Kalamazoo River Watershed Land Conservation Plan

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Abstract: The Kalamazoo River Watershed Land Conservation Plan was developed to select for conservation targets among ownership parcels in the Kalamazoo River Watershed (MI). The watershed, while historically degraded, features large areas of preserved Midwestern habitats. To facilitate for the permanent protection of these lands, this plan was developed using an ArcGIS-based analysis that scored ownership parcels based on the following conservation criteria: land cover, presence of wetlands, proximity to hydrology, proximity to existing conserved lands, presence of cold lands, and presence of threatened and endangered species habitat. These criteria were developed using a literature review of existing conservation plans and Kalamazoo River Watershed stakeholder input. The results from this analysis were used to identify conservation priorities, including: the top 100 scoring parcels in the basin, a database of the top 20% scoring parcels and their contact information, and priority subwatersheds for conservation.

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Acronyms

AOC – Area of Concern
BUI – Beneficial Use Impairment
C-CAP – Coastal Change Analysis Program
CERCLA – Comprehensive Environmental Response, Compensation and Liability Act
FEMA – Federal Emergency Management Agency
GIS – Geographic Information System
GLWQA – Great Lakes Water Quality Agreement
HI – Habitat Index
HUC – Hydrologic Unit
IBI – Index of Biotic Integrity
KRWC – Kalamazoo River Watershed Council
KRWLCP – Kalamazoo River Watershed Land Conservation Plan
KRWMP – Kalamazoo River Watershed Management Plan
KRWPAC – Kalamazoo River Watershed Public Advisory Council
MDEQ – Michigan Department of Environmental Quality
MDNR – Michigan Department of Natural Resources
MI – Michigan
MiGDL – Michigan Geographic Data Library
MNFI – Michigan Natural Features Inventory
NPL – National Priority List
NWI – National Wetlands Inventory
OGL – Office of the Great Lakes
OU – Operable Unit
PCB – Polychlorinated-biphenyl
RAP – Remedial Action Plan
ROD – Records of Decision
SNRE – University of Michigan School of Natural Resources and Environment
SWMLC – Southwest Michigan Land Conservancy
TCRA- Time Critical Removal Actions
TMDL – Total Maximum Daily Load
USEPA – United States Environmental Protection Agency
WRD – Michigan Department of Environmental Quality, Water Resources Division

WWAT – Water Withdrawal Assessment Tool

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1.0-Introduction

The Kalamazoo River Land Conservation Plan (KRWLCP) is organized into the following sections:

- Introduction and Background
- Conservation Criteria
- Ranking and Weighting
- GIS Methods
- Conservation Model Results
- Area of Concern Conservation Strategy and Results
- Discussion and Community Outreach

1.1 Background (The Kalamazoo River)

The Kalamazoo River Watershed drains a total area of 2,020 square miles in southwestern Michigan (MI) and includes portions of ten counties (Figure-1): Allegan, Barry, Calhoun, Eaton, Hillsdale, Jackson, Kalamazoo, Kent, Ottawa, and Van Buren (Kalamazoo River Watershed Council (KRWC), 2011). This drainage area makes the watershed the seventh largest river basin in the State of Michigan (Wesley, 2005). The main stem of the Kalamazoo River forms near Albion, MI at the confluence of the North and South Branches of the river and flows west for 123 miles before discharging into Lake Michigan near Saugatuck, MI (Kalamazoo River Watershed Public Advisory Council (KRWPAC), 1998). The North and South Branches of the river originate further upstream in southern Jackson County and northeastern Hillsdale County, respectively (KRWC, 2011). Measured from the headwaters of the South Branch to Lake Michigan, the river has a total length of 175 miles; additionally, the basin features 899 miles of tributaries (Wesley, 2005).

The Kalamazoo River and its basin have been significantly shaped by human activities. Archeological evidence suggests that there has been a human presence in the area for over 11,000 years (KRWPAC, 1998). However, it was during the 19th century that the watershed began to see major human impacts; during this era, the cities of Battle Creek, Kalamazoo, Parchment, Plainwell, and Otsego developed into commercial centers and began hosting industries such as cereal, pharmaceuticals, automobile parts, and paper production (KRWC, 2011). Over this period, the basin saw further alterations in the form of dam and impoundment construction. Currently, there are over 100 dams in the watershed, including 15 on the Kalamazoo River mainstem (Wesley, 2005). By the mid-20th century, industrial contamination and other human stressors rendered the Kalamazoo River severely degraded. During this period, the river was considered an "eyesore" and largely avoided by the public (KRWPAC, 1998). However, since the passage of the Clean Water Act in the early 1970s, major efforts have been taken in the United States to restore surface waters. The Kalamazoo River is no exception and is much cleaner today than it was during this previous era. Thanks to regulation of point-sources and efforts to restore the river, the Kalamazoo River Watershed has seen an improvement in water quality, both in terms of clarity and safety, and is witnessing a return of diverse fish and clam communities (KRWC, 2011).

Today, the Kalamazoo River Watershed faces a different set of challenges. Despite the recovery that has been made, the legacy of industrial contamination still looms large over the river, most notably in the form of polychlorinated-biphenyl (PCB) contamination from earlier de-inking practices utilized by the paper industry. This legacy is epitomized by the Kalamazoo River's status as an Area of Concern (AOC) under the 1987 Great Lakes Water Quality Agreement (GLWQA) and the designation of an 80-mile stretch of the river from Morrow Lake dam to Lake Michigan as a federal "Superfund" site (KRWC, 2011). Additionally, while point-source pollution has largely been controlled by the Clean Water Act, non-point source pollution still threatens the integrity of the basin's surface waters. For example, Lake Allegan, a large lake formed by an impoundment west of Allegan, MI, suffers from eutrophication and has a Total Maximum Daily Load (TMDL) for total phosphorous due to non-point nutrient loading; several other TMDLs are also being targeted for development as a result of non-point source pollution. In addition to phosphorus, sediments and microbial pathogens are non-point source pollutants of concern within the watershed (KRWC, 2011). Addressing these diffuse sources of pollution is of primary concern for the health of the Kalamazoo River Watershed moving forward.

1.2 Purpose (The Land Conservation Plan)

In March 2011, the KRWC completed the *Kalamazoo River Watershed Management Plan* (KRWMP) to provide a unified vision for water resource management in the Kalamazoo River Watershed. In doing so the KRWMP "sets a direction for policy and management decisions over at least the next decade and should be used as a guide for policy setting, decision-making and prioritizing actions originating from funding agencies, governmental units, private entities, organizations, and individuals" (KRWC, 2011). In order to provide for effective implementation, the KRWMP outlines a number of specific goals to be achieved; these goals not only promote the health of the watershed, but are also intended to serve as guideposts to assess progress and keep watershed stakeholders moving in the same direction. These goals are split into two categories: goals and objectives for restoring and protecting the **designated uses** of water bodies as required by state and federal water quality programs, and goals for achieving **desired uses** which have been identified by watershed stakeholders and do not necessarily pertain to water quality.

A prominent component of the vision presented in the KRWMP, and featured specifically in its goals, is land conservation. The conservation of critical natural features present in the watershed is emphasized as an important strategy for preventing non-point source water pollution and protecting important ecosystem functions. Goals related to this strategy call for a watershed-wide conservation planning effort to prioritize lands to conserve. Specifically, the first designated use goal of the KRWMP calls for the development of a "watershed-wide land conservation vision" in an effort to "preserve and restore wetlands and open space". Additionally, KRWMP "desired use" goals include the following:

- Goal 1. Promote and implement coordinated land use planning in the Kalamazoo River Watershed
- Goal 3. Protect open space and promote sustainable agricultural practices
- Goal 4. Protect habitat for native aquatic and terrestrial wildlife
- Goal 6. Improve recreation infrastructure along river while respecting natural features

Thus, the purpose of the *Kalamazoo River Watershed Land Conservation Plan* (KRWLCP) is to address these goals and direct future conservation activities in the basin. To do so, **the KRWLCP identifies lands in the watershed that are of the highest priority for conservation based on their natural features and contribution to the overall health of water bodies in the watershed.** These high priority areas were identified using a geographic information system (GIS) overlay analysis that incorporated a set of conservation criteria derived from stakeholder input and the aforementioned goals detailed in the KRWMP. The KRWLCP is intended to serve as an appendix to the KRWMP and provide a watershed-wide conservation strategy for the Kalamazoo River basin.

1.3 KRWLCP Strategy

There is a real opportunity to promote the health of the Kalamazoo River Watershed through land conservation. Despite its history of pollution, the watershed maintains an abundance of natural landscapes, including high quality headwater streams, wetlands, and floodplains. Additionally, the watershed features several large patches of contiguous forest and grassland areas and a number of state parks and game areas; in total, there are about 55,000 acres of publically owned land in the basin (KRWC, 2011). Conserving critical areas will benefit the watershed by preserving important ecosystem functions that promote water quality and the overall condition of the basin. Additionally, conservation will prevent development in environmentally important areas, such as floodplains and wetlands. According to an analysis conducted by Kieser & Associates, LLC for the KRWMP, urban land cover only makes up 8% of the watershed's area but may be responsible for up to 50% of overall non-point source phosphorous loading to the Kalamazoo River (Kieser & Associates, LLC, 2010). This figure speaks to significant contribution of developed land to non-point source pollution. Land conservation can mitigate this contribution by directing development away from particularly important natural areas.

To identify these high priority areas for conservation, the KRWLCP utilized ArcGIS software to perform an overlay analysis of the watershed. Overlay analysis is conducted by superimposing different types of spatial information regarding a location in order to study relationships (ESRI, n.d.). In the KRWLCP, GIS is used to "stack" a set of conservation criteria on top of each other to reveal areas in the watershed that, if conserved, stand to contribute positively to overall water quality. GIS overlay has been widely applied within the practice of land use management to provide decision support in a wide variety of contexts including agriculture, forestry, recreation, and transportation (Hamerlinck, 2010). Common applications involve solving site selection and site suitability problems (Armenakis & Nirupama, 2012). Using GIS to identify candidate areas for conservation is also a well-established practice (Foody, 2008), as is its use in watershed management; for example, Zhang et al. (2011) describe the development of the Watershed Management Priority Indices which uses web-based GIS software to assist in watershed planning decisions.

Conservation of existing high quality landscapes, as opposed to the restoration of degraded landscapes, is the mainspring behind the KRWLCP GIS model. Identified below, and discussed further in Section 2.2, are the six conservation criteria utilized in the KRWLCP GIS analysis to identify high priority areas to focus future land conservation efforts. Unlike many conservation models, the KRWLCP utilizes criteria that emphasize the conservation of lands highly contributable to improved water quality within the watershed.

- Current Land Cover
- Presence of Wetlands
- Hydrology Buffer
- Proximity to Conserved Lands
- Presence of Cold Streams
- Threatened and Endangered Species

A weighting and ranking scheme is used in the GIS conservation model to give emphasis to the most important of these conservation criteria. Weighting is a common practice in multi-criteria overlay evaluations such as this and is used to assign more importance to some criteria over others based on the objective of the analysis (Walke, Obi Reddy, Maji, & Thayalan, 2012). The weighting and ranking schemed utilized in the KRWLCP is detailed in Section 3.

The conservation emphasis of the KRWLCP is in no way intended to devalue the restoration potential of lands identified by the conservation model. On the contrary, many of the Recovery Potential Indicators identified by the United States Environmental Protection Agency (USEPA) overlap with the conservation criteria identified by the KRWLCP and are utilized by the conservation model (USEPA, 2012). Restoration remains an important strategy in the management of the Kalamazoo River Watershed but is not the primary focus of this plan.

2.0- Conservation Criteria

In order to prioritize lands in the Kalamazoo River Watershed, the GIS conservation model identified ownership parcels in the watershed that exhibited high conservation values based on six conservation criteria:

- Current Land Cover
- Presence of Wetlands
- Hydrology Buffer
- Proximity to Conserved Lands
- Presence of Cold Streams
- Threatened and Endangered Species

2.1 Criteria Selection

In a collaborative effort, a planning team comprised of five students from the University of Michigan-School of Natural Resources and Environment (SNRE), the Southwest Michigan Land Conservancy (SWMLC), and the KRWC convened over an approximate six month period to discuss and ultimately decide on the conservation criteria used in the GIS conservation model. Throughout the process, experts in the field and stakeholders from within the Kalamazoo River Watershed were solicited for their local knowledge and understanding of conservation values and threats within the watershed.

The conservation criteria used in the model were largely derived from protection priorities identified in the KRWMP. Specifically, section four of the plan entitled "Natural Features and their Protection" provides a list of natural features that are of particular importance for management and protection. Broadly, these natural features of importance include:

- Terrestrial Ecosystems
- Streams and Rivers
- Lakes
- Wetlands and Floodplains
- Rare Species and Features

- Invasive Species

Because this is a conservation plan, mitigation of invasive species already present in the watershed is not represented in the GIS conservation model. However, the remaining emphasized natural features are represented by one or more layer. Table-1 illustrates conservation criteria, aligned against KRWMP natural features of importance. The GIS methodology used in this plan is discussed in detail in Section 4.

Table-1: Criteria and Natural Features Comparison

Criteria	Data Layer	KRWMP Natural Features
Land Cover	C-CAP 2006	Terrestrial Ecosystems
Wetlands	NWI 2005	Wetlands
Hydrology Buffer	MiGDL 2009	Floodplain, Streams and Rivers, Lakes
Proximity to Conserved Lands	CARL	Terrestrial Ecosystems
Cold Streams	WWAT Rivers and Streams	Streams and Rivers
Threatened and Endangered Species	MNFI	Rare Features and Species

The conservation criteria were also influenced by input from a variety of watershed stakeholders. In June 2013, a watershed stakeholder meeting was held to begin the conservation planning process; this meeting was well-attended by representatives of numerous organizations and agencies active in watershed management in the basin. A list of stakeholder attendees at this meeting is included in Attachment-1. Attendees were given the opportunity to identify conservation ideals that should guide the KRWLCP as well as threats to water quality in the basin. The ideals and threats identified by stakeholders were used in the development of the conservation criteria; concerns were closely related to the natural features highlighted in the KRWMP. Table-2 illustrates how the GIS model criteria approximate certain conservation values and threats that were identified at this meeting.

Table-2: Stakeholder Values and Threats

Criteria	Stakeholder Conservation Values	Stakeholder Conservation Threats
Land Cover	Landscape perspective, Ecosystem functions	Stormwater, Nutrient runoff
Wetlands	Water quality, Groundwater recharge	Wetland loss, Nutrient Runoff
Hydrology Buffer	Tourism, Flood control, Water quality abatement	Stormwater, Nutrient runoff
Proximity to Conserved Lands	Wildlife corridors, connectivity, recreation	Fragmentation of habitat
Cold Streams	Recreation, Tourism, Habitat preservation	Water Withdrawals, Temperature
Threatened and Endangered Species	Threatened Species protection, Habitat protection	Fragmentation of habitat

2.2 Criteria Descriptions

The subsequent sections detail the six conservation criteria used in the GIS conservation model to identify high priority parcels within the Kalamazoo River Watershed.

2.2.1 Land Cover

According to the USEPA, State reporting has identified non-point source pollution as the leading cause of water quality problems in the United States (USEPA, 2012). Because contaminated runoff from non-natural land covers is a principal component of non-point source pollution to surface waters, land cover is intimately linked with water quality. Scientific literature confirms that there is a strong relationship between land cover and water quality, with numerous studies documenting a correlation between water quality parameters and the proportion of different land covers within a watershed (Lee, Hwang, Lee, Hwang, & Sung, 2009). For example, Roth et al were able to use GIS-derived estimations of land cover within the River Raisin Watershed (MI) to predict variations in index of biotic integrity (IBI) and habitat index (HI) scores at downstream sites (Roth, Allan, & Erickson, 1996). A number of mechanisms through which land cover affects stream ecosystems have been identified and studied, including: sedimentation, nutrient enrichment, contaminant pollution, hydrologic alteration, riparian clearing, and loss of large woody debris (Allan, 2004).

In general, non-natural land covers have been associated with degraded water quality while natural land covers such as forest and grasslands have been linked to healthy watersheds. Within the Kalamazoo River Watershed, two land covers, urban and agriculture, have been found to produce runoff that significantly contributes to water quality problems (Wesley, 2005). Currently, by land cover, the watershed is approximately 47% farmland, 21% forest, 9% open land, and 7% developed (KRWC, 2011); conserving key natural land covers in the watershed will prevent land cover-related water quality degradation as a result of conversion to a non-natural land use. Agriculture, urban, and natural land covers in particular have a dramatic impact on watershed health and thus, have been given special consideration in the KRWLCP GIS analysis. Current land cover for the Kalamazoo River Watershed is illustrated in Figure-2.

Agriculture

Agricultural lands have been found to contribute to nutrient loading, bank instability, erosion, pesticides, pathogens, and lower levels of biodiversity in surface waters (USEPA Office of Water, 2011). It is believed that agricultural lands are accountable for approximately 46% of sediment, 47% of total phosphorus, and 52% of total nitrogen discharges into U.S. waterways (Allan & Castillo, 2007). Case studies confirm these findings and indicate that watersheds with a high proportion of agricultural land are likely to be subject to degraded water quality. A study of North Carolina streams found that the percentage of agriculture at the watershed scale was strongly related to poorer water quality as measured by benthic macroinvertebrate community structure (Potter, Cubbage, & Blank, 2004). Similarly, an analysis of 103 Wisconsin streams found that agricultural land cover was negatively correlated with IBI scores and habitat quality (Wang, Lyons, Kanehl, & Gatti, 1997).

Urban

Urbanization is accompanied by the proliferation of impervious surfaces such as buildings and pavement which do not allow precipitation to infiltrate into the ground. These impervious surfaces increase the volume of stormwater runoff, which has the potential to carry sediment, nutrients, toxic chemicals, road salts, heavy metals and other harmful pollutants into surface waters (USEPA, 2013). Streams suffering from the impacts of urbanization are often afflicted with what has come to be known as “urban stream syndrome”, symptoms of which include: flashier hydrographs, increased levels of nutrients and contaminants, and reduced biotic richness and diversity (Wallace, Croft-White, & Moryk, 2013). Consequently, the proportion of urban land within a watershed has been statistically linked with changes in biological communities within streams. For example, of several land cover categories studied, percent urban land was found to be most strongly associated with benthic macroinvertebrate IBI scores in a study conducted in Western Washington (Morley & Karr, 2002). Additionally, impervious surfaces have the potential to alter both the hydrology and geomorphology of streams as they are forced to respond to altered amounts of runoff and decreased infiltration (Paul & Meyer, 2001).

Natural Land Covers

While agriculture and urban land covers are correlated with water quality degradation, natural land covers including forest, wetlands, and grasslands exhibit the opposite relationship. In the River Raisin Watershed, IBI and HI scores were found to be higher in sites that contained a higher proportion of natural vegetated land (Roth, Allan, & Erickson, 1996). Likewise, the proportion of forest cover within a watershed has been correlated with better stream conditions in North Carolina (Potter, Cubbage, & Blank, 2004). In general, natural land covers have been associated with reduced pollutant runoff and normal flow dynamics and their presence within a watershed has been used as an indicator for ecological health (USEPA, 2012).

GIS Layer

Land cover is represented in the KRWLCP GIS model through the layer 2006 Coastal Change Analysis Program (C-CAP).

2.2.2 Wetlands

While various natural land cover types, including forests and grasslands, are linked to overall watershed health, wetlands have been widely recognized for their added contributions to improved water quality. Important wetland functions include an ability to store large volumes of water, filtration capabilities, and enhanced biological productivity (USEPA, 2001). Increasingly, these ecosystem services are being recognized and quantified for their economic benefits, including flood control, contributions to improved drinking water, fisheries health, recreational benefits and more (USEPA, 2006).

Water Storage and Water Quality

Wetlands, especially those located within floodplains or in close proximity to open water bodies, are recognized for their ability to act as sponges, providing water storage capacity and mitigating the effects of flash floods and extreme runoff events (Carter, 1997). While a single wetland's water storage capacity varies depending on its physical, chemical, and biological attributes, an average one-acre wetland can store approximately one million gallons of water (USEPA, 2006). Additionally, many wetlands are able to function as sediment, nutrient, and pollutant sinks, though the ability of a wetland to perform any of these functions varies depending on its specific features. However, in general, watersheds with more wetlands tend to have lower concentrations of nutrients, suspended solids, and other pollutants when compared to watersheds with few or no wetlands (Carter, 1997).

Biological Productivity

Wetlands are recognized as being biologically productive ecosystems, providing habitat for both terrestrial and aquatic life (USEPA, 2001). The biological significance of wetlands is compounded by their relatively low abundance when compared to historic land cover data. Many wetlands serve as home to threatened and endangered species of both flora and fauna within Michigan, and exist as unique environments in and of themselves.

Wetland Trends in Michigan

Historically, southern Michigan has lost an approximated 66% of wetlands (roughly 3,320,000 acres) when compared to pre-European land cover data (MDEQ, n.d.). Currently, wetlands make up approximately 13% of the Kalamazoo River Watershed land cover which is comparable to the statewide average for Michigan's Lower Peninsula (KRWC, 2011). Figure-3 illustrates the current distribution of wetlands in the Kalamazoo River Watershed.

GIS Layer

The GIS conservation model utilizes the 2005 National Wetlands Inventory (NWI) layer to represent the wetlands conservation criteria.

2.2.3 Hydrology Buffer

For the purpose of the KRWLCP, the hydrology buffer criterion is included to capture the value of those lands which, because of their spatial relationship to surface water bodies, act as riparian buffer zones. The criterion also serves to capture the value of those lands that reside within the 100-year floodplain of the Kalamazoo River and its tributaries.

Riparian Buffer

Riparian buffers, for the purpose of the KRWLCP, are vegetated lands (lands dominated by natural land cover) that are located adjacent to or within some proximity to surface water bodies such as rivers, streams, lakes, and open wetlands. Riparian vegetative buffer strips are valued for their contributions to adjacent water bodies, including stream temperature moderation, sediment reduction, and nutrient reduction (Osborne & Kovacic, 1993). Given the dynamic nature of non-point source pollution within the Kalamazoo River Watershed, there is no "one size fits all" prescription for riparian buffer size or location. Specific site conditions, such as topography, geology, hydrology, and land use need to be taken into consideration when determining the most effective riparian buffer width and location for any given site. While buffer strips as small as 1-25 meters in width have been found to be effective at removing nutrients, some studies suggest land covers as far as 4,000 meters away are directly linked to sediment and nutrient levels in adjacent water bodies (Houlahan & Findlay, 2004). These findings suggest that small scale solutions, only focusing on individual sites within a close proximity to open water, may be unsuccessful in addressing water quality problems at the watershed scale. Thus, those natural lands located both directly adjacent to water bodies, as well as those located many thousands of feet away, should be recognized for their potential ability to influence the overall water quality within a watershed.

Floodplains

The Federal Emergency Management Agency (FEMA) defines the 100-year floodplain as the area that has a one-percent chance of being inundated by a flood during any given year (FEMA). Within the context of the KRWLCP, this area is recognized for its potential to contain lands with many of the qualities associated with riparian buffers. Additionally, it is acknowledged that the conservation of lands within the 100-year floodplain may have economic benefits to communities, including the mitigation of costly flood damage, recreational opportunities, and aesthetics (Kousky & Walls, 2013).

GIS Layer

The hydrology buffers used in the KRWLCP GIS model were created using the Stream Rivers Assessment Units and Inland Lake Assessment Units layers downloaded from the Michigan Geographic Data Library. These two layers were combined to represent all surface water bodies.

2.2.4 Proximity to Conserved Lands

Parcels that are in close proximity to existing conserved lands in the watershed are given priority in the KRWLCP for logistical reasons. With over 55,000 acres of land already in a state of preservation, the watershed features a vast network of conserved and recreational lands (Figure-4). For the organizations and agencies tasked with managing these lands, adding additional acreage in close proximity to these preserves makes practical sense. Maintaining additional preserves will require significant work but can be made easier for land managers by prioritizing areas near existing conserved lands. Additionally, prioritizing parcels near existing conserved lands allows for the expansion of the watershed’s existing recreational infrastructure and will provide the public with greater opportunity to utilize them.

From a landscape-level perspective, the KRWLCP seeks to identify opportunities where adjacent parcels can be added onto already conserved lands. While the focus of this plan is water quality, conserving contiguous patches of natural land can provide significant benefits to terrestrial ecosystems and opportunities to do so should be considered. Habitat fragmentation, broadly, occurs when human-induced land conversion results in disjointed patches where contiguous habitat once existed (Lewis, Plantinga, & Wu, 2009). Such fragmentation is thought to threaten biodiversity and compromise the integrity of ecological systems through a variety of mechanisms such as edge effects, creating conditions that encourage exotic species invasion, and general habitat loss and isolation (Collinge, 1996). Using spatial models to simulate landscape management decisions, Huxel and Hastings (1999) found that restoring habitats adjacent to existing habitat can increase the efficacy of species recovery projects. This study speaks to the importance of considering adjacency in land use management decisions. To this end, the KRWLCP prioritizes parcels that are near existing conserved lands.

GIS Layer

Conserved lands are incorporated into the GIS model using the Conserved and Recreational Lands (CARL) layer developed by Ducks Unlimited (Ducks Unlimited, n.d.). For Michigan, this data includes conserved and recreational lands owned or protected by a variety of public and private organizations (The Nature Conservancy, 2007).

2.2.5 Cold Streams

Cold streams are a unique feature of the Kalamazoo River Watershed that warrant special consideration in the KRWLCP. As defined by the Michigan Department of Natural Resources (MDNR) - Fisheries Division, cold streams are those which typically have drainage areas of less than 80 square miles and maintain mean water temperatures of less than 63.5 degrees Fahrenheit during July (Institute of Water Research, Michigan State University, 2008). Cold streams in the Kalamazoo River Watershed obtain their distinct thermal characteristics via a significant contribution of groundwater (Wesley, 2005). According to the KRWMP, the cold streams in the basin represent some of the southernmost trout streams in the Midwest (KRWC, 2011). Cold streams provided habitat to a unique assemblage of fish including the brook trout, a sought-after game fish and the state fish of Michigan (MDNR, n.d.). Further, recreational activities related to the brook trout fishery provide significant revenue to the state of Michigan (Hamilton & Seelbach, 2011). Current cold stream distribution in the Kalamazoo River Watershed is illustrated in Figure-5.

Sensitivity

Unfortunately, land cover changes threaten to warm temperatures in cold streams, which can have deleterious effects on their biological communities. In particular, two land cover mechanisms that threaten cold streams in the Kalamazoo River Watershed have been identified in the KRWMP: **increased stormwater** as a result of impervious surfaces or the loss of riparian vegetation and **reduced canopy** cover as a result of riparian vegetation removal (KRWC, 2011). Fortunately, maintaining natural vegetation in riparian areas adjacent to cold streams can mitigate these impacts. For example, vegetation can interrupt and filter stormwater runoff and also provide shade from the sun to small streams (MDNR; MDEQ, 2009).

It is also important to consider the impact that land cover change can have on groundwater recharge. Because cold streams often maintain cold temperatures as a result of high contributions of groundwater flow, they can be significantly influenced by recharge rates. A study conducted in coldwater tributaries of the Muskegon River (MI) found that land cover alterations that affect recharge have the potential to influence the ability of streams to support brook trout (Waco & Taylor, 2010). For example, the conversion of grassland to urban land was predicted to increase stream temperatures as a result of reduced groundwater recharge (Waco & Taylor, 2010). For this reason, natural land covers near cold streams are given priority in the KRWLMP in an attempt to prevent alterations to groundwater recharge rates near these sensitive features.

GIS Layer

Cold streams are identified in the GIS conservation model using the "Streams and Rivers" layer utilized in Michigan's Water Withdrawal Assessment Tool (WWAT). This data layer uses a fish assemblage classification system that categorizes river segments by size and temperature using the variables drainage area and July mean water temperature, respectively (Hamilton & Seelbach, 2011).

2.2.6 Threatened and Endangered Species

The rare species of southwest Michigan are of environmental and cultural importance, adding value to the landscape via biodiversity, ecosystem services, recreational opportunities, and intrinsic value. While biodiversity is valued in and of itself, the habitats that support threatened and endangered species are also recognized as containing desirable qualities, representative of overall ecosystem health and resiliency (FWS, n.d.). Unfortunately, the rare species of the Kalamazoo River Watershed are threatened by anthropogenic and natural stressors, including climate change, land use changes, habitat fragmentation, and invasive species (KRWC, 2011). Through the identification and conservation of the habitats that support threatened and endangered species, it is anticipated that these recognized threats can be alleviated.

Rare Species in the Watershed

The Kalamazoo River Watershed includes portions of 10 southwest Michigan counties. In total, these counties contain nine **(9)** federally endangered and three **(3)** federally threatened species of flora and/or fauna. Table-3 summarizes the number of federally and state listed endangered and threatened species by county. Threatened and endangered species data were obtained through the Michigan Natural Features Inventory (MNFI) website.

Table-3: Number of Federally and State Listed Threatened and Endangered Species by County

County	State Endangered	State Threatened	Federal Endangered	Federal Threatened
Allegan	15	50	1	1
Barry	10	29	2	1
Calhoun	12	22	1	2
Eaton	6	10	1	2
Hillsdale	15	18	3	1
Jackson	10	27	2	0
Kalamazoo	18	62	2	0
Kent	13	45	3	0
Ottawa	9	27	0	1
Van Buren	17	43	2	1

GIS Layer and Model

Threatened and endangered species are represented in the GIS conservation model through the *Biological rarity index and probability value* GIS layer developed by the Michigan State University Extension as part of the Michigan Natural Features Inventory. For the purposes of the KRWLCP, the **Probability Model** was utilized to determine the likelihood that a threatened or endangered species exist in a given area. The probability model takes into consideration the spatial extent of an occurrence (sighting of a rare species), the presence of suitable habitat for the observed species, and the date of the most recent occurrence (Schools, Enander, & Paskus, n.d.). Based on combinations of the above criteria, an area within the model receives a probability score of high, medium, or low. Given the inclusion of suitable habitat conditions, the probability model allows the user to focus conservation efforts in areas where both species and habitat type are desirable.

3.0-Weighting and Ranking of Conservation Criteria

The conservation criteria used in the KRWLCP each received a weighting based on their relative importance to water quality or the general health of the watershed. These weights acted as a multiplier and were used to add emphasis to the most important criteria in the GIS conservation model. In addition to a weight, each criterion featured an internal ranking that assigned a value to the categories found in the data layer's attribute of interest. These ranking scores were based on each category's impact to water quality and the health of the watershed. To illustrate, consider the criterion of land cover. The data layer that represents land cover contains an attribute which describes land cover categories such as urban or forest; each attribute within this category was ranked based on its water quality or ecological impact. The weightings and rankings utilized in the GIS conservation model are shown in Table-4. The following sections will describe the weighting and ranking decisions in detail.

Table-4: Criteria Weighting and Ranking

Data Layer	**Weighting (10 in sum)**	**Reclassified Categories (Within Attribute)**	**<u>Ranking</u> High=3 Medium=2 Low=1, 0**
Land Cover	2.75	Forested (all types), Grasslands Others	3 0
Wetlands	3.0	Presence (all types) Others (open water)	3 0
Hydrology Buffer	2.0	Within 1000ft of hydrology Within 2000ft Within 3000ft > 3000ft from hydrology	3 2 1 0
Proximity to Conserved Land	1.0	Within 1 mile of conserved lands Within 2 miles Within 3 miles > 3 miles from conserved lands	3 2 1 0
Trout Streams	0.75	Cold streams Others	3 0
Threatened and Endangered Species	0.50	High Moderate Low N/A	3 2 1 0

3.1 Weighting

In order to calibrate the conservation model to select for priority lands, numeric weights (multipliers) were assigned to each criterion. An individual criterion's weight, relative to other criteria, was selected based on its natural features and contribution to overall water quality within the watershed. In determining the appropriate weight, the planning team performed an applicable literature review and coordinated with experts in the ecological, biological, and natural resource management fields. Additionally, local stakeholder input was considered when determining the final weighting scheme.

The weighting process was carried out in an iterative manner, allowing for recalibration and course-correction, as necessary. Three parcels within the watershed were used as "dummy parcels" to calibrate the model against. Each parcel had a predetermined conservation value, agreed upon by the planning team. The model was regulated to ensure that the final conservation model "output" scored the dummy parcels appropriately. The GIS analytical methods are further discussed in Section 4. Final results, including scores obtained for the dummy parcels are presented in Section 5.3.

3.2 Ranking

The conservation criteria are included in the GIS conservation model as individual raster layers. With the exception of the land cover and threatened and endangered species, data was obtained in vector format and had to be rasterized. Each criterion was thus incorporated into the model as a data layer that contained a grid of cells populated by discrete attribute values representing some environmental information about that location in the watershed. These attribute values were assigned based on the internal ranking described in Table-4. Rankings reflected the contribution of the attribute to water quality or the general health of the watershed. These values ranged from 0-3 with higher scores representing greater ecological importance; specifically, a score of three represented HIGH water quality or ecological value, a score of two represented MEDIUM value, a score of one represented LOW value, and zero represented NO value. It was not necessary to assign all ranks (0-3) within each data layer and in many cases, ranking simply expressed the presence (a score of three) or absence (a score of zero) of an important natural feature.

Land Cover

In the land cover layer, all natural land covers (forest and grasslands) were given a value of three, indicating highest water quality value. This ranking was based upon previously cited literature which found natural land covers to be correlated with healthy watersheds. All other land covers, including various types of agriculture and developed land were given a value of zero because they have not generally been found to contribute positively to water quality.

Wetlands and Cold Streams

Within both the cold stream and wetland layers, cells which indicate the presence of a cold stream or a wetland respectively were given a rank of three. This was to reflect the ecological value of both of these natural features and their relative uniqueness within the watershed. All other cells were given a value of zero to indicate the absence of the unique natural features.

Hydrology Buffer

For the proximity to water criterion, cells that fell within 1000 feet of a water body were assigned a rank of three and were intended to capture both natural floodplain and riparian areas. This 1000 foot distance was based on the KRWMP, which explicitly states "riparian areas, perhaps as much as 1000 feet in width if specific detail on runoff is not available, define a zone where land use needs to be scrutinized more carefully" (KRWC, 2011). Cells which fell 1000-2000 feet from a water body were assigned an attribute value of two and cells that were within 2000-3000 feet of a water body received a value of one. These rankings were designed to prioritize lands that were closer to water bodies rather than distant, upland areas. This was based on the assumption that parcels closer to water bodies exhibit a greater influence on water quality. It should be noted that one study found a relationship between land cover 2,250 meters away and wetland nitrogen and phosphorous levels (Houlahan & Findlay, 2004).

Proximity to Conserved Lands

Cells that fell in close proximity to existing conserved lands were given priority over those further away; this ranking was achieved by assigning attribute values in one-mile intervals. Cells that fell within one mile of a conserved land received a rank of three, cells that were one to two miles away from a conserved land received a rank of two, and cells that were two to three miles away from a conserved land received a rank of one. Cells that were not within three miles of a conserved land were assigned a rank of zero.

Threatened and Endangered Species

The threatened and endangered species criterion was assigned rankings based on the probability of encountering a rare species in that location. The MNFI probability model utilized by the KRWLCP contains the attribute "probability value", which places cells into the following categories: no status, low probability of encountering a rare species, medium probability of encountering a rare species, and high probability of encountering a rare species. Within the KRWLCP GIS conservation model, a rank of three was assigned to cells in the high category, a rank of two to cells in the medium category, a rank of one to cells in the low category, and a rank of zero to cells in the no status category. This ranking was intended to prioritize ownership parcels that feature rare species and/or high quality habitat.

4.0-GIS Methodology

The GIS analysis for the KRWLCP was conducted in two phases. The first was a raster overlay analysis that "stacked" the six conservation criteria layers upon 30X30 meter pixels to create a priority index map (Figure-6). The second phase used the ArcGIS zonal statistics tool to assign conservation scores to ownership parcels based on the 30X30 meter pixels in the priority index map.

4.1 Preparation of Data Layers

Once the data layers representing the six conservation criteria were obtained, they were used in a raster overlay analysis. Several of the layers had to be modified in order to do this. The wetlands, cold streams, hydrology, and conserved lands layers were acquired as vector layers and were converted into raster format to be used in this analysis. Table-5 shows the data layers used in this analysis and their original format. The conservation criteria "proximity to conserved lands" and "hydrology buffer" gave preference to areas nearer to conserved lands and open water, respectively (see Section 2.2). In order to reflect this, the Euclidean distance tool in the ArcGIS ArcMap tool box was used to create a series of buffers around these features. For the "hydrology buffer" criteria, a new raster layer was created with buffers of 1,000, 2,000, and 3,000 feet around water bodies. For "proximity to conserved lands", a new raster layer with buffers of one, two, and three miles surrounding conserved lands were created.

Table-5: Criteria Layer Formats (Original)

Criteria	Layer Type
Land Cover	Raster
Wetlands	Vector
Hydrology	Vector
Conserved Lands	Vector
Cold Streams	Vector
Threatened and Endangered Species	Raster

Based on the ranking determinations described in Section 3.2, attributes within the six layers were reclassified. This was done to establish the high, medium, and low ecological importance of the respective attribute categories in each layer. Tables 6-11 show how these layer attributes were reclassified.

Table-6: Land Cover Reclassification

Old Value	New Value
Developed, High Intensity	0
Developed, Medium Intensity	0
Developed, Low Intensity	0
Developed, Open Space	0
Cultivated Crops	0
Pasture/Hay	0
Grassland/Herbaceous	3
Deciduous Forest	3
Evergreen Forest	3
Mixed Forest	3
Scrub/Shrub	0
Palustrine Forested Wetland	0
Palustrine Scrub/Shrub Wetland	0
Palustrine Emergent Wetland	0
Estuarine Forested Wetland	0
Estuarine Scrub/Shrub Wetland	0
Estuarine Emergent Wetland	0
Unconsolidated Shore	0
Bare Land	0
Open Water	0
Palustrine Aquatic Bed	0

Table-7: Wetlands Reclassification

Old Value	New Value
Aquatic Bed	3
Aquatic Bed Mix	3
Emergent	3
Emergent Mix	3
Forested	3
Forested Mix	3
Open Water	0
Scrub Shrub	3
Scrub Shrub Mix	3
Shore	0

Table-8: Hydrology Buffer Reclassification

Old Value	New Value
0-1000ft	3
1000-2000ft	2
2000-3000ft	1
>3000ft	0

Table-9: Proximity to Conserved Lands Reclassification

Old Value	New Value
0-1 mile	3
1-2 miles	2
2-3 miles	1
>3 miles	0

Table-10: Cold Streams Reclassification

Old Value	New Value
Cool Small River	0
Cold Stream	3
Cool Stream	0
Warm Stream	0
Cold Transitional Stream	0
Cold Transitional Small River	0
Warm Large River	0
Warm Small River	0

Table-11: Threatened and Endangered Species-Reclassification

Old Value	New Value
No Status	0
Low	1
High	3
Moderate	2

4.2 Raster Overlay Analysis

Figure-7 depicts the model used in the raster overlay analysis. Blue ovals indicate the input raster layers for the six conservation criteria and green ovals show intermediate and final output raster layers. Yellow boxes show where various model tools were utilized. The yellow "reclassify" boxes represent where "proximity to conserved lands", "cold streams", and "threatened and endangered species" were reclassified as described above in Tables 9-11. Not shown here is the reclassification of "land cover", "wetlands", and "hydrology buffer"; these layers were reclassified separately, to allow for smoother model processing. For the input "cold streams" layer, the processing extent used in the reclassification step was defined by the "land cover" layer extent. This was done in order to ensure that the "cold streams" output layer covered the entire extent of the Kalamazoo River Watershed.

Once the data layers were reclassified, they were "stacked" upon each other using the raster calculator tool along with the Kalamazoo River Watershed boundary layer, which restricted the analysis to the extent of the watershed. To incorporate the weights described in Section 3.1, the raster calculator tool used the following formula:

(2.75 × Land Cover + 3 × Wetlands + 2 × Hydrology Buffer + 1 × Conservation Reclass + 0.75 × Cold Streams + 0.5 × MNFI Reclass) × Watershed Boundary

This raster calculation resulted in raw overall prioritization scores for each of the 30x30 meter grid cell pixels within the watershed.

In the final step of the overlay analysis, raw output index scores were transformed to a more user friendly scale ranging from 0-100 through the use of the stretch formula tool. A mask of conserved and developed lands was applied to the stretch formula in order to remove these pixels from the prioritization analysis and only include scores for natural lands that are not currently conserved. The scores were stretched to a 0-100 scale using the following formula:

((Output 1 - 0) × 100) / (30 - 0) × Conserved and Developed Land Mask

This last step produced a final raster output layer of overall prioritization index scores from 0-100 for the natural land pixel grid cells within the boundaries of the Kalamazoo River Watershed. Conserved lands were excluded from the final priority index map because the planning team wanted to identify new conservation opportunities, not those which are already in a state of conservation. Developed lands were excluded because they were thought to be of low ecological value.

4.3 Zonal Statistics

The raster overlay analysis produced a final map of conservation scores for 30x30 meter raster grid cell pixels. However, pixels do not offer practical conservation targets and thus, conservation scores were assigned to ownership parcels. To do this, it was necessary to incorporate datasets for all parcels within the watershed.

Original parcel datasets were provided by each of the ten counties in the Kalamazoo River Watershed. For the following analysis, these parcels were fit to the extent of the watershed using the ArcGIS ArcMap clip tool. These individual datasets were then combined into a single layer using the ArcGIS ArcMap merge tool**. Only parcels greater than or equal to 20 acres were added** to the parcel layer, given their greater and more practical conservation/land management benefits. In this way, parcel size could be considered as a seventh criterion used by this analysis to identify important lands to conserve.

To assign conservation scores to the vector parcels based on the raster pixel priority index map, the ArcGIS ArcMap zonal statistics tool was used. The final raster output priority index layer was used as the input value layer and the parcel data was used as the zonal layer. The resultant output table contained the statistical results (minimum, maximum, range, mean, standard deviation, summation) of the conservation value of the input pixels within each parcel. This output table was joined with the parcel layer data based on parcel IDs. Figure-8 illustrates this process.

5.0-Results

The KRWLCP GIS analysis assigned conservation scores to all parcels in the watershed with an area greater than or equal to 20 acres, excluding developed lands and lands that are currently in a state of conservation. These scores were derived from the conservation criteria described in Section 2, ranked and weighted as described in Section 3. The initial raster overlay analysis assigned these scores to 30X30 meter pixels (Figure-6). Ownership parcels were then assigned scores based on the pixels that fell within each of their bounds using the ArcGIS zonal statistics tool.

From the output produced by the zonal statistics tool, each ownership parcel received a value representing the maximum, minimum, mean, range, standard deviation, and sum of the pixels within its bounds. The mean value was used as the final conservation score for each parcel, as the planning team did not want parcels to be targeted or ignored based on extreme maximum or minimum values. Of the 15,668 applicable parcels, conservation scores ranged from zero to sixty-nine (0-69.2), with the highest possible score being 100.

From these conservation scores, conservation priorities can be established for the Kalamazoo River Watershed. To do so, the output from the KRWLCP GIS analysis was used to identify the following conservation opportunities:

- **Top 100 parcels** based on conservation score
- **Parcel priority tiers** to guide land acquisition efforts
- **Priority Hydrologic Units (HUCs)** for localized conservation

These opportunities are described in subsequent sections and provide tangible targets for watershed stakeholders involved in land conservation.

5.1 Top 100 Parcels

Based on the results, 100 parcels were identified as having the top 100 conservation scores. Scores were based on the mean pixel value within each parcel. In total, approximately **4,218 acres** are contained within the top 100 parcels. Conservation scores for the top 100 parcels range from 59.2-69.2. A map of the top 100 parcels within the Kalamazoo River Watershed is illustrated in Figure-9. While the top 100 parcel analysis is a useful approach to identifying top priority parcels, more focused conservation efforts will likely incorporate local environmental and socioeconomic conditions to truly assess conservation value(s) of individual parcels.

The top 100 parcels, along with identification information, were compiled into a Microsoft Excel database and are contained in Attachment-2. In some cases, complete identification information (e.g. parcel address) could not be obtained for the top 100 parcels.

5.2 Priority Tiers

To examine the highest scoring parcels in greater detail, parcels were aggregated into three tiers based on their conservation scores. Tier one included the top 10% scoring parcels, tier two included the following 10% scoring parcels (11%-20%), and tier three included those parcels scoring between the top 21%-30%. Parcels outside of the top 30% scoring parcels were categorized as having modest conservation value. Priority acreage and score range, based on tier, is illustrated in Table-12 below. A map of all priority parcels, broken into tiers, is illustrated in Figure-10.

Table-12: Priority Tier Analysis

	Total Acres	Score Range
Tier 1	68,460.07	48.75-69.17
Tier 2	73,673.24	42.17-48.75
Tier 3	81,011.09	36.61-42.17
Total	223,144.40	0-69.17

Parcels falling in the top two tiers, representing the top 20% scoring parcels, are considered to be initial conservation priorities of the KRWLCP. Given that 15,668 parcels were included in the GIS analysis, this top 20% yields **3,134 parcels**. Based on past experiences from local conservation groups, including the SWMLC, this provides a practical number of parcels on which to focus future conservation efforts. In total, these 3,134 conservation priority parcels include nearly **142,133 acres**, representing approximately 11% of the total acreage within the Kalamazoo River Watershed (1,300,164 acres). The grand mean (mean of means) for conservation scores in the top 20% was approximately 49.36.

In order to provide for the pursuit of these conservation priorities, the 3,134 parcels that compose the top 20% were compiled into a Microsoft Excel database. For each parcel, the database includes information regarding its conservation score and also landowner, location, and contact information. It is the hope of the planning team that this database will be used and distributed in an effort to engage landowners regarding the conservation of these priority lands.

5.3 Dummy Parcels and "Ground-Truthing"

In order to calibrate the conservation model, the planning team relied on three parcels with unanimously agreed upon conservation values and a form of "desktop ground-truthing" to compare against different model outputs. The first parcel (Parcel 1) is located in Kalamazoo County. The 35 acre parcel contains a mix of upland forests (primarily oak), prairie fen wetlands, and a natural groundwater spring. It was unanimously agreed upon by the planning team that Parcel 1 is of high conservation value, and should be reflected as such in the conservation model. Parcel 1 received a conservation score of 50.5 which places it in the top tier of priority parcels. Photographs of Parcel 1 are provided in Attachment-3.

The second parcel (Parcel 2) is located in Calhoun County. The 90 acre parcel contains a mix of upland forest (primarily maple, oak, and aspen), minimal agriculture, and a small area of forested wetland. No streams, rivers, or lakes run through or border Parcel 2. It was unanimously agreed upon by the planning team that Parcel 2, while a natural landscape, is of medium to modest conservation value when considering impacts to overall water quality within the watershed. Parcel 2 received a conservation score of 41.9 which places it in the third tier of priority parcels. Photographs of Parcel 2 are provided in Attachment-3.

The third parcel (Parcel 3) is located in Calhoun County, and adjacent to Parcel 2. The 88 acre parcel contains approximately 95% grassland with patches of deciduous and coniferous trees and minimal agriculture. No streams, rivers, lakes, or wetlands run through or border Parcel 3. It was unanimously agreed upon by the planning team that Parcel 3, while a natural landscape, is of modest conservation value when considering impacts to overall water quality within the watershed. Parcel 3 received a conservation score of 19.6 which places it in the "modest value" tier of priority parcels. Photographs of Parcel 3 are provided in Attachment-3.

5.4 HUC Analysis

Within the Kalamazoo River Watershed, there are 75 12-digit HUCs representing the subwatersheds that compose the basin. The results from the KRWLCP were used to determine which of these subwatersheds contain the largest amount of priority conservation parcels; those HUCs which contain a disproportionately large number of priority parcels are considered priority HUCs. Prioritization of HUCs was determined based on the total acreage of tier one and tier two parcels (representing the top 20% scoring parcels) falling within HUC boundaries. The Priority HUCs identified are candidates for future conservation efforts and planning at a subwatershed scale and their preservation will contribute to the overall health of the Kalamazoo River Watershed. In effect, these priority HUCs can also be thought to represent important clusters of priority conservation parcels and can be used to spatially focus conservation efforts.

Based on this analysis, four HUCs were identified as priority based on the 4,000+ acres of tier one and tier two parcels that they contain. The 4,000 acre break was mainly chosen for illustrative purposes, and thus should not devalue those subwatersheds with fewer priority parcels. While the subwatershed analysis is a useful approach to identifying clusters of top priority parcels, more focused conservation efforts will likely incorporate local environmental and socioeconomic conditions to truly assess conservation value(s). Table-13 details these four priority HUCs in the Kalamazoo River Watershed. The 75 subwatersheds (Top 10 identified) are illustrated in Figure-11. The four top scoring subwatersheds are illustrated in Figures 12-15.

Table-13: HUC Analysis Summary Stats

HUC Name	No. of Tier 1 and 2 Parcels	Tier 1 and 2 Acres
Swan Creek	128	5,548.31
Wanadoga Greek	106	4,770.26
Fenner Creek-Gun River	99	4,321.36
Ackley Creek	88	4,257.52

6.0-Kalamazoo River Area of Concern

6.1 Background

Under the GLWQA, originally signed by the US and Canada in 1972, fourteen AOCs were identified within the state of Michigan. As defined by the GLWQA, AOCs are "[…] geographic areas that fail to meet the general or specific objectives of the agreement where such failure has caused or is likely to cause impairment of beneficial use of the area's ability to support aquatic life" (USEPA). Under the agreement, the Kalamazoo AOC is listed as containing eight of a possible 14 beneficial use impairments (BUIs). The original remedial action plan (RAP), drafted in 1987 and redrafted in 1998 was prepared to identify and address the status of the eight Kalamazoo River AOC BUIs. Per the GLWQA, the RAP is updated every three years by the Michigan Department of Environmental Quality (MDEQ) Office of the Great Lakes (OGL), in cooperation with the USEPA Great Lakes National Program Office. At present, two of the eight BUIs identified for the Kalamazoo River AOC have been removed (McCarthy, 2014).

Additionally, in 1990 the Kalamazoo AOC site was added to the USEPA national priorities list (NPL) per the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). Under CERCLA, the USEPA divided the Kalamazoo River Superfund site into five operable units (OUs) (MDEQ-OGL, 2012). The OUs are as follows:

- OU #1, Allied Paper Property/Bryant Mill Pond Area;
- OU #2, Willow Boulevard and A-Site Landfill;
- OU #3, King Highway Landfill;
- OU #4, 12th Street Landfill; and
- OU #5, Portage Creek and Kalamazoo River sediments

To date, records of decision (ROD) have been reached for OUs 2, 3, and 4. With each completed ROD, the remedy selected has been a landfill with a cap (MDEQ-OGL, 2012). In addition, a number of time critical removal actions (TCRA) have taken place to remove PCB hot spots where direct contact threats were realized. AOC landfill locations are illustrated in Figure-16.

6.2-Conservation Strategy in AOC

Given the positioning of the OUs in relation to the Kalamazoo River and the different land use patterns in the area, land conservation goals in and around the Kalamazoo River AOC differ from conservation goals for the watershed as a whole. As a result of numerous TCRAs and the current RODs in place, it is understood that many of the sites associated with the AOC will no longer serve as functional landscapes in an ecological or recreational sense (KRWC, 2009). As evidenced by Table-14 below, approximately 85 acres of land will have restrictive land use controls associated with the landfill/cap remedies chosen for the respective sites. These landfills are located along the stream banks of Portage Creek and the mainstem of the Kalamazoo River. Historically, these lands were mixed hardwoods and wooded wetlands, as illustrated in Table-14.

As such, the conservation strategy in and around the Kalamazoo River AOC focuses on mitigating the impacts from hydrologically and ecologically isolating these OUs, by permanently conserving lands in and around the Kalamazoo River AOC that offer ecological and recreational benefits to the river. Local stakeholders and state and federal agencies proposed a 1:2 habitat lost to replacement ratio (KRWC, 2009). This ratio, which is directly derived from the MDEQ – Water Resources Division (WRD) wetland mitigation strategy, will be utilized as a benchmark in evaluating the success of conservation strategies in and around the AOC. It is understood by the planning team that the conservation acreage goals are subject to change, especially as the extents of all OUs are further delineated.

Table - 14: AOC Land Conservation Goals

Operable Unit	Acreage Lost	Conservation Acreage Goal	Pre-settlement land cover	Acreage Replaced to Date
OU#1	22	44	Mixed Oak Savanah	none
OU#2	33	66	Mixed Hardwood Swamp	none
OU#3	23.2	46.4	Mixed Hardwood Swamp	none
OU#4	6.5	13	Mixed Hardwood Swamp	none
Total	84.7	169.4		0

6.3 AOC Conservation Methods and Results

Conservation criteria and model outputs, as described in Sections 2.0 and 4.0 respectively were used in evaluating the conservation potential for parcels in and around the AOC. For the purposes of the KRWLCP, special attention was given to the spans of river stretching from the southernmost landfill (OU#1) to the northernmost landfill (OU#4), as depicted in Figure-16. This includes segments of Portage Creek and the mainstem of the Kalamazoo River. In order to evaluate the conservation suitability of parcels in this region, a 3,000 foot buffer was created using ArcGIS, around the subject stretch of river. Within the 3,000 foot buffer, an examination identical to the HUC analysis was conducted; the analysis identified the total of parcels and acreage scoring in the top 20% (Tier 1 and Tier 2).

Within the AOC buffer, approximately **130 parcels** scored in the top 20% of scoring parcels, containing approximately **5,900 acres**. The grand mean for the top 20% of scoring parcels in the AOC buffer was approximately 50.45, which is slightly higher than the grand mean for the watershed as a whole. The highest scoring parcel in the AOC buffer was 65.72. The top 20% of scoring parcels within the AOC are illustrated in Figure-17. Of the 130 parcels identified in the top 20%, **seven parcels** were identified in the top 100 scoring parcels, identified in Section 5.1. These seven parcels are highlighted in Attachment-2.

7.0-Discussion and Outreach

The results described in Section 5 provide a snapshot of conservation targets developed from the KRWLCP. The primary unit of focus of this plan was ownership parcels but these are not easy to succinctly include in a report. As a result (and with the exception of the top 100 of these parcels) specific priority conservation parcels are not individually identified in this report. To compensate for this, a database of these priority parcels, described in Section 5.2, was created to house this information. Organizations and individuals interested in pursuing these conservation targets should contact either the KRWC or the SWMLC to acquire a copy of this database. In addition to providing these concrete conservation targets, this plan can be thought of as a "jumping off" point for future conservation efforts. In particular, the subwatersheds identified as priorities can be thought of in this way and represent excellent candidates for future study and planning.

In the short term, to provide for the immediate implementation of the KRWLCP, the SWMLC and other project partners plan to conduct targeted mailings to high priority land owners. Initial contact will be made using a suite of postcards developed by the planning team, addressing specific natural features found on a targeted parcel (Attachment-4 for postcard examples). In addition, the SWMLC plans to hold several outreach meetings annually for owners of high priority parcels. These meetings will serve to provide information to landowners regarding conservation options available to them.

While it is believed by the planning team that those parcels and subwatersheds identified by the conservation model represent quality targets for future land conservation efforts, it is also understood that local conservation efforts should take into consideration local environmental and socioeconomic conditions when identifying priority lands. Additionally, the conservation model utilizes the appropriate GIS data layers available at the time it was constructed. As data layers are updated and new criteria relevant to water quality are made available as spatial data, the conservation model should be re-evaluated and the addition of new/relevant GIS data should be considered. It is recommended that the KRWLCP be reviewed and potentially updated on schedule with revisions to the KRWMP. In this sense, the KRWLCP should serve as a working or "living" plan that continually evolves based on shifting conservation values and realities.

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GIS Analysis References

Software:

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Data Layers:

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Conservation and Recreation Lands (CARL), Ducks Unlimited, http://www.ducks.org/conservation/glaro/carl-gis-layer

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2006 Coastal Change Analysis Program, provided by MDEQ, Water Resources Division – Wetlands, Lanes, and Streams Unit

The following layers provided by Michigan Geographic Data Catalog (MiGDL), http://www.mcgi.state.mi.us/mgdl/:

Inland Lakes Assessment Units
Stream Rivers Assessment Units
MI Geographic Framework All Roads (v13a)
MI Geographic Framework Cities (v13a)
MI Geographic Framework State Roads (v13a)
MI Geographic Framework Counties (v13a)
Watershed Boundary – 12 Digit
Watershed Boundary – 8 Digit

Additional Conserved Lands provided by:

Southwest Michigan Land Conservancy
Mid-Michigan Land Conservancy
Michigan Nature Association
Land Conservancy of West Michigan

Parcel Data

Ottawa County Ownership Parcels, Ottawa County GIS Department, gisdept@miottawa.org. West Olive, MI

Kent County Ownership Parcels, accessKent GIS Data Library, https://www.accesskent.com/GISLibrary/#Parcels&Streets. Grand Rapids, MI

Hillsdale County Ownership Parcels, Hillsdale County Equalization & Land Information, http://www.hillsdalecounty.info/equalization.asp. Hillsdale County, MI

Eaton County Ownership Parcels, Eaton County Information Systems, http://www.eatoncounty.org/departments/information-systems. Charlotte, MI

City of Kalamazoo Ownership Parcels, City of Kalamazoo GIS/CITY MAPS, http://www.kalamazoocity.org/city-maps-gis. Kalamazoo, MI

Calhoun County Ownership Parcels, Calhoun County GIS Department, http://www.calhouncountymi.gov/government/gis_maps/. Marshall, MI

Jackson County Ownership Parcels, Jackson County GIS, http://www.co.jackson.mi.us/countygis/Landing/index.html. Jackson, MI

Van Buren County Ownership Parcels, Van Buren County Land Management, http://www.vbco.org/land_management.asp . Paw Paw, MI

Barry County Ownership Parcels, Land Information / IT Services, http://www.barrycounty.org/directory/. Hastings, MI

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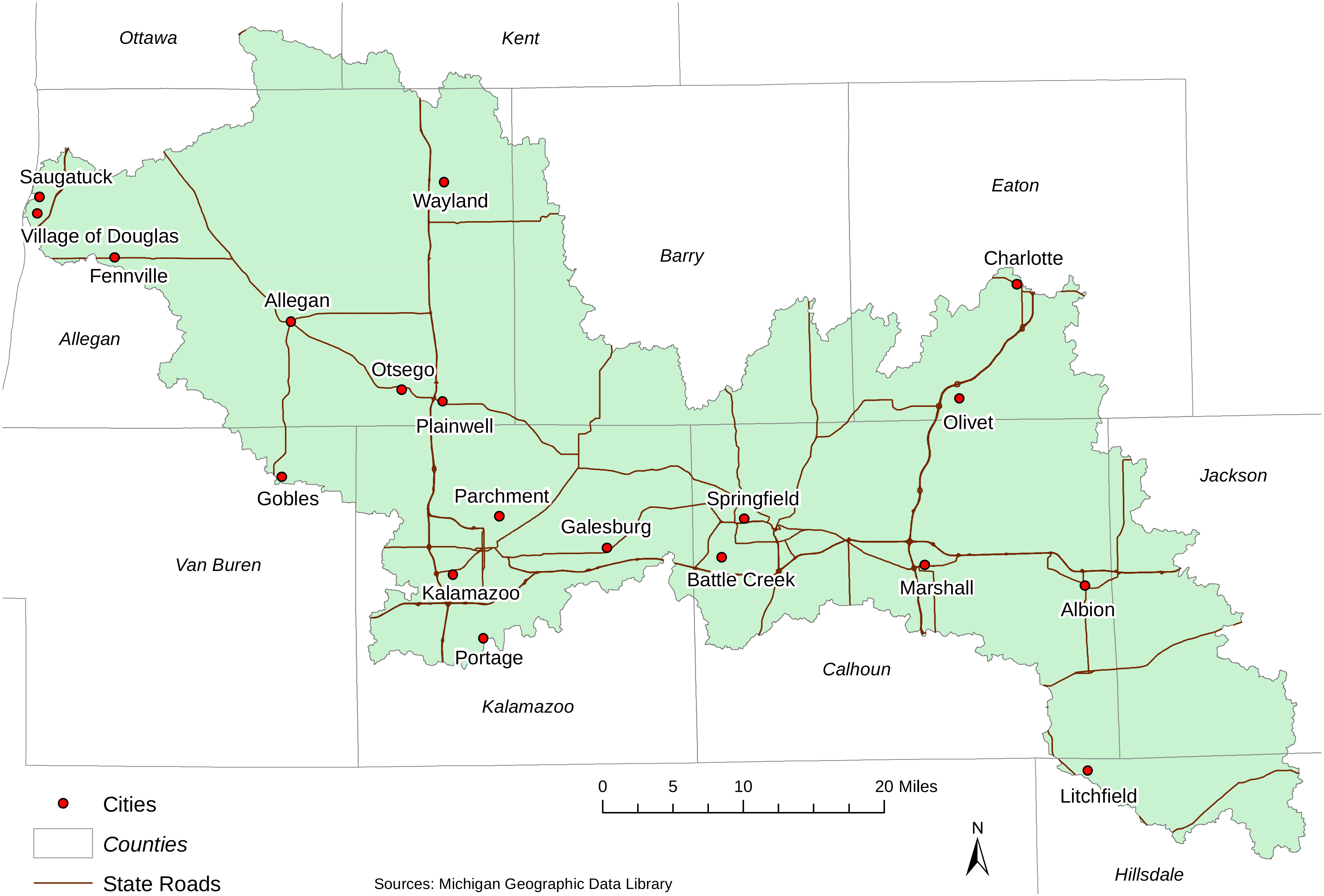
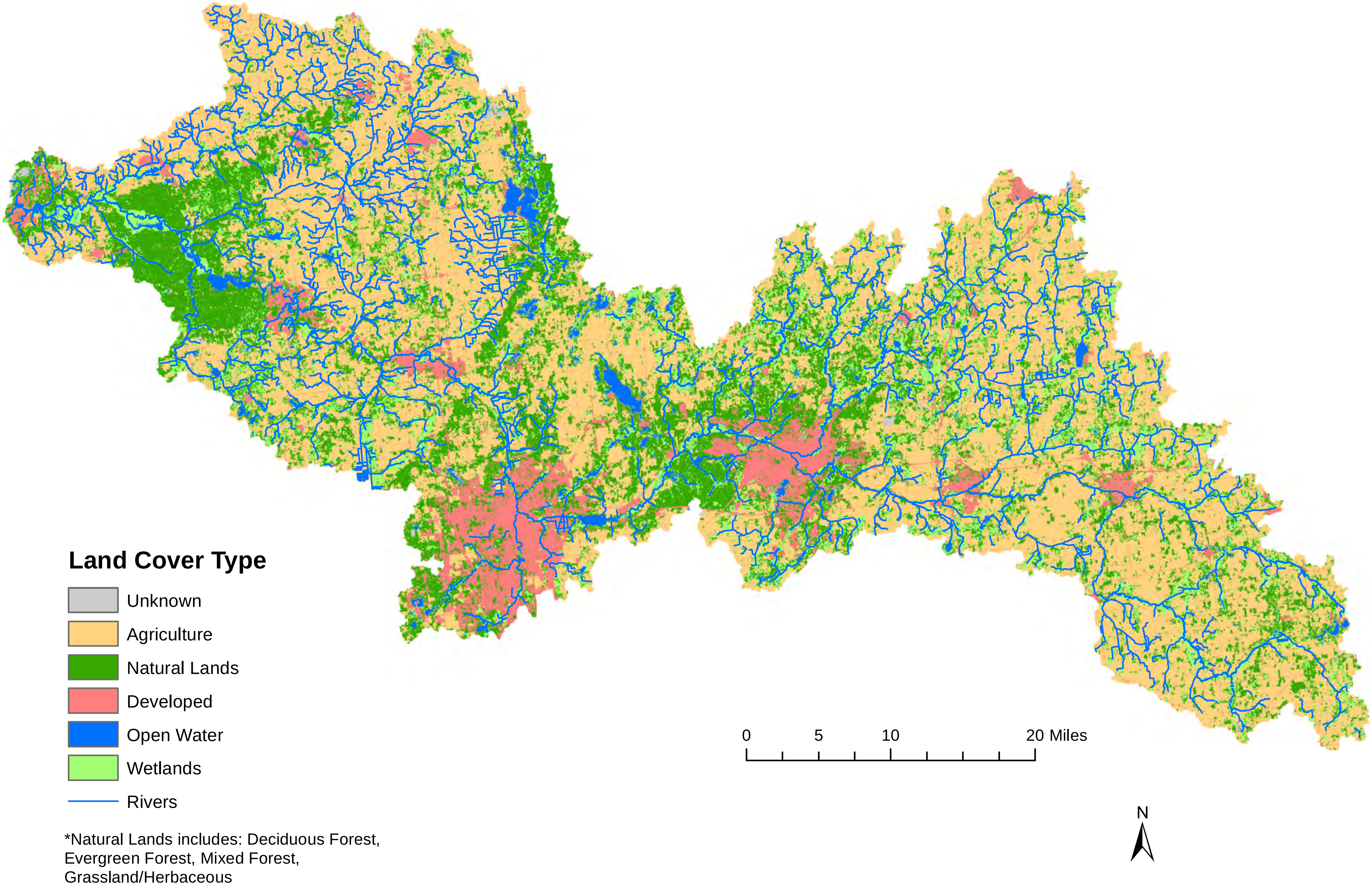
Site Map



Sources: Michigan Geographic Data Library

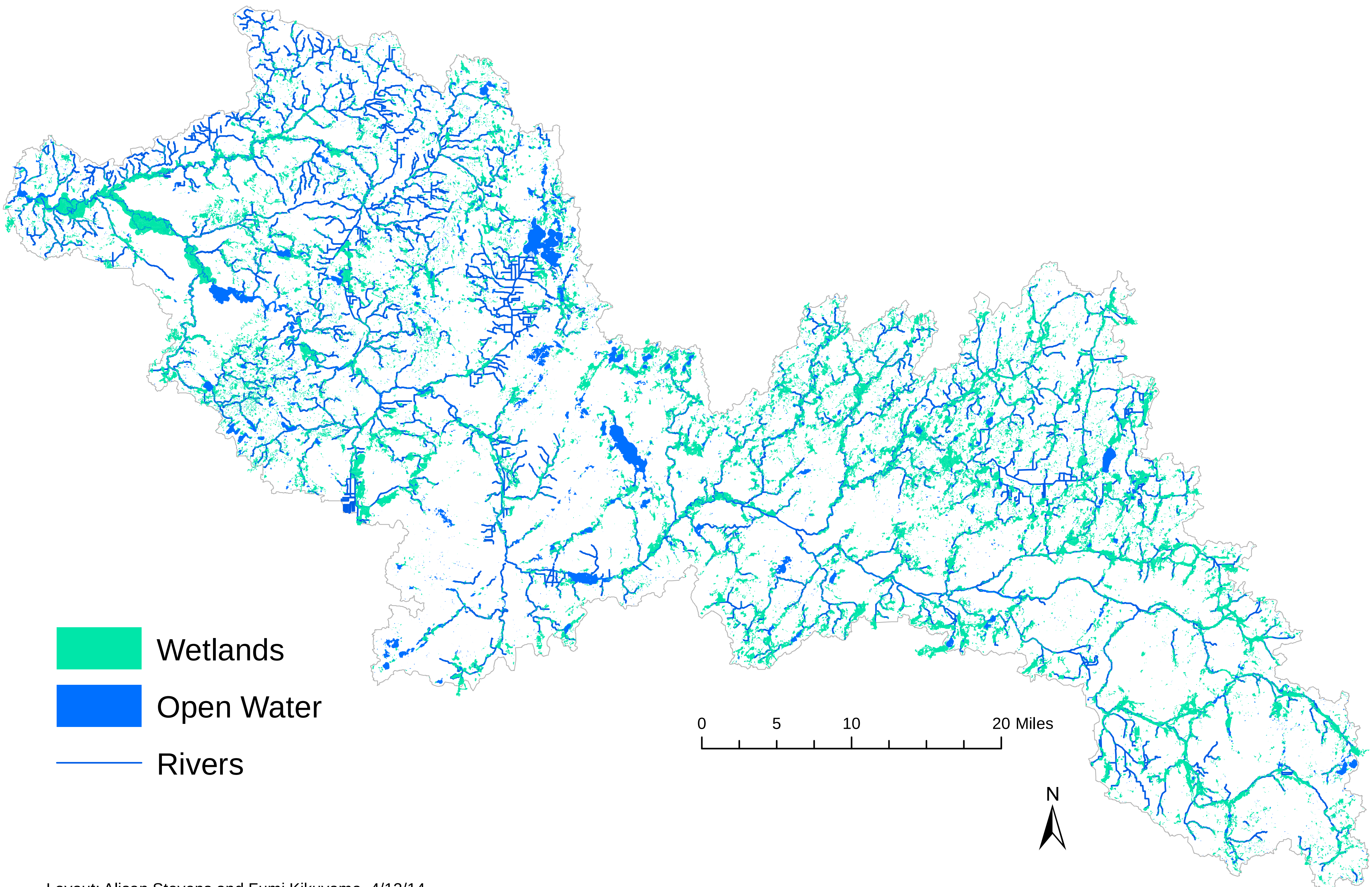
Figure-2

Kalamazoo River Watershed Land Cover Types



Alison Stevens and Fumi Kikuyama, 4/9/14
Source: MiDEQ, MiGDL

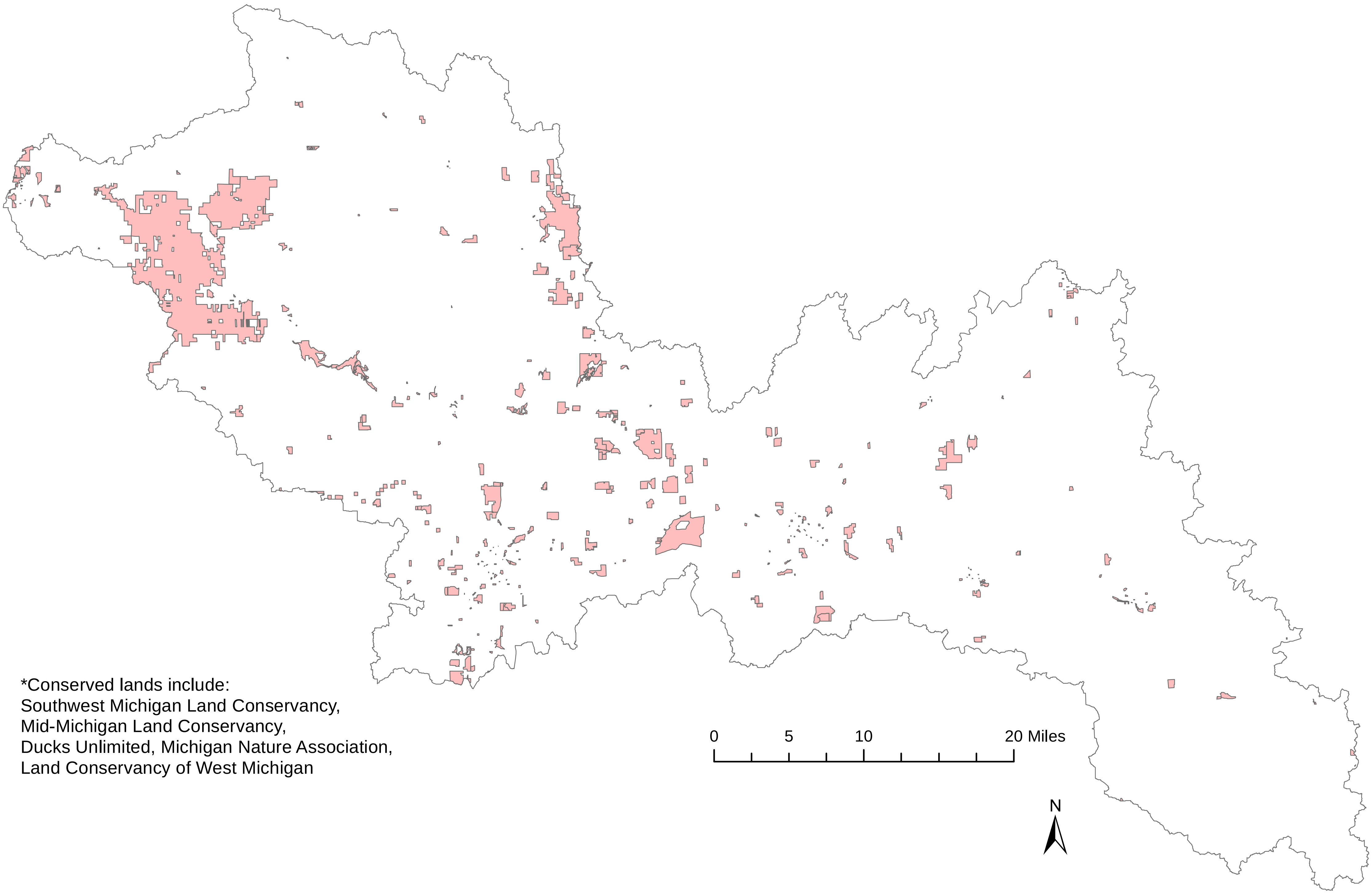
Kalamazoo River Watershed Wetlands



Layout: Alison Stevens and Fumi Kikuyama, 4/12/14
Sources: MDEQ, MiGDL

Figure-4

Kalamazoo River Watershed Conserved Lands

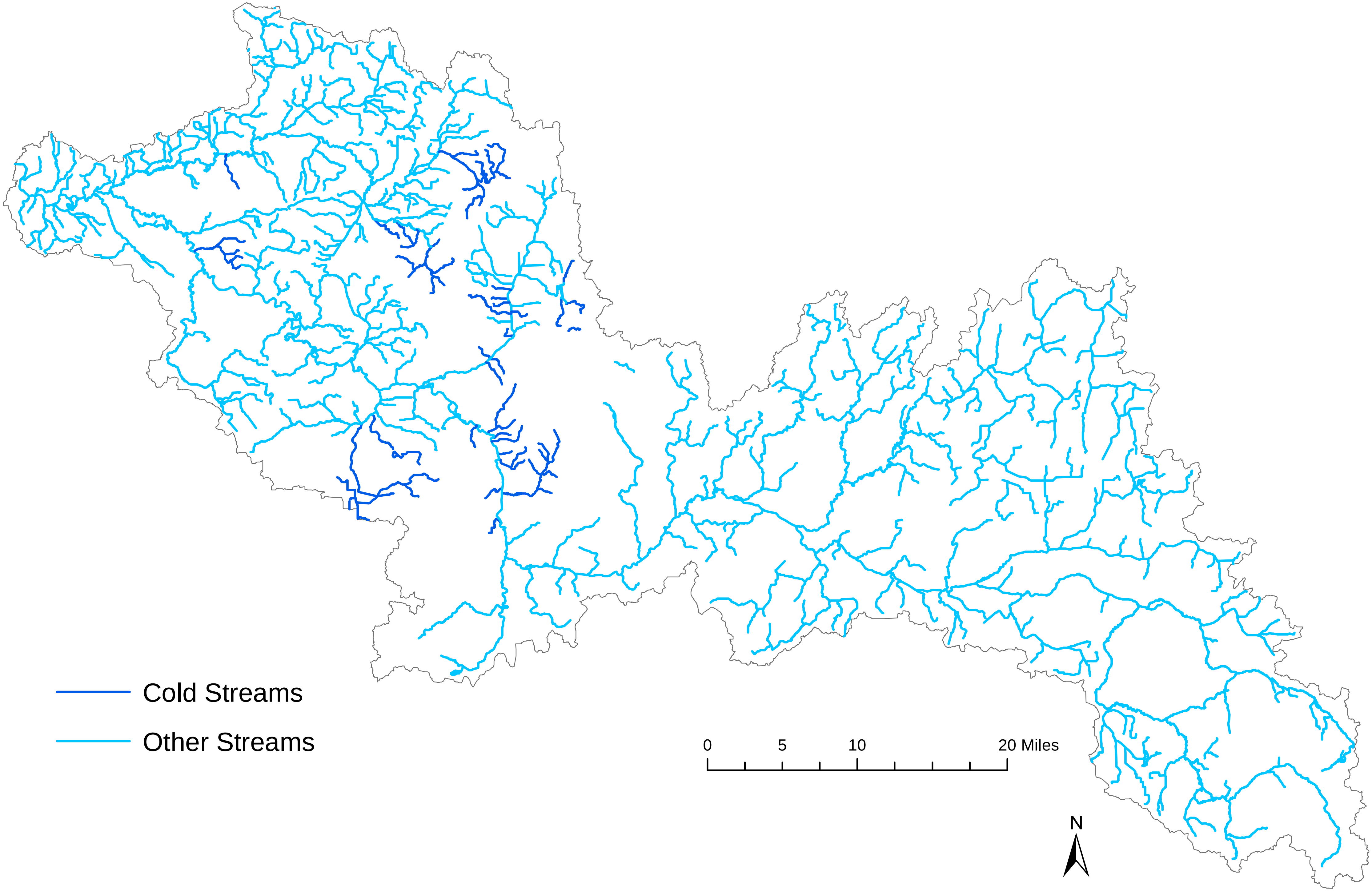


*Conserved lands include:
Southwest Michigan Land Conservancy,
Mid-Michigan Land Conservancy,
Ducks Unlimited, Michigan Nature Association,
Land Conservancy of West Michigan

Layout: Alison Stevens and Fumi Kikuyama, 4/12/14
Sources: SWMLC, MMLC, DU, MNA, LCWM

Figure-5

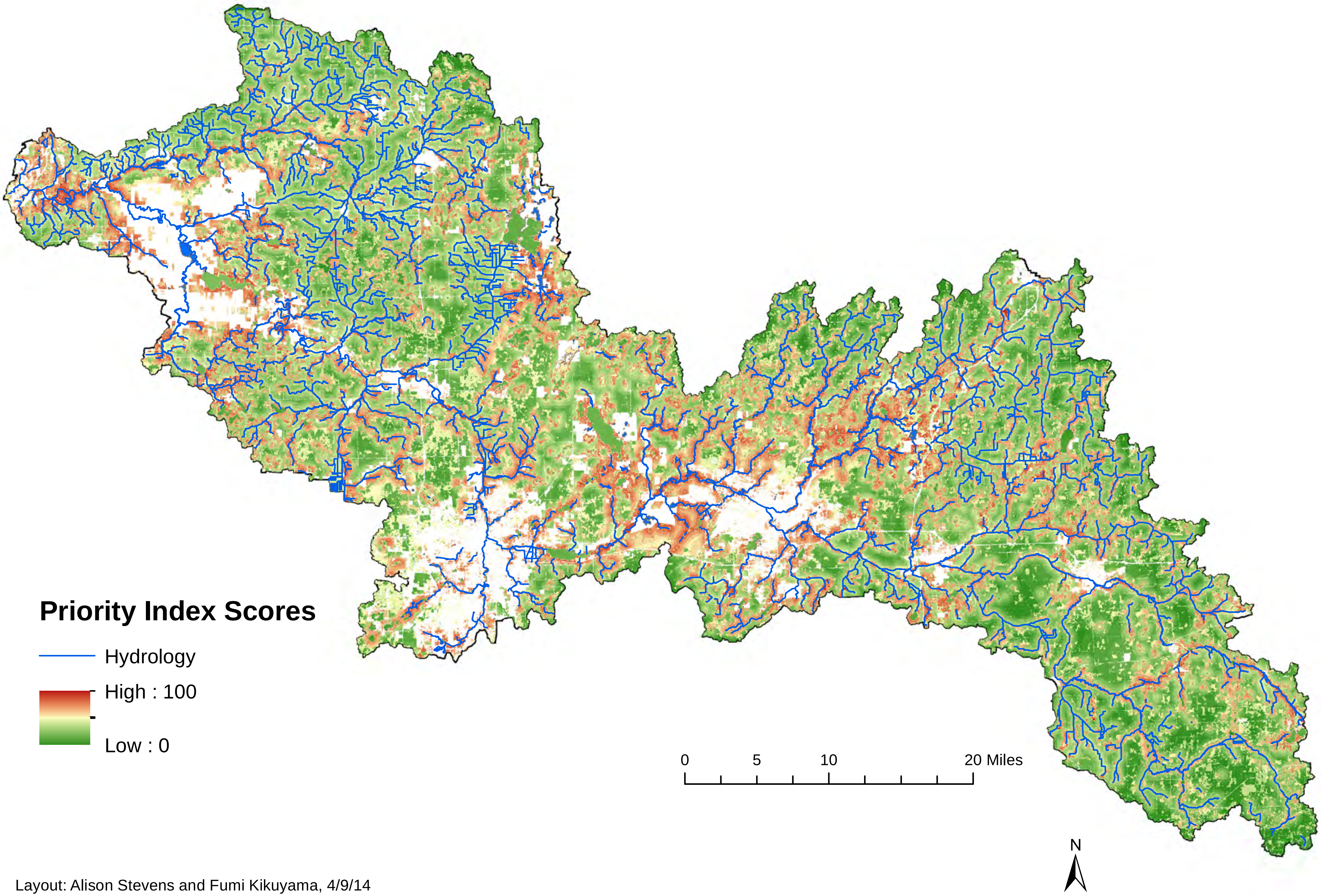
Kalamazoo River Watershed Cold Streams



Layout: Alison Stevens and Fumi Kikuyama, 4/12/14
Sources: MiGDL

Figure-6

Kalamazoo River Watershed Priority Index Map



Layout: Alison Stevens and Fumi Kikuyama, 4/9/14
Sources: MiGDL, MiDEQ, Ducks Unlimited, SWMLC, Michigan Nature Association, MSU Extension

Figure-7: Model Builder/Raster Analysis

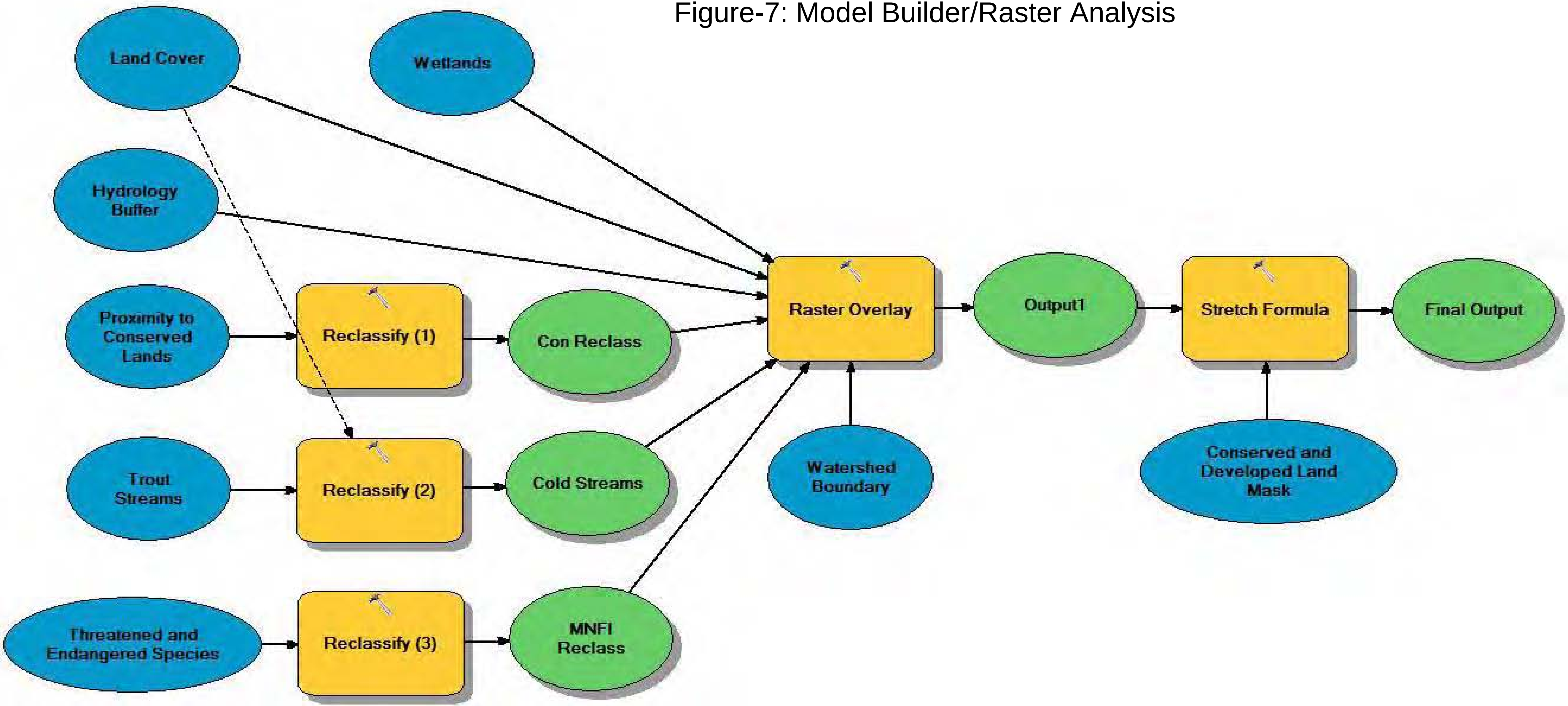
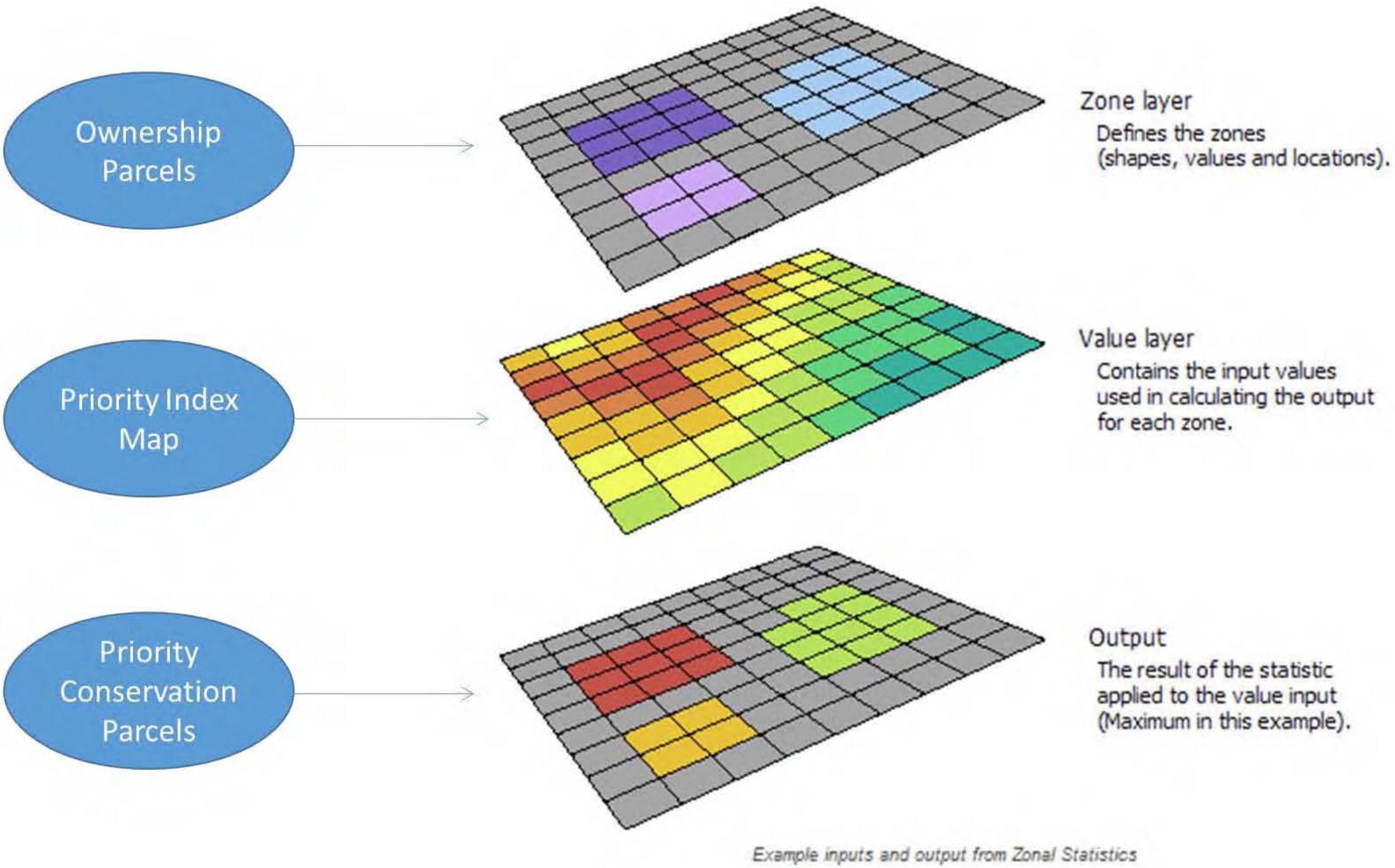


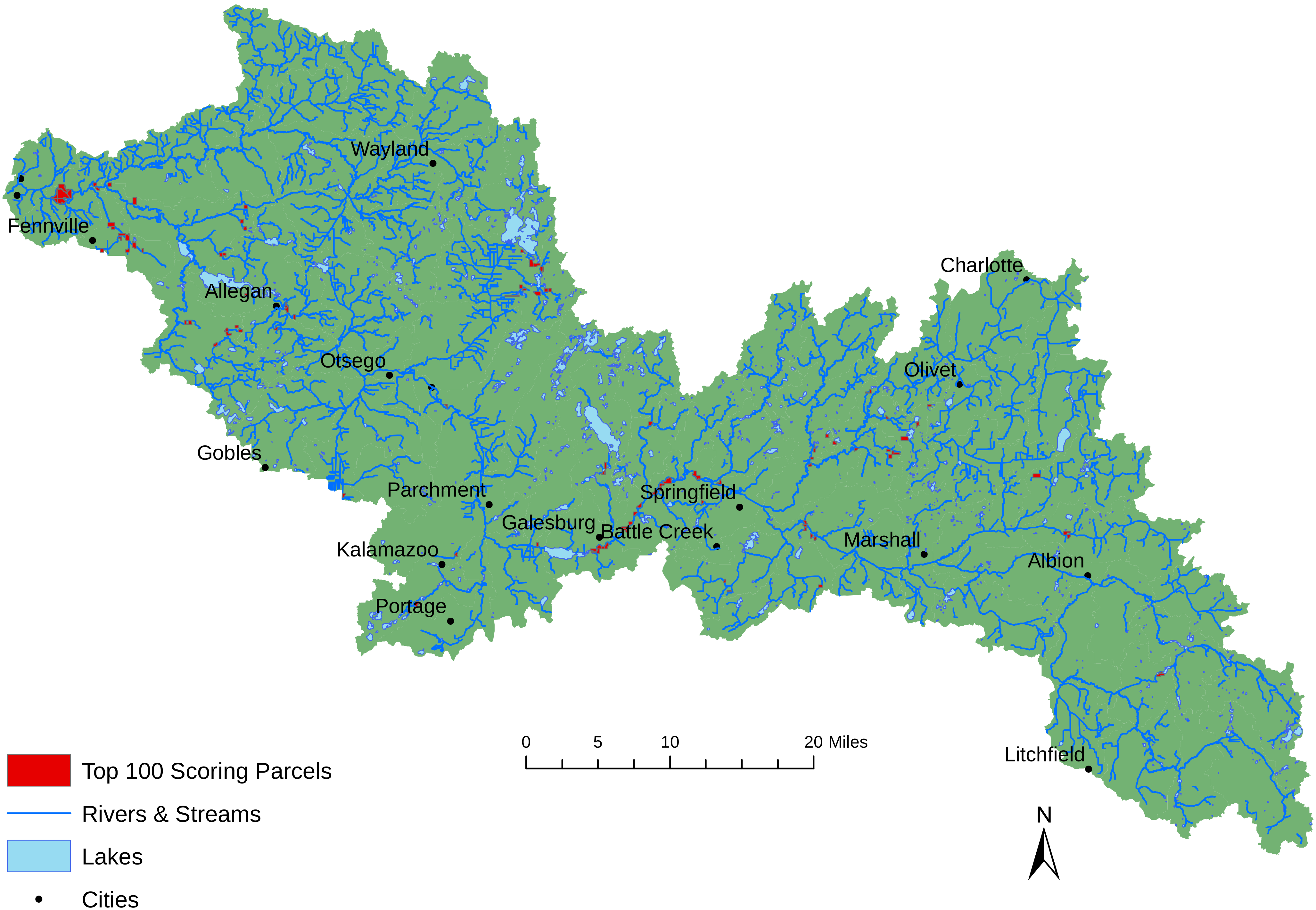
Figure-8: Zonal Statistics Diagram



Source:ArcGIS Help
Library 10.0

Figure-9

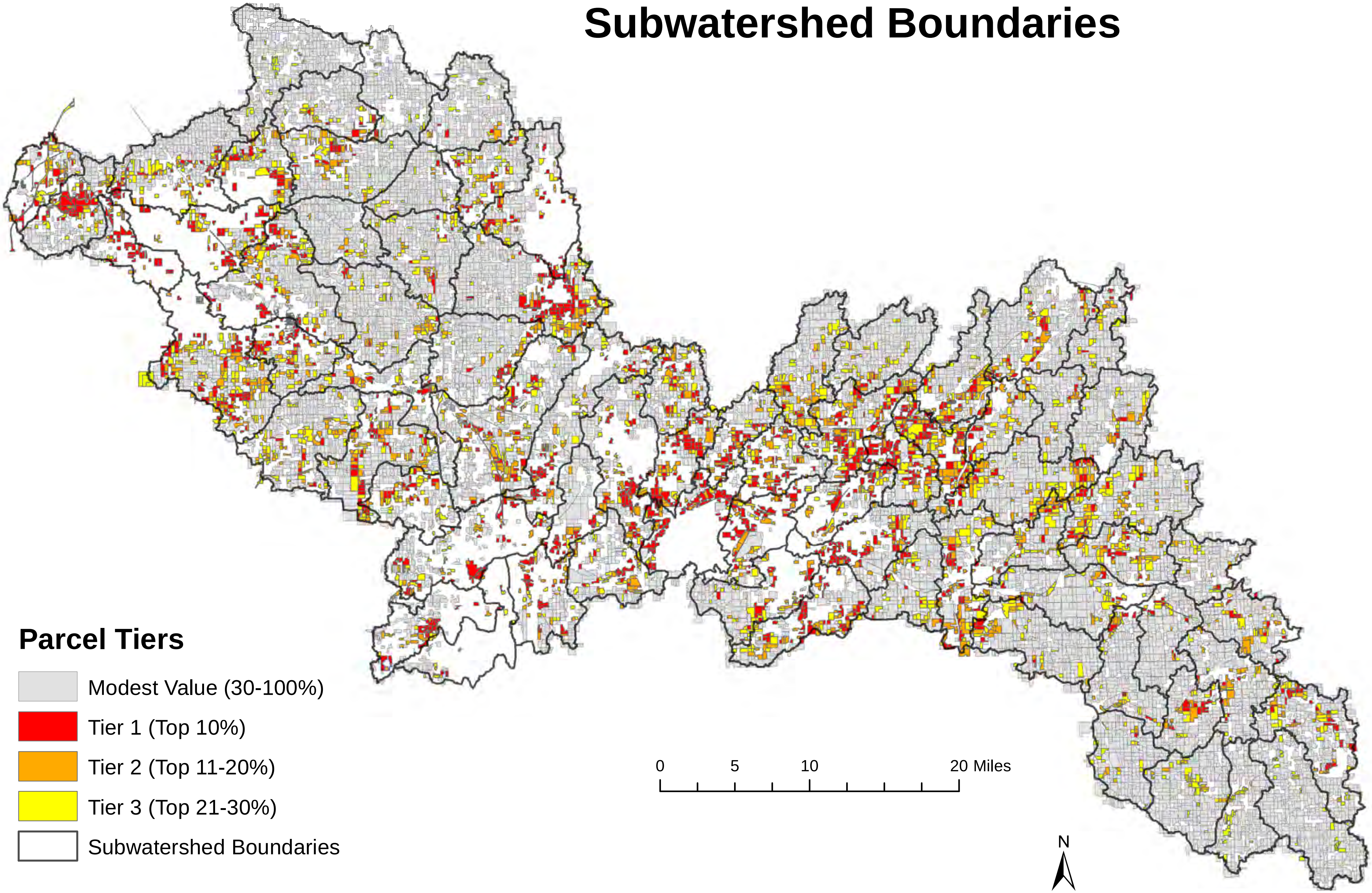
Top 100 Scoring Parcels



Layout: Ben Sasamoto, 4/16/2014
Source: Kalamazoo River Watershed County Contacts and Websites, MiGDL

Figure-10

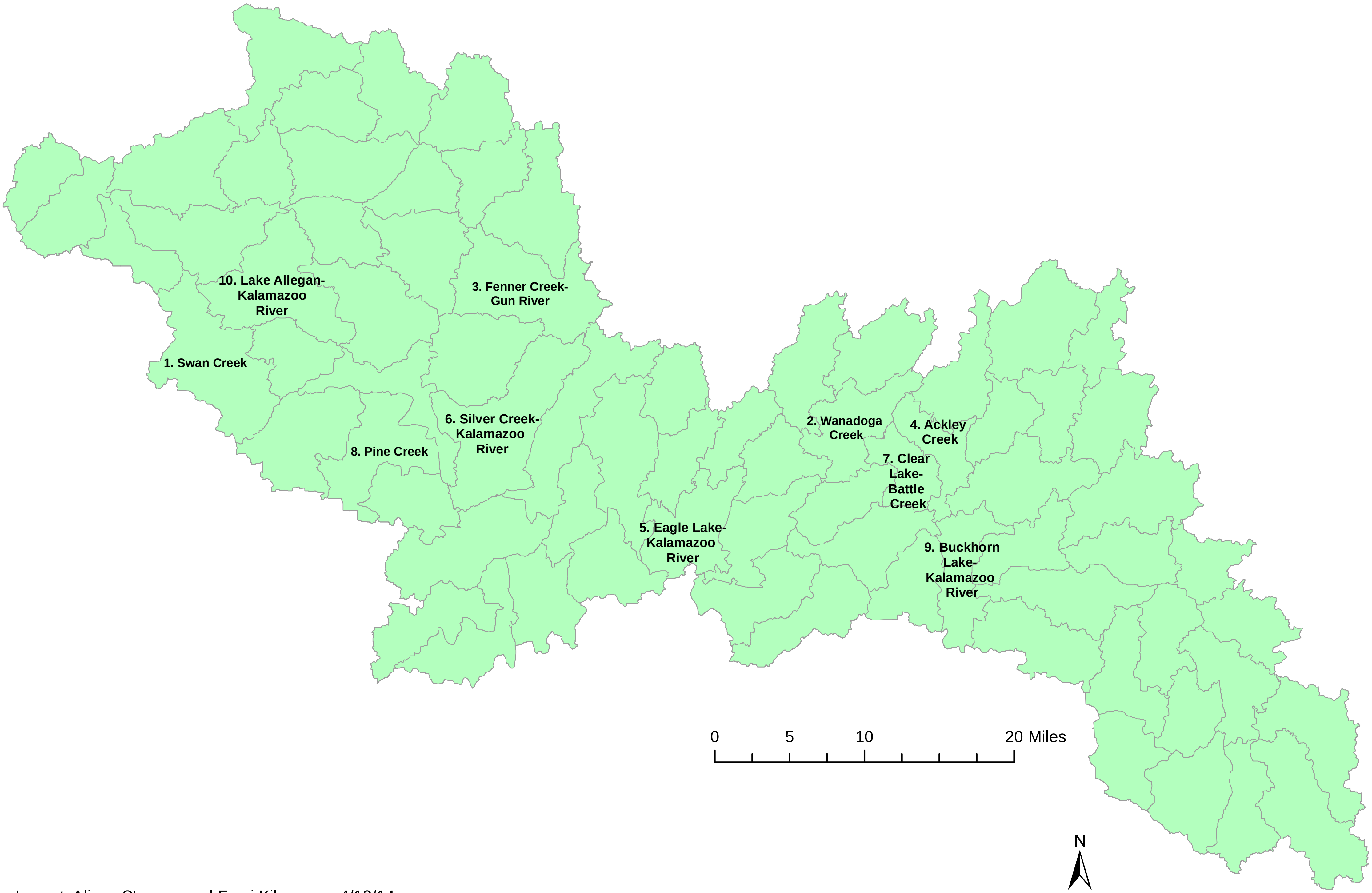
Kalamazoo River Watershed Parcel Tiers and Subwatershed Boundaries



Layout: Alison Stevens and Fumi Kikuyama, 4/9/14
Sources: Kalamazoo River Watershed County Contacts and Websites, MiGDL

Figure-11

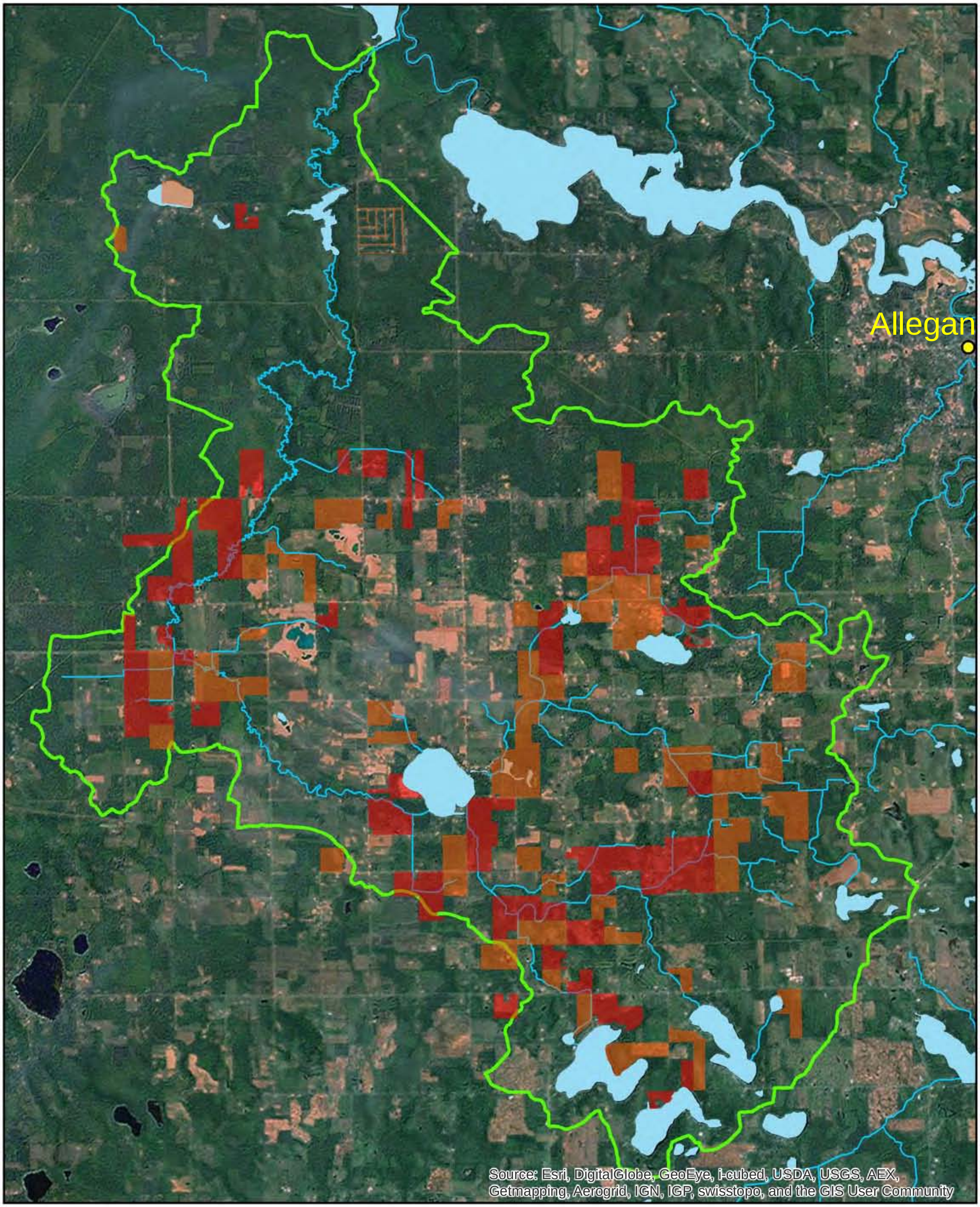
Kalamazoo River Watershed - Top 10 Scoring Subwatersheds



Layout: Alison Stevens and Fumi Kikuyama, 4/12/14
Sources: MiGDL

Swan Creek Subwatershed

Figure-12



Swan Creek Priority Parcels

Tier 1 (Top10%)

Tier 2 (Top 11-20%)

0 1.5 3 Miles

1:82,000

N

Layout: Kyle Alexander 4/20/14

Source: Framework - MiGDL, Google Maps

Figure-13

Wanadoga Creek Subwatershed

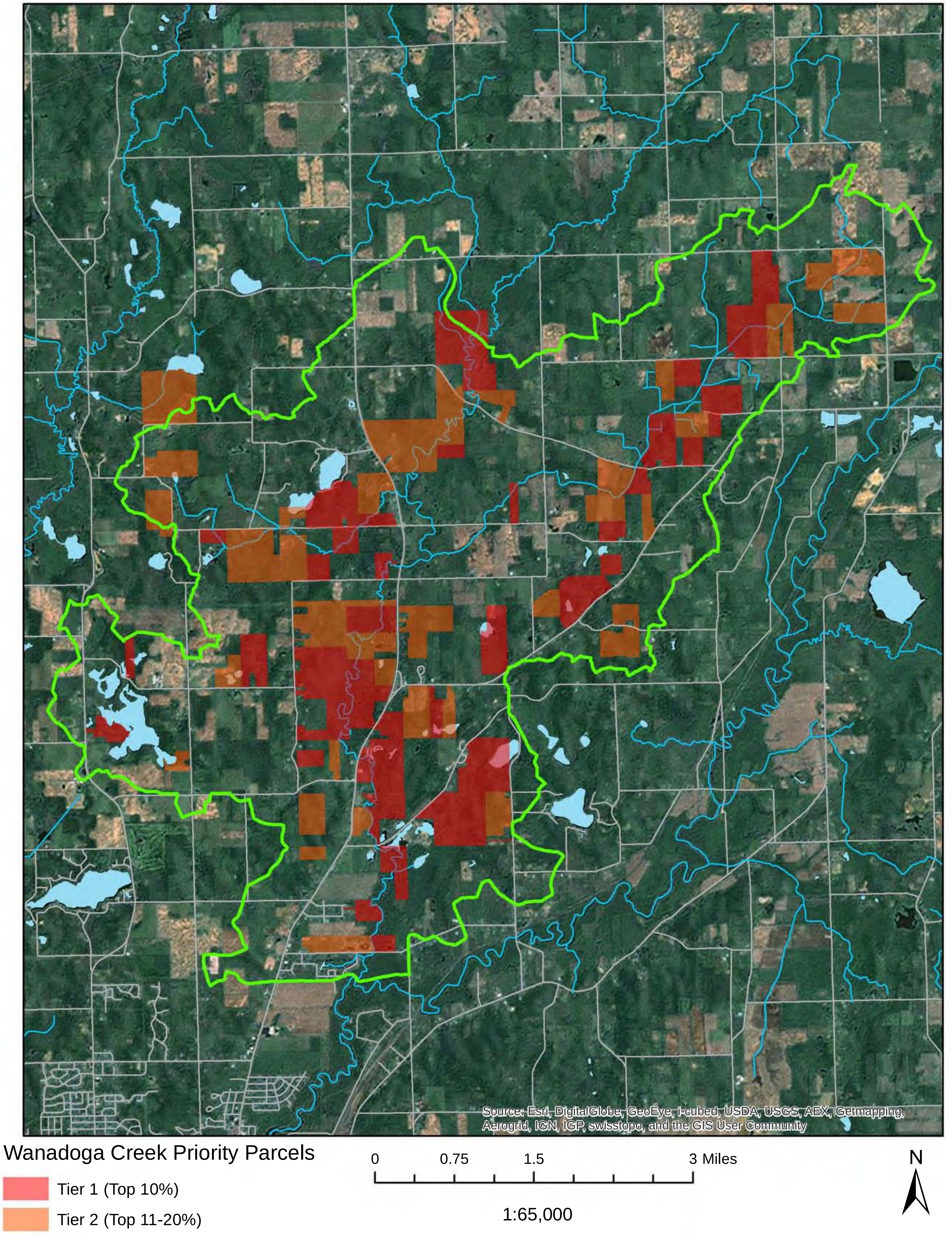
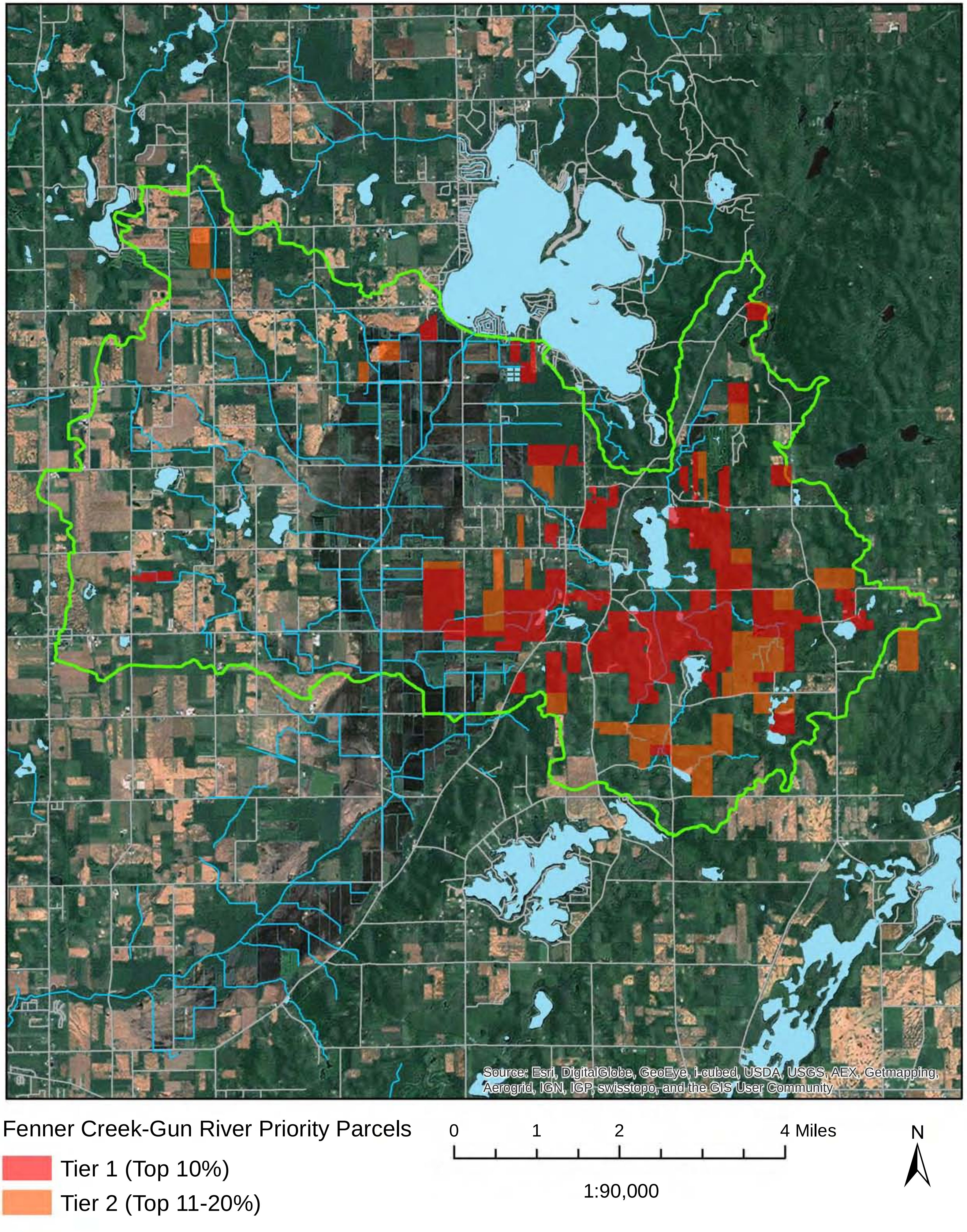
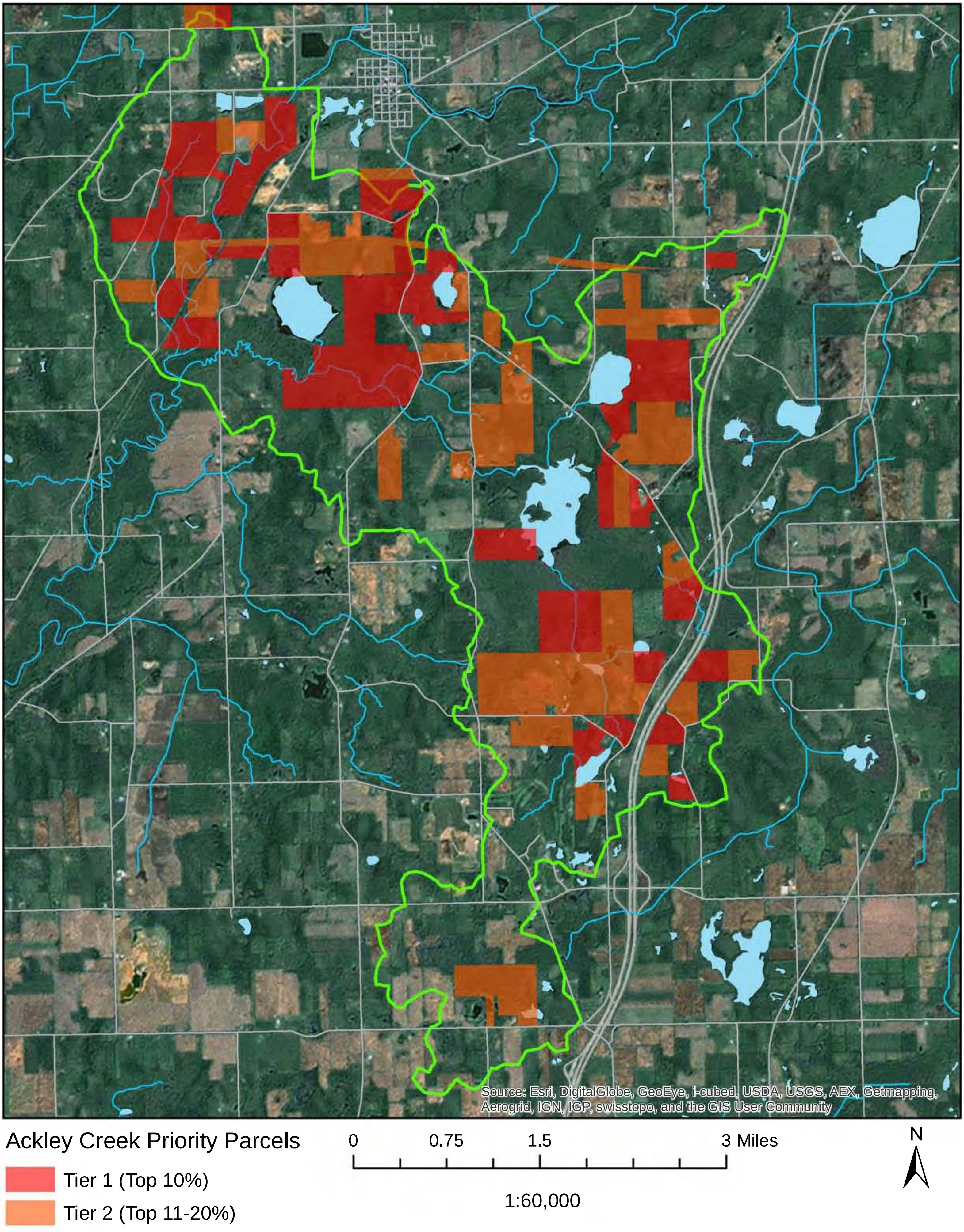


Figure-14

Fenner Creek-Gun River Subwatershed

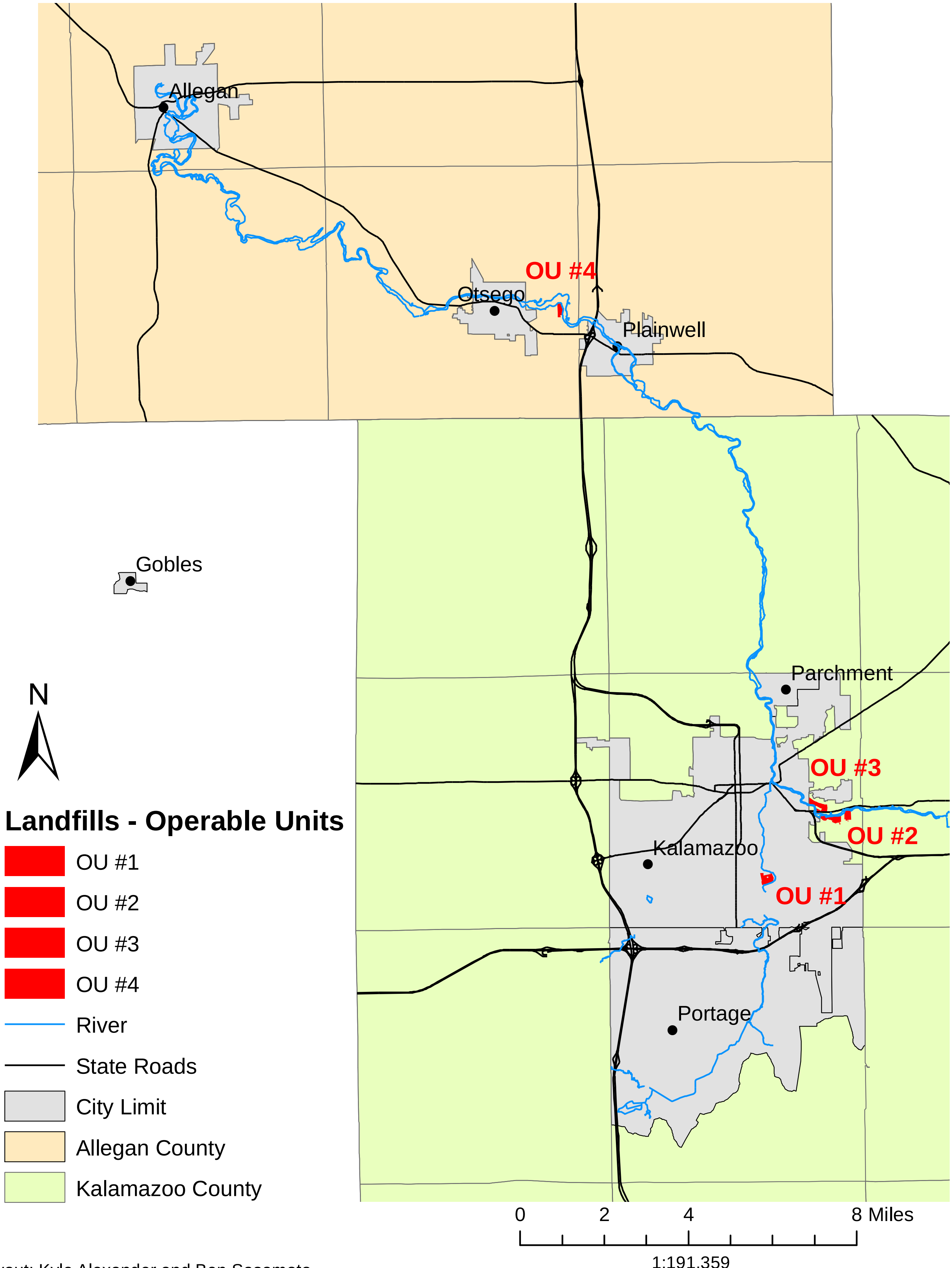


Ackley Creek Subwatershed



Kalamazoo River - AOC Operable Units

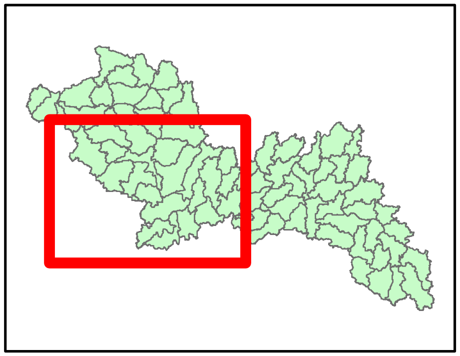
Figure-16



Layout: Kyle Alexander and Ben Sasamoto
Source: Kalamazoo and Allegan County Framework -MIGDL,
Landfill Locations - Google Maps

Figure-17

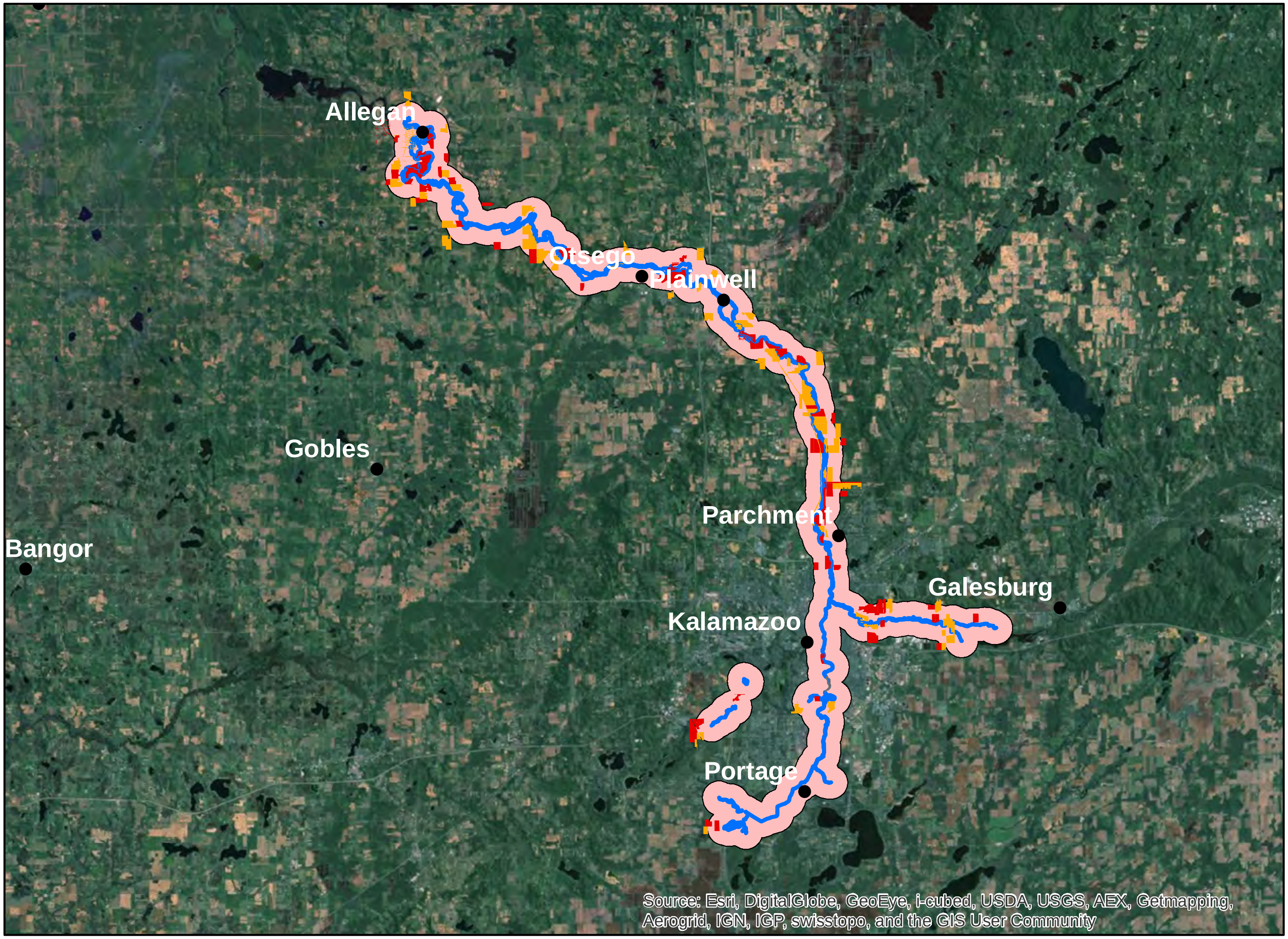
AOC Priority Conservation Parcels

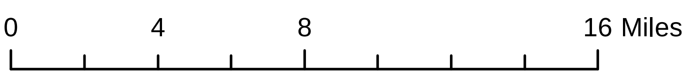


- Cities
- Kalamazoo River
- 3000 AOC Foot Buffer

Parcels

- Tier 1 (Top 10% of Scores)
- Tier 2 (Top 11-20% of Scores)





Layout: Ben Sasamoto 4/16/2014
Source: Kalamazoo River Watershed County Contacts and Websites, MiGDL

Attachment 1: June 2013 Stakeholder Attendees

Last	First	Organization	Email
Adams	Lee	Kalamazoo Co Dept of Planning & Community Development	laadam@kalcounty.com
Alexander	Kyle	SNRE	kydoran@umich.edu
Buckham	Kathy	Kalamazoo Conservation District	kathy.buckham@mi.nacdnet.net
Binoniemi-Smith	Liz	Gun Lake Tribe	eabinoniemi@mbpi.org
Bronson	Tracy	Calhoun Conservation District	tracy.bronson@macd.org
Coury	Jim	Kalamazoo River Watershed Council	Coury.James@yahoo.com
Cramer	Dane	Ducks Unlimited	dcramer@ducks.org
Crowley	Patricia	Kalamazoo County Drain Commissioner	pacrow@kalcounty.com
Eichorst	Tiffany	City of Battle Creek	taeichorst@ci.battle-creek.mi.us
Hamilton	Stephen	MSU Kellogg Biological Station	hamilton@kbs.msu.edu
Hammond	Charlotte	Trout Unlimited-Kalamazoo Chapter	Charlotte.hammond23@gmail.com
Hohm	Janelle	DEQ	HohmJ@michigan.gov
Kieser	Mark	Kieser & Associates	mkieser@kieser-associates.com
Kirkwood	Julia	DEQ	KIRKWOODJ@michigan.gov
Krauss	Bri	Audubon Society	bri@michiganaudubon.org
Mackay	Mark	DNR	mackaym@michigan.gov
McCarthy	Jamie	Kalamazoo River Watershed Council	krwc@kalamazooriver.org
Micklin	Philip	SWMLC board	philip.micklin@wmich.edu
Reding	Sarah	Kalamazoo Nature Center	sreding@naturecenter.org
Reed	Bill	The FORUM of Greater Kalamazoo	ForumofKal@gmail.com
Richards	Michele	Fort Custer	michele.richards@us.army.mil
Riley	John	DEQ	RILEYJ2@michigan.gov
Sanders	Jerrod	DEQ - Kalamazoo District Assistant Supervisor	sandersj3@michigan.gov
Sasamoto	Ben	SNRE	btsa@umich.edu
Schieber	Mark	Allegan Conservation District	mark.schieber@macd.org
Scholtz	April	Land Conservancy of West Michigan	april@nearbynature.org
Schultz	Matt	Michigan Nature Association, Regional Stewardship Organizer	MSchultz@michigannature.org
Simons	Jessica	Potawatomi RC&D Council	j.m.simons@hotmail.com
Smith	Sigrid	University of Michigan - SNRE	sdpsmith@umich.edu
Stevens	Ali	SNRE	aliwstev@umich.edu
Ter Louw Wager	Peter Gary	Southwest Michigan Land Conservancy Kalamazoo River Cleanup Coalition	terlouw@SWMLC.org glwager@gmail.com
Wilke	Emily	Southwest Michigan Land Conservancy	ewilke@swmlc.org
Zbiciak	Rob	DEQ - Wetlands	zbiciakr@michigan.gov

Attachment 2: Top 100 Parcels

Rank	Parcel Owner(s)	Mean Score	Parcel Address	Owner Address	Subwatershed Name	Area (Acres)
1	FLAMM PROPERTIES BATTLE CREEK LLC.	69.17	97 Kenosha Battle Creek, MI 49014	8282 North 27th Street Richland, MI 49083	Willow Creek-Kalamazoo River	61.0
2	POTTAWATOMIE CLUB	65.96	Kalamazoo River Marsh	638 Cascade Hills Hollow SE Grand Rapids, MI 49546	Peach Orchid Creek-Kalamazoo River	33.1
3	JR INVESTMENT GROUP LLC	65.72	113th Ave	1848 M-40 Allegan, MI 49010	Lake Allegan-Kalamazoo River	30.0
4	STS HYDROPOWER LTD	65.00	Miller Drive	14550 N Frank Lloyd Wright Blvd 210 Scottsdale, AZ 85260	City of Galesburg-Kalamazoo River	20.9
5	WINKLE TERRY & LOUANNE	64.12	2830 Baseline RD	916 Brownell SE Grand Rapids, MI 49508	Silver Creek-Kalamazoo River	20.1
6	HEWITT WILLIAM & CARRIE	64.11	14 Mile Road Battle Creek, MI 49014	21114 14 Mile RD Battle Creek MI 49014	Clear Lake-Battle Creek	20.2
7	MERVENNE ARTHUR J JR	64.03		5663 N Lakeshore Drive Holland, MI 49424	Peach Orchid Creek-Kalamazoo River	33.9
8	SYLVESTER PATRICIA A	63.97		S Helmer Rd Battle Creek, MI 49015	Minges Brook	22.7
9	HOWARD CHRISTOPHER & DEBRA	63.88		12929 Fort Custer Drive Galesburg, MI 49053	Eagle Lake-Kalamazoo River	24.6
10		63.70			Tannery Creek-Kalamazoo River	22.5
11	BLACKMORE WILLIAM	63.67	Guernsey Lake RD	9615 W Keller Rd Delton, MI 49048	Fenner Creek-Gun River	30.1
12	EMMONS ROBERT & ROSALIE	63.62	Miller Drive	10461 Miller Dr Galesburg, MI 49053	Eagle Lake-Kalamazoo River	35.0
13	PLOTTS WAYNE JR & SIBYL	63.55	13234 Augusta Drive Augusta, MI 49012	13234 Augusta Drive Augusta, MI 49012	Eagle Lake-Kalamazoo River	42.5

14	VILLAGE OF AUGUSTA	63.48			Eagle Lake-Kalamazoo River	42.7
15	WRIGHT LEO J & DOROTHY A /TRUST	63.45		2335 B Drive South Climax, MI 49034	Minges Brook	21.3
16	EASON RICHARD JR & MARTHA	63.19		10221 Guernsey Lake RD Box 472 Shelbybille, MI 49344	Fenner Creek-Gun River	39.8
17	BLAKESLEE RICHARD & JILLYNE	63.18	576 Streamside Dr Galesburg, MI 49053	576 Streamside Dr Galesburg, MI 49053	City of Galesburg-Kalamazoo River	51.0
18	GARDNER MARK V & WILLIAM A	63.05	Ceresco, MI 49033	464 Grace St Northville, MI 48167	Harper Creek	26.7
19	POTTAWATOMIE CLUB	63.02	Kalamazoo River Marsh	638 Cascade Hills Hollow SE Grand Rapids, MI 49546	Peach Orchid Creek-Kalamazoo River	54.8
20	TERBURG MARILYN M	63.01	Enzian Rd	5870 E Richplain DR Richland, MI 49083	Fenner Creek-Gun River	60.6
21	FRENCH W & THUNDER J & P HUNTINGTON	62.81		19381 East Ave North Battle Creek, MI 49017	Eagle Lake-Kalamazoo River	38.6
22	MAINSTONE LYLE D & CECELIA A	62.55	Q Drive North	22600 Clear Lake Road Battle Creek, MI 49014	Clear Lake-Battle Creek	40.2
23	BELDEN LAWRENCE C	62.51	122nd Ave	2316 Lincoln Road Allegan, MI 49010	Bear Creek-Kalamazoo River	39.0
24	FARNHAM LARRY TRUST	62.41	14 1/2 Mile Road Battle Creek, MI 49014	3011 Thorpe Road Delton, MI 49046	Ackley Creek-Battle Creek	20.1
25	WILSON FAMILY TRUST	62.37	Keller Road	38666 Covington Drive Wayne, MI 48184	Gun Lake-Gun River	29.3
26	CONCORD ASSOCIATES GROUP LLC	62.31	5289 124th Ave	810 Leonard Street NE Grand Rapids, MI 49503	Mann Creek	29.7
27	SUMMERS GLEN M TRUSTEE	62.22	E Fort Custer Drive	PO Box 123 Kalamazoo, MI 49007	Eagle Lake-Kalamazoo River	29.2

28	YOUNG HAZEL CALHOUN CO. LIMITED PA	62.20	8632 G Drive North Battle Creek, MI 49014	8632 G Drive North Battle Creek, MI 49014	Willow Creek-Kalamazoo River	29.3
29	POTTAWATOMIE CLUB	62.16	6022 Old Allegan Road	638 Cascade Hills Hollow SE Grand Rapids, MI 49546	Peach Orchid Creek-Kalamazoo River	363.7
30	PERRA ROBERT G & ANN C	62.16		11081 Greer Drive Richland, MI 49083	Gull Creek	30.3
31	WEST JANICE	62.08		2855 36th Street Allegan, MI 49010	Bear Creek-Kalamazoo River	40.2
32	CITY OF ALLEGAN	61.86	Mill District	112 Locust Street Allegan, MI 49010	Lake Allegan-Kalamazoo River	23.2
33	BIRDS EYE FOODS LLC	61.84	124th Ave	399 Jefferson Road Parsippany, NJ 07054	Mann Creek	39.8
34	POTTAWATOMIE CLUB	61.83	62ND/River Vacant NW QTR	638 Cascade Hills Hollow SE Grand Rapids, MI 49546	Peach Orchid Creek-Kalamazoo River	122.6
35	CALDERONE, ANTHONY & SANDRA	61.83	Reynolds RD bellevue, MI	75 Garrison Ave Battle Creek, MI 49017	Ackley Creek-Battle Creek	29.2
36	EMMONS ROBERT & ROSALIE	61.82	Augusta Drive	10461 Miller Dr Galesburg, MI 49053	Eagle Lake-Kalamazoo River	32.6
37	HENDRICK WILLIAM E & E RUTH	61.79	Miller Drive	10899 Miller Drive Galesburg, MI 49053	City of Galesburg-Kalamazoo River	38.5
38	WILLISTON GEORGE H & ROBBINS KELLY	61.76	Keller Road	10334 Keller Road Delton, MI 49046	Fenner Creek-Gun River	20.3
39	ON TARGET ENTERPRISES, LLC	61.69	Land Locked Battle Creek, MI 48014	6422 Enclave Drive Clarkston, MI 48348	Wanadoga Creek	21.6
40	ALEXANDER MARION & MANTARRO BARB	61.65	22684 Junction Road Bellevue, MI 49021	22684 Junction Road Bellevue, MI 49021	Ackley Creek-Battle Creek	35.5
41	MICHIGAN DEPT OF NATURAL RESOURCES	61.60	Bond Street	PO BOX 30028 Lansing, MI 48909	Lake Allegan-Kalamazoo River	35.6

42	SWAINS LAKE FARMS INC	61.30	Swains Lake Drive Concord, MI 49237	8651 Mohawk CT Stanwood, MI 49346	Swains Lake Drain-South Branch Kalamazoo River	58.1
43	COTTON DUANE M & COTTON JULIE A	61.19	1118 38th Street Allegan, MI 49010	1118 38th Street Allegan, MI 49010	Swan Creek	38.6
44	SCHOON ROBERT JR & BARBARA	61.14	2491 54th Street	PO BOX 378 Fennville, MI 49408	Mann Creek	39.4
45	OLIVER HARRY M JR TRUSTEE	61.10	Old Allegan RD	1948 North Lincoln Ave Chicago, IL 60614	Mann Creek	20.1
46	TURNER ELLA	61.09	Q Drive North Battle Creek, MI 49014	13175 6 1/2 Mile Road Battle Creek, MI 49014	Clear Lake-Battle Creek	21.5
47	JUNCTION (THE) LLC	61.07		1200 Central Ave Holland, MI 49423	Bear Creek-Kalamazoo River	40.4
48	WAITE PHILLIP L. & DEBORAH A.	61.05	8052 E River Road Battle Creek, MI 49104	8052 E River Road Battle Creek, MI 49104	Willow Creek-Kalamazoo River	26.1
49	BATTLE CREEK TIFA	61.02	Hill-Brady Road Battle Creek, MI 49037		Harts Lake-Kalamazoo River	22.5
50	4-D INVESTMENTS, LLC	60.97	Bellevue Road Battle Creek, MI 49014	7235 Tower Road Battle Creek, MI 49014	Clear Lake-Battle Creek	22.3
51	TRIPLE J HOLDINGS LLC	60.95	N 44th Street	PO BOX 50190 Kalamazoo, MI 49005	Augusta Creek	33.7
52	RABBERS JOYCE L NON-EX MAR TRUST	60.91	Lindsey Road	19459 Thompson Lane Three Rivers, MI 49093	Gun Lake-Gun River	65.3
53	CUTLER GREGORY J	60.90	4006 110th Ave	PO BOX 295 Allegan, MI 49010	Swan Creek	30.0
54	4-D INVESTMENTS, LLC	60.89	Feld Ave Battle Creek, MI 49017	620 South Main Street bellevue, MI 49021	Harts Lake-Kalamazoo River	31.9
55	LAURENS ANDREIS V & TEGAN A	60.89	11512 E DE Ave Richland, MI 49083	11512 E DE Ave Richland, MI 49083	Gull Creek	36.5
56	FLACH PAUL & ALICE TRUST	60.81	NRF	2714 North 38th Street Augusta, MI 49102	Eagle Lake-Kalamazoo River	35.3

57	TRUAX TODD E	60.80	1651 36th Street Allegan, MI 49010	1651 36th Street Allegan, MI 49010	Lake Allegan-Kalamazoo River	24.3
58	CITY OF KALAMAZOO	60.77		241 W. South Street Kalamazoo, MI 49006	West Fork Portage Creek	45.0
59	MESHKIN JOHN L	60.73	124th Ave	559 Elmdale CT Holland, MI 49423	Mann Creek	63.4
60	KENNEDY JOHN & BETH	60.71	N 2nd Street	8910 North 6th Street Kalamazoo, MI 49009	Pine Creek	24.9
61	STS HYDROPOWER LTD	60.69		14550 N Frank Lloyd Wright Blvd 210 Scottsdale, AZ 85260	City of Galesburg-Kalamazoo River	43.1
62	BATTLE CREEK CITY	60.67	Teal Street	00000 Teal Street Battle Creek, MI 49037	Eagle Lake-Kalamazoo River	97.2
63	HALL WILLIAM C	60.65		1169 37th Street Allegan, MI 49010	Tannery Creek-Kalamazoo River	30.1
64	MCENTYRE KENNETH W	60.57	1267 44th Street Pullman, MI 49450	1267 44th Street Pullman, MI 49450	Swan Creek	44.5
65	FRENCH W & THUNDER J & P HUNTINGTON	60.53		19381 East Ave North Battle Creek, MI 49017	Eagle Lake-Kalamazoo River	99.4
66	COMSTOCK CHARTER TOWNSHIP	60.53	River Villa Preserve	PO Box 449 Comstock, MI 49041	Davis Creek-Kalamazoo River	21.2
67	WMU STATE OF MICHIGAN	60.44	1940 Howard	1903 W. Michigan Ave Kalamazoo, MI 49008	Averill Lake-Kalamazoo River	21.9
68	STOREY REBECCA A TRUST	60.35	Pony Ave	124 Candlewood Lane Battle Creek, MI 49014	Spring Lakes-Battle Creek	25.0
69	BOURDO EARL, JUNE, TERRI, MARK	60.33	7615 Marsh Road Plainwell, MI 49080	7615 Marsh Road Plainwell, MI 49080	Fenner Creek-Gun River	23.0
70	HOBBS LARRY C & LINDA K	60.33	5224 123RD Ave Fennville, MI 49408	5224 123RD Ave Fennville, MI 49408	Mann Creek	30.1
71	SWEET LINDA TRUSTEE	60.33	36th Street	138 Grand Street Allegan, MI 49010	Bear Creek-Kalamazoo River	40.6

72	HAHN MARK & SUSAN	60.28	3741 112th Ave Allegan, MI 49010	3741 112th Ave Allegan, MI 49010	Swan Creek	29.1
73	BUFORD RAYMOND H./TRUST	60.19	G Drive North/Vacant	4162 H Drive South East Leroy, MI 49051	Willow Creek-Kalamazoo River	23.1
74	TRI-STATE HOLDINGS LLC.	60.15	E River Road/Vacant	PO Box 261047 Plano, TX 75026	Willow Creek-Kalamazoo River	21.5
75	GALLIHUGH RICHARD & SUSANNE	60.14	20981 15 Mile Road Bellevue, MI 49021	20981 15 Mile Road Bellevue, MI 49021	Clear Lake-Battle Creek	37.4
76	EAZY ACRES LLC	59.96	124th Ave	416 Hubbard Allegan, MI 49010	Mann Creek	67.2
77	SPARROW DANNY K & TRICIA	59.91	7329 Marsh Rd Plainwell, MI 49080	7329 Marsh Rd Plainwell, MI 49080	Fenner Creek-Gun River	39.7
78	ROBINSON MARILYN	59.91	21990 15 Mile Road Bellevue, MI 49021	1138 Henlon Circle Saline, MI 48176	Ackley Creek-Battle Creek	80.5
79	BROWN DENNIS H & SOILA	59.87	8719 Pennfield Road Battle Creek, MI 49017	8719 Pennfield Road Battle Creek, MI 49017	Wanadoga Creek	21.8
80	VOLKER DAVID W & VOLKER NATHAN	59.86	112th Ave	3638 115th Ave Allegan, MI 49010	Swan Creek	29.9
81	HARRY DOUGLAS A TRUST	59.83	2587 36th Street Allegan, MI 49010	2587 36th Street Allegan, MI 49010	Bear Creek-Kalamazoo River	33.2
82	WILLIAMS JONATHAN S	59.79	5010 123rd Ave	974 Bluebell Dr Holland, MI 49423	Mann Creek	20.0
83	CENSKE THOMAS W. & JUDY L.	59.78	S Dexter St/Vacant	337 Dexter St Battle Creek, MI 49014	Willow Creek-Kalamazoo River	27.8
84	ORTIZ CONRADO & REBECCA	59.78	27 Mile Rd Albion, MI 49224	14745 27 Mile Rd Albion, MI 49224	South Branch Rice Creek	32.5
85	NEWMAN JULIA SWEET	59.76	Clear Lake Ave	1349 Clear Lake Ave Battle Creek, MI 49014	Clear Lake-Battle Creek	38.6
86	REAGLE AMOS & CAROLYN	59.74	13031 15 Mile Road Marshall, MI 49068	13031 15 Mile Road Marshall, MI 49068	North Branch Rice Creek	80.4
87	BELDEN LAWRENCE C	59.66	122nd Ave	2316 Lincoln Road Allegan, MI 49010	Bear Creek-Kalamazoo River	31.5

88	RABBERS JOYCE L NON-EX MAR TRUST	59.66	Marsh Road	19459 Thompson Lane Three Rivers, MI 49093	Gun Lake-Gun River	80.7
89	RASMUSSEN JOHN	59.66	22111 Pine Lake Road Battle Creek, MI 49017	319 Eaton Battle Creek, MI 49017	Wanadoga Creek	38.4
90	NORTHBROOK ENERGY	59.60	Powerline	14550 N Frank Lloyd Wright Blvd 210 Scottsdale, AZ 85260	City of Galesburg-Kalamazoo River	52.0
91	WHEELER, HERBERT A & VICKIE L TRUST	59.57	9977 Ackley Road Bellevue, MI 49021	9977 Ackley Road Bellevue, MI 49021	Ackley Creek-Battle Creek	20.0
92	CITY OF KALAMAZOO	59.51		241 W. South Street Kalamazoo, MI 49006	West Fork Portage Creek	25.1
93	ALEXANDER ROSS C & EDNA M	59.35		2425 58th St PO BOX 28 Fennville, MI 49408	Mann Creek	77.6
94	WARREN ALVIN & JOAN	59.32	Marsh Road	10966 West Keller Road Delton, MI 49046	Fenner Creek-Gun River	39.3
95	GEYER JOHN & LUCINDA	59.31		1010 S Eaton Street Albion, MI 49224	South Branch Rice Creek	60.0
96	COOK STEVEN J	59.26	5426 126th Ave	PO Box 440 Fennville, MI 49408	Mann Creek	34.4
97	POTTAWATOMIE CLUB	59.26	Vacant Land	638 Cascade Hills Hollow SE Grand Rapids, MI 49546	Peach Orchid Creek-Kalamazoo River	116.3
98	HEINTZELMAN ROBERT II	59.26	1254 44th Street Pullman, MI 49450	1254 44th Street Pullman, MI 49450	Swan Creek	20.6
99	STEVENS GARY	59.21	4831 Torsten Drive	803 129th Ave Shelbyville, MI 49344	Gun Lake-Gun River	22.5
100	EMERICK STANLEY & CANDACE	59.19	5140 130th Ave Hamilton, MI 49419	5140 130th Ave Hamilton, MI 49419	Bear Creek-Kalamazoo River	79.6

Parcels highlighted in green fall within the AOC-buffer,
described in Section 6.

Attachment-3: Ground Truthing Parcel Photos

Attachment-1: Ground Truthing Photos

Parcel 1: Groundwater-fed stream (Source: SWMLC)

Parcel 1: Prairie Fen (Source: SWMLC)

Attachment-1: Ground Truthing Photos

Parcel 2: Hardwood forest (Source: Kyle Alexander)

Parcel 2: Forested wetland (Source: Kyle Alexander)

Attachment-1: Ground Truthing Photos

Parcel 3: Grassland (Source: Kyle Alexander)

Parcel 3: Grassland and young coniferous trees (Source: Kyle Alexander)

Attachment 4: Outreach Postcards

Preserve your forest!

What makes a forest a forest?
A forest is a large, non-agricultural area that is predominantly covered by trees.

Why do they matter?
Forests are helpful to both us and the environment. They do things like provide lumber, prevent floods, provide a home for many animals, and are a great place to relax and enjoy the outdoors.

Protecting your land!

Take action now and preserve the land for future generations to enjoy!

There are many reasons to protect your land in addition to helping the environment:

- Defending your land against development
- federal income, estate, and property tax deductions
- helping to preserve the water quality of the Kalamazoo River

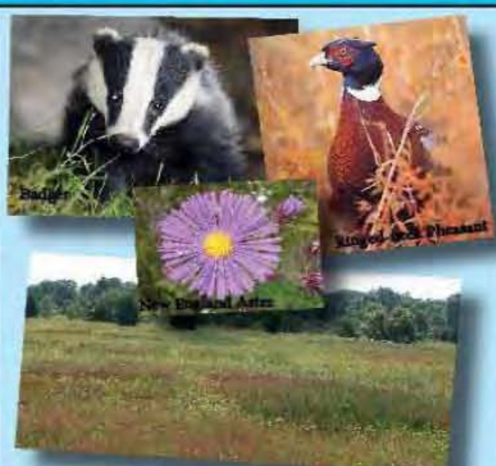
Kalamazoo River WATERSHED COUNCIL

SWMLC SOUTHWEST MICHIGAN LAND CONSERVANCY

Preserve your grassland!

What is a grassland? A grassland is an area of land in which the most common form of plant life is grass.

Why do they matter?
Grasslands are helpful to both us and the environment. They do things such as keep soil healthy, prevent erosion, provide a home for many animals including several game species, help keep water clean, and serve as a habitat for many species of wildflowers.



Protecting your land!

Take action now and preserve the land for future generations to enjoy!

There are many reasons to protect your land in addition to helping the environment:

- Defending your land against development
- federal income, estate, and property tax deductions
- helping to preserve the water quality of the Kalamazoo River

Kalamazoo River WATERSHED COUNCIL

SWMLC SOUTHWEST MICHIGAN LAND CONSERVANCY

Preserve your waterfront land!

Did you know? The land around your stream, river, or lake is called a **riparian area.** Riparian areas include the bank, bed, and land around the water.

Why do they matter?
Forests are helpful to both us and the environment. They do things such as keeping the water clean, controlling floods, providing a home for many plants and animals, and offering recreational opportunities.

Protecting your land!

Take action now and preserve the land for future generations to enjoy!

There are many reasons to protect your land in addition to helping the environment:

- Defending your land against development
- federal income, estate, and property tax deductions
- helping to preserve the water quality of the Kalamazoo River

Kalamazoo River Watershed Council

SWMLC Southwest Michigan Land Conservancy

Preserve your wetland!

What is a wetland? A wetland is an area where standing water covers the soil or an area where the ground is very wet. They may stay wet all year long, or the water may evaporate during the dry season.

Why do they matter?
Wetlands are helpful to both us and the environment. They do things such as cleaning up water, providing a home for many plants and animals (including certain game animals), and preventing floods.

Protecting your land!

Take action now and preserve the land for future generations to enjoy!

There are many reasons to protect your land in addition to helping the environment:

- Defending your land against development
- federal income, estate, and property tax deductions
- helping to preserve the water quality of the Kalamazoo River

Kalamazoo River Watershed Council

SWMLC Southwest Michigan Land Conservancy

Interested in conserving **your** land?

Contact information goes here!!!

Southwest Michigan Land Conservancy
6851 South Sprinkle Rd.
Portage, MI 49002

Mr. & Mrs. Smith
5481 Conservation Ln.
Kalamazoo, MI 48152