	12.75
Median[b]	65.37	5.99	10.92	19.76	3.76	5.25
Linear mean[c]	122.26	5.95	20.54	81.27	5.23	15.54
Fat tails corrected mean[d]	62.80	6.48	9.69	38.03	5.91	6.43
Fat tails corrected zero truncated mean[d]	65.55	6.61	9.90	46.52	8.27	5.63

Notes:

[a] Logistic regression, linear functional form

[b] Logistic regression, log-linear functional form

[c] Linear probability model

[d] Latent class logistic regression model

Table 15. Data summary: recreational use of Crab Bank

	Truncated Sample				
Variable	N	Mean	Std Dev	Minimum	Maximum
Visits in 2020	111	3.126	2.375	1	10
Visits in 2021	126	3.524	2.643	1	10
Visits in 2022	376	2.691	2.230	1	10
Travel cost	579	102.976	61.286	0	286.73

Table 16. Negative binomial recreation demand model: dependent variable is the number of visits to Crab Bank

	Coefficient	Standard Error	t value
Constant	-0.05115	0.22409	-0.23
Travel cost	-0.00359	0.00098	-3.65
Income	0.00727	0.00147	4.95
Year = 2021	0.28737	0.17214	1.67
Year = 2022	1.23476	0.10978	11.25
α (random effects	2.65823	0.35332	7.52
β (overdispersion)	0.59198	0.07001	8.46
Log Likelihood	-2639.22		
Sample size	1109		
Observations	2797		

Table 17. Aggregate benefit estimates

	Low	High	Notes
SC households	1,921,862	1,921,862	Census Quickfacts SC (2015-2019)
%donate	50.1%	50.1%	Survey Question
Donating SC households	962,853	962,853	SC households × %donate
%valid	42%	100%	Class 2 probability Table 10
Valid, donating SC households	400,932	962,853	Donating SC households × %valid
Willingness to donate	38.03	62.80	Fat tails corrected mean, Table 14
Aggregate benefit (millions)	15.25	62.47	Valid, donating SC households × Willingness to donate

Table 18. IMPLAN I-O Model Study Area of the South Carolina Tri-County Economy

2018 Dollars (Thousands)			
Model Year	2018	Regional Value Added	
Gross Regional Product	$44,246,057	Employee Compensation	$23,426,196
Total Personal Income	$38,324,778	Proprietor Income	$3,861,947
Total Employment	489,149	Other Property Income	$13,989,263
Number of Industries	413	Taxes on Production & Imports	$2,968,651
Land Area (Sq. Miles)	2,592	Total Value Added	$44,246,057
Population (2018)	787,643		
Total Households	304,817		

Table 19. Estimated Category Expenditures for Selected Crab Bank Related Activities (2019 Dollars).

	Outfitter Annual Category Expenditure [a]		Average Category Expenditures Per Boat Trip		
Expenditure Categories	Paddle Tours	Motor Tours	Paddle Clubs	Fishing	Shrimping
Auto Fuel	$177,453	$13,889	$11.07	$53.55	$35.70
Bait	$0.0	$0.0	$0.00	$15.39	$3.14
Food - Groceries	$643,363	$50,355	$19.09	$61.25	$40.84
Ice	$23,046	$1,804	$5.40	$3.69	$12.72
Lodging	$330,864	$25,896			
Outfitter Fees [b]	$1,244,475	$72,150			
Parking	$93,105	$7,287	$1.39	$1.39	$1.39
Restaurant - Full Service	$113,195	$8,860			
Restaurant - Limited Service	$226,732	$17,746			
Retail - Sporting Goods	$86,838	$6,798	$6.61	$24.68	$24.68
Outfitter Totals	$2,939,070	$204,785	NA	NA	NA
Weighted Total Category Averages Per Boat Trip			$43.56	$159.95	$118.46
Weighted Total Annual Boat Trips for Activity			1,490	1,200	1,720

Notes:

[a] These are approximated total (aggregated) category expenditures by participants on for-hire paddle and motor ecotours as well as paddle watercraft rental sales, mainly for kayaks.

[b] The paddle tours "Outfitter Fees" category total includes estimated rental sales to SC Tri-County club participants that rented a paddle boat (e.g., kayak, etc.) for a club activity and assumes other paddle tours category totals, except for "Lodging," apply to paddle club boat renters.

Table 20. IMPLAN Sector Scheme for Crab Bank Related Expenditures.

Expenditure Categories	IMPLAN 546 Sectors	IMPLAN Type
Auto Fuel	154	Industry/Margins
Bait	17	Industry/Margins
Food - Groceries	406	Industry
Ice	105	Industry/Margins
Lodging	507	Industry
Outfitter Fees	504	Industry
Parking	534	Local Government
Restaurant - Full Service	509	Industry
Restaurant - Limited Service	510	Industry
Retail - Sporting Goods	410	Industry

Table 21. Annual Economic Contribution to the SC Tri-County Economy Associated with Crab Bank Related Outfitter Ecotourism Activities

Impact Type	Employment	Labor Income	Value Added	Output
Direct Effects	38.7	$941,067	$1,394,279	$2,669,460
Indirect Effects	7.2	$344,202	$570,483	$1,201,342
Induced Effects	4.6	$226,161	$432,089	$734,022
Total Effects	50.6	$1,511,430	$2,396,851	$4,604,824

Note:

The economic contribution metrics include employment (the estimated number of annual full-time and part-time jobs), labor income (proprietor income and wages paid to salaried employees), value added (the sum of labor income, property income and indirect business taxes) and output (sum of value added and intermediate input costs).

Table 22. Annual Economic Contribution to the SC Tri-County Economy Associated with the Crab Bank Related to Recreational Fishing, Shrimping and Paddle Club Activities

Impact Type	Employment	Labor Income	Value Added	Output
Direct Effects	2.6	$78,254	$168,002	$358,219
Indirect Effects	0.8	$36,888	$61,489	$145,102
Induced Effects	0.5	$21,636	$40,889	$69,642
Total Effects	3.9	$136,777	$270,380	$572,963

Note:

The economic contribution metrics include employment (the estimated number of annual full-time and part-time jobs), labor income (proprietor income and wages paid to salaried employees), value added (the sum of labor income, property income and indirect business taxes) and output (sum of value added and intermediate input costs).

Table 23. Total Annual Economic Contribution to the SC Tri-County Economy for Selected Crab Bank Activities

Impact Type	Employment	Labor Income	Value Added	Output
Direct Effects	41.3	$1,019,321	$1,562,281	$3,027,679
Indirect Effects	8.0	$381,090	$631,972	$1,346,444
Induced Effects	5.1	$247,797	$472,978	$803,664
Total Effects	54.4	$1,648,207	$2,667,230	$5,177,787

Notes:

These Crab Bank associated activities involved outfitter for-hire ecotour services, recreational fishing, shrimping and paddle club meet-ups.

Economic contribution metrics include employment (the estimated number of annual full-time and part-time jobs), labor income (proprietor income and wages paid to salaried employees), value added (the sum of labor income, property income and indirect business taxes) and output (sum of value added and intermediate input costs).

Figure 1. Restored Crab Bank

Photo Credit: Jon Engle/Southwings

Figure 2. An example of hypothetical donation scenarios

Consider the following Crab Bank donation scenario.

The number of homes that will be protected from shoreline erosion is **20**.

The number of bird nests in a typical summer is **5000**.

If the total amount of money raised is above $4 million then the **extra money would be returned to households who donate**.

If the total amount of money raised is below $4 million then all donations would be used to maintain Crab Bank but the island would be **maintained at 28 acres for less than 50 years**.

Would you be willing to make a one-time donation of **$250**, in 2022, to the Crab Bank Maintenance Fund?

- ○ Yes
- ○ No
- ○ I don't know

Figure 3. Willingness to donate responses

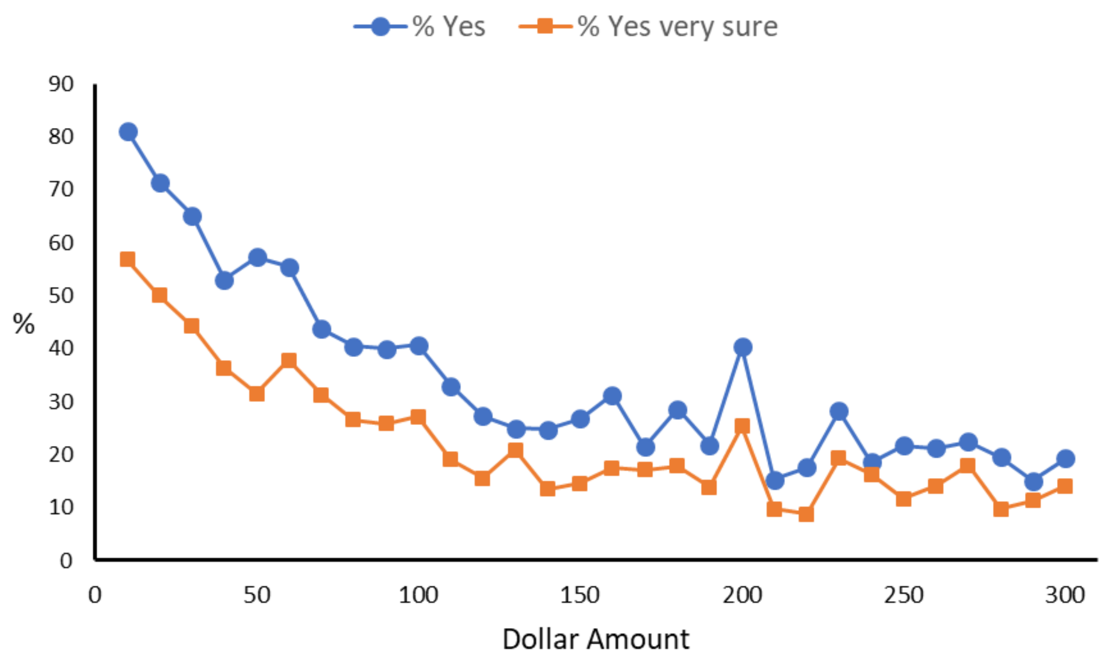
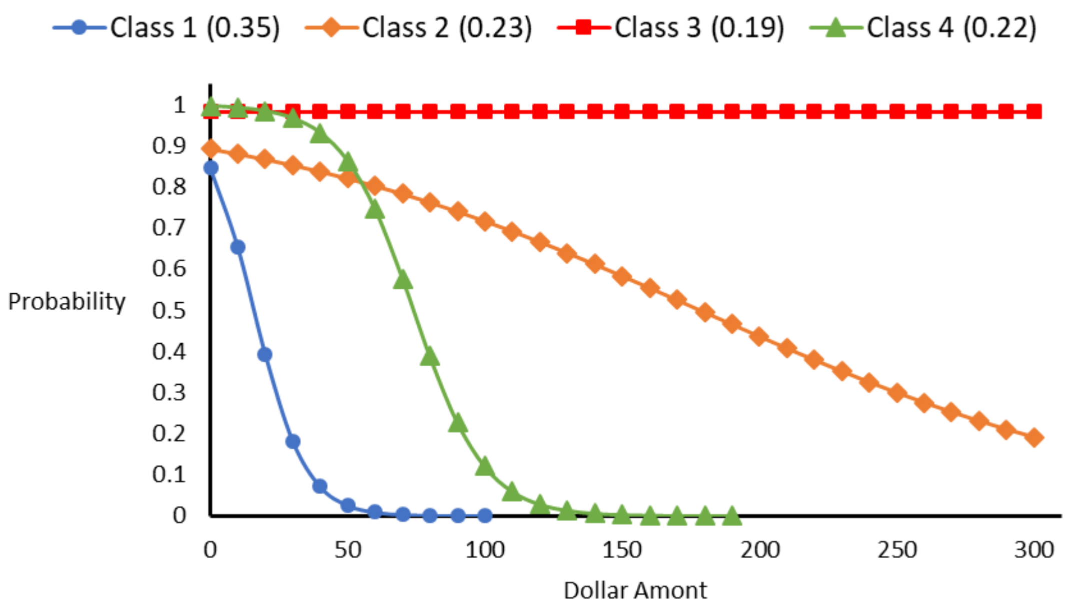


Figure 4. Estimated bid curves from a latent class logit model



Appendix A. Qualtrics Survey Questionnaire

Notes:

1. In the choice questions:
    - **H** is the randomly assigned number of homes protected {H = 10, 20, 30, 40, 50, 60, 70, 80, 90, 100}
    - **N** is the randomly assigned number of bird nests supported at Crab Bank {N = 2000, 3000, 4000, 5000}
    - **A** is the randomly assigned donation amount {A = 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 110, 120, 130, 140, 150, 160, 170, 180, 190, 200, 210, 220, 230, 240, 250, 260, 270, 280, 290, 300}
2. Labels [in brackets] were for internal use and did not appear on screen.
3. An online version of the questionnaire can be found here:

    https://appstate.az1.qualtrics.com/jfe/form/SV_cAzDSx4FEtj8BzE

Appendix B. SPSS Codebook: Raw Data Summary