A Comparison of Non-Market Approaches in Determining the Benefits of Remediation at a Great Lakes Area of Concern
Eighteenmile Creek, Niagara County New York

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Abstract

Valuations of environmental resources often require the use of non-market approaches. In this paper, three common non-market methods are employed to valuate restoration of Eighteenmile Creek, a Great Lakes Area of Concern (AOC) located in upstate New York. Using a survey of recreational anglers who visit the stream, we determine that travel cost and contingent valuation methods are consistent in their estimation of consumer surplus increases with site remediation. Implementation of a hedonic property approach indicates that the increases in property values with site remediation as determined in similar AOC studies may not occur at Eighteenmile Creek.

1. Introduction

There is little argument that the Great Lakes, which contain one-fifth of the world's freshwater, serve as one of the truly valuable natural resources in the United States. In addition to providing water for drinking, the Lakes provide food, recreation, and transportation to over 30 million Americans (EPA, March 2007).[1] However, the Great Lakes have faced significant environmental threats including aquatic invasive species, non-point pollution, and the disposal of toxic pollutants, all of which have left some areas of the Lakes severely degraded. The worst of these areas have been specially designated as Areas of Concern (AOCs)[2]. Cleanup of these areas has become a major priority of both the United States Environmental Protection Agency and the International Joint Commission. However, the costs associated with these cleanup activities are immense and funds for such efforts are limited.

[1] U.S. Environmental Protection Agency Great Lakes National Program Office homepage. http://www.epa.gov/glnpo/. Accessed March 2007.

[2] U.S. Environmental Protection Agency Great Lakes National Program Office Areas of Concern Online. http://www.epa.gov/glnpo/aoc/index.html. Accessed March 2007.

With limited funds available, it is important to prioritize cleanup efforts wisely. One approach to justifying and prioritizing AOC cleanup is to assess the economic benefits that might be expected with such efforts. To date, little has been done to quantify the economic benefits of AOC cleanup. One reason for this is that the market benefits for such cleanup efforts are not readily visible, nor do market benefits capture all of the benefits that humans might experience due to site remediation. This study will use three approaches to evaluate the non-market economic benefits that may be expected with remediation of an AOC at Eighteenmile Creek, near Newfane New York. The three approaches used consist of travel cost methods, contingent valuation, and hedonic methods. All of these methods have become standard tools in environmental economics, and each has advantages and disadvantages. The characteristics of the Eighteenmile Creek site combined with the data collected in this study allow an opportunity to apply each of these methods and compare the resulting non-market values.

2. Background

2.1 Great Lakes Areas Concern

A 1987 Protocol to the Great Lakes Water Quality Agreement (GLWQA) identified 42 highly degraded areas throughout the Great Lakes as Areas of Concern. (AOCs). These sites consist of those locations throughout the Great Lakes experiencing the most significant impairments to the beneficial uses outlined in the GLWQA. Of these 42 sites, 25 are located in the United States, 12 in Canada, and 5 are found in connecting channels between the two countries. In addition to establishing those sites which are listed as AOCs, the GLWQA directs the U.S. and Canadian governments to work with

state and local governments to develop Remedial Action Plans (RAP) to restore beneficial uses at these sites. To date, remediation efforts have resulted in only two sites being de-listed (both in Canada), despite millions of dollars being expended in both countries. In the U.S. alone, approximately $160 million has been spent in AOCs and work has taken place or is ongoing to remediate sediments in 14 of the 26 AOCs. Although the measures necessary to restore many AOCs are unclear, the U.S government has indicated that an expected $7.4 billion may be necessary to implement the wastewater infrastructure and sediment improvements necessary to restore beneficial uses in selected Areas of Concern for which detailed information is available (IJC, 2003)[3].

2.2 Eighteenmile Creek

Eighteenmile Mile Creek is located the northwest corner of upstate New York near the village of Newfane in Niagara County. The stream begins near the city of Lockport and flows northward for approximately 15 miles before entering Lake Ontario at Olcott Harbor. During the fall and early winter months, the creek serves as an important spawning location for several salmonid species, including Chinook Salmon, Coho Salmon, Rainbow (steelhead) trout, and Brown Trout. This fishery is maintained primarily New York State Department of Environmental Conservation (NYSDEC) stocking efforts. Each spring, the state plants approximately 117,000 Chinook Salmon, 30,000 Coho Salmon, and 7,000 steelhead in the stream (NYSDEC, 2007)[4]. These fish quickly drop down to Lake Ontario before returning three years later (3-5 for steelhead)

[3] International Joint Commission. Areas of Concern Special Report. April 2003. Available Online: http://www.ijc.org/php/publications/html/aoc_rep/english/report/index.html. Accessed March 2007.
[4] New York State Department of Environmental Conservation. 2005 Fish Stocking for Niagara County. Available Online: http://www.dec.state.ny.us/website/dfwmr/fish/stockniag.html. Accessed March 2007.

as adults to spawn. In addition to the Chinook, Coho, and steelhead, a large number of brown trout stocked in Lake Ontario enter the stream to spawn in the fall.

Due to both the abundance and size of the fish available during the fall spawning runs, large numbers of anglers travel to the stream for the high quality angling opportunities available. Each year, an estimated 10,300 angler trips occur at the stream, with the heaviest usage occurring during the months of October and November (Town of Newfane, 2007)[5].

In order to gain an understanding of angler usage of Eighteenmile Creek, as well as the economic value of angler expenditures, a survey was conducted as part of this study in Fall 2006. This study found that the distances anglers travel to fish at the site vary extensively, as some anglers surveyed in this study indicated that they had traveled from as far as Texas or Louisiana. Aside from New York, the most common states represented at the stream consisted of Ohio, Pennsylvania, and West Virginia. However, the majority of anglers indicated being from New York State, and many of these anglers were relatively local, traveling from less than 60 miles to reach the site. The expenditures made by these anglers in traveling to the site significantly contribute to the local economy due to expenses incurred for items such as hotels, food, gas, fishing licenses, bait and tackle etc. To date, this study is the first to attempt to quantify these expenditures using direct survey information provided by anglers at Eighteenmile Creek.

The section of Eighteenmile Creek between the mouth at Olcott Harbor upstream two miles to Burt Dam has been designated by the U.S. and Canada as one of 42 Areas of Concern (AOCs) in the Great Lakes[1]. As previously mentioned, these AOCs are

[5] Unofficial Parking Lot Count Data Provided by the Town of Newfane for the 2005-2006 seasons. Data Received February 2007.

typically the most heavily polluted streams and harbors in the Great Lakes, and have experienced significant beneficial use impairments. At Eighteenmile Creek, past disposal practices have resulted in heavy sediment contamination due to heavy metals, pesticides, PCBs, PAHs, dioxins, and dibenzofurans(EPA, 2007)[6]. Although the exact sources of many of the pollutants are unknown, it is likely that much of the pollution originated at the now currently inactive hazardous waste sites located throughout the watershed, as well as the New York State Barge Canal and other municipal discharges. A 1997 Summary of the Eighteenmile Creek Remedial Action Plan (RAP) indicates that a total of 15 former hazardous waste sites are located throughout the Eighteenmile Creek watershed. Although there is no information indicating the occurrence of discharges from these facilities into the stream, it is possible that such discharges occurred either directly or indirectly through leaching processes. In addition, the RAP report indicates that the Barge Canal is a likely source of PCBs, dioxin, and dibenzofurans (NYSDEC, 1997).[7]

The contamination present at Eighteenmile Creek has led to impairments to several beneficial uses, including fish and wildlife consumption, dredging activities, and degradation of benthos. Additionally, U.S. EPA has indicated that it is likely that bird, animal, and fish deformities and reproduction problems occur along the stream. Currently, the New York State Department of Health has placed a fish advisory on Eighteenmile Creek, recommending that no fish taken from the stream should be consumed[6].

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[6] U.S. EPA. "Eighteenmile Creek River Area of Concern". Available: http://www.epa.gov/glnpo/aoc/eighteenmile.html

[7] New York State Department of Environmental Conservation. Eighteenmile Creek Remedial Action Plan Summary. August 1997.

In addition to the restrictions on fish consumption, restrictions exist on dredging activities in Olcott Harbor. Currently, Olcott Harbor is dredged by the U.S. Army Corps of Engineers to allow for recreational boating opportunities. Due to elevated levels of chromium, copper, lead, manganese, nickel, zinc, cyanides, mercury and benzo(a)anthracene, sediments dredged from the middle portion of the harbor have been deemed unsuitable for open lake disposal. As a result, sediments dredged from this portion of the harbor must be transported to a confined disposal facility (CDF). Transport of sediments to such a facility is costly.

In order to address contamination issues at Eighteenmile Creek, a variety of Federal, state, and local agencies have formulated the Eighteenmile Creek Remedial Action Plan (RAP). The RAP's main purpose is to identify restoration goals and determine measures that may be implemented for site remediation. The majority of these measures are currently being developed, and to date have not been implemented, nor have their potential economic benefits been determined.

3. Methods

The use of non-market approaches to valuing environmental amenities and disamenities is common in environmental economic literature. However, the correlation between values determined by stated preference approaches such as the contingent valuation method and values determined by revealed preferences approaches such as the travel cost method or hedonic method has been an area of significant scrutiny in environmental economics. In a meta-analysis of convergent validity literature for quasi-public goods, Carson, et al. show that willingness-to-pay estimates from contingent

valuation surveys are on the same order of magnitude and are positively correlated with the estimates derived from revealed preference techniques. If this is indeed true, then the choice of non-market tool may not be critical when determining the value of environmental conditions. In addition to providing estimates of the economic impacts of the AOC designation at Eighteenmile Creek, this study will attempt to further the results found by Carson et al. by comparing the WTP values as derived from multiple non-market approaches (Carson et al., 1993)[8]. These approaches are discussed in the following sections.

3.1 Travel Cost

A common approach to valuing the recreational uses of environmental resources is the travel cost model. A travel cost model is determined by constructing a downward sloping demand function for the use of a particular site. Instead of a "quantity demanded", the travel cost model uses the number of visits to the site as a function of the cost of travel to get to the site (Parsons, 2003)[9]. This cost of travel, (travel cost) typically consists of the costs for lodging, food, equipment, gas, tolls, and the opportunity cost of time associated with traveling to the site. In this model, the opportunity cost of time is usually estimated as a function of the user's hourly salary. In our study, all of these costs were provided by the survey respondents.

For a user who resides further from the site, it is expected that the cost of traveling to the site will increase, and thus the number of trips made to the site will

[8] Carson, Richard T. and Robert Cameron Mitchell. 1993. The Value of Clean Water: The Public's Willingness to Pay for Boatable, Fishable, and Swimmable Quality Water. Water Resources Research, 29(7 July):2445-2454.

[9] Parsons, G. R., "The Travel Cost Model," Chapter 9 in *A Primer on Nonmarket Valuation*, edited by P. A.. Champ, K. J. Boyle, and T. C. Brown, London: Kluwer Academic Publishing, 2003

decrease. Provided this is the case, a traditional downward sloping demand curve can be developed for the site. Linearly, a travel cost model can be written as follows[9]:

$$r=\beta tc_r + \beta tc_s + \beta y + \beta z$$

In this model, r represents the number of trips to the site, tc_r is the travel cost, tc_s is the cost associated with traveling to a substitute site, y is income, and z is a vector of demographic variables that expected to influence the number of trips to the site. The β's are the coefficients to be estimated. In many cases, a Poisson distribution (λ) is used for the number of trips, as the data is in the form of trip "counts". In general, λ takes on a log-linear form such that the number of trip counts cannot be negative[9]. This results in a model as follows:

$$\ln(\lambda)=\beta tc_r + \beta tc_s + \beta y + \beta z$$

Based on the results of this regression, the average consumer surplus per user can be determined using the following equation:

$$\hat{S} = \lambda / -\beta_{tcr} = \exp(\beta tc_r + \beta tc_s + \beta y + \beta z)/ \beta tc_r$$

Consumer surplus is defined as the amount by which a user is actually willing to pay is greater than what the user is actually forced to pay to use a resource. The average consumer surplus as shown above can be factored up to the entire user population to obtain a total consumer surplus for the site.

In addition to providing insight to the total consumer surplus for a site, the travel cost method can be used to evaluate how changes in site conditions can affect this surplus. In a study of Lake Michigan trout and salmon Fishing, Lupi et al. used travel cost models to determine how changing catch rates impact angling usage on Lake Michigan and along its tributaries impact angler usage and consumer surplus. They found

that a fifty percent decrease in catch rates resulted in expected decreases in angler days of 25 percent, while a fifty percent increase in catch rates resulted in a forty three percent increase in the number of angler days. These changes resulted in an eleven million dollar decrease in consumer surplus and a twenty three million dollar increase in consumer surplus respectively. Although the Lake Michigan study values environmental quality somewhat differently than what may occur at Eighteenmile Creek, it is still an excellent example of the economic benefits that may occur with improved environmental quality, based on the assumption that improved environmental quality leads to improved catch rates (Lupi et al., 1997)[10].

Ideally, the valuation on an environmental change would be done by constructing travel cost models before and after a change. However, this would require that the necessary data was collected before and after the site change occurred. In their study of the impacts associated with Lake Erie Beach advisories, Murray and Sohngen were able to collect beach usage data over the course of a beach season to determine how temporary closings impact user consumer surplus (Murray and Sohngen, 2001)[11]. However, in the case of Eighteenmile Creek the economic impact of the AOC designation has become of interest only in recent years, and no travel cost data exists from before the site was designated as an AOC. Therefore, we must use other travel cost approaches to determine the impacts the AOC designation.

In order to assess the economic impact of the AOC designation on angler usage using travel cost models, a few different approaches were employed. The first method

[10] Lupi, Frank, John P. Hoehn, Heng Chen and Theodore Tomasi. 1997. The Michigan Recreational Angling Demand Model. *Agricultural Economics Staff Paper* 97-58, East Lansing, MI: Department of Agricultural Economics, Michigan State University.
[11] Murray, C. and B. Sohngen. 2001. "Valuing Water Quality Advisories and Beach Amenities." *Water Resources Research* 37(10):2583-2590

consists of a poisson model in which the number of trips taken is dependent on the travel cost, salary, catch rates for each of the four major species (Chinook, Coho, Steelhead and Brown trout) and whether or not the angler was aware of the streams designation as an AOC. The variable for whether the angler is aware of the AOC designation took the form of a dummy variable of 0 or 1 which indicates whether the survey respondent was aware of the designation. This approach is similar to the approach used by Murray and Sohngen who used a dummy variable to represent how beach users became aware of beach closings[11]. In theory, those anglers who are aware of the AOC designation should take fewer trips to the site than those unaware of the designation, all other variables held constant. The next approach used is similar to the first, except instead of using whether the angler is aware of the AOC as an explanatory variable, a dummy variable representing whether the AOC designation impacts the number of trips they take to the site was used. Again, if the angler indicates that the AOC designation impacts the number of trips he takes, then he should take fewer trips to the site than those who are not impacted by the AOC designation, all other variables held constant.

In the next approach, the same explanatory variables are used as in the second approach, except it is now assumed that the site had been remediated, and thus the only choice for whether the AOC designation impacted the number of days that chose to fish there would be no (0). This effectively removes the AOC designation from the travel cost equation, and creates a model that allows for a determination of the consumer surplus with site remediation. Comparing this consumer surplus with the consumer surplus determined in the second approach estimates the economic impact of the AOC

designation. Alternatively, it also shows the economic gains that would be expected if the site were remediated.

Another approach to determining the impacts of the AOC designation on angler usage was to take additional trips indicated by those respondents who indicated the AOC designation did impact their number of trips, and add the additional days anglers indicated they would take if the site were remediated to the number of trips they are currently taking under the AOC designation. With a greater number of trips indicated with site remediation, the consumer surplus would also increase. The final variation of the travel cost model was to create a subset of the data of those respondents who responded that the AOC designation impacted their number of trips and create a separate travel cost model for this subset. Separate travel cost models and consumer surpluses were calculated both with and without the dummy variable included. The results associated with each of these approaches are discussed in section 5.1

3.2 Survey Instrument

The angler survey used in this study was conducted over a roughly six week period from 10/9/06-11/22/06. This timeframe covered the majority of the fall salmon, steelhead, and brown trout runs. The survey was administered at the Fisherman's Park area located immediately adjacent to Burt Dam. Fisherman's Park is the only public access to the section of stream accessible to migrating fish (fish cannot pass Burt Dam) and thus surveying at that location would cover the vast majority of the Eighteenmile Creek angler population. As anglers enter Fisherman's Park, they are charged a two dollar parking fee by a parking attendant at the park entrance booth. In addition to

collecting the parking fee, the parking attendant handed each angler a survey which they were asked to return upon exiting the lot and the end of their fishing day. A total of 500 anglers were surveyed and a total of 127 responses were received (25.4%).

Questions in the angler survey could be broken up into 5 main groups. The first group included some general information on the angler, such as their choice of tackle, how long they had been fishing, target species, numbers of fish caught and numbers harvested. The second group of questions focused primarily on the expenditures incurred by each angler and included questions regarding the costs incurred for licenses (if bought for the sole purpose of fishing at Eighteenmile Creek), travel costs (gas, tolls, plane tickets etc.), lodging, food, and fishing equipment (rods, reels, bait and tackle). These questions were broken up into the total costs spent under each one of these categories, as well as the percentage of the total that was incurred in Niagara County.

The third group of questions were designed to determine angler awareness of the AOC designation, whether it impacted their decision to consume fish caught from the stream, and whether the designation impacted the number of trips that they made to the stream. If the AOC designation did impact the number of trips taken, anglers were asked how many additional trips they might be expected to make if the stream was restored to such a state such that the AOC designation were removed. Fourth, anglers were asked how much they would be willing to contribute as a one time payment to a fund that would be used to clean up Eighteenmile Creek to such a level that the AOC designation would be removed. This approach, the Contingent Valuation Method, is a common tool in non-market environmental valuation and provides another estimate of the increase in consumer surplus that may be expected with site remediation. Lastly, several

demographic questions, including questions on zip code, yearly salary, employment type and means of payment were included. The survey used is attached as Appendix A.

3.3 Hedonic Analysis

A third method for assessing the economic impacts associated with the AOC designation at Eighteenmile Creek is hedonic property method, where the impacts to housing value due to proximity to contaminated sediments are determined and conclusions are drawn regarding the increases in housing values that may be expected with sediment remediation (Chattopadhyay et al, 2005)[12]. To date, several studies have been conducted throughout the Great Lakes that have evaluated the impacts of contaminated sediments on housing values at other AOCs. Braden et al, estimated an increase in property values of $463 million for homes located along Waukegan Harbor, Illinois with full remediation (Braden et al, 2004)[13]. This represented an increase of approximately 19 percent over existing values. In a similar analysis, McMillen used a hedonic approach to estimate price discounts of up to 27 percent on housing values near the Calumet River AOC near Gary, Indiana (McMillen, 2003)[14]. This discount represented a total of nearly $6 million in property value lost due to proximity to the contaminated site[5].

In a slightly different context, Zegarac and Muir evaluated the increase in property values that occurred when a remediation project was completed at Hamilton

[12] Chattopadhyay, A.A, S, Braden, J.B., Patunru, A.A, S. "Benefits of Hazardous Waste Cleanup: New Evidence From Survey and Market Based Property Value Approach. Contemporary Economic Policy; 23(3): 357-374

[13] Braden, J.B., Patunru, A.A, S. Chattopadhyay, Mays, Nicole. "Contaminant Cleanup in the Waukegan Harbor Area of Concern: Homeowner Attitudes and Economic Benefits". Journal of Great Lakes Research. 30(4):474-491.

[14] McMillen, D.P., 2003. "Economic Benefits of the Grand Calumet River Dredging Plan: Evidence from the Gary Housing Market". Report to the Delta Institute, Chicago

Harbor, Ont. This study showed that remediation resulted in a 12 percent increase in the value of properties located near the site (Zegarac and Muir, 1998).[15]

While a variety of factors will determine housing values, it is believed that proximity to a contaminated site will be one factor that can determine people's choice of housing locations as well as the value of properties. In general, it is assumed that people respond to a local disamenity by choosing to reside away from it conditional on all other housing characteristics being held contant. As a result, it is implied that housing values near the disamenity will be discounted[12].

The property data used in this study was provided by the Village of Newfane's Assessors Office. Data was provided for 169 properties located within a two mile radius of the AOC. Variables in the dataset include land values, structure values, total parcel values, house size, lot size, year built, whether the house has a basement, number of stories, and a "grade" placed on each houses condition by the Assessor. Using online GIS mapping provided by Niagara County, the distance from each structure to the AOC were determined. It is expected that each of these attributes would positively affect housing price, including distance from the contaminated area. Descriptive statistics for each attribute are shown in Table 1. The results of the hedonic analysis are discussed in Section 4.5.

TABLE 1. Descriptive Statistics for Properties Near Eighteenmile Creek AOC

Attribute	Mean	St. Deviation	Min	Max
Structure Value	$94,616	$42,003	$22,700	$238,900
Square Footage	1,640	567.96	768	3720
Lot Size(acres)	2.92	6.85	0.24	45.06
Year Built	1951	39.95	1800	2004

[15] Zegarac, M., and Muir, T. 1998. "The Effects of Rap Related Restoration and Parkland Development on Residential Property Values: A Hamilton Harbor Case Study. Burlington, ONT": Environment Canada

Stories	1.52	0.56	1	2.5
Distance to AOC (miles)	0.26	0.30	0.04	1.89
Grade	3.01	0.35	2	4
Basement (percentage with)	87%	-	0	1

4. Results

4.1 Survey Results

As previously mentioned, a total of 127 anglers responded to the survey out 500 who were asked to participate. This represented a response rate of 25.4%. The relatively low survey response rate obtained in this study can be attributed to several factors. First, it is likely that the means by which the survey was administered were not ideal. First, it has been shown that face to face surveys often yield higher return rates than other survey administration types (Krysan et. al, 1994).[16] This may be particularly true for angler surveys, as it is likely that many anglers enjoy talking about their angling experience and are thus more likely to participate in a face to face interview. Second, the fact that anglers were asked to fill out the survey at the end of their fishing day may have resulted in many anglers forgetting to complete it, or not wanting to spend the time at the end of a fishing day answering the survey. Also, a few anglers who completed the survey commented on the length being too long. Lastly, due to project funding constraints, anglers were not compensated in any way for the time spent completing the survey. Based on Dillman's tailored design method for survey administration, it is likely that

[16] Maria Krysan, Howard Schuman, Lesli Jo Scott, Paul Beatty. Response Rates and Response Content in Mail Versus Face-To-Face Surveys Public Opinion Quarterly, Vol. 58, No. 3. (Autumn, 1994), pp. 381-399

providing even token compensation to survey respondents may have lead to significant increases in response rates (Dillman, 2000)[17].

A discussion of the survey results and resulting travel cost models follow in the next sections.

4.2 Angler Characteristics

While the majority of survey respondents indicated being from the state of New York (56.8%), a total of 12 states and the Canadian province of Ontario were represented in the sample population. Other states that were represented in the sample include Pennsylvania (9.6%), Ohio (7.8%), West Virginia (4.0%) and Michigan (2.4%). Additionally, anglers surveyed indicated traveling from as far as Texas and Louisiana. Data collected from the parking lot attendant over the 2004 and 2005 seasons indicated instate percentages of 52.4 and 50.9 for those years respectively[5]. Therefore, the data collected in this study is relatively consistent with the data collected over a larger sampling frame in previous seasons.

The majority of respondents indicated traveling over 100 miles (53.4%) while 43.4% indicated traveling over 200 miles. Using MAPQUEST[18], the average expected travel times were calculated and were determined to be 3.14 hours. However, removing data points for those respondents who traveled from Texas and Louisiana, the average travel time dropped to 2.65 hours. In total, 36.5% of all respondents indicated that they were spending at least one night away from home to fish at Eighteenmile, with an average number of nights away from home of 1.71.

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[17] Dillman, D. (2000). *Mail and Internet surveys: The tailored design method* (2nd Edition). New York: John Wiley and Sons

[18] MAPQUEST. Available online: www.mapquest.com. Accessed January 2007.

The average time spent fishing was 4.04 hours per day. This estimate is significantly higher than the 2.14 per trip hours estimated in a Fall 2005 Lake Ontario Tributary Angler Survey (NYSDEC, 2005)[19]. However, this discrepancy can easily be explained by the fact that the 2005 study covered all of the tributaries flowing into Lake Ontario, the majority of which do not generate nearly as much visitation from out of state anglers as Eighteenmile Creek. Since anglers typically travel from further away to fish at Eighteenmile, it is reasonable to assume that they would spend more time fishing per day.

4.2.1 Catch and Harvest Rates

Anglers were asked how many of each species they caught, as well as the numbers of each species harvested. Per hour catch and harvest rates were developed by dividing the numbers caught and harvested by the total number of hours spent fishing as indicated by each angler. These catch and harvest rates are presented in Table 2. In addition, the catch rates provided by the 2005 Lake Ontario Tributary Angler Survey for Eighteenmile Creek are also included. The catch rates found in the 2005 study are fairly consistent with the results found in this study, with the exception of Chinook Salmon which were significantly lower in the 2005 study. This difference may be due to the fact that the NYSDEC study covered a slightly longer timeframe than this study. Since October is considered the prime month for Chinook Salmon, the inclusion of dates from September 19-November 30 in the NYSDEC study likely included may days either before or after the prime season. Since our study covers a shorter timeframe that is more concentrated around the prime Chinook spawning season, it is not surprising that the

[19] New York State Department of Environmental Conservation. Fall 2005 Lake Ontario Tributary Angler Survey. 2005. Available Online: http://www.dec.state.ny.us/website/dfwmr/fish/lorpt05sec10.pdf. Accessed January 2007.

catch rates were found to be higher. Also, there are many factors that dictate the strength of the spawning runs including stream flows, water temperatures in both the Ontario and the stream, the survival rate of fish stocked in years previous etc. Variations from year to year in each of these factors likely contribute to stronger and weaker spawning runs.

Table 2. Catch and Harvest Rates for Eighteenmile Creek (Fish per Hour)

Species	Catch Rate	DEC Catch Rate	Harvest Rate	DEC Harvest Rate
Chinook Salmon	0.541	0.195	0.008	0.005
Coho Salmon	0.160	N/A	0.039	N/A
Steelhead	0.264	0.103	0.029	0.012
Brown Trout	0.188	0.328	0.040	0.025

4.2.2 Impacts of AOC

Anglers were asked questions regarding how the AOC designation impacts their usage at Eighteenmile Creek, as well as how much they would be willing to pay (WTP) for site remediation. Angler WTP is discussed in Section 5.2. However, some general discussion of AOC will be included in this section. First, of the anglers surveyed, 49.6% reported being aware of the AOC designation. Of those anglers who were aware of the AOC designation, 72.1 percent indicated that the designation impacted whether or not they chose to consume fish taken from the stream. This represents 35.8% of the overall angler population when responses for those anglers unaware of the AOC designation are included. Additionally, 28.0% indicated that the designation impacted the number of trips they took to the stream. Of the anglers who indicated that they AOC designation impacted the number of trips they took, respondents indicated that if the stream were remediated such that the AOC designation were removed, they would take an additional

2.29 trips per year. Spreading this increase over the entire survey population, Eighteenmile Creek anglers would take an additional .64 trips per year per person. This represents an increase in the number of total trips taken of 10.7%.

4.3 Travel Costs Total

Respondents were asked to provide the costs incurred for a variety of expenditure categories. These categories consist of license fees (if bought to fish solely at Eighteenmile), Guide fees, lodging costs, costs of equipment (rods, reels, bait and tackle), and food and the cost of time spent traveling to the site. In this analysis, the median value for the salary range indicated by the survey respondent was chosen to represent the annual salary. This annual salary was converted to an hourly wage by assuming a 40-hour work week and a total of 50 weeks annually This hourly salary was then multiplied by the estimated travel time. The average values for each of these categories are shown in Table 3. Note that no anglers indicating using a guide and thus this expense category was not included in the travel cost summary. It should also be noted that the standard deviation shown in this table is the standard deviation for the total trip cost, not the sum of the individual standard deviations listed for each cost item.

Table 3. Travel Costs for Eighteenmile Creek Anglers

Expenditure Category	Average Cost(Total Trip	St. Deviation
License	$8.40	$11.86
Lodging	$82.61	$151.35
Travel	$125.80	$199.05
Equipment	$36.32	$55.21
Cost of Travel Time	$98.22	$183.58
Food	$57.93	$79.30
TOTAL	$409.28	$559.48

These values represent the costs incurred over an entire trip to Eighteenmile Creek. Since the yearly parking count estimates collected by Niagara County are for daily uses, they do not account for multi-day trips (i.e, they assume each time a car arrives at Eighteenmile Creek it is a new trip). As a result, it would be inappropriate to apply the average expenditure estimate as determined above in Table 3 towards the total number of trips estimated by Niagara County. Therefore, the vehicle count estimate of 5,701 as provided by Niagara County was divided by the trip length estimate of 1.71 days per trip as determined in this study to get a new vehicle trip estimate of 3,334. Multiplying this trip estimate times the estimated per trip expenditure estimate of $409.28 resulted in total costs of $1,364,539.52 annually. However, the costs associated with travel time are not technically an expenditure. Removing travel costs leaves total expenditures of $311.06 per trip for total actual expenditures of $1,037,074.

As mentioned in Section 4.2.2, remediating the AOC such that the designation could be removed would lead to an expected 10.6% increase in the number of trips taken to Eighteenmile Creek. Multiplying this percentage times the estimated number of trips yields indicates an expected increase in the number of trips by 353. Combining this with the existing number of trips yields a new total of 3,687 if the AOC designation were to be removed. Based on per trip expenditures of $311.06, total angler expenditures would be expected to increase by $109,804 annually, for total annual expenditures of $1,146,878.

4.3.1 Niagara County Travel Costs

In addition to providing their total travel costs, respondents also indicated the percentage of each of these costs incurred in Niagara County. While a majority of the travel costs incurred while traveling to Eighteenmile Creek are incurred outside of the county (particularly cost of travel time and costs associated with gas and tolls), a significant portion of the expenditures do occur in Niagara County. These in-county expenditures constitute contribution to the local economy and provide for the livelihood of many of its residents. In order to provide a planning tool for Niagara County, it is important to quantify these costs. Since the purpose of this section is to indicate the economic benefits to the local economy provided by the Eighteenmile Creek fishery, the opportunity cost of time traveling is not considered, as it does not represent funds actually expended in Niagara County. Thus, the opportunity costs of time for those traveling in Niagara County are not considered in the percentage incurred in Niagara County. Table 4 shows both the weighted percentages of the total expenditures that were incurred in Niagara County as well as the total in-county expenditures.

Table 4. Eighteenmile Creek Angler Expenditures in Niagara County

Expenditure Category	**Average Cost (Total Trip) per angler**	**% in Niagara County**	**Total in Niagara County**
License	$8.40	100.00%	$8.40
Lodging	$82.61	71.52%	$59.08
Travel	$125.80	39.85%	$50.13
Equipment	$36.32	52.58%	$19.10
Cost of Travel Time	$98.22	0.00%	$0.00
Food	$57.93	66.16%	$38.32
TOTAL	$409.28	42.77%	$175.03

Once again, these values represent the costs incurred over an entire trip to Eighteenmile Creek and were thus multiplied by the yearly vehicle trip estimate of 3,334 as determined in the previous section. Multiplying this trip estimate times the estimated

per trip in-county expenditure estimate of $175.03 resulted in total in-county expenditures of $583,550.

As discussed in Section 4.3, removal of the AOC designation would lead to an expected increase of 353 in the number of trips taken to Eighteenmile Creek. This would lead to an increase of $61,785 in direct expenditures within Niagara County. With removal of the AOC, total expenditures for Niagara County alone would total $645,335.

5. Impacts of AOC Designation on Consumer Surplus

The travel costs determined in Section 4.3 provide an indication of the expenditures anglers are willing to incur to fish at Eighteenmile Creek, but do not indicate overall value, or consumer surplus of the site. The following sections provide determinations of the economic impacts of the AOC designation at Eighteenmile Creek, as well as the expected economic benefits that may be expected if site remediation was conducted such the AOC designation were lifted by determining the current consumer surplus provided by the site, as well as determining how the consumer surplus may change with site remediation.

5.1 Travel Costs

In order to determine the consumer surplus of the existing site, several variations of the travel cost model were run. In all cases, the response variable is the number of trips taken to the site. As described in earlier sections, the travel cost model is poisson and takes on the form:

$$\ln(\lambda)=\beta tc_r + \beta tc_s + \beta y + \beta z$$

In this analysis, the travel costs to substitute sites were ignored as it is assumed that Eighteenmile Creek is the only stream in the region that provides this type of stream fishery. In this regression model, it is assumed that the variables most likely to impact the number of trips would be the travel cost, salary, awareness of the AOC, and catch rate per hour. While the angler's catch rate is available only for this trip, it is assumed that in general the catch rate is tied to the angler's skill, and thus would be relatively consistent from trip to trip. Provencher and Bishop have shown that an angler's success in previous trip does affect the number of future trips taken, thus the reason for including this variable in the model (Provencher and Bishop, 1997)[20].

5.1.1 Standard Travel Cost Regression

The first regression consists of using the variables travel cost, salary, awareness of the AOC, and catch rate per hour to determine a poisson regression model which would predict the number of trips that anglers take each year. Although the awareness of AOC and number of trips are based on what the anglers report, this approach can be considered one of revealed preferences, as the number of trips taken indicate how anglers respond to each of the variables considered. In general, it is expected that holding all variables constant, that those anglers who are aware of the AOC designation will take fewer trips than those who are unaware of its existence. The results of this regression (Regression 1) along with standard errors are as follows:

Regression 1.

Variable	Coefficient	St. Error
Intercept	2.31269	0.37070*
Travel Cost	-0.00183	0.00042*

[20] Provencher, B. and R. C. Bishop. 1997. "An Estimable Dynamic Model of Recreation Behavior with an Application to Great Lakes Angling." *Journal of Environmental Economics and Management* **33**:107-127

Salary	-8.36E-06	4.59E-06*
Chinook Catch Rate	0.03793	0.14699
Coho Catch Rate	0.26100	0.19585
Steelhead Catch Rate	-0.21677	0.18808
Brown Trout Catch Rate	-0.19894	0.15139
Aware of AOC	0.42561	0.19733*
Observations	125	
log-likelihood	-298.6792	

*indicates significance at the 95% confidence level

The results for this regression are somewhat surprising, yet reasonable. First, the travel cost variable is negative as expected. However, the salary, catch rate and awareness of AOC coefficients are all opposite of what might normally be expected. The salary variable can be explained in that those anglers who take the greatest number of trips to the site are generally those closest to the site. Since Niagara County is a relatively rural area with no industry of significance, it makes sense that the local anglers who use the site the most may have the lower salaries than those traveling to the site. Although not significant at the 95% confidence level, the catch rate coefficients for Chinook and Coho were positive, while the coefficients for steelhead and brown trout were negative. This indicates that anglers may be more concerned with catching the two salmon species than brown trout and steelhead. The awareness of AOC variable, which was expected to be negative was highly positive. However, this can be explained by the fact that local anglers are more likely to be aware of the AOC designation than anglers from other states. This is supported by the fact that of those anglers located within 100 miles of the site, 57.1% indicated that they were aware of the AOC designation, while only 43.2% of anglers located further than 100 miles away indicated an awareness of the

designation. Since local anglers are likely to take more trips, this explains the positive coefficient on this variable. Since the coefficient on this variable was positive, it is implied that restoring the site to such a level that the AOC designation were removed would result in a reduced number of trips (and reduced consumer surplus), which is not reasonable, as if anything, removing the AOC designation would result in an increase in the number of angler trips.

5.1.2 Regression Using Impact of AOC Designation on Number of Days

Since anglers located near the AOC are more likely to be aware of the AOC designation that those located further, it is likely that a strong correlation exists between travel costs and awareness of the AOC which is resulting in the positive coefficient for the awareness of the AOC variable. As a result, the awareness of AOC variable was removed from the next regressions and replaced with the dummy variable for whether or not the AOC designation impacts the number of days the angler chooses to fish at Eighteenmile Creek. Since an angler must be aware of the designation to have it impact the number of days he chooses to fish at Eighteenmile, including the impact decision variable may eliminate the correlation between being aware of the AOC and the distance to the site (and hence travel cost). It is expected that if the angler indicates that the AOC designation does impact the number of days they choose to fish at Eighteenmile, then these anglers will take fewer trips than those anglers who do not indicate that the AOC impacts the number of days, all other variables held constant. The results of this regression (Regression 2) are as follows:

Regresssion 2

Variable	Coefficient	St. Error
Intercept	2.51589	0.29682*
Travel Cost	-0.00211	0.00049*
Salary	-6.87E-06	4.87E-06
Chinook Catch Rate	0.01794	0.14862
Coho Catch Rate	0.30590	0.23077
Steelhead Catch Rate	-0.20018	0.21359
Brown Trout Catch Rate	-0.20540	0.14401
AOC Impact Days	0.02943	0.25074
Observations	125	
log-likelihood	-310.0746	

*indicates significance at the 95% confidence level

In this regression, all of the coefficients took on the same signs as in the first model with the exception that the question of whether the AOC impacted the number of days anglers chose to fish at Eighteenmile Creek replaced the variable for whether they were aware of the AOC. In this second model, the variable for whether the AOC designation impacted the number of days they chose to fish was positive, but was not significant, and was much closer to zero (i.e. it had little impact). Since this variable was expected to be negative, it is likely that it is still accounting for some of the fact that local anglers are taking the most trips and are most likely to be aware of the AOC designation and have it impact the number of days they chose to fish. Once again, the positive value associated with this variable indicates that if the AOC designation were to be removed, then anglers would take *fewer* trips than they currently do. Obviously, remediating the site would likely result in at least the same number of trips, and most likely more trips. Despite this positive correlation, it is possible that these anglers, although taking more

trips than anglers from further away who are unaware of the AOC designation, would still take more if the designation were removed. This possibility is discussed in Section 5.1.4.

Based on the coefficients determined in this model, the average consumer surplus was calculated using the formula: $\hat{S} = \lambda / -\hat{\beta}_{tcr} = \exp(\beta tc_r + \beta tc_s + \beta y + \beta z) / \beta tc_r$

Using this formula, the average consumer surplus was calculated to be $1,895.34.

5.1.3 Regression Using Impact on Number of Days With Remediation

In order to estimate the impact of the AOC designation on consumer surplus, the variable for whether the AOC designation impacted the number of days chosen to fish at Eighteenmile Creek, the dummy variable was switched to 0 for all users. This indicates that since the stream would have been cleaned up, the AOC designation would no longer exist and thus could not impact the number of days an angler chooses to fish at Eighteenmile Creek. Therefore, it is expected that the number of trips taken to the stream would increase with the removal of the "impact number of days" dummy variable, all other variables held constant.

The results associated with this regression are shown in table X below. The consumer surplus for this regression totaled $1900.75. This value represents an increase in consumer surplus of only $5.41 per trip over the consumer surplus calculated in Section 5.1.2. Based on an estimate of 3,334 trips annual, the impact of the AOC designation is estimated to be a decrease in consumer surplus of $18,036.94. This consumer surplus would be realized if the site were remediated to such a level that the AOC designation was removed. However, since the coefficient on the AOC impact days

variable was positive in Section 5.1.2, removing the AOC would not result in an increase in the number of days according to the model. Therefore, it is once again likely that the correlation between the distance to the site (and travel cost) and whether the AOC designation impacts the number of days is resulting in incorrect results. To attempt to address these concerns, we turn to the stated preference approaches as discussed in the following sections.

Regression 3.

Variable	Coefficient	St. Error
Intercept	2.52345	0.29541*
Travel Cost	-0.00210	0.00047*
Salary	-6.91E-06	4.75E-06
Chinook Catch Rate	0.02005	0.14570
Coho Catch Rate	0.31132	0.21851
Steelhead Catch Rate	-0.19917	0.20909
Brown Trout Catch Rate	-0.20651	0.14522
AOC Impact Days	-	-
Observations	125	
log-likelihood	-310.1256	

*indicates significance at the 95% confidence level

5.1.4 Stated Preference Travel Cost Model

As mentioned in the previous sections, there appears to be a strong correlation between awareness of the AOC designation and whether it impacts the number of days a person chooses to fish at Eighteenmile, and the distance from the stream. Therefore, although we were able to calculate consumer surplus values both with and without the AOC designation based solely on revealed preferences, it is likely that these values do not fully capture the changes in consumer surplus that may be expected if the AOC were

remediated. Therefore, we use a stated preference approach to attempt to address these concerns.

In their survey responses, many anglers who were aware of the AOC designation and said that indicated the number of trips they took also indicated that they would take more trips if the site was remediated such that the designation was removed. In a study of recreation demand, Loomis has found that the stated number of trips and actual number of trips do not differ significantly under varying environmental conditions (Loomis, 1993)[21]. As a result, a regression was run under which the current estimated trips was replaced with the total of current and additional tips indicated by an angler if the AOC designation were removed. For those anglers who were either unaware of the AOC designation, or were aware but indicated that it did not impact their number of trips, the original number of indicated trips was used. The results of this model are as follows: Regression 4.

Variable	Coefficient	St. Error
Intercept	2.53242	0.28557*
Travel Cost	-0.00211	0.00045*
Salary	-6.33E-06	4.57E-06
Chinook Catch Rate	0.00054	0.14364
Coho Catch Rate	0.29129	0.21911
Steelhead Catch Rate	-0.20028	0.20441
Brown Trout Catch Rate	-0.21190	0.14396
AOC Impact Days	-	-
Observations	125	
log-likelihood	-307.5432	

[21] J. B. Loomis, An investigation into the reliability of intended visitation behavior, *Environ. Res. Econom.* 3, 183-191 (1993).

*indicates significance
at the 95% confidence
level

Again, it is assumed that the variable for knowledge of the AOC, or whether it impacts the number of days chosen to fish there is left out since the AOC would have been remediated and thus would not exist. The average consumer surplus as determined by this model was $1941.15. This suggested an increase in average consumer surplus of $45.81 over the value determined in regression two. Factoring this increase over the total estimated trips of 3,334 results in a total consumer surplus increase of $152,730.

5.1.5 Stated Preference Using Data Subset

The approaches discussed in the previous sections have attempted to use various travel cost approaches to determine the impact on consumer surplus caused by Eighteenmile Creek's designation as an AOC. We now attempt to determine the consumer surplus using a subset of the data consisting of only those anglers who indicated that they would make more trips if the site were remediated. The regression model associated with this approaches consists of augmenting the existing data by creating a second observation for each angler. In this second observation, the stated number of trips with site remediation is used, whereas in the first observation for each angler the current number of trips were used. In both observations, the travel costs and other explanatory variables remain the same. The data used under this approach would generally appear as follows:

Individual	Trips	AOC	Travel Cost	Salary	Catch Rates
1	Current Trips	1	x	x	x

1	Trips w/remediation	0	x	x	x
2	Current Trips	1	x	x	x
2	Trips w/remediation	0	x	x	x

The regression results associated with this approach (Regression 5) are as follows:

Variable	Coefficient	St. Error
Intercept	2.68656	0.37753*
Travel Cost	-0.00252	0.00061*
Salary	-1.30E-06	4.85E-06
Chinook Catch Rate	0.08118	0.15395
Coho Catch Rate	0.33542	0.21553
Steelhead Catch Rate	-0.47261	0.36723
Brown Trout Catch Rate	-0.39728	0.15687*
AOC Impact Days	-0.27115	0.24432
Observations	60	
log-likelihood	-222.2389	

*indicates significance at the 95% confidence level

Based on these regression results, we see that the variable for whether or not the AOC impacts the number of days anglers choose to fish now has the expected negative sign. Based on these results, the average consumer surplus is calculated to total $1,957.01. This value represents an increase of $61.67 over the consumer surplus determined by regression 2.

5.2 Contingent Valuation Approach

Since the travel cost method as discussed above serves only as an indication of a sites use value, it may be interesting to gain some insight as to the site's nonuse value. In

the case of a contaminated site such as Eighteenmile Creek, it is reasonable to suggest that people may lose value simply by knowing the site is contaminated without regards to their actual usage of the site. Alternatively, it would make sense that assuming the site was remediated, people would gain value by knowing a site is now clean. While this would potentially be true of the entire population (as least for those residing in the vicinity of the site), this study is limited to the valuation provided by anglers. However, it does provide some interesting insight as to how one segment of the population would value site remediation. Additionally, determination of a WTP for remediation based on contingent valuation may serve as a comparison to the stated increased number of trips provided by survey respondents. The question used to determine how much anglers would be willing to pay to remove the AOC designation at Eighteenmile was as follows:

> If clean-up measures were identified so that 18-Mile could be cleaned to such a level that the AOC designation and restrictions on fish consumption were to be removed, how much would you be willing to pay as a one-time contribution, to ensure that such clean-up measures were implemented?

Circle the additional cost you would pay from the list below:

$0	$5	$10	$15
$25	$35	$50	$75
$100	$150	$200	$300
$400	$500	$600	$700
$800	$900	$1000	$1500

If the amount you would be willing to pay is not shown on the list above, please write in the amount here $_____

A total of 68% of the respondents indicated they would be willing to make at least a minimal payment to such a fund. Of those who did not indicate a willingness to

contribute, 48.7 indicated the reason for answering as they did was because they did not want to place a dollar value. This suggests that they value both the resource and remediation of the site, but may not want to place a dollar value. Considering both those respondents who were not willing to contribute and those who would, a mean WTP value of $18.43 was determined. Based on the respondent's annual salary indications, this value does not seem unreasonable. Over the 2004-2005 fishing seasons, Niagara County maintained records of all of the unique license plates to enter the Fisherman's Park. On average 2,046 unique vehicles entered the park annually over those two seasons[5]. In our study, survey respondents indicated an average party size of 2.33 anglers per vehicle. As a result, the unique vehicle count of 2,046 was multiplied by the per vehicle estimate of 2.33 anglers/vehicle to arrive at a total of 4,767 unique anglers. Multiplying the average WTP value of $18.43 times the unique angler estimate resulted in a total WTP for AOC remediation of $87,855.81.

It should be noted that this estimate is only for the anglers who actually fish at Eigteenmile Creek. It is possible that many anglers who do not fish at Eighteenmile Creek due to the AOC designation, but would like to would also have a WTP value associated with remediation of the site. Additionally, anglers who do not fish at the site, and may never intend to, as well as the general population who have a general concern for a clean environmental are likely to have a WTP for cleanup simply for the fact that they obtain value by knowing that a clean ecosystem exists at Eighteenmile Creek. These non-use, or existence values likely represent a significant benefit category that would be realized if the site were to be restored. However, the determination of existence values is somewhat controversial, and would require detailed surveys of a much broader

population. As a result, the determination of the WTP values of these non-users is beyond the scope of this effort. In addition, a major goal of this study is to determine how the different non-market approaches to environmental valuation compare. By including only anglers in the contingent valuation portion, we are able to arrive at a value that can be compared to the consumer surplus value determined by the travel cost approach.

A linear regression model was constructed to analyze the factors driving angler WTP for site remediation. The variables chosen included salary, awareness of the AOC, and distance from the AOC. The model is as follows:

$$WTP = \beta Salary + \beta AwareAOC + \beta Distance + \acute{\epsilon}i$$

The coefficients and associated standard errors of this model are shown in Table 9. All variables except for the constant were significant at the 95% confidence level. All of the significant variables took on the expected signs. As shown in this table, the knowledge of the AOC designation was the major factor in how much someone was willing to pay. Salary was also significant, but less important. This may be due to the fact that the WTP values were all fairly low and thus would not have a large impact on a person's financial situation. The distance variable was negative as expected since it is likely that people living closer to the site would have a WTP greater than those living further.

Table 5. Contingent Valuation Regression analysis

Variable	Coefficient	Std. error
Intercept	-1.84	5.46
Salary	0.0003	0.0001
aware_aoc	17.2691	5.5002
Distance	-0.0155	0.0090

5.3 Hedonic Approach

Although much of this study has focused on the impacts of the AOC designation on recreational anglers, the AOC designation may have an impact on property values in the area as discussed in Section 3.3. Based on the data available, a hedonic price equation was developed which explains home prices near Eighteenmile Creek using the characteristics of the property and the home itself. In this model the coefficients indicate that marginal effect that each attribute has on housing prices. As described by Braden et al, the marginal effect is a lower bound estimate of the WTP to be free of the environmental disamenity (contaminated sediments) because "it assumes that marginal WTP remains constant as distance to the disamenity decreases while economic theory predicts that it should increase"[13].

The results of the hedonic regression are shown in Table 3. A variety of transformations were made on the property data until the following model was chosen:

$$\text{Property Value} = a_0 + a_1\text{housesize} + a_2\text{houseage} + a_3\text{basement} + a_4\log(\text{distance}) + a_5\text{stories} + a_6\text{grade} + a_7\text{logacres}$$

where housesize is the size of the house in square feet, houseage is the year that the house was built, basement is a dummy variable indicating whether or not the house has a basement, distance is the distance of the house to the AOC in miles, stories is the number of stories in the house, grade is the condition grade placed on the house by the town assessor, and acres is the size of the lot in acres.

The R^2 value of .8159 indicates that the model explains a significant amount of variation. As indicated in Table 3 the regression has produced coefficients with the expected signs except for the distance variable which had a negative correlation with

housing price. With the exception of the dummy variable for basement, all of the variables were significant at the 90 percent confidence level.

Table 3. Hedonic Estimation Results

Variable	Coefficient	Std. error
Intercept	-5.62E+05	1.08E+05
HouseSize	4.41E+01	4.60E+00
HouseAge	2.33E+02	5.43E+01
Basement	1.91E+04	1.36E+04
Stories	9.52E+03	4.47E+03
logdistance	-4.91E+03	2.62E+03
grade	2.81E+04	6.51E+03
logacres	8.73E+03	2.40E+03

Despite the benefits suggested by earlier hedonic studies at Great Lakes AOCs, the hedonic model developed for Eighteenmile Creek did not show the result of increased housing values with increased distance from the AOC. Instead, the regression analysis indicated that housing values actually decrease with distance from the contaminated site. The reasons for this result are unknown, but several possible suggestions can be made. First, it may be that there is another amenity closer to the further properties that is driving there value up, such as proximity to an employment center or better quality schools. However, the project sites lies in a relatively rural area, with a distance of nearly 40 miles to Buffalo, NY and 30 miles to Niagara Falls, NY. Therefore, it is unlikely that a relatively small change in distance from these metropolitan areas would result in a

significant change in housing values. Additionally, all properties evaluated in this study are located within the same school district so distance to a better school district is not a factor.

The most plausible explanation for the negative correlation between distance and housing values may be that the desire to live near a stream overrides any concern over living near contaminated sediments, resulting in people being willing to actually pay more for stream side properties. The fact that the contamination issues at Eighteenmile Creek are sediment based may mean that the pollution issues are less visible than at other AOCs. For example, the Waukegan study indicated that beach closings were a beneficial use impairment at that site[13]. This would tend to suggest that the issues at Waukegan are more visible to property owners living near that site. With less visible problems occurring at Eighteenmile, it is possible that the contaminants are less of a concern for home buyers. Additionally, it is possible that people living along Eighteenmile Creek are unaware that sediment contamination issues even exist. As shown in the angler survey many local anglers who fish at Eighteenmile Creek are completely unaware of the stream's designation as an AOC and the associated contamination issues/beneficial use impairments. If anglers who are potentially consuming fish caught from the stream are unaware of the streams designation, it is likely that homeowners may also be unaware of such issues. However, at other AOC sites, there is evidence that homeowners are aware of contamination issues. Lichtkoppler and Blaine found that voters in Ashtabula County Ohio were moderately aware of pollution problems in the Ashtabula River AOC

(Lichtkoppler and Blaine, 1999)[22]. Braden et al also reported finding that many residents were aware of contamination issues at Waukegan Harbor[13]. In our study of anglers, less than half indicated being aware of the AOC designation, and many of those who were aware of the designation indicated that they do not consume fish from Eighteenmile Creek because of the designation. However, it is possible that many of these anglers are aware of the designation only because of the fish consumption advisories in place on the stream. If this were the case, then many people who may not be interested in fishing or consuming fish would be unaware of the AOC designation. This would likely include many homeowners in the area. In order to fully understand homeowner perceptions of the AOC designation and contamination issues, a full survey of homeowners near Eighteenmile Creek would be required. It is possible that property owners are aware of the contamination issues and the impacts are reflected in the housing values, but would be willing to pay even more for there streamside property if the contamination issues did not exist. Hedonic analysis will not allow for this determination. Instead, interviews with homeowners would be required to determine whether or not they would be willing to pay more (and how much more) for their houses if the contamination issues did not exist.

The results of this hedonic analysis provide some important implications as to the usage of benefit transfer when assessing the impacts on housing values of contaminated sediments in the Great Lakes. Since many of the previous hedonic studies at Great Lakes AOCs indicated significant reductions in consumer surplus due to the AOC, it has shown to not be the case at Eighteenmile Creek. Instead, it is apparent that even though other

[22] Lichtkoppler, F.R., and Blaine, T.W. 1999. Environmental Awareness and Attitudes of Ashtabula County Voters Concerning the Ashtabula River Area of Concern: 1996-1997. Journal of Great Lakes Research. 25: 500-514

site characteristics may be similar, the impacts to housing values may be different across AOCs. Therefore, it is recommended that benefit transfer be used cautiously.

5. Discussion and Conclusion

Based on the analysis conducted in previous sections, it is apparent that the Eighteenmile Creek's recreational fishery provides significant contributions to the local and regional economies in the form of angler expenditures. On an annual basis, these expenditures total over $1 million overall, with over half occurring within the county, helping to provide livelihood for many of its residents. However, the impacts associated with the stream's designation as a Great Lakes Area of Concern are somewhat less clear. A variety of revealed and stated non-market approaches were employed in order to attempt an assessment of the impact of the AOC on both economic expenditures and consumer surplus to both anglers and local property owners.

First, travel cost methods were applied to determine the consumer surplus both with and without the AOC designation. However, the results determined by the initial iterations (Regressions 1 and 2) were somewhat troublesome due to the positive correlation associated with the "awareness of AOC" and "impact of AOC on number of days" variables. As previously mentioned, it is difficult to envision any scenario under which an angler would choose to take more trips because of the AOC designation. Therefore, it is likely that this positive correlation between these variables and the number of trips is due to a correlation between awareness of the AOC and distance to the site since the anglers who live near the site tend to take the greatest number of trips. As a result, using these revealed preference approaches provide somewhat unreliable results

regarding the consumer surplus impacts of the AOC designation. However, when the variable for whether the AOC designation impacted the number of days and angler chose to fish was included, the coefficient, although positive was only slightly positive and insignificant. Therefore, a consumer surplus was calculated which totaled $1,895.34 per angler. In order to determine the benefits associated with remediating the AOC, the variable for whether the designation impacted the number of trips was left out of the model since there would be no AOC designation to impact the number of trips. The consumer surplus under this scenario totaled $1900.75 per angler (Regression 3), indicating that the AOC does have a slight impact on consumer surplus. However, the positive correlation of the awareness of AOC and impact on the number of trips variables makes these results somewhat uncertain.

In order to address some of the concerns with the revealed preference approach discussed above, we employed a stated preference aspect to the travel cost approach. This consisted of increasing the number of trips for those anglers who indicated they would take more trips if the stream were remediated such that the AOC designation were removed by the increased number of trips the anglers stated they would take. This approach resulted in an average consumer surplus of $1941.15 (Regression 4). As another approach to addressing concerns with the revealed preference approaches, a combined revealed and stated preference model was constructed using a subset of the data comprised of the anglers who indicated that they would take more trips if the AOC were remediated. The regression model (Regression 5) associated with this approaches consisted of augmenting the existing data by creating a second observation for each angler. In the second observation, the stated number of trips with site remediation was

used, whereas in the first observation the current number of trips were used. In this case, the average consumer surplus totaled $1,957.01. The fact that this value is not significantly different from the consumer surplus in Regression 4, provides some indication that the estimates are likely somewhat accurate. Additionally, the fact that the stated, revealed, and the combination of revealed and stated approaches to the travel cost models are all fairly consistent indicates that a level of consistency between the approaches. Regardless of the approach to determining consumer surplus, it is apparent that Eighteenmile Creek's designation as an AOC does have an impact on the number of trips anglers choose to take, and this impact does significantly impact both consumer surplus and angler expenditures.

In order to further evaluate the consistency between stated and revealed approaches at Eighteenmile Creek, a Contingent Valuation approach was employed based on an anglers "willingness to pay" for remediation at the AOC. On average, anglers were willing to pay $18.43 for remediation efforts. Since only anglers were included in this survey, it is suggested that this WTP value for the most part represents a use value, rather than an existence value for a restored site. As a result, it is reasonable to compare this WTP value with the increases in consumer surplus as determined by the various iterations of the travel cost model. The WTP value as determined by the Contingent Valuation Method appears relatively consistent with the increases in consumer surplus of $5.41, $45.81, and $61.67 as determined by the travel cost approaches in Regression 3, 4, and 5 respectively. Although fairly consistent, it is apparent that the WTP as determined by the Contingent Valuation stated approach is somewhat lower than the values determined by the stated approaches to the travel cost model. This can likely be attributed to the fact

that the cost of a direct payment, as in the Contingent Valuation question may be less readily apparent to the respondents then the costs they are actually occurring over the cost of a fishing trip such as food, gas, equipment etc.

As a final approach to determining the impacts of the AOC designation, a hedonic property approach was to determine the impacts that proximity to the AOC have on property values. Unlike the results found in similar studies throughout the Great Lakes, a positive correlation was found between property values and proximity to the site. Since it is extremely unlikely that proximity to the contamination is driving property values up, it is believed that the desire to live near a stream is resulting in increases in property values that are overriding any decreases in property values that may be occurring due to site contamination. Additionally, the fact that pollution issues at Eighteenmile Creek are not visually apparent may result in homeowners either being unaware of, or being less concered about the contamination issues at the site. As mentioned in Section 5.3, only through a survey of homeowners would we be able to determine if this is the case. Without such a survey, it is impossible to determine the true impacts of the AOC on property values. We can however, be relatively certain that the positive correlation between property values and proximity to the site as found in this study is not truly representative of the impacts of the AOC on property values.

As shown in this study, the contamination issues at the Eighteenmile Creek AOC are important to at least the angling segment of the population. Although the costs associated with remediation are likely to be high, these costs may be at least partially offset by benefits in the form of increased consumer surplus and increased angler expenditures by recreational fishermen.

References

APPENDIX A. Eighteenmile Creek Angler Survey

PLEASE READ EACH QUESTION CAREFULLY. WHERE CHOICES ARE SUPPLIED, MARK THE BOX TO THE LEFT OF THE MOST APPROPRIATE ANSWER WITH AN "X".

Please record the Zip Code of your residence in the space provided here.

_____

1. Including yourself, how many people rode in your vehicle today to 18-Mile Creek? _____

2. Did you buy your fishing license specifically to fish at 18-Mile Creek?

[ ] Yes [ ] No

3. What type of gear did you use to fish today?

[ ] Spin [ ] Fly [ ] Other _____

4. How long did you fish today? Hours_____ Minutes_____

5. Please mark the following table with the fish species targeted, the number caught, and the number harvested.

	Target Species	# Caught	# Harvested
	(Please Check One)		
Any Species			
Chinook Salmon			
Coho Salmon			
Steelhead			

Brown Trout			
Other			

The following questions relate to the amount of money you spent to go fishing today. Please try to give answers based on <u>your share</u> of the costs.

1. Did you hire a professional guide today?

[ ] Yes [ ] No

1b. If yes, how much was your share of the cost? $_____

2. Including today, what is the total number days you will spend fishing during this trip? _____

3. For this fishing trip, are you staying away from your residence overnight?

[ ] Yes [ ] No

If yes, how many nights on this trip are you staying at each of the following?

Motel/Hotel/Bed and Breakfast_____ Campground_____
Friend's House _____ Cottage_____
Other _____

For each of the following questions, please indicate the total amount of money you will spend in each of the following areas, as well as the percentage of this total that will be incurred in Niagara County.

What will be the total cost for lodging spent on this trip $_____

% spent in Niagara County_____

4. How much will you spend on travel costs over the course of this trip (gas, tolls, car rental air fare etc)

$_____

% spent in Niagara County_____

5. How much will you spend on fishing equipment this trip (rods, reels, bait, tackle, ect.)

$_____.

% spent in Niagara County_____

6. How much will you spend on food (meals, snacks, and drink) for this trip? $_____

% spent in Niagara County_____

7. Typically, how many times do you fish at 18-Mile Creek annually? _____

8. Are you aware that 18-Mile Creek is currently listed as a Great Lakes Area of Concern (AOC) with restrictions on fish and wildlife consumption due to PCBs and dioxin?

[ ] Yes [ ] No

9. Does this designation impact your decision whether or not to consume fish caught at 18-Mile Creek?

[ ] Yes [ ] No

Does this designation influence your decision on the number of days you choose to fish at 18-Mile Creek each year?

[ ] Yes [ ] No

If a clean-up project at 18-Mile Creek was implemented that resulted in the removal of the AOC designation and restrictions on fish consumption, how many additional days per year would you fish at 18-Mile Creek? _____days

10. If clean-up measures were identified so that 18-Mile could be cleaned to such a level that the AOC designation and restrictions on fish consumption were to be removed, how much would you be willing to pay as a one-time contribution, to ensure that such clean-up measures were implemented?

Circle the additional cost you would pay from the list below:

$0	$5	$10	$15
$25	$35	$50	$75
$100	$150	$200	$300
$400	$500	$600	$700
$800	$900	$1000	$1500

If the amount you would be willing to pay is not shown on the list above, please write in the amount here $_____

Please mark the answer that best describes your reason for answering the previous question the way you did.

[ ] That's what it's worth to me
[ ] It's worth more to me, but it's all I can afford to pay
[ ] Not enough information is provided
[ ] I didn't want to place a dollar value
[ ] Other _____

Background Information: The Following information will help to analyze the results of the study properly.

1. Which of the following best describer your present employment status?

[ ] Employed full-time
[ ] Employed part-time
[ ] Retired
[ ] Not employed
[ ] Other (Please specify) _____

2. How are you paid?

[ ] Hourly

[ ] Salaried
[ ] Other (Please specify) _____

2. Here is a list of income categories. Mark the category that best describes the combined annual income before taxes that you and all other members of your household earned from all sources during 2005:

[ ] Under $25,000
[ ] $25,000 - $49,999
[ ] $50,000 - $74,999
[ ] $75,000 - 99,999
[ ] $100,000 or more

Thank you for completing this questionnaire. If you have any comments regarding Eighteenmile Creek or this questionnaire we would like to know. Please feel free to fill the space provided below.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Thank you for your time. Your cooperation in filling out this questionnaire is greatly appreciated. Please drop this questionnaire off at the booth as you exit the parking area.

If you have any questions about the survey, the point of contact is Doug Gorecki who can be reached at (716) 984-9471.