Natural Features Inventory and Management Recommendations for the Waterloo Wildlife Unit in Waterloo Recreation Area.

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Cover Photos (left to right):
American Bitterns (*Botaurus lentiginosus*, state special concern) were documented in nine locations within the vast Portage Marsh Wetland Complex (photo by Micheal J. Monfils).

Wild Rice (*Zizania aquatica* var. *aquatica*, state threatened) grows in abundance in the South Portage Marsh, the largest element occurrence of emergent marsh documented in Michigan to date (photo by John Fody).

Blanding's Turtles (*Emydoidea blandingii*, special concern) were documented at seven locations within the Waterloo Wildlife Unit (photo by Yu Man Lee).

ABSTRACT

In 2010, Michigan Natural Features Inventory (MNFI) conducted surveys for exemplary natural communities and rare animals in IFMAP Compartment 1 of the Waterloo Recreation Area. For the purposes of this report, this area is referred to as the Waterloo Wildlife Unit or wildlife unit. During the surveys 24 new element occurrences were identified and 9 previously identified records were updated. Natural community surveys resulted in 17 new natural community element occurrences and 2 new rare plant element occurrences (Tables 1 and 2). In addition, four previously identified natural community and two rare plant records were updated. Newly documented natural community element occurrences included two bogs, one emergent marsh, four dry southern forests, one dry-mesic southern forest, one inundated shrub swamp, two prairie fens, one rich tamarack swamp, two southern wet meadows, two southern hardwood swamps, and one wet prairie (Figure 9, Table 1). Newly documented rare plant occurrences identified during natural community surveys included wild rice (*Zizania aquatica* var. *aquatica*, state threatened) and horsetail spike rush (*Eleocharis equisetoides*, state special concern). During surveys for rare animals, five new rare animal element occurrences were documented and seven previous records were reconfirmed (Table 2). New rare animal element occurrences included two occurrences of red-legged spittlebug (*Prosapia ignipectus*, state special concern), one of paper pondshell *Utterbackia imbecillis*, state special concern), and one of trumpet vallonia (*Vallonia parvula*, state special concern). In addition, the following previously documented rare animal occurrences were reconfirmed: American Bittern (*Botaurus lentiginosus*, state special concern), Least Bittern (*Ixobrychus exilis*, state threatened), Henslow's Sparrow (*Ammodramus henslowii*, state endangered), Marsh Wren (*Cistothorus palustris*, state special concern), and two occurrences of Blanding's Turtle (*Emydoidea blandingii*, state special concern). Based on this recent assessment of available habitat, future surveys are likely to have some success in documenting additional element occurrences of emergent marsh, southern wet meadow, and southern shrub-carr natural communities and rare animal taxa including forest and grassland songbirds, raptors (especially marsh hawk), herps, insects, unionid mussels, and snails. Primary management recommendations include 1) implementing prescribed fire on a regular basis in fire-adapted community types such as dry southern forests, dry-mesic southern forests, southern wet meadows, prairie fens, and wet prairies, and 2) controlling and monitoring invasive plants (see Tables 3 and 4). Because the vast majority of the upland forests in the Waterloo Wildlife Unit directly border large wetland complexes, they likely serve as important nesting sites for turtles. Reducing the cover of shade-tolerant red maples within these otherwise oak-dominated forests will facilitate higher levels of sunlight reaching the ground, significantly benefitting turtle reproduction. The increased levels of sunlight reaching the forest understory and ground layer will also help improve oak and hickory regeneration, both important food resources for wildlife, and bolster native plant diversity.

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INTRODUCTION

During the spring, summer, and fall of 2010, Michigan Natural Features Inventory (MNFI) conducted surveys for exemplary natural communities and rare terrestrial and aquatic animals in the northern portion of the Waterloo Recreation Area. The area in which our surveys were focused is encompassed by IFMAP Compartment 1 of the Waterloo Recreation Area. Although the Waterloo Recreation Area is jointly managed by the Michigan Department of Natural Resources and Environment, Wildlife Division and Recreation Division (DNRE), the Wildlife Division is responsible for leading the management of Compartment 1. Thus, for the purposes of this report, this area is referred to as the Waterloo Wildlife Unit or wildlife unit. This project is part of a long-term effort by the DNRE to document and sustainably manage areas of high conservation significance on state lands. This report summarizes the findings of MNFI's 2010 surveys of the Waterloo Wildlife Unit.

The regional landscape ecosystems of Michigan have been classified and mapped based on an integration of climate, physiography, soils, and natural vegetation (Albert 1995) (Figure 1). This classification system can be useful for conservation planning and integrated resource management because it provides a framework for understanding the distribution patterns of species, natural communities, and natural disturbance regimes. The classification has a nested, hierarchical structure composed of sections, subsections, and sub-subsections. The Waterloo Wildlife Unit discussed in this report occurs within the Jackson Interlobate Sub-subsection (VI.1.3) of the Washtenaw Subsection (VI.1) of the Southern Lower Michigan Section (VI) (Figure 1) (Albert 1995).

The Jackson Interlobate Sub-subsection is characterized by relatively steep, sandy and gravelly end moraines and ice-contact ridges, which are surrounded by sandy, pitted outwash deposits (Figure 1). The sandy outwash deposits range from level to gently sloping, broad outwash plains to narrow outwash channels. Numerous wetlands and kettle lakes occur throughout the sub-subsection, especially within the poorly drained outwash deposits. The glacial drift is generally less than 100 feet thick within the sub-subsection and less than 50 feet within the Waterloo Wildlife Unit (Akers 1938). Underlying the glacial drift are Mississippian- and Pennsylvanian-aged bedrocks, comprised primarily of limestone and sandstone (Dorr and Eschman 1984, Milstein 1987).

The Waterloo Wildlife Unit is located in the Upper Grand River Watershed on an expansive outwash plain that encompasses several low islands of coarse-textured end moraines (Figure 1). West and north of the wildlife unit are large, rolling, coarse-textured ground moraines. South of the wildlife unit is a large area of relatively steep and dissected ice-contact topography.

Interpretations of 1800s vegetation indicate that the sandy, well-drained end moraines and drier portions of the outwash plains at the Waterloo Wildlife Unit supported oak barrens, mixed oak forests, and oak-hickory forests (Figure 2). On the poorly drained areas of the outwash plains, a variety of wetlands occurred, including emergent marsh, wet meadow, wet prairie (which included areas of wet-mesic prairie and prairie fen), shrub-carr, and mixed conifer swamp (including rich tamarack swamp and poor conifer swamp).

In the Waterloo Wildlife Unit today, the uplands continue to support mixed oak forests (i.e., dry southern forest) and oak-hickory (i.e., dry-mesic southern forest), while the lowlands harbor expansive areas of emergent marsh and southern wet meadow, tiny remnants of wet prairie, wet-mesic prairie, and prairie fen, large areas of southern shrub-carr, and several significant blocks of conifer swamp, including a poor conifer swamp and several rich tamarack swamps (Figure 3). In addition, the wildlife unit also contains areas of bog, inundated shrub swamp (i.e., button bush depressions), southern hardwood swamp.

METHODS

All state and federally listed rare species and high quality natural communities are referred to as elements and their occurrence at a specific location is referred to as an element occurrence or "EO."

The distribution of survey effort across the wildlife unit is illustrated in Figures 4 to 8 each survey target (i.e., natural communities, rare birds, rare herps, rare insects, and rare mollusks). Field work was facilitated by handheld PDAs containing a GIS database and GPS capability. The GIS database was designed to record both survey location and survey target (e.g., natural communities, rare species, species groups, etc.). The database was loaded on IPAQ brand PDAs, which were paired with Bluetooth receivers

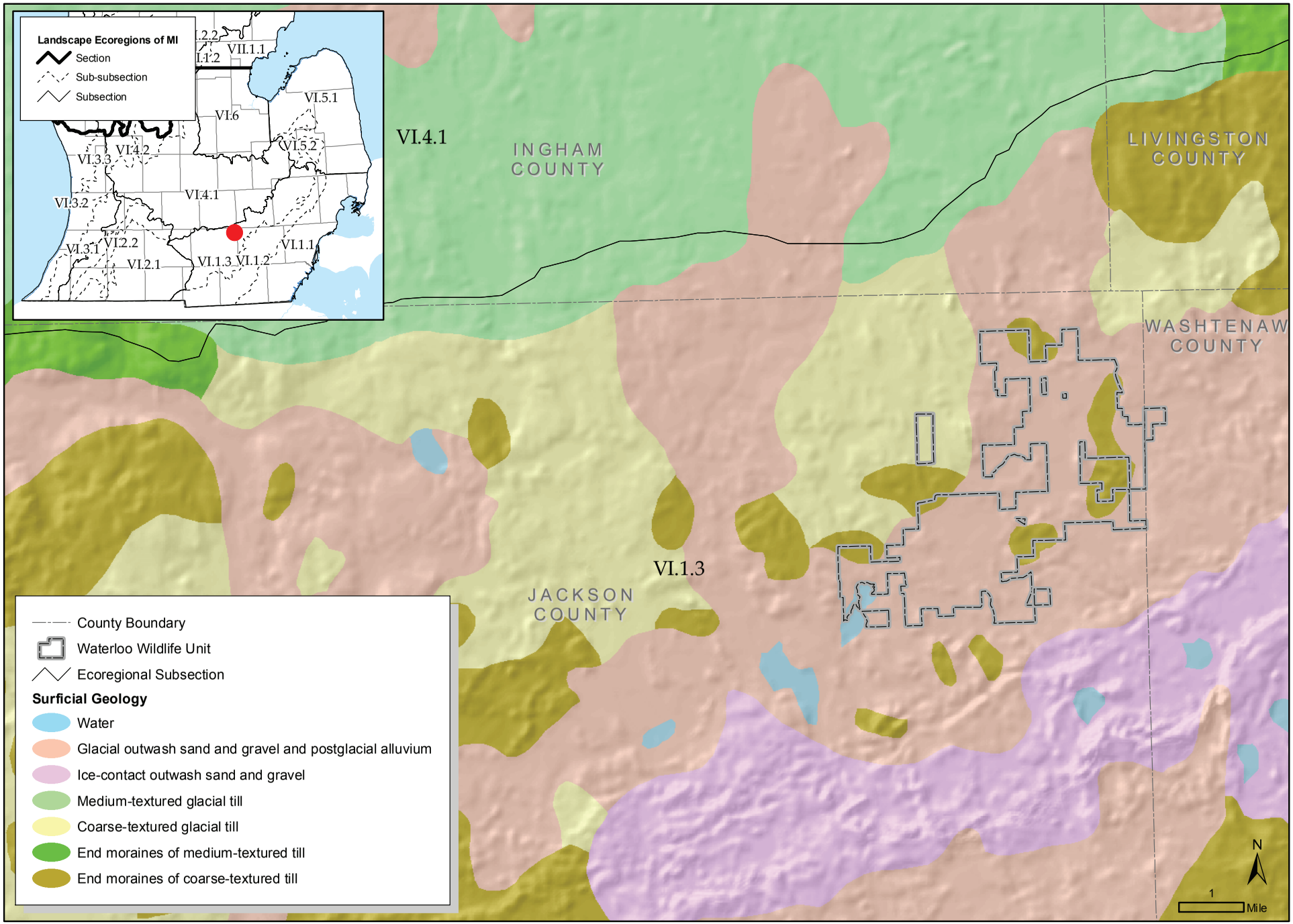


Figure 1. Ecoregions and Quaternary Geology of southwestern Lower Michigan (Albert 1995, Farrand and Bell 1982).

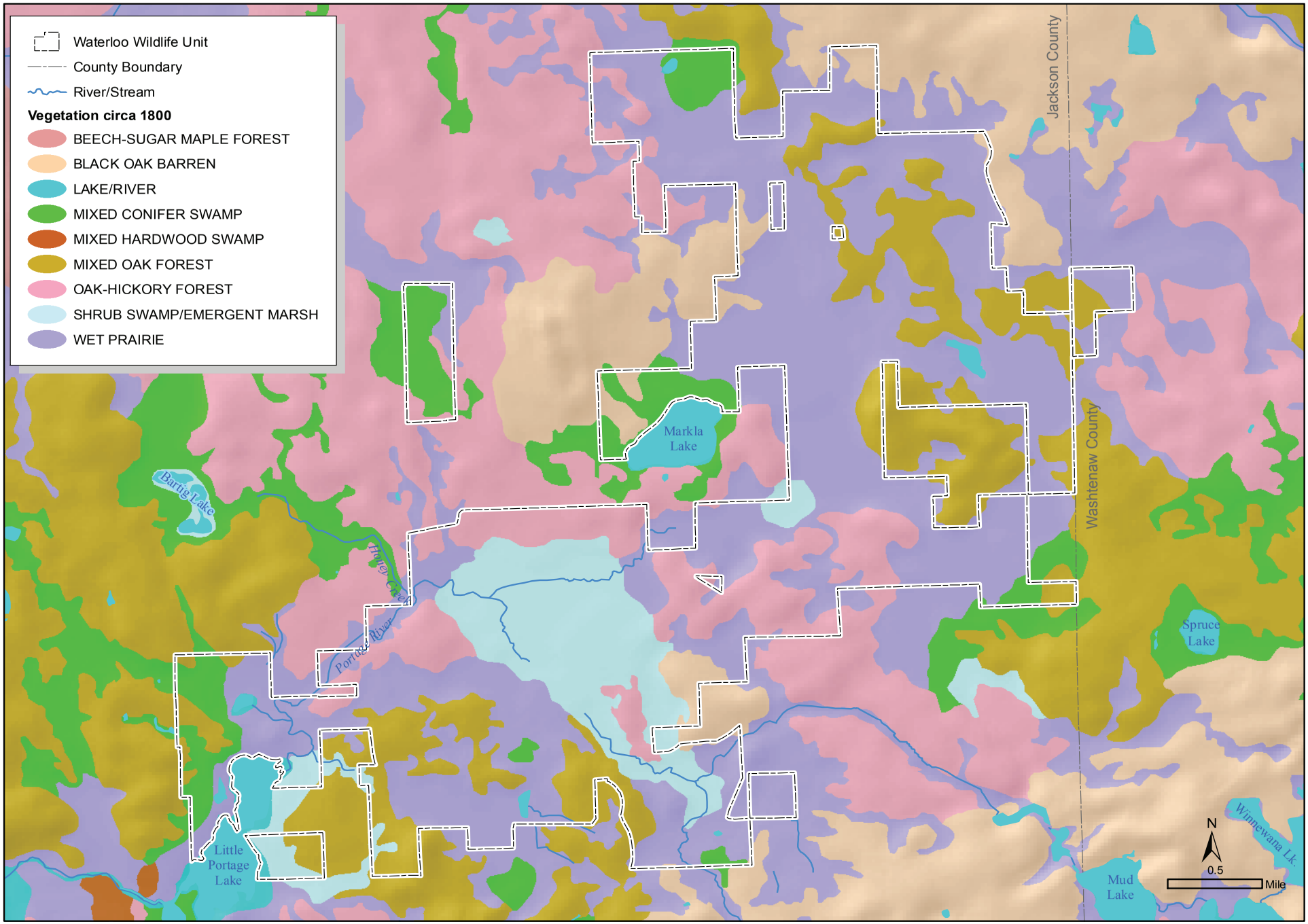


Figure 2. Circa 1800 Vegetation for southwestern Lower Michigan (Comer, et al. 1995).

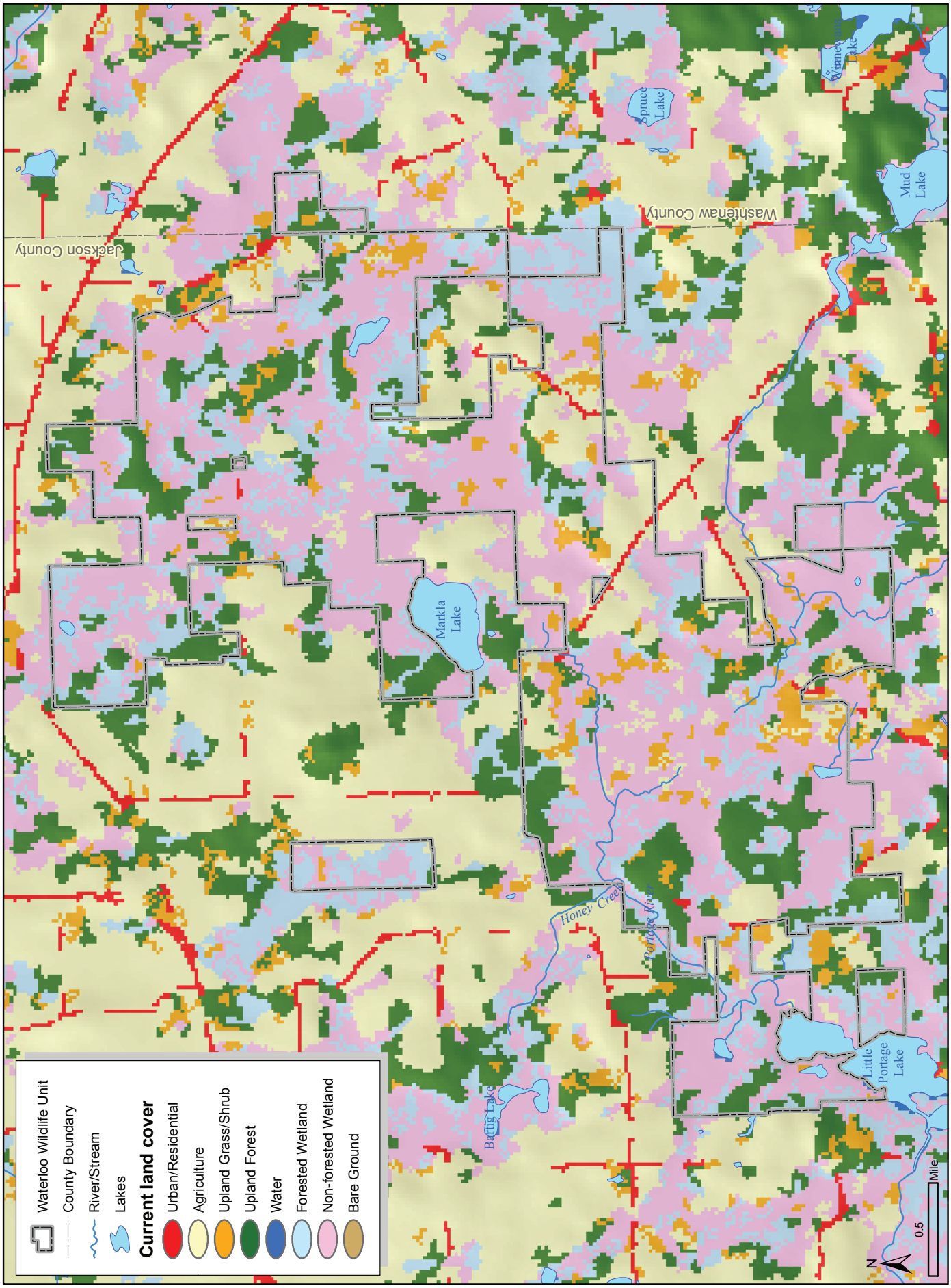


Figure 3. 2001 Land Cover (DNR 2001).

to allow recording of GPS locations. The IPAQ units were loaded with ArcPad and relevant GIS layers such as digital photos, state land boundaries, IFMAP Stage 1 stand boundaries, roads, element occurrence records, etc. IPAQ units and Bluetooth receivers were carried into the field to support data collection during field work. Garmin GPS units were also carried during field work and used redundantly to insure against electronic data loss.

Natural Community Methods

Prior to surveys, the Biotics database was queried for pre-existing natural community element occurrences records within a ten mile radius of the wildlife unit. The element occurrence records were used to help determine targets for field survey work. In addition to reviewing the natural community element occurrences within and near the wildlife unit, stand information contained in IFMAP (DNRE's Integrated Forest Monitoring, Assessment, and Prescription System) and aerial images from 1938, 1998, and 2005 were reviewed and interpreted to determine the types of natural communities likely to be present. Comparisons among 1938, 1998, and 2005 aerial photos were then used to help select high priority stands for surveys. Stands that appeared to have remained structurally unchanged (e.g., remained forested) from 1938 to 2005 were given the highest priority for surveys. Field surveys for high quality natural community occurrences were conducted from 2 June to 11 November. Natural community field surveys were accomplished for all pre-existing element occurrence records, for sites with little apparent structural change over time, for uncommon community types, and for stands deemed to have potential to significantly improve with restoration. Stands surveyed for natural communities are illustrated in Figure 4. Data collection focused on identifying and documenting new natural community element occurrences, updating information for pre-existing element occurrences, and recording overall management concerns (such as evidence of fire suppression, invasive species, hydrologic manipulation, and excessive deer herbivory). Plant species lists were generated for all natural community element occurrences and for those areas deemed to have potential to significantly improve with restoration. When state-listed plant or animal species (i.e., state-endangered, threatened, or special concern) were encountered during field surveys, their presence was documented with GPS points and special plant and animal forms. In addition, photographs were taken to document the presence of natural communities and rare species.

Rare Animal Inventory Methods

Rare animal target species were identified based on historical distribution in the region or current occurrences in the recreation area, or had a high likelihood of occurrence based on available habitat within the recreation area. Natural community and habitat information was based on IFMAP data layers, aerial photo interpretation, occurrences in the MNFI Biotics database, and on-the-ground observations by ecologists. Rare animal inventories were performed in appropriate habitat during periods when the targeted animals were most active (or when adults would be expected to occur). Surveys emphasized both the identification of new occurrences and the review of historical occurrences of rare species.

Avian Surveys Methods

We conducted surveys for rare species of three bird groups: (1) marsh birds, (2) forest songbirds, and (3) grassland songbirds. We focused most of our survey effort on rare marsh birds, because of their secretive nature and the abundance of emergent wetland within the recreation area. Primary target species for rare marsh bird surveys were American Bittern (*Botaurus lentiginosus*), Least Bittern (*Ixobrychus exilis*), King Rail (*Rallus elegans*), Common Moorhen (*Gallinula chloropus*), Black Tern (*Chlidonias niger*), and Marsh Wren (*Cistothorus palustris*), but we also collected data on other Species of Greatest Conservation Need, such as Virginia Rail (*Rallus limicola*), Sora (*Porzana carolina*), and Sedge Wren (*Cistothorus platensis*). Surveys for rare forest and grassland songbirds were conducted in the largest blocks of potential habitat available within the survey area, as indicated by IFMAP data and aerial photograph interpretation. Based on the available habitat, our primary target species for rare songbird surveys were Cerulean Warbler (*Dendroica cerulea*), Henslow's Sparrow (*Ammodramus henslowii*), Grasshopper Sparrow (*Ammodramus savannarum*), and Dickcissel (*Spiza americana*).

We conducted marsh bird surveys using point-count methods described by Conway (2009) for the National Secretive Marsh Bird Survey. Survey points were at least 400 m apart and placed randomly within emergent wetlands identified through the National Wetlands Inventory and IFMAP surveys. A complete round of surveys consisted of one visit to each survey point during each of the following three periods: May 1-14, May 15-31, and June 1-15. Multiple surveys within a given breeding season are recommended for marsh birds, because of variable nesting phenologies and low detectability of some secretive species. Marsh birds were surveyed between 0.5 hr before to three hr after sunrise. We conducted 10-min point counts consisting of a five-min passive period followed by one-min broadcast periods for American Bittern, Least Bittern, King Rail, Virginia Rail, and Sora. We recorded the locations of target species using GPS or estimated distances and bearings from point count locations.

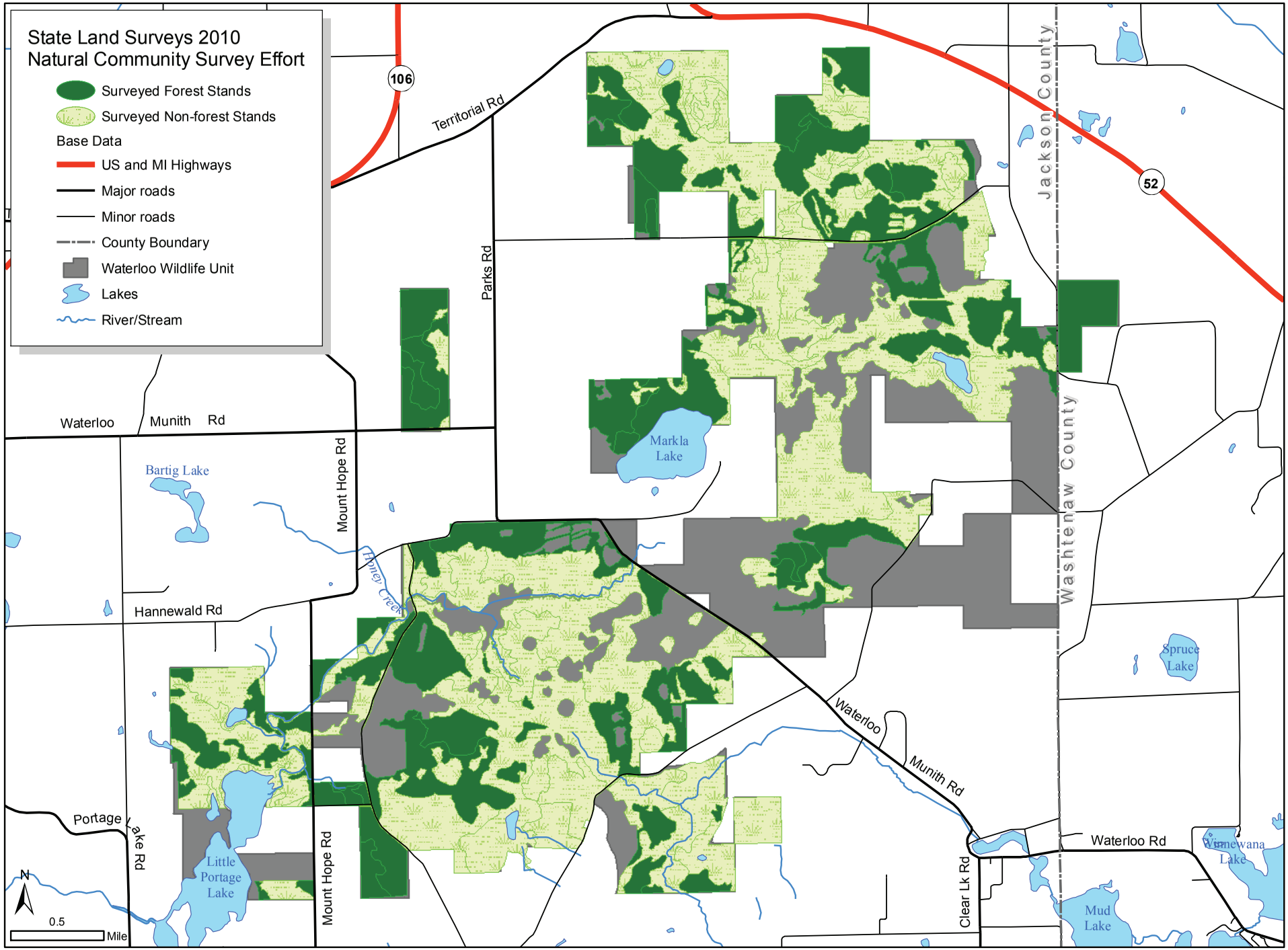


Figure 4. Natural Community Survey Effort.

We conducted 10-min point counts to find active Cerulean Warbler territories and to characterize the overall forest breeding bird community. Point count stations were placed in large stands of mature forest as indicated by IFMAP data layers. We used survey methods similar to the standard protocol recommended by Ralph et al. (1995). Surveys were done during late June and early July, 2010 between sunrise and four hours after sunrise. We recorded the species and number of individuals observed during three independent periods (3 min, 2 min, and 5 min) for a total survey time of 10 min at each point. Use of the three survey periods provides flexibility in making comparisons with other commonly used protocols (e.g., North American Breeding Bird Survey). Each bird observation was assigned to one of four distance categories (0-25 m, 25-50 m, 50-100 m, and >100 m) based on the estimated distance from the observer to facilitate future distance analyses and refinement of density estimates. We also recorded qualitative information about the estimated quality of the habitat for Cerulean Warbler.

We conducted surveys for rare grassland-nesting songbirds in the following four general areas (Figure 5): (1) west of Riethmiller Road, (2) northeast of Waterloo-Munith Road, (3) southwest of Waterloo-Munith Road, and (4) east of Moeckel Road. Surveys were done by walking transects through potential habitat and stopping periodically to look and listen for target species. The area west of Riethmiller Road was visited twice, while all other grassland blocks were surveyed once. For each rare species observed, we counted the number of individuals encountered within each block and recorded their locations using GPS equipment.

In addition to the aforementioned bird survey work, we also spent an entire day in early April searching for Great Blue Heron rookeries within the wildlife unit. Rookery surveys were road-based; all roads in the wildlife unit were slowly driven as two observers scanned the area for stick nests using 10 x 40 binoculars and when needed a 20-60x spotting scope with a window mount. We documented all rookery observations and completed MNFI special animal survey forms, and recorded all locations using GPS equipment.

Reptile and Amphibian Survey Methods

The following species of reptiles and amphibians (i.e., herpetofauna or herps) were targeted for surveys: Northern or Blanchard's Cricket Frog, (*Acris crepitans* (Frost et al. 2008) or *Acris crepitans blanchardi*, state threatened), Smallmouth Salamander (*Ambystoma texanum*, state endangered), Spotted Turtle (*Clemmys guttata*, state threatened), Blanding's Turtle (*Emydoidea blandingii*, special concern), Eastern Box Turtle (*Terrapene carolina carolina*, special concern), Gray Ratsnake (*Pantherophis spiloides*, special concern) (formerly Black Ratsnake, *Elaphe obsoleta obsoleta*, Crother et al. 2008), and Eastern Massasauga (*Sistrurus catenatus catenatus*, federal candidate and state special concern). Additional amphibian and reptile species that have been identified as SGCN in Michigan's Wildlife Action Plan also were targeted for surveys (see Appendix 3). Several techniques were used to survey for these species. These included meander or visual encounter surveys, breeding frog call surveys, trapping with aquatic funnel traps, road cruising, and dipnetting.

Meander or visual encounter surveys were conducted to survey for amphibians and reptiles from 6 May to 17 September during periods in which the probability of sightings were relatively high (e.g., May and June). Meander/visual encounter surveys are a standard method for surveying terrestrial amphibians and reptiles (Campbell and Christman 1982, Corn and Bury 1990, Crump and Scott 1994, Heyer et al. 1994, Manley et al. 2005). These surveys have potential for detecting all targeted herp species, particularly the targeted turtle and snake species. Visual encounter/meander surveys were conducted at multiple locations in the wildlife unit, focusing on areas with available suitable habitats for targeted species. Each survey location was visited one to four times for targeted herp surveys during the field season. The visual encounter surveys were conducted during daylight hours and under appropriate weather conditions when targeted species were expected to be active and/or visible. These surveys consisted of walking slowly through suitable or potential habitats, overturning cover (i.e., logs, boulders, etc.), inspecting retreats, and looking for basking, resting, and/or active individuals in or along the edge of open wetlands, waterbodies (i.e., pools, ponds, streams, and rivers), and upland and lowland forest stands. Surveys for turtles and snakes basking, resting, or moving in wetland habitats or waterbodies also were conducted by scanning habitats with binoculars and slowly walking around the wetland edges. Surveys for turtles and snakes in terrestrial habitats focused on looking for individuals in open areas and areas along the interfaces between wetland and upland habitats as well as open and forested habitats. Several potential nesting habitats near wetlands were also searched for nesting turtles. Discoveries of rare reptiles and amphibians also were documented during natural community surveys and surveys for other rare animals.

Breeding frog call surveys were conducted to survey for the Blanchard's Cricket Frog. Frog call surveys were conducted on 28 June 2010 at six locations along or near lake-sized water bodies (i.e., Markla Lake and Little Portage Lake) and stream crossings on Riethmiller, Mount Hope, and Portage Lake roads (Figure 6). A known Blanchard's Cricket Frog site nearby within the Pinckney

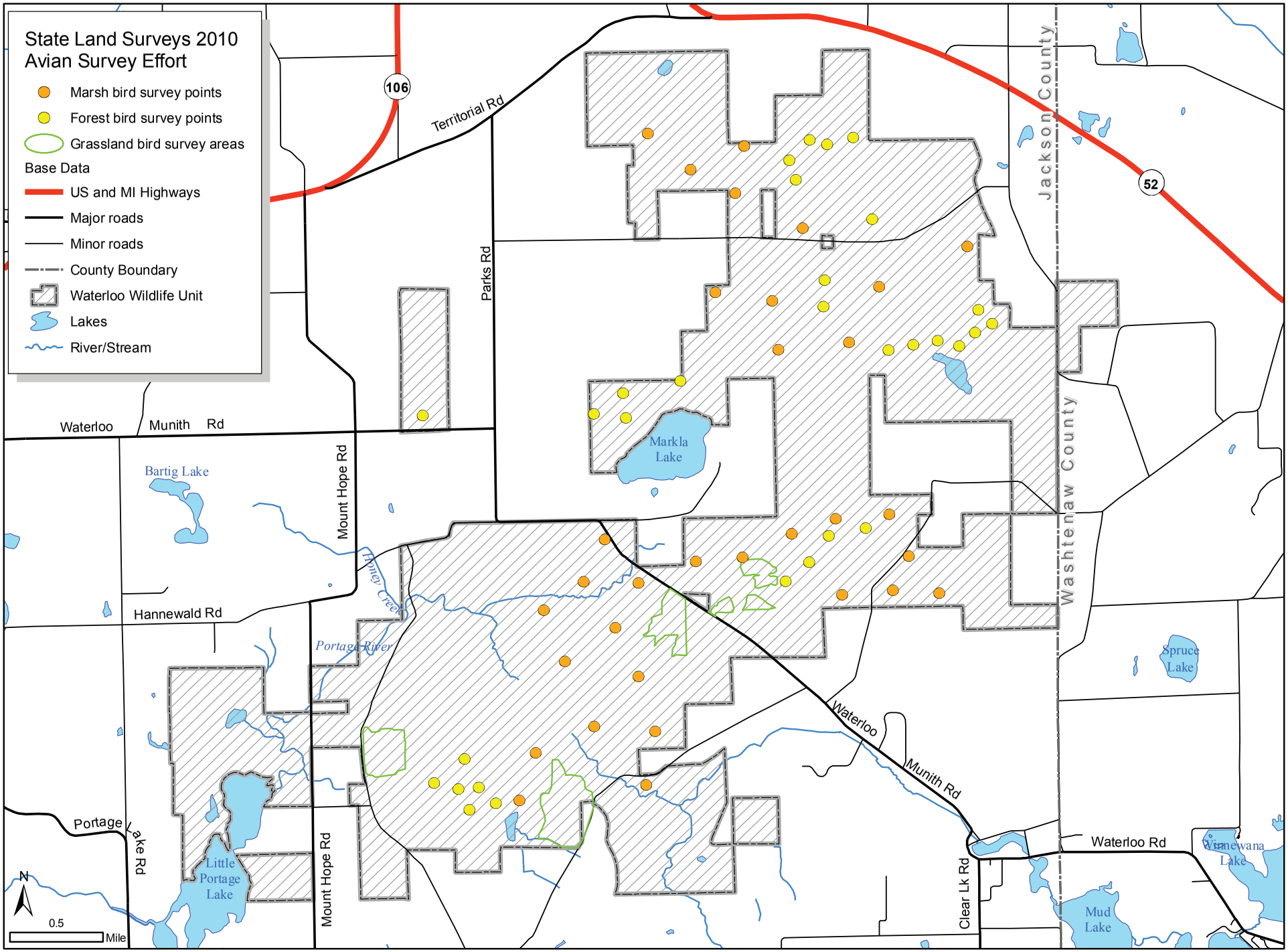


Figure 5. Avian Survey Effort.

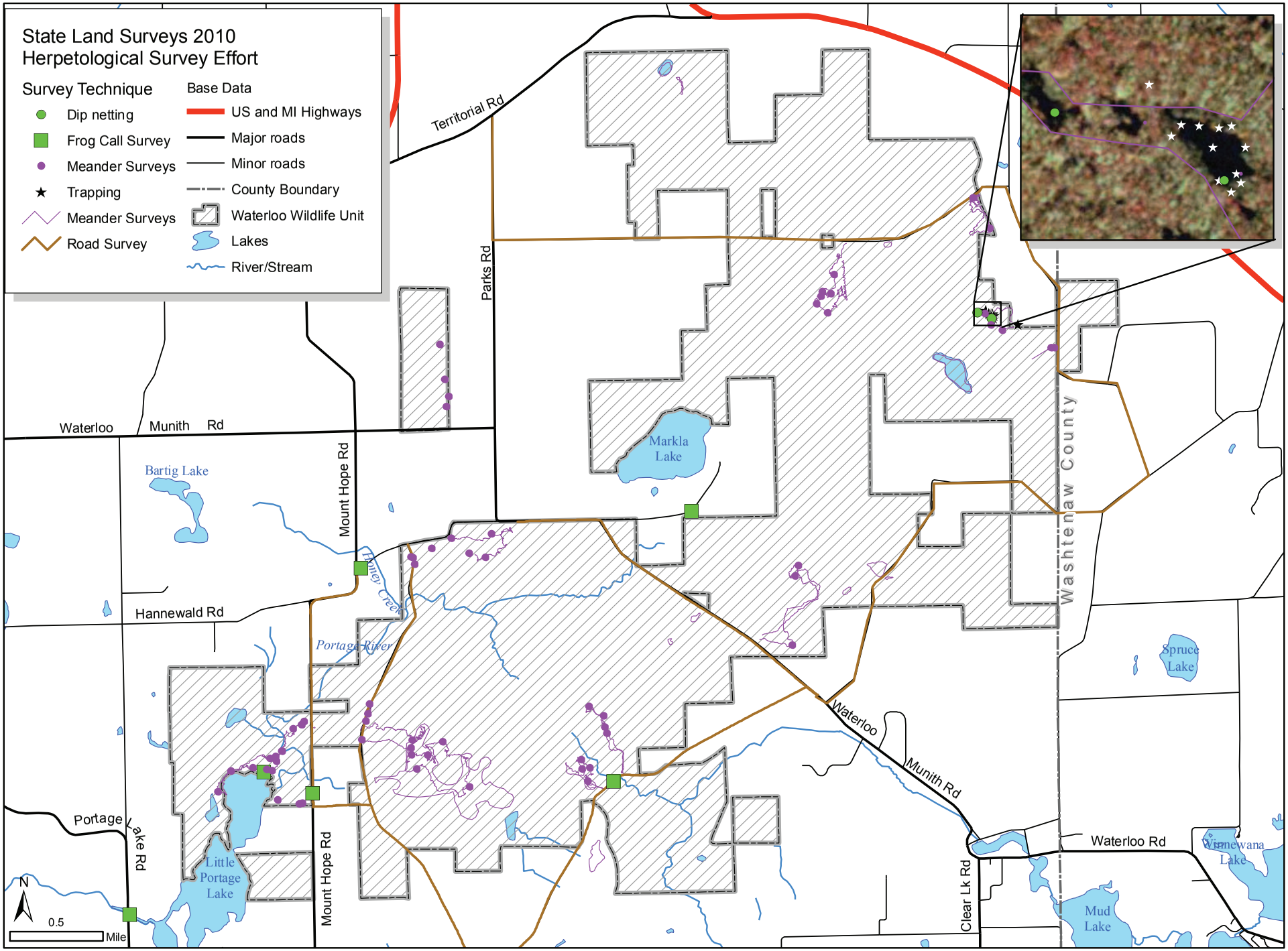


Figure 6. Herpetological Survey Effort.

Recreation Area also was surveyed the same night to ensure that the species was still calling and could be detected during the frog call surveys. Surveys were conducted by listening for calling frogs after dark (9 pm to 1 am) for ten minutes from the road or adjacent upland habitat. Species, call index values indicating relative abundance, location, time, and weather conditions were recorded. Call indices were defined in the following manner: 1 = individuals can be counted, space between calls (i.e., 1-5 individuals); 2 = individual calls can be distinguished but some overlapping calls (6-12 individuals); and 3 = full chorus, calls are constant, continuous and overlapping, unable to count individuals (Michigan Department of Natural Resources Frog and Toad Survey Protocol 2000).

Trapping with aquatic funnel traps was conducted on 17-18 June 2010 to survey for Smallmouth Salamander larvae and other salamander SGCN. Trapping was conducted at three small, shallow wetlands northeast of Leeke Lake, which included one forested vernal pool and two inundated shrub swamps (Figure 6). These wetlands were located in a dry southern forest (stand 296), and were primarily forested or surrounded by forest with more open, shrubby sections dominated by buttonbush in two of the wetlands. At least two of the three wetlands are likely temporary wetlands and dry completely or significantly in the summer or fall. Commercially available modified minnow traps were used for aquatic funnel traps. These traps are about 46 cm long x 25 cm wide (i.e., 18 in long x 12 in wide) and consist of a collapsible, spring loaded, metal or wire frame covered with 3-mm mesh nylon webbing with funnels with 5-cm (2 in) openings extending inward at both ends (H1 – salamander trap photo). As water temperatures warm and oxygen levels decrease in the wetlands, it is important that a small section of the funnel or minnow trap penetrates the water surface to allow any terrestrial animals captured access to air. Since trapping was conducted in late spring when the water was warmer than earlier in the spring, plastic water bottles were placed in the traps to keep the top of the trap floating above the water surface to provide captured organisms access to air (H2). A total of 22 traps were set in the three wetlands (10 in one wetland, 8 in the second wetland, and 4 in the third and smallest wetland) during the day. These traps were left overnight in the wetlands, and checked the following day. This resulted in a total of 22 trap-nights. Amphibian larvae and adults that were captured in the traps were identified to the extent possible, noted, and released. Some dead specimens were collected to confirm identification. Several live salamander larvae and tadpoles also were collected and reared to confirm species identification after metamorphosis to adults.

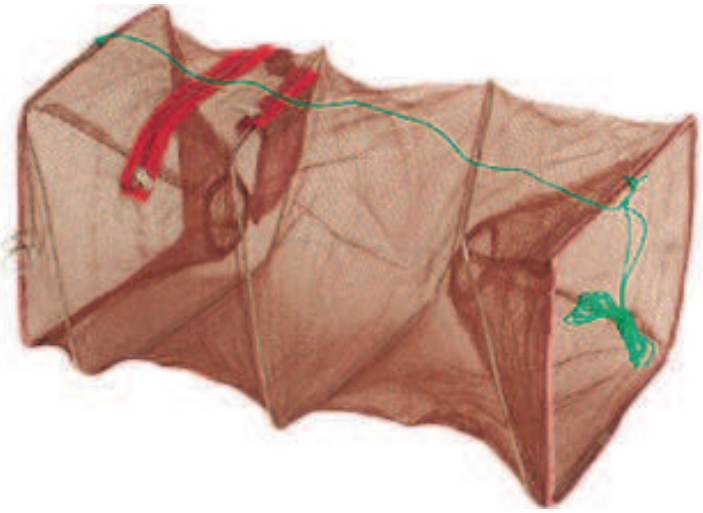
Road-cruising surveys also were conducted to survey for reptiles and amphibians in the wildlife unit (Figure 6). These surveys consisted of driving along the roads and looking for live or dead reptiles and amphibians in the road or in suitable habitat along the road (Karns 1986). All amphibians and reptiles encountered during roadside surveys were recorded. Amphibians and reptiles observed incidentally while driving through the wildlife unit during other natural features surveys also were recorded.

Dipnetting also was conducted in several of the small, shallow wetlands such as vernal pools and inundated shrub swamps northeast of Leeke Lake (Figure 6). Dipnetting is a useful method for sampling herpetofauna in small aquatic or wetland habitats, particularly aquatic amphibians and amphibian larvae as well as some aquatic reptiles (Graeter et al. *in press*). Dipnetting consisted of slowly walking through the wetland and sweeping an aquatic D-net through the water and along the substrate in the wetland in order to capture amphibians and reptiles (Graeter et al. *in press*). Several dipnet samples were taken in each wetland that was surveyed.

Survey data forms (Appendix 1 and 2) were completed for all surveys, and survey locations were recorded with a GPS or IPAQ unit. All reptiles and amphibians and other animals encountered during surveys were recorded. The species, number of individuals, age class, location, activity, substrate, and time of observation were noted. Weather conditions and start and end times of surveys also were recorded. MNFI special animal survey forms were completed when rare reptile or amphibian species were encountered, and locations were recorded with a GPS or IPAQ unit. Photos of rare species also were taken for supporting documentation, when possible.

Butterflies and Moths Survey Methods

Areas that received survey attention for rare butterfly and moths included those areas that supported prairie fen or remnant parcels with a prairie plant component. These surveys were focused primarily south of Tophith Road and along parts of Harr Road. Targeted butterflies included the following: swamp metalmark (*Calephelis mutica*, special concern), Poweshiek skipperling (*Oarisma poweshiek*, state threatened), and Dukes' skipper (*Euphyes dukesi*, state threatened). Surveys for targeted butterflies were conducted by walking through suitable habitat during appropriate weather conditions and visually observing adults in flight, perched on vegetation, or nectaring on flowers. In the case of the Duke's skipper, roadsides were driven in search of suitable wetland habitats (*Carex lacustris*-dominated areas) and then further inventoried on foot. Species that looked similar to the target species were captured with an aerial



Promar Collapsible Minow Trap for sampling salamanders as pictured on Cabela's web site (www.cabelas.com)

Yu Man Lee

Salamander trap floating at Waterloo Wildlife Unit

net, identified in hand, and then released. Stands surveyed for rare butterflies and moths are illustrated in Figure 7.

Moth species targets were the maritime sunflower borer moth (*Papaipema maritima*, special concern), blazingstar borer moth (*Papaipema beeriana*), regal fern borer moth (*Papaipema speciosissima*, special concern), and the Culver's root borer moth (*Papaipema sciata*, special concern). Moth surveys utilized two techniques, which we refer to as either blacklighting or placement of blacklight traps.

The first survey technique, blacklighting, consisted of standard mercury-vapor and UV lights powered by a portable generator. A 2 m x 2 m metal conduit frame supporting a large white sheet was used as a collecting surface. The second technique, blacklight traps, is a passive survey method whereby a bucket-type trap is placed in the field and a 15 watt UV light is powered by a battery. Moths that are attracted to the light then hit a baffle with directs moth down and funnel and into the bucket where the moths remain until the traps are checked the next day. Both the frame and bucket traps were placed in the field in a central location with larval host plants on all sides to maximize the likelihood of collecting adults. These locations were recorded using a hand-held GPS unit and *Papaipema* moth survey forms were completed for each site. Blacklighting occurred at three sites in areas containing the host plant of the targeted moths. The first site was located in an area of prairie fen-like vegetation south of Tophith Road and near the eastern boundary near Leeke Lake Road (Figure 7). This site contained a population of giant sunflower (*Helianthus giganteus*) and blazingstar (*Liatris spicata*). Sampling occurred during the four hours from 8:00 PM to 12:00 Midnight on 20 September and again from 8:00 PM to 10:30 PM until a thunderstorm rolled through the area on September 21. A second site was located again south of Tophith Road but further to the west in a small pocket of prairie fen-like vegetation which contained a small population of giant sunflower and also regal fern is in the vicinity (Figure 7). Sampling occurred at this site from 8:00 PM on 22 September to 12:00 Midnight. The third site was along the edge of a wet meadow/prairie fen-like area northwest off Harr Road which contained a small population of royal fern (*Osmunda regalis*) as well as cinnamon fern (*Osmunda cinnamonea*). Sampling occurred here on 23 September from 8:00 PM through 12:45 AM September 24. Upon completion of the active blacklighting here, we then placed a blacklight trap and checked it the following mourning around 11:00am. We also placed a blacklight trap which ran during the same time period of 8:00 PM September 23 through 11:00 AM September 24 in an area of Tophith Road, in a small parking area which contained a small population of Culver's root (*Veronicastrum virginicum*)

Leafhopper and Spittlebug Survey Methods
Sweep net samples were taken in prairie, wet meadow, and fen remnants that contained appropriate host plants for three leafhoppers (*Flexamia reflexus*, special concern, *F.*

David L. Cuthrell

Blacklighting for rare insects

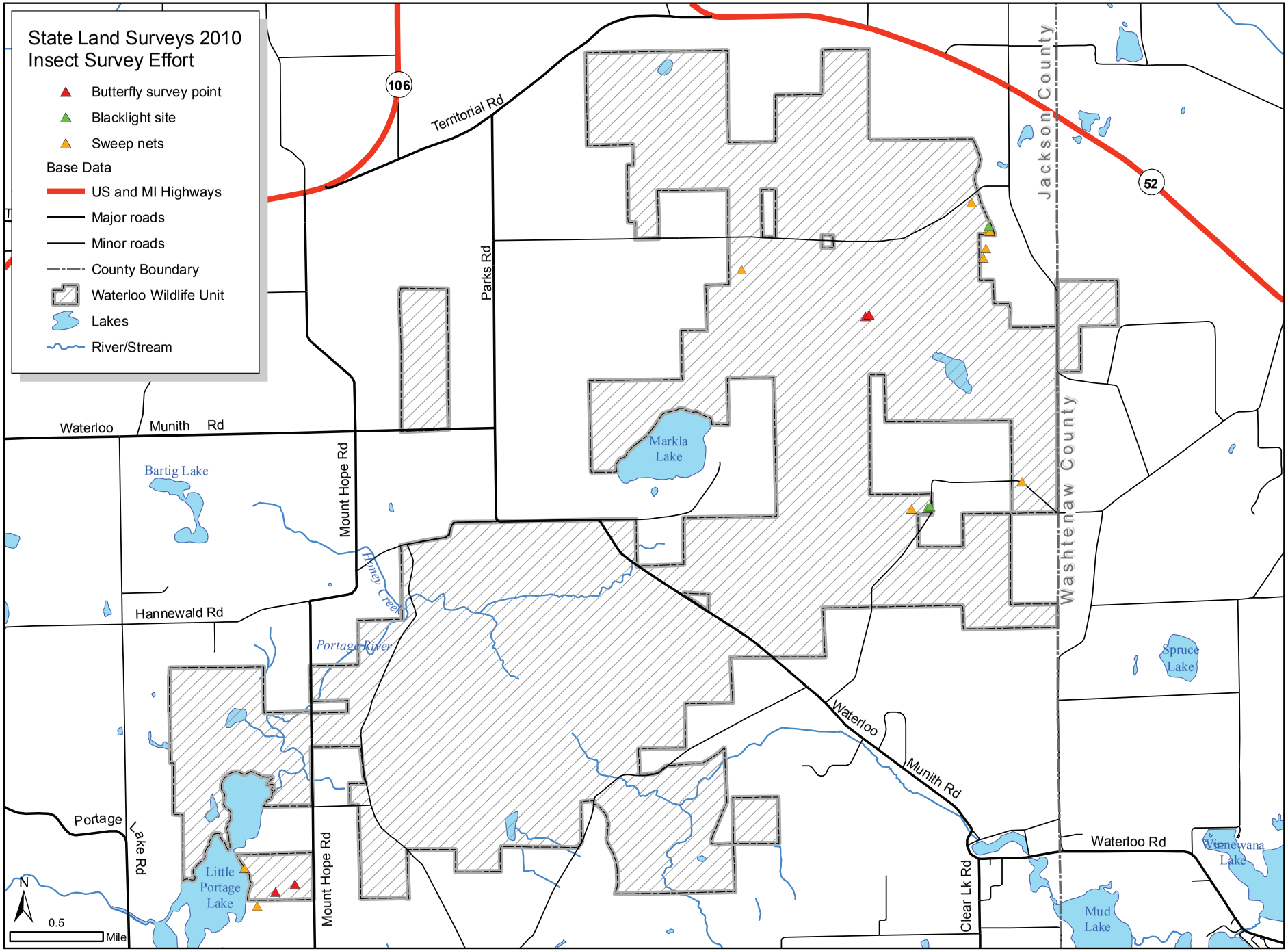


Figure 7. Insect Survey Effort.

delongi, special concern, and *Dorydiella kansana*, special concern), the angular spittlebug (*Lepyronia anguliferia*, special concern), and red-legged spittlebug (*Prosapia ignipectus*, special concern). At each location, vegetation was sampled while meandering through appropriate habitat. A standard sample consisted of approximately 100 swings of a sweepnet, with one swing taken with each step. The contents of the net were emptied into a large killing jar charged with ethyl acetate. When the specimens had stopped moving, they were transferred to a zip-lock plastic bag and placed into a cooler. Bagged samples were then frozen until they could be processed later in the lab. Processing consisted of sorting all insects from the vegetation, pinning larger specimens and pointing smaller ones. Those specimens that were similar to the targets were labeled and keyed or directly compared to specimens contained in the Michigan Natural Features Inventory Reference Collection. Stands surveyed for rare leafhoppers and spittlebugs are illustrated in Figure 7.

Rare Mollusk Survey Methods

Rare aquatic animals in Michigan include unionid mussels, gastropods (snails), fish, and insects (dragonflies, beetles, caddisflies, etc.). An initial assessment of habitat within the wildlife unit was made to prioritize aquatic survey efforts. Gastropods and unionid mussels were chosen as primary survey targets for this study based on the best likelihood of occurrences of rare species, and lack of previous surveys for these taxa in the wildlife unit.

Aquatic and terrestrial gastropods were collected by hand from a variety of microhabitat types within wetlands, lakes, and an upland field. In total, aquatic and terrestrial gastropod samples were collected from seven sites and a variety of microhabitats (Sites E to K, Figure 8). Four sites were located in wetlands, two in lakes, and one in an upland field. Latitude and longitude of sites and microhabitat types sampled are given in Appendix 4. Live specimens and shells were placed in vials with 75% ethanol along with a label. Handheld GPS units (Garmin 12XL) were used to document the position of collection sites. Gastropods were later identified to species in the lab with the aid of a stereo-microscope.

Unionid mussel surveys were performed at three sites (Sites B, C, and D, Figure 8). The surveys were designed to determine the presence/absence and abundance of each unionid mussel species. Sections of Portage Creek upstream (northeast) of Little Portage Lake were walked to assess available unionid mussel habitat. An additional site was targeted for unionid mussel surveys, but after a qualitative assessment it was not surveyed due to lack of appropriate habitat (Site A, Figure 8, a small tributary at the Riethmiller Rd. crossing). At each survey site, a measured search area was used to standardize sampling effort among sites and allow unionid density estimates to be made. Typically 128m^2 provides a good compromise between amount of search effort per site and the number of sites to be completed within the timeline of the project. The search area extended from bank to bank in order to include a wide range of microhabitats. Handheld GPS units (Garmin 12XL) were used to document the position of survey sites.

Live unionids and shells were located with a combination of visual and tactile means. Glass bottom buckets were used to facilitate visual searches. Occasional tactile searches through the substrate were made at sites where primarily visual detection was used to help ensure that buried unionids were not being overlooked. Live individuals were identified to species and planted back into the substrate anterior end down (siphon end up). Shells were also identified to species. Presence/absence was recorded for the invasive exotic Asian clam (*Corbicula fluminea*), zebra mussel (*Dreissena polymorpha*), and quagga mussel (*Dreissena bugensis*).

The substrate within each transect was characterized by estimating percent composition by volume of each of the following six particle size classes (diameter); boulder (>256mm), cobble (256-64mm), pebble (64-16mm), gravel (16-2mm), sand (2-0.0625mm), silt/clay (<0.0625) (Hynes 1970).

RESULTS

During surveys of the Waterloo Game Unit, we identified 24 new element occurrences, including 17 natural community occurrences, 2 rare plants occurrences, and 5 animal occurrences (Tables 1 and 2). In addition, the presence of 9 previously identified element occurrences was reconfirmed, and updated information was entered into the Biotics database (Tables 1 and 2). The distribution of survey effort across the wildlife unit was documented with GPS and is graphically illustrated by survey target in Figures 4 to 8. The locations of all natural community and rare species occurrences (both new and prior occurrences) for the Waterloo Game Unit are illustrated in Figures 9 to 12.

Natural Community Inventory Results

The natural community surveys resulted in the

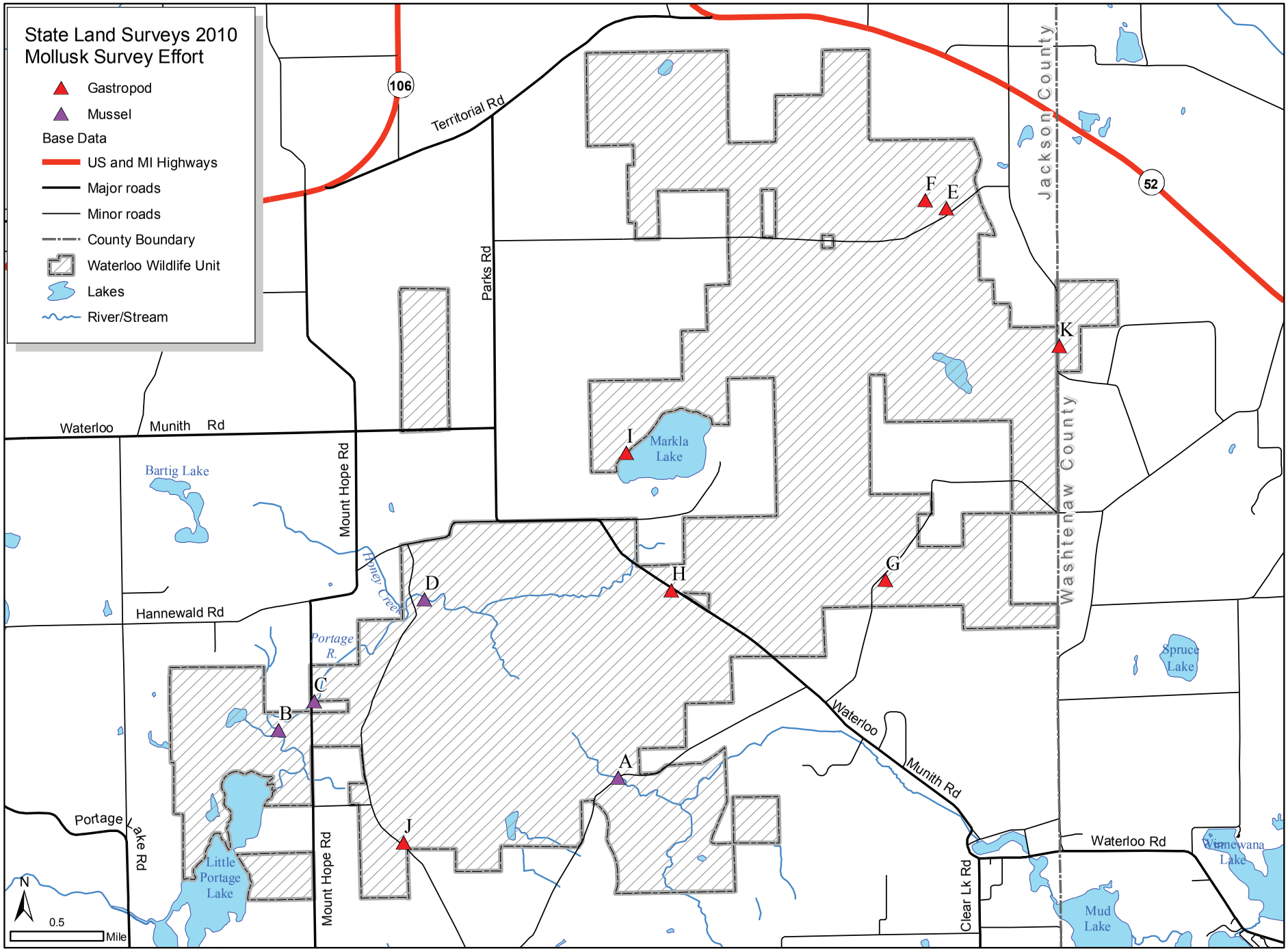


Figure 8. Mollusk Survey Effort.

Table 1. Newly documented and previously known and natural community element occurrences for the Waterloo Wildlife Unit in 2010.

Site Name	Community Type	EO ID	EO Rank	Year First Observed	Year Last Observed	Global Rank	State Rank
Moeckel Road Tall Shrub Bog	Bog	17489	C	2010	2010	G3G5	S4
Moeckel Road Shrub and Tree Bog	Bog	17490	C	2010	2010	G3G5	S4
South Portage Marsh	Emergent Marsh	17549	B	2010	2010	GU	S4
Moeckel Road Woods	Dry Southern Forest	17491	BC	2010	2010	G4	S3
Little Portage Lake Woods	Dry Southern Forest	17492	C	2010	2010	G4	S3
Tophith Road Woods	Dry Southern Forest	17496	C	2010	2010	G4	S3
North Waterloo Woods	Dry Southern Forest	17497	BC	2010	2010	G4	S3
Markla Lake Woods	Dry-Mesic Southern Forest	17500	BC	2010	2010	G4	S3
Tophith Road Buttonbush Swamps	Inundated Shrub Swamps	17494	BC	2010	2010	G4	S3
Waterloo Black Spruce Bog	Poor Conifer Swamp	16762	C	1966	2010	G4	S4
Little Portage Lake Fen	Prairie Fen	16876	BC	1999	2010	G3	S3
Tophith Road Fen	Prairie Fen	17521	C	2010	2010	G3	S3
Reithmiller Road Fen	Prairie Fen	17523	C	2010	2010	G3	S3
M52 Tamarack Swamp	Rich Tamarack Swamp	7962	AB	1998	2009	G4	S3
Little Portage Lake Swamp	Rich Tamarack Swamp	15946	B	1999	2010	G4	S3
Leeke Lake Swamp	Rich Tamarack Swamp	15947	B	1999	2010	G4	S3
Riethmiller Road Tamarack Swamp	Rich Tamarack Swamp	17535	BC	2010	2010	G4	S3
Tophith Road Oak Swamp	Southern Hardwood Swamp	17498	BC	2010	2010	G3	S3
Waterloo-Munith Road Oak Swamp	Southern Hardwood Swamp	17522	C	2010	2010	G3	S3
North Waterloo Wet Meadow	Southern Wet Meadow	17525	BC	2010	2010	G4?	S3
Riethmiller Road Wet Meadow	Southern Wet Meadow	17534	B	2010	2010	G4?	S3
Tophith Road Prairie	Wet Prairie	17493	CD	2010	2010	G3	S2

identification of 17 new natural community element occurrences including two bogs, one emergent marsh, four dry southern forests, one dry-mesic southern forest, one inundated shrub swamp, two prairie fens, one rich tamarack swamp, two southern wet meadows, two southern hardwood swamps, and one wet prairie (Figure 9, Table 1). At each of the new element occurrences, the community boundaries were mapped and information was recorded on vegetation composition, soils, and management concerns. In addition, four previously identified natural community element occurrences were resurveyed, which included one poor conifer swamp, one prairie fen, and two rich tamarack swamps (Figure 9, Table 1). At each of the resurveyed sites, the community boundaries were reassessed and information was recorded on vegetation composition and management concerns. In Figure 9 and Table 1, we also listed the M52 Tamarack Swamp (rich tamarack swamp, EO ID 7962), but the area where this swamp occurs is not technically within the wildlife unit, and most of the element occurrence is located on adjacent, privately-owned land.

In addition to the natural community element occurrences we identified, the wildlife unit possesses numerous natural areas that are important to protect and steward because they provide significant wildlife habitat and harbor critical components of biodiversity. With restoration and management, these natural areas have great potential for becoming high quality natural communities and contributing significantly to regional biodiversity and wildlife habitat in southern Lower Michigan.

During the natural community surveys, two new rare plant element occurrence were documented (Table 1). The horsetail spike rush (*Eleocharis equisetoides*, state special

concern) was found growing along the shore Markla Lake (Figure 9). A new population of wild rice (*Zizania aquatica* var. *aquatica*, state threatened) was found associated with a small unnamed pond in the far northern portion of the wildlife unit north of Tophith Road (Figure 9). Two additional rare plant occurrences were updated: one for hay-scented fern (*Dennstaedtia punctilobula*, threatened) and another for wild rice (Table 1 and Figure 9).

Descriptions of the natural community element occurrences and associated management recommendations are provided in the section below. For this section of the report, community element occurrences are grouped by community type and preceded by a brief description of the natural community type. Management recommendations and a list of invasive species for each natural community element occurrence are included in Tables 3 and 4.

Table 2. Newly documented and previously known rare plant and animal element occurrences for the Waterloo Game Unit at Waterloo Recreation Area in 2010. State status abbreviations are as follows: E, state endangered; T, state threatened; SC, state species of special concern.

Scientific Name	Common Name	State Status	EO Number	Year First Observed	Year Last Observed
Plants					
Eleocharis equisetoides	Horsetail spike-rush	SC	19	2010	2010
Dennstaedtia punctiloba	Hay-scented fern	T	2	2006	2010
Zizania aquatica	Wild rice	T	30	1995	2010
Zizania aquatica	Wild rice	T	38	2010	2010
Herpatiles					
Emydoidea blandingii	Blanding's turtle	SC	23	1994	2010
Emydoidea blandingii	Blanding's turtle	SC	37	1995	2010
Clemmys guttata	Spotted turtle	T	36	1970	1970
Clemmys guttata	Spotted turtle	T	133	1970	1970
Sistrurus catenatus	Eastern massasauga	SC	34	1920	1920
Birds					
Gallinula chloropus	Common moorhen	T	2	1986	1995
Botaurus lentiginosus	American bittern	SC	2	1982	1995
Botaurus lentiginosus	American bittern	SC	5	1984	2010
Botaurus lentiginosus	American bittern	SC	8	1996	2010
Ixobrychus exilis	Least bittern	T	1	1984	1984
Ixobrychus exilis	Least bittern	T	2	1983	2010
Chlidonias niger	Black tern	SC	4	1982	1982
Rallus elegans	King rail	E	47	1990	1992
Dendroica cerulea	Cerulean warbler	T	9	1988	2005
Ammodramus henslowii	Henslow's sparrow	E	1	1982	2010
Ammodramus savannarum	Grasshopper sparrow	SC	20	2005	2006
Cistothorus palustris	Marsh wren	SC	6	2002	2010
Mammals					
Cryptotis parva	Least shrew	T	9	1922	1922
Myotis sodalis	Indiana bat	E	17	1947	1947
Insects					
Oecanthus laricis	Tamarack tree cricket	SC	10	1999	1999
Oecanthus laricis	Tamarack tree cricket	SC	11	1999	1999
Prosapia ignipectus	Red-legged spittlebug	SC	42	2010	2010
Prosapia ignipectus	Red-legged spittlebug	SC	43	2010	2010
Prosapia ignipectus	Red-legged spittlebug	SC	44	2010	2010
Unionid Mussels					
Utterbackia imbecillis	Paper pondshell	SC	5	2010	2010
Snails (Gastropods)					
Vallonia parvula	Trumpet vallonia	SC	1	2010	2010

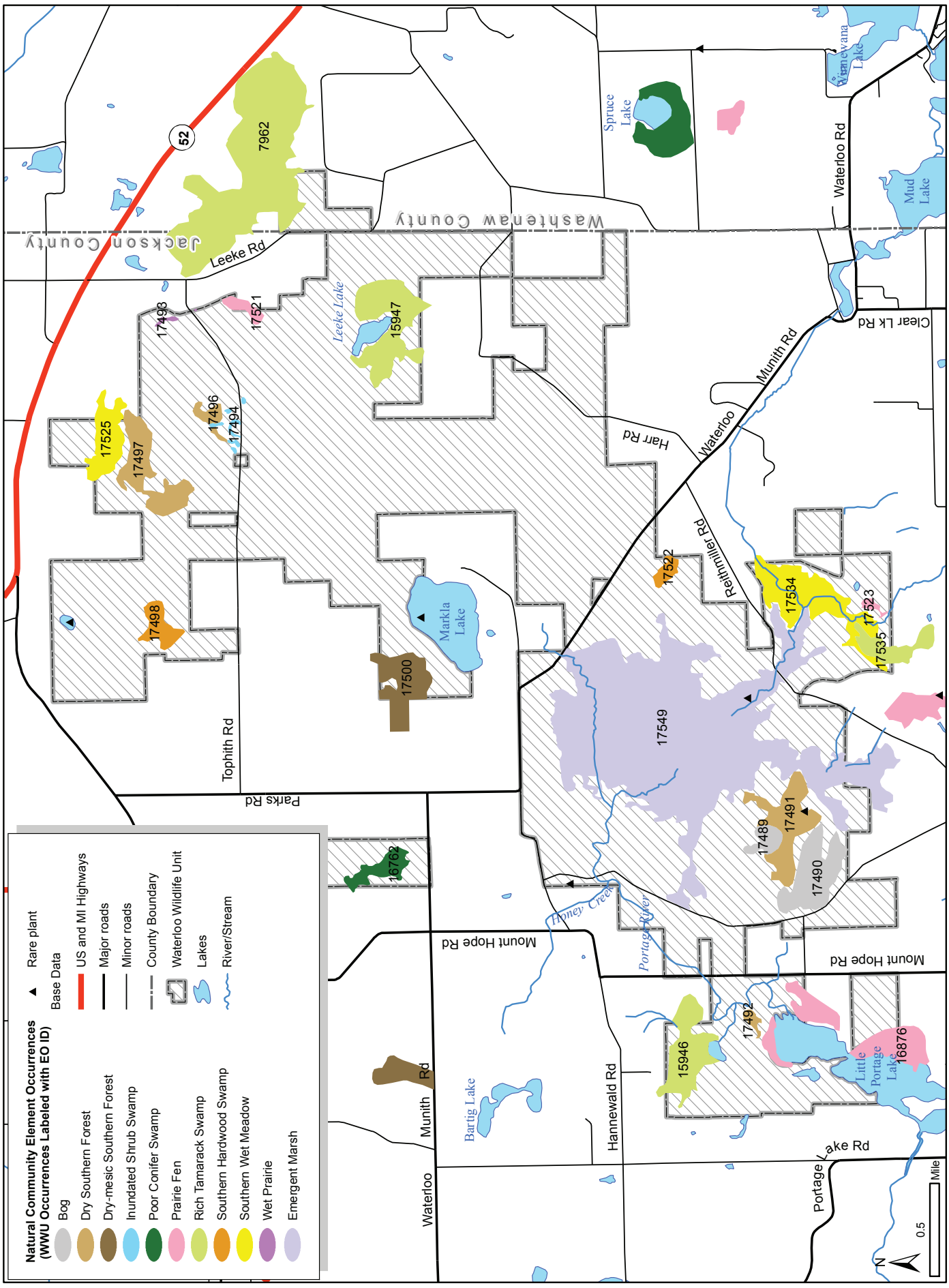


Figure 9. Natural Community and Rare Plant Element Occurrences.

Table 3. Summary of management recommendations for natural community element occurrences for the Waterloo Wildlife Unit in 2010.

Site Name	Community Type	Management Recommendations
Moeckel Road Tall Shrub Bog	Bog	• control and monitor invasive species • assess hydrologic impact of drainage ditch and fill if feasible • restore and protect hydrology • allow prescribed fires from adjacent sites to burn into bog
Moeckel Road Shrub and Tree Bog	Bog	• control and monitor invasive species • assess hydrologic impact of earthen dam to the east • restore and protect hydrology • allow prescribed fires from adjacent sites to burn into bog
South Portage Marsh	Emergent Marsh	• control and monitor invasive species • reduce runoff from roads and farm fields • restore and protect hydrology • apply prescribed fire in conjunction with invasive species control efforts
Moeckel Road Woods	Dry Southern Forest	• regularly apply prescribed fire • control and monitor invasive species • reduce cover of red maple
Little Portage Lake Woods	Dry Southern Forest	• regularly apply prescribed fire • control and monitor invasive species • reduce cover of red maple
Tophith Road Woods	Dry Southern Forest	• regularly apply prescribed fire • control and monitor invasive species • reduce cover of red maple
North Waterloo Woods	Dry Southern Forest	• regularly apply prescribed fire • control and monitor invasive species • reduce cover of red maple
Markla Lake Woods	Dry-Mesic Southern Forest	• regularly apply prescribed fire • control and monitor invasive species • reduce cover of red maple
Tophith Road Buttonbush Swamps	Inundated Shrub Swamps	• control and monitor invasive species • protect hydrology • allow prescribed fires from adjacent sites to burn into shrub swamps
Waterloo Black Spruce Bog	Poor Conifer Swamp	• control and monitor invasive species • reduce cover of maples in conifer swamp through girdling and stump-application of herbicide • assess hydrologic impact of drainage ditch to west and fill if feasible • restore and protect hydrology
Little Portage Lake Fen	Prairie Fen	• control and monitor invasive species • apply prescribed fire • remove trash and construction debris • protect hydrology
Tophith Road Fen	Prairie Fen	• control and monitor invasive species • reduce shrub and tree cover • apply prescribed fire • protect hydrology

Table 3. continued

Site Name	Community Type	Management Recommendations
Riethmiller Road Fen	Prairie Fen	• control and monitor invasive species • reduce shrub and tree cover • apply prescribed fire • protect hydrology
M52 Tamarack Swamp	Rich Tamarack Swamp	• control and monitor invasive species • protect hydrology • assess long-term protection options (site is mostly privately owned)
Little Portage Lake Swamp	Rich Tamarack Swamp	• control and monitor invasive species • reduce red maple cover through girdling and stump-application of herbicide • allow prescribed fires from adjacent sites to burn into swamp • protect hydrology
Leeke Lake Swamp	Rich Tamarack Swamp	• control and monitor invasive species • reduce red maple cover through girdling and stump-application of herbicide • allow prescribed fires from adjacent sites to burn into swamp • protect hydrology
Riethmiller Road Tamarack Swamp	Rich Tamarack Swamp	• monitor for invasive species and promptly remove if found • allow prescribed fires from adjacent sites to burn into swamp • protect hydrology
Tophith Road Oak Swamp	Southern Hardwood Swamp	• control and monitor invasive species • allow prescribed fires from adjacent sites to burn into swamp • protect hydrology
Waterloo-Munith Road Oak Swamp	Southern Hardwood Swamp	• control and monitor invasive species • apply prescribed fire • protect hydrology
North Waterloo Wet Meadow	Southern Wet Meadow	• control and monitor invasive species • reduce shrub cover • apply prescribed fire • protect hydrology
Riethmiller Road Wet Meadow	Southern Wet Meadow	• control and monitor invasive species • apply prescribed fire • reduce shrub cover • protect hydrology
Tophith Road Prairie	Wet Prairie	• regularly apply prescribed fire • reduce shrub and tree cover • control and monitor invasive species • protect hydrology

Natural Community Descriptions and Management Recommendations

The Waterloo Wildlife Unit contains an extensive wetland complex associated with the Portage River, a tributary of the Grand River. This massive wetland complex, referred to locally as the Portage Marsh, is a large, heterogeneous wetland comprised of a variety of wetland natural community types, including *submergent marsh* occupying zones of open water within the rivers, ponds, and lakes; *emergent marsh* comprised of emergent plants, such as cattails, standing in shallow water; *southern wet meadow* dominated by sedges; *prairie fen* dominated by grasses, sedges, and calciphilic forbs; *wet prairie* dominated by prairie grasses and sedges; *southern shrub-carr* dominated by willows (*Salix* spp.), dogwoods (*Cornus* spp.), and other wetland shrubs; *inundated shrub swamp* dominated by buttonbush (*Cephalanthus occidentalis*), *bog* dominated by smooth highbush blueberry (*Vaccinium corymbosum*) and

Table 4. Invasive plant species found within natural community element occurrences for the Waterloo Wildlife Unit in 2010. * indicates the native strain of common reed is also present.

Site Name	Community Type	**Garlic mustard (*Alliaria petiolata*)**	**Barberry (*Berberis thunbergii*)**	**Autumn olive (*Elaeagnus umbellata*)**	**Eurasian honeysuckles (*Lonicera* spp.)**	**Purple loosestrife (*Lythrum salicaria*)**	**Reed canary grass (*Phalaris arundinacea*)**	**Common reed (*Phragmites australis*)**	**Glossy buckthorn (*Rhamnus frangula*)**	**Multiflora rose (*Rosa multiflora*)**	**Bittersweet Nightshade (*Solanum dulcamara*)**	**Narrow-leaved cattail (*Typha angustifolia*)**	**Hybrid cattail (*Typha xglauca*)**	**Common Buckthorn (*Rhamnus cathartica*)**	**Hedge Parsley (*Torilis japonica*)**
Moeckel Road Tall Shrub Bog	Bog						X		X						
Moeckel Road Shrub and Tree Bog	Bog								X						
South Portage Marsh	Emergent Marsh					X	X	X*	X		X	X	X		
Moeckel Road Woods	Dry Southern Forest	X		X						X					X
Little Portage Lake Woods	Dry Southern Forest			X						X					
Tophith Road Woods	Dry Southern Forest	X		X	X				X	X					X
North Waterloo Woods	Dry Southern Forest	X		X	X					X					X
Markla Lake Woods	Dry-Mesic Southern Forest			X											
Tophith Road Buttonbush Swamps	Inundated Shrub Swamp	X					X		X						
Waterloo Black Spruce Bog	Poor Conifer Swamp								X						
Little Portage Lake Fen	Prairie Fen					X		X*	X			X			
Tophith Road Fen	Prairie Fen						X		X						
Reithmiller Road Fen	Prairie Fen			X						X					
M52 Tamarack Swamp	Rich Tamarack Swamp								X						

Table 4. continued

Site Name	Community Type	Garlic mustard (*Alliaria petiolata*)	Barberry (*Berberis thunbergii*)	Autumn olive (*Elaeagnus umbellata*)	Eurasian honeysuckles (*Lonicera* spp.)	Purple loosestrife (*Lythrum salicaria*)	Reed canary grass (*Phalaris arundinacea*)	Common reed (*Phragmites australis*)	Glossy buckthorn (*Rhamnus frangula*)	Multiflora rose (*Rosa multiflora*)	Bittersweet Nightshade (*Solanum dulcamara*)	Narrow-leaved cattail (*Typha angustifolia*)	Hybrid cattail (*Typha xglauca*)	Common Buckthorn (*Rhamnus cathartica*)	Hedge Parsley (*Torilis japonica*)
Little Portage Lake Swamp	Rich Tamarack Swamp						X		X						
Leeke Lake Swamp	Rich Tamarack Swamp				X	X									
Riethmiller Road Tamarack Swamp	Rich Tamarack Swamp														
Tophith Road Oak Swamp	Southern Hardwood Swamp						X	X		X					
Waterloo-Munith Oak Swamp	Southern Hardwood Swamp		X	X			X			X	X		X	X	
North Waterloo Wet Meadow	Southern Wet Meadow					X	X		X						
Riethmiller Road Wet Meadow	Southern Wet Meadow					X									
Tophith Road Wet Prairie	Wet Prairie				X		X								
Totals		4	1	7	4	5	9	3	11	7	2	2	2	1	3

sphagnum mosses, and forested wetlands comprised of *rich tamarack swamp* and *southern hardwood swamp*. Nested within this vast wetland matrix are upland islands that support *dry southern forest* and *dry-mesic southern forest*, both of which frequently contain vernal pools. Element occurrences were documented for all of the community types listed above except submergent marsh and southern shrub-carr and are discussed below. It is likely that with additional survey effort and associated time for data processing, an element occurrence for southern-shrub-carr could be also documented.

Emergent Marsh
Global/State Rank: GU/S4
One new element occurrence of emergent marsh was documented in the wildlife unit, South Portage Marsh (discussed below). Emergent marshes are semi-permanently inundated wetlands that are often found on mucky soils of depressions and along the margins of lakes, ponds, and rivers (Kost et al. 2007, Kost et al. 2010). Emergent marshes are usually dominated by emergent graminoids and herbs, but often contain patches of floating-leaved aquatics plants, submerged vegetation, open water, shrubs,

and even scattered trees. In deeper water where submerged aquatic plants become dominant, the community is termed submergent marsh (Kost et al. 2007, Kost et al. 2010). Emergent and submergent marshes can be degraded or altered by hydrologic changes, pollution, invasive plants, excessive boat traffic, elimination of key wildlife species, and fire suppression.

Management of emergent marsh communities includes maintaining natural hydrology, water quality, fire regimes, and native animal populations. Maintaining natural hydrology and water quality normally includes preventing artificial hydrologic impacts (e.g. water drainage, large withdrawals, water control structures, or discharge activities) and preventing the entry of anthropogenic surface, septic, or agricultural runoff. Muskrat and beaver play important roles in maintaining patch types and biodiversity in many emergent marshes, and their populations should be sustainably managed. Colonization by invasive plants is often associated with hydrologic alteration and pollution from runoff. It is imperative to implement invasive species control efforts in the early stages of infestation, before they spread throughout the system. Although it is often unnecessary to directly target emergent marshes for prescribed fire, allowing fire to carry naturally into emergent marshes will help maintain plant diversity and habitat heterogeneity.

South Portage Marsh (EO ID 17549, Figure 9)
South Portage Marsh is the largest (276 ha [681 acres]) element occurrence of emergent marsh that has been documented in Michigan. The area mapped for this occurrence represents only a portion of this vast wetland complex (Figure 9). The marsh continues north throughout the central and northern portions of the wildlife unit and adjoining private land and encompasses a variety of other wetland natural communities, especially areas of southern wet meadow and southern shrub-carr. Because of the vastness and structural complexity of the marsh, the area we mapped is not an exact representation of the community's boundaries. Additionally, the area we mapped as South Portage Marsh likely includes several zones that may be more accurately characterized as southern wet meadow. The South Portage Marsh supports four rare species including several large colonies of wild rice (state threatened), and three rare bird species: American Bittern (state special concern), Least Bittern (state threatened), and Marsh Wren (state special concern). Dominant to abundant native plants species observed during our surveys included broad-leaved cattail (*Typha latifolia*), common arrowhead


John Fody

South Portage Marsh

(*Sagittaria latifolia*), lake sedge (*Carex lacustris*), tussock sedge (*C. stricta*), wiregrass sedge (*C. lasiocarpa*), water sedge (*C. aquatilis*), marsh fern (*Thelypteris palustris*), common bur-reed (*Sparganium eurycarpum*), water smartweed (*Polygonum amphibium*), softstem bulrush (*Schoenoplectus tabernaemontani* [*Scirpus validus*]), and bluejoint grass (*Calamagrostis canadensis*). Invasive plants were abundant in some locations, especially near roads (Waterloo-Munith Road, Riethmiller Road, and Moeckel Road), and included the following species: narrow-leaf cattail (*Typha angustifolia*), hybrid cattail (*T.* x*glauca*), purple loosestrife (*Lythrum salicaria*), and common reed (*Phalaris arundinacea*), among others (see Table 4). Management needs for this community include controlling invasive plants, minimizing runoff from adjacent roads and agricultural fields, and protecting hydrology. Habitat heterogeneity and plant diversity could be significantly increased with the use of prescribed fire. However, any prescription burning should be accompanied by control measures for the invasive plants listed above to prevent their further spread. Lastly, it is likely that the marsh contains both the native and introduced strains of common reed. Control efforts should be implemented only for the introduced strain of common reed, because it can spread aggressively and significantly reduce structural complexity and plant diversity.

Southern Wet Meadow
Global/State Rank: G4?/S3
Two new element occurrences of southern wet meadow were documented in the wildlife unit: Riethmiller Road Wet Meadow and North Waterloo Wet Meadow (discussed below). In addition to these occurrences, the wildlife unit contains numerous other areas of southern wet meadow, many of which have great potential to significantly improve with prescribed fire management, invasive species control, and reductions in shrub encroachment. Following are IFMAP stand numbers for several southern wet meadows that are in relatively good condition and could reach element occurrence quality with management: 192, 221, and 252.

Southern wet meadows are sedge-dominated wetlands (i.e., sedge meadows) in which the water table typically remains present near the soil surface throughout the year (Kost et al. 2007). Southern wet meadows primarily occur over sapric peat soils on flat or gently sloped ground, and in addition to sedges, usually contain grasses, forbs, and scattered shrubs (Kost 2001a, Kost et al. 2007, Kost et al. 2010).

Groundwater is the primary hydrologic source of most southern wet meadows. Primary factors that maintain structure and diversity within these communities are hydrologic processes, fire, and beaver activity. Thus, southern wet meadows are susceptible to degradation or conversion to other community types such as southern shrub-carr when hydrology is disrupted, fire is suppressed, or beaver are eliminated. In addition, these communities can be significantly degraded by the presence of invasive species such as reed canary grass (*Phalaris arundinacea*) and invasive cattails (*Typha angustifolia* and *T.* x *glauca*).

Management of southern wet meadows includes protection of natural hydrologic processes. The hydrology of wet meadow depends on the infiltration of precipitation into uplands and higher elevation wetlands, and the movement of that infiltrated water downward toward the wet meadow. Activities and land uses that disrupt or alter this cycle can negatively impact the wet meadow. Potential impacts can include large-scale land cover changes, drainage ditches, water pumping, and surface water runoff and discharge into the wetland.

Southern wet meadow management includes an awareness of these hydrologic impacts so that damage can be avoided. Management of southern wet meadows also includes the application of periodic prescribed fires and/or allowing landscape-scale fires to carry into these communities. Fire reduces the build up of plant litter, which helps to increase seed germination and seedling establishment and promote the survival of smaller-statured plant species (Leach and Givnish 1996, Kost and De Stevens 2000). Fire also reduces the density of woody vegetation, although in many wet meadows, cutting and/or herbicide application is also required (Reuter 1986). Beaver can play a key role in southern wet meadow creation or maintenance through their consumption of woody plants and temporary pond creation (Kost 2001a). Allowing beaver populations to survive, build dams, and abandon dams can help prevent shrub and tree encroachment. Fire suppression, livestock grazing, mechanical disturbance, and hydrologic alterations facilitate shrub encroachment and establishment of invasive plants. It is important to monitor and control invasive species before they become widespread in this community.

Riethmiller Road Wet Meadow (EO ID 17534, Figure 9) Riethmiller Road Wet Meadow is a large (33 ha [82 acres]) southern wet meadow dominated by wiregrass sedge (*Carex lasiocarpa*) and bluejoint grass (*Calamagrostis canadensis*). The community borders the Riethmiller Road Tamarack Swamp to the south and is very close to the Riethmiller Road Fen. As such, it contains numerous species associated with prairie fens, and tamarack is abundant in some areas. Management needs for this site include controlling the invasive plant purple loosestrife and conducting prescribed burns to reduce litter levels and bolster plant diversity (Tables 3 and 4).

Steve Thomas

North Waterloo Wet Meadow

North Waterloo Wet Meadow (EO ID 17525, Figure 9) North Waterloo Wet Meadow is a moderately-sized (16 ha [39 acres]) southern wet meadow dominated by tussock sedge (*Carex stricta*), wiregrass sedge (*Carex lasiocarpa*), and bluejoint grass (*Calamagrostis canadensis*). The community occurs in an extensive outwash plain along with other wetland types including southern shrub-carr and rich tamarack swamp. The North Waterloo Woods, an element occurrence of dry southern forest, occurs along the southern border of this wetland complex. Management needs for this community include controlling invasive species (purple loosestrife, reed canary grass, and glossy buckthorn) and conducting prescribed burns to reduce litter and bolster plant diversity (Tables 3 and 4).

Wet Prairie
Global/State Rank: G3/S2
One element of wet prairie was documented in the wildlife unit, the Waterloo Wet Prairie (discussed below). In addition to this site, a thin band of wet-mesic prairie (G2/S2) occurs along the lower slope of the large grassland plantings on Riethmiller Road (IFMAP stands 276 and 291) where they border a small wet meadow (stand 251) and inundated shrub swamp (stand 239). This wet-mesic prairie was not entered into Biotics as an element occurrence because of its small size and abundance of invasive shrubs (i.e., autumn olive). However, with management aimed at reducing shrub encroachment and bolstering plant diversity through prescription burning, this small wet-mesic prairie will significantly improve in overall quality.

Wet prairie is a native lowland grassland occurring on saturated and/or seasonally inundated stream and river floodplains, lake margins, and outwash depressions in the southern Lower Peninsula. Dominant plant species include bluejoint grass (*Calamagrostis canadensis*) and cordgrass (*Spartina pectinata*), with sedges (*Carex* spp.) often important subdominants. The community is typically found on outwash plains and outwash channels near moraines. Soils are primarily neutral loams or silt loams with high organic content. Natural disturbances that strongly influence species composition and community structure include fluctuating water levels, beaver flooding, and fire. Management of wet prairies includes prescription burning, which acts to reduce shrub and tree cover, set back robust perennials, and remove excess plant litter. The excess light and space at the soil surface and newly available minerals from the ash help bolster plant diversity by stimulating seed germination and facilitating seedling establishment. In the absence of fire, woody species eventually come to

dominate and many shade-intolerant plant species are lost from the site.

Waterloo Wet Prairie (EO ID 17493, Figure 9)
Waterloo Wet Prairie is a small (<1 ha [2 acres]) wet prairie community dominated by tussock sedge and bluejoint grass. The community contains many prairie species including big bluestem (*Andropogon gerardii*), tall coreopsis (*Coreopsis tripteris*), marsh blazing star (*Liatris spicata*), black-eyed Susan (*Rudbeckia hirta*), and golden alexanders (*Zizia aurea*). This wet prairie community is located upslope from a southern wet meadow and down slope from a dense zone of shrubs and trees. The shrub and tree zone is encroaching on the wet prairie and has already eliminated what had been a band of wet-mesic prairie along the upland edge of this site. Management needs for this community include reducing shrub and tree encroachment through cutting and herbicide application and conducting prescribed burns on a regular basis (Tables 3 and 4). Another very small patch of this wet prairie occurs nearby along the south side of Tophith Road in the northeast corner of stand 252.

Prairie Fen
Global/State Rank: G3/S3
Two new element occurrence of prairie fen were identified within the wildlife unit: Riethmiller Road Fen and Tophith Road Fen (discussed below). In addition to these sites, a much smaller and more degraded prairie fen was located in the southwestern portion of IFMAP stand 56. Because of its small size and degraded condition, this site was not entered into Biotics as an element occurrence for prairie fen. However, it will significantly increase in size and overall quality with prescription burning and management aimed at reducing shrub and tree cover and controlling invasive species, which include glossy buckthorn, autumn olive, and reed canary grass. During our surveys of this site, we recorded the presence of a rare insect, the red-legged spittlebug (*Prosapia ignipectus*, state special concern), which feeds on big bluestem, a common grass at this site. Another very small (approx. 1 ha [<3 acres]) patch of prairie fen vegetation not of sufficient quality for inclusion in Biotics was observed in the far northeast corner of stand 288 adjacent to Harr Road. This patch of native vegetation was surrounded by the invasive reed canary grass.


Steve Thomas
Shrub encroachment is severe in the Waterloo Wet Prairie

Prairie fens occur on peat and marl soils and are dominated by grasses, sedges, and other graminoids (Spieles et al. 1999, Kost et al. 2007, Kost et al. 2010). They are found where cold, calcareous groundwater reaches the surfaces and forms permanent springs and seeps. Prairie fens typically have several vegetation zones, which may include fen meadow, wooded fen, and sparsely vegetated marl flat (Kost and Hyde 2009). Fires are necessary to maintain the open structure and high plant diversity that characterize the community (Kost et al. 2007).

Prairie fens are susceptible to degradation from fire suppression, hydrologic alteration, and invasive species. Management of prairie fen includes the application of periodic prescribed fire. Fire reduces the build up of plant litter, which helps to increase seed germination and seedling establishment and promote the survival of smaller-statured plant species (Leach and Givnish 1996, Kost and De Stevens 2000). Fire also reduces the density of woody vegetation, although in many sites, cutting and/or herbicide application is also required (Reuter 1986). The hydrology of prairie fens is dependent upon the infiltration of precipitation into uplands and higher-elevation wetlands, and the steady movement and release of groundwater into the fen. Activities and land uses that disrupt or alter this hydrologic cycle can negatively impact prairie fens. Potentially harmful factors can include large-scale forest cover removal, drainage ditches, gravel mining, groundwater withdrawal, and surface water runoff inputs and discharges. Prairie fen management includes an awareness of hydrologic processes and potential impacts so that damage can be avoided. Invasive species can significantly degrade prairie fen communities. In particular, the invasive shrub glossy buckthorn has significantly reduced species diversity and altered community structure in numerous prairie fens in southern Michigan. Fire suppression, livestock grazing, mechanical disturbance, and hydrologic alteration tend to facilitate shrub encroachment and establishment of invasive species. It is important to monitor and control invasive species before they spread throughout a prairie fen.

Riethmiller Road Fen (EO ID 17523, Figure 9)
Riethmiller Road Fen is a small (1 ha [3 acres]) prairie fen that occurs within the large wetland complex south of Riethmiller Road. The fen is located in a large outwash plain between two small upland rises and is situated near two element occurrences: Riethmiller Road Wet Meadow and Riethmiller Road Tamarack Swamp. Plant diversity is high, with 90 species noted during our surveys. In the past, fires likely carried across this large wetland complex and kept the fen in an open condition. Today, shrub and tree cover is high, which is likely the result of many years of fire suppression. Management needs for this site include reductions in shrub and tree cover and prescribed fires to bolster native plant diversity (Tables 3 and 4). Additional surveys are needed to further delineate the extent of the fen and to detect the presence glossy buckthorn, which occurs in many nearby wetlands but was not observed in the portion of the fen we surveyed in 2010. If found glossy buckthorn is found, it should be promptly removed.

Tophith Road Fen (EO ID 17521, Figure 9)
Tophith Road Fen is a moderately-sized (4 ha [9 acres]) prairie fen located south of Tophith Road in large outwash plain. The prairie fen is situated downslope from two fields (an old field and an agricultural field) and upslope from a large wet meadow and shrub-carr. Sedges and prairie grasses dominate much of the prairie fen. A new occurrence of the red-legged spittlebug (state special concern) was documented at this site during our surveys. This species feeds on big bluestem, which is abundant in the prairie fen. Management needs for this site include reducing shrub and tree and encroachment, conducting prescribed fires to bolster plant diversity, and controlling invasive plants such as glossy buckthorn and reed canary grass (Tables 3 and 4).

Little Portage Lake Fen (EO ID 16876, Figure 9)
Little Portage Lake Fen is a large (28 ha [69 acres]) prairie fen that occupies the broad, level marl flats that surround the northern and eastern portions of Little Portage Lake. Vegetation is sparse near the lake due to high water levels and the moderately alkaline, marl soils. Further from the shore, the fen is dominated by prairie grasses, twig-rush (*Cladium mariscoides*), shrubby cinquefoil (*Potentilla fruticosa*), and many other fen species. North of the fen on a dry, sandy glacial kame is The Little Portage Lake Woods, a dry southern forest EO, and further north within the same wetland complex, is the Little Portage Lake Swamp, a rich tamarack swamp EO. Management needs for the Little Portage Lake Fen include removing litter and construction debris, which washed into the site when lake levels were high, and controlling invasive plants including purple loosestrife, glossy buckthorn, narrow-leaved cattail, and common reed (*Phragmites australis*) (Tables 3 and 4). Note that both native and introduced strains of common reed likely occur at the site and only the introduced type should be targeted for control. At present, a band of shrubs separates this fen from the Little Portage Lake Woods. Removing this zone of shrubs along the wetland-upland interface will allow turtles easy access to this upland island for nesting.

Bog
Global/State Rank: G3G5/S4
Two new bog element occurrences were documented in the wildlife unit: Riethmiller Tall Shrub Bog and Moeckel Shrub and Tree Bog (discussed below). Bogs are

John Fody

Riethmiller Road Fen

Michael R. Penskar

Tophith Road Fen

permanently saturated wetlands characterized by the dense cover of sphagnum mosses (*Sphagnum* spp.) and dwarf, ericaceous shrubs (Kost et al. 2007, Cohen and Kost 2008, Kost et al. 2010). Cover of other strata such as scattered trees, tall shrub zones, and an herb layer are often present but varies among bogs or within the same bog depending upon hydrology and successional stage. In southern Michigan, bogs are mostly restricted to kettle depressions. Bog soils are usually comprised of wet fibric peat, which lacks physical strength and can deteriorate when exposed to oxygen. Bogs can be degraded or even eliminated by ORV traffic, sphagnum peat mining, hydrologic alteration, water pollution, and invasive species (Kost et al. 2007). In addition, some bogs can shift toward forest cover types if deprived of natural fire events (Cohen and Kost 2008), and while apparently somewhat resilient to ungulate activity, bogs can be impacted by very high deer densities.

Many of the remaining bog communities in southern Michigan are in reasonably good condition, and management often needs only to maintain these conditions. This includes preventing artificial hydrologic impacts (e.g., dams, water drainage or discharge activities), preventing the entry of runoff from agricultural or impervious surfaces (e.g., roads), preventing alterations in overall groundwater levels, preventing ORV traffic or other excessive trampling or overuse, and prohibiting mining or other large scale resource extractions. Invasive plant species such as glossy buckthorn (*Rhamnus frangula*) can proliferate in bogs if ignored; monitoring and/or control of such invasive plants is critical to protect biodiversity. While it is probably not necessary to directly target bogs for prescribed fire, allowing fire to carry naturally into bogs or portions thereof will allow natural cycles of succession and associated biodiversity to continue. Very high deer densities can alter bog vegetation (Pellerin 2006), and deer have a tendency to browse some species (e.g., orchids) within bogs that are uncommon on the overall landscape. Thus, deer hunting within the wildlife unit is beneficial to the bog community.

Moeckell Road Tall Shrub Bog (EO ID 17489, Figure 9)
Moeckell Road Tall Shrub Bog is a small bog (5 ha [13 acres]) dominated by tall shrubs, especially highbush blueberry (*Vaccinium corymbosum*) and sphagnum mosses (*Sphagnum* spp.). Other abundant tall shrubs include winterberry (*Ilex verticillata*), black chokeberry (*Aronia prunifolia*), mountain holly (*Nemopanthus mucronatus*), and poison sumac (*Toxicodendron vernix*). Small trees are widely scattered throughout the bog including tamarack, yellow birch (*Betula alleghaniensis*), and red maple. The site is surrounded by the Moeckel Road Woods, a dry southern forest EO. It is likely that prior to widespread fire suppression in the 1800s, this site was likely more open because fires would have occasionally carried into the bog from surrounding oak woodland. A drainage ditch was dug along the south side of the bog and drains into the eastern portion of the Moeckel Road Shrub and Tree Bog to the south. Along with fire suppression, this artificial drainage likely accounts for the dense tall shrub layer at the site today. Management needs for the site include controlling the invasive shrub glossy buckthorn (*Rhamnus frangula*) and allowing prescribed fires conducted in adjacent stands to carry into the bog (Tables 3 and 4). Additionally, the hydrology of this site should be assessed to determine if the ditch that drains the bog should be plugged.

Moeckel Road Shrub and Tree Bog (EO ID 17490, Figure 9)
Moeckel Road Shrub and Tree Bog is a moderate-sized (24 ha [60 acres]) bog dominated by tall shrubs, scattered trees, and sphagnum mosses. Dominant shrubs include highbush blueberry and winterberry. Abundant trees include red maple, silver maple (*Acer saccharinum*), and possibly a hybrid species of two species. Along its eastern boundary, the bog borders the Moeckel Road Woods, a dry southern forest EO. It is likely that prior to widespread fire suppression in the 1800s, this site was likely more open because fires would have occasionally carried into the bog from this oak woodland. Also quite possible is that tamarack and possibly even black spruce were once been abundant in this bog (then a poor conifer swamp); tamarack was widely harvested in this region for barn beams, fence posts, and wooden wheel spokes, so its absence from the site may be an artifact of past resource extraction. An earthen dam to the east (used as a road to access the Moeckel Road Woods) blocks the outflow of this wetland and has raised water levels, which has resulted in widespread tree mortality. Management needs for this site include controlling the invasive shrub glossy buckthorn and allowing fires conducted in adjacent stands to carry into the bog (Tables 3 and 4).

Poor Conifer Swamp
Global and State Rank: G4/S4
One poor conifer swamp element occurrence record was updated for wildlife unit, the Waterloo Black Spruce Bog (discussed below).

Poor conifer swamp is a nutrient-poor forested peatland that occurs most commonly in the Upper Peninsula and northern Lower Peninsula and rarely in the southern Lower Peninsula (Cohen 2006, Kost et al. 2007, Kost et al. 2010). This forested bog community is characterized by the prevalence of coniferous trees, ericaceous shrubs, and sphagnum mosses. Poor Conifer swamp occurs on extremely acidic, saturated peat in depressions on glacial outwash, moraines, and sandy glacial lakeplains and within kettles on pitted outwash and ice-contact topography.

John Fody

Moeckell Road Tall Shrub Bog

John Fody

Moeckell Road Shrub and Tree Bog

Natural disturbances that strongly influence species composition and community structure include windthrow, flooding by beaver, insect outbreaks, and occasional fires.

Waterloo Black Spruce Bog (EO ID 16762, Figure 9) Waterloo Black Spruce Bog is a very small (8 acres [21 acres]) poor conifer swamp dominated by black spruce, highbush blueberry, and sphagnum mosses. Widely scattered tamaracks occur throughout the swamp. In addition to highbush blueberry, the dense tall shrub layer also includes poison sumac, black chokeberry, and mountain holly. In the spring, moccasin flower (*Cypripedium acaule),* a pink lady-slipper orchid, can be seen growing on the dense carpet of sphagnum mosses. The bog is surrounded by a narrow band of hardwood swamp dominated by silver maple and red maple. An artificial drainage ditch along the western edge of the site has likely drained the site and led to the dominance of maples around the perimeter of the conifer swamp. Many dead-standing and downed black spruce and tamarack now occur under the tall, dense maple canopy; these conifers are intolerant of dense shade and typically die when overtopped by taller, broad-leaved trees. The invasive shrub glossy buckthorn has recently become established within the interior of the poor conifer swamp, and appears to be increasing very rapidly, possibly as a result of the hydrologic alteration. Management needs for the site include eliminating the drainage ditch, controlling glossy buckthorn, and girdling and stump-treating the maples that have established directly within the interior of the conifer swamp (Tables 3 and 4).

Inundated Shrub Swamp
Global/State Rank: G4/S3
One element occurrence of inundated shrub swamp was documented in the wildlife unit, the Tophith Road Buttonbush Swamps (discussed below). Inundated shrub swamps are wetlands dominated by buttonbush (*Cephalanthus occidentalis*) that typically occur in small kettle depressions (Kost et al. 2007, Slaughter et al. 2010, Kost et al. 2010). Standing water in these communities is often semi-permanent, and can be more than one meter deep. In addition to buttonbush, these communities often contain other wetland shrubs and trees along margins. Floating duckweed (*Lemna minor)* and scattered sedges, grasses, and forbs are also common.

Due to their low relief, inundated shrub swamps can be degraded by alterations to hydrology and water quality. In addition, invasive plant species can become established within these communities. Management of inundated

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Black spruce, smooth highbush blueberry, and sphagnum mosses dominate the Waterloo Black Spruce Bog

Michael A. Kost

Inundated shrub swamps are dominated by buttonbush

shrub swamps should normally include protection from hydrologic and water quality alterations, and monitoring and controlling invasive species. Hydrologic impacts and water quality alterations can occur in association with forest cover removal, drainage ditches, water pumping, or surface water runoff and discharge into these communities. In general, the closer these activities are to an inundated shrub swamp, the more likely they are to cause degradation. One of the easiest ways to help maintain the hydrologic and water quality integrity of these systems is to establish a "no disturbance" buffer around their perimeters (Kost et al. 2007). Invasive species such as glossy buckthorn and reed canary grass can become established in inundated shrub swamps. Management should include monitoring for these species. If invasive species become established, a rapid control response can prevent them from spreading throughout the community.

Tophith Road Buttonbush Swamps (EO ID 17494, Figure 9)
Tophith Road Buttonbush Swamps consists of six very small (mostly < .4 ha [1 acre]), isolated, wetland depressions that are dominated by buttonbush and surrounded by upland and lowland forests. These buttonbush depressions are in close proximity to each other and have been grouped into one element occurrence of inundated shrub swamp. The depressions vary in overall species and structure but generally have an open center of standing water ringed by buttonbush. Wetland trees such as silver maple (*Acer saccharinum*) and American elm (*Ulmus americana*) typically dominate the perimeter of each depression. Management needs for this community include controlling invasive species, especially reed canary grass, and maintaining an adequate forested buffer around each depression (Tables 3 and 4).

Rich Tamarack Swamp
Global/State Rank: G4/S3
One new element of occurrence of rich tamarack swamp was documented (Riethmiller Road Tamarack Swamp) and two previously documented element occurrences of this community type were updated (Little Portage Lake Swamp and Leeke Lake Swamp) (discussed below). In addition to these sites, rich tamarack swamps of lesser quality also occur in IFMAP stand 57 along the Portage River and IFMAP stand 59 along Markla Lake. With management aimed at controlling invasive plants and reducing the cover of red maple, these sites are likely to significantly improve in overall quality.

Rich tamarack swamps are groundwater-influenced, forested wetland dominated by tamarack (*Larix laricina*) (Kost 2001b, Kost et al. 2007, Kost et al. 2010). They occur primarily in the southern Lower Peninsula on neutral to mildly alkaline deep peat soils within outwash channels and in depressions and kettles on outwash plains and moraines. The community is found in areas of groundwater seepage associated with headwater streams and lakes and is often associated with prairie fens. Natural disturbances that strongly influence species composition and community structure include groundwater seepage, seasonal water level fluctuation, insect outbreaks, windthrow, beaver flooding, and occasional fires.

Within the interlobate regions of southern Lower Michigan, rich tamarack swamps often occur near upland oak forests. The absence of fire in the oak forests has allowed red maple to become a canopy dominant and spread into nearby rich tamarack swamps with negative consequences to many plant and animal species. Because tamarack is a shade-intolerant tree, it is easily outcompeted for light when red maples become abundant within rich tamarack swamps. The dense shade cast by red maple colonization contributes to tamarack mortality and significantly reduces the cover of native shrubs (Kost 2001b, Kost 2001c). The loss of tamarack and native shrub abundance negatively impacts wildlife since these plants provide important cover and food reserves to many animals.

Management for rich tamarack swamp includes reducing red maple cover in both the swamp itself and in neighboring oak forests. Additionally, the invasive shrub glossy buckthorn can quickly dominated a variety of wetland types including rich tamarack swamps. Prompt removal of glossy buckthorn through cutting and herbicide application before it becomes widespread will help protect this diverse community.

Riethmiller Road Tamarack Swamp (EO ID 17535, Figure 9)
Riethmiller Road Tamarack Swamp is a small (11 ha [27 acres]) rich tamarack swamp that occurs south of Riethmiller Road. The community has a semi-open canopy dominated by tamarack and a dense shrub comprised of poison sumac (*Toxicodendron vernix*), red osier dogwood (*Cornus stolonifera*), grey dogwood (*Cornus foemina*), and willows (*Salix* spp.), swamp rose (*Rosa palustris*), winterberry (*Ilex verticillata*), and American hazelnut (*Corylus americana*). The community borders the Riethmiller Road Wet Meadow (EO ID 17534) to the north and is very close to the Riethmiller Road Fen (EO ID 17523). Management needs for this site include monitoring to detect the presence of invasive plants and promptly removing them when detected (Tables 3 and 4).

Little Portage Lake Rich Tamarack Swamp (EO ID 15946, Figure 9)
The Little Portage Lake Rich Tamarack Swamp is a moderately-sized (23 ha [57 acres]) rich tamarack swamp that occurs in an outwash plain near the edge of a coarse-textured end moraine. The community borders a small, unnamed lake north of Little Portage Lake. Because of the high volume of groundwater seepage associated with the lake and proximity to the edge of an end moraine, the community occurs on a quaking mat of peat measured to a depth of at least 4 m (13 ft). The site has a diverse flora that includes at least 108 plants species. The overstory is dominated by tamarack along with scattered yellow birch (*Betula alleghaniensis*). Red maple and American elm (*Ulmus americana*) dominate in the understory. Like other rich tamarack swamps, this site supports a dense and diverse shrub layer that includes at least 28 shrubs species, including poison sumac (*Toxicodendron vernix*), smooth highbush blueberry (*Vaccinium corymbosum*), spicebush (*Lindera benzoin*), musclewood (*Carpinus caroliniana*), winterberry (*Ilex verticillata*), nannyberry (*Viburnum lentago*), and juneberry (*Amelanchier arborea*). The invasive shrub glossy buckthorn has recently invaded the swamp and should be removed before it becomes widespread. Additional management needs include girdling red maples, which has increased in dominance since the site was originally documented in 1999 (Tables 3 and 4).

Leeke Lake Rich Tamarack Swamp (EO ID 15947, Figure 9)
The Leeke Lake Rich Tamarack Swamp is a large (32 ha [78 acres]) rich tamarack swamp that occurs along the margins of Leeke Lake in a large outwash plain bordered by a coarse-textured end moraine. The soils are peat to a depth of at least 4 m (12 ft). The swamp contains a diverse flora with at least 72 plant species recorded from the site. When the site was first documented in 1999, tamarack dominated the overstory, but it has since declined as a result of an insect outbreak, likely the larch casebearer (*Coleophora laricella*), an exotic, invasive insect. The decline of tamarack has allowed red maple to increase in importance. Additional canopy trees include swamp white oak (*Quercus bicolor*), American elm, and yellow birch. A dense and diverse shrub layer supports 15 species, including winterberry, poison sumac, grey dogwood, silky dogwood, smooth highbush blueberry, swamp rose, hazelnut, nannyberry, and juneberry. Management aimed at reducing the cover of red maple through girdling and herbicide treatment will help maintain a sparse overstory and facilitate the regeneration of tamarack (Tables 5). Two invasive plants were recently observed, purple loosestrife and Morrow's honeysuckle (*Lonicera morrowii*), and they should be removed before they become widespread (Tables 6). Additional surveys are needed to detect the presence

John Fody

Riethmiller Road Tamarack Swamp

glossy buckthorn, which occurs in many nearby wetlands but was not observed in the portion of the swamp we surveyed in 2010. If found glossy buckthorn is found, it should be promptly removed.

M52 Tamarack Swamp (EO ID 7962, Figure 9)
The M52 Tamarack Swamp is the largest (108 ha [268 acres]) rich tamarack swamp that has been documented in Michigan. The community occurs primarily on private land, east of the wildlife unit. A small portion of this high quality rich tamarack swamp occurs within the Waterloo Recreation Area in an area that is primarily managed by the Recreation Division of the DNRE. The soils are peat to a depth of at least 4 m (12 ft). The M52 tamarack swamp is structurally very heterogeneous and floristically diverse. Because of its large size, high-quality condition, and importance to regional biodiversity, this site is worthy of consideration for acquisition and management by the DNRE and other conservation agencies. Management needs for this site include reducing the cover of red maple and controlling the invasive shrub glossy buckthorn, which was first observed at this site in 2009 (Tables 3 and 4).

Southern Hardwood Swamp
Global/State Rank: G3/S3
Two element occurrences of southern hardwood swamp were documented in the wildlife unit: Waterloo-Munith Road Oak Swamp and Tophith Road Oak Swamp (discussed below). Southern hardwood swamp is a groundwater-influenced forested wetland dominated by a mixture of lowland hardwoods that occurs in the southern Lower Peninsula (Kost et al. 2010, Slaughter 2009, Kost et al. 2007). Canopy dominants typically include silver maple (*Acer saccharinum*), red maple (*A. rubrum*), green ash (*Fraxinus pennsylvanica*), and black ash (*F. nigra*). Soils range from mineral to organic and acidic to alkaline but are typically neutral. Southern hardwood swamp occupies shallow depressions and high-order stream drainages on a variety of landforms. On lakeplains and within depression on fine- to medium-textured moraines, an underlying impermeable clay lens is often present and allows for prolonged seasonal flooding. Natural disturbances that strongly influence species composition and community structure include seasonal flooding, beaver flooding, and windthrow.

Waterloo-Munith Road Oak Swamp (EO ID 17522, Figure 9)
Waterloo-Munith Road Oak Swamp is a very small (3 ha [8 acres]), wet, savanna-like community dominated by large-diameter (30 to 70 cm [12 to 28 inches]) swamp white oaks. The community was very likely once a rich tamarack swamp. Today only a few mature tamaracks are present, and fallen tamarack logs were seldom encountered in the area we surveyed. Because of its ecological significance as a wet oak savanna, this occurrence has been placed into the southern hardwood swamp category so that it may be tracked. Management needs for this community include controlling invasive species and conducting prescribed fires to bolster plant diversity (Tables 3 and 4).

Tophith Road Oak Swamp (EO ID 17498, Figure 9)
Tophith Road Oak Swamp is a very small (8 ha [20 acres]) forested wetland with a discontinuous canopy of swamp white oak, bur oak, American elm, and red maple. Tall shrubs are common, especially winterberry. Like the Waterloo-Munith Road Oak Swamp discussed above, the origin of this site is unclear, and it may have been formerly a rich tamarack swamp. This site would benefit from invasive species management. Prescribed fires conducted in nearby stands should be allowed to carry into the site. Management needs for this community include controlling invasive species (Tables 3 and 4).

Dry Southern Forest
Global/State Rank: G4/S3
Four new dry-mesic southern forest element occurrences were documented in the wildlife unit, including Moeckel Road Woods, North Waterloo Woods, Little Portage Lake Woods, and Tophith Road Woods (discussed below). In addition to these sites, numerous other stands of dry southern forest are in good condition and have great potential to significantly improve with prescribed fire management and invasive species control, particularly IFMAP stands 32, 113, 124, 193, 243, and the northeastern portion of 249.

Dry southern forest is a fire-dependent forest dominated by oaks, particularly white oak (*Quercus alba*), black oak (*Q. velutina*), and scarlet oak (*Q. coccinea*) (Kost et al.


Michael A. Kost
Waterloo-Munith Road Oak Swamp is dominated by swamp white oaks

2007, Kost et al. 2010). The community occurs primarily in the southern Lower Peninsula on glacial outwash, and less frequently on sand dunes, sandy glacial lakeplains, and coarse-textured moraines. Soils are well-drained, medium to strongly acid sands, loamy sands, or sandy loams with low nutrient content. Historically, frequent fires maintained semi-open conditions and promoted oak regeneration and plant diversity. In addition to fire, windthrow, droughty low-nutrient soils, and insect outbreaks and pathogens associated with oak decline strongly influence species composition and community structure. Prolonged fire suppression results in canopy closure, colonization by red maple and black cherry (*Prunus serotina*), and sharp reductions in oak regeneration and floristic diversity.

Management of both dry southern forest and dry-mesic southern forest (site discussed below) includes the regular application of prescribed fire. Fires burn through the dry plant litter, releasing nutrients and facilitating increased levels of sunlight at ground level. The newly released nutrients and additional sunlight promote floristic diversity, bolster seed and fruit production, and ultimately favor the reproduction of oaks, hickories, and native shrubs. The fruits provided by the oaks, hickories, and native shrubs are important food resources for many species of wildlife. Control of invasive plants, especially woody plants, can be greatly facilitated by the application fire, although in many situations cutting and/or herbicide application is also necessary to fully eradicate invasive plants. Depending upon site conditions and specific activities, logging can increase or lessen the viability of dry and dry-mesic southern forests (Lee 2007, Lee and Kost 2008). Unless oaks and hickories are already present in high densities in the seedling and sapling classes (referred to as "advanced regeneration"), removal of mature oaks and hickories tends to accelerate the growth of competitors and contributes to the loss of oak and hickory from the stand. However, removal of shade tolerant or fast growing competitors, such as red maple, sugar maple, black cherry, and sassafras, from the sapling and understory prior to logging can help to sustain the natural community.

Moeckel Road Woods (EO ID 17491, Figure 9)
Moeckel Road Woods is a moderately-sized (24 ha [58 acres]) dry southern forest dominated by white oak and black oak. Nearly 100 native plant species have been recorded from the site, including the rare hay-scented fern (state threatened). The community contains a vernal pool and encompasses several additional wetlands including the Moeckel Road Tall Shrub Bog. Regular prescribed fire management and invasive species control will help open the canopy, stimulate oak regeneration, and maintain plant diversity (Tables 3 and 4). Oak regeneration and plant diversity will also significantly benefit from efforts to reduce the cover of red maple, which currently dominates the understory. Because much of this forest borders wetlands, it is likely an important nesting site for turtles. Management aimed at reducing the cover of red maple will facilitate increased levels of sunlight the ground, significantly benefitting turtle reproduction.

North Waterloo Woods (EO ID 17497, Figure 9)
North Waterloo Woods is a moderately-sized (21 ha [51 acres]) dry southern forest dominated by white oak, bur oak (*Quercus macrocarpa*), scarlet oak, shagbark hickory, and black cherry. The forest contains two vernal pools that support swamp white oaks along their margins. Regular prescribed fire management is needed to open the forest canopy, stimulate oak regeneration, bolster native plant diversity, and reduce the cover of red maple (Table 3). In addition to conducting prescribed fires, plant diversity in this forest will benefit from efforts to control invasive plants (Table 4). Because this forest serves as an upland island surrounded by wetlands, it is likely an important nesting site for turtles. Management aimed at reducing the cover of red maple will facilitate increased levels of sunlight reaching the ground, significantly benefitting turtle reproduction.

Tophith Road Woods (EO ID 17496, Figure 9)
Tophith Road Woods is a very small (4 ha [9 acres]) dry southern forest dominated by scarlet oak and white oak. The community includes dry knolls that support oak and hickory as well as low, level areas that support species associated with mesic conditions. Regular prescribed fire management is needed to open the forest canopy, stimulate oak regeneration, bolster native plant diversity, and reduce the cover of red maple (Table 3). In addition to conducting prescribed fires, plant diversity in this forest will benefit from efforts to control invasive plants (Table 4). Because much of this forest borders wetlands, it is likely an important nesting site for turtles. Management aimed at reducing the cover of red maple will facilitate increased levels of sunlight reaching the ground, significantly benefitting turtle reproduction.

Little Portage Lake Woods (EO ID 17492, Figure 9)
Little Portage Lake Woods is a very small (2 ha [5 acres]) dry southern forest dominated by white oak and scarlet oak. The community occupies a small glacial kame along the north side of Little Portage Lake, and is situated between two natural community occurrences, the Little Portage Lake Fen to the south and the Little Portage Lake Swamp to the north. The forest contains one vernal pool. Regular prescribed fire management is needed to open the forest canopy, stimulate oak regeneration, bolster native plant diversity, and control red maple (Table 3). In addition to conducting prescribed fires, plant diversity in this forest

Michael A. Kost

After many years without fire, red maple now dominates the understory of Moeckel Road Woods and other oak forests in the Waterloo Wildlife Unit.

Michael A. Kost

Vernal pools, like the one pictured here in Moeckel Road Woods, are common in the oak-dominated forests of the Waterloo Wildlife Unit.

will benefit from efforts to control invasive plants (Table 4). Because this forest serves as an upland island surrounded by wetlands, it is likely an important nesting site for turtles. Management aimed at reducing the cover of red maple will facilitate increased levels of sunlight reaching the ground, significantly benefitting turtle reproduction.

Dry-mesic Southern Forest
Global/State Rank: G4/S3
One new dry-mesic southern forest element occurrence was documented, Markla Lake Woods (discussed below).

Dry-mesic southern forest is a fire-dependent forest dominated by oaks or oaks and hickories, particularly white oak, black oak, red oak (*Q. rubra*), pignut hickory (*Carya glabra*), shagbark hickory (*C. ovata*), and bitternut hickory (*C. cordiformis*) (Lee 2007, Kost et al. 2007, Kost et al. 2010). The community occurs in the southern Lower Peninsula on glacial outwash, coarse-textured moraines, sandy lakeplains, kettle-kame topography, and sand dunes. Soils are slightly acid to neutral sandy loams or loams. Historically, frequent fires maintained semi-open conditions and promoted oak regeneration and plant diversity. Windthrow and insect outbreaks and pathogens associated with oak decline also strongly influence species composition and community structure. Prolonged fire suppression results in canopy closure, colonization by red maple, and sharp reductions in oak regeneration and floristic diversity. For a discussion of management, please see dry southern forest above.

Markla Lake Woods (EO ID 17500, Figure 9)
Markla Lake Woods is a moderately-sized (21 ha [51 acres]) dry-mesic southern forest dominated by white oak, bur oak (*Quercus macrocarpa*), red oak, shagbark hickory, and red maple. Many of the larger oaks have diameters greater than 100 cm (39 inches). The interior of this site is relatively level with slight depressions supporting vernal pools and pockets of mesic and wet-mesic soils and vegetation, including red maple, basswood (*Tilia americana*), American elm (*Ulmus americana*), and spicebush (*Lindera benzoin*). Regular prescribed fire management is needed to open the forest canopy, stimulate oak regeneration, bolster native plant diversity, and reduce the cover of red maple (Table 3). In addition to conducting prescribed fires, plant diversity in this forest will benefit from efforts to control invasive plants (Table 4). Because of its close proximity to Markla Lake, this forest likely serves as an important nesting site for turtles. Management aimed at reducing the cover of red maple will facilitate increased levels of sunlight reaching the ground, significantly benefitting turtle reproduction.

Rare Animal Inventory Results
Surveys for rare animals resulted in 5 new element occurrences and reconfirmed 7 previously documented records (Table 2). New element occurrences consisted of the following: two occurrences of red-legged spittlebug (*Prosapia ignipectus*, state special concern), one of paper pondshell *Utterbackia imbecillis*, state special concern), and one of trumpet vallonia (*Vallonia parvula*, state special concern). Reconfirmation of previously documented records included two occurrences of Blanding's Turtle (*Emydoidea blandingii*, state special concern), one occurrence of each of the following species: American Bittern (*Botaurus lentiginosus*, state special concern), Least Bittern (*Ixobrychus exilis*, state threatened), Henslow's Sparrow (*Ammodramus henslowii*, state endangered), and Marsh Wren (*Cistothorus palustris*, state special concern) (Table 2). Details for all new and updated records are provided below.

Avian Survey Results
Marsh Birds: We conducted 76 point counts for secretive marsh birds at 32 randomly selected locations between early May and mid June (Figure 5). Fourteen points were surveyed three times, 16 points were visited twice, and two points were surveyed only once. We documented several occurrences of American Bittern (State special concern), Least Bittern (State threatened), and Marsh Wren (State special concern) within the recreation area (Figure 10). We also observed the following five Species of Greatest Conservation Need (SGCN) using wetlands in the wildlife unit: Great Blue Heron (*Ardea herodias*), Green Heron (*Butorides virescens*), Virginia Rail, Sora, and Sedge Wren. Sandhill Crane (*Grus canadensis*), a DNRE featured species, was regularly observed in the survey area.

Nine American Bittern observations were made at seven points (Figure 10). All of the American Bittern observations were at new locations, but occurred closer than the minimum recommended separation distance (10 km; NatureServe 2010) to two existing element occurrences (EO numbers 5 and 8). We observed Least Bitterns at two new locations that represented an update to an existing element occurrence (EO number 2; Figure 10). We documented 46 Marsh Wren observations at 17 survey points and one additional incidental location. Although Marsh Wrens had not been previously documented in the survey area and occurred at many widely scattered locations (Figure 10), these observations are considered part of an existing element occurrence (EO number 6) in Unadilla State Wildlife Area due to a required 5 km separation distance (NatureServe 2010).

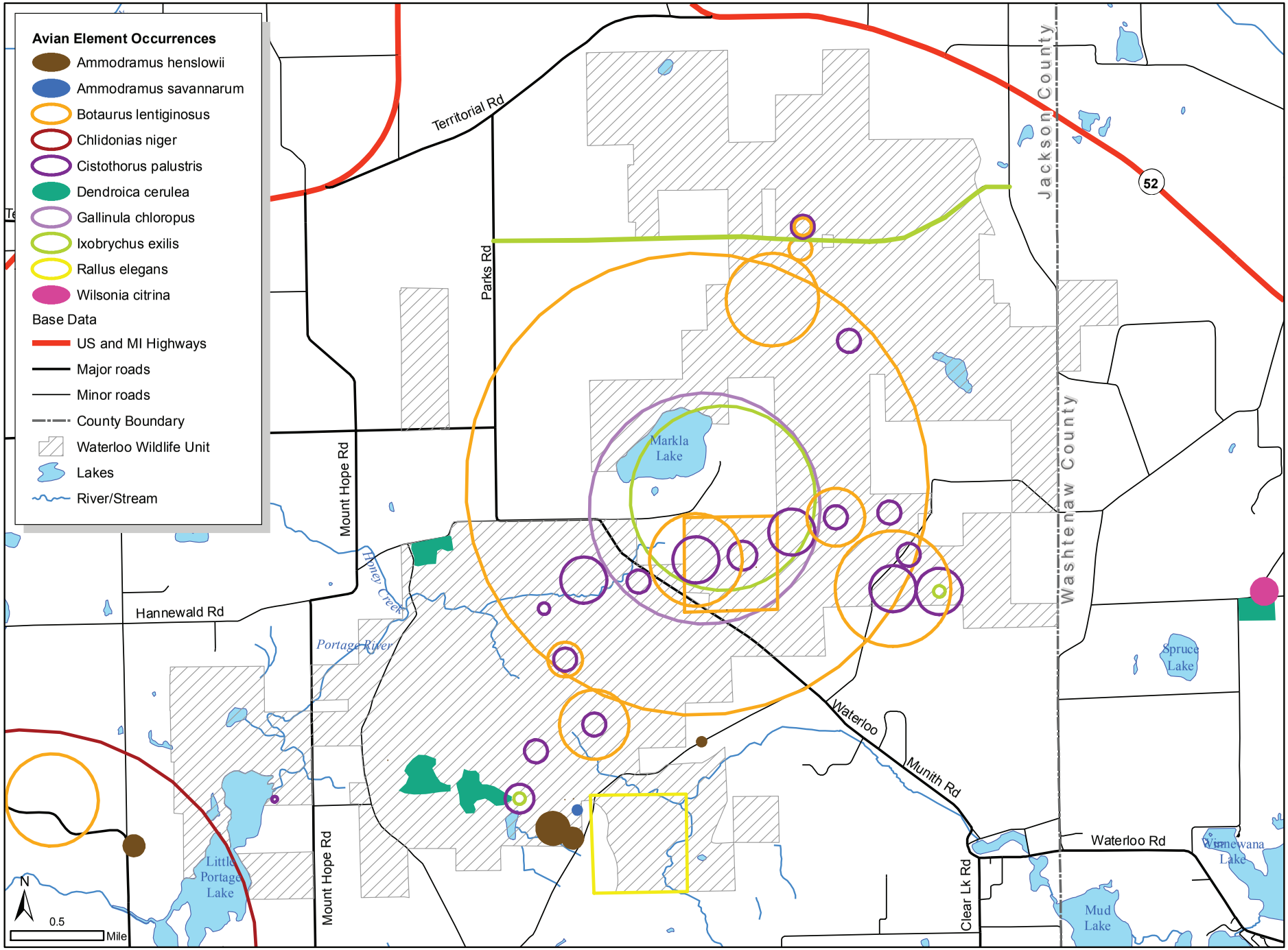

Figure 10. Avian Element Occurrences.

We observed a male Northern Harrier (*Circus cyaneus*) on two occasions during marsh bird surveys foraging in open wetland just south of Tophith Road (stand 252). Other MNFI staff also observed Northern Harriers in the same area, so it is possible that breeding was occurring in the vicinity given the presence of appropriate nesting habitat. However, we did not consider this a new element occurrence because we could not confirm the presence of a breeding pair and had no evidence of nesting.

Grassland Songbirds: Henslow's Sparrow was the only rare grassland bird species detected during surveys and was observed at three of the four habitat blocks surveyed. We observed 10 singing male Henslow's Sparrows at three locations: (1) west of Riethmiller Road in the northwest quarter of section 27 (6 males); (2) northeast of Waterloo-Munith Road in the northwest quarter of section 23 (2 males); and (3) east of Moeckel Road in the northwest quarter of section 28 (2 males). Henslow's Sparrows had been documented previously at the Riethmiller Road site (EO number 1), but we observed a greater number of singing males than had been recorded before. Although our other observations represent new locations for the species in the recreation area, they are considered part of the known Henslow's Sparrow element occurrence, due to a 5 km minimum separation distance for element occurrences (NatureServe 2010). Bobolink (*Dolichonyx oryzivorus*) and Sedge Wren, both SGCN, were also observed using the grassland west of Riethmiller Road.

Forest Songbirds: We did not observe any rare songbird species while conducting point counts in forests within the recreation area. We completed 31 point counts for rare songbirds in large blocks of mature forest during late June and early July (Figure 5). We observed 44 bird species during surveys, of which the following six are considered SGCN: Northern Flicker (*Colaptes auratus*), Acadian Flycatcher (*Empidonax virescens*), Sedge Wren, Wood Thrush (*Hylocichla mustelina*), Eastern Towhee (*Pipilo erythrophthalmus*), and Field Sparrow (*Spizella pusilla*). Although no rare species were observed during point counts, we documented singing male Cerulean Warblers at three locations incidentally early in the breeding season. A Cerulean Warbler element occurrence (EO number 9) has been documented at several locations within the recreation area previously, including two locations within the wildlife unit (northeast quarter of section 21 and southeast quarter of section 28). We did not use these incidental observations to update the existing element occurrence, because they occurred early in the breeding season and were not relocated in subsequent visits, which could indicate that the birds we heard were migrants that did not establish breeding territories at those sites.

Heron Rookeries: One Great Blue Heron rookery was recorded outside the wildlife unit, but still within the Waterloo State Recreation Area. The rookery was located south of Clear Lake Road near an unnamed lake approximately 1 km (.6 miles) north of Clear Lake (T02S R02E Section 36 NW ¼ of SW ¼).

Reptile and Amphibian Survey Results

Reptile and amphibian surveys in the wildlife unit updated two previously documented element occurrences of the Blanding's Turtle but were not able to reconfirm previously documented occurrences of the Spotted Turtle or Eastern Massasauga (Table 2).

Ten Blanding's Turtles were observed at seven different locations or areas during surveys in 2010 (Figure 11). Seven of these turtles were found at four sites located in the southern portion of the wildlife unit in the large wetland-upland complex bordered by Riethmiller, Waterloo-Munith, Hannewald, and Moeckel roads (i.e., South Portage Marsh and surrounding wetland-upland habitats). These seven observations represent updates of a Blanding's Turtle element occurrence (EO #23), which was based on a turtle observation from 1994 in the large emergent wetland north of Riethmiller Road. In 2010, one Blanding's Turtle was observed in the water on 20 May in a small emergent wetland with open standing water along the northeastern edge of a prairie-planted field and west of a large emergent marsh north of Riethmiller Road about 1.6 km (1 mi) east of Waterloo-Munith Road (T01S R02E Section 27 NW ¼; along interface between stands 239 and 291) (Figure 11). Two adult Blanding's Turtles were observed on 2 June in the same general area, one between the interface of stands 251 and 256, and one between the interface of stands 276 and 291, near the western edge of the prairie-planted fields on the north side of Riethmiller Road (T01S R02E Section 27 NW ¼). Two adult Blanding's Turtles were observed on 28 May in a wetland on the east side of Moeckel Road about 0.2 km (0.1 mi) south of the intersection of Moeckel Road and Hannewald Road (T01S R02E Section 21 NE ¼) (Figure 11). One adult Blanding's Turtle (likely female) was found in the middle of Moeckel Road on 9 June near the parking area just south of where the road is closed north of Hoffman Road (T01S R02E Section 28 NW ¼) (Figure 11). Another adult turtle was observed on 15 June in a small open water wetland about 0.4 km (0.25 mi) east of the parking area on Moeckel Road south of where the road is closed north of Hoffman Road (T01S R02E Section 28 NE ¼).

The other three Blanding's Turtles observed in 2010 were found at three sites located in the northern portion of the wildlife unit in the wetland-upland complex west of Leeke Road and south of Tophith Road (Figure 11). These three

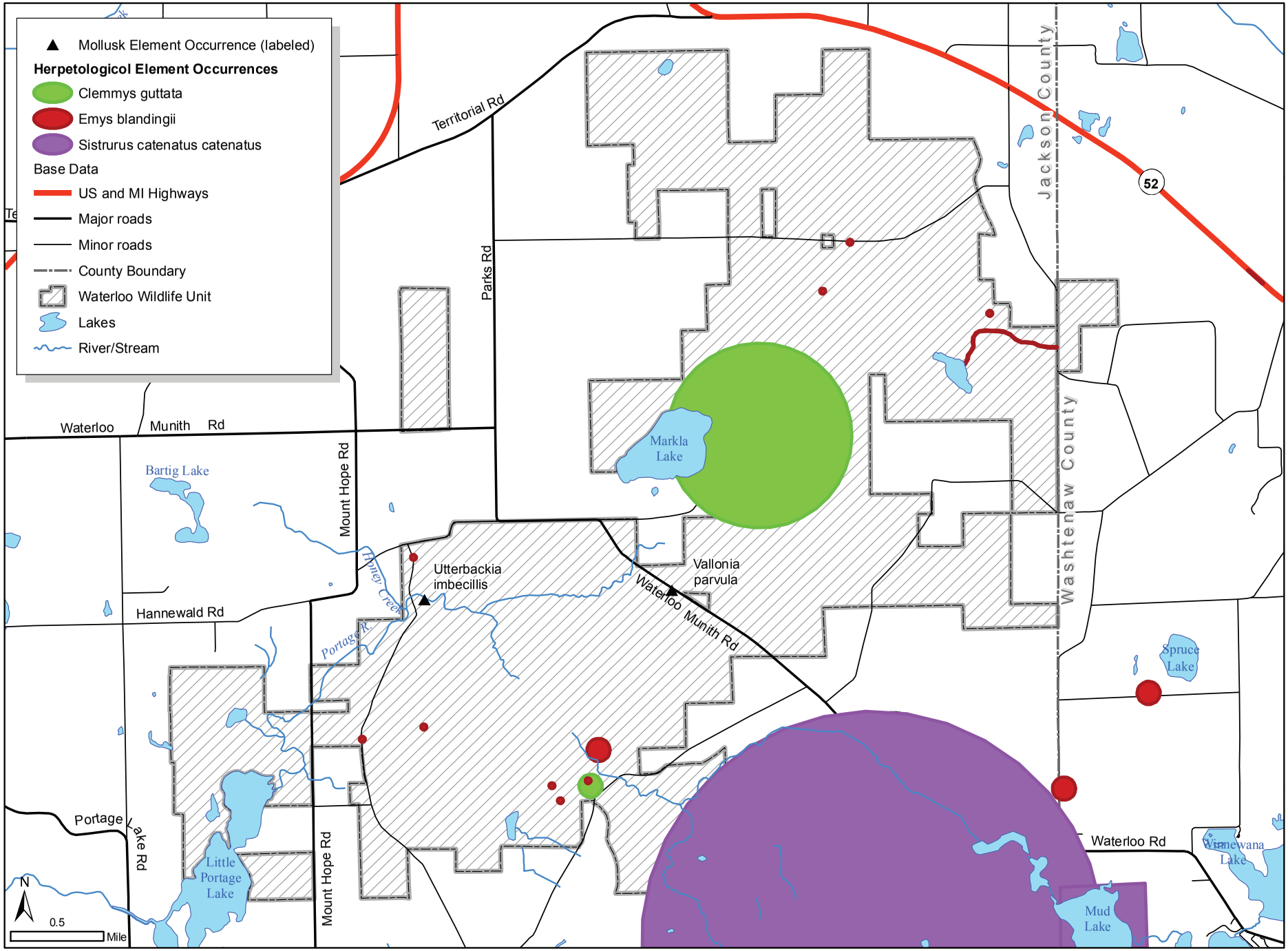

Figure 11. Herpetological and Mollusk Element Occurrences.

Yu Man Lee

Blanding's Turtle habitat north of Riethmiller Road

Yu Man Lee

Blanding's Turtle habitat east of Moeckel Road and south of Hannewal Road

observations represent updates of a Blanding's Turtle element occurrence (EO #37), which is based on a turtle that was observed in 1995 along the trail to Leeke Lake. One adult Blanding's Turtle was seen on 14 May west of Leeke Road and northeast of Leeke Lake in a small shrub-scrub wetland located within a dry southern forest (T01S R02E Section 12 SE ¼) (Figure 11). A second adult/sub-adult Blanding's Turtle was observed in the water on 27 May in a small emergent wetland within a deciduous forest about 0.5 km (0.3 mi) south of Tophith Road about 1.0 mi west of Leeke Road (T01S R02E Section 11 SE ¼) (Figure 11). Finally, an adult Blanding's Turtle was found on 9 June on Tophith Road about 1.6 km (1.0 mi) west of Leeke Road (T01S R02E Section 11 SE ¼) during a road-cruising survey (Figure 11).

Many of the Blanding's Turtles were observed in small, shallow wetlands that often contained buttonbush, dogwood, cattails, other emergent vegetation, duckweed, scattered trees (e.g., willow or silver maple), and logs. These wetlands included inundated shrub swamp, southern wet meadows, emergent marsh, small ponds, and vernal pools. The wetlands were located within or along the edge of upland forest or open upland habitats including dry southern forests, old fields, and prairie-planted fields.

Frog call surveys were not able to document Blanchard's Cricket Frogs in the wildlife unit in 2010, but were able to update a previously known occurrence of the species within the Pinckney Recreation Area (i.e., Joslin Lake). Overlapping calls of this species were heard at this site. The only frog species that was heard during the frog call surveys within the wildlife unit was the Green Frog (*Lithobates clamitans*, formerly *Rana clamitans*). Overlapping calls (i.e., call index of 2) of this species was heard at four of the six sites surveyed within the wildlife unit (Markla Lake, Little Portage Lake (off of Portage Lake Road), Portage Lake Road stream crossing, and wetland/stream crossing on Riethmiller Road) as well as at the known cricket frog site.

Trapping with aquatic funnel or minnow traps captured a total of 33 salamander larvae and 61 tadpoles from two of the three wetlands that were surveyed. None were captured in the other wetland. All of the salamander larvae were identified as *Ambystoma* larvae, and all or most of the larvae were identified as or were likely Blue-spotted Salamander (*Ambystoma laterale*) larvae based on salamander larval identification keys and three larvae that were reared to adults (T01S R02E Section 12 SE ¼). None of the salamander larvae were identified as

Yu Man Lee

Blanding's Turtle habitat south of Tophith Road

Smallmouth Salamander larvae. The tadpoles that were captured in the traps included tadpoles of Wood Frogs (*Lithobates sylvaticus*, formerly *Rana sylvatica*), Northern Spring Peepers (*Pseudacris crucifer crucifer*), and Western Chorus Frogs (*Pseudacris triseriata triseriata*) based on tadpole identification keys and photos as well as several tadpoles that were collected and reared to adults (T01S R02E Section 12 SE ¼). Tadpoles of additional frog and toad species also may have been captured but were not able to be identified in the field. None of the tadpoles were identified as Blanchard's Cricket Frogs. A partial dead specimen of a minnow (possibly a Central Mudminnow (*Umbra limi*)) also was found in one of the aquatic funnel traps in one of the wetlands. The Blue-spotted Salamander and the Western Chorus Frog have been identified as SGCN in Michigan's Wildlife Action Plan (Eagle et al. 2005).

Seven additional amphibian and reptile species were documented during herp surveys in the wildlife unit in 2010 (Appendix 3). These include the Red-backed Salamander (*Plethodon cinereus*), Eastern American Toad (*Anaxyrus [Bufo] americanus americanus*), Northern Leopard Frog (*Lithobates [Rana] pipiens*), Eastern Snapping Turtle (*Chelydra serpentina serpentina*), Painted Turtle (*Chrysemys picta*), Northern Water Snake (*Nerodia sipedon sipedon*), and Northern Ribbon Snake (*Thamnophis sauritus septentrionalis*). These include one additional SGCN, the Northern Leopard Frog (Eagle et al. 2005). One Red-backed Salamander (lead phase) was found under a log in a dry southern forest stand northeast of Little Portage Lake during meander surveys on 6 May (T01S R02E Section 29 NE ¼). Eastern American Toads were found in an emergent wetland along the north side of Little Portage Lake (Section 29 NE ¼) and in a southern hardwood swamp north of Waterloo-Munith Road and west of Parks Road (T01S R02E Section 16 NE ¼) during meander surveys on 6 May and 24 June, respectively. Northern Leopard Frogs were found in an emergent wetland along the north side of Little Portage Lake (Section 29 NE ¼) and in grassy habitat along Moeckel Road bordered by emergent wetlands (southern wet meadows and emergent marsh) about 0.8 km (0.5 mi) north of Hoffman Road (T01S R02E Section 28 NW ¼). Painted Turtles were found in a small emergent wetland along the edge of a prairie-planted field north of Riethmiller Road (T01S R02E Section 27) on 20 May, on Tophith Road about 1 mi west of Leeke Road (T01S R02E Section 11) on 27 May, and in an emergent wetland on the west side of Moeckel Road about 1 km (0.6 mi) north of Hoffman Road (T01S R02E Section 21 SW ¼) on 9 June. Snapping Turtles also were found in the same small emergent wetland along edge of prairie-planted field north of Riethmiller Road (Section 27) on 20 May, and on Tophith Road on edge of wetlands on Parks or Tophith Road on 27 May. One Northern Water Snake was seen swimming along the edge of a large emergent wetland/marsh north of Riethmiller Road north of the prairie-planted field on 20 May (Section 27 NW ¼). Northern Ribbon Snakes were observed in an old field on west side of Leeke Road south of the trail to Leeke Lake (T01S R02E Section 13 NE ¼) on 18 May and along Tophith Road about 0.4 km (0.25 mi) west of Leeke Road (T01S R02E Section 12 NE ¼) on 17 September. A Spring Peeper also was observed in an oak forest/oak openings south of Tophith Road during meander surveys on 27 May (Section 11 E ¼).

Butterflies and Moths Survey Results

No rare butterfly or moth species were recorded in the wildlife unit during meander or blacklight surveys.

Leafhopper and Spittlebug Survey Results

Three occurrences of the red-legged spittlebug were documented in the wildlife unit during our surveys (Table 2). This rare insect was found in the following locations: Tophith Road Fen; the small, degraded patch of prairie fen south of Tophith Road in the southwest portion of IFMAP stand 56; and a remnant patch of big bluestem alongside Harr Road (Figure 12). No rare leafhoppers were found in the wildlife unit.

Rare Mollusk Survey Results

A total of 20 gastropod species were recorded (Appendix 5) including one new element occurrence for a terrestrial snail, the trumpet vallonia (*Vallonia parvula*, state special concern) (Table 2). The trumpet vallonia was found in old field south of Waterloo-Munith Road (IFMAP stand 196; Site H, Figure 8; Figure 11). Among all sites, there were an equal number of aquatic and terrestrial gastropod species observed (Appendix 5). The weather during terrestrial gastropod collections was relatively cool (~70deg. F), with light rain, which made for good conditions for live individuals to be active and visible. All but two species were represented by live individuals.

A total of four unionid species were observed (Appendix 6) including one new element occurrence for the paper pondshell (*Utterbackia imbecillis*, state special concern) (Table 2). The paper pondshell was found in the Portage River just east of Moeckel Road (Site D, Figure 8; Figure 11). No exotic bivalves (zebra mussels or Asian clams) were observed. The tributary of Mud Lake near the Riethmiller Rd. bridge (Site A) had a thick layer (50cm+) of organic material on the stream bottom. This type of substrate typically does not support unionid mussels. No shells were seen during a qualitative assessment of the site. Substrate composition and stream habitat type for unionid mussel survey sites are given in Appendix 7.

Yu Man Lee

Ambystoma salamander larva from wetland south of Tophith Road

Yu Man Lee

Wood Frog metamorphs from wetland northeast of Leeke Lake

Yu Man Lee

Red-backed Salamander Lead Phase found northeast of Little Portage Lake

Yu Man Lee

Eastern American Toad found north of Little Portage Lake

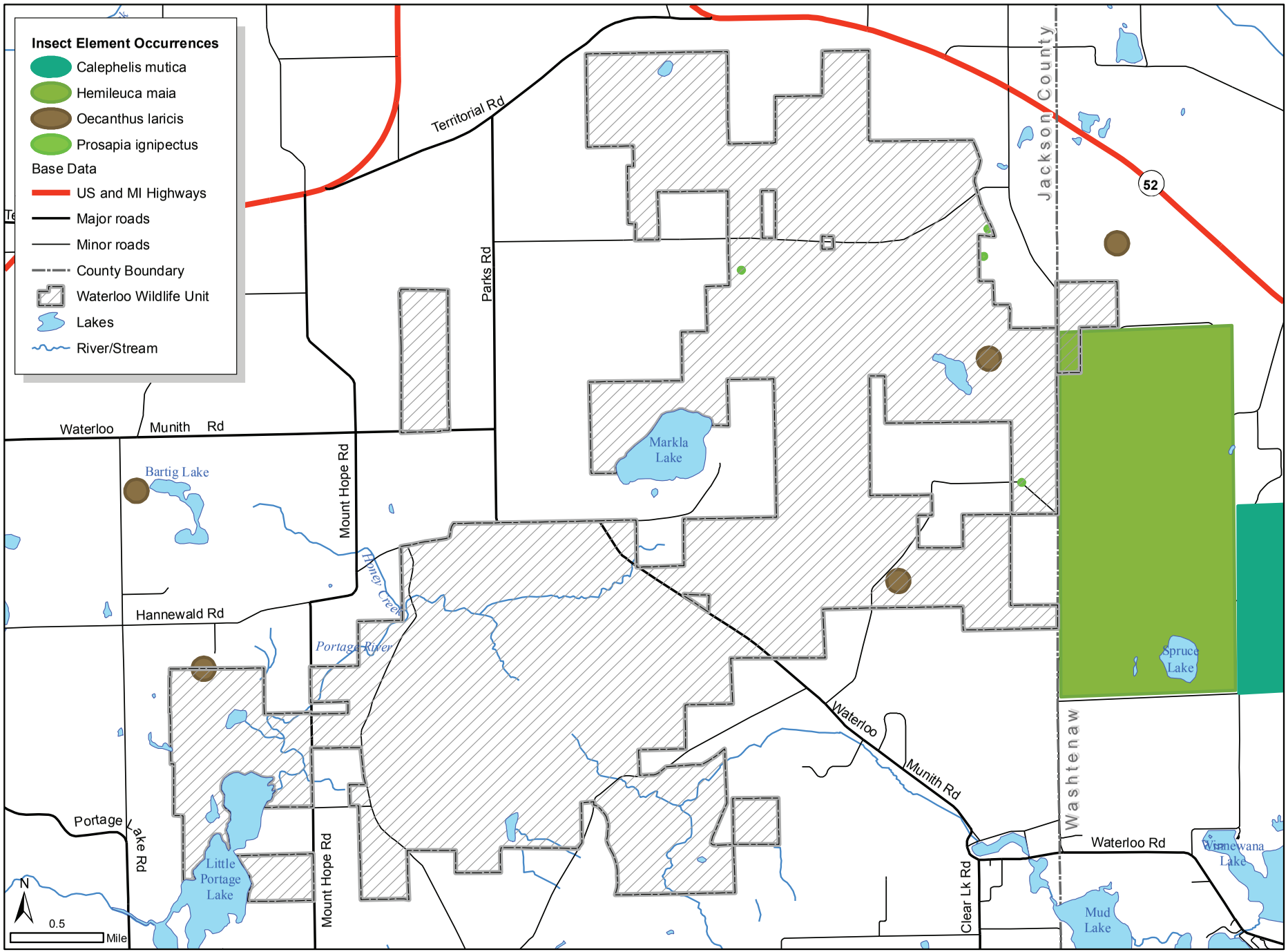

Figure 12. Insect Element Occurrences.

David L. Cuthrell

This red-legged spittlebug was observed on big bluestem in the Tophith Road Fen

David L. Cuthrell

The red-legged spittlebug feeds on big bluestem, a clump-forming, native prairie grass, which is abundant in the Tophith Road Fen

Paper pondshell was found in the Portage River

DISCUSSION

Natural Community Discussion and Recommendations
Descriptions of each natural community element occurrence and associated management recommendations are provided in the section above entitled Natural Community Descriptions and Management Recommendations. In addition, management recommendations for each natural community occurrence are listed in Table 3, and lists of invasive plants for all natural community occurrences are included in Table 4.

Although our surveys succeeded in documenting many new natural community element occurrences (Table 1), the wildlife unit harbors many additional ecologically significant lands that could reach element occurrence quality with stewardship. The vast Portage Marsh wetland complex contains many areas of southern wet meadow and emergent marsh that would improve significantly with management aimed at controlling invasive plants, conducting prescribed fires, and reducing shrub encroachment within the wet meadows. Additionally, many stands of dry southern forest contain large-diameter trees, but because of fire suppression, their understories are now often dominated by shade-tolerant red maple saplings. In addition, invasive plants such as garlic mustard, hedge parsley (*Torilis japonica*), multiflora rose, and autumn olive have become increasingly abundant. With regular prescribed fire management and efforts to control invasive plants, these forests are likely to significantly improve in overall quality.

Fire as an Ecological Process
Much of the land within the wildlife unit historically supported fire-dependent ecosystems such as black oak barrens, mixed oak forest, oak-hickory forest, wet prairie, southern wet meadow, prairie fen, and bog. In the past, lightning- and human-set fires frequently spread over large areas of southern Michigan and other Midwestern states, helping to reduce colonization by trees and shrubs and maintaining the open character of the landscape (Curtis 1959, Dorney 1981, Grimm 1984). In the absence of frequent fires, open oak savanna and woodland communities converted to closed canopy forests dominated by shade tolerant native and invasive species (Cohen 2001, Lee and Kost 2008). Similarly, in the absence of fire, open wetlands such as wet prairie, southern wet meadow, prairie

fen, and bog convert to shrub-carr and swamp forests (Curtis 1959). Historically, many of the areas mapped as mixed oak forests and oak-hickory forests circa 1800 were best described as oak woodlands with open canopies, rather than the dense, closed-canopy forests common today. The conversion of open barrens and oak woodland to closed-canopy forests typically results in significant reductions in species and habitat diversity (Curtis 1959; McCune and Cottam 1985; McClain et al. 1993; Wilhelm 1991). This pattern was evident at many of the sites we surveyed. For example, the dry southern forests regularly had insufficient oak and hickory regeneration, supported dense understories of shade tolerant trees, and had little ground layer diversity. These forests currently are experiencing strong regeneration of shade-tolerant plants such as red maple and invasive shrubs such multiflora rose and autumn olive. Repeated prescribed burns will eventually reduce the density of shade-tolerant seedlings, saplings, and invasive shrubs. A sustained fire management program will allow for increased recruitment of fire-adapted native shrubs and oak and hickory seedlings and saplings.

Fire suppression has also strongly influenced successional trends in the open wetlands. For example, the wet prairie, prairie fens, and southern wet meadows we surveyed often had high coverage of shrubs and small trees. Regular prescribed fire management of these communities can help reduce shrub and tree cover and promote high species diversity.

Plant communities benefit from prescribed fire in several ways. Depending on the season and intensity of a burn, prescribed fire may be used to decrease the cover of exotic, cool-season grasses and woody species, and increase the cover of native warm-season grasses and forbs (White 1983, Abrams et al. 1987, Tester 1989, Collins and Gibson 1990, Glenn-Lewin et al. 1990, Anderson and Schwegman 1991). Prescribed fire helps reduce litter levels, allowing sunlight to reach the soil surface and stimulate seed germination and enhance seedling establishment (Daubenmire 1968, Hulbert 1969, Knapp 1984, Tester 1989, Anderson and Schwegman 1991, Warners 1997). Important plant nutrients (e.g., N, P, K, Ca, and Mg) are elevated following prescribed fire (Daubenmire 1968, Viro 1974, Reich et al. 1990, Schmalzer and Hinkle 1992). Prescribed fire has been shown to result in increased plant biomass, flowering, and seed production (Abrams et al. 1986, Laubhan 1995, Warners 1997, Kost and De Steven 2000). Prescribed fire can also help express and rejuvenate seed banks, which may be especially important for maintaining species diversity (Leach and Givnish 1996, Kost and De Steven 2000).

Although prescribed fire typically improves the overall quality of habitat for many animal species, its impact on rare animals should be considered when planning a burn. Larger, more mobile, and sub-terrainian animals can temporarily move out of an area being burned. Smaller and less mobile species can die in fires—this includes some rare insects (Panzer 1998) and reptiles. Dividing large contiguous areas into two or more separate burn units that can be burned in alternate years or seasons can protect populations of many species. This allows unburned units to serve as refugia for immobile invertebrates and slow-moving amphibian and reptile species. When burning relatively large areas, it may be desirable to strive for patchy burns by burning either when fuels are somewhat patchy or when weather conditions will not support hot, unbroken fire lines (such as can occur under atypically warm, dry weather and steady winds). These unburned patches may then serve as refugia, which can facilitate recolonization of burned patches by fire-sensitive species. In addition, burning under overcast skies and when air temperatures are cool (<55°F) can help protect reptiles, since they are less likely to be found basking above the surface when conditions are cloudy and cool. Conducting burns during the dormant season (late October through March) may also help minimize impacts to reptiles.

Invasive Species

Invasive species pose a major threat to species diversity and habitat heterogeneity within the wildlife unit. By out-competing and replacing native species, invasives change species composition, alter vegetation structure, and reduce native species diversity, often causing local or even complete extinction of native species (Harty 1986). Invasive exotic species can also upset delicately balanced ecological processes such as trophic relationships, interspecific competition, nutrient cycling, soil erosion, hydrologic balance, and solar insolation (Bratton 1982). Lastly, exotic invasive species often have no natural predators and spread aggressively through rapid sexual and asexual reproduction.

While numerous invasive species occur within the wildlife unit, the species likely to pose the greatest threats because of their ability to invade and quickly dominate intact natural areas in southern Lower Michigan include narrow-leaved cattail, hybrid cattail, common reed, reed canary grass, purple loosestrife, garlic mustard, hedge parsley, glossy buckthorn, common buckthorn (*Rhamnus cathartica*), multiflora rose, autumn olive, and Eurasian honeysuckles (especially *Lonicera maackii*, *L. morrowii*, *L. tatarica*, and *L.* x*bella*). Additionally, new invasive species that were not seen in the wildlife unit have great potential to erode biodiversity should they become established. Examples of such species include black swallow-wort (*Vincetoxicum nigrum*), white swallow-wort (*Vincetoxicum rossicum*), and Japanese knotweed

(*Polygonum cuspidatum*). Newly establishing species should be removed as rapidly as possible, before they infest additional areas. Invasive species abstracts, which include detailed management guidelines, can be obtained at http://www.imapinvasives.org/GIST/ESA/index.html.

Setting Stewardship Priorities

Threats such as invasive species and fire suppression are common across most of the surveyed portions of the wildlife unit. The list of stewardship needs may outweigh the resources available to meet those needs. Prioritizing activities by location, scale, method, and timing can help close the gap between resource needs and availability. We recommend that priority criteria and activities include the following:

1) A preference toward high quality sites (e.g., natural community EOs) with minimal infestations of invasive species. Biodiversity is most easily and effectively protected by preventing high quality sites from degrading, and invasive plants are much easier to eradicate when they are not yet well established.

2) A focus on sites that harbor high levels of native species diversity or unique elements of biodiversity (e.g., wet prairies, prairie fens, bogs, rich tamarack swamps, poor conifer swamps, streams, etc.).

3) Sites that enhance core areas of high quality habitat or act as critical corridors for wildlife, such as the Portage Marsh wetland complex.

4) High profile sites that are frequently viewed by many visitors, such as well used trails or scenic vistas. Opportunities to educate the public about biodiversity and stewardship are maximized by actively working to restore frequently visited sites.

5) The use of natural processes such as prescribed fire and beaver activity (where appropriate) in conjunction with manual cutting and herbicide application to control shrub encroachment in wetlands and shade tolerant and invasive woody plants in dry-mesic southern forests.

6) Activities that will have direct, lasting, and widespread effects (i.e., activities with a high payoff). This can mean directing energy into activities that are able to be applied:

a. at the frequency required for effectiveness;

b. to situations that are not anticipated to require continually higher resource allocations in successive years;

c. at larger scales when doing so lowers the cost per acre;

d. with small resource allocations in comparison to large ecological gains;

e. to situations in which there will be a relatively lasting impact.

Rare Plant Discussion

Wild Rice (*Zizania aquatica* var. *aquatica*) is listed as state threatened, and is now known from 38 occurrences statewide following the identification of one new locality in the wildlife unit. A previously known population was also identified, surveyed, and updated during this project. All but two localities documented for this species in the state are restricted to southern Lower Michigan, with one-half of these occurrences (19) known only from historical records. Given the large proportion of historical occurrences, the state status of this species is poorly known, particularly with regard to the level of impact wild rice has sustained due to degradation in water quality and to wetlands, and whether artificial changes in water regime, such as lake level stabilization or the placement of dams have affected the viability of this species. Many animal species are known to benefit from wild rice, including migrating waterfowl. This species is also a well known and important food plant to Native American communities, within which there has been a strong renewal of interest in relearning the rituals of wild rice harvesting and use and passing this cultural knowledge on to current and future generations. For more information see the rare plant abstract on wild rice (Penskar et al. 2000).

Hay-scented Fern (*Dennstaedtia punctilobula*) is listed as state threatened and is known from only two documented occurrences in Michigan. The species was discovered in Michigan in 1889 near or within the city of Owosso in Shiawassee County, where it is now considered long extirpated. This occurrence is known only via a single herbarium specimen with vague locality information and no collection data. The species was rediscovered as extant within the state when a small colony of approximately 60 stems, possibly representing a single clone, was documented in the wildlife unit in 2006. This colony was assessed during our surveys in 2010 and found to be stable, consisting of approximately 80 stems persisting in the Moeckel Road Woods, a community element occurrence of dry southern forest. This species was not encountered during inventories of similar forest stands within the wildlife unit. Largely a species of eastern North America, hay-scented fern ranges from Ontario and Quebec south to Georgia, occurring from Minnesota through Illinois to Missouri and Arkansas in the western portion of its range. The single known locality in the wildlife unit is highly significant, comprising the state's only disjunct population of this largely eastern species. It is likely that in the next biennial review of the rare species list, this species will be considered for elevation to state endangered to more appropriately reflect its Michigan status. For more information and photos see the MNFI Rare Species Explorer summary at: http://web4.msue.msu.edu/mnfi/pub/abstracts.cfm.

Horsetail spike-rush (*Eleocharis equisetoides*) is listed as state special concern, and is known from 19 state occurrences, 13 of which are known only from historical records. The species is concentrated in southern Lower Michigan, principally in the southwest and southeast with an outlying

John Fody

Wild Rice grows in abundance in some areas of the South Portage Marsh

locality in Montcalm County. Largely a plant of the Atlantic Coastal Plain, horsetail spike-rush occurs from New York and Massachusetts south to Florida and west to Texas through the Gulf states, with disjunct localities occurring in the upper Midwest in Michigan and Wisconsin south through Illinois and Indiana to Missouri and Arkansas. Because only six populations are currently known to be extant within Michigan, the occurrence within the wildlife unit is very significant. Another occurrence is known from South Lake in the Pinckney Recreation Area. The status of horsetail spike-rush within the state is uncertain given the large number of historical sites that require reassessment, but it is possible that the species is overlooked owing to its similarity to Equisetum fluviatile (water horsetail) and other species. For more information and photos see the MNFI Rare Species Explorer summary at: http://web4.msue.msu.edu/mnfi/pub/abstracts.cfm.

Avian Species Discussion and Recommendations

Marsh Birds: Large areas of emergent marsh and southern wet meadow wetland exist within the recreation area that are providing breeding habitat for American Bittern, Least Bittern, and Marsh Wren. The area also holds potential for King Rail, Common Moorhen, and Black Tern, all of which have been documented in or near the wildlife unit previously. The large marshes and wet meadows of this recreation area are significant because they can accommodate potentially area-sensitive marsh birds, such as American Bittern, while also providing habitat for a variety of bird species that can breed in small marshes. Two invasive plant species, common reed (Phragmites australis) and reed canary grass (Phalaris arundinacea), were observed at several locations in the wetlands surveyed for marsh birds. Management to control these invasive species, if feasible, could help maintain and improve the habitat for breeding marsh birds and other wildlife. Because we did not observe King Rail, Common Moorhen, or Black Tern during our surveys, we recommend additional surveys in the future to determine if these species are present at or near areas where they were previously detected. Given our observations of adult Northern Harriers in open wetlands within the survey area, more surveys are warranted to determine if nesting is occurring.

Grassland Songbirds: All of the sites surveyed appear to have been actively managed to provide habitat for grassland birds. The presence of Henslow's Sparrow and other grassland bird species at several of these sites indicates that DNRE management has been successful. Management

to maintain and, where feasible, expand these grasslands could improve conditions for nesting grassland birds. For example, the grassland areas to the northeast and southwest of Waterloo-Munith Road could potentially be expanded by removing narrow areas of shrubs and trees (e.g., old fence rows) that separate grassland patches. Other rare grassland birds, such as Grasshopper Sparrow and Dickcissel, could occur in the recreation area, so additional surveys should be conducted periodically.

Forest Songbirds: Some of the larger blocks of forest within the recreation area appear to be providing nesting habitat for some neotropical migrant songbird species, such as Wood Thrush, Eastern Wood-pewee, and Scarlet Tanager. The maintenance and expansion of mature forest blocks in the recreation area could benefit forest-interior bird species, including Cerulean Warbler. Cerulean Warbler is considered an area-sensitive species and, within the core of its breeding range, typically occupies forest tracts that are 3,000 ha or larger (Hamel 2000). Hamel (1992) noted that the needs of Cerulean Warbler may be compatible with low-intensity timber management (e.g., single-tree selective removal) that mimics natural forest gaps. Activities that reduce the cover of mature forest or increase forest fragmentation could reduce the value of the existing forest blocks to forest-interior nesting songbirds. Brown-headed Cowbirds (Molothrus ater) were observed in the wildlife unit, so efforts to reduce forest fragmentation could decrease nest parasitism by this species on songbirds. We recommend periodic surveys at sites with previous Cerulean Warbler observations and areas of potential habitat, especially the Moeckel Roads Woods (stand 219), located east of Moeckel Road and west of Riethmiller Road.

Reptile and Amphibian Discussion and Recommendations

Amphibian and reptile surveys conducted in 2010 were able to reconfirm and expand the extent of two previously documented occurrences of the Blanding's Turtle in the wildlife unit. Prior to our surveys, both these occurrences were first and last documented in 1994 and 1995 and were based on observations of a single turtle at each site. Surveys in 2010 were able to document the species at a number of additional locations and expand the known distribution and extent of these two occurrences, particularly regarding the occurrence in the southern portion of the wildlife unit south of the Waterloo-Munith Road (EO #23). Both known element occurrences of this species and associated locations at which individual turtles were observed are located within a mosaic of aquatic-wetland and undeveloped upland habitats, and are less than 10 km apart (which is the minimum separation distance for element occurrences of this species, Hammerson and Hall 2004, NatureServe 2010). Given this, these two element occurrences could be merged into a single element occurrence. However, these occurrences were retained as two separate occurrences at this time because it is unclear if turtles can successfully cross the Waterloo-Munith Road and move between the two occurrences.

Although the size of these Blanding's Turtle populations are unknown, they have a good to fair probability of persisting into the foreseeable future (i.e., at least 20-30 years) because of the extensive wetland-upland habitat and protected status of these sites, their long history at these sites, and the long-lived nature of this species. Nest predation and lack of population recruitment appear to threaten the long-term viability of many populations of this species and other turtle species (Rivard and Smith 1973, Temple 1987, Browne 2003, Browne and Hecnar 2007). It is unclear at this time if population recruitment is successfully occurring at this site since only adult turtles were observed and no young or juvenile turtles were documented during surveys in 2010, although young and juvenile turtles can be difficult to find. Road mortality also poses a threat to both occurrences. Thus, despite extensive available habitat, protected status, and a long history of both Blanding's Turtle occurrences in the wildlife unit, the long-term viability of these occurrences remains uncertain. However, because this species is so long-lived (e.g., 60+ years (Congdon and van Loben Sels 1991, Congdon et al. 1993), populations of this species can persist for a number of years even if population recruitment is limited or not occurring. Additional information regarding the size and extent of the occurrences and recruitment and threats facing the population associated with these two occurrences would help clarify the estimated viability of this population.

The Blanding's Turtle is a species that warrants conservation and management attention. In addition to currently being listed as a species of special concern in Michigan and a Species of Greatest Conservation Need (SGCN) in the Michigan Wildlife Action Plan, the species has a S3-state rank which indicates a vulnerable conservation status based on NatureServe's ranking system (NatureServe 2010). It also has been ranked as vulnerable, imperiled or critically imperiled in almost every state in its range in the U.S. and Canada (NatureServe 2010). Thus, management and conservation efforts for this species within the wildlife unit would not only contribute to conservation of this species within the state but also across the species' range.

The most critical conservation need for this species in general is protection and management of suitable wetland and adjacent upland habitats (Lee 1999). Blanding's Turtles inhabit clean, shallow waters with abundant aquatic vegetation and soft, muddy bottoms over firm

substrates (Ernst et al. 1994). This species utilizes a variety of temporary and permanent wetlands and waterbodies including ponds, marshes, swamps, bogs, wet prairies, fens, river backwaters, embayments, sloughs, slow-moving rivers, protected coves, and lake shallows and inlets (Kofron and Schreiber 1985, Harding and Holman 1990, Ernst et al. 1994, Harding 1997). Blanding's Turtles also utilize upland habitats for locating mates, nesting, basking, aestivating, and dispersing/travelling (Rowe and Moll 1991, Harding 1997, Joyal et al. 2001, NatureServe 2010). They prefer to nest in open, sunny areas with moist but well-drained sandy or loamy soil, but also will use lawns, gardens, plowed fields, or road edges for nesting if suitable natural nesting habitat is not available (Harding 1997). Blanding's Turtle also make frequent overland movements to utilize multiple wetlands within a given year, and may travel considerable distances overland to locate mates, nest sites, and aestivation sites (Harding 1997, Joyal et al. 2001, NatureServe 2010). Wetland habitats in which Blanding's Turtles were found or had potential to occur within the wildlife unit include southern wet meadow, wet-mesic prairie, prairie fen, inundated shrub swamp, forested vernal pools, small open ponds and lakes, emergent marsh, and southern hardwood swamp. Upland habitats in the wildlife unit include dry southern forest, dry-mesic southern forest, old field, and prairie plantings. Maintaining landscape complexes comprised of a diversity of wetland habitats located in clusters or groups as well as the surrounding upland habitats or matrix is critical for maintaining populations of this species. It is especially important to protect small (<0.4 ha) wetlands within habitat complexes for this species since this species has been found to use small wetlands, and these wetlands are highly vulnerable to destruction and degradation (Joyal et al. 2001). It also is important to identify and maintain suitable overwintering, dormancy, and nesting sites in sufficient quantities that are accessible (Joyal et al. 2001). Efforts to maintain or restore habitat corridors both within the wildlife unit and the surrounding landscape would benefit this species as well.

Maintaining good water quality in wetland habitats also would be beneficial to the Blanding's Turtle. This can often be accomplished by maintaining natural buffers around wetlands, minimizing roads near wetlands, restricting use of pesticides in or near wetlands, and using only herbicides approved for use in open water when working in and adjacent to wetlands. Maintaining the availability and quality or ecological integrity of wetland-upland habitat complexes is critical to ensuring continued persistence of this species in the wildlife unit.

Habitat fragmentation, roads and road mortality, nest predation, and illegal collection may be potential additional threats facing the Blanding's Turtle in the wildlife unit. Habitat fragmentation (e.g., due to roads and residential or agricultural development) can lead to increased nest predation from meso-predators such as raccoons, skunks, opossums, and foxes, which consequently can result in reduced or minimal population recruitment (Temple 1987). Predator control and protection of nest sites are management strategies that can help increase recruitment, and may be necessary to maintain populations of this species within the wildlife unit. Road mortality also poses a substantial threat to Blanding's Turtles particularly because of the species' tendencies to make frequent and long distance migrations over land (Joyal et al. 2001). The Blanding's Turtle also is vulnerable to collection for personal collection or the pet trade (Harding 1997). Populations of this species within the wildlife unit may be particularly vulnerable to collection because they occur on readily-accessible public land. Minimizing adult and juvenile loss and mortality is important because these turtle populations require high annual adult and juvenile survivorship to maintain stable populations due to their life history characteristics (Congdon et al. 1993). Long-lived vertebrates, such as turtles, typically exhibit life histories that are characterized by delayed sexual maturity, low annual recruitment rates, and high adult survival rates (Congdon et al. 1993 and 1994). Some long-term demographic studies of various turtle species have reported that even small increases in adult and subadult or juvenile mortality (e.g., <10% increase in annual mortality of mature females or only 2-3% increase in annual mortality overall) could lead to population declines (Brooks et al. 1991, Congdon et al. 1993 and 1994). Research and monitoring should be conducted to assess and monitor these threats and associated potential impacts over time, and additional management efforts should be implemented to address these threats.

Although surveys in 2010 were not able to document new occurrences or reconfirm previously known occurrences of Spotted Turtles in the wildlife unit, suitable habitat for this species was documented during the surveys. Spotted Turtles were last documented in the wildlife unit in 1970 in the Portage Marsh Complex north of Riethmiller Road and by Markla Lake. Potential habitat for this species still exists within the wildlife unit. In addition to its state threatened and SGCN status, the Spotted Turtle is ranked as S2 or imperiled in Michigan based on NatureServe's state conservation status ranks, and is ranked as vulnerable, imperiled or critically imperiled in many of the states within its range (NatureServe 2010). Spotted turtles require clean, shallow, slow-moving bodies of water with muddy or mucky bottoms and some aquatic and emergent vegetation (Ernst et al. 1994, Harding 1997). This species utilizes a variety of shallow wetlands including shallow

ponds, wet meadows, tamarack swamps, bogs, fens, wet prairies, shallow emergent marshes, sphagnum seepages, small streams and roadside ditches (Ernst et al. 1994, Harding 1997). Although spotted turtles are considered fairly aquatic, they are frequently found on land in parts of its range during certain times of the year (i.e., during the mating and nesting seasons and during the summer) (Ward et al. 1976, Joyal et al. 2001). Terrestrial habitats in which spotted turtles are found include open fields, forests, roadsides, yards, and pastures (Harding 1997, Joyal et al. 2001). Potential exists for this species to occur throughout the extensive and diverse wetland-upland habitat complexes within the wildlife unit. Trapping with baited aquatic hoop traps has been used to successfully document and capture this species in other research studies (e.g., Joyal et al. 2001, Mauger pers. comm.) and may be considered for use during future surveys of the wildlife unit. The Spotted Turtle faces similar threats as the Blanding's Turtle (Lee 2000). Thus, conservation and management efforts that are implemented for the Blanding's Turtle, as described above, would benefit Spotted Turtles as well.

Targeted surveys in 2010 also were not able to document the presence of Eastern Massasaugas, but still there is some potential for the species to occur in the wildlife unit. This species was last documented in the Waterloo area in 1920 based on a general historical record in the MNFI Biotics Database. The species also has been documented at several sites to the east within both the Waterloo and Pinckney Recreation Areas (MNFI 2010). In addition to being listed as a SGCN, the Eastern Massasauga also has been identified as a featured species for habitat management by the Michigan Department of Natural Resources and Environment's Wildlife Division, and a candidate for federal listing by the U.S. Fish and Wildlife Service (USFWS) (USFWS 1999). Protection of Eastern Massasauga populations on public or other protected lands in Michigan can play an important role in conservation of this species rangewide because Michigan is considered to be the last stronghold for this species (Szymanski 1998). Habitat loss and degradation is the primary reason for this species' decline across its range (Szymanski 1998). Recent conservation efforts for this species at federal and state levels have focused on managing and restoring habitat for this species on public and other protected lands because this is believed to be the most effective or likely strategy for halting or slowing the species' decline. Eastern Massasaugas can be found in a variety of wetland habitats including bogs, fens, shrub swamps, wet meadows, marshes, wet prairies, and floodplain forests (Hallock 1990, Harding 1997, Szymanski 1998). In some populations, massasaugas also utilize adjacent open as well as forested upland habitats for foraging, basking, mating, dispersal, gestation, birthing, and/or hibernation (Szymanski 1998). While massasaugas will use forested habitats, they will generally avoid closed-canopy forests (Reinert and Kodrich 1982, Seigel 1986, Kingsbury 1996 and 1999). Potential exists for this species to occur within the wildlife unit particularly in the Little Portage Lake Fen (stands 172 and 209) and the Tophith Road Fen (stand 252) and their surrounding habitats. Additional surveys for massasaugas should be conducted to determine whether this species occurs in the wildlife unit. Surveys should follow recommended survey guidelines developed by the USFWS and Casper et al. (2001).

In addition to the Blanding's Turtle, a number of other herp species were found in the wildlife unit during surveys in 2010, particularly frogs and salamanders. Frogs and salamanders are important components of ecosystems. These species can represent significant biomass and important components of food chains (Burton and Likens 1975). Frogs and salamanders also can serve as important bioindicators of ecosystem health because of their amphibious life cycles and permeable skin and eggs. For example, the Pickerel Frog prefers cool, clear waters, and is intolerant of pollution (Harding 1997). Many of the frogs and salamanders were found in forested vernal pools, other shallow, temporary wetlands, and adjacent forested habitats in the wildlife unit. Vernal pools are of critical importance to amphibian populations. As small, often isolated, temporary, and fish-free wetland environments, vernal pools provide key breeding habitats for some frog and salamander species, and important general habitats for other herp species (Calhoun and deMaynadier 2004, Colburn 2004, Thomas et al. 2010). Identification and protection of vernal pools are essential for maintaining healthy and diverse amphibian and reptile populations in the wildlife unit and supporting other wildlife populations as well. Protecting the surrounding upland forest and maintaining buffers around vernal pools also are critical for maintaining habitat for herp species (Calhoun and deMaynadier 2004). For example, pool-breeding amphibians, such as the Blue-spotted Salamanders found north of Leeke Lake, readily travel 0.1 km (400 ft) or more, and Wood Frogs may disperse 1.2 km (0.75 mi) from breeding ponds (Semlitsch 1998). Calhoun and deMaynadier (2004) provide habitat management guidelines for conserving vernal pool wildlife during forest harvesting activities and recommend maintaining closed or partial forest canopy, natural litter, and coarse woody debris; protecting the forest floor; avoiding the use of chemicals; and maintaining a 30 m (100 ft) buffer or protection zone around vernal pools and a 30-122 m (100-400 ft) amphibian habitat buffer or protection zone. Additional habitat management recommendations

for amphibians and reptiles are provided in "Habitat Management Guidelines for Amphibians and Reptiles in the Midwest" (Partners in Amphibian and Reptile Conservation (PARC) 2002).

Finally, additional surveys and monitoring are needed to determine the size, extent, and viability of populations of rare herp species that have been documented within the wildlife unit. Because many herp species are cryptic and can be difficult to detect, especially if they are rare, additional surveys should be conducted for other amphibian and reptile species of conservation interest that have potential for occurring in the wildlife unit. These include the state endangered Smallmouth Salamander, state endangered Kirtland's Snake (*Clonophis kirtlandii*), state special concern Gray Rat Snake, and several SGCN including the Mudpuppy (*Necturus maculosus maculosus*), Spotted Salamander (*Ambystoma maculatum*), Eastern Tiger Salamander (*Ambystoma tigrinum*), Four-toed Salamander (*Hemidactylium scutatum*), Pickerel Frog (*Lithobates [Rana] palustris*), Blue Racer (*Coluber constrictor foxii*), Northern Ring-necked Snake (*Diadophis punctatus edwardsii*), and Eastern Hog-nosed Snake (*Heterodon platirhinos*). The habitats used by these species are summarized in Appendix 3. Suitable habitats for the federally threatened and state endangered Copperbelly Water Snake (*Nerodia erythrogaster neglecta*) are present in the wildlife unit, and we searched for this species in suitable habitat and under appropriate survey conditions. Suitable habitats for this species include inundated shrub swamp, vernal pools, emergent marsh, ponds, small lakes, southern hardwood swamp, old fields, and dry and dry-mesic southern forests (Lee 2010). The species also requires extensive landscape complexes comprised of diverse, suitable wetlands and surrounding upland habitats, particularly upland forests (Kingsbury et al. 2003, Roe et al. 2003 and 2004, Lee 2010). The wildlife unit is outside of the species' documented range in the state, but this species has potential for occurring in other areas. Future herp inventory and monitoring efforts should keep this species in mind when surveying or working in areas with suitable habitat within the wildlife unit.

Butterfly and Moth Discussion and Recommendations

No rare butterfly or moth species were recorded in the wildlife unit during meander or blacklight surveys. There is much potential for the blazingstar borer moth (*Papaipema beeriana*) to occur within the Tophith Road Fen because the site contains a fairly large population of *Liatris spicata*, one of the host plants for the moth. Any management that benefits the community and host plants would be appropriate. It will be important to maintain the natural hydrology of any fen or wet meadow communities within the wildlife unit. In addition, controlling invasive species and maintaining open areas for native host plants to thrive is recommended. Prescribed fire would be one way to maintain the open sedge meadows but monitoring the spread of narrow-leaved cattail and hybrid cattail at any site being burned would be important. If the invasive cattails appear to spread following prescribed fire management, control methods that involve using herbicides approved for use in open-water likely will be needed. Additional surveys and monitoring efforts to further document the extent, viability, and response of any rare moth populations to any prescribed management is also recommended. This may include surveys for the moths, their larval host plants, their habitat, or ideally all of the above.

Leafhopper and Spittlebug Discussion and Recommendations

Although we did document three new occurrences of the red-legged spittlebug, there is presently limited potential for most rare leafhoppers or spittlebugs to occur within the wildlife unit. Further survey for the *Eleocharis* inhabiting spittlebug, *Lepyronia angulifera* may find populations of this species within the wildlife unit. With further intensive management, including prescribed burning of prairie fen, sedge meadow, and upland oak systems, habitat is likely to improve, and some rare species may be recorded in the future.

Rare Mollusk Discussion and Recommendations

The gastropod species of special concern, trumpet vallonia (*Vallonia parvula*), was reported from only one county in Michigan (Monroe Co.) by Hubricht (1985). Since it was only recently designated a species of special concern, this is the first element occurrence entered into the Biotics database for this species. Further consultation with one or more university mollusk collections is needed to determine if this occurrence is a new county record (Jackson Co.).

The trumpet vallonia found in this study occurred in an upland field dominated by goldenrod (*Solidago spp.*) (Site G). It is not uncommon to find rare species in altered habitats, and this record is another example. This altered habitat apparently provides the structure necessary to create a suitable microhabitat. Trumpet vallonia is a land snail that belongs to the family Valloniidae, and is oviparous (eggs hatch outside of the adults body) (Burch and Pearce 1990). This species is reported to be "found in grassy situations, but in dryer habitats than those of *V. pulchella* [a similar species of the same genus]" (Hubricht 1985). It is also reported to be found "under wood, leaves, stones, old logs, on moss, and on the banks of streams" (Baker 1902), and "in samples of soil and decaying vegetation" (Gugler 1963).

Paper pondshell (a species of special concern) is often associated with lakes, impoundments, or slow moving rivers. It is one of relatively few unionid mussel species to

be associated with silty substrate and still water conditions. It is not surprising that it was found at Site D given the high proportion of silt found there. Although paper pondshell is tolerant of silt and low/no current, it is uncommon in Michigan and could be limited by other factors such as water quality. This occurrence is one of only five in the Biotics database. This is due in part to the fact that is was only recently designated as a species of special concern and there is a backlog of occurrences of these newly listed species to enter, as well as the fact that it is uncommon in Michigan.

Paper pondshell is known to use several fish species as hosts that have the potential to occur in the Portage River and Little Portage Lake. These including bluegill (*Lepomis macrochirus*), creek chub (*Semolitus atromaculatus*), green sunfish (*Lepomis cyanellus*), and pumpkinseed (*Lepomis gibbosus*) (Watters 1994). Protecting the fish communities of the Portage River and Little Portage Lake from impact will help ensure the availability of hosts for unionid mussels within the wildlife unit.

Unionid mussel species richness tends to be higher in larger streams than in smaller ones. A positive correlation between mussel species richness, fish species richness, and stream size has been documented (Watters 1992). It is therefore, not surprising that only four unionid species were found in the Portage River.
Exotic dreissenid mussels (zebra and quagga mussels) are having dramatic negative impacts on native mussel populations in most of Michigan's major watersheds. Larger rivers appear to have a much worse problem with these exotics due to the inadvertent transportation of dreissenids by recreational and commercial boating. Streams like the Portage River that are too small for boats, canoes, etc., can act as refugia for native unionid mussels. Preventing the introduction of dreissenids into this watershed can help ensure that present unionid populations will persist into the future.

The primary mechanism for gene flow among unionid mussel populations, and for unionid migration to new habitats is the movement of host fish while mussels are in the larval stage. In the long term, unionid populations within the wildlife unit are reliant on the passage of fish within the Portage River watershed, and between the Portage River watershed and Grand River. Barriers to fish host movement are also barriers to unionid mussels (Watters 1995). Being a much larger and more species rich system, the Grand River may act as a source for host fish and unionids. Barriers to fish passage, such as dams or stretches of heavily altered habitat can prevent gene flow and migration between the Grand River and unionid mussel populations in the wildlife unit. For general information on unionid mussels see the "Freshwater Mussels of Michigan" brochure on MNFI's website (http://web4.msue.msu.edu/mnfi/pub/publications.cfm).

CONCLUSION

Surveys for high quality natural communities and rare terrestrial and aquatic animal species in the Waterloo Wildlife Unit yielded 24 new element occurrences and allowed 9 previously identified records to be updated. Natural community surveys resulted in 17 new natural community element occurrences and 2 new rare plant element occurrences (Tables 1). In addition, 4 previously identified natural community records and 2 rare plant records were updated. Rare animal surveys documented 5 new rare animal element occurrences, and 7 previously documented records were reconfirmed (Table 2). Based on this recent assessment of available habitat, future surveys are likely to be successful for additional element occurrences of emergent marsh, southern wet meadow, and southern shrub-carr natural communities, and rare forest and grassland songbirds, raptors (especially marsh hawk), herps, insects, unionid mussels, and snails.

Primary management recommendations include 1) implementing prescribed fire on a regular basis in the fire-adapted community types such as dry southern forest, dry-mesic southern forest, wet prairie, southern wet meadow, and prairie fen and 2) controlling and monitoring invasive plants, particularly in the areas identified as natural community occurrences (Tables 4). Because the vast majority of the upland forests in the Waterloo Wildlife Unit directly border large wetland complexes, they likely serve as important nesting sites for turtles. Reducing the cover of shade-tolerant red maples within these otherwise oak-dominated forests will facilitate higher levels of sunlight reaching the ground, significantly benefitting turtle reproduction. The increased levels of sunlight reaching the forest understory and ground layer will also help improve oak and hickory regeneration, both important food resources for wildlife, and bolster native plant diversity.

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APPENDICES 1 - 7

Appendix 1. State Lands Herp Survey Data Form 2010

STATE LANDS INVENTORY SPECIAL ANIMAL SURVEY FORM - HERPS

I. LOCATION INFORMATION

Site Name _____ Stand Number(s)_____ Date_____

Observer(s)_____ Stand classifications_____

Quad_____County_____ Town, Range, Sec_____

Directions/access _____

_____

GPS Unit Type & #: _____ GPS Waypoint(s): _____ GPS Track(s): _____

II. SURVEY INFORMATION

Time Start _____ Time End _____ Weather: Start Air Temp _____ End Air Temp _____

% Sun _____ Wind _____ Precip _____ Comments _____

Target species/group & survey method_____

Target/rare species found? Yes No Comments: _____

Habitat for target species/group found? Yes No Comments: _____

Species found (common or rare)	Number	Location (GPS, landmarks)	Notes (habitat, behavior, condition, etc.)

Survey comments (area surveyed, potential for other rare species, revisit warranted, photos taken? etc.)

_____

_____

_____

III. GENERAL SITE DESCRIPTION (describe in relation to species surveyed for – presence, quantity, and quality of appropriate habitat, crayfish burrows, hostplants/nectar sources, dominant vegetation, natural communities, habitat structure, etc.)

_____

_____

_____

_____

IV. MANAGEMENT CONSIDERATIONS

Threats (e.g., ORV's, excessive mt. bike use, grazing, structures, past logging, plantations, development, erosion, ag, runoff, hydrologic alteration, etc.) _____

_____

Exotic species (plants or animals)_____

_____

Stewardship Comments _____

_____

11/24/2009

V. LISTED ANIMAL OR PLANT SPECIES or COMMUNITY EOS _____

_____

_____

VI. ADDITIONAL ASSOCIATED SPECIES FOUND

Species found (common or rare)	Number	Location (GPS, landmarks)	Notes (habitat, behavior, condition, etc.)

VII. Map/drawing of general area surveyed and approximate locations of suitable habitat and/or rare species found

Appendix 2. State Lands Salamander Trapping Survey Data Form 2009

MNFI SALAMANDER TRAPPING SURVEY DATA FORM

Date:_____ County: _____ Site _____ Owner _____

Crew:_____ Approx wetland size: _____ GPS file: _____

Sampling Method		Time			
		Start	Stop	Elapsed	notes:
	Traps, no. _____				
	Visual, num observers _____				
	Dipnet				

Collections

	Method	Time	Species	Tissue sample	GPS location	Microhabitat	SVL	Sex	Photo?	Disposal?
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										
16										
17										
18										
19										
20										

MH: pond, leaves, rock, log, (on, under, in)

Notes:

Appendix 3. Summary of amphibian and reptile species that had potential for occurring and /or were documented in Waterloo Wildlife Unit during MNFI surveys in 2010.

Common Name	Scientific Name	US Status	State Status	SGCN	Target Rare Species	Species Found in 2010	General Habitats (primarily from Harding 1997)
Mudpuppy	*Necturus maculosus maculosus*			X			Permanent waters - rivers, reservoirs, inland lakes, Great Lakes bays and shallows
Eastern Newt	*Notophthalmus viridescens*						Small, permanent ponds, temporary ponds, and shallows of large lakes, river sloughs and backwaters with abundant aquatic vegetation
Spotted Salamander	*Ambystoma maculatum*			X	X		Moist closed canopy deciduous or mixed forests, temporary/semi-permanent ponds within or adjacent to woods
Blue-spotted Salamander	*Ambystoma laterale*			X	X	X	Deciduous and coniferous forests from moist bottomlands to dry uplands; ponds that retain water into midsummer essential
Smallmouth Salamander	*Ambystoma texanum*		E	X	X		Floodplain forests, open habitats, shallow bodies of water - vernal pools, runoff ponds, floodings, river backwaters, roadside ditches
Eastern Tiger Salamander	*Ambystoma tigrinum*			X	X		Forests, marshes, and grasslands; breeding - permanent and semi-permanen ponds
Red-backed Salamander	*Plethodon cinereus*					X	Deciduous, coniferous, and mixed forests
Four-toed Salamander	*Hemidactylium scutatum*			X			Moist deciduous, coniferous, or mixed forests, usually in vicinity of spring-fed creeks, sphagnum seepages, bogs, or boggy ponds
Eastern American Toad	*Anaxyrus [Bufo] americanus americanus*					X	Open forests, forest edges, prairies, marshes, and meadows
Blanchard's Cricket Frog	*Acris crepitans blanchardi*		T	X	X		Open, muddy edges of permanent ponds, lakes, bogs, and slow-moving streams or rivers with abundant aquatic vegetation, including fens and wet or sedge meadows
Western Chorus Frog	*Pseudacris triseriata triseriata*			X		X	Marshes, wet meadows, swales, and other open habitats, also mesic forests and swamp forests
Northern Spring Peeper	*Pseudacris crucifer crucifer*					X	Temporary and permanent ponds, marshes, floodings, and ditches, as well as forests, old fields, shrubby areas
Gray Treefrog	*Hyla versicolor/Hyla chrysoscelis*						Temporary ponds, swamps, floodings, shallow edges of permanent lakes, and sloughs, surrounded by forested or open habitats
Bullfrog	*Lithobates [Rana] catesbeianus*						Permanent waterbodies - river backwaters, sloughs, lakes, farm ponds, impoundments, marshes, shallow Great Lakes bays; abundant emergent and submergent vegetation
Green Frog	*Lithobates [Rana] clamitans melanotus*					X	Ponds, lakes, swamps, sloughs, impoundments, and slow streams
Wood Frog	*Lithobates [Rana] sylvaticus*					X	Moist, forested habitats (deciduous, coniferous, and mixed); breeding - vernal ponds, floodings, forested swamps, and quiet stream backwaters
Northern Leopard Frog	*Lithobates [Rana] pipiens*		(SC)*	X		X	Open wetland habitats including marshes, bogs, lake and stream edges, and sedge meadows, and adjacent open uplands incldluing hay fields, lawns; breed in shallow temporary ponds, stream backwaters, and marsh pools
Pickerel Frog	*Lithobates [Rana] palustris*			X			Bogs, fens, ponds, streams, springs, sloughs, and lake coves; cool clear waters, grassy stream banks
Eastern Snapping Turtle	*Chelydra serpentina serpentina*					X	Permanent waterbodies including shallow, weedy Great Lakes inlets and bays; muddy ponds, lakes, sloughs and slow streams with dense aquatic vegetation
Eastern Musk Turtle	*Sternotherus odoratus*						Permanent waterbodies - ponds, lakes, marshes, sloughs, rivers; highly aquatic
Spotted Turtle	*Clemmys guttata*		T	X	X		Shallow ponds, wet meadows, tamarack swamps, bogs, fens, marshes, sphagnum seepages, slow streams; require clear shallow water with mud/muck bottom and ample aquatic and emergent veg
Eastern Box Turtle	*Terrapene carolina carolina*		SC	X	X		Deciduous or mixed forests, esp. with sandy soils, also adjacent old fields, pastures, dunes, marshes, and bog edges
Blanding's Turtle	*Emydoidea blandingii*		SC	X	X	X	Shallow, weedy waters - ponds, marshes, forested and shrub swamps, wet meadows, lake inlets and coves, rivers backwaters, embayments, sloughs, vernal pools
Northern Map Turtle	*Graptemys geographica*						Larger lakes, rivers, reservoirs, oxbow sloughs, open marshes, Great Lakes bays and inlets; also smaller lakes and streams and ponds
Painted Turtle	*Chrysemys picta*					X	Quiet, slow-moving permanent water bodies with soft bottom substrates, abundant aquatic vegetation, and basking sites; temporarily occupy vernal ponds, imoundments, ditches and faster streams and rivers
Eastern Spiny Softshell	*Apalone spinifera spinifera*						Rivers and larger streams, inland lakes, reservoirs, protected Great Lakes bays and river mouths; often with sandy or muddy bottoms, and open with little aquatic vegetation
Five-lined Skink	*Emumeces fasciatus*						Moist but not wet, forested or partially forested habitats with ample cover and basking sites - stumps, logs, rock outcrops, wood or brush piles, sawdust piles, fallen bark; moist not wet habitats
Northern Water Snake	*Nerodia sipedon sipedon*					X	Permanent water bodies - rivers, streams sloughs, lakes, ponds, bogs, marshes, swamps, wet meadows, impoundments; also utilize shallow, small temporary ponds and wetlands including vernal pools and shrub swamps
Copperbelly Water Snake	*Nerodia erythrogaster neglecta*	LT	E	X	*		Shrub swamps, ponds, vernal pools, lakes, oxbow sloughs, and slow moving streams usually in mature or second growth forests, but also in forested swamp and open habitats including old fields, meadows, and pastures, located within primarily forested landscape (e.g., upland forests o mesic southern forest, or dry-mesic southern forest)
Queen Snake	*Regina septemvittata*		(SC)*	X			Warm, shallow, rocky-bottomed streams with abundance of crayfish; also edges of ponds, lakes, marshes, ditches and canals, open to mostly forested
Kirtland's Snake	*Clonophis kirtlandii*		E	X			Damp habitats near streams, ditches, marshes or open grassy haibtats such as wet prairies, wet meadows, fens, swales, and pastures, also forested swamps
Eastern Garter Snake	*Thamnophis sirtalis sirtalis*						Almost any natural habitats - open and forested habitats and moist grassy places - edges of ponds, lakes, streams ditches,
Butler's Garter Snake	*Thamnophis butleri*						Wet meadows and prairies, marshy pond and lake borders, and other moist habitats
Northern Ribbon Snake	*Thamnophis sauritus septentrionalis*					X	Edges of lakes, ponds, streams, marshes, especially with grasses, sedges and low shrubs, open sunny areas/habitats
Brown Snake	*Storeria dekayi*						Variety of habitats from dense forests and shrubby habitatss to open prairies, meadows, and marshes; prefer areas with moist soils but also found on dry hillsides, pine forests, and railroad embankments

Appendix 3. continued

Common Name	Scientific Name	US Status	State Status	SGCN	Target Rare Species	Species Found in 2010	General Habitats (primarily from Harding 1997)
Northern Red-bellied Snake	*Storeria occipitomaculata occipitomaculata*						Deciduous or mixed forests, and adacentj fields, pastures, road embankments, marshes and sphagnum bogs
Smooth Green Snake	*Opheodrys vernalis*			X			Moist grassy places including prairie remnants and savannahs, meadows, old fields, pastures, roadsides, marsh and lake edges, also open deciduous and pine forests
Blue Racer	*Coluber constrictor foxii*			X			Dry sunny, open habitats with access to cover - old fields, hedgerows, shrul thickets, open forests, forest edges, also grassy lake borders and marshes
Gray Rat Snake	*Pantherophis spiloides*		SC	X	X		In or near forests, and adjacent open habitats - shrubby fields, pastures, marsh and bog edges
Eastern Milk Snake	*Lampropeltis triangulum triangulum*						Open forests, bogs, swamps, forest edges, marshes, lakeshores, old fields, and pastures
Northern Ring-necked Snake	*Diadophis punctatus edwardsii*			X			Moist, shady forests and adjacent open habitats including old fields, grassy dunes; often found under leaf litter or cover or in burrows
Eastern Hog-nosed Snake	*Heterodon platirhinos*			X	X		All types of terrestrial habitats - from open pine or deciduous forests to old fields, meadows, and pastures
Eastern Massasauga	*Sistrurus catenatus catenatus*	C	SC	X	X		Open and forested wetlands including shrub swamps, bogs, fens, marshes, wet or sedge meadows, moist prairie, and forested swamps, and adjacent open and forested upland habitats including prairies, old fields, meadows, shrub thickets, and deciduous, coniferous, and mixed forests.

Key:
U.S. Status: LT = Federally Threatened; C = Federal Candidate
State Status: E = Endangered; T = Threatened; SC = Special Concern; (SC)* = Proposed Special Concern, not finalized
*Note: Looked for this species during herp surveys when surveying suitable habitat for the species, but did not specifically target surveys for this species.

Sources:
Harding 1997, Eagle et al. 2005, Crother et al. 2008, Collins and Taggart 2009

Appendix 4. Locations and habitat type of gastropod collections and unionid mussel surveys.

Site	Latitude (N)	Longitude (W)	Habitat Type
Gastropod collections			
E	42.40389	-84.14287	wetland: from cattail, moss, and wet leaf litter
F	42.40454	-84.14509	wetland: at edge of forest in sedges and ferns
G	42.37499	-84.14964	pond: at water's edge with duckweed and grasses
H	42.37434	-84.17212	old field: soil at base of vegetation (goldenrod etc.)
I	42.38510	-84.17672	Markla Lake: submerged vegetation at water's edge
J	42.35485	-84.20050	wetland: wet vegetion and large woody debris
K	42.39308	-84.13130	wetland: at edge of forest in sedges and cattail
Unionid mussel sites			
A	42.17790	-84.35990	small tributary at Riethmiller Rd. crossing
B	42.36373	-84.21354	Portage River upstream of Little Portage Lake
C	42.36594	-84.20982	Portage River upstream of Little Portage Lake
D	42.37379	-84.19809	Portage River upstream of Little Portage Lake

Appendix 5. Scientific and common names of aquatic and terrestrial gastropods found within the Waterloo Wildlife Unit, Sites E-K. (L=live individuals; S=species represented by shell only; SC=species of special concern)

		E	F	G	H	I	J	K
Aquatic Gastropods								
lance aplexa	*Aplex elongata*	L	L					
disc gyro	*Gyraulus circumstriatus*	L	L					
star gyro	*Gyraulus crista*	L						
ash gyro	*Gyraulus parvus*					S		
two-ridge rams-horn	*Helisoma anceps*					L		
glass physa	*Physa skinneri*	L	L					
tadpole physa	*Physella gyrina*			L		L		
bellmouth rams-horn	*Planorbella campanulata*					L		
thicklip rams-horn	*Planorbula amigera*					L		L
marsh pondsnail	*Stagnicola elodes*	S	L	L				
Terrestrial Gastropods								
suboval Ambersnail	*Catinella vermeta* (=*avara*)			L				
glossy pillar	*Cochlicopa lubrica*						L	
Appalacian pillar	*Cochlicopa morseana*				L			
brown hive	*Euconulus fulvus*		L					
amber glass	*Nesovitrea electrina*		S					
blunt ambersnail	*Oxyloma retusa*		L	L	L	L	L	L
trumpet vallonia	*Vallonia parvula* (SC)				L			
ovate vertigo	*Veritgo ovata*	L	L	L				
eastern glass-snail	*Vitrina angelicae* (=*limpida*)				L			
black gloss	*Zonitoides nitidus*						L	
Number of species per site		6	8	5	4	6	3	2

Appendix 6. Scientific and common names of unionid mussels found within the Waterloo Wildlife Unit, Sites B-D. (L=live individuals; S=species represented by shell only; SC=species of special concern)

		Portage River		
Common name	Species	B	C	D
fatmucket	*Lampsilis siliquoidea*	1	15	
giant floater	*Pyganodon grandis*	S	S	
strange floater	*Strophitus undulatus*		1	
paper pondshell	*Utterbackia imbecillis* (SC)			S
Area searched (m^2)		128	128	150
Asian clam	*Corbicula fluminea*			
zebra mussel	*Dreissena polymorpha*			

Appendix 7. Substrate composition and stream habitat type (% of each) for unionid mussel survey sites.

Site	Boulder	Cobble	Pebble	Gravel	Sand	Silt	Pool	Riffle	Run
B				10	45	45			100
C		5	10	20	40	25	10		90
D					20	80			100