# The Effects of Marine Debris on Beach Recreation and Regional Economies in Four Coastal Communities: A Regional Pilot Study

**Final Report**

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## Executive Summary

Marine debris is a persistent problem in many coastal areas of the United States. There are a variety of potential economic losses associated with marine debris, including effects on commercial fisheries, effects on waterfront property values, costs incurred by local governments and volunteer organizations to remove and dispose of marine debris, and more general "existence" values reflecting the public's preference for a clean environment. This study evaluates two types of economic loss that result from the effects of marine debris on beach recreation: the loss of recreational value to beach visitors, and the regional economic impact from reduced spending on beach visits in a particular region.

The goal of this study was to better understand the economic effects of changes in the amount of debris on beaches. The results may help federal, state, and local agencies structure future debris abatement and mitigation projects to maximize social benefits provided by coastal resources. To address these goals, we collected data from four coastal areas in the United States: Gulf Coast beaches in Alabama, Atlantic Ocean beaches in Delaware and Maryland, Lake Erie beaches in Ohio, and Pacific Ocean beaches in Orange County, California.

We estimated the effect of marine debris using two different economic concepts: the **value of recreation** and the **economic impacts of recreation**. The value of recreation is a monetary measure of the enjoyment people get from participating in beach recreation. It can also be described as people's willingness to pay for recreational access to beaches, or for policies that improve beach recreation. The economic impact of recreation is a measure of the effect of beach recreation on spending by consumers and businesses in the region. It includes both direct spending on recreational activities and the effects of direct spending in stimulating the local economy. Because spending in some regions may increase as a result of a decrease in spending in other regions, amounts calculated for different regions should not be added together. Because they are interpreted in fundamentally different ways, economic impacts should also not be added together with estimates of recreation value.

**Recreational Value**

Recreational value is a monetary measure of the enjoyment people get from participating in beach recreation, or their "willingness to pay" for recreation and clean beaches.

**Economic Impacts of Recreation**

Economic impacts of recreation measure the effect of beach recreation on spending by consumers and businesses in the local economy.

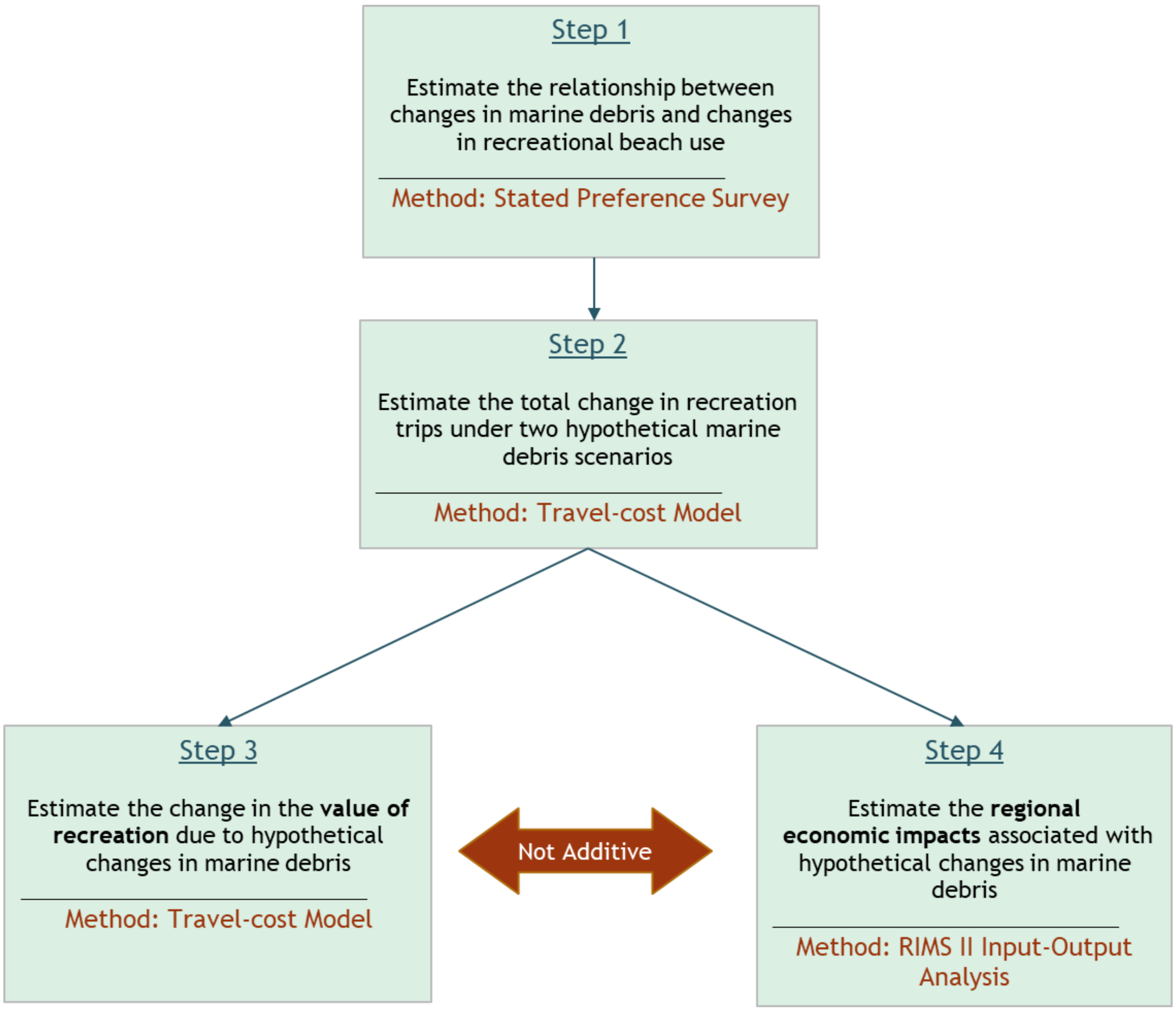
We measured recreational value and economic impacts for two hypothetical scenarios involving marine debris on beaches: a **reduction in debris to almost none** (defined in the study as one piece of debris per 500 square feet of beach), and a **doubling of debris**.

### Study Design

This study evaluated the relationship between marine debris and recreational beach use by recruiting participants at beaches in the four selected coastal areas. Those willing to participate in the study were sent a mail-in survey with questions about their beach recreation, their opinions about marine debris, and how their recreation would change if there were different amounts of debris on beaches.

The data from the surveys were used to estimate the total effect of changes in marine debris on the number of beach visits in each area. These estimates in turn were used in a nationwide recreation model originally developed during the natural resource damage assessment for the *Deepwater Horizon* oil spill (English et al., 2018) to estimate the change in recreational value from the hypothetical changes in debris. In addition, the estimates of changes in visits were incorporated into a regional input/output model to determine the regional economic impacts of marine debris (Figure ES-1).

**Figure ES-1. Steps for estimating changes in recreational value and regional economic impacts associated with changes in marine debris on beaches.**



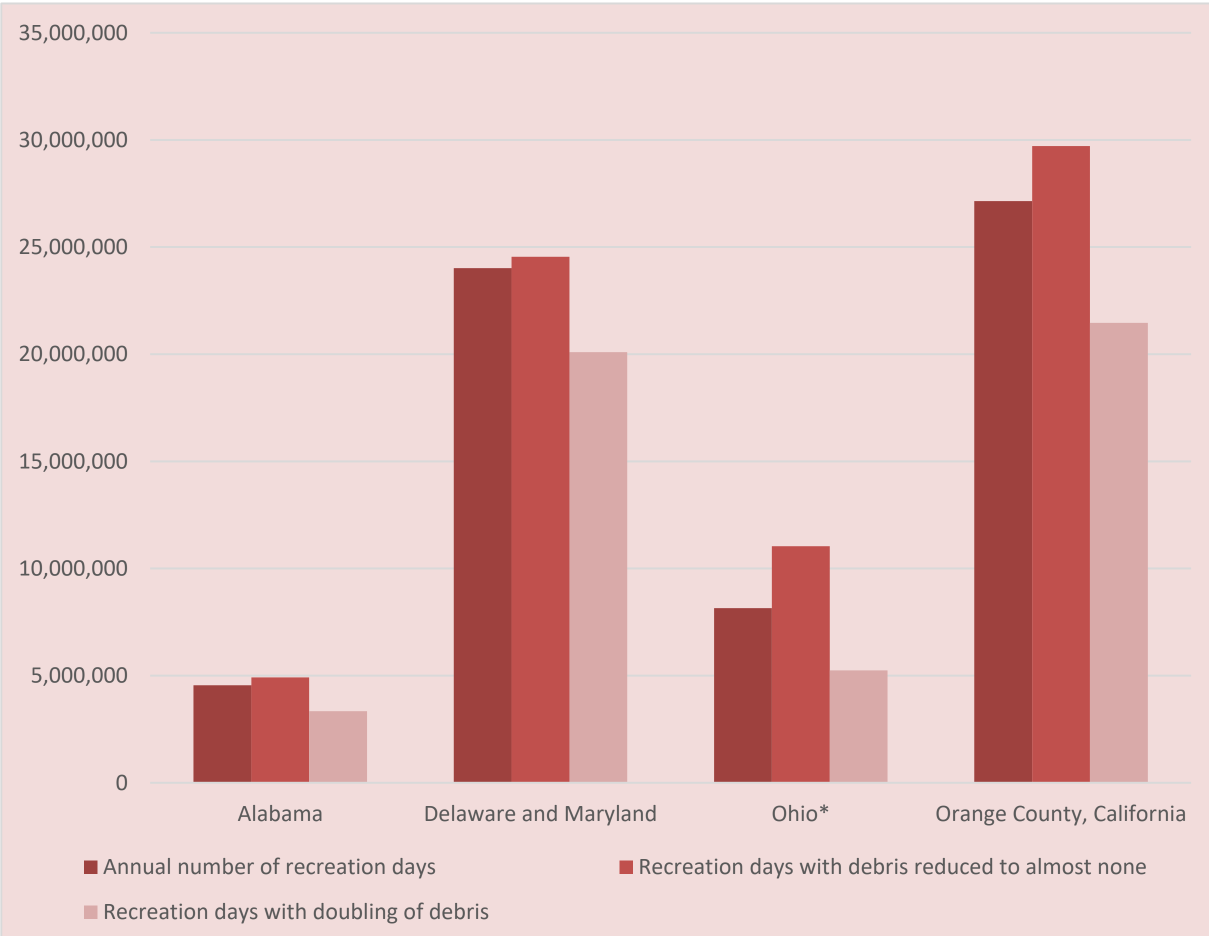

## Survey Results

The results of the mail survey indicate a potentially strong relationship between marine debris and beach recreation. The estimated effect of a reduction in debris to almost none is an increase in recreation days of between 2.2% and 9.5% for the three ocean coasts, and in increase of 35.4% in Ohio.[1] The increase in the number of beach visits ranged from 369,000 visitor days per year in

1. Numbers in the text and tables of this report have been rounded for presentation. Calculations performed on these rounded numbers may not reproduce final results.

Alabama to 2.9 million visitor days per year in Ohio (Figure ES-2). A doubling of debris would result in an estimated decrease in recreation days of between 16.3% and 26.5% for the three ocean coasts, and a decrease of 35.6% in Ohio. The decrease in the number of beach visits ranged from 1.2 million visitor days per year in Alabama to 5.7 million visitor days per year in Orange County.

**Figure ES-2. Changes in the annual number of recreation days if the amount of marine debris is reduced to almost none, and if the amount of marine debris doubles.**




* Ohio estimates account for multiple-day trips only.

## Recreational Value

The change in recreational value is calculated based on the change in the number of recreation days. For example, the nationwide recreation model from the *Deepwater Horizon* research estimates the annual number of recreation days at Alabama beaches is 4.55 million. Based on the results of our survey, if marine debris at those beaches were reduced to almost none, recreation days in Alabama would increase by 8.1%, for an estimated increase of approximately 369,000 recreation days. Based on the nationwide recreation model, recreators value each day of recreation at Alabama beaches at $27.27. Thus if the a reduction in debris to almost none results in an additional 369,000 days of recreation, the resulting change in the value of recreation is estimated to be $10.1 million ($27.27 per day x 369,000 days). Estimates of recreation value for all four study areas are summarized in Table ES-1. For Alabama, Delaware/Maryland, and Orange County, California, the results account for trips of all lengths, including single-day and multiple-day trips. For Ohio, the national recreation model was able to provide results for multiple-day trips only.

**Table ES-1. Recreation value from changes in debris on beaches (2018 dollars)**

| Scenario | Alabama | Delaware and Maryland | Ohio[a] | Orange County, California |
|---|---|---|---|---|
| Annual number of recreation days | 4,552,112 | 24,014,592 | 8,155,158 | 27,143,415 |
| **Debris reduced to "almost none"** | | | | |
| Percent change in recreation days | 8.1% | 2.2% | 35.4% | 9.5% |
| Change in days | 368,525 | 536,341 | 2,889,191 | 2,571,725 |
| Value per day | $27.27 | $36.81 | $30.46 | $50.43 |
| Change in recreation value | $10,051,517 | $19,741,209 | $88,006,606 | $129,689,616 |
| **Doubling of marine debris** | | | | |
| Percent change in recreation days | -26.5% | -16.3% | -35.6% | -20.9% |
| Change in days | -1,206,006 | -3,915,792 | -2,907,188 | -5,682,362 |
| Value per day | $26.82 | $35.99 | $28.87 | $48.41 |
| Change in recreation value | -$32,347,029 | -$140,914,688 | -$83,935,614 | -$275,077,340 |

a. For Ohio, estimates account only for multiple-day trips and exclude the value and quantity of single-day trips.

Our results indicate that changes to recreation associated with marine debris provide substantial value to recreators. If marine debris were reduced to almost none, the estimated annual increase in recreation value is $10.1 million in Alabama, $19.8 million in Delaware/Maryland, $88.0 million in Ohio (multiple-day trips only), and $129.7 million in Orange County, California (Table ES-1). If the amount of marine debris on beaches were to double, the estimated annual decrease in recreational value is $32.3 million in Alabama, $140.9 million in Delaware/ Maryland, $83.9 million in Ohio (multiple-day trips only), and $275.1 million in Orange County, California.

### Regional Economic Impacts

As noted previously, changes in recreational beach visits because of changes in marine debris quantities would have cascading economic impacts on regional economics. We expressed the regional economic impacts using two key metrics:

- *Value added*: The value of gross output less intermediate inputs. The value of this metric is equal to the sum of compensation of employees, taxes on production and imports less subsidies, and gross operating surplus.
- *Employment*: Number of full- and part-time jobs (including proprietors' jobs).

We calculate that a reduction of debris to almost none would contribute an additional $29 million in economic activity (measured as value added) in Alabama, $27.8 million in Delaware and Maryland; $206.0 million in Ohio, and $137.8 million in Orange County, California (Table ES-2). This economic activity is estimated to provide between 464 and 3,703 jobs. Conversely, a doubling of debris is estimated to cost the local economies $96.3 million in Alabama, $203.2 million in Delaware and Maryland, $207.3 million in Ohio, and $304.5 million in Orange County, California; resulting in a loss of between 2,198 and 4,254 jobs (Table ES-2).

**Table ES-2. Regional economic impacts of changes to debris levels at the four study areas (2018 dollars)**

| | Alabama | Delaware and Maryland | Lake Erie beaches in Ohio | Orange County, California |
|---|---|---|---|---|
| Average visitor spending per day | $112.40 | $72.74 | $76.72 | $89.49 |
| **Reduce debris to almost none** | | | | |
| Change in visitor days | 308,365 | 478,410 | 2,823,268 | 2,092,920 |
| Change in visitor spending | $34,660,000 | $34,802,000 | $216,593,554 | $187,294,000 |
| Change in jobs | 672 | 464 | 3,703 | 1,925 |
| Change in economic activity (value added) | $29,423,000 | $27,834,000 | $205,976,434 | $137,830,000 |
| **Doubling of debris** | | | | |
| Change in visitor days | -1,009,130 | -3,492,845 | -2,840,854 | -4,624,417 |
| Change in visitor spending | -$113,427,000 | -$254,086,000 | -$217,943,258 | -$413,837,000 |
| Change in jobs | -2,198 | -3,386 | -3,726 | -4,254 |
| Change in economic activity (value added) | -$96,288,000 | -$203,211,000 | -$207,259,895 | -$304,542,000 |

In summary, the results of this study indicate that the amount of marine debris on beaches have a substantial effect on recreational value and regional economies, outside of the costs municipalities incur to remove debris. Beachgoers surveyed indicated that they would increase their beach visits somewhat if marine debris were eliminated, and they would decrease beach visits substantially if the amount of marine debris on the beach were to double. These results can be used by policy and program evaluators to help understand how programs aimed at reducing marine debris levels can provide both significant value to recreators and contributions to the regional economy.

## 1. Introduction

Marine debris is a persistent problem in many coastal areas of the United States. There are a variety of potential economic losses associated with marine debris, including effects on commercial fisheries, effects on waterfront property values, costs incurred by local governments and volunteer organizations to remove and dispose of marine debris, and more general "existence" values reflecting the public's preference for a clean environment. This study evaluates two types of economic loss that result from the effects of marine debris on beach recreation: the loss of recreational value to beach visitors, and the regional economic impact from reduced spending on beach visits in a particular region.

Research suggests that litter on beaches detracts from visitors' enjoyment and reduces the amount and value of recreation on coastal beaches (Ofiara and Brown, 1999; Brouwer et al., 2017; Krelling et al., 2017; Leggett et al., 2018). Marine debris may reduce the likelihood that people return to the same location, particularly among first-time visitors (Ballance et al., 2000; Schuhmann, 2012). Effects on beach recreation have implications for regional economies because tourism and spending by beach visitors is significant in many coastal communities (Kosaka and Steinback, 2018; Office for Coastal Management, 2019).

Visitors may perceive a decline in the natural beauty of an area if marine debris is present. Visitors may also perceive potential physical harm due to cuts or bacterial infections, which would have economic costs in terms of medical expenses and lost wages if such harm were to occur (Campbell et al., 2016). In contrast to debris or litter along the roadside or in parks, there is a high potential for dermal contact with marine debris on beaches as visitors frequently go barefoot, lie directly on the sand, and dig in the sand. The existence of numerous volunteer efforts to remove debris from beaches (Zielinski et al., 2019) and the fact that many municipalities regularly rake beaches to remove debris are also indications that beach visitors prefer cleaner beaches.

This study was designed to determine how the quantity of marine debris on beaches affects the number of days that recreators will visit the beach, and how those changes in behavior translate to lost recreational value and regional economic impact. The goal of this study was to better understand the economic effects of changes in the amount of debris on beaches. The results may help federal, state, and local agencies structure future debris abatement and mitigation projects to maximize social benefits provided by coastal resources. To address these goals, we collected data from four coastal areas in the United States: Gulf Coast beaches in Alabama; Atlantic Ocean beaches in Delaware and Maryland; Lake Erie beaches in Ohio; and Pacific Ocean beaches in Orange County, California (Figure 1).

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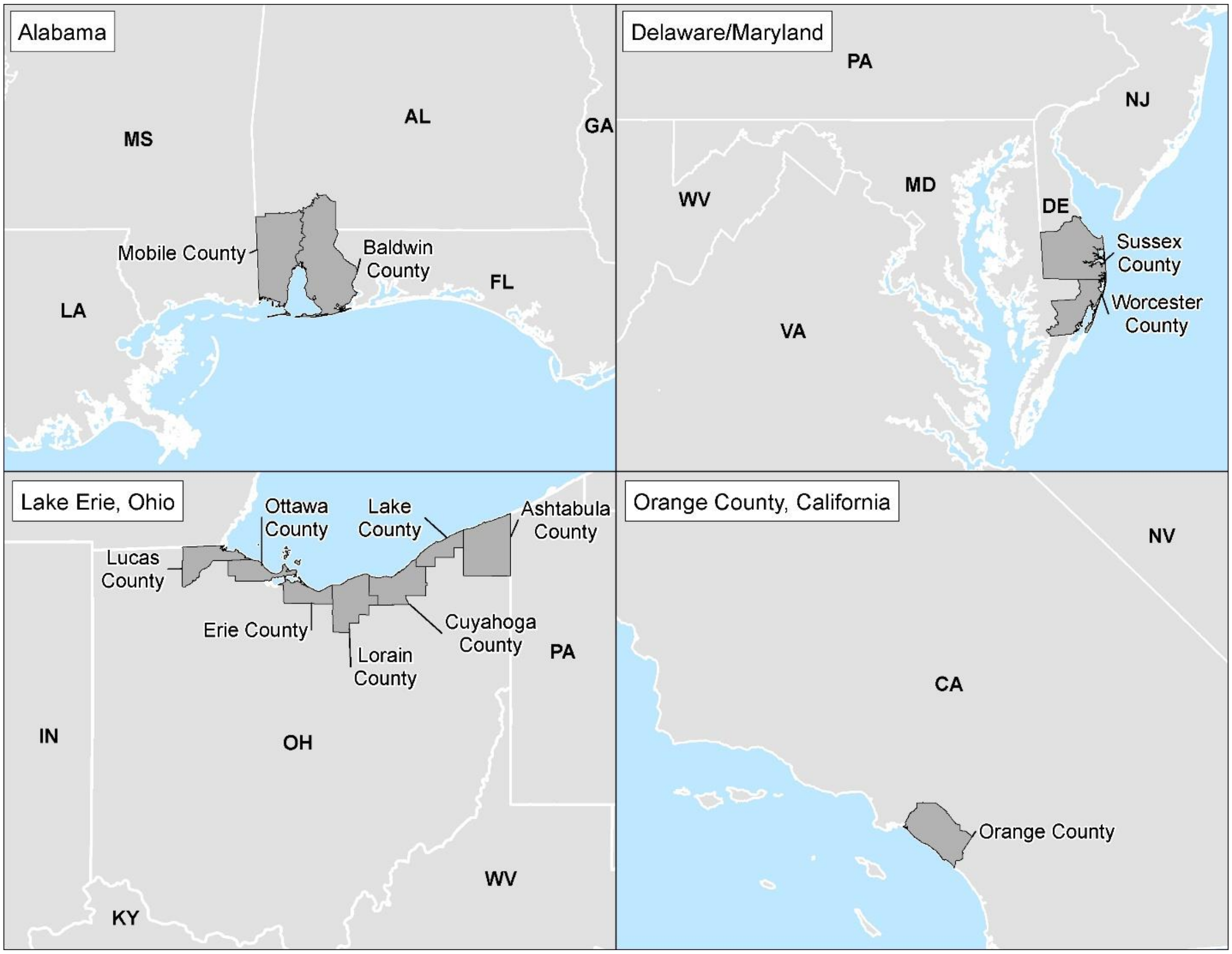
We estimated the effect of marine debris using two different economic concepts: the **value of recreation** and the **economic impacts of recreation**. The value of recreation is a monetary measure of the enjoyment people get from participating in beach recreation. It can also be described as people's willingness to pay for recreational access to beaches, or for policies that improve beach recreation. The economic impact of recreation is a measure of the effect of beach recreation on spending by consumers and businesses in the region. It includes both direct spending on recreational activities and the effects of direct spending in stimulating the local economy. Because spending in some regions may increase as a result of a decrease in spending in other regions, amounts calculated for different regions should not be added together. Because they are interpreted in fundamentally different ways, economic impacts should also not be added together with estimates of recreation value.[2] We measured these effects for two hypothetical scenarios of marine debris levels: a **reduction of debris to almost none** (defined in the study as one piece of debris per 500 square feet of beach), and a **doubling of debris**.

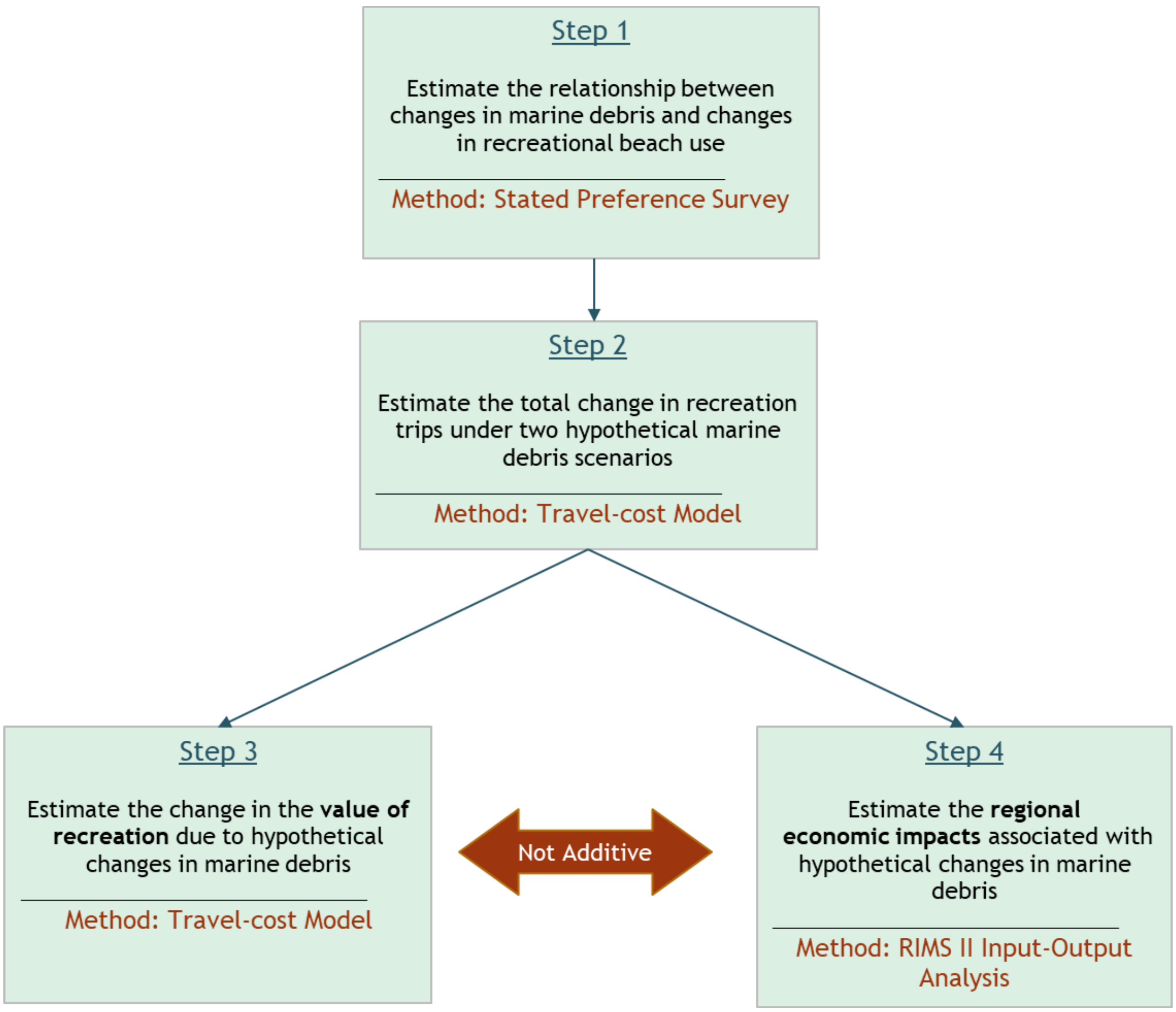
**Figure 1. Study areas that define where beachgoers were interviewed and where regional economic impacts were evaluated.**




2. For additional information, Stynes (2005) provides a review of concepts and methods for estimating the economic significance of recreational uses of public lands and provides a distinction between valuation and impact studies, aimed at non-economists, and Rosenberger et al. (2017) provides an overview of recreation valuation.

The first step in this study was an evaluation of the relationship between marine debris and recreational beach use using a survey. The data from the survey were used to estimate how changes in marine debris would influence the number of beach trips that recreators would take. These data in turn were used in a nationwide recreation model developed during the *Deepwater Horizon* oil spill (English et al., 2018) to estimate the value of recreation. In addition, the data on lost trips were incorporated into a regional input/output model to determine the regional economic impact of marine debris (Figure 2).

**Figure 2. Steps for estimating changes in recreational value and regional economic impacts associated with changes in marine debris on beaches.**




As will be explained in subsequent sections, the scope of the recreational value study includes almost all beach recreation by residents from throughout the United States, occurring at beaches in each of the four study areas. For the assessment of regional economic impacts, the scope of the study includes the regional economies of the coastal counties where the beaches in each study area are located. Each study area was delineated to match a group of beaches that was aggregated into a single regional destination in data developed for the *Deepwater Horizon* oil spill assessment (English et al., 2018). The *Deepwater Horizon* dataset, collected from June 2012 to May 2013, is the basis for the nationwide recreation model.

The survey utilized stated preference techniques, an economic valuation method in which survey respondents are presented with hypothetical choice scenarios and asked what they would do in each scenario. When the choices involve changes in recreation behavior, the particular stated-preference technique is called “contingent behavior.” In our study, respondents were asked how many more or fewer recreation trips they would take to beaches in a given study area if levels of marine debris decreased or increased. While stated-preference surveys have a long history of use in economics, it is worth noting the potential uncertainty in stated-preference methods because what people say they would do may not always reflect what they would actually do. Studies examining the accuracy of contingent behavior methods include Haener et al. (2001), Grijalva et al. (2002), and Morgan and Huth (2011).

For this study, estimating recreational value and regional economic impacts required benefit function transfer, a way of taking economic data and analysis developed for one purpose and revising it to be applied to a new research problem. We adapted recreation data and analyses developed for the *Deepwater Horizon* oil spill assessment (English et al., 2018) to evaluate recreation changes in our four study areas, including estimating the public’s value for changes in marine debris in monetary terms. Finally, we analyzed regional economic impacts using the Regional Input-Output Modeling System (RIMS II) developed and maintained by the U.S. Bureau of Economic Analysis (U.S. BEA, 2018, 2019).

Below we describe the key steps of the study, grouped into the three major components: the marine debris survey, the model of recreation value, and the economic impact analysis.

## 1.1 Marine Debris Survey

The marine debris survey (Section 2) was a mail survey where previously identified beachgoers were asked a series of questions about how marine debris affects their behavior. Specifically, the surveys involved the following steps:

- Interviews conducted onsite at beaches in each study area to collect information about the recreation trip the respondent was taking at the time of the interview, the respondent’s demographic characteristics, and the respondent’s address for use in a follow-up mail survey
- Implementation of a mail survey that asked respondents about their recreation activities at beaches in the study area during the previous year, the amount of debris they have seen on those beaches (ranking debris levels on a 1-to-5 scale, where 1 is almost no debris and 5 is a “high amount” of debris), and their response to hypothetical changes in the amount of debris on those beaches
- Development of onsite and mail-survey sampling weights that accounted for each respondent’s likelihood of being selected into the sample, to help ensure that the opinions of sampled respondents accurately represent all beachgoers
- Analyses comparing respondents’ demographic characteristics with their answers to the hypothetical debris scenarios to identify key characteristics that most influence preferences for marine debris

- Adjustment of mail-survey sampling weights such that mail survey respondents match the much larger sample of onsite respondents with respect to the key demographic characteristics, further improving the representativeness of mail survey respondents
- Calculation of the impact of potential changes in marine debris, including a reduction to almost no debris and a doubling of debris, on the number of recreations trips in each study area.

## 1.2 Nationwide Recreation Model

The key result from the marine debris survey is the estimated percentage change in the number of trips to each study area resulting from the two debris scenarios (reduction to almost zero debris and doubling of debris). The percentage changes were incorporated into a nationwide model of recreation to estimate the resulting changes in total recreation trips and value. The primary steps in implementing the recreation model were:

- Adapting the nationwide model of recreation trips using data available from the *Deepwater Horizon* oil spill assessment (English et al., 2018) to apply to the four study areas using benefit function transfer
- Assessing the consistency of survey and model results with previous research, including a previous study in Orange County, California (Leggett et al., 2018) that used data on actual recreation choices (revealed preference) rather than hypothetical choices (stated preference) to value the effects of marine debris on recreation
- Adjusting model parameters to reproduce the percentage changes in trips from the marine debris survey, leading to final estimates of the total change in recreation trips and the total change in recreation value from the two study scenarios in the four study areas.

## 1.3 Regional Economic Impact Analysis

The change in the number of recreation trips estimated using the national recreation model was also used to estimate regional economic impacts for the marine debris scenarios. A change in recreation trips results in a change in visitor spending, which we use to estimate the economic impacts of the two marine debris scenarios using input-output models. The primary steps in the economic impact analysis were as follows:

- Calculation of the proportion of trips in each study area coming from outside the local region, and the average number of recreation days per nonlocal trip, leading to an estimate of the increase or decrease in the number of nonlocal recreation days for each marine debris scenario
- Estimation of the average expenditures per recreation day in each study area using the National Economic Ocean Expenditure Survey (NORES) data on recreation expenditures (NOAA, 2012; Kosaka and Steinback, 2018)[3]

3. Kosaka and Steinback (2018) recently published the NOAA (2012) NORES data. We were originally provided the data in 2017. For this report, we converted all dollar values to 2018 USD.

- Estimation of the regional economic impact of increased spending by visitor day in each study area by first mapping the NORES expenditure category to the appropriate RIMS II industry and then applying industry-specific RIMS II multipliers
- Calculation of estimates of the regional economic impacts from changes in beach recreation for each of the two marine debris scenarios (reduce debris to near zero and double the debris) in each of the four study areas.

The details of the study and the results are presented in subsequent sections. Section 2 presents information on the marine debris survey. Section 3 presents the model of recreational value, and Section 4 presents the regional economic impacts model. This is followed by the literature cited and appendices.

## 2. The Marine Debris Survey

The marine debris survey consisted of an onsite survey conducted at beaches in each study area, and a follow-up survey mailed to people who had been interviewed onsite and agreed to participate in the follow-up survey. The purpose of the onsite survey was to recruit people for the mail survey from the target population of beachgoers in each area, and to briefly collect minimal data on the respondents' trips, opinions, and characteristics. The purpose of the mail survey was to ask recreators about the effect of marine debris on their recreation choices, and to collect more extensive data on respondents' opinions and characteristics.

The main focus of the mail survey was to ask respondents the number of trips they took to the beach during the previous twelve months and how many more or fewer trips they would have taken under two contingent behavior scenarios: (1) if there had been almost no debris on beaches in the study area, and (2) if there had been twice as much debris on beaches in the study area. The term contingent behavior refers to survey questions that ask respondents how their recreation choices would change in response to changes in the quality of recreation sites. The mail survey also asked respondents to estimate the amount of debris on beaches in their area, and included other questions about their opinions and knowledge of debris on beaches.

Data collection occurred in 2018, with onsite interviews conducted from July 24 to September 3 and mail surveys sent out and received between October 5 and December 6. Response rates varied across the study areas and between the two stages of the study (onsite vs. mail). The overall response rate for the onsite survey was 76.7%. Accounting for recruitment into the mail survey and the mail-stage response rates, the final overall response rate for the mail survey was 19.0%. The number of responses provided to specific questions, as well as the number of missing responses to certain questions, was calculated and evaluated.

We weighted the sampling to help ensure that data from the survey was representative of the target population of people who used beaches in each study area. Sampling weights are critical in analyzing survey data whenever the sample design deviates from simple random sampling (Schaeffer et al., 2012). The weights include a base weight to control for differences among respondents in the probability of being selected into the sample, which was influenced by factors such as the amount of time a respondent spent at the beach. To further improve representativeness, the weights also include adjustments to make mail-survey respondents more similar to the much larger onsite sample with respect to key demographic characteristics, such as the proportion of people with a college degree.

Results of the marine debris survey included average ratings of the amount of debris on beaches and the total percentage change in the number of trips to beaches in each study area under the scenarios of a decrease or an increase in debris.

## 2.1 Survey Design

Below we first describe a pretest for the marine debris survey that was conducted in Orange County, California. A pretest is a common way to evaluate and refine a survey before final implementation. We then describe the final onsite and mail surveys and explain the reasons for each of the questions that were included. The surveys are provided in Appendix A.

### 2.1.1 Onsite and Mail Survey Pretest

During the survey pretest, we conducted onsite interviews at eight beaches in Orange County on Wednesday, September 27, 2017 and again on the following Saturday, September 30. The onsite interviewers asked several brief questions about each respondent's recreation and also elicited the respondent's address for completion of a follow-up mail survey. We intercepted 777 recreators and obtained onsite interviews with 504 of them. We obtained addresses for the follow-up mail survey from 345 onsite respondents.

On December 6, 2017, we mailed surveys to the 345 addresses and sent reminder postcards one week later. For any valid addresses from which we had not obtained a completed survey, we sent a follow-up survey on December 20 and a second reminder post card on January 18, 2018. By the end of January, we had received 49 completed surveys. The U.S. Postal Service returned a total of 64 surveys as undeliverable due to invalid addresses.

One issue identified in the pretest was a low response rate of only 17.4% in the mail stage of the study. We believed this was due to scheduling the first mailing before the December holidays and the second mailing after the holidays, an interruption necessitated by the timeline for completing the pretest. In fact, the final mail response rate in Orange County was 30.8% in the final study. Response rates for the full study are discussed in more detail below.

In the pretest, we also found that the item nonresponse rate was high for the contingent behavior questions. "Item nonresponse" refers to missing responses to particular questions in completed surveys, as opposed to nonresponse from those who did not return the survey. In the question about a reduction in debris, 3 out of 49 respondents (6.1%) did not provide a usable answer of either no change or a specified increase in trips. In the pretest question about a doubling of debris, 9 out of 49 respondents (18.3%) did not provide a usable answer of either no change or a specified decrease in trips. The formatting of the contingent behavior questions in the pretest required people to fill out a small table with the abbreviated question "How many more trips if there had been almost no garbage or manmade debris?" in the row heading and "day trips" and "overnight trips" as column headings.

To address this item nonresponse rate, we revised the original question to be two separate and complete questions about day trips and then overnight trips, with the belief that this might improve the clarity of the questions for some respondents. However, the rate of item nonresponse did not improve and as reported below it in fact increased to 7 out of 52 (13.4%) for a reduction in debris and 13 out of 52 (25.0%) for a doubling of debris in the final Orange County results. We do not believe the changes in formatting or wording had an effect on nonresponse or that other refinements could have induced more people to answer the question. High item nonresponse rates are typical for contingent behavior questions (Eisworth et al., 2000; Whitehead et al., 2010), possibly because such questions require an open-ended “fill in the blank” response. Some respondents may be unsure how their recreation would be affected in hypothetical situations and may find it difficult to make a quantitative estimate of the change in their annual total number of trips.

The pretest also included “probing” questions that asked respondents about the design of the survey, particularly the graphical representations. There is a page in the survey that shows a picture of a beach with an area outlined in red and defined as 500 square feet or “an area approximately equal to three parking spaces” (see Appendix A). Pictures are also included that show different amounts of debris that could potentially be found in a 500 square-foot area of a beach. In the pretest, probing questions asked about the pictures and descriptions. Regarding the area of beach defined as 500 square feet, 89.8% of respondents said the description was clear or somewhat clear. Regarding the pictures of debris, 83.7% of respondents said they were able to find a picture that accurately reflected the amount of debris on beaches in their area. These results were considered satisfactory and no changes were made to the description or pictures of marine debris.

One additional concern addressed in the pretest was the possibility that people associated debris on beaches with other types of pollution. A probing question in the pretest asked “When you answered the questions about your trips, were you thinking primarily about garbage or manmade debris, or were you also thinking about other types of pollution, such as runoff from factories or farms?” Of the 49 respondents in the pretest, 71.4% said they were thinking primarily about debris on beaches. This was viewed as acceptable and did not lead to any changes the survey.

#### 2.1.2 Onsite Survey – Regional Pilot

Using an onsite survey to reach people on the beach and recruit respondents for the mail survey ensured that the sample included only respondents who visited beaches in each study location. Reaching an equivalent number of beachgoers using a random sample of addresses would have required considerably more effort and expense, especially given that some beachgoers may live hundreds of miles from the coast in areas where the participation rate for beach recreation is quite low.

The onsite sampling involved intercepting people at beaches in each study location. The beaches were selected to represent the various types of beach experiences available, including more- and less-developed beaches. Interviews were conducted on both weekdays and weekend days to reach people taking anything from short visits to longer vacations. Although we had obtained statistically robust estimates from just 49 observations in the pretest, the target number for completed mail surveys was 100 in each study area to allow for potential shortfalls in recruitment or response rates.

The onsite interviewers collected data to assist in developing sampling weights, including the size of the party from which each respondent was selected (we interviewed only one person in a given party); the number of hours they would spend at the beach on the day of the interview; and for those engaged in a multiple-day trip, the number of days during the trip when they would spend time at the beach. The onsite survey also included several demographic questions, such as age and education, and several attitudinal questions about beach characteristics such as the presence of marine debris. Finally, we asked the respondent's name and mailing address. Those who did not agree to participate in the mail survey were asked their zip code so that data collected onsite could be used in calculating the proportion of trips from outside the local area.

### 2.1.3 Mail Survey – Regional Pilot

Four versions of the mail survey were developed for the four study areas. Differences across versions included different maps showing the beaches specific to each study area. The wording used to refer to beaches also differed across survey versions, such as "ocean beaches in Delaware and Maryland" or "Lake Erie beaches in Ohio." All other aspects of the mail survey were identical for each of the study areas.

The first question in the mail survey asked respondents to review the map of beaches and indicate the beaches familiar to them. This served to familiarize respondents with the set of beaches they would be asked about in subsequent questions.

The next two questions asked respondents about the total number of their single-day and multiple-day trips during the previous year to all beaches in the study area. Respondents' total number of trips throughout the year were used as a baseline to which changes in trips, estimated in later questions, could be compared.

Question 4 of the mail survey asked about the importance to respondents of 13 beach attributes when they chose which beaches to visit. The attributes included things like water quality, the presence of natural debris on the beach, scenic beauty, how crowded a beach is, and presence of manmade debris. These questions allowed us to evaluate the importance of marine debris in a qualitative way. They may also have encouraged respondents to think carefully about how they respond to marine debris relative to other beach characteristics when answering the contingent behavior questions.

Question 5 asked respondents to report which beaches they visited over the last year and to rate the level of marine debris they encountered at each beach on a scale of 1-to-5 using the photographs of debris amounts provided. The debris ratings allowed us to characterize current debris levels, at least in relative terms. Current debris levels are the starting point for the contingent behavior questions, which ask about changes in debris that are proportionate to current levels.

To specify the size of the beach area respondents were asked to evaluate, the survey included a photograph that showed an area of beach outlined in red. The area was described as 500 square feet, or approximately the area of three parking spaces. Below the beach photo were pictures showing different amounts of debris that could be found in an area of the size shown. The debris photos included cigarette butts, plastic straws, and other common items found on beaches in the United States (NOAA, 2018).

Questions 6 and 7 asked whether respondents would have changed the number of trips they took over the past year to the beaches in a given study area under two hypothetical scenarios: (1) "If there had been almost no garbage or manmade debris at beaches," and (2) "If there had been twice as much garbage or manmade debris at beaches." These questions were to be used for estimating the total percentage change in trips in each scenario, the key input to the recreation model.

Questions 8 through 12 asked whether respondents were concerned about the presence of various types of garbage or manmade debris while visiting a beach, the types of debris they have actually seen on beaches, their understanding of the sources of debris found on beaches, and whether they had participated in beach cleanup efforts. These questions seek to provide helpful context for evaluating marine debris policies. This series of question also asked respondents whether they think marine debris is a problem on beaches in the study area. This question was used to adjust mail survey sampling weights to be consistent with onsite respondents, as described in Section 2.3.

Questions 13 through 19 asked respondents to report the number of adults and children in their household as well as their gender, age, ethnicity, race, education level, and income. These questions were used to investigate the relationship between the response to changes in marine debris levels and demographic characteristics and some of them were used to adjust the sampling weights in Section 2.3.

## 2.2 Survey Implementation

The survey schedule, the response rates for each stage of the survey, and the total number of completed surveys are reported below for each study area. The sampling procedures are also described, including the approach to selecting respondents during the onsite survey. Sample statistics showing the final number of responses and missing responses for key questions in the final mail survey data are presented and discussed.

### 2.2.1 Survey Schedule and Response Rates

We conducted the survey in 2018, beginning with an initial onsite interview with respondents during the late summer, followed by a mail survey in the fall. Those who participated in the onsite interview were asked if they were willing to take part in the mail survey and if so, to provide their address. Although the mail survey asks about a full year of beach activity, we wished to reach visitors in the fall so that their activities during the peak summer beach season would be fresh in their minds. We scheduled our initial onsite interviews in the late summer to avoid an extended period between the initial onsite interviews and the final mail survey.

Table 1 shows the schedule of data collection in each study area. The number and timing of days spent interviewing onsite varied based on weather and the availability of interviewers. A minimum of eight person-days were spent interviewing onsite in all study areas, distributed approximately evenly between weekdays and weekend days. We avoided bad weather days to maximize the number of interviews. While such a practice underrepresents low-activity days and would be problematic in a survey designed to estimate total activity, in our study totals come from the nationwide recreation model. Even if visitors on bad weather days differ systematically with respect to their preferences about marine debris, the small number of people using the beach on bad weather days would mitigate the effects of any such difference when calculating the response to marine debris in the total population of beachgoers.

The field period for the mail survey was approximately two months. The initial mailing took place on October 5, 2018. Reminder postcards were sent October 15, though in Alabama the reminder was delayed one week to avoid contacting people during the immediate aftermath of Hurricane Michael. The second mailing of the mail survey took place November 5. In the three areas where the target of 100 completed surveys had not been met, an additional reminder postcard was sent on November 21.

**Table 1. Survey implementation**

| Implementation stage | Alabama | Delaware and Maryland | Ohio | Orange County, California | Total |
|---|---|---|---|---|---|
| **Onsite survey** | | | | | |
| Field period | August 11–September 3, 2018 | August 10–30, 2018 | July 27–August 29, 2018 | July 24–29, 2018 | July 24–September 3, 2018 |
| Completed surveys | 533 | 353 | 195 | 246 | 1,327 |
| Response rate | 88.7% | 91.2% | 76.9% | 50.3% | 76.7% |
| Recruitment for mail survey | 249 | 219 | 104 | 169 | 741 |
| Recruitment rate | 46.7% | 62.0% | 53.3% | 68.7% | 55.8% |
| **Mail survey** | | | | | |
| Field period | October 5–December 6, 2018 | October 5–December 6, 2018 | October 5, 2018–December 6, 2020 | October 5, 2018–December 6, 2021 | October 5, 2018–December 6, 2022 |
| Completed surveys | 99 | 116 | 62 | 52 | 329 |
| Response rate | 39.8% | 53.0% | 59.6% | 30.8% | 44.4% |
| Cumulative response rate[a] | 16.5% | 30.0% | 24.4% | 10.6% | 19.0% |

a. The cumulative response rate accounts for the onsite response rate, the recruitment rate, and the mail response rate. Mail survey responses were reweighted to be representative of respondents to the onsite survey in each study area.

In total there were 1,327 completed onsite surveys, with a response rate of 76.7% (Table 1). Of the 802 addresses provided for a follow-up survey, 61 were invalid. This left 741 valid addresses for the mail survey, a recruitment rate of 55.8%. The overall mail response rate was 44.4%, with a total of 329 completed mail surveys. The cumulative response rate was 19.0%. This is a typical response rate in survey research, and low levels of response are not necessarily indicative of bias (Groves and Peytcheva, 2008; Pew Research Center, 2012). As described in Section 2.3, the sampling weights for mail respondents in each study area were adjusted so that mail respondents were similar to onsite respondents with respect to key characteristics. This technique can improve representativeness by taking advantage of higher response rates in earlier stages of the study.

The number of onsite interviews, response rates and recruitment rates varied considerably among the four study areas. In Ohio, a low number of onsite interviews was partly offset by a high mail response rate. Onsite response, recruitment, and mail response were all high in Delaware/Maryland, leading to more than the targeted number of completes. Low onsite and mail response rates in Orange County were ultimately responsible for the low number of completed mail surveys in that area.

### 2.2.2 Onsite Sampling Procedures

Onsite sampling procedures are important in ensuring representativeness and developing sampling weights. On the beach, interviewers approached a party of people and randomly selected one adult over 18 for an interview. Random selection ensures that interviewers do not oversample any particular type of person, which could lead to results that are not representative of all beachgoers. Interviewing only those over 18 is standard survey practice to avoid issues of parental consent. For random selection, interviewers picked the person farthest to the right-hand side of the party from wherever the interviewer was standing. Interviewers generally made a judgement about who was over 18 but if unsure, the interviewer would politely explain the situation and ask whether someone was over 18. When asking an address, the full name of the respondent was also elicited because questions in both the onsite and mail survey, including demographic characteristics and preference-based responses, were specific to an individual.

Interviewers walked from party to party along a beach. Interviewers proceeded in one direction from the main access point of a beach, and then returned to the main access point and proceeded in the other direction. The extent of the total sampling area was defined as the area easily accessible on foot from the main access point, determined by the interviewer's discretion. When interviewers had spent at least 1.5 hours at a beach, or had approached every party, they would proceed to the next beach in a prescribed order. The order was agreed upon by the research team in advance, based on the proximity of beaches and logistical efficiency in getting from one beach to the next. In some cases the list was broken into two groups of beaches that were geographically close to one another, with sequential sampling of beaches proceeding separately for each group.

When starting a new day of sampling, the interviewers began at the next beach on the list after the beach where they had last conducted interviews. The list included at least eight beaches located throughout each study area, which helped to ensure reasonable representation of the different types of beaches in the area. Including significantly more than eight beaches would have entailed excessive time requirements for interviewers to become familiar with the location and layout of beaches, find where public parking is available, check whether permission is required to sample at a beach, and other issues.

Maps of the beaches included in each study area are provided as part of the mail surveys provided in Appendix A. Below is a list of beaches where onsite surveys were administered:

**Alabama**

- Cotton Bayou Beach
- Orange Beach
- Gulf State Park Pavilion
- Gulf Shores Public Beach
- Alabama Point/Florida Point
- Dauphin Island West End Beach
- Dauphin Island Public Beach
- Dauphin Island East End Beach.

**Delaware/Maryland**

- Rehoboth Beach
- Dewey Beach
- Conquest Road Beach
- Bethany Beach
- Cape Henlopen Beach
- Assateague Island National Seashore
- Ocean City (Boardwalk)
- Assateague State Park.

### Ohio

- Euclid Beach Park
- Headlands Beach State Park
- Fairport Harbor Lakefront Park
- East Harbor State Park
- Cedar Point Beach
- Nickel Plate Beach
- Headlands Beach State Park
- Camp Perry Beach
- Edgewater Park Beach.

### Orange County, California

- Balboa Beach
- Doheny State Beach
- Bolsa Chica
- Huntington City Beach
- Huntington State Beach
- Newport Beach
- Crystal Cove State Park Beach
- Laguna Beach.

Because of the high prevalence of single-day respondents on Ohio beaches, samplers skipped every other single-day respondent in an attempt to reach more multiple-day respondents. This feature of sampling was addressed in the sampling weights, described in Section 2.3.

### 2.2.3 Sample Statistics

We compiled descriptive statistics of the unweighted onsite and mail survey sample data prior to describing the development of sampling weights (Table 2). Section 2.3 discusses how we used these data to create sampling weights.

**Table 2. Selected descriptive statistics from samples collected via both the onsite and mail surveys.**

| | Alabama | Delaware and Maryland | Ohio | Orange County, California |
|---|---|---|---|---|
| Onsite survey | | | | |
| Single-day trips | 212 | 153 | 222 | 175 |
| Multiple-day trips | 357 | 200 | 47 | 92 |
| Mail survey | | | | |
| Beaches visited by at least one respondent | 10 | 20 | 22 | 22 |
| Beaches rated for debris by at least one respondent | 10 | 17 | 21 | 20 |
| Beach ratings (person-beach pairs) | 261 | 281 | 182 | 197 |
| Respondents who took single-day trips | 59 | 62 | 60 | 48 |
| Respondents who took multiple-day trips | 70 | 83 | 12 | 16 |
| Single-day trips | 1,108 | 733 | 630 | 1,937 |
| Multiple-day trips | 549 | 478 | 32 | 57 |

**Table 2. Selected descriptive statistics from samples collected via both the onsite and mail surveys.**

| | Alabama | Delaware and Maryland | Ohio | Orange County, California |
|---|---|---|---|---|
| Respondents reporting an increase in trips, "almost no" debris | 7 | 3 | 12 | 7 |
| Respondents reporting no change in trips, "almost no" debris | 83 | 106 | 43 | 38 |
| Missing responses, "almost no" debris | 9 | 7 | 7 | 7 |
| Respondents reporting a decrease in trips, doubling of debris | 40 | 27 | 35 | 22 |
| Respondents reporting no change in trips, doubling of debris | 25 | 61 | 11 | 17 |
| Missing responses, doubling of debris | 34 | 28 | 16 | 13 |

The number of single-day and multiple-day trips from the onsite sample is important for several reasons. Statistics on the origin of trips, as well as the number of recreation days in a multiple-day trip, were taken from the onsite data. These statistics determine the proportion of recreation days coming from outside the local area. A small sample of multiple-day trips could make these statistics, and the regional economic analysis in which they are used, less reliable. The proportion of trips that are single-day trips was also taken from the onsite data and this statistic was used to make final adjustments to the recreation model as part of the benefit function transfer, described in Section 3. Finally, the value of recreation is often expressed in terms of a value per recreation day, an approach we also take in our findings. This calculation again uses the number of recreation days per multiple-day trip from the onsite data.

The sample statistics also show that all beaches in each study area, as enumerated in the mail surveys, had been visited by least one respondent to the mail survey. Almost all beaches received a debris rating from at least one respondent. The total number of debris ratings provided for all beaches ranged from a low of 182 ratings for beaches in Ohio to a high of 281 ratings for Delaware/Maryland beaches (Table 2).

We aimed to have good representation of both single-day and multiple-day trips in the mail survey. It could be important in determining the total response to the debris scenarios if people view the importance of marine debris differently when planning these different types of trips. The number of people taking at least one multiple-day trip was lower in Ohio and Orange County, California. Multiple-day trips in both areas appear to be better represented in terms of the absolute number of trips.

Data from the contingent behavior questions are divided into three categories: those reporting a change in trips, those reporting no change in trips, and missing responses (Table 2). The number of people reporting a change in trips is somewhat low for the scenarios where debris is reduced, but this is not likely to present a problem for the final results. For example, only three people in Delaware/Maryland report an increase in trips in response to a reduction in debris. This fits with the evidence that debris levels are already perceived to be quite low and suggests that most people would not be significantly affected by a further reduction. Indeed, confidence intervals calculated in Section 2.4 indicate that results for all debris scenarios are statistically quite precise.

The number of missing responses is high and suggests that many people had trouble answering the contingent behavior questions. Overall, 9.1% of respondents did not provide an answer when asked about a reduction in debris and 27.7% did not provide an answer when asked about a doubling of debris. We do not believe this is due to the formatting or wording of the questions, which are relatively straightforward. It may be due in part to the fact that the scenarios involve a large area that includes many beaches, some of which may be unfamiliar to the respondent. Questions focusing on a single beach familiar to the respondent may have been preferred, but would not have been feasible given the need to match scenarios to the aggregate sites defined in the *Deepwater Horizon* data. A high rate of missing responses, often 25% or more, appears to be typical for contingent behavior questions (Eisworth et al., 2000; Whitehead et al., 2010). When performing analysis and computing results, respondents who did not provide an answer to the questions about changing their trips in response to changes in debris were assumed to make no change in their trips. This approach is considered conservative and valid for stated-preference analysis (Carson et al., 2003).

There were a small number of missing responses for other mail-survey variables, such as age, education, and gender. The percentage of missing responses for all variables used in the analysis is shown as part of the summary statistics presented in Appendix B. The greatest number of missing responses for any variable was 6.7% for the question asking about household income, but this variable was not used in the analysis. Of the variables used in the analysis, the highest rate of missing responses was 4.0% for the question about level of education. In preparing the data for analysis, missing responses for all demographic variables were filled in using a random draw from all non-missing responses for the same variable (Andridge and Little, 2010).

## 2.3 Development of Sampling Weights

Sampling weights ensure that survey data is as representative as possible of the population of interest. A thorough description of sampling and weighting procedures can be found in Schaeffer et al. (2012). In this study, the population includes all people recreating at beaches in each study area. The first step in developing the sampling weights was calculating the base weights, which ensure that differences in the probability of being selected into the sample do not lead to over- or under-representation in the sample. For example, people who go to the beach frequently are more likely to be intercepted in the onsite surveys, so these respondents are given lower weights to ensure they are not overrepresented in the data. Even when accurately represented, the most active recreators are still likely to be more influential than other respondents in estimates of total recreation trips and value.

The second step in developing the sampling weights was adjusting the base weights so that mail-survey respondents represent as accurately as possible the much larger group of onsite-survey respondents. Reweighting to a larger sample with a higher response rate can make the data more representative of the target population. This adjustment to the weights involved first estimating a model that showed how certain key respondent characteristics and opinions were positively or negatively associated with respondents' response to the marine debris scenarios. We then adjusted the sampling weights so that the proportion of reweighted mail-survey respondents with each key characteristic matched the proportion for the analogous group of respondents in the onsite survey. While adjustments for some of the variables led to significant changes in the weights, we found that results were robust to the reweighting and there were only modest changes in the estimated total effect of the debris scenarios.

### 2.3.1 Base Weights

Base weights account for sample selection probabilities, which are determined by the sample design and by behavioral variables elicited in the onsite and mail surveys. Because data from the surveys are used to calculate proportions only and statistics are not expanded to the full population, selection probabilities and sampling weights can be expressed in relative rather than absolute terms (Piazzi, 2010).

There are four components used in calculating the base weights, reflecting four variables that determine the relative probability of selecting each respondent into the sample. The first variable is party size, or the number of people in the group from which an individual was selected during onsite sampling. The probability of selection for an individual is inversely related to party size, so the first factor for calculating relative selection probabilities is $f_1$ = 1 / party size. The second variable is the number of hours the respondent spent at the beach during the day of the onsite interview. The probability of selection is directly proportional to time spent at the beach, so the second factor is $f_2$ = number of hours at the beach. The third variable is the number of days the respondent went to the beach during the trip when he or she was interviewed. The probability of selection is directly proportional to the number of days in the trip, so $f_3$ = number of days in the trip. The fourth variable is the number of trips the respondent took during the year. This is again directly proportional to the selection probability, so $f_4$ = the number of trips the respondent took during the year.

The final base weights are inversely proportional to selection probabilities, so weights are calculated using the inverse of each of the above factors. Also, relative weights are scaled so that the sum of the weights equals the sample size, which is equal to the number of completed surveys shown in Table 1. Using *i* to represent individual respondents in the sample, $f_{i1}$ through $f_{i4}$ to represent the above factors for individual *i*, and $N_{ia}$ to represent the mail-survey sample size for area *a* in which individual *i* was interviewed, the base weighs are calculated as

$$w_{ib} = N_{ia}\frac{\left(1/_{f_{i1}}\right)\left(1/_{f_{i2}}\right)\left(1/_{f_{i3}}\right)\left(1/_{f_{i4}}\right)}{\sum_i\left(1/_{f_{i1}}\right)\left(1/_{f_{i2}}\right)\left(1/_{f_{i3}}\right)\left(1/_{f_{i4}}\right)} \tag{1}$$

Although mail surveys were addressed to the specific individual who was interviewed onsite, in some instances the gender or age reported in a mail survey was different from what was recorded onsite, suggesting that someone else filled out the mail survey. We retained these surveys in the data and assumed that onsite variables needed for weighting procedures, such as party size and number of hours on the beach, could be applied to the mail respondent. In the 16 cases where mail survey respondents reported taking no trips during the previous year, we assumed they took a single trip. This assumption is required to calculate a sampling weight for these individuals. The same assumption was also used when calculating total baseline trips, which was the starting point for computing a percentage change in trips in the marine debris scenarios.

In certain instances, noted below, we used weights derived solely from the onsite survey. Weights for the onsite survey are calculated as

$$w_{io} = N_{iao}\frac{\left(1/_{f_{i1}}\right)\left(1/_{f_{i2}}\right)\left(1/_{f_{i3}}\right)}{\sum_i\left(1/_{f_{i1}}\right)\left(1/_{f_{i2}}\right)\left(1/_{f_{i3}}\right)} \tag{2}$$

$N_{iao}$ is the sample size for the onsite survey in area *a* where *i* was interviewed, equal to the number of completed onsite survey shown in Table 1. The final factor $f_4$ is omitted because the number of trips respondents take during the year is obtained only in the mail survey.

### 2.3.2 Reweighting Mail Respondents

Respondents' characteristics and opinions are often related to their preferences. Using the mail-survey data, we developed a model to find which respondent characteristics and opinions, if any, helped predict how people would answer the contingent behavior questions about marine debris. The model estimated the relationship between respondents' stated change in trips for each scenario and eight explanatory variables, including the respondent's age, education, and gender; whether there were children in the respondent's household; whether the respondent felt that debris was a problem on local beaches; and the importance to the respondent of free or inexpensive parking, no crowds, and no debris. The model specification was a logit choice model, which is widely used is recreation applications (Train, 2003). Details of the model are described in Appendix C. In the model, three key variables were significant predictors of a response to debris: age, education, and whether the respondent felt marine debris was a problem on area beaches.

We then compared mail respondents to onsite respondents with respect to the three key variables. For any variable where mail respondents were significantly over- or under-represented relative to onsite respondents, we reweighted the responses. For example, in the mail survey, 23% of respondents in Alabama were 45 years old or younger and 77% were older than 45. In the onsite survey, the percent frequencies were 52% for those 45 or younger and 48% for those older than 45. Therefore, we reduced the representation of older respondents in the mail survey could improve representativeness. A table showing detailed percent frequencies for all three key variables in the mail and onsite surveys is given in Appendix C.

Based on a review of the percent frequencies, we chose to reweight respondents in all four regions by all three variables, with one exception: for Ohio, the percentage of people who viewed marine debris as a problem was the same in the onsite survey and mail survey. Since it remained nearly the same after reweighting by age and education, reweighting by the two variables age and education was determined to be sufficient.

Table 3 shows the amount that representation of the key demographic groups changed before and after reweighting. The reweighing procedure changed the representation of all three key variables, in some cases by a factor as high as 2 or as low as 0.5. However, the results concerning the impact of marine debris changed only modestly, as shown in the last two rows of Table 3 for each study area. The largest absolute change was the estimated response to a decrease in debris in Alabama, which rose from 5.4% to 8.1%.

**Table 3. Representation of demographic categories and estimated response to debris scenarios before and after reweighting mail respondents**

| Region/statistic | Before reweighting | After reweighting | Ratio: after/before |
|---|---|---|---|
| **Alabama** | | | |
| Age ≤ 45 (proportion) | 0.23 | 0.52 | 2.3 |
| Age > 45 (proportion) | 0.77 | 0.48 | 0.6 |
| Education ≤ bachelors (proportion) | 0.38 | 0.57 | 1.5 |
| Education > bachelors (proportion) | 0.62 | 0.43 | 0.7 |

**Table 3. Representation of demographic categories and estimated response to debris scenarios before and after reweighting mail respondents**

| Region/statistic | Before reweighting | After reweighting | Ratio: after/before |
|---|---|---|---|
| Problem = yes (proportion) | 0.36 | 0.45 | 1.3 |
| Problem = no (proportion) | 0.64 | 0.55 | 0.9 |
| Change in number of trips when debris is reduced to almost none | 5.4% | 8.1% | 1.5 |
| Change in number of trips when debris doubles | -27.0% | -26.5% | 1.0 |
| **Delaware and Maryland** | | | |
| Age ≤ 55 (proportion) | 0.54 | 0.79 | 1.5 |
| Age > 55 (proportion) | 0.46 | 0.21 | 0.5 |
| Education ≤ bachelors (proportion) | 0.47 | 0.50 | 1.1 |
| Education > bachelors (proportion) | 0.53 | 0.50 | 0.9 |
| Problem = yes (proportion) | 0.33 | 0.18 | 0.5 |
| Problem = no (proportion) | 0.67 | 0.82 | 1.2 |
| Change in number of trips when debris is reduced to almost none | 3.5% | 2.2% | 0.6 |
| Change in number of trips when debris doubles | -14.8% | -16.3% | 1.1 |
| **Ohio[a]** | | | |
| Age ≤ 55 (proportion) | 0.48 | 0.66 | 1.4 |
| Age > 55 (proportion) | 0.52 | 0.34 | 0.7 |
| Education = high school (proportion) | 0.41 | 0.25 | 0.6 |
| Education ≠ high school (proportion) | 0.59 | 0.75 | 1.3 |
| Problem = yes (proportion)[a] | 0.64 | 0.63 | 1.0 |
| Problem = no (proportion) | 0.36 | 0.37 | 1.0 |
| Change in number of trips when debris is reduced to almost none | 34.9% | 35.4% | 1.0 |
| Change in number of trips when debris doubles | -34.7% | -35.6% | 1.0 |
| **Orange County, California** | | | |
| Age ≤ 45 (proportion) | 0.51 | 0.75 | 1.5 |
| Age > 45 (proportion) | 0.49 | 0.25 | 0.5 |
| Education ≤ graduate degree (proportion) | 0.44 | 0.24 | 0.5 |
| Education > graduate degree (proportion) | 0.56 | 0.76 | 1.4 |
| Problem = yes (proportion) | 0.55 | 0.49 | 0.9 |
| Problem = no (proportion) | 0.45 | 0.51 | 1.1 |
| Change in number of trips when debris is reduced to almost none | 8.8% | 9.5% | 1.1 |
| Change in number of trips when debris doubles | -20.4% | -20.9% | 1.0 |

a. In the mail weights for Ohio, observations were not adjusted to match the onsite data with respect to the proportion of people saying marine debris was a problem because the proportions were both 64% before adjustments. After adjusting for age and education the mail proportion saying debris was a problem dropped to 63%, but this small difference was viewed as acceptable.

## 2.4 Results of the Marine Debris Survey

Below we describe the main results of the marine debris survey. For the complete set of weighted mail-survey statistics, see Appendix B. The main results include the proportion of trips that are single-day trips and the number of recreation days in a multiple-day trip. Both come from the onsite data and are used later in the modeling and analysis. We also report three of the importance ratings from Question 4 of the mail survey (q4 variables in Appendix B) that are helpful in providing context for people's response to marine debris. Finally, we report the percent change in trips for the two scenarios in each of the four study areas, the key inputs to the nationwide recreation model that calculates the number and value of trips.

### 2.4.1 Population Statistics

We calculated statistics from the onsite survey using the onsite weights described in Section 2.3.1 and statistics from the mail survey were calculated using the final mail sampling weights, including the demographic adjustments described in Section 2.3.3 (Table 4). To calculate standard deviations, we used the formula for weighted standard deviations. To calculate standard errors, we used a jackknife variance procedure (Tukey, 1958) in which any given statistic was calculated separately $N_a$ times, once with each of the $N_a$ observations removed, where $N_a$ refers to the number of respondents in a given study area.

**Table 4. Selected population statistics from the onsite and mail surveys by region**

| Statistic | Alabama | | Delaware and Maryland | | Ohio | | Orange County, California | |
|---|---|---|---|---|---|---|---|---|
| | Value | St. Dev. or St. Err. | Value | St. Dev. or St. Err. | Value | St. Dev. or St. Err. | Value | St. Dev. or St. Err. |
| **Onsite survey statistics (with standard errors)** | | | | | | | | |
| Proportion of trips that are single-day trips | 70.6% | 2.5% | 72.3% | 2.4% | 97.7% | 0.7% | 88.2% | 2.2% |
| Average number of recreation days in a multiple-day trip | 3.10 | 0.10 | 3.21 | 0.11 | 1.98 | 0.14 | 2.42 | 0.13 |
| Proportion of recreation days from outside the local area | 83.7% | 1.7% | 89.2% | 1.8% | 97.7% | 1.2% | 81.4% | 3.9% |
| **Mail survey statistics (with standard deviations)[a]** | | | | | | | | |
| Average importance rating: manmade debris on the beach | 4.75 | 0.55 | 4.42 | 1.20 | 4.77 | 0.48 | 4.40 | 0.77 |
| Average importance rating: good water quality | 4.76 | 0.59 | 4.58 | 0.86 | 4.76 | 0.55 | 4.30 | 0.71 |
| Average importance rating: no natural debris on the beach | 2.67 | 1.36 | 2.43 | 1.30 | 3.00 | 1.28 | 2.18 | 1.27 |
| **Mail survey statistics (with standard errors)** | | | | | | | | |
| Average debris rating | 1.65 | 0.06 | 1.60 | 0.07 | 2.27 | 0.10 | 2.09 | 0.12 |
| Change in the number of trips – "almost no" debris | 8.1% | 0.40% | 2.2% | 0.02% | 35.4% | 1.56% | 9.5% | 0.60% |
| Change in the number trips – doubling of debris | -26.5% | 0.58% | -16.3% | 0.37% | -35.6% | 0.84% | -20.9% | 0.77% |

a. Population statistics for demographic variables appear in Appendix B.

The proportion of trips that are single-day trips ranged from 70.6% in Alabama to 97.7% in Ohio. This reflects a variety of factors, including the appeal of beaches for those who wish to spend a few hours at the beach relative to those who wish to spend several days at the beach. It also reflects the number of people who live within a distance close enough to make single-day trips feasible, versus the number people who live at distances better suited to multiple-day trips. The average number of days in a multiple-day trip is determined by similar factors, and in our data it is generally inversely related to the proportion of single-day trips.

We also obtained estimates of the proportion of single-day trips from the mail survey data. Those numbers are 63.7% in Alabama, 61.0% in Delaware/Maryland, 94.5 % in Ohio, and 93.2% Orange County. We chose to use the onsite data in our calculations due to the larger number of observations available in the onsite data and the higher accuracy that is likely to result when people are reporting about the trip they are currently on rather than recalling trips over the course of the previous year.

Three importance ratings from Question 4 of the mail survey are useful in providing context for people's preferences about marine debris. The importance ratings were presented in the survey as a scale from 1 to 5, with 1 representing "not important," 3 representing "somewhat important," and 5 representing "very important." The first rating in Table 4 is for the importance of manmade debris. The average ratings were quite high, with a majority of respondents in all study areas giving this factor a rating of 5, or "very important." However, to the extent that there is variation, it is consistent with other results of the survey. For example, the average debris rating at beaches in Alabama is slightly higher but quite close to that of Delaware/Maryland. The difference in the estimated response to changes in debris may therefore be due to differences in preference more than differences in current conditions (recall that the scenarios describe changes in debris that are proportionate to current levels). Indeed the average importance rating for debris is higher in Alabama, supporting the idea that preferences are a factor in explaining the divergent results. Perceptions of current debris levels in Orange County are somewhat higher than those in Alabama, but the reported response to changes in debris are similar in the two areas. Orange County has the lowest importance rating for debris, which again suggests that differences in preference may be offsetting the difference in debris levels in determining the response to changes in debris levels.

Other important ratings shown in Table 4 include water quality and the presence of natural debris such as kelp or seaweed. Water quality is related to manmade debris in that both factors involve a disruption to the natural environment. The presence of natural debris is related to manmade debris in that both factors involve debris on the beach. All three factors show a similar pattern when comparing across regions, with the highest levels of importance in Ohio and the lowest levels of importance in Orange County. Since the importance ratings are not used in calculating final results, the precision of the average ratings is not important. Instead of standard errors, standard deviations are reported for these statistics to assist in understanding the variation in ratings across respondents.

The average debris ratings indicate that Ohio beaches have the highest levels of debris, while Alabama and Delaware/Maryland have comparatively low levels of debris. The average debris ratings were calculated as the weighted average of all ratings provided by respondents for all beaches in a given study area. The average ratings retained the same 1-to-5 scale used in data collection.

There are at least two alternative ways to aggregate the debris ratings. One alternative approach would involve averaging the ratings for each beach and then taking an average of the beach-specific ratings. Relative to the first method, this would place a greater emphasis on ratings for any beaches rated by only small number of people, since all beaches would get an equal weight in the average. Both measures lead to similar ratings for all study areas except Orange County, California, where the average rating increased to 2.43 using this alternative method. We think a single average grouping all ratings together is preferred because it represents beaches in proportion to their familiarity to people who use the area, which is likely to better represent people's overall impression of debris in each study area.

A second method for calculating an average of debris ratings would involve first converting the ratings to actual estimated debris amount using information provided to survey respondents. For example, the rating of "1" would correspond to 1 piece of debris per 500 square feet, as shown in pictures provided in the mail survey. Likewise a rating of "5" would correspond to 16 pieces of debris per 500 square feet. We found that this alternative method generated ratings that varied dramatically across beaches. Importantly, there was a slight negative correlation between the debris averages for specific beaches calculated using this method and the onsite measurements of debris for those beaches. As described in Section 3.2, when the 1-to-5 debris ratings were averaged for the same beaches, the correlation with the onsite measurements was quite high. Although they can be interpreted in relative terms only, we retain the original 1-to-5 ratings when calculating summary measures of debris in the four study areas.

### 2.4.2 Effects of Marine Debris on Recreation Trips

The final estimates of the change in demand for trips that results from the two debris scenarios are shown in the last section of Table 4. For a reduction in debris to almost none, the percentage change in the number of trips is 8.1% in Alabama, 2.2% in Delaware/Maryland, 35.4% in Ohio, and 9.5% in Orange County, California. For a doubling of debris, the percentage change in the number of trips is -26.5% in Alabama, -16.3% in Delaware/Maryland, -35.6% in Ohio, and -20.9% in Orange County, California. Standard errors are reported, and all estimates have high statistical precision. To evaluate the implications of these results for total trips, recreation value, and regional economic impacts, the percentage changes are used as an input to the nationwide recreation model, described below.

## 3. Recreational Value Model

The key result from the marine debris survey was the percentage change in recreation trips from two potential debris scenarios in each study area: a decrease in debris to almost none and a doubling of current debris levels. In this section, we estimate the implication of these percentage changes on the total number and value of recreation trips using a nationwide model of people's recreation choices.

The basis for this analysis is the nationwide recreation model that was developed using data collected in 2012 and 2013 by experts working on behalf of state and federal agencies to assess recreation impacts from the *Deepwater Horizon* oil spill (English et al., 2018). The *Deepwater Horizon* data includes complete information on recreation trips for the Southeast United States, but only includes information about trips lasting two nights or more in other areas. We adapted these data to examine the recreational value in this study, a method known as benefit function transfer. Specifically, we used data from onsite surveys to adjust the model so that it would correctly estimate all trips in the three study areas outside the Southeast. However, we found that Lake Erie beaches in Ohio were too different from other areas to effectively complete the benefit transfer, and only impacts to multiple-day trips were estimated for that study area.

We evaluated the reliability of our methods by comparing key results to external sources. We found that the estimated effects from changes in debris in our study were either comparable to or somewhat higher than the effects estimated in a previous study in Orange County (Leggett et al,, 2018), depending on the scenario examined. The results are not directly comparable because our model accounts for all trips and the previous model included single-day trips only. We found that respondents' ratings of the relative amounts of marine debris on beaches were highly correlated with previous onsite debris measurements, but that converting the ratings to absolute amounts of debris did not give reliable estimates. We also found some evidence that people using beaches at different times of the year may have a different response to marine debris, suggesting that additional efforts to contact recreators at beaches throughout the year could yield somewhat different results. The final estimates of changes in recreation trips and value for the two scenarios and the four regions are presented in Section 3.4.

## 3.1 Nationwide Recreation Model

The nationwide recreation model developed for the marine debris study is a type of travel-cost model. It involves a system of demand functions where the price is the cost of traveling to recreation sites and the quantity is the number of trips people take to the sites. The model is based on data collected for the assessment of beach recreation losses following the *Deepwater Horizon* oil spill. An overview of data collection methods, procedures for cleaning the data, and calculation of model inputs are provided in a series of memoranda that are available in the *Deepwater Horizon* administrative record.[4] Specific memoranda are referenced below for details not provided in this report. An overview of the *Deepwater Horizon* beach recreation assessment can be found in English et al. (2018).

### 3.1.1 Nationwide Coastal Recreation Data

The *Deepwater Horizon* data were collected in a telephone survey of 41,708 respondents conducted over a 12-month period beginning June 2012. This was after the effects of the *Deepwater Horizon* spill had ended, according to onsite studies of recreation activity (Tourangeau et al., 2017). The sample for the survey was drawn from the full population of the contiguous 48 states. The data include information about all recreation trips to beaches in the Southeast United States. For other coastal areas the data include information only about trips lasting at least two nights away from home and originating from outside the Southeast. Specifically, respondents in eastern Texas, Louisiana, Mississippi, Alabama, Florida and southern Georgia were asked about all their beach trips to coastal areas from Texas to Georgia. These respondents were not asked about their trips to other areas of the country. Respondents from the remainder of the contiguous United States were asked about all their coastal trips to anywhere in the contiguous United States lasting at least two nights. Respondents from outside the Southeast were not asked about shorter trips because all of their trips to the Gulf Coast from Louisiana to Florida, the focus of the *Deepwater Horizon* assessment, were at least two nights. On the other hand, these respondents were not asked to limit their answers to Gulf Coast destinations, because the additional information about overnight trips elsewhere in the country was viewed as potentially valuable in understanding the substitution of longer trips to areas outside the Gulf after the spill.

For this marine debris analysis, we simplified the *Deepwater Horizon* dataset in two ways. First, we eliminated trips with travel distances greater than 750 miles. This improved consistency of the data across regions. For example, while the full dataset includes trips from California to Alabama but omits trips from Alabama to California, we limited the geographic focus of the model in all regions. The 750-mile cutoff still retains 95.6% of all trips in the data to areas

4. The technical memoranda in the *Deepwater Horizon* administrative record are available at https://www.diver.orr.noaa.gov/deepwater-horizon-nrda-data#.

outside the Gulf, and a higher percentage of trips to areas within the Gulf where single-day and one-night trips are a large portion of total trips. Second, when reporting our results we avoid making a distinction between trips of two nights or more and multiple-day trips, a term which also includes trips with an overnight stay of just one night. Instead, we refer only to multiple-day trips as distinct from single-day trips.

For all estimates based on the *Deepwater Horizon* data, we made adjustments to convert trips of two nights or more into an estimate of all multiple-day trips, using the ratio of total multiple-day trips (including one-night stays) to trips of two nights or more. This ratio was estimated for each study area using data from the onsite marine debris survey, which asked respondents about the length of their trips and their overnight lodging.

In addition to information about recreation trips, the *Deepwater Horizon* data include information about respondents' demographic characteristics, such as age, income, education level, and gender. Sampling weights were developed for each respondent using sample selection probabilities as well as adjustments that matched key demographic groups in the sample to population statistics from the U.S. Census (English, 2015a, 2015b). All respondents were included in the recreation model regardless of whether they took coastal recreation trips or not.

The *Deepwater Horizon* data groups coastal beaches into 76 aggregate sites covering all coastal areas of the continental United States, including the Great Lakes. Travel costs from respondent origins to the 76 destinations were constructed using a weighted average of driving and flying costs (Leggett, 2015). The weights for a given respondent and site were equal to the proportion of people driving or flying for trips reported by respondents with similar incomes who traveled a similar distance. Driving costs were based on driving distances and travel times as calculated using PC*Miler software. The cost per mile of driving, including gasoline and per-mile automobile depreciation, was estimated to be 25 cents per mile based on information from the American Automobile Association (2012). The cost per hour of travel time was set equal to one-third of the respondent's household income divided by 2,080. This procedure for estimating an individual's value of travel time is consistent with evidence in the literature (English et al., 2015). Flying costs were computed using the 30th percentile of fares for round-trip tickets as reported in the Airline Origin and Destination Survey, a 10% sample of all airline tickets collected each year by the U.S. Bureau of Transportation Statistics. Using the 30th percentile was intended to eliminate the effects of high fares related to business travel (Leggett, 2015).

### 3.1.2 Model Structure

The nationwide recreation model developed for the marine debris study uses a common mathematical structure called nested logit (Train, 2003). A nested logit model consists of a set of demand functions, one for each of the recreation sites in the model. It also allows sites that are similar to one another to be grouped together so that the greater amount of substitution between similar sites can be reflected in the model's behavior predictions.

The nesting structure in the nationwide recreation model first groups the 76 sites into distinct regions where sites may be more similar to each other than they are to sites outside each region. This allows the model to account for the possibility that if one site is affected by a decline in quality people are more likely to switch to other sites within a given region of the country rather than, say, switching between Lake Erie and the New Jersey shore. The regions were defined based on an exploration of the best model fit and were selected to be the Gulf Coast, the Atlantic

Coast from Florida to Virginia, the Mid-Atlantic region from Maryland to New York, the Northeast from Connecticut to Maine, the Great Lakes, southern California from San Diego to Santa Barbara, and the remainder of the West Coast from San Luis Obispo, California to Washington State.

The nested-logit structure also includes a "participation" component, which is a separate nest describing substitution into and out of beach recreation. This allows for changes in the total number of trips to all sites in response to changes in beach amenities in addition to switching of trips between sites. Each site in the model is represented by an estimated constant that reflects the total effect of all site attributes, such as the size of each site and quality characteristics.

As noted earlier, single-day trips and one-night trips are not included in the data for sites outside of the Southeast United States. This would cause problems in model estimation because demand functions must be fit to data that shows an increase in trips as price decreases. In other words, the model expects complete data that would show people close to the beach taking more trips than people far from the beach. Since most trips from close to the beach are single-day trips, the exclusion of single-day and one-night trips means that low prices correspond to fewer trips rather than more trips in the *Deepwater Horizon* data.

To overcome this problem, we do not attempt to fit the model to trips originating less than 125 miles from a given site. Instead, we fit the model's prediction of total demand for all observations within 125 miles of a site to a constructed total number of trips that accounts for trips of all lengths. We chose the 125-mile threshold because in the data for Southeast sites, 88.3% of all one-night trips originated from within 125 miles of the trip destination. Adding in single-day trips, the 125-mile area accounted for 99.2% of all trips. This total was constructed using the average relationship between the number of longer and the number of shorter trips at sites in the Southeast, where complete data on trips is available. Specifically, we found that the total number of single-day and one-night trips to Southeast sites was six times greater than the total number of trips lasting two nights or longer. For a given site, we therefore multiplied the number of trips lasting two nights or more, as reported in the data, by a factor of six to estimate the number of single-day and one-night trips to the site. Finally, we added together the constructed total number of single-day and one-night trips to the total number of trips lasting two nights or more that also originated from within 125 miles of the site. In model estimation, this constructed total was matched to the sum of model predictions for all respondents living within 125 miles of the site.

We made one final adjustment to ensure accurate trip predictions for study area sites. The factor of six times as many short trips as long trips used above is an average. Therefore it is only an approximation for any given site. For the study area sites, we adjusted this factor until model predictions matched information from the onsite marine debris survey. For example, onsite data for Orange County, California indicates that 88.2% of trips are single-day trips. The number of single-day trips was calculated as the model's estimate of total trips minus the number of multiple-day trips reported in the data. Using the average factor of six times as many short trips as long trips, our initial model estimated that 79.1% of trips in Orange County were single-day trips. We adjusted the constructed total number of trips within the 125-mile threshold until the model predictions matched the onsite estimate of 88.2%. A similar adjustment was performed for the Delaware/Maryland site. No adjustment was needed for Alabama, since complete trip information was available for Gulf Coast sites.

For the Ohio study area we did not attempt to make an adjustment because the original model predicted almost no single-day trips. By contrast, the onsite data indicated that 98% of trips were single-day trips. We also found that the average distance people traveled to Ohio beaches for trips lasting at least two nights was considerably lower than the average distance in other regions of the country. We concluded that our model was not able to accurately estimate total trip demand for the Ohio study area. We therefore limited our results to multiple-day trips estimated directly from the *Deepwater Horizon* data and the onsite marine debris survey. The failure of the model to predict total trips for Ohio also indicates there is some uncertainty about using the model's estimate of value per day for multiple-day trips. However, with this caveat in mind we exclude only single-day trips and report both trip demand and value for multiple-day trips in the Ohio estimates.

#### 3.1.3 Estimated Model Parameters

The estimated coefficients and standard errors for the nationwide recreation model are shown in Table 5. The sample size 41,708, and the model was estimated using the maximum likelihood procedure in Aptech Gauss 12 software. The travel cost coefficient is negative and highly statistically significant (Table 5), indicating that people have a strong preference for sites that are closer and less expensive to access. The nesting structure of the model involves estimating scale parameters that characterize the effect of the nested groupings. The scale parameter for grouping the sites into the seven regions defined above is highly significant (Table 5), indicating that sites within regions are good substitutes for one another and that the selected nesting structure is preferred to a model without the regional nests. The scale parameter for participation is also highly significant (Table 5), indicating that this component of the nesting structure is also important to the model.

Most demographic variables are statistically significant determinants of the demand for recreation trips, and the coefficient on income is highly significant. The constants representing the attractiveness of each of the 76 sites to some extent represent variation in the quality but to a large extent represent variation in the size of the defined sites. Site constants cannot be interpreted in relation to zero but only in relation to each other, so the *p* values are omitted and the lowest constant for any site was normalized to zero. Most site constants are omitted from Table 5, but we report the estimated constants for the four study areas.

The last eight parameters in Table 5 show the adjustments needed to simulate the two debris scenarios in each of the four areas. For example, to simulate the 20.9% decrease in trips (see Table 5) from a doubling of debris in Orange County, California, a value of 0.338 must be subtracted from the site constant for Orange County. This causes the model's prediction of trips in Orange County to decline from 27.1 million to 21.5 million, a decline of 20.9%. No standard errors are reported for the debris-scenario parameters because they are not estimated as part of the model but are found by searching for the value that matches model predictions to the percentage changes from the marine debris survey.

**Table 5. Parameter estimates from the recreation demand model using *Deepwater Horizon* nationwide recreation data**

| Variable | Coefficient | Standard error | *p* value |
|---|---|---|---|
| Travel cost | -0.027 | 0.002 | 0.000 |
| Scale parameter, regions | 2.373 | 0.148 | 0.000 |
| Scale parameter, participation | 1.270 | 0.084 | 0.000 |
| 25k ≤ income < 50k | -0.786 | 0.145 | 0.000 |
| 50k ≤ income < 75k | -1.113 | 0.171 | 0.000 |
| 75k ≤ income < 100k | -1.409 | 0.190 | 0.000 |
| 100k ≤ income < 150k | -1.578 | 0.190 | 0.000 |
| 150k ≤ income | -2.859 | 0.375 | 0.000 |
| % urban | -0.626 | 0.103 | 0.000 |
| Age/100 | -3.778 | 1.577 | 0.017 |
| (Age/100)2 | 5.313 | 1.482 | 0.000 |
| High school diploma | 0.518 | 0.159 | 0.001 |
| College degree | -0.210 | 0.115 | 0.068 |
| Full time | -0.444 | 0.189 | 0.019 |
| Part time | -0.586 | 0.204 | 0.004 |
| Retired | -0.615 | 0.223 | 0.006 |
| White | -0.646 | 0.196 | 0.001 |
| Male | -0.006 | 0.137 | 0.967 |
| HH members ≥ 18 | -0.010 | 0.160 | 0.949 |
| HH members < 18 | 0.162 | 0.078 | 0.037 |
| **Site constants for the four study areas** | | | |
| Alabama | 7.763 | 0.852 | |
| Delaware/Maryland | 6.814 | 1.500 | |
| Ohio | 3.118 | 1.400 | |
| Orange County, California | 5.846 | 0.835 | |
| **Parameter for simulating debris scenarios** | | | |
| Alabama, “almost no debris” | 0.088 | | |
| Delaware/Maryland, “almost no debris” | 0.033 | | |
| Ohio, “almost no debris” | 0.465 | | |
| Orange County, California, “almost no debris” | 0.136 | | |
| Alabama, doubling of debris | -0.340 | | |
| Delaware/Maryland, doubling of debris | -0.263 | | |
| Ohio, doubling of debris | -0.640 | | |
| Orange County, California, doubling of debris | -0.338 | | |

## 3.2 Comparisons to External Sources

In this section we evaluate key results of the marine debris study using comparisons to external sources. To the extent that results from different sources are similar, the comparison provides some assurance that our estimates are accurate and robust. To the extent that results from different sources diverge, it is worth assessing the potential reasons and possible implications. The discussion in this section refers to results presented in Table 6.

**Table 6. Consistency with external sources and benefit-transfer calibration.** See text for discussion of these values.

| Statistic | Value |
|---|---|
| **Effects of debris on recreation: Comparison of study results to previous revealed-preference estimates in Orange County** | |
| *Scenario: Eliminating marine debris (or reducing to almost none)* | |
| Change in value per baseline trip, marine debris study | $5.58 |
| Percent change in the number of recreation trips, marine debris study | 9.5% |
| Change in value per baseline trip, 2014 revealed-preference study[a] | $6.05 |
| Percent change in the number of recreation trips, 2014 revealed-preference study[a] | 16.0% |
| *Scenario: Increasing marine debris by 50%* | |
| Change in value per baseline trip, marine debris study | -$6.26 |
| Percent change in the number of recreation trips, marine debris study | -10.9% |
| Change in value per baseline trip, 2014 revealed-preference study[a] | -$2.31 |
| Percent change in the number of recreation trips, 2014 revealed-preference study[a] | -6.1% |
| **Seasonal consistency: Comparison of survey respondents intercepted on the beach in summer versus fall in Orange County** | |
| Change in trips from reducing debris to “almost none,” fall 2017 pretest[b] | 4.9% |
| Change in trips from doubling of debris, fall 2017 pretest[b] | -16.3% |
| Change in trips from reducing debris to “almost none,” summer 2018 respondents[c] | 8.8% |
| Change in trips from doubling of debris, summer 2018 respondents[c] | -20.4% |
| **Debris ratings: Comparison of debris ratings to onsite debris measurements** | |
| Correlation between debris ratings and onsite measurements | 0.87 |
| **Benefit function transfer: Comparison and calibration of single-day trip predictions[d]** | |
| *Delaware/Maryland* | |
| Percent of all trips that are single-day trips, marine debris survey (onsite survey) | 72.3% |
| Percent of all trips that are single-day trips, nationwide recreation model unadjusted | 54.4% |
| Percent of all trips that are single-day trips, nationwide recreation model adjusted | 72.3% |
| *Orange County, California* | |
| Percent of all trips that are single-day trips, marine debris survey (onsite survey) | 88.2% |
| Percent of all trips that are single-day trips, nationwide recreation model unadjusted | 79.1% |
| Percent of all trips that are single-day trips, nationwide recreation model adjusted | 88.2% |

a. These values are from a revealed-preference pilot study of marine debris impacts in Orange County, California, that was conducted by NOAA from July 2013 through January 2014 (IEc, 2014, Exhibit 29). Dollar values are in 2018 dollars, adjusted for inflation using the CPI (Federal Reserve Bank of St. Louis, 2019).

b. A pretest of the marine debris survey was conducted in Orange County, California, using methods that were similar to those of the final study. There were 49 completed mail interviews and 343 completed onsite interviews in the pretest.

c. Pretest results could not be reweighted to match onsite data because attitudinal questions such as “Do you think marine debris is a problem” were not included in the onsite survey for the pretest. We therefore compare pretest results to full-study results that have not been adjusted to match the onsite sample. As shown in Table 4, the differences between adjusted and unadjusted full-study results are modest.

d. The parameters for the Delaware/Maryland site and the Orange County, California, site were adjusted so that model predictions of single-day trips matched information obtained in the onsite surveys. No adjustment was made in Alabama because the *Deepwater Horizon* data includes complete information on trips of all lengths throughout the Southeastern United States. No adjustment was made in Ohio because the site was determined to be sufficiently different from other coastal sites that model predictions of single-day trips would not be reliable.

### 3.2.1 Effects of Debris on Recreation

Economic methods for valuing environmental quality fall broadly into two categories: revealed-preference methods and stated-preference methods. Revealed-preference involves inferring the value of environmental amenities based on choices people make about how to spend their time and money. For example, if people avoid nearby beaches with high levels of debris and instead travel further to get to clean beaches, we can infer they have a value for clean beaches. Stated-preference methods involve inferring value based on how people say they would spend their time and money in hypothetical circumstances. For example, people could be asked in a survey whether they would travel further to get to clean beaches. A comparison between revealed-preference and stated-preference results is one of the most common ways of evaluating the performance of studies using either method.

The first results in Table 6 compare our stated-preference estimates of the effect of debris on beach recreation to revealed-preference estimates from a previous study in Orange County, California (IEc, 2014; Leggett et al., 2018). The IEc (2014) study involved a survey of Orange County residents about their single-day trips to 31 local beaches in the summer of 2013. The study used a model of recreation choice to estimate the importance of marine debris to beach recreation based on which beaches people went to and the attributes of those beaches, including the amount of marine debris. Exhibit 29 of the IEc (2014) report shows model results for several debris scenarios. For comparison to our study, we selected two scenarios and two measures of the effects of marine debris for each scenario.

The first scenario we selected involves the elimination of debris at all 31 beaches in the IEc (2014) study. We compared this to our scenario of a reduction to almost no debris for beaches in Orange County. The scenarios are not directly comparable, because 13 of the 31 beaches in IEc (2014) were outside of Orange County, and the elimination of debris involves a greater change than a reduction in debris to almost none. The second scenario involves an increase in marine debris of 50% at all 31 beaches in IEc (2014). While still different from the scenario in our study with respect to the number of beaches, we were able to simulate the 50% increase by assuming a linear relationship between debris levels and the importance of debris to recreators. Specifically, we took the parameter of -0.338 for a doubling of debris and reduced it by half, to -0.169. This revised parameter was then entered into our recreation model to simulate the effects of a 50% increase in debris. A linear relationship between measured site attributes and their importance in a recreation model is an assumption used in many studies, including IEc (2014).

The first measure of effects we selected was the "benefit per baseline trip to impacted sites," as presented in Exhibit 29 of IEc (2014). This is the total change in recreation value resulting from the change in debris divided by the baseline number of recreation trips before the change. This measure is not directly comparable between the two studies, because in our study recreation trips includes both multiple-day trips and single-day trips, while IEc (2014) examined single-day trips only. However, it is preferable to normalize values to a per-trip amount since we expect that a total measure of value would be much higher in our study, given that our study includes trips by residents from throughout country rather than just residents of Orange County. The second measure of effects we selected was the percentage change in recreation trips resulting from a change in debris. There is no definitive reason why this percentage change should be higher or lower in either study, given a comparable scenario. However, the fact that the scope of the studies differ in both the types of trips analyzed and extent of the population could also lead to a divergence in this measure of results.

For the scenario of a reduction in debris, our model estimated a value of $5.58 per baseline trip for Orange County. This is quite close to the value of $6.05 in IEc (2014). We adjusted all dollar values from IEc (2014) upward by a factor of 1.08 to account for inflation between 2013 and 2018 using the CPI (Federal Reserve Bank of St. Louis, 2019). The percentage increase in trips was 9.5% in our study, compared to 16.0% in IEc (2014). Due to the difference in scenarios, with a reduction in debris to almost none in our study rather than the complete elimination of debris, a smaller percentage change in our study is expected. The comparison of per-trip values is more ambiguous. A lower value per trip from a smaller change in debris in our study would be at least partially offset by the fact that the per-trip value for multiple-day trips (and therefore for all trips combined) is likely to be greater than the per-trip value for single-day trips only. Overall, we view the comparison for this scenario to be consistent with expectations. The lower effects in our study make sense given the smaller change in debris, but the difference in less pronounced with respect to value because of the inclusion of higher-value multiple-day trips.

For the scenario of a 50% increase in debris, our model estimated a value of -$6.26 per baseline trip. This compares to a value of -$2.31 in IEc (2014). The percent change in trips was -10.9% in our model, compared to -6.1% in IEc (2014). In this instance both measures of the change are definitively higher in our study. However, the divergence is sufficiently modest that it could be explained by differences in the scope of the two studies with respect to trips and population. One methodological difference that could also play a role is the assumption in IEc (2014) that the importance of debris to beachgoers is linear with respect to debris amounts over all ranges. In our study, we allow the effects of debris increases to be independent of the effect of debris reductions. If the response to a given change in debris is higher at higher levels of debris, the greater flexibility in debris response permitted in our model could help explain the greater divergence of results in the second scenario.

### 3.2.2 Seasonal Consistency

Respondents to the marine debris mail survey reported their beach recreation trips, and the effects of changes in debris on their trips, for the period of an entire year. However, respondents were first contacted over a period of just several weeks in July, August, and September 2018. It is possible that preferences differ for those using beaches during late summer versus the full population of beachgoers that could be contacted with more extensive onsite sampling. The differences may be greater in areas where beach use continues throughout most or all of the year, such as Alabama and California.

To investigate this potential source of bias we compared results from the final survey in Orange County, California with earlier results obtained from the pretest phase of our study, also conducted in Orange County. Onsite recruitment for the full study in Orange County occurred in July 2018 and onsite recruitment for the pretest occurred in late September 2017. The pretest results for a reduction in debris showed a 4.9% increase in trips and the pretest results for a doubling of debris showed a 16.3% decrease in trips. In the pretest, our methods for reweighting mail survey respondents to match onsite respondents could not be applied because the pretest onsite survey did not ask whether debris was a problem at area beaches, one of the variables used in the reweighting. For a more consistent comparison, Table 6 therefore reports results from the final survey that are also calculated using the onsite base weights only. These results show an 8.8% increase in trips and a 20.4% decrease in trips for the two scenarios.

The results from the pretest suggest a potentially lower response to debris by people contacted in fall rather than late summer. This comparison indicates that some bias may result from sampling people onsite over a period of a just a few weeks, and that a more extensive study that involves sampling onsite over the full year or full beach season could lead to different estimates.

### 3.2.3 Debris Ratings

Respondents were asked to estimate the amount of marine debris on beaches in a given study area. It is important to understand the accuracy of respondents' estimates for at least two reasons. First, the debris estimates were used to characterize current conditions in the four study areas and provide context for other study results. For example, if it is true that current debris levels are higher on Lake Erie beaches relative to other study areas, then the high estimated response to the debris scenarios, which involve changes proportionate to current levels, would be expected. Second, if the debris ratings are consistent with external evidence then it suggests that respondents pay attention to debris on beaches and are aware of the relative amounts of debris on beaches. This indicates that respondents have some context for providing accurate responses to the hypothetical debris scenarios.

We compared the ratings of debris levels from survey respondents with estimates of debris from onsite measurements conducted by NOAA in the summer of 2016. The comparison accounts for all 13 beaches that were included in both studies: Ocean City, Maryland (Boardwalk area); Lewes Beach, Delaware; South Bethany Beach, Delaware; Fenwick Isle, Delaware; Bolsa Chica, California; Cedar Point Beach, Ohio; East Harbor State Park, Ohio; Nickel Plate Beach, Ohio; Port Clinton City Beach, Ohio; South Bass Island, Ohio; Fort Morgan, Alabama; Gulf State Park, Alabama; and Orange Beach, Alabama.

The correlation between respondent ratings and onsite measurements was 0.87. Consistent with the average rating calculated for a study area, the average rating for a given beach was calculated as the weighted average of all ratings provided for the beach. The high correlation with onsite measurements suggests that people have a high awareness of the relative levels of debris at beaches. However, as noted earlier, the consistency between respondent perceptions and onsite measurements applies only to the 1-to-5 debris ratings. If these ratings are converted into absolute measures of debris based on the debris levels associated with each numeric rating (1 item per 500 square feet for a rating of 1, up to 16 items per 500 square feet for a rating of 5), the resulting measure is not correlated with the onsite debris measurements. For this reason we used only the 1-to-5 numeric ratings in this study.

### 3.2.4 Benefit Function Transfer

The *Deepwater Horizon* data has complete information about the number of trips to sites in the Southeast United States. In other coastal areas, the data only include longer trips with at least two overnight stays. As described earlier, for all model sites outside the Southeast United States we accounted for shorter trips using a constructed total number of trips for an area within 125 miles of each site. The constructed total was based on the ratio of longer trips to shorter trips for sites in the Southeast United States, and the result is what we call the "unadjusted" model in the last section of Table 6. In the final "adjusted" model, the constructed totals in Delaware/Maryland

and Orange County, California were further increased to ensure that the proportion of single-day trips predicted by the model exactly matched the proportion of single-day trips estimated from the onsite surveys. This type of adjustment falls under the classification of "benefit function transfer" in the economics literature (e.g., Wilson and Hoehn, 2006; Navrud and Ready, 2007).

The last section of Table 6 shows the original estimates from the unadjusted model, as well as the effect of the final adjustments. We include these results in Table 6 because they play a role in evaluating the reliability of the nationwide recreation model and the use of benefit function transfer in two ways. First, the unadjusted estimates of the percentage of single-day trips is lower in Delaware/Maryland (54.4%) than in Orange County, California (79.1%). A similar difference across regions is apparent in the adjusted percentages of 72.3% for Delaware/Maryland and 88.2% for Orange County, California. This suggests that the model is accurately accounting for important factors that differ across regions. For example, a large population density close to the coast in California would lead to predictions of a large number of single-day trips.

Second, the final adjustments illustrate how we are able to combine information from the *Deepwater Horizon* data with information from the marine debris survey to estimate the total number of trips as accurately as possible. The unadjusted model, while developed from reasonable assumptions, would likely be less reliable than the final adjusted model.

## 3.3 Caveats and Uncertainties

There are a variety of caveats and uncertainties associated with the methods described above. We summarize them here and discuss their implications.

Stated preference methods have the advantage that they can directly examine a specific issue. If researchers wish to know the effect of a particular beach attribute on beach recreation, a hypothetical scenario can be developed in which only the attribute of interest changes. This differs from revealed-preference methods, in which two beaches that have different levels of one attribute will almost certainly differ with respect to other attributes as well. This makes stated-preference methods applicable to a wider variety of research problems than revealed-preference methods, and less likely to be biased due to the influence of confounding factors. The drawback of stated-preference data is that responses to hypothetical scenarios, and the resulting estimates of value, may differ from the values implied by people's actual choices.

The comparison of our results in Orange County, California to results from an earlier revealed-preference study in the same location provides some assurance that both studies are reliable. For a reduction in debris, the scenarios in the two studies were not exactly comparable and the more modest effects measured in our study could be attributable to the assumption of a smaller change in debris. For an increase in debris, our study measured a greater response than the previous study. The difference was within a modest range that could be explained by the more extensive scope of our study. While the previous study involved single-day trips by the local population, our study encompassed virtually all trips by people from throughout the county.

Another source of uncertainty was the high item nonresponse rate for the contingent behavior questions. Overall, 9.1% of respondents did not provide an answer when asked about a reduction in debris and 27.7% did not provide an answer when asked about a doubling of debris. It is not possible to know whether or how these respondents may differ from those who answered the contingent behavior questions. In our calculations we assumed these respondents made no change in their trips in response to changes in debris. This could be viewed as conservative. Other options would include filling in the missing responses using the average of the available responses, or analyzing the demographic characteristics of respondents who did not provide an answer and filling in missing responses using other similar respondents. These alternative options would have led to an increase in the size of the estimated change in trips and value from the debris scenarios.

We used onsite sampling to efficiently reach a target population of beachgoers. Some aspects of our onsite sampling procedures were randomized. For example, we selected randomly from each party of people on the beach and used party size to control for selection probabilities. Other aspects of our sampling procedures were nonrandom. For example, we divided beaches into more developed and less developed categories and ensured that both types of beach were included in our onsite surveys. This procedure was similar to stratified sampling. However, a fully random stratified sample would have involved drawing a random selection of days and times for conducting interviews at each type of beach, and then incorporating the sampling rates for each beach stratum into the sampling weights. Without these procedures, we cannot guarantee that our sample accurately represents beachgoers who use different types of beaches in the correct proportion. Likewise, the representation in our sample of times of day and weekdays versus weekend days is unlikely to match the correct proportions of a fully randomized sample. As discussed earlier, our sample does not represent the various seasons throughout the year.

Our comparison of results for different seasons, discussed above, suggested that preferences about marine debris may vary somewhat for people using the beach at different times of the year. It is also possible that a randomized selection of days, times, and beaches, resulting in a sample that better represents all beachgoers, would have led to changes in the estimated effect of debris on recreation. There is no reason to suspect a specific type of sample-selection bias, such as sampling onsite at beaches with high debris levels and therefore biasing the sample toward those who are tolerant of debris. However, there is no basis at this time for estimating the direction or magnitude of any effect of the nonrandom aspects of the onsite sampling.

Onsite sampling also omits from the study population those people who do not currently go to the beach in a given study area but would go if beaches had less debris. This means that some people who would benefit from a reduction in debris are excluded from the study and that the effects of a reduction in debris could be underestimated. This type of bias could be significant if current debris levels are high enough to significantly change not just the number of trips people take, but the number of people who take any trips in a given study area.

Our estimates of the total change in recreation trips and total change in recreation value for the two debris scenarios was based on a benefit-function transfer using the *Deepwater Horizon* data set. Benefit transfer is widely used in economic analysis because it allows researchers to evaluate policy or environmental changes without the potentially prohibitive expense of a full original study. The use of benefit transfer is supported by numerous precedents in the literature and guidance from government agencies (Wilson and Hoehn, 2006; Navrud and Ready, 2007; U.S. EPA, 2014). Benefit function transfer, which involves adapting an economic model to a new research problem, is considered preferable to simpler forms of benefit transfer, such as applying values calculated in a previous study without the ability to revise the calculations.

The most significant assumption in the nationwide recreation model is that longer trips lasting at least two nights away from home provide sufficient information about the quality of beaches and the preferences of recreators to reliably estimate a recreation demand model. There are situations where this would not be the case. For example, two beaches may be equally attractive to area residents taking day trips, while only one of the beaches may be developed with hotels and beachfront resorts. The number of overnight trips to the less developed beach would not be a good predictor of the number of day trips. However, this type of issue may diminish as sites with divergent characteristics are aggregated together. Continuing the example of overnight accommodations, most of the 76 aggregate sites in our model are likely to be large enough that a lack of suitable hotels or campgrounds would not be a significant factor limiting overnight recreation trips.

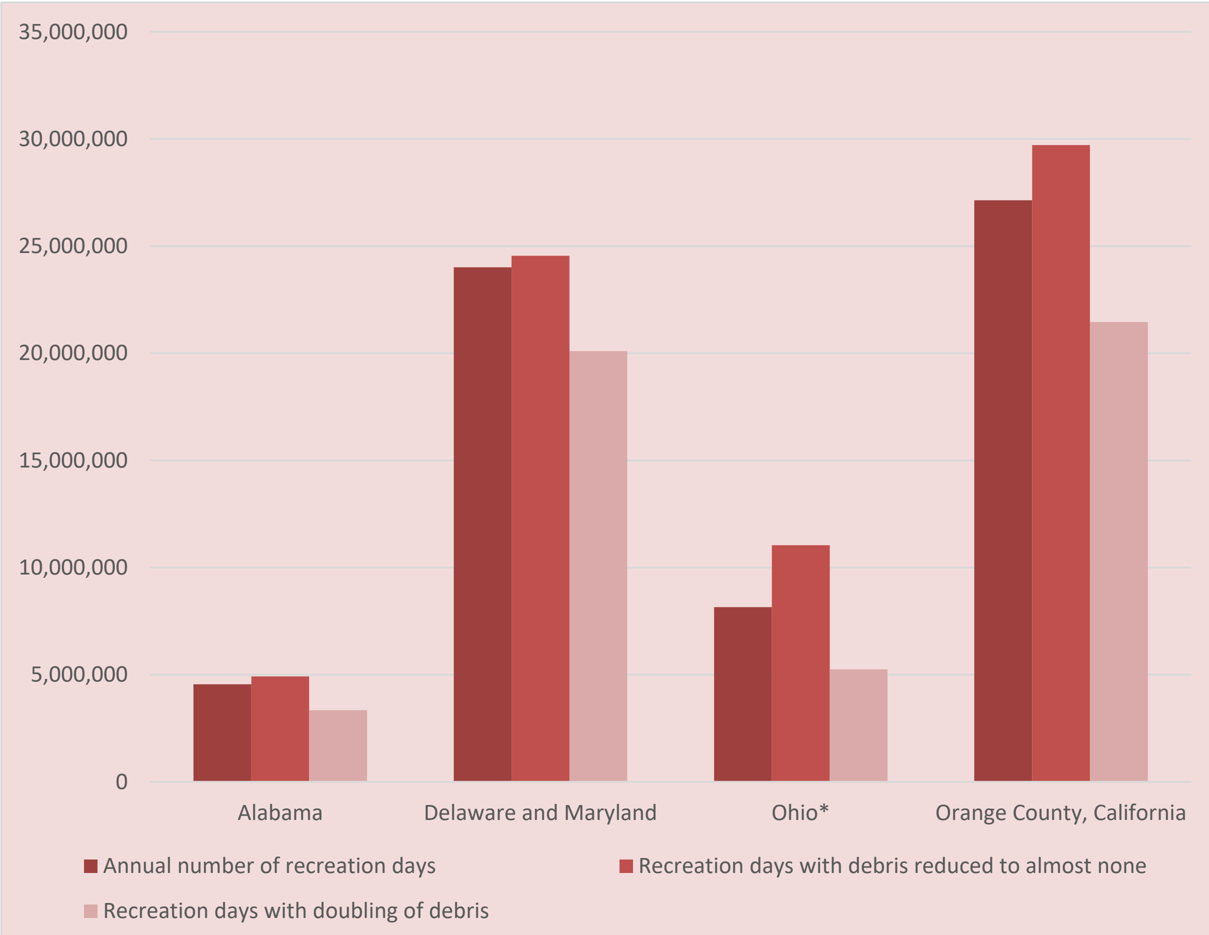
The aggregation of beaches into larger areas would not diminish the effect of differences in beach attributes if beaches in one area are consistently different from beaches in another area. As noted earlier, this appears to be the case for Ohio beaches. For Delaware/Maryland and Orange County, California, where trips data from the nationwide model were incomplete, we believe the benefit function transfer is reliable. This is reflected in the fact that model parameters demonstrated consistency with a standard model specification, including a nesting structure that grouped sites into regions and that included a component for recreation participation, as shown in Table 5. Reliability of the benefit function transfer is also reflected in the fact that only modest adjustments were required to match model predictions in Maryland/Delaware and Orange County, California to information from the onsite data, as shown in Table 6.

## 3.4 Effects of Marine Debris on Recreation Value

The recreational value model shows noteworthy effects of marine debris on beach recreation for the two scenarios and four study areas examined in the marine debris survey (Figure 3, Table 7). All amounts reflect annual total trips and value by residents living within 750 miles of the coast in the contiguous 48 states. As described previously, the two scenarios are a reduction in debris on beaches to almost none and a doubling of debris, and the four study areas are Gulf Coast beaches in Alabama, Atlantic beaches in Delaware and Maryland, Lake Erie beaches in Ohio, and Pacific beaches in Orange County, California. While confidence intervals were provided for earlier results derived directly from the marine debris survey, results in Table 7 rely on benefit function transfer and therefore do not include confidence intervals. The combination of multiple data sources and researcher judgments make confidence intervals difficult to estimate or justify in most benefit transfer contexts (McConnell, 1992).

The annual number of recreation days under “baseline conditions” ranges from 4.5 million in Alabama to over 27.1 million in Orange County (Table 7). Baseline conditions describes debris levels prior to the changes introduced in the hypothetical scenarios. The baseline number of recreation days was estimated using the nationwide recreation model, developed from data collected in 2012 and 2013 for the *Deepwater Horizon* oil spill assessment. Where possible the model was adjusted to match information collected as part of the marine debris survey. We assume that beach attributes and recreation activity at beaches in the four study areas have not changed significantly over the past several years and that the two sources combined in this study accurately summarize the starting point for the debris scenarios.

**Figure 3. Changes in annual number of recreation days if the amount of marine debris doubles, and if the amount of marine debris is reduced to almost none.**




* Ohio estimates account for multiple-day trips only.

**Table 7. Recreation value from changes in debris on beaches (2018 dollars)**

| Scenario | Alabama | Delaware and Maryland | Ohio[a] | Orange County, California |
|---|---|---|---|---|
| Annual number of recreation days | 4,552,112 | 24,014,592 | 8,155,158 | 27,143,415 |
| **Debris reduced to "almost none"** | | | | |
| Change in days | 368,525 | 536,341 | 2,889,191 | 2,571,725 |
| Value per day | $27.27 | $36.81 | $30.46 | $50.43 |
| Change in recreation value | $10,051,517 | $19,741,209 | $88,006,606 | $129,689,616 |
| **Doubling of marine debris** | | | | |
| Change in days | -1,206,006 | -3,915,792 | -2,907,188 | -5,682,362 |
| Value per day | $26.82 | $35.99 | $28.87 | $48.41 |
| Change in recreation value | -$32,347,029 | -$140,914,688 | -$83,935,614 | -$275,077,340 |

a. For Ohio, estimates account only for multiple-day trips and exclude the value and quantity of single-day trips.

The estimated change in days is the percentage change in trips for each scenario, calculated from the marine debris survey and presented in Table 5, multiplied by the baseline number of days. The change in recreational value is derived using the nationwide recreation model. The value per day is the change in value divided by the change in days. The value per day is usually reported in economic studies of recreation as a common point of comparison across studies. Differences in the value per day across study areas reflect modeling assumptions, differences in recreation preferences by beachgoers in each study area, and differences in income, which is an input to travel cost for beachgoers in each area. The decision to limit recreation trips to a threshold of 750 miles, necessitated by limitations in the *Deepwater Horizon* data, is likely to reduce per-day values in areas with high demand from greater distances.

For a reduction to almost no debris, the estimated annual increase in recreation value is $10.1 million in Alabama, $19.8 million in Delaware/Maryland, $88.0 in Ohio (multiple-day trips only), and $129.7 million in Orange County, California. For a doubling of debris, the estimated annual decrease in value is $32.3 in Alabama, $140.9 in Delaware/Maryland, $83.9 million in Ohio (multiple-day trips only), and $275.1 million in Orange County, California.

## 4. Regional Economic Impacts Model

Coastal recreation is a significant component of the economies of coastal communities. A recent NOAA National Marine Fisheries Service study found that coastal recreation in the United States accounts for $225 billion in gross domestic product (GDP; Kosaka and Steinback, 2018). The four study areas included in our analysis were selected because coastal recreation and tourism is an important part of the local economy in each area. Table 8 shows the total economic contribution of coastal recreation and tourism for the four study areas (Office for Coastal Management, 2019).

**Table 8. Economic contribution of coastal recreation and tourism by study area (2018 dollars)**

| | Alabama | Delaware/Maryland | Ohio | Orange County, California |
|---|---|---|---|---|
| Employment[a] | 17,252 | 16,509 | 38,224 | 44,240 |
| Wages ($million) | $313.9 | $368.7 | $682.5 | $1,145.6 |
| GDP ($million) | $642.4 | $849.6 | $1,514.1 | $2,337.3 |

a. Employment numbers are for 2015.

Source: Office of Coastal Management, 2019.

The total economic impact of recreation visits includes direct expenditures and subsequent flow-on impacts, which includes both indirect and induced expenditures. Direct expenditures include money that non-local residents spend while visiting and participating in recreation activities in coastal communities (e.g., park entrance fees, gas, equipment, retail purchases, lodging). Local businesses that benefit from direct spending then spend additional money on goods and services that they need to operate their businesses. These are termed indirect expenditures. Direct and indirect spending generates employment in the local region, creating additional income for households, which generates further spending known as induced expenditures.

To estimate the economic impact associated with marine debris, we multiplied the total change in recreation days for residents who live outside each study area by estimates of spending per recreation day. We include spending from only non-local residents because economic impact analysis assumes that residents who live in a given region and choose not to spend money on a particular good will spend the money on something else in the local economy. As noted earlier, for the economic impact assessment we define the scope of our analysis to be the coastal counties where the beaches in each study area are located.

Our analysis of economic impacts from marine debris can be summarized in the following three steps.

1. We began with the change in the number of nonlocal recreation days estimated in the previous steps for each of the four study areas and for each of the two scenarios in the marine debris survey.
2. We used the NORES dataset to estimate expenditures per recreation day in each of several categories and multiplied the expenditures per day by the change in recreation days. The result is an estimate of the change in direct expenditures in each study area.
3. We then multiplied direct expenditures in each category by the appropriate RIMS II multipliers (U.S. BEA, 2018, 2019). For each expenditure category there are several multipliers for several different types of indirect and induced economic impacts.

In the remainder of Section 4, we describe details of the estimated expenditures per day and the RIMS economic multipliers. In Section 4.1 we present the expenditures per recreation day associated with recreation activities impacted by marine debris. In Section 4.2, we estimate the economic impacts of a coastal-recreation day using the RIMS multipliers; and in Section 4.3, we present the economic impacts of our two marine debris scenarios – a reduction of debris to almost none and a doubling of debris – in the four tourism-dependent communities.

## 4.1 Trip Expenditures

As our first step in conducting the economic impact analysis, we estimated the direct effects by determining the average spending per day by non-local visitors to the study areas. We included all expenditures that visitors make during their visits, not just those associated with recreational activities. This is based on the fact that the primary purpose of recreation trips in our data was to visit the beach, so a canceled trip to the beach is likely to be a canceled trip to the study area. The NORES data (NOAA, 2012) provide comprehensive expenditures for recreation trips, including spending on hotels, restaurants, transportation, entrance fees, etc.

The NORES data included estimates of trip expenditures for the Pacific, Northeast, Mid-Atlantic, South Atlantic, and Gulf of Mexico regions. There are also estimates of overall average expenditures for all regions. For each study area, we used the region that included that study area. Because the NORES study did not include estimates for the Great Lakes, we applied the U.S. average expenditures to estimate the trip expenditures for the Lake Erie, Ohio region.[5]

Although the NORES data included separate estimates for local and nonlocal recreation trips, we did not use this breakout. Their “local” regions are much larger than our coastal county areas. For example, the NORES Pacific region considers all recreators from California, Oregon, and

5. We checked the appropriateness of applying the U.S. average expenditures to the Ohio region using the Consumer Expenditure Survey (U.S. BLS, 2017). In the year the expenditure data were collected, 2012, average annual expenditures in the Midwest and Cleveland metropolitan area were 97% of the U.S. average.

Washington to be local, whereas our study defines recreators from outside of Orange County as "nonlocal." Thus, we used the average trip expenditures across all respondents to be more representative of our nonlocal respondents.

The NORES data provide average daily spending on trip-related items for trips involving a variety of recreational activities. Each trip is identified with a single activity based on the respondent's "most preferred" activity on the trip. NORES included eight types of coastal recreation activities. We used the four activities likely to involve trips to the beach:

- Viewing or photographing the ocean or coast
- Beachcombing, tidepooling, or collecting items
- Water contact sports
- Outdoor activities not involving water contact that occur near the ocean or coast because of the view or access to the water (e.g., sunbathing, walking, camping).

Spending by category varies by the type of activity.[6] We calculated the average visitor spending per day (Table 9) using the weighted average expenses and participation in the various marine debris-related beach activities.

To apply the RIMS II multipliers, we kept the average expenditures separate by category. For example, visiting recreators spend money on lodging, food, and transportation. These expenditure types have different impacts on the local economy and thus different multipliers. This is explained in more detail below. The detailed list of the average expenditures by category is included in Appendix D.

We next apply the changes in the number of recreation days estimated in Section 3 to the average expenditures per day for each of our four study areas and two debris scenarios. The results are described in the following section.[7]

**Table 9. Average visitor spending per day in the four regions examined in this study (2018 dollars)**

| | Alabama | Delaware and Maryland | Ohio | Orange County, California |
|---|---|---|---|---|
| Average visitor spending per day | $138.55 | $92.06 | $96.61 | $89.49 |

## 4.2 Economic Impacts of Coastal Recreation

The next step in estimating the potential impacts of a change in marine debris levels on beaches in our four study areas is to estimate the economic contribution of visitor expenditures on the local economy. Coastal recreation contributes to the local economy by bringing outside money into the economy in the form of visitor spending. Visiting recreators spend money on a number

6. For example, the average auto fuel expense in the Pacific region is $17.48 for "viewing or photographing the ocean" and $22.10 for beachcombing participants.

7. The aggregated changes in visitor spending are not used in the analysis. As described in the next section, in order to apply the RIMS II multipliers, we must keep visitor spending disaggregated by expenditure category. The expenditure categories are then mapped to the RIMS II industries, and the multipliers applied. These totals are presented here to illustrate the scale of money flowing into the economy.

of goods and services, including hotel rooms, food, and retail, which affect several local industries, including restaurants, hotels, retail shops, and other tourist-related enterprises. These industries directly affect the economy by purchasing intermediate goods, such as restaurant supplies and wholesale goods, and by providing jobs. The industries that provide intermediate goods and services to the recreation and tourism industry purchase their own intermediate goods and services form other local industries, and the pattern repeats itself. Thus, the original money from visitor spending creates a multiplier effect on the local economy. At every stage, some portion of expenditures goes toward goods or services generated outside the local area. This is known as “leakage” and is incorporated in the calculations of multiplier effects (Bess and Ambargis, 2011).

Economists use input-output (I/O) analysis to estimate multiplier effects. I/O analysis entails calculating the extent to which direct activities – in our case, increased spending from tourists – stimulate further economic effects, spreading employment and income, thus accounting for linkages among industries (University of South Carolina, 2009). That is, I/O analysis accounts for the production linkages between different industries of the local economy, and in turn, calculates economic impacts using a multiplier effect. We used RIMS II multipliers developed by the Bureau of Economic Analysis (U.S. BEA, 2018, 2019).

We quantified the economic impacts of a visitor coastal recreation day using four metrics: output (sales), value added (GDP), earnings, and employment (full- and part-time jobs). These metrics are defined formally as follows (Bess and Ambargis, 2011):

- *Gross output*. Sum of the intermediate inputs and value added, where intermediate inputs are defined as goods and services that are used in the production process of other goods and services and are not sold in final-demand markets; also measured as the sum of the intermediate inputs and final use. Multipliers measure the total industry output per $1 change in final demand.
- *Value added*. The value of gross output less intermediate inputs. The value of this metric is equal to the sum of compensation of employees, taxes on production and imports less subsidies, and gross operating surplus.
- *Earnings*. Sum of wages and salaries, proprietors’ income, and employer contributions for health insurance excluding contributions for social insurance. Multipliers measure the total household earnings per $1 change in final demand.
- *Employment*. Number of full- and part-time jobs (including proprietors’ jobs). Multipliers measure the total number of jobs per $1 change in final demand.[8]

Output is less preferred as a metric because it counts transactions at all stages of production without including the value of goods and services in previous stages. Value added is preferable because it eliminates this double counting, and is analogous to GDP for a local region. Earnings is a subset of value added, representing the portion that ends up as wages and salaries rather than as a return on investment.

8. Employment multipliers are originally expressed as the change in jobs per $1 million change in final demand.

A fifth measure of economic impacts is government tax revenue. Calculating tax revenues can be quite complex because tax rates depend on the finances of numerous individual companies. We have not attempted to estimate government tax revenues in this study.

The multipliers are provided by industry type and are specific to each region. The multipliers estimate the economic impact of *outside money* coming into a region; thus, we estimate the economic impact of changes in coastal recreation associated with the marine debris scenarios for visiting recreators only.

As described above, the NOAA (2012) NORES dataset provides spending per coastal recreation day by study area and expenditure type. Different sectors of the economy such as lodging and food service contribute to the regional economy to different degrees. The RIMS II multipliers are provided for 64 aggregated industries. We mapped the expenditure categories provided in the NOAA (2012) NORES dataset to the appropriate RIMS II industry. That is, each industry has a unique multiplier, which we apply to the corresponding expenditure category. The total economic impact is the sum of the multipliers applied to the corresponding expenditure. We include the expenditure by category and RIMS II industry in Appendix D. We have included the multipliers in Appendix D, Table D-2.

To illustrate the regional economic impact of a change in spending, we provide the following example for increased spending on lodging in Alabama: From the NORES data, we estimated the average expenditure per day for lodging to be $39.68 (see Appendix D, Table D-1). We then mapped the expenditure category "lodging" to the RIMS II industry "accommodation." The RIMS II final-demand multipliers (Appendix D, Table D-2) for the accommodation industry in Alabama (Baldwin and Mobile counties) are:

- Output: 1.6311
- Earnings: 0.4604
- Jobs: 0.0000173756
- Value added: 1.0023.

First, we multiply the accommodation output multiplier, 1.6311, by the average daily expenditure for lodging of $39.68. This yields output generated per recreation day from expenditures on lodging equal to $64.72. This is $25.39 more than the initial or direct expenditure of $39.68. This additional increase of $25.39 in output is the measure of the indirect and induced effects that result from the initial direct change in spending of $39.33 on lodging. This is because the initial increase in spending stimulates additional changes in spending, such as by hotel employees. These additional changes in spending then cause further changes in production, income, and employment in the region.

Next we estimate the value-added portion of this output, which is the value of gross output less intermediate inputs. Multiplying our value-added multiplier, 1.0023, estimates the value added of lodging expenditures equal to $39.77. The earnings portion of this value-added is $18.27 (0.4604 times $39.77). To estimate the expected change in jobs, we would next apply the jobs multiplier of 0.0000173756, but we skip this final calculation in our per-day example.

We conduct this step for each of the expenditure categories and industry combinations. The total economic impact is the sum of the product of each expenditure category/industry combination for each metric.

Finally, we conduct an additional step for retail industries in which we convert consumer value (i.e., the visitor expenditures) into producer value. This step is explained in Appendix D.

## 4.3 Regional Economic Impacts of Marine Debris

The results of this regional economic impact analysis show that marine debris can have profound effects on regional economies. A reduction of debris to almost none is estimated to contribute an additional $29 million in economic activity (measured as value-added) in Alabama; $27.8 million in Delaware and Maryland; $206.0 million in Ohio; and $137.8 million in Orange County, California (Table 10). Conversely, a doubling of debris is estimated to cost the local economies $96.3 million in Alabama; $203.2 million in Delaware and Maryland; $207.3 million in Ohio; and $304.5 million in Orange County, California (Table 10).

**Table 10. Economic impacts of changes to debris levels at the four study areas (2018 dollars)**

| | Alabama | Delaware and Maryland | Ohio | Orange County, California |
|---|---|---|---|---|
| Recreation day expenditures | $139 | $92 | $97 | $89 |
| Output generated per recreation day | $169 | $102 | $130 | $116 |
| Earnings generated per recreation day | $50 | $27 | $34 | $30 |
| Jobs generated per recreation day | 0.0022 | 0.0010 | 0.0013 | 0.0009 |
| Value added generated per recreation day | $95 | $58 | $73 | $66 |
| **Debris change to almost none** | | | | |
| Change in visitor days | 308,365 | 478,410 | 2,823,268 | 2,092,920 |
| Change in visitor spending | $42,724,928 | $44,040,576 | $272,761,000 | $187,294,392 |
| Change in output | $52,116,000 | $48,879,000 | $367,522,000 | $241,994,000 |
| Change in earnings | $15,547,000 | $13,076,000 | $96,026,000 | $61,797,000 |
| Change in jobs | 672 | 464 | 3,703 | 1,925 |
| Change in value added | $29,423,000 | $27,834,000 | $205,977,000 | $137,830,000 |
| **Doubling of debris** | | | | |
| Change in visitor days | -1,009,130 | -3,492,845 | -2,840,854 | -4,624,417 |
| Change in visitor spending | -$113,427,000 | -$254,086,000 | -$274,460,000 | -$413,837,000 |
| Change in output | -$170,551,000 | -$356,865,000 | -$369,811,000 | -$534,698,000 |
| Change in earnings | -$50,877,000 | -$95,467,000 | -$96,624,000 | -$136,543,000) |
| Change in jobs | -2,198 | -3,386 | -3,726 | -4,254 |
| Change in value added | -$96,288,000 | -$203,211,000 | -$207,260,000 | -$304,542,000 |

## 4.4 Caveats and Uncertainties

There are several areas of uncertainty in this calculation of regional economic impacts. First, the NOAA (2012) NORES dataset reports all expenditures per trip, which is not limited to expenditures made for individual respondents. For example, the NORES data include hotel expenditures for a family. To align these expenditures with the increased number of trips estimated in Section 3, we assume that the trips referred to in the NORES data and the trips referred to in our marine debris surveys have the same average number of people.

Second, as noted previously, the NOAA (2012) NORES data estimate trip expenditures that occur in a larger region than our study areas. Thus, some of the trip expenditures (e.g., gas, transportation) in the larger NORES regions may occur outside of our study area. For this analysis, we applied the trip expenditures to our smaller study region, noting that this may overstate transportation spending in the regions.

Finally, we note that RIMS II multipliers measure the impact of employment using a count of jobs that include both full-time and part-time workers (Bess and Ambargis, 2011). Since the tourism industry may have a large portion of part-time and seasonal workers, the employment impact may be an upper-bound.

## 5. Summary of Results

This study provides estimates of recreation value and regional economic impacts, including an evaluation of key features in the design of the study, the comparison of model output to external estimates, and potential implications for future research. Highlights of our study findings are described below.

- We adjusted mail-survey sampling weights to match key characteristics of respondents in the onsite survey, thereby taking advantage of the high response rate in the onsite survey (77%) and potentially improving representativeness of the mail survey data. The adjustments led to significant changes in the representation of certain demographic groups but only modest changes in the estimates of recreation value and economic impacts.
- We found a high correlation (0.87) between ratings of debris levels on beaches provided by survey respondents (where respondents rated debris levels on a 1-to-5 scale, with one referring to “almost no” debris and 5 referring to a “high amount” of debris) and actual debris amounts estimated from onsite measurements conducted by NOAA.
- The benefit function transfer based on the extensive *Deepwater Horizon* nationwide dataset resulted in a model that appeared to provide reliable estimates when applied to study areas in Alabama, Delaware/Maryland and Orange County, California. However, the model did not appear to fit well with Lake Erie beaches in Ohio, particularly for estimating changes in day use, and thus we only provide estimates of changes to multiple-day trips in Ohio.
- We compared our results in Orange County, California to recent estimates from a revealed-preference study in the same location (Leggett et al., 2018). Our estimates of the impacts from debris on the value and number of trips were either comparable or somewhat higher than those of the previous study, depending on the scenario examined. However, an exact comparison was not possible because the Leggett et al. (2018) study focused exclusively on single-day trips, whereas our analysis included multiple-day trips.
- We used data from NORES that provides estimates of recreator expenditures during coastal recreation trips. We adjusted the expenditure values to account for differences with our study, which provided recently estimated expenditures for relevant recreation activities for each study area. The NORES data did not include the Great Lakes, however, so we used the national average for Lake Erie beaches in Ohio.

Table 11 provides a summary data table for all the results of this study. This section provides a summary of only selected data; additional information is included in subsequent sections and in the Executive Summary.

**Table 11. Summary of study results.**

| | Alabama | Delaware and Maryland | Ohio[a] | Orange County, California |
|---|---|---|---|---|
| Annual number of recreation days | 4,552,112 | 24,014,592 | 8,155,158 | 27,143,415 |
| Average debris ratings | 1.7 | 1.6 | 2.3 | 2.1 |
| Percent of recreation days from outside the local area (visitor recreation days) | 83.7% | 89.2% | 97.7% | 81.4% |
| Spending per day by non-local residents | $139 | $92 | $97 | $89 |
| **Debris reduced to almost none** | | | | |
| Percent change in recreation days | 8.1% | 2.2% | 35.4% | 9.5% |
| Change in recreation days | 368,525 | 536,341 | 2,889,191 | 2,571,725 |
| Change in recreational value | $10,051,517 | $19,741,209 | $88,006,606 | $129,689,616 |
| Change in visitor recreation days | 308,365 | 478,410 | 2,823,268 | 2,092,920 |
| Change in employment | 672 | 464 | 3,703 | 1,925 |
| Change in value added[b] | $29,423,000 | $27,834,000 | $205,976,434 | $137,830,000 |
| **Doubling of debris** | | | | |
| Percent change in recreation days | -26.5% | -16.3% | -35.6% | -20.9% |
| Change in recreation days | -1,206,006 | -3,915,792 | -2,907,188 | -5,682,362 |
| Change in recreational value | -$32,347,029 | -$140,914,688 | -$83,935,614 | -$275,077,340 |
| Change in visitor recreation days | -1,009,130 | -3,492,845 | -2,840,854 | -4,624,417 |
| Change in employment | -2,198 | -3,386 | -3,726 | -4,254 |
| Change in value added[b] | -$96,288,000 | -$203,211,000 | -$207,259,895 | -$304,542,000 |

a. Estimates for Lake Erie beaches in Ohio account for multiple-day trips only.

b. Value added is net combined value of all goods and services, analogous to GDP for the local area.

Although the data collection and analysis was based on changes in recreation trips, we have expressed the results in units of recreation days to reflect the relative importance of multiple-day trips in influencing economic value. Based on a benefits function transfer from the *Deepwater Horizon* dataset, the estimated annual number of recreation days is 4.5 million on beaches in Alabama, 24.0 million on beaches in Delaware and Maryland, and 27.1 million on beaches in Orange County, California (Table 11). We also estimate there are 8.2 million recreation days taken annually on Lake Erie beaches in Ohio, accounting for multiple-day trips only. As noted previously, estimates for Ohio account only for multiple-day trips because of limitations in how the nationwide recreation model could be applied to Lake Erie beaches.

All estimates include uncertainties that reflect not only statistical error, but also potential error from the combined use of data collected at different times between 2012 and 2018 and from a benefit-transfer analysis that relies on reasonable but imperfect assumptions about similarities in recreation behavior across different coastal locations.

Respondents' ratings of the amount of debris on beaches on a 1-to-5 scale ranged from 1.6 for Delaware/Maryland beaches to 2.3 for Lake Erie beaches in Ohio. The effect of changes in debris on recreation was lowest in Delaware/Maryland, where respondents said the beaches had less debris, and highest in Ohio, where respondents said that beaches have more debris. These results are consistent because the debris scenarios presented in the survey involved changes in debris that are proportionate to current debris levels. Estimates of the percentage increase in trips from reducing debris to "almost none" (defined in the survey as one piece of debris per

500 square feet) are 8.1% in Alabama; 2.2% in Delaware/Maryland; 35.4% in Ohio; and 9.5% in Orange County, California (Table 11).

The effect of a doubling of current debris levels is a decrease in trips and is a larger percentage change compared to debris reduction in all areas. The specific estimates of decreasing trips are 26.5% in Alabama, 16.3% in Delaware/Maryland, 35.6% in Ohio, and 20.9% in Orange County, California (Table 11).

Table 11 also shows changes in the value of recreation, reflecting the public's enjoyment of area beaches. If marine debris were reduced to almost none, the estimated annual increase in recreation value is $10.1 million in Alabama, $19.8 million in Delaware/Maryland, $88.0 in Ohio (multiple-day trips only), and $129.7 million in Orange County, California (Table 11). If the amount of marine debris on beaches were to double, the estimated annual decrease in recreational value is $32.3 million in Alabama, $140.9 million in Delaware/Maryland, $83.9 million in Ohio (multiple-day trips only), and $275.1 million in Orange County, California (Table 11).The differences in dollar amounts among study areas reflect differences in the baseline number and value of trips in each area in addition to the percentage changes in trips. All recreation values were adjusted for the 7.9% Consumer Price Index (CPI) inflation (Federal Reserve Bank of St. Louis, 2019) from 2013 (when the *Deepwater Horizon* data collection was completed) to 2018.

Reductions or increases in marine debris leads to changes in spending by non-local beach visitors that has a significant impact on the regional economies of beach communities. In all four of our study areas, the portion of recreation days that come from outside the local area is greater than 80% (Table 11). Based on NORES data (NOAA, 2012), spending by non-local visitors ranges from $89 per day in Delaware/Maryland to $139 per day in Alabama (Table 11).

Direct spending by visitors leads to "multiplier effects," which include additional spending for supplies by local business and additional spending by new employees hired by local businesses. Multiplier effects also account for the portion of visitor and additional spending that leaves the local economy, called "leakages" (Bess and Ambargis, 2011).

We expressed the regional economic impacts using two key metrics:

- *Value added*: The value of gross output less intermediate inputs. The value of this metric is equal to the sum of compensation of employees, taxes on production and imports less subsidies, and gross operating surplus. Value added is the net combined value of all goods and services and is analogous to GDP for the local area.
- *Employment*: Number of full- and part-time jobs (including proprietors' jobs).

For a reduction in debris to almost none, the increase in employment ranges from 464 additional jobs in the Delaware/Maryland study area to 3,703 additional jobs in Ohio (Table 11; as above, accounting only for multiple-day trips in Ohio). Under this scenario, value added ranges from an increase of $27.8 million in the Delaware/Maryland study area to an increase of $206.0 million in Ohio (Table 11).

For a doubling of debris, there is a decrease in employment ranging from 2,198 jobs in the Alabama study area to 4,254 jobs in Orange County, California (Table 1). Under this scenario, the decrease in value added ranges from $96.3 million in the Alabama study area to $304.5 million in Orange County, California (Table 11).

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# Appendix A: Example Surveys

## Onsite Recruitment Survey Form

## Beach Recreation Surveys

Alabama
Delaware and Maryland
Lake Erie, Ohio
Orange County

*For any selected party that did not give an interview, go to Sheet REFUSALS to record Reason, Respondent Gender, Age, and Party Size*

| Number recruited | 0 | Do not change this cell |
|---|---|---|

**Hello my name is __________. I am doing research on beach recreation for the federal government. I have just a few questions. May I begin?**

| Interview number | Interviewer initials | Beach | City | Date | Time | AM/PM |
|---|---|---|---|---|---|---|
| ex1 | CW | Huntington Beach | Huntington beach | 7/11/2018 | 10:30 | AM |
| ex2 | MD | Doheny State Beach | Dana Point | 7/11/2018 | 10:45 | AM |
| 1 | | | | | | |
| 2 | | | | | | |
| 3 | | | | | | |
| 4 | | | | | | |
| 299 | | | | | | |
| 300 | | | | | | |

| 1. Is your visit here today part of a trip away from home lasting more than one day? | | | | | | 2. How many hours in total will you spend at the beach today? |
|---|---|---|---|---|---|---|
| No *Indicate with "x". Skip to Q2 or end interview* | Yes *Indicate with "x".* | 1a. How many days will your trip last in total? | 1b. How many of those days will you spend time at the beach? | 1c. How many nights will you pay for lodging during your trip? | 1d. Is going to the beach the main reason for your trip? *Indicate with "y" or "n"* | |
| x | | n/a | n/a | n/a | n/a | 4 |
| | x | 7 | 6 | 5 | y | 2 |
| | | | | | | |
| | | | | | | |
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| | | | | | | |

| 3. What year were you born? | 4. What is the highest degree or level of school you have completed? ***Indicate with "x", select one*** | | | | | 5. Including yourself, how many adults and children live in your household? | | *6. Record respondent gender. Indicate with "x"* | |
|---|---|---|---|---|---|---|---|---|---|
| | Less than high school graduate | High school graduate (includes GED) | Some college or Associate's degree | Bachelor's degree | Graduate or professional degree | Adults (18 and older) | Children (Under 18) | Male | Female |
| 1982 | | | | | x | 2 | 2 | | x |
| 1998 | | x | | | | 1 | 0 | x | |
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| | 8. Would you be willing to take part in a short mail survey that we will send to your home? | | | | |
|---|---|---|---|---|---|
| *7. Record number of people in party including respondent* | YES: Could I get your name and address? It will be used only to mail this survey and will be deleted immediately after. *Record address and confirm verbally, including spelling of cities or streets if necessary. Provide this info:* The survey will be mailed to you in early September. It will come in a large envelope from the National Oceanic and Atmospheric Administration. Please complete it and mail it back as soon as you are able. There are 20 questions, and the survey should take around 10 minutes to complete. We greatly appreciate your participation in this research!" | | | | |
| | First and last name | Street address | City | State | ZIP code |
| 4 | Jane Doe | 1881 Ninth St. Suite 805 | Boulder | CO | 80302 |
| 2 | John Smith | 20 Main St. | Atlanta | GA | 80303 |
| | | | | | |
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| NO: Could I get your zip code ***(if refused, type "no")*** | 9. Lastly, please tell me how important the following characteristics are to you when you decide which beaches to visit. On a scale of 1 to 5, where 1 is Not Important and 5 is Very Important: ***(Read each characteristic and enter the response as a number 1 - 5)*** | | | 10.Do you think garbage or manmade debris is a problem on Orange County beaches? ***Y or N*** |
|---|---|---|---|---|
| | Parking is free or inexpensive | Not crowded | No garbage or manmade debris on the beach | |
| n/a | 3 | 3 | 3 | Y |
| n/a | 2 | 5 | 1 | N |
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# Beach Recreation Survey
# ALABAMA

**Thank you for speaking with us a few weeks ago at the beach.**

**This mail survey is the final step in our study. We appreciate your participation!**

Coastal beaches are vital to the area's economy and quality of life. Your answers to this survey will help inform decisions about improving and protecting coastal resources. We want to hear from everyone about things people want to experience when they visit the beach. Your response is important – please complete this **voluntary** survey.

Our questions are about ocean beaches in Alabama, shown in the map below.

**1. In the list below, please circle the names of any beaches you went to between September 1, 2017 and August 31, 2018. If you don't know the name of a beach you went to or it is not on the list, please circle the name of a nearby beach.**


1. Dauphin Island West End Beach
2. Dauphin Island Public Beach
3. Dauphin Island East End Beach
4. Fort Morgan Public Beach
5. Bon Secour National Wildlife Refuge
6. Gulf Shores Public Beach
7. Gulf State Park Pier
8. Gulf State Park Pavilion
9. Cotton Bayou/Orange Beach
10. Alabama Point/Florida Point

Now we would like to ask you about the number of day trips and overnight trips you took to ocean beaches in Alabama. A **day** trip is any time you went to the beach and returned home the same day. An **overnight** trip is when you spent at least one night away from home.

**2. Between September 1, 2017 and August 31, 2018, did you take any day trips to ocean beaches in Alabama? Please check ☒ one box.**

☐ No ☐ Yes ➔ How many day trips? ☐ day trips

**3. Between September 1, 2017 and August 31, 2018, did you take any overnight trips where the main purpose was visiting ocean beaches in Alabama? Please check ☒ one box.**

☐ No ☐ Yes ➔ How many overnight trips? ☐ overnight trips

The next question is about beach characteristics.

**4. Please tell us how important the following characteristics are to you when you decide which beaches to visit. Please check ☒ one box in each row.**

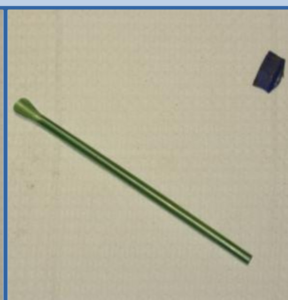
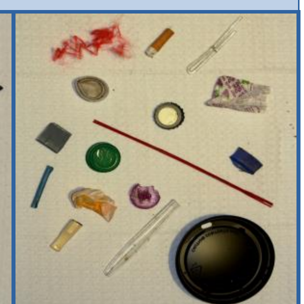
| | Not Important 1 | 2 | Somewhat Important 3 | 4 | Very Important 5 |
|---|---|---|---|---|---|
| Scenic beauty or view | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Good water quality | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Close to home | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Parking is convenient | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Parking is free or inexpensive | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Good surfing available | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Sandy (rather than rocky) | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Not crowded | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Long enough to go for a walk/run | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Bike path available | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Fishing opportunities available | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| No garbage or manmade debris on the beach | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| No natural debris like kelp or seaweed on the beach | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |

## Garbage or Manmade Debris You May See on Beaches

Different beaches can have different amounts of garbage or manmade debris. Garbage or manmade debris refers to items like bottles, wrappers, straws, plastic fragments, or cigarettes. It does not include twigs or seaweed.

The pictures below illustrate the amount of debris commonly found on United States beaches. Imagine you are picking up debris over an area of 500 square feet or approximately the area of three parking spaces, outlined in red below.

If you walked back and forth in this area and picked up all the debris, you might find different amounts ranging from "almost none" to a "high amount." As the pictures below show, different levels of debris on the beach can be given a score from 1 to 5. Higher scores mean more debris.

| Almost None | ⟵ | | ⟶ | High Amount |
|---|---|---|---|---|
|  |  |  |  |  |
| 1 | 2 | 3 | 4 | 5 |

On the next page, we will ask you to use the above scale to estimate the amount of garbage or manmade debris you saw on ocean beaches you have been to in Alabama.

5. In the table below, please write the names of ocean beaches in Alabama that you went to between September 1, 2017 and August 31, 2018. You may want to refer back to the map at the beginning of this survey.

   **To the right of each beach you went to, use the debris scale from the previous page and write a number between 1 and 5, indicating the amount of garbage or manmade debris you saw on the beach. Writing a "1" indicates you saw almost none, while writing a "5" indicates you saw a high amount of garbage or manmade debris. For any beach where you don't recall the amount of debris, please write "don't recall" in place of a number.**

| Beach Name | How Much Garbage or Manmade Debris Did You See on the Beach? (1 = Almost None) (5 = High Amount) (Don't Recall) |
|---|---|
| Orange Beach | 4 |
| Dauphin Island Beach Example | 2 |
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**6. Between September 1, 2017 and August 31, 2018, if there had been <u>almost no</u> garbage or manmade debris on ocean beaches in Alabama, would you have gone to the beach more often or the same number of times? Please check ☒ one box.**

☐ More often ➔ **Please answer the two questions below.**

Between September 1, 2017 and August 31, 2018, how many more day trips would you have taken if there were almost no garbage or manmade debris on ocean beaches in Alabama? ☐ more day trips

Between September 1, 2017 and August 31, 2018, how many more overnight trips would you have taken if there were almost no garbage or manmade debris on ocean beaches in Alabama? ☐ more overnight trips

☐ The same number of times

**7. Between September 1, 2017 and August 31, 2018, if there had been <u>twice as much</u> garbage or manmade debris on ocean beaches in Alabama, would you have gone to the beach less often or the same number of times? Please check ☒ one box.**

☐ Less often ➔ **Please answer the two questions below.**

Between September 1, 2017 and August 31, 2018, how many fewer day trips would you have taken if there had been twice as much garbage or manmade debris on ocean beaches in Alabama? ☐ fewer day trips

Between September 1, 2017 and August 31, 2018, how many fewer overnight trips would you have taken if there had been twice as much garbage or manmade debris on ocean beaches in Alabama? ☐ fewer overnight trips

☐ The same number of times

The next few questions ask about your experiences with debris on beaches.

**8. How concerned would you be to see the following types of garbage or manmade debris while visiting a beach? Please check ☒ one box in each row.**

| | Not At All Concerned 1 | 2 | Somewhat Concerned 3 | 4 | Very Concerned 5 |
|---|---|---|---|---|---|
| Plastic items or bottles | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Styrofoam | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Paper products | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Wooden items | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Metal items or cans | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Glass | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Rubber items | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Cloth or clothing | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Cigarette butts | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Fishing gear | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Medical waste | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Animal waste | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |

**9. Please look at the list below and check ☒ the box next to all the types of garbage or manmade debris that you have actually seen on ocean beaches in Alabama.**

- ☐ Plastic items or bottles
- ☐ Styrofoam
- ☐ Paper products
- ☐ Wooden items
- ☐ Metal items or cans
- ☐ Glass
- ☐ Rubber items
- ☐ Cloth or clothing
- ☐ Cigarette butts
- ☐ Fishing gear
- ☐ Medical waste
- ☐ Animal waste
- ☐ Other (please specify) ______

**10. Do you think garbage or manmade debris is a problem on ocean beaches in Alabama? Please check ☒ one box.**

☐ Yes ☐ No ☐ Not sure

**11. To the best of your knowledge, what do you think is the <u>largest</u> source of garbage or manmade debris found on ocean beaches in Alabama?**
**Please check ☒ one box.**

☐ Left by beach visitors

☐ Blown to the beach from nearby areas on land

☐ Washed ashore from the ocean

☐ Washed ashore from nearby rivers or storm drains

☐ Other (please specify) ________________

Finally, we have just a few questions about you and your household. These questions are a way to make sure that we understand the values and opinions of all types of people visiting beaches in Alabama.

**12. Have you participated in any beach cleanups within the last three years? Please check ☒ one box.**

☐ No ☐ Yes

**13. How many adults and children live in your household?**

____ Adults (18 and older) ____ Children (under 18)

**14. What is your gender? Please check ☒ one box.**

☐ Male ☐ Female

**15. In what year were you born?**

____ Year

**16. Are you of Hispanic, Latino, or Spanish origin? Please check ☒ one box.**

☐ No ☐ Yes

**17. What is your race? Select all that apply.**

- ☐ American Indian or Alaskan Native
- ☐ Asian
- ☐ Black or African American
- ☐ Native Hawaiian or other Pacific Islander
- ☐ White
- ☐ Other (please specify) ____________________

**18. What is the highest degree or level of school you have completed? Please check ☒ one box.**

- ☐ Less than high school graduate
- ☐ High school graduate (includes GED)
- ☐ Some college or Associate's degree
- ☐ Bachelor's degree
- ☐ Graduate or professional degree, beyond a bachelor's degree

**19. Which of the following income categories best describes your total household income last year, before taxes? Please check ☒ one box.**

- ☐ Less than $15,000
- ☐ $15,000 to $24,999
- ☐ $25,000 to $34,999
- ☐ $35,000 to $49,999
- ☐ $50,000 to $74,999
- ☐ $75,000 to $99,999
- ☐ $100,000 to $150,000
- ☐ More than $150,000

**Thank you for participating!**

Please return your survey in the enclosed Business Reply Mail envelope.

# Beach Recreation Survey
# DELAWARE AND MARYLAND

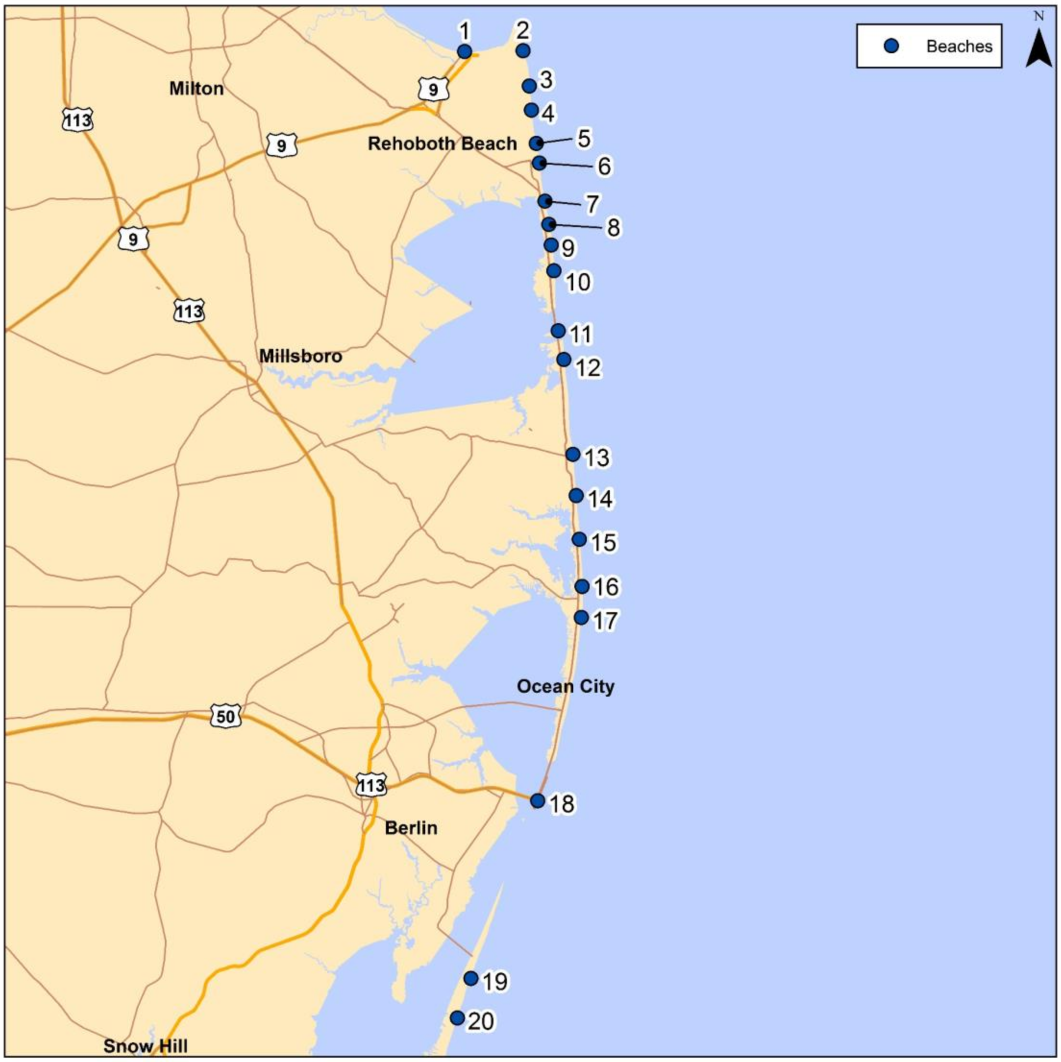
**Thank you for speaking with us a few weeks ago at the beach.**

**This mail survey is the final step in our study. We appreciate your participation!**

Coastal beaches are vital to the area's economy and quality of life. Your answers to this survey will help inform decisions about improving and protecting coastal resources. We want to hear from everyone about things people want to experience when they visit the beach. Your response is important – please complete this **voluntary** survey.

Our questions are about ocean beaches in Delaware and Maryland, shown in the map below.

**1. In the list below, please circle the names of any beaches you went to between September 1, 2017 and August 31, 2018. If you don't know the name of a beach you went to or it is not on the list, please circle the name of a nearby beach.**




1. Lewes Beach
2. Cape Henlopen Beach
3. Herring Point Beach
4. Gordon's Pond Beach
5. Deauville Beach
6. Rehoboth Beach
7. Dewey Beach
8. Towers Beach
9. Keybox Road Beach
10. Conquest Road Beach
11. South Indian River Inlet Beach
12. 3 R's Road Beach
13. Bethany Beach
14. South Bethany Beach
15. Fenwick Island State Park Beach
16. Town of Fenwick Island Beach
17. Ocean City (140th Street)
18. Ocean City (Boardwalk)
19. Assateague State Park
20. Assateague Island National Seashore

Now we would like to ask you about the number of day trips and overnight trips you took to ocean beaches in Delaware and Maryland. A **day** trip is any time you went to the beach and returned home the same day. An **overnight** trip is when you spent at least one night away from home.

**2. Between September 1, 2017 and August 31, 2018, did you take any day trips to ocean beaches in Delaware and Maryland? Please check ☒ one box.**

☐ No ☐ Yes → How many day trips? ☐ day trips

**3. Between September 1, 2017 and August 31, 2018, did you take any overnight trips where the main purpose was visiting ocean beaches in Delaware and Maryland? Please check ☒ one box.**

☐ No ☐ Yes → How many overnight trips? ☐ overnight trips

The next question is about beach characteristics.

**4. Please tell us how important the following characteristics are to you when you decide which beaches to visit. Please check ☒ one box in each row.**

| | Not Important 1 | 2 | Somewhat Important 3 | 4 | Very Important 5 |
|---|---|---|---|---|---|
| Scenic beauty or view | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Good water quality | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Close to home | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Parking is convenient | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Parking is free or inexpensive | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Good surfing available | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Sandy (rather than rocky) | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Not crowded | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Long enough to go for a walk/run | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Bike path available | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Fishing opportunities available | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| No garbage or manmade debris on the beach | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| No natural debris like kelp or seaweed on the beach | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |

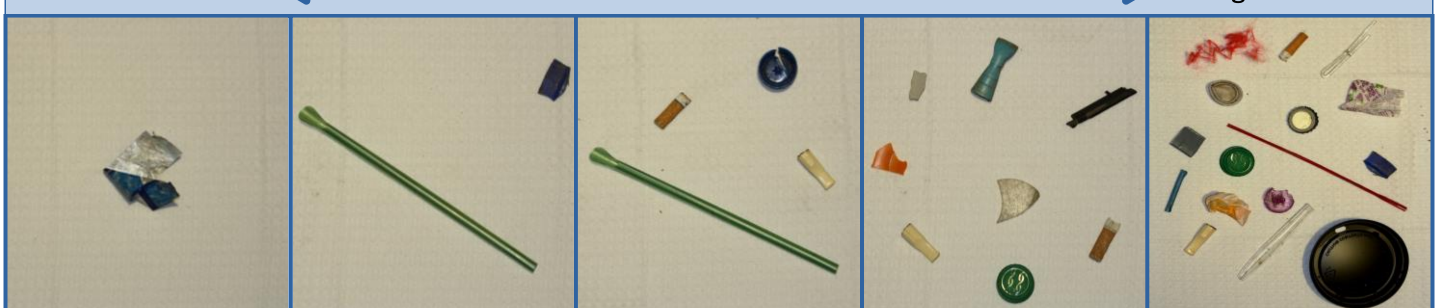
# Garbage or Manmade Debris You May See on Beaches

Different beaches can have different amounts of garbage or manmade debris. Garbage or manmade debris refers to items like bottles, wrappers, straws, plastic fragments, or cigarettes. It does not include twigs or seaweed.

The pictures below illustrate the amount of debris commonly found on United States beaches. Imagine you are picking up debris over an area of 500 square feet or approximately the area of three parking spaces, outlined in red below.

If you walked back and forth in this area and picked up all the debris, you might find different amounts ranging from "almost none" to a "high amount." As the pictures below show, different levels of debris on the beach can be given a score from 1 to 5. Higher scores mean more debris.

Almost None ⟷ High Amount



| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|

On the next page, we will ask you to use the above scale to estimate the amount of garbage or manmade debris you saw on ocean beaches you have been to in Delaware and Maryland.

5. **In the table below, please write the names of ocean beaches in Delaware and Maryland that you went to between September 1, 2017 and August 31, 2018. You may want to refer back to the map at the beginning of this survey.**

   **To the right of each beach you went to, use the debris scale from the previous page and write a number between 1 and 5, indicating the amount of garbage or manmade debris you saw on the beach. Writing a "1" indicates you saw almost none, while writing a "5" indicates you saw a high amount of garbage or manmade debris. For any beach where you don't recall the amount of debris, please write "don't recall" in place of a number.**

| Beach Name | How Much Garbage or Manmade Debris Did You See on the Beach? (1 = Almost None) (5 = High Amount) (Don't Recall) |
|---|---|
| Rehoboth Beach | 4 |
| Lewes Beach | 2 |
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Example

**6. Between September 1, 2017 and August 31, 2018, if there had been <u>almost no</u> garbage or manmade debris on ocean beaches in Delaware and Maryland, would you have gone to the beach more often or the same number of times? Please check ☒ one box.**

☐ More often ➔ **Please answer the two questions below.**

Between September 1, 2017 and August 31, 2018, how many more day trips would you have taken if there were almost no garbage or manmade debris on ocean beaches in Delaware and Maryland? ______ more day trips

Between September 1, 2017 and August 31, 2018, how many more overnight trips would you have taken if there were almost no garbage or manmade debris on ocean beaches in Delaware and Maryland? ______ more overnight trips

☐ The same number of times

**7. Between September 1, 2017 and August 31, 2018, if there had been <u>twice as much</u> garbage or manmade debris on ocean beaches in Delaware and Maryland, would you have gone to the beach less often or the same number of times? Please check ☒ one box.**

☐ Less often ➔ **Please answer the two questions below.**

Between September 1, 2017 and August 31, 2018, how many fewer day trips would you have taken if there had been twice as much garbage or manmade debris on ocean beaches in Delaware and Maryland? ______ fewer day trips

Between September 1, 2017 and August 31, 2018, how many fewer overnight trips would you have taken if there had been twice as much garbage or manmade debris on ocean beaches in Delaware and Maryland? ______ fewer overnight trips

☐ The same number of times

The next few questions ask about your experiences with debris on beaches.

**8. How concerned would you be to see the following types of garbage or manmade debris while visiting a beach? Please check ☒ one box in each row.**

| | Not At All Concerned 1 | 2 | Somewhat Concerned 3 | 4 | Very Concerned 5 |
|---|---|---|---|---|---|
| Plastic items or bottles | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Styrofoam | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Paper products | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Wooden items | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Metal items or cans | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Glass | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Rubber items | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Cloth or clothing | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Cigarette butts | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Fishing gear | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Medical waste | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Animal waste | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |

**9. Please look at the list below and check ☒ the box next to all the types of garbage or manmade debris that you have actually seen on ocean beaches in Delaware and Maryland.**

- ☐ Plastic items or bottles
- ☐ Styrofoam
- ☐ Paper products
- ☐ Wooden items
- ☐ Metal items or cans
- ☐ Glass
- ☐ Rubber items
- ☐ Cloth or clothing
- ☐ Cigarette butts
- ☐ Fishing gear
- ☐ Medical waste
- ☐ Animal waste
- ☐ Other (please specify) ____________

**10. Do you think garbage or manmade debris is a problem on ocean beaches in Delaware and Maryland? Please check ☒ one box.**

☐ Yes ☐ No ☐ Not sure

**11. To the best of your knowledge, what do you think is the largest source of garbage or manmade debris found on ocean beaches in Delaware and Maryland?**
**Please check ☒ one box.**

- ☐ Left by beach visitors
- ☐ Blown to the beach from nearby areas on land
- ☐ Washed ashore from the ocean
- ☐ Washed ashore from nearby rivers or storm drains
- ☐ Other (please specify) ____________

Finally, we have just a few questions about you and your household. These questions are a way to make sure that we understand the values and opinions of all types of people visiting ocean beaches in Delaware and Maryland.

**12. Have you participated in any beach cleanups within the last three years? Please check ☒ one box.**

☐ No ☐ Yes

**13. How many adults and children live in your household?**

____ Adults (18 and older) ____ Children (under 18)

**14. What is your gender? Please check ☒ one box.**

☐ Male ☐ Female

**15. In what year were you born?**

____ Year

**16. Are you of Hispanic, Latino, or Spanish origin? Please check ☒ one box.**

☐ No ☐ Yes

**17. What is your race? Select all that apply.**

- ☐ American Indian or Alaskan Native
- ☐ Asian
- ☐ Black or African American
- ☐ Native Hawaiian or other Pacific Islander
- ☐ White
- ☐ Other (please specify) ______

**18. What is the highest degree or level of school you have completed? Please check ☒ one box.**

- ☐ Less than high school graduate
- ☐ High school graduate (includes GED)
- ☐ Some college or Associate's degree
- ☐ Bachelor's degree
- ☐ Graduate or professional degree, beyond a bachelor's degree

**19. Which of the following income categories best describes your total household income last year, before taxes? Please check ☒ one box.**

- ☐ Less than $15,000
- ☐ $15,000 to $24,999
- ☐ $25,000 to $34,999
- ☐ $35,000 to $49,999
- ☐ $50,000 to $74,999
- ☐ $75,000 to $99,999
- ☐ $100,000 to $150,000
- ☐ More than $150,000

**Thank you for participating!**

Please return your survey in the enclosed Business Reply Mail envelope.

# Beach Recreation Survey
# LAKE ERIE, OHIO


**Paperwork Reduction Act Statement**

The National Oceanic and Atmospheric Administration (NOAA) is authorized by 33 U.S.C. 1951 et seq. to conduct this survey. The information collected will be used by NOAA to estimate economic impacts associated with marine debris on beaches.

Public reporting burden for this collection of information is estimated to average 10 minutes per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other suggestions for reducing this burden to Amy V. Uhrin, NOAA NOS, 1305 East-West Hwy, SSMC4, Room10240, Silver Spring, MD 20910.

The questionnaire has an identification number for mailing purposes only. Your name and address will be deleted after we receive your completed questionnaire. Notwithstanding any other provisions of the law, no person is required to respond to, nor shall any person be subjected to a penalty for failure to comply with, a collection of information subject to the requirements of the Paperwork Reduction Act, unless that collection of information displays a currently valid OMB Control Number.OMB Control Number 0648-0756 I Current Expiration Date: 08/31/2020

**Privacy Act Statement**

Authority: The collection of this information is authorized under 33 U.S.C. 1853 et seq, the Marine Debris Research, Prevention and Reduction Act, which, along with the Marine Debris Amendments of 2012, established the NOAA Marine Debris Program to "identify, determine sources of, assess, prevent, reduce, and remove marine debris and address the adverse impacts of marine debris on the economy of the United States, the marine environment, and navigation safety."

Purpose: The information will be used to estimate economic impacts associated with marine debris on beaches.

NOAA Routine Uses: The survey data will be combined with a national model of coastal recreation, which relies on data collected for the Deepwater Horizon oil spill assessment, to estimate the economic impacts of marine debris on tourism-dependent communities. Disclosure of this information is permitted under the Privacy Act of 1974 (5 U.S.C. Section 552a) to be shared among NOAA staff for work-related purposes. Disclosure of this information is also subject to all of the published routine uses as identified in the Privacy Act System of Records Notice Commerce/NOAA-11, Contact Information for Members of the Public Requesting or Providing Information Related to NOAA's Mission.

Disclosure: Furnishing this information is voluntary; the only consequence of failure to provide accurate information is thatyour responses will not contribute to the successof this research.

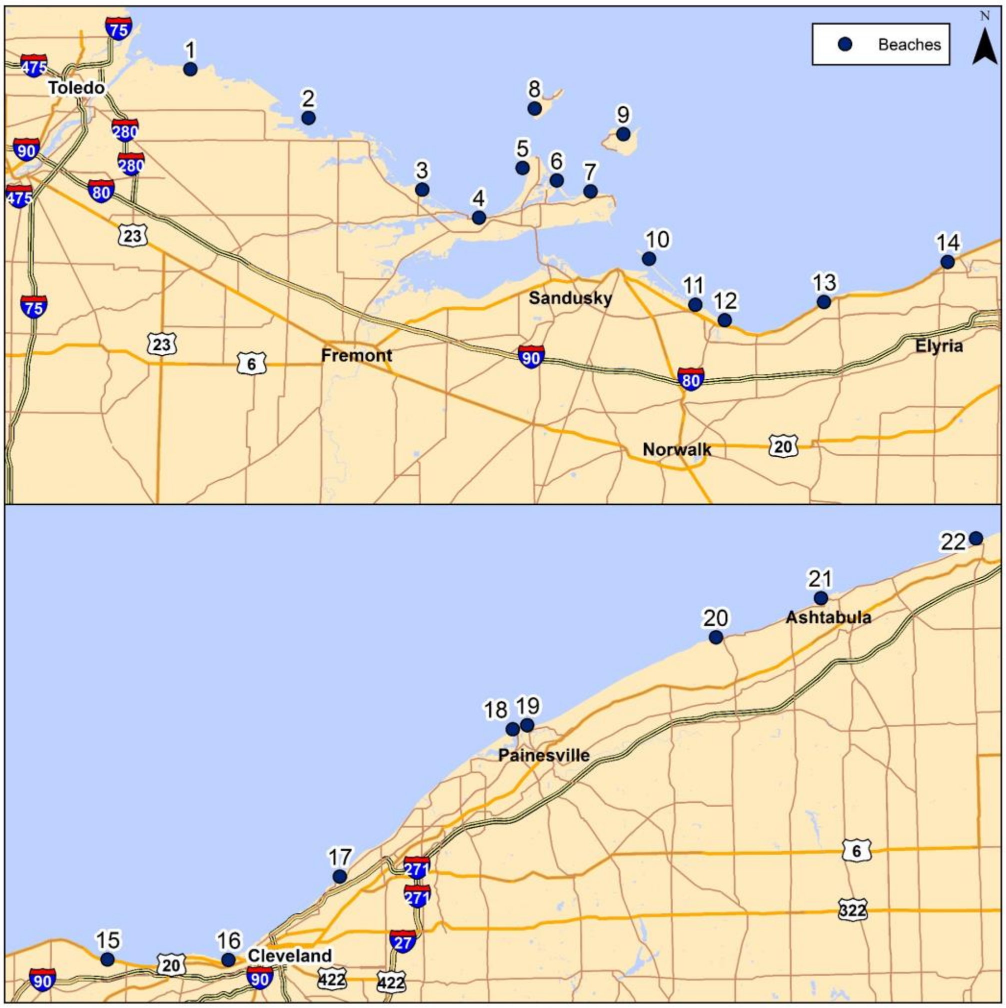
**Thank you for speaking with us a few weeks ago at the beach.**

**This mail survey is the final step in our study. We appreciate your participation!**

Coastal beaches are vital to the area's economy and quality of life. Your answers to this survey will help inform decisions about improving and protecting coastal resources. We want to hear from everyone about things people want to experience when they visit the beach. Your response is important – please complete this **voluntary** survey.

Our questions are about Lake Erie beaches in Ohio, shown in the map below.

**1. In the list below, please circle the names of any beaches you went to between September 1, 2017 and August 31, 2018. If you don't know the name of a beach you went to or it is not on the list, please circle the name of a nearby beach.**




| | | |
|---|---|---|
| 1. Maumee Bay State Park | 9. Kelleys Island State Park | 16. Edgewater Park Beach |
| 2. Crane Creek State Park | 10. Cedar Point Beach | 17. Euclid Beach Park |
| 3. Camp Perry Beach | 11. Sawmill Creek Beach | 18. Headlands Beach State Park |
| 4. Port Clinton City Beach | 12. Nickel Plate Beach | 19. Fairport Harbor Lakefront Park |
| 5. Catawba Island State Park | 13. Sherod Park Beach | 20. Geneva State Park |
| 6. East Harbor State Park | 14. Lakeview Park Beach | 21. Walnut Beach Park |
| 7. Lakeside Beach | 15. Huntington Beach | 22. Conneaut Township Park |
| 8. South Bass Island State Park | | |

Now we would like to ask you about the number of day trips and overnight trips you took to Lake Erie beaches in Ohio. A **day** trip is any time you went to the beach and returned home the same day. An **overnight** trip is when you spent at least one night away from home.

**2. Between September 1, 2017 and August 31, 2018, did you take any day trips to Lake Erie beaches in Ohio? Please check ☒ one box.**

☐ No ☐ Yes ➔ How many day trips? ____ day trips

**3. Between September 1, 2017 and August 31, 2018, did you take any overnight trips where the main purpose was visiting Lake Erie beaches in Ohio? Please check ☒ one box.**

☐ No ☐ Yes ➔ How many overnight trips? ____ overnight trips

The next question is about beach characteristics.

**4. Please tell us how important the following characteristics are to you when you decide which beaches to visit. Please check ☒ one box in each row.**

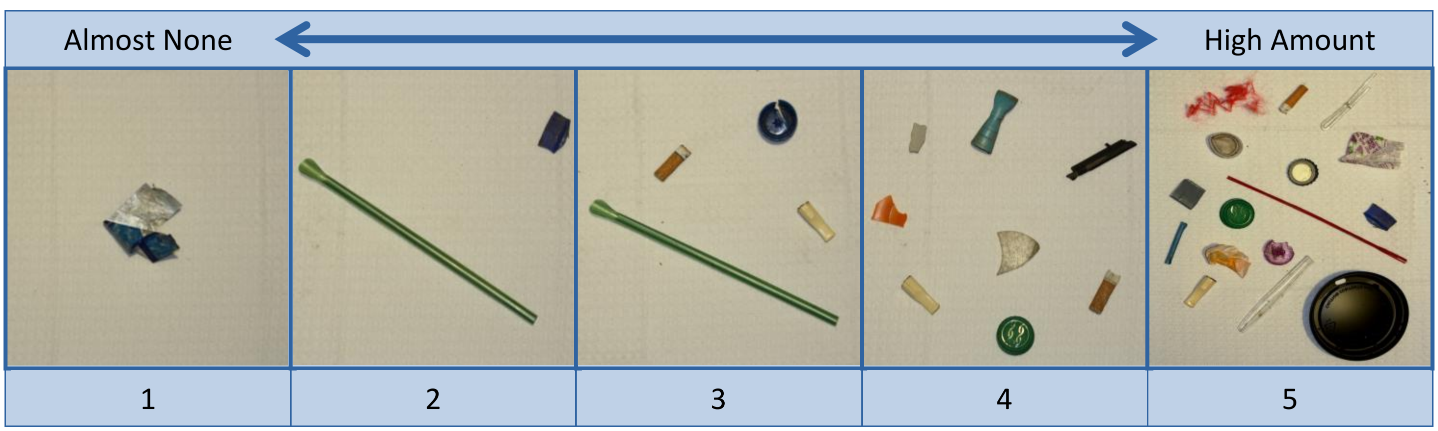
| | Not Important 1 | 2 | Somewhat Important 3 | 4 | Very Important 5 |
|---|---|---|---|---|---|
| Scenic beauty or view | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Good water quality | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Close to home | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Parking is convenient | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Parking is free or inexpensive | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Good surfing available | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Sandy (rather than rocky) | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Not crowded | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Long enough to go for a walk/run | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Bike path available | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Fishing opportunities available | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| No garbage or manmade debris on the beach | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| No natural debris like kelp or seaweed on the beach | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |

# Garbage or Manmade Debris You May See on Beaches

Different beaches can have different amounts of garbage or manmade debris. Garbage or manmade debris refers to items like bottles, wrappers, straws, plastic fragments, or cigarettes. It does not include twigs or seaweed.

The pictures below illustrate the amount of debris commonly found on United States beaches. Imagine you are picking up debris over an area of 500 square feet or approximately the area of three parking spaces, outlined in red below.

If you walked back and forth in this area and picked up all the debris, you might find different amounts ranging from “almost none” to a “high amount.” As the pictures below show, different levels of debris on the beach can be given a score from 1 to 5. Higher scores mean more debris.




On the next page, we will ask you to use the above scale to estimate the amount of garbage or manmade debris you saw on Lake Erie beaches you have been to in Ohio.

5. In the table below, please write the names of Lake Erie beaches in Ohio that you went to between September 1, 2017 and August 31, 2018. You may want to refer back to the map at the beginning of this survey.

**To the right of each beach you went to, use the debris scale from the previous page and write a number between 1 and 5, indicating the amount of garbage or manmade debris you saw on the beach. Writing a "1" indicates you saw almost none, while writing a "5" indicates you saw a high amount of garbage or manmade debris. For any beach where you don't recall the amount of debris, please write "don't recall" in place of a number.**

| Beach Name | How Much Garbage or Manmade Debris Did You See on the Beach? (1 = Almost None) (5 = High Amount) (Don't Recall) |
|---|---|
| Lakeside Beach *Example* | 4 |
| Huntington Beach | 2 |
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6. **Between September 1, 2017 and August 31, 2018, if there had been <u>almost no</u> garbage or manmade debris on Lake Erie beaches in Ohio, would you have gone to the beach more often or the same number of times? Please check ☒ one box.**

☐ More often ➔ **Please answer the two questions below.**

| | |
|---|---|
| Between September 1, 2017 and August 31, 2018, how many more day trips would you have taken if there were almost no garbage or manmade debris on Lake Erie beaches in Ohio? | ☐ more day trips |
| Between September 1, 2017 and August 31, 2018, how many more overnight trips would you have taken if there were almost no garbage or manmade debris on Lake Erie beaches in Ohio? | ☐ more overnight trips |

☐ The same number of times

7. **Between September 1, 2017 and August 31, 2018, if there had been <u>twice as much</u> garbage or manmade debris on Lake Erie beaches in Ohio, would you have gone to the beach less often or the same number of times? Please check ☒ one box.**

☐ Less often ➔ **Please answer the two questions below.**

| | |
|---|---|
| Between September 1, 2017 and August 31, 2018, how many fewer day trips would you have taken if there had been twice as much garbage or manmade debris on Lake Erie beaches in Ohio? | ☐ fewer day trips |
| Between September 1, 2017 and August 31, 2018, how many fewer overnight trips would you have taken if there had been twice as much garbage or manmade debris on Lake Erie beaches in Ohio? | ☐ fewer overnight trips |

☐ The same number of times

The next few questions ask about your experiences with debris on beaches.

**8. How concerned would you be to see the following types of garbage or manmade debris while visiting a beach? Please check ☒ one box in each row.**

| | Not At All Concerned 1 | 2 | Somewhat Concerned 3 | 4 | Very Concerned 5 |
|---|---|---|---|---|---|
| Plastic items or bottles | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Styrofoam | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Paper products | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Wooden items | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Metal items or cans | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Glass | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Rubber items | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Cloth or clothing | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Cigarette butts | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Fishing gear | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Medical waste | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Animal waste | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |

**9. Please look at the list below and check ☒ the box next to all the types of garbage or manmade debris that you have actually seen on Lake Erie beaches in Ohio.**

- ☐ Plastic items or bottles
- ☐ Styrofoam
- ☐ Paper products
- ☐ Wooden items
- ☐ Metal items or cans
- ☐ Glass
- ☐ Rubber items
- ☐ Cloth or clothing
- ☐ Cigarette butts
- ☐ Fishing gear
- ☐ Medical waste
- ☐ Animal waste
- ☐ Other (please specify) ____________

**10. Do you think garbage or manmade debris is a problem on Lake Erie beaches in Ohio? Please check ☒ one box.**

☐ Yes ☐ No ☐ Not sure

**11. To the best of your knowledge, what do you think is the largest source of garbage or manmade debris found on Lake Erie beaches in Ohio?**
**Please check ☒ one box.**

- ☐ Left by beach visitors
- ☐ Blown to the beach from nearby areas on land
- ☐ Washed ashore from the ocean
- ☐ Washed ashore from nearby rivers or storm drains
- ☐ Other (please specify) ____________

Finally, we have just a few questions about you and your household. These questions are a way to make sure that we understand the values and opinions of all types of people visiting Lake Erie beaches in Ohio.

**12. Have you participated in any beach cleanups within the last three years? Please check ☒ one box.**

☐ No ☐ Yes

**13. How many adults and children live in your household?**

____ Adults (18 and older) ____ Children (under 18)

**14. What is your gender? Please check ☒ one box.**

☐ Male ☐ Female

**15. In what year were you born?**

____ Year

**16. Are you of Hispanic, Latino, or Spanish origin? Please check ☒ one box.**

☐ No ☐ Yes

**17. What is your race? Select all that apply.**

- ☐ American Indian or Alaskan Native
- ☐ Asian
- ☐ Black or African American
- ☐ Native Hawaiian or other Pacific Islander
- ☐ White
- ☐ Other (please specify) ____________

**18. What is the highest degree or level of school you have completed? Please check ☒ one box.**

- ☐ Less than high school graduate
- ☐ High school graduate (includes GED)
- ☐ Some college or Associate's degree
- ☐ Bachelor's degree
- ☐ Graduate or professional degree, beyond a bachelor's degree

**19. Which of the following income categories best describes your total household income last year, before taxes? Please check ☒ one box.**

- ☐ Less than $15,000
- ☐ $15,000 to $24,999
- ☐ $25,000 to $34,999
- ☐ $35,000 to $49,999
- ☐ $50,000 to $74,999
- ☐ $75,000 to $99,999
- ☐ $100,000 to $150,000
- ☐ More than $150,000

**Thank you for participating!**

Please return your survey in the enclosed Business Reply Mail envelope.

# Beach Recreation Survey
# ORANGE COUNTY

**Your opinions are important to us!**

**Paperwork Reduction Act Statement**

The National Oceanic and Atmospheric Administration (NOAA) is authorized by 33 U.S.C. 1951 et seq. to conduct this survey. The information collected will be used by NOAA to estimate economic impacts associated with marine debris on beaches.

Public reporting burden for this collection of information is estimated to average 10 minutes per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other suggestions for reducing this burden to Amy V. Uhrin, NOAA NOS, 1305 East-West Hwy, SSMC4, Room 10240, Silver Spring, MD 20910.

The questionnaire has an identification number for mailing purposes only. Your name and address will be deleted after we receive your completed questionnaire. Notwithstanding any other provisions of the law, no person is required to respond to, nor shall any person be subjected to a penalty for failure to comply with, a collection of information subject to the requirements of the Paperwork Reduction Act, unless that collection of information displays a currently valid OMB Control Number.
OMB Control Number 0648-0756 I Current Expiration Date: 08/312020

**Privacy Act Statement**

Authority: The collection of this information is authorized under 33 U.S.C. 1853 et seq, the Marine Debris Research, Prevention and Reduction Act, which, along with the Marine Debris Amendments of 2012, established the NOAA Marine Debris Program to "identify, determine sources of, assess, prevent, reduce, and remove marine debris and address the adverse impacts of marine debris on the economy of the United States, the marine environment, and navigation safety."

Purpose: The information will be used to estimate economic impacts associated with marine debris on beaches.

NOAA Routine Uses: The survey data will be combined with a national model of coastal recreation, which relies on data collected for the Deepwater Horizon oil spill assessment, to estimate the economic impacts of marine debris on tourism-dependent communities. Disclosure of this information is permitted under the Privacy Act of 1974 (5 U.S.C. Section 552a) to be shared among NOAA staff for work-related purposes. Disclosure of this information is also subject to all of the published routine uses as identified in the Privacy Act System of Records Notice Commerce/NOAA-11, Contact Information for Members of the Public Requesting or Providing Information Related to NOAA's Mission.

Disclosure: Furnishing this information is voluntary; the only consequence of failure to provide accurate information is that your responses will not contribute to the success of this research.

**Thank you for speaking with us a few weeks ago at the beach.**

**This mail survey is the final step in our study. We appreciate your participation!**

Coastal beaches are vital to the area's economy and quality of life. Your answers to this survey will help inform decisions about improving and protecting coastal resources. We want to hear from everyone about things people want to experience when they visit the beach. Your response is important – please complete this **voluntary** survey.

Our questions are about ocean beaches in Orange County, shown in the map below.

**1. In the list below, please circle the names of any beaches you went to between September 1, 2017 and August 31, 2018. If you don't know the name of a beach you went to or it is not on the list, please circle the name of a nearby beach.**


| | | |
|---|---|---|
| 1. Seal Beach | 9. Balboa Beach | 16. Monarch Beach |
| 2. Surfside Beach | 10. Corona del Mar State Beach | 17. Dana Point Headlands Beach |
| 3. Sunset Beach | 11. Crystal Cove State Park Beach | 18. Doheny State Beach |
| 4. Bolsa Chica | 12. Emerald Bay Beach | 19. Capistrano Beach Park |
| 5. Huntington City Beach | 13. Laguna Beach | 20. Poche County Beach |
| 6. Huntington State Beach | 14. Aliso Beach | 21. San Clemente City Beach |
| 7. Santa Ana River County Beach | 15. Salt Creek Beach | 22. San Clemente State Beach |
| 8. Newport Beach | | |

Now we would like to ask you about the number of day trips and overnight trips you took to beaches in Orange County. A **day** trip is any time you went to the beach and returned home the same day. An **overnight** trip is when you spent at least one night away from home.

**2. Between September 1, 2017 and August 31, 2018, did you take any day trips to beaches in Orange County? Please check ☒ one box.**

☐ No ☐ Yes ➔ How many day trips? ☐ day trips

**3. Between September 1, 2017 and August 31, 2018, did you take any overnight trips where the main purpose was visiting beaches in Orange County? Please check ☒ one box.**

☐ No ☐ Yes ➔ How many overnight trips? ☐ overnight trips

The next question is about beach characteristics.

**4. Please tell us how important the following characteristics are to you when you decide which beaches to visit. Please check ☒ one box in each row.**

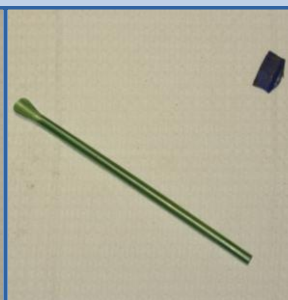
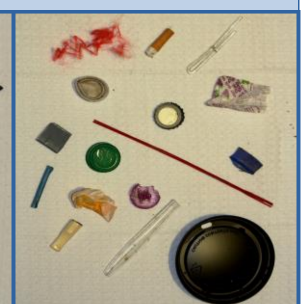
| | Not Important 1 | 2 | Somewhat Important 3 | 4 | Very Important 5 |
|---|---|---|---|---|---|
| Scenic beauty or view | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Good water quality | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Close to home | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Parking is convenient | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Parking is free or inexpensive | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Good surfing available | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Sandy (rather than rocky) | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Not crowded | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Long enough to go for a walk/run | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Bike path available | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Fishing opportunities available | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| No garbage or manmade debris on the beach | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| No natural debris like kelp or seaweed on the beach | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |

# Garbage or Manmade Debris You May See on Beaches

Different beaches can have different amounts of garbage or manmade debris. Garbage or manmade debris refers to items like bottles, wrappers, straws, plastic fragments, or cigarettes. It does not include twigs or seaweed.

The pictures below illustrate the amount of debris commonly found on United States beaches. Imagine you are picking up debris over an area of 500 square feet or approximately the area of three parking spaces, outlined in red below.

If you walked back and forth in this area and picked up all the debris, you might find different amounts ranging from "almost none" to a "high amount." As the pictures below show, different levels of debris on the beach can be given a score from 1 to 5. Higher scores mean more debris.

| Almost None | | | | High Amount |
|---|---|---|---|---|
|  |  |  |  |  |
| 1 | 2 | 3 | 4 | 5 |

On the next page, we will ask you to use the above scale to estimate the amount of garbage or manmade debris you saw on beaches you have been to in Orange County.

5. In the table below, please write the names of beaches in Orange County that you went to between September 1, 2017 and August 31, 2018. You may want to refer back to the map at the beginning of this survey.

   **To the right of each beach you went to, use the debris scale from the previous page and write a number between 1 and 5, indicating the amount of garbage or manmade debris you saw on the beach. Writing a "1" indicates you saw almost none, while writing a "5" indicates you saw a high amount of garbage or manmade debris. For any beach where you don't recall the amount of debris, please write "don't recall" in place of a number.**

| Beach Name | How Much Garbage or Manmade Debris Did You See on the Beach? (1 = Almost None) (5 = High Amount) (Don't Recall) |
|---|---|
| Surfside Beach Example | 4 |
| Monarch Beach | 2 |
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**6. Between September 1, 2017 and August 31, 2018, if there had been <u>almost no</u> garbage or manmade debris on beaches in Orange County, would you have gone to the beach more often or the same number of times? Please check ☒ one box.**

☐ More often ➔ **Please answer the two questions below.**

| | | |
|---|---|---|
| Between September 1, 2017 and August 31, 2018, how many more day trips would you have taken if there were almost no garbage or manmade debris on Orange County beaches? | ☐ | more day trips |
| Between September 1, 2017 and August 31, 2018, how many more overnight trips would you have taken if there were almost no garbage or manmade debris on Orange County beaches? | ☐ | more overnight trips |

☐ The same number of times

**7. Between September 1, 2017 and August 31, 2018, if there had been <u>twice as much</u> garbage or manmade debris on beaches in Orange County, would you have gone to the beach less often or the same number of times? Please check ☒ one box.**

☐ Less often ➔ **Please answer the two questions below.**

| | | |
|---|---|---|
| Between September 1, 2017 and August 31, 2018, how many fewer day trips would you have taken if there had been twice as much garbage or manmade debris on Orange County beaches? | ☐ | fewer day trips |
| Between September 1, 2017 and August 31, 2018, how many fewer overnight trips would you have taken if there had been twice as much garbage or manmade debris on Orange County beaches? | ☐ | fewer overnight trips |

☐ The same number of times

The next few questions ask about your experiences with debris on beaches.

**8. How concerned would you be to see the following types of garbage or manmade debris while visiting a beach? Please check ☒ one box in each row.**

| | Not At All Concerned 1 | 2 | Somewhat Concerned 3 | 4 | Very Concerned 5 |
|---|---|---|---|---|---|
| Plastic items or bottles | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Styrofoam | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Paper products | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Wooden items | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Metal items or cans | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Glass | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Rubber items | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Cloth or clothing | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Cigarette butts | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Fishing gear | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Medical waste | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Animal waste | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |

**9. Please look at the list below and check ☒ the box next to all the types of garbage or manmade debris that you have <u>actually seen</u> on beaches in Orange County.**

- ☐ Plastic items or bottles
- ☐ Styrofoam
- ☐ Paper products
- ☐ Wooden items
- ☐ Metal items or cans
- ☐ Glass
- ☐ Rubber items
- ☐ Cloth or clothing
- ☐ Cigarette butts
- ☐ Fishing gear
- ☐ Medical waste
- ☐ Animal waste
- ☐ Other (please specify) ____________________

**10. Do you think garbage or manmade debris is a problem on Orange County beaches? Please check ☒ one box.**

☐ Yes ☐ No ☐ Not sure

**11. To the best of your knowledge, what do you think is the largest source of garbage or manmade debris found on beaches in Orange County?**
**Please check ☒ one box.**

- ☐ Left by beach visitors
- ☐ Blown to the beach from nearby areas on land
- ☐ Washed ashore from the ocean
- ☐ Washed ashore from nearby rivers or storm drains
- ☐ Other (please specify) ________

Finally, we have just a few questions about you and your household. These questions are a way to make sure that we understand the values and opinions of all types of people visiting beaches in Orange County.

**12. Have you participated in any beach cleanups within the last three years? Please check ☒ one box.**

☐ No ☐ Yes

**13. How many adults and children live in your household?**

____ Adults (18 and older) ____ Children (under 18)

**14. What is your gender? Please check ☒ one box.**

☐ Male ☐ Female

**15. In what year were you born?**

____ Year

**16. Are you of Hispanic, Latino, or Spanish origin? Please check ☒ one box.**

☐ No ☐ Yes

**17. What is your race? Select all that apply.**

- ☐ American Indian or Alaskan Native
- ☐ Asian
- ☐ Black or African American
- ☐ Native Hawaiian or other Pacific Islander
- ☐ White
- ☐ Other (please specify) ____________________

**18. What is the highest degree or level of school you have completed? Please check ☒ one box.**

- ☐ Less than high school graduate
- ☐ High school graduate (includes GED)
- ☐ Some college or Associate's degree
- ☐ Bachelor's degree
- ☐ Graduate or professional degree, beyond a bachelor's degree

**19. Which of the following income categories best describes your household income last year, before taxes? Please check ☒ one box.**

- ☐ Less than $15,000
- ☐ $15,000 to $24,999
- ☐ $25,000 to $34,999
- ☐ $35,000 to $49,999
- ☐ $50,000 to $74,999
- ☐ $75,000 to $99,999
- ☐ $100,000 to $150,000
- ☐ More than $150,000

**Thank you for participating!**

Please return your survey in the enclosed Business Reply Mail envelope.

## Appendix B: Mail Survey Summary Statistics

**Table B-1. Variables in STATA survey data.** The variables refer to the question numbers in the mail survey (Appendix A). Additional statistics for each question (variable) are provided in the subsequent tables in this appendix.

| Variable | Number of Obs | Mean (arithmetic) | Standard Deviation |
|---|---|---|---|
| q4a | 323 | 4.5368 | 0.7475567 |
| q4b | 322 | 4.683071 | 0.6270579 |
| q4c | 319 | 3.372723 | 1.189056 |
| q4d | 322 | 4.033061 | 0.9473828 |
| q4e | 318 | 3.932792 | 1.07588 |
| q4f | 319 | 1.583717 | 1.092779 |
| q4g | 326 | 4.040598 | 1.000017 |
| q4h | 322 | 3.656785 | 0.8938503 |
| q4i | 324 | 3.359708 | 1.21757 |
| q4j | 323 | 2.102542 | 1.14559 |
| q4k | 324 | 2.013652 | 1.217244 |
| q4l | 325 | 4.716321 | 0.5838761 |
| q4m | 327 | 2.68117 | 1.286081 |
| q8a | 322 | 4.276305 | 0.9278153 |
| q8b | 324 | 4.335596 | 0.8825632 |
| q8c | 322 | 3.715351 | 1.140694 |
| q8d | 322 | 3.398923 | 1.17883 |
| q8e | 323 | 4.500011 | 0.7438369 |
| q8f | 323 | 4.697954 | 0.6825499 |
| q8g | 323 | 4.307 | 0.8572738 |
| q8h | 323 | 3.60704 | 0.9968901 |
| q8i | 325 | 4.139015 | 0.9070701 |
| q8j | 322 | 4.15308 | 0.9713461 |
| q8k | 324 | 4.971814 | 0.2278477 |
| q8l | 324 | 4.213526 | 1.129816 |
| q9a[a] | 275 | 1 | 0 |
| q9b[a] | 151 | 1 | 0 |
| q9c[a] | 213 | 1 | 0 |
| q9d[a] | 119 | 1 | 0 |
| q9e[a] | 158 | 1 | 0 |
| q9f[a] | 113 | 1 | 0 |
| q9g[a] | 81 | 1 | 0 |
| q9h[a] | 126 | 1 | 0 |
| q9i[a] | 262 | 1 | 0 |

**Table B-1. Variables in STATA survey data.** The variables refer to the question numbers in the mail survey (Appendix A). Additional statistics for each question (variable) are provided in the subsequent tables in this appendix.

| Variable | Number of Obs | Mean (arithmetic) | Standard Deviation |
|---|---|---|---|
| q9j[a] | 99 | 1 | 0 |
| q9k[a] | 29 | 1 | 0 |
| q9l[a] | 94 | 1 | 0 |
| q9m[a] | 26 | 1 | 0 |
| q10 | 327 | 1.922661 | 0.8546131 |
| q11 | 278 | 1.360309 | 0.9004653 |
| q12 | 328 | 1.205919 | 0.4049896 |
| q13_adults | 319 | 2.130537 | 0.7557102 |
| q13_children | 153 | 1.514315 | 1.635995 |
| q14 | 323 | 1.580502 | 0.4942426 |
| q15 | 323 | 1968.255 | 13.93063 |
| q16 | 321 | 1.0171 | 0.1298465 |
| q17a[a] | 0 | | |
| q17b[a] | 3 | 1 | 0 |
| q17c[a] | 1 | 1 | |
| q17d[a] | 0 | | |
| q17e[a] | 298 | 1 | 0 |
| q17f[a] | 13 | 1 | 0 |
| q18 | 316 | 3.790975 | 0.9911346 |
| q19 | 295 | 5.790274 | 1.777295 |

a. Denotes a dummy variable.

| q4a | Freq. | Percent | Cumulative Percent |
|---|---|---|---|
| 1 | 0.465270436 | 0.14 | 0.14 |
| 2 | 6.44418623 | 1.96 | 2.1 |
| 3 | 28.1870333 | 8.57 | 10.67 |
| 4 | 73.5298536 | 22.35 | 33.02 |
| 5 | 217.57721 | 66.13 | 99.15 |
| Missing | 2.796446 | 0.85 | 100 |
| *Total* | *329* | *100* | |

| q4b | Freq. | Percent | Cumulative Percent |
|---|---|---|---|
| 2 | 3.5523906 | 1.08 | 1.08 |
| 3 | 18.0294583 | 5.48 | 6.56 |
| 4 | 56.8946862 | 17.29 | 23.85 |
| 5 | 248.444812 | 75.52 | 99.37 |
| Missing | 2.07865269 | 0.63 | 100 |
| *Total* | *329* | *100* | |

| q4c | Freq. | Percent | Cumulative Percent |
|---|---|---|---|
| 1 | 30.8056405 | 9.36 | 9.36 |
| 2 | 30.996049 | 9.42 | 18.78 |
| 3 | 106.60122 | 32.4 | 51.19 |
| 4 | 85.4165294 | 25.96 | 77.15 |
| 5 | 62.555489 | 19.01 | 96.16 |
| Missing | 12.6250721 | 3.84 | 100 |
| *Total* | *329* | *100* | |

| q4d | Freq. | Percent | Cumulative Percent |
|---|---|---|---|
| 1 | 3.69250807 | 1.12 | 1.12 |
| 2 | 13.31390398 | 4.05 | 5.17 |
| 3 | 77.7193064 | 23.62 | 28.79 |
| 4 | 103.240732 | 31.38 | 60.17 |
| 5 | 126.139939 | 38.34 | 98.51 |
| Missing | 4.89361112 | 1.49 | 100 |
| *Total* | *329* | *100* | |

| q4e | Freq. | Percent | Cumulative Percent |
|---|---|---|---|
| 1 | 10.5836478 | 3.22 | 3.22 |
| 2 | 22.2386043 | 6.76 | 9.98 |
| 3 | 58.3728326 | 17.74 | 27.72 |
| 4 | 102.6387679 | 31.2 | 58.92 |
| 5 | 113.917606 | 34.63 | 93.54 |
| Missing | 21.2485416 | 6.46 | 100 |
| *Total* | *329* | *100* | |

| q4f | Freq. | Percent | Cumulative Percent |
|---|---|---|---|
| 1 | 223.636678 | 67.97 | 67.97 |
| 2 | 42.9462081 | 13.05 | 81.03 |
| 3 | 24.1138373 | 7.33 | 88.36 |
| 4 | 9.69906202 | 2.95 | 91.31 |
| 5 | 16.121357 | 4.9 | 96.21 |
| Missing | 12.4828579 | 3.79 | 100 |
| *Total* | *329* | *100* | |

| q4g | Freq. | Percent | Cumulative Percent |
|---|---|---|---|
| 1 | 14.5699689 | 4.43 | 4.43 |
| 2 | 3.909818293 | 1.19 | 5.62 |
| 3 | 57.1293851 | 17.36 | 22.98 |
| 4 | 128.7410869 | 39.13 | 62.11 |
| 5 | 121.904106 | 37.05 | 99.17 |
| Missing | 2.74563449 | 0.83 | 100 |
| *Total* | *329* | *100* | |

| q4h | Freq. | Percent | Cumulative Percent |
|---|---|---|---|
| 1 | 0.378126 | 0.11 | 0.11 |
| 2 | 22.11331 | 6.72 | 6.84 |
| 3 | 135.5761 | 41.21 | 48.04 |
| 4 | 97.20097 | 29.54 | 77.59 |
| 5 | 69.47877 | 21.12 | 98.71 |
| Missing | 4.25273 | 1.29 | 100 |
| *Total* | *329* | *100* | |

| q4i | Freq. | Percent | Cumulative Percent |
|---|---|---|---|
| 1 | 34.89423 | 10.61 | 10.61 |
| 2 | 36.81815 | 11.19 | 21.8 |
| 3 | 93.31505 | 28.36 | 50.16 |
| 4 | 99.42796 | 30.22 | 80.38 |
| 5 | 62.37014 | 18.96 | 99.34 |
| Missing | 2.174457 | 0.66 | 100 |
| *Total* | *329* | *100* | |

| q4j | Freq. | Percent | Cumulative Percent |
|---|---|---|---|
| 1 | 130.8723 | 39.78 | 39.78 |
| 2 | 77.60353 | 23.59 | 63.37 |
| 3 | 72.95473 | 22.17 | 85.54 |
| 4 | 26.69719 | 8.11 | 93.66 |
| 5 | 12.46578 | 3.79 | 97.44 |
| Missing | 8.406503 | 2.56 | 100 |
| *Total* | *329* | *100* | |

| q4k | Freq. | Percent | Cumulative Percent |
|---|---|---|---|
| 1 | 163.5065 | 49.7 | 49.7 |
| 2 | 56.16639 | 17.07 | 66.77 |
| 3 | 57.32418 | 17.42 | 84.19 |
| 4 | 35.72227 | 10.86 | 95.05 |
| 5 | 13.06174 | 3.97 | 99.02 |
| Missing | 3.218888 | 0.98 | 100 |
| *Total* | *329* | *100* | |

| q4l | Freq. | Percent | Cumulative Percent |
|---|---|---|---|
| 1 | 0.797679 | 0.24 | 0.24 |
| 2 | 1.771307 | 0.54 | 0.78 |
| 3 | 11.93473 | 3.63 | 4.41 |
| 4 | 59.10748 | 17.97 | 22.37 |
| 5 | 248.8711 | 75.64 | 98.02 |
| Missing | 6.517668 | 1.98 | 100 |
| *Total* | *329* | *100* | |

| q4m | Freq. | Percent | Cumulative Percent |
|---|---|---|---|
| 1 | 78.13972 | 23.75 | 23.75 |
| 2 | 74.598 | 22.67 | 46.42 |
| 3 | 78.29913 | 23.8 | 70.22 |
| 4 | 66.60926 | 20.25 | 90.47 |
| 5 | 29.91576 | 9.09 | 99.56 |
| Missing | 1.438135 | 0.44 | 100 |
| *Total* | *329* | *100* | |

| Q8a | Freq. | Percent | Cumulative Percent |
|---|---|---|---|
| 1 | 3.788065 | 1.15 | 1.15 |
| 2 | 6.709796 | 2.04 | 3.19 |
| 3 | 64.68349 | 19.66 | 22.85 |
| 4 | 71.83337 | 21.83 | 44.69 |
| 5 | 179.7556 | 54.64 | 99.32 |
| Missing | 2.229706 | 0.68 | 100 |
| *Total* | *329* | *100* | |

| Q8b | Freq. | Percent | Cumulative Percent |
|---|---|---|---|
| 1 | 3.880809 | 1.18 | 1.18 |
| 2 | 5.846718 | 1.78 | 2.96 |
| 3 | 49.79547 | 15.14 | 18.09 |
| 4 | 84.88491 | 25.8 | 43.89 |
| 5 | 183.0123 | 55.63 | 99.52 |
| Missing | 1.579805 | 0.48 | 100 |
| *Total* | *329* | *100* | |

| Q8c | Freq. | Percent | Cumulative Percent |
|---|---|---|---|
| 1 | 8.50777 | 2.59 | 2.59 |
| 2 | 42.68206 | 12.97 | 15.56 |
| 3 | 88.68301 | 26.96 | 42.51 |
| 4 | 74.3102 | 22.59 | 65.1 |
| 5 | 107.8922 | 32.79 | 97.9 |
| Missing | 6.924797 | 2.1 | 100 |
| *Total* | *329* | *100* | |

| Q8d | Freq. | Percent | Cumulative Percent |
|---|---|---|---|
| 1 | 17.35829 | 5.28 | 5.28 |
| 2 | 56.32591 | 17.12 | 22.4 |
| 3 | 110.2657 | 33.52 | 55.91 |
| 4 | 63.98914 | 19.45 | 75.36 |
| 5 | 78.67321 | 23.91 | 99.27 |
| Missing | 2.387715 | 0.73 | 100 |
| *Total* | *329* | *100* | |

| Q8e | Freq. | Percent | Cumulative Percent |
|---|---|---|---|
| 1 | 2.157791 | 0.66 | 0.66 |
| 2 | 0.418666 | 0.13 | 0.78 |
| 3 | 35.07331 | 10.66 | 11.44 |
| 4 | 83.35541 | 25.34 | 36.78 |
| 5 | 205.7804 | 62.55 | 99.33 |
| Missing | 2.214463 | 0.67 | 100 |
| *Total* | *329* | *100* | |

| Q8f | Freq. | Percent | Cumulative Percent |
|---|---|---|---|
| 1 | 2.88934615 | 0.88 | 0.88 |
| 2 | 4.45316302 | 1.35 | 2.23 |
| 3 | 10.6898452 | 3.25 | 5.48 |
| 4 | 52.2793732 | 15.89 | 21.37 |
| 5 | 256.048805 | 77.83 | 99.2 |
| Missing | 2.63946719 | 0.8 | 100 |
| *Total* | *329* | *100* | |

| Q8g | Freq. | Percent | Cumulative Percent |
|---|---|---|---|
| 1 | 1.88567992 | 0.57 | 0.57 |
| 2 | 8.74995417 | 2.66 | 3.23 |
| 3 | 47.473652 | 14.43 | 17.66 |
| 4 | 97.9651042 | 29.78 | 47.44 |
| 5 | 171.061221 | 51.99 | 99.43 |
| Missing | 1.86438909 | 0.57 | 100 |
| *Total* | *329* | *100* | |

| Q8h | Freq. | Percent | Cumulative Percent |
|---|---|---|---|
| 1 | 3.576701 | 1.09 | 1.09 |
| 2 | 37.64481 | 11.44 | 12.53 |
| 3 | 116.6838 | 35.47 | 48 |
| 4 | 94.16568 | 28.62 | 76.62 |
| 5 | 74.4097 | 22.62 | 99.23 |
| Missing | 2.519295 | 0.77 | 100 |
| *Total* | *329* | *100* | |

| Q8i | Freq. | Percent | Cumulative Percent |
|---|---|---|---|
| 1 | 0.395085 | 0.12 | 0.12 |
| 2 | 14.29139 | 4.34 | 4.46 |
| 3 | 69.23019 | 21.04 | 25.51 |
| 4 | 98.46537 | 29.93 | 55.44 |
| 5 | 144.4301 | 43.9 | 99.33 |
| Missing | 2.187868 | 0.67 | 100 |
| *Total* | *329* | *100* | |

| Q8j | Freq. | Percent | Cumulative Percent |
|---|---|---|---|
| 1 | 5.191183 | 1.58 | 1.58 |
| 2 | 15.04663 | 4.57 | 6.15 |
| 3 | 54.76564 | 16.65 | 22.8 |
| 4 | 98.29962 | 29.88 | 52.68 |
| 5 | 149.91 | 45.57 | 98.24 |
| Missing | 5.78689 | 1.76 | 100 |
| *Total* | *329* | *100* | |

| Q8k | Freq. | Percent | Cumulative Percent |
|---|---|---|---|
| 1 | 0.49919 | 0.15 | 0.15 |
| 3 | 0.993103263 | 0.3 | 0.45 |
| 4 | 5.24560921 | 1.59 | 2.05 |
| 5 | 320.673051 | 97.47 | 99.52 |
| Missing | 1.589046488 | 0.48 | 100 |
| *Total* | *329* | *100* | |

| Q8l | Freq. | Percent | Cumulative Percent |
|---|---|---|---|
| 1 | 9.945969 | 3.02 | 3.02 |
| 2 | 25.2586 | 7.68 | 10.7 |
| 3 | 44.90734 | 13.65 | 24.35 |
| 4 | 51.45356 | 15.64 | 39.99 |
| 5 | 194.9905 | 59.27 | 99.26 |
| Missing | 2.444054 | 0.74 | 100 |
| *Total* | *329* | *100* | |

| Q9a | Freq. | Percent | Cumulative Percent |
|---|---|---|---|
| 1 | 273.5497 | 83.15 | 83.15 |
| Missing | 55.45026 | 16.85 | 100 |
| *Total* | *329* | *100* | |

| Q9b | Freq. | Percent | Cumulative Percent |
|---|---|---|---|
| 1 | 159.938 | 48.61 | 48.61 |
| Missing | 169.062 | 51.39 | 100 |
| *Total* | *329* | *100* | |

| Q9c | Freq. | Percent | Cumulative Percent |
|---|---|---|---|
| 1 | 202.6654 | 61.6 | 61.6 |
| Missing | 126.3346 | 38.4 | 100 |
| *Total* | *329* | *100* | |

| Q9d | Freq. | Percent | Cumulative Percent |
|---|---|---|---|
| 1 | 87.66652 | 26.65 | 26.65 |
| Missing | 241.3335 | 73.35 | 100 |
| *Total* | *329* | *100* | |

| Q9e | Freq. | Percent | Cumulative Percent |
|---|---|---|---|
| 1 | 147.6069 | 44.87 | 44.87 |
| Missing | 181.3931 | 55.13 | 100 |
| *Total* | *329* | *100* | |

| Q9f | Freq. | Percent | Cumulative Percent |
|---|---|---|---|
| 1 | 117.5638 | 35.73 | 35.73 |
| Missing | 211.4362 | 64.27 | 100 |
| *Total* | *329* | *100* | |

| Q9g | Freq. | Percent | Cumulative Percent |
|---|---|---|---|
| 1 | 61.27066 | 18.62 | 18.62 |
| Missing | 267.7293 | 81.38 | 100 |
| *Total* | *329* | *100* | |

| Q9h | Freq. | Percent | Cumulative Percent |
|---|---|---|---|
| 1 | 103.6768 | 31.51 | 31.51 |
| Missing | 225.3232 | 68.49 | 100 |
| *Total* | *329* | *100* | |

| Q9i | Freq. | Percent | Cumulative Percent |
|---|---|---|---|
| 1 | 268.5817 | 81.64 | 81.64 |
| Missing | 60.41826 | 18.36 | 100 |
| *Total* | *329* | *100* | |

| Q9j | Freq. | Percent | Cumulative Percent |
|---|---|---|---|
| 1 | 119.6409 | 36.37 | 36.37 |
| Missing | 209.3591 | 63.63 | 100 |
| *Total* | *329* | *100* | |

| Q9k | Freq. | Percent | Cumulative Percent |
|---|---|---|---|
| 1 | 22.5913 | 6.87 | 6.87 |
| Missing | 306.4087 | 93.13 | 100 |
| *Total* | *329* | *100* | |

| Q9l | Freq. | Percent | Cumulative Percent |
|---|---|---|---|
| 1 | 101.4602 | 30.84 | 30.84 |
| Missing | 227.5398 | 69.16 | 100 |
| *Total* | *329* | *100* | |

| Q9m | Freq. | Percent | Cumulative Percent |
|---|---|---|---|
| 1 | 29.94231 | 9.1 | 9.1 |
| Missing | 299.0577 | 90.9 | 100 |
| *Total* | *329* | *100* | |

| Q9m | Freq. | Percent | Cumulative Percent |
|---|---|---|---|
| | 301.911902 | 91.77 | 91.77 |
| Balloons & Ribbons Shotgun Shell Casing | 0.077010125 | 0.02 | 91.79 |
| Balloons/Balloon Strings | 0.290259182 | 0.09 | 91.88 |
| Bird Feathers – Very Common | 3.55020999 | 1.08 | 92.96 |
| Bucket | 0.944605824 | 0.29 | 93.24 |
| Campfire Debris | 0.337247609 | 0.1 | 93.35 |
| Condoms | 0.629406093 | 0.19 | 93.54 |
| Condoms, Tampons | 0.139868021 | 0.04 | 93.58 |
| Dead Bird | 0.184361383 | 0.06 | 93.64 |
| Dead Fish Decaying | 0.620689509 | 0.19 | 93.83 |
| Diapers | 0.147608906 | 0.04 | 93.87 |
| Diapers/Tampons | 4.43776225 | 1.35 | 95.22 |
| Dirty Diapers! | 0.021963626 | 0.01 | 95.23 |
| Dog-Not On Leash! | 0.024418583 | 0.01 | 95.23 |
| Don't Really Remember | 2.19378471 | 0.67 | 95.9 |
| Fire Remnants | 0.084700189 | 0.03 | 95.93 |
| Fireworks | 1.6551721 | 0.5 | 96.43 |
| I Do Think They Have Become Much Cleaner | 5.83357857 | 1.77 | 98.2 |
| None | 0.570842145 | 0.17 | 98.38 |
| Plastics | 0.087626762 | 0.03 | 98.4 |
| Shipwreck | 0.488371669 | 0.15 | 98.55 |
| Small, Dead Jellyfish Occasionally | 1.93506109 | 0.59 | 99.14 |
| Tennis Balls | 0.708081839 | 0.22 | 99.35 |

| Q9m | Freq. | Percent | Cumulative Percent |
|---|---|---|---|
| Trash from Ships, Plastic Caps, Balloon | 0.011237546 | 0 | 99.36 |
| Very Little Garbage | 1.90280711 | 0.58 | 99.94 |
| Wrappers | 0.211423024 | 0.06 | 100 |
| *Total* | *329* | *100* | |

| Q10 | Freq. | Percent | Cumulative Percent |
|---|---|---|---|
| 1 | 132.764391 | 40.35 | 40.35 |
| 2 | 87.00607479 | 26.45 | 66.8 |
| 3 | 107.456936 | 32.66 | 99.46 |
| Missing | 1.77259856 | 0.54 | 100 |
| *Total* | *329* | *100* | |

| Q11 | Freq. | Percent | Cumulative Percent |
|---|---|---|---|
| 1 | 240.093478 | 72.98 | 72.98 |
| 2 | 7.43887217 | 2.26 | 75.24 |
| 3 | 12.8481432 | 3.91 | 79.14 |
| 4 | 22.9884512 | 6.99 | 86.13 |
| Missing | 45.6310558 | 13.87 | 100 |
| *Total* | *329* | *100* | |

| Q12 | Freq. | Percent | Cumulative Percent |
|---|---|---|---|
| 1 | 261.238622 | 79.4 | 79.4 |
| 2 | 67.7438075 | 20.59 | 99.99 |
| Missing | 0.017570794 | 0.01 | 100 |
| *Total* | *329* | *100* | |

| Q13_adult | Freq. | Percent | Cumulative Percent |
|---|---|---|---|
| 0 | 0.488313442 | 0.15 | 0.15 |
| 1 | 44.7352698 | 13.6 | 13.75 |
| 2 | 210.2766934 | 63.91 | 77.66 |
| 3 | 48.0574236 | 14.61 | 92.27 |
| 4 | 16.146302 | 4.91 | 97.17 |
| 5 | 0.044918481 | 0.01 | 97.19 |
| 6 | 1.80025634 | 0.55 | 97.74 |
| Missing | 7.45082288 | 2.26 | 100 |
| *Total* | *329* | *100* | |

| Q13_children | Freq. | Percent | Cumulative Percent |
|---|---|---|---|
| 0 | 58.5541417 | 17.8 | 17.8 |
| 1 | 29.109033 | 8.85 | 26.65 |
| 2 | 52.6726524 | 16.01 | 42.66 |
| 3 | 18.5743402 | 5.65 | 48.3 |
| 4 | 8.687789412 | 2.64 | 50.94 |
| 5 | 0.553287415 | 0.17 | 51.11 |
| 7 | 0.066206887 | 0.02 | 51.13 |
| 9 | 3.55020999 | 1.08 | 52.21 |
| Missing | 157.232339 | 47.79 | 100 |
| *Total* | *329* | *100* | |

| Q14 | Freq. | Percent | Cumulative Percent |
|---|---|---|---|
| 1 | 135.686246 | 41.24 | 41.24 |
| 2 | 187.762502 | 57.07 | 98.31 |
| Missing | 5.55125187 | 1.69 | 100 |
| *Total* | *329* | *100* | |

| Q15 | Freq. | Percent | Cumulative Percent |
|---|---|---|---|
| 1934 | 0.074870951 | 0.02 | 0.02 |
| 1938 | 0.591800906 | 0.18 | 0.2 |
| 1941 | 0.639178557 | 0.19 | 0.4 |
| 1942 | 5.83357857 | 1.77 | 2.17 |
| 1943 | 1.90077471 | 0.58 | 2.75 |
| 1944 | 1.107090939 | 0.34 | 3.08 |
| 1945 | 0.084505647 | 0.03 | 3.11 |
| 1946 | 3.04781218 | 0.93 | 4.04 |
| 1947 | 1.3777715 | 0.42 | 4.46 |
| 1948 | 12.7418869 | 3.87 | 8.33 |
| 1949 | 9.30144942 | 2.83 | 11.16 |
| 1950 | 4.84057041 | 1.47 | 12.63 |
| 1951 | 8.96105836 | 2.72 | 15.35 |
| 1952 | 0.550644875 | 0.17 | 15.52 |
| 1953 | 1.98817121 | 0.6 | 16.12 |
| 1954 | 11.4541054 | 3.48 | 19.6 |
| 1955 | 2.53151116 | 0.77 | 20.37 |
| 1956 | 6.42728621 | 1.95 | 22.33 |
| 1957 | 8.14833361 | 2.48 | 24.8 |
| 1958 | 1.46830603 | 0.45 | 25.25 |
| 1959 | 1.29674611 | 0.39 | 25.64 |
| 1960 | 10.0863543 | 3.07 | 28.71 |
| 1961 | 4.03392168 | 1.23 | 29.94 |
| 1962 | 7.60492488 | 2.31 | 32.25 |
| 1963 | 10.54472139 | 3.21 | 35.45 |

| Q15 | Freq. | Percent | Cumulative Percent |
|---|---|---|---|
| 1964 | 12.2118266 | 3.71 | 39.16 |
| 1965 | 14.30379091 | 4.35 | 43.51 |
| 1966 | 7.65839568 | 2.33 | 45.84 |
| 1967 | 22.1889382 | 6.74 | 52.58 |
| 1968 | 10.198818 | 3.1 | 55.68 |
| 1969 | 1.11117051 | 0.34 | 56.02 |
| 1970 | 12.00261659 | 3.65 | 59.67 |
| 1971 | 2.22521773 | 0.68 | 60.35 |
| 1972 | 2.75979206 | 0.84 | 61.18 |
| 1973 | 12.05605129 | 3.66 | 64.85 |
| 1974 | 3.40031766 | 1.03 | 65.88 |
| 1975 | 10.4544393 | 3.18 | 69.06 |
| 1976 | 2.76773814 | 0.84 | 69.9 |
| 1977 | 5.06276673 | 1.54 | 71.44 |
| 1978 | 9.774746662 | 2.97 | 74.41 |
| 1979 | 3.85749973 | 1.17 | 75.58 |
| 1980 | 11.1293337 | 3.38 | 78.97 |
| 1981 | 1.704603674 | 0.52 | 79.48 |
| 1982 | 4.385268823 | 1.33 | 80.82 |
| 1983 | 2.78065366 | 0.85 | 81.66 |
| 1984 | 13.4307986 | 4.08 | 85.75 |
| 1985 | 0.6845865 | 0.21 | 85.95 |
| 1986 | 2.32661944 | 0.71 | 86.66 |
| 1987 | 5.98357601 | 1.82 | 88.48 |
| 1988 | 2.29331421 | 0.7 | 89.18 |
| 1989 | 8.12466529 | 2.47 | 91.65 |
| 1990 | 0.98396444 | 0.3 | 91.94 |
| 1991 | 0.962745574 | 0.29 | 92.24 |
| 1992 | 0.629406093 | 0.19 | 92.43 |
| 1993 | 3.80622767 | 1.16 | 93.59 |
| 1994 | 7.68842692 | 2.34 | 95.92 |
| 1995 | 0.29518932 | 0.09 | 96.01 |
| 1996 | 0.859969613 | 0.26 | 96.27 |
| 1997 | 6.14318834 | 1.87 | 98.14 |
| 1998 | 1.36330092 | 0.41 | 98.56 |
| 2001 | 0.290259182 | 0.09 | 98.64 |
| Missing | 4.46240036 | 1.36 | 100 |
| *Total* | *329* | *100* | |

| Q16 | Freq. | Percent | Cumulative Percent |
|---|---|---|---|
| 1 | 313.670578 | 95.34 | 95.34 |
| 2 | 5.45708684 | 1.66 | 97 |
| Missing | 9.8723348 | 3 | 100 |
| *Total* | *329* | *100* | |

| Q17a | Freq. | Percent | Cumulative Percent |
|---|---|---|---|
| Missing | 329 | 100 | 100 |
| *Total* | *329* | *100* | |

| Q17b | Freq. | Percent | Cumulative Percent |
|---|---|---|---|
| 1 | 5.77040758 | 1.75 | 1.75 |
| Missing | 323.229592 | 98.25 | 100 |
| *Total* | *329* | *100* | |

| Q17c | Freq. | Percent | Cumulative Percent |
|---|---|---|---|
| 1 | 1.69057619 | 0.51 | 0.51 |
| Missing | 327.309424 | 99.49 | 100 |
| *Total* | *329* | *100* | |

| Q17d | Freq. | Percent | Cumulative Percent |
|---|---|---|---|
| Missing | 329 | 100 | 100 |
| *Total* | *329* | *100* | |

| Q17e | Freq. | Percent | Cumulative Percent |
|---|---|---|---|
| 1 | 301.1354 | 91.53 | 91.53 |
| Missing | 27.86457 | 8.47 | 100 |
| *Total* | *329* | *100* | |

| Q17f | Freq. | Percent | Cumulative Percent |
|---|---|---|---|
| 1 | 4.63993341 | 1.41 | 1.41 |
| Missing | 324.360067 | 98.59 | 100 |
| *Total* | *329* | *100* | |

| Q17_specify | Freq. | Percent | Cumulative Percent |
|---|---|---|---|
| | 326.5538513 | 99.26 | 99.26 |
| American/NYOB | 0.050585009 | 0.02 | 99.27 |
| Doesn't Matter | 0.067449517 | 0.02 | 99.29 |
| European | 0.066206887 | 0.02 | 99.31 |
| European/ American | 0.006150371 | 0 | 99.31 |
| Hispanic | 0.893990544 | 0.27 | 99.59 |
| Humans, People, Earthlings | 0.08692009 | 0.03 | 99.61 |
| Italian/Southern European | 0.570842145 | 0.17 | 99.79 |
| Middle Eastern | 0.04957331 | 0.02 | 99.8 |

| Q17_specify | Freq. | Percent | Cumulative Percent |
|---|---|---|---|
| Polish, Irish, Slovenian | 0.620689509 | 0.19 | 99.99 |
| Why Does It Matter | 0.033741321 | 0.01 | 100 |
| *Total* | *329* | *100* | |

| Q18 | Freq. | Percent | Cumulative Percent |
|---|---|---|---|
| 1 | 4.97862701 | 1.51 | 1.51 |
| 2 | 20.3752626 | 6.19 | 7.71 |
| 3 | 103.557481 | 31.48 | 39.18 |
| 4 | 93.7122933 | 28.48 | 67.67 |
| 5 | 93.2239724 | 28.34 | 96 |
| Missing | 13.1523635 | 4 | 100 |
| *Total* | *329* | *100* | |

| Q19 | Freq. | Percent | Cumulative Percent |
|---|---|---|---|
| 1 | 13.9969713 | 4.25 | 4.25 |
| 2 | 5.72833636 | 1.74 | 6 |
| 3 | 18.1299508 | 5.51 | 11.51 |
| 4 | 20.4721055 | 6.22 | 17.73 |
| 5 | 42.765065 | 13 | 30.73 |
| 6 | 81.42122586 | 24.75 | 55.48 |
| 7 | 82.4757779 | 25.07 | 80.54 |
| 8 | 42.0623832 | 12.78 | 93.33 |
| Missing | 21.948184 | 6.67 | 100 |
| *Total* | *329* | *100* | |

## Appendix C: Methods for Reweighting Mail Respondents

The first step in reweighting methods was to identify key variables that influence people's recreation response to marine debris on beaches. To estimate the relationship between explanatory variables and the effect of marine debris on an individual's recreation trips, we began with a logistic demand equation that is frequently used in recreation applications (Train, 2003). Individual $i$'s trips $y_i$ are given by:

$$y_i = K \times 1/\left(1 + e^{\theta_i}\right) \tag{C1}$$

$K$ is a scalar that converts the logistic function that follows it from a number between zero and one into a demand function that can describe any quantity of trips less than $K$. The constant $e$ generates the exponential function. $\theta_i$ is the variable the determines the value of the logit expression and will later be defined in specific terms. We set $K$ to equal 500 so that it was comfortably larger than the highest demand of 365 trips for any respondent in our data that further increases in $K$ did not change the results. Since each respondent's baseline number of trips, $t_i$, is known from the survey, we can rearrange the demand equation to show that under baseline beach conditions, with no change in debris:

$$e^{\theta_i} = (K - t_i)/t_i \tag{C2}$$

We can then represent an individual's demand after a change in beach quality as:

$$y_{i\Delta} = K \times e^{\Delta_i}/(e^{\Delta_i} + (K - t_i)/t_i) \tag{C3}$$

Here $e^{\theta_i}$ has been replaced with $(K - t_i) / t_i$, and $\Delta_i$ has been introduced to represent the perceived quality change to individual $i$ from a change in debris. We specify $\Delta_i$ for a reduction in debris to almost none ($n$) as:

$$\Delta_{in} = \beta_{a_i n} + \beta_x x_i \tag{C4}$$

The term $\beta_{a_i n}$ is a constant representing the average effect on demand of a reduction to almost no debris, and is specific to the study area $a$ where individual $i$ was intercepted at the beach. The term $\beta_x x_i$ represents individual-specific deviations from the average, in which $\beta_x$ are coefficients and $x_i$ are characteristics of individual $i$. We represent individual $i$'s perceived quality change for a doubling of debris ($d$) as:

$$\Delta_{id} = \beta_{a_i d} - \beta_x x_i \tag{C5}$$

These expressions allow us to interpret a positive $\beta_{an}$ as the average perceived increase in quality from a reduction of debris in area $a$ and a negative $\beta_{ad}$ as the average perceived decrease in quality from a doubling of debris in area $a$. Given the addition in the first expression and subtraction in the second expression, it is also possible to consistently interpret a positive coefficient $\beta_x$ to mean that $x$ is positively associated with a concern for marine debris. This is because in each case a positive coefficient augments the size of the estimated constant. For example, if the starting point for $\Delta_{in}$ is a positive constant $\beta_{an}$, then $\Delta_{in}$ becomes more positive when $\beta_x$ is positive and $x_i$ is increasing. Likewise, if the starting point for $\Delta_{id}$ is a negative constant $\beta_{ad}$, then $\Delta_{id}$ becomes more negative if $\beta_x$ is positive and $x_i$ is increasing.

The final demand equations used in estimation are:

$$y_{in} = K\frac{e^{\beta_{a_i n}+\beta_x x_i}}{e^{\beta_{a_i n}+\beta_x x_i}+(K-t_i)/t_i} \quad \text{(C6)}$$

$$y_{id} = K\frac{e^{\beta_{a_i d}-\beta_x x_i}}{e^{\beta_{a_i d}-\beta_x x_i}+(K-t_i)/t_i} \quad \text{(C7)}$$

Using a Poisson estimator and defining $t_{in}$ and $t_{id}$ to be $i$'s trips with almost no debris and a doubling of debris, respectively, the likelihood function is:

$$L(\beta; x, t) = \prod_i \left(\frac{e^{-y_{in}} y_{in}{}^{t_{in}}}{t_{in}!}\frac{e^{-y_{id}} y_{id}{}^{t_{id}}}{t_{id}!}\right)^{w_{ib}} \quad \text{(C8)}$$

The base weights $w_{ib}$ are the mail-survey base weights derived in Section 2.3.1.

There were eight attitudinal or demographic variables included in $x_i$. Since the goal was to detect the presence of an effect for each variable rather than a detailed characterization of the effect, all eight variables were expressed in a simple binary form for the purpose of model estimation. The eight variables were:

- Age = 1 if the respondent was 50 years old or older
- Education = 1 if the respondent had a bachelor's degree or higher
- Children in household = 1 if there were children in the respondent's household
- Female = 1 if the respondent was female
- Debris is a problem = 1 if the respondent answered "yes" to the question whether debris was a problem on local beaches
- Parking = 1 if the respondent gave a rating of "4" or "5" for the importance of free or inexpensive parking
- Not crowded = 1 if the respondent gave a rating of "4" or "5" for the importance of beaches not being crowded
- No debris = 1 if the respondent gave a rating of "5" for the importance of no debris on beaches.

Different break points were tested for each variable to find the binary specification with the greatest effect. The model was estimated using the maximum likelihood procedure in Aptech Gauss 12 software.

Table C-1 shows the results of the contingent behavior model. The sample includes all 329 completed mail surveys, with a breakout by region as presented in Table 1 of the report. The model coefficients have no intuitive interpretation apart from the way the sign and magnitude of the coefficients affect predicted demand. The constants representing the average effect of the two scenarios show the expected sign for all four study areas, with positive constants indicating an increase in trips when debris is reduced to almost none and negative constants indicating a decrease in trips when debris is doubled. The constants are larger for a doubling of debris than for a reduction in debris, consistent with the larger change in debris in the first scenario than in the second. Three of the four constants for a reduction in debris are not statistically significant at the 5% level, with *p* values greater than 0.05. However, we are not using the model to estimate the effects of the scenarios; the sampling-based estimates for the effect of the changes in debris reported in Table 4 of the report in fact have quite narrow confidence intervals.

**Table C-1. Results of the contingent behavior model**

| Variable | Coefficient | Standard error | *p* value |
|---|---|---|---|
| **Debris reduced to almost none** | | | |
| Constant – Alabama | 0.174 | 0.104 | 0.094 |
| Constant – Delaware/Maryland | 0.174 | 0.110 | 0.113 |
| Constant – Ohio | 0.381 | 0.093 | 0.000 |
| Constant – Orange County, California | 0.156 | 0.098 | 0.110 |
| **Doubling of debris** | | | |
| Constant – Alabama | -0.465 | 0.110 | 0.000 |
| Constant – Delaware/Maryland | -0.316 | 0.113 | 0.005 |
| Constant – Ohio | -0.524 | 0.100 | 0.000 |
| Constant – Orange County, California | -0.325 | 0.102 | 0.001 |
| **Demographic and attitudinal variables[a]** | | | |
| Age ≥ 50 | -0.230 | 0.046 | 0.000 |
| Education ≥ bachelor's | 0.101 | 0.039 | 0.010 |
| Children in household | -0.080 | 0.049 | 0.104 |
| Female | -0.055 | 0.041 | 0.183 |
| Debris is a problem on local beaches | 0.129 | 0.040 | 0.001 |
| Importance of "parking is free or inexpensive" | -0.017 | 0.046 | 0.711 |
| Importance of "not crowded" | -0.008 | 0.044 | 0.863 |
| Importance of "no debris" | -0.017 | 0.046 | 0.713 |

a. Coefficients apply to both scenarios but with opposite signs, so that positive coefficients indicate a positive association with effects in both scenarios: a larger increase in trips for a reduction of debris to almost none, and a larger reduction in trips for a doubling of debris.

To help evaluate the performance of the contingent behavior model, we provide the total percentage change in trips implied by the model for each scenario in each study area, which are similar to the final estimates in Table 4. The model estimates for a decline in debris to almost none are 8.8% in Alabama, 6.6% in Delaware/Maryland, 38.8% in Ohio, and 8.2% in Orange County, California. The model estimates for a doubling of debris are -29.3% in Alabama; -17.1% in Delaware/Maryland; -36.5% in Ohio; and -19.6% in Orange County, California.

The purpose of the contingent behavior model is to identify the characteristics or attitudinal variables that most influence people's answers to the debris scenarios. Only three of the explanatory variables are statistically significant: age, education, and the response to the question of whether marine debris is a problem on beaches in a given study area. In the case of age, those at least 50 years old had a lower than average response to debris, reflected in the negative coefficient of -0.230. Those with a bachelor's degree or higher had a higher than average response to debris, reflected in the positive coefficient of 0.101. Those who answered "yes" to the question whether marine debris is a problem on local beaches had a higher than average response to debris, indicated by the positive coefficient of 0.129.

## Adjusting Sampling Weights Using Key Variables

The overall response rate for the onsite survey was 76.7%. Some onsite respondents did not provide their address, and some who provided their address did not return the mail survey that was sent to them. As a result, the overall response rate for the mail survey, which accounts for nonresponse at every stage of the study, was 19.0%. A common way to test and correct for potential nonresponse bias is to reweight the final mail-survey observations so that the proportions of reweighted mail-survey respondents with given key demographic characteristics match the proportions for the analogous groups of respondents in the onsite survey. This is a form of post-stratification described in Little (1993).

Table C-2 shows the onsite and mail survey percent frequencies for the four demographic variables that were included in both the onsite survey and the mail survey: age, education, whether there are children in the respondent's household, and the respondent's gender. Table C-2 also shows the percent frequencies for the question about whether debris is a problem on beaches in the area. Two attitudinal variables that were asked in both the onsite and mail surveys about the importance of crowding and free parking at beaches, are not shown in Table C-2 because they were not found to be associated with a response to marine debris.

**Table C-2. Onsite and mail survey percent frequencies showing mail survey over- and under-representation[a]**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Alabama** | | | | | | | | |
| Age | Value | 18 to 25 | 26 to 35 | 36 to 45 | 46 to 55 | 56 to 65 | 65+ | Missing |
| | Onsite | 16% | 22% | 15% | 20% | 19% | 8% | 1% |
| | Mail | 6% | 9% | 8% | 27% | 36% | 14% | 1% |
| Education | Value | < H.S. | H.S. | Some Col. | Bach. | Grad. | | Missing |
| | Onsite | 1% | 24% | 33% | 28% | 14% | | 0% |
| | Mail | 2% | 10% | 27% | 36% | 24% | | 1% |
| Children in household | Value | No | Yes | | | | | Missing |
| | Onsite | 60% | 34% | | | | | 7% |
| | Mail | 87% | 13% | | | | | 0% |
| Gender | Value | Male | Female | | | | | Missing |
| | Onsite | 43% | 56% | | | | | 0% |
| | Mail | 41% | 59% | | | | | 1% |
| Debris a problem[b] | Value | No | Yes | No | Not sure | | | Missing |
| | Onsite | 60% | 40% | | | | | 0% |
| | Mail | | 36% | 45% | 19% | | | 0% |
| **Delaware and Maryland** | | | | | | | | |
| Age | Value | 18 to 25 | 26 to 35 | 36 to 45 | 46 to 55 | 56 to 65 | 65+ | Missing |
| | Onsite | 7% | 21% | 22% | 28% | 11% | 11% | 0% |
| | Mail | 5% | 6% | 17% | 25% | 16% | 28% | 1% |
| Education | Value | < H.S. | H.S. | Some Col. | Bach. | Grad. | | Missing |
| | Onsite | 0% | 9% | 33% | 43% | 11% | | 4% |
| | Mail | 3% | 16% | 28% | 19% | 33% | | 2% |
| Children in household | Value | No | Yes | | | | | Missing |
| | Onsite | 78% | 22% | | | | | 0% |
| | Mail | 69% | 31% | | | | | 0% |
| Gender | Value | Male | Female | | | | | Missing |
| | Onsite | 47% | 51% | | | | | 2% |
| | Mail | 29% | 70% | | | | | 1% |

**Table C-2. Onsite and mail survey percent frequencies showing mail survey over- and under-representation[a]**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Debris a problem[b] | Value | No | Yes | No | Not sure | | | Missing |
| | Onsite | 68% | 18% | | | | | 6% |
| | Mail | | 33% | 41% | 25% | | | 0% |
| **Ohio** | | | | | | | | |
| Age | Value | 18 to 25 | 26 to 35 | 36 to 45 | 46 to 55 | 56 to 65 | 65+ | Missing |
| | Onsite | 8% | 10% | 27% | 21% | 23% | 11% | 0% |
| | Mail | 2% | 9% | 23% | 15% | 26% | 22% | 4% |
| Education | Value | < H.S. | H.S. | Some Col. | Bach. | Grad. | | Missing |
| | Onsite | 1% | 20% | 25% | 36% | 18% | | 1% |
| | Mail | 0% | 7% | 41% | 29% | 20% | | 4% |
| Children in household | Value | No | Yes | | | | | Missing |
| | Onsite | 39% | 53% | | | | | 4% |
| | Mail | 65% | 35% | | | | | 0% |
| Gender | Value | Male | Female | | | | | Missing |
| | Onsite | 45% | 54% | | | | | 1% |
| | Mail | 53% | 44% | | | | | 3% |
| Debris a problem[b] | Value | No | Yes | No | Not sure | | | Missing |
| | Onsite | 36% | 64% | | | | | 0% |
| | Mail | | 64% | 15% | 21% | | | 0% |
| **Orange County, California** | | | | | | | | |
| Age | Value | 18 to 25 | 26 to 35 | 36 to 45 | 46 to 55 | 56 to 65 | 65+ | Missing |
| | Onsite | 6% | 20% | 26% | 23% | 17% | 7% | 1% |
| | Mail | 2% | 17% | 16% | 15% | 35% | 14% | 0% |
| Education | Value | < H.S. | H.S. | Some Col. | Bach. | Grad. | | Missing |
| | Onsite | 0% | 13% | 35% | 28% | 24% | | 0% |
| | Mail | 0% | 7% | 28% | 20% | 44% | | 2% |
| Children in household | Value | No | Yes | | | | | Missing |
| | Onsite | 46% | 52% | | | | | 0% |
| | Mail | 66% | 34% | | | | | 0% |
| Gender | Value | Male | Female | | | | | Missing |
| | Onsite | 50% | 46% | | | | | 4% |
| | Mail | 58% | 42% | | | | | 0% |
| Debris a problem[b] | Value | No | Yes | No | Not sure | | | Missing |
| | Onsite | 51% | 49% | | | | | 0% |
| | Mail | | 55% | 20% | 23% | | | 2% |

a. Dark gray and light gray show, respectively, over-representation and under-representation by at least five percentage points in mail survey responses relative to onsite survey responses. Attitudinal variables involving crowded beaches and inexpensive parking are available from both the onsite and mail surveys but are excluded from the table because they are not related to marine debris and were not found to be associated with a response to marine debris in the contingent behavior model. For the demographic variables "children in household" and "gender," over- and under-representation are not highlighted because these variables were not found to be associated with a response to marine debris in the contingent behavior model.
b. The variable "debris a problem" refers to the question, "Do you think garbage or marine debris is a problem [on beaches in your local area]?" The mail survey elicited one of three responses: "yes," "no," or "not sure." The onsite survey elicited only a "yes" or "no" response.

In Table C-2, age is grouped into 6 categories, divided at age 25, 35, 45, 55, and 65. Education is divided into five categories, including those with less than a high school degree, those with a high school degree, those with some college but no bachelor's degree, those with a bachelor's degree, and those with a graduate degree. The categories for whether a household has children are “yes” and “no,” and the categories for gender are “male” and “female.” The categories for whether debris is a problem are “yes” and “no” for the onsite survey and “yes,” “no,” and “not sure” for the mail survey. Given the option of “not sure” included in the mail survey, we do not view the “no” response category as comparable in the two surveys. They are therefore separated into different columns in the table. The frequencies for the onsite survey and mail survey are both weighted using the onsite weights, so that measured differences between the two surveys reflect differences in representation of demographic groups rather than differences in sampling weights.

Cells shaded in light gray show under-representation in the mail survey relative to the onsite survey by at least five percentage points for the three key variables. This threshold was chosen as a reasonable way to highlight the most significant areas of divergence between the two surveys. Cells shaded in dark gray show over-representation by at least five percentage points.

To illustrate the selection of categories for reweighting, we use as examples age and education in Alabama. The first 3 age categories, including respondents aged less than or equal to 25, respondents aged 26 to 35, and respondents aged 36 to 45, are under-represented in the mail survey by at least five percentage points. The remaining three categories, including those aged 46 to 55, 56 to 65, and older than 65, are all over-represented by at least five percentage points. Representativeness could be improved by increasing the sampling weights for the first 3 groups and decreasing the sampling weights for the last three groups. For reweighting, we therefore combine the first 3 groups into a single category of those aged 45 or under and we combine the last 3 groups into a single category of those aged 46 or older. Aggregating into just two categories helps reduce variation in the size of the weighting adjustments and in the variance of the final weights.

In the case of education, Alabama respondents with a high school diploma or with some college but not a bachelor’s degree are under-represented in the mail survey by at least five percentage points. Those with a bachelor’s degree or a graduate degree are over-represented by at least five percentage points. We therefore combine the first two groups and the second two groups, respectively. The remaining group, those without a high school degree, is quite small and is unlikely to significantly affect the adjusted weights or final weighted results. For simplicity, we combined it with the two other groups without a bachelor’s degree to form two weighting categories: those with less than a bachelor’s degree and those with a bachelor’s degree or higher.

Based on a similar review of all variables in Table C-2, we chose to reweight by three variables (age, education, and debris is a problem) in all four regions, with one exception: for Ohio, the percentage of people who viewed marine debris as a problem was the same in the onsite survey and mail survey, and remained nearly the same after reweighting by age and education. Although the discrepancy in Alabama for the debris question was less than 5 percentage points (Table C-2), this diverged to more than 5 percentage points after reweighting by age and education, so all three variables were ultimately used in the adjustment.

The selection of variables for reweighting leads to the definition of “cells” used in the reweighting. Each variable was divided into two categories so that there were two cells for *n* variables. For example, if age were the only variable used, and respondents were divided into those age 45 or younger and those over 45, then there would be two cells. If the mail survey proportions for these two cells are 0.5 and 0.5 and the onsite survey proportions are 0.25 and

0.75, then the base weights for mail respondents in the first cell would each be reweighted by a factor of 0.25/0.5 and the base weights for mail respondents in the second cell would each be reweighted by 0.75/0.5. If the education variable were also used, with a division into those without a bachelor's degree and those with a bachelor's degree, there would now be four cells: "age ≤ 45" and "education < bachelor's degree"; "age > 45" and "education < bachelor's degree"; "age ≤ 45" and "education ≥ bachelor's degree"; "age > 45" and "education ≥ bachelor's degree."

The final adjustments involved reweighting by eight cells in Alabama, Delaware/Maryland, and Orange County, California; and by four cells in Ohio as follows:

- In Alabama, every combination of "age ≤ 45" or "age > 45," "education < bachelor's degree" or "education ≥ bachelor's degree," and "problem = yes" or "problem ≠ yes" formed one of eight cells.
- In Delaware/Maryland, every combination of "age ≤ 55" or "age > 55," "education = either high school or graduate school" or "education ≠ either high school or graduate school," and "problem = yes" or "problem ≠ yes" formed one of eight cells.
- In Ohio, every combination of "age ≤ 55" or "age > 55" and "education = some college" or "education ≠ some college" formed one of four cells.
- In Orange County, California, every combination of "age ≤ 55" or "age > 55," "education < graduate degree" or "education = graduate degree," and "problem = yes" or "problem ≠ yes" formed one of eight cells.

Due to an oversight, the question asking whether marine debris was a problem at area beaches was not asked in exactly the same way in the onsite and mail surveys. The mail survey included the option to choose "not sure" while this option was not offered to onsite respondents. One might therefore expect that both the "yes" and "no" categories would be overstated in the onsite survey relative to the mail survey, all else equal. This suggests that upward reweighting of "yes" responses in the mail survey to match "yes" responses in the onsite survey could lead to bias and would not be appropriate. In all cases described above, the proportion of respondents answering "yes" in the mail survey was weighted down to match the onsite survey. Although "yes" responses for the mail survey in Alabama initially appeared low, as shown in Table C-2, once the responses were reweighted by age and education, the reweighted frequency of "yes" responses was 45%, or five percentage points higher than the onsite frequency. This means that including the debris variable in the reweighting procedures for Alabama was appropriate, because it ultimately led to a downward reweighting of the variable relative to a procedure that only used age and education.

## Appendix D: Detailed Methods of Economic Impacts Model

In this appendix, we present additional technical details of the economic impacts model.

### D.1 Converting Visitor Spending into Producer Value

We used type II final demand multipliers from the U.S. Bureau of Economic Analysis's Regional Input-Output Modeling system (RIMS II). Type II multipliers are used to measure the economic impact of industry and household expenditures. These multipliers estimate the economic input using the *producer's value,* which excludes distribution costs such as transportation costs and wholesale and retail trade margins, but includes excise taxes collected and paid by producers (U.S. BEA, 2018). Producer values are calculated from expenditures using ratios from the RIMS II national distribution cost tables (Rebecca Bess, BEA, personal communication, August 20, 2009). Our analysis includes two expenditure categories that map to industries where we convert the consumer value (i.e., the visitor expenditures) into a producer value:

- Auto fuel costs are mapped into industry "petroleum and coal products manufacturing"
- Grocery and convenience stores are mapped into industry "food and beverage and tobacco product manufacturing."

Applying the ratios from the national accounts table, we assume 10.7% of the expenditures on auto fuel and 15.6% of expenditures on grocery and convenience stores flow into the local economy. These ratios are multiplied by the RIMS II multiplier for each of these industries.

### D.2 Expenditure and Multiplier Tables

In Table D-1, we present the expenditures by category included in our analysis as final demand changes. We report the expenses by category for marine-debris related activities, weighted by participation in each activity. Table D-2 presents final RIMS multipliers used in this study.

**Table D-1. Daily visitor expenditures by category[a]**

| Expenditure category | RIMS II industry | Daily expenditures | | | |
|---|---|---|---|---|---|
| | | Alabama | Delaware and Maryland | Ohio | Orange County, California |
| Auto fuel cost | 24 Petroleum and coal products manufacturing | $26.15 | $19.31 | $19.89 | $18.69 |
| Auto rental cost | 36 Transit and ground passenger transportation | $3.77 | $0.55 | $2.48 | $3.00 |
| Bus, taxi, etc. | 36 Transit and ground passenger transportation | $5.09 | $1.40 | $3.55 | $4.50 |
| Parking, beach fees, etc. | 63 Other services[a] | $1.48 | $2.35 | $1.71 | $1.54 |
| Lodging | 61 Accommodation | $39.33 | $27.77 | $27.07 | $24.86 |
| Vacation package | ½ accommodation – ½ amusements | $0.69 | $1.01 | $0.85 | $0.57 |
| Restaurants, bars, etc. | 62 Food services and drinking places | $45.32 | $31.71 | $30.95 | $26.13 |
| Grocery, convenience stores | 19 Food and beverage and tobacco product manufacturing | $16.54 | $7.87 | $9.69 | $8.71 |

**Table D-1. Daily visitor expenditures by category[a]**

| Expenditure category | RIMS II industry | Daily expenditures | | | |
|---|---|---|---|---|---|
| | | Alabama | Delaware and Maryland | Ohio | Orange County, California |
| Viewing whale, wildlife watching boat fees | 38 Other transportation and support activities[a] | $0.14 | $0.07 | $0.20 | $0.38 |
| Viewing rental fees for sailboat, etc. | 34 Water transportation | $0.04 | $0.00 | $0.17 | $0.15 |
| Water contact rented equipment, gear for snorkeling, etc. | 60 Amusements, gambling, and recreation | $0.00 | $0.00 | $0.00 | $0.33 |
| Water contact rented equipment, gear for surfing, etc. | 60 Amusements, gambling, and recreation | $0.00 | $0.00 | $0.00 | $0.24 |
| Water contact rented equipment, gear for kayaking, etc. | 60 Amusements, gambling, and recreation | $0.00 | $0.00 | $0.00 | $0.32 |
| Outdoor rented equipment, gear for activities like biking, hiking, etc. | 60 Amusements, gambling, and recreation | $0.00 | $0.02 | $0.04 | $0.07 |
| Outdoor rented equipment, gear for games like volleyball, frisbee, etc. | 60 Amusements, gambling, and recreation | $0.00 | $0.00 | $0.00 | $0.00 |
| Outdoor horseback riding fees | 60 Amusements, gambling, and recreation | $0.00 | $0.00 | $0.00 | $0.00 |
| **Total daily expenditures** | | **$138.55** | **$92.06** | **$96.61** | **$89.49** |

a. Source: NOAA (2012), using average expenditures for all recreators (see Section 4.1). Average expenditures are weighted by participation in four marine-debris impacted recreation activities (see Section 4.1).

**Table D-2. RIMS II final demand multipliers[a]**

| RIMS II industry/Economic sector | Output multiplier | Earnings multiplier | Jobs multiplier (for $1 change in final demand) | Value added multiplier |
|---|---|---|---|---|
| **Alabama** | | | | |
| 24 Petroleum and coal products manufacturing | 1.4877 | 0.268 | 0.0000051560 | 0.5459 |
| 29 Food and beverage stores (retail) | 1.7498 | 0.5798 | 0.0000231406 | 1.1119 |
| 34 Water transportation | 1.969 | 0.3968 | 0.0000092139 | 0.8125 |
| 36 Transit and ground passenger transportation | 2.0576 | 0.7027 | 0.0000323946 | 1.0328 |
| 38 Other transportation and support activities | 1.96 | 0.6468 | 0.0000163615 | 1.1381 |
| 60 Amusements, gambling, and recreation | 1.7889 | 0.5289 | 0.0000253024 | 1.0243 |
| 61 Accommodation | 1.6311 | 0.4604 | 0.0000173756 | 1.0023 |
| 62 Food services and drinking places | 1.7268 | 0.528 | 0.0000251495 | 0.9466 |
| 63 Other services | 1.8773 | 0.6108 | 0.0000188710 | 1.0651 |

**Table D-2. RIMS II final demand multipliers[a]**

| RIMS II industry/Economic sector | Output multiplier | Earnings multiplier | Jobs multiplier (for $1 change in final demand) | Value added multiplier |
|---|---|---|---|---|
| **Delaware and Maryland** | | | | |
| 24 Petroleum and coal products manufacturing | 1.26 | 0.1855 | 0.0000026361 | 2.6361 |
| 29 Food and beverage stores (retail) | 1.5187 | 0.4403 | 0.0000144831 | 0.9824 |
| 34 Water transportation | 1.4677 | 0.2614 | 0.0000047682 | 0.5756 |
| 36 Transit and ground passenger transportation | 1.5729 | 0.5601 | 0.0000298866 | 0.7994 |
| 38 Other transportation and support activities | 1.5734 | 0.5612 | 0.0000125574 | 0.9317 |
| 60 Amusements, gambling, and recreation | 1.4961 | 0.3305 | 0.0000114617 | 0.8561 |
| 61 Accommodation | 1.4534 | 0.3625 | 0.0000102803 | 0.9024 |
| 62 Food services and drinking places | 1.5902 | 0.4425 | 0.0000177161 | 0.8637 |
| 63 Other services | 1.5851 | 0.5198 | 0.0000146296 | 0.9137 |
| **Ohio** | | | | |
| 24 Petroleum and coal products manufacturing | 1.2881 | 0.183 | 0.0000027883 | 0.4114 |
| 29 Food and beverage stores (retail) | 1.8588 | 0.5221 | 0.0000199355 | 1.1662 |
| 34 Water transportation | 2.0162 | 0.3485 | 0.0000075218 | 0.834 |
| 36 Transit and ground passenger transportation | 2.1424 | 0.6069 | 0.0000286231 | 1.0656 |
| 38 Other transportation and support activities | 1.9707 | 0.5665 | 0.0000128953 | 1.1291 |
| 60 Amusements, gambling, and recreation | 1.823 | 0.4023 | 0.0000138182 | 1.0336 |
| 61 Accommodation | 1.783 | 0.4491 | 0.0000147213 | 1.0835 |
| 62 Food services and drinking places | 1.9485 | 0.5206 | 0.0000219974 | 1.0616 |
| 63 Other services | 2.013 | 0.5873 | 0.0000168018 | 1.1316 |
| **Orange County, California** | | | | |
| 24 Petroleum and coal products manufacturing | 1.2504 | 0.1718 | 0.0000021136 | 0.4067 |
| 29 Food and beverage stores (retail) | 1.7644 | 0.4838 | 0.0000145975 | 1.1273 |
| 34 Water transportation | 1.7721 | 0.2929 | 0.0000051666 | 0.7484 |
| 36 Transit and ground passenger transportation | 1.9323 | 0.5405 | 0.0000206913 | 1.0001 |
| 38 Other transportation and support activities | 1.7736 | 0.4772 | 0.0000097029 | 1.0415 |
| 60 Amusements, gambling, and recreation | 1.6984 | 0.3996 | 0.0000132521 | 0.9679 |
| 61 Accommodation | 1.7498 | 0.427 | 0.0000107093 | 1.0762 |
| 62 Food services and drinking places | 1.8616 | 0.4874 | 0.0000170229 | 1.0307 |
| 63 Other services | 1.9649 | 0.5613 | 0.0000135477 | 1.1214 |

a. Data source: U.S. BEA, 2019.