CASE STUDY OF A TRAVEL-COST ANALYSIS: THE MICHIGAN ANGLING DEMAND MODEL[15]

Background

This case study estimates the demand for recreational angling in Michigan using the travel-cost model. By "demand for angling," we mean both where and how often anglers wish to fish. Michigan has abundant water resources that provide a diverse array of fresh-water recreational fishing opportunities. The application discussed here attempts to account for this richness. The result is a large-scale, state-of-the-art model that lies at the upper end of the spectrum in terms of complexity, cost, and effort involved in travel-cost method studies. The model was developed at Michigan State University by the authors and their colleagues. The work was supported by the Michigan Department of Environmental Quality and Michigan Department of Natural Resources (MDNR), and the findings are summarized in Lupi, et. al. (1997). We refer to the estimated model as the Michigan angling demand model, or the Michigan model.

Great Lakes fish population levels interact with a host of Great Lakes environmental quality issues including fish stocking, fish habitat restoration and preservation, and control and prevention of aquatic nuisance species. To illustrate how one might estimate some of the economic value associated with changes in fish populations, we use the Michigan model to value changes in trout and salmon catch rates at Great Lakes fishing sites in Michigan. Because Great Lakes trout and salmon are mobile species, valuing changes in these fisheries requires a model with a broad geographic scope.

As we mentioned in Chapter 6, the travel-cost method establishes a relationship between recreational use and the costs and characteristics of recreation sites. Given this demand relationship, the travel-cost method cannot tell us anything about values that are not associated with recreational use. Fortunately, environmental quality often is a value associated with recreational use, and in these cases the travel-cost method can link changes in environmental quality to the demand for recreation trips and the value of these trips. This is accomplished by including measures of environmental quality as variables that describe site characteristics in the travel-cost model.

In this study, trout and salmon catch rates were key site characteristics in the model revealing any linkage between catch rates and angler behavior. Valuing environmental quality through the fish variables requires appropriate evidence from the physical sciences linking some change in environmental quality to changes in fish, and these changes in fish must be translated into changes in catch rates (Figure 7.2). Clearly,

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establishing such a valuation pathway involves several types of knowledge and data.

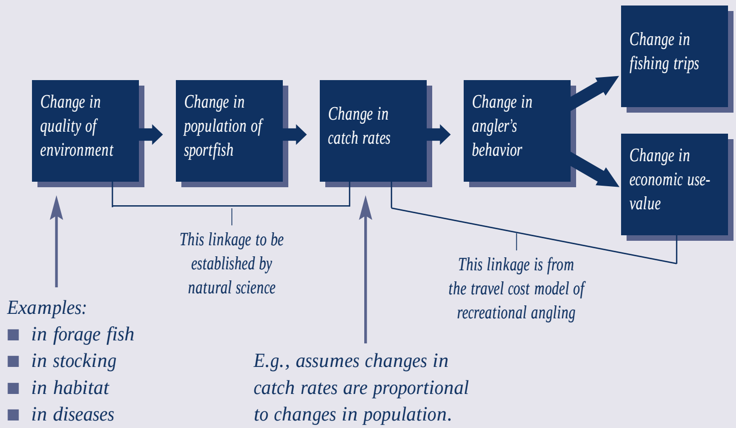
This case study does not investigate the entire valuation pathway. Rather, the Michigan model is directed at the later portions of the pathway, as indicated in Figure 7.2. As we stated in the Chapter 6, any travel-cost method valuation of environmental quality is only as good as the statistical link between site-quality characteristics and the travel-cost method demand for trips to the site. Nonetheless, we use the example to highlight some of the environmental data needed in order to establish pathways for valuing environmental quality with the travel-cost method.

In addition to establishing the portion of the pathway that the case study addresses, it is also important to define all possible valuation pathways to clarify what values are being measured in any particular environmental valuation. This study focuses on *catch rates*, a measure of the number of fish that anglers can expect to catch. Although catch rates often have a direct relationship to angler satisfaction and, therefore, to the use value of the fishery, catch rates speak only to quantity, not quality. Angler satisfaction also depends on the size of fish, their fitness, their fight, their suitability for human consumption, and so on. As a result, a change in catch rates captures only a portion of the use values accruing to anglers. Figure 7.2 depicts a valuation pathway for a change in environmental quality that affects catch rates, yet there is nothing that prevents a change in environmental quality from causing a complex array of changes in a fishery other than population density and catch rates. For example, sediment remediation might increase fish populations as well as the size of fish. Alternatively, an aquatic nuisance species could supplant native forage fish and lead to smaller fish, although populations are just as numerous. Both of these scenarios might affect angler behavior. However, in Michigan, because data on the size of fish do not exist for all the sites in the Michigan model, fish size cannot be linked to angler behavior.

What Makes the Model Tick

Fishing destinations differ in their travel costs and characteristics, and anglers must make a tradeoff between travel costs and site characteristics. Anglers' choices reveal their relative preferences for site characteristics and travel costs (i.e., anglers' willing-

Figure 7.2.
ESTABLISHING A PATHWAY FOR VALUING ENVIRONMENTAL QUALITY THROUGH FISH CATCH RATES



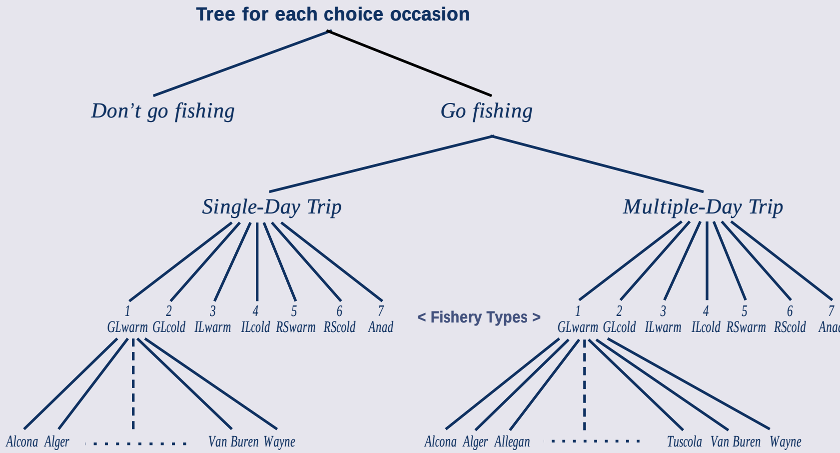
ness to trade costs, or money, for site characteristics). This is what makes the travel-cost model tick.

The travel-cost method used by the Michigan team is referred to as a random utility model (RUM). The RUM approach assumes that anglers pick the site they consider to be best and applies advanced statistical techniques to data on individual trips to explain angler choices. The model relates these choices to the costs and characteristics (e.g., environmental quality) of alternative fishing sites.

Categorizing Angler Opportunities

To increase the precision of the study with respect to angler choices, researchers carefully categorized the broad array of fishing opportunities available to Michigan anglers. The study differentiated opportunities by trip duration (single versus multiple day trips), water body (Great Lakes, inland lakes, rivers/streams), and species targeted for fishing (so-called warm species, such as bass, perch, and walleye, versus so-called cold species, such as salmon and trout). Figure 7.3 presents a diagram of the different types of fishing activities and sites included in the Michigan model. The model structure builds on previous research in Michigan (Kikuchi; Jones and Sung 1993).

Figure 7.3.
FISHING CHOICE STRUCTURE IN THE MICHIGAN ANGLING DEMAND MODEL



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

The Great Lakes destination sites were defined by the stretch of Great Lake shoreline within the county (the bottom level of Figure 7.3) and categorized within fishery types. There are 41 Great Lakes counties in each of two Great Lakes fishery types, Great Lakes warm and Great Lakes cold. Within the Great Lake cold branch of the Michigan model, sites were further 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). They are based on an analysis of angler party interview records from the Michigan creel survey data.

For river and stream fishing, destinations are distinguished according to the three types of species that can be targeted on a fishing trip: warm species, nonanadromous cold species, and anadromous species. Anadromous run refers to Great Lakes trout and salmon on migratory runs up or downstream. Destinations within the river and stream fishery types are defined as the counties in Michigan that contain river fishing opportunities for that species type. Inland lake warm and cold fishing sites are also defined at the county level.

Discovering Angler Choices

Angler choices can be discovered through direct surveys. Clearly, the quality of the travel-cost method survey is critically important to the accuracy of the study, as evidenced in the wide divergence between various state and federal estimates of the amount of fishing in Michigan and on the Great Lakes (Bence and Smith, 1999). There are pitfalls particular to data gathering on recreational trips. Survey research conducted by the Fisheries Division of MDNR and other agencies has established that surveys asking anglers to recall the number of trips they have taken over some period of time tend to contain upward biases that increase with the length of the recall period. Because the economic use values derived from the travel-cost method are directly related to use (i.e., the number of trips taken by anglers), potential recall biases are a concern. In light of these results, one goal of the study reported here was to collect data on the number of annual fishing trips made by individual anglers that were as accurate and representative as possible.

The data for this study describing where and how often anglers go fishing in Michigan were collected in an extensive telephone panel survey that followed over 2,000 anglers during the course of the 1994-1995 fishing year. The panel members were recruited from the general population of Michigan residents to ensure that the results would be representative. 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, placing bounds on the dates anglers were asked to recall to avoid double counting of trips across panel interviews, and provision of 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.

Calculating Site Choice Occasions

As we noted above, the basic RUM model describes site choice. In a repeated RUM such as the Michigan model, the season is divided into a series of *site choice occasions*. In each occasion, anglers decide whether to take a trip and, if so, where to fish. In the Michigan model, the choice occasion depicted in Figure 7.3 is repeated twice-weekly over the course of the season. Consequently, the repeated RUM can explain site choices and the number of trips (i.e., where and how often anglers fish). In all, the Michigan model contains over 850 distinct fishing opportunities in each choice occasion (the number of nodes at the bottom of Figure 7.4), and this set of opportunities is available for over 60 occasions for each sampled angler in the model. Moreover, the model contains about 80 parameters that were estimated statistically.

Although our focus is on fishing for trout and salmon, it is essential to include all the potential alternative (i.e., substitute) types of fishing available in Michigan. Generally, the more high-quality substitutes that are available, the less valuable a specific fishing site will be. The Michigan model is appropriate to the Great Lakes valuation task because it is a statewide model and it includes the full range of fishing opportunities available in Michigan. Few models combine such a range of activities and cover such a broad geographic area. By tabulating the predicted patterns of trips, we use the catch rate scenarios to illustrate the extent to which Michigan anglers are likely to switch in to (or out of) Great Lakes trout and salmon fishing as catch rates change. The trip predictions underscore the role of the potential substitute sites and activities.

Table 7.4 displays the estimated user days by Michigan fishery types (as defined in Figure 7.3). The Great Lakes trout and salmon fisheries account for 13 percent of the user days (the sum of the user days for Great Lakes cold and anadromous run fishery types). The table shows that most of the fishing trips taken in Michigan by resident anglers are taken to inland water bodies such as lakes and rivers, and that warm species are targeted on most of the trips.

One does not need an economic model to generate use information as presented in Table 7.4. Use estimates can be obtained by extrapolating appropriately from the survey data. However, an economic model is needed to predict changes in trip demand, to translate the use information into values, and to link use to environmental quality. We turn to these issues in the next section.

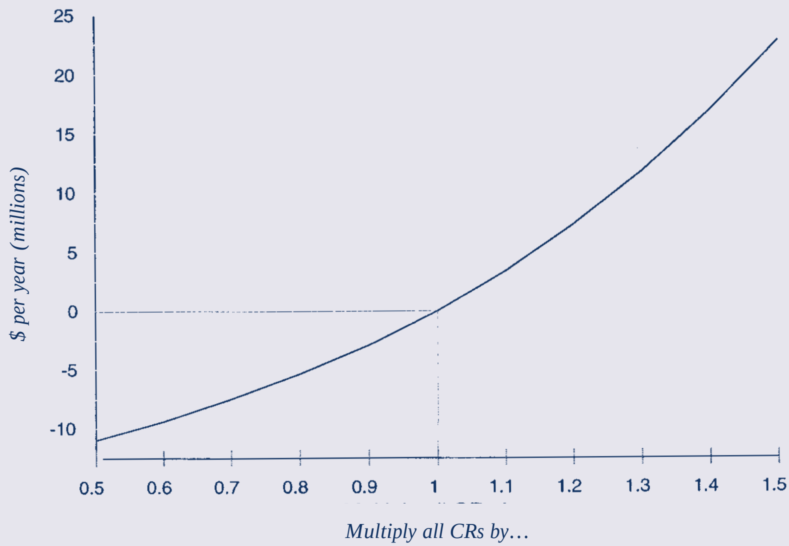
Table 7.4.
USER DAYS BY FISHERY TYPE

Fishery Type	Total User Days[1] Number *(thousands)*	Percent
Great Lakes warm	2,776	23
Great Lakes cold	922	8
Inland warm	5,513	46
Inland cold	198	2
RS warm	1,452	12
RS cold	588	5
Anadromous run	663	5
Totals	*12,111*	*100*[2]

[1] Estimated sport fishing user days in Michigan by resident anglers from April to October 1994, for each fishery type defined in Figure 7.4.

[2] Percentages add to more than 100 due to rounding.

Figure 7.4.
USE VALUE OF CHANGES IN ALL GREAT LAKES TROUT AND SALMON CATCH RATES IN MICHIGAN



Linking Angler Choices to Catch Rate and Value

Great Lakes trout and salmon valuation consists of multiplying catch rates by factors ranging from 0.5 to 1.5 (50 percent decreases to 50 increases). The species affected are chinook salmon, coho salmon, lake trout, and rainbow trout in the Great Lakes cold fishery type, and chinook salmon, coho salmon, and rainbow trout in the anadromous run fishery type. For each valuation scenario, angler well-being under the baseline array of catch rates is compared to angler well-being under the altered catch rates. For decreases in catch rates, anglers experience losses; for increases in catch rates, anglers experience gains. A description of the methods and associated caveats are described in Lupi et. al.(1997).

Figure 7.4 presents a graph of the valuation results, and Table 7.5 presents the results used to plot the figure. 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. The estimated economic values for the changes in catch rates range from a benefit of about $23 million for a 50 percent increase to a loss of about $11

Table 7.5.
GREAT LAKES TROUT AND SALMON VALUATIONS

Multiply Great Lakes Trout and Salmon Catch Rates by	Value *(million $)*	Great Lakes Trout and Salmon 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	0.00	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

million for the 50 percent decrease. Table 7.5 also presents the changes in the estimated user days associated with the Great Lakes trout and salmon fishery types (i.e., the Great Lakes cold and anadromous run fishery types). The 50 percent decrease in catch rates results in a 25 percent decrease in estimated user days, and the 50 percent increase in catch rates results in an estimated 43 percent increase in user days.

From Figure 7.4 and the results in Table 7.5, one can see that the estimated gains from increasing catch rates exceed the estimated losses for an equivalent decrease in catch rates. These results are due to the role of site and activity substitution embodied in the model. *Site and activity substitution* refers to the possibility that anglers would switch fishing sites or activities in response to a change in the characteristics of some sites. In the case at hand, when the catch rates for the Great Lakes trout and salmon fisheries decrease (increase), anglers substitute out of (in to) this fishery. Thus, for decreases in catch rates, anglers who are taking trips to fish for Great Lakes trout and salmon experience losses, but the magnitude of these losses is limited by their ability to switch 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, he or she does not experience any further losses if catch rates at the site he or she is no longer visiting continue to decrease.

Conversely, when the catch rates at a site increase, anglers who are currently using the site experience benefits. In addition, some anglers are induced to switch to the site where catch rates increase, and these additional users also benefit from the increase in catch rates. 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 7.4. The difference between the values for increases and decreases in fishing quality demonstrates the importance of accounting for potential substitutes in travel-cost models.

Conclusion

Although the valuation scenarios reported here illustrate how the travel-cost method can be used to value changes in environmental quality, the scenarios represent a fairly simple use of the model. More generally, models such as the Michigan model can be used to value any spatial and temporal pattern of catch rates relative to any other pattern of catch rates. For example, if one wanted to evaluate fish stocking programs at different Great Lakes, one might want to compare the benefits associated with stocking a certain number of fish in Lake Huron to the benefits associated with stocking those fish in Lake Michigan. If the effect of stocking the fish can be translated into changes in the catch rates at each lake, the model can then be used to produce benefit estimates that are specific to the individual lakes.

As another example, one might be interested in the value of a change in river habitat at a major Great Lake tributary that is expected to affect spawning success. Over time, the habitat change might translate into larger fish stocks for the lake and, hence, larger catch rates for the whole lake. However, over some initial periods of time, the changes in fish stocks might be more localized. Such a scenario can be evaluated in the Michigan model, provided that the temporal pattern of catch rate changes can be specified for each site in the model. Obviously, changes in catch rates that would occur at some subset of the Great Lakes sites would be less valuable than a comparable change at all Great Lakes sites (the latter is depicted in Figure 7.4).

A real benefit of the travel-cost method is that it yields a standing demand model that can be used repeatedly to predict changes in fishing trips associated with changes in characteristics of the fishing sites.