Feasibility Report
and
Environmental Impact Statement

on

Coastal Storm Damage Reduction

SURF CITY AND NORTH TOPSAIL BEACH, NORTH CAROLINA

Appendix O

Recreation Analysis

Surf City & North Topsail Beach
Recreation Analysis

Abstract

Full and accurate valuation of public goods is essential for appraising projects and policies affecting the use of environmental resources. Under-valuation of recreational resources can bias beach recreation value in directions that are not consistent with maximizing economic welfare. A measure of the economic value of beach improvement is the amount of money an individual is willing to pay (WTP) to attain the improvement and which leaves the individual just as well off as if there were no improvement to the beach and no payment. A positive WTP for an initial beach improvement beyond the existing condition suggests that beach nourishment can be considered an economic good and is therefore a candidate for cost-benefit analysis of a beach fill project. This study estimates WTP of a beach day for the average visitor within a travel cost model (TCM) framework. Onsite visitation data for seventeen North Carolina beaches were collected between July and August 2003 and a telephone survey conducted in May 2004, with a target population based upon the results of the onsite survey conducted in 2003. Estimation results for the TCM measure the incremental value of having access to a particular beach when other substitute beaches are available, and the value of changes in beach characteristics, such as beach width. Additionally, the data was used to predict annual and peak visitation at the subject beaches and parking and access requirements to handle projected visitation. Finally, the National Economic Development (NED) benefits for the with-project conditions for the subject beaches were estimated. The expected average annual benefit (AAB) for Surf City and North Topsail beaches for the with-project condition tentative selected alternative of 1550 plan are approximately $12,709,000 and $7,796,000, respectively. The 1550 design plan will add an additional beach width of 65 feet and 73 feet for Surf City and North Topsail beaches.

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.

Planning and Guidance (P&G) describes recreation benefits as incidental benefits of the National Economic Development Account. As described in ER 1105-2-100: Single purpose shore protection projects are formulated exclusively for hurricane and storm damage reduction (HSDR) and recreation is an incidental benefit. Recreation benefits can be included in the benefit/cost ratio for a project. However, HSDR benefits must account for at least half of the total benefits required to justify the project or the federal government will not share the project costs for that shoreline reach. 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 after a plan has been selected.

The focus of this collaborative study effort was on day trip visitors who use 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; 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 report will provide an outline methodology that will be used to analyze data collected from the on-site survey, telephone survey, parking counts, and aerial photography. The final analysis 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 that will be calculated using the travel cost method (TCM) and the contingent valuation method (CVM).

This analysis will answer the following key questions for the reader:

- 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 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 feet increase in beach width at Surf City or at North Topsail Beach?

Additionally, this report will provide an overview of how the data will be used to establish baseline parking and access needs for Surf City and North Topsail Beach and project future parking needs in the with project condition.

2.0. METHODOLOGY

A multi-method approach was used in examining this studies 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. Survey data obtained from telephone and on-site survey invariably suffer from spurious records coming from missing values, outliers, and duplicate values, etc. Basic analytic methods for surveying data required first and foremost scrubbing the data and removing outliers. LIMDEP (2002)[i], a statistical software having specialized features for the statistical analysis of complex survey data, will be employed to analyze the survey data. The analysis will be accomplished by fitting nonlinear econometric models to observed data. 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, 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.

One objective of this study is 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 was 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.

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		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.

The 2003 beach width was used as a baseline for this study. The without project condition assumed 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 were employed in this model. Table 1 presents the demographic information of North Carolina and the sampling area.

3.0 ESTIMATING AVERAGE ANNUAL BENEFITS

This section of the appendix will detail the steps that will be taken to derive average annual benefits (AAB) of recreation for Surf City and North Topsail Beach and the other beaches included in the surveys. Willingness to pay for beach improvement was used in calculating AAB. It was 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 were 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 improvement cannot be observed from market data, we use the contingent valuation method to estimate the WTP.

3.1 On Site Survey (OSS) - Estimating Willingness to Pay Using Contingent Valuation Method (CVM)

The first step in developing average annual benefits (AAB) of recreation is to determine a person's willingness to pay (WTP) for a visit to the beach and how certain factors will increase or decrease the likelihood that they pay more or less to visit a certain beach. Contingent valuation survey questions focus on specific environmental service(s) and the context that is clearly defined and understood by survey respondents. To determine the average day-user's net willingness to pay (WTP) for beach recreation for each project, we used a binomial probit model (Haab and McConnell 2002, Chapter 2). In this study, we used the procedure to generate an equation that expresses willingness to pay (WTP) as a function of a set of socioeconomic and attitudinal variables. We specify WTP as a function of gender, age, income, beach width in feet, number of parking spaces per mile of beach length, weather condition and holiday.

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 model explain the respondent's "yes/no" response to the willingness to pay question. The variables 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.[ii][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-2.

Table O-2. 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-3 gives the coefficients and standard errors of the binomial probit regression. Based on the regression results, the significant likelihood ratio chi-square test indicates that the model overall is significant at the 1% level. However, only explanatory variables BID, GENDER and PARTYSZ are statistically significant at the 1% and 5% level, while PKPERMIL is significant at the 10% level.

Table O-3. 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.

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 suggests that higher BID amounts *decrease* the likelihood that respondents will answer “yes” to the willingness to pay question (as expected). 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. The estimated coefficient on BID is highly significant and of the expected sign.

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

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

where the estimated β coefficients are given in Table O-3 and the variable values are either mean values across all beaches (see Mean column in regression results Table O-3) 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-4.

Table O-4. 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-4 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.

3.2 OSS – Estimating WTP for Site Access Using Travel Cost Method (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 (see Haab and McConnell, 2002) and (3) the indirect utility function is linear in its arguments.

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, 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 creates 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[1].

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:

$$ACCPRI_{i,j} = ((0.37 * 2 * DIST_{i,j}) + (((1/3) * (INCOME_j / 2000)) * (2 * DIST_{i,j} / SPED_{i,j})) \Rightarrow\Rightarrow (2)$$

The conditional logit regression model was estimated using LIMDEP procedures. The dependent variable BEACH 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-5:

Table O-5. 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.

[1] The software 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.

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:

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

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-6:

Table O-6. 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-6 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-6. The values in Table O-6 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-6 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.

3.3 <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:

$$WTP_i = (\tfrac{1}{\beta PRICE})\{\ln[1 - \Pr_i^{'}(q^{'})] - \ln[1 - \Pr_i^{0}(q^{0})]\} \Rightarrow\Rightarrow (4)$$

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.

3.4. <u>Project Scenarios</u>

Several alternative policy scenarios involving changes in beach quality characteristics can be evaluated using the conditional logit model results. This analysis will focus only on the change in beach width effecting WTP. 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 are the selected scenarios. Econometric regression analyses were performed for each beach separately, which allowed us to investigate the impact of changes in beach width of one town while assuming that the beach widths at the other towns remain constant at the 2003 base year levels.

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-7.

Table O-7. 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 0-7 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-7 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-7 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 - 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. The final requirement necessary to calculate the average annual benefits (AAB) of recreation 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, pp 164-174; 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.

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-8.

Table O-8. Beach Trips made by 1,067 Telephone Survey Respondents to Southeastern North Carolina Beaches in 2003

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:

$$ACCPRI_{i,j} = ((2 * 0.37) * DIST_{i,j}) + (((1/3) * (INCOME_j / 2000)) *$$
$$(2 * DIST_{i,j} / SPED_{i,j}))) \Rightarrow\Rightarrow (5)$$

General descriptive statistics of the respondents are listed in Table O-9.

Table O-9. 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:

$$TRIPS_{i,j} = EXP[\beta_c + (\beta_a + \beta_{xx} DDD_{xx}) ACCPRI_{i,j} + \beta_{18} * BWIDTH_i + \beta_{19} * BLENGTH_i$$
$$+ \beta_{20} * BSPACES_i + \beta_{21} * BACCESS_i + \beta_{22} * INCOME_j + \beta_{23} * FEMALE_j + \beta_{24} * MARRIED_j$$
$$+ \beta_{25} * NUMKIDS_j + \beta_{26} * MINORITY_j + \beta_{27} * AGE_j + \beta_{28} * AGESQ_j + \varepsilon_{i,j}] \Rightarrow\Rightarrow (6)$$

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 $\varepsilon_{i,j}$ is normally distributed error term.

The results of the Poisson equation are listed in Table O-10.

Table O-10. 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-10 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.

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-8.

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:

$$\begin{aligned} &Baseline \circ \Pr edicted \circ Trips \circ in \circ Year_t \circ \Pr oject \circ Beach_i = \Pr ojected \circ Households \\ &\circ in \circ Area \circ of \circ \inf luence * 0.63 * Trips \circ per \circ Beach \circ Trip - taking \circ household \circ to \\ &\circ project \circ beach_i \Rightarrow\Rightarrow (7) \end{aligned}$$

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-11.

Table O-11. 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. 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 beachgoer's willingness to pay additional money for four alternative beach widths.

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. Table O-12 shows a summary of recreation visitors, WTP, NPV, and AAB, truncated from 2012 to 2020, of the with- and without- project conditions for North Topsail and Surf City. A complete set of results can be made available upon request.

Each of the models was used to develop a demand curve of benefits expressed in present worth, 2004 dollars at the then interest rate of 5.375%. These benefits were later updated to 2010 dollars based on the Consumer Price Index ratio of 1.16 and an updated interest rate of 4.125%. The ratio of 1.16 was obtained through the Federal Reserve Bank of Minneapolis website by inflating 2003 WTP dollars to 2010 WTP dollars, then taking the 2010 WTP dollar amount and dividing by the 2003 WTP dollars. 1.16 was the resulting ratio. Based on survey data, a logit model and linear regression analysis were used to estimate benefits. The average annual net benefits will then be added to the coastal storm damage reduction benefits. Figure O-1 and Figure O-2 show the expected recreation AAB for Surf City and North Topsail Beach, respectively. The with-project condition selected alternative of 1550 plan for each beach would add an additional 65 feet and 73 feet and result in approximately $12,709,000 and $7,796,000 AAB for Surf City and North Topsail Beach, respectively. These recreation benefits for North Topsail Beach apply only to the portion of the town within the selected plan, roughly the southern 1/3 of the town.

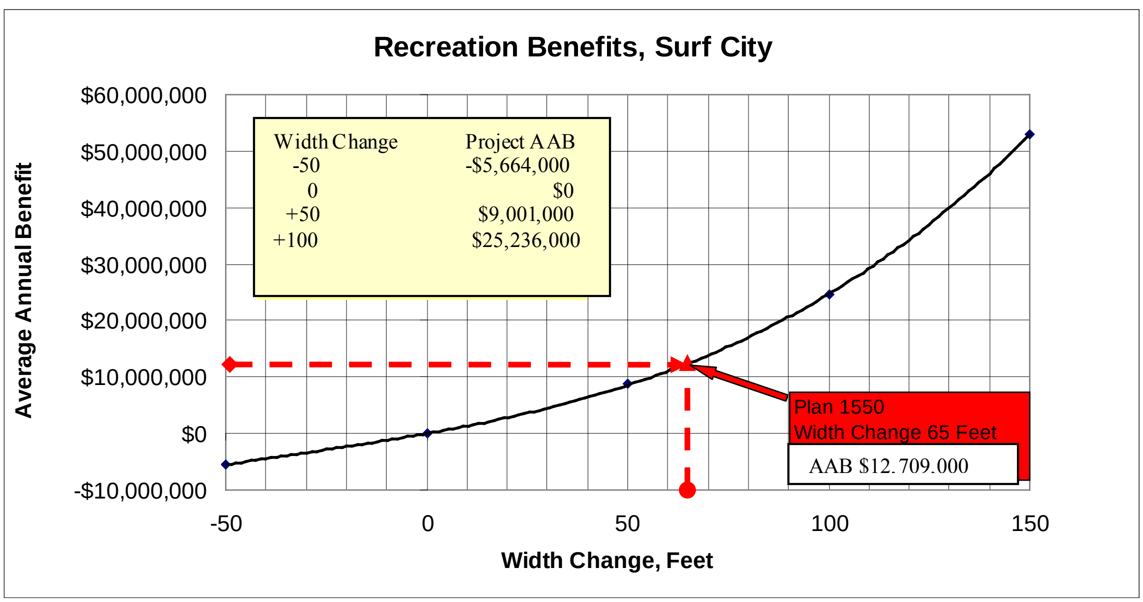


Figure O-1, Surf City Recreation Benefits

Table O-12. Recreation Visitors, WTP, and NPV of the With and Without Project Conditions at North Topsail and Surf City

						North Topsail							
						Trip Estimates							WTP per Trip
	2004	2009	2014	2019	2024	2029	2034	2039	2044	2049	2054	2059	Estimates
NC State Gov't projections of households in telephone survey area	1,570,551	1,696,934	1,820,259	1,952,670	2,078,075	2,210,320	2,338,273	2,466,227	2,594,181	2,722,134	2,850,088	2,978,042	
2003 Baseline Trips to this beach	548,608	592,755	635,833	682,086	725,891	772,085	816,780	861,476	906,171	950,866	995,562	1,040,257	$ 42.89
Trips w. -50 width	486,712	525,878	564,096	605,130	643,993	684,976	724,628	764,281	803,934	843,586	883,239	922,892	$ 39.54
Trips w. +50 width	618,375	668,136	716,693	768,827	818,203	870,272	920,651	971,031	1,021,410	1,071,790	1,122,169	1,172,548	$ 50.66
Trips w. +100 width	697,015	753,104	807,836	866,600	922,255	980,946	1,037,732	1,094,518	1,151,304	1,208,091	1,264,877	1,321,663	$ 65.96
Trips w. +150 width	785,655	848,878	910,570	976,807	1,039,540	1,105,694	1,169,702	1,233,710	1,297,718	1,361,725	1,425,733	1,489,741	$ 90.24
						NPV							
Yearly NPV(Baseline WTP)	$ -	$ -	$ 24,558,610.43	$ 20,277,367.80	$ 16,609,473.88	$ 13,597,587.36	$ 11,071,694.85	$ 8,988,018.14	$ 7,276,845.79	$ 5,877,120.13	$ 4,736,148.88	$ 3,808,990.65	
Yearly NPV(WTP w. -50 width)	$ -	$ -	$ 20,088,754.86	$ 16,586,731.24	$ 13,586,422.17	$ 11,122,722.10	$ 9,056,561.42	$ 7,352,129.86	$ 5,952,404.01	$ 4,807,439.16	$ 3,874,133.43	$ 3,115,725.12	
Yearly NPV(WTP w. +50 width)	$ -	$ -	$ 32,697,974.69	$ 26,997,816.55	$ 22,114,286.88	$ 18,104,182.58	$ 14,741,143.40	$ 11,966,881.85	$ 9,688,582.35	$ 7,824,951.08	$ 6,305,832.19	$ 5,071,389.54	
Yearly NPV(WTP w. +100 width)	$ -	$ -	$ 47,985,726.65	$ 39,620,492.01	$ 32,453,695.85	$ 26,568,690.11	$ 21,633,281.09	$ 17,561,929.35	$ 14,218,423.88	$ 11,483,462.42	$ 9,254,088.13	$ 7,442,488.85	
Yearly NPV(WTP w. +150 width)	$ -	$ -	$ 74,003,834.07	$ 61,102,926.25	$ 50,050,256.40	$ 40,974,370.32	$ 33,362,957.20	$ 27,084,097.64	$ 21,927,726.33	$ 17,709,854.72	$ 14,271,702.24	$ 11,477,844.53	

						Surf City							
						Trip Estimates							
NC State Gov't projections of households in telephone survey area	1570551.3	1696934.4	1820259.006	1952670.275	2078074.68	2210319.578	2338273.236	2466226.893	2594180.551	2722134.209	2850087.866	2978041.524	
2003 Baseline Trips to this beach	455564.76	492224.3	527996.6686	566404.7791	602780.4309	641140.2827	678255.3882	715370.4937	752485.5991	789600.7046	826715.8101	863830.9156	$ 47.23
Trips w. -50 width	404166.32	436689.8	468426.2021	502500.9726	534772.5937	568804.5502	601732.1972	634659.8442	667587.4911	700515.1381	733442.785	766370.432	$ 45.47
Trips w. +50 width	513499.61	554821.21	595142.8016	638435.3294	679436.9278	722675.0598	764510.1493	806345.2387	848180.3281	890015.4176	931850.507	973685.5964	$ 51.63
Trips w. +100 width	578802.13	625378.66	670828.0102	719626.1142	765841.9477	814578.7383	861734.0592	908889.3801	956044.701	1003200.022	1050355.343	1097510.664	$ 61.36
Trips w. +150 width	652409.27	704909.01	756138.2202	811142.0526	863235.2234	918169.9452	971322.0794	1024474.214	1077626.348	1130778.482	1183930.616	1237082.75	$ 79.29
						NPV							
Yearly NPV(Baseline WTP)	$ -	$ -	$ 22,460,050.70	$ 18,544,644.87	$ 15,190,176.44	$ 12,435,658.86	$ 10,125,606.59	$ 8,219,982.30	$ 6,655,031.48	$ 5,374,913.88	$ 4,331,439.85	$ 3,483,508.30	
Yearly NPV(WTP w. -50 width)	$ -	$ -	$ 19,180,967.79	$ 15,837,196.47	$ 12,972,467.82	$ 10,620,099.45	$ 8,647,306.12	$ 7,019,895.80	$ 5,683,421.91	$ 4,590,196.67	$ 3,699,065.93	$ 2,974,929.19	
Yearly NPV(WTP w. +50 width)	$ -	$ -	$ 27,671,248.26	$ 22,847,387.07	$ 18,714,612.40	$ 15,320,989.62	$ 12,474,957.32	$ 10,127,188.67	$ 8,199,136.80	$ 6,622,005.37	$ 5,336,423.72	$ 4,291,754.47	
Yearly NPV(WTP w. +100 width)	$ -	$ -	$ 37,071,517.34	$ 30,608,930.17	$ 25,072,200.26	$ 20,525,721.39	$ 16,712,856.32	$ 13,567,521.30	$ 10,984,486.10	$ 8,871,583.40	$ 7,149,273.60	$ 5,749,717.13	
Yearly NPV(WTP w. +150 width)	$ -	$ -	$ 53,994,310.11	$ 44,581,613.77	$ 36,517,419.66	$ 29,895,516.70	$ 24,342,115.24	$ 19,760,964.89	$ 15,998,798.85	$ 12,921,376.30	$ 10,412,848.55	$ 8,374,407.96	

***Notes: Total use over the life of the project is presented in 5 year intervals.
Annual dollar values decline over time because the NPV is declining over time.
Change in the number of trips is according to WTP from the Conditionl Logit Regression Results

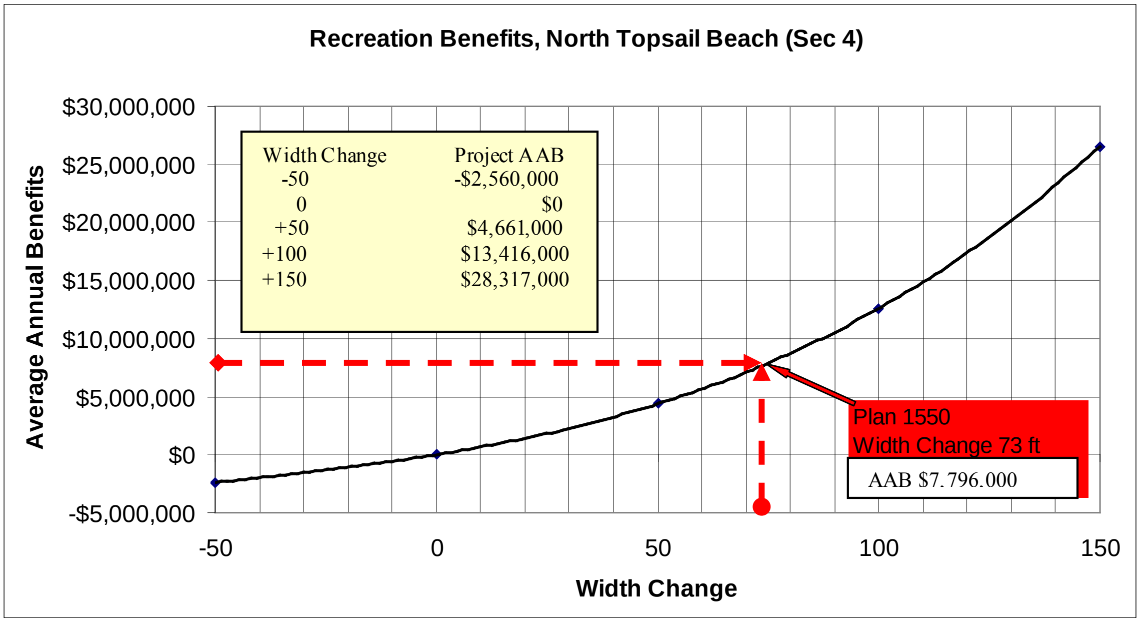


Figure O-2, North Topsail Beach Recreation Benefits

6.0 - PUBLIC BEACH ACCESS AND PARKING REQUIREMENT

The preceding sections focused on the valuation of beach improvement, emphasizing the use of contingent valuation and travel cost methods to determine the recreation value of visitation for Surf City and North Topsail Beach. The following sections will focus on the use of parking space counts, on-site field survey, telephone survey, and aerial photography to meet the objective of developing a method for determining parking space and distribution requirements to support anticipated visitation. Although beach trip demand and beach parking are simultaneously determined theoretically, existing variation in the number of parking spaces across beaches was found not to be a significant determinant of beach demand when other determinants of beach demand were controlled, whereas the index of beach demand was found to have a significant impact on filled parking spaces. As a result, a two-stage model was developed in which an index of beach demand is determined in the first stage, followed by estimation of filled parking spaces as a function of the beach demand index.

6.1 – Parking and Access

The Army Corps of Engineers has several requirements that must be met in order to fully cost share in a shore protection project (see ER 1105-2-100 and ER 1165-2-130). One of these requirements is that the beaches must be available for public use. As described in ER 1165-2-130 (Federal Participation in Shore Protection, paragraph 6.h.) public use implies reasonable access and parking. The Corps' Wilmington District, additionally, has developed more specific minimum parking requirements for participation in shore protection projects within the District's boundaries.

One objective of the recreation study was to predict public access and parking demand. ER1165-2-130 stipulates that in order to qualify for Federal cost sharing of Hurricane and Storm Damage Reduction projects, the local community must, at a minimum, provide public access and parking within a one quarter mile radius of any point of the project. Parking must satisfy the lesser of beach capacity or peak hour demand for that beach community. The peak demand hour had been previously identified as noon on the 4th of July holiday by USACE. The Wilmington District has further established a ten-space minimum for parking lots within one-quarter mile of each required public access point. Total beach visitation and the associated recreation benefit depend on day trip visitors having adequate available public parking. In areas where adequate parking is not provided, the recreation benefits for that portion of the project cannot be counted towards the justification of the project. It is required by guidance that an analysis be conducted to determine the peak hour demand for Surf City and North Topsail Beach. The analysis of the data will be used to determine additional parking needed to meet the Corps' requirements for peak hour demand over the 50-year life of the project.

Another objective of this study was to estimate peak and latent or potential demand of the beaches under study. Latent demand is the number of individuals who would come to the beach if conditions were more conducive to recreation. This demand is modeled from the stated preference of the respondent versus their revealed preference. The recommended methodology and data collected from survey instruments was used to develop a model to calculate the estimated 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 used to predict a decrease in trips with a decrease in beach width, or erosion of the beach. The results for this study focused on the with-project and the without-project conditions in each study area. It was expected that an increase in beach width would generate latent demand for beach recreation, resulting in a future need for additional parking spaces. Econometric models were developed to analyze the data using the procedures in LIMDEP. The models recommended by UNCW were used to compute the number of trips taken to each beach community and the latent demand for those beach communities if the beach width were increased. The number of trips taken to each beach community and the increase in those trips derived from the latent demand was used to develop parking requirements for each beach community. For the purpose of this analysis, parking requirements for a beach are defined as the number of parking spaces that would accommodate all visitors to that beach on a specified percentage (e.g., 70%, 90%, etc.) of peak summer weekend days.

The data for this project was collected separately for Surf City and North Topsail, NC. Therefore, the information and analysis for this report are presented separately for each town.

6.2 Present Conditions

6.2.1. Access

Surf City has 33 public beach access points within the project limits and North Topsail has 22. The access points generally consist of small parking areas and wooden walkways to the beach. There are four regional access parking lots in North Topsail Beach and one vehicle cross-over in Surf City for beach maintenance and emergency access. Tables 12 and 13 list the existing and proposed public access locations. The column titled "Access Points" contains the name of the nearest cross street or other landmark. ER 1165-2-130 states that, "… public use is construed to be effectively limited to within one-quarter mile from available points of public access to any particular shore." Therefore the maximum distance between public access points is one half mile. Through most of the project length the public access sites surpass this definition. However, there are three portions within the project limits that do not meet the access distance requirements. Two of these in North Topsail Beach include a 1000-foot shoreline in the 3600 block of Island Drive and a 900-foot shoreline within the vicinity of Permuda Wynd. In Surf City, a 900-foot shoreline in the 1700 and 1800 blocks of South Shore Drive does not meet the access requirements. The shoreline length currently not meeting the access distance requirements is 2,800 feet: 1,900 feet in North Topsail Beach and 900 feet in Surf City. Additional access points will be necessary to meet the requirements for Federal Cost sharing.

6.2.2 Parking

There are a wide variety of public parking spaces throughout Surf City and North Topsail Beach. These are located at the access sites, on nearby street right-of-ways, and at 4 large parking lots. In 2003 and in 2008, parking space counts were administered on site visits by the Wilmington District and town officials. All right of way areas were considered eligible for parking with the exception of areas that met designated restrictions (e.g. driveways, fire hydrants, intersection, physical barriers). For North Topsail Beach, only the project reaches were included in the count. The combined total from the 2008 count was 1,992 spaces, with 785 at Surf City and 1,207 at North Topsail Beach. These numbers are included in Tables O-13 and O-14.

The Wilmington District requires a minimum of 10 spaces for within a quarter mile of each access point regardless of demand. Criteria for minimum parking requirements was established for Wilmington District projects in North Carolina based on using an average lot size along the shoreline area and determining how many parking spaces could be provided in that lot size (e.g. a 50' x 95' lot size can provide 8 spaces + 1 handicapped space or 10 spaces without a handicapped space.) Where the spacing of the accesses is less than one half mile, having a total sum of 10 parking spaces within one quarter mile of any point in the project provides the 10-space minimum parking requirement. For the project length of 52,150 feet the minimum number of accesses and parking spaces are computed as follows:

$$52{,}150.\,feet\_x\frac{1.access}{0.5.mile.(2640.\,feet)} = 19.8.accesses,.approximately.20$$

$$20.accesses\_x\frac{10.spaces}{access} = 200.spaces$$

The combined total of 1,992 spaces exceeds the minimum total of 200 spaces. However, the distribution of parking spaces is uneven with a large amount in the northern and central project reaches and few in the southern project reaches in both Surf City and North Topsail Beach. A total of 37 additional parking spaces are needed in the southern portion of the project limits in Surf City and a minimum of 20 in North Topsail Beach are needed to satisfy the 10-space minimum requirements.

Table O-13. Public Access Locations and Parking Availability Surf City, July 2008.

Access Points	Parking Spaces			Access Points	Parking Spaces		
	Lot	ROW	Total		Lot	ROW	Total
2111 N. Shore	8	0	8	Roland/Central	15	8	23
9th St.	0	10	10	Kinston	15	20	35
2001 N. Shore	9	9	18	High Point	8	3	11
5th St.	9	9	18	Raleigh	6	2	8
1719 N. Shore	5	28	33	Durham	9	8	17
Broadway	43	7	50	Charlotte	20	19	39
Pender	6	40	46	Quarterhorse	0	37	37
Lenior	8	32	40	1140 S. Shore	0	33	33
Jones	2	34	36	Windward	0	35	35
Craven	12	42	54	Oceanair Estates	0	39	39
Mecklenburg	0	11	11	Elizabeth St.	0	6	6
Dolphin	17	34	51	Roberts St.	0	1	1
508 N. Shore	15	5	20	Pirates Cove	0	0	0
Wilmington	10	16	26	Abigail Place	0	4	4
New Bern	12	15	27	Bland Shores	0	2	2
Goldsboro	10	12	22	Hispanola	0	6	6
Greensboro	6	13	19				
Total							785

Table O-14. Public Access Locations and Parking Availability North Topsail Beach, July 2008.

Access Points	Parking Spaces			Access Points	Parking Spaces		
	Lot	ROW	Total		Lot	ROW	Total
Myrtle	32	67	99	14th Ave	0	27	27
2nd Ave	0	39	39	15th Ave	0	34	34
4th Ave	0	32	32	18th Ave	0	41	41
5th Ave	0	19	19	20th Ave	0	13	13
6th Ave	0	23	23	21st Ave	12	51	63
7th Ave	0	15	15	OCBA #4	400	34	434
9th Ave	0	43	43	Chestnut St	12	30	42
10th Ave	0	27	27	Gray St	12	23	35
11th Ave	0	16	16	Green St	6	0	6
12th Ave	0	23	23	Reeves	0	83	83
13th Ave	0	22	22	Sea Shore Dr	6	65	71
Total							1207

Figure O-3, Surf City Public Access Locations and Parking Availability

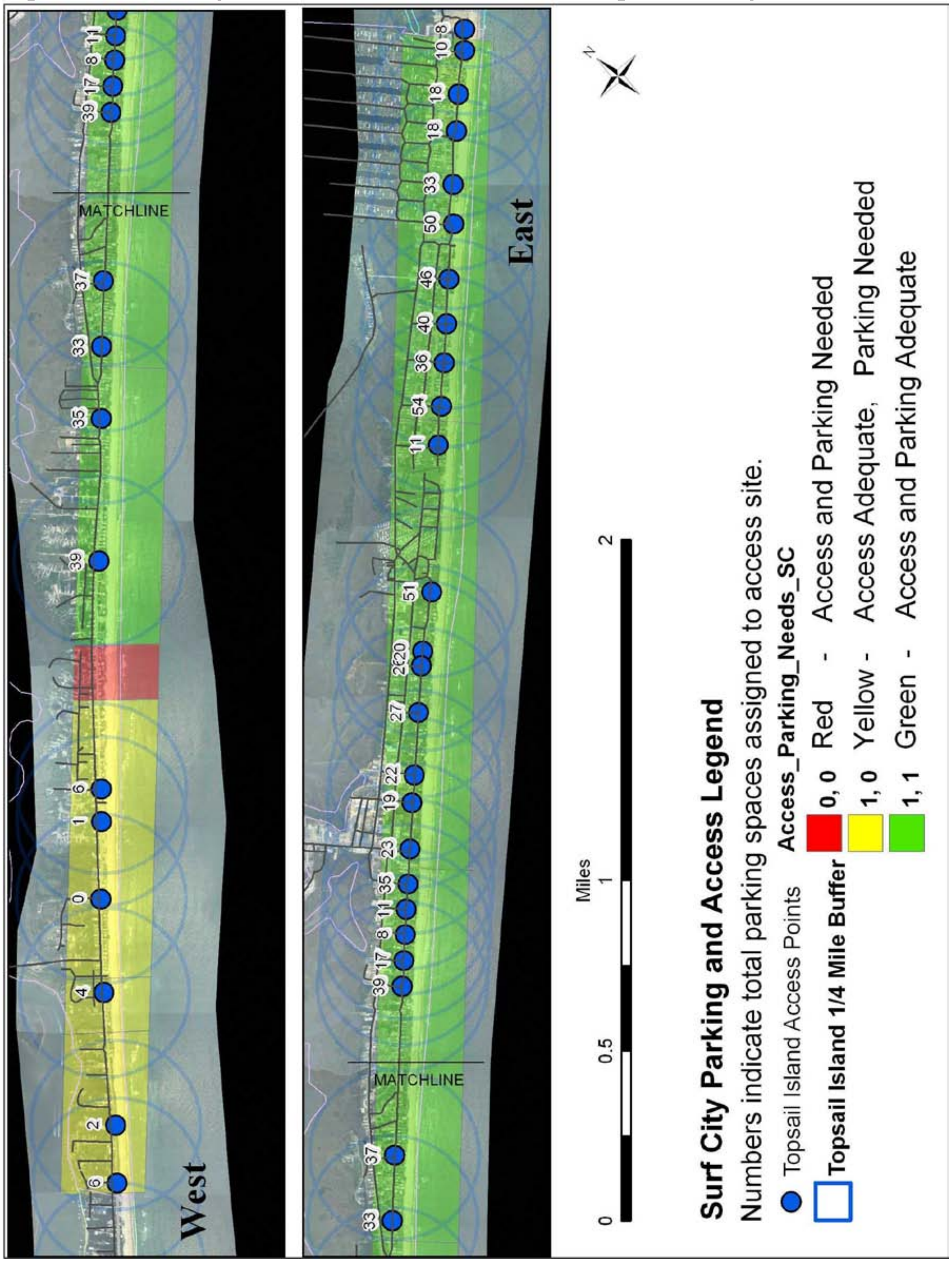
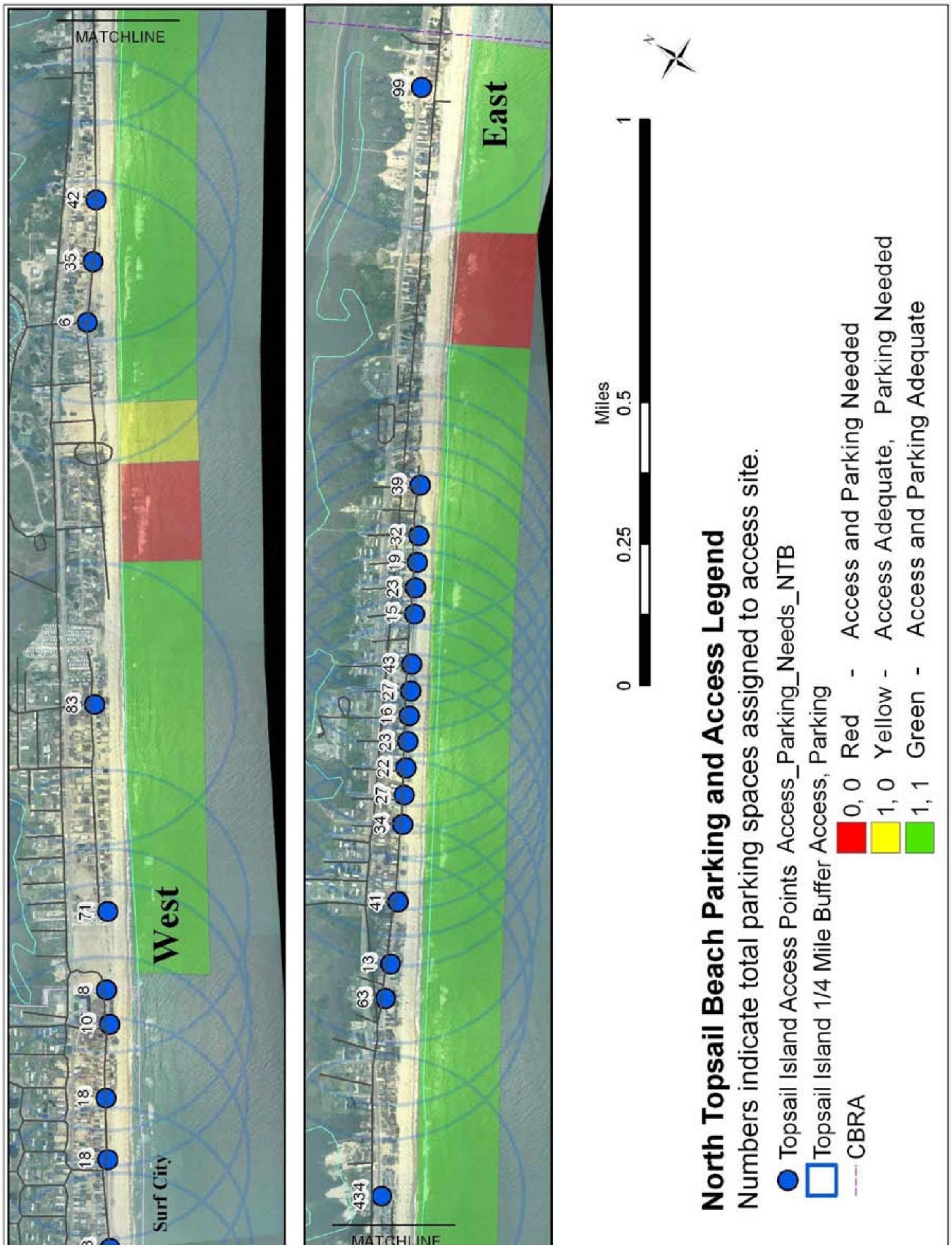


Figure O-4, North Topsail Public Access Locations and Parking Availability



6.2.3 - Map

Maps of the access locations are shown in Figures O-3 and O-4. The access points are labeled with the Access Point designation. The one-quarter mile radius circles centered on each existing and proposed access site show the project areas serviced by the accesses. Color coding illustrates the adequacy of beach access and parking availability for all stretches of beach within the project area.

6.3.0. With Project Condition

The sponsor is in the process of obtaining the additional public access sites and public parking for the project area to meet the definition of a public use shoreline. There will be no placement of material on private-use shores.

All project reaches will be eligible for cost sharing of 65% Federal and 35% non-Federal sponsor once the requirements have been met. These requirements will be affected if more, less, or different access sites are decided upon prior to signing the Project Cooperation Agreement (PCA). Once all access and/or parking sites are obtained, and prior to signing the PCA, the Corps will obtain specific measurements using GIS and or survey data of these sites to make a final determination on project cost sharing. The sponsor will be responsible for ensuring that the access and parking requirements are met throughout the life of the project.

6.4.0 On-Site Parking Lot Data

As part of the on-site filed survey effort in 2003, ancillary data were collected on the number of parking lots, parking spaces (SPACES), and filled parking spaces (FILLEDSP) at the beach, for several times each day, during peak (weekend) days of July and August, 2003. Two holidays (dummy HOLIDAY) were included in the survey effort: the Fourth of July weekend, and the Labor Day weekend. These holidays represent the "peak of the peak" days in terms of beach parking demand. Preliminary tests of significance of time of day dummy variables in the parking model described below indicated that hours could be pooled into three time periods, morning (dummy DMORN), midday (Dummy DMD) and afternoon (dummy DAFTN). The on-site survey of beach recreationist provided an estimate of average number of hours spent on the beach by each party of recreationists for each beach (STAYTIME). The STAYTIME variable provides an index of parking space turnover time. The duration of stay is assumed to affect parking demand. If the duration of stay is usually long, more parking spaces should be provided.

Descriptive statistics for the variables are presented in Table O-15.

Table O-15. Descriptive Statistics for variables in Tobit Regression
Mean Values across all Beaches. N=668

Variable	Mean	Std Dev.	Minimum	Maximum
SPACES	436.47	294.30	75.00	929.00
FILLEDSP	282.86	221.49	2.00	909.00
DMORN	0.38	0.49	0.00	1.00
DAFTN	0.21	0.41	0.00	1.00
STAYTIME	4.34	1.32	0.19	9.50
HOLIDAY	0.53	0.50	0.00	1.00
TRIPINDX	428.96	255.16	146.00	924.00

6.4.1 Tobit Parking Model

A censored regression model, or "Tobit" model, was used to estimate parking space demand for each beach. The dependent variable, $FILLEDSP_{idt}$, is the number of parking spaces that are filled at beach *i,* on day *d,* at hour *h.* When parking lots are full, the dependent variable is "censored," in the sense that some visitors may not be able to find parking spaces, and hence their visits will not be reflected in the value of the dependent variable. In effect the parking needs of these visitors are "censored" from the dependent variable values.

The Tobit regression model estimates an unconditional probability distribution of FILLEDSP, i.e., the number of FILLEDSP that would occur if the number of parking spaces were unconstrained. The resulting probability distributions can be used to estimate parking demand (and potential parking requirements) beyond current parking space capacity.

The independent variables used in the Tobit regression model are: $TRIPINDX_{i,}$ an index of household demand for trips to beach i; $STAYTIME_{id}$, the average length of time in hours that a visitor remained at beach i on day d; DB_i, beach-specific dummy variables that shift the regression intercept, where i indicates beach 00-09 (the dummy for beach 10 is omitted to avoid the dummy variable trap; note that beach 08 is omitted from the entire analysis due to lack of sufficient survey data for beach 8); DMORN and DAFTN, dummy variables capturing time of day effects (if t=9am-11am, DMORN=1, DMORN=0 otherwise; if t=3pm-5pm, DAFTN=1, DAFTN=0 otherwise; and $HOLIDAY_d$, a dummy variable equal to 1 if the day is July 4 or 5, or August 30 or 31, days corresponding to the fourth of July and Labor Day holidays. Note that under this specification, with all dummy variables set to zero, the Tobit regression predicts uncensored FILLEDSP at midday on a non-holiday weekend day on beach 10 (Atlantic Beach, NC). Setting appropriate dummy variables to the value "1" adjusts the regression predictions for alternative time of day or beach destination.

The TRIPINDX variable can be any measure of relative recreation demand across beaches. Recall that TRIPINDX was developed via a separate Poisson regression using telephone survey data in section 4. Trips taken in 2003 by telephone survey household j to each of the seventeen southeastern North Carolina beaches$_i$, ($TRIPS_{ij}$) are regressed on a list of explanatory variables measuring characteristics of the household and characteristics of the beaches. $TRIPINDX_i$ is formed by summing predicted values of $TRIPS_{ij}$ over the 1,067 households in the sample. The expected number of day trips to beach i, per household per year, denoted ETRIPS, is estimated by dividing $TRIPINDX_i$ by 1,067.

For this analysis the variable SPACES, which gives the existing number of parking spaces at each beach, is used as a censoring variable by the Tobit regression procedure. Each beach, i, has a separate censoring limit, as specified by the SPACESi variable. Each of these variables was used in a censored regression analysis to create a demand curve over a series of years using 2004 as the base year. Along the curve parking requirements will be expressed in percentage of demand met for that increment.

The Tobit regression model (with upper and lower tail censoring) is specified as:

$$Ln(FILLEDSP_{idt}) = \beta_o + \beta_1 DMORN + \beta_2 DAFTN + \beta_3 DB00 + ...\beta_{11} DB09$$
$$+ \beta_{12} STAYTIME_{id} + \beta_{13} HOLIDAY_d + \beta_{14} TRIPINDX_i + e_{idt} \Rightarrow\Rightarrow 8$$

If $\ln(FILLEDSP_{idt}) \leq 0$, then $\ln(FILLEDSP_{idt}) = 0$,
If $\ln(FILLEDSP_{idt}) \geq \ln(SPACES_i)$, then $\ln((FILLEDSP_{idt}) = (SPACES_i)$,

where FILLEDSP, STAYTIME, SPACES, HOLIDAY, DMORN, DAFTN, DB00…DB9, and TRIPINDX are variables defined above, $\beta_0 - \beta_{14}$ are the parameters to be estimated, and e_{idt} is a heteroskedastic error term. The error term is specified as $e_{idt} \sim N(0, \sigma^2 . \exp(\alpha . TRIPINDX_i))$, where σ (the standard deviation of the uncensored dependent variable in the absence of heteroskedasticity) and α are the parameters to be estimated. Parameter α allows testing for heteroskedasticity as a function of beach demand index $TRIPINDX_i$; Ho: $\alpha = 0$ is rejected, the null hypothesis of homoskedasticity is rejected in favor of heteroskedasticity as a function of the beach demand index $TIPINDX_i$.

6.4.2. Tobit Parking Model Results

Tobit regression results are presented in Table O-16. The Tobit regression is estimated using LIMDEP.

Table O-16 Tobit Regression Results - Dependent Variable: FILLEDSP,

Explanatory Variables	Coefficient	Std. Error.	t-ratio	P-value	Mean
Constant	4.557***	0.506	9.00	0	1
DMORN	-0.666	0.488	-1.36	0.1727	0.3772
DAFTN	-0.307	0.490	-0.63	0.5311	0.2111
DB00	-0.518	0.567	-0.92	0.3601	0.0329
DB01	0.699	0.512	1.37	0.1723	0.0449
DB02	-0.379	0.527	-0.719	0.4722	0.0404
DB03	0.166	0.595	0.279	0.7803	0.0449
DB04	-0.706	0.564	-1.252	0.2105	0.0404
DB05	-0.101	0.543	-0.186	0.8521	0.0404
DB06	-0.262	0.5577	-0.47	0.6383	0.0389
DB07	-0.946*	0.5378	-1.76	0.0785	0.0404
DB09	-1.271**	0.5544	-2.293	0.0218	0.0434
STAYTIME	0.008	0.0206	0.362	0.7175	4.339
HOLIDAY	0.364***	0.0536	6.78	0	0.5329
TRIPINDX	0.003***	0.00018	12.6	0	428.656
Sigma σ	0.451***	0.0161	28.023	0	----
Alpha α	0.0007***	0.000067	10.992	0	----
Log-likelihood	-623.66				

Notes: ***, **, and * refer to significance at the 1%, 5%, and 10% levels, respectively. The chi-square and overall likelihood ratio statistics are 29.1 and 546.7, respectively. Number of observations =699. Dependent variable: FILLEDSP. D13 is the omitted time of day dummy variable.

A likelihood ratio test indicates that the overall regression is significant at the $p < 0.01$ level. The negative coefficient on DMORN and DAFTN indicate that the number of filled spaces is lower in the morning and afternoon, but the effect is not significant for this sample. Beach specific fixed effect dummy variables $DB_{00} \ldots DB_{09}$ vary in sign, reflecting differences in the estimated value of ln(FILLEDSP) at midday across beaches. However, after controlling for other variables in the regression, only beach dummy DB_{09} is statistically significant. STAYTIME has a positive but insignificant effect on ln(FILLEDSP). HOLIDAY has a positive and strongly significant on filled spaces. TRIPINDX, a beach-specific index of recreation demand, is positive and strongly significant. The heteroskedasticity parameter α is positive and strongly significant, indicating that larger values of TRIPINDX increase the variance of ln(FILLEDSP).

With the estimated Tobit coefficients, it is possible to calculate the number of spaces that would be necessary to accommodate all peak (weekend holiday) day beach visitors 60% of the time, 95% of the time, etc. For each beach, ln(FILLEDSP) follows a normal distribution, with a beach-specific, unconditional mean values $\overline{u_i}$ given by the Tobit regression equation (9) (with variables replaced by their mean values):

$$\bar{\mu} = \beta_0 + \beta_1 \text{ DMORN} + \beta_2 \text{ DAFTN} + \beta_3 \text{ DB00} + \ldots + \beta_{11} \text{ DB09} + \beta_{12} \text{ STAYTIME}_{id} + \beta_{13} \text{ HOLIDAY}_d + \beta_{14} \text{ TRIPINDX}_i, \quad (9)$$

and a beach-specific standard deviation SD_i given by:

$$SD_i = (\sigma^2 \cdot \exp[\alpha \cdot TRIPINDX_i])^{0.5}. \quad (10)$$

The unconditional 90 percentile, for example, of $FILLEDSP_i$ is then given by:

$$FILLEDSP_{i,90\,percentile} = EXP(NORMINV(0.90, \bar{u}_i, SD_i)), \quad (11)$$

where NORMINV is the inverse normal cumulative distribution function.

6.5 PARKING DEMAND DISCUSSION AND CONCLUSION

For each beach, the frequency of FILLEDSP can be graphed against FILLEDSP to determine the number of spaces that would be necessary to accommodate all peak (weekend holiday) day beach visitors 60% of the time, 95% of the time, etc. Figure O-5 shows the estimated frequency of (latent, uncensored) filled parking spaces at North Topsail Beach on peak, summer weekend holidays in base year 2004.

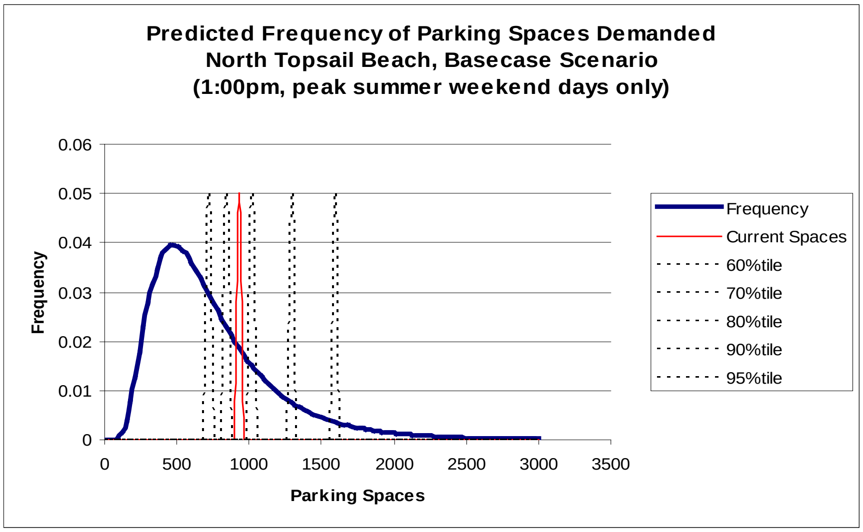


Figure O-5

The current, existing number of parking spaces at North Topsail Beach is 905, indicated by the solid indicator spike, which are used solely to designate particular values of parking spaces. Sixty-three percent of the frequency distribution of FILLEDSP occurs to the left of 905 spaces, suggesting that the existing spaces (summer 2004) fully accommodate all North Topsail Beach visitors on 75% of peak (summer holiday weekend) days. Note that 25% of the frequency distribution of FILLEDSP lies to the right of 905 spaces, indicating that the existing spaces do not accommodate all North Topsail Beach visitors 25% of peak days. Providing additional parking spaces would accommodate additional visitors. The remaining, dashed indicator spikes on the graph mark the numbers of parking spaces that would be required to accommodate all Topsail Beach visitors on 60%, 70%, etc., of peak days. Again, the spikes are used solely to designate particular values of parking spaces.

Similarly 68 percent of the frequency distribution of FILLEDSP for Surf City occurs to the left of 245 spaces, suggesting that the existing spaces (2004) fully accommodate all Surf City visitors on 68% of peak day.

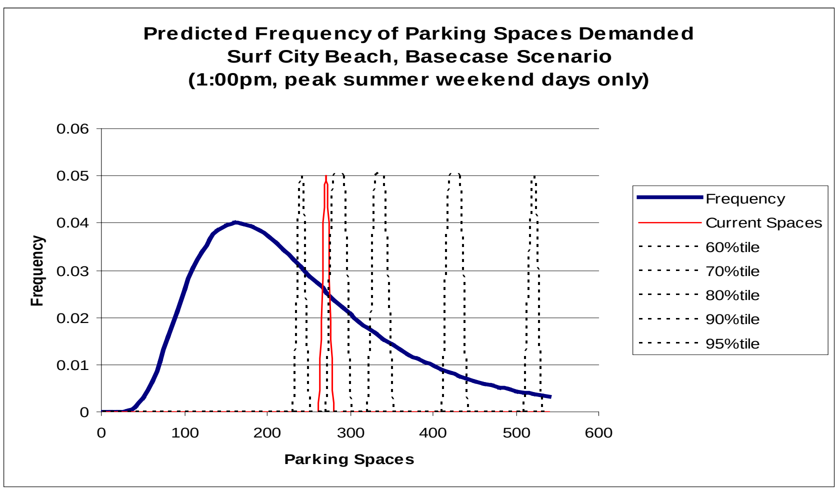


Figure O-6

Furthermore, changes in beach conditions may shift the cumulative frequency distribution of FILLEDSP and the associated number of parking spaces needed to meet a given accommodation policy target. Figure O-7 shows the predicted frequency of FILLEDSP at North Topsail Beach with a 73 ft increase in beach width. The increase in beach width attracts additional beach visitation, which shifts the frequency distribution to the right. As the distribution shifts to the right, the current number of parking spaces accommodates all visitors less frequently. In this example, the current number of spaces (905) would accommodate all North Topsail Beach visitors on only 60% of peak days with a 73 ft increase in beach width. The indicator spikes mark the number of parking spaces that would be required to accommodate parking demand on 60%, 70%, etc., of peak days

In this example, the current number of spaces (905) would accommodate all North Topsail Beach visitors on only 60% of peak days with a 73 ft increase in beach width.

The indicator spikes mark the number of parking spaces that would be required to accommodate parking demand on 60%, 70%, etc., of peak days. The same argument can also be made of Surf City. The current number of spaces (245) would accommodate all Surf City visitors on only 53% of peak days with a 65 ft increase in beach width. See Figure O-8.

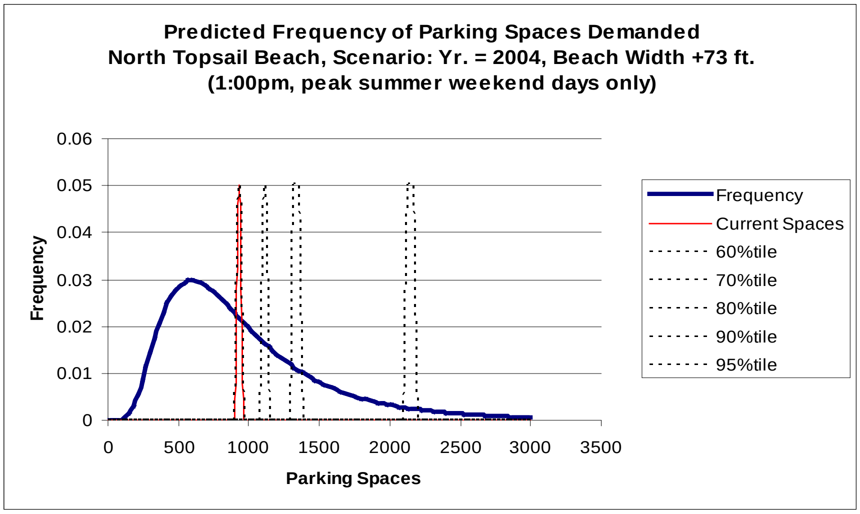


Figure O-7

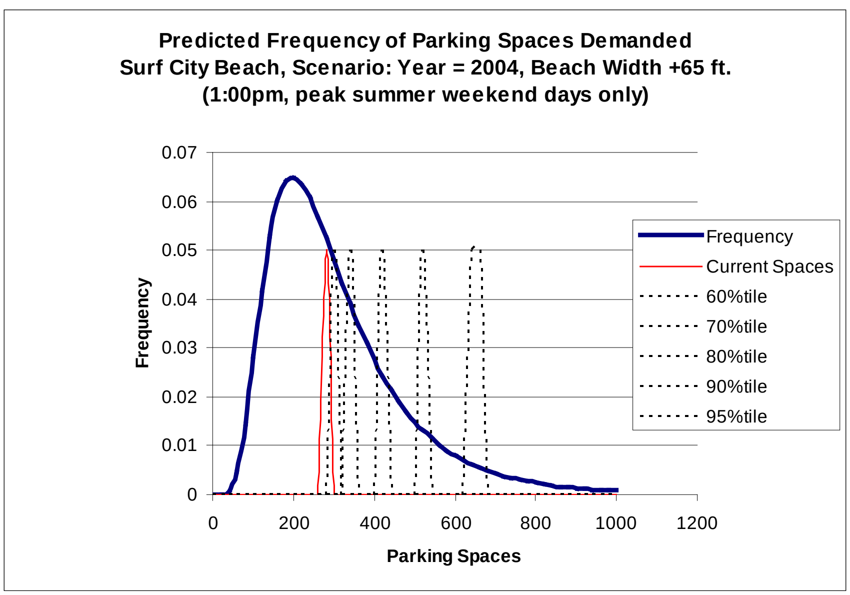


Figure O-8

As state population increases, the number of visitors to North Topsail Beach and Surf City is expected to increase, assuming that the number of trips per household remains roughly constant. Tables O-17 and O-18 show the predicted frequency of filled parking spaces at Surf City and North Topsail Beach under +65 and +73 beach width conditions from the base year 2004 through 2024, based on projected increases in population of the telephone survey region. Under the assumption that an increase in projected population in the telephone survey region results in a proportional increase in the $TRIPINDX_i$ value for North Topsail Beach and Surf City, the cumulative frequency distribution of FILLEDSP for North Topsail Beach and Surf City shifts to the right. As the curve shifts to the right, the current number of parking spaces accommodates all North Topsail Beach visitors less frequently. It is estimated that by 2008, 707 and 2,403 parking spaces would be required to accommodate peak demand on ninety five percent of peak days for Surf City and North Topsail Beach, respectively. For recreation benefit estimates, however, peak parking demand for North Topsail Beach was only considered for areas within the project reach, or roughly the southern 1/3 of the town. Thus, parking demand for North Topsail Beach was determined to be 801 spaces by multiplying the total number of spaces (2403) by 33%.

Table O-17. Projected Surf City Beach Parking Peak Day Demand, 65 foot width increase.

Year	Pop. Index*	TRIP-INDX	FILLEDSP					
			Mean	Percentile				
				60%	70%	80%	90%	95%
2004	1.000	572	257	296	344	411	525	643
2005	1.015	581	262	302	351	419	537	658
2006	1.031	590	267	308	359	429	549	674
2007	1.047	599	273	315	367	439	562	690
2008	1.064	608	279	322	375	449	576	707
2009	1.080	618	285	329	384	459	590	725
2010	1.097	627	291	336	392	470	604	744
2011	1.112	636	297	343	400	480	618	761
2012	1.127	645	302	350	409	490	632	778
2013	1.143	654	309	357	418	501	646	796
2014	1.159	663	315	365	427	513	661	816
2015	1.175	672	322	373	436	525	677	836
2016	1.192	682	329	381	446	537	694	857
2017	1.209	691	336	390	456	550	711	879
2018	1.226	701	343	399	467	563	729	902
2019	1.243	711	351	408	479	577	748	926
2020	1.261	721	359	417	490	591	767	950
2021	1.276	730	367	426	500	604	784	972
2022	1.291	739	374	435	511	617	802	995
2023	1.307	748	382	444	522	631	820	1019
2024	1.323	757	390	454	534	645	840	1044

Table O-18. Projected North Topsail Beach Parking Peak Day Demand for Entire Town, 73 foot width increase

Year	Pop. Index*	TRIP-INDX	FILLEDSP					
			Mean	Percentile				
				60%	70%	80%	90%	95%
2004	1.000	702	814	944	1107	1334	1726	2137
2005	1.015	713	834	968	1136	1369	1774	2198
2006	1.031	724	855	993	1166	1406	1825	2262
2007	1.047	735	877	1020	1198	1446	1878	2331
2008	1.064	747	900	1047	1231	1488	1935	2403
2009	1.080	758	925	1076	1266	1532	1994	2479
2010	1.097	770	949	1106	1302	1576	2054	2556
2011	1.112	781	972	1133	1335	1617	2110	2628
2012	1.127	791	996	1162	1369	1660	2168	2703
2013	1.143	802	1021	1192	1406	1705	2230	2782
2014	1.159	814	1047	1223	1444	1753	2295	2867
2015	1.175	825	1075	1256	1484	1804	2364	2955
2016	1.192	837	1104	1291	1526	1856	2435	3047
2017	1.209	848	1133	1326	1569	1910	2509	3143
2018	1.226	860	1164	1363	1614	1967	2587	3244
2019	1.243	873	1198	1403	1663	2028	2671	3352
2020	1.261	885	1231	1443	1712	2089	2755	3462
2021	1.276	896	1261	1480	1756	2145	2832	3562
2022	1.291	906	1292	1517	1802	2203	2911	3665
2023	1.307	917	1325	1557	1850	2263	2995	3774
2024	1.323	929	1359	1598	1901	2328	3084	3890

***** Telephone Survey Region Population Index (2004 Base Year)

7.0 LIMITATIONS

As in every application of the travel cost method, assumptions and simplifications based on professional judgment have been necessary to use in some aspects of the analysis. Although the focus of this study was on the estimation of recreation benefits and peak parking demand, there are several qualifications to our results and further research would be necessary to address those limitations.

A bias frequently encountered in using onsite surveys is the avidity bias - when avid users are more likely to be included in the sample than occasional users. This is the problem of endogenous stratification and causes bias and inconsistency in the estimates of the parameters (Shaw 1988). Due to time constraints, endogenous stratification due to oversampling of avid users was not considered in the analysis. Not including this analysis could potentially result in an overestimation of benefits.

One important site characteristic that was not considered in this study is beach congestion (i.e., number of persons per unit area), as this can impact the quality of recreational experience. McConnell and Duff (1976) demonstrated that estimates of net benefits may be biased downward if there is excess demand for the recreation site. Ideally, quality differences in the beach sites in demand estimation should be accounted for. Unfortunately, due to limits on the amount of data collected, the effect of congestion on net benefits was not examined. Not properly accounting for congestion issues could also potentially result in an overestimation of benefits.

Finally, overnight users were not considered in the study survey. This group of recreationists was left out of the sample because they were outside the target population, as they would not be expected to utilize public parking. The goal of this study was to develop a method for estimating peak day trip demand for beach parking spaces. Leaving out overnight users from the sample results in an underestimation of benefits.

It should also be noted that because a life-cycle analysis was not conducted on the recreation benefits, the projected recreation benefits are based on the assumption that the difference in beach width in the with- and without project conditions is relatively constant throughout the economic period of analysis. In reality, this difference in width can vary to some degree at various points in the analysis period, particularly immediately after the beach is renourished.

8.0 SUMMARY & CONCLUSIONS

The purpose of this analysis was to improve the recreation benefit analysis for Hurricane and Storm Damage Reduction projects and establish a baseline parking and access requirement and determine future parking needs for Surf City and North Topsail Beach. As previously stated, recreation benefits are included as incidental benefits in the total benefit accounting, but are not included in the formulation of the project with respect to size and scope. However, with respect to Surf City and North Topsail 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 will increase the total net benefit of the selected plan and increases the project's benefit cost ratio.

This study analyzed the demand for beach parking in Surf City and North Topsail Beach using a Tobit regression estimation approach. The study employed data collected through telephone and onsite surveys conducted by the University of North Carolina at Wilmington. The Tobit model provides a framework for estimating peak demand for beach parking spaces. The framework is especially useful for those beaches where current parking capacity constraints parking on peak days.

The analyses show that an increase in beach width will attract additional visitation and will shift the frequency distribution of filled parking spaces (FILLEDSP) to the right. Furthermore an increase in projected population in the telephone survey region increases the trip index value for Surf City and North Topsail Beach, which in turn shifts the predicted frequency distribution of FILLEDSP to the right. It is estimated that by 2008, 707and 801 parking spaces would be required to accommodate peak demand on ninety five percent of peak days for Surf City and North Topsail Beach, respectively, with parking demand for North Topsail Beach projected for only the project reaches of the island (NT4).

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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][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.