THE INFLUENCE OF WATER CLARITY ON RECREATION AND HOME PURCHASING DECISIONS ON NEW HAMPSHIRE LAKES

Kevin Scribner
457 Clinton Street
Concord, NH 03301

John Halstead
Professor and Chairperson
Resource Economics & Development

Ryan McCarthy
Graduate Student
University of New Hampshire

Julie Gibbs
Former Graduate Student
University of New Hampshire

Abstract

This article looks at whether or not the water clarity of New Hampshire Lakes influences a persons' purchase decision of lakefront property. The influence of water clarity was compared against nine independent variables to look at the characteristics of the people who are influenced by water clarity. The results of this study should allow for better management of New Hampshire Lakes, as it is better understood how people use their lakes and the characteristics of these people. This research shows that water clarity does influence a person's decision to buy, and that selected personal characteristics do influence the desire for improved water clarity.

1.0 Introduction

In recent years the use and development of New Hampshire lakes has increased. Both people within the state and outside the state have bought houses on New Hampshire lakes. This study looks at the influence of water clarity of these lakes on potential buyers of lakefront property and how concerns for fishing, swimming and other factors are affected by water clarity.

An understanding of the importance of water clarity is a good tool for future management of New Hampshire lakes. Due to the fact that water quality and clarity are in many respects public goods it is difficult to monitor their health. It is important to understand the level of clarity people desire in their lakes in order to implement a long-range strategy for environmental monitoring of New Hampshire lakes.

The utility of a lake house is a function of its structural, location and environmental characteristics. The environmental characteristics are made up of water clarity, the size of the lake, its depth, and other aspects. This paper looks at the water clarity aspect. The objectives of this study are to determine if people base their decision to purchase lakefront property on the lakes' water clarity. In addition, this study will look at the characteristics of these people to see what types of people are influenced by water clarity.

1.1 The Survey

This survey was originally conducted in 1999 by Julie Gibbs and was entitled "New Hampshire Lake Water Quality Survey". It consisted of 55 questions, broken down into six different sections. The sections looked at the important characteristics of a lake to the buyer, what structures were on the property at the time of purchase, the location of the lakefront property, the familiarity of the lake prior to purchase, the minimum water clarity during summer months and the demographic data of the respondent.

The objective of the survey was to determine possible effects that water clarity has on lakefront properties in New Hampshire. The surveys were sent to individuals who purchased lakefront property between 1990 and 1995. One hundred and seventy-eight surveys were collected from an area of 16 lakes. From the 178 responses, 75 were useable for this study, after deleting the observations with missing data points. The water clarity question in the survey served as the dependent variable and was stated "Did the minimum water clarity during the summer months at the time you purchased the property influence your decision to buy the property". It was selected because clarity best serves as a generalization for many of the most sought after water characteristics, although it does not account for any chemicals (harmful or otherwise) in the lake.

1.2 Case Study Area

The Lakes Region in Central New Hampshire was selected as the study area to examine the effects water clarity had on specific behaviors of lakefront property owners. The study includes the area around Lake Winnipesaukee, however does not include the lake itself.

Lake Winnipesaukee consists of several geographical and political barriers, and could not be included for logistical and financial factors in the original survey. Sixteen lakes were studied within the Lakes Region (Bearcamp, Squam, Sunset, Hills, Winnesquam, Suncook, Waukewan, Winona, Crystal, Wicwas, Lee, Loon, Wentworth, Mirror, Whiteoak and Merrymeeting Lakes).

2.0 Literature review

A search of existing literature concerning water clarity and property value provided limited results. A master's thesis by Julie Gibbs (2000) examined the freshwater lakes in the State of New Hampshire. She attempted to quantify the effects varying water clarity had on lakefront property pricing. Six market areas in the state were identified and water clarity was determined to have an influence on an individual's decision to buy.

A paper by Shapiro and Kroll (2001) was an attempt to study the economic values of the surface waters in the state of New Hampshire. It was done as the first stage of a multi-level project. Phase One was a preliminary assessment of relevant literature, data, and methodological approaches for estimating the economic value of surface water. They found there were many values associated with the waters, including aesthetic, spiritual, and cultural. A NHDES study of Lake Wentworth (1999) yielded some interesting insight into this issue. The study noted that the water clarity in Lake Wentworth has actually improved over the past several decades, and also notes that the lake is considered "Class A" by NHDES. The property values on the lake have increased over the past two decades. The report falls short, however, of linking the two characteristics.

A search was also performed regarding the type of model to utilize for the study. A paper by Capps and Kramer (1985) used a qualitative choice model to determine household participation in a food stamp program using a logit and probit model. The authors concluded there was no relative advantage to either methodology. Another study reviewed was by Miller and Hay (1981) that used a logit model or a linear probability model to determine duck hunter participation in a particular geographic region. The authors concluded that a logit model was superior on theoretical and statistical grounds. Also examined was a bivariate logit model used in the paper by Halstead et al. (1990) that examined the likelihood of a farmer to use manure testing for their soil.

3.0 Model Details

An econometric model was pieced together from the results of the survey to estimate the effects water clarity had on several use and demographic variables of current lakefront property owners. Logit analysis, or a multinomial logit model is a general model of maximization. An individual is assumed to have preferences defined over a set of alternatives. It is assumed that the primary determination of the choice is the characteristics of the individual. Whether or not a person was influenced by water clarity had to do with the characteristics of that person.

Since the only possible answers to the question, "Did water clarity affect your decision to buy your lakefront property?" are "yes" and "no", it was decided to use a qualitative choice model (logit analysis). This technique has been employed in various other fields including wildlife (Miller and Hay 1981), social programs (Capps and Kramer 1985), and agriculture (Halstead et al. 1990).

Water clarity was measured as whether or not it had an influence on the purchasing of the property. Nine independent variables were chosen to see what effect they had on water clarity; that is, to see if the independent variables influenced the desire for water clarity. The variables are described below. Expected results are also presented in the following variable descriptions.

4.0 Variable Descriptions

Lake Frontage (FF). Does the need for greater water clarity increase with an increase in frontage? It would follow that this would be the case as people with more lake frontage see more water. It seems that it would be in their best interest to see clear, unpolluted water.

Good Salmon/Trout Fishing (E). Do people with a greater desire for salmon/trout fishing have a need for better water clarity? Salmon and trout need clear, clean water. Anyone who values trout fishing would also, it seems, want good water clarity.

Good Bass/Perch Fishing (F). Do people with a greater desire for bass/perch fishing have a need for better water clarity? Bass and perch occur in most, if not all of the lakes in our study area. They, unlike trout and salmon, do not need really clear water. If the species do not require

Table 1.—Relationship and Strength of Relationship Between Dependent and Independent Variables

Coefficient	Asymptotic t-ratios	Significance Interval	Mean
Constant	-0.529	0.5968	
Foot Frontage	-1.59	0.1118	150.2
Trout/Salmon Fishing	-1.962	0.0497	3.84
Bass/Perch Fishing	1.469	0.142	3.96
Swimming	1.945	0.0518	4.87
Water Quality	-2.89	0.0038	4.29
Weeds	-0.044	0.9651	3.13
Buyer's Age	0.538	0.5902	46.29
Education	1.923	0.0545	5.05
Employment	-0.34	0.7338	1.59

clean, clear water, than the anglers who target them do not need it either.

Good Swimming (G). Do people with a greater desire for good swimming have a need for better clarity? People like to swim in clear water where they can see the bottom. People who enjoy swimming should partially base their purchase decision on the clarity of the lake.

Water Quality (H20LMH). Does how people rate the overall water quality influence their desire for water clarity? This seems relatively straightforward. If they rate the water quality as low and still purchased the property, then they did not base their decision on the water clarity. These two variables would seem to be correlated.

Weed Growth (in water) in Front of Property (WEEDS). Does weeds in front of house influence your need for water clarity? If there was a high level of weeds and they still purchased the property, then the water clarity wouldn't be very good. You could say they did not base their decision to purchase on the water clarity.

Age (BUYERSAGE). Does the age of a person influence their need for water clarity? Do older people care less? More? Maybe younger people are more environmentally biased in their decisions and activities.

Level of Education (EDUCATION). Does the education of a person influence their need for water clarity? The higher the education, maybe, the better informed the person on the importance for good water clarity. The expectation in this case would be that there is a correlation between the two variables.

Employment Level at Time of Purchase (EMPLOYED). Do retired people want better water clarity? Do people who work full time want better water clarity? Does employment influence this decision?

5.0 Results

Results of the model are presented in Table 1. The sign of the t-ratios indicate whether or not each independent variable increased or decreased the probability the buyer was influenced by water clarity. The t-ratios show if the coefficient is statistically significant. The significance interval is how reliable this relationship between the variables is. The mean is the average of all the responses for each variable.

A word of caution should be given here before proceeding with the interpretation of the results. The dependent variable, water clarity, had a scale where yes = 0 and no = 1. The scale used for the independent variables is inversed. That is, the scale or ordering of "yes" type responses would be 1 and a "no" type response would be 0. This applies to all of the independent variables except Weeds, which had the same ordering as the dependent variable. A positive sign reduces the probability the buyer was influenced by water clarity and a negative sign increases the probability the buyer was influenced by water clarity. In the case of weeds the negative sign means it decreased the probability the buyer was influenced by water clarity, because both variables used the same scale.

For the study six variables were significant at a confidence level of 0.15. Three variables were found to be not statistically significant. These were: the employment level of the individual, the buyer's age and the weed growth in front of the property. The fact that weeds were not significant was surprising, and will be discussed later in the paper.

The results for bass/perch fishing (negative relationship), salmon/trout fishing (positive relationship), water quality (positive relationship) and foot frontage (positive relationship) were as expected. Salmon and trout fishing increased the probability the buyer would be influenced by water clarity in their decision to purchase. This was at a .05 confidence level, suggesting it's a strong relationship. Another variable that was significant at .05 was water quality. A high level of water quality increased the probability the person was influenced by water clarity in their purchase decision. The amount of lakefront

footage was significant at the .15 level. This was at the periphery of allowable significance, but was included in this study. The results for this variable showed that the greater amount of lake frontage increased the probability the owner was influenced by water clarity. If the person has more lake frontage and sees more of the lake, they'll want that view to be a nice one.

The fact that the relationship for bass and perch fishing was negative was not a surprise. This is due to the fact that bass and perch not only live in water with low clarity, they can thrive there. So anyone who is fishing for them isn't going to mind low water clarity because the fish don't mind. The results of the variables indicate that bass and perch fishing reduce the probability the buyer was influenced by water clarity. This also indicates that a fair amount of background knowledge on the part of the purchaser.

Two coefficients that were significant and went against the predicted results were swimming and the education level of the buyer. The desire for good swimming reduced the probability the buyer was influenced by water clarity (at a significance level of 0.10). Wouldn't people who enjoyed good swimming want clear water to swim in? People may base good swimming on other factors (such as the bottom substrate, swimming area, etc.).

The other variable that went against predicted results was the level of education. A negative relationship says that a higher level of education reduces or decreases the probability the buyer was influenced by water clarity (significant at 0.10). Possibly the level of education does not have any bearing on the buyer's decision. Or, maybe a more educated person believes that water clarity alone is not enough for home buying decisions.

The McFadden R^2 examines the variable's goodness of fit. McFadden's R^2 is interpreted as the model's explanatory power. The variables included in the model explain 31% (0.31375) of the probability of getting a "Yes" response. McFadden's R^2 is sometimes referred to as a "pseudo R^2" (Halstead et al. 1990). A traditional R^2 is what portion of our dependent variable's variance can be explained by our independent variables.

The accuracy of the model was also tested comparing the actual response rate of "yes" and "no" for the dependent variable (did water clarity affect decision to purchase)

Table 2

Actual	Predicted		
	0	1	Total
0	33	7	40
1	8	27	35
Total	41	34	75

compared to the predicted response rate of "yes" and "no". The results are displayed in Table 2. The model predicted that 41 of the responses were 0 ("yes") when the actual number was 40. The model also predicted that 34 respondents would not be affected by the water clarity, while the actual number was 35. Also shown in this table is the fact that 40 respondents out of 75 total said that water clarity affected their decision to purchase their property (over 50 percent).

6.0 Conclusions

There were several variables that behaved as originally predicted through the statistical analysis. As initially expected the coefficient of the trout and salmon fishing variable was found to be statistically significant based on an individual's need for water clarity. Knowing the specific habitat requirements for these fish led to the expectations of how the respondents who value them would answer. Also knowing the non-specific habitat requirements for bass and perch species led to the belief that individuals who target bass and perch would not have the same need for water clarity as the trout and salmon anglers. As predicted there was a significant negative relationship between bass and perch fishing and the need for water clarity.

Knowing how valued water clarity is, the public's desire for trout and salmon fisheries should demonstrate a greater need for proper management strategies. The population that responded to the survey would applaud regulations put in place to protect the fragile habitats. Knowing how much the public values the combination of trout and salmon fishing and water clarity, state agencies would be able to better allocate resources to address these issues.

The swimming variable was found to go against our predicted results. Seemingly, an individual would seek the clearest, cleanest water for which to swim in.

Perhaps people base their swimming area preference on the availability of facilities, clean beaches, or bottom substrate (sandy bottom versus mucky). This could be studied further to establish the variables that determine what qualifies as good swimming.

As the amount of lake frontage an individual looks to buy increases, so does the price for that property. It should be clear that there is a positive relationship between the amount of lake frontage an individual has and their need for water clarity. As an individual spends more of their resources on lake frontage, they would want to ensure they are buying it on an environmentally stable, effectively managed water body. Their investment is more likely to hold its value if the abutting water body is desirable for its clarity and overall quality.

The variable of weed growth went against the predictions of the study. With the recent outcry against invasive species, it is difficult to understand how such a hot topic was found to be not significant. There are several reasons why this might have occurred. For one, when this survey was done, the concern about Milfoil and other invasive weeds was not great. Or, perhaps the lakes surveyed did not have a significant problem with weed growth. A third explanation could be that people think of weeds and water clarity as separate. Water can have a high clarity and still have weeds growing in it.

Whatever the reason for this lack of relationship it seems that more research should be done. Milfoil has become a large concern throughout New Hampshire as it chokes out other plants and fish, rendering the water it resides in almost unusable. There have been documented studies by the New Hampshire Department of Environmental Services (NHDES) (Smagula and Connor 1999), the New Hampshire Lakes Association (NHLA), and the University of New Hampshire (UNH) (Halstead et al. 2003) among others, suggesting the dangers that invasive and exotic species pose to property values.

Education was another variable that behaved contrary to original predictions. Logically, as a person's education level increases, their knowledge of the importance of water clarity and quality would increase. In the model, there was a negative relationship, suggesting as an individual's education level increases, their need for water clarity decreases. Perhaps it does not take a well educated

person to understand the advantages to having a lake with a high level of water clarity. Or perhaps a well-educated person knows to look at other factors besides water clarity when making their purchase decision.

Overall the results in our study were split. Several variables behaved as originally predicted (salmon/trout fishing, bass/perch fishing, foot frontage) while others did not (swimming, education). The data has applicable uses in the management of New Hampshire's lakes. The results of this paper could provide a guiding analysis for state and local decision makers and managers.

7.0 Limitations

The analysis performed in this study used 75 observations. This is inadequate for a generalization for all of the Lakes Region in New Hampshire. The limited number of usable observations undoubtedly compromised the accuracy of the results. The age of the data is also something that should give analysts pause. The survey was done of people who had purchased between 1990 and 1995. This is almost 15 years ago, in some cases. The priorities of buyers and the conditions of the lakes could very likely have changed during this time.

Another limitation to the accuracy of the study is the exclusion of Lake Winnipesaukee. Popular thinking suggests that the large lake is the centerpiece of the Lakes Region, and not including it presents a huge gap in the data set. As logistically challenging as it may be to collect the pertinent information, it would benefit the accuracy of the study overall if it were included for analysis. Invasive species also pose a danger on Lake Winnipesaukee, and its inclusion in the data would provide more insight on if the need for water clarity is affected by weed growth.

Expanding the survey population outward by one level to include people who bought property with water access or water rights would also help the study be more comprehensive. This population of people has the same opportunity to use a lake as lakefront property owners, therefore they should be considered when studying concerned or affected stakeholders. This population, although not directly on the lake, has the same concern for protecting the water body and seeing that it is managed properly as lakefront owners.

8.0 Citations

Capps, O. & Kramer, R. A. (February 1985). Analysis of Food Stamp Participation Using Qualitative Choice Models. American Journal of Agricultural Economics.

Gibbs, J. (2000). The Influence of Water Clarity on Marginal Prices for Residential Lake Front Property in New Hampshire. Thesis. University of New Hampshire. Durham, NH.

Halstead, J. M., Kramer, R. A., & Batie, S. S. Logit Analysis of Information in Animal Waste Management. Journal of Production Agriculture. Volume 3. Number 4. 540-544.

Halstead, J. M., Michaud, J., Hallas-Burt, S., & Gibbs, J. P. (2004). Hedonic Analysis of Effects of Nonnative Invader (Myriophyllum heterophyllum) on New Hampshire (USA) Lakefront Properties. Environmental Management. In press.

LIMDEP Version 7.0 Manual. Chapter 24. Multinomial Logit and Discrete Choice Models - LOGIT and NLOGIT. Pg. 483- 490. http://www.et.bs.ehu.es/docpub/manuales/limdep/chap24.pdf

Miller, J. R., & Hay, M. J. (November 1981). Determinants of Hunter Participation: Duck Hunting in the Mississippi Flyway. American Journal of Agricultural Economics.

Shapiro, L., & Kroll, H. (August 1, 2001). A Study of the Economic Values of the Surface Waters of New Hampshire, Phase I Report. New Hampshire Lakes Association.

Shapiro, L., & Kroll, H. (June 2003). Estimates of Select Economic Values of New Hampshire Lakes, Rivers, Streams, and Ponds, Phase II Report. New Hampshire Lakes Association.

Smagula, A., & Connor, J. (October 1999). Lake Wentworth Diagnostic Study, Final Report. New Hampshire Department of Environmental Services.