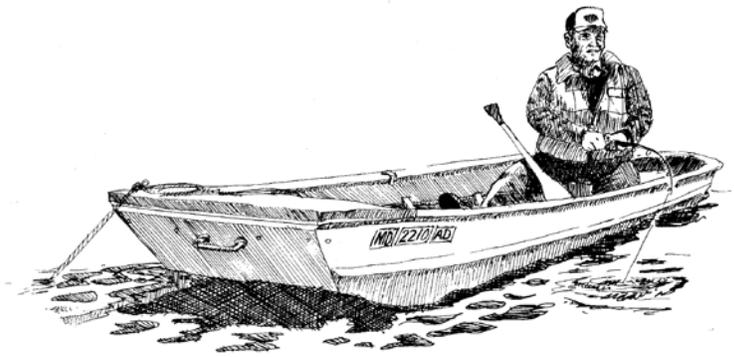# Net Benefits of Recreational Fishing in the Great Lakes Basin:
A Review of the Literature

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Executive Summary

This report reviews the recreational valuation literature on fishing in the Great Lakes Basin. Its purpose is to determine whether the existing literature is sufficient to: (a) estimate the current net value of recreational fishing activities in the study region; and (b) estimate how these values might change with the introduction of aquatic nuisance species.

Estimating the net value of a recreational activity requires: (a) an estimate of the average net value per day; and (b) an estimate of the total number of days taken to engage in that activity.

- No single study in the existing literature is sufficient to estimate a comprehensive net value of recreational fishing in the Great Lakes Basin. Although a number of studies have estimated the net value per day fishing, they have been limited in their geographic coverage and/or species targeted. Because recreational values can be expected to vary in different parts of the study region and across fishing types, none of these existing individual studies can be used as an estimate of the average net value per day for the entirety of the Great Lakes Basin.

- However, if a sufficient number of studies is conducted within a region, even if each of those studies is limited in its geographic focus, these studies can, *considered as a set*, help determine the range of net values per day that might be expected for the region. This range of net values per day can be multiplied by the number of days users take part in the activity to approximate the total annual recreation net value.

The following conclusions were drawn with regard to estimating a baseline net value of recreational fishing in the Great Lakes proper, a subset of the Great Lakes Basin:

- A sufficient number of studies have been conducted to establish that the net value per day of recreational fishing likely falls between $20 and $75 ($2012). When the endpoints of this range are multiplied by the USFWS estimate of about 19.661 million angler days in the Great Lakes in 2011, it is **estimated that the aggregate annual net value of recreational fishing in the Great Lakes lies in the range of $393 million to $1.47 billion ($2012)**.

- It is important to note that this range is an estimate of *net value*, which is distinct from other economic measures that may have been reported such as *expenditures* and *economic impacts*. We report net values because, according to economic theory and Federal regulation, net value is considered the appropriate measure for assessing the benefits of public policy alternatives.

Estimating the change in net value of an activity in response to ANS requires estimates of how: (a) resource quality would change in response to ANS (e.g., the change in the numbers of fish that anglers would catch); (b) the average net value per day would change as resource quality changed; and (c) the total number of trips to engage in that activity would change. With regard to estimating how the net values of recreational activities would change if ANS were introduced:

- Insufficient evidence exists in the literature to address any of these questions and, consequently, **it is not possible based on the existing literature to estimate how the total annual net value of recreational fishing would change if ANS were introduced into the Great Lakes Basin.**

However, we note that the aggregate net value estimated for Great Lakes recreational fishing provides an upper bound on the potential economic losses associated with ANS. Further, this upper bound value lies far below estimated values from economic impact analyses that have been widely reported in the regional, national and international press.

The above findings and the reviews herein, provide motivation for conducting original basin-wide studies of the value of recreational fishing in the Great Lakes Basin.

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I. Introduction and Report Summary

Objectives of this Report

The broad purpose of this literature review is to identify previously published studies of recreational fishing that are potentially relevant to estimating the net value of recreational fishing in the Great Lakes Basin and how that value might change with the introduction of aquatic nuisance species.   This work was funded in part by the United States Army Corps of Engineers (USACE) in conjunction with their Great Lakes and Mississippi River Interbasin Study (GLMRIS), although this report is not a GLMRIS product.

There are two specific objectives of this review:

> Objective 1: To assess whether the existing body of recreational valuation studies can be used to estimate the current net value of recreational fishing for the Great Lakes Basin, and

> Objective 2: To assess whether these studies can be used to provide estimates of how the net value of recreational fishing in the Great Lakes Basin might change with the introduction of aquatic nuisance species.

The first objective focuses on establishing a baseline value of recreational fishing in the Great Lakes study area. The second objective is directed toward assessing how much this baseline value is likely to be affected by aquatic nuisance species. The values estimated in Objective 1 provide a conceptual upper bound for potential losses under Objective 2.

For the purposes of this report, the region on which we will focus in this report includes the watersheds within the following Great Lakes states: Minnesota, Wisconsin, Illinois, Indiana, Michigan, Ohio, Pennsylvania and New York. All dollar values reported in this review are updated to FY $2012 using the consumer price index (CPI Value=226.889, USACE 2012), unless otherwise noted.

The following process was used to identify studies to be included in this review. First, we examined existing recreational valuation data bases (e.g., Loomis and Richardson, 2008; EVRI, 2002) and data bases and literature reviews of valuation estimates for recreational fishing (e.g., Boyle et al., 1999; NOEP, 2012).   These studies were supplemented with others identified in original web and journal searches for recreational valuation studies conducted within the study area. We generally have not included estimates for studies for which the sample data used in the study were collected prior to 1985, due to concerns about the "shelf life" of recreational values and the substantial evolution of non-market valuation methods, particularly the travel cost method, since the mid-1980s. For reference, we use Talhelm's

1985 "Economics of Great Lakes Fishing" Report (Talhelm, 1988) as a reference point for Great Lakes recreational fishing values prior to 1985.

As a preview of our findings, we conclude that, with respect to establishing a baseline value for recreational fishing:

- There are several studies that estimate the value per day for recreational fishing in the Great Lakes. These estimates generally range from $20 to $75 per day ($2012 dollars). Combining these estimates with an estimate of the total participation in recreational fishing generates an estimated aggregate value from recreational fishing in the Great Lakes of $393 million to $1.47 billion per year ($2012).

With respect to Objective 2, we conclude that the existing literature is not sufficient to generate reliable estimates of the impact that aquatic nuisance species might have on the net recreational values enjoyed by anglers. The remainder of this report provides our evidence and logic for these claims.

Overview of Conceptual Foundations: Net Value

This report focuses on economic measures of the value of recreational fishing in the Great Lakes Basin (GL), and on how this value might change due to transfer of aquatic nuisance species from the Upper Mississippi River Basin. As the present review was funded by the USACE, we have endeavored to make our analyses comport with USACE methods and conceptual framework. Consistent with USACE procedures and guidelines (USACE, 1983, 2000, 2012), the net (economic) value is defined as the amount that those recreational resources contribute to the federal planning objective of national economic development (NED).

> "The Federal objective of water and related land resources project planning is to contribute to national economic development consistent with protecting the Nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements… Contributions to national economic development (NED) are increases in the net value of the national output of goods and services, expressed in monetary units. Contributions to NED are the direct net benefits that accrue in the planning area and the rest of the Nation. Contributions to NED include increases in the net value of those goods and services that are marketed, and also of those that may not be marketed." (USACE, 1983, p. iv).

While our motivation for focusing on net values is to be consistent with the needs of federal procedures, it is important to note that these methods are also consistent with basic economic concepts in benefit-cost analysis (Boardman et al., 2001. See Chapter II for additional details.)

Because many different measures of the economic value of recreational activities have been reported in various outlets, it is important to distinguish the NED concept of net value from other, related measures that are often reported, such as "expenditures" and "economic impacts." The net value of a resource is the difference between the amount an individual would be willing to pay to access the resource and the amount that they actually have to pay for gasoline, lodging, entry fees, and food at the recreation site and other trip-related costs. For reference we provide a discussion of the alternative measures of economic activity in the second chapter. The interested reader is also referred to Scodari (2009) and Aiken (2009) for further discussion.

Measures of net value are typically expressed as value per unit, such as net value per day of a recreational activity. The aggregate annual net value generated by a recreational resource is the average net value per day (or per trip) multiplied by the total number of days (trips) taken to engage in that activity. This is the appropriate measure of the annual net value generated by a recreational resource from a NED perspective for the purposes of Objective 1 of this review.

The issue of interest in Objective 2 is how the baseline net value might change as a consequence of inter-basin transfer of aquatic nuisance species. Here, a change in the quality of the recreational resource will typically affect both the net value per trip for that activity and the total number of trips taken to engage in that activity. For example, if fishing quality in a region were to decline as a consequence of an aquatic nuisance species, recreationists may continue their recreational activities at the site(s) they currently use, but get less satisfaction (and less net value) from each trip; they may choose to recreate at other sites that provide less net value than they previously enjoyed; they may choose to fish fewer times per year; or they may cease fishing altogether. The change in aggregate annual net value from the fishery would account for both the change in net value per trip and the change in total number of trips.

Overview of Conceptual Foundations: Methods of Valuing Recreation

Because most outdoor recreation activities are publicly provided, rather than being purchased from a private supplier, it is usually not possible to estimate either total value or net value directly from observed market data (USACE, 2012). The USACE recognizes alternative "non-market valuation" procedures "for estimating use and willingness to pay by means of travel behavior, user surveys, and other quantifiable measures" (USACE, 2000, p. E-183). Three non-market valuation methods -- the travel cost method, the contingent valuation method, and unit day values -- are specified in USACE procedures and guidelines for estimating the net values of recreational activities and estimating how those net values change in response to water-related projects. To this list we add two other methods widely

used in contemporary project analyses, benefit transfers and meta analysis. We briefly describe each of these methods below.

The *travel cost method* uses actual visitation data on the number of trips taken to a recreation site to estimate the net value of the resource and how that net value changes as the quality of the resource changes. The travel cost method works by comparing the number of trips taken to a site by people who live close to the site to the number of trips taken by people who live farther from the site: "The basic premise of the travel cost method is that per capita use of a recreation site will decrease as out-of-pocket and time costs of traveling to the site increase, other variables being constant" (USACE, 2000, p. E-184). The total value per trip, net value per trip, and number of trips taken can be calculated for recreationists living different distances from the site and for sites with different resource quality.

Contingent valuation relies on survey questions about hypothetical behavior to estimate the net value of a resource or the net value of a change in resource quality: "The contingent valuation method estimates NED benefits by directly asking individual households their willingness to pay for changes in recreation opportunities at a given site." (USACE, 2000, p. E-185). Depending on how the survey questions are structured, contingent valuation can be used to measure the total amount the recreationist is willing to pay for access to a site (total value), the amount the recreationist is willing to pay over and above the actual cost of visiting the site (net value), or the amount the recreationist would be willing to pay if a change occurred to the quality of the site (change in net value). The aggregate net value of the resource or of a change in the quality of the resource can be estimated by summing the individual net values for all users in the study area. A variation on contingent valuation called *contingent behavior* uses survey methods to elicit how behavior might change if the quality of a resource changes. For example, a survey might ask, "If your catch rate at site xxx dropped by yyy percent, would you still fish at site xxx?"

Often times, original estimates that use the travel cost method or contingent valuation are not available for a specific project. In such instances, a third approach identified by the USACE is the *unit day value* method.

> "The unit day value method relies on expert or informed opinion and judgment to estimate the average willingness to pay of recreational users. By applying a carefully thought-out and adjusted unit day value to estimated use, an approximation is obtained that may be used as an estimate of project recreation benefits" (USACE, 2000, p. E-185).

The principles for using unit day values in the USACE planning process are grounded in the economic and environmental principles and guidelines stated in USACE 1983 and 2000. Ranges for these values are annually updated in USACE memoranda (e.g. USACE, 2012) to account for changes in economic conditions by multiplying the 1982 unit day value by

Consumer Price Index (CPI) factors published by the Bureau of Labor Statistics. Unit day values are selected from the updated ranges using a system that assigns points based on five criteria: activities, facilities, relative scarcity, ease of access and aesthetic factors.

The USACE provides a range of unit day values to use as a proxy for the net value of different types of recreation. USACE procedures and guidelines state that unit day values should not be used when evidence suggests that the value of a recreational activity lies outside the range of published unit day values. Accordingly, in our review of the net value of recreational angling, we assess whether estimates of net value per recreational day fall within the published range of unit day values for that activity.

The unit day value method represents the simplest type of a *benefits transfer* valuation approach. Broadly defined, "Benefits transfer refers to the process of using valuation results for one or more sites derived in original demand studies (the study sites) to calculate benefits estimates at another site (the project site)" (Scodari, 2009 p. 49).   The unit day value method uses administratively-determined unit-day values for general and specialized recreation activities developed using expert judgment. In this report, two additional benefits transfer methods are used. The first, which we refer to as *average benefits transfer* in the remainder of this report, calculates the average of estimates from a number of previous studies of like resources within the region being studied and uses these averages to predict the value of the current site being studied. We will also draw from *meta analysis* research, wherein a statistical model is developed that accounts for differences among published estimates between regions and/or activities or due to differences in methodology.

Thus far, we have presented each of the valuation methods separately, which is not always the case in the studies we review. For example, Rosenberger and Loomis (2000, 2001) provide both benefits transfer and meta analysis estimates for Great Lakes and Northeast recreational fishing.   Breffle et al. (1999) uses both the travel cost method and a variation of contingent valuation in a study of Great Bay recreational fishing.

Summary of Results for Recreational Fishing

Here we summarize the findings of our literature review organized around the two objectives identified in the introduction and, where appropriate, provide net value estimates drawn from the literature. Chapter III of this study provides details on the individual studies reviewed. To facilitate comparisons across studies, all dollar values reported in this review are updated to FY $2012 using the consumer price index (CPI value=226.889, USACE 2012), unless otherwise noted. The appendix of this report provides additional technical and econometric details of individual studies.

Estimating the Net Value of Fishing

Chapter III reviews available studies that estimate the net value of recreational fishing in the Great Lakes Basin. Table I.1 provides a summary of estimates of net value per day of recreational fishing from selected studies reviewed in Chapter III, organized by the valuation method used. Studies included in the table are those that provide sufficiently reliable estimates of the net value of fishing applicable to the study area.

No single study in Table I.1 covers the entirety of the study region in terms of geography or species targeted. This lack of a comprehensive, region-wide study is important because evidence provided in a number of studies suggests that fishing values will vary across recreational sites and types of fishing.   Therefore, fishing values estimated in one part of our study region may not apply very well to other parts of our study region. For this reason, we conclude that no existing individual study can be used to provide a representative net value per day estimate for the entirety of either or both basins.

Nevertheless, when considered as a set, we believe that the studies included in Table I.1 can be used to help determine the range of net values per fishing day that might be expected for the Great Lakes Basin. While the range of net values provided by the various studies is broad, there is some convergence across studies. Because these studies were conducted in a variety of settings within the Great Lakes region, this range of net values likely encompasses the average net value within that region. An examination of the values in Table I.1 reveals that the number of observations above $75 are few and spread out. Dropping the top three value estimates (Boyle et al., 1999, Salmon; Boyle et al., 1999, Bass; and Aiken, 2009, Walleye (WI)), which we characterize as outliers, suggests that average net value estimates will likely lie in the range from $20 to $75 ($2012). As discussed in the individual reports, the Boyle et al. values were derived from a meta analysis model and that had a relatively high degree of variance in the estimated values.

The estimates of net value in Table I.1 can be used to evaluate whether it is appropriate to use USACE's published unit day values to estimate the net value of recreational fishing in the study region. Because the relevant unit day values tend to be lower than the estimates from these studies, unit day values should not be used to estimate the net value of fishing in the Great Lakes Basin.

Table I.1. Estimated Willingness to Pay Values per Person per Fishing Day

Valuation Method	Estimated Net Value/ Day ($2012)[a]	Fish Category	Location	Reference
Average Benefits Transfer	45	Cold water fish	Great Lakes and the Northeast	Loomis and Richardson (2008)
Average Benefits Transfer	48	Warm water fish	Great Lakes and the Northeast	Loomis and Richardson (2008)
Average Benefits Transfer	44	Anadromous runs	Great Lakes and the Northeast	Loomis and Richardson (2008)
Average Benefits Transfer	23	Mixed species	Great Lakes and the Northeast	Loomis and Richardson (2008)
Average Benefits Transfer	56	Species not specified,	Great Lakes and the Northeast	Loomis and Richardson (2008)
Average Benefits Transfer/Meta Analysis	45-54	General	Great Lakes and the Northeast	Rosenberger and Loomis (2001)
Meta Analysis	90[b]	Bass	Great Lakes	Boyle et al. (1999)
Meta Analysis	109[b]	Salmon	Great Lakes	Boyle et al. (1999)
Travel Cost Method	41	Trout	Michigan Great Lakes	Lupi and Hoehn (1997)
Travel Cost Method	51	Salmon	Michigan Great Lakes	Lupi and Hoehn (1997)
Travel Cost Method	42	Salmon and/or Trout	Wisconsin Water, Southern Lake Michigan	Phaneuf et al. (1998)
Travel Cost Method	42-55	Anadromous Runs	Lake Erie Tributaries	Kelch et al. (2006)
Travel Cost Method	33-34	General	New York Inland and Great Lakes Waters	Spink (2014)
Contingent Valuation	54	Yellow Perch	Green Bay	Bishop et al. (1990)
Contingent Valuation	25	General	New York Great Lakes	Connelly and Brown (1991)
Contingent Valuation	28	General	New York Inland Waters	Connelly and Brown (1991)
Contingent Valuation	41	Salmon and Trout	Wisconsin Water, Great Lakes	Lyke (1993)

(continued on next page)

Table I.1. Estimated Willingness to Pay Values per Person per Fishing Day (continued)

Valuation Method	Estimated Net Value/ Day ($2012)[a]	Fish Category	Location	Reference
Contingent Valuation	22	General	New York Great Lakes	Connelly et al. (1997a)
Contingent Valuation	22	General	New York Inland Waters	Connelly et al. (1997a)
Contingent Valuation	50 (IA), 50 (IL), 69 (IN)	Bass	Selected States in Great Lakes Basin	Aiken (2009)
Contingent Valuation	48 (PA), 53 (NY)	Trout,	Selected States in Great Lakes	Aiken (2009); Harris (2010);
Contingent Valuation	49 (MI) 68 (MN), 74 (OH), 91 (WI)[b]	Walleye	Selected States in Great Lakes and UMORB[c]	Aiken (2009)

a. Rounded to the nearest dollar.
b. As discussed in the text, these three observations are regarded as outliers.

As noted above, identifying the value of a fishing day is only one element needed to estimate the aggregate net value of recreational fishing. A measure of how much fishing occurs, such as angler days per year, is also needed. The US Fish and Wildlife Service provides periodic estimates of Great Lakes fishing effort as part of its National Survey of Fishing Hunting and Wildlife Associated Recreation (e.g. USFWS, 2002, 2008, 2012). This report does not break out participation data for the Great Lakes Basin. However, it does report fishing participation for the Great Lakes, a resource that has received substantial popular attention due to concern about aquatic nuisance species in recent years and for which aggregate expenditure and economic impact values have been reported by private and government entities (American Sportfishing Association, 2008, 2013; Great Lakes Commission, 2012).

We use participation data from the 2011 National Recreation Survey (USFWS, 2012) for the Great Lakes, as this is the most recent basin-wide survey of recreational angling that has been reported. This source of estimates has been used elsewhere for calculating the impact of recreational fishing for the Great Lakes (American Sportfishing Association, 2008, 2013; Austin et al., 2007). For comparative purposes it is helpful to use the same baseline for aggregating values.

Multiplying the USFWS estimate of about 19.661 million angler days in the Great Lakes in 2011 by the range of a net values ($20 to $75 in $2012 dollars) identified above, results in a total annual recreation net value estimate ranging from $373 million to $1.47 billion.[1]

Estimating Changes in the Net Value of Fishing in Response to Aquatic Nuisance Species

While several studies have been conducted within the study region that attempt to estimate the impact that changes in fishing quality would have on recreational values from fishing, we conclude that individually and collectively these studies do not provide a good basis for calculating economic losses associated with potential declines in catch rates, a measure of fishing quality that can potentially be linked to aquatic nuisance species. Our review of available studies shows that changes in net values that occur due to changes in catch rate depend on current catch rates at a site, the availability of alternative fishing sites, and other factors. Therefore, transferring estimates of economic losses associated with a decline in fishing quality based on a study at one site to other sites within the study area is not recommended.

Outline of the Remainder of the Report

The remainder of the report is organized into two chapters, an appendix, and a glossary of acronyms used in this report. Chapter II provides information about economic concepts and methods of valuing recreational activities such as fishing, with attention given to clarifying the difference between the net economic value approach adopted here and other measures of economic contribution, such as expenditures and economic impact analyses. Chapter III presents a survey of the relevant economic valuation literature on recreational fishing: this chapter begins with an overview, provides a description of each study that is potentially relevant to recreational valuation in the Great Lakes Basin, and concludes with a short synthesis. The appendix to this review provides additional technical and econometric details about the studies reviewed in Chapter III for readers who are interested in additional information on each study.

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[1] It is informative to contrast this range of net value estimates with available estimates of expenditures and economic impact from fishing in the Great Lakes. The USFWS (2012) reports that Great Lakes recreational angling-related expenditures in 2011 totaled $1.9 billion, of which trip-related expenditures were $1.1 billion ($2012). Using data from the USFWS 2011 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, an analysis conducted for the American Sportfishing Association estimates the economic importance of Great Lakes fishing to be approximately $7.2 billion in 2011 (American Sportfishing Association, 2013). For reference we provide a discussion of the alternative measures of economic activity in Chapter II. The interested reader is also referred to Scodari (2009) and Aitken (2009) for further discussion.

II. Economic Concepts and Methods of Measuring the Net Value of Recreational Activities

There are two necessary components underlying estimates of the recreational value of a resource: 1) the concept of use value per unit of activity, such as a recreational day or a multi-day trip; and 2) a measure of total effort in a period of time, such as angler days per year. The product of these two elements provides a measure of the total value of a particular resource, typically expressed in dollars per year. This same method can potentially be applied to changes in the value of recreational resources associated with a policy intervention such as reductions in pollution levels that increase angling catch rates. In this case, it would be necessary to have both a change in value for a trip and how the pattern of trips changes as a result of the policy instrument.

Three categories of "Economic" values are commonly reported in the literature on the net recreational fishing values of a resource such as the Great Lakes (GL) Basin. These are: 1) the net values or consumer surplus, which are appropriate the appropriate measures for use in benefit-cost analyses for policy interventions, as will be discussed below; 2) total expenditures by recreational users, which are often used, in the absence of net value measures, to suggest that a resource is valuable because of the amount that users pay to access the resource; and 3) economic impact, which is typically used by localities or regions to express how much recreational expenditures contribute to the economic output of a local economy. While, for completeness and comparative purposes, we describe each of these measures in this section, the primary focus of this review will be on providing a summary of the literature on the net values of recreational angling in the GL. It is this type of information that is needed for conducting benefit-cost analyses of public interventions such as controlling aquatic pathways between the GL and the Upper Mississippi River Basin currently being considered by the U.S. Army Corps of Engineers' Great Lakes and Mississippi River Interbasin Study (USACE 2014).

We begin by providing a simple introduction to relationship between economic value, expenditures and net-economic benefits at the individual level, and then proceed to extend these concepts to the market level and to techniques of estimating these values in a non-market setting.

Total Value, Expenditures, and Net Value at the Level of the Individual

A useful tool for introducing the economic concepts of value, expenditures and net-benefits is the idea of individuals participating in an auction. More specifically, consider an auction for a single item, such as a day fishing pass for a private, world-class fishing stream, in which there are many potential users who submit confidential bids for the single license. As is the case in many auctions, the winner of the auction - the person with the highest bid pays the second

highest bid, which is equivalently the highest rejected bid. Economic theory posits that the best decision for an individual in this type of auction setting is to reveal their own private value (Davis and Holt, 1993). It is not in an individual's strategic best interests to misrepresent his or her value by bidding above or below their underlying value for the fishing pass.

To add concreteness, suppose further that there are five individuals, A, B, C, D, and E, with respective values of $50, $40, $30, $20, $10 for the fishing pass. By value we mean that that is the most money that an individual would be willing to pay for the license and still be better off buying the license than not buying the license. While we use money as a metric, this is just a convenience to aggregate all other, perhaps disparate, goods that the winner would be willing to give up to obtain the fishing pass. Given these values and this auction institution, individual A would "win" the fishing pass, and have to pay $40 (individual B's value). The four other individuals do not get a pass to use this resource and hence get no use value from this activity.[2]

Recall that individual A would have been willing to pay $50 for the fishing pass. But individual A only has to expend $40 to purchase the fishing pass. As such, we can say that the value of the fishing pass to the individual is $50, the cost of the fishing pass to the individual is $40, and the difference of these two values, $10, is the net value of the license to the individual. Viewed in the other direction, $10 is the amount that individual A would lose if the opportunity to fish was taken away from him or her, and the $40 returned, presumably to be spent on the next best use.

Now suppose that instead two day passes are offered and, as in the previous auction, the five potential license holders submit their sealed bids. This time, however, the first rejected bid would be the third highest bid, $30, by individual C, which would now be the "price" of the fishing pass to the two winners of the auction A and B (This is often referred to as the uniform-price as all winners pay the same amount per license). With a lower uniform price of $30, individual A would now garner $20 in net value ($50 - $30). Individual B, with a lower value for the license of $40, would get a lower amount of net value ($10 = $40 - $30). In this setting, the aggregate net benefits across individuals would be $30 ($20 for individual A and $10 for individual B) and total expenditures would be $60 (two licenses multiplied by $30/license).

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[2] Throughout this review we focus only on recreational "use values" associated with actually accessing or using the resource. It is likely that other individuals who don't use a particular resource would have values for this resource, or changes in the quality of this resource. Also, users of these resources may value them over and above, or independently, of their resource use. While such "non-use" values are real and, if measurable with reasonable accuracy, allowed in Federal benefit-cost analyses, we do not address them in this document. The focus here is on recreational use values.

Table II.1: Aggregate Value, Expenditures and Net Value in a Hypothetical Fishing Pass Auction

Number of Licenses Auctioned	1	2	3	4	5
Aggregate Value of Licenses Auctioned	$50	$90	$120	$140	$150
Price (cost) of each License	$40	$30	$20	$10	$5
Aggregate Cost of Licenses to Winners (Expenditures)	$40	$60	$60	$40	$25
Net-Value to Auction Winners	$10	$30	$60	$100	$125

This process could be continued for three, four and five day passes. Assuming that the "price" in the five-pass setting was externally determined to be $5, the relationship between total value, total expenditure, and net value for each auction are presented in Table II.1.   A comparison of rows in this table indicates that aggregate use value and net-benefits increase with the number of licenses purchased. As the uniform price falls, net value converges to aggregate value. In the case where licenses are given away for free, as in a no-fee lottery, the two value measures would be equal. As shown, there is no direct relationship between the aggregate net-value and the aggregate costs (expenditures) across the numbers of licenses sold.   While the aggregated net value increases across licenses sold, as would be expected, aggregate cost to the winners rises and then falls. This last relationship, or lack thereof, between net value and expenditures is an important point to which we will return to in the next section.

Net-Economic Value, Expenditures and the Economic Impact of Recreational Activities[3]

The concepts introduced above at the individual level are readily extended to the recreational "market". In the above presentation individuals were sorted by decreasing value for a pass. This inverse relationship between the value of an individual license and the number of licenses could conceptually be extended to an entire recreational activity to create a market for passes. More typically, however, the unit of measure for recreational activities at a resource is a recreational day or trip.

Figure II.1 presents a value per day relationship in a many-person market, in which values (measured on the vertical axes) are sorted from high to low across user days (measured on the horizontal axes). The downward sloping relationship of the valuation curve represented by the line CDF may reflect the fact that some users will have higher values than others, as in the individual valuation example.   Or for an individual who takes multiple trips to use a resource, the declining value across trips reflects the general observation that, as the number

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[3] The graphical presentation in this and subsequent sections follows the presentations in the various economic valuation addendums to the National Surveys of Fishing, Hunting and Wildlife Associated Recreation.

Figure II.1: Demand, Cost and Net Value (Consumer Surplus)
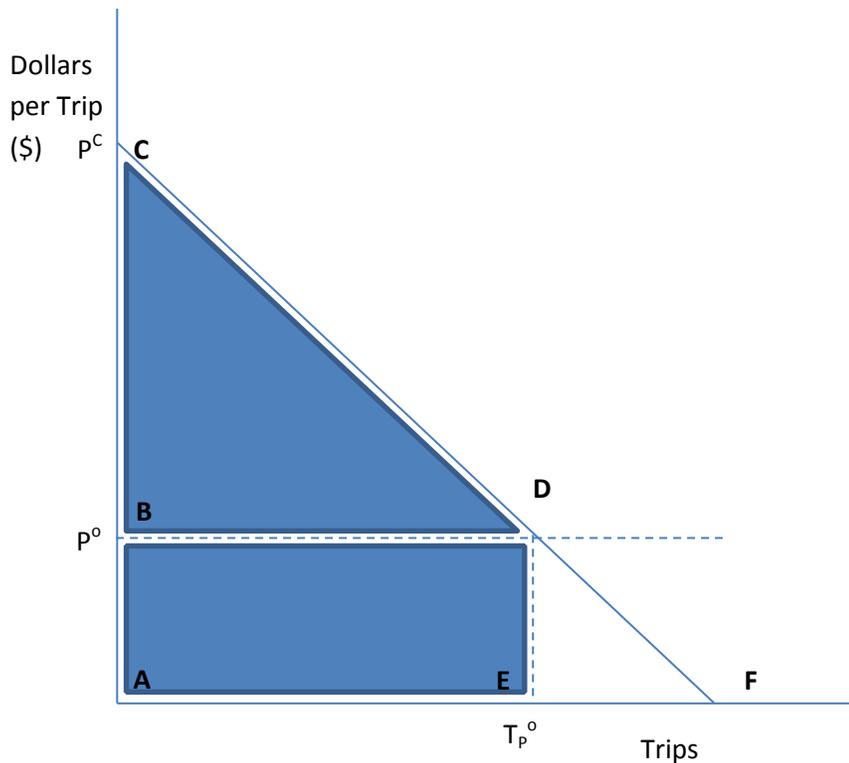
of trips per person increases, the "marginal" value of each additional trip is worth less than the previous one. As the marginal trip value falls, the average trip value falls also. While we have been speaking of value per trip as a function of the number of trips taken, this relationship can be reversed. Economists often speak of the demand for trips, which expresses the number of trips taken as a function of the price of the trip. So, if trip price was P^O the number of trips demanded would be $T_P{}^0$. Only those trips that are valued more than P^O would be "purchased." If trip prices rose to P^C (the "choke price") or above, then no trips would be taken. In contrast if taking a trip was free, e.g. you live on the shores of a fishing pond or stream, F trips would be taken. As such the relationship indicated by CDF represents both a demand function (quantity as a function of price) as well as a marginal trip value function (willingness to pay for each additional trip). Importantly, in constructing these relationships between quantity and price, it is assumed that individual income and prices for all other goods are held constant.[4]

A bit more detail about the graph needs to be provided to introduce the market concepts of aggregate consumer surplus and expenditures. As already discussed, the line CDF can be

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[4] Economists refer to these as *ceteris paribus* conditions. Correspondingly the demand curves represented in Figures II.1 and II.2 are referred to as partial equilibrium models.

interpreted as the marginal trip value function, sorted from high to low across trips. The area under this curve, ACFA, represents the total value of the resource if everyone could access the resource as much as they would like.

Let P^o represent the price of a trip, which would include the entire expenses specific to a particular trip. As such, price and cost of a trip are interchangeable terms. For ease of presentation we assume that P^o is constant across all trips. For instance this cost may be particular to individuals living a similar distance from the resource. Given this cost each individual will choose to take only those trips for which the value of the trip exceeds the costs for the individual. By using this logic, the total number of trips taken is $T_P{}^O$, as before, at which point the value of an additional trip (the marginal value or benefit) just equals the (marginal) cost of taking the trip. At this point the value of the trips taken is equal to the area underneath the value function up to $T_P{}^O$, represented by the area ACDEA.

Aside from determining how many trips will be taken, the cost of the trip has to be accounted for in determining the net value of using the resource. Individuals must spend money to access the resource in terms of entrance fees, travel costs, equipment costs and so on. As in the individual level discussion previously, these costs must be subtracted out from total values to achieve a measure of net value provided by the resource. Extending the above discussion on auctions, this can be achieved by taking the difference between the recreationalist's willingness to pay for each trip less the expenditures incurred with taking that trip, summed over all the trips taken. Graphically, this difference is represented by the triangle BCD, which is the market equivalent of our net-value measure described above, but is typically referred to in market analyses as the consumer surplus in the market depicted. It is this net amount that would be lost to the recreationists if the site were closed (which is conceptually equivalent to raising the price to P^C or above. Hence some recreational texts refer to this consumer surplus measure as an "all-or-nothing" or "access" value. Average consumer surplus per trip or equivalently net-benefits per trip are computed by dividing the area BCD by the number of trips taken.

Lacking information about the underlying values of a resource, which would require an estimate of the demand for the resource, more easily gathered expenditures data is often used to provide an indicator of the economic importance of the recreational site. This approach represents a paradigm shift of what is valuable about recreation and resource quality. The net-value approach discussed previously adopts the perspective that the fishery provides value to users of the resource, and that changes in these values are what should be measured for assessing the impact of a policy for benefit-cost purposes. An expenditures approach instead implies that how much is spent is the important measure. It is important to reiterate that there is no consistent relationship between expenditures and net-economic

benefits within or across recreational activities. For example, with respect to fisheries angling, the 1985 Talhelm Report (1988) estimates that net-economic benefits of Great Lake angling are about 70 percent of expenditures. In contrast, in a study for steelhead angling in Ohio, Kelch et al. (2006) estimate that consumer surplus values are 51 to 72 percent higher than expenditures.

Expenditures are also commonly used as an input for computing Regional Economic Impacts. In such analyses expenditures data are conventionally referred to as direct effects. These direct effects are multiplied by a multiplier (k) intended to capture the subsequent "secondary" or "ripple" effects of market activity on a local economy. For example, an intervention that improves the quality of a fishery via stocking or some other action will likely be reflected in the demand for fishing, and hence the number of fishing trips taken is expected to rise. Given this change in the primary fishing market there is expected to be increased demand for products from local businesses in secondary markets, such as boat charters, bait shops, restaurants, hotels etc. In turn there is the claim that:

> "Such products result in multiplier effects; that is as purchases from nearby businesses increase, these businesses will, in turn also spend their newly gained revenues nearby, and this, in turn will generate more revenues that will be spent locally, and so forth." (Boardman et al., 2001, p. 114)

Multipliers used in impact analyses for localized fisheries in the Great Lakes are usually of the magnitude of k=1.5 (Murray and Shields, 2004; Cook and Nieswender, 2007; O'Keefe and Miller, 2011). Multipliers tend to be higher when applied at a regional level because of greater opportunities for re-spending: Austin (2007) notes that regional multipliers range from 1.5 to 2.5, and apply a multiplier of 1.67 in their analysis of the value of Great Lakes protection; The Great Lakes Recreational Boating Study (USACE, 2008) used regional multipliers of 1.5 to 1.9; and Talhelm (1988) utilized a multiplier of 2. Assessments the economic impact of Great Lakes fishing reported by the American Sportfishing Association have used multipliers of 2.4 (American Sportfishing Association, 2008) and 2.8 (American Sportfishing Association, 2013) in converting angler expenditures to economic output.

From the narrow perspective of the benefits to the local community, it is tempting to view these direct and secondary impacts as benefits from recreational activities: this is the amount of additional purchases of goods and services within a community resulting from expenditures by recreational anglers. From the broader social perspective, however, expenditures and secondary effects merely represent a transfer of income from recreationists to regional businesses. This is because they occur only as a result of recreationists shifting their monies from non-recreation consumption or consumption outside the region to

recreation-related consumption within the region. Conversely, if fishing activity were to decline, expenditures would shift to other recreational activities or other regions. For example, the 1985 Talhelm Report (1988), which used a regional multiplier of 2, argues:

> "…if the sport fishing for Great Lakes fish were stopped and anglers reallocated their $1-2 billion spending on other purposes, up to $2-4 billion in business revenues (sales) would be lost by present businesses in the region. Much of this business activity would be shifted to other businesses and individuals in the region and other regions, depending on what the (former) Great Lakes anglers purchase." (p. 32)

In this manner, neither expenditures nor multipliers of expenditures count as a benefit of the recreational resource per se – they are merely transfers of income that would surely lead to "business failure and unemployment for some, and business success and employment for others" (Talhelm et al., 1988, p. 12). This point was recently made by a Congressional Research Service report, which attempts to shed light on a well-publicized economic impact study conducted for the American Sportfishing Association (2008) that reported an annual economic impact of $7 billion associated with Great Lakes recreational angling.

> "It has been widely reported that Great Lakes fisheries generate U.S. economic activity of approximately $7 billion annually. One should exercise caution in using this figure for assessing public policy alternatives or to make comparisons with the value of other economic sectors… Measures of economic activity such as the $7 billion … cannot be used to estimate changes in social welfare, to assess trade-offs among public policy alternatives, or to conduct benefit-cost analysis." (Buck et al., 2010, p. 7)

In addition to making the point that Economic Impact analyses are not appropriate for benefit-cost studies, the above quote also suggests that changes in net value, what the CRS report refers to as social welfare, associated with policy interventions are the appropriate measures for benefit-cost analyses. Up until this juncture, we have only presented the net-benefits that are gained from having a recreational activity. As noted, this value is often referred to the "all or nothing" or access value. However, most policy interventions are typically not all or nothing. Rather, policy choices typically address less than complete changes in the quality of the recreational activity: the catch rate in a fishery. In turn, such changes effect a shift in the demand and a change in consumer surplus, which we address in the following section.

Valuing Changes in Recreation Demand

Up until this juncture, we have only presented the net-benefits that are gained from having a recreational activity.   As noted, this value is often referred to the "all or nothing" or access value. However, most policy interventions are typically not all or nothing. Rather, policy choices typically address less that than complete changes in the quality of the recreational activity: the catch rate in a fishery. In turn, such changes effect a shift in the demand and a change in consumer surplus. As above, we will follow economic theoretical assumptions indicated in Footnote and arguments that lead us to conclude that the loss in net value can

Figure II.2, below, presents a shift in demand for a resource that might result from a reduction in the quality of the resource. For example, the catch rate of a desired game fish might decline with the introduction and establishment of an aquatic invasive species.   This in turn could be represented by an inward shift in demand from CDF to C'D'F'.   From a marginal willingness-to-pay or marginal value perspective, each trip is worth less to the angler.

Figure II.2. Changes in Consumer Surplus Associated with a Decline in Recreational Quality
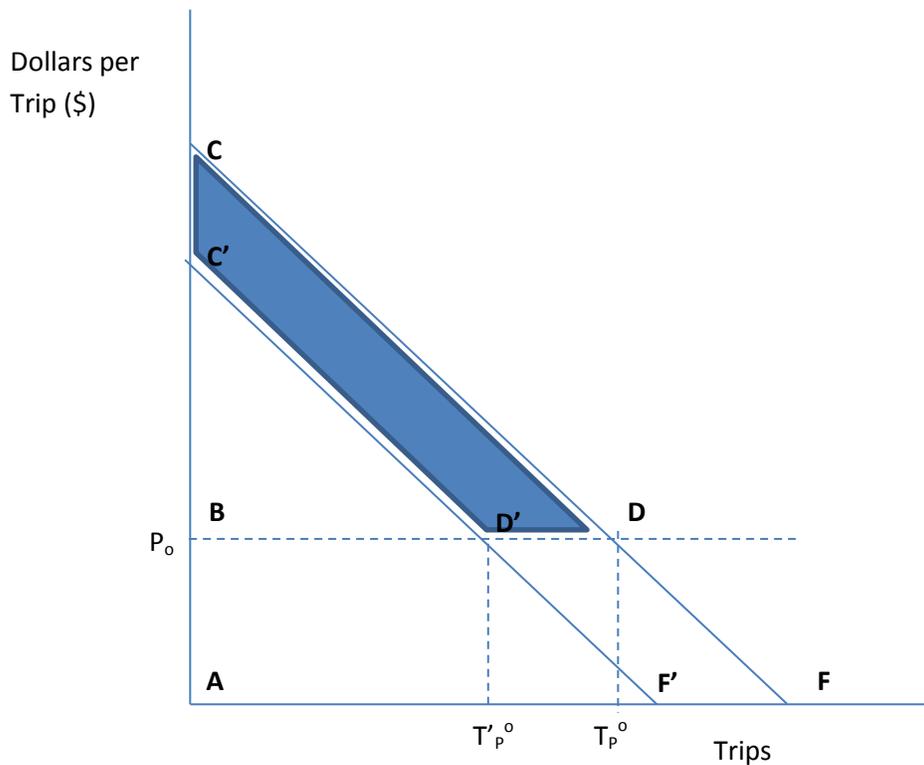
Assuming that the cost of the trip remains constant at P^o, the number of trips taken would decline from T_P^0 to $T'_P{}^0$. This makes intuitive sense: we would expect that anglers would take fewer trips to resources that have lower quality. As a result of lower values per trip and fewer trips taken, net value declines from BCD to BC'D'. The difference between these two areas is C'CDD', representing the lost consumer surplus associated with the decline in recreational quality. Conversely, it can be viewed as the net value accruing to recreationists of protecting the resource.[5] Estimates of these benefits could serve as inputs into a benefit-cost analysis of such as controlling aquatic pathways between the Great Lakes and Upper Mississippi River Basin.

Methods of Measuring the Net Value of Recreational Activities

The economic-theoretic notion of benefit-cost analysis is based on the (Hicks-Kaldor) compensation test. Adopting the more commonly used version – if the winners from a project can completely compensate the losers from a project and still be better off, then the project is desirable. This is equivalent to saying the benefits exceed the costs, or, in the terminology used in this review, the increase in net value exceeds the costs of project.

The application of benefit-cost analysis in water policy analyses finds its source in the Flood Control Act of 1936, in which projects should be undertaken by the Federal Government is "the benefits to whomsoever they may accrue are in excess of the estimated costs" (Dorfman, 1976, p. 2). This principle has been adopted more generally in regulatory impact analyses in recent years through a series of Executive Orders that require benefit-cost analyses for major (i.e. greater than $100 million effect on the economy) rule-making undertaken by Federal Agencies. Although subsequent Presidents have slightly modified President Reagan's 1981 E.O. 12291 (now replaced and supplanted by E.O. 12866 and E.O.

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[5] The presentation in the text has sidestepped an important issue in welfare economics by focusing on market demand functions and consumer surplus measures that could conceptually be measured from observed behaviors, as in market prices and quantities. These are typically referred to as Ordinary or Mashallian demands that capture the relationship between the quantity of a product demanded and price, holding income constant. For conducting benefit-cost analyses the appropriate form of the demand is called the Hicksian demand, which holds utility (the level of individual well-being) rather than income constant. In a seminal paper, Willig (1976) showed that for typical market goods the Marshallian and Hicksian demands are proximate (within 5 percent). As a result, consumer surplus measures in Figure II.1 can be used as reasonable approximations of the exact benefits measure to be used in benefit-cost analyses. The so-called "Willig bounds" do not however extend to areas between demand curves as depicted in Figure II.2. That is, the use of C'CD'D as a measure of the benefits of a project may be a biased estimate of the true benefits (see Freeman, 2003 pp. 116-118 for a discussion of these issues). For pedagogical purposes appropriate to this review we will continue to use the graphical analyses and consumer surplus concepts presented in Figures II.1 and II.2, the reader should note that these approaches may not provide exact measures of benefits for use in benefit-cost analyses when there is a shift in demand. Fortunately, the revealed and stated preference methods used in estimating recreational quality changes in the last two plus decades, and discussed later in this report, do adopt Hicksian-based approaches, and thus report values that are appropriate for benefit-cost analyses.

13463), the intent that actions "shall not be undertaken unless the potential benefits to society for the regulation outweigh the potential costs to society" has been renewed by subsequent administrations. For water resources, the use of benefit-cost analyses is embodied in the 1983 Water Resources Council Economic and Environmental Principles and Guidelines for Water and Related Land Resource Implementation Studies and subsequent related publications (USACE, 1983).

Two non-market valuation methods, the travel cost method and the contingent valuation method, have been widely used to value recreational and changes in recreational activities. These methods are discussed below.

The Travel Cost Method (TCM)

The travel cost method (TCM) is a type of revealed preference valuation approach, in that it uses actual trip expenditures to access a recreation site to estimate demands for resources.

> "The basic premise of the travel cost method … is that per capita use of a recreation site will decrease as the out-of-pocket and time costs of traveling from place of origin to the site increase, other things remaining equal. The method consists of deriving a demand curve for a recreation site by using the variable costs of travel and the value of time as proxies for price. By use of data collected from users of existing sites, the travel cost method permits development of (1) estimated use of the proposed site; (2) a per capita demand function for recreation at the site; and (3) an estimate of the…recreation [net] benefits of the site." (Water Resources Council, 1983, p. 75)

Because the travel cost method measures values indirectly from resource related expenditures rather than directly eliciting these net values, it is categorized as an indirect valuation method.

Although the basic concept of using travel costs to derive an estimate of demand and net-value for a resource has continued to provide the basic motivation for the TCM, the application of this method has evolved substantially over time. Following the initial development of the TCM by Clawson (1959) and Knetsch (1963), early studies used a zonal travel cost (ZTCM) framework in which visitation rates from (concentric) zones surrounding a recreation site were related to the average cost of traveling from the zone to the site (e.g. Mullen and Menz, 1985). Visitation rates could be determined by on-site data collection or broader surveys of the relevant population of prospective users. In this way a downward sloping trip demand curve is estimable, representing visits per person as a function of the price (i.e. travel cost) of taking a trip. This data could be manipulated to derive an aggregate demand curve for the resource and an associated net-value for the resource. While this method seems appropriate for valuing unique recreational sites, such as a national park, it is not well linked to the choices facing individual fishermen with numerous fishing opportunities

spatially and temporally.   To accommodate a limited number of substitute sites, and their interdependencies, these single site models were expanded to regional recreational demand systems approaches to jointly estimate a system of demand functions that include substitute sites (Cicchetti et al., 1976).

Over the years, the zonal and regional travel cost approaches have been supplanted by models that focus on discrete choices made by individual respondents. One approach is to use count data estimators intended to capture the non-negative integer characteristics of the frequency that individuals visit a recreational site (Shaw, 1988; Hellerstein and Mendelsohn, 1993): in other words visitors can take 0, 1, 2, 3 … trips. As with the ZTCM, this count data travel modeling approach (CD-TCM) can be expanded into a system of recreation demand functions (e.g., Ozuna and Gomez, 1994).

An alternative travel cost based approach has been to use a multi-site Random Utility Modeling (MS-TCM) approach that estimates the probability that a fisherman will choose a particular site out of many possible fishing sites on a choice occasion (e.g. Bockstael et al., 1987; Morey et al., 1993). The probability of a choice amongst alternatives can be made a function of the characteristics of the site as well as the cost of visiting the site. Consequently, the primary advantage of the MS-TCM models are to value changes in site quality (such as catch rate) or the closure of certain sites (such as a group of lakes). While such methods are amenable to valuing the loss or gain from changes in quality of a resource, they are generally not designed to calculate the "all or nothing" value of a site or activity, although approximations can be made from these analyses.   Because it can address quality changes and closures within a site that directly models substitution, the MS-TCM is widely used in Natural Resource Damage Assessments (e.g. Hoehn et al., 1996; Breffle et al., 1999; Desvousges et al., 2000; Besedin et al., 2004). Conversely, the CD-TCM is typically formulated to readily estimate "all or nothing values" but not changes in quality.

The Contingent Valuation Method (CVM)

The contingent valuation method (CVM) uses a stated preference approaches to directly measure net benefits. It relies on hypothetical survey questions to elicit values for a resource or values for a change in resource quality.

> "The CV method uses survey questions to elicit people's preferences for public good by finding out what they would be willing to pay for specified improvements in them. The method is thus aimed at eliciting their willingness to pay (WTP) in dollar amounts. It circumvents the absence of markets for public goods by presenting consumers with hypothetical markets in which they have the opportunity to buy the good in question. The hypothetical market may be modeled after either a private goods market or a political

market. Because the elicited WTP values are contingent upon the particular hypothetical market, this approach came to be called the contingent valuation methods." (Mitchell and Carson, 1989, pp. 2-3)

The method of eliciting values can range from discrete choice methods that elicit "Yes" or "No" responses to whether the individual would participate in the activity at a specific price, to open-ended formats that have individuals specify their maximum willingness to pay for a fishing day. Values elicited can be total values or net values.

CVM can also be used to value changes in the quality of a resource by eliciting how much an individual would be willing to pay for improved quality. A variation on contingent valuation called contingent behavior uses survey methods to elicit how behavior might change if the quality of a resource changes.

Benefits Transfer

The third approach, which the Water Resources Council document refers to as the unit day value method relies on "expert or informed opinion and judgment to estimate the average willingness to pay of recreation users. By applying a carefully thought-out and adjusted unit day value to estimated use, an approximation is obtained that may be used as an estimate of project recreation benefits." (USACE, 1983, p. 68). Rather than relying on expert opinion, this is now more typically accomplished through data-based approaches referred to as benefit transfer methods.

> "Benefit transfer uses research results from pre-existing primary research to predict welfare estimates for other sites of policy significance for which primary valuation estimates are unavailable. It may be described as the 'application of values and other information from a "study" site where data are collected to a "policy" site with little or no data' (Rosenberger and Loomis, [2000] p. 1097), or the 'practice of . . . adapting value estimates from past research . . . to assess the value of a similar, but separate, change in a different resource' (Smith *et al.*, 2002, p. 134). Although the use of primary research to estimate values is generally preferred, the realities of the policy process often dictate that benefit transfer is the only feasible option." (Johnston and Rosenberger, 2010 p. 479, footnotes removed)

As such, TCM and CVM studies provide original research conducted for the "policy" site. The benefits transfer method instead takes data from other (study) sites that have had original studies and applies these estimates to policy sites. While this approach is limited by the fact that values may be site and circumstance specific, it is frequently employed in policy analyses because conducting original TCM and CVM studies are expensive and time consuming.

III. Economic Valuation Studies of Recreational Fishing in the Great Lakes (GL)

Over the years a large body of non-market valuation research on recreational fishing has developed, with several major studies conducted in the Great Lakes (GL). This attention has been driven by the importance and widespread nature of this recreational activity as well as the fact that catch rate statistics were a readily available measure of the quality of the resource. This latter feature fostered the development of new methods of valuation techniques that accounted for quality changes, particularly in the travel cost method.

Several authors have collected and summarized fisheries valuation research for the purposes of conducting benefit transfers and meta-analyses. Sorg and Loomis (1984) covered the literature on outdoor recreation from the mid-1960's to 1982, identifying 93 benefit estimates in all. Walsh et al. (1992) summarized estimates of net value from 70 study sites from recreational value research in the United States from 1968-1988. This data set was updated and combined with other literature reviews in a series of reports by Loomis and co-authors, including Rosenberger and Loomis (2000, 2001), Kaval and Loomis (2003), and Loomis (2005). Loomis and Richardson (2008) added additional studies, cross-checking with a separate Sport Fishing Data Base (Boyle et al., 1999). Rosenberger and Loomis (2000, 2001) demonstrate that although there is substantial variation in estimates of net values across studies, the body of recreational valuation estimates do make sense, in that they vary systematically, and in expected/explainable ways.

We now turn to a discussion of the various studies that are potentially relevant to the GL study area, and assess the relevance of individual studies and the collected body of research to estimating net values for recreational angling in the study area and how these net values might be affected by quality changes. The reports are ordered by method: Average Benefits Transfer (ABT), Meta Analysis (MA), Travel Cost Method (TCM), Contingent Valuation (CVM), and methods that use a combination of techniques.

We limit our literature review to studies that use data collected in 1985 or after. Limiting the data collection to this time period is motivated by concerns about the "shelf life" of non-market valuation estimates.[6] Our particular choice of cut off in 1985 is somewhat arbitrary,

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[6] Researchers in non-market valuation have not identified, or to our knowledge specifically discussed and debated, the "shelf life" for non-market values beyond a single study undertaken by Bomans et al. (2011) which compared CVM estimates for moose hunting in Sweden in 1997 and 2006. In other words it has not been documented whether WTP estimates provided in research from decades ago are relevant as measures of value for current policy purposes even after they are adjusted by CPI indices. For example, the Bomans et al. analysis "suggests caution in using results from old contingent valuation studies for e.g. benefits transfer exercises (2011, p. 515). This is of particular concern for recreational activities such as recreational fishing in the Great Lakes for which the level of activity, and hence underlying demand, has changed substantially over generations and over time. For example, the 2006 National Survey of Fishing, Hunting, and Wildlife-Related Recreation reports that

but is also informed by the fact that Talhelm et al.'s (1979, 1988) well-known reports on the Great Lakes fishery cover research up to 1985. Further, in the mid-1980s the statistical approaches use used in travel cost analyses underwent fundamental change.[7]

Moreover, we only include studies in our review that endeavor to provide values over a geographical region, rather than a single inland lake (e.g. Eiswerth et al., 2008) or river stretch (e.g. Collins et al., 2005) or narrowly defined subset of fishermen (e.g. Provencher and Bishop, 1997). An exception to these inclusion criteria is Kelch et al. (2006), as their research provides unique insights into Ohio/Lake Erie Steelhead Salmon. Finally, our review of the data does not include valuation studies measuring the effects of toxic contamination (e.g. Montgomery and Needleman, 1997; MacNair and Desvousges, 2007) or changes in water quality without accounting for changes in catch rate (e.g. Parsons and Kealy, 1992; Feather et al., 1995).

The 1985 Talhelm Report (1988)

A standard reference for the benefits of Great Lakes recreational angling is Talhelm's (1988) Great Lakes Fishery Commission report "Economics of Great Lakes Fisheries: A 1985 Assessment." The "1985 Talhelm Report" provides estimates of net value per angler day and aggregate expenditures and net value for the Great Lakes fishery "developed by a workshop or 'committee' of economists…who have actively worked on Great Lakes fisheries values and impacts over the last few years" (p. v). The resulting expert values were largely based on the following four net economic benefits studies of major portions of the Great Lakes sport fishing resource: 1)   Talhelm's 1976 travel cost study of Great Lakes fish throughout Michigan (Talhelm, 1981); 2) Kealy and Bishop's (1986) modeling of travel cost data for Wisconsin waters of Lake Michigan in the 1978 fishing season; 3) Brown's (1982) 1976-77 travel cost study of angling on New York's Great Lakes coast (including the Niagara and Saint Lawrence Rivers); and 4) Hushak's (1984) travel cost study of private boat angling (i.e. not including charter boat or shore anglers) of western and central basins of Lake Erie in the 1981 and 1982

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from 1996 to 2006 Great Lakes recreational fishing declined by 30% (USFWS, 2008, p. 18). While some research is ongoing on generational effects on recreational values (e.g. Englin 2012), the appropriateness of transferring values over extended time periods remains an open empirical issue. Economic methods for valuing recreational activities such as angling have evolved substantially over time.

[7] In the decades since the 1985 Talhelm Report (1988), "single site" recreation valuation studies of the type employed in the work prior to the Talhelm report, have largely been replaced by "Multisite" choice methods that use statistical approaches that better account for substitutability across fishing activities and sites and the incorporation of fishing quality into the econometric modeling.   In turn this more complete accounting is able to accommodate the effects of a change in quality in one part of the fishery: if the quality of angling in one part of a fishery is affected by, say, pollution or aquatic nuisance species, anglers may decrease their effort in that site/fishing mode combination and offset their reduced fishing by increasing effort at other fishing and or other fishing modes.

seasons. Using the term "net all-or-none values" to mean net value/consumer surplus that would be lost by closing the recreational fishery, Talhelm writes:

> "The committee computed net all-or-none values per angler day in these cases for comparison purposes. Most ranged from $24 to $33. Considering the difference in assumptions, possible statistical errors, and the relationship between angling values and the type of angling, they estimated that if these values were expanded to other portions of the Great Lakes, the overall average would be between $23 and $33, most likely about $26. Multiplying by the estimated 55 million angler days for the Great Lakes in 1980 [Talhelm 1988] the all-or-none value for the entire Great Lakes fishery resource would be $1.3 to $1.8 billion per year in 1985, most likely about $1.4 billion.
>
> Since the total number of angler days is itself an estimate, with some unknown degree of error, the confidence interval around the $1.4 billion estimate should be even wider…Assuming an average all-or-non value of $26 per angler day and a range of 27-55 million angler days, aggregate net all-or-none value would be between $0.7 and $1.4 billion. Considering both kinds of error together, the actual value would be between $0.5 and $1.8 billion." (p. 18)

For reference, the estimated expenditures attributable to angling for the Great Lakes in 1985 were between $1 billion and $2 billion (Talhelm, 1988, p. 20). Using a multiplier of 2, the corresponding economic impact of recreational fishing to the Great Lakes region was estimated to be $2 billion to $4 billion per annum.

It would be tempting to obtain a back-of-the-envelope estimate of the aggregate net economic benefits of the Great Lakes angling by converting the aggregate 1985 Talhelm Report net-value estimates to present-day dollars: this would result in a range of estimates between $1.1 billion/year and $3.8 billion/year in 2012 dollars. However, as Talhelm is reported as stating in a recent interview: such a calculation would "likely be too high now because it's based on the number of people that were fishing in 1985. Fishing participation has gone down in the Great Lakes in the last 20 years" (Gillies, 2010).   Supporting this reasoning, the 2006 National Survey of Fishing, Hunting and Wildlife Recreation reports that from 1996 to 2012 recreational fishing in the Great Lakes declined by 30 percent (USFWS, 2008, p. 18). In addition, the 1985 Talhelm report openly recognizes that the report's estimate of Great Lakes fisheries effort may have been biased upwards.

A more appropriate approach would be to adjust the 1985 Talhelm Report's estimates of net benefits per angler day to 2012 values, and then multiply these values by the 2011 National Survey estimate of Great Lakes angling days.[8] Using the Consumer Price Index, the 1985 Talhelm Report's range ($24-$33) and "most likely" ($26) 1985 estimates of net benefits per angling day translate into $51 to $70 and $55 respectively in 2012 dollars. Multiplying these

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[8] The US Fish and Wildlife Service has conducted periodic national surveys of wildlife-related recreation since 1955.

values by the 2011 National Survey estimate of 19.661 million Great Lake Anglers yields a range of estimated aggregate annual net-benefits estimates for the Great Lakes of $1.00 billion to $1.37 billion, with a "most likely" estimate of $1.08 billion. While we have deemed this approach to be "more appropriate" it is far from perfect. As noted, the demand for fishing has declined substantially since the studies reported by Talhelm were conducted. Given this evident decline in fishing demand, one would also expect that the net-benefit per user day to decline for those anglers that continue to participate in the fishery. As such, caution should be taken when conducting intertemporal transfers over extended periods of time.

Post-Talhelm Net Value of Great Lakes Recreation Angling Studies

For reasons mentioned above, our review concentrates on research that has been conducted subsequent to the 1985 Talhelm Report. Each review will be structured following the outline in Box III.1 on the following page.

For the travel cost studies additional attention will be given to the "objective" mileage and "computed opportunity costs or time" because past research has suggested that estimated values will depend these assumptions. For example, in reviewing fish advisory studies, MacNair and Desvousges (2007) wrote:

> "The estimates of WTP to avoid advisories shows little consensus, with the reported values ranging from $-4.20 per trip to $23.97…Perhaps, somewhat surprising, we find that differences in travel-cost assumptions dominate the results. A large part of the variation in estimates is attributable to travel-cost assumptions used in these studies…" (p. 604)

These authors found that when they normalized the travel costs assumptions to a common driving speed, operation costs and cost of time, the range of WTP values to avoid fishing advisories was smaller, from $-1.26 to $7.43. While we do not normalize assumptions in our discussions below, we report values used for travel cost per mile and opportunity cost of time in each of the studies.   Driving speed assumptions are generally not reported in the studies we reviewed.

For the contingent valuation and behavior studies, one of the questions used in the study is replicated for each study. This is done, in part, because past meta-analysis research has shown systematic effects of different elicitation formats and other question design features on WTP estimates for environmental resources. The accepted wisdom is that dichotomous choice questions provide higher estimates of WTP values than more-continuous methods such as open-ended or payment-card elicitation formats (e.g., Welsh and Poe, 1998; Ready et

al., 1995; Champ and Bishop, 2007)   Also, in a kind of "beauty is in the eyes of the beholder" syndrome, stated preference valuation practitioners often have strong, often intuitive rather than fact-based, preferences about how a contingent valuation question should be structured. Replicating the question allows such individualized assessment.

Selected econometric and technical details for each study are reported in the Appendix to this report.

Box III.1: The Structure of Each Review

Identifying Name of Study (date)

Location:

Data Type, Date:

Project Sponsor:

Publications (Date, Type):

Stated Purpose of Research Effort:

Data Collection/Sampling Information:

Reported Values:

Assessment of Study and Relevance to Great Lakes:

Notes   *r.r. = response rates*
        n   = number of complete responses
        WTP = willingness to pay
        ABT = average benefits transfer
        MA = meta analysis
        TCM = travel cost method
        MS = multiple site
        CD = count data
        CVM = contingent valuation method
        Unless otherwise indicated, all reported values are adjusted to $2012 using the CPI.

Loomis and Richardson (ABT 200):

Location: Northeast recreation area, including the Great Lakes

Data Type, Date: Average benefits transfer, using original estimates from 1967 to 2005.

Project Sponsor: National Council of Science and the Environment

Publications: Loomis and Richards (2007, Report)
Loomis (2012, personal communication)

Stated Purpose of Research Effort: Within the limits of the then available literature, this study sought to provide up-to-date benefit transfer values and estimated meta-analyses equations for various types of outdoor recreational activities. Values for fisheries and other recreation use values were reported in tabular form by region.

Data Collection/Sampling Information: This report is the most recent iteration of a cumulative effort to assimilate recreational values studies that includes Sorg and Loomis (1984), Walsh et al. (1992), Loomis et al. (1999), Rosenberger and Loomis (2000, 2001), Kaval and Loomis (2003) and Loomis (2005). The fishing values were updated and cross-checked with a separate Sport Fishing Data Base (Boyle et al., 1999, see the review Boyle et al. MA, 1999 below.). While attention was paid at each stage of data collection to determine the body of studies that were of adequate enough quality to be included in the analysis, the averaging of these values is only as good as the underlying values reported.

Reported values: The following average values were reported for different fishing categories for fresh and saltwater fishing in the Great Lakes and the Northeast (Loomis, 2011, Personal communication), where N represents the number of estimated values used.

Species	Cold Water	Warm Water	Anadromous	Mixed	Not Specified
Average	45	48	44	22	56
N	58	119	33	30	112

Assessment of Study and Relevance to Great Lakes: The above values include observations for salt water fishing and for other fishing activities in the Northeast Recreation Area outside the GL region. However, because the values include the GL region, these values are relevant to the GL study area with respect to providing an estimate of the current net value of the fishery. These data are not appropriate for changes in fishing quality however.

Rosenberger and Loomis (ABT/MA 2001):

Location: Northeast recreation area, including the Great Lakes

Data Type, Date: Average benefits transfer and meta analysis, using original estimates from 1967 to 1998.

Project Sponsor: United States Forest Service (USFS)

Publications: Rosenberger and Loomis (2001, Report)
Rosenberger and Loomis (2000, Journal Article)

Stated Purpose of Research Effort: Within the limits of the then available literature and data, this study sought to provide up-to-date benefit transfer values and estimated meta-analyses equations. Values for fisheries and other recreation use values were reported in tabular form by region.

Data Collection/Sampling Information: This report is an interim iteration of the cumulative efforts of assimilating recreational values studies discussed in the main text and the above Loomis and Richardson (ABT 2008) review. This string of research includes Sorg and Loomis (1984), Walsh et al. (1992), Loomis (1999), Kaval and Loomis (2003), Loomis (2005) and Loomis and Richardson (2007). While attention was paid at each stage of data collection to determine the body of studies that were of adequate enough quality to be included in the analysis, the authors note that "a meta analysis can only be as good as the quality of past research efforts" on which it is based (Rosenberger and Loomis, 2000, p. 1097).

Reported values: The net benefits per recreational fishing day in the Great Lakes and the Northeast, based on the averaging the values estimates from 43 studies is $45 ($2012). The corresponding value from the meta analysis is $73. These data include both fresh and saltwater studies.

Assessment of Study and Relevance to Great Lakes: The above values include observations for salt water fishing and for other fishing activities in the Northeast Recreation Area outside the GL study area. However, because the values include the GL region, these values are relevant to the GL study area with respect to providing an estimate of the current net value of the fishery. These data are not appropriate for changes in fishing quality however.

Boyle et al. (MA 1999)

Location: National, including the study region

Data Type, Date: Meta analysis, using original estimates from 1982 to 2005.

Project sponsor: U.S. Fish and Wildlife Service (USFWS)

Publications: Boyle et al. (1998, Report)
                  Boyle et al. (1999, Report)

Stated Purpose of Research Effort: This study involved developing a database of recreational valuation studies (Boyle et al., 1998) and a meta analysis of the values in the data base (Boyle et al., 1999) as part of an effort by the USFWS to improve the efficacy of, and consistency in, their analyses involving the economic valuation of sports fishing opportunities. Specifically, the meta analysis of these data was intended to: 1) provide a means to systematically explore the variation in sport fishing value estimates across studies; 2) provide formal models for use in developing welfare estimates for sport fishing opportunities in cases where original estimates are not available; and 3) identify where there are gaps in the economic valuation for various sportfishing opportunities.

Data Collection/Sampling Information: A review of the literature identified citation information on over 250 sport fishing studies, but active collection efforts were limited to 150 studies due to resource limitations. After winnowing this data using various criteria, the data base resulted in detailed study information for 70 studies that provided a total of 1002 per-day and per-trip welfare estimates. A statistical, meta analysis was conducted on these data (see technical information in Appendix), indicating that estimated net values varied significantly with the type of fish caught, the type of waterbody and method used to collect data. While care was taken to only include supportable estimates, it is important to recognize that the resulting average and meta analysis values are only as good as the underlying estimates selected.

Reported Values: The net benefits per day, based on the simple average of 461 value estimates for recreational fishing across the county, is $62 ($2012). The corresponding value from the meta analysis is $73. Two sample scenarios were estimated for Great Lakes fisheries: Great Lakes Bass ($90) and Great Lakes Salmon ($109).

Assessment of Study and Relevance to the Great Lakes: The estimated values are relevant to the GL, although some caution is merited in adopting these values because the estimated values have relatively large standard deviations and thus lack statistical precision.

Lyke (MS-TCM 1993):

Location: Wisconsin Waters of Lake Superior and Lake Michigan and inland fisheries.

Data Type, Date: Multisite TCM; Primary data collection, 1990. (1989 fishing season)

Project sponsor: University of Wisconsin Sea Grant Institute.

Publications: Lyke (1993, Dissertation)

Stated Purpose of Research Effort: The purpose of this study was to investigate whether the net value of fishing quality to anglers, as represented by catch rates per unit of effort, could be measured using the TCM, and whether TCM and CVM estimates are similar for the same quality change. For a discussion of the comparability across the two methods, refer to the Lyke (CVM-1993) entry below.

Data Collection/Sampling Information: A stratified sample based on geographic location and the estimated number of Great Lakes anglers within a county was drawn from 1988 fishing licenses purchased in Wisconsin. Screening postcards were used to identify people who fished for trout or salmon in the Wisconsin Great Lakes and/or inland waters in 1989 (r.r. = 70%). Based on the postcard information, two separate mail survey questionnaires were distributed to respondents who: 1) Indicated that they fished on the Wisconsin Great Lakes in 1989 (Wisconsin Great Lakes Sport Fishing Survey (WGL), r.r. = 90%, n = 274); or 2) Indicated that they did not fish on the Wisconsin Great Lakes in 1989 (Wisconsin Sport Fishing (WSF) Survey, r.r. 85%, n = 239).

The questionnaires were mailed in February 1990, using a recall approach to elicit travel cost information from 1989[9]. In the WGL questionnaire, 29 separate Lake Michigan and Lake Superior areas were identified, and anglers were allowed to supplement this list. More detailed information (e.g. catch rates for particular species, seasonal variation in fishing effort, average distance and time traveled, and method of fishing) was requested about the two most frequently visited areas by the respondent. A similar approach was used for the

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[9] Ideally travel cost data could be collected immediately after every trip or through the use of a regularly collected travel log. However, such an approach is simply beyond the capacity of most survey efforts. The question thus arises as to the consequences of relying on lengthy recall periods. The USFWS suggests that there is systematic recall bias: the USFWS's "Research found that the amount of activity and expenditures reported in 12-month recall surveys was overestimated in comparison with that reported using shorter recall periods." (2008, p. vii). This finding of upward recall bias is consistent with past research conducted at Cornell University (Connelly and Brown 1995, Connelly et al.2000). However, more recent research by Connelly and Brown (2011) that more carefully controls for potential methodological effects in comparisons across more and less frequent contacts provides evidence that the recall effects may occur in the other direction, and that even if there are significant effects they are not substantial (<10%) at a statewide level. As such, the issue of recall bias effects remains unsettled. Nevertheless, calls for shorter recall periods should not be abandoned. Other variables being constant, shorter recall periods will be preferred to longer recall periods.

(WSF) survey, with the difference being that the respondent self-identified the specific bodies of water fished.

Per mile travel costs were specific to the class of vehicle typically used by the respondent for recreational fishing trips (compact, intermediate-sized car, full-sized car, vans/pick-up trucks or recreational vehicle), using vehicle class cost data from the American Automobile Association for gas, oil maintenance and tires. If a car type was not specified, a value near the middle of the distribution of costs was used. Mileage estimates were calculated by the researcher for the distance from every angler's home to every site in their choice set. The opportunity cost of time was set at one-third third of the wage rate, computed form the total household income before taxes.

Reported Values: The results from a number of TCM net value estimates are provided in this dissertation for various scenarios. Of most relevance to the Great Lakes are the mean net-benefit per trip values for All Wisconsin Great Lakes ($35.38 per trip ($2012), p. 172), Wisconsin parts of Lake Michigan ($34.33 per trip ($2012), p. 140), Wisconsin parts of Lake Superior ($1.04 per trip, p. 140) and Inland Wisconsin ($260.32 per trip ($2012, p. 140). Because the net values for Great Lakes fishing were elicited for each *trip*, and trips "may mean stopping for an hour on the way to work, or it may mean fishing for several days hundreds of miles from home" (p. 141) it is not clear how the values translate into per day values. As a rough estimate, we convert the All Wisconsin Great Lakes trip value to a per-day value estimate of $28 by dividing the per-trip value by 1.25. This indirect adjustment factor (1.25=25/20) was derived from the 1991 National Survey of Fishing, Hunting and Wildlife-Associated Recreation by dividing the estimated 25 million annual Great Lakes fishing days by the estimated of 20 million annual Great Lakes trips fishing trips. In comparing these values to other results in the literature, the author notes that the estimated values are "compatible or a little low relative to the cold water fishing literature" but that the "per day values for Inland fishing are much higher than other values" (p. 139) in the literature.

Assessment of Study and Relevance to the Great Lakes: The sampling effort was rigorous and resulted in a high response rate. The data has been used for further modeling development by Phaneuf et al. (MS-TCM 1997 - see review below). However, there are aspects of the methodology that are not described sufficiently to judge their reliability (see the Appendix), and the dissertation lacks sufficient detail explaining how values were derived, which complicates assessment of the quality of the analysis.

Due to the concerns about and lack of documentation regarding modeling issues we conclude that the values from this study are not appropriate for estimating values for the entire GL region.

Jones and Sung (MS-TCM 1993):

Location: Michigan inland fisheries and waters of the Great Lakes.

Data Type, Date: Multisite TCM; Primary data collection, 1983-1984.

Project sponsor: Michigan Department of Natural Resources (MDNR), U.S. Environmental Protection Agency (USEPA)

Publications: Jones and Sung (1993, Report)
                    Jones and Lupi (2000, Journal Article)

Stated Purpose of Research Effort: This research had two major objectives. The first was to address several methodological issues associated with travel cost models. The second was to allow the state to use the model to improve fisheries management and to perform Natural Resource Damage Assessment for injuries to Michigan State fisheries.

Data were taken from a mail survey to 1% of the anglers licensed to fish in Michigan during the 1983 and 1984 license years (r.r.= 59%; n = 10,948). Questionnaires were sent out at various times over the period from November 1983 to September 1984, resulting in recall periods from less than a month to almost 14 months. While the survey data used in this study was collected prior to our general cutoff data of 1985, we include this study in our review because its method of categorizing anglers by fishing activity is utilized in later research and because of the statistical methods used.

The questionnaire requested detailed information on the angler's most recent fishing trip, including species sought, location, trip length, trip expenditures etc., as well as demographic background including fishing experience and preference information. Importantly, while details were provided about the most recent trip, the data collection effort had "severe data limitations at the total participation level. We do not know the total number of season trips" (Jones and Sung, 1993, p. 4). Catch rates for Great Lakes warm and cold water fish and for anadromous runs were obtained from MDNR creel studies. It was determined that creel data could not be used for inland fishing: instead proxies for fishing quality, total lake acreage per county for each of cold water and warm water lakes, and miles of cold water and warm water rivers and streams broken down by quality level (top quality, second quality, other), were used. The MDNR classifies top quality streams as those that have good self-sustaining stocks of warm/cold game fish. Secondary quality streams contain populations of warm/cold game fish, but these populations are appreciably limited by factors such as pollution, competition, or inadequate natural production.

Per-mile vehicle operating costs were taken from the American Automobile Association cost of driving publications, multiplied by the share of the total fishing party size represented by the respondent's family. Distance from the individual's residence to each county in his or her choice set using home and destination county centroids were calculated for in-state residents. For out of state residents, mileage estimates were based on calculations involving the self-reported distance and estimated travel distance within the state of Michigan. The opportunity cost of time was taken to be the full wage rate for respondents who were employed and the minimum wage for those who were unemployed. These values were not multiplied by an opportunity cost adjustment factor.

Reported values: Standard values such as net value per day of fishing were not reported for these data, in part because of the data limitation on total fishing days. The model was used to demonstrate how changes in recreation days might be affected by eliminating PCB contamination on the Kalamazoo River. However, the estimated improvement values are not germane to aquatic nuisance species.

Assessment of Study and Relevance to the Great Lakes: The overall contribution of the study to estimating fishing recreation values in the GL area is limited by the lack of data on total trips taken during the season, which prevents consideration of how quality affects the frequency of trips and shifts in trip locations across a season. As such, this work is not relevant to the objective of estimating net values of recreational angling in the study area and does not provide adequate information for estimating how changes in quality will affect net values of the recreational fishing resource.

MSU (MS-TCM 1996)

Location: The Great Lakes and Inland Waters of the State of Michigan

Data Type, Date: Multisite TCM; Primary data collection 1994-1995.

Project sponsor: Michigan Department of Natural Resources (MDNR)

Publications: Hoehn et al. (1996, Report)
Various conference papers/staff reports: e.g. Chen et al. (1999), Lupi and Hoehn (1997), Lupi et al. (1998)
Lupi et al. (2003, Journal Article)

Stated Purpose of Research Effort: This study was funded to provide an economic model of recreational angling which could help the MDNR protect and manage Michigan's fishery resources.   The results of the study were to be consistent with Natural Resource Damage Assessment guidelines, allowing for defensible estimates of environmental injuries under Federal and State environmental laws. As such, the economic model had to be capable of measuring the economic value of changes in natural resource quality at a number of sites.

The MSU study implemented a repeated travel cost site-choice model that involved multiple contacts during the 1994 fishing season. Random digit dialing was used to identify Michigan Residents who were potential anglers for the 1994 season, where potential meant that they fished in the previous year or stated an intention to fish in the upcoming season. Of the respondents who were identified as potential anglers, 78% agreed to participate. Of those who agreed to participate, 80% completed the entire CATI panel survey that followed anglers during the course of the 1994-95 fishing year. To balance respondent burden with the need for accuracy, frequent anglers were called more than infrequent anglers, with panel frequencies ranging from three to eight interviews over the fishing season. Each interview basically consisted of asking whether the respondent had fished or not since the previous interview, and if they fished, respondents were asked the location, duration, and species targeted for each trip. To enhance accuracy, fishing logs were provided. In this manner MSU was able to get detailed cost and quality data for each trip.   This approach to collecting data avoids possible recall biases and other issues associated with aggregating estimated trips and costs across an entire season.

Driving costs per mile were calculated using a regression-based prediction of per-mile fuel costs plus a per mile depreciation charge obtained from the American Automobile Association for miles driven in excess 15,000 miles driven annually for a full size passenger vehicle: the dependent variable in the fuel cost regression was the reported fuel cost for the fishing trip and explanatory variables included distance, whether costs were shared with other

households, whether a boat was towed, and whether the vehicle was a truck or camper. The wage information was similarly derived using a regression approach from the survey data: the dependent variable was wage and independent variables were years of education, age, gender, experience, the number of kids and the number of adults in the area and a dummy for metropolitan counties. These values were not multiplied by an opportunity cost adjustment factor to estimate a shadow cost of time.

Reported values: In various reports the authors demonstrated how days fishing and consequent changes in total WTP would be affected by specified changes in the fishery. For example, they provided simulations for lake closures in specific counties (due perhaps to a contamination incident) and increases in lake trout on the St. Mary's River (an outcome of increases in lamprey treatments). As a result, this effort only provided limited information regarding net-benefits per day of recreational angling.   They reported user day values for trout and salmon of about $41 and $51, respectively ($2012, Lupi et al., 1998).

Assessment of Study and Relevance to the Great Lakes: Because of the high quality data collection methods and the application of state of the art statistical methods, this study can be regarded as an exemplar for Great Lakes travel cost fisheries research. The MSU model provides a snapshot of how anglers responded to travel costs and site quality for Michigan fisheries circa 1994-95, but it remains an open question of whether its estimated values are applicable beyond Michigan state waters. The model could be used to simulate the catch rate impacts associated with hypothetical aquatic nuisance species, and indeed has been used so for evaluating the benefits of Sea Lamprey control (Lupi et al., 2003). As discussed in the Appendix, this modeling exercise is also useful in that it demonstrates assymetry in the values attached to decrements and improvements in catch rates.

Phaneuf et al. (MS-TCM 1997)

Location: Wisconsin waters of Lake Superior and Lake Michigan.

Data Type, Date: Multisite TCM; Secondary data from Lyke (1993) (1989 fishing season)

Project sponsor: US EPA, USDA Western Regional Project W-133.

Publications: Phaneuf (1997, Dissertation)
Phaneuf et al. (1998, 2000, Journal Articles)
Herriges et al. (1999, Book Chapter)

Stated Purpose of Research Effort: The broad aspects of this data collection effort are described in the TCM entry for Lyke (MS-TCM 1993). Phaneuf and co-authors used the Lyke (1993) Wisconsin Great Lakes Fishing Survey to develop a new modeling approach for recreational modeling.

Reported Values: Phaneuf et al. (1998) reported seasonal values from a variety of statistical models that effectively close the Southern portion of Lake Michigan (this could be attributed to an environmental disaster). Converting these seasonal values to average per trip net value using information provided in Lyke (TCM 1993) provides an estimate of about $53/trip. We convert this value to a rough per-day value estimate of $42 by dividing the per-trip value by 1.25. This indirect adjustment factor (1.25=25/20) was derived from the 1991 National Survey of Fishing, Hunting and Wildlife-Associated Recreation by dividing the estimated 25 million annual Great Lakes fishing days by the estimated of 20 million annual Great Lakes trips fishing trips.

Assessment of Study and Relevance to the Great Lakes: The new approach to modeling recreation is a contribution. However, such a modeling approach is appropriate only for limited numbers of site choices, and is not extendable to settings with more choices. The use of only the GL data set from the Lyke (TCM 1993) study preempts concerns about substitutes mentioned in that review.

Phaneuf et al.'s values could be aggregated to estimate net values. Yet expanding a localized study to the entire geographical area of the Great Lakes basin would not be appropriate because of the widely varying opportunities and conditions across this broader region.

Upneja et al. (TCM 2001)

Location: Inland and Great Lakes waters of Pennsylvania

Data Type, Date: TCM; Primary data collection 1995-1996

Project sponsor: Center for Rural Pennsylvania

Publications: Upneja et al. (2001, Journal Article)

Stated Purpose of Research Effort: The objective of this study, which might be best classified as a regional travel cost model, was to determine the economic benefits of sportfishing activities in the commonwealth of Pennsylvania.

Data Collection/Sampling Information: Drawing every 70th name from the list of licensed Pennsylvania anglers in 1994, a mail survey was administered in stages between June 1995 and May 1996. Anglers were asked to report trip expenditures of their most recent fishing trip, the species targeted, the total number of fishing trips taken and other recreational information. The response rate was 6.5% (n=987).

Trip costs were estimated using anger responses to "out of pocket" expenditure questions in the survey related to the "last fishing trip" taken. The opportunity cost of time was not accounted for.

Reported values: Estimated mean net value per person per day is $435.

Assessment of Study and Relevance to the Great Lakes: The 6.5% response rate and technical issues discussed in the Appendix preclude this study for use in basin-wide estimates of net value in the GL study area.

Besedin et al. (MS-TCM 2004)

Location: Michigan Great Lakes (Michigan, Huron, Erie, Superior)

Data Type, Date: Multisite TCM; Secondary data 2001

Project sponsor: USEPA

Publications: Besedin et al. (2004, Presentation)
US EPA (2004, Report)

Stated Purpose of Research Effort: Building from an analysis of Michigan State Great Lake waters, this study evaluates recreational fishing losses in the Great Lakes hydrological region caused by "impingement and entrainment" of fish by power plant cooling water intake structures (CWIS). It was completed as part of the Environmental Protection Agency's (EPA's) regulatory impact analysis for regulations of power plant CWIS under section 316(b) of the Clean Water Act.

Data Collection/Sampling Information: A sample of 10,000 anglers was taken from a subset of the Michigan Department of Natural Resources (MDNR) Measurement of Sportfishing Harvest in Lakes Michigan, Huron, Erie, and Superior study, conducted in 2001, which surveyed boat, shore and ice anglers at fishing sites in Michigan State's Great Lakes waters. No socio-economic data was collected. Catch rate data were estimated from ten years of MDNR creel data. After excluding non-Michigan residents and anglers who traveled more than 120 miles one way to the fishing site, single-day TCM data were available for 9,758 GL and tributaries anglers.

Travel distances were calculated from the fisherman's home zip code to the fishing site. Travel cost per mile values used operating costs based on the government reimbursement rate per mile.   The opportunity cost of time was set at one-third the household wage rate computed from the household zip code.

Reported values: Per-Trip net values are reported for simulated scenarios of reductions in "impingement and entrainment" of fish by cooling water intake structures. These values cannot be used to estimate the current net value of fishing or how that value might change in response to aquatic nuisance species because they are specific to this source of environmental impact. Net values for an additional fish caught on a trip were also reported.

Assessment of Study and Relevance to the Great Lakes: The limited discussion of data collection provided in the conference presentation and the US EPA report make it difficult to assess the quality of the data and, hence, the overall study. From the econometric modeling perspective (see technical report for this study in the Appendix) there is some concern that

modes of fishing (e.g. warm water fishing) could not be/were not separated in the statistical analyses creating potential biases in the estimates.

The reported WTP values are not appropriate for developing an estimate of the net value of the total recreational fishing resource as they report only changes in net benefits associated with the regulation being considered. A subset of the WTP estimates reported in this study, i.e. WTP for an additional fish per trip, are relevant to estimating net economic value of the fishing resources in the entire Great Lakes Basin only to the extent that values per fish could be used as a measure of quality change.

Murdock (MS-TCM 2006)

Location: Michigan Great Lakes

Data Type, Date: Multisite TCM; Secondary data 1998.

Project sponsor: The data collection was funded by the Fox River Group

Publications: Murdock (2002, Dissertation)
                    Murdock (2006, Journal Article)

Stated Purpose of Research Effort: The contribution of this study is primarily methodological in that it focuses on developing a way to address unobserved quality characteristics of recreation sites in statistical models.

Data Collection/Sampling Information: The model was applied to data collected as part of an Natural Resource Damage Assessment plan potentially resulting from releases of hazardous substances to the Lower Fox River and the Bay of Green Bay (see Desvousges et al., 2000 and MacNair and Desvousges, 2007). A random digit dialing telephone survey recruited Wisconsin anglers willing to complete a fishing diary each month for June through September 1998. Of the recruited anglers, 81% returned at least one of their monthly diaries and 64% completed all four months. This paper uses data on the 512 anglers who completed all four months of the survey and reported taking a single day fishing trip. The fish trip log collected information on fishing location, distance travelled, trip and location characteristics, and number of fish caught of each species, size and the number of fish eaten. As with the Breffle et al. (1999) study reported below, contingent behavior data were also collected, but are not reported here because it pertains mostly to fish consumption advisories.

Fish catch measures were obtained by combining information from the Wisconsin Department of Natural Resources (WDNR) and the data collected in the survey. As a result catch rates vary across sites but not anglers. 737 fishing sites were visited by anglers and organized into roughly seven by five mile quadrangles.

Distance traveled was calculated from the zip code of residence to each fishing site. Travel costs were estimated using the average operating costs for gas, oil maintenance and tires provided by the American Automobile Association. The opportunity cost of time was accounted for by using the after tax wage rate for individuals that work full or part-time and the predicted wage rate from a hedonic wage regression for those that were not working.

Reported values: No estimates of WTP per day are provided. Illustrative policy values for a 10% increase in walleye and musky catch are reported in miles rather than dollars.[10] The objective of the manuscript is to demonstrate biases associated with quality variables and econometric issues rather than to provide values for policy purposes.

Assessment of Study and Relevance to the Great Lakes: The net values are provided in one-way miles rather than dollars in part because of unexpected econometric results when constructed travel costs were used. Since dollar values are not reported, the estimated models are not relevant to this GL project objectives.

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[10] In addition to the econometric issues noted in the text, expressing net benefits in miles rather than dollars is consistent with the philosophy underlying the compensatory restoration Natural Resource Damage Assessment motivation of collecting the original data as expressed in Desvousges et al. (2000).   These authors argue that such an "approach does not require a determination of the monetary valuation of restoration projects" (p. 17) and note that the parties that were involved in the NRDA were concerned that the absence of consensus in the economics literature regarding "the appropriate method for monetizing distances in a travel cost framework (Randall, 1994)" (MacNair and Desvousges, 2007). They subsequently demonstrate, however, that utils associated with miles traveled can be converted to dollars by multiplying the utils by travel cost, and apply this to change in fish advisory levels over a range of assumed travel costs.

Kelch et al. (CD-TCM 2006)

Location: Lake Erie Tributaries

Data Type, Date: Count data TCM; Primary data collection 2003

Project sponsor: Ohio Sea Grant College

Publications: Kelch et al. (2006, Journal Article)

Stated Purpose of Research Effort: The objective of this research was to provide net value estimates to policy makers interested in assessing the effectiveness of steelhead salmon stocking programs and providing access and opportunities for fishing operations. Angling for anadromous fish represents a high quality fishing experience, and that interest in steelhead fishing in Lake Erie tributaries has risen in recent years.

Data Collection/Sampling Information: Between October 2002 and April 2003 Ohio Sea Grant staff contacted over 500 steelhead anglers on the streambanks of eight Lake Erie tributaries and asked them to participate in a mail survey about steelhead angling. Of the over 500 anglers contacted, 487 agreed to provide their names and addresses, and 375 responded to the mailed survey with usable information (r.r. =77%). Of this 93% were on single day trips, and only these data were used in the analyses.

Distances travelled were based on self-reported information from survey responses. Costs-per-mile were based on the Internal Revenue Service standard mileage reimbursement. Wage rate was calculated from income range reported in the survey multiplied by 0.30.

Reported values: Estimated net-benefits per single-day angling ranged from $42 to $55 ($2012).

Assessment of Study and Relevance to the Great Lakes: This is a straightforward, solid study. If it can be assumed that there is little substitution between anadromous run fishing and other fishing activities and that substitution options to other tributaries are low, then this provides a useful contribution.

Subject to the caveats above regarding substitution alternatives and concerns that conditions differ in other parts of the Great Lakes, the net values could be used to contribute to estimates of the current net value of anadromous fishing in the Great Lakes. Yet expanding these localized estimates to the entirety of anadromous fishing effort in the Great Lakes may not be appropriate because of varying conditions at other sites.

Spink (MS-TCM 2014)

Location: New York State Great Lakes and Inland Waters

Data Type, Date: Multiple site TCM; Primary data collection 2007

Project sponsor: New York State Department of Environmental Conservation (NYSDEC)

Publications: Spink (2014, Master's Thesis)

Stated Purpose of Research Effort: The purpose of this study was to use the data collected from the 2007 New York Statewide Angler Survey, which is the most recent data collection effort of this type conducted by the research group in the Connelly et al. CVM studies discussed below (see Connelly and Brown, CVM 1990 and Connelly et al., CVM 1997).

The New York Statewide Angler Survey conducted in 2007 was designed to provide information about how to effectively manage New York fisheries. The survey had three main objectives: to assess angler fishing effort, estimate angler expenditures, and determine the satisfaction that anglers have with their experience fishing. In addition, the survey attempted to address two common sources of bias in survey data, nonresponse bias and recall bias. The existence of fishing effort data and expenditures provided an opportunity to apply multisite travel costs methods. In contrast with the 1988 and 1996 studies discussed below, no contingent valuation questions were elicited.

Data Collection/Sampling Information: This survey was conducted by mail in three phases from January to May, June to September, and October through December. A shorter annual survey was conducted by mail at the end of 2007 to estimate the degree of recall bias. A random sample of 17,000 licenses of anglers of at least 16 years of age who were registered to fish in New York fisheries during the sample period were drawn for each phase of the survey. The samples were drawn by license type (lifetime, annual resident fishing and sportsman, annual nonresident fishing and sportsman, short-term resident and short term nonresident) in the same proportions as they were purchased by anglers. The three sample periods were Phase 1 (January 1_{st} – May 31_{st} r.r. =42.1%), Phase 2 (June 1_{st} – September 30_{st}, r.r. =37.9.1%), and Phase 3 (October 1_{st} – December 31st, r.r. =48.8%). The response rate for the annual survey was 39.9%. Surveys were sent out shortly after the end of the phase period. Up to three additional reminder surveys were sent to anglers who did not complete the initial survey. To estimate nonresponse bias, 200 follow-up telephone interviews were given to non-respondents in each phase. Details of the survey and the estimated impacts of recall bias on days fished and expenditures per day are provided in Connelly and Brown (2009 and 2011). The general finding from the Connelly and Brown research is that the estimated number of days fished across the entire state "were significantly different, but were not substantially

different (<10%)" (Connelly and Brown, 2011, p. 85). Nevertheless, the difference in estimated fishing effort on some of the larger, individual water bodies was significant.

Distance traveled was calculated from the zip code of residence to the center of each county, for those New York countries within three driving hours from the home zip code, where driving time was calculated using PC Miler. Travel costs were estimated using the average operating costs for gas, oil maintenance and tires provided by the American Automobile Association. The opportunity cost of time was accounted for by multiplying the average income per ZIP code from SOI Tax Statistics provided by the Internal Revenue Service by 1/3.

Reported values: Using a nested logit framework similar to the MSU studies in which participation, fishing type (Great Lakes or Inland Waters) the estimated net value per day are $32.42 ($2012) for the annual survey and $39.19 ($2012) for the phase survey. The phase survey provides greater number of day fished and a higher value per day estimates. The parameters of the nested logit model represented an improvement over non-nested models, and the nesting coefficients (scale parameters) were consistent with utility theory.

Assessment of Study and Relevance to the Great Lakes: This study makes a contribution in showing that phase survey approaches will increase estimates for the number of days fished and estimates of value per day fished in comparison to a standard annual recall survey.

The estimates from this study provide a regional net value for a fishing day under the conditions that would be relevant to the GL study area. Yet expanding a single state study to the entire geographical area of GL would not be appropriate because of the widely varying opportunities and conditions in the Great Lakes.

Milliman (CVM 1986):

Location: Green Bay, Wisconsin.

Data Type, Date: CVM; Primary data collection 1986

Project sponsor: University of Wisconsin – Madison, Wisconsin Sea Grant, National Sea Grant.

Publications: Bishop et al. (1990, Journal Article)
                    Milliman et al. (1992, Journal Article)

Stated Purpose of Research Effort: In 1983, the Wisconsin Department of Natural Resources (WDNR) initiated a regulatory program for yellow perch in Green Bay, WI with the intent of rehabilitating this fishery. Amongst other efforts, this study sought to estimate WTP values for the current fishery and WTP values for the projected improvements to the fishery.

Data Collection/Sampling Information: The basis for estimating the value per angler trip was a CVM survey of perch anglers conducted in 1986. WDNR creel census clerks and university-employed clerks intercepted perch anglers at all the significant fishing sites along the Wisconsin shores of Green Bay. Anglers were asked whether they would be willing to complete a mail questionnaire from the university regarding perch fishing. A sample of 600 anglers was drawn at random from those who agreed to participate in the study. The survey was mailed during the fall of 1986 (r.r. = 91%).

In the mail survey respondents were asked about the fishing trip during which they were initially intercepted. Expenditure and other travel cost information were collected along with information about the number of fish caught and the average size of these fish. To estimate net value, respondents were asked if they would have still taken the trip if their total expenses had increased by a specified number of dollars, wherein the dollar value varied across respondents. Respondents answered "Yes" or "No" to the following dichotomous choice question.

> Fishing expenses often go up or down. For example, until recently gas prices were quite high, but have recently fallen. If the total expenses you just calculated for your trip in question B-1 increased by $_____ , would you still have taken your Green Bay perch fishing trip?

Reported values: Estimated average net-benefits per trip under existing conditions was about $54 ($2012). Other values are reported for hypothetical improvements in catch and fish length, but are not replicated here.

Assessment of Study and Relevance to the Great Lakes: This is a straightforward application of dichotomous choice CVM. This provides a localized net value for a fishing day under the

conditions that existing in Green Bay in 1986 and is thus relevant to the GL. Yet expanding a localized study to the entire geographical area of GL would not be appropriate because of the widely varying opportunities and conditions in the Great Lakes.

Connelly and Brown (CVM 1990)

Location: Inland and Great Lakes waters of New York

Data Type, Date: CVM; Primary data collection 1989 (for 1988 fishing season)

Project sponsor: New York State Department of Environmental Conservation (NYSDEC)

Publications: Connelly et al. (1990, Report)
Connelly and Brown (1991, Journal Article)

Stated Purpose of Research Effort: This research was conducted to provide baseline data on the recreational value of the freshwater fisheries in New York State and to show how comparisons of value can be made over time. The authors note that these valuation estimates were needed to help justify fisheries management expenses and as a data base for evaluating future policy alternatives.

Data Collection/Sampling Information: A systematic sample of resident and nonresident New York fishing license holders was selected for the license year over the period from October 1987 through September 1988. The licenses were sorted and the sample was stratified by county of purchase. A questionnaire was mailed in January 1989, in which respondents were ask to list for calendar year 1988 the number of days fished, species sought and travel cost by location (r.r. =62.4%; n=10,314, of which about ½ were asked CV questions).

After eliciting information about the entire fishing season, respondents were asked to recall a specific fishing trip from amongst those they had previously identified. Respondents were then asked how many days they spent on the trip and the cost for their share of the expenses. Next, a series of questions was asked to get respondents to think in more detail about whether they would have taken the trip if the costs of taking the trip has increased two, three or four times what they paid because of a sudden increase in the "price of gasoline, food, or lodging, or any other expense items". Finally, respondents were asked the open ended willingness to pay question:

> What is the MAXIMUM total amount that you would have been willing to pay for this fishing trip before you would have decided not to go?
>
> MAXIMUM total cost you would have paid: $ _____

Reported values: This research provides a number of values for various fresh water resources in New York. Considered in total, these suggest that there is variation in recreation values

across locations within a state. Despite this, the overall variation between GL and inland waters is not that large. Net value for GL was about $25 ($2012). For inland lakes the value is $28 ($2012).

Assessment of Study and Relevance to the Great Lakes: The large sample in this study provides broad coverage across the entire state, and was stratified in ways that would allow aggregation across sites. The demonstration of variation of values across sites within a state demonstrates the concerns raised in various parts of this review about potential biases associated with aggregation of data in which values are not matched with effort.

The estimates from this study provide a regional net value for a fishing day under the conditions that would be relevant to the upper portions of the GL study area. Yet expanding a single state study to the entire geographical area of GL would not be appropriate because of the widely varying opportunities and conditions in the Great Lakes.

Lyke (CVM 1993)

Location: Wisconsin Waters of Lake Superior and Lake Michigan and inland fisheries.

Data Type, Date: CVM; Primary data collection, 1990. (1989 fishing season)

Project sponsor: University of Wisconsin Sea Grant Institute.

Publications: Lyke (1993, Dissertation)

Stated Purpose of Research Effort: The purpose of this study was to investigate whether valuation of environmental quality, as represented by catch rates per unit of effort, could be measured using the TCM, and whether TCM and CVM estimates converge for the same quality change. The TCM model and overall data collection effort was discussed in the Lyke (MS-TCM 1993) entry above. Here we concentrate on the CVM estimates.

Data Collection/Sampling Information: Several contingent valuation questions were asked, including increased daily catch limits, reduced contaminants in fish, health risks of consuming fish and restoring natural lake trout populations. Here we focus on the net value questions related to Great Lakes fishing, which characterizes the format used in the other topic areas. After individually estimating personal expenditures for Great Lakes fishing, respondents were asked the following dichotomous choice question:

> In the last section you told us how much you spent on Wisconsin Great Lakes fishing in 1989. Suppose that fishing conditions (catch rates, regulation, contaminant levels etc.) in 1990 are roughly the same as those in 1989 with one exception:
>
> o Your annual costs will be $ _____ higher than you paid in 1989.
>
> Under these conditions would you still choose to fish in the Wisconsin Great Lake in 1990 (*CIRCLE ONE NUMBER)*
>
> 1 No
> 2 Yes, I would still fish the Wisconsin Great Lakes.

Reported values: Annual mean net values were estimated and the information in the dissertation allows these values to be converted into net value per trip. The average CVM net value per Great Lakes trip was estimated to be about $51 ($2012). This is larger than the corresponding estimate from the TC model of about $35 ($2012) although this interpretation is made with some qualifications because of concerns about the TCM values estimated in Lyke (TCM 1993). We convert Lyke's estimated CVM value to a rough per-day value estimate of $41 by dividing the per-trip value by 1.25. This indirect adjustment factor (1.25=25/20) was derived from the 1991 National Survey of Fishing, Hunting and Wildlife-Associated Recreation by dividing the estimated 25 million annual Great Lakes fishing days by the estimated of 20 million annual Great Lakes trips fishing trips.

Assessment of Study and Relevance to the Great Lakes: Much of the data and estimation issues raised in the Lyke (MS-TCM 1993) review do not carry over to the CVM analysis, as the latter uses only the CVM responses to the Wisconsin Great Lakes Sport Fishing Survey. A limitation of the data is that it measures per trip net value rather than per day net value, making it difficult to compare with other surveys. The CVM data is found to provide higher values than the TCM in this instance. Such results contrast with revealed preference/stated preference comparisons found in Carson et al. (1996)

This study provides a regional net value for a marginal fishing trip under the conditions that existing in Wisconsin Great Lake Waters in 1989. It is thus relevant to the present objective of estimating net value of GL fishing. Yet expanding a localized study to the entire geographical area of GL would not be appropriate because of the widely varying opportunities and conditions in the Great Lakes.

Connelly et al. (CVM 1997)

Location: Inland and Great Lakes Waters of New York

Data Type, Date: CV; Primary data 1996-1997

Project sponsor: New York State Department of Environmental Conservation (NYSDEC)

Publications: Connelly et al. (1997, Report)

Stated Purpose of Research Effort: A systematic sample of resident and nonresident New York fishing license holders was selected for the license year over the period from October 1995 through September 1996. The licenses were sorted and the sample was stratified by county of purchase. A questionnaire was mailed in January 1997, in which respondents were ask to list for calendar year 1996 the number of days fished, species sought and travel cost by location (r.r. =62.4%; n=8,760, of which about ½ were asked CV questions). While this mail survey asked respondents to recall activities across the entire year, a separate phone survey was conducted each quarter in 1996. The completion rate for the entire year was 30%. Although the response rates varied greatly across methods, the average annual fishing days (17.6-17.7 days in 1996) were nearly identical.

After eliciting information about the entire fishing season, respondents were asked to recall a specific fishing trip from amongst the trips they had listed in the seasonal section. Respondents were then asked how many days they spent on the trip and the cost for their share of the expenses. Next, a series of questions was asked to get respondents to think in more detail about how much they would be willing to pay for that trip if their share of expenses had increased. Finally, respondents were asked the following open ended question:

> 'What is the MAXIMUM total amount that you would have been willing to pay for this fishing trip before you would have decided not to go?'
>
> $_____ MAXIMUM total cost you would have paid

These questions were designed to parallel those in Connelly and Brown (1990) and allow comparison of values across time.

Reported values: This research provides a number of values for various fresh water resources in New York. Net value per day for GL angling was about $22 ($2012). For inland lakes the value is also $22 ($2012).

Assessment of Study and Relevance to the Great Lakes: This large sample provides broad coverage across the entire state, and was stratified in ways that would allow aggregation

across sites. In conjunction with Connelly and Brown (CVM 1991) this research is unique in the sense that it allows comparison of estimates obtained using the same methods for fishing seasons eight years apart. Site-by-site comparisons across the two survey years indicated that values either remained the same or declined over time, which would be consistent with a fall in recreational angling effort on the GL that commenced in the early 1990s. In combination with a decline in fishing effort, the total estimates for the net-benefits of New York GL angling fell from $133 million dollars in 1988 ($2012) to $91 million dollars in 1996 ($2012).

The estimated values provide a regional net value for a fishing day under the conditions that existing in New York in 1988 and are relevant as such to the GL region. Yet expanding a single state study to the entire geographical area would not be appropriate because of the widely varying opportunities and conditions in the Great Lakes.

National Survey of Fishing, Hunting and Wildlife Associated Recreation – NFHWAR (CV 2006)

Location: All 50 states and the District of Columbia

Data Type, Date: CVM, Primary Data 2006

Project sponsor: U.S. Department of Interior, Fish and Wildlife Service (USFWS), and U.S. Department of Commerce, U.S. Census Bureau.

Publications: USFWS (2008)
 Aiken (2009)
 Harris (2010)

Stated Purpose of Research Effort: In an effort to provide information about the importance of wildlife-based recreation in the U.S., the current form of National Survey of Fishing, Hunting, and Wildlife-Associated Recreation has been conducted every five years since 1991 with only minor changes during that period.

Data Collection/Sampling Information: A multistage probability sample of "sportspersons" was drawn from Census Bureau files, generating 22,000 complete interviews (r.r. = 77%). Interviews were conducted by telephone and in person. While the survey is motivated, in part, by requests from State agencies to provide state-level information, small sample sizes in some Great Lakes and individual states were "too small to report data accurately" and in other cases consisted of only 10-29 observations.

The survey elicits information about type and frequency of fishing, species targeted, fishing and boat expenditures and demographic characteristics, From the perspective of this review, the above information is augmented by CV questions that differentiated between within-state and out-of-state residents. After asking respondents to think about their share of expenses for a typical trout (or bass or walleye) trip during 2006, respondents were asked to provide an open ended CVM response indicting the additional cost that would have prevented him/her from taking even one such trip. To wit, for trout fishing:

> What is the cost that would have prevented you from taking even one such trip? In other words, if the trip cost was below this amount, you would have gone TROUT fishing in [fill RESIDENT STATE], but if the trip cost was above this amount, you would not have gone.

> Keep in mind that the cost per trip of other kinds of fishing, hunting and recreational activities would not have changed.

The valuation question sequence was posed in terms of number of trips and cost per trips "because respondents were thought more likely to think in terms of trips." (Harris, 2010, p. 21). The economic values were converted to, and reported in, days to facilitate their use in analysis.

Reported values: Harris (2010) and Aiken (2009) provide estimates of net value per day of bass, trout and walleye fishing for selected states. The values reported exclude the Great Lakes. Average $2012 net value per day for in-state residents in the Great Lakes Basin for Bass Fishing are $50 (Iowa), $68 (Missouri), $50 (Illinois), and $69 (Indiana). For trout fishing, WTP/day is $48 (Pennsylvania) and $53 (New York). Walleye fishing net value per day is $68 (Minnesota), $91 (Wisconsin), $48 (Michigan) and $74 (Ohio).

Assessment of Study and Relevance to the Great Lakes: This periodic survey is important because it provides a series of snapshots of fishing effort. As such it is a source that is used for aggregating fishing effort across states and regions. A limit of this data is that coverage is thin in some settings, and the CV data are spotty and not linked to the quality of the resource. We note that contingent valuation estimates are also reported for previous iterations of this nationwide survey (see Boyle et al., 1998 and Aiken and Larouche, 2003) but we only report the most recent here because it most closely reflects current values. For reference, Appendix II provides the net economic values reported in the 1996 and 2001 surveys for states and regions in the GL and UMORB. The results from these two data collection efforts provide results consistent with the range of values provided in Table III.1.

With respect to providing net values the results from this study could be of relevance to the Great Lakes to fill in gaps for some species in some states where other non-market valuation studies have not been conducted.

Breffle et al. (Combined Methods 1999)

Location: Wisconsin Waters of Lake Superior and Lake Michigan and inland fisheries.

Data Type, Date: Combined travel cost method and choice experiments (a variation on contingent valuation), Primary Data Collection, 1999. (1998 fishing season)

Project sponsor: University of Wisconsin Sea Grant Institute.

Publications: Breffle et al. (1999, Report)
                   Morey and Breffle (2006, Journal Article)

Stated Purpose of Research Effort: The USACE documents (2000, 2012) treat TCM and CVM methods as mutually exclusive. However, beginning in the 1990s, non-market valuation researchers began combining these two methods (Whitehead et al., 2008). The following study uses an approach that combines the travel cost method with choice experiments (a variation on contingent valuation).

The objective of this research was to assess compensable values of losses of recreational fishing opportunities as a result of releases of polychlorinated biphenyls (PCBs) into the waters of Green Bay. This report was prepared as part of the Lower Fox River/Green Bay Natural Resource Damage Assessment. This study offers a counterpart to the MacNair and Desvousges study referenced in the review of Murdock (MS-TCM 2003) above.

Data Collection/Sampling Information: A three-step procedure was used to collect data from a random sample of individuals in the target population of anglers who purchased licenses in counties near Green Bay and who were active in fishing the Wisconsin waters of Green Bay. First, a random sample of anglers was drawn from county lists of 1997 resident and non-resident license holders. Second, using the license holder list, a telephone survey was conducted to identify and recruit Green Bay anglers for a follow-up mail survey. The telephone survey (r.r. = 69.4%), conducted from November 1998 to January 1999, collected data on the per day costs per angler and the number of fishing days under then current, 1998, conditions at Green Bay, along with attitudinal data. The cost and visitation data served as the primary inputs for the RP model. Third, a mail survey with the stated preference questions was conducted with the current Green Bay anglers (r.r. = 78.9%, n=647). Respondents who agreed to participate in the mail survey were mailed a survey booklet within one week after they completed the telephone survey.

The stated preference valuation section consisted of a sequence of paired choices in six characteristics (e.g. time to catch a fish for each of four species, daily fee, water contamination level) were systematically varied (See box on next page).   Random parameter

choice modeling methods were used to derive the marginal willingness to pay for improvements in fishing conditions.

If you were going to fish the waters of Green Bay, would you prefer to fish the waters of Green Bay under Alternative A or Alternative B? *Check one box in the last row*		
	Alternative A ▼	**Alternative B** ▼
Yellow Perch		
Average catch rate for a typical angler.........................	40 minutes per perch	30 minutes per perch
Fish consumption advisory.........	No more than one meal per week	No more than one meal per week
Trout and Salmon		
Average catch rate for a typical angler.........................	2 hours per trout/salmon	2 hours per trout/salmon
Fish consumption advisory.........	Do not eat	No more than one meal per month
Walleye		
Average catch rate for a typical angler.........................	8 hours per walleye	4 hours per walleye
Fish consumption advisory.........	Do not eat	No more than one meal per month
Smallmouth bass		
Average catch rate for a typical angler.........................	2 hours per bass	2 hours per bass
Fish consumption advisory.........	No more than one meal per month	Unlimited consumption
Your share of the daily launch fee.......................	Free	$3
Check the box for the alternative you prefer.............................	❏	❏

Reported values: The reported values in the study primarily pertain to the values estimated for reduced levels of water pollution in Green Bay, Wisconsin. As such the values are generally not applicable to valuing entire fisheries in the GL. For example, Breffle et al, (1999) report the following WTP values ($2012) for a 10% increase in catch rates for a range of species in Green Bay holding the contamination level constant: Yellow Perch ($1.03), Trout/Salmon ($1.07), Walleye ($0.56), Smallmouth Bass ($0.90), All Species at Once ($3.56). For these estimates the fish consumption advisory (FCA) level was kept constant at 4, which corresponds to the least restrictive of the actual FCAs then present in Green Bay in 1998 (FCA 4: do not eat more than once a week for perch, and once a month for trout/salmon, bass and walleye).

Assessment of Study and Relevance to the Great Lakes: The study is useful in that it provides an example of how combined valuation methods could be used for fishing quality changes at one, and only one, site. The minimalist modeling approach proposed in Morey and Breffle (2006) could lead to defensible estimates of compensatory damages without the additional cost of "collecting legally defensible data on all the sites [which] can cost hundreds of thousands of dollars." (Morey and Breffle, 2006, p. 151). The values however pertain to an area of the GL that is relatively contaminated and may hence be specific to those conditions.

Further, the values reported here are not appropriate for valuing decrements in fish catch because they only focus on improvements in water quality as measured by FCA level. As shown in the Jones and Sung and MSU technical summaries in Appendix I, values for losses and gains in quality are not symmetric because of entry and exit into recreational fishing.

Synthesis of Recreational Fishing Net Values

Estimating the Net Value of Fishing: This chapter reviews available studies that estimate the net value of recreational fishing in the Great Lakes Basin. Table III.1 provides a summary of estimates of net value per day of fishing from selected studies reviewed in this chapter, organized by the valuation method used. Studies included in the table are those that provide sufficiently rigorous estimates of the net value of fishing applicable to the study area.

The estimates of net value in Table III.1 can be used to evaluate whether it is appropriate to use USACE's published unit day values (UDVs) to estimate the net value of recreational fishing in the study region. The USACE procedures and guidelines state that the UDV approach is not appropriate "If evidence indicates a value outside the published range" (USACE 2012). For "most warm water fishing" the relevant UDV would be "General Recreation" with an associated $2012 range of $3.72 to $11.17 (USACE 2012, p. 1). For "unique experiences such as inland and marine fishing for salmon and steel head" the UDV would be classified as "Specialized Recreation", with corresponding UDVs of $15.13 to $44.21 (USACE 2012, UDV attachment, p. 1). Because the estimates of the net value per day of fishing in Table I.1 tend to lie above the range of UDVs published by USACE – particularly for warmwater fishing. USACE UDVs should not be used to estimate the net value of fishing in the Great Lakes Basins. Instead, estimates should be used from studies conducted specific to the region for the specific activities (coldwater and warmwater fishing).

No single study in Table III.1 covers the entirety of the study region in terms of geography or species targeted. This lack of coverage is important because evidence provided in a number of studies suggests that fishing values will vary across recreational sites and types of fishing. Therefore, fishing values estimated in one part of our study region may not apply very well to other parts of our study region. For this reason, we conclude that *no existing individual study* can be used to provide an average net value per day estimate for the entirety of the Great Lakes Basin.

Nevertheless, when *considered as a set,* we do believe that the studies included in Table III.1 can be used to help determine the range of net values per fishing day that might be expected for the study area. While the range of net values provided by the various studies is broad, there is some convergence across studies. Because these studies were conducted in a variety of settings within the Great Lakes region, this range of net values likely encompasses the average net value within the region. An examination of the values in Table III.1 reveals that the number of observations above $75 are few and dispersed. Dropping the top three value estimates (Boyle et al., 1999, Salmon; Boyle et al., 1999 Bass, and Aiken, 2009 Walleye), which

Table III.1. Estimated Willingness to Pay Values per Person per Fishing Day

Valuation Method	Estimated Net Value/ Day ($2012)[a]	Fish Category	Location	Reference
Average Benefits Transfer	45	Cold water fish	Great Lakes and the Northeast	Loomis and Richardson (2008)
Average Benefits Transfer	48	Warm water fish	Great Lakes and the Northeast	Loomis and Richardson (2008)
Average Benefits Transfer	44	Anadromous runs	Great Lakes and the Northeast	Loomis and Richardson (2008)
Average Benefits Transfer	23	Mixed species	Great Lakes and the Northeast	Loomis and Richardson (2008)
Average Benefits Transfer	56	Species not specified,	Great Lakes and the Northeast	Loomis and Richardson (2008)
Average Benefits Transfer/Meta Analysis	45-54	General	Great Lakes and the Northeast	Rosenberger and Loomis (2001)
Meta Analysis	90[b]	Bass	Great Lakes	Boyle et al. (1999)
Meta Analysis	109[b]	Salmon	Great Lakes	Boyle et al. (1999)
Travel Cost Method	41	Trout	Michigan Great Lakes	Lupi and Hoehn (1997)
Travel Cost Method	51	Salmon	Michigan Great lakes	Lupi and Hoehn (1997)
Travel Cost Method	42	Salmon and/or Trout	Wisconsin Water, Southern Lake Michigan	Phaneuf et al. (1998)
Travel Cost Method	42-55	Anadromous Runs	Lake Erie Tributaries	Kelch et al. (2006)
Travel Cost Method	33-34	General	New York Inland and Great Lakes Waters	Spink (2013)
Contingent Valuation	54	Yellow Perch	Green Bay	Bishop et al. (1990)
Contingent Valuation	25	General	New York Great Lakes	Connelly and Brown (1991)
Contingent Valuation	28	General	New York Inland Waters	Connelly and Brown (1991)
Contingent Valuation	41	Salmon and Trout	Wisconsin Water, Great Lakes	Lyke (1993)

(continued on next page)

Table I.1. Estimated Willingness to Pay Values per Person per Fishing Day (continued)

Valuation Method	Estimated Net Value/ Day ($2012)[a]	Fish Category	Location	Reference
Contingent Valuation	22	General	New York Great Lakes	Connelly et al. (1997a)
Contingent Valuation	22	General	New York Inland Waters	Connelly et al. (1997a)
Contingent Valuation	50 (IA), 50 (IL), 69 (IN)	Bass	Selected States in Great Lakes	Aiken (2009)
Contingent Valuation	48 (PA), 53 (NY)	Trout,	Selected States in Great Lakes	Aiken (2009); Harris (2010)
Contingent Valuation	49 (MI) 68 (MN), 74 (OH), 91 (WI)[b]	Walleye	Selected States in Great Lakes	Aiken (2009)

a.   Rounded to the nearest dollar.
b.   As discussed in the text, these three observations are regarded as outliers.

we characterize as outliers, suggests that average net value estimates will likely lie in the range from $20 to $75 ($2012).

As noted above, identifying a range of the value of a fishing day is only one of the components needed to estimate value of recreational fishing in the region. A measure of how much fishing occurs, such as angler days per year, is also needed. The US Fish and Wildlife Service provides periodic estimates of Great Lakes fishing effort as part of its National Survey of Fishing Hunting and Wildlife Associated Recreation (e.g. USFWS, 2006). This report does not break out participation data for the either the Great Lakes Basin. However, it does report fishing participation for the Great Lakes, a resource that has received substantial popular attention due to concern about aquatic nuisance species in recent years and for which aggregate expenditure and economic impact values have been reported by the government and private entities (Great Lakes Commission, 2012; American Sportfishing Association, 2008).

We use participation data from the 2011 National Recreation Survey (USFWS, 2013), as this is the most recent survey reported. Although the USACE has expressed concerns about using the USFWS (2008) report for generating a value of recreation for GLMRIS (USACE, 2011), the USFWS estimates of Great Lakes angler days remain the best currently available. Moreover, these estimates have been used elsewhere for calculating recreational value for the Great Lakes. For comparative purposes it is helpful to use the same baseline for aggregating values.

Multiplying the USFWS estimate of about 19.661 million angler days in the Great Lakes in 2006 by the range of net values ($20 to $70 in $2012 dollars) identified above, results in a an estimate of the aggregate annual net value of recreational fishing in the Great Lakes region of $393 million to $1.47 billion ($2012).

Estimating Changes in the Net Value of Fishing in Response to ANS: While several studies have been conducted within the study region that attempt to estimate the impact that changes in fishing quality would have on recreational values from fishing, we conclude that individually and collectively these studies do not provide a good basis for calculating economic losses associated with potential declines in catch rates, a measure of fishing quality that can potentially be linked to aquatic nuisance species. Our review of available studies shows that changes in net values that occur due to changes in catch rate depend on current catch rates at a site, the availability of alternative fishing sites, and other factors. Therefore, transferring estimates of economic losses associated with a decline in fishing quality based on a study at one site to other sites within the study area is not recommended.

An analysis by Johnston et al. (2006) points to another possible approach to estimating damages, multiply WTP per fish by the reduction in fish catch. Motivated by policy analyses that call for welfare estimates denominated in per fish units (e.g. US EPA, 2004), they conduct a meta analysis of the marginal value of catching an additional fish. The meta regression results demonstrate that reported values vary systematically with methodological variations across studies, angler attributes, and resource and context attributes. After statistically accounting for these variations across studies, "These results suggest that WTP per fish is closely related to the type of species targeted. Moreover, model results appear to be consistent with common intuition regarding the highest verses lowest value recreational fish" (Johnston et al. 2006, p. 23). Despite this positive result, a closer examination of the data suggests that WTP per fish varies widely for a species across studies. For example, Johnston estimates marginal WTP for walleye to be $5.10 ($2012) in the Breffle et al. (RP/SP 1999) study and $27.95 ($2012) based on Murdock's analysis.

On the basis of this wide variability in value per fish across studies, we would not recommend using a WTP per fish approach based on the existing literature to address quality changes in the GLMRIS study area.

Appendix I. Technical and Econometric Details of Studies Reviewed

This Appendix provides additional information about technical details for many of the recreational valuation studies reviewed in Chapter III.   The order of presentation follows the ordering in those chapters.

Loomis and Richardson (ABT 2007): Technical Econometric Details.

There are no technical features that merit attention for this report.

Rosenberger and Loomis (ABT/MA 2001): Technical Econometric Details.

There are no technical features for the average benefits transfer portion of the study that merit attention for this report.

The meta analysis includes 701 net value estimates from 131 studies of 21 recreation activities from 1967 to 1998. An ordinary least squares model of a linear form was used to estimate the meta regression. From the perspective of this review, the meta regressions finds that the valuation method, region, and water body were significant explanatory factors. The coefficient on fishing, however, was not significantly different from general recreation.

A separate meta regression was not run for fisheries data by itself and net value estimates are derived from the broader model.

Boyle et al. (MA 1999): Technical Econometric Details.

The data used were not the complete population of studies available at the time. Because of resource constraints, data collection was truncated at 150 of the 250 or so studies identified in the literature.

An ordinary least squares model of a linear form was estimated. Coefficients that were significant in the full sample model included the type of fish, the water body, valuation technique and method used to elicit values (e.g. a mail survey).

Of relevance to this review are the two hypothetical policy scenarios, assuming a travel cost method, for Great Lakes Salmon and Great Lakes Bass Fishing. The respective estimated total day values in $1996 were $62.06 ($48.50) and $75.10 ($48.61) with the standard deviation of the estimates provided in the parentheses. As such, the estimated are relatively imprecise with coefficients of variation of 1.28 to 1.55. Hence, utilization of these net value estimates should be done with caution.

Lyke (MS-TCM 1993): Technical, Econometric Details.

The TCM data were estimated using various random utility modeling specifications. It was found that a two-level nested logit model was estimable and performed best amongst alternatives considered. The two nesting levels were fishing mode (charter fishing, fishing from a private boat, stream fishing or another kind of fishing) and fishing site (defined as a fishing area in relation to a location). Estimated coefficients on trip cost and time were negative. Coefficients for catch rates were positive.

There are several technical concerns with this study. The data collected from the Wisconsin Great Lakes (WGL) and Wisconsin Sportfishing (WSF) surveys are distinct in the sense that no site specific data is collected on inland fisheries activities in the WGL. Within the inland questionnaire, the locational data is collected for only two of the most visited sites, raising questions about the completeness of the site choice set and subsequent biases. Further, it is not clear how alternative sites were identified and included into the analyses. These limitations on spatial resolution hamper consideration of substitution effects between Great Lakes and Inland Waters, and uncertainty about how site alternatives were handled raises concerns about the overall econometric analyses. Variation in catch rates is significant in the model, but is based on self-reported catch data which has been argued against in the literature because of endogeneity. Finally, there is a lack of clarity in the dissertation explaining how values were derived, which complicates external assessment of the quality of the analysis.

**Jones and Sung (MS-TCM 1993): Technical, Econometric Details.**

The authors developed a random utility model of demand for recreational fishing, covering all water bodies and all species types throughout all 83 counties in the state. A nested multinomial logit RUM was used for the site choice model. Three levels of choices were modeled for each choice occasion: type of trip (single day or multiple day), fish product line (type of fish pursued), and destination site. A major innovation in this study was the use of "product lines", drawn from an earlier factor analysis study of the 1983-84 fishing season that identified distinct fishing experiences across license holders (Kikuchi, 1986). The resulting product lines incorporate distinctions among type of water body (Great Lake, tributaries, and inland rivers/streams) and type of fish species (warm water and cold water). The inclusive values of the nested RUM model lie within the expected utility theoretic range, indicating that the product line groupings represent an improvement over models without such groupings. Within the product lines, the coefficient on the trip cost was negative, and quality measures tended to be positive. While a participation model was estimated, its acceptability is hampered by the lack of trip frequency data and is not discussed here.

Jones and Lupi (2000) find that a 10% decrease in catch rates creates a decline in aggregate fisheries use-value that is 7% to 14% lower than the increase in aggregate fisheries use value associated with a 10% increase in catch rates. For a 50% change in catch rate, the value associated with a decrease is 34% to 45% lower that the corresponding value for an increase. In conjunction with the MSU (TCM 1996) study discussed below, this provides evidence that there is an asymmetry between gains and losses in catch rates.

MSU (MS-TCM 1996): Technical, Econometric Details.

The basic structure of the nested multinomial logit model followed that of Jones and Sung (1993). Three levels of nested decisions were modeled: trip length (single day versus multiple day), product line (Great Lakes (GL) cold water fishing, GL warm water fishing, Inland lakes (IL) warm water fishing, IL cold water fishing, Rivers and Streams (RS) cold water fishing, RS warm water fishing, and Anadromous Runs), and destination site choice within each one of these trip length/product line decision branches. A difference from the Jones and Sung (1993) model is that the panel data allowed MSU to model 63 choice occasions across the season in which the probability of taking a trip and, if a trip is taken, the series of nested probabilities leading to the destination choices were estimated. Thus, the total number of trips taken during the season can be modeled. Site quality for the GL warm water, GL cold water and the anadromous product lines are calculated using Michigan Department of Natural Resources creel data for each county and vary by month. IL stream and river miles were aggregated and categorized as described in the Jones and Sung (1993) above. The quality measures were generally statistically significant and positively correlated with the probability of being chosen. The coefficient on trip costs was negative, and varied between single day and multiple day trips. The inclusive values for each nest were consistent with utility theory, and support the nesting structure over a non-nested model.

The MSU analyses allow for the possibility of estimating changes in net benefits across a broad range of percentage changes in fish catch rates. The figure below demonstrates an important result from this study, that because of entry and exit, willingness to pay for a change in catch rates (CR) is non-linear (source: Source: Lupi and Hoehn, 1997, Figure 4)
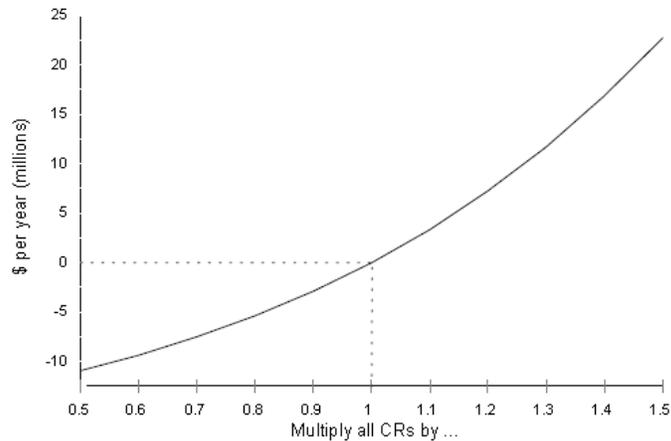
The reason for this asymmetry in a recreational fishery travel cost model is discussed by Lupi and Hoehn (1997):

> "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 is 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." (p. 13)

Phaneuf et al. (MS-TCM 1997): Technical, Econometric Details.

The authors develop a utility-theoretic Kuhn-Tucker modeling approach for recreational modeling in which many site choices have zero observations. As noted above, the Great Lakes portion the Lyke (TCM, 1993) study provides for adequate information about substitute Great Lake activities but not information about inland product lines. The extension of Kuhn-Tucker modeling to recreation is a contribution. However, such a modeling approach is appropriate only for limited numbers of site choices, and is not extendable to more extensive choice settings. The use of only the Great Lakes data set from the Lyke study preempts concerns about substitutes mentioned in that review.

The coefficients of trip price and catch rate are negative and positive, respectively.

Upneja et al. (TCM 2001)

An ordinary least squares regression strategy was used for the recalled trip and the total number of trips taken in the previous 12 months. While the coefficient on trip cost was negative, the significance levels of the coefficient are not provided. There is no correspondence between the trip cost and the total number of trips taken. Substitute sites are not accounted for in the model, leading to possible omitted variable bias in the estimates.

Besedin et al. (MS-TCM 2004): Technical, Econometric Details.

A random utility, site choice model was estimated using a multinomial logit model. Choice sets included up to 74 randomly selected sites per angler within 120 miles from the angler's home zip code. Since socioeconomic data was not collected, median household income by zip code from the 2000 census was used as an income variable. The authors attempted to estimate a nested logit model with separate nests for warm water and cold water species. However, in contrast to the Jones and Sung (TCM, 1993) and the MSU (TCM 1996) studies, nested models are reported not to fit as well, with the authors suggesting that the poorer fit was due to overlap between warm water and cold water fishing sites. In addition, data was not available on the number of trips by mode, so that welfare estimates were based only on the total number of trips. The coefficients in the resulting model have the expected signs: notably the coefficient on travel cost is negative and coefficients on catch rates are positive.

The modeling does not account for a trip participation model for the Great Lakes, "because the required data were not available" (US EPA, 2004, G4-9).

Murdock (MS-TCM 2006): Technical, Econometric Details.

This research argues that the use of quality in travel costs models captures many other site characteristics. Hence, the estimates of the coefficients for site are likely biased. An alternative two stage method of analysis is developed that simply uses binary variables for each county and then regresses the county specific coefficients on quality variables.

Because of econometric complications which results in an incorrect coefficient on travel cost, illustrative policy values for a 10% increase in walleye and musky catch are reported in miles rather than dollars. The proposed modeling approach provided WTP estimates for changes in quality that are notably larger, up to a factor of four, than when estimated with traditional modeling approaches.

Kelch et al. (MS-TCM 2006)

Although individuals were contacted at different streams, the model was estimated like a single site count model. Site specific dummy variables were used to account for potential unobserved characteristics across sites. Corrected and uncorrected negative binomial count models were estimated. The coefficient on travel cost was negative and significant. Quality data were not collected and hence were not included in the model.

Spink (MS-TCM 2007)

A random utility, nest-logit model was run with three decision levels (nests): participation (whether to go fishing of not on a particular choice occasion), fishing type (Great Lakes or Inland waters), and site choice. The scale coefficients for each nest were consistent with utility theory, descending in value as they move from the top to lower nests.

The value per day (-σ/ $\beta_{Travel\ Cost}$) was estimated by scaling the inverse of the travel cost value (i.e. the marginal utility of income = -1/$\beta_{Travel\ Cost}$) by the participation nest scale parameter (σ

Milliman (CV 1986):

Respondents answered s dichotomous choice question which was modeled using a logit random utility model. The probability of a yes response declined significantly with the dollar value, but was not significantly related to catch rate or average size.

Connelly and Brown (CV 1990)

A linear demand function was mentioned but not reported. WTP values were derived from the demand estimate.

Lyke (CV 1993)

Simple logit random utility models were estimated for the dichotomous choice responses with only the cost value as a covariate. The coefficient on costs was negative.

Connelly et al. (CV 1997)

A linear demand function was mentioned but not reported. WTP values were derived from the demand estimate.

Breffle et al. (RP/SP 1999)

The authors estimated what they refer to a as a minimal RUM that they identified as being appropriate for estimating compensatory values in Natural Resource Damage Assessment for

unique settings in which the quality varies only at one site. This model used a complete data set in the sense that all alternative fishing sites, and the alternative of not fishing, were included in the choice set.   However, details about the individual fishing sites were not utilized. Instead fishing at all other sites was combined with all the nonfishing alternatives. The authors recognized that such a model will not suffice if one wants to value changes at multiple fishing sites or how much demand at another site will drop when one site is improved. This model combined travel costs and choice experiment data to value improvements relative to the current level of contamination.

Estimated coefficients on catch rates and indicators characterizing the level of fishing advisories were significant and corresponded to directional expectations.

Appendix II. Net Benefits Estimates from the 1996 and 2001 USFWS National Surveys of Fishing, Hunting and Wildlife-Related Recreation

The main body of this report provides contingent valuation estimates for recreational angling obtained from the 2006 USFWS National Survey of Fishing, Hunting and Wildlife-Related Recreation. The 2006 survey is the most recent of the periodic USFS surveys for which estimated net-benefits are reported. As indicated in the text, these are presently the most relevant estimates to the objectives of the report. For reference, we report estimated values from the 1996 and 2001 USFWS national surveys.

The following values were reported in Boyle et al. (1998), for the 1996 National Survey and Aiken and La Rouche (2003)

Table AII.1. Estimated Willingness to Pay Values per Person per Fishing Day, 1996 USFWS National Survey

Valuation Method	Estimated Net Value/ Day ($2012)[a]	Fish Category	Location	Reference
Contingent Valuation	22	Bass	USFS Service Region (IA,IL, IN, MO)	Boyle et al. 1998
Contingent Valuation	35	Bass	East North Central US Bureau of Census Region (IL,IN)	Boyle et al. 1998
Contingent Valuation	32 (WV), 44 (IA), 46 (IN),67 (IL), 67 (MO), 78 (KY)	Bass	Selected States in Great Lakes and UMORB	Aiken and La Rouche (2003)
Contingent Valuation	49 (NY), 78 (PA)	Trout	Selected States in Great Lakes and UMORB	Aiken and La Rouche (2003)
Contingent Valuation	56 (OH), 61 (MN), 67 (WI)	Walleye	Selected States in Great Lakes and UMORB	Aiken and La Rouche (2003)

a. Rounded to the nearest dollar.

A paper by Whitehead and Aiken (2007) compares values elicited and trends in values across earlier USFWS surveys.

Glossary of Acronyms

ABT – Average Benefits Transfer

ANS – Aquatic Nuisance Species.

CATI – Computer Assisted Telephone Interviewing

CPI – Consumer Price Index

CR - Catch Rates

CV – Contingent Valuation

GLMRIS – Great Lakes and Mississippi River Interbasin Study

MA – Meta Analysis

NED – National Economic Development

r.r. – Response Rate

TCM – Travel Cost Method

USACE – U.S. Army Corps of Engineers

USFWS – U.S. Fish and Wildlife Service

WTP – Willingness to Pay

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