

Natural Features Inventory and Management Recommendations for Port Huron State Game Area



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Cover Photo: Port Huron Mesic Northern Forest at sunrise in early May, 2011 (Photo by John Fody).

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EXECUTIVE SUMMARY

During 2010 and 2011, Michigan Natural Features Inventory conducted IFMAP (DNR's Integrated Forest Monitoring, Assessment, and Prescription System) Stage 1 inventory and surveys for high quality natural communities and rare animal species in the Port Huron State Game Area (PHSGA) as part of the Integrated Inventory Project. The surveys resulted in 17 new element occurrences (EOs) and provided information for updating an additional 21 EOs. In all, 38 species of greatest conservation need (SGCN) were documented including 19 rare animal species.

Surveys for exemplary natural communities relied on information collected during IFMAP Stage 1 inventories in 2010 to help target the locations of potential new natural community EOs. The natural community surveys resulted in four new EOs for the following communities: dry-mesic northern forest, floodplain forest, southern hardwood swamp, and inundated shrub swamp. In addition, a previously documented EO of northern mesic forest was updated and remapped. Rare plants encountered during natural community surveys were also documented, resulting in three new EOs and four updated records. New rare plant EOs included heart-leaved plantain (*Plantago cordata*, state endangered), Canadian milk vetch (*Astragalus canadensis*, state threatened), and downy sunflower (*Helianthus mollis*, state threatened); and updates were processed for painted trillium (*Trillium undulatum*, state endangered), goldenseal (*Hydrastis canadensis* state threatened), beak grass (*Diarrhena obovata*, state threatened), wahoo (*Euonymus atropurpurea*, state special concern), and broad-leaved pucoon (*Lithospermum latifolium*, state special concern).

Surveys for rare avian species included conducting 146 songbird point counts and 175 red-shouldered hawk point counts in forested habitats throughout the game area, targeted surveys of open grasslands and wetlands, and searches for great blue heron rookeries. The surveys resulted in three new EOs and six updated records. New occurrences were documented for grasshopper sparrow (*Ammodramus savannarum*, state special concern), American bittern (*Botaurus lentiginosus*, state special concern, DNR featured species), and a great blue heron rookery; and updates were processed for the following six species: red-shouldered hawk (*Buteo lineatus*, state threatened, DNR featured species) marsh wren (*Cistothorus palustris*, state special concern), cerulean warbler (*Dendroica cerula*, state threatened), Louisiana waterthrush (*Seiurus motacilla*, state threatened), hooded warbler (*Wilsonia citrina*, special concern), and a great blue heron rookery. Including the rare bird species mentioned above, a total of 22 avian SGCN were documented on the game area during the 2011 breeding season.

Surveys for rare amphibians and reptiles included visual encounter or meander surveys, trapping with aquatic funnel traps, egg mass surveys, basking turtle surveys, and breeding frog call surveys. Surveys resulted in one new EO for Blanding's turtle (*Emydoidea blandingii*, state special concern), one EO update for Blanchard's cricket frog (*Acris crepitans blanchardi*, state threatened), and documentation of two salamander and one frog SGCN.

Surveys for rare unionid mussels were conducted at 10 sites, seven in the Black River and three in Mill Creek, and utilized a combination of visual and tactile searches. Results included documenting six new EOs for the following species: purple wartyback (*Cyclonaias tuberculata*, state threatened), black sandshell (*Ligumia recta*, state endangered), three-horned wartyback (*Obliquaria reflexa*, state endangered), kidney shell (*Ptychobranhus fasciolaris*, state special concern), deertoe (*Truncilla truncata*, state special concern), and rainbow (*Villosa iris*, state special concern). In addition, updated records were processed for the following six mussel species: elktoe (*Alasmidonta marginata*, state special concern), slippershell (*Alasmidonta viridis*, state threatened), wavy-rayed lampmussel (*Lampsilis fasciola*, state threatened), round hickorynut (*Obovaria subrotunda*, state endangered), rayed-bean (*Villosa fabalis*, federally and state endangered), and rainbow (*Villosa iris*, state special concern). Lastly, two additional non-listed mussel SGCN were documented, cylindrical papershell (*Anodontoides ferussacianus*) and pimpleback (*Quadrula pustulosa*).

Surveys for rare tree crickets were conducted at four sites utilizing sweep nets of the lower branches of hemlock and occasionally other conifers. Although unknown species of tree crickets were frequently heard calling from the upper branches of nearby trees, none were captured for identification. Additional surveys are needed to determine if rare tree crickets occur in the game area.

Because the landscape surrounding PHSGA is dominated by agriculture and rural residential development, the large area of forest within the game area serves as an important island of biodiversity for the local region. With over 2,100 acres (>850 ha) of high quality forest and numerous acres of younger forest, the game area provides critical habitat to many forest-dependent species, including many rare species and SGCN, and the following five DNR featured species: red-shouldered hawk, wood thrush (*Hylocichla mustelina*), black-throated blue warbler (*Setophaga caerulescens*), golden-winged warbler (*Vermivora chrysoptera*), and eastern red-backed salamander (*Plethodon cinereus*). In all, over 60 bird species were documented while conducting surveys within the forests at PHSGA during the 2011 breeding season including 4 rare species and an additional 13 SGCN. In addition, these forests provide habitat to at least 9 rare plants, one rare turtle, and two salamander and one frog SGCN. Lastly, although they were not documented as breeding within

the game area, bald eagles (*Haliaeetus leucocephalus*, state special concern) and osprey (*Pandion haliaetus*, state special concern, DNR featured species) were occasionally observed foraging and perching in the Black River corridor within the game area. Maintaining the forest canopy will help ensure that high quality habitat remains for this diverse array of forest-dependent species.

By preventing erosion, filtering runoff, and providing shade, these forests also serve to protect the water quality of the Black River, Mill Creek, and their many headwater tributary streams. This is an extremely valuable ecological function given the statewide and national importance of the mussel fauna of the PHSGA. The stretches of the Black River and Mill Creek that flow through the PHSGA support over half (54%) of all unionid mussel species known to occur in Michigan, including 11 rare species, and one of these species, the rayed-bean, is listed as federally endangered. Efforts to protect the water quality of the Black River and Mill Creek and prevent the invasion of the exotic zebra mussel are critically important to the long-term viability of these species.

Primary management recommendations for the PHSGA include 1) maintaining the forest canopy, 2) controlling invasive plant species, 3) reducing soil erosion and runoff into the Black River, Mill Creek, and their headwater tributary streams within the many ravines, 4) and encouraging boaters to avoid accidentally introducing the zebra mussel (*Dreissena polymorpha*) to the Black River and Mill Creek by washing and drying their equipment (e.g., boats, canoes, kayaks, waders, bait buckets, etc.) before using it in the watershed. In addition, occasionally conducting prescribed burns within the dry-mesic northern forests will help bolster plant diversity, control invasive woody plants, and facilitate oak and pine regeneration. Lastly, maintaining the open structure of the grasslands and wetlands in the northwestern portion of the game area (Compartment 3, Stands 1, 2, 3, and 4) will provide critical habitat to the three rare bird and one rare herp species that inhabit this area.

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INTRODUCTION

In 2010 and 2011, Michigan Natural Features Inventory (MNFI) conducted IFMAP (Integrated Forest Monitoring, Assessment, and Prescription System) Stage 1 inventory and surveys for exemplary natural communities and rare animals in the Port Huron State Game Area (PHSGA) as part of the Integrated Inventory Project. This project is part of a long-term effort by the Michigan Department of Natural Resources (DNR) Wildlife Division to document and sustainably manage areas of high conservation significance on state lands. This report summarizes the findings of MNFI's 2010 and 2011 surveys of the PHSGA.

The regional landscape ecosystems of Michigan have been classified and mapped based on an integration of climate, physiography, soils, and natural vegetation (Albert 1995) (Figure 1). This classification system can be useful for conservation planning and integrated resource management because it provides a framework for understanding the distribution patterns of species, natural communities, anthropogenic activities, and natural disturbance regimes. The classification has a nested, hierarchical structure composed of sections, subsections, and sub-subsections. The PHSGA occurs within the Sandusky Lake Plain Sub-subsection (VI.5.1) of the Huron Subsection (VI.5) of the Southern Lower Michigan Section (VI) (Albert 1995) (Figure 1).

The Sandusky Lake Plain Sub-subsection is characterized by broad expanses of relatively level clay lakeplain near the shores of Lake Huron and the Saginaw Bay and areas of rolling ground moraine (i.e., till plain) and end moraine further inland. In addition, the sub-subsection contains large areas of sand lakeplain, narrow bands of sandy glacial outwash, and low dune ridges that occur both near Lake Huron and the Saginaw Bay, as well as much farther inland. Paralleling the Lake Huron shoreline are several long and narrow end and ground moraines. The thickness of the glacial drift in the area of the PHSGA generally ranges from approximately 150 to 250 ft (50 to 75 m) in depth (Akers 1938). Underlying the glacial drift is Devonian-aged bedrock comprised chiefly of shale and sandstone (i.e., Antrim Shale and Berea Sandstone and Bedford Shale) (Dorr and Eschman 1984, Milstein 1987).

The PHSGA is located approximately six miles inland from Lake Huron and the St. Clair River. It is situated on a clay lakeplain between two long, linear end moraines that parallel the Lake Huron shoreline. The Black River, a major tributary to Lake Huron, flows southward through the game area between these end moraines and is joined by Mill Creek, which flows westward into the Black River

near the center of the game area. Although the majority of the game area is located on a clay lakeplain, a deep layer of sand covers the clay. Consequently, soils range from being well drained to poorly drained depending on the season, the thickness of the sand layer, and the overall morphology of the underlying clay layer. The clay layer can be seen outcropping along the lower side walls and bottoms of many of the deep ravines that lead to the Black River. Small portions of the game area also occur on end moraines. The end moraine along the east side of the game area is comprised of fine-textured glacial till. The moraine in the southwest portion of the game area is comprised of coarse-textured glacial till and is bisected in two locations by low dune ridges. In general, fine-textured glacial till tends to support richer soils than coarse-textured sediments and sand dunes.

Circa 1800s Vegetation

In 1822 and 1823, surveyors from the General Land Office (GLO) recorded information on the tree species composition, tree size, and general condition of the lands within and surrounding the PHSGA. Abundant tree species recorded by the GLO surveyors in the uplands of this area included American beech (*Fagus grandifolia*), sugar maple (*Acer saccharum*), Eastern hemlock (*Tsuga canadensis*), white pine (*Pinus strobus*), white oak (*Quercus alba*), white ash (*Fraxinus americana*), red maple (*Acer rubrum*), and paper birch (*Betula papyrifera*). Less frequently recorded trees were basswood (*Tilia americana*), American elm (*Ulmus americana*), red oak (*Quercus rubra*), black oak (*Q. velutina*), quaking aspen (*Populus tremuloides*), bigtooth aspen (*P. grandidentata*), ironwood (*Ostrya virginiana*), black cherry (*Prunus serotina*), and hickory (*Carya* spp.).

One of the most striking features of the GLO notes for this area is the great abundance of large-diameter white pines. White pines were regularly recorded measuring more than 30 inches (76 cm) in diameter at breast height (DBH) and many were 40 inches (102 cm) DBH or larger. Two white pines were particularly large, with one measuring 60 inches (152 cm) DBH and the other 58 inches (147 cm) DBH. Large diameter (30 inches [76 cm] or larger) hemlock, white oak, and American elm were also occasionally recorded.

Interpretations of the GLO surveyor notes by MNFI ecologists indicated that the area contained several distinct vegetation assemblages (Comer et al. 1995). The matrix community type covering much of the area was mapped by MNFI as Beech-Sugar Maple Forest (Figure 2). However, a review of the tree species recorded by the GLO surveyors

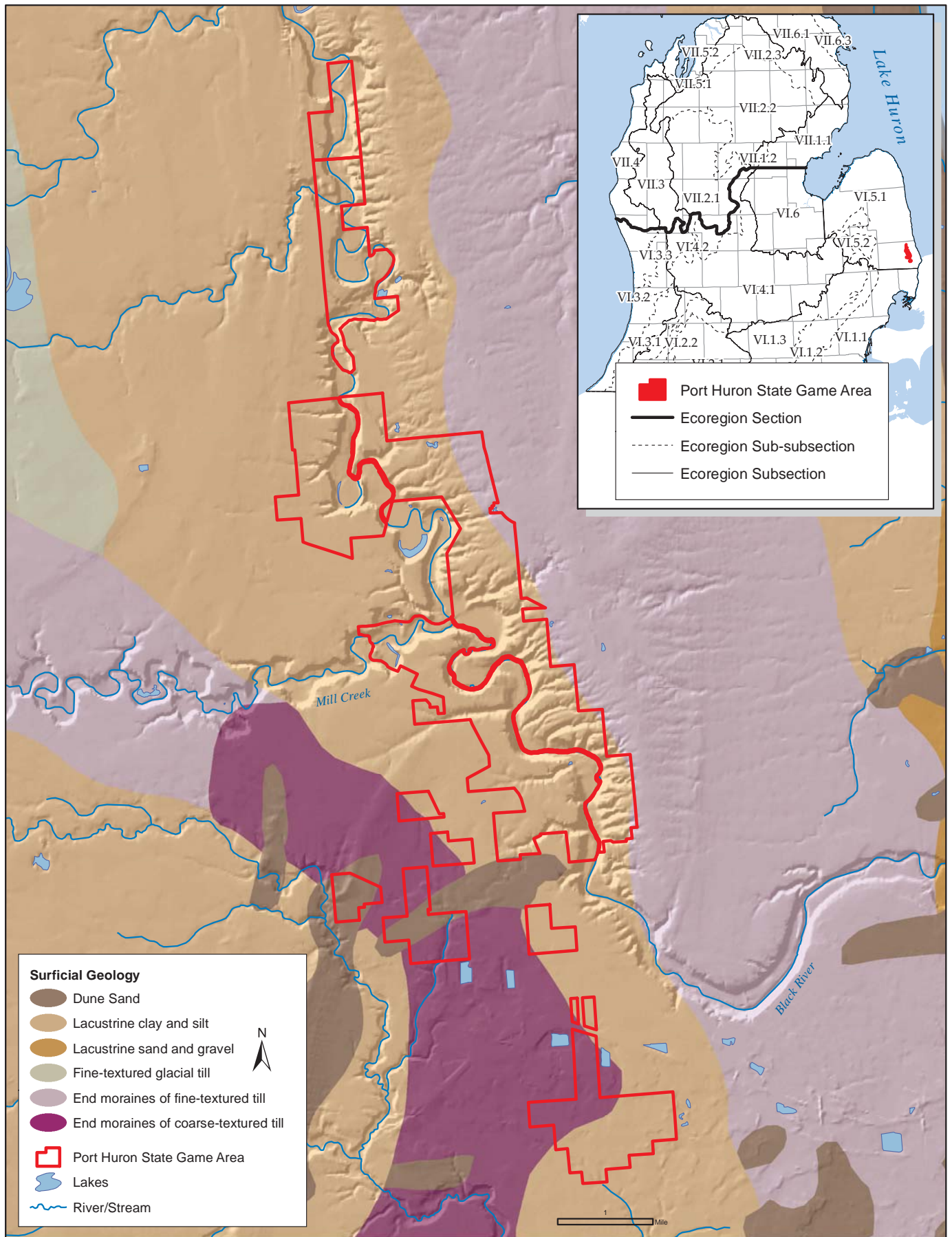


Figure 1. Ecoregions and surficial geology with relief.

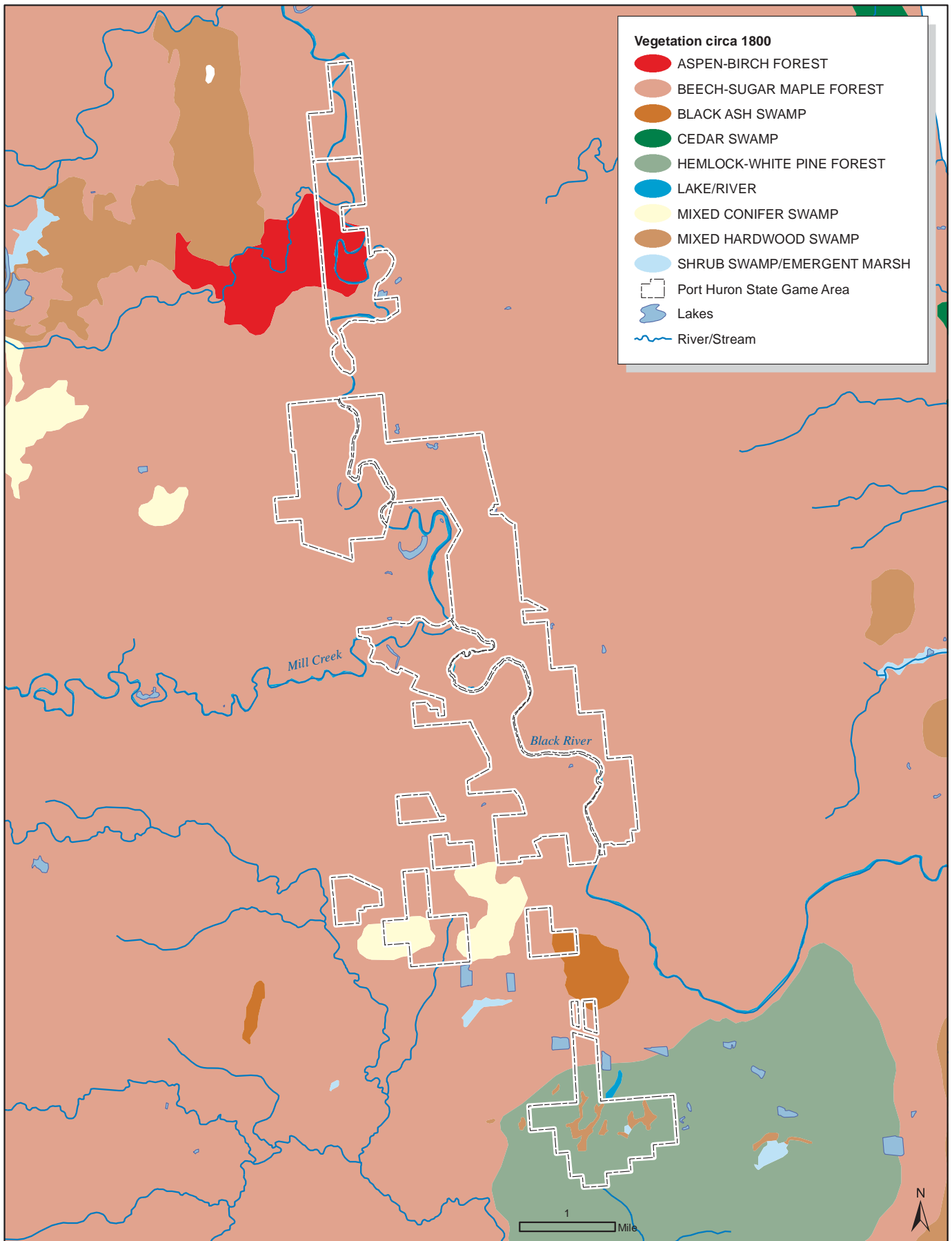


Figure 2. Circa 1800s vegetation (Comer et al. 1995).

indicates that in addition to beech and sugar maple, white pine was also very common, and hemlock was frequently recorded in the ravines near the Black River.

A large area of Hemlock-White Forest was mapped by MNFI in the far southern portion of the game area located south of I-69 and the town of Wadhams. This area had a very high concentration of hemlock and white pine along with abundant black ash (*Fraxinus nigra*), beech, and birch, and occasional white oak and basswood.

A large area mapped as Aspen-Birch Forest occurred in the northwest portion of PHSGA and extended westward for approximately one mile. This forest type may have originated in the wake of a large blowdown, which were common in this area of the Sandusky Clay Plain because of its high water table and close proximity to Lake Huron. The GLO notes for the area contain numerous references to blowdowns. For example, the following comments by the GLO surveyors indicate a massive blowdown had recently occurred just southwest of PHSGA between the towns of Kimball and Thornton (T6N, R16E sections 16, 17, 20, 21, and 28): “Pine fallen”; “Timber entirely fallen”; “No bearings [no bearing trees]”; “Timber fallen”; and “Timber nearly all fallen”. Common trees recorded in this area include white pine, hemlock, and beech. Further evidence of recent blowdown events near PHSGA in 1822-1823 are indicated by the GLO surveyor comments of “Pine wind fall” just east of the PHSGA and northeast of the town of Wadhams along a section and township line (T7N, R16E section 25 and T7N, R17E section 30) and “Much fallen timber” noted southeast of PHSGA and the town of Sparlingville (T6N, R16E section 13).

The GLO notes indicate that several large wetlands occurred in the south-central portion of PHSGA. The two wetlands shown in Figure 2 as Mixed Conifer Swamp were described by the GLO surveyors as “Mostly Spruce/Alder Swamp”, and the presence of black spruce (*Picea mariana*) was recorded in both of these wetlands. Additional trees noted within or near these swamps included white pine, beech, maple (likely red maple), and paper birch. Another wetland in this area was mapped by MNFI as a Black Ash Swamp because of the prevalence of black ash in the surveyor notes. Other species recorded in the Black Ash Swamp included bigtooth aspen and black gum (*Nyssa sylvatica*). Additional wetland plants recorded by the GLO surveyors from PHSGA or the surrounding area included American elm, sycamore (*Platanus occidentalis*), ash (likely green ash [*Fraxinus pensylvanica*]), tamarack (*Larix laricina*), spicebush (*Lindera benzoin*), and maple (species not recorded). Currently, black maple (*Acer nigrum*) and silver maple (*Acer saccharinum*) are common in the floodplain forests along the Black River and both

were likely present in the 1800s. Although it is not shown in Figure 2, several areas of floodplain forest were likely present in the 1800s along the Black River.

Current Vegetation Cover

The current vegetation at PHSGA primarily consists of a heterogeneous forest that supports several ecologically distinct forest types set within an agriculturally dominated landscape (MDNR 2003) (Figure 3). Scattered throughout the game area are small open habitats maintained by mowing or farming (e.g., plowing, planting, crop rotation, etc.). Several large open habitats and small created wetlands are maintained in the north-central portion of the game area. Additionally, small, inundated depressions throughout the game area occasionally support inundated shrub swamp (Kost et al. 2007, Slaughter et al. 2010) dominated by buttonbush (*Cephalanthus occidentalis*).

The forest composition varies considerably based on soils, moisture, slope, aspect, elevation, and disturbance history. The relatively level clay lakeplain above the Black River Valley supports at least four distinct forest types.

- 1) Dry-mesic northern forest (Cohen 2002, Kost et al. 2007) dominated by white oak, red oak, red maple, and white pine occurs on very well-drained loamy sand and sandy loam soils. The diverse canopy of this forest also supports abundant shagbark hickory (*Carya ovata*), tulip tree (*Liriodendron tulipifera*), and occasional hemlock.
- 2) Mesic northern forest (Cohen 2000, Kost et al. 2007) dominated by sugar maple, beech, hemlock and white pine occurs on sandy loam soils on the level to gently sloping areas between the deep ravines (the latter of which are described below).
- 3) Hardwood-conifer swamp (Kost et al. 2007, Slaughter et al. 2007) dominated by red maple, red oak, white pine, and hemlock occurs on the poorly drained sandy loam to loamy soils. The high water table associated with this forest type results in frequent windfall, which over thousands of years, has led to the formation of a highly pronounced and nearly continuous pit-and-mound microtopography along the forest floor. During the early part of the growing season, the pits are flooded while the mounds remain dry, which results in high levels of plant and animal diversity.
- 4) Southern hardwood swamp (Kost et al. 2007, Slaughter et al. 2009) dominated by silver maple, red maple, and swamp white oak occurs in the inundated to very-poorly-drained shallow depressions on sapric peat (muck) and loam soils.

The deeply incised and very steeply sloping Black River Valley supports at least three distinct forest types. 1) The steep slopes above the Black River and deep ravines and support mesic northern forest (Cohen 2000, Kost et al. 2007) dominated primarily by hemlock but with abundant sugar maple and red oak. This forest type also occurs on

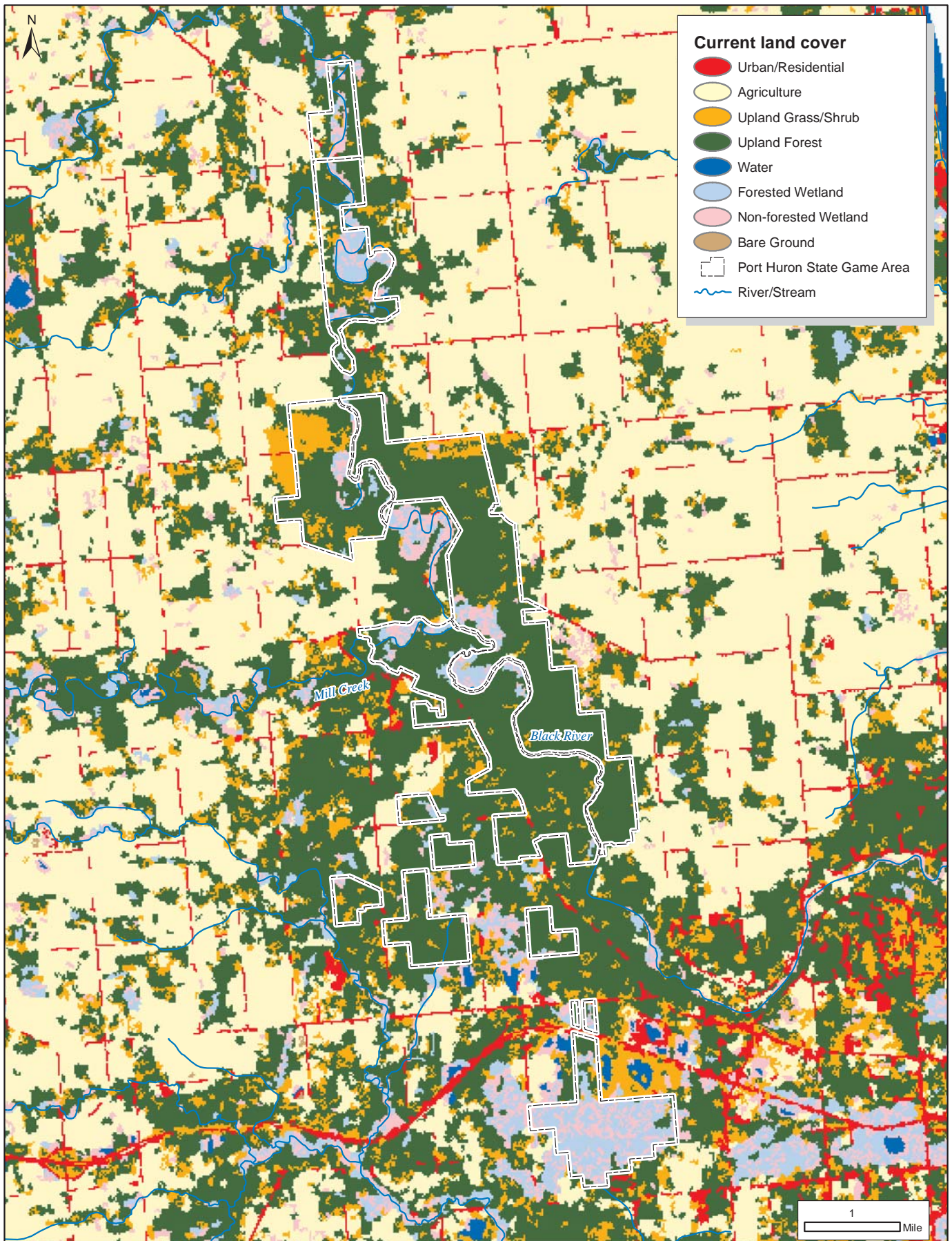


Figure 3. Current land cover (MDNR 2003).

some of the second bottoms of the Black River floodplain. In addition to northern mesic forest, the floodplains along the Black River support 2) floodplain forest (Tepley et al. 2004, Kost et al. 2007) dominated by black maple, bitternut hickory (*Carya cordiformis*), and basswood on second bottoms with moderately well drained, rich loamy soils, 3) as well as areas of floodplain forest dominated by silver

maple. The silver maple-dominated areas of floodplain forest sometimes occur in backswamps where prolonged inundation is common. These backswamps are typically associated with meander scars (former river channels) of the Black River. Within all the forest types noted above, dead standing ash trees are common as a result of infestation by the emerald ash borer.

METHODS

Throughout this report, all high quality natural communities and state and federally listed rare species are referred to as elements and their documented occurrence at a specific location is referred to as an element occurrence or “EO.”

The distribution of survey effort across the PHSGA is illustrated in Figures 4 to 7 for each survey target (i.e., high quality natural communities and rare birds, herps, insects, mollusks). Field work was facilitated by handheld PDAs containing a GIS database and GPS capability. The GIS database was designed to record both survey location and survey target (e.g., natural communities, rare species, species groups, etc.). The database was loaded on IPAQ brand PDAs, which were paired with Bluetooth receivers to allow recording of GPS locations. The IPAQ units were loaded with ArcPad and relevant GIS layers such as digital photos, state land boundaries, IFMAP Stage 1 stand boundaries, roads, element occurrence records, etc. IPAQ units and Bluetooth receivers were carried into the field to support data collection during field work. Garmin GPS units were also carried during field work and were occasionally used to ensure against electronic data loss. In addition, handwritten field notes were also routinely taken.

Natural Community Survey Methods

In 2010, IFMAP Stage 1 inventory was conducted at PHSGA. During the Stage 1 inventory, the entire game area was evaluated for potential natural community EOs (for descriptions and a list of Michigan natural communities see Kost et al. 2007). This information was then used to help target the location of field work during the natural community surveys. In addition, prior to the natural community surveys, the Biotics database was queried for pre-existing natural community EO records within a ten-mile radius of the PHSGA. The EO records were used to help determine targets for field survey. In addition to reviewing the natural community EOs within and near the game area, stand information contained in IFMAP and aerial images from 1938, 1998, and 2005 were reviewed and interpreted to determine the types of natural communities likely to be present. Comparisons among

1938, 1998, and 2005 aerial photos were then used to help select high priority stands for surveys. Stands that appeared to have remained structurally unchanged (e.g., remained forested) from 1938 to 2005 were given the highest priority for surveys. Field surveys for high quality natural community occurrences were conducted from 25 May to 13 September, 2011. Natural community field surveys were accomplished for all pre-existing EO records, for sites with little apparent structural change over time, for uncommon community types, and for stands deemed to have potential to significantly improve with restoration. Stands surveyed for natural communities are illustrated in Figure 4. Data collection focused on identifying and documenting new natural community EOs, updating information for a pre-existing EOs, and recording overall management concerns such as invasive species, evidence of fire suppression, hydrologic alteration, and excessive deer herbivory. Plant species lists were generated for all natural community EOs 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 and special plant and animal forms. In addition, photographs were taken to document the presence of natural communities and rare species.

Rare Animal Survey Methods

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

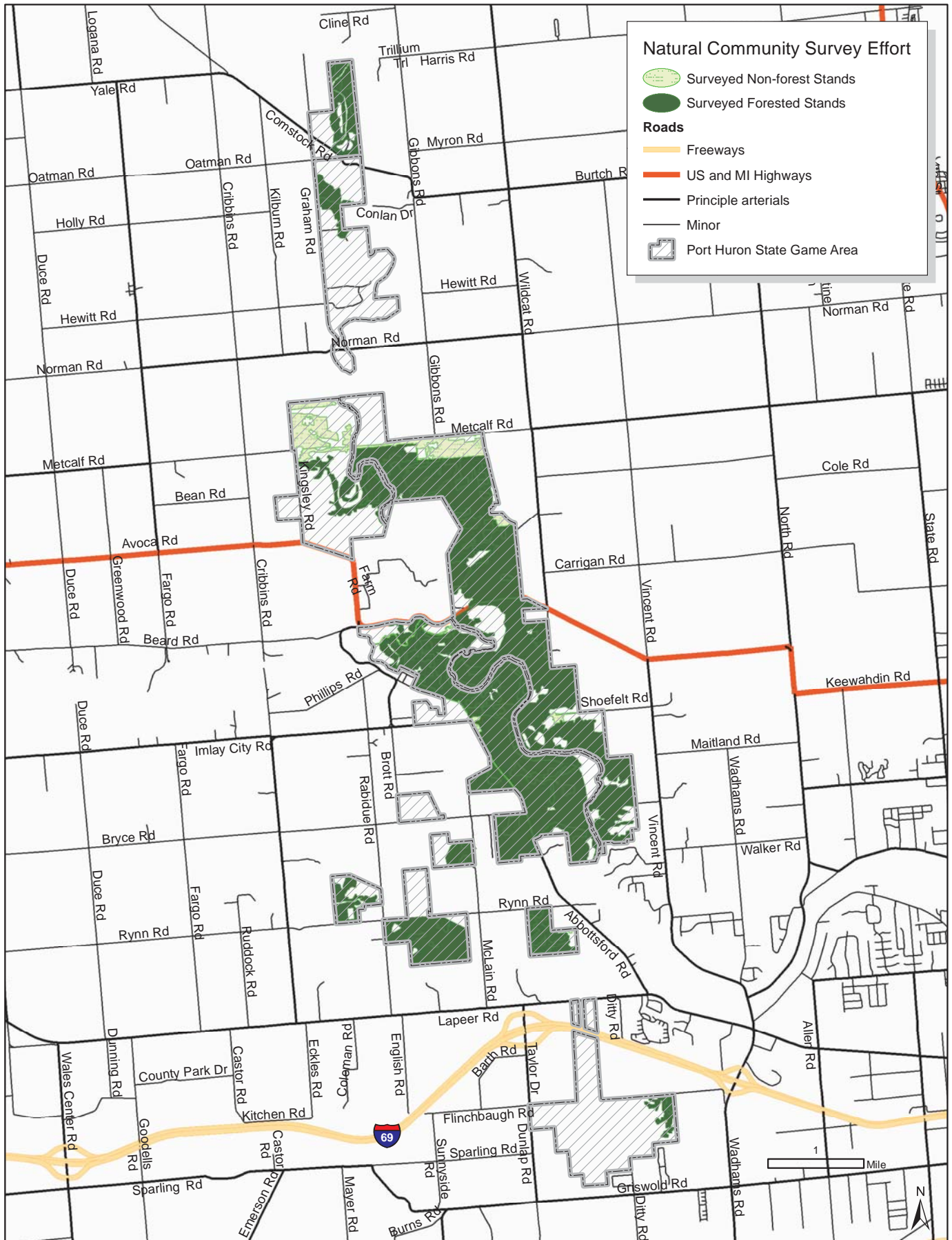


Figure 4. Natural community survey effort.

we also noted encounters with other Species of Greatest Conservation Need (SGCN) as listed in Michigan's Wildlife Action Plan (Eagle et al. 2005). Note that nearly all rare animal species in Michigan are included as SGCN in the Michigan Wildlife Action Plan (Eagle et al. 2005).

Avian Survey Methods

The game area contained substantial areas of forest, so surveys focused on red-shouldered hawk (*Buteo lineatus*, state threatened, DNR featured species) and rare forest songbirds. Surveys were also conducted in several open grasslands and wetlands. In addition, searches were made for great blue heron rookeries.

For surveys of rare forest songbirds and red-shouldered hawks, we placed point count stations within forested inventory stands with canopy closure rankings of 2 or 3 and at least 10 acres in size. We avoided placing survey points directly along steep slopes to minimize erosion and damage to sensitive areas caused by repeated walking for surveys. We generated grids of sampling points in each stand using ArcMap and separation distances of 250 m for red-shouldered hawk and 150 m for songbird surveys. Sampling points were given unique identification numbers and uploaded to a GPS unit for field navigation. For both red-shouldered hawk and forest songbird surveys, we attempted to cover as many forest stands as possible.

Red-shouldered hawk surveys involved broadcasting a series of conspecific calls at 176 stations positioned systematically across forested stands using a 250 m X 250 m grid (Figure 5) (Mosher et al. 1990, Anderson 2007, Bruggeman et al. 2011). Each point was surveyed for three minutes, which consisted of two min of broadcasts and one min of silent listening. Surveys were conducted between March 17 and April 21, 2011. At each station the following data were recorded: whether or not a red-shouldered hawk was detected, all other raptor sightings or vocalizations, other bird observations, and other rare animal species detections or potential habitats. When a red-shouldered hawk was observed, the vicinity surrounding the point was searched for potential nests. While walking and driving between station locations, we also visually inspected trees for stick nests.

We targeted the following rare species during forest songbird surveys: 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 all, 146 points were situated in forested stands systematically using a 150 m X 150 m grid and a minimum distance of 150 m from stand boundaries (Figure 5). In addition to surveying for rare songbirds, point-count

sampling was employed to gather baseline information about the forest bird community, including relative abundance, species richness, and bird diversity. We used methods similar to the standard protocol recommended by Ralph et al. (1995). Monitoring was conducted during May 31 – June 29, 2011 between sunrise and four hours after sunrise. 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. Each bird observation was assigned to one of four distance categories (0-25 m, 25-50 m, 50-100 m, and >100 m) based on the estimated distance from the observer to facilitate future distance analyses and refinement of density and population estimates. Qualitative information about the available songbird habitat (e.g., dominant overstory species, suitability for rare species) was noted at each point.

A small area of grassland containing constructed wetlands (southeast quarter sec. 31; IFMAP Compartment 3, Stands 1, 2, 3, and 4; Figure 5) was surveyed for rare grassland and wetland birds. The area was surveyed on May 31, 2011 by slowly walking through potential habitat and periodically stopping to listen for birds. We documented any rare species observed and recorded their locations using GPS.

Reptile and Amphibian Survey Methods

The following five rare species of amphibians and reptiles (i.e., herps, herpetofauna, or herptiles) were targeted for surveys in the PHSGA in 2011: Blanchard's or northern cricket frog, (*Acris blanchardi* (Gamble et al. 2008) or *Acris crepitans* (Frost et al. 2008, state threatened), small-mouthed or smallmouth salamander (*Ambystoma texanum*, state endangered), Blanding's turtle (*Emydoidea blandingii*, state special concern), eastern box turtle (*Terrapene carolina carolina*, state special concern), and gray ratsnake (*Pantherophis spiloides*, state special concern) (formerly black ratsnake, *Elaphe obsoleta obsoleta*, Crother 2008). Additional amphibian and reptile species that have been identified as Species of Greatest Conservation Need (SGCN) in Michigan's Wildlife Action Plan (Eagle et al. 2005) also were targeted for surveys (Appendix 1). Several techniques were used to survey for these species. These included visual encounter or meander surveys, trapping with aquatic funnel traps, egg mass surveys, basking turtle surveys, and breeding frog call surveys.

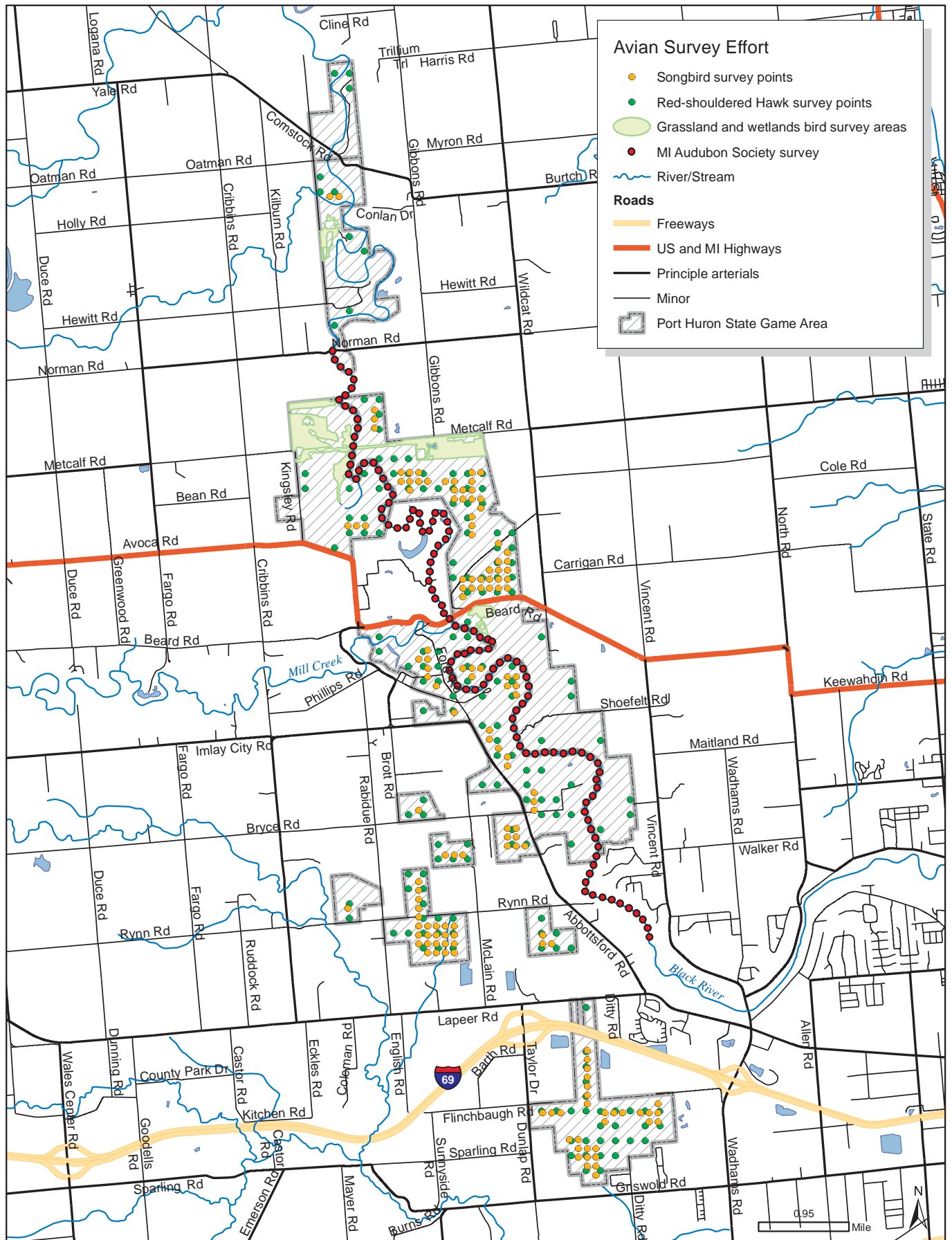


Figure 5. Avian survey effort.



Salamander trap (Photot by John Fody).

Visual encounter or meander surveys were conducted from 21 April to 24 June, 2011. Visual encounter surveys are a standard method for surveying 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 had potential for detecting all targeted herp species, particularly the turtles and snakes. Visual encounter surveys were conducted at a number of locations in the PHSGA, focusing on areas with available suitable habitats for targeted species (Figure 6). Survey locations were visited multiple times during the field season. 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 one to two surveyors walking slowly through areas with suitable habitat for survey targets, overturning cover (i.e., logs, rocks, etc.), inspecting retreats, and looking for basking, resting, and/or active individuals on the surface or under cover. Visual encounter surveys were conducted in or along the edge of open wetlands, waterbodies (i.e., pools, ponds, streams, and rivers), upland and lowland deciduous or mixed forest stands, and open uplands adjacent to wetlands or waterbodies.

Trapping with aquatic funnel traps was conducted on 21-22 April and 23-24 June, 2011 to survey for smallmouth

salamanders and other salamander SGCN. These included the spotted salamander (*Ambystoma maculatum*), blue-spotted salamander (*Ambystoma laterale*), and eastern tiger salamander (*Ambystoma tigrinum*). Trapping was conducted at four sites (Figure 6). These sites included the following: 1) a seasonally flooded backswamp (Compartment 3, Stand 113) on the east side of the Black River within the Black River Floodplain Forest, a small forested open vernal pool with the Port Huron Mesic Northern Forest (Compartment 3, Stand 141); 2) a small, lowland deciduous swamp (Compartment 3, Stand 163) surrounded by the Port Huron Dry-mesic Northern Forest; 3) and a small forested wetland depression within the Port Huron Dry-mesic Northern Forest (Compartment 3, Stand 201) (Photos H2: 1-4 – salamander trapping sites). (For detail habitat information on these sites see the section the Natural Community Descriptions and Management Recommendations section.) Commercially available modified minnow traps were used for aquatic funnel traps. These traps are about 46 cm long x 25 cm wide (i.e., 18 in long x 12 in wide) and consist of a collapsible, spring loaded, metal or wire frame covered with 3-mm mesh nylon webbing with funnels with 5-cm (2 in) openings extending inward at both ends. Traps were placed in the water so that the funnel openings at the ends of each trap were completely submerged in the water but the top of the trap was above the surface of the water to provide an air pocket



Forested vernal pool salamander trapping site within the Port Huron Mesic Northern Forest (Compartment 3, Stand 141) (Photot by John Fody).



Backwamp salamander trapping site within the Black River Floodplain Forest (Compartment 3, Stand 113) (Photo by Yu Man Lee).



Lowland deciduous swamp salamander trapping site surrounded by the Port Huron Dry-mesic Northern Forest (Compartment 3, Stand 163) (Phtot by Yu Man Lee).



Forested wetland depression salamander trapping site within the Port Huron Dry-mesic Northern Forest (Compartment 3, Stand 201) (Phtot by Yu Man Lee).

for animals captured in the trap. In April, 39 traps were set in the four wetlands during the day (10 traps in three of the wetlands, 9 traps in the fourth wetland). These traps were left overnight in the wetlands, and checked and removed the following day. In June, 30 traps were set in three of the four wetlands (10 traps in each wetland, Compartment 3, Stand 113 was not trapped), and checked and removed the following day. This resulted in a total of 69 trap nights for April and June surveys combined. Amphibian adults and larvae captured in the traps were identified to the extent possible, noted, and released. Photographs were taken of the amphibian adults and/or larvae captured in the traps for species verification and documentation.

Egg mass surveys were conducted on 21 and 22 April to survey for targeted salamanders to supplement the aquatic funnel trapping surveys. Egg mass surveys were conducted at the same four wetland sites as the aquatic funnel trapping surveys (Figure 6). Egg mass surveys consisted of walking slowly through the shallow wetlands to look for egg masses of targeted salamander species along the surface of the water, along the bottom of the wetland, and attached to vegetation, branches, and/or sticks that overhang or extend above the surface of the water in the wetland. Egg masses observed during surveys were documented, identified, and photographed when possible.

Basking turtle surveys were conducted from 20-31 May and 2-3 June. The basking turtle surveys were conducted primarily to document Blanding's turtles. These surveys were conducted at multiple wetlands or waterbodies that appeared to provide suitable habitat for Blanding's turtles (Figure 6). Basking turtle surveys consisted of slowly walking around the edge or shore of the wetlands or waterbodies and scanning the habitat with binoculars to look for turtles basking on logs or other woody debris, islands, or other structures or partially submerged in the water. These surveys also were used to look for snakes basking in the wetlands or waterbodies.

Breeding frog call surveys were conducted to survey for the Blanchard's or northern cricket frog on 20 May and 2 June. These surveys were conducted at two small created wetland mitigation sites (Compartment 3, Stands 2 and 4) located west of the Black River about 0.25 mile northeast of the intersection of Metcalf and Kingsley roads (Figure 6). The frog call surveys for the Blanchard's cricket frog were conducted during the day, and consisted of listening for breeding frog calls while walking around the wetlands. Species, call index values, location, time and weather conditions were recorded. Call indices were defined in the following manner: 1 = individuals can be counted, space between calls (i.e., 1-5 individuals); 2 = individual calls can be distinguished but some overlapping calls (6-

12 individuals); and 3 = full chorus, calls are constant, continuous and overlapping, unable to count individuals (Michigan Department of Natural Resources Frog and Toad Survey Protocol 2000).

Survey data forms (Appendix 2 and 3) 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, general habitat, behavior, and time of observation were noted. Weather conditions and start and end times of surveys also were recorded. MNFI special animal survey forms were completed when rare reptile or amphibian species were encountered, and locations were recorded with a GPS or IPAQ unit. Photos of rare species also were taken for supporting documentation, when possible.

Tree Cricket Survey Methods

Port Huron State Game supports potential habitat for two rare tree crickets: tamarack tree cricket (*Oecanthus laricis*, state special concern) and pine tree cricket (*Oecanthus pini*, state special concern). Surveys for these rare tree crickets were conducted in four locations in early to mid August, 2011 and involved using sweep nets to sweep the lower branches of hemlock and occasionally other conifers at four locations within the game area (Figure 7).

Mussel Survey Methods

The Black River watershed supports a species rich unionid mussel fauna, including several rare species. Unionid mussels were chosen as the primary survey target for rare aquatic animals based on the fact that past surveys have documented several state listed mussel species in the Black River near PHSGA. In addition, one species known to occur within the game area, the rayed bean (*Villosa fabalis*, federally and state endangered), was recently listed as federally endangered. The rayed bean was first documented in Mill Creek in 2001 within the PHSGA approximately 0.4 miles upstream from the confluence with the Black River.

Unionid mussel surveys were performed to determine the presence/absence and abundance of each species at ten sites, seven in the Black River and three in Mill Creek (Figure 7). A measured search area was used to standardize sampling effort among sites and allow unionid density estimates to be made. Typically 128m² provides a good compromise between amount of search effort per site and the number of sites to be completed within the timeline of the project. The search area extended from bank to bank in order to include a wide range of microhabitats. Handheld GPS units (Garmin) were used to document the position of survey sites and incidental finds. Latitude and longitude of each point were recorded (Appendix 4).

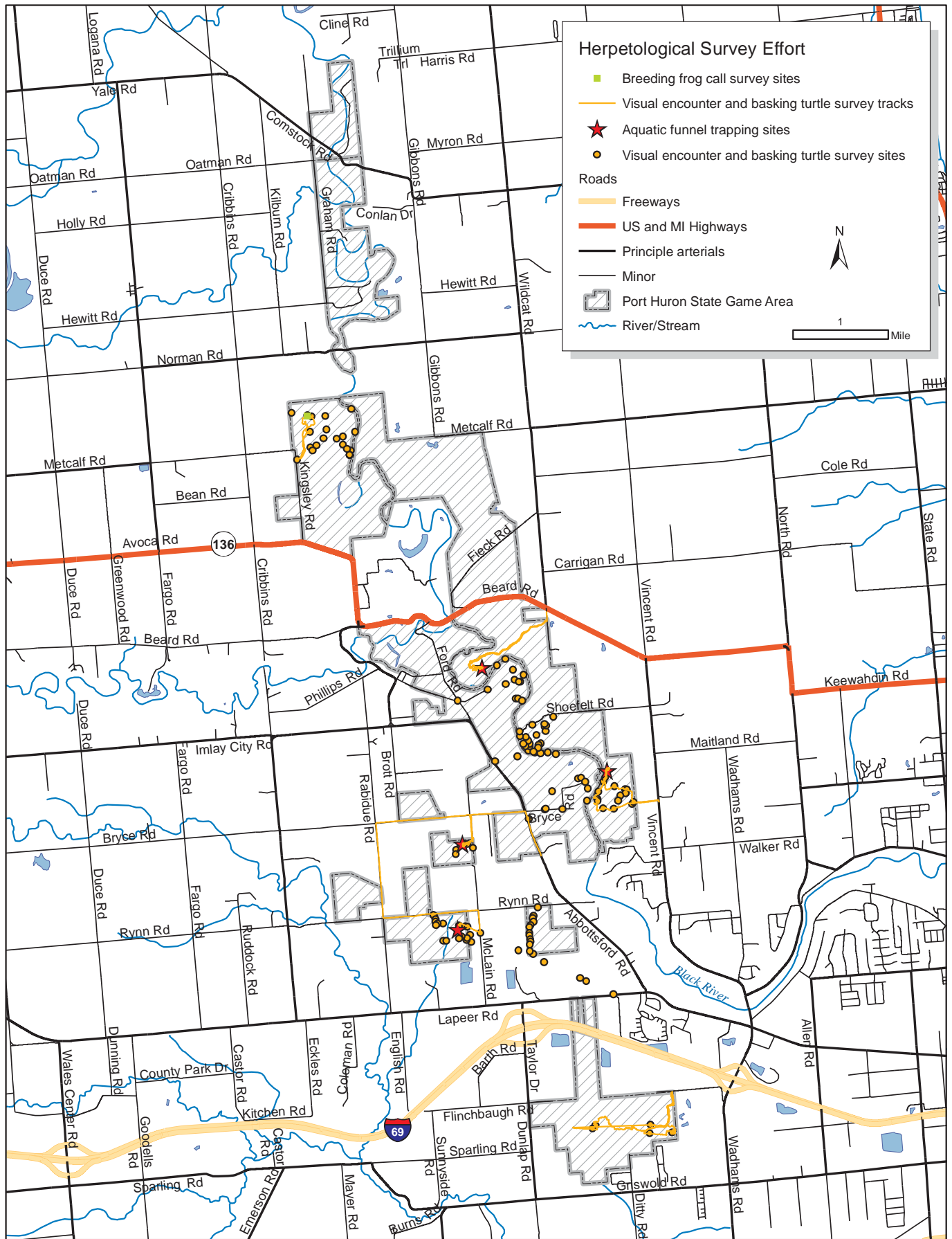


Figure 6. Herpetological survey effort.

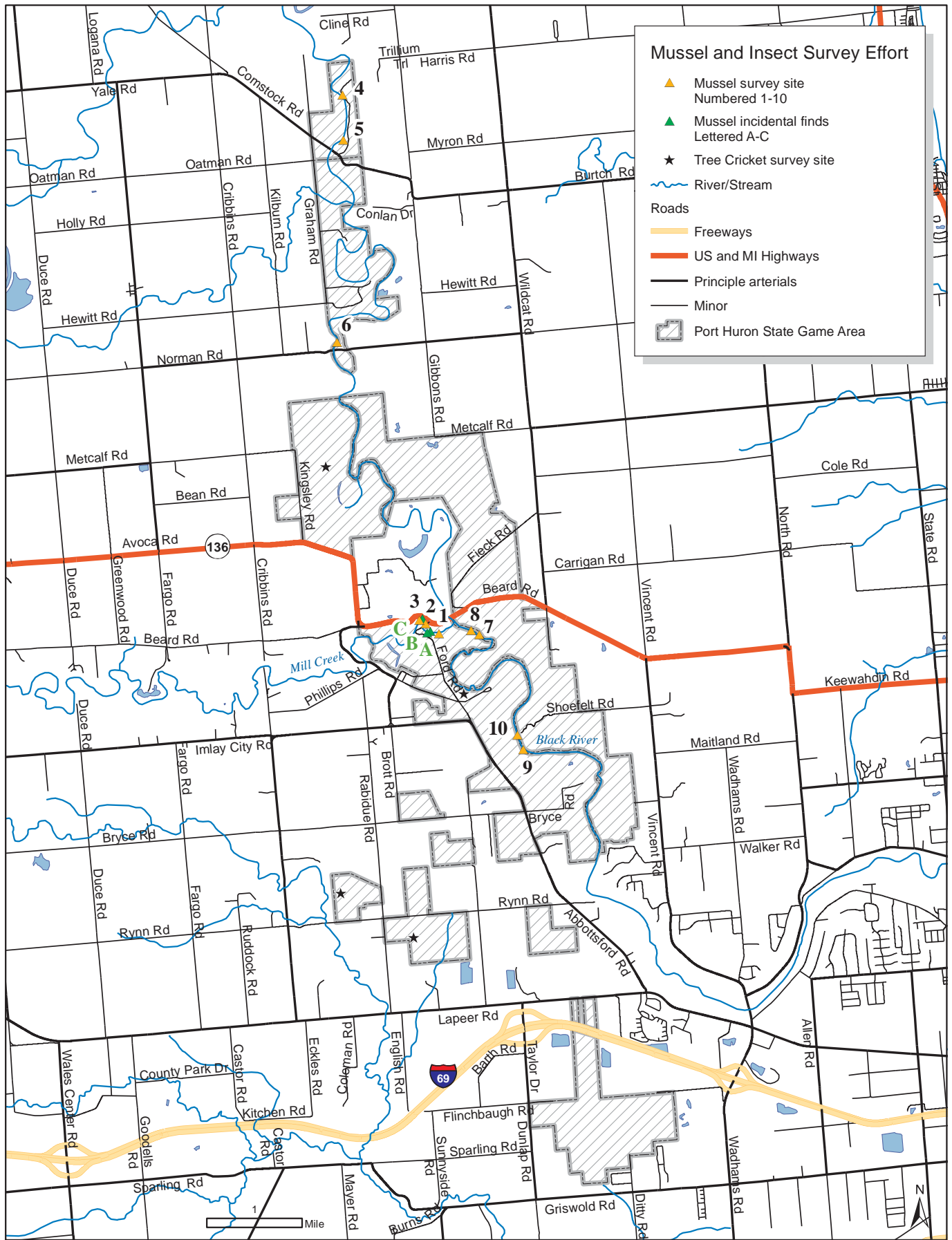


Figure 7. Mussel and insect survey effort.

Live unionids and shells were located with a combination of visual and tactile means. Glass bottom buckets were used to facilitate visual searches. Visual inspections were occasionally followed up with tactile searches to ensure that buried unionids were not overlooked. Live individuals were identified to species and planted back into the substrate anterior end down (siphon end up) in the immediate vicinity of where they were found. Shells were also identified to species. Presence/absence was recorded for the invasive exotic zebra mussel (*Dreissena polymorpha*) and Asian clam (*Corbicula fluminea*).

Habitat data were taken to describe and document stream conditions at the time of the surveys. The substrate within each transect was characterized by estimating percent composition by volume of each of the following six

particle size classes (diameter): boulder (>256mm), cobble (256-64mm), pebble (64-16mm), gravel (16-2mm), sand (2-0.0625mm), silt/clay (<0.0625) (Hynes 1970). Woody debris, aquatic vegetation, exposed solid clay substrate, and eroded banks were noted when observed. The percentage of the search area with pool, riffle, and run habitat, and a rough assessment of current speed were estimated visually.

Water chemistry data were taken at three survey sites in Mill Creek in the vicinity of rayed bean shell observations. 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. The water chemistry data were taken prior to searching for unionids to avoid stirring up silt that could affect measurements.

RESULTS

During surveys of the PHSGA, 17 new EOs were identified, including four natural community occurrences, ten rare animal occurrences, and three rare plants occurrences (Tables 1 and 2). In addition, the presence of 21 previously identified EOs was reconfirmed and updated information was entered into the Biotics database (Tables 1 and 2) (MNFI 2012). In all, 38 Species of Greatest Conservation Need (SGCN) were documented including 19 rare animal species (Table 3). The distribution of survey effort across the game area was documented with GPS and is illustrated by survey target in Figures 4 to 7. The locations of all natural community and rare species occurrences (both new and prior occurrences) for the PHSGA are illustrated in Figures 8 to 11.

Natural Community Survey Results

The natural community surveys resulted in the identification of four new natural community EOs, including a dry-mesic northern forest, southern hardwood swamp, floodplain forest, and inundated shrub swamp (Figure 8, Table 1). At each of the new EOs, the community boundaries were mapped and information was recorded on vegetation composition, invasive plants, soils, natural and anthropogenic disturbances, and management needs. In addition, a previously identified, mesic northern forest natural community EO was resurveyed and remapped (Figure 8, Table 1). Descriptions of the natural community EOs and associated management recommendations are provided in the section below. Management recommendations and a list of invasive species for each natural community EO are included in Tables 4 and 5.

Invasive plants were relatively uncommon within the natural community EOs but were encountered frequently along roadsides, forest edges, and within areas of the PHSGA that had previously been disturbed. Several invasive species that had not been observed within any of the natural community EOs were present in a degraded floodplain forest in Compartment 1, Stand 2. This stand contains several highly invasive species including ox-eye daisy (*Chrysanthemum leucanthemum*), Amur honeysuckle (*Lonicera maackii*), reed canary grass (*Phalaris arundinacea*), and glossy buckthorn (*Rhamnus frangula*). Although this stand is not an EO, it was included in the table of invasive species for EOs (Table 5) because these species represent potential future threats to the ecological integrity of the natural community EOs.

During the IFMAP Stage 1 inventory in 2010 and the natural community surveys in 2011, three new rare plant EOs were documented and information was gathered to allow five previously documented rare plant EOs to be updated (Table 2). Newly documented rare plants species included heart-leaved plantain (*Plantago cordata*, state endangered), Canadian milk vetch (*Astragalus canadensis*, state threatened), and downy sunflower (*Helianthus mollis*, state threatened) (Table 2). Updates were processed for the following rare plant EOs: Painted trillium (*Trillium undulatum*, state endangered), goldenseal (*Hydrastis canadensis* state threatened), beak grass (*Diarrhena obovata*, state threatened), wahoo (*Euonymus atropurpurea*, state special concern), and broad-leaved pucoon (*Lithospermum latifolium*, state special concern). The general location of these EOs is illustrated along with the natural community EOs in Figure 8.

Table 1. Newly documented and previously known natural community element occurrences for the Port Huron State Game Area in 2011.

Site Name	Community Type	EO ID	EO Rank	Year First Observed	Year Last Observed	Global Rank	State Rank
Port Huron Mesic Northern Forest	Mesic Northern Forest	194	B	1981	2011	G4	S3
Port Huron Dry-mesic Northern Forest	Dry-mesic Northern Forest	18589	BC	2011	2011	G4	S3
Rynn Road Hardwood Swamp	Southern Hardwood Swamp	18586	BC	2011	2011	G3	S3
Black River Floodplain Forest	Floodplain Forest	18587	AB	2011	2011	G3?	S3
Black River Shrub Swamp	Inundated Shrub Swamp	18588	B	2011	2011	G4	S3

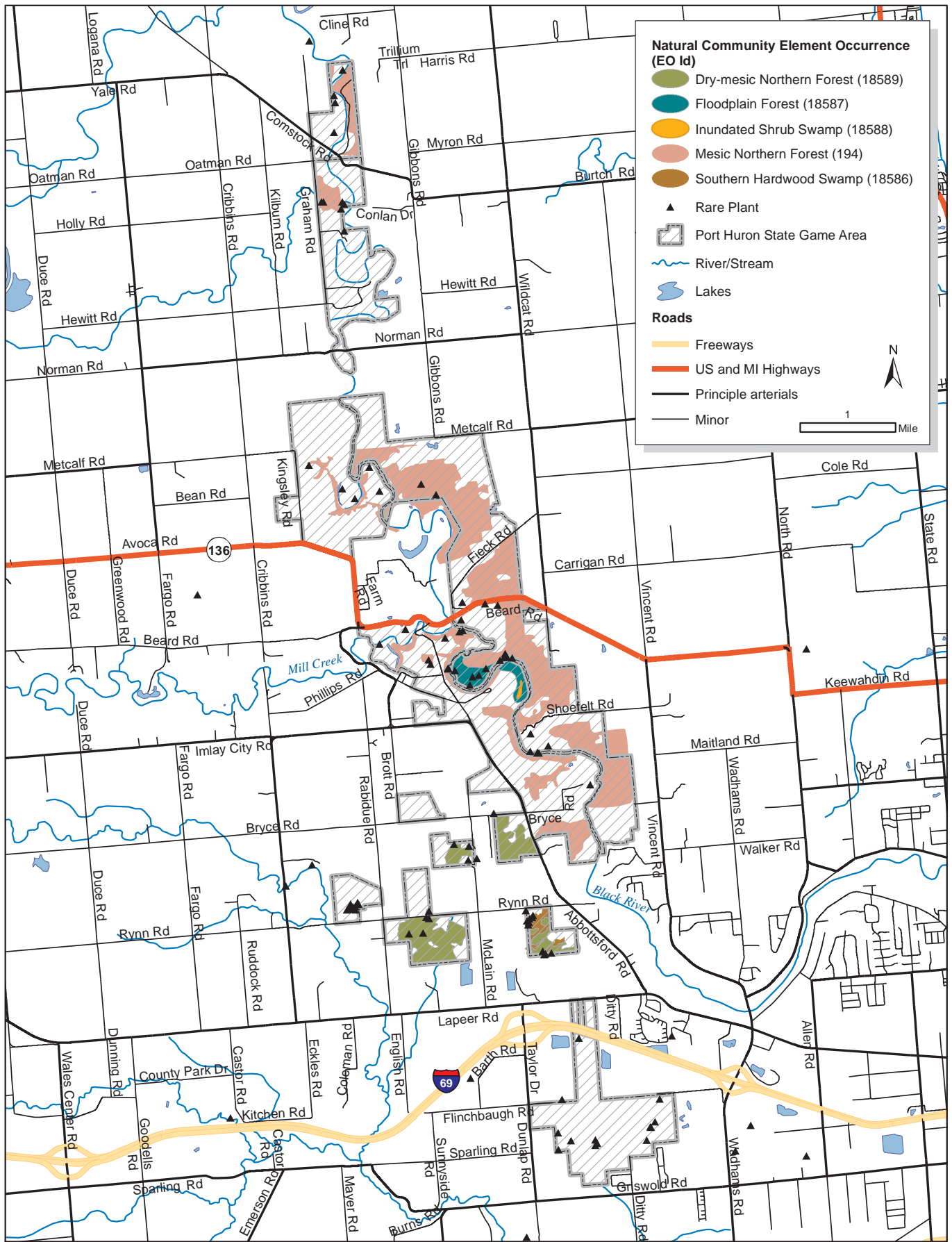


Figure 8. Natural communities and rare plant element occurrences.

Table 2. Newly documented and previously know rare animal and plant element occurrences at the Port Huron State Game Area in 2010 and 2011. State and federal status abbreviations are as follows: E, state endangered; T, state threatened; SC, state special concern; LE, federally endangered; and C, candidate for federal listing. * Indicates the EO was newly documented in 2010 or was updated with information collected during the IFMAP Stage 1 Inventory.

Common Name	Scientific Name	US Status	State Status	EO Number	Year First Observed	Year Last Observed
Birds						
Henslow's sparrow	<i>Ammodramus henslowii</i>		E	7	2000	2006
Grasshopper sparrow	<i>Ammodramus savannarum</i>		SC	124	2011	2011
American bittern	<i>Botaurus lentiginosus</i>		SC	46	2011	2011
Red-shouldered hawk	<i>Buteo lineatus</i>		T	364	2004	2011
Marsh wren	<i>Cistothorus palustris</i>		SC	48	2006	2011
Cerulean warbler	<i>Dendroica cerulea</i>		T	53	2003	2011
Louisiana waterthrush	<i>Seiurus motacilla</i>		T	7	2003	2011
Hooded warbler	<i>Wilsonia citrina</i>		SC	30	2003	2011
Great blue heron rookery *				103	1978	2010
Great blue heron rookery				322	2011	2011
Herptiles						
Blanchard's cricket frog [Northern cricket frog]	<i>Acris crepitans blanchardi</i> [<i>Acris blanchardi</i>]		T	134	2005	2011
Blanding's turtle	<i>Emydoidea blandingii</i>		SC	261	2009	2009
Blanding's turtle	<i>Emydoidea blandingii</i>		SC	273	2011	2011
Mussels						
Elktoe	<i>Alasmidonta marginata</i>		SC	55	2001	2011
Elktoe	<i>Alasmidonta marginata</i>		SC	57	2001	2011
Elktoe	<i>Alasmidonta marginata</i>		SC	58	2001	2011
Elktoe	<i>Alasmidonta marginata</i>		SC	76	2003	2011
Slippershell	<i>Alasmidonta viridis</i>		T	46	2001	2005
Slippershell	<i>Alasmidonta viridis</i>		T	47	2001	2011
Purple wartyback	<i>Cyclonaias tuberculata</i>		T	80	2011	2011
Wavy-rayed lampmussel	<i>Lampsilis fasciola</i>		T	43	2003	2011
Wavy-rayed lampmussel	<i>Lampsilis fasciola</i>		T	45	2001	2005
Black sandshell	<i>Ligumia recta</i>		E	66	2011	2011
Three-horned wartyback	<i>Obliquaria reflexa</i>		E	15	2011	2011
Round hickorynut	<i>Obovaria subrotunda</i>		E	12	1930	2011
Kidney shell	<i>Ptychobranthus fasciolaris</i>		SC	52	2011	2011
Salamander mussel	<i>Simpsonaias ambigua</i>	C	E	11	2003	2003
Salamander mussel	<i>Simpsonaias ambigua</i>	C	E	12	2001	2001
Deertoe	<i>Truncilla truncata</i>		SC	25	2011	2011

Table 2. continued

Common Name	Scientific Name	US Status	State Status	EO Number	Year	
					First Observed	Year Last Observed
Rayed bean	<i>Villosa fabalis</i>	LE	E	16	2001	2011
Rainbow	<i>Villosa iris</i>		SC	39	2001	2005
Rainbow	<i>Villosa iris</i>		SC	248	2011	2011
Plants						
Canadian milk vetch *	<i>Astragalus canadensis</i>		T	26	2010	2011
Large toothwort	<i>Dentaria maxima</i>		T	1	1894	2003
Large toothwort	<i>Dentaria maxima</i>		T	6	2003	2003
Beak grass *	<i>Diarrhena obovata</i>		T	20	2003	2011
Wahoo *	<i>Euonymus atropurpurea</i>		SC	9	2003	2011
	<i>Gentianella quinquefolia</i>		T			
Stiff gentian	<i>quinquefolia</i>			8	1892	1895
Downy sunflower	<i>Helianthus mollis</i>		T	15	2011	2011
Goldenseal *	<i>Hydrastis canadensis</i>		T	23	1892	2011
Broad-leaved puccoon *	<i>Lithospermum latifolium</i>		SC	15	1892	2011
Ginseng	<i>Panax quinquefolius</i>		T	56	1900-PRE	1900-PRE
Heart-leaved plantain *	<i>Plantago cordata</i>		E	14	2010	2011
Bog bluegrass	<i>Poa paludigena</i>		T	14	1904	1904
Painted trillium *	<i>Trillium undulatum</i>		E	13	1962	2011

Natural Community Element Occurrences and Management Recommendations

Port Huron Mesic Northern Forest (EO ID 194). Size: 1,649 acres (667 ha). EO Rank: B.

The Port Huron Mesic Northern Forest occupies deep ravines and steep slopes above the Black River throughout the northern and central portions of the game area (Figure 8). The surrounding landscape is comprised of a level clay lakeplain that is overlain by a thick layer of easily erodible sand. Over a period of more than 10,000 years, the Black River and its headwater tributaries carved a vast network of deep ravines through the otherwise level lakeplain. Headwater streams emerge within the upper portions of the ravines and cascade down through the ravines to meet the Black River. The underlying clay layer is exposed along the lower slopes and bottoms of the ravines, where groundwater seepage is prevalent. Surface soils vary from extremely acid (pH <4.5) loamy sands and sandy loams to neutral (pH 6.6-7.3) loams.

The Port Huron Mesic Northern Forest is structurally very complex and supports a diverse flora and fauna. Among the many factors contributing to the complex forest structure are the prevalence of large-diameter conifers within the forest canopy, abundant large-diameter coarse woody debris, many steep-sided ravines that contain cold headwater streams, and the meandering Black River. Over 154 native plant species were recorded, including 23 tree,

18 shrub, 68 forb, 17 fern, 11 sedge, and 7 grass species. At least 11 rare species utilize this forest including three rare raptors, three rare songbirds, and five rare plants. These include the following: Red-shouldered hawk (*Buteo lineatus*, state threatened), bald eagle (*Haliaeetus leucocephalus*, special concern), osprey (*Pandion haliaetus*, state special concern), cerulean warbler (*Dendroica cerulea*, state threatened), Louisiana waterthrush (*Seiurus motacilla* state threatened), hooded warbler (*Wilsonia citrine*, state special concern), heart-leaved plantain (*Plantago cordata*, state endangered), Canadian milk vetch (*Astragalus canadensis*, state threatened), large toothwort (*Dentaria maxima*, state threatened), goldenseal (*Hydrastis canadensis* state threatened), and broad-leaved puccoon (*Lithospermum latifolium*, state special concern).

A dense overstory of hemlock occurs within the ravines and along the slopes above the Black River. Other common canopy associates include sugar maple, red oak, beech, red maple, yellow birch (*Betula alleghaniensis*), bitternut hickory, shagbark hickory, white ash, tulip tree, white pine, black cherry, white oak, and basswood. Black maple is dominant in a floristically rich area that occupies the third bottom of an oxbow channel in Compartment 3, Stand 141. Common understory trees include musclewood (*Carpinus caroliniana*), alternate leaved dogwood (*Cornus alternifolia*), witch hazel (*Hamamelis virginiana*), ironwood, and choke cherry (*Prunus virginiana*). The shrub layer is generally sparse except within light



The Port Huron Mesic Northern Forest occupies deep ravines that contain cold, groundwater-fed, headwater streams that feed into the Black River (Photo by Michael Kost).

gaps. Common shrubs include gray dogwood (*Cornus foemina*), beaked hazelnut (*Corylus cornuta*), American hazelnut (*Corylus americana*), leatherwood (*Dirca palustris*), running strawberry bush (*Euonymus obovata*), American fly honeysuckle (*Lonicera canadensis*), prickly gooseberry (*Ribes cynosbati*), common blackberry (*Rubus allegheniensis*), black raspberry (*Rubus occidentalis*), red berried elder (*Sambucus racemosa*), snowberry (*Symphoricarpos albus*), maple-leaved viburnum (*Viburnum acerifolium*), and downy arrow wood (*Viburnum rafinesquianum*). A rich ground flora occurs near seeps and on the bottoms of the ravine bottoms along the meandering headwater streams. Ferns recorded include maidenhair fern (*Adiantum pedatum*), lady fern (*Athyrium filix-femina*), narrow leaved spleenwort (*Athyrium pycnocarpon*), silvery spleenwort (*Athyrium thelypteroides*), rattlesnake fern (*Botrychium virginianum*), bulblet fern (*Cystopteris bulbifera*), fragile fern (*Cystopteris protrusa*), spinulose woodfern (*Dryopteris carthusiana*), Goldie's woodfern (*D. goldiana*), evergreen woodfern (*D. intermedia*), marginal woodfern (*D. marginalis*), ostrich fern (*Matteuccia struthiopteris*), sensitive fern (*Onoclea sensibilis*), and

Christmas fern (*Polystichum acrostichoides*). Although the south-facing slopes often harbor a diverse ground flora, the north-facing slopes are often sparsely vegetated below the dense hemlock canopy.

Recommended management for Port Huron Mesic Northern Forest includes 1) maintaining the forest canopy, 2) controlling invasive plants, 3) preventing erosion from adjacent farm fields from entering ravines, and 4) reducing the impacts associated with local campfire pits (Tables 4 and 5).

The natural disturbance regime of mesic northern forests is characterized by frequent, small-scale windthrow events (i.e., gap-phase dynamics), which promote regeneration of the shade-tolerant canopy trees (Cohen 2000). These frequent, small-scale blowdowns give rise to a complex forest structure that includes pit-and-mound microtopography, large-diameter coarse woody debris, dead standing snags, and a diverse, multi-generational forest canopy. The Port Huron Mesic Northern Forest is a very diverse and structurally complex forest that provides habitat

Table 3. Rare species, Species of Greatest Conservation Need (SGCN), and DNR featured species documented at the Port Huron State Game Area (PHSGA). Note that all rare animal species known from PHSGA are included as SGCN in the Michigan Wildlife Action Plan (Eagle et. al 2005) except for the deertoe (*Truncilla truncata*, state special concern). State and federal status abbreviations are as follows: E, state endangered; T, state threatened; SC, state special concern; LE, federally endangered; and C, candidate for federal listing.

Common Name	Scientific Name	US Status	State Status	SGCN	DNR Featured Species	Year Last Observed
Birds						
Henslow's sparrow	<i>Ammodramus henslowii</i>		E			2006
Grasshopper sparrow	<i>Ammodramus savannarum</i>		SC	X		2011
Great blue heron rookery	<i>Ardea herodias</i>			X		2011
American bittern	<i>Botaurus lentiginosus</i>		SC	X	X	2011
Red-shouldered hawk	<i>Buteo lineatus</i>		T	X	X	2011
Green Heron	<i>Butorides virescens</i>			X		2011
Canada warbler	<i>Cardellina canadensis</i> [<i>Wilsonia canadensis</i>]			X		2011
Killdeer	<i>Charadrius vociferus</i>			X		2011
Marsh wren	<i>Cistothorus palustris</i>		SC	X		2011
Yellow-billed cuckoo	<i>Coccyzus americanus</i>			X		2011
Black-billed cuckoo	<i>Coccyzus erythrophthalmus</i>			X		2011
Northern flicker	<i>Colaptes auratus</i>			X		2011
Cerulean warbler	<i>Dendroica cerulea</i>		T	X		2011
Acadian flycatcher	<i>Empidonax virescens</i>			X		2011
Wood thrush	<i>Hylocichla mustelina</i>			X	X	2011
Eastern towhee	<i>Pipilo erythrophthalmus</i>			X		2011
Louisiana waterthrush	<i>Seiurus motacilla</i>		T	X		2011
Northern parula	<i>Setophaga Americana</i>			X		2011
Black-throated blue warbler	<i>Setophaga caerulescens</i>			X	X	2011
Golden-winged warbler	<i>Vermivora chrysoptera</i>			X	X	2011
Blue-winged warbler	<i>Vermivora pinus</i>			X		2011
Hooded warbler	<i>Wilsonia citrina</i>		SC	X		2011
Herptiles						
Blanchard's cricket frog [Northern cricket frog]	<i>Acris blanchardi</i> [<i>Acris crepitans</i>]		T	X		2011
Blue-spotted salamander	<i>Ambystoma laterale</i>			X		2011
Spotted salamander	<i>Ambystoma maculatum</i>			X		2011
Blanding's turtle	<i>Emydoidea blandingii</i>		SC	X		2011
Eastern red-backed salamander	<i>Plethodon cinereus</i>				X	2011
Western chorus frog	<i>Pseudacris triseriata</i> <i>triseriata</i>			X		2011
Mussels						
Elktoe	<i>Alasmidonta marginata</i>		SC	X		2011
Slippershell	<i>Alasmidonta viridis</i>		T	X		2011
Cylindrical papershell	<i>Anodontoides ferussacianus</i>			X		2011
Purple wartyback	<i>Cyclonaias tuberculata</i>		T	X		2011
Wavy-rayed lampmussel	<i>Lampsilis fasciola</i>		T	X		2011
Black sandshell	<i>Ligumia recta</i>		E	X		2011
Three-horned wartyback	<i>Obliquaria reflexa</i>		E	X		2011

Table 3. continued

Common Name	Scientific Name	US Status	State Status	SGCN	DNR Featured Species	Year Last Observed
Round hickorynut	<i>Obovaria subrotunda</i>		E	X		2011
Kidney-shell	<i>Ptychobranchnus fasciolaris</i>		SC	X		2011
Pimpleback	<i>Quadrula pustulosa</i>			X		2011
Salamander mussel	<i>Simpsonaias ambigua</i>	C	E	X		2003
Deertoe	<i>Truncilla truncata</i>		SC			2011
Rayed bean	<i>Villosa fabalis</i>	E	E	X		2011
Rainbow	<i>Villosa iris</i>		SC	X		2011

to many rare species including at least three rare forest interior songbird species, two rare raptor species, and five rare plant species. **Maintaining an intact forest canopy** will allow this forest to continue providing critical habitat to these and other species.

At present (2011), outbreaks of **invasive plants** are relatively limited in extent and remain manageable. However, several very aggressive invasive plants occur here and will continue to spread. Controlling invasive species now will be cost effective in comparison with waiting and is a critical step in maintaining the ecological integrity of this forest. Some of the invasive plant species documented include garlic mustard (*Alliaria petiolata*), Oriental bittersweet (*Celastrus orbiculata*), autumn olive (*Elaeagnus umbellata*), moneywort (*Lysimachia nummularia*), black locust (*Robinia pseudoacacia*), multiflora rose (*Rosa multiflora*), bittersweet nightshade (*Solanum dulcamara*), and coltsfoot (*Tussilago farfara*).

Minimizing erosion from adjacent farmlands and drainage ditches will help improve and protect water quality of the Black River and Mill Creek. Improving and protecting water quality is a key factor in maintaining the diverse assemblages of unionid mussels found in these rivers. In addition, minimizing erosion will also help protect populations of native plant growing within the ravine bottoms. Soil erosion is particularly intense along the eastern boundary of the game area just north of Shoefelt Road (Stand 141). In this location, soil erosion from an adjacent farm-field drainage ditch enters a ravine within the state game area and covers its bottom with a thick layer of silt.

Numerous campfire pits occur throughout this forest in the vicinity of the Black River and Mill Creek. These fire pits are typically associated with exacerbated soil erosion and widely scattered trash. Reducing the erosion and trash around fire rings will help protect the forest.

For additional information on mesic northern forests see the MNFI natural community abstract for mesic northern

forest (Cohen 2000) and Michigan natural community classification (Kost et al. 2007) available through the MNFI website: <http://mnfi.anr.msu.edu/>

Port Huron Dry-mesic Northern Forest (EO ID 18589). Size: 329 acres (133 ha). EO Rank: BC.

The Port Huron Dry-mesic Northern Forest consists of four separate blocks of forest that are all located on the level clay lakeplain west of Abottsford Road in the south-central portion of the game area (Figure 8). Because these blocks of forest were likely all connected in the past, they have been combined into a single EO. The clay lakeplain in this area is overlain by sand, which results in wide fluctuations in soil moisture depending on the depth of the sand deposits. Areas of deep sand deposits are very well drained in comparison with areas of thin sand deposits. As a result, very slight changes in elevation can result in very large changes in soil moisture. Shallow depressions are often inundated in the spring and early summer while slightly higher areas remain very well drained. Pit-and-mound microtopography is especially pronounced in low, level areas where windthrow frequently occurs due to the high water table and shallow tree rooting. In spring, the hollows between the tip-up-mounds are typically inundated. This community nearly surrounds the Rynn Road Hardwood Swamp (EO ID 18586) in the block of forest located south of Rynn Road near Abottsford Road (Figure 8). The soils on slightly elevated, well drained areas vary from extremely acid (pH 4.0) loamy sands to very strongly acid (pH 4.5) sandy loams. Soils in the low areas often contain approximately 6 inches (15 cm) of slightly acid (pH 6.5) muck or sapric peat over neutral (pH 7.0) grey-colored sand or brownish-grey loam.

Although this forest occurs on a relatively level lakeplain, it has a complex structure, which contributes to high plant and animal diversity. Over 150 native plant species were recorded within the four blocks of forest. In addition, four rare species were utilizing this forest in 2011 including two forest interior songbirds, one forest raptor, and one rare plant. These include the following: Cerulean warbler (state

Table 4. Summary of management recommendations for natural community element occurrences for the Port Huron State Game Area in 2011.

Site Name	Community Type	Management Recommendations
Port Huron Mesic Northern Forest	Mesic Northern Forest	<ul style="list-style-type: none"> • Maintain forest canopy • Control and monitor invasive species • Reduce runoff from adjacent farm fields (Compartment 3, Stand 141 north of Shoefelt Road) • Reduce soil erosion and remove litter associated with local campfire pits
Port Huron Dry-mesic Northern Forest	Dry-mesic Northern Forest	<ul style="list-style-type: none"> • Maintain forest canopy • Control and monitor invasive species • Periodically conduct prescribed burns
Rynn Road Hardwood Swamp	Southern Hardwood Swamp	<ul style="list-style-type: none"> • Maintain forest canopy • Maintain forested buffer • Control and monitor invasive species
Black River Floodplain Forest	Floodplain Forest	<ul style="list-style-type: none"> • Maintain forest canopy • Control and monitor invasive species
Black River Shrub Swamp	Inundated Shrub Swamp	<ul style="list-style-type: none"> • Control and monitor invasive species • Maintain forested buffer



The Port Huron Dry-mesic Northern Forest occurs on level lakeplain sites with extremely acidic, sandy soils (Photo by Michael Kost).

threatened), hooded warbler (state special concern), red-shouldered hawk (state threatened), and painted trillium (*Trillium undulatum*, state endangered).

The forest overstory is primarily dominated by white oak, red oak, and red maple. Common to occasional canopy associates include white pine, sassafras (*Sassafras albidum*), black cherry, sugar maple, yellow birch, paper birch, shagbark hickory, beech, tulip tree, ironwood, big-toothed aspen, and rarely, hemlock. Scattered supercanopy white pine and occasional hemlocks add significantly to the complex structure of this forest. Further contributing

to a complex forest structure is the presence of large, dead standing snags of white ash, which had recently been killed by the emerald ash borer. Common tall shrubs and small trees include witch hazel, service berry (*Amelanchier* sp.), alternate-leaved dogwood (*Cornus alternifolia*), beaked hazelnut, elderberry (*Sambucus canadensis*), huckleberry (*Gaylussacia baccata*), smooth highbush blueberry (*Vaccinium corymbosum*), maple-leaved arrow wood, northern haw (*Viburnum cassinoides*), and smooth arrow wood (*Viburnum dentatum*). Common ground layer species include blueberry (*Vaccinium angustifolia*), Pennsylvania sedge (*Carex pensylvanica*), Canada

Table 5. Invasive plant species found within the natural community element occurrences and one degraded floodplain forest stand (Compartment 1, Stand 2, not an EO) at the Port Huron State Game Area in 2011. Species followed by an asterisks (*) are known to spread quickly and be particularly detrimental to ecological integrity.

Invasive Species	Port Huron Mesic Northern Forest	Port Huron Dry-mesic Northern Forest	Rynn Road Hardwood Swamp	Black River Floodplain Forest	Black River Shrub Swamp	Comp 1 Stand 2 No EO	Total Sites
garlic mustard (<i>Alliaria petiolata</i>) *	X	X		X		X	4
common burdock (<i>Arctium minus</i>)				X			1
Japanese barberry (<i>Berberis thunbergii</i>)*	X			X			2
Oriental bittersweet (<i>Celastrus orbiculata</i>)*	X	X					2
oxeye daisy (<i>Chrysanthemum leucanthemum</i>)						X	1
bull-thistle (<i>Cirsium vulgare</i>)						X	1
Lily-of-the-valley (<i>Convallaria majalis</i>)	X						1
autumn olive (<i>Elaeagnus umbellata</i>)*	X	X		X			3
ground ivy (<i>Glechoma hederacea</i>)		X					1
orange daylily (<i>Hemerocallis fulva</i>)	X						1
Dame's rocket (<i>Hesperis matronalis</i>)*	X			X		X	3
Amur honeysuckle (<i>Lonicera maackii</i>)*						X	1
Morrow's honeysuckle (<i>Lonicera morrowii</i>)*	X						1
moneywort (<i>Lysimachia nummularia</i>)*	X			X	X	X	4
forget-me-not (<i>Myosotis scorpioides</i>)						X	1
reed canary grass (<i>Phalaris arundinacea</i>)*						X	1
common reed (<i>Phragmites australis</i>)*			X				1
glossy buckthorn (<i>Rhamnus frangula</i>)*						X	1
black locust (<i>Robinia pseudoacacia</i>)*	X						1
multiflora rose (<i>Rosa multiflora</i>)*	X	X	X	X			4
bitter dock (<i>Rumex obtusifolius</i>)				X		X	2
bouncing bet (<i>Saponaria officinalis</i>)						X	1
bittersweet nightshade (<i>Solanum dulcamara</i>)	X	X	X	X		X	5
common lilac (<i>Syringa vulgaris</i>)		X					1
coltsfoot (<i>Tussilago farfara</i>)*	X	X		X		X	4
Total Number of Invasive Species	13	8	3	10	1	13	

mayflower (*Maianthemum canadense*), wild sarsaparilla (*Aralia nudicaulis*), winterberry (*Gaultheria procumbens*), large-leaved aster (*Aster macrophyllus*), false Solomon seal (*Smilacina racemosa*), New York fern (*Thelypteris noveboracensis*), downy Solomon seal (*Polygonum pubescens*), and merrybells (*Uvularia sessilifolia*).

Recommended management for Port Huron Dry-mesic Northern Forest includes 1) maintaining the forest canopy, 2) controlling invasive plant species, and 3) periodically conducting prescribed burns (Tables 4 and 5).

Maintaining the forest canopy will allow this forest to continue providing habitat to the rare forest interior songbirds and red-shouldered hawk. At present **invasive species** are uncommon to rare to within the forest interior, but they are abundant along some of the adjacent roads, especially along Abbottsford Road on the edge of Compartment 3, Stand 175 directly across from the game area parking lot. Invasive species observed and their relative abundance include the following: Oriental bittersweet (*Celastrus orbiculata*) is very dense along Abbottsford Road (Stand 175); autumn olive (*Elaeagnus umbellata*) is very dense along Abbottsford Road (Stand 175) and also occurs as widely scattered individuals in other locations; multiflora rose (*Rosa multiflora*) is dense along Abbottsford Road (Stand 175) and also occurs as widely scattered individuals in other locations; common lilac (*Syringa vulgaris*) is dense in a small area along Abbottsford Road (Stand 175); coltsfoot (*Tussilago farfara*) is concentrated along the trail/two-track near the Rynn Road parking area in Stand 201; bittersweet nightshade (*Solanum dulcamara*) is uncommon but does occur occasionally in wet depressions in several locations; ground ivy (*Glechoma hederacea*) occurs along McLain Road on the edge of Stand 169.

Fire is rare or absent today, but based on the level topography, prevalence of oaks and white pines, and composition of the ground flora (blueberry, Pennsylvania sedge, wintergreen, etc.), periodic wildfires were likely historically common within this forest. Conducting occasional prescribed fires will help maintain the oaks and pines, promote ground layer diversity, and aid in controlling woody invasive plants.

For additional information on dry-mesic northern forests see the MNFI natural community abstract for dry-mesic northern forest (Cohen 2002) and Michigan natural community classification (Kost et al. 2007) available through the MNFI website: <http://mnfi.anr.msu.edu/>

Rynn Road Hardwood Swamp (EO ID 18586). Size: 41 acres (17 ha). EO Rank: BC.

The Rynn Road Southern Hardwood Swamp occurs on a level lakeplain in the west-central portion of the game area (Figure 8). The high water table in this swamp prevents trees from rooting deeply, which makes them prone to uprooting during heavy downbursts. As a result of frequent windfall, the swamp has a pit-and-mound microtopography. The hollows (pits) and low, level areas fill with water during late winter and remain flooded into early to mid summer during many years. The wetland soils consist of shallow (approximately 6 inches [15 cm] deep), sapric peat (muck) over slightly acid (pH 6.5) grey sand. The adjacent low sandy rises support high quality dry-mesic northern forest (EO ID 18589) with abundant red oak, white oak, white pine, and red maple. The hardwood swamp has a dense overstory dominated by silver maple with abundant red maple, swamp white oak (*Quercus bicolor*), paper birch, and green-ash snags (dead standing trees due to the emerald ash borer). White pine is very rare within the overstory. However, it is relatively common in the adjacent dry-mesic northern forest and was likely historically common in this wetland. A patchy, tall-shrub layer is present and includes musclewood, elderberry, spicebush, and beaked hazelnut. Ground layer vegetation is dense on the raised hummocks (tip-up-mounds) but sparse in the hollows and low level areas where prolonged inundation hinders plant establishment and growth. Common ground flora include brome-like sedge (*Carex bromoides*), southern blue flag (*Iris virginiana*), wood nettle (*Laportea canadensis*), sensitive fern (*Onoclea sensibilis*), royal fern (*Osmunda regalis*), cinnamon fern (*Osmunda cinnamomea*), New York fern (*Thelypteris noveboracensis*), and marsh fern (*Thelypteris palustris*).

Three rare species were utilizing this swamp in 2011 including the red-shouldered hawk (state threatened), hooded warbler (state special concern), and painted trillium (state endangered).

Recommended management for Rynn Road Hardwood Swamp includes 1) maintaining the forest canopy, 2) maintaining the canopy of the adjacent dry-mesic northern forest to serve as a buffer, and 3) removing invasive species (Tables 4 and 5). At present invasive plants are rare within the swamp, and thus could be easily managed. Invasive plants observed in 2011 include multiflora rose (*Rosa multiflora*), bittersweet nightshade (*Solanum dulcamara*), and common reed (*Phragmites australis*). Controlling invasive plants while their populations are small and easy to manage is a cost effective means of protecting the long-term ecological integrity of this swamp.



The Rynn Road Hardwood Swamp occurs in a shallow depression on level lakeplain with well-developed pit-and-mound microtopography. The swamp is surrounded by the Port Huron Dry-mesic Northern Forest (Photo by Michael Kost).

For additional information on southern hardwood swamps see the MNFI natural community abstract for southern hardwood swamp (Slaughter et al. 2009) and Michigan natural community classification (Kost et al. 2007) available through the MNFI website: <http://mnfi.anr.msu.edu/>

Black River Floodplain Forest (EO ID 18581). Size: 105 acres (42 ha). EO Rank: AB.

A large floodplain forest occurs along both sides of the Black River in the central portion of PHSGA (Figure 8). The community occupies the first and second bottoms of two large oxbows of the Black River and contains several meander scars associated with former river channels. The community structure and vegetation composition of the floodplain forest vary based on past natural disturbance, river morphology, duration of flooding, elevation, and extent and frequency of soil deposition and erosion. Over 150 plant species were documented in a variety of ecological zones of this floodplain forest. Rare species

utilizing the floodplain forest in 2011 included three rare songbirds, one forest raptor, and three rare plants. These include the following: Cerulean warbler (state threatened), Louisiana waterthrush (state threatened), hooded warbler (state special concern), wahoo (*Euonymus atropurpurea*, state special concern), beak grass (*Diarrhena obovata*, state threatened), and broad-leaved puccoon (*Lithospermum latifolium*, state special concern). In addition, bald eagle (state special concern) and osprey (state special concern) were occasionally observed foraging and perching in the Black River corridor within the vicinity of this forest.

The Black River Floodplain Forest contains several distinct ecological zones. A wide sandbar (Compartment 3, Stand 116) occupies the first bottom directly adjacent to the Black River and contains areas of exposed sand as well as a sparse canopy of cottonwood (*Populus deltoides*), sycamore, willow (*Salix* spp.), and black maple. The second bottom (Compartment 3, Stands 114 and 127) contains rich, loamy soils that have a circumneutral pH and support a very diverse flora. The tree canopy of the second

bottom is dominated by black maple, bitternut hickory, and basswood with occasional bur oak (*Quercus macrocarpa*), American beech, hemlock, white pine, sugar maple, and mostly dead green ash and white ash. The shrub layer here is sparse, but the ground layer is dense and very diverse. Garlic mustard is present in this rich second-bottom forest and represents a serious threat to diversity. A seasonally inundated backswamp (Compartment 3, Stand 113) dominated by silver maple occurs in a meander scar located between the second bottom and the next higher terrace (i.e., third bottom), which supports a high quality mesic northern forest (EO ID 194). Long-term flooding in this backswamp significantly limits herbaceous plant establishment but seedlings and resprouts of American elm and green ash are common. Another meander scar occurs across the main river channel and supports both an inundated shrub swamp (Compartment 3, Stand 131; EO ID 18588) dominated by buttonbush and a small backswamp dominated by silver maple. An abandoned beaver lodge occurs within this meander scar between the inundated shrub swamp and the small silver maple backswamp. Many of the trees near the

lodge have been girdled by beaver (*Castor canadensis*). The skeleton of a beaver was observed about 100 ft (30 m) from the lodge.

Recommended management of the Black River Floodplain Forest includes 1) maintaining the forest canopy and 2) controlling invasive plants (Tables 4 and 5). At present, invasive plants occupy only local areas within the floodplain forest and so control efforts accompanied by regular monitoring and follow up are likely to be successful. Invasive species observed and their relative abundance include: garlic mustard (locally dominant in Compartment 3, Stand 114 and locally common in Stand 127); common burdock (*Arctium minus*) (uncommon in Stand 127); Japanese barberry (*Berberis thunbergii*) (uncommon in Stand 127); autumn olive (uncommon in Stand 127); Dame's rocket (*Hesperis matronalis*) (uncommon in stands 114 and 127); moneywort (*Lysimachia nummularia*) (locally abundant in Stand 127); reed canary grass (*Phalaris arundinacea*) (uncommon in Stand 116); multiflora rose (*Rosa multiflora*) (occasional in Stand 127); bitter dock (*Rumex obtusifolius*)



The Black River Floodplain Forest contains several distinct ecological zones including this rich second bottom forest (Photo by Michael Kost).



Located within the Black River Floodplain Forest, this silver maple-dominated backswamp occupies a meander scar (former river channel) of the Black River (Compartment 3, Stand 113) (Photo by Michael Kost).

(uncommon); bittersweet nightshade (*Solanum dulcamara*) (uncommon in Stand 127); and coltsfoot (*Tussilago farfara*) (uncommon in Stand 127).

For additional information on floodplain forests see the MNFI natural community abstract for floodplain forest (Tepley et al. 2004) and Michigan natural community classification (Kost et al. 2007) available through the MNFI website: <http://mnfi.anr.msu.edu/>

Black River Shrub Swamp (EO ID 18588). Size: 2.3 acres (1 ha). EO Rank: B.

An inundated shrub swamp occupies the far end of a long, narrow meander scar associated with a former channel of the Black River (Figure 8). The community is dominated by a dense canopy of buttonbush (*Cephalanthus occidentalis*) and occasional winterberry (*Ilex verticillata*). Silver maples and an extensive floodplain forest (EO ID 18581) surround the shrub swamp. With the exception of abundant duckweed (*Lemna minor*), ground layer vegetation within the shrub swamp is sparse as a result of frequent inundation

and a dense shrub layer. When the Black River overflows its banks, water flows into the meander scar and inundates the shrub swamp. Based on the plant species composition of the inundated shrub swamp, it is likely that in most years, the community remains flooded during much of the growing season. Soils are silt loam and very slightly acid (pH 6.5).

An abandoned beaver lodge occurs on the edge of the inundated shrub swamp where it borders a small, silver maple-dominated backswamp. Nearly all of the trees near the lodge had been girdled by beaver (*Castor canadensis*, DNR featured species). The skeleton remains of a beaver were observed near the main river channel about 100 ft (30 m) from the lodge.

At the time of the survey in mid September, several very small, deeper depressions within the shrub swamp were filled with tadpoles struggling to remain alive in the shallow puddles. Upon approaching these tiny depressions during our survey, we flushed several wood ducks that had been feeding on the stranded tadpoles.



The Black River Shrub Swamp occurs within a meander scar (former river channel) of the Black River and is surrounded by the Black River Floodplain Forest. Buttonbush (*Cephalanthus occidentalis*) dominates this shrub swamp (Photo by John Fody).

Recommended management for Black River Shrub

Swamp includes 1) Removing and monitoring for invasive plants and 2) maintaining a forested buffer (Tables 4 and 5). The only invasive plant species observed was moneywort (*Lysimachia nummularia*). Control of this species followed up by annual monitoring and removal of this and other invasive plants will help maintain the ecological integrity of this natural community.

For additional information on inundated shrub swamps see the MNFI natural community abstract for inundated shrub swamp (Slaughter et al. 2010) and Michigan natural community classification (Kost et al. 2007) available through the MNFI website: <http://mnfi.anr.msu.edu/>

Rare Animal Survey Results

Surveys for rare animals resulted in 10 new EOs and reconfirmed 15 previously documented records (Table 2). New EOs included 3 birds, 1 reptile, and 6 mussels of the following species: grasshopper sparrow (*Ammodramus savannarum*, state special concern), American bittern

(*Botaurus lentiginosus*, state special concern, DNR featured species), great blue heron rookery, Blanding's turtle (*Emydoidea blandingii*, state special concern), purple wartyback (*Cyclonaias tuberculata*, state threatened), black sandshell (*Ligumia recta*, state endangered), three-horned wartyback (*Obliquaria reflexa*, state endangered), kidney shell (*Ptychobranthus fasciolaris*, state special concern), deertoe (*Truncilla truncata*, state special concern), and rainbow (*Villosa iris*, state special concern). Details of the animal surveys are provided below within the respective Results and Discussions sections for avian, herp, insect, and mussel species.

Avian Survey Results

We conducted 175 point counts for **red-shouldered hawk** within the game area. Adults were detected at 16 of the 175 points. We found 10 potential raptor stick nests near points with red-shouldered hawks, of which only one appeared to be active as indicated by nest decoration. The active nest was located west of the Black River in the northwest ¼ of section 27 near the western property boundary and east of Abottsford Road (Figure 9).

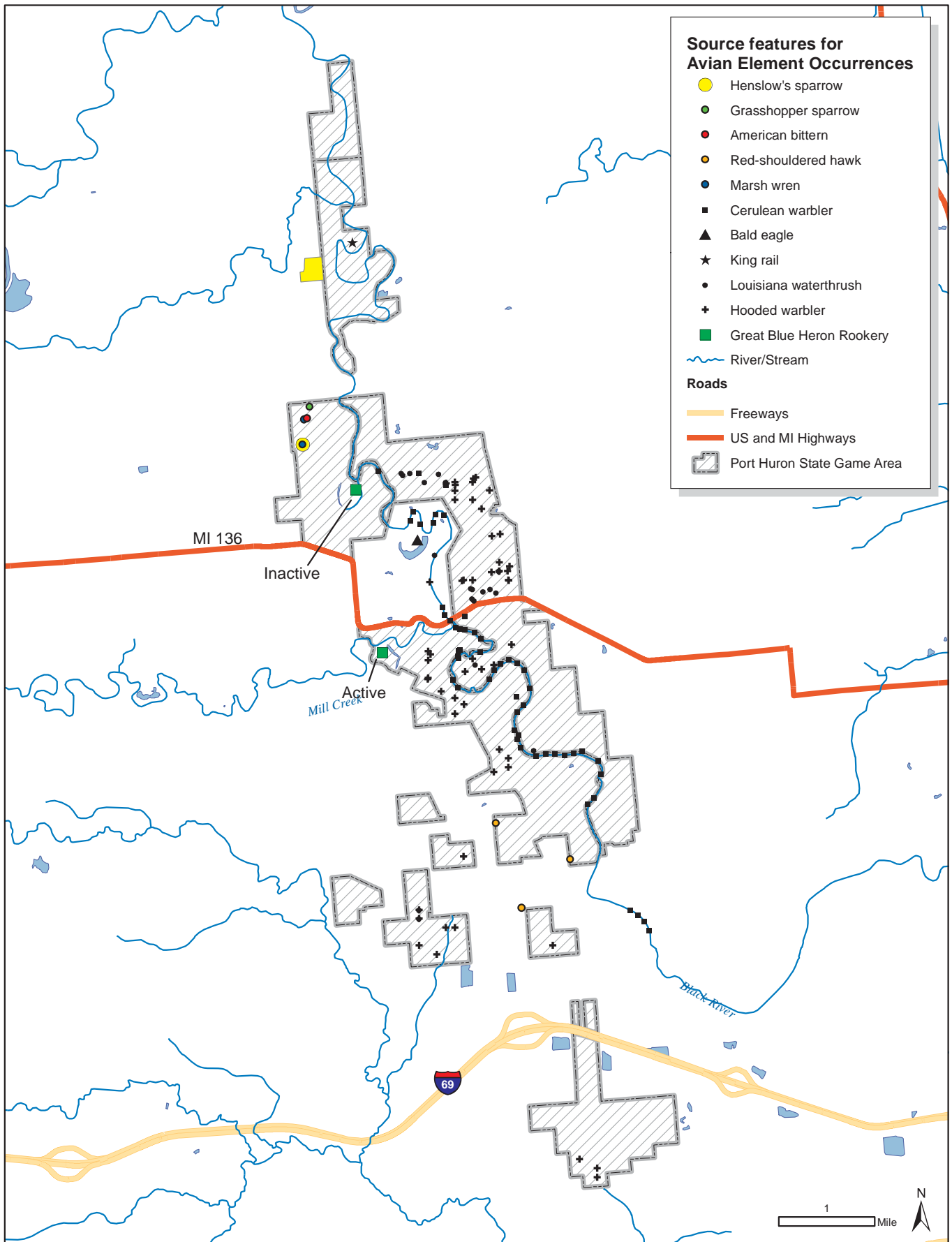


Figure 9. Avian element occurrences.

We completed 146 point counts for rare forest-nesting songbirds in Port Huron State Game Area. Three rare species, Louisiana waterthrush, hooded warbler, and cerulean warbler, were observed. Although all three species were previously observed in the game area, our systematic surveys resulted in many new locations that greatly expanded the existing element occurrences.

We documented 18 observations of **Louisiana waterthrush** at 18 locations in the game area (Figure 9 and Appendix 5). Eight of these observations occurred during systematic point count surveys, whereas the remaining 10 observations were made while conducting other surveys. Michigan Audubon also recorded Louisiana waterthrush at two locations along the Black River (Robert Haas pers. comm.; Figure 9). Most Louisiana waterthrush observations were made near small tributary creeks to the Black River, especially those to the north of Beard Road/136 and south of Metcalf Road.

Hooded warbler was the most common of the three target songbird species observed in the game area. We documented 54 observations at 52 locations, of which 30 were recorded during systematic point counts and 22 were observed while conducting other surveys (Appendix 5). Michigan Audubon detected a hooded warbler at one point on the Black River while conducting surveys for cerulean warblers (Robert Haas pers. comm.). Approximately two thirds of all hooded warbler observations occurred in forest near the Black River within the central portion of the game area to the north of Imlay City Road and south of Metcalf Road. The remaining hooded warblers were documented at scattered locations in the southern portion of the game area (Figure 9).

We documented **cerulean warblers** at seven locations within the game area (Figure 9). Two observations were made during systematic point counts (Appendix 5) and five while conducting other surveys. Most cerulean warbler observations occurred near the Black River. Other cerulean warbler surveys were coincidentally conducted by Michigan Audubon volunteers along the Black River via canoe/kayak. The Michigan Audubon point counts were conducted at 0.1-mile intervals along the river between Norman Road and Wadhams Road (Figure 5). Each point was surveyed twice between early and mid June. Michigan Audubon recorded 22 cerulean warblers at 18 points during the first survey and 31 cerulean warblers at 29 points during the second survey, which resulted in a total of 53 observations at 42 points along the river.

While conducting surveys for rare songbirds, we also recorded all other bird species observed. In total, 63 bird species were documented during the 146 point counts

conducted in the forested areas of the game area (Appendix 5). In addition to the rare species mentioned above, 13 SGCN were documented, including four DNR featured species (Table 3 and Appendix 5). The two most common SGCN were Acadian flycatcher (*Empidonax vireescens*; 66 individuals at 53 points) and wood thrush (*Hylocichla mustelina*, DNR featured species; 61 individuals at 52 points) (Appendix 5). Northern flicker (*Colaptes auratus*) was the third most common SGCN, with 16 individuals recorded at 13 points. Canada warbler (*Cardellina canadensis*; 9 individuals at 8 points) and eastern towhee (*Pipilo erythrophthalmus*; 8 individuals at 7 points) were the fourth and fifth most common SGCN, respectively. The remaining bird SGCN were observed sporadically (4 or less points): Green heron (*Butorides vireescens*), killdeer (*Charadrius vociferus*), yellow-billed cuckoo (*Coccyzus americanus*), black-billed cuckoo (*Coccyzus erythrophthalmus*), northern parula (*Setophaga Americana*), and black-throated blue warbler (*Setophaga caerulescens*, DNR featured species), golden-winged warbler (*Vermivora chrysoptera*, DNR featured species), and blue-winged warbler (*Vermivora pinus*).

Three additional rare bird species, **American bittern**, **marsh wren**, and **grasshopper sparrow**, were observed during meander surveys conducted in an area of grassland containing a two small constructed wetlands (Figure 9). An American bittern was observed in one of the constructed wetland, and several marsh wrens were seen and heard calling in the adjacent grassland. The American bittern observation represents a new element occurrence, whereas marsh wren was documented nearby in 2006. One singing male grasshopper sparrow was observed in the grassland, which is a new element occurrence for the game area. Henslow's sparrow was recorded at the site previously (2000-2006), but was not observed in 2011.

A new **great blue heron rookery** was documented within an abandoned oxbow channel of Mill Creek in the east-central portion of the game area. At the time of the survey in April 2011, the area was flooded and contained many dead standing green ash (*Fraxinus pennsylvanica*) and an abundance of floating aquatic plants such as duckweed (*Lemna minor*) and watermeal (*Wolffia* sp.). In addition to this new rookery, a previously documented great blue heron rookery (EO#103) was revisited during the IFMAP Stage 1 Inventory in 2010. This site no longer contains standing trees, and the rookery (EO #103) was determined to be inactive. The new rookery (EO#322) was entered into Bitoics, and the former record was updated.

Lastly, both **bald eagle** (*Haliaeetus leucocephalus*, state special concern) and **osprey** (*Pandion haliaeetus*, state special concern, DNR featured species) were occasionally

heard and observed as we conducted surveys in the Black River and Mill Creek corridors. An active bald eagle nest occurs north of M136 within approximately 500 m (< .33 miles) of the game area (Figure 9). These species regularly utilize habitat within PHSGA for foraging and perching. The structurally diverse forests along within the Black River corridor such as the Port Huron Mesic Northern Forest and Black River Floodplain Forest likely provide important habitat for these species (Figure 8). Other raptors observed during our surveys but not documented as breeding within the game area include a pair of juvenile golden eagles (*Aquila chrysaetos*) in migration, broad-winged hawk (*Buteo platypterus*), and red-tailed hawk (*Buteo jamaicensis*).

Reptile and Amphibian Survey Results

Amphibian and reptile surveys in the PHSGA documented a new element occurrence of the Blanding's turtle, and updated a previously documented element occurrence of the Blanchard's cricket frog (Table 2 and Figure 10). In

addition, three SGCN were documented including the spotted salamander, blue-spotted salamander, and western chorus frog (Table 3) (Eagle et al. 2005).

An adult **Blanding's turtle** was observed basking on 20 May on a log in a small emergent wetland with open water (Compartment 3, Stand 245) located within a large forested hardwood swamp complex south of US-69 and south of Flinchbaugh Road and west of Ditty Road (T6B R16E Section 9 NE1/4). This wetland is located on the north side of railroad tracks that run east-west through the forested swamp complex. The railroad tracks impounded the natural water flow in this area and likely created or expanded this open water wetland as well as several other emergent, open water wetlands along the railroad track. The forested swamp complex includes additional small wetland inclusions, including an inundated shrub swamp and vernal pools, surrounded by northern hardwood and mixed upland deciduous forest.



Egg masses (pictured above) of the spotted salamanders (*Ambystoma maculatum*) and blue-spotted salamanders (*Ambystoma laterale*) and/or blue-spotted salamander unisexual hybrids were found in a small forested vernal pool within the Port Huron Mesic Northern Forest (Compartment 3, Stand 141) (Photo by Yu Man Lee).

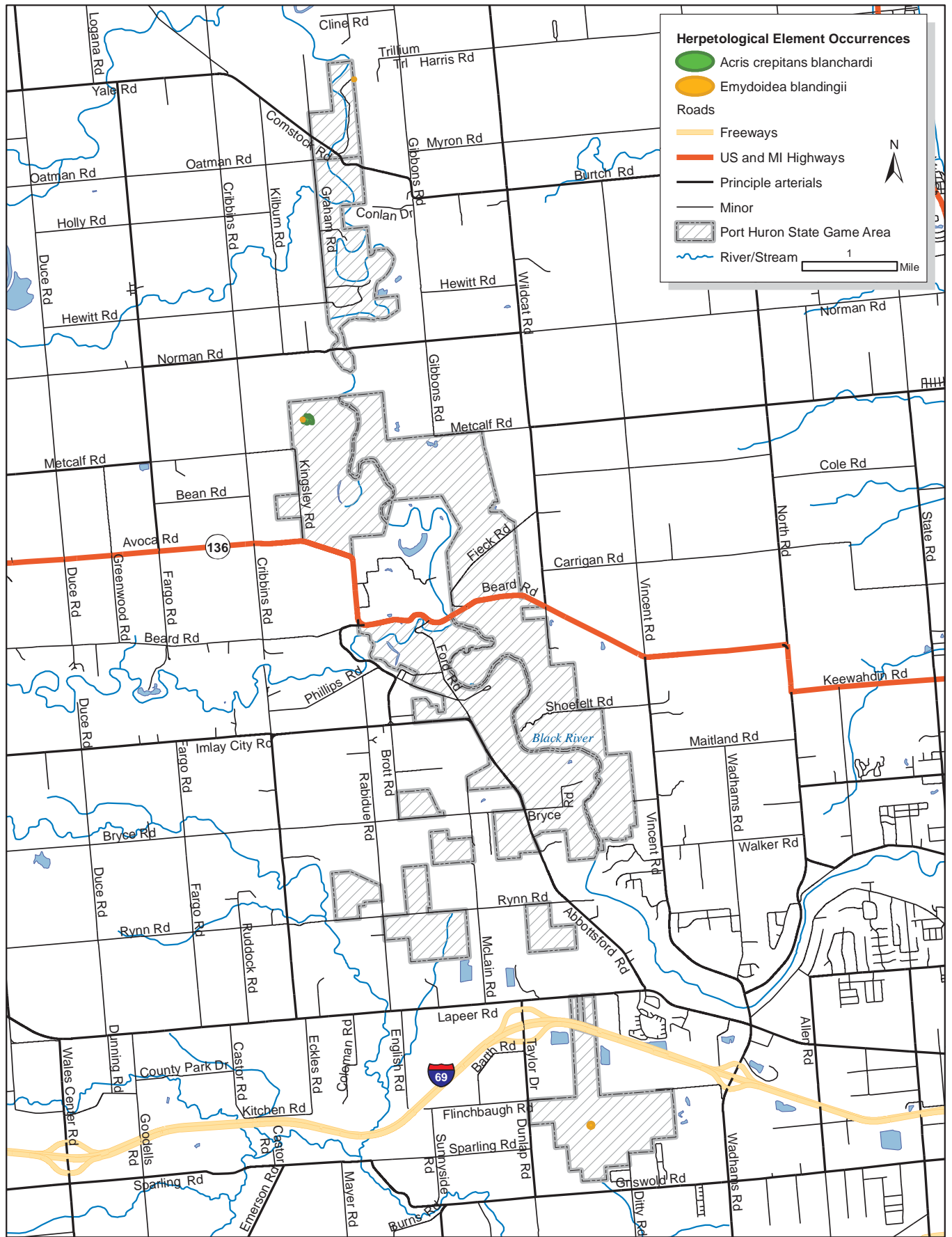


Figure 10. Herpetological element occurrences.



Aquatic funnel trapping in June captured 77 *Ambystomatid* salamander larvae in a small forested vernal pool within the Port Huron Mesic Northern Forest (Compartment 3, Stand 141) (Photo by Ann Zurbriggen).

Breeding frog call surveys in 2011 reconfirmed a previously documented occurrence of **Blanchard's cricket frog** in a created emergent wetland mitigation site (Compartment 3, Stand 2) located west of the Black River approximately 0.3 mile northeast of the intersection of Kingsley and Metcalf roads (T8N R16E Section 31 SE1/4). One cricket frog was heard calling on 20 May, and overlapping calls of this species were heard on 2 June. Green frogs (*Lithobates* [*Rana*] *clamitans*) also were seen and heard calling at this site on 2 June. Several painted turtles (*Chrysemys picta*) also were seen basking in this wetland on 2 June. No cricket frogs were seen or heard calling at a smaller created emergent wetland mitigation site (Compartment 3, Stand 4) adjacent to this wetland.

Trapping with aquatic funnel traps in April failed to capture any adult salamanders of the targeted species, but egg mass surveys were able to document egg masses of spotted salamanders and blue-spotted salamanders and/or blue-spotted salamander unisexual hybrids (Photo H6 – Blue-spotted and hybrid egg masses) in a small forested vernal pool within the Port Huron Mesic Northern Forest

(Compartment 3, Stand 141) on the east side of the Black River in T7S R16E Section 22 SW1/4. Aquatic funnel trapping in June captured 77 *Ambystomatid* salamander larvae in this pool. These included larvae of spotted salamanders, blue-spotted salamanders and/or blue-spotted salamander hybrids (Photo H7 - salamander larvae). None of the larvae were identified as smallmouth salamander larvae because none had a well-pigmented throat which is a key characteristic that distinguishes this species from spotted and blue-spotted salamanders. Adult smallmouth, spotted, and blue-spotted salamanders or their egg masses were not documented in the other three wetlands in which aquatic funnel trapping and egg mass surveys were conducted.

Nine additional amphibian and reptile species were documented during herp surveys in the PHSGA in 2011 (Appendix 3). These include the eastern newt (*Notophthalmus viridescens*), eastern red-backed salamander (*Plethodon cinereus*, DNR featured species), eastern American toad (*Anaxyrus* [*Bufo*] *americanus americanus*), western chorus frog (*Pseudacris triseriata*

triseriata), northern spring peeper (*Pseudacris crucifer crucifer*), gray treefrog (*Hyla versicolor*) green frog (*Lithobates [Rana] clamitans melanotus*), wood frog (*Lithobates [Rana] sylvaticus*), and painted turtle (*Chrysemys picta*). Five eastern newts were captured in aquatic funnel traps in three of the four wetlands in which trapping was conducted (Compartment 3, Stand 141 - T7S R16E Section 22 SW1/4, Stand 163 - T7S R16E Section 29 NE1/4, and Stand 201 - T7N R16E Section 32 NE1/4). A number of red-backed salamanders were found on 22 April under logs and other woody debris around the forested vernal pool and in the surrounding upland forest in Compartment 3, Stand 141. A red-backed salamander also was found on 22 April around the forested swamp depression in Compartment 3, Stand 201. An eastern American toad was observed on 31 May during visual encounter surveys in T7N R16E Section 21 NE1/4. A gray treefrog was heard calling on 20 May in or around an emergent wetland (Compartment 3, Stand 239) along the railroad track just west of the Blanding's turtle site in T7N R16E Section 32. Green frogs were seen and/or heard calling in the created wetland mitigation site (Compartment 3, Stand 2) in which cricket frogs were documented on 2 June, in the emergent wetland in which the Blanding's turtle was observed (Compartment 3, Stand 245) on 20 May, in T7N R16E Section 6 NE1/4 on 24 May, and in T7N R16E Section 21 NE1/4 on 31 May. Green frogs also were documented in three of the four wetlands in which trapping was conducted in June (Compartment 3, Stands 141, 163 and 201). Western chorus frogs were heard calling from the parking area in T17N R16E Section 22 on the way to Compartment 3, Stand 141 on 21 April, and Northern Spring Peepers were heard calling in the distance from Compartment 3, Stand 113 in T7N R16E Section 16. Wood frogs were documented in Compartment 3, Stand 113 during egg mass surveys on 21-22 April and in Compartment 3, Stands 163 and 201 during aquatic funnel trapping surveys on 23-24 June. A wood frog also was documented in the NE1/4 of T7N R16E Section 21 during visual surveys on 31 May. Painted turtles were observed basking in emergent wetlands along the railroad track in Compartment 3, Stands 245 and 267 in the NE1/4 of T7N R16E Section 32 where the Blanding's turtle was observed and nearby on 20 May, in Compartment 3, Stand 18 in the NE1/4 of T7N R16E Section 6 on 24 May, and in the created emergent wetland mitigation site (Compartment 3, Stand 2) with the cricket frogs on 2 June.

Tree Cricket Survey Results

The low branches of conifer trees, primarily hemlock, were swept in four locations within the game in early to mid August, 2011. Although unknown species of tree crickets were frequently heard calling from the upper branches of nearby trees, none were captured for identification. Because

the PHSGA supports extensive potential habitat for the tamarack tree cricket (state special concern) and pine tree cricket (state special concern), a more thorough survey is needed before concluding that these species are absent from the game area.

Mussel Survey Results

The stretches of the Black River and Mill Creek that flow through the PHSGA support both high unionid mussel species richness and a high number of listed species. In fact, 25 of the 46 (54%) species known to occur in Michigan were found during this survey, including 11 rare species (Appendices 6 and 7). Survey results included documenting six new EOs and updating six previous records. New EOs were documented for the following species: purple wartyback (*Cyclonaias tuberculata*, state threatened), black sandshell (*Ligumia recta*, state endangered), three-horned wartyback (*Obliquaria reflexa*, state endangered), kidney shell (*Ptychobranchus fasciolaris*, state special concern), deertoe (*Truncilla truncata*, state special concern), and rainbow (*Villosa iris*, state special concern) (Table 2). Updated EOs were processed for the following species: elktoe (*Alasmidonta marginata*, state special concern), slippershell (*Alasmidonta viridis*, state threatened), wavy-rayed lampmussel (*Lampsilis fasciola*, state threatened), round hickorynut (*Obovaria subrotunda*, state endangered), rayed-bean (*Villosa fabalis*, federally and state endangered), and rainbow (state special concern) (Table 2). Also documented were two non-listed SGCN, the cylindrical papershell (*Anodontoides ferussacianus*) and pimpleback (*Quadrula pustulosa*) (Tables 3). Three shells of the federally and state endangered rayed bean were found in Mill Creek at three locations ranging from approximately 0.25 to 0.4 miles upstream from the confluence with the Black River. These were found in a meander search while walking Mill Creek. State endangered, threatened, or special concern species were found at nine of the ten sites surveyed in addition to the three incidental finds mentioned above (Appendix 7). No zebra mussels or Asian clams were found in this survey. Severe erosion of the stream bank was noted at Site 2 in Mill Creek. Physical and chemical habitat measures are provided in Appendices 8 and 9, respectively.

In the summer of 2003, unionid mussel surveys were performed at three sites within PHSGA (Badra 2004). These were located in the Black River just south of M-136 (BL1), Mill Creek adjacent to the M-136 parking area (BL2), and Black River just north of Comstock Rd. (BL3). These sites correspond (respectively) to Site 8, Sites 2 and 3, and Site 5 in this 2011 survey (Figure 7). Incidental finds at Sites A, B, and C also fall within the area searched at BL2 in the 2003 survey (Figure 7). Qualitative survey methods were used in 2003 in order to maximize



Unionid mussels found in Mill Creek at mussel survey Site 3 and pictured above include the following eight species: elktoe (*Alasmidonta marginata*, state special concern), spike (*Elliptio dilatata*), wavy-rayed lampmussel (*Lampsilis fasciola*, state threatened), fatmucket (*Lampsilis siliquoidea*), pocketbook (*Lampsilis ventricosa*), white heelsplitter (*Lasmigona complanata*), fluted-shell (*Lasmigona costata*), and strange floater (*Strophitus undulatus*) (Photo by Sarah Coury).

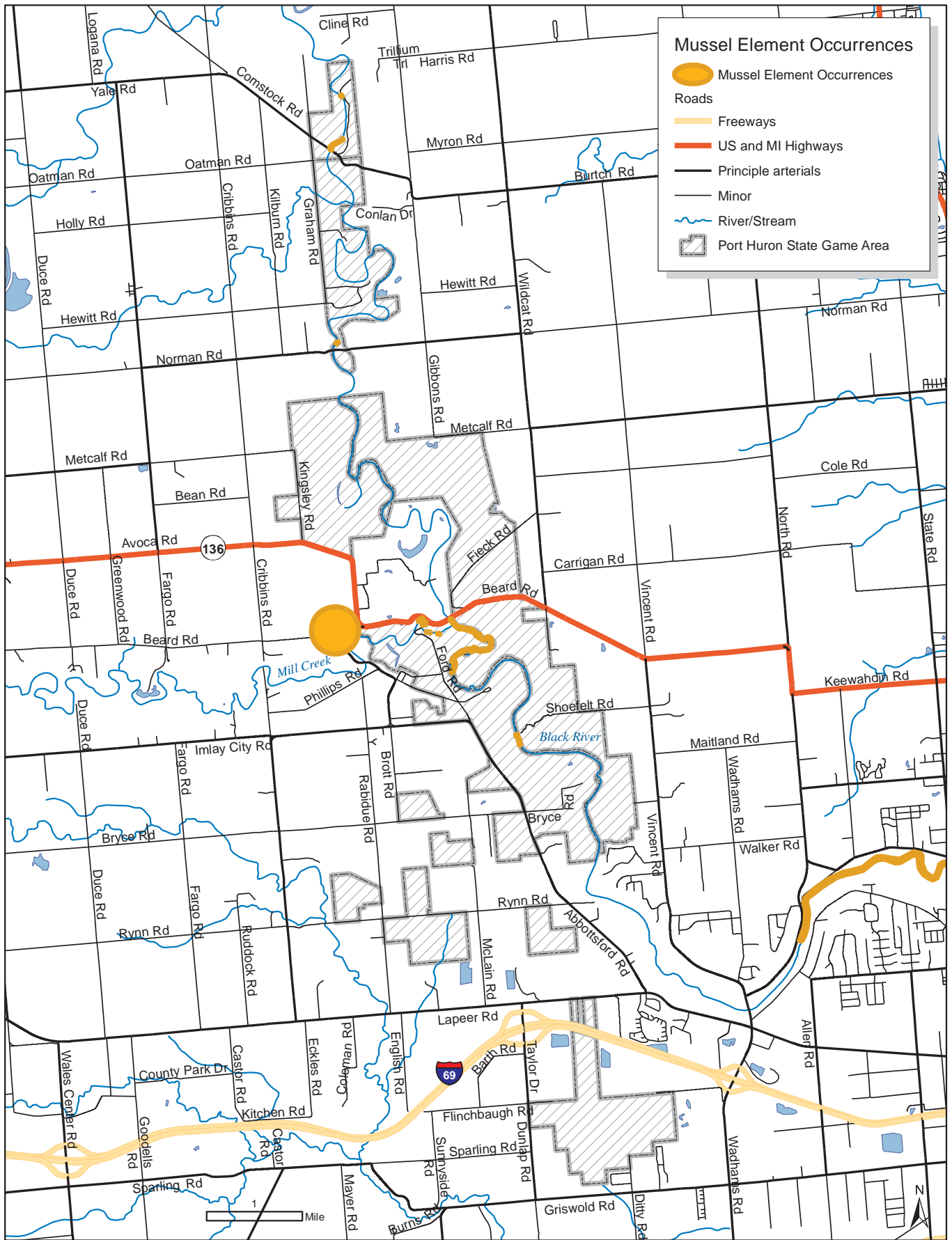


Figure 11. Mussel element occurrences.

the chances of finding the very rare northern riffleshell (*Epioblasma torulosa rangiana*, federally and state endangered); therefore, results between 2003 and 2011 are only roughly comparable. Twenty person-hours were spent surveying BL2 covering approximately 600m². Fourteen species were found at BL2 in 2003 versus ten species at Sites 2, 3, A, B, and C combined in 2011 (Appendix 7 and Figure 7). One live salamander mussel (*Simpsonaias ambigua*, state endangered and federal candidate) was found at BL2 in 2003, but no live individuals or shells of this species were found in 2011.

Mill Creek Water Chemistry Measures: Conductivity, which ranged from 695-700 μ S, was somewhat high but not unusually so (Appendix 9). Conductivity, a measure of the ability of water to carry an electrical current, is determined by the amount of inorganic dissolved substances including chloride, nitrate, sulfate, and phosphate (negatively charged ions), and sodium, magnesium, calcium, iron, and aluminum (positively charged ions). The geology of a given watershed is normally a strong factor in determining the amount of these substances present in river water. Streams, such as the Black River and Mill Creek, that run through clay soils pick up materials in the clay that ionize in water resulting in higher conductivity, while streams that run through areas dominated by granitic bedrock, like parts of the western Upper Peninsula, have lower conductivity

because granite has an abundance of minerals that do not ionize in water. Conductivity can be affected by point and non-point discharges into streams as well. Input of chlorides, phosphate, and nitrates can raise conductivity in rivers and lakes. Unusually high conductivity measures can be indicative of impacts such as excessive input of fertilizer or sewage overflows. Conductivity of rivers in the United States ranges between 50 and 1500 μ S. Streams supporting good fisheries typically measure between 150 and 500 μ S.

Alkalinity and hardness measures in Mill Creek, which ranged from 175-420 mg/l CaCO₃, and 300-320 mg/l, respectively, indicate relatively hard water with plenty of buffering capacity to help protect aquatic life from normal fluctuations in pH (Appendix 9). Alkalinity is a measure of how much calcium carbonate (mg/liter of CaCO₃) is present in water and is one factor in determining how much acid can be added to water without causing a change in pH. In this way, alkalinity buffers against rapid changes in pH. Hardness is a similar measure and accounts for other minerals such as magnesium and iron, in addition to calcium carbonate. Alkalinity is influenced by the surficial geology of the watershed. Streams flowing through areas with limestone tend to have high alkalinity. The U.S. EPA has suggested that 20 mg/l CaCO₃ is a minimum to support aquatic life.



The Black River (pictured above) and its tributary Mill Creek flow through Port Huron State Game Area where they support at least 25 species of unionid mussels or over half (54%) of all mussel species known from Michigan, including 11 rare species (Photo by Sarah Coury).

DISCUSSION

Natural Community Discussion and Recommendations

Descriptions of each natural community EO and associated management recommendations are provided in the Results section above. In addition, management recommendations for each natural community occurrence are listed in Table 4, and a list of invasive plants for each natural community occurrence appears in Table 5.

Forest Biodiversity

The PHSGA supports over 2,100 acres (>850 ha) of high quality forest. Because the landscape surrounding PHSGA is dominated by agriculture (Figure 3), the large area of forest within the game area serves as an important island of biodiversity for the local region. Maintaining the forest canopy will help ensure that high quality habitat remains for the diverse array of plants and animals, including the many rare species and SGCN that utilize this forested island.

The forests at PHSGA are structurally complex, which greatly contributes to their ability to support a diverse flora and fauna. Contributing to the complex forest structure at PHSGA are the following factors: the presence of a wide diversity forest types; the prevalence of large-diameter conifers such as hemlock and white pine; a multi-generational canopy; frequent windfalls and associated light gaps, large-diameter coarse woody debris, dead standing snags, and pit-and-mound microtopography; drastic changes in elevation, slope (from level to steep), and aspect; an abundance of cold, headwater streams and groundwater seeps; and the Black River and Mill Creek, which continue to meander and carve through the clay lakeplain, and thereby create a plethora of diverse habitats.

This complex forest structure supports very high levels of plant and animal diversity. In total, these forests provide habitat for over 300 species of native plants, including eight rare species, as well as over 60 bird species, including three rare songbirds and three rare raptors. The conservation significance of these forests is further heightened by the presence of at least 21 SGCN, including 17 bird and four herp species (two salamander, one frog, and one rare turtle species). Lastly, the forests at PHSGA provide habitat for the following five DNR featured species: red-shouldered hawk, wood thrush (*Hylocichla mustelina*), black-throated blue warbler (*Setophaga caerulescens*), golden-winged warbler (*Vermivora chrysoptera*), and eastern red-backed salamander (*Plethodon cinereus*).

In addition to the complex forest structure, another factor contributing to the high plant and animal diversity of the forests at PHSGA is that many plant and animal species

reach their range limits within Michigan in this area. For example, hemlock, white pine, and paper birch are common within the PHSGA and farther north but are uncommon to rare farther south within the state. Conversely, tulip tree, shagbark hickory, bitternut hickory, sycamore, and black maple, occur in abundance within the game area and farther south but are uncommon to rare farther north. As might be expected, this range-limit phenomenon was also observed within the avian community at PHSGA (see Avian Discussion and Management Recommendations below). Thus, the forests of PHSGA provide critical habitat to species approaching their southern range limit as well as those nearing their northern range limit.

Factors that likely contribute to PHSGA acting as a climate refugia for both northern and southern species include its proximity to Lake Huron, an abundance of deep ravines, the prevalence of cold, groundwater seepage both on the level lakeplain and within the numerous ravines where it forms headwater streams, and the meandering Black River and Mill Creek. Because moisture helps buffer temperature change, the proximity of Lake Huron along with an abundance of groundwater seepage and flowing surface water significantly moderates the local climate of the game area. In addition, since cold damp air collects in the lowest parts of the landscape, the ravines are often cooler and more humid than the adjacent level lakeplain, which likely allows them to support plant and animal species that are adapted to a shorter growing season, such as conifers. Lastly, plants growing in the ravines receive fewer hours of direct sunlight than species in the adjacent level areas, further contributing to a cooler and moister ravine microclimate and strongly favoring shade-adapted, hydrophilic (moisture loving) species like hemlock and many ferns.

Invasive Species

Invasive species pose a major threat to species diversity and habitat heterogeneity within the game area. 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 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, non-native invasive species often have no natural predators and spread aggressively through rapid sexual and asexual reproduction.



The Port Huron Mesic Northern Forest (pictured above) along with other forested areas of Port Huron State Game Area provide habitat for over 300 species of native plants, including eight rare species, as well as more than 60 bird species, including three rare songbirds and three rare raptors. The conservation significance of these forests is further heightened by the presence of at least 21 SGCN, including 17 bird and four herp species (two salamander, one frog, and one rare turtle species), and five DNR featured species (Photo by John Fody).

While numerous invasive species occur within the game area, the species likely to pose the greatest threats because of their ability to invade and quickly dominate intact natural areas in southern Lower Michigan include garlic mustard (*Alliaria petiolata*), Japanese barberry (*Berberis thunbergii*), Oriental bittersweet (*Celastrus orbiculata*), autumn olive (*Elaeagnus umbellata*), Dame's rocket (*Hesperis matronalis*), moneywort (*Lysimachia nummularia*), Amur honeysuckle (*Lonicera maackii*), Morrow's honeysuckle (*Lonicera morrowii*), reed canary grass (*Phalaris arundinacea*), common reed (*Phragmites australis*), glossy buckthorn (*Rhamnus frangula*), black locust (*Robinia pseudoacacia*), multiflora rose (*Rosa multiflora*), and coltsfoot (*Tussilago farfara*). Additionally, new invasive species that were not seen in PHSGA, such as Japanese knotweed (*Polygonum cuspidatum*), have great potential to erode biodiversity should they become established. Newly establishing invasive 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 the following website: <http://www.imapinvasives.org/GIST/ESA/index>

Fire as an Ecological Process

In the past, lightning- and human-set fires frequently spread over large areas of southern Michigan and other Midwestern states (Curtis 1959, Dorney 1981, Grimm 1984). Historically, fire likely occurred frequently within the dry-mesic northern forests of the PHSGA because of their level topography and combustible vegetation (oaks, pines, blueberry, Pennsylvania sedge, etc.). At present, these forests are experiencing strong regeneration of thin-barked, shade-tolerant trees such as red maple and invasive shrubs such as multiflora rose and autumn olive. A sustained fire-management program would reduce the density of shade-tolerant seedlings, saplings, and invasive shrubs and help facilitate increased recruitment of fire-adapted native shrubs, conifers, oaks, and hickories.

Depending on the season and intensity of a burn, prescribed fire may be used to decrease the cover of invasive woody species, and increase the cover of native grasses and forbs (White 1983, Abrams and Hulbert 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-terranean animals can temporarily move out of an area being burned. Smaller and less mobile species can die in fires; this includes some rare insects (Panzer 1998) and reptiles. Dividing large contiguous areas into two or more separate burn units that can be burned in alternate years or seasons can protect populations of many species. This allows unburned units to serve as refugia for immobile invertebrates and slow-moving amphibian and reptile species. When burning relatively large areas, it may be desirable to strive for patchy burns by burning either when fuels are somewhat patchy or when weather conditions will not support hot, unbroken fire lines (such as can occur under atypically warm, dry weather and steady winds). These unburned patches may then serve as refugia, which can facilitate recolonization of burned patches by fire-sensitive species. In addition, burning under overcast skies and when air temperatures are cool (<55°F) can help protect reptiles, since they are less likely to be found basking above the surface when conditions are cloudy and cool. Conducting burns during the dormant season (late October through March) may also help minimize impacts to reptiles.

Setting Stewardship Priorities

Threats such as invasive species are common across the PHSGA. Although the list of stewardship needs may outweigh available resources, prioritizing activities can help close the gap between resource needs and availability. We recommend using the following criteria for prioritizing stewardship efforts:

- 1) Focus on high quality sites, such as natural community EOs, with minimal infestations of invasive species. Biodiversity is most easily and effectively protected by preventing high quality sites from degrading, and invasive plants are much easier to eradicate when they are not yet well established, and their local population size is small.
- 2) Concentrate on sites that harbor high levels of native species diversity or unique elements of biodiversity (e.g., Port Huron Mesic Northern Forests, Port Huron Dry-mesic Northern Forests, Black River Floodplain Forest, and Rynn Road Hardwood Swamp).
- 3) Choose sites that enhance core areas of high quality habitat or act as critical corridors for wildlife. At PHSGA, this includes sites such as the Port Huron Mesic Northern Forest and Black River Floodplain Forest, which occur within the Black River corridor.
- 4) Work at high profile sites that are 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.

Rare Plant Discussion and Management Recommendations

Beak grass (*Diarrhena obovata*) is a state threatened species found primarily in floodplain forests in Lower Michigan, and is now known from 25 occurrences ranging throughout southern Lower Michigan below the floristic tension zone. This clump-forming species usually occurs in small, localized colonies of fewer than 100 plants. At Port Huron, this species was observed growing sparsely within a high quality floodplain forest. Occurrences discovered and reconfirmed in Lower Huron, Willow, and Oakwoods Metroparks in 2002-2003 are unusually large (e.g., 2,000 to 10,000 plants) and comprise some of the most extensive, contiguous populations in the state. Additional occurrences, some of which are extensive, have been discovered in recent years along the Maple River and also the Thornapple River, and the species is likely present in other large, southern Michigan riparian systems as well. This species can be recognized in sterile form throughout the growing season by experienced botanists but is most easily identified in August and September by its characteristic inflated spikelets. Longer-term conservation strategies to protect beak grass include removing invasive species, protecting the hydrology of river systems and corresponding cyclical flooding regimes, maintaining healthy, intact, mature floodplain forests, and using conservation planning and restoration to connect previously fragmented floodplain forests to create contiguous riparian corridors. For more information see the

plant abstract for beak grass (O'Connor and Penskar 2004) available at: http://mnfi.anr.msu.edu/abstracts/botany/Diarrhena_obovata.pdf

Broad-leaved puccoon (*Lithospermum latifolium*) is a state special concern species known only from floodplain forests, occurring primarily in southern Lower Michigan and ranging to just north of the floristic tension zone. At Port Huron, this species was observed growing very sparsely (only a few individual plants) near streams within ravines and within floodplain forests along the Black River. This species has relatively few occurrences for a plant in this listing category, as it is known from only 18 occurrences within the state, seven of which (nearly 40% of the total) are classified as historical records, although it is generally considered to be overlooked. This small, somewhat obscure forb is typically found along riverbanks and in rich woods and edges associated with floodplains. Unlike the familiar colorful puccoons of prairies, oak barrens, and dunes, broad-leaved puccoon has smaller, pale-yellow flowers, which produce hard, white, stony fruits similar to those found in the upland puccoon species. Longer-term conservation strategies to protect beak grass include removing invasive species, protecting the hydrology of river systems and corresponding cyclical flooding regimes, maintaining healthy, intact, mature floodplain forests, and using conservation planning and restoration to connect previously fragmented floodplain forests to create contiguous riparian corridors. For more detailed information see the MNFI Rare Species Explorer summary for broad-leaved puccoon at: <http://mnfi.anr.msu.edu/explorer/species.cfm?id=13723>

Canada milk vetch (*Astragalus canadensis*) is listed as state threatened, and is known from 26 statewide occurrences, although 15 occurrences (58%) are known only from historical records and may no longer be extant. At Port Huron, only one small population of this species was observed growing near the edge of a low cliff that borders the Black River. Relatively little is known about this species, which is widely distributed in the state, and for which most records provide very limited habitat information. It occurs in a several habitat types, including oak barrens, open areas in rich, moist soil over limestone, and in moist openings, wet ground, and along sandy lake shores, thus representing a wide diversity of potential natural communities. This species may also occur in such natural communities as lakeplain oak openings, lakeplain wet-mesic prairie, and mesic sand prairie. The status of this species in Michigan is very poorly known, and thus it is difficult to provide specific management guidelines and recommendations. Given the known habitat types, this species may benefit from prescribed fire and other management activities that maintain seral plant communities and openings. The primary need for this species at present is to conduct

status surveys to determine the condition of populations and acquire more detailed data on habitat and habitat requirements. For more detailed information see the MNFI Rare Species Explorer summary for Canada milk-vetch at: <http://mnfi.anr.msu.edu/explorer/species.cfm?id=14113>

Downy sunflower (*Helianthus mollis*) is listed as state threatened and is known only from 11 occurrences in Michigan, two of which are known only from relatively vague, historical records. At Port Huron, one clump of this species was observed near a bike trail on an old sandy beach ridge. With the exception of a western Upper Peninsula occurrence, which may represent an introduction, this species is restricted to southern Lower Michigan, where even within that region, some occurrences may also consist of introduced populations. This rare, perennial, clone-forming forb, which is very striking when in flower, is found in prairie remnants in open sandy ground, and in dry, sandy disturbed areas along railroads as well as in oak savannas. Much of the habitat type of this species been lost or severely degraded, and thus in order to persist, it likely requires the natural disturbances associated with prairie habitat, including fire management and possibly mechanical brush removal to prevent woody plant succession and maintain openings. For more detailed information see the MNFI Rare Species Explorer summary for downy sunflower at: <http://mnfi.anr.msu.edu/explorer/species.cfm?id=13540>

Goldenseal (*Hydrastis canadensis*) is listed as state threatened, and is known from 91 statewide occurrences, although 29 localities (32%) are known only from historical records and may no longer be extant. At Port Huron, two small populations of this species were observed growing in mesic northern forests within the floodplain of the Black River. 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, unsustainable timber removal, and competitive 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



Heart-leaved plantain (*Plantago cordata*, state endangered) occurs in deep ravines along cold, groundwater-fed, headwater streams that feed into the Black River. This species is known from less than a dozen occurrences in Michigan, all in the southern Lower Peninsula (Photo by John Fody).

more information see the rare plant abstract for goldenseal (Penskar et al. 2001) available at: http://mnfi.anr.msu.edu/abstracts/botany/Hydrastis_canadensis.pdf

Heart-leaved plantain (*Plantago cordata*) is listed as state endangered, and is known from 11 statewide occurrences, although six occurrences (54%) are known only from historical records. This species was also once known from several additional localities in southeastern Lower Michigan, including Washtenaw and Wayne counties, where it is now considered to be extirpated (Voss and Reznicek 2012). At Port Huron, this species was observed growing along groundwater streams in the bottoms of ravines near the Black River. Once under consideration for federal listing, this species occurs over a broad geographical range in eastern North American but tends to have rather localized populations. Heart-leaved plantain is an obligate wetland species found in forested floodplains and commonly in small streams and tributaries in bottomland forests and swamps. It is likely that this species is extirpated in a number of sites due to habitat fragmentation, changes to local

hydrology, and other land use practices coupled with the decline of small, widely distributed, isolated populations no longer able to interbreed and persist. Two of Michigan's largest occurrences occur in state game areas in Tuscola County and Ionia County, with a third vigorous population known in Hillsdale County, where the species was rediscovered by a botanist in 1990 after being classified as extirpated within the state. Watershed protection is the primary management and stewardship concern for this species, and it is unlikely that it can be maintained without the perpetuation of natural hydrological regimes. Land-use patterns in adjacent upland areas strongly influence the functioning of riverine systems and their tributaries, which this species depends on, and thus large-scale conservation planning should be employed to help sustain all known populations. For more information see the rare plant abstract for heart-leaved plantain (Penskar 2010) available at: http://mnfi.anr.msu.edu/abstracts/botany/Plantago_cordata.pdf



Painted trillium (*Trillium undulatum*, state threatened) occurs on level lakeplain sites with extremely acidic sandy soils, a high water table, and well developed pit-and-mound microtopography. This species is known from less than a dozen occurrences in Michigan, all within in St. Clair and Sanilac Counties (Photo by Michael Kost).

Painted trillium (*Trillium undulatum*) is a state endangered species known only from 11 occurrences within Michigan, three of which are known only from historical records. Of the remaining occurrences, only one is ranked as high quality, with the remainder comprising occurrences largely considered to be viable but of relatively modest size and condition. At Port Huron, this species was observed growing very sparsely (i.e., only a few plants per site) in wet-mesic forests characterized by pit-and-mound microtopography and acidic sandy soil. This striking, diminutive trillium is primarily an eastern species, ranging from the New England region to Georgia, reaching the western edge of its range in the Midwest. Throughout its range this species occurs in cool, moist forest with humus-rich, acid soils. In Michigan it occurs in low, moist second-growth woodlands with a strong preference for the tops and sides of small hummocks formed by tip-up mounds (via treefalls) and on the bases of old white pine stumps. Several occurrences of this species are currently protected in nature sanctuaries. Outside of these preserves, this species is threatened by habitat destruction through development

activities, and in some areas, excessive deer densities are also a concern due to their strong preference for trilliums as a favored browse. Maintaining a shaded environment and moist substrate appears to be an important consideration for management at present, although one study in the East found significant increases in painted trillium densities 10 to 14 years after a major canopy disturbance (Slater 2000). Until the natural history of this species is better understood in Michigan, the clearing of overstory trees is strongly discouraged. For more information see the rare plant abstract for painted trillium (O'Connor and Penskar 2004) available at: http://mnfi.anr.msu.edu/abstracts/botany/Trillium_undulatum.pdf

Wahoo (*Euonymus atropurpurea*) is listed as a state special concern species and is known from 23 occurrences in Michigan, all of which are distributed in southern Lower Michigan, with a locality documented in Midland comprising the northernmost occurrence near the state's floristic tension zone. At Port Huron, this species was observed near the Black River in a high quality floodplain forest. Wahoo

is primarily a species of eastern North America but occurs west to the Great Plains, and ranges as far south as Alabama and South Carolina. It is a wetland species occurring almost always in or near floodplain forests in Michigan, although it will occasionally occur in southern swamp forests. In floodplain forests this species is typically found on or close to riverbanks (e.g. levees) but can occur in any successive river bottoms or terraces away from the water's edge, including into adjacent upland forests along riparian areas. Wahoo is best stewarded by conserving the ecological integrity of the floodplain forest environment, which includes maintenance of hydrological regime (e.g. seasonal flooding cycles), protection from pollution, and control of the many competitive, non-native, invasive species that tend to invade and establish in riparian communities. Conservation efforts that work toward maintaining and restoring connectivity and enhancing the size of forest tracts and buffers will be the most effective over the long-term. For more detailed information see the MNFI Rare Species Explorer summary for wahoo (Penskar 2008) available at: http://mnfi.anr.msu.edu/abstracts/botany/Euonymus_atropurpurea.pdf

Avian Discussion and Management Recommendations Red-shouldered Hawk

Although we only documented one active nest, we observed adult red-shouldered hawks at several locations within the game area. Port Huron SGA and adjacent private lands have been known to support nesting red-shouldered hawks since 2004 (MNFI 2012). We suggest the draft *Management Guidelines for Red-shouldered Hawks on State-owned Lands in Michigan* be followed at the active nest site we identified and in other forest stands identified in the past that supported red-shouldered hawk nesting. Guidelines were developed for three zones surrounding an active nest: (1) nest tree zone (0 to 330 ft from nest tree); (2) buffer zone (330 to 660 ft from nest tree); and (3) tertiary zone (660 to 2,310 ft from nest tree). Management intensity decreases in each zone with increasing distance from the nest. No cutting or road construction should be conducted in the nest tree zone. Big-tree management, as described in the guidelines, should be applied in the buffer zone, which includes maintaining 85% average canopy closure. In the tertiary zone, an average canopy closure of 80% should be maintained and total openings should not



This Red-shouldered Hawk nest had been newly decorated in early April, 2011 (Photo by John Fody).

exceed 10% or 35 acre of the area. The draft guidelines suggest avoiding planned activities in all zones between March 1 and August 1 in northern Michigan; however, because this game area occurs in the southern Lower Peninsula, we believe this period should begin at February 1 and continue to July 15. We recommend periodic surveys for red-shouldered hawk to track its breeding status in the game area and identify active nesting territories, so that appropriate management actions can be implemented.

Rare Songbirds

We observed three rare songbird species, cerulean warbler, Louisiana waterthrush, and hooded warbler, during point count surveys, and all of these species are known to occur in landscapes dominated by mature deciduous forest. Management at the state game area has maintained large blocks of forest within a landscape dominated by agricultural land, residential development, and small forest fragments. These large blocks of forest are providing valuable nesting habitat for these and other neotropical migrant songbirds.

Port Huron SGA is unique in that it supports forest songbird species occurring at both northern and southern edges of breeding ranges. For example, the three rare songbird species observed are all near the northern edge of their breeding ranges in southern Michigan. Conversely, several forest-nesting songbirds at the southern edge of their breeding range were observed in the game area, including black-throated blue warbler (*Setophaga caerulescens*), black-throated green warbler (*Setophaga virens*), and blackburnian warbler (*Setophaga fusca*). The maintenance and expansion of mature forest blocks at the game area would benefit rare songbirds and other forest-interior bird species, such as Acadian flycatcher and wood thrush. Activities that reduce the cover of mature forest or increase forest fragmentation could reduce the value of the area to forest-interior nesting songbirds. Brown-headed cowbirds (*Molothrus ater*) were regularly observed in the game area (documented at 22% of points surveyed), so efforts to reduce forest fragmentation could decrease nest parasitism by this species on rare and other forest-interior songbirds.

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 adjacent upland forest at locations where Louisiana waterthrushes were observed.

We recommend conducting songbird point counts periodically to monitor use of the game area 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 rare songbirds are present at sites where the habitat appeared suitable, but they were not observed.

Other Rare Bird Species

Rare grassland (**Henslow's sparrow** and **grasshopper sparrow**) and wetland (**American bittern** and **marsh wren**) bird species have been recorded in the grassland and wetland complex northeast of the intersection of Kingsley and Metcalf roads. Maintaining the open nature of the grassland and emergent wetlands through periodic mowing or burning would benefit these bird species, as well as the Blanchard's cricket frogs known to occur in the wetlands at this site. Future surveys of this site are recommended to monitor for the continued presence of these species.

Reptile and Amphibian Discussion and Management Recommendations

Reptile and amphibian surveys conducted in 2011 were able to identify a new occurrence of the Blanding's turtle in the southern portion of the PHSGA. Prior to our surveys, Blanding's turtles had been documented in 2009 from two other sites in the northern and central portions of the PHSGA. These two sites comprise a single element occurrence or population because there appears to be extensive, intact habitat along the Black River corridor that connects these two sites, and these sites are located within the species' element occurrence separation distance as specified by NatureServe. This Blanding's turtle occurrence has been ranked as having good to fair viability or probability of persistence into the foreseeable future (i.e., at least 20-30 years, EO rank - BC) because of the extent and contiguous nature of available habitat at this site, the protected status of this occurrence, and the long-lived nature of this species. The viability of the new Blanding's turtle occurrence documented in 2011 has not been ranked (EO rank - E or extant) because of insufficient information at this time. Additional information regarding the size and

extent of the Blanding's turtle population at the new site and previously documented sites in the game area would help refine or clarify the estimated viability ranks of both these occurrences. Although there are a fairly large number of Blanding's turtle occurrences statewide, there are only four known extant occurrences of this species in St. Clair County including these two occurrences in the PHSGA. Thus, these occurrences in the PHSGA are significant and important to conserve, particularly from a local perspective given the highly fragmented and developed landscape in the surrounding area and county.

Maintaining viable populations of Blanding's turtles requires protecting and managing landscape complexes of suitable wetland and adjacent upland habitats (Lee 1999). Blanding's turtles inhabit clean, shallow waters with abundant aquatic vegetation and soft, muddy bottoms over firm substrates (Ernst et al. 1994). This species utilizes a variety of temporary and permanent wetlands and waterbodies including ponds, marshes, swamps, bogs, wet prairies, fens, river backwaters, embayments, sloughs, slow-moving rivers, protected coves, and lake shallows and inlets (Kofron and Schreiber 1985, Ernst et al. 1994, Harding 1997). It is important to protect clusters of small wetlands (<0.4 ha/1 ac) within habitat complexes for this species since it has been found to frequently use small, multiple wetlands, and these wetlands are highly vulnerable to destruction and degradation (Joyal et al. 2001). Blanding's turtles also require upland habitats (open and forested) for locating mates, nesting, basking, aestivating, and dispersing (Rowe and Moll 1991, Harding 1997, Joyal et al. 2001, NatureServe 2012). They prefer to nest in open, sunny areas with moist but well-drained sandy or loamy soil. It is important to maintain sufficient suitable overwintering and nesting sites within habitat complexes (Joyal et al. 2001). Suitable nesting habitat can be created if limited. Blanding's turtles also make frequent movements and may travel considerable distances over land to locate mates, nest sites, and aestivation sites (Harding 1997, Joyal et al. 2001, NatureServe 2012). Therefore, maintaining or restoring connectivity between suitable wetland and upland habitats within landscape complexes is essential for this species.

Minimizing mortality or loss of adult and juvenile Blanding's turtles also is important for maintaining viable populations of this species. The Blanding's turtle is a long-lived species characterized by delayed sexual maturity and low annual recruitment, and require high annual adult and juvenile survivorship (i.e., >93% adult survivorship and over 72% juvenile (ages 1-13) survivorship) to maintain stable populations (Congdon et al. 1993). Because this species is so long-lived (e.g., 60+ years), populations of this species can persist for a number of years even if population

recruitment is limited or not occurring (Congdon and van Loben Sels 1991, Congdon et al. 1993). 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).

Habitat fragmentation, nest predation, road mortality, and illegal collection can threaten the viability of Blanding's turtle populations, and some of these threats may occur in the PHSGA. Habitat fragmentation (e.g., due to roads, residential or agricultural development, land management activities) can lead to increased populations of meso-predators such as raccoons, skunks, opossums, and foxes, which can result in increased turtle nest predation and reduced or minimal population recruitment (Temple 1987). Predator control and protection of nest sites are management strategies that can help increase recruitment, and may be necessary to maintain populations of this species within the game area. Road mortality, in general, can pose a substantial threat to Blanding's turtles particularly because of the species' tendency to make frequent and long distance migrations over land (Joyal et al. 2001). Fencing (e.g., silt fencing) could be installed along roads where turtle road mortality is an issue. The railroad track that runs through the habitat complex in which the new Blanding's turtle occurrence is located could cause turtle mortality, especially if turtles are moving and/or nesting along the track. The Blanding's turtle also is vulnerable to illegal collection for personal collections, the commercial pet trade, and/or consumption (e.g., Asian turtle markets) (Harding 1997). Research and monitoring are needed to determine whether these threats are impacting the Blanding's turtle populations and other turtle populations in the PHSGA, and if so, ascertain the location and extent of these threats. Additional management and monitoring may be needed to address these threats and monitor the impact and effectiveness of management efforts.

Surveys in 2011 were able to confirm the continued persistence of the previously documented Blanchard's cricket frog occurrence in the PHSGA. This population of Blanchard's cricket frog was translocated and introduced to this site in 2004 and 2005 (MNFI 2012). This occurrence or population was estimated to have fair viability (EO rank – C?) because of the limited habitat available at this site. Blanchard's cricket frogs typically inhabit the open edges of permanent ponds, lakes, floodings, bogs, seeps and slow-moving streams and rivers (Harding 1997, Lee et al. 2000). They prefer open or partially vegetated mud flats, muddy or sandy shorelines, and mats of emergent aquatic vegetation



A variety of factors contribute to the complex community structure of the Port Huron Northern Mesic Forest (pictured above), including the following: a multi-generational canopy with an abundance of large-diameter conifers such as hemlock and white pine; frequent windfalls and associated light gaps, large-diameter coarse woody debris, dead standing snags, and pit-and-mound microtopography; drastic changes in elevation, slope, and aspect; an abundance of cold, groundwater-fed, headwater streams; and 10,000 or more years of carving and meandering by the Black River and Mill Creek (Photo by Michael Kost).

in shallow water (Harding 1997, Lee et al. 2000). Quiet, permanent water is essential for this species, with transient shallow pools occupied only if near a larger body of water (Harding 1997, Lee et al. 2000). Appropriate habitat for this species should be maintained at this site, and additional potential habitat should be identified and maintained, restored, and/or created in the surrounding area to increase available habitat for cricket frogs at this site. This would allow the population to expand and would enhance the long-term viability of this population. Blanchard's cricket frogs have declined significantly in southeast Michigan, and there are currently less than 20 known extant populations in southeast Michigan (MNFI 2012). Maintaining and expanding the cricket frog population in the PHSGA would contribute significantly to conservation of this species in southeast Michigan. Continued monitoring of this population also is recommended.

The occurrence of spotted salamanders, blue-spotted salamanders, and/or blue-spotted salamander complex unisexual hybrids in Compartment 3, Stand 141 has important implications for forest management within this stand. Salamanders can represent significant biomass and important components of food chains in forest ecosystems (Burton and Likens 1975). Salamanders also can serve as important bioindicators of ecosystem health because of their amphibious life cycles and permeable skin and eggs. Spotted and blue-spotted salamanders and other pool-breeding salamanders require vernal pools for breeding, but only inhabit these pools for a few days to a couple of weeks per year. They spend the majority of their time in the upland forest surrounding the breeding pools, and readily travel about 125 m (400 ft) or more from the breeding pools (Semlitsch 1998). Regosin et al. (2005) also found that spotted and blue-spotted salamanders wintered over 100 m (328 ft) from the breeding pool. Spotted and blue-spotted salamanders are considered to be forest management-sensitive species, and require relatively undisturbed upland forests with temporary woodland ponds of pH > 4.5 (Wilbur 1977, Downs 1989a and 1989b, DeGraaf and Rudis 1983, Van Buskirk and Smith 1991, deMaynadier and Hunter 1998, Petranka 1998, Knox 1999). Guerry and Hunter (2002) found that spotted salamanders and blue-spotted hybrid salamanders are positively associated with forest area and adjacency. Homan et al (2004) also found that spotted salamanders (and wood frogs) appear to have critical habitat thresholds in which species occupancy or probability of occurrence declines significantly below a certain level of suitable habitat, which was about 30% forest cover (although this varied slightly depending on distance from pool edge). *Ambystomatid* salamanders, such as the spotted and blue-spotted, also return to the same ponds to breed (Semlitsch et al. 1993). The main threats to spotted and blue-spotted salamanders are habitat loss

and degradation, deforestation, forest fragmentation, and acidification of breeding ponds.

Based on the ecology and habitat needs of spotted and blue-spotted salamanders, the following forest management recommendations have been developed for these species and are provided for Compartment 3, Stand 141 and other areas in the PHSGA with vernal pools and suitable upland forest in which these species might occur. Activities that disturb soils or tree canopies in and near vernal pools should be avoided or minimized, particularly during critical time periods for most amphibians (i.e., March through July) (Thomas et al. 2010). A buffer of native forest vegetation should be maintained around vernal pools to protect them from land use activities such as agriculture and development and alterations to water quality (Calhoun and deMaynadier 2008). Recommended concentric forest harvest buffer zones are 15-30 m (50-100 ft) around the pool with very limited (e.g., retain >70% canopy cover) or no harvest, and the next 120 m (400 ft) with limited harvest (e.g., retain \geq 70% of the area with \geq 75% canopy cover of trees \geq 9 m (30 ft) in height) and protection practices for the forest floor and woody debris (Calhoun and deMaynadier 2008, Massachusetts Natural Heritage and Endangered Species Program (MA NHESP) 2007, Michigan DNR and Michigan DEQ 2009). If feasible, extending the buffer zone beyond 140-180 m (450-600 ft) or greater would enhance conservation of these and other pool-breeding salamander species (Semlitsch 1998, MA NHESP 2007).

Many of the frogs and salamanders that were documented in the PHSGA in 2011 were found in forested vernal pools, other shallow, temporary wetlands, and adjacent forested habitats in the wildlife unit. Vernal pools are of critical importance to amphibian and other wildlife species. As small, often isolated, temporary, and fish-free wetland environments, vernal pools provide critical breeding habitats for some frog and salamander species, and important habitats for other herp species (Calhoun and deMaynadier 2004, Colburn 2004, Thomas et al. 2010). Identification and protection of vernal pools are essential for maintaining healthy and diverse populations of amphibian and reptile species as well as other wildlife species. Protecting the surrounding upland forest and maintaining buffers around vernal pools are critical for maintaining habitat for herp species (Calhoun and deMaynadier 2004). For example, pool-breeding amphibians, such as blue-spotted salamanders discussed earlier and wood frogs may disperse quite a distance from breeding ponds (e.g., 1.2 km (0.75 mi) for wood frogs) (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. Recommended buffers between roads and vernal pools range from at least 30 to 100 m (100 to 330 ft) wide (MA NHESP 2007, Calhoun and deMaynadier 2008). Maintaining connectivity between vernal pools or clusters of vernal pools, particularly with different hydrology, also would be beneficial.

Finally, additional surveys and monitoring are needed to determine the viability of populations of rare herp species that have been documented and identify other rare species within the PHSGA. Because many herp species are cryptic and can be difficult to detect, especially if they are rare, additional surveys should be conducted for other amphibian and reptile species of conservation interest that have potential for occurring in the PHSGA. These include the state special concern gray rat snake, state special concern eastern box turtle, and SGCN including the mudpuppy (*Necturus maculosus maculosus*), four-toed salamander (*Hemidactylium scutatum*), northern leopard frog (*Lithobates [Rana] pipiens*), pickerel frog (*Lithobates [Rana] palustris*), Smooth green snake (*Opheodrys vernalis*), blue racer (*Coluber constrictor foxii*), and northern ring-necked snake (*Diadophis punctatus edwardsii*). The habitats used by these species are summarized in Appendix 1.

Mussel Discussion and Management Recommendations

Within the boundaries of the PHSGA, the Black River and its tributary Mill Creek support over half (54%) of all unionid mussel species known to occur in Michigan. The conservation significance of these aquatic habitats is further heightened by the presence of at least 11 rare species of unionid mussels found during our 2011 surveys within PHSGA. Of primary importance for the long-term viability of these species are efforts to protect the water quality of the Black River and Mill Creek and prevent the invasion of the exotic zebra mussel.

The ranges of the unionid species we documented in PHSGA have been heavily colonized by zebra mussels and in some areas urbanized and industrialized. The southern Lower Peninsula, especially southeast Michigan, has the highest unionid mussel species diversity and supports the majority of rare mussel species found in Michigan. Unfortunately, river systems in this area have been more negatively impacted than in other parts of the state. Invasive species, point source and non-point source pollution, and habitat alteration have had negative impacts on these species and further threaten their status in Michigan.

In order to protect unionid mussels it is helpful to understand their life cycle. Unionid mussels rely on fish hosts to reproduce. The larvae, also known as glochidia, attach to the gills or fins of their host where there is a stable environment that enables their transformation to the adult form. Without the proper species of fish co-occurring with the unionid population, reproduction cannot occur. Some species of mussel are specialists and have only a few species of fish known to act as hosts, others are generalists and are known to utilize a dozen or more different host species. Glochidia are transported with their host fish until they transform into the adult form and drop off the fish. This allows unionid mussels, which are otherwise mostly sedentary, to migrate to new habitats and exchange genes among populations. The salamander mussel (state endangered and federal candidate) is unique in that it uses the mudpuppy (*Necturus maculosus*), an aquatic salamander, as a host instead of a fish.

The absence of zebra mussels in the Black River watershed is crucial in maintaining populations of native unionid mussels. They have had dramatic negative effects on native unionid mussels in Michigan (Gillis and Mackie 1994, Schloesser et al. 1998). Zebra mussel larvae do not require a fish host to complete their life cycle. They are free swimming and are not normally able to migrate upstream in lotic (riverine) habitats. The most common pathway for zebra mussel introduction is inadvertent transportation on boats and trailers. Both larvae and adults can be introduced in this way. Zebra mussel larvae are microscopic and can exist in small amounts of water that can be found in boats, boat trailers, and live wells. Bait buckets and waders are other possible pathways for introduction. In waterways like the Black River and Mill Creek that have very little, if any boat traffic, bait buckets and waders may be the most likely pathways. The risk of introduction can be reduced by promoting the washing and drying equipment (e.g., boats, canoes, kayaks, waders and any other gear that could transport zebra mussel larvae or adults) before it is used in the watershed.

Continuing to address point source and non-point source pollution within the entire watershed may be required for the rayed bean and other unionid species to persist in PHSGA. Point source discharges of substances known to be harmful to unionid mussels continue to occur in the Black River. For example, the 2008 Toxic Release Inventory reports that 725 pounds of ammonia were discharged into the Black River by the Michigan Sugar Company upstream of the PHSGA at Crosswell, MI. Unionid mussel larvae have been shown to be sensitive to ammonia (Newton et al. 2003). In particular, juvenile wavy-rayed lampmussels are one of the most sensitive aquatic organisms to unionized ammonia (Mummert et al. 2003, Cope et al. 2008). Allowable concentrations of ammonia and other substances



Erosion of stream bank in Mill Creek just upstream of mussel survey Site 2. The steel wall was installed a few years ago (Photo by Peter Badra).

have been established for EPA water quality criteria using adult unionid mussels, which are more tolerant and less sensitive to pollution than larvae or juveniles. Thus, EPA water quality criteria might not be protective of unionid mussels (Auspurger et al. 2003). Ongoing water quality monitoring, especially for ammonia, may be beneficial in determining if conditions in PHSGA are likely to sustain rayed bean and other unionid species found there.

The water quality of the Black River and Mill Creek can also be protected by maintaining a wide forested buffer along the Black River and Mill Creek and minimizing soil erosion and nutrient input from adjacent farmlands. Soil erosion and farm-nutrient runoff is particularly intense along the eastern boundary of the game area just north of Shoefelt Road (Compartment 3, Stand 141). In this location, soil erosion from an adjacent farm-field drainage ditch enters a ravine within the game area and covers its bottom with a thick layer of silt. The deposition of sediments along the bottom of this ravine has already buried many native plants, introduced several invasive plants, and impacted local water quality within the Black

River. In addition, stream bank erosion along Mill Creek is severe at Mussel Survey Site 2 (Figure 7). (Photo 643. Erosion of stream bank)

Following are brief descriptions of the conservation status of the endangered and threatened mussels documented at PHSGA within the Black River and Mill Creek in 2011 and short discussions of the salamander mussel (state endangered and federal candidate) and northern riffleshell (federally and state endangered), both of which have potential to occur within the game area based on previous surveys. For more information on these and other rare unionid mussel species in Michigan, see the MNFI website's Rare Species Explorer and Rare Species Abstracts at - <http://mnfi.anr.msu.edu>.

The **rayed bean** (*Villosa fabalis*, federally and state endangered) was federally listed as endangered on March 15, 2012 (USFWS 2012). (See report cover for photo of the rayed bean.) It is a small unionid mussel (approx. 1-1.5 inches in length) that is typically found in high quality creeks and small rivers. Its maximum life span is 11 years or more. The historical range of rayed bean in Michigan in-



Rayed bean (*Villosa fabalis*, federally and state endangered) was found in three locations in Mill Creek, a tributary to Black River, within Port Huron State Game Area (Photo by Kurt Stepnitz).

cludes the Belle, Black, Clinton, Detroit, Huron, Pine, and Raisin watersheds. In recent decades its status and range have declined in Michigan, as well as throughout its global range. Rayed-bean has a global conservation rank of G2 (Imperiled), meaning only a small percentage of its former populations are known to exist and remaining populations are small, isolated, and of questionable long-term viability. The Black River watershed (including Mill Creek) is one of only four watersheds in Michigan where rayed-bean have been found since 2000 (other include the Belle, Black, Huron, and Pine Rivers). The rayed bean has only one potential host documented, the Tippecanoe darter (*Etheostoma tippecanoe*), which is not native to Michigan. Other fish species clearly act as hosts for rayed bean but have yet to be documented. Co-occurring populations of host fish species in adequate densities are required for rayed bean and other unionid mussel species to reproduce and maintain viable populations in the PHSGA.

The status of rayed bean within PHSGA is difficult to ascertain beyond the fact that at least one population appears to be extant in Mill Creek. This is indicated by the

presence of shells found in multiple years over a 10 year span. Rayed bean shells have been found in Mill Creek near the location of Site 2 on at least four occasions (2001, 2 shells; 2002, 5 shells; 2003, 5 shells; 2011, 3 shells). Determining time post mortem based on shell condition is imprecise. The rate of shell deterioration varies depending on substrate type, water chemistry, local flow conditions, shell thickness, chance events such as whether a particular shell becomes buried or remains exposed to the abrasive action of stream current and substrates, and other factors. Rayed bean shells found in this survey (2011) were all resting exposed on the surface of dry sand/gravel bars. The shells were estimated to be at least several months post mortem.

Three-horned wartyback (*Obliquaria reflexa*, state endangered) were once present (pre-1960) in at least six watersheds in Michigan. Only 1 record of live individuals has been documented in recent years. Live individuals were found in the lower Huron River in 2003. The known hosts for three-horned wartyback are silverjaw minnow (*Eriocymba buccata*), common shiner (*Luxilus chrysocephalus*),



Three-horned wartyback (*Obliquaria reflexa*, state endangered) was found at mussel survey Site 10 in the Black River along with ten other species (Photo by Sarah Coury).

and longnose dace (*Rhinichthys cataractae*), species which are relatively common in Michigan. Maximum lifespan is at least 18 years.

Round hickorynut (*Obovaria subrotunda*, state endangered) was historically present in at least seven watersheds in Michigan. Recent records (post 1989) of live individuals have been found in only three watersheds (Black, Clinton, and Menominee). Though populations exist in the less impacted Menominee River watershed, round hickorynut has undergone severe declines in Southeastern Michigan, a former stronghold for the species. Host species have not been determined for round hickorynut. Glochidia are present in early fall and overwinter in marsupial gills within the female until the following spring.

Black sandshell (*Ligumia recta*, state endangered) is a medium/large river species that historically (pre-1960) was present in 17 watersheds in Michigan. In recent years (post 1989) it has been found in ten watersheds. Most recent records of this species consist only of one live individual or a few empty shells. Twenty-two fish species have been documented as hosts for black sandshell, including a variety of

centrarchids, minnows, percids, and other taxa that occur in Michigan. Maximum lifespan is at least 30 years. Glochidia develop in late summer and overwinter in marsupial gills within the female until mid-summer the next year.

The slippershell (*Alasmidonta viridis*, state threatened) is a headwater/small stream species that has a wide distribution in Michigan but is rarely found live in substantial numbers. Known hosts for the slippershell are mottled sculpin, banded sculpin, and Johnny darter. Maximum lifespan is 10 years.

The purple wartyback (*Cyclonaias tuberculata*, state threatened) is typically found in large creeks and rivers in sand and gravel. Historically the species was present in 13 watersheds in Michigan. Post-1989 it has been recorded in seven. Known hosts for the purple wartyback are black bullhead, yellow bullhead, channel catfish, and flathead catfish. Maximum lifespan is up to 40 years.

The wavy-rayed lampmussel (*Lampsilis fasciola*, state threatened) is most often found in fast flowing, high quality streams. Historically it was known from seven watersheds



Black sandshell (*Ligumia recta*, state endangered) was found at mussel survey Site 7 in the Black River along with seven other species (Photo by Sarah Coury).



Wavy-rayed lampmussel (*Lampsilis fasciola*, state threatened) was found at mussel survey Site 3 in Mill Creek along with seven other species (Photo by Sarah Coury).

in Michigan. Since 1989 it has been recorded in six. Known hosts are longear sunfish, smallmouth bass, and largemouth bass. Maximum lifespan is at least 20 years.

Though no **salamander mussels** (*Simpsonaias ambigua*, state endangered and federal candidate) were found in this survey, there was a live individual found in 2003 within the game area (Badra 2004). This is the only occurrence of a live individual that has been documented in Michigan since 1989, and may be the only live occurrence record since the mid-1930's. Salamander mussels occurred in three Michigan watersheds historically. This species is difficult to detect due to its specialized habitat and small size, and is possibly still present within PHSGA.

The PHSGA is within the historic range of the Federally endangered **northern riffleshell** (*Epioblasma torulosa*

rangiana, federally and state endangered). Since the decline and possible extirpation of the northern riffleshell population in the Detroit River due to zebra mussels, the Black River is the most likely river to support or re-establish this species in Michigan. The Black River appears to remain free of zebra mussels. Parts of the Black River were channelized and dredged the late 1980's before the northern riffleshell was listed as federally endangered in 1993. In 1998 a fresh dead northern riffleshell was found by MNFI staff in the Black River several miles north of PHSGA. Soft tissue was still intact indicating it was less than a few days post mortem. This was one of the last signs of live riffleshell in the Black River recorded to date. No live northern riffleshell or shells were found in this 2011 survey or in the 12 sites surveyed in the Black River watershed in 2003.

CONCLUSION

During the Integrated Inventory Project at PHSGA in 2010 and 2011, MNFI documented 17 new EOs and collected information for updating an additional 21 EOs (Tables 1 and 2). In total, 38 SGCN were documented during the project including 19 rare animal species (Table 3). Newly documented natural communities included dry-mesic northern forest, floodplain forest, southern hardwood swamp, and inundated shrub swamp. In addition, a previously documented northern mesic forest EO was updated and remapped. Rare plant EOs documented during the natural community surveys included three species, heart-leaved plantain (state endangered), Canadian milk vetch (state threatened), and downy sunflower (state threatened); and updates were processed for the following five species: Painted trillium (state endangered), goldenseal (state threatened), beak grass (state threatened), wahoo (state special concern), and broad-leaved puccoon (state special concern). Three new bird EOs were documented including grasshopper sparrow (state special concern), American bittern (state special concern), and a great blue heron rookery. Updated EOs were processed for the following six rare bird species: red-shouldered hawk (state threatened), marsh wren (state special concern), cerulean warbler (state threatened), Louisiana waterthrush (state threatened), hooded warbler (state special concern), and a great blue heron rookery. For rare herps, a new EO of Blanding's turtle (state special concern) was documented, and an EO for Blanchard's cricket frog (state threatened) was updated. Surveys for rare mussels documented six new EOs for the following species: purple wartyback (state threatened), black sandshell (state endangered), three-horned wartyback (state endangered), kidney shell (state special concern), deertoe (state special concern) and rainbow (state special concern). In addition, updated records were processed for the following six mussel species: elktoe (state special concern), slippershell (state threatened), wavy-rayed lampmussel (state threatened), round hickorynut (state endangered), and rayed-bean (federally and state endangered), and rainbow (state special concern).

The PHSGA serves as an island of forest within a landscape dominated by agriculture and rural residential development. With over 2,100 acres (>850 ha) of high quality forest and numerous acres of younger forest, the game area provides critical habitat to many forest-dependent species, including many rare species and SGCN and the following five DNR featured species: red-shouldered hawk, wood thrush, black-

throated blue warbler, golden-winged warbler, and eastern red-backed salamander. In all, over 60 bird species were documented while conducting surveys within the forests of PHSGA during the 2011 breeding season, including 4 rare species and an additional 13 SGCN. In addition, these forests provide habitat to at least 9 rare plants, one rare turtle, and two salamander and one frog SGCN. Lastly, although they were not documented as breeding within the game area, bald eagles (state special concern) and osprey (state special concern, DNR featured species) were occasionally observed foraging and perching in the Black River corridor within the game area. Maintaining the forest canopy will help ensure that high quality habitat remains for this diverse array of forest-dependent species.

By preventing erosion, filtering runoff, and providing shade, these forests also serve to protect the water quality of the Black River, Mill Creek, and their many headwater tributary streams. This is an extremely valuable ecological function given the national and statewide importance of the mussel fauna of the PHSGA. The stretches of the Black River and Mill Creek that flow through the PHSGA support over half (54%) of all unionid mussel species known to occur in Michigan, including 11 rare species, and one of these rare species, rayed-bean, is listed as federally endangered. Efforts to protect the water quality of the Black River and Mill Creek and prevent the invasion of the exotic zebra mussel are critically important to the long-term viability of these species.

Primary management recommendations for the PHSGA include 1) maintaining the forest canopy, 2) controlling invasive plant species, 3) reducing soil erosion and runoff into the Black River, Mill Creek, and their headwater tributary streams within the many ravines, 4) and encouraging boaters and anglers to avoid accidentally introducing the zebra mussel to the Black River and Mill Creek by washing and drying their equipment (e.g., boats, canoes, kayaks, waders, bait buckets, etc.) before using it in the watershed. In addition, occasionally conducting prescribed burns within the dry-mesic northern forests will help bolster plant diversity, control invasive woody plants, and facilitate oak and pine regeneration. Lastly, maintaining the open structure of the grasslands and wetlands in the northwestern portion of the game area (Compartment 3, Stands 1, 2, 3, and 4) will provide critical habitat to the three rare bird and one rare herp species that inhabit this area.

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Appendix 1. State Lands Herp Data Form 2012.

STATE LANDS INVENTORY SPECIAL ANIMAL SURVEY FORM - HERPS

I. LOCATION INFORMATION

Site Name _____ Compt/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 (ST/END) _____ Wind (ST/END) _____ Precip (ST/END) _____ 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 _____

Appendix 2. State Lands Salamander Trapping Survey Data Form 2012.

MNFI SALAMANDER TRAPPING SURVEY DATA FORM

Date: _____ County: _____ Site _____ Owner _____

Crew: _____ Approx wetland size: GPS file:

Sampling Method

Traps, no. _____
 Visual, num observers _____
 Dipnet

Time

Start	Stop	Elapsed	notes:

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 Port Huron State Game Area during MNFI surveys in 2012.

State Lands Inventory 2011
Port Huron SGA, St. Clair County, MI
Amphibian and Reptile Survey Targets and Results

Amphibian/ Reptile	Common Name	Scientific Name	US Status	State Status	WAP SGCN	WLD Featured Species	Target Rare Species	Species Found in 2011	General Habitats (primarily from Harding 1997)
Amphibian	Mudpuppy	<i>Necturus maculosus maculosus</i>			X				Permanent waters - rivers, reservoirs, inland lakes, Great Lakes bays and shallows
Amphibian	Eastern Newt	<i>Notophthalmus viridescens</i>						X	Small, permanent ponds, temporary ponds, and shallows of large lakes, river sloughs and backwaters with abundant aquatic vegetation
Amphibian	Spotted Salamander	<i>Ambystoma maculatum</i>			X		X	X	Moist closed canopy deciduous or mixed forests, temporary/semi-permanent ponds within or adjacent to woods
Amphibian	Blue-spotted Salamander	<i>Ambystoma laterale</i>			X		X	X	Deciduous and coniferous forests from moist bottomlands to dry uplands; ponds that retain water into midsummer essential
Amphibian	Small-mouthed / Smallmouth Salamander	<i>Ambystoma texanum</i>	E		X		X^		Lowland floodplain woods, also open habitats such as prairie and farmlands, forested vernal pools for breeding.
Amphibian	Eastern Tiger Salamander	<i>Ambystoma tigrinum</i>			X		X^		Forests, marshes, and grasslands; breeding - permanent and semi-permanent ponds
Amphibian	Northern Dusky Salamander	<i>Desmognathus fuscus fuscus</i>							Edges of rocky streams, hillside springs, and seepage areas, usually in wooded or partly wooded terrain. Only known from one site in state.
Amphibian	Eastern Red-backed Salamander	<i>Plethodon cinereus</i>				X (in WUP)		X	Deciduous, coniferous, and mixed forests
Amphibian	Four-toed Salamander	<i>Hemidactylium scitatum</i>			X		X^		Moist deciduous, coniferous, or mixed forests, usually in vicinity of spring-fed creeks, sphagnum seepages, bogs, or boggy ponds
Amphibian	Northern Two-lined Salamander	<i>Eurycea bislineata</i>							In vicinity of flowing water with sufficient cover in the form of rocks, logs, mats of fallen leaves, both in woodlands and more open habitats. Only known from one site in state.
Amphibian	Eastern American Toad	<i>Anaxyrus [Bufo] americanus americanus</i>						X	Open forests, forest edges, prairies, marshes, and meadows
Amphibian	Blanchard's Cricket Frog / Northern Cricket Frog	<i>Acris blanchardi / Acris crepitans</i>	T		X		X	X	Open, muddy edges of permanent ponds, lakes, bogs, and slow-moving streams or rivers with abundant aquatic vegetation, including fens and wet or sedge meadows
Amphibian	Western Chorus Frog	<i>Pseudacris triseriata triseriata</i>			X		X	X	Marshes, wet meadows, swales, and other open habitats, also mesic forests and swamp forests
Amphibian	Northern Spring Peeper	<i>Pseudacris crucifer crucifer</i>						X	Temporary and permanent ponds, marshes, floodings, and ditches, as well as forests, old fields, shrubby areas
Amphibian	Gray Treefrog	<i>Hyla versicolor/Hyla chrysoceles</i>						X	Temporary ponds, swamps, floodings, shallow edges of permanent lakes, and sloughs, surrounded by forested or open habitats
Amphibian	Bullfrog	<i>Lithobates [Rana] catesbeianus</i>							Permanent waterbodies - river backwaters, sloughs, lakes, farm ponds, impoundments, marshes, shallow Great Lakes bays; abundant emergent and submergent vegetation
Amphibian	Green Frog	<i>Lithobates [Rana] clamitans melanotos</i>						X	Ponds, lakes, swamps, sloughs, impoundments, and slow streams
Amphibian	Wood Frog	<i>Lithobates [Rana] sylvaticus</i>						X	Moist, forested habitats (deciduous, coniferous, and mixed); breeding - vernal ponds, floodings, forested swamps, and quiet stream backwaters
Amphibian	Northern Leopard Frog	<i>Lithobates [Rana] pipiens</i>			X		*		Open wetland habitats including marshes, bogs, lake and stream edges, and sedge meadows, and adjacent open uplands including hay fields, lawns; breed in shallow temporary ponds, stream backwaters, and marsh pools

State Lands Inventory 2011
Port Huron SGA, St. Clair County, MI
Amphibian and Reptile Survey Targets and Results

Amphibian/ Reptile	Common Name	Scientific Name	US Status	State Status	WAP SGCN	WLD Featured Species	Target Rare Species	Species Found in 2011	General Habitats (primarily from Harding 1997)
Amphibian	Pickered Frog	<i>Lithobates [Rana] palustris</i>			X		*		Bogs, fens, ponds, streams, springs, sloughs, and lake covers; cool clear waters, grassy stream banks
Reptile	Eastern Snapping Turtle	<i>Chelydra serpentina serpentina</i>							Permanent waterbodies including shallow, weedy Great Lakes inlets and bays; muddy ponds, lakes, sloughs and slow streams with dense aquatic vegetation
Reptile	Eastern Musk Turtle	<i>Sternotherus odoratus</i>							Permanent waterbodies - ponds, lakes, marshes, sloughs, rivers; highly aquatic
Reptile	Spotted Turtle	<i>Clemmys guttata</i>		T	X		*		Shallow ponds, wet meadows, tamarack swamps, bogs, fens, marshes, sphagnum seepages, slow streams; require clear shallow water with mud/muck bottom and ample aquatic and emergent vegetation
Reptile	Eastern Box Turtle	<i>Terrapene carolina carolina</i>		SC	X		X^		Deciduous or mixed forests, esp. with sandy soils, also adjacent old fields, pastures, dunes, marshes, and bog edges
Reptile	Blanding's Turtle	<i>Emydoidea blandingii</i>		SC	X		X	X	Shallow, weedy waters - ponds, marshes, forested and shrub swamps, wet meadows, lake inlets and coves, rivers backwaters, embayments, sloughs, vernal pools
Reptile	Northern Map Turtle	<i>Graptemys geographica</i>							Larger lakes, rivers, reservoirs, oxbow sloughs, open marshes, Great Lakes bays and inlets, also smaller lakes and streams and ponds
Reptile	Painted Turtle	<i>Chrysemys picta</i>						X	Quiet, slow-moving permanent water bodies with soft bottom substrates, abundant aquatic vegetation, and basking sites; temporarily occupy vernal ponds, impoundments, ditches and faster streams and rivers
Reptile	Eastern Spiny Softshell	<i>Apalone spinifera spinifera</i>							Rivers and larger streams, inland lakes, reservoirs, protected Great Lakes bays and river mouths; often with sandy or muddy bottoms, and open with little aquatic vegetation
Reptile	Five-lined Skink	<i>Emumeces fasciatus</i>							Moist but not wet, forested or partially forested habitats with ample cover and basking sites - stumps, logs, rock outcrops, wood or brush piles, sawdust piles, fallen bark; moist not wet habitats
Reptile	Northern Water Snake	<i>Nerodia sipedon sipedon</i>							Permanent water bodies - rivers, streams sloughs, lakes, ponds, bogs, marshes, swamps, wet meadows, impoundments; also utilize shallow, small temporary ponds and wetlands including vernal pools and shrub swamps
Reptile	Queen Snake	<i>Regina septemvittata</i>		(SC)*	X		*		Warm, shallow, rocky-bottomed streams with abundance of crayfish; also edges of ponds, lakes, marshes, ditches and canals, open to mostly forested but totally shaded sites are avoided; often bask at water's edge or in overhanging shrubbery or tree branches.
Reptile	Eastern Garter Snake	<i>Thamnophis sirtalis sirtalis</i>							Almost any natural habitats - open and forested habitats and moist grassy places - edges of ponds, lakes, streams ditches.
Reptile	Butler's Garter Snake	<i>Thamnophis butleri</i>							Wet meadows and prairies, marshy pond and lake borders, and other moist habitats
Reptile	Northern Ribbon Snake	<i>Thamnophis sauritus septentrionalis</i>							Edges of lakes, ponds, streams, marshes, especially with grasses, sedges and low shrubs, open sunny areas/habitats
Reptile	Brown Snake	<i>Storeria dekayi</i>							Variety of habitats from dense forests and shrubby habitats to open prairies, meadows, and marshes; prefer areas with moist soils but also found on dry hillsides, pine forests, and railroad embankments

State Lands Inventory 2011
Port Huron SGA, St. Clair County, MI
Amphibian and Reptile Survey Targets and Results

Amphibian/ Reptile	Common Name	Scientific Name	US Status	State Status	WAP SGCN	WLD Featured Species	Target Rare Species	Species Found in 2011	General Habitats (primarily from Harding 1997)
Reptile	Northern Red-bellied Snake	<i>Storeria occipitomaculata</i> <i>occipitomaculata</i>							Deciduous or mixed forests, and adjacent fields, pastures, road embankments, marshes and sphagnum bogs
Reptile	Smooth Green Snake	<i>Ophedrys vernalis</i>			X				Moist grassy places including prairie remnants and savannahs, meadows, old fields, pastures, roadsides, marsh and lake edges, also open deciduous and pine forests
Reptile	Blue Racer	<i>Coluber constrictor foxii</i>			X				Dry sunny, open habitats with access to cover - old fields, hedgerows, shrub thickets, open forests, forest edges, also grassy lake borders and marshes
Reptile	Gray Rat Snake	<i>Pantherophis spiloides</i>		SC	X		X		In or near forests, and adjacent open habitats - shrubby fields, pastures, marsh and bog edges
Reptile	Eastern Fox Snake	<i>Pantherophis gloydi</i>		T	X	X	*		Great Lakes shoreline marshes, vegetated dunes and beaches, nearby farm fields, pastures, woodlots, lakeplain prairie and wet prairie.
Reptile	Eastern Milk Snake	<i>Lampropeltis triangulum triangulum</i>							Open forests, bogs, swamps, forest edges, marshes, lakeshores, old fields, and pastures
Reptile	Northern Ring-necked Snake	<i>Diadophis punctatus edwardsii</i>			X				Moist, shady forests and adjacent open habitats including old fields, grassy dunes; often found under leaf litter or cover or in burrows
Reptile	Eastern Hog-nosed Snake	<i>Heterodon platirhinos</i>			X		X		All types of terrestrial habitats - from open pine or deciduous forests to old fields, meadows, and pastures. Prefer sandy, well-drained soils.
Reptile	Eastern Massasauga	<i>Sistrurus catenatus catenatus</i>	C	SC	X		*		Open and forested wetlands including shrub swamps, bogs, fens, marshes, wet or sedge meadows, moist prairie, and forested swamps, and adjacent open and forested upland habitats including prairies, old fields, meadows, shrub thickets, and deciduous, coniferous, and mixed forests.

Key:

U.S. Status: LT = Federally Threatened; C = Federal Candidate

State Status: E = Endangered; T = Threatened; SC = Special Concern

^ - Port Huron outside of current known species' range in the state but close to species' range so included as survey target.

* - Species not targeted for survey in 2011 because little to no available habitat for species in the PHSGA, or were not aware of areas of with suitable habitat.

Species targeted for surveys and found in the PHSGA in 2011

Species not targeted for surveys but found in PHSGA in 2011

Sources:

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

Appendix 4. Access points, and latitude and longitude of mussel survey sites.

Site #	Waterway	Access	Latitude (N)	Longitude (W)
1	Mill Creek	M-136 parking area	43.04890	-82.59878
2	"	"	43.05041	-82.60136
3	"	"	43.05101	-82.60257
A*	"	"	43.04928	-82.60041
B*	"	"	43.04906	-82.60111
C*	"	"	43.05125	-82.60194
4	Black River	Trail North of Comstock Rd.	43.13119	-82.61418
5	"	"	43.12444	-82.61434
6	"	Norman Rd.	43.09323	-82.09380
7	"	Beard Rd.	43.04846	-82.59029
8	"	"	43.04913	-82.59201
9	"	Shoefelt Rd.	43.03081	-82.58218
10	"	"	43.03298	-82.58325

* Incidental finds

Appendix 5. Avian species and the total number of locations (i.e., points) at which they were recorded while conducting 146 songbird point count surveys in the forested areas of Port Huron State Game Area in 2011. State status abbreviations are as follows: T, state threatened; and SC, state special concern.

Common Name	State Status	SGNC	DNR Featured Species	Total Locations Recorded
Acadian Flycatcher		X		53
Alder Flycatcher				4
American Crow				62
American Goldfinch				11
American Redstart				10
American Robin				56
Baltimore Oriole				1
Belted Kingfisher				1
Black-and-White Warbler				4
Black-billed Cuckoo		X		4
Black-capped Chickadee				22
Black-throated Blue Warbler		X	X	3
Black-throated Green Warbler				7
Blue Jay				48
Blue-winged Warbler		X		2
Broad-winged Hawk				1
Brown Creeper				3
Brown-headed Cowbird				32
Canada Goose				8
Canada Warbler		X		8
Cedar Waxwing				7
Cerulean Warbler	T	X		2
Chestnut-sided Warbler				4
Chipping Sparrow				9
Common Yellowthroat				13
Downy Woodpecker				3
Eastern Bluebird				3
Eastern Towhee		X		7
Eastern Wood-Pewee				91
Golden-winged Warbler		X	X	1
Gray Catbird				14
Green Heron		X		1
Gull sp.				1
Hairy Woodpecker				24
Hooded Warbler	SC	X		30
Indigo Bunting				4
Killdeer		X		2
Louisiana Waterthrush	T	X		8
Mallard				2
Mourning Dove				1
Nashville Warbler				1
Northern Cardinal				37
Northern Flicker		X		13
Northern Parula		X		1
Northern Waterthrush				7
Ovenbird				131

Appendix 5. Continued

Common Name	State Status	SGNC	DNR Featured Species	Total Locations Recorded
Pileated Woodpecker				8
Red-bellied Woodpecker				50
Red-eyed Vireo				60
Red-shouldered Hawk	T	X	X	1
Red-tailed Hawk				4
Red-winged Blackbird				7
Ring-necked Pheasant				1
Rose-breasted Grosbeak				26
Scarlet Tanager				58
Song Sparrow				5
Tufted Titmouse				39
Veery				41
White-breasted Nuthatch				14
Wild Turkey				1
Wood Duck				2
Wood Thrush		X	X	52
Yellow Warbler				10
Yellow-billed Cuckoo		X		2

Appendix 6. A checklist of Michigan’s unionid mussel species found within Port Huron State Game Area in 2011. State and federal status abbreviations are as follows: E, state endangered; T, state threatened; SC, state special concern; LE, federally endangered; and C, candidate for federal listing.

Scientific Name	Common Name	US Status	State Status	SGCN	Port Huron SGA
<i>Actinonaias ligamentina</i>	Mucket				
<i>Alasmidonta marginata</i>	Elktoe		SC	X	X
<i>Alasmidonta viridis</i>	Slippershell		T	X	X
<i>Amblema plicata</i>	Threeridge				X
<i>Anodontooides ferussacianus</i>	Cylindrical papershell			X	X
<i>Cyclonaias tuberculata</i>	Purple wartyback		T	X	X
<i>Elliptio complanata</i>	Eastern elliptio			X	
<i>Elliptio crassidens</i>	Elephant-ear				
<i>Elliptio dilatata</i>	Spike				X
<i>Epioblasma obliquata perobliqua</i>	White catspaw	E	E	X	
<i>Epioblasma torulosa rangiana</i>	Northern riffleshell	E	E	X	
<i>Epioblasma triquetra</i>	Snuffbox	E	E	X	
<i>Fusconaia flava</i>	Wabash pigtoe				X
	Wavy-rayed				
<i>Lampsilis fasciola</i>	lampmussel		T	X	X
<i>Lampsilis siliquoidea</i>	Fatmucket				X
<i>Lampsilis ventricosa</i>	Pocketbook				X
<i>Lasmigona complanata</i>	White heelsplitter				X
<i>Lasmigona compressa</i>	Creek heelsplitter			X	
<i>Lasmigona costata</i>	Fluted-shell				X
<i>Leptodea fragilis</i>	Fragile papershell				X
<i>Leptodea leptodon</i>	Scaleshell	E	SC	X	
<i>Ligumia nasuta</i>	Eastern pondmussel		E	X	
<i>Ligumia recta</i>	Black sandshell		E	X	X
	Three-horned				
<i>Obliquaria reflexa</i>	wartyback		E	X	X
<i>Obovaria olivaria</i>	Hickorynut		E	X	
<i>Obovaria subrotunda</i>	Round hickorynut		E	X	X
<i>Pleurobema clava</i>	Clubshell	E	E	X	
<i>Pleurobema sintoxia</i>	Round pigtoe		SC	X	
<i>Potamilus alatus</i>	Pink heelsplitter				X
<i>Potamilus ohioensis</i>	Pink papershell		T		
<i>Ptychobranchus fasciolaris</i>	Kidney-shell		SC	X	X
<i>Pyganodon grandis</i>	Giant floater				X
<i>Pyganodon lacustris</i>	Lake floater		SC		
<i>Pyganodon subgibbosa</i>	Lake floater		T	X	
<i>Quadrula pustulosa</i>	Pimpleback			X	X
<i>Quadrula quadrula</i>	Mapleleaf				X
<i>Simpsonaias ambigua</i>	Salamander mussel	C	E	X	
<i>Strophitus undulatus</i>	Strange floater				X
<i>Toxolasma lividus</i>	Purple lilliput		E	X	
<i>Toxolasma parvus</i>	Lilliput		E	X	
<i>Truncilla donaciformis</i>	Fawnsfoot		T	X	
<i>Truncilla truncata</i>	Deertoe		SC		X
<i>Utterbackia imbecillis</i>	Paper pondshell		SC		
<i>Venustaconcha ellipsiformis</i>	Ellipse		SC	X	
<i>Villosa fabalis</i>	Rayed bean	E	E	X	X
<i>Villosa iris</i>	Rainbow		SC	X	X

Appendix 7. Unionid mussels found in surveys of Mill Creek and the Black River within Port Huron State Game Area, Summer 2011. (#=number of live individuals; RA=relative abundance; D=density (indvs./m²); S=species represented by shell only) (LE=federally listed as endangered; E=state listed as endangered; T=state listed as threatened; SC=state species of special concern)

Species	Mill Creek											
	1			2			3			A*	B*	C*
	#	RA	D	#	RA	D	#	RA	D			
Elktoe	2	0.13	0.02	S(1)			1	0.05	0.01			
Slippershell												S(1)
Threeridge												
Cylindrical papershell												
Purple wartback							1	0.05	0.01			
Spike												
Wabash pigtoe												
Wavy-rayed lampmussel												
Fatmucket	2	0.13	0.02				1	0.05	0.01			
Pocketbook	6	0.38	0.05				4	0.20	0.03			
White heelsplitter	S						2	0.10	0.02			
Fluted-shell	3	0.19	0.02	S(1)			6	0.30	0.05			
Fragile papershell												
Black sandshell												
Three-horned wartback												
Round hickorynut												
Pink heelsplitter												
Kidney-shell	S											
Giant floater	1	0.06										
Pimpleback												
Mapleleaf												
Strange floater	2	0.13	0.02				3	0.15	0.02			
Deertoe												
Rayed bean										S(1)	S(1)	S(1)
Rainbow												
Total # individuals and density	16		0.13	0			20		0.16			
# species live	6			0			8					
# species live or shell	8			2			8					
Area searched (m ²)	128			128			128					
<i>Corbicula fluminea</i>												
<i>Dreissena polymorpha</i>												

* Incidental finds

Appendix 7. Continued

	Black River																							
	4			5			6			7			8			9			10					
	#	RA	D	#	RA	D	#	RA	D	#	RA	D	#	RA	D	#	RA	D	#	RA	D			
<i>Alasmidonta marginata</i> (SC)	1	0.25	0.01	S(1)			3	0.27	0.02	1	0.04	0.01	2	0.06	0.02				1	0.13	0.01			
<i>Alasmidonta viridis</i> (T)																								
<i>Ambleria plicata</i>				S												1	0.07	0.01						
<i>Anodontoideus ferussacianus</i>																						S		
<i>Cyclonaias tuberculata</i> (T)				S(1)																				
<i>Ellipio dilatata</i>																								
<i>Fusconia flava</i>																						S		
<i>Lampsilis fasciola</i> (T)							1	0.09	0.01	S			1	0.03	0.01							S		
<i>Lampsilis siliquoides</i>				S																				
<i>Lampsilis ventricosa</i>	2	0.50	0.02	1	0.14	0.01	6	0.26	0.05	6	0.26	0.05	3	0.09	0.02									
<i>Lasmsgona complanata</i>	S			S			3	0.13	0.02	3	0.13	0.02	3	0.09	0.02	S					3	0.38	0.02	
<i>Lasmsgona costata</i>				6	0.86	0.05	5	0.45	0.04	2	0.09	0.02	13	0.37	0.10	2	0.13	0.02			1	0.13	0.01	
<i>Leptodea fragilis</i>							5	0.22	0.04	6	0.17	0.05	2	0.13	0.02	2	0.13	0.02			1	0.13	0.01	
<i>Ligumia recta</i> (E)							1	0.04	0.01															
<i>Obliquaria reflexa</i> (E)																						S(1)		
<i>Obovaria subrotunda</i> (E)																						S(1)		
<i>Potamilius alatus</i>							3	0.13	0.02	2	0.06	0.02	2	0.06	0.02	6	0.40	0.05			2	0.25	0.02	
<i>Psychobranchius fasciolaris</i> (SC)																								
<i>Pyganodon grandis</i>							1	0.09	0.01													3	0.20	0.02
<i>Quadrula pustulosa</i>													1	0.03	0.01									
<i>Quadrula quadrula</i>							2	0.09	0.02	2	0.09	0.02	2	0.06	0.02									
<i>Strophitus undulatus</i>	1	0.25	0.01				S			S			2	0.06	0.02									
<i>Truncilla truncata</i> (SC)							S			S			S(1)									S		
<i>Villosa fabalis</i> (LE, E)																								
<i>Villosa iris</i> (SC)				S(1)																				
Total # individuals and density	4		0.03	7		0.05	11		0.09	23		0.18	35		0.27	15		0.12			8		0.06	
# species live	3			2			5			8			10			6					5			
# species live or shell	5			7			6			11			11			7					11			
Area searched (m ²)	128			128			128			128			128			128					128			
<i>Corbicula fluminea</i>																								
<i>Dreissena polymorpha</i>																								

Appendix 8. Physical habitat components at unionid mussel survey sites. Percent pool, riffle, and run habitat was estimated visually within each survey area, as well as percent composition of each substrate size class.

	Site #	Current speed*	Aquatic vegetation?	Woody debris?	Pool	Riffle	Run	Boulder	Cobble	Pebble	Gravel	Sand	Silt
Mill Creek	1	slow	N	Y	0	0	100	1	14	15	15	35	20
	2	slow	N	Y	0	0	100	5	5	10	20	30	30
	3	slow	N	Y	0	0	100		5	30	25	20	20
Black River	4	medium	Y	Y	0	0	100	3	12	25	20	15	25
	5	med/fast	Y	N	0	75	25	3	62	5	5	10	15
	6	slow/med	N	Y	0	0	100	5	25	20	15	15	20
	7	slow	N	Y	0	0	100			20	20	30	30
	8	medium	N	Y	0	34	66		5	30	30	20	15
	9	slow	N	Y	10	0	90	5	35	10	10	15	25
	10	slow	N	Y	0	0	100			15	25	35	25

* slow = approx. 0.2m/second; medium = approx. 1m/second; fast = approx. 2m/second

Appendix 9. Chemical habitat measures and water temperature from Mill Creek mussel survey sites 1-3.

	Site #	pH	Conductivity (µS)	Alkalinity (mg/l CaCO ₃)	Hardness (mg/l)	Water Temp. (C)
Mill Creek	1	8.40	699	175	300	23.6
	2	8.40	700	180	320	25.5
	3	8.45	695	420	320	26.4