CHAPTER 3

ECOLOGICAL ASSESSMENT

3. ECOLOGICAL ASSESSMENT

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3.1 INTRODUCTION

An integrated assessment (IA) brings together policy makers, scientists, and key stakeholders to address a common issue of concern through collaboration and a formal analysis process. An IA is an approach to synthesizing and delivering relevant, independent scientific input to decision making through a comprehensive analysis of existing natural and social scientific information in the context of a policy or management question (Michigan Sea Grant [MSG], 2005). The goal of an IA is to link existing natural and social scientific knowledge about a problem with policy options in order to help decision makers evaluate possible actions.

The Northeast Michigan Integrated Assessment (NEMIA) - the first IA led by MSG – was conducted for the three-county region of Presque Isle, Alpena, and Alcona Counties in Northeast Michigan. This coastal area in along Lake Huron includes rich natural and cultural resources. Historically, the region has depended on its natural resources and accessibility to the Great Lakes for economic development. However, in recent years, as the traditional economic base (lumbering, mining, manufacturing, agriculture, hunting, and fishing) has declined, community leaders have turned to tourism to boost the economy by promoting the natural and cultural resources unique to the area, especially those associated with the coast. Despite the potential for economic development, the communities located here wish to proceed cautiously to avoid overdevelopment and destruction of the area's unique resources. These resources represent not only a growth opportunity but also a quality of life for local citizens (Northeast Michigan Integrated Assessment [NEMIA], 2005). A desire to strike a balance between these two interests is reflected in this IA's key policy question, as developed by the NEMIA stakeholders:

> How can coastal access be designed, in a regional context for sustainable tourism that stimulates economic development while maintaining the integrity of natural and cultural resources and quality of life?

After working with stakeholders to identify the policy or question to be addressed by the IA, assessment teams were built to conduct value-independent descriptions of the status and trends of environmental, social, and economic conditions related to the question, as well as consider the causes and consequences of those conditions. (For more information on the NEMIA process, see Chapter 1.) The cultural, socioeconomic, and planning and zoning assessment teams addressed social science aspects of this question, while the goal of the ecological team was to highlight the region's ecologically valuable lands by gathering existing GIS data layers of the region's natural features.

3.1 STUDY AREA

The NEMIA study area consisted of Alcona, Alpena, and Presque Isle counties. The three counties are located on the northeastern side of the state's Lower Peninsula, are heavily forested,

contain a large number of wetlands, and have extensive undeveloped Great Lakes shoreline on the northwest coast of Lake Huron. The three counties total just under 2000 square miles, Total population is 57,500. There are four cities, with the city of Alpena being the most populous at 20,000. The rest of the population is spread throughout the region, with roughly 14,400, 11,700, and 31,400 residents in Presque Isle, Alcona, and Alpena counties, respectively (US Census, 2007).

Historically, mining and forestry have been the staples of the regional economy, but have decreased in importance, though the area still has several large quarries. Manufacturing, agriculture, and the military have also been important in the past, but the majority of these jobs have been lost, and the region is facing economic challenges. The current major attractions to the area include Great Lakes cultural tourism, and hunting and fishing activities. However, these industries are currently addressing their own problems such as health concerns in some of the popular game species, and a lack of shoreline amenities such as hotels.

3.2 METHODS

We chose to use GIS (Geographic Information Systems) software extensively to develop two information products: 1) a set of standardized digital datasets representing natural and built features of the NEMIA region, to be transferred to the NEMIA workgroup at the conclusion of the assessment, and 2) a series of maps displaying different combinations of the digital datasets.

GIS makes it possible to collect, analyze, and display multiple sets of digital spatial data simultaneously. Datasets can be layered on top of one another to produce maps that show multiple spatial datasets and provide tools to analyze the relationships between the phenomena represented by the datasets (also called “layers”). These maps can be distributed cheaply to decision makers and the public to inform policy-making processes. Another benefit of GIS is that the information products (in this case, data layers and maps) are easily updatable. This was ideal for this inventory; at the conclusion of the IA process the data layers and maps can be transferred to decision makers who can update and improve them as new information becomes available. However, due to the lack of GIS layers representing features at a variety of points in time, we could not provide information on trends, and instead focused on identifying and mapping the current status of the region’s natural features.

To develop the information products, we acquired as many existing digital layers as possible representing features of the natural and built environment in the NEMIA study area. This process consisted of first identifying a feature of interest (e.g. highways, forest cover, rivers) and then finding an agency that may have converted the spatial information on the feature to a GIS-compatible format. A full list of all layers used and their sources is available in Appendix A of this report.

The layers representing the six ecological features that formed the basis of our analysis are: endangered ecosystems, endangered animals, endangered plants, wetlands, interior forests, and pre-settlement landcover. These layers were developed by and acquired from the following sources:

- Forest cover data was downloaded from the United States Geological Survey website

- The National Wetlands Inventory (NWI), developed by the United States Fish and Wildlife Service
- Pre-settlement landcover, developed by Michigan Natural Features Inventory (MNFI) based on data Michigan Department of Natural Resources (DNR) data.
- The endangered ecosystems and species information was acquired from the MNFI.

We standardized all layers we collected by converting them to the Michigan Georef projection.[1] Next, to focus all layers on the NEMIA region, we reduced the extent of those layers that covered an area larger than the region, and combined layers that covered an area smaller than the region. For example, layers from the Michigan Online Geographic Data Library are produced at the county scale, which means that for example, rivers in the three-county NEMIA region are represented by three separate layers. In this case, we combined the three layers to create one new layer showing rivers in the entire NEMIA region.

After acquiring all available layers and standardizing them, we produced a set of maps that would be useful for decision makers in planning for sustainable tourism and natural features protection. These maps are presented in the results section (Figures 3.1-3.12), in addition to details about what they show. Figures 3.4 and 3.5, maps displaying areas of ecological importance, were created using existing spatial data layers and data we collected specifically for this assessment. Using the results of a survey and a ranking activity to weight each natural feature, these maps compare the opinions of the NEMIA workgroup about the location of valuable natural features with researchers' opinions.[2] More details about the development of the ranking maps are included in the results section.

3.3 RESULTS

The products of this natural features inventory are a set of digital data layers and maps developed using those layers that are designed to be useful for decision makers in planning for sustainable tourism and natural features protection. A list of all data layers obtained, their sources, and details about what they represent is available in Appendix A. All of the layers used to make these maps will be transferred to the NEMIA work group for future use in regional planning and sustainable tourism efforts. The work group can then make maps specific to their needs using different combinations of layers we have provided. The remainder of this section is a presentation of themed maps developed by combining layers that we obtained in this process. For each map we list the layers included and a brief description of what each layer represents.

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[1] When converting individual shapefile layers to and from the raster format, the projection file in each shapefile format had to be manually adjusted to make up for a flaw in how ArcGIS 9.1 converts shapefiles from rasters in the Michigan Georef projection. This flaw involves the misreading of decimal-degrees and degrees-minutes-seconds by the program in the conversion process.

[2] The use of opinions in GIS is well established, and has been used in a variety of contexts; from modeling perceptions of groundwater contamination, to modeling the distribution of flora and fauna (Pearce, Cherry, Drielsma, Ferrier, & Whish, 2001; Clevenger, Wierzchowski, Chruszcz, & Gunsuns, 2002; Theriault et al., 1999). Using the opinions of residents to help in the planning of a community's future is known as participatory Geographic Information Systems (Hawthorne, 2005). It gives residents' views a new vitality by changing them into a tool for decision makers. While the opinion maps produced for this assessment do not accurately reflect local sentiments, since the only opinions polled were members of the workgroup, the opinion mapping does represent an important first step in gauging local sentiment (Geertman, 2002).

3.3.1 Study Area Base Map

Figure 3.1 is a base map of the NEMIA study area to serve as a reference, indicating the locations of municipalities, transportation routes, and major development infrastructure. Included in this map are the following features (sources in parentheses):

- Rivers (IFR) – Lake Huron tributaries
- Trails (NEMCOG) – non-motorized trails and the Huron Greenways route systems (which includes existing trails and roads)
- Roads (MiGDL)– all roads, including highways
- Railroads (MiGDL) – Detroit and Mackinaw railways
- Highways (MiGDL) – federal and state designated routes
- Utilities (MiGDL) – power transmission lines and pipelines
- State Parks (MiDNR) – parks in the Michigan DNR's state parks system

3.3.2 Natural Features

Figure 3.2 displays the type and extent of the natural features in the region. These are the some of the features that will provide the basis for land preservation and sustainable tourism.

To clarify the areas of high concentrations of the natural features included in Figure 3.2, we created Figure 3.3, a complementary map showing areas with multiple natural features present. In GIS software, datasets are layered on top of one another, such that in areas where multiple layers overlap, only the features in the layer that was placed "on top" by the user is visible. When creating Figure 3.2, we arranged the order of the layers in such a way as to place layers with features covering a smaller spatial extent above layers with larger spatial extents. The effect is that the smaller layers are visible because they are displayed "on top" of the larger ones. Because of this aspect of the software, in Figure 3.2, it is not easy to locate the areas of high natural feature concentration because in places where multiple features overlap, only the layer on the top is visible. Using Figures 3.2 and 3.3 in conjunction provides a more complete picture of the distribution of natural features in the region.

The following features (sources in parentheses) were included in Figure 3.2 and used in developing Figure 3.3.

- Protected Lands (DU) – land that is currently mostly undeveloped, including state, county, and city parks, state and national forests, nature preserves, and golf courses (note: While golf courses are intensively managed and typically have limited significant natural features, from the perspective of the data source (DU) golf courses provide valuable staging grounds for waterfowl and geese. The structure of the data layer was binary, such that either a pixel was protected or not protected. As such, we had no way to exclude only golf courses.
- Trails (NEMCOG) – non-motorized trails and the Huron Greenways route systems (which includes existing trails and roads). We included trails to demonstrate the

Figure 3.1

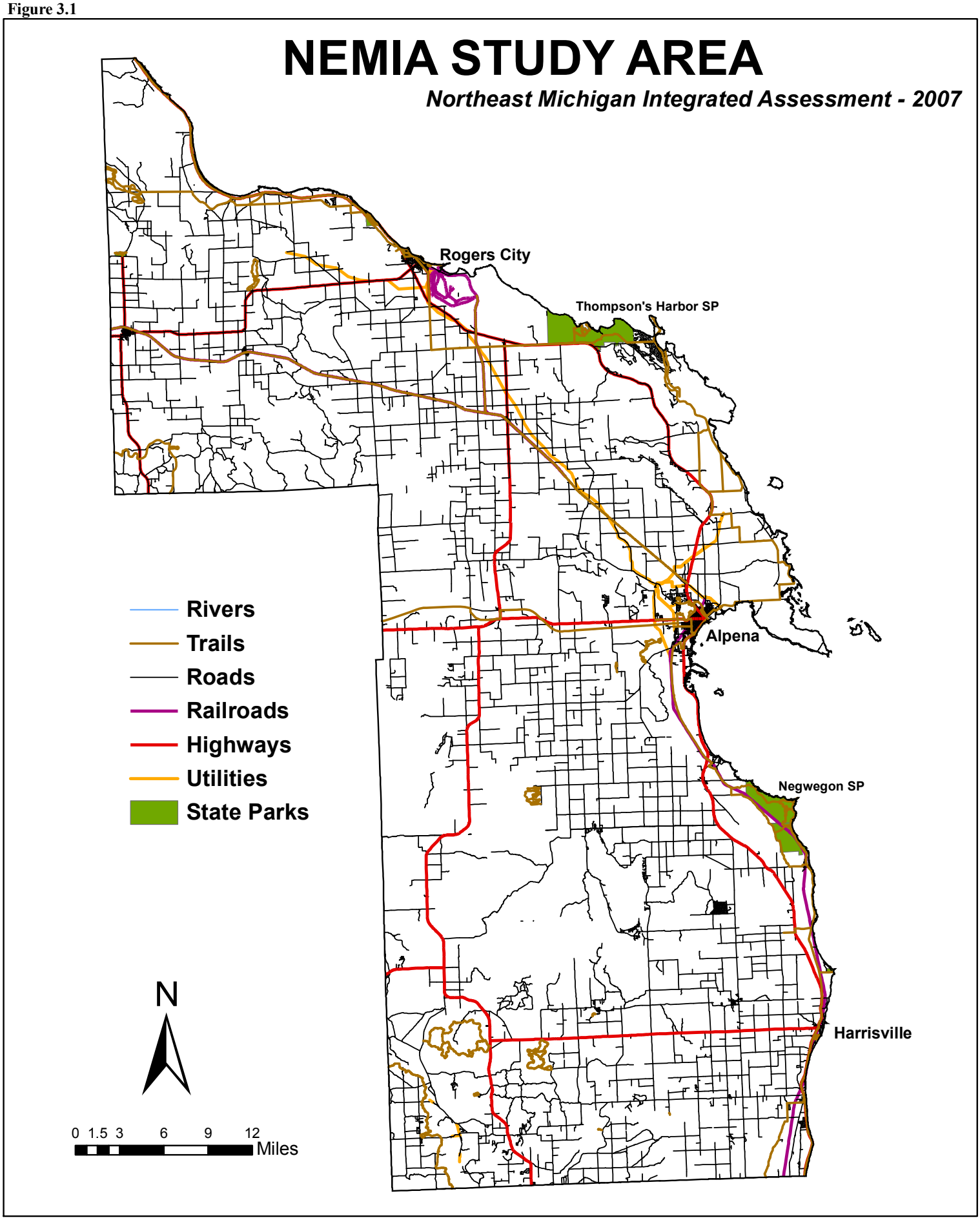

NEMIA STUDY AREA
Northeast Michigan Integrated Assessment - 2007
Rogers City
Thompson's Harbor SP
Alpena
Negwegon SP
Harrisville
Rivers
Trails
Roads
Railroads
Highways
Utilities
State Parks
N
0 1.5 3 6 9 12
Miles

Figure 3.2

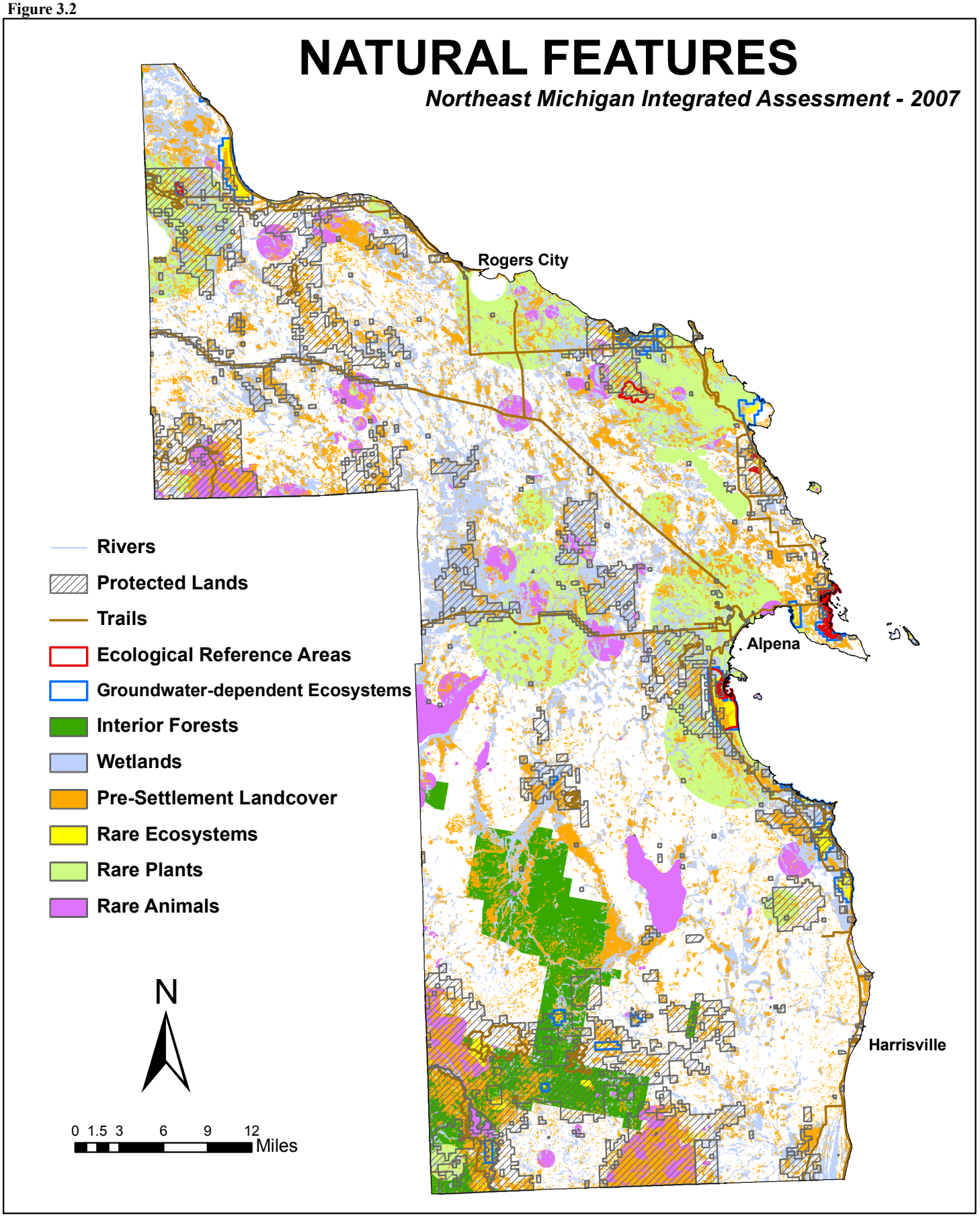
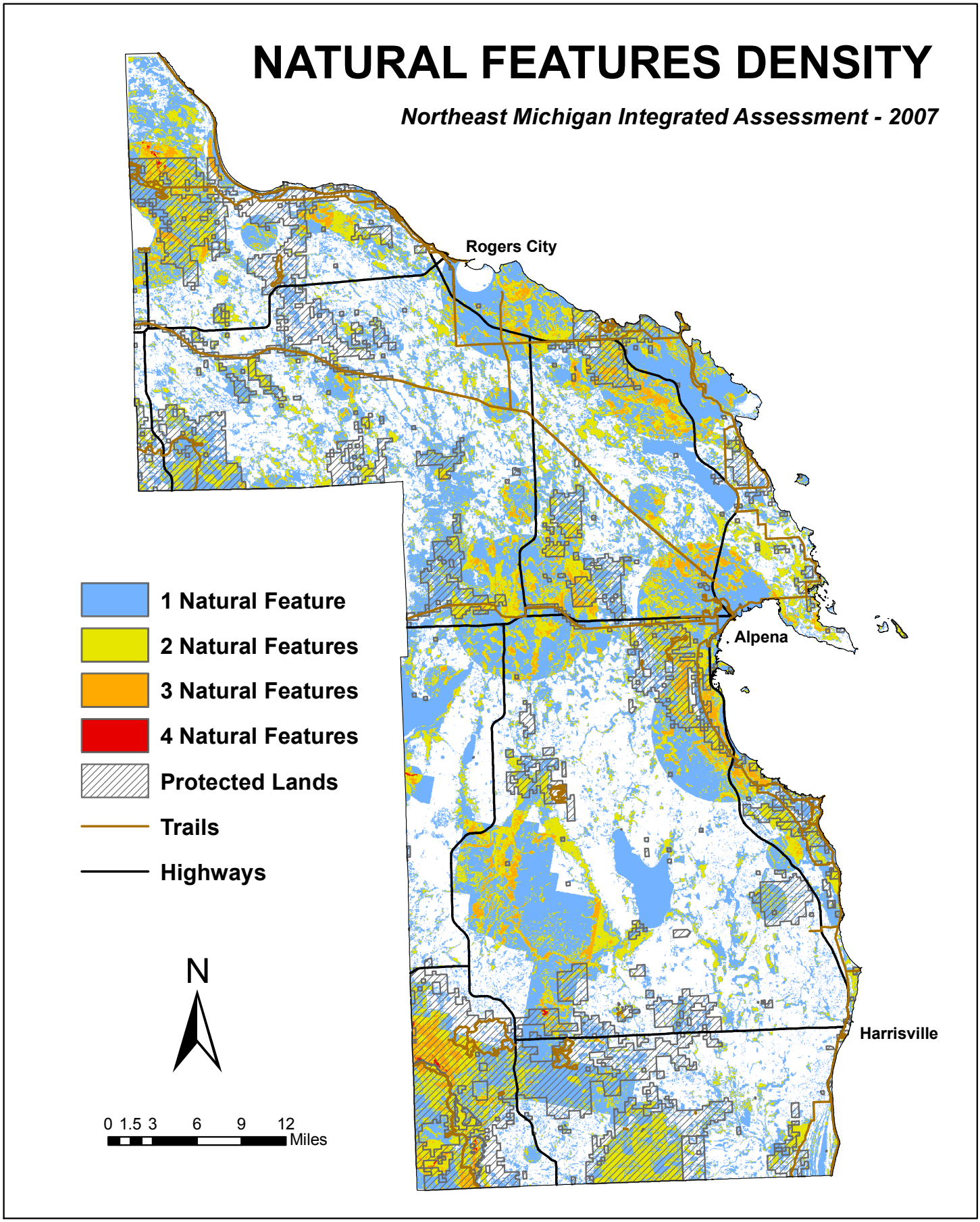

NATURAL FEATURES
Northeast Michigan Integrated Assessment - 2007
Rogers City
Alpena
Harrisville
Rivers
Protected Lands
Trails
Ecological Reference Areas
Groundwater-dependent Ecosystems
Interior Forests
Wetlands
Pre-Settlement Landcover
Rare Ecosystems
Rare Plants
Rare Animals
N
0 1.5 3 6 9 12
Miles

Figure 3.3


NATURAL FEATURES DENSITY
Northeast Michigan Integrated Assessment - 2007
Rogers City
Alpena
Harrisville
1 Natural Feature
2 Natural Features
3 Natural Features
4 Natural Features
Protected Lands
Trails
Highways
N
0 1.5 3 6 9 12
Miles

accessibility of some of these important areas, both for recreational purposes and as an indicator of potential vulnerability.

- Ecological Reference Areas (MNFI) – areas that serve as models of ecological reference within the State of Michigan. They are high quality examples of functioning ecosystems that are primarily influenced by natural ecological processes, and they may be located upon any land ownership in the State. This layer includes an initial set of ERAs in the NEMIA region. They were selected because they meet the initial base requirements for ERA selection: they are known high quality sites in the Michigan Natural Features Inventory (MNFI) natural community classification system with an Element Occurrence (EO) rank of A or B and Global (G) or State (S) element ranking of endangered (1), threatened (2), or rare (3).
- Groundwater-dependent Ecosystems (MNFI) – 1000m x 1000m sections of land that are considered one of the 28 "groundwater dependent" natural community types as mapped by the Michigan Natural Features Inventory. The integrity of these natural communities depends on the presence of groundwater.
- Interior Forests (USGS) – a 1000m x 1000m section of forested land that is fully surrounded by other 1000m X 1000m sections of forested or partially forested land
- Wetlands (MiGDL) – land with one or more of the following three attributes: 1) at least periodically, the land supports predominantly hydrophytes (plants adapted to living in water or moist soils); 2) the substrate is predominantly undrained hydric soil; and 3) the substrate is non-soil and is saturated with water or covered by shallow water at some time during the growing season of each year. Does not include land that is flooded on a permanent or seasonal basis because of human activity.
- Rivers (IFR) – Lake Huron tributaries, shown as reference (not included in the ranking exercise)
- Pre-settlement Landcover (MNFI) – land that has maintained its ecological character since pre-settlement times (early 1800s) even though it may have been lumbered, farmed, burned over, or otherwise altered by humans.
- Rare Ecosystems (MNFI) – the area where an ecosystem with a Global Conservation State Rank of G1 (critically imperiled), G2 (imperiled), or G3 (vulnerable) was reported (the size of the area shown relates to the certainty of the reported sighting)
- Rare Plants – (MNFI) the area where a plant species with a Global Conservation State Rank of G1 (critically imperiled), G2 (imperiled), or G3 (vulnerable) was reported (the size of the area shown relates to the certainty of the reported sighting)
- Rare Animals – (MNFI) the area where an animal species with a Global Conservation State Rank of G1 (critically imperiled), G2 (imperiled), or G3 (vulnerable) was reported (the size of the area shown relates to the certainty of the reported sighting)

The layers showing rare organisms and ecosystems represent confirmed sightings of rare plants, animals, or ecosystems from the Michigan Natural Features Inventory. Therefore the absence of a feature on the map does not mean that it is not there, it means that no one has reported any rare species in the region. In other words, an *absence of presence* of a feature on this map does not confirm the *presence of absence.* Even though common plants, animals, and ecosystems are valuable natural assets, we focused on rare organisms and ecosystems because they have priority for targeted conservation and because they have more potential as new tourist attractions. Similarly, data on the ranges and population sizes of game species would be useful since many

visitors come from outside the region to hunt, however hunting is an established tourism market, and we decided to provide information useful for developing new markets.

A special note about data layers developed using MNFI data: The MNFI uses historical records as one of its sources in developing its data layers. Each historical record is assessed for uncertainty, and this uncertainty is taken into account when developing spatial data layers. For example, in Figure 3.2, the locations of rare plants and animals are indicated by circular areas. Contrary to intuition, this does not mean that the rare plant or animal is present throughout the entire indicated area. Rather it means that someone reported the presence of a rare plant or animal at the center of that circle, and the diameter of the circle is a reflection of the amount of uncertainty associated with that reported occurrence. The larger the circle, the more uncertainty is associated with the location of the reported occurrence. Inaccuracy in the historical data led to widening of the habitat area to cover for the uncertainty. Therefore, for the MNFI data layers, it is best to view the circles as showing areas where the feature of interest may occur, rather than of actual occurrence.

We could not gain access to current data on land divisions and parcel boundaries, but these data would enhance Figure 3.2. Parcel boundaries are valuable because they show the intensity of land division, which is a good indicator of current and future development. (An area with many small parcels is more likely to have more development than a similarly sized area with only a few large parcels). In terms of preservation, it can be difficult to protect natural features when land division is intense since natural features do not follow political or civil boundaries. When a significant natural feature is located on land owned by multiple parties, preservation requires cooperation among a number of landowners who likely have diverse values and goals for their property.

3.3.3 Ranking Areas of Ecological Importance

Figures 3.4 and 3.5 provide a visual comparison of the opinions of experts (a group of researchers from the University of Michigan's School of Natural Resources and Environment) and regional decision makers (members of the NEMIA workgroup) about the relative importance of different natural features in the NEMIA study area. The opinions were used to rank each natural feature compared to the others. The purpose was twofold: to see what features each group values most (relative to the other features) and to target areas for protection by identifying the features that both groups agree are important for protection (Kyem, 2004; Theriault, 2002).

Figures 3.4 and 3.5 were developed using the results from the NEMIA Natural Features Opinion Survey (see Appendix B), which was administered to participants of the August, 2006 NEMIA work group meeting. The survey consisted of a ranking exercise in which the respondent was asked to rank each of the six ecological features of interest based on their understanding of the importance of the feature relative to the other features in the survey. The results of the survey were standardized and then used to weight each natural feature layer. It should be clarified that the spatial information for these maps was not created for this assessment; rather the expert input was incorporated as attributes for existing polygons to change how that information could be displayed. Table 3.1 summarizes the results of the survey. For example, when ranking the ecological importance of wetlands, 14 people ranked them as highest priority (3 points), 5 people

Figure 3.5

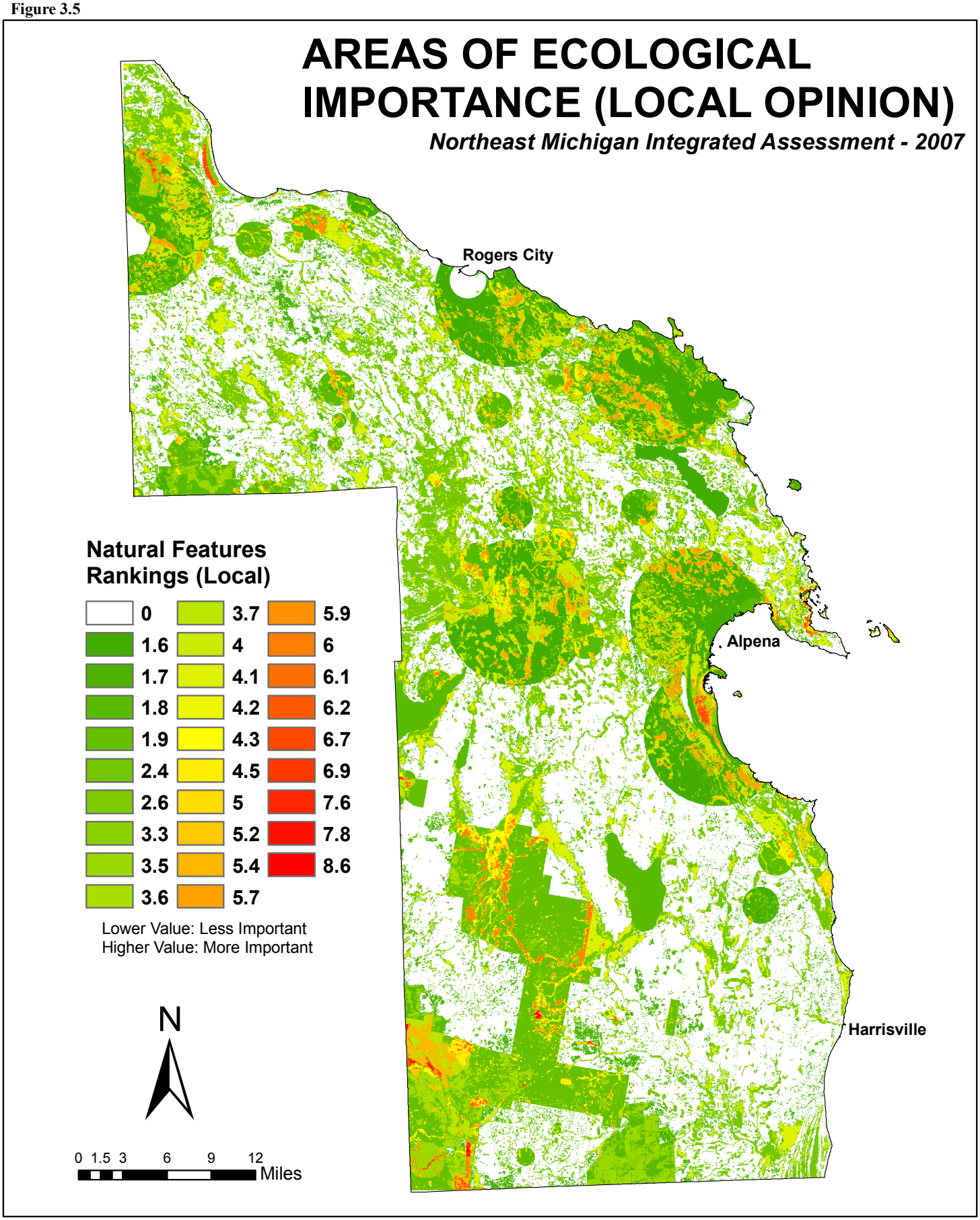
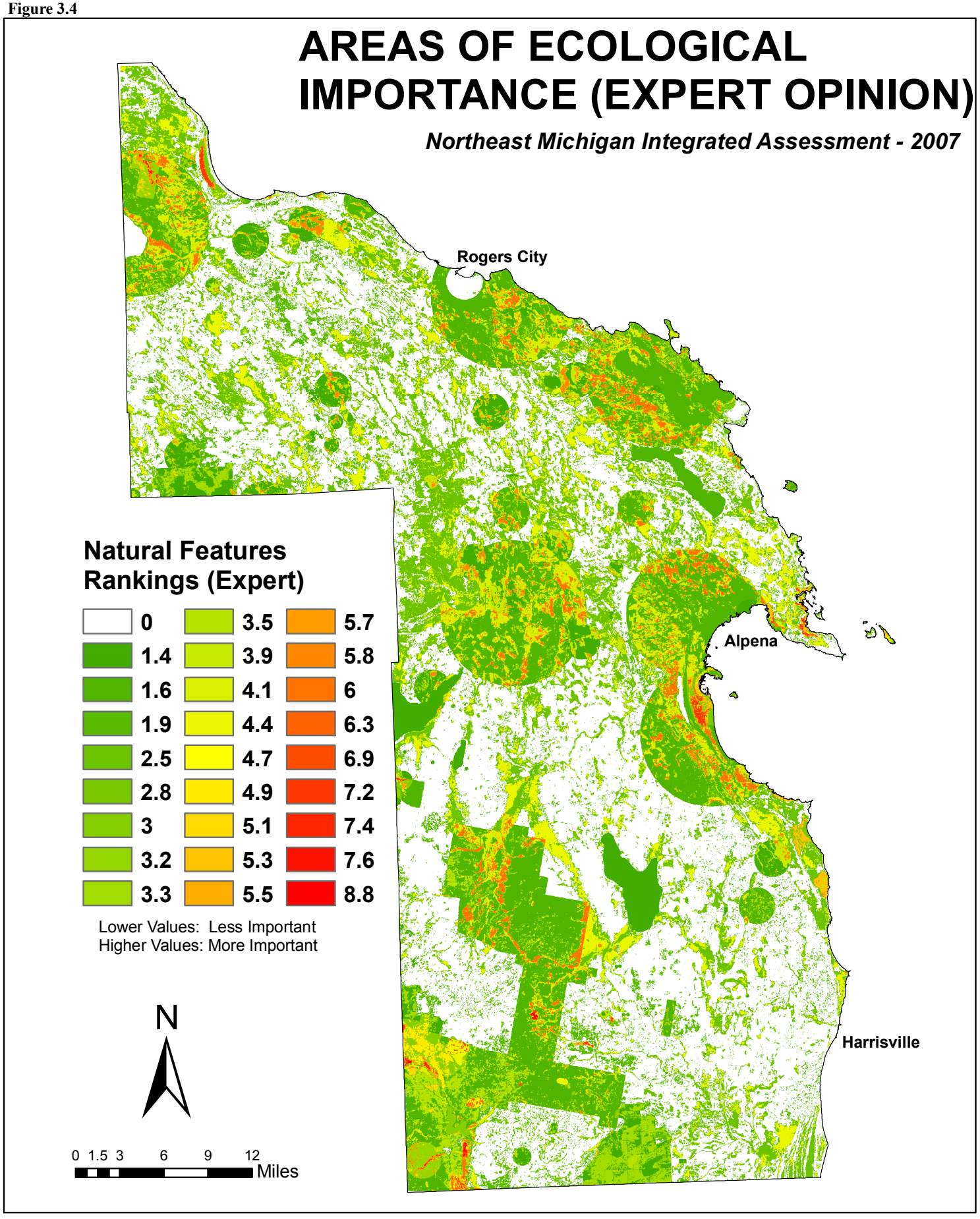

AREAS OF ECOLOGICAL IMPORTANCE (LOCAL OPINION)
Northeast Michigan Integrated Assessment - 2007
Rogers City
Alpena
Harrisville
Natural Features Rankings (Local)
0
1.6
1.7
1.8
1.9
2.4
2.6
3.3
3.5
3.6
3.7
4
4.1
4.2
4.3
4.5
5
5.2
5.4
5.7
5.9
6
6.1
6.2
6.7
6.9
7.6
7.8
8.6
Lower Value: Less Important
Higher Value: More Important
N
0 1.5 3 6 9 12
Miles

Figure 3.4


AREAS OF ECOLOGICAL IMPORTANCE (EXPERT OPINION)
Northeast Michigan Integrated Assessment - 2007
Rogers City
Alpena
Harrisville
Natural Features Rankings (Expert)
0
1.4
1.6
1.9
2.5
2.8
3
3.2
3.3
3.5
3.9
4.1
4.4
4.7
4.9
5.1
5.3
5.5
5.7
5.8
6
6.3
6.9
7.2
7.4
7.6
8.8
Lower Values: Less Important
Higher Values: More Important
N
0 1.5 3 6 9 12
Miles

ranked wetlands second (2 points), and 4 people voted wetlands as third priority (1 point). Appendix C, Figure 1 shows a flowchart explaining the details of development of Figures 3.4 and 3.5.

Table 3.1. Results of the Natural Features Opinion Survey.

Local Opinions	*"3 points"*	*"2 points"*	*"1 point"*	*Votes*	*"Total Points"*	*Weight=total points/votes*
Endangered Communities/Ecosystems	18	3	3	24	63	2.6
Wetlands	14	5	4	23	56	2.4
Large Forest Interiors	6	9	9	24	45	1.9
Endangered Animals	4	10	10	24	42	1.8
Pre-settlement Landcover	4	7	12	23	38	1.7
Endangered Plants	1	12	9	22	36	1.6
Expert Opinions						
Endangered Communities/Ecosystems	10	3	0	13	36	2.8
Wetlands	9	2	1	13	32	2.5
Pre-settlement Landcover	3	7	2	13	25	1.9
Large Forest Interiors	2	4	7	13	21	1.6
Endangered Plants	1	6	6	13	21	1.6
Endangered Animals	1	3	9	13	18	1.4

Note: The names of the some of the natural features used in the survey and listed in the Table 3.1 differ from those used in the rest of this document. Specifically, the terms Endangered Ecosystems, Endangered Animals, Endangered Plants, and Large Interior Forests, which were used in the survey, were changed to Rare Ecosystems, Rare Animals, Rare Plants, and Interior Forests, respectively, for this document. The changes were made to the first three terms to eliminate confusion surrounding the word endangered, which carries legal and regulatory connotations that we did not intend to invoke. We changed Large Forest Interiors to Interior Forests simply to shorten the heading.

These maps provide guidance on regional opinion and researcher opinions; however they do not represent the opinion of all residents of the region, regional decision makers or all ecologists. The maps illustrate the opinions of only the decision-makers in attendance at the NEMIA meeting where the survey was administered, and the ecologists surveyed at SNRE. The maps are designed to serve as conversation starters and to highlight the geographic areas that regional decision makers and ecologists agree need to be protected (Hansen, 2004; Balram, Dragicevic, & Meredith, 2004). Areas where these maps intersect are important to both experts and locals and should be prioritized for protection.

It should also be emphasized that these rankings are relative, not absolute. The final weights applied to each natural feature layer are based on the average rankings from the opinion survey. These maps display only the relative rankings among natural features as determined by the survey.

These maps are only meant to show how experts and regional decision makers compare a specific set of natural features to each other. They do not show how the decision-makers or ecologists would rank natural features against development. These maps do not display or provide insight into potential conflict over priority of use for the areas where these features are located.

To complement this set of maps, a more robust survey of local opinion regarding ecological features should be performed to identify the areas with strong public support for protection. This survey would explore the possibility that regional decision makers and residents have different views. The survey methodology could also be improved to better reflect residents' feelings about specific places and regions in the area, and include features not included in the original survey.

3.3.4 Geological Features

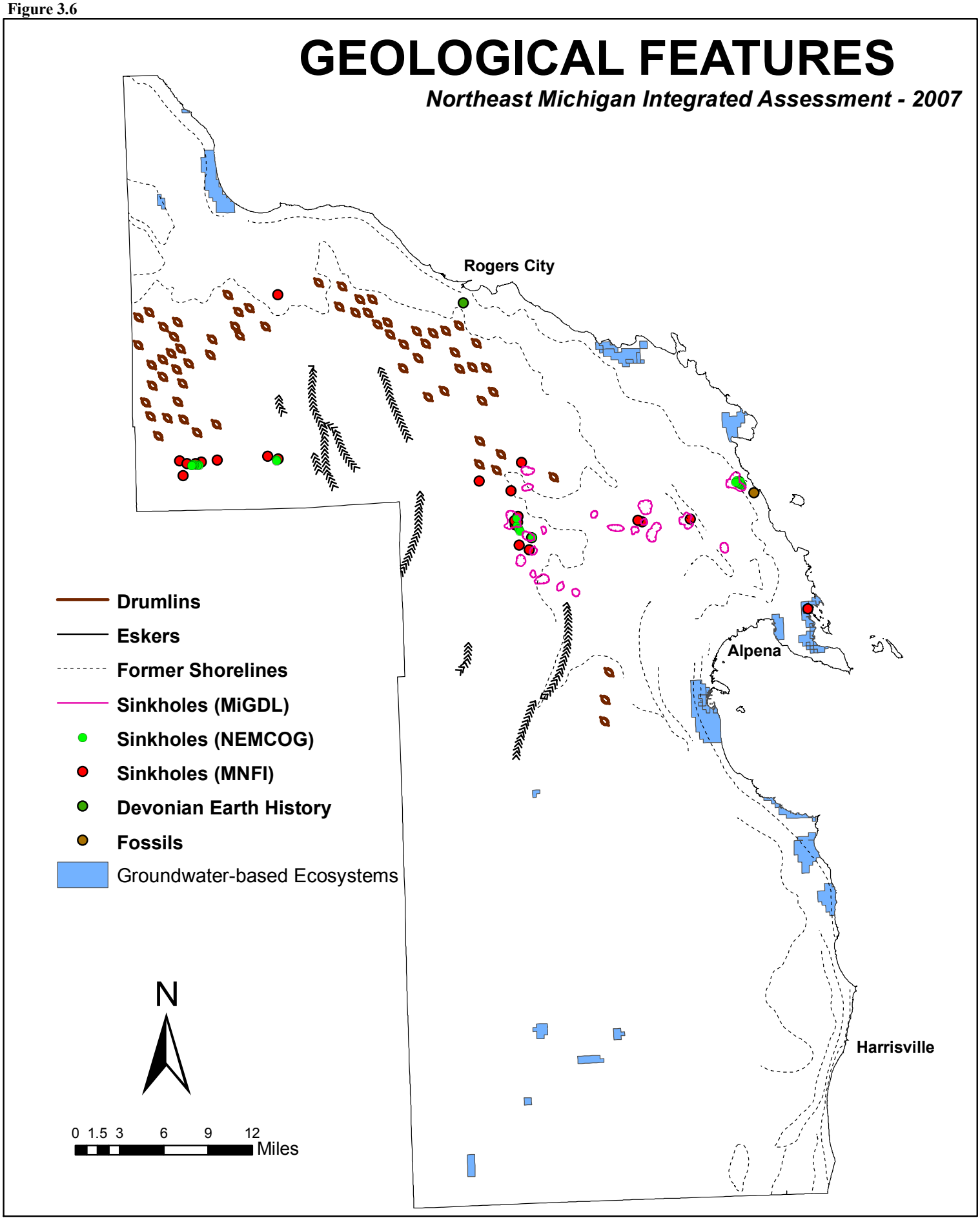
Figure 3.6 shows aboveground geological features in the NEMIA region. The region's karst topography has created unique geological features that remain untapped in terms of tourism potential. These features often possess unique historical, social, and ecological importance and should be preserved and considered for tourism development. We also included groundwater-dependent ecosystems because they are areas where geology and hydrology combine to create unique plant and animal communities.

The following features (sources in parentheses) were included in Figure 3.6:

- 1982 Quaternary Geology (MiGDL)
    - Drumlins – whale-shaped elongated hills formed by glacial action
    - Eskers – winding ridges formed from gravel and sand deposited in tunnels running through a glacier.
    - Former Shorelines – former Lake Huron shorelines
- Sinkholes (NEMCOG) – depressions or holes in the land surface resulting from the gradual removal of soluble bedrock (such as limestone) by water
- Geological Features (MNFI)
    - Sinkholes – depressions or holes in the land surface resulting from the gradual removal of soluble bedrock (such as limestone) by water
    - Devonian earth history – artifacts from the Devonian Period
    - Fossils – preserved remains of animals, plants, and other organisms
- Groundwater-dependent Ecosystems (MNFI) - land (divided into 1000m x 1000m sections) that is considered one of the 28 "groundwater dependent" natural community types as mapped by the Michigan Natural Features Inventory.

There is a lack of agreement regarding locations of sinkholes, as shown by three different sources of sinkhole data. While multiple layers agree on the location of some features, all layers show at least one sinkhole that is not shown in the other two layers, and this inconsistency should be rectified in future geological surveys. Also missing from this map are layers representing subterranean geological features.

Figure 3.6


GEOLOGICAL FEATURES
Northeast Michigan Integrated Assessment - 2007
Rogers City
Alpena
Harrisville
Drumlins
Eskers
Former Shorelines
Sinkholes (MiGDL)
Sinkholes (NEMCOG)
Sinkholes (MNFI)
Devonian Earth History
Fossils
Groundwater-based Ecosystems
N
0 1.5 3 6 9 12
Miles

3.3.5 Rivers

Figure 3.7 shows the rivers in the study area that have been most impacted by human activity and those that remain relatively free of human-induced changes. This map depicts mile-long river reaches that are affected by dams, reaches that are listed as impaired (polluted) waters under Section 303(d) of the *Clean Water Act*, and reaches affected by both dams and pollution.

The following features (sources in parentheses) were included in Figure 3.7:

- Rivers (IFR) – Lake Huron tributaries
- Road Crossings (IFR) – where roads intersect with hydrology features. (Road crossings were included to indicate locations where flow modification or road run-off may pose a threat to water quality and clarity. Road crossings that do not appear to be located on a river indicate roads that pass over streams too small for this display. These crossings have been left in the display since their impact remains, even though the impacted stream is not shown.)
- Reaches with Dams (IFR)– mile-long reaches of rivers containing dams
- Polluted Reaches with Dams (IFR) – mile-long reaches of rivers containing areas listed in section 303d of the Clean Water Act and a dam
- Polluted Reaches (IFR) – mile-long reaches of rivers containing areas listed in section 303d of the Clean Water Act

The map displays mile-long river reaches containing dams because showing all individual dams at this scale is not possible. We also chose to exclude small streams (the smallest class of water bodies from the source data layer) because they are so numerous that they would have nearly filled the map and because most of the dams in the region are located on larger streams and rivers. Additional information about the size and influence of the dams and their impact on the hydrologic regime of rivers and aquatic species would allow us to refine this map. Lakes were excluded from the map because data on pollution or regime modifications for lakes could not be found in a GIS format. Further information on pollution that is not listed in Section 303(d) of the *Clean Water Act* such as dioxins and solid waste would improve the utility of this map, as would developing quantitative data about the impact of road crossings on rivers.

3.3.6 Potential Ecotourism Sites

Figure 3.8 shows the natural areas or features in the study area with potential to be successful ecotourism sites due to their uniqueness, natural beauty, accessibility, and location proximate to protected land.

We considered the following features (sources in parentheses) as potential ecotourism attractions:

- 1982 Quaternary Geology (MiGDL)
    - Drumlins – whale-shaped elongated hills formed by glacial action
    - Eskers – winding ridges formed from gravel and sand deposited in tunnels running through a glacier.

Figure 3.7

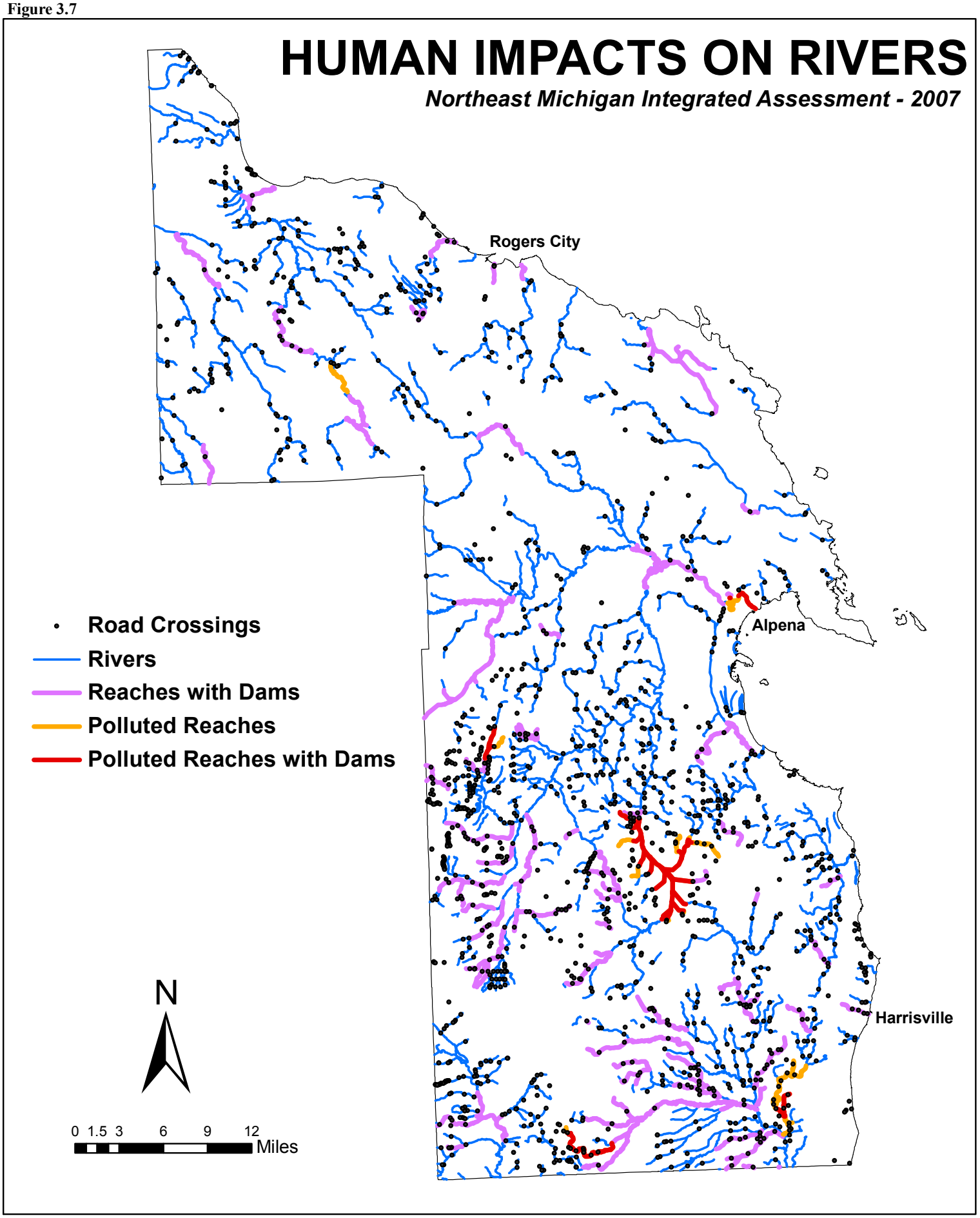
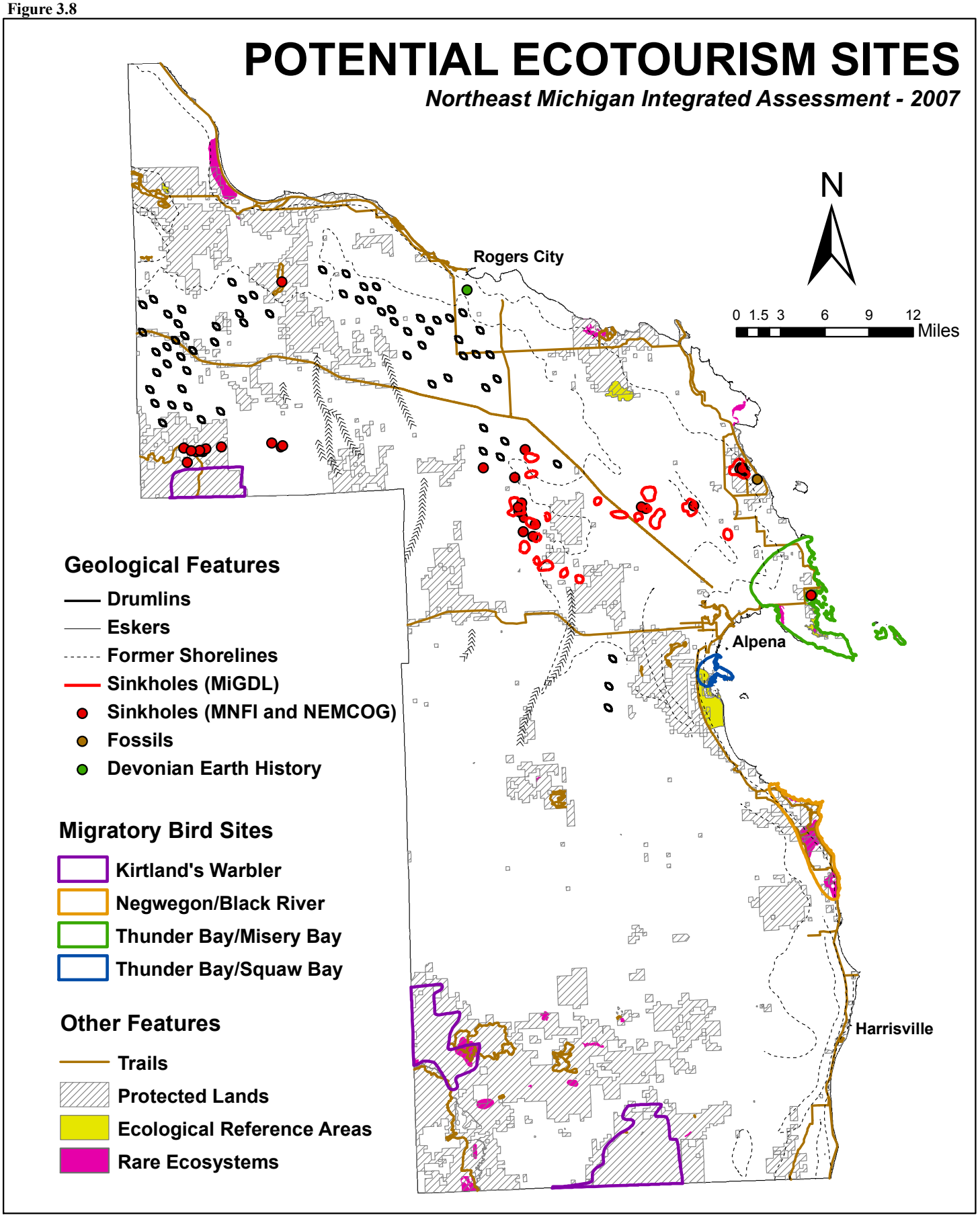

HUMAN IMPACTS ON RIVERS
Northeast Michigan Integrated Assessment - 2007
Rogers City
Alpena
Harrisville
Road Crossings
Rivers
Reaches with Dams
Polluted Reaches
Polluted Reaches with Dams
N
0 1.5 3 6 9 12
Miles

Figure 3.8


POTENTIAL ECOTOURISM SITES
Northeast Michigan Integrated Assessment - 2007
N
0 1.5 3 6 9 12
Miles
Rogers City
Alpena
Harrisville
Geological Features
Drumlins
Eskers
Former Shorelines
Sinkholes (MiGDL)
Sinkholes (MNFI and NEMCOG)
Fossils
Devonian Earth History
Migratory Bird Sites
Kirtland's Warbler
Negwegon/Black River
Thunder Bay/Misery Bay
Thunder Bay/Squaw Bay
Other Features
Trails
Protected Lands
Ecological Reference Areas
Rare Ecosystems

    - Former Shorelines – former Lake Huron shorelines
- Sinkholes (MiGDL, NEMCOG, MNFI) – depressions or holes in the land surface resulting from the gradual removal of soluble bedrock (such as limestone) by water
- Fossils (MNFI) – preserved remains of animals, plants, and other organisms
- Devonian earth history (MNFI) – artifacts from the Devonian Period
- Areas of importance for birds (TNC) – polygons indicating areas of importance to migratory birds in Michigan (for breeding, migration, or overwintering)
- Ecological Reference Areas (MNFI) – The areas that the Michigan DNR has labeled as "ecological reference areas" are considered to be ideal examples of how a particular ecosystem should function. When performing restoration work, or trying to distinguish between similar ecosystems, these designated ecosystems are used as reference to a system's integrity and function. Although sites in the region have been selected, the formal approval process had not been completed, and the official status of these areas is currently unknown to the ecological assessment team.
- Rare Ecosystems (MNFI)– the area where an ecosystem with a Global Conservation State Rank of G1 (critically imperiled), G2 (imperiled), or G3 (vulnerable) was reported (the size of the area shown relates to the certainty of the reported sighting)

Potential for expansion of ecotourism opportunities may be highest on land adjacent to areas that are already protected and/or support ecotourism activities. Protected lands increase the ecotourism potential of the privately owned land adjacent to them by providing a variety of opportunities for hiking, hunting, camping, and other outdoor activities. By identifying these ecologically important areas as economically valuable, private landowners seeking economic benefit from their land will have an alternative to development or extractive uses. If private landowners can derive economic benefit from their land through ecotourism, the larger community will benefit: the landowners will earn money, the land will be preserved, and tourists will benefit from enjoying the natural resources the land has to offer. It should be noted that that offering tourist activities on a property does not in itself equate to protection of the natural resources within, although such goals can be compatible.

3.3.7 Migratory Bird Stopover Sites

Using methodology developed by The Nature Conservancy (TNC) to model stopover sites for priority species of migratory birds in the western Lake Erie basin (Ewert et al., 2006) the ecological assessment team developed a model for predicting migratory bird stopover sites in the NEMIA region. Figures 3.9-3.12 are a series of maps identifying potential migratory bird "hot spots" that should be considered for land preservation efforts or ecotourism development. These maps are a prediction of potential bird presence during migration based on landscape attributes (landcover and patch size). The model was composed of three parts: landbird and raptor habitat (Figure 3.10), shorebird habitat (Figure 3.11), and waterfowl habitat (Figure 3.12). Each cell is scored on a scale of 0 through 5 for in terms of its potential as habitat, with 0 being non-habitat and 5 being most important stopover habitat for that avian group. Those areas that score higher are more likely to be stopover sites for migratory birds because their landscape attributes more closely match the habitat needs of the group(s) of birds in question. (See Appendix D for details on development of Figures 3.9-12).

Figure 3.9

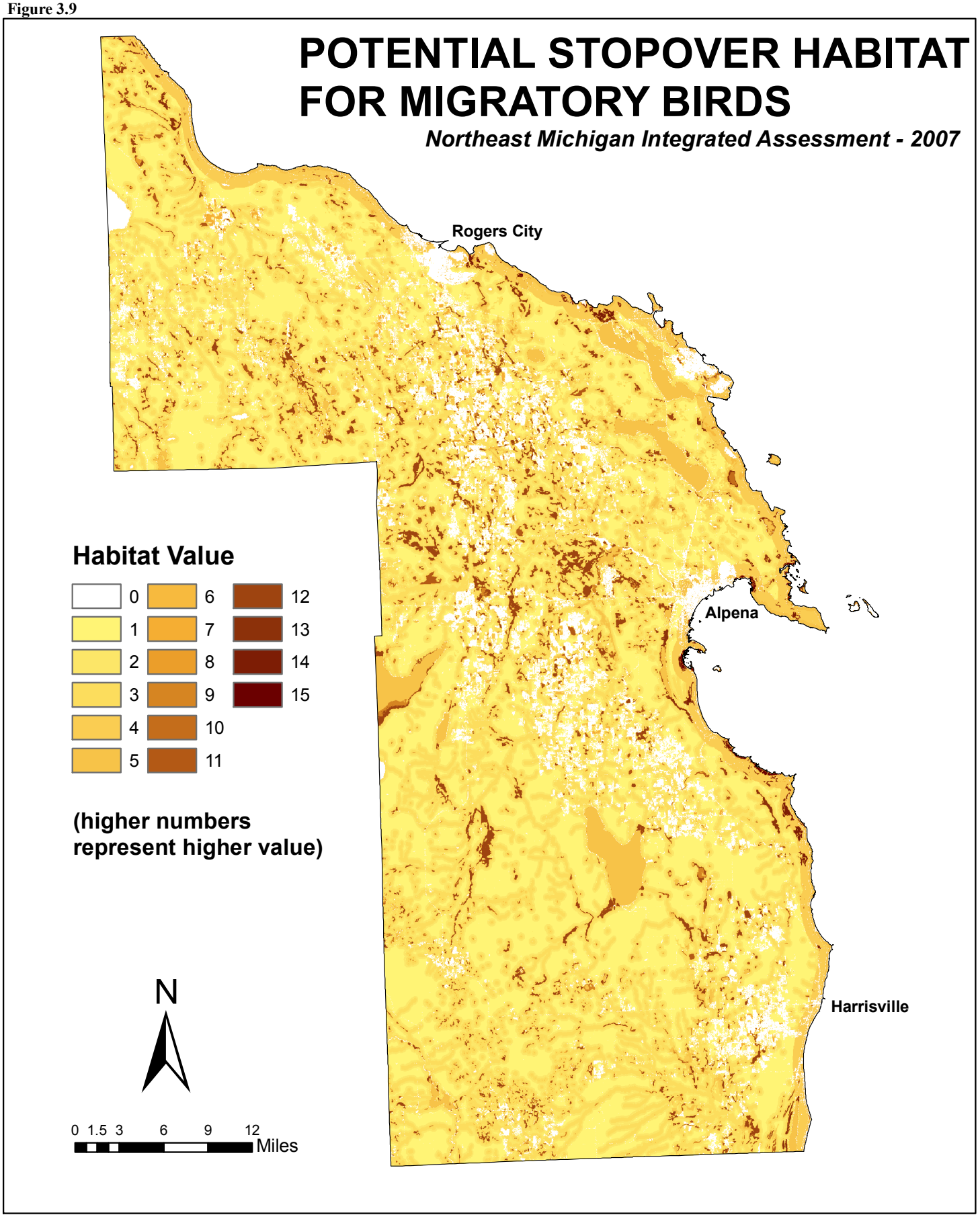

POTENTIAL STOPOVER HABITAT FOR MIGRATORY BIRDS
Northeast Michigan Integrated Assessment - 2007
Rogers City
Alpena
Harrisville
Habitat Value
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
(higher numbers represent higher value)
N
0 1.5 3 6 9 12
Miles

Figure 3.10

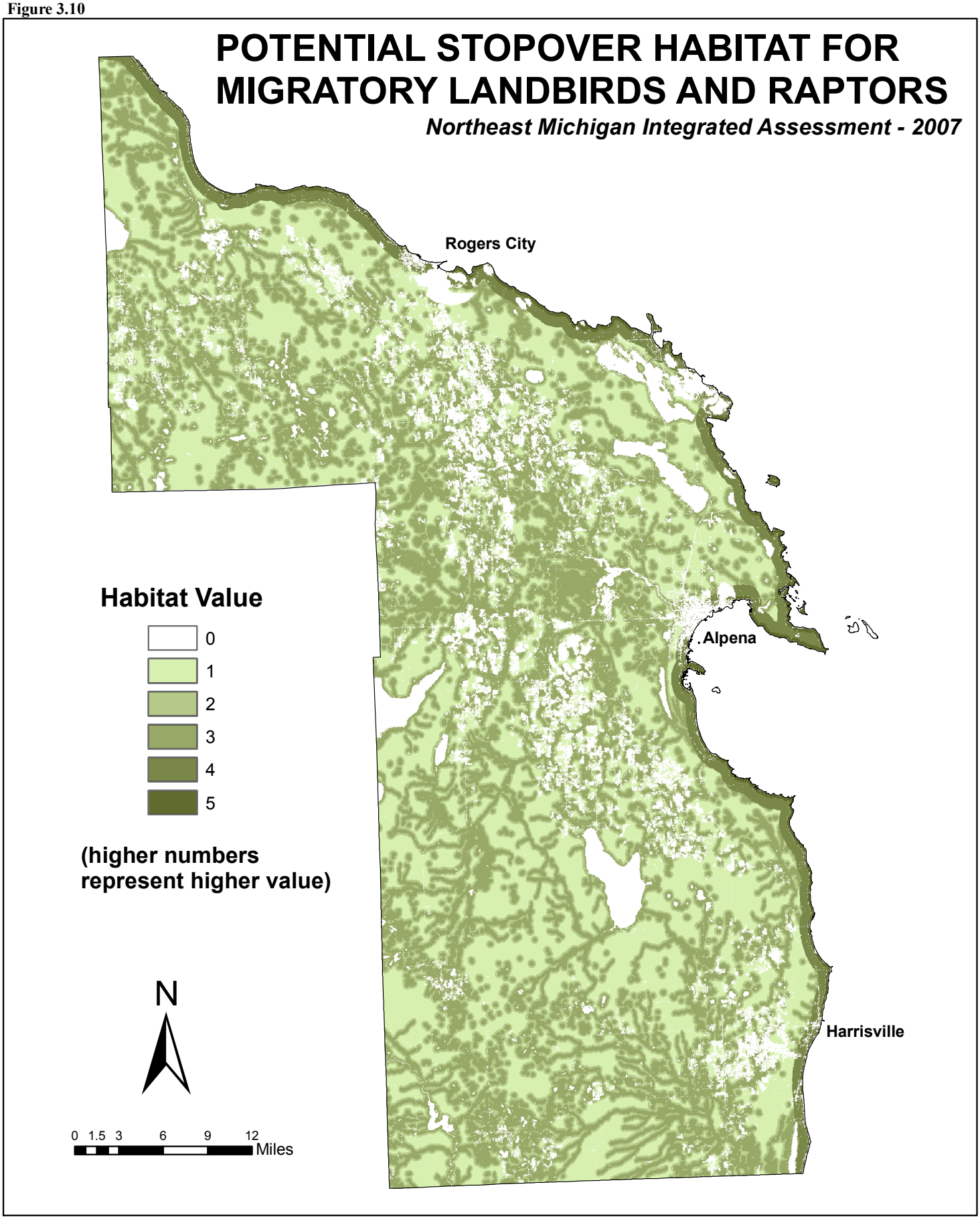

POTENTIAL STOPOVER HABITAT FOR MIGRATORY LANDBIRDS AND RAPTORS
Northeast Michigan Integrated Assessment - 2007
Rogers City
Alpena
Harrisville
Habitat Value
0
1
2
3
4
5
(higher numbers represent higher value)
N
0 1.5 3 6 9 12
Miles

Figure 3.11

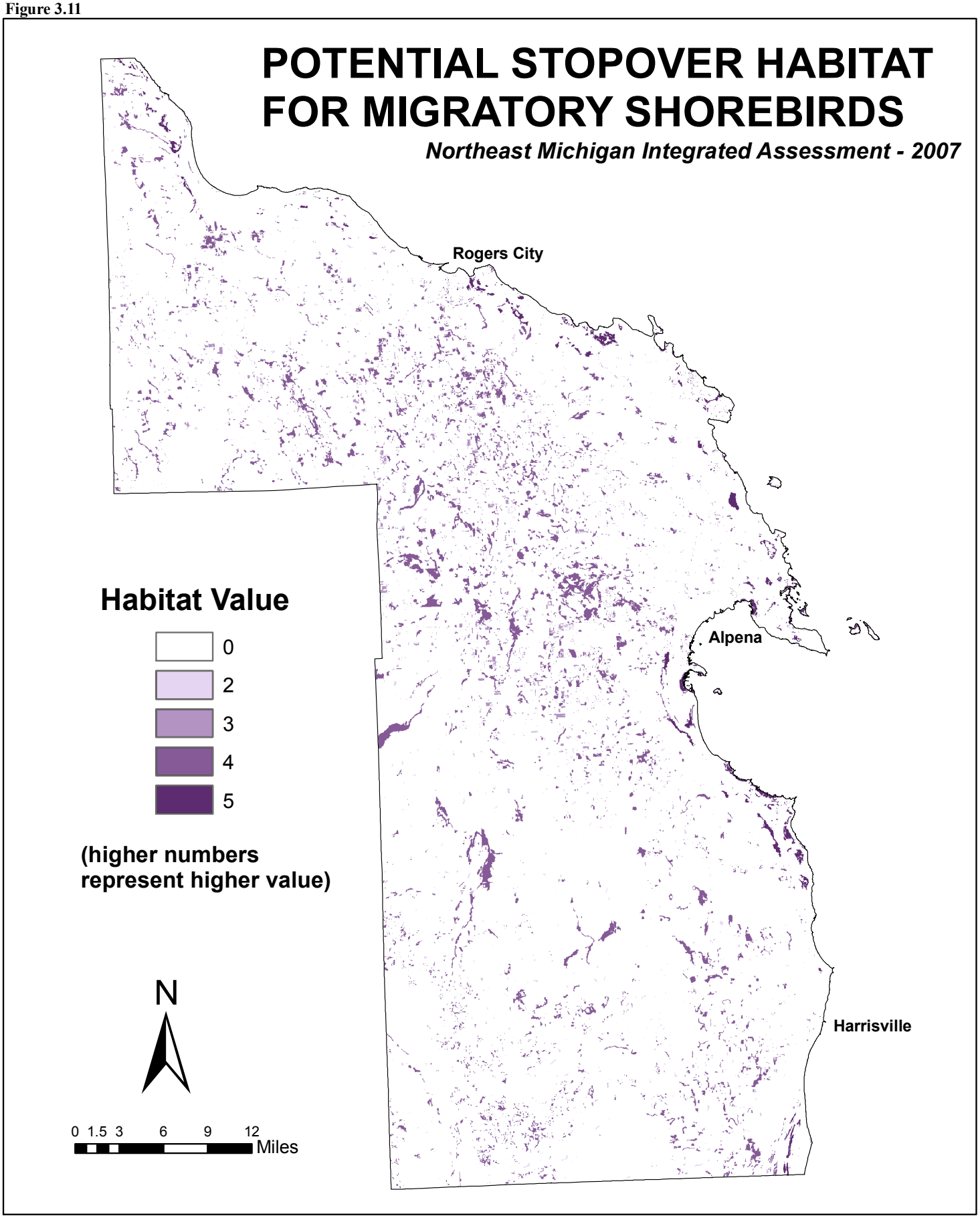
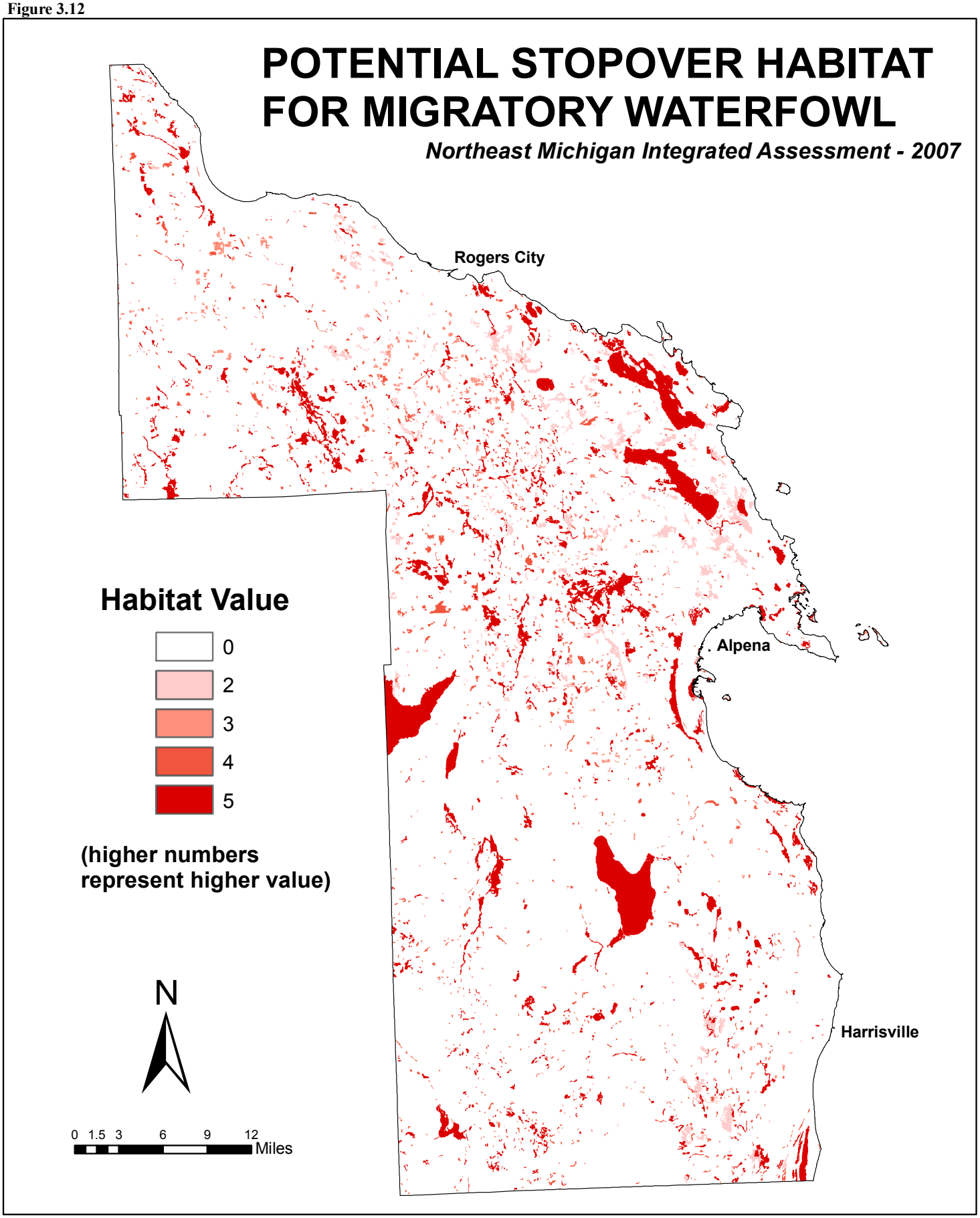

POTENTIAL STOPOVER HABITAT FOR MIGRATORY SHOREBIRDS
Northeast Michigan Integrated Assessment - 2007
Rogers City
Alpena
Harrisville
Habitat Value
0
2
3
4
5
(higher numbers represent higher value)
N
0 1.5 3 6 9 12
Miles

Figure 3.12


POTENTIAL STOPOVER HABITAT FOR MIGRATORY WATERFOWL
Northeast Michigan Integrated Assessment - 2007
Rogers City
Alpena
Harrisville
Habitat Value
0
2
3
4
5
(higher numbers represent higher value)
N
0 1.5 3 6 9 12
Miles

Although the model was developed for the western Lake Erie basin, most of the priority species of concern in the original model were also found in the study area, therefore it is assumed the model is also applicable in Northeast Michigan. The map does not model the stopover habitat needs for every species of migratory bird, only the needs of species that TNC considered "priority" migratory bird species in the Western Lake Erie region. There are other important species in Northeast Michigan, such as the endangered Kirtland Warbler, that are not present in Western Lake Erie region, and were not part of this model. Additionally, these maps do not show the actual distribution of migratory birds when they stop in the region, and no groundtruthing has been done to verify the model's accuracy. The maps also do not show whether birds will prefer one habitat patch to another or how often patches are utilized, it only shows which areas are more likely to be utilized than others.

3.4 CONCLUSION

As part of the NEMIA process, we gathered existing GIS data relating to the natural and built environment in Alcona, Alpena, and Presque Isle counties. Performing this task entailed contacting a variety of sources in local, state, and federal agencies to gather the necessary information. As information was collected, themes in the data were identified, and maps were created to illustrate these themes. Additionally, a poster was produced for the working group meeting in January, 2007. This poster (Appendix E) was developed using locations with similarly high scores from the two opinion maps, and the previously mentioned layers from the natural features map (Figure 3.2). The poster highlights the regional areas of interest and displays the natural features as well as human land uses and infrastructure to illustrate the layout of the region (Ceccato, 2000).

This ecological inventory is intended to inform policy making in the NEMIA region by providing data layers and maps that display some of the many ecological factors that need to be incorporated into regional decision-making processes. However, lack of data in GIS format, and lack of time and funds limited this effort. Despite these limitations, decision makers will benefit from using these products as a starting point for a comprehensive ecotourism and green infrastructure planning effort. Future work should focus on the following:

Gathering information that could more completely inform current status of ecological features and begin to identify regional trends by incorporating data and information on the following themes if/when it becomes available, in order of priority:

- Land use at the parcel scale - a visual representation of how land is currently used in the region (including categories such as urban, agriculture, industrial, natural resource extraction, parks, brownfields, etc) would provide at minimum a coarse snapshot of where incompatible land uses may threaten natural resources, and where natural resources may be relatively cushioned from human impacts.
- Gather and/or create data GIS format data on the following features: Lake Huron access points, including boat launches and beaches; inland lakes; aquatic features of Lake Huron; subterranean geological features; game species habitats, ranges, and populations; and migratory species patterns, ranges, and season of use;

- Threats to ecological important areas and natural features - threats such as invasive species, incompatible land use, and pollution (such as dioxins, solid waste, or endocrine disruptors that are not included in Section 303d of the *Clean Water Act*) must be addressed to maintain and improve the integrity of these areas for conservation and tourism.

The development of these maps gives decision makers access to a well-rounded visual representation of the natural features in the region. Decision makers will benefit from using these products as a starting point for a comprehensive ecotourism and green infrastructure planning effort. Additionally, this ecological inventory will be incorporated into the final NEMIA document so as to ensure that regional decision makers can access this information in concert with a more complete knowledge of the region's economy, cultural resources, and planning and zoning practices.

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APPENDIX A. ECOLOGICAL ASSESSMENT SPATIAL DATA INVENTORY.

We consulted multiple sources to obtain the spatial data that we used to develop the information products in this assessment. Tables 1 and 2 list all spatial data layers that we obtained from outside sources or created ourselves (using data we obtained from outside sources) throughout the ecological assessment process. Data that we obtained from an outside source we refer to as "source layers" while data that we created using one or more source layers are called "derived layers." In addition to the name of each layer (as designated by the ecological assessment team, not the organization from which we obtained it) the table includes a description of what features it represents, the methods used to create it (for derived layers), or the organization from which we obtained it (for source layers) and the date we obtained or created it. Some layers listed are not actually displayed in any of the maps we have created, but were created as intermediate steps in developing one or more of the final maps.

It should be noted that the organization from which we obtained a layer is not necessarily the organization that created the dataset. Also, the date we obtained the dataset does not reflect the date the dataset was created. Finally, all layers except those obtained from the Michigan Geographic Framework (which are already produced at the county level) were clipped to limit their extent to the three county study area.

Table 1. Source Layers.

Name*	What the layer represents	Source (more details)	Date Obtained
303(d) Impaired Water	river segments, lakes, and estuaries designated under section 303(d) of the Clean Water Act	IFR ("LHB_rad303d_area_EPA," "LHB_rad303d_line_EPA," and "LHB_rad303d_point_EPA")	Jul-06
Coastal Change Analysis Program Landcover (CCAP 2000)	land cover	IFR (derived from USGS National Land Cover Dataset)	Jul-06
Dams	Contains information on all known dams in the Lake Huron basin. Includes location information, physical dimensions of the dam, hydraulic information on the dam, as well as information on the regulatory status of the dam.	IFR ("LHB_dams_IFR")	Jul-06
DNR Land Ownership	MDNR Land and Mineral Rights information is derived weekly from the MDNR's Land Ownership Database. Parcel information is compiled to the quarter-quarter section level. Multiple parcels with varying types of rights within a quarter-quarter section result in a Mixed Ownership category. Mineral and Surface = DNR owns both mineral and surface rights on parcel(s) within the quarter-quarter section. Minerals = DNR owns only mineral rights on parcel(s)within the quarter-quarter section. Surface = DNR owns only surface rights on parcel(s) within the quarter-quarter section. Mixed Ownership = DNR has some combination of mineral and surface rights on parcels within the quarter-quarter section. Other Rights = DNR has an easement, right of way, and/or other non-ownership rights only on parcel(s) within the quarter-quarter section. Reserved Minerals = DNR owns the surface rights on parcel(s) within the quarter-quarter section. Mineral rights are held by private party for a specified period of time. Mineral rights are scheduled to revert to the MDNR when reservation period expires.	MiGDL ("Michigan DNR Land and Mineral Ownership")	Jun-06

Ecological Reference Areas	areas that serve as models of ecological reference within the State of Michigan. They are high quality examples of functioning ecosystems that are primarily influenced by natural ecological processes, and they may be located upon any land ownership in the State. This layer includes an initial set of ERAs in the NEMIA region. They were selected because they meet the initial base requirements for ERA selection: they are known high quality sites in the Michigan Natural Features Inventory (MNFI) natural community classification system with an Element Occurrence (EO) rank of A or B and Global (G) or State (S) element ranking of endangered (1), threatened (2), or rare (3).	MNFI Biological and Conservation Database	Sep-06
Geological Features	points representing sinkholes, fossils, and Devonian earth history	MNFI Biological and Conservation Database (extracted only those points representing karst topography: sinkholes, fossils, and Devonian earth history)	May-06
Groundwater-dependent Ecosystems	1000m x 1000m grid representation of the groundwater-dependent natural communities as mapped by the Michigan Natural Features Inventory (MNFI). In the MNFI Biological and Conservation Database, 28 of 74 natural community types included are considered "groundwater dependent." This sensitive database was intersected with the MDNRs quarter/quarter section polygon file to mask the exact location of the natural features. Out of the MNFI Biotics database only Palustrine and Palustrine/Terrestrial community types were used for this file. Submergent marsh, emergent marsh, Great Lakes marsh, northern wet meadow, southern wet meadow, inland salt marsh, intermittent wetland, coastal plain marsh, interdunal wetland, lakeplain wet prairie, lakeplain wet-mesic prairie, northern wet-mesic praire, wet prairie, wet-mesic prairie, prairie fen, northern fen, patterned fen, poor fen, rich conifer swamp, relict confier swamp, hardwood-conifer swamp, northern swamp, southern swamp, southern floodplain forest, northern shrub thicket, southern shrub-carr, inundated shrub swamp, and wooded dune and swale complex. It should be noted that there are numerous other groundwater dependent natural resources throughout Michigan that are not shown on this map because they have not yet been surveyed by the MNFI (e.g. most persistent lakes, streams and wetlands are probably groundwater dependent).	MNFI Biological and Conservation Database	May-06
Highways	US 23, and State Routes 32 and 65	MiGDL ("Michigan Geographic Framework")	May-06
IFMAP	Land cover data for the Southern Lower Peninsula of Michigan derived from classification of Landsat Thematic Mapper (TM) imagery (2001)	MiGDL	May-06
Inland Lakes	Inland water bodies	IFR ("LHB_inland_lakes")	Jul-06
Interior Forests	Interior forest areas are determined by the USGS based on the dominant land cover for a region on a 1000 meter by 1000 meter grid. To be considered an “interior” forest, a forest grid must be fully surrounded by other cells that qualify as either interior or edge forests.	USGS	Jun-06
Lake Huron	Lake Huron	IFR	Jul-06
Land Cover Change Map	classifies changes in ca. 1800 land cover and 2001 IFMAP land cover	TNC	Jun-06
Protected Lands	land that is currently mostly undeveloped, including state, county, and city parks, state and national forests, nature preserves, and golf courses.	Ducks Unlimited	Jun-06
Quaternary Geology	Drumlins, Eskers, Striations/Grooves, Shorelines, Sinkholes	MiGDL ("Michigan Quaternary Geology")	Jul-06
Railroads	is intended to show all railroads, both active and inactive, but appears to only show the Detroit and Mackinaw railways	MiGDL ("Michigan Geographic Framework")	May-06

Rivers	all Lake Huron tributaries	IFR ("LHB_NHD_routes_USGS")	Jul-06
Road Crossings	where MIRIS roads intersect MIRIS hydrology features	IFR ("LHB_roadcrossings_MIRIS")	Jul-06
Roads	all roads, including MDOT National Functional Classification (NFC) codes: 1-Rural Interstate (principal arterial), 2-Rural Other Prinicipal Arterial (non-freeway), 5-Rural Other Freeway (principal arterial), 6-Rural Minor Arterial, 7-Rural Major Collector, 8-Rural Minor Collector, 9-Rural Local, 11-Urban Interstate (principal arterial), 12-Urban Other Freeway (principal arterial), 14-Urban Other Principal Arterial (non-freeway), 16-Urban Minor Arterial, 17-Urban Collector, 19-Urban local, 0 or uncoded-not a certified public road; including ownership codes: 1-State Trunkline, 2-County Primary, 3-County Local, 4-City Major, 5-CIty Minor, 9-Not an Act-51 Certified Public Road	MiGDL ("Michigan Geographic Framework")	May-06
Sinkholes	sinkholes	NEMCOG	Oct-06
Soil Moisture Index (SMI)	Relative moisture levels in soil. Class 1 (very wet), class 2 (wet), class 3 (intermediate), class 4 (dry), and class 5 (very dry)	Ducks Unlimited	Aug-06
State Parks	parks in the Michigan DNR's state parks system	Michigan DNR	May-06
Three County Outline	the NEMIA study area	MiGDL ("Michigan Geographic Framework")	May-06
TNC Migratory Bird Sites	polygons indicating areas of importance to migratory birds in Michigan (for breeding, migration, or overwintering)	The Nature Conservancy	Sep-06
Trails	non-motorized trails in the NEMIA region, including trails for hiking, biking, skiing, horsebacking. The trail segments were gathered by various means - GPS and digitizing. Information about the surface type, use type, and maintenance is contained in the attributes.This layer depicts trails that are actually on the ground as well the Huron Greenways which is a designated route consisting of existing trails and roads.	NEMCOG	Oct-06
US-23	US Highway 23	MiGDL ("Michigan Geographic Framework")	May-06
Utilities	power transmission lines and pipelines	MiGDL ("Michigan Geographic Framework")	May-06

Note: All layers that covered an extent larger than the study area were clipped to limit their extent to Alcona, Alpena, and Presque Isle Counties

**as designated by the Ecological Assessment Team, not the source agency*
***MNFI data is updated on a yearly basis. MNFI data does not cover most private lands.*
****MiGDL website: http://www.mcgi.state.mi.us/mgdl/*

Table 2. Derived Layers (all layers created May 2006)

Name	What the layer represents	Methods	Source/Input layers
Agricultural Hydric Soils	all cultivated land classes that were also either wet or very wet soil	clip "Agricultural Lands" with "Hydric Soils" to extract areas that were both cultivated and wet or very wet	Agricultural Land, Hydric Soil
Agricultural Lands	cultivated land	extract cultivated lands	CCAP 2000
Agriculture	areas of high concentrations of agricultural land	extract all features in the following classes: Non-vegetated Farmland, Row Crops, Forage Crops/Non-tilled Herbaceous, Orchards/vineyards/Nursery, draw polygons around areas of high concentration of these features (estimate by eye)	IFMAP
Coastal Corridor	land within 5 miles of the Lake Huron shoreline	extract all land within 5 miles of Lake Huron	Lake Huron
Emergent Wetland Complexes	emergent and scrub shrub wetlands that are within .25 km of another emergent or scrub shrub wetland	buffer by .125km (created so that if the buffer of a wetland overlay with the buffer of another wetland, they are within .25km of each other), use 'identify overlapping polygons' script to select emergent wetlands that were within .25km of each other, reclassify selected wetlands as "emergent wetlands complexes"	Emergent Wetlands
Emergent Wetlands	emergent and scrub shrub wetlands	extract emergent and scrub-shrub wetlands	Wetlands
Forestry	areas of high concentrations of forested land	extract all features in forest classes (14-22, 24-26), draw polygons around areas of high concentration of these features (estimate by eye)	IFMAP
Hydric Soils	wet and very wet soils	extract very wet (class 1) and wet (class 2) soils	Soil Moisture Index
Natural Features Rankings (Expert Opinion)	a visual summary of the results of the NEMIA Natural Features Opinion Survey (Expert Opinion). It displays how experts ranked natural features against each other in terms of ecological importance in the NEMIA region	weight each of the layers included in "Natural Features," using the survey results listed in Table 3.1	Natural Features
Natural Features Rankings (Local Opinion)	a visual summary of the results of the NEMIA Natural Features Opinion Survey (Local Opinion). It displays how members of the NEMIA work group ranked natural features against each other in terms of ecological importance in the NEMIA region	weight each of the layers included in "Natural Features," using the survey results listed in Table 3.1	Natural Features
Polluted Reaches	reaches of rivers located within 1/2 mile (as the crow flies) of areas listed in section 303(d) of the Clean Water Act	extract reaches of rivers located within .5mi of 303(d) impaired water bodies	Rivers, 303(d) Impaired Water
Polluted Reaches with Dams	reaches of rivers located within .5mi (as the crow flies) of areas listed in section 303(d) of the Clean Water Act and within .5mi (as the crow flies) of a dam	extract reaches of rivers located within .5mi of 303(d) impaired water bodies" and within .5mi of a dam	Rivers, Dams, 303(d) Impaired Waters

Potential Migratory Bird Stopover Habitat	potential stopover habitat for migratory waterfowl, shorebirds, landbirds, and raptors	use raster calculator to sum the values of analagous pixels in each of the input layers	Potential Migratory Landbird/Raptor Stopover Habitat, Potential Migratory Shorebird Stopover Habitat, Potential Migratory Waterfowl Stopover Habitat
Potential Migratory Landbird/Raptor Stopover Habitat	potential stopover habitat for migratory landbirds and raptors	adopt attributes 1-6 from TNC model for landbirds/raptors (see Appendix 3.4 for details)	Ewert et al (2006) model for Lake Erie
Potential Migratory Shorebird Stopover Habitat	potential stopover habitat for migratory shorebirds	adopt attributes 1-6 from TNC model for shorebirds (see Appendix 3.4 for details)	Ewert et al (2006) model for Lake Erie
Potential Migratory Waterfowl Stopover Habitat	potential stopover habitat for migratory waterfowl	adopt attributes 1-3, 5-8 from TNC model for waterfowl (see Appendix 3.4 for details)	Ewert et al (2006) model for Lake Erie
Pre-settlement Landcover	Pre-settlement land cover areas are defined as having maintained their ecological character even though they may have been lumbered, farmed, burned over, or otherwise altered by humans before the development of this layer. The value of such sites is that an ecological continuity exists: these areas may serve as a species refuge and help to maintain the mosaic of land cover types and habitats necessary in an ecologically healthy region.	extract all categories of unchanged land cover	Land Cover Change Map
Rare Animals	The area where an animal species with a Global Imperilment Rank of G1 (critically imperiled - 5 or fewer occurrences range-wide or very few remaining individuals or acres), G2 (imperiled globally - 6 to 20 occurrences or few remaining individuals or acres) or because of some factor(s) making it very vulnerable to extinction throughout its range), or G3 (vulnerable - either very rare and local throughout its range or found locally (even abundantly at some of its locations) in a restricted range (e.g. a single western state, a physiographic region in the East) or because of other factor(s) making it vulnerable to extinction throughout its range; in terms of occurrences, in the range of 21 to 100) was reported. The size of the area shown relates to the certainty of the reported sighting.	select animals with GRANK of G1, G2, and G3	MNFI Biological and Conservation Database
Rare Ecosystems	The area where an ecosystem with a Global Imperilment Rank of G1 (critically imperiled - 5 or fewer occurrences range-wide or very few remaining individuals or acres), G2 (imperiled globally - 6 to 20 occurrences or few remaining individuals or acres, or because of some factor(s) making it very vulnerable to extinction throughout its range), or G3 (vulnerable - either very rare and local throughout its range or found locally (even abundantly at some of its locations) in a restricted range (e.g. a single western state, a physiographic region in the East) or because of other factor(s) making it vulnerable to extinction throughout its range; in terms of occurrences, in the range of 21 to 100) was reported. The size of the area shown relates to the certainty of the reported sighting.	select ecosystem types with GRANK of G1, G2, and G3	MNFI Biological and Conservation Database

Rare Plants	The area where a plant species with a Global Imperilment Rank of G1 (critically imperiled - 5 or fewer occurrences range-wide or very few remaining individuals or acres), G2 (imperiled globally - 6 to 20 occurrences or few remaining individuals or acres) or because of some factor(s) making it very vulnerable to extinction throughout its range), or G3 (vulnerable - either very rare and local throughout its range or found locally (even abundantly at some of its locations) in a restricted range (e.g. a single western state, a physiographic region in the East) or because of other factor(s) making it vulnerable to extinction throughout its range; in terms of occurrences, in the range of 21 to 100) was reported. The size of the area shown relates to the certainty of the reported sighting.	select plants with GRANK of G1, G2, and G3	MNFI Biological and Conservation Database
Reaches with Dams	reaches of rivers located within 1/2 mile (as the crow flies) of a dam	extract reaches of rivers located within .5mi of a dam	Rivers, Dams
Sensitive Natural Resources	areas of high concentrations of natural features	draw polygons around areas of high concentrations of natural features (estimate by eye)	Natural Features
Undeveloped Lands	grassland, forests, scrub/shrub, wetlands, and unconsolidated shore	extract grassland, forests, scrub/shrub, wetlands, and unconsolidated shore	CCAP 2000
Unweighted Overlay	areas where multiple natural features (Endangered Ecosystems, Endangered Plants, Endangered Animals, Groundwater dependent Ecosystems, Protected Lands, Interior Forests, Ecological Reference Areas) intersect	use raster calculator to sum the values of analagous pixels in each of the input layers	Rare Ecosystems, Rare Plants, Rare Animals, Pre-settlement Landcover, Wetlands, and Interior Forests
US-23 Corridor	land within 1/2 mile of US-23	extract land within 1/2 mile of highway US-23	US-23
Wetlands	land with one or more of the following three attributes: 1) at least periodically, the land supports predominantly hydrophytes; 2) the substrate is predominantly undrained hydric soil; and 3) the substrate is non-soil and is saturated with water or covered by shallow water at some time during the growing season of each year. However, we have excluded areas that appear in the NWI but are flooded on a permanent or seasonal basis by human activity.	extract all wetlands identified in Alcona, Alpena, and Presque Isle Counties, excluding areas that are flooded on a permanent or seasonal basis by human activity	NWI/MiGDL

APPENDIX B. NATURAL FEATURES OPINION SURVEY.

Opinion Survey:

The opinion survey was conducted at the August 2006 meeting of the NEMIA working group, and the beginning of the fall 2006 semester at the University of Michigan's School of Natural resources and Environment (SNRE). At the working group meeting, each member of the working group was given three colored stickers, told what vote each color represented, and directed to place their votes on a large chart at the front of the room. For the survey of ecologists in SNRE, the request was phrased in the same terms as it had been presented to the working group. This request was distributed by email, and responses were collected in the same manner. The survey used at the working group meeting and distributed to the SNRE ecologists is displayed below.

Survey:

As part of our master's practicum involving the Northeast Michigan Integrated assessment under the guidance of Don Scavia and Jen Read, we have been collecting GIS layers for important land based ecological features. At our most recent meeting with local stakeholders, we put the features we had already collected up for the community to rank in terms of importance, with the goal of showing them ecologically important areas that were not simply important, but that they knew were important. The goal was to try to help the local residents and their representatives feel that they have a place in the ecological decision making. Now, I would like to ask you to rank the same things. The goal of this is to be able to draw parallels between public opinion and expert opinion.

I would ask you to rank these six ecological features in terms of ecological importance, based on your professional opinion. The six layers are:

- Endangered animals – as defined by the Michigan Natural Features Inventory
- Endangered plants - as defined by the Michigan Natural Features Inventory
- Endangered communities/ecosystems - as defined by the Michigan Natural Features Inventory
- Wetlands – as defined by the USFWS and their National Wetlands Inventory
- Pre-settlement landcover – an analysis done by the Nature Conservancy using DNR models of circa 1800 land cover patterns
- Large forest interiors – as defined by the USGS, on the scale of 1000 square meter parcels

I would like you to rank the 6 layers by giving out two votes each of High importance (H), medium importance (M), and low importance (L) in the spaces below:

Animals:
Plants:
Ecosystems:
Wetlands:
Old growth:
Forests:

APPENDIX C. METHODS FOR FIGURES 3.4 AND 3.5.

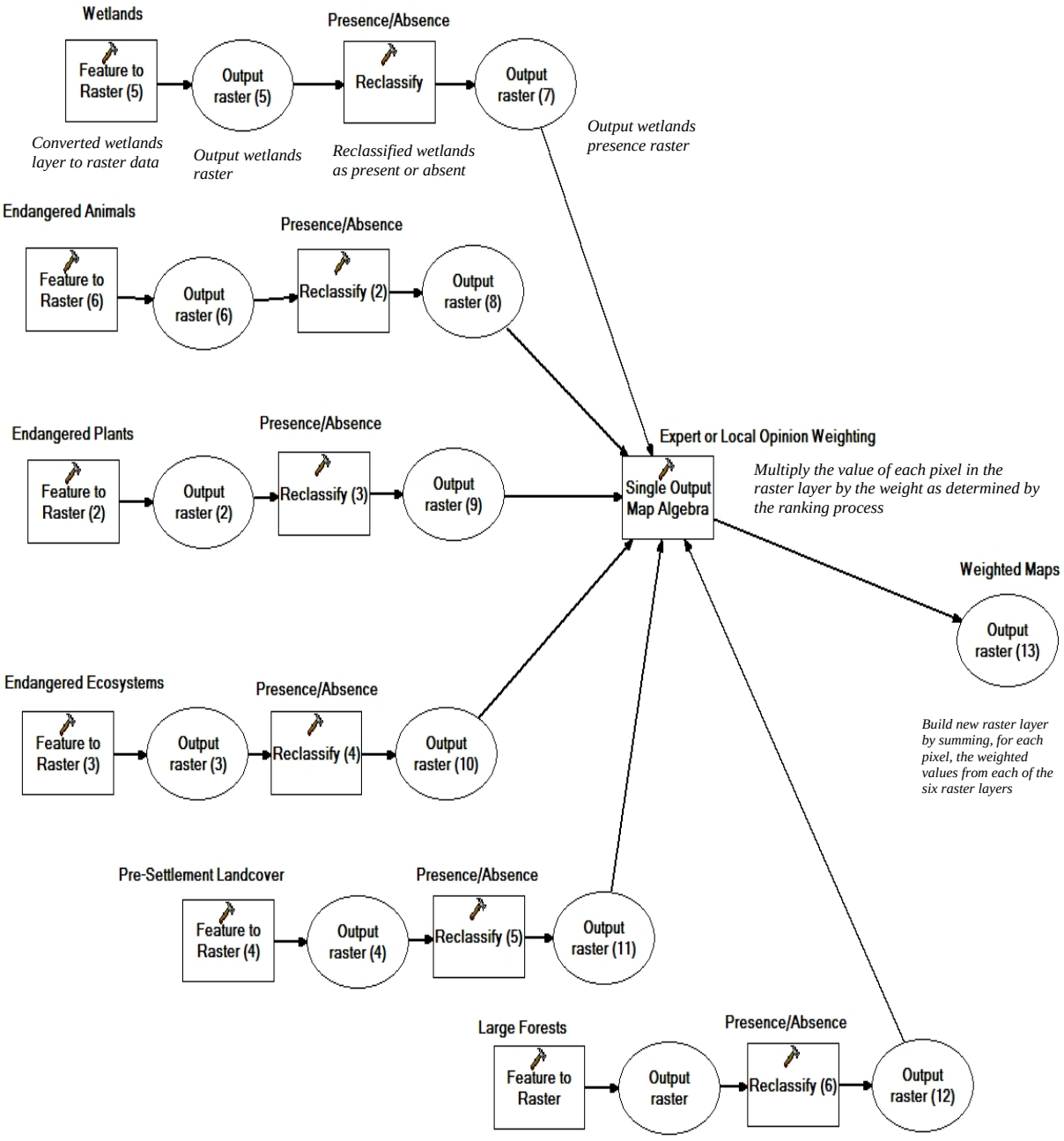
The Areas of Ecological Importance maps (Figures 3.4 and 3.5) were developed by first converting each of the six component natural features included in Figure 3.2 (Rare Animals, Rare Plants, Rare Ecosystems, Wetlands, Pre-settlement Landcover, and Interior Forests) from their shapefile format to a raster format. The raster layers were then reclassified for presence and absence of the feature of interest. (e.g., in the reclassified Wetlands raster layer, any pixel with a wetland present was given a value of 1, while pixels without wetlands were given a value of 0). Each of the newly reclassified raster layers was then weighted according to the results of the Natural Features Opinion Survey (see Appendix 3.2) displayed in Table 1 below. The raster calculator function of the ArcMap software was used to apply the weights to the six raster layers and then combine them mathematically into one combined layer, which is the layer displayed in Figures 3.4 and 3.5.

Table 1. Results of the Natural Features Opinion Survey.

Local Opinions	*"3 points"*	*"2 points"*	*"1 point"*	*Votes*	*"Total Points"*	*Weight=total points/votes*
Endangered Communities/Ecosystems	18	3	3	24	63	2.6
Wetlands	14	5	4	23	56	2.4
Large Interior Forests	6	9	9	24	45	1.9
Endangered Animals	4	10	10	24	42	1.8
Pre-settlement Landcover	4	7	12	23	38	1.7
Endangered Plants	1	12	9	22	36	1.6
Expert Opinions						
Endangered Communities/Ecosystems	10	3	0	13	36	2.8
Wetlands	9	2	1	13	32	2.5
Pre-settlement Landcover	3	7	2	13	25	1.9
Large Interior Forests	2	4	7	13	21	1.6
Endangered Plants	1	6	6	13	21	1.6
Endangered Animals	1	3	9	13	18	1.4

The raster calculator works by first multiplying the value of each pixel in a raster layer by the weight it was assigned (e.g. each pixel in the Wetlands raster is multiplied by 2.4, the result being that any pixel with wetlands present now has a value of 2.4, and those pixels with wetlands absent have a value of 0). This is done for each of the six raster layers. Then the raster calculator builds a new raster layer by summing, for each pixel, the weighted values from each of the six raster layers. Each pixel in the final raster layer was thus a composite of the same cells from each of the six contributing layers. The resulting layer displays the weighted and summed component layers, and as such is a visual summary of the opinion survey.

Figure 1. Flowchart showing development of Figures 3.4 and 3.5.



APPENDIX D. METHODS FOR FIGURES 3.10-3.13.

Figures 3.10-3.13 model the NEMIA study area in terms of its value as stopover habitat for migratory birds. The maps are based on a model developed by Ewert et. al (2006) for The Nature Conservancy for predicting stopover habitat for migratory birds along the Lake Erie shoreline. The Breeding Bird Survey (USGS, 2007) and Chartier and Ziarno (2004) suggest that most of the priority species that Ewert et. al (2006) used to develop the Lake Erie model (8 of 10 waterfowl species, 14 of 14 shorebird species, and 17 of 18 landbirds and raptors) also occur or have occurred in Northeast Michigan. Therefore, we assumed that the same model can be applied to the NEMIA study area to predict the location of migratory bird stopover sites.

The development of Figures 3.10-3.13 began with the creation of base layers representing landscape features important for migratory bird stopover habitat, such as wetlands, riparian areas, and open areas. We used the following sources to develop these base layers: Coastal Change Analysis Program Land Cover 2000 map (developed by the National Oceanic and Atmospheric Administration (NOAA), the National Wetlands Inventory map (developed by the United States Fish and Wildlife Service), a Soil Moisture Index map (developed by Ducks Unlimited), and maps showing the location of inland lakes, rivers, and Lake Huron obtained from the Institute for Fisheries Research. Table 1 explains the specific methods we used to create the base layers that went into building the model.

To build the potential stopover habitat maps, we first combined base layers to form "attributes," new data layers that represented features of the landscape useful for determining its value for stopover habitat. For each group of birds (migratory waterfowl, migratory shorebirds, migratory landbirds/raptors, and all migratory birds) we created a set of attributes – taking directly from the TNC model – that collectively model the stopover habitat needs for each group. We gave each attribute a score based on its importance to that group of birds' stopover habitat needs. The scores range from 0 to 5, where 0 represents non-habitat, and 5 represents critical habitat. Tables 2-4 show the attributes used in each bird group's habitat model, as well as the preparation process that went into creating each attribute layer, and each attribute's score.

Once the attribute layers were developed using the base layers, we created a habitat map for each group of birds by overlaying all attribute layers that applied to that group. In areas where attributes overlap, the attribute with the higher score took priority. This resulted in Figures 3.10-3.13, three maps showing modeled stopover habitat by bird group, and one map of modeled stopover habitat for all bird groups combined.

Table 1. Base layers used for all migratory bird stopover habitat models.

Layer name	Source layers	Method of layer development
Undeveloped land	Coastal change analysis program (CCAP) land cover	The CCAP classifications of "grassland", "forests", "scrub/shrub", "wetlands", and "unconsolidated shore" were reclassified as "undeveloped land."

Agricultural land	CCAP land cover	The CCAP classifications of "cultivated lands" were reclassified as "agricultural land."
Hydric soil	Soil Moisture Index (SMI)	Areas classified as "very wet" or "wet" were reclassified as "hydric."
Agricultural hydric soil	Agricultural land Hydric soil	Agricultural lands were clipped with the hydric soil layer to extract areas that were both agricultural land and had hydric soil.
Emergent wetlands	NWI	Areas that were classified as "emergent" or "scrub-shrub" according to NWI were turned into a new layer called "emergent wetlands."
Emergent wetland complex	Emergent wetlands	The emergent wetlands layer was buffered by 0.125 kilometers and an "identify overlapping polygon" script was used to select wetlands that were within 0.25 kilometers of each other. The selected wetlands were turned into a new layer called "emergent wetland complex."

Table 2. Migratory Landbird/Raptor Stopover Habitat Model: Attributes, Scores, and Methods.

Attribute number	Conservation importance	Layers used	Method of layer development
1	5	Undeveloped land Lake Huron	Undeveloped lands within 0.4 km of Lake Huron were extracted. These undeveloped lands were given the score of 5.
2	4	Undeveloped land Lake Huron	Undeveloped lands within 1.6 km of Lake Huron were extracted. Areas that overlapped with attribute 1 were removed. The remaining undeveloped lands were given the score of 4.
3	3	Undeveloped land Rivers Inland lakes Emergent wetlands	Undeveloped lands within 200 meters of rivers, lakes, or wetlands were selected. Areas that overlapped any of the above attributes were removed. The remaining undeveloped lands were given the score of 3.
4	2	Undeveloped land Rivers Inland lakes	Undeveloped lands within 400 meters of rivers, lakes, or wetlands were selected. Areas that overlapped any of the above attributes were removed.

		Emergent wetlands	The remaining undeveloped lands were given the score of 2.
5	2	Undeveloped land	Undeveloped lands were buffered by 2 kilometers to identify any undeveloped lands that were isolated by 4 kilometers. No such areas were found.
6	1	Undeveloped land	Undeveloped lands that did not fit into any of the above classifications were turned into a new layer. They were given the score of 1.

Table 3. Migratory Shorebird Stopover Habitat Model: Attributes, Scores, and Methods.

Attribute number	Conservation importance	Layers used	Method of layer development
1	5	Emergent wetlands Emergent wetlands complex Lake Huron	Emergent wetland complexes were combined with single emergent wetlands larger than 10 hectares. Those that were within 3.2 km of the Lake Huron coastline were selected. These were turned into a new layer and were given the score of 5.
2	4	Emergent wetlands Emergent wetlands complex Lake Huron	Emergent wetland complexes were combined with single emergent wetlands with areas larger than 10 hectares. Those that overlapped with attribute 1 were removed. The remaining wetlands were turned into a new layer and were given the score of 4.
3	4	Hydric soil Lake Huron	Hydric soil areas within 16 km of the Lake Huron coastline were selected. These were turned into a new layer and were given the score of 4.
4	3	Hydric soil Lake Huron	Hydric soil areas that were not selected as attribute 3 were selected. They were turned into a new layer and were given the score of 3.
5	3	Emergent wetlands Lake Huron	Emergent wetlands smaller than 10 hectares were selected. Those within 3.2 km of the Lake Huron coastline were selected. The selected wetlands were turned into a new layer and were given the score of 3.

6	2	Emergent wetlands Lake Huron	Emergent wetlands smaller than 10 hectares were selected. Those that were selected as attribute 5 were removed. The remaining wetlands were turned into a new layer and were given the score of 2.

Table 4. Migratory Waterfowl Stopover Habitat Model: Attributes, Scores, and Methods.

Attribute number	Conservation importance	Layers used	Method of layer development
1	5	Emergent wetlands Inland lakes	Emergent wetlands larger than 16 hectares were selected. From that group, those that were adjacent to a body of open water larger than one hectare were selected. Wetlands selected from that group were turned into a new layer and were given the score of 5.
2	5	Emergent wetlands Inland lakes	Initially, emergent wetlands and water bodies larger than one hectare were selected. For this group, those that were within 120 meters of another emergent wetland larger than one hectare were selected. The selected wetlands and lakes were turned into a new layer and were given the score of 5.
3	4	Emergent wetlands	Any emergent wetlands with areas larger than 1 hectare were selected and turned into a new layer. They were given the score of 4.
4	4	n/a	Use expert knowledge to identify known Diving Duck concentration areas. Due to lack of time and resources this attribute was not included in our analysis.
5	3	Agricultural hydric soil Lake Huron	Any agricultural fields with hydric soil areas larger than 5 hectares were selected. Those within 24 km of Lake Huron were selected. These areas were then turned into a new layer and were given the score of 3.
6	3	Agricultural hydric soil Lake Huron Inland lakes	Any agricultural fields with hydric soils larger than 5 hectares were selected. Within that selection those that were within 1.6 kilometers from an inland lake were selected, and those that overlapped with attribute 5 were removed. These were made into a new layer and given the score of 3.

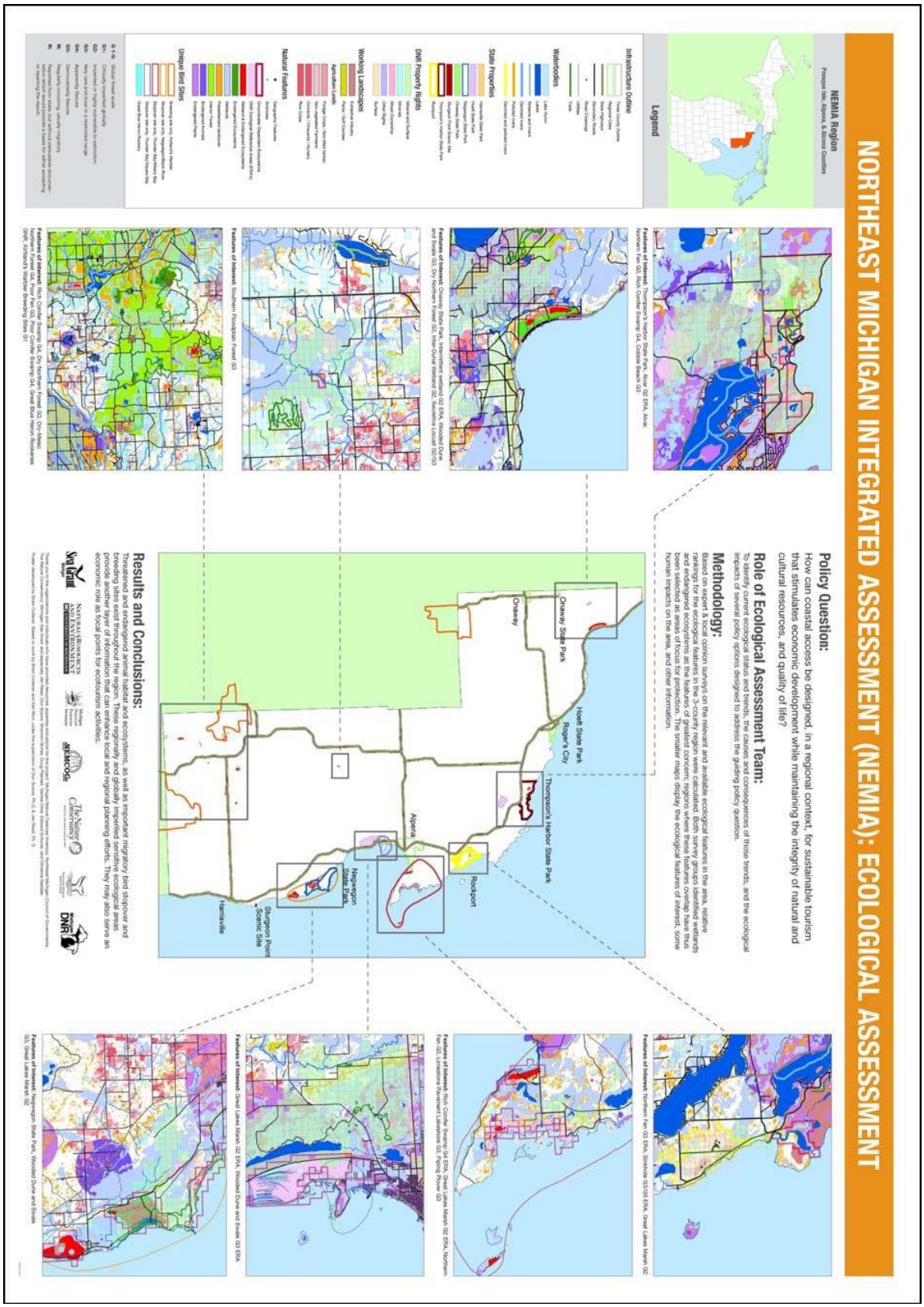
7	2	Agricultural hydric soil Lake Huron	Any agricultural fields with hydric soil areas larger than 5 hectares that were not in attribute 5 or 6 were selected. These were turned into a new layer and were given the score of 2.
8	2	NWI	NWI classification of forested class and broad-leaved deciduous wetlands were selected, and areas larger than 1 hectare were selected. These were turned into new layer and were given the score of 2.

Works Cited – Appendix D

Chartier, Allen T. and Ziarno, Jerry. (2004). *A birder's guide to Michigan*. Colorado Springs, CO: American Birding Association.

United States Geological Survey (USGS). *The Breeding Bird Survey*. Retrieved April 2007 from http://www.pwrc.usgs.gov/BBS/

APPENDIX E. POSTER FOR NEMIA WORKGROUP MEETING.



APPENDIX F. CERTAINTY ASSESSMENT

While the sources of data were all reliable, some of the information used in this report does have a certain degree of built in uncertainty. Though the layers used were the most up to date available, due to a lack of metadata by the source organizations, it is unknown how current the information displayed is, since none of the information was "ground-truthed". The exception to this is the MNFI, which is updated on a yearly basis.

Summary of potential data problems:

Unknowns:

- How old the data are. Most of our data had a statement on date of collection for information, but many did not. Because we did not collect this data, the ecological team can not verify how up to date this information is
- The positional accuracy of the information when it was gathered
- What information was not included in the attribute tables
- Data collection methodology

Summary of specific layer accuracy issues:

MNFI:

- Some of the information is historically based, and may lack spatial accuracy.
- Some of the endangered species have not been observed for many years.
- The lack of accuracy in the historical data led to widening of the habitat area to cover for the lack of accuracy.
- Most private lands were not surveyed.

USGS interior forest:

- Very large resolution. 1 km x 1 km, as opposed to 30 meter x 30 meter for most land cover maps
- 2002 data

Potential analysis errors:

Methodology

- Potential errors with opinion maps
    - Participant bias
    - How we presented the question in the survey may have influenced participant responses

- Potential errors with river map
    - The influence of dams may be more or less than the half a mile upstream and downstream. This was done because the dam layer was not perfectly aligned with our rivers layer, possibly due to an error in the layer itself

    - The reaches highlighted may be further than a half mile away from the dam, depending on the length of the highlighted reach.

- Potential errors with bird model maps
    - The model was originally developed for the western Lake Erie basin, not the northeastern coast of Lake Huron.
    - There are other important species in northeast Michigan such as the Kirtland Warbler that are not present in Western Lake Erie region, and were not part of this model.