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Buffernomics: Assessing Willingness to Pay for Lake Conservation on North Pond and East Pond

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ABSTRACT

Hedonic property valuations in Maine have estimated that a one-meter decrease in water clarity can reduce shoreline property values by 4 to 16%. To avoid a loss on their lakefront investment, shoreline property owners have a particularly large incentive to conserve lake water quality. Nevertheless, while some shoreline residents voluntarily install vegetated buffers and actively participate in lake stewardship, others continue to ignore shoreline zoning laws at the expense of lake health. In this thesis, I examine the dichotomy of active and indifferent shoreline residents by analyzing the motivations that distinguish residents who are willing to pay (WTP) for and participate in lake conservation from those who are not. To do so, I designed and implemented a contingent valuation (CV) survey of shoreline residents on two lakes with different water qualities: East Pond and North Pond. The survey, delivered to the permanent addresses of 89 shoreline residents, yielded an effective response rate of 44% (N=39). I performed a non-parametric analysis to assess three categories of potential determinants of WTP, including demographic characteristics, lake water quality, and perceptions of lake water quality. The results reveal that income, age, lake association membership, and water quality perceptions were the most significant determinants of willingness-to-pay for lake conservation. The findings of this study suggest that using a more targeted approach for stakeholder engagement and increasing lake association membership are important for effective water quality conservation on East Pond and North Pond. Furthermore, this study creates a survey model that Maine's lake conservation organizations and lake associations can use to better understand how to motivate residential lake stewardship.

ACKNOWLEDGEMENTS

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INTRODUCTION

Maine's clean lakes are an essential resource for its inhabitants. They support aquatic life, provide the state with 64% of its public drinking water, attract tourists from in and out of state, and generate $2.5 billion annually in total direct expenditures (Michael et al. 1996; MBPL 2009; Tolman 2010; MDEP 2010). However, these ecological and economic benefits are being compromised by residential development. According to the Maine Department of Environmental Protection (MDEP) residential districts impair 35,477 lake acres, and are the second largest source of lake impairment in Maine (MDEP 2010). Impairment is defined as the failure to attain the water quality standards established by the US Environmental Protection Agency (MDEP 2010).

Residential development, in the form of fertilized lawns, chemical-covered roads, and aged septic systems, produces large amounts of phosphorus and nitrogen. When these nutrients wash into nearby lakes, the result is cultural eutrophication—the growth of algae associated with excessive nutrient loads from anthropogenic sources (MVLMP 2009). By depleting dissolved oxygen and decreasing water clarity, prolific algal growth threatens aquatic life, lake recreation, and shoreline property values (Boyle et al. 1999; MBPL 2009). Consequently, in addition to the 30 Maine lakes that are already impaired, 244 are at risk from current and future development (MRS Title 38 §420-D 1995; MDEP 2010).

In many ways the problem of lake impairment and residential development fits the paradigm of public environmental goods and economic externalities. In other words, residents do not have to pay the full cost of using lakes as waste reservoirs for the phosphorus they emit (Hartwick and Olewiler 1998). The "full cost" includes reduced water quality, biodiversity loss, and inferior recreation, and is shared among all lake-users. However, the cost is not shared equally; since the cost of lake pollution is partially internalized within lakefront property prices, shoreline residents absorb a disproportionate amount of the burden (Michael et al. 1996; Boyle et al. 1999, Poor et al. 2007).

Hedonic property valuations in Maine have estimated that a one-meter decline in water quality as measured by the secchi disk can reduce shoreline property values by 4 to 16% (Michael et al. 1996; Boyle et al. 1998). Therefore, to avoid a loss on their lakefront investment, shoreline property owners have a particularly large incentive to conserve lake water quality. One of the easiest ways to participate in lake conservation is to create a vegetated buffer between their property and the lake. A vegetated buffer is an undeveloped area adjacent to the water, comprised of native trees, shrubs, and/or groundcover, that infiltrates phosphorus and nitrogen run-off (BLWQ 2011).

Nevertheless, while some shoreline residents voluntarily create vegetated buffers and actively participate in lake stewardship, others continue to fertilize their lawns and develop their lakeshore at the expense of lake health. This presents a complex challenge for local conservation organizations and lake associations looking to improve lake water quality. In this thesis, I seek to better understand the dichotomy of active and indifferent shoreline residents by analyzing the motivations that distinguish residents who are willing to pay for and participate in lake conservation from those who are not.

Using two of Maine's Belgrade lakes (East Pond and North Pond) as case studies, I designed a contingent valuation (CV) survey to elicit shoreline residents' willingness to pay (WTP) for conservation projects that protect and improve water quality. I then assessed four broad categories of potential determinants of WTP, including lake association membership, demographic characteristics, lake water quality, and perceptions of lake water quality. These categories represent some of the motivators of environmental stewardship defined in past studies by environmental psychologists, managers, and economists (Cooper et al. 2004; Bateman et al. 2006; Story and Forsyth 2008; Del Saz-Salazar et al. 2009; Steg and Vlek 2009; Kreutzwiser et al. 2011). In combination, my analysis begins to create a model for "buffernomics", the study of how much and why residents are willing to pay for lake conservation (e.g. vegetated buffers) that will either maintain or improve lake water quality. In this model, buffers are the currency used to buy water quality improvements.

The rest of this paper is organized as follows. I first review past studies on pro-environmental behavior and contingent valuations of lake and river water quality, and summarize the research questions that remain unanswered. I then describe my case studies (East Pond and North Pond), including their historical water quality and demographic profiles. Next, I present my methodology and survey design, which is followed by a summary of the results of my survey of shoreline residents. Finally, I present my conclusions and discuss recommendations for watershed conservation groups, lake associations, and lake-town municipalities in Maine.

LITERATURE REVIEW

Pro-Environmental Behavior

Motivations for environmental stewardship, defined by USEPA as "the responsibility for environmental quality shared by all those whose actions affect the environment" (USEPA 2011), have been widely studied by environmental psychologists, economists, planners, and managers. Past environmental value studies have indicated that age, education, income, and political ideology are consistently associated with environmental stewardship (Fransson and Garling 1999; Steg and Vlek 2009). Specifically, the studies show that young, highly educated, wealthy, and liberal individuals are more likely to engage in pro-environmental behavior. Holding these basic demographic characteristics constant, other studies have found additional motivations for pro-environmental behavior, including knowledge of how to conserve, social comparison, and perceptions of the environmental problem. Conversely, obstacles to stewardship include inconvenience, cost, and ignorance (Steg and Vlek 2009; Kreutzwiser et al. 2011).

From a management perspective, Kreutzwiser et al. (2011) find that the challenge of engaging people in environmental stewardship can be mitigated by better law enforcement and more accessible educational materials. In the case of lake conservation, the former would include better zoning enforcement and the latter would include pamphlets and web pages with different household practices that could reduce phosphorus and nitrogen pollution, as well as workshops and seminars about how to construct a vegetated buffer.

Additionally, the environmental psychology studies conducted by Welsch and Kühling (2009) and Steg and Vlek (2009) find that social comparison can be an important motivator for positive conservation behavior. Moreover, "reference people"—friends, family, and neighbors who engage in pro-environmental behavior—may help to evoke a sense of environmental responsibility among individuals. Brody et al. (2005) confirm these findings with a spatial analysis of residents around rivers in Texas. Their results indicate that people with similar environmental perceptions tend to be clustered in certain neighborhoods, and that "hot spots" of accurate water quality perceptions are located around community activists and environmental advocates.

Furthermore, Story and Forsyth (2008) find awareness, appraisal, and responsibility to be the main determinants of pro-environmental behavior. The authors observe conservation behavior in a watershed framework, and find that watershed residents who are aware of water quality problems, and appraise them to be detrimental, are more likely to feel responsible to engage in conservation behavior. The authors also find that a respondent's sense of responsibility is contingent on the intensity of the problem. This is an especially important issue for watershed conservation, because water quality degradation happens slowly and subtly over long periods of time.

Contingent Valuation

While psychologists, managers, and planners have assessed the determinants of environmental stewardship through spatial and social analysis, environmental economists assess the determinants of environmental stewardship by observing consumer demand. Moreover, economists measure environmental values using "willingness-to-pay" (WTP). Since environmental goods are often not directly marketable, this value is elicited through contingent valuation– a survey that directly asks how much respondents are willing to pay for an improvement in environmental quality, contingent upon a given scenario (Whitehead 2006).

Contingent valuation is useful for two main reasons. First, it has been shown that environmental attitudes are often not good indicators of actual conservation behavior (Fridgen 1994; Loomis et al. 2000; Cooper et al. 2004; Story and Forsyth 2009). Since contingent valuations provide the respondent with a scenario specific to their environmental good, and ask respondents to report a dollar amount that they would be willing to contribute each month or year, WTP is a more substantiated measurement of environmental stewardship than environmental values alone. Second, the aggregated WTP of all environmental consumers can give local conservation groups and policymakers an estimate of how much their shared environmental good is worth. This estimate can then be used to assess the costs and benefits of implementing or forgoing conservation policies (Whitehead 2006).

Recent contingent valuation (CV) studies of lake and river water quality have analyzed a wide variety of determinants of WTP. The most common categories of explanatory variables are demographic characteristics, perceptions of lake water quality, and environmental attitudes. Del Saz-Salazar et al. (2009) estimate that income, gender, employment, number of children, and average annual river visits all have positive and statistically significant effects on WTP. Additionally, studies show a negative relationship between age and WTP and a positive relationship between low water quality perceptions and WTP (Bateman et al. 2006; Del Saz-Salazar et al. 2009). Azevedo et al. (2001) also find that residents and visitors are willing to pay more for preventing the deterioration of water quality than they are for improving water quality. These results may indicate that poor water quality stimulates stronger sentiments of environmental responsibility and that older people recognize their shorter outlook of use and, therefore, value water quality less.

In addition to water quality perceptions and demographic characteristics, Cooper et al. (2004) evaluate the effects of environmental values, altruism, and use motives on WTP. To do so, Cooper et al. (2004) use the New Environmental Paradigm (NEP) and the Altruism Scale (ALT) to score respondents' environmental and human values. NEP is a sequence of questions used on surveys to measure environmental values. The authors, however, do not find a correlation between higher scores on either test and WTP. The result that pro-environmental attitudes alone are not indicative of actual environmental stewardship is confirmed by Fridgen (1994) and Story and Forsyth (2008). Other papers use more simple measurements of environmental awareness by asking outright about membership in environmental organizations and interest in the environment. These variables tend to have positive effects on WTP (Loomis et al. 2000; Del Saz-Salazar et al. 2009).

The focus of my study was to estimate the motivations behind willingness to pay for lake conservation on North Pond and East Pond. In accordance with the empirical literature, I examined the effects of basic demographic characteristics, including household income, level of education, and age on WTP. However, I took a novel approach at contingent valuation analysis by comparing two different water bodies that are geographically similar, but are trophically different. By separating and comparing the two sample groups, I was able to distinguish perceptions of water quality from actual water quality, and by combining the data I was able to compare willingness to pay over a larger spectrum of water quality assessments and demographic characteristics. I used two different payment mechanisms to decipher between shoreline residents' preference for improving water quality or preventing water quality degradation, as well as their preference for allocating the responsibility of lake conservation to either local conservation groups or themselves.

CASE STUDY: EAST POND AND NORTH POND

The Belgrade Lakes

The seven Belgrade Lakes, located just west of Waterville in central Maine, are a dynamic network of water bodies with varying physical, biological, and chemical characteristics. Over the past century, the region has transformed from a forest-based economy to a tourist-based economy (Peter Kallin, pers. comm.). Over a similar time period, the seven lakes have experienced a trend of decreasing water quality; with the recent addition of Great Pond to Maine's 303(d) list of impaired water bodies, three of the seven Belgrade Lakes make up 10% of the state's impaired lakes (Figure 1) (MDEP 2010).

As a result of reoccurring algal blooms and reduced water clarity, the Belgrade Regional Conservation Alliance (BRCA) and the local lake associations are investing time and resources to protect their lakes from further degradation. Their efforts, however, have been complicated by variable physical characteristics among the lakes; while the lakes share a similar anthropological and geological history, they differ in size, shape, water quality, and municipal boundaries. These differences, while frustrating for local conservation groups attempting to conserve the greater watershed, create an excellent laboratory in which to study coupled human and lake interactions.

In this study, I surveyed shoreline residents on two of the Belgrade Lakes (East Pond and North Pond) to assess the motivations behind WTP for lake conservation. These two lakes provided good case studies for two main reasons. First, the lakes are distinguished by unique water qualities; while East Pond is considered impaired and has conspicuously poor water quality in the late summer, North Pond has comparatively good water quality and rarely experiences algal blooms (PEARL 2006; King 2011). This difference was important for my analysis of the effect of water quality perceptions on WTP for lake conservation. Furthermore, the lakes share similar locations, dimensions, and shoreline population sizes. These similarities made it possible to use the same survey, with the exception of the contingent valuation scenario (see Appendix A and B), and sample size for both lakes.

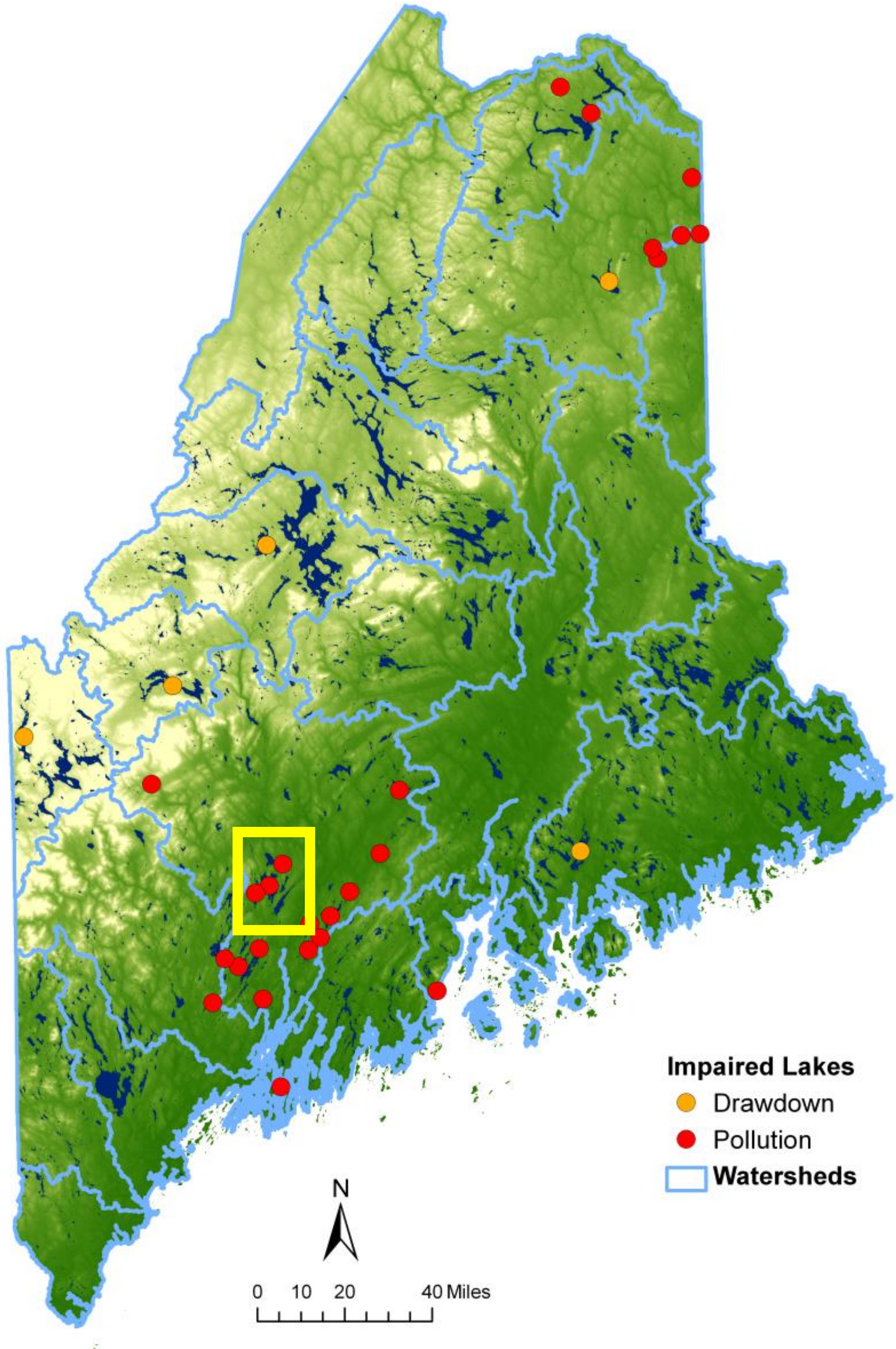

Figure 1. A spatial representation of Maine's thirty impaired lakes. The Belgrade Lakes, three of which are impaired by pollution, are highlighted by the yellow locator square (MEGIS 1990, 2003; MDEP 2010).

East Pond

Physical Characteristics

East Pond, located to the east of North Pond within the towns of Smithfield and Oakland, covers an area of approximately 1,717 acres. With an average depth of 5.8 meters, East Pond is a relatively shallow lake. At its deepest point, the lake reaches about 7.5 meters (PEARL 2006; King 2011). East Pond has experienced algal blooms for 7 of the past 10 summers, and has been on the state's impaired lakes list since 1996 (MDEP 1996). In August and September the blooms of Anabaena, a nitrogen fixing cyanobacteria, turn most of the lake green (Whitney King, pers. comm.). The intensity of these late summer blooms is illustrated by aerial imagery of East Pond compared to North Pond (Figure 2). The large algal biomass present in the lake is further revealed by its high levels of chlorophyll, which average to about 9.2 ppb (PEARL 2006). Consequently, East Pond is considered the most impaired among the Belgrade Lakes (Shannon, pers. comm.).

Residential Characteristics

There are approximately 227 residences along the shoreline of East Pond (PEARL 2006; BRCA 2010). According to Robert Jones, the East Pond Lake Association (EPLA) president, the lake residents are relatively engaged in lake conservation. This is demonstrated by EPLA's membership of about 140 residents. Additionally, a majority of shoreline residents have vegetated buffers, and many have taken advantage of the Belgrade Regional Conservation Alliance Youth Conservation Corps, who install best management practices free of labor cost (Robert Jones, pers. comm.).

According to Jones, one of the largest obstacles EPLA faces is making residents believe that their actions can fix East Pond's water quality problems. This obstacle is recognized in the study of pro-environmental behavior by Story and Forsyth (2008), which illustrates that an environmental problem must seem fixable for individuals to be motivated to engage in environmental stewardship. Jones also reports that the obstacles to lake stewardship on East Pond are less likely a matter of affordability, and more likely a matter of ignorance about conservation opportunities. Currently, few of EPLA's resources go towards reducing pollution. The annual budget of the lake association is about $15,000, $8,000 of which funds their courtesy boat inspection program, which helps to protect the lake from invasive species (Robert Jones, pers. comm.).

Figure 2. An aerial image of North Pond and East Pond illustrating the large discrepancy in water quality between the two connected ponds after an August Anabaena bloom in East Pond (NAVTEQ 2010).

While East Pond residents are relatively active, they still contribute to the lake's water quality problems. In accordance with the Clean Water Act (1972), MDEP created a Total Maximum Daily Load (TMDL) report in 2001 for East Pond. The report surveyed the watershed and estimated the total phosphorus absorbed by the lake each year. The results indicated that although residents only made up 10% of shoreline land use, they were responsible for 31% of the lake's total phosphorus load. These numbers indicate the large impact that shoreline residents have on East Pond's lake health (MDEP 2001).

North Pond

Physical Characteristics

North Pond, located within the towns of Rome, Mercer, and Smithfield, is slightly larger than East Pond with an area of approximately 2,531 acres. The lake is also shallower than East Pond, with an average depth of 3.96 meters. At its deepest point, the lake reaches 6.1 meters (PEARL 2006). The approximate one-meter difference between East Pond and North Pond is one of the major contributing factors to North Pond's superior water quality. Moreover, North Pond's one meter less of water subjects the lake to less temperature related stratification in the summer. Consequently, phosphorus does not get trapped in the bottom of the lake as it does in East Pond. Additionally, North Pond has a smaller sediment load than East Pond (Whitney King, pers. comm.). As a result, North Pond rarely blooms and generally looks clearer and less green than East Pond. Additionally, the lake has never been listed on the state's impaired lake list, and thus has always been in attainment of state and national water quality standards (MDEP 1996, 1998, 2000, 2002, 2004, 2006, 2008, 2010).

Residential Characteristics

North Pond's 50,417 feet of shoreline is covered by approximately 251 properties (BRCA 2010). Since the lake has never been on the state's 303(d) list of impaired water bodies, its annual residential phosphorus load remains unmeasured. However, Rick Watson, the North Pond Lake Association (NPLA) president, says that many of the shoreline residents on North Pond do not have buffers. He believes this is a matter of aesthetics and safety rather than affordability. Moreover, residents want a good view of the lake and their children swimming. Although Watson was awarded a grant from the New England Grassroots Environment Fund for $1,000 to install buffers around the lake, there has been sparse interest among residents (Rick Watson, pers. comm.).

Another obstacle NPLA faces is engaging townspeople, who do not reside on the shoreline, in issues regarding the lake. NPLA has about 100 members, most of whom are shoreline residents. The association reaches out to residents through their website and through a biannual newsletter. They have also advertised at local restaurants and municipal events. The association's budget is about $12,000 a year. NPLA, like EPLA, would like to devote more funding towards infiltrating pollution, but currently most of it goes toward the courtesy boat inspection program (Rick Watson, pers. comm.).

Water Quality Trends in North Pond and East Pond

Transparency, assessed using a secchi disk, is one of the measurements of water quality that the state of Maine uses to classify its lakes. A higher secchi reading indicates greater clarity and less eutrophication. However, comparing average secchi disk readings between lakes is not necessarily a good way to compare lake water quality. For example, East Pond and North Pond have similar secchi averages at about four meters each (PEARL 2006; King 2011). This seems counterintuitive considering the frequency of algal blooms in East Pond and its consistent classification as impaired. A closer examination of the secchi data reveals that over the years East Pond has seen increasingly good water quality at the beginning of the summer and increasingly bad water quality at the end of the summer (King 2011). Thus, the discrepancy between the highest reading, observed in May or June, and the lowest reading, observed in August or September, has grown increasingly large.

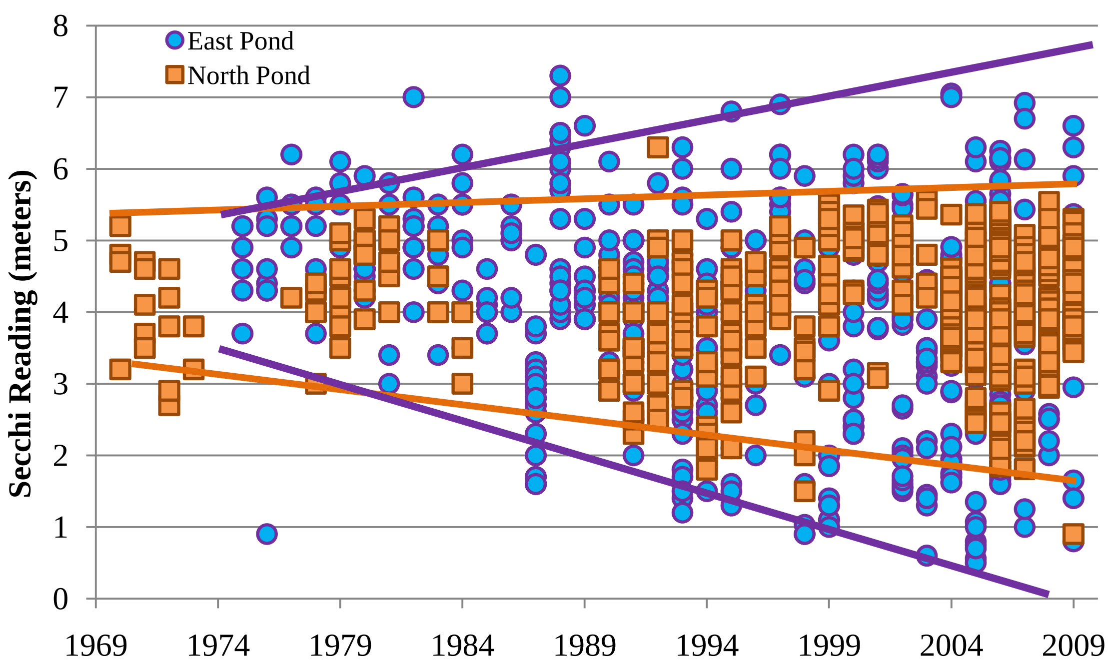

Figure 3. North Pond and East Pond secchi disk readings from 1970 to 2009. The graph illustrates the trend of increasing distance between the highest and lowest secchi readings for East Pond compared to those of North Pond (PEARL 2006; King 2011).

For example, in 1979 the minimum secchi reading recorded was 4.3 meters and the maximum was 5.8 meters. Thirty years later in 2009, secchi readings ranged from 0.8 to 6.92 meters (Pearl 2006; King 2011). During the same time period, the discrepancy between the early and late summer readings for North Pond has remained relatively consistent (Figure 3). So while North Pond and East Pond have similar average secchi readings, East Pond experiences increasingly egregious blooms at a vital time in August when most residents are visiting the lake.

METHODOLOGY

I began my research in the fall of 2010 with a thorough review of government reports and journal articles to synthesize the history of watershed management in Maine, the impact of lakes on the state's economy and the impact of development on lake water quality, from which I co-authored a report called The State of Lakes in Maine 2010 (D'Hemecourt et al. 2010). Building off some of the key findings in that report, I then started to research the physical, chemical, and biological characteristics of North Pond and East Pond. Additionally, I conducted interviews of Rick Watson and Robert Jones, the lake association presidents of North Pond and East Pond, Peter Kallin, the director of the Belgrade Regional Conservation Alliance (BRCA), and Maggie Shannon, the director of the Maine Congress of Lake Associations (MCoLA), to better understand the state of lake water quality in the Belgrade region, the general attitudes of residents and visitors, and the common mechanisms used to encourage lake stewardship.

My preliminary research also included an extensive review of recent contingent valuation and pro-environmental behavior studies to learn the methodology behind CV survey design, and to assess the research questions left unanswered by the literature. After synthesizing the above information, I designed a survey to ask shoreline residents on North Pond and East Pond how and why they value the water quality of their lakes. I received responses from 39 (44%) of the 89 residents in my sample.

Survey Design

The formatting and wording of my survey questions was largely based on the Dillman (2007) Tailored Design Method, but the question content and the structure of the survey were derived from my literature review. The survey was divided into five major sections: basic personal characteristics, lake-use and recreation, water quality perceptions, the CV scenario, and demographics. The two surveys can be found in Appendix A and B. The first section contained basic questions about seasonal or year-round residential status, years spent on the lake, and the location of the respondent's permanent address. These questions helped define the sample, and helped make respondents familiar with the survey (Whitehead 2006).

The second section consisted largely of behavior questions. Specifically, I asked respondents about the amount of time that they spend at their lake residence, their participation in recreational activities on the lake, and their lake association membership status. The third section was designed to elicit each respondent's perceptions of and attitudes toward water quality. In this section, I asked about their water quality perceptions during the first half of the summer (May-July) and during the second half of the summer (August-October). I also asked respondents to rank the water quality of their lake compared to their perception of the other Belgrade lakes.

The fourth section, the contingent valuation scenario, was the most important for my analysis. For this section I designed a "water quality ladder" describing the lake-use associated with different levels of water quality to accompany a physical description of either East Pond or North Pond. This was followed by two different CV scenarios. The first referred to a watershed wide conservation program that would be funded by monthly payments from residents and would increase the number of residential, commercial, and agricultural buffers on the shoreline of either lake. The second CV scenario asked respondents how much they would be willing to pay, in a one-time payment, to install vegetated buffers on their properties. For each scenario, I asked respondents to report their WTP to improve water quality, as well as their WTP to prevent water quality deterioration. In this thesis I refer to the WTP values elicited from the first CV scenario as WTP_1 and WTP_2 and the WTP values elicited from the second CV scenario as WTP_3 and WTP_4. WTP_1 and WTP_3 were for water quality improvements, and WTP_2 and WTP_4 were for the prevention of water quality deterioration.

Though most CV studies use a tax or an increase in the water utilities bill as a payment mechanism to elicit WTP (Loomis et al. 2000; Azevedo et al. 2001; Cooper et al. 2004; Bateman et al. 2006; Whitehead 2006; Del Saz-Salazar et al. 2009) I decided that, given the local aversion to taxes and the high incidence of well water, neither would be appropriate. Instead, I used a monthly conservation fee for the first scenario, and a one-time homeowner payment for the second. Additionally, I chose a discrete choice question model to elicit respondents' maximum WTP, but included an open-ended option where respondents could fill in a unique value. The price options were chosen based on past CV studies of lake and river water quality (Loomis et al. 2000; Bateman et al. 2006; Del Saz-Salazar et al. 2009).

The fifth and last section of my survey contained demographic questions that have been shown to affect environmental stewardship and WTP for conservation, including age, gender, household income, education level, number of children in the household, and internet access (Fransson and Garling 1999; Cooper et al. 2004; Bateman et al. 2006; Del Saz-Salazar et al. 2009; Steg and Vlek 2009; Kreutzwiser et al. 2011).

Survey Implementation

Upon approval for human subjects by the Colby Institutional Review Board, I administered 100 mail-out, mail-back surveys to shoreline property owners on North Pond and East Pond. I randomly selected fifty respondents from each lake using a database of shoreline residents constructed out of public per parcel tax information by the Belgrade Regional Conservation Alliance. The surveys were mailed to their permanent addresses. Respondents had the option of taking an online version of the survey that could be accessed via a URL given with the paper survey. The online version was created and administered using *Qualtrics*. Of the 100 surveys, 11 were undeliverable. I received responses from 39 (44%) of the 89 residents left in the sample.

Table 1: Summary Survey Response Statistics

Lake	Total Mailed	Wrong Address	Online Response	Mail-back Response	Total Responses	Effective Response Rate
North Pond	50	5	5	15	20	44%
East Pond	50	6	9	10	19	43%
Total	100	11	14	25	39	44%

Data Analysis

In this thesis, I used non-parametric analysis to test for differences between the average demographic characteristics, recreational behaviors, water quality perceptions, and willingness-to-pay values of respondents. Non-parametric tests (e.g. Mann-Whitney U Test) do not assume a normal population distribution, and are good alternatives to parametric tests (e.g. Two Sample T-Test), when the sample population is small. I used the two-sample Mann-Whitney U Test to test for differences between the numeric (e.g. willingness to pay) and ordinal-categorical variables (e.g. water quality rank). To test for differences between the binary variables (e.g. lake association membership), I used tabulation analysis with the Pearson Chi Square Test. For some cross tabulations, when the number of observations was particularly small, I invoked Fisher's Exact Test to increase the accuracy of my results.

Comparison of Respondent Characteristics

I began my analysis with descriptive statistics of the basic personal characteristics that defined the collective two-lake sample. I then compared these characteristics—seasonal status, permanent Maine residency, lake association membership, and the length of time respondents have lived on the lake—between the East Pond and North Pond samples. For the binary variables I performed a tabular analysis using the Pearson Chi Square Test. For the numeric variable—length of time respondents have lived on their lake—I used the Mann-Whitney U test for independence between the East Pond and North Pond samples.

I then summarized the demographic characteristics of the sample, and analyzed whether there were significant differences between the East Pond and North Pond respondents. The demographic section of the survey was comprised of mostly discrete choice questions, each with six possible answers. The first answer choice was the lowest grouping and the sixth was the highest. For example, respondents could chose one of six age categories, where 1 was the youngest age group (18-25) and 6 was the oldest age-group (76+) (see Appendix A and B). When the median values are reported in the results section, they represent the median value given that the answer choices were ranked from 1-6. Using age as an example, a median value of 4 would imply that the median age of respondents was 50-59 years old. Since the choices were not linearly distributed, I considered them to be categorical in my analysis, and compared the East Pond and North Pond samples using a

One-Sided Fisher's Exact Test. I used this test instead of the Pearson Chi Square, because in some cases the sample size was very small.

The third category of variables that I analyzed was recreational behavior. For these variables I compared both the number of residents who participated in each activity and the frequency of participation between the two ponds. For the former (number of participants), I used a Pearson Chi Square Test. The latter (frequency of participation), however, was ranked on a 1-7 scale: Never=1, Less than once a month= 2, Once a month=3, 2-3 times a month=4, Once a week=4, 2-3 times a week= 6, and Daily=7. I treated this variable as ordinal-categorical, and used the Mann-Whitney U test of independence.

Water Quality Perceptions

To begin my analysis of water quality perceptions across the two lakes, I compared respondents' perceptions of water quality to actual secchi data from East Pond and North Pond. I did so to see whether residents accurately perceived water quality. The secchi data were collected in the summer of 2009 by Colby students and faculty (Whitney King, pers. comm.). Using this data, I observed whether the general graphical trends between the secchi data and the survey responses aligned. I then analyzed the differences in water quality perceptions between respondents on North Pond and East Pond. In the survey, respondents were asked to rank their perception of water quality on a 1-5 scale: crystal clear water=1, not quite crystal clear, slight algae visible=2, definite algal greenness=3, high algal levels with limited clarity=4, and severely high algae levels with massive floating scum=5. They were also asked to rank the water quality of their lake compared to the other Belgrade lakes on a 1-7 scale: worst water quality=1 and best water quality =7. I considered both of these variables ordinal-categorical and used a Mann Whitney U Test of independence to test for differences between the North Pond and East Pond samples.

Willingness to Pay

In total, the survey had four different willingness-to-pay questions. In my analysis, the first two WTP variables (WTP_1 and WTP_2) could not be compared with the second two (WTP_3 and WTP_4), because they used different valuation scenarios. Moreover, the first valuation scenario asked respondents how much they would be willing to pay, in a monthly conservation fee, for a watershed wide program that would increase the number of residential, commercial, and agricultural buffers on the shoreline. This fee would be paid for as long as the respondents lived on the lake. The second valuation scenario, however, asked about respondents' willingness to pay, in a one-time payment, for a vegetated buffer on their property. WTP_1 and WTP_3 were for water quality improvements, while WTP_2 andWTP_4 were for the prevention of water quality deterioration (Appendix A and B). In order to compare the values elicited from the two different valuation scenarios I would need more information about the average time residents live on the lake. Otherwise, it is not possible to compare a one-time payment with an indefinite payment. More respondents answered the questions from the first valuation scenario (N=36) than the second valuation scenario (N=26), because many respondents indicated that they already had a vegetated buffer.

I then analyzed the differences between 14 binary variables and all four measurements of willingness-to-pay, using the Mann-Whitney U Test. Most of the demographic, recreational, and water quality perception variables were multi-category so I re-categorized them to be binary. I chose 60 as a cut-off for the age variable, because it is the age at which people begin to retire, and assigned a value of 1 to respondents over the age of 60 (Age>60), and 0 otherwise. For the household income variable, I chose $50,000 as a cut-off for above middle-class respondents, because the median annual household income in Maine is $46,419 (USCB 2008). I then assigned a value of 1 to those who made more than $50,000 annually (Income>$50,000), and 0 otherwise. Lastly, I divided the schooling variable into respondents who had at least completed college (college=1), and those without a college degree (college=0).

Furthermore, I also created binary water quality perception variables. First I assigned a value of 1 to respondents who perceived at least "definite algae" during the second half of the summer. This included respondents who ranked their lake "3" or higher on the 1-5 water quality scale (Definite algal greenness, brownness, or yellowness= 3, High algal levels=4, and Severely high algal levels=5). I assigned a value of 0 to those respondents who ranked their lake "2" or lower on the 1-5 water quality scale (2= Not quite crystal clear, slight algae visible and 1= Crystal clear water). In the results section, I refer to the first group as "definite algae" and the second group as "slight/no algae". I also re-categorized the Belgrade water quality rank variable by assigning a value of 1 to those who ranked their lake as 2 or worse (on a 1-7 scale, where Worst water quality=1 and Best water quality=7), and 0 to those who ranked their lake as 3 or better compared to the other Belgrade Lakes.

In accordance with past literature on environmental stewardship (Bateman et al. 2006; Del Saz-Salazar et al. 2009), I hypothesized that younger (Age<60), wealthier (Income >$50,000), college graduates would be willing to pay significantly more for water quality conservation than respondents who did not fit these categories. Furthermore, I hypothesized that lake association members, East Pond respondents, respondents who perceive definite algae, and respondents who rank their lake's water quality "low", would be willing-to-pay significantly more than others. Respondents in these categories are more likely to be aware of their lake's water quality problems, appraise the problems to be severe, and consequently feel a stronger sense of lake stewardship (Story and Forsyth 2008).

RESULTS

I received responses from 39 (44%) of the 89 residents who received surveys. Given that there are approximately 478 residences between the two lakes, the sample represents about 8.2% of the actual population. Since not all respondents answered every question, the sample population varies throughout my analysis. I report the number of respondents (N) in parentheses when I report percentages. My results are presented in the following order: respondent characteristics—including demographic characteristics, lake-visitation, and recreational behavior—lake water quality perceptions, and willingness to pay for lake water quality conservation.

Respondent Characteristics

The combined East Pond and North Pond sample (N=39) came from Smithfield (62%), Oakland (23%), Mercer (13%), and Rome (3%). A majority of the 39 respondents (69%) were permanent Maine residents, and the remaining 31% were from Massachusetts, Florida, California, New York, Michigan, Washington, DC, and Arizona. The respondents were mostly seasonal visitors (82%), but all respondents owned their lake property. Additionally, a majority (82%, N=38) were lake association members. Most were also long-term lake residents; the average length of time that respondents have lived on their lake was 40 years (N=33).

Non-parametric comparisons of the above characteristics between East Pond and North Pond indicated no statistical significance. Therefore, the numbers of respondents who were seasonal residents, permanent Maine residents, and lake association members were not statistically different for the East Pond and North Pond sample populations. Additionally, the average length of time respondents have lived on the lake did not differ significantly between East Pond and North Pond respondents.

The results are summarized in Tables 2 and 3. In Table 2, the column labeled "N" holds the number of respondents who answered the question and the column labeled "Mean" holds the mean number of years that respondents have lived on their lake. The Mann-Whitney U statistic is reported in the second to last column, followed by the resulting p-value. In Table 3, the number of respondents who answered "yes" to the given characteristics are compared between the East Pond and North Pond sample populations. The column labeled "N" holds the number of respondents who answered "yes", and the column labeled "%" holds the number of respondents who answered "yes" as a percentage of the number of respondents who answered the question. The Pearson Chi Square test statistic for each comparison is reported with the degrees of freedom in parentheses. The last column holds the p-value, which would be starred if the difference between the East Pond and North Pond samples were statistically significant.

The organization of the tables throughout the rest of the results section is consistent with Tables 2 and 3, unless otherwise indicated (e.g. Tables 7 and 8). If the Fisher's Exact Test was utilized, only a p-value is reported, because the test does not yield a test statistic.

Table 2. Average number of years that North Pond and East Pond respondents have lived on their lake. The Mann-Whitney U Test statistic is reported with the resulting p-value. The p-value, which is greater than 0.05, indicates no statistical difference between the North Pond and East Pond sample populations.

	East Pond		**North Pond**		**Significance Test**	
	N	Mean (years)	N	Mean (years)	Mann-Whitney U	P-Value
Length of time on lake	16	35	17	44	1.280	0.201

Table 3. Percentages of North Pond and East Pond respondents who indicated permanent Maine residency, seasonal residency, and lake association membership. The Pearson Chi Square Test statistic is reported with the number of degrees of freedom in parentheses. The p-values, which are consistently greater than 0.05, indicate no statistical difference between the North Pond and East Pond sample populations.

Respondent Characteristic	**East Pond**		**North Pond**		**Significance Test**	
	N	%	N	%	Pearson Chi Square (DF)	P-Value
Permanent Maine Resident[a]	13	68	14	70	0.0114 (1)	0.915
Seasonal Resident[a]	16	84	16	80	0.1173 (1)	0.732
Lake Association Member[b]	17	89.5	15	79	0.7917 (1)	0.374

(a) East Pond N=19, North Pond N=20; (b) East Pond N=19, North Pond N=19

Demographic Characteristics

Most respondents from the combined sample were older than 60 years (57%, N=35), made more than $50,000 annually (63%, N=27), and had at least a college education (75%, N=36). Additionally, the gender distribution was split almost evenly between female respondents (49%, N=35) and male respondents (51%, N=35). Given that people can retire at age 60, and that the median household income in Maine is about $46,419 (USCB 2008), the sample was largely comprised of well-educated, middle and upper middle class retirees.

In combination, these characteristics create an interesting study for assessing WTP for lake stewardship, because past CV studies have found that wealthy, highly educated individuals tend to be willing to pay more for environmental quality, but that WTP decreases with age (Bateman et al. 2006; Del Saz-Salazar et al. 2009). A Fisher's Exact Test comparing the above characteristics between respondents on East Pond and North Pond yielded no statistically significant results (Table 4). This indicates that the North Pond and East Pond sample populations are demographically similar in terms of age, level of schooling, and income.

Table 4. Median income, schooling, and age characteristics of North Pond and East Pond respondents. Since the Fisher's Exact Test does not yield a test statistic, only the p-value is reported below. The p-values, which are consistently greater than 0.05, indicate no statistical difference between the North Pond and East Pond sample populations.

Demographic Characteristic	East Pond		North Pond		Significance Test
	N	Median*	N	Median*	Fisher's Exact P-value
Income	14	5.5	13	4.0	0.191
School	19	4.0	17	4.0	0.353
Age	19	4.0	16	5.0	0.173

(*) For each demographic question, respondents were given six discrete answer choices to select from. The median was calculated by assigning each answer a rank from 1 to 6, where 1=the lowest category and 6=the highest category. See Methods for a complete explanation of the answer choices.

Lake Visitation and Recreational Activity

Like the demographic characteristics above, most of the recreational behaviors of respondents were similar between the two lake populations. Respondents from both lakes visited their lake residences at similar times and participated in recreational activities at similar frequencies**.** All 39 respondents (100%) claimed to visit their lake house in August, when East Pond's Anabaena population is in full bloom. Most of the 39 respondents also visited in July (95%) and June (87%) (Figure 4). On average, respondents on both lakes swim and boat about 2-3 times a week and enjoy the scenery daily. More respondents on North Pond (84%, N= 19) fish than do respondents on East Pond (65%, N=17), but not by a statistically significant amount.

The results of a One-Sided Fisher's Exact Test comparing the number or participants in each activity between the two lakes, and a Mann-Whitney U Test comparing the frequency at which respondents on the two lakes participate in each activity are summarized in Table 5. All participants claimed to "enjoy the scenery" at least sometimes, so this variable was left out of the tabulation analysis. Neither the number of participants nor their frequency of participation significantly differed between East Pond and North Pond. This may indicate that decreased recreation may not be one of the major costs associated with East Pond's poor water quality.

Table 5. Non-parametric comparisons of the recreational behavior of respondents on North Pond and East Pond. The top half of the table compares the median frequency of participation in each activity among the East Pond and North Pond sample populations. The bottom half of the table compares the number respondents who participate in each activity among the East Pond and North Pond sample populations. The p-values, which are consistently greater than 0.05, indicate no statistical difference between the North Pond and East Pond sample populations.

Recreational Activity*	**East Pond**		**North Pond**		**Significance Test**	
	N	Mean	N	Mean	Mann-Whitney U	P
Enjoying the scenery	19	6.58	17	6.59	0.118	0.906
Swimming	18	5.58	18	5.26	-0.783	0.434
Fishing	11	4.00	16	4.11	-0.114	0.910
Boating	17	5.83	17	5.44	-0.685	0.494
	N	%	N	%	Fisher's Exact P-value	
Enjoying the scenery[a]	19	100	17	100	-	
Swimming[b]	18	94.7	18	94.7	0.757	
Fishing[c]	11	64.7	16	84.2	0.168	
Boating[d]	17	94.4	17	94.4	0.757	

**Participation in the four activities was ranked on a 1-7 scale, where Daily=7 and Never=1. (a) East Pond N=19, North Pond N=17; (b) East Pond N=19, North Pond N=19; (c) East Pond N=17, North Pond N=19; (d) East Pond N=18, North Pond N=18).*

The above results show that there were no statistically different personal, demographic, and recreational characteristics among respondents on East Pond and North Pond. In combination, these results indicate that the lake variable, which represents the lake on which respondents reside, is a measurement of water quality, rather than a proxy for characteristic differences between the populations on each lake.

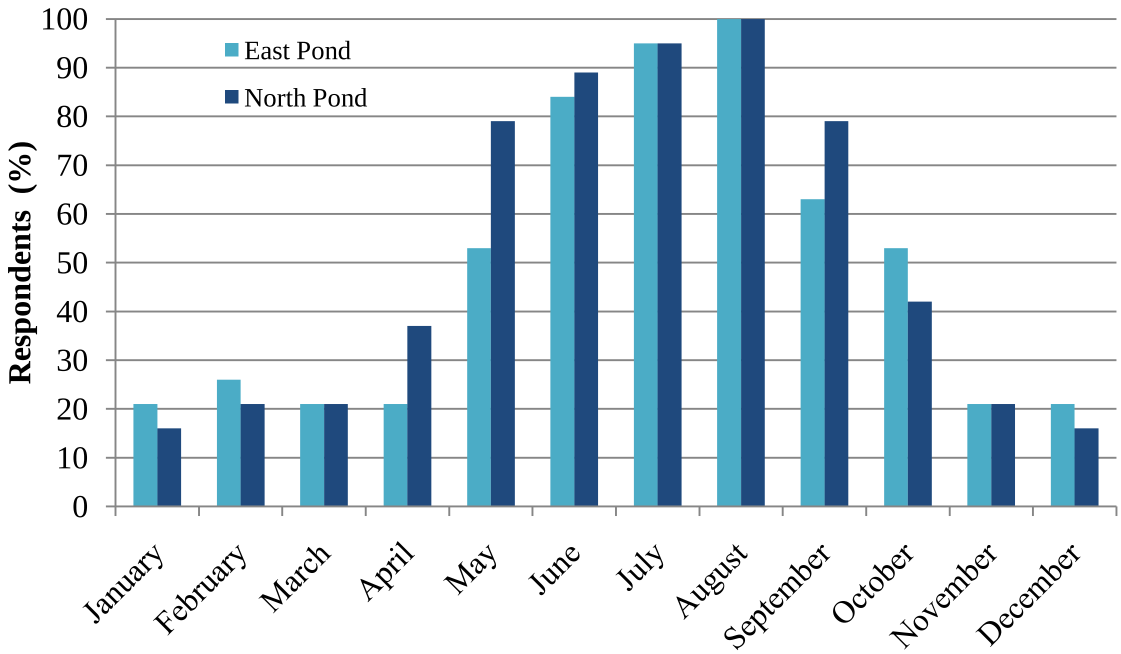

Figure 4. The months during which respondents most often visited their lake residences on North Pond and East Pond (N_{east}= N_{north}=19).

Water Quality Perceptions

The water quality trends of East Pond and North Pond are complex and, especially for East Pond, vary greatly throughout the summer. Figure 5 is a graph of secchi disk readings from East Pond and North Pond observed during the summer of 2009. This figure shows that from May until July the water quality of both ponds was quite good. Furthermore, during the first half of the summer East Pond's water quality average (4.66 meters) exceeded that of North Pond (4.24 meters). Additionally, the maximum clarity of 6.6 meters in East Pond, which occurred in mid-July, surpassed the maximum clarity of 5.3 meters in North Pond, which occurred in early June. These differences were well perceived by respondents; on average during the first half of the summer (May-July) East Pond respondents considered their lake to be "crystal clear", the highest ranking possible, while North Pond respondents consider their lake to be one level lower at "not quite crystal clear, slight algae visible" (Figures 6 and 7).

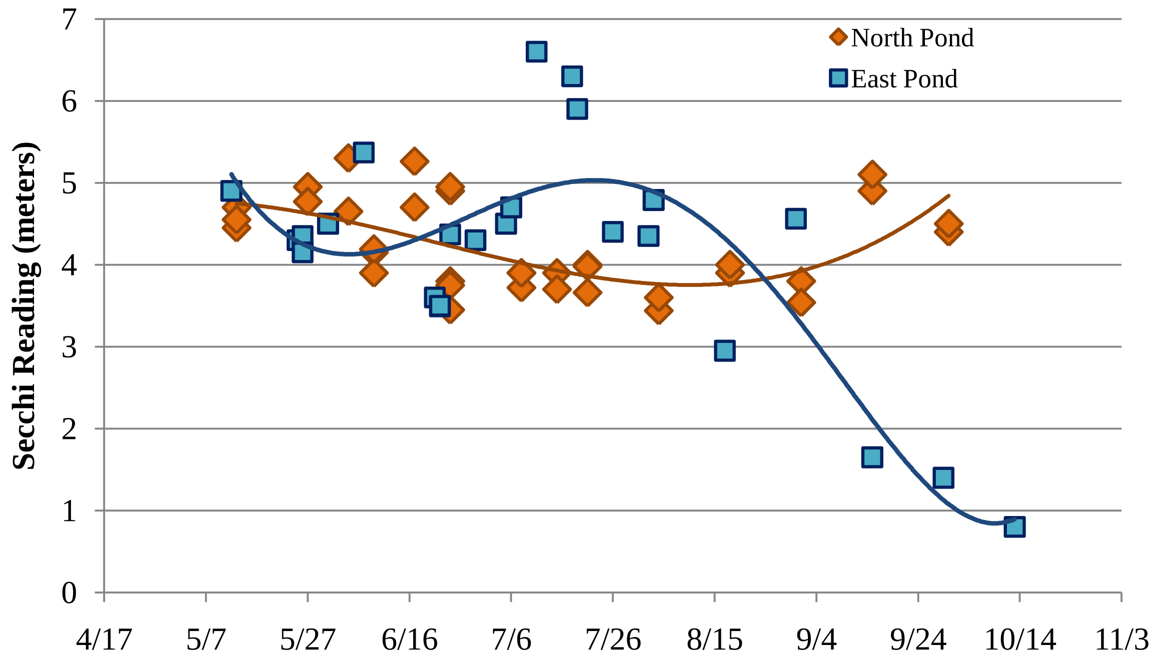

Figure 5. A graph of East Pond and North Pond Secchi Readings from the Summer of 2009 (PEARL 2006; King 2011).

Figure 5 also shows the dramatic change in East Pond's water quality that begins in September and continues through October. It should be noted, however, that 2009 was unusual in terms of when the shift in water quality began. Usually, East Pond starts blooming in mid-August. In 2009, however, the secchi readings do not dramatically decrease until mid-September. This does not affect my analysis, because I compare the first half (May-July) and the second half of the summer (August-October) rather than the individual months.

While the average water quality of North Pond falls slightly from 4.24 meters to 3.84 meters during the second half of the summer, the average water quality of East Pond falls from 4.66 to 2.93 meters. At its minimum, East Pond's clarity is 0.8 meters deep compared to North Pond's 3.44 meters. Again, survey respondents were very perceptive of these changes in water quality; on average during the second half of the summer (Aug-October) East Pond respondents considered their lake to have "high algal levels with limited clarity and/or mild odor apparent", the second lowest ranking, while North Pond respondents did not change their opinion from "not quite crystal clear, slight algae visible".

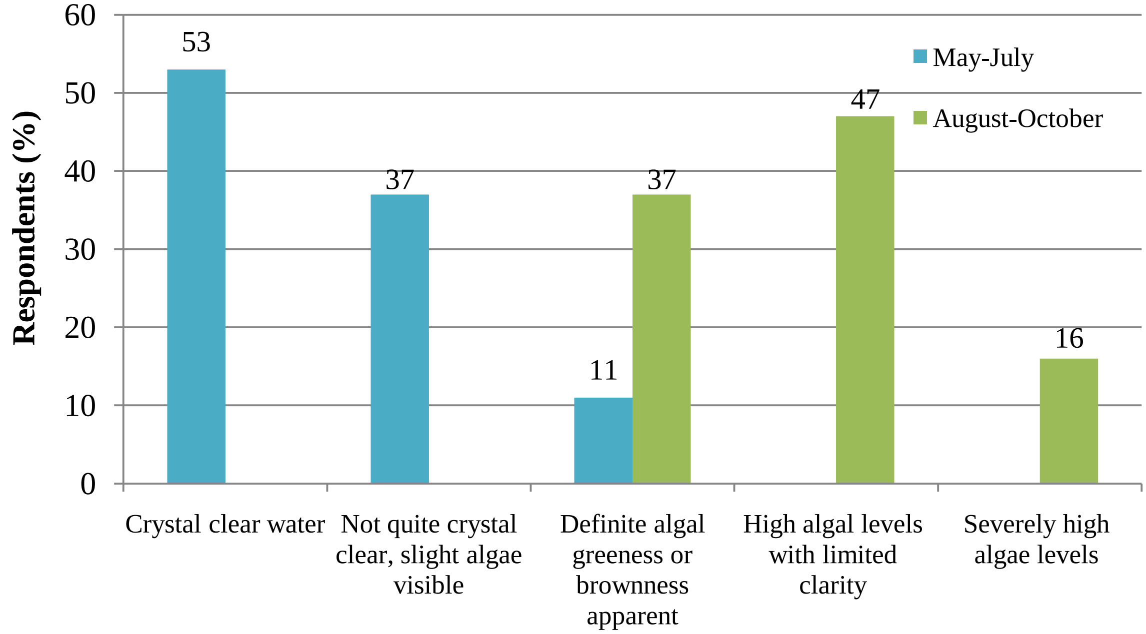

Figure 6. The water quality perceptions of East Pond respondents during the first half of the summer (May-July) and the second half of the summer (August-October). Percentages are given above each bar (N=19).

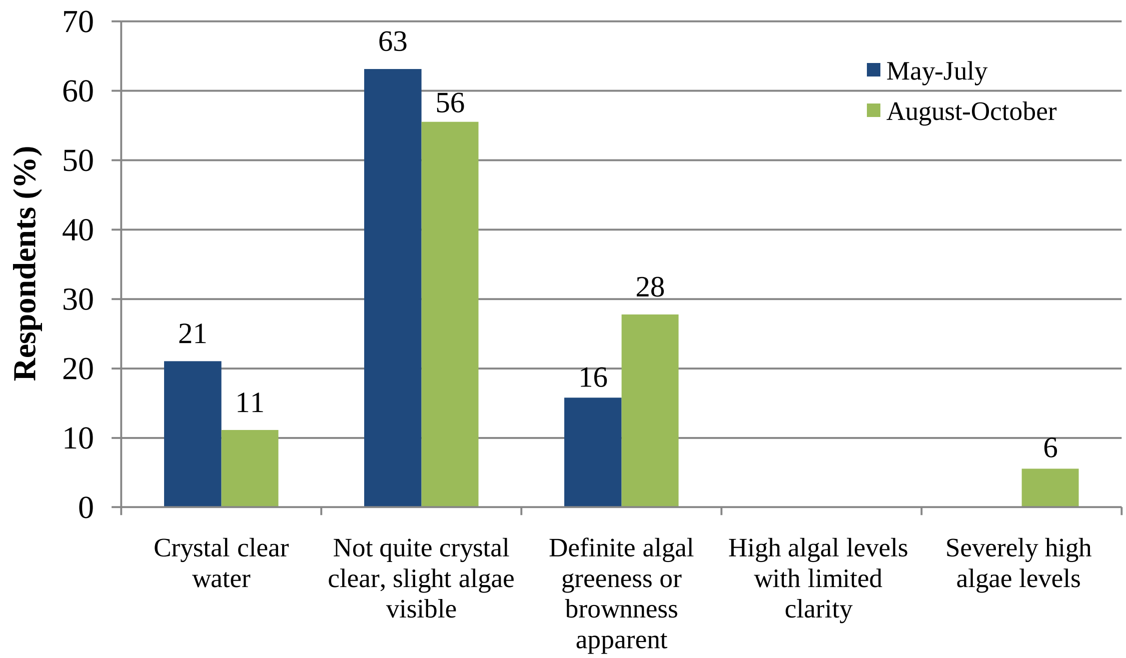

Figure 7. The water quality perceptions of North Pond respondents during the first half of the summer (May-July) and the second half of the summer (August-October). Percentages are given above each bar (N=19).

The results of two Mann-Whitney U tests comparing the water quality perceptions of East Pond and North Pond respondents during the first half and second half of the summer are summarized in Table 6. During the first half of the summer, perceptions of water quality were not significantly different between the two lakes. However, during the second half of the summer East Pond respondents perceived lake water quality to be lower than did North Pond respondents. The difference in perceptions was highly significant ($p<0.01$).

In addition to asking respondents to choose a description of their lake water quality during the two halves of the summer, I also asked respondents to rank their lake's water quality compared to the other Belgrade Lakes on a 1-7 scale (Figure 8). On this scale, 1= worst water quality out of the Belgrade Lakes and 7= the best water quality out of the Belgrade Lakes. A few respondents could not answer the question because they did not know about the other Belgrade Lakes. In total, 17 individuals from each lake responded. The average rank of East Pond respondents was 2.65 compared to North Pond's 4.59. This difference was highly significant ($p<0.01$).

Table 6. Average water quality perceptions of respondents on North Pond and East Pond. The first two variables are measurements of how respondents perceived water quality during the first half and second half of the summer (1-5 scale). The third variable is a measurement of how respondents ranked their water quality compared to the rest of the Belgrade Lakes (1-7 scale). See Methods for a complete explanation of the answer choices.

Perception of Water Quality	**East Pond**		**North Pond**		**Significance Test**	
	N	Mean	N	Mean	Mann-Whitney U	P
First half of summer (May-July)[a]	19	1.58	19	1.95	1.786	0.074
Second half of summer (Aug-Oct)[a]	19	3.79	19	2.33	-4.283	0.001**
Water quality compared to other Belgrade Lakes[b]	17	2.65	17	4.59	3.561	0.001**

(a) Water quality was ranked on a 1-5 scale, where Crystal Clear Water=1 and Severely high algal levels=5
(b) Water quality compared to the other Belgrade Lakes was ranked on a 1-7 scale, where Best water quality=7 and Worst water quality=1
(*)p<0.05; (**)p<0.01

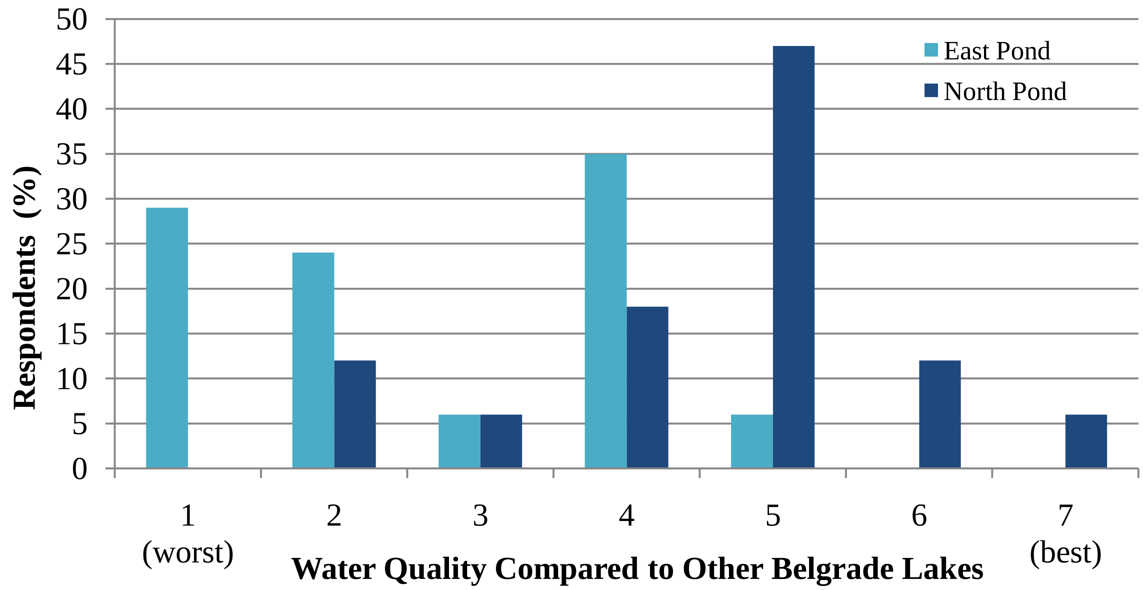

Figure 8. A comparison of how North Pond and East Pond respondents perceive the water quality of their lake compared to the other Belgrade Lakes. Respondents ranked their lake on a 1 to 7 scale, where 1 = "worst quality" and 7 = "best quality" (N_{east}=N_{north}= 17).

Willingness-to-Pay for Water Quality Conservation

I ran several Mann-Whitney U Tests to determine whether certain groups among the collective two-lake sample population were willing to pay more than others for lake water conservation. I report the results of 32 of these tests in Tables 7 and 8**.** I analyzed 18 binary variables, seven of which were significant for at least two of the four WTP variables, and four (lake association membership, income >$50,000, age>60, and perception of definite algae) of which were significant for all four WTP variables. I do not discuss the eight recreation variables in this section, because none of them were statistically significant at any level.

When aggregated, the two-lake sample of respondents was collectively willing to pay $5,652/year for the watershed wide conservation program if it would improve water quality (WTP_1, N=36), and $5,172/year if the program would prevent water quality from deteriorating (WTP_2, N=35). Additionally, respondents were on average willing to pay $259.62 to install a vegetated buffer on their property if it would improve water quality

(WTP_3, N=26), and $278.85 if it would prevent water quality from deteriorating (WTP_4, N=26).

East Pond versus North Pond

On average, respondents from East Pond were willing to pay $18.35/month ($220.00/year) for WTP_1 and $15.44/month ($185.00/year) for WTP_2. On the other hand, North Pond respondents were willing to pay an average of $8.37/month ($100.00/year) for the former and $9.68/month ($116.00/year) for the latter. The discrepancy in average willingness to pay between the two lakes is illustrated by Figure 9. The Mann-Whitney U test of independence between the sample populations (East Pond and North Pond) did not yield statistically significant results. This indicates that under the first contingent valuation scenario, respondents from East Pond were not willing-to-pay more than respondents from North Pond for lake conservation.

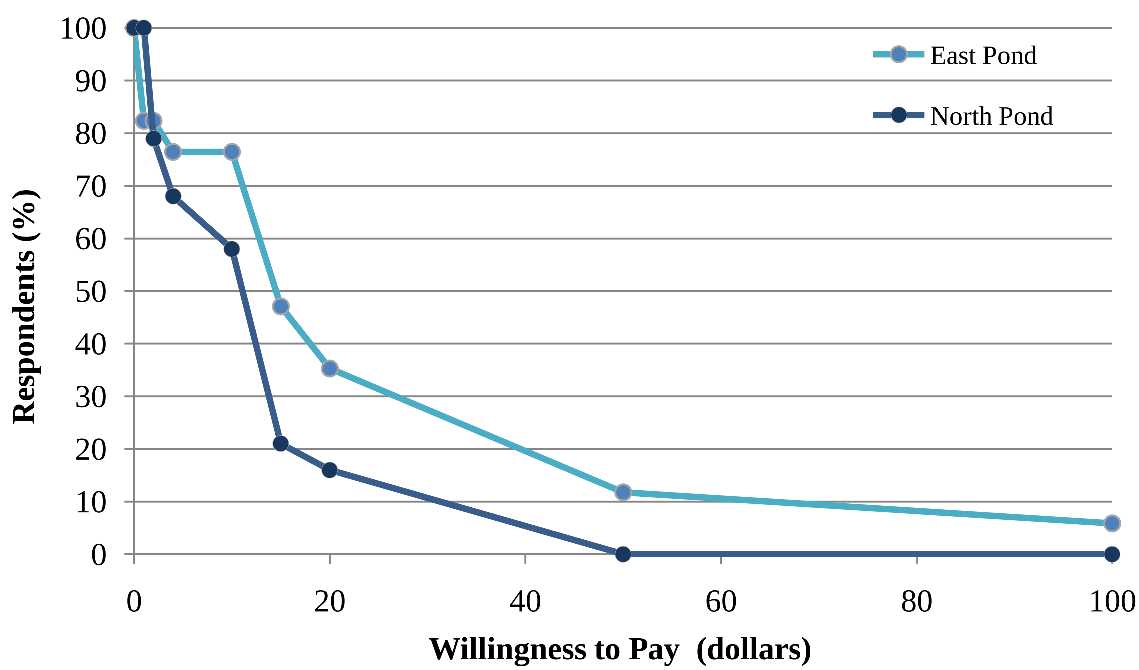

Figure 9. A comparison of the dollar amount that respondents from North Pond and East Pond were willing to pay in a monthly "conservation fee" that would fund the watershed wide construction of vegetated buffers and would improve lake water quality (WTP_1) (N_{east}=17; N_{north}= 19).

There were, however, statistically significant differences between how much residents on the two ponds were willing to pay to install vegetated buffers on their properties

(WTP_3 and WTP_4). Moreover, East Pond respondents were willing to pay $416.67 for a vegetated buffer on their property that would improve water quality (WTP_3) and $441.67 if the buffer would prevent water quality deterioration (WTP_4) (Figure 10). North Pond residents were willing-to-pay $125.00 for the former and $139.29 for the latter. Since 82% of respondents were lake association members, extrapolating these values to the entire shoreline populations of both lakes would potentially yield inflated results. Thus, I only extrapolated the WTP values for water quality improvement (WTP_3) to lake association members on East Pond (N=140) and North Pond (N=100). In so doing, I found that East Pond lake association members would be willing to pay an average of $58,240 in a one-time payment to install buffers on their properties and North Pond members would be willing to pay an average of $12,500. The former is equivalent to about four times the annual budget of the East Pond Lake Association, and the latter is nearly equivalent to the North Pond Lake Association's annual budget.

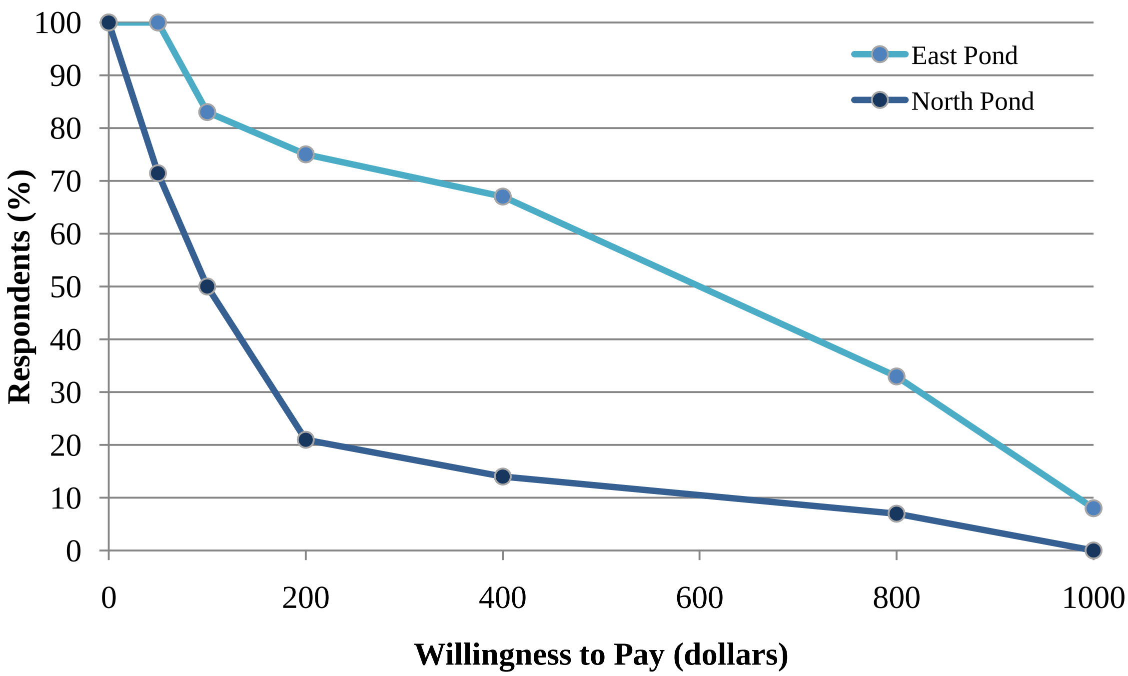

Figure 10. A comparison of the dollar amount respondents from North Pond and East Pond were willing to pay in a one-time payment to install a vegetated buffer on their properties, which would prevent water quality from falling (WTP_4) (N_{east}=12; N_{north}= 14).

The differences between the ponds were statistically significant for both WTP_3 ($p=0.023$) and WTP_4 ($p= 0.019$) at the 95% level. Thus, my hypothesis that East Pond residents would be willing-to-pay more for lake conservation was true in the case of personal vegetated buffers, but not true in the case of the watershed wide conservation program.

Lake Association Membership

In accordance with my hypothesis, lake association members, regardless of income, education, and age, were willing to pay significantly more than non-members. Upon examination of their demographic characteristics, I found that there were no significant differences between the ages, incomes, and schooling levels of lake association members and non-members in my sample population. For the watershed conservation program, members were willing to pay an average of $15.03/month ($180.36/year) to improve water quality (WTP_1) compared to the $2.50/month ($30.00/year) non-members were willing to pay. Additionally, for WTP_2 they were willing to pay $14.00/month ($168.00/year) compared to the $4.17/month ($50.00/year) that non-members were willing to pay. Furthermore, lake association members were willing to pay more to install vegetated buffers on their properties. On average, the WTP_3 ($302.27) and WTP_4 ($325.00) of members were much higher than the WTP_3 ($25.00) and WTP_4 ($25.00) of non-members. The differences were statistically significant at the 95% level for all four WTP values: WTP_1 (p=0.014);WTP_2 (p=0.021);WTP3 (p=0.029); WTP4 (p=0.026).

The sample population of lake association members (N=21) represents approximately 9% of the total lake association membership of both lakes. When the willingness to pay values from the first contingent valuation scenario (WTP_1 and WTP_2) are extrapolated to all 240 lake association members, members would be willing-to-pay an average of $43,286 a year to improve water quality and $40,320 a year to prevent water quality from deteriorating. These numbers are equivalent to about 1.5 times the collective annual budgets of the two lake associations.

Demographic Characteristics

Of the demographic categories (gender, income, education, and age) gender was the only characteristic for which there was no statistical significance. The income variable was highly significant for all four measurements of WTP: WTP_1 (p=0.005); WTP_2 (p=0.002); WTP3 (p=0.001); WTP4 (p=0.001). Moreover, the 16 respondents who made greater than

$50,000 a year were willing to pay an average of $15.75/month ($189.00/year) for the WTP_1 question while respondents who made less than $50,000 a year were willing to pay an average of $6.50/month ($78.00/year). These results support my hypothesis that respondents who made more than Maine's median household income would be willing-to-pay significantly more for lake conservation than those who did not.

Additionally, the age variable was significant for WTP_1 (p=0.043), WTP_3 (p=0.040) and WTP_4 (p=0.018), and highly significant for WTP_2 (p=0.005). These results support my hypothesis that people under the age of 60 would be willing to pay more for lake water conservation than retirees who may have fixed incomes and shorter outlooks of lake use. The average amount respondents under the age of 60 were willing to pay for a vegetated buffer on their property that would prevent water quality deterioration (WTP_4) was $445.83 compared to the average $150.00 that retirees were willing to pay.

Lastly, the college-graduate variable was significant for WTP_1 (p=0.012) and WTP_4 (p=0.044), and highly significant for WTP_2 (p=0.010), indicating that for the most part, respondents with a college degree were willing to pay more for lake water quality conservation than those who never started or finished college. This is in line with my hypothesis that higher education is a significant indicator of an individual's conservation behavior.

Water Quality Perceptions

As predicted, regardless of which lake they were from, respondents who perceived their lake as having "definite algal greenness, brownness, or yellowness", "high algal levels" or "severely high algal levels" (the three lowest ranks on the 1-5 scale) during the second half of the summer, were willing to pay significantly more than respondents who perceived their lake as only having "slight algae" or being "crystal clear" (the two highest ranks on the 1-5 scale). This difference was highly significant for all WTP values: WTP_1 (p=0.005); WTP_2 (p=0.005); WTP_3 (p=0.009); WTP_4 (p=0.006). On average, respondents who perceived "definite algae" or worse were willing to pay $17.04/month to improve water quality (WTP_1) and $15.55/month to prevent water quality from declining (WTP_2). On the other hand, respondents who perceived "slight /no algae" were only willing to pay $4.92/month to improve water quality (WTP_1) and \$5.33/month to prevent water quality from declining (WTP_2).

Additionally, respondents who ranked their lake's water quality as low compared to the other Belgrade Lakes were for the most part willing to pay significantly more for lake conservation. This difference was significant for WTP_1 ($p=0.026$), WTP_3 ($p=0.019$), andWTP_4 ($p=0.013$), but not for WTP_2 ($p=0.016$). The above results support my hypothesis that willingness to pay for lake conservation is associated with water quality perceptions. Regardless of which lake they lived on, respondents who were aware of their lake's water quality problems, and assessed these problems to be severe, were more likely to feel a sense of responsibility to participate in conservation that would preserve or improve water quality.

Water Quality Improvements Versus Prevention of Water Quality Deterioration

I designed the survey with four different willingness to pay variables to compare whether or not respondents would be willing to pay more for water quality improvements (WTP_1 and WTP_3) or the prevention of water quality deterioration (WTP_2 and WTP_4). For the first valuation scenario, respondents were willing to pay nearly the same amount on average for improving water quality (\$13.36/month) as they were for preserving water quality (\$12.56/month). For the second valuation scenario, respondents were willing to pay slightly less on average to improve water quality (\$270.00) than they were to preserve water quality at its current state (\$290.48). These differences, however, were not statistically significant at any level. It seems that respondents did not have a preference for one over the other.

Table 7. Mean willingness to pay values (in dollars) for a watershed wide program that would improve lake water quality (WTP_1) and prevent lake water quality deterioration (WTP_2). The mean WTP values are compared across 8 different respondent categories, listed in the column on the left. The Mann-Whitney U tests compare the mean WTP values of sequential rows (e.g. East pond versus North Pond respondents). For each comparison, the Mann-Whitney U statistic is reported above the p-value, which is in parentheses.

Variable	**WTP_1**			**WTP_2**		
	N	Mean ($)	Mann-Whitney (P-value)	N	Mean ($)	Mann-Whitney (P-value)
Lake						
East Pond	17	18.35	-1.497	16	15.44	-1.134
North Pond	19	8.37	(0.134)	19	9.68	(0.257)
Lake Association						
Non-member	6	2.50	-2.467	6	4.17	-2.306
Member	29	15.03	(0.014)*	28	14.00	(0.021)*
Gender						
Female	16	15.11	-0.948	15	11.78	-0.697
Male	17	10.82	(0.343)	17	12.88	(0.486)
Income						
<$50,000	10	6.50	-2.81	10	7.00	-3.158
>$50,000	16	15.75	(0.005)**	16	17.94	(0.002)**
Education						
Non-graduate	9	5.56	-2.1512	9	6.11	-2.566
College graduate	25	16.84	(0.012)*	24	15.67	(0.010)**
Age						
>60	18	12.61	2.025	17	8.94	2.782
<60	15	15.47	(0.043)*	15	17.80	(0.005)**
Water Quality Perceptions						
Slight/No Algae	12	4.92	-2.787	12	5.33	-2.807
Definite Algae	23	17.04	(0.005)**	22	15.55	(0.005)**
Belgrade_High	22	8.68	-2.234	22	10.50	-1.392
Belgrade_Low	11	25.55	(0.026)*	10	19.00	(0.164)

(*)$p<0.05$; (**)$p<0.01$

Table 8. A comparison of willingness to pay values (in dollars) for a vegetated buffer on one's property that would improve lake water quality (WTP_3) and prevent lake water quality deterioration (WTP_4). The mean WTP values are compared across 8 different respondent categories, listed in the column on the left. The Mann-Whitney U tests compare the mean WTP values of sequential rows (e.g. East pond versus North Pond respondents). For each comparison, the Mann-Whitney U statistic is reported above the p-value, which is in parentheses.

Variable	**WTP_3**			**WTP_4**		
	N	Mean ($)	Mann-Whitney (P-value)	N	Mean ($)	Mann-Whitney (P-value)
Lake						
East Pond	12	416.67	-2.273	12	441.67	-2.351
North Pond	14	125.00	(0.023)*	14	139.29	(0.019)*
Lake Association						
Non-member	4	25.00	-2.187	4	25.00	-2.225
Member	21	302.27	(0.029)*	21	325.00	(0.026)*
Gender						
Female	9	172.22	0.833	9	227.78	0.352
Male	14	310.71	(0.405)	14	307.14	(0.7251)
Income						
<$50,000	6	33.33	-3.295	6	33.33	-3.333
>$50,000	13	400.00	(0.001)**	13	438.46	(0.001)**
Education						
Non-grad	5	100.00	-1.912	5	100.00	-2.019
College-grad	19	328.95	(0.056)	19	355.26	(0.044)*
Age						
>60	12	154.17	2.054	12	150.00	2.372
<60	12	404.17	(0.040)*	12	445.83	(0.018)*
Water Quality Perceptions						
Slight/No Algae	9	55.56	-2.621	9	55.56	-2.732
Definite Algae	16	378.13	(0.009)**	16	396.88	(0.006)**
Belgrade_High	16	178.13	-2.334	16	190.63	-2.490
Belgrade_Low	8	462.50	(0.019)*	8	500.00	(0.013)*

(*)p<0.05; (**)p<0.01

DISCUSSION

In summary, the above results indicate that East Pond and North Pond respondents did not differ significantly in terms of residential status, age, income, schooling, lake association membership, or recreational activity. Consequently, the lake variable, which distinguished East Pond and North Pond respondents, could proxy for lake water quality. Although East Pond respondents perceived their water quality lower than North Pond respondents, they participated in recreational activities—swimming, fishing, boating, and enjoying the scenery— as frequently as North Pond respondents. This may indicate that decreased recreation is not yet a significant cost associated with water quality degradation in East Pond.

On average, the water quality perceptions of respondents were in line with secchi disk data from May-October 2009. Furthermore, the water quality perceptions of East Pond and North Pond respondents were not significantly different during the first half of the summer when both lakes were characterized by good water quality, but perceptions did differ significantly during the second half of the summer when East Pond experienced its worst blooms. East Pond respondents perceived their lake to have "high algal levels", the second to worst ranking (4 out of 5 on a 1-5 scale), while North Pond respondents' perceptions remained at "not quite crystal clear, slight algae visible", the second highest ranking (2 out of 5). This difference was highly significant ($p<0.01$). Lastly, East Pond respondents ranked their lake lower among the Belgrade Lakes than did North Pond respondents. On a 1-7 scale, where 1 was the worst water quality out of the Belgrade lakes and 7 was the best, East Pond respondents ranked their lake at an average of 2.65 compared to North Pond's 4.59. This difference was highly significant ($p<0.01$).

Furthermore, in accordance with past contingent valuation and pro-environmental behavior studies (Bateman et al. 2006; Del Saz-Salazar et al. 2009), all four measurements of WTP were significantly higher for respondents who were under the age of 60, made greater than $50,000 annually, perceived at least "definite algae" during the second half of the summer, and were lake association members. Additionally, at least two of the four measurements of WTP were significantly higher for respondents who were college graduates, from East Pond, and ranked their water quality as low compared to the other Belgrade Lakes (2 or below on a 1-7 scale).

These results suggest that specific characteristics—age, income, lake association membership, and water quality perceptions—are associated with higher willingness to pay for lake conservation among residents on North Pond and East Pond. The water quality perceptions outcome is consistent with past studies that found environmental responsibility to be conditional on the intensity of the environmental problem (Bateman et al. 2006; Story and Forsyth 2008; Del Saz-Salazar et al. 2009). Moreover, East Pond's poor water quality provides a motivation for residents to invest in lake conservation that could potentially improve lake water quality. For these residents, spending more on lake conservation and water quality improvement could have a direct impact on their current recreational experiences and property values. This motivation is much smaller for North Pond residents who might not gain as much from an improvement in the lake's already good water quality.

Nevertheless, there are several limitations to this study. Firstly, the sample size is quite small, and consists of mostly older lake association members. Therefore, the results do not necessarily represent the full lake populations. Additionally, the sample observations were not normally distributed, which prevented me from performing a regression analysis. A regression analysis would yield more robust results, because it would show the causal relationship between the explanatory variables (e.g. water quality perceptions and age) and willingness-to-pay, holding all else constant. It would also yield coefficients for each explanatory variable, which would estimate how much willingness to pay increases or decreases given specific demographic characteristics and water quality perceptions.

I also only analyzed willingness to pay for one form of lake conservation—vegetated buffers. However, there are many other forms of lake conservation, such as septic system upkeep, decreased road construction, and lawn care. Surveying residents about all of these forms of lake conservation is necessary for a more comprehensive analysis, which would indicate the forms of lake conservation that are the most desirable or important to residents.

Conventional contingent valuation studies usually survey hundreds of people and use regression analysis to elicit an accurate estimate of the value of an environmental good. This estimate is then used to weigh the costs and benefits of initiating more restrictive policies for the source, such as development or industry, of environmental quality degradation (Whitehead 2006). This study, however, has a small sample size of relatively homogeneous respondents (mostly lake association members), and does not necessarily yield accurate estimates of the economic value of each lake's water quality.

The intention of this study, however, was not necessarily to identify motivations for lake conservation that could be extrapolated to all lakeshore residents in the country. Nor was the intention to use contingent valuation and willingness-to-pay to estimate the economic value of East Pond and North Pond. Instead, this study was conducted to determine some of the key motivations for lake conservation, among two lakes with different water qualities, to begin to design a model for what I have termed buffernomics—the study of how much and why residents are willing to pay for lake conservation. In this model, an economic measurement—willingness to pay—is used to more accurately assess the motivations behind lake stewardship than would environmental value measurements—such as the NEP— which tend to yield inflated results (Fridgen 1994; Cooper et al. 2004; Story and Forsyth 2008). The survey model in this study may be used by conservation organizations and lake associations to assess how much residents are willing to fund lake conservation efforts. Additionally, it will help lake conservation groups design more effective programs for engaging residents in lake stewardship by improving their understanding of the key motivators of conservation behavior and finance among watershed residents.

Recommendations for North Pond and East Pond

Based upon the results of this study and a literature review, I propose the following three recommendations for local lake associations and interested conservation groups: (1) increase awareness of lake water quality problems, (2) develop a targeted approach for lake conservation projects, (3) and increase lake association membership and fees.

Increase Awareness of Lake Water Quality Problems

Regardless of which lake respondents were from, water quality perceptions were a significant determinant of willingness to pay for lake conservation. Therefore, raising awareness about the indicators of water quality deterioration and consequences of decreased water quality—like decreased property values—should be a focus for residential engagement campaigns. Conservation groups should increase educational programs about lake water quality and focus these programs on residents who are not as perceptive of the water quality problems that affect the lake. Additionally they should focus their financial assistance for conservation projects, like vegetated buffers, on residents who are low income and cannot afford to pay for best management practices on their properties.

Targeted Approach for Lake Conservation

In combination with the literature review, the findings of this study indicate that a more targeted approach for stakeholder engagement may be necessary for effective water quality conservation (Brody et al. 2005). Instead of investing resources in attempting to engage all residents in lake conservation programs that require financial support, the local lake associations may want to consider pitching the program to specific areas of residents who are willing-to-pay the most to protect or improve lake water quality. In the case of East Pond and North Pond, these areas would be concentrated with younger and higher-income lake association members. Once the program is established in these areas with consistent funding, then lake associations can continue to implement the program in other areas of the watershed.

Increase Lake Association Membership and Fees

In this study, lake association membership was shown to a have a significant and positive impact on willingness-to-pay for lake conservation. Moreover, lake association members were willing to invest significantly more money into protecting their lakes than non-members. Increasing lake association membership may be a way to improve lake stewardship. In fact, the local municipalities should consider making lake association membership, like homeowner association membership, a requirement for living on the shoreline. The funds generated from membership fees can go towards protecting and improving lake water quality through programs—like the one described in the survey—that increase the number of buffers along the shoreline.

Additionally, the East Pond and North Pond lake associations currently spend most of their budgets on programs to protect their lakes from invasive species. While these programs are extremely important for protecting lake ecosystems, the results of this study show that there is an additional interest in lake conservation that focuses specifically on water quality, especially among East Pond residents. The local lake associations should consider raising the annual membership fee for residents who are interested in improving and preserving water quality. This increased membership should be marketed as an investment in the lake and a consequent investment in one's shoreline property.

CONCLUSION

This study used a contingent valuation survey to assess the motivations behind shoreline residents' willingness to pay for lake conservation on North Pond and East Pond. The results indicate that age, income, lake association membership, and water quality perceptions were the most significant determinants of willingness to pay. Regardless of which lake respondents lived on, those who perceived worse water quality were more inclined to pay for lake conservation projects that would improve lake water quality. These findings indicate that lake conservation organizations may want to use a more targeted approach for lake conservation programs, and focus their efforts on increasing lake association membership.

While the results of this study begin to demonstrate some of the key characteristics that contribute to an individual's willingness to pay for lake conservation, they are explanatory in nature. Moreover, a study that includes all seven of the Belgrade Lakes is necessary to perform a regression analysis that will indicate causal relationships. Additionally, the next survey should include non-shoreline residents who also contribute to the nutrient loads that catalyze cultural eutrophication, and it should use more types of lake conservation besides vegetated buffers. Lastly, a spatial analysis should be conducted in combination with the larger survey, to determine whether there are significant clusters of residents who are willing to pay more for lake water quality improvement. The results of this study are the first step towards designing a new model—buffernomics— that lake associations and conservation organizations can use to better assess motivations for lake conservation and thus improve their policies for engaging residents in lake stewardship.

PERSONAL COMMUNICATIONS

Ann Speers – PhD. Candidate	University of Maine
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Maggie Shannon – Director	Maine Congress of Lake Associations
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Rick Watson – President	North Pond Lake Association
Robert Jones – President	East Pond Lake Association
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APPENDIX A: EAST POND SURVEY

Perceptions of Water Quality in East Pond and North Pond: A Research Survey

It is my understanding that you currently own or rent property on either East Pond or North Pond. I am a student at Colby College and for my senior honors thesis I am contacting a random sample of residents from the two lakes to learn about lake resident perceptions of water quality. Your answers are confidential and will only be used to perform analysis and create summaries in which no individual's answers can be identified. Thank you for taking a few minutes to share your experiences and opinions about East Pond or North Pond. **If you have internet access, please fill this survey out online. To access the online version, please use the following link (which is case sensitive):**

http://atrial.qualtrics.com/SE/?SID=SV_9ohZkEWPpEqbqmg

If you prefer to use a hard copy, please fill this survey out and mail it back using the enclosed envelope by **March 18.**

1. **On which of the Belgrade Lakes is your lake residence? (if you own more than one, answer the following questions about your primary lake residence)**
   ☐ North Pond ☐ East Pond
2. **Do you own or rent your lake residence?**
   ☐ Own ☐ Rent ☐ Other (please specify):__________________
3. **In what town is your lake residence?**
   ☐ Mercer ☐ Oakland ☐Rome ☐Smithfield ☐Other (please specify):____________________
4. **Since what year have you lived at your lake residence? __________________________** year
5. **Since what year have you lived on North Pond or East Pond? __________________________** year
6. **Do you live in your lake residence year round or seasonally?**
   ☐ Year round ☐ Seasonally
7. **If you are a seasonal resident, what is the zip code of your permanent residence?**
   _______________________________________ zip code
8. **On average how much time do you spend in your lake residence <u>annually</u>?**
   ☐ A couple of days ☐ A couple of weeks ☐ 1-3 months ☐ 4-6 months ☐ More than 6 months
9. **During which months do you visit your lake residence? (select all that apply)**
   ☐ January ☐ February ☐ March ☐ April ☐ May ☐ June
   ☐ July ☐ August ☐ September ☐October ☐ November ☐ December
10. **During the summer season (May-October), do you rent your residence out to tenants?**
    ☐Yes ☐No ☐Other (please specify):____
11. **Does your lake have a lake association?**
    ☐ Yes ☐ No (Skip to 12) ☐ Not sure (Skip to 12)

    → **11a. (If Yes), are you a member of the lake association?**
    ☐ Yes ☐ No ☐ Not sure

    → **11b. Do you know anyone who is a member of the lake association?**
    ☐ Yes ☐ No ☐ Not sure

    → **11c. How active in engaging residents is your lake association?**

Not Active (1) **Very Active (7)**

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7

12. **During the summer season (May-October), how often do you engage in the following activities on North Pond or East Pond? (please mark one box for each activity)**

	Never	Less than once a month	Once a month	2-3 times a month	Once a week	2-3 times a week	Daily
Relaxing and enjoying the scenery	☐	☐	☐	☐	☐	☐	☐
Swimming	☐	☐	☐	☐	☐	☐	☐
Fishing	☐	☐	☐	☐	☐	☐	☐
Boating	☐	☐	☐	☐	☐	☐	☐
Other (please specify):	☐	☐	☐	☐	☐	☐	☐

13. **On average, how would you best describe the water quality of your lake during the <u>first</u> half of the summer season (May-July)?**

☐ Crystal clear water

☐ Not quite crystal clear, slight algae visible

☐ Definite algal greenness, yellowness or brownness apparent

☐ High algal levels with limited clarity and/or mild odor apparent

☐ Severely high algae levels with one or more of the following: massive floating scum on lake or washed up on shore, strong foul odor or fish kill

☐ Other (please specify):____

14. **On average, how would you describe the water quality of your lake during the <u>second</u> half of the summer season (August-October)?**

☐ Crystal clear water

☐ Not quite crystal clear, slight algae visible

☐ Definite algal greenness, yellowness or brownness apparent

☐ High algal levels with limited clarity and/or mild odor apparent

☐ Severely high algae levels with one or more of the following: massive floating scum on lake or washed up on shore, strong foul odor or fish kill

☐ Other (please specify):____

15. **How do you think the general water quality of your lake compares to the general water quality of the other Belgrade Lakes?**

Worst (1) **Best (7)**

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7

16. **How important is the lake's water quality for your enjoyment of your lake residence?**

Not important (1) **Very important (7)**

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7

17. **To what extent do you think the lake's water quality affects your property's value?**

No effect (1) **Large effect (7)**

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7

The following is a table describing different levels of water quality and the characteristics that follow:

Quality Index	**Level**	**Characteristics**
Best Possible	A	Beautiful, could not be any nicer
	B	Very minor aesthetic problems. Excellent for swimming, boating and enjoyment.
	C	Swimming and aesthetic enjoyment slightly impaired because of algae levels.
	D	**Desire to swim and level of enjoyment of the lake substantially reduced because of algae levels.**
Worst Possible	E	Swimming and aesthetic enjoyment of the lake nearly impossible because of algae levels.

<u>East Pond is currently at level D</u> and has been on the Department of Environmental Protection's impaired lake list since 2001, because of reoccurring algal blooms. These algal blooms are partially a result of phosphorus pollution that "runs-off" the surrounding watershed when it rains. Out of the seven Belgrade Lakes, East Pond is one of the most affected by phosphorus. Fifty-one percent of phosphorus run-off into East Pond comes from residential development and roads. One way to reduce phosphorus run-off is through the implementation of best management practices, such as a buffer between a property and the lake, to prevent run-off from entering the lake and reduce erosion.

For this survey let's assume that improvements to water quality could be made through a watershed wide program that would redirect phosphorus run-off away from the lake. The program would increase the number of buffers between the lake and surrounding residential properties, commercial properties, and farms. The cost to build these buffers would be paid for by a conservation fund supported by monthly payments from watershed residents that would be paid for as long as they lived on the lake.

18. How much would you be willing to pay in a monthly conservation fee to <u>improve</u> East Pond's water quality from <u>level D to level C</u>?

☐ $0 ☐ $1 ☐ $2 ☐ $5 ☐ $10 ☐ $15 ☐ $20

☐Other (please specify):_____________

19. How sure are you of your answer to Q.18?

No Certainty (1) **Absolute Certainty (7)**

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7

20. How much would you be willing to pay in a monthly conservation fee to <u>prevent</u> East Pond's water quality from <u>falling</u> from <u>level D to level E</u>?

☐ $0 ☐ $1 ☐ $2 ☐ $5 ☐ $10 ☐ $15 ☐ $20

☐Other (please specify):_____________

21. How sure are you of your answer to Q.20?

No Certainty (1) **Absolute Certainty (7)**

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7

22. If you selected at least $1/month for either Q. 18 or Q.20, what are the reasons you <u>would</u> be willing to pay?

____

____

____

____

23. **If you selected $0 for either Q. 18 or Q.20, what are the reasons you <u>would not</u> be willing to pay any amount?**

____

____

____

____

Another way that residents can help to improve lake water quality is by voluntarily installing a vegetative buffer between their property and the lake. Two examples are shown below:

24. **Do you have a vegetative buffer between your property and the lake?**

☐ Yes ☐ No ☐ Not sure ☐Other (please specify):______________________________

25. **If you do not already have a vegetative buffer, would you be willing to install one?**

☐ Yes ☐ No ☐ Not sure ☐Other (please specify):______________________________

26. **How much would you be willing to pay in a one-time cost to install a vegetative buffer if it could <u>improve</u> East Pond's water quality from <u>level D to level C</u>?**

☐ $0 ☐ $50 ☐ $100 ☐ $200 ☐$400 ☐$800

☐Other (please specify):_____________

27. **How sure are you of your answer to Q.26?**

No Certainty (1) **Absolute Certainty (7)**

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7

28. **How much would you be willing to pay in a one-time cost to install a vegetative buffer if it could <u>prevent</u> East Pond's water quality from <u>falling</u> from <u>level D to level E</u>?**

☐ $0 ☐ $50 ☐ $100 ☐ $200 ☐$400 ☐$800

☐Other (please specify):_____________

29. **How sure are you of your answer to Q.28?**

No Certainty (1) **Absolute Certainty (7)**

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7

30. If you answered any dollar amount larger than $0 in Q.26 or Q.28, what are the reasons you <u>would</u> be willing to pay?

____

____

____

____

31. If you answered $0 in Q.26 or Q. 28, what are the reasons you <u>would not</u> be willing to pay?

____

____

____

____

32. If you are <u>not</u> willing to pay anything, would you reconsider if you were offered a municipal tax break?

☐ Yes ☐ No ☐ Not sure ☐Other (please specify):_______________________________

33. What is your gender?

☐ Male ☐ Female ☐ Other

34. What is your age?

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

35. What is the highest level of schooling that you have completed?

☐ Some high school or less ☐ High school graduate ☐ Some college/vocational school

☐ College graduate ☐ Some post graduate schooling ☐ Advanced graduate or professional degree

36. Which of the following broad categories best describes your total income from all sources in 2010?

☐ $10,000 or less ☐ $10,001 to $20,000 ☐ $20,001 to $35,000 ☐ $35,0001 to $50,000 ☐ $50,001 to $100,000

☐$ 100,001 or more

37. How many people live in your lake residence including yourself? _______________

38. Of the people living in your lake residence, how many are 18 years of age or younger? _______________

39. Do you have internet access in your lake residence?

☐Yes ☐No ☐Other (please specify):_____________________

APPENDIX B: NORTH POND SURVEY

Perceptions of Water Quality in East Pond and North Pond: A Research Survey

It is my understanding that you currently own or rent property on either East Pond or North Pond. I am a student at Colby College and for my senior honors thesis I am contacting a random sample of residents from the two lakes to learn about lake resident perceptions of water quality. Your answers are confidential and will only be used to perform analysis and create summaries in which no individual's answers can be identified. Thank you for taking a few minutes to share your experiences and opinions about East Pond or North Pond. **If you have internet access, please fill this survey out online. To access the online version, please use the following link (which is case sensitive):**

http://atrial.qualtrics.com/SE/?SID=SV_3a9sTZetSAimIpC

If you prefer to use a hard copy, please fill this survey out and mail it back using the enclosed envelope by **March 18.**

1. **On which of the Belgrade Lakes is your lake residence? (if you own more than one, answer the following questions about your primary lake residence)**
   ☐ North Pond ☐ East Pond
2. **Do you own or rent your lake residence?**
   ☐ Own ☐ Rent ☐ Other (please specify):__________________
3. **In what town is your lake residence?**
   ☐ Mercer ☐ Oakland ☐Rome ☐Smithfield ☐Other (please specify):____________________
4. **Since what year have you lived at your lake residence? __________________________** year
5. **Since what year have you lived on North Pond or East Pond? __________________________** year
6. **Do you live in your lake residence year round or seasonally?**
   ☐ Year round ☐ Seasonally
7. **If you are a seasonal resident, what is the zip code of your permanent residence?** _______________________________zip code
8. **On average how much time do you spend in your lake residence annually?**
   ☐ A couple of days ☐ A couple of weeks ☐ 1-3 months ☐ 4-6 months ☐ More than 6 months
9. **During which months do you visit your lake residence? (select all that apply)**
   ☐ January ☐ February ☐ March ☐ April ☐ May ☐ June
   ☐ July ☐ August ☐ September ☐October ☐ November ☐ December
10. **During the summer season (May-October), do you rent your residence out to tenants?**
    ☐Yes ☐No ☐Other (please specify):____
11. **Does your lake have a lake association?**
    ☐ Yes ☐ No (Skip to 12) ☐ Not sure (Skip to 12)

    11a. (If Yes), are you a member of the lake association?
    ☐ Yes ☐ No ☐ Not sure

    11b. Do you know anyone who is a member of the lake association?
    ☐ Yes ☐ No ☐ Not sure

    11c. How active in engaging residents is your lake association?
    Not Active (1) **Very Active (7)**
    ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7

12. During the summer season (May-October), how often do you engage in the following activities on North Pond or East Pond? (please mark one box for each activity)

	Never	Less than once a month	Once a month	2-3 times a month	Once a week	2-3 times a week	Daily
Relaxing and enjoying the scenery	☐	☐	☐	☐	☐	☐	☐
Swimming	☐	☐	☐	☐	☐	☐	☐
Fishing	☐	☐	☐	☐	☐	☐	☐
Boating	☐	☐	☐	☐	☐	☐	☐
Other (please specify):	☐	☐	☐	☐	☐	☐	☐

13. On average, how would you best describe the water quality of your lake during the <u>first</u> half of the summer season (May-July)?

☐ Crystal clear water

☐ Not quite crystal clear, slight algae visible

☐ Definite algal greenness, yellowness or brownness apparent

☐ High algal levels with limited clarity and/or mild odor apparent

☐ Severely high algae levels with one or more of the following: massive floating scum on lake or washed up on shore, strong foul odor or fish kill

☐ Other (please specify):____

14. On average, how would you describe the water quality of your lake during the <u>second</u> half of the summer season (August-October)?

☐ Crystal clear water

☐ Not quite crystal clear, slight algae visible

☐ Definite algal greenness, yellowness or brownness apparent

☐ High algal levels with limited clarity and/or mild odor apparent

☐ Severely high algae levels with one or more of the following: massive floating scum on lake or washed up on shore, strong foul odor or fish kill

☐ Other (please specify):____

15. How do you think the general water quality of your lake compares to the general water quality of the other Belgrade Lakes?

Worst (1) **Best (7)**

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7

16. How important is the lake's water quality for your enjoyment of your lake residence?

Not important (1) **Very important (7)**

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7

17. To what extent do you think the lake's water quality affects your property's value?

No effect (1) **Large effect (7)**

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7

The following is a table describing different levels of water quality and the characteristics that follow:

Quality Index	Level	Characteristics
Best Possible	A	Beautiful, could not be any nicer
	B	Very minor aesthetic problems. Excellent for swimming, boating and enjoyment.
	C	**Swimming and aesthetic enjoyment slightly impaired because of algae levels.**
	D	Desire to swim and level of enjoyment of the lake substantially reduced because of algae levels.
Worst Possible	E	Swimming and aesthetic enjoyment of the lake nearly impossible because of algae levels.

North Pond is currently at level C. Declining water quality is often a result of phosphorus pollution that "runs-off" the surrounding watershed when it rains. One way to reduce phosphorus run-off is through the implementation of best management practices, such as a buffer between a property and the lake, to prevent run-off from entering the lake and reduce erosion.

For this survey, let's assume that improvements to water quality could be made through a watershed wide program that would redirect phosphorus run-off away from the lake. The program would increase the number of buffers between the lake and surrounding residential properties, commercial properties, and farms. The cost to build these buffers would be paid for by a conservation fund supported by monthly payments from watershed residents that would be paid for as long as they lived on the lake.

18. How much would you be willing to pay in a monthly conservation fee to improve North Pond's water quality from level C to level B?

☐ $0 ☐ $1 ☐ $2 ☐ $5 ☐ $10 ☐ $15 ☐ $20

☐Other (please specify):_____________

19. How sure are you of your answer to Q.18?

No Certainty (1) **Absolute Certainty (7)**

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7

20. How much would you be willing to pay in a monthly conservation fee to prevent North Pond's water quality from falling from level C to level D?

☐ $0 ☐ $1 ☐ $2 ☐ $5 ☐ $10 ☐ $15 ☐ $20

☐Other (please specify):_____________

21. How sure are you of your answer to Q.20?

No Certainty (1) **Absolute Certainty (7)**

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7

22. If you selected at least $1/month for either Q. 18 or Q.20, what are the reasons you would be willing to pay?

____

____

____

____

23. If you selected $0 for either Q. 18 or Q.20, what are the reasons you <u>would not</u> be willing to pay any amount?

____

____

____

____

Another way that residents can help to improve lake water quality is by voluntarily installing a vegetative buffer between their property and the lake. Two examples are shown below:

24. Do you have a vegetative buffer between your property and the lake?

☐ Yes ☐ No ☐ Not sure ☐Other (please specify):______________________________

25. If you do not already have a vegetative buffer, would you be willing to install one?

☐ Yes ☐ No ☐ Not sure ☐Other (please specify):______________________________

26. How much would you be willing to pay in a one-time cost to install a vegetative buffer if it could <u>improve</u> North Pond's water quality from <u>level C to level B</u>?

☐ $0 ☐ $50 ☐ $100 ☐ $200 ☐$400 ☐$800

☐Other (please specify):_____________

27. How sure are you of your answer to Q.26?

No Certainty (1) **Absolute Certainty (7)**

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7

28. How much would you be willing to pay in a one-time cost to install a vegetative buffer if it could <u>prevent</u> North Pond's water quality from <u>falling</u> from <u>level C to level D</u>?

☐ $0 ☐ $50 ☐ $100 ☐ $200 ☐$400 ☐$800

☐Other (please specify):_____________

29. How sure are you of your answer to Q.28?

No Certainty (1) **Absolute Certainty (7)**

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7

30. If you answered any dollar amount larger than $0 in Q.26 or Q.28, what are the reasons you would be willing to pay?

____

____

____

____

31. If you answered $0 in Q.26 or Q. 28, what are the reasons you would not be willing to pay?

____

____

____

____

32. If you are not willing to pay anything, would you reconsider if you were offered a municipal tax break?

☐ Yes ☐ No ☐ Not sure ☐Other (please specify):_______________________________

33. What is your gender?

☐ Male ☐ Female ☐ Other

34. What is your age?

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

35. What is the highest level of schooling that you have completed?

☐ Some high school or less ☐ High school graduate ☐ Some college/vocational school

☐ College graduate ☐ Some post graduate schooling ☐ Advanced graduate or professional degree

36. Which of the following broad categories best describes your total income from all sources in 2010?

☐ $10,000 or less ☐ $10,001 to $20,000 ☐ $20,001 to $35,000 ☐ $35,0001 to $50,000 ☐ $50,001 to $100,000

☐$ 100,001 or more

37. How many people live in your lake residence including yourself? _______________

38. Of the people living in your lake residence, how many are 18 years of age or younger? _______________

39. Do you have internet access in your lake residence?

☐Yes ☐No ☐Other (please specify):_____________________