CONSERVATION AND MANANGEMENT PLANNING FOR THE LIVINGSTON LAND CONSERVANCY

by

Julie Beth McLaughlin

A practicum submitted
in partial fulfillment of the requirements
for the degree of
Master of Science
(Natural Resources and Environment)
at the University of Michigan
April 2015

Faculty advisor:
Professor Ines Ibañez

ABSTRACT
The Livingston Land Conservancy (LLC) is a volunteer-run non-profit based in Brighton, Michigan. Formed in 1995, the Conservancy now protects 612 acres of land in Livingston County through a combination of nature preserves and conservation easements. The Conservancy has a long-term goal to obtain Land Trust Accreditation through the demonstration of certain practices. This Practicum was developed to address two related practices: management planning for natural areas, and selection of lands for conservation.

I combined field surveys and GIS data to inventory each property, followed by a written management plan, which recommends specific goals, targets, and methods based on theories of forest ecology, wetland ecology, and ecological restoration. In order to address the need for a decision-making tool for conservation, I used a GIS-based multi-criteria evaluation method to identify the properties with the highest conservation value. This tool can be adapted for changes in values or as more data becomes available. Both the management plans and the evaluation method demonstrate the efficiency and adaptability of using remotely sensed data in order to make conservation decisions.

ACKNOWLEDGEMENTS

I would like to acknowledge the following members of the conservation community, who provided me with inspiration, critique and support: first and foremost my client, the Livingston Land Conservancy, and my Practicum/lab/faculty advisor Ines Ibañez. Thank you to the University of Michigan School of Natural Resources faculty in the Conservation Ecology and Environmental Informatics tracks, and the Dirty Oaks lab.

Special thanks to my parents, Esther and Martin, for their writing genes and lifelong encouragement.

Funding was provided by the University of Michigan School of Natural Resources.

TABLE OF CONTENTS

Chapter 1
Introduction

The natural features of southeast Michigan were shaped by the most recent glacial retreat during the Pleistocene era (c. 15,000 years ago). The receding of glaciers created the unique topographic conditions in a given region, such as the interlobate area that runs through the middle of Livingston County (Figure 1.1)(Farrand 1998). These topographic differences in slope, elevation, aspect, and soil drainage have been the driving force (along with soil texture and episodic disturbances) in determining plant community distributions. However, in the past two centuries, human practices have taken over as the main driver of ecological change (Rosa et al 2004). Due to intensive logging in the 19th century to fire suppression and rapid development in the 20th, the current state of natural areas can only be linked to presettlement conditions by examining historical documents or using traditional ecological knowledge. For example, the General Land Office Surveys from 1816-1856 have been used to map 200 years of land cover change in Michigan (Figure 1.2)(MNFI 1997).

Figure 1.1 Location of Livingston County, Michigan (https://www.livgov.com).

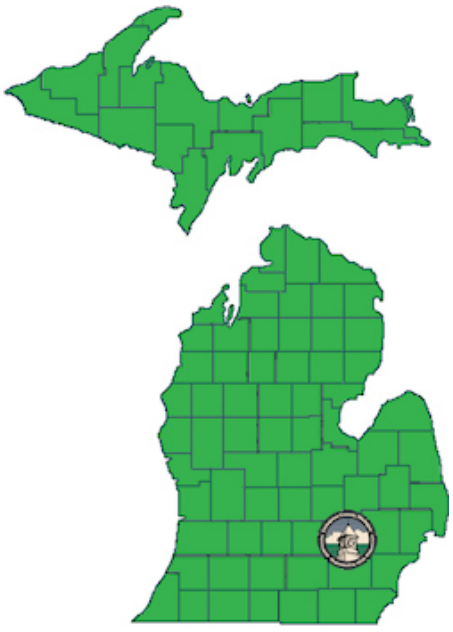
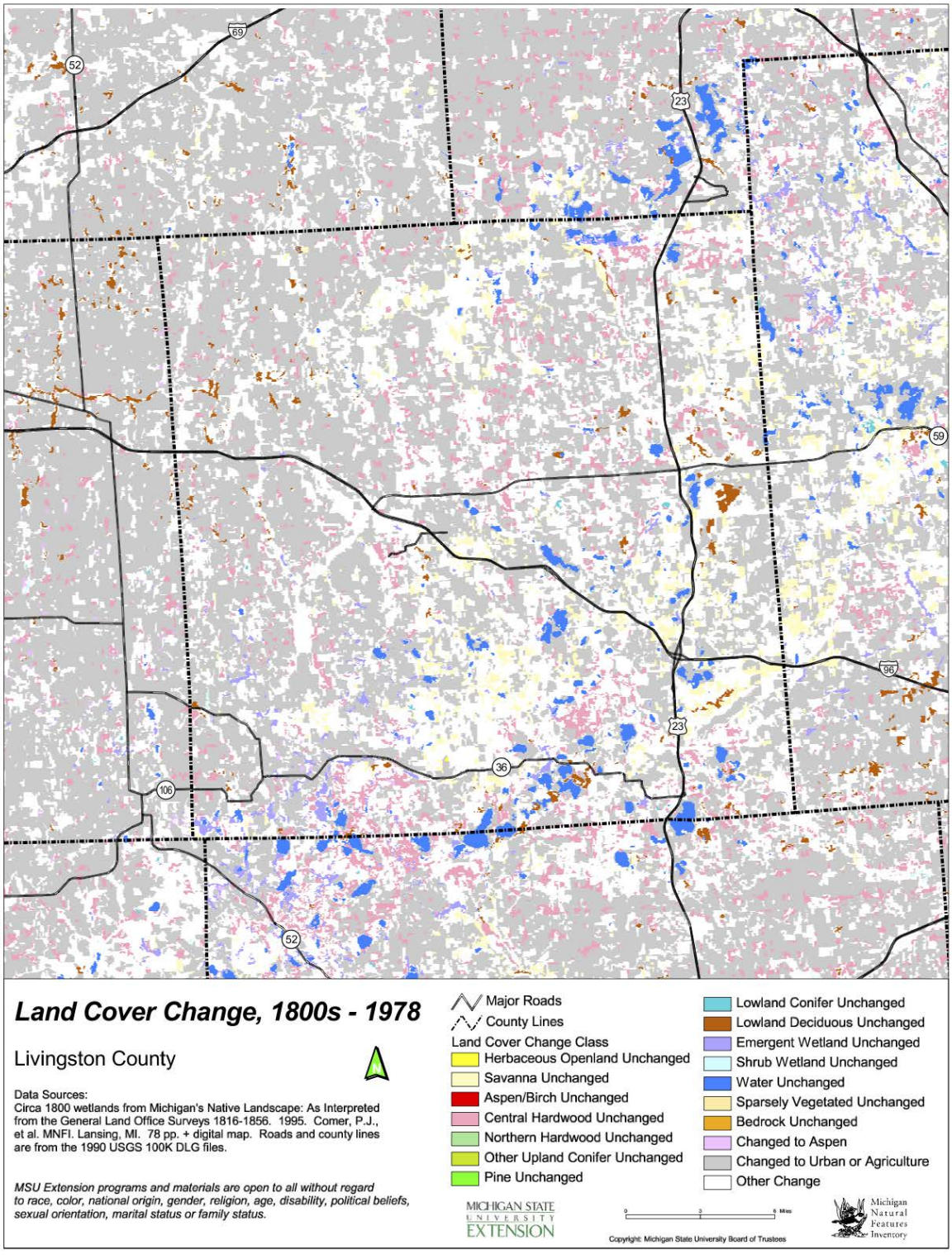
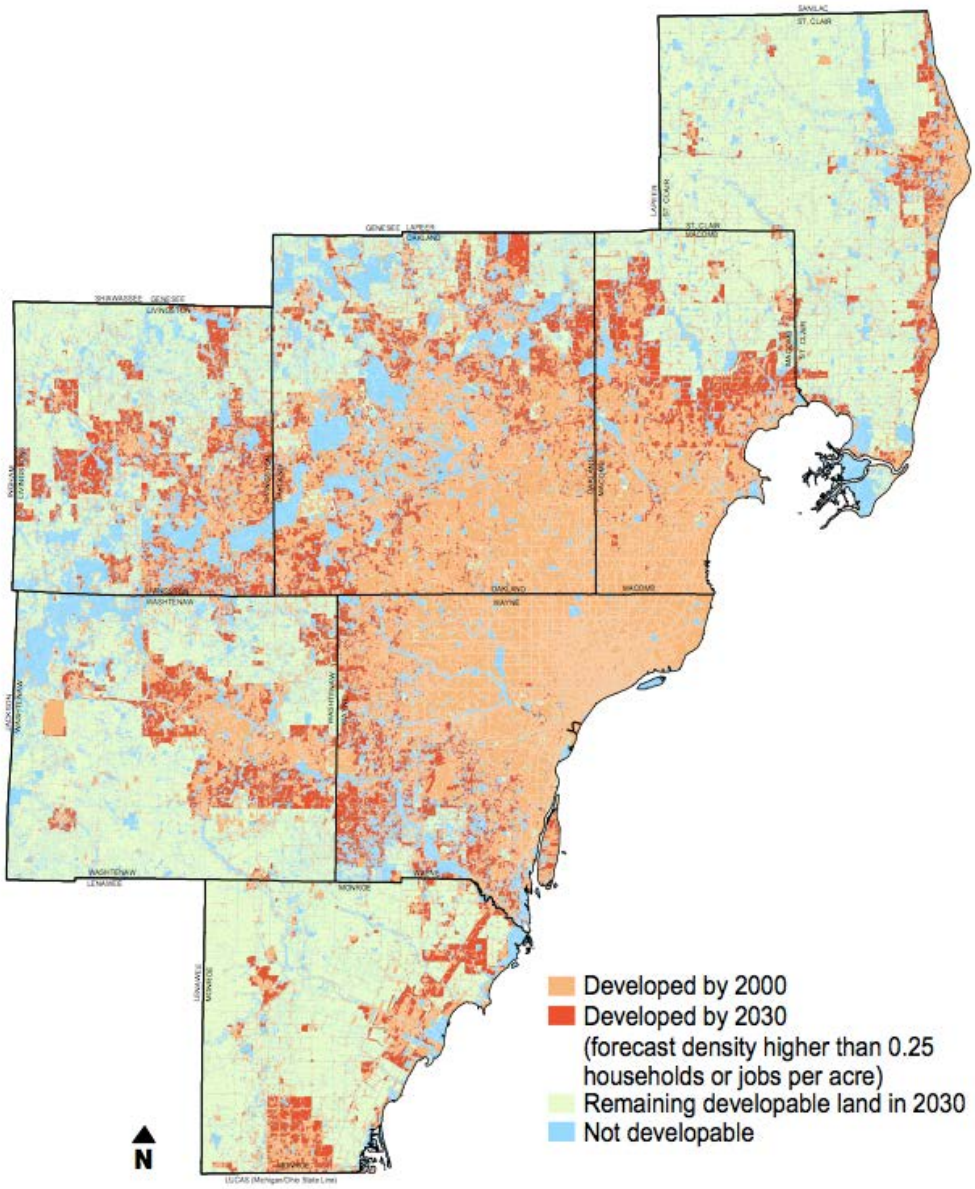


Figure 1.2. Land Cover Change in Livingston County (MNFI).



The shift of development from urban to suburban and rural areas has affected southeast Michigan (Figure 1.3), particularly in areas such as Livingston County, which had the fastest growing population in the state of Michigan from 1990-2000, with a growth rate of 50% (Vogt and Marans 2004). Despite countywide growth slowing to15.3% between 2000-2010, the top three townships continue to have rates of growth above 30% (U.S. Census Bureau 2010).

Figure 1.3. Current and Predicted Developed Areas in Southeast Michigan (SEMCOG).



Source: SEMCOG

The Livingston Land Conservancy (LLC) is a non-profit, volunteer-run land conservancy headquartered in Brighton, MI, formed in 1995 in response to this increasing development. Their mission is to "protect the natural heritage and rural character of the greater Livingston County Area," and they current have 612 acres of land protected through a combination of nature preserves and conservation easements. The Conservancy is passionate about increasing the amount of protected land, as well as transitioning to accredited professional organization in the next 3-5 years. Accreditation is done by applying to the Land Trust Accreditastion Commission, an independent program of the Land Trust Alliance. Becoming accredited will create more opportunities for LLC, such as increased public exposure and funding options. The process of Accreditation is lengthy and intensive, and on average takes 1-2 years of full-time dedication to this goal. The application consists of 12 Indicator Practices, of which I chose two to focus on: Practice 8B, Project Selection and Criteria, and Practice 12C, Management Plans.

This Practicum was developed to address two related issues: the current status of nature preserves, and the future opportunities for land purchases.
My main research questions are:
1. What are the current threats to biodiversity affecting these properties, and what restoration measures should be enacted?
2. How can GIS be used to determine conservation priorities?

METHODS

In February of 2014 I first met with four members of the LLC Board of Directors. Their original project proposal described processes and skill sets with which I was proficient, for example to develop stewardship of existing/future properties, to expand and update GIS mapping efforts, and prioritize high quality lands for future protection (SNRE 2014).

After learning about LLC's desire to achieve accreditation, I researched the steps of the process (LTA site), including the 12 Indicator Practices. I found the Practices that best fit with my project and deliverable ideas, and wrote a project proposal to pursue a Practicum with LLC as my client. I presented this interim proposal to one board member who would serve as my liaison, Brian Hartmann.

In March 2014 I attended my first board meeting, and the board approved my proposal. I developed a timeline and detailed my deliverables. I then visited the office of the Conservation Chair, Sara Thomas, in order to browse through current data, plans, and supplies. Ms. Thomas suggested sites that I could update and develop management plans for. Based on these suggestions, I received copies of the relevant data and conducted field surveys in April, June and August 2014. I wrote a draft management plan, which was approved by the board, and used this format to complete another plan (chapter 1).

Throughout winter 2014-2015 I focused on using remotely sensed GIS data in order to analyze current sites as well as develop the Multi-Criteria Evaluation process (chapter 2). The MCE idea was proposed to the board and approved. I then used this process in order to rank conservation potential for sites throughout Livingston County, based on a

weighted combination of criteria that the board had chosen as the most important for their conservation purposes.

Chapter 2
Natural Areas Inventory and Management Planning

ABSTRACT

The Livingston Land Conservancy (LLC) is a volunteer-run non-profit based in Brighton, Michigan. Formed in 1995, the Conservancy now protects 612 acres of land in Livingston County through a combination of nature preserves and conservation easements. The Conservancy has a long-term goal to obtain Accreditation through the Land Trust Accreditation Commission, a partner of the Land Trust Alliance. For the fulfillment of Indicator Practice 12C, Land Management, my goal was to update current management plans, create a new management plan, and develop a framework for surveying newly acquired properties. This required conducting field surveys to inventory each property, followed by a written management plan, which recommends specific goals, targets, and methods based on theories of forest ecology, wetland ecology, and ecological restoration.

INTRODUCTION

The Livingston Land Conservancy (LLC) is a volunteer-run non-profit based in Brighton, Michigan with the mission to "protect the natural heritage and rural character of the Greater Livingston County Area." Formed in 1995, the Conservancy now protects 612 acres of land through a combination of nature preserves and conservation easements.

The Conservancy has a long-term goal to obtain Accreditation through the Land Trust Accreditation Commission, a partner of the Land Trust Alliance. In preparing the application, a conservancy must document a group of practices, referred to as the 12 Indicator Practices. This chapter focuses on the development of management plans in order to meet requirement 12C, Land Management, which states:

> *"The land trust inventories the natural and cultural features of each property prior to developing a management plan that identifies its conservation goals for the property and how it plans to achieve them…. The organization has a written land management plan for each property it holds in fee."* (Land Trust Alliance 2004)

As discussed in Chapter 1, the landscape in Livingston County has undergone drastic changes due to development, primarily turning natural areas into residential or agricultural zones. In order to get a complete picture of these areas, it can be helpful to determine the pre-settlement and recent past conditions of the site. By comparing the current status of the preserve to its historic condition, one can map the ways in which the ecosystem has changed trajectories, and make predictions about its future conditions. The management approach taken in these plans is based on the idea of planning an ideal trajectory for the current system, and this ideal is based on research into historic site conditions.

The attempt to restore a site to an ideal reference or historic version is the primary focus of ecological restoration. The Society for Ecological Restoration International defines ecological restoration as "the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed" (SER 2002). Choosing the goal for a site is somewhat subjective, and is usually based on the particular values of the decision-makers, a cost/benefit analysis, and knowledge of ecological principles. One ideal goal of a restored ecosystem is that it is resilient - able to return to a previous trajectory following a disturbance. Restoration may involve the removal of an antagonist and allowing for natural recovery over time. More often, restoration is practiced on ecosystems that may not be able to recover naturally, and thus require intervention and maintenance (Suding 2011).

As a relatively new field, ecological restoration can be thought of as a science-based practical application. This means that restoration plans should include: 1) explicitly stated goals, 2) a design informed by ecological knowledge, and 3) quantitative assessment of system responses via data collection, and 4) adaptation to results in order to make further decisions (Palmer 2006).

The practice of ecological restoration allows us to both contribute to the scientific theory, and to deal with local issues through an understanding of the broader theoretical context. As our knowledge of ecosystem processes and functions changes, so must the practices we implement within the ecosystems we wish to conserve. Where restoration projects have often failed is in not including criteria for success, and not having a method for quantitative monitoring (Suding 2011). Successful management and restoration relies on post-restoration evaluation, monitoring, and if necessary, adaptation.

METHODS

First I conducted a literature review of journal articles and books related to two of my main operating concepts: management planning and restoration ecology. I searched for these phrases within the University of Michigan Library Articles Plus database and Google Scholar. I also read through the Land Trust Accreditation Commission Applicant Handbook, Requirements Manual, and Standards and Practices. These documents outline the process for developing management plans under Practice 12C: Land Management.

Next I met with the Conservancy Board of Directors, including the Land Protection Chair, Sara Thomas, who suggested two properties that needed work. Round Lake of Hartland Nature Preserve (RLHNP) had draft management plans that needed updating, and Bullard Lake Nature Preserve (BLNP) was a newly acquired property that needed a brand new inventory plan. She provided me with copies of draft management plans, paper maps, aerial and point photos, and GIS data. After reviewing all of the current information, I determined what further data to collect in order to write my management plans for each site.

I then gathered data remotely in order to reduce fieldwork and create maps, and used this later to validate some of my field survey findings. I searched for free, publically available spatial data that I analyzed and processed using ArcGIS (10.2.2). I clipped and reclassified this data to create maps for the site plans (Table 2.1).

Table 2.1 GIS Data and Sources

Data Layer	**Source**
Soils	Natural Resource Conservation Service
Pre-Settlement Vegetation	Michigan Resource Information System
Land Use/Land Cover	Michigan Department of Natural Resources (1978); MDNR, Forest, Mineral and Fire Management Division (2001)
Hydrography	Michigan Department of Environmental Quality; Center for Shared Solutions and Technology Partnerships; National Wetlands Inventory; 12 Digit Watershed Boundary Dataset
Parcels	Livingston Land Conservancy (via Livingston County GIS)
County Boundaries	Center for Shared Solutions and Technology Partnerships
Roads	Center for Shared Solutions and Technology Partnerships
Digital Elevation Model	NASA's Earth Observing System Data and Information System
Aerial Photography	USGS Earth Explorer

After deciding what data still needed to be collected in the field, I visited both of the sites. I spent a total of 8 hours at RLHNP in April and June 2014 and 9 hours at BLNP in August 2014. First I walked the boundaries, checking the condition of signage. I walked along any trails, noting their condition and impacts of visitor use. I then walked throughout the property in an informal grid pattern. As I walked, I listed all of the plants I could accurately identify, and delineated the ecological communities by walking along the borders using a handheld GPS. This delineation was later assessed for accuracy using aerial photographs. If I saw non-native invasive species, I recorded species names, GPS points, and estimated sizes. In forested areas I noted which species were canopy dominants, common, or uncommon, and did the same for the understory. I looked on the ground for seedlings and saplings of overstory species to qualitatively assess recruitment. I also visually estimated canopy coverage based on the proportion of sun vs shade on the ground at mid-day, and sky visible through the canopy. In wetlands I walked with the GPS along the perimeter, using the presence of obligate wetlands species as the boundary between wetland and upland, which was also verified with aerial photos. I also visually estimated water levels and soil inundation.

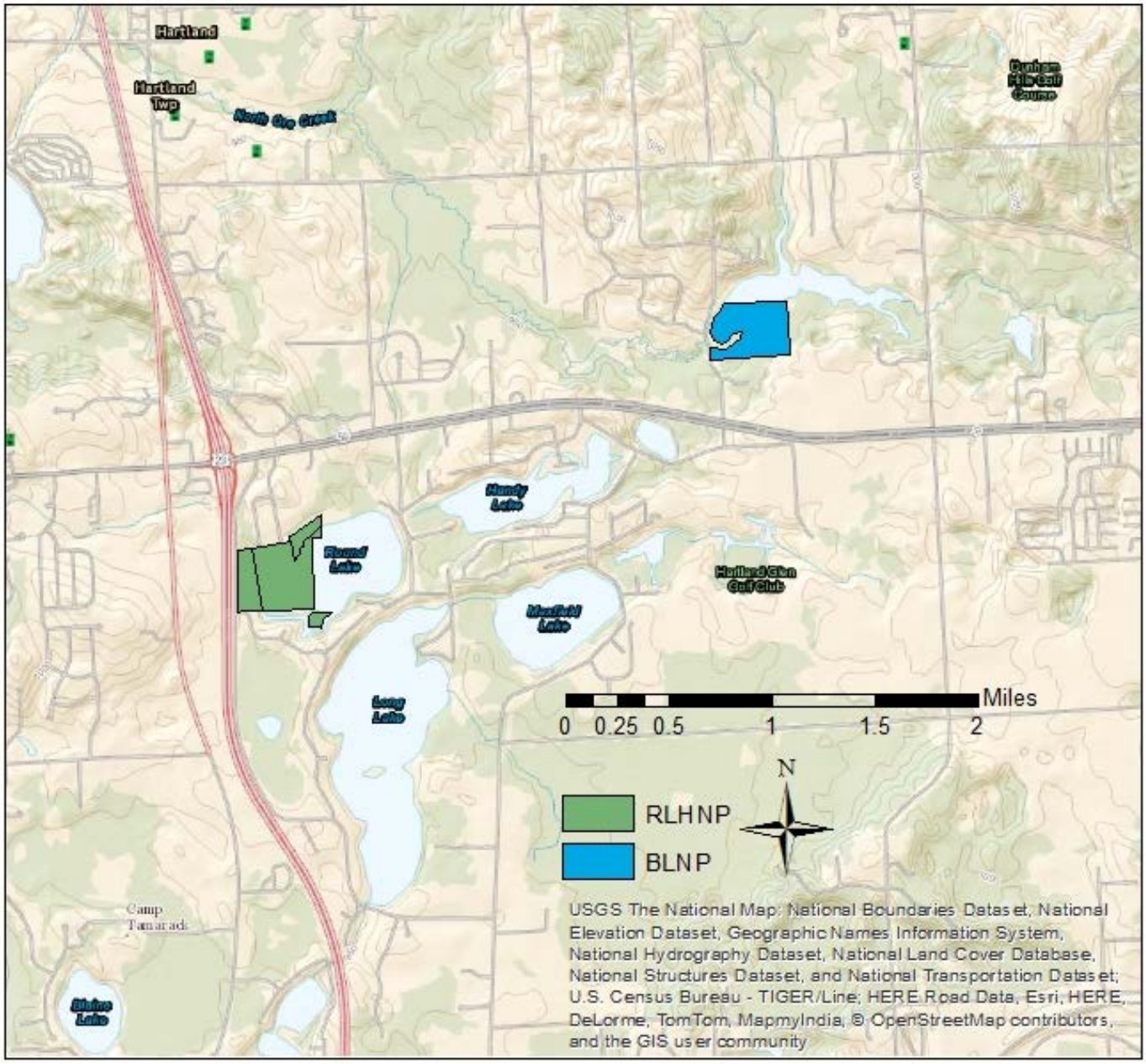
Once I had gathered sufficient data, I wrote an updated first draft of the Round Lake management plan, generally following the format of the LLC baseline documents and the guidelines in Howell et al (2011). I made recommendations based on a second literature review, which was more specific to the natural communities and species found at each site. Nomenclature for plant species was standardized with Michigan Flora, and natural communities with the Michigan Natural Features Inventory. I then had the draft reviewed by my lab members and advisor and edited it based on their feedback. I presented this second version to the Board of Directors at a board meeting. Following their edits and approval, I wrote the BLNP plan, using the same format as the first one.

Upon request of the Board, I created a survey spreadsheet to take into the field, and wrote a guide for how to develop a management plan, so that this process can be repeated for future properties.

RESULTS

The two sites I surveyed are Round Lake of Hartland Nature Preserve (RLHNP) and Bullard Lake Nature Preserve (BLNP) (Figure 2.1) Each Management Plan is divided into two sections: a Master Plan, which describe property-wide features and recommendations, and Site Plans, which focuses on objectives for specific units within the site.

Figure 2.1 Location Map of RLHNP and BLNP



MANAGEMENT PLAN FOR BULLARD LAKE NATURE PRESERVE

TAX IDENTIFICATION NUMBER:

4708-23-300-032

LOCATED: SECTION 28, T3N, R6E

HARTLAND TOWNSHIP,

LIVINGSTON COUNTY, MICHIGAN

Report Date: April 16, 2015

Livingston Land Conservancy

Prepared by Julie B. McLaughlin

Introduction

This management plan identifies and inventories the natural and cultural features of Bullard Lake Nature Preserve in order to determine a course of action so as not to impair resources that we wish to conserve. Along with defining resources, this document outlines management objectives for the short and long term, addresses public use issues and stewardship, and helps build public support for the property. The plan defines conservation goals, objectives, targets, and monitoring.

It is divided into a Master Plan, which outlines the Preserve as a whole, and Site Plans, which divide the site into management units according to natural communities and Livingston Land Conservancy (LLC) goals.

The Purpose of Bullard Lake Nature Preserve, and thus the goal for this management plan, is:

1. To perpetually preserve wildlife habitat
2. To help protect the N. Ore Creek watershed, a tributary to the Shiawassee River, and the associated Bullard Lake ecosystem
3. To provide a natural area and relief from urban development pressure

(Thomas 2013)

SECTION I: MASTER PLAN

Site Information

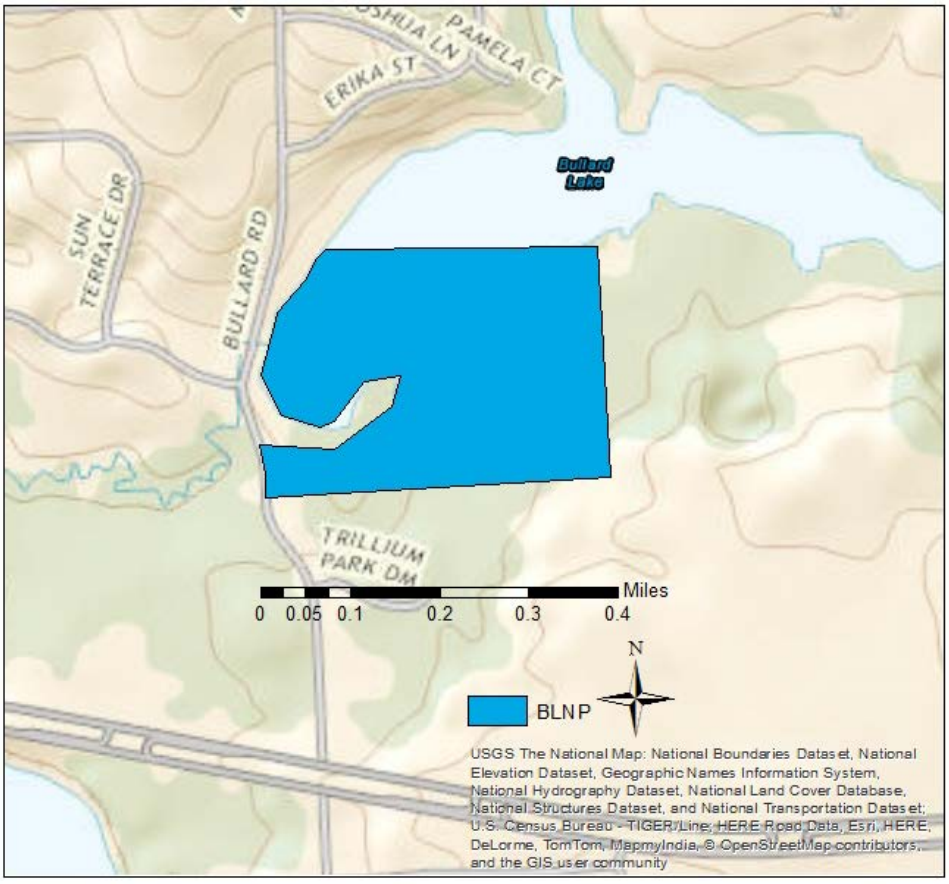
Location

Tax ID No.: 4708-23-300-032
Parcel: Parcel B on survey dated November 19, 2013
Address: Bullard Road, Hartland, Michigan
County: Livingston
Acres Preserved: 30.44
Adjacent To: The Protected Property is adjacent on the north side to both private property owned by Bullard Lake, Inc. as well as the actual lake; property owned by Hartland Township is to the east; 3 large parcels owned by private individuals are to the south; and Bullard Road is to the west (Figure 2.2.)
Access: From Bullard Road or through Access Easement through the parcel to the north owned by Bullard Lake, Inc.

Donor

Arnold D. Becker Living Trust
35 W. Huron, Suite 900
Pontiac, MI 48342

Figure 2.2. Location Map of Bullard Lake Nature Preserve.



Use restrictions:

- No building/construction
- No dumping
- No filling or excavating
- No mining or drilling
- No detrimental use
- No motor vehicles (except for access by Conservancy)
- No commercial recreational use
- No division or subdividing
- No industrial activity
- No farming
- No hunting or trapping unless approved by Conservancy for biological control of species that may be damaging conservation values.

Natural resource inventory for BLNP

Climate

BLNP is located in Hartland Township, MI, in the easternmost part of Livingston County, roughly halfway between the north and south borders of the county. Recent data for the Howell weather station was unavailable, however the next closest station in East Lansing can serve as a proxy (Table 2.2)

Table 2.2 Climate Data for East Lansing, MI 1981-2010
(Michigan State University Department of Geography 2014)

	Minimum	Maximum
Annual Mean Temperature (F)	37.3	57.6
Annual Mean Precipitation (in.)	31.55	
Annual Extreme Temperature Mean (F)	-9.7	93.8

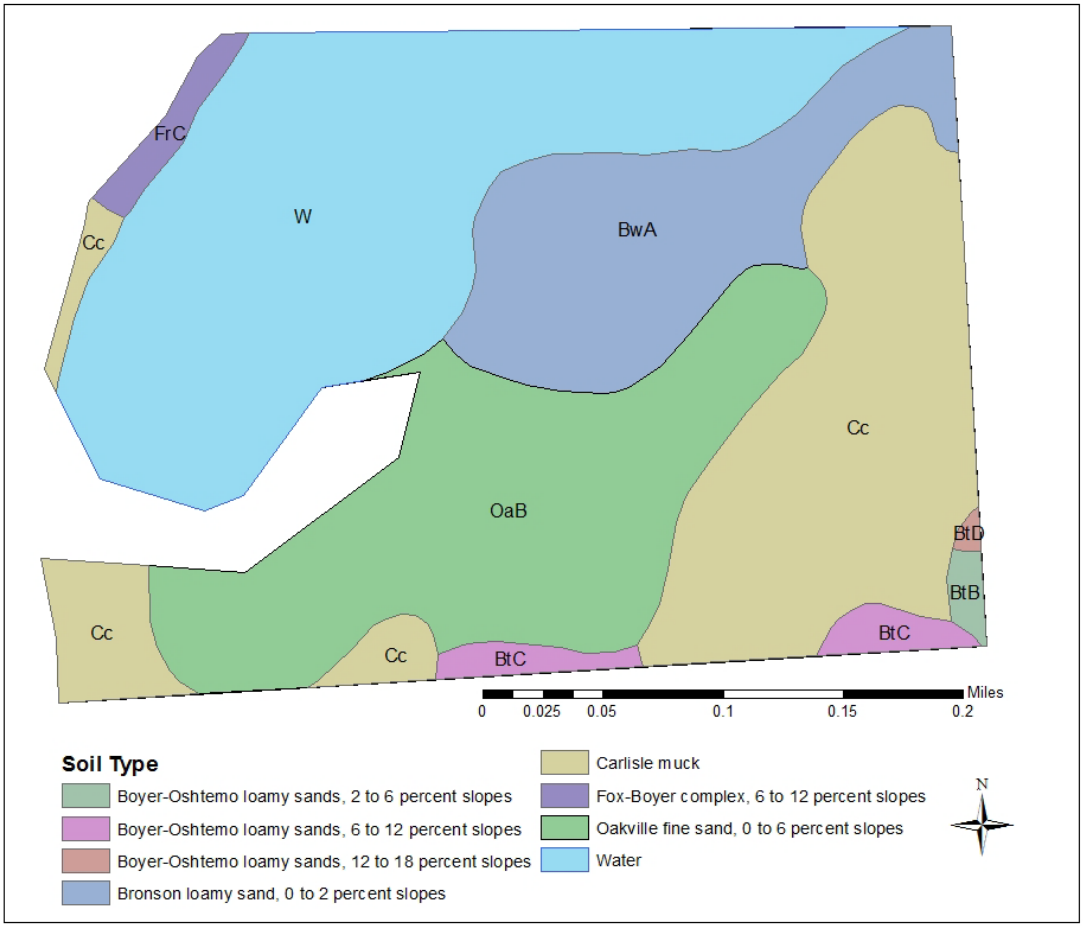
Glaciation and Soil

The landscape of eastern Livingston County was created by retreating glaciers, whose meltwaters carried sand and gravel over the land. These glacial deposits were sorted by water to define the current landscape of hills and lakes. Till and outwash are the dominant types of glacial deposits in Livingston County. Both moraines and till plains are composed of till, a compilation of clay, silt, sand, gravel, and boulders, and both may contain outwash. The majority of the till in Livingston County is medium-grained. Outwash is composed of sand and gravel (USGS 2007). BLNP is primarily made up of loamy sands, with portions of muck and fine sand. (Table 2.3)(Figure 2.3.)

Table 2.3. Soil Characteristics of BLNP

Series name	Slope	Drainage	Texture	Geology
Boyer-Oshtemo loamy sands	2 to 18 percent	Well drained	Loamy sand	Outwash plains and moraines
Bronson loamy sand	0 to 2 percent	Moderately well drained	Loamy sand	Outwash plains and valley trains
Carlisle muck	0 to 2 percent	Very poorly drained	Muck	Depressed areas of till plains, moraines, glacial drainageways, and lake plains
Fox-Boyer complex	6 to 12 percent	Well drained	Sandy loam	Outwash plains, valley trains, moraines
Oakville fine sand	0 to 6 percent	Well drained	Fine sand	Low moraines, till plains, and outwash plains

Figure 2.3. Soil Map of BLNP.



Hydrology

BLNP is located within the Shiawassee River watershed (Hydraulic Unit Code 4080203010030). The property borders Bullard Lake, a relatively new man-made lake, and contains several small wetlands less than ½ acre in size, as well as vernal pools. North Ore Creek is north of the property and is connected to the west and east ends of Bullard Lake (Figure 2.4).

Figure 2.4 Hydrological Features of BLNP.

Vegetation

Historically, the area surrounding Bullard Lake was lowland hardwoods. Currently land cover is classified generally as central hardwoods and lowland hardwoods under the Andersen classification system. Using more detailed vegetation, soil, and hydrological characteristics, the site can be divided into natural communities based on the key provided by the Michigan Natural Features Inventory (Kost 2007). The ecological communities present include southern hardwood swamp, mesic southern forest, southern shrub-carr, and wet meadow.

Table 2.2. Floristic Quality Assessment for BLNP, August 2014

Number of taxa	99
Mean coefficient of conservatism	3.18
FQI	31.66
% Adventive (exotic) species	16.16
% Native species	83.84

The FQI is not to be used as an independent measurement, but to compare sites – for example a degraded site and a reference site. However, tests of this system have shown that most of the remaining undeveloped land registers an FQI < 20 and thus does not represent high-quality native communities. Areas with a FQI higher than 35 are said to be floristically important (Herman et al 2001).

Because the inventory was only conducted once in late summer, it is likely that many early-season species were unable to be identified; therefore a follow-up survey should be conducted the following spring, and the FQI recalculated.

Wildlife

Two site visits in April and December 2013 recorded the following bird species: *Aix sponsa* (wood duck), *Ardea alba* (great egret), *Ardea herodias* (great blue heron), *Contopus virens* (eastern wood-pewee), *Hylatomus pileatus* (pileated woodpecker), *Meleagris gallopavo* (wild turkey), and *Regulus satrapa* (golden-crowned kinglet.) A thorough point-count breeding bird survey (USDAFS 1997) would be an easy and useful inventory and should be conducted as soon as possible.

The site visits also noted two reptile species, *Chrysemys picta* (painted turtle) and *Emydoidea blandingii* (Blanding's turtle.) Blanding's turtle is a designated Species of Concern in the State of Michigan, and a herpetological survey may be desired to evaluate the status in this site. Habitat suitability modeling based on occurrence data may be important for determining potential areas for threatened and endangered wildlife, and prioritizing areas for further surveys.

Cultural use

There is a signed entrance to the preserve, which should be updated to indicate the specific use rules. This would assist in educating the visitors. Additional signage if management actions are taken would also be beneficial. If evidence of unwanted activity is encountered, a visitor-use monitoring program should be initiated. The legal boundaries of the parcel should be marked with appropriate markers and signs.

A site visit conducted in August 2014 showed a history of logging and perhaps agricultural ditching, suggested by the presence of large logs and brush piles, a two-track road, and a berm running along the north end of the property.

SECTION II: SITE PLANS

This section of the plan lists specific goals, and outlines the actions necessary to accomplish those goals. It will need to be updated as yearly accomplishments and subsequent timetables unfold.

The goals for BLNP are:
1. To perpetually preserve wildlife habitat
2. To help protect the N. Ore Creek watershed, a tributary to the Shiawassee River, and the associated Bullard Lake ecosystem
3. To provide a natural area and relief from urban development pressure

Before deciding on a specific plan of action, one should evaluate the merits and issues with each alternative in order to decide on the best strategy, in case an alternative avenue needs to be pursued in the future. Adaptive management allows for variation in the kinds of communities proposed for restoration, in the extent/scale of the project, and in the types of monitoring pursued. The following management units are defined by similar ecological communities and therefore similar management practices.

Unit A. Mesic Southern Forest and Floodplain Forest

The forested areas are approximately 90% tree cover. An on-site visit conducted in August 2014 found overstory is dominated by *Acer* saccharum (sugar maple), *Betula allegheniensis* (yellow birch), *Liriodendron tulipifera* (tulip tree) and *Tilia americana* (basswood). Less common are *Quercus alba* (white oak), *Q. rubra* (red oak), and *Q. velutina* (black oak).

The sub-canopy includes native small trees and shrubs, primarily *Lindera benzoin* (spicebush), as well as *Carpinus caroliniana* (hornbeam), *Corylus americana* (American hazelnut), *Hamamelis virginiana* (witch-hazel), *Juniperus communis* (ground juniper), and *Ostrya virginiana* (ironwood).

The seedling and sapling layer contains many *Fagus* and *Quercus* seedlings, and few *Acers.* The groundcover includes *Carex pensylvanica,* several species of fern, and various wildflowers.

Forest Management

Objectives

Maintain high-quality mesic southern forest and floodplain forest

Targets

1. Remove non-natural debris
2. Conduct large-tree survey to determine relative dominance of species
3. Conduct sapling/seedling survey to assess regeneration

Methods

To preserve BLNP as a natural area, all non-biodegradable material should be removed from the berm. If the presence of logs and brush impacts visitor use or management, they should also be removed; otherwise they may be left in place to decompose.

A formal comparison of the canopy and seedling species is a method to assess the successional trajectory of a forest. In order to analyze the canopy species, a 10x10m square plot should be outlined. Within the plot, measure the diameter at breast height (dbh) of all live trees above 10cm dbh, and record the species and dbh. Dbh can be converted mathematically from the circumference of the tree, but the use of a pre-converted dbh measuring tape is recommended for field measurements.

To measure regeneration, again use a $100m^2$ plot and record species counts for stems with <2.0 cm dbh. In addition, stems <2.0 cm dbh are further subdivided into two height classes, with those <50 cm tall recorded as "seedling" and those ≥50 cm tall recorded as "sapling."

Unit B. Wetland Complex and Southern Wet Meadow

Objectives

Maintain high-quality wetlands and wet meadow

Targets

1. Conduct a preliminary wetland survey
2. Visually assess invasives and remove them if present in undesirable quantities

Methods

A preliminary wetland survey should be conducted as outlined in the Michigan Rapid Assessment Method for Wetlands (MIRAM)(DNRE 2010). This survey is used to identify, describe, and calculate the "functional value" for a particular wetland in order to compare it to other wetlands. The survey should be done during the growing season so as to properly identify plant species.

Part of the assessment includes noting the presence, size, and density of invasive/non-native aquatic species. This site contains *Lythrum salicaria* (purple loosestrife) on the northern edge on the berm adjacent to an agricultural field. If this species is found on BLNP property, it should be eradicted as soon as possible. This can be done by applying a foliar spray with a 2% solution of an aquatic-approved herbicide (e.g. Rodeo, Aquaneat). If possible, the plants should be treated before flowering (May and June). However, identification is easier once the plant is flowering (July – September), in which case the flowering heads should be clipped and bagged, and the remaining foliage treated (MN DNR 2015).

Phalaris arundinacea (reed canary grass) and *Typha spp.* (cat-tail) are also present in limited amounts on the western wet edge adjacent to Bullard Road, and these invasions should be mapped and quantified in order to determine if removal is desired. A simple

method is to take a handheld GPS into the field and create points at each patch, estimating the size of the area containing the species, and density in terms of % cover of that area.

Researchers have found that *Phragmites* negatively impacts plant diversity in most systems (D'antonio and Meyerson 2002), but may have positive or neutral impacts on fauna, including birds. Removal of *Phragmites* may increase species richness in invaded sites (Farnsworth and Meyerson 1999). The most successful removal technique has been targeted application of the same aquatic herbicides discussed previously. Herbicide should be applied to the foliage during the growing season prior to flowering. Studies suggest that repeat applications are necessary for successful removal (USFWS 2007).

MANAGEMENT PLAN FOR ROUND LAKE of HARTLAND NATURE PRESERVE

TAX IDENTIFICATION NUMBERS:

4708-28-100-041, 4708-28-200-015, 4708-28-200-023, 4708-28-401-094

LOCATED: SECTION 28, T3N, R6E

HARTLAND TOWNSHIP,

LIVINGSTON COUNTY, MICHIGAN

Report Date: June 30, 2014

Livingston Land Conservancy

Prepared by Julie B. McLaughlin

Introduction

This management plan identifies and inventories the natural and cultural features of Round Lake of Hartland Nature Preserve in order to determine a course of action so as not to impair resources that we wish to conserve. Along with protecting resources, this document outlines management objectives for the short and long term, addresses public use issues and stewardship, and helps build public support for the property. The plan defines conservation goals, objectives, targets, and monitoring.

It is divided into a Master Plan, which outlines the Preserve as a whole, and Site Plans, which divide the site into management units according to natural communities and Livingston Land Conservancy (LLC) goals.

The Purpose of Round Lake of Hartland Nature Preserve is to: “perpetually preserve wildlife habitat, protect watershed quality for Round Lake, and provide open space and relief from development pressure” (Thomas 2010). Thus, the primary goals for this management plan are as follows:

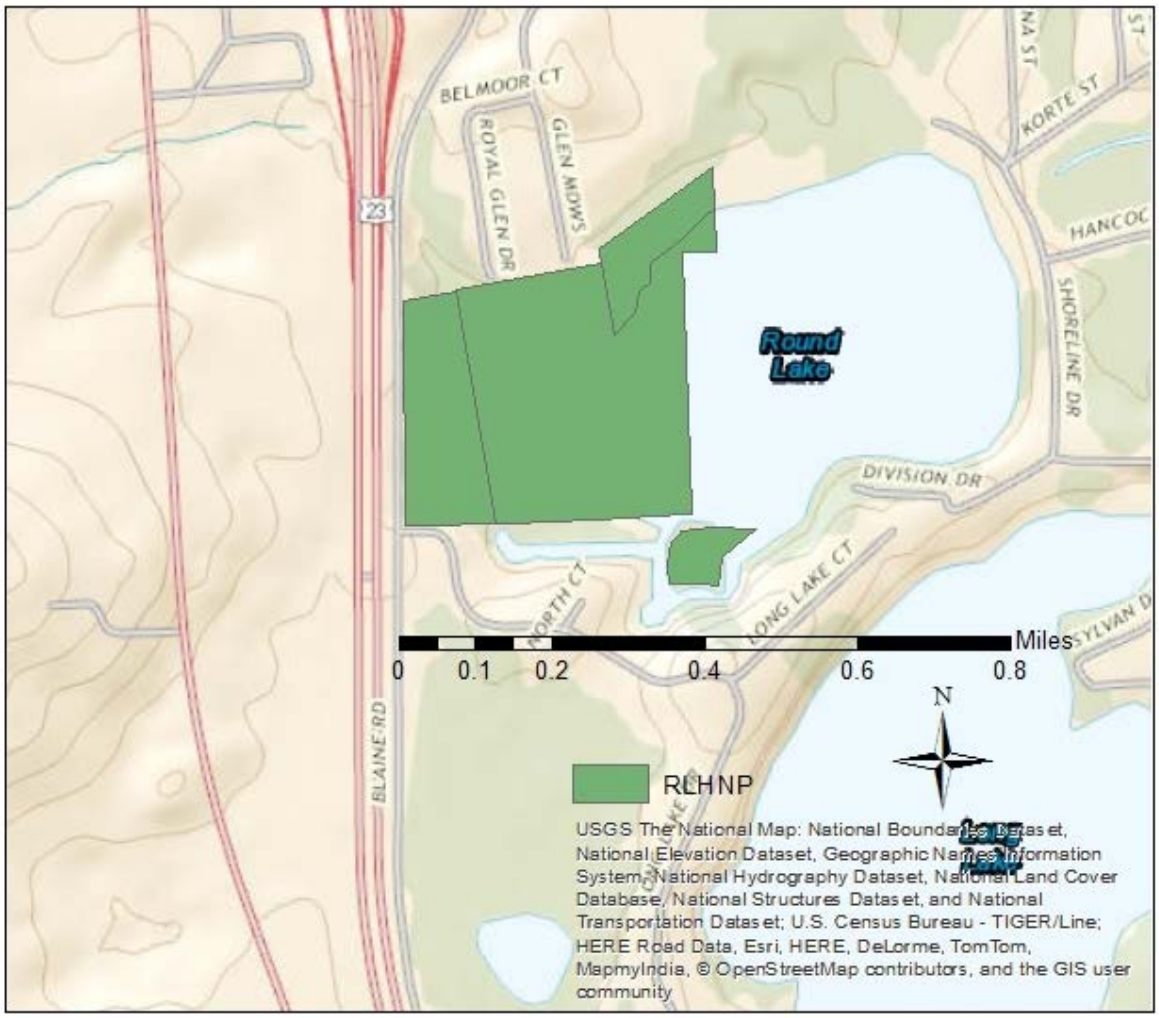
1. Preserve and maintain wildlife habitat
2. Protect watershed quality
3. Ensure passive visitor use and encourage stewardship

SECTION I: MASTER PLAN

Site Information

The Round Lake of Hartland Nature Preserve (RLHNP) is comprised of four parcels totaling 47 acres, located in Hartland Township, Livingston County, Michigan. It is owned and managed by the Livingston Land Conservancy, P.O. Box 236, Brighton, MI 48116-0236, (810) 229-3290. It is bordered by Blaine Road to the west, commercial development to the north, Round Lake to the east, and residential housing to the south. The primary access is via Blaine Road (Figure 2.5).

Figure 2.5. Location Map of Round Lake of Hartland Nature Preserve.



For the purposes of management, the four adjacent parcels listed below shall be managed under one Management Plan due to their location and similarity.

West parcel
Donor: Wal-Mart Stores East, LP.
2001 S.E. Tenth Street
Bentonville, Arkansas 72716-0550

Parcel: Tax ID #4708-28-100-041
Size: 9.98 acres
Location: Southeast of the Intersection of US-23 and M-59. Adjacent to East parcel on the east, Hartland Shore Estates No. 1 to the south, Blaine Road to the west, and the Wal-Mart development to the north.

The parcel was donated by Wal-Mart as requested by Hartland Township when Wal-Mart was developing their store at the north end along M-59. An easement had to be implemented by Wal-Mart to allow access to that parcel.

East parcel
Donor: Round Lake Woods, LLC.
28800 Orchard Lake Road, Suite 200
Farmington Hills, MI 48334

Parcel: Tax ID #4708-28-200-023
Size: 29.62 acres
Acquired: July 2008.
Location: West side of Round Lake, Hartland Township, MI. Adjacent to West parcel to the west, north parcel to the north, Round Lake to the east, and private property to the south. This was originally owned by an area homebuilder who had planned to develop condominiums but then cancelled the plans due to monetary concerns. LLC had an appraisal done and made an offer to buy it for $125,000 using funds secured through a capital campaign as well as a few temporary private loans. The southern boundary has yet to be defined due to a previous surveying error.

North parcel

Donor: Round Lake Land Conservation, Inc.
1407 Division Drive
Hartland, MI 48353

Parcel: Tax ID #4708-28-200-015
Size: 5.8 acres
Acquired: December 18, 2009
Location: Adjacent to private property on the east; Round Lake to the south; RLHNP to the west; commercial property to the north.

Five acres on the north side of Round Lake were donated to LLC by Round Lake Land Conservation, Inc. Their sole purpose was to buy this parcel when it came up for sale to prevent development and protect their lake. LLC has a Memorandum of Understanding (MOU) with them that if LLC doesn't comply with preserving it, ownership will revert to RLLC. This parcel is legally accessible by an easement drafted by the developers of the land along M-59.

Island parcel
Donors: Chris & Donna Schaidt
1384 North Court
Brighton MI 48114

Dave Starr
1398 North Court
Brighton MI 48114

Parcel: Tax ID #4708-28-401-094
Size: 1.96 acres
Acquired: November 13, 2012
Location: Southeast of the mainland section of the preserve, surrounded by Round Lake. The island was purchased by adjoining homeowners in the Hartland Lake Estates subdivision, who bought it along with a small access easement near their respective lots in order to incorporate the easement portion into their lots. They then decided to donate the island to the Conservancy for preservation. Main access to the island now is via watercraft.

Use restrictions as determined by Livingston Land Conservancy:

- No building/construction (except for actions taken by Conservancy to protect conservation values, such as fencing, or to provide access, such as parking area off of Blaine Road)
- No dumping
- No filling or excavating
- No mining or drilling
- No detrimental use
- No motor vehicles (except for access by Conservancy)
- No commercial recreational use
- No division or subdividing
- No industrial activity
- No cutting or removal of trees or other vegetation except for trail clearing/maintenance or removal of invasive species to be conducted by the Livingston Land Conservancy or its authorized agent
- No farming
- No hunting or trapping unless approved by Conservancy for biological control of species that may be damaging conservation values

Natural resource inventory for RLHNP

Climate

RLHNP is located in Hartland Township, MI, in the easternmost part of Livingston County, roughly halfway between the north and south borders of the county. Recent data for the Howell weather station was unavailable, however the next closest station in East Lansing can serve as a proxy.

Table 2.3 Climate Data for East Lansing, MI 1981-2010
(Michigan State University Department of Geography 2014)

	Minimum	Maximum
Annual Mean Temperature (F)	37.3	57.6
Annual Mean Precipitation (in.)	31.55	
Annual Extreme Temperature Mean (F)	-9.7	93.8

Glaciation and Soil

The landscape of eastern Livingston County was created by retreating glaciers, whose meltwaters carried sand and gravel over the land. These glacial deposits were sorted by water to define the current landscape of hills and lakes.

Till and outwash are the dominant types of glacial deposits in Livingston County. Both moraines and till plains are composed of till, a compilation of clay, silt, sand, gravel, and boulders, and both may contain lenses of outwash. The majority of the till in Livingston County is medium-grained. Outwash is composed of sand and gravel (Apple & Reeves 2007). The western half of the site is primarily sand and sandy loam, while the northern and eastern portions are muck (Table 2.4) (Figure 2.6).

Hydrology

RLHNP is located within the Shiawassee watershed (Hydraulic Unit Code 4080203010030) (USDA 2013). The property borders Round Lake, and contains six wetlands ranging from .01 acres to ~20 acres (Atwell-Hicks 2006). The wetlands are formed primarily from precipitation and snowmelt. The lake is fed from groundwater, with no inlet or outlet. A culvert exists in the northwest side to provide storm drainage from Blaine Road and U.S. 23. There is a narrow, slow-moving creek running through one of the large wetlands.

Vegetation

Historically, the area that is currently RLHNP was comprised of mixed-oak savanna, muskeg/bog, and lake/river (Figure 2.7). The current land cover is a mosaic of deciduous forest, emergent wetlands, woody wetlands, and open water. Continuous areas of habitat have undergone fragmentation, and the muskeg/bog area has filled in with woody species. There is no remnant mixed-oak savanna, but now an oak-hickory forest.

Table 2.4 Soil characteristics of RLHNP

Series name	Slope	Drainage	Texture	Geology
Brookston	Nearly level	Poorly drained	Loam or light clay loam	Till plains and depressions in moraines
Carlisle	0 to 1 percent	Poorly drained	Muck	Depressions on moraines, outwash plains, or adjacent to lakes
Conover	0 to 2 percent	Poorly drained	Loam or light clay loam	Till plains and depressions in moraines moraines
Gilford	0 to 2 percent	Very poorly drained	Sandy loam	Depressions on glacial drainage channels, outwash plains, lake plains
Houghton	0 to 1 percent	Very poorly drained	Muck	Depressions on moraines, outwash plains, or adjacent to lakes
Miami	2 to 18 percent	Well-drained	Loam	Till plains and moraines
Oakville	0 to 6 percent	Well drained	Fine sand	Knolls on outwash plains, deltas on till plains
Pewamo	0 to 2 percent	Poorly drained	Clay loam	Depressions on till plains, drainageways on till plains

Figure 2.6 Soil Map of RLHNP.

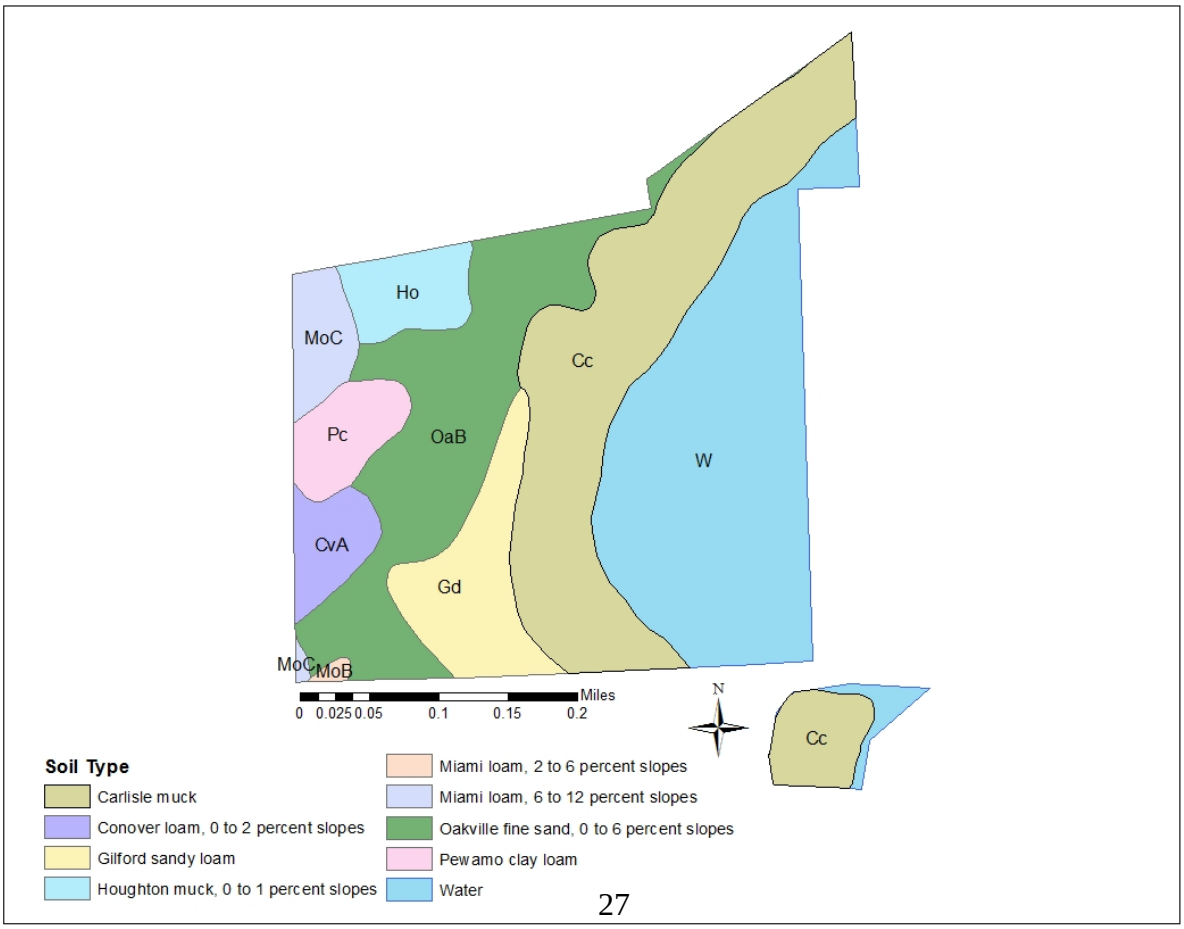
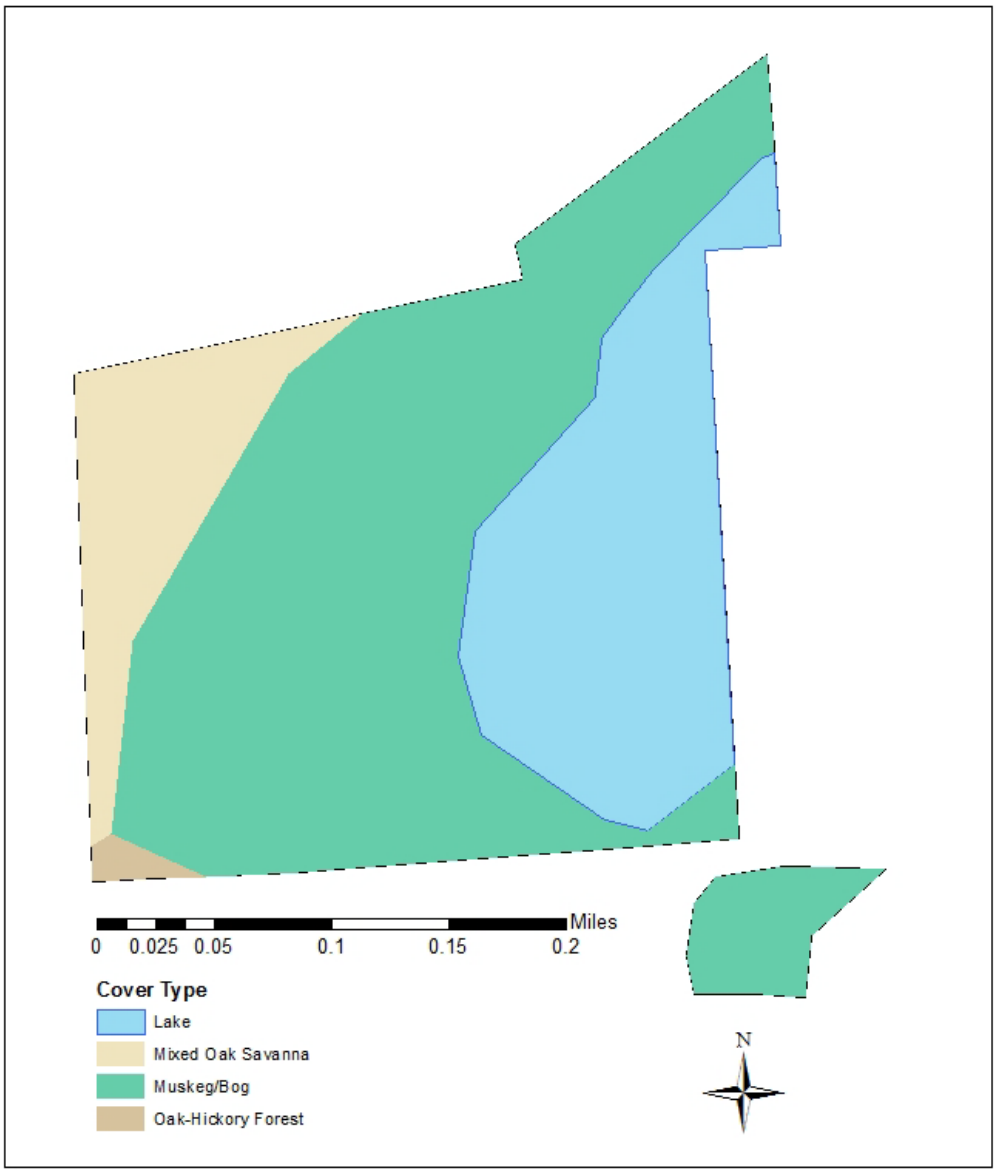


Figure 2.7. Pre-settlement (c. mid-1800's) Vegetation at RLHNP.



Using vegetation, soil, and hydrological characteristics, the site can be divided into natural communities based on the key provided by the Michigan Natural Features Inventory (Kost 2007). These communities are then grouped into forested and wetland management units. This plan recommends managing separately purchased units as singular if the natural communities are similar and/or continuous.

Table 2.5. Floristic Quality Assessment for BLNP, August 2014

Number of taxa	145
Mean coefficient of conservatism	2.61
FQI	31.47
% Adventive species	26.90
% Native species	73.10

The FQI is not to be used as an independent measurement, but to compare sites – for example a degraded site and a reference site. However, tests of this system have shown that most of the remaining undeveloped land registers an FQI < 20 and thus does not represent high-quality native communities. Areas with a FQI higher than 35 are said to be floristically important (Herman et al 2001).

Because the inventory was only conducted once in mid-summer, it is likely that many early-season species were unable to be identified; therefore a follow-up survey should be conducted the following spring, and the FQI recalculated.

Wildlife

An assessment by the State of Michigan DNR determined that the Indiana bat is known to occur in the area. Suitable habitat within 2-3 km of a body of water should be considered potential foraging habitat. A survey by Atwell-Hicks showed that the parcel south of the Wal-Mart developments (which is contained within RLHNP) has moderate potential for bat roosting sites, although no bats were seen on this site. Identifying habitats that are selected for by critical species is the first step towards locating said species. To this end, habitat suitability modeling may be important for determining potential areas for threatened and endangered wildlife (Harvey and Weatherhead 2006).

A thorough point-count breeding bird survey (USDAFS 1997) would be an easy and useful inventory and should be conducted as soon as possible.

Cultural use

A site visit conducted in June 2014 showed little to no human use, indicated by the lack of social trails and trash. Additionally, the boundary signage, abundance of poison-ivy, heavily wooded understory, and downed woody debris discourage travel through the site.

Yard waste, including brush piles, tree trunks, and wood chips, has been dumped near the southwest corner off of Long Lake. An overgrown social trail exists on the site, running from the retention ponds adjacent to Wal-Mart, along the west side of the Northern parcel, and ending at Round Lake, where people have accessed the lake for fishing. A walk-through in June 2014 found very little scattered trash, which likely blew over from the Wal-Mart development. The lake is an all-sports lake, with approximately 53 homes built on the shores. Two-thirds of the shoreline remains undeveloped.

A Baseline Environmental Assessment (BEA) was provided by Atwell-Hicks for Wal-Mart in December 2007 and shows that although there is groundwater contamination and some soil contamination in the West and North parcels, they do not pose a threat to the site.

Boundary signage is present along the southern and western boundaries. Signs along the northern boundary with Wal-Mart state “WETLAND AREA – DO NOT MOW” but do not indicate ownership of the site.

Current easements include:

- Michigan Bell, 1994, 41.25 feet east of Blaine Road centerline and 16.5 feet in width running north and south along Blaine Road.
- Access easement agreement with Round Lake Woods, LLC from Blaine Road to their property to the east, February 2008.
- Utility easements of North parcel
- Relocation of Right of Way on North parcel, March 2008.

Entrance(s) to the Preserve should be marked with signage indicating the specific use rules. This would assist in educating visitors on the passive use rules. Signage educating visitors on current management actions and other points of interest would also be beneficial. If evidence of unwanted activity is encountered, a visitor-use monitoring program should be initiated.

SECTION II: SITE PLANS

This section of the plan lists specific goals, targets, and outlines the actions necessary to accomplish those goals. It will need to be updated as yearly accomplishments and subsequent timetables unfold.

The goals for RLHNP are:

1. Preserve and maintain wildlife habitat
2. Protect watershed quality
3. Ensure passive visitor use and encourage stewardship

Before deciding on a specific plan of action, the merits and issues of each alternative should be evaluated in order to decide on the best strategy, in case an alternative avenue needs to be pursued in the future. Adaptive management allows for variation in the kinds of communities proposed for restoration, in the extent/scale of the project, and in the types of monitoring pursued.

Unit A: Dry-Mesic Southern Forest

The forested areas are approximately 95% tree cover. Wal-Mart, in the course of doing extensive environmental reviews ahead of developing, had a very thorough tree survey performed since many trees in the north end were going to be removed. An on-site visit conducted in June 2014 confirmed that the overstory is dominated by *Carya glabra* (pignut hickory), *C. ovata* (shagbark hickory), *Prunus serotina* (wild black cherry), *Quercus rubra* (red oak), and *Q. velutina* (black oak). Uncommon are *Acer rubrum* (red maple), *A. saccharinum* (silver maple), *Q. alba* (white oak), and *Q. macrocarpa* (bur oak).

The sub-canopy includes native small trees and shrubs such as *Corylus Americana* (American hazelnut), *Lindera benzoin* (spicebush), *Ostrya virginiana* (ironwood), *Prunus virginiana* (chokecherry), and *Ulmus Americana* (American elm).

The seedling and sapling layer contains many *Carya* and *Fraxinus* seedlings, and few *Quercus*. The groundcover includes *Carex pensylvanica* (Pennsylvania sedge), *Parthenocissus quinquefolia* (Virginia creeper), *Toxicodendron radicans* (poison-ivy), several species of fern, and various wildflowers.

There is a large amount of both standing snags and downed woody debris, including large *Fraxinus* and *Ulmus*, possibly indicating some effects from the emerald ash borer and dutch elm disease, as well as wind-throw disturbance.

Non-native invasives are scattered throughout the forest and include the woody species *Berberis thunbergii* (Japanese barberry), *Euonymus alatus* (winged-wahoo), *Eleagnus umbellate* (autumn-olive), *Lonicera tatarica* (Tartarian honeysuckle) and *Rosa multiflora* (multiflora rose), and the herbaceous *Alliaria petiolata* (garlic mustard) and *Convallaria majalis* (lily-of-the-valley).

Human disturbance, in the form of yard and other waste, is apparent in the southwest corner of the site near Blaine and Long Lake Road.

Forest Management

Objectives

Maintain oak-hickory-dominated dry-mesic southern forest

Targets

1. Remove all yard and other waste
2. Survey non-native invasive plants and enact restoration measures if there is greater than 30% coverage
3. Survey seedling/sapling layers for recruitment and enact restoration measures if necessary

Methods

Understory density and composition seems to play a significant role for overstory tree regeneration and herbaceous layer composition. Because a visual assessment showed little oak regeneration, a formal survey should be conducted. To measure regeneration, a 5.64-m rope centered on the sampling point can be used to construct a $100m^2$ circular plot. All stems with <2.0 cm diameter at breast height (dbh) within the plot are counted and recorded by species. In addition, stems <2.0 cm dbh are further subdivided into two height classes, with those <50 cm tall recorded as "seedling" and those ≥50 cm tall recorded as "sapling." To include a sufficient sample, multiple $100m^2$ plots should be surveyed. Dbh can be converted mathematically from the circumference of the tree, but the use of a pre-converted dbh measuring tape is recommended for field measurements. This survey should be repeated again after 3 and 5 years of any restoration action taken.

A large portion of the understory is primarily composed of the non-native invasive *Lonicera tatarica*, which may decrease the abundance of forest-floor herbs (Christopher et al 2013). Woods (2003) found that *Lonicera tatarica* populations exceeding 30% cover substantially depressed total herbaceous cover, herb species richness, and density of tree seedlings. Removal of understory stems >1.5m in height has been found to increase oak regeneration (Lorimer et al 1994).

Immediate removal of this species would likely increase floristic quality, regeneration of desirable canopy species, and light levels on the forest floor, potentially allowing native herbaceous material to thrive. A calculation and map of the densities and size classes of current *Lonicera* populations in combination with the FQI assessment and location of any rare species will be essential for managing the highest-quality/least-invaded areas first, and eventually moving toward more degraded sections. Volunteer workdays towards this end can encourage community-based stewardship and provide a sense of ownership for neighbors.

The most effective treatment is a cut stump method using loppers, hand saw, or chain saw, cutting all stumps to 2" or lower, followed by immediately treating the cambium using a 1:1 mixture of glyphosate and water (or triclopyr and oil if temperatures are

below freezing). Cutting is recommended when plants are not actively growing, e.g., late summer, fall, and winter. Because of the inaccessibility of the site, debris can be piled or scattered throughout the site, depending on the amount of material produced from the treatment. One possibility is to pile brush in areas where it can then be burned in the winter.

After three continuous years of cut-stump treatments of woody invasives, the entire site should be re-surveyed to calculate the percentage of non-native woody coverage; once the goal of less than 30% non-native vegetation is achieved, the site should continue to be visually monitored for the following five years to ensure depletion of the seed bank.

Once the forested areas have met this target, the decision will need to be made whether to pursue further restoration measures in order to convert the site into its former state as a Mixed-Oak Savanna.

Unit B: Southern Shrub-Carr and Emergent Marsh

This unit is 14 acres in size and is located in the northern end of the site. It borders Round Lake and has year-round standing water, as well as a small creek that connects to the lake. Creek flow appears uniform with clear water and little algae. The vegetation has distinct zones, including open water, emergent marsh, forb/wildflowers, and shrub. (HWRC) The primary community is defined as southern shrub-carr.

Tree species include *Acer rubrum* and *Quercus bicolor.* Wetland shrub species include *Salix spp.* (willow), *Cornus stolonifera* (red-osier dogwood), *C. foemina* (grey dogwood), *C.amomum* (silky dogwood), and *Ilex verticillata* (winterberry). Herbaceous plants include *Carex stricta* (sedge), *Eutrochium purpureum* (Joe-pye-weed), and *Symplocarpus foetidus* (skunk cabbage).

Invasives are distributed primarily within the wetland interior and in isolated pockets, and include *Typha spp.* (cat-tail), *Lythrum salicaria* (purple loosestrife), and *Phalaris arundinacea* (reed canary grass).

Unit C: Inundated Shrub Swamp

This wetland is ~1 acre in the middle of the site. It has standing water and appears to occasionally flood. It includes an open water area and an area of shrubs that is dominated by *Cephalanthus occidentalis* (buttonbush).

Unit D: Floodplain Forest

This unit consists of multiple small wetlands (not larger than .5 acres) scattered throughout the southwest portion of the preserve, which together make up approximately 20 acres. They are dominated by *Acer rubrum, A. saccharinum, Fraxinus pensylvanica* (green ash), *Quercus bicolor* and *Ulmus Americana.* These wetlands generally lack a shrub or herbaceous layer. They are potentially seasonal wetlands as determined by periods of flooding and drought.

Unit E: Rich Tamarack Swamp

A dense forested wetland dominated by *Larix laricina* (tamarack), which borders Round

Lake and is mostly inaccessible due to high water levels.

Wetland Management

Objectives

All wetlands will be surveyed prior to any restoration practices, in order to:

1. Map invasive species and determine the percentages of native/invasive cover
2. Conduct a Rapid Assessment wetland survey

Targets

1. Eradicate *Lythrum salicaria* within 5 years
2. Achieve at least 90% success in removal treatments annually
3. Prevent woody exotic encroachment
4. Maintain water quality within the wetlands at or above a MiRAM score of 80/100.

Post-restoration, these measurements should be taken again and used to judge the success of restoration activities. Edges should also be visually monitored for woody invasions.

Methods

Most wetlands on the site contain hybrid and/or invasive *Typha*, and pockets of *Phalaris arundinacea* and *Phragmites australis*. The creek has one infestation of *Lythrum salicaria*. Because invasives are distributed within the wetland interiors, and are fairly isolated, invasions should first be mapped and quantified. Based on their percent cover and size, the conservancy may wish to implement an integrated pest management approach, which utilizes a combination of manual and chemical removal, depending on the size and accessibility of the area.

A preliminary wetland survey should be conducted as outlined in the Michigan Rapid Assessment Method for Wetlands (MIRAM)(DNRE 2010). This survey is used to identify, describe, and calculate the "functional value" for a particular wetland in order to compare it to other wetlands. The survey should be done during the growing season so as to properly identify plant species.

Part of the assessment includes noting the presence, size, and density of invasive/non-native aquatic species. This site contains a small population of *Lythrum salicaria* (purple loosestrife) in the stream, which should be eradicated. This can be done by applying a foliar spray with a 2% solution of an aquatic-approved herbicide (e.g. Rodeo, Aquaneat). If possible, the plants should be treated before flowering (May and June). However, identification is easier once the plant is flowering (July – September), in which case the flowering heads should be clipped and bagged, and the remaining foliage treated (MN DNR 2015).

Phalaris arundinacea (reed canary grass) and *Typha spp.* (cat-tail) are also present in sizeable areas of the wetlands, and these invasions should be mapped and quantified in order to determine if removal is desired. A simple method is to take a handheld GPS into the field and create points at each patch, estimating the size of the area containing the

species, and density in terms of % cover of that area. This can also be done using high-resolution aerial photography.

Researchers have found that *Phragmites* negatively impacts plant diversity in most systems (D'antonio and Meyerson 2002), but may have positive or neutral impacts on fauna, including birds. Removal of *Phragmites* may increase species richness in invaded sites (Farnsworth and Meyerson 1999). The most successful removal technique has been targeted application of the same aquatic herbicides discussed previously. Herbicide should be applied to the foliage during the growing season prior to flowering. Studies suggest that repeat applications are necessary for successful removal (USFWS 2007)

The *Lonicera* understory discussed earlier is fairly dense on the east side of the forest, bordering the wetland. The same management strategy for stems >1.5 m should be implemented here to prevent the encroachment into the wetland.

Unit F: Island

This unit has yet to be surveyed. It must be accessed by watercraft, or possibly if the lake freezes over in winter.

Unit G: Road and Wal-Mart Border

Edge effects appear to be prevalent in the form of non-native noxious weeds and early successional species typical of old field succession. The western border along Blaine Road, and northern border adjacent to Wal-Mart, contains large populations of *Centaurea stoebe* (spotted knapweed), *Cirsium arvense* (Canada thistle), *Hypericum perforatum* (St. John's wort), *Leucanthemum vulgare* (ox-eye daisy), *Lotus corniculatus* (bird's-foot trefoil), *Melilotus spp.* (clover), and *Securigera varia* (crownvetch). Due to their location, management of these areas is low priority, but edges of native habitat should be visually monitored for invasions. Because of their affect on overall habitat quality as measured by the floristic quality assessment, eventual removal of noxious species and transitioning to native prairie species, which already occur on the north end of the site, would increase the overall site quality.

DISCUSSION

The most common forests currently in southeast Michigan are dry-mesic southern forest and mesic southern forest. These two communities are prevalent at the sites I surveyed. Each of these forest types requires specific combinations of sunlight, moisture, and disturbance. Dry-mesic southern forests, dominated by *Quercus* (oak) typically occur on well-drained soils, and were maintained pre-European settlement with episodic fires (Lee 2007). The disturbance of fire created edge environments where oaks are better competitors than in the full shade of the forest understory (Crow 1988). As a result of this fire regime, oaks are more fire-adapted than competing seedlings. Southern mesic forest is categorized by a canopy of *Fagus grandifolia* (American beech) and *Acer saccharum* (sugar maple), and is considered a late-successional community, which is better adapted to shade.

Forest ecological theory suggests that a lack of disturbances, such as fire and thinning, may be responsible for the succession from dry-mesic to mesic forest types. This process is termed "mesophication," and is thought to depend on feedback loops, where shade-tolerant mesophytes (e.g. beech and maple) create conditions under which they are better adapted than shade-intolerant, fire-adapted species (Nowacki and Abrams 2008). In light of this trend toward increased shade and moisture, forest managers are concerned that oak regeneration is decreasing on a regional scale. Many studies have proposed reinstating disturbance regimes in order to maintain long-term dominance of oaks in these transitional communities. Fire has been shown to enact structural changes to vegetation, but it may be successful only in conjunction with canopy thinning (Franklin et al 2003). Other potential solutions include removal of tall understory saplings in order to reduce competition with oak saplings (Lorimer et al 1994).

As it relates to Livingston Land Conservancy sites, forest restoration will most likely be practiced in the form of removal of unwanted disturbances, such as invasive plants, and the re-introduction of required disturbances, such as fire. Invasive species are defined as unwanted species that cause ecological and/or economic damage to a system. Invasive plants can reduce ecosystem services and function (D'antonio 2006). The invasion of riparian forests by the *Lonicera* species is strongly correlated with nearby urban land cover (Borgman and Rodewald 2005).

There are both preventative and responsive methods to reducing invasion. Restoration efforts should prioritize least-disturbed sites first, in order to protect habitat quality. The practice of early detection and rapid response can be a cost-effective method for preventing widespread invasion.

The next steps in this process include conducting rapid wetland assessments; additional vegetation surveys at multiple times in the growing season, and formal tree counts in order to predict regeneration and succession. As this data is collected, these plans should be updated to reflect the current habitat quality and ensure that management goals are being met. The management plan is an adaptive document that should be used to determine restoration actions and judge their success (Howell et al 2011). While specific targets are outlined, the thresholds described above are subject to change due to

circumstance. It is thus recommended that this plan also be revisited annually for revision and amendments.

The management techniques and prescriptions described above are encouraged to be used by the Livingston Land Conservancy to manage other current and future nature preserves, with the eventual goal of maintaining or increasing suitable habitat for rare and endangered species.

Chapter 3
Conservation Planning Using a GIS-based Multi-Criteria Evaluation Approach

ABSTRACT

The Livingston Land Conservancy (LLC) is a volunteer-run non-profit based in Brighton, Michigan. Formed in 1995, the Conservancy now protects 612 acres of land in Livingston County through a combination of nature preserves and conservation easements. The Conservancy has a long-term goal to obtain Accreditation through the Land Trust Accreditation Commission, a partner of the Land Trust Alliance. For the fulfillment of Indicator Practice 8B, Project Selection and Criteria, I used a GIS-based multi-criteria evaluation (MCE) process in order to identify and rank the most suitable lands for conservation in Livingston County. I incorporated weights and criteria for conservation from board members into a weighted linear regression, which was applied to remotely sensed GIS layers. This produced a raster map which, when aggregated by parcels, identified the properties with the highest Conservation Score. This product will be used by the Conservancy in order to quickly evaluate parcels, and can be easily adapted in response to changing values and as more data becomes available.

INTRODUCTION

The Livingston Land Conservancy (LLC) is a volunteer-run non-profit based in Brighton, Michigan with the mission to "protect the natural heritage and rural character of the Greater Livingston County Area." Formed in 1995, the Conservancy now protects 612 acres of land through a combination of nature preserves and conservation easements.

The Conservancy has a long-term goal to obtain Accreditation through the Land Trust Accreditation Commission, a partner of the Land Trust Alliance. In preparing the application, a conservancy must document a group of practices, referred to as the 12 Indicator Practices. This chapter focuses on the development of management plans in order to meet requirement 8B, Project Selection and Criteria, which states:

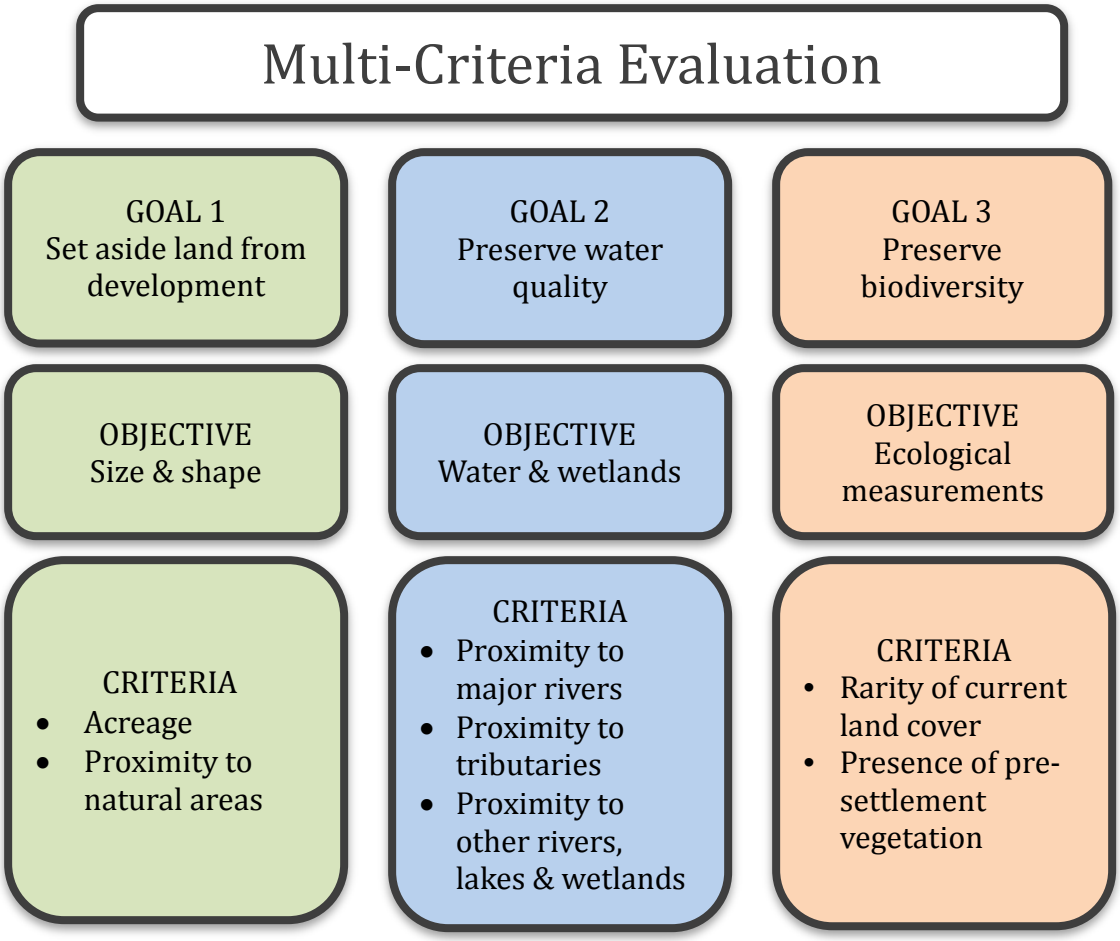
> *"Practice 8B ensures that the land trust has a defined process for selecting land and easement projects, including written selection criteria that are consistent with its mission"* (Land Trust Alliance 2004).

As development continues to increase in Livingston County, it is important that the conservancy focus its efforts and capital on preserving the highest-quality lands. Livingston Land Conservancy has a written list of criteria, but no explicit ranking procedure for how to select its land projects. A commonly used method of weighing alternative land uses is the Multi-Criteria Evaluation (MCE)(Eastman 1995). The objective of the MCE is to help decision-makers select the "best" from a given set of alternatives (Jankowski 1995). Criteria are chosen by decision-makers, then brought together in a weighted linear combination. This type of model is produced by applying a weight to each criterion, and performing a summation of the results. This calculation can be performed easily in a GIS, resulting in a suitability map. This map can then be analyzed for the highest-scoring areas (Brown 2014). This model was developed specifically to highlight the most desirable parcels of land within Livingston County.

METHODS

I gathered official Conservancy documents pertaining to project-selection criteria and grouped these criteria under three main goals. I combined all criteria into one list, to see which criteria were mentioned the most often as being important for conservation decision-making. Based on these criteria, I developed a conceptual model of the MCE (Figure 3.1). In this model, goals are the qualitative descriptions relating to the mission of the Conservancy. Each goal is translated into a corresponding objective, which gives a suggestion of a quantitative measurement to use as a proxy. Then objectives are measured using criteria, with values that are produced using GIS (geographic information systems).

Figure 3.1 Conceptual Model of MCE.



I then collected and processed remotely sensed raster and vector data in order to assign values to the various criteria. I processed the data by projecting each layer into the same Projection, and clipped each layer to the boundaries of Livingston County. I rasterized all layers at a 30m cell size. I then analyzed each layer in ArcMap 10.2.2, reclassing and calculating distances as necessary to meet the defined criteria (Table 3.1). I rescaled the values for each layer so they all were on a matching scale of 1-100. For pre-settlement vegetation, I allocated values to each land-cover type based on statewide and global rarity. Ecosystems with S1 ranking indicate the most rare within the state, and were given a value of 100. S2 was given 75, S3 was 50, and S4 was 25. Similarly, I gave pixels with the same land-cover type as in pre-settlement times a value of 1, and land cover that had changed received a 0.

Table 3.1. Data Sources and Processing for MCE Criteria.

Criteria	Data Source	Data Processing
Proximity to natural areas	Livingston County	Reclass – Euclidean Distance
Proximity to Huron, Grand, Shiawassee rivers	Hydrography (MIGDL)	Reclass – Euclidean Distance
Proximity to secondary rivers	Hydrography (MIGDL)	Reclass – Euclidean Distance
Proximity to other rivers, lakes and wetlands	Hydrography (MIGDL)	Reclass – Euclidean Distance
Rarity of current land cover	2011 land use (NLCD)	Reclass (4 categories based on LC rarity in the county)
Presence of pre-settlement vegetation	Pre-settlement Vegetation (MNFI)	Raster Calculator (Current land cover – 1800s land cover)

I then asked each board member to rank each criterion on a scale of 1, 2, and 3 where 1 is lowest priority and 3 is highest priority. They were allowed to rank multiple criteria with the same number if they were considered of equal importance. I then averaged the weights from the six board members who responded, and re-calculated them so that each had a proportion that in total added up to 1 (Table 3.2).

Table 3.2. Criteria and weights used in MCE.

Criterion	Average Original Score	Proportion of Total Score
Proximity to natural areas	2.17	0.145
Proximity to Huron, Grand, Shiawassee rivers	3	0.211
Proximity to secondary rivers	2	0.139
Proximity to other rivers, lakes and wetlands	2	0.136
Rarity of current land cover	3	0.211
Presence of pre-settlement vegetation	2.34	0.157

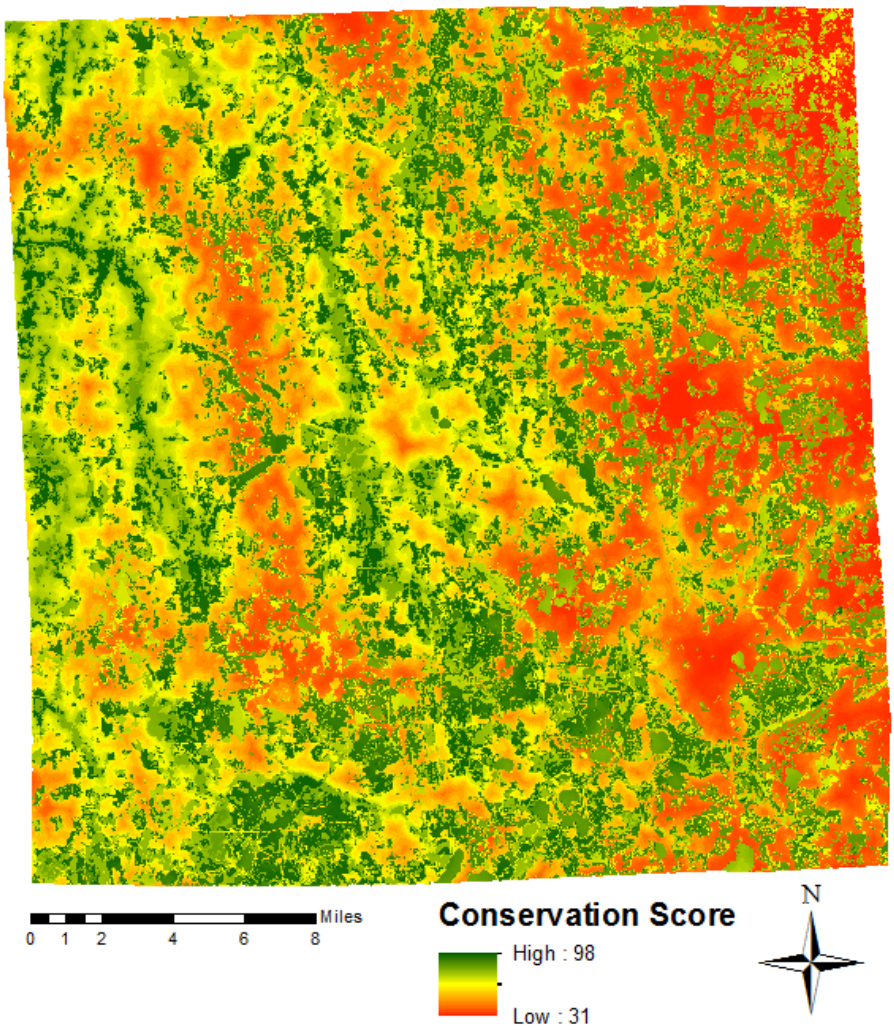
I then input those proportions into the Weighted Sum tool in ArcGIS. With the raster output map that was created, I used the Zonal Statistics tool to calculate the mean conservation score for each parcel. Individual parcels can now be interacted with by clicking on them with the Identify tool.

RESULTS

Raster map: Livingston County

Each 30x30m pixel within the County is assigned a cumulative Conservation Score on a scale of 1-100. The scores ranges from a low of 31 to a high of 98, with a mean of 59.8 and standard deviation of 9.79. Some trends are immediately apparent: high conservation score areas are located primarily in the western half of the county. The eastern quarter of the county is dominated by red areas, indicating low conservation value. This follows trends of urbanization, with the area surrounding the City of Brighton having almost 100% low conservation value.

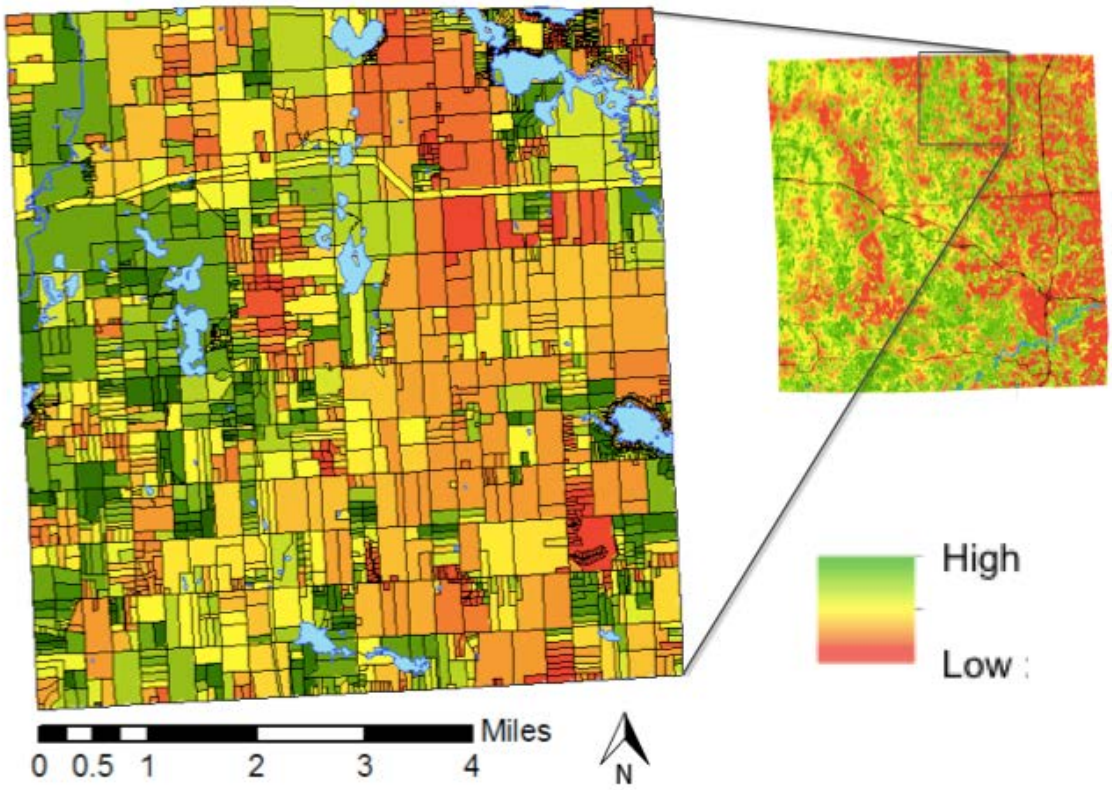
Figure 3.2. Raster map of Conservation Scores for Livingston County.



Township Level

Using Deerfield Township as an example, Figure 3.3 shows an output map with each parcel delineated. Each parcel is a vector polygon with the mean conservation score. At this level, we can mask out bodies of water, rights-of-way, and parcels that are already preserved by other conservancies or government organizations. We can also look at the conservation score for the parcels that LLC currently owns.

Figure 3.3 Deerfield Township Parcel-Level Conservation Scores.



Individual Parcel Attributes

Using the Identify tool on a single parcel displays an Attribute Table for that parcel (highlighted in Figure 3.4), including information such as parcel ID number, parcel address, owner name and address, class description (e.g. residential-vacant), assessed value, and most importantly for our purposes, the Mean Conservation Score. In addition we can sort parcels according to the larger Attribute Table (Figure 3.5) and remove superfluous fields. This will be useful for comparing the acreage of parcels, as this criterion was not included in the MCE. The Conservancy is primarily interested in conserving parcels >40 acres. This data can also be exported into an Excel table for further analysis and ease of use.

Figure 3.4. Selection of an Individual Parcel.

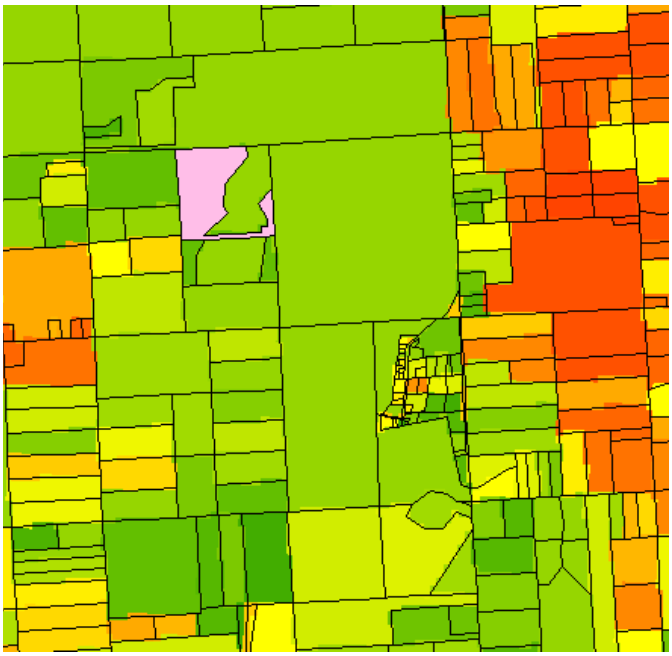


Figure 3.5. Attribute Information for a Selected Parcel.

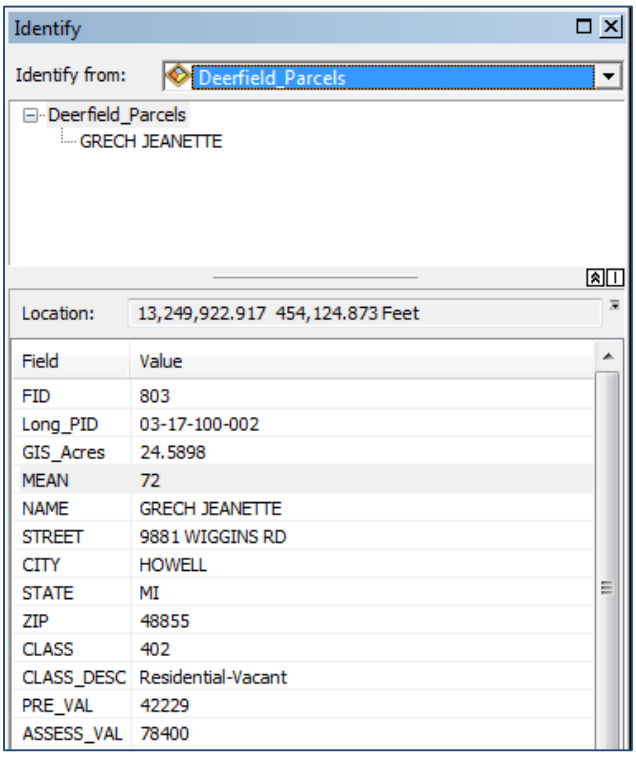
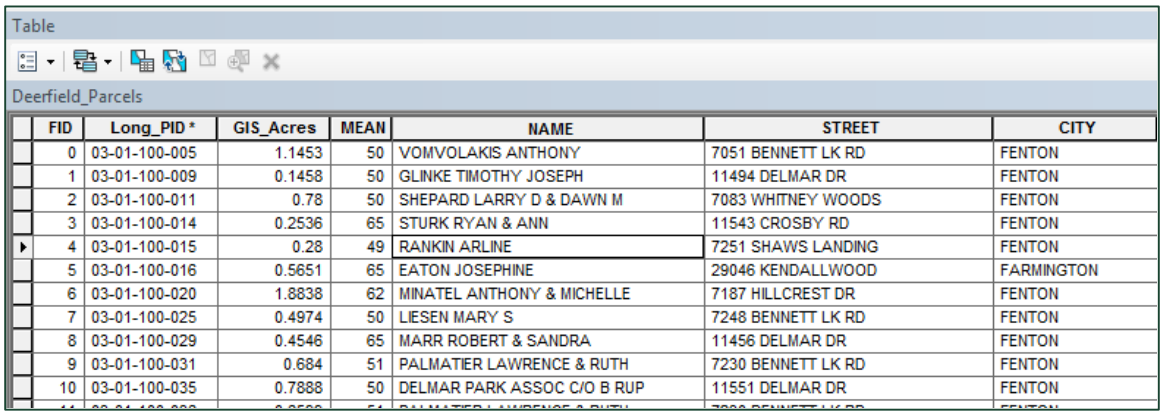


Figure 3.6. Attribute Table for Deerfield Township Parcels.



Table

Deerfield_Parcels

FID	Long_PID *	GIS_Acres	MEAN	NAME	STREET	CITY
0	03-01-100-005	1.1453	50	VOMVOLAKIS ANTHONY	7051 BENNETT LK RD	FENTON
1	03-01-100-009	0.1458	50	GLINKE TIMOTHY JOSEPH	11494 DELMAR DR	FENTON
2	03-01-100-011	0.78	50	SHEPARD LARRY D & DAWN M	7083 WHITNEY WOODS	FENTON
3	03-01-100-014	0.2536	65	STURK RYAN & ANN	11543 CROSBY RD	FENTON
4	03-01-100-015	0.28	49	RANKIN ARLINE	7251 SHAWS LANDING	FENTON
5	03-01-100-016	0.5651	65	EATON JOSEPHINE	29046 KENDALLWOOD	FARMINGTON
6	03-01-100-020	1.8838	62	MINATEL ANTHONY & MICHELLE	7187 HILLCREST DR	FENTON
7	03-01-100-025	0.4974	50	LIESEN MARY S	7248 BENNETT LK RD	FENTON
8	03-01-100-029	0.4546	65	MARR ROBERT & SANDRA	11456 DELMAR DR	FENTON
9	03-01-100-031	0.684	51	PALMATIER LAWRENCE & RUTH	7230 BENNETT LK RD	FENTON
10	03-01-100-035	0.7888	50	DELMAR PARK ASSOC C/O B RUP	11551 DELMAR DR	FENTON

DISCUSSION

The multi-criteria evaluation approach takes decision-makers' preferences and converts them into quantities in order to compare a group of alternatives. Although it seems quantitative in nature, the decisions on which criteria to use, and what weights to assign to each, are completely subjective. When dealing with multiple stakeholders, this can be a way to average preferences, or reduce conflicting values.

The ability of GIS to produce impressive visual results is a great strength of this method. For many users, distributions can be better understood spatially rather than mathematically. The output maps encourage interaction, and allow the user to focus on any area of interest, from a single parcel to a countywide distribution. The ability to sort an attribute table based on a given parameter saves time compared to having to search through superfluous data.

This process had some limitations, including the impossibility of including all criteria desired by the board members. Some criteria, such as "habitat for threatened and endangered species," have no standard measurement, but could theoretically be calculated from habitat suitability models using similar remotely sensed data. Including this criterion, while important to the board, is beyond the scope of this project. However, the benefit of this process is that once the framework is built, it can be easily updated with additional layers, and simply re-run. Other criteria, such as "source of public education," could be quantified using proxies such as distance from schools.

In addition, while most of the data I used was free and easy to obtain and interpret, I had difficulty obtaining the parcel-level data from Livingston County. My hope is that as GIS-based decision-making becomes more widely used, that data will become less expensive and more widely available.

In order for this model to be as useful as possible, a sensitivity analysis (SA) should be performed. An SA looks at how the weights of each criterion impact the final cumulative score. By producing multiple output maps based on removing or varying criteria weights,

we can see how the individual inputs affect the overall model (Chen et al 2010). I predict that because the proportions of criteria are currently within 0.075 of each other, that changing one variable will not strongly affect the output, but this should be tested and modified as criteria, weights, and the number of stakeholders changes.

As I continue to work with the Conservancy, I will be writing a guide for how to use the GIS data and weighted sum model, and training their GIS technician on this tool. I would also like to include a geodatabase with other layers that were not included in this MCE but may be of interest in the future.

CONCLUSION

As seen in many case studies, decision-making for land allocation faces multiple challenges. The number of stakeholders, as well as the subjective nature of individual preferences, can be resolved by using the Multi-Criteria Evaluation approach. By using a weighted linear regression process, these preferences can be converted into weighted values that are combined to give a singular result. With this framework completed, the inputs can be changed as values shift and/or more data becomes available. The goal is that this process will streamline decision-making by saving time, reducing conflict, and making sure that only the highest-quality properties are purchased for conservation.

Chapter 4
Conclusion

I developed the following deliverables for LLC:
1. Management Plans for two nature preserves, Round Lake of Hartland Nature Preserve and Bullard Lake Nature Preserve. Each document contains a Master Plan, which includes adaptive management guidelines for existing and future properties, and Site Plans, which use natural communities as units for restoration and maintenance.

2. Searchable digital database containing primary data: maps, species lists, GIS data.

3. County-wide conservation planning tool based on the Multi-Criteria Evaluation. This includes a geodatabase that can be manipulated in the ArcGIS suite, as well as a user's guide.

4. A poster with the MCE process and output maps, on display as part of a student poster competition at the 2015 Stewardship Network Conference.

5. Oral presentations using Powerpoint slides were given to classes in Conservation Biology and Natural Resource Applications for GIS. A Capstone presentation was delivered to the SNRE community in April 2015.

This practicum provided me the opportunity to work with a local non-profit that shared my passion for conservation. By sitting in on board meetings, I learned about how the conservancy was run and the roles of each board member, as well as their relationships within the Livingston community. The project also required inter-agency cooperation for making land use decisions, in both the data gathering process as well as receiving feedback and support.

Quantitative methods to management and decision-making are gaining ground with practitioners. Both of these deliverables demonstrate the use of remotely sensed data and GIS in order to make conservation decisions. This practice will continue to expand, allowing for similar agencies to save time, effort, and money on management and conservation strategies.

LITERATURE CITED

Apple, B. A. and H. W. Reeves. 2007. Summary of Hydrogeologic Conditions by County for the State of Michigan. U.S. Geological Survey.

Atwell-Hicks. 2006. Threatened and Endangered Species Habitat Assessment for the Indiana Bat (Myotis sodalis).

Atwell-Hicks. 2008. Tree Survey Section 21 & 28, Town 3 North, Range 6 East, Hartland Township, Livingston County, MI. Herman, K.D. 2001. Floristic Quality Assessment with Wetland Categories and Examples of Computer Applications for the State of Michigan. Michigan Dept. of Natural Resources.

Borgmann, K. L. and A. D. Rodewald. 2005. Forest Restoration in Urbanizing Landscapes: Interactions Between Land Uses and Exotic Shrubs. Restoration Ecology 13(2): 334-340.

Brown, D. 2014. Multi-Criteria Evaluation and Multi-Objective Decision Making. Lecture outline and Lab for NRE 534.

Center for Shared Solutions and Technology Partnerships. Michigan Geographic Framework: All Roads. 2014.

Center for Shared Solutions and Technology Partnerships. Michigan Geographic Framework: Livingston County. 2014.

Chen, Y., Yu, J., and S. Khan. Spatial sensitivity analysis of multi-criteria weights in GIS-based land suitability evaluation. Environmental Modelling & Software 25: 1582-1591.

Christopher, C.C., Matter, S.F. and G. N. Cameron. Individual and interactive effects of Amur honeysuckle (Lonicera maackii) and white-tailed deer (Odocoileus virginianus) on herbs in a deciduous forest in the eastern United States. Biological Invasions.

Crow, T. R. 1988. Reproductive Mode and Mechanisms for Self-Replacement of Northern Red Oak (Quercus rubra)--A Review. Forest Science 34(1): 19-40.

D'Antonio, C. and L. A. Meyerson. 2002. Exotic Plant Species as Problems and Solutions in Ecological Restoration: A Synthesis. Restoration Ecology 10(4): 703-713.

D'antonio, C.M. & J.C. Chambers. Using Ecological Theory to Manage or Restore Ecosystems Affected by Invasive Plant Species. In Falk, D.A., Palmer, M.A., and J.B. Zedler (Eds.), Foundations of Restoration Ecology. 2006. Washington, D.C.: Island Press.

Eastman, J.R., Weigen, J., Kyem, P.A.K., Toledano, J. 1995. Raster Procedures for Multi-Criteria/Multi-Objective Decisions. Photogrammetric Engineering & Remote Sensing, 61 (5): 539-547.

Engberg, C.A. & F.R. Austin. 1974. Soil survey of Livingston County, Michigan. USDA Soil Conservation Service.

Farrand, W.R. 1988. The Glacial Lakes Around Michigan. Geological Survey Division, Michigan Department of Environmental Quality.

Franklin, S.B., Robertson, P.A., and J.S. Fralish. 2003. Prescribed burning effects on upland Quercus forest structure and function. Forest Ecology and Management 184: 315-335.

Freyman, W.A. and L.A. Masters. 2013. The Universal Floristic Quality Assessment (FQA) Calculator [Computer program]. Available at http://universalFQA.org (Accessed 6.1.14)

Harvey, D. S. and P. J. Weatherhead. 2006. A test of the hierarchical model of habitat selection using eastern massasauga rattlesnakes (Sistrurus c. catenatus). Biological Conservation 130: 206-216.

Herman, K.D., L.A. Masters, M.R. Penskar, A.A. Reznicek, G.S. Wilhelm, W.W. Brodovich, and K.P. Gardiner. 2001. Floristic quality assessment with wetland categories and examples of computer applications for the state of Michigan. 2nd Edition. Michigan Dept. of Natural Resources, Lansing, MI. 19 pp. + appendices. http://www.michigandnr.com/publications/pdfs/HuntingWildlifeHabitat/FQA_text.pdf

Herman, K.D., L.A. Masters, M.R. Penskar, A.A. Reznicek, G.S. Wilhelm, W.W. Brodovich, K.P. Gardiner. 2001. Floristic quality assessment with wetland categories and examples of computer applications for the state of Michigan. Revised, 2nd edition. Michigan Department of Natural Resources.

Howell, E. A., Harrington, J. A., and S. B. Glass. 2011. Introduction to Restoration Ecology (The Science and Practice of Ecological Restoration Series). Island Press.

Huron River Watershed Council. 2013. HWRC Bioreserve Site Assessment.

Jankowski, P. 1995. Integrating geographical information systems and multiple criteria decision-making methods. Int. J. Geographical Information Systems, 9(3): 251-273.

Jin, S., Yang, L., Danielson, P., Homer, C., Fry, J., and Xian, G. 2013.A comprehensive change detection method for updating the National Land Cover Database to circa 2011. Remote Sensing of Environment, 132: 159 – 175.

Kost, M.A. 2001. Natural community abstract for rich tamarack swamp. Michigan Natural Features Inventory, Lansing, MI. 7 pphttp://www.ewashtenaw.org/government/departments/parks_recreation/napp/preserves/goodrich.html

Kost, M.A., D.A. Albert, J.G. Cohen, B.S. Slaughter, R.K. Schillo, C.R. Weber, and K.A. Chapman. 2007. Natural Communities of Michigan: Classification and Description. Michigan Natural Features Inventory, Report No. 2007-21, Lansing, MI.

Land Trust Alliance. 2004. Land Trust Accreditation Standards and Practices.
Lee, J.G. 2007. Natural community abstract for dry- mesic southern forest. Michigan Natural Features Inventory, Lansing, MI. 16 pp.

Livingston County GIS Department. https://www.livgov.com.

Livingston Land Conservancy. May 2009. Baseline Documentation Report for the Round Lake of Hartland Nature Preserve.

Lorimer, C.G., Chapman, J.W. and W.D. Lambert. 1994. Tall Understorey Vegetation as a Factor in the Poor Development of Oak Seedlings Beneath Mature Stands. Journal of Ecology 82(2): 227-237.

Luneack, Meredith & Sara Thomas. April 2013. Round Lake of Hartland Preserve Management Plan – Draft.

MDNR, Forest, Mineral and Fire Management Division. 2003. IFMAP/GAP Lower Peninsula Land Cover.

Michigan Department of Environmental Quality. 2011. Michigan's Major Watersheds - Subbasins.

Michigan Department of Natural Resources and Environment. 2010. Michigan Rapid Assessment Methods for Wetlands. MiRAM Version 2.1.

Michigan Department of Natural Resources. 1999. Land Use/Land Cover 1978.

Michigan Flora Online. A. A. Reznicek, E. G. Voss, & B. S. Walters. February 2011. University of Michigan. Web. 9-14-2014. http://www.michiganflora.net/home.aspx.

Michigan Geographic Data Library. http://www.mcgi.state.mi.us/mgdl/

Michigan Natural Features Inventory, Vegetation circa 1800 Maps. Michigan State University Extension. Available online at http://mnfi.anr.msu.edu/data/veg1800.cfm. Accessed 12/10/14

Michigan Natural Features Inventory. Key to Michigan's Natural Communities. http://mnfi.anr.msu.edu/communities/key.cfm accessed 6.1.14.

Michigan Resource Information System. Template - Landuse/Cover Circa1800 Arc. 1978.

Michigan State University Department of Geography. Michigan State Climatologist's Office. Climate tables for East Lansing, MI. http://climate.geo.msu.edu/climate_mi/stations/2395 accessed April 2014.

Minnesota Department of Natural Resources. Controlling purple loosestrife with herbicides. http://www.dnr.state.mn.us/invasives/aquaticplants/purpleloosestrife/control_herbicides.html. Accessed April 20 2015.

Natural Resource Conservation Service (NRCS). SSURGO Soils. 2000.

Nowacki, G.J. and M.D. Adams. 2008. The Demise of Fire and "Mesophication" of Forests in the Eastern United States. Bioscience 58(2): 123-138.

Reznicek, A.A., E.G. Voss, and B.S. Walters. February 2011. MICHIGAN FLORA ONLINE. University of Michigan. http://michiganflora.net/home.aspx

Rosa, E. A., York, R., and T. Dietz. 2004. Tracking the Anthropogenic Drivers of Ecological Impacts. Royal Swedish Academy of Sciences 33(8): 509-512.

School of Natural Resources and Environment. 2014. Master's Project Proposal Submission Form: Livingston Land Conservancy.

Southeast Michigan Council of Governments. http://semcog.org/Data-and-Maps/GIS.

Sudding, K. N. 2011. Toward an Era of Restoration in Ecology: Successes, Failures, and Opportunities Ahead. Annu. Rev. Ecol. Evol. Sys. 42: 465-487.

Thomas, Sara. Baseline Documentation Report for the Bullard Lake Nature Preserve. Hartland Township, Livingston County, Michigan. December 19 2013.

Thomas, Sara. June 2010. Baseline Documentation Report for the Round Lake of Hartland Nature Preserve – East.

Thomas, Sara. March 2009. Wal-Mart property, Hartland Township Baseline Environmental Assessment Review.

Thomas, Sara. May 12 2010. Baseline Documentation Report for the Round Lake of Hartland Nature Preserve – North.

U.S. Fish & Wildlife Service, National Wetlands Inventory. National Wetlands Inventory Data. 1979-1994.

United States Census Bureau. 2010. Livingston County, Michigan Census Survey. http://quickfacts.census.gov/qfd/states/26/26093lk.html accessed April 2015.

United States Department of Agriculture Forest Service. Monitoring Bird Populations by Point Counts. April 1997.

United States Department of Agriculture. Web Soil Survey.

United States Fish and Wildlife Service. 2007. Phragmites: Questions and Answers. http://www.fws.gov/gomcp/pdfs/phragmitesqa_factsheet.pdf. Accessed April 2015.

United States Geological Survey 2007. Summary of Hydrogeologic Conditions by County for the State of Michigan. http://pubs.usgs.gov/of/2007/1236/pdf/OFR2007-1236.pdf accessed April 2015.

University of Michigan Library - Articles Plus http://www.lib.umich.edu

USDA/NRCS - National Geospatial Management Center. 12 Digit Watershed Boundary Dataset. 2013.

Vogt, C. A. and R. W. Marans. 2003. Natural resources and open space in the residential decision process: a study of recent movers to fringe counties in southeast Michigan. Landscape and Urban Planning 69(2-3): 255-269.

Voss, E. G. and A. A. Reznicek. 2011. Field Manual of the Michigan Flora. University of Michigan Press, Ann Arbor, MI. 990 pp.