Estimating the Real Estate Price Premium of Two Northwest Montana Lakes – Flathead Lake and Whitefish Lake

Nanette Nelson, Flathead Lake Biological Station, Polson, MT
Lori Curtis, Whitefish Lake Institute, Whitefish, MT

Introduction

The Flathead River Basin in northwest Montana is home to hundreds of lakes including iconic Flathead Lake, the largest natural freshwater lake west of the Mississippi, and Whitefish Lake (Figure 1). Montanans value these fresh water bodies for their provision of recreational and aesthetic amenities, wildlife habitat, and overall well-being. Less well known among laypersons but essential to quality of life are the ecosystem services of water filtration, nutrient recycling, water absorption during flood events and release during extended drought, and temperature regulation. Water quality is an integral component of how these ecosystem services contribute to Montanans welfare; thus, water quality is inextricably linked to the benefits that arise from the use of these freshwater resources. Federal protection of most of the basin (~60%) has preserved the functional integrity of the Flathead River Basin. As such, the waters that flow within the catchment are of very high quality. Population growth in the watershed as well as our use and enjoyment of the outdoors, however, can degrade these freshwater resources. If local decision makers are to enact policies that protect water quality, an understanding of how local residents' value maintaining watershed services and water quality is needed. The analysis of real estate transactions is one way to estimate the value people place on local environmental quality.

The amenity value of living in close proximity to a lake is typically capitalized into property values, reflecting the extra amount buyers are willing to pay to have access to the amenities that lakes provide (Brown & Pollokowski, 1977; Lansford & Jones, 1995; Anderson & West, 2006; Wyman et al., 2014). Economists use hedonic pricing models, which exploit variations in housing prices within the same market area, to estimate how much more people are willing to pay for lake-associated amenities compared to similar properties without such amenities, while controlling for other factors that affect prices. For these economic estimates to be useful in a policy context, economists assume that residential homeowners derive utility from the fresh water resources within their local watershed (Poor, Pessagno & Paul, 2007). This assumption is credible for Montana given that functional integrity of a watershed is vital to conserving an outdoor way of life and necessary for supporting an outdoor recreation economy. The U.S. Bureau of Economic Analysis (2020) estimated that the outdoor recreation economy in Montana accounted for 4.7% ($2.5 billion) of the state's gross domestic product and employed over 31,000 people in 2019.

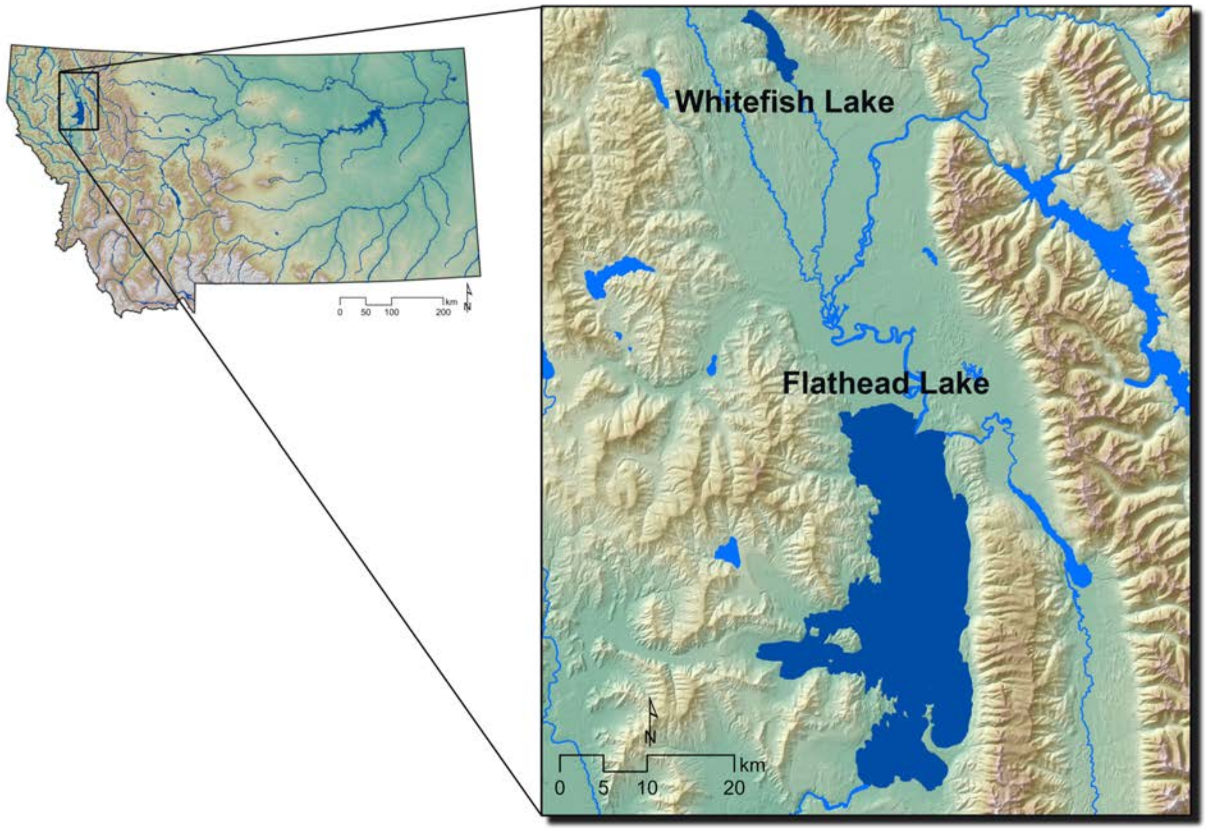

Figure 1. Flathead and Whitefish Lakes, Montana

Here, we present the benefits that two northwest Montana lakes – Whitefish and Flathead – impart to home values in the form of price premiums for lakefront and nearby real estate located within Flathead County and Lake County. In these two lakes where water quality has been essentially stable over the period of real estate transactions used in the study, our analysis relies on the variation in distance to the lake to estimate the premium property owners are willing to pay for proximity to the lake. This premium can be roughly interpreted as the aesthetic benefit landowners derive from living on or near lakes with exceptional water quality. Lakes can also supply landowners with other benefits such as opportunities for boating, swimming, and fishing or from supplying water for household use. These other use benefits are not quantified in this study.

Potential Threats to Lake Water Quality in Western Montana

Nutrient Pollution

Of concern is the shift in trophic state of many U.S. lakes with the number of oligotrophic lakes declining and the number of eutrophic or hypereutrophic increasing due to excessive nutrient inputs. Trophic state is a typical method for categorizing the biological productivity of a lake and is one of several indicators used in the National Lakes Assessment (NLA) in evaluating the condition of lakes across the nation (U.S. EPA, 2016). Oligotrophic lakes have low concentrations of nutrients and low rates of productivity and thus appear very clear. Eutrophic lakes have high nutrient levels and high rates of plant productivity resulting in reduced water clarity from suspended algae. Mesotrophic lakes fall between these two states. All three trophic states occur naturally; however, lakes that are considered highly disturbed from excessive nutrient inputs are classified as hypereutrophic.

The "greening" of lakes from surplus nutrients is prevalent in the U.S. with 40% of lakes having excessive total phosphorus concentrations and 35% having excessive total nitrogen (U.S. EPA, 2016). Elevated nutrient concentrations increase suspended algal biomass, which often results in a host of undesirable effects such as nuisance algae, murky water, decreased levels of dissolved oxygen, odor, and fish kills. Runoff from urban areas and agricultural operations, leaking septic systems, wastewater discharge, and the burning of fossil fuels are the primary sources of excess nutrients in lakes and rivers (U.S. EPA, 2016).

Of particular concern in the Flathead River Basin is septic leachate from poorly maintained and failing onsite septic systems. This nonpoint source of excess nutrients is a major threat to water quality and a public health issue. Both Flathead and Lake County Health Departments, however, do not maintain electronic records of permits issued for onsite septic systems before 1970 complicating estimates of the scope of the problem. Rough estimates suggest approximately 70% of Lake County and over half (57%) of Flathead County's developed properties are on septic systems (S. Rosso, pers. comm. July 2, 2020). These numbers, however, are derived based on the assumption that there is a residence at every permitted address, which includes subdivisions that may or may not yet be built out. According to the Flathead County Health Department, pre-1990 septic systems generally last 15 to 20 years, and post-1990 systems can last up to 30 years depending on soil quality and site suitability (Flathead County Health Department, 2012). Approximately 2,900 septic systems (1 in 4) in Lake County and over 15,780 septic systems (2 in 5) in Flathead County are over 50 years old (S. Rosso, pers. comm. July 2, 2020). Aging infrastructure coupled with increased demand for onsite wastewater treatment highlights the importance of quantifying the potential costs of failing to address future degradation from excess nutrients. The twenty-three member governor-appointed Flathead Basin Commission is currently working to address the septic leachate issue through GIS analysis and legislative engagement.

Many lakes in the U.S. are also undergoing a "browning" due to the presence of colored dissolved organic matter from increased runoff from the surrounding catchment (Leech et al, 2018). An increase in a lake's brown color affects chemical and physical processes in the lake and by extension water quality and food web structure (Leech et al., 2018). A nutrient-color classification scheme has been developed that combines the two processes – "greening" and "browning" – as a means of categorizing lake condition. Lakes are identified as oligotrophic (blue), eutrophic (green), dystrophic (brown) or mixotrophic (murky) based on a lake's total phosphorus (TP) concentration and true color. Data from the 2012 NLA show that 35% of lakes were murky, followed by blue lakes (~28%), green lakes (~27%), and brown lakes (~10%).

U.S. lakes are becoming murkier as revealed in a comparison of the 2007 and 2012 NLA data sets (Leech et al., 2018). From 2007 to 2012, blue lakes across the continental U.S. decreased by 18 percentage points (46% of lakes in 2007 to 28% in 2012); whereas, the proportion of murky lakes increased 11 percentage points (24% of lakes in 2007 to 35% in 2012). There were no significant shifts in the proportion of green or brown lakes from 2007 to 2012. Of the nine ecoregions that characterize the U.S., four regions showed no significant changes in the proportion of lakes in each nutrient-color state. The Western Mountains ecoregion, which includes northwest Montana, is among them.

Aquatic Invasive Species

In addition to nutrient pollution, Western Mountain ecoregion lakes are increasingly subject to invasive plant and animal infestations. Invasive species often have no natural competitors and/or predators in these new environments, allowing them to outcompete native species. Once established invasive species can fundamentally change the natural processes of the ecosystem. The net result is a loss in water quality and in the diversity of native plants and animals as invasive species rapidly multiply and take over ecosystems.

Many U.S. waterbodies have been dramatically altered due to aquatic invasive species, particularly dreissenid mussels. These tiny mussels have huge appetites for microscopic plants and animals, they reproduce rapidly, and can severely alter their adopted environment by reducing the food supply for native species and by enhancing conditions for the rapid growth of blue-green algae (cyanobacteria) and aquatic vegetation. This results in decreasing water quality and substantial ecological and economic damage. Although not currently present in Montana, the potential economic damages to the state should dreissenid mussels be introduced and become established ranged from $96 to $234 million annually in mitigation costs and lost revenue and an additional $288 to $497 million in property value loss (Nelson, 2019).

Water Quality Protections

The Clean Water Act is the primary federal law governing water pollution in the U.S. The Act is intended to restore and maintain the chemical, physical, and biological integrity of the nation's waters through programs within the U.S. Army Corps of Engineers, the United States Environmental Protection Agency, the U. S. Fish & Wildlife Service, and the U.S. Forest Service. Tools such as Water Quality Standards, Designated Uses, and Water Quality Criteria are deployed to define water quality conditions. These federal agencies then rely on and sometimes provide funding to states to address actual pollution issues. The Montana Department of Natural Resources and Conservation; the Flathead Conservation District; and Montana Fish, Wildlife & Parks and a few legislatively enacted commissions (the Montana Invasive Species Council, the Upper Columbia Conservation Commission, and the Flathead Basin Commission) are all charged—to various degrees with addressing water quality issues at the state level. However, the resulting programs delivered by these resource management agencies generally lack teeth when it comes to enforcement. Most water quality issues are therefore left to be addressed by local resource managers and water quality groups.

In the early 1970s, development concerns on both Whitefish and Flathead Lakes drew the attention of Senator Bob Brown from Whitefish who co-sponsored Senate Bill 175 which passed in 1975 and became Montana Code Annotated 75-7-201. The new law's purpose was two-fold: To conserve and protect Montana's natural lakes and their scenic and recreational values; and To provide local governing bodies with adequate statutory power to protect lake areas. This law led to the formation of lakeshore protection regulations that were adopted by the County for all Flathead County lakes.

Relevant Literature

The desire to live next to water is evident in the development patterns in the vicinity of lakes, rivers, oceans, and wetlands across the U.S. Long skinny waterfront lots exemplify the value of having water access and the premium developers can receive from squeezing in as many lots as local development ordinances allow. Multiple studies have demonstrated that water access as well as views generate substantial property price premiums. These same studies also show how degradation in water quality can result in lower property values or conversly, how improved water quality increases property values. Nicholls and Crompton (2018) summarized over 40 studies providing convincing evidence that property values are positivily affected by clean water. Employing various measures of water quality from Secchi disk depth (a measure of water clarity) to nutrient concentrations to the presence of aquatic invasive species, the following studies quantify the capitilazation of water quality in the value of waterfront or near waterfront homes.

The tourism-based economy of Cape Cod depends on the quality of its coastal waters; yet a majority of Cape Cod's estuaries are experiencing severe eutrophication due to excess nitrogen from leaking septic systems (Ramachandran, 2015). The Cape Cod Commission developed an economic model to estimate the effects of water quality on the price of a single-family home in the Three Bays area of the Town of Barnstable. The study found home prices fell an average of 6.1% for every 10% decline in water quality. Between 2002 and 2013 nitrogen concentrations increased by 27%, from 0.55 milligrams per liter (mg/L) to 0.76 mg/L. If applied Cape-wide, the results suggest a decline in housing values totaling hundreds of millions of dollars. A study on the effect of ambient water quality on housing prices in the St. Mary's River watershed in Maryland found that a 10% increase in dissolved organic nitrogen decreased property values by 0.6% (Poor et al., 2007). Average dissolved organic nitrogen was 0.625 mg/L and ranged from 0.082 mg/L to 0.956 mg/L across the study area.

A study of 113 lakes across the U.S. found water clarity had a positive and statistically significant affect on housing price (Moore et al., 2020). The authors estimated a one-meter change in Secchi disk depth (a measure of water clarity) resulted in a 9.9% change in housing price. Using a mean house price of $401,146 (2013 dollars) a 0.1 meter change in Secchi disk depth resulted in a $3,971 change in mean price. Homes sales used in the analysis were either lakefront or within 160 m (0.1 miles) of the lakeshore. The Sechhi disk depth values in the sample ranged from 0.2 m to 9.5 m and averaged 2.1 m. Results from multiple studies in multiple states (Minnesota, New Hampshire and Maine) showed a 1-meter decrease in water clarity decreased property values from 3.1 to 8.6% with a median value of 5.8% (Jakus et al., 2013).

While the majority of studies using the hedonic price method to estimate the effects of water quality on home values focus on lakefront, a few studies have estimated the effect of water quality on non-waterfront homes. Walsh et al.'s (2017) study of water quality in Chesapeake Bay across 14 Maryland counties estimated price premiums associated with water clarity for waterfront and non-waterfront homes. The authors found water clarity affected housing prices in several counties up to 1,000 m from the waterfront. Netusil et al. (2014) examined the effect of five water quality variables on single-family housing values in two urbanized watersheds in the Portland, Oregon-Vancouver, Washington metropolitan area. Water quality was found to affect the sales price of properties within ¼ mile, ½ mile, one mile, or two mile buffers of the stream. Estimated effects varied for some water quality parameters depending on the watershed, distance to the stream, and whether a seasonal (wet/dry) average or annual average was used in the model specification.

Hedonic pricing methods have also been used to study the effect of invasive spieces on property values. In northern Wisconsin, lakefront property values decreased by 8%, on average, after invasion of Eurasian milfoil (Horsch & Lewis 2009). The presence of milfoil and native aquatic vegetation in Vermont lakes decreased property value ranging from <1% to 16.4% depending on the degree of total macrophyte (aquatic plant) coverage (Zhang & Boyle, 2010). Liao et al. (2016) assessed the economic impacts of water quality and Eurasian milfoil on the sale of lakefront property on Lake Coeur d'Alene, Idaho between 2010 and 2014. The authors estimated that a 10% increase in Secchi depth increased lakefront property value by 2.2% whereas the presence of milfoil decrease property value by 12.6% (Liao et al., 2016).

Of note in the studies summarized above is that each study exploited the variation in water quality, either over time or over space, to estimate the change in housing value as a result of a change in the water quality parameter. Water quality in Flathead Lake and Whitefish Lake has not appreciably changed over the study period 2004-2018. Due to the stability of water quality our model does not include a water quality parameter and thus, we are unable to directly estimate the effect of water quality on housing values for the two lakes in our study. Given the evidence presented above one can surmise that lake water quality in Flathead and Whitefish lakes is capitalized into housing values and that any degradation in water quality would negatively effect those values.

Home Values and Oligotrophic Lakes

Study Area (Flathead Lake and Whitefish Lake)

The 18,290 square kilometers (km^2) Flathead watershed is located in northwest Montana and southern British Columbia (Figure 1). Flathead Lake is approximately 48 km long and 26 km wide, covering 500 km^2 and is about 116 m at its deepest point. The area begins across the Canada-U.S. border in the north, reaching down to the Clark Fork drainage in the south, and extends from the Salish Range in the northwest to the Continental Divide in the east including many smaller watersheds, lakes, and drainages. Approximately 60% of the basin is within federally protected areas – Glacier National Park, the Bob Marshall-Great Bear-Scapegoat Wilderness, and other National Forest wilderness areas and roadless areas (Ellis, 2008). Hence, most of the water that reaches Flathead Lake originates from an untouched watershed and thus, is of very high quality. The remaining 40% of the watershed is extensively roaded with the predominant land uses being timber production, agriculture (crop and pasture lands), urban, and semi-urban (rural home and small acreage sites; Ellis, 2008).

The Whitefish Lake Watershed is nestled within the Flathead Watershed and is defined in the north by the Swift Creek Headwaters and in the south by the outfall of Whitefish Lake to the Whitefish River. The western border includes Stryker Peak and Stryker Ridge in the north and Lion Mountain in the south. The eastern border below Link Mountain encompasses Diamond Peak in the north, and a portion of the Whitefish Range south past Big Mountain, Whitefish's ski area. The watershed drains to Whitefish Lake, which is fed by six perennial tributaries, and is one of the major contributory waters to Flathead Lake. Whitefish Lake is approximately 9.3 km long and 2.3 km wide, covering approximately13 km^2 and is about 71 m at its deepest point. (Whitefish Lake Institute, 2015)

Water quality conditions in Flathead and Whitefish Lakes are excellent in relation to other similarly sized lakes at this latitude. Water clarity averages 9 m in depth at midlake and the amount of nitrogen and phosphorus, which are pollutants in excessive amounts, are at levels that currently support aquatic life and provide high quality recreation and aesthetic enjoyment. However, a growing population, improperly installed or poorly maintained septic systems, and imminent aquatic invasive species infestations are all threats to the current status of these lakes and the wellbeing of those who live and recreate in the watershed.

Flathead and Whitefish Lakes are classified as oligotrophic. Though, Whitefish Lake shows evidence of transitioning to mesotrophic conditions, nearing a trophic state "tipping point" (Whitefish Lake Institute, 2015). Likewise, the Montana Department of Environmental Quality (DEQ) has listed Flathead Lake since 1996 as impaired for aquatic life support because of excess nutrient concentrations (Montana DEQ, 2018).

Data

Our study used data on 7,029 residential home sales that transpired between January 2004 to June 2018 in Flathead and Lake Counties in northwest Montana. We obtained sales data from the Multiple Listing Service of Montana, a realtor-owned sales database covering Central and Western Montana. Information detailing the structural attributes of a house (living area, bathrooms, single-family), characteristics of the parcel (lot size, proximity to lake, shoreline length), neighborhood characteristics (location), and time (year of sale) were used to estimate the relationship between each characteristic and the sale price of a home. Summary statistics for real estate transactions used in this analysis are provided in Table A.1 in the appendix.

To construct a data set that reflects a homogenous market and that minimizes the influence of outliers we excluded the top and bottom 1% of sale prices in each year. This exclusion avoids sale prices that are too low due to overly cheap sales (e.g. between family) and too high from the tail of the housing distribution (e.g., Shelter Island). Other screening measures included the number of bedrooms or bathrooms must be at least one but not exceed 10, living space was limited to a minimum of 500 square feet and a maximum of 8,000 square feet, and no short-sale or bank-owned sales (arms length sales only). All sales prices were inflated to 2018 dollars using the consumer price index for all urban consumers in the West region (U.S. Bureau of Labor Statistics, n.d.). This adjustment removed the effects of inflation from the sale price. Finally, we limited sales to within a 4,000 m buffer of each lake to fully capture the effect of Flathead and Whitefish on nearby residential properties[1].

Past studies have shown price effects of freshwater lakes and streams can extend up to 1600 m (one mile) away (Walsh et al., 2017; Netusil et al., 2014). In our study we measured proximity to the lake as to whether the home is located on the lake, or is a non-lakefront home within 0 to 500, 500 to 1000, 1000 to 1500, or 1500 to 2000 m of the lake. The 2000 to 4000 m buffer distance served as our reference category and as such was excluded from the model. In doing so, we are imposing the condition that the lake has no effect on the price of homes in this distance category. We predict that the effect of the lake on sales price is highest for lakefront homes and declines with distance from the lake. By including proximity to the lake as discrete distance intervals we allow the influence of lake proximity to vary independently across distance intervals (i.e., we did not impose a particular form on this relationship such as linear or inverse distance).

Lake access was also included in our data set. We expect having lake access will increase a home's value. Condos and townhomes characteristically share access to the lake whereby ownership of the lakefront property belongs to a homeowners association (HOA). In addition, some neighborhoods have joint ownership of lakefront property that is maintained through a HOA. Hence, the value of lakefront property is shared among multiple owners. Given the number of condos and townhomes, we included an "access only" variable in our model to account for lakefront property that is shared among multiple homeowners. Further, while these properties may be lakeside we did not define them as lakefront in our data set but included them in the 0 to 500 m distance to lake category.

Flathead Lake is nearly 500 km^2 with 260 km of shoreline. To control for location we included zip codes for real estate transactions related to Flathead Lake (Whitefish Lake has only one zip code). The zip code associated with Polson was the reference category in our model. For Whitefish Lake we included distance to center of downtown Whitefish as measured by street network distance. Distance to downtown Kalispell was correlated with zip codes as signified by variance inflation factors greater than 30, so it was not included in the model.

[1] Whitefish Ski Resort is located within 4000 m of Whitefish Lake. Real estate transactions associated with the ski resort, sales within 1600 m of the base of the mountain, were excluded from the data set because the property's primary attraction is access to the ski hill and not the lake.

Empirical Model

Real estate comprises a variety of characteristics, which are differentiated in quality and quantity. Consumers express their preferences for these characteristics through their choice to buy a home with a particular set of characteristics. Using statistical techniques, it is possible to estimate the marginal implicit price of any characteristic with information on sales price and characteristics of the home. The resulting prices are considered implicit because we don't directly observe these prices but instead they are revealed indirectly through the purchase of a home that comprises the various characteristics. When the characteristics include goods not traded in markets, like lake proximity, then the difference in price between two identical properties that differ only in distance to the lake is equal to the price premium due to the lake. This is an overly simplified example and so we use a hedonic model to control for a suite of property characteristics when estimating the effect of the lake on the sale price of a home.

Assuming a single competitive housing market, the interaction between multiple buyers and sellers results in the hedonic price function. The hedonic price function maps the values of a property's characteristics to its market price as follows:

$$p_{it} = f(\boldsymbol{S}_i, \boldsymbol{L}_i, \boldsymbol{D}_i, \boldsymbol{T}_t),$$

where p_{it} is the sales price of home i, when it was sold in time period t, $\boldsymbol{S}_i$ is a vector of the home and property characteristics, $\boldsymbol{L}_i$ is a vector representing locational characteristics; $\boldsymbol{D}_i$ is a vector of dummy variables denoting distance to lake, and $\boldsymbol{T}_t$ is a vector of dummy variables indicating year of sale.

Although the specification of the hedonic equation can have a significant effect on the estimates of the coefficients, little theoretical guidance exists because the price schedule for the housing characteristics is determined in the market place (Michael, Boyle & Bouchard, 2000; Taylor, 2017). Since marginal prices are not likely to be constant across all characteristics we elected to use a semilog functional form, which allows for a nonlinear affect on the sales price.

Ordinary least squares regression is used to estimate the following empirical hedonic model:

$$\ln(p_{it}) = \beta_0 + \beta_1\boldsymbol{S}_i + \beta_2\boldsymbol{L}_i + \beta_3\boldsymbol{D}_i + \beta_4\boldsymbol{T}_t + \varepsilon_{it}$$

where the dependent variable is the natural log of the sale price of home i in period t, the coefficients β_0 through β_4 are to be estimated, and ε_{it} is an error term. The vectors β_1 and β_2 are the implicit prices associated with a home's structural and property characteristics. The influence of proximity to the lake on a home's value is contained in vector β_3. Overall housing market trends are represented in vector β_4.

The differentiation of price with respect to any one of the characteristics used in the model yields the marginal implicit price for that particular characteristic. Marginal implicit prices for the semilog functional form of the hedonic price function are calculated by multiplying the estimated coefficient ($\hat{\beta}$) by the mean house price ($\bar{p}$) of our sample:

$$Implicit\ Price = \hat{\beta}\bar{p}$$

Categorical variables, like lakefront and the distance buffers, are interpreted as the approximate percentage change in price due to the presence of the characteristic in question (Taylor, 2017). The estimated effect on price is calculated as follows:

$$Percent\ Change\ in\ Price = \left(e^{\hat{\beta}} - 1\right)100$$

We estimated hedonic models for Flathead and Whitefish Lakes separately because the two lakes represent distinct real estate markets. First, the two lakes differ in their size and thus the makeup of the communities that surround them. Since Whitefish Lake is much smaller than Flathead Lake the competition among buyers for lakefront lots on Whitefish is likely considerably greater. Lake size also determines the number of communities or towns that are near the lake. Whitefish Lake has one town, the City of Whitefish, compared to eight towns along the shores of Flathead Lake. The smaller size of Whitefish Lake therefore imposes an exclusivity that is not reflected in communities around Flathead Lake. Another factor is lake level management. Flathead Lake is actively managed through the Seli'š Ksanka Qlispe' Dam with changes of up to 3 m in lake levels between winter and summer. Lake levels in Whitefish Lake are not intentionally modified but experience a natural seasonal mean fluctuation of 1.16 m.

Effect of Lake Proximity and Shoreline on Sale Price

As expected, a lakefront home on Flathead or Whitefish sold for considerably more than the same home that was 2 km or more from the lake (the reference category in our model). Homes on Whitefish Lake commanded a price premium of 254% on average whilst homes on Flathead Lake had a price premium of 114% on average (Table 1). The dollar values of these premiums were roughly \$1.3 and \$0.5 million per house for Whitefish and Flathead, respectively.[2] Evidence of a price premium for lakefront homes can be seen in the considerable difference in the mean sale price of homes on the lake versus homes not on the lake (Table 2). The percent increase in price for a home on Whitefish Lake was larger in part because the lake is considerably smaller than Flathead Lake and it is located in the exclusive resort town of Whitefish. This difference in price premiums is also reflected in the mean sale price of lakefront homes for Whitefish Lake compared to Flathead Lake, \$1.86 million compared to \$0.95 million, respectively (Table 2).

The length of shoreline can also contribute to a home's value. The estimated coefficient for shoreline length in our model was positive and significant for Flathead Lake. Shoreline length was not significantly different from zero for Whitefish Lake. This result was likely due to the uniformity in shoreline length among lakefront properties on Whitefish Lake as evidenced by the smaller standard deviation for this variable compared to Flathead Lake (Table 2). The marginal implicit price for shoreline is equal to the product of the estimated coefficient (0.007) times the mean house price in our sample (\$436,685). Thus an additional meter of shoreline was worth \$3,087 on Flathead Lake. The average length of shoreline ownership on Flathead Lake is 40 m, which equates to \$123,470 in value or roughly 28% of the mean sale price. The added boost to

[2] Dollar value equals the percentage change in price times the mean sale price of the sample.

property value from shoreline length reduced the difference in price premium for lake front homes we found for the two lakes in our study.

The effect of Whitefish Lake on home values diminished the further the property was from the waterfront. Homes within 500 m of the lake sold for 11% more than homes that were 2 km from the lake. The price premium ranged from 5% to 29% for the remaining three distance categories (Table 1). The non-monotonic decay in the estimated price premium with increasing distance from the lake is not unusual given that landscape features and density of construction vary around the lake. For instance, homes further away from the lake may benefit from a view of the lake because they are at a higher elevation than closer in homes.

Contrary to our *a priori* assumptions, proximity to Flathead Lake did not positively influence real estate values for homes that were not on the lake. Our analysis showed that homes not on the lake sell for less than homes that were over 2 km away as indicated by the negative percent change in price for these distance categories (Table 1). Here again, landscape features might explain these findings. Homes over 2 km from the lake tend to be at a higher elevation compared to homes closer to the lake and thus, might benefit from a view of the lake. Unfortunately, data on lake views was sporadic and so could not be included in the model.

Property values were also influenced by access to the water. For homes not on the lake, we estimated a price premium of 30% and 33% for homes that have deeded access to Flathead or Whitefish, respectively, compared to homes without access to the water. The lake access premiums were likely the result of limited public access for both lakes. Flathead Lake is the largest, freshwater, natural lake west of the Mississippi River with over 260 km of shoreline. Public access to the lake includes six state parks, one tribal campground, three city parks, and six fishing access sites. Whitefish Lake has 25 km of shoreline with only two state parks, a city park, and two small county sites available for public access.

For the remaining right hand side variables related to structural and property characteristics, location and year of sale, the signs on these variables were as expected and primarily statistically significant. Consistent with theory, the square footage, number of bathrooms, and lot size increased a home's value. Townhomes and condos increased a home's value on Flathead Lake but decreased a home's value on Whitefish Lake. Distance to downtown Whitefish was negatively correlated with a home's value. Estimated coefficients for zip codes were positive and statistically significant (with the exception of Kalispell) suggesting that a home in Bigfork, Lakeside, Somers, and Rollins were worth more, on average, relative to the same home in Polson. Regression results are presented in the Appendix.

Table 1. Estimated Effects of Proximity and Access to Lake on Sale Price of a Home[1]

Proximity to Lake	Flathead Lake	Whitefish Lake
Lakefront	114% [97, 132]	254% [192, 328]
0 – 500 m	-8% [-12, -4]	11% [7, 16]
500 – 1,000 m	-15% [-18, -12]	5% [2, 9]
1,000 – 1,500 m	-9% [-12, -5]	29% [24, 35]
1,500 – 2,000 m	n.s.	9% [5, 14]
Access Only	30% [25, 36]	33% [27, 40]

[1] Relative to the same home 2 km from the lake.
95% confidence intervals in square brackets.
n.s. – not significant

Table 2. Select Summary Statistics: Lakefront and Non-lakefront Homes

	Lakefront		Non-lakefront	
	Mean	Std. Dev.	Mean	Std. Dev.
Flathead Lake	(N=528)		(N=3,662)	
Real sales price ($2018)	$949,450	$530,090	$362,750	$270,970
Shoreline length (m)	39.8	22.7	--	--
Whitefish Lake	(N=88)		(N=2,355)	
Real sales price ($2018)	$1,860,570	$663,880	$451,570	$354,560
Shoreline length (m)	25.4	12.8	--	--

Aggregate Value of Property Price Premiums

Using data from the Montana Cadastral, a database of assessed properties completed by county governments, we identified the number of residential parcels within each distance category for each lake. Multiplying the number of parcels by the upper and lower 95% confidence intervals of the respective distance category price premium estimates yielded aggregate premium values of $1.2 to $1.6 billion for Flathead Lake and $0.4 to $0.6 billion for Whitefish Lake (Table 3). Shoreline length also contributed to the value of property for lake front properties on Flathead

Lake. Shoreline length was measured for all residential properties using ArcGIS; county-owned, tribal-owned, and commercial properties were excluded. We estimated Flathead Lake shoreline contributed an additional $0.4 to $0.6 billion to property values. Combining lakefront and shoreline premiums for Flathead Lake equaled $1.6 to $2.2 billion in added value due to the presence of the lake.

In Montana, local government and school district tax collections arise almost entirely from property taxes (96.4%; Montana Department of Revenue, 2016). Property taxes are levied against the taxable portion of a property's value. In 2020, the tax rate for residential property was 1.35% of assessed value. The total amount of annual taxes owed on a residential property is equal to the taxable value of the property multiplied by the cumulative mills in which the property resides (Montana Department of Revenue, 2016). Estimated gains in property tax revenue from property value premiums ranged from $11.9 to $16.9 million per year for Flathead Lake and $4.5 to $8.2 million per year for Whitefish Lake (Table 3).

Table 3. Aggregate Value of Price Premium and Associated Property Tax Revenue

		Price Premium ($ thousands)	Aggregate Premium Value ($ millions)	Property Tax Revenue ($ millions)
Flathead Lake				
Lakefront	2,854 parcels	$425 - $576	$1,213 - $1,644	$9.2 - $12.4
Shoreline	156 km	$2.3 - $3.8	$359 - $593	$2.7 – $4.5
Total			$1,572 - $2,237	$11.9 – $16.9
Whitefish Lake				
Lakefront	394 parcels	$964 - $1,648	$380 - $649	$2.9 - $5.0
0 to 500m	1,437	$33 - $81	$47 - $116	$0.4 - $0.9
500 to 1000m	1,050	$11 - $43	$12 - $45	$0.1 - $0.3
1000 to 1500m	1,032	$119 - $177	$123 - $183	$0.9 - $1.4
1500 to 2000m	1,028	$26 - $70	$27 - $72	$0.2 - $0.6
Total			$588 - $1,065	$4.5 - $8.2

Note: Millage rates for Flathead County and Lake County used in this analysis equaled 567.05 and 556.71 per $1,000 in taxable value, respectively.

Conclusions

In this study we provided estimates of aesthetic benefit residential land owners derived from living on or nearby two northwest Montana lakes – Flathead and Whitefish – that exhibit exceptional water quality as evidenced by water clarity measures of 9 m deep, on average. We have shown that Flathead and Whitefish contributed a significant price premium for homes on the lake. Non-lakefront homes up to 2 km from Whitefish Lake also exhibited a price increase because of the lake. Property tax revenues resulting from the price premium equaled upwards of $17 million for Flathead Lake and $8 million for Whitefish Lake.

The significance of our benefit estimates and the associated property tax revenue emphasizes what is at stake should water quality be degraded in the watershed due to excess nutrients from an increasing population and associated development. Over the past decade Flathead County grew by 14.2% (U.S. Census Bureau, n.d.). As more people move into the watershed, greater amounts of nitrogen and phosphorus flow into surface waters thereby increasing the pressure on rivers and lakes to assimilate the increased nutrient levels. Land use, planning, and development decisions are locally driven. Whether these policies improve or decrease locals' welfare is contingent on whether the benefits of additional development outweigh the costs. As we have quantified herein, one potential cost is degraded water quality. Consequently, the value of maintaining water quality should be considered and integrated into local land use planning (Poor, et al., 2007; Liao et al., 2016).

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Table A.1. Structural, Property and Location Variables for Flathead Lake and Whitefish Lake

			Flathead Lake		Whitefish Lake	
Variable	**Definition**	**Units**	**Mean**	**Std Dev**	**Mean**	**Std Dev**
Price2018	Real sale price	$ 2018	$436,684	$370,731	$502,323	$453,707
Structural & Property Variables						
Sqft	Building square feet	Sq. feet	2,145	1,017	1,982	1,063
Bathrooms	Number of bathrooms	Count	2.3	0.9	2.3	1.1
Townhome	Condo or townhome	Dummy	0.17	0.37	0.28	0.45
Lot_acres	Lot size	Acres	1.74	6.11	0.57	1.96
Lot_acres_missing	Lot size missing	Dummy	0.12	0.33	0.15	0.36
Shoreline_m	Shoreline length	Meters	5.06	15.49	0.91	5.31
Location Variables						
Lakefront	Lakefront	Dummy	0.13	0.33	0.04	0.19
Dist_lake_500_m	Lake within 0 to 500 meters	Dummy	0.28	0.45	0.23	0.42
Dist_lake_1000_m	Lake within 500 to 1000 meters	Dummy	0.21	0.41	0.24	0.43
Dist_lake_1500_m	Lake within 1000 to 1500 meters	Dummy	0.15	0.36	0.15	0.35
Dist_lake_2000_m	Lake within 1500 to 2000 meters	Dummy	0.10	0.30	0.13	0.33
Dist_lake_gt2000_m	Lake over 2000 meters away	Dummy	0.13	0.33	0.22	0.42
Access_Only	Lake access only	Dummy	0.15	0.35	0.15	0.35
Dist_Kalispell_m	Distance to downtown Kalispell	Meters	47,176	25,905	--	--
Dist_Whitefish_m	Distance to downtown Whitefish	Meters	--	--	2,586	2,179
zipAg_59860	Polson zip code	Dummy	0.37	0.48	--	--
zipAg_59901	Kalispell zip code	Dummy	0.01	0.11	--	--
zipAg_59911	Bigfork zip code	Dummy	0.34	0.47	--	--
zipAg_59922	Lakeside zip code	Dummy	0.15	0.36	--	--
zipAg_59931	Rollins zip code	Dummy	0.05	0.22	--	--
zipAg_59932	Somers zip code	Dummy	0.07	0.26	--	--
zipAg_59937	Whitefish zip code	Dummy	--	--	1	0

Table A.2. Regression results for Flathead Lake

Variable	estimate	std.error	statistic	p.value
(Intercept)	11.5124	0.0293	392.8963	0.0000
Bathrooms	0.1528	0.0098	15.5469	0.0000
Sqft	0.0002	0.0000	27.5543	0.0000
Lot_acres_recode	0.0125	0.0010	13.0003	0.0000
Lot_acres_missing	0.0504	0.0200	2.5232	0.0117
Townhome	0.1667	0.0182	9.1826	0.0000
Access_Only	0.2652	0.0195	13.6069	0.0000
Shoreline_m	0.0071	0.0007	10.0662	0.0000
Dist.Lakefront	0.7603	0.0369	20.5925	0.0000
Dist.0-500	-0.0838	0.0216	-3.8787	0.0001
Dist.500-1000	-0.1653	0.0210	-7.8729	0.0000
Dist.1000-1500	-0.0895	0.0222	-4.0386	0.0001
Dist.1500-2000	-0.0397	0.0244	-1.6276	0.1037
zipAg.59901	-0.0702	0.0535	-1.3121	0.1896
zipAg.59911	0.2597	0.0144	17.9809	0.0000
zipAg.59922	0.2413	0.0177	13.6006	0.0000
zipAg.59931	0.0781	0.0277	2.8158	0.0049
zipAg.59932	0.2338	0.0234	9.9856	0.0000
Y2018	-0.0085	0.0367	-0.2331	0.8157
Y2017	0.0227	0.0265	0.8575	0.3912
Y2016	-0.0442	0.0269	-1.6448	0.1001
Y2015	-0.0131	0.0276	-0.4752	0.6347
Y2014	-0.0250	0.0288	-0.8685	0.3852
Y2013	-0.0754	0.0283	-2.6670	0.0077
Y2012	-0.1397	0.0296	-4.7151	0.0000
Y2011	-0.1109	0.0344	-3.2198	0.0013
Y2010	0.0601	0.0324	1.8538	0.0638
Y2009	0.0765	0.0342	2.2383	0.0253
Y2008	0.2434	0.0326	7.4644	0.0000
Y2007	0.3203	0.0280	11.4550	0.0000
Y2006	0.3175	0.0266	11.9384	0.0000
Y2005	0.1542	0.0256	6.0211	0.0000

Table A.3. Regression results for Whitefish Lake

Variable	estimate	std.error	statistic	p.value
(Intercept)	11.7686	0.0300	392.0692	0.0000
Bathrooms	0.1464	0.0104	14.0779	0.0000
Sqft	0.0002	0.0000	22.8720	0.0000
Lot_acres_recode	0.0135	0.0035	3.8614	0.0001
Lot_acres_missing	-0.0132	0.0221	-0.5991	0.5491
Townhome	-0.0312	0.0167	-1.8657	0.0622
Access_Only	0.2880	0.0240	11.9873	0.0000
Shoreline_m	0.0038	0.0025	1.4900	0.1364
Dist.Lakefront	1.2627	0.0724	17.4473	0.0000
Dist.0-500	0.1064	0.0228	4.6726	0.0000
Dist.500-1000	0.0520	0.0182	2.8584	0.0043
Dist.1000-1500	0.2569	0.0206	12.4662	0.0000
Dist.1500-2000	0.0904	0.0227	3.9802	0.0001
Dist_Whitefish_m	0.0000	0.0000	8.5818	0.0000
Y2018	-0.0073	0.0400	-0.1817	0.8558
Y2017	0.0616	0.0299	2.0624	0.0393
Y2016	0.0385	0.0307	1.2545	0.2098
Y2015	-0.0205	0.0314	-0.6508	0.5152
Y2014	-0.0312	0.0318	-0.9803	0.3270
Y2013	-0.1230	0.0314	-3.9194	0.0001
Y2012	-0.1315	0.0336	-3.9097	0.0001
Y2011	-0.1478	0.0361	-4.0906	0.0000
Y2010	-0.0230	0.0391	-0.5884	0.5563
Y2009	-0.0241	0.0380	-0.6346	0.5257
Y2008	0.1336	0.0352	3.7947	0.0002
Y2007	0.2231	0.0307	7.2654	0.0000
Y2006	0.2278	0.0291	7.8385	0.0000
Y2005	0.1889	0.0301	6.2783	0.0000