Final Report

Ohio Lake Erie Commission Lake Erie Protection Fund
Small Grant SG 417-2012
Lake Erie Shoreline Creel Economic Impact Study

PI: Joseph E. Lucente
Ohio State University Extension / Ohio Sea Grant College Program

Dr. Thomas Blaine
Ohio State University Extension

Frank Lichtkoppler
Ohio State University Extension / Ohio Sea Grant College Program

Timothy Bader
Ohio Department of Natural Resources, Division of Wildlife

Travis Hartman
Ohio Department of Natural Resources, Division of Wildlife

This project was funded in part through the Lake Erie Protection Fund, administered by the Ohio Lake Erie Commission. The LEPF is supported by the voluntary contribution of Ohioans who purchase the Erie…Our Great Lake license plate, featuring the Marblehead Lighthouse.

Abstract
Shoreline angling on the Ohio waters of Lake Erie is enjoyed by thousands of anglers annually, but there is little information on the value of this fishery. In order to quantify economic impacts and benefits of Ohio's Lake Erie shoreline angling, the Ohio Department of Natural Resources Division of Wildlife, as part of a creel survey of shoreline anglers in 2006 and 2007, added several socio-economic questions to the creel survey. Respondents were asked to reveal how many visits they make for shoreline angling per year, their location of residence, and how much money they spent per visit apart from transportation. Using answers from the survey in combination with other data concerning angler visits, we were able to compute total spending per angler trip. We were also able to calculate, by way of the travel cost method (TCM), a non-market economic value of Lake Erie shoreline angling.

On average, Lake Erie shoreline anglers who provided socio-economic information make 21 annual trips to the shore to fish. While 50% live within 9 miles of their angling destination, the mean one-way travel distance is 32 miles. A total of 6.2% live over 100 miles from the Lake Erie shore. Not including travel costs, the average angler spends $8.22per day locally. With total angler visits of 172,665 in 2006, and 102,871 in 2007 this yields an estimated total annual spending of $1.42 million of shoreline local spending in 2006 and $0.85 million in 2007.

The results of this study may be useful to managers and policy makers in decision making relating to the allocation of resources to enhance Lake Erie public access, improve shoreline water quality, and develop amenities for shoreline anglers. The values from this study can be

added to similar studies for other use values of Lake Erie including, private boat and charter angling, as well as other boating activities (water skiing, etc.), swimming, sightseeing, bird watching and fishing from tributaries to get a total recreational use value for Ohio's portion of the Lake.

Activities
J. Lucente secured the services of OSU economist Dr. Thomas Blaine to analyze 2006-2007 creel survey data supplied by T. Bader and T. Hartman from ODNR, Division of Wildlife. F. Lichtkoppler worked with all authors to develop, analyze and compile final report/paper to accurately reflect the economic value of the Lake Erie shoreline fishery.

Timeline
Our timeline was slightly adjusted when we applied for a three month extension of time to complete the analysis and report/paper.

Outcomes and Technical Report
Results presented in the technical report will be submitted to a peer-reviewed journal for publication in 2013 with proper credit and acknowledgement to the Ohio Lake Erie Commission and Lake Erie Protection Fund.

Changes in Project Activities and Hurdles Experienced
Additional salary was added for Dr. Thomas Blaine to conduct an expanded in-depth analysis of the 2006-2007 Lake Erie shoreline creel survey dataset. The survey dataset was extensive and we obtained additional funding to help analyze the socio-economic data collected by the ODNR, ODW. Utilizing Google Earth™ we obtained the latitude and longitude of the creel survey sites. We were able to determine the estimated straight line distance from the survey respondents' home zip code to the creel site where they were interviewed with the help of a system engineer/web applications developer. In addition, we were also able to obtain a mean household income for the home zip code for each survey respondent. This enabled us to develop a TCM (Travel Cost Method) model and analyze the data using SPSS (Statistical Package for Social Sciences) and standard statistical methods. The TCM models we developed are described in the results and discussion section.

Lessons Learned
In surveying over 6,000 anglers and analyzing the results, we gained considerable insight into Ohio's Lake Erie shoreline angling and its participants. We found that anglers come from a wide range of income categories and a wide geographic range as well. Angler expenditures in the local economy are between $880,000 and $1.41 million. While these expenditures are not trivial, they run less than 10% of the environmental economic value the Lake provides for shoreline angling.

These results drive home the importance of Lake Erie as an environmental asset. They can be combined with similar results estimating the value of environmental services provided by the Lake for a host of other activities, including boating (and angling from boats), swimming, and sightseeing. In terms of shoreline angling itself, the results suggest that ensuring access to the shoreline for anglers should be a priority to resource managers and policy makers in the future.

Economic Value of Shoreline Angling in the Lake Erie Waters of Ohio

Dr. Thomas W. Blaine*
Associate Professor Ohio State University Extension
416 Park Drive Apt B
Wooster, Ohio 44691
Blaine.17@osu.edu
Phone: 330.466.7877 & fax

Timothy Bader
Fisheries Biologist
Fairport Harbor Fisheries Research Unit
Ohio Department of Natural Resources, Division of Wildlife
1190 High Street
Fairport Harbor, Ohio 44077 USA
Tim.bader@dnr.state.oh.us
Phone: 440-352-4199 Fax: 440-352-4182

Travis Hartman
Fisheries Biologist
Sandusky Fisheries Research Unit
Ohio Department of Natural Resources, Division of Wildlife
Travis.hartman@dnr.state.oh.us
305 E. Shoreline Drive
Sandusky, Ohio 44870

Joseph Lucente
Extension Educator, Sea Grant and
Assistant Professor Ohio State University Extension
1 Government Center, Suite 550
Toledo, Ohio 43604
Lucente.6@osu.edu
Phone: 419.213.2028 Fax: 419.213.4241

Frank Lichtkoppler
Extension Specialist, Sea Grant and
Professor Ohio State University Extension
99 East Erie Street
Painesville, Ohio 44077 USA
flichtkoppler@lakecountyohio.gov
Phone: 440.350.2267 Fax: 440.350.5928

*Corresponding Author

Executive Summary

Shoreline angling on the Ohio waters of Lake Erie is enjoyed by thousands of anglers annually, but there is little information on the value of this fishery. In order to quantify economic impacts and benefits of Ohio's Lake Erie shoreline angling, the Ohio Department of Natural Resources Division of Wildlife, as part of a creel survey of shoreline anglers in 2006 and 2007, added several socio-economic questions to the creel survey. Respondents were asked to reveal how many visits they make for shoreline angling per year, their location of residence, and how much money they spent per visit apart from transportation.

Using answers from the survey in combination with other data concerning angler visits, we were able to compute total spending per angler trip. We were also able to calculate, by way of the travel cost method (TCM), a non-market economic value of Lake Erie shoreline angling.

On average, Lake Erie shoreline anglers who provided socio-economic information make 21 annual trips to the shore to fish. While 50% live within 9 miles of their angling destination, the mean one-way travel distance is 32 miles. A total of 6.2% live over 100 miles from the Lake Erie shore. Not including travel costs, the average angler spends $8.22per day locally. With total angler visits of 172,665 in 2006, and 102,871 in 2007 this yields an estimated total annual spending of $1.42 million of shoreline local spending in 2006 and $0.85 million in 2007.

Mean round trip cost for transportation to and from the shore per trip is $30.72. When time cost is added ($9.33), the average travel cost is calculated at $40.05.

Regression analysis shows that travel cost and income are highly statistically related to angler visits, and suggests that the two factors act in ways that are inter-related. For anglers who have relatively low travel costs (typically those who live close to the shore), higher incomes are associated with fewer visits. As travel costs rise, the effect of income is lowered until, for those who face relatively high travel costs (primarily anglers who live relatively far away), higher incomes are associated with more trips.

Utilizing the results from the two separate travel cost regression equations, we obtained estimates of consumer surplus of $103.53 and $92.75 per angler trip. These values are estimates of the non-market value of a shoreline angler visit, a value which accrues directly as a result of the amenity offered by Lake Erie to the average Ohio shoreline angler. Given the 172,665 annual angler visits in 2006 and 102,871 in 2007, the results render a total of between $16.01 and $17.88 million in 2006 and $9.54 and $10.65 million in 2007 in recreational/environmental benefits provided to Ohio shoreline anglers by Lake Erie.

The results of this study may be useful to managers and policy makers in decision making relating to the allocation of resources to enhance Lake Erie public access, improve shoreline water quality, and develop amenities for shoreline anglers. The values from this study can be added to similar studies for other use values of Lake Erie including, private boat and charter angling, as well as other boating activities (water skiing, etc.), swimming, sightseeing, bird watching and fishing from tributaries to get a total recreational use value for Ohio's portion of the Lake.

Introduction

While Lake Erie shoreline angling was just 3.8% to 8.1% of the total Lake Erie sport fishery in 2007 and 2006 respectively, it is of comparable magnitude to the Lake Erie tributaries steelhead fishery and is one of the larger fisheries in the state. Prior to 2006, research on the shoreline fishery focused primarily on sport fishery metrics such as estimating angler hours, harvest rates and harvest of major species. A better understanding of the magnitude and value of this fishery to the shoreline angler may help to raise the visibility of this fishery among fishery administrators and lead to additional work to improve shoreline angling opportunities.

Lake Erie provides environmental benefits to many people who visit is shores and islands, and who swim, fish and boat in its waters. The value of these environmental benefits is important, but not easy to measure. Unlike the values of goods and services bought and sold in markets, environmental benefits are not readily observable. This is not because they are small, but because they do not come with a market price.

Efforts to place monetary values on environmental resources are important though, because in their absence a society may overlook them and only make policy decisions based on the values of market goods, which would inevitably lead to an inefficient allocation of resources to those goods (Freeman, 1993). In turn, this tends to lead to lack of protection for resources that have no market price, like clean air, but are still important to people and even essential to their well-being.

In recent decades, economists have made great strides in estimating the non-market values of a host of environmental amenities. They have been able to place monetary values on these amenities by employing two types of approaches, contingent valuation method (CVM) and implicit markets (Phaneuf and Smith, 2004).

CVM proceeds by surveying members of the public to find out what values they place on a resource or amenity. One advantage of CVM is that it can allow respondents to give a total value of the resource – how much they think it is worth. A disadvantage is that the procedure is not based on actual behavior or monetary transactions.

The implicit market approach is based on actual behavior and transactions, and this is seen by many economists as an advantage. The key disadvantage is that implicit markets approaches are non-aggregated. This means that a project designed to observe a segment of the population that uses a resource for one purpose will only capture one component of the resource's overall value. Never the less, careful analysis of the disaggregated benefits of an environmental amenity is an important endeavor because: (1) it reveals information about the scope of values incorporated in the resource; (2) it can be combined with studies of values associated with other uses to obtain total value and (3) by giving details on a specific use value, it can help policy makers as they consider decisions that affect that specific use.

The study reported here was designed to place just such a measure on one aspect of Lake Erie's value: the amount of annual environmental services provided by Lake Erie to Ohio shoreline anglers. It should be emphasized therefore that we are estimating one narrow segment of Lake Erie's use value. This same kind of approach can and should be made to measure values that

include recreational boating (including angling from boats), swimming, bird-watching, sailing, and sightseeing, and all of these recreational activities need to be considered along with commercial enterprises that include charter fishing and the commercial fishing industry.

The Travel Cost Method (TCM)

When an individual makes a trip to Ohio's Lake Erie shoreline to fish, that person is spending time and money to "produce" an angling trip. The most obvious market purchase necessary for many anglers to make the trip include expenditures for gasoline. Less obvious costs also accrue, including depreciation on a vehicle to the angler who uses one to get to the site. Another important cost is the value of the angler's time, as the person who takes a fishing trip may be forgoing an opportunity to work or spend time in another leisure activity.

The implicit market approach to valuation of an amenity like Lake Erie, for the purpose of something like a fishing trip, begins with an assumption that is based on the law of demand: an assumed inverse relationship between the travel cost and the number of trips the angler makes. Known as the travel cost method (TCM), this technique has emerged as the most commonly applied implicit market tool for valuing natural resource/environmental amenities like Lake Erie (Hanley and Spash, 1995).

The data requirements for implementing TCM are fairly significant and straightforward. TCM analysis lends itself well to an onsite intercept survey where the interviewer can ask the respondent the basic questions necessary to measure number of visits, and to construct a travel cost variable. As the ODNR, ODW creel survey is an intercept survey, it was appropriate to use the TCM and incorporate travel cost questions into the creel.

Conducting an isolated TCM study of shoreline anglers would be expensive, however, in this example TCM was incorporated into a creel survey with only a modest additional effort (Lupi, Thayer and Wallmo, 2004). Compared to fishing from a boat, shoreline angling requires a minimal amount of equipment and is a relatively low cost fishery to enter. Only a few TCM items need to be added to the creel survey process to provide information on the value of this fishery to its participants. We were able to add four TCM survey items to the ongoing creel survey and provide a value added human dimensions feature to the planned creel survey research.

Materials and Methods

The Lake Erie shoreline creel survey was designed to efficiently collect fishing data (angler effort and catch) with a minimum of sampling bias (ODW, 2011). Specific written instructions detailing the procedures for contacting anglers were provided to the creel clerks conducting the survey. The surveyors were instructed to contact anglers based on a specific schedule that included week days and weekend days. The survey days and work hours were carefully chosen to adhere to an efficient statistical design and no variance from the schedule were permitted (ODW, 2011).

The creel survey was conducted from Toledo, Ohio to Conneaut, Ohio at 39 major shoreline access sites along Ohio's portion of the Lake Erie shoreline (Figure 1.). Three shoreline creel survey clerks were hired and trained - each assigned to survey one of three creel areas. In 2006 the survey ran from May 10 to October 29. The 2007 survey ran from May 9 to October 31.

Surveys were confined to daylight hours and were adjusted for shorter daylight hours in August, September and October. The survey schedules included morning and afternoon start times, and east and west starting points. The survey dates, start times and starting points were randomly selected within each weekday-weekend strata for each month (ODW, 2011).

From 1975 to 1977 and 1980 to 1984 the ODW conducted Lake Erie shoreline and boat creel surveys. After 1984 they shifted to doing only Lake Erie boat surveys every year as the shoreline angling was about 11% or less of the angler effort and harvest. Before 2006 and 2007 the last shoreline creel was in 1993 (Bader and Johnson, 1994). Only in the shoreline creels of 2006 and 2007 were economic survey items added to the list of questions asked by the creel clerks conducting the angler interviews.

In March of 2006, ODW biologists, an Ohio Sea Grant extension specialist and an Ohio State University economist discussed the possibility of including some economic items in the creel survey. The idea was to answer some key economic questions concerning the Ohio Lake Erie shoreline fishery that had not been previously studied.

An estimate of the angler expenditures per trip is important to local businesses, local county visitor bureaus and others interested in the local economy. Additionally, we wanted to estimate the "consumer surplus" of shoreline angling. This is an estimate of the value anglers place on the fishing experience above the cost of the trip. It is the value over and above what they spend in time and money on shoreline angling trips. Graphically it is the area under the demand curve that represents the difference between the price paid and the price an angler is willing to pay for the shoreline angling experience, (Figure 2). Economists have shown that consumer surplus is therefore an important method for placing dollar values on non-market goods and services, especially those associated with natural resource/environmental amenities (Haab and McConnell, 2002). Lake Erie shoreline angling is in many respects a textbook example of potential use of the consumer surplus approach to resource valuation.

The challenge was to get enough of the necessary data to be able to develop good economic estimates and yet keep the time involved in getting the data to a minimum. In addition to the standard creel catch and effort items that included the angler's home zip code, the anglers were asked the following: Have you been interviewed this year? If no, they asked the following items:

a. In an average year how many trips do you make to this site to fish?

b. How did you get to this site? (1=car, 2=bike, 3=walk, 4=other)

c. Excluding transportation, how much will you spend today for this fishing trip? (1= $1 to 10, 2 = $11 to 20, 3 = $21 to 30, 4 = $31 or more)

d. Are you an hourly wage earner, salaried employee or retired or currently not working? (1 = Hourly wage earner, 2 = salaried employee, 3 = retired or not working) (ODW, 2011).

A total of 5,305 and 3,320 shoreline angler interviews were conducted in 2006 and 2007 respectively. Of these 3,446 anglers in 2006 and 2,650 anglers in 2007 provided information on their fishing expenditures, Sample sizes varied slightly for the other economic questions. (ODW, 2011). Descriptive information on angler effort and catch data is included in the report, "Ohio's Lake Erie Fisheries 2010" (ODW, 2011).

In mid-2011 we obtained additional funding to help analyze the socio-economic data collected by the ODNR, ODW. Utilizing Google Earth™ we obtained the latitude and longitude of the creel survey sites. We were able to determine the estimated straight line distance from the survey respondents' home zip code to the creel site where they were interviewed with the help of a system engineer/web applications developer. In addition, we were also able to obtain a mean household income for the home zip code for each survey respondent. This enabled us to develop a TCM model and analyze the data using SPSS (Statistical Package for Social Sciences) and standard statistical methods. The TCM models we developed are described in the results and discussion section

Results and Discussion

The results (Figure 3) show the distribution of daily local spending by shoreline anglers. Note that the distribution is in the shape of a reverse J, with 3,955 of the 5,914 anglers who responded to this question spending less than $10 per day. This is roughly two thirds of respondents (67%). One fourth of anglers (24%) spend between $10 and $20 per day, while 5% spend between $20 and $30, and about 4 % spend more than $30.

These results reveal that, although shoreline angling is not an intense activity financially, the amount of money being spent near the shore in association with angling trips is not negligible. In order to estimate the total amount of spending, we need to make some assumptions about how spending patterns are distributed within the four groups that we have. We could assume that the average spending within each group is at the midpoint, but that would likely inflate the estimate, given the shape of the overall distribution. If we assume that the spending patterns within each group mimic the overall distribution (reverse J), we will get a slightly more conservative, but probably more accurate estimate of average spending per trip.

Since we had four separate spending categories, we divided each category into subgroups and allowed the percentage of respondents in each of those subgroups to equal the percentage in the respective overall categories. Among the 3,955 respondents who spent below $10.00 per day, we assumed that two thirds spent $2.50 or less, 25% spent between $2.50 and $5.00, etc. We repeated this for the other categories, and truncated total spending at $40 per day. This procedure pulls the average spending within each group down from the midpoint for the group and it also disallows any outliers who may have spent a large sum of money locally. These effects are appropriate given the nature of the results we obtained, namely that we have a reverse J shaped distribution with a very small percentage of respondents spending more than $40 per day. The mean spending per angler day results in an estimate of $8.22. This translates into $1.42 million in 2006 and $0.85 million in 2007 (Table 1).

The consumer surplus estimates for 2006 and 2007 were determined by multiplying the consumer surplus per trip, as determined by two types of regression models used to explain or predict the number of trips anglers take. The remainder of this report explains how we developed and ran the two types of regressions: Poisson and negative binomial.

Travel Demand Function

Travel Costs

The estimation of consumer surplus relies on the development of a function that expresses number of visits as a function of travel costs (Figure 1). In order to measure travel costs, we identified two separate components of costs that the angler bears in getting to and from the angling destination: the cost of transportation and the value of travel time. We used the information on the angler's zip code and destination in order to measure travel distance and to derive an estimate of income for each respondent.

The distances are calculated from an Open Source online database of the latitudes and longitudes of the zip code centers (US Census, 2000). The values were from "The Zip Code Database Project" (2006).

More than 99% of respondents chose automobile as their mode of transportation to and from the site with 83% travelling less than 50 miles (Figure 4).

In order to obtain transportation costs per visit, we multiplied travel distance by two to get round trip distance and then multiplied by $0.445 per mile for 2006 (IRS 2005) and $0.485 per mile for 2007 (IRS 2006) to reflect the Internal Revenue Service (IRS) estimates for transportation costs for those years. We estimated the average travel distance to be 32 miles one-way and the average transportation cost to be $30.72 per trip.

To estimate travel time we used round trip distance and then and divided by 55 miles per hour and added 30 minutes. For both local and out-of town visitors, the 30 minute component of the time value measures the amount of time moving about locally and/or near the site. The 55 mile per hour component has a minimal influence on the calculation of travel time for those who live very close to the angling sites, but is highly appropriate for those who live even a few miles from the site.

Measuring the cost of travel time in recreation demand models has been subject to a great deal of discussion (Feather and Shaw, 1999). Most economists agree that travel time has some value. The fact that a person is willing to expend time to get to and from a recreation site demonstrates that the person places value on the trip and resulting experience, but the value of the time the person sacrifices is not at all clear (Phaneuf and Smith, 2004). Imputing a person's hourly wage as a measure of the value of travel time seems to have a basis in economic analyses (Cesario, 1976). However, many people are not paid hourly, but instead are on salary. Even for those who are paid hourly, it is not clear if they are actually giving up an hourly wage for time at work in order to take a trip. Some may be giving up more, if overtime pay exists at time and a half wages, as it sometimes does. However, many do not have the opportunity to work more than a given number of hours per week. For both hourly and salaried workers, vacation time can accrue that allows them to take trips without losing time at work. Beyond the issues we can identify for salaried and wage earners, many visitors to angling sites are unemployed or retired. While unemployment/retirement might mean that the value of a person's time is relatively small, it does not mean their time has no value at all. A substantial percent (32%) of Lake Erie shoreline anglers are retired or not working, with over 44% being hourly wage earners and 23% being salaried employees (Figure 5).

In order to obtain estimates of the value of travel time, we adopted a procedure based largely on conventions that have been adopted by economists over the years (Victoria Transport Policy Institute, 2012). First we measured an imputed wage rate by dividing annual income in dollars by 2,080 hours. For respondents who are currently employed we divided the wage by three. For those who were unemployed or retired we divided by six to place a lower value on the opportunity cost of their travel time while recognizing that their time still has value.

The Dependent Variable: Number of Trips Taken

As stated above, in order to measure consumer surplus, we have to develop an equation that specifies number of visits (quantity in Figure 1) as a function of price (travel cost) and calculate the area under the curve identified as consumer surplus.

The most commonly used statistical procedure for developing this kind of equation is regression analysis, but use of a standard regression procedure here is not appropriate, because the dependent variable (number of angling trips) is not continuous. Instead, the variable only comes in integer values. These data are called "count" data because they are in the form of counting numbers (1, 2, 3…). We must choose an estimation procedure which not only disallows negative numbers, but also disallows fractions. The most commonly used estimation technique for an equation where the dependent variable can only come in the form of positive integers is the Poisson regression (Cameron and Trivedi, 1998), named for the French mathematician who first formed the mathematics for the distribution in the early 1800s.

An alternative to Poisson regression is a negative binomial regression, which is generally used when values of the mean and variance of the dependent variable (in this case number of angler trips) diverge considerably.

Both of these regression procedures transform the number of trips into logarithms, which means that the straight line in the graph in Figure 1 morphs into a curve that asymptotically approaches the axes. The area it sweeps out (consumer surplus) remains finite, and is fairly straightforward to calculate from regression results.

Independent Variables: Beyond Travel Cost

Thus far we have established the basis for a Poisson regression of number of angler trips as a function of travel cost, with a negative relationship hypothesized between the two variables. The most important variable beyond these two that are normally included in travel cost modeling is income. Economic theory posits that income is an important shifter of the demand relationship between quantity and price for any kind of purchase or activity. In this analysis, income has entered into the calculation of travel cost already. Still, studies show that even with that inclusion, income as a separate variable potentially plays an important role in recreation demand (Phaneuf and Smith, 2004). Economic theory suggests that income can interact with prices to make the relationship even more complicated. Income must be considered because higher (lower) income means more (fewer) opportunities for the respondent. For example, those with higher incomes are more able to take a wider variety of angling trips (such as fishing from a boat, or traveling to more types of fishing destinations). As travel costs change, the influence income has on travel demand can change.

We obtained a measure of household income for respondents by using their respective zip codes. The 1999 median household income for the respondents was derived from National and Ohio

2000 US Census data via the respondents' zip code (US Department of Commerce, 2012). Lake Erie shoreline angling appeals to people across the income spectrum, with peak participation in the $30 thousand to $40 thousand income category (Figure 5).

Many travel demand equations also include a variety of other socio-demographic variables in the demand equation. These often include items such as age, gender, and experience with outdoor activities, to name a few. The survey utilized for this study did not obtain these items from respondents, so we are left with straightforward demand estimation with number of trips specified as a function of travel cost and income.

The equation is:

(1) Log angler trips (y) $= B_0 + B_1$Income ($thousands) $+ B_2$Travel Cost ($) $+ B_3$Income X Travel Cost

Travel Cost was calculated by multiplying the mean mileage rate by distance to and from the site and adding the value of time traveled. Value of time traveled was calculated by computing the time traveled to and from the site by dividing the distance by 55 miles per hour and adding 30 minutes, and then multiplying by annual income in dollars divided by 2,080 hours to calculate an imputed wage. For respondents who are currently employed, we then divided the wage by 3. For those who were unemployed or retired at the time of the survey, we divided by 6 in order to place a lower value on the opportunity cost of travel time.

Poisson Model

The results from the regression, with standard errors in parentheses are presented in Table 2.
(results should be specifically summarized here with a table to reference following the summary)

In order to measure consumer surplus per trip we need to get the negative reciprocal of the rate of change in the angler trips with respect to travel cost (Haab and McConnell, 2002). The rate of change of the Log of angler trips with respect to travel cost is:

(2) ∂Logy/∂TC $= B_2 + B_3$Income Therefore:

(3) Consumer surplus $= -1/ (B_2 + B_3$Income)

Evaluating this expression at the mean income level of $39,116 (calculated at 39.116) yields a consumer surplus of $103.34 per trip:

-1/(-.014 + 1.11E-4*39.116) = $103.53

Income effects

The association between income and angler trips is given by the expression

(4) ∂Logy/∂Income $= B_1 + B_3$Travel Cost

Setting the value of (4) to zero and solving yields

(5) Travel Cost $= -B_1/B_3 =$ $72.07

The result in equation (4) reveals that for those who face a travel cost below $72.04, the effect of income on angler trips is negative. For those facing costs above this amount, rising income has a positive effect on trips. The mean travel cost of anglers is $40.07, so it is quite likely that a profile of anglers at the shoreline would include a large number of relatively low income "locals" along with higher income anglers who traveled further than the mean distance for the sample (38.29 miles). This makes economic sense as Lake Erie shoreline angling appears to be highly valuable to low income local residents primarily because it offers a low cost outdoor recreation benefit. Low income anglers do not have as many recreational options that higher income people have such as boating trips, charter fishing, or trips to more distant recreation sites.

Negative Binomial Model

A common pitfall with the Poisson regression model is that the Poisson distribution forces the mean of the dependent variable (in this case angler trips) to equal the variance. Often in data sets however, the variance is much greater than the mean. This problem is called over dispersion, and renders the standard errors smaller than they would be if the regression model were "efficient." Analysis of our data set reveals that we indeed have over dispersion, since mean trips per angler is 21, while the variance is 892.

A common strategy used when confronting over dispersion is to run another kind of regression applicable to count data called a negative binomial model. We ran such a model, with the results presented in Table 3.

In this model, the parameter estimate on the interaction between income and travel cost is not statistically significant (p=.15). The peculiar results we obtained on income in the Poisson model, along with those obtained in the negative binomial model imply that either income is interacting with travel cost or the dependent variable (Log of trips) is not a linear function of income.

A common functional form economists use when a non-linear relationship appears to emerge is a logarithmic transformation. As we have already seen, the dependent variable in both the Poisson and the negative binomial regression is already in log form. If we use the logs of travel cost and income as independent variables as well, we have a "double-log" model. This transformation not only allows us possibly to obtain reliable results, but also allows us to interpret each parameter as an elasticity of demand (Alston, Chalfant and Piggott, 2002). Elasticity is expressed in percentage terms, meaning that for every one percent change in any given independent variable (i), the number of trips changes by B_i percent. The results of the double-log negative binomial regression are presented in Table 4.

Note that the parameter estimate on income is now positive, implying that for every ten percent increase in income, number of trips increase by 0.72 percent. The parameter on travel cost indicates that every ten percent increase in travel cost is associated with a 4.32 percent reduction in trips.

Recall that the consumer surplus is obtained by the negative reciprocal of ∂Logy/∂TC, which in the current case is:

(6) $-1/(B_2/\text{Travel Cost})$

Evaluating this expression at the mean travel cost of $40.07 yields an estimate of $92.75 per trip:

(7) -1/ (-.432 /$40.07) = $92.75

We have estimated two very different models that yield similar consumer surplus estimates. Despite the differences in the way the two models are specified, both yield consumer surplus estimates that are very similar ($103.53 and $92.75). So we have confidence that these estimates are sound because despite the fact that the two models are different we get comparable results.

Conclusions and Suggestions

The purpose of this study was to estimate a non-market value of Ohio shoreline angling. We undertook this effort by using survey data of anglers collected during 2006-2007, and applying the travel cost method (TCM) to measure consumer surplus per trip and multiplying by the total number of trips to obtain a range of values of $16.01 to $17.88 million and $9.54 to $10.65 million for the respective years.

In surveying over 6,000 anglers and analyzing the results, we gained considerable insight into Ohio's Lake Erie shoreline angling and its participants. We found that anglers come from a wide range of income categories and a wide geographic range as well. Angler expenditures in the local economy are between $880,000 and $1.41 million. While these expenditures are not trivial, they run less than 10% of the environmental economic value the Lake provides for shoreline angling.

These results drive home the importance of Lake Erie as an environmental asset. They can be combined with similar results estimating the value of environmental services provided by the Lake for a host of other activities, including boating (and angling from boats), swimming, and sightseeing. In terms of shoreline angling itself, the results suggest that ensuring access to the shoreline for anglers should be a priority to resource managers and policy makers in the future.

Additional research into the human dimensions of this fishery to better understand the needs of anglers utilizing this fishery resource may provide insight into determining how best to provide the access and amenities desired by shoreline anglers. A better understanding of the anglers participating in this fishery may lead to policies to improve shoreline angling opportunities.

The shoreline angling consumer surplus is in the range of $10 to $17 million annually. The loss of shoreline angling access could result in loss of $10 to $17 million in value to Ohio anglers. The majority of these anglers are of modest income in urban areas that may have few other angling opportunities. Thus it is important for fishery managers to look for ways to improve and increase Lake Erie shoreline angling opportunity.

Acknowledgements

This publication is the result of work that was supported, in part, by the Ohio Lake Erie Commission and the Ohio Lake Erie Protection Fund of which all monies for the Lake Erie Protection Fund are supported by citizens of Ohio through their purchase of the Lake Erie License Plate (LEPF grant SG 417-12) the Ohio Department of Natural Resources, Division of Wildlife, the Ohio Sea Grant College Program (project A/EP-1) from the National Oceanic and Atmospheric Administration (NOAA grant NA10OAR4170074), U.S. Department of Commerce. Support was also provided by the Ohio Board of Regents, The Ohio State University, and Ohio State University Extension. The authors thank Dr. Brent Sohngen for his significant contributions to this project. Additionally we thank George Oommen for his assistance in obtaining estimates for the straight line distance from the survey respondents' home zip code to the creel site and for obtaining a median household income for the home zip code for each survey respondent.

References

Alston, J.M., J.A. Chalfant and N.E. Piggott (2002). Estimating and testing the compensated double-log demand model. Applied Economics 34: 1177-1186.

Bader, T.J., T. Hartman and K. Kayle (2011). Project Final Report -Lake Erie Shoreline Creel Surveys - FFDR07. Ohio Department of Natural Resources, Division of Wildlife, Lake Erie Fisheries Units, Fairport and Sandusky.48 pp.

Bader, T.J. and D. Johnson (1994). Lake Erie Summer Sport Fishery Assessment. Annual project performance Report, FY 1994. Project FFDR01. Federal Aid in Fish restoration Project F-69-P Ohio Department of Natural Resources, Division of Wildlife, Lake Erie Fisheries Units, Fairport and Sandusky. 24 pp. November 30, 1994.

Cameron, A.C. and P.K. Trivedi (1998). Regression Analysis of Count Data. (Cambridge University Press: Cambridge, UK and New York, USA).

Cesario, F. J., 1976. Value of time in recreation benefit studies. Land Economics. 52 (1), 32-41.

Colson, J. (2006). Zip Code Database Project. Available online at: http://zips.sourceforge.net/ Accessed on February 2012.

Feather, P. and W. D. Shaw (1999). Estimating the cost of leisure time for recreation demand models. Journal of Environmental Economics and Management 38 (1), 49–65.

Freeman, A.M. III (1993). The measurement of environmental and resource values, theory and methods. Washington: Resources for the Future.

Haab, T.C. and K.E.McConnell (2002). Valuing Environmental and Natural Resources: The Econometrics of Non-Market Valuation. Edward Elgar Publishing Inc: Northampton, MA.

Hanley, N. and C.L. Spash (1995). Cost Benefit Analysis and the Environment. Edward Elgar Publishing Inc: UK.

IRS. 2005. IRS Announces 2006 Standard Mileage Rates.IR-2005-138 http://www.irs.gov/uac/IRS-Announces-2006-Standard-Mileage-Rates. Accessed on 25 October 2012.

IRS, 2006 IRS Announces 2007 Standard Mileage Rates. IR-2006-168 http://www.irs.gov/uac/IRS-Announces-2007-Standard-Mileage-Rates Accessed on 25 October 2012.

Lupi, F., Thayer, S., and Wallmo, K. "The Potential for Collecting Angler Socio-Economics from Great Lakes Creel Surveys." Annual Meeting American Fisheries Society, Madison, WI; August 24, 2004.

Ohio Division of Wildlife (ODW). 2011. Ohio's Lake Erie Fisheries, 2010. Annual status report. Federal Aid in Fish Restoration Project F-69-P. Ohio Department of Natural Resources, Division of Wildlife, Lake Erie Fisheries Units, Fairport and Sandusky. 140 pp.

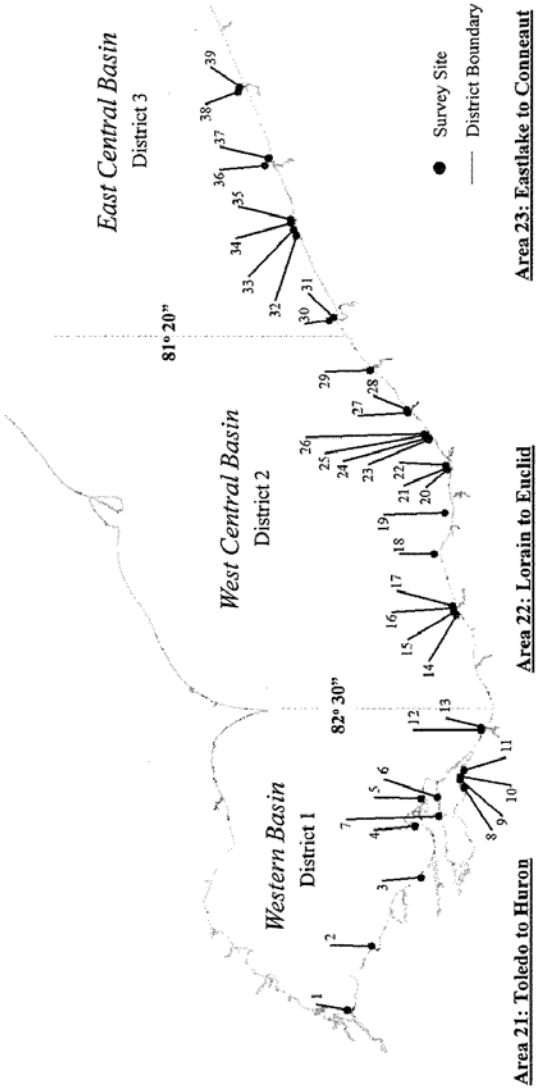
Phaneuf, D.J, and V.K. Smith (2004). Recreation Demand Models. Prepared for Handbook of Environmental Economics, K. Maler and J. Vincent, editors. Available online: http://are.berkeley.edu/~gh082644/262/Recreation%20Demand%20Models%202004%20revision.pdf Accessed November 1, 2012.

Sohngen, B., Lichtkoppler, F., and Bielen, M. 1999. The value of Day Trips to Lake Erie Beaches. Technical Bulletin OHSU – TB – 039. Ohio Sea Grant College Program. Columbus, Ohio.

US Department of Commerce. United States Census Bureau. Census 2000 Gateway (2012). Accessed at http://www.census.gov/main/www/cen2000.html.

Victoria Transport Policy Institute (2012). Transportation Cost and Benefit Analysis II: Travel Time Costs. Available online http://www.vtpi.org/tca/tca0502.pdf Accessed on 29 October, 2012.

Figure 1. Locations of the 2006 and 2007 Shoreline Creel Survey sites (from Bader, Hartman and Kayle 2011)



Area 21: Toledo to Huron

1. Bayshore Power Plant
2. Metzger Pier
3. Camp Perry Pier
4. Catawba State Park Pier
5. Mazurik Pier
6. Dempsey Pier
7. Sandusky Bay Bridge
8. Jackson St. Pier
9. Shoreline Park
10. Battery Park Pier
11. Police Station Pier
12. Huron Pier
13. Nickel Plate Pier

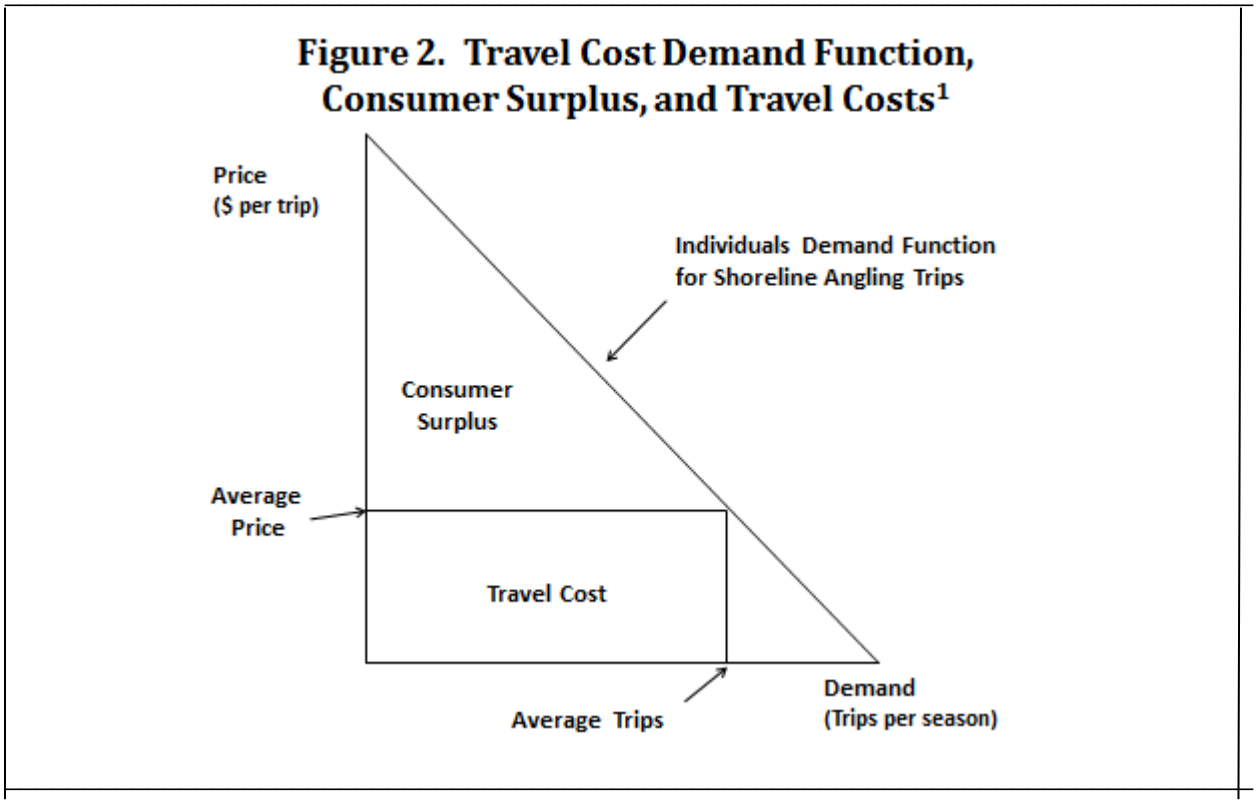
Area 22: Lorain to Euclid

14. Lorain Hot Waters
15. Lorain Ore Dock Pier
16. Lorain Disposal Plant Pier
17. Lorain Mile Pier
18. Avon Lake Pier
19. Bay Village Pier
20. Edgewater I Pier
21. Edgewater Breakwall
22. Edgewater Treatment Plant
23. Edgewater E. 55th St. Pier
24. Edgewater U Pier
25. Edgewater E. 72nd St. Pier
26. Gordon State Park Pier
27. Villa Angela Pier
28. Wildwood State Park Pier

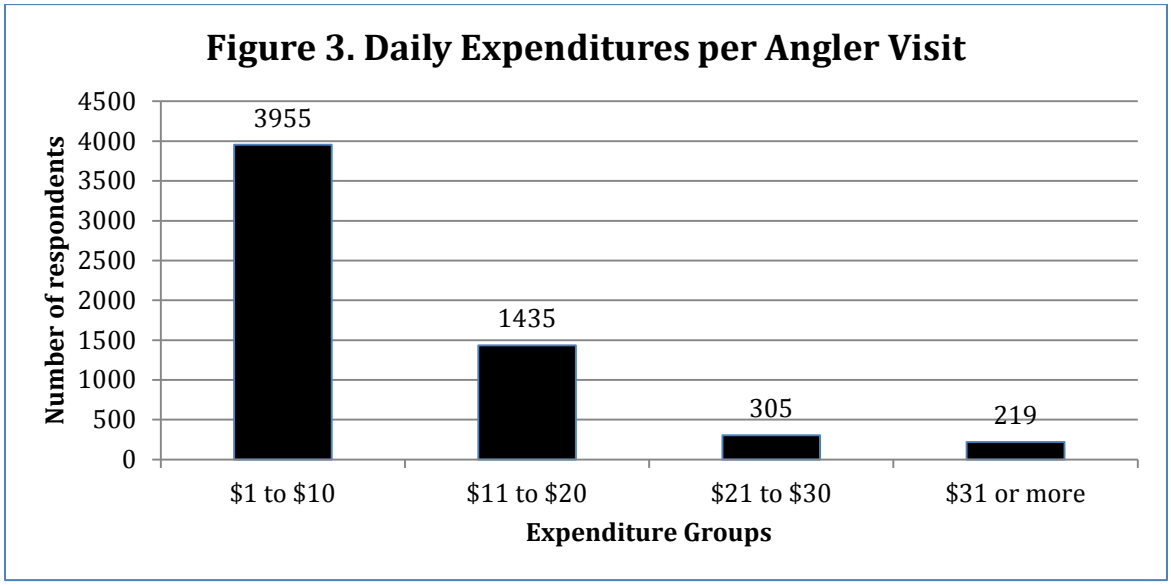
Area 23: Eastlake to Conneaut

29. Eastlake CEI Pier
30. Headlands Beach Pier
31. Fairport Harbor Pier
32. Arcola Cr.
33. Wheeler Cr.
34. Geneva State Park Pier
35. Cowles Cr.
36. Ashtabula West Breakwall
37. Lakeshore Park Pier
38. Conneaut West Breakwall
39. Conneaut City Pier

Figure 1. Creel survey areas and count locations for Ohio's Lake Erie shore creel survey.



[1]from Sohngen, Lichtkoppler and Bielen 1999



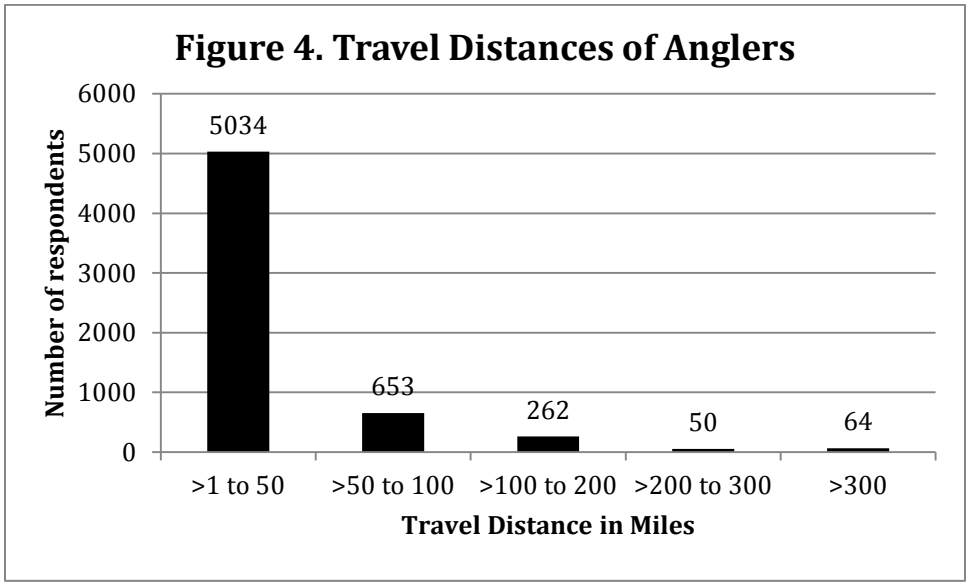


Figure 4. Travel Distances of Anglers
6000
5000
4000
3000
2000
1000
0
Number of respondents
5034
653
262
50
64
>1 to 50
>50 to 100
>100 to 200
>200 to 300
>300
Travel Distance in Miles

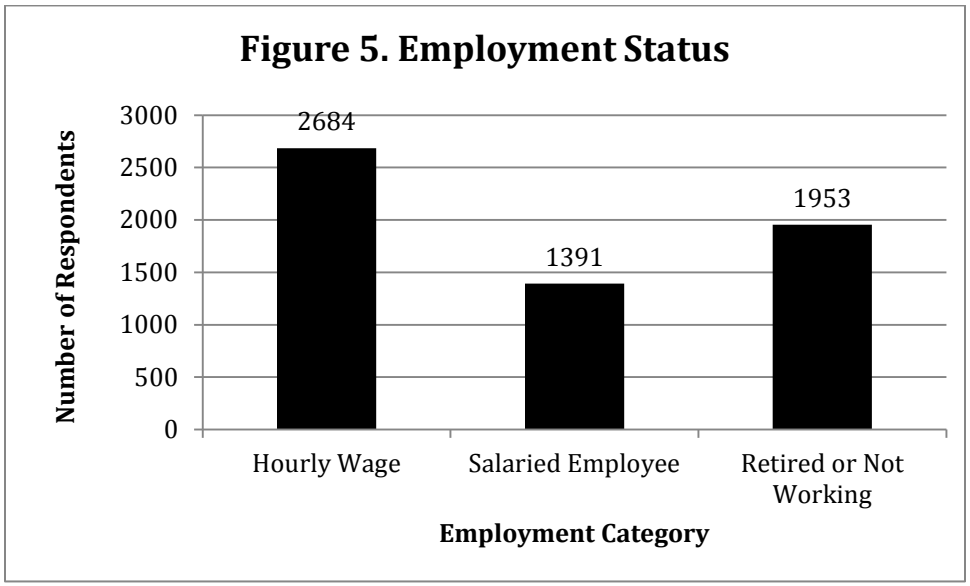


Figure 5. Employment Status
3000
2500
2000
1500
1000
500
0
Number of Respondents
2684
1391
1953
Hourly Wage
Salaried Employee
Retired or Not Working
Employment Category

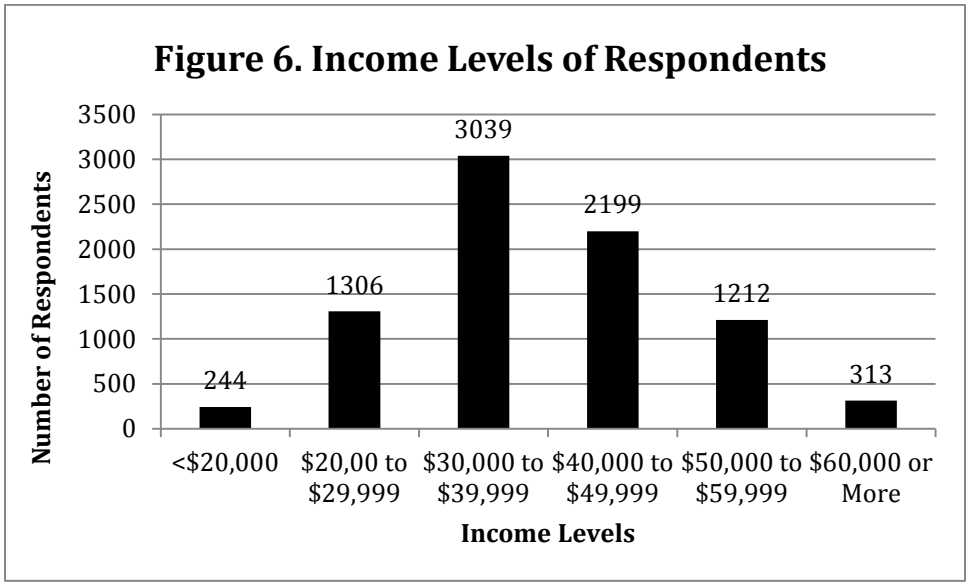


Figure 6. Income Levels of Respondents
Number of Respondents
3500
3000
2500
2000
1500
1000
500
0
244
1306
3039
2199
1212
313
<$20,000
$20,00 to $29,999
$30,000 to $39,999
$40,000 to $49,999
$50,000 to $59,999
$60,000 or More
Income Levels

Table 1. Average and yearly number of respondents, number of angler trips, expenditures and consumer surplus from the 2006 and 2007 Lake Erie Shoreline Creel Surveys using the Poisson and Negative Binomial Models.

Year	2006	2007	Average
Number of respondents	3,446	2,650	3,048
Number of trips	172,665	102,871	137,768
Expenditures	$1.47 Million	$.88 Million	$1.18 Million
Consumer Surplus			
Poisson Model	$17.84 Million	$10.63 Million	$14.19 Million
Negative Binomial Model	$16.01 Million	$ 9.54 Million	$12.78 Million

Table 2: Results of Poisson Regression

Dependent Variable: Log of Angler Trips

Independent Variable	Parameter	Standard Error
Intercept	3.592	.0099***
Income	-.008	.0002***
Travel Cost	-.014	.0002***
Income X Travel Cost	1.11E-4	3.6E-6***

*** denotes statistically significant at p <.01

Table 3: Results of Binomial Regression – Model 1

Dependent Variable: Log of Angler Trips		
Independent Variable	Parameter	Standard Error
Intercept	3.416	.0432***
Income	-.008	.0011***
Travel Cost	-.003	.0003***
Income X Travel Cost	1.00E-5	6.71E-6

*** denotes statistically significant at p <.01

Table 4: Results of Binomial Regression – Model II

Dependent Variable: Number of Angler Trips		
Independent Variable	Parameter	Standard Error
Intercept	3.388	.4118***
Log Income	0.072	.0398*
Log Travel Cost	-.432	.0116***

***denotes statistically significant at p <.01, * denotes statistically significant at p <.10