Valuing Great Lakes Beaches

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Abstract

This study aims to estimate the recreational use values of Great Lakes beaches using a two-level nested logit Random Utility Model. The choice set contains all 594 public Great Lakes beaches in Michigan. Beach sites located in the same Great Lakes water body are arranged into a nest. The trip data were obtained from a 2006 online survey using a web-panel of Michigan adults accessed through Survey Sampling International (SSI). The variables that affect the amount of utility derived from a particular site are the travel cost and site quality variables, which include beach length, days of beach advisory, and days of beach closure in 2006. We report the economic loss of permanently losing an individual beach site or a group of beach sites as well as benefits of reducing beach advisories and closures through water quality improvement along Michigan's Great Lakes shoreline.

Key words: Great Lakes, freshwater beaches, non-market valuation, travel costs model, nested logit
JEL codes: Q26, Q57

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1. Introduction

The Great Lakes basin is the largest freshwater system on the earth. The Great Lakes provide a wide array of ecosystem services ranging from the provision of food and water to the regulation of local climate to more than 30 million people living in its watershed *[U.S. Environmental Protection Agency, EPA]*. In fact, the 10,900 miles of Great Lakes shoreline is equivalent in length to almost half of the earth's circumference. The Great Lakes support numerous publicly accessible beaches that provide coastal amenities such as swimming, sunbathing and other water-related characteristics and activities and obviate the need of many to travel to seashore areas for recreation *[Sohngen et al., 1999]*. Lakeshore tourism especially beaches help local economies and generate substantial revenue for state and local government. However, each swimming season, state and local health and environmental protection agencies must monitor the quality of water at the nation's beaches, including Great Lake beaches. The loss of Great Lakes beaches as well as the closure of these beaches to recreational use represent significant economic costs. This paper presents estimates of the economic values of reducing beach advisories and closures through water quality improvement in Great Lakes. Additionally, we estimate the economic costs of permanently losing individual Great Lake beaches or groups of beaches.

Background. Economic values of beaches are of interest to beach managers, policy makers, and the public for informed policy decisions. Beach recreation is threatened by water quality issues including bacterial contamination such as *Escherichia coli (E. coli)* and high level of phosphorous coming from municipal and industrial wastewater treatment plants, combined and sanitary sewer overflows and agricultural runoffs, etc [*Alm et al*., 2006; *Liu et al*. 2006]. Bacterial contamination can pose health risks for beach visitors. High levels of phosphorous can lead to abnormally high growth of algae, aquatic vegetation, and related health and aesthetic concerns. When bacteria levels or other pollution levels in the water are too high, state and other agencies are supposed to notify the public by posting beach warnings or closing beaches. The problem of beach closures resulting from threats to human health and the environment has resulted in Congress passing the Beaches Environmental Assessment and Coastal Health (BEACH) Act in 2000. BEACH is aimed at improving water quality testing at the beach and to help beach managers better inform the public when there are water quality problems. Section 406 of this Act authorizes the U.S. Environmental Protection Agency (EPA) to award grants to eligible states, territories and tribes to develop and implement beach water quality monitoring and notification programs for coastal and Great Lakes recreational beach waters. Furthermore, these grants are supposed to help local, state, and regional governments develop and implement programs for informing the public about the risk of exposure to disease-causing microorganisms in the water at the nation's beaches *[EPA 2010]*. As a result of these risks and concerns, beach managers have to post advisories or even close beaches, causing economic loss for beach visitors and local economies [*Moore et al*,. 1978; *Calderon et al.*, 1991; *Rabinovici et al.*, 2004]. Another threat to beaches is the potential for environmental accidents such as oil spills or other contamination events. Although rare, the economic loss of these accidents can be very large since they could result in the closure of many beach sites simultaneously [*Grigalunas, et al*., 2000; *Carson et al.,* 2003; *Decon and Kolstad*, 2000]. Furthermore, coastal property provides substantial amenity values and has increasingly been subject to intense development and land use/land cover changes (Woltner et al, 2006). These changes can encroach on public beaches.

Estimating economic values of beaches can provide policy makers with necessary information for cost-benefit analysis of efforts to protect the beaches, improve beach amenities, and, when necessary, for damage assessment of environmental harms.

Previous Economic Research. Some researchers have studied the recreational value of beaches using various non-market valuation techniques. The travel cost method has been used by Bell and Leeworthy (1990) to estimate the value of Florida beaches to out-of-state visitors. Silberman, Gerlpwski, and Williams [1992] used a contingent valuation approach to estimate use (recreation) and nonuse (existence) values for New Jersey beaches. The work of *Shivlani et al. [2003]* examined issues of coastal erosion, beach restoration, and public willingness-to-pay for beach nourishment (sand replacement) in southern Florida. *Shivlani et al.* [2003] used a contingent valuation survey to estimate the value that visitors place on beach restoration at three southern Florida locations. Among other things, Shivlani et al. explored respondents' beach attribute preferences (availability of space, cleanliness, amenities, distance from home, wildlife/vegetation, and other. Their results found important differences among beach visitors and preferences for sites that are nearby. In their work on Californian beaches, *Lew and Larson* [2005] presented measures of economic values associated with beach recreation in San Diego County, California. Using a telephone-mail-telephone survey, they conducted their study with about 600 participants; only 494 survey provided enough information to be used to estimate the economic model. Lew and Larson specifically incorporated respondents' perspectives on factors that made beach selection more or less desirable. Of the 11 factors affecting beach experiences in the *Lew and Larson*'s study, the number 1 ranking was water quality/cleanliness. Recently, *Cervantes et al.* [2008] asked beach goers to evaluate four beaches that share physical and ecosystem characteristics but that differed in socio-economic terms. These beaches were in

Mazatlan, Ensenada, Rosariot, and Oceanside. Their research revealed that even for beaches that shared the same bio-geo-chemical, it was still common for socio-economic and cultural items to differ significantly.

As pointed out by Shivlani et al. [2003] and *Freeman* [1995], it is surprising how small the economic literature on estimating the value of beach access is considering the high levels of participation in beach recreation and high cost of beach protection . Among the valuation studies of beaches, saltwater beaches have received most attention as above examples show. In contrast,freshwater beaches, such as beaches along the Great Lakes, have received very little environmental and resource economic scholarly attention despite their significant recreational use by the public. *Sohngen et al.* [1999] explored the recreational value of two Lake Erie beaches using a single-site travel cost model. Their work found that the average consumer surplus of visiting the two beaches in their study to be $25.5 and $15.5 respectively per person per trip and that the annual value of single day trips were valued at $6.1 million and $3.5 million respectively. The Lake Erie beaches in the Sohngen et al study are but two of a very large number of Great Lake beaches. Because there are many substitute beaches in the Great Lakes, single site methods may be criticized because they may not fully capture site substitutes effects. A subsequent Great Lake focused study, *Murray and Sohngen* [2001], used a multiple-site choice model to estimate the value of improving water quality in 15 Lake Erie beaches in Ohio. Murray and Sohngen found that improving water quality to reduce beach advisories across all 15 study sites can increase consumers' surplus by $1.85 per person per trip. They went on to estimate the aggregate seasonal benefit of reducing an advisory at each beach in Ohio to be about $3.2 to 3.4 million.

2. Method

Study Site. The few previous studies on valuation of Great Lake beaches have focused on a very small subset beaches along Lake Erie in Ohio. Our study expands beach visitors' choice set beyond a limited number of local sites by incorporating almost all of the many public beaches along Michigan's Great Lakes coastline. We do this by using a two-level nested logit Random Utility Model (RUM) to study the beach visitors' choice behavior among the public beaches along Michigan's Great Lakes shoreline. Michigan is surrounded by four Great Lakes, Superior, Michigan, Huron, and Erie (including Lake St. Clair), and has 3288 miles or about one third of the Great Lake shorelines, the largest of all Great Lakes states [Michigan Department of Environmental Quality (MDEQ)][1]. Michigan has nearly 600 public beaches providing tremendous recreational opportunities for the public [MDEQ, 2007].

Currently, Michigan has 594 Great Lakes public beaches that have been identified by local health departments and state agencies (e.g., Michigan Department of Environmental Quality (MDEQ) [*MDEQ*, 2007]. Because some of these beaches are adjacent to each other and some have different local and 'official' names, it can be hard to differentiate them. In our survey, respondents who were beach visitors were asked to give the name of the Michigan Great Lakes beach they visited the most during the last 3 years. Not all of their responses were readily identified in our geo-spatial database. For example, a survey response might identify the beach as "North Muskegon." However, there are two beaches identified by state agencies in our database as in North Muskegon (i.e., Muskegon State Park and Pioneer County Park). Rather than

[1] http://www.michigan.gov/deq/0,1607,7-135-3313_3677-15959--,00.html

consider each beach as an individual site in the choice set, we instead aggregated the beaches by their zip codes and obtained 143 “grouped” beach sites.

For our study we adopted a natural nesting strategy in our model by arranging the beach sites located in the same Great Lakes water body into a nest, since they are geographically located nearer to each and share more similar characteristics. For example, the beach sites along Lake Superior are more remote from populous areas and are longer in length than beach sites along other Great Lakes[2]. The nesting structure used in our empirical analyses is presented in Figure 1.

Model. First applied by Hanemann [1978] and Bockstael et al. [1987], the RUM model has been widely applied to value recreational resources. The RUM model is a ‘discrete choice’ model which considers an individual’s choice of one recreational site among many possible sites [Parsons and Massey, 2003]. It is generally preferred to a single-site model because it can capture site substitution effects as well as value quality changes [Parsons, 2003]. The RUM model assumes that the individual chooses the site that maximizes his/her indirect utility, which consists of a deterministic component and a random component. The deterministic component depends on the costs of visiting the sites and the characteristics of the sites. The random component is due to the fact that researchers do not have perfect knowledge about how the individuals make decisions. If the random component is assumed to follow the extreme value distribution, the RUM model takes the form of conditional logit specification. Although the conditional logit model is well suited to analyze a wide range of recreational sites choices, it has an important disadvantage known as independence of irrelevant alternatives (IIA) property. IIA

[2] Beaches on Lake St. Clair are grouped with those on Lake Erie.

implies that the error terms for all sites are uncorrelated with one another [Kling and Thomson, 1996]. Under IIA, the alteration, introduction or elimination of a site will not alter the relative probability of choosing among the other sites.

The IIA assumption is not realistic in our case because, with nearly 600 public beaches in Michigan, we can anticipate that some of the beach sites may have unmeasured similarities and thus are better substitutes for one another than other sites. To relax the IAA assumption, we employ a two-level nested logit model in which beach sites believed to be close substitutes are arranged into groups or nests. The nests are the upper-level choices and each upper-level choice contains a group of sites as a set of lower-level choices. The IAA assumption still holds for sites within a nest, but it is relaxed for sites from different nests. Let k and j index the nests and beach sites respectively. Let K be the number of nests and J_k be the number of beach sites within the nest. Each beach site can be indexed as the combination of (j,k). The individual's indirect utility for choosing the site (j,k) can be written as:

$$v_{jk} = \beta_{tc} tc_{jk} + \beta q_{jk} + \varepsilon_{jk} \qquad (1)$$

where tc_{jk} is the cost of reaching the beach (j,k), q_{jk} is a vector of the beach characteristics, ε_{jk} is a random error term accounting for unobserved factors from the researchers' perspective and the $\beta's$ are parameters. β_{tc} is expected to be negative, and -β_{tc} serves as a measure of the marginal utility of income. β_q is the marginal utility of site characteristics and is expected to be positive if a characteristic is desirable and negative if it is undesirable.

Following *Haab and McConnel* [2002], let $\Pr(j,k)$ be the probability of choosing the beach site (j,k) among all feasible combinations; that is, it is the probability indirect utility from site (j,k) exceeds the indirect utility from any other site. The probability of choosing site (j,k) in the two-level nested logit model has the closed form expression as follows:

$$\Pr(j,k) = \frac{\exp(\frac{v_{jk}}{\theta_k})[\sum_{l=1}^{J_k} \exp(v_{lk})]^{\theta_k - 1}}{\sum_{m=1}^{K} [\sum_{l=1}^{J_m} \exp(\frac{v_{lm}}{\theta_m})]^{\theta_m}} \tag{2}$$

where $\theta_k \ \forall k$ are parameters that measure the degree of substitution between the nests. They are often referred as "inclusive value coefficients" or "dissimilarity parameters". Let $\Pr(k)$ be the probability of choosing nest k and $\Pr(j \mid k)$ be the conditional probability of choosing site j conditional on choosing nest k. Using Bayes rule we can write $\Pr(j,k)$ as the product of the conditional probability of choosing site j given nest k times the probability of choosing nest k as following:

$$\Pr(j,k) = \Pr(j \mid k)\Pr(k) = \frac{\exp(\frac{v_{jk}}{\theta_k})}{\sum_{l=1}^{J_k} \exp(\frac{v_{lk}}{\theta_k})} * \frac{[\sum_{l=1}^{J_k} \exp(v_{lk})]^{\theta_k}}{[\sum_{m=1}^{K} \sum_{l=1}^{J_m} \exp(\frac{v_{lm}}{\theta_m})]^{\theta_m}} \tag{3}$$

where $\Pr(j \mid k)$ and $\Pr(k)$ are given by

$$\Pr(j \mid k) = \frac{\exp(\frac{v_{jk}}{\theta_k})}{\sum_{l=1}^{J_k} \exp(\frac{v_{lk}}{\theta_k})} \tag{4}$$

and $$\Pr(k) = \frac{[\sum_{l=1}^{J_k} \exp(v_{lk})]^{\theta_k}}{[\sum_{m=1}^{K}\sum_{l=1}^{J_m} \exp(\frac{v_{lm}}{\theta_m})]^{\theta_m}} \quad (5)$$

A common expression of $\Pr(k)$ is

$$\Pr(k) = \frac{\exp(\theta_k IV_k)}{\sum_{m=1}^{K} \exp(\theta_m IV_m)} \quad (6)$$

where $IV_k = \ln(\sum_{l=1}^{J_k} \exp(v_{lk}))$ which is known as inclusive value for nest k and θ_k is the inclusive value parameter. In equation (4) we have a conditional logit model for the lower level choice of choosing site *j* among the J_k sites in nest k and in equation (5) another conditional logit model for the upper level choice of choosing nest k among all the nests. We will employ a consistent estimator for this model by using two-stage sequential estimation in which the first step estimates the parameters of the conditional logit model based on the lower level decision and second step estimates parameters of conditional logit model based on the upper level decision.

After the parameter estimation, the beach visitors' welfare change due to the closure of any site or changes in any site characteristics can be obtained. The compensation variation (CV), which is defined as the payment that equates the expected maximum indirect utility across sites before and after site closure or changes in site quality, is given by

$$CV = \frac{\ln \sum_{k=1}^{K} [\sum_{j=1}^{J_m} \exp(\frac{v_{jk}^{After}}{\theta_k})]^{\theta_k} - \ln \sum_{k=1}^{K} [\sum_{j=1}^{J_k} \exp(v_{jk}^{Before})]^{\theta_k}}{-\hat{\beta}_{tc}} \quad . \tag{7}$$

3. Data and Variables

The data on beach visits and respondent characteristics for this research were obtained using a specially designed online survey in 2006 that was administered to a panel of Michigan adults. The sample list (panel) for the study was obtained from a representative web-based survey panel maintained by Survey Sampling International (SSI). The survey instrument focused on Great Lakes beaches, beach use, and visitation details and asked potential survey participants if they had visited a Great Lakes beach in the past year. Along with the survey question response data, SSI provided the researchers with records of panelists' personal information including their home address zip codes and demographic characteristics. Altogether, 2,566 respondents reported having visited at least one Great Lakes public beach in Michigan during the past 12 months. In order to help researchers identify the location of the beach that respondents had visited, respondents were asked to provide the beach name(s), the name(s) of the water body that the beach was on, as well as the name of the nearest town or city. In the end, 1,710 respondents reported enough information for us to precisely locate the Graet Lakes beach site they report to have visited.

To improve the representative nature of our results, the survey responses were weighted to more accurately reflect the demographic composition of Michigan. Each set of survey responses was assigned a weight based on the race and age of the respondent and region where the respondent lives[3] so that the proportion of groups with different races, ages and spatial locations in our sample matches the proportion of adults in the state's population based on 2000 Michigan

[3] Michigan is divided into six regions: Upper Peninsula, Northern Lower Peninsula, West Central, East Central, Southwest, Southeast.

Census data. Combining respondents' personal information (including income), trip information, and weights yielded 1212 observations for use in our analysis.

The variables that pertain to the utility derived from a particular site in our model (see equation (1)) are specified and presented in Table 1. Price is the travel cost for each beach visitor, which consists of the costs of driving and the opportunity costs of time spent on the trip. The costs of driving were estimated by multiplying the round-trip distances, which are obtained using the software PC Miler, by an average cost of operating a vehicle per mile, which is 38 cents according to American Automobile Association 2006's estimation[4]. The opportunity costs of time were estimated by multiplying the travel time by one third of the wage rate [*Parsons*, 2003]. The travel time is obtained by dividing the travel distance by an assumed average speed of 55 miles per hour. The wage rates are calculated from dividing annual income by 2,000 hours of work time (50 weeks at 40 hours per week). We only knew the income range of the beach visitors participating in our study--$0-20K, $20K-30K, $30K-40K, $40K-50K, $50K-60K, $60K-75K, $75K-100K, and over $150K. We use the midpoint of the range for first eight categories as a proxy for the annual income. People indicating income level over $150K$ were assigned an annual income of $175K.

Site quality variables included in the model are: the length of the beach, number of days of beach advisory(ies) in 2006 and number of days of beach closure in 2006, which are obtained from MDEQ. Beach length at each site is the total length of the beaches at the site. Although the beach length is expected to have a positive effect on individual's indirect utility, it is likely to be at a decreasing rate. To capture this effect, we use natural log of it. MDEQ keeps records of the

[4] According to AAA, the 2006 average operating costs per mile were 9.5 cents for gas, 4.9 cents for maintenance, 0.7 for tires and 23 cents for vehicle depreciation.

advisory and closure information for those monitored beaches. Since our survey was conducted in 2007, we use duration of advisory and closure in 2006 to indicate the water quality of each site. In 2006, monitoring was conducted at 207 or 38% of Great Lakes public beaches in Michigan[5]. Due to *E. coli* exceeding Michigan's water quality standards, there were 20 beach advisories and 32 beach closures lasting 153 and 179 days respectively for 41 Michigan Great Lakes beaches in 2006. Since we aggregate beaches into groups (sites) by their zip codes, we weighted the number of days of closures and advisories by the beaches within each site. For example, if one beach in a site (e.g., #5) that consists of 7 beaches was closed for one day, the duration of closure for the model's site #5 is 1/7. The state does not monitor beaches that have no reported contamination of pollution problems. As a result, unmonitored sites did not have any advisory days or closure days during the study period.

4. Results

Table 2 presents the estimated parameters and p-values from the two-stage sequential estimation of the beach choice model. All coefficients are significant at the 1% level except the number of advisory days. As expected, the travel cost coefficient is negative, meaning that higher trip costs to a site lowers the probability of respondents' visiting it. The length of the beach is an attractive characteristic. An increase in beach length has a positive effect on the site utility and the probability of respondents visiting it, but at a decreasing rate as the log form

[5]Although not all the sites are monitored, it can be argued that the beaches that not monitored are the ones that have less water quality problems assuming the agencies has good priors about where to monitor.

indicates. Water quality does concern beach visitors as evidenced by the significant and negative parameter on closure days.

Table 3 shows the marginal implicit prices of beach length and closure days. The marginal implicit price for a variable is its coefficient divided by the absolute value of the coefficient of travel cost. The marginal implicit price measures the marginal value per trip of a unit change in the characteristic at all sites [Hanemann, 1983]. Computation of marginal implicit prices for model variables facilitate comparison acrs models because they are independent of underlying, unidentified differences in variance across models [Knoche and Lupi, 2007]. The results reveal that a 1,000 meter increase in beach length from the average beach length of 5,733 meters, at all sites, increases a beach visitor's welfare by $4.2 per trip. The marginal implicit price of beach length change is nonlinear and accounted for in the model by use of the logarithm of beach length. The results also show that an increase of one beach closure day at all sites results in a welfare loss of $0.94 per trip. These results support management decisions that, all else equal, favor reducing the number of beach closure days and to protect/maintain longer beaches.

5. Policy simulation

Above we shared model results as estimates of welfare change associated with changes in Great Lakes beach characteristics. However, policymakers are often interested in understanding and accessing the economic damages associated with closing a beach (i.e., the economic benefits of access to a beach). In this section, we estimate welfare change associated with eliminating one or more beach sites from beachgoers choice sets. We fist use the compensating variation formula given in equation (7) to estimate the welfare loss of closing an individual site while all other sites remaining open. Instead of reporting the closure value for each beach site in the sample, we report the summary statistics of the closure values for each “Great Lake beach nest” as well as select Michigan sites in Table 4 (Column 1-3). For example, our estimations show that, all else equal, closing Belle Isle beach on Lake St. Clair would result in the largest welfare loss for beaches in our study at $1.85 per person per trip. Alternatively, closing Houghton City beach on Lake Superior would result in the smallest welfare loss. On average, beach sites on Lake Erie and Lake St. Clair are valued highest by respondents at $0.92 per person per trip. There seem to be two reasons for this. First, the Michigan beaches on these lakes are located in southeast Michigan is the most densely populated region of the state and therefore these beaches are the most visited in our sample. Second, the beaches on Lake Erie and Lake St. Clair are relatively scarce and have fewer substitutes. There are only 10 sites on these two lakes, the fewest number of public beach site among the four Great Lakes nests in our model. Although beach sites on Lake Superior are much longer in length, they are valued least, on average, at $0.10 per person per trip, in part, because they are remote and thus have fewer visits. Looking at the value of avoiding beach closures, the average beach closure values on Lake Michigan and Huron are $0.40 and $0.24, ranking in the middle within the four lakes.

In general, the estimated economic loss per person per trip of closing an individual site is not large. This appears to reflect the presence of many substitutes for the loss/closure of one beach site. While that may be true for individual sites, it is less true for the loss of a region or even all Great Lakes beaches. Therefore, we also estimate welfare loss associated with closing all beach sites within one Great Lakes beach nest while all other Great Lakes beach sites remain open. As shown in the last column of Table 4, as expected, closing a large number of beach sites in a region yields much higher welfare losses when compared to closing an individual beach site. Lake Michigan has the most Great Lakes beach sites in the study area (Michigan) and these sites are popular. Our model shows that closing all of Lake Michigan's beaches in Michigan, all else constant, would result in a welfare loss of $75.55 per person per trip. In comparison, closing all the beach sites on Lake Erie and Lake St. Clair results in similar magnitudes of welfare loss to those associated with closing the beach sites on Lake Huron, which are $13.28 and $13.89 per person per trip respectively. Consistent with the expectation of and reported low visitation of Lake Superior great Lakes beaches, the welfare loss of closing all beach sites on Lake Superior is the lowest among all four Great Lakes, only $2.67 per person per trip. When interpreting the "per trip" values reported here, it is important to bear in mind that the values are per trip to any of the sites, not just the trips to areas being closed. To aid in the understanding of the reported values, in Table 6 we report the values per trip *to a particular beach site*, which is defined as the welfare loss of closing a site (using equation 7) divided by the probability of visiting that site (equation 3). These values per trip to a particular site are more readily compared to values in the literature and are more amenable to use in benefit transfer. From table 6, the average value of a site, per trip to a specific Great Lakes beach site in Michigan, is $47.34, ranging from $37.57 to $58.20.

6. Conclusion and discussion

The Great Lakes are a defining geographic and natural resources for the upper Midwest of the U.S. Great Lakes beaches provide important recreational opportunities to residents of the area. Great Lakes beaches attract people from all around the country and boost local economy. This paper uses a two-level nested travel cost model with all Michigan Great Lakes public beaches in the choice set to estimate the value these sites and to relate values to water quality and the size of a beach. The results show increasing a beach closure day across all sites will result in an average welfare loss of $0.94 per person per trip. Given the many high quality beaches for Michigan residents to choose from, the per trip occasion welfare losses of elimination of an individual beach site are relatively small, ranging from $0.01 to 1.85 per person per trip depending on the beach. However, aggregate welfare impacts of water quality improvement and economic loss of closing an individual beach site or a group of beach sites require that these per trip occasion measures be scaled up by the total number of beach trips by Michigan residents. Unfortunately, the survey data at hand and other available data sources are not well-suited to providing an accurate estimate of the total number of trips to Michigan's Great Lakes beaches that are made by Michigan residents. To illustrate the types of total values implied by the results, we consider some possible estimates of the number of trips.

Murray and Sohngen [2001] estimated 1.7 million person-visits per year for the 15 beaches they studied, or an average of 113 thousand person-visits per beach per year. Transferring this to our case implies a total number of 16 million person-visits to the 143 beach sites per year in our analysis. Another study by Austin et al. [2007] provided a very rough estimate of 8 million swimmers and 80 million swimming days annually in Great Lake region.

Since Michigan has one third Great Lakes shorelines, we could assume there are one third or 27 million swimming days in Michigan annually. In our sample, 74% survey respondents indicate that they swim when visit beach. Accordingly we can infer that there are 36 million person-trips to Michigan Great Lakes beaches. Finally a report conducted by *D.K. Shifflet & Associates, Ltd* [2004] for Michigan Tourism Industry estimated that 94.8 million person-trips were taken in Michigan in 2002, of which 14% are associated with beach or waterfront. This implies roughly 13 million person-trips to beaches were taken in 2002. Assuming the same number of person-trips in 2006 when our survey was conducted. As one can see, there is a wide range of possible estimates for the total trips. Clearly the higher the total number of beach visits is the higher the aggregate beach values will be. Considering the most conservative estimate of 13 million person-trips implies that reducing one beach closure day would increase the seasonal aggregate welfare by $12 million. The seasonal aggregate loss of closing an individual site would range from $130 thousand to $24 million. Closing all beach sites on Lake Michigan would result in a loss as high as nearly $1billion. Taking instead the highest estimate of 36 million person-trips implies a seasonal aggregate welfare increase by $34 million due to a reduction in each beach closure day. The seasonal aggregate loss of closing an individual site would range from $360 thousand to $24 million. Closing all beach sites on Lake Michigan would result in a loss as high as $2.7 billion. Clearly, improved estimates of the total number of beach trips are called for.   Moreover, since there may be substantial trips to Michigan beaches by persons residing outside of Michigan, future efforts should seek to quantify non-resident visits.

Our results show that the recreational values of Great Lake beaches are potentially substantial. However, like coastal ocean beaches, these beaches are also experiencing interruption both from natural disasters and human activities, such as erosion, water pollution etc.

This study contributes to the applied valuation in general, and to the literature on Great Lakes beach valuation in particular. We expect the results will be particularly useful to policy makers given the scarcity of information on Great Lakes beach recreational value. These results can be used to facilitate public land use decision, costs-benefit analysis of improving water quality programs or prevention and/or compensation for environmental accidents.

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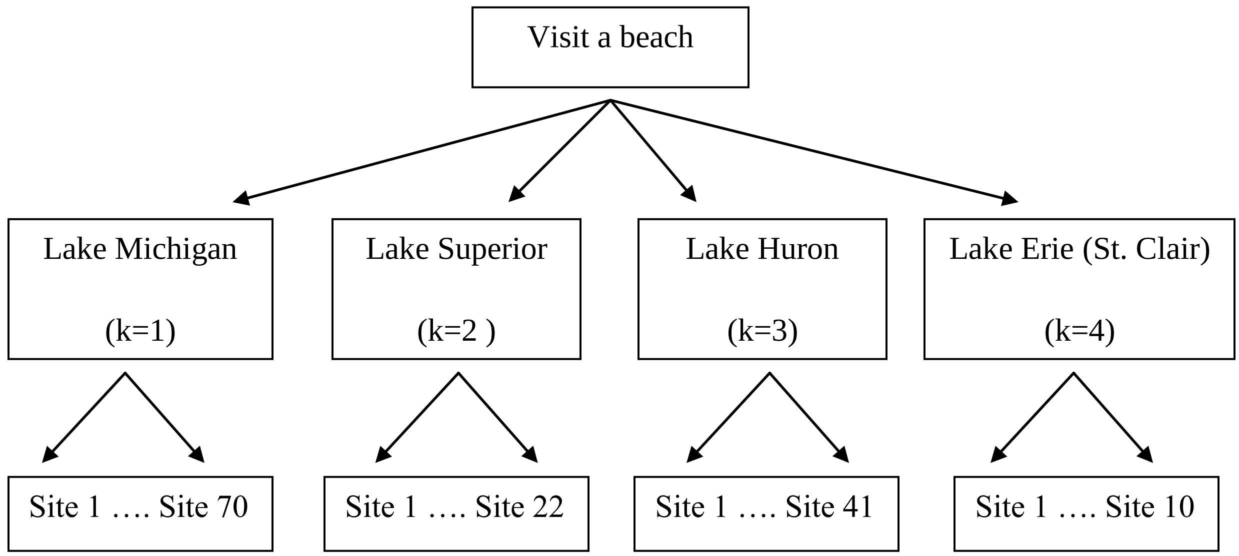

Figure 1. Two-Level Nesting Structure

Table 1. Description and statistics of model explanatory variables

	Variable description	Mean	Std. Dev.	Min.	Max.
Price	Travel cost from individuals home to each site (in $)	259.67	156.22	0.00	1249.97
Llength	Natural logarithm of site Log of beach length (in meters)	7.45	1.88	2.56	10.76
Cdays06	Beach closure days in 2006	0.09	0.60	0.00	7.00
Adays06	Beach advisory days in 2006	0.88	6.49	0.00	75.00
IV_k	Inclusive values of Lake k	n.a.	n.a.	n.a.	n.a.
LMich	Dummy variable for Lake Michigan	n.a.	n.a.	n.a.	n.a.
LSuper	Dummy variable for Lake Michigan	n.a.	n.a.	n.a.	n.a.
LHuron	Dummy variable for Lake Huron	n.a.	n.a.	n.a.	n.a.

Table 2. Nested logit model sequential estimation results

Variable		Coefficient	p-value
Stage 1: conditional logit model based on lower level site choice			
Price		-0.021	0.000
Llength		0.505	0.000
Cdays06		-0.020	0.002
Adays06		-0.003	0.981
Psuedo R^2	0.292		
LogL	-3624.849		
Stage 2: conditional logit model based on Upper level lake choice			
IV_k		0.794	0.000
Lake Michigan		0.480	0.000
Lake Superior		0.592	0.008
Lake Huron		-0.549	0.000
Psuedo R^2	0.450		
LogL	- 919.003		

Table 3. Marginal implicit prices for a change in characteristics at all sites

Beach characteristics	Change in the characteristics	Implicit Price ($)
Beach length	increase1000 meters from the average length of 5733 meters	4.20
Beach closure	increase 1 closure day	-0.94

Table 4. Summary statistics of beach closure values (in $ per choice occasion)

Great Lakes	Average loss of closing a site	Minimum loss of closing a site	Maximum loss of closing a site	Average loss of closing all sites in the lake
Michigan	-0.40	-0.02	-1.78	-75.55
Superior	-0.10	-0.01	-0.28	-2.67
Huron	-0.24	-0.01	-1.27	-13.89
Erie	-0.92	-0.17	-1.85	-13.28
All sites	-0.34	-0.01	-1.85	

Table 5. The detailed list of the beaches included in the most valued sites figure

Zip code area	**Beaches**	**Lake associated**
48207	Belle Isle Beach	St. Clair
49441	Bronson Park; Lake Harbor Park; Pere Marquette Park;P.J. Hoffmaster State Park	Michigan
49436	Cedar Point County Park; Silver Lake State Park;	Michigan
48059	Burtchville Township Park; Jeddo Road Beach; Keewadhin Road Beach; Krafft Road Beach; Lakeport State Park; Metcalf Road Beach	Huron
48045	HCMA - Metropolitan Beach Metropark	St. Clair
48162	Sterling State Park	Erie
49445	Muskegon State Park; Pioneer County Park	Michigan
48634	Nayanquing Point Wildlife Area; South Linwood Beach Township Park	Huron
48157	Luna Pier City Beach	Erie
49417	Grand Haven City Beach; Grand Haven State Park; Rosy Mound Recreation Area	Michigan
48060	Conger-Lighthouse, Holland Road Beach, Lakeside Beach, Lakeside Park Beach	Huron
48236	Pier Park	St Clair
49460	Kirk Park, Kouw Park, Mountain Beach	Michigan
49090	South Haven Beach, Van Buren State Park Beach	Michigan
49431	Buttersville Park Beach, Ludington State Park Beach, Pere Marquette Harbor, Sterns Park Beach, Summit Township Beach	Michigan
49423	Windsnest Park, Castle Park	Huron
49424	Holland State Park, Tunnel Park	Michigan
48631	Brissette Beach Township Park	Huron
49437	Medbury Park Beach, Meinert County Park, Old Channel Beach	Michigan
49127	Grand Mere State Park, Lincoln Township Park	
49125	Cherry Beach, Harbert Beach, Warren Dunes Beach, Weko Beach	Michigan
49085	Hagar Township Park, Lions Park,Silver Beach	Michigan
48082	St. Clair Shores Memorial Park Beach	St Clair
49013	Wenona Beach	Huron
48039	Marine City Beach	St Clair

Table 6. Summary statistics of per trip value to a particular beach site

Great Lakes	Mean	Minimum	Maximum
Michigan	46.01	39.06	53.41
Superior	41.53	37.57	49.83
Huron	50.49	42.85	55.97
Erie	55.88	54.10	58.20
All sites	47.34	37.57	58.20

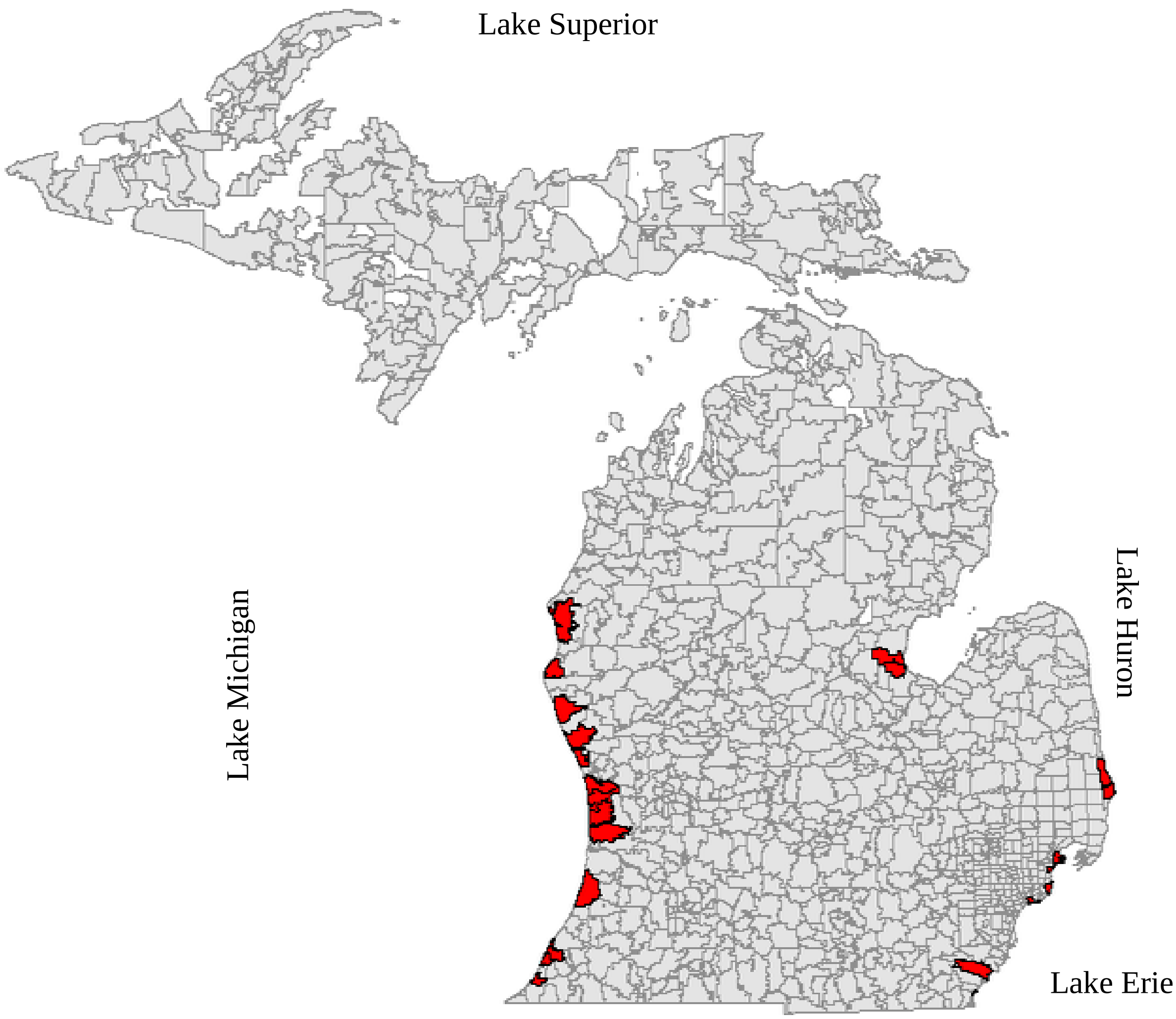

Figure 2. Locations of top ten valued Great Lake beach sites in Michigan