Habitat Characterization and Evaluation of Community Types Utilized by Copperbelly Water Snake (Nerodia erythrogaster neglecta) in Michigan and Northern Ohio

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Michigan Natural Features Inventory
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ABSTRACT

To characterize and evaluate the community types in which copperbelly water snake (*Nerodia erythrogaster neglecta*) occurs in southern Michigan and northern Ohio, 48 communities at 9 different sites were sampled. Species composition and abundance, soil substrate, physiography, community rank, landscape context, abundance of invasive species, habitat alteration, hydrologic alteration, and soil erosion were all considered. The communities were comprised of 10 different types, including 6 wetland and 4 upland types. Wetland types included pond, emergent marsh, southern wet meadow, inundated shrub swamp, southern floodplain forest, and southern swamp. Upland types included mesic southern forest, dry-mesic southern forest, old field, and pasture. A common attribute shared by all communities was the presence of heavy-textured soil, which impedes drainage. Copperbelly water snake was found to utilize a variety of community types, many of which exhibited significant anthropogenic disturbances. Vegetation composition was often strongly influenced by past land use changes such as agriculture, selective logging, stream channelization, and pond creation. However, the presence of invasive, exotic species represents a more recent threat and may negatively impact copperbelly water snake by altering trophic relationships. Conservation planning for the copperbelly water snake should strive to 1) protect all wetland types, including small, isolated, seasonally inundated depressions; 2) protect riparian corridors and habitat corridors among wetlands; 3) protect existing upland forests; and 4) reduce forest fragmentation.
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INTRODUCTION

Copperbelly water snake (*Nerodia erythrogaster neglecta*) is a federally-listed threatened species (NatureServe 2005). In Michigan and Ohio, however, it is critically imperiled and has an endangered status. Two disjunct populations occur in the United States. The southern population spans southeastern Illinois, southwestern Indiana, and northwestern Kentucky. The northern population spans southern Michigan, northeastern Indiana, and northwestern Ohio. Warmer climate 4,000-6,000 years ago likely allowed distribution of copperbelly water snake to extend northward to its current extent. This species is highly mobile (Roe et al. 2003, 2004), and it utilizes various wetland and upland ecosystems for feeding, basking, mating, and hibernating. Compared to the closely related northern water snake (*Nerodia sipedon sipedon*), the copperbelly water snake can move twice as far, exploit areas four times as large, utilize a greater number of wetland and upland ecosystems at a greater frequency, and is more specific in prey preference (Roe et al. 2003, 2004). Undoubtedly, this dependence on large connected areas has threatened copperbelly water snake populations because of the increased fragmentation of landscapes, hydrologic manipulations, and habitat disturbances and destruction caused by anthropogenic pressures.

Common descriptions for habitats used by copperbelly water snakes include swampy woodlands, river bottoms, oxbow lakes, brushy ditches, wooded lakes, and shallow, slow-moving streams (NatureServe 2005). Favorable hibernation sites include felled tree root networks in bottomlands, dense brush piles, fieldstone piles, beaver and muskrat lodges, and inactive crayfish burrows (U.S. Fish and Wildlife Service 1993). Although a general sense of these habitats is conveyed, detailed characterizations of vegetation, soil, and physiographic context are lacking. Furthermore, the tolerance and resilience of this species to the effects of habitat alteration, invasive species, hydrologic manipulation, and increased edge to interior ratio of natural systems is largely unknown.

The current study aims to provide a more in-depth characterization of the community types of Michigan and northern Ohio in which there are known copperbelly water snake occurrences. The information provided will hopefully guide management and restoration practices to account for the relevant ecosystem attributes affecting copperbelly water snake viability at multiple landscape scales. The specific objectives are to:

1) Identify community types in which copperbelly water snakes have been observed.

2) Characterize these community types on the basis of vegetation composition, dominant soil substrate, and physiography.

3) Evaluate within-site habitat quality and landscape context quality. Also, evaluate the impact of invasive species, hydrologic alterations, habitat alterations, and soil erosion on the future persistence of copperbelly water snake.

4) Suggest management strategies that would bolster current copperbelly water snake populations and reduce the likelihood of placing this species in further peril.

METHODS

Habitat for the copperbelly water snake at the community level was characterized through field site evaluations conducted in October 2001, June-October 2002, June 2004, and September 2005. Community-level habitat evaluations were conducted at nine sites, including three extant and six historical copperbelly water snake sites. Sites occurred in the far lower central and southwestern portions of the Lower Peninsula of Michigan (Figure 1) and in northwestern Ohio.
The following habitat information was recorded: 1) estimates of the relative abundance of plant species in the overstory, understory, and ground layer (species lists were compiled using the Floristic Quality Assessment Program (Herman et al. 2001)); 2) soil type, soil pH, and litter depth; 3) water depth; 4) short description of the general habitat; 5) description of the landscape context and surrounding land use(s); and 6) rankings of the natural area quality of the vegetative community. A habitat evaluation form was developed and used to record data in the field (Appendix 1).

A detailed field assessment of potential threats was also conducted as part of the habitat characterization. The field assessment of threats included: 1) recording exotic plant species and estimating their relative abundance; 2) characterizing any hydrologic alterations; 3) recording evidence of habitat destruction or disturbance; 4) documenting habitat manipulation, such as mowing or grazing; and 5) noting evidence of soil erosion. A data form for recording habitat threats in the field was developed (Appendix 2).

Figure 1. Site locations in Michigan.

RESULTS

During the course of this five-year study, 48 communities were evaluated at 9 different sites (Table 1). The number of communities evaluated at each site ranged from 1 to 12 and were selected based upon known or suspected use by copperbelly water snakes for foraging, basking, or hibernating. The communities were comprised of 10 different types, including 6 wetland and 4 upland types. Wetland types included pond, emergent marsh, southern wet meadow, inundated shrub swamp, southern floodplain forest, and southern swamp. Upland types included mesic southern forest, dry-mesic southern forest, old field, and pasture. For general descriptions of the natural community types, which include all types listed above except pond, old field, and pasture, please see the excerpt from the MNFI community classification in Appendix 3 and the natural community abstracts for southern wet meadow (Kost 2001), southern floodplain forest (Tepley et al. 2004), and mesic southern forest (Cohen 2004).

Vegetation Composition

Most of the sites contained a variety of community types. As stated above, we focused our efforts on characterizing the vegetation composition of communities that were presently or historically utilized by copperbelly water snakes (Table 1). Of the sampling sites, only Hillsdale County Element Occurrence #8 (EO .008), Williams County-Ohio, and Hillsdale County EO .010 are known to have extant populations of the copperbelly water snake. Species lists are provided for each community we evaluated in Appendices 4-12, and species found to be dominant or abundant within the overstory, understory, and ground layer are listed in Appendix 13. Comparisons among similar communities are provided below.
Table 1. Community types evaluated at each site.

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<tr>
<th>Site</th>
<th>pond</th>
<th>emergent</th>
<th>wet</th>
<th>marsh</th>
<th>southern</th>
<th>shrub</th>
<th>floodplain</th>
<th>southern</th>
<th>swamp</th>
<th>mesic</th>
<th>southern</th>
<th>forest</th>
<th>old</th>
<th>field</th>
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<td><strong>48</strong></td>
</tr>
</tbody>
</table>
Pond

The vegetation along the margins of four ponds was evaluated at three sites: Cass-St. Joseph County EO .002, Hillsdale County EO .008, and Hillsdale County EO .010 (Table 1). Evidence of dead tamarack trees at Hillsdale County EO .008 suggests that the pond was formerly a relict conifer swamp. Dredging has caused a dramatic rise in standing water and the subsequent mortality of most overstory vegetation. Overstory cover ranged from 0 to 10 percent with pin oak (*Quercus palustris*) serving as a dominant species at Cass-St. Joseph County EO .002 and black willow (*Salix nigra*) at Hillsdale County EO .008 and Hillsdale County EO .010 pond (A) (Appendix 13). Understory cover ranged from 1 to 60 percent and was dominated by buttonbush (*Cephalanthus occidentalis*) at all sites, except at Hillsdale County EO .010 pond (B), where black willow was dominant. Ground layer vegetation ranged from 5 to 35 percent cover, with duckweed (*Lemna minor*), broad-leaved cattail (*Typha latifolia*), purple loosestrife (*Lythrum salicaria*), Kentucky bluegrass (*Poa pratensis*), and spotted touch-me-not (*Impatiens capensis*) as dominant species.

Emergent Marsh

The two emergent marshes we evaluated occurred as small narrow bands along the margins of man-made ponds at Hillsdale County EO .005 (Table 1). Neither supported an overstory, and understory vegetation was similarly sparse (e.g., one and two percent cover) (Appendix 13). Understory species that occurred in the emergent marshes were silky dogwood (*Cornus amomum*), red-osier dogwood (*Cornus stolonifera*), and gray dogwood (*C. foemina*). The cover of ground layer vegetation in the two marshes was 80 and 90 percent, with broad-leaved cattail, purple loosestrife, and narrow-leaved cattail (*Typha angustifolia*) as dominant species.

Southern Wet Meadow

Six southern wet meadows were evaluated at three sites, with four occurring at Hillsdale County EO .008 and one each at Calhoun County EO .013 and Hillsdale County EO .004 (Table 1). The flora and vegetation structure varied considerably among southern wet meadows, likely due to differences in landscape context and anthropogenic disturbances. The cover of overstory vegetation ranged from 0 to 30 percent, with silver maple (*Acer saccharinum*), cottonwood (*Populus deltoides*), box elder (*Acer negundo*), swamp white oak (*Quercus bicolor*), and black willow as dominant species (Appendix 13). Similarly, the cover of understory vegetation ranged from 1 to 50 percent. Dominant species in the understory included gray dogwood, ninebark (*Physocarpus opulifolius*), and slender willow (*Salix petiolaris*). Ground layer vegetation showed little variation in overall cover, ranging from 80 to 90 percent. Dominant ground layer plants included sedges (*Carex stricta*, *C. lacustris*, and *C. sartwellii*), swamp milkweed (*Asclepias incarnata*), reed canary grass (*Phalaris arundinacea*), Joe-Pye weed (*Eupatorium maculatum*), sensitive fern (*Onoclea sensibilis*), and marsh fern (*Thelypteris palustris*).

Inundated Shrub Swamp

The 13 inundated shrub swamps we evaluated occurred at 5 different sites, with 4 at Cass-St. Joseph County EO .002, 1 each at Hillsdale County EO .008 and Williams County-Ohio, 2 at Branch County EO .012, and 5 at Hillsdale County EO .010 (Table 1). The inundated shrub swamp and pond communities we evaluated appeared very similar in their flora, vegetation structure, and soil. Like the ponds, the inundated shrub swamps had relatively sparse overstory cover, which averaged 23 percent and ranged from 5 to 60 percent (Appendix 13). The overstory trees were typically limited to the margins of the shrub swamp or occurred on raised islands within the swamp. Typical overstory trees included red maple (*Acer rubrum*), swamp white oak, silver maple, pin oak, black willow, American elm (*Ulmus americana*), and red ash (*Fraxinus*).
Each of the inundated shrub swamps had dense understory cover that was dominated by buttonbush. The cover of understory vegetation averaged 71 percent and ranged from 38 to 95 percent. The degree of buttonbush cover in the understory is directly related to canopy closure and the amount of radiant sunlight penetrating lower vegetation strata. Buttonbush is a shade-intolerant shrub requiring open conditions, and, in instances where there was moderate overstory cover (e.g. Williams County-Ohio, 60%), there was subsequently low coverage of buttonbush in the understory (Williams County-Ohio, 40%). In addition to buttonbush, other common understory species included swamp rose (Rosa palustris) and winterberry (Ilex verticillata). Ground layer vegetation varied greatly among inundated shrub swamps with cover averaging 39 percent and ranging from 1 to 90 percent. Common ground layer species included duckweed, reed canary grass, clearweed (Pilea pumila), and sedges (Carex stricta, C. rostrata, and C. lacustris, and C. crinita).

Southern Floodplain Forest

The eight southern floodplain forests that we evaluated occurred in seven different sites: Hillsdale County EO .007, Calhoun County EO .013, Hillsdale County EO .004, Hillsdale County EO .008, Branch County EO .012, Williams County-Ohio, and Hillsdale County EO .010 (Table 1). Each site contained a single occurrence of southern floodplain forest, with the exception of Hillsdale County EO .010, where there were two separate stands. The sites differed considerably with respect to landscape setting. Hillsdale County EO .007, Hillsdale County EO .008, Branch County EO .012, and Hillsdale County EO .010 occurred along the upper reaches of major river systems. Calhoun County EO .013 and Hillsdale County EO .004 straddled narrow streams, and Williams County-Ohio was adjacent to an intermittent stream flowing through a ravine within a mesic southern forest. Although the communities at Calhoun County EO .013, Hillsdale County EO .004, and Williams County-Ohio do not adhere to the strict definition that southern floodplain forests occur along streams that are at least third order in magnitude (Appendix 3), the overstory and understory composition was similar to that of the other sites (Appendix 13). These communities could have been typed as either southern swamps or, because of their small size, included within the broader matrix communities of mesic southern forests or dry-mesic forests. The overstory cover ranged from 60 to 90 percent, and understory cover ranged from 20 to 75 percent. Dominant overstory species included black walnut (Juglans nigra), silver maple, basswood (Tilia americana), red ash, American elm, black maple (Acer nigrum), black ash (Fraxinus nigra), white ash (Fraxinus americana), and cottonwood. Many of these species also occurred as dominants within the understory. Additional dominant understory species included pawpaw (Asimina triloba), musclewood (Carpinus caroliniana), nannyberry (Viburnum lentago), shagbark hickory (Carya ovata), box elder, and buttonbush. Ground layer vegetation showed considerable variation among sites with cover ranging from 35 to 95 percent. Species that occurred as dominants in the ground layer included black snakeroot (Sanicula gregaria), white grass (Leersia virginica), richweed (Collinsonia canadensis), wood nettle (Laportea canadensis), clearweed, and lizard’s tail (Saururus cernuus).

Southern Swamp

Only one southern swamp was evaluated, and it occurred in Williams County-Ohio (Table 1). The southern swamp was situated at the bottom of a narrow, steep-sided ravine. The narrowly-shaped ravine and rapid change in elevation allowed varied soil moisture conditions to exist in a relatively small area. As a result, mesic and wet-mesic species occurred in proximity. Overstory cover was 60 percent and was dominated by black maple and white oak (Quercus alba) (Appendix 13). The latter species was more prevalent on lower slopes where there was better drainage. Also present in the overstory were silver maple, bur oak (Quercus macrocarpa), basswood, and red ash. Understory cover was 80 percent and was dominated by sugar maple (Acer saccharum) and basswood. Also present in the understory
were American elm, alternate-leaved dogwood (*Cornus alternifolia*), musclewood, red ash, and northern haw (*Viburnum cassinoides*). Ground layer cover was 60 percent and was dominated by wild-ginger (*Asarum canadense*), Virginia creeper (*Parthenocissus quinquefolia*), black snakeroot, and honewort (*Cryptotaenia canadensis*). Additional mesic ground flora species included running strawberry bush (*Euonymus obovata*), great waterleaf (*Hydrophyllum appendiculatum*), and sedge (*Carex plantaginea*). More wet-mesic ground flora species included false nettle (*Boehmeria cylindrica*), clearweed, and elderberry (*Sambucus canadensis*).

**Mesic Southern Forest**

The 10 mesic southern forests we evaluated occurred at 6 sites, with 1 each at Cass-St. Joseph County EO .002, Hillsdale County EO .004, and Hillsdale County EO .010, 2 each at Hillsdale County EO .005 and Williams County-Ohio, and 3 at Hillsdale County EO .008 (Table 1). With the exception of Hillsdale County EO .004, which was in an early stage of succession, all the communities had well-developed vegetation structures and were similar in species composition (Appendix 13). Overstory cover ranged from 70 to 90 percent with American beech (*Fagus grandifolia*), sugar maple, white ash, red oak (*Quercus rubra*) occurring as dominant species. Understory cover ranged from 25 to 70 percent with many of the overstory species reoccurring as understory dominants. Additional species abundant in the understory included musclewood, ironwood (*Ostrya virginiana*), prickly-ash (*Zanthoxylum americanum*), maple-leaved arrow-wood (*Viburnum acerifolium*), and black cherry (*Prunus serotina*). Ground layer cover ranged from 30 to 75 percent and was dominated by a variety of species including wood nettle, bottlebrush grass (*Hystrix patula*), black snakeroot, sedge (*Carex pensylvanica*), jumpseed (*Polygonum virginianum*), wild-ginger, and blue-stemmed goldenrod (*Solidago caesia*).

**Dry-Mesic Southern Forest**

The two dry-mesic southern forests we evaluated at Calhoun County EO .013 and Hillsdale County EO .005 (Table 1) were found to be relatively similar in their flora and vegetation structure. The cover of the overstory vegetation was estimated at 80 and 70 percent, respectively, with black oak (*Quercus velutina*), white oak, red maple, shagbark hickory, and pignut hickory (*Carya glabra*) occurring as dominant species (Appendix 13). Understory cover was estimated at 60 and 50 percent, respectively, and was dominated by red maple and shagbark hickory at Calhoun County EO .013 and shrubby St. John’s-wort (*Hypericum prolificum*), raspberry (*Rubus sp.*), and hawthorn (*Crataegus sp.*) at Hillsdale County EO .005. Ground layer cover was estimated at 80 and 40 percent, respectively, with sedge (*Carex pensylvanica*) occurring as a dominant species at both sites.

**Old Field**

Only one old field was evaluated, and it occurred in Hillsdale County EO .010 (Table 1). Severe habitat manipulation and disturbance had caused invasion by many exotic plant species. Overstory and understory cover was sparse at two percent for both strata (Appendix 13). The most common overstory species was sugar maple, and the most common understory species were autumn-olive (*Elaeagnus umbellata*), sugar maple, and red maple. Exotic or weedy species covered 90 percent of the ground layer with tall goldenrod (*Solidago altissima*), alsike clover (*Trifolium hybridum*), red clover (*Trifolium pratense*), Queen-Anne’s-lace (*Daucus carota*), reed canary grass, and timothy (*Phleum pratense*) being most dominant.

**Pasture**

The one pasture we evaluated occurred at Hillsdale County EO .010 and was dominated by invasive species (Table 1). The pasture lacked an overstory but supported a sparse understory with 30 percent cover (Appendix 13). Autumn-olive and hawthorn occurred as dominant species. Ground layer cover was 90 percent and
was dominated by a variety of species, including yarrow (*Achillea millefolium*), Queen-Anne’s-
Table 2. Numbers of invasive species observed per community and site.

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<th>Community Type</th>
<th>Invasives per Community</th>
<th>Invasives per Site</th>
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<td>inundated shrub swamp (A) 1</td>
<td>1</td>
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</tr>
<tr>
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<td>inundated shrub swamp (B) 2</td>
<td>2</td>
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<td>inundated shrub swamp (C) 1</td>
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<td>Hillsdale County EO .007</td>
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<td></td>
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<td>Calhoun County EO .013</td>
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<td>mesic southern forest 3</td>
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<td></td>
</tr>
<tr>
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<td>pond 1</td>
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</tr>
<tr>
<td></td>
<td>southern wet meadow (A) 9</td>
<td>9</td>
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</tr>
<tr>
<td></td>
<td>southern wet meadow (B) 2</td>
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</tr>
<tr>
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<td>southern wet meadow (C) 0</td>
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<tr>
<td></td>
<td>southern wet meadow (D) 2</td>
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<tr>
<td></td>
<td>inundated shrub swamp 1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>mesic southern forest (A) 1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>mesic southern forest (B) 0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>mesic southern forest (C) 1</td>
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</tr>
<tr>
<td></td>
<td>southern floodplain forest 1</td>
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<td>mesic southern forest (A) 0</td>
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</tr>
<tr>
<td></td>
<td>mesic southern forest (B) 0</td>
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</tr>
<tr>
<td></td>
<td>dry-mesic southern forest 3</td>
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<tr>
<td>Branch County EO .012</td>
<td>southern floodplain forest 0</td>
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<td></td>
<td>inundated shrub swamp (A) 2</td>
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<td>inundated shrub swamp (B) 1</td>
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Table 2. (cont.).

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<tr>
<th>Site</th>
<th>Community Type</th>
<th>Invasives per Community</th>
<th>Invasives per Site</th>
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<td></td>
<td>southern floodplain forest</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>mesic southern forest (A)</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>mesic southern forest (B)</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>southern swamp</td>
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<tr>
<td>Hillsdale County EO .010</td>
<td>pond (A)</td>
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<td>26</td>
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<tr>
<td></td>
<td>pond (B)</td>
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</tr>
<tr>
<td></td>
<td>southern floodplain forest (A)</td>
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</tr>
<tr>
<td></td>
<td>southern floodplain forest (B)</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>inundated shrub swamp (A)</td>
<td>1</td>
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</tr>
<tr>
<td></td>
<td>inundated shrub swamp (B)</td>
<td>3</td>
<td></td>
</tr>
<tr>
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<td>inundated shrub swamp (C)</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>inundated shrub swamp (D)</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>inundated shrub swamp (E)</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>mesic southern forest</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>pasture</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>old field</td>
<td>16</td>
<td></td>
</tr>
</tbody>
</table>
Table 3. Frequency of invasive species occurrence by community type.

| Species                  | pond | emergent | wet | southern | shrub | wet | southern | forest | southern | mesic | southern | forest | dry- | mesic | southern | forest | old | field | pasture | Number of community types with species | Number of sites with species |
|--------------------------|------|----------|-----|----------|-------|-----|----------|--------|----------|-------|----------|--------|      |       | southern | forest |     |       |         |                                              |                            |
| Alliara petiolata        | 1    | 3        | 1   | 5        | 1     |     |          |        |          | 1     |          | 5      | 6    |       | 8       | 4     |     |       |         |                                              |                            |
| Arctium minus           | 1    |          | 1   |          | 1     |     |          |        |          | 1     |          | 1      | 1    |       | 1       | 1     |     |       |         |                                              |                            |
| Berberis thunbergii     | 1    |          | 1   |          | 5     |     |          |        |          | 1     |          | 1      | 1    |       | 1       | 1     |     |       |         |                                              |                            |
| Carduus nutans          | 1    |          | 1   |          |       | 1   |          |        |          | 1     |          | 1      | 1    |       | 1       | 1     |     |       |         |                                              |                            |
| Chrysanthemum leucanthenum | 1   |          | 1   |          | 1     |     |          |        |          | 1     |          | 1      | 1    |       | 1       | 1     |     |       |         |                                              |                            |
| Cirsium arvense         | 1    |          | 1   |          | 1     |     |          |        |          | 1     |          | 1      | 1    |       | 1       | 1     |     |       |         |                                              |                            |
| Clovev                  | 1    |          | 1   |          |       |     |          |        |          | 1     |          | 1      | 1    |       | 1       | 1     |     |       |         |                                              |                            |
| Daucus carota           | 1    |          | 1   |          | 1     | 1   |          |        |          | 3     |          | 2      | 1    |       | 1       | 1     |     |       |         |                                              |                            |
| Dianthus armeria        | 1    |          | 1   |          | 1     |     |          |        |          | 1     |          | 1      | 1    |       | 1       | 1     |     |       |         |                                              |                            |
| Dipsacus laciniatus     | 1    |          | 1   |          | 1     |     |          |        |          | 1     |          | 1      | 1    |       | 1       | 1     |     |       |         |                                              |                            |
| Elaeagnus umbellata     | 2    | 1        | 2   |          | 1     |     |          |        |          | 1     |          | 1      | 1    |       | 1       | 1     |     |       |         |                                              |                            |
| Exotic Pine             | 1    |          | 1   |          |       |     |          |        |          | 1     |          | 1      | 1    |       | 1       | 1     |     |       |         |                                              |                            |
| Festuca sp.             | 1    |          | 1   |          |       |     |          |        |          | 1     |          | 1      | 1    |       | 1       | 1     |     |       |         |                                              |                            |
| Glechoma hederacea      | 1    |          | 1   |          |       |     |          |        |          | 1     |          | 1      | 1    |       | 1       | 1     |     |       |         |                                              |                            |
| Hieracium caespitosum   | 1    |          | 1   |          | 1     |     |          |        |          | 1     |          | 1      | 1    |       | 1       | 1     |     |       |         |                                              |                            |
| Lolium perenne          | 1    |          | 1   |          |       |     |          |        |          | 1     |          | 1      | 1    |       | 1       | 1     |     |       |         |                                              |                            |
| Lonicera morrowii       | 1    |          | 1   |          | 1     |     |          |        |          | 3     |          | 3      | 3    |       | 3       | 3     |     |       |         |                                              |                            |
| Lotus corniculata       | 1    |          | 1   |          |       | 1   |          |        |          | 1     |          | 1      | 1    |       | 1       | 1     |     |       |         |                                              |                            |
| Lysimachia nummularia   | 1    |          | 1   |          | 1     |     |          |        |          | 3     |          | 3      | 3    |       | 3       | 3     |     |       |         |                                              |                            |
| Lythrum salicaria       | 2    | 2        | 3   |          | 1     |     |          |        |          | 1     |          | 5      | 4    |       | 5       | 4     |     |       |         |                                              |                            |
| Melilotus alba          | 1    |          | 1   |          |       |     |          |        |          | 1     |          | 1      | 1    |       | 1       | 1     |     |       |         |                                              |                            |
| Melilotus officinalis   | 1    |          | 1   |          |       |     |          |        |          | 1     |          | 2      | 1    |       | 2       | 1     |     |       |         |                                              |                            |
| Phalaris arundinacea    | 4    | 4        | 4   |          |       |     |          |        |          | 1     |          | 3      | 4    |       | 3       | 4     |     |       |         |                                              |                            |
| Phleum pratense         | 1    |          | 1   |          |       |     |          |        |          | 1     |          | 1      | 1    |       | 1       | 1     |     |       |         |                                              |                            |
| Poa pratensis           | 1    |          | 1   |          |       |     |          |        |          | 1     |          | 3      | 2    |       | 3       | 2     |     |       |         |                                              |                            |
| Potamogeton crispus     | 1    |          | 1   |          |       |     |          |        |          | 1     |          | 1      | 1    |       | 1       | 1     |     |       |         |                                              |                            |
| Potentilla recta        | 1    |          | 1   |          |       |     |          |        |          | 1     |          | 1      | 1    |       | 1       | 1     |     |       |         |                                              |                            |
Table 3. (cont.).

<table>
<thead>
<tr>
<th>Species</th>
<th>emergent pond</th>
<th>southern marsh</th>
<th>wet meadow</th>
<th>inundated shrub</th>
<th>swamp</th>
<th>southern floodplain forest</th>
<th>southern swamp</th>
<th>mesic southern forest</th>
<th>dry-mesic southern forest</th>
<th>old field</th>
<th>pasture</th>
<th>Number of community types with species</th>
<th>Number of sites with species</th>
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<td>7</td>
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<tr>
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<tr>
<td>Trifolium sp.</td>
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</tr>
<tr>
<td>Typha angustifolia</td>
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<tr>
<td><strong>Total number of invasive species per community type</strong></td>
<td><strong>11</strong></td>
<td><strong>2</strong></td>
<td><strong>12</strong></td>
<td><strong>9</strong></td>
<td><strong>6</strong></td>
<td><strong>1</strong></td>
<td><strong>5</strong></td>
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<td><strong>16</strong></td>
<td><strong>4</strong></td>
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</table>
The presence of high water tables and extended periods of standing water was also evident at all sites (Appendix 15). For example, all sites contained communities with gleyed soil, which forms when mineral soil (e.g., sand, silt, and clay) is saturated for much of the year. Iron mottling, which is indicative of high water tables and fluctuating water levels, was evident in communities at seven sites: Cass-St. Joseph County EO .002, Hillsdale County EO .007, Calhoun County EO .013, Hillsdale County EO .004, Hillsdale County EO .008, Williams County-Ohio, and Hillsdale County EO .010. Organic soil, which forms when microbial decomposition of litter is retarded due to constantly saturated conditions, was present in wetlands at five sites: Cass-St. Joseph County EO .002, Hillsdale County EO .004, Hillsdale County EO .008, Branch County EO .012, and Hillsdale County EO .010.

Landscape Context

All of the sites occurred within a landscape dominated by agriculture and rural housing. Row-crop agriculture, hay fields, animal pastures, and old fields were adjacent, or in close proximity, to all sites. Embedded within this agricultural matrix were scattered homesteads that directly abutted the natural communities in some locations.

A review of landscape context ranks reveals that 17 communities ranked low, 29 ranked medium, and 2 ranked high (Appendix 16). Although several communities occurred on public lands or within private preserves, most of these were either adjacent to roads, homes, old fields, or agricultural fields. Only southern floodplain forest (B) and inundated shrub swamp (C) in Hillsdale County EO .010 were deemed to have high quality landscape context. The former community was five acres in size and was surrounded by a river, mesic southern forests, and inundated shrub swamps (i.e., buttonbush depressions). The latter community was surrounded by a southern floodplain forest and mesic southern forest (Appendix 16).

Communities assigned ranks of medium were only partially bordered by natural communities of significant size. Communities assigned ranks of low were almost completely surrounded by agriculture or mowed lawns.

Collectively, communities of most sites were assigned similar ranks for landscape context. For example, all communities were assigned ranks of medium at the following three sites: Cass-St. Joseph County EO .002, Hillsdale County EO .004, and Branch County EO .012. The single community evaluated at Hillsdale County EO .007 was assigned a low rank. Four sites contained communities with both low and medium ranks: Calhoun County EO .013, Hillsdale County EO .008, Hillsdale County EO .005, and Williams County-Ohio. Hillsdale County EO .010 was the only site that contained communities of low, medium, and high quality landscape context.

Emergent marsh was the only community type with multiple occurrences to receive a consistent rank for landscape context (Appendix 16). The landscape context rank was low for two emergent marshes at Hillsdale County EO .005. Southern floodplain forest and inundated shrub swamp were the only community types to receive all three ranks for landscape context. All other community types with multiple occurrences were assigned both low and medium ranks for landscape context.

Natural Community Rank

The number of communities assigned low and medium ranks was 23 and 22, respectively (Appendix 16). Despite its relatively large, five-acre size, inundated shrub swamp (B) at Hillsdale County EO .010 was assigned a rank of low-medium because of hydrologic runoff and overflow from a nearby pond and horse pasture. Two communities, mesic southern forest (A) in Williams County-Ohio and inundated shrub swamp (C) in Hillsdale County
EO .010, were assigned a high natural community rank. The two communities ranked as high were large in size, had high levels of diversity (respective to community type) in the overstory, understory, and ground layer, and lacked recent anthropogenic disturbance and invasive plants. Communities with medium ranks were typically moderate to large in size, had moderate to high levels of diversity, experienced low levels of recent anthropogenic disturbance, and lacked, or had been minimally impacted by, invasive plants. Communities with low ranks were typically small in size, had low plant diversity, experienced recent anthropogenic disturbance, and harbored invasive plants.

Most sites contained communities with an assortment of natural community ranks. The 5 communities evaluated at Williams County-Ohio and the 12 communities evaluated at Hillsdale County EO .010, for instance, received three different ranks (i.e., low, medium, and high). Four sites contained communities with both low and medium ranks: Cass-St. Joseph County EO .002, Calhoun County EO .013, Hillsdale County EO .008, and Hillsdale County EO .005. Three sites contained communities that all received the same within-site rank: Hillsdale County EO .007, Hillsdale County EO .004, and Branch County EO .012. For example, the three evaluated communities at Hillsdale County EO .004 and Branch County EO .012 all received low and medium ranks, respectively.

The majority of community types with multiple occurrences received a variety of natural community ranks. The 10 mesic southern forest communities, for example, received ranks of low, medium, and high. These communities occurred at six different sites: Cass-St. Joseph County EO .002 (one ranked medium), Hillsdale County EO .004 (one ranked low), Hillsdale County EO .008 (two ranked low, one ranked medium), Hillsdale County EO .005 (two ranked medium), Williams County-Ohio (one ranked medium, one ranked high), and Hillsdale County EO .010 (one ranked medium). Three of the community types with multiple occurrences had consistent ranks at all sites. All emergent marshes, southern wet meadows, and dry-mesic southern forests consistently received low natural community ranks at all sites.

**Hydrologic Alterations**

Evidence of hydrologic alterations from either water level manipulation or increased surface water flow was observed at all sites and most communities (Appendix 17). Three communities in which hydrologic alterations were not noted were the two mesic southern forests at Cass-St. Joseph County EO .002 and Hillsdale County EO .010 and the pasture at Hillsdale County EO .010. Due to the effects of grazing and mowing, however, the pasture at Hillsdale County EO .010 likely receives surface runoff in a different manner today than during the pre-settlement era.

Water level changes due to damming of creeks, blocked culverts at road crossings, dredging for the creation of ponds, ditching, and drain tiling were common occurrences. Water levels controlled by dams influenced the hydrology of some communities at three sites: Calhoun County EO .013, Hillsdale County EO .005, and Hillsdale County EO .010. Restricted water flow due to culverts at road crossings impacted communities at five sites: Hillsdale County EO .007, Hillsdale County EO .004, Hillsdale County EO .008, Williams County-Ohio, and Hillsdale County EO .010. Man-made ponds influenced water levels and hydrology at seven sites: Cass-St. Joseph County EO .002, Calhoun County EO .013, Hillsdale County EO .004, Hillsdale County EO .008, Hillsdale County EO .005, Williams County-Ohio, and Hillsdale County EO .010. A drainage ditch along a gravel road may have been inadvertently lowering the water table and facilitating shrub encroachment of the southern wet meadow at Hillsdale County EO .004. Drain tile runoff from an agricultural field directly influenced water levels of three communities at Hillsdale County EO .008: southern wet meadow (C), inundated shrub swamp, and mesic southern forest (B). Similarly, drain tiling affected two communities at Hillsdale County EO .010: inundated shrub swamp (E) and the old field.
Increased surface water flow as a result of impervious surfaces or non-native ecosystems, such as agricultural fields, pastures, old fields, and lawns, was almost universally observed (Appendix 17). Runoff from gravel roads led to increased surface water flow into wetlands at seven sites: Cass-St. Joseph County EO .002, Hillsdale County EO .004, Hillsdale County EO .008, Hillsdale County EO .005, Branch County EO .012, Williams County-Ohio, and Hillsdale County EO .010.

### Habitat Alterations

All of the sites had communities that had undergone significant changes since pre-settlement. Some of these changes were very recent, and the impacts were easily observed. Other impacts, such as those caused by early logging and road building activities, were no longer obvious. For example, while all of the forests we evaluated were likely harvested by the early 1900s, indication of logging was only readily apparent at five sites: Cass-St. Joseph County EO .002, Hillsdale County EO .004, Hillsdale County EO .008, Hillsdale County EO .005, and Branch County EO .012 (Appendix 18). Activities associated with road building in the distant past may have altered the shape and depth of several wetlands that were directly adjacent to roads at Cass-St. Joseph County EO .002, Hillsdale County EO .007, Hillsdale County EO .008, and Hillsdale County EO .010. It is even possible that these wetlands were inadvertently created by mining gravel to build the adjacent roads. However, evidence for these plausible past events was no longer readily apparent. Therefore, because of the difficulty in recognizing and interpreting signs of past anthropogenic disturbances, this study aims to document more recent habitat alterations.

Habitat destruction was observed at six sites: Cass-St. Joseph County EO .002, Calhoun County EO .013, Hillsdale County EO .004, Hillsdale County EO .008, Hillsdale County EO .005, and Hillsdale County EO .010 (Appendix 18). A house was built on a portion of the floodplain forest at Hillsdale County EO .004. Dredging and/or damming to create ponds had flooded swamp forests and other wetland types at five sites: Cass-St. Joseph County EO .002, Calhoun County EO .013, Hillsdale County EO .008, Hillsdale County EO .005, and Hillsdale County EO .010. Buildings, campsites, fire pits, and observation platforms occupied portions of both dry-mesic southern forests at Calhoun County EO .013 and Hillsdale County EO .005 and mesic southern forest (A) at Hillsdale County EO .005.

Habitat disturbances were observed at all sites (Appendix 18). The types of observed disturbances included ORV and logging trails, grazing, excessive nutrient input, excessive deer herbivory, trash piles, fire suppression, shrub encroachment, domesticated pet use, and frequent recreational use (e.g., swimming, fishing, boating, hiking, camping, etc.). Trails used for logging and/or ORVs were observed within communities of eight sites: Cass-St. Joseph County EO .002, Hillsdale County EO .007, Calhoun County EO .013, Hillsdale County EO .004, Hillsdale County EO .008, Hillsdale County EO .005, Branch County EO .012, and Williams County-Ohio. At Hillsdale County EO .008, southern wet meadow (A) was formerly used as a sheep pasture and was presently receiving nutrient input from a cattle holding area and walkway. Similarly, at Hillsdale County EO .010, cattle were observed grazing a pasture adjacent to an inundated shrub swamp. Excessive deer herbivory was observed in all communities of Calhoun County EO .013. Old abandoned trash piles were observed at the base of a steep slope in the southern floodplain forest at Hillsdale County EO .007 and along a ravine in the southern swamp at Williams County-Ohio. Fire suppression had likely contributed to shrub encroachment in the southern wet meadow at Hillsdale County EO .004. A domesticated dog was reported to harass copperbelly water snakes in pond (B) at Hillsdale County EO .010. Lastly, frequent recreational use of the communities we evaluated was observed at five sites: Cass-St. Joseph County EO .002, Calhoun County EO
Habitat manipulations including logging, mowing, herbicidal treatment, flooding, and planting of agricultural forage species were observed in the communities evaluated at all sites (Appendix 18). Logging was evident at five sites: Cass-St. Joseph County EO .002, Hillsdale County EO .004, Hillsdale County EO .008, Hillsdale County EO .005, and Branch County EO .012. Mowing was observed at four sites: Calhoun County EO .013, Hillsdale County EO .004, Hillsdale County EO .005, and Hillsdale County EO .010. The use of herbicides was observed only once in pond (B) at Hillsdale County EO .010. Flooding had altered communities at five sites: Calhoun County EO .013, Hillsdale County EO .008, Hillsdale County EO .005, Williams County-Ohio, and Hillsdale County EO .010. Invasive species, such as reed canary grass, were likely planted in three sites: in southern wet meadow (A) at Hillsdale County EO .008, on the edge of inundated shrub swamp (D) at Cass-St. Joseph County EO .002, and on the edges of both inundated shrub swamps at Branch County EO .012.

Soil erosion was evident in communities at all sites (Appendix 18). Poorly vegetated slopes occurred above the eight southern floodplain forests at seven sites: Hillsdale County EO .007, Calhoun County EO .013, Hillsdale County EO .004, Hillsdale County EO .008, Branch County EO .012, Williams County-Ohio, and Hillsdale County EO .010. Soil erosion on steep slopes within mesic southern forests was observed at five sites: Cass-St. Joseph County EO .002, Hillsdale County EO .004, Hillsdale County EO .008, Hillsdale County EO .005, and Williams County-Ohio. Soil erosion was also evident along a steep-sided channelized stream in the dry-mesic southern forest at Hillsdale County EO .005.

**DISCUSSION**

**Vegetation Composition**

Comparisons among similar community types reveals that most of the differences in vegetation composition were likely the result of anthropogenic disturbances, such as selective logging, mowing, planting of agricultural forage species, mowing, or nutrient input. While we did not evaluate all communities at each site, ponds (including artificially created ponds), emergent marshes, southern wet meadows, inundated shrub swamps, southern floodplain forests, and southern swamps all appear to be important wetland communities for the copperbelly water snake. These community types correspond with Herbert’s (2003) palustrine open canopy, lacustrine open canopy, palustrine forest, and palustrine shrub-scrub habitats utilized by copperbelly water snakes in south central Michigan and northwestern Ohio. Using a variety of wetland community types likely helps ensure a varied and reliable base of prey throughout the active season. Furthermore, opportunities for thermoregulation are enhanced when both forested and non-forested community types are available. Seasonal life history activities in wetland communities such as basking, foraging, and mating were visually apparent during Herbert’s (2003) study. All sites we evaluated contained permanent sources of water, such as ponds, streams, or rivers. These features are especially critical to the copperbelly water snake during late summer when many seasonally inundated wetlands lack standing water.

Unlike its more common sympatric congener, the northern water snake, the copperbelly water snake exploits more upland habitats at a greater frequency (Herbert 2003). Upland forested communities, such as mesic southern forests and dry-mesic southern forests, are important community types for the copperbelly water snake. They provide cover for concealing movement between wetland foraging sites. Concealment from predators is especially important for the copperbelly water snake because of its habit of frequently moving...
through uplands to reach isolated wetlands (Roe et al. 2003, 2004). Aside from their function as travel corridors, upland communities are frequently visited by copperbelly water snakes during prey searches. Anuran prey densities fluctuate intra- and inter-annually, and foraging activities of copperbelly water snakes must sometimes extend beyond wetland boundaries. Other, more stationary behaviors reported to occur in upland communities are ecdysis (shedding), feeding and digestion, injury recovery, refuge seeking, hibernation, and birthing (Herbert 2003).

Invasive Species

While 37 species of invasive plants were observed in the communities we evaluated, 7 pose very serious threats to biodiversity because of their ability to rapidly colonize new habitats and form nearly monotypic structural layers. Purple loosestrife and reed canary grass threaten to erode biodiversity of non-forested wetlands, such as emergent marshes, southern wet meadows, and along margins of inundated shrub swamps. Multiflora rose, autumn-olive, Morrow honeysuckle, and Japanese barberry threaten diversity in all types of uplands (e.g., forested and non-forested) and can invade wetlands that lack standing water, such as the margins of inundated shrub swamps. Garlic mustard rapidly colonizes mesic and wet forests (Meekins and McCarthy 2001), such as dry-mesic southern forests, mesic southern forests, and southern floodplain forests. In addition, it can invade the margins of inundated shrub swamps that occur within forests.

Invasive plant species can cause a significant reduction in overall biodiversity, thus impacting the copperbelly water snake. As numerous native plants are outcompeted and replaced by a single or few invasive species, longstanding, complex ecological relationships may be lost. The resulting changes in species composition and structure upset delicately balanced ecological processes, such as trophic relationships, interspecific competition, nutrient cycling, soil erosion, hydrologic balance, and solar insulation (Bratton 1982). When invasive species, such as the seven egregious ones mentioned above, cause reductions in plant diversity, trophic web structure is disrupted due to reduced food and nectar sources, elimination of host plants, and alteration of overall community structure. For example, when insect diversity and abundance are reduced as a result of simplification in the plant community, populations of insect predators, like frogs, are also negatively impacted. The decline of prey for frogs, in turn, leads to smaller frog populations. This ultimately affects the viability of copperbelly water snakes, for they are almost solely reliant on frogs for nutrition (Roe et al. 2003, 2004).

Soil

Signs of high water tables and saturated conditions were clearly evident in the soil of all sites. Iron mottling, gleyed soil horizons, silt and clay layers, and organic soil were all repeatedly observed during this study. The soil types associated with copperbelly water snake habitat allow water to remain at or near the surface for extended periods. The ability of the soil to retain water and resist rapid drainage is critical for survival of the copperbelly water snake for several reasons.

Copperbelly water snakes feed almost exclusively on anurans (i.e., frogs and toads) (Roe et al. 2003, 2004). All anurans require standing water for breeding, and several species, such as green frog (Rana clamitans), bull frog (Rana catesbeiana), and northern leopard frog (Rana pipiens), require standing water throughout the year. Because prey of the copperbelly water snake are dependent on standing water (e.g., ephemeral pools or permanent ponds), soil types that retain water are critical habitat components.
Equally critical to its survival are the availability of suitable hibernacula. For hibernacula, copperbelly water snakes rely on the extensive networks of underground tunnels built by crayfish (Roe et al. 2003, 2004). Because crayfish require the presence of water at or near the surface, soil with a predominance of silt and clay are important habitat components for many species of crayfish. In addition, the structural integrity of the crayfish burrows that are built in silt and clay soil is ensured because of the strong chemical bonds formed among these soil particles. Thus, crayfish burrows are a critical habitat component for copperbelly water snakes, and the presence of soil types that prevent drainage allow for the presence of crayfish.

**Landscape Context**

The landscape context at all publicly and privately owned sites was dominated by agriculture and rural residential. Even the sites that occurred on public land were adjacent to homes, roads, agricultural fields, and old fields, and thus were similar in landscape context to privately owned sites. Differences in landscape context between extant and historical sites were not apparent. The increasing fragmentation of natural areas is of great concern, since the copperbelly water snake is reported to avoid residential and agricultural developments. A minimum patch size in which this species can sustain a viable population should be further investigated. Based on Herbert’s (2003) study, wetland complexes situated in an undeveloped upland matrix with a range of successional stages should have conservation priority.

**Natural Community Rank and Habitat Alterations**

Only two of the communities we evaluated, mesic southern forest (A) at Williams County-Ohio and inundated shrub swamp (C) at Hillsdale County EO .010 were in good ecological condition. Therefore, it appears that the ecological condition of natural communities is not an important factor in determining copperbelly water snake utilization of a particular site or community. Comparisons among the three sites with extant populations of copperbelly water snakes show that this species utilized communities with predominately low and medium ranks (e.g., Hillsdale County EO .008 and Hillsdale County EO .010), as well as communities with high and medium ranks, like Williams County-Ohio. While we do not yet understand how disturbances, such as selective logging, flooding, grazing, and nutrient input, are impacting the copperbelly water snake, it has thus far survived these assaults to its habitat at Hillsdale County EO .008 and Hillsdale County EO .010. Therefore, other factors, such as a consistently available base of prey, multiple wetlands in close proximity (e.g., within 125 m of each other) (Roe et al. 2003, 2004), and adequate hibernacula, are likely to have a much greater influence on copperbelly water snake viability than the absence of anthropogenic disturbances.

**Hydrologic Alterations**

Many of the sites have experienced significant human-induced changes in hydrology. Flooding to create ponds through dredging or damming was frequently observed. Nonetheless, extant populations of copperbelly water snakes were using man-made ponds at Hillsdale County EO .008, Williams County-Ohio, and Hillsdale County EO .010. Copperbelly water snakes were also using wetlands that received drainage from agricultural fields lined with drain tiles at Hillsdale County EO .008 (southern wet meadow (C) and the inundated shrub swamp) and Hillsdale County EO .010 (inundated shrub swamp (E)). While these types of hydrologic alterations are typically thought of as a form of degradation, they are likely benefiting the copperbelly water snake by supporting a consistently reliable base of prey. As noted, copperbelly water snakes feed almost exclusively on frogs and toads (Roe et al. 2003,
Thus, the creation of additional habitats with standing water throughout the year, which provides habitat for species, like green frogs, bull frogs, and northern leopard frogs, may significantly improve the copperbelly water snake’s ability to survive extended droughts.

**Management Considerations**

Invasive plants have the potential to significantly impact the copperbelly water snake by reducing the abundance of its prey. Control measures should be taken to reduce and eliminate invasive species from its habitat and the surrounding landscape. Presently, the following species pose the greatest threat to the copperbelly water snake: purple loosestrife, reed canary grass, garlic mustard, Morrow honeysuckle, autumn-olive, multiflora rose, and Japanese barberry. Other equally pernicious invasive species that were not observed but are present within the surrounding landscape include glossy buckthorn (*Rhamnus frangula*), common buckthorn (*Rhamnus cathartica*), and oriental bittersweet (*Celastrus orbiculata*). Information on detailed methods for controlling invasive species and abstracts concerning invasive species can be obtained at [http://tncweeds.ucdavis.edu/](http://tncweeds.ucdavis.edu/).

Copperbelly water snakes utilize a variety of forested and non-forested wetlands, which helps ensure the availability of prey and a broad range of conditions for thermoregulation. Thus, management of copperbelly water snake sites should strive to maintain a heterogeneous mix of wetland types. Ideal areas for conservation have been suggested to be moderately-sized, open-canopied wetlands integrated with smaller ephemeral shrub and forested wetlands in a contiguous but clustered complex (Herbert 2003). Maintaining open conditions in non-forested, seasonally inundated wetland types, such as southern wet meadows, will require the most active forms of management. In the past, wildfires and beaver flooding were responsible for reducing shrub and tree encroachment in southern wet meadows. In the absence of these natural forms of disturbance, active management, such as prescribed burning, purposeful flooding, or cutting of woody vegetation accompanied by herbicide application to cut stumps, will be necessary. In addition to maintaining open conditions that contribute to a diversity of prey and increased opportunities for thermoregulation, shrub and tree removal helps maintain higher water levels because of reduced rates of transpiration and water table drawdown.

In the surrounding upland communities, stratified structural layers such as coarse woody debris, graminoid patches, tall herbaceous plants, and thick woody shrubs should be maintained for copperbelly water snakes to allow for thermoregulation, concealment, and hibernation (Herbert 2003). Multi-structured communities can be achieved through natural maturation of the ecosystem, whereby various seral stages develop over time to form vegetation strata of varying age and size classes. Furthermore, conservation activities should be accomplished at the landscape level to facilitate greater inclusiveness of multiple natural communities at differing seral stages. Following a landscape-level management protocol will increase the potential seasonal home range of copperbelly water snakes (Herbert 2003). See the natural community abstracts for more information on management of southern wet meadows (Kost 2001), southern floodplain forests (Tepley et al. 2004), and mesic southern forests (Cohen 2004).

Protecting the hydrology of copperbelly water snake sites is also critically important. Lowering of water tables from excessive irrigation or urban sprawl can cause seasonally inundated wetlands and hibernacula sites to become permanently dry. The loss of either of these habitat components can result in the extinction of copperbelly water snake populations. Protecting riparian corridors and hydrologic processes, such as seasonal flooding and stream meandering is also critically important, as these processes create habitat for the copperbelly water snake and its prey.
CONCLUSIONS

The copperbelly water snake requires sites with heavy soil (e.g., silt or clay) that support forested uplands and a diversity of wetland community types in close proximity, including those with year-round standing water. The species appears to be tolerant of alterations to portions of its habitat, such as selective logging, flooding or dredging to create ponds, and mowing. It readily uses man-made ponds, which, in the absence of other sources of standing water, become critical habitat components. It occurs within an agrarian-based landscape and occupies sites that have been heavily impacted by surrounding land use practices. While past and present land use practices have altered its habitat, the rampant spread of invasive species poses a new threat with the potential to significantly impact its prey.

Conservation planning for the copperbelly water snake should strive to 1) protect all wetland types, including small, isolated, seasonally inundated depressions; 2) protect riparian corridors and habitat corridors among wetlands; 3) protect existing upland forests; and 4) reduce forest fragmentation. Because the copperbelly water snake moves frequently between wetlands and utilizes both large and small (e.g., <1 acre) wetlands (Roe et al. 2003, 2004), all wetlands within one mile of a copperbelly water snake site should be strongly protected. The active nature of the copperbelly water snake also necessitates the protection of riparian corridors and land situated among isolated wetlands that are in close proximity. Protection of riparian corridors will also allow rivers to overflow and meander, thus continually creating new, stranded wetlands for the copperbelly water snake and its prey. The use of forests for hibernacula and cover necessitates that all existing blocks of upland forest be protected, and, where feasible, enlarged by allowing adjacent old fields to convert to forest. Lastly, creating forested corridors among existing forest blocks and among isolated wetlands will help reduce mortality by providing additional cover and potential sites for hibernacula.

ACKNOWLEDGEMENTS

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APPENDICES
Appendix 1. Example field form for copperbelly habitat evaluation.

COPPERBELLY WATER SNAKE HABITAT EVALUATION

Date: __________________ Site: ________________________________

Community: ____________________________

Habitat Description
D=Dominant or Co-dominant; A=Abundant; C=Common; O=Occasional; U=uncommon; L=Locally, as in LD, Locally Dominant; LA, Locally Abundant; or LC, Locally Common

Code: Ground Cover (% cover) Code: Understory (% cover)

________________________________________________________________________

________________________________________________________________________

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________________________________________________________________________

Soil Type: ______________________ pH: ___________ Litter Depth: ___________

Water Conductivity: ______________________________

Water Depth: ___________________________________

________________________________________________________________________

Describe Habitat: _______________________________________________________

________________________________________________________________________

________________________________________________________________________

Estimate extent of community and overall habitat: ____________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

Describe and Rank Landscape Context (Low, Medium, High), comment on surrounding landuse: ____________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

Natural Community Quality and Viability (comments and rank: Low, Medium, High): __________________________

________________________________________________________________________
Appendix 2. Example field form for copperbelly habitat threats.

COPPERBELLY WATER SNAKE THREATS
Date:_________________ Site:_________________________________________

Community:________________________

Exotic Plants:
D, Dominant or Co-dominant; A, Abundant; C, Common; O, Occasional; U, uncommon;
L, Locally; as in LD, Locally Dominant; LA, Locally Abundant; or LC, Locally Common

<table>
<thead>
<tr>
<th>Abundance</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phalaris arundinacea</td>
<td>___________________</td>
</tr>
<tr>
<td>Phragmites australis</td>
<td>___________________</td>
</tr>
<tr>
<td>Typha angustifolia</td>
<td>___________________</td>
</tr>
<tr>
<td>Lythrum salicaria</td>
<td>___________________</td>
</tr>
<tr>
<td>Rhamnus frangula</td>
<td>___________________</td>
</tr>
<tr>
<td>Rhamnus cathartica</td>
<td>___________________</td>
</tr>
<tr>
<td>Lonicera morrowii</td>
<td>___________________</td>
</tr>
</tbody>
</table>

Other:
________________________
________________________

Hydrologic Alteration:

<table>
<thead>
<tr>
<th>Type</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drainage ditch draining wetland:</td>
<td>___________________</td>
</tr>
<tr>
<td>Drain tiled:</td>
<td>___________________</td>
</tr>
<tr>
<td>Surface water flow into wetland from farm field or development (roads, culverts etc.):</td>
<td>__________</td>
</tr>
<tr>
<td>Surface run-off into wetland from non-native upland system (erosion):</td>
<td>________________</td>
</tr>
<tr>
<td>Excessive draw-down of aquifer:</td>
<td>___________________</td>
</tr>
<tr>
<td>Water control structures present (dams, pumps etc.):</td>
<td>___________________</td>
</tr>
</tbody>
</table>

Habitat Destruction/Disturbance

________________________
________________________
________________________

Habitat Manipulation:
Mowing:
Water level manipulation:
Grazing:

________________________
________________________

Soil Erosion: ___________________

PALUSTRINE

MARSH

EMERGENT MARSH

Overview: A shallow water marsh characterized by emergent narrow- and broad-leaved herbs and grass-like plants as well as floating-leaved herbs at the shores of lakes and streams.
Similar communities: emergent marsh, southern wet meadow, northern wet meadow
Disturbance effects: Dredging for marl has destroyed many marshes along lake margins in eastern Upper Michigan and portions of Lower Michigan.

SOUTHERN WET MEADOW

Overview: A sedge and grass dominated wetland located mostly south of the transition zone.
Physiography and geology: In stream valleys, along lake margins, and in depressions and channels in glacial outwash.
Soils: Typical muck soil is neutral to medium acid.
Dominant plants: *Calamagrostis canadensis*, *Carex* (*C. stricta, C. aquatilis, C. lanuginosa, C. bebbii, C. lacustris*), *Phalaris arundinacea*. Other plants which are abundant include *Eleocharis, Juncus, Typha*, *Eupatorium maculatum*, and *E. perfoliatum*.
Variation: Species of northern wet meadow are present, but southern species distinguish the type.
Similar communities: northern wet meadow, emergent marsh, southern shrub-carr
Natural processes: Fire and flooding help maintain open conditions.
Disturbance effects: *Leersia, Phalaris arundinacea*, and *Phragmites australis* in abundance usually indicate past disturbance, often grazing.

FOREST

SOUTHERN SWAMP

Overview: A wetland deciduous forest type located south of the transition zone.
Physiography and geology: Situated primarily in depressions and channels of ground moraines, on glacial lake plains, and also in depressions of glacial outwash, especially near moraines.
Soils: Loam and silt loam soil (sometimes sandy loam) often possesses a clay layer; pH is neutral to slightly acid (in sandier soils).
Dominant plants: Dominant species often are *Acer saccharinum, Acer rubrum, Fraxinus pensylvanica, F. nigra* and, before the elm blight arrived, *Ulmus americana*.
Associated species: Several other species which codominate in the canopy include *Acer rubrum, Quercus bicolor, Q. palustris, Nyssa sylvatica*, the last two principally on sandy glacial lake plains.
Similar communities: southern floodplain forest, mesic southern forest
Natural processes: Sites are often inundated in the spring, a condition which can last into the summer, hence the groundlayer, except on elevated areas, is often sparse.
Appendix 3. (cont.).

SOUTHERN FLOODPLAIN FOREST

Overview: A bottomland deciduous forest type located south of the transition zone and occurring on mineral soil (less frequently on shallow muck).

Physiography and geology: Located along streams which are third order or greater.

Soils: Loam or silt loam (sometimes sandy loam and occasionally thin muck); neutral pH.

Dominant plants: Dominant plants nearly always include *Acer saccharinum*, often *Fraxinus pennsylvanica*, and sometimes *A. rubrum*. *Ulmus americana* was once important but was eliminated from the canopy by elm blight. Several other species can be important, especially in the southernmost watersheds, resulting in complex patterns of dominance. These additional species include *Juglans cinerea*, *Acer nigra*, *Aesculus glabra*, *Acer negundo*, *Fraxinus nigra*, *Salix nigra*, and *Populus deltoides*, the last two in former channels and on low riverbanks. *Ulmus rubra* is occasionally important.

Associated species: When sufficient elevation in the floodplain exists, species of surrounding higher ground will invade (e.g., *Acer saccharum*, *Fagus grandifolia*, *Tilia americana*, *Fraxinus americana*, *Carya cordiformis*). Other typical canopy species include *Quercus bicolor*, *Platanus occidentalis* (which may dominate less frequently flooded "flats"), *Celtis occidentalis* and *Juglans nigra*. *Crataegus* spp., *Lindera benzoin*, *Cornus alternifolia*, *Carpinus caroliniana*, and *Cercis canadensis* often occur in the understory. A number of species reach their northern limit in this forest type, including *Aesculus glabra*, *Asimina triloba*, *Camassia scilloides*, *Cercis canadensis*, *Diarrhena americana*, *Gleditsia tricanthos*, *Gymnocladus dioica*, *Mertensia virginica*, *Trillium nivale*, *T. recurvatum*, and *T. sessile*.

Variation: The flora of many of the river floodplains north of the tension zone, such as the Menominee and Sturgeon Rivers in the southern Upper Peninsula, contain species with a more southern affinity. A more complete survey of these streams is needed to determine whether the range of the community should be extended north or whether additional floodplain types should be added.

Similar communities: southern swamp, mesic southern forest

Natural processes: Flooding and windthrow.

Disturbance effects: Flooding and windthrow introduced frequent disturbance to floodplain forest. Weedy exotics and natives like *Ambrosia trifida*, *Alliaria officinalis*, *Lysimachia nummularia*, and *Urtica dioica* are common. Grass and herb dominated openings of *Phalaris*, *Elymus virginicus*, *E. riparia*, and *Solidago altissima* are often present.

RELI CT CONIFER SWAMP

Overview: A minerotrophic forested peatland located primarily south of the transition zone.

Physiography and geology: Situated on glacial outwash drainageways, at stream headwaters in end moraines, in kettle depressions in kettle-kame or coarse end moraine topography, and rarely on sandy glacial lake plain.

Soils: Saturated muck soil is neutral due to groundwater infusion, but surface soil layers may be acid.

Dominant plants: Dominance is nearly always by northern conifers: *Larix laricina* most commonly, *Thuja occidentalis* occasionally, and *Pinus strobus* and others only rarely.

Associated species: Other occasional canopy trees include *Acer rubrum*, *Fraxinus nigra*, *Betula allegheniensis*. *Lindera benzoin*, *Vaccinium corymbosum*, *Toxicodendron vernix*, *Ilex verticillata*, *Viburnum lentago*, etc. typically are present, the first often abundantly. Species of northern conifer swamps are present, as are several southern species not found in the north and also certain rare insects, e.g. *Neonympha mitchellii mitchellii* (Mitchell's satyr), *Oecanthus laricis* tamarack tree cricket).

Similar communities: rich conifer swamp, hardwood-conifer swamp

Natural processes: Larch sawfly outbreaks may have periodically opened the canopy, increasing plant diversity.

Appendix 3. (cont.).

**SHRUB**

**INUNDATED SHRUB SWAMP**

**Overview:** A moderate to long persistent, shrub-dominated successional community. Successionally intermediate between emergent marsh and forested swamp or bog. Characterized by fluctuating water levels and very poor drainage.

**Physiography and geology:** Occupies kettleholes in kettle/kame ice-disintegration topography, in moats around bogs and less frequently associated with wetland depressions on outwash and sandy lake plains.

**Soils:** Inundated to deeply inundated (1-2 feet deep) muck, or (less frequently) mineral soil.

**Dominant plants:** *Alisma plantago-aquatica*, *Cephalanthus occidentalis*, *Lemna minor*, *Polygonum punctatum*, *Salix spp.*, and *Typha latifolia*.

**Associated plants:** *Acer saccharinum*, *Alopecurus aquatilis*, *Agrostis gigantea*, *Asclepias incarnata*, *Carex scoparia var. condensa*, *C. vulpinoidea*, *Convulvulus arvensis*, *Cornus stolonifera*, *C. amomum*, *Glyceria septentrionalis*, *Juncus acuminatus*, *J. effusus var. solutus*, *J. tenuis*, *Lycopus americanus*, *Lysimachia quadrifolia*, *Penthorum sedoides*, *Phalaris arundinacea*, *Quercus bicolor*, *Ranunculus flabellaris*, *Rosa carolina*, *Sagittaria latifolia*, *Scirpus atrovirens*, *Sium suave*, *Sparganium chlorocarpum*, and *Veronica scutellata*.

**Characteristic plants:** This type is recognized by the overwhelming dominance of *Cephalanthus occidentalis*, frequently in combination with either *Salix bebbiana* and/or *S. discolor*.

**Variation:** This type is floristically depauperate, however, northern and southern variations are likely.

**Similar communities:** emergent marsh, northern shrub thicket, southern shrub-carr

**Natural processes:** Strong seasonal hydrologic cycling.


**TERRESTRIAL**

**FOREST**

**MESIC SOUTHERN FOREST**  [SOUTHERN HARDWOOD FOREST]

**Overview:** A southern hardwood forest type on moist ground with little oak, lying mostly south of the transition zone.

**Physiography and geology:** Occurring principally on medium- or fine-textured ground moraine, on fine-textured end moraine, and on silty/clayey glacial lake plains. Within 10-20 miles of the shores of the Great Lakes, due to improved evapotranspiration conditions, can also occur on sandy lake plains and sand dunes.

**Soils:** Variable, with a predominance of clay to loam texture.

**Dominant plants:** *Acer saccharum*, *Fagus grandifolia*; occasionally, *Quercus rubra* or *Liriodendron tulipifera* codominate.

**Associated species:** Other important canopy species are *Fraxinus americana*, *Tilia americana*, *Prunus serotina*, *Carya cordiformis*, and sometimes *Acer rubrum*, *Quercus alba*, and *Q. macrocarpa*.

**Characteristic plants:** The spring flora of this mesophytic woods shows striking diversity, typified by large colonies of such herbs as *Allium tricoccum*, *Asarum canadense*, *Dentaria laciniata*, *Dicentra cucullaria*, *Erythronium americanum*, *Hydrophyllum virginianum*, *Isopyrum biternatum*, *Phlox divaricata*, *Trillium grandiflorum*.

**Variation:** Three subtypes can be recognized: one on the eastern lake plains, one in the western sand dunes, and one on the glacial materials between these areas.

**Similar communities:** mesic northern forest, dry-mesic southern forest, southern swamp, southern floodplain forest

**Natural processes:** Windthrow is the most common natural disturbance.
Appendix 3. (cont.).

**Disturbance effects:** A natural preponderance of *Fagus* could possibly signify a longer time in mature forest conditions, but it could also be the result of heavy selective cutting of sugar maple or of moderately poor drainage conditions for which beech has better tolerance.

**DRY-MESIC SOUTHERN FOREST  [OAK-HARDWOOD FOREST]**

**Overview:** An oak or oak-hardwood forest type on generally dry-mesic sites lying mostly south of the transition zone.

**Physiography and geology:** Occurring principally on glacial outwash, coarse-textured end moraines, and sandy glacial lake plains; also on kettle-kame topography, coarse-textured ground moraines, and sand dunes.

**Soils:** Sandy loam and loam soils are slightly acid to neutral.

**Dominant plants:** *Quercus alba, Q. velutina* (always dominant or important in the canopy, the former more than the latter).

Associated species: Other trees sometimes codominant or important are *Acer rubrum, Carya ovalis, Fraxinus americana, Quercus coccinea*. Constant canopy trees are *Prunus serotina* and *Sassafras albidum*. *Quercus rubra* localized on moister lower slope position.

**Characteristic plants:** Typical species include *Actaea alba, Brachyletrum erectum, Bromus pubescens, Carex albursina, C. convoluta, Carya ovata, Corallorhiza maculata, Galium triflorum, Hamamelis virginiana, Ostrya virginiana, Sanicula marilandica, Smilax tamnoides, Viola pubescens*.

**Variation:** *Pinus strobus* enters toward the transition zone.

**Similar communities:** dry southern forest, mesic southern forest

**Natural processes:** Present dry-mesic southern forests were probably oak openings prior to fire suppression, based on comparison of General Land Office survey reports and present vegetation in Oakland County.

**SCS Soil pH Ranges**

- < 4.5 extremely acid
- 4.5-5.0 very strongly acid
- 5.1-5.5 strongly acid
- 5.6-6.0 medium acid
- 6.1-6.5 slightly acid
- 6.6-7.3 neutral
- 7.4-7.8 mildly alkaline
- 7.9-8.4 moderately alkaline
- 8.5-9.0 strongly alkaline
- > 9.0 very strongly alkaline
Appendix 4. Plant species observed at Cass-St. Joseph County EO .002. "x" indicates the species occurred within the site and "." indicates the species was not observed at the site. Capitalized scientific and common names indicate non-native species. Life form acronyms are as follows: Nt, native; P, perennial; Ad, adventive; B, biennial; A, annual. "W" is the Coefficient of Wetness and varies from 5 to -5, with positive values indicating that the species most commonly occurs in uplands and negative values indicating an affinity for wetlands (Herman et al 2001, Reed 1988, Wilhelm 1989). A Wetness Index was calculated for each community as the mean of the species wetness coefficients.

<table>
<thead>
<tr>
<th>Scientific Name</th>
<th>Common Name</th>
<th>Life Form</th>
<th>W</th>
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<th>inundated shrub swamp (B)</th>
<th>inundated shrub swamp (C)</th>
<th>inundated shrub swamp (D)</th>
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<th>mesic</th>
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<td>-</td>
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</tr>
<tr>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>x</td>
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</tr>
<tr>
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<td>BASSWOOD</td>
<td>Nt Tree</td>
<td>3</td>
<td>-</td>
<td>x</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Toxicodendron radicans</td>
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<td>-1</td>
<td>-</td>
<td>x</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<td>Toxicodendron vernix</td>
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<td>-</td>
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<tr>
<td>Trientalis borealis</td>
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<td>-1</td>
<td>x</td>
<td>-</td>
<td>-</td>
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<td>-</td>
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<tr>
<td>Trillium grandiflorum</td>
<td>COMMON TRILLIUM</td>
<td>Nt P-Forb</td>
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<td>-</td>
<td>x</td>
<td>-</td>
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<tr>
<td>Ulmus americana</td>
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<td>-2</td>
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<td>x</td>
<td>x</td>
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<td>x</td>
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<td>x</td>
<td>x</td>
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<td>-</td>
<td>x</td>
<td>-</td>
<td>-</td>
<td>x</td>
<td>-</td>
</tr>
<tr>
<td>Vaccinium corymbosum</td>
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<td>x</td>
<td>x</td>
<td>x</td>
<td>-</td>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Viola sp.</td>
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<td>Forb</td>
<td>-</td>
<td>-</td>
<td>x</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>x</td>
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<tr>
<td>Vitis riparia</td>
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<td>-2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>x</td>
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</tr>
<tr>
<td>Woodwardia virginica</td>
<td>VIRGINIA CHAIN FERN</td>
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### Appendix 4. (cont.)

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<td>Total number of species observed</td>
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<th>Wetness Index</th>
<th>Cass-St. Joseph County EO .002</th>
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<td>inundated shrub swamp (A)</td>
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<td></td>
<td>-2.2</td>
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Appendix 5. Plant species observed at Hillsdale County EO .007. "x" indicates the species occurred within the site and "-" indicates the species was not observed at the site. Capitalized scientific and common names indicate non-native species. Life form acronyms are as follows: Nt, native; P, perennial; Ad, adventive; B, biannual; A, annual. "W" is the Coefficient of Wetness and varies from 5 to -5, with positive values indicating that the species most commonly occurs in uplands and negative values indicating an affinity for wetlands (Herman et al 2001, Reed 1988, Wilhelm 1989). A Wetness Index was calculated for each community as the mean of the species wetness coefficients.

<table>
<thead>
<tr>
<th>Scientific Name</th>
<th>Common Name</th>
<th>Life Form</th>
<th>W</th>
</tr>
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<tbody>
<tr>
<td>Acer saccharinum</td>
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<tr>
<td>ALLIARIA PETIOLATA</td>
<td>GARLIC MUSTARD</td>
<td>Ad B-Forb</td>
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<tr>
<td>Arisaema triphyllum</td>
<td>JACK IN THE PULPIT</td>
<td>Nt P-Forb</td>
<td>-2</td>
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<tr>
<td>Asarum canadense</td>
<td>WILD GINGER</td>
<td>Nt P-Forb</td>
<td>5</td>
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<tr>
<td>Asimina triloba</td>
<td>PAWPAW</td>
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<td>0</td>
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<tr>
<td>Aster lateriflorus</td>
<td>SIDE FLOWERING ASTER</td>
<td>Nt P-Forb</td>
<td>-2</td>
</tr>
<tr>
<td>Carex intumescens</td>
<td>SEDGE</td>
<td>Nt P-</td>
<td>-4</td>
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<tr>
<td>Carpinus caroliniana</td>
<td>BLUE BEECH</td>
<td>Nt Tree</td>
<td>0</td>
</tr>
<tr>
<td>Clematis virginiana</td>
<td>VIRGIN'S BOWER</td>
<td>Nt W-</td>
<td>0</td>
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<tr>
<td>Cornus alternifolia</td>
<td>ALTERNATE LEAVED DOGWOOD</td>
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<td>5</td>
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<tr>
<td>Crataegus sp.</td>
<td>HAWTHORN</td>
<td>Tree</td>
<td>-</td>
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<td>Cryptotaenia canadensis</td>
<td>HONEWORT</td>
<td>Nt P-Forb</td>
<td>0</td>
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<tr>
<td>Fraxinus pennsylvanica</td>
<td>RED ASH</td>
<td>Nt Tree</td>
<td>-3</td>
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<td>Galium asperrimum</td>
<td>ROUGH BEDSTRAW</td>
<td>Nt P-Forb</td>
<td>-5</td>
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<tr>
<td>Geranium maculatum</td>
<td>WILD GERANIUM</td>
<td>Nt P-Forb</td>
<td>3</td>
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<td>Helenium autumnale</td>
<td>SNEEZEWEED</td>
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<td>-4</td>
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<td>Heracleum maximum</td>
<td>COW PARSNIP</td>
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<td>Iris virginica</td>
<td>SOUTHERN BLUE FLAG</td>
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<td>Juglans nigra</td>
<td>BLACK WALNUT</td>
<td>Nt Tree</td>
<td>3</td>
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<tr>
<td>Laportea canadensis</td>
<td>WOOD NETTLE</td>
<td>Nt P-Forb</td>
<td>-3</td>
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<tr>
<td>Lilium philadelphicum</td>
<td>WOOD LILY</td>
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<td>LYSIMACHIA NUMMULARIA</td>
<td>MONEYWORT</td>
<td>Ad P-Forb</td>
<td>-4</td>
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<td>Osmorhiza longistylis</td>
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<td>Parthenocissus quinquefolia</td>
<td>VIRGINIA CREEPER</td>
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<td>Platanus occidentalis</td>
<td>SYCAMORE</td>
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<td>Polygonatum biflorum</td>
<td>SOLOMON SEAL</td>
<td>Nt P-Forb</td>
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Appendix 5. (cont.).

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<th>Common Name</th>
<th>Life Form</th>
<th>W</th>
<th>Wetness Index</th>
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<tr>
<td>Populus deltoides</td>
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<tr>
<td>Prunus virginiana</td>
<td>CHOKE CHERRY</td>
<td>Nt Shrub</td>
<td>1</td>
<td>x</td>
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<tr>
<td>Rubus sp.</td>
<td>BERRY</td>
<td>Nt Shrub</td>
<td>5</td>
<td>x</td>
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<tr>
<td>Rudbeckia laciniata</td>
<td>CUT LEAVED CONEFLOWER</td>
<td>Nt P-Forb</td>
<td>-4</td>
<td>x</td>
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<tr>
<td>Sanguinaria canadensis</td>
<td>BLOODROOT</td>
<td>Nt P-Forb</td>
<td>4</td>
<td>x</td>
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<tr>
<td>Sanicula gregaria</td>
<td>BLACK SNAKEROOT</td>
<td>Nt P-Forb</td>
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<tr>
<td>Scutellaria lateriflora</td>
<td>MAD DOG SKULLCAP</td>
<td>Nt P-Forb</td>
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<tr>
<td>Smilax sp.</td>
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<td>-</td>
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<tr>
<td>Solidago gigantea</td>
<td>LATE GOLDENROD</td>
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<tr>
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<td>Tilia americana</td>
<td>BASSWOOD</td>
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<td>3</td>
<td>x</td>
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<tr>
<td>Toxicodendron radicans</td>
<td>POISON IVY</td>
<td>Nt W-Vine</td>
<td>-1</td>
<td>x</td>
</tr>
<tr>
<td>Ulmus americana</td>
<td>AMERICAN ELM</td>
<td>Nt Tree</td>
<td>-2</td>
<td>x</td>
</tr>
<tr>
<td>Viburnum lentago</td>
<td>NANNYBERRY</td>
<td>Nt Shrub</td>
<td>-1</td>
<td>x</td>
</tr>
<tr>
<td>Viola sp.</td>
<td>VIOLET</td>
<td>Forb</td>
<td>-</td>
<td>x</td>
</tr>
<tr>
<td>Vitis riparia</td>
<td>RIVERBANK GRAPE</td>
<td>Nt W-Vine</td>
<td>-2</td>
<td>x</td>
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<tr>
<td>Zanthoxylum americanum</td>
<td>PRICKLY ASH</td>
<td>Nt Shrub</td>
<td>5</td>
<td>x</td>
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<tr>
<td>Zizia aurea</td>
<td>GOLDEN ALEXANDERS</td>
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Total number of species observed: **45**

Wetness Index: **-0.5**
Appendix 6. Plant species observed at Calhoun County EO .013. "x" indicates the species occurred within the site and "-" indicates the species was not observed at the site. Capitalized scientific and common names indicate non-native species. Life form acronyms are as follows: Nt, native; P, perennial; Ad, adventive; B, biannual; A, annual. "W" is the Coefficient of Wetness and varies from 5 to -5, with positive values indicating that the species most commonly occurs in uplands and negative values indicating an affinity for wetlands (Herman et al 2001, Reed 1988, Wilhelm 1989). A Wetness Index was calculated for each community as the mean of the species wetness coefficients.

<table>
<thead>
<tr>
<th>Scientific Name</th>
<th>Common Name</th>
<th>Life Form</th>
<th>W</th>
<th>southern floodplain forest</th>
<th>southern wet meadow</th>
<th>dry-mesic southern forest</th>
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<td>Acer rubrum</td>
<td>RED MAPLE</td>
<td>Nt Tree</td>
<td>0</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Acer saccharinum</td>
<td>SILVER MAPLE</td>
<td>Nt Tree</td>
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<td>x</td>
<td>x</td>
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<td>Nt P-Forb</td>
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<tr>
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<td>SWAMP MILKWEED</td>
<td>Nt P-Forb</td>
<td>-5</td>
<td>-</td>
<td>x</td>
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<tr>
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<td>Nt Fern</td>
<td>3</td>
<td>-</td>
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<td>Aster firmus</td>
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<tr>
<td>Aster lateriflorus</td>
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<td>x</td>
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<td>Nt P-Sedge</td>
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<td>x</td>
<td>-</td>
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<td>Carex sp.</td>
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<td>Cyperus sp.</td>
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### Appendix 6. (cont.)

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<th>Scientific Name</th>
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<th>southern floodplain forest</th>
<th>southern wet meadow</th>
<th>dry-mesic southern forest</th>
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<tbody>
<tr>
<td>Dryopteris carthusiana</td>
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<td>ELAEAGNUS UMBELLATA</td>
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</tr>
<tr>
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### Appendix 6. (cont.)

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<th>Scientific Name</th>
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<th>southern wet meadow</th>
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**Total number of species observed**: 33

**Wetness Index**: 0.8 -3.8 1.9
**Appendix 7.** Plant species observed at Hillsdale County EO .004. "x" indicates the species occurred within the site and "-" indicates the species was not observed at the site. Capitalized scientific and common names indicate non-native species. Life form acronyms are as follows: Nt, native; P, perennial; Ad, adventive; B, biannual; A, annual. "W" is the Coefficient of Wetness and varies from 5 to -5, with positive values indicating that the species most commonly occurs in uplands and negative values indicating an affinity for wetlands (Herman et al 2001, Reed 1988, Wilhelm 1989). A Wetness Index was calculated for each community as the mean of the species wetness coefficients.

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<td></td>
<td></td>
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<td>forest</td>
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<td>x</td>
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| Total number of species observed | 39 | 30 | 28 |
| Wetness Index                   | -0.1 | -2.2 | 2.8 |
Appendix 8. Plant species observed at Hillsdale County EO .008. "x" indicates the species occurred within the site and "-" indicates the species was not observed at the site. Capitalized scientific and common names indicate non-native species. Life form acronyms are as follows: Nt, native; P, perennial; Ad, adventive; B, biannual; A, annual. "W" is the Coefficient of Wetness and varies from 5 to -5, with positive values indicating that the species most commonly occurs in uplands and negative values indicating an affinity for wetlands (Herman et al 2001, Reed 1988, Wilhelm 1989). A Wetness Index was calculated for each community as the mean of the species wetness coefficients.

<table>
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<tr>
<th>Scientific Name</th>
<th>Common Name</th>
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| Total number of species observed | 17 | 32 | 32 | 33 | 43 |
| Wetness Index                  | -2.6 | 1.7 | 2.1 | 3.5 | 1.6 |
Appendix 9. Plant species observed at Hillsdale County EO .005. "x" indicates the species occurred within the site and "-" indicates the species was not observed at the site. Capitalized scientific and common names indicate non-native species. Life form acronyms are as follows: Nt, native; P, perennial; Ad, adventive; B, biannual; A, annual. "W" is the Coefficient of Wetness and varies from 5 to -5, with positive values indicating that the species most commonly occurs in uplands and negative values indicating an affinity for wetlands (Herman et al 2001, Reed 1988, Wilhelm 1989). A Wetness Index was calculated for each community as the mean of the species wetness coefficients.

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<td>LATE GOLDENROD</td>
<td>Nt P-Forb</td>
<td>-3</td>
<td>-</td>
<td>-</td>
<td>-</td>
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</tr>
<tr>
<td>Tilia americana</td>
<td>BASSWOOD</td>
<td>Nt Tree</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>x</td>
<td>x</td>
<td>-</td>
</tr>
<tr>
<td>Toxicodendron radicans</td>
<td>POISON IVY</td>
<td>Nt W-Vine</td>
<td>-1</td>
<td>-</td>
<td>-</td>
<td>x</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>TYPHA ANGUSTIFOLIA</td>
<td>NARROW LEAVED CATTAIL</td>
<td>Ad P-Forb</td>
<td>-5</td>
<td>x</td>
<td>x</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
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<td>AMERICAN ELM</td>
<td>Nt Tree</td>
<td>-2</td>
<td>-</td>
<td>-</td>
<td>x</td>
<td>x</td>
<td>-</td>
</tr>
<tr>
<td>Urtica dioica</td>
<td>NETTLE</td>
<td>Nt P-Forb</td>
<td>-1</td>
<td>-</td>
<td>-</td>
<td>x</td>
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<td>-</td>
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<tr>
<td>Vernonia missurica</td>
<td>MISSOURI IRONWEED</td>
<td>Nt P-Forb</td>
<td>-1</td>
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<tr>
<td>Viburnum acerifolium</td>
<td>MAPLE LEAVED ARROW WOOD</td>
<td>Nt Shrub</td>
<td>5</td>
<td>-</td>
<td>x</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<tr>
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<td>VIOLET</td>
<td>Nt P-Forb</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>x</td>
<td>x</td>
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<tr>
<td>Vitis riparia</td>
<td>RIVERBANK GRAPE</td>
<td>Nt W-Vine</td>
<td>-2</td>
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<tr>
<td>Zanthoxylum americanum</td>
<td>PRICKLY ASH</td>
<td>Nt Shrub</td>
<td>5</td>
<td>-</td>
<td>x</td>
<td>-</td>
<td>x</td>
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<tr>
<td>Zizia aurea</td>
<td>GOLDEN ALEXANDERS</td>
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<td>-1</td>
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<tr>
<th>Total number of species observed</th>
<th>14</th>
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<td>-3.7</td>
<td>2.6</td>
<td>1.6</td>
<td>3.1</td>
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</table>
**Appendix 10.** Plant species observed at Branch County EO .012. "x" indicates the species occurred within the site and "-" indicates the species was not observed at the site. Capitalized scientific and common names indicate non-native species. Life form acronyms are as follows: Nt, native; P, perennial; Ad, adventive; B, biannual; A, annual. "W" is the Coefficient of Wetness and varies from 5 to -5, with positive values indicating that the species most commonly occurs in uplands and negative values indicating an affinity for wetlands (Herman et al 2001, Reed 1988, Wilhelm 1989). A Wetness Index was calculated for each community as the mean of the species wetness coefficients.

<table>
<thead>
<tr>
<th>Scientific Name</th>
<th>Common Name</th>
<th>Life Form</th>
<th>W</th>
<th>southern floodplain forest</th>
<th>inundated shrub swamp (A)</th>
<th>inundated shrub swamp (B)</th>
</tr>
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<tbody>
<tr>
<td>Acer saccharinum</td>
<td>SILVER MAPLE</td>
<td>Nt Tree</td>
<td>-3</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Aster lateriflorus</td>
<td>SIDE FLOWERING ASTER</td>
<td>Nt P-Forb</td>
<td>-2</td>
<td>x</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Boehmeria cylindrica</td>
<td>FALSE NETTLE</td>
<td>Nt P-Forb</td>
<td>-5</td>
<td>-</td>
<td>x</td>
<td>-</td>
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<tr>
<td>Calamagrostis canadensis</td>
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<td>Nt P-Grass</td>
<td>-5</td>
<td>-</td>
<td>x</td>
<td>-</td>
</tr>
<tr>
<td>Carex lacustris</td>
<td>SEDGE</td>
<td>Nt P-Sedge</td>
<td>-5</td>
<td>-</td>
<td>x</td>
<td>-</td>
</tr>
<tr>
<td>Carex stricta</td>
<td>SEDGE</td>
<td>Nt P-Sedge</td>
<td>-5</td>
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<tr>
<td>Carex stricta</td>
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<td>Nt P-Sedge</td>
<td>-5</td>
<td>-</td>
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<tr>
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<td>SHAGBARK HICKORY</td>
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<td>x</td>
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<td>-</td>
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<tr>
<td>Cephalanthis occidentalis</td>
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<td>Nt Shrub</td>
<td>-5</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Cornus amomum</td>
<td>SILKY DOGWOOD</td>
<td>Nt Shrub</td>
<td>-4</td>
<td>x</td>
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<td>-</td>
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<tr>
<td>Cornus stolonifera</td>
<td>RED OSIER DOGWOOD</td>
<td>Nt Shrub</td>
<td>-3</td>
<td>x</td>
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<td>-</td>
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<td>Eupatorium maculatum</td>
<td>JOE PYE WEED</td>
<td>Nt P-Forb</td>
<td>-5</td>
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<td>-</td>
<td>-</td>
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<td>Fraxinus nigra</td>
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<tr>
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<td>Glyceria striata</td>
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<td>-5</td>
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<tr>
<td>Leersia oryzoides</td>
<td>CUT GRASS</td>
<td>Nt P-Grass</td>
<td>-5</td>
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<td>-</td>
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<td>Lindera benzoin</td>
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<td>Lobelia cardinalis</td>
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<tr>
<td>Lycopus americanus</td>
<td>COMMON WATER HOREHOUND</td>
<td>Nt P-Forb</td>
<td>-5</td>
<td>x</td>
<td>-</td>
<td>-</td>
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<tr>
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<td>NORTHERN BUGLE WEED</td>
<td>Nt P-Forb</td>
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<tr>
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<td>MONEYWORT</td>
<td>Ad P-Forb</td>
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<td>-</td>
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<td>Nt Fern</td>
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<td>x</td>
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<td>Osmunda regalis</td>
<td>ROYAL FERN</td>
<td>Nt Fern</td>
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<td>Nt P-Forb</td>
<td>1</td>
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Appendix 10. (cont.).

<table>
<thead>
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<th>Scientific Name</th>
<th>Common Name</th>
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<th>W</th>
<th>southern floodplain</th>
<th>inundated shrub swamp (A)</th>
<th>inundated shrub swamp (B)</th>
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<tbody>
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<td>Pilea pumila</td>
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<td>-3</td>
<td>x</td>
<td>x</td>
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<td>Polygonum sp.</td>
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<td></td>
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<td>Populus deltoides</td>
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<td>Nt Tree</td>
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<td>x</td>
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<td>Quercus bicolor</td>
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<tr>
<td>Rosa palustris</td>
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<td>-</td>
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<td>GREAT WATER DOCK</td>
<td>Nt P-Forb</td>
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<td>x</td>
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<tr>
<td>Salix nigra</td>
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<td>-5</td>
<td>-</td>
<td>x</td>
<td>x</td>
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<tr>
<td>Saururus cernuus</td>
<td>LIZARD'S-TAIL</td>
<td>Nt P-Forb</td>
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<tr>
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<td>MAD DOG SKULLCAP</td>
<td>Nt P-Forb</td>
<td>-5</td>
<td>x</td>
<td>x</td>
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</tr>
<tr>
<td>Smilax tamnoides</td>
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<td>Nt W-Vine</td>
<td>0</td>
<td>x</td>
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<td>-</td>
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<tr>
<td>SOLANUM DULCAMARA</td>
<td>BITTERSWEET NIGHTSHADE</td>
<td>Ad P-Forb</td>
<td>0</td>
<td>-</td>
<td>x</td>
<td>x</td>
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<td>Thelypteris palustris</td>
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<td>Nt Fern</td>
<td>-4</td>
<td>-</td>
<td>x</td>
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<tr>
<td>Toxicodendron radicans</td>
<td>POISON IVY</td>
<td>Nt W-Vine</td>
<td>-1</td>
<td>x</td>
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<td>-</td>
</tr>
<tr>
<td>Ulmus americana</td>
<td>AMERICAN ELM</td>
<td>Nt Tree</td>
<td>-2</td>
<td>x</td>
<td>x</td>
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<tr>
<td>Viola sp.</td>
<td>VIOLET</td>
<td>Forb</td>
<td>-</td>
<td>x</td>
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</table>

Total number of species observed | 27 | 28 | 8
Wetness Index                  | -2.9 | -4.1 | -3.5
Appendix 11. Plant species observed at Williams County-Ohio. "x" indicates the species occurred within the site and "-" indicates the species was not observed at the site. Capitalized scientific and common names indicate non-native species. Life form acronyms are as follows: Nt, native; P, perennial; Ad, adventive; B, biannual; A, annual. "W" is the Coefficient of Wetness and varies from 5 to -5, with positive values indicating that the species most commonly occurs in uplands and negative values indicating an affinity for wetlands (Herman et al 2001, Reed 1988, Wilhelm 1989). A Wetness Index was calculated for each community as the mean of the species wetness coefficients.

<table>
<thead>
<tr>
<th>Scientific Name</th>
<th>Common Name</th>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>x</td>
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<tr>
<td>Acer saccharinum</td>
<td>SILVER MAPLE</td>
<td>Nt Tree</td>
<td>-3</td>
<td>-</td>
<td>x</td>
<td>-</td>
<td>-</td>
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<td>Acer saccharum</td>
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<td>Nt Tree</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>x</td>
<td>-</td>
<td>x</td>
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<td>GARLIC MUSTARD</td>
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<td>0</td>
<td>-</td>
<td>-</td>
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<td>-</td>
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<td>x</td>
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<td>x</td>
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<td>Forb</td>
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<tr>
<td>Bidens frondosus</td>
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<td>Nt A-Forb</td>
<td>-3</td>
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<tr>
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<td>FALSE NETTLE</td>
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<td>x</td>
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<td>Carya ovata</td>
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<tr>
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Appendix 11. (cont.)

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### Williams County-Ohio

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Appendix 12. Plant species observed at Hillsdale County EO .010. "x" indicates the species occurred within the site and "-" indicates the species was not observed at the site. Capitalized scientific and common names indicate non-native species. Life form acronyms are as follows: Nt, native; P, perennial; Ad, adventive; B, biannual; A, annual. "W" is the Coefficient of Wetness and varies from 5 to -5, with positive values indicating that the species most commonly occurs in uplands and negative values indicating an affinity for wetlands (Herman et al 2001, Reed 1988, Wilhelm 1989). A Wetness Index was calculated for each community as the mean of the species wetness coefficients.

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**Total number of species observed** | **24** | **28** | **29** | **31**

**Wetness Index** | **-3.3** | **-2.2** | **-2.2** | **-1.7**
## Appendix 12. (cont.)

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Hillsdale County EO.010
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| Total number of species observed      | 26                             | 27         | 13 | 33        | 22 |
| Wetness Index                         | -2.1                           | -2.9       | -3.7| -1.6      | -2.8 |
### Appendix 12. (cont.)

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</table>

**Total number of species observed**

|                   | 37 | 27 | 35 |

**Wetness Index**

|                   | 2.7 | 2.0 | 1.7 |
### Appendix 13. Vegetation structure and dominant species.

<table>
<thead>
<tr>
<th>Site</th>
<th>Community Type</th>
<th>Structural Layer</th>
<th>Dominant Species</th>
<th>% Cover</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cass-St. Joseph</td>
<td>inundated shrub swamp (A)</td>
<td>Overstory</td>
<td>Acer rubrum, Quercus bicolor</td>
<td>20</td>
</tr>
<tr>
<td>County EO .002</td>
<td></td>
<td>Understory</td>
<td>Cephalanthus occidentalis, Rosa palustris</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>Ground Layer</td>
<td>Lemna minor, Carex crinita</td>
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<tr>
<td>Cass-St. Joseph</td>
<td>inundated shrub swamp (B)</td>
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<tr>
<td>County EO .002</td>
<td></td>
<td>Understory</td>
<td>Cephalanthus occidentalis</td>
<td>65</td>
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<tr>
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<td></td>
<td>Ground Layer</td>
<td>Sium suave, Glyceria canadensis, Symplocarpus foetidus, Solidago patula</td>
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<tr>
<td>Cass-St. Joseph</td>
<td>inundated shrub swamp (C)</td>
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<td>Quercus palustris, Salix nigra, Juglans nigra</td>
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<tr>
<td>County EO .002</td>
<td></td>
<td>Understory</td>
<td>Cephalanthus occidentalis, Rosa palustris, Ilex verticillata</td>
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<tr>
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<td>Ground Layer</td>
<td>Puccinellia pallida, Lemna minor, Phalaris arundinacea</td>
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<td>Cephalanthus occidentalis, Ilex verticillata, Rosa palustris</td>
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<td>Ground Layer</td>
<td>Carex rostrata, Puccinellia pallida, Lemna minor, Bidens sp.</td>
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# Appendix 13. (cont.)

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<td>mesic southern forest</td>
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<td>Fagus grandifolia</td>
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<td></td>
<td>Understory</td>
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<td>Ostrya virginiana Fagus grandifolia</td>
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<td>Laportea canadensis Thelypteris noveboracensis</td>
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<td></td>
<td>Understory</td>
<td>Asimina triloba Ulmus americana</td>
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<td>Cryptotaenia canadensis Parthenocissus quinquefolia Thalictrum dasycarpum Viola sp.</td>
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<td></td>
<td>Understory</td>
<td>Elaeagnus umbellata Carpinus caroliniana Ulmus americana Viburnum lentago</td>
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<td>Sanicula gregaria Leersia virginica Carex pensylvanica</td>
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### Appendix 13. (cont.)

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<td><strong>Overstory</strong></td>
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<td><strong>Understory</strong></td>
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<td><strong>Ground Layer</strong></td>
<td>Asclepias incarnata, Carex stricta, Mentha arvensis, Phalaris arundinacea, Sparganium sp.</td>
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<td>Calhoun County</td>
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<td></td>
<td><strong>Understory</strong></td>
<td>Acer rubrum, Carya ovata</td>
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<td></td>
<td></td>
<td><strong>Ground Layer</strong></td>
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<tr>
<td>Hillsdale County</td>
<td>southern floodplain forest</td>
<td><strong>Overstory</strong></td>
<td>Tilia americana, Fraxinus pennsylvanica</td>
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<tr>
<td>EO .004</td>
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<td><strong>Understory</strong></td>
<td>Tilia americana, Fraxinus pennsylvanica, Ulmus americana</td>
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<td>Sanicula gregaria, Elymus virginica, Solidago caesia, Collinsonia canadensis</td>
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<td>Hillsdale County</td>
<td>southern wet meadow</td>
<td><strong>Overstory</strong></td>
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<td>Cornus foemina, Physocarpus opulifolius, Ulmus americana, Vitis riparia</td>
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<td><strong>Ground Layer</strong></td>
<td>Carex stricta, Lythrum salicaria, Eupatorium maculatum</td>
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### Appendix 13. (cont.)

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<th>Dominant Species</th>
<th>% Cover</th>
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<td><strong>Overstory</strong></td>
<td>Populus grandidentata</td>
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<tr>
<td>EO .004</td>
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<td><strong>Understory</strong></td>
<td>Zanthoxylum americanum, Carpinus caroliniana, Carya ovata, Hamamelis virginiana, Tilia americana, Acer rubrum</td>
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<tr>
<td></td>
<td></td>
<td><strong>Ground Layer</strong></td>
<td>Sanicula gregaria, Hystrix patula, Rubus sp.</td>
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<td>Hillsdale County</td>
<td>pond</td>
<td><strong>Overstory</strong></td>
<td>Salix nigra</td>
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<td><strong>Understory</strong></td>
<td>Cephalanthus occidentalis</td>
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<td>EO .008</td>
<td></td>
<td><strong>Understory</strong></td>
<td>Cornus foemina, Salix discolor</td>
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<td></td>
<td><strong>Ground Layer</strong></td>
<td>Carex stricta, Onoclea sensibilis, Bidens cernuus</td>
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### Appendix 13. (cont.)

<table>
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<th>Site</th>
<th>Community Type</th>
<th>Structural Layer</th>
<th>Dominant Species</th>
<th>% Cover</th>
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<tbody>
<tr>
<td>Hillsdale County</td>
<td>southern wet meadow (C)</td>
<td>Overstory</td>
<td>Quercus bicolor</td>
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<td>EO .008</td>
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<td>Understory</td>
<td>Cornus foemina</td>
<td>30</td>
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<tr>
<td></td>
<td></td>
<td>Ground Layer</td>
<td>Carex lacustris&lt;br&gt;Thelypteris palustris&lt;br&gt;Glyceria striata&lt;br&gt;Solidago gigantea&lt;br&gt;Cinna arundinacea&lt;br&gt;Onoclea sensibilis&lt;br&gt;Iris virginica&lt;br&gt;Verbena hastata&lt;br&gt;Rubus sp.&lt;br&gt;Vitis riparia</td>
<td>90</td>
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<tr>
<td>Hillsdale County</td>
<td>southern wet meadow (D)</td>
<td>Overstory</td>
<td>Salix nigra</td>
<td>20</td>
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<tr>
<td>EO .008</td>
<td></td>
<td>Understory</td>
<td>Salix petiolaris&lt;br&gt;Cornus foemina</td>
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<tr>
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<td></td>
<td>Ground Layer</td>
<td>Carex sartwellii&lt;br&gt;Phalaris arundinacea&lt;br&gt;Aster lanceolatus&lt;br&gt;Bidens cernua&lt;br&gt;Lysimachia nummularia</td>
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</tr>
<tr>
<td>Hillsdale County</td>
<td>inundated shrub swamp</td>
<td>Overstory</td>
<td>Salix nigra&lt;br&gt;Ulmus americana</td>
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<td>Understory</td>
<td>Cephalanthus occidentalis</td>
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<td></td>
<td>Ground Layer</td>
<td>Lemna minor&lt;br&gt;Polygonum persicaria&lt;br&gt;Bidens cernua</td>
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<td>Hillsdale County</td>
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<td>Acer saccharum</td>
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<td>Fraxinus americana&lt;br&gt;Prunus serotina&lt;br&gt;Acer saccharum&lt;br&gt;Amelanchier sp.</td>
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<td>Ground Layer</td>
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### Appendix 13. (cont.)

<table>
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<th>Structural Layer</th>
<th>Dominant Species</th>
<th>% Cover</th>
</tr>
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<td>Fraxinus americana</td>
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<td>Acer saccharum</td>
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<td>Glyceria striata</td>
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**Appendix 13. (cont.)**

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<td>Sanicula gregaria</td>
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<td>Asarum canadensis</td>
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<td>Collinsonia canadensis</td>
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## Appendix 13. (cont.)

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Appendix 14. Invasive species present in the observed communities at each site.

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<td>Alliaria petiolata</td>
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<td>EO .013</td>
<td></td>
<td>Rosa multiflora</td>
<td>multiflora rose</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>Berberis thunbergii</td>
<td>Japanese barberry</td>
<td>Uncommon</td>
</tr>
<tr>
<td></td>
<td>southern wet meadow</td>
<td>Phalaris arundinacea</td>
<td>reed canary grass</td>
<td>Locally Dominant</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Elaeagnus umbellata</td>
<td>autumn olive</td>
<td>Locally Dominant</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rosa multiflora</td>
<td>multiflora rose</td>
<td>Occasional</td>
</tr>
<tr>
<td></td>
<td>dry-mesic southern forest</td>
<td>Elaeagnus umbellata</td>
<td>autumn olive</td>
<td>Abundant throughout</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rosa multiflora</td>
<td>multiflora rose</td>
<td>Occasional throughout</td>
</tr>
<tr>
<td>Site</td>
<td>Community</td>
<td>Scientific Name</td>
<td>Common Name</td>
<td>Estimated Abundance</td>
</tr>
<tr>
<td>---------------------</td>
<td>----------------------------------</td>
<td>-----------------</td>
<td>-------------------</td>
<td>-------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Hillsdale County</td>
<td>southern floodplain forest</td>
<td>Lythrum salicaria</td>
<td>purple loosestrife</td>
<td>Locally Common along stream</td>
</tr>
<tr>
<td>EO .004</td>
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<td>Lythrum salicaria</td>
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<td>Abundant throughout wetland</td>
</tr>
<tr>
<td></td>
<td>mesic southern forest</td>
<td>Lonicera morrowii</td>
<td>Morrow honeysuckle</td>
<td>Occasional</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Elaeagnus umbellata</td>
<td>autumn olive</td>
<td>Occasional</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rosa multiflora</td>
<td>multiflora rose</td>
<td>Occasional</td>
</tr>
<tr>
<td></td>
<td>pond</td>
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<td>purple loosestrife</td>
<td>Occasional along edge of pond</td>
</tr>
<tr>
<td>EO .008</td>
<td>southern wet meadow (A)</td>
<td>Lythrum salicaria</td>
<td>purple loosestrife</td>
<td>Occasional along creek near road</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Typha angustifolia</td>
<td>thin-leaved cattail</td>
<td>Locally Dominant</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Phalaris arundinacea</td>
<td>reed canary grass</td>
<td>Locally Dominant along creek near road</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lonicera morrowii</td>
<td>Morrow honeysuckle</td>
<td>Occasional</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Elaeagnus umbellata</td>
<td>autumn olive</td>
<td>Occasional</td>
</tr>
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<td></td>
<td></td>
<td>Rosa multiflora</td>
<td>multiflora rose</td>
<td>Occasional</td>
</tr>
<tr>
<td></td>
<td>southern wet meadow (B)</td>
<td>Lythrum salicaria</td>
<td>purple loosestrife</td>
<td>Occasional on northeast side of pond</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Daucus carota</td>
<td>Queen Ann's Lace</td>
<td>Locally Common along upland edges</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Phalaris arundinacea</td>
<td>reed canary grass</td>
<td>Uncommon along upland edges</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lotus corniculata</td>
<td>birdfoot trefoil</td>
<td>Locally Abundant</td>
</tr>
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<td></td>
<td></td>
<td>Lolium perenne</td>
<td>ryegrass</td>
<td>Dominant</td>
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<tr>
<td></td>
<td></td>
<td>Poa pratensis</td>
<td>Kentucky bluegrass</td>
<td>Dominant</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Alliaria petiolata</td>
<td>garlic mustard</td>
<td>Locally Abundant</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Alliaria petiolata</td>
<td>garlic mustard</td>
<td>Locally Abundant</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Solanum carolinense</td>
<td>horse nettle</td>
<td>Common</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Phalaris arundinacea</td>
<td>reed canary grass</td>
<td>Locally Dominant</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Alliaria petiolata</td>
<td>garlic mustard</td>
<td>Locally Dominant</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Alliaria petiolata</td>
<td>garlic mustard</td>
<td>Locally Dominant</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lythrum salicaria</td>
<td>purple loosestrife</td>
<td>Occasional near pond</td>
</tr>
<tr>
<td></td>
<td></td>
<td>none observed</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Phalaris arundinacea</td>
<td>reed canary grass</td>
<td>Locally Dominant</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lysimachia nummularia</td>
<td>moneywort</td>
<td>Locally Abundant</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Solanum carolinense</td>
<td>horse nettle</td>
<td>Common</td>
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<tr>
<td></td>
<td></td>
<td>Alliaria petiolata</td>
<td>garlic mustard</td>
<td>Locally Abundant</td>
</tr>
<tr>
<td></td>
<td></td>
<td>none observed</td>
<td></td>
<td></td>
</tr>
<tr>
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<td></td>
<td>Alliaria petiolata</td>
<td>garlic mustard</td>
<td>Locally Dominant</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lythrum salicaria</td>
<td>purple loosestrife</td>
<td>Occasional along road on the south side of the creek</td>
</tr>
<tr>
<td></td>
<td></td>
<td>none observed</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Alliaria petiolata</td>
<td>garlic mustard</td>
<td>Locally Dominant</td>
</tr>
</tbody>
</table>

*Appendix 14. (cont.)*
## Appendix 14. (cont.)

<table>
<thead>
<tr>
<th>Site</th>
<th>Community</th>
<th>Scientific Name</th>
<th>Common Name</th>
<th>Estimated Abundance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hillsdale County</td>
<td>emergent marsh (A)</td>
<td>Lythrum salicaria</td>
<td>purple loosestrife</td>
<td>Abundant</td>
</tr>
<tr>
<td>EO .005</td>
<td>emergent marsh (B)</td>
<td>Lythrum salicaria</td>
<td>purple loosestrife</td>
<td>Dominant</td>
</tr>
<tr>
<td></td>
<td>mesic southern forest (A)</td>
<td>Typha angustifolia</td>
<td>narrow-leaved cattail</td>
<td>Locally Dominant</td>
</tr>
<tr>
<td></td>
<td>mesic southern forest (B)</td>
<td>none observed</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>dry-mesic southern forest</td>
<td>Lonicera morrowii</td>
<td>Morrow honeysuckle</td>
<td>Uncommon along edge of camping area</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Alliaria petiolata</td>
<td>garlic mustard</td>
<td>Uncommon along edge of camping area</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Arctium minus</td>
<td>common burdock</td>
<td>Uncommon along edge of camping area</td>
</tr>
<tr>
<td>Branch County</td>
<td>southern floodplain forest</td>
<td>none observed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EO .012</td>
<td>inundated shrub swamp (A)</td>
<td>Solanum dulcamara</td>
<td>bittersweet nightshade</td>
<td>Occasional</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lysimachia nummularia</td>
<td>moneywort</td>
<td>Occasional</td>
</tr>
<tr>
<td></td>
<td>inundated shrub swamp (B)</td>
<td>Solanum dulcamara</td>
<td>bittersweet nightshade</td>
<td>Occasional</td>
</tr>
<tr>
<td>Williams County-Ohio</td>
<td>inundated shrub swamp</td>
<td>none observed</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>southern floodplain forest</td>
<td>none observed</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>mesic southern forest (A)</td>
<td>Alliaria petiolata</td>
<td>garlic mustard</td>
<td>Common on upland slope</td>
</tr>
<tr>
<td></td>
<td>mesic southern forest (B)</td>
<td>Glechoma hederacea</td>
<td>ground ivy</td>
<td>Uncommon near slope leading to stream</td>
</tr>
<tr>
<td></td>
<td>southern swamp</td>
<td>Alliaria petiolata</td>
<td>garlic mustard</td>
<td>Occasional in ravine bottom</td>
</tr>
<tr>
<td>Hillsdale County</td>
<td>pond (A)</td>
<td>Lythrum salicaria</td>
<td>purple loosestrife</td>
<td>Abundant on edge of pond</td>
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<tr>
<td>EO .010</td>
<td></td>
<td>Rosa multiflora</td>
<td>multiflora rose</td>
<td>Abundant along pond edge and road</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Elaeagnus umbellata</td>
<td>autumn olive</td>
<td>Common along road</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Festuca sp.</td>
<td>Fescue</td>
<td>Locally Dominant</td>
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<tr>
<td></td>
<td></td>
<td>Exotic Pine</td>
<td>Exotic Pine</td>
<td>n/a</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Clover</td>
<td>Clover</td>
<td>n/a</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Melilotus officinalis</td>
<td>yellow sweet-clover</td>
<td>n/a</td>
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</tbody>
</table>
### Appendix 14. (cont.)

<table>
<thead>
<tr>
<th>Site</th>
<th>Community</th>
<th>Scientific Name</th>
<th>Common Name</th>
<th>Estimated Abundance</th>
</tr>
</thead>
<tbody>
<tr>
<td>savory floodplain forest (A)</td>
<td>none observed</td>
<td>Alliaria petiolata</td>
<td>garlic mustard</td>
<td>Locally Abundant along road near bridge</td>
</tr>
<tr>
<td>savory floodplain forest (B)</td>
<td>none observed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>inundated shrub swamp (A)</td>
<td>Solanum dulcamara</td>
<td>bittersweet nightshade</td>
<td>Common</td>
<td></td>
</tr>
<tr>
<td>inundated shrub swamp (B)</td>
<td>Phalaris arundinacea</td>
<td>reed canary grass</td>
<td>Local along water's edge</td>
<td></td>
</tr>
<tr>
<td>inundated shrub swamp (C)</td>
<td>Phalaris arundinacea</td>
<td>reed canary grass</td>
<td>Locally Dominant and Common along water's edge</td>
<td></td>
</tr>
<tr>
<td>inundated shrub swamp (D)</td>
<td>Rosa multiflora</td>
<td>multiflora rose</td>
<td>Locally Dominant along old field edge</td>
<td></td>
</tr>
<tr>
<td>inundated shrub swamp (E)</td>
<td>Elaeagnus umbellata</td>
<td>autumn olive</td>
<td>Occasional along old field edge</td>
<td>n/a</td>
</tr>
<tr>
<td>mesic southern forest</td>
<td>Elaeagnus umbellata</td>
<td>autumn olive</td>
<td>Abundant</td>
<td></td>
</tr>
<tr>
<td>pasture</td>
<td>Daucus carota</td>
<td>Queen Anne's lace</td>
<td>Abundant</td>
<td></td>
</tr>
<tr>
<td>old field</td>
<td>Prunella vulgaris</td>
<td>lawn prunella</td>
<td>Common</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cirsium vulgare</td>
<td>bull thistle</td>
<td>Occasional</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Phalaris arundinacea</td>
<td>reed canary grass</td>
<td>Locally Dominant near creek/ditch on north side</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lythrum salicaria</td>
<td>purple loosestrife</td>
<td>Uncommon on edge of field near road</td>
<td></td>
</tr>
<tr>
<td>Site</td>
<td>Community</td>
<td>Scientific Name</td>
<td>Common Name</td>
<td>Estimated Abundance</td>
</tr>
<tr>
<td>--------------</td>
<td>--------------------</td>
<td>----------------------------</td>
<td>------------------</td>
<td>----------------------------------------------------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Elaeagnus umbellata</td>
<td>autumn olive</td>
<td>Occasional scattered mostly &lt;2 m tall</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dipsacus laciniatus</td>
<td>cut-leaved teasel</td>
<td>Locally Abundant scattered in northern portion</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Melilotus officinalis</td>
<td>yellow sweet-clover</td>
<td>Locally Dominant throughout</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Melilotus alba</td>
<td>white sweet-clover</td>
<td>Occasional throughout</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rosa multiflora</td>
<td>multiflora rose</td>
<td>Uncommon scattered</td>
</tr>
<tr>
<td></td>
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<td>Chrysanthemum leucanthemum</td>
<td>ox-eye daisy</td>
<td>n/a</td>
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<td></td>
<td>Daucus carota</td>
<td>Queen Ann's Lace</td>
<td>n/a</td>
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<td>Dianthus armeria</td>
<td>deptford pink</td>
<td>n/a</td>
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<td>Hieracium caespitosum</td>
<td>king-devil</td>
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<td>Phleum pratense</td>
<td>timothy</td>
<td>n/a</td>
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<td>Poa pratensis</td>
<td>Kentucky bluegrass</td>
<td>n/a</td>
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<td>Potentilla recta</td>
<td>rough-fruited cinquefoil</td>
<td>n/a</td>
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<tr>
<td></td>
<td></td>
<td>Trifolium hybridum</td>
<td>alsike clover</td>
<td>n/a</td>
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<tr>
<td></td>
<td></td>
<td>Trifolium pratense</td>
<td>red clover</td>
<td>n/a</td>
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</table>
Appendix 15. Soil descriptions of the observed communities at each site.

<table>
<thead>
<tr>
<th>Site</th>
<th>Community Type</th>
<th>Soil Type(s)</th>
<th>Soil Description</th>
<th>Soil pH</th>
<th>Litter Depth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cass-St. Joseph County EO .002</td>
<td>inundated shrub swamp (A)</td>
<td>Organic</td>
<td>black muck to 4 inches; brown highly decomposed peat (hemic peat) with sedge pieces to 3.5 ft with woody debris at 3 ft on edges of wetland: thin layer of muck over gleyed clay and coarse-textured, sandy, gleyed clay</td>
<td>5.5</td>
<td>soil surface covered with water</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mineral</td>
<td></td>
<td>6.5 (muck); 7.0 (gleyed clay)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>7.0</td>
<td>soil surface covered with water</td>
</tr>
<tr>
<td></td>
<td>inundated shrub swamp (B)</td>
<td></td>
<td>shrub swamp: thin layer of coarse-textured sand and organic matter, over gray, brown, and black mottled clay to 10 inches. Deeper soil horizons consist of coarse-texture gleyed sandy clay to 18 inches, black, iron-mottled clay to 22 inches; and gleyed, sandy, silty clay to 28 inches</td>
<td>7.0</td>
<td>soil surface covered with water</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>inundated shrub swamp (C)</td>
<td>Organic over</td>
<td>1 ft of muck over 4 inches of tan colored silt; over fine- to medium-tetured gleyed sandy clay</td>
<td>5.5-6.0</td>
<td>soil surface covered with water</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mineral</td>
<td></td>
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<td></td>
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</tr>
<tr>
<td></td>
<td>inundated shrub swamp (D)</td>
<td>Organic</td>
<td>muck soils to 2 ft over medium- to fine-textured sand mixed with organic matter, small pebbles, and chert. Silt and fine sand at occur 3.5 ft</td>
<td>5.5-7.0</td>
<td>soil surface covered with water</td>
</tr>
<tr>
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<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mineral</td>
<td>&lt; 1 inch of muck over gleyed silt to 6 inches, then gleyed clay</td>
<td>5.5-7.0</td>
<td>soil surface covered with water</td>
</tr>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>pond</td>
<td>n/a</td>
<td>n/a</td>
<td>5.5</td>
<td>soil surface covered with water</td>
</tr>
</tbody>
</table>
### Appendix 15. (cont.)

<table>
<thead>
<tr>
<th>Site</th>
<th>Community Type</th>
<th>Soil Type(s)</th>
<th>Soil Description</th>
<th>Soil pH</th>
<th>Litter Depth</th>
</tr>
</thead>
<tbody>
<tr>
<td>mesic southern forest</td>
<td>Mineral</td>
<td>sandy loam A horizon to 6 inches; over a dry clay layer with iron-colored mottling</td>
<td>7.0</td>
<td>0-1 inch</td>
<td></td>
</tr>
<tr>
<td>007</td>
<td>Hillsdale County</td>
<td>southern floodplain forest</td>
<td>Mineral</td>
<td>sandy clay loam to 1.5 ft; over iron mottled sandy clay loam to 3 ft; over medium textured, gleyed sandy clay loam with iron mottling</td>
<td>6.5</td>
</tr>
<tr>
<td>013</td>
<td>Calhoun County</td>
<td>southern floodplain forest</td>
<td>Mineral</td>
<td>6 inches of sandy loam; over iron mottled sandy loam to 18 inches; over iron mottled sandy clay loam to 26 inches; over gleyed sandy clay loam with iron mottling to 30 inches; over gleyed silt to 3 ft; over very wet gleyed sandy, silty, clay to 3.5 ft</td>
<td>7.0</td>
</tr>
<tr>
<td>013</td>
<td>southern wet meadow</td>
<td>Mineral</td>
<td>iron mottled sandy clay to 1 ft; over gleyed sandy clay mixed with small pebbles</td>
<td>8.0</td>
<td>soil surface covered with water</td>
</tr>
<tr>
<td>013</td>
<td>dry-mesic southern forest</td>
<td>Mineral</td>
<td>in vernal pool (dry): 6 inches black sandy loam; over 6 inches slightly gleyed sandy clay loam with iron mottling; over gleyed sandy clay with iron mottling. Near edge of vernal pond: 6 inches brown sandy loam; over 6 inches light brown sandy loam (E horizon); over 6 inches sandy clay loam with iron mottling; over sandy clay. Further up slope from vernal pool: brown-colored sandy loam to 18 inches; over finer textured tan-colored sand (E horizon)</td>
<td>6.0</td>
<td>0-1 inch</td>
</tr>
</tbody>
</table>
### Appendix 15. (cont.)

<table>
<thead>
<tr>
<th>Site</th>
<th>Community Type</th>
<th>Soil Type(s)</th>
<th>Soil Description</th>
<th>Soil pH</th>
<th>Litter Depth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hillsdale County</td>
<td>southern floodplain forest</td>
<td>Mineral</td>
<td>sandy loam to 6 inches; iron mottled sandy loam with gleyed concretions to 12 inches; iron mottled sandy clay to 20 inches; gleyed sandy clay to 2 ft; gleyed coarse-textured sandy clay loam to 3 ft; gleyed silty coarse-textured sand with many pebbles to 3.5 ft</td>
<td>7.0-7.5</td>
<td>0-1 inch</td>
</tr>
<tr>
<td>Hillsdale County</td>
<td>southern wet meadow</td>
<td>Mineral</td>
<td>4 inches of muck; over iron mottled, slightly gleyed clay to 1 ft; over gleyed clay mixed with roots and organic matter to 1.5 ft; over coarse- to medium-textured sandy clay to 2.5 ft; over gravely, gleyed coarse-textured sandy clay to 3.5 ft</td>
<td>8.0</td>
<td>soil surface covered with water</td>
</tr>
<tr>
<td>Hillsdale County</td>
<td>mesic southern forest</td>
<td>Mineral</td>
<td>sandy clay loam with large peds to 6 inches; over sandy clay loam to 12 inches; clay content and iron mottling increase with depth</td>
<td>7.0</td>
<td>0-1 inch</td>
</tr>
<tr>
<td>Hillsdale County</td>
<td>pond</td>
<td>Mineral</td>
<td>clay</td>
<td>8.0</td>
<td>soil surface covered with water</td>
</tr>
<tr>
<td>Hillsdale County</td>
<td>southern wet meadow (A)</td>
<td>Mineral</td>
<td>clay</td>
<td>8.0</td>
<td>2 inches</td>
</tr>
<tr>
<td>Hillsdale County</td>
<td>southern wet meadow (B)</td>
<td>Mineral</td>
<td>loam over sandy gleyed clay</td>
<td>8.0</td>
<td>4 inches</td>
</tr>
<tr>
<td>Hillsdale County</td>
<td>southern wet meadow (C)</td>
<td>Mineral</td>
<td>sandy clay loam over gleyed sandy clay</td>
<td>8.0</td>
<td>1-2 inches</td>
</tr>
<tr>
<td>Hillsdale County</td>
<td>southern wet meadow (D)</td>
<td>Mineral</td>
<td>1.5 inches of muck over gleyed clay</td>
<td>8.0</td>
<td>soil surface covered with water</td>
</tr>
<tr>
<td>Site</td>
<td>Community Type</td>
<td>Soil Type(s)</td>
<td>Soil Description</td>
<td>Soil pH</td>
<td>Litter Depth</td>
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<td>-----------------------------</td>
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<td>------------------------------------------------------------------------------------------------------</td>
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</tr>
<tr>
<td></td>
<td>inundated shrub swamp</td>
<td>Organic over</td>
<td>6 to 10 inches of muck over gleyed clay</td>
<td>6.5-7.0</td>
<td>soil surface covered with water</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mineral</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>mesic southern forest (A)</td>
<td>Mineral</td>
<td>near edge of pond: loamy sand with strong iron mottling to 2 ft; over slightly gleyed wet, sandy clay to 3.5 ft. Further inland from pond: sandy loam to 2 ft; over iron mottled sandy loam to 2.5 ft; over gleyed sandy clay loam to 3.5 ft</td>
<td>5.0-5.5</td>
<td>0-1 inch</td>
</tr>
<tr>
<td></td>
<td>mesic southern forest (B)</td>
<td>Mineral</td>
<td>loamy sand over gleyed clay</td>
<td>7.0</td>
<td>0-1 inch</td>
</tr>
<tr>
<td></td>
<td>mesic southern forest (C)</td>
<td>Mineral</td>
<td>six inches of sandy clay loam/sandy clay over sandy clay with iron mottling and gleyed pockets</td>
<td>7.0</td>
<td>n/a</td>
</tr>
<tr>
<td></td>
<td>southern floodplain forest</td>
<td>Mineral</td>
<td>sandy clay with varying amounts of sand and iron mottling. Sand increases and decreases with depth</td>
<td>7.0</td>
<td>n/a</td>
</tr>
<tr>
<td>Hillsdale County</td>
<td>emergent marsh (A)</td>
<td>Mineral</td>
<td>gleyed clay</td>
<td>8.0</td>
<td>soil surface covered with water</td>
</tr>
<tr>
<td>EO .005</td>
<td>emergent marsh (B)</td>
<td>Mineral</td>
<td>clay</td>
<td>8.0</td>
<td>soil surface covered with water</td>
</tr>
<tr>
<td></td>
<td>mesic southern forest (A)</td>
<td>Mineral</td>
<td>clay loam</td>
<td>5.5</td>
<td>0-1 inch</td>
</tr>
<tr>
<td></td>
<td>mesic southern forest (B)</td>
<td>Mineral</td>
<td>clay loam</td>
<td>8.0</td>
<td>0-1 inch</td>
</tr>
<tr>
<td></td>
<td>dry-mesic southern forest</td>
<td>Mineral</td>
<td>clay loam</td>
<td>6.0</td>
<td>0-1 inch</td>
</tr>
<tr>
<td>Site</td>
<td>Community Type</td>
<td>Soil Type(s)</td>
<td>Soil Description</td>
<td>Soil pH</td>
<td>Litter Depth</td>
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</tr>
<tr>
<td>Branch County EO .012</td>
<td>southern floodplain forest</td>
<td>Organic</td>
<td>8 inches of muck mixed with sand over gleyed, coarse-textured silty sand to 3.5 ft</td>
<td>7.0</td>
<td>0-1 inch</td>
</tr>
<tr>
<td></td>
<td>(A) inundated shrub swamp</td>
<td>Mineral</td>
<td>4 inch root mat; over organic deposits (muck) mixed with clay to 2 ft; over mucky peat (hemic peat) with sedge pieces to 2.5 ft; over mucky peat with sedge pieces, and woody debris to 33 inches; coarse textured-sand to 3.5 ft</td>
<td>6.0</td>
<td>0-1 inch</td>
</tr>
<tr>
<td>Williams County-Ohio</td>
<td>inundated shrub swamp</td>
<td>Organic</td>
<td>10 inches of highly decomposed muck (sapric peat) containing easily crushed, gleyed silt nodules; over mucky peat (hemic peat) to 1.5 ft; mucky peat continuing throughout profile mixed with woody debris and roots to 2 ft; mucky peat with sedge pieces, woody debris, and silt deposits to 3.5 ft</td>
<td>6.0</td>
<td>0-1 inch</td>
</tr>
<tr>
<td></td>
<td>(B) inundated shrub swamp</td>
<td>Mineral</td>
<td>1 ft of iron mottled clay over gleyed clay with iron concretions</td>
<td>6.0</td>
<td>0-1 inch</td>
</tr>
<tr>
<td></td>
<td>southern floodplain forest</td>
<td>Mineral</td>
<td>6 inches of iron mottled loam over clay loam to 2 ft</td>
<td>7.0</td>
<td>0-1 inch</td>
</tr>
<tr>
<td></td>
<td>mesic southern forest (A)</td>
<td>Mineral</td>
<td>6 inches of clay loam over rock (probably large glacial erratic in area of soil probe)</td>
<td>6.0</td>
<td>0-1 inch</td>
</tr>
<tr>
<td></td>
<td>mesic southern forest (B)</td>
<td>Mineral</td>
<td>black loam to 4 inches; over blackish sandy clay to 12 inches; over B horizon (pH 7.5) with iron mottling and concretion to 24 inches</td>
<td>7.0</td>
<td>0-1 inch</td>
</tr>
<tr>
<td>Site</td>
<td>Community Type</td>
<td>Soil Type(s)</td>
<td>Soil Description</td>
<td>Soil pH</td>
<td>Litter Depth</td>
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</tr>
<tr>
<td>southern swamp</td>
<td>Mineral</td>
<td>loam (pH 7.2-7.5) to 2 inches; over dark iron-colored clay to 8-12 inches; over gleyed/gray clay matrix with iron mottling to 18-20 inches; over gray sandy clay with iron mottling</td>
<td>7.8</td>
<td>0-1 inch</td>
<td></td>
</tr>
<tr>
<td>Hillsdale County EO .010</td>
<td>pond (A)</td>
<td>Organic</td>
<td>6 inches of muck; over gleyed clayey silt mixed with fine gravel and coarse textured sand (probably runoff from road) to 12 inches; over gleyed clayey silt to 1.5 ft; over gleyed clayey silt mixed with muck to 3 ft; over mucky peat with woody debris, a thin layer of gleyed clayey silt, and then more muck to 3.5 ft</td>
<td>7.0</td>
<td>soil surface covered with water</td>
</tr>
<tr>
<td></td>
<td>pond (B)</td>
<td>Mineral</td>
<td>gleyed clay with very little iron mottling at 2 feet into pond</td>
<td>7.0</td>
<td>n/a</td>
</tr>
<tr>
<td>southern floodplain forest (A)</td>
<td>Mineral</td>
<td>6 inches of sandy clay loam with little mottling; over iron-mottled sandy clay loam (clay content increasing with depth) to 1 ft; over slightly gleyed, iron-mottled clay to 1.5 ft; over gleyed iron-mottled clay to 2 ft; over gleyed sandy loam with iron mottling to 2.5 ft; over gleyed sandy clay loam and then gleyed clay to 3 ft</td>
<td>7.0</td>
<td>0-1 inch</td>
<td></td>
</tr>
<tr>
<td>southern floodplain forest (B)</td>
<td>Mineral</td>
<td>0-1 inch of organic matter, leaves, and debris; over 6-12 inches of gray clay with iron mottling and easily crushed iron nodules</td>
<td>n/a</td>
<td>0-1 inch</td>
<td></td>
</tr>
<tr>
<td>inundated shrub swamp (A)</td>
<td>Mineral</td>
<td>4 inch root mat; over 4 inches of iron-mottled gleyed clay to 2 ft; over gleyed silt to 2.5 ft; over gleyed coarse-textured, clayey silt to 3 ft; over gleyed clayey silt with small woody debris to 3.5 ft</td>
<td>7.0</td>
<td>0-1 inch</td>
<td></td>
</tr>
<tr>
<td>Site</td>
<td>Community Type</td>
<td>Soil Type(s)</td>
<td>Soil Description</td>
<td>Soil pH</td>
<td>Litter Depth</td>
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<td>--------------</td>
</tr>
<tr>
<td>inundated shrub swamp</td>
<td>Mineral</td>
<td>gleyed clay with roots</td>
<td>7.0</td>
<td>1 inch fibric root mat with a lot of CWD</td>
<td></td>
</tr>
<tr>
<td>(B)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>inundated shrub swamp</td>
<td>Organic over Mineral</td>
<td>2 inches of black sapric muck; over a hemic root mat with sapric muck and clay mixed up to 3 inches; over dark gray clay with iron mottling</td>
<td>7.0</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>(C)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>inundated shrub swamp</td>
<td>Mineral</td>
<td>6 inches of sandy clay; over purplish clay mixed with woody debris</td>
<td>7.0+</td>
<td>0-1 inch of leaves</td>
<td></td>
</tr>
<tr>
<td>(D)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>inundated shrub swamp</td>
<td>Mineral</td>
<td>thin organic matter layer over dark clay within two inches; clay becomes lighter in color with depth (gray) with iron mottling and organic streaks</td>
<td>7.0</td>
<td>0-1 inch of leaves</td>
<td></td>
</tr>
<tr>
<td>(E)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>mesic southern forest</td>
<td>Mineral</td>
<td>8 inches of clay loam; over sandy clay with mottling</td>
<td>7.0</td>
<td>0-1 inch</td>
<td></td>
</tr>
<tr>
<td>pasture</td>
<td>Mineral</td>
<td>6 inches of sandy clay loam; over clay loam to 12 inches; over iron-mottled clay</td>
<td>7.0</td>
<td>0-1 inch</td>
<td></td>
</tr>
<tr>
<td>old field</td>
<td>Mineral</td>
<td>10 inches of sandy clay loam; over reddish brown clay with iron mottling</td>
<td>7.0</td>
<td>0-1 inch</td>
<td></td>
</tr>
</tbody>
</table>
Appendix 16. Landscape context and natural community ranks.

<table>
<thead>
<tr>
<th>Site</th>
<th>Community Type</th>
<th>Landscape Context Rank</th>
<th>Natural Community Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cass-St. Joseph County</td>
<td>inundated shrub swamp (A)</td>
<td>Medium adjacent to gravel road, ag field, wetland, and mesic forest; surrounding landscape is ag and rural residential</td>
<td>Medium moderate size, good diversity</td>
</tr>
<tr>
<td>EO .002</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>inundated shrub swamp</td>
<td>(B)</td>
<td>Medium adjacent to gravel road, driveway, wetland, and mesic forest; surrounding landscape is ag and rural residential</td>
<td>Low small size, low diversity</td>
</tr>
<tr>
<td>inundated shrub swamp</td>
<td>(C)</td>
<td>Medium adjacent to gravel road, old field, and small swamp forest; surrounding landscape is ag and rural residential</td>
<td>Medium moderate size, good diversity</td>
</tr>
<tr>
<td>inundated shrub swamp</td>
<td>(D)</td>
<td>Medium bordered by ag, wetland, and mesic forest, surrounding landscape is ag and rural residential</td>
<td>Medium large size, high diversity, invasive plants dominate portion of community near ag field</td>
</tr>
<tr>
<td>pond</td>
<td></td>
<td>Medium adjacent to old field and swamp forest; surrounding landscape is ag and rural residential</td>
<td>Medium large size, pond edges contains a narrow perimeter of shrub swamp with low diversity, presence of invasive species</td>
</tr>
<tr>
<td>mesic southern forest</td>
<td></td>
<td>Medium adjacent to Wood Lake to the north, a buttonbush inundated shrub swamp to the south, and an old field to the east; surrounding landscape is ag</td>
<td>Medium large CWD and snags; well-developed pit and mound topography; good plant diversity; presence of groundwater seepage at base of forested slopes; high grading in the past; gravel two-track cuts through forest; trash present</td>
</tr>
<tr>
<td>Site</td>
<td>Community Type</td>
<td>Landscape Context Rank</td>
<td>Natural Community Rank</td>
</tr>
<tr>
<td>---------------------</td>
<td>---------------------------</td>
<td>--------------------------------------------------------</td>
<td>----------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Hillsdale County</td>
<td>southern floodplain forest</td>
<td>Low</td>
<td>Medium high species diversity but very narrow floodplain, impacted by ORV trail, presence of invasive species and old trash pile</td>
</tr>
<tr>
<td>EO .007</td>
<td></td>
<td>dissected by river; surrounding landscape is ag and rural residential</td>
<td></td>
</tr>
<tr>
<td>Calhoun County</td>
<td>southern floodplain forest</td>
<td>Medium</td>
<td>Medium narrow floodplain, presences of invasive plants</td>
</tr>
<tr>
<td>EO .013</td>
<td></td>
<td>adjacent to dam and gravel drive, dissected by small creek, surrounding landscape is ag and rural residential</td>
<td></td>
</tr>
<tr>
<td></td>
<td>southern wet meadow</td>
<td>Low</td>
<td>Low very small and narrow band of wet meadow at edge impoundment, invasive plants abundant</td>
</tr>
<tr>
<td></td>
<td></td>
<td>adjacent to dam, lawn, and gravel drive, surrounding landscape is ag and rural residential</td>
<td></td>
</tr>
<tr>
<td>dry-mesic southern forest</td>
<td>Medium</td>
<td>bordered by floodplain forest, impoundment, and old field; surrounding landscape is ag and rural residential</td>
<td>Low small size, low diversity, highly disturbed, dissected by gravel roads and trails, presence of invasive plants</td>
</tr>
<tr>
<td>Hillsdale County</td>
<td>southern floodplain forest</td>
<td>Medium</td>
<td>Low small, narrow, early successional floodplain forest, low diversity, poor structure, presence of invasive plants</td>
</tr>
<tr>
<td>EO .004</td>
<td></td>
<td>adjacent to gravel road, house, and early successional mesic forest; surrounding landscape is ag and rural residential</td>
<td></td>
</tr>
<tr>
<td></td>
<td>southern wet meadow</td>
<td>Medium</td>
<td>Low moderate size, shrub encroachment is causing conversion to shrub-carr, presence of invasive plants</td>
</tr>
<tr>
<td></td>
<td></td>
<td>adjacent to gravel road and floodplain forest, surrounding landscape is ag and rural residential</td>
<td></td>
</tr>
</tbody>
</table>
## Appendix 16. (cont.)

<table>
<thead>
<tr>
<th>Site</th>
<th>Community Type</th>
<th>Landscape Context Rank</th>
<th>Natural Community Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>mesic southern forest</td>
<td>Medium</td>
<td>Low</td>
<td>low diversity, early successional forest, presence of invasive plants</td>
</tr>
<tr>
<td>adjacent to gravel road, house, and floodplain forest; surrounding landscape is ag and rural residential</td>
<td>Adam County pond</td>
<td>Low</td>
<td>man-made, stocked with large-mouth bass, invasive plants along pond margin</td>
</tr>
<tr>
<td>Hillsdale County EO 008</td>
<td>Low</td>
<td>Low</td>
<td>very small (1 acre), low diversity, grazed, highly disturbed, many invasive plants</td>
</tr>
<tr>
<td>southern wet meadow (A)</td>
<td>Low</td>
<td>Low</td>
<td>very small, fair diversity, shrub encroachment, invasive species locally abundant</td>
</tr>
<tr>
<td>adjacent to house, gravel road, cattle milkhouse, walkway, and holding area; surrounding landscape is ag and rural residential</td>
<td>southern wet meadow (B)</td>
<td>Low</td>
<td>very small, cut stumps occur within wet meadow</td>
</tr>
<tr>
<td>adjacent to man-made pond, Christmas tree plantation, degraded wet meadow, and small block of mesic southern forest; surrounding landscape is ag and rural residential</td>
<td>southern wet meadow (C)</td>
<td>Medium</td>
<td>Low</td>
</tr>
<tr>
<td>occurs within mesic forest, near edge, which borders a pasture</td>
<td>southern wet meadow (D)</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>adjacent to mowed lawn, gravel driveway and road</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Site</td>
<td>Community Type</td>
<td>Landscape Context Rank</td>
<td>Natural Community Rank</td>
</tr>
<tr>
<td>----------------------</td>
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<td>------------------------</td>
<td>----------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td></td>
<td>inundated shrub swamp</td>
<td>Medium</td>
<td>Medium small shrub swamp but in good condition</td>
</tr>
<tr>
<td></td>
<td>mesic southern forest (A)</td>
<td>Low</td>
<td>Low very small and invasive plants are present</td>
</tr>
<tr>
<td></td>
<td>mesic southern forest (B)</td>
<td>Low</td>
<td>Low fair ground layer diversity but has been logged in recent past</td>
</tr>
<tr>
<td></td>
<td>mesic southern forest (C)</td>
<td>Medium</td>
<td>Medium good species diversity and various size classes are present; large diameter trees have been removed and large CWD is lacking; soil erosion associated with abandoned animal burrows and steep slopes; forest is highly dissected by steep-sided tributary channels</td>
</tr>
<tr>
<td></td>
<td>southern floodplain forest</td>
<td>Medium</td>
<td>Medium good species diversity, zonation, and heterogeneity; diverse tree size classes; hydrologic processes intact with natural stream meandering and groundwater seepage; evidence of past logging</td>
</tr>
<tr>
<td>Hillsdale County</td>
<td>emergent marsh (A)</td>
<td>Low</td>
<td>Low consists of thin (1 to 3 m wide) band of purple loosestrife and cattail along margin of man-made lake.</td>
</tr>
<tr>
<td>Site</td>
<td>Community Type</td>
<td>Landscape Context Rank</td>
<td>Natural Community Rank</td>
</tr>
<tr>
<td>---------------------</td>
<td>------------------------------------</td>
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<td>---------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>emergent marsh (B)</td>
<td>Low</td>
<td>Low</td>
<td>small, narrow (10 m wide) band of marsh, highly infested by invasive plants</td>
</tr>
<tr>
<td></td>
<td>surrounded by mowed two-track and</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>adjacent to man-made lake</td>
<td></td>
<td></td>
</tr>
<tr>
<td>mesic southern forest (A)</td>
<td>Low</td>
<td></td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>surrounded by rural residential,</td>
<td></td>
<td>paths, two-track roads, and out buildings occur throughout forest</td>
</tr>
<tr>
<td></td>
<td>pasture, and old field</td>
<td></td>
<td></td>
</tr>
<tr>
<td>mesic southern forest (B)</td>
<td>Medium</td>
<td></td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>borders river and pond, residential boy scout cabins, and old field</td>
<td></td>
<td>young forest, selectively logged, good plant diversity</td>
</tr>
<tr>
<td>dry-mesic southern forest</td>
<td>Low</td>
<td></td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>bordered by man-made lake, lawn, and old fields</td>
<td></td>
<td>small size, several invasives, selectively logged, and frequently disturbed</td>
</tr>
<tr>
<td>Branch County</td>
<td>Branch County EO .012</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>southern floodplain forest</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>dissected by creek, surrounded by ag and rural residential</td>
<td></td>
<td>large size, good habitat heterogeneity, recently selectively cut, logging roads and staging areas</td>
</tr>
<tr>
<td>inundated shrub swamp (A)</td>
<td>Medium</td>
<td></td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>occurs within floodplain, adjacent to shrub swamp and reed canary grass meadow, surrounded by rural residential and ag fields</td>
<td></td>
<td>very small, fair diversity, invasive species locally dominant</td>
</tr>
<tr>
<td>inundated shrub swamp (B)</td>
<td>Medium</td>
<td></td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>occurs within floodplain, adjacent to floodplain forest and reed canary grass meadow, surrounded by rural residential and ag fields</td>
<td></td>
<td>good size but low plant diversity</td>
</tr>
</tbody>
</table>
### Site Community Type Landscape Context Rank Natural Community Rank

<table>
<thead>
<tr>
<th>Site</th>
<th>Community Type</th>
<th>Landscape Context Rank</th>
<th>Natural Community Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Williams County-Ohio</td>
<td>inundated shrub swamp</td>
<td>Medium</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td></td>
<td>occurs near edge of upland forest that borders old fields and a pond</td>
<td>very small, no invasives observed</td>
</tr>
<tr>
<td>southern floodplain forest</td>
<td>Medium</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td></td>
<td>occurs near edge of upland forest that borders old fields</td>
<td>small, narrow ravine with intermittent stream, dominant trees are reproducing, no invasive plants observed</td>
</tr>
<tr>
<td>mesic southern forest (A)</td>
<td>Medium</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td></td>
<td>surrounded by old fields, ponds, and rural residential</td>
<td>good species diversity in overstory and understory, no invasive plants observed</td>
</tr>
<tr>
<td>mesic southern forest (B)</td>
<td>Low</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td></td>
<td>narrow ecosystem extending 40 m from both sides of the creek; surrounded by ag</td>
<td>young stand with service road running through; invasives like garlic mustard are present</td>
</tr>
<tr>
<td>southern swamp</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td></td>
<td>bordered by an old field to the south and east and by a road to the north; overall landscape is ag</td>
<td>retains large, moss-covered CWD and natural headwater stream channel; narrow, trash, and garlic mustard</td>
</tr>
<tr>
<td>Hillsdale County EO .010</td>
<td>pond (A)</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td></td>
<td>bordered by gravel two-track and early successional floodplain forest, surrounding landscape is ag and rural residential</td>
<td>invasive plants along pond margins, good size, road construction may have altered shape and depth of wetland and created a dam, thus contributing to year-round flooding</td>
</tr>
<tr>
<td></td>
<td>pond (B)</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td></td>
<td>pond with 0.5 m band of wet meadow and scattered shrubs; mowed lawn surrounds the pond</td>
<td>this is a man-made pond with an earthen dam and drainage pipe; pond treated with herbicide</td>
</tr>
<tr>
<td>Site</td>
<td>Community Type</td>
<td>Landscape Context Rank</td>
<td>Natural Community Rank</td>
</tr>
<tr>
<td>------</td>
<td>---------------------------------</td>
<td>------------------------</td>
<td>------------------------</td>
</tr>
<tr>
<td></td>
<td><strong>southern floodplain forest (A)</strong></td>
<td>Medium</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>bordered by pasture, old field, gravel road, pine plantation, and shrub swamp/pond, dissected by stream, surrounding landscape is ag and rural residential</td>
<td>early successional, low overstory diversity</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>southern floodplain forest (B)</strong></td>
<td>High</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>5+ acres that borders Clear Fork, mesic forests, and buttonbush depression</td>
<td>small diameter trees and relatively small size; lacks recent anthropogenic disturbances</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>inundated shrub swamp (A)</strong></td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>borders thin band of early successional hardwood swamp, pasture, and upland forest, surrounding landscape is ag and rural residential</td>
<td>small, west edge of swamp was pastured in past</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>inundated shrub swamp (B)</strong></td>
<td>Low</td>
<td>Low-Medium</td>
</tr>
<tr>
<td></td>
<td>bordered by mowed lawn on one side; thin band of forest borders most of swamp; mowed trail runs through forest and around swamp; horse pasture is nearby</td>
<td>5 acres and receives water overflow from adjacent forest</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>inundated shrub swamp (C)</strong></td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>surrounded by floodplain forest and mesic southern forest</td>
<td>3 acres; good landscape context and zonation</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>inundated shrub swamp (D)</strong></td>
<td>Medium</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>borders old field to the southeast and west and mesic southern forest to the north</td>
<td>formerly an inundated, forested depression currently dominated by buttonbush and <em>Lemna</em> sp. in the open water</td>
<td></td>
</tr>
<tr>
<td>Site</td>
<td>Community Type</td>
<td>Landscape Context Rank</td>
<td>Natural Community Rank</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>------------------------------------</td>
<td>------------------------</td>
<td>------------------------</td>
</tr>
<tr>
<td>inundated shrub swamp (E)</td>
<td>Medium</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>surrounded by early successional forest where drain tile ditch feeds into wetland; borders steep slope to the east with heavy soil erosion and formerly logged hardwoods now dominated by aspen</td>
<td>slightly altered hydrology due to the drainage ditch</td>
<td></td>
</tr>
<tr>
<td>mesic southern forest</td>
<td>Low</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>borders old field on two sides and also narrowly borders a floodplain forest and buttonbush depression</td>
<td>large diameter trees; low ground flora diversity; newly fallen CWD that are large and few; no old, highly decomposed CWD</td>
<td></td>
</tr>
<tr>
<td>pasture</td>
<td>Medium</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>bordered by gravel road, early successional floodplain forest, and shrub swamp; surrounding landscape is ag and rural residential</td>
<td>low diversity, many invasive plants</td>
<td></td>
</tr>
<tr>
<td>old field</td>
<td>Medium</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>mostly surrounded by natural areas like forested wetlands; borders Buckeye Road and a homestead with mowed lawn, horse pasture, and created pond</td>
<td>this is an old abandoned ag field about 30 acres in size; erosion on steep, south-facing slope in a narrow gully channel that meanders toward Buckeye Road</td>
<td></td>
</tr>
</tbody>
</table>
## Appendix 17. Water depth and hydrologic alterations.

<table>
<thead>
<tr>
<th>Site</th>
<th>Community Type</th>
<th>Water Depth (ft)</th>
<th>Water Level Manipulation (dams, pumps, culverts, drainage ditches, drain tile, etc.)</th>
<th>Surface Water Flow into Community from Non-Native Upland System (e.g., agricultural field, lawn, development, road, etc.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cass-St. Joseph County</td>
<td>inundated shrub swamp (A)</td>
<td>2</td>
<td>-</td>
<td>runoff from gravel road likely during heavy rain and snowmelt</td>
</tr>
<tr>
<td></td>
<td>inundated shrub swamp (B)</td>
<td>2.5</td>
<td>-</td>
<td>runoff from gravel road and adjacent driveway likely during heavy rain and snowmelt</td>
</tr>
<tr>
<td></td>
<td>inundated shrub swamp (C)</td>
<td>1</td>
<td>-</td>
<td>runoff from gravel road likely during heavy rain and snowmelt</td>
</tr>
<tr>
<td></td>
<td>inundated shrub swamp (D)</td>
<td>1.5</td>
<td>-</td>
<td>receives runoff from adjacent ag field to the south; shrub swamp borders old field to east and may have received runoff in past when field was used for agriculture</td>
</tr>
<tr>
<td></td>
<td>pond</td>
<td>unknown but up to 2 ft along shore</td>
<td>-</td>
<td>pond borders old field to west and may have received runoff in past when field was used for agriculture</td>
</tr>
<tr>
<td></td>
<td>mesic southern forest</td>
<td>0</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Hillsdale County</td>
<td>southern floodplain forest</td>
<td>0</td>
<td>adjacent road crossing may act as a dam during high water events</td>
<td>runoff from ag fields upslope</td>
</tr>
<tr>
<td></td>
<td>southern willow wet meadow</td>
<td>0</td>
<td>earthen dam and control structure regulates water flow into creek</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>southern wet meadow</td>
<td>0-0.5</td>
<td>earthen dam has flooded adjacent wetland to create Big Marsh Lake</td>
<td>surface water flow from mowed lawn atop earthen dam drains directly into wet meadow</td>
</tr>
</tbody>
</table>
### Appendix 17. (cont.)

<table>
<thead>
<tr>
<th>Site</th>
<th>Community Type</th>
<th>Water Depth (ft)</th>
<th>Water Level Manipulation (dams, pumps, culverts, drainage ditches, drain tile, etc.)</th>
<th>Surface Water Flow into Community from Non-Native Upland System (e.g., agricultural field, lawn, development, road, etc.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hillsdale County</td>
<td>dry-mesic southern forest</td>
<td>0</td>
<td>earthen dam has flooded most of wet meadow to create Big Marsh Lake; water levels controlled by dam</td>
<td>-</td>
</tr>
<tr>
<td>EO .004</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hillsdale County</td>
<td>southern floodplain forest</td>
<td>0</td>
<td>blocked culvert is restricting water flow in creek</td>
<td>blocked culvert at adjacent gravel-road crossing is causing stream to flow over road as it enters narrow floodplain.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.33</td>
<td>ditch along road may be draining wetland</td>
<td>runoff from gravel road</td>
</tr>
<tr>
<td></td>
<td>mesic southern forest</td>
<td>0</td>
<td>culvert at road crossing creates a dam at base of forested slope</td>
<td>-</td>
</tr>
<tr>
<td>Hillsdale County</td>
<td>pond</td>
<td>14</td>
<td>pond was created in 1989 by digging out wetland</td>
<td>runoff from sheep pasture, cattle feedlot, barnyard, and cattle walkway</td>
</tr>
<tr>
<td>EO .008</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>southern wet meadow (A)</td>
<td>0-0.83</td>
<td>wet meadow borders man-made pond; creek enters wetland through culvert under road</td>
<td>wet meadow receives wastewater from milkhouse and runoff from cattle holding pen, cattle walkway, and adjacent gravel road</td>
</tr>
<tr>
<td></td>
<td>southern wet meadow (B)</td>
<td>0-1</td>
<td>wet meadow borders man-made pond</td>
<td>runoff from Christmas tree plantation on sandy slope</td>
</tr>
<tr>
<td></td>
<td>southern wet meadow (C)</td>
<td>0</td>
<td>drain tile from surrounding ag fields flows into intermittent streams within forest and then enters adjacent shrub swamp</td>
<td>runoff from ag field</td>
</tr>
<tr>
<td>Site</td>
<td>Community Type</td>
<td>Water Depth (ft)</td>
<td>Water Level Manipulation (dams, pumps, culverts, drainage ditches, drain tile, etc.)</td>
<td>Surface Water Flow into Community from Non-Native Upland System (e.g., agricultural field, lawn, development, road, etc.)</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>---------------------------------</td>
<td>------------------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>southern wet meadow (D)</td>
<td>0.25-0.33</td>
<td>culvert at driveway crossing may create a dam during high water events</td>
<td>runoff from lawn and driveway</td>
<td></td>
</tr>
<tr>
<td>inundated shrub swamp</td>
<td>0-1</td>
<td>drain tile from surrounding ag fields flows into intermittent streams within forest and then enters shrub swamp</td>
<td>runoff from ag field</td>
<td></td>
</tr>
<tr>
<td>mesic southern forest (A)</td>
<td>0</td>
<td>borders man-made pond</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>mesic southern forest (B)</td>
<td>0</td>
<td>drain tile from surrounding ag fields causes flow into intermittent streams within forest</td>
<td>runoff from ag field</td>
<td></td>
</tr>
<tr>
<td>mesic southern forest (C)</td>
<td>0</td>
<td>old railroad grade causes pooling of intermittent streams before water drains into floodplain</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>southern floodplain forest</td>
<td>variable; mostly none but standing water in depressions and in abandoned stream channels</td>
<td>-</td>
<td>runoff from ag field</td>
<td></td>
</tr>
</tbody>
</table>
Appendix 17. (cont.).

<table>
<thead>
<tr>
<th>Site</th>
<th>Community Type</th>
<th>Water Depth (ft)</th>
<th>Water Level Manipulation (dams, pumps, culverts, drainage ditches, drain tile, etc.)</th>
<th>Surface Water Flow into Community from Non-Native Upland System (e.g., agricultural field, lawn, development, road, etc.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hillsdale County</td>
<td>emergent marsh (A)</td>
<td>0-0.80</td>
<td>water levels controlled by dam</td>
<td>runoff from grass-covered, steep-sloped earthen dam</td>
</tr>
<tr>
<td>EO .005</td>
<td>emergent marsh (B)</td>
<td>0.33-1.30</td>
<td>marsh borders man-made lake</td>
<td>runoff from adjacent lawn</td>
</tr>
<tr>
<td></td>
<td>mesic southern forest (A)</td>
<td>0</td>
<td>marsh borders earthen dam and man-made lake</td>
<td></td>
</tr>
<tr>
<td></td>
<td>mesic southern forest (B)</td>
<td>0</td>
<td>-</td>
<td>runoff from gravel road and lawn</td>
</tr>
<tr>
<td></td>
<td>dry-mesic southern forest</td>
<td>0</td>
<td>forest borders man-made lake</td>
<td></td>
</tr>
<tr>
<td>Branch County</td>
<td>southern floodplain forest</td>
<td>0</td>
<td>footings from former bridge along creek</td>
<td>runoff from pasture and ag fields; runoff from abandoned two-track that leads from former bridge up steep, forested slope to cattle pasture</td>
</tr>
<tr>
<td>EO .012</td>
<td>inundated shrub swamp (A)</td>
<td>0</td>
<td>-</td>
<td>runoff from adjacent reed canary grass meadow</td>
</tr>
<tr>
<td></td>
<td>inundated shrub swamp (B)</td>
<td>0</td>
<td>-</td>
<td>runoff from adjacent reed canary grass meadow</td>
</tr>
<tr>
<td>Williams County-Ohio</td>
<td>inundated shrub swamp</td>
<td>0</td>
<td>-</td>
<td>runoff from adjacent old field</td>
</tr>
<tr>
<td>Site</td>
<td>Community Type</td>
<td>Water Depth (ft)</td>
<td>Water Level Manipulation (dams, pumps, culverts, drainage ditches, drain tile, etc.)</td>
<td>Surface Water Flow into Community from Non-Native Upland System (e.g., agricultural field, lawn, development, road, etc.)</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>---------------------------------------</td>
<td>-----------------</td>
<td>--------------------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>southern floodplain forest</td>
<td>southern floodplain forest (A)</td>
<td>0</td>
<td>-</td>
<td>runoff from adjacent old field</td>
</tr>
<tr>
<td></td>
<td>mesic southern forest (A)</td>
<td>0</td>
<td>-</td>
<td>runoff from adjacent old field</td>
</tr>
<tr>
<td></td>
<td>mesic southern forest (B)</td>
<td>0</td>
<td>channelization of stream; service road runs along stream and crosses stream 10 m to the north</td>
<td>runoff from old field 100 m to the south</td>
</tr>
<tr>
<td></td>
<td>southern swamp</td>
<td>0</td>
<td>culvert under road; road acts like a dike</td>
<td>surface runoff from roads</td>
</tr>
<tr>
<td>Hillsdale County</td>
<td>pond (A)</td>
<td>unknown but up to 2 ft along shore</td>
<td>road may act as a dam and contribute to year-round flooding</td>
<td>runoff from gravel road</td>
</tr>
<tr>
<td>EO .010</td>
<td>pond (B)</td>
<td>unknown with gradually sloping shoreline</td>
<td>earthen dam with drain that feeds into the lower wetland</td>
<td>runoff from mowed lawn surrounding pond</td>
</tr>
<tr>
<td></td>
<td>southern floodplain forest (A)</td>
<td>0</td>
<td>bridge (now closed) may act as dam during high water events</td>
<td>runoff from gravel road and drainage ditches alongside road</td>
</tr>
<tr>
<td></td>
<td>southern floodplain forest (B)</td>
<td>0.5-1.0</td>
<td>-</td>
<td>possible runoff from ag fields that has been filtered through other nearby wetlands</td>
</tr>
<tr>
<td></td>
<td>inundated shrub swamp (A)</td>
<td>0</td>
<td>-</td>
<td>runoff from pasture</td>
</tr>
</tbody>
</table>
### Appendix 17. (cont.)

<table>
<thead>
<tr>
<th>Site</th>
<th>Community Type</th>
<th>Water Depth (ft)</th>
<th>Water Level Manipulation (dams, pumps, culverts, drainage ditches, drain tile, etc.)</th>
<th>Surface Water Flow into Community from Non-Native Upland System (e.g., agricultural field, lawn, development, road, etc.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>inundated shrub swamp (B)</td>
<td>2.5 at 15 ft from shore</td>
<td>drainage ditch with overflow into adjacent shrub swamp; earthen dam above wetland; Brown's Pond feeds into wetland</td>
<td>possible runoff from nearby horse pasture</td>
<td></td>
</tr>
<tr>
<td>inundated shrub swamp (C)</td>
<td>3</td>
<td>-</td>
<td>some drainage occurs from adjacent wetlands that receive runoff from ag fields; connects to inundated shrub swamp (E) and receives input from three other inundated shrub swamps</td>
<td></td>
</tr>
<tr>
<td>inundated shrub swamp (D)</td>
<td>2.5 at 10 ft from shore</td>
<td>connecting channel from another buttonbush depression and a swale in an old field appears to feed this shrub swamp</td>
<td>erosion and runoff from old field</td>
<td></td>
</tr>
<tr>
<td>inundated shrub swamp (E)</td>
<td>2</td>
<td>drainage ditch feeding wetland; drain tiled ag field feeds into wetland</td>
<td>surface flow from culverts</td>
<td></td>
</tr>
<tr>
<td>mesic southern forest</td>
<td>0</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>pasture</td>
<td>0</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>old field</td>
<td>0</td>
<td>drain tiled with subsequent flow into a ditch located in the center of the field that eventually feeds a buttonbush depression</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>
**Appendix 18.** Habitat alterations.

<table>
<thead>
<tr>
<th>Site</th>
<th>Community Type</th>
<th>Habitat Destruction</th>
<th>Habitat Disturbance</th>
<th>Habitat Manipulation</th>
<th>Soil Erosion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cass-St. Joseph County EO .002</td>
<td>inundated shrub swamp (A)</td>
<td>road construction in past may have altered shape and depth of wetland</td>
<td>-</td>
<td>selective logging of adjacent uplands</td>
<td>runoff from gravel road and possibly following selective logging of uplands</td>
</tr>
<tr>
<td></td>
<td>inundated shrub swamp (B)</td>
<td>road construction in past may have altered shape and depth of wetland</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>inundated shrub swamp (C)</td>
<td>road construction in past may have altered shape and depth of wetland; old fields border shrub swamp</td>
<td>shrub swamp is adjacent to gravel road</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>inundated shrub swamp (D)</td>
<td>-</td>
<td>-</td>
<td>reed canary grass likely planted in portion of swamp adjacent to ag field</td>
<td>soil erosion on slope in mesic southern forest above shrub swamp</td>
</tr>
<tr>
<td></td>
<td>pond</td>
<td>old fields border pond</td>
<td>pond is surrounded by trails and used by anglers</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>mesic southern forest</td>
<td>-</td>
<td>gravel two-track cuts through forest</td>
<td>removal of large trees in the past and present</td>
<td>on slopes grading into wetland to the south and into Wood Lake to the north</td>
</tr>
<tr>
<td>Hillsdale County EO .007</td>
<td>southern floodplain forest</td>
<td>-</td>
<td>trash pile at base of slope; ATV trails along river; evidence of seasonal flooding</td>
<td>selective logging</td>
<td>soil erosion on steep slope above floodplain</td>
</tr>
</tbody>
</table>
## Appendix 18. (cont.)

<table>
<thead>
<tr>
<th>Site</th>
<th>Community Type</th>
<th>Habitat Destruction</th>
<th>Habitat Disturbance</th>
<th>Habitat Manipulation</th>
<th>Soil Erosion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calhoun County</td>
<td>southern floodplain forest</td>
<td>earthen dam built over small portion of floodplain forest</td>
<td>excessive deer herbivory</td>
<td>dam regulates stream flow and prevents seasonal flooding and sediment deposition</td>
<td>soil erosion likely on adjacent steep slopes</td>
</tr>
<tr>
<td>EO .013</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>southern wet meadow</td>
<td></td>
<td>earthen dam has resulted in flooding of southern wet meadow</td>
<td>excessive deer herbivory</td>
<td>mowing small portion of wet meadow; water levels of pond are controlled by dam</td>
<td>runoff from lawn on earthen dam</td>
</tr>
<tr>
<td>dry-mesic southern forest</td>
<td>gravel roads, buildings and parking areas occupy former areas of upland forest</td>
<td>car and foot traffic along paths and gravel roads that dissect forest and around wooden viewing platforms within forest; excessive deer herbivory</td>
<td>large mowed parking lot and mowed areas around buildings; selective logging</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Hillsdale County</td>
<td>southern floodplain forest</td>
<td>house occupies part of floodplain forest; gravel roads and residential gravel driveways border floodplain forest</td>
<td>-</td>
<td>selective logging of adjacent uplands; mowed yard adjacent to wetland</td>
<td>soil erosion likely on adjacent steep slopes and following logging of adjacent uplands</td>
</tr>
<tr>
<td>EO .004</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>southern wet meadow</td>
<td></td>
<td>construction of road may have altered shape of wetland and drainage pattern</td>
<td>shrub encroachment, possibly a result of fire suppression in surrounding uplands</td>
<td>drainage ditch along road may be draining wetland</td>
<td>runoff from gravel road</td>
</tr>
<tr>
<td>mesic southern forest</td>
<td></td>
<td>-</td>
<td>two-track runs through community; used for recreation</td>
<td>logged in past</td>
<td>soil erosion on slope leading to floodplain forest and creek</td>
</tr>
</tbody>
</table>
### Appendix 18. (cont.)

<table>
<thead>
<tr>
<th>Site</th>
<th>Community Type</th>
<th>Habitat Destruction</th>
<th>Habitat Disturbance</th>
<th>Habitat Manipulation</th>
<th>Soil Erosion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hillsdale County EO .008</td>
<td>pond</td>
<td>construction of pond flooded wetland and killed many tamarack, willow, American elm, and buttonbush</td>
<td>pond used for swimming</td>
<td>pond dug in wetland in 1989, stocked with largemouth bass</td>
<td>runoff on forested slope above pond</td>
</tr>
<tr>
<td></td>
<td>southern wet meadow (A)</td>
<td>road construction in past may have altered shape and depth of wetland</td>
<td>nutrient input from adjacent cattle lane, holding pen, and wastewater input from milkhouse; grazing - used as sheep pasture in past</td>
<td>planted with pasture mix (non-native spp.)</td>
<td>runoff from gravel road and driveway</td>
</tr>
<tr>
<td></td>
<td>southern wet meadow (B)</td>
<td>-</td>
<td>grazing - used as sheep pasture in past</td>
<td>adjacent wetland was flooded to create pond</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>southern wet meadow (C)</td>
<td>-</td>
<td>-</td>
<td>large cut stumps occur within meadow</td>
<td>runoff from pasture into wet meadow</td>
</tr>
<tr>
<td></td>
<td>southern wet meadow (D)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>runoff from lawn and gravel driveway</td>
</tr>
<tr>
<td></td>
<td>inundated shrub swamp</td>
<td>-</td>
<td>-</td>
<td>selective logging in adjacent upland</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>mesic southern forest (A)</td>
<td>-</td>
<td>occasionally grazed by horses and cattle</td>
<td>selectively logged in past</td>
<td>soil erosion on slopes</td>
</tr>
<tr>
<td></td>
<td>mesic southern forest (B)</td>
<td>-</td>
<td>wide trail through forest</td>
<td>selectively logged in recent past</td>
<td>runoff from pasture into forest</td>
</tr>
<tr>
<td>Site</td>
<td>Community Type</td>
<td>Habitat Destruction</td>
<td>Habitat Disturbance</td>
<td>Habitat Manipulation</td>
<td>Soil Erosion</td>
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</tr>
<tr>
<td>mesic southern forest (C)</td>
<td>-</td>
<td>old railroad grade</td>
<td>passes through forest and forms an artificial dam that causes an intermittent stream to pool before draining into floodplain</td>
<td>evidence of past logging</td>
<td>erosion associated with animal burrows and steep slopes of upland terraces; erosion deposits in floodplain</td>
</tr>
<tr>
<td>southern floodplain forest</td>
<td>-</td>
<td>old railroad grade</td>
<td>cuts into first terrace</td>
<td>evidence of past logging, reported to occur in 1978</td>
<td>natural erosion from steep slopes associated with terrace risers</td>
</tr>
<tr>
<td>Hillsdale County EO .005</td>
<td>emergent marsh (A)</td>
<td>man-made lake may</td>
<td>have flooded former marsh</td>
<td>mowed lawn adjacent to marsh; water levels of pond are controlled by dam</td>
<td>runoff from grass-covered, steep-sloped earthen dam</td>
</tr>
<tr>
<td></td>
<td></td>
<td>pond is actively</td>
<td>used by boy scouts for recreation</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>used by boy scouts</td>
<td>for recreation</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>for recreation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>mestic southern forest (A)</td>
<td>clearings used for</td>
<td>camping and fire pits</td>
<td>selective logging in recent past</td>
<td>forest is dissected by steep ravine carrying a narrow, shallow creek; forested, short, steep slope leads to lake</td>
</tr>
<tr>
<td></td>
<td></td>
<td>paths, two-tracks</td>
<td>and out-buildings scattered throughout forest; recreational use by boy scouts</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>and out-buildings</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>scattered throughout</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>forest</td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>recent past</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>trails</td>
<td></td>
<td>selective logging</td>
<td></td>
</tr>
<tr>
<td></td>
<td>mestic southern forest (B)</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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<table>
<thead>
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<th>Site</th>
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<th>Soil Erosion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Branch County</td>
<td>dry-mesic southern forest</td>
<td>clearings used for camping and fire pits</td>
<td>paths, two-tracks and out-buildings scattered throughout forest; recreational use by boy scouts</td>
<td>selective logging in recent past</td>
<td>soil erosion along small channelized stream</td>
</tr>
<tr>
<td>EO .012</td>
<td>southern floodplain forest</td>
<td>-</td>
<td>heavily rutted logging roads and staging areas; windthrow</td>
<td>selective logging in recent past</td>
<td>from logging roads and staging areas; along forested slopes above floodplain</td>
</tr>
<tr>
<td></td>
<td>inundated shrub swamp (A)</td>
<td>-</td>
<td>-</td>
<td>selective logging in adjacent floodplain forest; reed canary grass likely planted in adjacent wet meadow</td>
<td>-</td>
</tr>
<tr>
<td>Williams County</td>
<td>inundated shrub swamp (B)</td>
<td>-</td>
<td>-</td>
<td>selective logging in adjacent floodplain forest; reed canary grass likely planted in adjacent wet meadow</td>
<td>-</td>
</tr>
<tr>
<td>Ohio</td>
<td>southern floodplain forest</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>mesic southern forest (A)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Site</td>
<td>Community Type</td>
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</tr>
<tr>
<td></td>
<td>mesic southern forest (B)</td>
<td>-</td>
<td>service road runs along stream and crosses stream 10 m to the north</td>
<td>channelized stream with water flowing to the south</td>
<td>runoff from adjacent old field 100 m to the south</td>
</tr>
<tr>
<td></td>
<td>southern swamp</td>
<td>-</td>
<td>trash along slopes and bottom of ravine</td>
<td>grazing likely in the past; culvert under road with road acting like a dike</td>
<td>along steep slopes and from the nearby road</td>
</tr>
<tr>
<td>Hillsdale County EO .010</td>
<td>pond (A)</td>
<td>road construction in past may have altered shape and depth of wetland</td>
<td>-</td>
<td>-</td>
<td>runoff from gravel road</td>
</tr>
<tr>
<td></td>
<td>pond (B)</td>
<td>created pond/lake with earthen dam and drainage pipe</td>
<td>domesticated dog reported to harass copperbelly snakes</td>
<td>vegetation treated with herbicide; 10-20 ft wide mowed strip adjacent to pond; drain feeds into lower wetland</td>
<td>not observed but likely to occur</td>
</tr>
<tr>
<td></td>
<td>southern floodplain forest (A)</td>
<td>-</td>
<td>-</td>
<td>early successional forest, appears to have been open in past</td>
<td>runoff from gravel road</td>
</tr>
<tr>
<td></td>
<td>southern floodplain forest (B)</td>
<td>-</td>
<td>some drainage into this forest may contain runoff from ag fields that have been filtered through other nearby wetlands</td>
<td>-</td>
<td>soil erosion likely on slopes</td>
</tr>
<tr>
<td></td>
<td>inundated shrub swamp (A)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>runoff from slopes of adjacent pasture</td>
</tr>
</tbody>
</table>
### Appendix 18. (cont.)

<table>
<thead>
<tr>
<th>Site</th>
<th>Community Type</th>
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<th>Soil Erosion</th>
</tr>
</thead>
<tbody>
<tr>
<td>inundated shrub swamp</td>
<td>(B)</td>
<td>likely existed as a former swamp forest that has been purposely inundated to create more open conditions</td>
<td>earthen dam above wetland; overflow from Brown's Pond feeds into wetland</td>
<td>mowed trail occurs in adjacent forest</td>
<td>some erosion detected</td>
</tr>
<tr>
<td>inundated shrub swamp</td>
<td>(C)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>some drainage occurs from adjacent wetlands that receive runoff from ag fields</td>
</tr>
<tr>
<td>inundated shrub swamp</td>
<td>(D)</td>
<td>formerly a forested wetland; hydrologic manipulation likely altered the water table</td>
<td>-</td>
<td>old field and area to the south has been mowed</td>
<td>erosion and runoff likely occurs because of formation of old field</td>
</tr>
<tr>
<td>inundated shrub swamp</td>
<td>(E)</td>
<td>degree of altered hydrology unknown; original ecosystem may have been irreversibly damaged</td>
<td>altered hydrology due to drainage ditch and tiles; both hydrologically feed this wetland</td>
<td>logged hardwoods in adjacent forest now aspen-dominated</td>
<td>heavy soil erosion on adjacent steep slope to the east</td>
</tr>
<tr>
<td>mesic southern forest</td>
<td></td>
<td>formerly a contiguous forest tract now fragmented greatly in a matrix of ag fields</td>
<td>ag drainage in surrounding landscape probably influences inundation along forest edge</td>
<td>likely selectively logged</td>
<td>-</td>
</tr>
<tr>
<td>pasture</td>
<td></td>
<td>-</td>
<td>cattle grazing</td>
<td>cattle grazing</td>
<td>runoff from slopes</td>
</tr>
<tr>
<td>Site</td>
<td>Community Type</td>
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<td>Habitat Manipulation</td>
<td>Soil Erosion</td>
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<td>------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>old field</td>
<td>-</td>
<td>-</td>
<td>former ag field with trash dumped in drainage ditch in center of field; drain tiled in center of field and drains into buttonbush depression</td>
<td>mowing and grazing likely occurred in past</td>
<td>likely in past when in ag; erosion on steep, south-facing slope in a narrow gully channel that meanders toward Buckeye Road</td>
</tr>
</tbody>
</table>