PERCEPTION OF HARD & NATURAL SHORELINES ON INLAND WATER BODIES IN MICHIGAN

By

Marlena J. Smith

A THESIS

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

Environmental Design – Master of Arts

2016

ABSTRACT

PERCEPTION OF HARD & NATURAL SHORELINES ON
INLAND WATER BODIES IN MICHIGAN

By

Marlena J. Smith

Shorelines of inland lakes in regions of Michigan are continuously eroded by wave energy and ice movement. With the erosion of these shorelines sediment builds up changing the ecology of the lake by eliminating fish and other wildlife habitat ("Shoreline Erosion", 2014). Studies have shown that natural shorelines can provide adequate erosion protection, while providing habitat for wildlife and improving water quality (Bariteau, 2013, Hartig et. al. 2011, & Bilkovic et. al. 2013). This study uses a picture preference method to determine if there is any significant difference in the perception of natural versus hard shorelines across seven dimensions, namely: aesthetic, maintenance, cost efficiency, erosion protection, recreation opportunities, habitat capacity, and improving water quality. It was found that while people find natural shorelines attractive and know the ecological benefits of them, they perceive them as requiring maintenance and not protecting against erosion as much as a hard shoreline can. Incentive programs and policy need to be put in place to ensure the ecological health of Michigan's inland lakes.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1: INTRODUCTION

In the United States, there are only two states that are over 40% water; one is the island state of Hawaii, composed of 41.2% water; the other is the state of Michigan, just beating out Hawaii with 41.5% of the state comprised of water ("How Much of Your State is Wet?", 2015). This 41.5% is roughly made up of 11,000 lakes and 36,000 miles of rivers and streams ("Facts About Michigan", 2013 & "Michigan's Land, Michigan's Future", 2003). Of all inland lakes in Michigan that are greater than 10 acres in size, their shoreline lengths combined total 14,426 miles (Kirkwood, 2016). Aside from its 11,000 inland lakes, Michigan's five Great Lakes make up approximately 95% of the United State's fresh water ("Michigan's Land, Michigan's Future", 2003). The amount of water in Michigan could be what attracts homeowners to purchase a second or "vacation" homes in Michigan. In the year 2000 census, Michigan ranked in the top 15 in the United States for percentage of second homes, coming in at 5.6% of housing units deemed as "recreational" or "seasonal" use ("Census of Housing", 2011). Since then, the number of second homes in Michigan has only continued to grow. An article by National Association of Home Builder's used a tax-based definition of vacation home and found that there were 26 counties in the United States where at least half of the housing was secondary vacation homes; Michigan was number one on the list with six northern counties having half of their housing made up of vacation homes (Dietz, 2011). On a count basis, Michigan was also one of few states where at least one county had 25,000 vacation homes or more (Dietz, 2011). In recent years, Michigan has seen an increase of 19,000 second homes from 2009 to 2013 (Duggal, 2015).

In accordance with housing development, the Michigan Department of Natural Resources developed a report whose purpose was to document the results of the Status and Trends Program's first six years of monitoring from 2002-2007 and to document the current status of Michigan's inland fishery resources (Wehrly, 2015). Part of this report looks at dwelling density and hard armoring of shorelines (Wehrly, 2015). Of all surveyed inland lakes in Michigan, the average amount of dwellings per kilometer was 12.3. The status and trends report also found that on these same lakes hard armoring of shorelines varied between size of lakes, with the percent of hard shorelines being higher in large and medium sized lakes, and an overall average of 17.3% (Wehrly, 2015). In 2007, the National Lakes Assessment conducted by the Environmental Protection Agency found that of 50,000 surveyed lakes, 22% of those lakes were in poor condition and 36% of them had poor shoreline habitat (National Lakes Assessment: A Collaborative Survey of the Nation's Lakes, 2009). Rock rip rap, seawalls, and lawn running right up to the edge of the lake all have negative effects on lake health ("The Water's Edge", 2010 & "Shoreline Protection", n.d.). Fertilizers, pet waste, and lawn clippings run-off more quickly from lawn and rock rip-rap into lakes during rain, which can increase the growth of algae on the shoreline ("The Water's Edge", 2010). Thick algal growth blocks sunlight from reaching shallow water plants that aquatic species need for habitat and feeding ("The Water's Edge", 2010 & Brown et al., 2000). Seawalls do not cushion any wave energy and deflect off of the seawall instead, stirring up bottom sediments, which can contain settled nutrients such as phosphorus and nitrogen, and also increase turbidity of the water ("Shoreline Protection", n.d., Herbert et al., 2010, & Brown et al., 2000). With increased turbidity and no "nooks and cranny's" in a seawall, fish and wildlife have nowhere to spawn along the shoreline

and cannot properly feed in turbid water (“The Water’s Edge”, 2010, “Shoreline Protection”, n.d., & Brown et al., 2000). Shorelines of Michigan lakes are continuously eroded by wave energy and ice movement (“Shoreline Erosion”, 2014). With the erosion of these shorelines sediment builds up and changes the ecology of the lake (Shoreline Erosion 2014). If a lake exhibits poor shoreline habitat, it is three times more likely to exhibit poor biological health (“National Lakes Assessment: A Collaborative Survey of the Nation's Lakes”, 2009).

By the definition given by the national oceanic and atmospheric administration, a natural shoreline or soft shoreline, uses only plants, organic materials, and ecological principles to restore, protect or enhance the natural shoreline environment and provide habitat for aquatic species (“Shoreline Management Types: Definitions”, 2014). A way to create natural or soft shorelines is by biotechnical stabilization, sometimes called bioengineering (Gray et al., 1996). This technique combines live and dead plant material with engineering techniques to stabilize stream banks and slopes in low tidal energy situations (“Shoreline Management Types: Definitions”, 2014, & Gray et al. 1996). These techniques are meant to mimic the natural process of soil stabilization and plant regrowth that occurs after erosion (“Shoreline Management Types: Definitions”, 2014). Natural shorelines not only can provide habitat for fish and other aquatic species, but root systems of vegetation can stabilize soils, and also trap nutrients from running off into the lake (“The Water’s Edge”, 2010 & “Natural Shorelines for Inland Lakes”, n.d.). If we take the number of dwellings per kilometer found by the Michigan Department of Natural Resources and put it into terms of mileage, 1.6 km = 1 mile, that is approximately 19.7 houses per mile. Thus, there is roughly 14,000 miles of shoreline in Michigan, there would potentially be 276,000 houses along Michigan’s shorelines. If the

Department of Natural Resources estimate of hard shorelines of 17.3% holds true for every one of Michigan's inland lakes, nearly 50,000 lakefronts are hard armored (Wehrly, 2015). With the recent growth of vacation homes in Michigan (Dietz, 2011 & Duggar, 2015), the number of hard shorelines along lakefront homes could be even larger. These hard shorelines are not contributing to shoreline habitat, which can negatively influence the health of Michigan's 11,000 inland lakes and 36,000 miles of streams ("National Lakes Assessment: A Collaborative Survey of the Nation's Lakes", 2009 & "Michigan's Land, Michigan's Future", 2003). By using combinations of plant material, rock rip rap, and slow decaying logs, a longer lasting and visually pleasing solution can be created. Creating a natural shoreline encourages habitat growth and cushions low wave energy, thereby decreasing erosion and its adverse effects ("The Water's Edge", 2010 & "Natural Shorelines for Inland Lakes", n.d.). A study showed the positive habitat growth in salt marshes in Chesapeake Bay, USA (Bilkovic et al. 2013). Overall habitat capacity is greater in a created marsh, rather than in a hard shoreline of steel, concrete, or rock rip rap.

While studies show that natural or soft shorelines are overall better for the ecology of an aquatic system, the question remains as to why they are not implemented more often (Bariteau et. al. 13, Hartig et. al. 2011, & Bilkovic et. al. 2013). Studies of perception of natural environments have been done that may aid in understanding the potential perception of natural shorelines (Helfand et. al. 2006, Stedman et. al. 2006, Zheng et. al. 2011, & Nassauer et. al. 2009). An exploration conducted with residents of Southeast Michigan showed that residents were willing to pay more for a native planting design, as opposed to a typical manicured lawn (Helfand et al. 2006). If residents are willing to pay more for a native planting

design, then maybe they would be willing to pay for natural shoreline designs, both which have ecological benefits. A similar study surveyed only students to see if there was a trend in preference to wildness or neatness in the landscape in accordance with their field of study (Zheng et. al. 2011). The study found that students in wildlife sciences preferred more natural landscapes, while students in horticulture, social sciences, and agricultural economics preferred neat, well-kept environments (Zheng et al. 2011). The results of another study with homeowners' yard preference suggested that when cultural norms conflicted with neighborhood norms, the neighborhood norm overpowered the cultural norm (Nassauer et al., 2009). The results of these studies can all suggest that while homeowners may be willing to pay for a design with native plantings, social and neighborhood norms tend to determine what type of landscape a homeowner will install.

This study seeks to find the reasons as to why natural shorelines are not more widely used on Michigan's inland lakes. The hypotheses that will be addressed are as follows. There could possibly be a lack of knowledge to the general public of the benefits of a soft shoreline. Natural shorelines could also be perceived as expensive or not as attractive on the waterfront. Lakefront 'norms' may also influence shoreline stabilization choice, just as neighborhood yard 'norms' influenced yard design (Nassauer et. al., 2009). Michigan is a state which is known for its Great Lakes. In order to protect those lakes, both 'Great' and smaller inland, people need to be aware of various ways to protect the shorelines they live on. Hard shoreline protection measures such as steel seawalls and rock rip rap are widely used techniques for protection against erosion. This study can contribute to finding the reasons why natural shorelines are not as popular or what can potentially influence people in their perception of hard and natural

shorelines. If reasons can be pinpointed, then we can work to educate Michigan's residents and inform policy on alternative ways to protect Michigan's beautiful inland shorelines, while enhancing the ecology of these inland lakes.

CHAPTER 2: LITERATURE REVIEW

There are many reasons and benefits of implementing a natural shoreline as opposed to a hard shoreline. Various techniques exist in order to stabilize a shoreline. Some techniques are more engineered and others use a natural approach to stabilization. The following section will review both hard shoreline techniques, cost, and effectiveness and natural shoreline techniques, costs, effectiveness, and guidelines.

2.1 EXISTING HARD SHORELINE COSTS, TECHNIQUES, & EFFECTIVENESS

Some shorelines may already have erosion protection methods in place such as steel seawalls or large concrete walls to protect against large and frequent wave energy. The average cost of these types of hard shoreline measures varies. Just to go over a few methods; for a concrete seawall the cost varies from $45-200 per linear foot installed by a contractor depending on backfill and the price of labor (“Natural Shorelines for Inland Lakes”, n.d.). As for rock rip-rap, if installed by a resident, it would approximately be $20-30 per linear foot and $35-75 per linear foot if installed by a contractor (“Natural Shorelines for Inland Lakes”, n.d.). There is no estimate for a steel or wood seawall, but one could assume it would be close to that of a concrete all when taking into account the cost of labor and cost of materials.

While many shorelines already have hard protection measures in place, few studies have evaluated the effectiveness of the technique and looked at potential solutions (Toft et al., 2013 & Nordstrom & Jackson, 2013). A study in Puget Sound of Washington looked at what habitat enhancements could do along these already armored shorelines in high wave energy situations (Toft et al., 2013). This study did biological sampling over a course of three years at

two different sites at Olympic Sculpture Park of Elliott Bay. One was a habitat bench in front of an existing seawall which stimulated shallow water habitat; the other a linear area that was excavated from a 100-meter stretch of rip-rap (Toft et al., 2013). Both sites over the three years seemed to be stable at supporting a consistent development of aquatic plants and wildlife, even with the high wave energy of Elliott Bay (Toft et al., 2013).

Some hard shoreline measures exist popularly in marinas. After some time, these types of walls begin to deteriorate leaving behind more than just sediment. In the case of Sandy Hook Spirit, New Jersey, seawalls were already in place from the mid-1900s (Nordstrom & Jackson, 2013). Some members of the community found these walls to be historic to the area and wanted them to be restored (Nordstrom & Jackson, 2013). However, others saw the walls as an eyesore and also did not provide any type of habitat or ecological benefit. With protection methods already in place at this location, it became apparent that taking down every seawall would not be financially feasible (Nordstrom & Jackson, 2013). The end result was to remove walls that were already crumbling to allow vegetation to emerge in combination with rock rip rap to cushion the wave action of the area (Nordstrom & Jackson, 2013). Walls that still maintained structural integrity were kept to combat washouts of areas that would inevitably happen without time for vegetation to establish stabilization of the areas with large amounts of wave energy (Nordstrom & Jackson, 2013). These studies illustrate that adding areas for habitat enhancement and vegetation in combination with hard shoreline measures could be a way to combat high wave energy areas, while improving aquatic wildlife, which in turn can improve water quality. While the studies also take place in high wave energy and salted waters, the

ideas and conclusions could be used as ground work to begin to rework some of Michigan's hard armored shoreline measures.

2.2 EXISTING NATURAL SHORELINE COSTS, TECHNIQUES, & EFFECTIVENESS

Techniques of implementing natural shorelines range from planting of vegetation along a waterfront, combining vegetation and biologs, to man-made materials interspersed with plantings; all combinations designed for low wave energy. The type of natural shoreline to implement depends on the level of need for stabilization, cost to implement, and varying benefits of types of natural shorelines. With the range of possibilities for natural shorelines, multiple studies have been done on a technique and its effectiveness (Bariteau et. al. 13, Hartig et. al. 2011, & Bilkovic et. al. 2013). Costs of these techniques do vary just as hard shoreline technique's costs vary. If a homeowner were to implement a strictly vegetated natural shoreline their self, the cost would be roughly $10-15 per linear foot ("Natural Shoreline for Inland Lakes", n.d.). By incorporating biologs with the vegetation, the cost would go up only slightly to $15-20 per linear foot ("Natural Shoreline for Inland Lakes", n.d.). These prices vary on the type and size of plants chosen and also on the potential cost of labor, which has increased since the original publication, just as hard shoreline costs have ("Natural Shoreline for Inland Lakes", n.d.).

Multiple studies have looked at the effectiveness of various techniques of implementing natural shorelines. In a study done by Bariteau et al. (2013), on about 30 miles of the Ottawa River, rounded granular material was used to stabilized slopes, allowed natural vegetation to emerge and further stabilize the along banks of the Ottawa. Fifteen years later, 2011, a follow

up was conducted to assess the effectiveness of the material in combination with the natural vegetation. The granular material had become covered 80-90% with native vegetation along the entire 30 miles, successfully stopping erosion along the banks. The restoration of this shoreline successfully enhanced river ecology and fulfilled expectations of stakeholders (Bariteau et al. 2013). This is one of very few projects of vegetated stabilization have been monitored since installation. Another instance is in the Great Lakes Region, where habitat loss and degradation are a major issue (Hartig et al. 2011). Hartig et al. surveyed 38 soft shoreline engineering projects long the Lake Erie and Detroit River watershed system. Of these 38 projects, only six had any type of quantitative monitoring for ecological effectiveness. However, the six that were monitored were found to be working successfully in enhancing ecology for the brief one to two years that they were monitored. In order to ensure effectiveness of a soft engineered shoreline, monitoring of how the system is working needs to continue for more than just the first few years of installation (Hartig et al. 2011). With regard to successfully enhancing ecology, a study was done to test the habitat capacity of elements of natural shorelines (Bilkovic et al., 2013). Bilkovic et al. (2013), composed a study that tested habitat capacity in salt marshes comparing plant, sediment, and lowest water level large invertebrate attributes in different shoreline types of the Chesapeake Bay, USA. The findings of this study concluded that created marsh's as natural shorelines take at least five years to attain comparable biogeochemical processes such as organic matter and nutrient accumulation as natural wetlands (Bilkovic et al., 2013). The study done by Bilkovic et al. solidifies Hartig et al.'s suggestion that monitoring of the system needs to continue after the first couple years, to

ensure the engineered shorelines' processes are comparable to that of a non-engineered system.

2.3 NATURAL SHORELINE GUIDELINES, RESOURCES, & POLICY

Previous studies have been conducted on techniques and effectiveness of creating natural shorelines (Bariteau et. al. 13, Hartig et. al. 2011, & Bilkovic et. al. 2013). With an array of options existing for implementation of natural shorelines, conferences and summits have been held to create a range of best management practices or guidelines to create and implement a natural or sometimes called a 'living' shoreline. One of these conferences was the Binational Conference Sponsored by the Greater Detroit American Heritage River Initiative and Partners (2000). The goal of this conference was to, "provide insights and technical advice to local governments, developers, planners, consultants, and industries on when, where, why, and how to incorporate soft engineering of shorelines into shoreline redevelopment projects and reap subsequent benefits, "(Caulk et al. 2000, i). A framework was created at the conference that helped incorporate natural shorelines more into shoreline development. The framework suggested to follow was: define geographic extent of study area; inventory existing uses (habitat, public access, etc.); evaluate existing uses against historical conditions and desired future uses; identify stakeholders and establish partnerships; reach agreement on goals and multiple objectives; set quantitative targets; evaluate management alternatives and set priorities; take action; and finally; monitor and evaluate effectiveness (Caulk et al. 2000). In 2006, the Virginia Department of Environmental Quality's Coastal Zone Management Program held a summit to educate and promote the use of living shorelines. From the summit, funding was provided to develop guidelines for living shoreline protection. The guidelines produced are

very similar to those produced by the Binational Conference held in Detroit., but added in guidelines that include evaluating cost of implementing a natural shoreline. The cost guidelines include; cost of design, permitting, materials, site access preparation, installation, site work, restoration of access areas, and mitigation for impacts (Duhring et al. 2010). Parameters involved in designing living shorelines are; site boundaries, site characteristics, bank height and composition, shore zone and backshore zone width and elevation, presence and size of boat wake, and existing shoreline protection measures, (Duhring et al. 2010). After cost and site parameters are taken into account, the summit proposed creating a coastal profile for the area to be protected. A coastal profile shows what can be done to the area to provide habitat, erosion protection, and improve water quality without affecting the integrity of the site. According to Duhring et al. (2010, 15), "Developing a gradual, vegetated coastal profile is the key to designing a successful living shoreline system". After their study of various Virginia estuarine environments and creating these guidelines, they have now been integrated into the Bay Act Performance Criteria for Shoreline Erosion Control Projects in Virginia. While the study was done for Virginia's estuarine environments, they can serve as a basis for similar environments that are in need of living shoreline protection.

Multiple guides and resources are at the disposal of lakefront home and property owner's that describe how to install a natural shoreline and what the best solution could be for a particular waterfront. The Michigan Department of Environmental Quality (MDEQ) website notes the adverse effects of hard shoreline measures and recommends the implementation of natural shorelines ("Shoreline Protection", 2014). This page of the MDEQ website has a brief paragraph of suggestions to solutions but also provides links to the Michigan Natural Shoreline

Partnership's website and "Natural Shoreline for Inland Lakes" created by the organization, a list of certified natural shoreline professionals, and also a link to inland lakes and streams permits ("Shoreline Protection", 2014). The Michigan Natural Shoreline Partnership was formed in was formed in 2008 to promote the use of natural landscaping and erosion control to protect Michigan's inland lakes and to educate property owner's and contractor's on natural shorelines ("Michigan Natural Shoreline Partnership", n.d.). The organization developed a manual for implementing natural shorelines that may be purchased and offers a certification program. Aside from providing design guidelines and cost of a natural shoreline, the manual is split up into related sections to better help users create a natural shoreline (Herbert et al., 2010). A section of the training manual goes over soil types and understanding the chemical and biological characteristics, assessing levels of erosion on your shorelines, and drainage thus emphasizing the importance of designing for a soil type (Herbert et al., 2010). Another important subject the training manual goes over allows the user to have an understanding of native plants and communities, ecoregions, upland and wetland systems, and types of plant stock (Herbert et al., 2010). It stresses the importance of picking the correct plants for the lakefront property owner's region. Permitting, water laws, and maintaining and monitoring of natural shorelines also are included in the handbook to ensure user's have a full understanding of what they are implementing on their property (Herbert et al., 2010).

Current regulations do exist in Michigan to aid in the implementation of natural shorelines at varying government levels. On a state level, Part 301, Inland Lakes and Streams, of the Natural Resources and Environmental Protection Act, was amended to include the requirement of permitting for construction activities on inland lakes and streams ("Inland Lakes

& Streams Permits", n.d.). This authorizes the Michigan Department of Environmental Quality to define different activities and review them through the permitting process. These activities include those that could potentially have a minor impact on inland lakes and streams ("Inland Lakes & Streams Permits", n.d.). Michigan residents applying for a permit must show that the project being installed on the lakefront will not negatively affect public trust or riparian rights ("Inland Lakes & Streams Permits", n.d.). Some township and city ordinances have taken the initiative to have their own policies regarding shorelines. For example, Charlevoix Township, Michigan amended zoning ordinances (2007) and included a policy that prohibited altering areas below the ordinary high water mark ("Charlevoix Township Zoning Ordinance"). As an extension of this regulation, within the first 50 feet of the ordinary high water mark, no existing trees or shrubs are to be removed; and within the first 25 feet of the ordinary high water mark, native vegetation shall be maintained with no cultured grass or vegetation to be permitted ("Charlevoix Township Zoning Ordinance", 2007). Another northern Michigan community, Long Lake Township, touches on shoreline ordinances by deeming shorelines as a secondary natural conservation area ("Long Lake Township Zoning Ordinance #109", 2010). This ordinance also limits walls within the water to three feet and also prohibits any seawall that significantly extends or or reduces land area or redefines the ordinary high water mark or the shape of the shoreline ("Long Lake Township Zoning Ordinance #109", 2010). Michigan's policy and examples of ordinances are just some examples of current efforts to encourage the implementation of natural shorelines in Michigan.

2.4 RELATED PERCEPTION STUDIES

The perception of natural landscapes is something that varies among cultures and classes of people. Studies have found that education background, neighborhood norms, and cultural background can influence perception of a landscape (Nassauer et al., 2009, Stedman et al., 2006, Zube at al., 1981, Zheng et al. 2011). A study was conducted with three different groups, Yugoslavians, West Indians, and Americans, to see if they have differing opinions on scenic and heritage landscapes and the variability of those perceptions from these cultures. It was found that due to cultural differences, there are indeed differences among the cultures surveyed in perception of what is valued in a scenic landscape. They found that these differences result from learned perception from the culture one is raised in (Zube et al. 1981). If perceptions on scenic and heritage landscapes are different among cultures, then what could be said of opinions of landscapes with the same culture and living within the same type of environment? In Vilas County, Wisconsin, a study focused on 1000 lakeshore residents and their perceptions on water quality of the lakes where they live (Stedman et al., 2006). Overall respondents were positive about "their" lake (Stedman et al., 2006). It was found that one's perception of a developed lake is viewed as more polluted and having lower water quality. The reverse observation was also found true, less developed lakes are less polluted and have better water quality (Stedman et al., 2006).

With many developed lakes, manicured lawns run into the edge of a lake. As lawns are not very ecologically beneficial, a study was done to see if homeowners in southeast Michigan would pay more for designs with native plantings that are ecologically beneficial (Helfand et al. 2006). Participants were asked to rank four different designs, three included native plantings, in

three different settings while taking into account maintenance costs. The findings indicated that homeowners ranked the native planting designs the highest and were willing to pay more to have those designs as opposed to a typical lawn (Helfand et al. 2006). In relation to preference of native plantings as opposed to the neatness of a manicured lawn, a study explored what the preference was among students to wildness or neatness in a landscape and if that corresponded to their area of study. Students in agricultural economics, horticulture, wildlife sciences and social sciences were asked to score four different housing designs. Overall, students preferred more trees in combination with a neat landscape. However, students in wildlife sciences preferred more natural landscapes, while students in horticulture, social sciences, and agricultural economics preferred neat, well-kept environments (Zheng et al. 2011). With students' perceptions of landscapes influenced by their area of study, the question still remains of what kind of landscapes general homeowners prefer. Again in southeast Michigan, a random image based survey of homeowners was taken to assess the influence of neighborhood norms on perceptions of landscapes. The images included six front yard designs ranging from conventional lawns to woodlands and native prairie garden designs (Nassauer et al. 2009). In the study, it was hypothesized that homeowners' yard preferences would conform to broad cultural norms and to neighborhood norms which was confirmed after conducting the survey. Where cultural norms tended to conflict with neighborhood norms, the neighborhood norms overpowered the cultural aspect. For example, if a manicured lawn was broadly used in the neighborhood, then a manicured lawn was also preferred. The opposite was also found true: in a neighborhood with prairie gardens, similar yards were more preferred (Nassauer et al. 2009).

Multiple studies have also been done on the general perception of naturalistic designs versus a more manicured look to a landscape (Nassauer et al., 1995, Ozguner and Kendle, 2006, and Weber, 2014). These studies and others (Zheng et al., 2011 and Helfand et al., 2006) have shown that the perception of landscapes and the value of them has been gradually changing. Over two decades ago, in 1995, a study had approximately 250 homeowners in a suburb of Minnesota rate seven landscape photographs where the design of the landscape increasingly became more "ecologically rich" (Nassauer et al., 1995). The results of this exploration concluded that a landscape with either overgrown lawn or an ecologically beneficial lawn was perceived as messy or unattractive (Nassauer et al., 1995). Another study done in the United Kingdom yielded similar results (Ozguner and Kendle, 2006). The study had participants choose one word that described two different landscapes, a more formal botanical garden and a natural park, in accordance with various categories such as pattern, safety, management, etc. (Ozguner and Kendle, 2006). In roughly a decade between these studies, people still saw the designed landscape of the botanical garden as more attractive (Ozguner and Kendle, 2006) as they did in Nassauer's study in 1995, but unlike that study, participants were able to see the values and benefits of the more natural park (Ozguner and Kendle, 2006). Previous studies have looked at perception of public parks and landscapes of homes (Nassauer et al., 1995, Ozguner and Kendle, 2006, Weber, 2014, Nassauer et al., 2009, Stedman et al., 2006, Zube at al., 1981, Zheng et al. 2011) but a recent study in 2014 looked at the perception related to roadside greening (Weber, 2014). This study in two German cities asked passers-by to answer open-ended questions about the roadside greenery around them (Weber, 2014). They found that in both cities, between "Urban Devotees" and "Wildness Enthusiasts", wild roadside vegetation

had high approval with only maintained vegetation having the slightest preference (Weber, 2014). Weber's study, "suggests that prevailing preference for cultivated vegetation can coexist with a positive view of wild urban vegetation," (Weber, 2014, 6). If these changing perceptions of landscapes to valuing a wild or natural look, then it is possible that this shoreline perception study could result in similar views.

2.5 PURPOSE OF STUDY

Many studies have analyzed effectiveness and benefits of natural shoreline protection in comparison to lack of habitat and contribution to improvement of water quality from hard shorelines (Bariteau et. al. 13, Hartig et. al. 2011, & Bilkovic et. al. 2013, "Shoreline Protection", n.d. & Brown et al., 2000), it can be said that natural shorelines should be preferred to a 'hard' shoreline. They provide ecological benefits while protecting a shoreline from eroding away and improving water quality (Bariteau et. al. 13, Hartig et. al. 2011, & Bilkovic et. al. 2013). With the benefits of cleaner water and healthy ecology of a lake, the question remains of why are natural or 'living' shorelines not more widely used. The hypotheses that will be addressed are; potentially a lack of knowledge to the general public of the benefits of a soft shoreline, perceived as expensive, or to some, natural shorelines could be perceived as not as attractive on the waterfront. It could be that since manicured lawns and seawalls are widely used in lakeshore landscapes, that they have become widely accepted among property owners along lakeshores; just as the study in Nassauer et al. (2009) demonstrated that neighborhood norms tend to influence a homeowner's preference to a type of yard design. These are questions that are still un-explored which if answered could explain why natural shorelines are not as implemented as they should be or what influences people on their perception of natural and

hard shorelines. The findings of this study could be used to contribute in educating lakefront owners and forming policy to encourage natural shoreline stabilization techniques. Michigan has almost 14,500 miles of shoreline, not including the Great Lakes, where a part of its economy depends on the health of these shorelines and its lakes. Incentive programs and policy needs to be put in place to enhance and implement natural shoreline stabilization.

CHAPTER 3: METHODOLOGY

This study uses a picture preference survey as an instrument to assess what the public perception of natural and hard shorelines is and if there is a preference towards one of the other in visual quality, maintenance, erosion protection, and habitat. The survey was done where respondents were asked three demographic questions followed by a series of questions that involved ranking the shoreline photographs (Helfand et al. 2006, Zheng et al. 2011, Nassauer et al. 2009). Pictures were taken from the following inland lakes and rivers of Michigan- Gull Lake in Gull Lake, Michigan; Indian River in Indian River, Michigan; Big Manistee River in Lake City, Michigan; and Morrison Lake of Clarksville, Michigan. These Lakes were chosen for being representative of the roughly 46,000 varying sizes of water bodies in Michigan.

3.1 SELECTION OF SHORELINES

Gull Lake is located mostly in Kalamazoo County with one end slightly extending into Barry

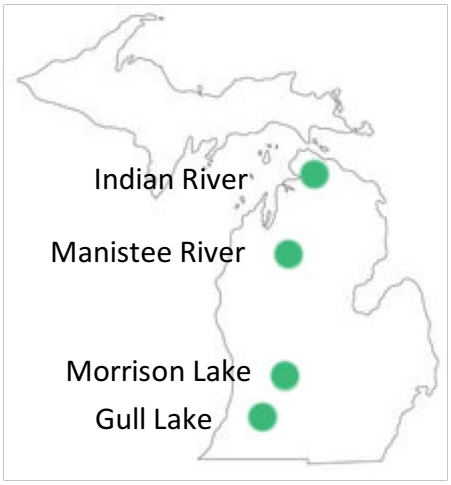

FIGURE 1 Locations of survey pictures.

County in southwest Michigan (Figure 1). This lake is lined with residential development with approximately three square miles of surface area and its deepest point being 110 feet (Hamilton 2011). Kalamazoo's population is approximately 259,000 with the median household income of $46,000, and the median house costing $136,000 ("Quick Facts: Kalamazoo County, Michigan," 2015). The lake has a high rate of activity for recreational activities with no wetlands along its shores and very little aquatic plant growth (Hamilton, 2011). Morrison Lake of Clarksville, Michigan (Figure 1) is located in Ionia County and is much smaller than Gull Lake, coming in at only half of a square mile in surface area and only reaches a depth of 35 feet ("Michigan Department of Environmental Quality Water Bureau", 2008). Ionia county has a population of about 64,000, a median household income of $48,000, and the median home value is $109,000 ("Quick Facts: Ionia County, Michigan", 2015). Only about 19% of the lake is developed with residences, the remaining shorelines are open land or agricultural land ("Michigan Department of Environmental Quality Water Bureau", 2008). The Manistee river runs for 231 miles draining into Lake Michigan after passing through eleven counties of northwest Michigan (Rozich, 1998). Of the eleven counties, the portion of the river that was visited was Missaukee County, shown in figure 1. This counties population is roughly 15,000 and a median household income of $41,000 with a median home value of $99,800 ("Quick Facts: Missaukee County, Michigan", 2015). The Indian River, located in Cheboygan County of northern Michigan, (Figure 1) runs between Burt Lake and Mullet Lake for a much shorter distance of 38 miles, emptying into Lake Huron ("Indian River, Michigan", 2014). Cheboygan county's population is approximately 26,000, and has a median household income of $39,500 with a median home value of $110,000 ("Quick Facts: Cheboygan County, Michigan", 2015).

The ten shoreline photographs included five hard shoreline protection measures and five natural shoreline protection measures, shown in figure one below. The five hard shorelines and five natural shorelines were picked to show a variety of types of each shoreline.

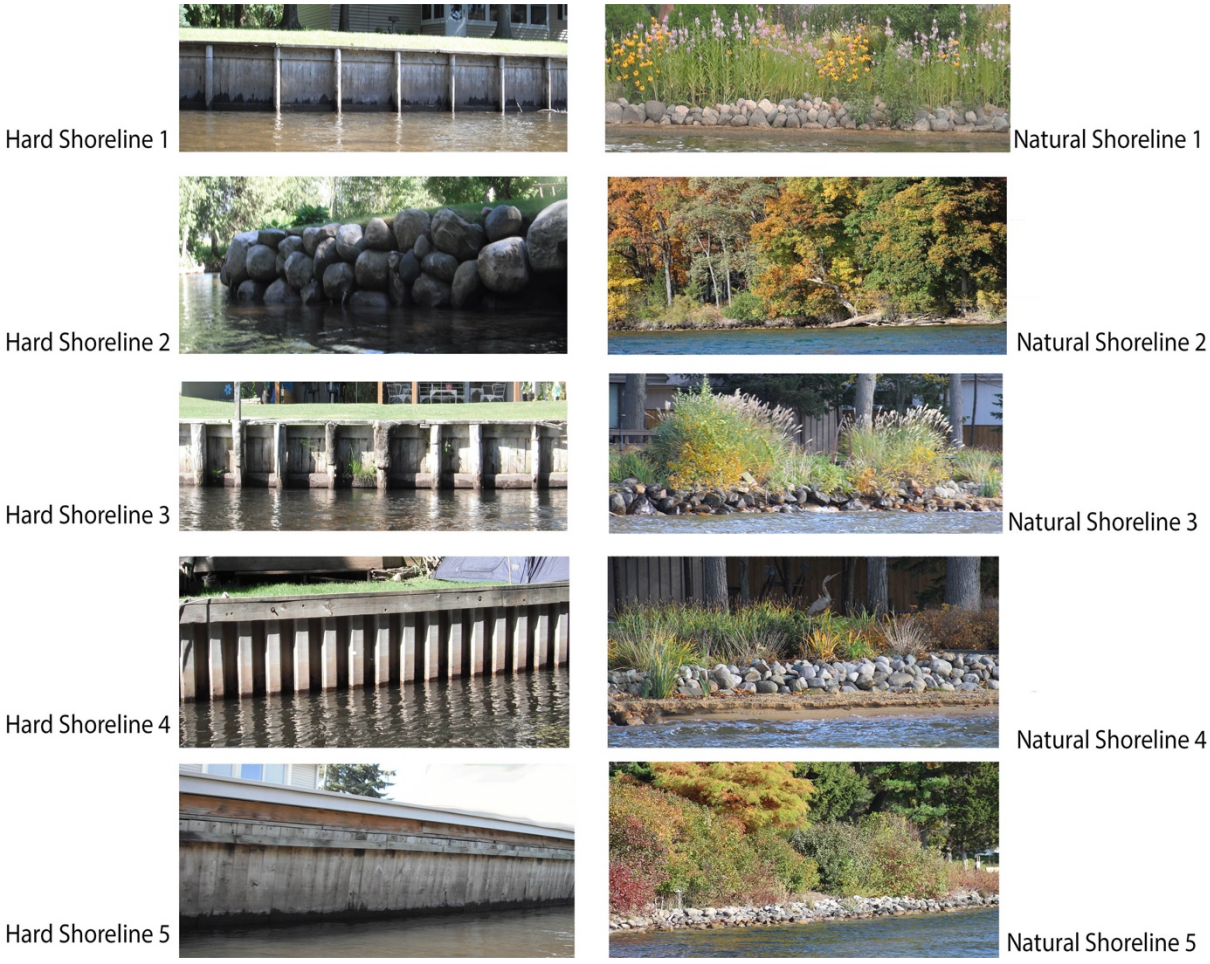

FIGURE 2 Pictures used in the ranking questions of the survey.

3.2 SELECTION OF RANKING QUESTIONS & SURVEY DISTRIBUTION

These pictures, were used in a series of ranking questions and three demographic questions to better understand perception of natural shorelines. The following questions were asked to respondents:

1. What county do you reside in?
2. Are you part of Michigan Lake & Stream Associations or a related organization?
3. Have you taken an environmental science, fisheries and wildlife, or related classes?
    a. No
    b. Yes, 3-5 classes
    c. Yes, my degree is in this field or a related area
4. Rank what you find to be the least attractive shoreline (1) to most attractive shoreline (10).
5. Rank what is most familiar (10) to you to least familiar to you (1).
6. Rank what you think is the least cost effective (1) to most cost effective.
7. Rank what you think would have the most maintenance (10) to the least maintenance (1).
8. Rank what you think provides the most opportunities for recreation (10) to providing the least amount of opportunities for recreation (1).
9. If you lived on a lake, rank what you would most likely have your shoreline look like (10), to least likely (1).
10. Rank what you think prevents the most protections against erosion (10) to the least protections against erosion (1).
11. Rank what you think would least likely improve water quality (1) to most likely to improve water quality (10).
12. Rank what you think provides the most wildlife habitat (10) to providing the least amount of wildlife habitat (1) for fish and aquatic animals.

13. Rank what you think provides the most wildlife habitat (10) to the least amount of wildlife habitat (1) for waterfowl.

A small focus group was used to narrow down survey questions, improve wording of questions, and decide how many photographs of shorelines to use. Before making the survey open for participants, an exempt application to the institutional review board was submitted and approved (Appendix B) to ensure that the survey would be conducted in accordance with federal, institutional, and ethical guidelines. Survey respondents were completely anonymous and could choose to not participate in the survey at any point (Appendix A). Two groups of respondents were sought to participate in this shoreline perception study. One group was a random mixture of participants and the second group was members of lake and streams associations. The instrument used to create the questionnaire was Survey Monkey. This survey engine was chosen for its ease of set up and ability to upload photographs as part of a survey question. A brief overview of shorelines and a link to the survey was distributed through social media and email. Respondents were welcome to pass along the link through their own social media or email to not only increase the number of responses, but also in attempt to collect a wide range of respondents from varying backgrounds.

3.3 DATA ANALYSIS

The survey was open for 40 days and collected responses for this period of time. Once the survey was closed, individual questions as well as individual responses were exported to excel from Survey Monkey. Survey Monkey assigned each respondent a number to organize respondents' responses. For each question, a score was calculated for each of the 10

shorelines, to identify any “stand-out” shoreline. This was done by taking the number of respondents (N) that assigned a shoreline a ranking one through ten, and multiplying it by the corresponding ranking (R). Each questions’ response was also separated with each individuals’ response for each question. Rankings were then separated into two categories, hard and natural and rankings totaled to get a score for each of the two categories for each respondent. This was done by finding the sum of the rankings for the five hard shoreline pictures, as well as the sum of the rankings for natural shoreline pictures. Each question and their individual responses was then brought into a statistical software program known as SPSS to run a paired sample t Test. A paired sample t Test is a statistical test that can show if there is a significance in the difference of rankings of the two groups sampled, hard shorelines and natural shorelines (“Paired Samples T Test”, 2016). In order to run a paired sample t Test, the following data is required; a dependent variable that is continuous, two related groups, a random sample of data from the population, normal distribution of the difference between paired valuables, and no outliers in the difference between the groups (“Paired Samples T Test”, 2016). The t Test formula is as follows:

$$t = \frac{\bar{x}_{\text{diff}} - 0}{s_{\bar{x}}} \qquad s_{\bar{x}} = \frac{s_{\text{diff}}}{\sqrt{n}}$$

where:

$\bar{x}_{\text{diff}}$ =Sample mean of differences

n= sample size

s_{diff} = Sample standard deviation of the differences

s_x = Estimated standard error of the mean

df= degrees of freedom

The calculated *t* value is then compared with the critical *t* value with df = *n* - 1 from the *t* distribution table for a chosen confidence level. If the calculated *t* value is greater than the critical *t* value, then it can be concluded that the means of the scores between hard and natural shorelines are significantly different for each question ("Paired Sample T Test", 2016). Significance is a p-value that corresponds to the given test statistic *t*. If P<.05 the differences are statistically different, if P<.001 the differences are definitive, and if P>.01 the differences are not significant ("Paired Sample T Test", 2016).

CHAPTER 4: RESULTS

4.1 CHARACTERISTICS OF PARTICIPANTS

The sample population consisted of 139 respondents, (only two were non-residents of Michigan), with 13 respondents (9.4%) being part of a Lake and Stream Association or related organization and 126 respondents (90.6%) not part of a Lake and Stream Association or related organization. Respondents were also asked to name the county that where they resided. These responses were divided into three categories based on county population; rural, urban, and mixed. Rural counties were those with populations less than 150,000, urban counties were those with more than 400,000, and mixed counties were those with between 151,000 and 399,000. Of 131 responses, 31 respondents (23.7%) were from rural counties, 29 respondents (22.1%) were from urban counties, and 49 respondents (37.4%) were from counties considered a mix between rural and urban; 26 respondents (19.8%) either skipped the question or responded “United States”. When asked if participants had any education background in a fisheries and wildlife, environmental science, or related course, 64 respondents (46.4%) answered no, leaving the remaining 53.6% to be divided as the following; 48 respondents (34.8%) had 1-3 classes in related course, 6 respondents (4.3%) had 3-5 classes in a related course, and 20 respondents (14.5%) had a degree in this field or a related area.

4.2 SHORELINES WITH THE HIGHEST SUMS

This study found after conducting the survey that one shoreline ranked consistently above the rest. To make it easier to determine which shoreline had the most participants rank it the highest, sums of the rankings for each of the shorelines was calculated. by taking the number of responses (N) for a shoreline type, multiplied by the corresponding ranking number

(R). As seen in Tables 1 through 10, natural shoreline two ranked the highest in seven of ten ranking questions; most attractive, most familiar, most cost effective, most opportunities for recreation, most likely to improve water quality, most amount of habitat for fish, aquatic, and waterfowl species, and most likely to model their own shoreline after. Natural shoreline two was also tied with hard shoreline two for most maintenance. Also shown in Tables 1 through 10, hard shoreline four and natural shoreline three consistently ranked on the lowest.

Rank what you find to be the least attractive shoreline (1) to most attractive shoreline (10).										
Answer Options	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Hard Shoreline 1	9	39	17	20	3	0	2	2	9	4
Hard Shoreline 2	2	0	1	5	72	14	4	2	3	3
Hard Shoreline 3	4	18	33	31	3	1	10	2	1	3
Hard Shoreline 4	8	22	29	30	0	1	4	10	2	1
Hard Shoreline 5	68	10	8	2	1	1	3	3	4	8
Natural Shoreline	3	4	7	3	6	22	15	24	11	12
Natural Shoreline	10	4	3	2	3	3	6	7	10	58
Natural Shoreline	2	1	4	7	10	23	20	27	12	0
Natural Shoreline	0	6	4	6	4	25	29	17	13	3
Natural Shoreline	5	7	3	3	8	13	11	9	38	10
Sums										
Hard Shoreline 1	9	78	51	80	15	0	14	16	81	40
Hard Shoreline 2	2	0	3	20	360	84	28	16	27	30
Hard Shoreline 3	4	36	99	124	15	6	70	16	9	30
Hard Shoreline 4	8	44	87	120	0	6	28	80	18	10
Hard Shoreline 5	68	20	24	8	5	6	21	24	36	80
Natural Shoreline	3	8	21	12	30	132	105	192	99	120
Natural Shoreline	10	8	9	8	15	18	42	56	90	580
Natural Shoreline	2	2	12	28	50	138	140	216	108	0
Natural Shoreline	0	12	12	24	20	150	203	136	117	30
Natural Shoreline	5	14	9	12	40	78	77	72	342	100

TABLE 1 Response count and sums of question 4.

Rank what is most familiar (10) to you to least familiar to you (1).										
Answer Options	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Hard Shoreline 1	14	9	15	11	5	8	5	4	9	9
Hard Shoreline 2	26	10	7	8	12	2	9	5	3	7
Hard Shoreline 3	3	12	15	9	7	7	9	16	6	6
Hard Shoreline 4	4	11	7	15	7	8	10	13	14	2
Hard Shoreline 5	29	12	5	9	9	12	3	2	5	5
Natural Shoreline	4	11	11	11	10	17	6	7	6	7
Natural Shoreline	7	5	5	1	5	4	7	8	9	41
Natural Shoreline	2	9	12	11	12	9	16	15	2	2
Natural Shoreline	3	4	8	11	10	13	17	9	10	4
Natural Shoreline	0	6	6	5	11	10	8	10	27	7
Sums										
Hard Shoreline 1	14	18	45	44	25	48	35	32	81	90
Hard Shoreline 2	26	20	21	32	60	12	63	40	27	70
Hard Shoreline 3	3	24	45	36	35	42	63	128	54	60
Hard Shoreline 4	4	22	21	60	35	48	70	104	126	20
Hard Shoreline 5	29	24	15	36	45	72	21	16	45	50
Natural Shoreline	4	22	33	44	50	102	42	56	54	70
Natural Shoreline	7	10	15	4	25	24	49	64	81	410
Natural Shoreline	2	18	36	44	60	54	112	120	18	20
Natural Shoreline	3	8	24	44	50	78	119	72	90	40
Natural Shoreline	0	12	18	20	55	60	56	80	243	70

TABLE 2 Response count and sums of question 5.

Rank what you think is the least cost effective(1) to most cost effective (10).										
Answer Options	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Hard Shoreline 1	13	11	13	12	8	5	3	3	2	2
Hard Shoreline 2	16	6	7	3	22	4	4	3	1	6
Hard Shoreline 3	1	12	20	14	6	2	7	7	3	1
Hard Shoreline 4	10	14	11	13	8	2	5	4	5	1
Hard Shoreline 5	17	12	4	13	10	1	4	2	3	7
Natural Shoreline 1	4	6	5	4	2	20	12	9	6	6
Natural Shoreline 2	7	5	1	0	6	2	6	1	4	43
Natural Shoreline 3	0	3	9	3	4	10	16	23	6	0
Natural Shoreline 4	4	1	1	8	3	19	11	15	10	1
Natural Shoreline 5	2	4	3	4	5	7	5	5	33	6
Sums										
Hard Shoreline 1	13	22	39	48	40	30	21	24	18	20
Hard Shoreline 2	16	12	21	12	110	24	28	24	9	60
Hard Shoreline 3	1	24	60	56	30	12	49	56	27	10
Hard Shoreline 4	10	28	33	52	40	12	35	32	45	10
Hard Shoreline 5	17	24	12	52	50	6	28	16	27	70
Natural Shoreline 1	4	12	15	16	10	120	84	72	54	60
Natural Shoreline 2	7	10	3	0	30	12	42	8	36	430
Natural Shoreline 3	0	6	27	12	20	60	112	184	54	0
Natural Shoreline 4	4	2	3	32	15	114	77	120	90	10
Natural Shoreline 5	2	8	9	16	25	42	35	40	297	60

TABLE 3 Response count and sums of question 6.

Rank what you think would have the most maintenance (10) to the least maintenance (1).										
Answer Options	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Hard Shoreline 1	4	5	5	7	4	10	10	6	8	6
Hard Shoreline 2	5	3	4	4	9	11	5	4	7	13
Hard Shoreline 3	1	5	10	4	3	4	6	19	7	6
Hard Shoreline 4	2	7	7	6	5	8	8	6	13	3
Hard Shoreline 5	7	4	3	4	7	10	10	6	4	10
Natural Shoreline 1	6	5	8	8	13	4	6	3	4	6
Natural Shoreline 2	32	9	0	2	1	4	2	1	1	13
Natural Shoreline 3	1	4	15	11	6	5	2	12	7	1
Natural Shoreline 4	1	7	9	14	6	3	10	5	4	5
Natural Shoreline 5	6	16	4	5	11	4	5	2	9	2
Sums										
Hard Shoreline 1	4	10	15	28	20	60	70	48	72	60
Hard Shoreline 2	5	6	12	16	45	66	35	32	63	130
Hard Shoreline 3	1	10	30	16	15	24	42	152	63	60
Hard Shoreline 4	2	14	21	24	25	48	56	48	117	30
Hard Shoreline 5	7	8	9	16	35	60	70	48	36	100
Natural Shoreline 1	6	10	24	32	65	24	42	24	36	60
Natural Shoreline 2	32	18	0	8	5	24	14	8	9	130
Natural Shoreline 3	1	8	45	44	30	30	14	96	63	10
Natural Shoreline 4	1	14	27	56	30	18	70	40	36	50
Natural Shoreline 5	6	32	12	20	55	24	35	16	81	20

TABLE 4 Response count and sums of question 7.

Rank what you think provides the most opportunities for recreation(10) to providing the least amount of opportunities for recreation(1).										
Answer Options	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Hard Shoreline 1	12	11	9	7	4	5	5	3	1	2
Hard Shoreline 2	6	7	2	5	25	5	2	1	6	2
Hard Shoreline 3	0	10	15	13	4	4	6	5	2	0
Hard Shoreline 4	3	9	14	13	8	3	3	2	3	1
Hard Shoreline 5	27	6	3	5	5	1	1	5	1	6
Natural Shoreline	1	5	3	3	3	19	9	8	5	3
Natural Shoreline	5	3	3	3	3	9	6	1	7	19
Natural Shoreline	3	1	5	3	1	6	12	15	10	3
Natural Shoreline	2	3	2	3	1	4	8	11	10	15
Natural Shoreline	1	4	3	4	5	2	7	8	15	9
Sums										
Hard Shoreline 1	12	22	27	28	20	30	35	24	9	20
Hard Shoreline 2	6	14	6	20	125	30	14	8	54	20
Hard Shoreline 3	0	20	45	52	20	24	42	40	18	0
Hard Shoreline 4	3	18	42	52	40	18	21	16	27	10
Hard Shoreline 5	27	12	9	20	25	6	7	40	9	60
Natural Shoreline	1	10	9	12	15	114	63	64	45	30
Natural Shoreline	5	6	9	12	15	54	42	8	63	190
Natural Shoreline	3	2	15	12	5	36	84	120	90	30
Natural Shoreline	2	6	6	12	5	24	56	88	90	150
Natural Shoreline	1	8	9	16	25	12	49	64	135	90

TABLE 5 Response count and sums of question 8.

If you lived on a lake, rank what you would most likely(10) have your shoreline look like, to least likely (1).										
Answer Options	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Hard Shoreline 1	9	13	12	8	4	2	2	3	1	1
Hard Shoreline 2	3	3	2	1	29	7	3	2	4	1
Hard Shoreline 3	3	8	19	12	5	1	2	3	2	0
Hard Shoreline 4	3	15	8	15	3	0	4	0	4	3
Hard Shoreline 5	32	9	3	4	2	0	0	1	0	5
Natural Shoreline 1	2	1	2	4	2	16	9	6	11	2
Natural Shoreline 2	2	2	0	3	7	5	6	2	7	22
Natural Shoreline 3	1	1	3	1	0	13	8	18	7	3
Natural Shoreline 4	1	1	4	1	2	5	9	13	5	15
Natural Shoreline 5	0	2	2	6	1	6	12	7	14	5
Sums										
Hard Shoreline 1	9	26	36	32	20	12	14	24	9	10
Hard Shoreline 2	3	6	6	4	145	42	21	16	36	10
Hard Shoreline 3	3	16	57	48	25	6	14	24	18	0
Hard Shoreline 4	3	30	24	60	15	0	28	0	36	30
Hard Shoreline 5	32	18	9	16	10	0	0	8	0	50
Natural Shoreline 1	2	2	6	16	10	96	63	48	99	20
Natural Shoreline 2	2	4	0	12	35	30	42	16	63	220
Natural Shoreline 3	1	2	9	4	0	78	56	144	63	30
Natural Shoreline 4	1	2	12	4	10	30	63	104	45	150
Natural Shoreline 5	0	4	6	24	5	36	84	56	126	50

TABLE 6 Response count and sums of question 9.

Rank what you think provides the most protection against erosion(10) to the least protections against erosion(1)?										
Answer Options	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Hard Shoreline 1	5	3	6	3	1	4	9	16	4	0
Hard Shoreline 2	6	4	3	1	8	20	5	0	2	3
Hard Shoreline 3	0	4	9	2	2	7	9	11	9	0
Hard Shoreline 4	1	5	3	6	3	1	6	4	15	9
Hard Shoreline 5	8	3	0	5	5	2	6	1	4	20
Natural Shoreline	5	7	10	2	9	6	5	4	2	2
Natural Shoreline	19	4	2	2	4	2	5	1	3	11
Natural Shoreline	2	7	8	9	7	2	3	10	3	1
Natural Shoreline	5	10	9	10	2	5	3	4	5	0
Natural Shoreline	3	6	2	12	9	4	2	1	6	8
Sums										
Hard Shoreline 1	5	6	18	12	5	24	63	128	36	0
Hard Shoreline 2	6	8	9	4	40	120	35	0	18	30
Hard Shoreline 3	0	8	27	8	10	42	63	88	81	0
Hard Shoreline 4	1	10	9	24	15	6	42	32	135	90
Hard Shoreline 5	8	6	0	20	25	12	42	8	36	200
Natural Shoreline	5	14	30	8	45	36	35	32	18	20
Natural Shoreline	19	8	6	8	20	12	35	8	27	110
Natural Shoreline	2	14	24	36	35	12	21	80	27	10
Natural Shoreline	5	20	27	40	10	30	21	32	45	0
Natural Shoreline	3	12	6	48	45	24	14	8	54	80

TABLE 7 Response count and sums of question 10.

Rank what you think would least likely improve water quality(1) to most likely to improve water quality(10).										
Answer Options	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Hard Shoreline 1	7	15	9	9	1	2	3	3	1	1
Hard Shoreline 2	2	3	1	4	30	7	0	0	2	1
Hard Shoreline 3	2	7	18	10	2	0	4	3	2	2
Hard Shoreline 4	6	14	9	11	2	0	3	2	1	2
Hard Shoreline 5	24	2	3	6	6	1	0	1	3	4
Natural Shoreline 1	1	4	1	2	2	13	9	10	6	2
Natural Shoreline 2	4	0	2	1	1	1	6	5	4	27
Natural Shoreline 3	0	1	5	3	1	12	9	14	4	1
Natural Shoreline 4	2	2	2	3	1	13	10	7	7	3
Natural Shoreline 5	3	2	0	1	4	1	6	5	20	8
Sums										
Hard Shoreline 1	7	30	27	36	5	12	21	24	9	10
Hard Shoreline 2	2	6	3	16	150	42	0	0	18	10
Hard Shoreline 3	2	14	54	40	10	0	28	24	18	20
Hard Shoreline 4	6	28	27	44	10	0	21	16	9	20
Hard Shoreline 5	24	4	9	24	30	6	0	8	27	40
Natural Shoreline 1	1	8	3	8	10	78	63	80	54	20
Natural Shoreline 2	4	0	6	4	5	6	42	40	36	270
Natural Shoreline 3	0	2	15	12	5	72	63	112	36	10
Natural Shoreline 4	2	4	6	12	5	78	70	56	63	30
Natural Shoreline 5	3	4	0	4	20	6	42	40	180	80

TABLE 8 Response count and sums of question 11.

Rank what you think provides the most wildlife habitat (10) to providing the least amount (1) of wildlife habitat for fish & other aquatic species?										
Answer Options	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Hard Shoreline 1	7	14	12	9	1	2	1	2	1	0
Hard Shoreline 2	1	1	2	3	35	4	0	3	1	0
Hard Shoreline 3	1	7	16	19	1	0	5	1	0	0
Hard Shoreline 4	5	15	11	11	3	1	0	2	2	0
Hard Shoreline 5	31	8	1	3	3	0	0	0	1	3
Natural Shoreline	1	1	3	0	3	12	10	13	7	0
Natural Shoreline	3	1	0	0	0	0	3	2	3	39
Natural Shoreline	1	1	5	1	0	16	18	4	4	0
Natural Shoreline	1	1	0	3	2	11	10	11	8	3
Natural Shoreline	0	1	0	1	2	3	3	12	23	5
Sums										
Hard Shoreline 1	7	28	36	36	5	12	7	16	9	0
Hard Shoreline 2	1	2	6	12	175	24	0	24	9	0
Hard Shoreline 3	1	14	48	76	5	0	35	8	0	0
Hard Shoreline 4	5	30	33	44	15	6	0	16	18	0
Hard Shoreline 5	31	16	3	12	15	0	0	0	9	30
Natural Shoreline	1	2	9	0	15	72	70	104	63	0
Natural Shoreline	3	2	0	0	0	0	21	16	27	390
Natural Shoreline	1	2	15	4	0	96	126	32	36	0
Natural Shoreline	1	2	0	12	10	66	70	88	72	30
Natural Shoreline	0	2	0	4	10	18	21	96	207	50

TABLE 9 Response count and sums of question 12.

Rank what you think provides the most wildlife habitat(10) to providing the least amount (1) of wildlife habitat for waterfowl?										
Answer Options	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Hard Shoreline 1	10	10	7	13	1	1	0	2	0	1
Hard Shoreline 2	1	4	1	3	34	1	1	0	0	0
Hard Shoreline 3	2	5	20	12	2	0	2	1	1	0
Hard Shoreline 4	2	18	10	8	3	0	0	1	2	1
Hard Shoreline 5	26	4	4	5	2	0	2	0	1	2
Natural Shoreline	1	0	0	0	1	16	6	9	10	2
Natural Shoreline	2	1	0	1	0	2	6	4	0	29
Natural Shoreline	0	0	3	0	1	9	16	13	2	1
Natural Shoreline	0	1	0	3	1	10	10	9	6	5
Natural Shoreline	1	2	0	0	1	6	2	5	23	5
Sums										
Hard Shoreline 1	10	20	21	52	5	6	0	16	0	10
Hard Shoreline 2	1	8	3	12	170	6	7	0	0	0
Hard Shoreline 3	2	10	60	48	10	0	14	8	9	0
Hard Shoreline 4	2	36	30	32	15	0	0	8	18	10
Hard Shoreline 5	26	8	12	20	10	0	14	0	9	20
Natural Shoreline	1	0	0	0	5	96	42	72	90	20
Natural Shoreline	2	2	0	4	0	12	42	32	0	290
Natural Shoreline	0	0	9	0	5	54	112	104	18	10
Natural Shoreline	0	2	0	12	5	60	70	72	54	50
Natural Shoreline	1	4	0	0	5	36	14	40	207	50

TABLE 10 Response count and sums of question 13.

4.3 MEAN VALUES OF HARD SHORELINES VS. NATURAL SHORELINES

This shoreline perception study also sought out to find which shoreline type, hard or natural, would consistently be ranked the highest. Summations of the two categories, hard and natural, were found and means calculated across all respondents to do so. The first ranking question asked respondents to rank the shorelines based on attractiveness, to test the hypothesis that a lack of positive visual quality of a natural shoreline could be a factor in choosing natural shorelines. Shown in Table 11 Q4, natural shorelines ranked much higher than hard shorelines with natural shoreline two ranking the highest. Another ranking question related to visual quality asked participants to rank the shorelines in order of which they would most likely have their own shoreline look like, if they were to live on a lake. This hypothesized that respondents would rank the shorelines similarly to how they ranked their attractiveness. As hypothesized, the mean values of the categories for this were similar to Q4, shown in Table 11 Q9. Both of these questions had a definitive significance of differences with a p-value of .000 (Table 11). Familiarity of a shoreline type was also included in the survey to test the hypothesis that if a hard shoreline was more familiar to a respondent. Shown in Table 11 Q5, natural shorelines were ranked as more familiar, mean score 30.6, with a definitive significance of differences (p-value) between hard and natural shorelines.

In regards to knowledge of natural shorelines, a series of related questions were included. Participants were asked two separate questions about aquatic and waterfowl habitat to test the hypothesis that maybe the public is not educated on the wildlife benefits of natural shorelines. Again, natural shorelines ranked above hard shorelines in providing wildlife habitat, with a definitive significance of differences, shown in Table 11 Q12 and Q13. Another ecological

question regarding improvement of water quality was asked to see if respondents were educated on the improvements to water quality natural shorelines can make, with responses again favoring natural shorelines with a mean score of 35.2 (Table 11 Q11).

Various other questions were asked in regards to erosion protection, maintenance, recreation opportunities, and costs associated to identify other perceptions that may be tied with hard and natural shorelines. In order to test the hypothesis that respondents may think that natural shorelines are more expensive, respondents were asked to rank the shorelines in accordance to cost effectiveness. Overall, natural shorelines ranked highest in being most cost effective with a mean score of 34.2, and again a definitive significance of differences (Table 11 Q6). This study also hypothesized that people may think there are more opportunities for recreation with hard shorelines. To see if this was a reason for not implementing natural shorelines, a related question was included. Again, natural shorelines ranked higher with a mean score of 34.1 and a definitive significance of differences (Table 11 Q8). In regards to maintenance, the hypothesis was that the public may think that natural shorelines have more maintenance and could be a reason they are not chosen over natural shorelines. Hard shorelines were actually ranked as having more maintenance with a mean score of 30.76 (Table 11 Q7). The significance of differences was still definitive with a p-value of .008, but this is not as definitive as previous p-values (Table 11 Q7). The only time significances of differences were not significant is when respondents were asked to rank which shorelines provided the most protection against erosion. Hard shorelines ranked higher in providing protection against erosion, however the difference between responses was not significant with a p-value of .027

(Table 11 Q10). All mean scores and p-values (significances of differences), are included in Table 11 below.

		Paired Sample Statistics		Paired Sample T Test					
		Mean	N	Mean	Std. Deviation	Std. Error Mean	t	df	Sig. (2-tailed)
Q4	Hard Shoreline - Natural Shoreline	19.35 35.64	101	-16.287	17.678	1.759	-9.259	100	.000
Q5	Hard Shoreline - Natural Shoreline	23.85 30.62	89	-6.77528	15.99840	1.69583	-3.995	88	.000
Q6	Hard Shoreline - Natural Shoreline	20.76 34.17	71	-13.36620	18.92937	2.24650	-5.950	70	.000
Q7	Hard Shoreline - Natural Shoreline	30.76 24.14	64	6.62500	19.35098	2.41887	2.739	63	.008
Q8	Hard Shoreline - Natural Shoreline	20.796 34.101	59	-13.30508	18.66516	2.43000	-5.475	58	.000
Q9	Hard Shoreline- Natural Shoreline	19.27 35.72	55	-16.45455	14.88949	2.00770	-8.196	54	.000
Q10	Hard Shoreline - Natural Shoreline	31.0196 23.9804	51	7.03922	22.11060	3.09610	2.274	50	.027
Q11	Hard Shoreline - Natural Shoreline	19.8 35.2	50	-15.40000	18.68755	2.64282	-5.827	49	.000
Q12	Hard Shoreline - Natural Shoreline	17.76 37.12	50	-19.36000	14.32959	2.02651	-9.553	49	.000
Q13	Hard Shoreline - Natural Shoreline	17.178 37.822	45	-20.64444	13.81889	2.06000	-10.022	44	.000

TABLE 11: Paired sample T Test results for each ranking question.

CHAPTER 5: DISCUSSION

Potential reasons that natural shorelines are not more widely used hypothesized prior to the study included; perceived high cost and maintenance of natural shorelines, lack of education of ecological benefits of natural shorelines, natural shorelines perceived as less attractive than hard shorelines, and the potential for existing lakefront homeowner's with hard shorelines to cause other lakefront homeowner's to conform to a hard shoreline. Overall, this survey illustrated that (i) natural shorelines ranked above hard shorelines in almost every ranking category and (ii) people's awareness to the ecological benefits of natural shoreline's such as providing habitat and water quality was surprisingly high.

5.1 PERCEIVED VISUAL QUALITY

Natural shorelines dominated in ranking higher than hard shorelines when it came to terms related to attractiveness (Tables 1 and 6). Over half of the respondents ranked natural shoreline two as being the most attractive, with the remaining four shorelines following suit with high responses of rankings six through nine (Table 1). The same pattern occurred in another visual quality related question asking respondents which shoreline they would most likely have their own shoreline look like if they were to live on a lake (Table 6). The significance (P) of differences of both of these rankings were definitive ($P<.001$), as shown in Table 11 Q4 and Q9. With natural shorelines ranking much higher than hard shorelines in visual quality, this contradicts previous studies conclusions, of the public disliking a natural look (Nassauer, 1995 add Ozgunder and Kendle, 2006). The high perceived attractiveness of natural shorelines suggests that natural shorelines do not have low visual quality and is not a reason for lack of implementation. The results relating to visual quality suggest that perceptions have changed

from a more manicured and man-made look, to favoring a more natural look to a landscape. This reinforces multiple studies conclusions, (Weber, 2014 and Helfand et al. 2006) that people do see the beauty in a natural landscape and appreciate it. The recent positive perceptions of natural environments could be connected to the current trend of 'going green'. An article in 2009 notes how 'going green' is a trend spreading through the country (Johnson, 2009). More hybrid cars, clothing items displaying 'go green' on the label, and other items made from recycled material, are becoming more available (Johnson, 2009). There is now a market for a green industry, that sells to many Americans. This "green" market could potentially be influencing the publics perception of "green" natural spaces, into viewing them as more attractive.

5.2 PERCEIVED COST & MAINTENANCE

When respondents were asked to rank the shorelines in accordance to cost effectiveness, natural shorelines again trumped hard shorelines by ranking overall as most cost effective again with significance between differences being definitive (Table 11 Q6). Respondents possibly could have interpreted cost as the cost of materials, in which most cases plantings of the natural shorelines would be less expensive. Although respondents thought natural shorelines were more cost effective, the question related to maintenance of each type of shoreline varied a little across the ten shorelines, with natural shoreline two and hard shoreline two being perceived as having the most maintenance (Table 4). Ultimately hard shorelines were ranked as having more maintenance, with a mean score of 30.76 (Table 11 Q7). The significance was still definitive with a p-value of .008, but this is not as definitive as other results (Table 11). Since the results of this question was not as definitive, respondents could

have been wavering between shoreline choices. Participants could be thinking that repairing chips in a concrete seawall, or replacing rotted wood planks or steel sheets is more daunting of a task than just trimming back or replanting some plants on a natural shoreline, or some could think the opposite. It should not be concluded that people think one type of shoreline has more maintenance than the other. While natural shorelines rank higher in cost effectiveness, the wide range of perceived maintenance could be what keeps homeowner's from implementing natural shorelines.

5.3 ECOLOGICAL AND RECREATIONAL BENEFITS OF NATURAL SHORELINES

Approximately one third of questions asked to respondents related to their knowledge of natural shorelines to see if a lack thereof contributes to the lack of implementation of natural shorelines. Previous studies show that improved ecological conditions and benefits come with natural shorelines (Bariteau et. al. 13, Hartig et. al. 2011, & Bilkovic et. al. 2013), but maybe these benefits just are not known by the general public. In all categories relating to knowledge of shorelines including water quality, recreation opportunities, and habitat for aquatic wildlife and waterfowl, natural shorelines again came out on top ranking overall higher than hard shorelines (Tables 5, 8, 9, 10 and Table 11 Qs 8, 11, 12, &13). Significances of differences were definitive in respondents high ranking of natural shorelines providing more habitat for wildlife, opportunities for recreation, and improving water quality (Table 11 Qs 8, 11, 12, & 13). The positive perception of natural shorelines having ecological benefits suggests that a lack of knowledge of these benefits is not what deters people from using natural shorelines; but that it could be that because hard shorelines perceived as having greater protection against erosion, they are chosen above natural shorelines, regardless of the lack of

ecological benefits. Since roughly 53% of respondents had some sort of education background in fisheries and wildlife, ecology, or a related field, these respondents have probably learned about the ecological benefits that plants can have on lakes and other bodies of water. If they have a base background, it makes sense that natural shorelines ranked higher in questions related to providing ecological benefits. With this high percentage of respondents with a fisheries and wildlife related educational background, it may not be representative of the general public; thus we cannot say that the general public is educated on the benefits ofa natural shoreline. In the question relating to knowledge of protection against erosion, hard shorelines beat out natural shorelines with an average score of 31.01 (Table 11 Q10). The significance of differences however was a p-value of .027, meaning there is no significant statistical difference between ranking scores. Though the average score for a hard shoreline in providing erosion protection was 31.01, this lack of significant differences in scores means that participants just did not know which shoreline type provided more protection. Publications and fliers are available to lakefront property owners such as “The Water’s Edge” 2010, “Natural Shorelines for Inland Lakes”, n.d., and the “Certified Natural Shoreline Professional Training Manual”, 2010; not all of these works of literature put a heavy emphasis on the erosion protection natural shorelines can provide. The majority of these works focus on how to implement natural shorelines and their ecological benefits, which could cause readers to glean over important erosion control benefits. The Natural Shoreline Training Manual does a great job of informing readers about erosion, its effects, and how natural shorelines can provide adequate protection against erosion; however, the manual is only available through purchase. This may not be something a typical lakefront homeowner would be inclined to do with other

free pamphlets and information packets available. Even though results showed participants were educated in ecological and recreational benefits of natural shorelines, they are not educated on the adequate erosion protection they can provide.

5.4 FAMILIARITY OF NATURAL AND HARD SHORELINES

Previous studies concluded that cultural and and neighborhood norms tended to influence what was accepted in a landscape (Zube et al., 1981 and Nassauer et al. 2009). To see if this idea would hold true in relation to shorelines, respondents were asked to rank shorelines in accordance to familiarity. The thought behind this was that perhaps hard shorelines would be ranked as more familiar since they are widely used (Wehrly 2015) or maybe the "norm" of hard shorelines influences what people would choose to install, just as the results in Nassauer et al. (2009) suggests with yard landscapes. If people ranked them as more familiar to them, then perhaps they are more valued and accepted among those who live on lakes. This hypothesis was rejected when natural shorelines again ranked higher than hard shorelines in familiarity (Tables 2 and 11 Q5). Again the trend of "going green" and performing ecologically friendly practices (Johnson, 2009) could be influencing the high familiarity of natural shorelines. The combination of this trend and education on ecological benefits of natural shorelines, which this study showed is present, may have increased familiarity in recent years. However, just because respondents are familiar with a natural shoreline, does not necessarily mean they have seen it in use on a lakefront more than a hard shoreline. This question regarding familiarity could have been asked in a simpler way to obtain results better related to findings in Zube et al. 1981 and Nassauer et al., 2009; such as asking respondents to rank which type of shoreline they have seen the most, to which type of shoreline they have seen the least. By doing so, the

results could tell us what is considered the “norm” on a lakefront, and if that “norm” has an influence on fellow lake residents.

5.5 LIMITATIONS & SUGGESTIONS FOR FUTURE RESEARCH

In previous studies location influenced people’s perception of landscapes in previous studies, (Nassauer et al. 2009, Stedman et al. 2006, and Zube et al., 1981), respondents were asked to name the county they resided in. The counties were split up into three categories based on population, rural, mixed, and urban with the idea that those from rural areas would like the “wild” look of natural shorelines and those from mixed and urban areas would like the more manicured look of hard shorelines. While there were at least 25 responses for each category (*4.1 Characteristics of Participants*), there were many respondents who chose not to complete the survey in full. Due to the lack of full response rate for each category, we cannot conclude that location influenced preference to a type of shoreline.

Education background also has played a part in influencing perception of landscapes, (Zheng et al. 2011), so two demographic questions were asked regarding education background and lake and river association involvement to see if similar findings would occur with shorelines. However again, not enough responses in either background (*4.1 Characteristics of Participants*) were abundant enough to conclude any relation between education and background and perception of shorelines. Number of survey participants dwindled throughout the 13 questions, from 131 at the beginning to only 45 by question 13. This could possibly be due to length of survey and/or repetitiveness of questions and photographs. The survey would have to be reworked to increase participant numbers throughout the entire survey. If the study

were to be repeated, changing pictures every question, making the survey shorter, and distributing at a larger scale, would possibly yield similar findings to Nassauer et al. 2009, Stedman et al. 2006, Zube et al.1981, and Zheng et al. 2011, and hopefully solidify findings in this study. The lack of erosion knowledge and perception that natural shorelines cannot protect as well as hard shorelines cannot be the only reason holding people back from using natural shorelines. With a little over half of the respondents having a fisheries and wildlife related background, this could be the reason for results showing that people are knowledgeable of natural shoreline benefits. If the study were done with a wider variety of participants and a higher number of participants, it would be interesting to see if the responses for the questions related to ecological benefits holds true if there were less respondents with a fisheries and wildlife related educational background. While median home value and median income of the surrounding county of the water bodies was taken into account, they were not representative of the participants or dwellings on a lake or river; no part of the study looked to find a correlation between income or home value as a contributing factor to the amount of maintenance or cost a homeowner is willing to put into a natural shoreline. If we assume that second homeowners have higher than average income, then they may be willing to pay more for a shoreline of their choice, but what would that choice be? Since it is a second home they may want something that they do not have to maintain since they are not at the residence full time.

5.6 POLICY IMPLICATIONS & RECOMMENDATIONS

This study found that while participants preferred the look of a natural shoreline and understood the low cost and ecological and recreational benefits, the perception of not

providing enough erosion control and perceived maintenance may be holding lakefront property owner's back from installing a natural shoreline. We can educate the public that natural shorelines can provide by putting a heavier emphasis on erosion protection and low maintenance in available literature, but sometimes education is not enough. Incentive programs are something that could be implemented to encourage lakefront property owners to create a natural shoreline. A possible incentive could be property tax break if a lakefront has a minimum amount of feet of natural shoreline in proportion to the total length of water frontage that they own. Another potential incentive is offering dollar amount paid back to an owner per linear foot of natural shoreline; that dollar amount would probably have to be researched to see what amount would a lakefront property owner find worth it to install a natural shoreline. Even something as simple as providing a fishing license if your natural shoreline is a minimum amount of linear feet.

Michigan has current permitting systems to limit construction on shorelines, thus encouraging implementation of natural shorelines ("Inland Lakes & Streams Permits", n.d.). With the same goal in mind, the state of Minnesota legislature in recent years directed the Minnesota Department of Natural Resources to begin a rulemaking process to shoreland management ("Protecting Our Rivers and Lakes", 2008). This became the Shoreland Management Program, which requires all local municipalities and governmental units to develop ordinances or, "land use controls to orderly development and protection of Minnesota's shorelands," and make sure regulations are being followed ("Shoreland Management Programs", n.d.). This program also provides technical assistance, sample ordinances, reference materials (similar to Herbert et al., 2010 and "Natural Shorelines for

Inland Lakes", n.d.), permit information, and tips for landowners ("Shoreland Management Programs", n.d.). Some Michigan townships or communities have put their own ordinances in place to protect and enhance ecology of their lakes, however these ordinances are not required by all townships in Michigan ("Charlevoix Township Zoning Ordinance", 2007, "Long Lake Township Zoning Ordinance #109", 2010). Townships such as these can serve as a starting point for other local municipalities in combination with Michigan's permitting system. Other ordinances could include putting a maximum percentage that a lake can be developed or maximum percentage of total shoreline length that can be a hard shoreline measure. If hard shoreline measures are already in place, lake residents could be given a specified number of years to feasibly enhance their shoreline with the help of the Department of Natural Resources. Should they not be able to afford it, maybe grant assistance could be available to apply for. Education and availability of literature may not be enough to get lakefront property owners to install natural shorelines. Incentive programs, implementing policy, or a combination of both could help conserve and enhance Michigan's thousands of miles of shoreline and the health of the associated lakes and streams, thereby keeping the "Great Lakes" state great.

CHAPTER 6: CONCLUSION

For the more than 11,000 inland lakes and 36,000 miles of rivers and streams in Michigan, shorelines are an important part of improving water quality and providing wildlife habitat while providing protection against erosion (Bariteau et. al. 13, Hartig et. al. 2011, Bilkovic et. al. 2013, "The Water's Edge", 2010 & "Natural Shorelines for Inland Lakes", n.d.). While this study found that natural shorelines are preferred in terms of attractiveness and that the public is aware of the ecological benefits of natural shorelines, they also perceive natural shorelines as having maintenance and not providing as much protection against erosion as hard shorelines. We need to educate new incoming and existing lakefront homeowner's on the shoreline erosion protection natural shorelines can provide on Michigan's inland lakes through different combinations of materials (Bariteau et. al. 13, Hartig et. al. 2011, & Bilkovic et. al. 2013) and low maintenance associated wtih using natives in natural shorelines ("Natural Shorelines for Inland Lakes", n.d.). By doing so, people may be more apt to install them instead of hard shorelines, thereby enhancing shorelines, habitat, and overall lake health throughout Michigan. With increasing development and purchase of second homes in the Great Lakes state (Dietz, 2011 and Duggal, 2015), and prominence, approximately 17.3%, of hard armored shorelines on 14,426 miles of inland lake shorelines (Wehrly, 2015 and Kirkwood, 2016), the importance of shoreline health for overall lake health is prevalent. Education, workshops, and availability of natural shoreline information may not be enough to increase the implementation of natural shorelines. Incentive programs and policy would encourage and require lakefront

property owner's to be more aware of the impact they can have on a shoreline and what they can and must do in order to protect and enhance the lake they live on.

APPENDICES

APPENDIX A: CONSENT FORM

The Perception of Natural & Hard Shorelines of Inland Lakes in Michigan
IRB #i049302
Consent Form

You are being asked to participate in a research study of the perception of natural & hard shorelines of inland lakes in Michigan. Natural shorelines use native plants, biodegradable products, and other natural materials to provide a stable shoreline. Hard shorelines are hard structures such as rocks, steel seawalls, and wooden posts and/or paneling to protect shorelines against erosion. For this survey, you will be asked three demographic questions to start. The following eight questions will ask you to rank the photos given in correlation to the question. Please answer all questions to the best of your abilities.

Participation in this research project is completely voluntary and you must be 18 years of age or older to participate. You have the right to say no. You may change your mind at any time and choose to stop participating. You indicate your voluntary agreement to participate by completing this survey. If you do not consent, please do not continue to the survey.

If you have concerns or questions about this study, such as scientific issues, how to do any part of it, please contact the researcher:

Marlena Smith
1850 Abbot Rd. #A8
East Lansing MI 48823
smit1478@msu.edu
(517)490-4432

If you have questions or concerns about your role and rights as a research participant, would like to obtain information or offer input, or would like to register a complaint about this study, you may contact, anonymously if you wish, the Michigan State University's Human Research Protection Program at 517-355-2180, Fax 517-432-4503, or e-mail irb@msu.edu or regular mail at 207 Olds Hall, MSU, East Lansing, MI 48824.

Please proceed to the survey and thank you for helping me with my research!

APPENDIX B: IRB APPROVAL FORM

MICHIGAN STATE UNIVERSITY

Initial IRB Application Determination *Exempt*

September 4, 2015

To: Patricia MACHEMER
101 UPLA Bldg
MSU

Re: **IRB# x15-820e** Category: Exempt 2
Approval Date: September 4, 2015

Title: The Perception of Natural & Hard Shorelines of Inland Lakes in Michigan

The Institutional Review Board has completed their review of your project. I am pleased to advise you that **your project has been deemed as exempt** in accordance with federal regulations.

The IRB has found that your research project meets the criteria for exempt status and the criteria for the protection of human subjects in exempt research. **Under our exempt policy the Principal Investigator assumes the responsibilities for the protection of human subjects** in this project as outlined in the assurance letter and exempt educational material. The IRB office has received your signed assurance for exempt research. A copy of this signed agreement is appended for your information and records.

Renewals: Exempt protocols do not need to be renewed. If the project is completed, please submit an ***Application for Permanent Closure***.

Revisions: Exempt protocols do not require revisions. However, if changes are made to a protocol that may no longer meet the exempt criteria, a new initial application will be required.

Problems: If issues should arise during the conduct of the research, such as unanticipated problems, adverse events, or any problem that may increase the risk to the human subjects and change the category of review, notify the IRB office promptly. Any complaints from participants regarding the risk and benefits of the project must be reported to the IRB.

Follow-up: If your exempt project is not completed and closed after three years, the IRB office will contact you regarding the status of the project and to verify that no changes have occurred that may affect exempt status.

Please use the IRB number listed above on any forms submitted which relate to this project, or on any correspondence with the IRB office.

Good luck in your research. If we can be of further assistance, please contact us at 517-355-2180 or via email at IRB@msu.edu. Thank you for your cooperation.

Sincerely,

H. McGee

Harry McGee, MPH
SIRB Chair

c: Marlena Smith

Office of Regulatory Affairs
Human Research Protection Programs

Biomedical & Health Institutional Review Board (BIRB)

Community Research Institutional Review Board (CRIRB)

Social Science Behavioral/Education Institutional Review Board (SIRB)

Olds Hall
408 West Circle Drive, #207
East Lansing, MI 48824
(517) 355-2180
Fax: (517) 432-4503
Email: irb@msu.edu
www.hrpp.msu.edu

BIBLIOGRAPHY

BIBLIOGRAPHY

Bariteau, Line, D. Bouchard, G. Gagnon, M. Levasseur, S. Lapointe, and M. Bérubé (2013). A Riverbank Erosion Control Method with Environmental Value. *Ecological Engineering 58.* 384-92.

Bilkovic, D.m., and M.m. Mitchell (2013). Ecological Tradeoffs of Stabilized Salt Marshes as a Shoreline Protection Strategy: Effects of Artificial Structures on Macrobenthic Assemblages. *Ecological Engineering 61*. 469-81.

Brown, E., Wolfson, L., Smith, K., Peterson, A., & Kline-Robach, R. (2000). Developing a Watershed Management Plan for Water Quality: An Introductory Guide. 1-51.

Caulk, Andrew D., J.E. Gannon, J.R. Shaw, J.H. Hartig (2000). Best Management Practices for Soft Engineering of Shorelines Based on a Binational Conference Sponsored by the Greater Detroit American Heritage River Initiative and Partners. *Greater Detroit American Heritage River Initiative and Partners.* 1-85.

Census of Housing. (2011). Retrieved from https://www.census.gov/housing/census/data/vacation.html

Charlevoix Township Zoning Ordinances. (2007). 1-95. Retrieved from http://www.lakecharlevoix.org/Governing/charlevoix_twp_zoning_ordinance_effective_52107.pdf

Dietz, Robert. Where are the Nation's Second Homes? (2011). Retrieved from http://eyeonhousing.org/2011/08/where-are-the-nations-second-homes/

Duggal, M., & Plowman, D. (2015, November 12). Vacation Home Trends Update. Retrieved from http://www.rclco.com/advisory-vacation-home-trends-update-2015

Duhring, Karen, Hardaway, C. Scott, Jr., and Donna A. Milligan (2010). Living Shoreline Design Guidelines for Shore Protection in Virginia's Estuarine Environments. Virginia Institute of Marine Science. *Virginia Institute of Marine Science*

Facts About Michigan's Lakes. (n.d.). Michigan Department of Natural Resources (2013) Retrieved from http://www.michigan.gov/dnr/0,4570,7-153-10364_52261_63251-160092--,00.html

Gray, Donald H., and Robbin B. Sotir (1996). Biotechnical and Soil Bioengineering Slope Stabilization: A Practical Guide for Erosion Control. New York: John Wiley & Sons

Hartig, J.h., M.a. Zarull, and A. Cook (2011). Soft Shoreline Engineering Survey of Ecological Effectiveness. *Ecological Engineering 37.8*. 1231-238.

Helfand, G.E., Joon Sik Park, Joan I. Nassauer, and Sandra Kosek (2006). The Economics of Native Plants in Residential Landscape Designs. *Landscape and Urban Planning 78.3*. 229-40.

Herbert, J., Schutzki, R., Skubinna, J., Lounds, A., Majka, B., Bohling, M., & Tripp, E. (2010). Certified Natural Shoreline Training Manual: Principles of Natural Landscaping and Erosion Control on Inland Lakes. East Lansing, MI: Michigan State University Extension.

How Much of Your State is Wet? (2015). United States Geological Survey. Retrieved from http://water.usgs.gov/edu/wetstates.html

Indian River Michigan. (2014). Retrieved from http://www.indianrivermi.com/

Inland Lakes & Streams Permits. (n.d.). Retrieved from http://www.michigan.gov/deq/0,1607,7-135-3313_3681_28734-161112--,00.html

Johnson, A. (2009, February 28). Has going green become more of a trend than a solution?. Kalamazoo Gazette. Retrieved from http://www.mlive.com/opinion/kalamazoo/index.ssf/2009/02/has_going_green_become_more_of.html

Kirkwood, J. (2016, March 7). Length of Michigan Shoreline [E-mail interview].

Long Lake Township Zoning Ordinance #109. (n.d.). 1-30. Retrieved from http://www.longlaketownship.com/Portals/1040/zoning ordinances/Zoning Ord. 109 Final 8-25-15 lltwp.pdf

Michigan Natural Shoreline Partnership. (n.d.). Retrieved from http://www.mishorelinepartnership.org/

Nassauer, J. I. (1995). Messy Ecosystems, Orderly Frames. Landscape Journal, 14(2), 161-169.

Nassauer, J.I. , Zhifang Wang, and Erik Dayrell (2009). What Will the Neighbors Think? Cultural Norms and Ecological Design*. Landscape and Urban Planning 92.3-4*. 282-92.

National Lakes Assessment: A Collaborative Survey of the Nation's Lakes. (2009). United States of America, Environmental Protection Agency, Office of Water and Office of Research and Development. (pp. 1-103).

Natural Shorelines for Inland Lakes. (n.d.). Michigan Department of Environmental Quality and Michigan Sea Grant. Retrieved from http://www.michigan.gov/documents/deq/wrd-natural-shorelines-inland-lakes_366530_7.pdf

Nordstrom, K., and Nancy L. Jackson (2013). Removing Shore Protection Structures to Facilitate Migration of Landforms and Habitats on the Bayside of a Barrier Spit. *Geomorphology 199*. 179-91.

Ozguner, H., & Kendle, A. D. (2006). Public attitudes towards naturalistic versus designed landscapes in the city of Sheffield (UK). Landscape and Urban Planning, 74, 139-157.

Paired Samples T Test - SPSS Tutorials - LibGuides at Kent State University. (2016). retrieved from http://libguides.library.kent.edu/SPSS/PairedSamplestTest

Protecting Our Rivers and Lakes. (2008, May). Retrieved from http://files.dnr.state.mn.us/publications/waters/shoreland_rules_fact_sheet_origin.pdf

Quick Facts: Cheboygan County, Michigan. (2015). Retrieved from http://www.census.gov/quickfacts/table/PST045215/26031

Quick Facts: Ionia County, Michigan. (2015). Retrieved from http://www.census.gov/quickfacts/table/PST045215/26067

Quick Facts: Kalamazoo County, Michigan. (2015). Retrieved from http://www.census.gov/quickfacts/table/PST045215/26077

Quick Facts: Missaukee County, Michigan. (2015). Retrieved from http://www.census.gov/quickfacts/table/PST045215/26113

Shoreline Erosion. (2014). *Michigan Inland Lake Shorelines*. N.p.

Shoreline Protection. (n.d.). Michigan Department of Environmental Quality. Retrieved from http://www.michigan.gov/deq/0,4561,7-135-3313_3681_28734-164820--,00.html

Shoreland Management Programs. (n.d.). Minnesota Department of Natural Resources. Retrieved from http://www.dnr.state.mn.us/waters/watermgmt_section/shoreland/index.html

Shoreline Management Types: Definitions. (2014) *NOAA Office of Ocean and Coastal Resource Management* : Shoreline Management Types : Definitions. N.p.

Stedman, R.C., and Roger B. Hammer (2006). Environmental Perception in a Rapidly Growing, Amenity-Rich Region: The Effects of Lakeshore Development on Perceived Water Quality in Vilas County, Wisconsin*. Society & Natural Resources: An International Journal 19.2*. 137-51.

The Water's Edge. (2010). Michigan Department of Natural Resources and Environment. Retrieved from http://www.michigan.gov/documents/deq/Wateredge_340005_7.pdf

Toft, J. D., Ogston, A. S., Heerhartz, S. M., Cordell, J. R., & Flemer, E. E. (2013). Ecological response and physical stability of habitat enhancements along an urban armored shoreline. Ecological Engineering, 57, 97-108.

Weber, F., Kowarik, I., & Saumel, I. (n.d.). A walk on the wild side: Perceptions of roadside vegetation beyond trees. Urban Forestry & Urban Greening, 13, 205-212.

Wehrly, K. E., Hayes, D. B., & Wills, T. C. (2015, August). Status and Trends of Michigan Inland Lake Resources, 2002–2007. Retrieved from http://www.michigandnr.com/PUBLICATIONS/PDFS/ifr/ifrlibra/FR08.pdf

Zheng, Bin, Yaoqi Zhang, and Jiquan Chen (2011). Preference to Home Landscape: Wildness or Neatness? *Landscape and Urban Planning 99.1*. 1-8.

Zube, E.H., and D.G. Pitt (1981). Gross-Cultural Perceptions of Scenic and Heritage Landscapes. *Landscape Planning 8*. 69-87. Web