The Recreational Fishing Value of Sea Lamprey Control: Project Overview

Frank Lupi and John P. Hoehn

Department of Agricultural Economics
Michigan State University
East Lansing MI 48824-1039

Research summary submitted to the Great Lakes Fishery Commission

July, 1998

Direct comments/questions to: Lupi@pilot.msu.edu
The Recreational Fishing Value of Sea Lamprey Control: Project Overview

The purpose of this document is to summarize research that was conducted as part of a grant from the Great Lakes Fishery Commission (GLFC) to Michigan State University (MSU) entitled “The Recreational Fishing Value of Sea Lamprey Control.” Drs. John P. Hoehn and Frank Lupi of the Department of Agricultural Economics, MSU, were the principal investigators. Throughout the course of the project, we have worked closely with Gavin Christie, Integrated Management Specialist at the GLFC.\(^1\)

One of the aims of the project was to estimate some of the economic value that recreational anglers in Michigan place on changes in populations of lake trout. The value estimates were derived from a model of the demand for recreational fishing in Michigan that was developed at Michigan State University, the "MSU model." The MSU model relates where and how often anglers go fishing to the travel costs and the catch rates of alternative fishing sites in Michigan. This relationship serves as estimate of anglers' willingness to trade costs (money) for catch rates. The estimated relationship between travel costs and catch rates was used to estimate some of the economic values associated with changes in catch rates.

*What does the model measure?* Since the model is based on anglers use of fishing resources, it can only be used to estimate "use-values." That is, the model can only capture changes in economic value that affect anglers' use of fishery resources, and it cannot measure values that do not affect use. For example, the model cannot be used to assess general values the public might attach to the rehabilitation of native stocks of fish. In addition, the model applies only to Michigan resident anglers and does not capture use-values that might accrue to anglers in other jurisdictions. Finally, what is measured and reported here is the net economic value

\(^1\) Douglas B. Jester of the Michigan Department of Natural Resources was instrumental in initiating the project and has provided valuable input throughout the course of the project. Dr. Heng Z. Chen, formerly at MSU and now with American Express, also contributed to the initial phases of the project.
associated with *changes* in the quality of fishing. By net economic value we mean the difference between willingness-to-pay and actual expenditures. Thus, we are not estimating the economic impact (measured in terms of jobs and incomes) that fishing expenditures may have on the economy. Instead, we are estimating the difference between anglers’ willingness-to-pay for fishing quality minus what they actually spend which is an appropriate measure of benefits for use in benefit cost assessments of resource management alternatives.

A complete discussion of the original model and survey data is contained in Hoehn *et al.*\(^2\) The Hoehn *et al.* model and survey data serve as the starting point for the current project. The current project had 3 main parts which are discussed below. The methods and results of each part of the project are documented and presented in three separate reports also submitted to the Great Lakes Fishery Commission.


Part I: Values-per-fish (VPF)

The first part of the project is documented in: A Preliminary Valuation of Lake Trout Using the Michigan Recreational Angling Demand Model, as referenced above. This report discusses and assesses methods for using the MSU model to develop basin-specific estimates of the value-per-fish for lake trout at Lakes Michigan, Huron, and Superior. The report also discusses alternative means of applying the MSU model to the task of estimating economic values associated with changes in the population of lake trout.

Why values-per-fish (VPF)? There are several reasons why it would be useful to be able to express anglers' values for changes in lake trout populations in per-fish units. VPF estimates are easy to use, and they facilitate comparisons between recreational and commercial fishing values. Moreover, VPF "fit" into existing frameworks for modeling fishery problems -- see for example the framework for setting sea lamprey control targets developed by Koonce et al.3 Perhaps the most important reason for developing VPF estimates is that they are amenable to benefits transfer. This means that VPF estimates can be used to represent economic values for all the anglers living in and around a particular Great Lake whereas the MSU model can only capture values for Michigan residents.

Key findings from Part I:

1. Limited support for turning economic values from the complex models into VPF

The MSU model was used to derive average values per fish for lake trout at each of lakes Michigan, Superior and Huron. Average values per fish for lake trout were derived by dividing an estimate of total lake trout value by an estimate of the number of lake trout

---

caught by anglers. The total lake trout value was estimated by setting lake trout catch rates to zero and using the economic model to value this reduction in catch rates. The total lake trout catch was estimated by using the economic model to derive predictions of fishing effort at each site and then multiplying by catch rates at each site.

The approach for estimating average values-per-fish was examined to see how sensitive the results would be to the following: (a.) changes in the assumptions used to translate fishing trips and catch rates into estimated harvest of lake trout; (b.) different assumptions regarding the relative baseline level of catch rates at the Great Lake where lake trout policies were being examined; and (c.) different assumptions regarding the relative baseline level of catch rates at Great Lakes other than the lake where lake trout policies were being examined (that is, the fishing quality at potential substitute fishing sites).

For several reasons, the results of these inquiries were not encouraging for the use of a value per fish approach. First, the values per fish obtained from this approach were very sensitive to plausible alternative methods of using the model to estimate harvest of lake trout (as examined in a. above). Second, the estimated values per fish were shown to be moderately sensitive to the baseline levels of quality used to derive the estimates (as examined in b. above). In some cases the average value per fish was 50% larger when calculated from a different level of initial quality. Third, in some cases the average value per fish estimates differed by over a factor of two across the Great Lakes. Finally, related research\(^4\) suggests that setting the lake trout catch rates to zero will not adequately capture the total use-value of lake trout fishing. This limitation affects the usefulness of the estimated average values per fish. All of these results suggest that the average VPF estimates are too sensitive to the context in which they are derived to support broad use of

the VPF estimates for benefit transfer purposes, thereby undermining the key advantage of the value-per-fish approach.

2. *The MSU model can be used to directly evaluate changes in lake trout populations*

   The report also discusses the fact that there is no direct need to rely on VPF to get values for the Michigan population. The MSU model can be used to directly evaluate policies if a relationship between catch rates and lake trout population levels is assumed, e.g., a proportional relationship between catch rates and fish population. While this approach limits both the ease of use of the economic values and the transferability of the results, it does not present a significant hurdle to the use of the model.

3. *Economic values for changes in catch rates at one Great Lake can be treated as if they are independent of possible changes in the conditions at other Great Lakes*

   An examination of a range of hypothetical scenarios revealed that the estimated recreational fishing values for changes in lake trout catch rates at an entire Great Lake were relatively insensitive to the assumed levels of fishing quality at alternative Great Lakes (as examined in c. above). This result provides strong support for using the economic model to evaluate policies for one Great Lake without worrying about possible changes in the quality of other lakes. This greatly simplifies the task of performing economic assessments of changes in fish populations. For example, in conducting an assessment of potential changes over time in lake trout populations at Lake Huron, one can proceed *as if* fish populations at other Great Lakes remain at their baseline levels.
Part II: Catch rate estimation

The Hoehn et al. version of the recreational fishing model is based on Great Lake catch rates that were estimated in the late 1980s. The catch rates vary by site, species, and month. The second phase of the current project was devoted to updating these catch rate estimates so that the recreational demand model could be re-estimated using catch rates estimates more in line with the 1994 survey data on anglers' fishing site choices. This part of the project is documented in Trout and Salmon Catch Rates at Michigan Great Lakes Sites, 1986 to 1995, as cited above.

In this phase of the research, an extensive set of catch rate models that are novel and of potentially broader use were developed. Negative binomial regression models were used to estimate catch-per-hour for recreational anglers fishing for trout and salmon in Michigan waters of the Great Lakes. Dependent variables were observations on catch and hours fished for angler parties interviewed in Michigan creel surveys from 1986 to 1995. The estimated models relate catch rates to independent variables for year, month, and fishing location. Interactions between months and locations are included to permit a rich array of spatial and temporal variation in estimated catch rates. Additional variables control for charter boat use, angler party size, and extent of species targeting (e.g., fishing for "salmon" versus "chinook"). Separate models are estimated for nine combinations of species and Great Lakes. While lake trout is treated as a separate species, chinook and coho salmon are grouped together as are rainbow and brown trout. The estimation results indicate significant relationships between catch rates and most independent variables, including large positive effects for charter boats and targeting, positive but declining effects for increases in fishing party size, and significant spatial and temporal differences.

By utilizing the annual data, the catch rate modeling approach provided predictions of the 1994 catch rates that were specific to specie targeted, lake, site, month, and year -- even for
combinations of specie, site, and month where any one year contained too few observations to estimate the combined effect. These predictions serve as inputs to the final stage of the research project.

**Part III: Economic model re-estimation and policy evaluations**

The final phase of the project involved re-estimating the recreational demand model using the new catch rate data and applying the revised model to some potential lake trout rehabilitation scenarios. A complete description of the re-estimated model is contained in *A Partial Benefit-Cost Analysis of Sea Lamprey Treatment Options On the St. Marys River*, as cited above.

**Re-estimated model results**: Re-estimation of the recreational angling demand model using the updated catch rates revealed some interesting results. A general finding after estimating under a variety of model specifications was that the parameters on the catch rates for individual species were fairly unstable and were often insignificant. For example, some model specifications resulted in the lake trout parameter being insignificant and sometimes even negative, while other specifications resulted in the salmon catch rate being very low and insignificant. Interestingly, in almost all specifications examined, we could not reject the restriction that all the species of Great Lakes trout and salmon had the same parameter. One possible explanation for this result is that the specie-specific catch rates are significantly correlated with one another which complicates attempts to identify their separate effects. Another possible explanation is that anglers who are targeting a specific trout or salmon species may not care about the catch rates of other species when they make their site choices. The implication of the result that the catch rate variables have the same parameter is that each of the species is equally important to anglers and equally valuable. Put differently, it means that when making a Great Lakes trout and salmon fishing site choice, anglers prefer high catch rates, and there were not significant differences in this preference among trout and salmon species.
Perhaps the biggest caveat associated with the model re-estimation phase is that a close inspection of the data revealed a fairly thin data set for the types of trips of interest for this application. Specifically, of the more than 4,000 trips that were used in the original Hoehn et al. model, less than 10% are fishing trips where Great Lakes trout and salmon were being sought. Thus, while we were successful in estimating an economic model that predicts where anglers will take Great Lake trout and salmon fishing trips, the available data on trout and salmon fishing limits our ability to capture potentially important trade-offs anglers might make in their choice of which trout and salmon species to target on a fishing trip.

Policy evaluation: To illustrate how the recreational demand model can be used, the model was applied to the evaluation of alternative lamprey treatment options at the St. Marys river. The complete results are presented in A Partial Benefit-Cost Analysis of Sea Lamprey Treatment Options On the St. Marys River. We refer to this as a "partial" benefit-cost analysis to emphasize that only a portion of the economic values associated with the treatment options can be captured by the MSU economic model. A more complete set of caveats is presented in the report.

Three alternative policies for sea lamprey treatment were evaluated against the annual baseline associated with not undertaking additional treatment on the St. Marys river. The three policies are: A = annual trapping and sterile male release; C = annual trapping and sterile male release with granular bayer applications every five years; and E = annual trapping and sterile male release with one granular bayer application. Research results provided by the GLFC linked each treatment option to long run changes in lamprey populations and lake trout populations by age class. Treatment option A results in the slowest growth in the lake trout populations while option results in the fastest growth. Both options A and E converge to the same long run lake trout populations while option C converges on a somewhat larger population level. All three options result in substantially larger long run lake trout populations than would occur were the St.
Marys not treated.

The time series of changes in the age 8+ lake trout population by region of Lake Huron that were projected for each policy were translated into a time series of proportional changes in lake trout populations by regions of Lake Huron. These proportional changes in regional lake trout populations were then used to proportionally change the lake trout portion of the catch rate variable at the sites within each region in the recreational demand model. The outcome was a time path of changes in regional lake trout catch rates for each of the three treatment options, as well as a time path for baseline lake trout catch rates. The economic model is then used to estimate the value to anglers of the change in catch rates for each year along the time path of changes in catch rates.

The evaluation of the St. Marys treatment options builds on the research results of the first two phases of the project. For example, the linkages between the economic model and the lake trout population changes is based on the conclusions from the first part of the research project (as outlined above in finding 2). Moreover, when the time paths of Lake Huron lake trout catch rates are being evaluated in the economic model, the possible changes in catch rates at other lakes are assumed to remain at their baseline levels. This assumption permits a substantial reduction in the computational burden required to evaluate the Lake Huron scenarios and the results of part one suggest that this simplification has little impact on the estimated values for the changes in catch rates at Lake Huron (see finding 3 above). In addition, the model from this phase of the project is entirely dependent on the catch rate modeling that was done in part two.

Before presenting an evaluation of the entire time path of changes in the regional lake trout catch rates, we will examine the estimated benefits in the year 2015. The un-discounted estimates of the economic use-values associated with each of the policy options in the year 2015 are: $2,617,000 for Option A; $4,742,000 for Option C; and $3,333,000 for Option E. These are estimates of the economic use-values accruing to Michigan resident anglers, and
they are denominated in 1994 US dollars. The estimates reveal that each of these options yield substantial benefits in future years. Note that in these scenarios, the northern portions of the lake experience much larger changes in population than do the southern portions. However, it is the southern portion of the lake that lies closest to the bulk of the Michigan population. Not surprisingly then, if the lake wide average changes in lake trout population for policy A were used to change catch rates at all sites (instead of breaking them out by regions), the estimated values for option A would be over 3 times larger. The implication is that the spatial distribution of the changes in fish population matters.

Just looking at the estimated economic benefits for the different treatment options in the year 2015 only reveals part of the picture since the costs of the policies differ, as does the timing of the costs and benefits for each policy. In such situations economists often argue for comparing the "net present value" of the alternative investment options. The net present value is the difference between the present value of the stream of benefits minus the present value of the stream of costs. Present values are the values in some future year multiplied by a discount rate. Discount rates reflect the fact that capital is productive so that investments in one activity mean one forgoes the opportunity to invest in other activities. Thus, discount rates are inversely proportional to the interest rates that one assumes are available on alternative investments (such as putting money in a bank account). If the interest rate is $r$, the discount rate for some benefit, $B$, in year $t$ is $d_t=(1+r)^{-t}$, and the present value of the benefit that occurs in year $t$ is $B_t \times d_t = B_t/(1+r)^t$. Thus, the larger is the interest rate, the lower is the net present value of a benefit or a cost that occurs in year $t$.

The get the stream of benefits for the alternative St. Marys treatment options, the regional changes in catch rates were evaluated for the years 1999 to 2030 with the regional lake trout populations in future years assumed to stay at the 2030 levels. The stream of costs was estimated by the GLFC to be about $300,000 per year for trapping and sterile male release, and
about 5 million dollars per granular bayer treatment. The net present value of the streams of benefits minus cost was calculated for each option using a variety of discount rates and are reported in Table 1. The columns of the table represent the results for the different treatment options, and the rows show the sensitivity of the results to alternative discount rates.

The results presented in Table 1 show that all three treatment options are estimated to have positive net present values at reasonable discount rates. In addition, treatment Option E which involves the one time granular bayer application combined with lamprey trapping and release of sterile males is best in the sense that it yields the largest net present values, (except at very high discount rates). Also, option C is better than option A at lower discount rates (<6%) with the converse holding at higher discount rates. The economic value of the three treatment options differs for several reasons. While option C grows fastest and leads to a larger lake trout population, it also has large recurring costs. Alternatively, option A has the lowest costs, but it also has the slowest growth in lake trout populations. The best alternative, option E, suggests the faster initial growth provided by the first treatment of granular bayer is beneficial, but continued granular bayer treatments do not yield enough additional growth to offset the large application costs.

It is important to bear in mind some of the caveats associated with the numbers reported in Table 1. For instance, the estimated benefits used to calculate the net benefits are based only on the estimated recreational use-value accruing to Michigan recreational anglers. There are likely other economic benefits associated with the treatment options that have not been

---

5 In "Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs," (Circular No. A-94-Revised, October 29, 1992) the US Office of Management and Budget recommends using an interest rate of 7%. However, the OMB circular states that guidance for water resource projects is found in "Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies" which recommends use of a discount rate of xx ** traditionally around 3% -- double check latest version **
measured. Potentially important benefits that have not been measured include such things as: benefits to non-resident anglers that fish in Michigan; benefits to anglers that fish in Canadian portions of the lake; benefits due to possible increases in catch rates in northern Lake Michigan; potential reductions in stocking costs; and values that the general public might have for rehabilitation of native fish stocks. Moreover, the changes in lake trout catch rates are based on changes in the growth of age 8+ lake trout which likely over-states the growth in the population of lake trout entering the recreational fishery (about age 5+). In addition, the analysis does not take account for uncertainties associated with the projected lake trout growth for each scenario, nor does the analysis account for any uncertainties associated with the economic value estimates. Finally, a sensitivity analysis of the physical and economic assumptions underlying the results has not been conducted. A complete discussion of the uncertainties and assumptions underlying the estimates net present values of the three treatment options is given in the report.
Table 1:  Net Present Value of the St. Marys River treatment policies under alternative interest rates  (The economic values in table are in $1,000 units)†

| interest rate | Option A  
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(SMRT only)</td>
<td>(SMRT + G.B. every 5 yrs.)</td>
<td>(SMRT + G.B. only once)</td>
</tr>
<tr>
<td>----------------</td>
<td>--------------------------</td>
<td>--------------------------</td>
<td>--------------------------</td>
</tr>
<tr>
<td>3.0%</td>
<td>93,340</td>
<td>96,470</td>
<td>192,110 *</td>
</tr>
<tr>
<td>5.0%</td>
<td>40,410</td>
<td>40,730</td>
<td>81,910 *</td>
</tr>
<tr>
<td>7.0%</td>
<td>21,030</td>
<td>19,800</td>
<td>40,520 *</td>
</tr>
<tr>
<td>10.0%</td>
<td>9,200</td>
<td>6,680</td>
<td>14,510 *</td>
</tr>
<tr>
<td>12.5%</td>
<td>4,940 *</td>
<td>1,840</td>
<td>4,820</td>
</tr>
<tr>
<td>15.0%</td>
<td>2,690 *</td>
<td>(740)</td>
<td>(380)</td>
</tr>
<tr>
<td>25.0%</td>
<td>(40)</td>
<td>(3,730)</td>
<td>(6,730)</td>
</tr>
</tbody>
</table>

† Negative numbers in parentheses (based on partial benefits estimate, measures only the use-value that accrues to Michigan resident anglers as a result of the changes in lake trout catch rates).

* Option with largest net present value (present value of Michigan angling benefits minus present value of treatment costs).
Future research possibilities

Additional model applications: The brief review of the St. Marys River application illustrates one of the ways that the economic model developed for this project can be used. The model can continue to be applied to the St. Marys case if alternative assumptions regarding lake trout were to be developed. For example, the model could be used to evaluate the range in benefits that might be associated with different ranges of uncertainty in the lake trout growth scenarios. Naturally, the model is of broader applicability than illustrated.

Another area that the model might be applied is in examining lamprey control targets at each Great Lake. Using part of the framework developed by Koonce et al.,\textsuperscript{6} alternative lamprey control levels can be linked to lake trout population levels. The changes in lake trout population levels can then be evaluated with the economic model by applying the methodology developed in phase one of this project and illustrated in St. Marys River case study.

Research issues: Several important research issues have been raised in the course of this project. A key issue regards anglers’ preferences for alternative species of trout and salmon. In the model applied here, we lacked enough data to identify potential differences in anglers’ preferences for various trout and salmon species. As a consequence, the model treats all these species as equally valuable and implicitly holds the allocation of fishing effort constant across species. There are many possible research steps that might shed more light on this issue. One approach would be to incorporate more data into further refinements of the recreational angling model. This might be accomplished by using a larger data source on recreational species choices such as the Michigan Creel survey. The additional data might permit the modeling of anglers species target decisions in addition to their site choices.

Another possibility would be to use a new survey to directly question anglers about their species preferences. In such a survey, it would also be possible to elicit anglers’ preferences for

\textsuperscript{6} See note 3.
alternative lake management plans. In this way, valuable information could be acquired about anglers’ specie preferences as well as their preferences regarding the lake community objectives. While survey methods are commonly used to collect information about anglers’ activities and opinions, specific formulations of these questions are suitable for estimating economic benefits associated with lake management plans. Finally, there is nothing that prevents the collection of preference information from the general public, as opposed to just anglers.