Center for Natural Hazards Research
Thomas Harriot College of Arts and Sciences
East Carolina University
A 113 Brewster Bldg. • Greenville, NC 27858
Tel: (252) 328-5718 • Fax: (252) 328-6743
www.ecu.edu/hazards • hazardcenter@ecu.edu

Measuring the Economic Impacts of Sea-Level Rise on Marine Recreational Shore Fishing in North Carolina

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John C. Whitehead

Professor of Economics, Appalachian State University, Boone, North Carolina 28608, whiteheadjc@appstate.edu

Chris Dumas

Associate Professor of Economics, University of North Carolina at Wilmington, Wilmington, North Carolina 28403, dumasc@uncw.edu

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Abstract

In this study we develop estimates of the economic effects of climate change-induced sea level rise on marine recreational shore fishing in North Carolina. We estimate the relationship between angler behavior and spatial differences in beach width using Marine Recreation Fishing Statistics Survey and geospatial data. We exploit this relationship by simulating the effects of sea level rise on beach width and beach width on angler behavior. We find that impacts on anglers' economic welfare are potentially substantial, ranging up to a present value of $1.29 billion over 75 years, using conservative estimates of fishing participation growth and a 2% discount rate. In addition, the present value of lost business sales, labor income, capital income, and state and local tax revenue in coastal North Carolina due to reduced angler spending amount to $828 million, $307 million, $130 million, and $63 million, respectively, resulting in the loss of over 500 jobs.

Keywords: marine recreational fishing, travel cost method, climate change, sea level rise

Introduction

Rapid economic growth in the coastal zone in the last few decades has resulted in larger populations and more valuable coastal property. However, coastal development is exposed to considerable risk as sea level is projected to rise 0.18 to 0.59 meters over the next century (Intergovernmental Panel on Climate Change 2007) creating potential problems for the coastal economy. In this study we estimate the economic impacts of sea level rise on marine recreational shore fishing in North Carolina. This research offers a unique integration of geospatial data and economic models of the coastal economy.

North Carolina was chosen as the case study primarily due to its economic vulnerability to climate change, especially sea level rise. Coastal North Carolina is located within the relatively low-income eastern region of the state. The coastal tourism market is an important economic sector in this region. Given the barrier island roads and highways that act as barricades in the absence of beach retreat, sea-level rise is expected to result in significant changes in beach width impacting the land that currently hosts beach cottages and beach recreation.

Assessing the benefits of climate change mitigation policy is especially important because the costs of climate change policy are fairly well known. The costs can be measured with observable parts of the economy: changes in market prices, etc. The benefits of climate change policy often occur outside of markets or only indirectly by market prices. Often, when the costs of environmental policy are well known and the benefits are less well known, the costs are given more weight and there is a policy bias towards not doing enough to protect the environment. This research fills one of these knowledge gaps.

The concept of consumer surplus is the basis for the theoretical definition of the economic benefits of climate change mitigation policy. Consumer surplus is the difference between what the consumer is willing (and able) to pay and the market price or cost of the product. Consumer surplus is also called net willingness to pay since it is willingness to pay net of the costs. In the case of marine recreational fishing, if the angler is willing to pay $100 for a fishing trip and the out-of-pocket expenditures are $25 then the consumer surplus is $75. The consumer surplus is the value of the recreation experience to the recreationist, while the out-of-pocket expenditures represent the initial, direct economic impact of the trip on the local beach economy. Hereafter, we refer to consumer surplus as willingness to pay, or WTP.

Estimation of WTP from demand curves is relatively straightforward if market data exist to estimate the demand curves. Without market data, a number of methodologies have been developed to estimate WTP for environmental, and other, non-market goods. The travel cost method is a revealed preference approach that is most often used to estimate the benefits of outdoor recreation. The travel cost method begins with the insight that the major cost of outdoor recreation is the travel and time costs incurred to get to the recreation site. Since individuals reside at varying distances from the recreation site, the variation in distance and the number of trips taken are used to estimate a demand curve for the recreation site. The demand curve can then be used to derive the

WTP associated with using the site. With data on appropriate demand curve shift variables (i.e., independent variables such as beach width), the economic benefits (i.e., changes in WTP) associated with changes in the shift variables (e.g., changes in beach width) can be derived.

Past research on the impact of climate change on outdoor recreational activities in the United States is sparse. Early studies find that precipitation and temperature impacts beach recreation activities (McConnell, 1977, Silberman and Klock, 1988). More recently, Englin and Moeltner (2004) find that temperature and precipitation affects the number of skiing and snowboarding days in expected ways.

Two studies have related the effects of temperature and precipitation on outdoor recreation activities and used these results to model the impacts on WTP of climate change. This research finds that the impacts of climate change on outdoor recreation will be positive. Mendelsohn and Markowsi (1999) consider the effects of changes in temperature and rainfall on boating, camping, fishing, hunting, skiing and wildlife viewing using statewide aggregate demand functions. Considering a range of climate scenarios, the authors find that increased temperature and precipitation increases the aggregate WTP of hunting, freshwater fishing and boating and decreases the aggregate WTP of camping, skiing and wildlife viewing. The net impacts of climate change on aggregate WTP are positive.

Loomis and Crespi (1999) take an approach similar to Mendelsohn and Markowsi (1999) but use different sources and more disaggregate data. They consider the effects of temperature and precipitation on beach recreation, reservoir recreation, stream recreation, downhill and cross-country skiing, waterfowl hunting, bird viewing and forest recreation. Overall, they find that climate change will have positive impacts on the aggregate WTP of outdoor recreation activities. In particular, they consider the impacts of sea level rise on beach recreation and waterfowl hunting. For beach recreation they use the positive relationship between beach length and the number of beach days per month to assess the loss of beaches. The joint effects of increased temperature, increased precipitation and beach loss leads to a positive economic impact. For waterfowl hunting they use the relationship between wetland acres and waterfowl hunting participation and find a negative economic impact with sea level rise.

In contrast to the previous studies, Richardson and Loomis (2004) employ a stated preference approach to estimate the impacts of climate change on WTP for recreation at Rocky Mountain National Park. Stated preference surveys ask outdoor recreation participants for their willingness to pay for climate change or for their hypothetical changes in visitation behavior with changes in climate. Richardson and Loomis' hypothetical scenario explicitly considers the direct effects of climate, temperature and precipitation, and the indirect effects of temperature and precipitation on other environmental factors such as vegetation composition and wildlife populations. Using visitor data, they find that climate would have positive impacts on visitation at the Rocky Mountain National Park.

Stated preference and revealed preference methods can both be used to estimate the impact of sea level rise on marine recreational shore angling. Stated preference surveys would ask anglers for their willingness to pay to avoid a narrower beach or for their hypothetical changes in visitation behavior with changes in beach width. Since sea level rise is a long term process, hypothetical questions may be problematic due to a lack of realism or immediacy. To estimate recreational impacts from sea level rise on beach conditions we follow the methods employed in past revealed preference climate and outdoor recreation research. We estimate the relationship between behavior and spatial differences in beach width. We exploit this relationship by simulating the effects of sea level rise on beach width and beach width on angling behavior.

In particular, we use the random utility model version of the revealed preference travel cost method (Haab and McConnell 2002). In this model it is assumed that individuals choose recreation sites based on tradeoffs among trip costs and site characteristics (e.g., beach width, catch rates). Beach width might affect angling decisions in North Carolina due to the complementary between the use of beach buggies and beach site access. Narrow beaches do not support the transportation of gear and anglers to fishing sites. If anglers make fishing site selections based on beach width then the existing relationship between variation in beach width and fishing site selection can be used to simulate the impact of an eroded beach. We calculate current erosion rates for fishing locations and model projected beach widths. Projected increases in erosion are estimated for the years 2030 and 2080. These erosion rates are then mapped spatially to describe changes in beach width assuming no beach nourishment, barrier island migration or beach retreat.

In addition to the recreation benefits (WTP value) enjoyed by anglers, the monetary expenditures made by anglers during ocean shore fishing trips generate economic impacts in coastal communities in the form of business sales, employment, labor and capital income, and tax revenue for state and local governments. A wide variety of goods and services are purchased by anglers from sporting goods stores, bait and tackle shops, fishing guide services, marinas, automobile service stations, hotels and motels, grocery stores, convenience stores, and restaurants. The economic impacts of these purchases ripple through coastal communities, supporting sales, employment, income, and tax revenues in other industries.

Assessing the benefits of climate change mitigation policy is especially important because the costs of climate change policy are fairly well known. The costs can be measured with observable parts of the economy: changes in market prices, etc. The benefits of climate change policy typically occur outside of markets or only indirectly by market prices. Often, when the costs of environmental policy are well known and the benefits are less well known, the costs are given more weight and there is a policy bias against implementation of environmental policy. This research fills one of these knowledge gaps. This is the first study to consider the economic impacts of climate change induced sea-level rise on marine recreational fishing.

In the rest of this paper we describe the methods used to measure the impacts of sea level rise on beach width. We describe the angler data and the empirical models of angler fishing site selection, trip frequency, willingness to pay, and regional economic impacts. The potential impacts of sea level rise on angler activity, willingness to pay, and the coastal economy are estimated and policy implications are discussed.

Geospatial Data and Analysis*

Thirty-seven fishing locations were identified in this study as important shore fishing locations (Figure 1). The vegetation line for each location was digitized for 1-3 km in either direction of the fishing location (initially identified as a lat/long point) using 2005 USDA National Air Inventory Program photographs. The beach width for the fishing locations was calculated by measuring the distance between the vegetation line and a vectorized 1998 shoreline provided by the North Carolina Division of Coastal Management.

To calculate the erosion rate for each beach we used erosion rate transect data provided by the USGS (Figure 2). These data consist of long and short-term erosion data measured directly from aerial photograph time sequences. Each transect extends from the ocean toward the estuary and with attributes describing erosion. A series of these transects run north to south and capture any spatial variation in the rates of erosion that exist along the shoreline. Transects (separated by approximately 100 meters) were intersected with the vegetation line for a beach to obtain erosion rates. The erosion attributes for each transect were then partitioned according to each beach providing a range of erosion estimates that were then summarized to mean, minimum, maximum, and standard deviation.

The same USGS dataset consisting of transects with erosion attributes was intersect with the fishing location data. The mean erosion rate for all non-nourished (and non-inlet) fishing locations was calculated. We did not use erosion rates from inlets to calculate the mean erosion rate because these locations are exceptionally dynamic and not representative of the entire coastline. Projected changes in beach width were then calculated for the years 2030 and 2080 using percent increase factors (personal communication, Orrin Pilkey).

An assumption is the lack of adaptation in terms of beach nourishment. Each of the beaches that we consider is bordered inland by highways and roads. We assume that beach erosion proceeds to the highway or road and, at that point, the sandy beach has vanished. This is the most extreme assumption but it allows us to estimate of the maximum loss of recreation values that might be expected from sea level rise. Periodic beach nourishment occurs in North Carolina but these efforts are costly.

Data to Support Angler Willingness to Pay (WTP) Analysis

The National Marine Fisheries Service (NMFS) collects recreational fishing data annually with the Marine Recreational Fishery Statistics Survey (MRFSS). The MRFSS is a creel survey with information on fishing location, mode, target species, catch and harvest, and fishing days during the past 2-month and 12-month time periods. Periodically, the NMFS collects additional data from anglers with economic add-on surveys. In the southeast region, economic add-ons have taken place in 1997, 1999 and 2000. An expenditure add-on was conducted in 2006.

* This section is taken from Bin et al. (2007).

The MRFSS add-on surveys requests additional information so that the travel cost method can be employed with the intercept creel survey data. Key information collected is on single-day vs. multiple-day trips and if fishing is the primary purpose of the trip. The travel cost method typically employs only single-day fishing trips (i.e., trips in which the respondent did not spend any nights away from the permanent residence) because overnight trips may have multiple purposes (McConnell and Strand, 1999).

The most comprehensive of the MRFSS southeastern add-on surveys was in 1997 when data on expenditures, household income, location-specific trips, mode-specific trips, target species-specific trips and WTP for various management measures were collected with on-site and telephone follow-up surveys. The 1997 data supports analysis of economic impacts and recreation demand (Haab, Whitehead and McConnell, 2000). In 1999 expenditures data were collected that supports economic impact analysis (Gentner, Price and Steinback, 2001). In 2000 income and other data were collected that supports recreation demand analysis.

We investigated the potential of the 1997 and 2000 MRFSS add-on data to support a shore-based demand model for North Carolina. Unfortunately, too few cases exist for demand analysis. Instead, we adapt the most recently available MRFSS data from 2005 and 2006. Forty-five percent of the North Carolina anglers fish from the shore and almost all of these shore anglers use hook and line gear. We consider only those anglers who fished in ocean waters (excluding the sounds of coastal North Carolina). In an attempt to focus on day trips we exclude about one-half of these anglers who reside outside of NC. In a further attempt to consider only day trip anglers we exclude anglers who live greater than 200 miles away from any of the fishing sites. In 2005 and 2006, 1905 and 1699 angler trips are available for analysis.

To measure site quality in the standard NMFS demand model (Haab, Whitehead and McConnell, 2001), the catch and keep rate is measured with the 5-year historic targeted harvest of big game fish (e.g., tunas), bottom fish (e.g., spot, groupers), flat fish (e.g., flounders), and small game fish (e.g., mackerels). In contrast, we consider all targeted species in the catch rates for the North Carolina shore fishing model, because only twenty-six percent of anglers in our data set target specific species (others target “anything they can catch”). Of those that target species the most popular are spot, flounder, kingfish, seatrout, bluefish, striped bass, Spanish mackerel, red drum and king mackerel. Three year targeted historic catch and keep rates per hour are calculated using MRFSS data at each of the sites to measure site quality.

Sixty-two percent of the anglers fish from manmade structures. The frequency of trips at each site is presented for the 22 manmade fishing sites (Table 1) and the 28 beach fishing sites (Table 2).

Travel distances and time between each survey respondent’s home zip code and the zip code of the population center of each county are calculated using the ZIPFIP correction for “great circle” distances (Hellerstein et al. 1993). Travel time is calculated by dividing distance by 50 miles per hour. The cost per mile used is $0.37, the national average automobile driving cost for 2003 including only variable costs and no fixed costs as reported by the American Automobile Association (AAA) (AAA Personal communication, 2005). Thirty-three percent of the wage rate is used to value leisure time for each respondent. The round-trip travel cost is $p = (2 \times c \times d) + (\theta w \times [2 \times d / mph])$ where c is cost per mile, d is one-way distance, θ is the fraction of the wage rate, w, and mph is miles per hour. In the standard NMFS travel cost methodology, a measure of time cost is collected in the add-on survey for anglers who forego wages during the trip. Since income is not available with the creel surveys we use the zip-code level median household income from the 2000 Census, inflated to 2005 dollars, as a proxy for household income in the measurement of the opportunity cost of time. The average travel cost across all trip choice occasions is $143.

Data to Support Economic Impact Analysis

Economic impacts are calculated for a specified geographic region relative to economic conditions in a baseline period. The region considered in this study includes all counties with ocean beaches in North Carolina: Currituck, Dare, Hyde, Carteret, Onslow, Pender, New Hanover, and Brunswick Counties. Economic conditions in year 2006 serve as the baseline for this study. Three types of data are needed to support economic impact analysis: numbers of ocean shore fishing trips, expenditures made by anglers on ocean shore fishing trips, input-output model data contained in the IMPLAN model database.

As described in the preceding section, there were an estimated 3.84 million North Carolina shore-based ocean fishing trips in 2006. Changes in trips due to sea-level rise are estimated by the trip frequency model described in the following section of this report.

We estimate the monetary expenditures associated with these trips based on surveys of saltwater angler expenditures conducted in 1999 and 2000 as an add-on to the Marine Recreational Fisheries Statistics Survey (MRFSS) (Gentner, Price and Steinback 2001). Survey data on average daily trip expenditures per angler in North Carolina in 1999-2000 are adjusted for inflation to 2006-year equivalent dollars using the consumer price index (USDL-BLS 2008). The resulting inflation-adjusted average daily trip expenditures per angler and total expenditures for all anglers are presented in Table 3. Projections of numbers of trips and expenditures in years 2030 and 2080 without sea-level rise are presented in Table 4, assuming a 50% increase in the annual number of trips by 2030 and a 100% increase by 2080 (see discussion of these projections in preceding section).

The IMPLAN input-output modeling system consists of two parts: a mathematical computer model (described below) and a database. The present study relies on the 2006 IMPLAN database. The database is derived from federal and state employment and income data and government survey data of businesses and households. It contains information on the monetary flows between and among firms in over 500 industries, consumers in various household income categories, and federal, state and local government for the study region. The database also contains information on imports and exports for the region.

Shore Angler Willingness to Pay (WTP) Model

The shore angler willingness to pay (WTP) model is composed of two linked sub-models, a fishing site-selection model and a fishing trip frequency model. In the fishing site-selection model, suppose an angler considers *j* recreation sites. The individual utility from the trip is decreasing in trip cost and increasing in trip quality:

(1) $$u_i = v_i(y - c_i, q_i) + \varepsilon_i$$

where *u* is the individual utility function, *v* is the nonstochastic portion of the utility function, *y* is income, *c* is the trip cost, *q* is a vector of site qualities, *ε* is the error term, and *i* is a member of *s* recreation sites, *s* = 1, … , *i* , … *J*. The individual chooses the site that gives the highest utility:

(2) $$\pi_i = \Pr(v_i + \varepsilon_i > v_s + \varepsilon_s \;\; \forall\, s \neq i)$$

where *π* is the probability that site *i* is chosen. If the error terms are independent and identically distributed extreme value variates then the conditional logit model results:

(3) $$\pi_i = \frac{e^{v_i}}{\sum_{s=1}^{J} e^{v_s}}$$

The conditional logit model restricts the choices according to the assumption of the independence of irrelevant alternatives (IIA). The IIA restriction forces the relative probabilities of any two choices to be independent of other changes in the choice set. For example, if a quality characteristic at site *j* causes a 5% decrease in the probability of visiting site *j* then the probability of visiting each of the other *k* sites must increase by 5%. This assumption is unrealistic if any of the *k* sites are better substitutes for site *j* than the others.

The nested logit model relaxes the IIA assumption. The nested logit site selection model assumes that recreation sites in the same nest are better substitutes than recreation sites in other nests. Choice probabilities for recreation sites within the same nest are still governed by the IIA assumption.

Consider a two-level nested model. The site choice involves a choice among *M* groups of sites or nests, *m* = 1, … , *M*. Within each nest is a set of J_m sites, *j*= 1, … , J_m. When the nest chosen, *n*, is an element in *M* and the site choice, *i*, is an element in J_n and the error term is distributed as generalized extreme value the site selection probability in a two-level nested logit model is:

(4) $$\pi_{ni} = \frac{e^{v_{ni}/\theta}\left[\sum_{j=1}^{J_n} e^{v_{nj}/\theta}\right]^{\theta-1}}{\sum_{m=1}^{M}\left[\sum_{j=1}^{J_m} e^{v_{mj}/\theta}\right]^{\theta}}$$

where the numerator of the probability is the product of the utility resulting from the choice of nest *n* and site *i* and the summation of the utilities over sites within the chosen nest *n*. The denominator of the probability is the product of the summation over the utilities of all sites within each nest summed over all nests. The dissimilarity parameter, $0 \leq \theta \leq 1$, measures the degree of similarity of the sites within the nest. As the dissimilarity parameter approaches zero the alternatives within each nest become less similar to each other when compared to sites in other nests. If the dissimilarity parameter is equal to one, the nested logit model collapses to the conditional logit model where $M \times J_m = J$.

Welfare analysis is conducted with the nested logit model by, first, specifying a functional form for the site utilities. It is typical to specify the utility function as linear:

$$\begin{aligned} v_{ni}(y-c_{ni}, q_{ni}) &= \alpha(y-c_{ni}) + \beta' q_{ni} \\ &= \alpha y - \alpha c_{ni} + \beta' q_{ni} \\ &= -\alpha c_{ni} + \beta' q_{ni} \end{aligned} \tag{5}$$

where α is the marginal utility of income. Since αy is a constant it will not affect the probabilities of site choice and can be dropped from the utility function.

The next step is to recognize that the inclusive value is the expected maximum utility from the cost and quality characteristics of the sites. The inclusive value, *IV*, is measured as the natural log of the summation of the nest-site choice utilities:

$$\begin{aligned} IV(c,q;\alpha,\beta) &= \ln\left(\sum_{m=1}^{M}\left[\sum_{j=1}^{J_m} e^{v_{mj}/\theta_m}\right]\right) \\ &= \ln\left(\sum_{m=1}^{M}\left[\sum_{j=1}^{J_m} e^{(-\alpha c_{mj}+\beta' q_{mj})/\theta_m}\right]\right) \end{aligned} \tag{6}$$

Hanemann (1999) shows that the per choice occasion welfare change from a change in quality characteristics is:

$$WTP = \frac{IV(c,q;\alpha,\beta) - IV(q+\Delta q;\alpha,\beta)}{\alpha} \tag{7}$$

where willingness to pay, *WTP,* is the compensating variation measure of welfare. Haab and McConnell (2002) show that the willingness to pay for a quality change (e.g., changes in beach width) can be measured as

$$WTP(\Delta q_k \mid ni) = \frac{\beta_k \Delta q_{k|ni}}{\alpha} \tag{8}$$

where q_k is one element of the q vector at site i in nest n. Willingness to pay for the elimination of a recreation site from the choice set (e.g., beach erosion that eliminates the sandy beach) is

$$WTP(i \mid n) = \frac{\ln\left[\left(1-\Pr(i \mid n)\right)^{\theta}\Pr(n) + \left(1-\Pr(n)\right)\right]}{\alpha} \tag{9}$$

where $\Pr(i \mid n)$ is the unconditional probability of choosing site i given that nest n is chosen and $\Pr(n)$ is the unconditional probability of choosing nest n.

Willingness to pay for elimination of an entire nest is

(10) $$WTP(n) = \frac{\ln\left(1 - \Pr(n)\right)}{\alpha}$$

since $\Pr(i \mid n) = 1$ when the entire nest of sites is eliminated.

These welfare measures apply for each choice occasion, in other words, trips taken by the individuals in the sample. If the number of trips taken is unaffected by the changes in cost and/or quality, then the total willingness to pay is equal to the product of the per trip willingness to pay and the average number of recreation trips, $\bar{x}$.

If the number of trips taken is affected by the changes in cost and/or quality then the appropriate measure of aggregate WTP must be adjusted by the change in trips. There are several methods of linking the trip frequency model with the site selection model (Herriges, Kling and Phaneuf, 1999; Parsons et al., 1999), we choose the original approach that includes the inclusive parameter as a variable in the trip frequency model (Bockstael, Hanemann and Kling, 1987):

(11) $$x = x\left[IV\left(c, q; \alpha, \beta\right)\right]$$

where $x[\cdot]$ is a trip frequency model. These models are typically estimated with count (i.e, integer) data models such as the Poisson or negative binomial models (Haab and McConnell 2002, Parsons 2003).

Trips under various climate change scenarios can be simulated by substitution of quality change into the trip frequency model:

(12) $$x(\Delta) = x\left[IV\left(\Delta q; \alpha, \beta\right), y, z\right]$$

The total willingness to pay of a quality change that might affect the number of trips is aggregated over the number of trips:

(13) $$TWTP(\Delta q_k) = \sum_{m=1}^{M} \sum_{j=1}^{J_m} \left(\left[\bar{x}_{mj}(\Delta)\right] WTP(\Delta q_k \mid mj) + \left[\bar{x}_{mj} - \bar{x}_{mj}(\Delta)\right] WTP(m \mid j)\right)$$

The first component of the total willingness to pay, *TWTP*, is the product of the average number of trips taken with the quality change and the value of the quality change. The second component of the willingness to pay is the product of the difference in trips and the willingness to pay for a trip to a particular site.

Regional Economic Impact Model

We use input-output analysis (see, e.g., Miller and Blair 1985) to estimate the economic impacts of sea-level rise on marine recreational shore fishing in North Carolina. Input-output models are interconnected systems of linear equations that track the flow of dollars between and among households, businesses, and government in a specified geographic region. Input-output analysis is commonly used by economists to estimate the economic impacts of a change in spending in a regional economy. IMPLAN Professional® Input-Output Analysis computer software is used in this study to conduct input-output analysis (MIG 2005). IMPLAN is a leading input-output modeling software package used by university researchers, government agencies, and consultants nationwide.

The IMPLAN modeling system contains equations for over 500 industry categories plus additional equations that model household and government spending. In essence, there is one equation for each *industry* in a regional economy. Each industry equation specifies the dollar amounts of *input* goods and services required to produce the dollar amount of industry *output* in the region. The equations are linked together such that the output dollar amount produced by one industry is the total of all the input dollar amounts required by all of the other industries in the system. For example, the dollar value of electricity output produced by the electricity industry feeds into all of the other industry equations as the (dollar-valued) electricity inputs to those industries. (The electricity industry also uses some of its own electricity, which feeds back into its own equation.) In addition, some of the outputs leave the system as *exports* from the region, and some inputs enter the system as *imports* into the region. Furthermore, households (workers) and taxes are treated as inputs in the industry equations in the sense that industries pay for (send money to) workers and taxes. Households are treated as separate industries that receive their own inputs (e.g., wages, salaries, rental income, dividend payments, government program payments) and produce their own outputs (e.g., household expenditures for food, clothing, electricity, rent, mortgage payments, taxes). (In fact, there are multiple household industries, each corresponding to a different household income level, because households of different income levels have different patterns of inputs and outputs.) Each level of government (federal, state, and local) is treated as a separate industry that receives input tax receipts from households, businesses, and other levels of government and produces outputs (e.g., expenditures on the military, highway construction, public schools, health care programs, payments to other levels of government).

When conducting economic impact analysis, an initial change to the baseline economy is specified by the analyst. This initial change is called the *direct impact.* Changes in the numbers of ocean shore fishing trips and associated monetary expenditures in coastal North Carolina due to sea-level rise is the direct impact considered here. If fewer shore fishing trips are taken, less money is spent by anglers in coastal North Carolina counties on the goods and services produced by firms in the following IMPLAN model industry sectors: Food & Drink – Restaurants/Bars, Food & Drink – Grocery/Convenience Stores, Lodging, Private Transportation, Public Transportation, Parking/Access Fees, Equipment Rental, Bait, Tackle and Ice.

In turn, firms in these industries reduce spending on workers and various goods and services purchased from other industries. The industries producing these goods and services, in turn, purchase less from other industries, and so on. However, the process does not go on forever. At each round of purchasing, the dollar amount of purchases becomes smaller, eventually becoming negligible. The second and subsequent rounds of purchase reductions constitute the *indirect impacts* of the initial reduction in angler expenditures. If workers and firm owners receive less income due to the reduction in angler expenditures, they pay less in taxes, save less, and spend less. This reduction in spending by workers and firm owners initiates additional, attenuating rounds of purchase reductions called the *induced impacts* of the initial reduction in angler expenditures. The indirect and induced impacts are collectively known as *multiplier effects*. The sum of the direct, indirect, and induced impacts is called the *total impact.*

The direct, indirect, and induced impacts of changes in angler expenditures can be tracked and measured in several ways, including changes in business sales (also known as business activity or business output), employment, labor income (e.g., wages and salaries), capital income (e.g., rents, interest and dividend income), and taxes paid to various levels of government. IMPLAN tracks the changes in business sales, employment, and other impact measures separately for the direct, indirect, and induced impacts and also cumulates them into total impacts for all industries in the study region.

Results

Fishing Site-Selection Model

We model the angler fishing site choice in two stages. The first stage choice of shore anglers is between manmade structures (piers and bridges) and beach fishing. In addition, we assume that anglers choose between an Outer Banks trip and a southern North Carolina coastal trip. In the second stage decision, anglers choose fishing sites. The shore/region mode-site choice nested random utility model (NRUM) follows the standard NMFS methodology where possible with adjustments for North Carolina shore anglers. In particular, the smaller number of choices, 50 instead of 1050, allows the model to be estimated with the full information maximum likelihood routine.

The theory behind the NRUM is that anglers consider fishing sites based on the utility (i.e., satisfaction) that each site provides. Anglers will tend to choose fishing sites that provide the most utility. The NRUM exploits the empirical observation that anglers tend to choose fishing sites with relatively low travel costs and relatively high chances of fishing success.

The utility function is a linear function of the travel costs, the square root of the catch rate and beach width. The NRUM is estimated using the full information maximum likelihood PROC MDC in SAS and presented in Table 5. The full information maximum likelihood routine estimates the two stages of choice jointly.

The likelihood that an angler would choose a fishing site is negatively related to the travel cost and positively related to the historic targeted catch and keep rate. Beach width is positively related to site choice. In other words, beach anglers prefer a wider beach. Various other model specifications (e.g., including a squared width term and width +/- one standard deviation) were investigated to test the sensitivity of results to the simple linear specification. The simple linear specification is statistically preferred. The parameter estimates on the mode/region-specific inclusive value is between 0 and 1 and statistically different from zero and one which indicates that the nested model is appropriate.

Fishing Trip Frequency Model

A limitation of the fishing site-selection model (NRUM model) described above is that it holds the number of fishing trips constant. That is, with the loss of a fishing site, anglers are assumed to substitute other sites or fishing modes rather than to forego a fishing trip entirely. This assumption may be appropriate for many events and policies that have a minor impact on the fishing experience. But for lost beach fishing sites and lost quality it would not be surprising if the aggregate number of fishing trips declines. A practical approach to estimating this effect is with a trip frequency model in which angler trips are regressed on the inclusive value, which is constructed for each angler from the parameters of the NRUM, and other individual angler characteristics. If trips are positively related to the utility of fishing then a change in fishing conditions which lowers utility will lead to fewer trips taken.

The fishing trip frequency "demand" model is a negative binomial model estimated with Proc GENMOD in SAS. The negative binomial model accounts for the integer values of the dependent variable. The dependent variable in the negative binomial trip frequency model is the annual number of fishing days. Note that these are not necessarily equivalent to single-day trips since single-day trippers may also take multiple-day fishing trips over the course of a year.

The fishing trip frequency demand model does a reasonable job of explaining the variation in fishing days (Table 6). Shore anglers increase trips as the inclusive value increases. More intuitively, trips increase as travel costs decrease since the inclusive value is negatively related to travel costs (catch rates and width do not vary across angler). The dispersion coefficient is statistically different from zero which suggests that the negative binomial is the appropriate model. The regression model is used to simulate the number of fishing days that anglers would experience with the loss of beach width. The predicted number of annual fishing days falls from 37.11 in 2005-06 to 34.40 in 2030, a 7.3% decrease, and to 34.05 in 2080 (another 0.9% decrease).

Willingness to Pay

A large number of WTP estimates can be developed from the model including the loss of access to fishing sites, changes in catch rates and changes in beach width. For example, the change in WTP per trip from a change in the catch rate of one fish per hour at each site is $12.52. The change in WTP per trip from an increase in beach width of 10 meters is $2.09. Both results seem to be of an appropriate magnitude which lends validity to the model.

The WTP loss resulting from reduced beach width is estimated by calculating the change in angler utility using the beach width data. Beaches with negative width, choice numbers 23 and 50 in 2030 and 23, 29 and 50 in 2080, are removed from the choice set. The change in WTP per trip with reduced beach width in 2030 is $5.82. The change in WTP per trip with reduced beach width in 2080 is $6.45.

We aggregate WTP values over 3.84 million North Carolina shore mode ocean fishing trips in 2006 (personal communication, NMFS 2006). The baseline (without climate change) total number of trips in 2030 and 2080 is estimated as simple 50% and 100% increases in trip estimates relative to 2006, respectively. We use this simple approach for several reasons. First, Milon (2000) uses the MRFSS participation data and forecasts fishing participation out to 2025. He finds that participation, measured as the percentage of the population that takes at least one marine recreational fishing trip, will decline slightly. Second, an analysis of the National Survey of Recreation and the Environment saltwater fishing participation data finds that income increases do not significantly affect North Carolina saltwater fishing participation. In light of these results, we assume that the number of trips per angler stays constant while the number of participants increases with population, with a constant participation rate. Our estimates of future trips are significantly lower than a forecast that uses the trend line from the 1981-2006 aggregate MRFSS data obtained from the NMFS website to forecast trips into the future. Our simple estimate is 9% lower in 2030 and 32% lower in 2080. Therefore, our estimates of the economic effects of climate change on marine recreational fishing may be conservative.

Estimates of aggregate annual WTP losses in 2030 and 2080 due to sea-level rise and the present value of losses for all years between 2006 and 2080 are presented in Table 7. Assuming that the number of shore trips is constant between 2006 and 2080, aggregate annual WTP loss due to sea-level rise is $22 million in 2030 and $25 million in 2080. Assuming that the number of shore trips increases by 50% between 2006 and 2030, aggregate annual WTP loss is $34 million in 2030. Assuming that the number of shore trips increases by 100% between 2006 and 2080, aggregate annual WTP loss is $50 million in 2080.

The present value of the annual welfare costs from 2006-2080 due to reductions in fishing quality are estimated by assuming the impacts of sea level rise are equal to zero in 2006 and increase linearly to 2080. Using a 2% discount rate, the present value of the aggregate WTP loss is $630 million assuming no change in population and $1.1 billion assuming an increase in population. Using a 7% discount rate, the present value of the WTP loss is $140 million assuming no change in population and $224 million assuming increasing population.

We assume that anglers that would take fewer shore fishing trips due to sea-level rise, as estimated by the negative binomial model, do not find pier fishing to be a good substitute. The value of the lost trips is estimated by determining the value of lost beach sites using equation (10). The value of a lost beach fishing trip is $15.91. Considering the baseline 3.84 million shore fishing trips in 2006, a 7.3% reduction in trips is 280 thousand trips. The annual economic loss associated with the reduction in trips is $4.46 million in 2030 with no upward trend in fishing trips. The additional annual economic loss associated with the additional 0.9% reduction in trips in 2080 is an additional $550 thousand with no upward trend in fishing trips. Assuming that the number of shore trips increases by 50% between 2006 and 2030 and by 100% between 2006 and 2080, aggregate annual WTP loss due to a reduction in trips is an additional $6.69 million in 2030 and an additional $10.2 million in 2080.

The present value of the annual aggregate WTP loss from 2006-2080 due to reductions in trips are estimated by assuming the impacts of sea level rise are equal to zero in 2006 and increase linearly to 2080. Using a 2% discount rate, the present value of the WTP loss is $127 million assuming no change in population and $191 million assuming an increase in population. Using a 7% discount rate, the present value of the WTP loss is $28 million assuming no change in population and $43 million assuming increasing population.

Combining the WTP losses due to reductions in fishing quality of existing trips and reductions in fishing trips due to reductions in beach width provides an estimate of the total shore fishing WTP loss associated with sea-level rise. Using a 2% discount rate, the present value of the total WTP loss is $757 million assuming no change in population and $1.29 billion assuming an increase in population. Using a 7% discount rate, the present value of the WTP loss is $168 million assuming no change in population and $267 million assuming increasing population.

Regional Economic Impacts

North Carolina resident ocean shore anglers spend an average of $76.95 per fishing trip (2006 $'s), while non-resident anglers spend $89.69 per trip (Table 3). The largest components of trip expenditures are lodging (about 35-40 % of trip expenditures), private transportation (14-20%), and restaurants and bars (14-26 %).

Without sea-level rise, North Carolina resident and non-resident anglers each made an estimated 730 thousand fishing trips to North Carolina ocean shore sites in 2006, for a total of 1.46 million trips (Table 4). Without sea-level rise, we assume that the number of trips would increase by 50% by 2030 and by 100% by 2080 due to population growth alone. With sea-level rise, we assume that the number of trips remains the same in 2006 but is an estimated 7.3% smaller than without sea-level rise in 2030 and 8.2% smaller than without sea-level rise in 2080.

Without sea-level rise, the annual total direct expenditures made by all ocean shore anglers in NC are approximately $121 million/yr in 2006, rising to $182 million/yr in 2030 and $243 million/yr in 2080 with assumed population growth (Table 8). When multiplier effects are included, these direct expenditures support 3,374 jobs in the coastal region of North Carolina in 2006, $85 million/yr in labor income, $36 million/yr in capital income, and $17 million/yr in state and local government tax revenue (Table 9). In the absence of sea-level rise, these impacts rise in proportion to the increase in direct expenditures from 2006 to 2080.

With sea-level rise, annual total direct expenditures are unaffected in 2006, but fall by an estimated $13.3 million/yr in 2030 (a 7.3% reduction) and $19.9 million/yr in 2080 (an 8.2% reduction). When multiplier effects are included, these reductions in direct expenditures result in the loss of 369 jobs in the coastal region of North Carolina by 2030, $9.4 million/yr in labor income, $4 million/yr in capital income, and $1.9 million/yr in state and local government tax revenue (Table 10). By 2080, sea-level rise could result in the loss of 553 jobs, $14 million/yr in labor income, $5.9 million/yr in capital income, and $2.9 million/yr in state and local taxes.

With sea-level rise, and including economic multiplier effects, the present value (in 2006) of the cumulative annual losses in sales between 2006 and 2080 amounts to $828 million with a 2 % discount rate, or $190 million with a 7 % discount rate (Table 11). Similarly, the present value of lost labor income is $307 million, lost capital income is $130 million, and lost state and local taxes is $63 million at a discount rate of 2%, with losses of $71 million in labor income, $30 million in capital income, and $15 million in state and local taxes at a discount rate of 7 %.

Conclusions

In this study we develop estimates of the economic effects of climate change-induced sea level rise on marine recreational shore fishing in North Carolina. We find that the losses in anglers' economic welfare are potentially substantial, ranging up to a present value of $1.29 billion over 75 years, using conservative estimates of fishing participation growth and a 2% discount rate. These impacts on anglers result from a combination of fewer angler trips and reduced trip enjoyment due to deteriorating beach conditions.

In addition to impacts on anglers, the present value (in 2006) of the cumulative losses in business sales in coastal North Carolina between 2006 and 2080 due to reduced angler spending amounts to $828 million at a 2 % discount rate when economic multiplier effects are considered. Similarly, the present value of lost labor income is $307 million, lost capital income is $130 million, and lost state and local tax revenue is $63 million.

The impacts on shore anglers are partially muted since piers are a good substitute for fishing from the beach. However, pier fishing in North Carolina is becoming more limited as coastal property values rise. Some of the piers in the 2005 data are no longer available as substitute fishing sites in the 2006. Other piers are in jeopardy. Also, boat anglers might be affected by sea-level rise if marinas must be relocated. Our analysis does not include these impacts.

Second, a limitation of the MRFSS data is that it includes information on recreation participants only. Another potential impact of sea-level rise is its negative effect on participation. Marine recreational shore anglers may choose another recreation activity, such as freshwater fishing, if shore based fishing becomes unavailable. To the extent that substitute activities are not available, we underestimate the impacts of sea-level rise. We also do not consider the impacts of economic growth (i.e., increases in per-capita income) and other climate variables on participation in marine recreational fishing. These extensions are left for future research.

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Figure 1: Location of fishing beaches used in this study

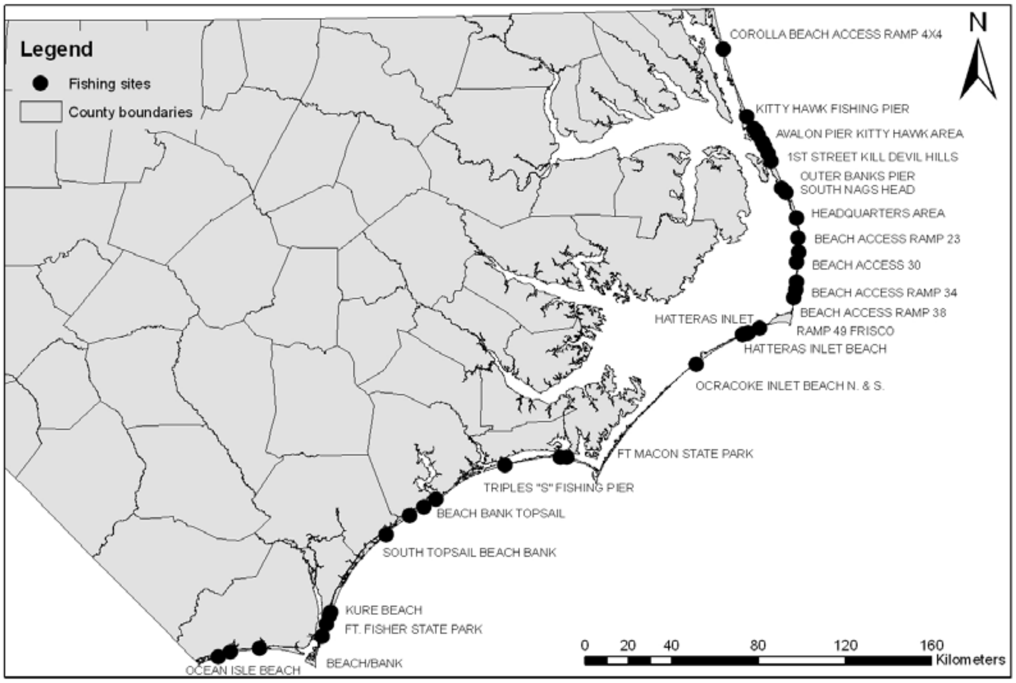

Figure 2: Erosion rates for fishing beaches calculated by intersecting USGS erosion transects with vegetation line. Beach width was computed as the distance between shoreline (determined by the NC Division of Coastal Management) and the vegetation line

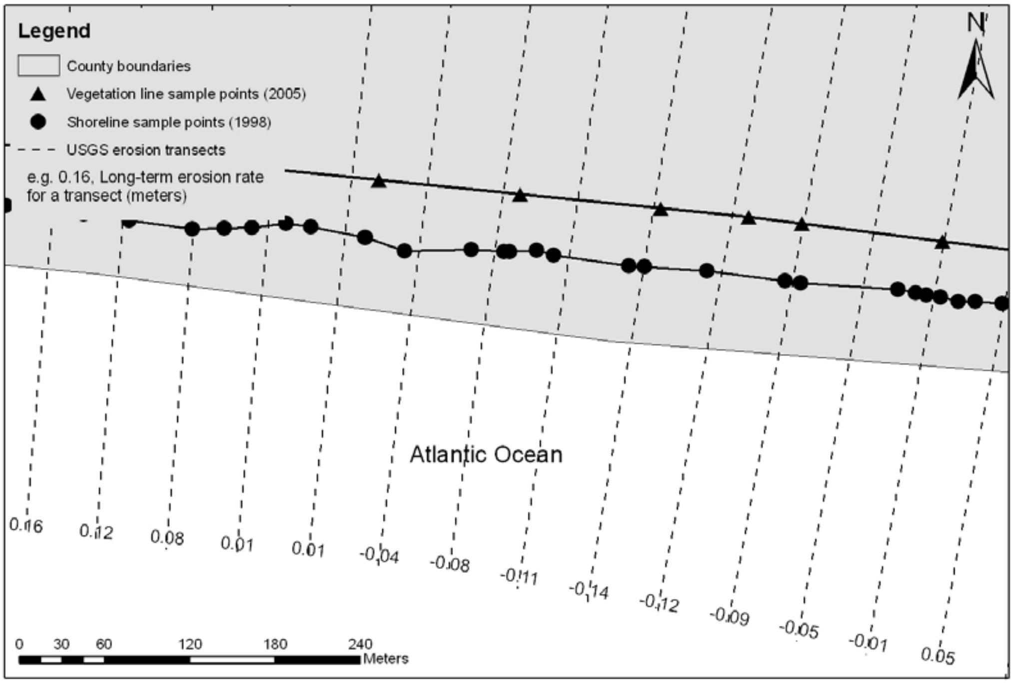

Table 1. Manmade Fishing Sites

Choice	Site Name	County	Frequency	Percent
1	Seaview Pier	Pender	63	1.75
2	Sunset Beach Fishing Pier	Brunswick	22	0.61
3	Yaupon Beach Fishing Pier	Brunswick	31	0.86
4	Ocean Isle Pier	Brunswick	4	0.11
5	Nags Head Fishing Pier	Dare	216	5.99
6	Avalon Pier Kitty Hawk Area	Dare	285	7.91
7	Bogue Inlet Fishing Pier	Carteret	260	7.21
8	Frisco Pier	Dare	70	1.94
9	Hatteral Fishing Pier	Dare	55	1.53
10	Holden Beach Fishing Pier	Brunswick	23	0.64
11	Jeanette's Ocean Fishing Pier	Dare	7	0.19
12	Outer Banks Pier South Nags Head	Dare	108	3.00
13	Oceanana Fishing Pier	Carteret	31	0.86
14	Sportsmans Pier	Carteret	290	8.05
15	Triple "S" Fishing Pier	Carteret	137	3.8
16	Jolly Rogers Pier	Pender	58	1.61
17	Surf City Ocena Pier	Pender	46	1.28
18	Oregon Inlet Bridge	Dare	22	0.61
19	Kure Beach Pier	New Hanover	100	2.77
20	Long Beach Fishing Pier	Brunswick	3	0.08
21	Avon Fishing Pier	Dare	153	4.25
22	Carolina Beach Pier	New Hanover	97	2.69

Table 2. Beach and Bank Fishing Sites

Choice	Site Name	County	Frequency	Percent
23	Oregon Inlet South	Dare	49	1.36
24	Cape Point	Dare	328	9.1
25	Hatteras Inlet	Dare	54	1.5
26	Kure Beach	New Hanover	44	1.22
27	Holden Beach	Brunswick	17	0.47
28	Ft Fisher State Beach	New Hanover	7	0.19
29	Ocracoke Inlet Beach N. & S.	Hyde	7	0.19
30	Avalon Pier Kitty Hawk Area	Dare	5	0.14
31	Ft Macon State Park	Carteret	204	5.66
32	Emerald Isle Public Access Area	Carteret	48	1.33
33	Oregon Inlet North Shore	Dare	357	9.91
34	Hatteras Inlet Beach	Hyde	21	0.58
35	Access at New River Inlet Drive	Onslow	5	0.14
36	Beach Access Ramp 20	Dare	41	1.14
37	Beach Access Ramp 23	Dare	21	0.58
38	Beach Access 27	Dare	12	0.33
39	Beach Access 30	Dare	23	0.64
40	Beach Access Ramp 34	Dare	17	0.47
41	Beach Access Ramp 38	Dare	37	1.03
42	New River Inlet, Topsail Island	Onslow	143	3.97
43	Carolina Beach NW Extension	New Hanover	4	0.11
44	Calvin Street Kill Devil Hills	Dare	20	0.55
45	1st Street Kill Devil Hills	Dare	27	0.75
46	Public Access E. Gulfstream S. Nags Head	Dare	5	0.14
47	Public Access E. Bonnett St Nags Head	Dare	10	0.28
48	Public Access E. Forest St Nagshead	Dare	2	0.06
49	Ramp 49 Frisco	Dare	14	0.39
50	South Topsail Beach Bank	Pender	1	0.03

Table 3. Average Expenditures in NC per Angler Trip, Shore Fishing Mode, by Industry Expenditure Category and Angler Residency (2006 $'s)

		Average Expenditures in NC per Angler Trip, Shore Fishing Mode (2006 $'s)	
Expenditure Category	IMPLAN Model Industry #	NC Resident Angler	Out-of-State Angler
Food & Drink – Restaurants/Bars	481	$11.23	$23.47
Food & Drink – Grocery/Convenience Stores	405	$5.53	$11.56
Lodging	479	$33.07	$31.49
Private Transportation	407	$15.73	$12.65
Public Transportation	395	$1.33	-----
Parking/Access Fees	478	$1.26	$0.62
Equipment Rental	409	$0.41	$0.04
Bait	16	$4.88	$7.04
Tackle	409	$2.20	$0.94
Ice	85	$1.30	$1.89
Total per Trip		$76.95	$89.69

Sources: IMPLAN Model Industry #'s from MIG (2005). Expenditure data from Gentner, Price and Steinback, (2001), deflated to 2006-year dollars using the consumer price index (USDL-BLS 2008).

Table 4. Annual Numbers of Ocean Angling Trips in North Carolina, 2006, 2030, and 2080, With and Without Sea-Level Rise.

	Without Sea-Level Rise			With Sea-Level Rise		
Year	2006	2030 (1)	2080 (2)	2006	2030 (3)	2080 (4)
Total Angler Trips/Yr	3,840,000	5,760,000	7,680,000	3,840,000	5,339,520	7,050,240
Trips/Yr -- Fish from Structure	2,380,800	3,571,200	4,761,600	2,380,800	3,310,502	4,371,149
Trips/Yr -- Fish from Shore	1,459,200	2,188,800	2,918,400	1,459,200	2,029,018	2,679,091
NC Resident Anglers	729,600	1,094,400	1,459,200	729,600	1,014,509	1,339,546
Out-of-State Anglers	729,600	1,094,400	1,459,200	729,600	1,014,509	1,339,546

Notes:

(1) Assumes a 50% increase in trips from 2006 to 2030 due to population increase.

(2) Assumes a 100% increase in trips from 2006 to 2080 due to population increase.

(3) Reflects a reduction of 7.3% in number of trips in 2030 due to sea-level rise, compared to number of trips in 2030 without sea-level rise.

(4) Reflects a reduction of 8.2% (7.3% + 0.9%) in number of trips in 2080 due to sea-level rise, compared to number of trips in 2080 without sea-level rise.

Table 5: Fishing Site Selection (Nested Random Utility) Model

	Mean	Coeff.	t-ratio
Travel Cost	143.87	-0.035	-30.82
Square root of catch rate per hour	0.87	0.43	8.86
Width	54.34	0.0072	25.61
IV		0.42	23.64
McFadden's R^2		0.10	
Trips		3604	
Sites		50	

Table 6. Fishing Trip Frequency (Negative Binomial) Model

Dependent Variable = Days Fished		
	Coeff.	t-statistic
Intercept	3.31	156.75
IV	0.36	32.30
Dispersion	1.50	47.38
Cases	3604	

Table 7. Reduction in North Carolina Ocean Shore Angler WTP Due to Sea-Level Rise

Assuming Constant Population

	Aggregate Annual WTP Loss		Present Value of Aggregate Annual WTP Loss 2006-2080	
	2030	2080	2%	7%
Loss due to reduction in number of trips	$4.46 million/yr	$5.01 million/yr	$127 million	$28 million
Loss due to poorer quality of remaining trips	$22 million/yr	$25 million/yr	$630 million	$140 million
Total	$26.46 million/yr	$30.01 million/yr	$757 million	$168 million

Assuming Population Increase of 50% by 2030 and 100% by 2080

	Aggregate Annual WTP Loss		Present Value of Aggregate Annual WTP Loss 2006-2080	
	2030	2080	2%	7%
Loss due to reduction in number of trips	$6.69 million/yr	$10.02 million/yr	$191 million	$43 million
Loss due to poorer quality of remaining trips	$34 million/yr	$50 million/yr	$1.1 billion	$224 million
Total	$40.69 million/yr	$60.02 million/yr	$1.29 billion	$267 million

Notes: WTP loss per trip not taken due to sea-level rise is $15.91 in 2006-year dollars. WTP loss per remaining trip due to lower trip quality resulting from sea-level rise is $5.82 in 2030 and $6.45 in 2080 in 2006-year dollars.

Table 8. Baseline Annual Total Direct Expenditures by Shore-Based Ocean Anglers in North Carolina, 2006, 2030, and 2080, and Reductions in Expenditures Due to Sea-Level Rise (2006-year $'s)

Expenditure Category	Baseline Annual Total Direct Expenditures Without Sea-Level Rise (2006 $'s)			Reductions in Annual Total Direct Expenditures With Sea-Level Rise (2006 $'s)		
	2006	2030	2080	2006	2030	2080
Food & Drink – Restaurants/Bars	$25,315,757	$37,973,636	$50,631,515	$0	$2,772,075	$4,151,784
Food & Drink – Grocery/Convenience Stores	$12,468,955	$18,703,433	$24,937,910	$0	$1,365,351	$2,044,909
Lodging	$47,102,313	$70,653,469	$94,204,625	$0	$5,157,703	$7,724,779
Private Transportation	$20,709,588	$31,064,382	$41,419,177	$0	$2,267,700	$3,396,372
Public Transportation	$968,619	$1,452,928	$1,937,238	$0	$106,064	$158,854
Parking/Access Fees	$1,371,496	$2,057,244	$2,742,992	$0	$150,179	$224,925
Equipment Rental	$325,730	$488,595	$651,461	$0	$35,667	$53,420
Bait	$8,691,855	$13,037,783	$17,383,711	$0	$951,758	$1,425,464
Tackle	$2,290,908	$3,436,362	$4,581,816	$0	$250,854	$375,709
Ice	$2,331,543	$3,497,315	$4,663,086	$0	$255,304	$382,373
Total	$121,576,765	$182,365,148	$243,153,530	$0	$13,312,656	$19,938,589

Notes: Baseline expenditures increase from 2006 to 2080 due to population increase. Figures reflect expenditures in NC made by both NC resident and non-resident shore anglers.

Table 9. Direct and Total Annual Economic Impacts of Shore Angler Expenditures in North Carolina, 2006, 2030, and 2080, without Sea-Level Rise.

Impact	2006		2030		2080	
Category	Direct Impacts	Total Impacts	Direct Impacts	Total Impacts	Direct Impacts	Total Impacts
Sales	$121 million	$229 million	$182 million	$343 million	$243 million	$458 million
Employment (jobs)	2,046	3,374	3,070	5,061	4,093	6,748
Labor Income	$35 million	$85 million	$53 million	$128 million	$71 million	$170 million
Capital Income	$15 million	$36 million	$22 million	$54 million	$30 million	$72 million
State/Local Taxes	----------	$17 million	----------	$26 million	----------	$34 million

Notes: Figures reflect impacts of expenditures made by both NC resident and non-resident shore anglers. Total Impacts = Direct Impacts + Indirect Impacts + Induced Impacts = Direct Impacts + Multiplier Effects. Sales are also known as “economic output” or “business activity.” Employment includes both full-time and part-time jobs. Labor Income includes wages, salaries, sole proprietorship income, and partnership income. Capital Income includes rents, interest income, and corporate dividend income. State/Local Taxes are calculated on a Total Impact basis only.

Table 10. Reductions in Direct and Total Annual Economic Impacts of Shore Angler Expenditures in North Carolina, 2006, 2030, and 2080, with Sea-Level Rise.

Impact	2006		2030		2080	
Category	Direct Impacts	Total Impacts	Direct Impacts	Total Impacts	Direct Impacts	Total Impacts
Sales	$0	$0	$13 million	$25 million	$20 million	$38 million
Employment (jobs)	0	0	224	369	336	553
Labor Income	$0	$0	$4 million	$9.4 million	$5.8 million	$14 million
Capital Income	$0	$0	$1.7 million	$4 million	$2.5 million	$5.9 million
State/Local Taxes	----------	$0	----------	$1.9 million	----------	$2.9 million

Notes: Figures reflect impacts of expenditures made by both NC resident and non-resident shore anglers. Total Impacts = Direct Impacts + Indirect Impacts + Induced Impacts = Direct Impacts + Multiplier Effects. Sales are also known as “economic output” or “business activity.” Employment includes both full-time and part-time jobs. Labor Income includes wages, salaries, sole proprietorship income, and partnership income. Capital Income includes rents, interest income, and corporate dividend income. State/Local Taxes are calculated on a Total Impact basis only.

Table 11. Present Value of Reductions in Total Annual Economic Impacts of Shore Angler Expenditures in North Carolina, 2006 through 2080, with Sea-Level Rise.

	Discount Rate	
Impact Measure	2%	7%
Sales	$823 million	$190 million
Employment	553 jobs	553 jobs
Labor Income	$307 million	$71 million
Capital Income	$130 million	$30 million
State/Local Taxes	$63 million	$15 million

Notes: Figures reflect impacts of expenditures made by both NC resident and non-resident shore anglers. Sales are also known as “economic output” or “business activity.” Employment includes both full-time and part-time jobs. Labor Income includes wages, salaries, sole proprietorship income, and partnership income. Capital Income includes rents, interest income, and corporate dividend income.