Steelhead Angler Survey
Lake Erie Tributary Streams

October 2002 – April 2003

Final Project Report
and
Survey Results

For the Lake Erie Protection Fund
Small Grants Program

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April 30, 2004

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Acknowledgements: The authors herein acknowledge and show appreciation to the following individuals, agencies and groups for their significant contribution to this project.

Ohio Sea Grant College Program
Ohio State University Extension
Ohio Lake Erie Protection Fund
Ohio Department of Natural Resources, Division of Wildlife
Lake County Visitors Bureau
Cleveland Museum of Natural History Trout Club
Central Basin Steelheaders
Trout Unlimited - Emerald Necklace Chapter #133
The Rodmakers Shoppe, Strongsville, Ohio
Western Reserve Fly Anglers
David and Melinda Rinehart
Steve Madewell
Kelly Reisen
Carmina Chiappone
Beth Bollas

I. Introduction and Survey Procedure

Steelhead (Onchorhynchus mykiss) are also known as a lake run rainbow trout. These hatchery reared non- native trout are stocked in the spring into five Ohio streams (Conneaut Creek, Grand River, Chagrin River, Rocky River, and Vermilion River) flowing into Lake Erie as 6 to 8 inch yearlings by the Ohio Department of Natural Resources. They quickly disperse into the open lake feeding in the deeper cooler waters of the lake in the summer and return as catchable fish in the streams in the fall. They spawn in Lake Erie tributaries but because the streams in Ohio get too warm in the summer for the young steelhead to survive natural reproduction does not sustain the fishery. Unlike salmon, steelhead do not die after spawning and have the potential of returning to Lake Erie tributaries for year after year growing to trophy size. One reason this is a popular fishery is that these hard fighting trophy fish are available to stream anglers from October to April. This is a time of relatively fewer fishing opportunities to anglers.

In 2002, several local steelhead angling associations contacted Ohio Sea Grant Extension and asked that we document some of the social and economic impacts of the Ohio Lake Erie tributary steelhead fishery. This fishery had achieved statewide and regional notoriety in the past few years. Antidotal evidence suggested that it was a popular recreational activity, however little was know about the economic impact of the fishery.

One goal of our research was to document the attitudes, priorities and expenditures of Ohio's Lake Erie tributary stream steelhead anglers in order to provide information to maintain and improve the steelhead angling opportunities in Ohio's Lake Erie tributaries. A second goal was to obtain useful information for use by local coastal visitor bureaus in their development of marketing strategies for this lucrative fishery.

In the summer and fall of 2002, Ohio Sea Grant worked with local steelhead anglers representing several northeast Ohio steelhead associations, the Lake County Visitors Bureau, Ohio Department of Natural Resources Division of Wildlife fishery biologists and Ohio State University faculty to develop a suitable questionnaire. Between October 2002 and April 2003 Ohio Sea Grant staff contacted over 500 steelhead anglers on the stream bank on eight Lake Erie tributaries and asked them if they would participate in a mail survey about their steelhead angling. The survey clerks went to stream locations that were known to be good for steelhead angling, were known to be fishable on the days survey work was planned, and were likely to have anglers fishing on the stream being surveyed. Our goal was to contact as many anglers as we could in the limited survey time we had.

A total of 487 anglers were mailed surveys and 375 responded with some usable information for a general response rate of 77%. Not every respondent answered every item in the questionnaire. Non-respondents were mailed up to two reminder letters for a maximum of three contacts by mail. Several incentives were offered to increase the response rate. Respondents were entered into a drawing for a rod and reel (two sets) and several gift certificates at local tackle shops specializing in steelhead equipment.

The typical respondent was a 46-year-old middle class male who had about 9 years of steelhead angling experience. About 63% fished with some type of spinning tackle and about one third used fly fishing tackle. The typical fishing group was small averaging only 1.7 persons.

II. Descriptive Results

Most respondents were contacted on the Rocky River (39%) followed by the Chagrin River (30%), Conneaut Creek (10%), Grand River (9%), Vermillion River (9%), Ashtabula River (less than 2%), Arcola Creek (about 1%) and the Cuyahoga River (less than 1%). About 93% of the 375 respondents were on a single day trip and less than 7% of the respondents were on a multi-day trip requiring overnight lodging.

Single day trip anglers came from 27 different Ohio counties and three different states. Multiple day trip steelhead anglers came from another four Ohio counties and another four states. Out-of-state steelhead anglers were less than one percent of the total respondents. About 42% of the anglers came from Cuyahoga County with another 33% coming from Lake, Summit, and Lorain counties. The responding anglers made over 30 trips to the stream where they were initially contacted and typically traveled and average of 54 miles round trip for their steelhead angling experience. Just less than 15% of the respondents traveled 100 miles or more round trip (50 miles one way). The respondents fished an average of 5 hours per trip, caught 2.63 fish per trip and released 2.45 fish per trip thus releasing 93% of the fish they caught.

It is likely that the results of this research is somewhat biased toward the frequent and successful angler for the following reasons. Surveyors typically went out on days with a high probability of finding steelhead anglers, which are likely to be better fishing days. Alternatively, individuals who had good experiences fishing on the day they were given the survey may have been more likely to respond to the survey. Additionally, the probability of surveyors contacting anglers who make a large number of trips would have been higher than that of contacting anglers who make relatively few angling trips.

Within the steelhead fishery, most anglers (94%) appear to take single-day trips. Due to the low number of respondents for multiple-day trips, the study has focused on single-day trips. Respondents on single-day trips indicated taking an average of 44 steelhead fishing trips per year (TABLE 1). About 72% of the trips individuals take are taken to the site where individuals were intercepted. Most trips are taken in fall of 2002 and spring of 2003, with a smaller proportion taken in winter; possibly because winter weather conditions are generally worse than fall or spring. However, for our survey this was largely because most, if not all of the prime steelhead fishing streams were frozen solid and not fishable. This scenario lasted from late December through the last week of March, 2003. Such conditions are seldom experienced for such a long period of time in northern Ohio.

TABLE 1: Summary statistics on trip taking behavior for single day trips only. The number of respondents was 311.

Total single day trips to stream per year where intercepted	31.7 trips
First time fishing this stream on day intercepted (percentage of respondents)	7 %
Total single day trips per year to all streams	44.3 trips
October single day trips to all streams	18.5 trips
January single day trips to all streams	10.0 trips
March single day trips to all streams	15.7 trips
Hours fished on day intercepted	5.1 hours
Miles traveled on day intercepted (roundtrip)	52.3 miles
People fishing together on day intercepted	1.7 people
Fish caught on day intercepted	2.7 fish
Number of streams fished on day intercepted	1.4
Annual fish caught/kept/eaten during typical year.	
Annual average estimated catch (N=345)	58.4fish
Annual average estimated number of fish kept (N=345)	7.1fish
Percentage of fish kept that are eaten by household that caught the fish. (N=321)	40.6%

Anglers indicate that they keep approximately 12% of the fish that they catch (7.1 fish kept vs 58.4 fish caught), and that they eat approximately 49% of the fish they kept (3.5 fish eaten vs 7.1 steelhead kept). Anglers catching relatively few steelhead tend to keep a higher percentage of the fish they catch than anglers who catch large amounts of steelhead. The survey did not consider other types of fishing in which the individuals potentially engage, but it does provide information on the way individual's fish for steelhead. Approximately 65% of steelhead anglers spin cast with bait or artificial lures while a smaller proportion fly fish (30%) (TABLE 2). The average angler surveyed had 9 years experience fishing for steelhead.

TABLE 2: Summary statistics on type of fishing and experience The number of respondents was 311.

Proportion spent in different types of fishing	
Spin casting with bait	41.3 %
Spin casting with artificial lures	24.0 %
Fly fishing	28.2 %
Fly fishing with bait	2.1 %
Other types of fishing	3.8 %
Years experience fishing for steelhead	9.1 years

Factors Affecting Steelhead Catch

One interesting question revolves around assessing the factors that affect steelhead catch rates. A number of individual characteristics may be expected to affect fish catch, including experience, fishing conditions, type of fishing (fly or spin casting), and other factors. Given that the survey asked individuals to report their actual catches for the day on which they were intercepted, catch rates can be estimated as a function of a number of explanatory variables relating to the individuals.

It is not practical to go into the methodology of estimating the factors affecting steelhead catch in this report. However, we will report some general results that may be of interest to the reader.

Two experience variables, average annual trips taken and the number of years the individual has been fishing for steelhead both, as expected, have positive effects on fish catch. The fishing method has an effect on fish catch. Interestingly, although most anglers are found to use spin casting (see TABLE 2 above), fly fishers appear to catch more fish. Individuals who fish on more streams are likely to catch more fish. Individuals who moved from one site to another due to congestion are a variable that influenced catch. Interestingly, this variable is positive. This may indicate that congested sights attracted anglers precisely because catch rates were high. Individuals that moved away from sites due to slow fishing was a variable that indicated a reduced catch. Slow fishing reduces catch rates, and likely represents overall slow conditions for the day on which the individuals were intercepted. Not surprisingly, more hours of fishing increased overall catch rates. Additionally, a higher income also increased overall fish catch rates. The impact of the income related variable may relate to more time available to fish, more expensive and potentially more effective equipment, or the opportunity to secure river guides to help learn better angling tactics and techniques.

III. Descriptive Economics

Individuals tended to spend relatively small amounts on individual categories, but for their entire trips, spend approximately $26 per trip (TABLE 3). This level of expenditure is similar to recent estimates of expenditures among visitors to Lake Erie beaches (Murray et al., 2001), as well as expenditures fishing in Southeastern Ohio (Sommer and Sohngen, 2003). Individuals spend more than 60% of the money within 10 miles of the sites where they are fishing, suggesting that each trip generates nearly $16 in local expenditures. For just the 311 visitors in our sample, taking 44 trips per year on average, this generates $218,000 in annual expenditures on steelhead fishing.

It is not possible, unfortunately, to extrapolate the expenditure values to all steelhead anglers since the sampling protocol provides no information on the proportion of the total population that fishes for steelhead. However, if as many as 1% of the 754,704 licensed resident anglers in Ohio in 2001 fished for steelhead this would give us a total of 7,547 anglers x 44 trips x $26 = $8.6 million. If only 1,000 anglers in Ohio fished for steelhead this would give us a total expenditure of over $ 1.1 million. While the number of trips may be biased upward due to the limitations of the survey methodology, the amount spent per trip is consistent with other similar economic studies as previously noted.

TABLE 3: Summary statistics on expenditures.
The number of respondents was 311.

Single day expenditures per trip	
Gasoline	$ 6.90
Food	$ 4.10
Bait	$ 5.50
Gear	$ 4.00
Restaurants	$ 4.50
Other	$ 1.00
Total Expenditures	$26.00
Proportion spent within 10 miles of site	61.4 %
Amount spent with in 10 miles of site	$15.96

The study explored the factors that affect steelhead catch rates and the value of steelhead fishing in tributaries to Ohio's portion of Lake Erie. Overall, the results suggest that steelhead fishing is a very valuable activity in Ohio. The travel cost model used estimated that the value per trip for anglers taking part in our study ranged from $36 to $50.

IV. Steelhead Angler Perceptions

Respondents reported that the probability of catching fish, avoiding congestion, public access, and stream water quality are important factors in choosing streams for steelhead angling (TABLE 4). Respondents were asked to rate a number of factors in importance in deciding which Lake Erie tributary stream to fish. They were asked to rate the factors on a scale of from one to five with one equal to "strongly disagree"; two equal to "disagree"; three equal to "neither disagree nor agree"; four equal to "agree" and five equal to "strongly agree". The probability of catching fish, avoiding congestion, public access and stream water quality (clear v muddy) were highly rated factors in choosing which stream to fish. Much less important were angling information (how?), proximity to my home, and nearby facilities (restrooms, parking).

TABLE 4. Steelhead angler perceptions

Reason for choosing a stream for steelhead fishing	Mean Score	Number of Respondents	Percent of respondents[1] SD	D	N	A	SA
Probability of catching fish	4.35	370	1.4	1.9	10.5	33.2	53.0
Avoiding congestion	4.21	369	1.9	3.0	14.4	33.6	47.2
Public Access	4.17	369	3.0	3.5	13.8	32.8	46.9
Stream water quality (clear vs muddy)	4.16	370	0.8	1.6	15.4	44.9	37.3
Angler ethics are good (stream etiquette good)	4.03	369	2.2	4.6	16.8	40.9	35.5
Natural beauty	3.98	366	1.6	5.5	19.9	39.1	33.9
Stream water quantity (high vs low flow)	3.94	371	0.5	4.9	20.8	48.2	25.6
Chances of angler conflicts are few	3.90	370	3.2	7.3	19.2	36.8	33.5
Safety from crime	3.79	368	5.7	7.6	23.9	27.4	35.3
Angling information (where?)	3.49	360	2.8	9.2	36.7	38.6	12.8
Angling information (how?)	3.41	360	3.9	9.2	41.4	33.6	11.9
Proximity to my home	3.40	370	7.0	11.9	33.5	29.2	18.4
Nearby facilities (restrooms, parking)	3.25	367	8.4	13.9	34.9	29.9	13.4

[1] SD = Strongly Disagree, D = Disagree, N = Neither disagree nor agree, A =Agree, and SA = Strongly Agree

V. Sources of steelhead angling information

Respondents were asked where they get their steelhead angling information and given a number of potential sources and asked to rank each potential source on a scale of one to four with one equal "very unimportant", two equal to "unimportant" three equal to "important" and four equal

to "very important" (TABLE 5). Friends, family, word of mouth were by far the most important source of steelhead angling information followed in importance by bait and tackle shops and internet web sites. Almost 56% of the respondents say that internet web sites are important or very important sources of steelhead angling information.
Is it possible that a home, driveway, sidewalk, utility line, sewer or road may be constructed over an abandoned wellhead or brine transmission with unknown consequences.

TABLE 5. Sources of Steelhead angling information

Steelhead angling information source	Mean Score	Number of Respondents	Percent of respondents[1] VU	U	I	VI
Friends / Family / Word of Mouth	3.44	371	2.7	5.4	36.7	55.3
Bait and tackle shops	2.89	367	7.4	21.3	46.9	24.8
Internet web site	2.61	350	21.4	22.9	28.9	26.9
Magazines	2.42	361	18.8	32.7	36.3	12.2
Newspapers	2.38	366	20.2	32.0	37.7	10.1
Fishing clubs / Club newsletters	2.18	359	25.9	39.3	25.3	9.5
Radio / Television	1.89	359	36.5	43.2	15.6	4.7

[1] VU = Very Unimportant; U = Unimportant; I = Important; VI = Very Important

VI. Travel Cost Estimates

This section of the study explores the factors that affect steelhead catch rates and the value of steelhead fishing in Ohio using the travel cost model. The travel cost model has long been applied to recreational activities (Haab and McConnell, 2001). The model is used to estimate the relationship between trips taken to a specific site, or a set of sites, and the price of accessing those sites. The price of accessing recreational sites includes the time costs associated with traveling from home to site, as well as the mechanical costs of driving a car.

Factors Influencing Steelhead Catch

One interesting question revolves around assessing the factors that affect steelhead catch rates. A number of individual characteristics may be expected to influence the number of fish each angler catches, including experience, fishing conditions, type of fishing (fly or spin casting), and other factors. Given that the survey asked individuals to report their actual catches for the day on which they were intercepted, catch rates can be estimated as a function of a number of explanatory variables relating to the individuals.

For analyzing fish catch rates, a poisson model is adopted. The poisson model assumes that the probability of catching an integer number of fish, y_i, given that an individual has already taken a trip, is

(1) $\text{Prob}(Y=yi) = \exp(-\lambda_i)(\lambda_i)^{y_i}/y_i!,\ y_i = 0,1,...,$

where

(2) $\ln(\lambda_i) = \beta' X_i.$

The model in equations (1) and (2) can be estimated with standard econometric techniques. Table 6 includes information on the variables used in the regression, and the results of the regression model are presented in table 7. Two experience variables are included in the equation, average annual trips taken (TRIPS) and EXPERNCE, which identifies the number of years the individual has been fishing for steelhead. Both, as expected, have positive effects on fish catch. FLY is a dummy variable indicating that the individual predominately fly fishes, and it has a positive effect on fish catch. Interestingly, although most anglers are found to use spin casting (see above), individuals who fish mostly with fly fishing gear appear to catch more.

Table 6: Variable definition for catch model.

Variables Used	Description
TRIPS	Average number of trips taken per year
FLY	Does the individual mainly fly fish
SDSTRMS	Number of streams visited
SDCONG	Moved on to different site due to congesting
SDSLOW	Moved on to different site due to slow fishing
SHOURS	Number of hours fished on the day intercepted
EXPERNCE	Years steelhead fishing
INCOME2	Income

Table 7: Fish catch rate model (N = 331).

Variable	Coefficient	SE
ONE	-1.120**	0.139
FLY	0.004**	0.001
SDSTRMS	0.069*	0.033
SDCONG	0.435**	0.124
SDSLOW	-0.451**	0.103
SDHOURS	0.127**	0.015
TRIPS	0.004**	0.000
EXPERNCE	0.275**	0.028
INCOME2	0.002*	0.001

** = significant at 1% level; * = significant at 5% level.

SDSTRMS is the number of streams the individual fished on the day they were intercepted. Individuals who fish on more streams are likely to catch more fish. SDCONG is a dummy variable indicating that individuals moved from one sight to another due to congestion. Interestingly, this variable is positive. This may indicate that congested sights attracted anglers precisely because catch rates were high. SDSLOW is a dummy variable indicating that individuals moved away from sites due to slow fishing. Slow fishing reduces catch rates, and likely represents overall slow conditions for the day on which the individuals were intercepted. SDHOURS represents the hours the individual fished on the day they were intercepted. Not surprisingly, more hours of fishing increases overall catch rates. Income (INCOME2) also increases overall fish catch rates.

Single Day Annual Trips Model

The travel cost model explores the relationship between the number of trips steelhead anglers take each year, and the price of those trips. Using this relationship, it is possible to estimate the value, or consumer surplus, that individual anglers obtain from steelhead fishing. Consumer surplus represents a measure of the value that fishing provides to the anglers themselves. It is distinct from the economic impact numbers described above, which show the money that anglers spend in the local economy when they take trips. Clearly, economic impacts are important for local communities because economic impacts represent local income. Having access to fishing sites, however, does not just benefit local businesses. In fact, most benefits are likely to accrue to the individuals who actually fish. Consumer surplus measures the benefits these individual anglers obtain.

Consumer surplus and economic impacts are likely related. Higher consumer surplus suggests a more valuable fishery. If consumer surplus for a fishery is declining, for instance, it may indicate that fewer people are taking trips, and the fishery may in fact be in decline. Fisheries with declining consumer surplus are likely to generate lower economic impacts, so local business have incentives to track consumer surplus and ensure that it is strong and growing. Efforts made to increase the value of the fishery for anglers will lead to increased consumer surplus, and likely to increased economic impacts because individuals who gain more from a fishery are more likely to take more trips. Thus, consumer surplus reveals the value individual anglers place on fishing trips, and higher consumer surplus suggests greater value.

To estimate a travel cost model, estimates of the price of taking a trip must first be obtained. The price of a trip is the cost of driving from home to the angling site and back plus the opportunity cost of time associated with making the trip. The direct mechanical costs of operating a car are estimated by using the distance individuals travel per trip, and multiplying that by an assumed average cost of owning and operating a vehicle of $0.36 per mile:

(3) Mechanical Cost = (Miles traveled)*($0.36 per Mile)

Opportunity costs of time are somewhat more complicated to estimate. When individuals decide to take recreational trips, they give up doing something else. For example, they give up the opportunity to take recreational trips elsewhere, they give up additional work or family hours, etc. Time is a valuable commodity and the further the site is from home, the more time an individual is taking from some other activity to engage in the recreation. It is important to value this time. In travel cost models, the time spent traveling to and from a site is used as an additional component of the total cost of accessing the site. These time costs are estimated as follows:

(4) Time Cost = (Miles traveled)*(1/40 miles per hour)*(0.3)*(Wage rate)

In most travel cost studies, we do not ask individual driving speed preferences, so we make the assumption that most individuals travel at an average of 40 miles per hour. Combining distance and speed, we can estimate the time an individual spends traveling to and from a site for recreation. To determine the value to place on that time, we start with the individuals wage rate, and then must determine whether recreational time is valued the same as the individuals work time. Within the travel cost literature there is some debate about whether to value travel time at 100% of the wage rate or some fraction thereof. Most studies have chosen to use the 30% estimate originally developed by Cesario (1976). That is the assumption we adopt for this study. The price of accessing a steelhead fishing trip is thus:

(5) Price = Mechanical Cost + Time Cost.

This price will vary across individuals in the survey depending on the distances they travel, and their wage rates.

The traditional travel cost model estimates a demand function for trips, where the number of trips a person takes in a given year is estimated as a function of the price, income, and other factors. Because the number of trips is an integer value, and can only be an integer value, poisson models have been widely adopted for estimating travel cost models. The typical poisson model applied to the travel cost problem, assumes that the probability that an individual takes a given number of trips in a year is:

(6) $\text{Prob}(y_i) = \exp(-\lambda_i)(\lambda_i)^{y_i}/(y_i)!,\ y_i = 0,1,...,$

For the poission model, λ_i is estimated parametrically as:

(7) $\ln(\lambda_i) = \beta' X_i.$

where X is a set of explanatory variables, and β is a vector of parameters.

One issue with the dataset employed with this study is that we used an intercept survey. That is, rather than mailing a survey randomly to households (a population survey), we intercepted individuals engaged in steelhead fishing at fishing sites. This leads to two potential statistical biases. First, all individuals surveyed are observed to have taken trips during the year, thus the model is truncated at 0 trips. Second, endogenous stratification is likely to occur, in that individuals who are sampled are likely to take more trips on average than the entire population of steelhead fishers. Both of these statistical issues can be addressed during estimation, as suggested by Haab and McConnell (2002). The corrected form of the poisson model is thus:

(8) Prob(y_i| $y_i > 0$) = $\exp(-\lambda_i)(\lambda_i)^{y_i-1}/(y_i-1)!$, $y_i = 0,1,...,$

The poisson model described above is one approach, but has the limitation that it assumes that the mean and variance in annual trips is equal. It is quite likely that in reality, the mean and variance in trips differs in the data. An alternative model that allows for differences in the mean and variance in trips is the negative binomial model. The negative binomial model assumes heterogeneity among the individuals. If u_i is this unobserved effect, the distribution of y_i can be written:

(9) Prob(y_i|u_i) = $\exp(-\lambda_i u_i)(\lambda_i u_i)^{y_i}/(y_i)!$

Assuming u_i follows a gamma distribution with mean λ and dispersion parameter θ, the density function be rewritten and estimated as:

(10) $$\text{Prob}(y_i|x_i) = \frac{\Gamma(\theta + y_i)}{\Gamma(y_i + 1)\Gamma(\theta)}\left[\frac{\lambda_i}{\lambda_i + \theta}\right]^{yi}\left[\frac{\theta}{\lambda_i + \theta}\right]^{\theta}$$

Following Englin and Shonkwiler (1995) and Haab and McConnell (2002), the form of this model that incorporates endogenous stratification is:

(11) $$\text{Prob}(y_i \mid y_i > 0) = \frac{y_i\Gamma(\theta + y_i)}{\Gamma(y_i + 1)\Gamma(\theta)}\left[\frac{\lambda_i}{\lambda_i + \theta}\right]^{yi}\left[\frac{\theta}{\lambda_i + \theta}\right]^{\theta}\left[\frac{1}{\lambda_i}\right]$$

For the negative binomial models, one must assume a parameterization for θ. In this study, we assume that θ is parameterized as $1/\alpha$, which is the negative binomial II model in Cameron and Trivedi (1986).

This study presents estimates from 8 different models to capture sensitivity in modeling approaches. First, we account for differences in how opportunity costs of time can be calculated. One approach, OCM1, assumes that each person's time is valued at 30% of their wage rate, where wages are estimated as annual household income/(number of wage earners*2040 hours working per year). A second approach, OCM2, accounts for the fact that retired or unemployed people may still have income, but do not have as high of opportunity costs of time. For these individuals, we assume no time costs, and for employed individuals, we value time at 30% of the wage rate. Second, we present models with and without the corrections for endogenous stratification discussed above. Finally, we present both poisson and negative binomial models. Thus, the following models are presented: poisson, poisson corrected for endogenous stratification, negative binomial, and negative binomial corrected for endogenous stratification. Each of the models is estimated under the assumptions of OCM1 (Tables 8 and 9) and OCM2 (Tables 10 and 11). Note that most of the variables used in the regressions are shown in table 6 above. The new variable introduced here is the travel cost variable. TC(OCM1) is the travel cost parameter using the OCM1 assumption, and TC(OCM2) is the travel cost using the OCM2 assumption.

Table 8: POISSON: Single day travel cost model with and without correction for endogenous stratification, using OCM1.

	Poisson		Poisson w/ Endog. Str.	
Variable	Estimate	Standard Error	Estimate	Standard Error
CONSTANT	3.298	0.047**	3.260	0.007**
TC(OCM1)	-0.020	0.001**	-0.021	0.000**
EXPERNCE	0.018	0.001**	0.019	0.000**
AGE	-0.005	0.001**	-0.005	0.000**
INCOME2	0.001	0.000**	0.001	0.000**
SDHOURS	0.093	0.005**	0.096	0.001**
SDSTRMS	0.055	0.009**	0.057	0.002**
FLY	0.000	0.000	0.000	0.000**

** Significant at 0.01 level; * significant at 0.05 level

Table 9: NEGATIVE BINOMIAL: Single day travel cost model with and without correction for endogenous stratification, using OCM1.

	Neg. Binomial		Neg. Binomial w/ Endog. Str.	
Variable	Estimate	Standard Error	Estimate	Standard Error
CONSTANT	3.237	0.202**	0.373	1.325
TC(OCM1)	-0.015	0.001**	-0.017	0.001**
EXPERNCE	0.022	0.006**	0.023	0.007**
AGE	-0.007	0.003*	-0.008	0.003*
INCOME2	0.001	0.001	0.001	0.001
SDHOURS	0.096	0.024**	0.102	0.027**
SDSTRMS	0.122	0.059*	0.135	0.066*
FLY	0.000	0.002	0.000	0.002
α	0.807	0.073**	15.461	0.091

** Significant at 0.01 level; * significant at 0.05 level

The results for the models using travel costs estimated with OCM1 conform to theoretical expectations. Specifically, the coefficient on the price of accessing a site, TC(OCM1), is negative, as expected. Individuals who face higher costs of access take fewer trips each year. Experience, measured as years the individual has fished for steelhead (EXPERNCE), is positive, implying that individuals with more experience take more steelhead fishing trips. AGE, however, is negative, indicating that older individuals are less likely to take steelhead trips. Steelhead fishing trips appear to be normal goods given that an increase in income increases trips, i.e. INCOME2 is positive. The number of hours spent on the fishing trip where we intercepted the individuals (SDHOURS) is positive, indicating that the individuals in our sample who fished longer on the day intercepted take more trips per year. The variable SDSTRMS is the number of streams the individual visited on the day that we intercepted them, and it is positive. Thus, individuals who visited more sites on the trip we intercepted them tend to take more trips pear year. SDSTRMS has potentially important implications for management, as it indicates that having access to more sites increases the number of trips and enhances the overall value of the steelhead fishing experience.

Table 10: POISSON: Single day travel cost model with and without correction for endogenous stratification, using OCM2.

	Poisson		Poisson w/ Endog. Str.	
Variable	Estimate	Standard Error	Estimate	Standard Error
CONSTANT	3.384	0.047**	3.351	0.007**
TC(OCM2)	-0.026	0.001**	-0.028	0.000**
EXPERNCE	0.018	0.001**	0.018	0.000**
AGE	-0.005	0.001**	-0.005	0.000**
INCOME2	0.001	0.000**	0.001	0.000**
SDHOURS	0.090	0.005**	0.093	0.001**
SDSTRMS	0.065	0.009**	0.067	0.002**
FLY	0.000	0.000	0.000	0.000

** Significant at 0.01 level; * significant at 0.05 level

Table 11: NEGATIVE BINOMIAL: Single day travel cost model with and without correction for endogenous stratification, using OCM2.

	Neg. Binomial		Neg. Binomial w/ Endog. Str.	
Variable	Estimate	Standard Error	Estimate	Standard Error
CONSTANT	3.361	0.203**	0.798	0.971
TC(OCM2)	-0.022	0.002**	-0.024	0.002**
EXPERNCE	0.023	0.006**	0.025	0.007**
AGE	-0.008	0.003**	-0.009	0.003**
INCOME2	0.000	0.001	0.000	0.001
SDHOURS	0.097	0.025**	0.104	0.028**
SDSTRMS	0.121	0.060*	0.133	0.067*
FLY	0.000	0.002	0.000	0.002
α	0.789	0.070**	11.314	0.092

** Significant at 0.01 level; * significant at 0.05 level

The results for the same models using the alternative measure of trip price, OCM2, are shown in tables 10 and 11. The coefficients have the same signs as with OCM1, so the interpretation of these variables is similar. One interesting difference is that the travel cost parameter TC(OCM2) is larger in general. This indicates that consumer surplus per trip is smaller, a result that makes sense since the measure of trip price does not include time costs for unemployed or retired anglers.

The models above can be used to estimate consumer surplus for annual trips (Tables 12 and 13). Several results can be seen in the tables. First, consumer surplus ranges from $36 per trip to $65 per trip. The lower values occur when using the second method for valuing time costs, OCM2. Recall that this method assigns no opportunity costs to individuals who are retired or unemployed. Second, consumer surplus per trip is smaller when the models correct for endogenous stratification. For the poisson models, consumer surplus per trip is $2 - $3 per trip smaller when correcting for endogenous stratification, and for the negative binomial models, it is $4 - $5 smaller per trip.

Table 12: Consumer surplus results for single day trips with OCM1

	Poisson		Negative Binomial	
		w/ end. Str		w/ end. Str
Predicted Trips per year	26.9	25.5	27.8	27.4
Annual Consumer Surplus	$1,344	$1,197	$1,830	$1,653
Consumer Surplus per trip	$49.97	$46.83	$65.81	$60.34

Table 13: Consumer surplus results for single day trips with OCM2

	Poisson		Negative Binomial	
		w/ end. Str		w/ end. Str
Predicted Trips per year	22.2	20.8	23.3	22.8
Annual Consumer Surplus	$852	$752	$1,078	$961
Consumer Surplus per trip	$38.40	$36.10	$46.17	$42.17

These results can be used to produce several additional policy-relevant estimates. First, we can estimate the value of catching fish. From table 1, individuals stated that they take 44.3 trips per year and catch 58.4 fish per year. This amounts to approximately 1.3 fish per trip. Consumer surplus from tables 12 and 13 ranges from $36 - $66 per trip, suggesting that the value of each fish caught ranges from approximately $27.69 - $50.77 per fish. Second, we can estimate the aggregate value of the steelhead fishery using some of the results provided in section III. In that section, it was suggested that the population of steelhead anglers in Ohio could range from 1,000

– 7,547. Note that the values in tables 12 and 13 focus only on trips to the streams where intercepted. If one assumes that trips to other streams are similar, then the aggregate value of trips could range from $1.6 million ($36 per trip * 44 trips per angler per year * 1,000 anglers) to $21.9 million ($66 per trip * 44 trips per angler per year * 7,547 anglers).

Third, it is possible also to compare these estimates to the costs of the stocking program in Ohio. For just the anglers in our survey, approximately 20,323 fish are caught per year (58.4 fish caught per year * 375 anglers intercepted). The estimate value of catching fish for these individuals is $0.6 to $1.1 million. In 2002, ODNR Division of Wildlife stocked 411,601 fish, for a cost of approximately $0.6 million per year. It is not possible to fully assess the relationship between the marginal fish stocked and the marginal benefit of catching a fish, but it appears that the total benefits for just the anglers in our survey are larger than the total costs of the stocking program.

VII. Conclusions and Recommendations

From the data collected during our survey, single day trip steelhead angling in Ohio Lake Erie tributaries appears to be a very valuable fishery. Local economic impacts are generated during traditionally slow tourism seasons. To the avid stream steelhead angler, the fishery offers a rewarding and highly valued opportunity. For the general shore bound angler, trophy size fishing opportunity is made available fall, winter and spring. Additionally, it appears from our study that the benefit of Ohio's steelhead program outweighs the cost of stocking.

However, due to survey methodology and unusually cold weather conditions, our research may be somewhat biased towards the frequent, more successful and avid steelhead angler, as they were more likely to be fishing on the streams when the survey clerk was working.

Because this was not a total creel of the anglers, due to funding limitations, we cannot determine the total number of anglers in Ohio, and those traveling to Ohio, who fish for steelhead. The absolute minimum must be the 500 or so anglers that were contacted on the streams.

In order to be more accurate in the valuation of this fishery, and in the number of participants, we recommend a more thorough, yet more costly, data collection methodology. This would provide information on other anglers who fish for steelhead less frequently. A possible methodology may incorporate the asking of two or three simple steelhead related angling questions during each purchase of the now computerized sale of Ohio annual fishing licenses; both in state an out-of-state purchases. Questions similar in nature are currently asked of those purchasing hunting licenses.

Further, it would be useful to have independently collected creel data to assist in benefit cost analysis of the stocking program. Finally, the results of the survey suggested strong differences in seasonal trips, and access to a variety of sites. Further evaluation of the timing of trips and access is needed to provide additional useful information.

VIII. References

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