

# Significant Natural Features in the Tri-County Region (Clinton, Eaton and Ingham Counties): Providing Ecological Information for a Green Infrastructure Plan (Phase 2)



Prepared by: Daria A. Hyde, Helen D. Enander, Bradford S. Slaughter,  
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Michigan Natural Features Inventory  
P.O. Box 30444  
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Prepared for:  
Tri-County Regional Planning Commission

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Right Insets : Cerulean warbler - Bill Dyer- Cornell Lab of Ornithology  
Blanding's turtle - Barbara. J. Barton, MNFI

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June 2009

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**Prepared for:**

Tri-County Regional Planning Commission

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# Table of Contents

<b>Land Use History and Land Cover Change in the Tri-County Region</b> .....	1
Historical Accounts of Clinton, Eaton and Ingham County.....	3
Land Cover Change.....	5
<b>Natural Communities of the Tri-County Region</b> .....	11
Natural Community Element Occurrence Descriptions by County.....	16
Clinton County.....	16
Eaton County.....	17
Ingham County.....	18
Information Gaps.....	20
<b>Rare Plant Diversity of the Tri-County Region</b> .....	22
Overview.....	22
Notable Rare Plant Element Occurrences by County.....	26
Information Gaps.....	27
<b>Rare Terrestrial Animals of the Tri-County Region</b> .....	29
Overview.....	29
Notable Rare Animal Element Occurrences by County.....	32
Information Gaps.....	33
<b>Aquatic Biodiversity Assessment of the Tri-County Region</b> .....	36
Overview.....	36
Ecosystem Level Analysis.....	40
River classification.....	40
Potentially Unique River Ecosystems.....	42
Potentially High-Quality Common River Ecosystems.....	42
Lake Classification.....	45
Potentially Unique Lake Ecosystems.....	46
Potentially High-Quality Common Lake Ecosystems.....	47
Intact Headwaters in Michigan.....	48
Functional (or least modified) Sub-Watersheds.....	48
Overall Functional Sub-Watershed Results.....	55
<b>Rare Aquatic Animals of the Tri-County Region</b> .....	57
Overview.....	57
Site-Level Analysis: Element Occurrence Data .....	58
Rare Species Richness.....	58
Species of Greatest Conservation Need Richness.....	61
Notable Rare Animal Element Occurrences by County.....	64
Information Gaps.....	66
<b>Description of the Ten Top-ranked Priority Conservation Areas</b> .....	68
<b>Literature Cited and References</b> .....	76
<b>Appendix 1</b> .....	79
List of Abstracts for Natural Communities, Rare Plants and Animals in the Tri-County Region.....	80

## Tables

Table 1. Tri-County Region Vegetation Circa 1800 (acres).....	1
Table 2. Tri-County Region: 2000 Land Cover.....	6
Table 3. Tri-County Land Cover Change: Circa 1800 Vegetation to 2000 Land Cover.....	8
Table 4. Summary of Natural Community Element Occurrences in the Tri-County Region.....	12
Table 5. Potential Natural Communities of the Tri-County Region.....	12
Table 6. Rare Plant Species with Extant Element Occurrence Records in the Tri-County Region.....	23
Table 7. Historical and Extirpated Rare Plant Occurrence Records in the Tri-County Region.....	24
Table 8. Presumed Extant Element Occurrence Records for Rare Animals in the Region.....	30
Table 9. Historical Element Occurrence Records for Rare Animals in the Region.....	31
Table 10. Landscape Variables Used to Determine Quality.....	43
Table 11. Summary of General Lake Statistics within the Southeast Lake Michigan EDU and the Tri-County Region.....	46
Table 12. Summary of Unique and Common Lake Ecosystems within the Southeast Lake Michigan EDU and the Tri-County Region.....	47
Table 13. Summary of the Number of High Quality Common Lakes by Size Class.....	48
Table 14. The Rare Aquatic Species that Occur in the Tri-County Region.....	60
Table 15. Species of Greatest Conservation Need (SGCN) that Occur in the Tri-County Region...	61

## Figures

Figure 1. Circa 1800 Land Cover Map.....	2
Figure 2. IFMAP 2000 Land Cover.....	7
Figure 3. 2000 Remaining Natural Land Cover .....	9
Figure 4. Tri-County Region Potential Conservation Areas.....	10
Figure 5. Clinton County High Quality Natural Communities and Highest Scoring PCAs.....	13
Figure 6. Eaton County High Quality Natural Communities and Highest Scoring PCAs.....	14
Figure 7. Ingham County High Quality Natural Communities and Highest Scoring PCAs.....	15
Figure 8. Important Terrestrial Features in the Tri-County Area.....	35
Figure 9. Southeast Lake Michigan Ecological Drainage Unit (EDU).....	37
Figure 10. The Grand River, Including the Maple, Looking Glass, Red Cedar and Thornapple Tributaries.....	38
Figure 11. River Valley Segment and Lake Classification Incorporating Size, Temperature and Connectivity.....	41
Figure 12. River Valley Segment and Lake Classification Indicating Unique and High Quality Common Aquatic Systems.....	44
Figure 13. Proportion of Headwater Reach Watersheds Composed of Natural Land Cover.....	49
Figure 14. Proportion of Natural Land cover in the Riparian Zone and the Entire Subwatershed...	50
Figure 15. Ranking of Subwatersheds for Degree of Fragmentation.....	53
Figure 16. Ranking of Subwatersheds for Potential Pollution.....	54
Figure 17. Percent of Subwatersheds in each Score Category of the Overall Functional Analysis...	55
Figure 18. Overall Classification of Functional Subwatersheds .....	56
Figure 19. Subwatersheds Classified by Rare Aquatic Species Richness per Mile of River.....	59
Figure 20. Subwatersheds Classified by Species of Greatest Conservation Need Richness.....	62
Figure 21. Important Aquatic Features in the Tri-County Area.....	63

## Land Use History and Land Cover Change in the Tri County Region

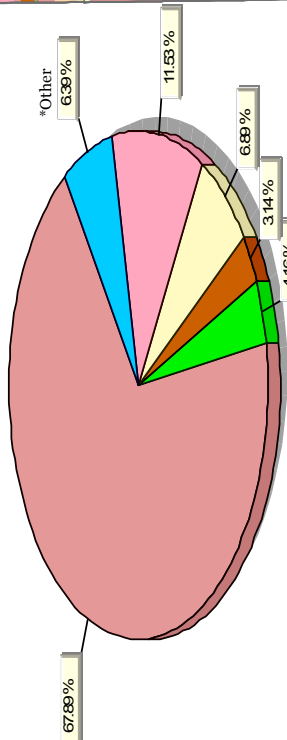
At the time of the General Land Office surveys in the early 1800s, the Tri-County Region was heavily forested. The dominant natural cover in Clinton, Eaton, and Ingham counties was beech – sugar maple forest, which accounted for 680,000 acres (280,000 hectares), or 62% of the total surface area in these counties (Table 1 and Figure 1). This forest type was particularly characteristic of fine-textured loamy soils on the gently rolling ground moraines that characterize much of the region. Oak-hickory forest, which occurred primarily on end moraines and sandy river bluffs, occupied approximately 180,000 ac (73,000 ha), or 16.5%, of the region, concentrated in southeastern Clinton County and southeastern Ingham County. Other upland communities of lesser prevalence included mixed oak savanna, mixed oak forest, black oak barren, and white pine – mixed hardwood forest. Upland grasslands were very small and local in the Tri-County Region, noted in northwestern Clinton County near St. Johns and near Charlotte in Eaton County (Comer et. al.1995a, b).

Wetlands were extensive in the Tri-County Region circa 1800, occupying linear outwash channels, poorly drained depressions, and glacial kettles. Mixed conifer swamps characterized by tamarack dominance occupied approximately 87,000 ac (35,000 ha), or 8%, of the region. Mixed hardwood swamp (including floodplain forest) was also prevalent, occupying 58,000 ac (23,000 ha), or 5%, of the region. Other wetland communities included shrub swamp/emergent marsh, wet prairie (including southern wet meadow and prairie fen), and black ash swamp. Acidic sphagnum bog and poor conifer swamp communities occurred locally in kettle depressions and lake basins (Comer et. al.1995a, b).

**Table 1. Tri-County Region Vegetation Circa 1800 (acres)**

Cover Type	Clinton	Eaton	Ingham	Total
Beech – Sugar Maple Forest	220,000	280,000	180,000	680,000
Oak – Hickory Forest	74,000	21,000	85,000	180,000
Mixed Conifer Swamp	17,000	35,000	35,000	87,000
Mixed Hardwood Swamp	24,000	18,000	16,000	58,000
Shrub Swamp/Emergent Marsh	9,600	4,800	18,000	32,000
Mixed Oak Savanna	4,600	5,000	5,500	15,000
Mixed Oak Forest	5,500	0	8,900	14,000
Wet Prairie	5,200	1,000	8,200	14,000
Lake/River	2,500	2,200	2,200	6,900
Black Oak Barren	440	450	2,600	3,500
Black Ash Swamp	450	1,200	370	2,000
White Pine – Mixed Hardwood Forest	1,300	0	0	1,300
Muskeg/Bog	180	150	17	350
Grassland	160	36	0	200
White Pine Forest	130	0	0	130
Exposed Bedrock	0	23	0	23

### Covertype Proportions



\*Other includes covertypes with < 3% total area

# Tri-County Region

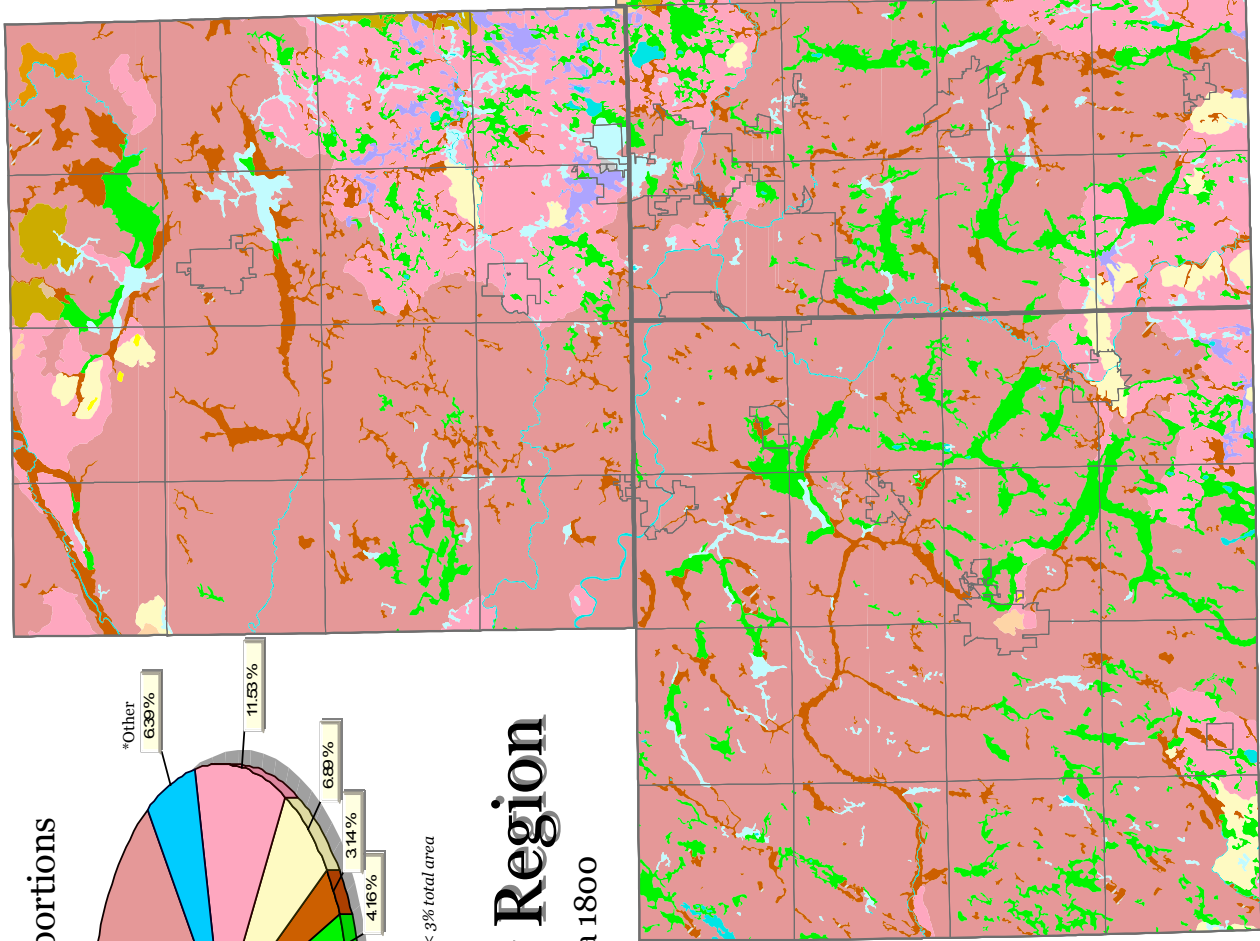
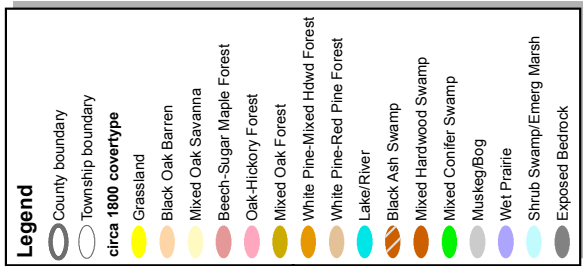
Vegetation circa 1800



Data Source:  
 Comer, P. J., D. A. Albert, H.A. Wells, B. L. Hart, J.B. Raab,  
 D. L. Price, D. M. Kishlun, R. A. Corner, and D. W. Schuen,  
 1995. Vegetation circa 1800 of Michigan. Michigan State  
 University Land Use and Forest Resources Center Land  
 Office Survey 161-185. Michigan Natural Features  
 Inventory. Lansing, MI. 78 pp. + digital map.



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Figure 1. Circa 1800 Land Cover Map

## **Historical Accounts of Clinton, Eaton and Ingham Counties**

Much of what we know today about the land use history of Michigan is derived from township plat maps and transcribed field notes of the initial land surveys conducted between 1816 and 1856 through the federal government's General Land Office. These maps and surveys provide the best available record on Michigan's land cover as it appeared just prior to widespread European settlement (Comer 1996). In addition, many authors of county histories supplemented this information with interviews, letters and accounts of people who lived in these counties at the time the area was being settled by Europeans. The following summaries are intended to provide a historical perspective for discussing land use change in the region.

### **Clinton County**

The surface geology of the county consists of gently rolling to flat ground moraine, outwash channels and sand lake plain (in the northeast portions of the county) with ground moraine dominating the southern two thirds of the county. Poorly drained depressions occur frequently throughout the landscape of predominantly loamy soil. In the 1830's much of the upland in the county was dominated by beech-sugar maple-basswood forest while oak-hickory forest and oak savanna were common in the southeast quarter of the county and along the northeastern border (Comer 1996). Franklin Ellis and Earl De La Vergne (1880), in their account of Clinton County history, relate that the types of timber noted in the first surveys of the county included oak, elm, beech, maple, white and black ash, aspen, tamarack, birch, cedar, black walnut, ironwood, hickory, cherry and spruce with a very thick undergrowth of prickly ash and willow. Surveyors also mentioned passing through "prairies" and "prairie lands" and the existence of "floating prairies," "marsh," "cranberry marsh" and "tamarack swamp". Comer (1996) explains that mixed hardwood swamp was the most common wetland type, concentrated primarily in river floodplains, while mixed conifer swamp, tamarack swamp and even a few black spruce swamps were found throughout poorly drained portions of the ground moraine. Wet prairie was common in Bath Township. From historical map data, it is estimated that there were 57,000 acres of wetland in the county, representing roughly 16% of its surface.

Many settlers and traders believed that valuable salt springs existed along the Maple River valley, and some had traded for salt with local Indians, who made it from the brine they collected there. The presence of the salt springs and salt marshes was formally documented in a report in 1838 by the state geologist, Dr. Douglass Houghton, who reported his examinations of the northwest township of Clinton County along the Maple River. He describes two marshes just barely elevated above the surface of the river and partially separated from each other, from which water was seen oozing through the sandy soil into the river, although no distinct spring was evident." Upon excavating a few feet, he noticed a constant discharge of water in small quantities, perfectly transparent and having a temperature of 46 °. Further analysis confirmed soda, lime, magnesia, carbonate of lime and iron and sulphate of lime. People living in the county decided though that there were not sufficient quantities of salt to warrant a manufacturing operation and focused instead on the more profitable business of farming the fertile soils (Ellis and De La Vergne 1880).

## **Eaton County**

Early European settlers in Eaton County found it heavily forested with whitewood (deciduous trees with soft, light-colored wood such as tulip tree, basswood, or cottonwood), cherry, black walnut, white and black ash, sugar maple, beech, ironwood, elm and oak. There was a small prairie, a mile across, located where the city of Charlotte now stands. Open areas, devoid of trees, had apparently been used by the Indians as cornfields. There were burr oak plains near Bellevue, and further to the east there were oak openings. These openings were also found east of Eaton Rapids along with several large swamps with thickly growing tamarack (Williams, 1915). Around 1800 the upland portions of the ground and end moraines were overwhelmingly dominated by beech-sugar maple-basswood forest while oak-hickory forest and oak savanna occurred in the drier end-moraine ridges at the southern end of the county (Comer 1996).

Comer (1996) estimated that there were approximately 60,000 acres of wetland in the county (representing 16% of the total area) with large swamp forests found in long linear depressions or along major river floodplains. Mixed hardwood swamps were common in these floodplains and were dominated by elm, black ash, red ash, silver maple and swamp white oak. Common wetland types occurring throughout the ground moraine and outwash deposits included tamarack swamp, mixed tamarack-hardwood swamp, willow-buttonbush swamp and emergent marsh. Wet prairie was found on poorly drained ground moraine in the extreme southeast part of the county.

Williams (1915) reported that in very hot summers, the peat in the tamarack swamps became so dry that it burned easily several inches deep, exposing the roots of trees so that they fell over and were consumed by fire in the next hot summer. The fire is reported to have smoldered in the peat beds for several weeks and through several hard rains. In time the tamarack swamps became "wet prairies" and "in a short time these prairies were covered with a dense growth of yellow flowers so that they appeared like one great sea of gold." In time, shrubs filled in the openings and many of these "wet prairies" reverted to tamarack swamp.

## **Ingham County**

Frank Turner in [An Account of Ingham County](#) (1924) provides an extensive description of the landscape at the time the first European settlers arrived in the early 1800's. He describes an area covered by primeval forest that was difficult to traverse and very intimidating to settlers leading their ox teams and creaking wagons behind them. Russell Callahon, a pioneer, recounted the effect of walking alongside his father's wagon as a boy as they left a clearing in Mason and headed into the blackness of the forest. Because this territory was so densely wooded, Ingham County was one of the last counties in the region to be settled by Europeans. In the 1820's, most of the upland was beech-sugar maple-basswood forest (Comer 1996). Turner (1924) further explains that maple was highly valued in the county and was found in most all of the townships, with the largest groves located in Vevay Township. Maple sugar during these times was a staple product that was used to pay taxes, buy groceries and to pay carriage on letters before postage stamps were used.

Turner (1924) notes that in the north and west part of the county there was a wide diversity of trees including oak, maple, beech, elm, basswood, black walnut, hickory, sycamore, dogwood, ash, ironwood, black cherry, cottonwood, poplar and hazel. The principal timber in the south and

east part of the county was oak that grew in more open places, which the earlier settlers called “oak openings”. Oak was abundant in Locke and Leroy townships, especially north of the Red Cedar River. Comer (1996) in his study of the General Land Office survey field notes, explains that oak-hickory forest, dry black oak-white oak forest and oak savanna were common on the outwash and ground moraines across the southern townships and that oak-hickory forest and oak savanna also occurred along the Red Cedar River and around Lake Lansing.

Oak timber was one of the most valuable assets of the county, with many lumberman claiming the quality and quantity to be greater than any county in Michigan. It is estimated that the amount of oak manufactured from the county ranged from four to eight million square feet. This is likely a small estimate; given that there was close to a 50 per cent loss during the manufacturing process. In 1872, a local botanist, Mr. Steward, told Frank Turner that he was asked by Asa Gray of Boston and Professor Beal of Michigan Agricultural College (M.A.C., now Michigan State University) to travel through the woods of the county and make a collection of the different species of oak. When he was done he reported twenty seven different species (today numerous species designations have been combined), which the founders of M.A.C. preserved for future generations to enjoy (Turner 1924).

The marshes in the central and southern part of the county, which the early settlers relegated to the rattlesnakes and fur-bearing animals, were either covered by tamarack, spruce or peat bogs that were later used for fuel. The open marshes covered by coarse grass were used by early settlers for hay and pasture for their livestock (Turner 1925). Comer (1996) further explains that the most common wetlands in the county were tamarack swamps that occurred in poorly drained valleys between moraine ridges. Mixed hardwood swamps were common in active river floodplains, and the outwash deposits in the southern part of the county supported wet prairie, emergent marsh, tamarack swamp and button-bush-willow swamp. Based on historical map data it is estimated that there were approximately 78,000 acres of wetland in the county. This represents roughly 22 % of the total county acreage.

## **Land Cover Change**

In 1815 the surveyor general Edward Tiffen wrote to the commissioner of the land office in Washington “that in the whole of Michigan territory there was not one acre in a hundred, if there would be in a thousand that would in any case admit of cultivation, it is all swampy and sandy” (Williams 1915). Eventually this long held belief was forgotten as European settlers learned of the fertile soils in the interior of the State. Most of the Tri-County Region was cleared for agriculture by the mid-1800s as the rich, fine-textured, loamy soils that supported beech maple forests proved excellent for farming. Agricultural development was aided by extensive use of drain tiles and ditches, which reduced wetland acreage by nearly 50% in the region. These drained organic soils were used to produce mint and other specialty crops (Albert 1995).

In this analysis current landcover in the tri-county region (Table 2 and Figure 2) is represented using the Integrated Forest Monitoring Assessment and Prescription data layer (hereafter referred to as IFMAP). IFMAP coverage is based upon LANDSAT satellite imagery rather than aerial photography and provides a finer classification scheme than the updated 2005 MIRIS coverage, which is useful when cross walking Circa 1800 vegetation with current land cover.

**Table 2. Tri County Region: 2000 Landcover (acres)**

<b>Class Name</b>	<b>Clinton</b>	<b>Eaton</b>	<b>Ingham</b>
Low Intensity Urban	3,852	5,584	11,676
High Intensity Urban	3,923	5,174	10,959
Airports	344	50	57
Roads / Paved	14,646	15,030	18,121
Non-vegetated Farmland	1,008	1,153	1,050
Row Crops	136,910	127,096	120,174
Forage Crops / Non-tilled herbaceous	111,914	97,507	74,580
Orchards / Vineyards / Nurserys	1,688	2,530	1,817
Herbaceous Openland	15,204	18,685	18,553
Upland Shrub / Low-density trees	2,689	4,134	3,381
Parks / Golf Courses	393	142	2,018
Northern Hardwood Association	7,950	11,495	9,626
Oak Association	8,350	12,739	11,424
Aspen Association	3,010	1,970	1,358
Other Upland Deciduous	1,856	2,823	1,460
Mixed Upland Deciduous	10,616	14,761	13,900
Pines	2,714	2,944	5,167
Other Upland Conifers	205	307	829
Upland Mixed Forest	2,102	2,676	3,147
Water	2,508	2,299	2,149
Lowland Deciduous Forest	16,377	20,297	23,712
Lowland Coniferous Forest	465	503	601
Lowland Mixed Forest	71	79	95
Floating Aquatic	974	1,272	1,428
Lowland Shrub	13,775	15,447	16,808
Emergent Wetland	1,695	2,105	2,398
Mixed Non-Forest Wetland	955	1,061	1,341
Sand / Soil	191	200	228
Other Bare / Sparsely Vegetated	1,039	460	520

Circa 1800 cover types for which we have acreages were cross-walked with IFMAP 2000 classes that were compatible (Table 3). For example, the circa 1800 cover type- Oak-Hickory Forest was cross-walked with the IFMAP Class- Oak Association. Those types which are more broadly defined and did not cross-walk neatly were not included in the land cover change analysis. These new types likely represent sites that were characterized by different circa 1800 cover types. Thus the 2000 acreage estimate for oak forest, oak savanna and black oak barren is likely a conservative one. In addition, mixed oak savanna and black oak barren are savanna types that have changed structurally, even in places still characterized by oaks (oak association). The apparent increase in shrub/emergent wetland cover type in the tri-county region is likely due to the conversion of coniferous and deciduous wetlands to shrub wetlands. Also the coarse scale of the circa 1800 General Land Office (GLO) notes likely underestimated wetlands as small patch communities like these were often not documented and included. Thus any type of land change analysis has limitations and is only used to suggest trends.

# Tri-County Region

## IFMAP circa 2000 Land Cover

Data Source: MDNR. 2003. Integrated Forest Monitoring Assessment and Prescription (IFMAP) Landcover for Michigan, MDNR, Lansing, Michigan. Raster data at 30 meter cell size; time-period of content 1997 – 2001 for source remotely-sensed Landsat TM satellite data. Data and metadata available online at <http://www.mcgi.state.mi.us/mgdl/>.

- County boundary
  - Township boundary
- IFMAP Land cover class**
- Developed
  - Agriculture
  - Grassland/Shrub
  - Aspen Association
  - Northern Hardwood Association
  - Oak Association
  - Mixed Upland Deciduous
  - Other Upland Deciduous
  - Pines/Other Upland Conifers
  - Mixed Upland Conifers
  - Upland Mixed Forest
  - Water
  - Lowland Shrub/Emergent Wetland
  - Floating Aquatic/Mixed Wetland
  - Lowland Coniferous Forest
  - Lowland Deciduous Forest
  - Lowland Mixed Forest
  - Bare/Sand/Soil

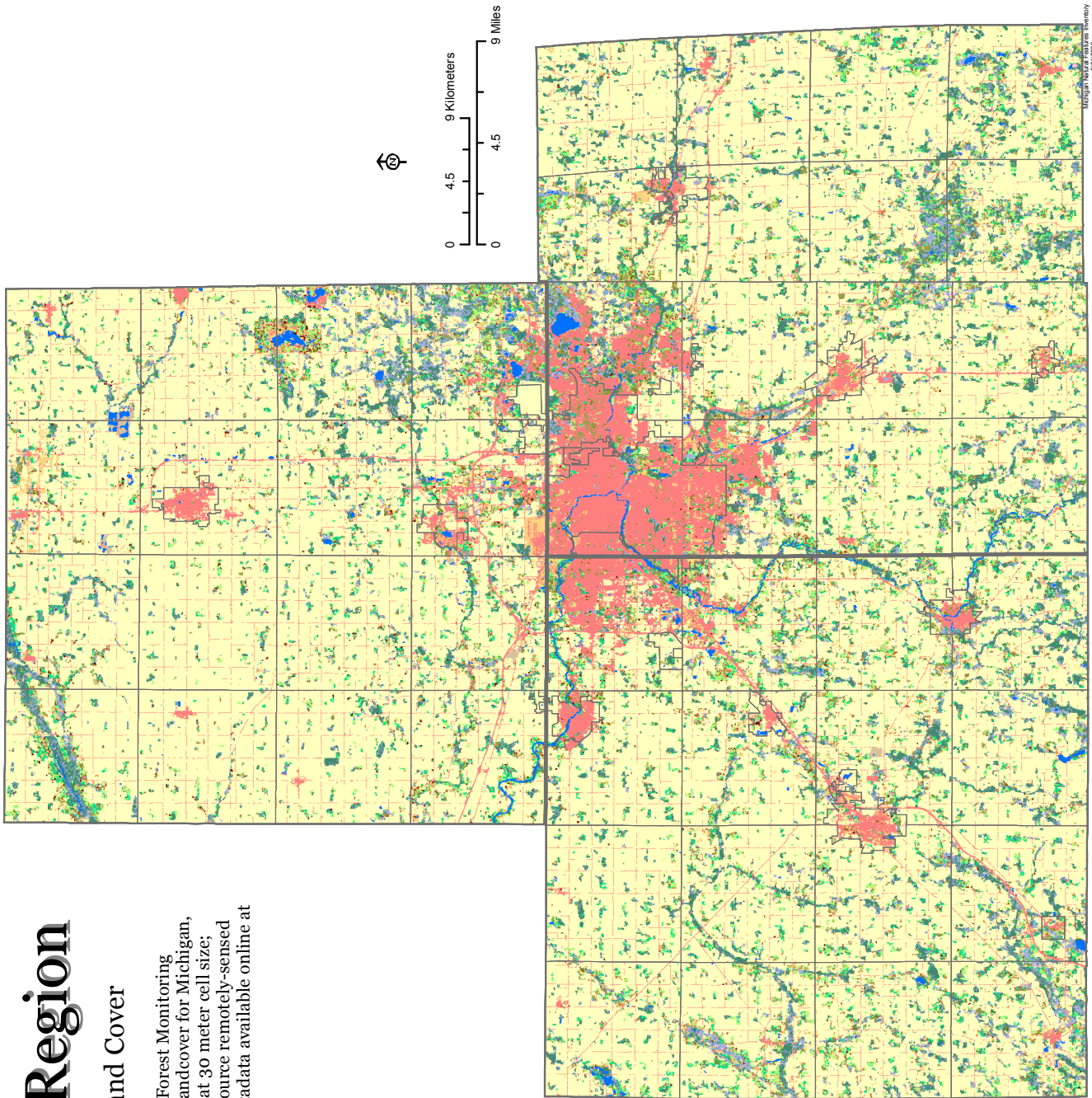







Figure 2. Circa 2000 Land Cover

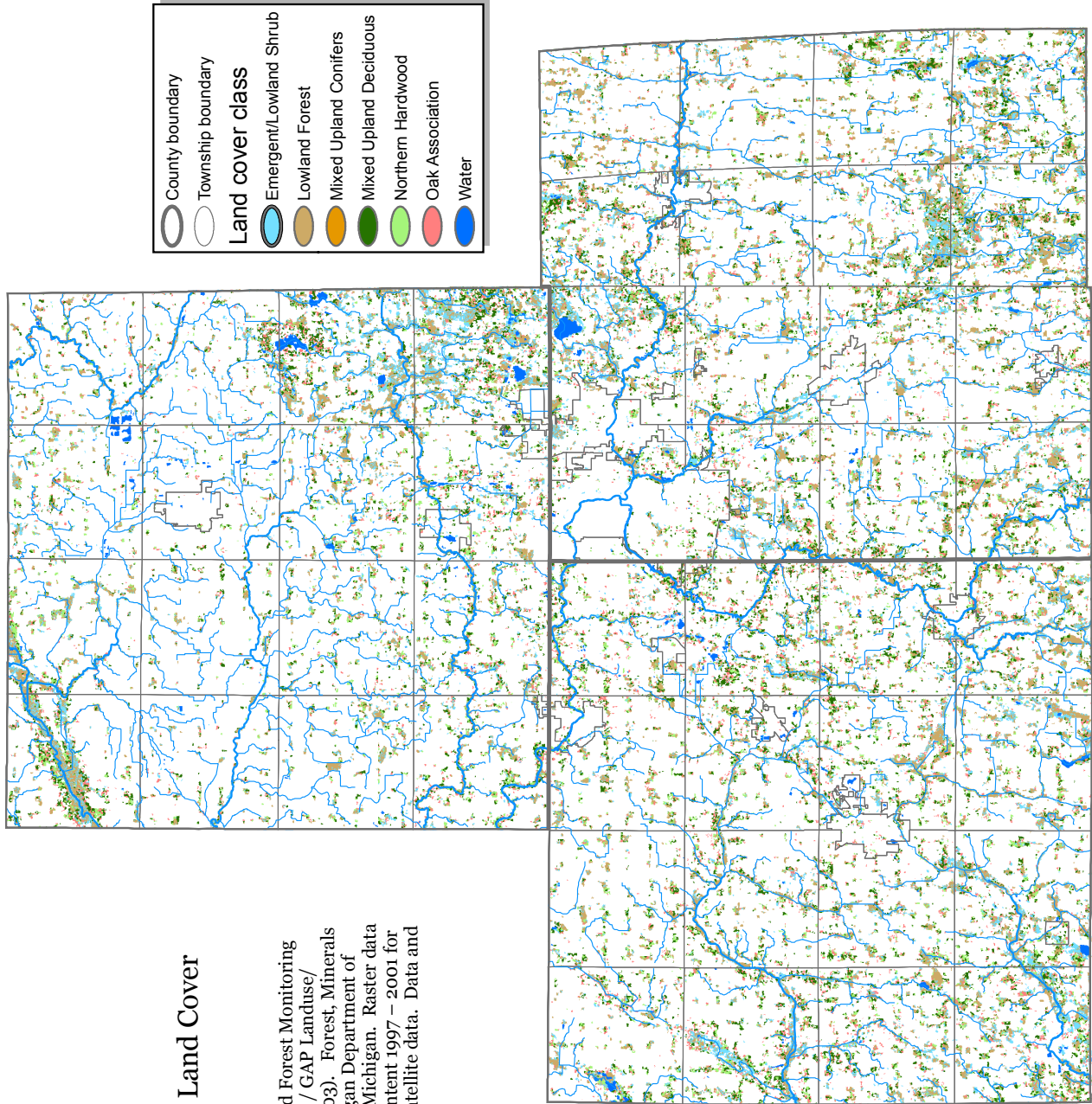
**Table 3. Tri County Land Cover Change: Circa 1800 Vegetation to 2000 Landcover (acres)**

Cover Type	Clinton Circa 1800	Clinton 2000	Eaton Circa 1800	Eaton 2000	Ingham Circa 1800	Ingham 2000	Total Circa 1800	Total 2000	Percent Change
Beech-Sugar Maple Forest	222,000	8,000	282,000	11,500	176,000	9,600	<b>680,000</b>	<b>29,100</b>	 96%
Oak-Forest/ Oak Savanna & Black Oak Barren)	84,800	8,400	26,600	12,700	102,300	11,400	<b>213,700</b>	<b>32,500</b>	 85%
Mixed Conifer Swamp	17,200	500	35,200	500	35,300	600	<b>87,700</b>	<b>1,600</b>	 98%
Mixed Hardwood Swamp/ Black Ash Swamp	24,900	16,400	19,000	20,300	16,800	23,700	<b>89,100</b>	<b>60,400</b>	 32%
Shrub/ Emergent Wetland	15,200	15,500	5,700	17,600	26,100	19,200	<b>47,000</b>	<b>52,300</b>	 10%
Lake/River	2,500	2500	2,200	2,300	2,200	2,100	<b>6,900</b>	<b>6,900</b>	0%

All natural vegetation types identified by the IFMAP land coverage were combined together to form a new all natural vegetation data layer (See Figure 3.). Natural vegetation includes grassland/herbaceous, shrub land, forested, and wetland. It is no surprise that there is little difference when comparing the natural land cover map and the PCA map (Figure 4.), even though different land use classification data sets were used.

## 2000 Remaining Natural Land Cover

Data Source: MDNR. 2003. Integrated Forest Monitoring Assessment and Prescription (IFMAP) / GAP Landuse/Landcover for Michigan, version 1 (2003). Forest, Minerals and Fire Management Division, Michigan Department of Natural Resources (MDNR), Lansing, Michigan. Raster data at 30 meter cell size; time-period of content 1997 – 2001 for source remotely-sensed Landsat TM satellite data. Data and metadata available online at <http://www.mcgi.state.mi.us/mgdl/>.



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Figure 3. Circa 2000: Remaining Natural Land Cover

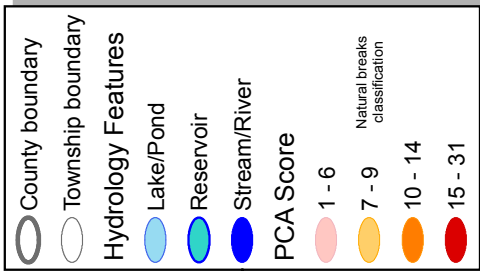
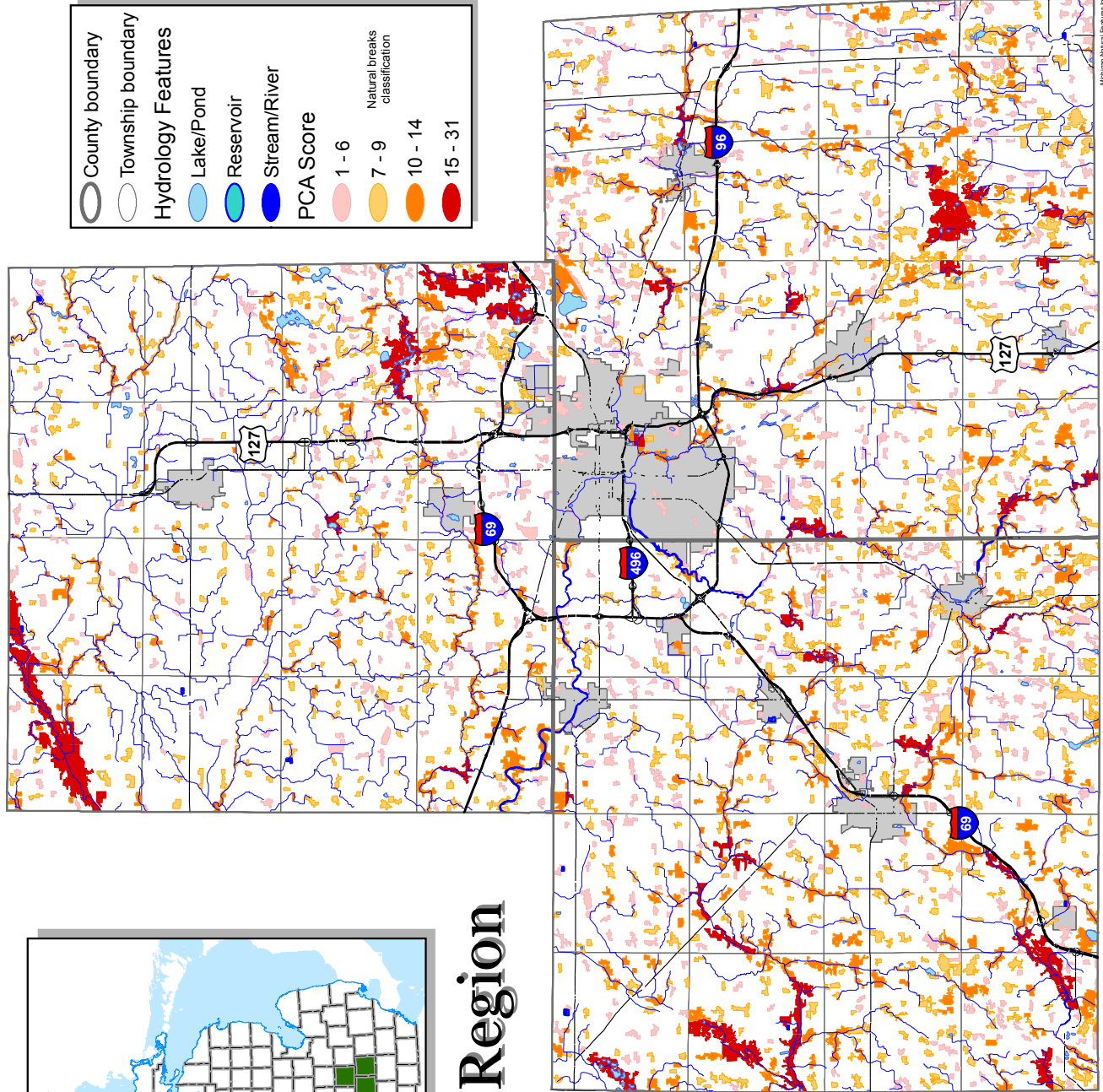
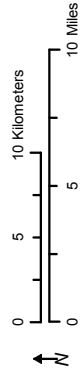


# Tri-County Region

## Potential Conservation Areas

Potential Conservation Areas (PCAs) are defined as places on the landscape dominated by native vegetation that have various levels of potential for harboring high quality natural areas and unique natural features. Scoring criteria used to prioritize sites included: total size, size of core area, length of stream corridor, landscape connectivity, restorability of surrounding land, parcel fragmentation, vegetation quality, and biological rarity score.

Data Sources: Tri-County Region land use/land cover; Michigan Natural Features Inventory (MNFI) Biotics Database (6/2007); Clinton, Eaton, and Ingham County parcel layer; and the National Hydrologic Database (NHD) streams (1:100,000).



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Figure 4. Tri-County Region Potential Conservation Areas

## Natural Communities of the Tri-County Region

The Michigan Natural Features Inventory has been inventorying and tracking Michigan's threatened, endangered, and special concern species and high quality natural communities since 1979. As of April 2009, MNFI tracked 426 plant species, 216 animal species, and 76 natural community types. In addition to species and natural communities, MNFI also tracks other natural features such as colonial bird nesting colonies and significant geological features. The tracked species include those with Federal and State legal protection and special concern species which have no legal protection. Like the special concern species, natural communities also have no legal protection status. As of April 2009, The MNFI database contained approximately 15,559 records of these natural features (plants, animals, and natural communities) ranging from historic information to very current information from the latest field season. The data in the MNFI database are based on ground-truthed observations by reliable experts and are continually updated. The database is the most complete record of Michigan's sensitive species and natural features. The MNFI database is more than a presence/absence database. Among other information, it contains dates of sightings, global and state imperilment rankings for species, and a quality (or viability) ranking for individual occurrences.

### **Limitations:**

The primary limitations to MNFI's element occurrence database are 1) it contains static information – each specific element occurrence is updated infrequently, 2) there is a lack of a statewide systematic survey, and 3) in some cases, it contains old and/or general (imprecise location) records. Biological information from the field is collected annually from MNFI staff and other reliable contributors. Once this information is entered into the database, it may be decades before it gets updated again. For example, approximately 36% of the records in the database are over 20 years old. More significantly, there has never been a systematic survey of element occurrences in the state. This means that something can be said about the biological significance of an area containing element occurrence records; however nothing can be said definitively about the biological significance of areas with no known element occurrence records. This is where the aphorism “absence of evidence is not evidence of absence” comes into play. Related to this, is that there have been small areas of the state that have been systematically surveyed; however they are predominantly owned by public agencies or non-governmental organizations such as The Nature Conservancy.

As of spring 2009, 12 natural community element occurrences (“EOs”) have been documented in the Tri-County Region, encompassing only 2,160 ac (870 ha), or 0.2% of the region (Table 4 and Figures 5-7). In general, EOs are examples of natural communities that exhibit high ecological integrity, including relatively unaltered structure, a full complement of characteristic native species, and functioning ecological processes. Two occurrences of floodplain forest account for 1,921 ac (780 ha) of the 2,160 acres of high quality natural communities in the region. Only five occurrences of mesic southern forest (beech – sugar maple forest) have been documented from the Tri-County Region, encompassing 194 ac (79 ha), or a mere 0.02% of the original acreage of this matrix forest type (MNFI Biotics database 2009). Many natural communities once prevalent in the region are not represented by any documented occurrences. Among these are dry-mesic southern forest, rich tamarack swamp, and southern hardwood swamp (mixed hardwood swamp) (Table 5). Among the 12 natural community occurrences, only

four are considered to be of good or excellent viability ( $\geq$ B-rank), including one floodplain forest and three small inland salt marshes (MNFBI Biotics database 2009). Remnant mesic southern forests are generally small and poorly buffered, all occurring in the urban setting of metropolitan Lansing. Other documented threats to the integrity of natural community occurrences in the Tri-County Region include invasive plant species, hydrologic alteration, and human recreational use.

**Table 4. Summary of Natural Community Element Occurrences in the Tri-County Region**

Natural Community	# EOs	Acreage
Floodplain Forest	2	1,921
Inland Salt Marsh	3	13
Mesic Southern Forest	5	194
Poor Conifer Swamp	1	30
Sandstone Cliff	1	2
<b>Total</b>	<b>12</b>	<b>2,160</b>

**Table 5. Potential Natural Communities of the Tri-County Region (see Kost et al. 2007)**

PALUSTRINE	TERRESTRIAL
<b>Marsh</b>	<b>Prairie</b>
Submergent Marsh	Dry-mesic Prairie
Emergent Marsh	Mesic Sand Prairie
Southern Wet Meadow	Mesic Prairie
Inland Salt Marsh	Hillside Prairie
Intermittent Wetland	<b>Savanna</b>
Coastal Plain Marsh	Oak Barrens
<b>Prairie</b>	Oak Openings
Wet Prairie	<b>Forest</b>
Wet-mesic Prairie	Dry Southern Forest
Wet-mesic Sand Prairie	Dry-mesic Southern Forest
<b>Fen</b>	Mesic Southern Forest
Prairie Fen	<b>Inland Cliff</b>
<b>Bog</b>	Sandstone Cliff
Bog	
<b>Shrub</b>	
Southern Shrub-Carr	
Inundated Shrub Swamp	
<b>Forest</b>	
Poor Conifer Swamp	
Rich Conifer Swamp	
Rich Tamarack Swamp	
Hardwood-Conifer Swamp	
Southern Hardwood Swamp	
Floodplain Forest	

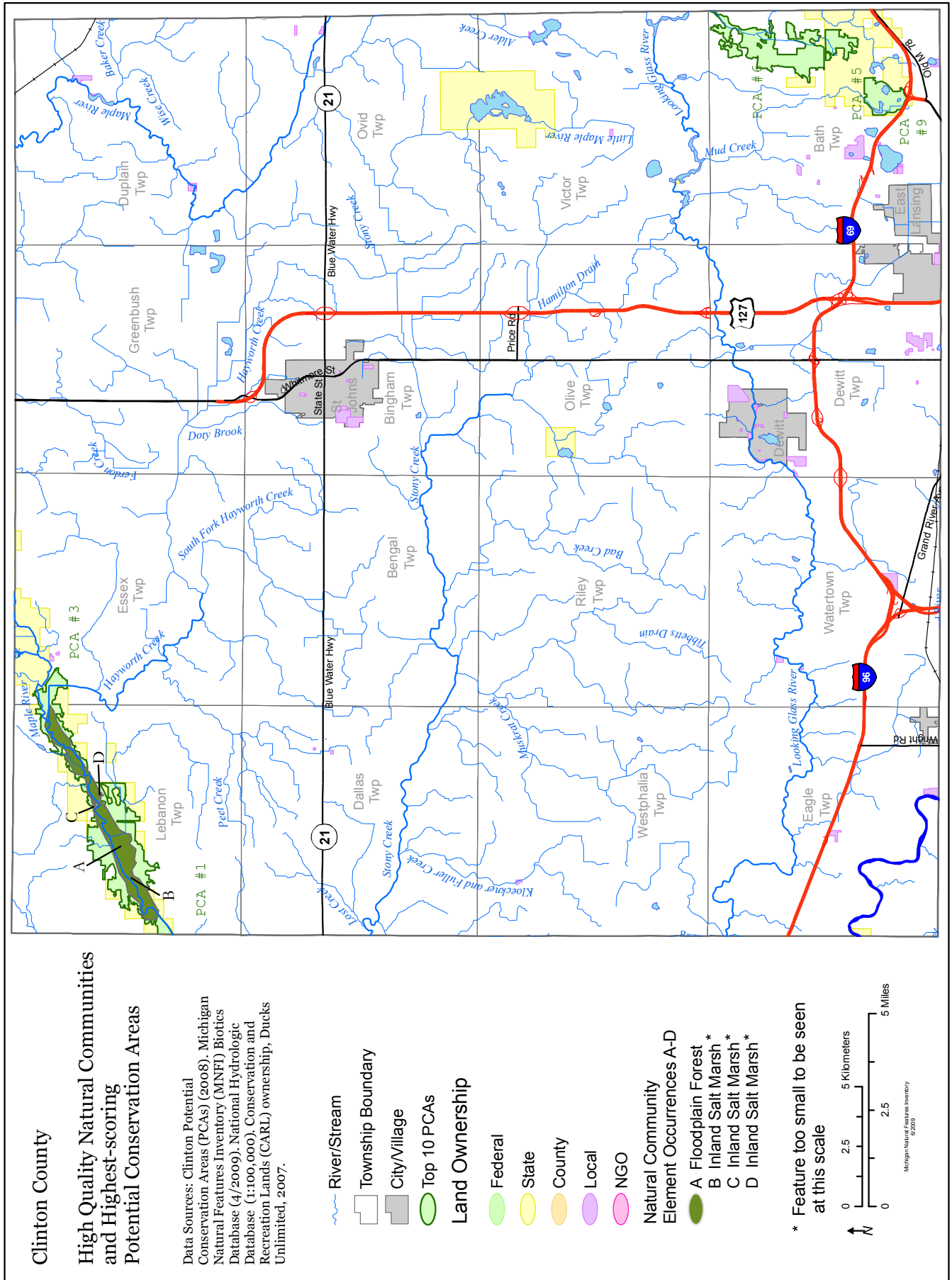


Figure 5. Clinton County: Natural Communities and Potential Conservation Areas

## Eaton County

### High Quality Natural Communities and Highest-scoring Potential Conservation Areas

Data Sources: Eaton Potential Conservation Areas (PCAs) (2008). Michigan Natural Features Inventory (MNFI) Biotics Database (4/2009). National Hydrologic Database (1:100,000). Conservation and Recreation Lands (CARL) ownership, Ducks Unlimited, 2007.

River/Stream

Township boundaries

City/Village

Top 10 PCAs

Land Ownership

Federal

State

County

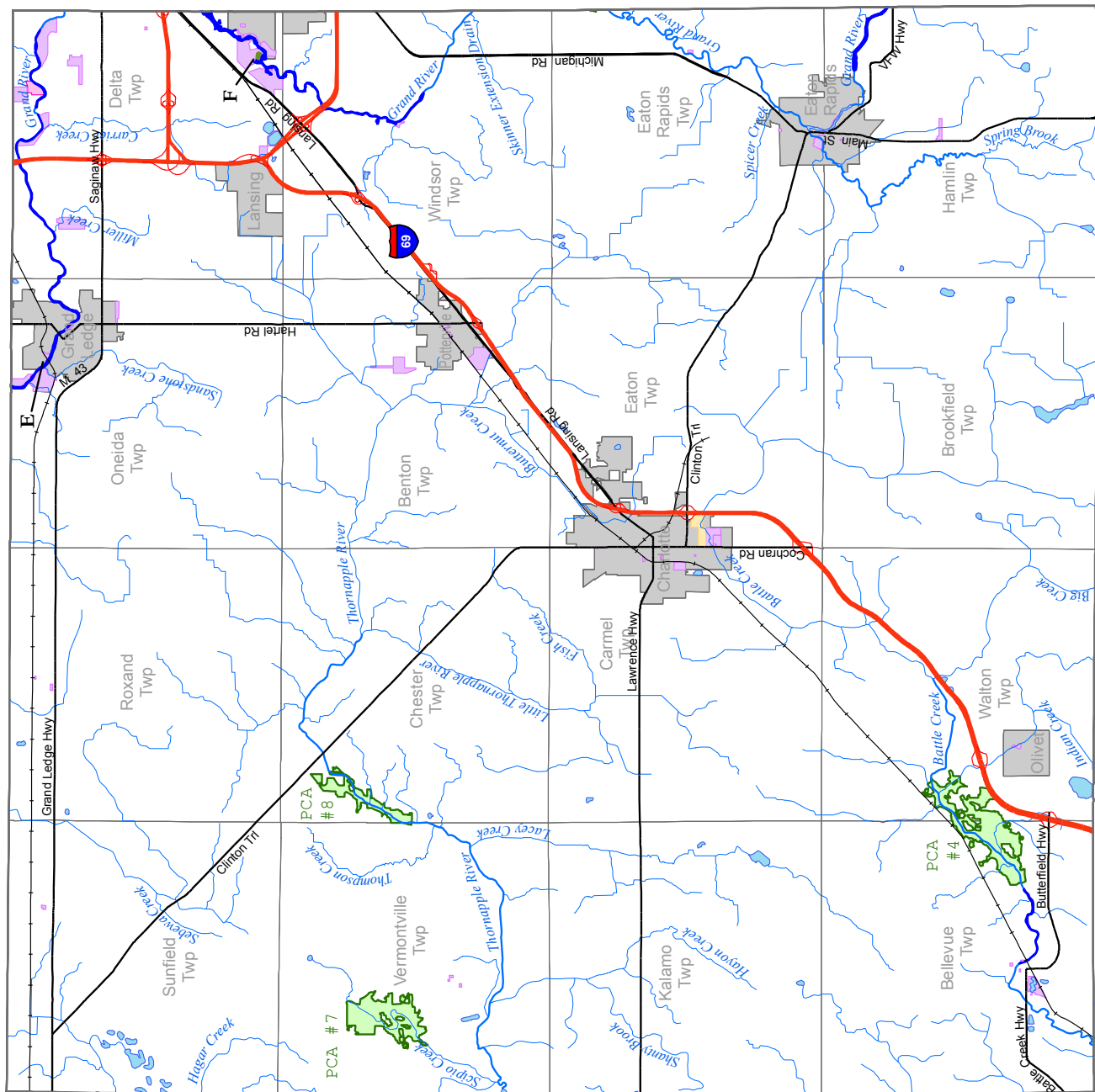
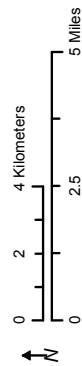
Local

NGO

Natural Community Element Occurrences E-F

E Sandstone Cliff\*  
F Mesic Southern Forest

\* Feature too small to be seen at this scale



Michigan Natural Features Inventory  
© 2008

Figure 6. Eaton County: Natural Communities and Potential Conservation Areas

# Ingham County High Quality Natural Communities and Highest-scoring Potential Conservation Areas

Data Sources: Ingham Potential Conservation Areas (PCAs) (2008), Michigan Natural Features Inventory (MNFI) Biotics Database (4/2009), National Hydrologic Database (1:100,000), Conservation and Recreation Lands (CARL) ownership, Ducks Unlimited, 2007.

- River/Stream
- Township boundaries
- City/Village
- Top 10 PCAs
- Land Ownership
  - Federal
  - State
  - County
  - Local
  - NGO

- Natural Community Element Occurrences G-L
  - G Poor Conifer Swamp
  - H Mesic Southern Forest
  - I Mesic Southern Forest
  - J Mesic Southern Forest
  - K Mesic Southern Forest
  - L Floodplain Forest

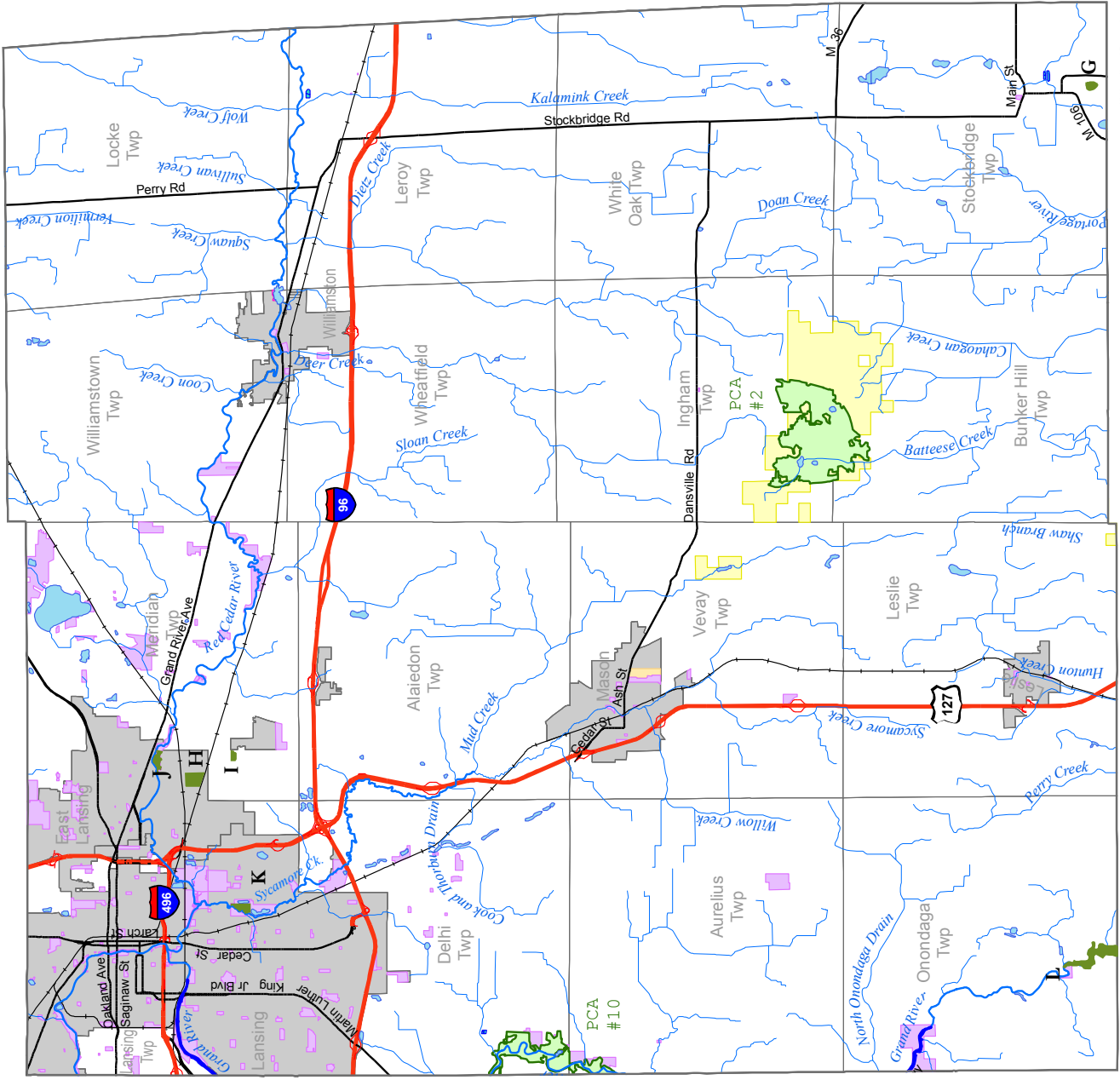
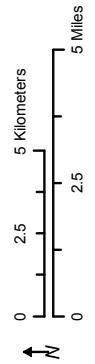


Figure 7. Ingham County: Natural Communities and Potential Conservation Areas

## Natural Community Element Occurrence Descriptions by County

CLINTON COUNTY (See Figure 5.)

### Floodplain Forest

#### Maple River Floodplain

**Location: T08N R04W S16, 14, 11, 1, 20, 17, 21, 19, 12, 10, 15**

This extensive, mature floodplain forest occurs in a broad outwash channel associated with the Maple River in northwestern Clinton County. The wide first bottom is mostly forested, dominated by silver maple (*Acer saccharinum*) and green ash (*Fraxinus pennsylvanica*), with most mature trees between 70 and 90 years old. Occasional very large cottonwoods (*Populus deltoides*) and bur oaks (*Quercus macrocarpa*) are scattered throughout the floodplain. Snags and large diameter downed wood are distributed throughout the occurrence. Frequently flooded, non-forested areas on saturated or inundated mucky soils are dominated by buttonbush (*Cephalanthus occidentalis*). Numerous oxbows and sloughs characterize the site. The site is narrowly buffered by young dry-mesic southern forest in an otherwise agricultural landscape. Non-native invasive species, including dame's rocket (*Hesperis matronalis*), are infrequent, but pose a threat to the integrity of the floodplain forest.

### Inland Salt Marsh

#### Maple River Floodplain

**Location: T08N R04W S20**

This site is one of three inland salt marshes embedded within an extensive floodplain forest along the Maple River. These small wetlands are the only remaining inland salt marshes known to occur in Michigan. These three in This approximately 200 square meter marsh is associated with a small salt seepage. Water samples are high in calcium, sodium, magnesium and potassium. A shallow inundated zone is ringed by a spike-rush (*Eleocharis* sp.), associated with duckweed (*Lemna minor*) and cursed crowfoot (*Ranunculus sceleratus*). An outer ring of vegetation is characterized by blue-joint (*Calamagrostis canadensis*), reed canary grass (*Phalaris arundinacea*), lake sedge (*Carex lacustris*), and several additional species. Potential threats to this high quality marsh include invasive species and off-road vehicular traffic.

#### Maple River Salt Marsh #1

**T08N R04W S15**

This site is one of three inland salt marshes embedded within an extensive floodplain forest along the Maple River. These small wetlands are the only remaining inland salt marshes known to occur in Michigan. This occurrence is separated from the river by a strip of floodplain forest, and is dominated by sedges in spring, and composites and grasses in autumn. A small halozone (salt-influenced zone) with high concentrations of sodium, calcium, and potassium supports two state-listed plant species, including the only currently documented site for dwarf spike-rush (*Eleocharis parvula*) and one of two modern sites for Olney's bulrush (*Schoenoplectus americanus*). No threats to the integrity of this salt marsh were noted in the 1982 field survey.

**Maple River Salt Marsh #2**  
**T08N R04W S15**

This site is one of three inland salt marshes embedded within an extensive floodplain forest along the Maple River. These small wetlands are the only remaining inland salt marshes known to occur in Michigan. This occurrence is located at the base of a steep north-facing slope, where a small halozone supports small brine pools and marsh vegetation, including the state-endangered three-square bulrush (*Schoenoplectus americanus*). Associated species include narrow-leaved cat-tail (*Typha angustifolia*), spearscale (*Atriplex patula*), spike-rush (*Eleocharis rostellata*), and Eastern lined aster (*Aster lanceolatus*). Potential threats to this high quality marsh include hydrologic disruption and invasive species.

**EATON COUNTY** (See Figure 6.)

**Sandstone Cliff**

**Ledges**

**T04N R04W S2, 3**

The Ledges is a north- to northeast-facing exposure of Eaton sandstone along a 0.3 mile stretch of the Grand River in the city of Grand Ledge, representing the only documented occurrence of the state-imperiled sandstone cliff community in the Lower Peninsula. The cliffs are largely shaded by a forested canopy and subcanopy dominated by sugar maple (*Acer saccharum*) and witch-hazel (*Hamamelis virginiana*). The dry rock lip supports bush honeysuckle (*Diervilla lonicera*) and common polypody (*Polypodium virginianum*). The cliff faces are generally moist, with seepy overhangs near the base. Vertical exposures are partially vegetated by lichens and mosses, including several species that occur primarily in northern Michigan. Vascular plants occurring south of their primary ranges include mountain maple (*Acer spicatum*) and dwarf Canadian primrose (*Primula mistassinica*). The Ledges have a long history of human use, with many areas scraped bare of vegetation by rock climbers. Excessive foot traffic and run-off from cleared uplands adjacent to the cliff threaten the viability of this unique site.

**Mesic Southern Forest**

**Anderson Nature Park**

**T04N R03W S35, 36**

Anderson Nature Park contains a small remnant of mature mesic southern forest on sandy loam, the matrix land cover in the region circa 1800. This occurrence is dominated by American beech (*Fagus grandifolia*), red oak (*Quercus rubra*), and white ash (*Fraxinus americana*), including large, mature trees. South-facing slopes and river bluffs are dominated by white oak (*Quercus alba*). The forest floor contains typical spring-flowering herbs, including Canada violet (*Viola canadensis*), large white trillium (*Trillium grandiflorum*), and yellow trout lily (*Erythronium americanum*). Numerous well-used trails pass through the site, and the presence of scattered stumps and poorly formed, open-grown canopy trees indicates historic selective cutting. The forest is buffered by early successional forest and old fields. Invasive species, including honeysuckles (*Lonicera* spp.) and Japanese barberry (*Berberis thunbergii*) threaten the site. The small size of the forest and its presence in a metropolitan area threaten its long-term viability.

## **INGHAM COUNTY (See Figure 7.)**

### **Poor Conifer Swamp**

#### **Stockbridge Swamp**

**T01N R02E S35**

Stockbridge Swamp represents the only poor conifer swamp documented in the Tri-County region. This swamp is situated in a small, peat-filled kettle depression, and is dominated by black spruce (*Picea mariana*), tamarack (*Larix laricina*), and highbush blueberry (*Vaccinium corymbosum*), with a ground layer of sphagnum mosses (*Sphagnum* spp.). The poor conifer swamp is buffered by southern hardwood swamp dominated by silver maple (*Acer saccharinum*). Adjacent wetland acreage has been converted to muck farms. Poor landscape context, localized invasion by the invasive shrub glossy buckthorn (*Rhamnus frangula*), and high deer densities threaten the integrity of this site.

### **Mesic Southern Forest**

#### **Baker Woodlot**

**T04N R01W S19**

Baker Woodlot is a moderate-sized, mature mesic southern forest on the campus of Michigan State University, dominated by sugar maple (*Acer saccharum*), red oak (*Quercus rubra*), and American beech (*Fagus grandifolia*). Despite poor landscape context and a history of disturbance, this site supports high vascular plant species richness, with 372 taxa documented in one study, including the state-listed goldenseal (*Hydrastis canadensis*), showy orchis (*Galearis spectabilis*) and ginseng (*Panax quinquefolius*) (Stevens and Beach 1980, MNFI Biotics database 2009). Several vernal ponds occur within the forest, providing important breeding habitat for amphibians. Invasive species, including Japanese barberry (*Berberis thunbergii*) and garlic mustard (*Alliaria petiolata*) occur at low densities and may be eradicable. Impressive displays of flowering large white trillium (*Trillium grandiflorum*) and other spring-flowering herbs indicate low deer browse pressure. Baker Woodlot is one of five high quality occurrences of mesic southern forest recorded in the Tri-County region, three of which occur on M.S.U.'s campus.

#### **Toumey Woods**

**T04N R01W S30**

Toumey Woods is a small, old-growth mesic southern forest on medium-textured ground moraine, surrounded by agricultural fields on M.S.U.'s campus. Sugar maple (*Acer saccharum*) is the dominant tree in all size classes, associated with American beech (*Fagus grandifolia*), basswood (*Tilia americana*), black cherry (*Prunus serotina*), slippery elm (*Ulmus rubra*), and white ash (*Fraxinus americana*). Common shrubs and ground layer species include red-berried elder (*Sambucus racemosa*), downy Solomon-seal (*Polygonatum pubescens*), yellow trout lily (*Erythronium americanum*), spring beauty (*Claytonia virginica*), jack-in-the-pulpit (*Arisaema triphyllum*), and cut-leaved toothwort (*Dentaria laciniata*). The site was never cut or grazed prior to its donation to M.S.U. in 1939, and is registered as a National Natural Landmark by the U.S. National Park Service. Although Toumey Woods is the least disturbed mesic southern forest recorded in the county, its small size and poor landscape context threaten its long-term viability.

## **Sanford Woods**

**T04N R01W S18, 17, 19**

Sanford Woods is one of three high quality occurrences of mesic southern forest on the campus of Michigan State University. This site is dominated by sugar maple (*Acer saccharum*), with American beech (*Fagus grandifolia*) subdominant, becoming co-dominant with oaks (*Quercus* spp.) on a terrace near the Red Cedar River. A small area of floodplain forest is dominated by silver maple (*Acer saccharinum*). Common ground layer species include enchanter's-nightshade (*Circaea lutetiana*), wood nettle (*Laportea canadensis*), false spikenard (*Smilacina racemosa*), common blue violet (*Viola sororia*), large white trillium (*Trillium grandiflorum*), and wild ginger (*Asarum canadense*). Sanford Woods has the most urban landscape context of the three mesic southern forest occurrences on the Michigan State University campus, and is also significantly impacted by heavy trail use and a history of timber management.

## **Scott Woods**

**T04N R02W S27**

Scott Woods is a small, mature example of mesic southern forest on sandy loam situated in an urban setting. Sugar maple (*Acer saccharum*), American beech (*Fagus grandifolia*), and white ash (*Fraxinus americana*) dominate the canopy. Sugar maple dominates the subcanopy and shrub layer, where it is associated with spicebush (*Lindera benzoin*). Common herbs include wood nettle (*Laportea canadensis*), Canada violet (*Viola canadensis*), wild geranium (*Geranium maculatum*), and blue cohosh (*Caulophyllum thalictroides*). The mesic southern forest is adjacent to a mature floodplain forest dominated by silver maple (*Acer saccharinum*). Old roads and trails bisect the forest, and heavy foot traffic has locally impacted the forest floor. Despite its poor landscape context, Scott Woods is one of the highest quality examples of mesic southern forest documented in the Tri-County region.

## **Floodplain Forest**

### **Onondaga Floodplain**

**T01S R02 W S 16, 9, 4, 10, 15; T01N R02W S 28, 33**

One of two documented high quality occurrences of floodplain forest in the Tri-County region, Onondaga Floodplain consists of an extensive, contiguous tract dominated by silver maple (*Acer saccharinum*), with scattered bur oak (*Quercus macrocarpa*) and slippery elm (*Ulmus rubra*). Other woody species include hackberry (*Celtis occidentalis*), sycamore (*Platanus occidentalis*), green ash (*Fraxinus pennsylvanica*), prickly-ash (*Zanthoxylum americanum*), bitternut hickory (*Carya cordiformis*), and spicebush (*Lindera benzoin*). Buttonbush (*Cephalanthus occidentalis*) dominates some open sloughs. The forest has been impacted by historic logging and Dutch elm disease, and is characterized by simplified forest structure and relatively low diversity. The site is poorly buffered, surrounded by agricultural lands, roads, and rural residential development.

## Information Gaps

The Tri-County Region has relatively few documented high quality examples of natural communities. Of Michigan's 15 metropolitan areas, the Tri-County Region surpasses only four areas that are comprised of a single county each (Bay City, Monroe, Flint, and Saginaw) in number of natural community occurrences, illustrating the relative scarcity of intact natural areas in the Lansing – East Lansing area. Although Clinton, Eaton, and Ingham counties have not been systematically inventoried, the fragmented, agricultural landscape that characterizes the region is unlikely to support many undocumented high quality sites. Surveys for remnant natural communities should focus on high-scoring PCAs with significant areas of intact natural cover. An examination of aerial photographs revealed many of these PCAs have potential to support examples of natural communities that were once prevalent in the Tri-County Region. Areas of natural cover that do not meet standards for inclusion in the MNFI database of high quality natural communities may nevertheless be locally important for the conservation of ecological function and biodiversity.

Mesic southern forest (beech – sugar maple forest) accounted for greater than 60% of the surface area of the Tri-County Region circa 1800, yet only five high quality extant occurrences have been documented by MNFI. Most of the remaining mesic southern forest occurs as fragmented woodlots in agricultural or urban landscapes. These woodlots serve as the only remaining seed sources for the potential recolonization of the local landscape by native trees, shrubs, and herbs, and, as such, the identification of the highest quality sites is warranted. No high quality occurrences of dry-mesic southern forest (oak – hickory forest), oak savanna, or prairie have been documented in the Tri-County Region, but some areas of closed-in oak forest and abandoned agricultural fields may be restorable with the use of prescribed fire and other restoration techniques. Oak forest, woodland, and savanna communities were always relatively restricted in the Tri-County Region to a few areas, centered on Bath Township in Clinton County, Bunker Hill and Stockbridge townships in Ingham County, and Onondaga and Hamlin townships in Ingham and Eaton counties, respectively. Savanna restoration should be focused in these areas.

Riparian forests, although fragmented, have fared better than upland forests, with several contiguous stretches occurring along streams and rivers in the three-county area. These forests serve as functional pathways for dispersal of terrestrial and aquatic plant and animal species, and represent opportunity for the conservation of much of the region's remaining biodiversity. Especially valuable are riparian corridors adjacent to areas of relatively intact upland habitats, as occurs in PCAs 1914 and 968, among others. The riparian areas provide linkages to upland habitats that are otherwise fragmented and isolated in the region. Non-floodplain wetlands have suffered steeper declines than floodplain forests, with no extant high quality occurrences of the most characteristic types (e.g., rich tamarack swamp, southern hardwood swamp) documented in the region. Widespread hydrologic alteration and conversion for agricultural use have significantly degraded wetlands in all three counties. However, the region does contain the only three inland salt marshes known to occur in Michigan. Systematic surveys should be conducted to identify the best remaining wetlands in the region. Hydrologic restoration may be required, even in the highest quality remaining sites, to improve wetland function and diversity.

A number of threats to the ecological integrity of remaining natural areas in the Tri-County region have been documented. In addition to the pervasive effects of resource extraction, habitat conversion, and landscape fragmentation that have replaced most of the region's natural cover with agricultural and urban development are several "modern" threats, including invasive native and non-native plants, animals, fungi, and microbes, overabundant deer, and climate change. The conservation of the region's ecological resources will require that these threats be minimized and mitigated. Examples of specific threats to high quality natural communities are documented in the Summary of Natural Community Elements (see above).

### **Recommendations**

- Inventory of high-scoring PCAs for all natural communities (see Table 5)
- Targeted inventory of lower-scoring PCAs with potential for rare natural communities
- Identification of important habitat corridors and areas of restorable natural cover
- Identification of regional and site-specific threats to identified areas
- Development of management, restoration, and protection plans for identified areas

## Rare Plant Diversity of the Tri-County Region

### Overview

According to the MNFI statewide database, 42 rare plant species have been documented for Clinton, Eaton, and Ingham counties, comprising a total of (72) rare plant occurrences known for the Tri-County Region. In terms of richness, the total of 42 identified rare taxa is significant in that it represents 10% of the listed rare flora of the state. Summarized in terms of rare plant diversity by county (and noting that several species have occurrences in more than one county), 15 rare plant species have been documented in Clinton County, 10 rare plant species have been documented in Eaton County, and 25 rare plant species have been documented in Ingham County. Tables 6 and 7 provide summaries of the extant and historical (records older than 40 years) or extirpated rare plant species, respectively, of the Tri-County Region, including federal and state listing status, global and state ranks, and the number of occurrences for each species.

Although collectively the number of documented rare species for the Tri-County Region is significant, the number of presumed extant (existing) records (30 EOs) is a relatively small percentage (41%) of the total occurrences documented, likely reflecting the high degree of land clearing and habitat alteration that have occurred in this area. The extant species are strongly related to riparian habitats, particularly floodplain forest, which corresponds with the significant acreage of this type remaining among the tracked natural community occurrences described earlier. Riparian forests also comprise an important component of the remaining intact natural corridors within the region. Species with a strong to nearly exclusive association with floodplain forest include rock cress, Davis's sedge, cat-tail sedge, beak grass, green violet, twinleaf, cup-plant, and snow trillium. Of the remaining extant species, two taxa, dwarf spike-rush and Olney's bulrush, are restricted to salt marsh, a globally rare natural community known only in Michigan in northern Clinton County within the Maple River drainage. Ginseng and goldenseal are strongly associated with beech-sugar maple dominated communities (mesic southern forest), the predominant circa 1800 forest cover type of the region.

Historical records (i.e.  $\geq 40$  yrs) make up the majority (59%) of the documented rare plant occurrences in the region. Many of these species are associated with riparian communities (floodplain forest) as well as well as other types of forested wetlands, including southern hardwood swamp, hardwood conifer swamp, and rich tamarack swamp. There are also a number of prairie species known to be associated with savanna communities (oak barrens and oak openings), which comprise Michigan's richest concentration of rare plant taxa, including such species as hairy angelica, purple milkweed, Cooper's milk-vetch, prairie false indigo, panicled hawkweed, Virginia flax, Clinton's bulrush, tall nut-rush, small skullcap, and Virginia spiderwort. While some extant examples are known, and additional remnants can be expected, most of Michigan's oak openings and oak barrens persist only as very small relicts, often consisting merely of roadside and other rights-of-way remnant prairie vegetation. In many cases, savanna communities have essentially been lost through succession and canopy closure through the loss of ecosystem and landscape level processes (e.g. wildfire) that formerly maintained natural community structure and function. Showy orchis is particularly notable, as it is represented by seven occurrences, the most of any rare plant species documented in the Tri-County Region; the lack of any extant occurrences is undoubtedly due to the outright loss and fragmentation of its principal natural community, mesic southern forest (See Figure 8.).

**Table 6. Rare plant species with extant element occurrence records in the Tri-County region.** Federal and State status, global and state ranks, and number of element occurrences (EOs) are listed.

Common Name	Scientific name	U.S. Status <sup>1</sup>	State Status <sup>2</sup>	Global Rank <sup>3</sup>	State Rank <sup>4</sup>	No. EOs	Primary Habitats and/or natural community types
Rock cress	<i>Arabis perstellata</i>	---	T	G5	S1	1	Riparian forests, floodplains
Prairie false indigo	<i>Baptisia lactea</i>	---	SC	G4Q	S3	1	Dry to mesic prairies
Gray birch	<i>Betula populifolia</i>		SC	G5	S3	1	Bog, Hardwood conifer swamp, Southern Shrub swamp
Davis's sedge	<i>Carex davisii</i>	---	SC	G4	S3	2	Riparian forests, floodplains
Cat-tail sedge	<i>Carex typhina</i>	---	T	G5	S1	2	Riparian forests, floodplains
American chestnut	<i>Castanea dentata</i>	---	E	G4	S1S2	2	Dry mesic to mesic southern forests
Beak grass	<i>Diarrhena obovata</i>	---	T	G4G5	S2	5	Riparian forests, floodplains
Dwarf spike-rush	<i>Eleocharis parvula</i>	---	E	G5	S1	1	Inland salt marsh
Green violet	<i>Hybanthus concolor</i>	---	SC	G5	S3	1	Riparian forests, floodplains, mesic southern forest
Goldenseal	<i>Hydrastis canadensis</i>	---	T	G4	S2	3	Mesic southern forest, riparian forests, floodplains
Twinleaf	<i>Jeffersonia diphylla</i>	---	SC	G5	S3	4	Mesic southern forest, riparian forests, floodplains
Red mulberry	<i>Morus rubra</i>	---	T	G5	S3	1	Riparian forests, floodplains
Ginseng	<i>Panax quinquefolius</i>	---	T	G3G4	S2	3	Mesic southern forest, riparian forests, floodplains
Olney's bulrush	<i>Schoenoplectus americanus</i>	---	E	G5	S1	1	Inland salt marsh
Cup-plant	<i>Silphium perfoliatum</i>	---	T	G5	S2	1	Riparian forests, floodplains
Snow trillium	<i>Trillium nivale</i>	---	T	G4	S2	1	Riparian forests, floodplains

<sup>1</sup>LE – listed endangered; LT – listed threatened; and C – species being considered for federal status.

<sup>2</sup>E – endangered; T – threatened; and SC – special concern.

<sup>3</sup>G1 – critically imperiled; G2 – imperiled; G3 – vulnerable; G4 – apparently secure; G5 – secure; and GNR – not ranked.

<sup>4</sup>S1 – critically imperiled; S2 – imperiled; S3 – vulnerable; S4 – vulnerable; S5 – demonstrably secure; and SU – possibly in peril, but status uncertain.

**Table 7. Historical and extirpated rare plant occurrence records in the Tri-County region.**  
Federal and State status, global and state ranks, and number of element occurrences (EOs) are listed.

Common Name	Scientific name	U.S. Status <sup>1</sup>	State Status <sup>2</sup>	Global Rank <sup>3</sup>	State Rank <sup>4</sup>	No. EOs	Primary Habitats and/or natural community types
Hairy angelica	<i>Angelica venenosa</i>	---	SC	G5	S3	3	Savannas, oak barrens, dry-mesic southern forest, lakeplain oak openings
Missouri rock cress	<i>Arabis missouriensis</i> var. <i>deamii</i>	---	SC	G4?	S2	1	Oak barrens, dry-mesic southern forest, lakeplain wet prairies
Rock cress	<i>Arabis perstellata</i>	---	T	G5T5	S1	1	Riparian forests, floodplains
Purple milkweed	<i>Asclepias purpurascens</i>	---	T	G4G5	S3	1	Lakeplain prairies, prairie fen, oak openings
Cooper's milk-vetch	<i>Astragalus neglectus</i>	---	SC	G4	S3	2	Alvar, oak barrens
Prairie false indigo	<i>Baptisia lactea</i>	---	SC	G4Q	S3	2	Dry to mesic prairies
Raven's-foot sedge	<i>Carex crus-corvi</i>	---	E	G5	SH	1	Emergent marsh, floodplain forest
False hop sedge	<i>Carex lupuliformis</i>	---	T	G3G4	S2	2	Southern hardwood swamp, floodplain forest
Hairy-fruited sedge	<i>Carex trichocarpa</i>	---	SC	G4	S2	2	Riparian forests, floodplains
Cat-tail sedge	<i>Carex typhina</i>	---	T	G5	S1	2	Riparian forests, floodplains
White lady-slipper	<i>Cypripedium candidum</i>	---	T	G4	S2	1	Prairie fen, lakeplain wet prairie
Small-fruited panic-grass	<i>Dichanthelium microcarpon</i>	---	SC	G5T5	S2	1	Southern hardwood swamp
Dwarf spike-rush	<i>Eleocharis parvula</i>	---	E	G5	S1	1	Inland salt marsh
Spike-rush	<i>Eleocharis radicans</i>	---	X	G5	SX	1	Bog
Showy orchis	<i>Galearis spectabilis</i>	---	T	G5	S2	7	Mesic southern forest, mesic northern forest, southern hardwood swamp, riparian forests, floodplains
Panicled hawkweed	<i>Hieracium paniculatum</i>	---	SC	G5	S2	1	Oak barrens, savannas
Goldenseal	<i>Hydrastis canadensis</i>	---	T	G4	S2	1	Mesic southern forest, riparian forests, floodplains

Table 7. continued

Common Name	Scientific name	U.S. Status <sup>1</sup>	State Status <sup>2</sup>	Global Rank <sup>3</sup>	State Rank <sup>4</sup>	No. EOs	Primary Habitats and/or natural community types
Whorled pogonia	<i>Isotria verticillata</i>	---	T	G2G3	S2	1	Bog, southern hardwood swamp, dry mesic northern forest
Virginia flax	<i>Linum virginianum</i>	---	T	G4G5	S2	1	Oak barrens, dry-mesic southern forest
Dwarf bulrush	<i>Lipocarpa micrantha</i>	---	SC	G4	S3	1	Coastal plain marsh
Broad-leaved puccoon	<i>Lithospermum latifolium</i>	---	SC	G4	S2	1	Riparian forests, floodplains
Virginia water-horehound	<i>Lycopus virginicus</i>	---	T	G5	S2	1	Riparian forests, floodplains
Virginia bluebells	<i>Mertensia virginica</i>	---	E	G5	S2	1	Riparian forests, floodplains
Ginseng	<i>Panax quinquefolius</i>	---	T	G4	S2S3	1	Mesic southern forest, riparian forests, floodplains
Heart-leaved plantain	<i>Plantago cordata</i>	---	E	G4	S1	1	Riparian forests, floodplains
Prairie fringed orchid	<i>Platanthera leucophaea</i>	LT	E	G2	S1	2	Lakeplain wet prairies, bog
Bog bluegrass	<i>Poa paludigena</i>	---	T	G3	S2	2	Southern hardwood swamp
Torrey's bulrush	<i>Schoenoplectus torreyi</i>	---	SC	G5?	S2S3	1	Intermittent wetland,
Tall nut-rush	<i>Scleria triglomerata</i>	---	SC	G5	S3	1	Dry to dry-mesic prairies, coastal plain marsh, lakeplain prairies, wet-mesic sand prairies
Small skullcap	<i>Scutellaria parvula</i>	---	T	G4	S2	1	Inland salt marsh
Virginia spiderwort	<i>Tradescantia virginiana</i>	---	SC	G5	S2	1	Dry sand prairie, oak barrens
Clinton's bulrush	<i>Trichophorum clintonii</i>	---	SC	G4	S3	2	Intermittent wetland, lakeplain prairies, wet-mesic sand prairie
Goosefoot com-salad	<i>Valerianaella chenopodiifolia</i>	---	T	G5	S1	1	Riparian forests, floodplains

<sup>1</sup>LE – listed endangered; LT – listed threatened; and C – species being considered for federal status.

<sup>2</sup>E – endangered; T – threatened; and SC – special concern; H – historical; X – state extirpated.

<sup>3</sup>G1 – critically imperiled; G2 – imperiled; G3 – vulnerable; G4 – apparently secure; G5 – secure; and GNR – not ranked; T – subspecies or varieties

<sup>4</sup>S1 – critically imperiled; S2 – imperiled; S3 – vulnerable; S4 – apparently secure; S5 – demonstrably secure; SH – only historical records known; and SU – possibly in peril, but status uncertain.

## Notable Rare Plant Element Occurrences by County

### Clinton County

Of the 42 rare plants species known for the Tri-County Region, 15 have been documented in Clinton County, although only less than half (9 of 21 EOs documented) comprise occurrences considered to be extant. Among the existing occurrences, two of the most significant for the county, as well as for the region, consist of two populations of state endangered species, Olney's bulrush (*Schoenoplectus americanus*) and dwarf spike-rush (*Eleocharis parvula*), both occurring in a globally rare salt marsh within the Maple River State Game Area (SGA). An occurrence of cat-tail sedge (*Carex typhina*) within the same SGA constitutes perhaps the exemplary occurrence of this species in the state. The locality of an historical occurrence of the globally rare, federal threatened and state endangered Eastern prairie fringed orchid (*Platanthera leucophaea*), documented in wetlands near Park Lake, has been searched by botanists without success. While the species may no longer exist in the original locality, this orchid, one of the rarest plants of eastern North America, should continue to be sought in potential habitat throughout the county and region. There is some evidence that further searching of remaining habitat patches on the periphery of Park Lake may have merit. Additional noteworthy occurrences elsewhere include populations of twinleaf (*Jeffersonia diphylla*) and goldenseal (*Hydrastis canadensis*) the latter associated with mesic southern forest communities. As described previously, these community types have been severely altered and converted in the Tri-County Region, with relatively small representative tracts remaining.

### Eaton County

The fewest rare plant elements and number of occurrences for the Tri-County Region are documented for Eaton County, comprised of only 10 species and 13 documented EOs, with only two extant occurrences. One occurrence of the state threatened ginseng (*Panax quinquefolius*) is known for the county, where it is considered of good quality within a mesic southern forest remnant. Ginseng is one of the most significant species of the region and of the state. It is sought as a medicinal species, and is often gathered illegally owing to the high value for dried roots exported largely to Asia. It is thought to have experienced severe decline in Michigan and throughout the Midwest because of heavy poaching pressure, and very little data exist confirming the existence of moderate to high quality populations. Eastern prairie fringed orchid, the most significant species documented for the county, is based on an historical specimen collected in the vicinity of Olivet in 1895. Despite the age of the record and its vague locality information, numerous wetlands occur within this region of the county and thus may provide potential habitat where this high priority species could persist.

### Ingham County

A total of 38 documented occurrences of 25 rare plant species have been documented in Ingham County, of which the majority, 22 EOs, are known only from historical records. This is not surprising given that several records were documented within the City of Lansing area, where habitat no longer remains or is likely to be minimal. Both the extant and historical records are strongly associated with two principal habitat types, upland mesic forests (mesic southern forest) and riparian zones (floodplain forest). Mesic southern forest remnants, such as tracts persisting within the Michigan State University campus, currently support populations of rare species such

as ginseng, goldenseal. This upland forest type also provided habitat for showy orchis (*Galearis spectabilis*), a state threatened species for which there are no current records for the county or elsewhere within the Tri-County Region, reflecting both the loss and degradation of tracts of this forest type. Several significant records of extant species are known for the Red Cedar River, including such floodplain forest species as American beak grass (*Diarrhena americana*), red mulberry (*Morus rubra*), Davis's sedge (*Carex davisii*), and green violet (*Hybanthus concolor*). The historical records include a number of species associated with oak barrens, savannas, and prairie grassland types now poorly represented in the county, represented by such records as hairy angelica (*Angelica venenosa*), purple milkweed (*Asclepias purpurascens*), prairie false indigo (*Baptisia lactea*), Clinton's bulrush (*Scirpus clintonii*), tall nut-rush (*Scleria triglomerata*), small skullcap (*Scutellaria parvula*), and Virginia spiderwort (*Tradescantia virginiana*). Such species may yet persist but typically tend to be relegated to roadsides, hedgerows, and other sites where artificially maintained openings support prairie remnants or elements of prairie vegetation. There is some potential for relatively intact remnants to occur but these would be small and likely restricted to steep hillsides and similar habitats that by virtue of their inaccessibility have avoided use and conversion.

## Information Gaps

As noted in the ecological overview, the Tri-County Region has very few documented high quality natural community occurrences. Although there are several areas with contiguous, intact natural cover, it is unlikely that many more high quality natural communities remain to be identified. Thus for several rare plant species known to have existing occurrences in these counties, the likelihood of discovering new populations is relatively small. There is an especially low likelihood of rediscovering some occurrences known only via historical records, particularly for species known to occur only in certain types of prairies (e.g. wet-mesic prairie) or other taxa requiring substantial tracts of undisturbed habitat to support the large populations necessary to maintain genetic vigor for long-term viability.

Many rare plants, however, can persist for long periods in small habitat remnants or artificially disturbed sites (e.g. rights-of-way), and thus the occurrence of high quality sites is not a prerequisite for the presence of rare plant populations. Given that nearly 2000 PCAs were identified for the Tri-County Region, of which 400 collectively scored in the highest two scoring PCA classes (highest and high, respectively), it is not unexpected that several rare plant occurrences would be identified during PCA field evaluations, including the documentation of rare plant species previously unknown for the Region.

Assessing the status and condition of existing occurrences as well as inventories to determine the same for numerous historical occurrences are primary information gaps for the Tri-County Region. Many occurrences, even existing records, have not been observed in several decades, and numerous records lack significant information fields. While it may not be feasible to systematically survey and assess all the known records of the region, occurrences can be prioritized by global rank and/or listing status. For example, Eastern prairie fringed orchid (*Platanthera leucophaea*) is a federal threatened and state endangered species, and ranked as globally imperiled (G2), and should be sought in suitable sites within and near its historically

known localities. Showy orchis (*Galearis spectabilis*) is a state threatened species that comprises the most occurrences (7) for a rare plant species in the Tri-County Region, yet is not known to be extant and therefore should be considered a priority species for future surveys.

A high percentage of existing records derive from occurrences known on public lands (state and local), and notably, some of the highest scoring PCAs consist of the large contiguous tracts represented by public land holdings, such as the Dansville State Game Area complex in Ingham County and the several Rose Lake Wildlife Area PCAs and the Maple River State Game Area in Clinton County. Despite the fact that additional detailed inventory should be completed in portions of these and other public lands, where there is high merit for surveys, considerable work needs to be completed on private lands to address another primary information gap for the Region. Because it is not feasible to survey all identified PCAs, surveys on private lands should be prioritized, with an emphasis on riparian systems (floodplain forest) and wetlands in general, which are known to support a high diversity of rare plant species and are more likely to consist of intact communities protected from conversion and development due to existing regulations.

Additional natural community types that should be emphasized for surveys include mesic southern forest, southern hardwood swamp, and prairie fen, as these are known to harbor several of the known rare plant occurrences for the region and would also comprise potential habitat for highly significant new species that could be documented for these counties.

## Rare Terrestrial Animals of the Tri-County Region

### Overview

Our assessment of the status of rare terrestrial animals in the Tri-County region is based on element occurrence (EO) records from the MNFI Biotics database. Eighty-eight EOs of 26 animal species were documented in the region. There were 52 rare animal EOs of 17 species recorded (Table 8 and Figure 8.). These species use a variety of forest, wetland, and grassland ecosystems. Six of the 17 species presumed extant have threatened or endangered status at the State or federal level (Table 8). Thirty-six historical EO records of 15 species were documented in the region (Table 9), which represents approximately 41% of the total animal EOs.

As described in the previous Natural Community section, the Tri-County region was dominated by forest, especially Beech – Sugar Maple Forest. Animals that rely on upland and lowland forest types have likely experienced the greatest declines within the region. Several rare species still considered extant such as Cerulean Warbler (*Dendroica cerulea*), Prothonotary Warbler (*Protonotaria citrea*), and Indiana Bat (*Myotis sodalis*), prefer mature riparian deciduous forest, and these species have undoubtedly declined since European settlement. Wetlands were abundant in the region circa 1800, but an estimated 50% of these wetlands have been lost and many of the remaining wetlands are now degraded. The following species with presumed extant records in the region are associated with wetlands: Common Moorhen (*Gallinula chloropus*), King Rail (*Rallus elegans*), Blanding’s Turtle (*Emys blandingii*), and Eastern Massasauga (*Sistrurus catenatus catenatus*). Since the Tri-County region was largely forested in presettlement times, grassland species were probably never common (see Brewer 1991). However, several grassland bird species increased in Michigan with deforestation and increasing amounts of open lands, including pastures and forage crops (Brewer 1991). Grassland species, such as Henslow’s Sparrow (*Ammodramus henslowii*), Grasshopper Sparrow (*Ammodramus savannarum*), and Dickcissel (*Spiza americana*), appear to have declined in Michigan since the early to mid 1900’s as agricultural practices have changed and reduced available grasslands (McPeck 1991, Beaver 1991, Zimmerman 1991). The conversion of pastures and hayfields to row crops in recent decades has impacted grassland birds by reducing nesting habitat.

Of the 26 rare species documented in the region, nine species, or about 35% of the total species recorded, only had historical records (i.e.  $\geq 20$  yrs) in our database. Similar to the species with extant records, these species occur in a variety of ecosystem types. Four of the nine species with only historical records have threatened or endangered status at the State or federal level (Table 9). Species with only historical records have suffered from the effects of forest, wetland, and grassland destruction and degradation. Woodland Vole (*Microtus pinetorum*), Wood Turtle (*Clemmys insculpta*), and Copperbelly Watersnake (*Nerodia erythrogaster neglecta*) use upland or wetland forests, which have become highly fragmented since presettlement times due to deforestation and conversion to agriculture and other uses. Wood Turtle and Copperbelly Watersnake are reliant on riparian habitats, such as floodplain forests. Other species, such as Swamp Metalmark (*Calephelis mutica*), Blanchard’s Cricket Frog (*Acris crepitans blanchardi*), and Spotted Turtle (*Clemmys guttata*), have been impacted by wetland loss and degradation, such as partial drainage, nutrient enrichment, and invasive species. The conversion of native grasslands, oak barrens, and prairie fens likely contributed to declines of Barrens Buckmoth (*Hemileuca maia*), Culvers Root Borer (*Papaipema sciata*), and Least Shrew (*Cryptotis parva*).

**Table 8. Presumed extant element occurrence records for rare animals documented in the Tri-County region.** Federal and State status, global and State ranks, and number of element occurrences (EOs) are listed.

Category/Common Name	Scientific name	U.S. Status <sup>1</sup>	State Status <sup>2</sup>	Global Rank <sup>3</sup>	State Rank <sup>4</sup>	No. EOs	Primary Habitats
<b>Birds</b>							
Cooper's Hawk	<i>Accipiter cooperii</i>	---	SC	G5	S3S4	1	Upland Forests
Henslow's Sparrow	<i>Ammodramus henslowii</i>	---	E	G4	S2S3	4	Grasslands
Grasshopper Sparrow	<i>Ammodramus savannarum</i>	---	SC	G5	S3S4	5	Grasslands
Great Blue Heron							
Rookery	<i>Ardea herodias</i>	---	---	G5	SU	3	Forests/Wetlands
Cerulean Warbler	<i>Dendroica cerulea</i>	---	T	G4	S3	2	Lowland Forests
Peregrine Falcon	<i>Falco peregrinus</i>	---	E	G4	S1	1	Cliffs/Artificial Structures
Common Moorhen	<i>Gallinula chloropus</i>	---	T	G5	S3	1	Herbaceous Wetlands
Prothonotary Warbler	<i>Protonotaria citrea</i>	---	SC	G5	S3	2	Lowland/Floodplain Forests
King Rail	<i>Rallus elegans</i>	---	E	G4	S1	2	Herbaceous Wetlands
Dickcissel	<i>Spiza americana</i>	---	SC	G5	S3	2	Grasslands
<b>Insects</b>							
Tamarack Tree Cricket	<i>Oecanthus laticis</i>	---	SC	G1G2	S1S2	4	Wetlands (with Tamarack)
Pinetree Cricket	<i>Oecanthus pini</i>	---	SC	GNR	S1S2	2	White Pine Forests
Regal Fern Borer	<i>Papaipema speciosissima</i>	---	SC	G4	S2S3	1	Lowland Forests
<b>Mammals</b>							
Indiana Bat	<i>Myotis sodalis</i>	LE	E	G2	S1	1	Riparian Forests/Savanna
<b>Reptiles</b>							
Blanding's Turtle	<i>Emys blandingii</i>	---	SC	G4	S3	14	Wetlands/Open Water
Eastern Massasauga	<i>Sistrurus catenatus catenatus</i>	C	SC	G3G4	S3S4	5	Herbaceous Wetlands
Eastern Box Turtle	<i>Terrapene carolina carolina</i>	---	SC	G5	S2S3	2	Upland Forests

<sup>1</sup>LE – listed endangered; LT – listed threatened; and C – species being considered for federal status.

<sup>2</sup>E – endangered; T – threatened; and SC – special concern.

<sup>3</sup>G1 – critically imperiled; G2 – imperiled; G3 – vulnerable; G4 – apparently secure; G5 – secure; and GNR – not ranked.

<sup>4</sup>S1 – critically imperiled; S2 – imperiled; S3 – vulnerable; S4 – vulnerable; S5 – demonstrably secure; and SU – possibly in peril, but status uncertain.

**Table 9. Historical element occurrence records for rare animals documented in the Tri-County region.**  
Federal and State status, global and State ranks, and number of element occurrences (EOs) are listed.

Category/Common Name	Scientific name	U.S. Status <sup>1</sup>	State Status <sup>2</sup>	Global Rank <sup>3</sup>	State Rank <sup>4</sup>	No. EOs	Primary Habitats
<b>Birds</b>							
Great Blue Heron	<i>Ardea herodias</i>	---	---	G5	SU	6	Forests/Wetlands
King Rail	<i>Rallus elegans</i>	---	E	G4	S1	4	Herbaceous Wetlands
<b>Insects</b>							
Swamp Metalmark	<i>Calephelis mutica</i>	---	SC	G3	S1S2	1	Herbaceous Wetlands
Barrens Buckmoth	<i>Hemileuca maia</i>	---	SC	G5	S2S3	2	Oak Barrens/Herbaceous Wetlands
Culvers Root Borer	<i>Papaipema sciata</i>	---	SC	G3G4	S2S3	1	Prairies/Prairie Fens
Regal Fern Borer	<i>Papaipema speciosissima</i>	---	SC	G4	S2S3	2	Lowland Forests
<b>Mammals</b>							
Least Shrew	<i>Cryptotis parva</i>	---	T	G5	S1S2	2	Grasslands
Woodland Vole	<i>Microtus pinetorum</i>	---	SC	G5	S3S4	2	Forests
Indiana Bat	<i>Myotis sodalis</i>	LE	E	G2	S1	1	Riparian Forests/Savanna
<b>Amphibians and Reptiles</b>							
Blanchard's Cricket Frog	<i>Acris crepitans blanchardi</i>	---	T	G5	S2S3	5	Herbaceous Wetlands/Open Water
Spotted Turtle	<i>Clemmys guttata</i>	---	T	G5	S2	3	Herbaceous Wetlands/Open Water
Wood Turtle	<i>Clemmys insculpta</i>	---	SC	G4	S2S3	1	Streams/Riparian Forests
Copperbelly Water Snake	<i>Nerodia erythrogaster neglecta</i>	LT	E	G5	S1	2	Floodplain Forests/Shrub Wetlands
Eastern Massasauga	<i>Sistrurus catenatus catenatus</i>	C	SC	G3G4	S3S4	3	Herbaceous Wetlands
Eastern Box Turtle	<i>Terrapene carolina carolina</i>	---	SC	G5	S2S3	1	Upland Forests

<sup>1</sup>LE – listed endangered; LT – listed threatened; and C – species being considered for federal status.

<sup>2</sup>E – endangered; T – threatened; and SC – special concern.

<sup>3</sup>G1 – critically imperiled; G2 – imperiled; G3 – vulnerable; G4 – apparently secure; G5 – secure; and GNR – not ranked.

<sup>4</sup>S1 – critically imperiled; S2 – imperiled; S3 – vulnerable; S4 – vulnerable; S5 – demonstrably secure; and SU – possibly in peril, but status uncertain.

## Notable Rare Animal Element Occurrences by County

### Clinton County

Twenty-seven EOs of 16 species were documented in Clinton County, of which 17 occurrences of 10 species are presumed extant and 10 EOs of seven species are considered historical. Six of the species recorded in the region are State threatened or endangered. Most of the rare animal species documented in Clinton County are associated with open wetlands (i.e., herbaceous or open water dominated) and forested ecosystems. Two State-listed wetland bird species, King Rail and Common Moorhen, were recorded in the vicinity of the Rose Lake Wildlife Research Area. Both species use herbaceous wetlands, such as emergent marshes and wet meadows. Records exist in the County for Blanchard's Cricket Frog, Spotted Turtle, Blanding's Turtle, and Eastern Massasauga, which use herbaceous wetlands or shallow open water areas like ponds, lakes, and slow-moving streams (see Harding 1997 for more information). A historical record exists for Swamp Metalmark, which also requires herbaceous wetlands, such as prairie fens, wet meadows, and marshes. Agricultural activities and development have resulted in wetland loss and degradation, which has reduced the quantity and quality of wetlands available for the above rare species. Cerulean Warbler, Prothonotary Warbler, and Woodland Vole have been documented in Clinton County and are typically found in large blocks of mature deciduous forest. Regal Fern Borer (moth) was documented in the County and is associated with swamp forest containing regal or cinnamon ferns (*Osmundia* spp.). A historical record for Culvers Root Borer, another moth species, is known in the County, which is a species that uses prairies or prairie fens that contain Culver's-root (*Veronicastrum virginicum*), its larval host plant.

### Eaton County

A total of 22 occurrences of 14 rare animal species were documented in Eaton County. Twelve EOs of 10 species are considered extant, while 10 EOs of six species are classified as historical. Six of the 14 species recorded in the County are listed as threatened or endangered at the State or federal level. Given the destruction and degradation of forests and wetlands that has occurred, it is not surprising that most of the rare species with records in Eaton County are associated with these ecosystem types. The federally listed Indiana Bat and Copperbelly Water Snake are typically found in mature floodplain forests and associated upland forests. Indiana Bat was recorded near Vermontville along the Thornapple River corridor. Two historical Copperbelly Water Snake EOs were documented in the Olivet area. Prothonotary Warbler was documented in the County and also similarly uses mature floodplain and bottomland forests. Eastern Box Turtle also requires forests with nearby water sources (Harding 1997) and Great Blue Herons typically locate their nesting colonies (rookeries) in mature trees. Several other rare animal species documented in the County require herbaceous or open water wetlands. Blanchard's Cricket Frog, Spotted Turtle, and Blanding's Turtle use a variety of wetlands and adjacent open water areas, such as ponds, lakes, and slow-moving streams (Harding 1997). In southern Michigan, Eastern Massasauga is usually associated with herbaceous wetlands like prairie fens and wet meadows. King Rail was documented in the County and also typically uses herbaceous wetlands, such as marshes and sedge meadows (Rabe 2001). Henslow's Sparrow, Grasshopper Sparrow, and Dickcissel, all declining grassland bird species, were recorded in the County. Changes in agricultural practices and development have reduced the amount of grassland habitats (e.g., old fields, hayfields, pastures) needed by these species for breeding.

## **Ingham County**

Thirty-nine EOs of 19 species were recorded in Ingham County, of which 23 occurrences of 11 species are classified as extant and 16 EOs of 11 species are considered historical. Seven of the 19 species documented in the County are listed as threatened or endangered at the State or federal level. Similar to Clinton and Eaton Counties, the rare animal species recorded in Ingham County occur in a variety of forest, wetland, and grassland ecosystems. Indiana Bat and Wood Turtle are associated with riparian forests and have been recorded in the County. Several other rare species that require forests have been documented in Ingham County: Cooper's Hawk, Woodland Vole, Eastern Box Turtle, and Regal Fern Borer. Great Blue Heron rookeries have also been recorded in Ingham County. Several EOs exist for Blanchard's Cricket Frog, Spotted Turtle, Blanding's Turtle, and Eastern Massasauga, which all require herbaceous wetlands and/or shallow open water areas. Several older (>20 yrs old) records for King Rail were documented. King Rails are threatened by wetland loss and degradation and possibly high pesticide residues (Rabe 2001). Rare grassland bird species (Henslow's Sparrow, Grasshopper Sparrow, and Dickcissel) were recorded in open lands of the County. Least Shrews also use herbaceous uplands (Kurta 1995) and two historical occurrences are known from the County. Historical Barrens Buckmoth EOs were recorded in the East Lansing area and Dansville State Game Area. Barrens Buckmoth feeds on oaks (*Quercus* spp.) and is associated with oak barrens, as well as nearby fens and fields. Peregrine Falcons have nested on various buildings in downtown Lansing in recent years. Nesting efforts should continue to be monitored and protected from disturbance.

## **Information Gaps**

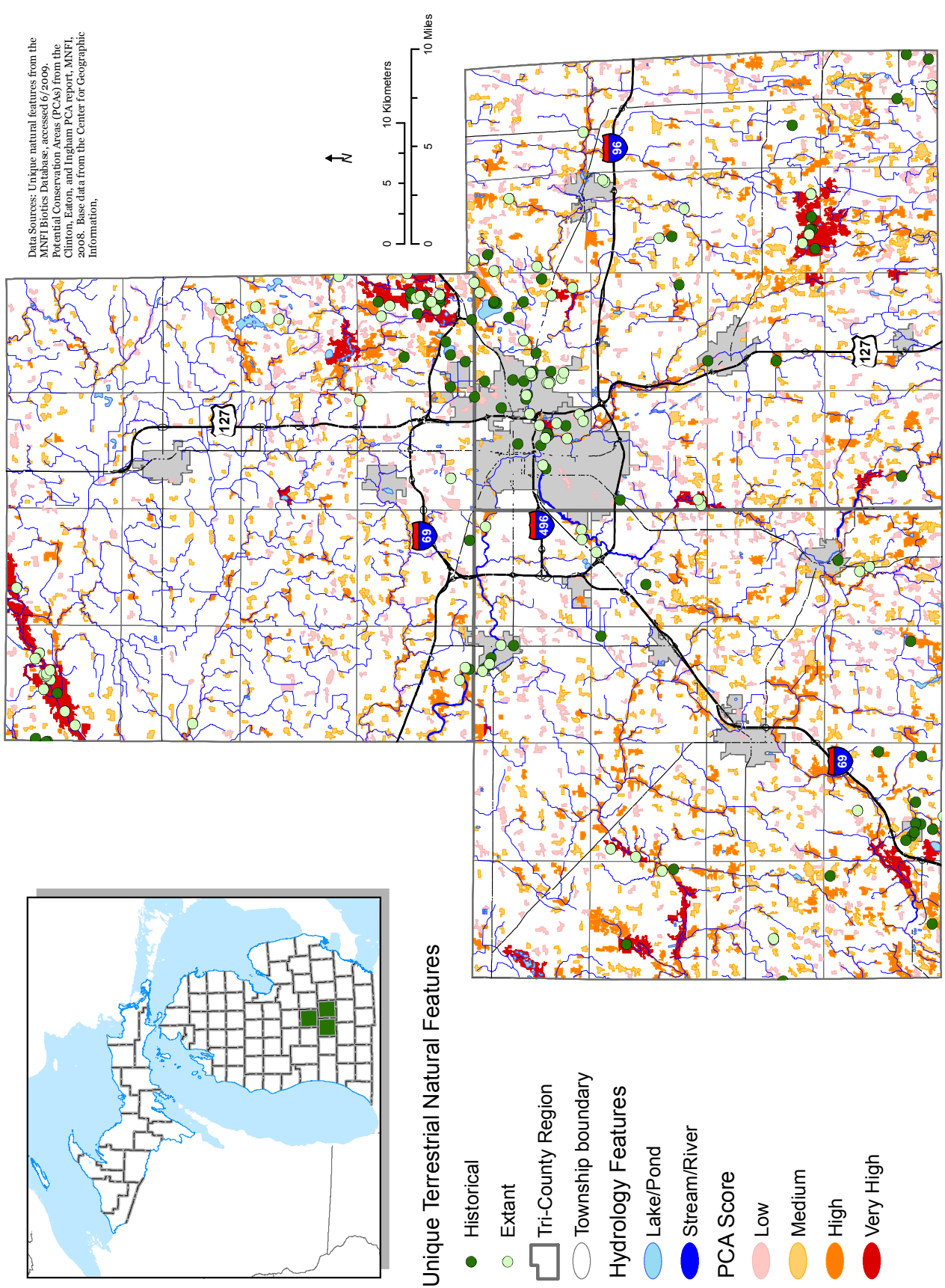
Given that most of the land in the Tri-County region is not publicly owned, private lands represent the largest and probably most important information gap with regard to rare animal species in the region. Most private lands have not been surveyed for any of the rare animal groups, and those that have been surveyed probably have not been revisited for decades. Larger blocks of forest, especially floodplain and riparian forest, herbaceous wetland, and grassland on private lands have the potential to harbor several rare animal species. A concerted effort to survey rare species on private lands is needed to fully understand the distribution and relative abundance of rare animals in the Tri-County region. Private lands also provide the greatest opportunities for the conservation of rare animal species in the region. There are several programs available to assist landowners with ecosystem restoration and wildlife habitat improvement activities, such as the Michigan DNR's Landowner Incentive Program, Farm Bill programs (e.g., Wetlands Reserve Program, Conservation Reserve Program) implemented through the U.S. Department of Agriculture, and the U.S. Fish and Wildlife Service's Partners for Fish and Wildlife Program.

Surveys are needed to monitor rare animal species at known and historic EOs and at sites never before surveyed. Potential rare animal species that could occur within the region can be categorized into three general ecosystem types: forests, herbaceous wetlands (e.g., prairie fens, marshes), and grasslands (e.g., native grasslands, hay fields). Several data gaps exist for forests within the Tri-County region. Given the federal and State endangered status of Indiana Bat, surveys for this species in suitable riparian forests are a high priority. Surveys for Copperbelly Water Snake are needed in large forested wetlands and associated uplands near

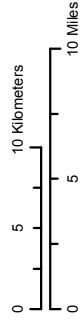
historical occurrences in Eaton County. Large blocks of deciduous forest should be surveyed for rare forest birds, such as Cerulean Warbler, Prothonotary Warbler, and Hooded Warbler (*Wilsonia citrina*). Few trapping surveys for small mammals, such as Woodland Vole, have been conducted in recent years. Woodland Vole surveys need to be done in suitable deciduous forests in the region. Records for Regal Fern Borer (moth) are limited in our database, so black light surveys are warranted in swamp forests and other ecosystems (e.g., prairies, fens, old fields) with abundant regal and/or cinnamon ferns, which are the larval host plants. Few records exist in our database for Pinetree Cricket, so sweep net surveys are needed at forests dominated by White Pine. Although Great Blue Heron is a common species in Michigan, more work is also needed to locate and monitor rookeries to ensure the species' status remains secure.

Since wetlands continue to be lost and degraded, understanding the status of rare species that rely on these ecosystems is vital. Surveys for Blanchard's Cricket Frog, Spotted Turtle, Blanding's Turtle, and Eastern Massasauga should be conducted in herbaceous wetlands and shallow open water areas, especially at or near known element occurrences. Both King Rail and Common Moorhen were documented in the region and other species, such as American Bittern and Least Bittern, could be present. Wetland bird species are not easily identified on the Breeding Bird Survey, so targeted wetland bird surveys are needed to track their status. Surveys for rare insect species, such as Swamp Metalmark, should be done in herbaceous wetlands like prairie fens and wet meadows where the larval host plant (Swamp Thistle, *Cirsium muticum*) exists. Tamarack Tree Cricket could occur in wetlands with Tamarack stands, so surveys should be done at sites where sweep netting has not been done previously.

Although grasslands are limited within the Tri-County region, several rare animal species depend on these ecosystems. Rare grassland bird species are not regularly encountered in the Breeding Bird Survey, so specific surveys for species like Henslow's Sparrow, Grasshopper Sparrow, and Dickcissel are required to monitor their status. Surveys for these rare birds should be done in large grasslands, such as pastures, hayfields, and open wetlands. Least Shrews use upland meadows with dense coverage of grasses and forbs, as well as marshy areas, fencerows, and forest edges (Kurta 1995). Little survey work has been done for Least Shrew in recent decades, so trap (e.g., live and/or pitfall) surveys are needed at sites with suitable habitat near historical records in Ingham County. Culvers Root Borer (moth) could occur in grasslands (e.g., prairies, prairie fens) when the larval host plant, Culver's-root, is present. Black light surveys are the most effective means of determining the presence of Culvers Root Borer.



Data Sources: Unique natural features from the MNFI Biodis Database, accessed 6/2009; Potential Conservation Areas (PCAs) from the Clifton, Eaton, and Ingham PCA report, MNFI, 2008. Base data from the Center for Geographic Information.



Michigan Natural Features Inventory  
6/16/2009

**Unique Terrestrial Natural Features**

- Historical
- Extant
- Tri-County Region
- Township boundary

**Hydrology Features**

- Lake/Pond
- Stream/River

**PCA Score**

- Low
- Medium
- High
- Very High

**Figure 8. Important Terrestrial Natural Features in the Tri-County Region**

### Overview- Part 1.

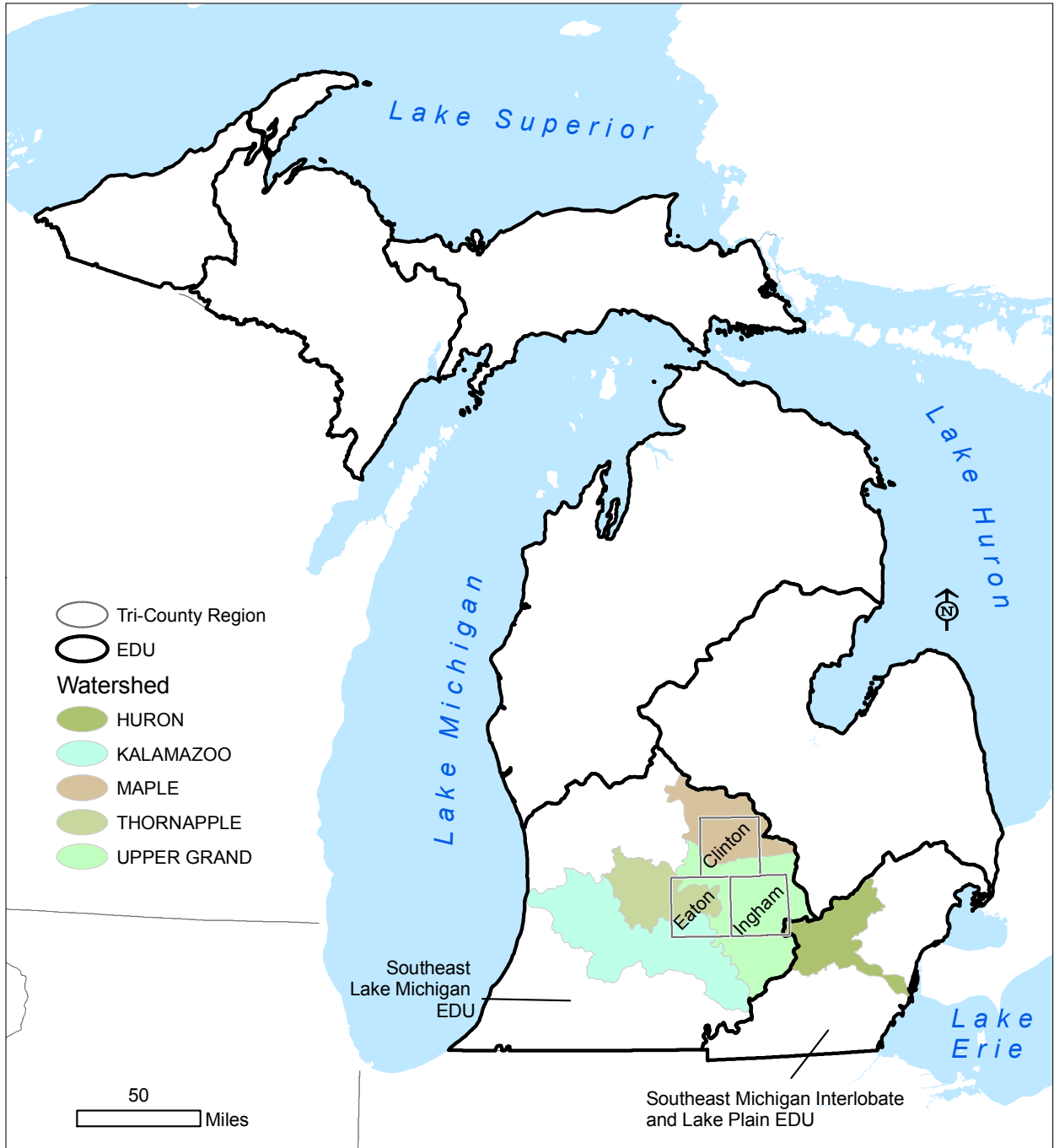
The aquatic assessment of the Tri-County region's biodiversity was based on two major categories of data: Landscape-based classification frameworks, and element occurrences of rare aquatic species. The landscape-based classifications (river and lake) were developed from multiple projects. The river classification framework was first proposed by Seelbach et al. (1997) and was then revised by Brenden et al. (2007). This latest version was modeled using expert opinion as the final review. The lake classification framework was developed by Higgins et al. (1998). The element occurrence dataset is a continuously updated database developed and maintained by the Michigan Natural Features Inventory (MNFI), which identifies places on the land that contain unique elements of biological diversity – rare species and high quality natural communities – which MNFI refers to as element occurrences (EOs). The combination of the ecosystem classification frameworks and the EOs resulted in new data layers that can be used to identify and prioritize potentially unique aquatic ecosystems and functional sub-watersheds.

The three counties in the region are almost entirely located in the northeast side of the Southeast Lake Michigan (SLM) Ecological Drainage Unit (EDU) (Figure 9). A small portion of the southeast corner of Ingham County falls in the Southeast Michigan Interlobate and Lake Plain EDU, which contains most of the Lake Erie drainage in Michigan. EDU's are aggregates of watersheds based on hydrologic units that share similar ecological characteristics such as climate, hydrologic regime, physiography, and zoogeographic history. The Southeast Lake Michigan EDU is the southern portion of the Lake Michigan basin. This EDU has three major river systems (Grand, Kalamazoo, and St. Joseph) which flow east to west. There are many kettle lakes in the interlobate region to the east, which forms the headwaters of all three river systems.

Note that we also use the terminology watershed and sub-watershed in this report. Watersheds will be defined here as the 8-digit Hydrologic Unit Codes (HUCs) from the United States Geological Survey and sub-watersheds will be defined here as the 12-digit HUCs, sometimes called sub-basins, developed by the Michigan Department of Environmental Quality. Portions of five watersheds (Figure 9) and 130 sub-watersheds cover the Tri-County region. Hydrologic units (or HUCs) were initially delineated to break the state up into similarly sized units based on hydrology. However, they are not hydrologically accurate. A true watershed is defined by all waters draining from an area to a particular point. HUCs often break up true watersheds such that a point in a HUC can actually receive all of its water from a completely different HUC. We used HUCs as a way to summarize the data, fully realizing that the use of these units does not provide a full picture of the area needed to protect or manage important aquatic species or ecosystems.

Figure 10. illustrates the major river systems and tributaries in the SLM EDU and in the Tri-County region. The Grand River, the longest river in Michigan, is the major system in the Tri-County Region. Major tributaries of the Grand include the Maple River in Clinton County and the Thornapple River in Eaton County. Minor tributaries include the Red Cedar River in Ingham County and the Looking Glass River in Clinton County. The Grand River flows to Lake Michigan at Grand Haven. With a watershed area of 5,660 square miles, the Grand River is the second largest drainage system in Michigan (The Saginaw River has the largest drainage area).

Figure



**Figure 9. Southeast Lake Michigan Ecological Drainage**

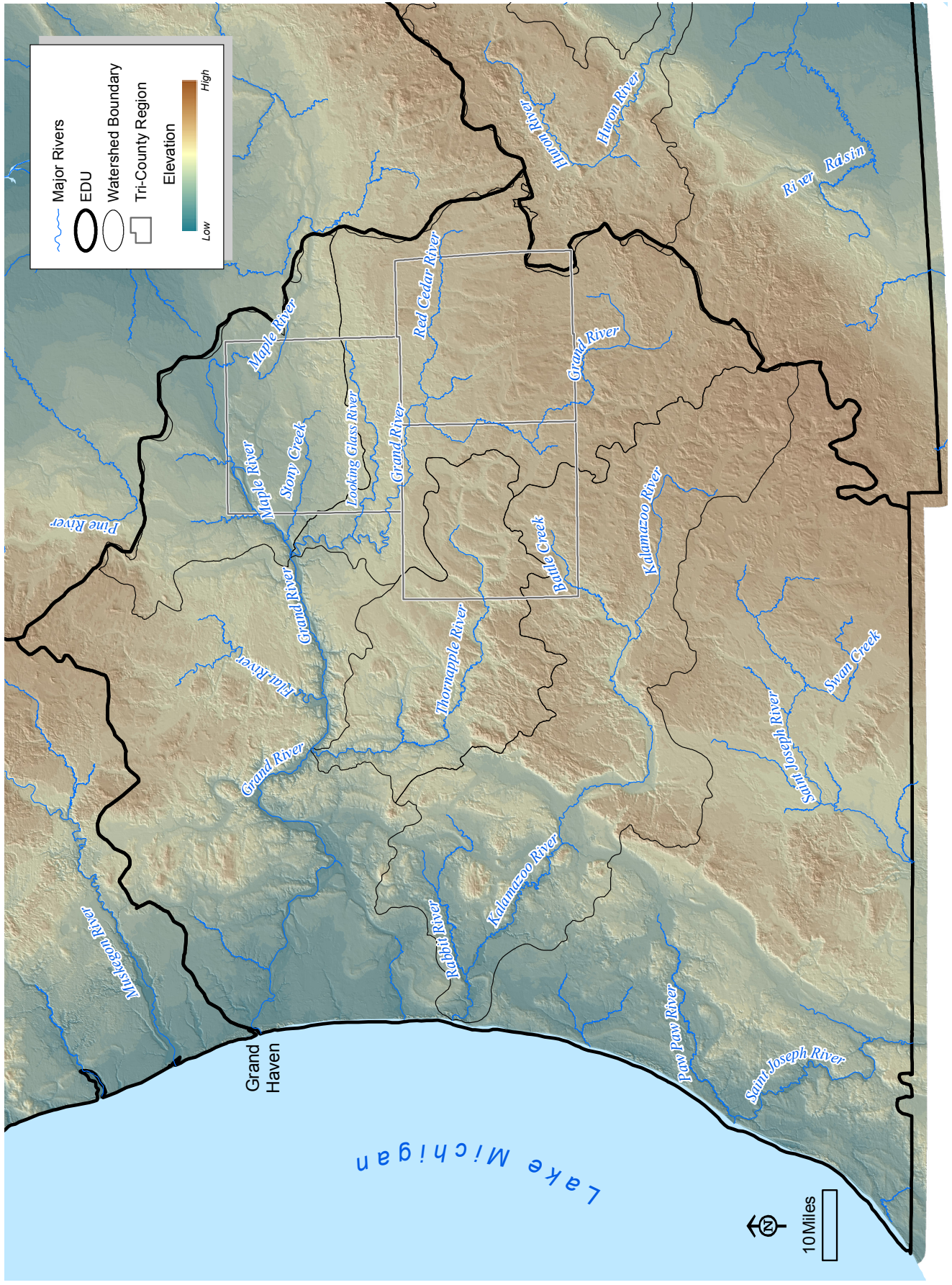


Figure 10. The Grand River, Including the Maple, Looking Glass, Red Cedar and Thornapple Tributaries

## ***Datasets presented in this document***

\*Landcover based level datasets:

1. Potentially unique river and lake ecosystems
2. Potentially high quality common rivers and lakes
3. Level of intactness of headwater watersheds
4. Functional sub-watersheds

\*It is important to note that all of these datasets are predictive models based on remote land cover data.

## ***Defining uniqueness***

Defining what is rare or unique is often subjective and can be difficult to quantify. Rare species are often determined using geographic distribution, habitat specificity, and population size (Rabinowitz 1981, Rabinowitz 1986). However, community rarity or uniqueness has received much less attention (Izco 1998). We do not know how many ecosystems are needed to ensure continued persistence but we expect that frequency of occurrence and geographical range are important components. Uniqueness is affected by the number of individual ecosystems, the classification framework used, and how uniqueness is defined.

We define ecosystem uniqueness using geographic range and frequency of occurrence. We considered those ecosystem types occurring in only one watershed statewide as having a restricted geographic range and hence unique. Additionally, we defined uniqueness as those lakes or rivers that have the fewest occurrences and that make up 5% of the total number of lakes or rivers within an EDU. We felt that this scheme captured what we intuitively felt was unique or rare and that it was easily applied to different classifications, so that if new classifications are introduced in Michigan this analysis could be easily reassessed.

## ***Determining quality***

It should be noted that all of the quality analysis conducted on aquatic ecosystems in this report rely on the surrounding terrestrial landscape and not within system data. Aquatic ecosystems are so tied and intricately linked to the surrounding lands and watershed that it is difficult to separate the aquatic ecosystem from the terrestrial landscape. The coarse filter approach is generally based on identifying areas of land that have intact natural processes. For terrestrial systems it is relatively easy to determine the size needed to allow for natural processes to occur in different types of ecosystems or natural communities because the surrounding landscape minimally influences that ecosystem. Aquatic systems function differently; the surrounding landscape directly influences these systems. For example, it is easy to draw a boundary around a lake. The natural processes that function within that lake are sediment and nutrient dynamics, internal water movements, water retention, turbidity, water temperature, and oxygen concentration, to name a few. Since most all of these processes rely on external inputs from the landscape or water bodies within the watershed of the lake, the lake can not function without these external inputs. Because these inputs are difficult and time-consuming to gather information on, we relied on landscape or terrestrial surrogates to help determine the quality of the lake or river segment.

## **Ecosystem Level Analysis**

### ***River classification***

#### **Description:**

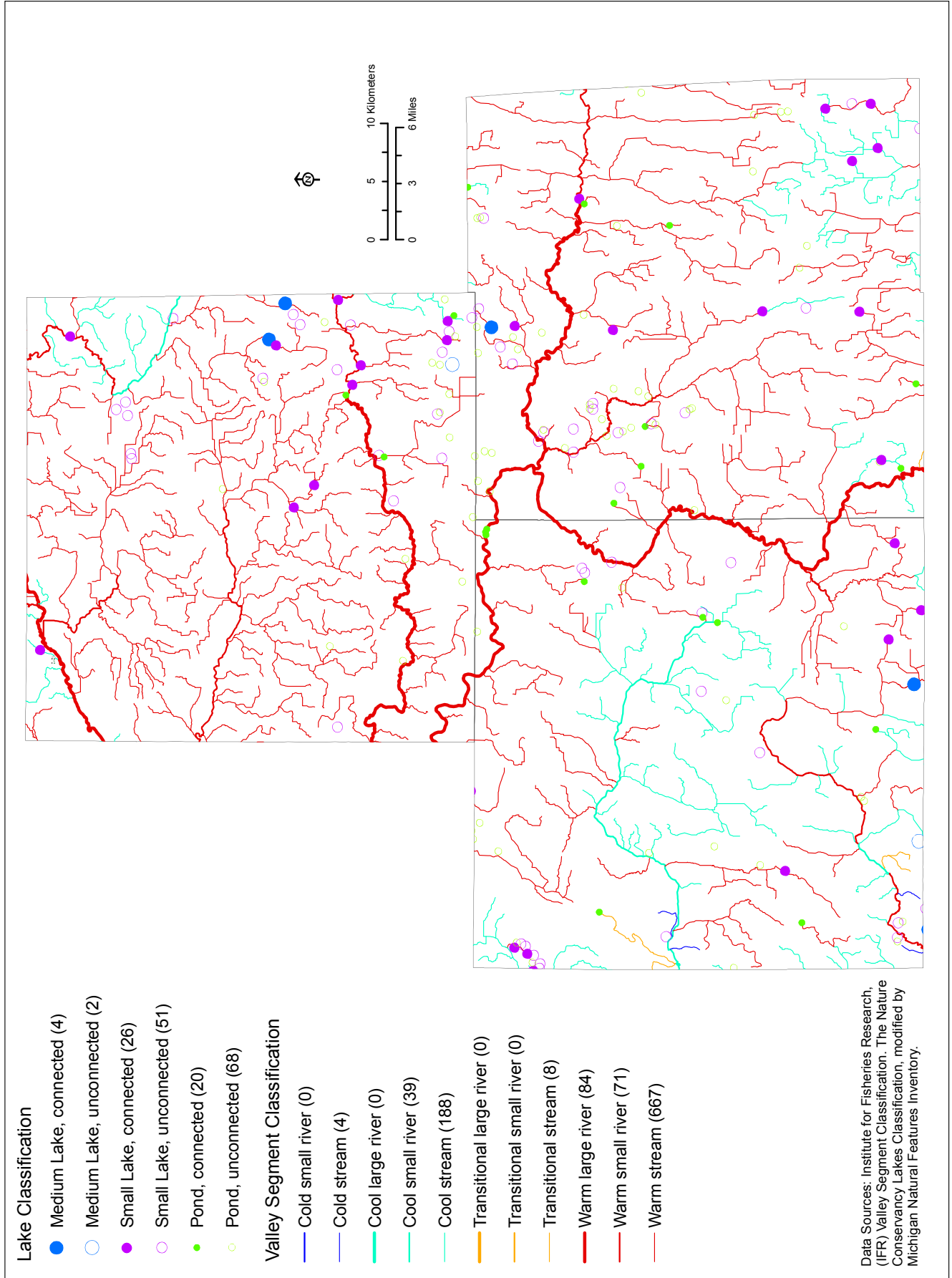
Riverine ecosystems were delineated using river valley segments (VSECs) as defined by the DNR Fisheries Division as of August 2007 (Seelbach et al. 1997, Brenden et al. 2007). VSECs are relatively large stretches of river that have similar hydrology, limnology, channel morphology, and riparian dynamics. VSECs often change at stream junctions or landform boundaries and were used to define the boundaries of river ecosystems in this analysis.

In this analysis, VSEC's are more classified and based on three variables: size, water temperature, and gradient. Physical, chemical, and biological changes occur on a longitudinal gradient from the headwaters to the very large rivers (Vannote et al. 1980). Headwaters and small tributaries tend to be shaded and rely on energy inputs from riparian vegetation; their macroinvertebrate communities tend to be dominated by shredders. Medium rivers tend to be less shaded and rely on energy inputs from primary production; their macroinvertebrate communities tend to be dominated by grazers. And large rivers tend to rely on energy inputs from upstream and their macroinvertebrate communities tend to be dominated by collectors. Fish, mussel, and aquatic plant communities all vary as well. Rivers do vary from this general model (the river continuum concept), however it provides insight into how size is an important factor in determining and defining river communities. Water temperature is also important because species have optimum temperature preferences. Gradient provides a measure of channel morphology which correlates to valley shape, sinuosity, water velocity, and substrate size. All three factors are important in determining species compositions in rivers.

Four size classes were defined using drainage areas of VSECs, following the DNR's Wildlife Action Plan (Eagle et al. 2005): headwaters and small tributaries are less than 40 mi<sup>2</sup>, medium rivers are between 40 and 179 mi<sup>2</sup>, large rivers are between 180 and 620 mi<sup>2</sup>, and very large rivers are greater than 620 mi<sup>2</sup>. Three classes of temperature were defined for each VSEC, generally defined as: cold (<19°C), cool (19-21°C) and warm (>21°C). And three classes of gradient were defined, where low were those VSECs with an average gradient less than 0.001, moderate was between 0.001 and 0.006, and high was greater than 0.006. Gradient classes were defined using the 25<sup>th</sup> and 75<sup>th</sup> percentiles of all stream reach gradients, so less than the 25<sup>th</sup> percentile was low, greater than the 75<sup>th</sup> percentile was high, and the rest were defined as moderate. Warm streams dominate the Tri-County region (Figure 11).

#### **Limitations:**

Classification requires discrete boundaries; however riverine ecosystems are essentially a continuum. As a result, river classification is inherently difficult. Another limitation with the classification is that the gradient classes are not necessarily ecologically based. However, we were unable to find literature backing specific gradient breaks. To build a stronger classification, future research is needed to determine or document gradient classes that are ecologically meaningful.



**Figure 11. River Valley Segment and Lake Classification Incorporating Size, Temperature, and Connectivity**

### ***Potentially Unique River Ecosystems***

#### **Description:**

River ecosystems or VSECs were classified as unique using a 5% rule at the EDU scale. By highlighting unique VSECs, we hope to capture potentially unique and important ecosystems that contribute to the diversity regionally. These layers provide a relatively simple representation of where unique river ecosystems might be located within an EDU. Future survey efforts are needed to determine true rarity, importance, and condition of these river systems.

#### **Limitations:**

Unique VSECs identified may be an artifact of the classification process and the accuracy of available digital data. As a result, true rarity is uncertain. But it does provide a basis that will help direct future survey efforts and analysis. In addition, we do not include a landscape context analysis with this layer because we are looking strictly at rarity. See river classification section for limitations associated with data used in this analysis.

#### **Results**

There are 1,061 river reaches in the Tri-County region which were aggregated into 550 VSECs. Five percent of the classified VSECs in the EDU were selected as unique, with a total of 26 of those VSECs falling within the Tri-County region (Figure 12).

#### **Clinton County:**

Hayworth Creek, a tributary of the Maple River, is a unique warm medium-sized river of moderate gradient located in northwestern Clinton County. The VSEC classified unique extends 7.8 miles and has a drainage area of 435 mi<sup>2</sup>.

#### **Ingham County:**

Doan Creek, a tributary of the Red Cedar River in eastern Ingham County, is in the same class as Hayworth Creek, with seven VSECs comprised of 15 reach segments classified as unique. This portion of river has a total length of 26.6 miles and drainage area of 216 mi<sup>2</sup>.

#### **Eaton County:**

Eaton County has three potentially unique river systems, the Thornapple River, Spring Brook, and Sebewa Creek. The Thornapple River, a major tributary of the Grand River, is classified as a cool, large river with low gradient, and extends 26.9 miles with a drainage area of 3512 mi<sup>2</sup>. Sebewa Creek and its tributaries that are classified unique belong to the warm, medium-sized river of moderate gradient class. Of the portion that is in the county, 23.4 miles of river drain an area of 74 mi<sup>2</sup>. Sebewa Creek flows north into Ionia County where it eventually feeds into the Grand River. Spring Brook, in southeastern Eaton County, is the fourth example of a warm, medium-sized moderate gradient river, extending 19.8 miles (drainage area 184 mi<sup>2</sup>) before draining into the Grand River to the north.

### ***Potentially High-Quality Common River Ecosystems***

#### **Description:**

River ecosystems or VSECs were classified as common in an EDU using a greater than 5% rule; see previous section on defining uniqueness for more detail. The quality of common VSECs

were assessed using Wang et al.'s (2006) analysis of landscape-level GIS data (Table 10). Quality is relative within an EDU. This analysis provides a relatively simple representation of where potential high-quality river ecosystems are located in each EDU and will help direct survey efforts to determine true condition and importance.

**Limitations:**

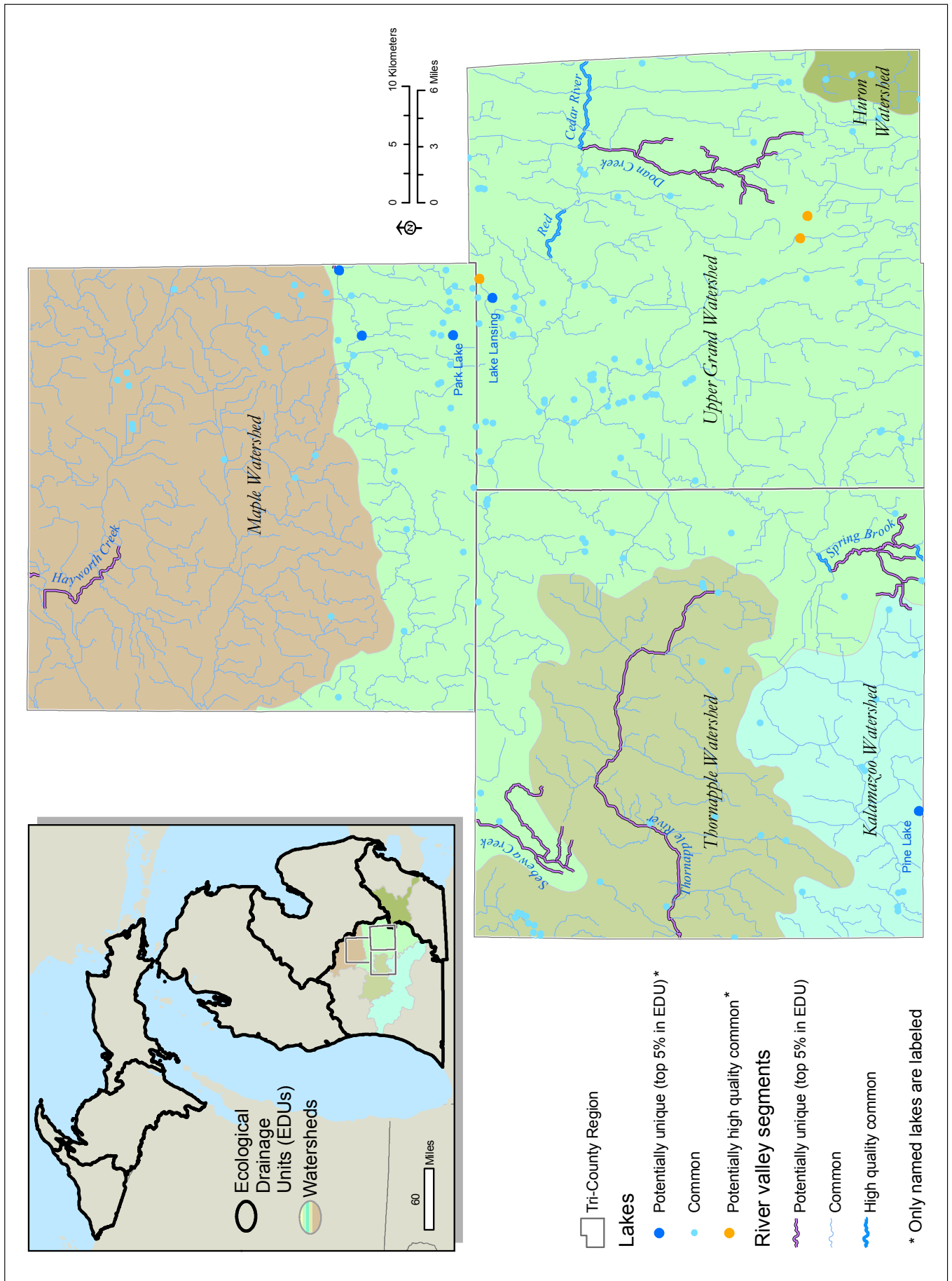
One limitation of this data layer is that it does not include representation of all common river ecosystems. In addition, no field survey data was used to determine true condition and integrity of the ecosystems, so the individual VSECs highlighted may not be the best representatives available. Local factors that are not captured in this analysis could drive the quality of ecosystems. However, it does provide a basis to start from that will help direct future survey efforts. See river classification section for limitations associated with data used in this analysis.

**Results**

Of the 550 VSECs in the Tri-County region, 524 were classified as common in the EDU using the greater than 5% rule. Using the disturbance classification created by Wang et al. (2006), we selected the highest quality of the common river ecosystems (Figure 12), which consisted of nine reaches comprising six VSECs. Four of these VSECs made up two segments of the Red Cedar River in Ingham County, classified as a large, warm river with low gradient (9.3 mi, 745 mi<sup>2</sup>). One VSEC classified as a warm, medium-sized low gradient river ran on the downstream side of the unique part of Spring Brook, while the other VSEC was directly upstream to the unique part of Spring Brook and was classified as a small-sized cool stream of moderate gradient. The combined length of these two VSECs was 2.9 miles and they drain an area of 78 mi<sup>2</sup>.

**Table 10. Landscape variables used to determine quality (from Wang et al. 2006).**

<b><i>Variables for all streams</i></b>
Active mining (#/10,000 km <sup>2</sup> )
Network watershed agricultural land use (%)
Network watershed urban land use (%)
MDEQ's permitted point source (PPS) facilities (#/100 km <sup>2</sup> )
MDEQ's PPS having direct connection with stream (#/100 km <sup>2</sup> )
USEPA's toxic release inventory sites (#/10,000 km <sup>2</sup> )
Population density (#/km <sup>2</sup> )
Road crossing (#/km <sup>2</sup> )
Road density (km/km <sup>2</sup> )
Total nitrogen plus (phosphorus*10) loading (kg/l/yr)
Watershed area treated with manure from barn yards (m/km)
<b><i>Additional variables for coldwater streams</i></b>
Total nitrogen plus (phosphorus*10) yield (kg/l/year)
<b><i>Additional variables for warmwater streams</i></b>
Dam density (#/100 km <sup>2</sup> )
USEPA's toxic release inventory sites discharging into surface water (#/10,000 km <sup>2</sup> )



**Figure 12. River Valley Segment and Lake Classification Indicating Unique and High Quality Common Aquatic Systems**

## ***Lake classification***

### **Description:**

Lake ecosystems were classified using Higgins et al. (1998), which was based on available GIS data. Most of the data used in this classification were queried from or calculated using queried information from available data layers. Lakes were classified based on size, connectivity, shoreline complexity, and proximate geology.

These particular variables were used based on available data, literature, and expert review. Size provides a measure of the availability and types of habitat in a lake or pond (Eagle et al. 2005). Small lakes can range in level of stratification from not stratified to fully stratified throughout the summer and winter. Oxygen levels can vary creating winter kills. In lakes that stratify, a true pelagic or open-water zone develops and is distinct from the shallow littoral (or nearshore) zone. In medium lakes stratification and winter oxygen levels are also variable. They tend to have more complexity in their shoreline (lakes with many bays) and basin (lakes with more than one deep hole). Large lakes tend to be more homogenous in their chemical and biological makeup, but more diverse in their habitats than smaller lakes and are dominated by the open water (pelagic) zone. Connectivity refers to whether or not there are stream connections to the lake. Streams can influence a lake through the input or removal of water and nutrients as well as an exchange of species. Shoreline complexity becomes more important as lake size increases, creating more varied habitats. We used proximate geology as a surrogate for lake hydrology. All of these factors can influence species composition and communities. Typically ponds have one community of fish, however with increasing size, the pelagic habitat becomes more abundant and a pelagic fish community will be also present.

We modified the size classes that Higgins et al. (1998) used as follows: ponds are  $>2$  and  $\leq 10$  acres, small lakes are  $>10$  and  $<100$  acres, medium lakes are  $\geq 100$  and  $< 1000$  acres and large lakes are  $>1000$  acres. These size classes generally follow the Wildlife Action Plan (ponds  $<5$  acres, small lakes 5-99 acres, medium lakes 100-999 acres, and large  $>1000$  acres), however we increased the size range of ponds because water bodies less than 10 acres are often treated differently than larger lakes. For example, they are not typically surveyed or monitored. Figure 11, illustrates the locations of the lakes in the Tri-County region classified by size and connectivity, with a preponderant number of unconnected small lakes and ponds.

### **Limitations:**

This classification is based on coarse available digital map data. To date there has been no ground-truthing and little analysis to determine accuracy and precision of assigned lake types in this classification. There are also many “single occurrence” lake types in this classification that may not be ecologically meaningful but artifacts of the classification process, which needs to be recognized in the unique lakes analysis. Although there are some critical issues with using this classification, it is currently the only lake classification for Michigan that is statewide and available in GIS format.

Lake ecosystems undergo succession and begin to fill in with sediment; this process is important to keep in mind when setting conservation priorities, especially for ponds. MNFI typically distinguishes ponds from marshes if they have an open water area. Those “ponds” that have

macrophytes across the entire water surface were identified as marsh for our work. Sampling for ponds can be difficult because they can be difficult to find, and during dry years could be designated as a marsh. We hope that by representing a variety of different types (Abell et al. 2002) of ponds that we will account for this process at least partially.

***Potentially Unique Lake Ecosystems***

**Description:**

Lake ecosystems were classified as unique within an EDU using a 5% rule; see previous section on defining uniqueness for more detail. By highlighting unique lakes, we hope to capture potentially unique and important ecosystems that contribute to the diversity of Michigan and the Great Lake Region. This analysis will provide a relatively simple representation of where unique ecosystems are located and will help direct future survey efforts to determine true rarity, importance, and condition of these ecosystems.

**Limitations:**

Unique lake types identified may be an artifact of the classification process and the accuracy of available digital data. Although true rarity is uncertain, this analysis provides a basis that will help direct future survey efforts. In addition, a landscape context analysis is not included with this layer because we are looking for rarity and not necessarily the best of the unique. See lake classification section for limitations associated with data used in this analysis.

**Results**

There are 2,547 lakes in the Southeast Lake Michigan EDU and 171 in the Tri-County region (Table 11). Using the 5% rule, a total of 131 lakes were targeted as unique in the Southeast Lake Michigan EDU. Of those, 9 were within the Tri-County region (Figure 12, Table 12.). Named lakes classified unique included Park Lake in Clinton County, Lake Lansing in Ingham County, and Pine Lake in Eaton County.

**Table 11. Summary of general lake statistics within the Southeast Lake Michigan EDU and the Tri-County region.**

<b>Waterbody Type</b>	<b>SLM EDU</b>	<b>Tri-County</b>
Number of lakes	2,547	167
Number of ponds	1,238	88
Number of small lakes	1,126	77
Number of medium lakes	177	2
Number of large lakes	6	0
Number of possible lake types (in Michigan)	176	176
Number of actual lake types	88	26

**Table 12. Summary of unique and common lake ecosystems within the Southeast Lake Michigan EDU and the Tri-County region.**

Category	Waterbody Type	SLM EDU	Tri-County
Unique	Number of lake types	46	7
	Number of lakes	131	5
	Number of ponds	31	0
	Number of small lakes	29	4
	Number of medium lakes	65	1
	Number of large lakes	6	0
Common	Number of lake types	42	19
	Number of lakes	2416	162

***Potentially High-Quality Common Lake Ecosystems***

**Description:**

Lake ecosystems were classified as common using a greater than 5% rule; see previous section on defining uniqueness for more details. Quality of common lakes was assessed by calculating percent natural land use and road density in a 500 m buffer around each lake (Soranno et al. in press). Values of the landscape variables were put into classes and lakes were ranked according to lowest road density and highest percent natural land use. Land use is known to affect the quality of aquatic ecosystems and species (Allen 2004). Road density was included as part of the landscape context analysis because we felt the scale of the satellite land cover classification data was too small to quantify roads accurately. Natural vegetation buffers often surround lakes, even if housing density is high.

For this analysis we targeted 10 unconnected ponds or small lakes, 5 connected ponds or small lakes, 5 medium lakes, and 1 large or very large lake ecosystem within an EDU with the best landscape context. No threshold values for quality were used, just target numbers of lakes. The best quality lakes were selected until we reached our target number. However, more lakes than the target number could be selected if several lakes had the same quality value. This analysis provides a relatively simple representation of where potential high-quality lake ecosystems are located in each EDU, and helps direct survey efforts to determine true condition and importance.

**Limitations:**

One main limitation of this data layer is that it does not include representation of all common lake ecosystems. In addition, no field survey data was used to determine true condition and integrity of the ecosystems. Individual lakes highlighted may not be the best representatives available, because local factors that are not captured in this analysis could drive the quality of an ecosystem. See lake classification section for limitations associated with data used in this analysis.

**Results:**

Three of the common ponds in the Tri-County region were selected as potentially high-quality based on the surrounding low road density and high percent natural land (Table 13, Figure 12). These ponds were all located in Ingham County.

**Table 13. Summary of the number of potentially high quality common lakes by size class.**

Waterbody Type	SLM EDU	Tri-County
Ponds	55	3
Small lakes	40	0
Medium lakes	7	0
Large lakes	1	0
Total:	103	3

***Intact Headwaters in Michigan***

**Description:**

A land cover analysis was conducted to identify intactness of headwater (stream order 1) reach watersheds. A reach watershed is the drainage basin for the stream reach, the smallest unit of a stream. Headwater reach watersheds are critical ecosystems that can serve as refuge areas, sources of organic material, and stream cooling. They are important areas for fish, macroinvertebrates, amphibians, and reptiles. These systems are also very sensitive to disturbance and any negative impacts to them can cause negative impacts downstream. Percent naturalness for all headwater watersheds was calculated based on IFMAP circa 2000 land cover.

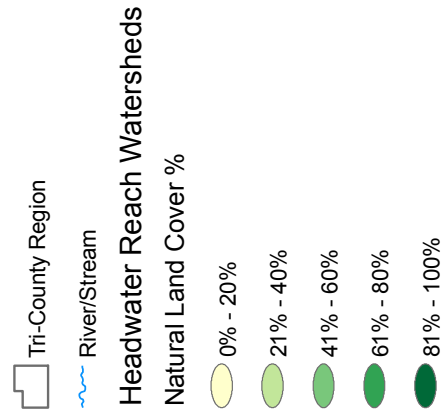
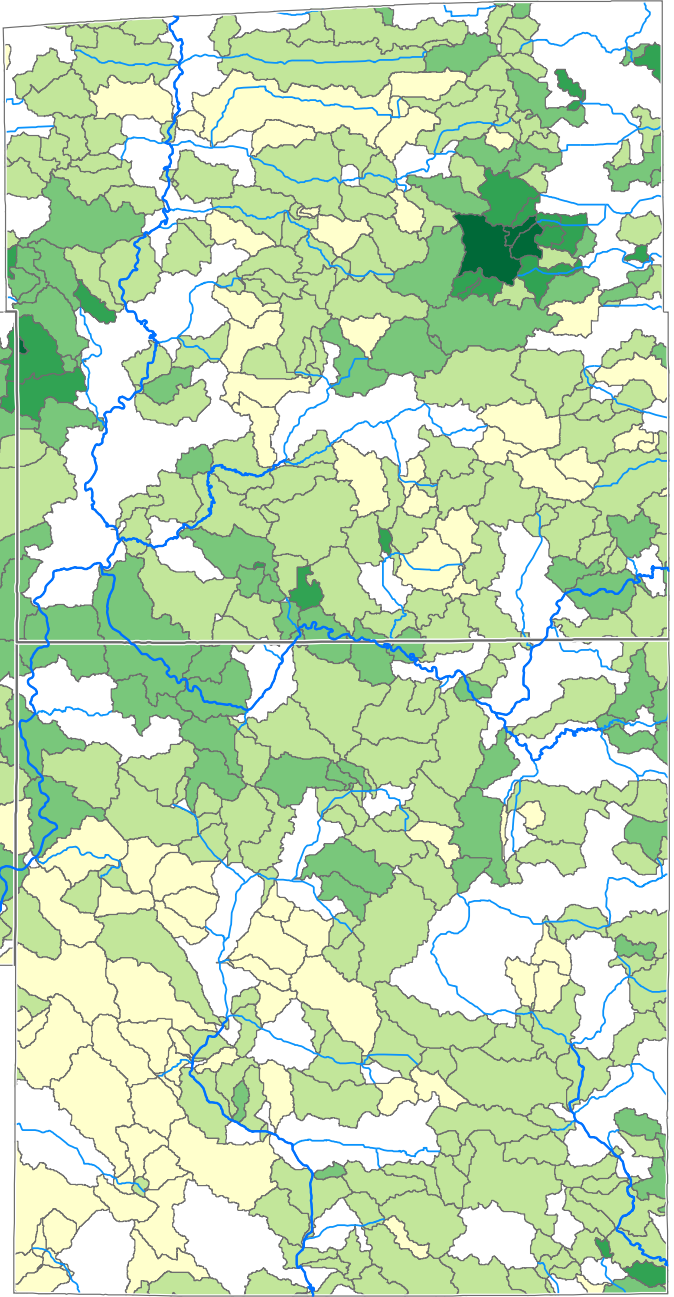
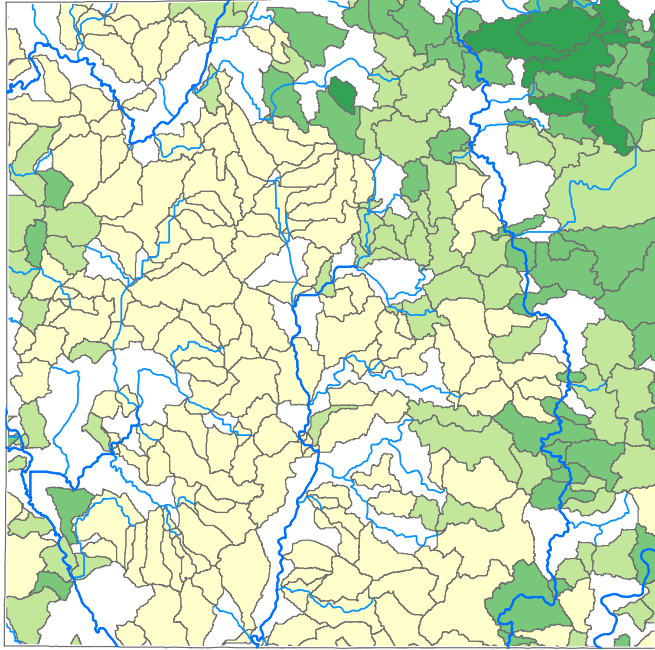
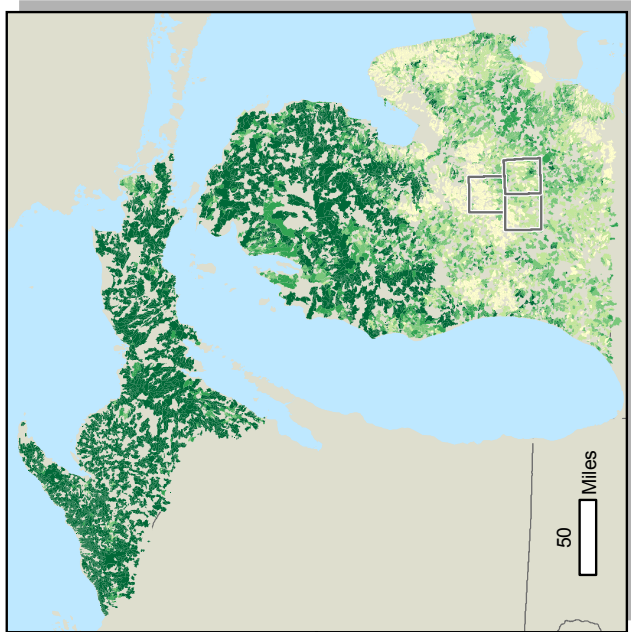
**Results:**

There are 43,288 miles of river in Michigan according to the data layer we used, and more than half of them, 25,227 miles, are first order streams. There are 19,426 first order (headwater) reach watersheds out of 35,858 reach watersheds. Headwater watersheds account for 22,802,925 acres in Michigan. There are 1,116 headwater watersheds with 100% natural land cover and they make up about 670,274 acres in Michigan. Most of the 100% natural headwater watersheds occur in the Upper Peninsula, however there are also some located in the Lower Peninsula (Figure 13 Inset). The proportion of natural land cover in the 755 headwater watersheds in the Tri-County region ranged from 0.5% – 94.3% with a median of 28.2% (sd 16.0%) (Figure 14). The headwater watershed that was 94.3% natural is a small (114 acres) watershed located within Lake Lansing Park North in Ingham County. A cluster of three headwater watersheds in southeast central Ingham County, approximately covering the Dansville State Game Area, averaged 82% natural and covered 3,510 acres.

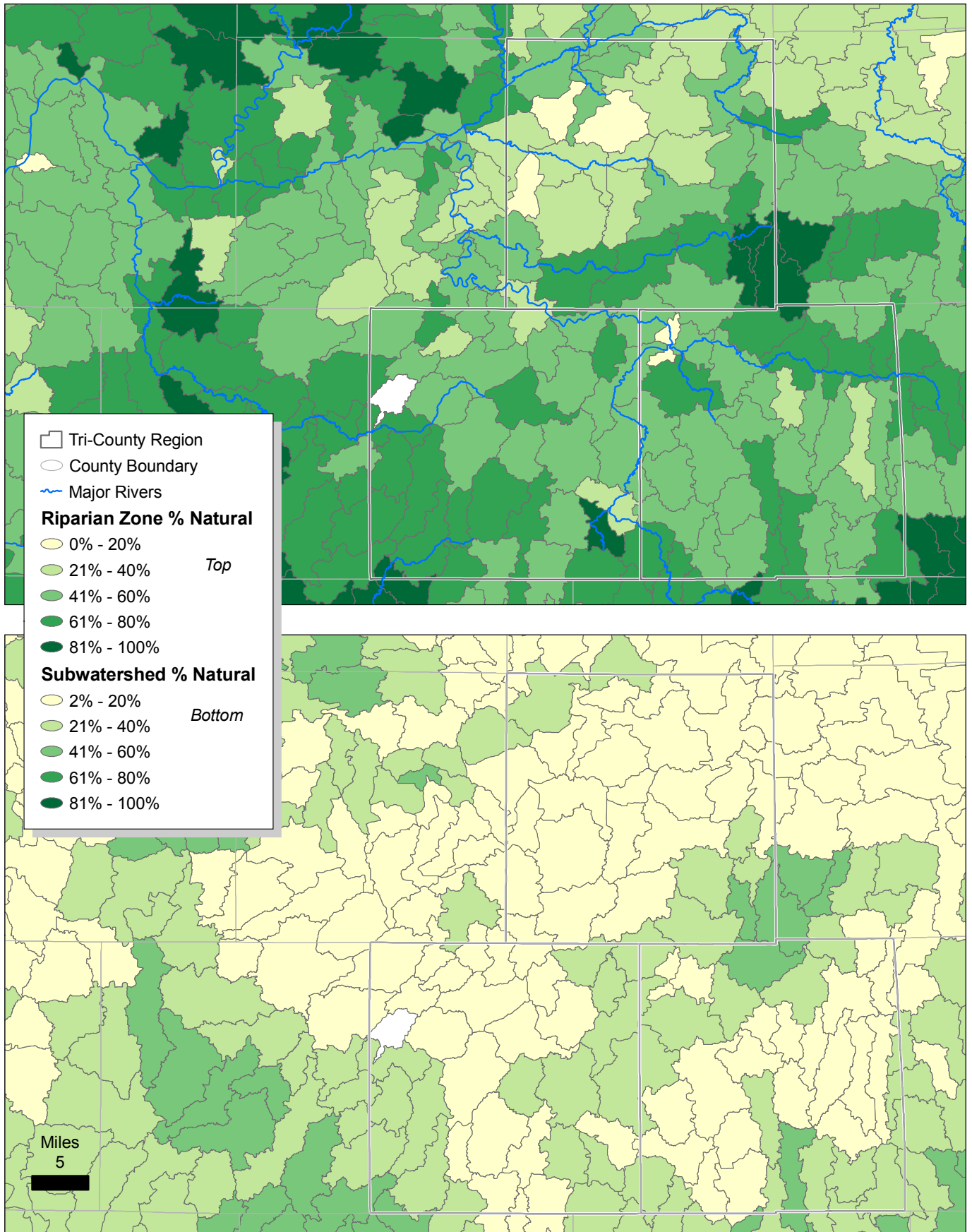
***Functional (or least modified) sub-watersheds***

**Description:**

This analysis integrated land cover, fragmentation, and pollution analyses to highlight potentially functional sub-watersheds. Three different analyses (land cover, fragmentation, and pollution) were conducted and scored between 1 and 5 using a quintile classification, with 1 being the least disturbed and 5 the most disturbed. Additionally the average of the three metrics was calculated to rank sub-watersheds on overall functionality. The quality of aquatic ecosystems is largely dependent upon the landscape context, which include those areas upstream. To truly protect or manage a river or lake the contributing watershed must be taken into account. This analysis provides a method for assessing the quality of sub-watersheds and watersheds based on available data. This information can be used to direct future surveys or target conservation efforts.



**Figure 13. Proportion of Headwater Reach Watersheds Composed of Natural Land Cover**



**Figure 14. Proportion of Natural Land Cover in the Riparian Zone and the Entire Subwatershed**  
*Significant Natural Features in the Tri-County Region- 50*

**Limitations:**

We call this analysis “functional sub-watersheds”, however true functionality is unknown. This layer is essentially our “best-guess” based on available data. Functionality and disturbance are complicated processes and in this layer we are only targeting a few potential indicators.

**Land cover analysis****Description:**

The land cover analysis was based on a combination of natural land cover for the entire catchment and within the riparian zones. All natural vegetation types identified by the IFMAP land coverage were combined together to form a new all natural vegetation data layer. Natural vegetation included grassland/herbaceous, shrub land, forest and wetland. The percent of sub-watershed with natural land cover was determined and placed in one of 5 classes based on quintiles. Additionally, all rivers and lakes were buffered outward by 60 m to create the riparian zone for analysis. The percent of natural land cover within riparian zones was determined and placed in one of 5 classes based on quartiles. These two analyses were added together and divided by 2 to determine the overall class (1-5) for each sub-watershed. One sub-watershed in the Tri-County region did not contain a river/stream, based on the NHD hydrology layer, and was removed from the analysis.

**Results:**

When only riparian land cover was considered, the sub-watersheds in the Tri-County region averaged 53% natural land cover (sd 16). A significant proportion of the sub-watersheds of the Looking Glass River in Clinton County and the Red Cedar River in Ingham County scored in the 60%-80% natural category (Figure 14, upper). The sub-watershed containing the eastern most portion of the Looking Glass (above Mud Creek) had the highest natural riparian land cover (90%) in the Tri-County region. When natural land cover in an entire sub-watershed was analyzed, the sub-watershed average fell to 29% (sd 11) (Figure 14, lower). The same sub-watershed (the eastern most portion of the Looking Glass) that topped the riparian analysis also had the highest proportion of natural land cover (62%) in the sub watershed.

**Fragmentation analysis****Description:**

This analysis provides information on the level of fragmentation of the rivers in each sub-watershed. There are two major fragmentation factors for rivers that can be easily gleaned from GIS data: dams and road crossings. Both can alter hydrologic flows, sediment exchange, and disrupt fish and mussel movements and population exchanges. Not all road and stream crossings fragment aquatic habitats, but they can if improperly installed and maintained. Because the quality of road crossing cannot be determined using available data, we treated all crossings as a level of fragmentation. In this analysis, the number of dams per river mile and the number of road and stream crossings per river mile in each sub-watershed were calculated, ranked within each watershed, and placed in one of 5 classes based on quintiles. These two analyses were averaged to determine the overall class (1-5) for each sub-watershed.

**Limitations:**

Sub-watersheds with <0.1 miles of river were eliminated from the analysis. The data used in this analysis are static and hence may be outdated for some areas. Additionally, these are not the only factors that create fragmentation in aquatic ecosystems, however they are the easiest to determine given the available data. Additionally, even if sub-watersheds have no dams and few roads, they can be substantially impacted by fragmentation upstream or downstream from the sub-watershed boundaries.

**Results:**

Some sub-watersheds, according to the available data, have very small sections of river, which can result in high numbers of dams and stream crossings per river mile. The sub-watershed with the highest number of stream and road crossings (22) resulted from a sub-watershed with 0.18 miles of river and 4 stream crossings.

Road crossings are a larger fragmentation issue in the southern Lower Peninsula, whereas dams are a bigger issue in the northern Lower Peninsula and the Upper Peninsula (Figure 15 inset). Figure 15 suggests that fragmentation is a significant issue for aquatic ecosystems in the Tri-County region, however there are few areas in the state where fragmentation is not an issue. The mean fragmentation class score for the Tri-County sub-watersheds was 2.8 (sd 0.8), slightly better than the mean for the SLM EDU (3.0, sd 1.0).

**Pollution analysis****Description:**

This analysis provides an overall pollution score to each sub-watershed, providing a broad look at both point and non-point pollution. This metric includes a variety of variables to target both point and non-point source pollution. The number of Michigan Department of Environmental Quality permitted point source facilities, and a count of active mining operations (2003) was determined for each sub-watershed. In addition, the percent impervious surface for each sub-watershed was calculated. Impervious surface refers to anything that keeps water from soaking into the ground. Common examples are roofs, sidewalks, roads, and parking lots. As in the previous analyses, each was placed in one of 5 classes (1-5) within a sub-watershed based on quintiles. The overall pollution metric was calculated by averaging the three individual ranks. This resultant metric ranged from 1 to 5, with 1 being the least polluted and 5 being the most polluted.

**Limitations:**

The point source and toxic release site data used in this analysis is static and may be outdated for some areas. In addition, the IFMAP land cover was documented from satellite imagery taken between 1999 and 2001. Some areas of land have been altered since that time period rendering the land cover outdated for those areas.

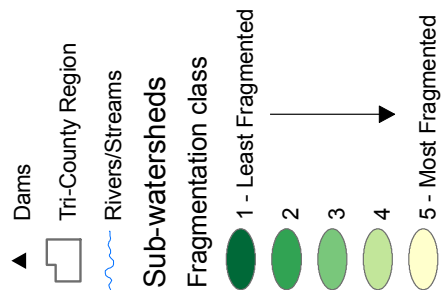
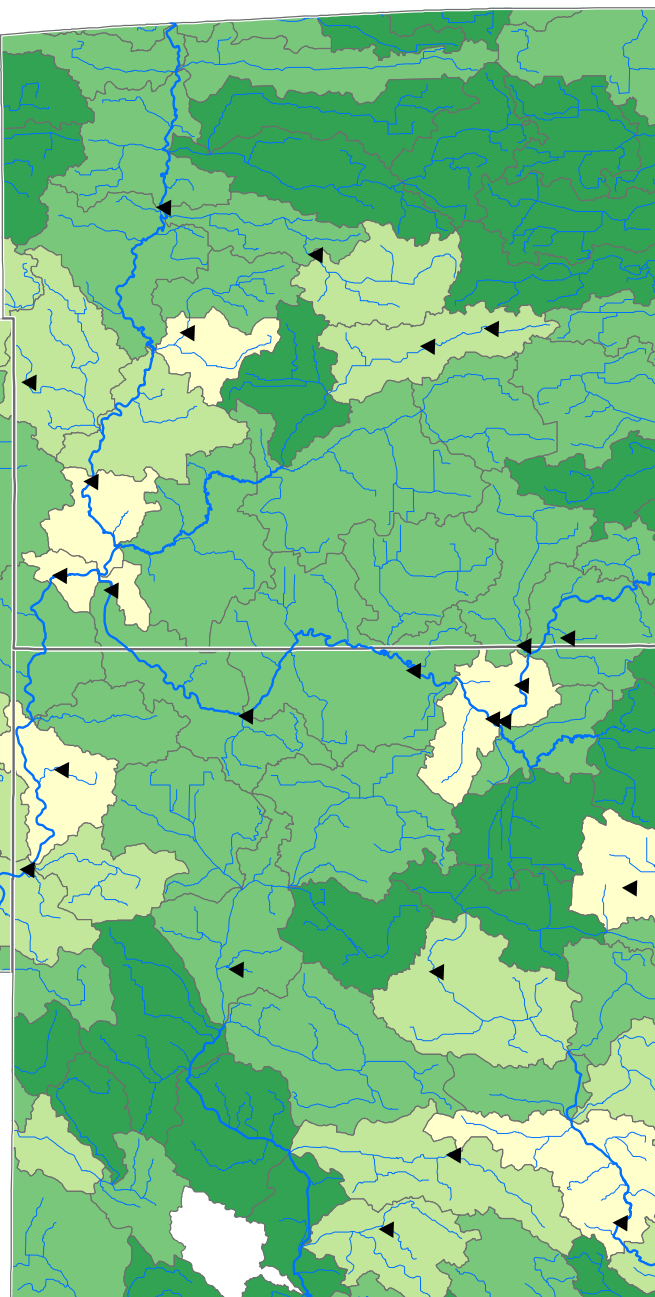
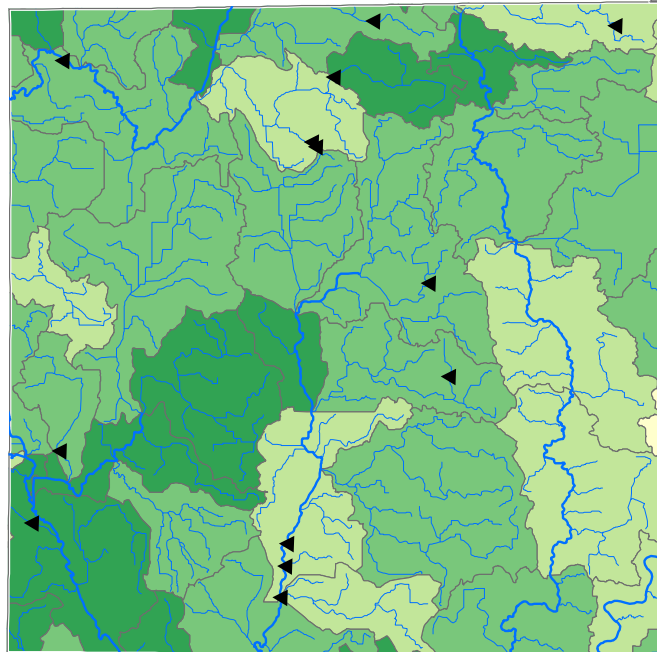
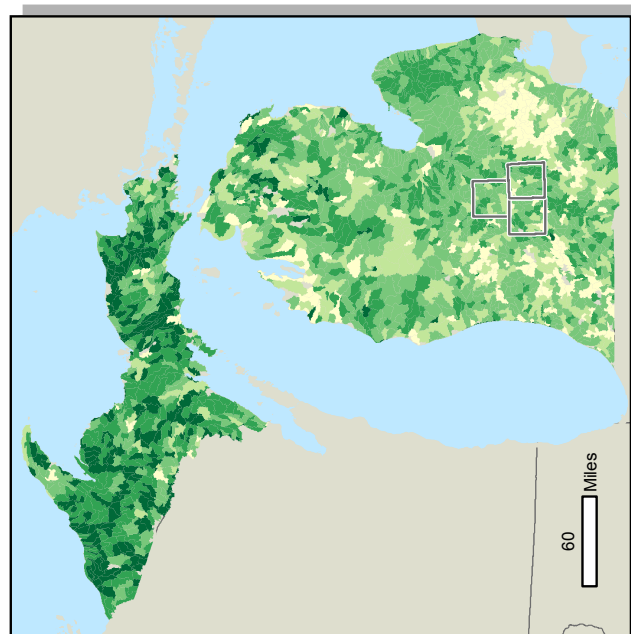


Figure 15. Ranking of Subwatersheds for Degree of Fragmentation

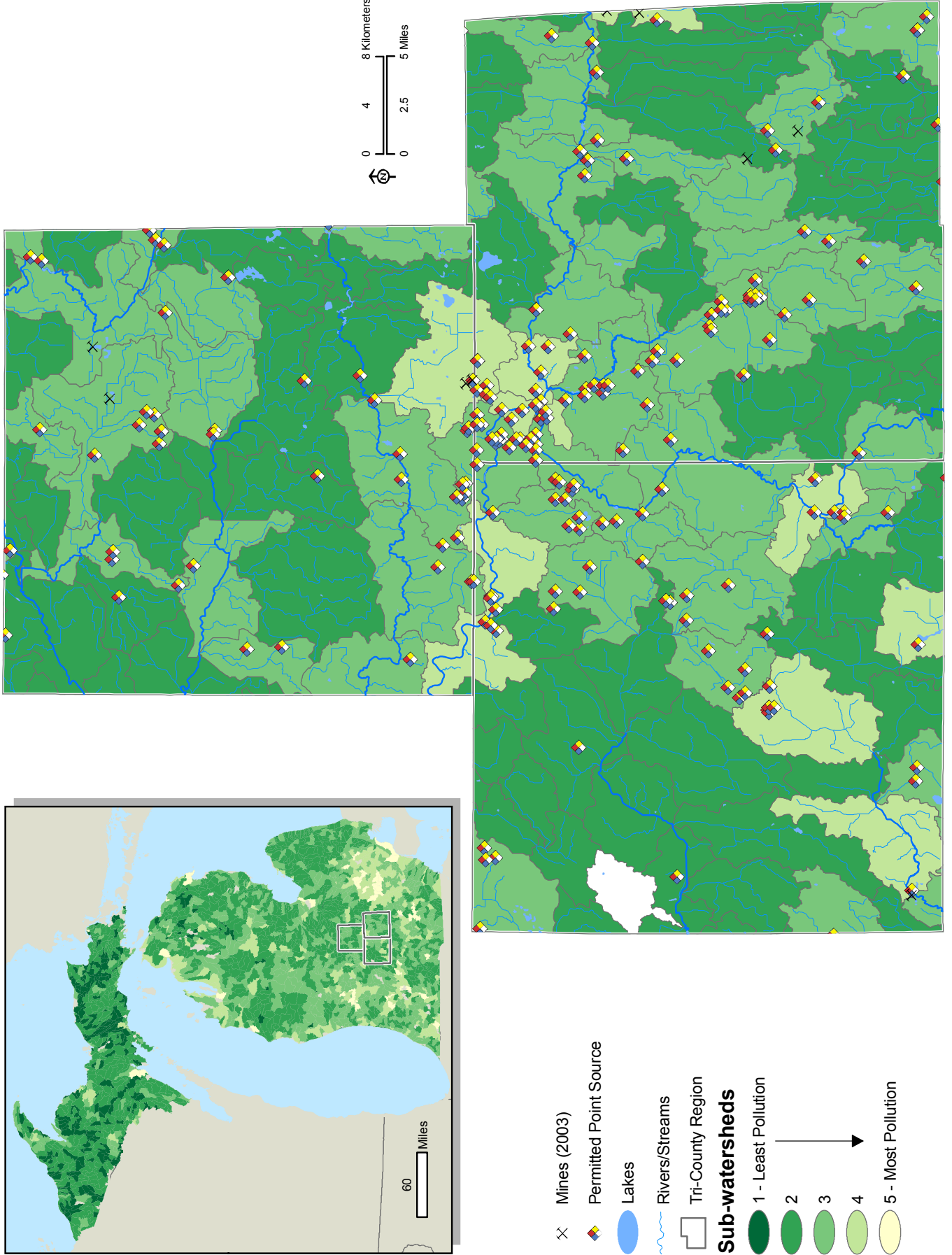


Figure 16. Ranking of Subwatersheds for Potential Pollution

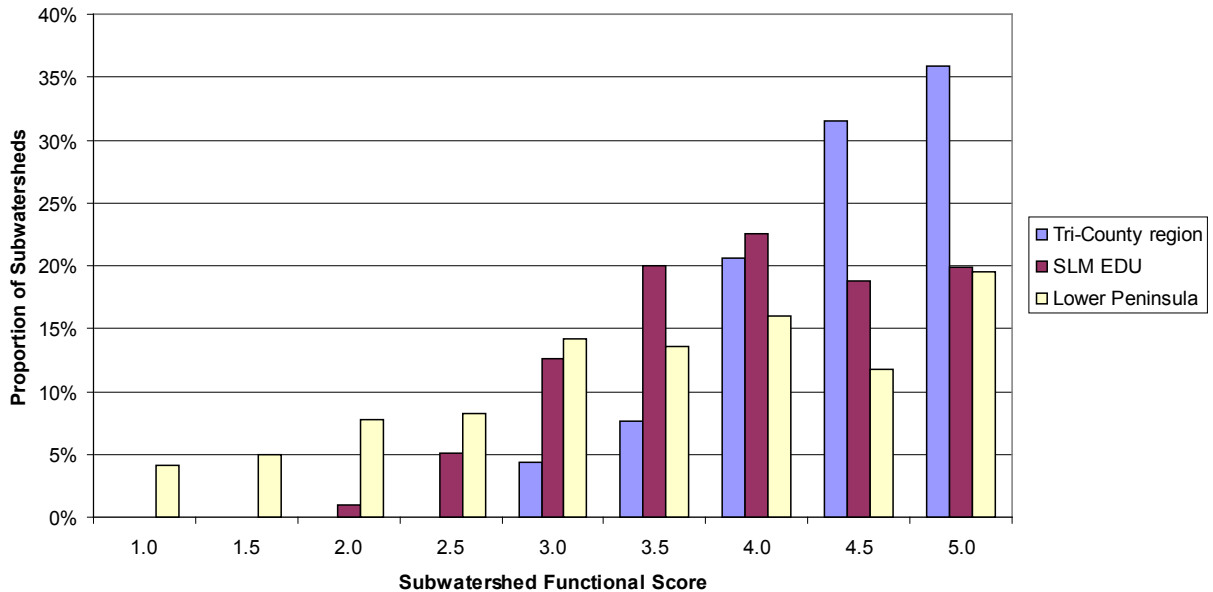
**Results:**

The overall pollution analysis (Figure 16 Inset) shows that most of the Lower Peninsula of Michigan has moderate to high pollution threats. However the indications of pollution in the Tri-County region (Figure 16) reveal an average pollution class score of 2.2 (sd 0.7), which is relatively low. Statistics of the three variables included in the overall pollution score include a mean permitted point source class score of 2.5 (sd 1.5), mean active mine class score of 1.1 (sd 0.5), and mean impervious surface class score of 4.1 (sd 0.7). The amount of impervious surface appears to be the over-riding pollution concern for the Tri-County region.

**Overall Functional Sub-Watershed Results**

As expected, the Upper Peninsula contains the most sub-watersheds that were classified as least modified, and the southern Lower Peninsula had the most sub-watersheds classified as modified (Figure 9 Inset). Overall the Lower Peninsula had very few sub-watersheds that were scored a 1 (least-modified). In the Southeast Lake Michigan EDU, most sub-watersheds had moderate amounts of modification. The Tri-County region had 4 sub-watersheds that scored a 3, with the remainder falling into the more highly modified categories of 4 or 5 (Figure 17 and Figure 18).

**Figure 17. Percent of sub-watersheds in each score category of the overall functional analysis, grouped by the Lower Peninsula of Michigan, SLM EDU, and the Tri-County region.** (Scores of 1 are the least modified sub-watersheds and scores of 5 are the most modified sub-watersheds.)



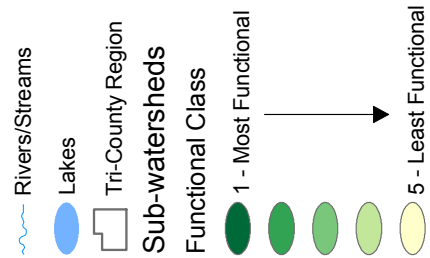
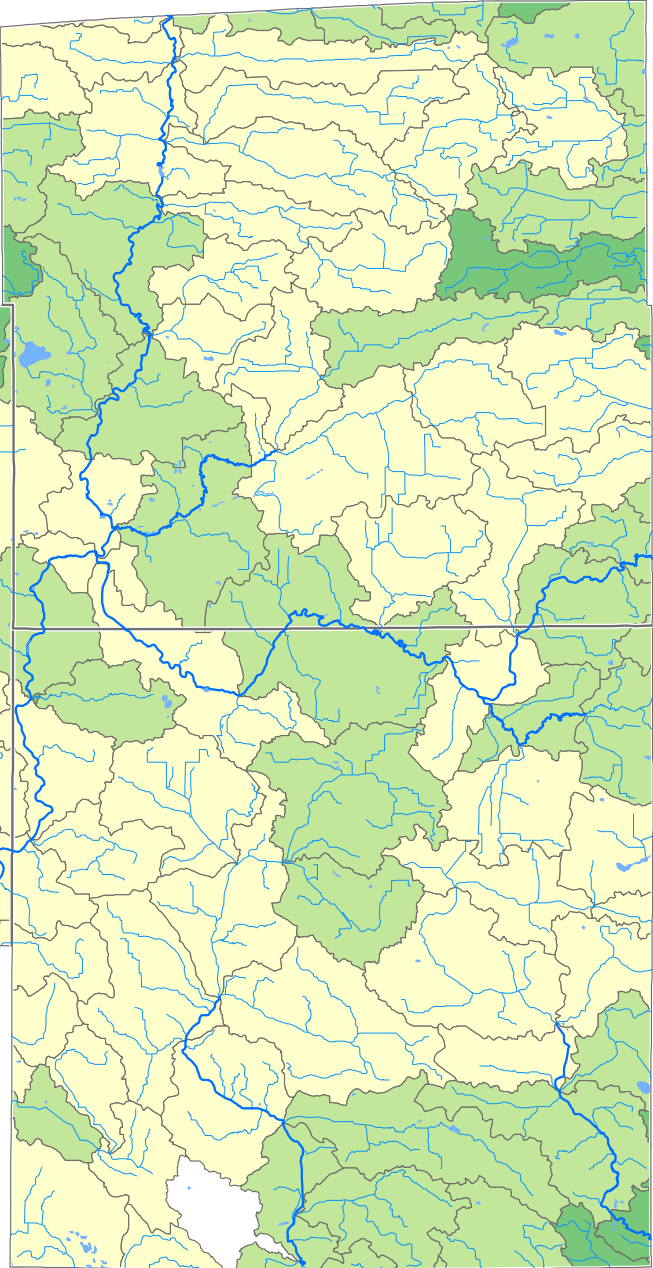
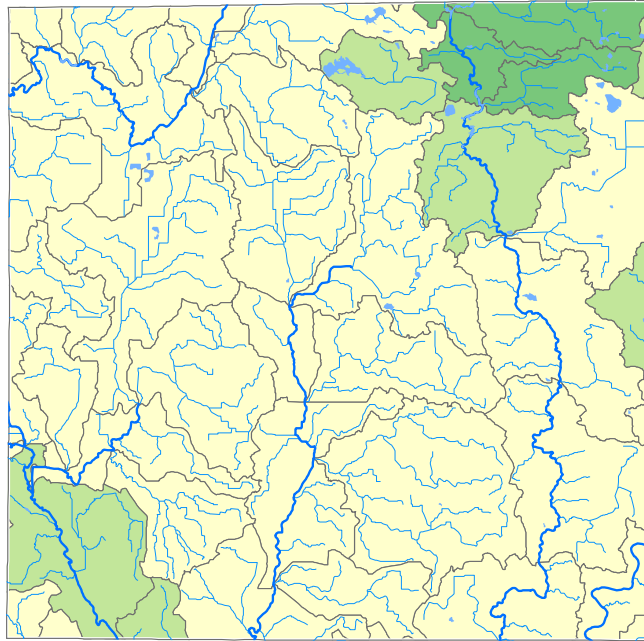
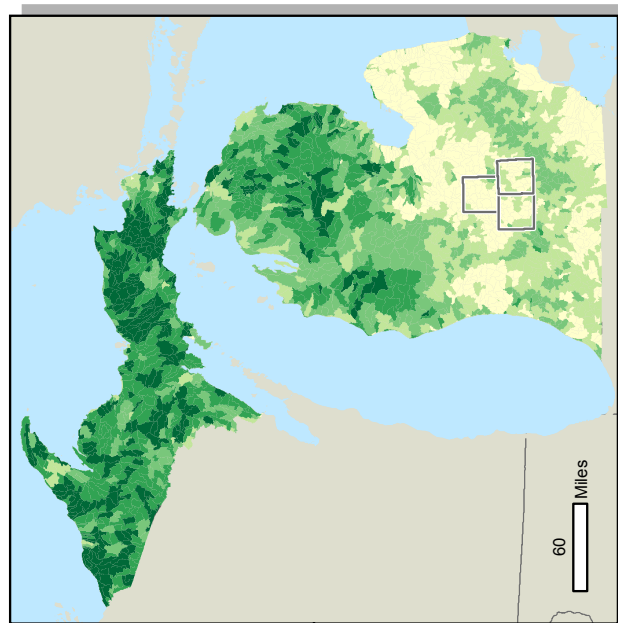


Figure 18. Overall Classification of Functional Subwatersheds

## Rare Aquatic Animals of the Tri-County Region

### Overview

The Tri-County area includes rivers and lakes that support a high diversity of fish and native mussels (Unionidae) relative to other water bodies in Michigan. Two state listed fish species have been recorded in the Tri-County area; the state endangered pugnose shiner (*Notropis anogenus*) from Lake Lansing, Ingham County, and the now thought to be extirpated weed shiner (*Notropis texanus*) from the Grand River, Eaton County. Nearly every site surveyed in the Tri-County area for mussels was found to support multiple species. Also, a high proportion of sites had mussel species of special concern and/or species listed as state threatened. Two state threatened mussel species, four mussel species of special concern, and one snail species of special concern are found within the Tri-County area (Table 14). Thirteen fish and two mussel, “species of greatest conservation need” also occur in the Tri-County area (Table 15).

These rare aquatic species rely on particular habitat conditions to survive. Common species tend to be habitat generalists, with an ability to thrive in a wider range of conditions, including degraded habitats in some cases. Rare species, on the other hand, tend to be more susceptible to habitat alteration and degradation. The presence of a healthy population of a rare aquatic species can be an indicator of a high quality and/or unique aquatic habitat or system. For example, the state threatened purple wartback requires medium to large river habitat with good current, and sand/gravel substrate with low levels of silt. Impacts such as siltation or impoundment can extirpate populations or prevent reproduction from occurring. Keeping the riparian zone intact with forest or other natural landcover can help protect riverine habitats from erosion, excess siltation, increases in water temperature, and altered flow regimes. Though there has been varying amounts of habitat degradation in all the river systems within the Tri-County area, the fact that they still support fish and mussel communities, including rare mussel species, indicates that a certain level of aquatic ecosystem function is still intact and could benefit from further conservation efforts.

Native mussels also rely on fish to complete their life cycle. Mussel larvae must attach to the gills or fins of a fish in order to survive and transform into the adult form. The fish provides a protected environment for the larvae to develop, and they transport the mussel larvae to new habitats. Larvae remain on the fish for up to several months, but do not harm their fish hosts. Some species of mussel are able to attach to only a few species of fish, while others can attach to a dozen or more fish species. Without acceptable habitat for their fish host species, native mussels cannot reproduce. This is one example of how species are interconnected in an aquatic system and how the loss of one species may have consequences for others.

## **Aquatic Biodiversity Assessment - Part 2.**

### ***Datasets presented in this document***

MNFI Element Occurrence (EO) based datasets:

1. Aquatic rare species richness by sub-watershed
2. Species of greatest conservation need (SGCN) richness by sub-watershed

### **Site-Level Analysis: Element Occurrence Data**

#### **Description:**

Approximately 50% of the mussels tracked by MNFI are considered globally critically imperiled (G1), imperiled (G2), or vulnerable (G3). This represents approximately 20% of all native mussels found in Michigan. In addition, 40% of the reptiles and 32% of the insects tracked in the MNFI database have a global rank of G1 – G3, some of which rely on aquatic ecosystems.

### ***Rare Species Richness***

#### **Description:**

This analysis counts the number of rare (state-listed and special concern) aquatic plant and animal species that fall within a given sub-watershed. The model also normalizes the data by river miles because the majority of aquatic rare species use riverine habitats. Species richness is a relatively simple representation of the element occurrence data. It is designed to highlight locations of known rare species richness.

#### **Results:**

The 550 sub-watersheds that contained a river/stream in the SELM EDU had a range of 0 – 5.6 rare species per river mile with a mean of 0.10 (sd 0.41). The count of species per sub-watershed ranged from 0 – 6. One sub-watershed in the Tri-County region did not contain a river/stream, based on the NHD hydrology layer, and was removed from the analysis. The remaining Tri-County region sub-watersheds ranged from 0 – 0.89 rare species per river mile, with a mean of 0.04 (sd 0.13) (Figure 19). The rare species richness ranged from 0 to 5 species per sub-watershed, with 24 sub-watersheds having at least one occurrence. The rare species that are known to occur in the Tri-County region (Table 14) consist of six mussel species, two fish, one aquatic insect and one aquatic snail.

The sub-watershed with the highest rare species richness (0.89 species/river mi) in the Tri-County region was located in northeastern Eaton County on the Grand River with the outlet at Sandstone Creek. This sub-watershed contained 3.37 miles of river/stream and three species of rare mussels. The sub-watershed coming in second (0.77 species per river mile, 6.51 miles of river) was located in Ingham County on the Red Cedar River. Five species of mussels have been found, all within the campus of Michigan State University. All of the sub-watersheds in the top category were on either the Grand or Red Cedar Rivers.

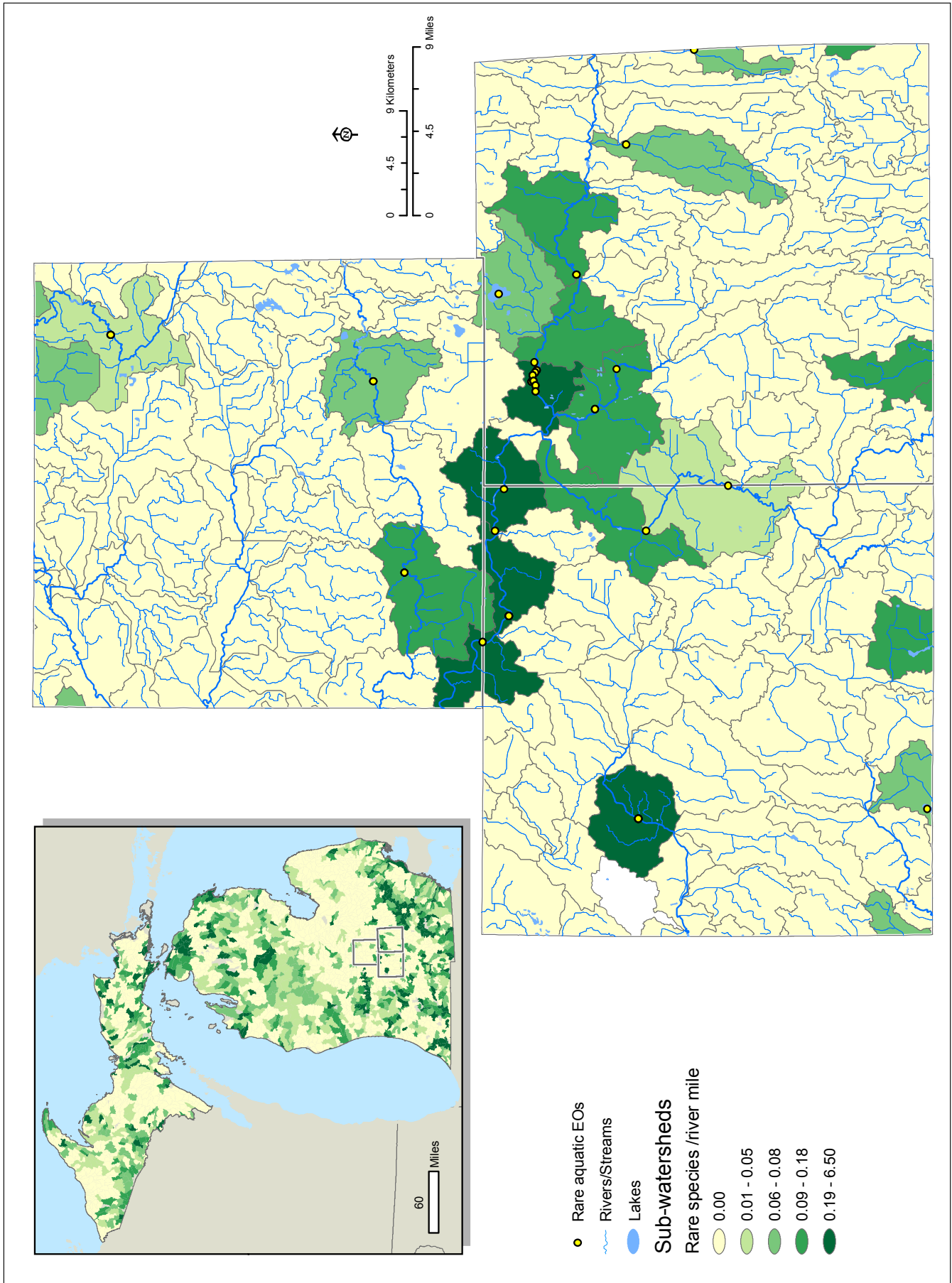


Figure 19. Subwatersheds Classified by Rare Aquatic Species Richness Per Mile of River or Stream

**Table 14. Element occurrence records for rare aquatic animals documented in the Tri-County region.** Federal and State status, global and State ranks, and number of recent element occurrences (EOs) are listed, with number historic records (20 or more years old) in parentheses.

Category/Common Name	Scientific name	U.S. Status <sup>1</sup>	State Status <sup>2</sup>	Global Rank <sup>3</sup>	State Rank <sup>4</sup>	No. EOs	Primary Habitats
<b>Fish</b>							
Pugnose shiner	<i>Notropis anogenus</i>	---	E	G3	S3	(1)	lakes and streams with aquatic vegetation and very clear water
Weed shiner	<i>Notropis texanus</i>	---	X	G5	S1	(3)	low gradient streams of varying sizes with sand, gravel, or rock substrates, usually with vegetation
<b>Mussels (Unionidae)</b>							
Elktoe	<i>Alasmidonta marginata</i>	---	SC	G4	S2S3	13 (1)	Small streams to medium rivers in sand/gravel substrates
Slippershell	<i>Alasmidonta viridis</i>	---	T	G4G5	S2S3	8	Small headwater streams in sand and gravel substrates
Purple wartyback	<i>Cyclonaias tuberculata</i>	---	T	G5	S2S3	1	Medium to large rivers in sand and gravel substrates
Round pigtoe	<i>Pleurobema sintoxia</i>	---	SC	G4G5	S2S3	4	Medium to large rivers in mud, sand, and gravel substrates
Ellipse	<i>Venustaconcha ellipsiformis</i>	---	SC	G4	S2S3	11 (1)	Small to medium streams in sand and gravel substrates
Rainbow	<i>Villosa iris</i>	---	SC	G5	S2S3	10 (1)	Small to medium streams in sand and gravel substrates
<b>Insects</b>							
Splendid Clubtail	<i>Gomphus lineatifrons</i>	---	SC	G4	S2S3	(1)	
<b>Snails</b>							
Spindle lymnae	<i>Acella haldemani</i>	---	SC	G3	S3	(1)	Shallow, eutrophic lakes and ponds, found underwater on the stems of rushes

<sup>1</sup>LE – listed endangered; LT – listed threatened; and C – species being considered for federal status.

<sup>2</sup>E – endangered; T – threatened; SC – special concern; X – extirpated from Michigan

<sup>3</sup>G1 – critically imperiled; G2 – imperiled; G3 – vulnerable; G4 – apparently secure; G5 – secure; and GNR – not ranked.

<sup>4</sup>S1 – critically imperiled; S2 – imperiled; S3 – vulnerable; S4 – apparently secure; S5 – demonstrably secure; and SU – possibly in peril, but status uncertain.

### ***Species of Greatest Conservation Need Richness***

#### **Description:**

This analysis counts the number of aquatic animal species of greatest conservation need (SGCN), as listed in Michigan’s Wildlife Action Plan (Eagle et al. 2005), that fall within a given sub-watershed. As in the rare species richness analysis, the data are normalized by river miles. The species of greatest conservation need richness count is another relatively simple representation of known areas important to species biodiversity.

#### **Results:**

This analysis highlighted a few additional sub-watersheds (Figure 20) than the previous analysis of rare species. The SELM EDU ranged from 0 – 26.6 SGCN species per mile of river (mean 0.27, sd 1.2) and was the richest EDU in Michigan for SGCN. The Tri-County region’s range of 0 – 1.18 was significantly lower, but still had a mean of 0.11 SGCN species per river mile (sd 0.19). SGCN that occur in the Tri-County region (in addition to the rare animal species listed above) include 13 fish and two mussels (Table 15). The two sub-watersheds with the greatest SGCN richness were the same as for rare species richness, but in addition to sub-watersheds associated with the Grand and Red Cedar River, the Looking Glass River had two and Battle Creek had one sub-watershed in the top classification category.

**Table 15. Species of greatest conservation need (SGCN) that occur in the Tri-County region.**

<b>Common Name</b>	<b>Scientific name</b>	<b>Type</b>	<b>Category</b>
Brown bullhead	<i>Ameiurus nebulosus</i>	SGCN	Fish
Cylindrical papershell	<i>Anodontooides ferussacianus</i>	SGCN	Mussel
Pirate perch	<i>Aphredoderus sayanus</i>	SGCN	Fish
Lake chubsucker	<i>Erimyzon sucetta</i>	SGCN	Fish
Grass pickerel	<i>Esox americanus vermiculatus</i>	SGCN	Fish
Barred fantail darter	<i>Etheostoma flabellare flabellare</i>	SGCN	Fish
Least darter	<i>Etheostoma microperca</i>	SGCN	Fish
Brassy minnow	<i>Hybognathus hankinsoni</i>	SGCN	Fish
Creek heelsplitter	<i>Lasmigona compressa</i>	SGCN	Mussel
Striped shiner	<i>Luxilus chrysocephalus</i>	SGCN	Fish
Spotted sucker	<i>Minytrema melanops</i>	SGCN	Fish
Black redhorse	<i>Moxostoma duquesnei</i>	SGCN	Fish
Golden redhorse	<i>Moxostoma erythrurum</i>	SGCN	Fish
Stonecat	<i>Noturus flavus</i>	SGCN	Fish
Tadpole madtom	<i>Noturus gyrinus</i>	SGCN	Fish

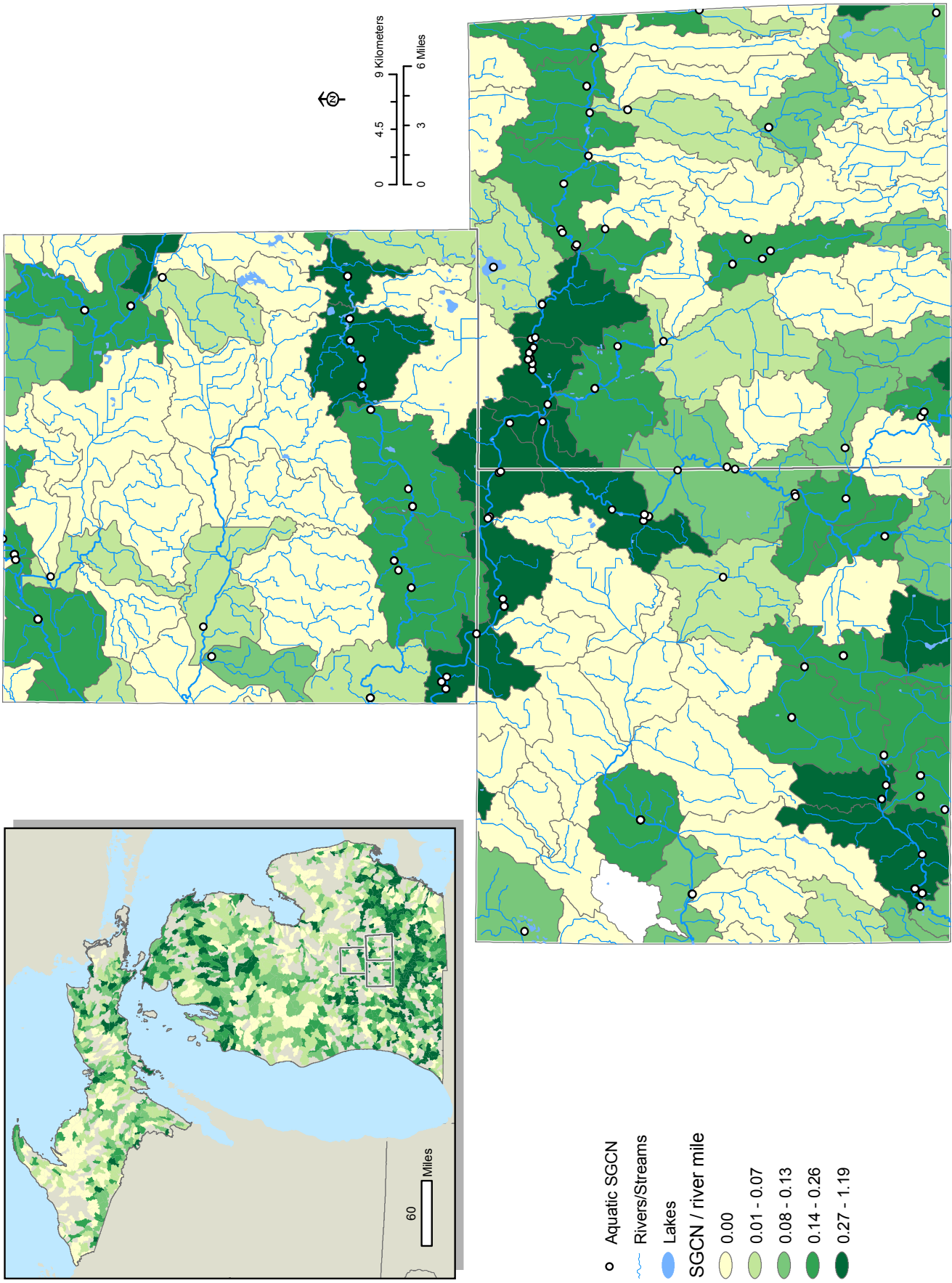


Figure 20. Subwatersheds Classified by Species of Greatest Conservation Need

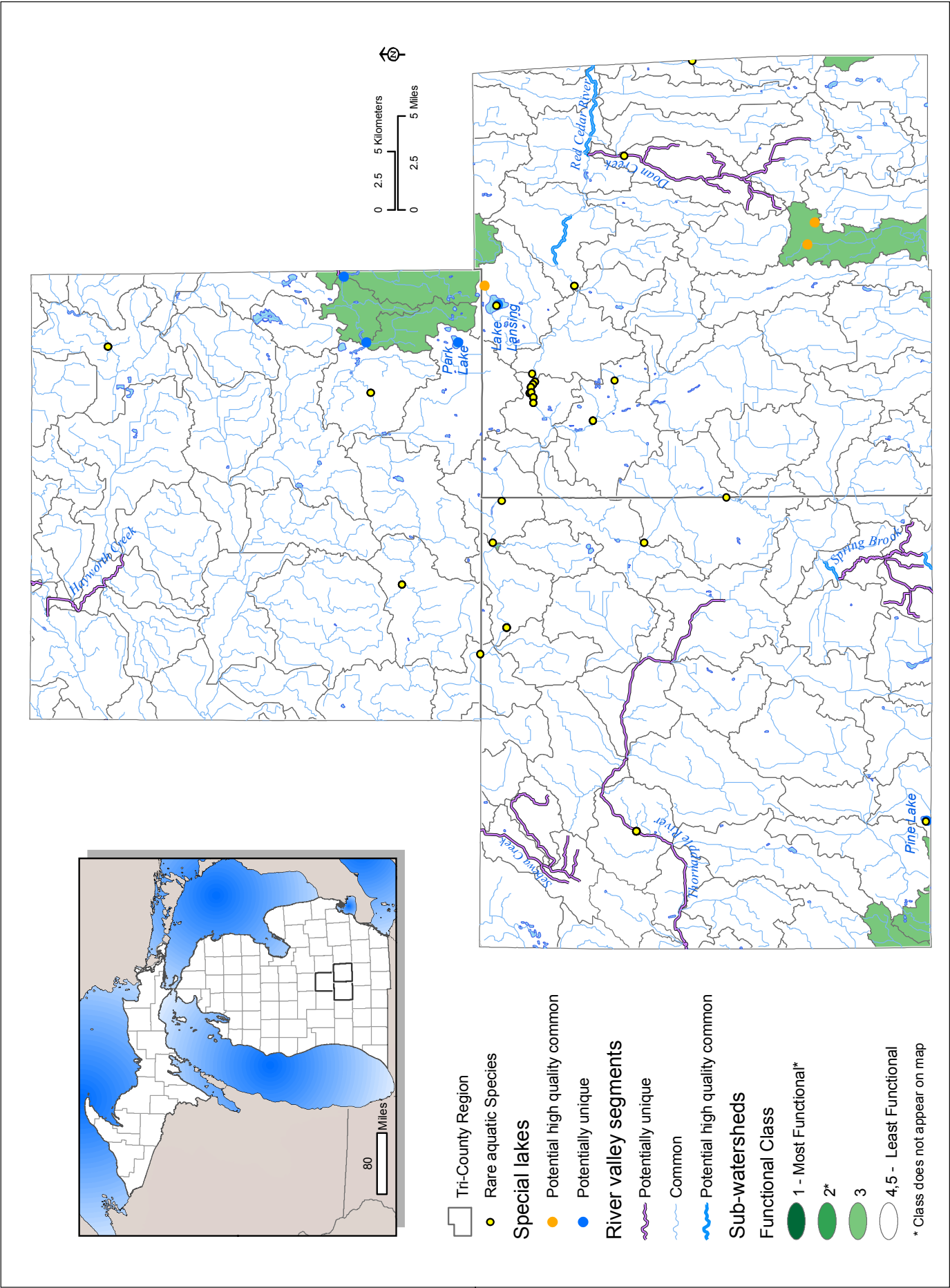


Figure 21. Important Aquatic Features in the Tri-County Region

## Notable Rare Aquatic Animal Element Occurrences by County

### Clinton County

The Looking Glass River in Clinton County supports one state threatened mussel: slippershell (*Alasmidonta viridis*), and four species of special concern: elktoe (*Alasmidonta marginata*), ellipse (*Venustaconcha ellipsiformis*), rainbow (*Villosa iris*), and round pigtoe (*Pleurobema sintoxia*). These occurrences were documented at two sites by MNFI in 2001. One site near Wacousta was found to have all the species above except for round pigtoe, and another site near Chandler Road was found to have elktoe and round pigtoe. In the Maple River, a couple miles north of Sleepy Hollow State Park, the state threatened slippershell and two species of special concern mussels (elktoe and rainbow) were documented in 2001.

### Eaton County

Two historic weed shiner (*Notropis texanus*) occurrences were reported in the Grand River in 1927, one from below the Dimondale dam in Eaton County, and another from above Waverly Road in northwest Lansing, Ingham County. This is the only record of weed shiner in Eaton County. The weed shiner grows to about 8cm, with light olive green back and upper sides, and a silvery white underside. The scales on the upper side of the fish have dark margins that create a cross hatched pattern. A dark band encircles the snout and continues back to the base of the caudal fin. The mouth is set at an oblique angle but not oriented as near to vertical as pugnose shiner. The weed shiner is associated with low gradient streams and slower moving portions of high gradient streams. It is found in streams of widely varying sizes with substrates of sand, gravel, or rock. Weed shiner often occur in streams with aquatic vegetation but they can also occupy streams with little or no vegetation (Thomas *et al.* 2007). This species has not been collected in Michigan since 1953, and is considered extirpated from the state. Reasons for its decline and resulting extirpation include habitat degradation, increased siltation and turbidity from the loss of riverine vegetation, deforestation, and wetland alteration. Though the weed shiner has historically been very rare in Michigan, its global conservation status is thought to be secure (G5).

Two state threatened mussels, the purple wartyback (*Cyclonaias tuberculata*) and slippershell, and four species of special concern, elktoe, ellipse, rainbow, and round pigtoe occur in Eaton County. The only documented occurrence for purple wartyback in the Tri-County area is a 1996 record from the Grand River, at Delta Mills in northwest Lansing. One site in the Thornapple River, northwest of Charlotte, was found in 2001 to support the threatened slippershell and all four species of special concern. A site in the Grand River, in Grand Ledge, was found in 2002 to support slippershell, rainbow, elktoe, and round pigtoe.

The spindle lymnae (*Acella haldemani*), an aquatic snail, is a species of special concern that was recorded at the southern edge of Eaton County in Pine Lake. This is a historic record (> 20yrs old) from the University of Michigan Museum of Zoology mollusk collection. This snail has a very slender, elongate spire, reaching about 1 inch long. It is found in the shallows of eutrophic lakes and ponds, usually on the stems of rushes (Juncaceae) 6 to 10 inches from the bottom. Use of molluscicides (chemicals such as copper sulfate) to kill snails in order to treat lakes for swimmers itch can be very detrimental to all snail and mussel species, including spindle lymnae.

Since this species requires habitat vegetated with rushes, removal of aquatic vegetation can have a negative impact. The introduction of certain game fish to lakes can also have negative impacts on snail populations. For example, the non-native redear sunfish (*Lepomis microlophus*) is a molluscivore. Snails make up the majority of its diet.

### **Ingham County**

Lake Lansing, in Ingham County, is the only location from which the pugnose shiner (*Notropis anogenus*) has been recorded in the Tri-County area. It was last collected there in 1959. The pugnose shiner grows to about 5cm, has a dark band extending across its snout to the tail, and a very small, almost vertically oriented mouth. This species belongs to the family Cyprinidae, which includes shiners, minnows, daces, chubs, and common carp. It occurs only in lakes and streams with very clear water, where there is an abundance of aquatic vegetation and the bottom consists of clean sand, marl, or organic debris (Trautman 1981). The status of pugnose shiner was recently changed from species of special concern to state endangered. This species has declined from 23 known Michigan populations in the 1970's, to only three. It is also in serious decline throughout the Great Lakes basin. The global conservation status of pugnose shiner is ranked by NatureServe as vulnerable (G3). The pugnose shiner's very low tolerance to turbidity is thought to be a primary factor in its decline. The removal of aquatic vegetation, with herbicide or by other means, is also a concern. Balancing the control of aquatic vegetation with the habitat needs of pugnose shiner is currently an important rare aquatic species management issue to address for the Tri-County area.

A historic (1927) occurrence for weed shiner was documented above Waverly Road in northwest Lansing. It is the only record of this species in Ingham County. The Waverly Road site was re-surveyed in the summer of 1993, but no weed shiners were found.

One state threatened mussel, the slippershell, and four species of special concern (elktoe, round pigtoe, ellipse, and rainbow) were found at several sites in the Red Cedar River during MNFI surveys in 2001. A "species of greatest conservation need", creek heelsplitter (*Lasmigona compressa*), was also found at one site. Particularly high densities of unionid mussels were documented in the Red Cedar River on the Michigan State University campus, despite the presence of trash and abandoned bicycles. One factor that may be contributing to the high densities at this site is its location just downstream of a low dam. This dam likely acts as a barrier to upstream movement of adult mussels as well as fish hosts. Populations of adult unionid mussels have been observed to have a net movement upstream on the order of 1 meter per month (Badra and Goforth 2001). As mussels move upstream they would accumulate at the downstream side of the dam. Unionid mussels have a larval stage that attaches to the gills of fish hosts, were they remain for weeks or months until transforming into the adult stage and dropping off the fish and onto the stream bottom. The fish host provides the main mechanism for migration of unionid mussels to new habitats. Barriers to fish host migration are also barriers to unionid mussel migration. High mussel density at this Red Cedar River site may also be due to the fact that fish host movement is blocked by the dam, resulting in more mussels dropping off fish hosts onto the stream bottom at this site.

## Information Gaps

The state endangered pugnose shiner was last documented in the Tri-County area in 1959. Surveys of Lake Lansing, the only waterbody in the Tri-County area known to have support this species, need to be performed in order to determine the current status of this species. Life history and behavior of pugnose shiner, such as spawning habits and seasonal/daily movement are not well known. A better understanding of these would facilitate management. Traditional methods of fish sampling are not effective with this species because it inhabits dense aquatic vegetation. Alternative methods that are more effective for sampling pugnose shiner need to be investigated or developed.

Most aquatic element occurrences in the tri-county area were last observed in 2001 or 2002. These were documented during unionid mussel surveys performed as part of a multi-discipline MNFI study of riparian buffer areas and a mussel survey of the Red Cedar River in 2001. Another relatively recent occurrence (1996) was documented by MNFI staff in the Grand River. The Grand, Thornapple, Maple, and Looking Glass Rivers remain largely un-surveyed for native mussels within the tri-county area. Given the results of the few surveys that have been done in the watersheds within the Tri-County area, there are very likely to be more populations of rare species that have not yet been documented. Surveys to update the status of old occurrence records would provide more accurate information for the environmental review process. This process is coordinated through Michigan's Department of Environmental Quality and Department of Natural Resources to assess potential impacts of various projects on unique natural features.

More information is needed on how to best manage Lake Lansing to allow for pugnose shiner habitat. Lake Lansing is an important recreational boating site for the Lansing area. The shallow depth of most of the lake allows sunlight to penetrate to the bottom, and aquatic vegetation to grow to densities that interfere with the operation of boat motors. Full lake treatment with herbicide and aquatic plant harvesters have been used to remove vegetation. Although the pugnose shiner requires habitat with an abundance of aquatic vegetation, letting aquatic vegetation grow unchecked may not be the best action for the fish. Complicating the situation is the presence of the exotic Eurasian watermilfoil (*Myriophyllum spicatum*) in Lake Lansing. If this species grows unchecked it could further displace native species of aquatic vegetation, and potentially have negative impacts on pugnose shiner habitat. It is not known whether the potential negative impacts of herbicide and other means of controlling vegetation outweighs the potential benefits to pugnose shiner. One benefit of aquatic plant harvesters is that they cut off vegetation at a certain depth, leaving the remaining lower portion of the plant intact and able to provide habitat for fish and other organisms. One drawback is that significant numbers of small fish, invertebrates, and amphibians can be collected and killed by aquatic plant harvesters. Management options that could be further investigated include spot treatment versus whole lake treatment with herbicides, and reducing the amount of nutrients (e.g. nitrogen, which contributes to vegetation growth) being introduced to Lake Lansing.

Lastly it is important to note that fish and unionid mussels comprise a small proportion of the aquatic animal taxa that contribute to the function of aquatic ecosystems in the Tri-County area.

The majority of the aquatic animal taxa in the Tri-County area have not been as well studied as fish or even mussels, but they play an essential role in supporting the ecosystem functions that our rivers and lakes provide. These include crustaceans, like crayfish (Decapods) and fairy shrimp (Branchiopods), snails and freshwater limpets (Gastropods), pea clams (Sphaeriids), freshwater sponge (Porifera), roundworms (Nematodes), flatworms (Platyhelminthes), and insects, like dragonflies (Odonata), caddisflies (Trichoptera), stoneflies (Plecoptera), and mayflies (Ephemeroptera). Little information on the status and distribution of these groups is available.

## Description of the Ten Top-Ranked Priority Conservation Areas

### PCA # 1

**Location:** CLINTON: T08N R04W S30, 19, 18, 17, 20, 21, 16, 15, 22, 10

#### Documented and Potential Natural Communities

This PCA encompasses the majority of the largest natural community element occurrence in the Tri-County Region, an extensive floodplain forest associated with the Maple River within the Maple River State Game Area. Three small inland salt marshes are also captured within the PCA and they represent the only state occurrences of this community. This PCA alone accounts for 65% of the documented high quality natural community acreage in the Tri-County Region. The PCA includes significant acreage of upland forests, and has the potential to harbor high quality examples of the following natural communities:

- Mesic southern forest
- Dry-mesic southern forest
- Emergent marsh
- Southern hardwood swamp
- Rich tamarack swamp
- Inundated shrub swamp
- Inland salt marsh

#### Documented and Potential Rare Plant Species

Several significant rare plant occurrences are contained within this PCA. The floodplain forest includes occurrences of twinleaf (*Jeffersonia diphylla*), cat-tail sedge (*Carex typhina*), and Davis's sedge (*C. davisii*), with the population of cat-tail sedge likely constituting the largest known for the state. Olney's bulrush (*Schoenoplectus americanus*) and a rare spike-rush (*Eleocharis parvula*) have been documented for the inland salt marshes, all of which are highly significant elements in that these two rare plant species and this community type, which is considered globally rare, are not known elsewhere in Michigan. Floodplain forests, particularly those located in southern Lower Michigan, have the potential to support a large number of rare plant taxa, especially within a riparian complex as large as the Maple River corridor. Species that should be sought include red mulberry (*Morus rubra*), pumpkin ash (*Fraxinus profunda*), American beak grass (*Diarrhena obovata*) – which is known in PCA # 3 as part of the same riparian basin –, snow trillium (*Trillium nivale*), goldenseal (*Hydrastis canadensis*), wahoo (*Euonymus atropurpurea*), broad-leaved puccoon (*Lithospermum latifolium*), Davis's sedge (*Carex davisii*), hairy sedge (*C. trichocarpa*), and Virginia snakeroot (*Aristolochia serpentaria*), among several other species.

#### Documented and Potential Rare Animal Species

Two rare animal species, Cerulean Warbler and Prothonotary Warbler, were recorded within this PCA. Most of the Prothonotary Warbler locations included in this EO are contained within the PCA. More than 100 Prothonotary Warblers and 50 nest locations were observed at this location along the Maple River in 2000, which represents the second largest total number of individuals observed of all of the Prothonotary Warbler EOs in the MNFI database. A historical Great Blue Heron rookery was also documented in the PCA. Several rare animal species requiring large

blocks of riparian, bottomland, or deciduous forest could occur in this PCA, including Indiana Bat, Red-shouldered Hawk, Louisiana Waterthrush, and Hooded Warbler. Woodland Vole could occur in upland forests of the PCA that have well-drained soils (Kurta 1995), and Blanding's Turtle could be present along the Maple River and in wetlands of the PCA. The Regal Fern Borer moth could occur in forested wetlands containing regal or cinnamon fern.

## **PCA #2**

**Location: INGHAM: T02N R01E S29, 32, 28, 33, 27, 34; T01N R01E S5, 4, 3**

This PCA comprises a significant portion of the Dansville State Game Area in southeastern Ingham County. The PCA is characterized by a large patch of relatively unfragmented, though disturbed, natural cover. Although no high quality natural community occurrences are documented in the Dansville State Game Area or this PCA, the site has the potential to harbor high quality examples of the following natural communities:

- Dry-mesic southern forest
- Dry southern forest
- Oak barrens
- Rich tamarack swamp
- Southern hardwood swamp
- Southern wet meadow
- Prairie fen
- Emergent marsh
- Submergent marsh
- Inundated shrub swamp
- Southern shrub-carr
- Wet prairie
- Wet-mesic prairie

### **Documented and Potential Rare Plant Species**

This PCA includes an occurrence of the state endangered American chestnut (*Castanea dentata*) and an occurrence of goldenseal. The American chestnut locality was identified in 2001, and contains about 80 trees, several of which were noted as mature and producing nuts. However, because this locality lies beyond what is felt to be the range limit within the state, considered by Barnes and Wagner (2004) to be extreme southeastern Lower Michigan, its presence in Ingham County may be questionable. This species has been planted throughout much of southern Lower Michigan (Brewer 1995) thus its origin in the SGA should be investigated. It is possible that it represents an outlier colony in the absence of any further information on provenance. The PCA also contains a moderately large occurrence of goldenseal, which currently has not been entered into the statewide database but has been confirmed in field surveys. Based on the diversity of potential habitats and natural communities identified for the SGA, a large number of rare plant species have the potential to occur at this site, particularly wetland species.

### **Documented and Potential Rare Animal Species**

A variety of forest and wetland types are present within this PCA. The following rare species were documented within the PCA boundaries: King Rail (historical), Spotted Turtle (historical),

Blanding's Turtle, Barrens Buckmoth (historical), and Tamarack Tree Cricket. A Great Blue Heron rookery was also observed in the area in 1991. In addition to the documented species, there is potential for several other wetland species to occur in the PCA. Rare wetland birds, such as American Bittern, Least Bittern, and Marsh Wren could be present in herbaceous wetlands (e.g., marshes, wet meadows). Blanchard's Cricket Frog could inhabit open water areas and adjacent wetlands. Eastern Massasauga could be found in a variety of herbaceous wetlands and shrub swamps. Swamp Metalmark may be present in prairie fens or wet meadows, and Pinetree Cricket could occur in conifer stands containing White Pine (*Pinus strobus*).

### **PCA #3**

**Location: CLINTON: T08N R04W S11, 14, 1, 12; T08N R03W S6, 7**

This PCA encompasses a large stretch of the Maple River and associated floodplain just upstream of PCA # 1 and is part of the same riparian corridor and drainage system. Although no high quality natural community occurrences are currently documented from this area, the site has the potential to harbor high quality examples of the following natural communities:

- Floodplain forest
- Emergent marsh
- Inland salt marsh
- Inundated shrub swamp
- Southern hardwood swamp
- Mesic southern forest
- Dry-mesic southern forest

### **Documented and Potential Rare Plant Species**

Two floodplain EOs have been documented in this PCA, consisting of Davis's sedge and American beak grass, indicating good potential for identifying several of the aforementioned floodplain taxa.

### **Documented and Potential Rare Animal Species**

The same Prothonotary Warbler occurrence described under PCA # 1 also falls within this PCA, which is the only EO documented for the area. There is potential for several rare species that use large blocks of deciduous forest. Indiana Bat could occur in floodplain forest along the Maple River. Red-shouldered Hawk, Cerulean Warbler, Louisiana Waterthrush, and Hooded Warbler could be present in floodplain and adjacent upland forests. Blanding's Turtle could occur in the Maple River and associated wetlands, and there is potential for Woodland Vole in upland forests of the PCA. Regal Fern Borer could be present in forested wetlands at this site.

### **PCA #4**

**Location: EATON: T01N R06W S26, 13, 24, 25; T01N R05W S18, 19, 17**

This PCA encompasses a portion of an extensive wetland associated with Battle Creek, northwest of the City of Olivet in south-central Eaton County. The forested and herbaceous wetlands appear heavily disturbed by the channelization of Battle Creek, in addition to other hydrologic alterations. Although no high quality natural community occurrences have been documented

from this PCA, the site has the potential to harbor high quality examples of the following natural communities:

- Southern hardwood swamp
- Rich tamarack swamp
- Southern shrub-carr
- Inundated shrub swamp
- Emergent marsh
- Submergent marsh
- Bog
- Dry-mesic southern forest
- Oak openings
- Mesic southern forest

### **Documented and Potential Rare Plant Species**

No documented rare plant EOs are currently known. Based on the potential communities highlighted for this PCA, the types most likely to harbor listed species include southern hardwood swamp for such species as bog bluegrass (*Poa paludigena*), rich tamarack swamp for species such as white lady's slipper (*Cypripedium candidum*), bog for such species as yellow fringed orchid (*Platanthera ciliaris*), dry-mesic southern forest and oak openings for prairie and woodland species, and mesic southern forest for such species as ginseng and goldenseal.

### **Documented and Potential Rare Animal Species**

Although no rare animal EOs were documented within this PCA, there is potential for several species to be present. Two historical Copperbelly Water Snake occurrences were recorded nearby to the southwest on Indian and Big Creeks, which are tributaries to Battle Creek. There is potential for this species to occur in forested or shrubby wetlands along Battle Creek. Indiana Bat could also occur in forested wetlands along the river. Blanchard's Cricket Frog, Spotted Turtle, and Blanding's Turtle could exist in open water areas and adjacent wetlands. Eastern Massasauga could be found in a variety of herbaceous wetlands and shrub swamps. There is potential for rare wetland bird species, such as King Rail, American Bittern, Least Bittern, and Marsh Wren, in marshes and wet meadows of the PCA. Swamp Metalmark could also be present in wet meadows, Tamarack Tree Cricket in wetlands containing Tamarack (*Larix laricina*), and Regal Fern Borer in forested wetlands.

### **PCA #5**

**Location: INGHAM: T05N R01W S23, 24**

This PCA is an approximately 250-acre (100 ha) block of mostly natural cover near the Michigan Department of Natural Resources (DNR) Rose Lake Wildlife Area in southeastern Clinton County. It consists of lowland and upland forest and shrub wetlands. No high quality natural communities are documented from this PCA. The site has the potential to harbor high quality examples of the following natural communities:

- Dry-mesic southern forest
- Rich tamarack swamp

- Southern hardwood swamp
- Emergent marsh
- Southern shrub-carr

### **Documented and Potential Rare Plant Species**

No documented rare plant EOs are currently known for this PCA. Based on the natural communities interpreted to be potentially present, the types most likely to harbor rare plant taxa include dry-mesic southern forest, rich tamarack swamp, and southern hardwood swamp. Examples of emergent marsh have modest potential for supporting populations of the state threatened wild rice (*Zizania aquatica* var. *aquatica*).

### **Documented and Potential Rare Animal Species**

A historical Blanchard's Cricket Frog record is known from the area. There is potential for Eastern Massasauga to be present in herbaceous and shrub wetlands. Woodland Vole could possibly occur in upland forests at this site. Tamarack Tree Cricket may be present in conifer swamps containing Tamarack. Pinetree Cricket could potentially exist at this site, if White Pine stands are present.

### **PCA #6**

**Location:CLINTON: T05N R01W S2, 11, 14, 1, 12, 13**

This PCA (located in close proximity to PCA # 5 is comprised of an extensive area of herbaceous, shrub and forested wetlands and associated uplands, located partly within the Michigan DNR Rose Lake Wildlife Area. This area appears to be significantly impacted by drainage projects and agricultural conversion. No high quality natural communities are documented from this PCA. Despite the apparent disturbance, the site has the potential to harbor high quality examples of the following natural communities:

- Southern wet meadow
- Prairie fen
- Wet prairie
- Wet-mesic prairie
- Southern shrub-carr
- Southern hardwood swamp
- Rich tamarack swamp
- Inundated shrub swamp
- Emergent marsh
- Submergent marsh
- Dry-mesic southern forest

### **Documented and Potential Rare Plant Species**

Of primary interest would be the potential presence of prairie fen, which could support populations of white ladyslipper, mat muhly (*Muhlenbergia richardsonis*), and prairie dropseed (*Sporobolus heterolepis*). Swamp communities have the potential to harbor such species as bog bluegrass among other species.

### **Documented and Potential Rare Animal Species**

Although there are no documented occurrences of rare animal species within the PCA, there is potential for several species to occur at the site. Eastern Massasauga, Spotted Turtle, and Blanding's Turtle could use wetlands in the PCA, as well as rare wetland birds, such as King Rail and American Bittern. There is also potential for Swamp Metalmark in prairie fens and wet meadows, as well as Tamarack Tree Cricket if Tamarack stands are present.

### **PCA #7**

**Location: EATON: T03N R06W S8, 17, 20, 9, 16**

This PCA is comprised of an area of herbaceous, shrub, and forested wetlands associated with Scipio Creek and a relatively large, intact mesic southern forest known locally as "Barber Woods" that supported old-growth conditions until logging removed old trees in the 1960s. Although no high quality natural community occurrences are documented in this PCA, the site has the potential to harbor high quality examples of the following natural communities:

- Mesic southern forest
- Southern wet meadow
- Southern hardwood swamp
- Rich tamarack swamp
- Southern shrub-carr
- Emergent marsh
- Submergent marsh
- Inundated shrub swamp

### **Documented and Potential Rare Plant Species**

One rare plant occurrence has been documented for this PCA, showy orchis (*Galearis spectabilis*). Based on the former existence of a high quality mesic southern forest, which prior to logging was known to have old-growth structure, rare plants that could persist include showy orchis, ginseng, and goldenseal.

### **Documented and Potential Rare Animal Species**

No rare animals have been documented in this PCA; however, there is potential for some rare species to occur. Blanchard's Cricket Frog, Spotted Turtle, and Blanding's Turtle could inhabit the creek, other areas of open water, and adjacent wetlands. Eastern Massasauga could use herbaceous and shrub wetlands at the site. There is potential for wetland birds, such as King Rail and American Bittern, in herbaceous wetlands, and forest songbirds, including Cerulean Warbler, Prothonotary Warbler, and Hooded Warbler, in larger forest areas. Swamp Metalmark could also occur in wet meadows containing swamp thistle and Tamarack Tree Cricket in wetlands with Tamarack stands.

### **PCA #8**

**Location: EATON: T03N R06W S13; T03N R05W S6, 7, 18, 5, 8**

This PCA contains a segment of the Thornapple River and associated floodplain northwest of Charlotte in Eaton County. Although no high quality natural community occurrences are

documented in this PCA, the site has the potential to harbor high quality examples of the following natural communities:

- Floodplain forest
- Mesic southern forest
- Inundated shrub swamp

### **Documented and Potential Rare Plant Species**

No rare plant occurrences have been documented for this PCA. Based on the potential for the occurrence of floodplain forest and mesic southern forest, several rare plant species, as detailed above and included in the rare plant tables, should be sought in this PCA.

### **Documented and Potential Rare Animal Species**

No rare animal element occurrences have been documented in this PCA. The riparian forests of this PCA could possibly support Indiana Bat. Since historical records of Copperbelly Water Snake exist for Eaton County, there is potential for the species to be present in the floodplain forest of this site. Blanding's Turtle may also use the river and associated wetlands. Several rare bird species could inhabit the floodplain forests, including Red-shouldered Hawk, Cerulean Warbler, Prothonotary Warbler, Louisiana Waterthrush, and Hooded Warbler. Regal Fern Borer may occur in the floodplain forest if larval host plants (i.e., regal and cinnamon fern) are present.

### **PCA #9**

**Location: CLINTON: T05N R01W S27, 34, 26**

This PCA encompasses a portion of the Michigan DNR Rose Lake Wildlife Area, including Mud Lake, Potter Lake, and associated wetlands and uplands. This PCA relative to the surrounding landscape, is topographically diverse, and includes the potential for a wide range of natural communities ranging from acid bog to wet prairie, prairie fen, various forested swamp types and dry-mesic southern forest. Although a portion of the wetlands are affected by ditching, much of the area appears relatively intact. No high quality natural communities are documented from this PCA. The site has the potential for high quality examples of the following natural communities:

- Submergent marsh
- Emergent marsh
- Southern wet meadow
- Wet prairie
- Wet-mesic prairie
- Prairie fen
- Southern shrub-carr
- Rich tamarack swamp
- Rich conifer swamp
- Hardwood-conifer swamp
- Southern hardwood swamp
- Bog
- Poor conifer swamp
- Inundated shrub swamp
- Dry-mesic southern forest

### **Documented and Potential Rare Plant Species**

No rare plant occurrences have been documented for this PCA. Numerous rare plant species could be sought for the range of potential types mentioned above, with the best potential for rare plant taxa represented by the wet prairie, wet-mesic prairie, and prairie fen types.

### **Documented and Potential Rare Animal Species**

No rare animal EOs were recorded in this PCA. A historical Blanchard's Cricket Frog record was documented nearby to the northeast, and the species could occur in the lakes and associated wetlands of the site. Spotted and Blanding's Turtles could also use open water areas and wetlands in this PCA, and Eastern Massasauga could occur in herbaceous wetlands. There is also potential for several rare wetland bird species, such as King Rail, American Bittern, Least Bittern, and Marsh Wren, to be present at this site. Least Shrew may occur in the grassy uplands, and the Culvers Root Borer could exist in these same areas if its larval host plant, Culver's-root (*Veronicastrum virginicum*), is present. Pinetree Cricket may also occur in conifer stands containing White Pine.

### **PCA #10**

**Location: INGHAM: T02N R03W S1; T03N R02W S30, 31; T02N R02W S6**

This PCA encompasses a large, contiguous portion of the Grand River drainage and associated floodplains, including Burchfield Park, owned and managed by Ingham County. Although no high quality natural community occurrences are documented in this PCA, the site has the potential to harbor high quality examples of the following natural communities:

- Floodplain forest
- Mesic southern forest
- Southern hardwood swamp
- Inundated shrub swamp

### **Documented and Potential Rare Plant Species**

Three EOs are documented for the PCA, including an occurrence of American beak grass, goldenseal, and ginseng, all of which are classified as state threatened species.

### **Documented and Potential Rare Animal Species**

No rare animal occurrences have been documented in this PCA, but several rare species associated with mature forest could occur at this site. There is potential for Indiana Bat to use the riparian forests of this PCA. Woodland Vole could occur in upland forests with sandy soils. Rare bird species, such as Cerulean Warbler, Prothonotary Warbler, Louisiana Waterthrush, and Hooded Warbler, may be present at the site. Regal Fern Borer could occur in the floodplain forest where regal and/or cinnamon fern are present.

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## **Appendix 1.**

### List of Abstracts for Natural Communities, Rare Plants and Animals that Occur in the Tri-County Region

\* Note that some of the species listed are known from historical records and may no longer be extant in the region.

**Appendix 1.** Plants, animals and natural communities in the Tri-County Region with abstracts on MNFI's website. <http://web4.msue.msu.edu/mnfi/>

**Plants**

<u>Common Name</u>	<u>Scientific Name</u>
1. Purple milkweed	<i>Asclepias purpurascens</i>
2. White lady-slipper	<i>Cypripedium candidum</i>
3. Showy orchis	<i>Galearis spectabilis</i>
4. Goldenseal	<i>Hydrastis canadensis</i>
5. Ginseng	<i>Panax quinquefolius</i>
6. Prairie fringed orchid	<i>Platanthera leucophaea</i>

**Terrestrial Animals**

<u>Common Name</u>	<u>Scientific Name</u>
<b>Birds</b>	
7. Cooper's Hawk	<i>Accipiter cooperii</i>
8. Henslow's Sparrow	<i>Ammodramus henslowii</i>
9. Cerulean Warbler	<i>Dendroica cerulea</i>
10. Peregrine Falcon	<i>Falco peregrinus</i>
11. Prothonotary Warbler	<i>Protonotaria citrea</i>
12. King Rail	<i>Rallus elegans</i>
<b>Insects</b>	
13. Culvers Root Borer	<i>Papaipema sciata</i>
14. Regal Fern Borer	<i>Papaipema speciosissima</i>
<b>Mammals</b>	
15. Woodland Vole	<i>Microtus pinetorum</i>
<b>Amphibians and Reptiles</b>	
16. Blanchard's Cricket Frog	<i>Acris crepitans blanchardi</i>
17. Spotted Turtle	<i>Clemmys guttata</i>
18. Wood Turtle	<i>Clemmys insculpta</i>
19. Blanding's Turtle	<i>Emys blandingii</i>
20. Eastern Massasauga	<i>Sistrurus catenatus catenatus</i>
21. Eastern Box Turtle	<i>Terrapene carolina carolina</i>

**Aquatic Animals**

<u>Common Name</u>	<u>Scientific Name</u>
<b>Fish</b>	
22. Pugnose shiner	<i>Notropis anogenus</i>
<b>Mussels (Unionidae)</b>	
23. Elktoe	<i>Alasmidonta marginata</i>
24. Slippershell	<i>Alasmidonta viridis</i>
25. Purple wartyback	<i>Cyclonaias tuberculata</i>
26. Round pigtoe	<i>Pleurobema sintoxia</i>
27. Ellipse	<i>Venustaconcha ellipsiformis</i>
28. Rainbow	<i>Villosa iris</i>
<b>Insects</b>	
29. Splendid Clubtail	<i>Gomphus lineatifrons</i>