Natural Features Inventory and Management Recommendations for Crane Pond, Three Rivers, and Fabius State Game Areas

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Cover Photo Captions (left to right):
MNFI field biologist David L. Cuthrell, measuring a cylindrical papershell mussel (*Anodontoides ferussacianus*) in Mill Creek at Three Rivers State Game Area (photo by Peter J. Badra).

MNFI field biologist John Fody, measuring the diameter of a large red oak (*Quercus rubra*) at Forked Lake Woods in Crane Pond State Game Area (photo by Michael A. Kost).

MNFI field biologist John Fody, surveying a large population of wild rice (*Zizania aquatica* var. *aquatica*) at Mill Creek Wet Meadow in Three Rivers State Game Area (photo by Michael A. Kost).

ABSTRACT

In 2009, Michigan Natural Features Inventory conducted surveys for exemplary natural communities and rare terrestrial and aquatic animals in three state game areas administered by the Michigan Department of Natural Resources, Wildlife Division: Crane Pond, Three Rivers, and Fabius. During the surveys, 35 new element occurrences were documented and 19 previously identified records were updated. For natural communities, ten new element occurrences were documented and eleven prior records were updated. Newly documented natural community element occurrences for Crane Pond consist of two dry-mesic southern forests, one prairie fen, two submergent marshes, and one emergent marsh. At Three Rivers, new natural community element occurrences consist of two dry-mesic southern forests and one prairie fen. At Fabius, one element occurrence of mesic southern forest was documented. Observations of existing vegetation made during natural community surveys resulted in eleven new rare plant element occurrences and the updating of four prior rare plant records. Newly documented rare plant occurrences include goldenseal (*Hydrastis canadensis*, state threatened), red mulberry (*Morus rubra*, state threatened), and black haw (*Viburnum prunifolium*, state special concern) at Crane Pond; wild rice **(***Zizania aquatica* var. *aquatica*, state threatened), starry campion (*Silene stellata*, state threatened), hairy skullcap (*Scutellaria elliptica*), and black haw at Three Rivers; and black haw at Fabius. Surveys for rare terrestrial animals resulted in nine new element occurrences, and four prior records were reconfirmed. New element occurrences at Crane Pond include Cerulean Warbler (*Dendroica cerulea*, state threatened), Hooded Warbler (*Wilsonia citrina*, special concern), Louisiana Waterthrush (*Seiurus motacilla*, state threatened), Least Bittern (*Ixobrychus exilis*, state threatened), Blanding's Turtle (*Emydoidea blandingii*, special concern), and Blanchard's Cricket Frog (*Acris crepitans blanchardi*, state threatened). New element occurrences at Three Rivers include Cerulean Warbler, maritime sunflower borer moth (*Papaipema maritima*, special concern), and golden borer moth (*Papaipema cerina*, special concern). Surveys for rare aquatic animals resulted in five new element occurrences at Three Rivers; these include new records for the slippershell (*Alasmidonta viridis*, state threatened), ellipse (*Venustaconcha ellipsiformis*, special concern), rainbow (*Villosa iris* special concern) round pigtoe (*Pleurobema sintoxia*, special concern), and watercress snail (*Fontigens nickliniana*, special concern). Based on findings of available habitat, future surveys for inundated shrub swamp and dry-mesic southern forest natural communities and for rare animal taxa such as songbirds, herps, insects, unionid mussels, snails, fish, aquatic insects, and other aquatic invertebrates are believed to have a good likelihood of documenting additional element occurrences. Primary management recommendations include implementing prescribed fire on a regular basis in fire-adapted community types such as dry-mesic southern forest, prairie fen, and southern wet meadow, and controlling and monitoring invasive plants (see Tables 5 and 6). Additionally, repairs of the Preston Road bridge over Mill Creek could help prevent excessive siltation and contribute to the long-term viability of at least four rare unionid mussel species and one rare snail located directly downstream of the bridge.

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INTRODUCTION

During the spring, summer, and fall of 2009 Michigan Natural Features Inventory (MNFI) conducted surveys for exemplary natural communities and rare terrestrial and aquatic animals in three state game areas administered by the Michigan Department of Natural Resources, Wildlife Division (DNR): Crane Pond, Three Rivers, and Fabius. This project is part of a long-term effort by the DNR to document and sustainably manage areas of high conservation significance on state lands. This report summarizes the findings of MNFI's 2009 surveys of Crane Pond, Three Rivers, and Fabius State Game Areas.

Landscape Context

Crane Pond State Game Area (Crane Pond), Three Rivers State Game Area (Three Rivers), and Fabius State Game Area (Fabius) are all located within seven miles of the Cass County-St. Joseph County Line in southwestern Lower Michigan.

The regional landscape ecosystems of Michigan have been classified and mapped based on an integration of climate, physiography (topographic form and geologic parent material), soil, and natural vegetation (Albert 1995). This classification system can be useful for biological conservation and in integrated resource management and planning because it provides a framework for understanding patterns of natural community and species distributions and natural disturbance regimes across the state. The classification has a nested hierarchical structure composed of broad landscape *sections*, medium-sized *subsections*, and smaller *sub-subsections*.

The three state game areas discussed in this report occur within the Kalamazoo Interlobate Subsection (VI.2) of the Southern Lower Michigan Section (VI) (Figure 1) (Albert 1995). The Kalamazoo Interlobate Subsection is characterized by a combination of relatively broad, gently sloped glacial outwash plains, and relatively dissected, steep glacial end moraine and ice contact areas. Within this subsection, kettle lakes and wetlands are numerous on rugged ice-contact topography, while streams and associated riparian wetlands are common in areas of glacial outwash. Common circa 1800s Vegetation within the subsection included tallgrass prairies, oak savannas, oak-hickory forests, beech-sugar maple forests, wet prairies, bogs, swamp forests, and shrub swamps (Albert 1995; Comer 1995) (Figure 2). Tallgrass prairies and oak savannas were more common on broad or gently rolling outwash plains where landscape-scale fires could carry uninterrupted, while oak forests and beech-sugar maple forests were more typical of rugged ice-contact topography and moraines. Wet prairies, bogs, swamp forests, and shrub swamps were nestled in ice-block depressions (i.e., kettles) and glacial outwash channels within the larger expanse of upland prairies, savannas, and forests.

The Kalamazoo Interlobate Subsection sub-divides into the Battle Creek Outwash Plain Sub-subsection (VI.2.1) and the Cassopolis Ice-Contact Ridges Sub-subsection (VI.2.2). Nearly all of Three Rivers, the far southern portions of Crane Pond, and the eastern portion Fabius occur within the Battle Creek Outwash Plain Sub-subsection (Figure 1). As its name implies, this sub-subsection contains large areas of level to gently rolling outwash plain with sandy to sandy loam soils that are derived from prehistoric glacial meltwater floodplains, terraces, sandbars, etc. These level to rolling outwash plains so characteristic of Three Rivers contrasts sharply with the hilly and rugged topography of the Cassopolis Ice-Contact Ridges Sub-subsection that characterizes Crane Pond. This sub-subsection is dominated by steep and hilly topography that formed alongside the broken and uneven edges of sloughing glaciers. These rugged lands typically have loamy and gravelly sand soils and numerous ice-block depressions. This Cassopolis Ice-Contact Ridges Sub-subsection includes almost all of Crane Pond, the far southwestern portion of Three Rivers, and the western portion of Fabius. Wetland soils in both sub-subsections are typically comprised of accumulated organic sediments (i.e., peats and mucks).

Vegetation circa 1800

The federal government's General Land Office (GLO) survey notes for Michigan were recorded during the period of 1818 to 1856. By contemporary standards, these notes are somewhat qualitative and lacking in fine ecological detail, and their mile-to-mile scale is coarse in comparison to many natural community patch sizes. However, these notes do provide at least snapshot information on vegetation structure (e.g., prairie, savanna, forest, etc.), tree species, soil fertility, and local topography. References to shrubs species or other notable features are also occasionally included and contribute to our understanding of the early Michigan landscape. By interpreting the GLO notes, MNFI ecologists were able to piece together a relatively accurate picture of the state's overall vegetation in the early 1800's (Comer et al. 1995) (Figure 2). Understanding these circa 1800 vegetation patterns is often key to interpreting contemporary vegetation patterns.

Crane Pond

The circa 1800 vegetation map reveals that in addition to numerous lakes, Crane Pond supported several different natural communities, including oak-hickory forest, mixed oak savanna, beech-sugar maple forest, mixed hardwood

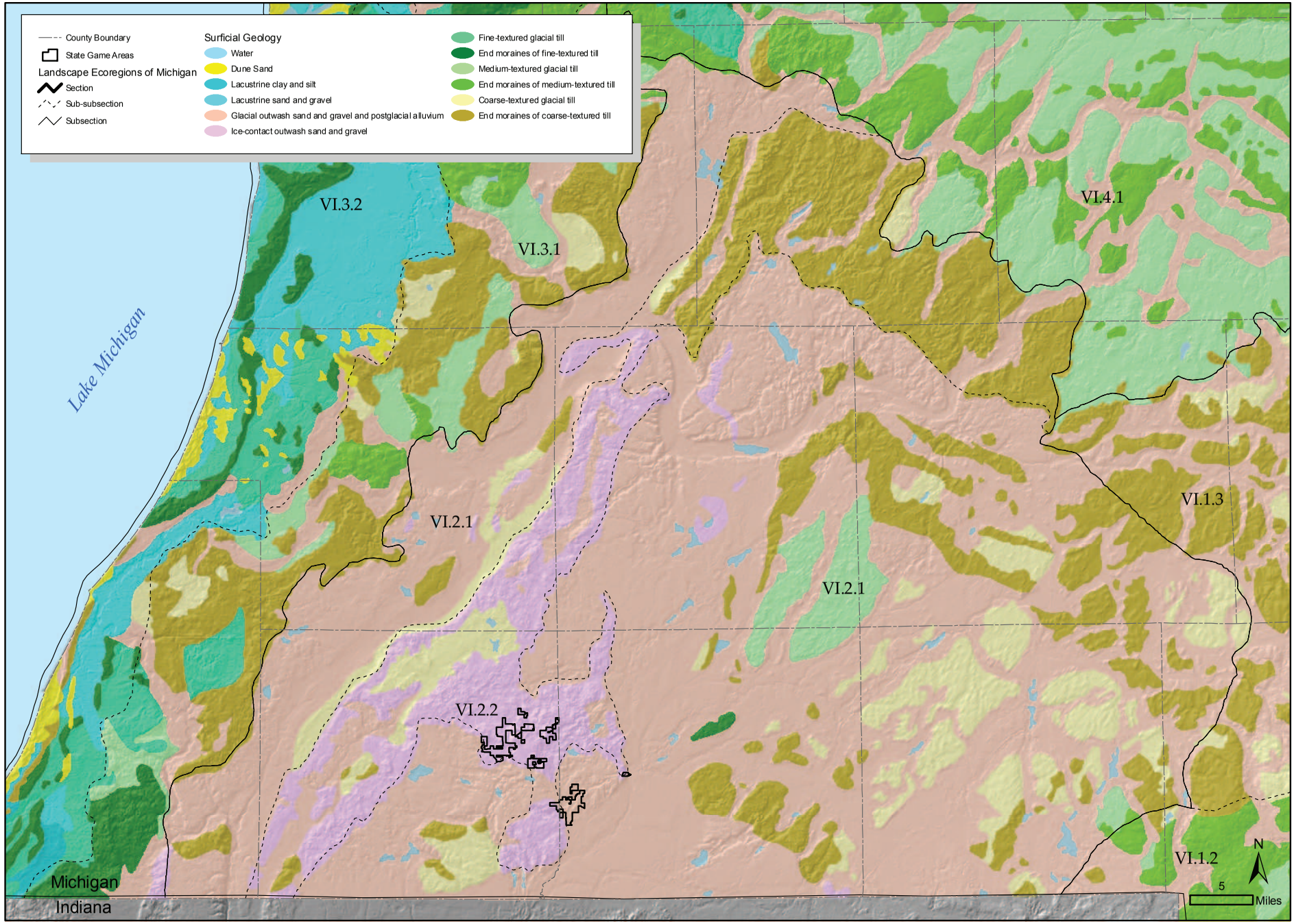


Figure 1. Ecoregions and Quaternary Geology of southwestern Lower Michigan (Albert 1995, Farrand and Bell 1982).

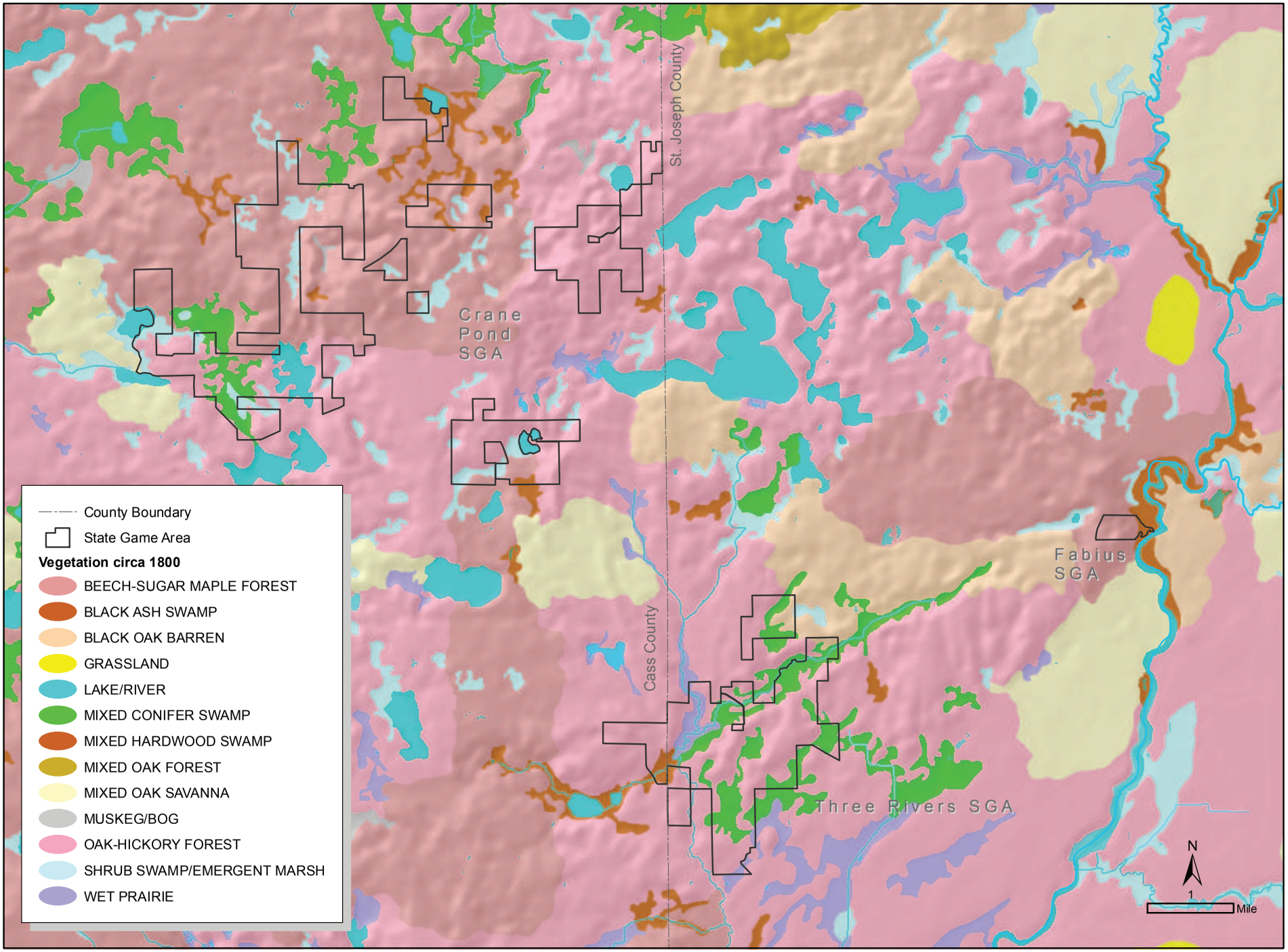


Figure 2. Circa 1800 Vegetation for southwestern Lower Michigan (Comer, et al. 1995).

swamp, mixed conifer swamp, and shrub swamp-emergent marsh (Figure 2). Circa 1800 oak savannas were maintained by fires that occurred frequently enough to keep trees widely spaced. Oak-hickory forest and mixed oak forest were also maintained by fires, but the fires would have been weak enough and/or infrequent enough to allow greater tree density to develop. It is worth noting that these historic oak forests typically contained lower tree densities than contemporary oak forests, which have experienced a century or more of fire suppression. One clue to historic forest composition lies in the frequency with which surveyors recorded or noted the presence of various tree species. In the areas mapped as oak-hickory forest at Crane Pond, surveyors recorded white oak (*Quercus alba*) very frequently; they periodically recorded "yellow oak" [probably scarlet oak (*Q. coccinea*), hill's oak (*Q. ellipsoidalis*), or black oak (*Q. velutina*)] and hickory (*Carya* spp.); and infrequently they recorded beech (*Fagus grandiflora*), white ash (*Fraxinus americana*), sassafras (*Sassafras albidum*), and red oak (*Quercus rubra*). In addition, undergrowth of hazel (*Corylus americana*), grape (*Vitis* spp.), oak, and sassafras were noted within this forest. The mixed oak savanna on the western edge of Crane Pond was largely dominated by white oak. Beech-sugar maple forests occurred on rugged ice-contact topography in Crane Pond, probably because the continual topographic change restricted the frequency and intensity of fires. Surveyors noted beech and white ash more frequently than other species in the beech-sugar maple forests. However, tree diversity was high—big-tooth aspen (*Populus grandidentata*), sugar maple (*Acer saccharum*), basswood (*Tilia americana*), elm (*Ulmus spp.*), white oak, ironwood (*Ostrya virginiana*), and hickory were also noted. Additionally, surveyors noted an undergrowth of spicebush (*Lindera benzoin*) and paw-paw (*Asimina triloba*) in the beech-sugar maple forests. At Crane Pond, areas of mixed conifer swamp were noted to contain primarily tamarack (*Larix laricina*) with some black ash (*Fraxinus nigra*). Areas of mixed hardwood swamp were widely scattered and not well documented at the game area. Hydrology and fire frequency likely influenced species composition, with conifer swamps occurring where fires were more frequent and water levels were more stable, and hardwood swamps found where fires were absent or less frequent and water levels fluctuated seasonally. Areas mapped as shrub swamp-emergent marsh can vary significantly from place to place and may have contained bulrush, cattail, or sedge-dominated marsh, or thick cover of buttonbush, willow, or dogwood.

Three Rivers

In the mid 1800s, the vegetation of Three Rivers supported oak-hickory forest, mixed hardwood swamp, mixed conifer swamp, shrub swamp-emergent marsh, and a few areas of black oak barrens and wet prairie (Figure 2). Black oak barrens and wet prairie are both fire-dependent communities. Historically, black oak barrens often occurred on level to rolling outwash plains with well-drained sandy or gravelly soils—as was found at Three Rivers. At the black oak barrens in the far northern portion of Three Rivers, surveyors noted rather widely spaced "yellow oak," white oak, black oak, and hickory trees. Areas mapped as wet prairies comprise a variety of open wetland types ranging from marsh, wet meadow, and prairie fen on peat soils to moist prairies on mineral soils. Because the survey notes provide no additional information of the species composition of these open wetlands, interpretations of probable past community types requires evaluation of other factors such as current vegetation, nearby cover types, landscape context, and hydrology. In the oak-hickory forests at Three Rivers, surveyors noted white oak and hickory most frequently, but also recorded "yellow oak," aspen (*Populus tremuloides*), big-tooth aspen, ironwood, white ash, and black oak. Also, less than one-tenth of a mile southwest of Three Rivers, surveyors noted a roughly half square-mile area of burned oak-hickory forest. Within areas mapped as mixed conifer swamp at Three Rivers, tamarack was the most common tree species noted.

Fabius

Interpretations of circa 1800 vegetation for Fabius indicate that the area contained beech-sugar maple forest on the hilly ice-contact topography and mixed hardwood swamp on the outwash plain and in the floodplain of the St. Joseph River. The GLO surveys occurred only on the section line along the far western edge of Fabius. In the beech maple forest along this section line, surveyors noted that timber was "first rate," implying large healthy trees, and they listed numerous tree species including big-tooth aspen, sugar maple, beech, oak (*Quercus spp.*), red oak, elm, basswood, and ironwood. Additional information included the presence of a sugar camp just one-third of a mile to the northwest, and an undergrowth of briars (*Rubus spp.*), wild grape, hazelnut, spicebush, and nettles [possibly wood nettle (*Laportea canadensis*)]. In the St. Joseph River floodplain near Fabius, surveyors recorded ash (*Fraxinus spp.*) and elm.

Existing Landcover

Much of the vegetation present during Michigan's GLO Surveys in the early 1800's has been significantly altered by changes in land management practice and resource use. Past and present activities such as logging, agriculture, hydrologic manipulation, fire suppression, and unregulated hunting have altered or eliminated many natural communities (Albert 1995, Albert and Comer 2008). As examples, fire exclusion within wet prairie often results in conversion to shrub-carr; and clearcutting of beech-maple

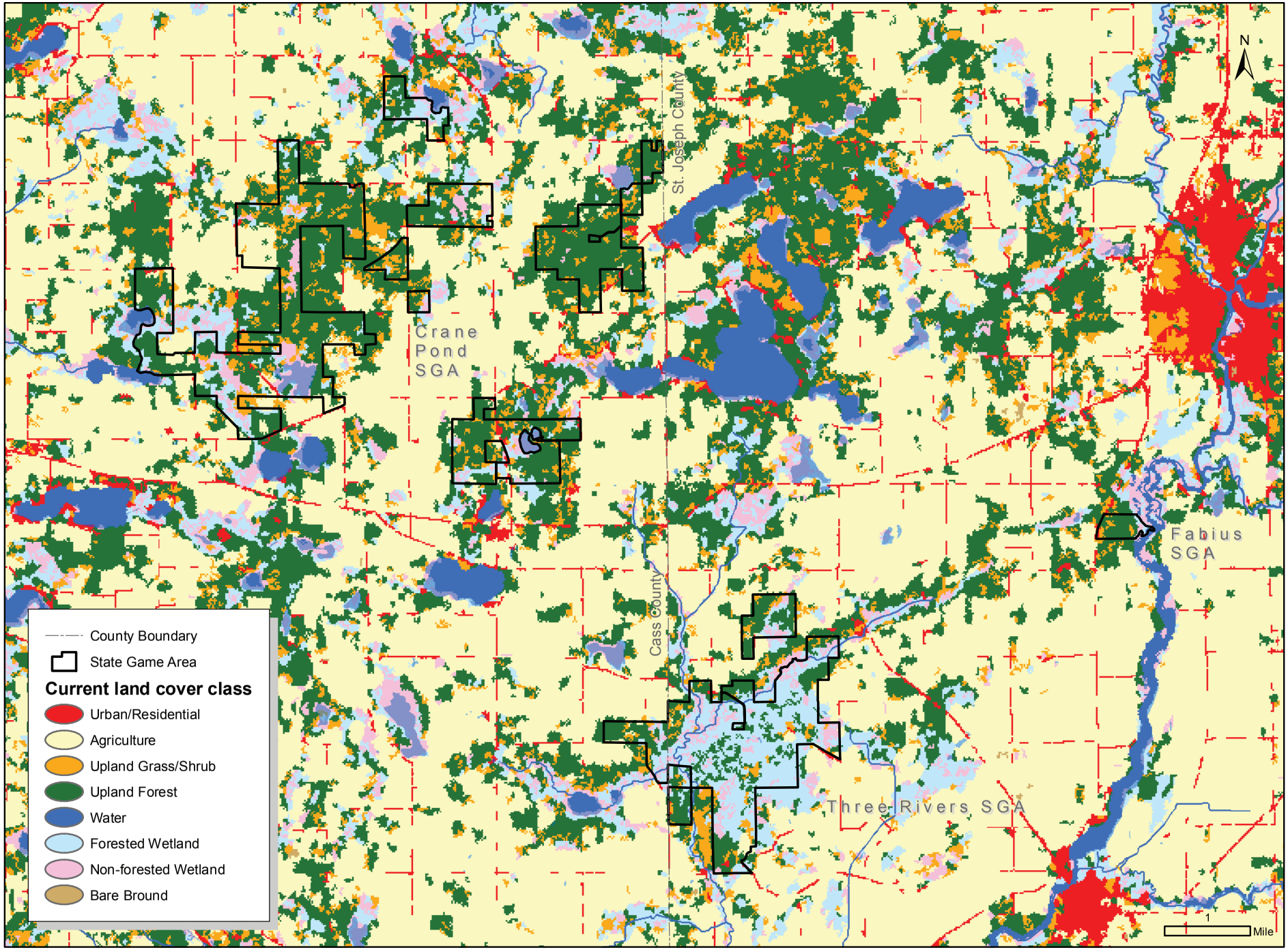


Figure 3. 2001 Land Cover (DNR 2001).

forest followed by pasturing or crop production effectively eliminates the original forest. Even when resource extraction is abandoned or land management activity is curtailed, long lasting or cascading effects typically continue. While these effects are evident throughout much of the game areas, their intensity often varies significantly. Local variability in topography and hydrology, differences in prior landowner activities, and local management activities have all caused significant variability in the intensity of landscape disturbances. Due to this variability, these game areas now contain patchworks of wetlands, forests, and openlands that range in condition from relatively unaltered natural communities to completely cultural cover types.

Significant areas of original forests remain in the three game areas (Figure 3). Several significant tracts of beech-sugar maple forest (i.e., mesic southern forest) occur in the northern portion of Crane Pond, while the central and southern portions continue to support many stands of oak-hickory forest (i.e., dry-mesic southern forest). Both forest types contain a variety of small wetlands, typically occurring in ice-block depressions, such as vernal pools, shrub swamps, swamp forests, and ponds. At Three Rivers, upland forests are dominated by white oak and black oak and frequently contain a variety of small wetlands similar to those at Crane Pond. Although significantly reduced in size, Fabius continues to support a stand of beech-sugar maple forest on the ice-contact ridge above the floodplain of the St. Joseph River. The St. Joseph River floodplain running through Fabius now contains an agricultural field and a narrow strip of trees along the river's edge.

Crane Pond and Three Rivers contain a variety of large and small wetlands. At Crane Pond, large ice-block depressions support lakes, submergent marshes, emergent marshes, or bogs. Smaller ice-block depressions at both Crane Pond and Three Rivers contain vernal pools, bogs, ponds, inundated shrub swamps (i.e., buttonbush depressions), or hardwood swamps. Three Rivers also contains long stream corridors that support large examples of southern wet meadow and hardwood-conifer swamp.

Active and abandoned agricultural fields (the latter termed old fields) also occur within the game areas as scattered patches among the forests and wetlands. In the broader landscape outside of the game areas, agricultural fields are a dominant feature, but forest patches are also frequently interspersed. The disjointed ownership pattern of state land and predominance of agricultural fields in the surrounding landscape contributes to an overall pattern of fragmentation for the natural communities within the game areas.

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."

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 to allow recording of GPS locations. The IPAQ units were loaded with ArcPad and relevant GIS layers such as digital photos, game area boundaries, roads, element occurrence records, etc. IPAQ units and Bluetooth receivers were carried into the field to support data collection during field work. In some cases, Garmin GPS units were also carried during field work and used redundantly to insure against electronic data loss. The distribution of survey effort across the game areas is illustrated by survey target in Figures 4 to 8.

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 game areas. 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 game areas, stand information contained in IFMAP (DNR's Integrated Forest Monitoring, Assessment, and Prescription system) and aerial images from 1998 and 2005 were reviewed and interpreted to determine the types of natural communities likely to be present in each of the game areas. Comparisons among 1938, 1998, and 2005 aerial photos were then used to select high priority stands for surveys. Stands that appeared to have unchanged gross structure (e.g., forested) from 1938 to 2005 were given the highest priority for surveys. Field surveys for high quality natural community occurrences were conducted from 20 May to 23 October. 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 those deemed to have potential to significantly improve with restoration. Stands surveyed for natural communities are illustrated in Figure 4. Data collection focused on

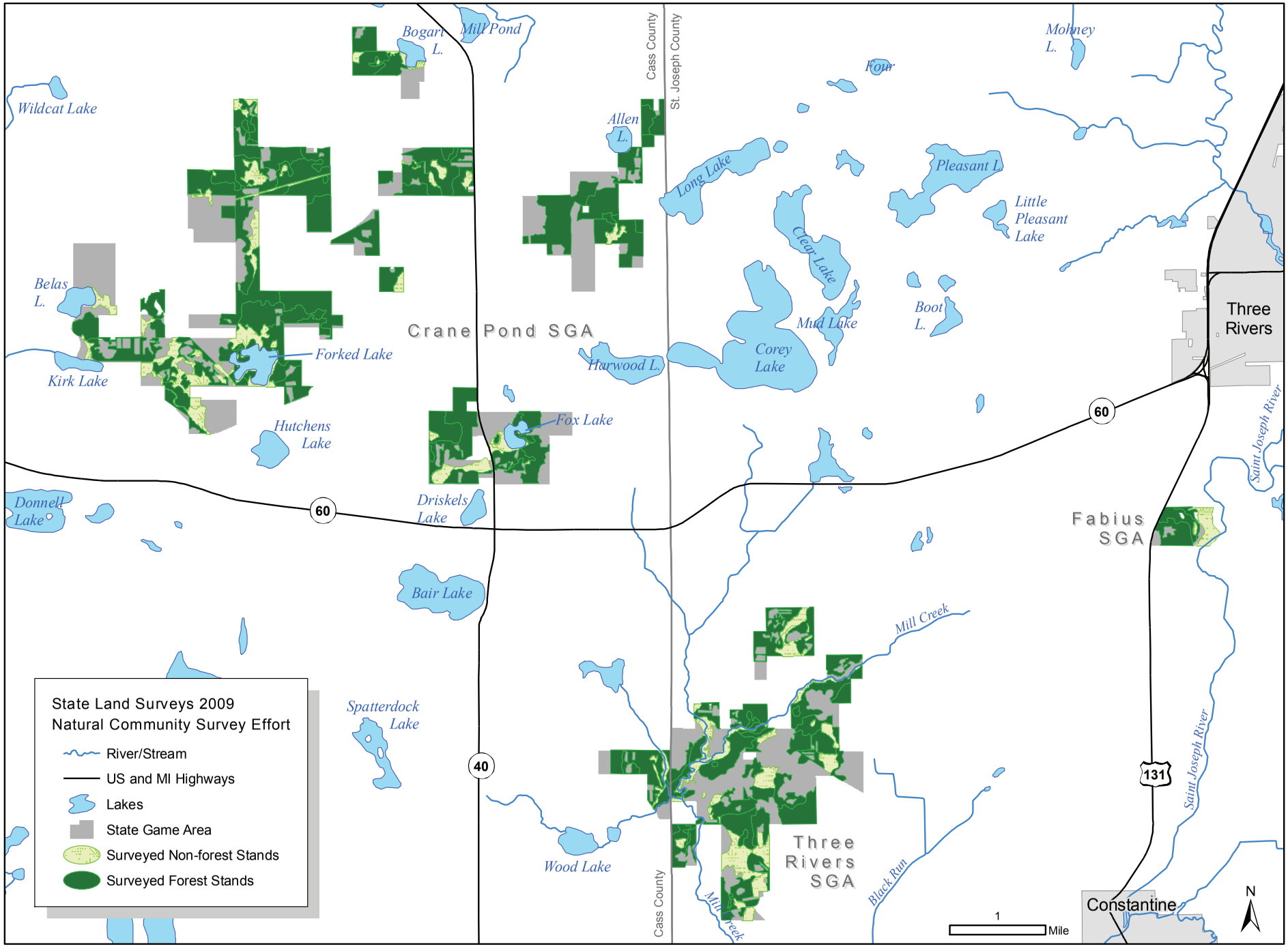


Figure 4. Natural Community Survey Effort.

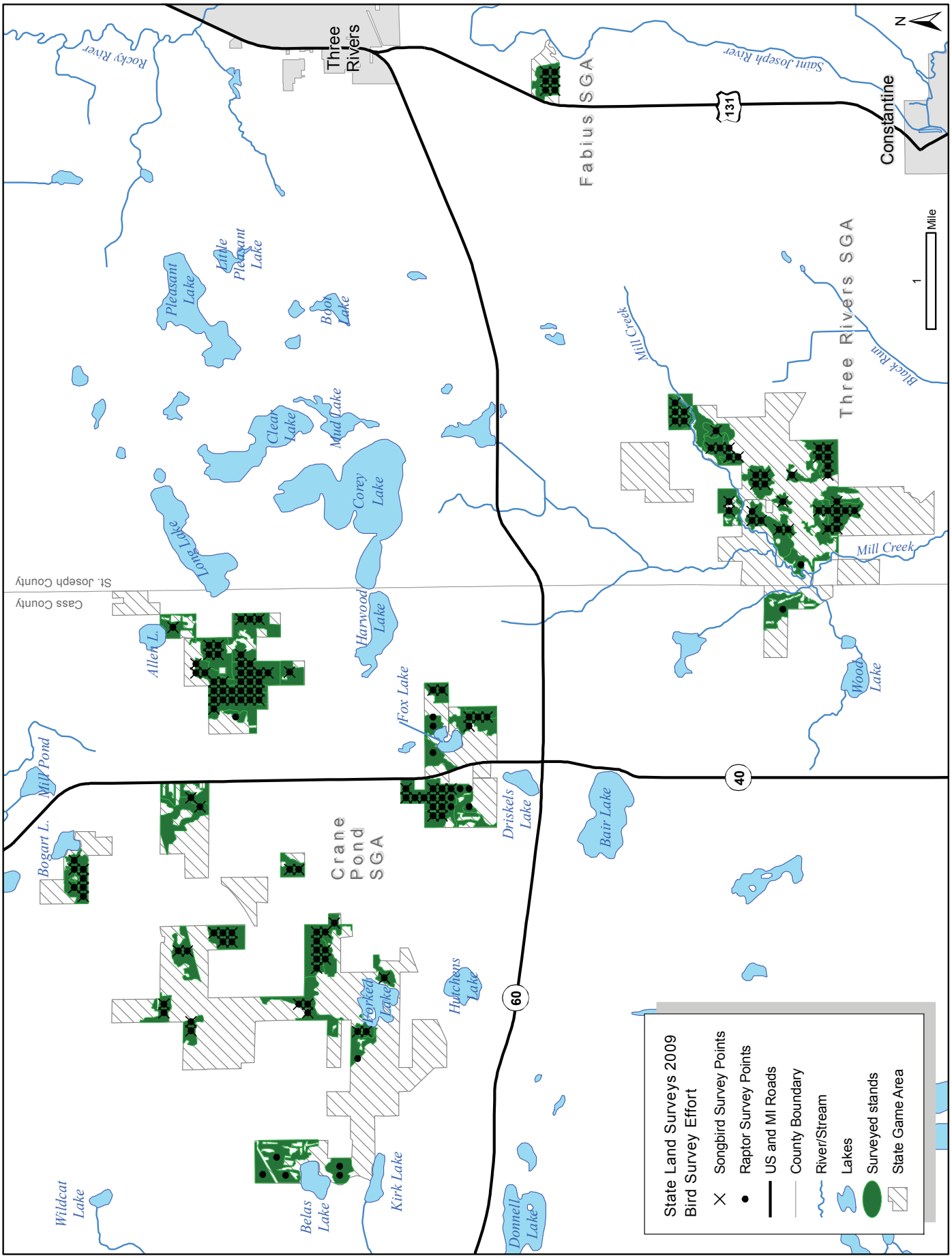


Figure 5. Bird Survey Effort.

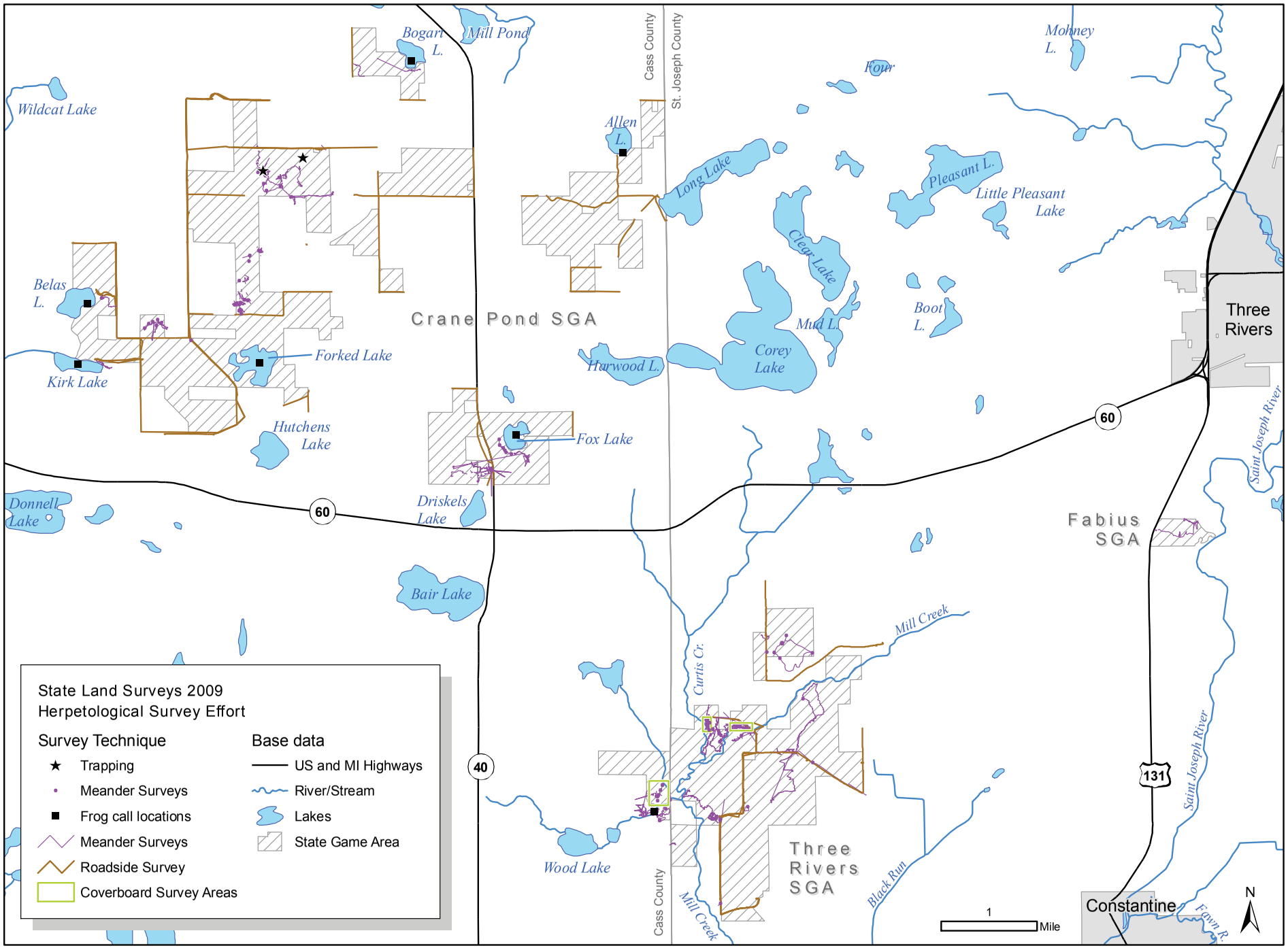


Figure 6. Herpetological Survey Effort.

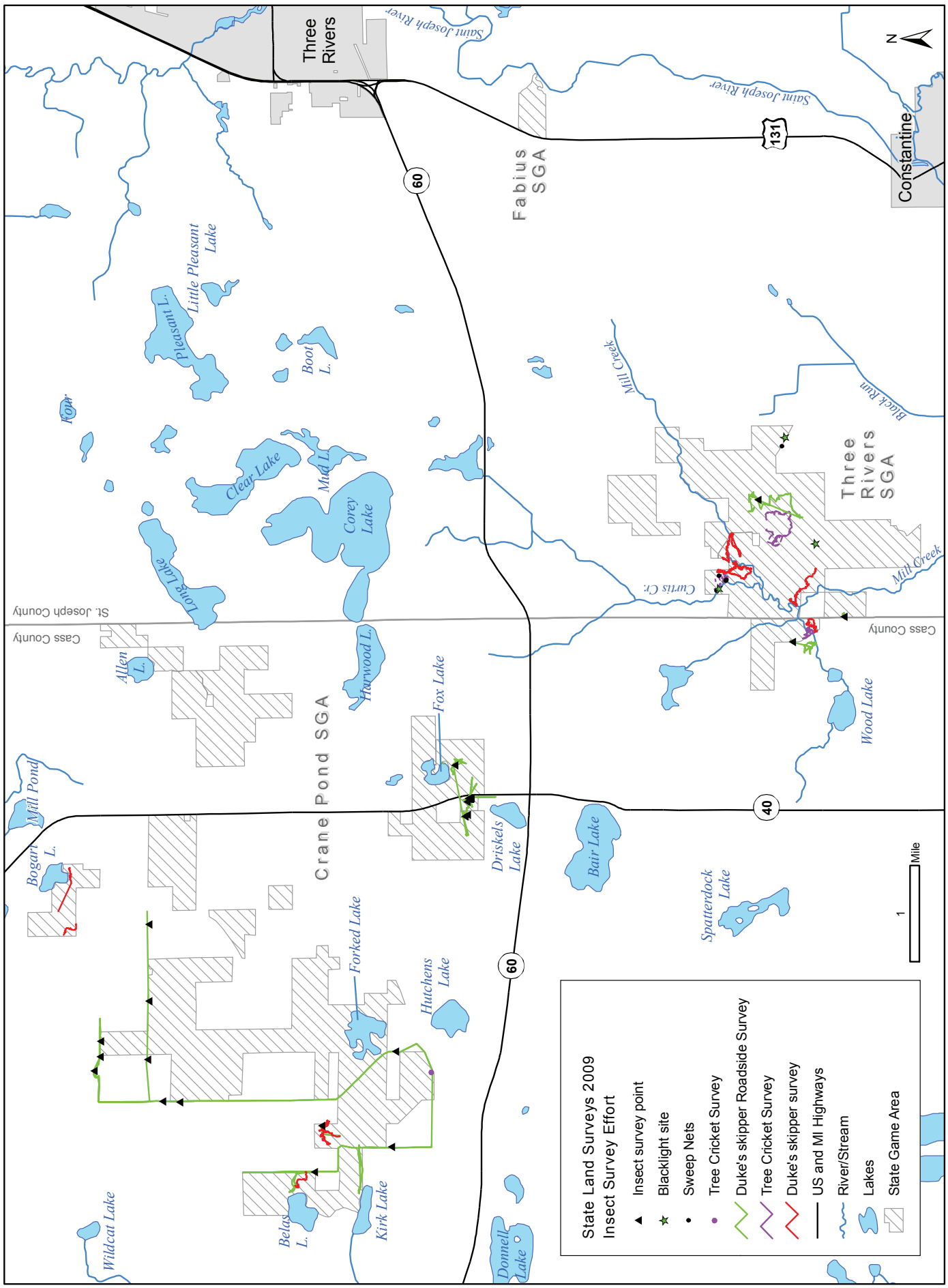


Figure 7. Insect Survey Effort.

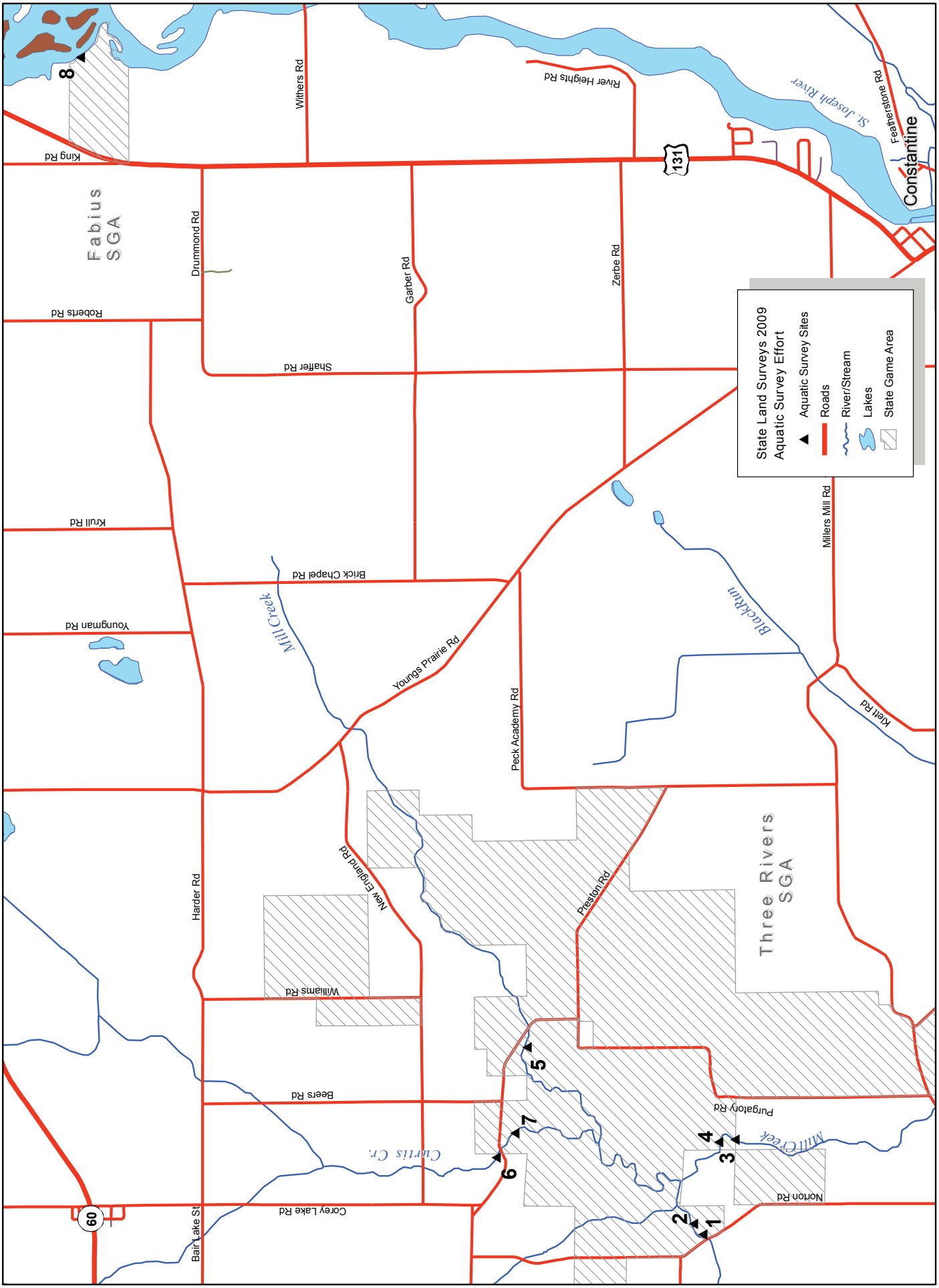


Figure 8. Aquatic Survey Effort.

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 forms. In addition, photographs were taken to demonstrated appearance or condition of natural communities and rare plants.

Rare Terrestrial Animal Methods

Rare animal target species were identified using the following criteria: historical distribution in the region, prior occurrences in the game area, and high likelihood of occurrence based on available habitat within the game area. Natural community and habitat information was based on IFMAP data layers, air 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.

Avian Survey Methods

The game area contained an abundance of forested stands so inventory focused on two groups of birds, forest raptors and forest songbirds. We selected all the forested inventory stand boundaries in IFMAP with a canopy closure of either 2 or 3, and with a minimum area of 10 acres. Stands surveyed for rare songbirds are illustrated in Figure 5. Using guidelines of 150 m equal spacings between points and a minimum of 150 m from the stand boundary, we generated a grid of sampling points in each stand using the Repeating Shapes Extension for Arc View 3.x (Jenness 2005). These sampling points were given unique identification numbers and uploaded to a GPS unit for field use.

The forest raptor targets were: Red-shouldered Hawk (*Buteo lineatus*, state threatened), Cooper's Hawk (*Accipiter cooperii*), and Northern Goshawk (*Accipiter gentilis*, state special concern). (Note that the status of Cooper's Hawk changed from special concern to unlisted after our surveys were complete). Raptor surveys within the game area involved broadcasting conspecific calls at stations positioned throughout forested stands (Mosher et al. 1990, Anderson 2007). Stations were identified on aerial photos and stand maps in Arc View, and points were uploaded to Garmin GPS units that were used to navigate to station locations during field surveys. Surveys were conducted during the 22, 23, 24, and 29 April and the 4 and 20 May. Stands surveyed for rare songbirds are illustrated in Figure 5. Red-shouldered Hawk and Cooper's Hawk calls were alternated at each station. At each station the following data was recorded: raptor species being electronically broadcast, raptor response if any, all additional raptor sightings or vocalizations, songbirds heard or seen, and other animal species observed. In addition, trees were visually inspected for stick nests during walking and driving between stations.

The forest songbird surveys targeted were Cerulean Warbler (*Dendroica cerula*, state threatened), Hooded Warbler (*Wilsonia citrina*, special concern), Louisiana Waterthrush (*Seiurus motacilla*, state threatened), and Prothonotary warbler (*Protonotaria citrea*, special concern). In addition to surveying for rare songbirds, point-count sampling was employed to gather baseline information about the overall community of forest birds, including relative abundance, species richness, and bird diversity. Methods similar to the standard protocol recommended by Ralph et al. (1995) were used. Monitoring was conducted from 28 May to 17 June between sunrise and four hours after sunrise. From a statistical perspective, it is usually more desirable to increase the number of independent point-count stations than to conduct repeated surveys at a smaller number of locations (Ralph et al. 1995), so we conducted one survey at the maximum number of stations. 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 surveys (e.g., North American Breeding Bird Survey) and commonly used protocols. To facilitate future distance analyses and refinement of density and population estimates, 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. Qualitative information about the available songbird habitat (e.g., dominant overstory species, suitability for rare species) was also noted at each point.

Reptile and Amphibian Survey Methods

The following species of reptiles and amphibians (i.e., herpetofauna or herps) were targeted for surveys: Blanchard's Cricket Frog, (*Acris crepitans blanchardi*, state threatened), Marbled Salamander (*Ambystoma opacum*, state endangered), Spotted Turtle (*Clemmys guttata*, state threatened), Blanding's Turtle (*Emydoidea blandingii*, special concern), Eastern Box Turtle (*Terrapene carolina*

carolina, special concern), Kirtland's Snake (*Clonophis kirtlandii*, state endangered), Copperbelly Water Snake (*Nerodia erythrogaster neglecta*, federally threatened and state endangered), 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). Several techniques were used to survey for these species. These included visual encounter surveys, breeding frog call surveys, trapping with minnow traps, road cruising, and coverboard surveys.

Visual encounter surveys were conducted for reptiles from 29 April to 1 October during periods in which probability of sightings were relatively high. 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, but particularly focused on the rare turtle and snake species (except for the Kirtland's Snake). Visual surveys were conducted at multiple locations in all three game areas, but focused primarily on Three Rivers and Crane Pond because of the availability of suitable habitats. 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. Discoveries of rare reptiles and amphibians also were documented during natural community surveys and surveys for other rare animals.

Visual encounter surveys specifically targeting the Copperbelly Water Snake were conducted in Three Rivers on 29 April and 6, 12, 19, and 23 May. These surveys were conducted in and around suitable wetland habitats, including inundated shrub swamps (e.g., buttonbush depressions), forested vernal pools, and open water ponds, at which the species had been documented previously

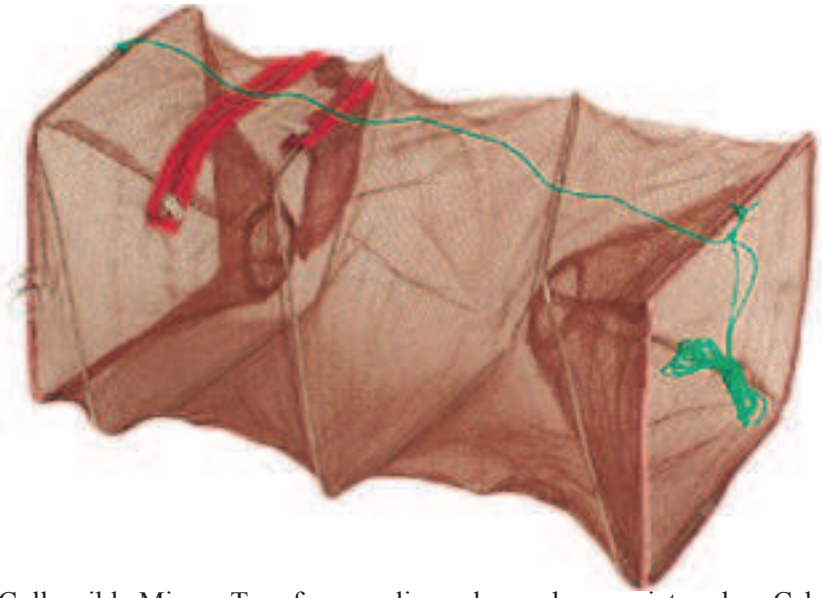
Copperbelly habitat at Three Rivers

Copperbelly habitat at Three Rivers

(Figure 6). Survey sites were visited one to three times during the survey period. Surveys consisted of slowly walking and stopping along the shoreline of wetland habitats and surveying the vegetation and open water with binoculars to look for snakes basking, resting, or foraging in the wetlands. Surveys were conducted during appropriate weather and survey conditions when the snakes were expected to be active and visible.

Breeding frog call surveys were conducted to survey for the Blanchard's Cricket Frog. Frog call surveys were conducted on 23 June 2009 at all lake-sized water bodies in the Crane Pond (i.e., Fox, Allen, Bogart, Forked, Belas, and Kirk Lakes) and at the Mill Creek and Norton Road crossing in the Three Rivers State Game Area (Figure 6). 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 Frog and Toad Survey Protocol 2000).

Trapping with minnow traps was conducted in June 2009 to survey for Marbled Salamander larvae. Trapping was conducted at six vernal pools in the Crane Pond, of which two were located south of Kinney Street and four were located south of Fox Lake (Figure 6). These vernal pools were primarily forested, with more open, shrubby sections dominated by buttonbush in two of the pools. Trapping was conducted from the 8th to 9th and 18th to 19th of June. Commercially available modified minnow traps were used. 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 (see salamander trap image). Ten traps were set in each vernal pool during the day, left overnight, and checked the following day. This resulted in a total of 60 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



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

confirm identification. Several live salamander larvae and tadpoles also were collected and reared to confirm species identification after metamorphosis to adults.

Roadcruising or roadside surveys also were conducted to survey for reptiles and amphibians in Three Rivers and Crane Pond (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 game areas during other natural features surveys also were recorded.

Coverboard surveys were used in September to survey for rare snakes, particularly the Kirtland's Snake, and other herps (Fellers and Drost 1994, Manley et al. 2005). A total of 56 coverboards were placed in the sedge meadow and adjacent forested habitats in Three Rivers along the west side of Mill Creek and east side of Curtis Creek south of Preston Road; and on the west side of Mill Creek north of Norton Road (Figure 6). Coverboards consisted of 0.9 m long x 0.6 m wide (3 ft x 2 ft) or 0.6 m long x 0.6 m wide (2ft x 2 ft) sheets of 1-cm thick untreated plywood. Coverboards were numbered, and placed in sets of two next to each other to create a larger cover object at each location (Manley et al. 2005) (see coverboard image). The location of each set of coverboards was recorded with a GPS unit. Coverboards were checked on the 17, 20, and 22 September, and all amphibian and reptile species found under coverboards were recorded.

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.

Butterfly and Moth Survey Methods

Targeted butterflies included the following: pipevine swallowtail (*Battus philenor*, special concern), swamp metalmark (*Calephelis mutica*, special concern), wild indigo duskywing (*Erynnis baptisiae*, special concern), Dukes' skipper (*Euphyes dukesi*, state threatened), and Henry's elfin (*Incisalia henrici*, 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 net, identified in hand, and then released. At each survey site, species lists were compiled and state lands inventory special animal survey forms – Leps were completed. 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), silphium borer moth (*Papaipema silphii*, state threatened), regal fern borer moth (*Papaipema speciosissima*, special concern),

Coverboards for sampling herps at Three Rivers

golden borer moth (*Papaipema cerina*, special concern), and spartina moth (*Spartinophaga inops*, special concern). Moth surveys utilized blacklighting, which 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. This frame was 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 within Three Rivers in areas containing the host plant of the targeted moths. The first site was located in an area of prairie fen-like vegetation along Curtis Creek, just south of Preston Road (Figure 7). This site contained a population of giant sunflower (*Helianthus giganteous*). Sampling occurred during the four hours from 8:00 PM to 12:00 midnight on 21 September. A second site was located within a powerline right-of-way on Preston Road that contained a small population of giant sunflower (Figure 7). Sampling occurred at this site from 8:45 PM on 22 September through 12:15 AM on 23 September. A third site was within a hardwood swamp off Purgatory Road with a small population of royal fern (*Osmunda regalis*) (Figure 7). Sampling occurred here on 23 September during the 3.25 hours from 8:45 PM through midnight.

Leafhopper and Spittlebug Survey Methods

Sweep net samples were taken in prairie, wet meadow, and fen remnants that contained appropriate host plants for two leafhoppers (*Flexamia reflexus*, special concern and *F. delongi*, special concern), the Great Plains spittlebug (*Lepyronia gibbosa*, 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 sixty 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.

Tree Cricket Survey Methods

Two species of rare tree crickets occur in Michigan, the tamarack tree cricket (*Oecanthus laricis*, special concern) and the pine tree cricket (*Oecanthus pini*, special concern), and both were surveyed for at Crane Pond and Three Rivers during 2009. Surveys were conducted in habitats with either tamarack trees or white pine trees on 13 and 14 August (Figure 7). Observers swept the branches of trees with a standard sweep net. A typical sweep net was used, but the handle was extended by 3 meters by fastening a piece of 2 cm conduit onto the handle. Tree crickets were collected, processed, and keyed to species.

Rare Aquatic Animal Methods

An initial assessment of aquatic habitat types of Crane Pond, Fabius, and Three Rivers was made to prioritize the game areas for aquatic survey efforts. A large majority of rare aquatic species in Michigan are found in streams and rivers versus inland lakes. Based on their potential to support rare aquatic animal species, we decided to focus surveys efforts on the Mill Creek watershed within Three Rivers, and to visit the small stretch of the St. Joseph River within Fabius.

Rare aquatic animals in Michigan include unionid mussels, aquatic gastropods (snails and limpets), fish, and insects (dragonflies, beetles, caddisflies, etc.). Unionid mussels were chosen as the primary survey target for this study based on the likelihood of occurrences of rare species. Aquatic gastropods were also targeted since they could be collected with relatively little added effort. There are no recent or historic surveys for unionids and gastropods documented in the Mill Creek watershed. It was decided that fish surveys would not be done at this time due to the lower potential for rare fish species within these game areas and cost of additional staff time (field crew of three to four people needed) and equipment.

Seven sites in the Mill Creek watershed at Three Rivers and one site in the St. Joseph River at Fabius were surveyed for unionid mussels (Figure 8). Gastropods were sampled at five sites. Water chemistry variables were taken at six sites in the Mill Creek watershed and the site in the St. Joseph River. Three stretches of stream in the Mill Creek watershed were also walked in a qualitative search for unionid mussels and assessment of habitat.

Handheld GPS units (Garmin 12XL) were used to document the position of survey sites. Water chemistry, substrate composition, stream morphology and other habitat variables were recorded to quantify and describe the aquatic habitat sampled. Water chemistry data were taken prior to searching for unionids to avoid stirring up silt that could affect measurements. Dissolved oxygen and temperature were recorded with a YSI Model 55 handheld meter. Conductivity and pH were recorded with an Oakton handheld meter. Alkalinity was measured with a LaMotte kit (model DR-A) and hardness was measured with a Hach kit.

Surveys were performed to determine the presence/absence and abundance of unionid mussel species at each site. A measured search area was used to standardize sampling effort among sites and allow unionid density estimates to be made. Typically 128m^2 provided 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 was measured by taking an average of three stream width measurements, and dividing it into 128 to obtain a reach length that would cover 128m^2 (the search area extended from bank to bank so that the area equaled the stream width multiplied by the reach length).

Live unionids and shells were located with a combination of visual and tactile means. Glass bottom buckets were used to facilitate visual searches. At sites where visual detection was difficult (e.g. pebble sized substrate with silt), hands were passed through the substrate to a depth of approximately 5cm. 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, measured for length, and planted back into the substrate anterior end down (siphon end up). Shells were identified to species. Qualitative visual searches were made for live gastropods and shells. These were hand picked from the stream, placed in vials with 95% ethanol, labeled, and identified in the lab with the aid of stereo microscopes. Presence/absence was recorded for the invasive exotic Asian clam (*Corbicula fluminea*) and dreissenid mussels such as the zebra mussel (*Dreissena polymorpha*) and quagga mussel (*Dreissena bugensis*). Other aquatic taxa observed, such as fish, crayfish, and herps were also noted.

Substrates within each transect were characterized by estimating the 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). Woody debris, aquatic vegetation, exposed solid clay substrate, and eroded banks observed during surveys were also noted.

RESULTS

The surveys identified 35 new element occurrences including 10 natural communities, 11 rare plants, 9 rare terrestrial animal, and 5 rare aquatic animals (Tables 1 to 4). In addition, the presence of 19 previously identified element occurrences was reconfirmed and updated information was entered into the Biotics database. The distribution of survey effort across the game areas was documented with GPS and is graphically illustrated by survey target in Figures 4 to 8.

Natural Community Inventory Results

The natural community surveys resulted in the identification of ten new natural community element occurrences including four dry-mesic southern forests, one mesic southern forest, two prairie fens, one emergent marsh and two submergent marshes (Figure 9, Table 1). At each of the new element occurrences, the community boundaries were mapped and information was recorded on vegetation composition, tree sizes (where applicable), soils, and management concerns. In addition, eleven previously identified natural community element occurrences were reassessed including two dry-mesic southern forests, two mesic southern forests, one hardwood-conifer swamp, one southern wet meadow, two emergent marshes, and three bogs. At each of the resurveyed sites, the community boundaries were reassessed and information was recorded on vegetation composition, tree sizes (where applicable), soils, and management concerns.

In addition to the natural community element occurrences we identified, these game areas possess 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 southwest Michigan.

During the natural community surveys, eleven rare plant element occurrences were documented, including five at Crane Pond, five at Three Rivers, and one at Fabius (Figure 5, Table 2). In addition, four previously identified rare plant records were updated. Rare plants documented at Crane Pond in 2009 were goldenseal (*Hydrastis canadensis*, state threatened), red mulberry (*Morus rubra*, state threatened),

Table 1. Newly documented and previously known natural community element occurrences for Crane Pond, Three Rivers, and Fabius State Game Areas, 2009.

Site Name	Community Type	EO ID	State Game Area	EO Rank	Year first Observed	Year last Observed
Crane Bog	Bog	4532	Crane Pond	C	1985	2009
Jones Bog	Bog	12442	Crane Pond	C	1985	2009
Belas Lake Woods	Dry-mesic southern forest	3955	Crane Pond	C	1985	2009
Mann Street Woods	Dry-mesic southern forest	6457	Crane Pond	BC	1985	2009
Forked Lake Woods	Dry-mesic southern forest	17085	Crane Pond	C	2009	2009
Born Street Woods	Dry-mesic southern forest	17110	Crane Pond	C	2009	2009
Allen Lake Marsh	Emergent marsh	4002	Crane Pond	C	1985	2009
Belas Lake Marsh	Emergent marsh	10212	Crane Pond	C	1985	2009
Fox Lake Emergent Marsh	Emergent marsh	17097	Crane Pond	C	2009	2009
East Crane Hills Forest	Mesic southern forest	1889	Crane Pond	B	1985	2009
Crane Hills Forest	Mesic southern forest	8650	Crane Pond	B	1985	2009
Kirk Lake Fen	Prairie fen	17090	Crane Pond	BC	2009	2009
Forked Lake Marsh	Submergent marsh	17091	Crane Pond	AB	2009	2009
Fox Lake Submergent Marsh	Submergent marsh	17092	Crane Pond	B	2009	2009
Fabius Forest	Mesic southern forest	17086	Fabius	C	2009	2009
Purgatory Bog	Bog	13404	Three Rivers	BC	2003	2009
Norton Rd. Woods	Dry-mesic southern forest	17089	Three Rivers	C	2009	2009
Wood Creek Woods	Dry-mesic southern forest	17088	Three Rivers	BC	2009	2009
Mill Creek Swamp	Hardwood-conifer swamp	13403	Three Rivers	AB	2003	2009
Wood Creek Fen	Prairie fen	17087	Three Rivers	CD	2009	2009
Mill Creek Wet Meadow	Southern wet meadow	14372	Three Rivers	B	2004	2009

Table 2. Newly documented and previously known rare plant element occurrences for Crane Pond, Three Rivers, and Fabius State Game Areas, 2009.

Scientific Name	Common Name	State Status	Year First Observed	Year Last Observed	State Game Area
Hydrastis canadensis	Goldenseal	T	2009	2009	Crane Pond
Morus rubra	Red mulberry	T	2009	2009	Crane Pond
Panax quinquefolius	Ginseng	T	1978	1982	Crane Pond
Scutellaria elliptica	Hairy skullcap	SC	1952	2009	Crane Pond
Scutellaria elliptica	Hairy skullcap	SC	1959	1959	Crane Pond
Scutellaria elliptica	Hairy skullcap	SC	1985	1985	Crane Pond
Scutellaria elliptica	Hairy skullcap	SC	1985	2009	Crane Pond
Viburnum prunifolium	Black haw	SC	2009	2009	Crane Pond
Viburnum prunifolium	Black haw	SC	2009	2009	Crane Pond
Viburnum prunifolium	Black haw	SC	2009	2009	Crane Pond
Viburnum prunifolium	Black haw	SC	2009	2009	Fabius
Berula erecta	Cut-leaved water parsnip	T	1986	2003	Three Rivers
Calamagrostis stricta	Narrow-leaved reed grass	T	1986	1986	Three Rivers
Scleria triglomerata	Nut-rush	SC	1950	1950	Three Rivers
Scutellaria elliptica	Hairy skullcap	SC	1950	2009	Three Rivers
Scutellaria elliptica	Hairy skullcap	SC	1950	2009	Three Rivers
Viburnum prunifolium	Black haw	SC	2009	2009	Three Rivers
Viburnum prunifolium	Black haw	SC	2009	2009	Three Rivers
Viburnum prunifolium	Black haw	SC	2009	2009	Three Rivers
Viburnum prunifolium	Black haw	SC	2009	2009	Three Rivers
Zizania aquatica var. aquatica	Wild rice	SC	1979	1979	Three Rivers
Zizania aquatica var. aquatica	Wild rice	SC	2009	2009	Three Rivers

hairy skullcap (*Scutellaria elliptica*, state special concern), and black haw (*Viburnum prunifolium*, state special concern). Rare plants documented at Three Rivers in 2009 included wild rice **(***Zizania aquatica* var. *aquatica*, state threatened), starry campion (*Silene stellata*, state threatened), hairy skullcap, and black haw. Black haw was also discovered at Fabius during the 2009 surveys.

Descriptions of the natural community element occurrences and associated management recommendations are provided in the section below. For this section, community element occurrences are grouped by community type (rather than game area) and are proceed 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 5 and 6.

Natural Community Descriptions and Management Recommendations

Dry-mesic Southern Forest

In association with this project, two pre-existing dry-mesic southern forest element occurrences were updated at Crane Pond, and four new element occurrences were identified (two at Crane Pond and two at Three Rivers). In addition to these six element occurrences, both Crane Pond and Three Rivers have numerous remnant stands of dry-mesic southern forest that still retain good qualities and are capable of significantly improving with regular prescribed fire management and invasive species control. While these stands have not yet been selected for inclusion in the Biotics database, many of them would readily acquire element occurrence-level quality if provided with such stewardship.

Dry-mesic southern forests are commonly dominated by oak and hickory species on upland locations. These forests require periodic fire (Kost et al. 2007). Fires help maintain canopy gaps, regeneration of oak and hickory, and dense groundcover. Without periodic ground fires, the forest canopy becomes closed, oak and hickory fail to reproduce in adequate numbers, shade-tolerant trees become established, native groundcover (both woody and herbaceous) wanes, and invasive plants can increase (Lee 2007). In addition to lack of fire and invasive plant species, high white-tailed deer population densities within these communities can reduce or eliminate both vegetation strata and native plant species.

Management of dry-mesic southern forests should normally include the application of periodic ground fires. Fires that burn through the dry leaf and plant layer in fall or spring facilitate increased levels of light, which support ample groundcover and ultimately favor reproduction of oaks, hickories, and native shrubs. The mast and fruit provided

Table 3. Newly documented and previously known and rare terrestrial animal element occurrences for Crane Pond, Three Rivers, and Fabius State Game Areas, 2009.

Scientific Name	Common Name	State Status	Year First Observed	Year Last Observed	State Game Area
Emydoidea blandingii	Blanding's turtle	SC	2009	2009	Crane Pond
Acris crepitans blanchardi	Blanchard's cricket frog	ST	1963	1963	Crane Pond
Acris crepitans blanchardi	Blanchard's cricket frog	ST	2009	2009	Crane Pond
Myotis sodalis	Indiana bat	SE	2005	2005	Crane Pond
Dendroica cerulea	Cerulean warbler	ST	2009	2009	Crane Pond
Wilsonia citrina	Hooded warbler	SC	2009	2009	Crane Pond
Seiurus motacilla	Lousiana waterthrush	ST	2009	2009	Crane Pond
Ixobrychus exilis	Least bittern	ST	2009	2009	Crane Pond
Battus philenor	Pipevine swallowtail	SC	1976	1976	Three Rivers
Papaipema maritima	Maritime sunflower borer moth	SC	2009	2009	Three Rivers
Papaipema cerina	Golden borer moth	SC	2009	2009	Three Rivers
Neonympha m. mitchellii	Mitchell's satyr	E	1952	1952	Three Rivers
Calephelis mutica	Swamp metalmark	SC	1956	1956	Three Rivers
Catocala dulciola	Quiet underwing	SC	1994	1994	Three Rivers
Emydoidea blandingii	Blanding's turtle	SC	1996	2009	Three Rivers
Erynnis persius	Persius duskywing	SC	1987	1987	Three Rivers
Myotis sodalis	Indiana bat	SE	1978	1978	Three Rivers
Nerodia erythrogaster neglecta	Copperbelly watersnake	SE	1963	1997	Three Rivers
Pantherophis spiloides	(Black) Gray rat snake	SC	1989	1989	Three Rivers
Sistrurus catenatus	Eastern massasauga	SC	1979	2009	Three Rivers
Terrapene carolina	Eastern box turtle	SC	1978	2009	Three Rivers
Wilsonia citrina	Hooded warbler	SC	2005	2009	Three Rivers
Dendroica cerulea	Cerulean warbler	ST	2009	2009	Three Rivers
Dendroica discolor	Prairie warbler	SC	1997	1997	Three Rivers

Table 4. Newly documented element occurrence of aquatic rare anmals at Three Rivers State Game Area, 2009.

Scientific Name	Common Name	State Game Area	State Status	Year First Observed	Year Last Observed
Alasmidonta viridis	Slippershell	Three Rivers	T	2009	2009
Fontigens nickliniana	Watercress snail	Three Rivers	SC	2009	2009
Pleurobema sintoxia	Round pigtoe	Three Rivers	SC	2009	2009
Venustaconcha ellipsiformis	Ellipse	Three Rivers	SC	2009	2009
Villosa iris	Rainbow	Three Rivers	SC	2009	2009

Table 5. Summary of management recommendations for natural community element occurrences at Crane Pond, Three Rivers, and Fabius State Game Areas, 2009.

Site Name	Community Type	State Game Area	Management Recommendations
Crane Bog	Bog	Crane Pond	• allow landscape prescribed fire to burn into site • monitor and control invasive species • protect hydrology
Jones Bog	Bog	Crane Pond	• allow landscape prescribed fire to burn into site • monitor and control invasive species • protect hydrology
Belas Lake Woods	Dry-mesic southern forest	Crane Pond	• regularly apply prescribed fire • control and monitor invasive species
Mann Street Woods	Dry-mesic southern forest	Crane Pond	• regularly apply prescribed fire • control and monitor invasive species • could expedite restoration by reducing shrub cover and thinning shade-tolerant sapling trees • possibly install deer exclosures to assess impacts
Forked Lake Woods	Dry-mesic southern forest	Crane Pond	• regularly apply prescribed fire • control and monitor invasive species • could expedite restoration by reducing shrub cover and thinning shade-tolerant sapling trees • possibly install deer exclosures to assess impacts
Born Street Woods	Dry-mesic southern forest	Crane Pond	• regularly apply prescribed fire • control and monitor invasive species • could expedite restoration by reducing shrub cover and thinning shade-tolerant sapling trees • possibly install deer exclosures to assess impacts
Allen Lake Marsh	Emergent marsh	Crane Pond	• allow landscape prescribed fire to burn into site • control and monitor invasive species • protect hydrology
Belas Lake Marsh	Emergent marsh	Crane Pond	• allow landscape prescribed fire to burn into site • control and monitor invasive species • protect hydrology
Fox Lake Emergent Marsh	Emergent marsh	Crane Pond	• allow landscape prescribed fire to burn into site • control and monitor invasive species • protect hydrology
East Crane Hills	Mesic southern forest	Crane Pond	• allow landscape prescribed fire to burn into site • control and monitor invasive species • possibly install deer exclosures to assess impacts • strive to reduce forest fragmentation
Crane Hills	Mesic southern forest	Crane Pond	• allow landscape prescribed fire to burn into site • control and monitor invasive species • possibly install deer exclosures to assess impacts • strive to reduce forest fragmentation
Kirk Lake Fen	Prairie fen	Crane Pond	• apply prescribed fire • control and monitor invasive species • could expedite restoration by reducing shrub cover and thinning hardwood saplings • protect hydrology
Forked Lake Marsh	Submergent marsh	Crane Pond	• allow landscape prescribed fire to burn into site • monitor and control invasive species • protect hydrology

Table 5. continued

Fox Lake Submergent Marsh	Submergent marsh	Crane Pond	• allow landscape prescribed fire to burn into site • control and monitor invasive species • protect hydrology
Fabius Forest	Mesic southern forest	Fabius	• allow landscape prescribed fire to burn into site • control and monitor invasive species • install deer exclosures to assess impacts • strive to reduce forest fragmentation
Purgatory Bog	Bog	Three Rivers	• allow landscape prescribed fire to burn into site • monitor and control invasive species • protect hydrology
Norton Rd Woods	Dry-mesic southern forest	Three Rivers	• regularly apply prescribed fire • allow landscape prescribed fire to burn into site • control and monitor invasive species • could expedite restoration by reducing shrub cover and thinning shade-tolerant sapling trees • possibly install deer exclosures to assess impacts
Wood Creek Woods	Dry-mesic southern forest	Three Rivers	• regularly apply prescribed fire • control and monitor invasive species • possibly install deer exclosures to assess impacts
Mill Creek Swamp	Hardwood-conifer swamp	Three Rivers	• allow landscape prescribed fire to burn into site • control and monitor invasive species • protect hydrology
Wood Creek Fen	Prairie fen	Three Rivers	• apply prescribed fire • control and monitor invasive species • could expedite restoration by reducing shrub cover and thinning hardwood saplings • protect hydrology
Mill Creek Wet Meadow	Southern wet meadow	Three Rivers	• apply prescribed fire • control and monitor invasive species • could expedite restoration by reducing shrub cover and thinning hardwood saplings • protect hydrology

Table 6. Invasive plant species found within natural community element occurrences at Crane Pond, Three Rivers, and Fabius State Game Areas, 2009.

Site Name	Community Type	State Game Area	Purple loosestrife (*Lythrum salicaria*)	Garlic mustard (*Alliaria petiolata*)	Narrow-leaved cattail (*Typha angustifolia*)	Barberry (*Berberis thunbergii*)	Reed canary grass (*Phalaris arundinacea*)	Periwinkle (*Vinca minor*)	Reed (*Phragmites australis*)	Multiflora rose (*Rosa multiflora*)	Eurasian honeysuckles (*Lonicera* spp.)	Autumn olive (*Elaeagnus umbellata*)	European privet (*Ligustrum vulgare*)	Glossy buckthorn (*Rhamnus frangula*)	Black locust (*Robinia pseudo-acacia*)	Tree of heaven (*Ailanthus altissima*)
Crane Bog	Bog	Crane Pond														
Jones Bog	Bog	Crane Pond														
Belas Lake Woods	Dry-mesic southern forest	Crane Pond								X		X				
Mann Street Woods	Dry-mesic southern forest	Crane Pond		X		X				X	X	X				X
Forked Lake Woods	Dry-mesic southern forest	Crane Pond		X						X						
Born Street Woods	Dry-mesic southern forest	Crane Pond		X		X				X						
Allen Lake Marsh	Emergent marsh	Crane Pond	X				X									
Belas Lake Marsh	Emergent marsh	Crane Pond							X							
Fox Lake Emergent Marsh	Emergent marsh	Crane Pond			X		X		X							
East Crane Hills Forest	Mesic southern forest	Crane Pond						X		X		X				
Crane Hills Forest	Mesic southern forest	Crane Pond		X						X					X	
Kirk Lake Fen	Prairie fen	Crane Pond	X									X		X		
Forked Lake Marsh	Submergent marsh	Crane Pond														
Fox Lake Submergent Marsh	Submergent marsh	Crane Pond														
Fabius Forest	Mesic southern forest	Fabius		X		X				X						

Table 6. continued

Site Name	Community Type	State Game Area	Purple loosestrife (*Lythrum salicaria*)	Garlic mustard (*Alliaria petiolata*)	Narrow-leaved cattail (*Typha angustifolia*)	Barberry (*Berberis thunbergii*)	Reed canary grass (*Phalaris arundinacea*)	Periwinkle (*Vinca minor*)	Reed (*Phragmites australis*)	Multiflora rose (*Rosa multiflora*)	Eurasian honeysuckles (*Lonicera* spp.)	Autumn olive (*Elaeagnus umbellata*)	European privet (*Ligustrum vulgare*)	Glossy buckthorn (*Rhamnus frangula*)	Black locust (*Robinia pseudo-acacia*)	Tree of heaven (*Ailanthus altissima*)
Purgatory Bog	Bog	Three Rivers														
Norton Rd. Woods	Dry-mesic southern forest	Three Rivers		X						X						
Wood Creek Woods	Dry-mesic southern forest	Three Rivers		X						X	X	X				
Mill Creek Swamp	Hardwood-conifer swamp	Three Rivers				X				X	X	X				
Wood Creek Fen	Prairie fen	Three Rivers					X			X	X	X	X			
Mill Creek Wet Meadow	Southern wet meadow	Three Rivers	X				X				X					

by oaks, hickories, and native shrubs are an important food source for many species of wildlife. Control of invasive plants, especially woody invasives, is usually facilitated by the application fire, although in many situations cutting and/or herbicide application is necessary to fully eradicate invasive plants. Depending upon site conditions and specific activities, logging can increase or lessen the viability of dry-mesic southern forests (Lee 2007, Lee and Kost 2008). Unless oaks and hickories are already present in high densities in 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. Many existing dry-mesic southern forests in southern Michigan were selectively cut at some point following European settlement, but the logging would not have caused stand conversion in many cases because oaks and hickories were probably dominant in the understory just prior to the logging activity. It is reasonable to assume that if advanced regeneration of oak and hickory can be fostered again (e.g., through the application of repeated ground fires), then they may persist in the longer term even as a variety of logging techniques are applied. Deer are one of the larger animals that utilize these forests, and in high densities they can stifle tree recruitment and alter groundcover composition (Alverson and Waller. 1997, Balgooyen and Waller 1995). The dry-mesic southern forests in these games areas benefit from deer hunting, and this practice should be continued. In addition, the effects of deer on native plant composition and regeneration should continue to receive consideration in setting future deer harvest goals.

At nearly 200 acres, **Mann Street Woods** at Crane Pond is a large block of dry-mesic southern forest that occurs on rugged ice-contact topography and has indications of past selective logging (Figure 9). The forest has high tree species diversity and includes species such as sugar maple, white oak, black oak, pignut hickory (*Carya glabra*), red oak, and white ash. However as a result of fire suppression, the understory is now heavily dominated by sugar maple and other similarly shade-tolerant tree species. In addition, invasive species such as garlic mustard and multiflora rose have become established, and tree-of-heaven (*Ailanthus altissima*) is colonizing the formerly clearcut area along

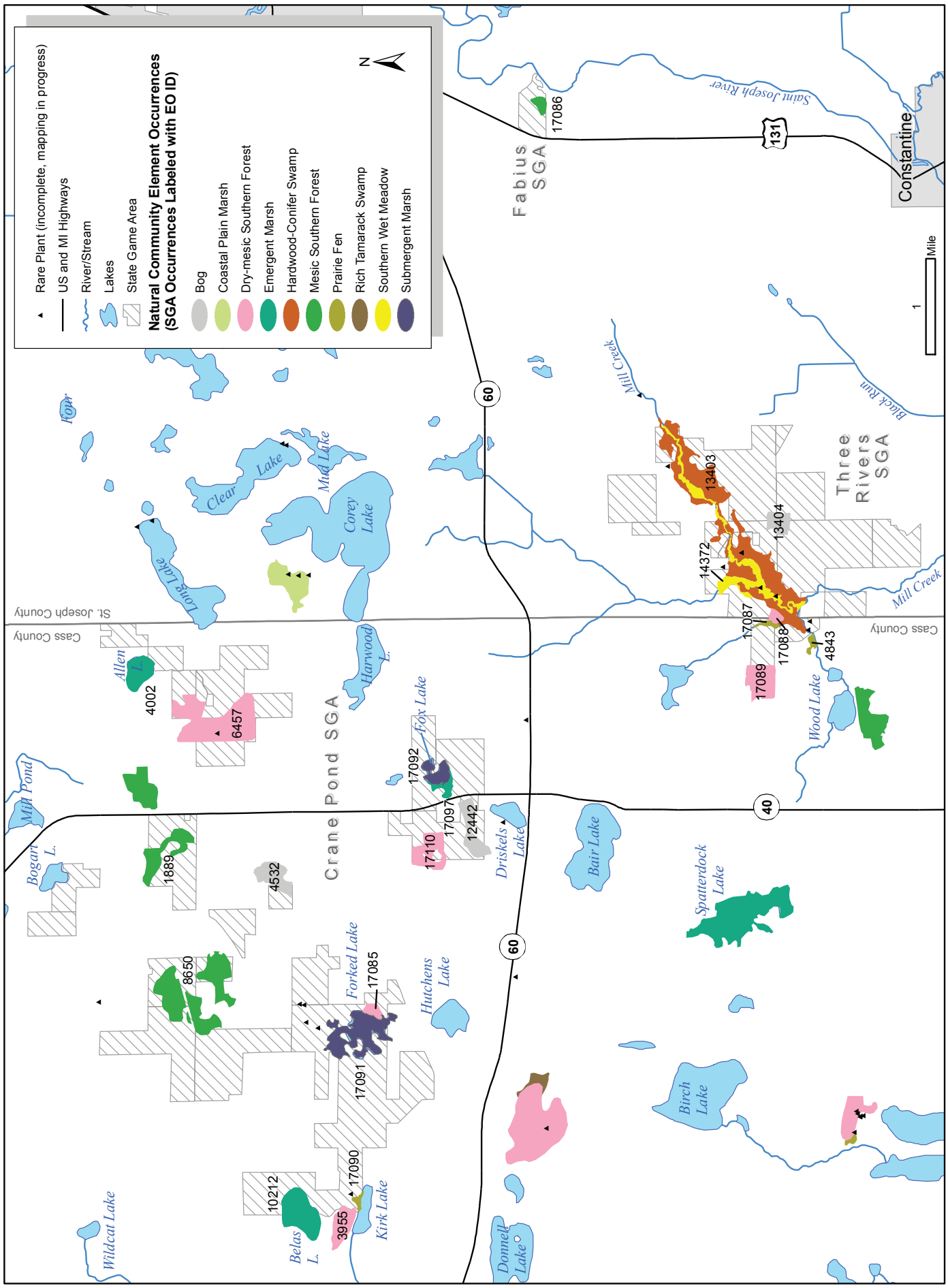


Figure 9. Natural Community Element Occurrences. See Table 1 for the EO ID of each natural community element occurrence.

the southern border. The condition of this forest would benefit significantly from both invasive species control and repeated prescribed fire (note that prescribed fires can increase the efficacy of invasive species control). This forest should be protected from overstory logging until fires and invasive species control have facilitated advanced regeneration of oak and hickory species.

Only the eastern edge of **Belas Lake Woods** occurs within Crane Pond (Figure 9). The portions of this dry-mesic forest that occur on private land were recently selectively logged, wherein a majority of the largest trees were removed. While its overstory is still dominated by white oak, the natural community has responded to the logging with increased sapling growth of red maple, American elm, and other shade-tolerant species, and with dense shrub growth—including brambles (*Rubus spp.*) and the invasive shrub multiflora rose. The small amount of this forest on state land could make it difficult to manage without the cooperation of the adjacent landowner(s), but any attempts to improve its natural condition should focus on application of prescribed fire, invasive species control, and protection from overstory logging until fires have allowed good numbers of oak and hickory seedlings and saplings to establish.

Forked Lake Woods at Crane Pond is a relatively small patch of dry-mesic forest located along the eastern side of Forked on a glacial kame (Figure 9). Its massive trees suggest no prior logging. Although Forked Lake Woods is fire-suppressed, its westerly aspect allowed adequate levels of sunlight to reach the understory and facilitate modest oak regeneration. Unfortunately, the forest is also experiencing dense growth of shade tolerant species in

Mann Street Woods at Crane Pond

Belas Lake Woods at Crane Pond

the understory, so oak regeneration is unlikely to continue without the application of prescribed fire. Oak and hickory regeneration may also be enhanced by thinning (felling on site without removal) red maple saplings and small trees. In addition to a need for fire management and red maple reduction, it would be valuable to control and monitor the invasive species that occur along the edges of this forest patch. Logging within this forest is not advised at this time. Additional significant patches of dry-mesic southern forest with large-diameter trees occur along the northeast shore of Forked Lake and on several peninsulas along the western side of the lake. Although these were not mapped as part of this element occurrence, they are highly restorable, especially the peninsulas.

Born Street Woods is a dry-mesic southern forest that occurs on moderately hilly ice-contact topography with sandy soils in the southern portion of Crane Pond (Figure 9). The community is dominated by large-diameter white oak, black oak, red oak, pignut hickory, and red maple. Large beech and sugar maple occur along with oaks and hickories in the north portion of the element occurrence. Little evidence of oak regeneration was observed, likely due to the high cover of shade-tolerant shrubs and tree saplings. The forest contains two picturesque ponds that provide habitat for ducks and a steep ravine that harbors plants associated with mesic southern forest along its north-facing slope. Management recommendations for Born Street Woods include regularly conducing prescribed burns to reduce the cover of shade-tolerant shrubs and tree saplings and controlling and monitoring invasive plants, especially multiflora rose and garlic mustard.

Norton Road Woods occupies rugged ice-contact terrain at the western edge of Three Rivers (Figure 9). Including portions on private land to the north and west, this dry-mesic forest occupies over 60 acres. State portions of this forest have very large trees indicative of unlogged stands. Field evidence suggests it experienced a significant windthrow event within the past six years. Dozens of enormous uprooted trees lay on the ground or are snapped off mid-trunk, leading to tremendous volumes of downed

Forked Lake Woods at Crane Pond

Born Street Woods at Crane Pond

Norton Road Woods at Three Rivers

wood and structural diversity. Because this forest was already fire-suppressed at the time of the windthrow, its understory is comprised mostly of shade tolerant beech and maple saplings that are now growing rapidly in response to the newly formed canopy gaps. The native herbaceous groundcover is high in this forest—also likely due in part to the temporary increase in light levels created by the windthrow. In spite of many dead trees, this forest still harbors many large oak, hickory, maple, and beech trees. Maintaining the quality of this forest requires the application of prescribed fire and monitoring and controlling the limited number of invasive species that have begun to establish. Although logging of this forest is not advised, sugar maple saplings could be manually thinned as part of a larger restoration program.

Wood Creek Woods is a relatively small patch of dry-mesic forest located on the sandy soils of a glacial outwash plain in Three Rivers (Figure 9). It is bordered mostly by pine plantation on the north, prairie fen on the west, and hardwood-conifer swamp on the south and east. This forest contains large trees, a relatively intact groundcover, several rare plant species, and virtually no presence of invasive species. We hypothesize that this forest remained ungrazed, unlogged (or minimally logged), and relatively free of invasive plants due to its section corner location and poor accessibility from the west, south, and east. The primary management need for this forest is prescribed fire. Control of the limited number of invasive shrub species present, along with continued monitoring are also recommended. Logging in this forest is not recommended. Finally, due to the small size of this forest, it would be valuable to allow it to expand toward another remnant dry-mesic forest about 100 m further north.

Mesic Southern Forest

In association with this project, two pre-existing mesic southern forest element occurrences were updated at Crane Pond, and one new element occurrence was identified at Fabius. Mesic Southern Forests typically occur on mesic soils or somewhat topographically protected upland locations and are dominated by beech, maple, basswood, and ash. These forests are characterized by tall, shade-tolerant, long-lived trees, and shady conditions near the ground level. Mesic southern forests were typically logged for their valuable timber following European settlement, and they are still often recovering from this event. These forests are susceptible to degradation from logging, high deer densities, and invasive species (Kost et al. 2007). Management of mesic southern forests should normally

allow forests to continue recovering from past logging and fragmentation. The healthy development of old growth characteristics such as multi-aged tree populations and large diameter trees, snags, and coarse woody debris will normally occur if stands are kept free of logging. The historic role of fires in these forests was probably low, but they likely experienced occasional, low intensity ground fires (Cohen 2004). While mesic southern forest should not be directly targeted for prescribed fire, allowing fire to carry naturally into these forests from adjacent fire-adapted communities could help to sustain their species and structural diversity. Invasive plant species occur more commonly along mesic southern forests edges and in previously disturbed areas (Cohen 2004). Limiting invasive species is best accomplished by limiting intensive disturbance and retaining or creating large areas of contiguous forest. However, if invasive species become established, controlling their spread in early stages through pulling or herbicide application often requires much less work than postponed control. Because native plants of mesic southern forests already cope with substantial levels of shade, they are especially vulnerable to damage when deer densities are high. Thus, deer hunting within the game areas benefits the mesic southern forests and should be continued. Similarly the impact of deer densities upon native plant composition and regeneration should continue receiving consideration in setting future deer harvest goals. However, if it is believed that even with hunting, mesic forest plant populations are suffering from over-browse, deer exclosures can be installed to demonstrate deer impact and to simultaneously protect the most vulnerable forest plant populations.

East Crane Hills Forest at Crane Pond is a sizeable stand (approximately 70 acres) of mesic southern forest found on rugged ice-contact topography above kettle wetlands (Figure 9). Dominant trees include very large (approaching 1 m diameter) sugar maple, beech, red oak, tulip tree (*Liriodendron tulipifera*), and black walnut (*Juglans nigra*). Control of the scattered invasive species including periwinkle (*Vinca minor*), multiflora rose (*Rosa multiflora*), and autumn olive (*Elaeagnus umbellata*) within this forest is recommended. This stand has no obvious signs of past logging, and continued protection from logging is recommended. In addition, forest fragmentation can be reduced by allowing adjacent open lands to convert to forest and refraining from clearcuts directly adjacent to this element occurrence.

Crane Hills Forest at Crane Pond is comprised of four nearby mesic southern forest patches that total approximately 200 acres (Figure 9). These forest patches occur on moderately to steeply sloped ice-contact topography with sandy to loamy soils. Dominant

Wood Creek Woods at Three Rivers

East Crane Hills Forest at Crane Pond

tree species include beech, sugar maple, tulip tree, and basswood. Conditions within this forest vary considerably—local moisture levels range from dry-mesic on exposed hillsides to wet-mesic near ravine bottoms. Some areas have no indications of past logging and are characterized by high plant species diversity and a remarkably dense native sedge and forb groundlayer. However, existing forest between the four high quality element occurrence patches have been disturbed by logging. Viability of the four patches will be strongly impacted by the forests between them, so restoring these disturbed forests through invasive species control and allowing them to mature without logging is recommended. It also could be very helpful to designate an external buffer to this forest complex, wherein only moderately disturbing activities are allowed, such as selective logging. Controlling and monitoring the invasive species that occur within this forest are recommended so that the core high quality areas do not degrade. Finally, it will be important to develop a working partnership with adjacent landowners to ensure that stewardship efforts are coordinated.

Fabius Forest is a small but good quality mesic southern forest on a moderate to steep ice contact slope at Fabius above the floodplain of the St. Joseph River (Figure 9). This forest is dominated by sugar maple, pignut hickory, and tulip tree; but the presence of numerous black oaks and scarlet oaks near ridge lines makes much of the forest somewhat transitional to the southern dry-mesic type. The size of the dominant tree strata in this forest is slightly smaller than would be expected from purely old-growth, unlogged stands, so it is probably recovering from past selective logging. In addition, it has relatively few standing dead trees or downed logs (again, possibly owing to past logging). This forest should be allowed to continue its recovery without further logging. Management should also include maintaining a wooded buffer around the recovering forest. Because the high quality portion of this forest continues onto privately owned land to the south, it will be important to establish a partnership or landuse agreement with the adjacent private landowner to ensure that protection and stewardship efforts are coordinated. In addition, deer browse is very heavy in

Crane Hills Forest at Crane Pond

portions of this forest, so it is important to continue hunting, and an exclosure could be considered for part of this forest. Finally, controlling and monitoring invasive species, especially multiflora rose and garlic mustard, is recommended.

Hardwood-Conifer Swamp

In association with this project, one pre-existing hardwood-conifer swamp element occurrence at Three Rivers was updated. Hardwood-conifer swamps are groundwater-fed wetland forests that are often found on peaty soils near headwater streams. Dominant tree species can vary from site to site and from patch to patch within a given forest, but often include red maple (*Acer rubrum*), black ash, American elm, yellow birch, blue beech (*Carpinus caroliniana*), white pine (*Pinus strobus*), and tamarack. Community patch type heterogeneity is often maintained, in part, by spatial variability in hydrology, windthrow, and fire history. These forests are susceptible to damage from logging, hydrologic alteration, high deer densities, and invasive species (Kost et al. 2007).

Management of hardwood-conifer swamp should allow forest dynamics and patch forming processes to proceed uninhibited. Removal of live or dead trees can be detrimental, especially for conifers, because these activities eliminate seed trees and potential nurse logs. Thus, as a general rule, tree harvest should not be conducted in these swamps. Natural hydrologic patterns and fluctuations in these communities should be allowed to proceed uninhibited: this often means allowing small stream flow volumes to ebb and wane according to fluctuations in weather and climate, allowing beaver to flood riparian zones, and allowing naturally saturated or seepage areas to persist. The fire return interval within these forests is not well known, but it is very likely that many stands were subject to periodic (though perhaps spatially limited) groundfires (Slaughter et al. 2007). While hardwood-conifer swamp stands should not be directly targeted for prescribed fire, allowing fire to carry naturally into these forests from adjacent fire-adapted communities could help to sustain their species and structural diversity. Very high deer densities can reduce tree seedling and survival

Fabius Forest at Fabius

of favored plants such as orchids. Without a substantial number of animal predators on the landscape, hunting or culling are the only viable means with which to control the deer population. Deer hunting within the game areas benefits hardwood-conifer swamps and should be continued, and the impact of deer densities upon native plant composition and regeneration should continue receiving consideration in the setting of deer harvest goals. The presence of invasive plants in these swamps should be monitored, and control activities should be carried out where they pose a threat to these forested systems. In particular, the invasive shrub glossy buckthorn (*Rhamnus cathartica*), which has significantly degraded other conifer swamps in southern Michigan, should be immediately removed if found growing within these areas.

Mill Creek Swamp in Three Rivers is a fine example of a relatively undisturbed, species-rich hardwood-conifer swamp (Figure 9). The swamp comprises the broad backwater zone of the Mill Creek stream corridor. Soils in this swamp are hemic peat and commonly saturated or puddled in response to the high groundwater levels draining toward Mill Creek. Dominant trees include black ash, red maple, yellow birch (*Betula alleghaniensis*), white pine, and tamarack. The shrub and ground layers are diverse, and include spicebush, smooth highbush blueberry (*Vaccinium corymbosum*), swamp goldenrod (*Solidago patula*), and cinnamon fern (*Osmunda cinnamomea*). Overall management of this swamp should include maintenance of natural hydrology and continued lack of intensive human disturbance (such as logging or visitation by motorized vehicles). In addition, fire and beaver should be allowed to play their natural roles in the system; this could mean allowing landscape-scale fires to burn into the swamp, and allowing beaver populations and associated activity to continue along Mill Creek. The small number of invasive species noted within this swamp should be controlled and periodically monitored to ensure they do not become prolific. Finally, deer hunting should continue within and near this swamp.

Bog

In association with this project, three pre-existing bog element occurrences were updated. Bogs are permanently saturated wetlands typified by a dense cover of sphagnum moss (*Sphagnum spp.*) and dwarf shrubs. Cover of other

Mill Creek Swamp at Three Rivers

strata such as scattered trees, tall shrub zones, and an herb layer are often present but this often varies from bog to bog or within the same bog depending upon hydrology and successional stage. In southern Michigan, bogs are restricted to kettle depressions, where groundwater and rainwater are the main water sources. 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 remain in reasonably good condition, and management often needs only to maintain these conditions. This normally means preventing artificial hydrologic impacts (e.g. 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 reed canary grass (*Phalaris arundinacea*) have a tendency to gain a foothold at bog edges (Cohen and Kost 2008); monitoring and/or control of such invasives is critical to insure they do not progress into bog interiors. 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 game areas is beneficial to the bog communities and should be continued.

Except for its privately owned southwestern tip, **Jones Bog** is within the boundaries of Crane Pond (Figure 9). Common plants within this bog include yellow birch, tamarack, smooth highbush blueberry, leatherleaf (*Chamaedaphne calyculata*), Virginia chain fern (*Woodwardia virginica*), and sphagnum mosses. This

Crane Bog at Crane Pond

Purgatory Bog at Three Rivers

wetland likely has been impacted by landscape-wide fire suppression, which may have allowed the dense growth of shrubs and trees within the eastern portions of the bog. The site also may have been impacted by runoff from the adjacent agricultural field along its southwest edge. However, observed portions of the bog appear to be in good condition overall. Management should include maintaining a buffer of natural vegetation of at least 50 feet around the wetland edge, allowing landscape-scale prescribed fires to carry into the bog, and periodic monitoring and control efforts to detect and remove invasive species.

Most of **Crane Bog** is on private land, but the southwestern portion is within Crane Pond (Figure 9). Common plants within the state-owned portion of this bog include red maple, smooth highbush blueberry, poison sumac (*Rhus vernix*), leatherleaf, cotton-grass (*Eriophorum virginicum*), sphagnum mosses, and clubmosses. This site has likely been impacted by landscape-wide fire suppression, and private portions are in close proximity to agricultural fields. However, the state-owned portions of Crane Bog are currently in good condition. Management should include maintaining a natural buffer of at least 50 feet around its perimeter, allowing landscape-scale prescribed fire to carry into the bog, and periodically monitoring and controlling any invasive species.

Purgatory Bog is completely within Three Rivers (Figure 9). Common plants within this bog include tamarack, white pine, smooth highbush blueberry, huckleberry (*Gaylussacia baccata*), leatherleaf, cotton-grass, and sphagnum mosses. Berms and a ditch along southern and western portions of this site suggest some hydrologic manipulation in the past. However, the bog vegetation is in fine condition, and it is possible that its "floating mat" character prevented water level changes from causing soil alteration and floristic degradation. Management should include maintaining a natural buffer of at least 50 feet around its perimeter, allowing landscape scale prescribed fire to carry into the bog, and periodic monitoring and control efforts to detect and remove invasive species.

Prairie Fen

In association with this project, two new element occurrences of prairie fen were identified, one at Crane Pond and another at Three Rivers. Prairie fens are grass, sedge, and rush-dominated wetlands fed by groundwater seepage. They are often sloped and occur on peaty or marly

substrates. Prairie fens typically include several vegetation zones, such as fen meadow, wooded fen, and sparsely vegetated marl flat. Fires are necessary to maintain the open, graminoid character of these communities (Kost et al. 2007). Prairie fens are susceptible to degradation from fire suppression, hydrologic alteration, and invasive species.

Management of prairie fen should normally include the application of periodic prescribed fire. Fires that burn through the dry plant layer in fall or spring help to control the density of woody vegetation and promote the survival of smaller-statured plant species (Spieles et a. 1999; Leach and Givnish 1996). Fen hydrology depends upon the infiltration of precipitation into uplands and higher elevation wetlands and the movement and continual release of groundwater into the fen. Activities or landuses 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 should include an awareness of hydrologic processes and potential impacts so that damage can be avoided. Invasive species can significant degrade prairie fen communities. In particular, the invasive shrub glossy buckthorn has significantly reduced species diversity and 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 given fen.

Kirk Lake Fen at Crane Pond is positioned along the north side of Kirk Lake and is bordered by southern shrub-carr to the north (Figure 9). This gently sloped prairie fen contains plant species such as poison sumac, gray dogwood, Ohio goldenrod (*Solidago ohiensis*), twig rush (*Cladium mariscoides*), sedge (*Carex pellita*), and beaked spikerush (*Eleocharis rostellata*). The shrub coverage in this fen has probably increased substantially over time, and will continue to do so under a pattern of fire suppression. In addition, glossy buckthorn, an aggressive invasive shrub, has begun to establish at this site. Prescribed fire

Kirk Lake Fen at Three Rivers

will help to control both native and invasive shrubs and is strongly recommended in conjunction with monitoring and controlling invasive species.

Wood Creek Fen at Three Rivers occupies the banks of a headwater tributary stream to Wood Creek (Figure 9). Groundwater seepage from the fen supplies the headwater stream with a steady flow of cold, clean water. The east side of this fen sits downslope of a southern dry-mesic forest (Wood Creek Woods EO) and a pine plantation. This moderately sloped fen contains plant species such as tamarack, blue beech, spicebush, golden ragwort (*Senecio aureus*), and tussock sedge (*Carex stricta*). Due to fire suppression, the shrub coverage in this fen has probably increased substantially over time. Also, invasive species such as Eurasian honeysuckle (*Lonicera morrowii*) and reed canary grass have spread throughout this fen. Shrub encroachment and invasive species establishment may have resulted, in part, from past disturbance of intensive livestock grazing. Prescribed fire at this site will help to control both native and invasive shrubs and is strongly recommended. In the more immediate term fire may not reduce cover of reed canary grass, and this grass may be too abundant at this site to easily control. However, fire will strengthen the native plant components that remain, and may keep the invasives in a holding pattern until adequate resources are available to control the reed canary grass. Finally, deer trampling within this fen was widespread, so continued deer hunting is also recommended.

Southern Wet Meadow

In association with this project, one pre-existing southern wet meadow element occurrence at Three Rivers was updated. 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 grass, herb, shrub, and small or scattered tree components. Groundwater is believed to be 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 and invasive cattails (*Typha angustifolia* and *T. x glauca*).

Management of southern wet meadows should include protection of indigenous hydrologic processes. Wet meadow hydrology depends upon the infiltration of precipitation into uplands and higher elevation wetlands, and the movement of that infiltrated water downward toward the wet meadow. Activities or landuses that disrupt or alter this cycle can negatively impact the wet meadow. Potential impacts can include large-scale landcover changes, drainage ditches, water pumping, and surface water runoff collection and discharge. Southern wet meadow management should include an awareness of these hydrologic impacts so that damage can be avoided. Management of southern wet meadows should also normally include the application of periodic prescribed fires and/or allowing landscape-scale fires to burn into these communities. Fires that burn through the dry plant layer in fall or spring help to control the density of woody vegetation, and to maintain and promote the survival of smaller-statured plant species (Reuter 1986; Leach and Givnish 1996). Beaver can play a key role in southern wet meadow creation or maintenance through their consumption of woody plants and temporary pond creation (Kost 2001). 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 invasives. It is important to monitor and control invasive species before they become widespread in these communities.

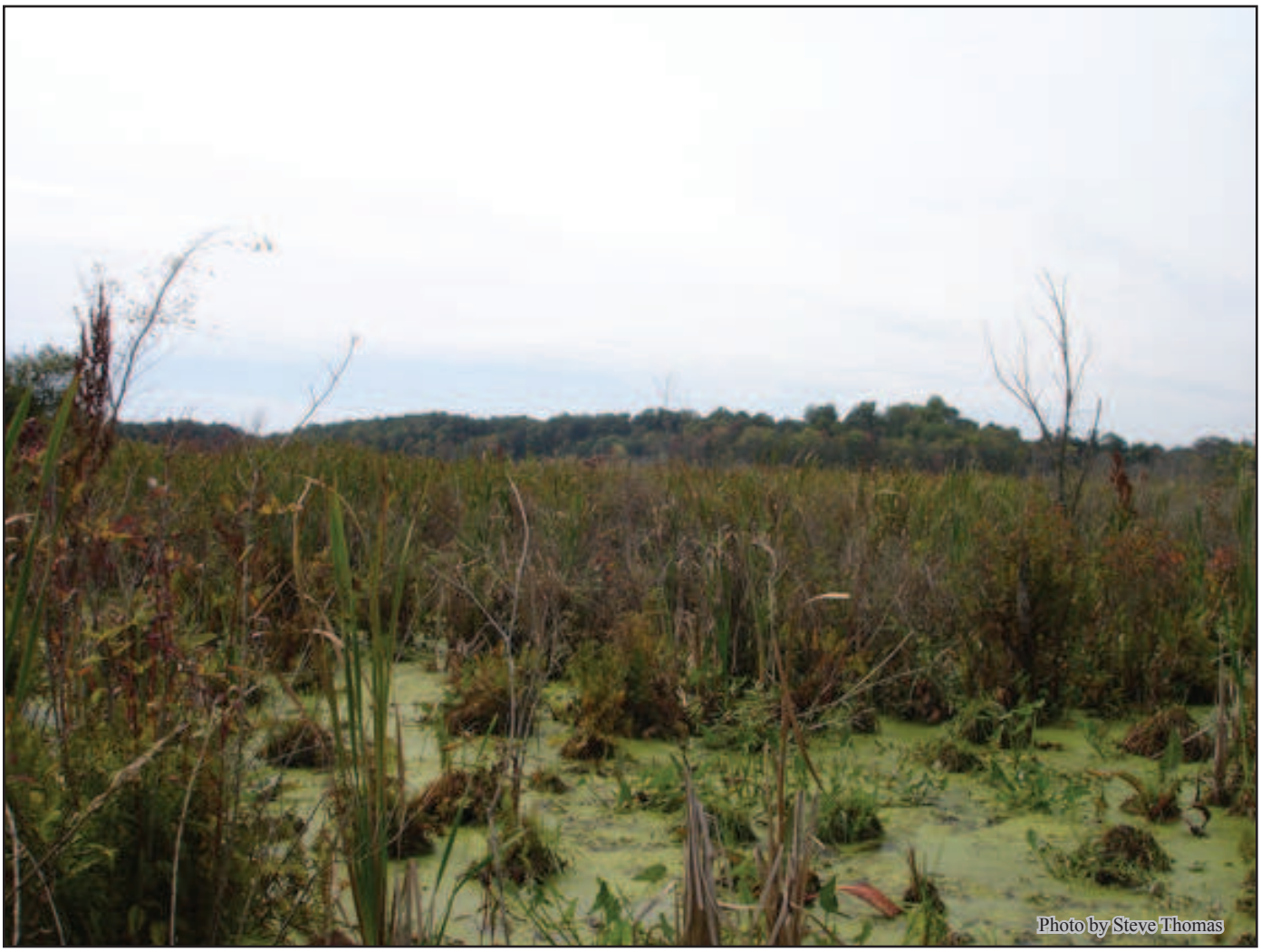
Mill Creek Wet Meadow runs along Mill Creek for more than a mile within Three Rivers (Figure 9). Common plant species within this good quality southern wet meadow include sedges (*Carex aquatilis*, *C. stricta*, etc.), swamp aster (*Aster puniceus*), shrubby cinquefoil (*Potentilla fruticosa*), poison sumac, and tamarack. In addition, a large population of wild rice (*Zizania aquatica var. aquatica*) was observed along the stream in several locations within the wet meadow. The shrub coverage in this wetland has probably increased over time due to both fire suppression and the absence of beaver from the 1800s up until very recently. During field surveys, several beaver dams were observed along Mill Creek and one had resulted in a small pond. Prescribed fire is recommended to help reduce shrub encroachment and to provide habitat for less robust plant species. In addition, the beaver living within this wetland should be allowed to continue to play their natural roles in the system. Finally, reed canary grass has become established along Mill Creek. Fire may not reduce this infestation (especially in the near term), so it would be advantageous to treat these populations with herbicide and monitor their abundance along with the application of fire.

Emergent Marsh and Submergent Marsh

In association with this project, two pre-existing emergent

Wood Creek Fen at Three Rivers

Mill Creek Wet Meadow at Three Rivers



Bellas Lake Marsh at Crane Pond

marsh element occurrences at Crane Pond were updated. In addition one new emergent marsh and two new submergent marsh element occurrences were identified at Crane Pond. Emergent marshes are semi-permanently inundated wetlands that are often found on mucky soils of depressions and along lakes, ponds, and rivers (Kost et al. 2007). 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). Submergent marshes often occur lakeward of emergent marshes, intercalated with emergent marshes, or as large beds across shallow ponds and lakes. 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 marsh communities should strive to maintain natural hydrology, water quality, fire regimes, and native animal populations. Management should also include monitoring and controlling invasive species and prevention of excessive boat traffic and associated wave action (Kost et al. 2007). Maintaining natural hydrology and water quality normally means preventing artificial hydrologic impacts (e.g. water drainage, large withdrawals, 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, so their populations should be sustainably managed. Preventing ORV traffic or boating overuse can reduce ground and wildlife disturbances and minimize opportunities for the introduction of invasive plant propagules. Once invasive plants are established (which often occurs in conjunction with hydrologic alteration, pollution, or excessive visitation) it is imperative to implement control procedures before they spread throughout the system. Finally, while it is often unnecessary to directly target emergent marshes for prescribed fire, allowing fire to carry naturally into emergent marshes will facilitate natural cycles of succession and associated biodiversity to continue.

Fox Lake Emergent Marsh at Crane Pond

Belas Lake Marsh is an emergent marsh that occurs along the western edge of Crane Pond and runs onto private land along the margins of Belas Lake (Figure 9). The portion of this element occurrence on state land transitions into southern shrub-carr eastward and submergent marsh westward. This site contains high structural diversity for an emergent marsh, with peaty hummocks, beaver routes, water pools, scattered trees, and shrub "islands." Common plants in this marsh include broad-leaved cattail (*Typha latifolia*), swamp rose (*Rosa palustris*), and duckweed (*Lemna minor*). One population of giant reed (*Phragmites australis*) occurs along the northern perimeter of this marsh; occasional stands of a giant reed native genotype can be found in Michigan, but this particular stand is more likely to be the invasive genotype, and should be controlled before it spreads over a much larger area. Other than the need to control reed and allow for landscape fires to burn into this site, Belas Lake Marsh is in good overall condition and should be monitored to retain its positive qualities.

Fox Lake Marsh Emergent Marsh and **Fox Lake Marsh Submergent Marsh** are two new element occurrences identified at Crane Pond (Figure 9). This large wetland complex supports an emergent marsh element occurrence on the west side of Fox Lake, a submergent marsh element occurrence within Fox Lake, areas of southern shrub-carr to the south and west of the emergent marsh, and areas of inundated shrub swamp along the south edge of Fox Lake. Most of the emergent marsh appears to be in good condition. Dominant native plants include wiregrass sedge (*Carex lasiocarpa*), willow (*Salix sp.*), and yellow pond-lily (*Nuphar advena*). However, a sizeable stand of invasive narrow-leaved cattail (*Typha angustifolia*) has taken hold near the center of the emergent marsh. Feasible eradication of this population with herbicide and/or timed cutting may still be possible. Control efforts should be initiated soon to prevent further spread on this invasive plant. If it cannot be directly eradicated, this infestation possibly may be held in check through muskrat herbivory—evident nearby—and prescribed fire, which tends to lessen any competitive advantages of taller plants such as cattail. The submergent marsh is also in good condition and contains native plants such as yellow pond-lily, sweet scented water lily (*Nymphaea odorata*), and pondweeds (*Potamogeton*

Fox Lake Submergent Marsh at Crane Pond

spp.). With its shallow water and ample vegetation, this submergent marsh provides excellent habitat for a variety of amphibians, reptiles, and birds. A more in depth evaluation of this marsh would require a boat survey and is recommended at some point.

Only the southeastern portion of **Allen Lake Marsh** is within Crane Pond (Figure 9). The remainder of this emergent marsh is on private land, and is bordered by a patchy landscape of forest and agriculture. This marsh has some uncommon conditions and an associated interesting flora, which make its community classification more challenging. Although typical emergent marsh with plants such as water willow (*Decodon verticillatus*) and burr reed (*Sparganium sp.*) occur along the shallow edge of Allen Lake, some interior portions appear to be developed upon floating mats, with species more typical of fens, bogs, or coastal plain marsh communities (such as three-way sedge (*Dulichium arundinaceum*) and twig rush). While landscape-scale fires should be allowed to burn into marshes, it is unlikely they could ever burn into this site except under the most extreme conditions. Reed canary grass was noted along the shallow edge of this marsh. Recommended stewardship of this site includes preventing hydrologic disruption or pollution and monitoring and controlling reed canary grass and other invasive species.

Forked Lake Marsh is a large submergent marsh that occupies the basin of Forked Lake at Crane Pond (Figure 9). The community is nearly entirely surrounded by southern dry-mesic forest including the Forked Lake Woods EO along its eastern shore. Dominant and common native plants include pondweeds, yellow pond-lily, sweet-scented waterlily, and water shield (*Brasenia schreberi*). Wetland shrubs are common along the margins of the marsh including buttonbush (*Cephalanthus occidentalis*), willows, swamp rose, steeplebush (*Spiraea tomentosa*), and meadowsweet (*Spiraea alba*). Management recommendations for the marsh include preventing hydrologic disruption and pollution and monitoring and controlling invasive species.

Inundated Shrub Swamp

Inundated shrub swamps are wetlands dominated by

Allen Lake Marsh at Crane Pond

Forked Lake Submergent Marsh at Crane Pond

buttonbush that typically occur in kettle depressions (Kost et al. 2007). 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 shrubs and small trees (e.g. winterberry (*Ilex verticilata*), dogwood, and willow) along shallower edges. Floating duckweed (*Lemna minor*) and scattered wetland-adapted herbs, sedges, and grasses 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 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 collection and discharge within or near 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.

Small inundated shrub swamps were scattered throughout the forests at Crane Pond and occurred occasionally at Three Rivers. In addition, zones of this community type were often noted along margins of large wetlands, such as bogs or marshes. Although none of these swamps were entered into Biotics as element occurrences, these wetlands contribute significantly to overall biodiversity and should be preserved.

Inundated Shrub Swamp

Rare Terrestrial Animal Survey Results
Prior to 2009, MNFI surveys at Crane Pond, Three Rivers, and Fabius had documented 13 rare animal species, and five of these records were reconfirmed during this 2009 survey (Table 3). Additionally, nine new rare animal element occurrences were documented during the surveys, including five state threatened and seven special concern species (Table 3). No federally listed species were documented during 2009 surveys. Results are presented below by game area and animal group.

CRANE POND
Avian Survey Results
We conducted surveys for rare woodland raptors at 107 stations (Figure 5) at Crane Pond and recorded one response for a Cooper's Hawk, 10 responses by Red-tailed Hawk, 2 by Barred Owls, and one by an unidentified raptor. The only nesting raptor we recorded from Crane Pond was a single nest for a Red-tailed Hawk.

For the rare songbirds, we conducted 93 point counts (Figure 5) at Crane Pond and documented three rare species: Cerulean Warbler, Hooded Warbler, and Louisiana Waterthrush (Table 3, Figure 10). We observed 10 male Cerulean Warblers singing in suitable nesting habitat. Although all of these observations are considered one new element occurrence (due to an element occurrence separation distance of five-kilometers for forest songbirds), they occurred in three general locations. Five of the 10 singing males were observed in forest near Bald Hill Street to the north and northeast of Forked Lake (north ½ sec. 20 and northwest ¼ sec. 21). We recorded four singing males in forest adjacent to and north of Mann Street between the easternmost parking area and Sodamon Road (northwest ¼ sec. 13 and southwest ¼ sec. 12). The third location consisted of one singing male and occurred in forest southeast of the parking area on Moorlag Road near a small stream (southeast ¼ sec. 4).

Hooded Warbler was the most abundant of the three rare species observed at Crane Pond. We documented 36 territorial males and one female Hooded Warbler during point counts. All of these observations are considered one new element occurrence; however, the Hooded Warbler observations were found in four clusters. More than half (20 individuals) of the observed Hooded Warblers were found in a large block of forest located west of Long Lake, east of Highway 40, north of Bald Hill Street, and south of Allen Lake. We recorded eight Hooded Warblers in forest north and northeast of Forked Lake (north ½ sec. 20 and northwest ¼ sec. 21). Seven Hooded Warblers were documented in forest west of Highway 40 and south of Born Street (east ½ sec. 27). Two singing males were observed north of Mann Street and west of Highway 40 (southeast ¼ sec. 10).

We observed one singing male Louisiana Waterthrush along a small stream north of Hoffman Street and east of Moorlag Road (near border of sections 3 and 4). A Louisiana Waterthrush was also observed at this location earlier in the spring while conducting raptor surveys. This observation represents a new element occurrence and the first for both Crane Pond and Cass County.

In addition to the rare songbirds documented during point count surveys, a Least Bittern (*Ixobrychus exilis*, state threatened) was heard calling in an emergent wetland on the west side of Fox Lake (i.e., Fox Lake Emergent Marsh EO) during the breeding season on 18 June during a visual encounter survey for rare reptiles and amphibians (Figure 10). Several calls were heard while surveyors were walking through the wetland during the day. The wetland was dominated by sedges and cattails with occasional buttonbush, willow and dogwood shrubs, particularly along the edge of the wetland. This represents a new occurrence of this species in the game area and also in the county and Southwest Michigan. This is one of only 22 occurrences of this species statewide. Additional surveys to verify this occurrence and assess the population size and health or condition of this species are recommended; surveys should be conducted at Fox Lake and nearby areas with potential habitat.

Reptile and Amphibian Survey Results
Surveys documented new occurrences of two rare reptile and amphibian species in Crane Pond, the Blanding's Turtle and Blanchard's Cricket Frog (Table 3, Appendix 3 and 4). Eleven Blanding's Turtles were observed at seven different locations during surveys in 2009 (Figure 11). These sites are all located in the northern portion of the game area on both public and private lands. Because these sites are located within a mosaic of aquatic-wetland and undeveloped upland habitats and are less than 10 km apart (which is the element occurrence separation distance for this species, Hammerson and Hall 2004), these observations represent one new element occurrence of this species in the area. One adult Blanding's Turtle was observed on 23 April on a log in a pond on the south side of Hoffman Road in the game area about 1 km (0.6 mi) east of Savage Road (T6S R13W Section 8 NE ¼). Two additional adult Blanding's Turtles were potentially observed in a small pond on the south side of Hoffman Road on private land at or near this location on 4 August, but the turtles went into the water before their identification was confirmed. Two adult Blanding's Turtles were observed along Kinney Street on private lands. One was observed

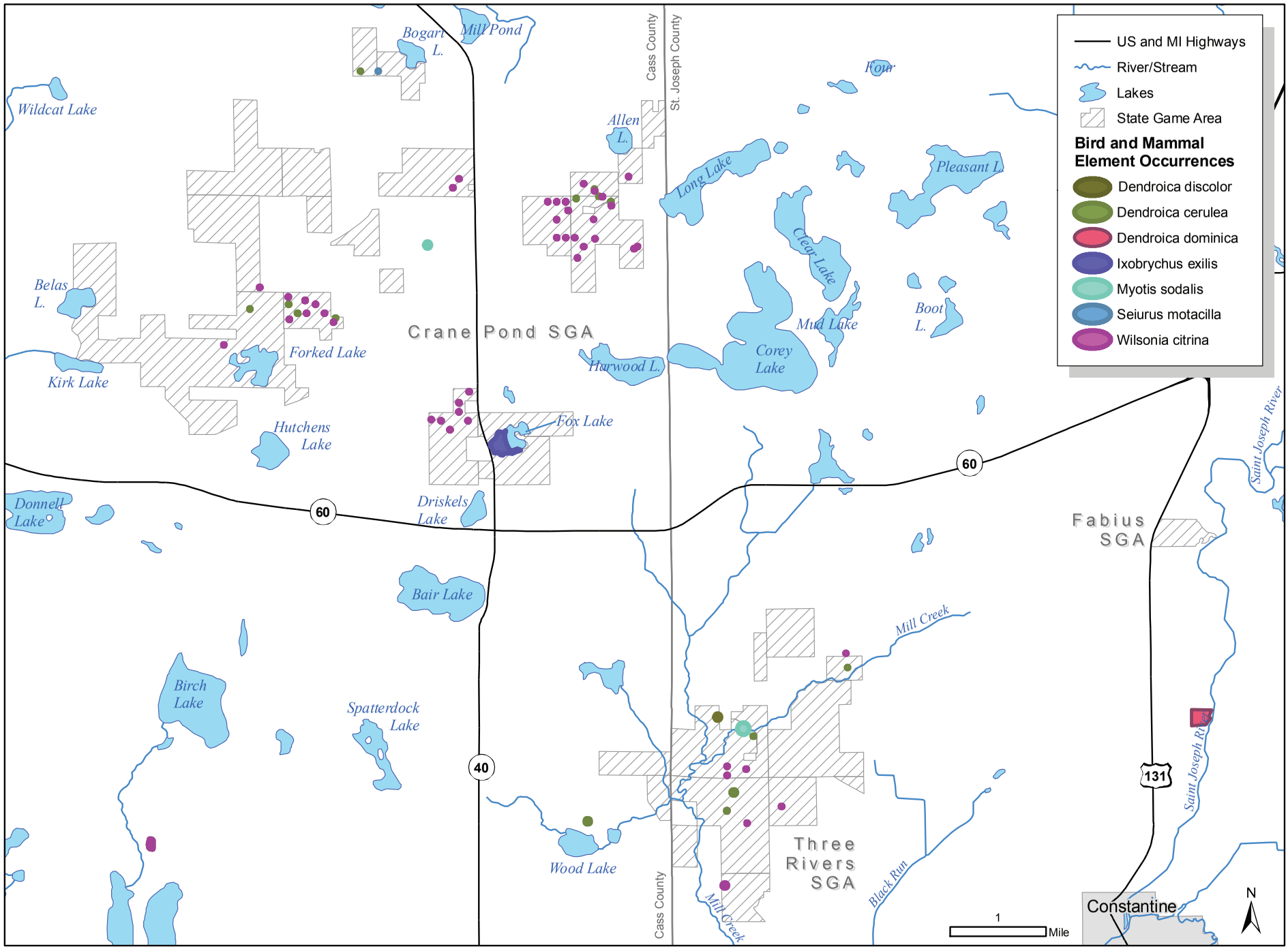


Figure 10. Bird and Mammal Element Occurrences.

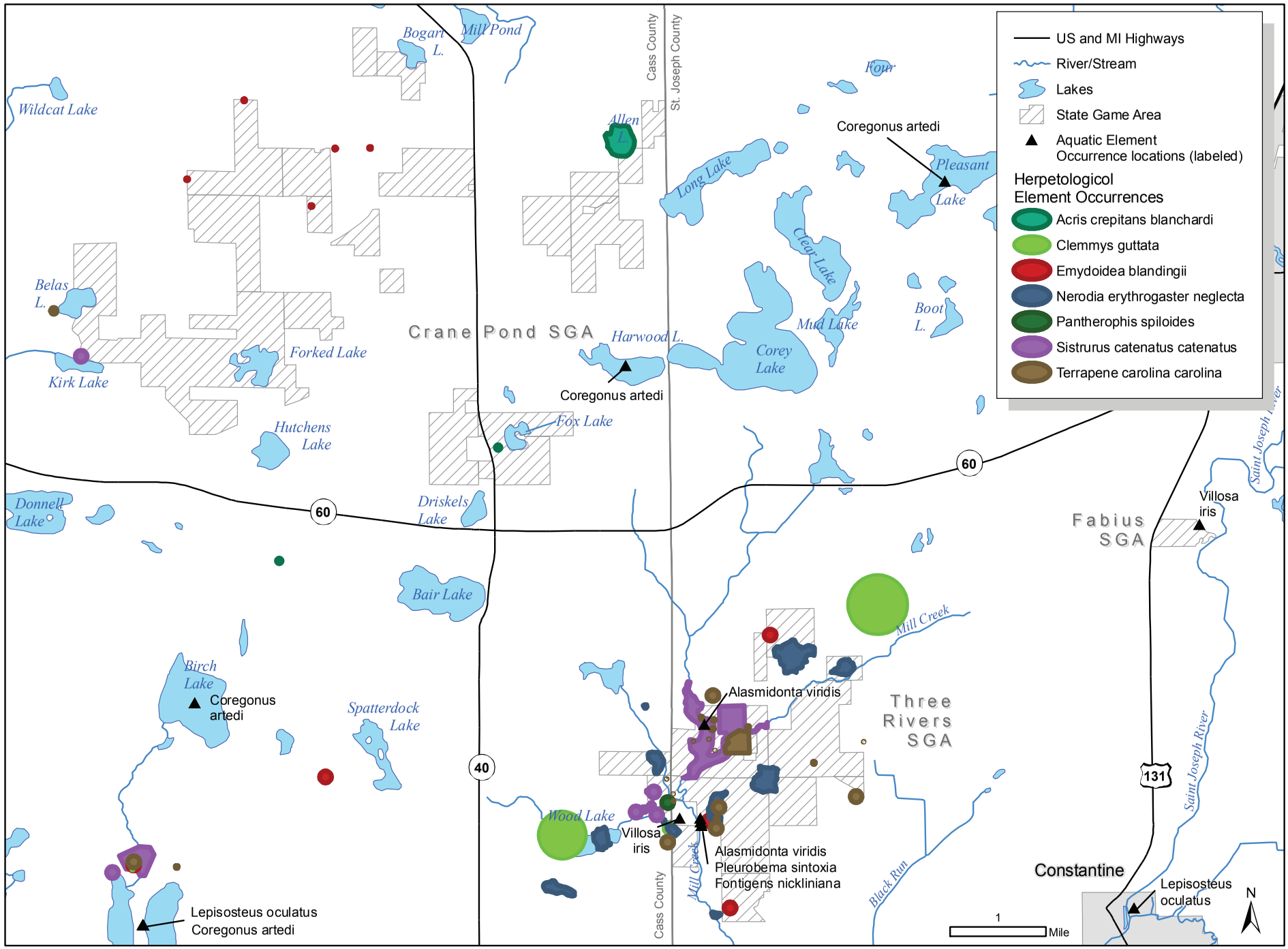


Figure 11. Herpetological Element Occurrences.

on 23 April basking on a log in a pond south of Kinney Street just west of Patterson Hill Road, and the other turtle (i.e., an adult female) was observed on 12 June on the side of the road about 0.8 km (0.5 mi) west of Patterson Hill Road (T6S R13W Section 9 SE ¼). Five Blanding's Turtles of various size or age classes were observed on 20 May basking on a log in the middle of a pond in a mesic southern forest (Crane Hills Forest EO) in the state game area about 0.25 mi west of where Mann Street ends and about 1.2 km (0.75 mi) west of Patterson Hill Road (T6S R13W Section 16 NW ¼). A large adult Blanding's Turtle was seen on 9 June in a small pond south of Mann Street on private land south of the game area between Patterson Hill Road and M-40 (T6S R13W Section 15). An adult female Blanding's Turtle was found on 12 June in the game area in the middle of Savage Road about 0.5 km (0.3 mi) south of Kinney Street (T6S R13W Section 8 SW ¼). Finally, an adult male Blanding's Turtle was observed on 20 August in an inundated shrub/buttonbush swamp on private land on Bald Hill Street between Patterson Hill Road and M-40 (T6S R13W Section 15 SW ¼). Many of the ponds in which Blanding's Turtles were observed were shallow, contained buttonbush, duckweed, scattered trees (e.g., willow or silver maple) and logs, and were surrounded by or adjacent to forests.

Breeding frog call surveys documented a new Blanchard's Cricket Frog occurrence in Crane Pond. One to two cricket frogs were heard calling on the night of 23 June 2009 at Allen Lake in the northeast corner of the state game area (T6S R13W Section 12) (Figure 11). Allen Lake is an element occurrence of emergent marsh and contains areas of shallow water, submergent aquatic vegetation, emergent marsh, and exposed mud or vegetated flats along the edges of the lake. The lake is partially surrounded by upland forest. The breeding frog call surveys were not able to reconfirm a historical occurrence of Blanchard's Cricket Frogs at Fox Lake. The species was last reported from this site in 1963. The frog call surveys also did not document any additional occurrences of Blanchard's Cricket Frogs at the other lakes in the game area.

Four additional species of reptiles and at least ten additional species of amphibians also were documented during herp surveys in the game area (Appendices 3 and 4). These include two additional herp species that have been identified as Species of Greatest Conservation Need (SGCN) in Michigan's Wildlife Action Plan, the Blue-spotted Salamander (*Ambystoma laterale*) and the Eastern Tiger Salamander (*Ambystoma tigrinum tigrinum*) (Eagle et al. 2005). Blue-spotted Salamanders, or salamanders in that complex, were found in the fall during visual encounter surveys under logs around small forested wetlands and vernal pools in the mesic southern forest stand south of Kinney Street and north of Forked Lake (T6S R13W Sections 8, 17, and 20). The Eastern Tiger Salamanders were captured as larvae in the minnow traps that were set in the vernal pools south of Fox Lake during trapping surveys in June (T6S R13W Section 26). The herp surveys were not able to reconfirm previously documented occurrences of the Eastern Box Turtle or the Eastern Massasauga in or near Crane Pond. Additionally, the trapping surveys did capture a large number of tadpoles and salamander larvae, but no Marbled Salamander larvae were documented. The visual encounter surveys also detected several salamander species, but no Marbled Salamanders were found.

Butterfly and Moth Survey Results

No rare butterflies or moths were recorded from Crane Pond during limited 2009 surveys. Of the rare moth species, the golden borer moth and the regal fern borer moth have the best potential to occur within the game area, as there appears to be habitat available for both species. The golden borer moth is associated with prairie, idle/old field, right-of-way, mesic hardwood, dry hardwood, lowland conifer, inland emergent wetland, fen, and swamp habitats. It is also associated with large contiguous natural landscapes. In Michigan, the larval host plant is likely one of the lilies (e.g., wood lily (*Lilium philadelphicum*) and other lily species), may apple (*Podophyllum peltatum*), bottlebrush grass (*Hystrix patula*), and dark green bulrush (*Scirpus atrovirens*). The larva bores into the shoot or roots of its host plant. The larvae start in grass and then generally switch to lilies, may apple and other plants. The regal fern borer moth typically inhabits swamp forests but also is associated with prairie, idle/old field, lowland shrub, lowland hardwood, fen, and river/stream/riparian/floodplain habitats. The larvae bore into the roots of their host plant, royal fern (*Osmunda regalis*) and cinnamon fern (*Osmunda cinnamomea*).

Tree Cricket Survey Results

Areas containing white pines were the primary areas surveyed during 2009. A total of three species of tree crickets were recorded, although no pine tree crickets were observed. There are areas within Crane Pond that contain white pine and some limited areas with tamarack, therefore further surveys may be warranted for these two elusive tree crickets.

THREE RIVERS

Avian Survey Results

We conducted surveys for woodland raptors at 41 points (Figure 5) within Three Rivers, and while we recorded responses from Red-shouldered Hawk (3 stations), Cooper's Hawk (1 station), and an immature Bald Eagle (1

station), no nesting raptors were documented. In addition to the rare raptor responses, we also recorded 5 Red-tailed Hawks, 1 Broad-winged Hawk, and 1 Barred Owl.

Several Cerulean and Hooded Warblers were recorded while surveying the 39 songbird points within Three Rivers (Table 3, Figure 10). Although element occurrences existed for these species in or near the game area prior to surveys, both occurrences were expanded with observations in new areas. Three male Cerulean Warblers were documented singing in suitable nesting habitat near Mill Creek, with one male in each of three locations: northeast ¼ of sec. 18, southeast ¼ of sec. 7, and the southeast ¼ of sec. 5. One male Cerulean Warbler was previously documented by MNFI in the northeast ¼ of sec. 18 in 2005, and another male was observed near Wood Lake in 2001.

Seven singing male Hooded Warblers were recorded within Three Rivers (Table 3, Figure 10). Five of the seven Hooded Warblers were observed near Purgatory Road in the northeast ¼ of sec. 18. One male was documented in the northwest ¼ of sec. 17, and another male was recorded south of New England Road and north of Mill Creek in the southeast ¼ of sec. 5. The previous Hooded Warbler element occurrence consisted of a singing male that was observed near Purgatory Road in 2005 by MNFI personnel.

Reptile and Amphibian Survey Results

Surveys reconfirmed the occurrences of three rare reptile species in Three Rivers (Table 3, Appendix 3 and 5). These included the Eastern Massasauga, Blanding's Turtle, and Eastern Box Turtle. An adult Eastern Massasauga was observed on 23 June crossing Norton Road just north of Withers Road (T7S R13W Section 13 NE ¼) (Figure 11). A number of Eastern Massasaugas have been seen in the prairie fen, southern wet meadow, and adjacent habitats along Mill Creek north and south of Norton Road and south of Preston Road over multiple years since 1979 (MNFI 2009). This observation represents an update of the previously documented massasauga occurrence in the state game area because of its proximity to locations where the species had been documented in the past.

Two adult male Blanding's Turtles were found in Three Rivers during visual encounter surveys on 12 May (see Blanding's turtle image). These turtles were found together partially buried in standing water in an inundated shrub swamp dominated by buttonbush surrounded by forested swamp on the west side of Purgatory Road where the road turns east about 2.4 km (1.5 mi) north of Millers Mill Road (T7S R12W Section 18 NW ¼) (Figure 11). Blanding's Turtles had been documented previously in a wetland adjacent to this wetland as well as along Williams Road

Eastern Massasauga at Three Rivers

Blanding's Turtle at Three Rivers

Eastern Box Turtles at Three Rivers

and New England Road to the north and Millers Mill Road to the south in 1996, 1997, and 2002. The NatureServe element occurrence specifications for Blanding's Turtles require that observations occurring in mosaics of aquatic-wetland habitat and undeveloped upland habitat be greater than 10 km apart to represent separate element occurrences (Hammerson and Hall 2004). As a result, all the Blanding's Turtle observations in Three Rivers were combined into one element occurrence.

Eight Eastern Box Turtles were found at four different sites in Three Rivers during surveys in 2009 (Figure 10). One dead adult male box turtle and one live adult box turtle were found on 29 April and 14 September in an inundated shrub swamp and a dry-mesic southern forest stand west and north of where Purgatory Road turns sharply to the east about 2.4 km (1.5 mi) north of Millers Mill Road (T7S R12W Section 18 NW ¼). One adult male box turtle was found on 4 June on the side of Preston Road about 0.8 km (0.5 mi) west of Peck Academy Road (T7S R12W Section 8 SW ¼). Three adult male box turtles were documented on 31 July and 16 September in a dry-mesic southern forest stand east of Mill Creek south of Preston Road and north of Purgatory Road (T7S R12W Section 7 SE ¼) (see Eastern Box Turtle image). Finally, two adult box turtles were found on 11 August and 17 September east of Curtis Creek south of Preston Road (T7S R12W Section 7 NW ¼). These turtles were found in a powerline right-of-way that was dominated by grasses and shrubs and surrounded by oak and pine forest, and in a sedge meadow opening surrounded by tamarack along the edge of the sedge meadow complex along Curtis Creek. Eastern Box Turtles also had been documented previously at multiple locations within the game area and adjacent private lands. Element occurrence specifications developed by NatureServe for Eastern Box Turtle specify that observations be separated by a barrier, at least 1 km (0.6 mi) of unsuitable habitat, or at least 5 km (3 mi) of suitable habitat to be considered separate occurrences (Hammerson 2004). Because all recent and previously documented observations of box turtles in Three Rivers are separated by less than 5 km of suitable habitat, these observations represent one element occurrence for this species in the game area.

In addition to the listed or special concern herp species, nine amphibian species and five reptile species also were documented during surveys in Three Rivers (Appendix 3 and 5). These include two herp species that have been identified as SGCN in Michigan's Wildlife Action Plan (Eagle et al. 2005). These species include the Northern Leopard Frog (*Rana pipiens*) and Pickerel Frog (*Rana palustris*). The Northern Leopard Frog also was proposed

Pickeral Frog at Three Rivers

Black lighting for rare insects at Three Rivers

to be added as a state special concern species by the Michigan Amphibian and Reptile Technical Advisory Committee during the State's endangered and threatened species list review process in 2005, but this designation is still under review and needs to be finalized. The Pickerel Frog was observed on 7 August on the east side of Curtis Creek south of Preston Road (Figure H9 – Pickerel Frog photo), and the Northern Leopard Frog was found on 22 September along Mill Creek south of Preston Road (T7S R12W Section 7). The herp surveys in 2009 were not able to reconfirm previously documented occurrences of Spotted Turtle and Gray Ratsnake in the state game area. However, it appears that suitable habitat for both these species is still available in the game area.

Butterfly and Moth Survey Results

No rare butterfly species were recorded during the 2009 surveys and habitat appears to be limiting for most species. We did not relocate the swamp metalmark element occurrence for Three Rivers, which had not been observed since 1934. There is a small amount of habitat, including host plants, for the swamp metalmark in the southern wet meadow complex (Mill Creek Wet Meadow EO) that extends throughout the game area.

Two rare moth species were recorded from Three Rivers including the maritime sunflower borer moth (*Papaipema maritima*) and the golden borer moth (*Papaipema cerina*). Both moths were collected during a night of blacklighting on 21 September, just east of Curtis Creek and just south of Preston Road in a wet meadow habitat (Mill Creek Wet Meadow EO) (Figure 12). These two discoveries have high conservation significance. It is just the 10th record for the maritime sunflower moth and the 8th record for the golden borer moth in Michigan. These records are also both firsts for St. Joseph County. The maritime borer moth had not been seen in the state since 1997. There also appears to be additional habitat for both species in the game area.

Leafhoppers and Spittlebug Survey Results

Sweep net samples from areas containing warm-season grasses and spike-rush (*Eleocharis* spp.) failed to document any rare leafhoppers or spittlebugs. There are limited amounts of habitat (e.g., prairie fen, prairie) and host plants within the game area and thus, it is not likely that rare leafhoppers or spittlebugs are currently present.

Tree Cricket Survey Results

Areas containing white pine and tamarack were the primary areas surveyed during 2009. A total of three species of tree crickets were recorded, although no pine tree crickets or tamarack tree crickets were observed. There are numerous areas within the game area that contain tamarack and some areas with white pine, which provide habitat for these species. In other areas in Michigan, multiple surveys are needed to record these elusive tree crickets, therefore further surveys are warranted.

FABIUS

Avian Survey Results

The six raptor and songbird points within Fabius did not result in any observations of the rare target species.

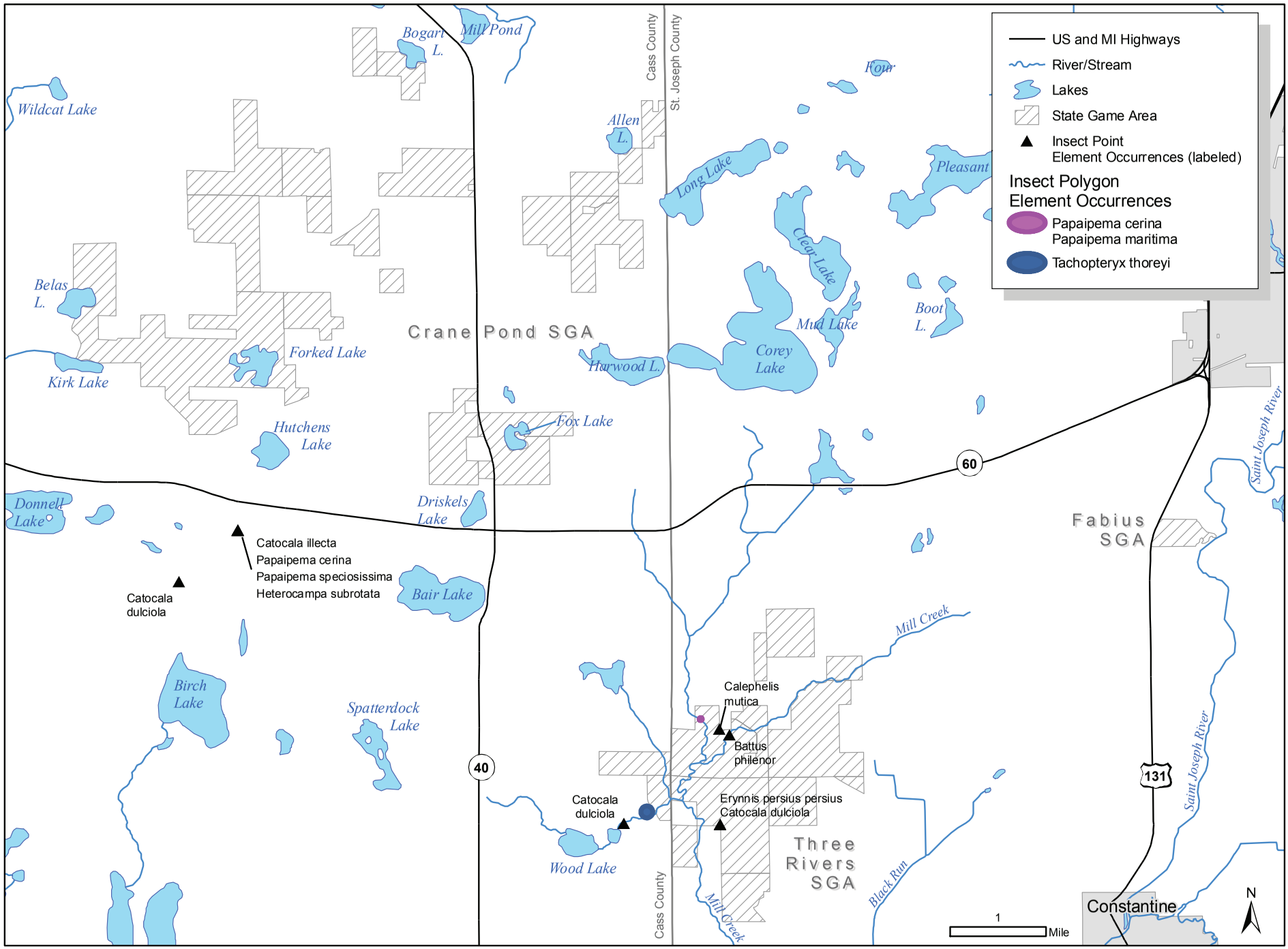


Figure 12. Insect Element Occurrences.

Ellipse at Three Rivers

However, the habitat appeared suitable for Cerulean and Hooded Warblers. Louisiana Waterthrush and Prothonotary Warblers could also occur near the St. Joseph River. Thus, future songbird surveys at this site are recommended.

Reptile and Amphibian Survey Results
As mentioned in the Methods section, limited herp surveys were conducted in the Fabius State Game Area. A visual encounter survey was conducted on 3 September, specifically targeting the Gray Ratsnake, Marbled Salamander, and Blanding's Turtle. Although these species were not observed during the survey, three other herp species and suitable habitat for the Gray Ratsnake and Blanding's Turtle were documented in the game area (Appendix 6).

Rare Aquatic Animal Survey Results
Unionid mussel surveys and water quality/habitat measures were completed at eight sites between 4 June and 24 September. Seven sites were sampled in Three Rivers, including two in Wood Creek, two in Curtis Creek, and three in Mill Creek. One site in Fabius was sampled. Locations of sites are given in Appendix 7 and Figure 8. A total of 12 unionid species were observed (Appendix 8). Live individuals of the state threatened slippershell (*Alasmidonta viridis*) were found at Sites 3 and 4 in Mill Creek, and one shell was found at Site 7 in Curtis Creek. The most abundant unionid of this study was the ellipse (*Venustaconcha ellipsiformis*), a species of special concern. Two other species of special concern were found, the rainbow (*Villosa iris*) and round pigtoe (*Pleurobema sintoxia*).

Searches for gastropods were made at four sites within the Mill Creek watershed, Three Rivers, and one site in the St. Joseph River at Fabius. Gastropods were sampled at Site 2 in Wood Creek, Site 4 in Mill Creek, Sites 6 and 7 in Curtis Creek, and Site 8 in the St. Joseph River. A total of 16 gastropod species were documented, with Site 4 in Mill Creek having the highest species richness. One species of special concern, the watercress snail (*Fontigens nickliniana*) was found in Mill Creek (Appendix 9).

No zebra mussels (*Dreissena polymorpha*) or Asian clams (*Corbicula fluminea*) were found in the Mill Creek watershed. Both exotics were found in the St. Joseph River at Fabius. Water chemistry and habitat measures are given in Appendices 10 and 11. Incidentally observed taxa, including three fish species, are given in Appendix 12. Three additional reaches were walked and assessed

for habitat. A reach of Mill Creek from Preston Rd. northward approximately 400 m was found to have low flow, and substrate with a thick layer of silt and fine organic matter that is unsuitable for unionid mussels. A reach approximately 200 m north of Preston Rd. in Curtis Creek and another 200 m reach south of Preston Rd. were found to have habitat no more suitable to unionids than the sites already surveyed.

DISCUSSION

Natural Community Discussion and Recommendations
Although our surveys succeeded in documenting several new natural community element occurrences, these game areas harbor many additional ecologically significant lands that could reach element occurrence quality with stewardship. In particular, the stands of dry-mesic southern forest in Crane Pond and Three Rivers have retained many large-diameter trees but because of fire suppression, their understories are now often dense with shade-tolerant saplings such as red maple and sugar maple. In addition, invasive plants such multiflora rose and garlic mustard are common. With regular prescribed fire management and invasive species control, these forests are likely to significantly improve in overall quality. Similarly, the current natural community element occurrences of dry-mesic forest, southern wet meadow, and prairie fen are also likely to significantly improve in quality with regular prescribed fire management and invasive species control.

Fire as an Ecological Process
Much of the land within Three Rivers and large portions of Crane Pond historically supported fire-dependent ecosystems such as oak-hickory forest, black oak barrens, southern wet meadow, and prairie fen. 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 convert 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 southern wet meadow and prairie fen convert to shrub-carr and swamp forest (Curtis 1959).

Historically, many of the areas mapped as oak-hickory forests circa 1800 were best described as oak woodlands with open canopies, rather than the dense, closed canopy forests so common today. The conversion of open barrens and oak woodland to closed canopy forest often results in a loss of 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 southern dry-mesic forests regularly had poor oak and hickory regeneration, supported dense understories of shade tolerant trees and shrubs, and had little ground layer diversity. These forests currently are experiencing strong regeneration of shade-tolerant plants such as red maple, sugar maple, beech, maple-leaved viburnum, and invasive shrubs such multiflora rose. Repeated prescribed burns will eventually reduce the density of shade tolerant seedlings, saplings, and invasive shrubs. A sustained fire management regime 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 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 insects (Panzer 1998) and rare reptiles such as box turtle and massasauga rattlesnake. 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 and habitat diversity within the state game areas. 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 game areas, the species likely to pose the greatest threats because of their ability to invade and quickly dominate intact natural areas in southwestern Lower Michigan include **glossy buckthorn**, **multiflora rose**, **Eurasian honeysuckles** (*Lonicera* spp.), **autumn olive**, **giant reed**, **reed canary grass**, **narrow-leaved cattail**, **garlic mustard, purple loosestrife (***Lythrum salicaria*), and **Japanese knotweed** (*Polygonum cuspidatum*). Additionally, new invasive species that were not seen in the game areas 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 **kudzu** (*Pueraria montana*). 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 game areas. 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 need and availability. We recommend that priority criteria and activities include the following:

1) A preference toward high quality sites with minimal infestations of invasive species. Biodiversity is most easily and effectively protected by preventing high quality sites from degrading, and invasives 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., hardwood-conifer swamps, prairie fens, bogs, streams, etc.).

3) Sites that enhance core areas of high quality habitat or act as critical corridors for wildlife, such as the Mill Creek corridor which runs through Three Rivers.

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.

Red Mulberry at Crane Pond

Rare Plant Discussion

Starry Campion (*Silene stellata*) is listed as state threatened and is known from only 18 occurrences statewide, of which eight localities are known only from historical records. This species, which reaches a northern range edge in Michigan, is known only from the two southern tiers of counties in central and southwest Lower Michigan. Although observed only in one locality in the game areas (Wood Creek Woods EO), where it had been browsed, it is distinctive in vegetative condition, and is likely to be more widespread and thus, should be sought nearby. For more information see the MNFI Rare Species Explorer summary on Starry campion at: http://web4.msue.msu.edu/mnfi/explorer/index.cfm.

Red Mulberry (*Morus rubra*) is listed as state threatened, and is known from only 26 sites outside of these game areas. Of these occurrences, only 16 sites have been observed since 1950. This species is dioecious (i.e. meaning that plants are either male or female), and almost always occurs as widely scattered individuals in forested river floodplains. With sufficient experience, red mulberry is recognizable throughout the growing season via its leaves, which are rough on the upper surface and soft-hairy (downy pubescent) beneath, which contrasts with the glossy, smooth leaves of the similar-looking white mulberry (*M. alba*) and also those of American basswood (*Tilia americana*) which is also very similar and commonly grows with it. Since red mulberry appears to occur in very small populations composed of widely scattered individuals, pollination and reproduction may be problematic due to the necessity of long-distance pollen transfer from male to female trees. In the absence of successful reproduction and recruitment, the long-term viability of these populations is considered only fair to low. It is worth noting that no seedling or sapling red mulberries were observed during our survey, similar to observations from other occurrences. Red mulberry is also imperiled due to disease susceptibility and the occurrence of the non-native white mulberry with which it is known to hybridize and backcross. For more detailed information see the rare plant abstract on red mulberry at: http://web4.msue.msu.edu/mnfi/pub/abstracts.cfm.

Goldenseal (*Hydrastis canadensis*) is listed as state threatened, and is known from 91 statewide occurrences,

although 33% of these localities are known only from historical records and are likely no longer extant. This species has declined significantly throughout its range due to the exploitation of its rhizomes for herbal medicine and the extensive loss of habitat due to development, habitat alteration, forest fragmentation, and invasive species, among other impacts. In Michigan, this woodland species is concentrated in the southern three tiers of counties in the Lower Peninsula, where few large blocks of forest remain. Typical habitat for goldenseal includes rich hardwood forests with canopies dominated by beech, sugar maple, basswood, and red oak (e.g., mesic southern forest). Goldenseal can be easily recognized in early May when it is flowering. This rare forb is also occasionally found growing on upland rises within floodplain forests. Conservation strategies for goldenseal include the protection and restoration of rich woodland habitats, monitoring of known populations to determine if plants are being poached or unsustainably harvested, and educating the public about the detrimental effects caused by poaching and the use and export of wild-grown herbs in the herbal trade markets. For more information see the rare plant abstract on goldenseal at: http://web4.msue.msu.edu/mnfi/pub/abstracts.cfm.

Wild Rice (*Zizania aquatica* var. *aquatica*) is listed as state threatened, and is known from 37 occurrences statewide. All but two localities are restricted to southern Lower Michigan, with more than 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

Wild Rice in flower at Mill Creek Wet Meadow in Three Rivers

Hairy Skullcap at Crane Pond

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 at: http://web4.msue.msu.edu/mnfi/pub/abstracts.cfm.

Hairy Skullcap (*Scutellaria elliptica*) is listed as state special concern and is known from about 30 statewide occurrences, all of which are found in the southwest Lower Peninsula, and of which a significant number (12 localities) are known only from historical records. Surveys for natural communities within the game areas revealed several new localities for hairy skullcap, verifying that the game areas are a stronghold for this woodland forb. The recent inventories resulted in the observation that this species, which was thought to essentially be restricted to mesic southern forests, is now known to occur frequently in dry-mesic southern forests and thus, is potentially broader in distribution than formerly believed. For more information see the MNFI Rare Species Explorer summary on hairy skullcap at: http://web4.msue.msu.edu/mnfi/explorer/index.cfm.

Black Haw (*Viburnum prunifolium*) is listed as state special concern and is known from about 25 statewide occurrences, of which five localities are known only from historical records. This shrub reaches a northern range edge of its distribution in southern Lower Michigan, where it is known thus far to occur only within the southern two tiers of counties, primarily in the southwest and southeast regions. During surveys for natural communities, several new occurrences of this species were discovered in the game areas, where this somewhat obscure shrub was found in a variety of habitats, particularly along community edges (e.g. roadsides) and other areas where it may have colonized sites following disturbance. For more information see the MNFI Rare Species Explorer summary on black haw at: http://web4.msue.msu.edu/mnfi/explorer/index.cfm.

Rare Terrestrial Animal Discussion and Recommendations

Rare Songbird Discussion

We observed three rare songbird species during point count surveys, Cerulean Warbler, Louisiana Waterthrush, and Hooded Warbler. All of these species are known to occur in landscapes dominated by mature deciduous forest. Management at the three game areas has maintained large blocks of forest within a landscape dominated by agricultural land and small forest fragments. These large blocks of forest are providing valuable nesting habitat for these and other neotropical migrant songbirds. The maintenance and expansion of mature forest blocks at the game areas would benefit rare songbirds and other forest-interior bird species. Activities that reduce the cover of mature forest or increase forest fragmentation could reduce the value of these sites to the rare species we observed. Brown-headed Cowbirds (*Molothrus ater*) were regularly observed at the game areas, so efforts to reduce forest fragmentation could decrease songbird nest parasitism. 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. Such low-intensity management may also be compatible with Hooded Warbler breeding habitat. Hooded Warblers nest in small trees or shrubs in the understory of mature deciduous forest (Dunn and Garrett 1997), and we regularly observed them in areas of dense young trees and shrubs associated with blow-downs. The Louisiana Waterthrush typically uses mature forest adjacent to fast-flowing streams within large blocks of deciduous forest (Eaton 1958, Dunn and Garrett 1997). We recommend managing for mature stands of riparian and contiguous upland forest at the location where we observed Louisiana Waterthrush in Crane Pond, as well as other sites with potential habitat.

We recommend periodically repeating the songbird point counts to monitor use of the game areas by the rare species we observed. These surveys would allow us to determine if the stands where rare songbirds were observed continue to be occupied over time and would provide an opportunity to monitor the effects of management actions on these species. Because rare species often are not detected even when present, additional surveys would also help determine if additional rare songbirds are present at sites where the habitat appeared suitable.

Reptile and Amphibian Discussion

We documented four rare reptile and amphibian species during herp and other natural features surveys in Crane Pond and Three Rivers in 2009, Eastern Massasauga, Blanding's Turtle, Eastern Box Turtle, and Blanchard's Cricket Frog. In addition to these state listed or special concern species, four additional SGCN were observed, including the Blue-spotted Salamander, Eastern Tiger Salamander, Pickerel Frog and Northern Leopard Frog. These rare species and SGCN were found in a variety of open and forested wetland habitats and forested upland habitats in the game areas. Wetland habitats in which these species were found include southern wet meadow, prairie fen, inundated shrub swamp, forested vernal pools, small open ponds and lakes, emergent marsh, southern hardwood swamp, and hardwood-conifer swamp. Upland habitats include mesic and dry-mesic southern forest. Many of these species require habitat complexes comprised of suitable wetland habitats as well as adjacent upland habitats to meet their life history requirements and maintain viable populations. Crane Pond and Three Rivers appear to provide suitable wetland-upland habitat complexes for a number of rare and/or declining herp species, as well as for many other more common species. Maintaining landscape complexes comprised of a diversity and high density of wetland habitats as well as adjacent upland habitats that connect these wetlands is critical for maintaining populations of rare and/or declining herp species and general herp diversity in the game areas and the surrounding landscape. Efforts to maintain or restore habitat corridors that connect habitat complexes both within the game areas and between the game areas and the surrounding landscape would benefit these species.

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. The updated Eastern Massasauga occurrence in Three Rivers is considered to have excellent to good estimated viability, and, if current conditions prevail, is likely to persist for the foreseeable future (i.e., at least 20-30 years) in its current condition or better. Although the size of the massasauga population at this site is unknown, this occurrence is estimated to have excellent to good viability because of the large amount of available habitat at this site, the natural and protected landscape context, multiple snake observations over multiple years, and a long history of occurrence persistence (i.e., 30 years). 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). Maintaining existing wetland-upland habitat complexes along Mill Creek and Curtis Creek and in other parts of the state game area is essential for maintaining the massasauga population at this site. While massasaugas will use forested habitats, they will generally avoid closed-canopy forest stands (Reinert and Kodrich 1982, Seigel 1986, Kingsbury 1996 and 1999). Creating canopy gaps in forested habitats by thinning, burning, or other forest management activities that allow sunlight to reach the ground can be beneficial to this species for thermoregulation. Maintaining access to adequate gestation and hibernation sites also is critical. This includes maintaining open habitats with some woody debris, other cover objects, or burrows for gestation and birthing. Burrows, which are often created by crayfish or small mammals, allow snakes to get below the frost line or access the water table for hibernation (Lee and Legge 2000). Additional surveys and research are needed to identify areas that provide gestation and hibernation sites for this Eastern Massasauga population. Maintaining hydrology in occupied habitats also is critical, particularly avoiding sudden and severe drops in the water table during hibernation and sudden and extended flooding during the active season (Johnson et al. 2000). Habitat management activities, such as prescribed burning, mowing, and disking, can have positive and negative impacts on Eastern Massasaugas, and should be conducted so as to minimize adverse impacts to the population. The draft habitat management guidelines for Michigan's Eastern Massasauga Candidate Conservation Agreement with Assurances and Johnson et al.'s (2000) "The Eastern Massasauga Rattlesnake: A Handbook for Land Managers" provide recommendations on how to conduct habitat management activities and minimize adverse impacts to the species.

In addition to maintaining suitable habitat, research is needed to assess the potential impacts of roads and other threats to the massasauga population at Three Rivers, and additional management efforts may be needed to address these impacts. Roads fragment habitat for the massasauga in the game area, and can act as barriers to movement (Kingsbury pers. comm.). This may prevent snakes from accessing habitats needed to complete their life history and/or dispersing to surrounding areas with suitable habitat or other populations. The degree to which a road can act as a barrier to snake movement also appears to vary by the type, surface, and/or width of the road (Kingsbury pers. comm.). For example, paved roads and gravel roads appear to be more of a barrier to snake movement than dirt roads (Kingsbury pers. comm.). Vehicle traffic along roads also may result in snake mortality or injury. Accidental or purposeful killing and/or illegal collection of massasaugas also may occur in or near the game area. Massasaugas have low reproductive rates, can have old ages at maturity, and are fairly long-lived (Reinert 1981, Seigel 1986, Parent pers. comm., Johnson et al. 2000). Given these life history traits and results from a massasauga population viability analysis conducted in Missouri, massasauga populations may be highly sensitive to even small changes in adult and juvenile mortality rates (Seigel and Sheil 1999). Research and monitoring as well as education and outreach should be conducted to assess and try to minimize these potential threats and associated impacts on the massasauga population in the game area.

Blanding's Turtle occurrences were documented in both the Crane Pond and Three Rivers, and an Eastern Box Turtle occurrence was reconfirmed at Three Rivers during surveys in 2009. All three of these occurrences are estimated to have excellent to good or fair viability, and are likely to persist into the foreseeable future (i.e., at least 20-30 years). Although the size of these turtle populations are unknown, these populations have high probability of persisting into the foreseeable future because of extensive available habitat complexes at these sites, protected status of these sites, and a fairly long history of occurring at these sites. Some evidence of successful reproduction or population recruitment based on observation of turtles of different size/age classes also was documented in the Blanding's Turtle population at Crane Pond. However, in the other two populations, only adult turtles have been found, and it is uncertain if population recruitment is occurring, although young and juvenile turtles can be difficult to find. Because this species is so long-lived (Congdon et al. 1993), populations can persist for a number of years even if population recruitment is limited or not occurring. Additional information regarding population size and recruitment would help clarify estimated viability of this population. The two Blanding's Turtle occurrences are important locally because only three other Blanding's Turtle occurrences are currently documented in Cass and St. Joseph counties (MNFI 2009), although additional occurrences likely occur in these counties.

The most critical conservation need for the Blanding's Turtle and Eastern Box Turtle is protection and management of suitable wetland and nesting habitats (Hyde 1999, Lee 1999, NatureServe 2009). Blanding's Turtles inhabit productive, clean, shallow waters with abundant aquatic vegetation and soft muddy bottoms over firm substrates (Ernst et al. 1994). This species is found in ponds, marshes, swamps, bogs, wet prairies, slow-moving rivers, and lake shallows and inlets (Harding

1997). 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). Maintaining large and small wetland systems connected to suitable upland habitat is crucial for Blanding's Turtles (Harding 1997). Maintaining good water quality in wetland habitats also would be beneficial to this species. 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 these habitat complexes is critical to ensuring continued persistence of this species in these game areas.

The Eastern Box Turtle is Michigan's only truly terrestrial turtle (Harding 1997, Hyde 1999). It typically occurs in forested habitats with sandy soils near waterbodies or wetlands such as streams, ponds, lakes, marshes or swamps (Tinkle et al. 1979). They also may be found in or along the edges of open upland and wetland habitats. Access to open, sunny, and sandy nesting areas also is essential for population viability (Harding 1997). Maintaining the extensive wetland and forested habitat complex along Mill and Curtis creeks and other nearby areas with open wetlands and adjacent forest in Three Rivers is essential for maintaining the species at this site. Similar to the Eastern Massasauga, the Eastern Box Turtle and Blanding's Turtle may be vulnerable to certain habitat management activities, such as prescribed burning. Habitat management activities can be implemented so as to minimize potential adverse impacts to these species based on currently available information and management techniques.

Habitat fragmentation, roads and road mortality, nest predation, and illegal collection may be potential additional threats facing the Blanding's Turtle and Eastern Box Turtle populations in Crane Pond and Three Rivers. 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 protecting nest sites are potential management strategies that could help increase recruitment. Roads/road mortality also can pose a substantial threat to Eastern Box Turtles and Blanding's Turtles particularly because of the Blanding's Turtle's tendencies to migrate long distances over land (Harding pers. comm.). These turtle species also are vulnerable to collection for pets, personal collections, or the pet trade (Harding 1997). These populations may be particularly vulnerable to collection because they are 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.

The new Blanchard's Cricket Frog occurrence that was documented at Allen Lake in Crane Pond in 2009 is significant given the status of this species and limited number of known extant sites in the state. The status of the Blanchard's Cricket Frog was recently elevated to State Threatened (Michigan DNR 2009). This species has declined dramatically in southern Michigan, with less than 5 known extant sites in southeast Michigan and less than 30 known extant sites in southwest Michigan (MNFI 2009). Blanchard's Cricket Frogs inhabit the open edges of permanent ponds, lakes, floodings, bogs, seeps, and slow-moving streams and rivers (Harding 1997). They prefer open or partially vegetated mud flats, muddy or sandy shorelines, and mats of emergent aquatic vegetation in shallow water (Harding 1997). Quiet, permanent water is essential for this species (Harding 1997, Lee et al. 2000). Cricket frogs also are the most aquatic of North American treefrogs, rarely leaving the vicinity of water after the breeding season except during rainy or wet conditions (Oldham and Campbell 1986). In addition to habitat loss, water pollution, vegetative succession, stocking of previously fishless lakes and ponds with fish, and competition and predation from bullfrogs are additional potential threats to this species (Lee et al. 2000).

In addition to the rare herp species, a number of other herp species were found in the state game areas during surveys in 2009, 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, which was found along Mill Creek in Three Rivers, prefers cool, clear waters, and is intolerant of pollution (Harding 1997). Many of the frogs and salamanders were found in forested and open canopy vernal pools and adjacent forested habitats in the game areas. 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). Identification and protection of vernal pools are essential for maintaining healthy and diverse amphibian and reptile populations in the game areas 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 salamanders, such as the Blue-spotted and Eastern Tiger Salamanders found in Crane Pond, 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.

Finally, additional surveys and monitoring are needed to determine the size, extent, and viability of the populations of rare herp species that have been documented at Crane Pond and Three Rivers. Because many herp species are cryptic and can be difficult to detect, particularly if they are rare, additional surveys to identify occurrences of rare herps in these game areas should be conducted In particular, surveys should target the Copperbelly Water Snake, especially at Crane Pond, and the Gray Ratsnake, and Spotted Turtle. The Kirtland's Snake is very difficult to detect, and the Marbled Salamander has not been reported in the state since the mid- to late 1980's and may be extirpated. However, there appears to be suitable habitat for these species to occur in these game areas, so additional surveys could continue to look for these species. Additional, targeted surveys for the Blanding's Turtle, Eastern Box Turtle, and Gray Ratsnake in Fabius also are warranted based on available habitats at this site. Additional surveys also are needed to determine the current status of Eastern Massasaugas at Crane Pond. Although recent surveys in 2009 and in 2003 and 2004 were unable to document this species in the game area, suitable habitat appears to still be available at the previously known site and in several small patches within the game area. Thus, there is still potential for massasaugas to occur at Crane Pond.

Butterfly and Moth Discussion

Two rare moth species, maritime sunflower borer and golden borer, were recorded in the game areas during blacklighting surveys. These two species occur in a variety of natural habitats including prairie fen and southern wet meadow communities. Any management that benefits the community and host plants would be appropriate for these species. It will be important to maintain the natural hydrology of any fen or wet meadow communities within the game areas. 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 open-water use likely will be needed. Additional surveys and monitoring efforts to further document the extent, viability, and response of the 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

There is presently limited potential for rare leafhoppers or spittlebugs to occur within the game areas. 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 Aquatic Animal Discussion and Recommendations

There are 45 species of unionid mussel native to Michigan. Of conservation significance is that a relatively large proportion (>25%) of Michigan's unionid mussel species are represented in this one small watershed. The state threatened slippershell is strongly associated with headwater and small streams. The ellipse (species of special concern) is also usually found in smaller streams. Round pigtoe is normally found in larger streams and rivers. The round pigtoe shell found in Mill Creek could be a chance occurrence made possible by the close proximity of the St. Joseph River. The St. Joseph is a large, species rich system that may provide the Mill Creek watershed with source populations for unionids and their fish hosts.

Throughout its range in Michigan, slippershell occurrences are most often represented by empty shells. The status

of this species was recently changed from species of special concern to state threatened in large part due to the low number of sites in Michigan (22), where live individuals have been found in recent years. Though only three live slippershells were found at Sites 3 and 4, these are significant occurrences for the status of the species in Michigan. The ellipse population found in Mill Creek (Sites 3 and 4) was relatively dense. This species also has relatively few recently documented occurrences of live individuals in Michigan (19). It was not surprising that the only unionid species found at the uppermost Mill Creek site (Site 5) was cylindrical papershell (*Anodontoides ferussacianus*). Unlike the majority of unionids, this species is tolerant of high levels of silt, and the substrate at Site 5 had the highest proportion of silt of any of the sites (70%). Cylindrical papershell is designated as a Species of Greatest Conservation Need (SGCN) in the Michigan Wildlife Action Plan, along with the slippershell and all mussel species of special concern. The watercress snail is also a SGCN.

Mussel species richness was higher at the two lower Mill Creek sites (3 and 4) than sites further upstream in the smaller tributaries. A positive correlation between mussel species richness, fish species richness, and stream size has been previously documented (Watters 1992). Gastropod species richness was also higher at the two lower sites in Mill Creek than sites in the smaller tributaries.

Repairs of the Preston Rd. bridge over Mill Creek could help prevent excessive siltation. A small rainfall drainage gully has formed on the bridge. Fine sediments, sand, and gravel from the dirt road are washing off the bridge into the stream. This erosion could have an effect on substrate composition and negatively impact populations of unionid mussels, fish, and other aquatic taxa.

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 Mill Creek that are too small for boats, canoes, etc., can act as refugia for native unionid mussels. Preventing the introduction of dreissenids into the Mill Creek watershed can help ensure that present unionid populations will persist into the future.

For unionid mussels, the main mechanism for gene flow among populations and migration to new habitats is the movement of host fish while mussels are in the larval stage. In the long term, unionid populations within Three Rivers are reliant on the passage of fish within the Mill Creek watershed and between the Mill Creek watershed and the St. Joseph River. Barriers to fish host movement are also barriers to unionid mussels (Watters 1995). Being a much larger and more species rich system, the St. Joseph may act as a source for host fish and unionids. Thus, barriers to fish passage, such as dams, can prevent gene flow and migration between the St. Joseph River and unionid mussel populations in Three Rivers. 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).

Survey Effort Discussion

Natural community surveys focused on areas that had remained structurally unchanged between 1938 and 2005 (Figure 4). Although we had good coverage of these upland and lowland forested and non-forest stands, future survey work could focus on identifying natural community element occurrences of inundated shrub swamp and additional stands of dry-mesic southern forest. Crane Pond and Three Rivers have many small buttonbush depressions (i.e., inundated shrub swamps) that often occur in clusters within stands of mesic southern forest and dry-mesic southern forest. Because our survey efforts concentrated on covering a maximum amount of ground and evaluating many small depressions is both time-consuming and yields very little coverage area, this community type was probably under surveyed. Although all stands of dry-mesic southern forest present in 1938 and today were surveyed, only a select few (4) were documented as element occurrences. While the overstories of most of these forests support large-diameter oaks and hickories, their understories were typically dominated by shade-tolerant maples, and invasive shrubs and herbs were often common. Further dedicated survey efforts to document current conditions and delineate additional element occurrences of dry-mesic southern forest would be of value, especially at Crane Pond.

Because many rare animal species are also cryptic and can be difficult to detect, additional surveys to identify occurrences of rare animals in these game areas should be conducted. For birds, the survey effort was focused on raptors and forested songbirds that require 50% or greater canopy coverage (Figure 5). Additional surveys for rare grassland, shrubland, or wetland birds are warranted, although habitat may be a bit limited. Insects can be one of the most difficult groups to survey for due to their short adult lifespan, very specific habitat/host plant requirements, and reluctance to be active during certain weather conditions. Few insect surveys were carried out in Crane Pond and none were conducted at Fabius (Figure 7). Additional nights of blacklighting are recommended for both Crane Pond and Fabius. The general herp surveys (Figure 6) were widespread throughout all game areas but

additional targeted surveys should focus on the Copperbelly Water Snake (particularly at Crane Pond), Gray Ratsnake, and Spotted Turtle. There also appears to be suitable habitat for Marbled Salamander and Kirtland's Snake, two species which are extremely difficult to detect.

Aquatic animal surveys focused on unionid mussels and gastropods (snails) in Three Rivers and one site in Fabius (Figure 8). However, with additional resources, surveys for other taxanomic groups such as fish, aquatic insects, and other aquatic invertebrates could produce useful information. The lakes within Crane Pond SGA could also be surveyed for all these aquatic taxanomic groups. Additional mussel and gastropod survey sites in the main stem of Mill Creek would provide a better understanding of the size and health of the rare species and SGCN populations found there.

CONCLUSION

Surveys for high quality natural communities and rare terrestrial and aquatic animal species in Crane Pond, Three Rivers, and Fabius yielded 35 new element occurrences and allowed 19 previously identified records to be updated. Natural community surveys resulted in ten new natural community element occurrences and eleven new rare plant element occurrences (Tables 1 and 2). In addition, eleven previously identified natural community and four rare plant records were updated. Rare terrestrial animal surveys documented nine new rare animal element occurrences and five previously documented records were reconfirmed (Table 3). Surveys for rare aquatic animals documented five new occurrences, all within Three Rivers (Table 4).

Future surveys for inundated shrub swamp, dry-mesic southern forest, and rare song birds, herps, insects, unionid mussels, snails, fish, aquatic insects, and other aquatic invertebrates are likely to have some success based on this recent assessment of available habitat.

Primary management recommendations include implementing prescribed fire on a regular basis in fire-adapted community types such as dry-mesic southern forest, prairie fen, and southern wet meadow, and controlling and monitoring invasive plants (see Tables 5 and 6). Repairs of the Preston Road bridge over Mill Creek could help prevent excessive siltation and contribute to the long-term viability of at least four rare unionid mussels species (i.e., slippershell, round pigtoe, ellipse, and rainbow) and one rare snail (i.e., watercress snail) located directly downstream of the bridge.

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Appendix 1. State Lands Herp Survey Data Form 2009

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 Crane Pond, Three Rivers, and Fabius State Game Areas during MNFI surveys in 2009.

Amphibian/ Reptile	Common Name	Scientific Name	US Status	State Status	SGCN	Target Species	Crane Pond	Three Rivers	Fabius
Amphibian	Mudpuppy	*Necturus maculosus maculosus*			X				
Amphibian	Western Lesser Siren	*Siren intermedia nettingi*			X				
Amphibian	Eastern Newt	*Notophthalmus viridescens*					X		
Amphibian	Spotted Salamander	*Ambystoma maculatum*			X				
Amphibian	Blue-spotted Salamander	*Ambystoma laterale*			X		X		
Amphibian	Marbled Salamander	*Ambystoma opacum*		E	X	X			
Amphibian	Eastern Tiger Salamander	*Ambystoma tigrinum tigrinum*			X		X		
Amphibian	Red-backed Salamander	*Plethodon cinereus*					X		X
Amphibian	Four-toed Salamander	*Hemidactylium scutatum*			X				
Amphibian	Eastern American Toad	*Bufo americanus americanus*					X	X	
Amphibian	Blanchard's Cricket Frog	*Acris crepitans blanchardi*		T	X	X	X		
Amphibian	Western Chorus Frog	*Pseudacris triseriata triseriata*			X				
Amphibian	Northern Spring Peeper	*Pseudacris crucifer crucifer*					X	X	X
Amphibian	Gray Treefrog	*Hyla versicolor/Hyla chrysoscelis*					X	X	
Amphibian	Bullfrog	*Rana catesbeiana*					X	X	
Amphibian	Green Frog	*Rana clamitans melanota*					X	X	
Amphibian	Wood Frog	*Rana sylatica*					X	X	
Amphibian	Northern Leopard Frog	*Rana pipiens*		(SC)*	X			X	
Amphibian	Pickerel Frog	*Rana palustris*			X			X	
Reptile	Snapping Turtle	*Chelydra serpentina*					X	X	
Reptile	Eastern Musk Turtle	*Sternotherus odoratus*							
Reptile	Spotted Turtle	*Clemmys guttata*		T	X	X		PD	
Reptile	Eastern Box Turtle	*Terrapene carolina carolina*		SC	X	X		X	
Reptile	Blanding's Turtle	*Emydoidea/Emys blandingii*		SC	X	X	X	X	
Reptile	Northern Map Turtle	*Graptemys geographica*							
Reptile	Painted Turtle	*Chrysemys picta*			X		X	X	
Reptile	Eastern Spiny Softshell Turtle	*Apalone spinifera spinifera*							
Reptile	Five-lined Skink	*Emumeces fasciatus*							
Reptile	Northern Water Snake	*Nerodia sipedon sipedon*						X	
Reptile	Copperbelly Water Snake	*Nerodia erythrogaster neglecta*	LT	E	X	X		PD	
Reptile	Queen Snake	*Regina septemvittata*		(SC)*	X				
Reptile	Kirtland's Snake	*Clonophis kirtlandii*		E	X	X			
Reptile	Eastern Garter Snake	*Thamnophis sirtalis sirtalis*					X		X
Reptile	Northern Ribbon Snake	*Thamnophis sauritus septentrionalis*			X		X	X	
Reptile	Brown Snake	*Storeria dekayi*						X	
Reptile	Blue Racer	*Coluber constrictor*			X				
Reptile	Gray Ratsnake	*Pantherophis spiloides*		SC	X	X		PD	
Reptile	Eastern Milk Snake	*Lampropeltis triangulum triangulum*							
Reptile	Northern Ring-necked Snake	*Diadophis punctatus edwardsii*			X				
Reptile	Eastern Hog-nosed Snake	*Heterodon platirhinos*			X				
Reptile	Eastern Massasauga	*Sistrurus catenatus catenatus*	C	SC	X	X	PD	X	

Key:
Yellow highlighted species = Species that were documented during surveys in 2009
Blue highlighted species = Rare species that were documented during surveys in 2009 or previously documented.
U.S. Status: LT = Federally Threatened; C = Federal Candidate
State Status: E = Endangered; T = Threatened; SC = Special Concern; (SC)* = Proposed Special Concern, not finalized
PD = Species previously documented in game area but not observed during surveys in 2009.

Note: Species not highlighted had potential for occurring in the game areas and may, in fact, occur in the game areas but were not observed during surveys in 2009.

Appendix 4. Amphibian and reptile species that were documented in the Crane Pond State Game Area during MNFI surveys in 2009.

Amphibian/ Reptile	Common Name	Scientific Name	US Status	State Status	SGCN
Amphibian	Eastern Newt	*Notophthalmus viridescens*			
Amphibian	Blue-spotted Salamander	*Ambystoma laterale*			X
Amphibian	Eastern Tiger Salamander	*Ambystoma tigrinum tigrinum*			X
Amphibian	Red-backed Salamander	*Plethodon cinereus*			
Amphibian	Eastern American Toad	*Bufo americanus americanus*			
Amphibian	Blanchard's Cricket Frog	*Acris crepitans blanchardi*		T	X
Amphibian	Northern Spring Peeper	*Pseudacris crucifer crucifer*			
Amphibian	Gray Treefrog	*Hyla versicolor/Hyla chrysoscelis*			
Amphibian	Bullfrog	*Rana catesbeiana*			
Amphibian	Green Frog	*Rana clamitans melanota*			
Amphibian	Wood Frog	*Rana sylatica*			
Reptile	Snapping Turtle	*Chelydra serpentina*			
Reptile	Painted Turtle	*Chrysemys picta*			X
Reptile	Blanding's Turtle	*Emydoidea/Emys blandingii*		SC	X
Reptile	Eastern Garter Snake	*Thamnophis sirtalis sirtalis*			
Reptile	Northern Ribbon Snake	*Thamnophis sauritus septentrionalis*			X
Reptile	Eastern Massasauga*	*Sistrurus catenatus catenatus*	C	SC	X

*Species was previously documented in the game area but was not observed during surveys in 2009.

Appendix 5. Amphibian and reptile species that were documented in the Three Rivers State Game Area during MNFI surveys in 2009.

Amphibian/ Reptile	Common Name	Scientific Name	US Status	State Status	SGCN
Amphibian	Eastern American Toad	*Bufo americanus americanus*			
Amphibian	Northern Spring Peeper	*Pseudacris crucifer crucifer*			
Amphibian	Gray Treefrog	*Hyla versicolor/Hyla chrysoscelis*			
Amphibian	Bullfrog	*Rana catesbeiana*			
Amphibian	Green Frog	*Rana clamitans melanota*			
Amphibian	Wood Frog	*Rana sylatica*			
Amphibian	Northern Leopard Frog	*Rana pipiens*		(SC)*	X
Amphibian	Pickerel Frog	*Rana palustris*			X
Reptile	Snapping Turtle	*Chelydra serpentina*			
Reptile	Spotted Turtle*	*Clemmys guttata*		T	X
Reptile	Eastern Box Turtle	*Terrapene carolina carolina*		SC	X
Reptile	Blanding's Turtle	*Emydoidea/Emys blandingii*		SC	X
Reptile	Painted Turtle	*Chrysemys picta*			X
Reptile	Northern Water Snake	*Nerodia sipedon sipedon*			
Reptile	Copperbelly Water Snake*	*Nerodia erythrogaster neglecta*	LT	E	X
Reptile	Northern Ribbon Snake	*Thamnophis sauritus septentrionalis*			X
Reptile	Brown Snake	*Storeria dekayi*			
Reptile	Gray Ratsnake*	*Pantherophis spiloides*		SC	X
Reptile	Eastern Massasauga	*Sistrurus catenatus catenatus*	C	SC	X

*Species were previously documented in the game area but were not observed during surveys in 2009.

Appendix 6. Amphibian and reptile species that were documented in the Fabius State Game Area during MNFI surveys in 2009.

Amphibian/ Reptile	Common Name	Scientific Name	US Status	State Status	SGCN
Amphibian	Red-backed Salamander	*Plethodon cinereus*			
Amphibian	Northern Spring Peeper	*Pseudacris crucifer crucifer*			
Reptile	Eastern Garter Snake	*Thamnophis sirtalis sirtalis*			

Appendix 7. Locations of survey sites for unionid mussels and gastropods (snails) in the Three Rivers and Fabius State Game Areas.

Site Number	SGA	Stream	Access	Latitude (N)	Longitude (W)
1	Three Rivers	Wood Creek	Norton Rd.	41.86195	-85.76305
2	Three Rivers	Wood Creek	Norton Rd.	41.86260	-85.76206
3	Three Rivers	Mill Creek	trail west of Purgatory Rd.	41.85969	-85.75427
4	Three Rivers	Mill Creek	trail west of Purgatory Rd.	41.86082	-85.75450
5	Three Rivers	Mill Creek	Preston Rd.	41.87408	-85.74562
6	Three Rivers	Curtis Creek	Preston Rd.	41.87627	-85.75585
7	Three Rivers	Curtis Creek	Preston Rd.	41.87496	-85.75358
8	Fabius	St. Joseph River	trails off of US-131	41.90478	-85.65358

Appendix 8. Scientific and common names of unionid mussels found in the Three Rivers and Fabius State Game Areas. Numbers of unionids (#), relative abundance (RA), and density (D, indvs./m2) recorded at each site. (L=live individuals; S=species represented by shell only; T=state listed as threatened; SpC=species of special concern)

		Wood Creek						Mill Creek								
		1			2			3			4			5		
Common name	Species	#	RA	D	#	RA	D	#	RA	D	#	RA	D	#	RA	D
Slippershell	*Alasmidonta viridis* (T)							3	0.05	0.02	3	0.05	0.02			
Cylindrical papershell	*Anodontoides ferussacianus*	S						S						3	1.00	0.02
Spike	*Elliptio dilatata*	S						6	0.10	0.05	2	0.04	0.02			
Wabash pigtoe	*Fusconaia flava*	4	0.57	0.03	34	0.92	0.27	13	0.22	0.10	6	0.11	0.05			
Fatmucket	*Lampsilis siliquoidea*				1	0.03	0.01									
Pocketbook	*Lampsilis ventricosa*	1	0.14	0.01							1	0.02	0.01			
Fluted-shell	*Lasmigona costata*							S								
Round pigtoe	*Pleurobema sintoxia* (SpC)							S(1)								
Giant floater	*Pyganodon grandis*	2	0.29	0.02	1	0.03	0.01									
Strange floater	*Strophitus undulatus*	S														
Ellipse	*Venustaconcha ellipsiformis* (SpC)							38	0.63	0.30	45	0.79	0.35			
Rainbow	*Villosa iris* (SpC)	S			1	0.03	0.01	S(1)								
	Total # individuals and density	7		0.05	37		0.29	60		0.47	57		0.45	3		0.02
	# species live	3			4			4			5			1		
	# species live or shell	7			4			8			5			1		
	Area searched (m^2)	128			128			128			128			128		
Asian clam	*Corbicula fluminea*															
Zebra mussel	*Dreissena polymorpha*															

Table 8 continued

		Curtis Creek						St. Joseph R.		
		6			7			8		
Common name	Species	#	RA	D	#	RA	D	#	RA	D
Slippershell	*Alasmidonta viridis* (T)				S(1)					
Cylindrical papershell	*Anodontoides ferussacianus*									
Spike	*Elliptio dilatata*									
Wabash pigtoe	*Fusconaia flava*									
Fatmucket	*Lampsilis siliquoidea*									
Pocketbook	*Lampsilis ventricosa*									
Fluted-shell	*Lasmigona costata*									
Round pigtoe	*Pleurobema sintoxia* (SpC)									
Giant floater	*Pyganodon grandis*									
Strange floater	*Strophitus undulatus*									
Ellipse	*Venustaconcha ellipsiformis* (SpC)									
Rainbow	*Villosa iris* (SpC)							S(1)		
	Total # individuals and density	0		0.00	0		0.00	0		0.00
	# species live	0			0			0		
	# species live or shell	0			1			1		
	Area searched (m^2)	128			128			128		
Asian clam	*Corbicula fluminea*							S		
Zebra mussel	*Dreissena polymorpha*							L		

Appendix 9. Scientific and common names of aquatic gastropods (snails) found in the Three Rivers and Fabius State Game Areas (Sites 2, 4, & 6-8).

		Wood Creek	Mill Creek	Curtis Creek		St. Joseph R.
Common name	Species	2	4	6	7	8
Mud amnicola	*Amnicola limosus*		x			
Pointed campeloma	*Campeloma decisum*		x			x
Liver elimia	*Elimia livescens*	x	x			
Watercress snail	*Fontigens nickliniana* (SpC)		x			
Disc gyro	*Gyraulus circumstriatus*		x			
Flexed gyro	*Gyraulus deflectus*		x			
Tuba gyro	*Gyraulus hornensis*		x			
Ash gyro	*Gyraulus parvus*		x	x		
Two-ridge rams-horn	*Helisoma anceps*	x	x	x	x	
Boreal marstonia	*Marstonia lustrica*	x	x			
Blunt ambersnail	*Oxyloma retusa*		x			
Tadpole physa	*Physella gyrina*	x	x			
Bellmouth rams-horn	*Planorbella campanulata*	x				
Marsh rams-horn	*Planorbella trivolvis*		x		x	
Two-ridge valvata	*Valvata bicarinata*		x			
Three-ridge valvata	*Valvata tricarinata*	x	x			

Appendix 10. Water chemistry measures.

Site	Stream	DO (mg/L)	pH	Temperature (°C)	Conductivity (µS)	Alkalinity (ppm)	Hardness (mg/L)
2	Wood Creek	9.56	8.26	22.4	410	360	280
3	Mill Creek	10.85	8.45	19.6	420	480	300
4	Mill Creek	10.15	8.15	18.8	442	400	272
5	Mill Creek	7.78	7.83	20.1	470	440	380
6	Curtis Creek	9.50	8.30	16.0	414	368	280
7	Curtis Creek	9.40	8.10	13.9	454	380	260
8	St. Joseph River	8.23	8.13	21.5	482	332	260

Appendix 11. Substrate composition and stream habitat type for each survey site.

Site	Stream	Boulder	Cobble	Pebble	Gravel	Sand	Silt	Pool	Riffle	Run
1	Wood Creek			10	5	45	40			100
2	Wood Creek				5	50	45	10		90
3	Mill Creek			10	30	30	30			100
4	Mill Creek			5	20	40	35			100
5	Mill Creek				5	25	70			100
6	Curtis Creek	15	30	30	15	10		20	50	20
7	Curtis Creek			10	40	40	10	10	5	85
8	St. Joseph River					50	50	100		

Appendix 12. Taxa observed incidentally while performing surveys for unionid mussels and aquatic gastropods.

	Site							
Species	1	2	3	4	5	6	7	8
Mottled sculpin, *Cottus bairdii*	x		x	x				
Iowa darter, *Etheostoma exile*						x		
Johnny darter, *Etheostoma nigrum*	x		x		x	x		
Snapping turtle, *Chelydra serpentina*	x							
N. watersnake, *Nerodia sipedon sipedon*						x		
Cooper's hawk, *Accipiter cooperii*						x		
Crayfish				x	x	x		