Recreational Fishing Use-Values for Michigan's Great Lake Trout and Salmon Fisheries

Frank Lupi *and* **John P. Hoehn**
Visiting Assistant Professor *and* Professor
The Environmental Economics Program
Department of Agricultural Economics
Michigan State University
East Lansing, MI 48824-1039
lupi@pilot.msu.edu; hoehn@pilot.msu.edu

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ABSTRACT

The manuscript summarizes the results of a travel cost model developed for recreational angling in Michigan. The model and method are briefly described. The discussion focusses on how Great Lakes trout and salmon catch rates were related to angler behavior. The model is used to value changes in trout and salmon catch rates at Great Lakes fishing sites in Michigan. Fish population levels can be linked to a host of Great Lakes environmental quality issues including fish stocking, fish habitat restoration/preservation, and control/prevention of non-indigenous species. Particular emphasis is placed on the environmental data needed in order to establish pathways for valuing environmental quality with the travel cost method.

Keywords: Travel cost method, random utility model, fishing, Great Lakes, trout and salmon, Michigan.

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Corresponding Author: Lupi, see above address.

The Demand for Recreational Fishing

Recreational fishing generates substantial economic activity in the Great Lakes region. Some estimates suggest that about four billion dollars of expenditures are tied to the recreational fisheries of the Great Lakes (Talhelm). Figures such as these tell us something about overall impacts, but they leave many important questions unanswered. For instance, resource management agencies may want to know if investments in the fisheries are targeted at the best angling activities, sites, and species. Coastal development agencies and businesses many be interested in how changes in site facilities will affect the number of anglers who visit a site or county. Environmental managers and planners may want to know the economic losses associated with contamination at a given site. These types of questions require a good deal more than knowledge of overall economic impacts. They require insight into the economic demands of anglers -- how anglers willingness to travel and pay for services varies with distance, site quality, and angling opportunities.

For non-market recreation activities such as sportfishing at the Great Lakes, demand is usually estimated using the travel cost method, which we discuss below. Knowledge of anglers' demands allows the economic value of the resource to be measured using the notion of consumer surplus, also discussed below. However, even knowledge of the "economic value" of the resources in question does not address the above questions. What is needed is knowledge of how the economic value of the resource *changes* with and without some management action or policy decision. This change in value is the appropriate measure of economic benefits (damages) for use in a benefit-cost analysis. Versions of the travel cost method have been developed to handle this task. By linking demand to the quality of fishing sites, these models can be used to estimate *changes* in economic value associated with *changes* in site quality.

The purpose of this manuscript is to report estimates of the change in economic value associated with changes in the catch rates of Great Lake trout and salmon. The valuation relies on a recent application of the travel cost method to estimate the demand for recreational angling in Michigan. The demand model was developed at Michigan State University (MSU) by the authors and their colleagues. The work was supported by Michigan’s Department of Environmental Quality and Department of Natural Resources, and the initial findings are reported in Hoehn *et al.* We refer to the estimated demand model as the MSU angling demand model, or, more briefly, the MSU model.

We anticipate that the trout and salmon valuation information will be useful for many general planning and fishery management purposes. Since there is very little contemporary information on the economic value of Great Lakes fishery resources, the results help to fill a void in the information available for Great Lakes management and policy. In addition to fishery management, many environmental issues in the Great Lakes have the potential to affect fish populations. Therefore, we discuss how the results could be used to address more general environmental quality issues. One of our goals is to provide the proper context for interpreting the valuation results from models such as the MSU model, rather than focussing on the theoretical details of the MSU model. In particular, we highlight what is and is not being valued.

The Travel Cost Method

Before presenting a summary of the MSU model, we briefly review the travel cost method and discuss how it can be used to measure changes in economic value associated with changes in environmental quality. A more complete discussion of the travel cost method and its use in valuing recreation activities can be found in Bockstael *et al*. or Freeman.

Economic value is based on people's willingness to give something up in order to obtain something else; economic value has nothing to do with money, *per se*. Value could be translated into any standardized units, but placing values on a dollar scale makes them comparable with other market activities (e.g., the costs of a program). To infer economic value, economists' rely on the choices made by individuals. Since many goods are traded in markets, the "market" is a convenient mechanism for revealing economic values. However, the fact that something does not have a market price does not mean that it does not have economic value. Economists have developed a suite of valuation techniques for non-market goods or services. In the case of recreation activities such as fishing, economists can use observations on individuals' willingness to spend time and money to get to a recreation site to estimate willingness to pay for the recreation trips. This technique is referred to as the travel cost method (TCM).

The essence of the travel cost method is to determine statistically the relationship between price (travel costs) and quantity (the number of visits to some site); this relationship is referred to as the "demand curve." Figure 1 presents a graph of two hypothetical recreational demand curves for trips to a recreation site. The two demand curves are linked to two different levels of environmental quality at the site ($Q^0<Q^1$). The

price (travel cost) per trip is on the vertical axis, and the number of trips is on the horizontal axis. As the price decreases, we expect anglers to take more trips to the site.

The travel cost demand curve does double duty. First, it shows the number of trips an individual will make at any given price. In the figure, when the price of a trip to the site is P, the number of trips taken by anglers is T^0 and T^1, respectively. Second, the demand curve shows the maximum amount individuals' would be willing to pay to take each trip. For the initial trips taken by anglers, the amount they would be willing to pay exceeds the price. Anglers will take trips until their benefit (willingness to pay) for an additional trip just equals their cost -- see points A and D for the two demand curves in Figure 1. Note from Figure 1 that the benefit for each trip is higher under level of quality, Q^1, than under Q^0. That is, the demand curves show that willingness to pay for each trip is larger when the level of quality at the site is higher. The total amount the anglers actually pay to take T trips is equal to P×T which is less than total willingness to pay. The total difference between what individuals would pay and actually pay is referred to as consumer surplus (the areas PAB and PDC in Figure 1). If access to the recreation site was eliminated, the anglers would loose the consumer surplus associated with the site. Consumer surplus is the appropriate measure of economic value associated with the use of any good such as a recreation site (Freeman).[1]

The shape of the demand curve will depend on many factors, including the travel costs and quality of potential substitute fishing sites. The more high quality substitutes that are available to anglers, the more responsive the demand for trips will be to price changes (i.e., the flatter the demand curve). Since the availability and quality of substitutes will affect the shape of the demand curve, substitutes also affect the value of individual sites. Because of the importance of substitute fishing opportunities, economists have developed demand systems which can account for complex arrays of substitution possibilities.

We note that the travel cost method is used to estimate the value of fishing *at a specific site*, as opposed to fishing at some other site or engaging in some other activity. The method can not measure all the general values associated with fishing. Moreover, since the method is based on relationships between recreational *use* and price and quality of a fishing site, factors that are not revealed through anglers fishing

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[1] Note that while the amount given by P×T is a measure of the expenditures at the site, it is not a measure of economic value. This money may be important to a local economy surrounding the recreation site, but the money (and the other opportunities it can provide) is not lost to the individual should the site close.

behavior cannot be measured. For this reason, the values are referred to as *use-values*. The fact that TCM can only measure use values does not preclude other non-use values from being held by individuals.

We have illustrated how TCM can be used for estimating the value associated with access to some recreation site, but we also argue that in many important cases this value is not very meaningful. Value information is useful if it can help policy makers and resource managers make decision. What resource managers usually need to know is how the value associated with a recreational activity changes as the quality of the resource changes. Establishing this change in value is more difficult than simply establishing the value of access to a site (given by the consumer surplus). For example, fishing quality can typically be linked to some management action such as fish stocking or pollution control, and these management actions have costs and benefits. The benefits are given by the *change* in the consumer surplus at the sites where quality changes. Knowledge of the consumer surplus is not enough. The consumer surplus for a site is only the appropriatte measure of the benefits of some management action *if* the site would be closed without the management action. For the Great Lakes, it is difficult to imagine scenarios where the relevant comparison involves complete closure of the entire Great Lake fisheries. Thus, the more germane resource issues are valued by determining the *changes* in consumer surplus that are associated with some policy action. Travel cost methods capable of doing the later are relatively new to the economist’s toolkit.

Valuing Changes in Environmental Quality

As mentioned, to measure changes in value associated with changes in quality, one needs to know how the demand curve shifts when quality changes. The value is then given by the change in consumer surplus. The two demand curves shown in Figure 1 illustrate the idea. Consider two levels of quality ($Q^0<Q^1$) at the site. The lower demand curve in Figure 1 represents the demand under the baseline level of quality, Q^0, and the upper demand curve reflects the upward shift in demand under some increased level of quality, Q^1. The value of the change in quality (Q^0 to Q^1) is given by the change in the consumer surplus, the area ABCD. When quality changes at multiple sites, one needs to establish the shifts in demand at *all* the sites where quality changes (Freeman; Bockstael *et al.*).

As we’ve discussed, in order to use TCM to measure the value of changes in the quality of a resource, one must have a means of predicting how demands will shift when quality changes. As such, TCM can only be used to measure the value of changes in environmental quality that can be linked to the demand curve. Typically, this linkage is accomplished by including a measure of environmental quality as a variable that describes site quality in a multiple-site travel cost model. A less common approach involves shifting the travel cost demand curve based on some external estimate of how demand would change in response to the changes in environmental quality. Such external information might come from a contingent behavior survey which seeks to elicit anglers' stated behavior in response to some change in resource quality. The bottom line is that, absent a linkage between the entity to be valued and the travel cost demand curve, changes in use cannot be predicted, and thus, changes in use-values cannot be measured.

The complete linkage between environmental quality and behavior can be referred to as a valuation pathway. In the case of valuing changes in trout and salmon populations, the inclusion of trout and salmon catch rates as a site characteristic in the MSU angling demand model provides the linkage between catch rates and angler behavior (discussed in detail below). Changes in angler behavior map to changes in predicted trips and to changes in use-value accruing to recreational anglers. However, valuing environmental quality *through* the fish variables requires appropriate evidence from the physical sciences which links some change in environmental quality to changes in fish, and these changes in fish must be translated into changes in catch rates (see Figure 3). Clearly, establishing a valuation pathway involves several types of knowledge. This research does not establish the entire valuation pathway. Rather, the MSU model is directed at the later portions of the pathway, as indicated in Figure 3.

When the valuation pathway relies on a site quality variable to shift the travel cost demand curve, it is important to recognize that the relationship between site quality and recreational use must be estimated statistically. In particular, with multiple site travel cost models such as the RUM, it is the *spatial* relationship between site characteristics (price and quality) and recreational use that is being estimated. This spatial relationship is then used to infer how the TCM demand curves will shift if environmental quality changes. This is depicted as the last step in the valuation pathway presented in Figure 3.

Because the linkage between recreational use and environmental quality must be established statistically, there are a host of data issues involved in identifying this linkage. Some of these data issues are listed below:

1. the data must exist to describe (quantify) the aspect of environmental quality to be valued;

2. the data must be available for all sites to be modeled;
3. the data should exhibit sufficient variation across sites;
4. the data cannot be highly correlated with other variables that influence site choice; and
5. the range of variation in the data should be sufficient to cover the range of policies to be examined.

Many of these concerns affect any multivariate statistical modeling efforts. However, they are particularly important for TCM since the environmental quality linkage is utilized to infer the value of changes in environmental quality. *Ultimately, any TCM valuation of site quality is only as good as the statistical link between quality and the TCM demand curve.*

The MSU Recreational Angling Demand Model

The type of TCM employed by the MSU team is referred to as a random utility model (RUM). RUMs use data on individual trips and advanced statistical techniques to explain anglers' choices of a fishing site and relate these choices to the prices and qualities of alternative fishing sites. Through this linkage, RUMs can be used to value changes in site quality. RUM approaches are considered the state-of-the-art methods for travel cost estimation of recreational demand when there are numerous substitute sites (Morey; Hausman *et al.*). The basic RUM choice model posits that on any occasion, anglers choose a fishing site from a set of alternative fishing sites. Since possible fishing destinations differ in their travel costs and quality, anglers must make a trade-off between travel costs (money) and site quality. The approach assumes that anglers pick the site that they consider to be best. Observations of angler's choices reveal their relative preference for site quality and money, i.e., the anglers' willingness to trade money for site quality.

The basic RUM model describes site choice. By including “don’t go fishing” as an alternative and repeating the site choice model over a season, the model can explain complex site choices as well as total seasonal demand for fishing (Morey). In a *repeated* RUM such as the MSU model, the season is divided into a series of choice occasions. In each choice occasion, anglers decide whether to take a trip, and if they are taking a trip, they must decide where to fish.

In the RUM approach, researchers acknowledge that they can not measure all of the factors that are relevant to individual anglers. To handle this, error terms are introduced, and the model becomes a statistical model. By combining actual data on anglers' choice of fishing site with the costs and quality of all alternative sites, the parameters of the statistical model can be estimated. The MSU model is specified statistically as a repeated nested logit, where "nested" refers to the patterns of correlations among the error terms (see McFadden or Morey for a complete description of the nested logit). The MSU model contains four levels of nesting, and the nesting structure is slightly more complex than depicted in Figure 2. There are about 80 parameters to be estimated in the model. The complete model results are presented in Hoehn *et al*.

The behavioral data describing where and how often anglers go fishing in Michigan was collected in an extensive panel survey. The survey was a telephone panel study which followed over 2000 anglers during the course of the 1994-95 fishing year. The panel members were recruited from the general population of Michigan residents using a stratified random digit dialing screening interview. Computer assisted telephone interviewing was used to streamline all interviews and improve response accuracy. Techniques to ensure response accuracy included a large pilot survey, fishing logs as memory aides, bounded recall to avoid double counting of trips across panel interviews, and providing multiple opportunities to revise trip counts. To balance the need to collect timely and accurate data against the burden of the interviews, frequent anglers were called more often than infrequent anglers -- panel interview frequencies ranged from eight interviews for the most avid anglers to three interviews for the least avid anglers. After selecting for complete data, the final sample used to estimate the MSU model contains data on every fishing trip made from April 1994 through October 1994 by a panel of over 1900 potential anglers.

In the MSU repeated RUM, trips are differentiated by trip durations (single versus multiple day trips), by water body fished at (Great Lakes, inland lakes, rivers/streams), and by species targeted ("warm" species such as bass, perch and walleye, versus cold species such as salmon and trout). Figure 2 presents a diagram of the choice structure of the MSU model. The model structure builds on previous research in Michigan (Kikuchi; Jones and Sung). In all, the MSU model contains over 850 distinct fishing opportunities in each choice occasion, and this set of opportunities is available for over 60 choice occasions for each sampled angler in the model.

For the Great Lakes, destination sites are defined by the stretch of Great Lake shoreline within a county. There are 41 Great Lake counties in each of two Great Lakes fishery types, Great Lake warm and Great Lake cold. Great Lake warm refers to fishing trips targeting warm water species such as bass, walleye, and perch. Great Lake cold refers to trips that target trout and salmon. Within the Great Lake cold branch of the MSU model, sites are described by the catch rates for each of the following species: coho salmon, chinook salmon, lake trout, and rainbow trout. These catch rates are specific to each county and vary on a monthly basis over the open water season (April to October). These catch rates are based on Poisson regression analysis of the Michigan creel survey party interview data and were provided by Douglas B. Jester of the Michigan Department of Natural Resources.

For river and stream fishing, the model distinguishes destinations according to the three types of species that can be targeted on a fishing trip: warm species, non-anadromous cold species, and anadromous species. These three specie types constitute the three river and stream fishery types that enter the model. Destinations within the river and stream fishery types are defined as the counties in Michigan which contain river fishing opportunities for that species type. Inland lake warm and cold fishing sites are also defined at the county level.

The valuation scenarios examined here are based on changes in the catch rates for Great Lakes trout and salmon and affect the Great Lakes cold and anadromous fishery types in the model. While our focus is on the valuation of changes in trout and salmon populations in the Great Lakes, it is essential to include all the potential substitute types of fishing that are available in Michigan. As mentioned above, the more high quality substitutes that are available, the less valuable a specific fishing site will be. The MSU model is appropriate to the Great Lakes valuation task since it is a statewide model and it includes the full range of substitute fishing opportunities that are available in Michigan. Few models cover such a range of alternative activities. By tabulating the predicted patterns of trips, we use the catch rate scenarios to illustrate the extent to which Michigan anglers are predicted to switch into (out of) Great Lake trout and salmon fishing as catch rates change. The trip predictions underscore the role of the substitute activities and highlight one of the strengths of the travel cost method: it can be used to predict changes in trips.

MSU Model Results

Selected estimation results for the MSU model that are pertinent to the Great Lakes trout and salmon fisheries are presented in Table 1. The estimation results revealed that for single day trips to Great Lake sites, the salmonids (chinook, coho, and rainbow) were about two to three times as valuable as lake trout. Put differently, salmonid catch rates explained anglers site choices about two to three times better than did lake trout. For multiple day trips to Great Lake sites, the estimation results revealed that the salmonids were about three to five times as valuable as lake trout. All of these variables were significant with the exception of the lake and rainbow trout catch rates for multiple day trips. For anadromous single day trips, rainbow catch rates were about two and a half times as valuable as chinook catch rates while coho catch rates were slightly negative but insignificant. For anadromous multiple day trips, all three catch rates were significant with roughly the same influence on site choice.

Table 1: Selected Parameter Estimates from the MSU Model.

		Single Day		Multiple Day	
Fishery type	**Variable**	**Coefficient**	**t-stat.**	**Coefficient**	**t-stat.**
	Trip Price (travel cost)[†]	-0.143	-58.8	-0.015	-13.3
Great Lakes Cold	Chinook salmon CR[‡]	9.17	5.14	15.28	6.05
	Coho salmon CR	12.69	5.45	13.62	5.27
	Lake trout CR	4.57	3.23	3.04	1.05
	Rainbow trout CR	10.91	2.19	10.25	1.34
Anadromous Runs	Chinook salmon CR	2.80	3.37	4.76	6.37
	Coho salmon CR	-0.88	-0.30	6.88	4.28
	Rainbow salmon CR	7.00	8.04	6.50	4.58

[†] Travel cost = per mile driving cost ×round trip distance + lodging costs + time valued at wage rate.
[‡] CR = catch rate in fish per hour, as derived from party interview data of the Michigan creel survey.

In terms of trip substitution, the model estimation results indicate that anglers are more likely to substitute trips across fishery types for single day trips than for multiple day trips. That is, when quality improves for a particular fishery type at some site, the predicted single and multiple day trips to that site for that fishery type will increase, and single day trips will draw a larger share of their trips from other fishery types than do multiple day trips. The model results also indicate that changes in multiple day trips are more diffuse than single day trips -- single day trips tend to be drawn from sites nearby while multiple day trips tend to be drawn from the same fishery type. Another model result is that as quality increases, the model predicts a small amount of substitution from single day trips to multiple day trips, with the opposite effect for decreases in quality. Finally, at the top level of the model (see Figure 2), when site characteristics change, there is very little change in the overall number of trips. The complete model estimation results are reported in the Hoehn *et al*. report.

Predicted user days: To reflect the relative number of "user days" spent fishing in Michigan, the baseline trip predictions from the MSU model are translated into estimated user days by multiplying the multiple day trips by 3.85 and adding the single day trips. The number 3.85 equals the mean number of days for multiple day trips. Table 2 presents the estimated user days by Michigan fishery types (as defined in Figure 2). The Great Lake trout and salmon fisheries account for 13% of the user days (the sum of the user days for GL cold and Anad.). The user day estimates reflect the fact that most of the fishing trips taken in Michigan by resident anglers target warm species, and most of the trips are taken to inland water bodies such as lakes and rivers.

Table 2: User Days by Fishery Type.

Fishery type	**Total user days by fishery type**† (thousands)	%
GL warm	2,776	23%
GL cold	922	8%
IL warm	5,513	46%
IL cold	198	2%
RS warm	1,452	12%
RS cold	588	5%
Anad.	663	5%
Totals	12,111	

† Fishery types are defined in Figure 2. Estimated sport fishing user days in Michigan by resident anglers, April to October. User days are defined by multiplying multiple-day trips by 3.85 and adding single-day trips.

Interestingly, about 35% of the Great lake cold trips and about 26% of the anadromous run trips were multiple day trips. In contrast, only about 14% of all other fishing trips made in Michigan by Michigan residents were multiple day trips. Thus, the Great Lakes trout and salmon fisheries account for a relatively larger share of the multiple day trips than do the other fishery types. This is important for valuation purposes because the data and MSU model results imply that multiple day trips are more valuable than single day trips.

Of course, one does not need an economic model to generate use information as presented in Table 2, all that is needed is the survey data. However, an economic model is needed to translate the use information into values, to predict changes in demand, and to link use to environmental quality. We turn to these issues in the next section.

Great Lake Trout and Salmon Valuations

The Great Lake trout and salmon valuation scenarios to be examined consist of multiplying catch rates for these species by various factors ranging from 0.5 to 1.5 (i.e., from 50% decreases to 50% increases). The species affected under these valuation scenarios are the chinook salmon, coho salmon, lake trout and rainbow trout catch rates in the GLcold fishery type and the chinook salmon, coho salmon, and rainbow trout catch rates in the anadromous run fishery type of the MSU model. For decreases in catch rates, anglers experience losses, while for increases in catch rates, anglers experience gains. These scenarios build on the lake trout valuations reported in Lupi and Hoehn, and the welfare measures and extrapolation to the Michigan population follow the methods described in detail in Chapter 3 of Lupi and Hoehn. Moreover, most of the caveats reported in Lupi and Hoehn also apply to the valuations presented here. For example, scenarios involving percentage changes in the existing catch rates have the advantage of preserving the existing spatial and temporal patterns of catch rates -- sites that have relatively high catch rates change more in absolute terms than do sites with lower catch rates. A potential disadvantage of such scenarios is that they “condemn” the poorer sites to stay poor. For instance, some of the sites have zero catch rates for some species and these remain zero under all the scenarios considered here. The valuation scenarios presented here serve to illustrate the MSU model. More generally, the model could be used to value any spatial and temporal pattern of catch rates relative to any other pattern of catch rates.

Figure 4 presents a graph of the valuation results, and Table 3 presents the tabulated results that are used to plot the figure. Table 3 also presents the changes in the estimated user days associated with the Great Lakes trout and salmon fishery (the GL cold and anadromous run fishery types). The estimated values represent the aggregate annual use-values accruing to Michigan residents in 1994 dollars as a result of the hypothesized change in catch rates. In the range of the baseline levels of catch rates, the changes in catch rates result in changes in Great Lake trout and salmon user days and changes in value that can be translated into user day values of about $30. This crude estimate of user day value is in the low end of the range of values for trout and salmon fishing reported by Walsh *et al*.

Table 3: Great Lake Trout and Salmon Valuations.

Multiply GL T&S CR's by	**Value** (millions)	**GL T&S user days** (thousands)	**change in user days** (thousands)
0.5	-$10.95	1,189	-395
0.6	-$9.36	1,250	-334
0.7	-$7.52	1,320	-265
0.8	-$5.38	1,398	-187
0.9	-$2.89	1,486	-99
1	0	1,585	0
1.1	$3.35	1,690	111
1.2	$7.23	1,819	235
1.3	$11.71	1,956	371
1.4	$16.86	2,106	521
1.5	$22.75	2,268	683

From Figure 4 and the results in Table 3, it is clear that the estimated gains from increasing catch rates exceed the estimated losses for an equivalent decrease in catch rates. The reason for this is due to the role of site and activity substitution embodied in the recreational demand model. When the quality of the Great Lakes trout and salmon fisheries decreases (increases), anglers substitute out of (into) this fishery. Thus, for decreases in quality, anglers who are taking trips to fish for Great Lakes trout and salmon experience losses, but the magnitude of these losses it limited by the utility they could receive from switching to their next best alternative. Their next best alternative could be fishing for a different species, fishing at a different site, or fishing less. Because the values being measured are use-values, once an angler switches sites, they do not experience any further losses if quality at a site they are no longer visiting continues to decrease. Conversely, when the quality of a site increases, anglers who are currently using the site experience benefits. In addition, some anglers are induced to switch to the site where quality increases, and these additional users also benefit from the increase in quality. Thus, site substitution in travel cost models plays a dual role, mitigating losses and accentuating gains relative to models that ignore such substitution possibilities. These factors help explain the shape of the benefits frontier depicted in Figure 4.

Another factor worth noting is that for the scenarios considered here, the predicted number of multiple day trips had higher percentage changes than did the predicted single day trips. Thus, as the quality of the fishery goes up, the composition of trips changes, with the share of multiple day trips increasing. Since the multiple day trips yield higher value from the MSU model than do the single day trips, this effect also contributes to the shape of the valuation function graphed in Figure 4.

Substitution: One of the strengths of multiple-site travel cost models is their ability to predict changes in the patterns of recreational activities. Table 4 presents the changes in estimated user days for two of the Great Lakes trout and salmon valuation scenarios: the 50% decrease and 50% increase in catch rates. The user days are calculated in the same manner as in Table 2. As expected, the GL cold and Anadromous fishery types experience the largest changes in user days which reflects the fact that these are the fishery types where catch rates were altered.

Table 4: Change in User Days By Fishery Types.[†]

	50% decrease in all GL T&S catch rates		**50% increase in all GL T&S catch rates**	
	change in user days by fishery	percent change	change in user days by fishery	percent change
GL warm	85,800	3%	-140,900	-5%
GL cold	-263,600	-29%	468,200	51%
IL warm	212,200	4%	-370,700	-7%
IL cold	8,800	4%	-15,000	-8%
RS warm	48,500	3%	-83,100	-6%
RS cold	32,000	5%	-55,300	-9%
Anad.	-131,900	-20%	214,800	32%
Total	-8,300		18,000	

[†] Fishery types are defined in the Figure 2.

The results also indicate that the user days are more responsive to increases in the quality of sites than to decreases in quality. Further, the user days in GL cold fishery are more responsive than the user days in the anadromous run fishery. This result is in part due to the fishing trips in GL cold having a greater share of multiple day trips than anadromous, and the multiple day trips were more responsive to changes in quality than were the single day trips. Finally, notice that the model estimates reveal very little change in total user days -- most of the deceases in the GL cold and anadromous fishery types are offset by increases in other fishery types. The relatively small changes in overall user days is a consequence of the very broad scope of the MSU model.

A few words of caution are in order in regards to interpreting the valuation results. First, since the estimated values are based on the travel cost method, they are only estimates of use-value that is related to the catch rate variables. Second, the results only apply to Michigan anglers who fish in Michigan. There are many non-resident anglers who fish in Michigan who are not accounted for, and there are many anglers who fish in other jurisdictions that would also be affected by the catch rate changes. Third, following standard practice in TCM, the trips that are included in the MSU model (and the resulting predicted user days) are only those trips where anglers indicated that fishing was the primary purpose of the trip. The survey results indicated that fishing was the primary purpose for 97% of the single day trips and for 67% multiple day trips. Thus, there are a fair amount of multiple day trips (and hence, user days) that involve fishing, but are outside realm of the MSU model. Finally, while the results presented here represent our best efforts to date, our research and the development of the MSU model is on-going, so the values should not be interpreted as the final word on the subject.

Some Final Comments on Valuing Fisheries

While catch rates are a commonly used quantitative measure of the quantity of fish anglers catch, they reveal little about the qualitative nature of the fishery (e.g., size of fish, their fitness, their fight, their suitability for human consumption, etc.). As such, the catch rates variables can't be used to account for all of the angling related use-value of a fishery. In addition, there are many non-fishing site characteristics that are of interest to anglers. For example, variables such as cabin locations partly explain trips in the MSU model. Thus, in typical travel cost model formulations, driving catch rates to zero will not result in *predicted* trips going to zero. This suggests that fitted relationships between catch rates and fishing trips are better suited to evaluating *small and moderate* changes in catch rates than large changes in catch rates. This is a restatement of point 5 above: driving the catch rates to zero at all sites is outside the range of the current data with which the model was estimated.

In addition, while Figure 3 depicts a valuation pathway that affects catch rates, there is nothing that prevents a change in environmental quality from causing a complex array of changes in a fishery. For example, sediment remediation might increase fish populations as well as the size of fish. Both of these might affect angler behavior. However, in Michigan, data on the size of fish does not exist for all the sites in the MSU model (point 2 above). In this example, a change in catch rates would only capture *a portion* of the use-values accruing to anglers. Therefore, identifying all possible “valuation pathways” serves to clarify what values *are* and *are not* being measured in any particular environmental valuation.

One of the aims of this paper was to highlight the role that sound environmental data plays in any economic valuation exercise. We close by noting that the valuation results presented here would not be possible had there not been an on-going angler contact creel survey providing widespread coverage of Great Lakes fishing sites in Michigan. This paper should serve to emphasize a perhaps unforeseen advantage of comprehensive collection of environmental data -- the data is a vital part of establishing values of environmental quality.

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Figure 1: Shift in Recreational Angling Demand Curve Due to a Shift in Site Quality (Q^0 to Q^1).

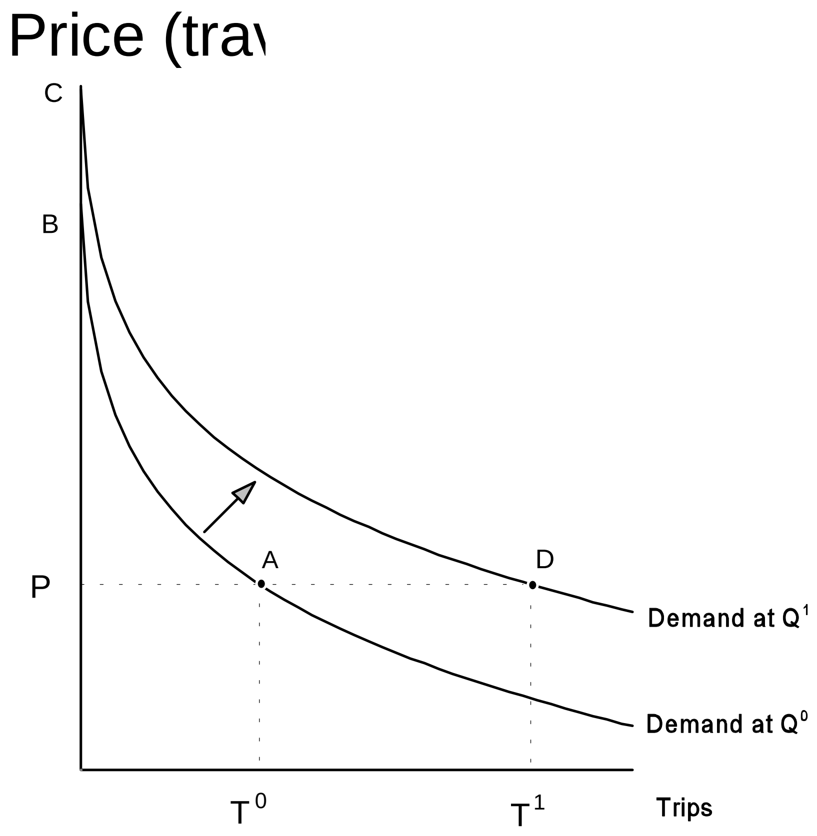
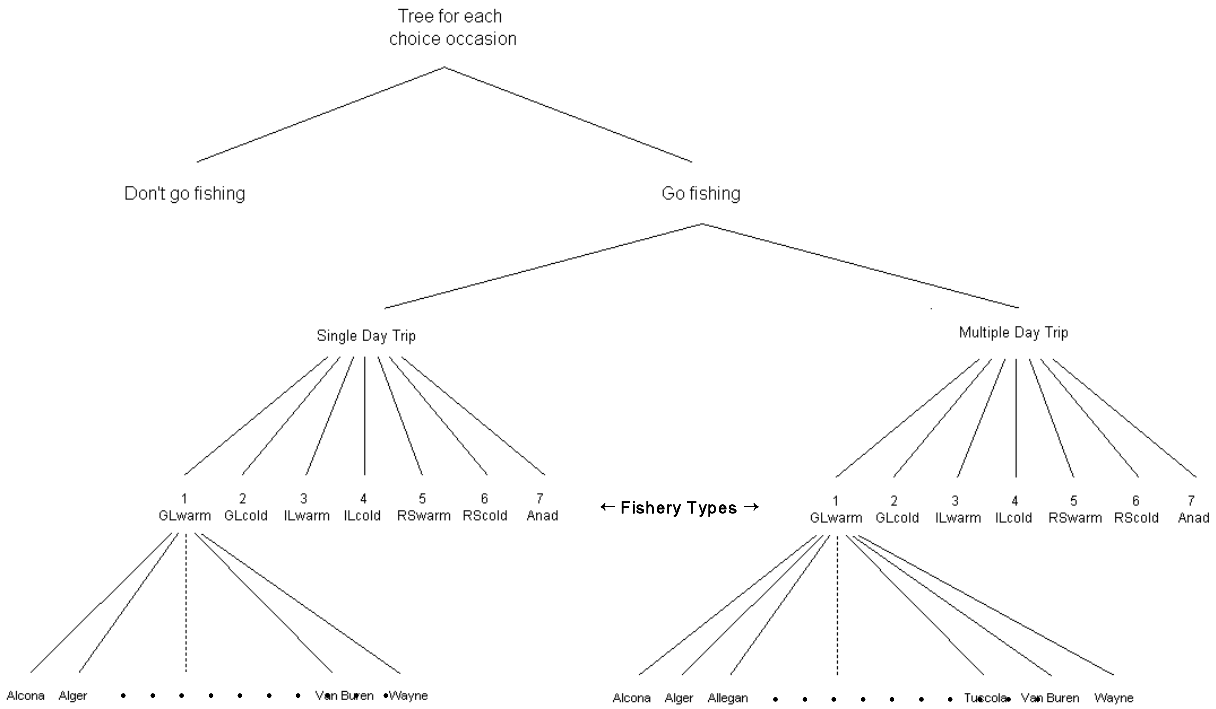


Figure 2: Fishing Choice Structure in the MSU Angling Demand Model.



Key: GL=Great Lakes; IL=inland lakes; RS=river/stream; Anad=anadromous rivers; Cold=trout, salmon; Warm=bass, perch, walleye, etc.

Figure 3: Establishing a Pathway for Valuing Environmental Quality Through Fish Catch Rates.

```
                                                                 Change
      Change in          Change        Change         Change    -->  in trips
      environmental  --> in fish  -->  in catch  -->  in angler
      quality            stocks        rates          behavior  -->  Change
                                                                 in value

    |       a linkage must be       |                                          |
    |<--     established by      -->|<--        from the travel cost        -->|
    |       physical science        |           angling demand model           |
```

Figure 4: Use-Value of Changes in All Great Lake Trout and Salmon Catch Rates in Michigan.