UNIVERSITY OF WISCONSIN WHITEWATER
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Tainter Lake & Lake Menomin

The Impact of Diminishing Water Quality on Value

Tainter Lake and Lake Menomin suffer from severe and often toxic Blue Green Algae blooms driven by high watershed loading of nutrients. These Blue Green Algae blooms are thick, putrid, and create poor water clarity, making it extremely difficult for residents and tourists in the area to fish and enjoy recreational activities during the summer months. This is creating a major challenge for both lake management associations and community leaders within the area. This report will test the hypothesis that the perceived reduction in water quality has caused a diminution in property value along the lake relative to what would be expected in the absence of a reduction in water quality.

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Executive Summary

This report is a summary of the larger Tainter and Menomin Lake Community Survey and Economic Impact Study. Much of the technical analysis is further developed in that larger volume. This report is comprised of two distinct sections. The first section is a hedonic analysis of the impact of poor water quality on real estate values. Through a hedonic analysis we isolate the effect of a change in lake water quality on the value of these properties. The major findings of this analysis include:

1. Tainter Lake's shoreline per foot ($401.83) is well over $100 less than the next comparable lake (Prairie Lake $532.61).
2. Because of increased eutrophication problems faced by these impounded lakes, property values have not kept pace with lake property of similar qualities.
3. An additional foot of shoreline is less beneficial to the homeowner than the first foot of shoreline

The second section is an input-output analysis. In this section we use IMPLAN to estimate the economic impact and contribution of the part time residents on Red Cedar Watershed area. Prior research has shown that projections of declining water quality leads part time lake property owners to indicate that they will use their property less in the future. As a result, the marginal and incremental dollars they inject into the local economy will diminish. The IMPLAN study in this report estimates both the current economic input these residents offer the regional economy and the projected losses due to continued degradation of the water. The major findings of this analysis include:

1. The economic contribution of part time residents on Red Cedar Watershed creates approximately 24 jobs.
2. The economic contribution of the part time residents on Red Cedar Watershed injects $1,109,683 into the surrounding counties' economies.
3. The economic contribution of the part time residents on Red Cedar Watershed injects $693,350 in labor income into the Dunn County economy.

This analysis demonstrates that the Red Cedar Watershed plays a vital role in the regional economy. Importantly, it also links economic activity with lake water quality and water level. The analysis indicates that both the demand for property and spending patterns by residents will suffer in response to these negative factors. Higher quality water attracts greater participation of part time residents and students. It also maximizes the taxable value of real estate. Overall, better quality of water leads to more revenue and higher wealth in the communities.

Part I: A Hedonic Analysis of the Impact of Poor Water Quality

Tainter Lake and Lake Menomin are two impoundments (lakes created by damming a portion of a river) in the lower portion of the Red Cedar River. Lake Menomin is located within and just north of the City of Menomonie, Wisconsin; Tainter Lake is located on the Red Cedar River at the confluence with the Hay River just a few miles upstream. The intrinsic nature of impounded lakes is that they trap sediment carried downstream by the river they are located on. This sediment often carries whatever has been eroded or washed off the landscape farther upstream. Therefore, these “man-made” lakes tend to suffer more water quality problems than similar natural lakes due to the modification of their natural hydrology and change in their natural ecology.

Tainter and Menomin lakes are a part of the Red Cedar River Basin (the land area that drains the Red Cedar River). The Red Cedar River Watershed drains 1,893 square-miles in west-central Wisconsin[1]. Large watersheds like the Red Cedar Basin carry vast amounts of sediment and other pollutants to impoundments. Phosphorus (P), a nutrient found naturally in soils and manure, is a leading pollutant causing problems in impounded lakes. When soil washes off farm fields and urban areas into rivers and lakes, Phosphorus becomes the main nutrient for the growth of algae (Wisconsin Department of Natural Resources). A major challenge presented to both lake management associations and community leaders is the diminishing quality of the lake during the summer months due to these algal blooms.

Tainter Lake is fed primarily by the Red Cedar River, but is also subsequently fed by the Hay River. Both of the rivers drain the farm fields north of Tainter Lake. This runoff water contains vast amounts of fertilizers that feed millions of green algae blooms during the summer months. The slow current of the lake and perfect water temperatures provide the ideal conditions for large algae blooms. This issue becomes even more problematic when the pollutants are carried downstream into Menomin Lake.

Tainter and Menomin both suffer from severe and often toxic Blue Green Algae blooms driven by high watershed loading of nutrients. These Blue Green Algae blooms are thick, putrid, and create poor water clarity, making it extremely difficult to fish and enjoy recreational activities during the summer months. In consideration of this issue, it is the goal of this analysis to determine whether the value of the lake property has kept pace with competing lakes within the same market. Therefore, this analysis will look at the changes in lakefront property on Red Cedar Lake, Prairie Lake, Chetek Lake, and Beaver Dam Lake.

This report will test the hypothesis that the perceived and real environmental degradation in water quality has caused a diminution in property values along the Tainter Lake and Lake Menomin relative to what would be expected in the absence of a reduction in water quality.

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[1] The Red Cedar River Basins drains parts of Barron, Chippewa, Dunn, Polk, Rusk, Sawyer, St. Croix and Washburn, Wisconsin Counties.

A Hedonic Analysis of Tainter and Menomin

In order to conduct a hedonic analysis, information on property valuation and housing characteristics was collected for numerous residential properties on and near lakes in Barron and Dunn Counties, Wisconsin. The lakes that were included in the analysis are all similar in terms of depth, with the maximum depth ranging from 37 feet to 106 feet. Drainage lakes are primarily fed by inlet streams or rivers and have outlets into streams or rivers. This makes these lakes particularly vulnerable to surface runoff eutrophication problems.

The premise behind a hedonic analysis is the idea that seemingly homogenous items, such as housing units, are actually comprised of many differentiated components. Rosen (1974) provided the original framework for hedonic empirical analysis utilizing this concept. This type of analysis is used to estimate the contribution of each these individual components has to the overall value of the dwelling unit both implicitly and explicitly. In a similar manner, a hedonic analysis estimates the marginal contribution of a clean lake to the overall value of lakefront property.

We employ these hedonic techniques to evaluate price variations over time and across homes in a heterogeneous but well-integrated housing market. The objective of this analysis is to isolate the effect of a change in lake water quality on the value of these properties. Through the inclusion of properties located on several similar, yet unique waterfronts, this analysis estimates whether the value of the Tainter Lake and Lake Menomin properties have been able to keep pace with competing lakes despite the persistent eutrophication problems.

Using a hedonic analysis allows us to take observations on housing values and specific real estate characteristics (i.e. bedrooms, square footage, bathrooms, etc.) to obtain implicit prices for these individual elements. Any given home provides a total utility based upon the utility yielded by the characteristics of these differentiated goods. The market for single-family housing units is not determined by a supply of homogeneous homes, but rather by these differentiated components. Therefore, the valuing of these individual housing characteristics is intrinsically important in order to determine the overall value of these lake area properties.

Empirical research that attempts to value the implicit price of water quality in residential housing is limited. However, literature utilizing hedonic valuing techniques in real estate is copious. Estimating the value of these specific real estate characteristics is desirable and obtaining the necessary data is manageable. These explicit parameters of the demand function are quite useful, and the same information on implicit parameters is just as vital. This is particularly true for shoreline valuation because the lake quality characteristic contains the nature of this public good, and this data is not readily available except in implicit markets.

Hedonic Analysis Literature Review

As stated above, a housing unit can be best characterized as a bundle of attributes which in summation depict the structure itself, the land upon which dwelling was built, and all of the relevant location characteristics. Previous research literature regarding housing markets utilizes hedonic framework modeling. This analysis will also explore the use of the hedonic approach to be able to separate the internal property attributes (i.e. bedrooms, bathrooms, square feet, etc.) from the external public good attributes of the dwelling. Such public good characteristics as shoreline focus primarily on its proximity and access to water and water-related open space.

While the literature on many environmental goods (such as air quality) is profuse, the existing empirical research using the hedonic model to determine the value of water quality is restricted. Waterfront housing offers unique measurable qualities that incorporate similar housing sets in both the waterfront and not-waterfront real estate environments. Waterfront properties produce different values due to the spillover effect from having a property located on a valuable resource. However, barriers to completing this analysis do persist.

The main barrier is a lack of a consistent and accurate water quality measurement variable available to the average consumer. Water borne particulates are often microscopic and thus unobservable; only in large concentrations are they finally noticed by homeowners. Additionally, a single lake may not be considered a single market because some lakes present a non-homogenous environment (Legget and Bockstael, 2000). Covers and inlets may store pollutants next to homeowner property while open areas of the lake appear clean. Furthermore, there is often a difference between water quality and perceived water quality (Poor, et al 2001).

Water quality is inherently a multi-dimensional concept that depends on the designated use of the body of water and varies dynamically over the population. Swimmers would probably prefer a body of water with high transparency, but recreational anglers would probably value greener water as it is a better fish habitat (Hoyer, Brown, and Canfield Jr., 2004). Individual perception of water pollution is the major concern in this area. However, the hedonic model intrinsically assumes that consumers know the level of water quality, and it translates this inherent knowledge into their buying decision (Walsh, 2009).

David's (1968) hedonic analysis examines the correlation between lakeshore property values on artificial lakes in Wisconsin and the intrinsic water quality of the observed lakes. Although David was able to find that lakeshore property prices were significantly correlated with water quality, the measure of water "quality" was subjective, and therefore limited this preliminary research. Epp and Al-Ani (1979) also investigated the relationship between changes in water quality and the property values. Their work helped provide support for pro-active methods to improve and retain water quality. They were able to find a positive and significant correlation between water quality and property value. However, a key finding from their analysis is that the price of houses adjacent to higher quality water are sensitive to changes in water quality, but in areas of poor water quality marginal improvements offer no benefit in valuation.

Young and Teti's (1984) study examined the effect of perceived water quality on Lake Champlain in St. Albans Bay, Vermont. Their research found that the inclusion of water quality perceptions results in a negative and significant relationship between the degraded perceived water quality and the sales price of homes. Additionally, Steinnes (1992) examined the relationship between the perception of poor water quality and home values. Steinnes found that the presence of tannic acid, which gives water a dark brown “root beer” color, negatively affects property values. However, while tannic acid does discolor the water it has no true negative effects in terms of environmental degradation. In contrast to these previous studies, Mendelsohn, et al (1992) found that true diminished water quality does not affect property values until awareness of the issues is elevated.

Michael, Boyle, and Brochard (2000) rated lakes for both subjective and objective water clarity. They used a Secchi Disk Measurement (SDM)[2] as their objective water quality indicator. Results from SDM typically claim that the clarity of the water can be interpreted as the quality of the water and this measurement technique is easily perceived by homebuyers. Their results indicated that implicit price estimates prove significant, and both the objective and subjective variables produced significant coefficients. The authors state that the significance of subjective variable creates concern that policy recommendations could result in the public perception of environmental water quality, and instead should be based on conceptually and theoretically sound logic.

Poor, et al (2001) used water clarity for lake front property owners in a hedonic model and compared it to the use of a directly comparable subjective measure of the same environmental amenity. They found that the coefficients on both water clarity variables are positive and significant. However, while the subjective measure of water clarity is significant (the greater the perceived water clarity, the higher the price), it is not as accountable as the objective SDM variable.

Walsh (2009) incorporated four alternative water quality indicators along with the traditional SDM into his empirical research study of 146 lakes in Orange County, Florida. The four additional indicators are total nitrogen, total phosphorus, chlorophyll and the tropic state index (TSI). These first three indicators are regularly used nationwide to classify lakes and are deemed the most important alongside SDM for nutrient criteria by the Environmental Protection Agency (EPA) (EPA 2000). The fourth indicator, TSI, plays a primary role in Florida lake classification and regulation. His study was able to find a negative and significant coefficient on all of these new water quality indicators and waterfront variable. This indicates waterfront homes are more negatively affected by increases in these physical environmental measures. Additionally, he utilized implicit pricing models based on the results from the hedonic analysis and found that SDM has a larger total non-lakefront benefit, but changes in water clarity due to changes in TSI caused housing values to increase at a higher rate for homes nearest to the lake. The results indicated that these differing water quality indicators result in substantially different benefit estimates. It should be noted that changes in SDM are valued for aesthetic and visual appeal, while improvements in the other environmental measures can be valued for a more holistic ecosystem and lake recreation restoration. Due to the lack of SDM and other alternative water quality indicators

[2] Obtaining an SDM reading involves lowering a black and white checkered disk into the water and recording the depth at which it disappears from sight.

for all the lakes and years in our analysis, we will not be including these water quality indicators in our hedonic analysis.

Data for the Hedonic Analysis of Tainter and Menomin

This study compiled data using "arm's length" real estate transactions (a transaction in which buyers and sellers of properties act independently and have no relationship to each other)[3] primarily in Dunn and Barron counties between 1999 and 2010. The properties included in this study were randomly chosen from all homes located on Tainter Lake, Menomin Lake, Red Cedar Lake, Beaver Dam Lake, Chetek Lake, and Prairie Lake areas, as well as including non-lake homes in the cities of Menomonie, Elk Mound, and Rice Lake, WI. Including properties on non-lake homes helps provide a comparison real estate market without lake frontage. A number of explanatory variables are also included in the hedonic regressions to capture the factors that are typically found to influence residential property values. Our study differs from previous studies due to expansion of the number lakes and proxies analyzed.

A total of 3,186 real estate transactions were included in this hedonic analysis to determine the effect of diminishing water quality on property value. All of these properties are non-manufactured, non-condo, single-family dwellings. There was a total of 139 properties on Tainter Lake, 22 properties on Lake Menomin, 93 properties on Red Cedar Lake, 56 on Chetek Lake, and 90 properties on Beaver Dam Lake[4]. In addition, there are 1,650 non-lake city of Menomonie properties, 276 non-lake town of Elk Mound properties, and 606 non-lake city of Rice Lake properties. All six lakes are geographically situated in western-central Wisconsin and are similar in size, depth, and natural ecology (drainage lakes). This creates a homogenous market for demand. As a comparison, Tainter Lake is 1,752 acres, Lake Menomin is 1,405 acres, Chetek Lake 770 acres, Red Cedar Lake 1,841 acres, Prairie Lake 1,037 acres, and Beaver Dam Lake 1,112 acres.

Appendix 1 shows the descriptive statistics for the dependent and explanatory variables used in regression analysis. There appears to be a lot of variation in the sale prices of properties and in the feet of water frontage. Overall, there seems to be a fair amount of variation in the explanatory variables which will hopefully lead to significant estimates in the regression results.

Development of the Hedonic Models

Following the lead of Rosen (1974) the value of property is determined as a function of the bundle of characteristics that embody the structure. Additionally, the final price a good increases as

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[3] The concept of an arm's length transaction is to ensure that both parties in the deal are acting in their own self interest and are not subject to any pressure or duress from the other transacting party.

[4] Lake Altoona was also considered as a comparable. However, the benefits of adding another lake were mitigated by the limited number of homes that sold through arms-length transactions from 2000 to 2010 (12 Altoona Lake homes). As a result, these 12 properties were not added to the database of 3,186 properties.

more desirable attributes are included. Therefore, we hypothesize that the existence of lake frontage will generally increase the value of the property, but the contribution of lake frontage to the value of a property can change over time. In particular, we hypothesize that due to the increasing eutrophication problems over time, property values have decreased on Tainter Lake and Lake Menomin. To address this issue, we institute an interaction variable that measures the lineal feet of lakefront with a lake location variable. This interaction variable of location multiplied by lake frontage will isolate the value of a foot of lake frontage. This will give us the tool needed to measure the impact of diminishing lake quality (in lieu of utilizing water quality measurement variables) on value relative to non-lake properties.

The assessed property value of homes on both the lake and non-lake homes is the dependent variable in the hedonic model. A number of traditional explanatory variables have been found to influence heterogeneous residential property values (Palmquist, 1984). These variables include: number of bathrooms, number of bedrooms, square feet of living space, the existence of an attached or detached garage, existence of a basement, the existence of central air conditioning, and the existence of a fireplace.

Following the work of Palmqusit (1984), we also include the square of the amount of shoreline feet to control for the diminishing marginal benefit. The expectation is that the coefficient on the shoreline feet variable will be positive because having shoreline increases property value. However, we hypothesize that the coefficient on the shoreline feet squared will be negative because of the diminishing marginal benefit. The diminishing marginal benefit argument suggests that while shoreline is a valuable asset to the property, an investment in an additional foot of shoreline is not as valuable as the initial foot. Therefore, we also created an interaction variable utilizing the lineal feet of lakefront squared times the lake location variable. This interaction term will allow us to examine how valuable the additional square footage of frontage is to properties located on the various lakes relative to non-lake properties.

The development of the hedonic model takes into account the internal and location attributes of lakefront properties. The internal attributes include such characteristics as bathrooms, bedrooms, square footage, etc. The individual lakes provide an important location environmental amenity. It is important to isolate these characteristics into individual variables to be able to examine which specific attribute is causing property values to change. As discussed before, the measurable characteristic most closely related to character of lake quality is the lineal feet of lake frontage. Changes in demand for the proximity to Tainter Lake and Lake Menomin are indicated by changes in demand for lake frontage. Therefore, isolating the demand for lake frontage from the demand for other attributes of real estate properties, will identify whether changes in the quality of Tainter and Menomin have an effect on demand for housing units.

Estimation of the Hedonic Price Function

As previously outlined, the goal of this analysis is to determine if there has been real estate depreciation for lake properties on Tainter and Menomin due to severe eutrophication problems diminishing the quality of the lakes. This paper argues that the available data indicates a change in demand for real estate on Tainter and Menomin Lake has created an adverse affect on property values. This adverse affect can be attributed to the intrinsic nature of impoundment lakes and the vast amount of pollutant accumulation feeding algal blooms during the summer months. This report will utilize an Ordinary Least Squares (OLS) regression method to analyze the value of waterfront property. This method will use a static analysis of current value (as determined by the real estate transaction data). Based on a preliminary review of this data, it appears that there has been an adverse change in demand for lake frontage on Tainter and Menomin relative to non-lake properties.

To determine the effect of diminished water quality on value, we will estimate the following equation:

$$\boldsymbol{V_{it} = \theta + \alpha(Lake_{it} * Lakefront) + \beta\left(Lake_{it} * Lakefront_{it}^2\right) + \mu(X_{it}) + \sigma(Y_{it})\,\delta(Time_t) + \varepsilon_{it}}$$

where $Lake_{it} * Lakefront_{it}$ is the interaction variable between the lake indicator variable and amount of lakefront, $Lake_{it} * Lakefront_{it}^2$ is the interaction variable between the lake indicator variable and the amount of lakefront squared, X_{it} is a vector containing all the housing characteristics mentioned above, Y_{it} is vector containing all the non-lake front property indicator variables[5], $Time_t$ is a vector including all the time indicator variables[6], and $\boldsymbol{\varepsilon_{it}}$ is a random error term. The estimation of the value of a foot of lake frontage on Tainter and Menomin relative to lake shoreline on Red Cedar, Prairie, Beaver Dam, and Chetek is the primary objective of this model. The inclusion of time indicator variables accounts for fluctuations from year to year in items such as inflation.

Hedonic Model Results

The estimation results of the hedonic regression based on equation (1) is given in Table 2. Heteroskedasticity is always a concern when dealing with observations of different sizes and in many cases the best correction is to use Huber-White robust standard errors. Fortunately, we are working with a rather large data set of 3,186 observations; therefore, the robust standard errors are asymptotically justified. The Huber-White robust standard error results are given in second half of Appendix 2; we will be using these results in the following discussion. By and large, the coefficients have the expected signs and magnitudes. Number of bedrooms, full bathrooms, partial bathrooms, detached garaged, living space (square footage), fireplace, forced air heat, patio, and 3 or 4 seasons room are all significant. An interesting result is the time indicator variables indicated depreciation in the early years of the study (1999-2002) and appreciation in the later years (2004-2008) relative to 2010 non-lake City of Menomonie properties.

In reference to the hypothesis of diminishing value due to reduction in lake quality, both Tainter and Menomin are significantly behind lakes of similar qualities relative to non-lake City of Menomonie properties. Tainter Lake's shoreline per foot ($401.83) is well over $100 less than the next comparable

[5] The non-lake Menomonie indicator variable is omitted to avoid perfect multicollinearity
[6] The 2010-time indicator variable is omitted to avoid perfect multicollinearity

lake (Prairie Lake $532.61). Lake Menomin's situation is even worse, indicating that shoreline per foot ($150.75) is almost $400 less than the comparable lake (Prairie Lake $532.61) and shoreline is roughly $250 less than Tainter Lake's. Therefore, this suggests that due to increased eutrophication problems faced by these impounded lakes that property values have not kept pace with lake property of similar qualities. The interaction variables utilizing water frontage squared and the lake indicator produced some very interesting results. All of interaction variables for the lakes, except Menomin (0.23), are negative and significant. Therefore, this shows that an additional foot of shoreline is less beneficial to the homeowner than the first foot of shoreline, except on Menomin. However, the values of the coefficients are all small and have little material impact on the value of shoreline.

Conclusion

The research conducted in this hedonic analysis evaluated the effect of a perceived and real environmental degradation in lake quality on properties on Tainter Lake and Lake Menomin. This analysis has shown that the severe eutrophication problems that plague both of these impounded lakes has resulted in financial harm to homeowners and the residing community that is dependent on their wealth as a tax base. This analysis has also confirmed our original hypothesis that Tainter and Menomin lake properties have experienced below market returns which can be attributed to severe pollution problems and subjective public knowledge of these events. This paper contributes to previous literature's theoretical link between property values and changes in lake quality.

This analysis suggests that, in the absence of water quality degradation, market forces would have led to a higher appreciation of real estate property values on Tainter Lake and Lake Menomin. The coefficients on the housing characteristic variables all the anticipated sign: number of full baths, number of partial baths, living space, fireplace, forced air heating, central air conditioning, and having a patio all are positive and significant. In addition, the time indicator variables evolve from negative (deprecation) to positive (appreciation) due to the overall inflationary pressures on home values, thus indicating that properties have in general appreciated over time.

As the literature view outlines, there is an estimated theoretical link between property values and changing environmental conditions. The empirical evidence provided in this hedonic analysis in conjunction with previous literature theoretical support provide evidence that diminishing lake quality has a negative effect on lake frontage values. Therefore, this study showcases that a declination in the water quality has caused a substantial change in demand that contributed to a significant decrease in waterfront property values.

Implications of the Hedonic Analysis

The research provided in this study evaluated the effect of a perceived and real degradation in water quality in Tainter and Menomin Lake. We have provided evidence that there is financial damage to the homeowners on these lakes. Our analysis has demonstrated that the environmental degradation from the eutrophication problems has caused Tainter and Menomin to achieve below market returns.

There are an estimated 172 properties with shorelines on Tainter Lake and 142 houses on Lake Menomin. In 2009, the equalized value of all property located in the City of Menomonie was $925,757,000, which generated tax revenues of $22,850,448. If the value of shoreline on Tainter and Menomin approached that of its comparable regional lakes, it is reasonable to anticipate higher equalized valuation for the community. Our hypothesis is based on the historic academic literature that contends that one of the strong factors that lead to the value of shoreline is water quality. What follows is a stylized model of fiscal impacts that could occur, if the city were to hold revenues constant in light of higher equalized valuation. Given this scenario, the mil rate would fall.

Using the results from the analysis, the comparable lakes have frontage values ranging from $832 to $1302 per foot. Improving lake quality for both Tainter and Menomin to these frontage values should increase property values and subsequently reduce property taxes by holding tax revenues at a constant level. By increasing property values on Tainter Lake and Lake Menomin to comparable frontage values of other lakes may reduce taxes from between $37.96 and $70.56[7]. Increasing the quality of the lake is important for lakefront property owners for appreciation purposes, but also for reducing property taxes on Tainter and Menomin, without reducing the tax base for the residing communities.

[7] While this study focuses on the condition of Lake Menomin and Tainter Lake, the lake quality efforts will spill over and improve river water quality on those rivers associated with the lakes. As a result this river water quality improvement increases the potential fiscal impact and the reduction of taxes to between $66 and $124 per property tax payer.

Part II: The Impact of Part Time Residents on the Local Economy

One of the features of the public policy survey explored the spending patterns of part time residents. The survey asked all respondents to report the "average amount of money your household spends in the county in which this property resides." This question was followed by a list of thirteen separate expenditure categories. Ultimately, through the use of IMPLAN, these questions offer insight into the economic impact of the casual or part time visitor to the region.

The initial results from this survey question, by expenditure category, are shown in Table 1. The largest mean expenditure is for the category "construction and remodeling." The average respondent stated that they spent $7,805.67 over the course of an average year. The part time lake residents compared to this average by spending $5358.82 over the course of the average year. This large mean value may be somewhat surprising at first glance, but it indicates the relative importance of this type of spending by Red Cedar Watershed residents. In the Red Cedar Watershed area 83.06 percent responded that they had incurred some expenses on remodeling/construction in the Red Cedar Watershed area.

Table 1: Average expenditure by all Respondents per year on:

	All Respondents	Part Time Respondents
Construction/Remodeling	$7,805.67	$5358.82
Bait/Tackle	$165.97	$243.61
Launch Fees	$31.13	$7.00
Dining Out	$1,631.74	$1050.00
Entertainment	$1,153.59	$263.23
Gas/Oil for Vehicle(s) or Boat(s)	$4,538.05	$1652.63
Groceries	$3,346.42	$2850.00
Rental of Watercraft	$13.48	$0.00
Watercraft Maintenance	$247.82	$290.63
Shopping – clothing, personal, household (etc.)	$7,562.57	$916.67
Shopping – all other shopping	$1,319.26	$492.31
Licenses/Permits	$149.21	$172.78
Medical Care	$3,064.57	$395.83
Total Expenditures	**$31,029.48**	**$13,693.51**

This money differentiates the community from the more traditional urban fringe township in southeastern Wisconsin. By looking specifically at their spending patterns, we can see the impact created by the monies they move from their primary community to their weekend or part time community. Our IMPLAN analysis (an input-output analysis) does not simply look at the effect created by these parties, but extends into the indirect and induced impacts of this spending. This is because a portion of these direct expenditures generates income for Red Cedar Watershed area businesses, and in turn a portion of this income is spent on labor and other inputs in the area.

This spending provides the owners of resources (individuals who supply time and labor; land owners; etc.) with additional income, a portion of which is spent on further goods and services in the

Red Cedar Watershed area in a second round of spending. This continuing chain of spending and income, which must be modeled in order to estimate total economic impact of the part time resident, is described in greater detail in Section 4. While this study does not reach back to the original spending data, we assume that all full-time residents will spend money and are the basis of the primary economy; it is possible to further explore economic impact by adding the primary impact of the full-time residents to the total economic impact of the part time resident.

Input-Output Analysis

The impact of receipts and expenditures of the part time resident attracted to these lakes is felt throughout the entire local economy. Mortgage payments, grocery bills, and new cars are all affected by expenditures made by property owners as well as lake visitors. This results in the revenue of banks, supermarkets, car dealers, etc… The second largest expenditure category was "Shopping - General" (mean = $7,562). Following in order of magnitude were "Gas/Oil for Vehicle(s) and Boat(s)" (mean = $4,538), "Groceries" (mean = $3,346), and "Medical Care" ($3,064.57). The mean expenditure data included in Table 1 represent our best estimates of the annual average direct expenditures per family among Red Cedar Watershed property owners. However, direct expenditure numbers are only the starting point to estimate the total economic impact from Red Cedar Watershed resident spending.

Due to the fact that all communities have residents who spend money at the grocery store, the gas station and the hardware store, this study focuses on the marginal dollars brought in by the part time property owner on the lakes are affected by these expenditures. The linkages between sectors within the regional economy can be measured using multipliers. While we use three types of multipliers in this analysis, we present a brief explanation of one (the expenditure multiplier) to illustrate this concept. Multipliers are composed of direct, indirect, and induced effects. The direct effect occurs in the first round through the direct expenditures of households and visitors. The indirect and induced effects focus on how the direct expenditures cause a ripple effect, which lead to additional spending in other sectors of the economy.

The induced multiplier effect is generated from the proportion of total expenditures spent by property owners and visitors in the Red Cedar Watershed area. On the other hand, any expenditures incurred outside this area is a leakage. Leakages are defined as a flow of dollars leaving the community as residents spend money in other communities. Analysts use the multiplier to describe and quantify the relationships, or linkages, between a region's various economic entities within. Multipliers describe these relationships using several different economic indicators such as industry output, personal income, and employment. This study uses the three indicators most commonly used in economic impact analysis: total expenditure, employment, and personal income.

Total expenditures provide a measure of total economic activity that is occurring within a specific sector as well as how it relates to total economic activity in the region. Similarly, employment estimates provide an evaluation of the number of jobs in a sector or specified sub-sector of the economy. Finally, personal income, defined as the wages, profits and other types of earned income, provides an indication of employee earnings attributable to a particular sector of the economy.

Economic Impact Analysis

One key objective of this report is to quantify the importance of the presence of the various lakes to the local economy. Due to the interrelationships between different sectors of an economy we must consider how the tourism sector (the part time resident) is linked to the rest of the economy. Importantly, we must quantify not only the direct economic impact of Red Cedar Watershed part time resident, but also the indirect and induced effects. However, not all household spending occurs in the defined region. We must take into consideration a leakage such as this. When a portion of these expenditures is made in the region a multiplier effect occurs: Household spending of part time residents stimulate additional spending in the local economy. Input output analysis enables us to capture the linkages between the tourism sector and the rest of the local economy. It does so by using regional data to generate multipliers, which are used to quantify the relationships between firms and households. In this context, we will use the multipliers to estimate the total economic impact of households and visitors coming to the region because of the Red Cedar Watershed lakes.

The software used to conduct the input-output analysis is IMPLANPro. While other software packages can be used to conduct this type of analysis, IMPLANPro was chosen because of its flexibility, modeling capability, ease of data management and interpreting impact analysis results. IMPLANPro utilizes secondary county level (for the Red Cedar Watershed) data such as economic output, employment, and personal income for the year 2008 obtained from published sources such as the Bureau of Census, the Bureau of Labor Statistics, and Regional Economic Information Systems (REIS).

Results

As shown in Table 2, the lakes are an important component of the local economy. The presence and economic activity of the part time residents is an important contributor to the overall economy of the surrounding areas. It is critical to recognize that Red Cedar Watershed has low water quality; yet it is a positive force in the economy. In total, economic activity associated with property owner spending results in approximately 24 jobs and $693,350 in labor income.

Table 2: Current Economic Impact of Part Time Property Owners Spending

	Direct	Indirect	Induced	Total Impact
Expenditures	899,272	86,523	123,888	1,109,683
Labor Income	582,658	53,674	57,018	693,350
Employment	20.4	1.6	2.1	24

The economic impact provides insight and an opportunity to the community. In the study, it was determined that 50 percent of the residents used their homes fewer than 50 days per year. While this may be a reflection of the busy lifestyle and demands on time these families have, it is not unreasonable for the community to strive for greater participation by this underutilized group. Since the IMPLAN numbers only evaluate these part time residents, increasing the time they spend in the Red Cedar Watershed could offer some economic stimulus to the surrounding areas. Once again, this analysis is limited to part time residents. If we add the full-time residents, lake visitors (people who visit the lake to fish or boat), and visitors to the county park the impact is greater.

Prior research has shown that improving water quality is a cause for part time lake owners to use their property more. In the publication "What Is the Value of a Clean and Healthy Lake to a Local Community?" the Fiscal and Economic Research Center determined that in response to the control of Eurasian watermill foil part time residents on Delavan Lake would increase their use of their lake property by 5.12 percent. This would result in an increase in labor income by over 95,000 dollars and an additional 2.9 jobs. In contrast, this study also found that a decline in water quality would result in a decline in usage by 2.17 percent.

This research can also be applied to the Red Cedar Watershed area. If part time residents spent an average of 10 additional days at their lake properties, additional money would be spent. This money would create a marginal increase in expenditures, labor income, and employment.

Conclusion

The preceding analysis demonstrates that the Red Cedar Watershed plays a vital role in the regional economy. Importantly, it also links economic activity with lake water quality and water level. The analysis indicates that both the demand for property and spending patterns by residents will suffer in response to these negative factors. The table below indeed illustrates that lake quality is a major component to residents and visitors of a specific area. As Table 3 illustrates, 72.9 percent of the respondents stated that the lake quality does affect their length of stay.

Table 3: Does Lake Quality Influence Visitation

	Frequency	Percent
No	101	11.4
Yes	646	72.9
Total	747	84.3

Improving the quality of the lake will have a significant effect for Tainter Lake and Lake Menomin. The reason for this is that these two lakes are the most commonly visited by college students in the area. As can be seen in the below table, 67.7 percent of college students surveyed have visited Lake Menomin, and 28.8 percent have visited Tainter Lake. Since 72.9 percent of the respondents stated that the quality of the lake does affect what lakes they visit, along with the length of their stay, increasing the quality of the lakes can have a significant economic impact.

Table 4: Student Lake Visitation

	Frequency	No	Yes	No%	Yes%
Bear Lake	886	836	50	94.4	5.6
Lake Chetek	886	799	87	90.2	9.8
Lake Menomin	886	286	600	32.3	67.7
Prairie Lake	886	844	42	95.3	4.7
Red Cedar Lake	886	679	207	76.6	23.4
Rice Lake	886	775	111	87.5	12.5
Tainter Lake	886	631	255	71.2	28.8

An additional consideration outside of part time lake owners and visitors is that improved water quality will create more opportunities to use the lake. For example, the City of Menomonie has had the privilege of hosting an "Iron Man" competition in the past. While we cannot quantify the direct number of dollars brought into the Menomonie community, it is safe to assume that the "Iron Man" competition had a direct, positive impact on the community.

The poor water of Tainter and Menomin Lakes have not only caused the loss of the "Iron Man" competition, but it has also caused the loss of countless other opportunities. Improved water quality would act as a catalyst for community parties, festivals, and other outdoor events that generate revenue. The loss of potential dollars grows every day because of poor water. For a more in depth look on the potential impact of outdoor events on surrounding communities, see *The Economic Impact of the Nature Valley Bicycle Festival: A Pilot Study of the Stage 5 Menomonie, WI Road Race*. A copy of this paper can be found at www.uww.edu/ferc.

Poor water quality in Tainter Lake and Lake Menomin creates a tremendous cost to the surrounding area. The lakes present a great opportunity for Menomonie in economic terms; improvements in water quality lead to higher property values, increased economic activity, and ultimately more jobs. Aside from the economic advantages of clean lakes, there are countless and less tangible benefits to the community. Clean lakes can trigger a greater sense of pride in the area, and the community can become more cohesive with events motivated by its rediscovered natural resources. Restoring Tainter Lake and Lake Menomin means economic and community prosperity of Menomonie.

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Appendix

Appendix 1: Descriptive Statistics

Variable	Mean (# of Dummy Obs.)	Std. Dev.	Min	Max
Sale Price of Property	165,485.20	87,357.62	13,200.00	1,100,000.00
Non-lake Menomonie Dummy	(1,650.00)	0.50	0.00	1.00
Non-lake Elk Mound Dummy	(276.00)	0.28	0.00	1.00
Non-lake Rice Lake Dummy	(606.00)	0.39	0.00	1.00
Number of Bedrooms	3.11	0.84	0.00	9.00
Number of Full Baths	1.63	0.71	0.00	9.00
Number of Partial Baths	0.42	0.57	0.00	3.00
Attached Garage Dummy	(1,940.00)	0.49	0.00	1.00
Detached Garage Dummy	(991.00)	0.46	0.00	1.00
Taxes on property	2,726.56	4,484.96	0.00	241,537.00
1999 Year Dummy	(29.00)	0.09	0.00	1.00
2000 Year Dummy	(211.00)	0.25	0.00	1.00
2001 Year Dummy	(281.00)	0.28	0.00	1.00
2002 Year Dummy	(286.00)	0.29	0.00	1.00
2003 Year Dummy	(323.00)	0.30	0.00	1.00
2004 Year Dummy	(355.00)	0.31	0.00	1.00
2005 Year Dummy	(401.00)	0.33	0.00	1.00
2006 Year Dummy	(376.00)	0.32	0.00	1.00
2007 Year Dummy	(321.00)	0.30	0.00	1.00
2008 Year Dummy	(273.00)	0.28	0.00	1.00
2009 Year Dummy	(237.00)	0.26	0.00	1.00
2010 Year Dummy	(93.00)	0.17	0.00	1.00
Finished Square Feet	1,945.32	784.42	360.00	5,472.00
River Dummy	(85.00)	0.16	0.00	1.00
Water Frontage Feet	32.09	102.56	0.00	2,000.00
Water Frontage Feet^2	11,544.26	118,270.10	0.00	4,000,000.00
Tainter Lake*Water Frontage	6.18	35.38	0.00	700.00
Red Cedar Lake*Water Frontage	5.29	42.79	0.00	1,200.00
Prairie Lake*Water Frontage	6.75	42.30	0.00	1,400.00
Menomin Lake*Water Frontage	1.32	22.44	0.00	900.00
Chetek Lake*Water Frontage	2.11	19.94	0.00	500.00
Beaver Dam Lake*Water Frontage	4.20	42.69	0.00	2,000.00
Fully Finished Basement Dummy	(538.00)	0.37	0.00	1.00
Central Air Conditioning Dummy	(1,925.00)	0.49	0.00	1.00
Concrete or Asphalt Driveway Dummy	(696.00)	0.41	0.00	1.00
Fireplace Dummy	(1,501.00)	0.50	0.00	1.00
Forced Air Heating Dummy	(2,360.00)	0.44	0.00	1.00
Patio Dummy	(654.00)	0.40	0.00	1.00
Porch Dummy	(161.00)	0.22	0.00	1.00
Deck Dummy	(1,749.00)	0.50	0.00	1.00
3 or 4 Season Room Dummy	(273.00)	0.28	0.00	1.00
City Sewer Dummy	(1,524.00)	0.50	0.00	1.00
City Water Dummy	(1,527.00)	0.50	0.00	1.00
Tainter Lake*Water Frontage^2	1,289.84	13,529.22	0.00	490,000.00
Red Cedar Lake*Water Frontage^2	1,858.53	33,403.37	0.00	1,440,000.00
Prairie Lake*Water Frontage^2	1,834.34	38,719.10	0.00	1,960,000.00
Menomin Lake*Water Frontage^2	505.02	15,855.27	0.00	810,000.00
Chetek Lake*Water Frontage^2	402.04	6,874.11	0.00	250,000.00
Beaver Dam Lake*Water Frontage^2	1,839.16	71,057.95	0.00	4,000,000.00

Appendix 2: OLS Regression Results

Dependent Variable: Sale Price of Property	Coef.	Std. Err.	P-Value	Heteroskedasticity Adjusted Std. Err. Coef.	Robust Std. Err.	P-Value
Non-lake Elk Mound Dummy	12,439.32***	3,323.07	0	12,439.32***	2,694.06	0
Non-lake Rice Lake Dummy	-3,825.48	2,476.80	0.123	-3,825.48*	2,158.77	0.076
Number of Bedrooms	-5,234.15***	1,340.83	0	-5,234.15***	1,653.14	0.002
Number of Full Baths	25,684.53***	1,947.73	0	25,684.53***	2,946.14	0
Number of Partial Baths	12,668.01***	1,927.23	0	12,668.01***	2,223.96	0
Attached Garage Dummy	-8,056.15**	3,785.14	0.033	-8,056.15	5,051.63	0.111
Detached Garage Dummy	-8,211.68**	3,670.64	0.025	-8,211.68*	4,678.77	0.079
Taxes on property	0.75***	0.21	0	0.75	0.70	0.284
Finished Square Feet	40.29***	1.84	0	40.29***	2.73	0
River Dummy	61,477.75***	5,717.39	0	61,477.75***	11,515.55	0
Tainter Lake*Water Frontage	414.23***	49.85	0	414.23***	50.01	0
Red Cedar Lake*Water Frontage	1,302.90***	40.93	0	1,302.90***	114.67	0
Prairie Lake*Water Frontage	536.97***	38.78	0	536.97***	37.63	0
Menomin Lake*Water Frontage	158.59*	94.09	0.092	158.59*	87.42	0.07
Chetek Lake*Water Frontage	832.18***	92.17	0	832.18***	102.47	0
Beaver Dam Lake*Water Frontage	986.38***	43.19	0	986.38***	128.31	0
Fully Finished Basement Dummy	-4,077.33	2,612.39	0.119	-4,077.33	2,887.37	0.158
Central Air Conditioning Dummy	12,258.25***	2,373.35	0	12,258.25***	2,398.81	0
Concrete or Asphalt Driveway Dummy	-3,684.97	2,965.17	0.214	-3,684.97	3,134.91	0.24
Fireplace Dummy	19,004.12***	2,026.54	0	19,004.12***	1,950.08	0
Forced Air Heating Dummy	4,134.33*	2,388.39	0.084	4,134.33*	2,336.09	0.077
Patio Dummy	4,408.97*	2,274.50	0.053	4,408.97*	2,565.61	0.086
Porch Dummy	1,734.66	4,174.50	0.678	1,734.66	4,559.77	0.704
Deck Dummy	1,185.25	1,905.03	0.534	1,185.25	1,830.67	0.517
3 or 4 Season Room Dummy	-8,613.14***	3,261.73	0.008	-8,613.14***	2,648.73	0.001
City Sewer Dummy	-1,178.08	1,855.24	0.525	-1,178.08	1,906.83	0.537
Tainter Lake*Water Frontage^2	-0.27**	0.13	0.038	-0.27*	0.14	0.059
Red Cedar Lake*Water Frontage^2	-0.96***	0.05	0	-0.96***	0.18	0
Prairie Lake*Water Frontage^2	-0.33***	0.04	0	-0.33***	0.04	0
Menomin Lake*Water Frontage^2	0.23*	0.13	0.086	0.23**	0.10	0.026
Chetek Lake*Water Frontage^2	-1.34***	0.27	0	-1.34***	0.33	0
Beaver Dam Lake*Water Frontage^2	-0.32***	0.03	0	-0.32***	0.06	0
Constant	20,619.85***	7,552.49	0.006	20,619.85**	8,166.48	0.012
N		3186			3186	
R-Squared		0.6651			0.6651	

*** significant at 0.01 level; ** significant at 0.05 level; *significant at 0.10 level
Year time dummies have been left out parsimony;
Omitting Chetek Lake (another lake with eutrophication problems) only improves the results by a slight margin thereby not affecting the tax consequences

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