Net Benefits of Recreational Fishing in the Great Lakes, Upper Mississippi River, and Ohio River Basins

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Executive Summary

This report provides estimates of the net value to anglers of recreational fishing in the Great Lakes and Upper Mississippi and Ohio River basins within the following 12 states: Minnesota, Iowa, Missouri, Wisconsin, Illinois, Indiana, Kentucky, Michigan, Ohio, West Virginia, Pennsylvania and New York. Within these three basins, particular attention is given to those lakes, ponds, rivers, and streams that are located downstream from all barriers impassable to fish (dams, waterfalls, etc.). It is these waters that the United States Army Corps of Engineers (USACE) considers susceptible to the effects of possible aquatic nuisance species (ANS) transfer between the Great Lakes basin and the Upper Mississippi and Ohio River basins (in either direction).

Cornell University (CU) developed an economic model to estimate net baseline recreational fishing values using the travel cost valuation method. The development of these net benefit estimates took place in three stages: (a) a series of focus groups with recreational anglers; (b) surveys of recreational anglers; and (c) the development and estimation of an economic model of angler behavior. The surveys were also used to develop estimates of trip expenditures.

Based on fishing license sales data provided by the states, it was estimated that 6.6 million anglers lived and fished in the 12-state study area in 2011. These anglers spent an estimated 62.9 million days fishing in those portions of the Great Lakes basin below barriers impassable to fish. They spent 57.6 million days fishing in those portions of the Upper Mississippi and Ohio River basins that are below barriers impassable to fish.

The average net value per angler day, estimated from CU's recreational fishing model, was $19.52. The aggregate net value of recreational fishing in those portions of the Great Lakes basin below barriers impassable to fish is estimated to be $1.228 billion for calendar year 2011. The corresponding aggregate net value of recreational fishing in those portions of the Upper Mississippi and Ohio River basins below barriers impassable to fish is estimated to be $1.124 billion.

Although CU was originally tasked with estimating the impacts of ANS on the net value of recreational fishing, USACE was not able to obtain sufficient information to quantify the timing or magnitude of impacts of ANS on sportfish populations in the Great Lakes, Upper Mississippi River, and Ohio River Basins. Consequently, this report serves as an indicator of the net value of recreational fishing that *could* be impacted in the future without-project (FWOP) condition – the case where no Federal action is taken to prevent the transfer of ANS between the Great Lakes and Mississippi River Basins.

Acknowledgments

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Critical input on econometric modeling and survey design were provided by Frank Lupi (Michigan State University) and John Whitehead (Appalachian State University). Interaction between the study group and these external reviewers was facilitated by funding through USDA Regional Project W-2133, which also provided support for computer software used to generate travel cost estimates in this research. Cornell University and Pennsylvania State University are also acknowledged for their support of this research effort.

The authors of this report are particularly indebted to the numerous recreational anglers throughout the 12-state study area who participated in our focus groups and surveys.

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Study Background

GLMRIS Background Information

The United States Army Corps of Engineers (USACE), in consultation with other federal agencies, Native American tribes, state agencies, local governments and non-governmental organizations, is conducting the Great Lakes and Mississippi River Interbasin Study (GLMRIS). In accordance with the study authorization, USACE will evaluate a range of options and technologies (collectively known as "ANS controls") to prevent the spread of aquatic nuisance species between the Great Lakes and Mississippi River basins by aquatic pathways.

An aquatic nuisance species (ANS) is a nonindigenous species that threatens the diversity or abundance of native species or the ecological stability of infested waters, or commercial, agricultural, aquacultural or recreational activities dependent on such waters. See 16 U.S.C. § 4702(1) (FY13).

As a result of international commerce, travel and local practices, ANS have been introduced throughout the Mississippi River and Great Lakes basins. These two basins are connected by man-made channels that, in the past, exhibited poor water quality, which was an impediment to the transfer of organisms between the basins. Now that water quality has improved, these canals allow the transfer of both indigenous and nonindigenous invasive species.

USACE is conducting a comprehensive analysis of ANS controls and will analyze the effects each ANS control or combination of ANS controls may have on current uses of: (a) the Chicago Area Waterway System (CAWS), the only known continuous aquatic pathway between the Great Lakes and Mississippi River basins; and (b) other aquatic pathways between these basins. Following the *Economic and Environmental Principles and Guidelines for Water and Related Land Resource Implementation Studies*, Water Resource Council, March 10, 1983, USACE will:

- Inventory current and forecast future conditions within the study area;
- Identify aquatic pathways that may exist between the Great Lakes and Mississippi River basins;
- Inventory current and future potential aquatic nuisance species;
- Analyze possible ANS controls to prevent ANS transfer, to include hydrologic separation of the basins;
- Analyze the impacts each ANS control may have on significant natural resources and existing and forecasted uses of the lakes and waterways within the study area; and
- Recommend a plan to prevent ANS transfer between the basins. If necessary, the plan will include mitigation measures for impacted waterway uses and significant natural resources.

Significant issues associated with GLMRIS may include, but are not limited to:

- Significant natural resources such as ecosystems and threatened and endangered species;
- Commercial and recreational fisheries;
- Current recreational uses of the lakes and waterways;
- ANS effects on water users; and
- Effects of potential ANS controls on current waterway uses such as flood risk management, commercial and recreational navigation, recreation, water supply, hydropower and conveyance of effluent from wastewater treatment plants and other industries.

GLMRIS Navigation and Economics Product Delivery Team

The GLMRIS Navigation and Economics Product Delivery Team (PDT) is tasked with demonstrating the economic activities that could be impacted by the implementation or lack of implementation of a GLMRIS project. The PDT is comprised of several sub-teams that examined several economic activities that take place within the GLMRIS detailed study area – which are displayed in Table 1.

The Fisheries Economics Team completed five studies that focus on the following economic activities: commercial fishing, recreation, charter fishing, subsistence fishing, and pro-fishing tournaments. This report is a portion of the "recreation" study. These study categories serve to encompass the fishery-related activities that are likely to be impacted in either the future without-project (FWOP) or future with-project (FWP) conditions considered in GLMRIS.

Purpose of Report

In support of GLMRIS, Cornell University (CU) was tasked with estimating the current net value of recreational activities that take place within the Great Lakes Basin (GL), and the Upper Mississippi River and Ohio River Basins (UMORB) that are potentially impacted by ANS transfer between these basins. Based on a literature review conducted by Cornell University, the GLMRIS Project Delivery Team determined that recreational fishing is the recreational activity that has the greatest potential to be impacted by the transfer of ANS between the basins. This report provides an estimate of the current net value of recreational fishing in the Great Lakes basin and the Upper Mississippi and Ohio River basins.

Although Cornell University was originally also tasked with estimating the impacts of ANS on the net value of recreational fishing, USACE was not able to obtain sufficient information to quantify the timing or magnitude of impacts associated with ANS on recreational fish populations. Therefore, this assessment evaluates the current net value of recreational fishing that *could* be impacted by ANS.

Table 1. GLMRIS Navigation and Economics PDT

Sub-Team	**Focus**	**Study Area**[a]
Fisheries Economics	Commercial Fishing	GL, UMORB
	Recreation	**GL, UMORB**
	Charter Fishing	GL Basin
	Subsistence Fishing	GL, UMORB
	Pro-Fishing Tournaments	GL, UMORB
Cargo Navigation	Cargo navigation activities	CAWS
Non-Cargo Navigation	Non-cargo navigation activities	CAWS
Hydropower	Lockport Lock and Dam hydropower generation	CAWS
Water Quality	Water Quality	CAWS
Water Supply	Water Supply	CAWS
Flood Risk Management	Flooding impacts due to hydrologic separation	CAWS
Regional Economic Development	Regional economic contribution and impacts associated with the economic categories studied in GLMRIS	CAWS, GL, UMORB

a. "GL" indicates the Great Lakes Basin; "UMORB" indicates the Upper Mississippi River and Ohio River Basins; "CAWS" indicates the Chicago Area Waterway System.

Introduction

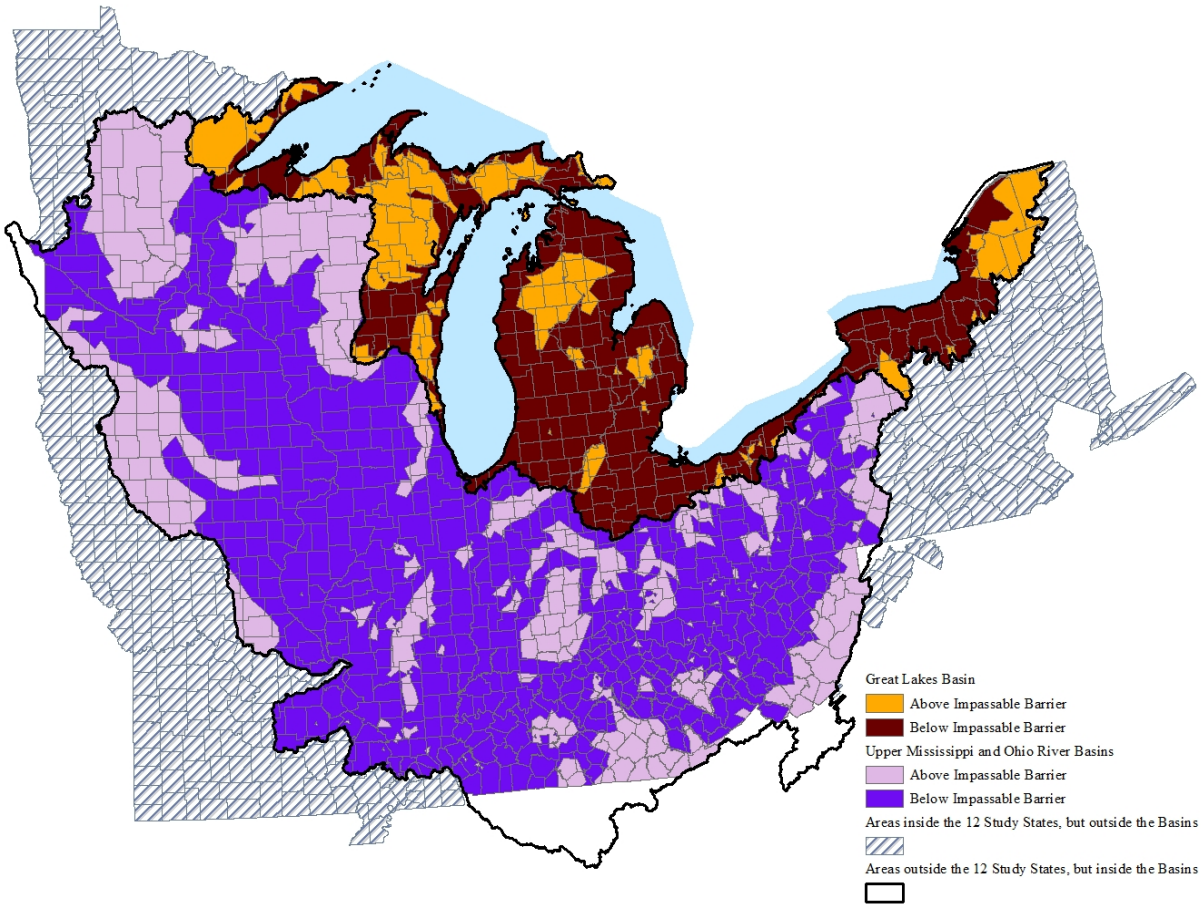
Objectives of this Report

As part of the USACE/ CU "Recreation Impacts of Aquatic Nuisance Species to the Great Lakes and Mississippi River Basins" cooperative agreement (W912HZ-11-2-0030), this report provides an estimate of the net value to anglers of recreational fishing in the Great Lakes and Upper Mississippi and Ohio River basins. The region on which this report focuses includes the watersheds of the Great Lakes and Upper Mississippi and Ohio River Basins within the following states: Minnesota, Iowa, Missouri, Wisconsin, Illinois, Indiana, Kentucky, Michigan, Ohio, West Virginia, Pennsylvania and New York (Figure 1). Consistent with USACE procedures and guidelines (USACE 1983), all dollar values reported in this document are updated to FY $2012 using the consumer price index (CPI Value=226.889, USACE 2012), unless otherwise noted[1].

This report is one product of a study designed to assess the possible effects if ANS transfer occurs between the Great Lakes basin and the Upper Mississippi and Ohio River basins (UMORB). The portions of the 12-state study area that were of particular interest, therefore, were the Great Lakes, the Upper Mississippi and Ohio Rivers, and those lakes, ponds, rivers, and streams that are not separated from these water bodies by any barriers impassable to fish (dams, waterfalls, etc.). It is these waters that USACE considers susceptible to the effects of possible ANS transfer between the Great Lakes basin and the Upper Mississippi and Ohio River basins (in either direction). Based on discussions with USACE and with biologists conducting research on invasive aquatic species in the Great Lakes basin and the UMORB, CU hypothesized that ANS transfer would affect the net value of recreational fishing by potentially decreasing the quality of the sport fishery resource. In particular, ANS transfer could lead to decreases in sportfish populations, which would lead to decreases in fishing success, as measured by catch rates. These decreases in catch rates could affect the net recreational value anglers derive from fishing in the study area in two ways. First, anglers could receive less value from each fishing trip they take. Second, anglers could choose to change where and how often they go fishing. CU's recreational fishing model is designed to be flexible enough to estimate projections of both types of impacts.

[1] The survey data was collected for Calendar Year 2011, which extends from January 1, 2011 to December 31, 2011. With exception of expenditure data for the most recent trip, the timing of fishing trips throughout CY 2011 is unknown. The U.S. government's Fiscal Year (FY) 2012 begins on October 1, 2011 and ends on September 30, 2012 and the Consumer Price Index (CPI) basis used by the USACE for FY 2012 is September 2011 (USACE 2012). Because the FY 2012 basis for the USACE lies in CY 2011, the values reported in this study can be regarded as either CY 2011 or FY 2012 values, the latter being appropriate for USACE reporting (US ACE 2012).

Figure 1. Map of study area.



This report focuses on the estimates of baseline fishing values generated using the travel cost method for fishing trips taken during 2011. Estimates of angler expenditures that can be used by USACE for regional economic impact analyses are also presented in this report.

Although Cornell University was originally tasked – in accordance with the United States Army Corps of Engineers (USACE)/Cornell University (CU) "Recreation Impacts of Aquatic Nuisance Species to the Great Lakes and Mississippi River Basins" cooperative agreement (W912HZ-11-2-0030) – to estimate the impacts of ANS on the net value of recreational fishing, USACE was not able to obtain sufficient information to quantify the timing or magnitude of impacts of ANS on sportfish populations in the Great Lakes, Upper Mississippi River, and Ohio River Basins. This lack of information prohibited CU from utilizing the full extent of their recreational fishing survey and subsequently developed logic model that would aid in the determination of the impacts of ANS on the net value of recreational fishing within these basins.

If USACE is able to quantify the timing and magnitude of ANS impacts on recreational fisheries in the future, the recreational fishing survey and logic model could be utilized to quantify the impact of ANS on the net value of recreational fishing.

Consequently, this report serves as an indicator of the net value of recreational fishing that could be impacted in the future without-project (FWOP) condition – the case where no Federal action is taken to prevent the transfer of ANS between the Great Lakes and Mississippi River Basins. However, it is important to note that this information does not preclude the possibility of changes in this net value of recreational fishing in the future with-project (FWP) condition, as other factors, aside from ANS transfer, could impact the behaviors of recreational anglers.

Overview of Conceptual Foundations: Net Value

This report generates an economic measure of the value of recreational fishing in the Great Lakes, Upper Mississippi and Ohio River Basins. Consistent with USACE procedures and guidelines (USACE, 1983, 2000, 2012), net (economic) value of a recreational resource is defined as the amount the recreational resource contributes 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).

Because a variety of 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 measures that are often reported, such as "expenditures" and "economic impacts." The net value of a recreational 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. CU provides a brief discussion of alternative measures such as expenditures and economic activity in the Appendix. The interested reader is also referred to Scodari (2009) and Aitken (2009) for further discussion.

Measures of net value are often 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 could then be estimated by multiplying the average net value per day (or per trip) by the estimated total number of days (trips) that anglers engaged in that activity. This is the appropriate measure of the annual net value generated by a recreational resource from a NED perspective and thus forms the basis for this study.

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). 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). The travel cost method and the contingent valuation method are two of these non-market valuation methods. USACE procedures and guidelines specify that these methods may be used for estimating the net values of recreational activities and estimating how those net values change in response to water-related projects.

The *travel cost method* uses actual visitation data on the number of trips taken to different recreation sites 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 a site and for sites with different resource quality. The travel cost method is

known as a *revealed preference* method because it is based on the current, actual behavior of recreationists.

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. The *contingent behavior* method is related to the contingent valuation method; in the contingent behavior method, recreationists are asked how their recreational choices (e.g., number of fishing trips taken) would change with an improvement or decrement in resource quality. Both the contingent valuation and contingent behavior methods are known as *stated preference* methods.

In this study, a combination of travel cost and contingent behavior approaches are used. The travel cost method and the contingent behavior method each have advantages and disadvantages. The advantages of the travel cost method are that it can provide an estimate of the baseline net value of the recreational resource (and subsequent changes in that value), it is based on actual behavior, it can model the entire causal chain linking resource quality to recreational value, and it is based on straightforward measures of actual behavior. The limitations of the travel cost method are that it requires extensive data on recreational activities and sophisticated economic modeling techniques, and it cannot be used to model situations that do not now exist (e.g. previously unexperienced changes in the composition of species.)

Stated preference methods, such as contingent behavior, can address some of the limitations of the travel cost method. Because recreationists are asked how their choices would change with changes in resource quality, these methods are very flexible and can be used to assess economic effects of scenarios that do not currently exist. This approach is also relatively less time consuming and less data intensive than using the travel cost model. One of the key limitations of stated preference models is that they are based on hypothetical questions about what an individual would do in a different, perhaps previously unexperienced, situation.

Models combining revealed and stated preference elements take advantage of the strengths, and avoid some of the limitations, of each of the two approaches (Whitehead et al., 2008).

Development of these models involves collecting data on actual trip behavior and adding hypothetical questions about behavior if resource quality were to change. This approach takes advantage of data on actual recreationist behavior but can introduce hypothetical situations and therefore model response to a wider variety of scenarios. The limitations of this approach are that data from questions about hypothetical and actual behavior may not be directly comparable, extensive data are needed, and considerable pre-survey work is required to develop sound survey methods.

Given CU's interest in: (a) developing estimates of changes in economic value that are based on reliable measurements of actual behavior; and (b) modeling recreationist responses to hypothetical future ecological scenarios that do not currently exist, CU adopted a combined revealed and stated preference model for this study.

Recreational Value of the Great Lakes and Upper Mississippi and Ohio River Basin Fishery: Literature Review

Poe et al. (2012) reviewed available studies that estimate the net value of recreational fishing in the Great Lakes, Upper Mississippi and Ohio River Basins. Table 2 provides a summary of estimates of net value per day of fishing from these studies. The studies reviewed were those that provided sufficiently reliable estimates of the net value of fishing applicable to the study area.

No single study in Table 2 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 the study region may not apply very well to other parts of the study region. For this reason, Poe et al. (2012) concluded that *no existing individual study* can be used to provide a representative estimate of net value per day or per trip for the entirety of either or both basins.

Nevertheless, Poe et al. (2012) argued that, when *considered as a set,* the studies included in Table 2 could be used to help determine the range of net values per fishing day that might be expected for the Great Lakes portion of 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 that region. An examination of the values in Table 2 reveals that the observations above $75 are few and spread out across a wide range of fishing types and/or locations. Dropping the top three value estimates (Boyle et al. 1999, Salmon; Boyle et al. 1999, Bass; and Aiken 2009, Walleye (WI)), which Poe et al. (2012) characterized as outliers, suggests that average net value estimates will likely lie in the range

Table 2. Estimated willingness to pay values per person per fishing day.

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

(continued on next page)

Table 2. Estimated willingness to pay values per person per fishing day (continued).

Estimated Net Value/ Day ($2012)[a]	Fish Category	Location	Reference
22	General	New York Inland Waters	Connelly et al. (1997)
50 (IA), 50 (IL), 68 (MO), 69 (IN), 71 (WV)	Bass	Selected States in Great Lakes and UMORB[c]	Aiken (2009)
48 (PA), 53 (NY)	Trout,	Selected States in Great Lakes and UMORB[c]	Aiken (2009); Harris (2010);
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 Poe et al. (2012), these three observations are regarded as outliers.

c. UMORB denotes the Upper Mississippi and Ohio River Basins.

from $20 to $75 ($2012) for Great Lakes fishing. An insufficient number of studies were available to develop similar net value estimates for the UMORB.

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 fishing effort as part of its National Survey of Fishing Hunting and Wildlife Associated Recreation (e.g. USFWS, 2002, 2008). The National Survey does not provide separate data for participation in the Great Lakes Basin (i.e., all the water bodies in the Great Lakes watershed, including but not limited to the Great Lakes) or the Upper Mississippi and Ohio River Basins. However, it does report fishing participation for the Great Lakes themselves, 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 (Austin et al., 2007; Great Lakes Commission, 2012).

While they are somewhat dated, Poe et al. (2012) used participation data from the 2006 National Recreation Survey (USFWS 2008), as this is the most recent survey of recreational fishing providing data on fishing in the Great Lakes that had been reported at the time the Poe

et al. (2012) report was written[2]. These estimates have been used elsewhere for calculating the impact of recreational fishing for the Great Lakes (USFWS, 2008; Austin et al., 2007). For comparative purposes it is helpful to use the same baseline for aggregating values.

Multiplying the USFWS estimate of about 18 million angler days in the Great Lakes in 2006 by the range of net values ($20 to $75 in $2012 dollars) identified above, Poe et al. (2012) concluded that the total annual recreation net value lies between $360 million and $1.35 billion. This range can serve as a point of comparison for the estimate reported in this study's results. Subsequent to the writing of the Poe et al. (2012) report, the USFWS released a preliminary report for the 2011 National Recreation Survey (USFWS 2012a) for angler days in 2011, which reported that an estimated Great Lakes angler days to be 19.7 million in 2011. Multiplying this level of effort by the endpoints on the range of net values ($20 to $75 in $2012) reported in Poe et al. (2012) provides an estimated range of total annual recreation net value for Great Lakes fishing of between $393 million and $1.475 billion.

Study Area

The study area on which this report focuses includes the watersheds of the Great Lakes and Upper Mississippi and Ohio River Basins within the following states: Minnesota, Iowa, Missouri, Wisconsin, Illinois, Indiana, Kentucky, Michigan, Ohio, West Virginia, Pennsylvania and New York (Figure 1). These states will collectively be referred to as the "12-state study area" throughout this report.

Methods

The development of a net benefit estimate associated with current recreational fishing in the Great Lakes and the Upper Mississippi and Ohio River Basins took place in three stages: (a) a series of focus groups with recreational anglers conducted in November and December 2011; (b) three surveys of recreational anglers conducted between January and August 2012; and (c) the development and estimation of an economic model of angler behavior based on the survey data, which was completed in the fall of 2012. Two of the surveys were also used to develop estimates of trip expenditures.

[2] A more recent survey was completed in March 2012, but only preliminary documents (USFWS, 2012a,b) were available at that this report was written.

Focus Groups

Focus groups with recreational anglers were conducted to inform the development of the subsequent survey of anglers (Evensen et al. 2012). A focus group is a type of group interview in which a researcher brings together a small number of people, with particular characteristics (e.g., age, gender, race, participation in certain activities), to discuss a topic relevant to that group. The researcher acts as a facilitator who introduces open-ended questions to which the group responds. Focus groups are used to solicit in-depth information from people about topics for which their possible responses might not be able to be predicted in advance.

Focus groups were used in this study to determine: the range of ways in which angler behavior might change if a decline in fishing quality was precipitated by ANS transfer; how anglers characterize different types of fishing; and how changes in sportfish populations could best be communicated to anglers. Eight focus groups, with eight to 21 participants in each group, were conducted in various locations in the study region in November and December 2011 (Table 3). Participants were identified through a variety of methods. When the researchers had contacts in a locality selected for a focus group, recruitment started with "snowball sampling" (i.e., contacting individuals who had knowledge of recreational anglers in the location and asking for recommendations of people to participate, then contacting those individuals, asking them to participate and asking for additional suggestions). In addition to snowball sampling, and particularly in locations where the researchers had no contacts, recruitment occurred by way of announcements in local newspapers and announcements via e-mail listservs of organizations supportive of the research being conducted.

The focus groups were conducted either by a single facilitator or by a team of two facilitators, with one person leading the questioning and the other helping with followup questions and data recording. The same facilitator led all the groups, with an additional facilitator present at three of the groups. The primary question topics[3] included patterns of fishing behavior, changes in fishing behavior and reasons for those changes, factors that could influence fishing behavior in the future, and how fishing behavior might change in response to a decline in the number and size of fish caught (the primary ways in which ANS were expected to influence anglers). The facilitators audio recorded each group; recordings were later transcribed.

The recordings and transcripts were reviewed to identify the range of ways anglers said they might respond to a decrease in fishing quality (e.g., change effort levels, stop fishing altogether,

[3] Please refer to the Appendix for details regarding the questions posed to the focus groups.

Table 3. Focus group characteristics.

Location	Date	Number of participants	Duration of discussion
Oswego, NY	Nov. 7, 2011	8	1h 45m
Peoria, IL	Nov. 15, 2011	6	1h 32m
Eagan, MN	Nov. 16, 2011	11	1h 54m
Duluth, MN	Nov. 17, 2011	21	1h 58m
Port Clinton, OH	Dec. 5, 2011	8	2h 08m
Bay City, MI	Dec. 13, 2011	8	2h 14m
Fort Wayne, IN	Dec. 14, 2011	15	1h 59m
Louisville, KY	Dec. 15, 2011	15	2h 00m

fish in different locations, fish for different species) and how to describe or characterize types of fishing experiences across a range of fishing types in ways that were meaningful to anglers[4].

Survey

CU conducted a survey of recreational anglers in a 12-state region containing the Great Lakes and Upper Mississippi and Ohio River basins: New York, Pennsylvania, Ohio, Indiana, Michigan, Illinois, Wisconsin, Minnesota, Iowa, Missouri, Kentucky, and West Virginia. The study population was defined as those living and fishing in the 12-state region. The primary purpose of the survey was to gather data from anglers that could be used to develop economic models that could estimate the net value of recreational fishing under current and hypothetical future conditions. The survey was conducted in three stages: (1) a screening survey conducted over the telephone; (2) a main survey conducted by mail or online; and (3) a followup survey conducted online. The design of the survey instruments was informed by the research team's past experience with a number of similar surveys. Although some limited pretesting of the main survey instruments was conducted, an extensive pretest was not possible to conduct because of the need to complete the project within a 14-month timeline.

Screening Survey

A sample of anglers was recruited in each state through a screening survey. In all states except Ohio and West Virginia, the sample was recruited from individuals identified through randomly selected fishing license records from the previous license year. License types included resident and non-resident licenses, both annual and short-term[5]. Among non-resident licenses, only those with addresses within the 12-state region were used to define the sample. CU drew an initial sample of 28,200 licenses in these 10 states. Lexis-Nexis searches identified telephone numbers for as many individuals as possible based on their names and addresses. Individuals with known telephone numbers were sent a pre-notice letter that described the study and requested their participation in it about one week before they were contacted by telephone. Individuals were then contacted by telephone to screen them for participation in the subsequent angler survey. The screening process consisted of a short series of questions designed to determine if respondents fished in 2011 and intended to fish in 2012[6]. A total of 7,201 individuals met these criteria, agreed to participate in the subsequent survey, and either provided their e-mail address or confirmed their mailing address. Individuals recruited in this

[4] See Evensen et al. (2012) for focus group results.
[5] The sample did not include one-day licenses because a very low response rate was anticipated from this group, and their fishing would have made up only a very small proportion of the total number of fishing days.
[6] Please refer to the Appendix for the questions used in the screening survey

way were also asked several questions about how much and what type of fishing they did in 2011. This information was used to target survey versions to individual respondents, and for assessing non-response bias after the subsequent survey.

Ohio and West Virginia would not release their fishing license data. Instead, a sample of anglers from each state was recruited through random digit dialing. Random digit dialing is a process that begins by identifying the set of telephone area codes and exchanges for a given state or region. Telephone numbers within the state are generated by pairing these area codes and exchanges with 4 random digits. Samples of 13,934 phone numbers (for Ohio) and 3,000 phone numbers (for West Virginia) were provided by the Marketing Systems Group. Respondents were contacted by phone and screened for eligibility (adults living in Ohio or West Virginia who fished in the study region during 2011). Eligible respondents were asked to provide an e-mail address or a postal address to use for the subsequent survey. A total of 5,780 households was reached through these numbers, and 558 of these households were determined to be eligible for participation in the survey. The same screening questions were used with these anglers as were used with the anglers living in the other 10 states. A total of 491 individuals agreed to participate in the angler survey.

Anglers who agreed to participate in the survey were classified into one of three groups according to the types of fishing that they did based on their answers to the screening survey questions:

- **Great Lakes Anglers:** Anglers who fished the Great Lakes or Great Lakes tributaries.
- **Coldwater Anglers:** Anglers who did not fish the Great Lakes or Great Lakes tributaries, but who did fish elsewhere for trout or salmon (in either the Great Lakes basin or UMORB).
- **Warmwater Anglers:** Anglers who did not belong to one of the previous two groups (in either the Great Lakes basin or UMORB).

These groups were used to assign variations of the survey instrument during the subsequent web survey.

The screening process through which a total of 7,692 anglers was recruited to participate in the survey, took place from January 9-March 6, 2012.

Web and Mail Survey Implementation

Data were collected through both a web-based survey and a mail survey, which were conducted from March 21-May 26, 2012. The sample was divided into two groups: those with

e-mail access who were willing to participate in the survey via the internet (n = 4,562) and those without e-mail access or who preferred to participate via mail (n = 3,112)[7].

Participants who agreed to participate in the web-based survey were sent a thank you e-mail to verify their e-mail address and remind them about the survey approximately one week before the survey began. At the outset of survey, an e-mail with a link to the web survey was sent to each angler in the sample. Non-respondents were sent up to four reminder e-mails[8] encouraging them to participate in the survey.

Mail survey participants were sent a cover letter with a copy of the survey instrument. Non-respondents were sent up to three reminder letters spaced seven to 10 days apart. The second reminder letter included a second copy of the survey instrument for those who may have misplaced it.

Web and Mail Survey Instruments

The web and mail survey instruments covered similar content except that: (a) some questions were formatted differently in the two instruments; and (b) some questions from the web survey were not included in the mail survey because of space constraints.

The topics covered in the surveys[9]can be divided into four primary areas: background information, expenditure data, travel cost data, and contingent behavior responses. The background information included:

- Number of years fished
- Factors influencing choice of fishing locations
- Types of fishing engaged in during 2011 (e.g., Great Lakes, inland lakes and ponds, etc.)
- Importance of fishing relative to other activities
- Boat ownership
- Socio-demographic information (e.g., age, gender, income)

To estimate mean angler expenditures per trip, respondents were asked information about their most recent fishing trip, including:

- Month and year
- Number of days fished (if an overnight trip)

[7] Some individuals who had been agreed to participate were found to live outside the 12-state study area, and so were not included in either sample.
[8] Standard protocol in *mail* surveys is to send up to three reminder letters, but because the cost of sending additional reminders in *web* surveys is negligible (no costs for materials or postage), a fourth reminder was sent.
[9] Please see the Appendix for the survey instruments.

- Primary type of fishing
- Location (county-level)
- Number of people in household on trip
- Expenditures (categorized)
- Mode of transportation

To develop the travel cost portion of the model, data were collected on all fishing trips taken in 2011 so that travel costs could be determined. These data included:

- Zip code of primary home and any secondary home (which provided a point of origin for fishing trips)
- Fishing locations
    - Locations of day trips taken within the study area. In the web survey, these locations were designated at the county level for the state in which respondents fished the most and at the state level for other locations. In the mail survey, these locations were designated at the county level for the respondents' state of residence and not specified for other trips within the study area. That is, in the mail survey, respondents reported total days fished outside their home state, but within the 12-state study area.
    - Locations of overnight trips taken within the 12-state study area. In the web survey, these locations were designated by the nearest city, village, or town (which were subsequently coded to the county level). In the mail survey, these locations were designated at the county level for the respondents' state of residence and not specified for other trips within the study area.
    - The number of trips taken to each location. For overnight trips, web survey respondents also provided the total number of days spent fishing on all trips to each location.
    - Primary types of fishing on the fishing trips to each location. Based on a literature review and the data collected during the focus groups, seven types of fishing were designated: Great Lakes for trout and salmon (GLCold); Great Lakes for warmwater species (GLWarm); inland lakes and ponds for trout and salmon (ILCold); inland lakes and ponds for warmwater species (ILWarm); salmon or steelhead on spawning runs (Anadromous); rivers and streams for trout and salmon, but not on spawning runs (RSCold), and rivers and streams for warmwater species (RSWarm).

We also included a series of contingent behavior questions to explore how angler behavior would change if fishing quality was reduced. To develop the contingent behavior portion of the

model, respondents were asked hypothetical questions about how the number of fishing trips they took would change if fishing quality declined. Data collected through these questions included:

- Number of day and overnight trips taken in a normal year for each of the seven types of fishing. (Respondents were encouraged to use the number of trips they had reported for 2011 as a "normal year" if they thought 2011 was typical.)
- The respondents' estimates of the number of day and overnight fishing trips they would take for each of the seven types of fishing in a normal year if the number of fish they could catch decreased by 0%, 30%, or 50%. Specific percentage decreases varied by fishing type. The range of percentage decreases was chosen based on discussions with USACE ecologists, to cover the range of possible impacts of ANS on sport fish populations in the study area.

In these questions, CU presented each respondent with a hypothetical scenario specifying changes to the number of fish they could catch in each of the seven fishing types. Thirty different hypothetical scenarios were developed. In each scenario, respondents were told that the number of fish they could catch for each of the seven types of fishing would decline by 0%, 30%, or 50% (Table 4). Each respondent was randomly assigned one scenario from among a subset of the 30 scenarios that were most likely to influence types of fishing in which they engaged (based on how they had been classified in the screening survey).

- Great Lakes Anglers in the web survey were randomly assigned to one of scenarios 1-8, or 11-20.
- Coldwater Anglers in the web survey were randomly assigned to one of scenarios 1-2 or 4-20.
- Warmwater Anglers in the web survey were randomly assigned to one of scenarios 2-20.
- Participants in the web survey who did not answer the screening survey questions about the type of fishing they did were randomly assigned to one of scenarios 2 or 4-30.
- Mail survey respondents were randomly assigned to one of scenarios 21-30.

Assigning the scenarios in this way assured that most respondents received a scenario that included a catch rate decrease for at least one type of fishing in which the respondent engaged.

Followup Survey

A short followup survey of 2,281 web survey respondents was implemented between June 27 and August 7, 2012, to collect additional expenditure data so that the expenditure data more

Table 4. Percentage decline in number of fish caught per day in hypothetical scenarios presented to survey respondents.

	Type of Fishing						
Scenario	Great Lakes for Trout and Salmon	Great Lakes for Warmwater Species	Inland Lakes and Ponds for Trout and Salmon	Inland Lakes and Ponds for Warmwater Species	Salmon or Steelhead on Spawning Runs	Rivers and Streams for Trout and Salmon but not Including Spawning Runs	Rivers and Streams for Warmwater Species
1	30	50	0	0	50	50	0
2	50	0	30	50	50	0	0
3	30	0	0	50	50	0	30
4	30	0	50	0	30	0	30
5	0	30	30	50	0	50	0
6	50	30	50	0	50	0	0
7	0	0	50	0	30	50	50
8	0	50	0	50	0	50	30
9	0	0	50	30	0	50	30
10	0	0	50	50	0	30	50
11	30	0	30	0	30	50	0
12	0	50	30	0	0	30	30
13	50	0	0	0	50	50	50
14	50	30	0	0	30	0	30
15	0	30	0	30	50	50	0
16	50	50	0	30	30	0	0
17	30	30	50	0	0	30	0
18	0	30	0	0	30	30	30
19	0	50	50	30	50	0	0
20	30	0	0	50	50	30	0
21	50	0	0	30	30	30	0
22	0	50	0	0	50	30	50
23	0	0	30	30	30	30	0
24	0	30	0	50	30	0	50
25	0	0	30	30	50	0	50
26	30	30	0	30	0	0	50
27	0	30	30	0	50	0	30
28	0	50	50	50	30	0	0
29	30	0	50	30	0	0	30
30	30	50	30	0	0	0	50

fully represented the range of types of fishing trips that take place over the course of an entire fishing season. At the outset of the survey, an e-mail with a link to the web survey was sent to each angler in the sample. Non-respondents were sent up to four reminder e-mails encouraging them to participate in the survey. Through this survey, expenditure data were collected about the most recent fish trip respondents took subsequent to their completion of the previous survey. The type of expenditure information collected was identical to that collected in the previous survey.

Analysis

Non-response Analysis

Respondents (individuals who completed both the screening survey and the subsequent web/mail survey) were compared to non-respondents (individuals who completed only the screening survey) to determine if non-response bias existed. The two groups were compared according to whether they fished in 2011, the types of fishing in which they participated, and the number of days they fished in 2011. These comparisons allowed determination of whether respondents to the web/mail survey (whose responses were used to generate CU's estimates of the economic value of recreational fishing) were more avid than other anglers, fished more days, or participated in different types of fishing.

Data Weighting

Weighting the data was necessary because of the different methods used for sample selection in different states. The need for random digit dialing sampling in Ohio and West Virginia resulted in fewer potential respondents to the survey from those states, compared with other states in the study area where license records were available. CU used the 2011 list of paid license holders by state from the US Fish and Wildlife Service National Fishing License Report to estimate the proportion of licenses (resident and non-resident) sold in each state. It was assumed that the sample from Ohio and West Virginia was representative of resident and non-resident license holders in those states. Before calculating the proportion from each state, the number of licenses sold in each state was decreased by the proportion of non-resident licenses purchased by people living outside the study area, as the study population was defined as those who lived and fished in the study area states (anglers who lived outside the study area were deleted when the sample was drawn). For Ohio and West Virginia, where it was unknown how many licenses were sold to those living outside the study area, CU used the mean proportion of surrounding states. Weight factors were calculated based on the proportion of licenses sold in each state and applied to number of respondents to the mail and web survey (n=3,539). The

same procedures were used for the followup web survey that estimated expenditures. New weight factors were calculated and applied to respondents of the web followup who indicated they had fished subsequent to the implementation of the main survey.

Estimating Per Day Expenditures from Main Survey and Followup Survey

In the main survey, anglers were asked about their household's expenditures on their most recent trip to the study area where the primary purpose was fishing; these trips could have been in 2011 or early in 2012. Information from respondents who reported a trip outside the study area or indicated no fishing took place on the trip was deleted from the analysis. The expenditures reported were divided by the number of days fished on the trip to get expenditures per day per household. The non-zero data were examined for values considered out of range. The top 1% of non-zero values were considered out of range. For example, spending $300 or more per day at bait and tackle shops, or $625 or more per day at hotels or campgrounds was considered out of range. These outliers, along with non-numeric responses (e.g., a lot, some), were replaced with the mean value of the valid values for the analysis. Expenditures by category were summed to get total expenditures. Expenditure estimates were weighted by state of license purchase as discussed above. They were not adjusted to FY $2012 because they already cover the FY $2012 time span.

In the followup survey, anglers were first asked if they had fished in the study area since completing the web survey. Only those who had taken a trip were asked about their most recent trip expenditures. The expenditures reported were divided by the number of days fished on the trip to get expenditures per day per household. The non-zero data were examined for values considered out of range. The results were very similar to the results of the main survey, so the cut-off values from the main survey were used in the followup survey as well. These outliers were replaced with the mean value of the valid values from the followup survey for the analysis. Expenditures by category were added to get total expenditures. Expenditure estimates were weighted by state of license purchase as discussed above.

Angler Characteristics

The mail and web surveys included questions about background characteristics of anglers, which allowed us to describe anglers in the study region. These background characteristics included state of residence and socio-demographic characteristics (e.g., age, gender, income, marital status, presence of children at home). Questions were also asked that related to fishing avidity, including motivations for fishing, self-assessments on the importance of the fishing to the respondent, number of years fished, and whether a fishing boat was owned. The results of these background variables are presented in the Results section.

Estimating the Number of Anglers and Total Days Fished in 2011

The total number of anglers living and fishing in the 12-state study area in 2011 was calculated by state of residence. The number of resident fishing licenses sold in each state was obtained from state databases. This number was increased by the proportion in the sample that lived in each state but fished only in other states in the study area, and therefore would not be counted in the number of resident licenses sold. For example, four people in the sample lived in Iowa but fished only in states other than Iowa, so they are not part of the population of Iowa resident fishing license buyers. Therefore, the number of resident fishing license buyers was increased by the proportion these four anglers represent of all Iowa residents in the sample. Further, based on survey responses, only 87.5% of 2011 fishing license buyers actually fished in 2011. To reflect this participation rate, the number of license buyers was reduced by this proportion in all states to get an estimate, based on license sales, of the number of anglers who lived and fished in the 12-state study area in 2011.

Total days fished in 2011 were calculated by multiplying the mean number of days fished per angler by state of residence times the number of anglers who lived and fished in the 12-state study area in 2011. Days fished within the 12-state study area were apportioned into 5 regions: (1) Great Lakes basin below barriers impassable to fish, (2) Great Lakes basin above barriers impassable to fish, (3) UMORB below barriers impassable to fish, (4) UMORB above barriers impassable to fish, and (5) areas within the 12-state study area but outside of either basin. The days of fishing that took place in each of these 5 regions was estimated by calculating the proportion of the water bodies in each county in each of the five regions and multiplying that proportion by the days fished in that county. For days reported by state (the county fished was not known) the same method of apportioning days by region was used.

Economic Modeling

The objective of the economic modeling was to provide estimates of net economic value per angler per fishing day based on the web and mail survey data[10]. The net value per angler day is the form of value most frequently reported in the recreational valuation literature and is used here to allow comparison to previous research. As discussed in the introductory section of the present report, previous fisheries research conducted in the Great Lakes suggests that a range of $20 to $75 would encompass the likely net value per day of fishing in the Great Lakes. When combined with participation estimates, these individual, trip-level estimates can, with appropriate caveats, be aggregated up to net value per angler season and total value of the fishery at basin or state level to provide approximate net economic values at regional levels.

[10] We have utilized the term “net value” throughout this report and in the preceding literature review (Poe et al. 2012). Net economic value is often referred to as “consumer surplus” in the recreational valuation literature.

The econometric model used in this analysis is referred to as a "Repeated Site Choice" model. This model accounts for three choices that the angler must make each time he or she has the opportunity to take a fishing trip. As depicted in Figure 2, these choices can be represented by a decision tree consisting of three decision levels.

The Repeated Site Choice modeling structure begins by assuming that a recreational angler has a number of "Choice Occasions" throughout a fishing season. For the purposes of this study, we defined the fishing season to be calendar year 2011. Within this season each angler has 365 choice opportunities, or days.

For each choice occasion, the angler must first decide whether to go fishing or to do something else, such as go to work, participate in another recreational activity etc. This is depicted as the participation level in Figure 2.

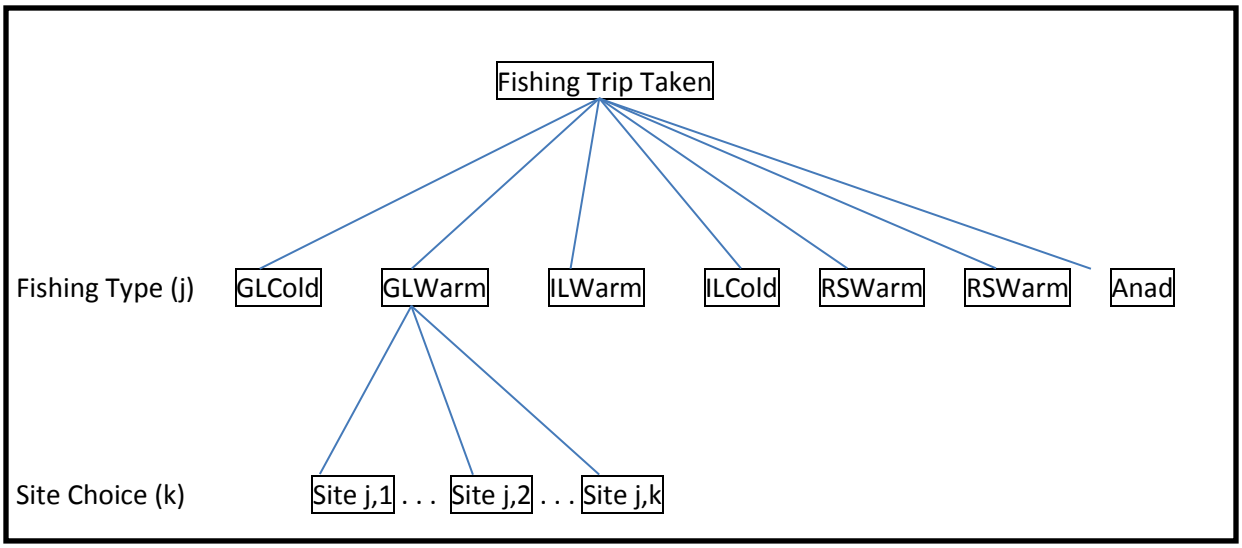
If the angler chooses to go fishing, then a second decision must be made – which fishing type to engage in on that trip. Consistent with previous recreational fishing studies of the Great Lakes and Inland Fishing in the State of Michigan by Kikuchi (1986), Jones and Sung (1993) and Hoehn et al. (1998), our modeling framework divides fishing types within the study region into seven categories: Great Lakes for trout and salmon (GLCold), Great Lakes for warmwater species (GLwarm), inland lakes and ponds for trout and salmon (ILCold), inland lakes and ponds for warmwater species (ILWarm), rivers and streams for trout and salmon but not on spawning runs (RSCold), and rivers and streams for warmwater species (RSWarm), and salmon or steelhead on spawning runs (Anadromous). These Fishing Type characterizations were used in the focus groups, and found to be salient to participants.

Having chosen a fishing type, the third decision the angler makes is where to go fishing. There will often be several alternative fishing sites available to each angler that offer the type of fishing he or she has chosen for that trip. With respect to this "Site Choice" from available sites, the fundamental premise of travel cost modeling is that the probability of choosing a particular site is positively related to the fishing quality at the site and inversely related to the travel costs to the site, all other factors held constant.

It is assumed that the angler proceeds through this series of participation, fishing type, and site choice decisions each day of the year, which is the reason this model is named "Repeated Site-Choice" model.

Anglers need not actually make the three decisions in sequence; they can be made simultaneously. The nesting structure presented in Figure 2, in which fishing sites are grouped by, or nested under, a fishing type, captures the idea that trips of the same fishing type are more similar to each other than they are to trips of a different fishing type. In other words, a day spent fishing for trout in streams in county A is more like a day spent fishing for trout in

Figure 2. Nested site choice model using Great Lakes for warmwater species example.



Notes: The acronyms used in this table are defined in the corresponding text. Although not depicted in the Figure, each Fishing Type nest has K sites available, where K can vary by Fishing Type.

streams in county B than it is like a day spent fishing for bass in a lake in County A. This assumption can be tested statistically.

Given the geographical extent of the study area, CU decided to define fishing sites at the county level (i.e., each fishing "site" considered in the modeling was a composite of all the sites within a given county), with 1042 counties in the 12-state study region[11]. Of these 1042 counties, 82 with shoreline on the Great Lakes were identified as Great Lakes coastal counties. All Great Lakes coastal counties were assumed to support fishing for both coldwater and warmwater species.

Based on expert opinion and survey responses, 99 counties were identified that contain rivers or streams that support fishing for anadromous salmon and/or steelhead on spawning runs.

Counties that support sportfishing for coldwater species (trout and salmon) in inland streams, rivers, lakes or ponds were identified by combining 1) those counties identified by state fish and wildlife agencies as supporting coldwater fishing and 2) those counties identified by survey respondents as inland salmon and trout fishing destinations. We do not differentiate in this study between naturally reproducing coldwater fisheries and those that exist only through stocking of catchable fish. On this basis, 671 of the 1042 counties in the 12-state study area, were designated as counties that support fishing for coldwater species in both rivers and streams and in lakes and ponds.

All counties were deemed to support inland warmwater fishing in both rivers and streams and in lakes and ponds.

Travel Cost Data: The travel cost to each fishing site was calculated for each angler using the geographical coordinates of the primary zip code for the respondent as the departure location and the centroid(s) of the destination county (counties) as the destination location. For respondents that indicated they owned two homes, travel costs were calculated from both the home zip code and the second home zip code. The PC*Miler™ software package was used to

[11] The decision to organize destinations at the country level was motivated by the large number of potential sites, the difficulty of identifying every possible fishing site across the entire region, and the difficulty for survey respondents of identifying their trip destinations at finer than a county level. By way of comparison, Murdoch (2005) identifies 569 sites visited by anglers in a study of the Green Bay area fisheries in Wisconsin. In a NY survey, Connelly et al. (2007) reported on the 80 most frequently fished waters from a list of over 5,000 waters in NY. In addition, information gathered in the process of conducting the focus groups suggested that anglers would have a difficult time identifying which waters were above or below impassable barriers. Hence, the unit of measurement of destinations was the county level and not further distinguished by reference to impassable barriers.

calculate the round trip miles, time traveled, and toll costs from each zip code to the centroid of each of the 1042 possible destination counties.

The travel cost per mile ($0.29) used in our analyses accounts for the operating costs of driving, including fuel costs, tire wear, and maintenance, and the depreciation associated with driving extra mileage. Estimated per-mile costs for maintenance, depreciation and tire wear were taken from the American Automobile Agency (AAA, 2011). Average fuel costs were taken from US Energy Information Administration data (USEIA, 2012) and average fuel efficiency for cars and light trucks were provided in the Bureau of Transportation Statistics (USBTS 2012). Data collected from the expenditure sections of the survey indicated that anglers used cars on about 23% of fishing trips and light-duty trucks on 77% of fishing trips. These proportions allowed the estimation of an average fleet value for per-mile travel costs. For reference, the per-mile travel costs used in this study are similar to recreational travel cost studies reported in the GLMRIS study region since 2000 and reviewed in Poe et al. (2012): $0.32 (Murray et al., 2001), $0.30 (Yeh et al., 2006), $0.35 (Kelch et al., 2006) and $0.38 (Song et al., 2010)[12].

The cost attributed to the anglers' travel time was estimated by first imputing a wage rate per minute (calculated as reported annual income per year/2000 working hours per year/60 minutes per hour), multiplying this by the estimated round trip time of travel, and then adjusting this value to account for the economic concept that the opportunity cost of travel time is only a portion of the imputed wage cost. The estimated round trip minutes traveled from the anglers home zip code to the destination county and back were provided by PC*Miler™ software. For the respondents who did not provide an income value, the state level average household income reported by survey respondents was used as a proxy. The resulting values per minute were divided by three (multiplied by 0.33) to reflect the opportunity cost of travel time. These opportunity cost adjustments and annual hours worked assumptions correspond to standards in travel cost modeling (Parsons, 2003), and fall within the range of recreational travel cost studies reported in the GLMRIS study region since 2000 and reviewed in Poe et al. (2012): 0.35, 2000 hours (Murray and Sohngen, 2001); 0.30, 2040 hours (Yeh et al., 2006); 0.30, 2000 hours (Kelch et al., 2006); and 0.33, 2000 hours (Song et al., 2010).

The third component of travel costs, toll costs, were estimated using the PC*Miler™ software and multiplied by two to estimate round trip toll costs.

[12] The cost-per-mile values are the values reported in the original studies. They are not updated to 2012 following standard USACE procedures that use Consumer Price Indices (USACE 1982), because the costs are very specific and not necessarily reflective of changes in the broader CPI. These values are reported here simply to provide comparative references for the pre-mile travel costs used in the present study, and are not used in any of the analyses reported herein.

The three components of travel cost - mileage cost, opportunity cost of time, and toll costs – were summed for each origin zip code/destination county pairing in the data set. When both a primary and secondary zip code were indicated, the lowest travel cost from the two origin zip codes was used for each possible destination county.

Site Choice Set: While there are 1042 potential destination counties in the data set, it is evident that many of these destinations far exceed the distances that would reasonably be travelled in a day trip from the angler's indicated zip code of origin. To eliminate trips that likely were undertaken for a primary purpose other than fishing, CU limited the set of possible destinations available to an angler to those counties that lay within 150 minutes (2.5 hours) of the zip code of origin for all fishing types except trips taken for Anadromous fishing. For Anadromous fishing, because of the relative rarity of this type of fishing, the time cutoff was higher, 180 minutes (3 hours). These cutoffs were chosen so that the data would capture at least 95% of the trips indicated by survey respondents, but still minimize the effect of outlier observations. Past travel cost fisheries studies conducted in the study region have used similar approaches to limiting the site choice set, frequently using a mileage cut off instead of the time limits we imposed: e.g. 150 miles (Hoehn et al., 1996) and 120 miles (US EPA, 2004). If anglers listed a second origin zip code, the set of feasible destinations was broadened to include all of the counties that lie within the designated time threshold from either the primary or the secondary zip code origin.

Feasible counties for each Fishing Type were further limited to those counties that support the indicated Fishing Type. For example, it is not possible to go Great Lakes fishing in Missouri, but there are counties in Missouri with coldwater fishing opportunities. It is assumed that all counties in the 12-state study area included warm water fishing opportunities. The resulting set of counties provides what we refer to as the "Site Choice Set" for each angler.

Destination County/Counties: In the web and mail surveys, respondents indicated the destination county(ies) to which they took each fishing day trip in a Fishing Type category, and the frequency of visits they took to each site in 2011. These destination counties represent the site choices that the angler made from the Site Choice Set. If the angler indicated a destination county outside of the Site Choice Set (i.e. a destination county that does not support the fishing type chosen), then this trip was not included in the Site Choice Model.

The degree of specificity with which anglers reported their fishing trip destinations varied across the survey mode and whether the fishing trip occurred within or outside of the home state. Three variations of destination county identification were accounted for in this analysis.

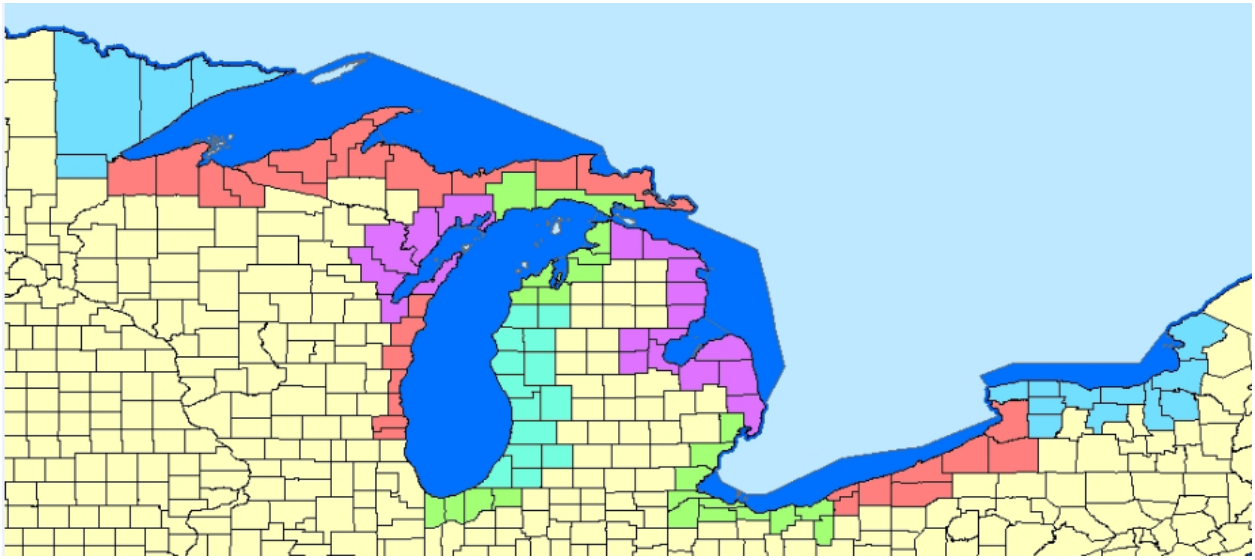
(1) If a fishing trip was taken within the angler's "home state" (for mail survey respondents) or the state in which they fished "the most" (for web survey respondents), then the specific destination county was indicated.
(2) In the web survey, for trips taken to states other than the state they fished in the most, respondents indicated which state was visited, and how often, for each fishing type. In these cases all counties in the destination state that were within the time cutoff from the angler's origin zip code and that supported the fishing type indicated were coded as possible destination counties.
(3) In the mail survey, anglers who traveled to fishing destinations outside their home state indicated the number of day-trips fished in "All other States in the Study Area" for each fishing type. In these cases, all the counties that were outside of the home state that were within the time cutoff from the anglers origin zip code and that supported the fishing type indicated were designated as possible destination counties.

On this basis, for each trip taken by an angler, the "Site Chosen" may include one or several destination counties. This variation is accounted for in the Site Choice Model.

Site Choice Characteristics: As noted above, the probability that an angler will chose a particular site is predicted to be positively related to the quality of the site and inversely related to the travel time and distance to the destination site. Recreational fishing models have often characterized site quality using expected catch rates (i.e. catch per unit of effort) obtained from creel surveys. In this study, CU did not adopt such an approach for two reasons. First, consistent catch rate estimates are not available at all sites in all the states in the study, and the methods used to estimate and report catch rates are not uniform across states. Second, as shown recently by Murdoch (2006), catch rates provide only one aspect of the overall quality of a site, and could lead to biased estimates of the effect of catch rates on the probability of site choice if other aspects for fishing quality are not included in the model. Other aspects of fishing quality at a site may be quite diverse and in many instances unobservable or difficult to measure, such as the beauty of a site, accessibility, location relative to other amenities, congestion, and other factors.

Lacking a complete characterization of site quality, Murdoch (2006) proposed that separate constants for each site, in our case county, be estimated. These county-specific constants would capture all the actual or perceived variations in site quality across sites. This approach was adapted for the Great Lakes and Anadromous fishing types. Because the total number of Great Lakes and Anadromous fishing trips in the survey data was not large enough to estimate reliable county-specific constants for each county, these counties were grouped into 11 contiguous shoreline segments. These segments are indicated in Figure 3 for the Anadromous

Figure 3. Anadromous run (AR) counties.



Segments, from east to west: AR1 – Northern Lake Superior/Minnesota; AR2 – Southern Lake Superior; AR3 – Green Bay; AR4 – Southern Lake Michigan/Wisconsin; AR5 – Southern Lake Michigan/Indiana; AR6 – Eastern Lake Michigan; AR7 – Northern Lake Michigan; AR8 – Lake Huron; AR9 – Lake St. Clair, Western Lake Erie; AR10 – Eastern Lake Erie; AR11 – Lake Ontario. Note that the Illinois Department of Natural Resources indicates that there are no streams in Illinois that support anadromous runs.

fishing type. The 11 Great Lakes fishing type segments correspond to those presented in Figure 3, but exclude the 17 counties that support anadromous runs but do not have Great Lakes shoreline. For the Anadromous fishing type, 11 segment-specific constants were estimated. Two segment-specific constants were estimated for each of the Great Lakes segments, one capturing site quality for GLCold fishing and the other capturing site quality for GLWarm fishing.

The four inland waters fishing types – ILWarm, ILCold, RSWarm and RSCold - were widely dispersed across the study region. Because sampling intensity varied from state to state, many inland counties received no fishing visits in our sample. This made it impossible to estimate county-specific constants for each fishing type. Inland counties were therefore grouped by state, and state-specific constants were estimated for each fishing type.

To improve our ability to model variation in fishing availability and quality among inland and anadromous counties, continuous habitat quality measures were also included in the model for these fishing types. In adopting this approach it is important to note that such an approach is not expected to provide unbiased estimates of the responsiveness of fishing site choice to the changes in specific measures of habitat quality used. Nevertheless, including habitat quality measures in the model allows CU to establish baseline utility levels for each inland and anadromous county that better match perceived quality from the anglers' perspectives.

The following continuous habitat measures were used to model baseline utility for each county for each fishing type. These were included in the model in addition to the state-specific and group-specific constants estimate for each fishing type

- For fishing types ILWarm, ILCold, RSWarm, RSCold, and Anadromous:
  - Habitat Condition Index: An index developed by the National Fish Habitat Partnership that measures the intensity of human disturbance of the landscape that can affect aquatic habitats. Low index values indicate high risk of habitat degradation, while high index values indicate low risk of habitat degradation (downloaded from ecosystems.usgs.gov/fishhabitat/).
- For fishing types ILWarm and ILCold:
  - Total area (in square miles) of all inland lakes and ponds
- For fishing types GLWarm and GL Cold
  - Great Lakes shoreline (in miles)
- For fishing types RSWarm, RSCold and Anadromous:
  - Total length (in miles) of all smaller streams (stream order 3 and 4)
  - Total length (in miles) of all larger streams and rivers (stream order 5 and higher)

Lake area and stream miles were calculated using ArcMAP from the USGS National Hydrography Dataset.

Results

Focus Group Results

Detailed results from the focus groups are reported in a separate report (Evensen et al 2012), but several results particularly pertinent to the development of our survey methods are summarized here. The focus groups were used to explore how anglers make decisions about fishing and to learn the potential range of behavioral responses that could occur in reaction to changes in sportfish catch rates. Participants' responses helped CU better understand the language used by anglers when discussing decisions of where to fish and what species to target, which informed the wording used in the surveys.

Focus group participants expressed a range of potential responses to changes in sportfish catch rates. Some participants said that they would not change their behavior if catch rates were to fall. Several, however, said that they would see a decline in catch rates as a challenge to their abilities, and that they might fish even more. Others said that they would fish less often, or would change where they fish or what species they target.

Most focus group participants easily understood the distinction between warmwater and coldwater target species, and stated that they were able to state which category of fish species they primarily targeted on an individual fishing trip. Further, focus group participants understood the distinction between Great Lakes waters and tributaries to those waters.

Of particular importance to development of the survey, focus group participants were not able to identify which waters were located upstream from barriers impassable to fish and which waters were located downstream from barriers impassable to fish. For this reason, the survey did not ask anglers to report whether their fishing trips were to waters upstream or downstream from impassable barriers.

Response Rates and Non-respondent Analysis

Screening Survey with Licensed Anglers

From the sample of 28,200 anglers selected from license records, Lexis-Nexis[13] searches identified phone numbers for 22,043 anglers based on their names and addresses. Some of

[13] Lexis-Nexis is a fee-based service that allows users to look up telephone numbers based on name and address information.

these anglers (n=365) were never contacted by phone because the response rate from their state was higher than other states, and resources were devoted to states with lower response rates. Of those contacted by phone (n=21,678), 29% of the phone numbers were determined to be out-of-service or incorrect. Of those with a working phone, 7,201 were contacted, interviewed, deemed eligible for the primary web and mail survey (the person fished in the study region during 2011 or planned to fish there in 2012), and agreed to participate in the web or mail survey by providing either their e-mail address or confirming their postal address. This represents 47% of those with a working phone. Only 4% of those with a working phone refused to either be interviewed or participate in the web or mail survey. Table 5 shows the results of the screening process by state of license purchase. Because CU wanted to maintain the same proportions by state in the web and mail survey as existed in the initial sample, more effort was devoted to certain states to increase response rates with the goal of having similar percentages agreeing to the web and mail survey in each state.

Screening Survey with Ohio and West Virginia Residents

Because CU was not able to obtain license records for Ohio and West Virginia, a random-digit dial (RDD) sampling strategy was used in these two states to identify and recruit eligible anglers. Samples of 13,934 phone numbers (targeting Ohio) and 3,000 phone numbers (targeting West Virginia) were purchased. Of these, 22% in Ohio and 13% in West Virginia were subsequently identified as non-working numbers. From the sample of those with a working phone number, 37% of those contacted in Ohio and 33% in West Virginia were not eligible for the web or mail survey because no one in the household fished in the study region. Few people refused to be interviewed or participate in the web or mail survey (Table 6). In Ohio 382 people agreed to complete the web or mail survey, and in West Virginia 109 people agreed.

Web and Mail Survey Response

Out of the 7,692 anglers who provided contact information for the web and mail survey, 18 were determined to live outside the study area and were not contacted, 4,562 provided working e-mail addresses, and 3,112 provided mailing addresses (Table 7). Of those contacted by e-mail to participate in the web survey, 50% completed the survey (n=2,281). Of those contacted by mail, 60 were undeliverable and 1,258 responded. The adjusted response rate (accounting for undeliverables) for the mail survey was 41%. Overall, the response rate across the two surveys was 46%.

Non- respondent Analysis

Of the 7,674 anglers contacted, 3,539 responded to either the web or mail survey. The non-respondent comparison analysis (as described above) revealed that respondents were slightly

Table 5. Response rates for screening interviews with licensed anglers.

State of license purchase	Initial sample	% with bad phone number	Of those with a working phone: % ineligible for follow-up	% refused screening or follow-up	% agreeing to follow-up	# agreeing to follow-up
IA	1,119	34.8	6.0	2.6	44.4	324
IL	1,995	21.1	17.5	5.3	39.2	616
IN	1,852	29.7	5.3	2.2	35.1	457
KY	1,596	33.5	9.8	4.8	47.9	508
MI	3,071	33.2	9.3	5.0	52.6	1079
MN	3,030	27.1	11.3	5.4	49.0	1081
MO	1,790	38.9	6.4	5.6	43.4	475
NY	1,917	27.5	9.7	2.8	51.4	714
PA	1,870	18.7	4.0	2.4	50.1	771
WI	3,438	28.3	6.5	4.5	47.7	1176
Total	21,678	29.0	8.8	4.2	46.8	7,201

Table 6. Response rates for screening interviews with Ohio and West Virginia residents.

State of license purchase	Initial sample	% with bad phone number	Of those with a working phone: % ineligible for follow-up	% refused screening or follow-up	% agreeing to follow-up	# agreeing to follow-up
OH	13,934	22.1	37.5	2.5	3.5	382
WV	3,000	12.9	32.7	2.1	4.2	109

Table 7. Web and mail survey response rates.

Survey mode	Initial sample	Undeliverables	Respondents	Response rate
Web	4,562	-	2,281	50%
Mail	3,112	60	1,258	41%
Total	7,674	60	3,539	46%

more likely to be active in fishing than non-respondents based on their answers to questions on the screening survey (Table 8). The difference in the percent indicating they fished in 2011 was statistically significant, but the practical difference (93% vs. 91%) is negligible. Corresponding differences were found for some of the more specific fishing participation variables such as fishing the Great Lakes, fishing other lakes and ponds, or fishing for trout and salmon. For those who fished in 2011, there was not a statistically significant difference in the average number of days fished between respondents (25.2 days) and non-respondents (24.0 days) based on their answers to questions in the screening survey. Accordingly, CU concluded that the data collected through our surveys adequately characterized the population of recreational anglers in the 12-state study area, and no adjustments to the data were made to account for non-response bias prior to economic modeling.

Followup Web Survey Response

Out of the 2,281 anglers who responded to the main web survey and were subsequently asked to participate in the followup web survey, 1,499 responded, yielding a response rate of 66% (Table 9). Of the 1,499 who responded, 30% (n=448) indicated they had not fished since filling out the main web survey and thus, were not asked to provide any further information. Analysis of trip expenditures was done using the remaining 1,051 respondents.

Socio-Demographic Characteristics

State of Residence

The data show the relatively unequal distribution of respondents by state of residence within the 12-state study area (Table 10). Particularly strongly represented are the lake states of Minnesota (13.7% of all respondents), Wisconsin (13.6%), and Michigan (10.9%). Only 2.7% of respondents were from West Virginia, and 3.3% were from Illinois. Based on fishing license sales data provided by the states, it was estimated that 6.6 million anglers lived and fished in the 12-state study area in 2011. Minnesota, followed by Michigan and Wisconsin had the largest populations of anglers who fished in the study area. (The total number of anglers who live in a state in the study area would be larger because some people only fish in states outside the study area, and so were not included in the sample. This is more likely true in states on the edge of the study area with good fishing opportunities outside the study area).

A number of angler characteristics (age, gender, income, marital status) were assessed because these characteristics may be related to fishing behavior. Anglers were disproportionately male (82.2%). Further, a strong majority of anglers (79%) is married—only 9% has never been married (Table 11). Over half (58%) of the married respondents' spouses/partners also fish.

Table 8. Fishing participation characteristics (from the screening interview) of those who responded to the web/mail survey compared with those who did not respond.

	Respondents	Non-respondents
	Percent	
Fished in 2011		
Yes	92.7	90.9
No	7.3	9.1
	(x^2 = 8.87, df = 1, p = 0.001)	
Fished Great Lakes in 2011		
Yes	20.4	17.3
No	79.6	82.7
	(x^2 = 11.35, df = 1, p = 0.001)	
Fished Great Lakes tributaries for trout or salmon in 2011		
Yes	15.0	11.7
No	85.0	88.3
	(x^2 = 16.60, df = 1, p < 0.001)	
Fished other lakes or ponds in 2011		
Yes	86.1	84.1
No	13.9	15.9
	(x^2 = 5.62, df = 1, p = 0.018)	
Fished large rivers in 2011		
Yes	38.7	39.4
No	61.3	60.6
	NS	
Fished other rivers or streams in 2011		
Yes	41.6	41.4
No	58.4	58.6
	NS	
Fished for salmon or trout in 2011		
Yes	38.6	34.3
No	61.4	65.7
	(x^2 = 13.67, df = 1, p < 0.001)	
Fished for other kinds of fish in 2011		
Yes	94.9	93.8
No	5.1	6.2
	NS	
Plan to fish in 2012		
Yes	99.2	98.2
No	0.8	1.8
	(x^2 = 14.19, df = 1, p < 0.001)	
	Mean	
# days fished in 2011	25.2	24.0
	NS	

NS = not significant

Table 9. Followup web survey response rate.

	Number	Percent
Respondents	1,499	66%
Fished since last survey?	448	30%
Initial Sample	2,281	

Table 10. Proportion of survey respondents by state of residence, and the estimated number of anglers derived from license sale information provided by the states by state of residence.

State of Residence	Percent of respondents	Estimated total # of anglers living and fishing in 12-state study area in 2011[1]
IA	5.3	269,003
IL	3.3	605,649
IN	7.0	332,061
KY	5.9	404,389
MI	10.9	805,792
MN	13.7	1,024,003
MO	10.5	545,902
NY	9.1	589,557
OH	8.1	520,789
PA	9.9	635,577
WI	13.6	728,604
WV	2.7	162,568
Total	100.0	6,623,893

[1]Based on fishing license sales (see Methods section for more details).

Table 11. Respondent marital status.

Marital Status	Percent
Never Married	8.7
Married	79.6
Unmarried Partner	2.8
Divorced	6.7
Widowed	2.2

Based on responses to the measure of age ("what year were you born"), anglers in the study region averaged 54 years old, with a roughly symmetric distribution around this mean (Figure 4).

Some 60% of anglers were employed full-time or self-employed, which may influence the amount of time they have available for fishing. The remaining anglers were retired (29%) or employed part-time or unemployed. With respect to income, only 18% of anglers had household incomes (in 2011) of less than $35,000 per year; 25% had household incomes of $100,000 or more. The modal single household income category (23.5%) is $50,000-$74,999 (Table 12). About 10% of respondents did not answer this question.

Fishing Behavior and Commitment

Number of Years Fished

On average, and consistent with the relatively high median age of our sample, anglers have extensive experience fishing: anglers have fished an average of 40 years (mean=39.9, median=40), and 75% had fished at least 30 years (Figure 5).

Fishing Motivations

Respondents were asked to describe the importance of several types of motivations for fishing, including those that emphasized achievement (expect to catch fish, expect to catch a lot of fish, big fish, and the right species of fish) and those that were less tied to catching fish (close to home, scenic, near family and friends). Each of these was measured on a five point scale ranging from 1=not at all important to 5=extremely important (Table 13).

Being able to fish for desired fish species (mean =3.57) was rated most important, followed by catching at least some fish (3.28). With regard to evaluating the potential impacts of ANS, there are anglers who care about catching fish (big fish, lots of them, and the species they want) and those who are interested in beauty, social relationships, convenience. Presumably the former group of anglers (those who care about catching fish) is more likely than the latter group to fish less if ANS transfer led to a decline in fishing quality – or alternatively to switch to other fishing locations or types of fishing with better opportunities for catching fish.

These results suggest that the type of fish sought is important, justifying the nesting approach used in the econometric model. Further, although fish catch rates appear to be important in site choice, other "quality" factors appear to be important in the site choice. This latter result

Figure 4. Angler age.

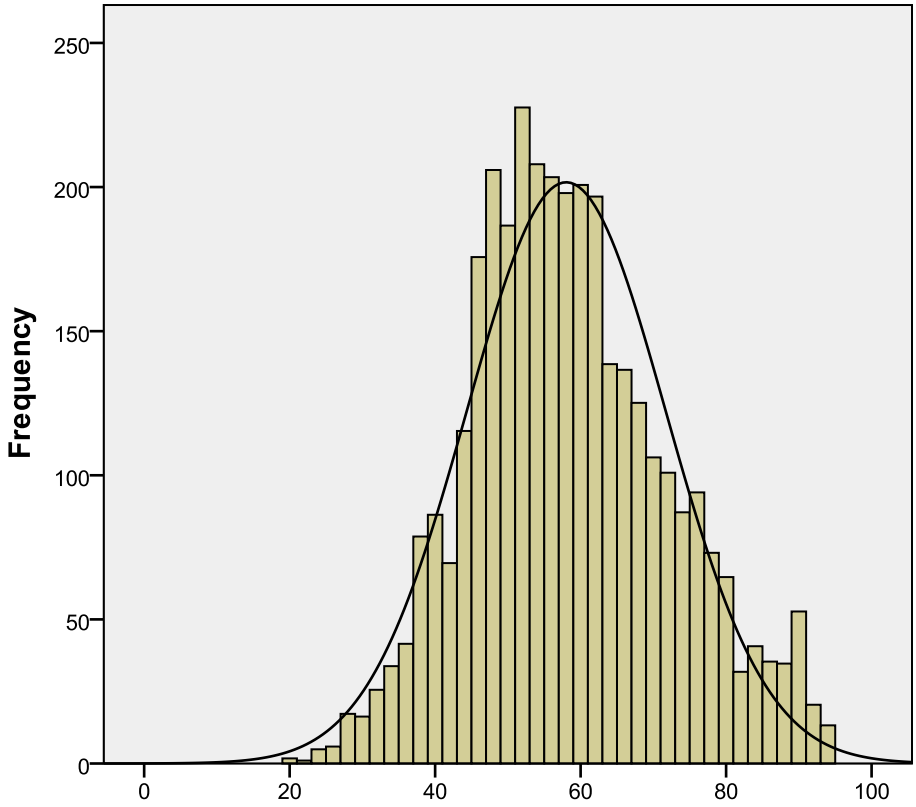


Figure 5. Number of years fished.

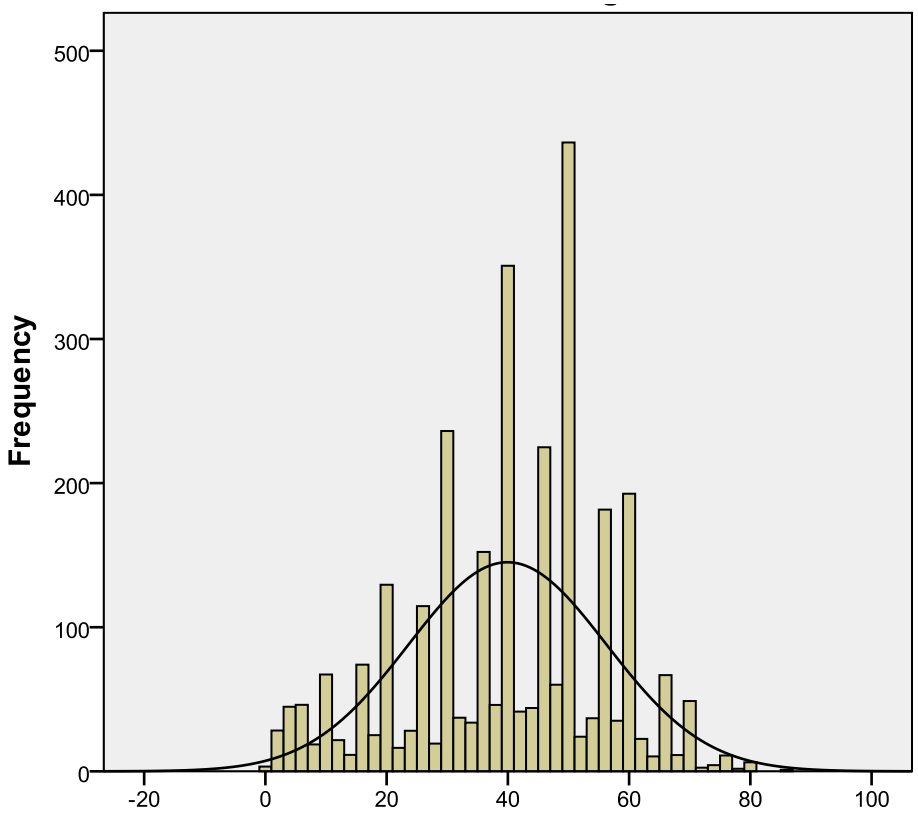


Table 12. Respondent income.

Income	Percent
Less than $15,000	4.2
$15,000 to 24,999	6.4
$25,000 to 34,999	7.9
$35,000 to 49,999	14.3
$50,000 to 74,999	23.5
$75,000 to 99,999	18.3
$100,000 to 149,999	17.2
$150,000 to 199,999	4.7
$200,000 or more	3.6

Table 13. Importance of fishing motivations.

	Fishing Motivation						
	Fishing location close to home/camp	Expect to catch some fish at location	Expect to catch a lot of fish at location	Fishing location has scenic beauty	Fishing location near family/friends	Fishing location contains fish species I like	Fishing location known for big fish
Mean	2.88	3.28	2.26	3.07	2.23	3.57	2.41
Median	3.00	3.00	2.00	3.00	2.00	4.00	2.00
SD	1.13	1.00	1.00	1.04	1.24	1.06	1.06

supports using state- and segment-specific constants in the Site-Choice Model as described above.

Fishing Commitment

It also might be expected that more committed anglers are more likely than less committed anglers to continue fishing even if they could catch fewer fish. Therefore, several measures of fishing commitment were examined. To begin with, respondents offered a self-assessment of their fishing commitment (Table 14). The distribution of responses was approximately normal, with only 25% in one of the two extreme values ("I would easily find something as enjoyable as fishing" and "I would miss fishing more than all other interests"). The anglers who "would miss fishing more than all other interests" would likely fish even if quality declined, and a decline in fish stocks, therefore, would not be expected to lead to an equal decline in recreational fishing.

Other measures of commitment are related to the opportunities anglers have to fish: whether they own a boat and whether they live within walking distance of fishing sites. Only 13% of respondents do not have a boat they use for fishing. Almost three times as many (35%, the most common response category) have both a motorized and non motorized boat (Table 15). Sixty-four percent, however, do not live within walking distance of any fresh water fishing.

Detailed Fishing Behavior Variables

Respondents reported the number of day trips and overnight trips they took for each of the seven fishing types. The total number of day trips, total number of overnight trips, and the total number of days spent on overnight trips were summed across all fishing types. Respondents reported an overall average of 28.0 days of fishing on day trips in the past year (Table 16). A strong majority of this fishing was on inland waters rather than the Great Lakes. Half of all day trips (14.1 days) were warmwater fishing on inland lakes. The second most common fishing type for day trips was warmwater river fishing (5.9 days). Thus, warmwater inland fishing (lakes and rivers combined) accounted for over 70% of all day trips. Inland coldwater fishing (lakes and rivers) accounted for 4.1 days of fishing, and Great Lakes fishing (coldwater, warmwater, and anadromous runs) accounted for 3.8 days of fishing (on day trips). About half of Great Lakes fishing day trips (1.9 days) were for warmwater species rather than coldwater.

Respondents reported an overall average of 3.28 overnight trips (Table 17); this figure is based only on the data from only the web survey, as inspection of the responses to this question from the mail survey revealed evidence that a high proportion of mail survey respondents misinterpreted the question and reported the number of days fished on overnight trips instead

Table 14. Fishing Commitment

Feelings about Fishing	Percent
Easily find something as enjoyable as fishing	12.4
Would miss fishing, but not as much as other things	34.4
Would miss fishing more than most other interests	39.2
Would miss fishing more than all other interests	13.9

Table 15. Boat ownership

Boat Owned?	Percent
No	13.1
Non-motorized	27.2
Motorized	25.0
Both non-motorized and motorized	34.7

Table 16. Number of day trips, by type of fishing.

	Great Lakes for trout and salmon	Great Lakes for warmwater species	Inland lakes and ponds for trout and salmon	Inland lakes and ponds for warmwater species	Inland rivers and streams for trout and salmon	Inland rivers and streams for warmwater species	Salmon or steelhead on spawning runs	Total
Mean	1.27	1.85	1.35	14.11	2.88	5.93	0.63	28.02
Median	0.00	0.00	0.00	6.00	0.00	0.00	0.00	15.00
SD	1.11	8.08	7.39	22.99	10.23	14.81	3.64	38.05

Table 17. Number of overnight trips, by type of fishing.

	Great Lakes for trout and salmon	Great Lakes for warmwater species	Inland lakes and ponds for trout and salmon	Inland lakes and ponds for warmwater species	Inland rivers and streams for trout and salmon	Inland rivers and streams for warmwater species	Salmon or steelhead on spawning runs	Total
Mean	0.23	0.24	0.14	1.80	0.33	0.45	0.09	3.28
Median	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SD	1.85	1.53	1.28	5.57	2.12	2.32	0.79	7.79

of the number of overnight trips[14]. The patterns within fishing type generally reflect those seen for day trips: over half of all overnight trips (1.80) were to inland lakes. The second most common fishing type was warmwater river fishing (0.45 overnight trips). Great Lakes fishing combined across warmwater, coldwater, and anadromous categories, accounted for 0.56 overnight trips per respondent.

With respect to the total number of days fished on overnight trips (Table 18), only the data from web respondents is included in the analysis for the reasons described above. Web respondents took multiple overnight fishing trips each year and fished an average of 5.89 days over the course of the year on these trips. The average number of days fished on each individual overnight trip was slightly less than 2.

Using CU's estimates of the number of anglers living and fishing in the study area in 2011 the estimates of the average days fished by fishing type were expanded to total days fished by type of fishing reflecting the relative importance of each fishing type (Table 19). It was estimated that 224 million days were spent fishing in the 12-state study area in 2011. The majority of those days were spent on inland lakes and ponds for warmwater species. Great Lakes fishing accounted for 32.8 million days (GL Warm, GL Cold and Anadromous). Preliminary estimates from the National Survey conducted in 2011 suggest far fewer days (19.7 million) spent fishing Great Lakes waters (USFWS 2012a). The discrepancy is likely due to the generally fewer days fished on average reported by National Survey respondents and the generally wide confidence intervals associated with National Survey data at the state and regional levels. In 2006 the 95% confidence interval around this estimate was 4.4 million days (USFWS 2008). Confidence interval data are not yet available for the 2011 USFWS National Survey.

Table 20 shows the average days fished by state of residence used to calculate the overall number of days fished in the study area by those living in the 12-state study area. These data are used in the calculations of net economic value later in the report. The data by state are informative because they can be compared with preliminary data from the 2011 National Survey (USFWS 2012b). Note: The National Survey data are for state residents fishing anywhere in the United States; CU's estimates are for fishing only in the 12-state study area. Estimates of days fished vary widely with some instances where the National Survey estimates

[14] Because of space constraints in the mail survey, different questions were used to collect data on overnight trips in the web and mail surveys. In the web survey, respondents were asked about the number of overnight trips and the total number of days spent fishing on those overnight trips for each fishing location. In the mail survey, respondents were asked only about the number of overnight trips to each location. The number of overnight trips reported by mail survey respondents was much higher than the number reported by the web survey respondents. In fact, the number of overnight trips reported by mail survey respondents was similar to the number of days spent fishing on overnight trips reported by web survey respondents, suggesting that mail respondents may have misinterpreted the question and reported days spent fishing on overnight trips rather than number of overnight trips.

Table 18. Number of days on overnight trips, by type of fishing.

	Great Lakes for trout and salmon	Great Lakes for warmwater species	Inland lakes and ponds for trout and salmon	Inland lakes and ponds for warmwater species	Inland rivers and streams for trout and salmon	Inland rivers and streams for warmwater species	Salmon or steelhead on spawning runs	Total
Mean	0.30	0.45	0.22	3.45	0.53	0.73	0.21	5.89
Median	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SD	2.54	2.52	1.77	9.04	2.84	3.58	1.94	12.11

Table 19. Estimated total number of days fished (on day trips and overnight trips) in 12-state study area in 2011 by type of fishing.

Type of fishing	Estimated total # of days on day trips	Estimated total # of days on overnight trips	Estimated total # of days fished in 12-state study area in 2011
Great Lakes for trout and salmon	9,039,490	1,901,318	10,940,808
Great Lakes for warmwater species	12,743,542	3,219,357	15,962,899
Inland lakes and ponds for trout and salmon	8,767,420	1,296,506	10,063,926
Inland lakes and ponds for warmwater species	92,782,895	24,138,904	116,921,798
Inland rivers and streams for trout and salmon	18,622,692	3,735,740	22,358,432
Inland rivers and streams for warmwater species	37,500,326	4,814,892	42,315,218
Salmon or steelhead on spawning runs	4,490,943	1,379,880	5,870,822
TOTAL	183,947,308	40,486,597	224,433,905

Table 20. Mean number of day trips and days spent on overnight trips by anglers, total days spent by anglers living and fishing in the 12-state study area, and comparison with preliminary estimates from the National Survey by state of residence.

State of residence	Mean days on day trips	Mean days on overnight trips	Total days	National Survey preliminary estimate of # of days fished in U.S. in 2011[2]
IA	31.5	7.4	10,464,209	6,909,000
IL	26.9	12.8	24,044,272	15,614,000
IN	34.0	7.5	13,780,540	21,542,000
KY	23.7	3.0	10,797,190	10,245,000
MI	29.3	5.5	28,041,564	26,744,000
MN	20.1	7.1	27,852,874	24,903,000
MO	24.0	7.9	17,414,270	14,448,000
NY	28.8	3.4	18,983,720	29,112,000
OH	29.6	2.0	16,456,921	19,116,000
PA	34.9	4.9	25,295,954	9,926,000
WI	27.9	5.6	24,408,221	15,320,000
WV	37.3	5.5	6,957,910	4,767,000
Total			224,497,646	198,646,000

[2]Source: 2011 National Survey of Fishing, Hunting, and Wildlife-associated Recreation: State Overview – September 2012.

are much larger (e.g., NY) and some instances where they are smaller (e.g., PA) or similar (e.g., KY) to CU's estimates. The discrepancies are likely due to the small sample sizes at the state level in the National Survey data, and to a lesser extent in CU's data. Using New York as an example and confidence interval data from the 2006 National Survey (2011 is not yet published) the New York estimate from the National Survey has a confidence interval of ± 10.9 million days. CU's estimate has a confidence interval of ± 3.3 million days. The confidence intervals around the two estimates overlap. The overall study area estimates are quite close, varying by about 13%.

Based on CU's method of apportioning days fished within a county to one of the two basins in the study area (using the proportion of the water bodies in each county that fell into each basin), CU estimated that 74 million days were spent fishing in the Great Lakes basin – 42% of the fishing effort in the two basins combined (Table 21). This Great Lakes basin is larger than the Great Lakes themselves because it includes all of the inland lakes, ponds, rivers, and streams draining into the Great Lakes (Figure 1). Similarly the UMORB accounts for 58% or 102 million days of fishing effort in the two basins combined. These numbers are used later in the report to estimate net economic value by basin.

Angler Expenditures

Twice during the course of this study, anglers were asked to report their trip expenditures for their most recent trip taken for the primary purpose of fishing. The reason for gathering this data was to provide information on expenditures that could be used in a regional economic impact analysis by USACE. The first time expenditure data were collected was during the main data collection effort that occurred in March-May and the second time occurred in July-August. In both surveys, anglers were asked about their most recent trip in an effort to reduce recall bias. The results are intended to be representative of fishing trips taken during the time periods when the surveys were conducted, but they do not necessarily represent all types of trips taken over the course of a fishing season.

Trip Expenditure Estimates from the Main Survey

Anglers reported their trip expenditures for their most recent trip. For some anglers, this was just prior to their filling out the survey (March-May, 2012) to as far back as January 2011. The majority of trips reported took place in June through October 2011. Almost all anglers (94%) traveled by car to the fishing site for this trip. Expenditures were reported by anglers for their household's share of the trip. The average number of household members participating in the trip was 1.4.

Table 21. Estimates of days fished by basin.

Study Area Basins	Proportion of days	Total days
Great Lakes basin		
Below impassable barriers	0.359	62,900,000
Above impassable barriers	0.061	10,668,000
UMORB		
Below impassable barriers	0.328	57,575,000
Above impassable barriers	0.252	44,154,000
Total		175,297,000

Anglers estimated that their per-day expenditures in the county where they fished were approximately $98, with another $26 spent in counties outside the county where they fished. The expenditure category with the highest mean expenditures in the county where they fished was gas stations (Table 22). Lodging, food, and fishing supplies accounted for most of the remaining expenditures. Gas stations and bait and tackle shops accounted for most of the spending outside the county where the fishing took place.

Expenditures varied based on the type of fishing (Tables 23 and 24). Average costs were highest for fishing trips to the Great Lakes (including Anadromous) and for trips targeting coldwater species. Anglers spent almost twice as much per day on Great Lakes fishing as compared to inland waters. (Note: Many more anglers reported on trips to inland waters than Great Lakes waters, reflected in the means in Table 22.) Expenditures at gas stations were generally the highest category on average across all types of fishing, but for Great Lakes fishing expenditures for fishing charters or guides was higher.

Expenditures by state fished may be the most useful information for regional economic impact analysis and are therefore included in Tables 25 and 26. These data were not weighted, so the variability in sample sizes should be taken into consideration in any impact analysis work. Information for West Virginia was not reported because of low numbers of respondents from this state.

Expenditures varied by state fished, with New York and Ohio having the highest average per day expenditures in the county fished and Iowa and Indiana having the lowest (Table 25). The expenditure category with the highest mean expenditures in the county where they fished was gas stations in all states except Minnesota, where lodging expenditures were higher.

Trip Expenditure Estimates from the Followup Survey

Anglers reported their trip expenditures for their most recent trip since filling out the main survey, which could range from March to July. The majority of trips reported took place in June 2012. Most anglers (81%) traveled by car to the fishing site for this trip. Expenditures were reported by anglers for their household's share of the trip. The average number of household members participating in the trip was 1.5.

Anglers estimated that their per-day expenditures in the county where they fished were approximately $96. An additional $27 was spent per day in counties outside the county where they fished. These averages varied little from the data collected in the main survey of $98 and $26 per day, respectively. The expenditure category with the highest mean expenditures in the county where they fished was gas stations (Table 27). Lodging, food, and fishing supplies

Table 22. Mean expenditures per day per household for the most recent fishing trip (May 2012 or earlier) by expenditure category in county where fishing took place and in other counties.

Expenditure Category	Spent in county where fished	Spent in other counties
	Mean expenditures per day per household	
Bait and tackle shops	$13.47	$5.43
Restaurants or bars	14.52	2.47
Grocery or convenience type stores	11.26	3.61
Lodging (hotels, motels, B&Bs, campgrounds)	17.25	1.69
Gas stations (fuel, sundries)	23.12	10.28
Marinas or yacht clubs (rental or launching fees, fuel, supplies)	6.66	0.80
Fishing charters or guides	6.56	0.63
Other	3.19	0.94
TOTAL	96.02	25.85

Table 23. Mean expenditures per day per household for the most recent fishing trip (May 2012 or earlier) by expenditure category in county where fishing took place, by type of water and species fished for.

Expenditure category	Money spent in county for fishing:			
	Great Lakes waters (including anadromous runs) (n = 330)	Inland waters (n = 2,445)	Coldwater species (n = 477)	Warm water species (n = 2,293)
	Mean expenditures per day per household			
Bait and tackle	$17.32	$12.85	$14.52	$13.26
Restaurants or bars	23.33	13.31	17.42	13.96
Grocery stores	13.34	10.93	10.57	11.38
Lodging	24.66	16.32	20.21	16.79
Gas stations	31.16	21.97	24.75	22.78
Marinas or yacht clubs	21.07	4.74	7.38	6.57
Fishing charters or guides	34.68	2.77	16.22	4.64
Other	3.58	3.17	2.36	3.40
TOTAL	169.16	86.07	113.45	92.79

Table 24. Mean expenditures per day per household for the most recent fishing trip (May 2012 or earlier) by expenditure category in other counties, by type of water and species fished for.

	Money spent in other counties for fishing:			
Expenditure category	Great Lakes waters (including anadromous runs) (n = 330)	Inland waters (n = 2,445	Coldwater species (n = 477)	Warm water species (n = 2,293)
	Mean expenditures per day per household			
Bait and tackle	$4.62	$5.42	$7.21	$4.95
Restaurants or bars	3.13	2.33	2.66	2.38
Grocery stores	3.24	3.61	3.91	3.51
Lodging	1.80	1.58	1.09	1.72
Gas stations	11.06	10.13	11.01	10.09
Marinas or yacht clubs	3.66	0.42	2.41	0.47
Fishing charters or guides	2.38	0.36	0.10	0.71
Other	3.82	0.56	1.23	0.88
TOTAL	33.70	24.41	29.63	24.72

Table 25. Mean expenditures per day per household for the most recent fishing trip (May 2012 or earlier) by expenditure category in county where fishing took place, by state where fishing trip took place.

	Money spent in county for fishing in:										
	IL (n = 94)	IN (n = 162)	IA (n = 131)	KY (n = 159)	MI (n = 448)	MN (n = 428)	MO (n = 209)	NY (n = 259)	OH (n = 101)	PA (n = 291)	WI (n = 519)
Expenditure category	Mean expenditures per day per household										
Bait and tackle	$10.36	$14.10	$12.64	$13.29	$12.92	$12.49	$9.71	$17.63	$17.28	$14.34	$13.41
Restaurants or bars	10.56	10.83	6.38	8.73	15.14	16.08	12.53	19.04	18.41	13.37	16.92
Grocery stores	8.33	7.73	7.77	12.52	12.68	13.88	10.14	14.36	10.35	7.90	10.22
Lodging	17.71	10.05	6.87	15.66	12.45	30.60	20.25	20.90	14.95	7.69	15.87
Gas stations	17.90	17.34	16.37	21.87	25.56	26.14	25.83	28.35	24.59	17.96	21.96
Marinas or yacht clubs	4.12	1.09	0.27	7.30	6.68	3.89	8.63	13.96	17.42	4.77	3.64
Fishing charters or guides	1.33	0.12	0.00	5.88	14.45	5.66	1.19	8.24	22.28	1.36	4.03
Other	1.99	0.73	1.06	4.16	6.08	5.94	3.02	2.15	0.15	1.03	3.43
TOTAL	72.30	61.99	51.37	89.41	105.96	114.69	91.31	124.64	125.43	68.41	89.49

*West Virginia was not included in this table due to sample size < 30.

Table 26. Mean expenditures per day per household for the most recent fishing trip (May 2012 or earlier) by expenditure category in other counties, by state where fishing trip took place.

	Money spent in other counties for fishing in:										
	IL (n = 94)	IN (n = 162)	IA (n = 131)	KY (n = 159)	MI (n = 448)	MN (n = 428)	MO (n = 209)	NY (n = 259)	OH (n = 101)	PA (n = 291)	WI (n = 519)
Expenditure category	Mean expenditures per day per household										
Bait and tackle	$9.69	$6.39	$3.34	$5.79	$4.49	$3.72	$8.35	$4.89	$6.13	$7.78	$2.86
Restaurants or bars	3.16	2.75	1.08	1.64	2.10	4.04	2.12	1.94	4.04	1.86	2.15
Grocery stores	2.52	4.14	2.93	3.02	3.66	6.58	3.98	2.91	2.47	2.57	2.57
Lodging	0.67	2.16	1.13	1.23	2.18	1.98	1.76	0.30	4.55	1.33	1.02
Gas stations	15.61	12.94	4.20	10.91	10.47	13.27	13.10	9.47	8.68	6.69	9.02
Marinas or yacht clubs	2.62	0.41	0.00	0.25	0.65	0.52	0.86	3.91	0.63	0.04	0.08
Fishing charters or guides	0.00	0.00	0.05	0.19	0.41	0.58	0.00	1.35	4.70	0.15	0.38
Other	1.24	0.06	0.10	0.17	0.52	0.89	2.11	2.02	0.37	0.84	0.55
TOTAL	35.11	28.85	12.83	23.20	24.48	31.59	32.29	26.79	31.58	21.26	18.64

*West Virginia was not included in this table due to sample size < 30.

Table 27. Mean expenditures per day per household for the most recent fishing trip (March – July 2012) by expenditure category in county where fishing took place and in other counties.

Expenditure Category	Spent in county where fished	Spent in other counties
	Mean expenditures per day per household	
Bait and tackle shops	$13.05	$5.01
Restaurants or bars	14.21	2.41
Grocery or convenience type stores	12.83	3.82
Lodging (hotels, motels, B&Bs, campgrounds)	16.50	2.44
Gas stations (fuel, sundries)	22.43	10.73
Marinas or yacht clubs (rental or launching fees, fuel, supplies)	5.68	0.69
Fishing charters or guides	7.46	1.09
Other	3.58	0.64
TOTAL	95.76	26.83

accounted for most of the remaining expenditures. Gas stations and bait and tackle shops accounted for most of the spending outside the county where the fishing took place.

Expenditures varied based on the type of fishing in the county fished (Table 28). Average costs were highest for fishing trips to the Great Lakes (including Anadromous). Anglers spent twice as much per day on Great Lakes fishing as compared to inland waters. This is the same finding as was seen in the main survey. Expenditures based on species sought (coldwater versus warmwater) did not appear to differ during this time period. Expenditures at gas stations were generally the highest category on average across all types of fishing, but for Great Lakes fishing expenditures for fishing charters or guides was higher. Expenditures varied little by type of fishing outside the county fished (Table 29).

Expenditures by state fished may be the most useful information for regional economic impact analysis and are included in Tables 30 and 31. These data were not weighted, so the variability in sample sizes and the small sample sizes in some states should be taken into consideration in any subsequent impact analysis work. Information for West Virginia was not reported because of low numbers of respondents from this state.

Expenditures varied by state fished, with Ohio (keeping in mind the small sample size from this state) having the highest average per day expenditures in the county fished and Iowa and Indiana having the lowest (Table 30). The expenditure categories with the highest mean expenditures in the county where they fished were gas stations and lodging.

Economic Modeling Results

Maximum likelihood, random utility modeling methods were used to estimate the Repeated Site-Choice model based on reported day trips taken in 2011[15]. Only general results from this modeling exercise are reported here, in part because the model involves over 100 estimated coefficients. Moreover, several of the estimated coefficients are specific to the statistical structure of the model, for which the discussion is relegated to the Technical Appendix.

Overall the estimated site-choice model is consistent with underlying economic theory. Specifically, two coefficients, called scale parameters, had estimated values that lay within the ranges necessary for the model to be consistent with economic theory. The scale parameter for the site choice was 0.1194 while the scale parameter for the fishing type choice was 0.1329. Both estimated values fall in the range from zero to 1, and the scale parameter for the higher-

[15] Estimation of a similar model for overnight trips failed to converge. When aggregating values, the net value estimate per day from the day trip model is used to value fishing days on overnight trips. This could introduce a downward bias, if a day spent fishing on an overnight trip generates higher net value than a day trip.

Table 28. Mean expenditures per day per household for the most recent fishing trip (March – July 2012) by expenditure category in county where fishing took place, by type of water and species fished for.

	Money spent in county for fishing:			
	Great Lakes waters (including anadromous runs) (n = 137)	Inland waters (n = 884)	Coldwater species (n = 126)	Warm water species (n = 896)
Expenditure category	Mean expenditures per day per household			
Bait and tackle	$18.35	$12.12	$12.14	$13.07
Restaurants or bars	23.06	12.70	13.71	14.15
Grocery stores	15.87	12.18	9.96	13.06
Lodging	19.27	16.22	13.81	17.03
Gas stations	32.91	20.67	25.93	21.81
Marinas or yacht clubs	16.18	4.11	7.04	5.55
Fishing charters or guides	38.86	2.54	11.92	6.78
Other	1.66	3.92	0.86	4.00
TOTAL	166.18	84.46	95.37	95.46

Table 29. Mean expenditures per day per household for the most recent fishing trip (March – July 2012) by expenditure category in other counties, by type of water and species fished for.

	Money spent in other counties for fishing:			
	Great Lakes waters (including anadromous runs) (n = 137)	Inland waters (n = 884)	Coldwater species (n = 126)	Warm water species (n = 896)
Expenditure category	Mean expenditures per day per household			
Bait and tackle	$4.73	$5.09	$8.00	$4.63
Restaurants or bars	2.21	2.46	3.40	2.29
Grocery stores	4.93	3.69	3.67	3.88
Lodging	3.95	2.22	0.40	2.74
Gas stations	11.99	10.60	14.05	10.32
Marinas or yacht clubs	1.43	0.59	0.00	0.80
Fishing charters or guides	0.00	1.26	0.00	1.25
Other	0.12	0.72	0.24	0.70
TOTAL	29.36	26.64	29.75	26.62

Table 30. Mean expenditures per day per household for the most recent fishing trip (March – July 2012) by expenditure category in county where fishing took place, by state where fishing trip took place.

	Money spent in county for fishing in:										
	IL (n = 50)	IN (n = 57)	IA (n = 42)	KY (n = 44)	MI (n = 140)	MN (n = 155)	MO (n = 69)	NY (n = 95)	OH (n = 39)	PA (n = 130)	WI (n = 195)
Expenditure category	Mean expenditures per day per household										
Bait and tackle	$4.46	$9.33	$6.72	$10.70	$13.37	$12.51	$12.13	$18.64	$17.95	$15.86	$11.16
Restaurants or bars	5.86	7.20	9.79	12.36	10.73	15.91	14.04	16.00	20.82	17.84	15.05
Grocery stores	3.88	7.07	7.93	11.91	12.97	14.32	15.65	12.01	13.32	13.02	12.71
Lodging	17.77	8.14	5.54	16.70	14.56	31.57	30.24	8.06	25.07	13.42	15.07
Gas stations	12.32	15.38	11.08	19.10	22.37	24.50	31.52	23.50	24.97	26.55	22.60
Marinas or yacht clubs	7.83	10.26	0.00	1.40	5.68	7.92	5.11	10.59	8.31	2.29	2.37
Fishing charters or guides	9.00	0.00	0.00	9.05	0.82	9.35	1.27	5.26	42.33	0.57	3.14
Other	5.60	0.94	3.20	.54	4.26	1.80	1.23	2.37	2.54	4.38	0.95
TOTAL	66.71	58.32	44.25	81.78	84.77	117.90	111.18	96.44	155.32	93.94	83.06

*West Virginia was not included in this table due to sample size < 30.

Table 31. Mean expenditures per day per household for the most recent fishing trip (March – July 2012) by expenditure category in other counties, by state where fishing trip took place.

	Money spent in other counties for fishing in:										
	IL (n = 50)	IN (n = 57)	IA (n = 42)	KY (n = 44)	MI (n = 140)	MN (n = 155)	MO (n = 69)	NY (n = 95)	OH (n = 39)	PA (n = 130)	WI (n = 195)
Expenditure category	Mean expenditures per day per household										
Bait and tackle	$5.73	$4.53	$4.97	$8.64	$5.36	$3.34	$4.61	$6.75	$2.56	$6.13	$4.57
Restaurants or bars	1.08	2.60	3.45	3.78	1.48	2.45	4.01	0.56	1.73	2.93	2.97
Grocery stores	2.63	4.58	2.46	9.05	3.59	4.96	5.12	3.10	1.15	3.02	3.97
Lodging	0.75	1.76	0.00	15.06	0.39	2.45	0.72	0.40	3.59	0.77	2.23
Gas stations	15.22	6.86	8.17	14.69	12.62	10.87	10.02	10.12	10.00	8.80	14.42
Marinas or yacht clubs	0.00	0.88	0.00	2.27	2.07	0.20	0.75	0.53	0.00	0.33	0.41
Fishing charters or guides	0.00	0.00	0.00	10.22	0.00	0.00	0.00	0.00	0.00	0.00	2.56
Other	1.00	0.68	3.57	0.11	0.13	0.51	2.24	0.00	0.00	0.60	0.31
TOTAL	26.41	21.90	22.63	63.83	25.64	24.79	27.47	21.47	19.04	21.89	31.45

*West Virginia was not included in this table due to sample size < 30.

level choice is larger than the scale parameter for the lower-level choice, which indicates that the estimated model is consistent with utility theory (Train, 2003). From a practical perspective, this result shows that anglers view fishing trips of the same fishing type as being more similar than fishing trips of different fishing types.

Taken together, the segment-specific constants for the Great Lakes trout and salmon and the Great Lakes warmwater fishing types are significant compared to a model in which such constants are not included. Similarly, the inclusion of the segment-specific constants for the Anadromous fishing type and the state-specific constants for the four inland fishing types significantly contribute to the statistical model. Estimated coefficients for continuous variables associated with fishing habitat and accessibility were of the expected sign and generally significant. Specifically, anglers were more attracted to counties with higher values of the habitat condition index for all five non-Great Lakes fishing types. For the ILWarm and ILCold fishing types, counties with more lake area were more attractive. For the RSWarm fishing type, anglers were attracted to counties with more miles of both smaller and larger streams, though larger streams had a bigger effect than smaller streams, indicating that warmwater stream and river anglers were particularly attracted by larger streams and rivers. For the RSCold fishing type, anglers were more attracted to counties with more miles of both smaller and larger streams, but it was smaller streams that had a larger effect, indicating that coldwater stream anglers were more attracted by smaller streams. These findings are consistent with general differences between warm and coldwater stream fishing, where typically the best coldwater fishing is in smaller headwater streams. For Anadromous fishing, anglers were attracted to counties with more large streams and rivers, but were not attracted to counties with more small streams and rivers, possibly indicating that anglers were more attracted to counties that lie farther down in the drainages, closer to the Great Lakes. For the GLWarm and GLCold fishing types, anglers were attracted to counties that had more shoreline miles.

A number of angler characteristics were included as explanatory variables in the participation level of the model. Most notably, anglers who were employed full time, who had higher income, or who were older tended to fish less often.

Within the repeated site choice framework the coefficient on travel costs is expected to take a negative value, as the probability of fishing at a site is expected to decline with travel cost to the site. That is, all other factors held constant, anglers prefer to visit sites closer to home (with lower travel costs). The estimated coefficient in the CU model is -0.00681, with a 95 percent confidence interval from -0.00617 to -0.00745.

These estimated coefficients can be used to calculate the net value of a fishing day. Over an entire season, each angler is expected to take a certain number of trips of each fishing type. This will vary between anglers. If fishing quality for one fishing type declines to the point where

an angler no longer wishes to participate in that fishing type, then the trips that would have been taken to engage in that fishing type are displaced. Some of these trips are still taken, but for different fishing types. For others of these displaced trips, the angler chooses to engage in a nonfishing activity instead. The loss in net economic value, per displaced trip, is measured by the ratio of the scale parameter for the fishing type choice divided by the absolute value of the parameter on travel cost. Applying this method results in an estimated net value (consumer surplus) of $19.52 per fishing day, with a 95% confidence interval from $19.01 to $20.06.[16]

Net Value

As discussed in the introductory section of this report, previous fisheries research conducted in the Great Lakes suggests that a range of $20 to $75 would encompass the likely net value per day of fishing in the Great Lakes. The average net value per angler day generated by CU's model was $19.52 (95% CI: $10.01-$20.06) which is at the lower end of this predicted range, presumably because it is based not only on Great Lakes fishing but fishing in inland waters in the Great Lakes basin and the UMORB, which are less highly valued.

CU notes that the Repeated Site Choice modeling framework used here is best suited for valuing marginal (small) changes in access to fishing sites or changes in the quality at a single site or group of sites. That same point would also apply to most values reported in the literature. With this caveat, CU obtained estimates of aggregate seasonal values for each basin by multiplying the estimated value from the site choice model by the estimated number of angler days provided in other sections of this report.

The total aggregate net value of fishing in the Great Lakes basin and the UMORB was $3.422 billion (Table 32). If the analysis is restricted to those portions of both basins that are below barriers impassable to fish (the portions that USACE considers susceptible to the effects of ANS transfer), the net value of fishing is $2.352 billion. Of this, $1.228 billion is in the Great Lakes basin and $1.124 billion is in the UMORB.

[16] This net value is strictly valid only for changes in fishing quality that result in small changes in fishing behavior. For declines in fishing quality that cause large changes in fishing behavior (for example, if multiple types of fishing were to decline simultaneously, thus offering fewer substitutes) the loss in net value per displaced trip will be larger (Haab and McConnell, 2002). This caveat applies also to many of the net value estimates from the literature reviewed by Poe et al (2012). The baseline estimates of net value for fishing in the Great Lakes, Upper Mississippi and Ohio River basins presented in this report should therefore be viewed as lower-bound estimates.

Table 32. Estimates of days fished and the associated net economic value, by basin.

Study Area Basins	Total days	Net economic value (in billions of dollars)
Great Lakes basin		
Below impassable barriers	62,900,000	1.228
Above impassable barriers	10,668,000	0.208
UMORB		
Below impassable barriers	57,575,000	1.124
Above impassable barriers	44,154,000	0.862
Total	175,297,000	3.422

Summary and Conclusions

This project sought to estimate the net value to anglers of recreational fishing in the Great Lakes and Upper Mississippi and Ohio River basins. Using focus groups and mail and web-based surveys of recreational anglers throughout the 12-state region, the team used travel cost techniques to establish baseline recreational fishing values and develop an economic model of angler behavior.

To summarize, results indicate that 6.6 million anglers lived and fished in the 12-state study area in 2011 and that this population spent 175 million days fishing in the Great Lakes basin and the UMORB. Anglers spent 74 million days fishing in the Great Lakes basin, which included fishing in Great Lakes waters, but also included fishing in the inland lakes, ponds, rivers, and streams that flow into the Great Lakes. Even more fishing (102 million days) took place in the Upper Mississippi and Ohio River basin.

The economic model revealed an average net value per angler day of $19.52. Fishing within the those portions of the Upper Mississippi and Ohio River basin that are below barriers impassable to fish (the portions that USACE considers susceptible to the effects of ANS transfer) accounted for an aggregate net value of $1.124 billion. Fishing within those portions of the Great Lakes basin that are below barriers impassable to fish accounted for an aggregate net value of $1.228 billion.

The net value approach employed in this study measures a fundamentally different concept than other economic measures such as expenditures or economic impact. Hence, the figures reported herein are not directly comparable with those derived using other methodologies. The net value approach is appropriate for benefit-cost analyses under the national economic development objectives indicated in USACE project evaluation guidelines.

Although CU was originally tasked with estimating the impacts of ANS on the net value of recreational fishing, USACE was not able to obtain sufficient information to quantify the timing or magnitude of impacts of ANS on sportfish populations in the Great Lakes, Upper Mississippi River, and Ohio River Basins. Consequently, this report serves as an indicator of the net value of recreational fishing that could be impacted in the future without-project (FWOP) condition – the case where no Federal action is taken to prevent the transfer of ANS between the Great Lakes and Mississippi River Basins.

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Appendix: On Net Economic Value, Expenditures and Economic Impact Analysis

The purpose of this appendix is to provide a non-technical discussion of net value as a measure of the contribution of recreational fishing to NED, and contrast that to two other measures that are often reported, expenditures and net economic impact. The interested reader is also referred to Scodari (2009), Aitken (2009) and Poe et al. (2013) for additional discussions using supply and demand graphs.

When an individual takes a trip away from home to engage in a recreational activity such as a day spent fishing, boating, or going to the beach, the *total value* to the recreationist of the trip is defined as the largest amount of money he or she would be willing to pay to go on that trip to do that activity. The amount the individual actually spends to take that trip is called the recreationist's *expenditures* for the trip. Expenditures would include money spent on such things as gasoline, lodging, entry fees, and food at the recreation site.

An individual will only go on a recreational trip if the benefit they get from doing so (their total value) is larger than the cost to them of the trip (the expenditures). The *net value* from the trip is defined as the recreationist's total value for the trip minus the expenditures for the trip. Net value is also commonly referred to as the *consumer surplus* that the individual gets from engaging in the activity – it is the surplus value they receive from the activity over and above what they actually have to pay for the activity. If a recreational opportunity were somehow lost, recreationists would lose this net value. They would, however, not incur any expenditures and would have that money to spend on other activities.

One point of clarification is necessary. CU's definition of net value of the resource includes only the value that recreationists place on participating in the activity - the so-called "use value" from the activity, or the "all-or-nothing value" of taking the trip (Talhelm , 1988). Many people who do not use water resources recreationally still may care about the quality of those resources. This review will not address these so-called "nonuse values."

CU defined expenditures as the amount that recreationists actually spend on products and services for each trip. Studies will often report expenditures made by recreationists in a region as an indication of the importance of recreational resources to local or regional

communities. Studies will also commonly use information on recreational expenditures to help calculate the regional *economic impact* from the activity. When visitors from outside a region spend money in that region while on a recreational visit, some of those new expenditures induce local businesses and households to spend more money themselves. For example, when a visiting recreationist purchases food at a local restaurant, that local restaurant may purchase some of its food from the local grocery store. Similarly, the server at the restaurant will spend some of his or her tip money inside the region. There is therefore a multiplier effect, where the regional economic impact from recreational expenditures is larger than the initial expenditure.

Information on the magnitude of recreational expenditures and their resulting regional economic impact is often of great interest to local officials and business owners. However, expenditures and economic impacts do not represent benefits from a NED perspective as discussed in the text. There are two reasons why. First, recreation expenditures do not take into account the cost of providing the goods and services that recreationists purchase. For example, if a fisherman or boater spends $40 for gasoline for his boat, the marina will have to purchase that gasoline from a wholesale supplier, and that gasoline is no longer available for someone else to use for another purpose. Second, when recreationists spend money in a region where they go to recreate, that is money they can no longer spend in other regions or on other activities. Recreation expenditures and economic impacts represent transfers of income from recreationists to local businesses, from one activity to another, and from one region to another, rather than an added value to the economy. This point was emphasized in a recent background document on issues surrounding the Chicago Area Waterway System: the Congressional Research Service noted that economic impact measures “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)

Appendix: Focus Group Guide

Recreational Impacts of Aquatic Nuisance Species to the Great Lakes and Mississippi River Basins

Focus Group Interview Guide

1. Introductory Script

Statement of Purpose

Cornell University is conducting this study in cooperation with the United States Army Corps of Engineers to evaluate the effects of aquatic nuisance species on recreation in the Great Lakes and Upper Mississippi River Basins. The purpose of the focus group is to help us understand how recreational anglers make their choices about fishing – where they fish, what types of species they fish for, and how their fishing might change if the types of species that are available changed. Your ideas will help us to determine how anglers would be affected if aquatic nuisance species affected the types of fish that anglers could catch.

We will ask a series of questions for discussion, with no right or wrong answers. For most of these questions, we'd like you to answer in an open discussion. We may follow up with additional questions in response to particular points individuals raise. All perspectives are important. There are no right or wrong answers. We may check in with different individuals occasionally to find out if they agree or disagree with points that have been made.

Participation in this focus group is voluntary. You do not have to participate if you don't want to. You may also refuse to answer specific questions. There is no penalty to you if you decide that you do not want to complete the focus group.

Your identity will remain completely confidential. No one but the researchers in this study will be able to associate your responses with your name. We will not report results in a way that would allow other people to determine who made particular comments to us. We may use direct quotations from some people in reports or publications, but we will delete any information that could be used to identify specific people before we do. The session will be audio-recorded and the recording will be transcribed.

2. Focus Group Questions

Opening Statement

Let's start by going around the table and have everyone introduce themselves.

Introductory Questions

First, I would like to ask you about your fishing preferences, addressing where you fish, how you fish, the species you pursue, and how often you fish.

1. Where do you go fishing? Where do you prefer to fish? Great Lakes? Inland lakes? Rivers and streams? Other locations?
2. What particular species do you fish for?
3. How do you go fishing? From a private boat? A charter boat? Shore? Pier? Other places?
4. How often do you usually go fishing?

Transition Questions

At this point, I would like to ask you about the reasons why you choose to go to particular fishing sites regularly over others.

1. What are your reasons for going to the site you most regularly fish? What about your favorite fishing sites?

    a. The particular species that are available? The number of fish you catch? The size of the fish? The condition of the fish? To find edible fish? Good water quality? Natural beauty? Peace and quiet? b. What kinds of features are important for you to have at your fishing sites? How important is it for you to have access to a boat ramp? To a bridge, pier, or beach?

    c. How convenient is it for you to get to the locations you prefer? How far away are these locations? How long does it take you to get there? How much does it cost you? Do you have to pay any access fees? Other costs? How much does cost matter?

    d. How important is it to you to go fishing with particular people? Who do you prefer to fish with?

    e. How long have you been going to the locations that you fish the most?

We have talked about the reasons why you choose to go to particular fishing sites regularly. I would like to understand a bit more about the importance of these reasons.

2. What is/are the most important factor(s) of all in choosing that specific location? What is/are the least important factor(s)?

We've been talking up until now about the reasons you choose particular fishing sites. But there also might be times when you are thinking about going fishing somewhere but decide NOT to fish at a particular spot or for a particular species. Maybe you choose a different spot or maybe you decide not to go fishing at all. We'd like to understand some of the reasons why you choose NOT to go fishing at some sites or for some species. (spot.)

3. When you decide not to fish at a specific location, what is the most important reason for not fishing there?
4. When you decide not to fish for specific species, what is the most important reason for not fishing for those species?
5. When you decide not to fish from shore, private boat, charter, or pier, what is the most important reason for not fishing from there?

Key Questions

1. Over the past 10 years, how has the type of fishing you do changed? Locations you fish? Species you fish for, how often you fish, or where you fish from? If you have made changes, can you tell us a bit about the reasons you've changed the type of fishing you do?

One of the things we're interested in is whether anglers might do things differently if there were changes in the species they fished for.

2. How would your fishing change if you only caught your preferred fish species about half as often as you do now at your favorite fishing sites (i.e., in your favorite spot it took you twice as long to catch the same number of fish)? No change? Stop fishing? Or fish less frequently? (Or more frequently?) Fish for different species at the same location? Change where you fish from: shore to boat or vice versa? Fish at other locations for the same species?
3. How much would your catch rate have to decline to get you to stop fishing at that location altogether?

4. What would you do if the fish you caught were on average a lot smaller than those you usually catch now at your favorite fishing sites? No change? Stop fishing? Or fish less frequently? (Or more frequently?) Fish for different species at the same location? Change where you fish from: shore to boat or vice versa? Fish at other locations for the same species?
5. How small would the average fish have to get for you to stop fishing at that location altogether?

Ending Questions

One of the things we wanted to learn from you is how the way you fish might change if the species you like to fish for weren't as common or were smaller. We've talked about a lot of different things you might do.

1. Is there anything we haven't talked about that you think is important for us to know?

If you're interested in receiving a copy of the report we prepare based on this study, provide me with your address or e-mail address. (*Provide them with my business cards.*)

THANK YOU!

Appendix: Survey Recruitment Script

Recreational Impacts of Aquatic Nuisance Species to

the Great Lakes and Mississippi River Basins

OMB control number 0710-0001

Telephone Survey Instrument

Introduction Version 1: Licensed anglers for whom we have names, addresses, and telephone numbers

Good (morning/afternoon/evening).

May I speak with _____? (If not available, ask for best time to reach this person. END INTERVIEW.)

My name is _____, and I work for Cornell University in Ithaca, NY. We are conducting a survey of people who bought fishing licenses in _____ *(State)* last year to find out a little bit about how much they fished, what species they fished for, and whether they plan to fish next year. This study is funded by the U.S. Army Corps of Engineers and will help us understand how fishermen and women might be affected if invasive species cause fish populations to go down in the future.

May I ask you a few questions about your recent fishing experience? This will only take a few minutes of your time.

Thank you. Before we begin, there are a few points I need to cover:

I want to assure you that all the information you give will be kept completely confidential and that none of it will be released in any way that would permit identification of you. Your participation in this study is, of course, voluntary, and you may choose not to participate at any time. If there is any question you would prefer not to answer, just tell me and we will go on to the next question.

Introduction Version 2: Licensed anglers from Illinois for whom we have addresses and telephone numbers, but not names

Good (morning/afternoon/evening). My name is _____, and I work for Cornell University in Ithaca, NY. We are conducting a survey of people who bought fishing licenses in Illinois last year to find out a little bit about how much they fished, what species they fished for, and whether they plan to fish next year. We are contacting your household because we believe someone at your address bought a fishing license last year.

1. Did anyone in your household age 18 or older go fishing in Illinois last year?

   _____ Yes

   _____ No (END INTERVIEW)

   1a. How many people over age 18 in your household went fishing in Illinois last year?

   _____ (*Number of people who fished*). (If one person, ask to speak with that person, skip question #2, and continue below. If that person is not available, ask for name and convenient time to call back. If more than one person, ask #2.)

2. Of those people, who had a birthday most recently?

   _____ (*First name of person).* If not individual on phone, ask to speak with them. If not available, ask for best time to reach this person and end interview.

Once you have fishing interviewee, continue here:

Thank you _____ *(Name)* for taking time to speak with me today. We are conducting a survey of people who bought fishing licenses in Illinois last year to find out a little bit about how much they fished, what species they fished for, and whether they plan to fish next year. This study is funded by the U.S. Army Corps of Engineers and will help us understand how fishermen and women might be affected if invasive species cause fish populations to go down in the future.

May I ask you a few questions about your recent fishing experience? This will only take a few minutes of your time.

Thank you. Before we begin, there are a few points I need to cover:

I want to assure you that all the information you give will be kept completely confidential and that none of it will be released in any way that would permit identification of you. Your participation in this

study is, of course, voluntary, and you may choose not to participate at any time. If there is any question you would prefer not to answer, just tell me and we will go on to the next question.

Introduction Version 3: Individuals identified through random digit dialing in West Virginia and Ohio

Good (morning/afternoon/evening). My name is _____, and I work for Cornell University in Ithaca, NY. We are conducting a survey of people who went fishing last year in Ohio or West Virginia.

1. Do you currently live in Ohio or West Virginia?

   _____ Ohio

   _____ West Virginia

   _____ Neither (END INTERVIEW)

2. Did anyone in your household age 18 or older go fishing in <Ohio,West Virginia> last year?

   _____ Yes

   _____ No (END INTERVIEW)

   (If they offer that someone fished in NY, PA, OH, IN, MI, IL, WI, MN, IA, MO, KY, or WV last year; continue with interview.)

   2a. How many people over age 18 (in your household) went fishing (in <Ohio,West Virginia> last year)?

   _____ *(Number of people who fished)*. (If one person, ask to speak with that person, skip question #3, and continue below. If that person is not available, ask for name and convenient time to call back. If more than one person, ask #3.)

3. Of those people, who had a birthday most recently?

   _____ *(First name of person).* If not individual on phone, ask to speak with them. If not available, ask for best time to reach this person and end interview.

Once you have fishing interviewee, continue here:

Thank you _____ *(Name)* for taking time today. We are conducting a survey of people who went fishing last year in <Ohio,West Virginia> to find out a little bit about how much they fished, what species they fished for, and whether they plan to fish next year. This study is funded by the U.S. Army Corps of Engineers and will help us understand how fishermen and women might be affected if invasive species cause fish populations to go down in the future.

May I ask you a few questions about your recent fishing experience? This will only take a few minutes of your time.

Thank you. Before we begin, there are a few points I need to cover:

I want to assure you that all the information you give will be kept completely confidential and that none of it will be released in any way that would permit identification of you. Your participation in this study is, of course, voluntary, and you may choose not to participate at any time. If there is any question you would prefer not to answer, just tell me and we will go on to the next question.

Main Survey Questions used with ALL individuals

1. Did you go fishing at all during 2011?

   _____No (Skip to Question 5)

   _____Yes (Continue with Question 2)

2. About how many days did you fish during 2011?

   _____ *(Number of days)*

3. Did you go fishing in…

   a) The Great Lakes (Lake Michigan, Lake Superior, Lake Huron, Lake Erie, and Lake Ontario)

      _____No

      _____Yes

   b) Any tributaries flowing into the Great Lakes for trout or salmon?

      _____No

      _____Yes

   c) Other lakes or ponds (not the Great Lakes)?

      _____No

      _____Yes

   d) Large rivers?

      _____No

      _____Yes

   e) Other rivers or streams?

      _____No

      _____Yes

4. During 2011, did you fish for…

    a) Salmon or trout?

        _____No

        _____Yes

    b) Other kinds of fish?

        _____No

        _____Yes

5. Do you plan to fish in 2012?

    _____No

    If the individual says no: That's all the questions I have for you. Thank you for taking the time to speak with me today. END INTERVIEW.

    _____Yes (Skip to 5b.)

    _____Not sure (Continue with 5a)

    5a. Do you think it's *likely* that you'll fish next year or not?

        _____No (END INTERVIEW)

        _____Yes (GO TO Question 5b)

    5b. Do you think it's likely that you'll fish in the state where you live?

        _____No

        _____Yes (Skip to Closing)

5c. Which states do you think it's likely that you'll fish in? *(Record if ANY of the following states are mentioned: NY, PA, OH, IN, MI, IL, WI, MN, IA, MO, KY, or WV)*

If the individual says no to 5b and doesn't mention any of the states in 5c: That's all the questions I have for you. Thank you for taking the time to speak with me today. END INTERVIEW.

Closing Statement and Questions

We'll be contacting you again in March to ask you more about your fishing experiences because it will help us to figure out how you and other fishermen and women might be affected if invasive species cause fish populations to go down. We'd prefer to survey you by e-mail because it doesn't cost as much and saves us all money. Would you please provide me with your e-mail address?

_____E-mail

E-mail address: _____

_____Mail

May I confirm your mailing address so we can send you our survey? Is it? _____
(Information comes from state fishing license records.)

_____Refuse to participate in survey

That's all the questions I have for you. Thank you for taking the time to speak with me today. END INTERVIEW.

Appendix: Web Survey Instrument

A Survey of Anglers in the Great Lakes and
Upper Mississippi and Ohio River Basins

Research conducted by the
Human Dimensions Research Unit
Department of Natural Resources
Cornell University

Earlier this year, we contacted you and asked about your fishing experiences in 2011 and your plans for 2012. You provided your e-mail address so we could contact you again to ask some more detailed questions about your fishing experiences in 2011 and how your fishing experiences might change if the quality of fishing changes. We are conducting this study for the U.S. Army Corps of Engineers who are looking at the effects of aquatic nuisance species in the Great Lakes and Upper Mississippi and Ohio River Basins.

Whether you fish a lot or only a little, your participation in this survey is important. The information you provide will be used to help decision makers assess alternative plans that may affect recreational fishing.

Your participation in this survey is voluntary, but we sincerely hope you will take just a few minutes to answer our questions. Your identity will be kept confidential and the information you give us will never be associated with your name.

THANK YOU FOR YOUR HELP!

1. About how many years have you fished?

_____ years

2. How important is each of the following factors in choosing **where** you fish? *(Check one number for each item.)*

Factor	Not Important	Somewhat Important	Important	Very Important	Extremely Important
Close to home or camp	1	2	3	4	5
You can expect to catch at least some fish	1	2	3	4	5
You can expect to catch a lot of fish	1	2	3	4	5
Scenic beauty of the area	1	2	3	4	5
You have friends/family nearby	1	2	3	4	5
The water contains the kind of fish you want to catch	1	2	3	4	5
The water is known for big fish	1	2	3	4	5

The next set of questions asks about where you fished in 2011, how many fishing trips you took, and the type of fishing you did. To help you identify the places where you fished we provide you with a series of maps.

For the purpose of this survey, a **FRESHWATER FISHING TRIP** is any time you leave your home for the **PRIMARY PURPOSE** of going fishing on lakes, rivers, streams or ponds, and could mean **going just down the street to fish for an hour**, or could mean **spending several days hundreds of miles from home.** A freshwater fishing trip could include fishing from a boat, from shore, or ice fishing.

3. Please look at the map of the states in our study area below (the shaded states). Did you take any **freshwater fishing trips** to fish in any of **the shaded states** in **2011**? *(Check one.)*

□ Yes
□ No *(Skip to Question 19)*

[MAP SHOULD APPEAR ON SCREEN FOR ANY SETS OF QUESTIONS THAT REFER TO SHADED AREA ON MAP.]

For the remainder of this survey, we are interested in knowing about the freshwater fishing trips you took to fish in the shaded states on the map.

4. What is your home zip code?

_____

4a. Do you have a second home or cabin from which you fish or leave to go fishing at other sites?

□ Yes
□ No *(Skip to Question 5)*

4b. What is the zip code of that residence?

_____

5. Did you take any fishing trips to fish in the **Great Lakes** (Erie, Huron, Michigan, Ontario, and Superior) in 2011 in one of the shaded states on the map? This includes fishing from a boat or from shore, but does **not** include fishing in tributaries (rivers and streams flowing into the Great Lakes).

□ Yes
□ No

6. Did you take any fishing trips to fish in **inland lakes and ponds** in 2011, either from a boat of from shore, in one of the shaded states on the map? An inland lake or pond is any lake, pond or reservoir that is not a Great Lake.

□ Yes
□ No

7. Did you take any fishing trips in one of the shaded states on the map to fish for **salmon or steelhead on spawning runs** in 2011?

□ Yes
□ No

8. Did you take any fishing trips to fish in **rivers or streams** in 2011 in one of the shaded states on the map, that were **not** for salmon or steelhead on spawning runs?

□ Yes
□ No

9. On the fishing trips you took in 2011, did you try to catch particular types of fish? (*Check all that apply.*)

□ On one or more of my fishing trips, I primarily tried to catch salmon or trout
□ On one or more of my fishing trips, I primarily tried to catch warmwater species, such as walleye, perch, bass, muskie, catfish, panfish, etc.

The next set of questions asks about your **DAY trips** to fish in 2011 – how many day trips you took and where you went. A day trip is a fishing trip where you leave home for the **PRIMARY PURPOSE** of going fishing, and **return home on the same day or later that night**.

Later on, we'll ask you about your overnight trips.

10. Now please think about the times you took **DAY trips** to fish in 2011. Did you take any day trips to fish in one of the shaded states on the map in 2011?

□ Yes
□ No *(Skip to Question 16)*

11. Please use the checklist to indicate all of the states where you took a day trip in **2011**. If you fished from a boat, please indicate the state where you launched. *(Check all that apply.)*

□ Illinois
□ Indiana
□ Iowa
□ Kentucky
□ Michigan
□ Minnesota
□ Missouri
□ New York
□ Ohio
□ Pennsylvania
□ West Virginia
□ Wisconsin

(If checked only one, skip to Question 13)
(If checked more than one, continue with Question 12)

12. In which state did you take the most day trips in 2011? *(Check **one**.)*

□ Illinois
□ Indiana
□ Iowa
□ Kentucky
□ Michigan
□ Minnesota
□ Missouri
□ New York
□ Ohio
□ Pennsylvania
□ West Virginia
□ Wisconsin

13. Below is a map of <<Primary State Name>>, showing the county boundaries. Please click on every county in which you took **DAY trips** in 2011 (up to a total of 8 counties where you fished the most). If you fished in more than one county on a particular fishing trip, please click on the county in which you fished the most. If you fished from a boat, please click on the county where you launched.

When you are done, click on the button below

Done

(Show map with <<COUNTY1>> highlighted)

[REPEAT QUESTION 14 FOR EACH COUNTY SELECTED IN QUESTION 13.]

14. You said that you took day trips to fish in <<COUNTY1>>. <<COUNTY1>> is highlighted on the map. How many **DAY trips** did you take to do each of the following types of fishing from **<<COUNTY1>>** in **2011**?
    - Please tell us both about your fishing for **trout and salmon** and your fishing for **warmwater species**, such as walleye, perch, bass, muskie, catfish, panfish, etc.
    - If you did more than one type of fishing on a trip, list the trip next to the one type of fishing that was most important to you on that trip.

Type of fishing (inside the shaded area on the map)	# of **DAY** trips I took to do this type of fishing in this county in 2011
Great Lakes for trout and salmon	_____
Great Lakes for warmwater species	_____
Inland lakes and ponds for trout and salmon	_____
Inland lakes and ponds for warmwater species	_____
Salmon or steelhead on spawning runs	_____
Rivers and streams for trout and salmon, but not including spawning runs	_____
Rivers and streams for warmwater species	_____
Total freshwater fishing DAY trips (sum of all seven categories) in this county	<<SUM>>

[If only 1 state selected in Question 11, skip to Question 16. Otherwise, repeat Question 15 for each state selected in Question 11 EXCEPT FOR the state selected in Question 12. A map of the state should appear each time this question is repeated.]

15. You said that you also took day trips to fish in <<STATE2>>. How many **DAY trips** did you take to do each of the following types of fishing anywhere in **<<STATE2>>** in **2011**?

Type of fishing (inside the shaded area on the map)	# of **DAY** trips I took to do this type of fishing in this county in 2011
Great Lakes for trout and salmon	_____
Great Lakes for warmwater species	_____
Inland lakes and ponds for trout and salmon	_____
Inland lakes and ponds for warmwater species	_____
Salmon or steelhead on spawning runs	_____
Rivers and streams for trout and salmon, but not including spawning runs	_____
Rivers and streams for warmwater species	_____
Total freshwater fishing DAY trips (sum of all seven categories) in this county	<<SUM>>

The previous set of questions asked you about your day trips. In this next section, we'd like to learn about all of the **OVERNIGHT trips** you took to fish in 2011 – how many overnight trips you took and where you went. An overnight fishing trip is a trip where you leave home for the **PRIMARY PURPOSE** of going fishing and you **stay away from home at least one night**, for example in a hotel, a cabin, a tent, or an RV.

16. Did you take any **OVERNIGHT trips** to go fishing in one of the shaded states on the map in **2011**?

□ Yes
□ No *(Skip to Question 19)*

In the next series of questions, we'll ask about each of the locations where you took **OVERNIGHT** trips to fish in 2011 to any of the shaded states on the map.

17. For each overnight trip you took (up to a maximum of 8 trips), please list the state and the city, village, or town closest to where you fished on that trip.
    - If you took more than one trip to the same location, you only have to list that location once.
    - If you fished in several locations on a particular fishing trip, please list the location where you did most of your fishing.
    - If you were fishing from a boat, please list the location where you launched your boat on that trip.

Trip Location 1

State: _____

City, village, or town: _____

Trip Location 2

State: _____

City, village, or town: _____

Trip Location 3

State: _____

City, village, or town: _____

Trip Location 4

State: _____

City, village, or town: _____

Trip Location 5

State: _____

City, village, or town: _____

Trip Location 6

State: _____

City, village, or town: _____

Trip Location 7

State: _____

City, village, or town: _____

Trip Location 8

State: _____

City, village, or town: _____

When you are done, click on the button below

Done

[REPEAT QUESTION 18 FOR EACH LOCATION ENTERED IN QUESTION 17.]

18. You said that you took at least one overnight trip to fish in the following location:

State: _____

City, village, or town: _____

How many **OVERNIGHT trips** did you take to this location to do each of the following types of fishing in 2011?

- If you did more than one type of fishing on a trip, list the trip next to the one type of fishing that was most important to you on that trip.
- We also ask that you tell us the **total number of days** that you fished on these overnight trips. So, for example, if you took two overnight trips, and you fished two days on the first trip, and three days on the second trip, then you fished a total of five days on overnight trips.

Type of fishing (inside the shaded area on the map)	# of **OVERNIGHT** trips I took to this location to do this type of fishing in 2011	Total # of days I fished on these trips
Great Lakes for trout and salmon	_____	_____
Great Lakes for warmwater species	_____	_____
Inland lakes and ponds for trout and salmon	_____	_____
Inland lakes and ponds for warmwater species	_____	_____
Salmon or steelhead on spawning runs	_____	_____
Rivers and streams for trout and salmon, but not including spawning runs	_____	_____
Rivers and streams for warmwater species	_____	_____
Total freshwater fishing DAY trips (sum of all seven categories) in this county	<<SUM>>	<<SUM>>

19. The table below lists all the freshwater fishing **DAY trips** and all the freshwater fishing **OVERNIGHT trips** you took in the 12 shaded states on the map in **2011**. But last year may not have been a normal year for you fishing.

Please tell us about how many **DAY** and **OVERNIGHT** freshwater fishing trips you take in a **normal or average year**.

- If you think 2011 was a normal or average year, you can just use the numbers from 2011.
- If you don't think 2011 was a normal or average year, make your best guess as to how many trips you would take in a normal or average year – you don't have to be exact.

[<<N1d>> through <<N7d>> in the table below are populated as follows:
<<N1d>> is the sum of all the answers entered into the first row of the table in Question 14 and the first row of the table in Question 15 for all the times questions 14 and 15 were answered.
<<N2d>> is the sum of all the answers entered into the second row of the table in Question 14 and the first row of the table in Question 15 for all the times questions 14 and 15 were answered.
<<N3d>> is the sum of all the answers entered into the third row of the table in Question 14 and the first row of the table in Question 15 for all the times questions 14 and 15 were answered.
<<N4d>> is the sum of all the answers entered into the fourth row of the table in Question 14 and the first row of the table in Question 15 for all the times questions 14 and 15 were answered.
<<N5d>> is the sum of all the answers entered into the fifth row of the table in Question 14 and the first row of the table in Question 15 for all the times questions 14 and 15 were answered.
<<N6d>> is the sum of all the answers entered into the sixth row of the table in Question 14 and the first row of the table in Question 15 for all the times questions 14 and 15 were answered.
<<N7d>> is the sum of all the answers entered into the seventh row of the table in Question 14 and the first row of the table in Question 15 for all the times questions 14 and 15 were answered.
<<NTotald>> is the sum of <<N1d>> through <<N7d>>.]
[<<N1o>> through <<N7o>> in the table below are populated as follows:
<<N1o>> is the sum of all the answers entered into the middle column of the first row of the table in Question 18 for all the times Question 18 was answered.
<<N2o>> is the sum of all the answers entered into the middle column of the second row of the table in Question 18 for all the times Question 18 was answered.
<<N3o>> is the sum of all the answers entered into the middle column of the third row of the table in Question 18 for all the times Question 18 was answered.
<<N4o>> is the sum of all the answers entered into the middle column of the fourth row of the table in Question 18 for all the times Question 18 was answered.
<<N5o>> is the sum of all the answers entered into the middle column of the fifth row of the table in Question 18 for all the times Question 18 was answered.
<<N6o>> is the sum of all the answers entered into the middle column of the sixth row of the table in Question 18 for all the times Question 18 was answered.
<<N7o>> is the sum of all the answers entered into the middle column of the seventh row of the table in Question 18 for all the times Question 18 was answered.
<<NTotalo>> is the sum of <<N1o>> through <<N7o>>.]

Type of fishing (inside the shaded area on the map)	# of **DAY** trips I took in 2011 to do this type of fishing	# of **DAY** trips I take in a **NORMAL** year to do this type of fishing	# of **OVERNIGHT** trips I took in 2011 to do this type of fishing	# of **OVERNIGHT** trips I take in a **NORMAL** year to do this type of fishing
Great Lakes for trout and salmon	<<N1d>>	_____	<<N1o>>	_____
Great Lakes for warmwater species	<<N2d>>	_____	<<N2o>>	_____
Inland lakes and ponds for trout and salmon	<<N3d>>	_____	<<N3o>>	_____
Inland lakes and ponds for warmwater species	<<N4d>>	_____	<<N4o>>	_____
Salmon or steelhead on spawning runs	<<N5d>>	_____	<<N5o>>	_____
Rivers and streams for trout and salmon, but not including spawning runs	<<N6d>>	_____	<<N6o>>	_____
Rivers and streams for warmwater species	<<N7d>>	_____	<<N7o>>	_____
Total freshwater fishing trips (sum of all seven categories)	<<NTotald>>	<<NTotalAd>>	<<NTotalo>>	<<NTotalAo>>

[The numbers entered in the middle column of the first 7 rows will be designated as <<N1ad>> through <<N7ad>>. <<NTotalAd>> is the calculated sum of <<N1ad>> through <<N7ad>>.]
[The numbers entered in the righthand column of the first 7 rows will be designated as <<N1ao>> through <<N7ao>>. <<NTotalAo>> is the calculated sum of <<N1ao>> through <<N7ao>>. If <<NTotalAd>> and <<NTotalAo>> are BOTH "0", skip to Question 22.]

In the next questions we ask you about how the number of fishing trips that you take in a normal year might change if the quality of fishing for different types of fishing changes.

20. Suppose that the quality of fishing changed for the type of fishing that you like to do the most. Suppose that the number of fish you caught per day decreased by 40% in the entire shaded area on the map. How would you change the number of DAY fishing trips you would take, compared to what you do in a NORMAL year? (Please select all that apply.)

- □ I would still take the same number of day fishing trips for this type of fishing
- □ I would take fewer day fishing trips for this type of fishing
- □ I would take more day fishing trips for other types of fishing
- □ I would take the same total number of day fishing trips for all types of fishing
- □ I would take fewer total fishing trips for all types of fishing in the shaded states on the map
- □ I would take more fishing trips outside the shaded area on the map
- □ I would stop fishing entirely

21. Now we want you to suppose **that number of fish you caught decreased** for *several types* of fishing. We are going to show you one or two tables describing possible ways that the number of fish you caught might decrease.

[If <<NTotalAd>> is “0”, skip to Question 21b.]

21a. The table below shows you one way that the number of fish you caught might decrease. It also shows the number of **DAY** trips you take in a normal year. (The **OVERNIGHT** trips, if you take them in a normal year, will appear in a later table.)

If the number of fish you caught decreased as shown, how many **DAY** fishing trips (inside the shaded area on the map) would you take for each type of fishing?

If you're not sure, make your best guess as to how many trips you would take. (Please enter a number in each space on the right hand side)

[NOTE: The % changes in this table will vary between 0-50% for different respondents.]

Type of fishing (inside the shaded area on the map)	# of **DAY trips** I take in a **NORMAL** year to do this type of fishing	% Change in # fish caught per day fishing	# of **DAY trips** I would take to do this type of fishing
Great Lakes for trout and salmon	<<N1ad>>	No Change	_____
Great Lakes for warmwater species	<<N2ad>>	**20% less than normal**	_____
Inland lakes and ponds for trout and salmon	<<N3ad>>	No Change	_____
Inland lakes and ponds for warmwater species	<<N4ad>>	No Change	_____
Salmon or steelhead on spawning runs	<<N5ad>>	**20% less than normal**	_____
Rivers and streams for trout and salmon, but not including spawning runs	<<N6ad>>	No Change	_____
Rivers and streams for warmwater species	<<N7ad>>	**30% less than normal**	_____
Total freshwater fishing DAY trips (sum of all seven categories) in this county	<<NTotalAd>>		_____

[If <<NTotalAo>> is "0", skip to Question 22.]

21b. This new table shows the number of **OVERNIGHT** trips you take in a normal year.
If the number of fish you caught decreased as shown, how many **OVERNIGHT** fishing trips (inside the shaded area on the map) would you take for each type of fishing?
If you're not sure, make your best guess as to how many trips you would take. (Please enter a number in each space on the right hand side)
[NOTE: The % changes in this table will vary between 0-80% for different respondents.]

Type of fishing (inside the shaded area on the map)	# of **OVERNIGHT trips** I take in a **NORMAL** year to do this type of fishing	% Change in # fish caught per day fishing	# of **OVERNIGHT trips** I would take to do this type of fishing
Great Lakes for trout and salmon	<<N1Ao>>	No Change	_____
Great Lakes for warmwater species	<<N2Ao>>	**20% less than normal**	_____
Inland lakes and ponds for trout and salmon	<<N3Ao>>	No Change	_____
Inland lakes and ponds for warmwater species	<<N4Ao>>	No Change	_____
Salmon or steelhead on spawning runs	<<N5Ao>>	**20% less than normal**	_____
Rivers and streams for trout and salmon, but not including spawning runs	<<N6Ao>>	No Change	_____
Rivers and streams for warmwater species	<<N7Ao>>	**30% less than normal**	_____
Total freshwater fishing DAY trips (sum of all seven categories) in this county	<<NTotalAo>>		_____

Now we'd like to find out more about what kinds of expenses you have when you go fishing. We'd like you to think back to the **most recent freshwater fishing trip** you took in **2011 or 2012** inside the shaded area on the map. Remember that when we say FRESHWATER **FISHING TRIP**, we mean any time you leave home for the **PRIMARY PURPOSE** of going fishing on lakes, rivers, streams or ponds, and could mean **going just down the street to fish for an hour**, or could mean **spending several days hundreds of miles from home.**

22. During what year did you take **your most recent freshwater fishing trip** in the **shaded area on the map**? (*Check one.*)

□ 2011
□ 2012

□ I did not take a trip in the shaded area on the map in either 2011 or 2012 *(Skip to Question 29)*

22a. During what month of that year did you take that trip? (*Check one.*)

□ January
□ February
□ March
□ April
□ May
□ June
□ July
□ August
□ September
□ October
□ November
□ December

23. How many nights were you away from home on this trip? *(If you were just out for the day or part of the day, please enter "0" nights.)*

_____ night(s) *(If "0" nights, skip to Question 23 b)*

23a. On how many different days during this trip did you fish?

_____ days

23b. How many people in your household (besides yourself) went with you in the same car and fished on this trip? *(If you fished by yourself, enter "0.")*

_____ people

24. Please check the **primary type of fishing** you did on that trip. (*Check one.*)

- □ Great Lakes for trout or salmon
- □ Great Lakes for warmwater species
- □ Inland lakes and ponds for trout or salmon
- □ Inland lakes and ponds for warmwater species
- □ Salmon or steelhead on spawning runs
- □ Rivers and streams for trout or salmon, but not including spawning runs
- □ Rivers and streams for warmwater species

25. In what state did you spend the most time fishing on that trip? (*Check one.*)

- □ Illinois
- □ Indiana
- □ Iowa
- □ Kentucky
- □ Michigan
- □ Minnesota
- □ Missouri
- □ New York
- □ Ohio
- □ Pennsylvania
- □ West Virginia
- □ Wisconsin

26. Please click on one of the counties on the map to show the approximate location of where you spent the most time fishing on the trip. If you fished from a boat, please click on the county where you launched.

[Map of state checked in Question 25 will appear.]

27. For this trip, **approximately** what was your household's share of the expenses for the trip: (1) that you paid in the county where you fished; and (2) that you paid in areas outside the county where you fished?

	Money spent in county where you fished	Money spent in areas outside of county where you fished
Bait and tackle shops	$_____	$_____
Restaurants or bars	$_____	$_____
Grocery or convenience type stores	$_____	$_____
Hotels, motels, B&Bs, campgrounds	$_____	$_____
Gas stations (fuel, sundries)	$_____	$_____
Marinas or yacht clubs (rental or launching fee, fuel, supplies)	$_____	$_____
Fishing charters or guides	$_____	$_____
Other	$_____	$_____

28. How did you get to the location where you fished on this trip? *(Check one.)*

- □ Walked or bicycled
- □ Motorcycle
- □ Compact or economy car
- □ Mid or full-size car
- □ Pickup truck or SUV
- □ RV
- □ Airplane
- □ Other

For the final questions, we'd like to ask a little bit more about you and your fishing.

29. Which statement below best describes your feelings about fishing? *(Check one.)*

- □ If I could not go fishing, I would easily find something else to do that would be equally enjoyable
- □ If I could not go fishing, I would miss it, but not as much as a lot of other things I enjoy
- □ If I could not go fishing, I would miss it more than most of the other interests I now have
- □ If I could not go fishing, I would miss it more than all the other interests I now have

30. Do you own a boat that you use for fishing?

- □ No *(Skip to Question 31)*
- □ Yes, non-motorized *(Skip to Question 31)*
- □ Yes, motorized

30a. What is your boat's length?

_____ feet

31. Is there a place that you go freshwater fishing within walking distance of your home?

- □ Yes
- □ No

32. What is your gender?

- □ Female
- □ Male

33. What is your marital status?

□ Never married *(Skip to Question 34)*
□ Married
□ Unmarried partner
□ Divorced *(Skip to Question 34)*
□ Widowed *(Skip to Question 34)*

33a. Does your spouse or partner fish?

□ Yes
□ No

34. How many children 18 or under live in your home?

_____ children

35. What is your employment status? *(Please check one.)*

□ Employed, full-time
□ Employed, part-time
□ Self-employed
□ Unemployed or not in labor force
□ Retired
□ Student
□ Non-wage employment (e.g.., stay at home parent)

36. In what year were you born? _____

37. What was your household income (before taxes) in 2011? *(Please check one.)*

□ Less than $15,000
□ $15,000 to $24,999
□ $25,000 to $34,999
□ $35,000 to $49,999
□ $50,000 to $74,999
□ $75,000 to $99,999
□ $100,000 to $149,999
□ $150,000 to $199,999
□ $200,000 and more

Appendix: Mail Survey Instrument

A Survey of Anglers in the Great Lakes and Upper Mississippi and Ohio River Basins

Cornell University
Human Dimensions Research Unit

OMB 0710-0001

A Survey of Anglers in the Great Lakes and Upper Mississippi and Ohio River Basins

Research conducted by the
Human Dimensions Research Unit
Department of Natural Resources
Cornell University

Earlier this year, we contacted you and asked about your fishing experiences in 2011 and your plans for 2012. You provided your mailing address so we could contact you again to ask some more detailed questions about your fishing experiences in 2011 and how your fishing experiences might change if the quality of fishing changes. We are conducting this study for the U.S. Army Corps of Engineers who are looking at the effects of aquatic nuisance species in the Great Lakes and Upper Mississippi and Ohio River Basins.

Whether you fish a lot or only a little, your participation in this survey is important. The information you provide will be used to help decision makers assess alternative plans that may affect recreational fishing.

Please complete this questionnaire at your earliest convenience, seal it with the white re-sealable label provided, and drop it in any mailbox; return postage has been provided. Your participation in this survey is voluntary, but we sincerely hope you will take just a few minutes to answer our questions. Your identity will be kept confidential and the information you give us will never be associated with your name.

THANK YOU FOR YOUR HELP!

1. About how many years have you fished?

_____ years

2. How important is each of the factors below in choosing <u>where</u> you fish? *(Check one box for each statement.)*

Factors	Not at all important	Somewhat Important	Important	Very Important	Extremely Important
Close to home or camp	☐	☐	☐	☐	☐
You can expect to catch at least some fish	☐	☐	☐	☐	☐
You can expect to catch a lot of fish	☐	☐	☐	☐	☐
Scenic beauty of the area	☐	☐	☐	☐	☐
You have friends/family nearby	☐	☐	☐	☐	☐
The water contains the kind of fish you want to catch	☐	☐	☐	☐	☐
The water is known for big fish	☐	☐	☐	☐	☐

3. Do you have a second home or cabin from which you fish or leave to go fishing at other sites?

☐ No

☐ Yes → What is the zip code of that residence? _____

In this survey when we say a **FRESHWATER FISHING TRIP** we mean any time you leave your home for the **PRIMARY PURPOSE** of going fishing on lakes, rivers, streams or ponds, and could mean **going just down the street to fish for an hour**, or could mean **spending several days hundreds of miles from home.** A freshwater fishing trip could include fishing from a boat, from shore, or ice fishing.

4. During what year and month did you take your most recent freshwater fishing trip (even just for part of a day) to a state shaded on the front cover? *(Check one year and write in the month.)*

- ☐ 2011 Month: _____
- ☐ 2012 Month: _____
- ☐ I did not take a trip in 2011 or so far in 2012 to a state in the study area *(Skip to Question 13.)*

5. How many nights were you away from home on this trip? *(If you were just out for the day or part of the day, please write in 0 nights.)*

_____ night(s)

5a. On how many different days during this trip did you fish?

_____ days

5b. How many people in your household (besides yourself) went with you in the same car and fished on this trip? *(If you fished by yourself, enter "0.")*

_____ people

6. Was this trip to fish: *(Check only one.)*

- ☐ in the Great Lakes (Erie, Huron, Michigan, Ontario, and Superior). *This includes fishing from a boat or from shore, but does **not** include fishing in tributaries (rivers and streams flowing into the Great Lakes).*
- ☐ in inland lakes or ponds, either from a boat or from shore? *An inland lake or pond is any lake, pond or reservoir that is not a Great Lake.*
- ☐ for salmon or steelhead on spawning runs?
- ☐ in rivers or streams but not for salmon or steelhead on spawning runs?

7. On this trip, did you fish primarily for: *(Check one.)*

- ☐ Trout or salmon
- ☐ Warmwater species, such as walleye, perch, bass, muskie, catfish, panfish, etc.

8. Please tell us the state and county where you spent the most time fishing on this trip. If you don't know the name of the county, please write in the nearest city, village or town. If you were fishing from a boat, please list the county where you launched your boat.

State: _____

County (or nearest city, village, or town): _____

9. For this trip, approximately what was your <u>household's share</u> of the expenses for the trip: (1) that you paid in the county where you fished; and (2) that you paid in areas outside the county where you fished?

	Money spent in county where you fished	Money spent in areas outside of county where you fished
Bait and tackle shops	$_____	$_____
Restaurants or bars	$_____	$_____
Grocery or convenience type stores	$_____	$_____
Hotels, motels, B&Bs, campgrounds	$_____	$_____
Gas stations (fuel, sundries)	$_____	$_____
Marinas or yacht clubs (rental or launching fee, fuel, supplies)	$_____	$_____
Fishing charters or guides	$_____	$_____
Other	$_____	$_____

10. How did you get to the location where you fished on this trip? *(Check one.)*

- ☐ Walked or bicycled
- ☐ Motorcycle
- ☐ Compact or economy car
- ☐ Mid or full-size car
- ☐ Pickup truck or SUV
- ☐ RV
- ☐ Airplane
- ☐ Other

11. Did you take any day or overnight trips <u>in 2011</u> to any of the states in the study area (states are shaded on the front cover) for the PRIMARY PURPOSE of freshwater fishing? Please include the trip you just told us about if it was in 2011.

☐ No (SKIP TO Question 13) ☐ Yes (Continue below)

12. In the table below, please write in all the counties you fished in 2011 for the state on the map included with this questionnaire (up to a total of 8 counties where you fished the most). If you're not sure of the county, make your best guess. If you fished in more than one county on a particular fishing trip, please indicate the county that you PRIMARILY fished in. If you fished from a boat, please list the county where you launched.

For each county, please write in how many day trips you took and how many overnight trips you took <u>for each of the 7 types of fishing listed</u>. If you did more than one type of fishing on a trip, list the trip next to the one type of fishing that was most important to you on that trip.

On the last line, please write in all the fishing trips you took in 2011 that were outside the state on the map, but inside the study area (shaded area on front cover).

Where did you fish in 2011?	Great Lakes for trout or salmon		Great Lakes for warmwater species		Inland lakes and ponds for trout and salmon		Inland lakes and ponds for warmwater species		Salmon or steelhead on spawning runs		Rivers and streams for trout and salmon, but not including spawning runs		Rivers and streams for warmwater species	
County (on enclosed map)	# of day trips	# of overnight trips	# of day trips	# of overnight trips	# of day trips	# of overnight trips	# of day trips	# of overnight trips	# of day trips	# of overnight trips	# of day trips	# of overnight trips	# of day trips	# of overnight trips
Number of Trips to All Other States in Study Area →														

13. We've been asking you about your fishing in 2011, but 2011 may not have been a normal fishing year for you. How many DAY and OVERNIGHT fishing trips do you take in a NORMAL or average year to states in our study area (shaded on the front cover map)? If you think 2011 was a normal year, you can just add the numbers in Question 12. Put each fishing trip in the category where it fits best.

Type of fishing (inside the shaded area on the map)	# of **DAY** trips I take in a normal year to do this type of fishing	# of **OVERNIGHT** trips I take in a normal year to do this type of fishing
Great Lakes for trout and salmon		
Great Lakes for warmwater species		
Inland lakes and ponds for trout and salmon		
Inland lakes and ponds for warmwater species		
Salmon or steelhead on spawning runs		
Rivers and streams for trout and salmon, but not including spawning runs		
Rivers and streams for warmwater species		

We've asked you about how much you fish in a normal year. Now we'd like to know how the number of fishing trips that you take in a normal year might change <u>if the number of fish you caught decreased</u>.

14. <u>If the number of fish you caught decreased</u> for some types of fishing, how many DAY fishing trips (inside the shaded area on the map) would you take for each type of fishing? If you're not sure, make your best guess as to how many trips you would take. *(The table on the next page will ask about overnight trips.)*

Type of fishing (inside the shaded area on the map)	% DECREASE in # of fish caught per day fishing	# of DAY trips I would take to do this type of fishing
Great Lakes for trout and salmon	**30% less than normal**	
Great Lakes for warmwater species	**50% less than normal**	
Inland lakes and ponds for trout and salmon	**30% less than normal**	
Inland lakes and ponds for warmwater species	No change	
Salmon or steelhead on spawning runs	No change	
Rivers and streams for trout and salmon, but not including spawning runs	No change	
Rivers and streams for warmwater species	**50% less than normal**	

15. <u>If the number of fish you caught decreased</u> for some types of fishing, how many OVERNIGHT fishing trips (inside the shaded area on the map) would you take for each type of fishing?

Type of fishing (inside the shaded area on the map)	% DECREASE in # of fish caught per day fishing	# of OVERNIGHT trips I would take to do this type of fishing
Great Lakes for trout and salmon	**30% less than normal**	
Great Lakes for warmwater species	**50% less than normal**	
Inland lakes and ponds for trout and salmon	**30% less than normal**	
Inland lakes and ponds for warmwater species	No change	
Salmon and steelhead on spawning runs	No change	
Rivers and streams for trout and salmon, but not including spawning runs	No change	
Rivers and streams for warmwater species	**50% less than normal**	

For the final questions, we'd like to ask a little bit more about you and your fishing.

16. Do you own a boat that you use for fishing? *(Check all that apply.)*

- ☐ No
- ☐ Yes, non-motorized
- ☐ Yes, motorized (How long is it? _____ ft.)

17. Is there a place that you go freshwater fishing within walking distance of your home?

- ☐ No
- ☐ Yes

18. What is your gender?

- ☐ Male
- ☐ Female

19. How many children 18 or under live in your home?

_____ children

20. What is your marital status?

☐ Never married

☐ Married (Does your spouse fish? ☐ No ☐ Yes)

☐ Unmarried partner (Does your partner fish? No Yes)

☐ Divorced

☐ Widowed

21. What is your employment status? *(Please check one.)*

☐ Employed, full-time

☐ Employed, part-time

☐ Self-employed

☐ Unemployed or not in labor force

☐ Retired

☐ Student

☐ Non-wage employment (e.g., stay at home parent)

22. In what year were you born? 19_____

23. What was your household income (before taxes) in 2011? *(Please check one.)*

☐ Less than $15,000

☐ $15,000 to $24,999

☐ $25,000 to $34,999

☐ $35,000 to $49,999

☐ $50,000 to $74,999

☐ $75,000 to $99,999

☐ $100,000 to $149,999

☐ $150,000 to $199,999

☐ $200,000 or more

Please use the space below for any comments you wish to make.

Thank you for your time and effort!

To return this questionnaire, simply seal it with the white removable seal, and drop it in the mail (return postage has been paid).

Appendix: Followup Survey Instrument

A Followup Survey of Anglers in the Great Lakes and

Upper Mississippi and Ohio River Basins

Research conducted by the

Human Dimensions Research Unit

Department of Natural Resources

Cornell University

Earlier this year, we sent you a survey and asked about your fishing experiences in 2011, your plans for 2012, and how your fishing experiences might change if the quality of fishing changes. In this much shorter, followup survey, we want to ask you just a few questions about your most recent fishing experiences. The questions should take about 5 minutes to answer.

We are conducting this study for the U.S. Army Corps of Engineers who are looking at the effects of aquatic nuisance species in the Great Lakes and Upper Mississippi and Ohio River Basins. Whether you fish a lot or only a little, your participation in this survey is important. The information you provide will be used to help decision makers assess alternative plans that may affect recreational fishing.

Your participation in this survey is voluntary, but we sincerely hope you will take just a few minutes to answer our questions. Your identity will be kept confidential and the information you give us will never be associated with your name.

THANK YOU FOR YOUR HELP!

We are going to be asking you just a few questions about **FRESHWATER FISHING TRIPS** that you have taken **THIS YEAR (2012)**.

For the purpose of this survey, a **FRESHWATER FISHING TRIP** is any time you leave your home for the **PRIMARY PURPOSE** of going fishing on lakes, rivers, streams or ponds, and could mean **going just down the street to fish for an hour**, or could mean **spending several days hundreds of miles from home.** A freshwater fishing trip could include fishing from a boat, from shore, or ice fishing.

1. Please look at the map of the states in our study area below (the shaded states). Have you taken any **freshwater fishing trips** to fish in any of the shaded states since you completed our earlier survey back in March, April, or May? *(Check one.)*

   □ Yes
   □ No *(Skip to "thank you" at end of survey.)*
   □ Don't Know

We'd like to find out a little bit of information about your **most recent freshwater fishing trip** inside the shaded area on the map.

2. During what month of 2012 did you take **your most recent fishing trip** in the **shaded area on the map**? (*Check one.*)

- □ March
- □ April
- □ May
- □ June
- □ July

3. Was this trip **a day trip** (you returned home on the same day or later that night) or **an overnight trip** (you stayed away from home at least one night)? (*Check one.*)

- □ Day Trip *(Skip to Question 5)*
- □ Overnight Trip

4. How many nights were you away from home on this trip? *(Enter "0" if it was a day trip)*

_____ night(s) [IF "0," SKIP TO QUESTION 5.}

4a. On how many different days during this trip did you fish?

_____ days

5. How many people in your household (besides yourself) went with you and fished on this trip? *(If you fished by yourself, enter "0.")*

_____ people besides yourself

6. In what state did you spend the most time fishing on that trip? (*Check one.*)

- □ Illinois
- □ Indiana
- □ Iowa
- □ Pennsylvania
- □ Michigan
- □ Minnesota
- □ Missouri
- □ New York
- □ Ohio
- □ Kentucky
- □ West Virginia
- □ Wisconsin

7. Please click on one of the counties on the map to show the approximate location where you spent the most time fishing on the trip. If you fished from a boat, please click on the county where you launched.

[Map of state checked in Question 6 will appear.]

8. For this trip, **approximately** what was your household's share of the expenses for the trip that you: (1) paid in the county where you fished; and (2) paid in areas outside the county where you fished?

	Money spent in county where you fished	Money spent in areas outside of county where you fished
Bait and tackle shops	$_____	$_____
Restaurants or bars	$_____	$_____
Grocery or convenience type stores	$_____	$_____
Hotels, motels, B&Bs, campgrounds	$_____	$_____
Gas stations (fuel, sundries)	$_____	$_____
Marinas or yacht clubs (rental or launching fee, fuel, supplies)	$_____	$_____
Fishing charters or guides	$_____	$_____
Other	$_____	$_____

[IF "OTHER" IS CHECKED, A BOX TO ENTER EXPLANATION APPEARS.]

9. How did you get to the location where you fished on this trip? *(Check all that apply.)*

- □ Walked or bicycled
- □ Motorcycle
- □ Compact or economy car
- □ Mid or full-size car
- □ Pickup truck or SUV
- □ RV
- □ Airplane
- □ Other

  [IF "OTHER" IS CHECKED, A BOX TO ENTER EXPLANATION APPEARS.]

10. Please check the **primary type of fishing** you did on that trip. (*Check one.*)

- "Great Lakes" includes Lakes Superior, Huron, Michigan, Erie, or Ontario.
- "Warmwater species" are species like walleye, perch, bass, muskie, catfish, and panfish.

□ Great Lakes for trout or salmon
□ Great Lakes for warmwater species
□ Inland lakes and ponds for trout or salmon
□ Inland lakes and ponds for warmwater species.
□ Salmon or steelhead on spawning runs
□ Rivers and streams for trout or salmon, but not including spawning runs
□ Rivers and streams for warmwater species

11. You said that the primary type of fishing you did on this trip was:

<<ANSWER FROM QUESTION 10>>

Imagine that before you went on this trip, you knew that the number of fish you would catch per day when doing this type of fishing was <<30%/50%>> lower than it would usually be in the entire shaded area on the map. The quality of other types of fishing would be the same as usual. What would you have done?

[THE NUMBER 30 OR 50 IS RANDOMLY INSERTED IN THE QUESTION.]

- □ Gone on the trip anyway and stayed about the same amount of time as I did
- □ Gone on the trip and stayed longer to try to catch more fish
- □ Gone on the trip, but not stayed as long
- □ Done another type of fishing at the same location
- □ Done another type of fishing at a different location
- □ Done the same type of fishing at a different location
- □ Done another activity away from home, not fishing
- □ Stayed at home

Those are all the questions we have. THANK YOU for participating in this survey!

Technical Appendix: Model Specification and Estimation

The Great Lakes/Upper Mississippi Recreational Angling Model (GLMRAM) is a repeated nested logit random utility model (RUM) that models the recreational angler behavior in the Great Lakes, Upper Mississippi and Ohio River basins. The model explains and predicts the following recreational behaviors:

- how often a recreational angler goes fishing
- what type of fishing they do
- where they do fish
- how those behaviors would change if catch rates were to decrease

Details on data collection are provided in the body of the report. This technical appendix describes the mathematical structure of the model and its estimation.

Definition of a Fishing Trip

A fishing trip is a trip taken away from home for the primary purpose of recreational angling. The trip begins when the angler leaves home and ends when he/she returns home again. The trip could be only for an hour or two or could last for several days. Trips where the angler leaves home and returns on the same day are defined as day trips. Trips where the angler is away from home overnight are defined as overnight trips.

For a given angler, a fishing trip is completely described by three factors:

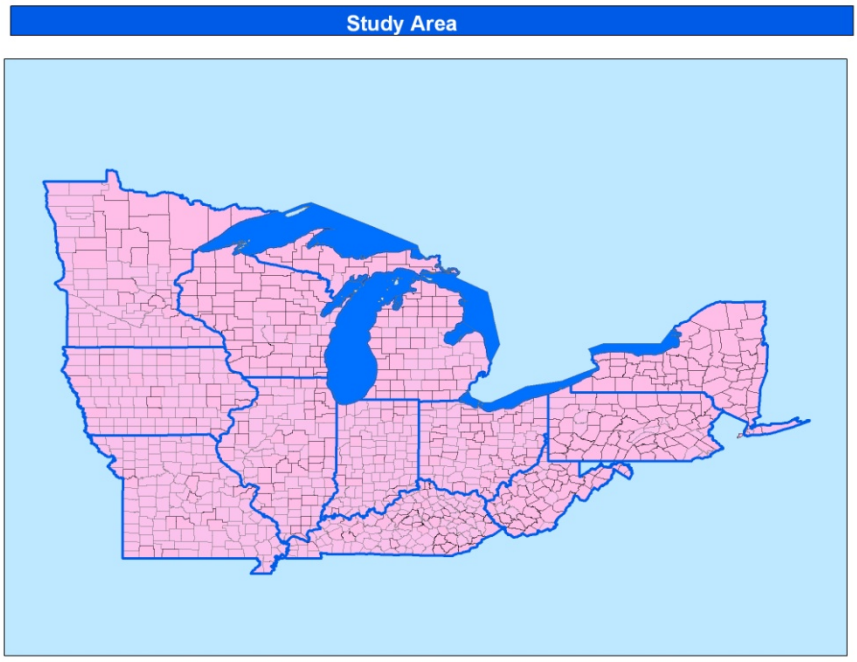
- whether the trip is a day trip or an overnight trip
- the trip origin and destination county
- the type of fishing done on the trip

Definition of Origin and Destination for a Trip

The study area is shown in the Figure TA-1. It includes almost all of the U.S. portions of the Great Lakes, the Upper Mississippi River, and the Ohio River basins. The study area includes 1024 counties.

Each county is treated as a unique fishing destination. Each time an angler goes fishing, he or she must choose one destination (county) for that trip. For trips where the angler fished from a boat, the destination county is defined as the county where the boat was launched. For trips where an angler fished in more than one county, the angler was asked to report the county he or she primarily fished in during that trip. Fishing trips taken to destinations outside of the study area are not included in the dataset or the model.

Figure TA-1. Study area.



The procedure for calculating round trip travel costs to each destination is described in detail in the report. For each trip, the trip origin is the zip code of either the angler's primary residence or their secondary residence if they have one. If a respondent has two homes, travel cost is measured from both the primary home zip code and the secondary home zip code, and the lesser of the two calculated travel costs is used. The Site Choice Set for each trip (set of destination counties that the angler can consider) includes all counties that support the indicated fishing type and that the angler can reach within a specified cutoff driving time.

Fishing Type

We identify seven different types of freshwater fishing that occur within the study area. These are

1. GLCold – fishing in the Great Lakes for coldwater species (trout and salmon)
2. GLWarm – fishing in the Great Lakes for warmwater species
3. ILCold – fishing in inland lakes and ponds for coldwater species (trout)
4. ILWarm – fishing in inland lakes and ponds for warmwater species
5. RSCold – fishing in rivers and streams for coldwater species (trout - excluding anadromous runs)
6. RSWarm – fishing in rivers and streams for warmwater species

7. Anad – fishing in rivers that drain into the Great Lakes for salmon and trout that are swimming upstream to spawn (anadromous runs)

Not every type of fishing can be done in every county in the study area. GLCold and GLWarm can only be done from counties that border the Great Lakes. ILCold and RSCold can only be done in counties that have coldwater fish present, either naturally or stocked. Anad can only be done in counties that have rivers with anadromous runs. Counties were designated as supporting coldwater fishing if either a survey respondent reported taking a trip to that county to fish for RSCold or ILCold or the county was identified by its state fish management agency as supporting wild or stocked coldwater fishing. Similarly, counties were designated as supporting anadramous fishing if they included river stretches hydrologically connected to the Great Lakes and either a survey respondent reported engaging in anadramous fishing in the county or a state fish management agency identified the county as supporting anadramous fish runs.

Each fishing trip is assigned to one fishing type. For fishing trips where more than one type of fishing occurs, the respondent was asked to report the fishing type he or she primarily engaged in during that trip.

Data Collected

More detail on how the data was collected and summary statistics are provided in the body of the report.

Three different types of data were collected. First, anglers were asked to describe every fishing trip they took within the study region during 2011. Second, if the angler felt that 2011 was not a normal year with regards to their fishing activity, the angler was asked how many trips of each fishing type they take in a normal year. Third, anglers were asked how many fishing trips they would take if recreational quality, as measured by catch rate, were to decrease.

Data on 2011 Trips

Data on fishing trips taken in 2011 was collected from two surveys, one conducted by mail and the other conducted through the web. These two surveys collected slightly different information about trips.

In both surveys, complete information was collected for all trips taken within the respondent's home state. This information included

- the destination county
- the fishing type
- whether the trip was a day trip or an overnight trip

For trips taken outside the respondent's home state, the following information was collected for each trip

- Web Survey
    - destination state is known (but not county)
    - the fishing type
    - whether the trip was a day trip or an overnight trip
- Mail Survey
    - only know that destination is outside of home state (specific destination state or county is not known)
    - fishing type
    - whether the trip was a day trip or an overnight trip

Normal Year Trip Frequency Data

Anglers may have felt that 2011 was not a normal year for them, perhaps due to illness or injury or some other unusual situation. After reporting their 2011 fishing trip data, each respondent was asked how many times they go fishing in a "normal year." In question 19 of the web survey and Question 13 of the mail survey, respondents reported the total number of day trips and the total number of over overnight trips taken for each fishing type in a normal year.. No destination information was collected for this data.

Contingent Behavior Trip Frequency Data

Respondents were then asked to imagine that fishing quality, as measured by catch rates, were to decline. Each respondent was presented with a specific catch rate decline scenario. As depicted in questions … and … of the web survey and questions 14 and 15 of the mail survey, each catch rate decline scenario included seven catch rate declines – one for each fishing type. The catch rate declines differed across fishing types, but were the same for all counties within each fishing type. All catch rate declines were described as a percentage of the catch rate for that fishing type in 2011. Respondents were asked how many times in a year they would go fishing for each fishing type in a year if catch rates were to decline according to the presented scenario. Different respondents got different combinations of catch rate declines. Respondents were not asked where they would go fishing, only how many total day and overnight trips they would take for each fishing type.

Trip Decision Model

The recreation model developed here is for day trips. Day trips account for 89% of all trips taken in the study region and 83% of all fishing days. An overnight trip model was not specified or estimated for two reasons. First, because there is less data on overnight trips with which to

identify spatially distinct quality parameters in the model, a model estimated based on overnight trips will be less reliable statistically. Second, angler behavior regarding overnight trips likely follows a different, more complex, decision process than for day trips. When calculating the net value generated by fishing in the study region, the value associated with overnight trips was calculated by multiplying the net value per fishing day estimated from the day trip model by the estimated total number of fishing days that occurred on overnight trips. The assumption is that the net value per fishing day is the same for day trips and for overnight trips.

For day trips, anglers are assumed to make their trip decisions (whether to go fishing, what type of fishing to do, where to go fishing) based on the utility they receive from engaging in each fishing type in each county. A repeated nested logit random utility model (NLRUM) is assumed (Morey et al. 1993). In the model, each angler has N opportunities to go fishing (choice occasions). On each choice occasion, the angler makes a series of decisions. First, they decide whether or not to take a trip (participation decision). If they decide to take a trip, they then decide what type of fishing to do (fishing type decision). Once they have decided what type of fishing to do, they decide where to go fishing (destination decision). The destination decision is constrained by the fishing type decision – the angler can only go to destinations that offer that type of fishing. The decision tree for each fishing opportunity is shown in Figure TA-2.

The Utility Function

An angler is assumed to obtain utility of 0 if they choose to stay home and do something other than going fishing. The utility that individual i obtains from engaging in fishing type k in county j consists to two components, a deterministic component, U_{ij}^{k}, and a random component, ε_{ij}^{k}

$$V_{ij}^{k} = U_{ij}^{k} + \varepsilon_{ij}^{k}$$

The deterministic component is assumed to take the following form

$$U_{ij}^{k} = \gamma_k Q_{jk} + \beta TC_{ij} + \varphi^k ln\left(CR_j^k\right) + \mu X_i + \delta_k Z_i + \omega_k S_i$$

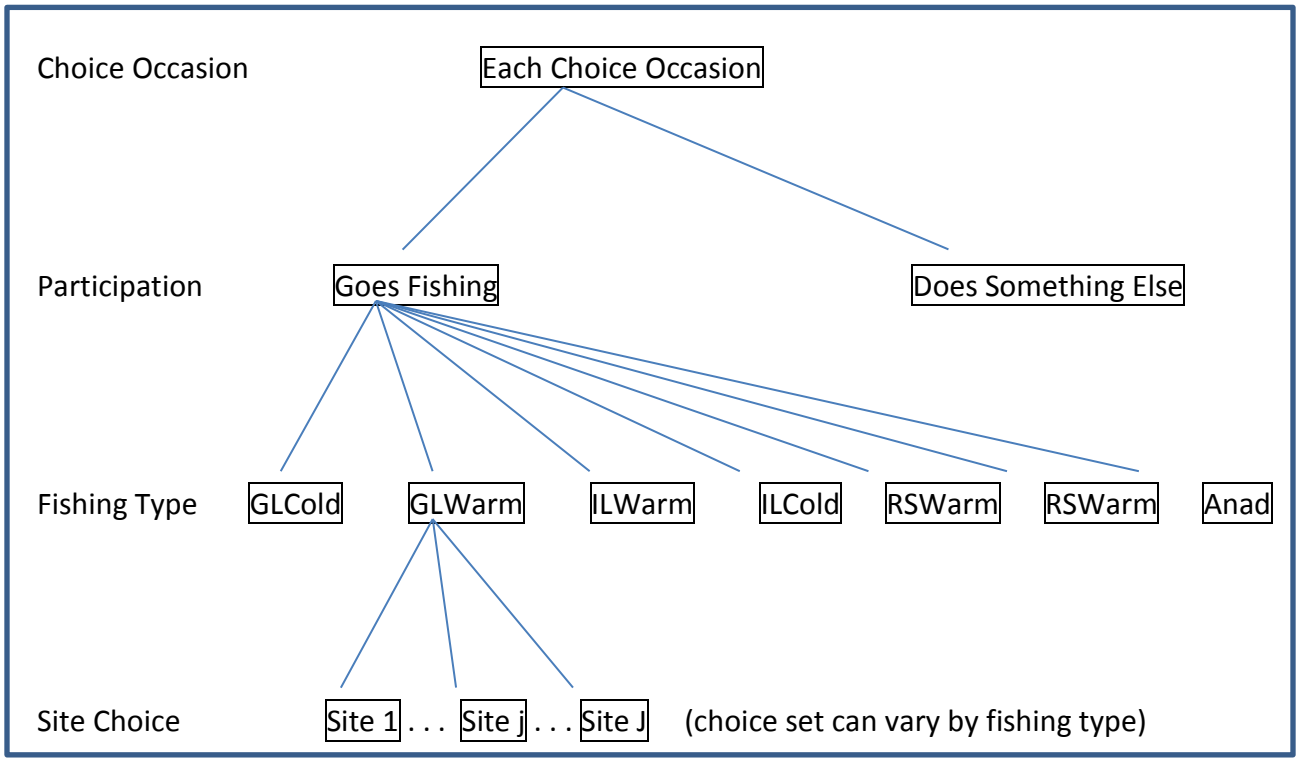
where

i = index for individual

j = index for county; j = 1,2,…,1042

k = index for fishing type; k=1,2,…,7

Figure TA-2. Nested logit decision tree.



TC_{ij} = Round trip travel costs from centroid of i's home zip code to centroid of jth county. If a respondent has two homes, travel cost to the jth county is measured from both the primary home zip code and the secondary home zip code, and the lesser of the two calculated travel costs is used.

β = Marginal utility of income.

CR_j^k = Catch rate for fishing type k in county j, expressed as percent of 2011 catch rate.

φ^k = parameter to capture influence of catch rate reduction on fishing type choice.

Q_{jk} = Vector of site characteristics relevant to fishing type k.

γ_k = Vector of marginal utilities of site characteristics for fishing type k.

X_i = Vector of characteristics of the individual that affect the participation decision.

μ = Vector of parameters for participation decision (marginal impact of each element of X_i on utility from going fishing)

Z_i^k = Vector of characteristics of the individual that affect fishing type choice.

δ_k = Vector of fishing type choice parameters for fishing type k (marginal impact of each element of Z_i^k on utility from engaging in fishing type k)

S_i = Dummy variable for whether a trip is based on observed behavior in 2011 or stated behavior (=1 if normal year or contingent behavior; =0 if actual trip taken in 2011)

ω_k = parameter to capture influence of hypothetical bias on fishing type choice.

ε_{ij}^k = random error term in utility for individual i of engaging in fishing type k in county j

Influence of Catch Rate on Utility and Behavior

A unique aspect of the model as it is applied here is how catch rate is included in the utility function. The catch rate measure, CR_j^k is defined as a percentage of the baseline (2011) catch rate. For all observed trips taken in 2011 and all "normal year" trips, CR_j^k=1, so that ln(CR_j^k)=0. For contingent behavior trips, CR_j^k<1 for fishing types whose catch rate declines in the hypothetical scenario, so that ln(CR_j^k)<0. As CR_j^k declines toward 0, ln(CR_j^k) declines to -∞ in the limit. The functional form therefore imposes the restriction that no trips will be taken to a destination that has catch rate of 0.

For CR_j^k values between 0 and 1, the shape of the utility function depends on the value of φ^k. Figure TA-3 shows how a catch rate reduction at one site can affect the probability of visiting that site. In this constructed example, the site has a probability of being chosen of 0.01 if CR_j^k=1. As CR_j^k declines, the probability of the site being chosen declines, but at a rate that depends on the value of φ^k. Three different curves are shown for different values of φ^k. If φ^k is small (blue curve), then the probability of choosing the site declines slowly with small decreases in catch rate. If φ^k is large (green curve) then the probability of choosing the site declines rapidly with small decreases in catch rate. An intermediate value of φ^k gives a roughly linear relationship between catch rate and probability of choosing the site. The functional form chosen is therefore very flexible with regards to the impact of catch rate reductions on behavior with the restriction that the probability of choosing a site/fishing type combination goes to zero as the catch rate for that fishing type for that site goes to 0.

The flexibility of the model means that it should be used with caution when projecting impacts of catch rate reductions outside the range of the data. In the catch rate reduction scenarios presented to survey respondents, catch rates for each fishing type were reduced by between 0% and 50%.Complete loss of a fishing type will logically lead to no fishing for that fishing type. However, we have no information on the specific shape of the lines in Figure TA-3 for catch rate reductions larger than 50% but less than complete loss.

Conditional Site Choice Probability

Complete information on destination choice is not available for all trips. In some cases, we only know which state or states were visited. Let g=1,2,…,G_i^k be an index, where each value of g represents an observed trip destination for angler i. If the observed trip destination is within the angler's home state, then g will represent a unique county. If the observed trip destination is outside the angler's home state, then g will represent a set of counties. For example, if the angler indicates that the trip was to a particular state other than the home state, then g represents all counties within that state that lie in the site choice set, i.e. those counties that offer that type of fishing and that are within the travel time cutoff for the angler.

The conditional probability of individual i taking a trip to destination set g, conditional on going fishing for fishing type k, is given by

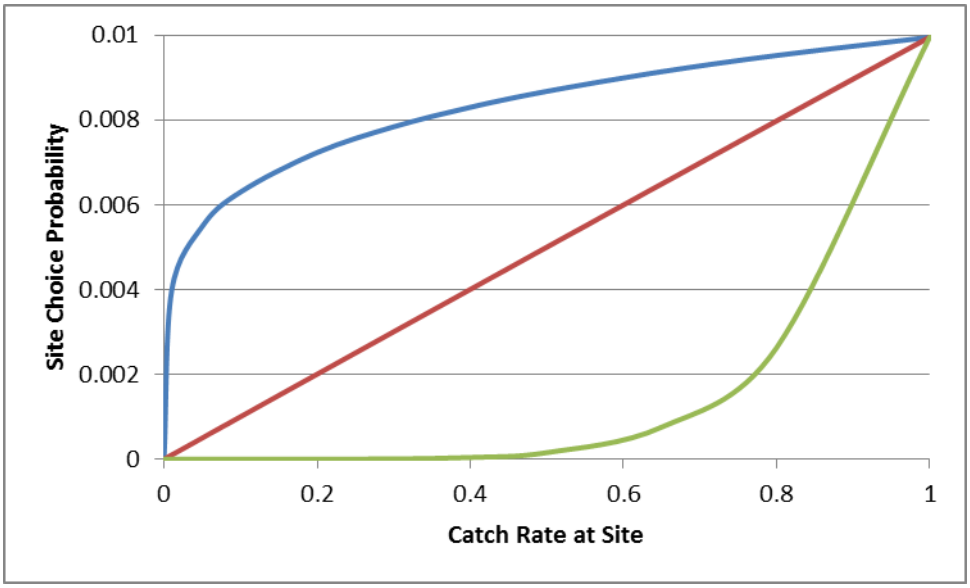
$$\Pr(g|k,p) = \frac{\sum_{j \in C_{ig}^k} \left\{ exp\left({U_{ij}^k}/{\lambda_k} \right) \right\}}{\sum_{j \in C_i^k} \left\{ exp\left({U_{ij}^k}/{\lambda_k} \right) \right\}}$$

where

p,np = indicator for participation (=p if angler goes fishing on that occasion; np if angler does not go fishing on that occasion)

C_i^k = individual i's full choice set for fishing type k. Includes all counties within the cutoff travel time from i's zip code that offer fishing type k.

Figure TA-3. Influence of catch rate on site choice probability.



C_{ig}^k = set of counties included in destination set g for fishing type k for individual i. C_{ig}^k is always a subset of C_i^k. If the visited county is known (i.e. in home state), C_{ig}^k will include that county only; if the visited county is not known, but visited state or states is known, C_{ig}^k will include all relevant counties in that state or states. For "normal year" trips and contingent behavior trips, no information about destination is known, and C_{ig}^k includes all of the same counties as C_i^k.

λ_k = Scale parameter for the site choice decision for fishing type k

Note that because Z_i, X_i and H_i do not vary among sites, they will cancel out in the formula and will not affect the site choice probabilities.

For each individual i, the inclusive value for fishing type k is given by

$$IV_i^k = ln\left[\sum_{j \in C_i^k}\left\{exp\left(U_{ij}^k \Big/ \lambda_k\right)\right\}\right]$$

The expected utility from taking a trip of fishing type k is given by

$$EU_i^k = \lambda_k IV_i^k$$

Fishing Type Choice Probability

The probability of choosing fishing type k, conditional of going fishing, depends on the expected utility from fishing type k as compared to the expected utility of the other fishing types, as follows

$$\Pr(k|p)\frac{exp\left[EU_i^k/_\sigma\right]}{\sum_{h\in 1\ldots 7}\left\{exp\left[EU_i^h/_\sigma\right]\right\}}$$

where σ is the scale parameter for fishing type decision. The inclusive value for going fishing is given by

$$IV_i^p = ln\left[\sum_{h\in 1\ldots 7}\left\{exp\left[EU_i^h/_\sigma\right]\right\}\right]$$

The expected utility from going fishing is given by

$$EU_i^p = \sigma IV_i^p$$

Probability of Going Fishing (participation)

The probability that individual i goes fishing on a given choice occasion depends on the expected utility from going fishing

$$Pr(p)\frac{exp\left(EU_i^p/_\rho\right)}{1+exp\left(EU_i^p/_\rho\right)}$$

where ρ is the scale parameter for the participation decision. Traditionally, ρ is normalized to equal 1. The inclusive value per choice occasion is given by

$$IV_i^{co} = \ln\left(1+exp\left(EU_i^p/_\rho\right)\right)$$

The expected utility per choice occasion is given by

$$EU_i^{co} = \rho IV_i^{co}$$

Welfare Measures

With knowledge of the model parameters, it is possible to calculate welfare impacts of changes in access, site quality, or catch rate. The change in net economic value over an entire season from a change in conditions is given by the compensating variation (CV):

$$CV_i = N * \frac{EU_i^{co}(0) - EU_i^{co}(1)}{-\beta}$$

where $EU_i^{co}(0)$ is the expected utility per choice occasion under the baseline (2011) catch rate and access conditions and $EU_i^{co}(1)$ is the expected utility per choice occasion under the new conditions.

For some changes in conditions that prevent anglers from taking trips that they otherwise would have taken, it is possible to calculate a user day value (for day trips). Examples would include closure of a site that prevents all trips to that site, or a decrease in catch rate for a specific fishing type that induces anglers to take fewer trips of that fishing type. For changes in conditions that displace angler trips, a user day value is defined as the compensating variation for the change in conditions divided by the expected number of fishing days that would be displaced by the change in conditions.

Consider first a change in access or catch rate that discourages or prevents anglers from visiting a specific site or set of sites for a specific type of fishing. Anglers will take fewer trips to the affected site or sites, but will substitute and fish some of the displaced trips at other, unaffected sites. If the number of displaced fishing days (the decrease in fishing days at the affected site or sites) is small, then the compensating variation per displaced fishing day for fishing type k is given by $-\lambda_k/\beta$. This user day value is appropriate for use when valuing changes that affect one site or a small group of sites. It accounts for substitution away from the affected site or sites to other, unaffected sites.

Alternatively, a change in conditions could discourage or prevent anglers from fishing for a specific fishing type at all sites. Anglers will fish less often for that fishing type, but will substitute and fish some of the displaced days for other, unaffected fishing types. If the number of displaced fishing days is small, then the compensating variation per displaced fishing trip is given by $-\sigma/\beta$. This user day value is appropriate for use when valuing changes that affect one fishing type across the entire study region. It accounts for substitution away from the affected fishing type to other fishing types. This is the user day value used for calculating the baseline value of fishing in the GLMRIS study area.

Finally, a change in conditions could prevent an angler from doing any type of fishing at any site (complete closure of all recreational fishing). For an angler with a very low probability of going

fishing, the user day value associated with complete loss of all fishing is given by –ρ/β. This is an extreme situation that is well outside the range of our observed data. Any estimate of this user day value will be very unreliable.

In all three cases, the formula for user day value is strictly valid only for changes that displace a small number of trips.

Construction of the Likelihood Function

On a given choice occasion, the probability of observing a particular trip of fishing type k to destination set g is given by

$$\Pr(g,k,p) = Pr(p) * \Pr(k|p) * \Pr(g|k,p)$$

The probability of the angler not taking a trip is given by

$$Pr(np) = 1 - Pr(p)$$

The likelihood function for an entire season's trip behavior is given by

$$lnL = \sum_i \left\{ \sum_k \sum_g \left(F_{ig}^k \ln[\Pr(g,k,p)] \right) + \left(N - \sum_k \sum_g F_{ig}^k \right) \ln(1 - \Pr(p)) \right\}$$

where

N = number of choice occasions per year (set at 365)

F_{ig}^k = Number of times during the season angler i took a trip to destination g to do fishing type k

Note that each angler can show up in the likelihood function up to three times: once for their 2011 trip data, once for their normal year trips, and once for their contingent behavior trips.

Estimation

An important objective of this research is to estimate a reliable model of recreational behavior under current (2011) conditions. For this reason, the model parameters were estimated in two steps. First, the model was estimated using only 2011 trip data (actual trips taken). For the first stage regression, the participation scale parameter, ρ, is normalized to 1. Because H_i=0 and CR_j^k=1 for all 2011 trips, the parameters φ^k and ω_k cannot be identified during the first step regression. This was done so that all parameters other than φ^k and ω_k would be estimated based on observed 2011 trip behavior only, and would not be based on stated behaviors associated with normal year or contingent behavior trips.

Previous research has shown that anglers tend to report future trip participation at higher rates than is observed in actual trip behavior. This could be due to optimism on the anglers' part, where they report the amount of angling they plan to do, but fail to take into account events that could prevent them from fulfilling those plans, such as sickness or other unanticipated events (Englin and Cameron 1996; Hensher et al 1998). We account for the tendency to overstate trip frequency by estimating a parameter for each fishing type, ω_k, that captures differences in trip frequency between hypothetical trip behavior and actual trips taken. A second observed issue is that survey respondents may report choices that imply random error terms that have higher variance than that implied by actual choice behavior. It has been speculated that recreationists facing actual trip choices have more of an incentive to evaluate their own utility, reducing the variance in the error terms.

In the second step, the estimated parameters from the first step regression were held fixed, and φ^k and ω_k were estimated using the "normal year" and contingent behavior data. This approach is admittedly inefficient, and there is the concern that estimated standard errors will be biased, particularly in the second-stage regression. To account for potential differences in error variance between hypothetical and actual trip choices, we estimate in the second stage regression new values for σ and ρ, so that the scale parameters for the hypothetical trip behavior are allowed to differ from the scale parameters for the actual 2011 trip behavior. Because we do not have information on site choice in the hypothetical data, it is not possible to estimate new values of the site choice scale parameters for hypothetical data.

Results

Details on construction of site quality measures, Q_{jk}, are discussed in the body of the report. The following county-specific quality measures were included in the first stage regression:

For GLCold and GLWarm:

- Fishing-type specific constant
- Constants for each of 10 county groups
- Shoreline Miles

For Anadromous:

- Fishing-type specific constant
- Constants for each of 10 county groups
- Aquatic Habitat Quality Index
- Miles of streams in the county (stream order 3-4)
- Miles of rivers in the county (stream order 5-7)

For ILCold, ILWarm: - Fishing-type specific constant
- Constants for each state (Omitted state is Michigan)
- Aquatic Habitat Quality Index
- Lake area in county (square miles)

For RSCold, RSWarm
- Fishing-type specific constant
- Constants for each state (Omitted state is Michigan)
- Aquatic Habitat Quality Index
- Miles of streams in the county (stream order 3-4)
- Miles of rivers in the county (stream order 5-7)

An estimation where the seven site-choice scale parameters were unrestricted resulted in some site-choice scale parameters larger than the estimated fishing-type scale parameter, which would be inconsistent with a random utility model. Hence, a common value of $\lambda_k = \lambda$ for all k fishing types is estimated.

All angler characteristics were included in the X_i vector, and none were included in the Z_i vector. That is, angler characteristics were assumed to affect participation frequency, not fishing type choice. This was done to reduce the number of parameters estimated.

The first stage estimation was done using day trips for the 2011 season. The results are presented in Table TA-1.

Economic theory predicts that the coefficient on travel cost will be negative, and that the scale parameters will satisfy the inequalities $\lambda<\sigma<\rho$. These conditions are satisfied for the first stage results, indicating that our observed trip data is consistent with expected utility theory.

Coefficients for continuous site quality measures are of the expected signs and almost all are statistically significant. Counties with more shoreline miles are more likely to be visited for GLCold and GLWarm trips. Counties with more lake area are more likely to be visited for ILWarm and ILCold trips. Counties with more stream miles are more likely to be visited for RSCold and RSWarm trips. Counties with more river miles are more likely to be visited for RSWarm and Anad trips. More river miles did not have a significant impact on visitation for RSCold trips, suggesting that RSCold anglers are targeting smaller streams. Stream miles had a negative impact on Anad trips, suggesting that Anadromous anglers are targeting counties located lower in the watersheds. Finally, higher values of the Aquatic Habitat Quality Score were associated with more trips for all five inland fishing types.

Higher income anglers fish less frequently, as do anglers with full time employment. The relationship between age and fishing frequency has an inverted U shape, with a peak between 30 and 40 years of age.

The second stage estimation included normal year and contingent behavior responses. As demonstrated in Table TA-2, the second stage regression results show that anglers, on average, project more trips in a normal year than they took in 2011 (i.e. ω_k>0). This was true for all fishing types. For all fishing types, decreased catch rate would lead to decreased fishing participation (i.e. φ^k>0). The fishing type that was most sensitive to decreases in catch rate was GLCold, while the fishing type that was least sensitive was Anadromous.

Based on the estimation results, The user day values for changes that affect trips to a given site is $17.53, while the user day value for changes that affect all trips of a single fishing type is $19.52.

The scale parameter for fishing type choice, σ, estimated from the hypothetical trips data was larger than that estimated from the data on 2011 trips. This would suggest that anglers project a higher rate of substitution between fishing types than they actually exhibit. The participation scale parameter, ρ, estimated from the hypothetical data was close 1, the normalized value imposed for the 2011 data.

Table TA-1. First stage model estimation results using 2011 trip data.

Variable	Estimate	T-Stat	Description
Site Quality Measures - GLCold			
GLCold	-2.4437	-64.846	Fishing-type-specific constant
GLCold Grp 1	0.1694	6.554	County group constant - County group 1
GLCold Grp 2	0.0253	1.615	County group constant - County group 2
GLCold Grp 3	0.0284	1.591	County group constant - County group 3
GLCold Grp 4	-0.1832	-9.239	County group constant - County group 4
GLCold Grp 5	-0.0718	-6.723	County group constant - County group 5
GLCold Grp 6	-0.0227	-1.866	County group constant - County group 6
GLCold Grp 7	-0.1717	-7.422	County group constant - County group 7
GLCold Grp 8	-0.3052	-11.790	County group constant - County group 8
GLCold Grp 9	0.0803	5.451	County group constant - County group 9
GLCold Grp 10	0.0252	1.672	County group constant - County group 10
GLCold x shoremi	1.0161	6.283	Shoreline Miles
Site Quality Measures - GLWarm			
GLWarm	-2.5664	-66.826	Fishing-type-specific constant
GLWarm Grp 1	0.0748	1.774	County group constant - County group 1
GLWarm Grp 2	0.0163	0.958	County group constant - County group 2
GLWarm Grp 3	0.0094	0.433	County group constant - County group 3
GLWarm Grp 4	0.0616	3.810	County group constant - County group 4
GLWarm Grp 5	-0.0759	-5.140	County group constant - County group 5
GLWarm Grp 6	-0.0568	-2.802	County group constant - County group 6
GLWarm Grp 7	0.2002	11.786	County group constant - County group 7
GLWarm Grp 8	0.2224	12.660	County group constant - County group 8
GLWarm Grp 9	0.2897	16.205	County group constant - County group 9
GLWarm Grp 10	0.2097	12.280	County group constant - County group 10
GLWarm x Shoremi	1.7606	9.664	Shoreline Miles
Site Quality Measures - Anadromous			
Anad	-2.8913	-60.093	Fishing-type-specific constant
Anad Grp 1	0.1141	1.429	County group constant - County group 1
Anad Grp 2	0.0479	1.673	County group constant - County group 2
Anad Grp 3	0.2052	8.258	County group constant - County group 3
Anad Grp 4	-0.0791	-1.979	County group constant - County group 4
Anad Grp 5	0.1701	9.459	County group constant - County group 5
Anad Grp 6	0.1436	7.572	County group constant - County group 6
Anad Grp 7	0.0988	3.758	County group constant - County group 7
Anad Grp 8	0.0762	3.203	County group constant - County group 8

Anad Grp 9	0.3283	15.518	County group constant - County group 9
Anad Grp 10	0.2796	14.230	County group constant - County group 10
Anad x habscore	0.0783	7.036	Aquatic habitat quality score
Anad x strms34	-0.1154	-2.306	Miles of streams (stream order 3-4)
Anad x strms57	0.8282	4.508	Miles of rivers (stream order 5-7)

Site Quality Measures - ILCold

ILCold	-2.9236	-62.803	Fishing-type-specific constant
IN x ILCold	-0.1076	-5.796	State-specific constant - Indiana
IL x ILCold	-0.0571	-3.433	State-specific constant - Illinois
IA x ILCold	-0.0049	-0.256	State-specific constant - Iowa
KY x ILCold	-0.1238	-6.756	State-specific constant - Kentucky
MN x ILCold	-0.4124	-11.972	State-specific constant - Minnesota
MO x ILCold	0.0720	5.555	State-specific constant - Missouri
NY x ILCold	0.1708	11.155	State-specific constant - New York
OH x ILCold	0.0494	3.365	State-specific constant - Ohio
PA x ILCold	0.1764	12.211	State-specific constant - Pennsyvlania
WV x ILCold	0.0143	0.919	State-specific constant - West Virginia
WI x ILCold	-0.1820	-11.289	State-specific constant - Wisconsin
ILCold x habscore	0.0813	8.845	Aquatic habitat quality score
ILCold x lake area	0.6468	17.646	Lake Area

Site Quality Measures - ILWarm

ILWarm	-2.5059	-68.662	Fishing-type-specific constant
IN x ILWarm	-0.1130	-12.469	State-specific constant - Indiana
IL x ILWarm	-0.0638	-8.242	State-specific constant - Illinois
IA x ILWarm	-0.0700	-7.617	State-specific constant - Iowa
KY x ILWarm	-0.0788	-10.072	State-specific constant - Kentucky
MN x ILWarm	-0.0925	-10.432	State-specific constant - Minnesota
MO x ILWarm	-0.1106	-12.564	State-specific constant - Missouri
NY x ILWarm	-0.0053	-0.616	State-specific constant - New York
OH x ILWarm	-0.0068	-1.123	State-specific constant - Ohio
PA x ILWarm	-0.0408	-2.849	State-specific constant - Pennsyvlania
WV x ILWarm	-0.1995	-17.562	State-specific constant - West Virginia
WI x ILWarm	-0.0413	-6.412	State-specific constant - Wisconsin
ILWarm x habscore	0.0615	5.988	Aquatic habitat quality score
ILWarm x lake area	0.4487	23.984	Lake Area

Site Quality Measures - RSCold

RSCold	-2.8376	-64.875	Fishing-type-specific constant
IN x RSCold	-0.5658	-9.976	State-specific constant - Indiana
IL x RSCold	-0.1357	-9.765	State-specific constant - Illinois
IA x RSCold	-0.0613	-4.463	State-specific constant - Iowa

KY x RSCold	-0.2388	-12.202	State-specific constant - Kentucky
MN x RSCold	-0.2296	-12.161	State-specific constant - Minnesota
MO x RSCold	-0.1800	-12.151	State-specific constant - Missouri
NY x RSCold	0.1033	8.639	State-specific constant - New York
OH x RSCold	-0.1266	-8.986	State-specific constant - Ohio
PA x RSCold	0.1859	14.678	State-specific constant - Pennsyvlania
WV x RSCold	0.0880	6.814	State-specific constant - West Virginia
WI x RSCold	-0.1612	-9.882	State-specific constant - Wisconsin
RSCold x habscore	0.0865	11.554	Aquatic habitat quality score
RSCold x strms34	0.2902	14.639	Miles of streams (stream order 3-4)
RSCold x strms57	0.0934	1.475	Miles of rivers (stream order 5-7)
Site Quality Measures - RSWarm			
RSWarm	-2.6913	-68.495	Fishing-type-specific constant
IN x RSWarm	-0.0965	-9.155	State-specific constant - Indiana
IL x RSWarm	0.0109	1.013	State-specific constant - Illinois
IA x RSWarm	0.1035	10.845	State-specific constant - Iowa
KY x RSWarm	-0.0061	-0.527	State-specific constant - Kentucky
MN x RSWarm	-0.0833	-6.513	State-specific constant - Minnesota
MO x RSWarm	-0.0907	-8.882	State-specific constant - Missouri
NY x RSWarm	0.0705	6.636	State-specific constant - New York
OH x RSWarm	0.0299	2.678	State-specific constant - Ohio
PA x RSWarm	0.0874	6.273	State-specific constant - Pennsyvlania
WV x RSWarm	0.0054	0.542	State-specific constant - West Virginia
WI x RSWarm	0.0110	1.276	State-specific constant - Wisconsin
RSWarm x habscore	0.0474	11.209	Aquatic habitat quality score
RSWarm x strms34	0.2821	16.993	Miles of streams (stream order 3-4)
RSWarm x strms57	0.6276	17.864	Miles of rivers (stream order 5-7)
Travel Cost			
β	-0.0068	-20.765	Round Trip Travel Cost
Angler Characteristics that affect participation decision			
μ - ln(income)	-0.0724	-6.345	natural log of income/10000
μ - FT Employed	-0.1926	-20.283	=1 if full time employed
μ - Age	1.8729	11.361	Age/100
μ - Age squared	-2.8688	-16.806	(Age/100)^2
Scale Parameters – 2011 Trip Data			
σ – 2011 data	0.1329	21.777	Scale parameter for fishing type decision
λ – 2011 data	0.1194	16.324	Scale parameter for site choice decision

Table TA-2: Second stage estimation using stated trip (normal year and contingent behavior) data**.**

Variable	Estimate	T-Stat	Description
Catch Rate Index Coefficient			
ϕ – GLCold	0.2186	9.351	Catch Rate Index Coefficient for GLCold
ϕ - GLWarm	0.1735	8.332	Catch Rate Index Coefficient for GLWarm
ϕ – ILCold	0.1523	13.417	Catch Rate Index Coefficient for ILCold
ϕ – ILWarm	0.1546	27.919	Catch Rate Index Coefficient for ILWarm
ϕ – RSCold	0.1745	15.660	Catch Rate Index Coefficient for RSCold
ϕ – RSWarm	0.1849	13.304	Catch Rate Index Coefficient for RSWarm
ϕ – Anad	0.0938	6.638	Catch Rate Index Coefficient for Anad
Stated Trips Data Constants			
ω - GLCold	0.7567	41.103	Stated trip data constant for GLCold
ω - GLWarm	0.8463	55.267	Stated trip data constant for GLWarm
ω - ILCold	0.8130	67.306	Stated trip data constant for ILCold
ω - ILWarm	1.3751	660.833	Stated trip data constant for ILWarm
ω - RSCold	1.0362	175.576	Stated trip data constant for RSCold
ω - RSWarm	1.1851	102.724	Stated trip data constant for RSWarm
ω - Anad	0.6528	65.011	Stated trip data constant for Anad
Scale Parameters – Stated Trips Data			
σ – Stated data	0.3786	431.501	Scale parameter for fishing type choice
ρ – Stated data	0.9148	148.519	Scale parameter for participation choice