Final General Reevaluation Report
and
Final Environmental Impact Statement

on

Hurricane Protection and Beach Erosion Control

WEST ONSLOW BEACH AND NEW RIVER INLET (TOPSAIL BEACH), NORTH CAROLINA

Appendix O

Recreation Analysis

Appendix O: Recreation Analysis

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Recreation Analysis

1.0 INTRODUCTION

In December of 2002 the Wilmington District United States Army Corps of Engineers (USACE) contracted with the University of North Carolina at Wilmington (UNCW) to collect data and develop methodologies for an in-depth and multi-faceted study of the recreation demand and benefits of visitors to four barrier islands on the North Carolina Coast: Bogue Banks, Topsail Island, Oak Island, and Holden Beach. The scope of work for the UNCW contract is contained in Attachment A.

Planning and Guidance (P&G) describes recreation benefits as incidental benefits of the National Economic Development Account. ER 1105-2-100 states specifically that shore protection projects are formulated exclusively for hurricane and storm damage reduction and that recreation is an incidental benefit. Recreation benefits can be included in the benefit/cost ratio for a project. However, the benefits cannot exceed 50% of the benefits needed for project justification. Therefore, when calculating net benefits for a storm damage reduction project, recreation benefits are added into the net benefits after the storm damage reduction benefits have been estimated from coastal and economic models and a plan has been selected.

The focus of this collaborative study effort was on day trip visitors who utilize public access and parking facilities. This study employed multiple methodologies that incorporated:

- An on site field survey administered during the summer vacation season of 2003
- A telephone survey of residents living in eastern North Carolina within a 120 mile radius of each beach community incorporated into the survey instrument in the spring of 2004 (Office of Management and Budget approved, control number 0710-0001, Attachment 2)
- A focus group session with each municipality and representatives from its major business organizations
- A secondary data literature search, and aerial photography and parking counts of the project area on the days that the on site surveys were conducted.

This study focused on four projects. These are:

- West Onslow Beach and New River Inlet GRR study
- Surf City/North Topsail Beach feasibility study
- Bogue Banks feasibility study
- Brunswick County Beaches feasibility study

The non-Federal sponsors for the four projects are, respectively, the town of Topsail Beach; the town of Surf City and the town of North Topsail Beach; Atlantic Beach, the town of Indian Beach, the town of Pine Knoll Shores, the town of Salter Path, the town of Emerald Isle, and Carteret County; and the town of Caswell Beach, the town of Oak Island, and the town of Holden Beach.

A telephone survey instrument was used to gather comparative data for New Hanover County Beaches including Wrightsville Beach, Carolina Beach, Kure Beach, Masonboro Island, and Fort Fisher State Park; the remaining Brunswick County beaches including Ocean Isle and Sunset Beach, and the Fort Macon State Park at Bogue Banks.

This appendix will provide a detailed analysis of the data collected from the on-site survey, telephone survey, parking counts, and aerial photography. This analysis and the data output will be used to determine the peak recreation demand for each beach community under study in the without project condition, the latent and expected future demand in the with project condition, and the recreational benefits of the with and without project conditions. The recreational benefits will be estimated using the travel cost method (TCM) and the contingent valuation method (CVM). The analysis will address the following questions:

- What is an individual beach recreationist's willingness to pay (WTP) per day trip for each of the beaches in our study region?
- How would the number of beach trips made by an individual beach recreationist to each of the beaches change with a change in beach width?
- How would WTP for an individual beach recreationist change with a change in beach width?
- What would be the change in present discounted value in aggregate WTP across all recreationists visiting a particular beach should a change occur in beach width? For example, what would be the increase in recreation value (i.e., aggregate WTP) associated with a 50' increase in beach width at Topsail Beach?

2.0 METHODOLOGY

A multi-method approach was used to examine this study research questions. The primary methods included on-site and telephone surveys and econometric analyses to examine data within the framework of TCM and CVM. Historically, Wilmington District has used the unit day value (UDV) method to determine recreation benefits for Hurricane and Storm Damage Reduction projects. The UDV method for estimating recreation benefits relies on expert or informed opinion and judgment to approximate the average willingness to pay of users of a particular project. However, given sufficient data, the UDV can be replaced with the TCM and the CVM estimates to provide a more valid and reliable monetary value of the recreation benefits for each project under feasibility study.

Questions on both the on-site survey and the telephone survey were specifically designed to generate data necessary to employ the TCM and the CVM. To proceed with the analysis issues common with survey data - data quality and missing data - were addressed. Data reliability is often of primary concern for any investigator dealing with survey data. Basic analysis methods for survey data require first and foremost cleaning up the data, filtering out unreliable answers from respondents whose answers lie distant from the most conceivable results. LIMDEP (2002)[i], a statistical software having specialized features for the statistical analysis of complex survey data, was used to analyze the survey data. The analysis was accomplished by fitting nonlinear econometric models to observed data. See Attachment 3 (Project Methodology) and Attachment 4 (National Economic Development Benefits Draft Final Report) for a full discussion of the econometric models employed in this analysis. These econometric models differ from standard regression models in that they can be adapted to handle the unique characteristics of survey data. In addition, the econometric models are developed to estimate economic values of interest, such as a beach recreationist's willingness to pay, or the amount of money the recreationist would be willing to spend for a day of beach recreation. Attachment 3 outlines UNCW's approach to data collection and recommendations for estimating WTP, visitation, and parking needs using the econometric models.

One objective of this study was to estimate peak and latent demand of the beaches under study. Latent or potential demand is the number of individuals who would come to the beach if conditions were more conducive for recreation. This demand is modeled from the stated preference of the respondent versus their revealed preference. The recommended methodology and data collected from the surveys were used to develop a model to estimate the number of trips taken to each beach in 2003 and the additional trips that the respondent would take if the width of the beach were increased. The model was also used to predict a decrease in trips with a decrease in beach width caused by erosion of the beach.

The 2003 beach width was used as a baseline for this study. The without project condition assumes that the baseline condition remains constant over an equivalent period of time to the expected life of the selected alternative for a hurricane and storm damage reduction project. The average annual benefits were calculated for a 50 feet decrease in beach width to capture the effects of erosion on recreation. Long term erosion and hurricane impacts were evaluated separately from the recreation analysis using coastal storm damage models.

Data collected from the aerial photography counts, parking counts and demographic data was also used in this model. Table O-1 presents the demographic information of North Carolina and the sampling area.

Table O-1. 2003 Demographic Information

Variable	Demographic Areas		On Site Survey Models		Telephone Survey Models	
Name	North Carolina	Phone Sampling	WTP Simple	WTP Clogit	Analysis 1	Analysis 2
Mean Age	36*	37	Respondents over 18 years old		42	42
Mean Household Income	$42,536*	$36,072*	$54,255	$68,081	$58,833	$59,153
Sex Female Male	 51% 49%*	 51% 49%*	 54% 46%	 57% 43%	 63% 37%	 62% 38%
Race White Minority	 72% 28%*	 64% 36%*	Not used in model		 81% 19%	 82% 18%
Population / Observations	8,421,050	3,891,199	571	2,131	15	3,424

*All variables are in 2003 values except those notated with asterisks and described below (http://www.nist.gov/itl/div898/strd/).

North Carolina Demographics Age from July 2004 from NC State Demographics website.
North Carolina Demographics Sex and Race are from the 2000 US Census.
North Carolina Demographics Household Income was inflated to 2003 value from 1999 value from the 2000 US Census.

Telephone Sampling Area Demographics Sex and Race are from the 2000 US Census.
Telephone Sampling Area Demographics Household Income was inflated to 2003 value from 1999 value from the 2000 US Census.

3.0 ESTIMATING AVERAGE ANNUAL BENEFITS

The following sections of this appendix will detail the steps that were taken to derive average annual benefits (AAB) for West Onslow Beach and the other beaches included in the surveys. Willingness to pay for beach enhancement will be used to calculate AAB. It is hypothesized that changes in beach characteristics such as beach width will lead to an increase/decrease in the expected number of day user trips per household per year. Changes in the expected number of day user trips per household per year due to changes in beach characteristics can be found by calculating the difference between the expected number of trips per household under baseline conditions and the expected number of trips per household under alternative beach conditions. Since recreationists' responses to changes in beach enhancement cannot be observed from market data, we use the contingent valuation method to estimate the WTP. The next section is devoted to the treatment of missing data for the on-site survey.

3.1 <u>On-Site Survey (OSS), Predicting Missing Income</u>

Some survey respondents did not provide information on household income. However, they completed the remaining survey questions. Obtaining estimates of missing income allows the information from as many survey respondents as possible to be included in the analysis. We developed an ordered probit model (LIMDEP 2002, pp. E18-1 to E18-11) to predict income category for respondents to the on site survey who either refused to answer the household income question, answered 'don't know,' or in cases where the income data was missing. Ordered probit regression methodology is used because the dependent variable, INCOME, is an ordered categorical variable rather than a continuous variable, as assumed in standard regression analysis. The income data are ordered categorical data because survey respondents reported household income by income category ($0-$14,999, $15,000-$29,999, $30,000-49,999, etc.). The recommended methodology for analyzing the data is contained in Attachment 4.

The ordered probit model predicts income category based on characteristics of the surveyed beach visitors. If the incomes of beach visitors differ from the average incomes of individuals within a particular zip code, the model predicts income estimates that are more accurate than estimates based on average income by zip code. Income predictions were obtained by regressing the dependent variable INCOME on the following explanatory variables: TYPE 2, a dummy variable indicating that the survey respondent was a day user; TYPE 3, a dummy variable indicating that the survey respondent was an overnight visitor to the beach; MILES, the reported distance from the respondent's home to the beach; EXPENSE)[ii][ii], total expenses per individual for this beach trip; and GENDER, male = "1", female = "0". The dummy variable indicating whether the survey respondent was a beach resident, TYPE1, was omitted from the analysis to avoid a dummy variable trap. Thus, the regression intercept represents beach residents, and TYPE2 and TYPE3 dummy variables measure differences between day users and overnight visitors, respectively, relative to beach residents. Demographic information on age and race were not collected in the on site survey. Therefore, these variables were not included in the ordered probit model. Table O-2 lists the general descriptive statistics of the variables

Table O-2: On-Site Survey, Ordered Probit Model, Descriptive Statistics

Variable	Mean	Std.Dev.	Skewness	Kurtosis	Min.	Max.	Num Cases
INCOME	2.94669	1.50166	-0.16071	2.01657	0	5	2495
TYPE2	0.210421	0.407689	1.42059	3.01767	0	1	2495
TYPE3	0.725852	0.446174	-1.01239	2.02454	0	1	2495
MILES	117.661	279.221	11.9428	275.909	0	8000	2495
EXPENSE	353.771	880.61	16.8997	521.968	0	30000	2495
GENDER	0.46493	0.498869	0.140599	1.01937	0	1	2495

The issue of multicolinearity between the predictor variables was a concern in this analysis. While it seems intuitive that more miles traveled or more trips taken would lead to higher cost or expenses, this does not seem to be the case in this data. A correlation analysis revealed a linear correlation coefficient of 0.12896 between miles and expense, indicating a weak association of the observed data for the two variables.

3.2 Results of the Ordered Probit Model

Estimated coefficients for the explanatory variables as well as log-likelihoods and chi squared statistics are reported in Table O-3.

Table O-3. Ordered Probit Regression Results

Variable	Coeff.	Std.Err.	t-ratio	P-value	Variable Mean
Index function parameters					
Constant	1.646196***	8.60E-02	19.132	2.89E-15	1
TYPE2	-0.55937***	9.46E-02	-5.913	2.16E-12	0.210421
TYPE3	3.25E-03	8.75E-02	0.037	0.9704	0.725852
MILES	2.84E-05	7.64E-05	0.371	0.7105	117.6615
EXPENSE	2.26E-04***	3.64E-05	6.207	0	353.7715
GENDER	0.152647***	4.21E-02	3.629	0.0003	0.46493
Threshold parameters for index					
μ_1	0.766593	2.62E-02	29.253	2.89E-15	-----
μ_2	1.408244	2.52E-02	55.959	2.89E-15	-----
μ_3	2.020914	2.57E-02	78.73	2.89E-15	-----
μ_4	2.51183	2.95E-02	85.08	2.89E-15	-----

Notes: ***,**, and * refer to significance at the 1%, 5%, and 10% levels, respectively. The chi-square and overall likelihood ratio statistics are 15.09 and 189.14, respectively. Number of observations =2495. Dependent variable: INCOME. In LIMDEP, μ_0 is normalized to zero.

With the exception of TYPE 3 and MILES, all parameters are strongly significant with the expected signs. The likelihood ratio test indicates that the overall model is significant at the α = 0.99 level of significance. The regression results indicate that a day user, TYPE 2, has a negative, statistically significant effect on income category, while EXPENSE has a positive, statistically significant effect on income, suggesting that those responding as day users typically fall in a lower income category than overnight and resident users. GENDER has a positive, significant effect on income, indicating that male survey respondents, on average, have higher income categories than female respondents. As mentioned earlier, both MILES and TYPE3 (overnight visitation) were statistically insignificant. Therefore, travel distance had no influence on the overnight user's decision to go to the beach. The estimated coefficient on MILES indicates that distance from the beach, when separated from the effect of distance on trip EXPENSE, does not contribute to predicting income category. On the other hand, the coefficient on TYPE3 indicates that the income categories of overnight visitors are similar to those of beach residents.

When calculating predicted incomes, dummy variable TYPE2 is set to the value "1," and dummy variable TYPE3 is set to the value "0," to reflect the incomes of day users. Income predictions were made for 1277 observations out of an initial 4780 observations in the data set.

3.3 <u>OSS - Estimating Average Willingness to Pay Using CVM</u>

The first step in developing average annual benefits (AAB) was to determine a person's willingness to pay (WTP) for a visit to the beach, and how certain factors would increase or decrease the likelihood that they would pay more or less to visit a certain beach. A binomial probit regression model (Haab and McConnell 2002, Chapter 2) was used to estimate the average day-user's net willingness to pay (WTP) for beach recreation for each project beach. Only those survey respondents who indicated that they were day users were included in this analysis. Binomial probit regression models are often used to describe the effect of one or more explanatory variables on a binary response variable. In this situation the binary dependent variable is a "yes/no" or "1/0" rather than a continuous variable. The dependent variable for this model is a "yes=1 and no=0", survey variable Q15. Question 15 asks whether or not the user would be willing to pay a specified dollar amount ($5, $10, $15, $25, $50, or $75, depending on the survey version), more than he or she is currently paying to access the beach.

The independent variables used in the binomial probit model attempted to explain the respondent's "yes/no" response to the willingness to pay question. The independent variables used in the regression analysis include: BID amount ($5, $10, $15, $25, $50, or $75, depending on the survey version); GENDER, a categorical variable (M=1, F=0); ALTACT, a categorical variable describing the recreation's alternative activity; MILES traveled to the beach; PARTYSZ , the number of people in the recreation's party; BWIDTH, the width of the beach in feet; PKPERMIL, the number of parking spaces per mile of beach length; RAIN, a dummy variable for rain; and HOLIDAY, a dummy variable to indicate whether the day was a holiday. ALTACT='1' indicated that the recreationist had an alternative activity (survey question Q17=2, 3, or 4), and ALTACT='0' if the recreationist indicated that he or she did not have an alternative activity (i.e., the recreationist would stay home, survey question Q17=1). RAIN='1' would be a response to whether there was 'light rain' or 'heavy rain', and RAIN='0' otherwise. HOLIDAY='1' would be a response to whether the date of the survey was conducted on the 4th of July or Labor Day weekends, and HOLIDAY='0' otherwise.[iii][iii]

Independent variables with missing observations were dropped from the data set. In all 571 observations were used in the binomial probit regression analysis. Descriptive statistics for the regression variables are presented in Table O-5.

Table O-5. Descriptive Statistics for Binomial Probit Regression Model Variables

Descriptive Statistics					
Variable	Mean	Std.Dev.	Min.	Max.	Observations
DEPENDENT VARIABLE	0.33275	0.471611	0	1	571
BID	27.1366	24.43191	5	75	571
GENDER	0.457093	0.498592	0	1	571
ALTACT	0.742557	0.437609	0	1	571
MILES	69.62263	146.5457	2.00E-02	3000	571
PARTYSZ	3.569177	3.224908	1	60	571
BWIDTH	106.6392	21.88758	80	135	571
PKPERMIL	74.23218	36.01124	29.41176	135.102	571
RAIN	0.161121	0.367965	0	1	571
HOLIDAY	0.478109	0.499959	0	1	571

Table O-6 gives the coefficients and standard errors of the binomial probit regression. The likelihood ratio test of the hypothesis that the restricted and unrestricted models are the same is rejected at the 1 % level of significance.

Table O-6. Estimation Results for Probit Model

Index function parameters					
Variable	Coeff.	Std.Err.	t-ratio	P-value	Mean
Constant	-1.28048***	0.350445	-3.654	0.0003	1
BID	2.99E-02***	2.56E-03	11.66	0	27.1366
GENDER	-0.25633**	0.12309	-2.082	0.0373	0.457093
ALTACT	-7.08E-02	0.140267	-0.505	0.6136	0.742557
MILES	-2.65E-04	3.33E-04	-0.795	0.4267	69.62263
PARTYSZ	-6.65E-02**	3.02E-02	-2.206	0.0274	3.569177
BWIDTH	7.68E-04	3.12E-03	0.247	0.8053	106.6392
PKPERMIL	3.07E-03*	1.78E-03	1.724	0.0847	74.23218
RAIN	8.33E-02	0.193155	0.431	0.6663	0.161121
HOLIDAY	0.101767	0.137109	0.742	0.4579	0.478109

Notes: ***,**, and * refer to significance at the 1%, 5%, and 10% levels, respectively. The chi-square and overall likelihood ratio statistics are 21.67 and 164.04, respectively. Number of observations =699. Dependent variable: YES=1/NO=0 Binomial variable.

Observe that the coefficient on BID is statistically significant at the 1% level of significance. The estimated coefficient on BID is highly significant and has the expected sign. The coefficients on GENDER and PARTYSZ are statistically significant at the 5% level, while the coefficient on PKPERMIL is significant at the 10% level. For all model variables except BID, positive coefficients estimates indicate that higher variable values increase the likelihood that respondent would answer, "yes" to the WTP. Hence, being male decreases mean WTP, larger party sizes decrease WTP, and a larger number of parking spaces per mile of beach length marginally increase WTP. In the binomial probit model specification, a positive BID coefficient estimate suggest that higher BID amounts decrease the likelihood that respondents will answer "yes" to the willingness to pay question. Its effect on respondent's choices generally agrees with *a priori* expectations. For the purpose of estimating mean net WTP, BID is the key variable. .

Mean WTP per day trip in the binomial probit model is given by (see Haab and McConnell 2002, Chapter 2):

$$Mean-WTP-per-day-trip=(\beta_{constant}+\beta_{gender}*GENDER+\beta_{altact}*ALTACT$$
$$+\beta_{miles}*MILES+\beta_{partysz}*PARTYSZ+\beta_{bwidth}*BWIDTH+\beta_{pkpermil}*PKPERMIL$$
$$+\beta_{rain}*RAIN+\beta_{holiday}*HOLIDAY)/(-\beta_{bid}) \quad (1)$$

Where the estimated β coefficients are given in Table O-6 and the variable values are either mean values across all beaches (see Mean column in regression results Table O-6) or mean value by beach, depending on whether one desires a mean WTP estimate across all beaches or WTP estimates for each beach.

Mean values across all beaches were used for GENDER, ALTACT, PARTYSZ, RAIN, and HOLIDAY. Beach-specific mean values were used for MILES, BWIDTH, and PKPERMIL. Estimates of mean WTP per day trip and associated 95% confidence intervals by beach are presented in Table O-7.

Table O-7. Estimates of Average (Mean) WTP per Day Trip by Beach (2003 $'s))

Beach	Mean WTP Per Day Trip	95% Confidence intervals
Atlantic Beach	$38.05	$29.44 - $46.65
Caswell Beach	$48.82	$41.14 - $56.50
Emerald Isle	$46.71	$38.45 - $54.97
Indian Beach	$47.98	$41.64 - $54.32
Holden Beach	$49.71	$42.33 - $57.09
North Topsail Beach	$42.88	$34.94 - $50.82
Oak Island Beach	$40.45	$34.31 - $46.59
Pine Knoll Shores	$47.82	$41.26 - $54.38
Salter Path	$47.67	$41.43 - $53.91
Surf City Beach	$47.23	$41.17 - $53.29
Topsail Beach	$46.17	$40.85 - $51.49

The WTP estimates for each particular beach in Table O-7 represent the amount of money that the average beach visitor, surveyed on that particular beach would be willing to pay per day trip to visit that particular beach. However, each value gives the total of two components: the value of visiting any beach in the study region and the additional value of visiting the particular beach on which the individual was surveyed. The additional value of visiting a particular beach will be addressed in estimating WTP for site access using TCM.

3.4 OSS - Estimating WTP for Site Access Using (TCM)

The binomial probit regression WTP estimates presented in the preceding section measure the value of beach day trips in the study region to beach recreationists. This section develops two additional measures of beach value using a conditional logit regression model (Haab and McConnell 2002, Chapter 8). The conditional logit regression model allows estimation of "site access" values and the value of changes in beach characteristics, such as beach width. WTP for site access is the incremental value of having access to a particular beach when other substitute beaches are available. Assuming that the substitute beaches are not perfect substitutes for the beach in question (due to differences across beaches in location and other beach characteristics) WTP for site access is positive. Alternatively, WTP for site access measures the loss in value associated with losing access to a beach, given that other (imperfect) substitute beaches are available.

In developing the conditional logit model we make three assumptions: (1) the proportion of all trips in the survey sample made to a particular beach is the same as the proportion of all trips made to that beach by the targeted population of beach visitors, (2) the 'independence of irrelevant alternatives' assumption holds, and (3) the indirect utility function is linear in its arguments (Haab and McConnell, 2002).

The conditional logit model attempts to explain the proportions of beach visitors in a survey sample visiting each beach as a function of beach characteristics such as beach length, beach width, the number of parking spaces at each beach, the weather forecast for each beach, and more importantly, the cost of traveling to each beach known as the 'access price.' WTP for site access may be estimated based on the estimated proportions. Because travel cost (access price) is used to predict beach choice, this model is a type of "travel cost model" (TCM).

The dependent variable for the conditional logit model is a dummy variable, BEACH. For each survey respondent, BEACH=1 if the respondent was interviewed on that beach and BEACH=0 otherwise. The conditional logit regression procedure in LIMDEP was used to create ten additional observations for each observation in the original dataset, one observation for each of the ten beaches not visited by the survey respondent on the date of the survey. Ultimately, the conditional logit model utilizes eleven observations for each survey respondent, the original observation containing BEACH=1 and the original data for all other variables, and ten additional observations containing BEACH=0 and copies of the original data for all other variables.

Additional non-survey data were collected to create the beach characteristics vector used in the model. Average beach width was estimated using USACE aerial photography from 2002 and was from the mean sea level (msl) to the first line of vegetation. Because the 2002 hurricane season did not significantly impact southeastern North Carolina beaches, USACE determined that average beach widths in 2002 would be adequate estimates of 2003 beach widths. Average beach length was obtained from the Wilmington District GIS database. Parking access points and parking spaces were also collected from USACE project data and the parking data collected by UNCW.

Data was collected from the National Weather Service for the weather station closest to each beach surveyed (only Morehead City and Wilmington stations were used). This data described weather forecasts for each day the on site surveys were administered. Air temperature and wind speed variables were used for each beach as well as variables describing the cloud cover and precipitation. Four dummy variables were created to represent the cloud cover and precipitation for each beach on each day of the survey. These variables include 1.) partly cloudy, 2.) mostly cloudy, no showers or storms, 3.) partly cloudy with scattered or isolated showers or storms, and 4.) mostly cloudy with numerous showers and storms. Values for these variables are '1' if those conditions are present and '0' otherwise. The default weather condition, if none of the variables listed above have values of '1', is mostly sunny.

The access price for each beach is different for each survey respondent, depending on the travel distance between the respondent's home and each beach, and the opportunity cost of the respondent's time. Travel distances and average travel speeds between each survey respondent's home zip code and every beach zip code included in the study were calculated using PCMiler (2005) software. PCMiler calculates distances and average speeds for travel between specified zip codes. This program is helpful for developing the costs of individuals' travel used in travel cost models. The travel distance for each respondent to each of the eleven beaches in the study was calculated using the 'miles' function of PCMiler with the default setting 'prac,' which is the setting for the individual choosing the most practical route. Average travel speed (mph) for each respondent to each beach was calculated by dividing distance by average drive time to each beach.

Distance, speed, and income or estimated income were used to calculate the access price, or a round trip travel cost for each survey respondent from their home zip code to each study area zip code. The cost per mile used was $0.37, the national average automobile driving cost, which includes only the variable costs and no fixed costs for 2003 as reported by American Automobile Association (AAA) (AAA Personal communication, 2005). As is common in recreation studies, one third of the wage rate (income/2000 hours/3) was used to value leisure time for each respondent. For each survey respondent, *i*, and each beach, access price of respondent was derived by the following:

$$Access\_Price_i = ((2*0.37)*distance\_at\_beach_i) + (((1/3)*(income_i/2000))* (2*distance\_to\_beach_i/speed*traveled_i)) \quad (2)$$

The conditional logit regression model was estimated using LIMDEP procedures. The dependent variable BEACH (a categorical 0/1 beach selection variable) was regressed on access price (PRICE), beach length (BLENGTH), beach width (BWIDTH), the number of beach access points (BACCESS), the number of parking spaces (BPARKSP), a dummy variable for rain occurrence (FCRAIN), a dummy for air temperature (FCTEMP), and a dummy for wind speed (FCWIND). The regression results are presented in Table O-8:

Table O-8. Conditional Logit Regression Results

Independent Variable	Parameter Estimate	Std. Error	T-Ratio	P-value
PRICE	-.0241***	0.001	-23.37	0
BLENGTH	0.1665***	0.014	12.025	0
BWIDTH	0.0201***	0.001	15.253	0
BACCESS	-0.0088***	0.002	-4.561	0
BPARKSP	0.0002	9.757E-05	1.548	0.1216
FCRAIN	-0.3020**	0.136	-2.218	0.0266
FCTEMP	0.0844***	0.026	3.249	0.0012
FCWIND	0.03064	0.027	-1.134	0.257

Notes: ***,**, and * refer to significance at the 1%, and 5% levels, respectively. The chi-square and overall likelihood ratio statistics are respectively 20.09 and 672. Number of observations = 2131. Dependent variable: BEACH.

The signs on the estimated coefficients give the qualitative effects of the regressors on the probability that a beach recreationist selects a particular beach. For example, the negative estimated coefficient on PRICE indicates that as the access price increases for a particular beach, the probability that a beach recreationist chooses to visit that particular beach decreases. Hence, the impact of increasing access price on the probability of beach selection is negative and significant. Increases in beach length or width have positive and significant impacts on the probability of beach selection. An increase in the number of available parking spaces has a positive, though marginally significant (p=0.1216), impact on the probability of beach selection. Perhaps surprisingly, the number of beach access points has a negative and significant impact on beach selection. However, the number of beach access points may be a proxy measure of "commercial development," which may be negatively related to the probability of beach selection if most recreationists desire a more solitary beach experience. Finally, the weather variables have the expected signs, with a forecast of rain and temperature having significant effects and a forecast of wind having an insignificant effect on the probability of beach selection. In all, the overall regression is significant at the 1% level of significance.

Measures of WTP for site access are calculated from the conditional logit regression results (Haab and McConnell 2002). WTP for site access to beach *i* is given by:

$$WTP_i = \left(\frac{1}{\beta PRICE}\right) \ln(1 - \Pr_i^0) \quad (3)$$

Where $\Pr_i^0$ is the predicted probability of an individual selecting beach *i* under baseline conditions and $\beta price$ is the coefficient on the access price. The values of $\Pr_i^0$ and WTP for site access for each beach are presented in Table O-9:

Table O-9. Site Access Values

Beach		Pr_i^0	(2003 $'s / trip)
0	Caswell Beach	0.03264	$1.38
1	Oak Island Beach	0.1094	$4.82
2	Holden Beach	0.09103	$3.97
3	North Topsail Beach	0.12304	$5.46
4	Surf City Beach	0.06635	$2.85
5	Topsail Beach	0.0813	$3.53
6	Pine Knoll Shores Beach	0.08142	$3.53
7	Salter Path Beach	0.02958	$1.25
8	Indian Beach	0.02809	$1.18
9	Emerald Isle Beach	0.22641	$10.67
10	Atlantic Beach	0.13072	$5.83

The site access WTP values in Table O-9 are the portion of WTP attributable to the beach on which the individual was surveyed. In other words, if the individuals were prevented from visiting that particular beach but were able to visit another beach within the study region, the beach visitor would experience a reduction in value equal to that in Table O-9. The values in Table O-9 are smaller than the WTP values in the preceding section because the site access WTP values give only the additional (marginal) value to the recreationist of visiting the chosen beach over the next-best substitute beach in the study region. This value is in addition to the value of visiting simply any beach within the study region. The WTP values in the preceding section of the report give the total of both value components: the value of visiting any beach in the study region and the additional value of visiting the particular beach on which the beach visitor was surveyed. The WTP values in Table O-9 are similar to those found by Parsons, Massey and Tomasi (1999), who used a conditional logit model to study beach recreation trips made by Delaware residents to New Jersey, Delaware and Virginia beaches in the fall of 1997.

3.5 <u>OSS - Estimating WTP for Changes in Beach Quality Using TCM</u>

The conditional logit model developed in the preceding section may also be used to estimate WTP for changes in beach quality, such as changes in beach width or the number of available parking spaces. WTP for a change in beach quality characteristic q at beach *i* from an original level of the characteristic q^0 to a new level of the characteristic q' is given by:

$$WTP_i = \left(\frac{1}{\beta PRICE}\right)\{\ln[1 - \Pr_i^{'}(q^{'})] - \ln[1 - \Pr_i^{0}(q^{0})]\} \quad (4)$$

Where $Pr_i^0(q^0)$ is the simulated probability of a beach visitor selecting that beach *i* when the level of beach quality characteristic q at beach *i* is q^0, and $Pr_i'(q')$ is the simulated probability of a beach visitor selecting beach *i* when the level of beach quality characteristic q at beach *i* is q' (Haab and McConnell 2002). The simulated probabilities Pr_i^0 and Pr_i' are calculated using the conditional logit model regression results presented in the preceding section.

Several alternative policy scenarios involving changes in beach quality characteristics can be evaluated using the conditional logit model results. This analysis focuses only on the change in beach width effecting WTP.

3.6 Project Scenarios

The purpose of developing project scenarios is to calculate WTP for specified changes in beach width compared to the 2003 base year. Beach width changes of –50ft, +50ft, +100ft, and +150ft were used as scenarios. LIMDEP simulations were carried out for each beach separately, meaning that the beach width was changed for only one of the eleven towns while assuming that the beach widths at the other ten towns remained constant, at the 2003 base year levels. Note that changing the width of a particular beach also affects WTP at other, nearby, substitute beaches. However, to simplify the presentation, results are presented only for the beach on which the change in width occurs.

The simulated probability of an individual selecting a particular beach varies depending on the changes in width. Equation 4 was used to estimate the WTP for changes in beach width. The conditional logit model estimates of changes in WTP per trip resulting from changes in beach width (BWIDTH) are reported in Table O-10.

Table O-10. Changes in WTP per Trip Resulting from Changes in Beach Width

	Changes in WTP per Trip (2003 $'s) Resulting From Changes in Beach Width(BWIDTH)			
	-50 feet	+50 feet	+100 feet	+150 feet
Caswell Beach	-$0.84	$2.05	$6.47	$14.61
Oak Island	-$3.17	$5.43	$14.69	$28.92
Holden Beach	-$2.38	$5.20	$14.94	$30.51
North Topsail Beach	-$3.34	$7.77	$23.07	$47.36
Surf City	-$1.77	$4.39	$14.13	$32.06
Topsail Beach	-$2.18	$5.30	$16.64	$36.53
Pine Knoll Shores	-$2.17	$5.14	$15.65	$33.22
Indian Beach	-$0.73	$1.91	$6.61	$16.74
Salter Path	-$0.77	$2.01	$6.93	$17.43
Emerald Isle	-$6.31	$12.63	$33.03	$60.13
Atlantic Beach	-$3.52	$7.72	$21.81	$42.91

It can be deduced from Table 0-10 that the average recreationist would be willing to pay an additional $5.30 per trip to enjoy a beach width of 160 ft at Topsail Beach as opposed to a beach width of 110 ft. This $5.30 value is not a “per foot of beach width” measure; rather, it is the willingness to pay for entire increase in beach width at Topsail Beach from 110 ft to 160 ft. Although not shown in Table O-10, an increase in beach width at a particular beach alone results in the attraction of some beach visitors to that beach and away from other beaches in the sample region. Observe that a decrease in beach width at a particular beach results in fewer trips to that beach and more trips to other beaches in the sample region.

Note that the values presented in Table O-10 reflect the effect of increased beach width at one particular beach only. If beach width were improved at all beaches simultaneously, then the increase in trips to that one particular beach would be smaller, as fewer individuals would be attracted away from other beaches in the study region to that beach.

4.0. TELEPHONE SURVEY (TS)

The site survey data was used to estimate recreation value per trip (net willingness to pay). The following section is devoted to the estimation of annual visitation model for each beach based on telephone survey data.

4.1 TS - Predicting Missing Income Data

Some survey respondents did not provide information on household income, yet they answered all other or at least the majority of the remaining survey questions. Obtaining estimates for missing income allows the information from as many survey respondents as possible to be included in the analysis. An ordered probit model was developed to predict income for telephone survey respondents, who either refused to answer the income question, answered 'don't know' to the income question, or for whom income data were missing. The ordered probit model specification is described in Attachment 4. The model predicts the dependent variable household income (INCOME), which is a categorical variable, using the independent variables collected via the telephone survey. If the incomes of beach visitors differ from the average incomes of individuals within a particular zip code, the model predicts income that are more accurate than estimates based on average income by zip code.

The conditioning variables used in the regression were: distance in miles from the respondent's home zip code to the zip code of the beach closest to the respondent's home zip code (MINDIST), sex (SEX), marital status (MARRIED, "No"=0, "Yes"=1), race (RACE, "White/Caucasian"=0, Other=1), age (AGE), age squared (AGESQ), a dummy variable indicating college (baccalaureate) graduation (COLLGRAD, "No"=0, "Yes"=1), and interaction variables for marriage and age (MARAGE = MARRIED*AGE) and marriage and college MARCOLL=MARRIED*COLLGRAD).

Table O-11 presents descriptive statistics for the variables employed in the regression.

Table O-11. Descriptive Statistics for Ordered Probit Regression Model

Variable	Mean	Std.Dev.	Skewness	Kurtosis	Min.	Max.	Obser-vations
INCOME	2.51029	1.53269	0.161413	2.08667	0	5	729
MINDIST	115.559	136.008	3.68654	18.365	0	808.2	729
SEX	0.603567	0.489492	-0.42316	1.17769	0	1	729
MARRIED	0.674897	0.468735	-0.74625	1.55552	0	1	729
RACE	0.148148	0.355491	1.97953	4.91716	0	1	729
AGE	42.4925	14.568	0.449375	2.54649	13	85	729
AGESQ	2017.54	1355.97	1.12074	4.06728	169	7225	729
MARAGE	30.262	23.7804	-0.05754	1.76408	0	85	729
COLLGRAD	0.447188	0.497544	0.212291	1.0437	0	1	729
MARCOLL	0.314129	0.464487	0.800329	1.63915	0	1	729

Table O-12 presents the regression results.

Table O-12. Ordered Probit Regression Model Results

Variable	Coefficient	Std.Error.	t-ratio	P-value
ONE	-1.50248***	0.344	-4.364	1.28E-05
MINDIST	0.00073**	0.0003	2.489	0.012826
SEX	-0.22794**	0.0811	-2.811	0.004946
MARRIED	1.01791***	0.2682	3.796	0.000147
RACE	-0.599***	1.14E-01	-5.248	1.53E-07
AGE	0.106275***	0.01568	6.778	1.22E-11
AGESQ	-0.00106***	1.70E-04	-6.233	4.57E-10
MARAGE	-0.00495	0.005995	-0.825	0.409313
COLLGRAD	0.843713***	1.44E-01	5.849	4.94E-09
MARCOLL	-0.03855	1.73E-01	-0.222	0.824125
Threshold parameters for index				
μ_1	0.907364	5.07E-02	17.898	0.000
μ_2	1.754921	5.04E-02	34.787	0.000
μ_3	2.480497	5.46E-02	45.396	0.000
μ_4	2.891494	6.29E-02	45.935	0.000

Notes: *** and ** refer to significance at the 1%, and 5%, levels, respectively. The chi-square and overall likelihood ratio statistics are respectively 21.67 and 307.78. Number of observations = 729. Dependent variable: INCOME. In LIMDEP, $\mu 0$ is normalized to the value zero;

With the exception of the interaction variables, all explanatory variables are statistically significant. MINDIST, MARRIED, AGE and COLLGRAD have positive impacts on predicted INCOME, while SEX, RACE, AGESQ have negative impacts. The ordered probit model was used to predict an income category for those cases listed above where the raw income variable value was missing, ‘don’t know,’ or ‘refused’. A spreadsheet is used to calculate predicted income numbers from the regression results in the table above. A new income category variable ‘INCCAT’ containing the predicted income categories was created. INCCAT was converted to numerical variable INCMIDPT using the midpoint of each income category, except that the numerical values for the first and last income categories were set at $15,000 and $110,000, respectively.

4.2 TS - Annual Visitation Model Using TCM

Thus far, this analysis has determined the recreationist’s WTP for a trip to the beach using data from the on site survey and the missing income data from both the on site and telephone survey responses. The final requirement necessary to calculate the average annual benefits (AAB) is to determine the annual visitation for each beach. The telephone survey data was used to estimate an annual visitation model for each beach. To address the fact that the dependent variable, trips per household per year, is an integer variable, a Poisson/negative binomial regression model framework was used (Haab and McConnell, 2002, pp164-174; LIMDEP Chapter E20). The Poisson regression model is appropriate unless the data are over-dispersed. The data are overdispersed when the variance in trips per year is greater than mean trips per year. If the data are over-dispersed, the negative binomial model is appropriate. Statistical tests reported in Table O-14 indicate that the data are not over-dispersed. Therefore, the use of the Poisson model is appropriate.

Each of the 1,067 respondents in the data set reported the number of recreational beach trips taken to each of 17 beaches in southeastern North Carolina during the summer of 2003. The 1,067 respondents reported a total of 9,002 trips as shown in Table O-13.

Table O-13. Distribution of 2003 Beach Trips Across Beaches

Beach Number	Beach Name	2003 Beach Trips	
		Number in Sample	Proportion of Sample
00	Caswell Beach	163	0.02
01	Oak Island	163	0.02
02	Holden Beach	183	0.02
03	North Topsail Beach	719	0.08
04	Surf City	279	0.03
05	Topsail Beach	245	0.03
06	Pine Knoll Shores	143	0.02
08	Salter Path and Indian Beach	135	0.01
09	Emerald Isle	1083	0.12
10	Atlantic Beach	919	0.10
11	Fort Macon	251	0.03
12	Carolina Beach	1502	0.17
13	Kure Beach	360	0.04
14	Fort Fisher	404	0.04
15	Ocean Isle Beach	353	0.04
16	Sunset Beach	153	0.02
17	Wrightsville Beach	1947	0.22
	Total Trips	9002	1.00

For modeling purposes, the data for each survey respondent were expanded into 17 rows of data, one row for each beach. The data set used for the Poisson regression therefore has 1,067*17 = 18,139 rows of data, with 17 rows for each survey respondent. Each row of data consists of the number of trips taken to a particular beach (TRIPS), the access price for that respondent and beach (ACCPRI), beach width (BWIDTH), beach length (BLENGTH), beach parking spaces (BSPACES), beach access points (BACCESS), respondent's household income in $1,000's (INCOME), the respondent's age (AGE), age squared (AGESQ), the number of children in the respondent's household (NUMKIDS), and dummy variables indicating whether the respondent was female, married, or a member of a racial minority. A system of dummy variables labeled DD01 through DD17 was created to allow each beach to have a separate slope coefficient for the variable ACCPRI, which allows the effect of access price on trips to vary by beach. Dummy variable DD07 was omitted because the relatively few data from beach 07 were pooled with the data from adjacent beach 08 for the analysis. To avoid the dummy variable trap, the dummy DD00 corresponding to Caswell Beach was omitted. The coefficient on ACCPRI is the coefficient corresponding to Caswell Beach, and the coefficients on the dummy variables shift the coefficient on ACCPRI as appropriate for the other beaches. Allowing the effect of access price to vary by beach is necessary in order to obtain separate estimates of willingness to pay for each beach.

Travel distances and average travel speeds between each survey respondent's home zip code and every beach zip code included in the study were calculated using PCMiler Software. If distance = 0, then the speed would be zero. In this case, speed was set equal to 2 mph to correspond to average walking speed and distance was set to equal 1 mph. Distance, speed, and estimated hourly wage (reported/estimated household income divided by 2000 work hours per year) were used to calculate the access price (ACCPRI), or a round trip travel cost, for each survey respondent from the home zip code to every beach zip code. The cost per mile used was \$0.37, the national average automobile driving cost for 2003 as reported by American Automobile Association (AAA) (AAA Personal communication 2005). The AAA cost per mile estimate is based on 15,000 miles driven per year for three typical cars, which only includes the variable costs and no fixed costs. One third of the wage rate was used to value leisure time for each respondent. For each survey respondent, *i*, beach-specific access price were calculated as follows:

$$ACCPRI = ((2 * 0.37) * distance) + (((1/3) * (INCMIDPT_i / 2000)) * (2 * distance / speed))) \quad (5)$$

General descriptive statistics of the respondents are listed in Table O-14.

Table O-14. Descriptive Statistics for the Poisson Regression Model

Variable	Mean	Std.Dev.	Minimum	Maximum	Observations
TRIPS	0.496279	5.875066	0	200	18139
ACCPRI	160.4209	135.8946	0	1169.75	18139
BWIDTH	129.5294	73.24627	80	400	18139
BLENGTH	4.547059	2.896755	1.1	11.5	18139
BSPACES	448.1765	353.8989	56	1479	18139
BACCESS	27.47059	19.93018	2	69	18139
INCOME	58.83318	28.50739	15	110	18139
FEMALE	0.633552	0.481847	0	1	18139
MARRIED	0.715089	0.451384	0	1	18139
NUMKIDS	0.940019	1.140643	0	8	18139
MINORITY	0.192127	0.393984	0	1	18139
AGE	42.42737	14.91017	18	104	18139
AGESQ	2022.382	1403.119	324	10816	18139

Since the surveying was done by telephone and the dependent variable in the TCM is the number of trips a respondent has taken in the past twelve months, statistical efficiency is improved by using a count data estimator. The number of trips taken is a non-negative integer, rather than a continuous variable as assumed in the normal distribution. The count data model estimated has a Poisson distribution with the following specification:

$$TRIPS = EXP[\beta_c + (\beta_a + \beta_{xx} DD_{xx}) ACCPRI + \beta_{18} * BWIDTH + \beta_{19} * BLENGTH$$
$$+ \beta_{20} * BSPACES + \beta_{21} * BACCESS + \beta_{22} * INCOME + \beta_{23} * FEMALE + \beta_{24} * MARRIED$$
$$+ \beta_{25} * NUMKIDS + \beta_{26} * MINORITY + \beta_{27} * AGE + \beta_{28} * AGESQ + \varepsilon] \quad (6)$$

Where “EXP” is the exponentiation operator, “xx” is a beach index variable, ACCPRI, BWDTH, BLENGTH, BSPACES, BACCESS, INCOME, FEMALE, MARRIED, NUMKIDS, MINORITY, AGE, and AGESQ are as defined and ε is normally distributed error term.

The results of the Poisson equation are listed in Table O-15.

Table O-15. Poisson/Negative Binomial Cluster Regression Results

Variable	Coeff.	Std.Err.	t-ratio	p-value	Variable Mean
Constant	-1.09355	0.968624	-1.129	0.2589	1
ACCPRI	-0.02553***	0.006365	-4.011	0.0001	160.4209
DDD01	-0.01683	0.011313	-1.488	0.1368	10.45277
DDD02	-.902962D-04	0.007629	-0.012	0.9906	9.215456
DDD03	-0.00515	0.009826	-0.524	0.6003	8.580884
DDD04	-0.00186	0.00739	-0.252	0.8008	8.292163
DDD05	-0.00631	0.009542	-0.661	0.5083	8.292163
DDD06	0.000829	0.006838	0.121	0.9035	9.93717
DDD08	0.002027	0.006035	0.336	0.737	9.910301
DDD09	0.002177	0.0105	0.207	0.8357	9.656682
DDD10	0.011904**	0.005727	2.079	0.0377	9.93717
DDD11	0.001691	0.006004	0.282	0.7782	9.93717
DDD12	0.009143	0.006296	1.452	0.1465	8.714047
DDD13	-.297979D-04	0.005936	-0.005	0.996	8.961451
DDD14	-0.00026	0.009382	-0.028	0.9777	8.961451
DDD15	0.005259	0.005899	0.892	0.3726	10.5665
DDD16	-0.009	0.010376	-0.868	0.3856	10.48006
DDD17	0.005387	0.006758	0.797	0.4253	8.072745
BWIDTH	0.002394	0.002572	0.931	0.352	129.5294
BLENGTH	0.025076	0.119415	0.21	0.8337	4.547059
BSPACES	0.000493	0.000452	1.091	0.2754	448.1765
BACCESS	0.017385	0.019619	0.886	0.3755	27.47059
INCOME	0.019647***	0.005355	3.669	0.0002	58.83318
FEMALE	-0.25952	0.240868	-1.077	0.2813	0.633552
MARRIED	-0.36621*	0.218787	-1.674	0.0942	0.715089
NUMKIDS	0.091765	0.100994	0.909	0.3635	0.940019
MINORITY	-0.65093**	0.287471	-2.264	0.0236	0.192127
AGE	0.038489	0.030273	1.271	0.2036	42.42737
AGESQ	-0.00046	0.000314	-1.462	0.1437	2022.382

Notes: ***,**, and * refer to significance at the 1%, 5%, and 10% levels, respectively. The chi-square and overall likelihood ratio statistics are 48.3 and 22373, respectively. Number of observations =699. Dependent variable: TRIPS.

Two tests of over-dispersion for the Poisson regression model results indicate that the data are not over-dispersed. Therefore, results of the Poisson version of the model in Table O-15 are retained, and the negative binomial regression model was not pursued. In general, the estimated coefficients in the regression results are of the anticipated signs and are statistically significant. Higher access prices ACCPRI reduce the number of expected beach TRIPS, while higher incomes INCOME increase expected TRIPS. Increases in beach width BWIDTH, beach length BLENGTH, the number of parking spaces BSPACES, or the number of beach accesses BACCESS increase expected TRIPS, while being MARRIED, having a larger number of children (NUMKIDS), being a member of a MINORITY group, or being older (AGE), decrease the number of expected TRIPS.

5.0. Calculating Project Average Annual Benefits (AAB)

The average annual benefits (AAB) of recreation under baseline 2003 conditions at each of the project beaches are calculated using estimates of annual trips to each beach, based on the telephone survey data, and estimates of recreation value per trip (net willingness to pay,) based on the on site survey data. This study calculates the AAB for day user trips only. The recreation benefits received by permanent beach residents and benefits associated with overnight trips are not included.

Estimates of the number of day user recreation trips to each project beach during the 2003 baseline season are developed from the telephone survey data. These estimated trips account only for trips originating from the geographic “area of influence” identified using the on site survey data. The “area of influence” is the geographic area where seventy percent of the on site survey day trips originated or a 120-mile radius of the beaches under study. The area of influence corresponds roughly to the eastern half of North Carolina. A random sample of telephone households in the area was conducted in the spring of 2003. Of the 1876 households surveyed, 1,187 or 63% reported taking a trip to one or more of the beaches included in this study in 2003. Survey questions gathered information on each respondent’s number of trips to each project beach in 2003. The 1,067 survey respondents who answered beach destination questions reported taking 9,002 trips to study area beaches in 2003. These trips were distributed across project area beaches as shown previously in Table O-13.

Based on the telephone survey trip data, a model was estimated to predict annual trips per beach trip-taking household for each beach. North Carolina state government projections of county household populations in the area of influence were used to project the number of households from 2004 through 2059. The number of households is multiplied by the 0.63 fraction of households taking a beach trip to a project beach in 2003 (assumed constant across years) and the number of trips to each beach per beach trip-taking household. For beach *i* in year *t*, the baseline predicted number of trips from all households in the area of influence is given by:

Baseline Predicted Trips in Year t to Project Beach i = Projected Households in Area of Influence *0.63 *Trips per beach trip-taking household to project beach i (7)

Estimates of recreation value per recreation trip, or net willingness to pay (WTP) per trip, are calculated for baseline 2003 conditions from the on-site survey data. These estimates are presented in Table O-16.

Table O-16. Baseline 2003/2004 WTP/trip values, Wald Test estimates

Beach	WTP	Std Error
Caswell	$48.82	$3.84
Oak Island	$40.45	$3.07
Holden	$49.71	$3.69
North Topsail Beach	$42.89	$3.97
Surf City	$47.23	$3.03
Topsail Beach	$46.17	$2.66
Pine Knoll Shores	$47.83	$3.28
Salter Path	$47.68	$3.12
Indian Beach	$47.98	$3.17
Emerald Isle	$46.71	$4.13
Atlantic Beach	$38.05	$4.30

Estimates of the annual recreation benefits (2004 year-dollars) of all beach trips taken to each beach in the baseline year are calculated by multiplying the estimated number of beach trips to each beach by the baseline WTP per trip. Annual recreation benefits in future years for each beach are calculated by multiplying estimated annual day trips to each beach (conditional on growth in the household population in the area of influence) by the WTP per trip for each beach (assumed to remain constant in real-dollar terms).

The net present value (NPV) (2004 dollars) of the annual recreation benefits occurring in each future year to each beach is calculated by discounting annual recreation benefits at the FY 2005 interest rate of 0.05375. For each project beach, present worth average annual benefits (PWAAB) are calculated by summing the annual NPV of recreation benefits across all project years and amortizing the accumulated NPV over the 50-year period of analysis. PWAAB are the average annual benefits of recreation expressed in current 2004 dollars, so that the amounts reflect what the recreation benefit due to nourishment is worth today. The estimated project start year for each project is shown in Table O-17. This project start year for construction is subject to change by a year or two for each study area. If changed, the recreation benefit calculations will not be significantly different.

Table. O-17. Project Start Year

Study Area	USACE Start Construction Fiscal Year
Topsail Beach	2011
Surf City/North Topsail Beach	2012
Bogue Banks	2009
Brunswick County Beaches	2009

AAB for each project is calculated by multiplying the PWAAB for each project by the 50-year, 5 3/8%, interest and amortization factor (.057981.) For the purpose of calculating AAB, zero benefits are assumed for years the project start year.

The recreation AAB for several alternative project scenarios were estimated. The project scenarios for each beach consider changes to beach widths and how those widths might increase or decrease a beach goer's willingness to pay additional money for four alternative beach widths. The alternative beach widths are defined relative to the baseline widths of each beach in 2003, presented in Table O-18.

Table O-18. Baseline 2003 Beach Widths

Beach	Average Width (ft)
Caswell	80
Oak Island	120
Holden	90
North Topsail Beach	82
Surf City	90
Topsail Beach	110
Pine Knoll Shores	110
Salter Path	90
Indian Beach	90
Emerald Isle	130
Atlantic Beach	135

The four scenarios are:

1) Subtract 50 ft from the width of each beach
2) Add 50 ft to the width of each beach
3) Add 100 ft to the width of each beach
4) Add 150 ft to the width of each beach

Based on the results of the survey data analysis and modeling effort changes in both the estimated numbers of trips made to each beach and the beach-specific WTP per trip resulting from the changes in beach widths are estimated. NPV, PWAAB, and AAB are re-calculated as outlined above for each beach under each of the four scenarios using the beach-specific estimates of changes in trips and changes in WTP per trip. A "project AAB" for each of the four scenarios for each beach is calculated by subtracting baseline AAB from the scenario AAB for each scenario for each beach. Next a curve was generated that would estimate and account for the increased beach width. In the case of West Onslow Beach, the original beach width was 110 feet measured from the first line of vegetation to mean sea level (msl). The recreation beach width for USACE Wilmington's 1550 plan cross section excludes the vegetated dune crest and dune slopes, and includes the 50 foot berm and the 15H:1V berm slope between the berm elevation of 7 feet NGVD and the mean sea level (assume 0 feet NGVD). This 1550 plan recreation beach width then is 50 feet + 15 * (7 feet - 0 feet) = 50 feet + 105 feet = 155 feet. The with project condition selected alternative of the 1550 plan would add an additional 45 feet and results in approximately $5,500,000 PWAAB for the Town of Topsail Beach as estimated in Figure O-1.

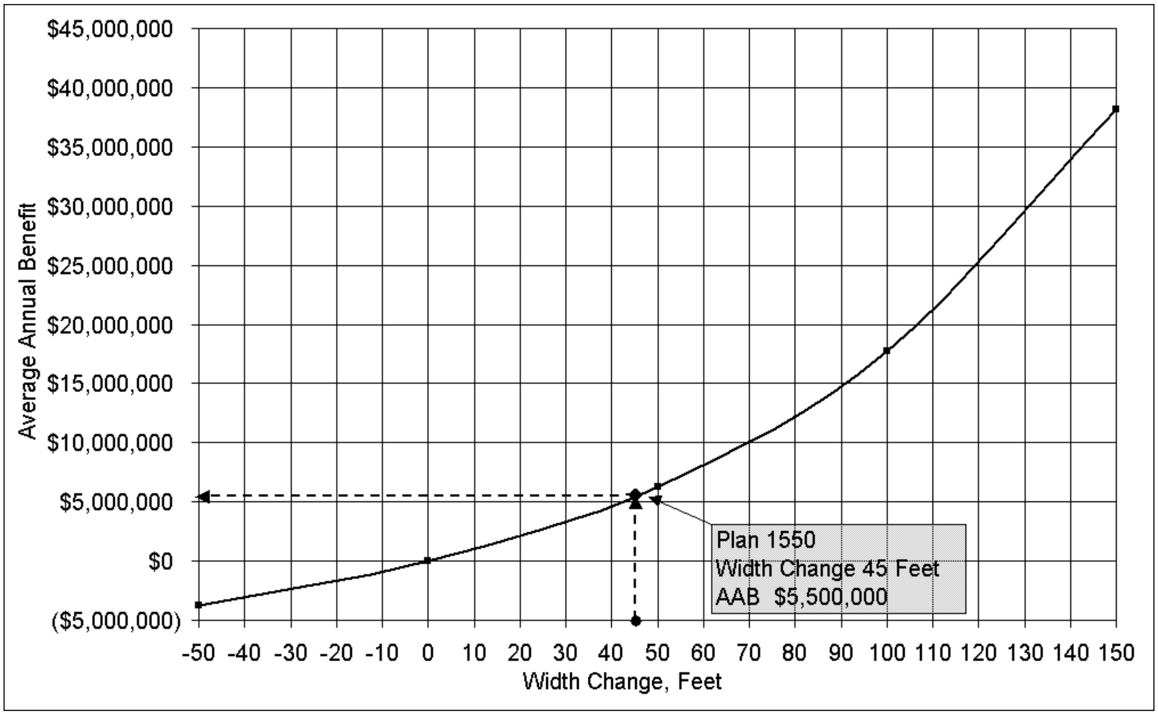

Figure O-1, Topsail Beach Recreation Benefits and Width Increase

6.0 CONCLUSION

The purpose of this study and subsequent evaluation was to improve the recreation benefit analysis for Hurricane and Storm Damage Reduction projects. As stated earlier, recreation benefits are included as incidental benefits in the total benefit accounting, but they are not included in the formulation of the project with respect to size and scope. However, with respect to West Onslow Beach the project selected alternative is justified on HSDR benefits alone; therefore, by improving the methodology for calculating recreation benefits more accurately the added benefit of providing sand for recreation increases the total net benefit of the selected plan and increases the project's benefit cost ratio significantly. Based on the data collection and results of this study, it can be supported that beach user's willingness to pay for beach visits adds to the structural value of hurricane and storm damage reduction to the beach as a recreational outlet for the public. Therefore, it is reasonable to use the figures established as a result of the economic models in this report to add to the net benefit of a hurricane and storm damage reduction project for Topsail Beach, NC. Assuming a project life of 50 years and an interest rate of 5 3/8 %, average annual benefits for recreation total approximately $5.5 million.

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i[i] McCullouch and Vinod (1999) have been documented the performance of LIMDEP relative to the National Institute of Standards and Technology, NIST, benchmarks for testing statistical software

ii[ii] Although it would be reasonable to suspect that MILES and EXPENSE could be highly correlated, which could lead to multicollinearity problems in the regression analysis, a correlation analysis revealed that these variables are not, if fact, highly correlated in this dataset (linear correlation coefficient 0.12896, n=2755).

iii[iii] Household income is not included as an independent variable in the binomial probit model because income effects "fall out" of this model specification. However, a varying parameters version of the binomial probit model was also estimated (Haab and McConnel 2002, Chapter 2, pp.48-49). The varying parameters model allows estimation of WTP by household income category. These estimates are available upon request.