Western Michigan University
ScholarWorks at WMU

Master's Theses

Graduate College

5-2015

Using an Interactive Mobile Application to Crowdsource Data Collection for Management Issues in Asylum Lake Preserve, Kalamazoo, MI

Ebenstein

Follow this and additional works at: https://scholarworks.wmich.edu/masters_theses

Part of the Geographic Information Sciences Commons, Human Geography Commons, and the Remote Sensing Commons

Recommended Citation

Ebenstein, "Using an Interactive Mobile Application to Crowdsource Data Collection for Management Issues in Asylum Lake Preserve, Kalamazoo, MI" (2015). *Master's Theses*. 562.
https://scholarworks.wmich.edu/masters_theses/562

This Masters Thesis-Open Access is brought to you for free and open access by the Graduate College at ScholarWorks at WMU. It has been accepted for inclusion in Master's Theses by an authorized administrator of ScholarWorks at WMU. For more information, please contact wmu-scholarworks@wmich.edu.

USING AN INTERACTIVE MOBILE APPLICATION TO CROWDSOURCE DATA COLLECTION FOR MANAGEMENT ISSUES IN ASYLUM LAKE PRESERVE, KALAMAZOO, MI

by

Alexander Ebenstein

A thesis submitted to the Graduate College
in partial fulfillment of the requirements
for the degree of Master of Arts
Geography
Western Michigan University
May 2015

Thesis Committee:

David Lemberg, Ph.D., AICP, Chair
Charles Emerson, Ph.D.
Brian Petersen, Ph.D.

USING AN INTERACTIVE MOBILE APPLICATION TO CROWDSOURCE DATA COLLECTION FOR MANAGEMENT ISSUES IN ASYLUM LAKE PRESERVE, KALAMAZOO, MI

Alexander Ebenstein, M.A.

Western Michigan University, 2015

As technology continues to improve, personal and mobile technologies are becoming ubiquitous, being used for everything from social media to data collection. Crowdsourcing is a form of mobile data collection that calls upon a group of people to help solve a complex problem. In recent years, crowdsourcing has become an important component in data collection for managing natural disasters, allowing disaster relief systems to improve response time and coordination protocols. Natural resource and land managers are also starting to use these new technology-based and location-aware systems to improve management. By calling upon users of the recreation areas to help identify management issues, managers can improve the response times to these issues, and alter their management plans in accordance with the types and frequencies of issues reported. In this study, a mobile, smartphone application was created for Asylum Lake Preserve, which is located in Kalamazoo, MI. The app contains user information, trail maps, and points of interest found within the preserve. More importantly, the app includes a form for reporting management issues that is sent to the manager of the preserve. The goal of this thesis is to determine if crowdsourcing management issues with a mobile application can improve the management of a natural recreation area.

Copyright by
Alexander Ebenstein
2015

ACKNOWLEDGEMENTS

In no way was this thesis completed through my effort alone. I owe many thanks to a number of people. First I would like to thank Steve Keto, Western Michigan University's Natural Areas and Preserves Manager, whose support and encouragement were critical to the completion of this research. Thank you for jumping in with both feet, your passion for Asylum Lake Preserve drove mine.

Thank you to my thesis committee members at Western Michigan University: Dr. Dave Lemberg, Dr. Charles 'Jay' Emerson, and Dr. Brian Petersen. Your guidance, support, and review of my work were greatly appreciated. Special thanks to Dr. Dave Lemberg for constantly providing ideas, and for always maintaining a vision for my research, even when my own wasn't so clear.

I would also like to thank my family and friends for their guidance, support, and patience throughout this lengthy process. I credit my parents for making me into the person I am today. Without them I would not be where I am, and would not have been able to accomplish this difficult task. Thank you to Korie Hamming for the never-ending support. Thank you to my Western buddies, Brad Farley and Rudy Bartels, for providing great company during those countless hours in Wood Hall.

Alexander Ebenstein

TABLE OF CONTENTS

ACKNOWLEDGEMENTS ii

LIST OF TABLES vi

LIST OF FIGURES vii

CHAPTERS 1

1. INTRODUCTION 1

Research Objectives 2

Chapter Descriptions 3

2. ASYLUM LAKE PRESERVE 5

Landscape Context 5

Management 6

Natural Aspects 10

Geology 10

Soils 10

Lakes 12

Land Cover 13

Flora and Fauna 13

Anthropogenic History 16

Importance of the Preserve 19

As a Natural Area or Urban Open Space 19

Table of Contents - continued

As a Recreation Area 21

3. LITERATURE REVIEW 25

Urban Open Space 25

Greenspaces 25

Recreation in Urban Open Spaces 27

Common Issues in Urban Open Spaces 28

Managing Open Spaces 30

Citizen Science 32

Volunteered Geographic Information and Crowdsourcing 33

Mobile Applications 38

Mobile Computing 38

Location-Bases Services and Mobile Guides 40

Android Development 41

Existing Android Apps 42

4. METHODS 45

Mobile Application Development 45

Data Collection 48

Interviews 48

Management Issue Reports 49

Surveys 50

Table of Contents - continued

Data Analysis 52

5. RESULTS AND ANALYSIS 53

Management Issue Report Results 53

Survey Results 58

Interview Results 62

6. CONCLUSIONS AND FUTURE RESEARCH 67

Reasons for Low Use 67

Other Reasons for Lack of Results 73

Ways to Increase Use and Results 74

Final Thoughts and Future Research 76

BIBLIOGRAPHY 80

APPENDICES 87

A. DETAILS OF MOBILE APPLICATION 87

B. HUMAN SUBJECTS INSTITUTIONAL REVIEW BOARD 95

C. APP RECRUITMENT FLYER 103

D. SURVEY INSTRUMENT 105

LIST OF TABLES

5.1 Response Percentages for Likert Type Questions on App Survey 61

5.2 Chi-Square Results for Likert Responses to App Survey (degrees of freedom = 4, critical value = 9.488, 0.05 α level) 61

LIST OF FIGURES

2.1 Location of Asylum Lake Preserve in Kalamazoo 7

2.2 Map of Asylum Lake Preserve with Parking Lots, Entrances, and Trails 8

2.3 Management Areas of Asylum Lake Preserve 9

2.4 Soils Found in and Around Asylum Lake Preserve 11

2.5 Presettlement Land Cover in Kalamazoo County, MI 14

2.6 Natural Areas and Rivers in Kalamazoo and Surrounding Areas 23

2.7 Recreation Areas in Kalamazoo and Surrounding Areas 24

4.1 Management Issue Report Form 51

4.2 Completed Management Issue Report Form 51

4.3 Example Report Sent to Asylum Lake Preserve Manager 51

5.1 Locations of Reported Management Issues 56

5.2 Trash Issue Report: Sytrofoam Containers 57

5.3 Trash Issue Report: Plastic Bags of Trash 57

5.4 Trail Maintenance Issue Report: Hole in Trail 57

5.5 Trail Maintenance Issue Report: Erosion Trench 57

5.6 Improper Use Issue Report: Canoes Chained by Asylum Lake 57

5.7 Other Issue Report: Downed Trees Branches at Lake Access 57

CHAPTER 1

INTRODUCTION

Throughout human history, the methods used for data collection have changed and evolved in conjunction with improvements in technology; geospatial data collection is no exception. The collection of geospatial data is a critical step towards spatial analysis, and can be used for any number of applications, such as ground truth data collection, measuring public opinion, or mapping hazardous waste and soil contamination sites (Lwin and Murayama 2011). Up until the middle part of the 20th century, geographic information systems (GIS) data had traditionally been collected and created via surveying techniques (Goodchild 2004). Though these methods are still used in certain capacities, the majority of geographic data collection is now being handled by high precision GPS units and through the interpretation of aerial photographs and images. However, when the data being collected needs to be continually up-to-date, such as the locations of current management issues in a recreation area, the traditional approaches to data collection are often not sufficient. To resolve this problem, GIS analyses and data collection have been trending towards the use of mobile technology, namely mobile devices—smartphones and tablets—and their applications. Mobile device applications, or 'apps', are software applications designed to run on a smartphone or tablet computer.

Mobile apps have many purposes. Most mobile apps are for simple entertainment, but they can also provide a means for collecting geographic data. That aspect of mobile technology has enabled the growth of spatial data into Volunteered Geographic Information (VGI), or a collection of digital spatial data produced by ordinary citizens (Goodchild 2007). Mobile technology has also enabled a related concept called crowdsourcing. Crowdsourcing, a form of mobile data collection, is a problem-solving model that consists of an open call to a group—often public and of undefined size—to engage in solving a complex problem (Chatzimilioudis 2012). Together, these new concepts have created a new form of data and information collection that has been used in a number of different fields, including geography and environmental studies. For example, crowdsourcing has become a critical component of disaster management, allowing disaster relief systems to improve response time and coordination protocols (Goodchild and Glennon 2010). These concepts can also be applied to the management of natural or recreation areas by allowing users to report management issues to the land managers. By reporting issues as they are found, with location information tagged to the report, managers may be able to expedite the process of fixing the issue. This concept is the focus of this research, applied to Asylum Lake Preserve in Kalamazoo, Michigan.

Research Objectives

To complete this research, a smartphone app for Asylum Lake Preserve was designed and coded. The app was implemented on the Android mobile operating system, and contains user information, trail maps, and points of interest found within

the preserve. More importantly, the app includes a form for reporting management issues that is sent to the manager of the preserve. The goal of the app was to provide an attractive and useful product that visitors to the preserve would want to use, while also allowing users to report management issues—trash, vandalism, trail maintenance, etc.—as they came across them in the preserve. In this way, the app acts as a mobile, interactive, self-guided tour that also enables the crowdsourcing of data collection for management issues. Data on the effectiveness of the app were acquired via informal interviews with the manager of Asylum Lake Preserve, surveys completed by users of the preserve, and anonymous management issue reports. The results of the data collection were used to help answer the question: "Can crowdsourcing management issues for Asylum Lake Preserve with a mobile application improve the management of the natural recreation area?" This research contributes to the knowledge of using mobile devices and applications for crowdsourcing, specifically in the context of improving the management of an urban greenspace. This research provides a basis for future research on incorporating mobile crowdsourcing into management plans for other managed open spaces and recreation areas.

Chapter Descriptions

There are five additional chapters in this thesis. Chapter 2 takes an in-depth look at Asylum Lake Preserve, the study area for this research, the history of the preserve, the features, and the context of the surrounding natural areas and recreation areas. Chapter 3 is a literature review, detailing the existing research on citizen science, urban

open spaces, and mobile applications. Chapter 4 describes the mobile application development and data collection methodology, as well as the analysis techniques used to answer the research question. Chapter 5 states the results of the data collection and the analyses conducted on these results, along with a discussion on what the results mean in regards to this research. Chapter 6 draws final conclusions about the research and its results, and offers recommendations for future research based on those results.

CHAPTER 2

ASYLUM LAKE PRESERVE

Landscape Context

Asylum Lake Preserve is a parcel of land in Kalamazoo County, MI, maintained for passive-use recreation under an agreement between the City of Kalamazoo and Western Michigan University. It is located on the western edge of the city in section 30 of Township 2 South, Range 11 West (Bassett and Knoll 2009). The preserve is approximately 274 acres in size, and is owned by Western Michigan University (Figure 2.1). It consists of the 47-acre Asylum Lake, 10-acre Little Asylum Lake, and the adjoining 217 acres of land. The property has six entrances for pedestrians including the two main entrances at the parking lots on Drake Road and Parkview Avenue. The other four include another entrance on Drake, two additional entrances on Parkview, and an entrance along Winchell Avenue. In total, Asylum Lake Preserve contains approximately 7 miles of trails that spread across the 274 acres of land. Figure 2.2 shows a map of the preserve, highlighting the entrances, parking lots, and trails.

Though Asylum Lake Preserve is one of the few remaining open spaces in Kalamazoo, it has been heavily influenced by human disturbance throughout its history. It is currently surrounded by an urban landscape: medium-density residential to the east; WMU's Engineering College and Business, Technology, and Research Park to the south; commercial and high-density residential to the north; and US-131, a major north-

south freeway to the west (Bassett and Knoll 2009). Together these factors provide a unique opportunity for ecological research and management.

Management

Asylum Lake Preserve is managed by the Asylum Lake Policy and Management Council, which is made up of representatives from local neighborhood organizations, environmental groups, and Western Michigan University departments. In 2008, the Council adopted a management plan for the preserve. The goals of this management plan include improving use of the property by humans for passive recreation, research, and education, as well as to restore and reconstruct native Michigan ecosystems by promoting the use and growth of native flora and fauna (ALPMC 2008). That being said, the idea was not to return the area back to presettlement conditions, but rather to use what currently exists and maximize biodiversity (ALPMC 2008). Due to these somewhat conflicting management goals, the committee believed that it is important to balance human use and the health of the natural environment. To help solve this problem, adaptive management has been used as the principle that guides the management of all natural habitats. Adaptive management is a technique that relies on experimentation to help design and implement natural resource and environmental management policies. The preserve is home to several types of habitats, grouped into separate management areas. The management areas designated by the management plan include a prairie (51.4 acres), two oak savannas (14.9 and 17.7 acres), two forest areas (28.7 and 78.0 acres), two wet meadows (5.9 and 8.8 acres), and the two lakes (Figure 2.3).

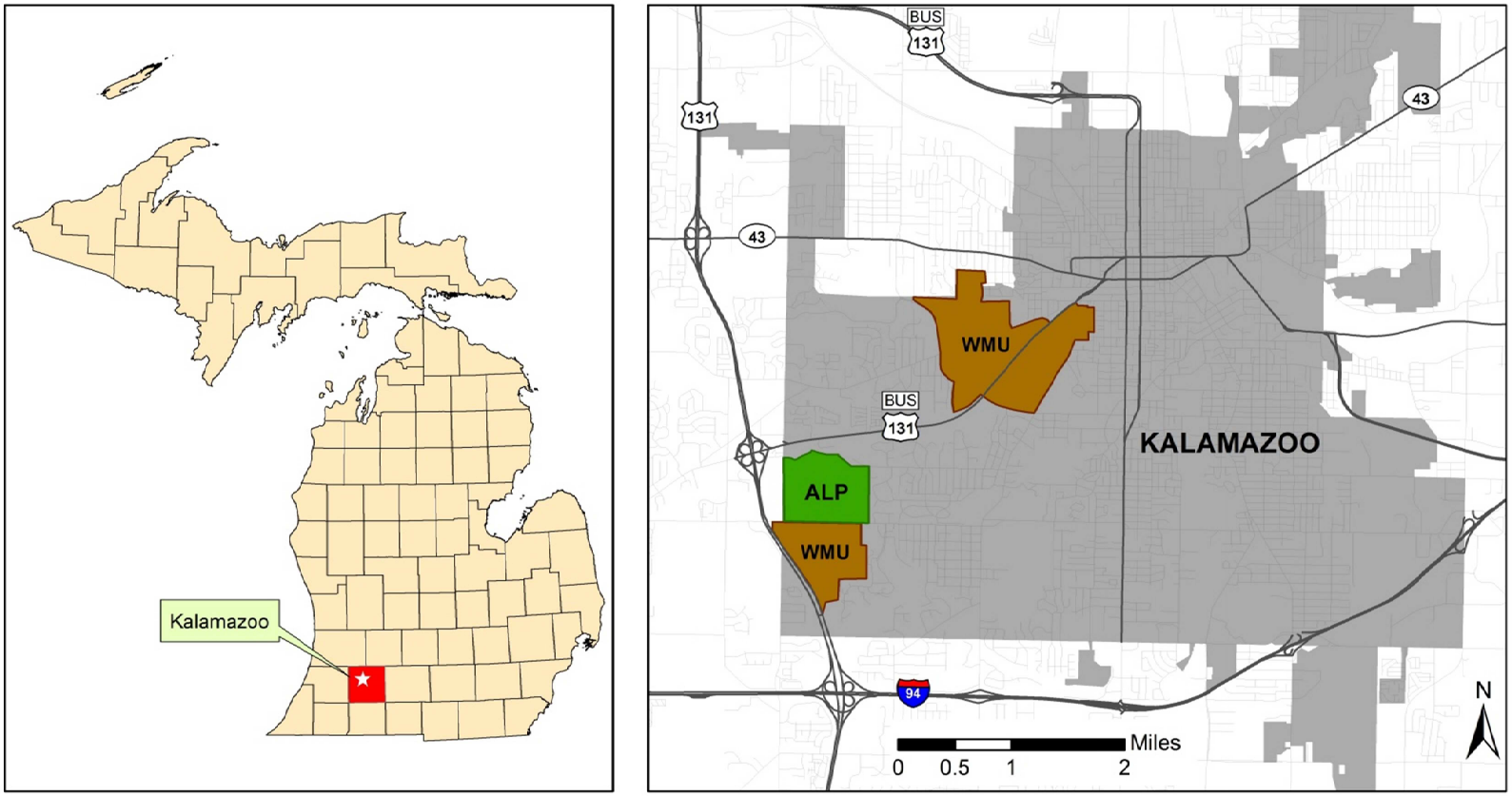

Figure 2.1 Location of Asylum Lake Preserve in Kalamazoo

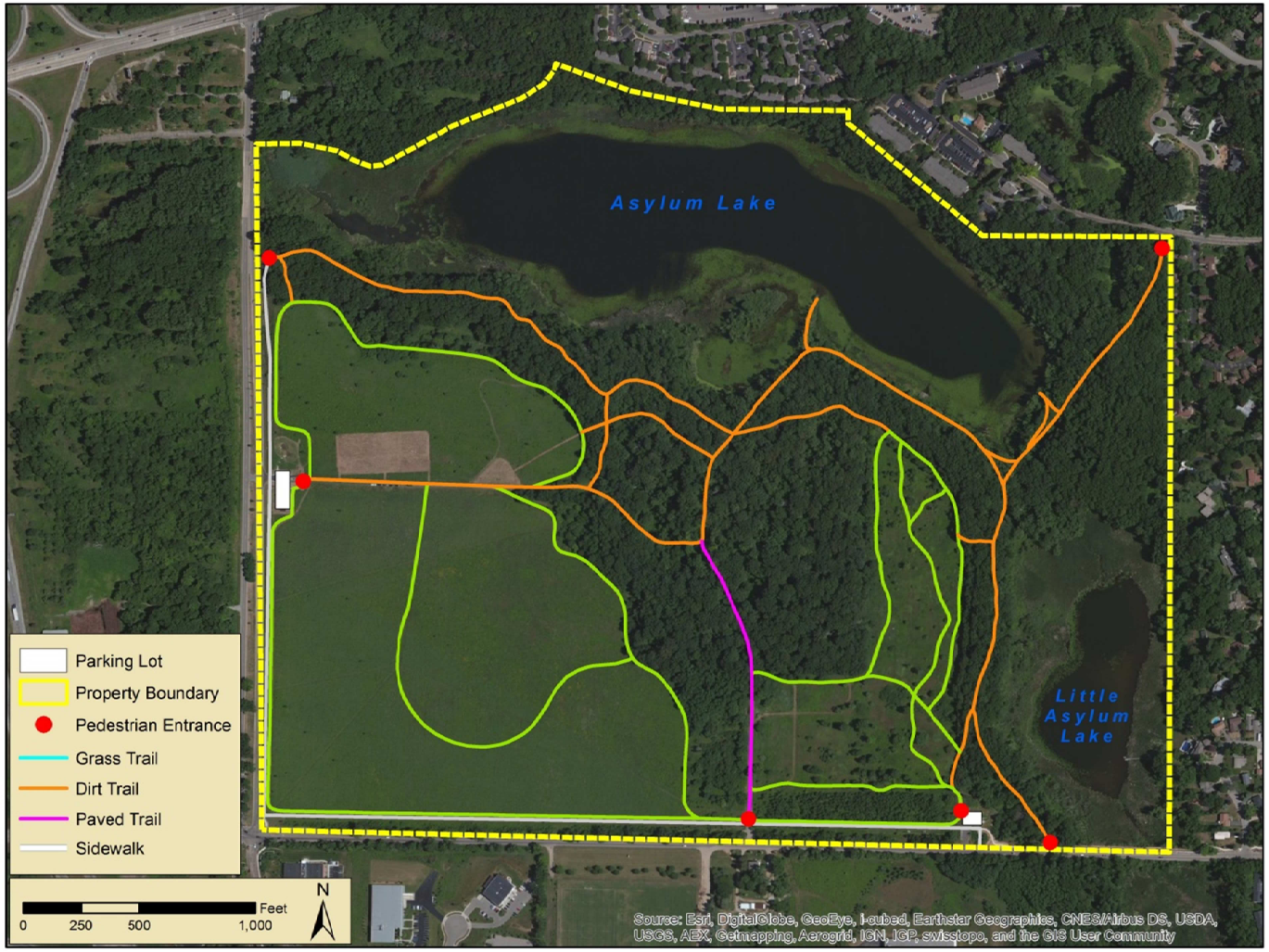

Figure 2.2 Map of Asylum Lake Preserve with Parking Lots, Entrances, and Trails

Figure 2.3 Management Areas of Asylum Lake Preserve

Natural Aspects

Geology

> "According to Regional Landscape Ecosystems of Michigan classification (Albert 1995), the Preserve is found within the Battle Creek Outwash Plain Subsection of the Kalamazoo Interlobate Section of southern Michigan, an area between three glacial lobes that were formed over Mississippian shale between 13,000 and 16,000 y.b.p. (Albert 1995). The prominent land forms are outwash deposits of sand and gravel placed by the receding glacier and the landscape is relatively flat or slightly rolling, as is typical of outwash deposits. This homogenous topography is broken by ice-contact ridges and kettle/kame features, the latter of which are prevalent at the Preserve (Dorr and Eschman 1970). Both lakes within the Preserve were formed in glacial kettles" (Bassett and Knoll 2009).

Soils

The majority of the land in Asylum Lake Preserve is on soils classified as loam, particularly Kalamazoo loam with slopes increasing from 0-2% up to 6-12% from the western edge of the preserve spreading to the east. This area also includes a Dowagiac loam (0-3% slope) in the southwestern corner of the preserve. Strips of land directly south of Asylum Lake and directly to the west of Little Asylum Lake are mapped as Oshtemo sandy loams (12-18% and 18-35% slopes). The wetland area between the lakes and along the north shore of Asylum Lake is on Houghton-Sebewa muck. The northeast corner of the preserve and the land along the north edge of the preserve are in the Urban Land-Oshtemo complex (12-25% slopes). Figure 2.4 is a map of these soil types in and around Asylum Lake Preserve according to the Soil Survey Geographic Database (SSURGO; NRCS 2000).

Figure 2.4 Soils Found in and Around Asylum Lake Preserve

Lakes

Asylum Lake and Little Asylum Lake are both kettle lakes, a type of lake formed by the burial of glacial ice that later melts leaving behind the depression that is now occupied by water. Asylum and Little Asylum Lakes form part of the West Branch of the Portage Creek, and in a broader sense, are a part of the Kalamazoo River Watershed (ALPMC 2008). It is estimated that around 1,644 acres of surrounding land make up the contributing watershed to these lakes.

The estimated surface area of Asylum Lake is approximately 47 acres. The approximate volume is 977 acre-ft and has a maximum depth of 54.5 ft. Little Asylum Lake is much smaller than Asylum Lake, with an estimated surface area of 9 acres, an approximate volume of 41 acre-ft, and a maximum depth of 12.8 ft. Asylum Lake is largely groundwater fed, the main source of its inflow, but also receives water from surrounding sub-watersheds through storm sewer outfalls and other runoff. The largest loss of water from Asylum Lake on an annual basis is to Little Asylum Lake through the outfall structure known as the "spillway". Subsequently, over 90% of Little Asylum Lake's water enters from the spillway. Almost all of the loss of water from Little Asylum Lake is through groundwater, with very little water actually leaving the lake through the culvert underneath Parkview Avenue to Cherry Creek (ALPMC 2008).

Land Cover

Asylum Lake Preserve and much of the City of Kalamazoo sit on what used to be mainly mixed oak savanna according to the presettlement land cover map (Figure 2.5). In fact, the only other presettlement land cover types in the preserve are open water and shrub swamp/emergent marsh. Now the land cover in Asylum Lake Preserve is mainly disturbed oak woodlands, reconstructed prairies and savannas, open water, and some wetlands (Bassett and Knoll 2009).

Flora and Fauna

According to the ecological assessment done by Adams et al. (2002) there is a notable lack of diversity in the vegetation at Asylum Lake Preserve. This is particularly problematic in the shrub layers due to the extensive populations of invasive plant species. The shrub layer is dominated by the native gray dogwood (*Cornus racemosa*), and the invasive glossy buckthorn (*Rhamnus frangula*) and bush honeysuckle (*Diervilla lonicera*). These invasive shrubs occupy about 60% of the forest understory (Bassett and Knoll 2009). In the herbaceous layer, the vegetation is species-poor, dominated by the invasive herb garlic mustard (*Alliaria petiolata*) (Bassett and Knoll 2009). Altogether, approximately 30% of the woody vegetation in the preserve is non-native (Adams et al. 2002). The increasing numbers of invasive species in the shrub and herbaceous layers may be causing a decrease in native wildflowers and the overall biodiversity of the preserve (Adams et al. 2002).

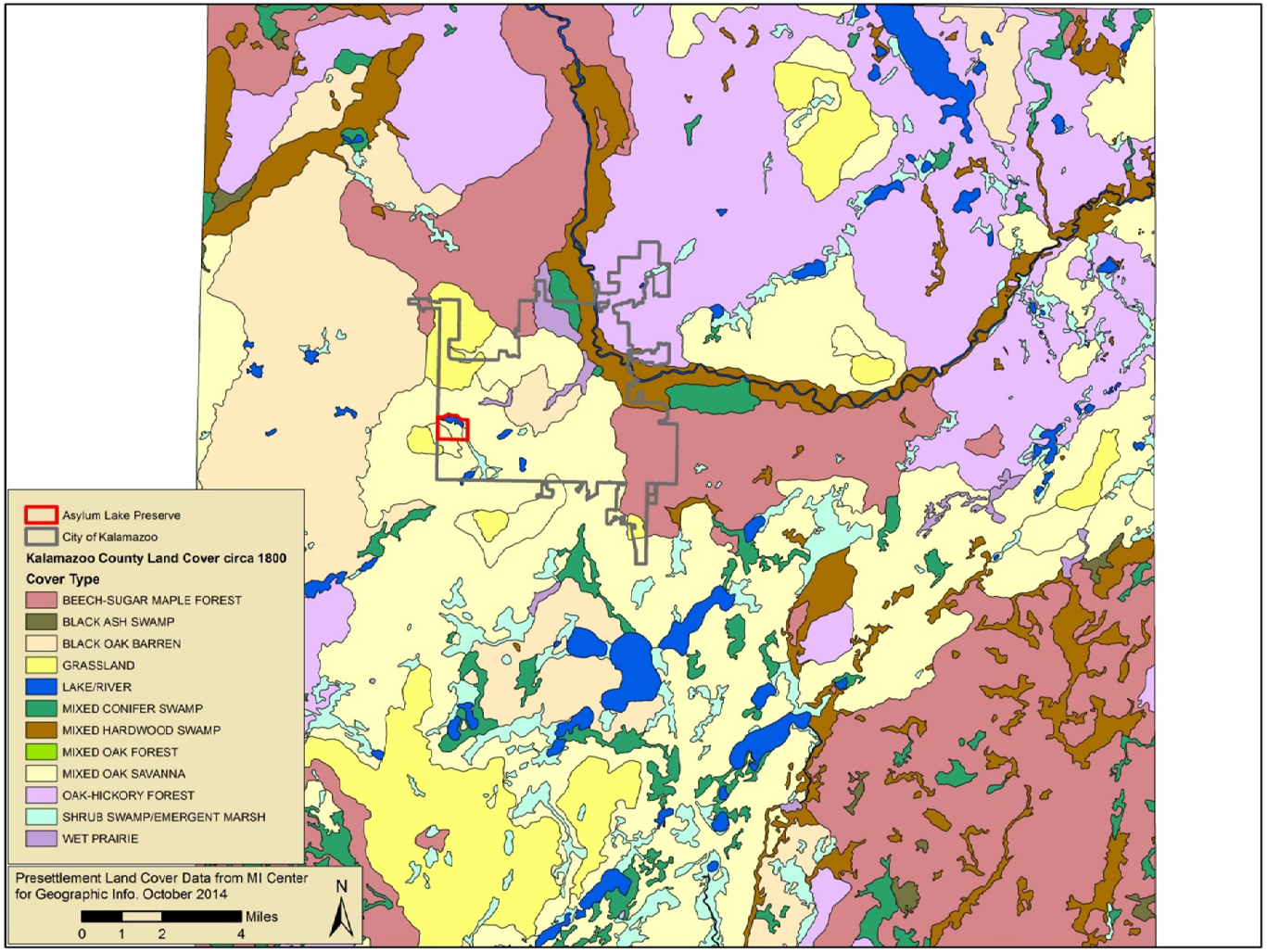

Figure 2.5 Presettlement Land Cover in Kalamazoo County, MI

The dominant species in the forest canopy are mature white oaks (*Quercus* alba), wild black cherry (*Prunus serotina*), and black oak (*Quercus velutina*), although red oak (*Quercus rubra*) and pignut hickory (*Carya glabra*) are also common (Adams et al. 2002; Bassett and Knoll 2009).

Asylum Lake Preserve also provides habitat for various animal species, such as resident and migrating birds (Adams et al. 2002). During avian surveys conducted by Bassett and Knoll (2009) in 2008-09, over 100 different bird species were recorded. The most prevalent species observed included the Canada goose (*Branta canadensis*), wood duck (*Aix sponsa*), American coot (*Fulica americana*), mallard (*Anus platyrynchos*), and yellow warbler (*Dendroica petechia*) in the wetlands; American robin (*Turdus migratorius*), gray catbird (*Dumetella carolinensis*), blue jay (*Cyanocitta cristata*), American crow (*Corvus brachyrhynchos*), and Northern cardinal (*Cardinalis cardinalis*) in the woodlands; and cedar waxwing (*Bombycilla cedrorum*) and savanna sparrow (*Passerculus sandwichensis*) in the grasslands (Bassett and Knoll 2009). Song sparrow (*Melospiza melodia*), American goldfinch (*Carduelis tristis*), common grackle (*Quiscalus quiscula*), and brown-headed cowbird (*Molothrus ater*) were also numerous, found in all of the different habitats (Bassett and Knoll 2009). Several frog species are found in the preserve—green frog (*Rana clamitans melanota*), American bullfrog (*Rana catesbeiana*), gray tree frog (*Hyla versicolor*), wood frog (*Lithobates sylvaticus*), spring peeper (*Pseudacris crucifer*), and eastern American

toad (*Bufo americanus*)—though the overall population numbers of amphibians were relatively low (Adams et al. 2002; Bassett and Knoll 2009). Reptiles were fairly numerous, and include the map turtle (*Graptemys geographica*), snapping turtle (*Chelydra serpentine*), eastern box turtle (*Terrapene carolina carolina*), Midland painted turtle (*Chrysemys picta marginata*), spiny softshell turtle (*Apalone spinifera*), Blanding's turtle (*Emydoidea blandingii*), Northern water snake (*Nerodia sipedon sipedon*), and eastern garter snake (*Thamnophis sirtalis sirtalis*) (Bassett and Knoll 2009). Mammals are the most abundant animals in the preserve, such as the fox squirrel (*Sciurus niger*), eastern chipmunk (*Tamias striatus*), muskrat (*Ondatra zibethicus*), groundhog (*Marmota monax*), and white-tailed deer (*Odocoileus virginianus*) (Adams et al. 2002; Bassett and Knoll 2009).

Anthropogenic History

The area of land where Asylum Lake Preserve now sits was first owned by Phineus Hunt, who bought the land from the Territory of Michigan's Kalamazoo District Land Office in 1831 (Durant 1993). In 1835, after only four years of ownership, Phineus Hunt sold the land to Neil Heindes (Massie 1991). For several decades after Neil Heindes purchased this land, its history is relatively unknown; however, in the county atlas of 1873, it is clear that Heindes owned about 240 acres to the south of the lake. The atlas also showed that Daniel and Jane McMartin owned 101 acres to the north of lake, which at the time had been named McMartin Lake. During this time that Neil Heindes owned

the land that would become Asylum Lake Preserve, the property was cleared for orchards and buildings. Studies have shown, though, that there is no evidence of farming or construction on the preserve property from this time (Becker and Nassaney 2005). The Heindes property was eventually transferred to his descendants when he died in 1874.

In the summer of 1887, Neil's children, led by his oldest daughter Margaret S. Smith, sold the Heindes Farm to the Michigan Asylum for the Insane for a total of $18,000 (State of Michigan 1887). Later that year, the Michigan Asylum for the Insane (later named the Kalamazoo State Hospital) purchased part of the McMartin Farm to the north of McMartin Lake (Becker and Nassaney 2005). At some point afterward, the lake became known as Asylum Lake (Massie 1991). The land was acquired by the Michigan Asylum to act as a recreation experiment for the patients, as indicated by the Trustees Report of the Michigan Asylum for 1887-1888 (Michigan Asylum for the Insane 1888).

By 1960, this 'Colony Farm' complex had five cottages to house patients, a central heating plant, two garages, a pump house, a water tower, and connecting tunnels. In 1969, the Colony Farm was completely phased out and abandoned, followed by the demolition of all the buildings and most of the aboveground infrastructure in 1971. The water tower and all of the entrances to the tunnels were eventually destroyed in 1977 (Massie 1991). Some of the remnants of the Colony Farm still exist above and below ground according to an archeological assessment of the property. These remnants were mapped in a study led by Dr. Michael Nassaney (Anthropology

Dept., WMU) and published in “An Archeological Assessment of Asylum Lake/Colony Farm Orchard Property in Kalamazoo, Michigan” (Becker and Nassaney 2005).

In 1975, the property was transferred from the State of Michigan to Western Michigan University through the Public Acts No.316 with the restriction that it be used “solely for public park, recreation, or open spaces purposes…” (Western Michigan University Board of Trustees 2004). For over 20 years after WMU gained ownership of the property, they leased the land out for agricultural purposes, including growing corn. The City of Kalamazoo and WMU then agreed to create an endowment for the conservation of Asylum Lake Preserve in 1998 (ALPMC 2008). The Kalamazoo Community Foundation also established the Asylum Lake Preservation Fund to be used for the development and maintenance of the land for public passive recreation (ALPMC 2008). In 2008, the Asylum Lake Management Plan was created as a result of the Declaration of Conservation Restrictions adopted by the WMU Board of Trustees on April 16, 2004 (Western Michigan University Board of Trustees 2004). The Declaration of Conservation Restrictions established the purpose of the preserve as ensuring passive recreation and supporting research and education, while also promoting ecosystem integrity (ALPMC 2008). It also included the outline for implementing these goals through the Asylum Lake Management Framework, which established the structure and duties of the Asylum Lake Policy & Management Council (ALPMC 2008).

Currently, the Council continues to promote the preserve as both a natural area and a recreation area. WMU’s Landscape Services provides the general maintenance of

the preserve, including removing fallen trees, picking up trash, and mowing. Two ecological assessments of the preserve have also been done in the past 14 years to study its history and assess its condition, specifically in regards to the health and diversity of the flora. Among other recommendations, both assessments stressed the importance of returning native flora species, restoring the oak savanna habitat, and removing the extensive invasive plant species to the overall health and quality of the preserve as a natural area (Adams et al. 2002; Bassett and Knoll 2009).

Importance of the Preserve

As a Natural Area or Urban Open Space

The term 'natural area' is often used to describe an area full of vegetation and animals, and void of built structures or other development, but that term can be a misnomer. It implies that the land has never been influenced by humans, but nearly every piece of land in the state, if not the country or world, has been impacted or disturbed by humans in some way. This prompts the question, "What is truly natural?" For that reason, a more appropriate term for describing a preserve such as this would be 'urban open space.' An urban open space, or a green space, is an area of land often open to the public that provides recreational, ecological, and aesthetic values. An urban open space is the counterpart of development. More specifically, Asylum Lake Preserve can be considered an open space reserve, meaning it is an area of land protected or conserved from development indefinitely for the above reasons. Despite the fact that 'preserve' is in the name, 'reserve' is a more appropriate term to use. While the two

terms, ‘reserve’ and ‘preserve,’ are often used interchangeably, there is a significant difference. Preserves imply the notion of preservation, meaning that the land is managed so as not to change it from its current condition. Reserves, however, imply the idea of conservation, meaning the land is managed at multiple scales for multiple uses, accepting change as a contributing factor to its growth and integrity. Asylum Lake Preserve has a history of extensive human disturbance, but despite that, is now set aside from development in order to offer recreational, ecological, and aesthetic benefits to the public.

This particular natural area, or open space reserve, is important for multiple reasons in terms of its ecological benefits. The most obvious is that it provides food and habitat to many different species in an otherwise extensively built-up landscape. There are few other areas in the immediate vicinity that offer up these resources. Not only does it provide these resources to its more permanent residents, the preserve also offers up a great location for migratory birds to find food and temporary refuge (Bassett and Knoll 2009). In fact, the preserve is used extensively by waterfowl and songbirds for nesting, food, and migratory purposes. Asylum Lake Preserve is also valuable as a source for biodiversity. Its history of disturbance has decreased the overall diversity, but with appropriate management, the preserve can one day return to a highly diverse ecosystem, a remnant of the pre-European settlement land cover.

Finally, Asylum Lake Preserve is important as being a part of a system of open space reserves in the region. This preserve, along with the other natural areas in

Kalamazoo County, such as Al Sabo Nature Preserve, Bow in the Clouds Preserve, Chipman Preserve, Kalamazoo Nature Center, Kellogg Forest, and Kleinstuck Preserve, act as habitat patches for various species in an urban matrix. These patches are vital to certain species in an urban area for providing refuge, as well as facilitating movement across the landscape. This movement between patches is attained through corridors, both manmade and natural. Examples of manmade corridors are roads and power lines, while common natural corridors are rivers. Figure 2.6 shows how these preserves act as patches with rivers acting as connecting corridors in the City of Kalamazoo and surrounding areas.

As a Recreation Area

The other main goal of maintaining and managing the Asylum Lake property was to provide the public with recreational opportunities. Though it is not the exclusive place for recreation in the area—there are nearly 100 township, city, county, and state parks and open spaces in Kalamazoo County—Asylum Lake Preserve is the only public recreational open space on the west side of the City of Kalamazoo. The preserve offers valuable recreational opportunities to the local community. In fact, one can argue the main reason that city officials have not invested in park areas on the west side is because WMU owns and operates a comparatively large chunk of land that already provides these resources to the people. Figure 2.7 illustrates the lack of park recreation areas around Asylum Lake Preserve in Kalamazoo.

Compared to other nearby parks, Asylum Lake Preserve does offer a unique experience not offered by most others in the area with its various habitat types, such as its prairie, savannas, or water features. For example, its collection of habitats that make it such a valuable place for the aforementioned bird populations also draws in recreational birders to observe the different species nesting, feeding, or visiting on their migrations. Asylum Lake Preserve is also somewhat unique in its restrictions on all types of motorized and mechanized recreation. To some this is a negative, but by restricting certain recreation types, other types can be enhanced. In this case, since bicycles and motorized vehicles are banned, people at the preserve to hike or walk their dog may feel more comfortable being on the trails, though allowing dogs can have negative impacts on wildlife. They also certainly benefit from the lack of noise pollution that would have been created from the motorized vehicles. However, similar to all of the other parks in the region, Asylum Lake Preserve contributes to the local tourism by providing recreational opportunities. This encourages people within the area and outside of it to get out in the community, spending time and money at surrounding businesses.

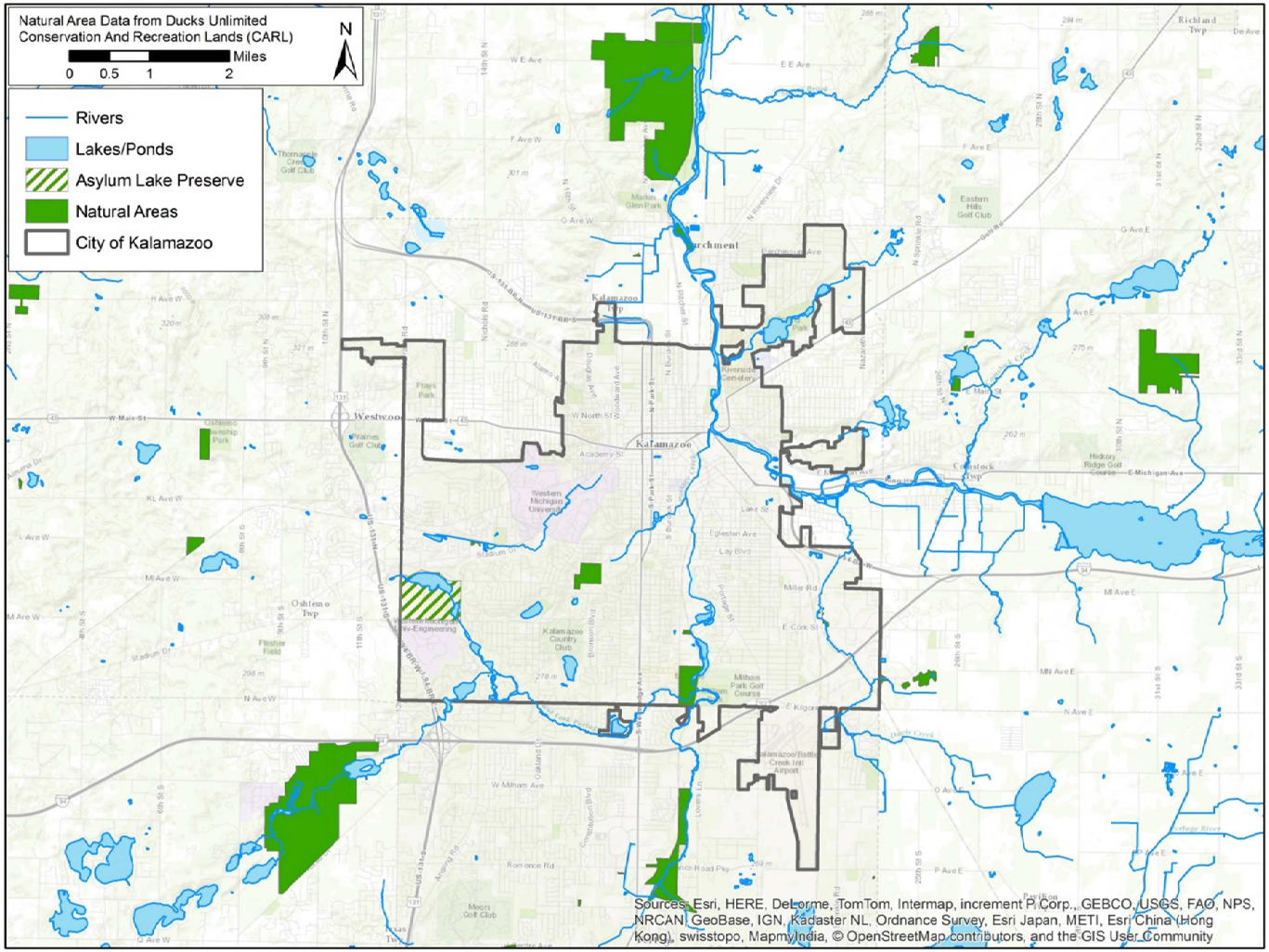

Figure 2.6 Natural Areas and Rivers in Kalamazoo and Surrounding Areas

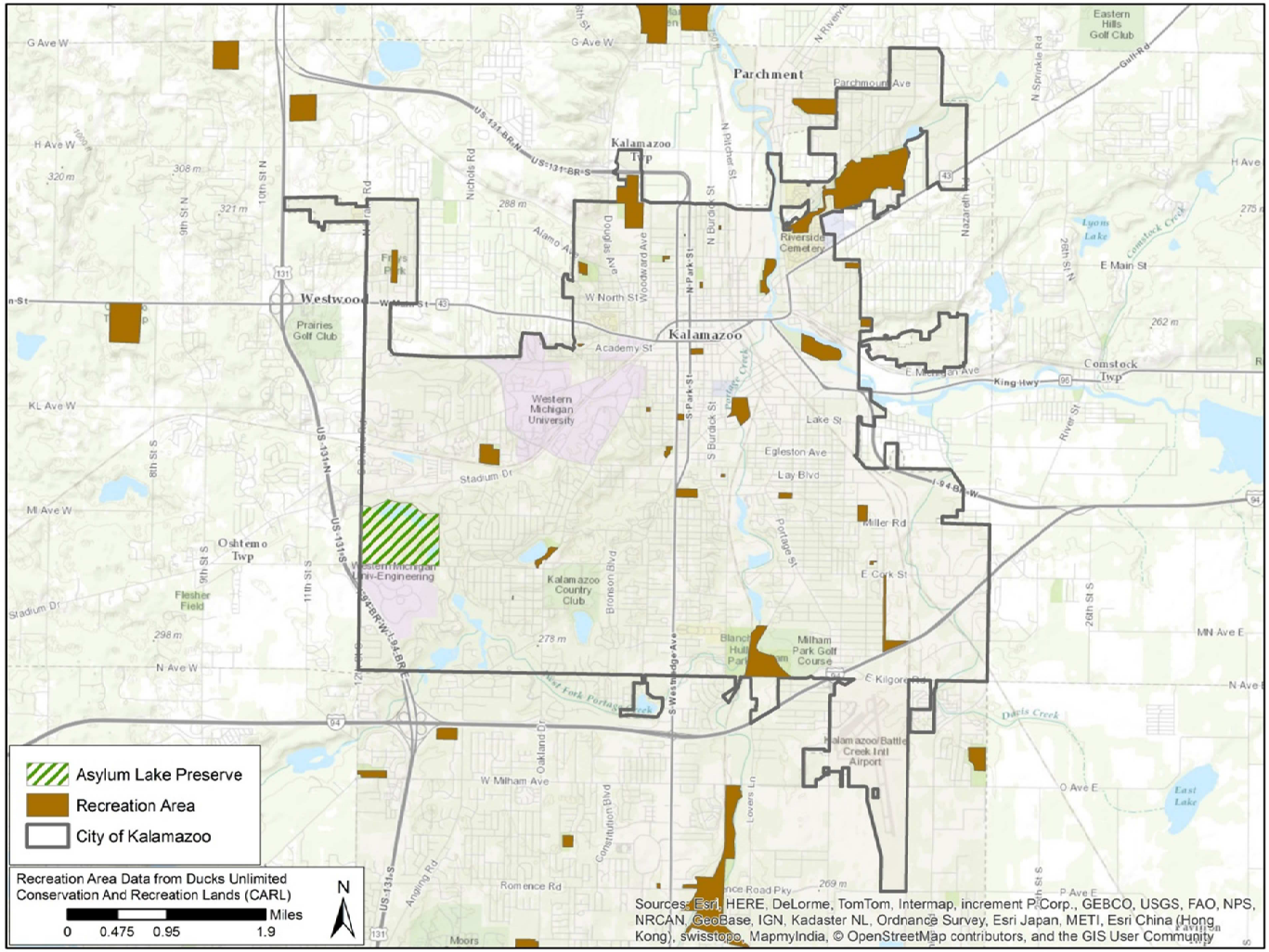

Figure 2.7 Recreation Areas in Kalamazoo and Surrounding Areas

CHAPTER 3

LITERATURE REVIEW

Urban Open Space

Greenspaces

In an urban region, there are often areas of unbuilt, open space called greenspaces. These areas contain natural systems where the different ecological patterns and processes are at least mostly natural, or not in a severely degraded condition (Forman 2008). Greenspaces can be covered by one natural system or several, such as forests, meadows, streams, or ponds (Forman 2008). These greenspaces in urban areas are significant to humans for several reasons, including for recreation, education, aesthetics, and the health and general well-being of the residents who live nearby (Perlman and Milder 2004; Forman 2008).

Not only is research being done on how to appropriately design and create urban nature areas for ecological reasons, but it is being done on how to increase the local quality of life as well. Greenspaces can offer opportunities of tranquility and leisure to people, providing them a sense of wonder and joy when observing nature in person (Perlman and Milder 2004). Furthermore, access and exposure to nature is beneficial, if not essential, to human health and well-being (Maller et al 2009). The health benefits are numerous, ranging from positive emotional states to encouraging people to be active (Maller et al 2009). Studies have also found that contact with nature can aid

recovery from mental fatigue and improve the ability of people to concentrate (Maller et al 2009). This idea also relates to concept of 'nature deficit disorder,' the hypothesis that people, especially children, are spending less time outdoors, which results in increasing behavioral problems (Louv 2008). By getting kids outside and exposed to nature, their physical and psychological health can be improved (Louv 2008). These nature areas also instill in people living in urban areas an understanding of their place in the complex system of life around them, and can even encourage these people to put an effort into protecting the environment (Perlman and Milder 2004).

Despite existing in an urban setting, these natural areas can also provide significant ecological benefits. Some important benefits are that they provide habitat and gene pools for native flora and fauna, often contain a reasonable biodiversity, and offer a good example of a natural community and ecosystem (Luymes and Tamminga 1995; Perlman and Milder 2004; Forman 2008). Other ecological benefits from greenspaces are improvements to microclimates, stream quality, wetland protection, and erosion and flood protection (Luymes and Tamminga 1995; Young 2010). Greenspaces also facilitate natural flows and movement of wildlife in an urban region (Forman 2008).

The greenspaces have other positive impacts on the urban areas in close proximity, as well, like acting as a source for species and biodiversity, cooling the area during hot periods, and absorbing and breaking down pollutants (Forman 2008). Conversely, the surrounding urban areas and the people in them can have numerous

negative effects on greenspaces. Humans create pollution, spread non-native and invasive species, disturb wildlife, damage sensitive habitats, and generally act as the major impetus for degradation of a greenspace (Forman 2008). Since urban greenspaces are typically created for human use, and are subjected to human influence, it is important to be able manage these negative effects while still balancing the other uses of the area, like recreation. This requires the attention of the land manager to maintain the quality of the greenspace by helping to prevent and resolve such issues as the dumping of trash, improper use, vandalism, and trail erosion.

Recreation in Urban Open Spaces

One of the main benefits of urban open spaces is the use of that land for recreation and tourism. Outdoor recreation, particularly in nature reserves and preserves, often results in many personal benefits, including escapism, exploration, nature appreciation, company, and fitness and health (Siderelis and Moore 1995; Bichis-Lupas and Moisey 2001). Outdoor recreation offers more than just personal benefits. For example, creating rail-trails for recreation also provides a substantial economic benefit, in the form of increased revenue, to surrounding communities by increasing the amount of visitors coming to the local businesses (Siderelis and Moore 1995; Tribe et al 2000). While the merits and benefits from recreational opportunities in suburban and urban areas are significant, recreation in rural areas often provides a better experience and a greater connection with the natural world around us (Siderelis and Moore 1995).

Common Issues in Urban Open Spaces

The inclusion of recreation and tourism to open spaces can also create negative impacts, particularly from an environmental standpoint. Human presence in nature reserves can disrupt breeding habits of the native fauna, cause damage to vegetation from trampling, and create pollution, such as water, air, and noise pollution. Heavy recreational use can also lead to increased erosion and surface run-off due to soil compaction (Hunter and Green 1995). When soil is compacted the absorption of moisture is greatly reduced, so water runs over the soil instead, creating erosion (Sternloff and Warren 1993). Particularly large areas of erosion on trails can lead to hazardous conditions for visitors. Some common methods for alleviating erosion problems include diverting the water flow across trails with concrete or wooden barriers, aerating the soil to reduce compaction, and replenishing the vegetation cover (Sternloff and Warren 1993). There are other trail maintenance issues as well. For example, in wooded areas, fallen trees and limbs across trails is a common issue, particularly after a heavy storm. The possibility of fallen trees requires periodic inspection of the trails to see if any need to be removed (Sternloff and Warren 1993).

Fencing and signs can also act as a negative impact. The installation of fencing can be costly depending on the type of fencing used, maintenance of the fencing can spend valuable time and money, and fencing can also be unsightly in a natural setting (Sternloff and Warren 1993). Signs are similar to fencing in that they are also typically necessary, but require careful consideration when being installed due to their unsightly

nature. The idea is to have as few signs as possible while still providing the necessary information. Signs and fences are also both often the recipient of vandalism, another common issue found in reserves and other open spaces. In fact, vandalism is one of the most common and costly problems found in recreation areas (Sternloff and Warren 1993). Some approaches to solving vandalism problems include educating the public about the issues, reducing vandalism opportunities through appropriate facility design, and by promptly repairing or replacing vandalized signs and facilities (Sternloff and Warren 1993).

Another significant impact from human use of open spaces or reserves is the production of solid waste or trash, particularly in the form of litter (Sternloff and Warren 1993; Tribe et al 2000). In open spaces and recreation areas, a significant amount of time and money is spent on litter pickup and removal (Sternloff and Warren 1993). Furthermore, aside from being a negative environmental impact by introducing potential hazardous materials to the environment, litter is also a visual impact (Tribe et al 2000). One of the more effective methods for reducing littering is through education. By educating the visitors, it is possible to make them more aware of the issues littering causes, and instill in them a sense of pride for the area and a desire to keep it clean (Sternloff and Warren 1993). Another method for reducing littering is to provide adequate trash receptacles. While receptacles are also a visual impact, proper design and placement can minimize that negative impact and at the same time help fix the littering problem (Sternloff and Warren 1993).

Managing Open Spaces

To combat the negative impacts of recreation on urban open spaces, careful management plans need to be implemented and rules and regulations have to be set by the managers of the land. It is the responsibility of the managers to provide recreational opportunities, but it is also their responsibility to protect the resource, whether it is natural or man-made (Sternloff and Warren 1993). A main type of management for recreation in nature reserves is visitor management. Visitor management is used to help reduce the impact users have on the physical environment, with its main goal being to influence visitor behavior in a way that minimizes the negative impacts while maximizing the user's experience. This is done through methods such as education and interpretation (Tribe et al 2000).

Oftentimes negative impacts are the result of thoughtless or selfish behavior of visitors. If a user is simply unaware that their actions are causing detrimental environmental effects, then it is essential for the manager to implement appropriate methods of educating them on sustainability and better actions. If visitors are aware of the consequences of their actions, however, it is now a matter of influencing them into changing their behavior and to convince them that they should care about these resources available to them. This can be done through interpretation. By providing information to users about the importance of these resources and how their actions affect the environment negatively, the users may gain some empathy for the environment (Tribe et al 2000). Traditionally, the education and interpretation methods

for influencing visitor behavior have been accomplished through pamphlets, guided walks, and signs. However, with the current technology, it is now possible to achieve both through the use of mobile devices, namely an interactive mobile application guide to the particular open space or reserve. At the same time, using a mobile guide could also help maximize the experience of the users, providing opportunities for better learning while visiting the area.

Another key component of open space management for minimizing negative impacts and maximizing user experience is the implementation of rules and regulations. Though regulations are designed to solve problems, they can also create tension with the conflicting concepts of recreation that exist (Lucas 1983). Recreation is defined by Driver and Tocher (1970) as a type of human experience that results from rewarding mental or physical engagements, and is based on personal choice during free time. This idea, which stresses the idea of free choice and internal control, is directly contradictory to regulation, which is governing by rule to create order and uniformity—an idea stressing external control and lack of choice (Lucas 1983). Thus, it is important to analyze the costs and benefits of any regulation before it is implemented.

The obvious cost of any regulation is some form of loss of the users' freedom, but there are also several benefits of regulations, including the promotion of safety, protection of natural resources, and the allocation of recreational opportunities (Lucas 1983). Regulations protecting the resources of the greenspace are vital because recreation can have significant ecological impacts, as mentioned above. Therefore, it is

often necessary to minimize use in some areas, or simply prohibit the more destructive forms of recreation, like motorized vehicles or bicycles (Cole 1993). In addition to certain forms of recreation being destructive, certain activities are simply not compatible. For example, while hiking and birdwatching are compatible, hiking and mountain biking tend to not work well together, so it is important to decide which types of recreation are going to be allowed (Tribe 2000). An alternative is the allocation of recreational opportunities, which is assigning the land to different parts of the recreation opportunity spectrum, thus determining who gets to use certain recreation areas and preventing conflicts between incompatible types of recreation (Lucas 1983). The behavior of recreationists also determines the impact on the land. Users who partake in malicious acts and vandalism create a disproportionate amount of the total impact from recreation (Cole 1993).

Citizen Science

Citizen science is the idea of enlisting the public to help collect large quantities of data, typically engaging a dispersed network of volunteers (Bonney et al 2009). The dispersed nature of the participants in these types of projects enables data collection to occur across potentially large areas and over significant lengths of time (Cooper et al 2007). The research process for citizen science projects typically consists of gathering participants and resources, defining the research questions, collecting and managing data, analyzing the data, disseminating the results, and evaluating the success of the project (Newman et al 2012).

This concept of allowing public participants to contribute to scientific research is not a new one; over the past century numerous projects have used public volunteers to collect data for various reasons such as monitoring water quality or documenting species distribution, like the National Audubon Society's annual Christmas Bird Count which began in 1900 (Bonney et al 2009). In recent years, citizen science projects have continued to be successful, helping to advance scientific knowledge (Bonney et al 2009). One of the main factors involved in the advancement of citizen science research is the emergence of technology over the past decade, specifically mobile devices with their applications, web capabilities, and wireless sensor networks (Newman et al 2012). Applications making use of location-based services and real-time mapping functions help improve the rate and quality of the data collected; however, the large quantities of data generated by these technologies produce a new challenge, making it important to also improve data management capabilities (Newman et al 2012).

Volunteered Geographic Information and Crowdsourcing

The citizen science model is directly related to the concepts of crowdsourcing and volunteered geographic information (VGI). In its most basic form, VGI can be described as user-generated, or volunteered, content, most often in the context of the web and social networking (Goodchild 2007, Goodchild and Glennon 2010). Similarly, crowdsourcing is the problem-solving model that uses an open call to a crowd of unlimited size to solve a complex problem traditionally solved by a designated agent (Howe 2006; Chatzimilioudis et al 2012). Crowdsourcing and Volunteered Geographic

Information are often used interchangeably, collectively used to describe the collection and production of spatial data produced by individuals and non-official institutions, or 'ordinary people' (Gill and Bunker 2012). However, Goodchild and Glennon (2010) indicate that using the term 'crowdsourcing' can imply one of two things: a group of people who lack relevant expertise can solve a problem more effectively than an expert, or that the data and information collected from a large number of people has a better chance of coming closer to the truth than the observations of one individual. Despite these differing definitions, VGI, crowdsourcing, and citizen science all share the commonality of extending outside the traditional sense of data collection by using the public to collect data.

Prior to the last decade or so, the development of geographic information had largely been restricted to mapping agencies and corporations in the form of maps and atlases (Goodchild and Glennon 2010). Two main reasons embedded in the emergence of new technologies over the past decade or two have shifted this traditional production of geographic information. The first is the ability to determine a relatively accurate position by average citizens; from standalone GPS units to the location-based services of mobile devices, ordinary people can now do what used to take professional expertise (Goodchild and Glennon 2010). The second reason is that it is now possible for nearly anyone to make a quality map from acquired data, thanks to the ever-increasing open-source map applications popping up on the Web (Goodchild and Glennon 2010). This means that now the traditional idea of geographic information production requiring

expertise and high capital no longer exists, and that the role of the expert is being replaced with non-experienced individuals using GPS, mapping software, and other new technologies (Goodchild and Glennon 2010). This concept is known as 'neogeography,' the breakdown of traditional distinctions between expert and non-expert, specifically in the context of producing geographic information (Goodchild 2009).

Though not necessarily dependent on web-based or mobile applications, VGI and crowdsourcing projects became particularly popular and important for research at about the same time as the emergence of Web 2.0—user-generated content such as blogs and Wiki pages—and improvements to mobile devices (Goodchild 2007). The most impactful features of these sensor-rich mobile devices in terms of their contribution to crowdsourcing and VGI are the GPS capabilities, Wi-Fi Internet access, and the general location-based services (Kanhere 2011; Lwin and Murayama 2011). These components, coupled with the ubiquity of mobile phones, have created a multi-functional data collection tool that allows for a coverage of data collection in both space and time that was previously impossible (Alt et al 2010; Kanhere 2011). Furthermore, the vast array of sensors built-in to mobile devices allows for numerous different types of data to be collected, including location, light, movement, audio, and visual data (Kanhere 2011; Chatzimilioudis et al 2012).

In previous research, these sensors have been used together to crowdsource to noise pollution monitoring. Urban noise pollution can be mapped by having the public use their mobile phones to capture audio measurements of the noise in their everyday

environment and tagging their location (Maisonneuve et al 2010; Stevens and D'Hondt 2010). Another common application of VGI and crowdsourcing is in the use of mobile technology to help natural disaster relief systems (Goodchild and Glennon 2010; Gao et al 2011; Xu et al 2013). Whether it is an earthquake, hurricane, or forest fire, natural disasters require quick and effective response from the government agencies and non-governmental organizations that often have limited staffs and a limited ability to collect pertinent information (Goodchild and Glennon 2010). By taking advantage of crowdsourcing to increase the inflow of important data, these agencies and organizations can expedite and improve the efficiency of disaster relief management (Gao et al 2011).

Crowdsourcing is also being used for other resource management applications, such as water resources. Research has been done using the public to act as sensors to collect important real-time measurements, such as water level, flow, and quality (Fraternali et al 2012; Lowry and Fienen 2013). Crowdsourcing is also useful as a tool for conservation, using the direct monitoring and active management of ecosystems by citizen participants (Cooper et al 2007). On top of the clear benefit of being able to collect vast amounts of data over potentially large areas, crowdsourcing often provides a low-cost alternative to traditional data collection as well (Welbourne et al 2014). Furthermore, crowdsourcing applications can help raise awareness of the issue at hand among the participating volunteers and the surrounding communities (Stevens and D'Hondt 2010). Examples of this are crowdsourcing projects used to address

environmental concerns, such as habitat conservation and global climate change issues (Biggar 2010; Wiggins and Crowston 2011).

Despite the benefits of crowdsourcing and VGI, there are several causes for concern when considering citizen science projects. First, the crowdsourcing project may not fully reach the intended target population. Certain demographic groups may be unlikely to participate, or they may not own the necessary tools, like a smartphone, and are subsequently unable to participate (Welbourne et al 2014). Second, the use of data collected by the public, or non-experts naturally creates a question of credibility, reliability, and quality of the data, specifically due to the nature of the data collection, often differing significantly from expert-driven protocols (Elwood 2008; Flanagin and Metzger 2008). Thus, it is important to consider where this data is coming from and the overall quality of that data, potentially prompting the intervention of an expert in the data management and analysis stages (Flanagin and Metzger 2008). Additional concerns with using crowdsourced data revolve around the user, specifically in ensuring the volunteer's privacy when it comes to using mobile devices to collect data. Since smartphones are now capable of collecting so much information, with or without the user's knowledge or consent, it can be a challenge to researchers to recruit volunteers to contribute to a given project (Kanhere 2011). It is therefore important to take into consideration how to prevent any privacy issues and gain the trust of the volunteers contributing to the data collection.

Mobile Applications

Mobile Computing

The concept of mobile computing has been researched for over two decades now, ever since the advances in wireless networking technology have allowed users with portable devices to communicate with others who have continuous access to networked services (Forman and Zahorjan 1994). Now this idea of mobile computing is realized in the form of mobile devices like smartphones and tablets. Increases in computing power, access to onboard sensors, and larger wireless network bandwidth have combined to allow mobile devices to rapidly flourish in the past several years (Dehlinger and Dixon 2011). In fact, as of 2013, 56% of adults in the United States own smartphones (Smith 2013). Equipped with global positioning sensors, wireless connectivity, and photo and video capabilities, mobile devices are now being used by over 2 billion users for social, entertainment, business, and gaming applications (Dehlinger and Dixon 2011).

For much of the past couple decades, the development of mobile devices has generally been limited to mobile network operators and phone manufacturers (Holzer and Ondrus 2011). In recent years, however, this has changed. With the arrival of new mobile phones and platforms like the iPhone and Android, third party organizations and individuals are beginning to make huge contributions to the development of mobile devices, specifically in the form of stand-alone mobile applications (Holzer and Ondrus 2011). Mobile applications, also known informally as 'apps'—which in itself stands for

‘application software’—are computer programs specifically designed for use on mobile devices, making use of the many built-in sensors and tools to provide context-aware content to users in a fashion similar to that of a standard PC (Dehlinger and Dixon 2011).

The operating system (OS) of the mobile device is the bridge between the hardware of the device and these mobile applications, like the operating system of a personal computer establishing a user interface and allocating the resources necessary to run the software (Karlberg 2011). The two main operating systems for mobile devices are Android OS and Apple’s iOS, although Windows Phone OS and BlackBerry OS are also somewhat common. The applications for mobile devices can be grouped into two categories: native applications and web applications. A native application can only be run on a particular OS, while a web application is run through the mobile device’s web browser and is effectively OS independent (Karlberg 2011). There are advantages and disadvantages to both. For example, native applications are limited in terms of their use on other operating systems, but since they are designed specifically for one particular OS, they are better suited for the particular hardware and features of that OS and run more efficiently (Karlberg 2011). On the other hand, since web applications are OS independent, the same application can be used on multiple operating systems, but may not run as well as a native application (Karlberg 2011). This means that each individual native application has to be programmatically rewritten for each of the different mobile platforms.

Despite having to be written for each individual platform, however, native apps are continuing to grow in popularity, getting much more use than web browser-based apps. In its study on mobile app usage, Flurry Analytics (2014) found that in 2013 apps were used by an average US consumer 80% of the time, as opposed to the mobile web's 20%. In 2014, this number increased, with apps getting 86% and the web getting 14% (Flurry Analytics 2014). In a 2012 mobile app survey report, the key findings were that users perceived mobile apps to be more convenient (55%), faster (48%), and easier to browse (40%) than web applications (Dynatrace 2012). In addition, native apps do not necessarily require internet access to run.

Location-Bases Services and Mobile Guides

For the past decade, the idea of online mapping has continuously grown, first starting on the web being accessed by desktops and laptops, and eventually finding its way to mobile devices (Kropfl et al 2012). A key component of mobile devices that make these online, mobile maps so useful are the location-based services (LBS), which determine the user's location via one of the various methods—cell towers, Wi-Fi, GPS, etc.—for determining geographic position (Zibuschka et al 2011). It is this ability to locate users and track user movements that most drastically separates mobile applications from web-based applications. While web-based applications can offer much of the same content as mobile applications, the mobile version can provide more dedicated location-based and navigation actions to users on the move (Haid et al 2008). This concept is being employed in "mobile tourism," a field of tourism that uses a

mobile device as a tour guide (Kenteris and Gavalas 2009). Specifically, the built-in GPS and LBS technologies allow users to find points of interest nearby, navigate to the points, and access content on that point directly from a mobile device in their hands (Haid et al 2008, Kenteris and Gavalas 2009). These technologies are also being applied to outdoor recreation in the form of trail guides, combining the recreation experience with information about geographical, ecological, and cultural aspects of a given area (Im et al 2013).

Android Development

With the continued widespread use of smartphone-based, mobile device technology in recent years came increasing contributions to the development of mobile applications by individuals and third party groups, or 'amateurs,' alongside the 'professional' developers. A catalyst for the boom in non-professional app development was the introduction of the Android software platform, produced by Google, Inc., in 2008 (Butler 2011). Android is an open source mobile device platform that includes a Linux-based operating system and uses mobile applications written in a Java-like programming language (Nimodia and Deshmukh 2012). Android provides the core applications like email, a short message service (SMS) program for text messaging, a calendar, maps, a browser, and contacts. Users can download additional Android apps and other content from the Google Play service.

One of the main goals of Google's mobile software platform was to keep creativity uninhibited, making the ability to create an original smartphone app an

increasingly easier task, and allowing any individual to become an app developer. The public release of App Inventor further increased the ease of building mobile apps without prior programming knowledge by allowing users to design an app interface and use blocks of code with the web-based tool (Hsu et al. 2012). Android's open source nature and easy-to-learn development tools are a main reason why Android caught and surpassed Apple's iPhone in the mobile device market. In the United States, the percentages of Android and iPhone owners are fairly equal as a whole, but Android does consist of the higher percentage. In 2013, 28% of smartphone owners said they had an Android phone, while 25% said they had an iPhone, which translates into about 48% and 43% of American adults for Android and iPhone, respectively (Smith 2013). However, worldwide, Android currently holds over 84% of the smartphone OS market share in unit shipments (IDC 2014). This fact, and the general ease and convenience of Android development are the reasons why Android was chosen for this research over iOS.

Existing Android Apps

Currently there are over 1.3 million Android apps on Google Play, and the number continues to steadily increase (AppBrain Stats 2014). While this number represents a large variety of different types of apps, a relatively small, but important proportion of these apps are focusing on the interaction of humans and their environment. The Pocket Ranger apps by ParksByNature Network LLC (2014) are a series of guides to the state parks in over half of the states, helping users find state parks within a specific state by location or activity, and providing the necessary user

information to enjoy the parks. Similarly, several other apps have been created for nature, river, driving and rail trails across the country, putting forth an interactive map and guide containing unique points of interest (BarZ Adventures 2011, PKC Mobile 2011, GHCS Software 2012, Northstar New Media USA 2013, TrailMapps.com 2014).

While all of these apps contain a guide to form of trail network, they each have some unique characteristics. The Otago Rail Trail app (PKC Mobile 2011) allows users to view all of the points of interest at once or one at a time, and also allows users to make the background map a Google road map or satellite imagery. The Creole Nature Trail app (BarZ Adventures 2011) gives users the opportunity to use the app while driving or walking, and it provides audio and video content to supplement the onscreen words and pictures. The Clinton River Trail Map (GHCS Software 2012) is an interactive map for rail-trail in the Detroit suburbs. This app provides photo-highlights of various points of interest along the trail to users. The Marquette Trails app (Northstar New Media USA 2013) provides a list and map of the numerous trails in Marquette, MI, offering general information, distance and elevation measurements, and difficulty of the biking, hiking, and running trails. The Whitehorse Trail Guide app (TrailMapps.com 2014) provides information on the biking and hiking trails in Whitehorse, Yukon, such as distance and difficulty, as well as info on the climate and wildlife at the trails.

There are also existing apps used for reporting some type of issue. The What's Invasive! app (Bugwood 2013), the Invasive Species app (Bond 2013) and the SeeClickFix app (SeeClickFix 2014) are examples of this. The What's Invasive! app is an app created

by National Park Service rangers and other professionals to show users what the top invasive species are in their area (Bugwood 2013). This app also allows the users to help prevent the spread of these species by uploading photos and GPS locations of the species to the experts (Bugwood 2013). The Invasive Species app enables users to report aquatic invasive species in the State of Maine (Bond 2013). The SeeClickFix app allows users to report issues in the city, like graffiti, by giving them the ability to geotag and upload a photo of the issue that is ultimately relayed to local governments to be fixed (SeeClickFix 2014).

CHAPTER 4

METHODS

This research project was completed in two stages: the mobile application development stage and the data collection stage. The mobile app development stage was completed during the summer of 2014 and the data collection stage was conducted during the fall of 2014. The data collection process consisted of three different parts: interviews with manager of Asylum Lake Preserve, surveys on the use and effectiveness of the app, and anonymous management issue reports from the app sent to the manager of the preserve.

Mobile Application Development

The Asylum Lake Preserve app was designed for Android, an operating system (OS) for mobile devices developed by Google. The Android OS is found on numerous kinds of smartphones carried by the various major phone service companies. To develop an Android application, Google provides Android Software Developer's Kit (SDK; Google 2015a) for free, available for download from the Android Developers website. The Android SDK was used in this project with the free Eclipse integrated development environment (IDE) software (Eclipse 2015). These things, in conjunction with the Android Development Tools (ADT; Google 2015b) Plugin, were used to develop the Asylum Lake Preserve app during the summer of 2014. Within Eclipse, the source code for the app was written in a Java-like programming language. During the app

development process, the source code was continuously debugged and tested for errors, and to make sure each component worked properly. The app was also tested by several volunteers with different Android phones to ensure that the app appeared correctly and worked as expected on different devices. The final product was completed at the end of August 2014, and was subsequently uploaded to the Google Play Store (Google 2015c), making the app available to the public free of charge. Once the app was available to the public, people were recruited to download the app by placing flyers at the main entrances to the preserve and by handing out flyers to visitors within the preserve. These flyers contained a QR code that brought users to the Asylum Lake Preserve app page on the Google Play Store. The flyer can be found in Appendix C.

The main component of the app in the context of this research is the management issue report form. This form, detailed below, allows users to anonymously report issues to the manager of the preserve. However, in order to get people to use the reporting system, it was incorporated into a full interactive guide to the preserve, rather than a standalone issue reporting app. If the user has a reason to want to use the app, then they are more likely to take the time to use it for reporting management issues.

From the home screen (Figure A-2 p. 87), users can access the 'Info and Directions' page (Figure A-3, p. 87). This page contains a button with the address of the parking lot on Drake Rd. When users press this button, they are redirected to Google Maps where they are shown directions to the preserve from their current location. The 'Info and Directions' page also has contact information for Landscape Services at WMU,

and a short section about the preserve with a link to a webpage on the history of the property.

The app also features four main maps (Figure A-5, p. 88): 'Trails,' 'Trail Loops,' 'Management Areas,' and 'Points of Interest.' For each one of these maps, the layers were overlaid on the satellite imagery in Google Maps. Also, each map contains general reference information, such as parking lot locations and visitor entry points. Specifically, the 'Trails' map shows the trails in the preserve, indicating the surface type for each section of trail (Figure A-6, p. 88). The data used to create the trails layer came from WMU's Physical Plant, which used GPS to create the trails. The 'Trail Loops' map shows three trail loops of differing lengths—1.0, 1.25, and 2.0 miles—along the trail system in the preserve, as well as the trails themselves that can be shown or hidden as desired (Figure A-8, p. 88). The 'Management Areas' map shows the management areas within Asylum Lake Preserve, as defined by the preserve management plan (Figure A-9, p. 88).

Finally, the 'Points of Interest' map shows the waypoints of selected points of interest found in the preserve (Figure A-10, p. 88). The majority of these points of interest were of the different tree species in the preserve, but there are also points at other various things, like the two lakes or the USGS observation wells. The points of interest are also found in a list on the app, also accessed from the home screen, with each point containing accompanying information and photos (Figure A-13, p. 89). Other features on the Asylum Lake Preserve app include seasonal and historical photos of the preserve (Figure A-19, p. 90), the rules and regulations (Figure A-32, p. 93), and a page

to share text and photos with social media (Figure A-33, p. 93). A complete set of screen captures showing the details and the features of the app can be found in Appendix A.

Data Collection

As the app development process was finishing up, the data collection period began, although some data collection did occur while the app was being created. The three different types of data collected for this research were interviews, surveys, and management issue reports. Before doing any data collection, the survey instrument and the informed consent documents for all three data types were submitted for review to the WMU Human Subjects Institutional Review Board. Since no personal information was required to complete the research and there were no known risks associated with participating in the research, the project was given exempt status by the review board, meaning no further review was necessary under federal regulations. The HSIRB approval letter and informed consent forms given to the participants for each of the three data collection types can be found in Appendix B.

Interviews

During the app development process, the initial interviews took place. These informal interviews with the WMU Natural Areas and Preserves Manager, Mr. Steve Keto, were conducted in order to get opinions on what the app should offer to users, in terms of both general use and reporting management issues, and they helped determine the key components of the final product. At the end of the data collection

period, when the surveys were completed and the management issue reports were collected, the final interviews were conducted. These interviews were also with Mr. Keto to gather opinions on the effectiveness of the app, specifically in regards to its utility for the management of the preserve. These interviews were the key data used to answer the research question, "Can crowdsourcing management issues for Asylum Lake Preserve with a mobile application improve the management of the natural recreation area?"

Management Issue Reports

The final data collected to answer the research question for this project were the management issue reports. If users came across a management issue while visiting the preserve, they were able to directly, and anonymously, report that issue to the manager of the preserve with the mobile app. The issue report component of the app presented a form for the user to complete and send (Figure 4.1). The first step is to choose an issue type from a dropdown list of issues—trash, vandalism, infrastructure damage, improper use, trail maintenance, and other. The second step is to enter in some details about the issue.

The final required step is to set the location of the issue within the preserve using the 'Set Location' function. This function opens a map of the preserve and automatically drops a marker at the user's last known location on the map as determined by the phone's GPS. The user has the option of moving the marker to another spot on the map if necessary. When satisfied with the marker location, the user

finalizes the location, and the coordinates are recorded to the 'Latitude' and 'Longitude' fields in the report form. The user also has the option of attaching a photo of the issue by taking a picture with the phone's built-in camera, and the option of providing an email address to allow for possible communication from the manager of the preserve. When all of the required fields in the form are complete (Figure 4.2), the report is sent directly to the manager in the form of an email (Figure 4.3).

Surveys

Following the completion of the app, users of the preserve were encouraged to download the app by flyers posted at the main entrances and handed out in person. This flyer also had a link to the Asylum Lake Preserve app survey on SurveyMonkey. A link to the survey could also be found within the app itself. The main focus of this survey is to get feedback on the general use of the app. The first question asks the user about the frequency with which they visit Asylum Lake Preserve, but the rest of the questions are specifically related to the app. The majority of the questions are Likert-type questions, done specifically to offer balanced and unbiased options to each question, including a neutral option. Likert-type questions were also used to allow for an appropriate statistical analysis of the survey results. The survey in its entirety can be found in Appendix D, along with a letter of permission to conduct research from SurveyMonkey.

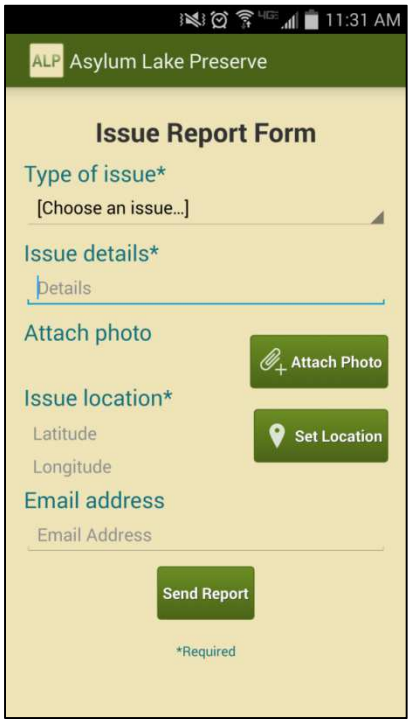

Figure 4.1 Management Issue Report Form

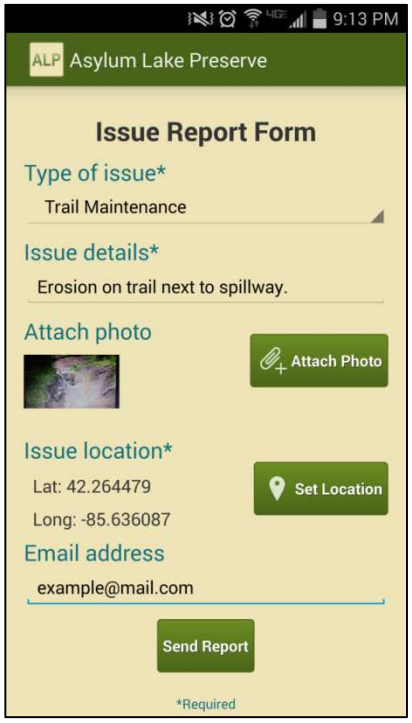

Figure 4.2 Completed Management Issue Report Form

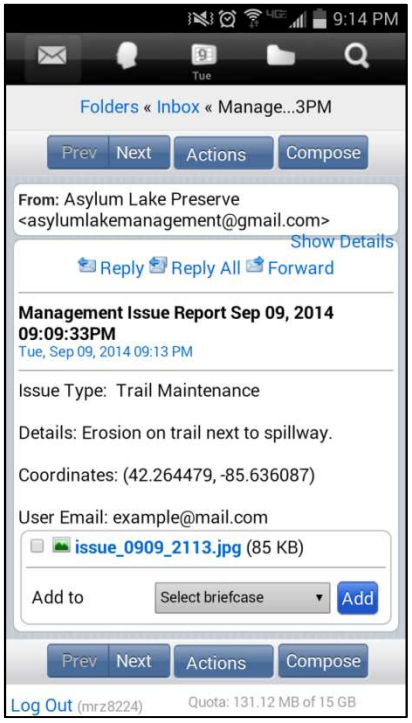

Figure 4.3 Example Report Sent to Asylum Lake Preserve Manager

Data Analysis

Since the interview and management issue report data were qualitative, no statistical tests were performed for those results. Instead, the interviews and reports were reviewed for discussion on the feedback received and how it relates to recommendations for changes or future full-scale implementation at Asylum Lake Preserve or another similar area that could benefit from a mobile guide app. The survey results obtained during the data collection period, however, were quantitative. These results were recorded into an Excel (Microsoft 2010) spreadsheet for statistical analysis where it was then analyzed using the standard statistical test chi-square in order to determine if the obtained responses for each question fit the expected model—evenly spread responses across all options.

CHAPTER 5

RESULTS AND ANALYSIS

Management Issue Report Results

During the data collection period only eight management issues were reported. Of the eight reports, three were for trash, three were for trail maintenance, one was for improper use, and one was marked 'Other.' Figure 5.1 shows the locations of the management issues reported. The trash reports were things like Styrofoam food containers (Figure 5.2), bottles, and plastic bags (Figure 5.3) found in the brush just off of the trail at various points. Of the issues labeled 'Trail Maintenance,' one was for a large, hidden hole in one of the trails (Figure 5.4), one was for a large trench in a trail caused by erosion (Figure 5.5), and the last one was for cut saplings and brush off the side of the trail left sticking up that caused a visitor to fall and break their wrist. The improper use report was about canoes chained to a tree near Asylum Lake (Figure 5.6) The issue labeled as 'Other' was for downed tree branches at the access point to Asylum Lake (Figure 5.7).

Though the number of issues reported was well below the expected amount, the issues that were reported did provide important opportunities for understanding what types of things are being reported, as well as whether or not the reporting system is an appropriate tool for reporting issues from the user's perspective and appropriate for responding to issues from the manager's perspective. Positive examples of both are the

trash reports. These reports demonstrated the simplicity and efficiency of the system. All users had to do was type a quick description, snap a photo, and tag their location, and it results in the manager getting an email that allows him to easily locate and remove the trash.

Another lesson learned about how well the reporting system worked was the final input: the user's email address. This input was made optional in order to allow the user to remain anonymous. Unfortunately, this created some problems; if the user decided to leave their email then Mr. Keto could communicate with them if necessary, but if they decided not to leave their email, then he could not explain if something is in the process of being fixed or why it could or would not be fixed. This was witnessed with the first report. A user reported two canoes chained up to a tree near Asylum Lake. According to the Declaration of Conservation Restrictions, all watercrafts and flotation devices are strictly prohibited, but these particular canoes were previously approved by The Asylum Lake Policy and Management Council for use in a long term Western Michigan University water quality study. Since the user who reported these canoes did not leave their email address, Mr. Keto had no way to contact them to inform them that the canoes were allowed to be there. Ultimately, it forced him to post a sign next to the canoes indicating their purpose. The user who reported the downed tree branches at the lake access spot also chose not to leave their email. Again, this prevented Mr. Keto from letting that person know that a situation such as this was not really a management issue, and that they should feel free to move the branches themselves.

Conversely, by providing their emails, users could give the manager an opportunity to reply to the report. Such was the case for each of the trail maintenance issue reports. This was especially important for the report from a user who tripped on the small stumps off the trail and broke their wrist. By providing an email, Mr. Keto was able to reply to the user and explain that the stumps are the result of an invasive species removal technique called cut stump treatment. This technique calls for the cutting of woody invasive trees and shrubs, then applying small amounts of herbicide directly into the cut. The stump is left relatively high so that they can be found again the following spring and summer for a second treatment if necessary. In his response, Mr. Keto also informed the user of the multiple reasons why traveling off-trail is not encouraged, such as safety reasons, soil compaction and erosion, and disturbance to volunteer vegetation. The main accomplishment of this response, though, was opening up a line of communication with the user in case they had any additional questions, a valuable asset for a manager of public recreation.

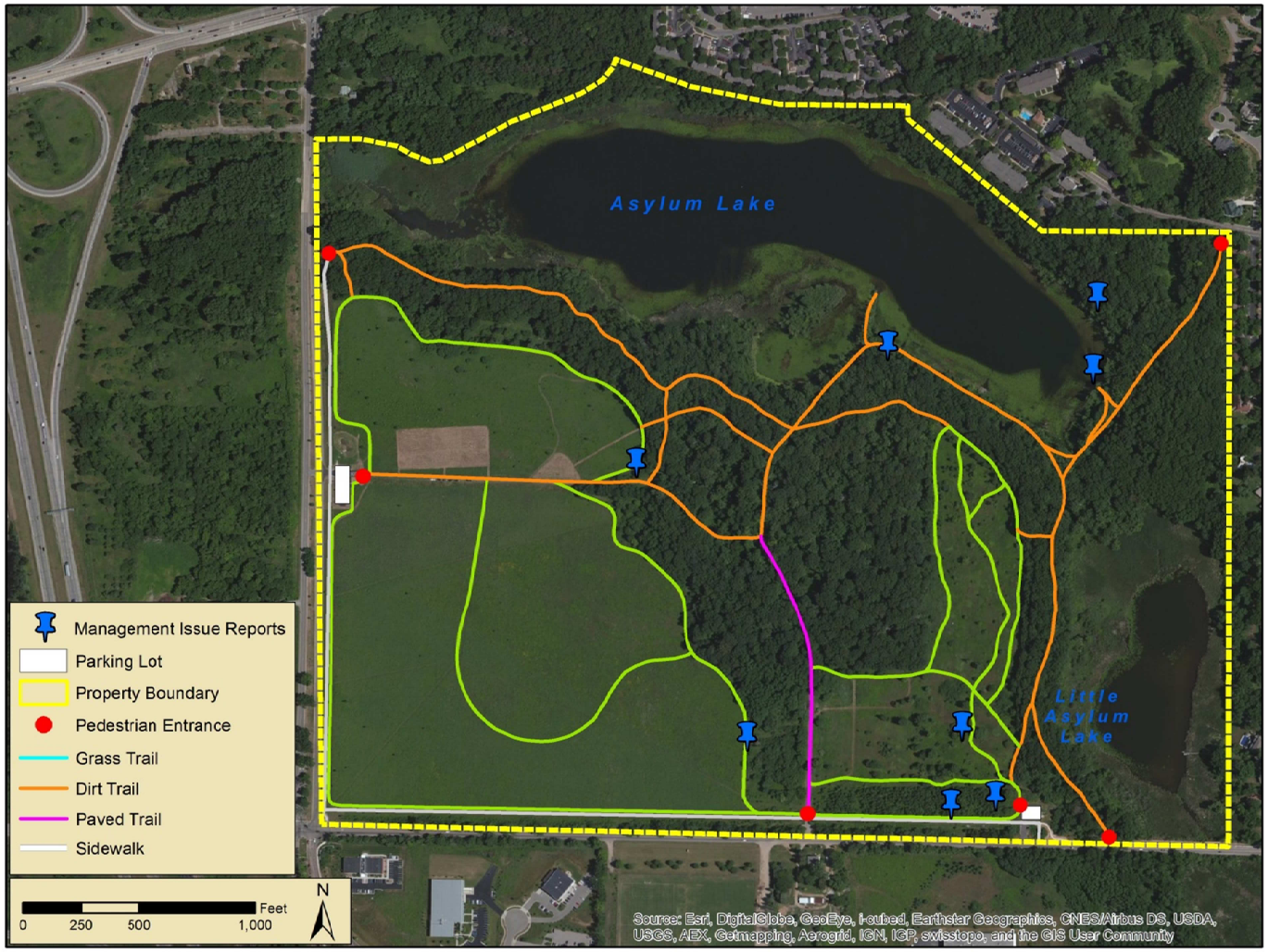

Figure 5.1 Locations of Reported Management Issues

Figure 5.2 Trash Issue Report: Styrofoam Containers

Figure 5.3 Trash Issue Report: Plastic Bags of Trash

Figure 5.4 Trail Maintenance Issue Report: Hole in Trail

Figure 5.5 Trail Maintenance Issue Report: Erosion Trench

Figure 5.6 Improper Use Issue Report: Canoes Chained by Asylum Lake

Figure 5.7 Other Issue Report: Downed Trees Branches at Lake Access

Survey Results

Throughout the data collection period 33 surveys were completed. The response percentages for each of the eight Likert scale questions on the survey are displayed in Table 5.1. Of these eight questions all but one asks participants specifically about their opinion of the app. The one that does not, the first question, asks the users how often they visit Asylum Lake Preserve. The highest percentage of participants said that they visit the preserve zero to one time in a given month. The majority of people either agreed or strongly agreed that the app was simple to use, user-friendly, informative, that it served its purpose as an interactive guide, and that they were overall satisfied with the app. The majority also said that they were somewhat to very likely to recommend the app to people they know. Most of the participants were neutral, however, on whether or not the app was fun to use.

Since most of the responses were on the positive side, rather than spread evenly across the different options, the results of the chi-square test on each set of responses are higher than the critical value (9.488) and significant ($P < 0.05$) (Table 5.2). What this means is that the survey responses for the sample population were favorable to the app, and the pattern of the responses were not due to random error.

The final question on the survey asked participants: “Do you have any additional comments about the usability and/or content of the Asylum Lake Preserve app?” Though the majority of survey respondents left this question blank, about a third of them left useful comments. Most of the answers from the final question reflect the

response percentages for the other questions and are simply comments about certain aspects users liked, such as the maps, points of interest, reporting system, and overall look. There were also suggestions for improvements to the app, namely the addition of current news and events, as well as fresh content and more historical information. The list of answers is below:

- Really liked the colors and the way it is presented.
- Points of interest were very accurate.
- I'm very impressed with the app. Looks nice on my tablet.
- Well done. Maps out the park effectively for main trails.
- It would be great to have a GPS feature that could show you where you were in the preserve and navigate to POIs.
- Very helpful to runners looking for trails to run. Could also be utilized by cross country skiers.
- Very well laid out. The reporting part is great and would work in a lot of other apps.
- I will definitely be visiting this preserve because of the information provided by this app.
- It could use a function for showing news and events going on in the preserve.
- It would be nice if on the historical section there was some information to go along with the photos.

- As a frequent user of ALP, the app starts to lose its usefulness after a period of time. Currently, I would not recommend this app, and don't find it entirely informative because it lacks new and updated content, like things for the different seasons, or news and events. But if it did, it would be much more useful.

Table 5.1 Response Percentages for Likert Type Questions on App Survey

Question 1	**Approximately how often do you visit Asylum Lake Preserve in a month?**				
	0-1	2-3	4-5	6-7	8 or more
	42%	15%	21%	12%	9%
Question 2	**I am satisfied with the Asylum Lake Preserve app.**				
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
	0%	0%	21%	39%	39%
Question 3	**The Asylum Lake Preserve app is simple to use.**				
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
	0%	3%	9%	45%	42%
Question 4	**The Asylum Lake Preserve app is fun to use.**				
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
	0%	0%	45%	30%	24%
Question 5	**The Asylum Lake Preserve app is user-friendly.**				
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
	0%	3%	9%	55%	33%
Question 6	**The Asylum Lake Preserve app is informative.**				
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
	0%	0%	15%	33%	52%
Question 7	**This app serves its purpose as an interactive guide to Asylum Lake Preserve.**				
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
	0%	6%	15%	42%	36%
Question 8	**How likely are you to recommend this app to people you know?**				
	Very Unlikely	Somewhat Unlikely	Neutral	Somewhat Likely	Very Likely
	3%	3%	9%	33%	52%

Table 5.2 Chi-Square Results for Likert Responses to App Survey (degrees of freedom = 4, critical value = 9.488, 0.05 α level)

	X^2 Statistic	P Value
Question 1	12.063	0.020
Question 2	24.563	<0.001
Question 3	31.125	<0.001
Question 4	25.813	<0.001
Question 5	35.813	<0.001
Question 6	30.813	<0.001
Question 7	21.438	<0.001
Question 8	28.625	<0.001

Interview Results

Before developing the Asylum Lake Preserve app, Mr. Keto, the manager of the preserve, was interviewed to get his initial thoughts on using a mobile app for crowdsourcing management issues, and to determine what components and functions the app should contain in addition to the management issue reporting system. During this first interview, he stated his desire to have several main functions available to users, including: how to get to Asylum Lake Preserve; how to get around once in the preserve; information about the preserve including historical information; a method for showing users the different features within the preserve; the rules and regulations of Asylum Laker Preserve; and contact information. He also discussed the types of management issues he thought were appropriate for reporting with the app, and which ones were not appropriate. Appropriate issues for reporting with the app were trash, vandalism, infrastructure damage, improper use, and trail maintenance, while any sort of emergency or public safety issue was not to be reported with the app.

Furthermore, he requested that the app explicitly state that emergencies and public safety issues should not be reported with the app, but rather they should be reported directly to the police. The reasoning for this explicit warning was to ensure that users did not assume that by reporting an emergency with the app, it would be seen and taken care of immediately, as that would not be the case. During the interview Mr. Keto also expressed his concern that the reporting function of the app might create a

substantial amount of extra work for him and that by not always being able to address issues immediately the users would get a negative impression of the management of Asylum Lake Preserve.

The information gathered from this first informal interview was directly incorporated into the design and development of the app. On the 'Info and Directions' page users can find basic information about the preserve with a link to a historical timeline, contact info, and a button showing the address of the Drake Road Parking Lot that when pressed opens Google Maps directions to the preserve from their current location. The 'Maps' page shows users four different maps containing user information like parking lots and entry points, the trails and their surface type, and various points of interest, such as different types of trees, scattered throughout the area. With the smartphone's GPS function turned on, the user can see their location on the maps and use the trails to get around the preserve. Per the manager's request, the app was originally going to include a routing mechanism along the trails, but due to inaccuracies with the GPS under the forest canopy, it was deemed unsuitable and ultimately left out of the final product. Photos of the preserve can also be found in the app, showing users what they might see when they visit. Finally, in accordance with his ideas, the app contained a page of the basic rules, as well as a link to the complete Declaration of Conservation Restrictions set by the Board of Trustees of Western Michigan University.

Following the data collection period, Mr. Keto was again interviewed, this time to get his opinion on the success of the app in regards to improving management, along

with his opinion on the lack of use and results—a topic noted in the previous sections on the survey and management report results, and explored in more detail in the following discussion section. During this interview, he also gave his general thoughts on the final app product and suggestions for how to improve the app. The first aspect he noticed about the whole process was that it was not as problematic or time-consuming to deal with as he originally thought. A big reason for this of course was the overall lack of issue reports sent in over the course of the data collection period. However, another reason for this is that the reporting system was generally set up in a way that made the issue easier to deal with. Specifically, the fact that the report was sent directly to his email made it easily accessible, and the inclusion of an issue type and details, along with a photo, allowed for better understanding of the issue being reported. Most importantly, by including geographic coordinates of the issue in the report that could be copied from the email into Google Maps or Google Earth, finding the issue within the preserve became quicker and more efficient.

Mr. Keto did, however, suggest a change for one aspect of the reporting system: making it possible for him to communicate with the users, specifically when they report an issue. Currently, including an email address on the issue report is optional, a feature designed to allow user to be anonymous. As mentioned above, the problem this creates for the manager is that it if the user does not include an email, he cannot contact them to discuss the issue. Either he wants to tell them that the issue has been or will be taken care of, or he wants to explain why a particularly will not be, or cannot be fixed. In any

case, the reporting system could be improved by giving him a method for contacting individual users directly or by creating a separate page in the app specifically for listing updates on management issues, informing users on what things have been reported, what has been fixed, what is scheduled to be fixed, and what cannot be fixed.

Mr. Keto also made other suggestions for the app not necessarily related to the issue report system. The main change he would like to see is the addition of a general 'Updates' page showing news and events for Asylum Lake Preserve. The biggest problem he has run into over the years is not being able to adequately inform the public of what is going on at the preserve. He thinks that a news feed in the app would be a great way to get information out to the people who use the preserve. Along the same lines, he would like to see a page for feedback, either separate from, or in conjunction with the report system. What this addition would bring to the table is a method for users to simply communicate with those in charge of the management of Asylum Lake Preserve, whether it is to ask a question or leave a comment. It could also be useful to Mr. Keto to reply back to users, opening a direct line between the two.

Mr. Keto would also like to have the app be more accessible to him and others in charge of Asylum Lake, specifically in regards to keeping the content on the app fresh and up-to-date, as one of the users suggested in the app survey. Currently, the app is hard-coded with content, and would require someone with programming skills to change the content. Altering the app code to enable someone without those skills to make changes to the app, like posting news and events, or updating photos and points

of interest would allow the manager, who knows the most about the preserve, to keep the app current and useful to those people who visit often. Moreover, by making these changes, he thought that the app could be more valuable, and would encourage more people to use the app and people to use the app more. With some improvements, it could become something that the majority of users would want to use each time they visit Asylum Lake Preserve, rather than something they may look at from time to time or only once or twice before finding it not useful anymore.

Mr. Keto's final thoughts on the overall effectiveness of the app and its uses for managing public land were positive. Considering the relatively low use, he thought that an app similar to the one used in this research could still be a valuable tool for any land manager, especially one that manages the land for human use. More to the point, he saw enough potential in the app that he thought it should be expanded upon and applied to the other natural areas managed by Western Michigan University.

CHAPTER 6

CONCLUSIONS AND FUTURE RESEARCH

Based on the results that were obtained, the app was successful to a degree. The survey results show that the nearly all of the respondents gave the app positive reviews, indicating that they liked the app and thought it fulfilled its purpose. Also, while it may not be perfect, the reporting system appears to be useful. The issues reported even brought attention to the deficiencies in the reporting system, and subsequently, components that could be added to make it more effective. On the other hand, another significant finding from the results was the general lack of them. Specifically, the overall app usage was far lower than originally expected. This lack of use can be seen clearly in the low numbers of both issues reported and surveys completed. The next section discusses in detail some of the likely reasons why app usage was low, followed by other reasons why results were lacking and ways to improve use.

Reasons for Low Use

Once it was determined that some form of mobile technology was going to be featured in this research, the first decision to be made was whether a mobile app was going to be used, or a web application accessed through the mobile web browser. After weighing the pros and cons of both types of applications, it was decided that for this research it would be best to create a native application. A native application was chosen specifically to get the most out of the mobile device features and to make sure the app

runs efficiently. In addition, a native app was chosen because mobile apps are now used significantly more than the web browser, and because users perceive mobile apps to be generally better than the web application. However, the immediate consequence of this decision was that either the app would have to be written for multiple operating systems—specifically Android OS and Apple's iOS—or one would be chosen over the other, ultimately cutting out a large portion of the total mobile smartphone market.

Android alone was chosen because there was not sufficient time to learn two mobile operating system development kits and to implement the app on both Android and iOS. This meant, regardless of which mobile operating system was chosen for this research, a significant section of the users was not going to be served and the reach of this study would be limited to one potential set of users. Android was chosen for this research for several reasons. The first reason was because Android represents a higher percentage of global mobile market. The second reason is because Android, owned by Google, has strived to make it possible for anyone, including amateurs, to contribute to the mobile app market, as seen through their open source resources and free and easy-to-learn development tools. Conversely, Apple has certain restrictions, proprietary resources, recurring fees, and requires a review of all new apps that can take several weeks—extra time that would have been hard to come by for this research. Finally, Android was chosen because the researchers involved with this study had access to Android phones, which is a necessity for testing and debugging the app during the development phase. That being said, however, while the decision to choose Android is

not regrettable, there are some reasons why choosing iOS might have been good a choice.

While Android has a much higher percentage of the global mobile market—over 84%—the percentage of smartphone users in the United States that has an Android phone is higher than iPhone users, but not by much (IDC 2014). Android and iPhone owners are nearly equally common within the smartphone owner population as a whole. In the Pew Research Center's 2013 survey, 50% of smartphone owners said they had an Android phone, while 45% said they had an iPhone (Smith 2013). Similarly, Nielsen's survey in 2014 showed 52% of American adults had Android smartphones, compared to 43% with iPhones (Nielsen 2014).

Though many of the demographic categories resembled the whole smartphone owner population, having a larger percentage of people with Android phones, there are certain demographic groupings that show the opposite of the population. For example, most of the age groups have higher percentages of Android users, except the last two age groups (55-64 and 65+), which have higher amounts of iPhone users—49% to 44%, and 61% to 39%, respectively (Smith 2013). Certain groupings on the upper end of the income and education attainment spectrum also have higher percentages of iPhone owners. For education attainment, three of the four groups have more Android users, but the top group (College +), which has the highest percentage of adults with smartphones (70%), has 54% iPhone users, compared to 41% for Android (Smith 2013). Similarly, most of the income groups have more Android users, but the highest income

group ($75,000 +), which has the most adults with smartphones (78%), has 51% of smartphone users with iPhones, as opposed to the 40% for Android (Smith 2013). What this means is that even though most of the demographic groups represent the population and have higher percentages of Android smartphone users, some of the groups show higher iPhone users, and these particular groups also represent the highest percentages of smartphone owners.

Taking into consideration the statistics and demographics of smartphone ownership, it is evident that the final decision should ultimately be based on the demographics of the potential customer base. Furthermore, it is essential to invest a significant portion of the research time to determine which operating system the potential customers are using the most and cater the mobile app to that platform if time permits the use of only one platform. By first studying the demographics that visit Asylum Lake Preserve, and determining which platform is being used more among the users, it is possible that the research would show a higher percentage of visitors having iPhone. If that indeed was the case, by following that research and making the app for iOS instead of Android, there could have been more usage and potentially stronger results for the given data collection time period.

There are other reasons why the app might not have seen much use. Crowdsourcing projects in general can be limited when they are not completely reaching their target population. The point of this particular research was to crowdsource management issue reports with smartphones, but if anyone in the target population—

users of Asylum Lake Preserve—does not have a smartphone, then they are not able to contribute to the study. In their 2013 survey, the Pew Research Center found that over 90% of adults in the United States owned a cellphone of some kind, but only about 56% of these adults owned a smartphone (Smith 2013). Nielsen (2014) found slightly higher numbers of smartphone owners in a 2014 survey, with approximately 71% of Americans eighteen years of age or older.

The two surveys agree that the percentage of American adults who own smartphones is not uniform across age demographics. Specifically, both surveys show that the older age demographics contain much lower percentages. Smith (2013) found that 55% of people between age 45 and 54 have smartphones, 39% of people between age 55 and 64, and only 18% of people over the age of 65, compared to 79%, 81%, and 69% for age groups of 18 to 24, 25 to 34, and 35 to 44, respectively. Again, Nielsen's (2014) numbers are higher, showing 85% (18-24), 86% (25-34), and 81% (35-44), compared to 71% (45-54), 61% (55-64), and 46% (65+); however, the trend of less smartphones owners in the older age demographics is the same. While passing out flyers for the app, the researcher observed that a large proportion of visitors in the preserve consisted of older demographics. This means that age groups with less smartphone owners on average is likely a large proportion of the potential user base, and thus, with the number of smartphone users likely less than expected the overall usage of the app was lower than expected.

Other demographic factors for smartphone ownership that could have played a role in this research are education attainment and household income. In both surveys, the percentage of U.S. adults who own smartphones is drastically different on the opposite ends of the spectrum. Specifically, 70% adults that have gone through college have smartphones, compared to only 36% with less than a high school degree (Smith 2013). Similarly, the high end of the income spectrum, $75,000 or higher, has 78% smartphone users, in contrast to the 43% of adults that have an income of less than $30,000 per year (Smith 2013). So, without knowing the Asylum Lake Preserve visitor demographics, it is possible that the people that visit fall into the lower education and income demographic groups and are less likely to own a smartphone.

Another of the biggest problems with the app related to use is that it was not appropriately marketed. Since a large proportion of the smartphone market was inherently going to be cut out of the research, marketing the app to the available customer base became that much more important. Since this particular app was focused on a local area, it is not realistic to think people would stumble across the app by chance on the Google Play Store. Instead, the app was only going to become popular if it was properly marketed to the people who use the preserve or who might be interested in visiting the preserve from surrounding communities. By the end of the data collection period, approximately 80 people had installed the app. It is highly unlikely that only 80 people with Android phones visit Asylum Lake Preserve, meaning that word on the app was not sufficiently getting around to the users of the preserve. The avenues used to get

the word out about the app for this research included posting flyers at the main entrances to the preserve, passing out flyers throughout the preserve, and posting information via social media. Clearly these methods were not sufficient.

Other Reasons for Lack of Results

Going beyond the general lack of use of the app for reasons such as those mentioned above, like people having iPhones instead of Android phones or no smartphone at all, there is also a lack of results from the people who did actually download and install the app. Approximately 80 people installed the app during the data collection period, but only 33 surveys were completed and only eight management issues reported. This means that even of the people that did install the app, most did not contribute to this research. If these users are not completing the surveys or issues reports, then one of two things is most likely going on: they are either not aware of or cannot figure out how to complete the survey or report an issue; or they are consciously not doing either because they simply are not interested in contributing.

If the users are not finding the survey, or do not understand how to report an issue, then the app is not appropriately designed to facilitate that. Regardless of how easy the developer of the app might think that is to accomplish, a good app needs to be designed to be "idiot-proof." While the reporting system could not be placed in the app in a more convenient way, the survey on the other hand may have suffered due to its location within the app. The link to the survey is currently accessed by backing out of the app, as opposed to hitting the phone's home button. This was done purposely to

catch the user as they back out of the app, and so as not to bombard the user. However, it is apparent now that this may have caused fewer users to notice it or at least pay less attention to the link, although it is important to note that a QR code link to the survey was also on the flyer. As for reporting issues, it is entirely possible that some people are just not interested in reporting issues, or perhaps they are not seeing anything worth reporting while visiting the preserve.

Ways to Increase Use and Results

The most obvious improvement, as discussed in the previous section, would be to create an iOS version of the Asylum Lake Preserve app to go along with the existing Android app, subsequently expanding the customer base greatly. Of course, not everyone has a smartphone, but the vast majority of smartphone owners have either an Android phone or an iPhone. The next improvement to be made is in the marketing of the app, particularly in terms of advertising the app to the surrounding communities. To get people to use the app, people need to first know that it exists, what it has to offer, and how it can be a useful tool for them to have. Since Asylum Lake Preserve is a Western Michigan University property, accessing their resources and normal channels of promotion—campus-wide bulletins, newspaper articles, and information on the website—to get word out to all of the students would have had multiple benefits: getting more use for the app and encouraging students to take advantage of the great resource that WMU has to offer in Asylum Lake Preserve. Spending more time in the

preserve passing out flyers to people could also have helped get people to download the app.

Momentarily ignoring the issues surrounding platform choice and marketing, improvements could also be made to the app itself in order to make the app more useful and to retain users. Currently, there are not many features on the app that would be entirely useful for someone who visits Asylum Lake Preserve frequently and is already familiar with what the preserve offers. As one of the survey comments mentioned, the content can become less interesting and useful after using the app a few times and becoming familiar with what the app is showing. In fact, nearly a quarter of the 80 or so downloads of the app during the data collection period eventually uninstalled the app from their phone, meaning the app was no longer interesting or useful to them.

Making the app more interactive and providing users with updates on what is going on in the preserve, though, could increase the use of the app, especially with frequent users. For example, the app could be more interactive and make users feel more involved in the preserve by creating a method of communication between Mr. Keto and the user, as he had suggested. In addition, having a feed with current news and events might prompt users to check the app more often to see what is going on, and subsequently decide to make a trip to the preserve, as opposed to only using the app while in the preserve. If users do not find the app useful or worthwhile to use on a visit to visit basis, then it simply becomes an issue reporting app that does not get much

use. Increasing the desire for people to use the app and keeping them more in-tune with news and upcoming events will likely also increase the desire for people to report management issues.

As for increasing the survey and issue report results for people who did download the app, certain changes to the app and to the marketing of the app could help. For one, putting the survey link in a more obvious spot on the app would be a great start. Also, for the people who saw the survey link, but were uninterested in taking it, an incentive for taking the survey might have helped increase the number of surveys completed. In terms of management issues, you cannot expect users to report issues if they do not think they are seeing any worth reporting. If they truly are not, then there is nothing that can be done; however, if there really are issues that they do not think are issues, then it might be a matter of educating the users of what types of things to look out for, and reasons why it is important for the ecological health of the preserve to report issues. This sort of thing can be down with the app itself through its content, or by sending out reminders at a specified time interval reminding users of what to look for while in the preserve. It can also be accomplished with signs at the preserve entrances or embedded within the app advertisements.

Final Thoughts and Future Research

After reviewing and analyzing the results, it is clear that there was a considerable limitation to this study due to lack of use stemming from the reasons discussed in the previous sections, namely the fact that the app was only available for Android

smartphones and that the app was perhaps not adequately marketed prior to and during the data collection period. That being said, however, the app and this research as a whole were, to some extent, successful. At the very least, the people who did take the time to fill out the survey liked the app and thought it served its purpose. Beyond that, though, one of the most important things to take away from this research is that the manager of Asylum Lake Preserve, Mr. Steve Keto, also liked the app. Despite some of the challenges that came up throughout the research, he thought that it would be worth the investment to improve and expand upon the app for not only future use at Asylum Lake Preserve, but in the other natural areas managed by Western Michigan University, as well.

Indeed, if done correctly, with appropriate attention paid to development and marketing, an app such as this can be a useful tool for getting information to users and crowdsourcing data collection to assist in the management of Asylum Lake Preserve. However, in order to ensure that it is useful, a few things must be taken into consideration. First, significant time should be dedicated to developing the app, preferably for multiple platforms to maximize the user base. Second, a nearly equal amount of time needs to be dedicated to marketing and distributing the app. Without properly advertising and exposing people to what the app is and what it has to offer, the use of the app and the results will suffer. Specifically in regards to the content of the app, it is also important to make it something worth using. If users do not find the content particularly helpful or interesting, then the app will quickly become unused or

even uninstalled. To do this, the content like the points of interest and photos need to be continuously expanded and update, as well as including information about current news and events. Finally, from the manager's perspective, it is crucial to include a mechanism for communicating with the users, especially with the people who report issues. Not only does this help the manager get specific information out to the users, it can also help make the users feel like they are playing a role in some of the decisions that are being made. By making changes to the app and accomplishing all of these things, a process that is currently underway, it is possible for a mobile app to become an important tool for providing information to users and bettering the preserve through management actions.

This study also has broader implications to other research areas outside of open space management. A main application of this study for future research is in regards to its environmental implications. As discussed in the literature review, there are significant problems related to the lack of access and exposure to the environment, particularly mental and physical health problems. For example, the 'nature deficit disorder' concept hypothesizes that children are spending less time outdoors, resulting in increasing behavioral problems (Louv 2008). By getting both children and adults to interactive with the environment, they will see improvements in concentration and their general well-being (Maller et al 2009). Increased exposure to the environment can also help create an appreciation for nature in people that may not normally care about the

environment, which can then lead to these people putting in an effort to help protect our natural resources (Perlman and Milder 2004).

Where apps like the one used here play a role is by helping to link people to nature, increasing that access and exposure. Creating an app that can act as an interactive guide for some piece of land will give the users valuable information about the land specifically and about the environment in general, thus educating them about what is there, what purpose it serves, and why it is important to help protect these valuable resources. Furthermore, an appropriately designed app can encourage people who would not typically spend their leisure time outside in nature to get out and explore new places. Using app technology to accomplish these things is especially important in this day and age because such a large portion of our population has a smartphone and spends considerable time using the device and its apps.

The app technology used here, specifically the reporting system, also has other possible applications. An example of an application that currently exists that could be the subject of future research would be using an app equipped with a reporting system to crowdsource data collection within in a city like pot holes or infrastructure damage. Another example is using it for observing and reporting the spread of invasive species within a given area, especially since the invasion of these nuisance species into our native landscapes is become increasingly problematic. And as technology continues to progress and the use of smartphones becomes ubiquitous, mobile applications, especially for crowdsourcing, will become all the more important.

BIBLIOGRAPHY

Adams, R.A., Jr., S. Allen, T. Bassett, T. Benson, L. Brown, C. Causey, M. Evans, M. Faurot, C. Ferguson, R. Klein, T. Mau-Crimmins, K. Miller, T. Moss, D. Powless, M. Richards, J. Schmidt, and J. Simoes. "Western Michigan University: Asylum Lake property. Historical uses and land cover, natural features inventory, and habitat enhancement recommendations." Kalamazoo Nature Center. Submitted to Western Michigan University, October 2001 (Revised February 2002); 352 pp.

Albert, D.A. 1995. *Regional landscape ecosystems of Michigan, Minnesota, and Wisconsin: a working map and classification*. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station.

ALPMC (Asylum Lake Policy and Management Council). 2008. Asylum Lake Management Plan. Unpublished document, 70 pp. http://wmich.edu/asylumlake/alpmc/council.html

Alt, F., Shirazi, A.S., Schmidt, A., Kramer, U., and Z. Nawaz. 2010. "Location-based crowdsourcing: extending crowdsourcing to the real world. In *Proceedings of the 6th Nordic Conference on Human-Computer Interaction: Extending Boundaries,* 13-22. ACM.

AppBrain Stats. "Google Play stats." Accessed September 15, 2014. http://www.appbrain.com/stats/stats-index

BarZ Adventures. 2011. "Creole Nature Trail." Accessed November 3, 2013. https://play.google.com/store/apps/details?id=com.barz.tourguide.creolenature trail

Basset, T. and S. Knoll. 2009. *An Ecological Assessment of the Asylum Lake Preserve.* Native Connections. Three Rivers, Michigan.

Becker, R.J. and M.S. Nassaney. 2005. *An Archeological Assessment of the Asylum Lake/Colony Farm Orchard Property in Kalamazoo, Michigan*. not published.

Bichas-Lupas, M. and R.N. Moisey. 2001. "A benefit segmentation of rail-trail users: implications for marketing by local communities." *Journal of Park & Rec Administration,* 19(3): 78-92.

Biggar, J. 2010. "Crowdsourcing for the environment: the case of brighter planet." *Journal of Media and Communication,* 2(2): 8-23.

Bond, C. 2013. “Invasive Species.” Accessed April 30, 2014. https://play.google.com/store/apps/details?id=maine.epscor.invasive_species

Bonney, R., Cooper, C.B., Dickinson, J., Kelling, S., Phillips, T., Rosenberg, K.V., and J. Shirk. 2009. “Citizen science: a developing tool for expanding science knowledge and scientific literacy.” *BioScience*, 59(11): 977-984.

Bugwood. 2013. “What’s Invasive!” Accessed May 1, 2014. https://play.google.com/store/apps/details?id=edu.ucla.cens.whatsinvasive

Butler, M. 2011. “Android: changing the mobile landscape.” *Pervasive Computing, IEEE*, *10*(1): 4-7.

Chatzimilioudis, G., Konstantinidis, A., Laoudias, C., and D. Zeinalipour-Yazti. 2012. “Crowdsourcing with smartphones.” *Internet Computing, IEEE*, 16(5): 36-44.

Cole, D.N. 1993. "Minimizing conflict between recreation and nature conservation." *Ecology of greenways: design and function of linear conservation areas. University of Minnesota Press, Minneapolis, Minnesota, USA*: 105-122.

Cooper, C.B., Dickinson, J., Phillips, T., and R. Bonney. 2007. “Citizen science as a tool for conservation in residential ecosystems.” *Ecology and Society*, 12(2).

Dehlinger, J., and J. Dixon. 2011. "Mobile application software engineering: challenges and research directions." *Workshop on Mobile Software Engineering*, 1-4.

Dorr, J.A. and D.F. Eschman. 1970. *Geology of Michigan*. Ann Arbor, MI: University of Michigan Press.

Driver, B.L., and S.R. Tocher. "Toward a behavioral interpretation of recreational engagements, with implications for planning." *Elements of outdoor recreation planning,* 8: 9-31.

Durant, S. 1993. *History of Kalamazoo County, Michigan*. Salem, MA: Higginson Book Company.

Dynatrace. 2012. “Mobile Apps: What Consumers Really Need and Want.” Accessed May 8, 2014. https://info.dynatrace.com/rs/compuware/images/Mobile_App_Survey_Report.pdf

Eclipse. 2015. “Eclipse Integrated Development Environment.” The Eclipse Foundation. Ottawa, Ontario.

Elwood, S. 2008. “Volunteered geographic information: future research directions motivated by critical, participatory, and feminist GIS.” *GeoJournal*, 72(3-4): 173-183.

Flanagin, A.J., and M.J. Metzger. 2008. “The credibility of volunteered geographic information. *GeoJournal*, 72(3-4): 137-148.

Flurry Analytics. 2014. “Apps Solidify Leadership Six Years into the Mobile Revolution.” Accessed May 8, 2014. http://www.flurry.com/bid/109749/Apps-Solidify-Leadership-Six-Years-into-the-Mobile-Revolution#.VLBVKyvF_Co

Forman, G.H., and J. Zahorjan. 1994. “The challenges of mobile computing.” *Computer,* 27(4): 38-47.

Forman, R.T.T. 2008. “Urban Regions: Ecology and Planning Beyond the City.” Cambridge University Press, Cambridge, UK.

Fraternali, P., Castelletti, A., Soncini-Sessa, R., Vaca Ruiz, C., and A.E. Rizzoli. 2012. “Putting humans in the loop: social computing for water resources management.” *Environmental Modelling & Software*, 37: 68-77.

Gao, H., Barbier, G., and R. Goolsby. 2011. “Harnessing the crowdsourcing power of social media for disaster relief.” *IEEE Intelligent Systems*, 26(3): 10-14.

Gill, A., and D. Bunker. 2012. “Crowd sourcing challenges assessment index for disaster management. *In AMCIS 2012 Proceedings*.

GHCS Software. 2012. “Clinton River Trail Map.” Accessed November 3, 2013. https://play.google.com/store/apps/details?id=com.ghcssoftware.fcrt

Goodchild, M. F. 2004. “GIScience, Geography, Form, and Process.” *Annals of the Association of American Geographers*, 94(4): 709-714.

Goodchild, M.F. 2007. “Citizens as sensors: the world of volunteered geography.” *GeoJournal*, 69: 8-10.

Goodchild, M.F. 2009. “Neogeography and the nature of geographic expertise.” *Journal of Location Based Services,* 3(2): 82-96.

Goodchild, M.F. and J.A. Glennon. 2010. “Crowdsourcing geographic information for disaster response: a research frontier.” *International Journal of Digital Earth*, 3(3): 231-241.

Google. 2015a. “Android Software Developer’s Kit.” Mountain View, CA.

Google. 2015b. “Android Development Tools.” Mountain View, CA.

Google. 2015c. “Google Play Store.” Mountain View, CA.

Haid, E., Kiechle, G., Goll, N. and M. Soutschek. 2008. “Evaluation of a web-based and mobile ski touring application for GPS-enabled smartphones. *Information and communication technologies in tourism 2008,* 313-323.

Halbert, C. 1993. “How adaptive is adaptive management? Implementing adaptive management in Washington State and British Columbia.” *Reviews in Fisheries Science* 1(3): 261-283.

Holzer, A., and J. Ondrus. 2011. “Mobile application market: a developer’s perspective.” *Telematics and Informatics*, 28: 22-31.

Howe, J. 2006. “The Rise of Crowdsourcing.” Wired.com. Retrieved 18 May, 2014 from http://www.wired.com/wired/archive/14.06/crowds.html.

Hsu, Y., Rice, K., and L. Dawley. 2012. “Empowering educators with Google’s Android App Inventor: an online workshop in mobile app design.” *British Journal of Educational Technology*, 43(1): 1-5.

Hunter, C., and H. Green. 1995. “Tourism and the Environment: a Sustainable Relationship?” Routledge, London, England.

IDC. 2014. “Smartphone OS Market Share, Q2 2014.” Accessed October 1, 2014. http://www.idc.com/prodserv/smartphone-os-market-share.jsp

Im, D.K., Yoon, H.R., and J.Y. Lee. 2013. “Development of the walking trail applications on GPS-based smartphone utilizing the local narrative.” *International Journal of Multimedia and Ubiquitous Engineering,* 8(3): 31-40

Kanhere, S.S. 2011. “Participatory sensing: crowdsourcing data from mobile smartphones in urban spaces.” *Mobile Data Management (MDM), 2011 12th IEEE International Conference on,* 2: 3-6.

Karlberg, M. 2011. “Mobile map client API design and implementation for Android.” Master’s thesis, Lund University.

Kenteris, M. and D. Gavalas. 2009. “An innovative mobile electronic tourist guide application.” *Personal and Ubiquitous Computing*, 13: 103-118.

Kropfl, M., Buchmuller, D., and F. Leberl. 2012. "Online maps and cloud-supported location-based services across a manifold of devices." *ISPRS Annals of the Photogrammetry, Remote Sensing and Spatial Information Sciences,* I-4: 151-156.

Louv, R. 2008. *Last child in the woods: Saving our children from nature-deficit disorder.* Algonquin Books.

Lowry, C.S. and M.N. Fienen. 2013. “CrowdHydrology: crowdsourcing hydrologic data and engaging citizen scientists.” *Ground Water*, 51(1): 151-156.

Lucas, R.C. 1983. “The role of regulations in recreation management.” *Western Wildlands,* 9(2): 6-10.

Luymes, D.T., and K. Tamminga. 1995. “Integrating public safety and use into planning urban greenways.” *Landscape and Urban Planning*, 33: 391-400.

Lwin, K.K., and Y. Murayama. 2011. “Web-based GIS system for real-time field data collection using a personal mobile phone.” *Journal of Geographic Information System*, 3: 382-389.

Maller, C., Townsend, M., St Leger, L., Henderson-Wilson, C., Pryor, A., Prosser, L., and M. Moore. 2009. “Healthy Parks, Healthy People: The Health Benefits of Contact with Nature in a Park Context.” *The George Wright Forum,* 26(2): 51-83.

Massie, L.B. 1991. *Report on the Historic Use of the Property Commonly Known as the Kalamazoo State Hospital Colony Farm, the Michigan State University Agricultural Experimental Orchard, and the Lee Baker Farm*. not published.

Maisonneuve, N. Stevens, M. and B. Ochab. 2010. “Participatory noise pollution monitoring using mobile phones.” *Information Polity*, 15(1): 51-71.

Michigan Asylum for the Insane. 1888. *Report of the Board of Trustees of the Michigan Asylum for the Insane for the Years 1887-1888.* Lansing: Thorp & Godfrey, State Printers and Binders.

Microsoft. 2013. “Microsoft Excel.” Redmond, Washington.

NRCS (Natural Resources Conservation Services). 2000. “Soil Survey Geographic Database (SSURGO).” United States Department of Agriculture.

Newman, G., Wiggins, A., Crall, A., Graham, E., Newman, S., and K. Crowston. 2012. “The future of citizen science: emerging technologies and shifting paradigms.” *Frontiers in Ecology and the Environment*, 10(6): 298-304.

Nielsen. 2014. “Mobile Millennials: Over 85% of Generation Y Owns Smartphones.” Accessed December 20, 2014. http://www.nielsen.com/us/en/insights/news/2014/mobile -millennials-over-85-percent-of-generation-y-owns-smartphones.html

Nimodia, C., and H.R. Deskhmukh. 2012. “Android Operating System.” *Software Engineering,* 3(1): 10-13.

Northstar New Media USA. 2013. “Marquette Trails.” Accessed April 30, 2014. https://play.google.com/store/apps/details?id=com.northstarnewmedia.mqttrails

ParksByNature Network LLC. 2014. “Pocket Ranger Apps.” Accessed April 30, 2014. https://play.google.com/store/apps/developer?id=ParksByNature+Network+LLC

Perlman, D.L., and J. Milder. 2004. “Practical Ecology for Planners, Developers, and Citizens.” Island Press, Washington, D.C.

PKC Mobile. 2011. “Otago Rail Trail.” Accessed November 3, 2013. https://play.google.com/store/apps/details?id=nz.co.pkc.maps.ort

SeeClickFix. 2014. “SeeClickFix.” Accessed April 30, 2014. https://play.google.com/store/apps/details?id=com.seeclickfix.ma.android

Siderelis, C. and R. Moore. 1995. “Outdoor recreation net benefits of rail-trails.” *Journal of Leisure Research*, 27(4): 344-359.

Smith, A. 2013. “Smartphone Ownership – 2013 Update.” Pew Research Center.

Stevens, M. and E. D’Hondt. 2010. “Crowdsourcing of pollution data using smartphones.” *Workshop on Ubiquitous Crowdsourcing*.

State of Michigan. 1887. *Deed for the transfer of land. Neil Heindes (by heirs) the State of Michigan*.

Sternloff, R.E., and R. Warren. 1993. “Park and Recreation Maintenance Management.” Publishing Horizons, Inc., Scottsdale, Arizona.

TrailMapps.com. 2014. “Whitehorse Trail Guide.” Accessed April 30, 2014. https://play.google.com/store/apps/details?id=air.com.trailmapps.AND.whitehorse

Tribe, J., Font, X., Griffiths, N., Vickery, R., and K. Yale. 2000. “Environmental Management for Rural Tourism and Recreation.” Cassell, London, England.

Welbourne, E., Wu, P. Bao, X., and E. Munguia-Tapia. 2014. “Crowdsourced mobile data collection: lessons learned from a new study methodology.” In *Proceedings of the 15th Workshop on Mobile Computing Systems and Applications*, ACM, 2.

Western Michigan University Board of Trustees. 2004. “Declaration of Conservation Restrictions.” Kalamazoo, Michigan.

Wiggins, A., and K. Crowston. 2011. “From conservation to crowdsourcing: a typology of citizen science.” *Systems Sciences (HICSS), 2011 44th Hawaii International Conference on,* 1-10.

Xu, J.H., Nie, G.Z., and X. Xu. 2013. “A digital social network for rapid collection of earthquake disaster information.” *Natural Hazards and Earth System Sciences,* 13: 385-394.

Young, R.F. 2010. “Managing municipal green space for ecosystem services.” *Urban Forestry & Urban Greening,* 9: 313-321.

Zibuschka, J., Rannenberg, K., and T. Kolsch. 2011. “Location-based services.” *Digital privacy.* Springer Berlin Hiedelberg: 679-695.

APPENDIX A

DETAILS OF MOBILE APPLICATION

Splash Screen and Main Menu

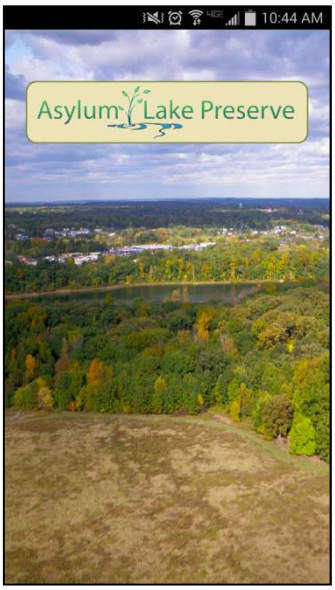

Figure A-1. Splash screen – opens when app is loading

Figure A-2. Main menu – contains seven options

Info and Directions

Figure A-3. Button for directions to ALP and contact information

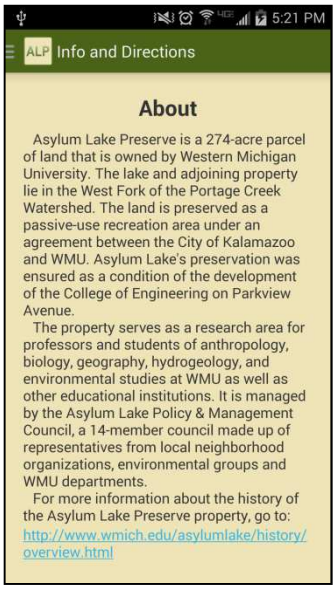

Figure A-4. About the preserve and link to ALP history

Maps

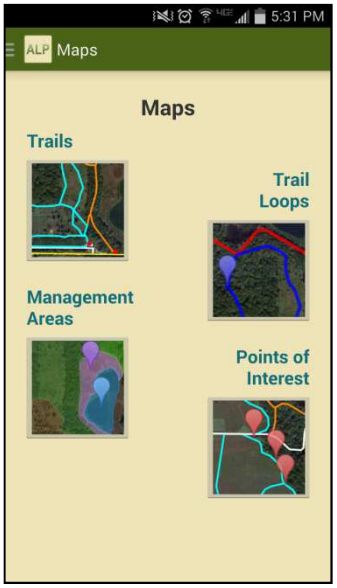

Figure A-5. Maps menu

Figure A-6. Trails map, no legend

Figure A-7. Trails map with legend

Figure A-8. Trail Loops map with legend

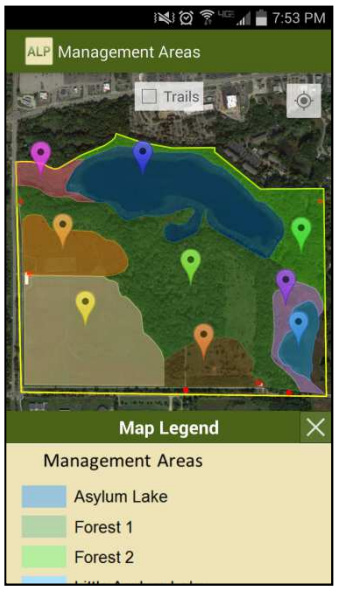

Figure A-9. Management Areas map with legend

Figure A-10. Points of Interest map

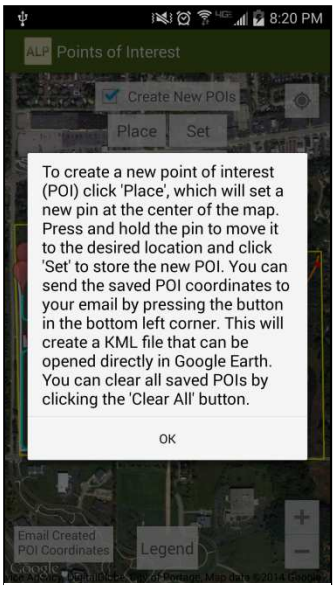

Figure A-11. 'Create New POIs' instructions dialog

Figure A-12. Points of Interest map with user-created POIs

Points of Interest

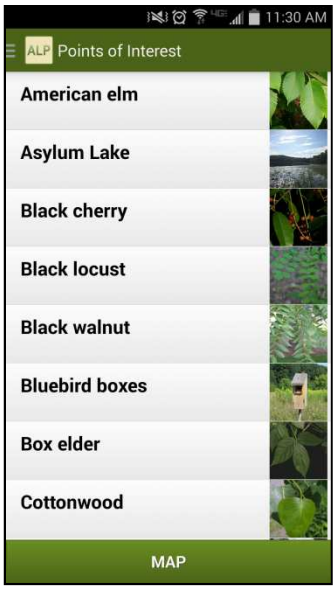

Figure A-13. Points of Interest list part 1

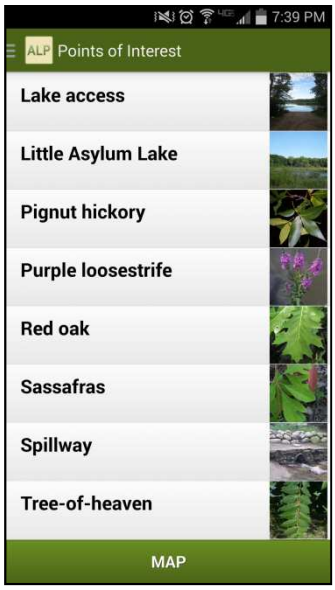

Figure A-14. Points of Interest list part 2

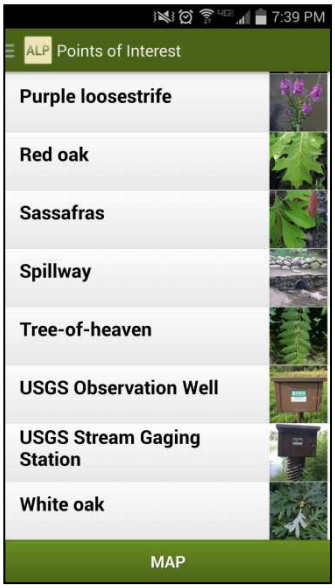

Figure A-15. Points of Interest list part 3

Figure A-16. Example point of interest text part 1

Figure A-17. Example point of interest text part 2

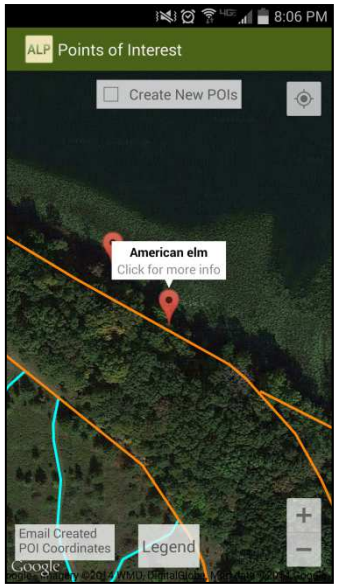

Figure A-18. Example point of interest shown on map

Photos

Figure A-19. Photos menu

Figure A-20. Spring photos list

Figure A-21. Summer photos list

Figure A-22. Fall photos list

Figure A-23. Winter photos list

Figure A-24. State Hospital Cottage photos list

Report an Issue

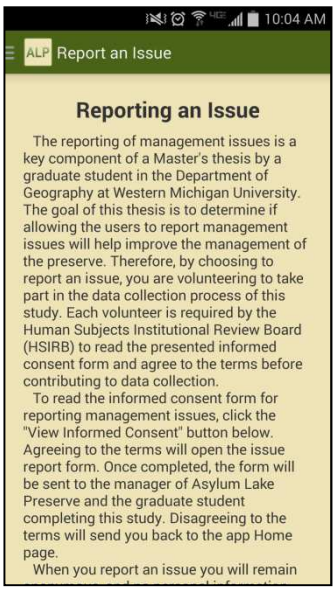

Figure A-25. Reporting an issue information part 1

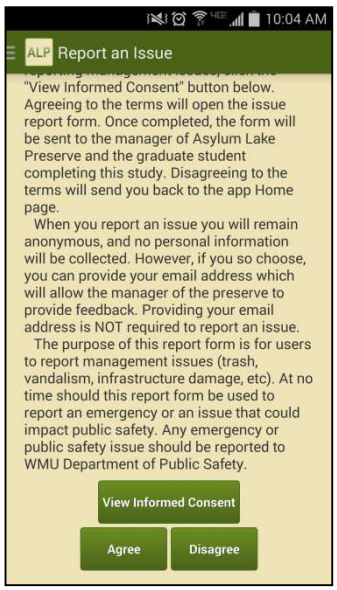

Figure A-26. Reporting an issue information part 2

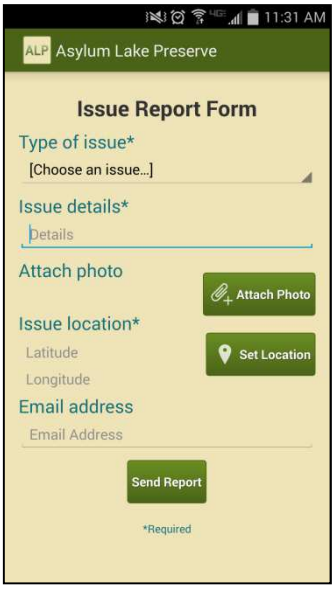

Figure A-27. Issue Report Form blank

Figure A-28. Issue Report Form type of issue list

Figure A-29. Issue Report Form issue location

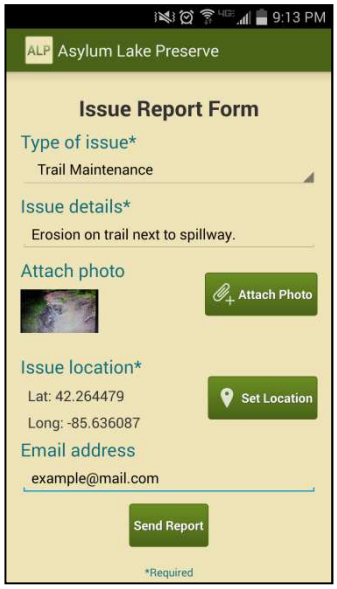

Figure A-30. Issue Report Form complete

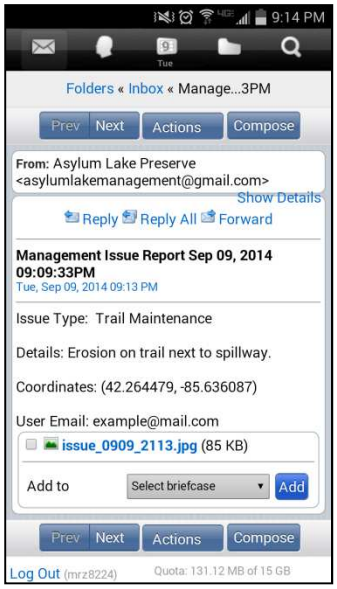

Figure A-31. Issue Report sent

Rules and Regulations

Figure A-32. ALP Rules and Regulations

Social Media

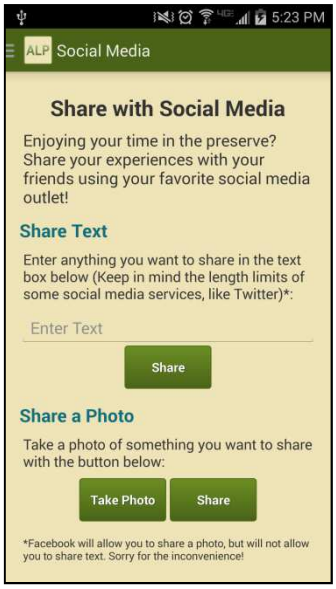

Figure A-33. Sharing text and photos with social media

APPENDIX B

HUMAN SUBJECTS INSTITUTIONAL REVIEW BOARD

HSIRB Approval Letter

WESTERN MICHIGAN UNIVERSITY

Human Subjects Institutional Review Board

Date: May 15, 2014

To: David Lemberg, Principal Investigator
Alexander Ebenstein, Student Investigator for thesis

From: Amy Naugle, Ph.D., Chair Amy Naugle

Re: HSIRB Project Number 14-05-14

This letter will serve as confirmation that your research project titled "Using an Interactive Mobile Application to Crowdsource Management Issues in the Asylum Lake Preserve, Kalamazoo, MI" has been **approved** under the **exempt** category of review by the Human Subjects Institutional Review Board. The conditions and duration of this approval are specified in the Policies of Western Michigan University. You may now begin to implement the research as described in the application.

Please note: This research may **only** be conducted exactly in the form it was approved. You must seek specific board approval for any changes in this project (e.g., ***you must request a post approval change to enroll subjects beyond the number stated in your application under "Number of subjects you want to complete the study***)." Failure to obtain approval for changes will result in a protocol deviation. In addition, if there are any unanticipated adverse reactions or unanticipated events associated with the conduct of this research, you should immediately suspend the project and contact the Chair of the HSIRB for consultation.

Reapproval of the project is required if it extends beyond the termination date stated below.

The Board wishes you success in the pursuit of your research goals.

Approval Termination: May 14, 2015

251 W. Walwood Hall, Kalamazoo, MI 49008-5456
PHONE: (269) 387-8293 FAX: (269) 387-8276

Interview Informed Consent

Western Michigan University
Department of Geography

Principal Investigator:	David Lemberg, Ph. D.
Student Investigator:	Alexander Ebenstein
Title of Study:	Using an Interactive Mobile Application to Crowdsource Management Issues in the Asylum Lake Preserve, Kalamazoo, MI

You have been invited to participate in a research project titled "Using an Interactive Mobile Application to Crowdsource Management Issues in the Asylum Lake Preserve, Kalamazoo, MI." This project will serve as Alexander Ebenstein's thesis for the requirements of the Masters of Arts in Geography. This consent document will explain the purpose of this research project and will go over all of the time commitments, the procedures used in the study, and the risks and benefits of participating in this research project. Please read this consent form carefully and completely and please ask any questions if you need more clarification.

What are we trying to find out in this study?
The purpose of this study is to determine if crowdsourcing management issues to the public for Asylum Lake Preserve by using a smartphone app can help improve management of the preserve.

Who can participate in this study?
To participate in this study, you must have some involvement with the use and management of Asylum Lake Preserve.

What is the time commitment for participating in this study?
The time commitment for participating in this study is approximately 15-20 minutes.

What will you be asked to do if you choose to participate in this study?
If you choose to participate in this study you will be asked to discuss the smartphone app developed and used for this project as it relates to the management of Asylum Lake Preserve.

What information is being measured during the study?
The information collected during this study consists of opinions related to the smartphone app developed and used in this study in terms of the management of Asylum Lake Preserve.

What are the risks of participating in this study and how will these risks be minimized?
There are no known risks involved with participating in this study.

What are the benefits of participating in this study?
By participating in the study, you will be contributing to the management process for Asylum Lake Preserve that directly relates to the experiences of you, the user of the preserve.

Are there any costs associated with participating in this study?
There are no costs associated with participating in this study other than a commitment of time.

Is there any compensation for participating in this study?
There is no compensation for participating in this study.

Who will have access to the information collected during this study?
The information collected during this study will be accessible to the investigators of this study. The information at a conference, but the identity of the participant will remain anonymous.

What if you want to stop participating in this study?
You can choose to stop participating in the study at anytime for any reason. You will not suffer any prejudice or penalty by your decision to stop your participation. You will experience NO consequences either academically or personally if you choose to withdraw from this study.

The investigator can also decide to stop your participation in the study without your consent.

Should you have any questions prior to or during the study, you can contact the primary investigator, Dr. David Lemberg, at 269-387-3408 or david.lemberg@wmich.edu, or the student investigator Alexander Ebenstein, at 616-560-3534 or alexander.j.ebenstein@wmich.edu. You may also contact the Chair, Human Subjects Institutional Review Board at 269-387-8293 or the Vice President for Research at 269-387-8298 if questions arise during the course of the study.

This consent document has been approved for use for one year by the Human Subjects Institutional Review Board (HSIRB) as indicated by the stamped date and signature of the board chair in the upper right corner. Do not participate in this study if the stamped date is older than one year.

I have read this informed consent document. The risks and benefits have been explained to me. I agree to take part in this study.

_____

Please Print Your Name

_____ _____

Participant's signature Date

Survey Informed Consent

Western Michigan University
Department of Geography

Principal Investigator:	David Lemberg, Ph. D.
Student Investigator:	Alexander Ebenstein
Title of Study:	Using an Interactive Mobile Application to Crowdsource Management Issues in the Asylum Lake Preserve, Kalamazoo, MI

You have been invited to participate in a research project titled "Using an Interactive Mobile Application to Crowdsource Management Issues in the Asylum Lake Preserve, Kalamazoo, MI." This project will serve as Alexander Ebenstein's thesis for the requirements of the Masters of Arts in Geography. This consent document will explain the purpose of this research project and will go over all of the time commitments, the procedures used in the study, and the risks and benefits of participating in this research project. Please read this consent form carefully and completely and please ask any questions if you need more clarification.

What are we trying to find out in this study?
The purpose of this study is to determine if crowdsourcing management issues to the public for Asylum Lake Preserve by using a smartphone app can help improve management of the preserve.

Who can participate in this study?
To participate in this study, you must have used the mobile guide app for Asylum Lake Preserve.

What is the time commitment for participating in this study?
The time commitment for taking this survey is approximately 5 minutes.

What will you be asked to do if you choose to participate and take the survey?
If you choose to take this survey you will be asked to answer 5 questions related to the usability of the mobile app.

What information is being measured during the study?
The information collected during this study consists of opinions related to the smartphone app developed and used in this study in terms of its usability.

What are the risks of participating in this study and how will these risks be minimized?
There are no known risks involved with participating in this study.

What are the benefits of participating in this study by taking this survey?
By participating in the study, you will help to make the mobile app for Asylum Lake Preserve better, which directly relates to the experiences of you, the user of the preserve.

Are there any costs associated with participating in this study?
There are no costs associated with participating in this study other than a commitment of time.

Is there any compensation for participating in this study?
There is no compensation for participating in this study.

Who will have access to the information collected during this study?
The information collected during this study will be accessible to the investigators of this study. The information at a conference, but the identity of the participant will remain anonymous.

What if you want to stop participating in this study?
You can choose to stop participating in the study at anytime for any reason. You will not suffer any prejudice or penalty by your decision to stop your participation. You will experience NO consequences either academically or personally if you choose to withdraw from this study.

The investigator can also decide to stop your participation in the study without your consent.

Should you have any questions prior to or during the study, you can contact the primary investigator, Dr. David Lemberg, at 269-387-3408 or david.lemberg@wmich.edu, or the student investigator Alexander Ebenstein, at 616-560-3534 or alexander.j.ebenstein@wmich.edu. You may also contact the Chair, Human Subjects Institutional Review Board at 269-387-8293 or the Vice President for Research at 269-387-8298 if questions arise during the course of the study.

This consent has been approved by the Western Michigan University Human Subjects Institutional Review Board (HSIRB) on "date"
Do not participate after "date" (The end date cannot be more than one year from the approval date).

ELECTRONIC CONSENT: Please select your choice below.

Clicking on the "agree" button below indicates that:

- you have ready the above information
- you voluntarily agree to participate
- you are at least 18 years of age

If you do not wish to participate in the research study, please decline participation by clicking on the "disagree" button.

Management Issue Report Informed Consent

Western Michigan University
Department of Geography

Principal Investigator: David Lemberg, Ph. D.
Student Investigator: Alexander Ebenstein
Title of Study: Using an Interactive Mobile Application to Crowdsource Management Issues in the Asylum Lake Preserve, Kalamazoo, MI

You have been invited to participate in a research project titled "Using an Interactive Mobile Application to Crowdsource Management Issues in the Asylum Lake Preserve, Kalamazoo, MI." This project will serve as Alexander Ebenstein's thesis for the requirements of the Masters of Arts in Geography. This consent document will explain the purpose of this research project and will go over all of the time commitments, the procedures used in the study, and the risks and benefits of participating in this research project. Please read this consent form carefully and completely and please ask any questions if you need more clarification.

What are we trying to find out in this study?
The purpose of this study is to determine if crowdsourcing management issues to the public for Asylum Lake Preserve by using a smartphone app can help improve management of the preserve.

Who can participate in this study?
To participate in this study, you must have a management issue to report.

What is the time commitment for participating in this study?
The time commitment for filling out a management issue report is approximately 5 minutes.

What will you be asked to do if you choose to participate and take the survey?
If you choose to participate you are asked to fill out the issue report form to report a management issue.

What information is being measured during the study?
The information collected during this study consists of management issue reports.

What are the risks of participating in this study and how will these risks be minimized?
There are no known risks involved with participating in this study.

What are the benefits of participating in this study by taking this survey?
By participating in the study, you will be contributing to the management process for Asylum Lake Preserve that directly relates to the experiences of you, the user of the preserve.

Are there any costs associated with participating in this study?
There are no costs associated with participating in this study other than a commitment of time.

Is there any compensation for participating in this study?
There is no compensation for participating in this study.

Who will have access to the information collected during this study?
The information collected during this study will be accessible to the investigators of this study. The information at a conference, but the identity of the participant will remain anonymous.

What if you want to stop participating in this study?
You can choose to stop participating in the study at anytime for any reason. You will not suffer any prejudice or penalty by your decision to stop your participation. You will experience NO consequences either academically or personally if you choose to withdraw from this study.

The investigator can also decide to stop your participation in the study without your consent.

Should you have any questions prior to or during the study, you can contact the primary investigator, Dr. David Lemberg, at 269-387-3408 or david.lemberg@wmich.edu, or the student investigator Alexander Ebenstein, at 616-560-3534 or alexander.j.ebenstein@wmich.edu. You may also contact the Chair, Human Subjects Institutional Review Board at 269-387-8293 or the Vice President for Research at 269-387-8298 if questions arise during the course of the study.

This consent has been approved by the Western Michigan University Human Subjects Institutional Review Board (HSIRB) on "date"
Do not participate after "date" (The end date cannot be more than one year from the approval date).

ELECTRONIC CONSENT: Please select your choice below.

Clicking on the "agree" button below indicates that:

- you have ready the above information
- you voluntarily agree to participate
- you are at least 18 years of age

If you do not wish to participate in the research study, please decline participation by clicking on the "disagree" button.

APPENDIX C

APP RECRUITMENT FLYER

Finally…a smartphone app for your favorite preserve! *Currently only available for Android

Asylum Lake Preserve

User information and trail maps are now at your fingertips! This app also includes various points of interest showing the locations of cool and interesting features found within the preserve.

Notice a management issue? Use this app to report the issue anonymously. All reports will be accessible to the managers of the preserve.

After using the app, please consider taking the app survey on SurveyMonkey to share your experience using the app. You can access the survey with the QR code to the right or from the app itself. Thanks!

Download the app on Google Play!

ANDROID APP ON Google play

APPENDIX D

SURVEY INSTRUMENT

Survey

Asylum Lake Preserve Survey

1. Approximately how often do you visit Asylum Lake Preserve in a month?

   0-1 2-3 4-5 6-7 8 or more

2. I am satisfied with the Asylum Lake Preserve app.

   Strongly disagree Disagree Neither disagree nor agree Agree Strongly agree

3. The Asylum Lake Preserve app is simple to use.

   Strongly disagree Disagree Neither disagree nor agree Agree Strongly agree

4. The Asylum Lake Preserve app is fun to use.

   Strongly disagree Disagree Neither disagree nor agree Agree Strongly agree

5. The Asylum Lake Preserve app is user-friendly.

   Strongly disagree Disagree Neither disagree nor agree Agree Strongly agree

6. The Asylum Lake Preserve app is informative.

   Strongly disagree Disagree Neither disagree nor agree Agree Strongly agree

7. This app serves its purpose as an interactive guide to Asylum Lake Preserve.

   Strongly disagree Disagree Neither disagree nor agree Agree Strongly agree

8. How likely are you to recommend this app to people you know?

   Very unlikely Somewhat unlikely Neither likely nor unlikely Somewhat likely Very likely

9. Do you have any additional comments about the usability and/or content of the Asylum Lake Preserve app?

   _____

Survey Monkey Permission to Conduct Research

SurveyMonkey

February 21, 2014

SurveyMonkey Inc.
www.surveymonkey.com

For questions, email:
support@surveymonkey.com

Re: Permission to Conduct Research Using SurveyMonkey

To whom it may concern:

This letter is being produced in response to a request by a student at your institution who wishes to conduct a survey using SurveyMonkey in order to support their research. The student has indicated that they require a letter from SurveyMonkey granting them permission to do this. Please accept this letter as evidence of such permission. Students are permitted to conduct research via the SurveyMonkey platform provided that they abide by our Terms of Use, a copy of which is available on our website.

SurveyMonkey is a self-serve survey platform on which our users can, by themselves, create, deploy and analyze surveys through an online interface. We have users in many different industries who use surveys for many different purposes. One of our most common use cases is students and other types of researchers using our online tools to conduct academic research.

If you have any questions about this letter, please contact us at the email address above.

Sincerely,

SurveyMonkey Inc.

285 Hamilton Avenue, Suite 500, Palo Alto, CA 94301 | O: 650.543.8400 | F: 650.289.0335
111 SW 5th Ave, Suite 1600, Portland, OR 97204 | O:503.225.1202 | F: 503.225.1200