AN ECONOMIC ASSESSMENT OF THE VALUE OF LAKES AND LAKE WATER QUALITY IN ITASCA COUNTY, MINNESOTA[^]

prepared by

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EXECUTIVE SUMMARY

Itasca County, Minnesota, is home to approximately 1000 lakes, which constitute the economic and cultural center of the county. The water quality in these lakes ranks among the highest in the state, and county residents have nurtured a legacy of high environmental quality and a commitment to sustainability. Maintenance of the county's high quality lakes requires careful monitoring and management decisions, as well as an understanding of the economic value generated by the resource base. This study is focused on the latter of these needs.

The lakes in the county provide recreation and aesthetic services to both Itasca County residents and visitors. The economic value provided by these services is reflected in the trips residents and visitors make to the county's lakes, the income earning opportunities the lakes provide, and the desire among county residents to provide future generations with access to the same high quality resource. Measurement of this economic value requires an understanding of the willingness to pay by residents and nonresidents for the continued maintenance of a high quality resource. A mail survey of county residents, along with an intercept survey of visitors to the county, provided the basis for estimating the willingness to pay for characteristics of the lakes related to (a) recreation access; and (b) water quality maintenance.

The travel cost method was used to measure the economic value of the recreation use of the county's major lakes. This approach infers visitors' willingness to pay for a visit to a lake by measuring the implicit costs of a visit, which includes the money and time commitments needed for travel. Application of this method suggests that county residents value the county's lakes for recreation purposes at a rate of $49 million annually. Visitors to the county enjoy an additional $34 million worth of benefits from their recreation visits. Together the recreation services provided by the county's major lakes are worth nearly $85 million per year, which is equivalent to approximately 12 percent of aggregate county income per year.

The contingent valuation method was used to measure the economic value of changes in lake water quality across the extent of the county. Lake water quality is potentially valuable both as a quality dimension of lake recreation and as a vehicle for providing more general environmental services. Application of the method in the Itasca County context shows that county residents are willing to pay at least $10 million per year (nearly 1.5 percent of total county income) to prevent a 20 percent decrease in future water quality, relative to today's high level. This number is notable in that it does not reflect changes in the existence or availability of lakes for recreation; rather, it suggests that high water quality in the county provides substantial economic value by augmenting the appeal of recreation access and through more general channels such as preservation and bequest motives.

Overall the findings from this study show that Itasca County residents attach significant value to their endowment of high quality lakes, and that the lakes provide economic benefits at a magnitude that ranks them among the major sources of well-being in the county. Care needs to be taken to ensure that this unique resource is managed in a way that allows these large and widely distributed economic benefit flows to continue unabated in the future.

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1) INTRODUCTION

Itasca County, Minnesota is home to over 1000 lakes, which provide residents and non-residents with a variety of recreation, aesthetic, cultural, and market services. The lakes' water quality is generally high, and the county is considered a prime destination for angling and other lake-based tourism. A roughly estimated 100,000 people visit the county each year, and county residents are frequent users of their water resources. Indeed, nearly 75 percent of residents reported visiting a lake in the county last year. Thus the economic and cultural core of the county is closely tied to the area's numerous, high quality lakes.

There is some concern that threats to water quality in the county may alter this equilibrium. In other parts of Minnesota pristine lake landscapes have been affected by economic trends such as rapid shoreline development, urban expansion, changes in agricultural practices, and up scaling of the tourism industry. Natural threats from invasive species and climate change have also played a role in changing the ecological conditions of some lakes. For example, the presence of zebra mussels in Lake Mille Lacs has profoundly affected the lake's ecology, and Asian milfoil has changed the way that infested lakes are used for recreation. Itasca County has not yet witnessed large scale changes of these types, and so county residents and resource managers are in a position to actively influence the future course of events. The main task will be to direct economic development along a path that complements, rather than degrades, the area's unique natural endowment. It will also be important to consider the benefits and costs of policies that are designed to protect water quality in the county. For this it is important to first understand how Itasca County's lakes and their high water quality contribute to economic well-being for county residents and visitors.

Measuring the economic value of environmental resources such as lakes and lake water quality is complicated for two reasons. First, environmental resources tend to be *nonmarket* goods, meaning they are not bought and sold in the same way that familiar commodities such as food and clothing are. For example, the price that a person pays for a new car says something about how she values it relative to other things her money can buy. In contrast, the same person may value a high quality lake, but she does not directly reveal this via her spending behavior. Second, environmental resources are often *public goods*, meaning many people can enjoy them at the same time. For example, a new car is something only its owner can derive value from, while lake water quality is something a group of people can jointly make use of. This creates a multiplier effect: even if individual people value an environmental resource only by a small amount, the summation of many persons' values can still be substantial. Nonetheless the tendency is for environmental goods such as lake water quality to be under protected, since no one person feels compelled to alter his behavior. Protection requires collective action, and this is usually predicated on widespread acceptance that the resource is indeed valuable. This latter point is the motivation for this study.

More specifically, the goal of this Blandin Foundation funded study is measure the contribution to economic well-being of lakes and lake water quality in Itasca County, Minnesota, by confronting the nonmarket and public good nature of lakes in the county. The scientific paradigm to be used comes from environmental economics, where researchers have developed several techniques for measuring the economic value of goods – such as water quality – that are not exchanged in markets. The primary data source for the study is a survey of Itasca County residents, which was conducted during the fall of 2013. I also make use of auxiliary data collected from visitors to the county in 2012, as well as secondary

sources. These data are used to estimate the economic benefits accruing to county residents and visitors from the current high quality of lakes in the county.

The following sections describe the details of the study. Section 2 presents the necessary background information on the county, its lakes, and trends in economic activity. Section 3 provides a non-technical overview of economic valuation concepts and techniques, while section 4 includes details about the survey instrument and summarizes the data. Sections 5, 6, and 7 present analysis results showing economic values derived using different methods and for different groups of people. Section 8 concludes the report. In the main body of the document I avoid describing technical and statistical methods when possible; these are instead included in appendix material, which also contains documents related to the survey and survey execution.

2) BACKGROUND ON ITASCA COUNTY

As of 2012, Itasca County was home to over 45,000 people divided into nearly 19,000 households. According to the most recent statistics, median household income is approximately $46,000 per year, and per capita income is $24,000. Over 92 percent of the adult population has graduated from high school, and 21 percent have earned a college degree. Over 80 percent of households are homeowners, and a high proportion of residents own some lakeshore property.[1]

For the county as a whole, the US Bureau of Economic Analysis estimates 2012 wage and business earnings at nearly $700 million, which provides a good proxy for the size of the market economy in Itasca County.[2] The largest contributors to these earnings are the retail and services industries, which together constitute 45 percent of the business establishments and 33 percent of the employment.[3] Statistics from Minnesota government agencies and NGOs paint a similar picture. In 2011 the leisure and hospitality industry alone provided 1,482 jobs, or 10 percent of private sector employment in the county. Gross sales in the industry were $65.5 million.[4]

The close connection between Itasca County's natural environment and its tourism industry suggests it is useful to summarize additional specifics on tourism in the county. In 2002 a Blandin Foundation report presented a detailed analysis of tourism in the county.[5] The relevant findings include the following:

- 65 percent of visitors to the county are from Minnesota
- Nearly half of visitors travel between 100 and 200 miles to reach the county
- The two most important reasons for selecting the region as a destination were its natural environment, and its lakes and rivers.
- The single largest activity category reason for visiting was outdoor recreation.

The study made some effort to quantify the number of visitors each year and their average spending. Using approximation methods it was estimated that the county received 1.2 million visitor days in 2000, and that travel parties spent over $400 on average per trip (adjusted to 2013 dollars). If we assume a visitor party on average contains four people, and that a typical visit last three days, this translates to a back of the envelope estimate of 100,000 visitor parties to the county per year.

Itasca County natural environment

Itasca County is home to over 1000 lakes, 1.3 million acres of forest land, and over 1000 miles of skiing and snowmobile trails. In general water quality in the county is quite high, though vulnerabilities in some studied lakes have been identified. The Itasca County region has been identified by developers as a target

[1] Census information on households is found at http://quickfacts.census.gov/qfd/states/27/27061.html.

[2] Information on personal income at the county level can be accessed via the Bureau of Economic Analysis web page at www.bea.gov.

[3] Information on the composition of establishments in the county can be accessed via the Census website http://censusstats.census.gov.

[4] From *Explore Minnesota* website accessed via www.exploreminnesota.com.

[5] *Evaluation of the Tourism Market and Development Potential of the Itasca County Area*, University of Minnesota Extension Service, Tourism Center, September 2002. Downloaded December 2013 from www.tourism.umn.edu/prod/groups/cfans/@pub/@cfans/@tourism/documents/article/cfans_article_127030.pdf.

area for the next major phase of lakeshore development in Minnesota, and 179 lakes in the county have been designated as 'recreational development' lakes.[6] Past experience suggests that development-induced landscape alterations can put pressure on lake water quality. As such, the Itasca Water Legacy Partnership has identified increased assessment of the county's lakes as an essential activity for ensuring the sustainability of the resource base. Beginning in 2008, assessment of water quality on 275 Itasca County lakes was initiated, with operations conducted by the Itasca Community College Water Lab. These data and information from future monitoring efforts will provide the input for ongoing evaluations of water quality trends and for decisions on watershed management.[7]

Individual lakes in the county have been studied in greater detail. For example, the *Deer and Pokegama Lakes Clean Water Partnership Diagnostic Study* is the most complete study of lakes in Itasca County, and noteworthy in the field of limnology for the extensive and detailed measurements that were made.[8] The study is important for lake management because it illustrates for the first time that Itasca County lakes may be changing, albeit in ways that cannot be detected by standard assessment methodologies. Specifically, nutrient chemistry in both lakes suggests phosphorus is the element limiting autotrophic production and is therefore the element of concern for gauging the consequences of degradation and the benefits of remediation. For Deer Lake, mass balance calculations indicate that about 73 percent of the phosphorus input derives from direct precipitation. Net phosphorus input to Pokegama Lake is four times that of Deer Lake and, in contrast, most of this load comes from surface sources, including tributary streams and inflow from the Mississippi River.

Both Deer and Pokegama Lakes have water quality problems stemming from these phosphorus loads. The deep waters are nearly devoid of oxygen for much of the summer; indeed, values are on par with those measured in eutrophic lakes. This finding suggests that both lakes are sensitive to additional nutrient enrichment. Furthermore, the lakes' low summer dissolved oxygen levels suggests their capacity to absorb additional nutrients is smaller than their overall phosphorus concentrations imply.

The Deer and Pokegama Lakes study has called attention to issues that are important for other lakes in this area. The findings confirm that more detailed and controlled monitoring of streams, groundwater, and precipitation that contribute excess phosphorus to lakes is necessary for informed management.

A second area of concern stems from aquatic invasive species. Species such as Eurasian water milfoil, flowering rush, faucet snails, and zebra mussels have been observed by the DNR in Itasca County. Resource managers and residents alike are concerned about the spread of existing invasive species, and the introduction of new species from places beyond the region, such as ocean going vessels in Lake Superior. Zebra mussels are a particular concern, in that immature forms were identified in several lakes and rivers in the county during 2013. This raises the possibility that other lakes have been infested, but not yet identified as such.

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[6] The remainder of this section is drawn from material provided by Dr. Harold Dziuk, in his role as liaison between this project and the IWLP.

[7] Information on water quality monitoring from the Itasca County Community College Water Lab can be found at http://limnoweb.eeob.iastate.edu/itascalakes/data.aspx.

[8] *Deer-Pokegama Clean Water Partnership*, Diagnostic Study Final Report, accessed February 2014 from http://www.itascawaterlegacypartnership.org/documents/DPCWP-Final-Report-7-25-13.pdf.

In recent years, efforts to control the spread of invasive species hitchhikers on watercraft from infested to non-infested lakes and streams have become a top priority. Educational programs and enhanced inspections and decontamination of watercraft leaving or entering public water accesses are being encouraged by agencies and concerned citizens. Limited county, state and federal sources of funding are being made available in competitive grants. Dr. Peter Sorensen, professor of fisheries at the University of Minnesota, is Scientific Director at the newly formed Minnesota Aquatic Invasive Species Research Center (MNAISRC). Funded by the MN state legislature, the MNAISRC seeks to better understand aquatic invasive species so that sustainable solutions for control and eradication of AIS can be developed.[9]

[9] See http://www.maisrc.umn.edu/ for more information on MAISRC.

3) ECONOMIC VALUATION

Concepts

The concept of economic benefits, and hence economic valuation, is closely related to the notion of individual well-being. Well-being in this context is broadly defined to include the enjoyment a person receives from her purchases and leisure time activities, her income earning possibilities, and her general quality of life. In this sense well-being depends on a person's preferences (the collection of her likes, dislikes, and viewpoints), income, type of employment, availability of free time, place of residence, and a host of other factors. At the most basic level, an action that increases a person's well-being creates economic value, while something that diminishes her well-being decreases economic value.

Consider the example of lake water quality in Itasca County. If quality in a local lake improves, the well-being of someone who visits that lake will likely increase – perhaps due to better fishing, or a generally improved experience. If quality in the lake falls, the well-being of someone else may decrease – perhaps due to a loss of tourism-based earnings. There are many other ways that circumstances and preferences determine the extent to which people benefit or suffer from a change in lake water quality. For example, people might care about water quality because of a sense of obligation to preserve it for future generations. In addition, the size of the implied well-being changes can vary immensely. A person who can just as easily select a different lake to visit will likely suffer less from a quality decrease than a person whose livelihood depends on that specific location.

While the notion of well-being is fundamental to economic valuation, it is a subjective and unobservable concept. The task therefore is to find an observable and quantifiable metric that is reliably related to well-being. Economists use two related concepts for this:

> Willingness to Pay (WTP): the highest amount of money a person is prepared to part with to have some outcome; and
> Willingness to Accept (WTA): the least amount of money a person is prepared to take in exchange for giving something up.

The basic idea behind WTP and WTA is that 'money talks'. For example, a person who goes to a used car auction prepared to pay up to $100,000 for a vintage Corvette is effectively saying "I will be better off if I can buy the car for $100,000 or less, but I will be worse off if I were to pay more." The person selling the car may be willing to accept a minimum of $90,000. She is effectively saying "I will be better off if I can get $90,000 or more for the car, but I will be worse off if I sell it for less." In this example the potential buyer's WTP is $100,000 and the potential sellers WTA is $90,000. Importantly, these concepts are independent of any transaction price that might subsequently occur. Thus they reflect the individual economic value that each person assigns to the potential action – regardless of if and when a transaction occurs.

For market goods such as used cars it is relatively easy to measure economic value since when transactions do occur, they reveal something about magnitudes. For the Corvette example, if a sale occurs for $95,000 we are able to infer that the buyer's WTP is greater than or equal to $95,000, and that the seller's WTA less than or equal to $95,000. Any time an exchange occurs it is therefore possible to infer something about how the participants value the good in question. Generally in this study

we will focus on using WTP to measure economic value.

Although this example shows that a transaction price can be related to WTP, it is important to stress that willingness to pay and the amount actually paid are distinct concepts. For example, a person may be willing to pay $25 for a favorite bottle of wine upon entering a store. Finding it on sale for $12 per bottle does not change that sentiment – it only means that he was able to purchase the wine for a lesser amount. Receiving a bottle as a gift is better still: he received $25 worth of benefits (his WTP), but did not have to actually spend anything.

The fact that WTP and actual purchases are distinct means the former can be usefully employed outside of the market concept. Consider again the lake example, and imagine a change that moves a local Itasca County lake from 'fair' quality to 'good' quality. If we discover that a person is willing to pay $50 per year to have the improvement, it means she is willing to forgo $50 worth of other things – movies, coffee, snacks, etc. – to be able to enjoy the higher quality lake. Thus the improvement would generate economic benefits for her equivalent to $50 per year, regardless of whether or not she ultimately had to pay to see the improvement through.

Going further with this example, an improvement at a lake will likely benefit many people, since water quality is non-rival – meaning many people can simultaneously enjoy its benefits. Suppose there are 100 local residents who use the lake as well as 50 non-resident visitors. If each of the former were willing to pay $50 per year and each of the latter $30 per year, the total group WTP is $\$50\times100 + \$30\times50 = \$6500$. Said another way, the group is collectively willing to pay $6500 to have the improvement, and hence the improvement would generate $6500 in economic benefits.

The lake example illustrates two important features about the economic benefits of nonmarket goods such as water quality. The public good nature of water quality means that the benefits can be large but widely dispersed – both residents and non-residents can share in the economic benefits. Second, the economic benefits of public goods such as water quality cannot be directly captured. While residents of Itasca County are largely responsible for maintaining the area's environmental quality, the benefits of these efforts are shared by both residents and visitors to the county.

Sources of economic value

The discussion on economic value has up to now been relatively abstract. To make the measurement task more concrete, in this subsection I will describe several possible pathways through which the Itasca County lakes and their water quality can generate economic value. The most obvious pathway is the direct use by county residents. Access to the suite of lakes available in the county provides economic benefits via residents' recreation visits; one can, for example, seek to measure people's WTP to maintain recreation access to Deer Lake for boating, fishing, and swimming.

The extent to which a county resident enjoys her visits to the lakes likely depends on the level of water quality. High quality levels – manifested as water clarity, abundant game fish, absence of invasive species, etc. – enhance the visit experience, while degraded water quality detracts from it. Thus the value of recreation visits to Itasca County lakes – i.e. the willingness to pay to maintain access – will increase/decrease with changes in quality. In this regard one can define WTP for changes in lake water

quality based on how it affects residents' recreation experiences.

A more general form of value comes from the bequest or option value of the water resources. People may value the county's lakes as part of the legacy that they want to leave for future generations. Similarly they may want to preserve access or quality levels so as to have the option of enjoying the lakes in the future. If people reporting such concerns are genuinely willing to part with other things that their money can buy to secure future quality, this is a valid (and potentially important) source of value.

There are also pecuniary reasons that residents of Itasca County might value the region's lakes and water quality. For example, resort owners, fishing guides, and equipment rental firms derive their income from visitors to the county's lakes. Loss of recreation access and/or decreases in lake water quality may impact the market demand for the services offered by these firms, thereby affecting owners and their employees. Thus the earning potential of the lakes for some residents is a source of economic value from the resource.

These examples focus on the economic value to county residents derived from their use and existence of the lakes for personal enjoyment and livelihood. Most of these classes of benefits – particularly the personal enjoyment pathways – can also accrue to non-residents. For example, visitors to the county may have positive WTP to protect water quality in the county for reasons related to their vacation and travel plans, future relocation possibilities, ownership of vacation property, or general bequest motives.

Capturing economic value

As noted above, the economic benefits of Itasca County's lakes and lake water quality are generated through interactions with the lakes by a wide range of county residents and non-residents. Because the lakes are open access, meaning people generally do not have to pay to use them, the economic benefits are not fully captured by local residents. To take an extreme example, a non-resident family can drive to a county lake in the morning, enjoy visiting during the day, and drive home that evening without purchasing anything, thereby generating benefits for themselves from the resource, without providing economic benefits for county residents.

While economic value from non-residents' use of the lakes cannot be directly captured, visitors' purchases of complementary services provide a vehicle for local businesses to benefit from the maintenance of a high quality recreation experience. Spending on travel, accommodation, and equipment are likely to increase when quality conditions increase, and correspondingly decrease when quality conditions worsen. Thus visitors' WTP to access the county's lakes is related to, but distinct from, the earnings local residents receive from providing tourism support services.

Measuring economic value

Economists have developed three complementary approaches for measuring the economic value of nonmarket resources such as water quality. The first, known as contingent valuation, is a survey-based approach whereby respondents are presented with detailed information about a specific environmental good (e.g., lake water quality in Itasca County), and then asked to consider a potential change in the good. Continuing the lake example from above, a resident of Itasca County can be given information about how the water quality in a lake near her home has been assessed (say) as 'fair'. Following this, steps can be

explained that eventually would advance quality in the lake to the level 'good'. These two pieces of information establish the current situation and some changed future, which the person may or may not be interested in.

A measure of the person's WTP for the changed future can be obtained from her answer to a question of the form *"Would you be willing to pay $X to have this change?"* If the survey is properly designed, we learn the following from her answer:

- A ***yes*** tells us that the person has a WTP that is at least as big as *$X* (and perhaps more); and
- A ***no*** tells us that the person has a WTP that is smaller than *$X* (and perhaps zero).

Obtaining answers of this type from many people, facing different values for the bid amount *X*, allows estimation of a WTP function that depends on characteristics of survey respondents. It also allows estimation of the population mean (or median) willingness to pay, which can then be scaled up to give an aggregate estimate of the population value.

The second measurement approach is based on the travel costs of accessing a lake. At the most basic level the 'price' of visiting a recreation destination is the money and time that must be spent to drive to the site. Observing a person's willingness to travel a particular distance (and hence pay the necessary travel costs) provides evidence that the visitor's WTP is at least as great as the travel expenses. Thus gathering data on how far a person traveled to access a particular destination, and inferring what their travel costs were based on the distance, allows estimation of her willingness to pay to gain access to the recreation site. Similarly, if we observe that people are willing to travel further (spend more in travel costs) to access destinations with better quality, we can infer that the better water quality is worth at least the additional travel costs.

The third measurement approach examines property values to gauge the extent to which homes near attractive environmental resources command a higher market price. For the water quality case one might examine sales prices for properties located on lakes throughout the county, in order to measure the extent to which homes on lakes with higher water quality command higher prices for otherwise similar locations.

In this study I make use of the first and second options. In particular, I use the contingent valuation method to measure Itasca County residents' willingness to pay to protect water quality in the county. I then use the travel cost method to measure residents' and visitors' willingness to pay for access to the county's lakes.

4) SURVEY BASICS AND SUMMARY STATISTICS

A survey of Itasca County residents was used to gather the primary data needed to estimate valuation models. The survey was developed during the summer and fall of 2013 and fielded in November of that year. In this section I describe the survey development and execution, and present summary statistics from the resulting data.

To execute the survey I partnered with the University of Wisconsin Survey Center (UWSC). At a general level the goal of the survey was to quantify Itasca County residents' use of and attitudes towards lakes and lake water quality in the county. Two survey modes were used: a traditional paper approach, and an online approach. My original intent was to rely only on the former. However, there was some interest amongst UWSC researchers in measuring how an online survey would perform in a rural area like Itasca County. As such they provided resources that allowed simultaneous use of both modes, which ultimately resulted in a larger and higher quality dataset.

The sample recruitment proceeded as follows. Two thousand randomly selected names and addresses of permanent Itasca County residents were provided by a commercial vendor. Among these, 1000 were sent a paper letter inviting them to complete the *Itasca County Lakes Survey* online. An example of this letter containing the IWLP letterhead is included as part of Appendix A to this report. A gratuity of $2 was included with the letter, and potential respondents were directed to a website and given an access code to reach the survey. The remaining 1000 people were sent a letter asking them to complete a paper survey that was included with the letter. An example of this letter is also included in Appendix A. Two dollars were once again included with the letter, along with a postage paid return envelope for the completed survey booklet. Following standard procedures for maximizing survey response rates, reminder postcards were sent two weeks after the initial solicitation to people who had not yet responded. Examples of the two postcard formats are also shown in Appendix A. Two weeks after the postcards were sent paper copies of the survey were mailed to all remaining non-respondents, including the people who had not responded to the online solicitation letter and postcard. These efforts produced an impressively high response rate. Specifically:

- 164 people completed the survey online, for a non-deliverable adjusted web-mode response rate of 16.9 percent.
- The people who did not respond to the web solicitation received a follow up paper survey. Among these, 30.2 percent filled out and returned the survey.
- The overall response rate for the web mode (online and paper) was 42.6 percent, which provided 396 completed surveys.
- 519 people completed the paper survey, for a non-deliverable adjusted paper-model response rate of 55.7 percent.
- The two modes together provided 915 returned surveys, based on a 48.4 percent response rate.

Appendix B contains the sample description and response rate report, which was provided by the UWSC.

Survey researchers report that it is increasingly difficult to obtain a perfectly representative sample, and the sampling method and survey mode can influence the extent to which the characteristics of the sample match the characteristics of the target population. Table 1 provides a summary of the characteristics of

Table 1: Comparison of sample and census data for key demographic variables

Variable	Mail Sample	Internet Sample	Full Sample	2010 Census
Household income	$54,526	$61,405	$55,819	$46,180
Age 65 or greater	0.17	0.02	0.14	0.20
Household size	2.28	2.43	2.31	2.33
High school graduate	0.97	0.99	0.97	0.93
College graduate	0.38	0.51	0.40	0.21
Male	0.57	0.60	0.58	0.51
Age	58	54	58	-
Kids in household	0.20	0.25	0.21	
Work full time	0.35	0.53	0.38	-
Retired	0.49	0.34	0.46	-
Own lake property	0.33	0.50	0.36	-
Own boat	0.64	0.75	0.66	-
Sample Size	746	162	908	-

Note: The sample sizes reported in the table do not precisely match the figures described on the previous page due to item non-response.

our sample, and compares some of the variables to data on Itasca County from the 2010 Census. Comparing the full sample to the census figures we can see that our survey sample is wealthier and better educated than the underlying county population. Although the sample population appears to be younger, this is most likely related to the age brackets used in the actual questionnaire, rather than genuine differences. The household size figures are similar for the sample and population groups.

Table 1 also summarizes data from the survey that are not available from the census, but are relevant for this study. The average respondent was male, in his fifties, owns a boat, and is either working fulltime or retired. In addition, 36 percent of survey respondents report that they own lake shore property. No data are available that report the percentage of Itasca County residents that owns lake shore property, but it is likely to be smaller than the sample percentage. If so this may be an important, additional dimension in which the sample and population differ..

The actual survey consisted of three main components: a section soliciting records of households' use of lakes in the county, a section containing the information and questions needed for the contingent valuation exercise, and a section on household demographics, which is the source for most of the information in table 1. Appendix C contains the full paper-mode survey, including question numbers and images. The question text and layout design is based on similar projects I have worked on for lakes in the southeastern US and in Iowa. The specific Itasca County context was developed in consultation with IWLP members.

Table 2: Lake visits by Itasca County residents

year	mean	std. dev.	median	percent > 0
trips in 2012	16.25	35.81	5	76%
trips in 2013	14.14	33.49	4	73%

Lake use section

The first part of the survey focused on gathering information on respondents' use of lakes in the county. To begin individuals were asked to indicate if they had made any visits to lakes in Itasca County during 2012 and 2013. The focus was on day trips, which were described as involving travel of at least 10 minutes to reach the destination – meaning we asked people to *not* count uses of their home lake if they resided on lakefront property.

Respondents were then asked to report which lakes they had visited. The survey provided a list of 69 major water bodies that people could reference (see Appendix C). For the online version of the survey respondents were given a screen that allowed them to check the lakes they visited in 2012, followed by a similar screen for 2013. Following this the program showed a screen with the short list of visited lakes, and asked people to indicate the number of visits they had made to each visited lake. Finally, people were given the chance to indicate if they had visited non-listed lakes. For the paper version of the survey respondents filled out a table by marking the ID numbers and visit counts for lakes they used in 2012 and 2013. The table also included space for people to write in the names of non-listed lakes they had visited.

The data from the lake use section show that residents of the county are avid lake uses. Table 2 provides summary statistics for residents' aggregate usage. Note that 76 percent of sampled households visited a lake in 2012 and as of the time of survey, 73 percent had visited a county lake in 2013. The median individual made four trips to the county's lakes in the most recent year. By way of comparison, the 2009 National Survey of Recreation and the Environment, a nationally representative study on recreation behavior, found that 36 percent of respondents went fishing, 42 percent went boating, 21 percent used a personal watercraft, and 13 percent hunted. Thus by national standards residents of Itasca County are unusual in their high rate of water-based, and more generally outdoor, recreation. In addition, in the 2011 National Survey of Fishing, Hunting, and Wildlife Associated Recreation, the US Fish and Wildlife Service estimates that 62 percent of Minnesotans fished in 2010 and 19 percent hunted. While not directly comparable these figures suggest that Itasca County residents are active outdoor enthusiasts even compared to other Minnesotans, who are by national standards frequent participants in outdoor activities.

Among the lakes listed in the survey, Pokegama Lake received the highest frequency of visitation in 2013, with 36 percent of respondents reporting having made a trip to the lake. Other lakes receiving a high percent of respondent visits include Trout Lake (Coleraine) at 14 percent, Cut Food Sioux Lake at 12 percent, Deer Lake (Deer River) at 11 percent, and Bowstring Lake at 11 percent.

The survey also asked people to report on their activities and group composition when visiting lakes in the county. Table 3, based on question 5 in the survey, reports break out participation levels in the various activities. Since people could select more than one activity the percentages do not add to one

Table 3: Activities by Itasca County residents on lake visits

Activity	percent yes
Swimming or playing in the water	46%
Fishing or hunting	57%
Motorized boating activities such as waterskiing, jet skiing, or tubing	27%
Non-motorized boating activities such as sailing, canoeing, or kayaking	21%
Nature appreciation of wildlife viewing	53%
Relaxing on or near the water	62%
Using walking trails or other near-shore facilities	33%

hundred. Relaxing on or near the water was the most frequent response, followed by fishing, nature viewing, and swimming or playing in the water. In terms of group composition, nearly half (45 percent) of respondents reported that a typical visit included other adults but no children, eight percent reported visiting alone, and 47 percent typically visited with both children and other adults.

Contingent valuation section

After the recreation participation questions, survey respondents began working through the contingent valuation section, which took up most of the remaining survey pages. Recall from the earlier discussion that contingent valuation is a method in which people are given information about an environmental resource, and then asked to consider whether or not they would pay some amount to improve or maintain its quality. For the Itasca County survey I presented several pages of information on water quality themes, and presented simple attitude and belief questions to help focus people's attention and establish relevant baselines. As discussed below, these latter questions also provide a sense of how knowledgeable residents are about water quality and related issues in the county.

The contingent valuation information was presented incrementally. Immediately following the lake use questions, and before detailed information on water quality was presented, respondents were asked two general questions related to water quality near their home (question #6) and in northern Minnesota (question #7). These were designed to ease people into thinking about an issue that may not be a daily conversation topic, and to establish baselines on respondents' experience with the subject matter. Tables 4 and 5 summarize the sample's answers to these questions.

These preliminary screening questions illustrate that the county population is relatively familiar with water quality issues, and that there is an appreciation for the fact that water quality in the area is currently high. Looking ahead, the three-level rating system introduced in question 6 was also used throughout the later survey pages. Drawing respondents' attention to the system early in the process was intended to help make the later presentation more familiar, and more acceptable.

Table 4: Water quality near home

How would you rate the quality of water in the lake nearest to your home?	Percent selecting
Good	70%
Fair	27%
Poor	3%

Table 5: Water quality in northern Minnesota

How familiar are you with water quality issues in northern Minnesota lakes?	Percent selecting
Very familiar	20%
Somewhat familiar	62%
Not familiar	18%

Following the rating and knowledge queries, the survey presented respondents with a page of information that was used to establish a common set of attributes for defining different lake water quality levels. These attributes included water clarity, the presence of invasive species, the health of fish populations, and the degree to which weed growth and algae blooms are visible. These were selected for their salience, in that they are attributes that people can observe and/or obtain information about, and because they are correlated with objective measures such as nutrient and sediment loadings. The survey used color photos and brief text to define the attributes. After the information was presented people were asked to state their belief on which of the attributes was most important. The sample results are shown in table 6. In general respondents rated the invasive species issue and the general health of fish populations as the most important indicator of water quality in the county, though by and large the four areas were all roughly equivalent in importance.

Table 6: Importance of water quality attributes

Which of the water quality indicators listed above is most important to you?	Percent selecting
Water clarity	23%
Invasive species	30%
Health of fish populations	29%
Weed/algae growth	18%

The next page of the survey was designed to map levels of the water quality attributes shown in table 6 (water clarity, invasive species, etc.) into the three-level quality ranking system that was referenced earlier in the survey (see table 4). The goal here was to establish an objective definition for the good, fair, and poor labels. Specifically, the following definitions were presented:

GOOD:

- Water clarity has not decreased from its natural state
- No invasive species are present
- Fish and other aquatic populations are healthy
- No excess weed or algae growth

FAIR:

- Water clarity has moderately decreased from its natural state
- One or more invasive species are present but effects on the lake are small
- Fish and other aquatic populations are healthy
- Excess weed or algae growth occasionally visible

POOR:

- Water clarity has substantially decreased from its natural state
- One or more invasive species have caused noticeable changes to the lake
- Fish and other aquatic populations have diminished
- Excess weed or algae growth are often visible

After the levels were defined using the four attributes respondents were once again queried about their perception of water quality, this time at the lake that they most recently visited. Table 7 contains a summary of responses to this question (question #10).

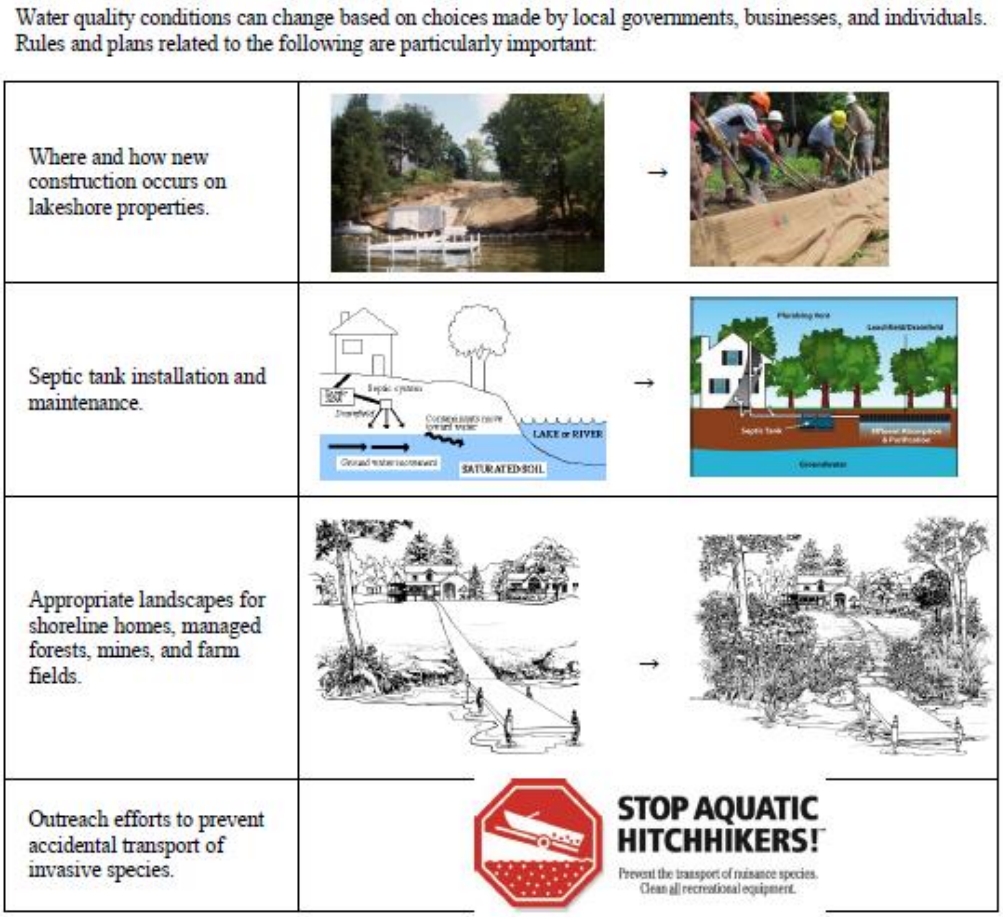
Table 7: Water quality rating at lake most recently visited

How would you rate the quality of water in the lake you most recently visited ?	Percent selecting
Good	62%
Fair	35%
Poor	3%

The percentages in table 7 differ slightly from those in table 4, though the baseline for response is different. More importantly, percentages in table 7 are conditional on the categories described in the survey and therefore are incrementally less subjective than the earlier response.

Questions 7 through 10 and the material surrounding them were intended to communicate the water quality criteria that respondents were to base their answers on in later sections. Beginning with page seven of the survey, the information provision and questioning shifted to focus on the specific context for

Figure 1: Individual and government actions can affect water quality

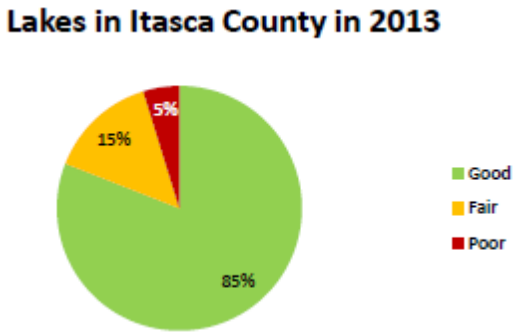


valuation. These pages prepared individuals to think about trading off income for better water quality. To begin, information was given on how different policies or practices can safeguard lake water quality. Graphics and brief text were used to convey the idea that steps such as new construction rules, septic tank maintenance, lake smart landscaping, and invasive species prevention outreach. Figure 1 replicates the information people were given in the survey. After reviewing this information, people were then asked to indicate which of the practices or programs they believed would be most effective at protecting water quality. Table 8 provides a summary of responses.

Table 8: Rating the effectiveness of different policies and practices

Which of the following rules/plans would most effectively protect water quality?	Percent selecting
New construction rules	12%
Septic tank maintenance	36%
Lake smart landscapes	21%
Invasive species outreach	31%

Figure 2: Status quo water quality presented to respondents (current year)



A defining characteristic of economic valuation is the need for specific endpoints. In the context of this survey we needed to establish a baseline level of water quality for lakes in Itasca County, against which any changes from the status quo could be compared. Discussions with IWLP members were used to define the proportion of lakes in the county that could plausibly fit into each of our three categories. Figure 2 illustrates the numbers we used: 85 percent good, 15 percent fair, and 5 percent poor.

To value water quality in the county it was necessary to design a specific, hypothetical change in water quality for people to respond to. The high current level of water quality in the county meant that the only plausible change would involve a decrease in quality. To convey this as a possibility, respondents were given the following text:

"*In spite of existing conservation efforts, continued population growth and shoreline development will lead to changes in the distribution of water quality in the county. One projection suggests the following is possible in 10 years."*

We then provided the graphic shown in figure 3, which presented the future water quality distribution absent additional conservation efforts. The numbers used were 60 percent good, 25 percent fair, and 15 percent poor.

Figure 3: Status quo water quality presented to respondents (10 years from now)

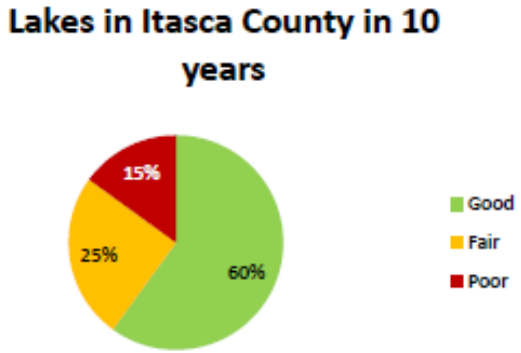


Table 9: How people would be affected by water quality decrease

How much would [the water quality decrease] affect your life?	Percent selecting
Not at all	9%
A little	47%
A lot	44%

Together the information in figures 2 and 3 provided the endpoints for respondents to consider. To help make the idea of a change more salient, question 12 on the survey inquired how much such a change would impact the person's life. Table 9 displays the distribution of response. The sample statistics illustrate that the large majority of people feel they would be affected in some way by a large, albeit seemingly plausible, decrease in water quality in the county.

With the baseline and changed conditions established, the subsequent survey questions focused on presenting a hypothetical, but plausible, local program that was designed to maintain the county's high water quality. The program was presented as involving a portfolio of actions based on the earlier discussion, including:

- Providing help to shoreline residents to upgrade leaky septic systems
- Encouraging shoreline property owners to re-vegetate cleared landscape
- Reducing invasive species transport
- Working with shoreline developers to reduce new construction's impact on lake water quality.

To encourage a sense of reality people were provided with the following text:

> *"Imagine county officials are planning activities designed to protect future water quality in the future called the **Itasca Lakes Preservation Initiative**. Without the program, water quality in Itasca County lakes will get worse…"*

Participants were once again shown the information in figures 2 and 3, to stress the difference that the initiative would make.

The critical component of the contingent valuation section is contained on page 10 of the survey, and centers on question 13. Here people were asked to participate in a simulated local referendum to determine if the policy should be put in place, to be paid for by an increase in peoples' utility bills. The survey section read as follows:

> *Like any local initiative, the Itasca Lakes Preservation Initiative would have a cost for Itasca County residents. Imagine that these costs would be to your utility bills.*
>
> ***The increase in your utility bill would be***
> ***$[amount] per year, or $[amount] per month.***

Although the program is not real, we would like you to think carefully about how you would actually vote in this situation. Please respond as though costs for your household really would go up if the program were implemented. Knowing how different Itasca County residents would vote on this program is very important for future decisions on how lakes in the county are managed….

Only you know what is best for you and your household. Please take a moment to consider both the benefits of the program and the costs to your household as you would any financial decision.

The amounts presented to people varied in the design of the survey, ranging from $36 per year to $360 per year, with equal proportions receiving one of five different bid amounts. Individuals were then asked to vote for or against the program, and present their reasoning. Overall 56.5 percent of respondents voted in favor of the program. Table 10 illustrates how the proportion voting 'yes' varied with the different cost amounts.

Table 10: Percentage of sample voting yes by cost amounts

Annual Increase in Utility Bill	Percent voting 'yes'
$36	68%
$72	68%
$120	57%
$216	52%
$360	39%

Summary statistics on how people voted in the hypothetical referendum reveal several things. First, the fact that the proportion of people voting yes decreases when the annual cost amount rises suggests people are responding to price effects as expected. Evidence to the contrary can be indicative of a poor survey design, and so table 10 provides initial evidence that people accepted the survey scenario and responded in the spirit that was requested. Other summary statistics support this conjecture. For example, people who reported owning lakefront property – presumably those with the most to gain from the program – were more likely to vote in favor of the program than the average respondent. Similarly, people with higher income, higher education, and higher participation in water recreation are more likely to vote yes, which again accords well with theory and intuition. Finally, information on the main reasons that people voted yes or no provides additional reasons for confidence. Following the hypothetical referendum people were asked to report the *most important* reason for their yes or no vote; summaries of their answers are reported in tables 11 and 12, respectively. Among those who voted yes, the sentiment that water quality should be preserved for future generations was by far the most important explanation. When interpreting these figures recall that people can have many reasons for voting yes, and that table 11 only summarizes the most important. Nonetheless, this figure is unusual in my experience with these types of surveys, and it suggests that Itasca County residents have great pride in and concern for their

Table 11: Most important reason person voted 'yes'

Most important reason why a person voted FOR the program	Percent selecting
The program is important and a good use of money for many reasons	16%
Water quality in the county is important for my household's livelihood	5%
Water quality in the county is important for my household's quality of life	11%
Water quality should be preserved for future generations	66%
Other reasons	2%

Table 12: Most important reason person voted 'no'

Most important reason why a person voted AGAINST the program	Percent selecting
The program in general is not a good use of money	8%
I cannot afford the proposed increase in my utility bill, given other expenses	37%
I do not believe water quality in the county will decrease without the program	15%
The costs of the program should be paid by those threatening the lakes, not me	24%
Other reasons	16%

water quality legacy. Among those who voted no, the most important reason was that the person could not afford the proposed increase in their utility bill. It is reassuring that this was frequently selected, because it demonstrates that people did consider their budget constraint when answering the question. This too is generally considered an indicator of a high quality contingent valuation survey. The second most important reason for voting against the program is often referred to in the literature as a 'protest no'. In particular, 24 percent of people voting no did so because they feel they are not responsible for *paying for* preservation – not necessarily because they do not value the resource. In the following section the contingent valuation information is used to provide specific estimates of the economic value that the currently high level of lake water quality provides for county residents.

5) CONTINGENT VALUATION ANALYSIS

In this section I present the basic results from analysis of the contingent valuation data. The analysis makes use of standard statistical techniques that were developed by environmental economists for applications similar to the present one. Appendix D contains information on the technical aspects of the analysis. Here I focus mainly on describing the primary empirical results.

The most basic analysis quantifies the likelihood that a person votes 'yes' on the program as a function of the underlying bid amount that he was presented with. As shown in table 10, summary statistics suggest that a person is less likely to vote in favor of the program as the cost to his household increases. Quantifying the average sample relationship between peoples' votes and their response to the cost variable provides a way of measuring the average willingness to pay to have the program amongst sample members. When I carry out this analysis I find that the mean willingness to pay to have the program – i.e. to prevent a future degradation of water quality in the county – is approximately $260 per resident household per year, with a standard error of $42 and a 95 percent confidence interval with endpoints $181 and $346.

To place this estimate in context recall that the average household income among survey respondents was $56,000 per year, meaning people are willing to part with nearly 0.5 percent of their gross income to prevent the degradation in quality. This is noteworthy when we recall that the quality degradation does not change access conditions or alter the recreation use profile in most of the county's lakes, since even with the modeled degradation, the scenario left nearly two thirds of lakes in good condition.

Additional insights are possible when we consider the aggregate willingness to pay for the quality program amongst county residents. Recall that water quality is a 'good' from which groups of people can simultaneously derive value, meaning we need to sum individuals' willingness to pays in order to obtain an aggregate measure. Section 2 of this document cited information from the census bureau suggesting that there are approximately 19,000 resident households in the county, which implies that Itasca County residents as a group are willing to pay an estimated $4.9 million per year to maintain the county's high level of water quality. Recall that wage and business earnings in the county are $700 million per year. Thus residents of the county derive economic value from continued maintenance of the area's high lake water quality at an annual rate of nearly 1 percent of market earnings.

These figures reflect the willingness to pay to prevent a decrease in water quality at a magnitude shown by figures 2 and 3. While substantial, the requirement that the scenario be viewed as plausible by survey respondents means the change is not large by the standards of other areas in the country, where on average nearly half of lakes have experienced some degradation. With suitable caveats and careful interpretation it is possible to interpolate from the modeled scenario, in order to gain a sense of magnitude for larger degradations. To this end note that the scenario described in the survey begins with a situation in which 95 percent of lakes are in the good or fair category, and moves to a future in which 85 percent of lakes are good or fair. One interpretation of this scenario, therefore, is that Itasca County residents are willing to pay nearly $5 million annually to prevent a permanent ten percent decrease in lake water quality. Interpolating linearly the following magnitudes are plausible and provide additional information on the high value that county residents attach to water quality:

- Annual willingness to pay to prevent a 10 percent decrease in water quality: $5 million
- Annual willingness to pay to prevent a 20 percent decrease in water quality: $10 million
- Annual willingness to pay to prevent a 30 percent decrease in water quality: $15 million
- Annual willingness to pay to prevent a 40 percent decrease in water quality: $20 million
- Annual willingness to pay to prevent a 50 percent decrease in water quality: $25 million

These higher degradation levels imply economic losses from the decrease in quality – or equivalently, economic benefits from maintaining high quality – that are equivalent to 3 to 4 percent of annual market earnings amongst county residents.

It is important to stress two elements of interpretation regarding these estimates. First, the estimates reflect values held by residents of the county for water quality, and generally do not include the value derived by visitors to the county, or the component of visitors' value captured by local businesses. The following section addresses this component of economic value. Second, the estimates are based on changes in water quality, rather than changes in the general availability of lakes in the county for recreation or other uses. Residents' and non-residents' actual use of the lakes under their current (high quality) condition provides information on the overall value of the county's lakes. This overall value depends on the water quality level and other attributes of the lakes. I take up this type of value amongst county residents in section 7.

6) VISITORS' ANALYSIS

The survey described in the previous two sections focused on understanding how Itasca County residents use their county's lakes and value the county's high water quality. As stressed in section 3, however, the value held by county residents constitutes only a portion of the overall economic value provided by the lakes and lake water quality. Visitors to the county also derive benefits from county's high environmental quality and the many outdoor recreation possibilities that the lakes and lake-rich landscape provide. In this section I present evidence from secondary sources and a small intercept survey of visitors to the county, in order to establish a range of magnitudes for the contribution of visitors to the economic value of the county's lake resources.

For context, recall that the report *Evaluation of the Tourism and Development Potential of the Itasca County Area* estimated that there were 1.2 million visitor days to the county in the year 2000. The rough calculation in section 2 based on this estimate implied that 100,000 visiting parties travel to the county each year. In what follows I will use this number as an approximate estimate of the number of 'visitor trips' made to the county each year.

As described in section 3, the travel cost approach is a commonly applied method for measuring a person's willingness to pay to access a recreation site. The basic logic is that at a minimum a person needs to spend the road costs (e.g. gasoline, vehicle depreciation) and travel time (forgone work or leisure time) to reach the destination from his home. Thus the implicit cost of travel provides an estimate of a visiting party's willingness to pay to use the resource.

To understand the travel costs borne by visitors to Itasca County, and hence to estimate their willingness to pay for access to the county's environmental resources, a protocol was designed to sample non-resident visitors to the county during the summer of 2012. Obtaining a representative, specialized sample of this type is one of the more difficult tasks in survey research. With substantial input and advice from IWLP leaders an intercept plan was designed whereby student employees were stationed at retail locations in Grand Rapids that are often frequented by visitors. Three to four students worked morning and afternoon shifts outside the entries of Ogles, Cub Foods, and Walmart over several weekends in July and August of 2012. Their task was to approach shoppers, ask if they were visiting from out of the county, and if so, record their address and other basic information. This protocol provided contact information on a convenience sample of over 100 visiting parties to the county during the summer of 2012.

In spite of the convenience nature of the sample, basic summaries on peoples' travel origins suggest the information is relatively valid. Over 55 percent of the intercepted visitors were from other parts of Minnesota, and over 85 percent were either from Minnesota or traveled from neighboring states such as Iowa, Wisconsin, North Dakota, Illinois, and Michigan. By matching respondents' zip codes to census information provided at the zip code level, it was also possible to estimate each visitor's household income. Finally, global information system (GIS) technology was used to compute the travel distance and travel time based on road networks from the person's reported address to Grand Rapids. These data provide the information necessary to compute and analyze the implicit travel costs borne by the sampled individuals. By way of summary, the median one-way travel distance amongst visitors from Minnesota and the surrounding states was 193 miles, and the median travel time was three hours. Using the zip code level census data the average household income among the out of county visitors was $47,000 annually.

Computing the implicit travel costs for these visitors requires assumptions on the per-mile out of pocket cost of road travel, and the implicit value of travelers' time. For the former I use the recent American Automotive Association (AAA) estimate of $0.40 per mile, which accounts for fuel and depreciation costs. For the implicit value of travelers' time I follow convention in the environmental economics literature and use a fraction of the average wage rate as a proxy for the value of a person's non-work time. In practice I treat household income as if it were generated by a single worker, divide it by 2000 to obtain the average wage, and divide by two to get the implicit value of travel time. This produces an average implicit cost of travel time per hour of $11.78, which is on par with other studies employing richer data sources and more sophisticated analyses. Using these assumptions on the value of travel time and out of pocket road costs, the average round trip travel costs borne by the sample of visitors to reach Grand Rapids was $343. The median travel cost in the sample was $244.

At a first order approximation these figures suggest that the average visiting party is willing to pay at least $343 to obtain access to the leisure and other opportunities provided by the greater Grand Rapids area. If we assume that the primary purpose of trips to the area is to enjoy the area's natural endowment, we can approximate the annual economic value held by out of town visitors for Itasca County's environmental resources as the product of the per visit willingness to pay and an estimate of the annual number of visiting parties. Using the 100,000 visiting party estimate from above, the annual willingness to pay by non-resident visitors to enjoy Itasca County's lakes and related resources is $34.4 million.

There are two things to keep in mind when interpreting this estimate. First, it is an underestimate in the sense that it does not account for the fact that many non-residents value the option of one day visiting Itasca County; our estimate of 100,000 visiting parties reflects only those who have actually made a trip. Similarly, just as residents of Itasca County reported a willingness to pay to preserve water quality for future generations, non-resident visitor and non-visitors may hold this type of value. Second, visitors' willingness to pay travel costs to visit the county is separate from, and additional to, other trip-related spending that might occur upon arrival. These latter expenditures are related to visitors' willingness to pay for access to the resource, and provide a means for local residents to capture some of the economic value held by visiting non-residents. Thus local economic impacts and core economic value are related, but distinct, concepts.

7) RESIDENTS' RECREATION USAGE

In this section I present basic results from analysis of the lake visits data gathered via the Itasca County resident survey. The goal is to provide estimates of the economic value of access to the lakes among county residents. The methodology used is similar to section 6 in that I will apply the travel cost approach, though in this case it will be used to examine visits made by residents to the 69 major lakes listed in the survey (rather than a single destination). As with the contingent valuation analysis, I focus here on providing a summary of findings, and relegate technical aspects to Appendix D.

The premise of the travel cost model in this context is that on a given recreation 'choice occasion' a person decides whether or not to visit a lake in the county. If a visit occurs the person then selects a lake from the available choice set, which in this case includes the 69 named lakes in the survey. The person's decisions are driven by four main factors: her avidity for lake recreation, the distance from her home to the lakes in the choice set, the characteristics of the lakes (e.g. their water quality, public access points, size, game fish populations, congestion levels, etc.), and idiosyncratic factors such as her household structure. The distance to each lake from the person's home, and the road network over which she must travel, determine the travel costs associated with access to each of the lakes in the choice set. For a visit to a particular site, dollar-denominated travel costs are based on the out of pocket cost per mile traveled and the implicit value of time spent in the car. As in section 6, I use the AAA estimate of $0.40 per mile for the former, and one-half of the average hourly wage implied by households' reported income, for the latter.

Estimation of the travel cost model requires detailed information on travel distances and times from each respondent's home to each of the destinations included in the analysis. For this Global Information System (GIS) software was used to match respondents' addresses to latitude/longitude coordinates for each of the 69 lakes, and travel distance and time were computed over the most efficient driving route for each. This process was completed for 831 sampled individuals; these survey respondents provide the information used in the analysis described below. Using the assumptions on the per mile and travel time costs the average round trip computed travel cost across all individuals and destinations in the sample is approximately $57. The average round trip travel cost for observed trips during 2012– i.e. travel that actually occurred – is approximately $28. Recall from section 4 that on average county residents made 16 trips in 2012 and that the median number of trips was five. Three quarters of residents reported visiting a lake during the year. These data were used to estimate the model that provides the basis for value predictions.

If all of the lakes in the choice set were identical outside of their placement in the landscape, visitors would simply select the lake that is nearest their home on each recreation occasion. In reality the lakes differ substantially across many dimensions, including perhaps water quality levels, and in recreation behavior datasets people are often observed traveling further to access destinations with more desirable quality attributes. These tradeoffs observed in the data between travel costs, which people want to minimize, and lake quality attributes that are desired, provide the empirical basis for distinguishing the economic values of the different lakes in the choice set. In the Itasca County context I assume a person has the opportunity to decide whether or not to make a recreation trip to a lake fifty times during the year, corresponding to approximately once per week or, equivalently, twice per week over the open water visitation season. During each choice situation the person decides which alternative will provide the

highest level of satisfaction: visiting one of the 69 lakes, or doing something else. The alternative with the highest satisfaction potential is selected. If she decides to visit one of the lakes she 'pays' the visit cost implicitly via her round trip travel costs. If she decides not to make a visit she does not pay any travel costs, and enjoys the satisfaction of whatever activity is done instead. The satisfaction provided by a visit to a lake *net* of travel costs comes from everything good and bad about that destination: its water quality, catch rates for game fish, presence of boat ramps, scenic beauty, and so on. The model I estimate quantifies both the role of travel cost and aggregate lake characteristics on peoples' choices. This provides two capabilities: we can rank the destinations by their net-of-travel cost quality levels, and compute the annual economic value of access to individual or sets of lakes by examining the ramifications of hypothetically removing them from the set of available choices.

Estimation of the model suggests the following lakes represent the top ten quality destinations, net-of-travel cost: Sugar Lake, Pokegama Lake, Bowstring Lake, Cut Foot Sioux Lake, Dora Lake, Deer Lake, Sand Lake, Trout Lake, Little Cut Foot Sioux Lake, and Little Winnibigoshish. In discussion on the values of individual lakes I will refer to these as the top destinations.

The annual economic value of access to a lake or a set of lakes is reflected in peoples' willingness to pay to maintain them as available options. In what follows I present estimates of specific scenarios that are designed to illustrate such values. In each case the interpretation is ex ante: as a recreation season consisting of fifty choice opportunities approaches, how much would the person pay to maintain the option of selecting the affected lakes? This perspective is appropriate because it reflects the existence of substitute lakes in the willingness to pay calculation.

Consider first the economic value of the individual lakes that were recently the subjects of a detailed water quality assessment: Pokegama and Deer Lakes. The per household willingness to pay to maintain recreation assess to these two lakes is $32 and $19, respectively, where the values are lake specific – i.e. Deer Lake remains available when Pokegama Lake is removed. The estimate for both lakes together is $51 per year. Using the census figure of 19,000 households in the county this implies that access to the two lakes by county residents for recreation trips is worth nearly $970,000 per year.

The figure is larger when we consider the value of access to the set of top destinations in the county. For these the average county resident is willing to pay $149 per year, which translates to an aggregate willingness to pay amongst residents of the county of $2.83 million per year.

Finally I consider the value of access to the full choice set. For this experiment the reference point is that the person loses access to all 69 lakes named in the survey; other lakes in the county and lakes in other parts of the state would still be available. This is an unrealistic experiment that extrapolates too far outside of the context in which the model was estimated to provide genuinely accurate prediction. Nonetheless the estimate is illustrative of the magnitude of value. In particular, this scenario suggests that the per household annual economic value of access to the county's 69 major lakes is in the range of $2600, meaning the aggregate value to county residents is in the range of $49 million per year. Using the earlier-cited estimate of $700 million for annual county income, this means residents derive economic value from the major lakes at a rate equivalent to 7 percent of market earnings.

8) SUMMARY AND CONCLUSIONS

The objective of this study has been to provide estimates of the economic value generated by lakes and lake water quality in Itasca County, Minnesota. The basic paradigm employed came from the field of environmental economics, where the concept of economic value is rooted firmly in the neoclassical economics tradition of using 'willingness to pay' as a reflection of value. Separate estimates were produced for the value of residents and nonresidents' access to the county's lakes for recreation, and the value held by residents for changes in lake water quality. Separate but complementary analysis methods were used to produce these estimates.

The economic benefits provided by the lakes to Itasca County residents were estimated using responses to a survey of county residents that was conducted during the fall of 2013. Information was gathered on recreation trips made to major lakes in the county as well as information on attitudes, beliefs, and values for lake water quality in the county. The survey revealed that county residents are avid users of local lakes, knowledgeable about water quality issues in northern Minnesota, and value the lakes and lake water quality for their own use as well as for the benefit of future generations. In particular, the county's major lakes provide residents with recreation opportunities that generate as much as $49 million per year in annual economic value. This figure was estimated using the travel cost model, which assesses value based on peoples' willingness to travel to access recreation resources. The travel cost model was also used to provide an approximate sense of economic value the county's lakes provide to nonresidents who visit the area. The estimate for this group of lake users is $34.4 million per year. Thus together the resident and nonresident users of the Itasca County lakes generate nearly $85 million per year in economic value. The most recent US census data suggest the aggregate wage and business earnings by Itasca County residents are in the range of $700 million per year. Thus the economic value generated by the recreational use of the county's lakes is equivalent to 12 percent of market earnings in the county.

These figures reflect the value of access for recreation purposes. It is widely acknowledged that the high quality of the natural environment in the county – including the high water quality in its lakes – is a major reason that residents stay in the county, and visitors travel to it. To measure the value of water quality in the county a stated preference approach was used in which survey respondents were asked to react to a hypothetical decrease in water quality across the expanse of the county's lakes. This analysis revealed, for example, that county residents in aggregate would be willing to pay up to $10 million per year to prevent a 20 percent decrease in water quality in lakes in the county, relative to the current high quality that is present. This figure reflects the way that residents' private uses of the lakes would be affected by this quality change, as well as their concerns for how it might affect future generations.

This study has used standard, well-accepted methods developed in the field of environmental economics to quantify the contribution of Itasca County's lakes and lake water quality to residents and non-residents well-being. The methods are fundamentally conservative in that efforts are made to ensure that estimates of willingness to pay – the preferred measure of value – realistically reflect actual income levels in the county. The results are definitive in suggesting that the county's lake resources are a major determinant of economic and cultural value.

Two additional points and caveats are useful for interpreting the estimates. First, the benefits of water quality in the county are non-rival, meaning they can be (and are) enjoyed by a broad cross section of

residents and county visitors. Thus while the value enjoyed by any one person could be small, adding up the many small values leads to a large total, meaning the benefits of high water quality are widely distributed. While this may have favorable equity ramifications, it poses a challenge for policy making when projects must compare seemingly large benefits that are concentrated and concrete, perhaps from lakeshore development projects, to potentially larger benefits that are more abstract and distributed, such as maintaining shorelines in their natural state.

Second, out of necessity the economic benefits quantified in this study do not reflect some sources of value. Nonresidents may have the same type of preservation or bequest motive that was uncovered in the survey of county residents. If so, additional economic value exists that is not counted in the contingent valuation analysis. Economic value is also generated by the use of complementary services such as boat rentals and fishing guides; the value of these services likely depends on the level of water quality. For these reasons the values presented here, though substantial, are likely to be underestimates of the full economic value provided by the Itasca County lakes and lake water quality.

Appendix A: Solicitation Letters and Reminder Postcards

Example letter soliciting participation in the survey via web link
Example letter soliciting participation in the survey through the mail
Example reminder postcards

Itasca Water Legacy Partnership
PO Box 881
Grand Rapids, MN 55744

Date

Address 1
Address 2
Address 3

Dear XXX:

I am writing to invite you to participate in an economic study that examines how people use Itasca County's lakes, and measures the economic value that lake water quality in the county provides. The study is being conducted by researchers at the University of Wisconsin-Madison in conjunction with the Itasca Water Legacy Partnership – a nonprofit organization focused on water issues in Itasca County.

As part of the study we are conducting a survey that will take 10-15 minutes of your time. Accompanying this letter you will find a survey booklet, which we hope you will fill out and return using the included postage-paid envelope.

Your participation in this survey is voluntary. Your responses will be kept confidential and you will in no way be linked to any of the results of the survey. There are no known risks or direct benefits to you from this study. If you have questions about your rights as a research participant, please call the University of Wisconsin Educational Research and Social & Behavioral Science Institutional Review Board Office at 608-263-2320.

It is critical for the accuracy of our results that invited participants complete the survey. As a token of our appreciation for your time we have included $2 with this request. We hope you will be willing to help us with this important research project.

If you have questions about the study please contact Nathan Jones at the University of Wisconsin Survey Center, at 608-890-4724 or nrjones@wisc.edu. You may also contact me, the Principal Investigator for the study, at 608-262-4908 or dphaneuf@wisc.edu.

Sincerely,

Daniel Phaneuf

Prof. Daniel J. Phaneuf
Department of Agricultural and Applied Economics
University of Wisconsin-Madison

P1015SAQ1: <csid>

Itasca Water Legacy Partnership
PO Box 881
Grand Rapids, MN 55744

Date

Address 1
Address 2
Address 3

Dear XXX:

I am writing to invite you to participate in an economic study that examines how people use Itasca County's lakes, and measures the economic value that lake water quality in the county provides. The study is being conducted by researchers at the University of Wisconsin-Madison in conjunction with the Itasca Water Legacy Partnership – a nonprofit organization focused on water issues in Itasca County.

As part of the study we are conducting a survey that will take 10-15 minutes of your time. The survey can be completed on the internet. To complete the survey, please type the following address into your browser:

web address

and enter the code XXXX to access the survey. To make sure our sample is representative the access code can only be used to complete the survey one time.

It is critical for the accuracy of our results that invited participants complete the survey. As a token of our appreciation for your time we have included $2 with this invitation. We hope you will be willing to help us with this important research project. If you have questions about the study please contact Nathan Jones at the University of Wisconsin Survey Center, at 608-890-4724 or nrjones@wisc.edu. You may also contact me, the Principal Investigator for the study, at 608-262-4908 or dphaneuf@wisc.edu.

Sincerely,

Daniel Phaneuf

Prof. Daniel J. Phaneuf
Department of Agricultural and Applied Economics
University of Wisconsin-Madison

p1015WEB1: <csid>

Postcard reminder – paper version

Not long ago we sent you a questionnaire asking you about your use and attitudes towards Itasca County lakes. We need your help to learn more about how those living in Itasca County use lakes in the county for recreation and how they value lake water quality.

Please take a few minutes to complete the questionnaire and return it in the provided postage-paid envelope. Your input is very important. If you've already returned your questionnaire, please accept our thanks for helping us with this important study.

If you have any questions about the survey, please contact Nathan Jones at nrjones@ssc.wisc.edu or 608-890-4724.

Sincerely,

Daniel Phaneuf

Prof. Daniel J. Phaneuf
Department of Agricultural and Applied Economics
University of Wisconsin-Madison

Postcard reminder – online version

Not long ago we invited you to participate in an online survey asking you about your use and attitudes towards Itasca County lakes. We need your help to learn more about how those living in Itasca County use lakes in the county for recreation and how they value lake water quality.

Please take a few minutes to complete the online survey. Your input is very important. If you've already completed the survey, please accept our thanks for helping us with this important study.

If you have any questions about the survey, please contact Nathan Jones at nrjones@ssc.wisc.edu or 608-890-4724

Sincerely,

Daniel Phaneuf

Prof. Daniel J. Phaneuf
Department of Agricultural and Applied Economics
University of Wisconsin-Madison

Appendix B: Sample Description and Response Rate Report

Sample description and response rate report for Itasca County Lakes Survey, provided by The University of Wisconsin Survey Center.

UWSC
UNIVERSITY of WISCONSIN
SURVEY CENTER

SAMPLE DESCRIPTION AND RESPONSE RATE REPORT FOR
Itasca County Lakes Survey
P1015

JANUARY 15, 2014

1. The University of Wisconsin Survey Center

The UW Survey Center (UWSC) was hired in July 2013 to conduct the Itasca County Lakes Survey for Dr. Daniel Phaneuf of the University of Wisconsin-Madison.

The UW Survey Center (UWSC) is a department of the College of Letters and Science at the University of Wisconsin-Madison, and is supported by the College and revenue generated from contractual work. The UWSC serves the survey research needs of University of Wisconsin faculty, staff, and administration; faculty at other universities, federal, state, and local governmental agencies and not-for-profit organizations. The mission of the Survey Center is to assist researchers by providing the highest quality survey research services and as such, the Survey Center provides the complete range of survey research capabilities. Professor Nora Cate Schaeffer is the Faculty Director of the UW Survey Center. Dr. Nathan Jones and Griselle Sánchez served as Project Directors on this project.

2. Sample Description

The goal of this project was to examine how people use Itasca County's Lakes, and measure the economic value that lake water quality in the county provides. The respondents for the survey were obtained from an address-based sample of households in Itasca County, Minnesota.

Sample for the survey was purchased by UWSC from AVP Social Science Research, Marketing Systems Group. The sample was composed of 2,000 residential, mailable addresses in Itasca County, Minnesota. The sample company was asked to remove from consideration addresses designated *seasonal* or *vacant*, but not *throwbacks* (rural addresses that have a residential format, but receive their mail at a post office box). The sample company also attempted to match names with the addresses selected for the sample and were successful for 90% of households (200 households were not matched). This result was somewhat better than expected as the sampling company had suggested 85% successful name matching was typical.

Sample members were randomly assigned to one of two modes for survey administration, half by mail and half by web. They were also randomly assigned to one of 5 versions of the instrument, each with different bid amounts.

3. Survey Procedures

The final survey design consisted of a Web-Mail experiment, with half of the sample recruited to a web survey and half to a mail survey.

For the Web portion the design included:

- Wave 1: Full mailing to 2,000 randomly selected USPS addresses in Itasca County, MN including a cover letter with URL and user name and password for accessing the web survey, and a $2 cash pre-incentive.
- Wave 2: Postcard Reminder
- Wave 3: Full mailing to those respondents who had not completed the Web survey 4 weeks after postcard mailing. This included cover letter, first class postage paid return envelope, and 12-page survey.

For the Mail portion the design included:

- Wave 1: Full mailing to 2,000 randomly selected USPS addresses in Itasca County, MN including cover letter, first class postage paid return envelope, $2 cash pre-incentive and 12-page survey.
- Wave 2: Postcard Reminder
- Wave 3: Full mailing to those respondents who had not returned the survey 4 weeks after postcard mailing. This included cover letter, first class postage paid return envelope, and 12-page survey.

4. Survey Administration Details

The mailing of survey invitation/packets and postcards occurred on the following dates:

November 1, 2013 - Wave 1 Survey invitation to Web portion (1,000) posted
November 4, 2013 - Wave 1 Survey packet to Mail portion (1,000) posted
November 8, 2013 - Wave 2 Postcard reminder (2,000) posted
December 6, 2013 - Wave 3 Survey Packet to both Web and Mail portions (1,357) posted

Respondents to Web survey completed the survey online. Respondents to the mail survey mailed completed surveys to the UWSC in the postage paid envelope provided, where trained data entry operators entered the responses into a Web programmed data entry instrument. UWSC will archive and maintain the SPSS data set in our computer archives, and hard copy surveys will be archived for the required 7 year storage.

5. Response Rate

Web Survey

At the time of the second mailing, 159 sample members had completed the online survey, and 28 invitations had been returned undeliverable. The remaining 812 non responders originally assigned to the Web group were followed up with a paper questionnaire. 5 more participants completed the survey online as a follow up to the paper mailing. At the close of data collection 71 were not deliverable by the USPS and 13 refused to participate. 4 additional cases completed partial web surveys. Data for these cases has been delivered but are not included as completes in the response rate report.

Response rates have been calculated below both for initial web invitation group and for the subsequent paper questionnaire follow.

Web/Mail Mixed Sample Disposition & Response Rate

	Number in Sample	Number of Completed Surveys	Number of Confirmed Ineligible	Number of Undeliverable Invitations to Web Survey	Response Rate
Web Invitation	1000	164		28	16.9%
Switched Mode	812	232		43	30.2%
Overall	1000	396		71	42.6%

The response rate was calculated using the following formula:

$$\text{Response Rate} = \frac{\text{completed surveys}}{\text{Total N} - [\text{ineligible members} + \text{undeliverable surveys}]}$$

$$= \frac{396}{1000 - 71}$$

$$= 42.6\%$$

Mail Survey

At the close of data collection, 519 Mail only sample members had returned completed surveys, 66 were not deliverable by the USPS, 13 refused to participate, 1 was noted as deceased, and 1 was noted as physically or mentally unable to participate. Several (n=11) respondents removed the case identification number from their survey before returning it. Typically, such responses are not included as completed surveys for the purpose of a response rate report; however, because this survey used an address-based sample and specified that mail should not be forwarded by the USPS, we can be reasonably confident that respondents who returned surveys have an address in Itasca County, MN. Data from de-identified surveys are included in the data set with case id's in the 8000 range.

Mail Only Sample Disposition & Response Rate

	Number in Sample	Number of Completed Surveys	Number of Confirmed Ineligible	Number of Undeliverable Surveys	Response Rate
Mail Survey	1000	519	2	66	55.7%

The response rate was calculated using the following formula:

$$\text{Response Rate} = \frac{\text{completed questionnaires}}{\text{Total N} - [\text{ineligible members} + \text{undeliverable surveys}]}$$

$$= \frac{519}{1000 - 68}$$

$$= 55.7\%$$

Overall Sample Disposition & Response Rate

	Number in Sample	Number of Completed Surveys	Number of Confirmed Ineligible	Number of Undeliverable Surveys	Response Rate
Overall	2000	901	2	137	48.4%

The response rate was calculated using the following formula:

$$\text{Response Rate} = \frac{\text{completed questionnaires}}{\text{Total N} - [\text{ineligible members} + \text{undeliverable surveys}]}$$

$$= \frac{901}{2000 - 139}$$

$$= 48.4\%$$

This report was prepared by Dr. Nathan Jones and Griselle Sánchez, Project Directors, University of Wisconsin Survey Center, University of Wisconsin-Madison, 475 N. Charter St., Madison, WI 53706.

Appendix C: Survey Vehicle

This appendix contains the paper survey, displaying its layout and associated images. The online version was similar in content but different in some presentation details.

Itasca County Lakes Survey 2013

Thank you for agreeing to take this survey. In the following pages we will ask you questions about lakes and lake water quality in Itasca County. Your answers will help researchers and local officials make decisions on managing the County's water resources.

1. Are you a year round resident of Itasca County?

◯ Yes
◯ No

Trips to Visit Lakes in the County

2. The following questions are about single-day trips you have taken to visit lakes in Itasca County. By single-day trips, we mean visits where you:

- traveled at least 10 minutes from home and did not spend the night away
- you went in the water, used a boat, or stayed on shore

If your primary residence is on a lake please do not count uses of your home lake as trips.

Did you take any single-day trips where the primary purpose was to spend time in or near a lake in Itasca County in 2012?

◯ Yes
◯ No

3. Have you taken any single-day trips where the primary purpose was to spend time in or near a lake in Itasca County in 2013?

◯ Yes
◯ No

If you answered no to BOTH of these questions, please skip to Question 9 on Page 5 – "Information on Lake Water Quality in Northern Minnesota".

List of Itasca County Lakes

ID #	Lake Name
1.	Ball Club Lake
2.	Balsam Lake
3.	Bass Lake (near Cohasset)
4.	Bear Lake
5.	Bello Lake
6.	Blackwater Lake
7.	Blandin Lake
8.	Bluewater Lake
9.	Bowstring Lake
10.	Buck Lake (near Nashwauk)
11.	Burrows Lake
12.	Coon Lake (near Effie)
13.	Coon-Sandwick Lake
14.	Crooked Lake (near Marble)
15.	Cut Foot Sioux Lake
16.	Cutaway Lake
17.	Decker Lake
18.	Deer Lake (near Deer River)
19.	Dixon Lake
20.	Dora Lake
21.	Grave Lake
22.	Gunn Lake
23.	Hart Lake
24.	Irma Lake
25.	Island Lake (near Northome)
26.	Jack the Horse Lake
27.	Jay Gould Lake
28.	Jessie Lake (near Talmoon)
29.	Johnson Lake (near Grand Rapids)
30.	Kenogama Lake
31.	King Lake
32.	Lawrence Lake (near Taconite)
33.	Little Bowstring Lake
34.	Little Cut Foot Sioux Lake
35.	Little Jessie Lake (near Deer River)
36.	Little Long Lake (near Grand Rapids)
37.	Little Sand Lake (near Squaw Lake)
38.	Little Turtle Lake
39.	Little White Oak Lake
40.	Little Winnibigoshish Lake
41.	Long (Main Bay) Lake
42.	Moose Lake (near Deer River)
43.	Morph Lake
44.	Natures Lake
45.	North Star Lake
46.	O'Brien Reservoir Lake
47.	Pickerel Lake
48.	Pigeon Dam Lake
49.	Pokegama Lake
50.	Portage Lake
51.	Prairie Lake (near Grand Rapids)
52.	Round Lake (near Squaw Lake)
53.	Rush Island Lake
54.	Sand Lake (near Squaw Lake)
55.	Shallow Lake (near Warba)
56.	Shoal Lake
57.	Siseebakwet Lake
58.	Spider Lake
59.	Split Hand Lake
60.	Stingy Lake
61.	Sugar Lake
62.	Swan Lake
63.	Thistledew Lake
64.	Trout Lake (near Coleraine)
65.	Turtle Lake
66.	Wabana Lake
67.	Wasson Lake
68.	White Oak Lake
69.	Whitefish Lake

4. Now we will ask you about the specific lakes you visited in 2012 and so far in 2013.

To assist you we have included a list of names and ID numbers for popular lakes in the county on the previous page. When you answer the question below, please use the ID number for lakes on the list. For lakes you visited that are not on the list, please write the lake name at the bottom of the table.

Which lakes did you visit in 2012 and so far in 2013 and how many times did you visit in each year?

	Lake ID number for visited lake	Number of visits in 2012	Number of visits in 2013
a.	__ __	#	#
b.	__ __	#	#
c.	__ __	#	#
d.	__ __	#	#
e.	__ __	#	#
f.	__ __	#	#
g.	__ __	#	#
h.	__ __	#	#
i.	__ __	#	#
j.	__ __	#	#
k.		#	#
l.		#	#
m.		#	#
n.		#	#

5. On these single-day trips, did you participate in any of the following recreational activities?

	Yes	No
a. Swimming or playing in the water	◯	◯
b. Fishing or hunting	◯	◯
c. Motorized boating activities, such as waterskiing, jet skiing, or tubing	◯	◯
d. Non-motorized boating activities, such as sailing, canoeing, or kayaking	◯	◯
e. Nature appreciation or wildlife viewing	◯	◯
f. Relaxing on or near the water	◯	◯
g. Using walking trails or other near-shore facilities	◯	◯
h. Other → Please tell us:	◯	◯

6. On these single-day trips, who usually went with you?

◯ No one
◯ One or more other adult
◯ One or more other people

7. Based on your current understanding of water quality, how do you rate the quality of water in the Itasca county lake nearest to your home?

◯ Good
◯ Fair
◯ Poor

8. How familiar are you with water quality issues in northern Minnesota lakes?

◯ Very familiar
◯ Somewhat familiar
◯ Not familiar

Many factors affect people's perceptions of water quality, including:

Water clarity	 A test for water clarity
Invasive species • Asian Milfoil • Zebra Mussels	 A common source of invasive hitchhikers
Health of fish populations	 Most game species prefer cleaner water
Weeds and algae	 Run off from septic tanks and fertilizer can cause excess growth

9. Which of the water quality indicators above is most important to you?

◯ Water clarity
◯ Invasive species
◯ Health of fish population
◯ Weed/algae growth

Water Quality in Itasca County

Itasca County has some of the best lake water quality in the state. Some individual water bodies are nonetheless degraded and a range of quality conditions are present.

In the following pages we will refer to a three level categorization of lake water quality in the county:

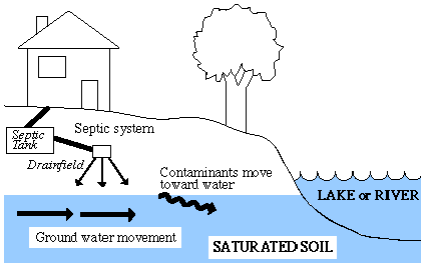
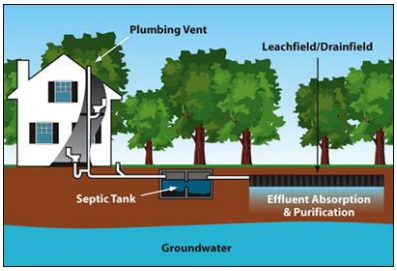
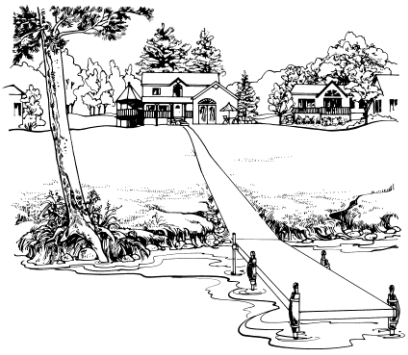
A lake is **GOOD** if • Water clarity has not decreased from its natural state. • No invasive species are present. • Fish and other aquatic populations are healthy. • No excess weed or algae growth.	
A lake is **FAIR** if: • Water clarity has moderately decreased from its natural state. • One or more invasive species are present but effects on the lake are small. • Fish and other aquatic populations are healthy. • Excess weed or algae growth occasionally visible.	
A lake is **POOR** if: • Water clarity has substantially decreased from its natural state. • One or more invasive species have caused noticeable changes to the lake. • Fish and other aquatic populations have diminished. • Excess weed or algae growth are often visible.	

10. How would you rate the quality of water in the Itasca County lake you visited most recently in 2013 (or this year)?

◯ Good
◯ Fair
◯ Poor

Regulations and policies that can affect water quality in Northern Minnesota

Water quality conditions can change based on choices made by local governments, businesses, and individuals. Rules and plans related to the following are particularly important:

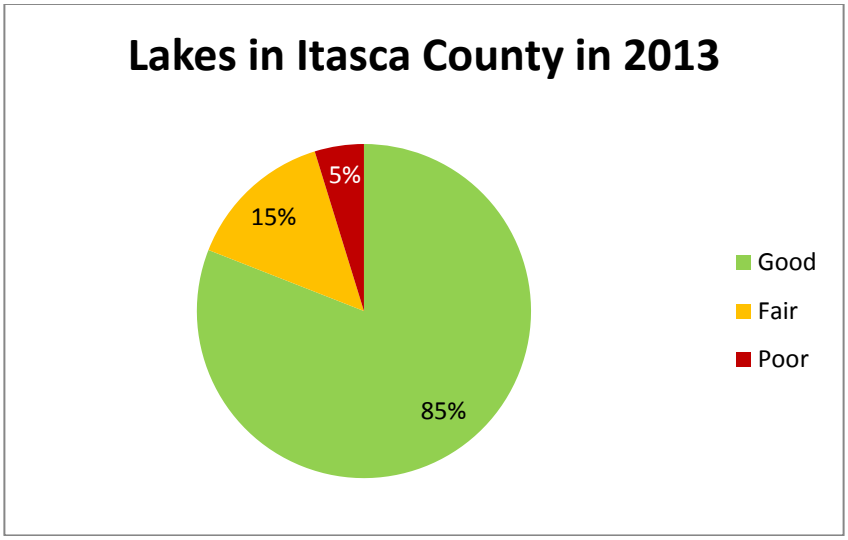
Where and how new construction occurs on lakeshore properties.	 → 
Septic tank installation and maintenance.	 → 
Appropriate landscapes for shoreline homes, managed forests, mines, and farm fields.	 → 
Outreach efforts to prevent accidental transport of invasive species.	

11. Which of these rules and plans do you think would most effectively protect water quality?

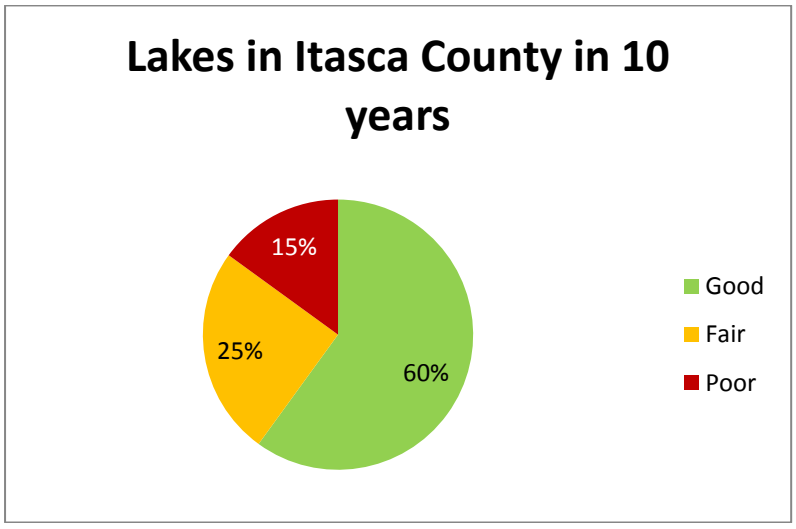
- ◯ New construction rules
- ◯ Septic tank maintenance
- ◯ Lake smart landscapes
- ◯ Invasive species outreach

Current and Future Water Quality Conditions

Water quality in the county is assessed on an ongoing basis by several organizations. The quality is very good in most lakes. Current water quality in Itasca County lakes is categorized as follows:



In spite of existing conservation efforts, continued population growth and shoreline development will lead to changes in the distribution of water quality in the county. One projection suggests the following is possible in 10 years:



12. How much would this kind of change in water quality affect your life?

◯ Not at all
◯ A little
◯ A lot

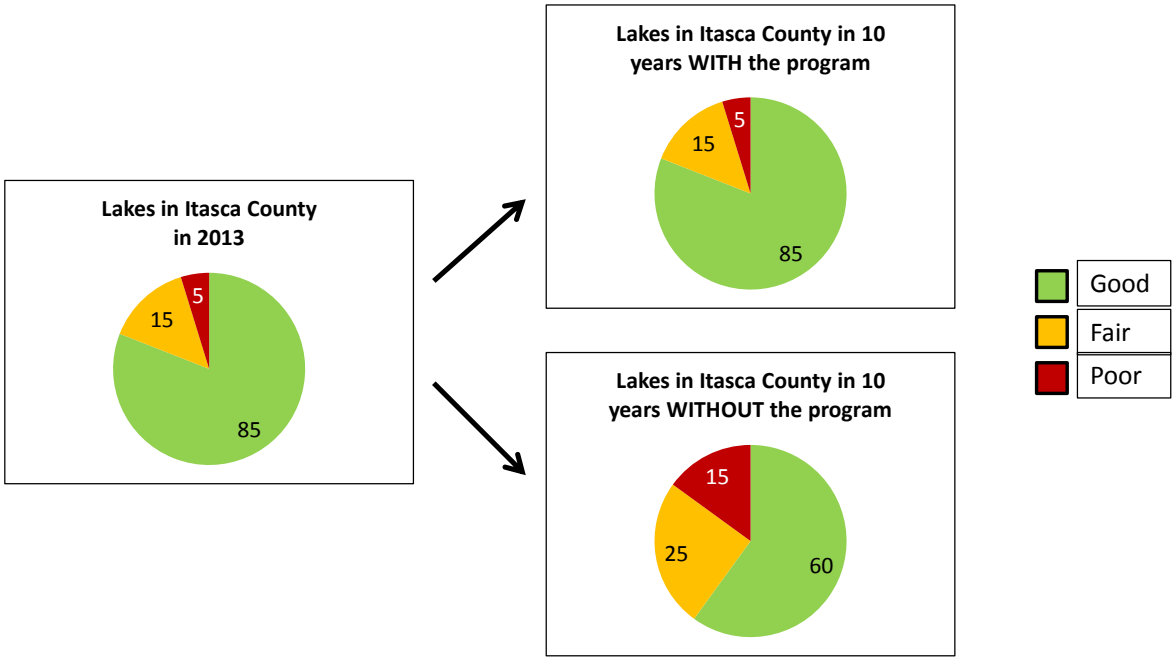
Future water quality programs

In following questions, please assume that water quality will deteriorate WITHOUT a new water quality program and that water quality can only be maintained at today's levels WITH a new program. Examples of steps that could be taken include:

- Providing help to shoreline residents to upgrade leaky septic systems.
- Encouraging shoreline property owners to re-vegetate cleared landscapes.
- Reducing invasive species transport.
- Working with shoreline developers to reduce new construction's impact on lake water quality

Imagine county officials are planning activities designed to protect lake water quality in the future called the **Itasca Lakes Preservation Initiative**. Without the program, water quality in Itasca County lakes will get worse. The diagram below compares the projected lake conditions in 10 years with and without the program.

Projected changes WITH and WITHOUT
Itasca Lakes Preservation Initiative



How Much Would the Program Cost My Household?

Like any local initiative, the **Itasca Lakes Preservation Initiative** would have a cost for Itasca County residents. Imagine that these costs would be to your utility bills.

The increase in your utility bill would be
(variable $AMOUNT) per year, or ($AMOUNT/12) per month.

Although the program is not real, we would like you to think carefully about how you would actually vote in this situation. Please respond as though costs for your household really would go up if the program were implemented. Knowing how different Itasca County residents would vote on this program is very important for future decisions on how lakes in the county are managed.

Reasons for voting **YES**	Reasons for voting **NO**
• Importance of lake water quality for your family's outdoor activities. • Importance of lakes for the county's tourism industry. • Desire to maintain water quality for future generations.	• Less money for other things or not being able to afford a higher utility bill. • Funds are better spent on other priorities such as schools, roads, or healthcare. • Degradation of the county's lakes is not an important issue.

Only you know what is best for you and your household. Please take a moment to consider both the benefits of the program and the costs to your household as you would any financial decision.

Ask yourself whether you believe the **Itasca Lakes Preservation Initiative** is worth $AMOUNT each year to your household.

13. If the vote were held today, how would you vote?

◯ FOR the program
◯ AGAINST the program → **Go to question 15**

14. To help us better understand your answer please indicate the most important reason why you would vote FOR the program:

◯ The program is important and a good use of money for many reasons
◯ Water quality in the county lakes is important for my household's livelihood
◯ Water quality in the county lakes is important for my household's quality of life
◯ Water quality should be preserve for future generations
◯ Other reason → Please tell us: _____

Please go to question 16

15. To help us better understand your answer please indicate the most important reason why you would vote AGAINST the program:

- ◯ The program in general is not a good use of money
- ◯ I cannot afford the proposed increase in my utility bill, given my other expenses
- ◯ I do not believe water quality in the county will decrease without the program
- ◯ The costs of the program should be paid by those threatening the lakes, not by me
- ◯ Other reason ⟶ Please tell us: _____

16. How confident are you that this is how you would vote?

- ◯ Not confident at all
- ◯ A little bit confident
- ◯ Somewhat confident
- ◯ Very confident
- ◯ Extremely confident

About You and Your Household

The following questions will help us better understand how household characteristics affect lake usage and attitudes in Itasca County.

17. What is your age?

- ◯ 18-25
- ◯ 26-34
- ◯ 35-49
- ◯ 50-59
- ◯ 60-75
- ◯ 76+

18. What is your gender?

- ◯ Male
- ◯ Female

19. What is the highest level of schooling you have completed? (*please check only one*)

- ◯ Some high school or less
- ◯ High school graduate
- ◯ Some college or trade/vocational school
- ◯ College graduate
- ◯ Advanced degree

20. How many adults (including you) live in your household?

☐ Number of adults in your household

21. How many children under 18 live in your household?

☐ Number of children in your household

22. What is your current employment status?

- ◯ Full time
- ◯ Part time
- ◯ Student
- ◯ Retired
- ◯ Unemployed or not working

23. Do you own lakeshore property in Itasca County?

- ◯ Yes
- ◯ No → **Go to question 25**

24. On which Itasca County lake do you own lakeshore property?

25. Do you own a boat that you use on Itasca County lakes?

- ◯ Yes
- ◯ No

26. What was your total household income in 2012, before taxes and from all sources?

- ◯ Less than $25,000
- ◯ $25,000 - $49,999
- ◯ $50,000 - $74,999
- ◯ $75,000 - $99,999
- ◯ $100,000 or more

Thank you for completing this survey!

Please return it in the enclosed postage-paid envelope to:
University of Wisconsin Survey Center
475 North Charter Street
Sterling Hall, Room B607
Madison, WI 53706-1507

V1

Appendix D: Technical Material

Contingent valuation analysis

The basic modeling assumption for binary choice contingent valuation data is that a respondent selects the alternative providing the highest utility, or well-being, level. Analysis requires a parametric specification for the deterministic components of the two conditional utility functions and an assumption on the distribution of the random component of the utility functions. I follow standard practice and specify the conditional utility functions as

$$\begin{aligned} U_{i1} &= \alpha + \beta(y_i - p_i) + \gamma X_i + \varepsilon_{i1} \\ U_{i0} &= \beta y_i + \varepsilon_{i0}, \end{aligned} \tag{D1}$$

where y_i is annual household income, p_i is the cost to household i of the hypothetical program, X_i holds variables describing the household such as education or wealth levels, and Greek letters are parameters to be estimated. The subscript '1' denotes the utility received when the person selects (and pays for) the program to protect water quality and the subscript '0' denotes the status quo. A person votes 'yes' when presented with the referendum if choice if

$$\alpha + \beta(y_i - p_i) + \gamma X_i + \varepsilon_{i1} \geq \beta y_i + \varepsilon_{i0} \tag{D2}$$

– i.e. utility with the program is larger than the status quo utility level. Given values for the utility function parameters, an estimate of person i's willingness to pay for the program is given by

$$WTP = \left(\alpha + \gamma X_i\right)\beta^{-1}.$$

For the main results presented in section 5, I use the simplest specification, so that $WTP=\alpha/\beta$.

Estimation of the unknown parameters is by maximum likelihood. Once again following standard practice, I assume that ε_{i0} and ε_{i1} are distributed type I extreme value, so that the probability of observing a person voting 'yes' on the referendum is

$$\Pr_{i1} = \frac{\exp(\alpha - \beta p_i + \gamma X_i)}{1 + \exp(\alpha - \beta p_i + \gamma X_i)}. \tag{D3}$$

Equation (D3) provides the information needed to construct the likelihood function, and maximization of the likelihood function provides estimates of the utility function parameters.

Table D1: Estimation results from contingent valuation models

parameter	Basic Model	Alternative 1	Alternative 2
constant (α)	0.8832	0.6108	0.5362
	(7.23)	(3.05)	(1.79)
price (β)	-0.0037	-0.0041	-0.0039
	(-6.24)	(-6.47)	(-5.15)
wealth (γ_1)		0.0076	0.0041
		(2.62)	(1.17)
log(trips) (γ_2)			0.1563
			(2.06)

Note: z-statistics in parenthesis.

Table D1 provides a summary of estimation results for three model specifications. In each case the effect of price is negative as expected (i.e. a higher price makes the program less attractive). In alternatives 1 and 2 we also see that higher wealth (represented by annual income) makes the water quality program more attractive, and that people who take more recreation trips to lakes in the county are more likely to favor the program. The solid statistical and intuitive properties of the estimated parameters lend credibility to the predictions described in section 5.

Recreation analysis for county residents

The basic modeling assumption for the resident recreation analysis in section 7 is that on a given choice occasion the person selects the alternative providing the highest utility level. The utility functions for the 70 alternatives are given by

$$\begin{aligned} U_{ijt} &= \delta_j - \eta p_{ij} + \varepsilon_{ijt}, \quad j = 1,...,69 \\ U_{i0t} &= \delta_0 + \varepsilon_{i0t}, \end{aligned} \tag{D4}$$

where options j=1,…,69 denote the utility levels available from a visit to one of the 69 lakes in the choice set, p_{ij} is the travel cost for person i to lake j, j=0 indexes the no trip option, and there are t=1,…,50 choice occasions. The parameter η measures the disutility of travel cost, while the parameters δ_j for j=0,…,69 capture the utility from the attributes (e.g. water quality) that are associated with alternative j. Estimation of the utility function parameters is again by maximum likelihood, and is based on the assumption that ε_{ijt} is distributed type I extreme value. The probability that person i selects alternative j on choice occasion t is given by

$$\Pr_{ijt} = \frac{\exp(\delta_j - \eta p_{ij})}{\sum_{k=0}^{J} \exp(\delta_k - \eta p_{ik})}. \tag{D5}$$

Equation (D5) provides the equations needed to construct the likelihood function, and maximization of the likelihood function provides estimates of the utility function parameters. The willingness to pay estimates are built up using the following formula derived from the estimated parameters:

$$EU = \ln\left(\sum_{j=0}^{69} \exp(V_j)\right), \tag{D6}$$

where $V_j=\delta_j-\eta p_{ij}$ for j=1,…,70 and $V_0=\delta_0$. For example, the willingness to pay to maintain the last three lakes in the choice set (i.e. j=67, 68, 69) in the available set is

$$WTP = \frac{1}{\eta}\left[\ln\left(\sum_{j=0}^{69} \exp(V_j)\right) - \ln\left(\sum_{j=0}^{66} \exp(V_j)\right)\right]. \tag{D7}$$

Estimation of the model resulted in η=0.0447 (z-statistic=30.30), and values for the δ_j's ranging from (−13.91) to (−1.10), where δ_0 is normalized such that δ_0=0.