Muskegon Lake Area of Concern Habitat Restoration Project: Socio-Economic Assessment

Final Project Report

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INTRODUCTION

In 1985, Muskegon Lake was designated a Great Lakes AOC because of the historic filling of open water and wetlands, and pollutant discharges that contaminated the lake bottom (U.S. Environmental Protection Agency 2009). In 2009, the National Oceanic and Atmospheric Administration (NOAA) made several awards under the American Recovery and Reinvestment Act of 2009 to restore damaged wetlands, shellfish beds, coral reefs, and reopen fish passages that boost the health and resilience of U.S. coastal and Great Lakes communities. For Muskegon Lake – one of only three such projects in the Great Lakes region – $10 million was awarded to restore wetlands and stabilize shoreline along the south shore of the lake (National Oceanic and Atmospheric Administration 2009). One of the project components includes environmental and socioeconomic monitoring. We focus here on the economic benefits measured via hedonic property values, travel cost survey for lake-based recreation, and contingent valuation.

Despite Muskegon Lake's history of environmental problems, it is still an important recreational resource for West Michigan (Alexander 2006). This ~17 km^2 lake is a drowned river mouth system with the Muskegon River flowing into it from the east and a navigation channel flowing from the lake into Lake Michigan to the west (Steinman et al. 2008) (Figure 1). Muskegon Lake offers opportunities for boating, kayaking, angling, sailing, and wildlife-watching. A trail along its south shore offers opportunities for walking, rollerblading, skateboarding, and cycling. While market-based data may exist for some of these activities (e.g., charter boat fishing, boat launch or marina fees, bicycle rentals, and fishing licenses), there are other nonmarket-based values and benefits that to date have not fully been taken into account (Daily et al. 2009; Heal 2000).

Figure 1. Muskegon Lake's geographic location in Muskegon County in the western portion of Michigan's lower peninsula.

Different economic models have been used to determine the value of recreation-based ecosystem services. The most commonly used methods are the travel cost method or the contingent valuation method (Ralston et al. 1991). The travel cost method is a revealed preference approach to environmental valuation that uses behavioral data such as travel distance to recreational sites, frequency of visits, and actual trip expenses, to estimate users' willingness-to-pay for recreational activities and opportunities (Whitehead et al. 2009; Seller et al. 1985; Sutherland 1982). Contingent valuation is a stated preference approach to economic valuation of environmental goods and services. Respondents are presented with information about specific environmental change; asked about theirperceptions, attitudes, and preferences regarding those changes, and to disclose their willingness-to-pay or willingness-to-accept compensation for gains or losses involved (Whitehead et al. 2009; Brouwer et al. 1999).

In addition to recreation, the softening of the shoreline would be a highly visible part of the restoration project, and therefore would likely affect housing prices. It is anticipated that homeowners would prefer natural shoreline over the aging hardened shoreline on the south side of Muskegon Lake. The effect of proximity to a natural shoreline can be explored using a hedonic analysis.

Hedonic analysis is a common and well-known method used when examining housing markets, and reveals through actual market transactions the marginal implicit price of individual housing attributes (Rosen 1974). A house is a composite of many different features, and the price can therefore reveal how much homebuyers are willing to pay for each one. This identifies marginal price for housing attributes, and we are able to determine the values of not only structural features, but also locational and environmental amenities. Because there is no actual market for environmental services, their valuation can be difficult. Therefore, hedonic analysis can play a crucial role in environmental valuation assessments.

METHODS

To determine the socioeconomic impacts of this wetland habitat restoration project along the south shoreline of Muskegon Lake, we are monitoring the economic value of the lake before, during, and after the restoration project is completed. It is anticipated that the restoration of aquatic habitat and coastal wetlands in this Great Lakes AOC will increase the economic value of ecosystem services associated with these restored wetlands, which local government and economic development authorities can use to promote local tourism.

Travel Cost Survey

The "Travel Cost Survey of Recreational Users of Muskegon Lake, MI" elicits individual information regarding recreational trip length, purpose (primary recreation activity), frequency of visits to different sites on Muskegon Lake, trip expenses, and demographic information (See, Appendix A). Utilizing a single-site travel cost model for one recreational site – i.e., Muskegon Lake – we orally administered the survey to recreational users accessing the lake primarily for fishing, boating or jet-skiing, bird/wildlife watching, walking, or biking at multiple access sites along the south shoreline of the lake.

Figure 2. Travel Cost survey site locations along the south shoreline of Muskegon Lake.

Survey sites were selected from the targeted restoration areas along the south shore of Muskegon Lake that also had public access to the lakeshore (Figure 2). Surveys were administered in four hour shifts[1] at each site on two randomly selected weekend days and two randomly selected weekdays (Table 1). To randomize the sample of recreational users, we interviewed every third adult-user at each location (Parsons 2003). Because of the large number of local respondents, whose recreational usage of these various sites was more frequent than "15 or more", we asked for additional information regarding their usage to try and avoid data truncation. Additional clarifications were also necessary for the questions regarding amount spent on trip and income. For multiple day trips, the amount spent on trip had to match the full length of the trip, and not just on that day's activities. Annual income reported had to be just for the respondent, and not the entire household.

[1] In three cases, shifts were shortened because of severe weather.

Table 1. Muskegon Lake Travel Cost Survey Schedule

2009				2010		
Survey Location	**Date**	**Start Time**		**Survey Location**	**Date**	**Start Time**
Cottage Grove	7/21/2009	5:00 PM		Cottage Grove	7/12/2010	5:00 PM
Cottage Grove	8/5/2009	5:00 PM		Cottage Grove	8/1/2010	5:00 PM
Fisherman's Landing	7/31/2009	5:00 PM		Cottage Grove	8/14/2010	5:00 PM
Fisherman's Landing	8/2/2009	5:00 PM		Cottage Grove	9/1/2010	5:00 PM
Fisherman's Landing	8/25/2009	5:00 PM		Fisherman's Landing	6/2/2010	5:00 PM
Fisherman's Landing	9/7/2009	12:00 PM		Fisherman's Landing	6/30/2010	5:00 PM
Grand Trunk	7/19/2009	10:00 AM		Fisherman's Landing	7/23/2010	5:00 PM
Grand Trunk	7/25/2009	5:00 PM		Fisherman's Landing	7/31/2010	5:00 PM
Grand Trunk	8/26/2009	5:00 PM		Grand Trunk	6/20/2010	10:00 AM
Grand Trunk	9/3/2009	3:00 PM		Grand Trunk	7/15/2010	10:00 AM
Hartshorn Marina	7/18/2009	5:00 PM		Grand Trunk	8/19/2010	5:00 PM
Hartshorn Marina	7/22/2009	5:00 PM		Grand Trunk	8/20/2010	5:00 PM
Hartshorn Marina	8/16/2009	5:00 PM		Hartshorn Marina	6/19/2010	5:00 PM
Hartshorn Marina	8/18/2009	5:00 PM		Hartshorn Marina	7/2/2010	3:00 PM
Heritage Landing	7/30/2009	3:00 PM		Hartshorn Marina	7/30/2010	5:00 PM
Heritage Landing	8/23/2009	10:00 AM		Hartshorn Marina	8/16/2010	5:00 PM
Nature Preserve	7/12/2009	10:00 AM		Hartshorn Marina	8/6/2010	5:00 PM
Nature Preserve	8/31/2009	10:00 AM		Heritage Landing	6/1/2010	10:00 AM
Nature Preserve	8/9/2009	10:00 AM		Heritage Landing	7/18/2010	10:00 AM
Nature Preserve	9/2/2009	10:00 AM		Heritage Landing	7/24/2010	10:00 AM
				Heritage Landing	8/18/2010	10:00 AM
				Nature Preserve	5/29/2010	10:00 AM
				Nature Preserve	6/9/2010	10:00 AM
				Nature Preserve	7/11/2010	10:00 AM
				Nature Preserve	7/17/2010	10:00 AM
				Nature Preserve	8/31/2010	10:00 AM

The data gathered from the travel cost survey need to be adjusted for outliers and other data problems. First, only day trips were included in the model, so multi-day trips were eliminated. Second, observations where the respondent reported more than 365 visits a year were eliminated as outliers. Finally, observations where the individual reported costs that were excessive or too small (the top 2% and bottom 2% of reported costs) for the activity were eliminated as outliers.

The remaining data were used to calculate travel costs in two different ways. Travel Cost 1 is calculated by taking the respondent's answer regarding how much money was spent and dividing it by the number of people travelled with. This value is then added to trip time value. Trip time value was calculated as 1/3 of the survey respondent's income divided by 2080 (the number of hours worked in a year given 40 hour weeks) which was then multiplied by the length of their trip, measured in hours. Travel Cost 2 is calculated by adding the cost of a launch fee ($10) to the mileage costs, which is the number of miles to Muskegon Lake roundtrip multiplied by $0.50, and finally dividing by the number of travelers. This value is then added to their trip time value.

Number of trips per year can then be modeled using a basic travel cost model (Parsons 2003). The expected number of trips by an individual, k, can be hypothesized as an exponential function:

(1) $E[TRIPS_k|X_k] = \lambda_k = exp(X_k\beta)$

This estimation can be handled by a Poisson regression since *TRIPS* is a non-negative integer.

Three specific issues that need to be addressed are heteroskedasticity, over-dispersion, and zero truncation. Tests for heteroskedasticity cannot be rejected at the 10% level. In addition there is some evidence of over dispersion; both problems are addressed by using robust (White corrected standard errors) standard errors. Using robust standard errors with the Poisson regression will provide consistent estimators. The surveys given only to actual users of Muskegon Lake also results in a zero truncation. This problem is addressed by adjusting the model for zero truncation by using ztp in Stata 11.

Contingent Valuation Survey

The "Muskegon Lake Area of Concern Habitat Restoration Survey" was designed as a dichotomous choice survey instrument (Boyle 2003) that would elicit stakeholder (i.e., Muskegon County residents) willingness-to-pay for additional habitat restoration in Muskegon Lake. The initial version of the survey first provided background information about Muskegon Lake and its historical environmental problems, it then described the habitat restoration project, and finally asked for the respondent's willingness to make a one-time payment of $A, which was randomized from six different amounts ($25, $50, $75, $100, $150, $200) to establish of a hypothetical fund to pay for future restoration work. Additional questions probed the likelihood the respondent thought they would make this payment, and explored potential reasons why a respondent might not make the suggested payment. This contingent valuation survey included some generalized travel cost-type questions about the respondent's visits to Muskegon lake, including frequency, distance traveled, activities; and concluded with demographic information similar to that requested in the Travel Cost Survey.

On February 4, 2010, we conducted an informal pretest of this contingent valuation survey. A small sample of interested stakeholders, including project partners and committee members, reviewed and completed the "Muskegon Lake Area of Concern Habitat Restoration Survey". These stakeholders recommended several changes that were incorporated into the survey design: local contact information was added for respondents with questions about the survey or the habitat restoration project; travel cost questions were moved to the beginning of the survey, and the willingness-to-pay paragraph was modified to clarify that this was a hypothetical question regarding a hypothetical *nonprofit* fund; and an online version of the survey was made available to respondents preferring that method of communication. This final version of the survey can be found in Appendix A.

The initial round of surveys consisted of 1,000 mailed surveys to a random sample of Muskegon County residents. A reminder postcard, which also provided the opportunity to complete the survey online, was issued approximately 3 weeks afterwards. A total of 143 surveys were returned, however only 116 were usable in the analysis. This resulted in an extremely low response rate which are systematically low, of 11.6%.

Another major issue with the mailed survey was the demographics of the respondents and their lack of correspondence with the County's demographics. This was determined by comparing the County demographics against the survey demographics by means of chi-square goodness of fit and one-sample binomial tests. After running the respective tests of the survey data against that of Muskegon County, income, age, education level, and gender variables were all statistically different that the distribution of the County, implying that our mailed survey did not bring in a sample representative of the population.

To address this, we included include in-person surveys. This is the preferred method stated by the NOAA Panel on Contingent Valuation, as they believe reliable estimates are unlikely using other methods (Arrow et al, 1993). A calculation of the desired sample size was needed to ensure accuracy of the model. Because the adult population of Muskegon County consists of around 130,000 people (US Census 2009), the sample size did not need adjustments for a finite population. Therefore, our sample was size calculated based on the formula below (Neter et al 1988);

$$n = \left(z^2 p[1 - p]\right) / h^2$$

where z is the z-value based on confidence level; p is the probability of a yes response, which is equal to 0.5 because of our dichotomous choice survey format; and h is the standard error. Our computations varied between 90-95% confidence and 5-7% error, and resulted in a sample size ranging from 138-384. Therefore, we chose a realistic goal of 200 responses.

After making slight revisions in the survey and adding in a few additional questions, survey administration began at various locations around the county. These included public libraries, a bowling alley, the local community college, a hockey game, a high school football game, and a community stakeholder meeting regarding a different local environmental project. While the survey locations and times were not determined randomly because of time restraints and efforts to reach the desired demographics, random sampling was done at each location by asking every n^{th} person depending on the flow of people. [2]

Respondents were read the background information regarding the impairments to the Muskegon Lake ecosystem, the proposed improvements, and the benefits such a project would generate. They were then handed a clipboard which contained the willingness to pay question and a follow-up question regarding their response, and were instructed to complete it privately in order to minimize interview effects. Significant efforts were made to ensure respondents understood the hypothetical nature of the question, although it was important to respond as if it was a realistic opportunity. When the willingness to pay question was completed, the interviewer then asked the remaining lake usage, travel cost, and demographic questions.

Hedonic housing valuation

To explore the relationship between the price of a house and the proximity to natural or hardened shoreline, data about the characteristics of the houses are needed as independent variables in a Hedonic model used to predict housing prices. Housing characteristics and sales data are provided by the County of Muskegon (Muskegon 2009).

[2] During events like football games there had to be an adjustment for the number between samples as there were large crowds.

To match the proximity of a house to lakeshore characteristics, spatial data are needed. Geographic Information Systems (GIS) is used to estimate spatial variables used in the regression, specifically ESRI's ArcGIS (ESRI). The map files used in the analysis are acquired from various sources. A shape file of Muskegon Lake and its watershed is obtained from the US Environmental Protection Agency (US EPA 2009), while transportation framework data is acquired from the Michigan Geographic Data Library (Michigan Center for Geographic Information). A shape file containing all Michigan counties is provided by the US Census TIGER Shape files (US Census Bureau 2008). Lastly, property parcel data for those houses within the Muskegon Lake watershed, as well as shoreline inventory data for Muskegon Lake, is provided by the Annis Water Resources (AWRI 2010).

Muskegon Lake watershed parcels are converted from polygons to points, based on the parcels' centroids. The Muskegon Lake shape file is also transformed from polygon to line, and then edited to exclude the watershed and the lake's tributaries in order to create a more accurate representation of the shoreline. The shoreline inventory of Muskegon Lake is used to determine which segments of the shoreline consisted of natural features, such as wetlands, and those of a hardened nature. Features labeled as hardened consisted of rock, concrete, or timber riprap and other similar classifications. The shoreline classification, in addition to information concerning the location of remediation sites on Muskegon Lake (WMSRDC 2010), is used to create four new shape files displaying natural shoreline before and after remediation, as well as hardened shoreline before and after remediation. The shoreline shape files after the remediation reflected the conversion of hardened shoreline to natural shoreline, thus allowing some properties to become closer to longer segments of natural shoreline.

Additional variables created using GIS consist of location characteristics, such as proximity to industrial and commercial centers, residence in neighborhood, and proximity to Muskegon and Bear Lakes. Based on a City of Muskegon Zoning map (City of Muskegon 2009b), all houses, selected as the parcels' centroids, within 100 meters of an industrial area were determined for use in the regression. Determining the neighborhood in which a house was located was done in a similar fashion. Upon creating a shape file of Muskegon neighborhoods based on a City of Muskegon map, houses in each of the fifteen neighborhoods in Muskegon were identified (City of Muskegon 2009a). Lastly, houses within 100 meters of Bear Lake were identified, as were properties on the shoreline of Muskegon Lake. All geographic coordinates were determined based on the location of each parcel's centroid for use in the spatial regression.

The raw housing data is cleaned to create consistent data to be used in the estimation. First, only residential housing sold in the last 20 years with a sales price greater than $40,000 are used. In addition, house types that behave statistically different than the other houses in the pooled data are dropped. These include houses older than 150 years old, houses below 500 square feet, houses above 4000 square feet, houses less than 2 years old, and houses that have a view of Lake Michigan.

RESULTS

Travel Cost

The results of running a zero truncated Poisson model on the 261 surveys is seen in table 2. The variable in table 2 are defined as:

- $TRIPS_k$ is the number of trips per year to Muskegon Lake reported by person k.
- $TRAVEL\ COST_k$ is the average of Travel Cost 1 and Travel Cost 2 for individual *k.*
- $TRAVEL\ COST\ WH_k$ is TRAVEL $COST_k$ plus the additional cost of travel cost needed to go to the substitute location of White Lake, Muskegon County, Michigan.
- $TRAVEL\ COST\ SL_k$ is TRAVEL $COST_k$ plus the additional cost of travel cost needed to go to the substitute location of Spring Lake, Ottawa County, Michigan.
- $FISHING_k$ is an instrumental variable that is 1 if person k's primary purpose at Muskegon Lake is fishing.

- *BOATING*$_k$ is an instrumental variable that is 1 if person k's primary purpose at Muskegon Lake is boating.
- *FIRST TIME*$_k$ is an instrumental variable that is 1 if person k's is on their first visit to Muskegon Lake is *fishing.*
- *MALE*$_k$ *is a*n instrumental variable that is 1 if person k's is on their first visit to Muskegon Lake is fishing.
- YEAR is an instrumental variable that is 1 if the survey was taken in 2010.
- *ACCESS 1*$_k$ is an instrumental variable that is 1 if person k's is accessing Muskegon Lake from Heritage Landing.

TABLE 2: Basic Model Results

Variable	Poisson Model
TRAVEL COST	-.024* (2.26)
TRAVEL COST WH	-.012 (0.47)
TRAVEL COST SL	.028 (0.97)
FISHING	.331 (1.77)
BOATING	-.025 (0.11)
FIRST TIME	-1.081* (2.23)
MALE	.331 (1.86)
YEAR	.339 (2.09)*
ACCESS 1	.454* (2.20)
CONSTANT	-676.98* (2.08)
N	261
Z stats below coefficient found using robust standard errors * p<.05;	

The primary result of the Poisson regression is a coefficient on *TRAVEL COST* of -0.024. Following the single trip cost model (Parsons 2003), the travel value of a single trip is found using $1/(-\beta_{TRAVEL\ COST})$. The negative inverse of the TRAVEL COST coefficient results in a travel value of $42.53. This will provide a basis for determining the effect of improved environmental benefits over the next few years.

Combining the user travel cost surveys with the demographic information contained in the willingness-to-pay survey can provide information on the increase in recreation value on the lake. The survey results show that 49.8% of the sample from Muskegon county were going to visit at least once more per year after the restoration. In addition, during 2011, the contingent valuation survey was repeated in Kent county, where 36 out of the 900 original survey sent (4%) also stated they would visit at least once more per year. Applying these percentages to the adult populations of Muskegon and Kent county results in 64,835 additional visits from people in Muskegon County and 17,789 additional visits from people in Kent County.

In addition to the increase in visits, each individual visit will be worth more since the quality of the recreational experience has increased. To estimate this, a Monte Carlo simulation was done. Using a random number generator, 49.8% of original responses had one additional trip added to their number of visits to Muskegon Lake in one year. That percentage was chosen based on responses from the Contingent Valuation survey; 49.8% of respondents who visit Muskegon Lake reported that they would make at least one additional trip to the lake because of the remediation. Using the new trip variable, the same model was estimated and the coefficient on *TRIPS* was used to calculate the value of a trip. This process was repeated 5,000 times, and the value of $42.9 for a trip post-restoration was calculated as an average of the repetitions. By subtracting the pre-restoration value from this new value, we find the added value per trip is $0.40 because of the restoration.

The recreation value can be applied to the additional recreational trips to Muskegon Lake to find the aggregate increase in recreational value. The result is an additional $2,757,444 per year in recreation value to residents of Muskegon County and $763,699 per year to residents of Kent County. Using a 7% discount rate the Net Present Value of 15 year is $35.6 million.

Contingent Valuation

Sampling was completed in January 2011 with 212 completed responses from residents of Muskegon County. Three hundred twenty-eight surveys were attempted thus yielding a response rate of 64.6%, a significant improvement compared to the mailed surveys. Most respondents answered each question completely; however 10% did not reveal their income. The responses indicate a general feeling of support for the proposed restoration project. Although 66% of respondents answered "no" to the willingness to pay question, their reasons demonstrate a high level of interest in the program. Of the "no" responses, only 4.3% indicated having no interest in the program. Contrarily, 51.1% indicated having some interest in the program but unwilling to pay for the changes, while 44.6% would only be willing to support the program for a lesser amount than $*X.*[3]

Willingness to pay was calculated using a distribution-free estimation and results in a lower-bound value of mean willingness to pay, as found in Carson et al (1994) and Haab & McConnell (2002). For each "yes" respondent, their willingness to pay falls between their bid amount and the next highest amount, however "no" respondents have a willingness to pay interval that falls between $0 and their amount. Therefore, the probability of answering "yes" for a value between that and the next highest value is multiplied by the bid amount, as shown in the equation below.

$$WTP = \sum_{j=0}^{M} t_j (F_{j+1} - F_j)$$

[3] X was the different amounts in the survey described earlier.

Where M is the highest bid amount, t_j is the offered bid amount, and F_j is the probability of a "yes" response between of bid amount t_j. Regardless of the distribution, this method always yields a conservative estimate by assuming willingness to pay is at the lower end of the range. This results in a lower-bound estimate of $48.41 with a variance of $66.22. When applied to all houses within 10 miles of Muskegon Lake, not including those within 800 meters of the lake, this results in aggregate willingness to pay of $3.1 million.

Hedonic Valuation

The model estimated used the following specification is a spatial error model containing only houses north of Muskegon Lake. This was done because we believe the coefficients to be more conservative due to the fact that the northern shoreline on Muskegon Lake contains more natural features. According to the shoreline inventory pre-remediation, 45% of the northern shoreline is natural, compared to only 24% in the south. This leads ultimately lead to a more conservative estimate of aggregate by accounting for decreasing returns.[4]

The basic model estimated is a spatial regression of:

$$\begin{aligned} \text{LNPRICE} = {} & \alpha + \beta_1(\text{FLOORAREA}) \\ & + \beta_2(\text{BASEMENTAREA}) + \beta_3(\text{GARAGETYPE}) \\ & + \beta_4(\text{BATHROOMS}) + \beta_5(\text{AGE}) + \beta_6(\text{AGE}^2) \\ & + \beta_7(\text{STONE}) + \beta_8(\text{INDUSTRIAL}) + \beta_9(\text{BEARLAKE}) \\ & + \beta_{10}(\text{MLDIST}) + \beta_{11}(\text{STONE}) \\ & + \sum_{t=2}^{20} \partial_t(\text{YEARSOLD}) + \sum_{i=2}^{3} \theta_i(\text{OCCUPANCY}) + \sum_{j=2}^{7} \gamma_j(\text{NEIGHBORHOOD}) \end{aligned}$$

Where:

[4] For additional tests for stability, endogeneity, and other specification errors contact the author. This specification highly stable to changes in the non-relevant variables included.

- *LNPRICE:* natural log of sale price
- *FLOOR AREA:* area of house in square feet
- *BASEMENT AREA:* area of basement in square feet
- *GARAGE TYPE:* number of car spaces in garage; equal to 0, 1 or 2
- *BATHROOMS:* number of bathrooms
- *AGE:* age of house at the time of sale; equal to year sold – year built
- *AGE^2:* age-squared of house
- *STONE:* dummy variable for exterior of house; equal to 1 if exterior is brick, brick/siding, or stone, 0 otherwise
- *INDUSTRIAL:* dummy variable for proximity to industrial and commercial areas; equal to 1 if within 100 meters, 0 otherwise
- *BEAR LAKE:* dummy variable for proximity to Bear Lake; equal to 1 if within 100 meters, 0 otherwise
- *YEARSOLD:* dummy variable for the year of sale; equal to 1 if sold in a given year, 0 otherwise (1990-2009)
- *OCCUPANCY:* dummy variable for occupancy of house; equal to 1 if house has a given occupancy, 0 otherwise (duplex, single-family, or town home)
- *NEIGHBORHOOD:* dummy variable for Muskegon neighborhoods; equal to 1 if house is within a given neighborhood, 0 otherwise (Angell, Beachwood-Bluffton, Jackson Hill, Lakeside, Nelson, or Nims)
- *MLDIST:* distance from Muskegon Lake shoreline in meters
- NATRATIO1*:* natural log of the length of the closest natural shoreline segment divided by the distance to the nearest natural shoreline segment in meters
- HARDRATIO1*:* natural log of the length of the closest hardened shoreline segment divided by the distance to the nearest hardened shoreline segment in meters
- NATRATIO2*:* natural log of the length of the second closest natural shoreline segment divided by the distance to the second nearest natural shoreline segment in meters
- HARDRATIO2*:* natural log of the length of the second closest hardened shoreline segment divided by the distance to the second nearest hardened shoreline segment in meters
-

Table3
Regression Results

Variable	Spatial Regression Model
FLOOR AREA	0.00031*
	(0.00002)
BASEMENT AREA	0.00012*
	(0.00002)
GARAGE TYPE	0.04005*
	(0.01826)
BATHROOMS	0.11915*
	(0.01985)
AGE	-0.00667*
	(0.00145)
AGE^2	0.00003*
	(0.00001)
STONE	0.04247
	(0.03006)
INDUSTRIAL	0.02577
	(0.08332)
BEAR LAKE	0.51618*
	(0.03384)
YEAR SOLD	Suppressed
SINGLE FAMILY	-0.14129
	(0.12386)
TOWN HOME	-0.07473
	(0.14108)
NEIGHBORHOOD	-
MLDIST	-0.00012
	(0.00007)
NATRATIO1	0.01850*
	(0.00908)
HARDRATIO1	-0.03304*
	(0.01006)
NATRATIO2	0.00121
	(0.00908)
HARDRATIO2	-0.03874*
	(0.00909)
CONSTANT	10.39001*
	(0.20193)
N	522
R^2 or pseudo R^2	0.82
robust standard errors below coefficients; *p<.05	

Using the results of the model, the estimated values for all houses between 100 and 800 meters is found using both the current shoreline distances and the new shoreline distances after the remediation. As distances and lengths of shoreline features change as a result of the remediation, the predicted values of each house will be affected. Figure 1 shows how a remediation along the shoreline affects the distances and lengths for a particular house. Figure 2 shows the predicted change in value after the remediation for the houses between 100 and 800 meters that have enough data to generate predicted prices for the year 2009.

FIGURE 1

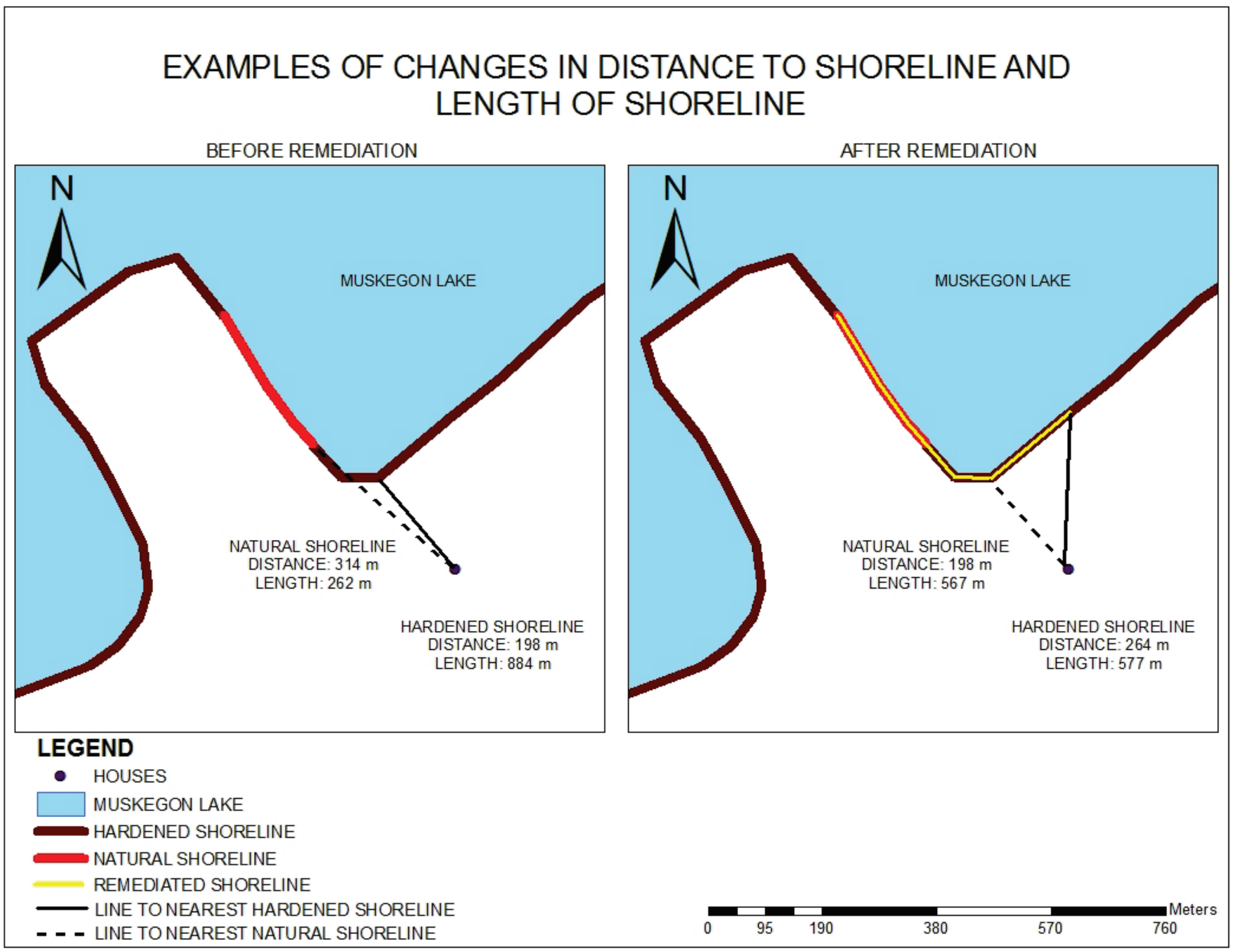
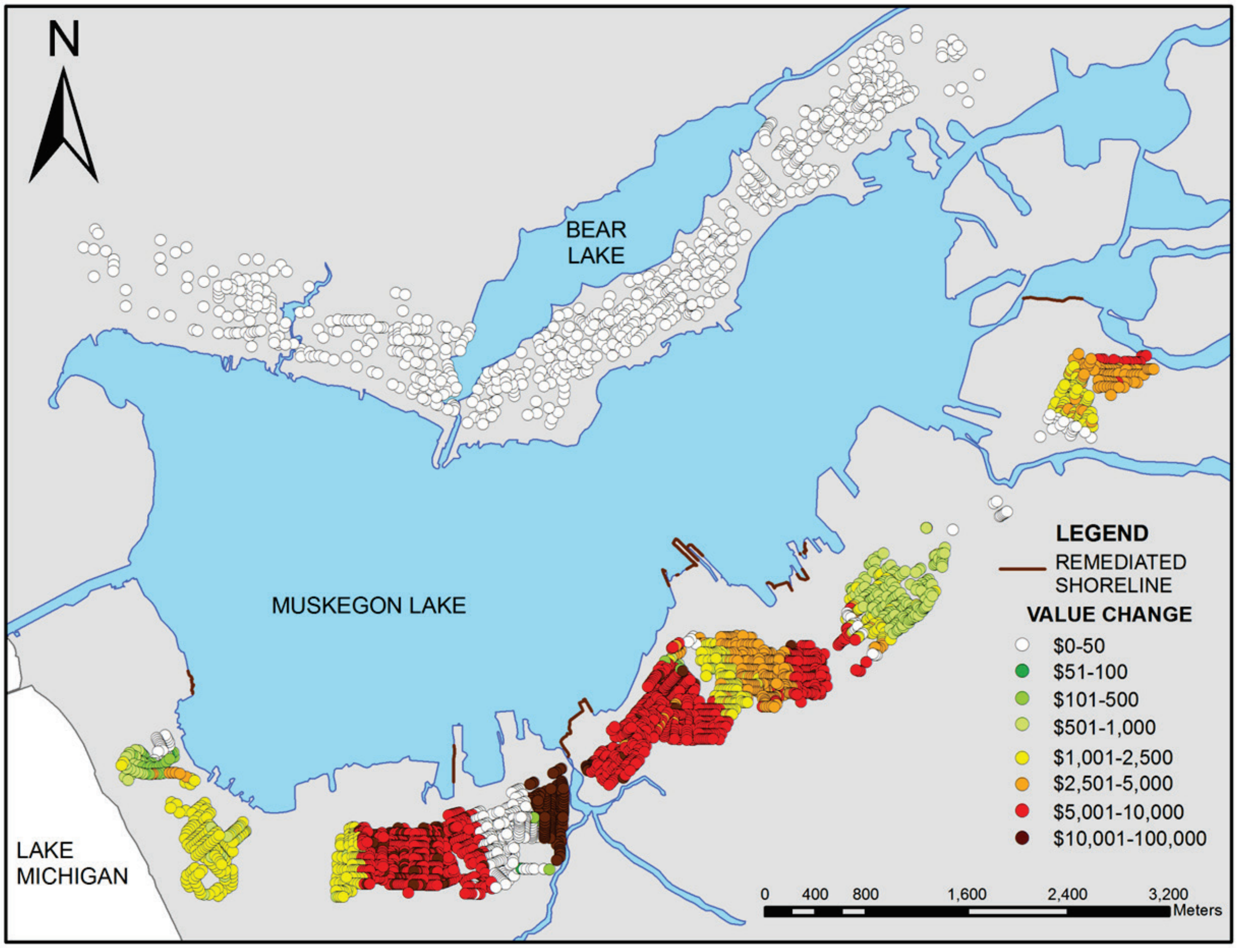


FIGURE 2

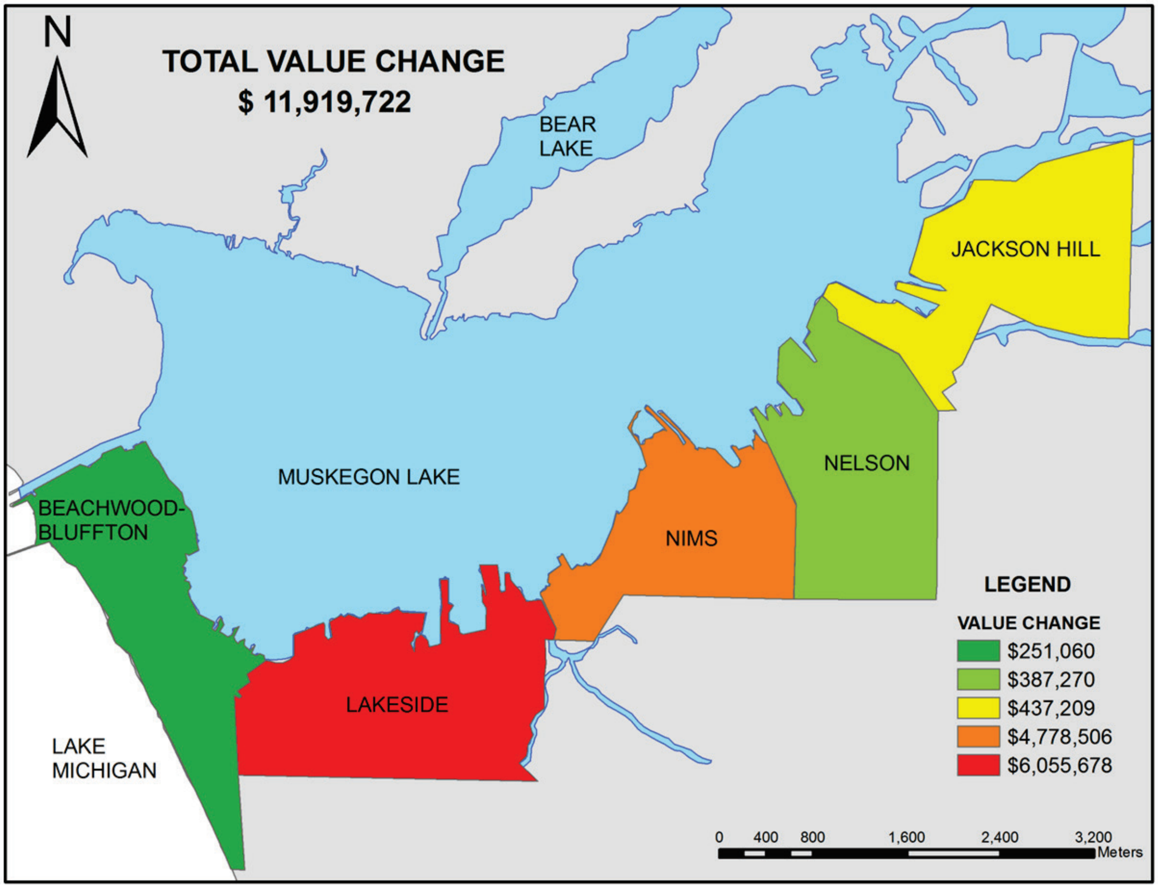
Predicted Housing Value Change after Remediation



Finally, the average change in each neighborhood for the sample was extended to all houses in a neighborhood. This is done by multiplying the average predicted change by the number of residential houses between 100 and 800 meters of the lakeshore (FIGURE 3). The result is a predicted $11.9 million in additional housing value as a result of the improved shoreline features.

FIGURE 3

Property Value Change by Neighborhood



Conclusion

As the travel cost estimates were calculated by not including the population within 800 meters of the lake the hedonic value and travel cost estimates can be added together resulting in $47.5 million in value in addition to the original $10 million spent. The result is that over 15 years the total value generated is nearly 6 times the initial investment. This number is estimated prior to the completion of the remediation, as such continuing monitoring will be required to confirm and refine this estimate.

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Appendix A: Muskegon Lake Wetland Habitat Restoration Project Survey Instruments

1. Travel Cost Study of Recreational Users of Muskegon Lake, MI
2. Muskegon Lake Area of Concern Habitat Restoration Survey

Travel Cost Study of Recreational Users of Muskegon Lake, MI

For the purposes of this study, a trip is the total time you spent between leaving and returning to your home address. It includes all activities that you may have done in that time period. A day-trip includes no overnight stay; a multiple day trip includes one or more overnight stays.

1. When did you leave home? (Date/time) ____

2. When do you expect to return home? (Date/time) ________________________________

3. What is the zip code at your home address? ____________________________________

4. What is the primary activity at Muskegon Lake today?

   a. Fishing ______
   b. Boating or Jet-Skiing ______
   c. Hiking ______
   d. Biking ______
   e. Bird-/Wildlife-Watching ______
   f. Festival/Special Event ______

   g. Other (specify) ____

5. If this is a multiple day trip, please identify other activities you have done/planned?

   a. Fishing ______
   b. Boating or Jet-Skiing ______
   c. Hiking ______
   d. Biking ______
   e. Bird-/Wildlife-Watching ______
   f. Festival/Special Event ______

   g. Other (specify) ____

6. How many people traveled with you on this trip? _________________________________

7. Is this the first time you have been to Muskegon Lake? YES NO

8. How many times do you plan to come to this location (launch/nature preserve) this year?

   1-2 3-4 5-6 7-8 9-10 11-12 13-14 15 or more

9. How many times to you plan to go to any location on Muskegon Lake this year?

   1-2 3-4 5-6 7-8 9-10 11-12 13-14 15 or more

10. Approximately how much money did you spend in total on this trip? $__________________

11. What is your annual income?

a. Less than $20,000 ______
b. $20,000 - $30,000 ______
c. $30,000 - $40,000 ______
d. $40,000 - $50,000 ______
e. $50,000 - $60,000 ______
f. $60,000 - $70,000 ______
g. $70,000 - $80,000 ______
h. $80,000 - $90,000 ______
i. $90,000 - $100,000 ______
j. $100,000 - $110,000 ______
k. $110,000 - $120,000 ______
l. More than $120,000 ______

12. How much of your annual household budget do you spend on recreation in a year?

a. Less than 5% ______
b. 6% - 10% ______
c. 11% - 15% ______
d. 16% - 20% ______
e. 21% - 25% ______
f. 26% - 30% ______
g. 31% - 35% ______
h. More than 35% ______

13. MALE FEMALE

14. What is your age?

a. 18 – 25 ______
b. 26 – 35 ______
c. 36 – 45 ______
d. 46 – 55 ______
e. 56 – 65 ______
f. 66 – 75 ______
g. Over 75 ______

15. Have you answered this survey more than once? YES NO (How many times? _____)

MUSKEGON LAKE AREA OF CONCERN HABITAT RESTORATION SURVEY

Background

As part of the Great Lakes coastal wetlands ecosystem, Muskegon Lake provides fish and wildlife habitat for many species of fish, birds, reptiles, amphibians, and mammals. The lake also provides habitat for fish and wildlife that live in the adjoining water bodies of Lake Michigan and the Muskegon River.

However, because of filling, development, and pollution, Great Lakes wetlands are listed by the U.S. Fish and Wildlife Service as "Imperiled Ecosystems." In 1987, Muskegon Lake was designated as a Great Lakes Area of Concern (AOC) because of historic filling of open water and wetlands, and polluted discharges that contaminated the lake bottom. Sawmill, industrial, and commercial demolition material has filled 798 acres of shallow water and wetlands, and approximately 74% of the shoreline has been hardened with broken concrete, foundry slag, sheet metal, slab wood, sawdust, and other materials. This has resulted in the loss, isolation, and fragmentation of shallow water and wetland habitats and their protective buffers, and the associated decline of fish and wildlife populations. These losses have also prevented public access to the lake's natural resources, degraded the quality of life for local residents, and hampered efforts to attract tourism and businesses to the area.

Muskegon Lake Area of Concern Habitat Restoration

The Muskegon Lake Area of Concern Habitat Restoration project will remove 182,862 metric tons (136,566 cubic yards) of unnatural fill to restore aquatic natural resources on 23.6 acres and restore 10,007 linear feet of hardened shoreline with native wetland vegetation. It will create or restore 11.6 acres of emergent wetlands and 15.6 acres of open-water wetlands, which is approximately 40% of the remaining restoration work needed for habitat restoration. This, in turn, will provide several benefits to the residents of Muskegon County:

- Restored and protected fisheries and wildlife habitat
- Improved public access to the lake
- Job creation and retention (~36,933 labor hours and 125 jobs)
- New business opportunities
- Increased property values
- Enhanced recreational opportunities for fishing, hiking, biking, and wildlife viewing
- Increased tourism

Survey

16. Do you visit Muskegon Lake?_____YES _____NO

17. How often do you visit Muskegon Lake? _______ per day/week/month/year *(Please circle appropriate timeframe.)*

18. How far away from Muskegon Lake do you live?

_____ Less than 1 mile _____ 1-5 miles _____ 5-10 miles
_____ 10-20 miles _____ More than 20 miles

(Survey continued on next page.)

19. What type of activities do you do at Muskegon Lake? (Check all that apply.)

_____ Fishing _____ Boating or Jet-Skiing _____ Hiking
_____ Biking _____ Bird-/Wildlife-Watching _____ Festival/Special Event
_____ Other (specify) ____

20. How long have you lived in Muskegon County? ______ months______ years

21. Do you own or rent your current home? _____OWN _____RENT

22. Do you have a high school diploma or GED? _____YES _____NO

23. If you attended more school after you received your high school diploma or GED, please indicate how many additional years you completed. ____________

24. For subsequent habitat restoration to occur in Muskegon Lake, additional contributions will be required. Assume that a nonprofit organization designates a special fund to raise money for this purpose. For each additional $15 contributed toward Muskegon Lake habitat restoration, 1 additional square foot of habitat can be restored. Every additional acre (43,560 square feet) restored is another 1% of the ultimate restoration goal. If not enough money is collected to restore at least 1 additional acre, then these additional funds will be returned. To restore just 1 acre of wetland habitat in Muskegon Lake, 1 in every 300 households in Michigan would need to contribute $A to this fund. If more households contribute, more habitat can be restored.

    Given your household income and expenses, would you be willing to make a one time, tax-deductible donation of $A? _____YES _____NO

25. If you indicated YES to question #9, on a scale of 1 to 10 where 1 is 'not sure at all' and 10 is 'definitely sure', how sure are you that you would make the one-time, tax-deductible donation of $A? *(Please circle your answer.)* 1 2 3 4 5 6 7 8 9 10

26. If you indicated NO to question #9, which one of the following statements best describes your reason for not contributing to this program?

_____ I have no interest in this program.
_____ I have some interest in this program, but I am unwilling to pay for it.
_____ I am willing to support this program, but for an amount less than $A.

27. What is your annual income?

_____ Less than $20,000 _____ $70,000 - $80,000
_____ $20,000 - $30,000 _____ $80,000 - $90,000
_____ $30,000 - $40,000 _____ $90,000 - $100,000
_____ $40,000 - $50,000 _____ $100,000 - $110,000
_____ $50,000 - $60,000 _____ $110,000 - $120,000
_____ $60,000 - $70,000 _____ More than $120,000

28. What is your gender? _____MALE _____FEMALE

29. Please indicate whether you are at least 18 years old? _____YES _____NO

30. What is your age? _____18 – 25 _____ 26 – 35 _____ 36 – 45
_____ 46 – 55 _____ 56 – 65 _____ 66 – 75 _____ Over 75