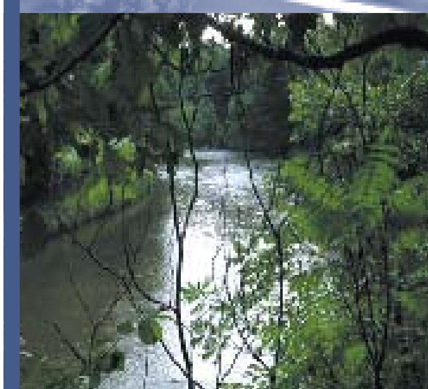

Tittabawassee River Watershed

PRIORITY CONSERVATION LANDS ASSESSMENT

THE LITTLE FORKS CONSERVANCY

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Tittabawassee River Watershed:
PRIORITY CONSERVATION LANDS ASSESSMENT

Jonathan Jarosz, Project Manager and Author
Joy Drohan, Editor

Design and layout by Shelley Koop

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Growth of Land Conservancies

According to the 2003 National Land Trust Census, there has been considerable growth in the number of small, local conservation organizations that are playing an increasingly important role and becoming effective agents in the goal of natural resource protection and open space land acquisition. First appearing in 1891 and growing in number and scope in the last half of the 20th century, land conservancies are nonprofit organizations that actively work to conserve land by undertaking or assisting in land or conservation easement acquisition, or by land stewardship.

The first nonprofit land conservancy was founded in the United States in 1891. Since that time, local and regional land conservancies have protected more than 9.4 million acres of open space (Table 1). In 2003, 1,537 local and regional land conservancies were operating throughout the United States, a 26% increase over the number that existed in 1998 (LTA 2003). In Michigan alone, there are 47 land conservancies protecting approximately 93,731 acres, with 30,018 owned outright, 44,243 under easement, and an additional 19,470 transferred to governmental agencies or conserved by other means (LTA 2003).

While land conservancies use a variety of methods to protect land, two of the most commonly used are the purchase or acceptance of donated land and the purchase or acceptance of donated conservation easements—legal agreements that permanently restrict the development and use of land to ensure protection of its conservation values. Much of the property that has been protected in the past ten years has been permanently protected through the use of conservation easements. Since 1998, the number of acres protected nationally by conservation easements increased 266% and now includes a little over 5 million acres nationally. By the end of 2003, local and regional land conservancies had signed and recorded more than 17,847 conservation easements with landowners who voluntarily decided to protect their land (LTA 2003).

TABLE 1. ***Local, State, and Regional Land Trusts: Total Acres Conserved by Region, 2003***

REGION	ACRES CONSERVED	% INCREASE '98 TO '03
Northeast	2,982,513	60
Pacific	1,521,007	147
Mid-Atlantic	1,419,539	91
Southwest	1,412,689	116
Northwest	933,528	109
Southeast	648,895	123
Midwest	416,428	92
	Total = 9,361,001	***Average Increase = 105***

Land conservancies are not government agencies. Rather, as private nonprofit organizations, they are independent and entrepreneurial, working with landowners who are interested in protecting open space. Land conservancies often work cooperatively with government agencies by acquiring or managing land, researching open space needs and priorities, or assisting in the development of open space plans. Some land trusts acquire land and then convey it to another nonprofit organization or a government agency for permanent protection and stewardship. Land conservancies also protect land by other means, some of which include providing funding to other groups for land acquisition; negotiating for the purchase of restricted property by conservation buyers; and facilitating negotiations for land to be acquired by another nonprofit organization or a public agency.

The growth of grassroots land conservancies is a result of a growing culture of conservation that is fueled by people's desire to preserve the open spaces and natural resources that characterize the communities across the country. In this regard, the private conservation movement is emerging as the fastest growing sector of the conservation community (LTA 2003).

Operational and Financial Issues

In an area that was once dominated by forests and other natural vegetation (see Table 2), northern Lower Michigan is now struggling with low density development and human-centered growth patterns that cause open space loss, fragmented forests, and degraded natural areas. Working to protect this region's significant natural lands and waterways from unsustainable development, a growing number of regional land conservancies are fighting these threats of land conversion and fragmentation.

As the land conservancies in northern Lower Michigan continue to develop capacity in staff and resources, attention must be given to prioritization at a landscape level as a proactive approach to conservation. While all of the land that a conservancy has protected is likely to be environmentally important and worthy of protection, a reactive method of land conservation can divert an organization from achieving the conservation projects that most effectively serve its mission. Knowing what properties are most beneficial to conserve can guide an organization's protection efforts in a meaningful and logical manner.

At the present time, there are four regional land conservancies that serve central northern Michigan. The Chippewa Watershed Conservancy, Headwaters Land Conservancy, Little Forks Conservancy, and Saginaw Basin Land Conservancy work within the confines of Michigan's Tittabawassee River watershed and are faced with at least two major planning issues: 1) In the world of land conservation, it's easy to operate in a reactive mode—letting land owner requests or imminent sales or threats of development determine which properties are protected. The result can be a patchwork of protected parcels—sometimes miles apart from one another—with very different resource values. 2) Because sources of conservation funding are often limited, land conservancies are forced into the position of having to decide which lands are most valuable or suitable for natural resource protection based on a particular donor's interest or the objectives of a governmental program.

In the effort to provide natural resource protection and combat landscape fragmentation, state and federal natural resource organizations have traditionally focused on acquisition for the creation of "public lands" as the primary means to ensure resource protection and integrity. With the rise of land conservancies as an effective means of resource protection, conservation easements and private landowner stewardship are becoming increasingly important tools. While many organizations work to conserve undeveloped lands and to manage their existing holdings of acquired land, their goals and associated strategies vary widely. Although all of these organizations help conserve ecosystems and biodiversity, their approach and priorities do not necessarily provide the greatest level of land protection and resource conservation.

In the promotion of proactive conservation action, there is a great need to change the focus of land conservation from the protection of individual species or sites to the protection of entire ecosystems and the preservation of biological diversity and ecosystem integrity. To effectively achieve these goals, there is also a need for improved coordination of the various conservation organizations, and their programs, to avoid duplication of effort (McGhie 1996). To reach these goals, a comprehensive, strategic approach to conservation is needed to fill the gap in useful information about land protection strategies and a fragmented and uncoordinated patchwork of conservation activities within northern Lower Michigan.

In response to these issues, prioritizing areas for conservation at local and regional scales is becoming an essential process throughout the land protection community, and particularly in Michigan. At all organizational levels, conservancies need methods to prioritize their conservation actions that are explicit, efficient, reliable, and cost-effective (Church et al. 1996, Kazmierski et al. 2004, Polasky et al. 1997). Although many land conservancies possess the in-house ecological background to identify critical resources for protection, their technical efforts are limited (Kellogg 1999). Most often, it is the small and regional nonprofit conservation organizations, such as those working in the Tittabawassee River Watershed, that do not have the technical capabilities to adequately interpret the spatial and resource data they need to objectively evaluate the conservation value of potential projects at a landscape scale.

The Little Forks Conservancy

Located in central northern Lower Michigan, the Little Forks Conservancy (LFC) is a land conservancy—a community-based organization that focuses on direct land protection. LFC is a 501(c)(3) nonprofit working to conserve the green and open spaces that provide diverse natural and cultural resources that add to the diversity of experiences for the communities in its service area. LFC works with private landowners to identify long-term conservation objectives and together find the best protection method for accomplishing those objectives.

Established in Midland, Michigan, in 1996, LFC conducts seminars, sponsors research such as this priority conservation lands assessment, and provides educational materials about important issues that affect land use in its service area. LFC does not lobby for changes to regulations or ordinances. LFC believes that a community must grow to remain vibrant, and seeks to balance that growth with a corresponding effort to provide permanently protected land that enhances both natural and cultural communities' quality of life. LFC is an independent, self-governing organization cooperating with other organizations, foundations, government agencies, and individuals to protect land.

Conservation Objectives

LFC's mission is *to permanently protect land with natural and cultural resources that add to the quality of life in our community*, and chose the following features of land as its primary conservation objectives:

- ❑ Protect river corridors in order to reduce erosion, preserve scenic views, and preserve and improve water quality;
- ❑ Protect fragile areas such as, but not limited to, bogs, wildflower habitat, wet-sand prairies, and other habitats;
- ❑ Protect sensitive historical sites and buildings;
- ❑ Protect additional scenic areas that are not along river corridors;
- ❑ Conduct an inventory of plants, animals, and ecosystems in Midland County and the Tittabawassee watershed;
- ❑ Create strong partnerships with other agencies that deal with land and resources; and
- ❑ Be a strong, viable component of the community by establishing a secure publicly supported and funded organization.

By 2006, LFC had protected more than 1,200 acres, including two nature preserves, 11 conservation easements, and more than six miles of stream, river, and lake shoreline. To address the growing impacts of development in the Tittabawassee River Watershed, LFC is working to transform its land protection efforts from an opportunistic to a strategic operation by developing a landscape-scale assessment of the resource value of lands within the basin.

The Tittabawassee River Watershed

LFC's service area includes the Tittabawassee River watershed, the largest watershed in Michigan's Saginaw Bay watershed. The Tittabawassee River watershed encompasses the waters of the Tittabawassee and the Chippewa river systems, includes all or a portion of 13 counties, and drains approximately 2,472 square miles of midand northern Michigan (Figure 1). Approximately 4.25% of the state's 37,210,224 acres drains to the Saginaw River, Saginaw Bay, and eventually Lake Huron via the Tittabawassee basin. Major tributaries include the Chippewa, Pine, and Tobacco rivers. The Tittabawassee River is the largest tributary to the Saginaw River, contributing approximately 50% of its flow. The Tittabawassee and its major tributaries have been, and continue to be, heavily used by industry and municipalities (PSC 2002).

The Tittabawassee River watershed also spans what is generally referred to as the "tension zone" or "transition zone," which is a geographic zone that bisects the lower peninsula of Michigan west to east roughly from Grand Haven to Bay City. This zone corresponds to a change in major climatic zones, which, in conjunction with sandier soils, accounts for a noticeable difference in land cover from south to north. In the southern portion of the watershed, the climate and soils are more amenable to agriculture, while areas north of the tension zone remain heavily forested (Soule et al. 1998).

Threats to the Watershed

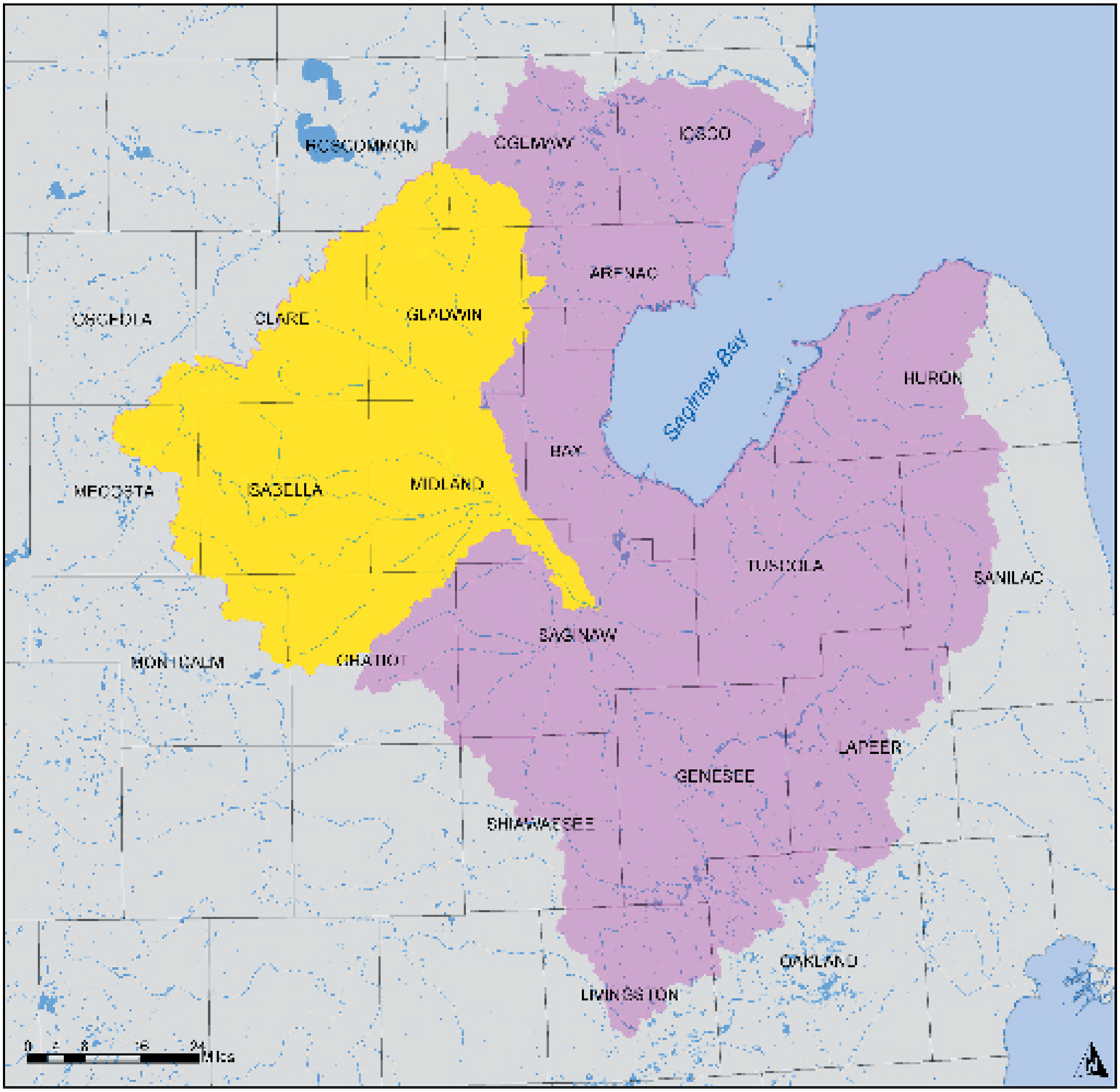
The land cover of Michigan, and correspondingly its resource base, has changed significantly since 1980, and that trend is predicted to continue as shown in Table 2. Dominant changes in the Tittabawassee River watershed's land cover between presettlement (circa 1800) and 2000 were deforestation and the establishment of agricultural and urban lands. Based on year 2000 land cover data from the Michigan Department of Natural Resources' Integrated Forest Monitoring, Assessment, and Prescription (IFMAP) program, the watershed's 1,557,852 acres of land area are approximately 34.73% human-modified and 65.27%

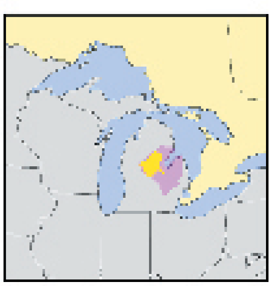
TABLE 2. ***Predicted Land Use Change in Michigan: 1980–2040***

LAND COVER CLASS	MILLION ACRES			
	1980	2040	Change	Percent
Agriculture	11.0	9.1	-1.9	-17
Built	2.3	6.4	+ 4.1	+178
Forest Land	18.2	16.9	-1.3	-8
Other Vegetation	2.9	2.2	-0.7	-24
Wetland	1.8	1.7	-0.2	-10

Source: Michigan Land Resource Project (PSC 2001)

Tittabawassee River Watershed





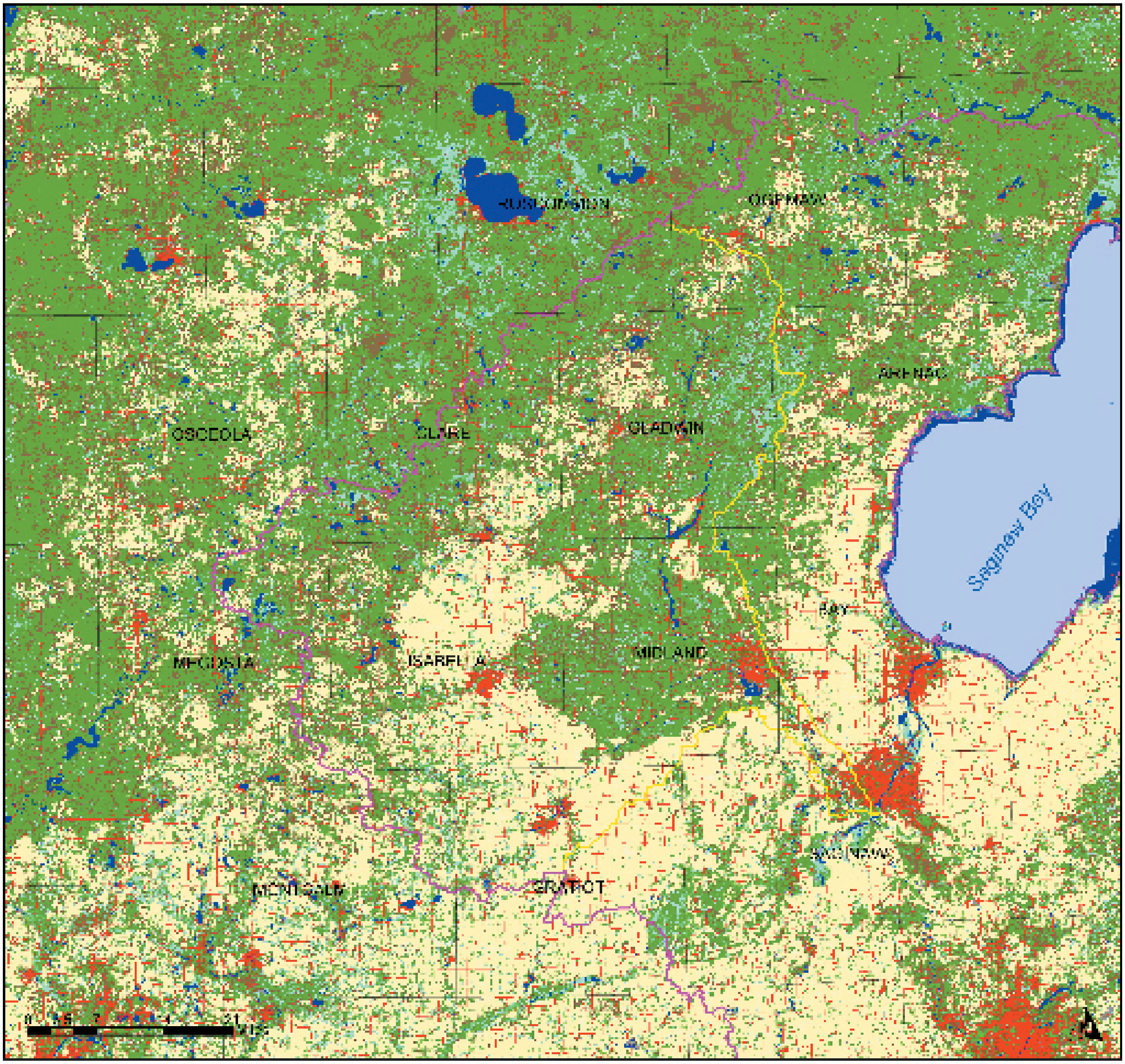
Map Legend

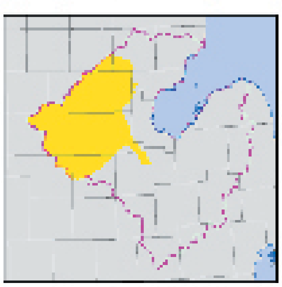
Landscape Features
Lakes
Rivers and Streams
County Boundaries
State Boundaries

Watersheds
Saginaw Bay
Tittabawassee River

Figure 1. Tittabawassee River Watershed

Tittabawassee River Watershed: IFMAP 2000 Land Cover





Map Legend

Land Cover Classes
- Urban
- Agriculture
- Upland Openland
- Bare Sparsely Vegetated
- Water
- Wetland
- Forest

Watersheds
- Saginaw Bay
- Tittabawassee River

Figure 2. Tittabawassee River Watershed Modern Land Cover.

natural in condition. Three land cover types—agriculture, forest, and urban—are dominant in distinct regions of the watershed, as illustrated in Figure 2.

Historically, the major developed areas within the watershed were found within the municipal boundaries of cities and villages, including Alma, Beaverton, Clare, Coleman, Gladwin, Harrison, Midland, Mt. Pleasant, and St. Louis. However, in recent years this has changed, as new development is no longer located in existing population centers, but rather broadly dispersed throughout the watershed (Jarosz et al. 2005).

Dispersed or low density human modification of natural lands creates new patterns in the landscape that alter plant and animal communities and associated ecological function and processes. Dramatic shifts in the ratio of natural to developed land use result in:

- Loss of natural lands – Increases in developed land for human needs reduces the amount of remaining natural lands. As these lands are diminished, so is habitat diversity, which results in a decline of the number of species present as well as in the number of individuals of those species that survive (Dale et al. 2000).

- Fragmentation of natural lands – As natural lands are converted to developed uses, they are fragmented into smaller and more isolated patches. This fragmentation alters the manner in which natural systems function by increasing edge habitat and the isolation between patches of natural cover (Dale et al. 2000).

- Degradation of water resources – The development of wetland and riparian zones threatens the health of natural systems by reducing their capacity to fulfill natural functions such as floodwater retention; filtration and detention of sediment, toxins, and excess nutrients; and the maintenance of plant and animal species (Dale et al. 2000).

- Decreased ability for nature to respond to change – Increases in developed land cover hinder the ability of natural systems to respond to climatic changes and reduce population viability for plants and animals by reducing genetic diversity and limiting movement (Dale et al. 2000).

Although the consequences of fragmentation and loss of habitat have been well documented, their effects are often not recognized until they are difficult or impossible to repair. Low-density residential, commercial, and industrial developments in traditionally rural areas usually accelerates urbanization rather than conversion to other land use types, and their impacts are persistent and influence long-term ecological integrity both directly and indirectly (Egan and Luloff 2000, Gobster et al. 2000, Schneider and Pontius 2001).

While it may seem logical that a distributed development pattern across a large area would minimize the impact on the natural resource base, lower level use of a larger quantity of land creates greater disturbance on aggregate than does concentrated urbanization with large, contiguous areas of open space and farmland between (Chazan and Cotter 2001). Within the Tittabawassee River watershed, this larger scale land conversion is of greatest concern because its inefficient use of resources taxes the watershed's human carrying capacity faster than necessary (Chazan and Cotter 2001).

This situation, however, is not unique to the Tittabawassee River watershed and is exemplary of the trends that are taking place across the state of Michigan. Between 1982 and 1997, Michigan's developed land acreage increased by more than 30%, primarily in rural areas (Norris and Soule 2003). While this rate of land development can be partially explained by the spread of low-density residential, commercial, and industrial developments into traditionally rural areas, it should also be noted that between 1980 and 2000, Michigan's population grew by only 6.9%. The state's average population density was at 3.8 persons per acre of land in the early 1980s and dropped to 2.8 persons per acre by the late 1990s (Norris and Soule 2003).

These trends translate into a continued increase in the amount of developed land without any major corresponding increase in population. Based on current growth patterns, on average the state of Michigan's rate of land development is 8 times the population growth rate (PSC 2001). Changes in the amount of built area between 1980 and 1995 were calculated in relation to population change during the same period. In this 15-year period, the amount of built area increased by 25%, while total population increased by about 3%. This ratio (25:3) represents more than an eight-fold increase in urban land usage in relation to the population increase (PSC 2001). Of the two metropolitan statistical areas closest to the Tittabawassee River watershed for which there is data, the cities of Bay City and Saginaw have land development to population growth ratios that are much higher than the state average. Saginaw's ratio is 14:1, while Bay City's ratio is 27:1, the highest in the state (PSC 2001). Projections made by the 2001 Michigan Land Resource Project suggest that these trends in land cover change are not only apt to continue, they are likely to increase. By the year 2040, Michigan's built or developed areas are projected to increase from 2.3 million acres in 1980 to 6.4 million acres, a 178% increase, at which point 17% of the state's land would be developed (PSC 2001).

The Land Protection Toolbox

To address these gathering threats, LFC employs a variety of tools in their land protection efforts. The conservation action or the protection tool varies from property to property based on such factors as the landowner's objectives, the uniqueness of the particular property, and the Conservancy's goals and management capabilities. LFC's conservation actions are focused on acquiring rights in land, including fee simple ownership and conservation easements, obtained through three land acquisition techniques: donations, bargain sales, and purchases.

Rights in Land

Fee Simple Ownership: Fee simple ownership or fee simple interest is a way of describing full ownership of a piece of land, including all of the legal rights of the property. The word "fee" comes from an old English word meaning "land that can be inherited." Holding land in fee simple ownership gives the owner "full title to and possession of all rights associated with the purchased property, subject only to the constraints imposed by nuisance laws and valid public regulations, including zoning and subdivision" (Duerksen et al. 1997).

Fee simple ownership is the most common acquisition tool. It provides one of the most effective and least complicated means of protecting land because it offers the straightforward transfer of title to land ownership. Once LFC assumes ownership, it controls development, redevelopment, preservation, and access, and can manage the land in accordance with its resource protection goals. Fee simple ownership is the most common acquisition tool and the least complicated because it is a straightforward transfer of title to land ownership. Fee simple acquisition can be accomplished through several different options, from purchase at full market value to outright donation of the parcel.

Conservation Easement: A conservation easement is a voluntary agreement through which a landowner limits the type or amount of development on the property. The conservation easement is a binding agreement between the landowner and LFC and is recorded with the Register of Deeds in the county where the property is located.

An easy way to visualize a conservation easement is to think of owning land as holding a bundle of sticks. Each of the sticks represents a landowner's right to do something on or with the property. These rights may include building houses or agricultural buildings, harvesting timber, subdividing the property, selling or giving the property away, farming or hunting, and many other traditional rights of ownership.

Through a conservation easement, a landowner voluntarily limits uses of the property to protect certain of its conservation values. These conservation values may be natural features such as rivers, streams, forests, floodplains, wildlife habitat, wetlands, or prime agricultural fields. Every easement is unique, written to address the circumstances of the landowner and the specific property and will include restrictions intended to protect these features of the land forever.

The landowner retains full rights to control and manage the property within the limits of the easement. The landowner continues to bear all the costs and liabilities related to ownership and maintenance of the property. LFC monitors the property once each year to ensure compliance with the easement's terms, but it has no other management responsibilities and exercises no control over other activities on the land. If the landowner wishes to grant the public the right to use the property, he or she may do so. It is the property owner's responsibility to control access to the land.

To be eligible for a federal tax deduction the easement must be given "in perpetuity"—it must last forever. The donation of a parcel of land allows the landowner to deduct up to 100% of the fair market value of the land at the time of the gift. Each easement contains provisions giving LFC the right to enforce the agreement. If a violation of an easement occurs, LFC will take steps to uphold the terms of the easement, including legal action. LFC has established a defense fund to ensure that every easement the Conservancy receives can be enforced. Rights that are given to LFC through a conservation easement are held by LFC. These rights cannot be sold or transferred to other properties or individuals (LFC 2005 and LTA 1993).

Land Acquisition Techniques

Donation: LFC will accept donations of land with significant natural or cultural value to the community. The reasons landowners choose this option vary, but may include the lack of an heir to accept the land, discontinued use of the property, a desire to preserve the ecological or historical importance of the land and a desire to preserve it as a legacy for the future, or a desire to reduce the exposure of the heirs to estate taxes.

For those properties of great significance LFC may maintain the property as a nature preserve. The preserve may or may not be open to the public for uses that do not compromise the land's conservation. LFC will evaluate other, less significant properties to determine the level of protection that is needed and make appropriate decisions to further their mission (LFC 2005).

Bargain Sale: If a landowner does not wish to donate property outright, it is possible to conduct a bargain sale of the property. LFC can purchase the property at below market value. The seller can take the difference between the sale price and full market value of the property as a tax deduction and use it to offset capital gains taxes triggered by the sale (Small 1997). A bargain sale also makes the land more affordable to LFC than a full market value purchase (LFC 2005).

Purchase: In special situations the protection of a property is important enough to warrant purchase by the Conservancy at its full market value. This may occur when a landowner will give up control of the property only through a sale. LFC is restricted from paying more than full market value for any property it wishes to obtain (LFC 2005).

The Decision Making Toolbox

Just as LFC staff employ a variety of tools in their land protection efforts, they also use a variety of processes for making decisions. The conservation action or protection tool that is ultimately utilized for a particular property depends as much on the characteristics of the land and the landowner as it does on how the decision to invoke a particular action was reached. As identified by Gustanski et al. (1999), six general forms (Table 3) of decision making are employed by land conservancies. These forms include routine, emergency, analysis-based, oligarchical, collaborative, and conflict mitigation decision making. It is important to note that these decision-making processes are not unique to land conservancies, that they take place in larger social and institutional contexts, and that they are often used in concert with one another as opposed to discrete, isolated forms.

TABLE 3. Six General Forms of Decision Making

PROCESS	INVOLVEMENT
Routine	Executive, administrative, or technical staff within the land conservancy make decisions relative to everyday situations following set procedures.
Emergency	A subset of individuals within the land conservancy is vested with the powers to make swift decisions in situations where lands valuable to the community or region are under imminent threat.
Analysis-based	Technical professionals associated with the land conservancy develop carefully crafted proposals on a specific conservation project or related land use issues for the ultimate decision maker, which is typically the board of directors or trustees.
Oligarchical	The executive committee of the land conservancy reaches either agreement or a majority view on prospective conservation projects or issues related to protected lands.
Collaborative	Individuals from a number of organizations, including the land conservancy, work together on a project to achieve a common conservation goal.
Conflict Mitigation	Staff or board members of the land conservancy undertake this process to solve disputes within their service area related to particular conservation efforts where there is conflict amongst outside parties.

At the present time, LFC makes use of four out of the six forms of decision making: routine, oligarchical, collaborative, and conflict mitigation. Policies for emergency decision making are currently under discussion (LFC 2005). The four approaches have served the organization well thus far. However, given the impending threats to the natural character of the Tittabawassee River watershed, the steadily increasing capacity of staff and resources at the Conservancy, and the desire to transform its land protection efforts from an opportunistic to a planned, proactive operation, LFC is working to round out its decision-making toolbox in a manner that complements the full range of land protection tools at its disposal.

To fulfill that need and to achieve the conservation projects that most effectively serve its mission, LFC sought the development of a strategy to assess the conservation attributes of land in the Tittabawassee River watershed and prioritize those with the highest conservation value. Funded by a grant from the Saginaw Bay Watershed Initiative Network in 2005, this priority conservation lands assessment is intended to provide a foundation enabling LFC to apply the analysis-based process to its decision making.

Project Goals and Benefits

Project Goals

The role of a land conservancy is not to isolate the communities it serves from the natural resources that surround them, but rather to incorporate those resources back into the community. As LFC works to conserve the green and open spaces that provide diverse natural and cultural resources in its service area, it recognizes that two important aspects of "community" include a region's natural resource base and its social fabric.

The shift by LFC to a more proactive approach to conservation requires that conservation activities be conducted in concert with the watershed's communities. Given the assumption that all communities must grow in order to remain viable and vibrant, their natural and cultural resources must complement rather than compete with one another. Additionally, given the number of communities that exist within LFC's service area, there is a need to examine the landscape for its conservation value and produce an assessment that is useful to as many of those communities as possible (Benedict and McMahon 2002). Therefore, the identification of priority conservation lands in the Tittabawassee River watershed must:

- Promote smart conservation at multiple scales
- Guide and integrate diverse conservation actions
- Recognize and address both natural and human needs
- Promote conservation and development certainty
- Provide a broad, unifying future vision that diverse people and organizations can buy into
- Base Decisions on a Logical, Scientifically Defensible Framework

Project Benefits

The identification of priority conservation lands may be used in several ways to support LFC's organizational goals and on-the-ground conservation activities. These activities include:

- Proactive conservation
- Evaluation of opportunistic acquisitions
- Justification of acquisitions
- Development of public relations

Lands identified in this assessment as having high conservation value can provide a focus for LFC and other conservancies working in the Tittabawassee River watershed's landscape, allowing them to engage in proactive rather than reactive conservation actions. Areas of high natural resource value can be targeted in the search for land available for protection.

Many times, landowners will offer their property or development rights to land conservancies. These opportunistic acquisitions provide a special challenge, because the resource value of such lands is often outwardly uncertain. Maps and analyses created by this assessment can aide the conservancies in determining the value of the property for resource protection and in justifying to granting organizations the importance of intended conservation actions.

Current conservation science and contemporary thinking in landscape ecology and conservation biology provide the foundation for the data and methods used in this assessment. These data and methods can provide sound justification for potential acquisitions by identifying the public interest in acquisitions that fall inside highly resource-rich regions of the landscape. Ultimately, this assessment can aid in highlighting the importance of local conservation organizations in protecting the natural and cultural resource base of a region.

GENERAL METHODOLOGY

Conservation Planning Approaches

Fine Filter and Coarse Filter Approaches

There are two traditional approaches to conservation planning. A "fine filter" approach focuses on individual species and their habitats and depends on fairly comprehensive or well distributed biological surveys to be most useful (Noss 2002). This approach has been favored traditionally because of public support for individual species and the local nature of many conservation programs, but has been shown to be inefficient and expensive for protecting biodiversity due to its narrow focus.

A "coarse filter" approach emphasizes a larger spatial scale and is designed to protect high-quality examples of all natural communities or ecosystems in a region. In general, the coarse filter approach has been proven to be a more efficient and effective conservation strategy, but if applied to localized occurrences of imperiled communities, as it often has been in practice, the coarse filter is really no different from the fine filter (Noss 2002). If applied on a landscape scale, however, with the notion of representing multiple resource values in a region, the coarse filter is complementary to rare species or habitat conservation (Noss 1983).

For the assessment of the Tittabawassee River watershed's priority conservation lands, a general resource presence prioritization is used as a coarse filter assessment of land's resource value. However, because rare species and communities can fall through the cracks of coarse filtering, this coarse filter approach is supplemented by the use of biodiversity value information generated by the Michigan Natural Features Inventory to identify rare species and communities in need of conservation action. Use of a coarse filter approach and a complementary fine filter contribution should result in a higher likelihood of conservation success with the least degree of uncertainty attainable given limitations in available data, analysis techniques, and project duration (Boyce 1992).

This enhanced coarse filter approach to conservation site selection tries to efficiently target both species and ecosystems to maximize the conservation of a landscape's natural resource base. Through the identification, targeting, and conservation of land containing multiple resources or linkages to additional resources, the protection of a full range of ecosystem elements, services, and functions can be ensured. One illustration of this enhanced coarse filter approach that guides this assessment and is exemplified by conservation planning programs in the United States (UF GeoPlan Center 1999) and throughout Michigan (Jarosz et al. 2005) is the integrated landscape approach.

Integrated Landscape Approach

An integrated landscape approach is a conservation strategy that recognizes the importance of interactions among the built environment, rural lands, and native ecosystems and incorporates research, planning, and management at appropriately large spatial and temporal scales so that land uses are effectively integrated to maximize compatibility and ensure the conservation of biological diversity (Noss 1983, Noss and Harris 1986, Noss and Cooperrider 1994). Through the incorporation of contemporary principles of landscape ecology and conservation biology, it is possible to perform an integrated landscape analysis with the goal of including a full range of ecosystem elements, services, and functions. Compared to traditional approaches, an integrated landscape approach incorporates the following characteristics:

- System-wide, not site specific – In contrast to traditional land use planning and resource analysis that tends to concentrate on the characteristics of a particular sites with little or no consideration of surrounding features, the priority conservation lands assessment for the Tittabawassee River watershed attempts to focus on the landscape as a whole and on the interrelationships among its biological and physical components (UF GeoPlan Center 1999).
- Applied at multiple scales – An integrated landscape approach recognizes the importance of considering features and interrelationships at many spatial scales across the landscape. Older single site/single scale approaches consider various scales separately. In contrast, this assessment for the Tittabawassee River watershed attempts to consider multiple scales at the same time—from the natural community level to the municipal political level to the watershed landscape level (UF GeoPlan Center 1999).
- Crosses political boundaries – Political boundaries are irrelevant to the functioning of natural systems and their associated plants and animals. Although an integrated landscape approach may recognize politically established boundaries in the evaluation of results, it uses natural ecological boundaries rather than political boundaries to set the focus of conservation analysis, prioritization, and action. Through the use of ecoblocks as analysis units, this assessment takes advantage of the most ecologically meaningful unit at the finest level of human landscape division (UF GeoPlan Center 1999).
- Integrates ecological and cultural considerations – At its origin, the focus of ecology is the natural world, and this science tends to ignore humans and their social impacts. An integrated landscape approach necessitates the understanding of both natural and cultural communities and the development of procedures that incorporate those natural and cultural features as part of its analytical methods. At the heart of this assessment is the recognition that the role of a land conservancy is not to isolate the communities it serves from the natural resources that surround them, but rather to reincorporate those resources into the community identity (UF GeoPlan Center 1999).
- Multidisciplinary and multisector – Traditional methods of analysis are usually characterized by experts of a single discipline making recommendations based on their own narrow focus of expertise and experience. In contrast, the priority conservation lands assessment for the Tittabawassee River watershed attempted to involve methods from a diversity of disciplines, including conservation biology, landscape ecology, environmental planning and design, and geographic information systems (GIS), and to produce recommendations that integrate the combined experience of those disciplines (UF GeoPlan Center 1999).

In addition to these defining characteristics, there are a number of guiding concepts that are fundamental to an integrated landscape approach, such as:

- Context – A fundamental concept of landscape ecology is that the study of content alone is not sufficient to understand relationships or predict long-term outcomes of natural or human-made alterations. An analysis of the context, the surrounding biological and physical factors, is also critical to understanding and predicting the change in native ecosystems and landscapes. To result in successful conservation action, the priority conservation lands assessment must consider how the Tittabawassee River watershed's natural resources contribute to, interact with, and are influenced by the ecosystems of surrounding areas (UF GeoPlan Center 1999).

- Sound ecological and environmental science – Due to its focus on landscape features and processes, an integrated landscape approach relies on a thorough understanding and incorporation of principles and methodologies from a variety of ecological and resource sciences. Without this sound basis in conservation biology and landscape ecology, the results of the priority conservation lands assessment would be incorrect and incomplete at best (UF GeoPlan Center 1999).
- Temporal and spatial links – Individual ecosystems and their associated plants and animals and processes change over space and time. The pattern and rate of growth and other variations in land use will likewise vary over space and time. Critical to an integrated landscape approach is the realization that what exists on the landscape at the present time is ever-changing. Due to static data sources, this assessment of the Tittabawassee River watershed's resource base is a snapshot in time. While the results are a picture of current conditions, the analytical technique, however, is replicable and repeatable. Repetition of the assessment over a period of time will provide for solid analysis of changes over both space and time, and is critical to predicting future changes and hence to the success of future conservation actions (UF GeoPlan Center 1999).

Landscape-Level Conservation Prioritization

All too often, conservation activities are not embedded in a comprehensive scientific framework, and they lack quantifiable and generally acceptable goals (Pressey 1994). Little attention is paid to the question of how local conservation measures should reflect ecosystem requirements at larger spatial scales. Instead, much of today's nature conservation is still ad hoc in action, guided by what is possible under the present political or social conditions rather than by what has been found necessary by careful, scientific analysis designed to reach a defined conservation goal (Suter 1998).

A landscape-scale analysis to determine conservation suitability of the natural resource base throughout the Tittabawassee River watershed seeks outcomes that identify the primary ecological network to provide a strategic framework for resource protection and land conservation activities. Recognizing the need for the immediate protection of such ecological networks as essential natural and cultural community resources (Benedict and McMahon 2002) and the appropriateness of long-term planning, results are intended to provide guidelines to decision makers responsible for protecting and managing the watershed's natural resource base over time.

The development of a simple analytical model can provide local conservation organizations with guidance in identifying the most important lands for conservation. Such a model is based on the notion that single-focus conservation prioritization is constructive and appropriate for many conservation actions and applications. All things being equal, any land that contains multiple resources, or linkages to additional resources, has more value than isolated properties.

A systems-level strategy seems to be the best way to preserve ecological integrity, and saving groups of species in self-maintaining ecosystems can be a cost-effective addition to species and resource protection and restoration (Scott et al. 1989). Traditional approaches to land conservation have resulted in a many high-quality natural areas being protected or restored, but such approaches still have several shortcomings.

Traditional approaches to stem natural resource depletion and biodiversity loss have historically proceeded on a threat-by-threat or species-by-species basis (Scott et al. 1993), and have been criticized for not addressing larger resource challenges such as fragmentation, habitat loss, and the disruption of ecological processes (Noss and Cooperrider. 1994). They do not provide a means to identify the most efficient areas within a landscape context on which to apply land conservation efforts. Nor do they take advantage of the synergistic efforts of organizations to conserve a complex matrix of habitat within a region. They also do not provide a means to monitor whether the conservation of high-quality resource areas exceeds their loss to development. A mechanism to help direct conservation activities more proactively to regions where they will provide the most benefit is critically needed (Margules and Pressey 2000).

Therefore, for the purposes of this assessment, areas in the Tittabawassee River watershed's landscape that possess a high co-occurrence of natural resources are critically important targets for protection because they represent the greatest value for the conservation dollar.

Multicriteria Conservation Prioritization

Because conservation prioritization seeks to accommodate the needs of all species and resources that are to be conserved, the consideration of a wide range of environmental and biological factors that are indicative of high quality resources is required (Soule and Simberloff 1986, Meffe and Carroll 1994, Noss and Cooperrider 1994). Multicriteria conservation prioritization involves the synthesis and integration of this information in a model that predicts overall value of various segments of the landscape. There are many criteria for conservation prioritization, including ecological, social, and economic factors. Often the social and economic factors ultimately outweigh the ecological factors in final selection of high priority resources for conservation action (Leader-Williams et al. 1990).

Historically, a considerable number and type of methods have been proposed for prioritizing natural areas (Duever and Noss 1990, Hyman and Leibowitz 2000). Past methods of prioritizing areas for protection and restoration have focused on lists of criteria or data layers (Margules and Usher 1981, Hamlett et al. 1992, Johnson 1995) or on algorithms for selecting sites (Kirkpatrick 1983, Margules et al. 1988, Pressey and Nicholls 1989, Kiester et al. 1996, Pressey et al. 1996).

Early approaches were based primarily on visual appearance, but over recent decades increasingly sophisticated criteria have been developed (Hyman and Leibowitz 2000). Ideally, evaluation procedures consider the physical content of an area as well as the context in which it exists (Noss 1987).

Critical elements that are commonly included in prioritization schemes are: 1) species and resource diversity—how many and what types of species or resources are present; 2) species and resource rarity—of those species and resources that are present how unique are they locally, regionally, and globally; 3) ecosystem representativeness—to what extent does the area of concern account for the diversity and rarity of species and resources; 4) spatial extent and structure—what is the size of the geographic coverage and the composition of the area of concern; 5) availability—what species or resources remain after human disturbance; and 6) vulnerability to human impact—what is the relative threat of local extinction due to human impact (Knutson et al. 1993). Evaluative criteria have evolved from a combination of ecological and biological theory, human social and political values, and practical considerations of long-term management and stewardship (Margules and Usher 1981, Hyman and Leibowitz 2000).

Unfortunately, one of the shortcomings of past prioritization efforts is the lack of a common and rigorous framework for ranking sites, such that the process is explicit and repeatable, necessary assumptions are highlighted, and commonalities and significant differences among prioritizations can be readily assessed (Hyman and Leibowitz 2000). Just as many conservation activities are not based in sound scientific analysis, those that are generally employ methods far ranging from one another. Differences among prioritizations can be seen as stemming from the use of different models, different assumptions associated with the same model, or different estimators of the same model terms (Hyman and Leibowitz 2000).

While the methods employed in each of these prioritization efforts may be valid for their particular application, lack of consistency and replicability across large regions or landscapes hinders the efforts of organizations working toward on-the-ground conservation successes. Without a common framework, it is difficult for local conservation organizations to know which areas are most important to conserve, to direct their protection efforts in a meaningful and logical manner, and to avoid inadvertent conflict in their conservation activities.

To provide a foundation from which this assessment can be replicable and complementary to other prioritization efforts in Michigan, the general framework is parallel to the Potential Conservation Areas (PCA) approach developed by the Michigan Natural Features Inventory (Paskus and Enander 2004).

The Michigan Natural Features Inventory (MNFI) (a joint program of Michigan State University and the Michigan Department of Natural Resources) defines PCAs as places on the landscape dominated by native vegetation and having various levels of potential for harboring high quality natural areas and unique natural features. The process established by the MNFI for identifying PCAs consists of delineating and then scoring or prioritizing natural areas based upon a set of specific scaled criteria, including total size, size of core area, presence of riparian feature, landscape connectivity, restorability of surrounding lands, vegetation quality, parcel fragmentation, and biodiversity value (Paskus and Enander 2004).

While other systematic methods of prioritization could have been adapted from programs throughout the United States (UF GeoPlan Center 1999, Weber and Wolf 2000, UNC 2001), the PCA analysis is native to Michigan. First developed in Michigan in 1997 for the Shiawassee & Huron Headwaters Resource Preservation Project, the PCA approach has be replicated in the counties of Oakland, Livingston, Macomb, Genesee, Lapeer, and Shiawassee, as well as the Huron River watershed and the Lake St. Clair region. The PCA approach was chosen as a guide for this assessment because of its successful use by land conservancies and municipalities in other regions of the state, its ease of explanation to major stakeholders and funders, its ease of replication, its relatively low cost to produce, and its use of freely available, public data layers (Keglovitz 2005).

Additionally, while a number of states have undertaken statewide, feature-based conservation prioritization initiatives, conservation planning in Michigan is most often limited to regional initiatives at the largest scale. Apart from the community-level written recommendations of a statewide wildlife conservation strategy (Eagle et al. 2005), Michigan currently does not have a strategy based on existing physical landscape features and locations. Given its widespread application across the state, the PCA approach is the closest approximation to a common analytical framework that presently exists in Michigan.

Using a parallel approach in this assessment, in conjunction with the philosophical underpinnings of an integrated landscape approach, is intended to provide continuity across physical regions, as well as further develop a common analytical and social framework through which municipalities and conservation organizations can collaborate on natural resource protection activities.

PROJECT METHODOLOGY

Study Area and Data Sources

Study Area

The study area chosen for the Tittabawassee River Watershed Priority Conservation Lands Assessment encompasses all of the ecoblocks (see description in the Landscape Division section below) that intersect the thirteen counties that contain the Tittabawassee River watershed (hereafter referred to as the raster grid

Tittabawassee River watershed landscape). While the use of the watershed boundaries for LFC's service area is appropriate for organizational and hydrologic considerations, it does not address terrestrial ecological concerns, nor does it align with any existing social or political boundaries. To maintain healthy ecosystems that cross political boundaries, multiorganizational partnerships are needed and political scale cannot be ignored (Soule and Terborgh 1999). Examining the larger Tittabawassee River watershed landscape will not only make this assessment useful to the greatest number of decision makers both inside the Conservancy and out, but ideally will also create a foundation from which coordination of the various conservation organizations in the Tittabawassee River watershed can be improved and from which multiorganizational partnerships for conservation action can be formed.

Data Sources

The Tittabawassee River watershed's landscape was analyzed in a GIS using freely available data (Table 4) from the Michigan Center for Geographic Information, the Michigan Department of Natural Resources, the Michigan Natural Features Inventory, and Ducks Unlimited, Inc. – Great Lakes/Atlantic Regional Office.

Table 4. ***Digital Data Sources***

DESCRIPTION	AGENCY OR ORGANIZATION	SOURCE NAME
Roads	Michigan Center for Geographic Information	Framework v4b
Streams	Michigan Center for Geographic Information	MIRIS Base 24k
Rivers	Michigan Center for Geographic Information	MIRIS Base 24k
Lakes	Michigan Center for Geographic Information	MIRIS Base 24k
Shoreline	Michigan Natural Features Inventory	MNFI Polit STCO24
Railroads	Michigan Center for Geographic Information	Framework v4b
Pipelines	Michigan Center for Geographic Information	MIRIS Base 24k
Power Lines	Michigan Center for Geographic Information	MIRIS Base 24k
Airports	Michigan Center for Geographic Information	MIRIS Base 24k
Conservation and Recreation Lands	Ducks Unlimited, Inc.	CARL
Biodiversity Value	Michigan Natural Features Inventory	MNFI
Native Vegetation	Michigan Natural Features Inventory	MNFI
Land Cover	Michigan Department of Natural Resources	IFMAP

Landscape Division

Because two primary objectives of conservation planning are the selection and prioritization of areas for conservation action, conservation planners must choose an analysis unit for which they can develop and summarize ecological attributes that represent their criteria for site selection and prioritization (Hyman and Leibowitz 2000). While other conservation assessments have used watersheds, square or hexagonal grid cells,

cells, and other geographic features as analysis units, none of these is discrete or specific enough in its spatial coverage to be of greatest use to a local or regional land conservancy. Because cadastral parcels (the official value, extent, and ownership of land for the purposes of taxation) are often the finest geographic unit at which conservation action is taken by a land conservancy, the analysis unit for this assessment must be equivalent or as close an approximation as possible.

Digital parcel boundaries are rarely available for an entire region or landscape, and this is the case in the Tittabawassee River watershed. Ecoblocks are shown on an integrated GIS data layer that represents contiguous areas of land or water, bounded by roads, railroads, power lines and pipelines, and major riparian features or shorelines. Each block is a contiguous polygon, which by definition is undissected by these linear features. Since ecoblock boundaries often follow parcel boundaries, they provide an intermediate assessment unit above the parcel level to help focus on important regions for conservation activities.

Discussions with LFC's land protection staff and other conservation professionals working in the Tittabawassee River watershed provided the foundation for two conclusions. First, that although cadastral parcels would be the most appropriate unit of analysis, conservation action is time-sensitive, and it makes no practical sense to put off this assessment until that time when digital parcel information is available watershed-wide. And second, in lieu of having the option to conduct the assessment at the parcel level, ecoblocks would provide a suitable alternative based on the following considerations.

Ecoblocks have a number of advantages over other analysis units, such as square or hexagonal grid cells, watersheds, or property parcels. They can serve as discrete well-defined geographic units for biodiversity assessment, planning, and inventory. Ecoblocks are more ecologically meaningful than arbitrary grid cells and other units due to the impact of roads on resource viability in terms of fragmentation, development threat, edge effects, and invasive species (Biasi and Olivero 2000). They are also more ecologically meaningful than watersheds when it comes to terrestrial rather than aquatic conservation targets. Ecoblocks are more ecologically meaningful than parcels in many ways, despite the fact that land ownership strongly determines land management.

Additionally, the fact that block boundaries are very discrete, well-defined, and relatively permanent also means that they are fairly easy to recognize by decision makers, landowners, the public, and field staff. In comparison with other geographic units, ecoblocks are easy to locate in the field and in aerial photography. The ability to develop ecoblocks from freely available public data sets provides another significant advantage.

Attributes of size, diversity, condition, etc., can be attached to each block through GIS analyses and expert knowledge. With such attributes, the ecoblock data layer becomes a multipurpose ecological census for conservation planning and inventory, analogous to the U.S. Census blocks used by urban planners and demographers for socioeconomic analysis and planning (Biasi and Olivero 2000). However, rather than being linked to human demographic statistics, they summarize ecological statistics for each block. They provide a complete spatial division of the Tittabawassee River watershed's landscape, and in turn, each block can be examined for its overall contribution to the integrity of the landscape's natural resource base.

Prioritization

Guided by methodology developed by Biasi and Olivero (2000), an ecoblock data layer was created for the Tittabawassee study area. Following the creation of the ecoblock data layer, an examination of the features inherent to each ecoblock was undertaken based upon specific scaled criteria to prioritize them for conservation action. The criteria used in the generation of the ecoblocks and additional resource information formed the basis for translation to a numerical scale. Each ecoblock could be assessed based upon these scaled criteria and a total calculated score, based upon the sum of the scores for each criterion.

To successfully identify and prioritize those lands most suitable for conservation, criteria were generated in conjunction with LFC's land protection staff. These "resource criteria" were based on physical landscape features found within the watershed's landscape and the value associated with them by LFC's conservation objectives. Specific criteria included size, core area, biodiversity value, management status, natural land cover, vegetation quality, riparian features, riparian land cover, and roadedness. Additionally, these criteria can be grouped into "families" of metrics that include physical characteristics, landscape characteristics, riparian characteristics, and human stressors.

To synthesize and integrate the recommendations of contemporary scientific literature and the expressed objectives of LFC land protection staff, the criteria used to develop the total score for each ecoblock could have been prioritized using any number of group discussion techniques, including Brainstorming, Crawford Slip Method, Delphi Technique, Analytical Hierarchy Procedure, or Nominal Group Technique.

The Nominal Group Technique is a structured version of brainstorming in which each participant offers an idea in turn followed by group discussion. When no more ideas are offered, the session ends. This technique takes advantage of pooled judgments and takes into consideration the ideas of a variety of people with varied talents, knowledge, and skills (Delbecq et al. 1975). The nominal group technique was used because, for the purposes of this assessment, it most effectively balanced contemporary concepts in conservation biology and landscape ecology, the wide range of environmental and biological factors that are indicative of high quality natural resources, and the preferences in land features as expressed by LFC's primary conservation objectives.

For each resource criterion, a scoring system was developed to assign a ranking to each ecoblock within the political counties that encompass the Tittabawassee River watershed. For example, blocks of land with less than 20% natural land cover received a score of 1, between 20% and 60%, a 5, and more than 60%, a score of 9. Using GIS software, each ecoblock within the Tittabawassee's landscape was assigned a score for each suitability criterion according the ranking system described above.

The majority of the criteria used in the development of the priority lands assessment were calculated with the Analytical Tools Interface for Landscape Assessments (ATtILA), an ArcView extension developed by the EPA Landscape Ecology Branch (Ebert and Wade 2000). Those not calculated by ATtILA will be noted in the following descriptions. Use of ATtILA requires ArcView software and the Spatial Analyst extension, both of which are commercial products available from Environmental Systems Research Institute (ESRI 2001).

The various scores for all of the criteria were then summed to provide a total suitability score for each ecoblock. A standard scale was applied to each criterion, and the values were compiled to create an overall score for each ecoblock. Since LFC's primary conservation objectives do not distinguish a higher or greater value for any particular feature of land over another, each criterion was weighted equally. Higher scores represent areas with greater ecological significance and thus the heightened need for protection and suitability for acquisition or conservation easement. Lower scores represent degraded areas with relatively low resource potential where restoration activities may be necessary to restore habitats and ecosystem integrity. Ideally, this measure of conservation suitability identifies areas with high potential to contribute to regional resource protection.

Specifically, the Tittabawassee River watershed assessment gives priority to ecoblocks containing large patches of natural land cover, assigning the greatest significance to:

- Larger areas with interior conditions
- Intact as opposed to fragmented conditions
- Lands that provide habitat for rare, threatened, or endangered species or unique natural communities
- Lands with a high diversity of plants, animals, and physical conditions
- Lands with aquatic or riparian habitats
- Areas less affected by human disturbance

The results of these suitability scores are not intended to be deterministic in LFC's decision-making and conservation planning processes. Rather, with their foundation in conservation biology and landscape ecology and in the preferences of land features as expressed by LFC's primary conservation objectives, the results are intended to help guide conservation action, which in the end is as least as much art as it is science (Soule and Terborgh 1999). The creation of a spatially explicit conservation strategy requires objective judgment and spatial analysis, both of which are provided in part by this assessment. This assessment is intended to help ensure that a framework for conservation is feasible and efficient and to reveal spatial relationships that might be overlooked if conservation actions are undertaken based on design and professional judgment alone.

Description of Criteria

Total Size

Human modification within a natural landscape most often results in land cover changes, loss of some land cover types, and fragmentation of remaining land cover into smaller and more isolated patches (Saunders et al. 2002). Patches are wide, relatively homogeneous nonlinear areas that differ from their surroundings. The dissection of natural landscapes by such linear elements as roads, railroads, utility corridors, and other rights-of-way contributes to this loss of habitat and is primarily responsible for the creation of more and smaller habitat patches, decreased connectivity between patches, decreased complexity of patch shape, and higher proportions of edge habitat (Ripple et al. 1991, Reed et al. 1996, Tinker et al. 1998, Baker 2000).

Fragmentation of natural areas can create barriers to dispersal and recolonization of wildlife, create opportunities for undesirable and invasive exotic species, and even alter the local climate conditions by introducing greater exposure to sun and wind. Large areas offer the possibility of water quality protection for aquifers and lakes, habitat to sustain interior-dwelling species, escape cover for large and charismatic species, near-natural disturbance regimes, and buffers against extinction during periods of severe environmental change (Forman 1995).

The acreage for each ecoblock was calculated in ESRI's ArcInfo Workstation ARC 8.2 using the ADDACRES. AML as provided by The Nature Conservancy's Ecoblock ArcInfo Macro Language (AML) Pack (Biasi and Olivero 2000). Categorical rank for the total size of an ecoblock was based on a combination of human and natural factors. Three considerations taken into account for the development of the ranks included LFC's internal guidelines for conservation action, the Public Land Survey System in Michigan and the development of county road networks along township section boundaries, and recommendations from scientific literature on minimum patch size required to sustain avian and mammal populations.

The initial break of 20 acres is an internal or organizational consideration for LFC. While there may be considerable natural resources contained in tracts of land smaller than 20 acres, the transaction costs incurred by the Conservancy are the same as they would be for larger pieces of land (Koop 2005). Ecoblocks with a total acreage below 20 acres received a score of 0 (Table 6). The second break of 137.5 acres is based upon the recommendations of a number of studies as summarized in the Environmental Law Institute's Conservation

Thresholds for Land Use Planners (ELI 2003). Ecoblocks with a total size between 20 and 137.5 acres received a score of 1, and ecoblocks with a total size between 137.5 and 640 acres received a score of 3.

The next break at 640 acres results from the Public Land Survey System in Michigan. Between 1816 and 1856, Michigan was systematically surveyed by the General Land Office, which had been established by the U.S. federal government in 1785. The state was divided into 640-acre or one-square-mile sections to aid in land transactions and the development of local governance. Most often and as is true in the Tittabawassee River watershed landscape, county road networks in Michigan follow the boundaries of these square mile sections. The result is isolated tracts of land uniformly dissected at 640 acres across the landscape. Ecoblocks with a total size between 640 and 2,500 acres received a score of 5.

The remaining categories, ecoblocks between 2,500 and 5,000 acres and ecoblocks over 5,000 acres, were developed based on discussions with LFC's land protection staff and their land committee. Contiguous blocks of land in the Tittabawassee River watershed's landscape of this size are rare, and it was felt that this rarity as well as their contribution to the integrity of landscape should be recognized. Only 101 ecoblocks out of 30,705 are over 2,500 acres, and only 29 ecoblocks out of 30,705 are over 5,000 acres. Combined, however, these size categories account for 12%, or 572,213 acres, out of the landscape's 4,845,590 acres. Ecoblocks between 2,500 and 5,000 acres were assigned a score of 7, and the remaining ecoblocks over 5,000 acres were placed in a category of their own and given a score of 9.

Core Area Index

Human development has the direct impact of removing existing natural habitat as well as fragmenting the habitat that remains into smaller patches (Dramstead et al. 1996). Paved roads and residential and commercial development often serve as barriers or hazards to wildlife movement and native plant dispersal. Human development also has indirect impact by creating a number of different kinds of intrusions with varying depth of impact into adjacent natural habitat. These intrusions include increased air, water, and noise pollution; changes in microclimatic conditions due to higher sunlight and wind levels; increased populations of invasive "weed" species; and increased frequency of disturbance due to direct contact with humans (Forman 1995).

The border area affected by these disturbances is labeled "edge," as compared to undisturbed "interior" habitat (Zipperer 1993). The interior area, or core area, of a patch is the total patch area minus the area of edge effect. Ecologically, the core represents the nonconvoluted, generally central portion of a patch, and it is this area that is critical for plant and animal species requiring remoteness from their surroundings, especially human disturbance (Forman 1995). Core areas are generally unaffected by the negative environmental and biotic changes associated with edge habitat (Riley and Mohr 1994).

Core areas are particularly attractive to land conservancies in regions with steadily increasing development rates, because while fragmentmentation decreases the total amount of a particular habitat, it proportionally causes a much greater loss of interior habitat. The general rarity and the difficulty in reproducing or restoring interior conditions, as well as the importance of core areas in maintaining larger populations of native species and their provision of habitat for interior-dwelling species makes their conservation a priority (Dramstead et al. 1996).

As is true with the total size of a patch area, the effects of linear elements on the Tittabawassee's landscape structure parallel the syndrome of fragmentation outlined by Baker (2000). With the introduction of linear human elements, the number of patches and patch density increases, while the mean patch size and core area size decrease. With the addition of new roads and other human elements, patch sizes and core area continually become more uniform (Baker 2000, Shinneman and Baker 2000), creating less variety and greater instability within a region.

LFC defines core areas as interior areas at least 300 meters from the edge of human-created features and 100 meters from the edge of natural features. Depending on the particular study or application, variations in what is determined to be an appropriate edge width can be significant. This in turn affects the identification of core area, and is most noticeably a factor when the degree of development in a region or the size and charisma of species are taken into consideration in the rigor of definition. Because the ecoblocks within the Tittabawassee River watershed's landscape are particularly compact and uniform, delimiting core area by a line paralleling the ecoblock's boundary is a good approximation of interior area (Forman 1995). Core area acreage of any ecoblock is the sum of acreage of all its core areas. The core area index in turn is defined as the number of acres of core area in an ecoblock divided by the total number of core areas contained within the same ecoblock. The index has the effect of normalizing bias introduced in the amount of core area acreage by the total size of an ecoblock. The index thus provides an objective comparison of core area acreage amongst all of the ecoblocks in the Tittabawassee River watershed landscape.

Using BLOCKCORE.AML (Biasi and Olivero 2000), linear elements used in the creation of ecoblocks for the Tittabawassee River watershed landscape were buffered based on the following (Table 5):

Table 5. ***Buffer Distances for the Identification of Core Areas***

DESCRIPTION	CLASS	DISTANCE (METERS)	SOURCE NAME
Under Construction	0	300	Framework v4b
Interstate/Freeway	1	300	Framework v4b
US Highway/State Highway	2	300	Framework v4b
Arterial/Collector	3	300	Framework v4b
Local	4	300	Framework v4b
Unnamed/Internal	6	300	Framework v4b
Nonvehicular	7	300	Framework v4b
Stream	22	100	MIRIS Base 24k
Shoreline	23	100	MNFI Polit STCO24
River	24	100	MIRIS Base 24k
Lake	25	100	MIRIS Base 24k
Railroad	30	300	Framework v4b
Pipeline	51	300	MIRIS Base 24k
Power Line	52	300	MIRIS Base 24k
Airport	70	300	MIRIS Base 24k

Of the 4,845,590 acres of land area in the Tittabawassee River watershed landscape, approximately 1,302,209 acres, or 26.87% of the landscape, is considered core area based on LFC's standards. Four categories were identified for the ranking of the core area index and were based on similar conservation planning initiatives (UF GeoPlan Center 1999, Weber and Wolf 2000, Jarosz et al. 2005) and the recommendations of LFC's land protection staff and its land committee. Categorical breaks were established at core area index values of 250 acres and 1,000 acres.

Those ecoblocks with a core area index of 0 received no score, and those with a core area index between 1 and 250 acres received a score of 3 (Table 6). The break point at 250 was established based on past work in Michigan (Jarosz et al. 2005) and similar conservation planning efforts throughout the United States (UF GeoPlan Center 1999, Weber and Wolf 2000). Core area of at least 250 acres is considered the minimum size to maintain viable populations of a number of interior breeding birds and to provide large foraging areas for top carnivores (Weber and Wolf 2000). One thousand forty-two ecoblocks produced a core area index between 250 acres and 1,000 acres and received a score of 7. As with total size, the rarity and landscape integrity contributions of large occurrences of core area were once again recognized by the LFC. Only 80 ecoblocks out of 30,705 produced a core area index over 1,000 acres, with a total core area of 178,273 acres. Those 178,273 acres provide 14% of the total core area in the landscape, and corresponding ecoblocks with a core area index over 1,000 were assigned a score of 9.

Biodiversity Value

As was discussed previously, a coarse filter conservation planning approach may allow rare species and communities to be missed entirely in a resource assessment. Use of biodiversity assessment information generated by the MNFI is intended to complement the coarse filter approach used here and provide a fine filter contribution to the overall assessment.

MNFI's biodiversity value model assigns biodiversity values, a unitless score derived from their in-house modeling efforts, to Michigan's landscape. The biodiversity value ranks areas relative to each other for conservation value based on the MNFI database of known species or natural community occurrences and is designed to help prioritize areas for protection based on known occurrences of sensitive species. It is based on the species's habitat requirements, spatial extent of the occurrence, the age of the record, the global and state ranks for the species and communities, and the viability ranking given to each occurrence.

Because the number of rare and threatened species faced with extinction far exceeds available conservation resources, there is a premium placed on identifying those areas where viable occurrences of these species are located. Areas with a known occurrence of a rare, threatened, or endangered species of plant or animal generally feature exceptional concentrations of endemic species on the whole (Myers et al. 2000). While protection of areas with high biodiversity value will not safeguard all of their species indefinitely, the presence of quality natural communities and rare species tracked by the MNFI is often indicative of the quality of a site being examined for conservation value (Paskus and Enander 2004).

Biodiversity values at the Public Land Survey System quarter-quarter section level were converted from a vector to a raster GIS format consisting of 30-meter cells to match the IFMAP land cover data, and the biodiversity values within each ecoblock were averaged. The average biodiversity value for all of the cells in an ecoblock was generated, and these averages were then ranked into five classes using the natural breaks classification. The natural breaks classification (also known as Jenk's optimization or goodness of variance fit) finds groupings and patterns inherent in data by minimizing the sum of the variance within each of the classes. It is used to minimize the squared deviations of the class means, and optimization is achieved when the quantity goodness of variance is maximized (Jenks 1967). Because the range of biodiversity values changes with the spatial extent of a study area and because the value does not represent any specific unit of measure, the natural breaks classification was used to determine where the break points between categories occurred.

The natural breaks classification was used for a number of other resource criteria in this assessment (management status, vegetation quality, riparian land cover, and roadedness), and ultimately for the total score ranking of ecoblocks across the watershed's landscape. The natural breaks classification was chosen for use throughout this assessment for three reasons: its relative ease of explanation by the Conservancy's decision makers to its stakeholders, its use as the default classification method in ArcView (ESRI 2001), and because of the assessment's focus on comparison of areas within the Tittabawassee landscape as opposed to the comparison of multiple landscapes. While LFC is concerned with the general goal of natural resource protection at a statewide level, its mission directs its conservation activities exclusively to the Tittabawassee River watershed. As such, for the purposes of its land protection activities and for the identification of priority conservation lands in which to undertake conservation action, the Conservancy is concerned only with the relative natural resource value of lands located exclusively in the Tittabawassee River watershed.

Biodiversity values in the Tittabawassee River watershed landscape range from 0 to 65.9079 with a mean of 1.2406. Ecoblocks with a mean biodiversity value of zero were assigned a score of zero (Table 6). Those with mean biodiversity values ranging from 0.01 to 0.75 were assigned a score of 1, from 0.75 to 3.35, a score of 3, from 3.35 to 7.67, a score of 5, from 7.67 to 15, a score of 7, and from 15 to 65.91, a score of 9.

Management Status

For the purposes of this assessment, management status refers to whether or not an area of land is dedicated to the protection and maintenance of biological diversity and of natural and associated cultural resources, administered through legal or other means. Three key considerations are taken into account with respect to management status. The first is that ecoblocks with a larger percentage of land already managed for conservation and/or recreation potentially provide greater opportunity for multiagency or organizational partnerships. Second, in such ecoblocks there is an increased likelihood that conservation action will provide for the protection of in-holdings (tracts of private land completely enclosed by public land) or the smoothing of edge and transition zones. Third, LFC believes that a *tipping point* or threshold exists with regard to the percentage of land in an area that is currently managed for conservation and/or recreation. As this percentage reaches 50% and continues to increase, the character of an area progressively changes and its identity is often focused around its natural resources. Focusing on areas with percentages of land managed for conservation and/or recreation far above the tipping point is impractical. First, if these lands are beyond the tipping point the chances are high that much of the remaining land will be conserved as well. Second, there are likely complex social and political factors that have contributed to the existing level of protection in that area. Promoting conservation action in areas below the 50% mark and reinforcing conservation action in areas just above that mark aids in securing the identity of those regions in their natural resource value.

Percent of managed Conservation and Recreation Land (CARL) within an ecoblock was calculated using a GIS overlay technique. To determine the proportion of CARL in an ecoblock, the following categories were removed from Ducks Unlimited, Inc.'s CARL data layer: golf courses, gravel pits, private parks, recreational campgrounds, raceway parks, ski areas, and utility corridors. The remaining categories included: access points, animal parks and zoos, arboretums and public gardens, county parks and fairgrounds, fish hatcheries, forest reserves, historic landmarks, municipal parks and fairgrounds, military reserves, natural areas, national forests, national natural landmarks, nature preserves, national wildlife refuges, outdoor recreation centers, public beaches, research areas, sportsmens clubs, state forests, state game areas, state nurseries, state parks, state recreation areas, trails, national parks, wildlife areas, and experimental forests. These remaining data categories were then converted from vector to raster format to match the IFMAP land cover data, and the boundary for that block was used to clip the CARL data. The clipped boundary was overlaid on the CARL grid, and any cell whose center was within the boundary was included in the analysis for that area.

To compute the proportion of CARL, the number of CARL cells inside the boundary was divided by the total number of cells inside the boundary minus those cells classified as water. A similar process was repeated for the natural vegetation index, the vegetation quality index, and the roadedness index, described below.

Categorical breaks for management status were identified using the natural breaks classification, and categorical ranks were assigned by LFC's land protection staff and developed in conjunction with its land committee based on the above considerations. The seven categories and corresponding ranks identified for management status are as follows: Ecoblocks containing 0% or 100% of land managed for conservation and/or recreation received a score of 0 (Table 6). Ecoblocks containing percentages between 1 and 11% received a score of 1, between 11 and 34%, a score of 5, between 34 and 59%, a score of 9, between 59 and 86%, a score of 7, and between 86 and 99%, a score of 3.

Table 6. *Physical Characteristics*

RESOURCE CRITERIA AND MEASUREMENT UNIT	DESCRIPTION AND RATIONALE	DETAIL	PTS.
Total Size *Acres*	Total size of the ecoblock in acres ❑ *Size is recognized as an important factor for viability of species and ecosystems*	0–20 20–137.5 137.51–640 640.1–2,500 2,500.1–5,000 >5,000	0 1 3 5 7 9
Core Area Index *Acres*	Acres of core area/Number of Core Areas Defined as total area of an ecoblock minus a 300-meter buffer from the edge of human-created features and a 100-meter buffer from the edge of natural features; divided by the number of resultant core areas. ❑ *Greater core area limits negative impacts on "edge-sensitive" animal species.*	0 1–250 250.1–1,000 >1,000	0 3 7 9
Biodiversity Value *Value*	Known occurrences of rare, threatened, or endangered species or unique natural communities increase the significance of an area. ❑ *The occurrence of quality natural communities and rare species tracked by the MNFI is often, although not always, indicative of the quality of a site.*	0.0 0.01–0.75 .75–3.35 3.351–7.67 7.671–15.00 15.001–65.91	0 1 3 5 7 9
Management Status *Percentage*	Percentage of land managed for conservation and/or recreation within an ecoblock. ❑ *Larger area of land already managed for conservation and/or recreation provides greater opportunity for multiagency or organizational partnerships.* ❑ *A higher percentage indicates an increased likelihood that conservation action will provide for the protection of in-holdings or the smoothing of edge and transition zones.*	0% 1–11% 11.1–34% 34.1–59% 59.1–86% 86.1–99% 100%	0 1 5 9 7 3 0

Note: Total possible points for all physical characteristic criteria = 36

Natural Vegetation Index

Maintaining a significant proportion of natural habitat in a landscape reduces the likelihood of local plant and animal extinctions and disappearances, while ensuring the continuance of natural ecological processes (Dale et al. 2000). Large areas of natural vegetation are the only places in a landscape that protect groundwater aquifers and riparian networks, sustain viable populations of most interior species, provide core habitat for large-home-range vertebrates, and provide for the possibility of natural disturbance regimes (Dramstead et al. 1996).PTS.

The calculations for the natural vegetation index used the same method as for management status above, but the numerator was changed to include multiple land cover types. For the natural vegetation index, the metric was calculated by dividing the number of cells with upland openland, forest, wetlands, or bare/sparsely vegetated values within a given ecoblock by that ecoblock's total number of nonwater land cover cells.

Categorical breaks for the natural vegetation index were based on the synthesis of past studies of the amount of necessary natural habitat in a landscape as represented by the Environmental Law Institute's Conservation Thresholds for Land Use Planners (ELI 2003). Four breaks were identified: Ecoblocks with an absence of any natural vegetation received a score of zero (Table 7). Those with percentages of natural vegetation between 1 and 20 received a score of 1, and those with percentages between 20 and 60 received a score of 5. Ecoblocks with natural vegetation percentages over 60, those most critical for sustaining long-term populations of area-sensitive species and rare species, received a score of 9 (ELI 2003).

Vegetation Quality

Vegetation quality is a critical component of the overall quality of natural areas. For the purposes of this assessment, vegetation quality refers to the degree of integrity and resiliency displayed by natural habitat as indicated by the presence of areas exhibiting land cover resembling pre-European settlement conditions. Vegetation quality can reflect past disturbance, external impacts, soil texture, moisture gradient, aspect, and geology (Paskus and Enander 2004), and if the vegetative composition and structure of a natural area resembles that of pre-European settlement conditions, it is likely that other ecological processes are intact and that the area has maintained many of its historic structural and functional components (Kazmierski et al. 2004). However, vegetative quality is very difficult to measure without recent field information (Parkes et al. 2003). As a surrogate to field surveys, a vegetation change map created by the MNFI comparing 2000 land cover data to circa 1800 vegetation data was created. The resulting potential unchanged vegetation can then act as an indicator of vegetation quality.

While the assumption that the presence of pre-settlement vegetation indicates greater ecological integrity is in itself subjective, the intent is not to imply that native vegetation prior to European settlement was in an ideal state, nor that native vegetation is static and unchanging in composition and function. Rather the use of potentially unchanged vegetation since 1800 provides a mature and potentially undisturbed benchmark. This benchmark can then provide a consistent and logical reference point for remnant vegetation against which loss of quality and restoration improvements can be considered (Parkes et al. 2003). Because the size of a patch of remnant vegetation is thought to play an important role in its long-term viability (Gilfedder and Kirkpatrick 1998), larger patches have a better chance for long-term survival (Drayton and Primack 1996).

The percentage of potentially unchanged vegetation within an ecoblock was measured by dividing the number of cells of unchanged vegetation within a given ecoblock by that ecoblock's total number of nonwater land cover cells.

At the present time there is a lack of Michigan-specific information on optimal levels of remnant vegetation in a landscape (Paskus 2004). Additionally, the vegetation quality index is intended to identify those locations in the Tittabawassee River watershed's landscape that contain relatively high percentages of unchanged vegetation. It is not intended to compare the Tittabawassee's landscape with other landscapes. As such, six categorical breaks for the vegetation quality ranking were determined using the Jenk's optimization formula. Ecoblocks with an absence of potentially unchanged vegetation were assigned a score of zero (Table 7). Those with potentially unchanged vegetation percentages ranging from 1 to 5 were assigned a score of 1, from 5 to 18, a score of 3, from 18 to 37, a score of 5, from 37 to 66, a score of 7, and from 66 to 100, a score of 9.

Table 7. ***Landscape Characteristics***

RESOURCE CRITERIA AND MEASUREMENT UNIT	DESCRIPTION AND RATIONALE.	DETAIL	PTS.
Natural Land Cover *Percentage*	Percentage of natural land cover within an ecoblock. Measures the amount of natural land cover based on "upland openland," "forest," "wetland," and "bare/sparsely vegetated" classes and 2000 IFMAP land cover data. ❑ *Maintaining a significant proportion of natural habitat in a landscape reduces the likelihood of extinctions and disappearances, while ensuring the continuance of natural ecological processes*	0% 1–20% 20.1–60% 60.1–100%	0 1 5 9
Vegetation Quality *Percentage*	Measures the percentage of potentially unchanged vegetation within an ecoblock. Estimates the quality of vegetation based on circa 1800 vegetation maps and 2000 IFMAP land cover data. ❑ *The quality of vegetation is critical to determining the quality of a natural area.*	0% 1–5% 5.1–18% 18.1–37% 37.1–66% 66.1–100%	0 1 3 5 7 9

Note: Total possible points for all landscape characteristic criteria = 18

Riparian Features

Riparian and coastal zones have considerable importance as natural corridors at a regional or landscape scale by providing wildlife connections between patches of habitat (Paskus and Enander 2004; Naiman et al. 1993). In addition to providing terrestrial habitat, intact and continuous riparian corridors maintain connectivity and movement pathways for aquatic organisms (Binford and Buchenau 1993). The presence of high biological diversity in riparian zones is likely the result of the interaction of small-scale topographic changes and the disturbance regime brought on by flooding. Collectively, these processes bring about a "non-equilibrium mosaic" of habitats that allows for the coexistence of a large variety of species (Soule and Terborgh 1999).

Habitat fragmentation is a major threat to the integrity of riparian systems, because excessive alteration of upland areas and riparian vegetation can reduce the movement of fish and other aquatic organisms (Binford and Buchenau 1993). Residential and agricultural use of riparian corridors has been shown to cause dramatic changes in water quality and isolate plant and animal populations in riparian networks (Vannote et al. 1980). Due to the potential of all corridors to facilitate the movement of undesirable species, however, a greater emphasis should be placed on protecting threatened riparian habitats that currently act as corridors, rather than on creating artificial riparian connections (Soule and Terborgh 1999).

To identify the presence of riparian features within an ecoblock, the streams, rivers, lakes, and shoreline maps were overlaid with the ecoblocks map, and any occurrence where riparian features and ecoblocks intersected was used in the metric.

Categorical breaks for riparian features were limited to presence and absence. Those ecoblocks containing a riparian feature received a score of 5 and all others 0 (Table 8).

Table 8. ***Riparian Characteristics***

RESOURCE CRITERIA AND MEASUREMENT UNIT	DESCRIPTION AND RATIONALE.	DETAIL	PTS.
Natural Land Cover *Percentage*	Presence/absence of a stream, river, lake, or shoreline within the ecoblock. ❑ *Riparian corridors and coastal zones provide wildlife connections between patches of habitat.*	Absent Present	0 5
Riparian Land Cover *Percentage*	Measures the percentage of natural land cover within a 90-meter buffer of riparian features. Estimates the percentage of vegetation within a 90-meter buffer of riparian features and 2000 IFMAP land cover data. ❑ *Vegetative buffers adjacent to riparian zones provide wildlife corridors and filter and retain excess water and suspended particulates.*	0% 1.0–15% 15.1–43% 43.1–68% 68.1–88% 88.1–100%	0 1 3 5 7 9

Note: Total possible points for all riparian characteristic criteria = 14

Riparian Land Cover

Riparian habitats are among the most ecologically productive and diverse environments, and have undergone serious decline during the last several decades due to increased modification within the riparian zone (Naiman et al. 1993). Natural vegetation adjacent to riparian zones provides wildlife corridors and filters and retains excess water and suspended particulates (Paskus and Enander 2004). Large patches of natural vegetation in the riparian zone act as sponges by absorbing, holding, and slowly releasing water into rivers and streams. Riparian vegetation is also highly influential in reducing ambient water temperature and the production of plankton and other aquatic vegetation. In many cases, natural riparian vegetation is also effective at controlling flow rates and dissolving particulate matter (Forman 1995).

Riparian data (streams, rivers, lakes, and shoreline) were converted to a raster format using 30-meter cells so they lined up with the IFMAP land cover data. The riparian data were then buffered on each side by 90 meters (3 cells). Land cover cells that were inside these expanded areas were then extracted from the initial land cover grid and placed into separate riparian zone land cover grids. Finally the ecoblock boundaries were overlaid with the riparian zone land cover data. For each ecoblock, natural land cover was calculated as the number of cells of upland openland, forest, wetlands, or bare/sparsely vegetated within that ecoblock's particular buffer zone divided by the number of nonwater land cover cells within the respective buffer zone.

Human modification and invasion by exotic plants has reduced the extent of riparian vegetation and resulted in the fragmentation of remaining habitat areas in the Tittabawassee River watershed landscape (Soule et al. 1998). By measuring the percentage of natural land cover within a 90-meter buffer of riparian features, the intent of the riparian land cover metric was to highlight riparian zones in the Tittabawassee River watershed's landscape that are least affected by human modification and contain natural riparian buffers. Natural break categories were used to highlight and rank those ecoblocks with high percentages of natural land cover in riparian zones.

Ecoblocks with an absence of any natural vegetation in riparian zones received a score of zero (Table 8). Those with percentages of natural riparian vegetation between 1 and 15% received a score of 1, and those with percentages between 15 and 43 received a score of 3. Ecoblocks with natural riparian vegetation percentages between 43 and 68 received a score of 5, those with percentages between 68 and 88, a score of 7, and those with percentages between 88 and 100, a score of 9.

Roadedness

Roads and their associated road zone or "depth-of-edge influence" are a convenient and replicable measure of human presence on a landscape, and provide a proxy for the suite of changes to landscape structure that are associated with human fragmentation of a landscape (Mladenoff et al. 1995). The presence of roads creates negative impacts on many species, including fragmentation, noise, edge effects, hunting pressure, predation by pets, spread of disease, and invasion of exotic pests (Dramstead et al. 1996). An important assumption in creating a map that depicts effects of roads on biodiversity is that larger roads typically affect species further from the road than do smaller roads, because larger roads are typically wider and carry more traffic (Theobald et al. 2001). Although road density is most often used as the measure of road effects on biodiversity, a "roadedness" index created following methodology developed in California and Colorado (Davis et al. 1996, Stoms 2000, Theobald et al. 2001) can provide a more useful indicator of habitat condition.

A roadedness index incorporates road size data to estimate the proportion of an area that is affected by roads—in other words, the buffer zone that defines its edge effects. Roadedness also accounts for the spatial distribution of roads, which road density does not (Theobald et al. 2001). For instance, closely spaced urban streets with a long total combined length have the same road density as a similar length of road spread uniformly across an ecoblock. However, each additional urban street has little effect on habitat because the urban area already is poor natural habitat. On the other hand, a single length of road through an ecoblock can sharply reduce its conservation value. By capturing this effect, roadedness does not suffer from bias introduced when calculating road density in areas where many roads close together result in very high road densities. Road data from version 4b of the Michigan Geographic Framework were buffered by a width related to the class of road. This buffer operation was used to estimate the area of land actually affected by the presence of each road. Total width of affected roaded portion is considered to be twice the buffer width (Table 9). The roadedness index was then calculated by summing the total area of buffered roads per ecoblock and converting the area to a percentage of the ecoblock area. Values ranged from roadless (i.e., index = 0) to fully roaded (index = 100), with a mean value of 69.36%.

TABLE 9. ***Roadedness Index Buffer Widths***				
FRAMEWORK CLASSIFICATION CODE	DESCRIPTION	ROAD CLASS	BUFFER WIDTH (METERS)	TOTAL WIDTH (METERS)
A11-A16	Interstate/Freeway	1	500	1,000
A21-A29	US Highway/State Highway	2	250	500
A31-A33	Arterial/Collector	3	100	200
A41-A49	Local	4	100	200
A61-A69	Unnamed/Internal	6	25	50
A00	Under Construction	0	0	0
A71-A74	Nonvehicular	7	0	0

The roadedness index is intended to identify those locations in the Tittabawassee River watershed's landscape whose ecological integrity is least stressed by close proximity to roads. It is intended as a surrogate for human disturbance and development, and is not meant to be used to compare the Tittabawassee's landscape with other landscapes. As such, six categorical breaks for the roadedness ranking were determined using the Jenk's optimization formula (Table 10). Ecoblocks that were entirely affected by road zone (100%) were assigned a score of zero. Those with road zone proportions ranging from 99.9% to 86% were assigned a score of 1, from 85.9% to 59.7% a score of 3, from 59.6% to 37.2% a score of 5, from 37.1% to 16.6% a score of 7, and from 16.5% to 0% a score of 9.

Table 10. ***Human Stressors***			
RESOURCE CRITERIA AND MEASUREMENT UNIT	DESCRIPTION AND RATIONALE.	DETAIL	PTS.
Roadedness Index *Percentage*	Measures the proportion of an ecoblock that is affected by roads.Evaluates the effect of road zones on biodiversity for an ecoblock by analyzing the area of land affected by the presence of roads. ❑ The results were classified using the Jenk's optimization formula. ❑ *The associated stress on land in close proximity to roads can adversely affect ecological integrity.*	0–16.5% 16.6–37.1% 37.2–59.6% 59.7–85.9% 86–99.9% 100%	9 7 5 3 1 0
Note: Total possible points for all human stressor criteria = 9			

Criteria Scores

As was discussed in the previous section, each ecoblock was assessed for its natural resource value using nine different resource criteria. Each criterion awarded between 0 and 9 points per ecoblock. Tables 11 and 12 display the number of acres and the number of ecoblocks that received the various point values for all nine criteria.

Table 11. *Acres per Score by Criterion*

SCORE	0	1	3	5	7	9
Size	85,617	316,006	2,222,273	1,649,481	353,012	219,201
Core Area Index	475,893	0	2,863,384	0	1,185,042	321,271
Biodiversity Value	3,170,358	784,722	590,358	126,576	89,441	84,135
Management Status	3,238,137	463,792	214,876	356,527	269,273	302,985
Natural Land Cover	23,176	0	896,875	1,167,511	0	2,758,028
Vegetation Quality	237,847	1,735,652	2,123,921	580,702	142,946	24,522
Riparian Features	1,731,138	0	0	3,114,451	0	0
Riparian Land Cover	1,751,545	155,153	251,381	379,912	622,553	1,685,045
Roadedness	112,942	72,793	175,449	564,705	3,171,247	748,455

Table 12. *Ecoblocks per Score by Criterion*

SCORE	0	1	3	5	7	9
Size	17,431	5,171	6,308	1,665	101	29
Core Area Index	22,751	0	6,832	0	1,042	80
Biodiversity Value	21,751	1,536	4,593	1,249	814	762
Management Status	27,786	870	405	692	454	498
Natural Land Cover	4,116	6,978	0	8,124	0	11,487
Vegetation Quality	15,008	6,382	5,966	1,952	923	474
Riparian Features	20,934	0	0	9,771	0	0
Riparian Land Cover	21,832	733	1,210	1,428	1,710	3,792
Roadedness	16,407	1,354	2,267	3,302	6,712	663

Total Score

By adding the points assigned to each ecoblock based on the criteria discussed above, a cumulative total score was calculated for each ecoblock. This cumulative score allows for identification of areas that have high scores for multiple criteria. While some ecoblocks may be high scoring in one or two of the nine criteria, only those areas that are well rounded and receive high scores for many different criteria have high cumulative scores. The study area consists of 30,705 ecoblocks or 4,845,590 acres total. Of the scores calculated for those ecoblocks, the total possible score for all criteria was 77. While none of the ecoblocks reached the highest total score of 77, the maximum score reached was 71 (Figure 3). The lowest score reached was 0, and the mean score for all of the ecoblocks was 16. Once the total scores were tabulated, the next step was to determine logical and reasonable categorical breaks between the priorities of ecoblocks.

Priority Rankings

Again in consultation with the land protection staff and the land committee of LFC, it was decided that the natural breaks classification, as used in the creation of break points for the criteria categories, would be used to establish the categorical breaks between the priorities of ecoblocks. The natural breaks method was chosen because it provides an objective division of classes that produces a distribution that can be explain with relative ease by the Conservancy's decision makers to its stakeholders.

Despite this objective approach to classification, the argument can still be made that ecoblocks scoring one point below should be included in the next highest category or that sites scoring one point above the low end of a category should be placed in the next lowest category. Should the issue arise as to which category a particular ecoblock is placed in, the individual numeric total score can be displayed for an ecoblock. This will allow decision makers and stakeholders to better understand how an ecoblock compares directly to another ecoblock without artificially categorizing it into a particular group.

Cumulative Score Statistics

Table 13 contains data on the Tittabawassee River watershed landscape's ecoblocks classified into 10 levels of priority.

Because there is no preset budget (time or financial) to be spent on conservation action for the identified priority lands, the prioritizations are represented in terms of categories rather than acreage amounts. For example, the Conservancy did not request that the 100,000 most ecologically valuable acres of land be identified. Rather their interest was in exploring how much land was indeed high priority rather than simply setting an arbitrary total amount as a goal. After reviewing the initial findings in conjunction with LFC, it was decided that the three highest scoring categories would be considered "priority conservation lands."

While the cutoff could have been made at any of the categorical break points, the highest three categories seem to provide a reasonable balance between identifying those lands with the highest resource values and a manageable amount of acreage for the Conservancy to target for future conservation action based on available staff and resources. Taken together, these three highest categories consisting of 1,150 ecoblocks and account for 1,420,757 acres of the Tittabawassee River watershed's landscape. Of that almost 1.5 million acres, 63.86% or 907,365 acres is in private ownership.

Priority One

Priority One ecoblocks (Figure 4) are those that have the highest total scores (56 or higher). According to the criteria discussed and the data used, these areas are the most ecologically valuable, and they play an important

Table 13. ***Total Score***					
PRIORITY	# OF POINTS	% OF ECOBLOCKS	TOTAL	ACREAGE	% OF ACREAGE
One	56–71	125	0.41	384,484	7.93
Two	49–55	338	1.10	483,059	9.97
Three	43–48	687	2.24	553,214	11.42
Four	37–42	1,688	5.50	763,655	15.76
Five	31–36	2,029	6.61	596,573	12.31
Six	25–30	2,792	9.09	652,168	13.46
Seven	18–24	4,432	14.43	804,329	16.60
Eight	11–17	5,317	17.32	492,553	10.16
Nine	4–10	7,578	24.68	92,759	1.91
Ten	0–3	5,719	18.63	22,797	0.47
	Total:	30,705	100%	4,845,591	100%

Note: Total possible points for all criteria = 77

role in the ecological integrity of the Tittabawassee River watershed's landscape. These ecoblocks are in most cases larger than 137 acres, contain a riparian zone, and are supported by the presence of existing CARL. While all of these ecoblocks include existing CARL, a full 41.58% of these highest priority lands are in private ownership.

Priority Two

Priority Two ecoblocks are those with total scores between 49 and 55 points. These ecoblocks have a mean size of 1,430 acres and range in size from 4 to 6,861 acres. Priority Two ecoblocks also play a key role in supporting the ecological integrity of the watershed's landscape. All 338 Priority Two ecoblocks contain a riparian feature and have a mean of 95.65% natural land cover in their riparian zones. While they are not necessarily comprised of large percentages of existing CARL (59.07% is in private ownership), they are most often located adjacent to Priority One ecoblocks.

Priority Three

Priority Three ecoblocks play a key role in maintaining the natural connections of the Tittabawassee River watershed's resource base. They are responsible for creating the physical connections between the majority of Priority One and Two ecoblocks. Although they have not necessarily received the highest scores for their size or location in relation to existing CARL, their physical composition or the combination of relatively high scores in a number of criteria make them a priority for conservation action. Totaling 687, Priority Three ecoblocks are the most numerous of the three highest categories. Their scores range from 43 to 48 points, and they make up 11.42%, or 553,214.1 acres of the Tittabawassee River watershed landscape.

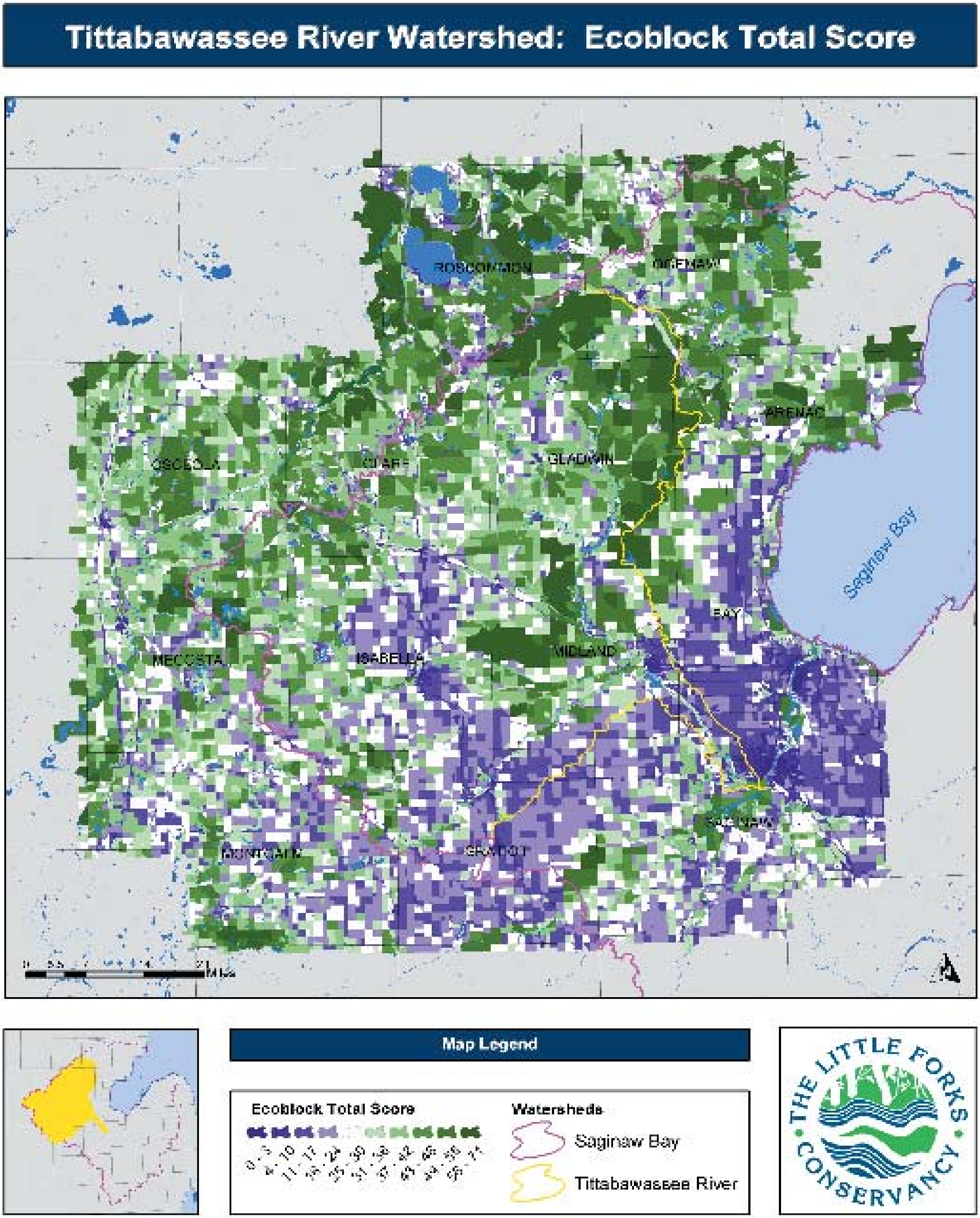


Figure 3. Priority Conservation Lands by Total Score.

Tittabawassee River Watershed: Highest Scoring Ecoblocks

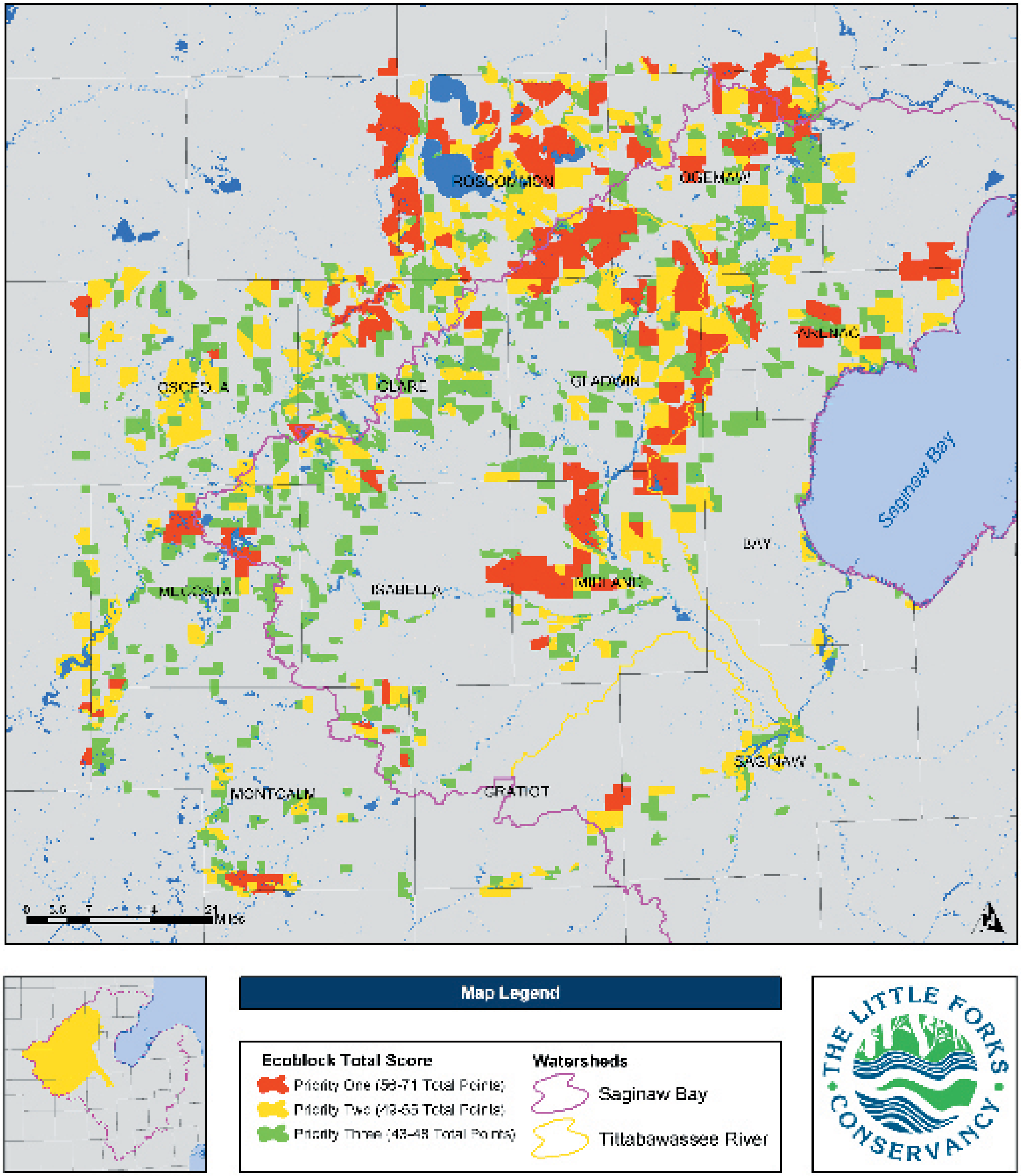


Figure 4. Priority Conservation Lands by Three Highest Categories.

DISCUSSION

Ecoblocks in the Tittabawassee River watershed landscape were assessed with the nine resource criteria using a conventional scoring and ranking scheme that identifies areas of potential importance within the watershed. A number of issues were identified with the prioritization scheme, including the potential bias of public land in the ranking, the nonindependence of resource criteria, the need for additional criteria in future work, and the inherent limitations of decision making and digital data. Despite these issues, the prioritization scheme has considerable potential for replication in other spatial or temporal situations because of its straightforwardness in calculating the resource criteria, making it attractive to planners, decision makers, and stakeholders alike. Ecoblocks were ranked using a set of resource criteria, which reflected their spatial form and composition. This method is a potentially valuable tool for conservation decision makers who have limited access to data sets and resources to undertake such an assessment. The prioritization scheme allows for the targeting of areas for conservation action based on their resource value and ideally provides a degree of economic efficiency in the face of limited funding for conservation.

This assessment attempted to integrate LFC's organizational objectives and contemporary concepts of landscape ecology and conservation biology in order to identify areas of high natural resource value for potential conservation action. However, LFC's decision makers and its major stakeholders will ultimately make the determination as to where future conservation actions are most appropriate. This assessment can serve as a guide and presents an illustrative example of the priority conservation lands in the Tittabawassee River watershed landscape based on one set of resource criteria.

Public and Private Land

This assessment did not take into account private land ownership boundaries. Some large ecoblocks may be entirely in one ownership, while conversely another ecoblock of the same size may include a large number of different landowners. Although land ownership plays a major role in determining the conservation action that can be undertaken in an area, it is beyond the scope of this assessment to include private land ownership data in the prioritization.

Public land ownership boundaries, were, however, taken into account. Large tracts of state-owned forest land occupy portions of the Tittabawassee River watershed landscape, and while there is a belief within LFC that using existing CARL (Table 14) as a foundation for conservation action is appropriate, there is also a belief that it is not the Conservancy's role to supplement state-level conservation action. With the Conservancy's emphasis on work with private landowners, they perform a level of service for their constituent communities that state-level conservation organizations cannot and do not. As such, the Conservancy expressed concern that there may be an overemphasis on existing CARL in the priority conservation lands assessment.

Of those ecoblocks in the Priority One category, all of them are based around existing CARL. Additionally, of those ecoblocks in the Priority One category, existing CARL (224,612 acres) accounts for approximately 58.42% of their acreage. Of those ecoblocks in the Priority Two category, 314 out of 338 are based on existing CARL. Existing CARL accounts for 197,736 acres or 40.93% of those ecoblocks in the Priority Two category. Of those ecoblocks in the Priority Three category, 456 out of 687 are based on existing CARL. Existing CARL, however, accounts for only 91,045 acres or approximately 16.46% of those ecoblocks in the Priority Three category. It is at this point in the prioritization scheme where the protection of ecoblocks with high natural resource value not only reinforces existing CARL, but also begins to build an interconnected network of conservation lands. Total area for the top three categories is 1,420,757 acres, of which a full 63.86% or 907,365 acres is in private ownership. While initially it may appear that there is considerable bias attributable to the

Table 14. ***Conservation and Recreation Land Statistics***					
PRIORITY	POINTS	# OF ECOBLOCKS	ACRES	ACRES OF CARL	CARL AS % OF TOTAL ACRES
One	56 – 71	125	384,484	224,611	58.42
Two	49 – 55	338	483,059	197,736	40.93
Three	43 – 48	687	553,214	91,045	16.46
Four	37 – 42	1,688	763,655	74,171	9.71
Five	31 – 36	2,029	596,573	59,136	9.91
Six	25 – 30	2,792	652,168	49,663	7.62
Seven	18 – 24	4,432	804,329	31,926	3.97
Eight	11 – 17	5,317	492,553	10,358	2.10
Nine	4 – 10	7,578	92,759	1,540	1.66
Ten	0 – 3	5,719	22,797	103	0.45
	Total:	30,705	4,845,591	740,289	15.28%

Note: ***CARL percentages are based on a modified version of Ducks Unlimited, Inc.'s Conservation and Recreation Lands data.***

presence of existing CARL, the correlation coefficient between the CARL score and the total score for all 30,705 ecoblocks is only 0.399. For those ecoblocks in Priority One, Two, and Three categories, the correlation coefficient between the CARL score and the total score increases slightly to 0.477.

Criteria Correlation

One issue that was not considered prior to selecting the criteria for the identification of priority conservation lands is the relative correlation among the resource criteria. Nor was any preliminary work undertaken to identify the type of lands the cumulative scoring of all nine criteria would select for conservation action. Admittedly, the subjective nature of the selection of criteria and the assignment of their relative ranks allows for the possibility of nonindependent criteria. Additionally, there is the possibility of artificially inflating total scores as a result of this lack of independence. However, because a statistical model was not the basis for the prioritization scheme and because including all nine criteria provided sufficiently distinct resource information, no criterion was removed.

While a multivariate regression analysis was not performed to determine the statistical correlation among all of the resource criteria, an overview of the data suggests some of the more obvious connections. Further statistical analysis would uncover whether more subtle connections among criteria also influence the location and relative importance of the highest ranking ecoblocks. For example, two of the criteria specifically evaluate an ecoblock's size and award more points for being larger or for having a larger core area. The concept that larger areas are more ecologically sustainable is a basic and generally accepted principle. While many of the other criteria focus on concepts concerned with ecological integrity, they can also be correlated to size. The larger an ecoblock is, the more likely it is to contain a larger core area. For the entire data set, the correlation coefficient between the size score and the core area index score is 0.880 (Table 15).

Table 15. *Mean Score of Four Resource Criteria*

PRIORITY	# OF ECOBLOCKS	SIZE	CORE INDEX	RIPARIAN FEATURES	RIPARIAN LAND COVER
One	125	5.9760	6.5440	5.0000	8.8560
Two	338	4.7249	4.8314	5.0000	8.7692
Three	687	3.9127	4.1645	4.7671	8.1674
Four	1,688	3.0267	2.9058	4.5942	7.5646
Five	2,029	2.2706	2.0172	4.1326	6.1360
Six	2,792	1.9491	1.7328	3.2414	4.1089
Seven	4,432	1.5957	1.3725	2.0408	1.9770
Eight	5,317	0.9298	0.6071	0.8191	0.4100
Nine	7,578	0.1411	0.0067	0.6169	0.0366
Ten	5,719	0.0198	0.0000	0.0000	0.0016
Total:	30,705				

Note: ***Size score and the core area index score correlation coefficient is 0.880.***
Riparian feature score and the riparian land cover score correlation coefficient is 0.814.

In another example, two of the criteria specifically evaluate riparian zones and award more points for the presence of a riparian zone or for the amount of natural vegetation in a riparian zone. The presence of a riparian zone itself allows for the possibility of having vegetation in a riparian zone. Those ecoblocks ranking in the Priority One and Two categories all contained riparian zones and thus had the opportunity to score points in the riparian land cover criterion. By comparison, none of the ecoblocks in the Priority Ten category contained riparian zones, and thus had no opportunity to score points in the riparian land cover criterion. For the entire set of ecoblocks in the landscape, the correlation coefficient between the riparian feature score and the riparian land cover score is 0.814.

This assessment is based in contemporary landscape ecology and conservation biology as well as LFC's organizational objectives. This dual basis suggests that there are likely to be correlations among a number of the criterion examined in this assessment due to their potentially subjective selection for inclusion. There is need for a multivariate regression analysis to properly understand the determinant or causative factor of one criterion on another. Inherent within this assessment was the acknowledgment that for the purposes of this study, those areas with multiple resources would be worth more than those with a single resource. Additional work is needed to understand what, if any, level of spatial causation is inherent in multifocus conservation prioritization.

Additional Criteria

Through the process of conducting this assessment, at least three additional criteria were considered for inclusion in the prioritization scheme. Of those three, landscape connectivity and financial cost would have added considerable value to this assessment of priority lands. The third, distance to human stressors, was intentionally not included.

Landscape Connectivity

Landscape connectivity refers to the connectivity between patches of natural habitat and is considered a critical factor for wildlife health. High connectivity improves gene flow between plant and animal populations, allows species to recolonize unoccupied habitat, improves resilience of the ecosystem, and allows ecological processes, such as flooding, fire, and pollination, to occur at a more natural rate and scale (Paskus and Enander 2004). Computation limitations prevented the inclusion of this criterion in the prioritization scheme. An ideal analysis would have included an additional resource criterion that ranked an ecoblock based upon the mean ecological score of its neighbors as calculated by the nine criteria used in this assessment. In this manner, the ecological integrity of surrounding ecoblocks would ultimately influence the natural resource value, and resultant score, of an individual ecoblock.

Financial Cost

As was discussed previously, digital cadastral data do not exist for the entire Tittabawassee River watershed landscape. In the absence of cadastral data, financial cost or market value of the lands contained within an ecoblock was not taken into consideration in the prioritization scheme. This shortcoming has serious implications in determining the overall amount of funding needed to support future conservation actions in the watershed, especially acquisition and the purchase of conservation easements. The nine criteria used in this assessment rank areas for potential conservation action from highest to lowest based on an ecoblock's natural resource value.

A simplistic implementation approach would have LFC acquiring the top-ranked ecoblocks until their available efforts and budget are exhausted. However, this approach provides for the potential of inefficient conservation action from both an ecological and economic perspective. Given additional consideration to financial costs and budget constraints, the opportunity may exist for the Conservancy to protect a greater number of lower ranked areas at a lower cost than protecting a smaller number of areas with high ecological value and high cost (Messer and Wolf 2004). Future prioritization efforts on behalf of LFC or other conservation organizations should make every attempt to include both landscape connectivity and financial cost in their prioritization schemes.

Distance to Human Stressors

The third additional criterion considered for inclusion in the prioritization scheme, distance to human stressors (Table 16), generated considerable discussion within LFC. For the purposes of this assessment, a human stressor was considered to be a major roadway such as a highway or freeway or a major concentration of human population such as a city or village. Conventional thinking in landscape ecology and conservation biology suggests that the farther away from human stressors a natural system is, the greater its ecological integrity is likely to be.

While the land protection staff and the land committee of LFC concur with this thinking, at the present time, human disturbance or human influence on a particular tract of land is technically not considered in the Conservancy's land protection criteria. Conversely, with its identity and foundation in the communities of its service area, LFC often considers one of its unwritten goals to be the protection of land for the sake of incorporating natural resources back into the cultural communities it serves. A decision concerning this dichotomy of protecting lands with the greatest ecological integrity versus protecting lands in close proximity to human populations was not reached during the period this assessment was conducted. As such, distance to human stressors was not included as an explicit criterion.

Table 16. *Mean Distance to Human Stressors*

PRIORITY	POINTS	# OF ECOBLOCKS	ACREAGE	MEAN DISTANCE TO HUMAN STRESSOR (MILES)
One	56 – 71	125	384,484	1.9433
Two	49 – 55	338	483,059	1.5332
Three	43 – 48	687	553,214	1.5736
Four	37 – 42	1,688	763,655	1.6433
Five	31 – 36	2,029	596,573	1.7822
Six	25 – 30	2,792	652,168	1.7168
Seven	18 – 24	4,432	804,329	1.6404
Eight	11 – 17	5,317	492,553	1.2760
Nine	4 – 10	7,578	92,759	0.8031
Ten	0 – 3	5,719	22,797	0.3348
	Total:	30,705	4,845,591	

***Note:** Human stressors were defined as major roadways such as a highway or freeway or a major concentration of human population such as a city or village.*

However, given the decisions made in the ranking of individual criteria, it is arguable that distance to human stressors was implicitly included in the prioritization scheme regardless. On average, those ecoblocks ranking high in total score were also the farthest from human stressors. Future discussions within LFC will need to continue to focus on how best to achieve a balance between its goals of protecting lands of highest resource value while still appropriately serving its constituent communities.

Decision Making and Data Limitations

The Tittabawassee River watershed's landscape contains nearly 4,845,590 acres of natural ecosystems of varying quality. Identifying those areas that have the highest ecological integrity can help LFC and its major decision makers improve land use planning and natural resource conservation efforts. This assessment provides sound scientific analysis of the Tittabawassee River watershed landscape's natural resources. However, the development of this assessment's prioritization scheme required frequent decision making regarding how to best balance sound science, the conservation objectives of the Conservancy, and practical considerations. Because both the procedures and weightings used in this assessment were at many times subjective, it is not intended to be the final step in evaluating the landscape's natural areas.

Further, this assessment was based on the best available knowledge at the time of it construction, and data-dependent planning is only as good as the data available and the elements of an ideal analysis. This assessment was based entirely on digital geographic data at a regional scale, and field data should be gathered before site-specific conservation decisions are made. A simple analytical model and existing regional data sets were used in the identification of priority conservation lands. The use of digital geographic data has inherent limitations that must be understood to avoid the misuse of any resultant products. The first is that the spatial resolution of the land cover data and any vector data converted to raster format used in this assessment is a 30-meter pixel. A 30-meter pixel represents an area roughly the size of a baseball infield and does not have the ability to represent features smaller than this size. Second, digital geographic data represent a snapshot in time of the features shown. It is current only for the time in which it is created, and users must be aware that on-the-ground features have likely changed since the creation of the digital product. The third major limitation is that there are always errors in the data. Geographic features may be inaccurately represented either spatially or categorically, due to human error or computation limitations.

Recommendations and Conclusions

Once dominated by forests and other natural vegetation, northern Lower Michigan is now struggling with low-density development and human-centered growth patterns that are causing a rapid change in the character of its landscape. Compounding the problems associated with these scattered patterns of development is the excessive consumption of land and an increasingly fragmented landscape. As the Tittabawassee River watershed's land use changes, wildlife habitat is lost and normal ecosystem functions are disturbed or destroyed. While a growing number of regional land conservancies are fighting these threats of land conversion and fragmentation and are attempting to minimize such impacts, they do not always know where the lands with highest natural resource value are situated.

This priority conservation lands assessment attempts to provide ready access to that spatial and resource data the conservancies need to objectively evaluate the conservation value of potential projects at a large scale. This information can be used to identify a primary ecological network that will protect the most critical lands in the region before they are altered forever. Alone, the development of a strategy to assess the conservation attributes of land in the Tittabawassee River watershed and prioritize those with the highest conservation value has little significance. To make best use of this priority conservation lands assessment, decision makers within LFC and other conservation organizations will need to refine their organizational decision-making processes to incorporate this additional tool.

To ensure access to the most timely and appropriate information on the state of natural resources in the Tittabawassee River watershed, this assessment will need to be updated as often as staff and resources allow. Because the currency of digital geographic data used in this assessment is key to its accuracy, the assessment itself should be updated as those data allow. At the current rate of update to landscape-level land cover data, update of the priority conservation lands assessment could occur as often as every five years. Additional steps to refine the assessment can be made in the interim, including the use of additional criteria as discussed previously, as well as the development of a cadastral parcel layer, at least for those areas identified as priorities.

Using GIS and principles of landscape ecology and conservation biology, the goal of this priority conservation lands assessment was to develop an ecologically sound prioritization of the lands within the Tittabawassee River watershed, and ultimately, to incorporate those lands of highest resource value into the varied conservation activities of organizations working in the watershed. One of the greatest potential challenges facing LFC and its organizational partners as they work toward conservation actions recommended by this assessment is the sheer amount of land identified as having high natural resource value. Key to the success of those conservation actions will be the identification of the appropriate "conservation tool" and potential funding sources for implementing each action. Only through collaborative partnerships and the development of one or more focused conservation initiatives will the regional land conservancies be able to achieve the landscape-scale conservation success that they desire.

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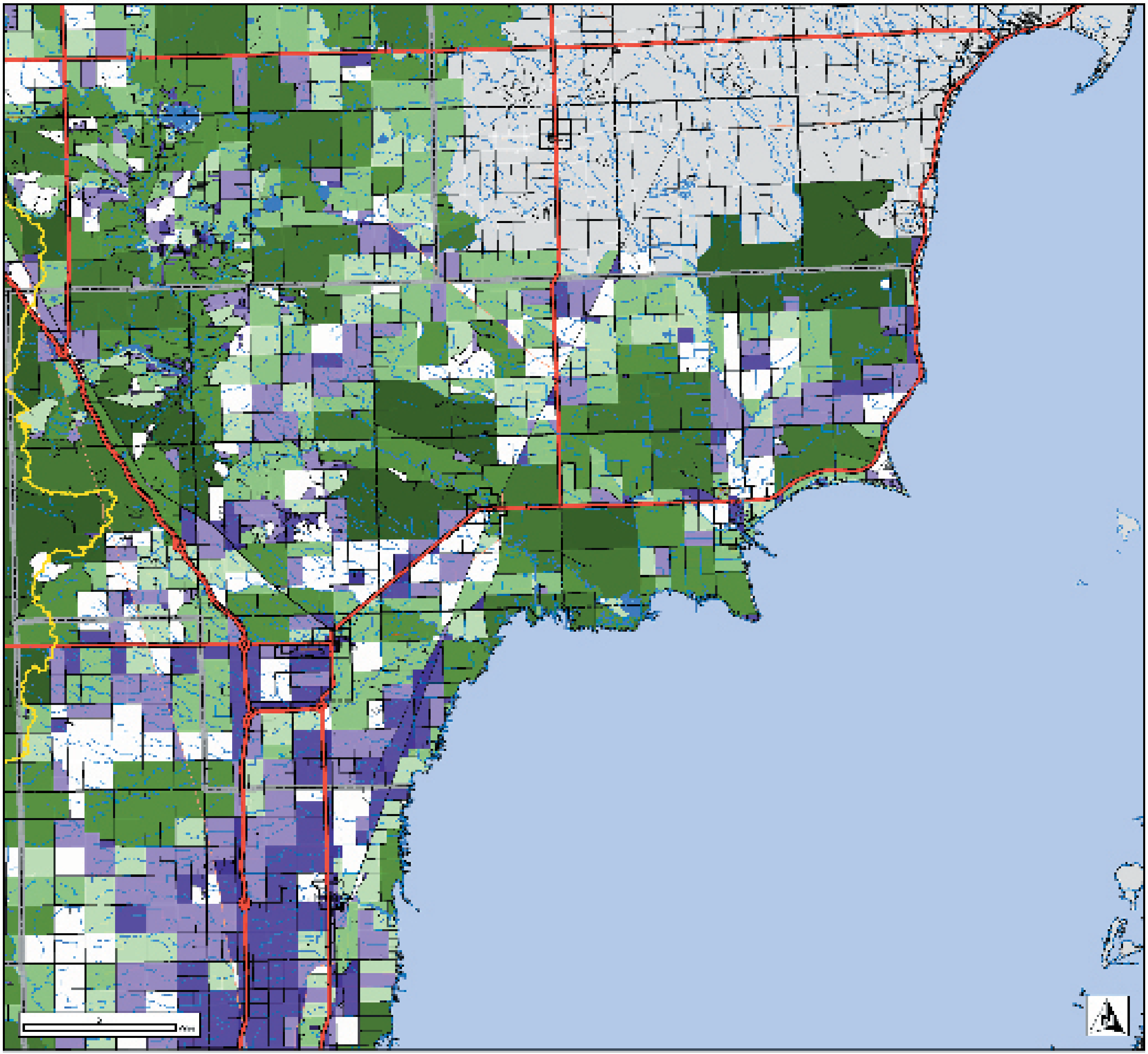
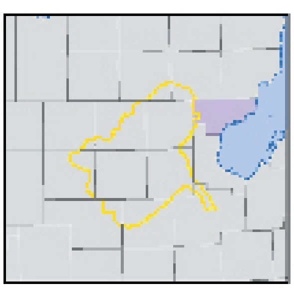
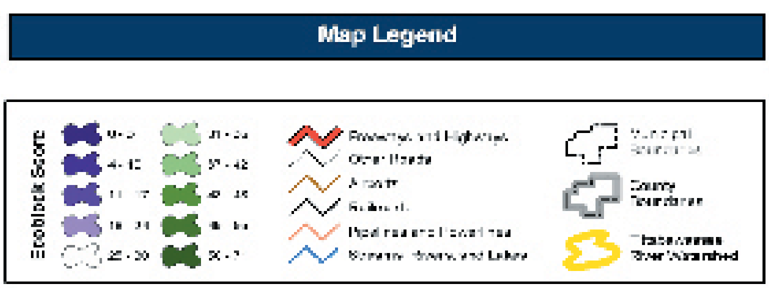
Arenac County: Priority Conservation Lands







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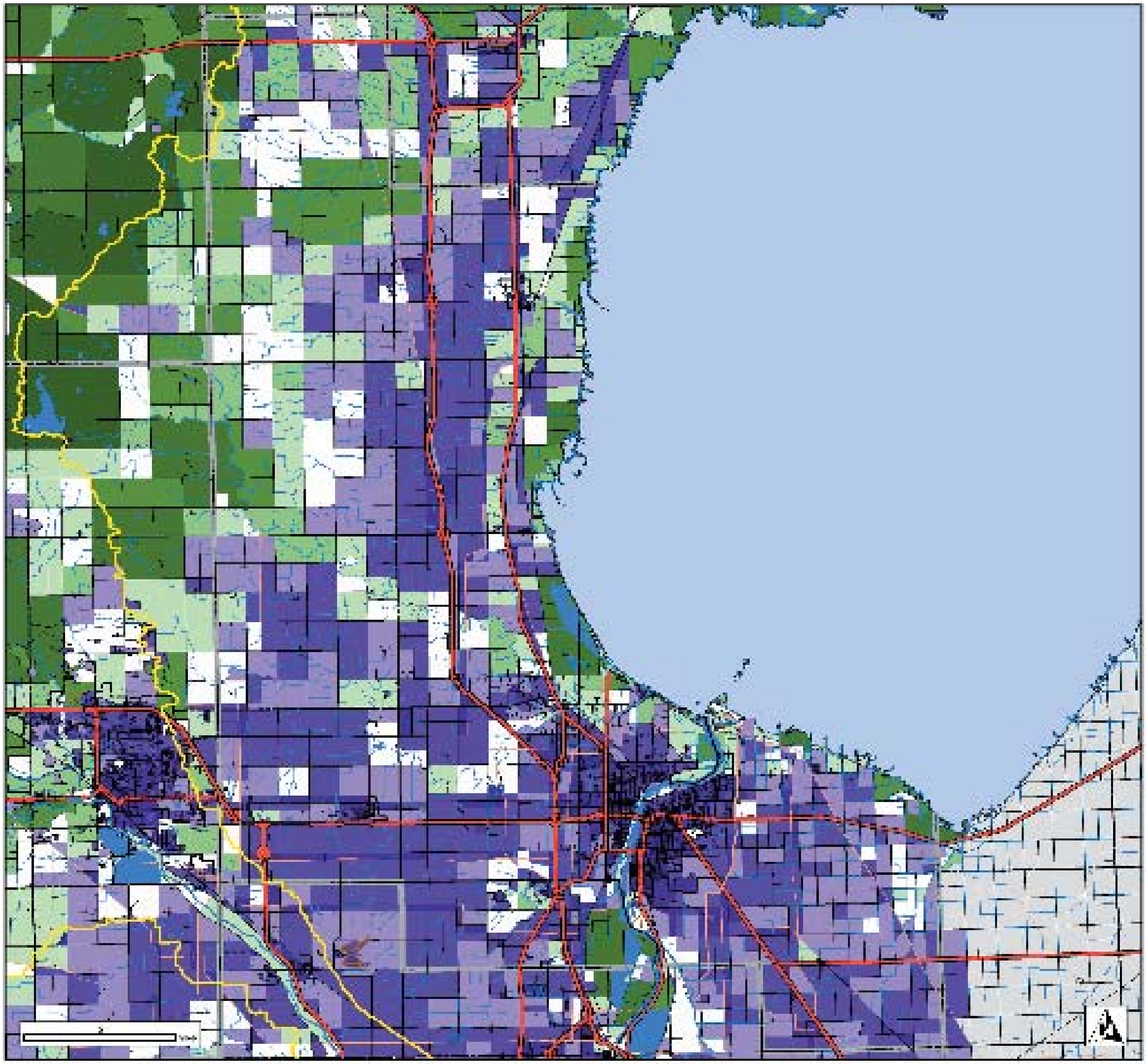
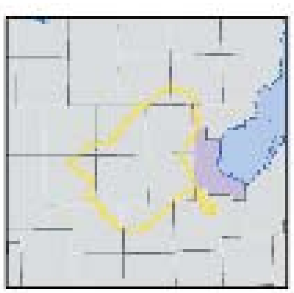
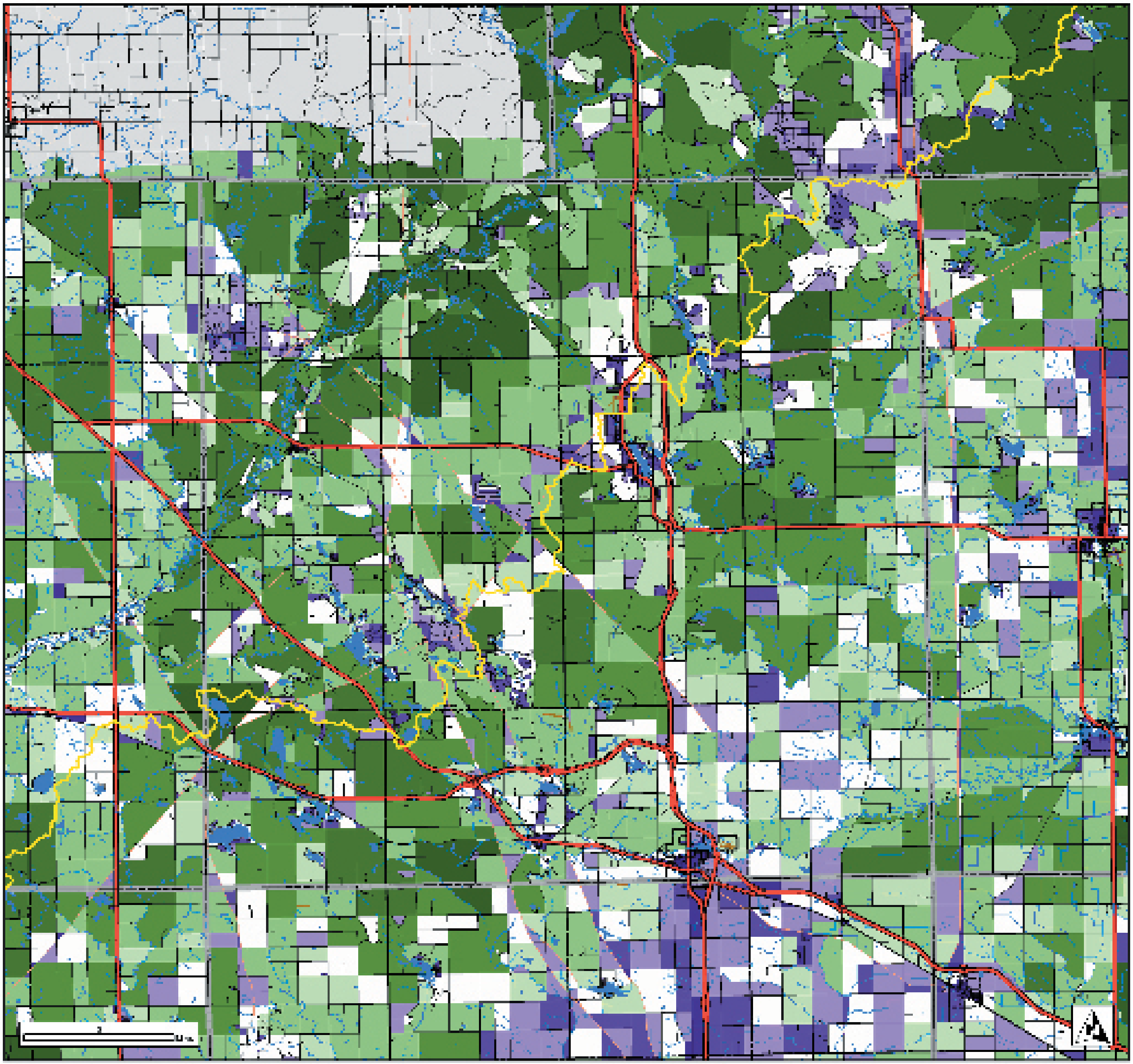
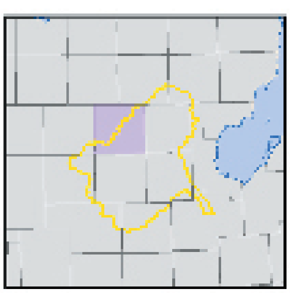
Bay County: Priority Conservation Lands





Clare County: Priority Conservation Lands





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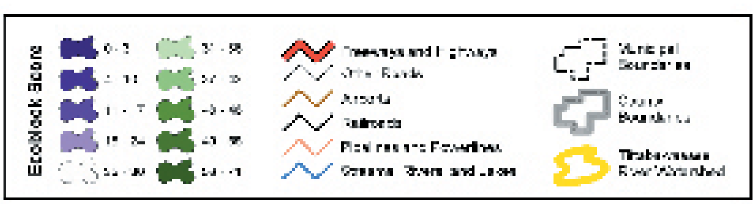

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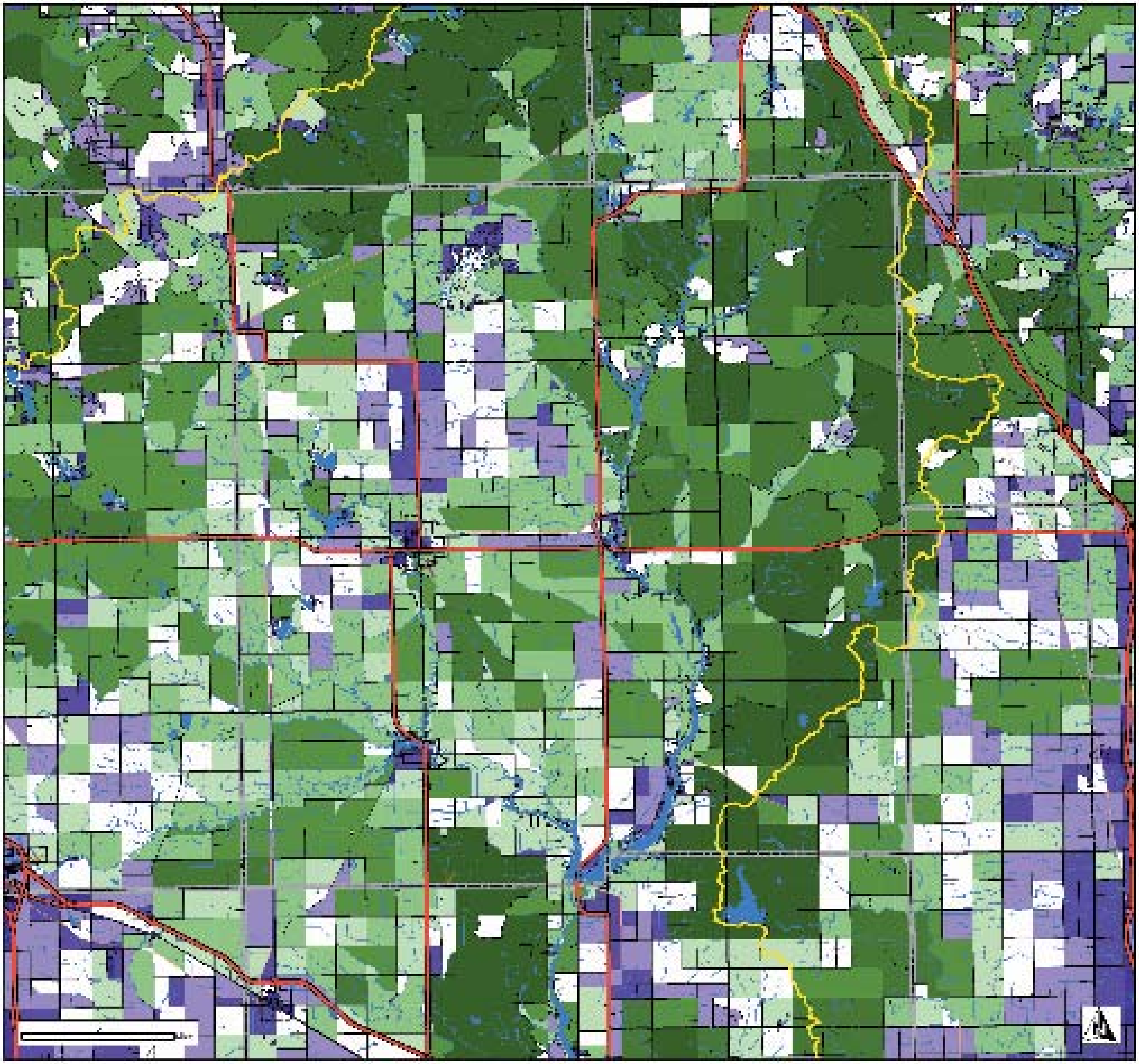

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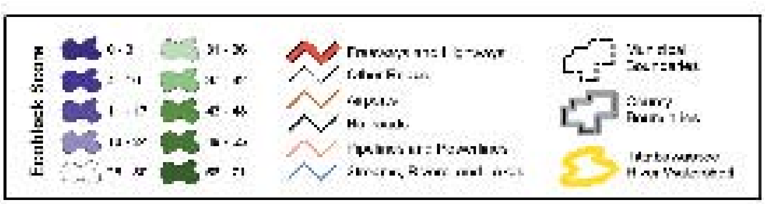

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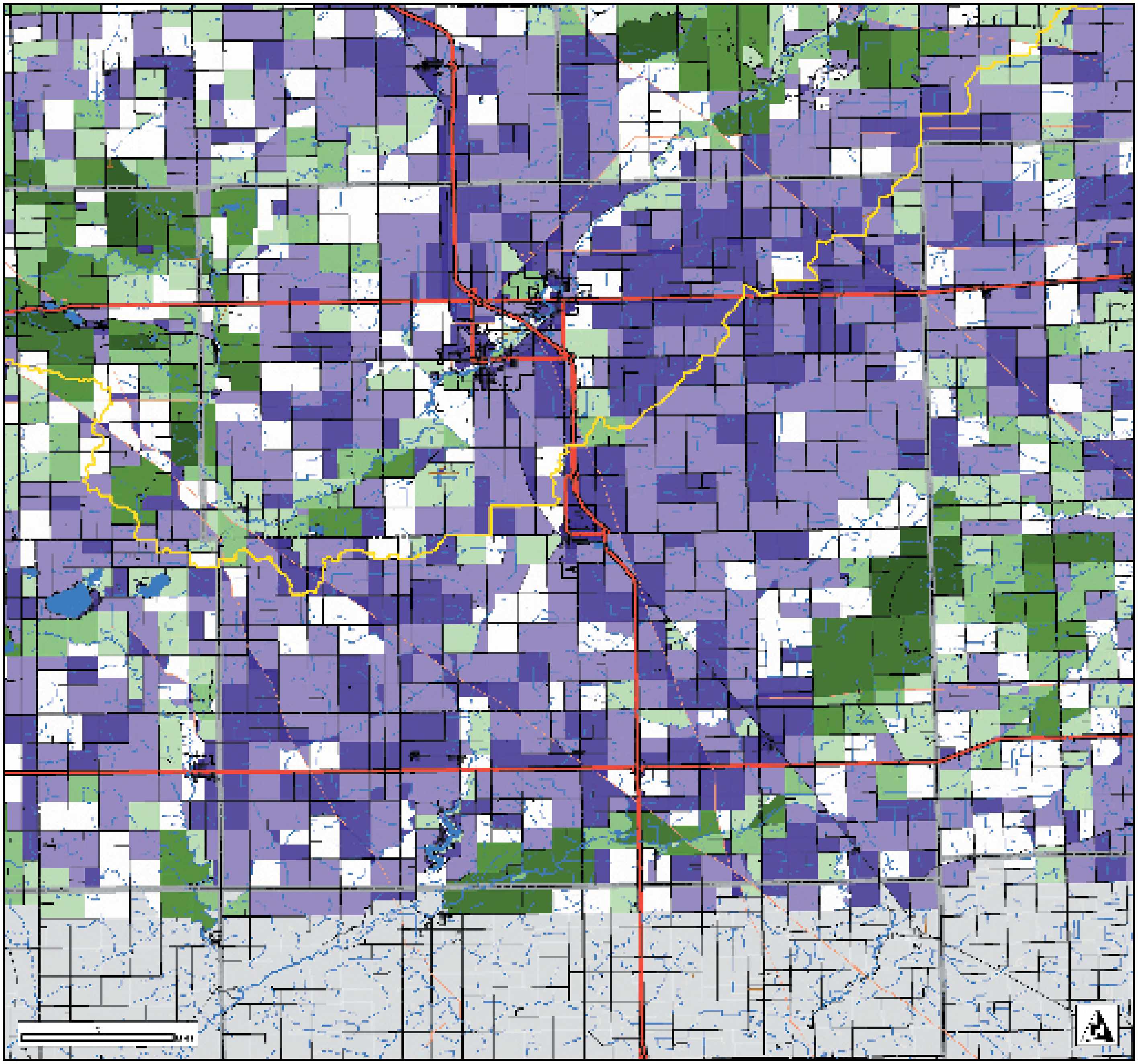
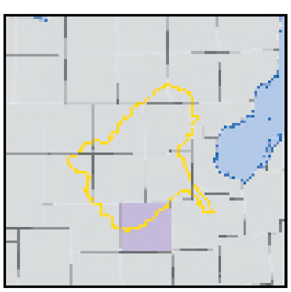
Gratiot County: Priority Conservation Lands





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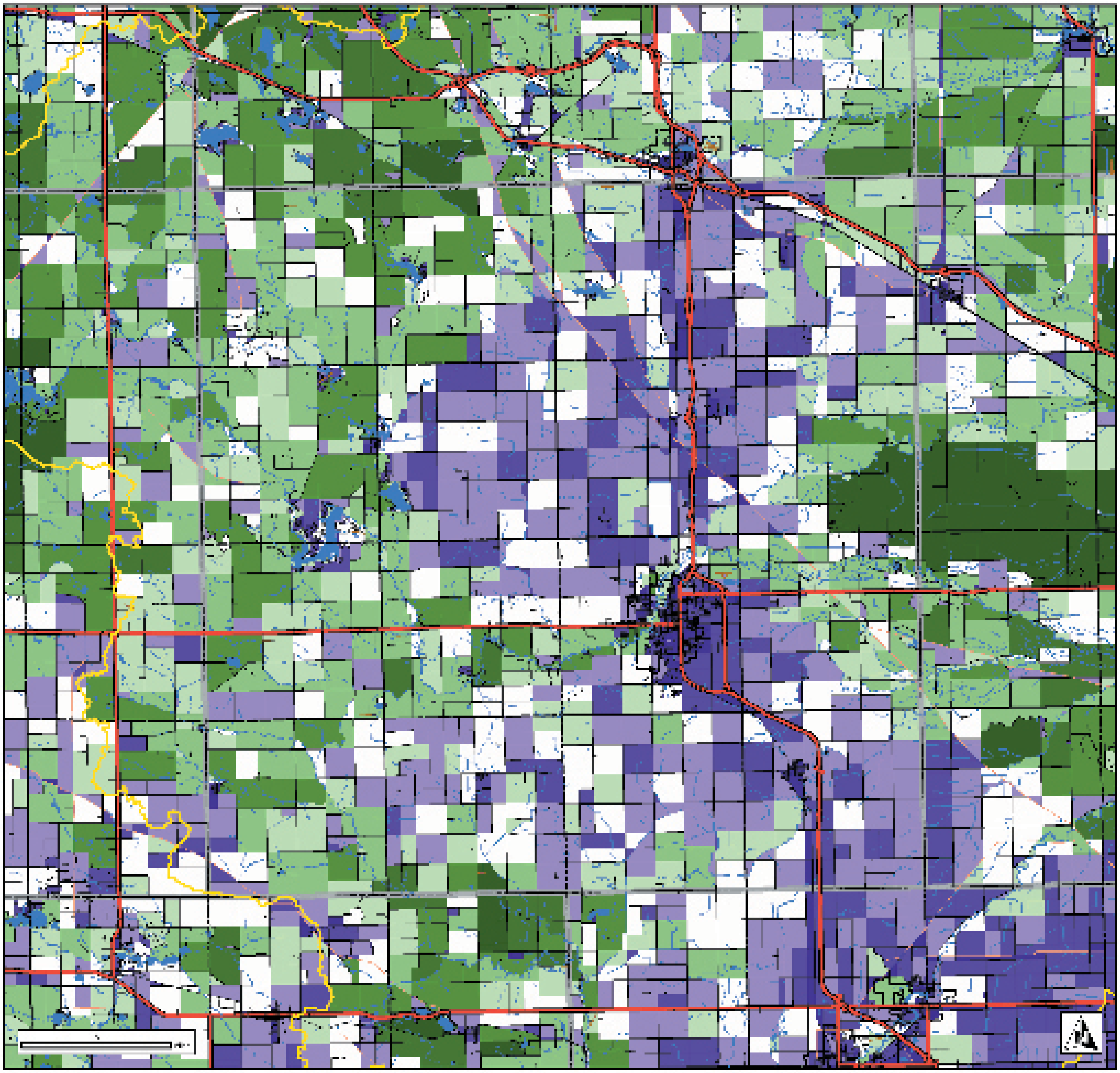

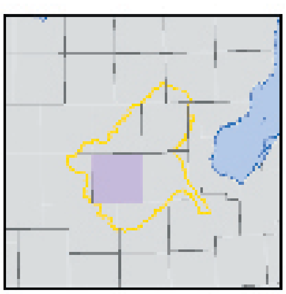

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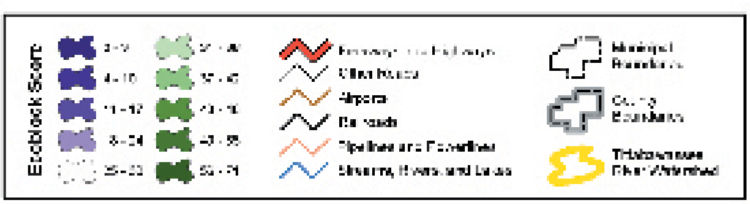

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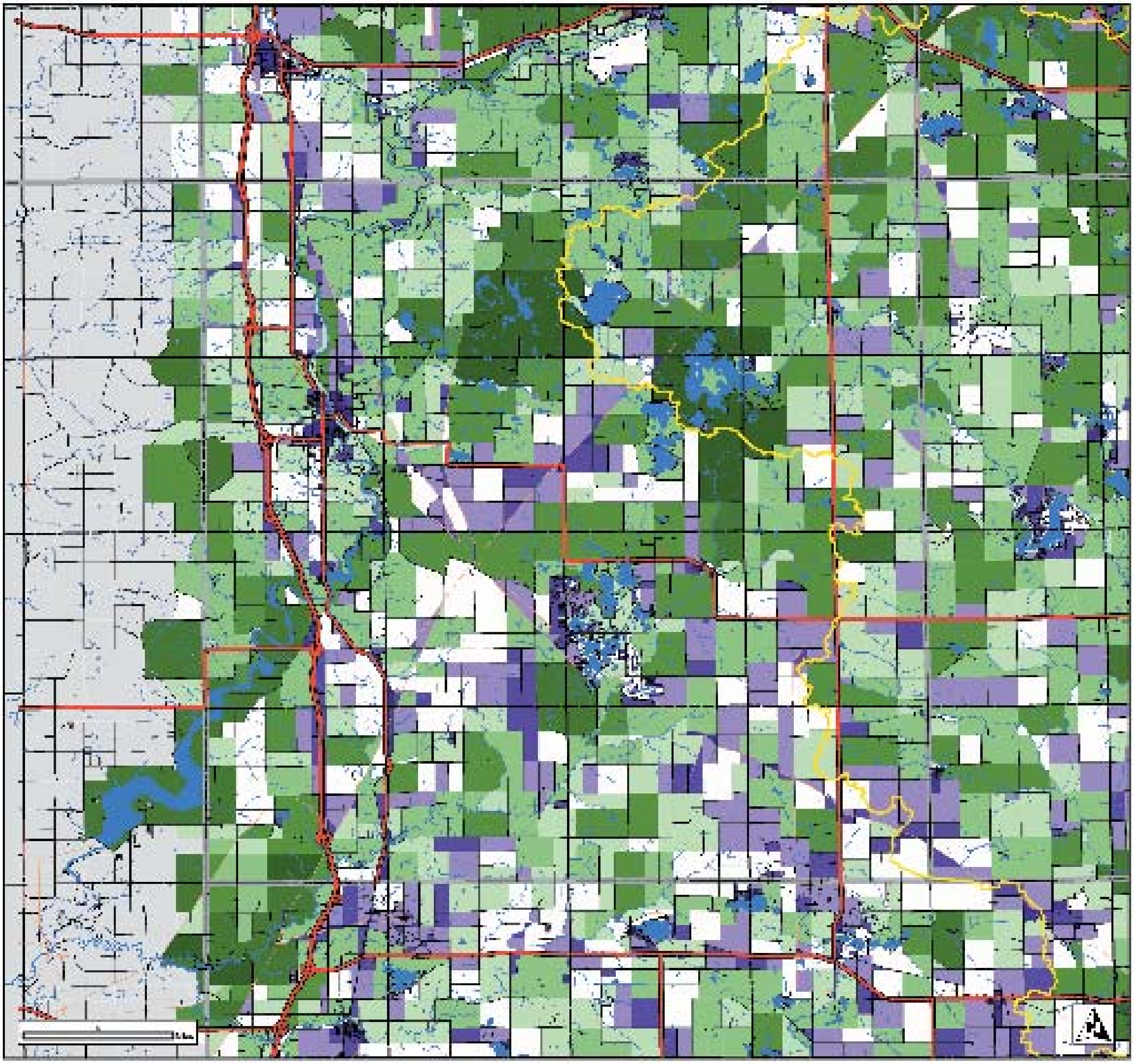

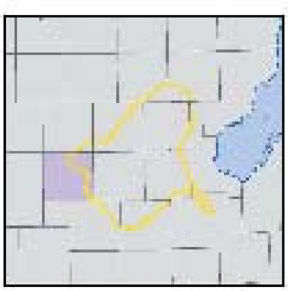

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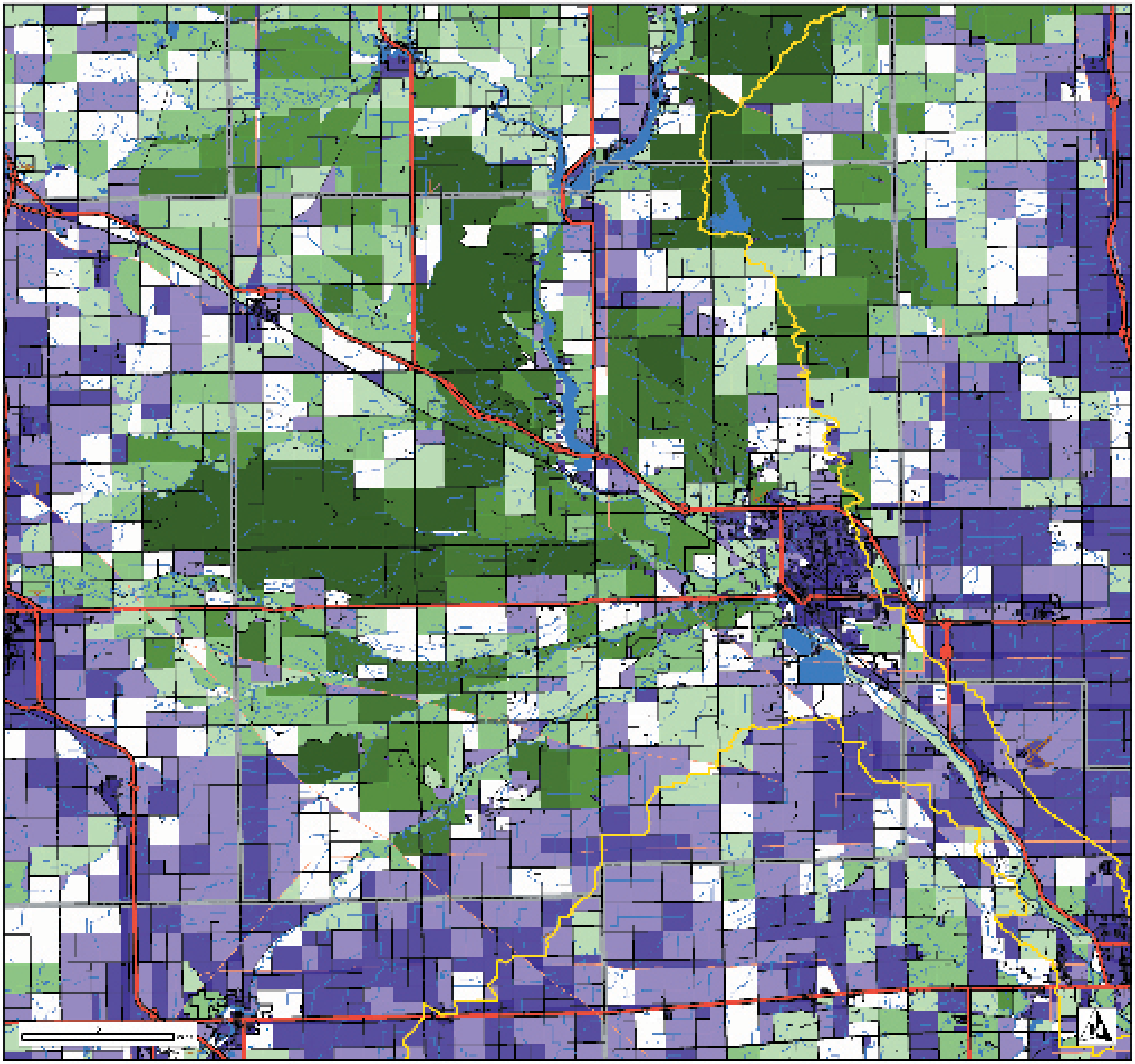

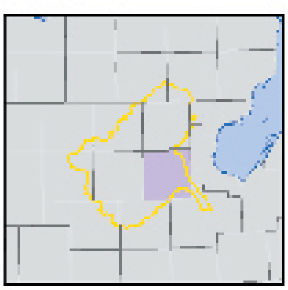

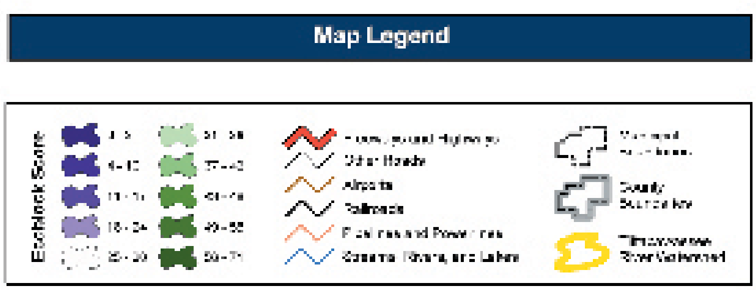

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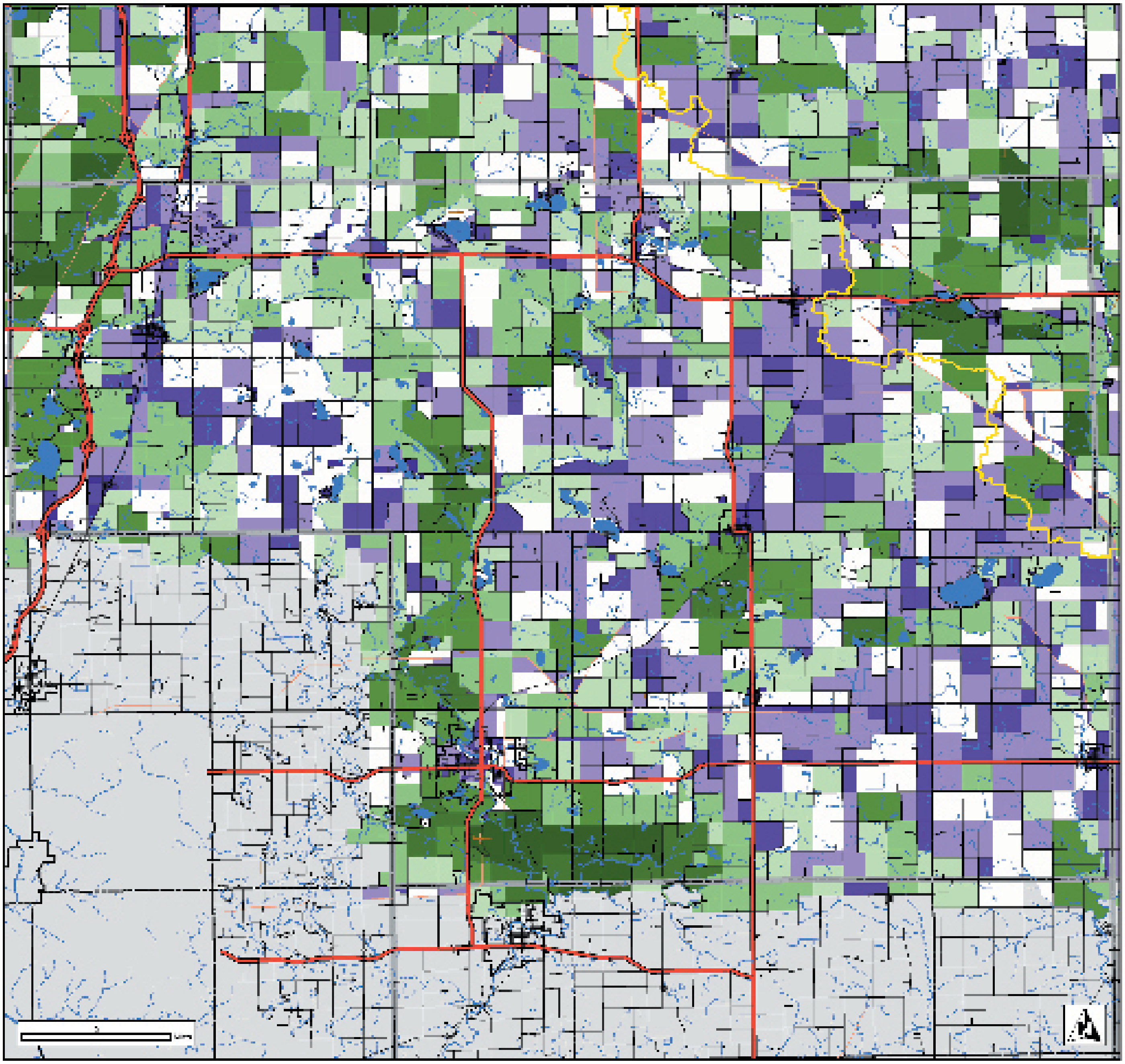

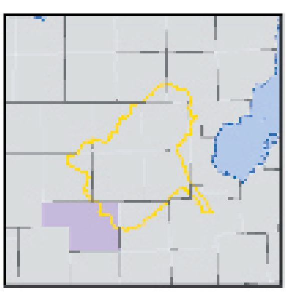

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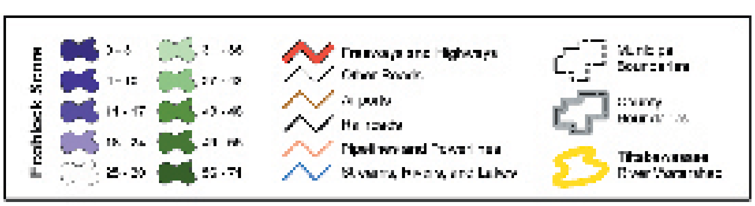

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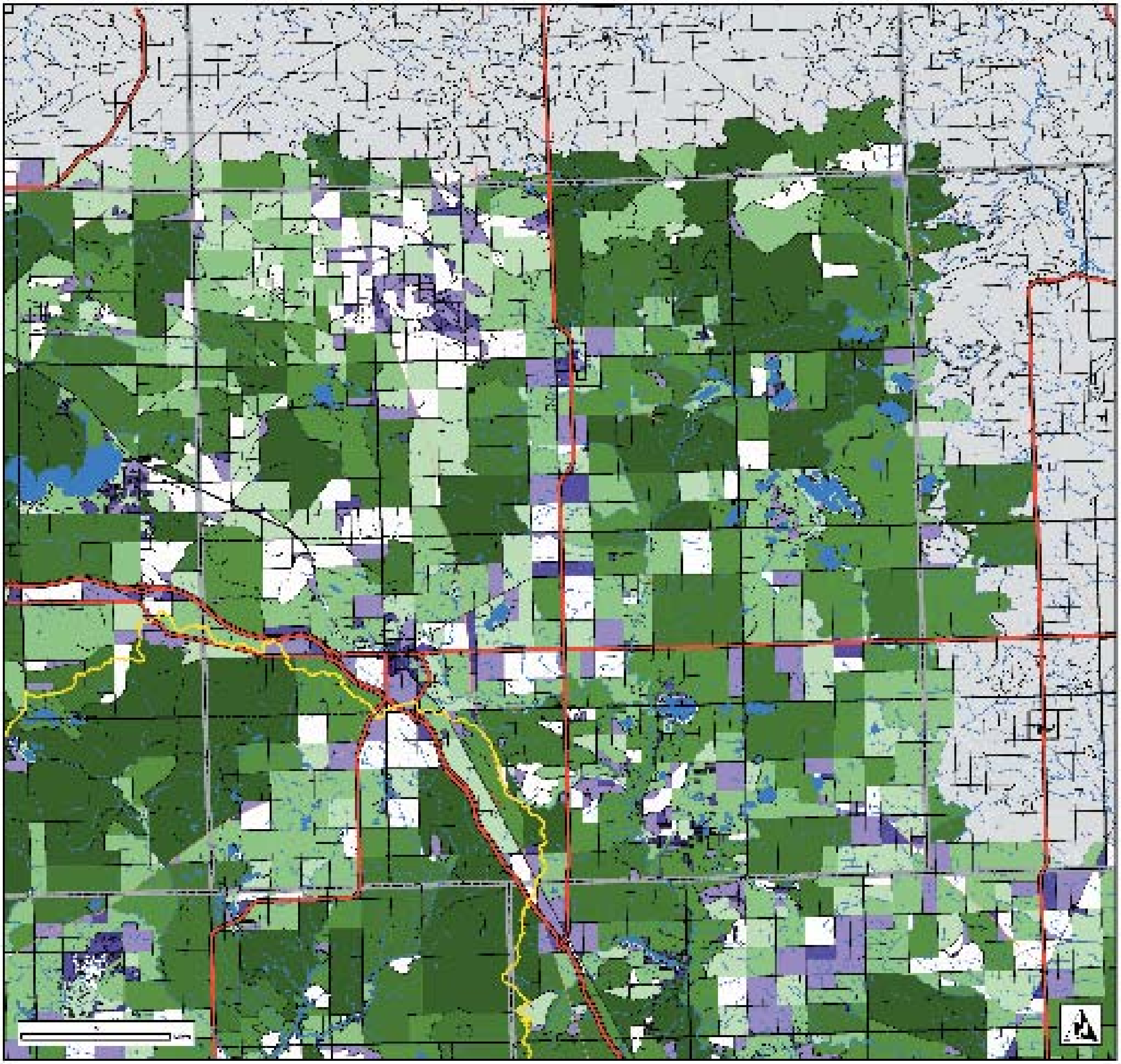
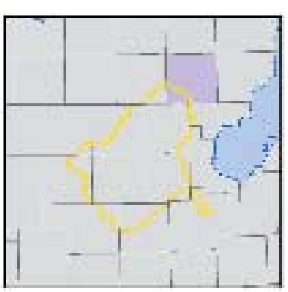
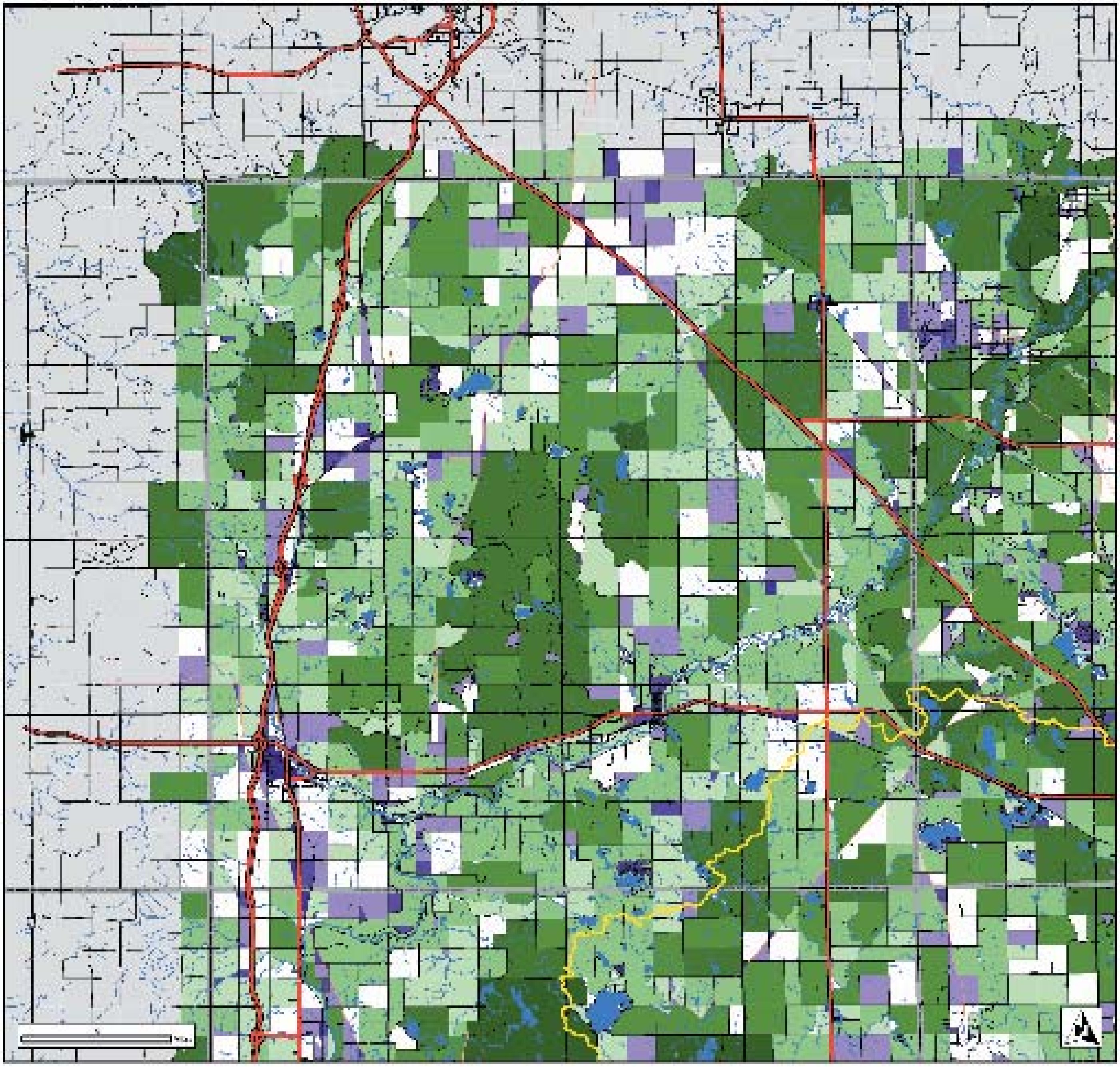
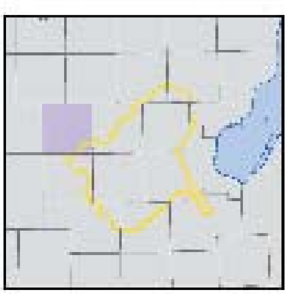




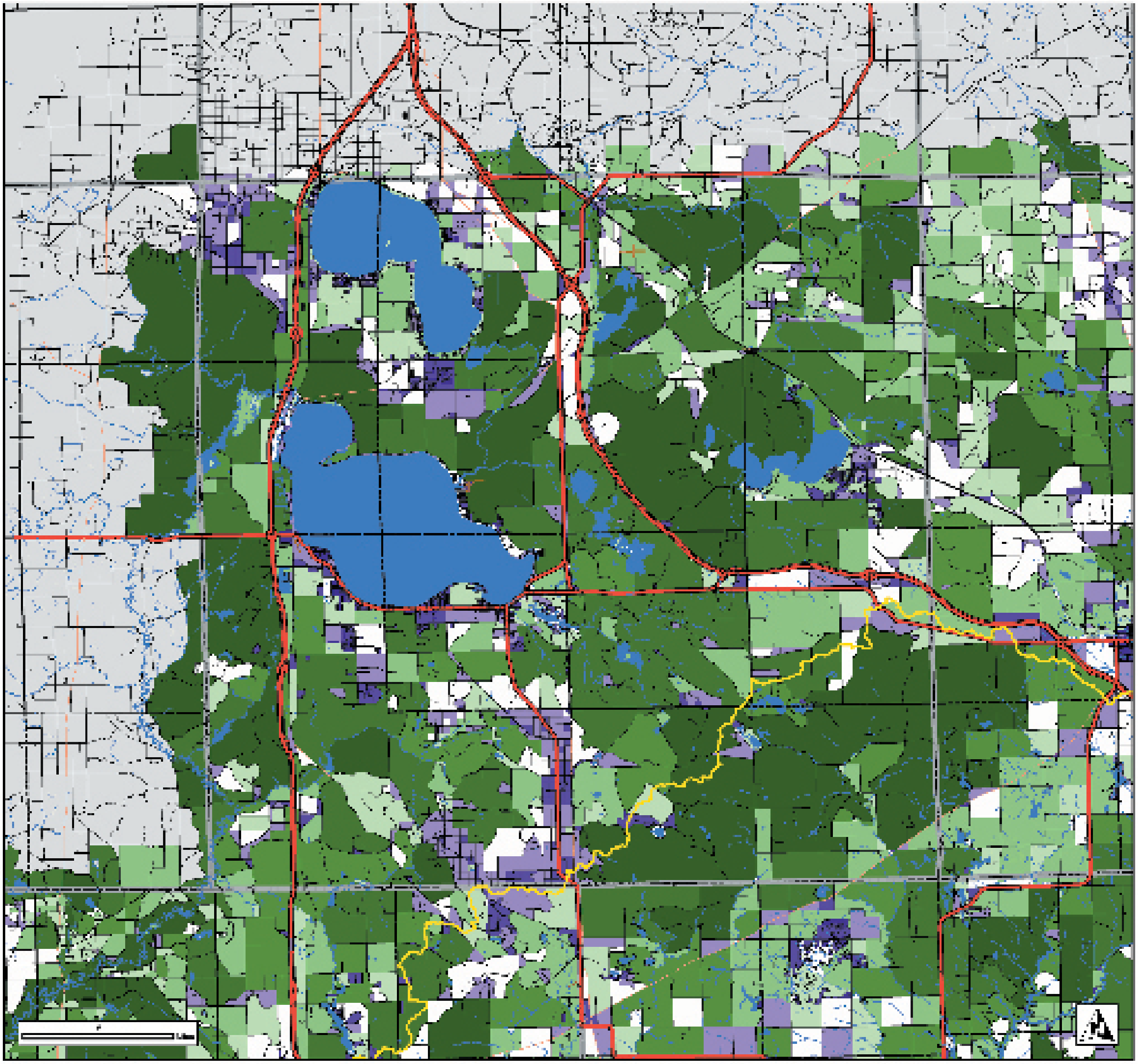
Osceola County: Priority Conservation Lands

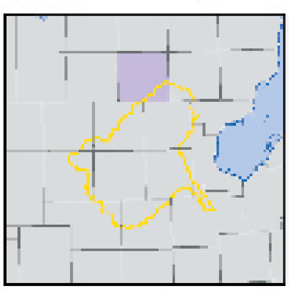




Map Legend

Roscommon County: Priority Conservation Lands





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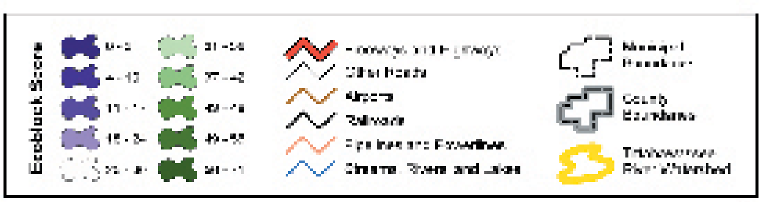

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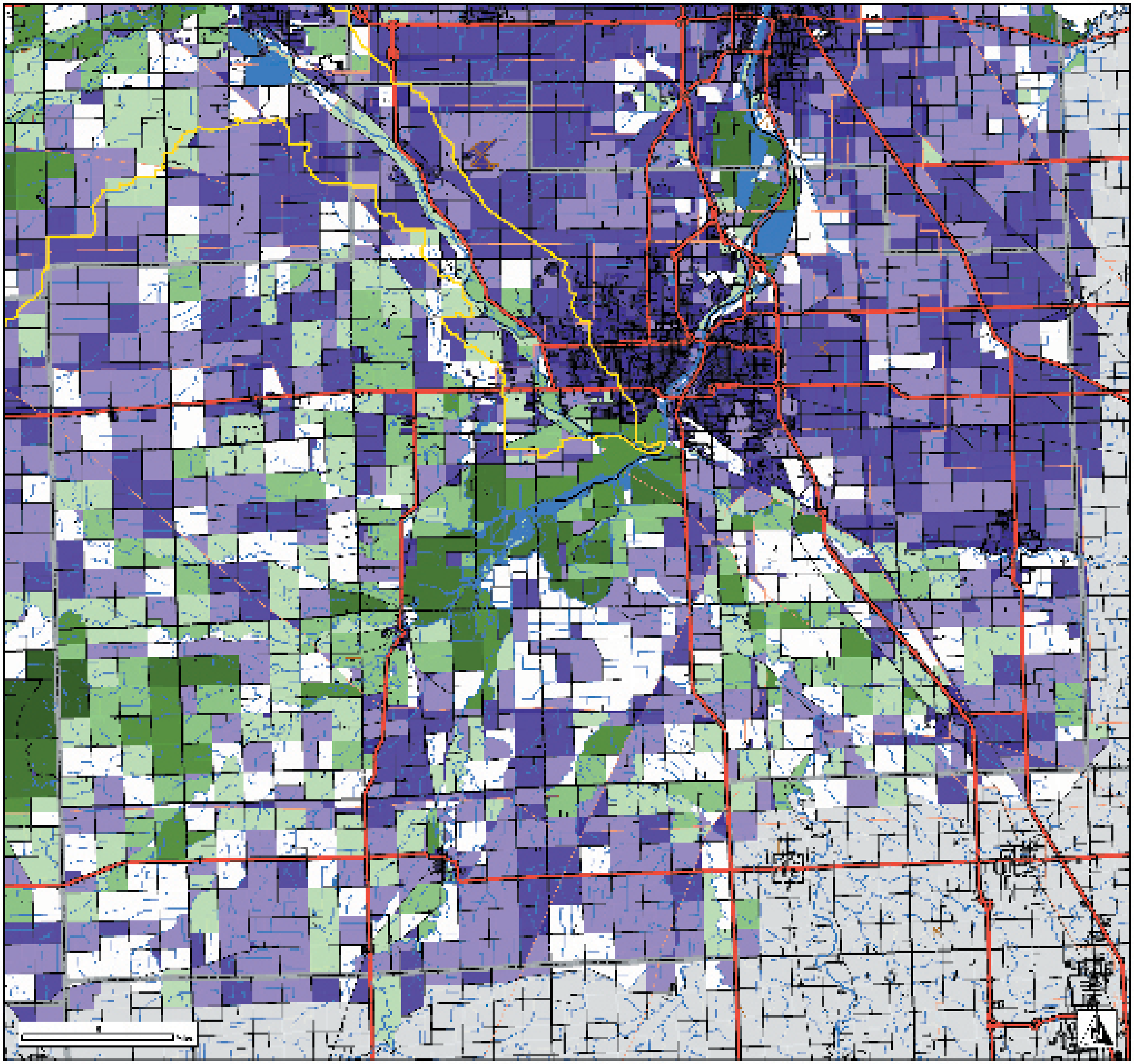
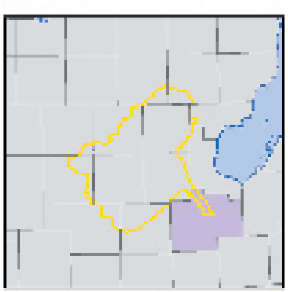
Saginaw County: Priority Conservation Lands





Map Legend

The Little Forks Conservancy
414 Townsend Street, Midland, Michigan 48640-5266
PH: 989-835-4886 • FAX: 989-835-4895 • www.littleforks.org