Estimating Lost Recreational Use Value of Visitors to Northwest Florida from the Deepwater Horizon Oil Spill using a Single Site Model with Cancelled Trips[1]

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Estimating Lost Recreational Use Value of Visitors to Northwest Florida from the Deepwater Horizon Oil Spill using Revealed and Stated Preference Data

Abstract. The lost recreational use values from the BP/Deepwater Horizon oil spill in the Gulf of Mexico that began April 20, 2010 were evaluated for cancelled recreational trips to Northwest Florida. The impacts were calculated using the travel cost method (TCM) for a single site with primary data collected from surveys and household population estimates from the U.S. Census. The primary data were collected August-September 2011 with respondents residing in 13 U.S. states that constitute the primary market for coastal tourism to Northwest Florida. The survey gathered information from 1633 respondents on their recreational visits to Northwest Florida, including detailed information on their past trips and the number of trips cancelled to the study region due to the oil spill. The empirical analysis involves the estimation of a number of models including random parameters negative binomial count data demand functions. Using these models we find significant preference heterogeneity surrounding the effects of the oil spill. Aggregate damages are estimated to be $174 million.

Introduction

The *BP/Deepwater Horizon* oil spill in the Gulf of Mexico began on April 20, 2010 and was officially designated a spill of national significance on April 29, 2010. While the primary leak was contained in July, the wellhead was not officially capped until early September. Reports from the National Incident Command indicate that 4.9 million barrels of oil were spilled into the Gulf of Mexico, which is over 19 times the amount of oil spilled by the *Exxon Valdez* in Alaska in 1989, making it the worst oil spill in U.S. history. Oil from the *BP/Deepwater Horizon* oil spill was observed in coastal areas of Northwest Florida from Pensacola to Panama City. Huffaker et al. (2012) present a study of the economic damages of the BP/DWH spill to Florida residents. The study includes estimates of lost passive use values, lost recreational use values and economic impacts. The lost recreational use values are estimated with single-site and multiple-site travel cost recreation demand models (Whitehead, Haab and Larkin 2012). In this paper we present updated estimates from the single-site models. In particular, we estimate random parameter models and aggregate damages over the entire NW Florida market region.

There are only a few published studies that estimate recreational damages from oil spills. Hausman, Leonard and McFadden (1995) use data on recreational fishing and boating, hunting and hiking trips collected before and after the 1989 Exxon Valdez oil spill and multiple site random utility and intensity models.[2] Their estimate of the recreational damages from the Exxon Valdez oil spill is $3.8 million for 1989. Chapman and Hanemann (2001) use benefit transfer methods to estimate damages from the 1990 American Trader

[2] See Parsons (2016) for an introduction to various types of recreation demand models.

oil spill in California. They estimated the damages to be $12 million (see also Deacon and Kolstad, 2002). The travel cost method (RUM) was used to estimate the lost economic value to nearby residents from a 1993 oil spill in Tampa Bay that closed coastal beaches and forced residents to go elsewhere for recreation (Bell, 2002). The economic damages were estimated to be $3.98 million. Alvarez et al. (2014, 2015a) use recreational fishing data and a mixed logit random utility model and estimate that the welfare loss by combining welfare losses and lost trips from the BP/Deepwater Horizon oil spill. Damages range from $41 million to $585 million depending on the geographical distribution of the sites affected by the spill with a best estimate of $78 million.[3]

In contrast to these studies we use the single-site travel cost method and combine revealed preference survey data on trips taken and cancelled trips. We combine these in a quasi-panel with cancelled trips added to trips taken in a counterfactual no oil spill scenario. This approach is similar to single-site studies that combine revealed and stated preference data to estimate the effects of changes in cost or environmental conditions on recreational trips (Whitehead et al. 2008, Simões, Barata, and Cruz. 2013). We compare a random parameters negative binomial demand model (Hynes and Greene 2015) to a number of alternatives. This paper is the first to estimate recreational losses from an oil spill with primary data on cancelled trips. In the rest of this paper we describe the survey methods, data, econometric results and aggregation of damages.

Market Area

For this study, the area of Northwest Florida includes the 12 coastal counties of

[3] See also Train (2015) and Alvarez et al. (2015b).

Escambia, Santa Rosa, Okaloosa, Walton, Bay, Gulf, Franklin, Wakulla, Jefferson, Taylor, Dixie, and Levy (Figure 1). Two sources of data were used to determine the domestic market area for recreational visitation to the study region. The first, from *VISIT FLORIDA*®, provides the geographic distribution of domestic overnight visitors by state to each of eight defined "Florida Vacation Regions," two of which include the Northwest Florida study region. The second, from the Marine Recreational Fisheries Statistics Survey (MRFSS) program, provides the geographic distribution of marine (saltwater) recreational fishermen who were intercepted at sites in the study region. Both sources of data reflect visitation in 2007-2009. Results from each source were considered in the determination of the market area for purposes of administering a survey because each is flawed with respect to determining the market for saltwater-based recreation to the study region,[4] but are the only secondary information sources available.

VISIT FLORIDA ® is the official tourism marketing corporation for the state of Florida, which publishes an annual comprehensive overview of visitation to the state each year. The *2009 Florida Visitor Study* includes a profile of domestic visitors to Florida overall and by region within the State. The information is obtained from sources including enplanement data at Florida's 14 major airports, *OAG/BACK* Aviation Data, *TNS TravelsAmerica*, and surveys by D.K. Shifflet and Associates. The Study provided information on the share of non-Florida resident visitors that stayed overnight in the study region. Table 3-1 shows the data for states that accounted for at least one percent of visitors in 2009.

[4] The *VISIT FLORIDA*® data contains information on non-coastal counties and the MRFSS data is characterized by avidity bias.

The MRFSS program is administered by the National Marine Fisheries Service and the resulting angler data is considered the best available information for estimating the annual activity of marine recreational fishermen. The MRFSS uses a combination of dockside interviews and follow-up telephone and mail surveys to collect recreational harvest information. Using the intercept data from 2009, the most recent year available, the geographic distribution of visitors was determined. The top 12 non-Florida states in 2007-2009 for general visitation (not shown) resulted in a total of 17 states, all of which were included in the recreational fishing list. Restricting the market area to these common 12 states resulted in the elimination of California, New Mexico, Michigan, Pennsylvania, and South Carolina. Removing these states from the 2009 general visitor totals leaves the 12 states accounting for 87.6 percent of non-Florida overnight visitors, which is consistent with the 88.8 percent of marine anglers. Despite the limitations of each independent data source, the data and market areas were near identical. In general, the market area is comprised of southern states and extends north to Indiana, Illinois and Ohio.

Note that the market area may account for no more than 89 percent of domestic visitors according to the secondary sources used, which means the resulting loss estimates from all households in the market area will underestimate the total recreational use losses to U.S. residents from the closure of Florida recreational sites as a result of the *BP/Deepwater Horizon* oil spill.

Survey Development and Implementation

Survey questionnaires were developed based on the investigators' experience with past recreational visitor surveys. Surveys were pre-tested with 145 respondents to assure that questions were clear and meaningful. The survey gathered information on past visitation to coastal destinations, saltwater-based recreational activities, details on their past trip to the study region and trip cancellations due to the oil spill, opinions about the quality of waterfront resources post-spill and respondent information. A copy of the questionnaire is provided in Appendix A.

To better define the study region and refine the analysis, the 12-county NWFL area was subdivided into five regions: Pensacola, Ft. Walton Beach, Panama City, Port St. Joe, and the Central Gulf Coast. The regions were defined by counties as shown in Figure 1. The target population of the survey was non-institutionalized adults age 18 and over residing in Georgia, Alabama, Tennessee, Louisiana, Texas, Missouri, Mississippi, Kentucky, Arkansas, Ohio, Indiana, Illinois, and Florida who had visited the Northwest Florida coast in the past 24 months, or canceled at least one trip to the Gulf of Mexico since June 1, 2010 due to the oil spill. Information on other coastal destinations is important for evaluating the impacts on recreational trips intended for Northwest Florida. To limit the scope of the analysis, the alternative destinations on which detailed information was gathered was restricted to 11 coastal regions in the Southeastern U.S.

The survey was implemented via the Internet by Knowledge Networks Inc. (KN), under contract with the University of Florida. For this study, survey respondents were drawn from a sample of households residing in the 13 states from the KN *KnowledgePanel*®, a probability-based panel designed to be representative of the United States. These respondents were supplemented by KN with email invitations sent through another firm that manages online panels. KN provided weighting factors that reflect each respondent's representativeness in the overall sample based on their socio-demographic information. In particular, three weights were used in the study: (1) a base weight to offset known deviations from a pure equal probability sample design in the selection process, (2) a panel demographic post-stratification weight to adjust for survey error in the panel, and (3) a study-specific post-stratification weight to adjust for the study's sample design and non-response.

The survey was conducted from August 12 through September 24, 2011. Each respondent's eligibility for the full survey was determined by a series of screening questions at the beginning of the questionnaire. Eligible participants completed the survey in a median time of 14 minutes. To enhance survey response rates, KN emailed reminders to non-responders. The response rate was 79.3 percent for KN panelists. This relatively high response rate is expected when using KN due to their agreements with their panelists, who are only invited to participate in 4 to 6 surveys each month and, once invited, are expected to respond. Those that did not respond (i.e., 'click' to begin the survey), made the decision irrespective of the content of the survey since the email invitations were generic. The response rate for non-panelists could not be obtained per the agreement between KN and their contracting firms; however, KN generated unique weights for all respondents, including the opt-ins such that the resulting sample data is representative of the targeted population.

Of the 15,014 individuals that began the survey, 2,181 (14.5%) were considered to be "qualified," that is, were either past or potential recreational visitors to the Northwest Florida study region. These qualified respondents constitute the full sample and are divided into two groups: (1) respondents who reported visiting the study region in the past two years (group 1: "past visitors," N = 1,835 or 84.1%), and (2) respondents who had not visited the study region in the past two years but reported cancelling at least one "planned trip" (where some arrangements had to be cancelled) to the Gulf or South Atlantic because of the oil spill (group 2: "cancellers only," N = 346 or 15.9%). In this study, visits refer to any trips that involved saltwater-related recreation including day trips and trips involving one or more nights away from home.

Respondents in group 1 were asked additional questions about their past trips to the region. Respondents in both groups 1 and 2 were questioned about planned trips to the region that they cancelled (since June 1, 2010) due to the *BP/Deepwater Horizon* oil spill. The June 1, 2010, cut-off was selected to be a conservative start date since it would exclude the Memorial Day weekend and was at least a month after the spill began.

Travel Cost Method

Recreational user values represent the non-market, or intangible, benefit of an activity. These types of economic values and changes in these values in particular, are legally considered compensable losses to responsible parties. In order to determine the recreational value of saltwater-related recreational experiences in Northwest Florida, and how they may have been affected by the *BP/Deepwater Horizon* oil spill, it is useful to first define some principles of economic theory. In general, it is challenging to assign a monetary value to recreation since the benefits vary between users and the methodologies that can be used to measure these benefits are often expressed in different units (Parsons, forthcoming). For example, some users may benefit from the health effects while others are simply interested in enjoying the view. Using dollars as a standard unit of recreational value has the positive attribute of relying on the concept of consumer surplus, which provides a conceptual basis that is standard among market goods.

The underlying principle of the TCM is that the costs individuals (consumers) incur to take a recreational trip can be used as a proxy for the "price" of the recreational opportunities at the site (Parsons, forthcoming). These costs reflect only the cost of access to the site, which means that only the costs associated with the transportation to and from the site, and the value of their time during the transport, are included. The TCM assumes that consumers' willingness-to-pay these travel expenses can be estimated from the number of trips taken at different travel costs. This approach is comparable to estimating the demand for any market good or service based on the quantities demanded (sold) to consumers at different prices.

Application of the TCM requires administering a detailed survey to visitors and conducting an analysis of the data. The survey needs to obtain - at a minimum - information on the distance between an individual's home and the site, the number of trips per year, the transportation expenses, and income and employment information. This information is used to calculate travel costs and estimate the relationship between the number of visits and travel costs in order to create a demand function for the typical visitor.

There are many advantages to the TCM including that it uses revealed preference data, however, there are several notable limitations. The limitations of the TCM include that: (1) the TCM can only be used to measure values associated with recreational use, (2) the site being valued must draw visitors from a wide geographic range to get differences in numbers of trips and travel costs, (3) the omission of substitute recreational sites may bias estimates of a site in a single-site TCM analysis[5], (4) if the recreational experience was part of a multipurpose trip, then the TCM will over-value the site, and (5) defining and measuring the value of time is important but complex (how do you value the time of a child or a retiree?).

Since trip cost is always included as one of the characteristics, the model implicitly captures tradeoffs between money and other site characteristics. This revealed trade off with money makes the economic valuation possible. The tradeoffs are easy to see in a simple example. If individuals are observed traveling to distant recreation sites to obtain better "site quality" such as nicer amenities or better fishing, they are implicitly revealing something about the value of quality by passing by the nearer sites of lower quality. They willingly incur a higher trip cost to obtain more "site quality." By the same reasoning, if individuals choose not to travel to more distant sites, they also reveal implicit values. With a variety of sites located at different distances from individuals' homes (giving variation in

[5] If there are substitute recreational sites, or site quality is important, then the choices that recreationists make may be needed to accurately evaluate (value) alternative sites. The random utility model (RUM), or multiple site travel cost model, attempts to explain the choice of a recreational site for a trip. This choice is assumed to depend on the characteristics of the sites and to reveal preferences for those characteristics, that is, how individuals implicitly tradeoff one site characteristic for another in their choices.

trip cost) and with many characteristics, it is possible to reveal implicit values for the characteristics of the sites and even the sites themselves.

For comparison, while the single site travel cost approach focuses on the number of trips recreationists make to a given site each year, a random utility model focuses on the choices recreationists make over a range of alternatives. The main advantage of the RUM is its use of observable market information, like the traditional TCM, but the RUM also shares many of the disadvantages of travel cost methods (e.g., sensitivity to choice of demand function specification and calculation of travel costs).

Data Summary

Using the single-site framework, a number of distinct analyses are conducted to assess the robustness of the estimates and ensure comparability of results. This analysis begins with use of the single-site travel cost method (TCM) with the most restricted (truncated) sample, those respondent households that took a trip to the study region since the oil spill, and then adds data from those that took trips prior but cancelled trips after the spill. Between models, the distinct characteristics of the data sets are described.

The single-site TCM is used to estimate recreation demand functions. In the single-site model, recreational trips to a specific site over a given period of time (e.g., per year) represents the quantity demanded and the travel cost to that site is considered the *implicit own-price*. While the linear demand function shown in Figure 1 depicts an inverse relationship between the implicit own price and the quantity demand, suggesting the own-price is the only explanatory variable that affects quantity demanded, when estimating the function it is typical to include other variables in the demand model. In this study, we begin by including the following three additional variables: a measure of the travel cost to a substitute site (i.e., the *implicit cross-price*), a measure of site quality, and respondent income for the purpose of accounting for the effect of income on demand (i.e., the *income elasticity*). Assuming just two sites, the model of demand for recreational trips becomes: $x_1 = x(p_1, p_2, q_1, y)$, where x_1 is the number of trips to Northwest Florida, p_1 is the travel cost to Northwest Florida, p_2 is the travel cost to a substitute site, q_1 is quality at the Northwest Florida site they last visited and y is income.

In order to employ the TCM we first need estimates of the travel cost (p_1 and p_2 in the previous equation). In particular, we need the cost for each respondent to travel to the site they visited and then we need an estimate of the costs they would have incurred to travel to each alternative site (i.e., the implicit own and cross price variables, respectively). Since we are interested only in the travel costs, we only need to include two measures: the money cost of travel and the opportunity cost of travel time. Both measures in the travel cost equation are calculated using the distance travelled from the mid-point of household i's home zip code to the midpoint of the coast in the j^{th} destination: $tc_{ij} = cd_{ij} + \gamma w_i \left(\frac{d_{ij}}{mph}\right)$,

where c is the cost per mile, d_{ij} is round trip distance; $0 < \gamma < 1$ is a fraction of the hourly wage rate, w_i, in order to account for the cost of leisure time; *mph* is miles per hour; $i = 1, \ldots,$ N respondent households; and $j = 1, \ldots, 11$ sites.

The cost per mile estimate, use $c = \$0.1736$, includes only variable costs associated with driving a passenger vehicle (American Automobile Association, 2010; Hake et al., forthcoming).[6] The opportunity cost of time is set at one-third of the wage rage, γ = 0.33, in order to account for the disutility of driving time (Parsons, forthcoming). The average driving distance covered per hour of travel (mph = miles/hour) is set to 50. The average of 50 miles per hour is based on a trip from Atlanta, GA to Destin, FL with two 20 minute stops (http://www.mapquest.com). The wage rate is the reported annual household income divided by 2,000 hours ($/hour).

The sites included in this study are all Gulf of Mexico and South Atlantic coastal states. The coastal areas in these states offer similar amenities to the Northwest Florida study region. This region was also included in the secondary data sources defining the market area. To facilitate the empirical analysis, the number of sites was limited. In particular, each non-Florida state was considered a separate site because within each state the coastal areas are similar. To isolate effects on the study region, the state of Florida was divided into four main sites: Northwest Florida (study region), Southwest Florida, the Florida Keys, and the Florida Atlantic Coast. Each of these sites is distinct overall with respect to several site characteristics including the nature of the beach area (color, consistency, slope and depth), coastal vegetation, and fishing opportunities (species and seasonality).

The single-site TCM analysis is conducted with the 84.14 percent of surveyed households that are considered to be "past visitors" (group 1). The average number of trips for those who took a trip to Northwest Florida over the past two years was 3.11 (N = 1835). At least one trip to the study region was taken by 85 percent of these respondents since

[6] Whitehead, Haab and Larkin (2012) use IRS mileage rates which are available at: http://www.irs.gov/taxpros/article/0,,id=156624,00.html.

June 1, 2010. The average number of trips to the study region since June 1, 2010 was 2.35 (N = 1518). Past visitors who reported a trip to the study region since June 1, 2010 (over a month after the spill began and after the Memorial Day weekend) were then asked about the number of trips they cancelled due to the oil spill. Fifteen percent (N = 231) reported cancelling a Gulf of Mexico trip. Of these, 40 percent (N = 92) reported that Northwest Florida was the intended destination for the cancelled trip. The average number of cancelled trips is 3.02 (N = 91) with a minimum of one and a maximum of 48 cancelled trips. For the sole respondent who reported cancelling a trip but did not report the number cancelled we impute one trip, which is a conservative assumption. With this additional observation, the average number of cancelled trips is 3.00 (N = 92). We deleted 46 household observations with missing zip code (N = 16) or household income (N = 30) information.[7] We are left with a sample of 1,518 households of which 6 percent (N = 88) cancelled trips to the study region due to the oil spill.

In the simulated scenario, households report that they would have taken an average of 2.50 trips without the oil spill (Table 1).[8] With the oil spill, the average number of trips is 2.35. We test for the difference in number of reported trips with and without the oil spill with a random effects linear regression model and no other covariates (explanatory variables). The 0.15 difference in average number of trips with and without the oil spill (2.50 – 2.35) is statistically significant at the p = 0.01 level.

[7] Also, in order to first conduct a consistent comparison with the corresponding CVM analysis, we delete those who did not answer the willingness-to-pay and follow-up certainty questions (N = 2).
[8] The data summaries are weighted.

The calculated travel cost to the nearest of five Northwest Florida sub-regions is $228. The calculated travel cost to the households' nearest alternative site (Texas through North Carolina) is $173. Seventy-one percent took trips with more nights away from home than days (at least one overnight trip). Average annual household income is $58,530. Of the households that visited the study region, 73 percent rated the quality of the site as very good or excellent on a 5-point Likert type scale (i.e., poor, fair, good, very good, excellent).

Of the group 2 "cancellers only" with zip code and income information (N = 324), 35 percent (N = 115) report planning to visit and participate in saltwater-related activities in Northwest Florida. Of these, 82 percent (N = 94) report cancelling an average of 1.30 trips to Northwest Florida with a range of one to five cancelled trips. For those who reported cancelling a trip but did not report the number cancelled trips (N=21), we impute one trip, which is a conservative assumption. The average number of cancelled trips for the sample of cancellers to Northwest Florida is 1.24 trips (Table 2). The calculated travel cost to the nearest of five Northwest Florida sub-regions is higher than in the sample without those who cancelled all of their trips, $269 compared to $228. The calculated travel cost to the households' nearest alternative site (Texas through North Carolina) is $179. Average annual household income is $55,310 compared to $58,530. For those households that cancelled all of their planned Northwest Florida trips we code the overnight variable as 1 and the site quality variable as 0 (not very good or excellent).

Econometric Model

With these data we create a pseudo-panel of respondent households with a simulated time period without the oil spill to represent pre-spill conditions and one with the oil spill to represent post-spill conditions. We next estimate the determinants of trips with the negative binomial count data demand model with information on pre- and post-spill trips. The trips variable are in the form of non-negative integers, or counts. Consider a count valued random variable, x_i, drawn from the set of non-negative integers: $x_i \in \{0,1,2,3,\ldots\}$. Assuming x_i is drawn from a Negative Binomial distribution, the probability density function for x_i is: $Pr(x_i = x) = \frac{\Gamma\left(x+\frac{1}{\alpha}\right)}{\Gamma(x+1)\Gamma\left(\frac{1}{\alpha}\right)}\left(\frac{\frac{1}{\alpha}}{\frac{1}{\alpha}+\lambda_i}\right)^{\frac{1}{\alpha}}\left(\frac{\lambda_i}{\frac{1}{\alpha}+\lambda_i}\right)^{x}$, where α and λ are distributional parameters to be estimated and Γ(z) is the incomplete gamma function, $\Gamma(z) = \int_0^\infty y^{z-1}e^{-y}\,dy$ (Haab and McConnell 2002). The parameter λ_i is the non-negative expected value of the Negative Binomial distribution, $E(x_i) = \lambda_i$. Covariates are typically incorporated into the Negative Binomial regression model through an exponential parametric mean specification: $\lambda_i = e^{z_i\beta}$. The estimates coefficient estimates, β, from the Negative Binomial are thus interpreted the same any exponential regression function: as the semi-elasticity effects of the associated covariate on the expected value of the dependent variable. That is, the estimated $\beta's$ are the estimated percentage changes in the expected value of the dependent variable due to a unit change in the corresponding covariate.

In addition to coefficient estimates, Negative Binomial regression routines will also provide maximum likelihood estimates of the additional distributional parameter, α. Referred to as the dispersion parameter, α can be interpreted loosely as the count data equivalent of a variance parameter. For the Negative Binomial distribution above, the variance of the dependent variable, x_i, is: $V(x_i) = \lambda_i(1 + \alpha\lambda_i)$. For $\alpha > 0$, the variance of the dependent variable exceeds the expected value, $V(x_i) > \lambda_i$. In such a case, the dependent variable is said to exhibit overdispersion. For $\alpha < 0$, $V(x_i) < \lambda_i$ and the dependent variable is said to exhibit underdispersion. If $\alpha = 0$, then the variance and expectation are identical and the dependent variable is equi-dispersed.

The special case where the dependent variable is equi-dispersed (equal mean and variance) is important because it highlights a common mistake in estimating count data models. While not obvious, if $\alpha = 0$, the Negative Binomial distribution collapses to the much simpler Poisson distribution: $Pr(x_i = x) = \frac{e^{-\lambda_i}\lambda_i^x}{x!}$. The Poisson model if oft-applied to count data for its presumed simplicity, but in practice, it is rare to find cases where the presumption of equidispersion, $\alpha = 0$, is valid. Much more often, at least in our experience, revealed and stated preference count data is overdispersed and the Poisson is misspecified—resulting in inconsistent estimates of the parameters of interest.

For the Negative Binomial models the parameter vector β is assumed to be constant across individuals. Imposing preference homogeneity may result in a mis-specified demand function and inaccurate estimates of the value of changes in the independent variables. To allow for preference heterogeneity, we will assume that individual preferences randomly vary according to a prespecified population distribution such that: $\beta = \tilde{\beta} + \gamma\eta$, where $\tilde{\beta}$ is an unknown, but constant locational parameter for preferences, η is an individual random error component for preferences that can take on a number of distributions and γ is the estimated scale factor. The model is estimated by maximum simulated likelihood. The simulations are Halton sequences with 500 draws.

Empirical Results

The data analysis for the sample that had either taken or planned and cancelled a trip to NWFL since June 1, 2010 is presented in Table 3. The model includes all of the variables in Tables 2 and 3 and an oil spill variable equal to one for actual trips scenario (OILSPILL = 1) and zero for simulated trips scenario (OILSPILL = 0). We also include an interaction term between the overnight variable (NIGHTS) and the own-price (TC). This variable is intended to capture longer trips that would be multiple purpose. Attributing all of the consumer surplus of a multiple purpose trip to the value of saltwater beach recreation would bias the damage estimates upwards.

We first present a Negative Binomial model estimated on the sample who took trips to NWFL. The own-price (TC) coefficient is negative and statistically significant. Demand is inelastic with an own-price elasticity of -0.82.[9] The cross-price (SUBTC) coefficient has a positive effect on trips, indicating that the alternative site is a substitute, with a cross-price elasticity of 0.26. Income has a positive effect on trips, indicating that Northwest Florida beach trips are normal goods, with an elasticity of 0.27. The coefficient on the dummy variable for multiple night trips is negative and the travel cost interaction coefficient is positive. Respondents who took multiple night trips take 76% fewer trips and have more inelastic demand functions. Households that considered their most recently visited site to have very good or excellent quality took 15% more trips.

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[9] Elasticity in the Poisson model is estimated as: $e_z = \beta_z^* z$, where z is the mean of the independent variable.

The random parameters negative binomial model is estimated with normal distributions for the random parameters.[10] In initial estimations the scale factors for the travel cost and substitute site travel cost are not statistically significant so we estimate these as fixed coefficients. The mean of the own-price coefficient is negative and statistically significant. Demand is inelastic with an own-price elasticity of -0.76. The mean of the cross-price coefficient has a positive effect on trips with a cross-price elasticity of 0.28. The mean of the income is positive with an elasticity of 0.19. The mean coefficient on the dummy variable for multiple night trips is negative and the mean of the travel cost interaction coefficient is positive. Respondents who took multiple night trips take 66% fewer trips and have more inelastic demand functions. Households that considered their most recently visited site to have very good or excellent quality took 23% more trips.

The estimated scale factors (i.e., standard deviations) for income, quality and the oil spill scenario indicate significant preference heterogeneity. The coefficient of variation, $CV = \gamma/\beta$, is 0.59 for income. Ninety-five percent of the individual income elasticities fall between -0.03 to 0.41. The coefficient of variation is 1.04 for quality which indicates that about 16% of respondents who consider the beach on their last trip to have at least very good quality take fewer trips. Ninety-five percent of the quality effects fall between -25% and 71%. The coefficient of variation is 2 for the oil spill scenario. Ninety-five percent of the oil spill effects on trips falls between -70% and 42%. In contrast, while the scale parameter

[10] Alternative distributions were explored with the uniform and triangular distributions providing usable estimates. But, the normal distribution outperformed these others statistically.

for overnight trip variable is statistically significant the standard deviation relative to the mean is relatively small.

Consumer surplus per trip in a log-linear regression is equal to the negative inverse of the coefficient on the travel cost variable, $CS/trip = -1/\beta_{TC}$ (Haab and McConnell, 2002; Parsons, forthcoming). Total consumer surplus for each household is the product of trips and consumer surplus per trip, $CS = -x/\beta_{TC}$. Consumer surplus per trip estimates are presented in Table 5. The consumer surplus per trip for each household is calculated at $276 in the negative binomial model for one night trips and $391 including the price effect for multiple night trips. The consumer surplus per trip for each household is calculated at $301 in the random parameter negative binomial model for one night trips and $492 including the price effect for multiple night trips. The effect of the oil spill on consumer surplus per trip is -$43. In other words, avoiding the oil spill would have increased consumer surplus by $43 for each trip taken to NWFL.

Two sensitivity analyses have been conducted. First we estimate the models with a cost per mile and opportunity cost per time estimates that are at upper end of the range of estimates that found in the literature by Hang et al. (2016). The cost per mile used is 0.566 and the opportunity cost of time is 50% of the wage rate. Using this variable in the random parameters Negative Binomial model the consumer surplus per trip is $691 and cost of the oil spill is $100 per household. We also consider the sensitivity of the model estimates to different distributional assumptions for the random parameters. Using a uniform distribution (and the low estimate of travel cost) the consumer surplus per trip is $309 and cost of the oil spill is $53 per household. Using a triangular distribution the consumer surplus per trip is $284 and cost of the oil spill is $17 per household.

Aggregate Damages

There are two approaches to aggregation. First, considering only trips taken to the study area, the consumer surplus per trip could be applied to the trips lost to the spill. His is potentially biased as respondents who choose not to take trips to the study area after the oil spill may be different than those who continue to take trips. Second, employing the counterfactual scenario with cancelled trips, the consumer surplus loss due to the oil spill could be applied to the population of the NWFL market.

The 13 states included in the survey sample constitute approximately 90 percent of the domestic market for visitors to Northwest Florida as explained previously. These states had 44 million households in 2010 (U.S. Census Bureau, 2011). 14.5% of 44 million households were "qualified" having taken a trip to the Gulf of Mexico or South Atlantic in the past 24 months. Seventy-five percent of the qualified households took or cancelled at least one trip to NWFL since June 1, 2010. The population for aggregation is 4.82 million households.

Of this sample of households the average number of trips to NWFL is 2.19 with the oil spill and 2.41 without the oil spill. The aggregate estimate of cancelled trips is 1.06 million, a 9% reduction. Using the consumer surplus per trip from the negative binomial model ($275), the aggregate damage estimate from the oil spill is $292 million with a 95% confidence interval of $252 and $332 million. Applying the change in consumer surplus due to the oil spill ($43) the aggregate loss is $207 million with a 95% confidence interval $114 and $302 million. Using the higher travel cost variable the aggregate damage estimate would rise to $482 million. Using the uniform and triangular distributions the aggregate damage estimate would be $82 million and $255 million, respectively.

Conclusions

The use of a revealed preference economic valuation approach and assumptions about variables and the data sample allowed us to estimate a range of lost recreational use values from the *BP/Deepwater Horizon* oil spill. The use of multiple techniques, statistical tests of differences and comparisons of confidence intervals all help to ensure the robustness and validity of the results presented. In summary, the estimates derived using the single-site TCM that uses both revealed preference and cancelled trip information generated lost recreational use value of between $82 and $482 million with a "best" estimate of $207 million. The lost recreational use value estimates presented in this study are conservative estimates for several reasons: The aggregate damage estimate may be too low because it only includes the loss due to trips that were planned but cancelled. It does not include: (1) a reduction in trips to NWFL that may have been considered but never planned, (2) cancelled future trips to NWFL and (3) the consumer surplus loss does not include lower quality trips that were taken during 2010.

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Figure 1. Map of study region that includes 12 coastal counties in Northwest Florida

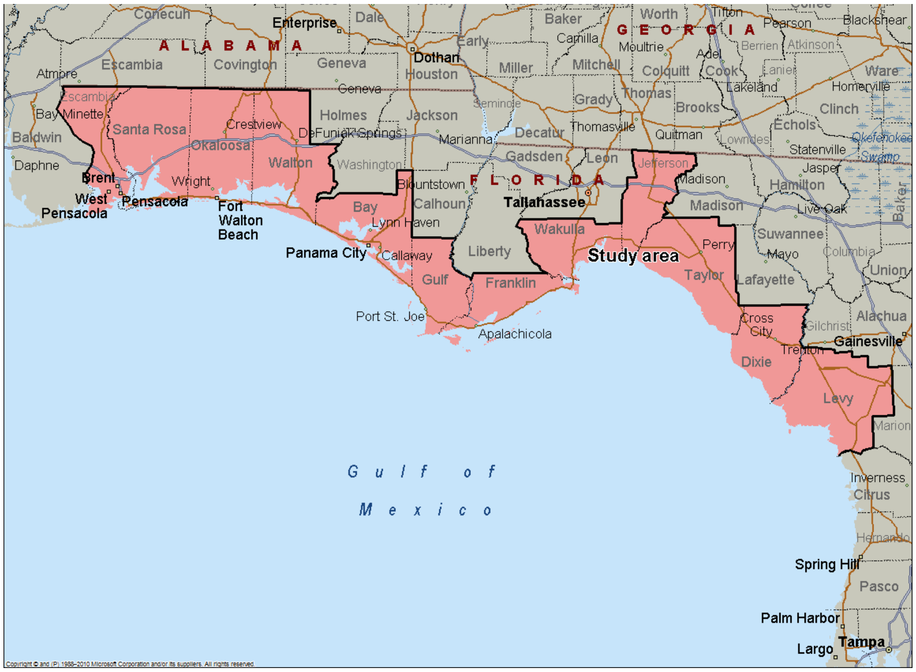

Figure 2. The 11 coastal regions for saltwater-based recreation in the Southeastern U.S. used in the study (7 states and 4 regions in Florida)

Figure 3. Representation of an individual's expenditures and consumer surplus for recreational trips to site i if the cost per trip were $C*

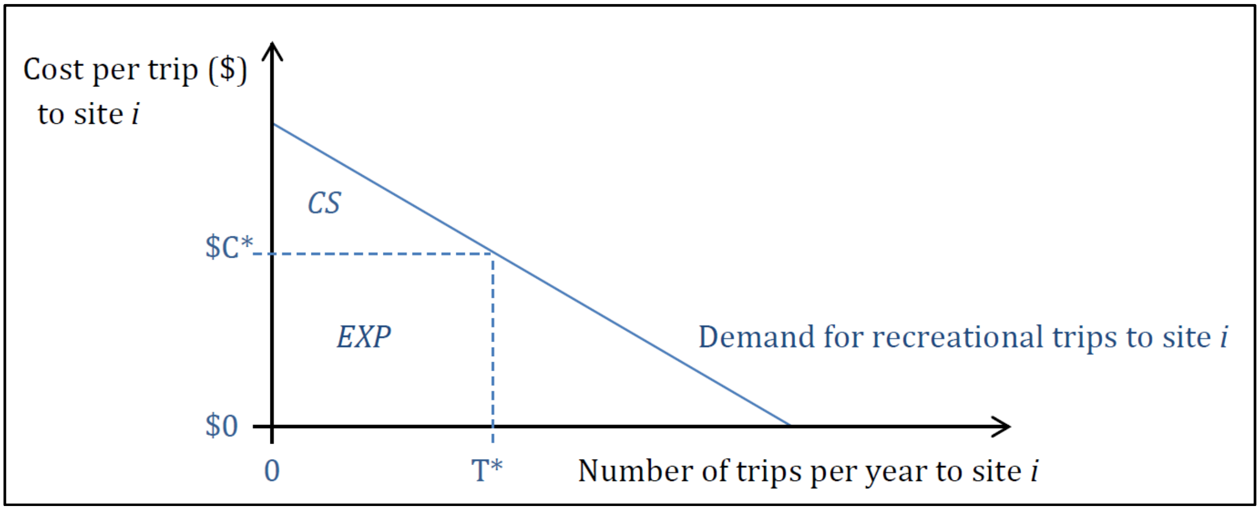

Table 1. TCM variable descriptions for the restricted sample of "past visitors" with a post-spill trip to the study area

		Variable statistics (N = 1518)			
Variable	Description	Mean	Std.Dev.	Min.	Max.
TRIPS0	Trips without oil spill (number)	2.50	4.72	1	49
TRIPS1	Trips with oil spill (number)	2.35	4.46	1	49
TC	Travel cost to NWFL ($)	227.95	190.69	1.11	1355
SUBTC	Substitute site travel cost ($)	172.54	161.34	0.11	1118
OVERNIGHT	1 if Nights > Trips	0.71		0	1
INCOME	Household income ($1,000)	58.53	40.14	2.50	175
QUALITY	1 if NW FL site quality is "excellent" or "very good"	0.73		0	1

Table 2. TCM variable descriptions and statistics for the restricted sample of "cancellers only" that cancelled their only planned trip(s) to the study area post-spill

		Variable statistics (N = 115)			
Variable	Description	Mean	Std. Dev.	Min.	Max.
TRIPS0	Trips without oil spill (number)	1.30	0.66	1	5
TRIPS1	Trips with oil spill (number)	0	0	0	0
TC	Travel cost to NW FL ($)	268.90	199.41	20.98	961
SUBTC	Substitute site travel cost ($)	179.38	147.69	0.57	797
NIGHTS	1 if Nights > Trips	1	0	1	1
INCOME	Household income ($1,000)	55.31	38.44	2.50	175.00
EXCELLENT	1 if NW FL site quality is "excellent" or "very good"	0	0	0	0

Notes: The sample of "cancellers only" in this table reflects qualified respondents that cancelled what would have been their only trip(s) to the study region since the oil spill. NW FL represents "Northwest Florida." For the dichotomous variable "EXCELLENT" the alternative category is 0 for "otherwise." All "cancellers only" are assumed to consider the site to be not of excellent quality with the oil spill, hence, they did not visit.

Table 3. Recreation demand models (dependent variable is trips per household, TRIPS)

Variables	Negative Binomial		Random Parameters Negative Binomial			
	Coefficient	t-stat	Mean Coefficient	t-stat	Standard Deviation	t-stat
Constant	1.44	23.79	1.11	25.12	0.45	31.40
TC	-0.0036	-14.46	-0.0033	-17.65		
SUBTC	0.0015	5.45	0.0016	8.37		
NIGHTS	-0.76	-15.87	-0.66	-17.59	0.04	1.94
TC × NIGHTS	0.0011	5.83	0.00099	6.61		
INCOME	0.0045	7.38	0.0032	7.83	0.0019	8.72
QUALITY	0.15	3.94	0.23	6.72	0.24	13.90
OILSPILL			-0.14	-4.45	0.28	13.95
α	0.59	17.09	4.14	16.84		
LLF	-3133		-6079			
McFadden's R^2	0.27		0.67			
Cases (N)	1518		1633			
Time periods	1		2			

Notes: TRIPS represents both TRIPS0 and TRIPS1, corresponding to the two time periods.

Table 4. Estimates of consumer surplus (CS) per trip

	Model 1: Negative Binomial		Model 2: Random Parameters	
CS/trip	Mean	Std. Err.	Mean	Std. Err.
One night trip	275.57	19.05	300.80	17.04
One+ night trips	390.90	37.90	429.04	32.29
Oil spill (0 to 1)			-43.16	9.99