Statewide Minimum Shoreland Zoning

An Economic Impact Analysis

Wisconsin Department of Natural Resources

07/03/2012

APPROVED BY:

Matt Moroney ____________________ DATE: 8/13/12

MATT MORONEY, DEPUTY SECRETARY

EXECUTIVE SUMMARY

This economic impact analysis predicts the expected outcomes of changes to ch. NR 115, Wis. Adm. Code, which establishes minimum standards for shoreland zoning. The key changes analyzed are a new requirement that impervious surfaces constitute 15% or less of the property within 1000 feet of the shoreline; an increase in protection for vegetation within 35 feet of the shoreline; and a more consistent treatment of legal nonconforming structures. Our analysis measured the environmental benefits of these changes primarily by predicting their impact on phosphorus runoff and water clarity and monetizing the value of increased enjoyment that comes from clearer water. We measured economic costs by predicting the number and average cost of mitigation projects required to bring homes into compliance, and by surveying county code supervisors on the likely costs of implementation and enforcement. Our analysis predicts a net benefit with a present value of $14.3 million, but because of high variability in many of our parameters the true value is indeterminate. Many significant benefits and costs were unable to be quantified. Benefits not quantified include:

- Improved fish habitat from woody debris
- Improved scenic beauty and quality of life
- Improved wildlife habitat and wildlife access to water resources
- Increased tourism

Costs not quantified include the potential cost of property rights restrictions reflected in property values. Additional studies would be needed to measure many of these key benefits and costs.

CONTENTS

1. INTRODUCTION

1.1 STATEMENT OF PURPOSE

The purpose of this document is to comply with section 9135 (3f)(b)3 and section 9135 (3f)(c) of 2011 Wisconsin Act 32 which requires that DNR prepare an economic impact analysis of ch. NR 115, Wis. Adm. Code that includes the information specified in section 227.137 (3), Wis. Stats. Chapter NR 115, Wis. Adm. Code establishes statewide minimum standards for shoreland zoning. This report was prepared by Wisconsin DNR with assistance from graduate students at the La Follette School of Public Affairs, University of Wisconsin-Madison. Students aided in researching the literature, developing methodology, and analyzing data. Professor David Weimer of the La Follette School and Tim Ryan of Wisconsin DNR also provided expertise and guidance on this project and coordinated between students and DNR staff.

1.2 OVERVIEW OF ANALYSIS

This report quantifies several impacts (positive and negative) that will result when the adopted rule is implemented. Important benefits and costs that were not able to be quantified are described. Because of these unquantifiable benefits and costs, the analysis is unable to provide a single definitive number for the economic impact of this rule. However, we find that the quantifiable benefits outweigh the quantifiable costs when measured using our best estimates, leading to a net present value of $7.2 million.

This report considers only the economic efficiency of the proposed rule. We did not address any issues of equity in distribution of benefits and costs, if those issues exist. Our analysis provides monetized values for the direct benefits and costs received by actors within the state from the policies set forth in the proposed rule. In this case, we determined it was not worthwhile to attempt an input-output or general equilibrium analysis of these benefits and costs, which would trace the indirect and secondary impacts caused by the rule. However, we did use cost-benefit analysis techniques to monetize some benefits that are not measured in normal markets, such as the value of water quality to property owners.

1.3 REVIEW PROCESS

The report was prepared at the staff level. Reviews were completed by the director of the Bureau of Watershed Management, the administrator for the Water Division, as well as by the Secretary's Office.

1.4 Overview of Layout

This report begins by establishing the questions that will be answered by the analysis. We follow with a detailed description of ch. NR 115, Wis. Adm. Code, comparing the newly adopted version of the rule to the previous version and to the rules of other states and examining the exact provisions of the rule that we believe will have effects. We describe the general methodology used in our analysis, followed by more specific descriptions of our assessment of each cost and benefit category and their point values. Finally, we address the uncertainty of our results, what steps we took to address that uncertainty, and what steps could be taken in the future to better improve our analysis.

2. Summary

This analysis of ch. NR 115, Wis. Adm. Code quantifies two categories of benefit and two categories of cost. The two categories of benefit are 1) benefits to property owners and 2) benefits to recreationists. These are measured in our analysis through changes to phosphorus runoff that would result from implementation of the rule. The two categories of cost are 1) the requirement that property owners restore vegetative buffers as mitigation and 2) implementation costs borne by county governments. Other categories of cost and benefit are discussed, but were unable to be quantified.

Based on our best estimates, we estimate the economic impact of this rule over the next 10 years to be a benefit of $7.2 million in net present value. To check the sensitivity of this estimate to errors in our measurements, we also conducted a Monte Carlo simulation, which found a standard deviation of $17.4 million. This simulation shows us that our estimated values are highly uncertain.

Table 1. Best estimates of all assessed costs and benefits

Benefit	**Effect can be Quantified?**	**10 year net present value**	**More information**
Increased property values from phosphorus reduction	Y	$29,871,401	Section 6.1.2
Improved recreational opportunities from phosphorus reduction	Y	$399,598	Section 6.1.1
Improved woody debris effects on fish	N	N	Section 6.2.1, Appendix I
Improved natural scenic beauty	N	N	Section 6.2.2, Appendix I
Improved wildlife habitat	N	N	Section 6.2.3, Appendix I
Increased tourism	N	N	Section 6.2.4, Appendix I

Costs	Effect can be Quantified?	Effect can be monetized?	More information
Cost of mitigation to property owners	Y	$21,678,742	Section 6.3.1,Appendix D
County implementation costs	Y	$1,207,140	Section 6.3.2, Appendix F
Property rights restrictions	N	N	Section 6.4.1
Enforcement costs	N	N	Section 6.4.2
Standardized treatment of nonconforming structures	N	N	Section 6.5.1, Appendix G
Total Net (Quantifiable) Costs and Benefits	**$7,385,117**		

3. Economic Questions Considered

Our analysis differs from a traditional economic impact analysis, instead using the framework of a cost-benefit analysis. In cost-benefit analysis, we attempt to provide monetized values for the direct benefits and costs received by actors within the state from the policies set forth in the proposed rule, including some that are not measured in normal markets, such as the value of water quality to property owners. A traditional economic impact analysis would only trace effects that were measured in markets.

Additionally, we determined that it was not worthwhile to attempt an input-output or general equilibrium analysis of the benefits and costs of this rule. These types of analyses would trace the indirect and secondary economic impacts caused by changes in primary markets affected by the rule. In the case of ch. NR 115, Wis. Adm. Code, we did not find many economic impacts that were valued in markets; the effects are mainly felt by property owners in terms of enjoyment of their property, which while important, do not impact the state economy directly. The primary market affected by this rule, tourism, was too difficult for us to quantify due to lack of key information, and other markets affected, such as landscaping, were too small to provide significant impacts that needed to be measured.

4. Specification of Baseline and Rule

4.1 Description of Baseline

Wisconsin's shoreland zoning standards contained in ch. NR 115, Wis. Adm. Code, were originally developed in the late 1960s based on a combination of the best available scientific information, best professional judgment, and the feasibility of implementation at the time. We assume that if the adopted rule is not implemented, shoreland regulation will continue under this previous version of ch. NR 115, Wis. Adm. Code, which we treat as our baseline. The standards for lot width minimums (65 feet for sewered lots, 100 feet for unsewered lots), lot size minimums (10,000 square feet for sewered lots, 20,000 square feet for unsewered lots), and the 75-foot building setback are identical in the adopted rule and baseline; these standards were not part of our analysis because if the adopted rule is not implemented, they will still be active. All costs and benefits that we measure are from the provisions of the adopted rule that are significantly different from those of the previous rule. Therefore, this analysis does not represent the costs and benefits from all shoreland regulations; it represents the costs and benefits from the specific changes in shoreland regulation in the adopted rule.

Chapter NR 115, Wis. Adm. Code constitutes a minimum standard, and counties are allowed to adopt rules that are more stringent if they choose. Many have done so over the years since this rule was first adopted. As scientific knowledge on environmental protection has increased, many counties have already added provisions to their rules that match those in the new version of ch. NR 115, Wis. Adm. Code. We assume that counties with existing mitigation standards will continue to use those standards; therefore, costs to homeowners in those counties will not be counted in the analysis. However, we assume that all counties will need to review their individual ordinance provisions for compliance with the new statewide standards; therefore, these counties are still counted towards the cost to counties of implementation.

4.2 Description of Rule

Chapter NR 115, Wis. Adm. Code underwent a major revision beginning in 2001. The rule was officially adopted in 2010, but implementation has been delayed until at least 2013. The adopted rule adds a cap on impervious surfaces of 15 percent of the lot, strengthens a requirement that natural vegetation within 35 feet of the water's edge be preserved, and standardizes the treatment of nonconforming structures that violate zoning rules but were built before the rules came into effect.

The intent of the revisions to ch. NR 115, Wis. Adm. Code is to protect the quality of Wisconsin's water resources without imposing an undue burden on property owners. Its restrictions, especially the limitation of impervious surfaces to 15 percent of the lot, help reduce the amount of runoff containing phosphorous that enters lakes and rivers from residential properties. A reduction of phosphorus entering lakes would limit algal blooms in lakes, which lead to detrimental effects on fish and aquatic life. The blooms also limit the recreational use of lakes for swimmers, recreational fishers, and boaters and are considered unattractive to property owners and tourists. If the revision of ch. NR 115, Wis. Adm. Code is implemented, we expect a decreased rate of phosphorus runoff into Wisconsin waters, protecting the important benefits of good water quality.

Natural vegetation within 35 feet of the shoreline would also be protected further under the adopted ch. NR 115, Wis. Adm. Code. Under the previous rule, vegetation could not be clear-cut, but was otherwise unprotected, leading some property owners to leave only a few trees standing on their shore. The adopted rule requires that 70 percent of existing vegetation remain standing in the 35-foot zone, allowing for some access corridors to the lake but protecting most vegetation from development. Additionally, expansion of impervious surfaces can be offset by restoring a vegetative buffer in the 35-foot zone where none exists. This vegetative buffer helps trap runoff, further limiting the process of eutrophication, the increase of plant biomass in a lake that leads to algal blooms and other negative environmental effects (Schindler &Vallentyne, 2008).Property owners can avoid the restrictions by performing mitigation. Mitigation plans are defined by the county, but usually involve restoring the vegetative buffer zones or planting rain gardens. If the property is surrounded by undeveloped land, an owner could also buy nearby land and leave it vacant in order to decrease the total impervious percentage. Mitigation can only increase the allowed impervious percentage up to 30 percent.

The adopted rule also provides more consistent treatment of nonconforming structures. Structures that were closer than 75 feet to the water were nonconforming under the previous iteration of ch. NR 115, Wis. Adm. Code, and had limitations on structural repair and expansion, with the intention that over time they would have to be removed. The adopted rule allows nonconforming structures to be altered and repaired as long as the size of the building is not increased. It also standardizes regulations that varied among counties regarding allowable expansions, creating a standard permit that would replace the more expensive and time-consuming variance procedure.

4.3 Differences between other states and adopted rule

Wisconsin appears to have been the first state to adopt shoreland zoning minimum standards, with the passage of ch. NR 115, Wis. Adm. Code in 1969. Since then, other lake-rich states have created their own minimum standards. Minnesota, Maine, and Michigan and Wisconsin all have areas belonging to the Northern Woods eco-region (as categorized by EPA), making them good states for comparison. Both Minnesota and Maine have statewide minimum standards that are stricter than Wisconsin's in most ways. Their standards also apply a classification system, where standards are higher in areas with less development and more environmental importance.

Regarding dimensional requirements, which were not changed in the revision of ch. NR 115, Wis. Adm. Code, Minnesota and Maine have stricter requirements for minimum lot size and lot width. We did not evaluate the effectiveness of these requirements, but their intent is to limit the amount of lots that can be placed on a shoreline, indirectly reducing impervious surfaces. We would expect a reduction in phosphorus runoff if minimum lot size and lot width were increased. Impervious surfaces are also limited in Minnesota and Maine, to 25% and 20% of the lot respectively. This cap is greater than Wisconsin's 15%, but Wisconsin also allows an increase up to 30% if mitigation is performed. The net effect is unknown, but it is worth noting that impervious surface caps are a common feature of these standards.

Buffer strip and vegetation standards are similar in the adopted rule and the rules of Minnesota and Maine. Maine requires a 75 foot buffer strip, while Minnesota and Wisconsin require 25 and 35 feet. Maine's larger buffer strip should be enough to provide habitat for some species, while Minnesota and Wisconsin's are only enough to provide runoff reduction. The stronger standards of the adopted rule in regards to removal of vegetation are similar to those of Minnesota and Maine. These standards ensure that the buffer zone provides its intended effects. Wisconsin's new rules regarding nonconforming structures are also similar to those of other states. The general standard is to not allow expansions of nonconforming structures that increase the nonconformity, i.e. building closer to the shore, but to allow vertical expansion and backward expansion.

Michigan takes a slightly different approach to shoreland zoning than the states previously mentioned: it requires counties to adopt ordinances, but does not give a minimum standard in most areas. However, it does require a 100 foot buffer strip, larger than any other state minimum. Michigan runs a program protecting rivers designated as "wild and scenic", with similar requirements to other shoreland zoning standards. Illinois and Iowa, Wisconsin's other neighboring states, are not part of the Northern Woods eco-region. Not sharing the same water-based natural resources, they appear to leave shoreland zoning standards to local government.

For more detailed information, see Appendix B, which contains a table comparing the states mentioned above.

4.4 Benefits and Costs Considered

The changes to ch. NR 115, Wis. Adm. Code affect shoreland habitat in many ways. We considered the following benefits to be important enough to be included in this report:

- Water-based recreation will increase because of clearer water. We were able to find a model predicting increases in fishing, swimming, and boating due to increased water clarity.

- The value of shoreline property will increase because of clearer water. This increase measures the total hedonic benefit gained by shoreland property owners, including their increased enjoyment of water-based recreation and scenic beauty.

- Natural scenic beauty will be improved because of the increased buffer standards. This beauty is a benefit to all who visit the shoreline, including property owners themselves, recreationists on and near the lake, and passers-by.

- The habitat of many shoreland species will be preserved by the higher buffer standards. Many fish species, including most game fish, will benefit from the preservation of coarse woody debris along the shoreline. Bird species diversity along the shore will improve with the preservation of trees and native plants. These effects benefit anglers, especially of game fish, and bird watchers.

- Increases in recreation mentioned above, especially for game fishing and boating, will preserve the tourism industry in the Northwoods region of the state. Economic benefits from tourism will continue to flow to Northwoods residents.

The following costs were also considered in our report:

- Property rights will be further restricted by the regulations added in this rule. Property owners will have to pay additional costs in order to make developments on their property that they may desire. Even if they do not make these developments, the loss of the ability to develop may decrease the market value of their property.

- Counties will bear implementation costs from the process of incorporating the minimum standards into their existing code, and from disseminating information to the public about the new standards. They may also bear increased costs in enforcing the new rule.

Finally, one additional effect was considered that was indeterminate in sign:

- Regulations on the treatment of nonconforming structures were changed to be more standardized across counties. These new regulations are stricter in some counties and less strict in others. The number of variances and permits issued in a given county may increase or decrease because of the new regulations. It is also likely that more standardized regulations across the state will increase regulatory stability for building companies operating in multiple counties.

5. METHODOLOGY

5.1 DATA SOURCES AND METHODS

We attempted in this analysis to measure all of the major costs and benefits that would result from the implementation of the adopted rule. The quantifiable benefits resulted from water clarity. By limiting impervious surface area and/or enhancing vegetative buffers, phosphorus delivery is decreased, improving water clarity compared to the baseline. The quantifiable costs came from increased mitigation requirements and county implementation requirements. The requirements limiting impervious surfaces potentially increase the amount of buffer restorations that must take place, and the process of adopting a new rule necessitates greater spending by county governments. Additionally, we measured the change in permits that would take place due to standardizing the rules for nonconforming structures. These four categories of major effects (water clarity, mitigation cost, county implementation, and nonconforming structure rules) were each analyzed separately. Water clarity was assessed through a combination of physical models, while mitigation cost, county implementation, and nonconforming structure rule effects were measured based on multiple surveys of county code administrators.

We assessed the impact of the adopted rule's policies on water quality using a "state lake" model based on advice from Stephen Carpenter (see Carpenter et al 2001 for an example).Water quality is measured by phosphorus concentration, which we find by combining the total volumes and the total phosphorus contained in all Wisconsin lakes using data from DNR's Surface Water Integrated Monitoring System (SWIMS) database (Appendix E). The average phosphorus concentration is 31.94 micrograms per liter.

We calculated the change in phosphorus each year due to the adopted rule resulting from two scenarios: first, when a property owner performs mitigation, and second, when a new house is built that must comply with the adopted rule. The mitigation scenario involves limiting phosphorus runoff by restoring the vegetative buffer zone or planting rain gardens. The adopted rule scenario represents the condition when a developer who wants to build a new house is required to limit the impervious surface to 15 percent of the lot size and is required to maintain a vegetative buffer zone. We employed a water quality model designed by Paul McGinley (2008) to predict changes in phosphorus resulting from both these scenarios (Appendix C). The number of adopted rule scenarios occurring each year was determined based on housing growth data from U.S. Census Bureau and an estimate of shoreland properties based on number of lakes in the county (Appendix A). The number of mitigation scenarios was based on a survey of Wisconsin county code administrators asking how many mitigation projects took place in counties with an existing mitigation ordinance (Appendix D). We found a total change of 658 pounds of phosphorus per year due to these two scenarios. We converted this into a change in Secchi depth using standard TSI equations (example in Appendix E).

We were then able to value this improvement in water by making use of studies that estimate "shadow prices" for these activities. Shadow prices are a method of valuing items or activities that do not have observable prices; they represent people's willingness to pay for activities that are not bought and sold on markets. Shadow prices can be estimated using a variety of methods. We used a 2001 study (Spalatro and Provencher) that measured a shadow price for water quality by comparing property values in areas of different water clarity, holding all else equal using regression analysis. This shadow price was applied to the improvement in water quality to quantify the environmental benefit in economic terms.

To measure the cost of mitigation, we obtained data from various county zoning officials on the cost of mitigation projects undertaken by property owners that were designed to offset the effects of expansions of impervious surfaces (Appendix D). The most expensive mitigation project had an estimated cost of $9,800, while other properties could allow native vegetation to regrow in order to fulfill mitigation at no cost. Since regulations will set a minimum standard, we felt it would be inaccurate to include the higher estimates. Therefore, we used an upper bound of $4,900, which was the highest estimate for what officials described as minimal projects, and a lower bound of $0, giving an average value of $2,450 for our estimate of mitigation costs.

We restricted our analysis to counties that did not report existing impervious surface averages on properties less than 15 percent. In these counties, we estimated an annual average of 950 expansions would take place that would trigger mitigation (Appendix D). We assumed that each of these expansion projects would increase impervious surface beyond 15 percent, but not beyond 30 percent. Given that assumption, these expansion projects can still take place if the homeowner is willing to pay the cost of mitigation estimated above. Therefore, the cost of mitigation serves as a proxy for the homeowner's willingness to pay to not have their property rights restricted.

Costs to counties can be divided into costs of rule implementation and costs of rule enforcement. Rule implementation describes the process of drafting new legal language, negotiating county standards with the state minimums, and explaining the adopted rule to the public through public hearings. We estimated these one-time costs using data from a 2006 survey of counties (Wisconsin DNR, 2006). Many counties expressed their inability to estimate the costs of implementing this particular policy: some felt it would be more controversial and far-reaching than past policies, while others felt that implementation would be simple and costless. The average county-estimated cost of implementation was $18,000, with a standard deviation of $33,059. We spread the implementation cost over the first three years of the rule change because it is likely to take some time to educate the public about the adopted rules. The statewide average cost of implementation is $1.2 million, with a 95 percent confidence interval from $376,000 to $2.1 million. (See Appendix F for further discussion of implementation costs).

Standardization of nonconforming structure rules was analyzed by surveying counties on their current policies for nonconforming structures and comparing them with the new standards to determine whether they would likely be more or less strict. We also asked for the number of permits they get annually for each category of expansion, or if that type of expansion is illegal, how many variances they issue. We then made the assumption that each permit issued in a category that would be made illegal would become a variance issued in the future, adding to costs. Variances require more time and a higher fee from the property owner than permits because they demand a more thorough review. We found that the new regulations would be slightly stricter on average, and used the difference between variance fees and permit fees as a measure of the new costs passed on to homeowners who wish to expand their nonconforming structures (Appendix G). We found a net cost for this provision using this method of analysis, but believe that unmeasured benefits actually make it a significant net benefit.

TIME SPAN AND DISCOUNT RATE USED

We chose a 10-year time horizon for the projection of our benefits. Many of our assumptions become less logical over time, so we wanted to pick a short time period. For example, we assumed that the amount of nonconforming structures remodeled each year would stay constant; over time, as more remodels take place, the stock of nonconforming structures will diminish and the number of remodels will decrease. We also used a real discount rate of 3.5 percent, as generally recommended by Boardman et al. (2011). It is important to note that a longer time horizon and lower discount rate may yield greater net benefits, due to the fact that implementation costs would be realized immediately while benefits continue to be realized indefinitely. However, a previous model that used a 40-year time horizon did not find a significantly different figure for net costs, so we believe our choice to be reasonable.

5.2 ASSESSMENT OF VARIABILITY

Due to incomplete and missing data, and uncertainties over assumptions made, we performed a Monte Carlo sensitivity analysis on several variables. A Monte Carlo analysis is designed to provide useful numbers and conclusions when there is a known range of uncertainty in some or all of the estimates being considered in an analysis. It works by establishing the known range and a distribution for each variable, and repeating a number of trials in which a random draw for each uncertain variable is taken and used to calculate a final value. Analyzing the results of a large number of trials, one can establish an expected value for net benefits, as well as a plausible range for net benefits.

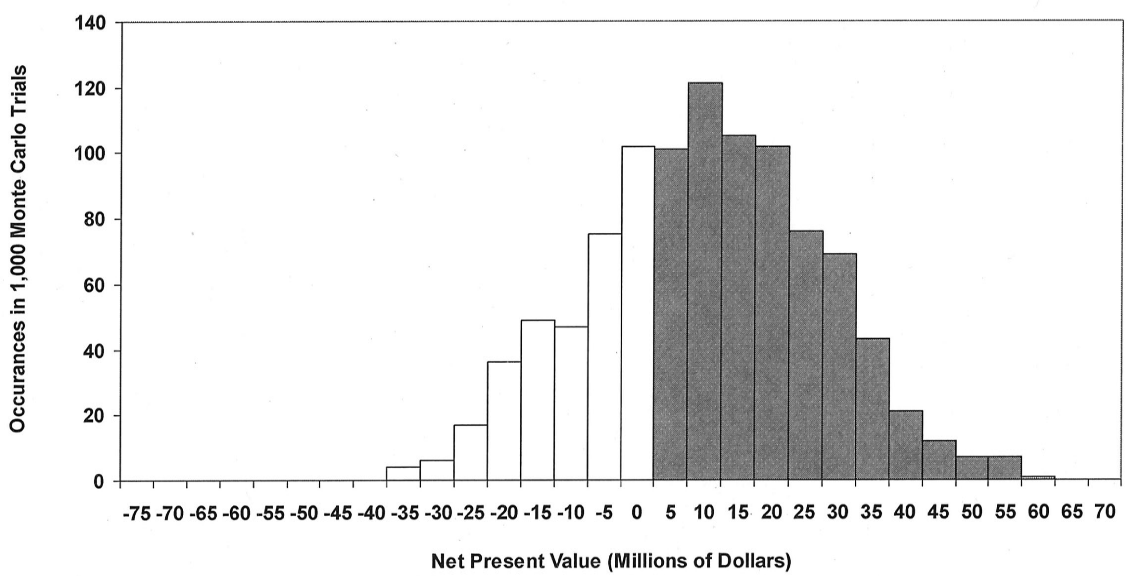
We varied the growth rate for lakeshore homes, the value to property owners of an increase in Secchi depth of one meter, the cost of mitigation projects, the implementation costs of ch. NR 115, Wis. Adm. Code, the number of mitigation buffers created, and the value of an additional day of recreation. See Appendix J for a list of the values that were varied in our analysis and the range of values used in the Monte Carlo simulation. We used a triangular distribution for the values we varied in the sensitivity analysis rather than a standard normal distribution because we knew a most likely value and minimum and maximum values, but did not know the standard deviation. See Table 2 for the results of the analysis, and see Table 3 for a histogram of the range of results.

Table 2: Monte Carlo Results

	Mean	Minimum	Maximum	Standard deviation
Net present value of benefits	$7.4 million	-$40.0 million	$55.6 million	$17.1 million

Source: Authors

Table 3: Histogram of Monte Carlo Trials



Source: Authors

6. Results and Discussion

Table 6 shows an overview of our results given the best estimates for each parameter and each category. See Appendix J for an overview of the values used to obtain these estimates.

Table 6: Results

Cost/Benefit Category	Value
Cost of mitigation to property owners	-$21.6 million
Increased property values from phosphorus reduction	$29.9 million
County implementation costs	-$1.2 million
Improved recreational opportunities from phosphorus reduction	$.4 million
Total	$7.4 million

Source: Authors

6.1 Quantified Benefits

The monetized benefits of ch. NR 115, Wis. Adm. Code addressed in our analysis mainly come from the improvements in water clarity. The benefits of improved water clarity are realized by shoreland property owners and water-based recreationists.

6.1.1 Reduced phosphorous runoff and its impact on recreation

It is often noted that recreation is one of the most important reasons for conserving and improving water quality. In fact, studies have estimated that 60 percent of the benefits of water quality improvement are in benefits to recreation (Rodgers et al., 1990). Chapter NR 115, Wis. Adm. Code is predicted to decrease the amount of phosphorus entering surface waters, which would lead to clearer water (water with greater Secchi depths). There are multiple recreational activities that likely benefit from water quality improvements; however, the typically analyzed activities are swimming, fishing, and boating. For our analysis, we measured the benefits for swimming and fishing to Wisconsin residents.

To calculate the benefits to recreationists, we used parameters from logit and negative binomial models reported in published research to calculate the changes in participation rates and number of recreational trips for swimming and fishing due to improvements in water clarity (see Appendix H). From the models we calculated the increased probability of going fishing, or the percentage of Wisconsinites who fish, from which we could then calculate the increased number of people who would fish if the water were more enjoyable to be on. We also calculated the increased frequency in recreational trips for fishing and swimming those Wisconsinites would take if water clarity improved. These increases were then multiplied by shadow prices for the consumer surplus values for a recreational day per person. We calculated a benefit with a net present value of $399,598 to Wisconsin recreationists.

6.1.2 REDUCED PHOSPHOROUS RUNOFF AND ITS IMPACT ON PROPERTY VALUES

Shoreland property owners enjoy many benefits from higher water quality, including improved fishing and wildlife viewing, opportunities to recreate in clear water, and increased enjoyment of natural beauty. The value of these benefits should be capitalized into the price of the property in a well-functioning real estate market. Therefore, we can look at the difference in property values for homes next to high-quality lakes and low-quality lakes to estimate the value of water quality to homeowners.

We found shadow prices from a number of different studies that estimated the effects of increased Secchi depth on property values. These studies used hedonic pricing models to examine the change in property values occurring over time. Provencher and Spalatro (2001) and Papenfus and Provencher (2006) studied lakes in Vilas County, WI and found a change of $7,894 to $17,892 in property value for an increase in Secchi depth of one meter. We felt that Vilas County properties were generally representative of shoreland properties in Wisconsin. Because of this, we did not attempt to find the prices of property in Vilas County to calculate an elasticity of price with respect to water quality change. Properties less valuable than those in Vilas County would probably experience less of a change in value than our model predicts. Additionally, we had to assume that Vilas County lakes were comparable to the average Wisconsin lake. The study found an average Secchi depth of 3.3 meters in Vilas County, much greater than our "state lake" average of 1.4 meters. It is likely that lakes with lower Secchi depth would experience greater benefits from a 1-meter improvement, so our values are likely an underestimate in this regard. To check the accuracy of these values, we also reviewed studies from other areas and found that their shadow prices for Secchi depth were generally consistent with this estimate (Michael et al., 1996; Boyle et al., 1999; Maine, 2001; Krysel et al., 2003; Eiswerth et al., 2005). Results from those studies ranged from a low of $3,059 to $16,766 per meter Secchi depth. We used the full range of estimates, from $3,059 to $17,892, as values in our Monte Carlo analysis.

The benefits of water quality are not only reflected in the prices of homes affected by this law, but by all lakefront properties in the state, including those in incorporated areas. Additionally, the benefits should be capitalized into the prices of undeveloped lots and provide value to their owners. Therefore, we must multiply the value above by the estimated number of total lakefront properties. This number was calculated by dividing total length of Wisconsin shoreline by average lot length. According to data provided by Wisconsin Lakes (2011), total length of Wisconsin shoreline is equal to 154,730,710 feet. We use 179.278 feet, which is the average lot length of Vilas County's lakeshore parcels (Spalatro and Provencher 2001), as the number of average lake lot length. After the division, we get 863,077 as our number of available lake lots.

In our analysis, we multiplied the Secchi depth increase per year estimated by our model (see Appendix C) by the shadow price range of $3,059 to $17,892 and by the total available lake lots to calculate the total benefits to property owners, which had a present value of $29.9 million.

6.2 Unquantified Benefits

6.2.1 Improved woody debris

There is a general consensus among conservationists and ecologists that there are substantial benefits for improving the woody debris via ecological buffers along lake and riverfronts, specifically in improved habitat for game fish species. However, there is also a consensus among these groups that sufficient data and robust models to calculate these benefits are lacking or altogether non-existent (Peterson et al., 2003; Westphal, 2003). Attempts to quantify and monetize these benefits in terms of real costs and dollar values have proven difficult because of the lack of reliable and sufficient data, which is why they have been excluded from the analysis (Appendix I).

6.2.2 Improved beauty via buffer

The aesthetic beauty of a given parcel of land or property is a characteristic that contributes to the overall value of a property. One perceived benefit of the adopted rule is that it requires that all properties must have a 35-foot natural buffer between the shoreline and any landowner use of the property. Buffers are necessary for the health and ecology of the surrounding ecosystems because they are effective in removing sediment and pollutants from runoff, while improving water quality in areas near farms and downstream (Lovell & Sullivan, 2005). Also, they reduce trenching and flooding, mitigate livestock odor, increase recreational opportunities on public land, and increase tourism (although, for the purposes of our study, almost all of the benefits from tourism are confined to within 30 miles of the source i.e. lake, see Appendix I). Further, there is a movement among conservationists and policy-makers alike to treat ecosystems as capital assets (Turner & Daly, 2008). The most reliable method to quantify the benefits gained from the improved beauty and aesthetics from buffers is through soliciting people's willingness to pay for beauty via contingent valuation studies and independent observer analysis (Daniel & Bolster, 1976; Turner & Daly, 2008). However, the main limitation of this method is that results vary not only by who is surveyed (urban residents or rural residents), but also the geographical location where the survey is conducted. Given the time and resources available to us we were unable to create or obtain an adequate contingent valuation survey measuring people's willingness to pay for beauty. As a result, we were not able to obtain a reliable shadow price for our calculation of net benefits.

6.2.3 Improved wildlife habitat via buffer

Another perceived benefit from creating mandatory vegetative buffers is the improved habitats of wildlife as a result of preserving the existing environmental integrity on waterfront properties. Studies show that wider widths of riparian buffers are consistent with greater abundances of native birds in these habitats (Hagar, 1999). This logic can be extended to lakes as well. However, the monetary impact of improved bird habitat is minimal in terms of its overall benefits. The only method that could be employed to quantify these benefits would be through the solicitations of willingness to pay via contingent valuation surveys of bird-watchers and ornithologists. The research we found indicated that other wildlife, like loons, small mammals, and amphibians, would need a much larger buffer zone for habitat. The 35-foot buffer mandated by the rule appears not to provide enough habitat for these species.

6.2.4 Increased tourism due to improved water quality

Just as with the other ecological and environmental benefits that can be gained from the adopted rule; there are also economic benefits, primarily increased tourism. However, the studies we have found seem to show that the majority of the economic benefits from increased tourism come from the immediate surrounding area, with very little spill over into other counties, let alone states (Appendix I). Counting this as a benefit in our analysis would result in inappropriate double-counting of benefits.

6.3 Quantified Costs

The quantifiable costs of the adopted rule are seen in three categories: the impact on property rights, the implementation costs of the adopted rules, and the change to the process of issuing variances by counties.

6.3.1 Cost of Mitigation

The most significant cost of ch. NR 115, Wis. Adm. Code as adopted would be borne by lakeshore property owners in the form of lost property rights. The adopted rules place restrictions on property owners' ability to develop their property as they would like by placing a cap on impervious surfaces at 15 percent of the property. However, impervious surfaces can be increased up to a 30 percent cap if property owners perform mitigation projects. This flexibility was the key to our analysis of the cost of property rights restrictions.

We obtained data from various county zoning officials on the cost of mitigation projects undertaken by property owners that were designed to offset the effects of expansions of impervious surfaces (Appendix D). The most expensive mitigation project had an estimated cost of $9,800, while other properties could allow native vegetation to regrow in order to fulfill mitigation at no cost. Since regulations will set a minimum standard, we felt it would be inaccurate to include the higher estimates. Therefore, we used an upper bound of $4,900, which was the highest estimate for what officials described as minimal projects, and a lower bound of $0, giving an average value of $2,450 for our estimate of mitigation costs.

We restricted our analysis to counties that did not report existing impervious surface averages on properties less than 15 percent. In these counties, we estimated an annual average of 950 expansions would take place that would trigger mitigation (Appendix D). We assumed that each of these expansion projects would increase impervious surface beyond 15 percent, but not beyond 30 percent. Given that assumption, these expansion projects can still take place if the homeowner is willing to pay the cost of mitigation estimated above. Therefore, the cost of mitigation serves as a proxy for the homeowner's willingness to pay to not have their property rights restricted.

This measure is likely an overestimate, because we assume that all property owners are willing to pay the cost. Property owners who choose not to expand in the face of this mitigation requirement are implicitly valuing their expansion at less than expansion cost plus mitigation cost. However, the price of most housing expansions is high enough that we believe our assumptions are reasonable.

An example may help illustrate this point. If adding a new deck onto the house would cost $15,000 and the homeowner values having that new deck at $16,000, the homeowner will build the deck and gain a net hedonic benefit valued at $1,000. But if that homeowner must pay an additional $2,000 to perform mitigation in order to build that deck, they will not undertake the project and they will lose out on this $1,000 benefit. In this case, the hedonic cost to the homeowner is $1,000, but our model would have valued it at $2,000.

We can see that if the homeowner places a hedonic value on the project of $17,000 or greater, they would want to undertake the project because they would gain a net benefit. For example, if the homeowner would be willing to pay up to $30,000 to have the deck, they would build the deck and pay $15,000 + $2,000 = $17,000 to do so, gaining a net benefit of $13,000. But under the previous rule, they would have only had to pay $15,000 and they would have gained a net benefit of $15,000, which is $2,000 more. In this case, our model would give the correct value.

The net cost is calculated by multiplying our cost of mitigation by the number of expansions triggering mitigation per year in these counties. The average parameters, using a mitigation cost of $2,450, give a net present cost of $21.7 million. However, this answer is very sensitive to the value of mitigation cost. Using a range of values between $0 and $9,800 with a mean of $4,900, as we did in the Monte Carlo analysis, produced a net present cost of $43.4 million.

6.3.2 County implementation costs

Costs to counties can be divided into costs of rule implementation and costs of rule enforcement. Rule implementation describes the process of drafting new legal language, negotiating county standards with the state minimums, and explaining the adopted rule to the public through public hearings. These are one-time costs and were estimated by counties in a 2006 survey (Wisconsin DNR, 2006). The average county-estimated cost of implementation was $18,000, giving a statewide estimated cost of implementation of $1.25 million. (See Appendix F for further discussion of implementation costs). We spread the implementation cost over the first three years of the rule change because it is likely to take some time to educate the public about the adopted rules.

Measurement of the initial costs of implementation was based on a 2006 survey of counties (Wisconsin DNR, 2006). The survey asked for the average cost to counties of adopting a model ordinance, conducting public hearings, resolving conflicts and other expenses related to new ordinances. Twenty-seven out of 70 affected counties responded to the survey, a response rate of 38 percent. To estimate the initial implementation cost, we added together the costs mentioned above. The average cost was $17,841, with a standard deviation of $33,059. Based on that average, the total costs to all counties to implement the rule would be approximately $1.2 million over three years.

The high variation in the sample makes it difficult to draw a firm conclusion on these costs. Many counties felt like they could not give an accurate estimate of implementation costs because the policy in question was significantly more far-reaching and controversial than the average ordinance change. Consequently, some counties guessed that ordinance change would require a lot of time and public outreach, and others guessed that it would be simple. Northern counties with many shoreland properties also gave much higher estimates, which is logical because more people would be affected. Because of these issues, a 95 percent confidence interval for the range of costs is $376,004 to $2,121,792.

6.4 Unquantified Costs

6.4.1 Property Rights Restrictions

Using the method stated above, we were able to quantify the direct cost of property rights restrictions to homeowners who were restricted by them. However, these restrictions can theoretically impose costs on all shoreland property owners. A piece of property that has restrictions placed on it may be considered less valuable than an identical piece of property without restrictions. Even if the current owner has no desire to expand in a way that would be restricted, a future owner might. Therefore, we would expect a lower market value for the restricted property.

Amenity and scarcity effects may also be generated by the regulation, both of which would increase the value of the property; these are discussed further in Appendix H. In brief, amenity value is created if the regulation increases the quality of the property, while scarcity value is created if the regulation limits the supply of similar properties. We attempted to measure the amenity effect earlier, through the shadow price of property values in response to water quality changes (Section 6.1.2). However, limiting development creates its own effect that should lower values, even if the amenity and scarcity effects combine to increase the net value.

A time-series analysis of housing values would be necessary to gather this type of information. It would allow for an improved determination of both the property rights restriction cost and the water quality benefits of the adopted rule. In this study, sales price data could be gathered for the ten years prior to the implementation on ch. NR 115, Wis. Adm. Code, and then collected for the 3 to 5 years after the implementation of the rule, to see if there is any causal effect.

A similar study can be seen in Provencher and Spalatro (2001), which primarily examined the effects of increased minimum frontage requirements on property values in Vilas County. They isolated and measured negative development effects caused by restricting the ability to develop property, in addition to positive amenity effects caused by preserving environmental benefits. Their analysis found no statistically significant development effect resulting from restrictions. However, the specifics of their regulation were quite different than the changes we analyze: it involved increases in minimum frontage requirements that would prevent developers from dividing lots to increase the total property value. Therefore, we decided their measured effect could not be applied to our analysis.

The significance and magnitude of this cost depends on the specific nature of the restrictions and can only accurately be measured after the rule has been implemented for a number of years. It is difficult to quantify this cost before the rule has been implemented, but previous studies such as Provencher and

Spalatro (2001) have not found significant costs. Additional studies would be needed to accurately measure this cost.

6.4.2 Enforcement

While most counties reported no need for higher enforcement, some counties were concerned that the adopted rule would be difficult to enforce without increased staff. Reported enforcement costs also varied widely, from $40,000 to $500,000 per year. In total, the annual costs of counties that reported a need for increased enforcement was $1,056,000.

It is difficult to make an accurate estimate of enforcement costs. The policy does not require increased enforcement beyond what already exists. It requires counties to add the new criteria into their codes and apply them to cases that come up; counties are not required to increase inspections in order to raise compliance with the adopted rule. Indeed, if counties are constrained by resources, we would expect them not to increase enforcement and increased enforcement costs would be $0. However, we might also imagine counties wanting to comply with the adopted rule would lobby for money to increase compliance. In this scenario, we assume that the counties who reported enforcement costs on the survey are those who would actually increase enforcement, and that the survey results are representative of the population of counties. If we extrapolate the average reported enforcement costs to all counties, using zero for counties in the sample that did not report a cost, the enforcement total would be $2,737,778 per year.

Another wrinkle to this story is that the level of enforcement affects the benefits gained from the policy. Under the status quo, we can assume a given level of disobedience (measuring this level was not attempted). This disobedience decreases the effectiveness of shoreland regulations, meaning that the costs under the old rule are greater than we have estimated. We assume that no actions are taken to decrease the level of disobedience under the new policy, and we assume that the effectiveness of shoreland regulations is then decreased by the same amount as it was under the status quo. If enforcement stays the same, then the effect is canceled out.

As we predicted positive benefits from the adopted rule, greater enforcement would increase this benefit by some amount. Without knowing how enforcement would increase, we cannot predict the amount of this benefit increase.

6.5 Other Effects

6.5.1 Standardized Treatment of Nonconforming Structures

The adopted rule makes a number of changes to the treatment of legal nonconforming structures - structures that are within the minimum legal distance from the lake, but were legally placed at the time of construction. Prior policy allowed counties the freedom to set their own rules for nonconforming structures to a great degree, creating a great deal of variation. The adopted rule standardizes this. We surveyed counties on their current policies for nonconforming structures and compared them with the new standards to determine whether they would likely be more or less strict. We found that the new regulations would be slightly stricter on average, and used the difference between variance fees and permit fees as a measure of the new costs passed on to homeowners who wish to expand their nonconforming structures (Appendix G). The net cost was measured at $26,000.

Despite this finding of net cost, we believe that standardizing treatment will provide an overall benefit. The Wisconsin Builders Association stated that standardizing the regulations will increase the number of homeowners who undertake building repair (Jerry Deschanes, personal communication 2011). The Wisconsin Realtors Association pointed out other provisions that standardize planned unit developments and substandard lots which they believe will improve housing development (Tom Larson, personal communication 2011). Creating a climate of greater regulatory consistency throughout the state should also be beneficial to these businesses. We project that standardizing the treatment of nonconforming structures will produce positive net benefits.

6.6 Impacts and Distribution

The vast majority of this rule's costs fall on the subset of shoreland property owners who have removed their vegetative buffer and wish to expand. The benefits, by contrast, are felt by a larger group. Our major quantified benefit, increased property values, is experienced by all shoreland property owners including those who bear no costs from the rule. They benefit by limiting the expansion of others that would otherwise pollute their lake. The unquantifiable benefit of natural scenic beauty, probably the most important benefit, is experienced by both property owners and visitors, including recreationists and tourists.

Counties are predicted to bear a small amount of the total costs. These costs are in the first few years of implementation. The cost of increased variances is passed on to homeowners who wish to expand through permit and variance fees, assuming counties charge fees equal to the cost of providing the service. We also believe enforcement costs will end up being low, because additional enforcement is not part of the rule; however, some counties believe that enforcement costs will be very significant.

6.7 Uncertainty and Sensitivity Analysis

The total impact measured was driven almost completely by the benefit of water clarity and the cost of restrictions to property owners. The other measured costs and benefits were insignificant in comparison. The specification of key parameters involved in the calculation of those two categories can change the result significantly. The cost of mitigation to property owners, which functioned as a proxy for the cost of restrictions, can range widely based on the specific policies of the county and characteristics of an individual property. In our Monte Carlo analysis, we assigned a large range of $0 to $4,900 to this cost. Our analysis may overstate the cost because the rule only requires the minimum; it is more likely that the costs will be near $0 than that they will be near $4,900. An increase of only $1 in the average cost of mitigation increased the total net cost of restrictions by $8,848. The shadow price of water quality, as determined by the studies mentioned in Section 5.1, was also highly variable, with a range of $3,059 to $17,892. An increase of $1 in the shadow price of water quality increased the total net benefit to property owners by $2,851. Because our results are highly sensitive to the values of these two parameters, an inaccurate assessment of their value will change our results significantly.

The number of mitigation scenarios taking place because of the rule is likely underestimated in our analysis. We have measured this before in terms of buffers created when mitigation takes place and in terms of buffers that would be kept when new houses are built. However, we know from Bernthal (1997) that the previous standard for vegetative buffers had many loopholes that allowed virtual clear-cutting of the area. Because of the new, stricter standard, people who have a buffer on their property would have to preserve that buffer, rather than mowing it down. To measure this effect we would require an estimate of the number of properties with buffers, and an estimate of the percentage of homeowners who want to cut down their buffer. We were unable to find a source for this information, but we expect that more buffers are preserved this way than are created through mitigation. Additionally, property owners do not have to pay a cost in this scenario. We can say, therefore, that the true impact of the rule in terms of phosphorus reduction, and therefore in terms of property value increase and recreation increase, is greater than we measured.

We also feel that our measured recreation benefits are smaller than the true benefits provided. Previous studies have estimated that 60 percent of the benefits of water quality improvement are in benefits to recreation (Rodgers et al., 1990), yet our recreation benefits comprised only 1 percent. A study measuring willingness to pay for water clarity would provide a more accurate measure of our recreation benefits. We currently measure benefits using shadow prices and equations from a Finnish study, which may be inaccurate when extrapolated to Wisconsin. Such a study would have to be conducted statewide and have an inclusive sample that is representative of the population in terms of socio-economic and demographic characteristics. These studies would allow for a more accurate and quantifiable means of determining the benefits of ch. NR 115, Wis. Adm. Code. Willingness to pay for increased scenic and aesthetic beauty resulting from increased vegetative buffers or other land-use regulations may provide a huge unmeasured benefit to tourists and recreationists.

6.8 Reasonableness of Methods

We were unable to provide any estimate of many benefits of this policy. While we estimated the response of anglers to changes in water quality, the effects on fish are even more important and we were unable to estimate these. Lakes with higher water quality and with coarse woody debris support valuable game fish like muskellunge, northern pike, bass, and walleye. More game fish habitat would provide more attraction for anglers and probably produce a much more significant benefit. Habitat for other species, including birds, frogs, and mammals, would also be provided by the riparian buffer zones, but we were unable to find an explicit benefit of having these species. Appendix I contains more information on these excluded benefits.

An area of future study would be to look at how the sale prices of the shoreland properties respond to the adopted rule. There are arguments that land-use regulations increase property values, which could potentially increase the measured net benefits of a rule like ch. NR 115, Wis. Adm. Code. A time-series analysis would be particularly useful because it would allow for a determination of the effect of the adopted rule, if it exists. For example, sales price data could be gathered for the ten years prior to the implementation on ch. NR 115, Wis. Adm. Code, and then collected for the 3 to 5 years after the implementation of the rule, to see if there is any causal effect. Similar studies demonstrated that the sales prices of shoreland properties increased by 46 to 62 percent after the implementation of similar land-use regulations (Jaeger, 2006).

Contingent valuation studies would also be beneficial in determining many of our unknown benefits. Willingness to pay for increased scenic and aesthetic beauty resulting from increased vegetative buffers or other land-use regulations may provide a huge unmeasured benefit to tourists and recreationists. A study measuring willingness to pay for water clarity would provide a more accurate measure of our recreation benefits. We currently measure benefits using a Finnish study, which may be inaccurate when extrapolated to Wisconsin. Such a study would have to be conducted statewide and have an inclusive sample that is representative of the population in terms of socio-economic and demographic characteristics. These studies would allow for a more accurate and quantifiable means of determining the benefits of ch. NR 115, Wis. Adm. Code.

Finally, it is important to remember that our study measures the marginal change between the previous version of ch. NR 115, Wis. Adm. Code and the new version. The existing shoreland zoning regulations provide untold benefits in terms of phosphorus reduction, wildlife habitat, and natural scenic beauty. An additional study would have to be done to measure the effects of this rule against a policy of no regulations. Our literature review (Appendix H) strongly suggests that significant net benefits would be found if this comparison was made.

References

Anderson, S. T., and S. E. West. 2006. Open Space, Residential Property Values, and

Spatial Context. Regional Science and Urban Economics 36 (6): 773-89.

Beaton, P.W. 1991. The Impact of Regional Land-Use Controls on Property Values: The Case of the New Jersey Pinelands. Land Economics 67 (2): 172-94.

Bennett, E.M., S.R. Carpenter and N.F. Caraco. 2001. Human impact on erodable

phosphorus and eutrophication: a global perspective. BioScience 51: 227-234.

Bernthal, Thomas. 1997. Effectiveness of Shoreland Zoning Standards to Meet Statutory

Objectives: A Literature Review with Policy Implications. Wisconsin Department of Natural Resources. Madison, WI.

Berson, D., D. Lereah, P. Merski, F. Nothaft, and D. Seiders. 2004.

America's Home Forecast: The Next Decade for Housing and Mortgage Finance. The Homeownership Alliance.Retrieved from http://www.freddiemac.com/news/pdf/americas_home_forecast.pdf.

Boardman, A. E., D. H. Greenberg, A. R. Vining, and D. L. Weimer. 1997. "Plug-in" Shadow Price Estimates for Policy Analysis. The Annals of Regional Science 31 (3): 299-324.

Boyle, Kevin J., Joan Poor, and Laura O. Taylor. 1999. Estimating the Demand for Protecting

Freshwater Lakes from Eutrophication. American Journal of Agricultural Economics: 1118-1122.

Brady, Nyle C., and Ray R. Weil. 2008. Elements of the Nature and Properties of Soils.

Brown, G. M., and H. O. Pollakowski. 1977. Economic Valuation of Shoreline. The Review of Economics and Statistics 59 (3): 272-8.

Christensen, D. L., B. R. Herwig, D. E. Schindler, and S. R. Carpenter. 1996. Impacts of Lakeshore Residential Development on Coarse Woody Debris in North Temperate Lakes. Ecological Applications 6 (4): 1143-9.

Cropper, M. L. 2000. Has Economic Research Answered the Needs of Environmental Policy? Journal of Environmental Economics and Management 39 (3): 328-50.

Daly, H. E., and J. B. Cobb, Jr. 1994. For the Common Good. Boston: Beacon Press.

Di, Z. X., N. McArdle, and G. S. Masnick. 2001. Second Homes: What, How Many, Where, and Who. Harvard University Joint Center for Housing Studies, Research Note N-01-2.

Daniel, T.C.; Boster, R. 1976.Measuring Landscape Aesthetics: The SBE Method. Res. Pap. RM-167. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain and Range Experiment Station.

Ditton, R. B., S. M. Holland, and D. K. Anderson. 2002. Recreational Fishing as Tourism. Fisheries 27 (3): 17-24.

Eiswerth, Mark, Russ Kashian, and Mark Skidmore. 2005. What Is the Value of a Clean and Healthy Lake to a Local Community?Prepared for Delavan Lake Improvement Association.

Epple, D., T. Romer, and R. Filimon. 1988. Community Development with Endogenous Land Use Controls. Journal of Public Economics 35 (2): 133-62.

ESRI. 2011. ArcGis. Retrieved from http://www.esri.com/software/arcgis/index.html.

Finland Ministry of the Environment. 2011. Water Protection. Retrieved from http://www.ymparisto.fi/default.asp?contentid=390566&lan=en&clan=en.

Glaeser, E. L., and B. A. Ward. 2009. The Causes and Consequences of Land Use Regulation: Evidence from Greater Boston. Journal of Urban Economics 65: 265–278.

Goetz, R. U., and D. Zilberman. 2007. The Economics of Land-Use Regulation in the Presence of an Externality: A Dynamic Approach. Optimal Control Applications and Methods 28 (1): 21-43.

Green, R. K. 1999. Land Use Regulation and the Price of Housing in a Suburban Wisconsin County. Journal of Housing Economics 8: 144-59.

Gyourko, J., A. Saiz, and A. Summers. 2008. A New Measure of the Local Regulatory Environment for Housing Markets: The Wharton Residential Land Use Regulatory Index. Urban Studies 45 (3): 693.

Haider, W., and L. Hunt. 2002. Visual Aesthetic Quality of Northern Ontario's Forested Shorelines. Environmental Management 29 (3): 324-34.

Hagar, J.C. 1999. Influence of Riparian Buffer Width on Bird Assemblages in Western Oregon. The Journal of Wildlife Management 63 (2): 484-496.

Heal, G., G. C. Daily, P. R. Ehrlich, and J. Salzman. 2001. Protecting Natural Capital through Ecosystem Service Districts. Stan.Envtl.LJ 20: 333.

Henneberry, D. M., and R. L. Barrows. 1990. Capitalization of Exclusive Agricultural Zoning into Farmland Prices. Land Economics 66 (3): 249-58.

Hilber, C.A.L., and F. Robert-Nicoud. 2009. On the Origins of Land Use Regulations: The 'Influential Landowner' Hypothesis. LSE Working Paper.

Ihlanfeldt, K. R. 2007. The Effect of Land Use Regulation on Housing and Land Prices. Journal of Urban Economics 61 (3): 420-35.

Jaeger, W. K. 2006.Effects of Land-Use Regulations on Property Values. Environmental Law 36: 105.

Jerry Deschanes, Wisconsin Builder's Association. Personal communication, August 2011.

Johnston, R. J., M. H. Ranson, E. Y. Besedin, and E. C. Helm. 2006. What Determines Willingness to Pay Per Fish? A Meta-Analysis of Recreational Fishing Values. Marine Resource Economics 21 (1): 1-32.

Jud, G. D. 1980. The Effects of Zoning on Single-Family Residential Property Values: Charlotte, North Carolina. Land Economics: 142-54.

Kauko, T., R. Goetgeluk, A. Straub, and H. Priemus. 2002. Presence of Water in Residential Environments– Value for Money? Paper presented at 10th ERES conference, Helsinki, Finland.

Kaval, P., and J. Loomis. 2003. Updated Outdoor Recreation Use Values with Emphasis on National Park Recreation. US Department of the Interior, National Park Service. Fort Collins, CO.

Kearney, Anne R., Gordon A. Bradley, Carl H. Petrich, Rachel Kaplan, Stephen Kaplan, and Diane Simpson-Colebank. 2008. Public Perception as Support for Scenic Quality Regulation in a Nationally Treasured Landscape. Landscape and Urban Planning 87 (2): 117-28.

Krysel, Charles, Elizabeth Marsh Boyer, Charles Parson, and Patrick Welle. 2003. Lakeshore

Property Values and Water Quality: Evidence from Property Sales in the Mississippi Headwaters Region. Prepared for Legislative Commission on Minnesota Resources

Lillie, R.A., S. Graham, and P. Rasmussen. 1993. Trophic State Index Equations and Regional

Predictive Equations for Wisconsin Lakes.

Wisconsin Department of Natural Resources Bureau of Research.Retrieved from http://dnr.wi.gov/org/es/science/publications/PUBL_RS_735_93.pdf.

Lovell, S.T. and W.C. Sullivan. 2006. Environmental Benefits of Conservation Buffers in the United States: Evidence, Promise, and Open Questions. Agriculture, Ecosystems, and Environment 112: 249-260.

Luken, R. A., F. R. Johnson, and V. Kibler. 1992. Benefits and Costs of Pulp and Paper Effluent Controls under the Clean Water Act. Water Resources Research 28 (3): 665-74.

Maine Department of Environmental Protection, Lake Assessment Program (Maine). 2001. More

on Dollars and Sense: The Economic Impact of Lake Use and Water Quality.

Malpezzi, Stephen, Gregory H. Chun, and Richard K. Green. 1998. New Place-to-Place Housing Price Indexes for U.S. Metropolitan Areas and Their Determinants: An Application of Urban Indicators. Real Estate Economics 235: 235-274.

McGinley, Paul. 2008. A shoreland quality estimator for evaluating riparian development on lakes. University of Wisconsin, Steven's Point.Prepared for the Wisconsin Department of Natural Resources.

McPhee, D. P., D. Leadbitter, and G. A. Skilleter. 2002. Swallowing the Bait: Is Recreational Fishing in Australia Ecologically Sustainable. Pacific Conservation Biology 8 (1): 40-51.

Michael, Holly J., Kevin J. Boyle, and Roy Bouchard. 1996. Water Quality Affects Property

Prices: A Case Study of Selected Maine Lakes. Maine Agricultural and Forest Experiment Station.Miscellaneous Report 398.

Mills, D. E. 1989. Is Zoning a Negative-Sum Game? Land Economics 65 (1): 1-12.

Mishan, E. J., and E. Quah. 2007. Cost-Benefit Analysis Psychology Press.

Murphy, M. L., and K. V. Koski. 1989. Input and Depletion of Woody Debris in Alaska Streams and Implications for Streamside Management. North American Journal of Fisheries Management 9 (4): 427-36.

Netusil, N. R. 2005. The Effect of Environmental Zoning and Amenities on Property Values: Portland, Oregon. Land Economics 81 (2): 227.

Oliva, S. 2006. The Effects of Waterfront Development on Housing Prices: The Case of Eastern Baltimore.PhD diss., University of Maryland. Retrieved from http://drum.lib.umd.edu/handle/1903/4205.

Oregon Department of Agriculture. 2005. The Conservation Reserve Enhancement Program. Salem, OR.

Palmquist, R. B., and C. M. Fulcher. 2006. The Economic Valuation of Shoreline: 30 Years Later. In Explorations in Environmental and Natural Resource Economics, edited by Robert Halvorsen and David F. Layton.

Papenfus, Michael, and Bill Provencher. 2006. A Hedonic Analysis of Environmental Zoning:

Lake Classification in Vilas County, Wisconsin. Staff paper, Department of Agricultural and

Applied Economics, University of Wisconsin.

Parkhurst, G. M., J. F. Shogren, C. Bastian, P. Kivi, J. Donner, and R. B. W. Smith. 2002. Agglomeration Bonus: An Incentive Mechanism to Reunite Fragmented Habitat for Biodiversity Conservation. Ecological Economics 41 (2): 305-28.

Parsons, G. R., E. C. Helm, and T. Bondelid. 2003. Measuring the Economic Benefits of Water Quality Improvements to Recreational Users in Six Northeastern States: An Application of the Random Utility Maximization Model. University of Delaware Manuscript.Retrieved from http://works.bepress.com/george_parsons/25.

Parsons, G. R., and M. J. Kealy. 1992. Randomly Drawn Opportunity Sets in a Random Utility Model of Lake Recreation. Land Economics 68 (1): 93-106.

Paterson, R. W., and K. J. Boyle. 2005. Costs and Benefits of Riparian Forest Management: A Literature Review Industrial Economics, Inc.

Personal communication.2011. Pamela Toshner, Paul Goggin, Mike Meyer, and Brian Standing (county zoning officials and Wisconsin DNR staff) in discussion with Jamie Bernthal.

Peterson, G.D., T.D. Beard, B.E. Beisner, E.M. Bennett, S.R. Carpenter, G.S. Cumming, C.L. Dent, and T.D. Havlicek. 2003. Assessing Future Ecosystem Services: a Case Study of the Northern Highlands Lake District, Wisconsin. Conservation Ecology 7 (3): Retrieved from http://www.consecol.org/vol7/iss3/art1.

Pogodzinski, J. M., and T. R. Sass. 1990. The Economic Theory of Zoning: A Critical Review. Land Economics 66 (3): 294-314.

Rodgers, C., K. W. Easter, and T. Graham-Tomasi. 1990. The Off-Site Economic Benefits of Soil Conservation: A Review and Discussion of Recent Literature on the Recreational Demand for Water Quality Improvement. Staff Papers.

Roth, B. M., I. C. Kaplan, G. G. Sass, P. T. Johnson, A. E. Marburg, A. C. Yannarell, T. D. Havlicek, T. V. Willis, M. G. Turner, and S. R. Carpenter. 2007. Linking Terrestrial and Aquatic Ecosystems: The Role of Woody Habitat in Lake Food Webs. Ecological Modelling 203 (3-4): 439-52.

Sass, G. G., J. F. Kitchell, S. R. Carpenter, T. R. Hrabik, A. E. Marburg, and M. G. Turner. 2006. Fish Community and Food Web Responses to a Whole-Lake Removal of Coarse Woody Habitat. Fisheries 31 (7): 321-30.

Schindler, David W., and John R. Vallentyne. The Algal Bowl: Overfertilization of the World's Freshwaters and Estuaries. Saskatoon: Earthscan, 2008.

Shilling, J. D., C. F. Sirmans, and K. A. Guidry. 1991. The Impact of State Land-Use Controls on Residential Land Values. Journal of Regional Science 31 (1): 83-92.

Shogren, J. F., G. M. Parkhurst, and C. Settle. 2003. Integrating Economics and Ecology to Protect Nature on Private Lands Environmental Science & Policy 6 (3): 233-42.

Smith, V. K., and W. H. Desvousges. 1986. Measuring Water Quality Benefits. Springer.

Smith, V. K., W. H. Desvousges, and A. Fisher. 1986. A Comparison of Direct and Indirect Methods for Estimating Environmental Benefits. American Journal of Agricultural Economics: 280-90.

Spalatro, F., and B. Provencher. 2001. An Analysis of Minimum Frontage Zoning to Preserve Lakefront Amenities. Land Economics 77 (4): 469.

Statistics Finland. 2011. Income and Consumption. Retrieved from

http://www.stat.fi/tup/suoluk/suoluk_tulot_en.html.

Sunding, David L., and Aaron M. Swoboda. 2010. Hedonic Analysis with Locally Weighted

Regression: An Application to the Shadow Cost of Housing Regulation in Southern California. Regional Science and Urban Economics 40: 550–573.

Tietenberg, Tom, and Lynne Lewis. 2008. Environmental & Natural Resource Economics.

Prentice Hall.

Turner, R.K. and G.C. Daly. 2008. The Ecosystem Services Framework and Natural Capital

Conservation. Environmental Resource Economics 39: 25-35.

Twynam, G.D., and D.W. Robinson. 1997. A Market Segmentation Analysis of Desired

Ecotourism Opportunities. Nat. Resourc. Can., Canadian Forest Service, Great Lakes Forestry Centre, Sault Ste. Marie, ON.NODA/NFP Tech. Rep. TR-34.

Vesterinen, J., and E. Pouta. 2008. Water Recreation Benefits from Reduced Eutrophication in

Finnish Surface Waters. Paper presented at 2008 International Congress, August 26-29, 2008, Ghent, Belgium.

Vesterinen, J., E. Pouta, A. Huhtala, and M. Neuvonen. 2010. Impacts of Changes in Water

Quality on Recreation Behavior and Benefits in Finland. Journal of Environmental Management 91 (4): 984-94.

Walsh, P. 2009. Hedonic Property Value Modeling of Water Quality, Lake Proximity, and

Spatial Dependence in Central Florida.MS diss., University of Central Florida.

Walsh, R. G., D. M. Johnson, and J. R. McKean. 1992. Benefit Transfer of Outdoor Recreation

Demand Studies, 1968–1988. Water Resources Research 28 (3): 707-13.

Weagraff, Benjamin S. 2004. The Contribution of Second Homes to Rural Economies.MS diss.,

Pennsylvania State University.Retrieved from http://nercrd.psu.edu/land_use/WeagraffMSthesis.pdf.

Westphal, Lynne M. 2003. Water, Water Everywhere... Integrated Riparian Research in the

North Central Region.Proceedings of the 13th Central Hardwood Forest Conference; Gen. Tech. Rep. NC-234. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Research Station: 108-113.

Wisconsin Department of Natural Resources (Wisconsin DNR). 1998. Digital Elevation Model of Wisconsin. Retrieved from ftp://gomapout.dnr.state.wi.us/geodata/elevation/

Wisconsin Department of Natural Resources (Wisconsin DNR).2011a. Implementation Survey.

On file at the Wisconsin Department of Natural Resources.

Wisconsin Department of Natural Resources (Wisconsin DNR). 2006. WCCA Survey.
On file at the Wisconsin Department of Natural Resources.

Wisconsin Department of Natural Resources (Wisconsin DNR). 2011b. Wisconsin Statewide Comprehensive Outdoor Recreation Plan: 2011-2016. Retrieved from http://dnr.wi.gov/planning/scorp/data.html.

U.S. Census Bureau. 2010a. Annual Estimates of the Housing Inventory by Region: 1984 to Present. Retrieved from http://www.census.gov/hhes/www/housing/hvs/historic/.

U.S. Census Bureau. 2010b. 2005-2009 American Community Survey 5-Year Estimates. Retrieved from http://www.census.gov/acs/www/.

U.S. Census Bureau. 2007. Census 2000 Summary File 1 (SF 1) 100-Percent Data. Retrieved fromhttp://factfinder.census.gov.

U.S. Census Bureau. 2011. State & County QuickFacts: Wisconsin.
Retrieved from http://quickfacts.census.gov/qfd/states/55000.html.

U.S. Department of the Interior, Fish and Wildlife Service, and
U.S. Census Bureau (U.S. DOI). 2006. National Survey of
Fishing, Hunting, and Wild-life Associated Recreation. Retrieved from
http://library.fws.gov/pubs/nat_survey2006_final.pdf.

U.S. Environmental Protection Agency (U.S. EPA). 2010. Carlson's Trophic State Index.
Retrieved from http://www.epa.gov/bioiweb1/aquatic/carlson.html.

USDA Forest Service. 1976. Measuring Landscape Aesthetics: The Scenic Beauty Estimation Method.

USDA Natural Resources Conservation Service (USDA NRCS). 2011. Geospatial Data Gateway. Retrieved from http://datagateway.nrcs.usda.gov.

APPENDICES

APPENDIX A: HOUSING STOCK AND HOUSING GROWTH RATES

Identifying the number of shoreland homes per county was a challenge because survey data tallied the number of shoreland lots rather than homes (Wisconsin DNR, 2011a). Research suggests that shoreland homes are especially likely to be second homes, and the number of second homes has been growing faster than housing overall since at least 1990. We found a correlation of 0.68 between the number of lakes per county and our estimate of the number of second homes per county. For our analysis, we have therefore used the number of second homes per county as a rough estimate of the number of affected homes per county. We use our estimate for the number of shoreland homes per county to help estimate the number of expansions and associated costs now and as the housing stock grows, as well as in our model of phosphorus runoff.

We assumed that the number of shorefront homes corresponds to the number of second homes in each county. This assumption was based on the high correlation coefficient between the number of lakes per county with the number of second homes per county. Specifically, we found a Pearson's correlation coefficient of 0.68.

The variables that could predict shoreland house expansion included county population, second homes, and the number of lakes; all were tested for their significance. We ran linear regression using these variables separately and also in combination for the counties that had survey information. We used statistical software "R" for this purpose. We found that only the number of lakes had a significant influence on shoreland house expansions, with a correlation coefficient of (R^2 =0.23, R = 0.52) at a P value of 0.027. The result showed that the number of lakes per county has a positive relationship with house expansion near shore land.

The number of expansions in counties with no survey data is estimated as follows:

$$\text{House Expansion}_{\text{County i}} = 52 + 0.356 * \text{Lake Number}_{\text{County i}}$$

Regression Output (Estimated using R software)

```
Regression = lm (HouseExpansion~LakesNo)
summary (Regression)
Call:
lm(formula = HouseExpansion ~ LakesNo)

Residuals:
   Min      1Q   Median     3Q    Max
-144.49  -49.80 -23.66    47.60 143.90

Coefficients:
             Estimate  Std. Error  t value  Pr(>|t|)
(Intercept)  52.0001    30.0251    1.732    0.1025
LakesNo       0.3560     0.1468    2.424    0.0276 *
---
Signif. Codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
Residual standard error: 82.88 on 16 degrees of freedom
Multiple R-squared: 0.2686,    Adjusted R-squared: 0.2229
F-statistic: 5.877 on 1 and 16 DF, p-value: 0.02755
```

Source: Authors

To estimate the number of shoreland homes per county now and in the future, we also require realistic growth rates for housing. We evaluate growth in second homes for two reasons. First, a number of studies suggest that consumers prefer waterfront property for second homes (Weagraff, 2004). Second, the number of second homes is growing faster than overall housing, both nationally and in the Midwest (Di et al., 2001; U.S. Census Bureau, 2010a). Ultimately, we decided to assume that shorefront homes are second homes because of the correlation above. We use our estimate for the number of shoreland homes per county to help estimate the number of expansions and associated costs now and as the housing stock grows, and in our model for phosphorus runoff reductions.

To be as current as possible, our baseline data for the number of total housing units per county comes from the 2005-2009 American Community Survey 5-Year Estimates (U.S. Census Bureau, 2010b). Because this survey does not provide second home data, we use data from the 2000 Decennial Census to estimate the proportion of housing in each county used for seasonal, recreational, or occasional use (U.S.

Census Bureau, 2007). Finally, our rates of growth in various types of housing are projected from historical housing data from the Census Bureau's Current Population and Housing Vacancy surveys for the Midwestern region. We begin with data from 1990 because mobile homes were counted differently before then. The data are also imperfect because the Census Bureau has used different methods for revising its housing data since 2003 (U.S. Census Bureau, 2010a).

Growth in the Midwest for seasonal or "usual residence elsewhere" housing since 1990 was about 1 percent per year, extending up to 3 percent for occasional use housing. Housing designated for these uses is likely to consist of second homes. Unfortunately, the seasonal category also included units held for migratory labor (Di et al., 2001). A weighted average of these three designations of housing growth rates produces a growth rate of 1.4 percent.

Second homes, especially vacation homes, are luxury expenditures most often purchased by heads of households in prime earning years prior to retirement (Di et al., 2001). Second home demand will remain heavily dependent on changes in incomes, the stock market, the cost of housing, and consumer preferences (Berson et al., 2003). Therefore, we have chosen to conduct our analysis using 1.4 percent as a growth rate for housing, with a range of 0.4 to 2.4 percent for our Monte Carlo analysis. We assumed that growth would continue at this rate over our analysis period; this may be a poor assumption, as surveys of county zoning administrators revealed that most developable shoreland property has already been developed. However, limiting our analysis to 10 years makes this a more accurate assumption. We base these rates in the rates of growth calculated for various types of housing in the Midwest, as described above.

Appendix B: Comparison Table of State Shoreland Zoning Ordinances

	Wisconsin	Minnesota	Michigan	Maine
Scope	All lakes and rivers in unincorporated areas	All lakes and rivers, classified by size and existing development	Wild and scenic rivers; mandates local ordinances but provides few standards	All lakes, rivers, wetlands, and coasts
First enacted	1969	1970, amend 1989	1994	1990
Land affected	1,000 ft from lake, 300 ft from river	1,000 ft from lake, 300 ft from river	400 ft or less from river	250 ft from lake, river, wetland, coast; 75 ft from

				stream
Lot size	10,000 sewered, 20,000 unsewered	NE: 40,000 s / 80,000 us RD: 20,000 s / 80,000 us GD: 15,000 s / 20,000 us	Restrictions allowed in local code	30,000 tidal areas, 40,000 non-tidal areas
Lot width	65 sewered, 100 unsewered	NE: 125 s / 200 us RD: 75 s / 150 us GD: 75 s / 100 us	Restrictions allowed in local code	150 tidal, 200 non-tidal
Setbacks	75	50 s / 75 us	Restrictions allowed in local code	75
Buffer strip	35 ft	25 s / 37.5 us	100 ft or less	75 ft
Access corridor	<30% of buffer or 200 ft	No rules (but added in alternative)	Included in buffer strip authority	250 ft
Impervious surface	15% or up to 30% with mitigation	25%	Not mentioned	20%
Height	<35 ft within 75 ft of OHWM	25 ft limit in residential only, 10 ft for accessory structures	Not mentioned	35 ft
Nonconforming structures	Unlimited maintenance, expansion if >35ft from OHWM and not discontinued for 12+ mo., relocation if >35ft from OHWM and not discontinued for 12+mo. and no other location outside setback is available	Upgrading required for sewer systems; nonconforming structures regulated by local code	"Completion, restoration, reconstruction, extension, or substitution of nonconforming uses" is allowed "upon reasonable terms"	Expansion limited to 1000 total sqft and 20 ft height within 75 ft of OHWM; 1500 total sqft and 25 ft height within 100 ft of OHWM; no expansion within 25 ft of OHWM
Variances	Allowed when not contrary to public interest and with finding of undue hardship	Local code allowed to vary if already developed or other circumstances	Applied for and granted pursuant to section 4 of the uniform condemnation procedures act, 1980 PA 87, MCL 213.54	Only for exemption from dimensional requirements and with finding of undue hardship
References	NR 115	6120.2500	Act 451 part 305 of 1994	38 M.R.S.A. sections 435-449

Appendix C: Calculation of Phosphorus Runoff Change

In this study, we examined three different scenarios: a) a baseline scenario which corresponds to current conditions, b) a mitigation scenario, a scenario under the adopted rule that requires homeowner who wants to expand to mitigate phosphorus runoff by restoring a vegetative buffer from 0 to 35 feet from the shoreline and c) a new house scenario, a scenario in which a new built house must have a vegetative buffer and have less than 15 percent impervious surfaces.

To calculate the amount of phosphorus runoff per year from shoreland property (the lots) in a county under the three above scenarios, we used the demo version of the water quality model developed by Paul McGinley (2008). Due to lack of data needed by the model, we made the following assumptions.

a. Lot size – 20,000 square feet. We assumed that every affected house has only one lot and that the lots are 20,000 square feet in size. This is the statewide minimum size of the lot in the state of Wisconsin. We examined the sensitivity of the water quality model in the phosphorus runoff by varying the size of the lots from 10,000 to 100,000 square feet and we found only an 8% percent change; thus concluding it to be insensitive.

b. Slope – 2 percent (default value). We estimated that the slope of the lands in the state of Wisconsin is in the range of 0 to 7.5. This estimation was based on analysis of 30 m resolution Digital Elevation Model for the state (Wisconsin DNR, 1998). Approximately 80 percent of the lands were in the range of 0 to 2 percent. Thus, we assumed the slope to be around 2 percent and it remains constant for all the counties in the state.

c. Number of impervious areas –1. We assumed that the number of impervious areas on a single lot is just one. More than one impervious area per lot would mean multiple buildings on the same lot. We thought that having only one house and no secondary structures on the average lot was a reasonable assumption.

d. Distance to the water – 75 feet. This is the minimum required distance of a primary structure from the high water mark, although some counties have a higher minimum.

e. Ground cover. This parameter differed based on the scenario. In the baseline scenario, we assumed 70% short grass and 30% gravel roads and walkways, representing a mowed lawn with a path to the water. In the mitigation and new house scenarios, we assumed 70% shrubs and 30% gravel roads and walkways, representing a vegetative buffer with the allowed amount of cleared area.

Apart from these parameters, the model requires the soil texture for each of the lots associated with shorefront properties. We assumed it to be the soil types that are predominantly found in each county. The soil type that is dominant in percentage is used as the representative soil for each county in Wisconsin. In ArcGIS software, we used the Majority option of the *Zonal Statistic* function to estimate the predominant soil type in the county, using county boundary and soil type GIS files.

The water quality model we used in this study was capable of predicting phosphorus runoff only for three soil categories – sandy, silty and clayey. The STATSGO soil database has more soil categories, so we generalized the soil categories (Table C1) based on a soil texture pyramid (Figure C1; Brady and Weil, 2008). The soil texture pyramid describes the characteristics of soil textures in terms of their clay, silt and sand percentage.

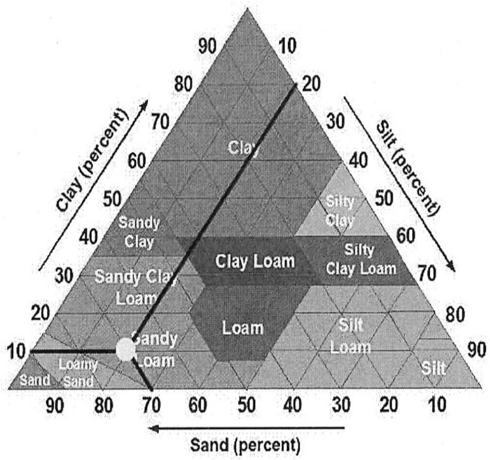


FIGURE C1 SOIL TEXTURE PYRAMID

Source: Brady and Weil, 2008

TABLE C1 GENERALIZED SOIL TEXTURE

	GIS Derived Data	Generalization
1	Sand	Sandy
2	Clay Loam	Silty
3	Coarse Sand	Sandy
4	Sandy Loam	Silty
5	Loamy Sand	Sandy
6	Loam	Silty
7	Fine Sandy Loam	Silty
8	Fine Sand	Sandy
9	Loamy Coarse Sand	Sandy
10	Silt Loam	Silty
11	Silty	Silty
12	Clay	Clayey

Source: Authors

Impervious area is estimated based on lot size and the percent impervious area. The output from the model is pounds of phosphorus runoff per year. We assumed that the yearly growth of housing is in the range of 0.4 percent to 2.4 percent, based on a weighted average growth rate of 1.4 percent for second homes (see Appendix A). We used second homes as a proxy for shoreland properties as we could not directly measure the number of shoreland properties. The correlation of 0.68 between the number of lakes and second homes provides support for our assumption (see Appendix A). Based on the number of new houses per year, we estimated total phosphorus that could be mitigated under the new house scenario mentioned above.

The McGinley runoff model provided us with estimates of changes in phosphorus runoff under the three scenarios mentioned above for each county. We found a statewide average for phosphorus mitigated under each scenario by weighting each county's average by the number of shoreland properties in that county. We took the average phosphorus mitigated under the mitigation scenario and multiplied it by the number of buffers created per year (Appendix D) to find the total phosphorus mitigated by that aspect of the rule. We added to that the average phosphorus mitigated under the new house scenario multiplied by the number of new houses per year (Appendix A). This gave us the total pounds of phosphorus mitigated by the rule. This number was then compared to the existing phosphorus in lakes (Appendix E) to find the change per year, and then converted to change in Secchi depth. The final change that we calculated was .0004 meters Secchi depth improvement per year.

Appendix D: Calculation of Costs to Property Owners

We discussed mitigation project costs with several county zoning officials, who gave us estimates of the costs of mitigation projects. Those estimates were:

- Patrick Goggin, Vilas County: $35-$45/linear foot to $75-$100/linear foot
- Pamela Toshner, Wisconsin Department of Natural Resources: $1-$4/square foot
- Brian Standing, Dane County: $8,083 for a sample project
- Mike Meyer, Wisconsin Department of Natural Resources: $30-50/linear foot

All of these sources also noted that in many circumstances, the homeowner can fulfill mitigation requirements simply by allowing native vegetation to regrow, which has no cost. We wanted to account for the fact that many expansions would not require mitigation. Expansions that do not exceed the 15 percent limit would not require mitigation, nor would vertical expansions. Housing expansions/ buffers created per year were estimated based on the number of mitigation permits applied for in counties that already have mitigation standards. Sixteen counties currently have mitigation standards, and their average number of permits per year was 17.6. We then averaged the total number of permits per year for those counties and found that 8 percent of the permits issued in those counties were for mitigation. We applied this percentage to the total number of expansions occurring per year in counties with higher than 15 percent impervious surface limits and which did not already have a mitigation standard (6,784 expansions per year), to get 542 buffers created per year because of the rule. This was used as the minimum value and 1,356 (20 percent of permits being for mitigation) was used as the maximum value, the assumption being that the increased strictness of mitigation standards would make mitigation a larger share of total permits.

We assumed that the average buffer would be 35 feet deep (the legally defined buffer zone is 35 feet from the water), and 70 feet long (taking the legal minimum shoreland frontage of 100 feet and allowing the required 30 percent access corridor). Some counties require greater than 100 feet of shoreland frontage, and some large properties have much more than 100 feet of frontage. But some subdivided properties also have less than 100 feet of frontage, so we thought it was a reasonable estimate. Our Monte Carlo analysis used a value of $2,450 for mitigation, the average of the range of estimates described as "low-end" by our sources ($0 to $4,900). This value is reasonable because legal requirements to meet mitigation are likely to be on the low end of costs.

Appendix E: Current Phosphorus Levels

To find the current level of phosphorus in Wisconsin lakes, we obtained data on over 16,000 lakes from the Department of Natural Resources' Surface Water Integrated Monitoring System (SWIMS) database. These data included natural community (deep headwater, deep lowland, deep seepage, shallow headwater, shallow seepage, small, and undefined), lake area, mean depth, Trophic Status Index (TSI) score, phosphorus concentration, and Secchi depth obtained through physical testing and satellite measurements. Satellite information on Secchi depth was available for almost all lakes, and it was used to estimate the TSI and phosphorus concentration using relationship given by the Environment Protection Agency (EPA, 2011).

$$TSI = 60 - 14.41 \ln \text{Secchi disk (meters)}$$

$$TSI = 9.81 \ln \text{Chlorophyll a (ug/L)} + 30.6$$

$$TSI = 14.42 \ln \text{Total phosphorus (ug/L)} + 4.15$$

Where TSI is the Carlson trophic state index; ln is natural logarithm. Ranges of trophic state index values are often grouped into trophic state classifications. The range between 40 and 50 is usually associated with mesotrophic, index values greater than 50 are associated with eutrophic, and values less than 40 are associated with oligotrophic (low productivity).

We summed the volume of water in lakes for each of the natural communities for every county in the state. Lake Winnebago, Lake Michigan, and Lake Superior were removed from the dataset because they were double-counted by being in multiple counties. The volume of each lake was determined by total lake area multiplied by average mean depth for lakes in that county. We used the volume to find what percentage of the county's water was in lakes of each natural community. Then, we took the average phosphorus concentration for that natural community group and multiplied it by volume to find the total phosphorus in that group. This value of total phosphorus was summed and then was divided by the total volume of all lakes to obtain the weighted average phosphorus concentration of lakes in Wisconsin. We refer to this as the "state lake" model: treating all the lakes of Wisconsin as if they were one combined lake with a single phosphorus concentration, Secchi depth, and TSI score.

We converted total phosphorus concentrations, measured in µg/L, to Secchi depth, measured in meters, using equations developed for Wisconsin by Lille et al. (1993). Based on analysis of a sample of 25 percent of lakes in each county, they estimated various equations for natural lakes and impoundment and for stratified lakes and for mixed lakes. The results showed that 12.6 percent of the lakes studied were impoundment and 87.4 percent were natural lakes; 58 percent were stratified and 42 percent were mixed. Based on their analysis, we assumed that the lakes in Wisconsin are classified in these various categories. We used four different equations for stratified and mixed lakes under natural and impoundment lake categories. Based on percent distribution of lakes in different categories, we estimated the average weighted total phosphorus and the Secchi depth (Lille et al., 1993).

Table E1. Statewide Linear regression equations for natural lakes and impoundment separated according to thermal stratification type.

	Natural Lakes		**Impoundments**	
Equation Format	**Stratified**	**Mixed**	**Stratified**	**Mixed**
lnSD = a+b (lnTP)	2.10 -0.44 Ln (TP)	2.15 - 0.57 LnTP	2.08 - 0.51 LnTP	1.14 - 0.30 LnTP
To predict Secchi given TP	(P=.0001; r2=0.22)	(P=.0001; r2=0.49)	(P=.0183; r2=0.48)	(P=.0001; r2=0.42)

Source: Lillie et al., 1993

Appendix F: Initial Implementation

Measurement of the initial costs of implementation was based on a 2006 survey of counties (Wisconsin DNR, 2006). The survey asked for the average cost to counties of adopting a model ordinance, conducting public hearings, resolving conflicts and other expenses related to new ordinances. Twenty-seven out of 70 affected counties responded to the survey, a response rate of 38 percent. To estimate the initial implementation cost, we added together the costs mentioned above. The average cost was $17,841, with a standard deviation of $33,059. Based on that average, the total costs to all counties to implement the rule would be approximately $1.2 million over three years.

The high variation in the sample makes it difficult to draw a firm conclusion on these costs. Many counties felt like they could not give an accurate estimate of implementation costs because the policy in question was significantly more far-reaching and controversial than the average ordinance change. Consequently, some counties guessed that ordinance change would require a lot of time and public outreach, and others guessed that it would be simple. Northern counties with many shoreland properties also gave much higher estimates, which is logical because more people would be affected. Because of these issues, a 95 percent confidence interval for the range of costs is $376,004 to $2,121,792.

Appendix G: Changes in Permits and Variances

The adopted rule makes a number of changes to the treatment of legal nonconforming structures (structures placed closer than the minimum distance from the lake that were legally placed at the time of construction). The status quo allowed counties freedom to set their own rules for nonconforming structures to a great degree, creating a great deal of variation. Under the new policy, nonconforming structures can be expanded without restriction if the expansion is greater than 75 feet from the water; they can be expanded vertically, but not horizontally, if the expansion is between 35 feet and 75 feet from the water; and they cannot be expanded if the expansion is closer than 35 feet from the water.

To measure the effects of this policy change, we asked counties to tell us their existing treatment of expansions in the three categories mentioned above. We also asked for the number of permits they get annually for each category of expansion, or if that type of expansion is illegal, how many variances they issue. We then made the assumption that each permit issued in a category that would be made illegal would become a variance issued in the future, adding to costs. Variances require more time and a higher fee from the property owner than permits because they demand a more thorough review. For example, if a county allowed horizontal expansion in the 35- to 75-foot zone under the status quo and issued five permits a year, they would issue five variances a year under the new policy. If variances cost $400 and permits cost $150, the total cost would be $250*5 = $1,250 per year. On the other hand, if a county forbid expansion beyond the 75-foot zone under the status quo and issued 5 variances a year, they would issue 5 permit a year under the new policy and would have a total benefit of $1,250 a year.

The example given is fairly representative of the average situation, and it shows the relatively small magnitude of this effect. The total cost predicted by the survey was $61,000 net present value for all counties. This cost is likely to be an overestimate, because counties would probably not allow the same number of projects to go forward with variances as they would have with permits.

Appendix H: Land-Use Controls & Environmental Zoning

Chapter NR 115, Wis. Adm. Code is a regulation that aims to restrict the ability of shoreland property owners to manipulate their property in an attempt to preserve the environmental integrity of surrounding lands and water systems. This is a classic example of a land-use control. Land-use controls, like zoning laws, place restrictions on specific types of property in order to either mitigate, or enhance some outcome. They also incur various costs and benefits which are borne by future landowners, and tend to constrain the activities and actions of future landowners. However, unlike zoning laws, which apply to large groups of people, land-use controls limit what individual property owners can and cannot do on their own properties. As a result, land-use controls tend to be less exclusionary than zoning laws in terms of an individual's access to property (Epple et al., 1988). Further, it is worth noting that even when exclusion does not occur, zoning is less efficient than land-use controls in terms of potential consumer benefits.

An explanation why land-use controls are more efficient is that land-use regulations typically increase the cost of housing, which in turn creates a positive return on investment for current and potential future owners (Green, 1997). Studies have shown that the greater the land-use restriction, the greater the rise in value (Beaton, 1991). This increase can be attributed to the various amenity and scarcity effects that are associated with land-use controls and regulations. Amenity effects occur "when land-use regulations protect, enhance, or create amenities or services that benefit property owners," (Jaeger, 1997). Scarcity effects occur by "increasing the scarcity of land available for a particular use in particular location," which can then lead to spillover effects for land prices in other locations (Jaeger, 1997). Scarcity effects are particularly prominent in metro and urban areas as they tend to be more highly regulated than rural and suburban areas (Gyourko et al., 2008). These spillover effects could be classified, and potentially quantified, as positive benefits from the implementation of land-use controls either though increased property values or increased property sale value.

Regardless of the positive spillover effects of land-use controls, there are arguments both for and against implementing land-use controls. The arguments that are for land-use controls posit that it preserves or improves home values, while preventing an undue burden on the community tax base. Our analysis has shown that there are measurable benefits from implementing land-use controls. Arguments against land-use regulations center on the fact that such regulations benefit certain households over others, introduce large transaction costs into the land-use succession process, often excludes households from certain backgrounds, and leads to allocative inefficiency (Green, 1997). Further, there is evidence to support the claim that like zoning, land-use regulations generate a premium in rents and housing values, particularly as locations move from less-stringent to more stringent regulations. Examples include a rise in housing rents in San Francisco from 13 to 26 percent and rise in property sales of 32 to 46 percent resulting from increased land-use regulations (Malpezzi et al., 1998). Other studies show that land-use regulations have increased property values along lakefronts by 21 percent in Wisconsin (Jaeger, 1997). There is also the contention that land-use controls promote rent-seeking behavior by current land-owners (Pogodzinski& Sass, 1990). However, this effect is more pronounced in urban settings (Oliva, 2006).

There is a dispute in the existing scholarship about the effect of land-use controls in terms if benefits and its costs. Some studies show that land-use regulations increase the demand for residential land, while others contend that it imposes additional costs on developers, which are then passed on to buyers (Schilling et al., 1991). However, contemporary evidence is beginning to demonstrate that land-use controls actually increase the demand for residential land. Shilling et al. (1991) conducted a national study and concluded that with a demand elasticity of .17, land-use regulations have actually increased the demand for land over time, which they attribute to decreasing uncertainty in the housing and land markets, and the impact of scarcity effects. This increased demand for housing points to the potential positive benefits of implementing land-use controls and there effect on surrounding communities and businesses. There is also evidence that the positive impact of land-use controls on property values is statistically significant, especially for residential properties (Jud, 1980).

The perceived increase in demand might be biased, however, in that studies of land-use regulations often treat these controls as exogenous to the market, potentially overestimating the positive effects of the regulations (Ihlanfeldt 2007). Ihlanfeldt found that by treating regulation restrictions as endogenous results in housing and land price effects that are substantially larger in absolute magnitude. He also found that greater regulation restrictiveness actually increases the price of single-family homes while reducing the price of vacant residential land. Further, the greater restrictiveness due to land-use regulations actually increases the lot size and floor space of newly constructed homes (Ihlanfeldt, 2007). All of these findings are contrary to many other studies about zoning and land-use regulations.

These studies show that there are disputes and uncertainties surrounding the perceived impacts of zoning and other land-use regulations on the rights of property owners and their abilities to use their land as they see fit. As a result, it is reasonable for us to use $0 as the lower bound in our Monte Carlo analysis for the property rights calculation because the surrounding uncertainty prohibits a concrete determination of the actual value.

Whether or not the impact of land-use controls is a cost or a benefit in terms of its effect on property values is uncertain. However, when regulations are aimed at dealing with environmental issues, such as ch. NR 115, Wis. Adm. Code, land-use controls can have significant effects on the environment, particularly when they restrict what landowners can and can't do with their property. There are three noticeable price effects when dealing with environmental zoning and land-use controls: fiscal effects, negative development effects, and positive amenity effects (Spalatro & Provencher, 2001). The fiscal effects of environmental zoning pertain to how zoning and land-use regulations in and of themselves impact the value of property or land. Negative development effects look at how a given parcel or parcels of land are used and impacted by the adoption of zoning or land-use regulations. Studies differ as to whether or not the development effect actually increases or decreases the value of land (Spalatro & Provencher, 2001). Positive amenity effects relate to the increase in the value of land as a result of a zoning or land-use regulation. In studying these effects on lakefront owners, we see that lakefront owners prefer low-density development, while strict frontage requirements on lakes increase the value of lakefront property (Spalatro & Provencher, 2001). This study seems to support the claim made by Jaeger, Malpezzi, and Jud that land-use regulations increase the value of properties.

However, the effect of environmental zoning on a property's sale price is uncertain (Netusil, 2005). As is seen with lakefront owners, there are positive amenity effects in terms of sale price if a property is close to wetlands (Netusil, 2005). However, as the location of the property moves further away from wetlands the price goes down, even if there is equal access to the wetlands. Further, sales prices increase by 25.6 percent to 80 percent depending on the environmental amenities associated with a given property (Netusil, 2005). This is corroborated by other studies that show that closeness to amenities is statistically significant in terms of increased property values and proximity to open space (Anderson & West, 2006). However, this amenity effect does not hold in all scenarios. If property is located near or on agricultural land, zoning and land-use regulations may have a negative price effect if it restricts the rights to develop (Henneberry & Barrows, 1990). This effect is tied to the size of the land parcels, with smaller sized parcels being impacted more than larger parcels. Indeed, zoning and land-use regulations both positively and negatively impact land and parcel characteristics (Henneberry & Barrows, 1990). This logic can also be extended to determining the potential costs and benefits of environmental land-use controls.

One topic that is worth mentioning is the "agglomeration bonus" policy afforded to landowners when land-use regulations and zoning are implemented. The agglomeration bonus is "mechanism that offers each landowner a contract schedule specifying a monetary transfer for acres retired," in a given land-use and environmental restriction, namely in an agricultural setting (Parkhurst et al., 2002). Such a policy is a way for government entities to incentivize the restricted use of land through payments to landowners, which in some cases can reach upwards of $30,000 (Oregon Department of Agriculture, 2005). By implementing such a program it allows for the possibility of maximizing environmental protection while maintaining landowner investment (Shogren et al., 2003). It also allows for the creation of a positive network externality across landholdings diffusing the burden on landowners (Parkhurst et al., 2002).

APPENDIX I: DISCUSSION OF EXCLUDED ENVIRONMENTAL BENEFITS

Improved woody debris via buffer improves fish habitat

Woody debris (coarse woody habitat) along the shoreline is an important connection between aquatic and terrestrial habitats in lakes, rivers and streams. Coarse woody habitat is typically defined as the fallen trees and branches in the shallow, near-shore waters and it provides habitat for a wide variety of organisms that are eventually food for game fish (Roth et al., 2007). Studies have shown that a reduction in density or removal of woody debris can affect both the growth rates and the population sizes of a variety of game fish (Sass et al., 2006; Roth et al., 2007). The negative impacts on game fish due to less coarse woody habitat would likely lead to a societal cost. However, there are currently no studies concerning recreational fishing that have estimated the values for the changes in fishing that arise from riparian management practice (Paterson and Boyle, 2005).

The amount of woody debris in the shallow, near-shore areas of lakes are significantly dependent on the riparian tree density (Christensen et al., 1996). Additionally, about 90 percent of the woody debris in surface waters come from within 35 feet of the shoreline (Murphy and Koski, 1989). If ch. NR 115, Wis. Adm. Code reduces the number of people clearing the riparian vegetation, there should be more trees left which would lead to more woody debris in the future. Additionally, more developed lakes typically contain less coarse woody habitat. Christensen et al. (1996) found a direct negative correlation between shoreline residential development and the amount of coarse woody habitat. Their study indicates that shoreline land owners would tend to remove this beneficial resource for freshwater organisms, if left unchecked by regulation.

Improved beauty via buffer improves natural beauty

Forests are a highly appreciated scenic background for water-based recreationists, and therefore have a social value (Twynam and Robinson, 1997). There have been some studies that have looked at peoples" preferences for shoreline views. People seem to prefer shoreline views with taller and wider trees. There was also a significant positive correlation between stand density and aesthetics (Haider and Hunt, 2002). From the water, people preferred shorelines with more dense stands of trees.

Taking these studies into account, there is likely an increase in benefits to recreationists on lakes in association to ch. NR 115, Wis. Adm. Code. Leaving a buffer of 35 feet would increase the density of the vegetation as well as protect the trees that people appreciate when out spending time on the lakes. No valuation studies were found that addressed this issue. However, this would be an import aspect of environmental valuation with which more studies need to be done.

Appendix J: Values of fixed and variable inputs to analysis

In order to derive a single best estimate for the overall present value, we found a range of possible values for each of the variables below.

Table J1. Analysis Input Values

Variable	Minimum	Mean	Maximum
Housing growth rate (annual % change)	.004	.014	.024
Property value shadow price (dollars per meter Secchi Depth)	3,059	10,476	17,892
Cost of Mitigation (dollars)	0	2,450	4,900
Implementation Costs (dollars)	376,004	1,248,898	2,121,792
Buffers created (units)	543	950	1,357
Recreation values (dollars)	2.40	54	106.00

Source: Authors

The following fixed values were also used in our analysis. These values were obtained via academic literature, available data, or through our water quality model. They were used in both the regular, best-estimate analysis and the Monte Carlo analysis.

Table J2. Fixed Inputs

Input	Value	Unit
Total Phosphorous	527,997,028,569,505	Micrograms
Value of water in "state lake"	16,531,212,686,937	Liters
Lakefront lots	710,665	Lots
Current shoreland homes	140,738	Lots
Increased annual recreation trips	950	Person-Days
Average amount of phosphorous mitigated by ch. NR 115, Wis. Adm. Code from expansions	0.09	Lbs
Average amount of phosphorous mitigated by ch. NR 115, Wis. Adm. Code from new homes	0.29	Lbs
Discount rate	3.5%	

Source: Authors