Natural Features Inventory and Management Recommendations for Rogue River State Game Area

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Cover Photo: Spring Creek Hardwood-Conifer Swamp, Rogue River State Game Area. Photo by Jesse M. Lincoln.

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EXECUTIVE SUMMARY

Rogue River State Game Area (SGA) is a large block of semi-continuous public land in southwest Lower Michigan, consisting of approximately 6,200 acres of Kent County. Between 2014 and 2016, Michigan Natural Features Inventory (MNFI) completed Stage 1 Michigan Forest Inventory (MiFI) and surveys for high-quality natural communities and rare animal species in Rogue River SGA as part of the Integrated Inventory Project for the Michigan Department of Natural Resources (DNR) Wildlife Division. Rogue River SGA is important ecologically because it provides critical habitat for a myriad of game and non-game species and supports over 5,022 acres of forest and over 261 acres of high-quality forest, primarily lowland forest (hardwood-conifer swamp and floodplain forest). Because the landscape surrounding Rogue River SGA is dominated by agriculture and rural development, the large area of natural cover within the game area serves as an important island of biodiversity for the local region. In addition, the numerous and diverse wetlands, vernal pools, and lakes within the game area support a variety of insect, herptile, avian, mammalian, plant, and aquatic species. The Rogue River and several creeks pass through the game area and provide critical habitat for many aquatic species.

Surveys resulted in 13 new element occurrences (EOs) and provided information for updating an additional 4 EOs. In all, 12 species of greatest conservation need (SGCN) and 9 rare animal species have been recorded in Rogue River SGA with 10 SGCN and 7 rare animal species documented during the course of this project. In total, 18 EOs have been documented in Rogue River SGA including 9 animal EOs, 2 plant EO, and 7 natural community EOs.

Surveys for exemplary natural communities relied on information collected during MiFI Stage 1 inventories to help target the locations of potential new natural community EOs. During the project, MNFI ecologists documented seven new high-quality natural communities and also removed one known high-quality community EO that no longer qualifies for consideration as a high-quality natural community. Five different natural community types are represented in the seven element occurrences surveyed including: bog (1 EO), dry-mesic northern forest (1 EO), floodplain forest (1 EO), hardwood-conifer swamp (3 EOs), and southern wet meadow (1 EO). We assessed the current ranking, classification, and delineation of these occurrences and detailed the vegetative structure and composition, ecological boundaries, landscape context, abiotic factors, threats, management needs, and restoration opportunities. This report provides detailed descriptions of each site as well as a comprehensive discussion of site-specific threats and stewardship needs and opportunities.

Over the course of the project, one rare plant EO, three-ribbed spike-rush (*Eleocharis trichostata*, state threatened), was opportunistically documented. Three-ribbed spike-rush is a coastal plain disjunct and within Rogue River SGA it was collected from a small wetland depression and occurred with other species characteristic of coastal plain marsh habitat. A historic record for orange fringed orchid (*Platanthera ciliaris*, state threatened) was documented in the wetlands around Chrishaven Lake but has not been observed since 1941. Potential habitat for this species remains throughout the game area, particularly along the margins of bogs and open wetland complexes.

In 2016, a total of 168 potential vernal pools (PVPs) were identified and mapped in the Rogue River SGA through aerial photograph interpretation, and 17 vernal pools were surveyed and verified in the field. These survey and mapping results provide baseline information on vernal pool status, distribution, and ecology in the game area, which will help natural resource planners and managers develop and implement appropriate management of these wetlands.

Surveys for rare avian species included point counts for forest songbirds and raptors. We conducted morning surveys for rare songbirds at 123 point-count locations within forest. These surveys resulted in updated records for Louisiana waterthrush (*Parkesia motacilla*, state threatened). Rare raptor surveys were completed at 112 points resulting in the documentation of a new EO for red-shouldered hawk (*Buteo lineatus*, state threatened). Two rare bird species have been documented in the game area with both being recorded during the 2016 breeding season. Point-count surveys resulted in the documentation of eight species that are considered featured species for habitat management by the Wildlife Division of the MDNR. These featured species are wood duck (*Aix sponsa*), mallard (*Anas platyrhynchos*), ruffed grouse (*Bonasa umbellus*), wild turkey (*Meleagris gallopavo*), red-shouldered hawk, pileated woodpecker (*Dryocopus pileatus*), wood thrush (*Hylocichla mustelina*), and eastern bluebird (*Sialia sialis*). Additionally, both rare birds – Louisiana waterthrush and red-shouldered hawk – are designated as SGCN.

We conducted visual encounter or meander surveys, basking surveys, dipnetting, aquatic funnel trapping, and breeding frog call surveys for rare amphibians and reptiles. During the course of the project several Blanding's turtles (*Emydoidea blandingii*, state special concern and SGCN) were observed, updating the existing EO for the species. Two blue racers (*Coluber constrictor foxii*) were also documented for a total of two reptile SGCN recorded during MNFI surveys.

The waterways of Rogue River SGA include the Rogue River, Duke Creek, Spring Creek, and several smaller headwater creeks. The Rogue River flows south past Sparta and Rockford, Michigan before joining the Grand River. The focus of aquatic surveys was on the three larger waterways in Rogue River SGA. We performed aquatic surveys at eleven sites within Rogue River SGA. Eight sites were located in the Rogue River main stem, four of which are within the southeast Extension Unit, two sites were located in Duke Creek, and one site in Spring Creek. A total of nine unionid mussel species were found including four rare species that are also SGCN. The state threatened slippershell (*Alasmidonta viridis*) was found in the main stem of the Rogue River and in Spring Creek, updating an existing EO and establishing a new EO for the species. The special concern ellipse (*Venustaconcha ellipsiformis*) was found at four sites in the main stem of the Rogue River and these observations update and expand an existing EO. Five rainbow (*Villosa iris*, state special concern) were found in the main stem of the Rogue River, establishing a new EO and the first record of the species within Rogue River SGA. Paper pondshell (*Utterbackia imbecillis*, state special concern) was found at the northern most part of the SGA in the Rogue River main stem and this new EO represents the first record of the species in the Rogue River watershed.

Primary management recommendations for the Rogue River SGA include: 1) the promotion of ecosystem integrity of the floodplain complexes along the Rogue River and the tributaries that feed it; 2) the maintenance of the canopy closure of mature upland and lowland forest ecosystems; 3) the reduction of fragmentation and promotion of connectivity across the game area but focused in the vicinity of riparian corridors, wetlands, and high-quality natural communities; 4) the use of landscape-scale prescribed fire focused in high-quality natural communities and with rotating non-fire refugia where fire-sensitive rare species occur; 5) focused invasive species control in high-quality ecosystems; and 6) the careful prioritization of management efforts in the most critical habitats. Monitoring of these management activities is recommended to facilitate adaptive management.

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One of the many small, clear tributaries within the Rogue River State Game Area that feed into the Rogue River; a regionally significant trout stream. Photo by Jesse M. Lincoln.

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INTRODUCTION

Rogue River State Game Area (SGA) is a large block of semi-continuous public land in southwest Lower Michigan, consisting of approximately 6,200 acres within Kent County. Rogue River SGA is important ecologically because it provides critical habitat for a myriad of game and non-game species and supports over 5,022 acres of forest. Because the landscape surrounding Rogue River SGA is dominated by agriculture and rural development, the forests within the game area serve as an important island of biodiversity for the local region (Figure 1). Additionally, the numerous and diverse high-quality wetlands, vernal pools, lakes, and streams within the game area support a wide array of insects, herptiles, avian, mammalian, plant, and aquatic species. The Rogue River and several creeks pass through the game area and provide critical habitat for as array of aquatic species. Rogue River SGA's forested ecosystems and the wetlands nested within the forested matrix support several rare herptiles, avian, and plant species. Within Kent County, natural cover constitutes 39% of the county. In comparison, natural cover constitutes approximately 92% of Rogue River SGA. Prior to this project, numerous rare species and a high-quality natural community had been documented in Rogue River SGA (Tables 2-6). Before 2015, six element occurrences (EOs) had been documented for Rogue River SGA composed of five rare species occurrences and one high-quality natural community. Of those rare species occurrences, one was a bird EO, two were rare herptiles, and two were mussel EOs (Tables 2-6).

From 2014 to 2016, Michigan Natural Features Inventory (MNFI) conducted Stage 1 Michigan Forest Inventory (MiFI) and surveys for additional exemplary natural communities and rare animals in Rogue River SGA as part of the Integrated Inventory Project. This project is part of a long-term effort by the Michigan DNR Wildlife Division to document and sustainably manage areas of high conservation significance on state lands. This report provides an overview of the landscape and historical context of Rogue River SGA, summarizes the findings of MNFI's surveys of Rogue River SGA for high-quality natural communities and rare animal species, and discusses stewardship needs, opportunities, and priorities within the game area. The focus of this project and the report is on native biodiversity with an emphasis on rare species and high-quality ecosystems. Biodiversity stewardship considerations are included in the report and we acknowledge that the DNR manages for multiple values including wildlife management, hunting, and other wildlife related recreation, as well as biodiversity and that the report does not necessarily reflect the planned management actions of the DNR. Specific management recommendations are provided for rare species and groups of rare species and also for each natural community EO found within the game area. In addition, to species-based and site-based stewardship discussion, general management recommendations for the game area as a whole are provided.

Landscape Context

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 2). 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 is hierarchically structured with three levels in a nested series, from broad landscape regions called **sections**, down to smaller **subsections** and **sub-subsections**. Rogue River SGA lies within Greenville Moraines sub-subsection (VI.4.2) of the Ionia subsection (Subsection VI.4) (Figure 2).

Ionia

The Ionia subsection (VI.4) is characterized by medium- to coarse-textured moraines. Morainal features within the subsection primarily include loamy till plain and narrow bands of loamy end moraine with areas of sandy glacial outwash, sandy ground moraine, and sandy, steep end moraine in the northern portion of the subsection. Streams are numerous throughout the subsection and lakes are common in the north. The subsection is underlain by Paleozoic Era bedrock, primarily Pennsylvanian sandstone, shale, coal, and limestone, with Mississippian shale and gypsum occurring at the western edge (Dorr and Eschman 1970). Prevalent soils include loams, sandy loams, and loamy sands, with sands occurring locally. The average growing season ranges from ~130 days at the northern edge of the subsection to 160 days at the western edge (Eichenlaub et al. 1990). Average annual precipitation ranges from 76 cm to 81 cm (30 in to 32 in) and average annual snowfall ranges from 102 cm to 203 cm (40 to 80 in), with highest levels in the west, closer to Lake Michigan. Extreme minimum temperature ranges from -31 °C to -38 °C (-24 °F to -36 °F) and generally become lower farther north in the subsection. Prevalent vegetation types within this region historically included beech-sugar maple forest, oak-hickory forest, oak-pine forest, and conifer and deciduous swamp forest. Much of the subsection has been converted to agriculture and much of the forest and swamp forest have been lost or now occur as small remnant fragments surrounded by agricultural lands (Albert 1995).

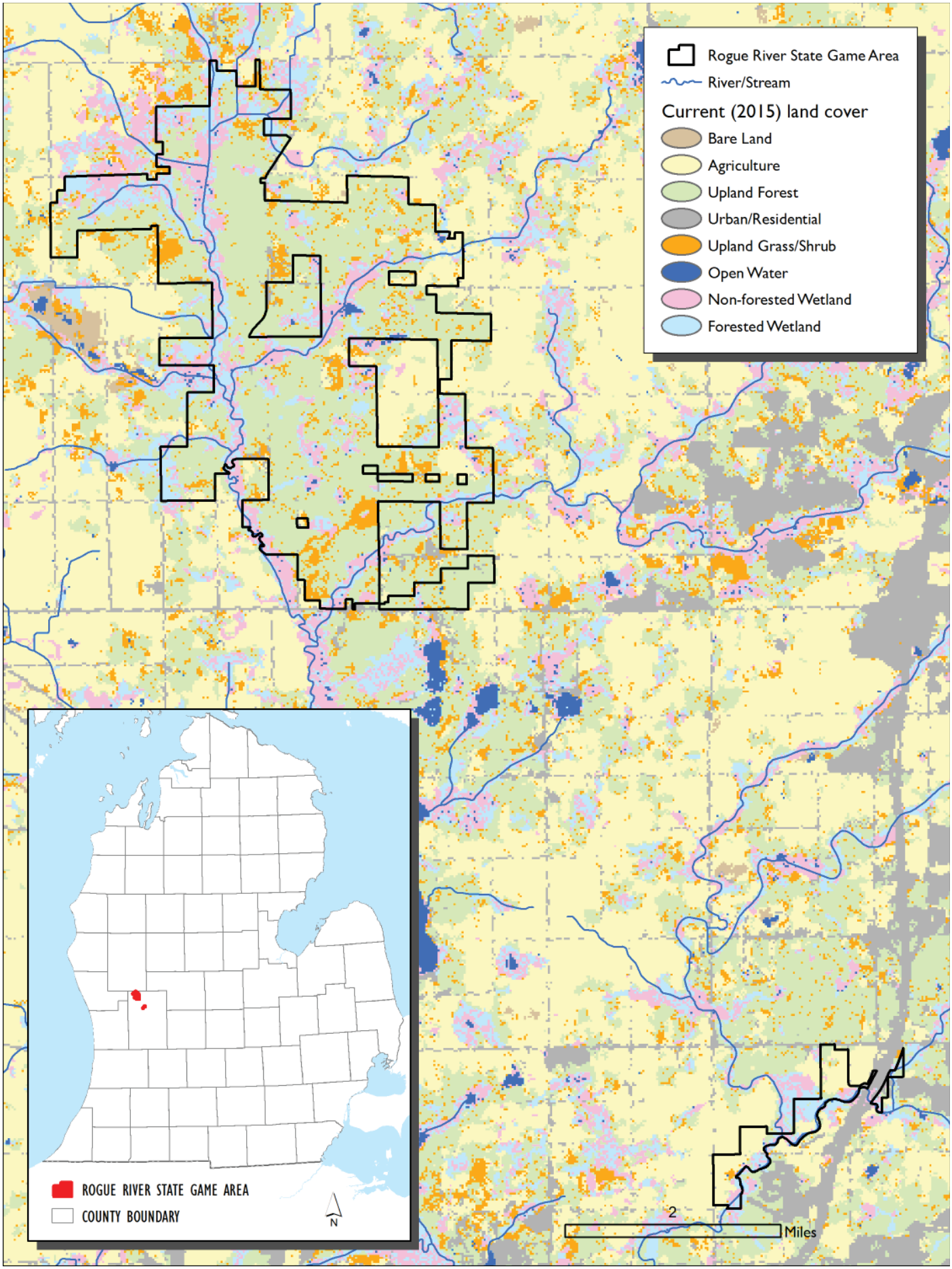


Figure 1. Current land cover of Rogue River State Game Area.

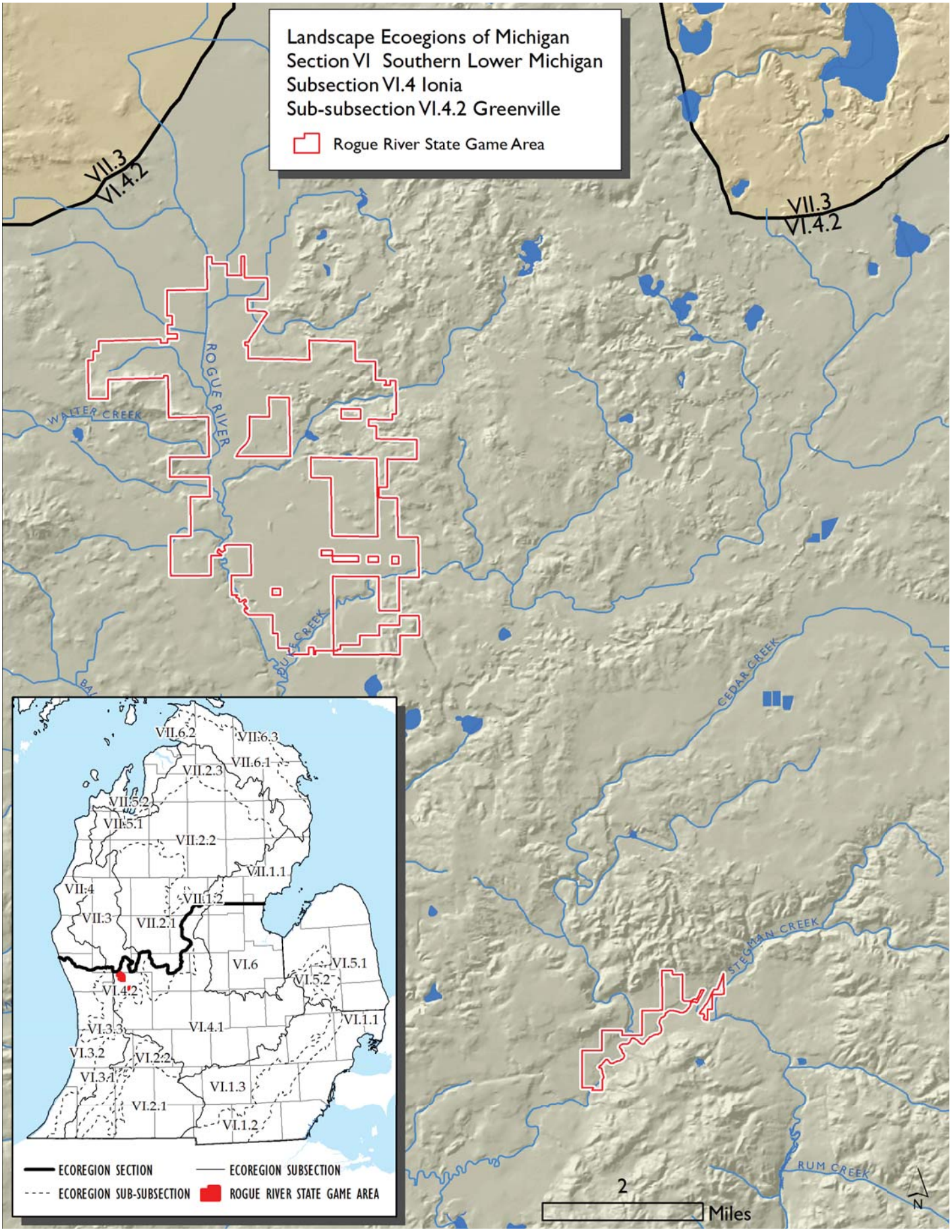


Figure 2. Ecoregions and topographic relief of Rogue River State Game Area (Albert 1995).

Greenville Moraines

The Greenville Moraines (VI.4.2) is characterized by coarse-textured end and ground moraines with areas of sandy glacial outwash (Figures 2 and 3). The terrain of the sub-subsection is generally hilly and dissected by outwash channels. The hills, up to 43 meters (140 ft) high, are moderately to steeply sloping. Both the ground moraine and end moraine are moderately to steeply sloping, but the ground moraine ridges are generally smaller than those of the end moraine. Within the game area, the prevalent landforms are outwash channel and ground moraine with localized areas of end moraine (Figure 3). Streams within the sub-subsection occupy glacial outwash channels. The numerous small kettle lakes are typically less than one square mile in area and are found on outwash, end moraine, and ground moraine. Soils within the uplands are well drained and excessively drained sands and loamy sands. Sand outwash deposits are common in lower slope positions and the majority of the outwash soils are poorly drained with shallow organics overlying sands. Historically, the upland vegetation was a mosaic of beech-sugar maple and oak-hickory forests. Oak-hickory forest was more common at the southern edge of the sub-subsection, whereas beech-sugar maple forest was more common to the north. This pattern was likely the result of gradual climatic changes that occur as the terrain rises northward into the adjacent Highplains Subsection (VII.2). White pine (*Pinus strobus*) was originally locally common on the drier upland sites, often growing with white oak (*Quercus alba*) in either open forests or savannas. Fires were important for maintaining these oak-pine and oak forests and savannas. Gap-phase dynamics or small-scale wind events were the primary driver in the closed-canopy mesic forests. The lowland vegetation contained elements of both deciduous hardwood swamp and hardwood-conifer and conifer swamps. Most of the swamp forests in the outwash channels were hardwood-conifer swamps containing hemlock (*Tsuga canadensis*), northern white cedar (*Thuja occidentalis*), white pine, trembling aspen (*Populus tremuloides*), and paper birch (*Betula papyrifera*).

Today, the sandy moraines of this sub-subsection remain largely forested, with oak-dominated forests most common. White pine-white oak forests have been largely eliminated and most oak savannas have closed in to become oak and oak-hickory forests. Most wetlands within the sub-subsection have not been significantly impacted by agricultural activities and many of the wetlands remain intact. Portions of this sub-subsection were farmed, both for row crops and pasture following logging, but much of the farmland has been abandoned due to low productivity and cold climate. Most agricultural activities in this sub-subsection have been concentrated in the uplands with the richest soils (Albert 1995).

Circa-1800s Vegetation

Interpretations of the General Land Office (GLO) surveyor notes by MNFI ecologists indicated that the Rogue River SGA and surrounding area contained several distinct vegetation assemblages (Comer et al. 1995) (Figure 4). Surveyors recorded information on the tree species composition, tree size, and general condition of the lands within and surrounding the Rogue River SGA. Circa 1800, the game area was predominantly forested with 96% of the area supporting forested ecosystems including White Pine-Mixed Hardwood Forest (56%), Beech-Sugar Maple Forest (20%), and Hemlock-White Pine Forest (2%). Outwash channels and depressions historically supported forested swamps (18% of the area) with Mixed Hardwood Swamp (17%), Mixed Conifer Swamp (1%), and Black Ash Swamp (<1%) occurring in the game area. The remainder of the game area (4% of the area) was characterized by open wetlands (3%), and lakes and rivers (1%).

Forested systems were found on the rolling ground moraines and steep end moraines that occur throughout the game area. The most prevalent tree species recorded in this area by the GLO surveyors in the forested uplands were white pine, beech, hemlock, sugar maple, white oak, and ironwood (*Ostrya virginiana*). Less frequently recorded trees were bur oak (*Quercus macrocarpa*), basswood (*Tilia americana*), American elm (*Ulmus americana*), maples (*Acer* spp.), and red oak (*Q. rubra*). Within the areas classified as upland forest, recorded diameters of trees ranged widely from 10 to 107 cm (4 to 36 in) with an average of 40 cm (18 in) (n = 93).

Circa 1800, wetlands were infrequently scattered throughout the game area, concentrated along the margins of small streams, within kettle depressions, in poorly drained portions of outwash channels, and along lower slopes of moraines (Figure 4). Circa-1800 wetland cover types included Mixed Hardwood Swamp (18% of the game area), Mixed Conifer Swamp (1% of the game area), Black Ash Swamp (<1%), and Shrub Swamp/Emergent Marsh (2%). Where the surveyors noted canopy composition of these swamps, tamarack (*Larix laricina*), white pine, maples (*Acer* spp.), and black ash (*Fraxinus nigra*) were prevalent canopy dominants with conifers more abundant in the Mixed Conifer Swamps and hardwoods more common in the Mixed Hardwood Swamps. Additional canopy associates included American elm, poplars (*Populus* spp.), and basswood. The Mixed Conifer Swamp class primarily includes hardwood-conifer swamp. Within these forested swamps, recorded diameters of canopy trees ranged from 15 to 92 cm (6 to 36 in) with an average of 46 cm (18 in) (n = 25). MNFI's open wetland classification for the circa-1800 map is very broad because within these systems the surveyors gathered limited information; this

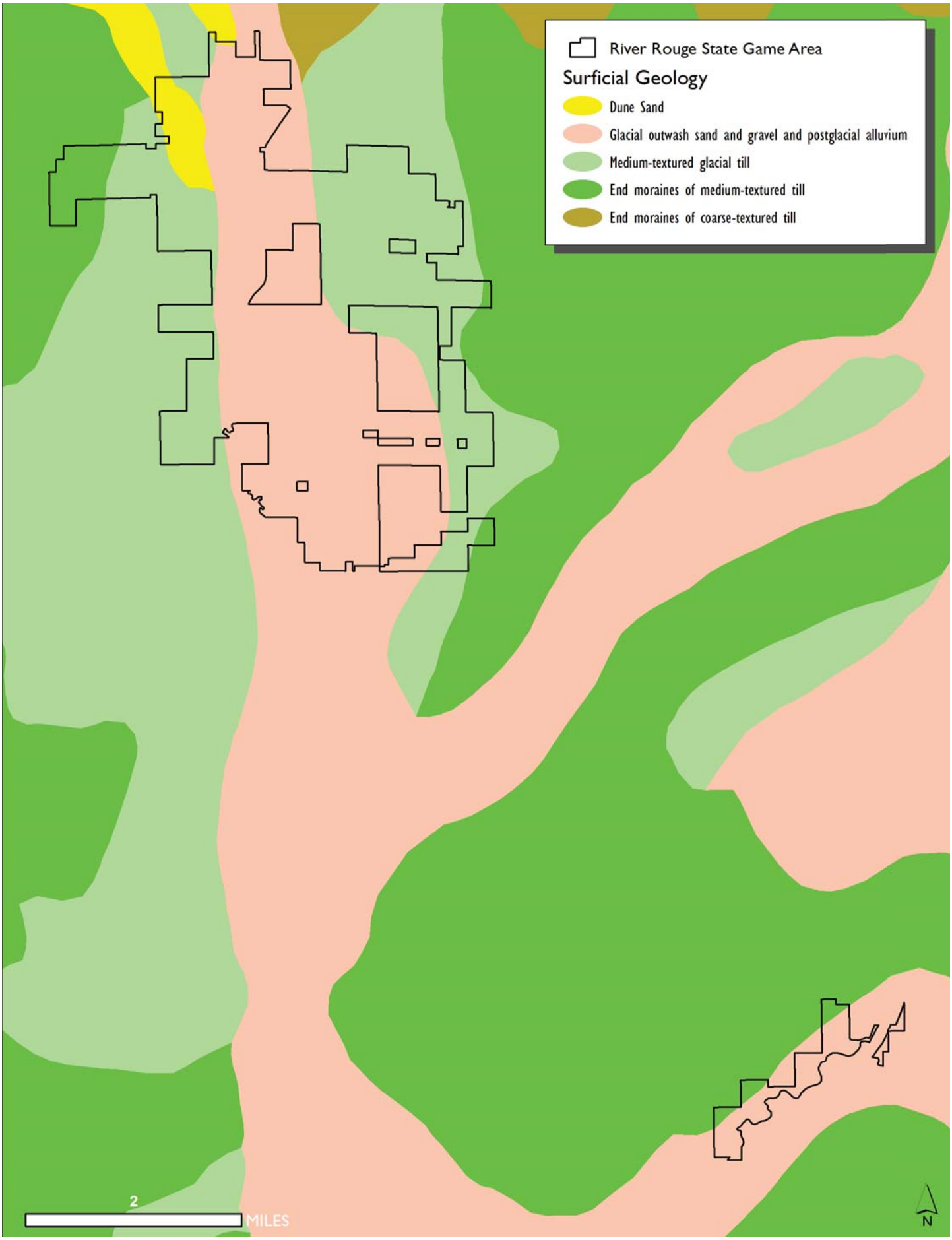


Figure 3. Surficial geology of Rogue River State Game Area (Farrand and Bell, USGS 1982).

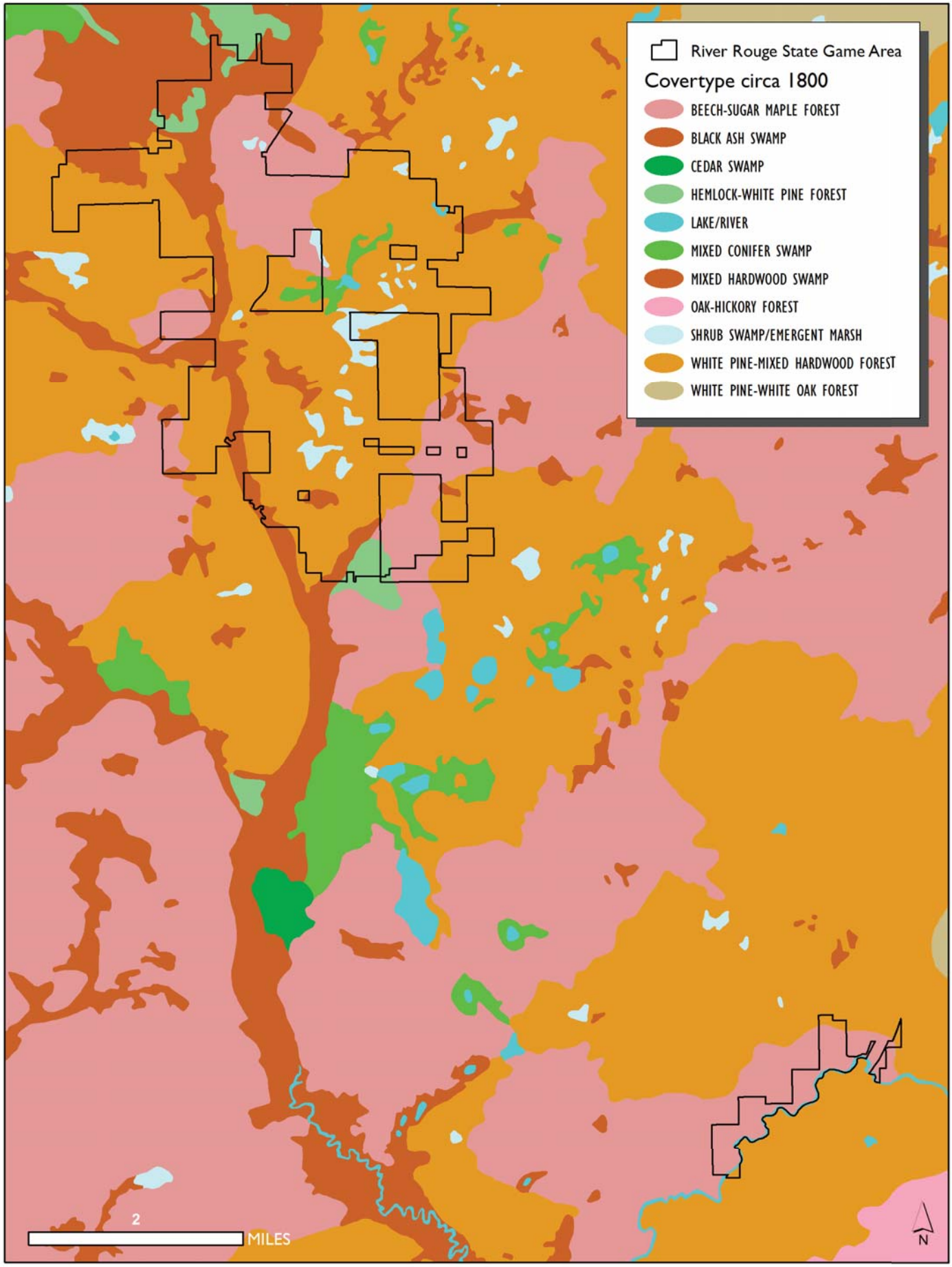


Figure 4. Circa-1800 vegetation of Rogue River State Game Area (Comer et al. 1995).

Historically, 56% of the area supported white pine–mixed hardwood forests simliar to Heiss Forest (Compartment 2; Stand 23). Photo by Jesse M. Lincoln.

paucity of data does not allow for current ecologists to more specifically classify the wetlands encountered. The very broad Shrub Swamp/Emergent Marsh cover type for the circa-1800 map likely included southern shrub-carr, inundated shrub swamp, bog, southern wet meadow, and emergent marsh.

Despite no mention of oak-pine barrens in the GLO notes, some areas found during MiFI surveys within the game area exhibited structure and had species characteristic of that community type and likely supported barrens habitat historically. These areas likely would have existed within a shifting mosaic of oak-pine forest and oak-pine barrens, depending on the frequency and intensity of fire. These potential sites occur in the sandiest and driest areas within the outwash plain in the Rogue River basin and were a minor component of the vegetation cover.

Current Land Cover

The land cover within the Rogue River SGA (Figures 1, 5, and 6) has changed significantly since 1800 due to logging, agriculture, deer herbivory, fire suppression, and hydrologic alteration. The mosaic of aerial photographs from 1938 (Figure 5) shows how logging and the expansion of agriculture heavily impacted the Rogue River SGA and the surrounding area. These photographs from 1938 also allowed ecologists to prioritize natural community surveys by identifying areas that have persisted as forested ecosystems despite agricultural development. Lands that remained forested were typically areas of steep slope or poor drainage. Many of the forested patches that persisted were nevertheless selectively logged with many oaks, white pine, and sugar maple being harvested. In addition, where forests and wetlands occurred adjacent to agricultural lands, grazing was prevalent. Much of the game area consists of formerly agricultural lands that have been since abandoned due to unfavorable slope, drainage, and/or soil conditions. Many of these former agricultural areas have reverted to early-successional forest or were converted to conifer plantations.

Current land cover in Rogue River SGA is dominated by upland forest (55% of the game area) (Figure 6). This forest is primarily composed of mixed oak forest (dry-mesic southern forest), oak-conifer forest (dry-mesic northern forest), and early-successional forest. MiFI stand types delineated in Rogue River SGA that fall within the broad class of upland forest include Oak Types (31%), Mixed Upland Deciduous (11%), Aspen Types (9%), Planted Pines (5%), Northern Hardwoods (4%), Upland Mixed Forest (< 1%), Natural Mixed Pines (2%), Upland Conifers (<1%), and Natural Mixed Pines (< 1%) (Figure 6). These forests occur throughout the game area and are especially prevalent within the outwash channel of the Rogue River and also on rolling ground moraine and moderate to steep end moraine. Conifer plantations and mixed conifer forest are notably prevalent on the droughty soils and potentially correspond to areas of former barrens or areas

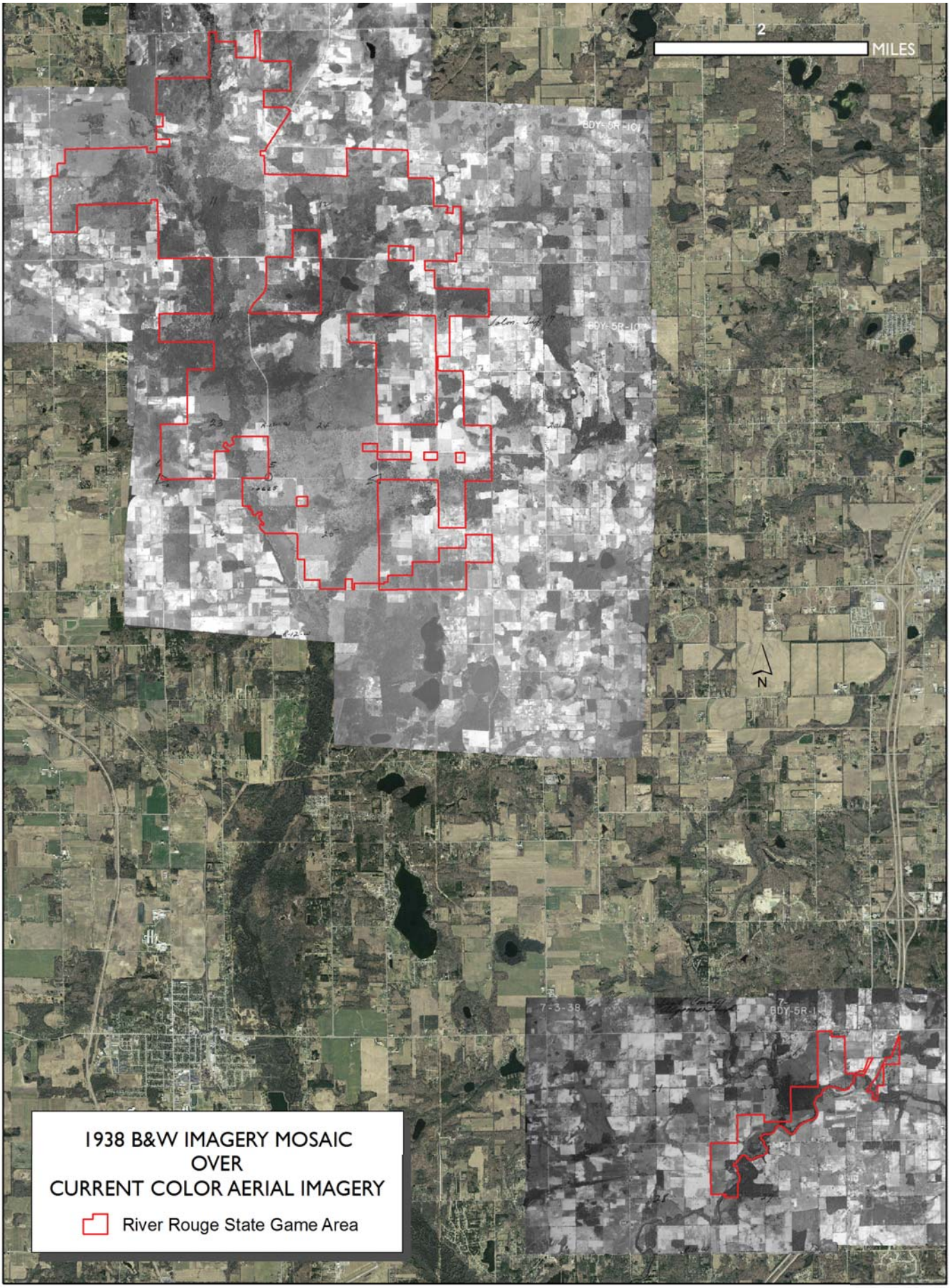


Figure 5. Mosaic of 1938 aerial photographs of Rogue River State Game Area (MNFI 2014).

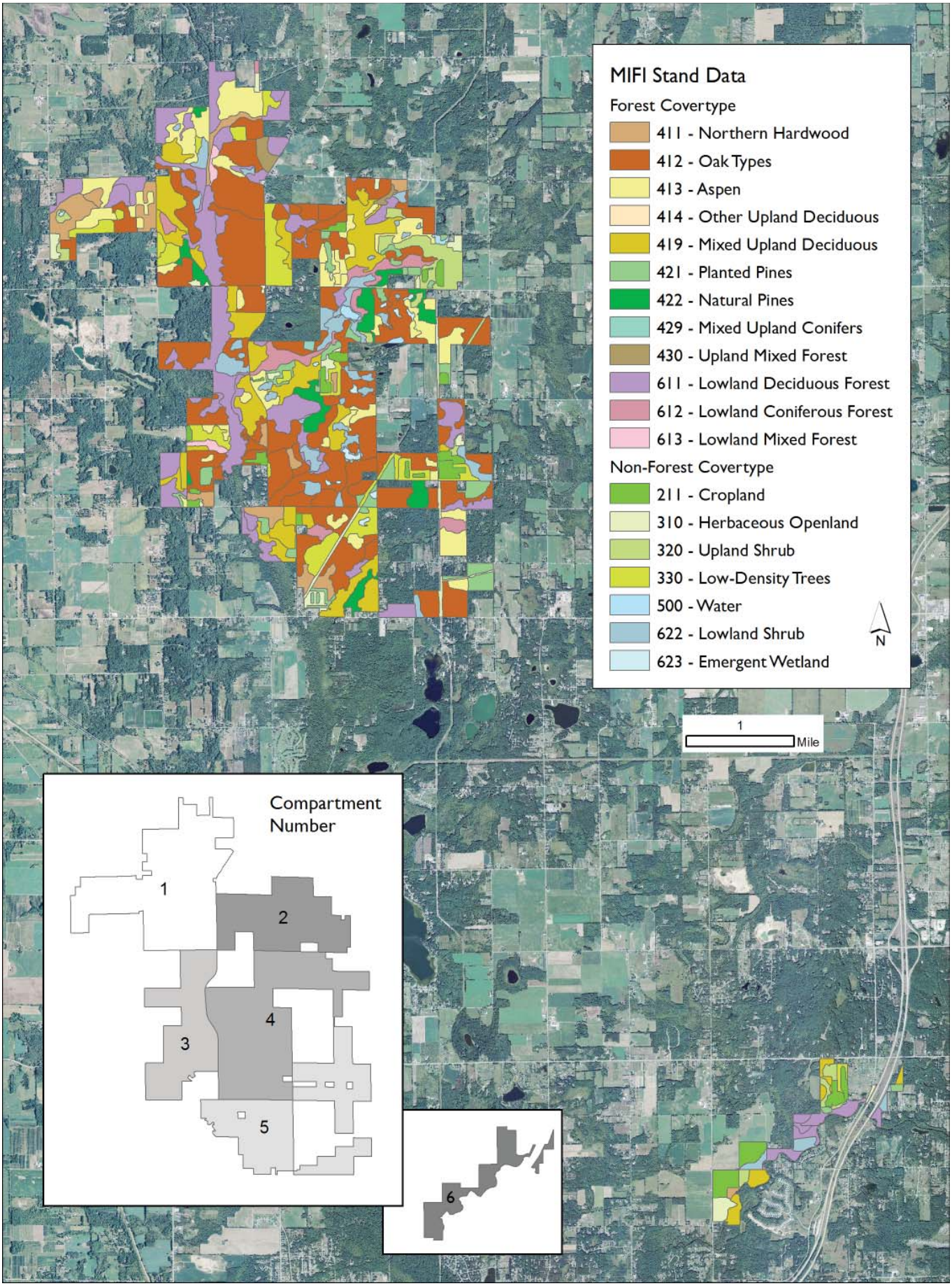


Figure 6. MiFI Covertype of stands of Rogue River State Game Area.

that experienced severe wildfires during the logging era. The majority of the forested systems within Rogue River SGA are early-successional forest with over 75% of the total forested acreage being less than 100 years old and 25% being over 100 years old or classified as uneven-aged. Early-successional forests have established on lands that were logged and/or farmed. High levels of invasive shrub species occur within the understory of these early-successional forests. In addition, many of the oak and oak-pine forest types are fire suppressed and have a significant component of mesophytic competition in the understory. As a result of fire suppression, competition, and high levels of deer herbivory, oak regeneration is sparse throughout the understory of many of these forests.

A significant portion of the game area (approximately 14%) is composed of open uplands that include Low-Density Trees (6%), Cropland (3%), Upland Shrub (3%), and Herbaceous Openland (2%) (Figure 6). Much of this open upland is likely abandoned agricultural lands.

Wetlands remain an important component of the game area with forested wetlands accounting for 18%, open wetlands accounting for 4%, and open water accounting for approximately 0.3% of the area. MiFI stand types delineated in Rogue River SGA that fall within the broad class of lowland forest include Lowland Deciduous (14%), Lowland Conifers (2%), Lowland Aspen/Balsam Poplar (1%), Tamarack (< 1%), and Lowland Mixed Forest (< 1%) (Figure 6). These lowland forests occur throughout the game area and are especially prevalent along outwash channels, within depressions, and along the lower slopes of moraines. The majority of these lowland forested systems within Rogue River SGA are early-successional forest with over 77% of the total lowland forested acreage being less than 100 years old and 23% being over 100 years. Open wetland types delineated in Rogue River SGA by MiFI stage 1 inventory include Lowland Shrub (3%), Bog (1%), Marsh (< 1%), and Treed Bog (< 1%) (Figure 6). Wetlands throughout Rogue River SGA have been impacted by hydrologic alteration (e.g., ditching and dredging), grazing, marsh haying, and invasive species encroachment.

Compared to the surrounding fragmented landscape, Rogue River SGA is characterized by a significant portion of natural cover. Within the Rogue River SGA, 92% of the of the land cover is natural cover. In comparison, only 31% of the Ionia subsection (VI.4) is natural cover. Surveys in 2015 identified seven natural community EOs including bog (1 EO), dry-mesic northern forest (1 EO), floodplain forest (1 EO), hardwood-conifer swamp (3 EOs), and southern wet meadow (1 EO). These natural community EOs will be described in detail within the **Natural Community Results** section. Documented high-quality natural communities constitute 4.2% of Rogue River SGA.

Vernal Pools

Vernal pools are small, generally isolated, temporary pools of water or wetlands that form in shallow depressions in forested areas throughout Michigan (Thomas et al. 2010). These wetlands fill with water from rainfall, snowmelt, and/or groundwater between late fall and spring, and usually dry up by mid to late summer. The periodic drying of vernal pools prevents fish from establishing populations

Forested wetlands comprise 18% of the game area and provide critical habitat for reptiles and amphibians. Photo by Jesse M. Lincoln.

in these wetlands. Because vernal pools lack predatory fish populations, these wetlands provide critical breeding habitats for a host of forest-dwelling amphibians and invertebrates, including some species that are specialized for life in vernal pools and depend on these unique habitats for their survival. These are referred to as vernal pool obligate or indicator species, and include the blue-spotted salamander (*Ambystoma laterale*), spotted salamander (*Ambystoma maculatum*), wood frog (*Rana sylvatica*), and fairy shrimp (*Eubranchipus* spp.) (Colburn 2004, Calhoun and deMaynadier 2008). Although wood frogs, spotted salamanders, and blue-spotted salamanders can reproduce in wetlands other than vernal pools, successful production of juveniles may be much higher in vernal pools than in other wetlands that have permanent populations of fish or other predators. The eggs and/or larvae of these species appear to be more palatable to fish and other predators because they lack defense mechanisms (e.g., toxic compounds, mechanical or physiological barriers, behavioral responses) that protect them from predators (Grubb 1972, Kruse and Francis 1977, Formanowicz and Brodie 1982, Woodward 1983, Kats et al. 1988). Some species, such as wood frogs, will actually avoid breeding in habitats with fish (Hopey and Petranka 1994). Fairy shrimp occur only in waters that are free of fish populations, and spend their entire lives in a single vernal pool (Colburn 2004). Their eggs may require drying, flooding, and freezing to successfully hatch, and can survive in the sediment for several years (Colburn 2004).

Vernal pools also provide habitat for a number of other animals, including snakes, turtles, waterfowl, wetland birds, woodland birds, and mammals. Over 550 animal species have been found in vernal pools in the northeastern U.S. (Colburn 2004). Many animal species use vernal pools for food and water throughout the growing season, as breeding and nursery areas for development of their young, and as resting areas and stepping stones to travel to other areas with suitable habitat (Gibbs 1993, Semlitsch and Bodie 1998, Gibbs 2000, Mitchell et al. 2008). Vernal pools have high species richness due to their structural complexity and ability to provide both aquatic and terrestrial habitats (Calhoun and deMaynadier 2008).

Species that use vernal pools include white-tailed deer (*Odocoileus virginianus*), black bear (*Ursus americanus*), raccoon (*Procyon lotor*), wood duck (*Aix sponsa*), American black duck (*Anas rubripes*), barred owl (*Strix varia*), wild turkey (*Meleagris gallopavo*), American woodcock (*Scolopax minor*), northern ribbonsnake (*Thamnophis sauritus septentrionalis*), and northern watersnake (*Nerodia sipedon*). Several endangered, threatened, or rare species in Michigan use vernal pools extensively, such as the Blanding's turtle (*Emydoidea blandingii,* state special concern), spotted turtle (*Clemmys guttata,* state threatened), wood turtle (*Glypemys insculpta,* state special concern), small-mouthed salamander (*Ambystoma texanum,* state endangered), copperbelly water snake (*Nerodia erythrogaster neglecta,* federally threatened and state endangered), red-shouldered hawk (*Buteo lineatus,* state threatened), and little brown bat (*Myotis lucifugus,* state special concern). Vernal pools also contribute other important ecosystem services including nutrient cycling, water storage and infiltration, groundwater recharge, and flood control. The large numbers of invertebrates and amphibians that occur in and emerge from vernal pools significant biomass, nutrients, and energy to the surrounding wildlife and forest ecosystems (Colburn 2004, Calhoun and deMaynadier 2008).

Due to increased awareness of the ecological significance of vernal pools, there has been growing interest in identifying, mapping, monitoring, and protecting these small but valuable wetlands in Michigan. Because vernal pools are small, isolated, and dry for part of the year, they can be easily overlooked and unintentionally damaged or destroyed during forest management and other land-use activities. They also are not well-protected under current federal and state wetland regulations, although they have been afforded some protection under several voluntary guidelines such as the State of Michigan's Sustainable Soil and Water Quality Practices on Forest Land manual and the Sustainable Forestry Initiative (SFI) and Forest Stewardship Council's (FSC) forest certification standards (Michigan Department of Natural Resources and Michigan Department of Environmental Quality 2009, Sustainable Forestry Initiative 2010, Forest Stewardship Council 2010). Information regarding the status, distribution, and ecology of vernal pools within the state is limited but also critical for management and conservation of Michigan's vernal pools and the diverse array of species that depend on them.

Potential and verified vernal pools were identified and mapped in Rogue River SGA in 2016 using remote sensing and field sampling. The primary goal of this mapping and survey effort is to provide resource managers and planners with baseline information on vernal pool status and distribution within the game area. Knowing where vernal pools are located in the game area and the species and habitats found in and around them will help managers plan and implement appropriate management and protection of these wetlands. Vernal pools also were identified and mapped to pinpoint potential sites for amphibian and reptile surveys in the game area since these wetlands provide habitat for amphibian and reptile species targeted for surveys in 2016.

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."

Natural Community Survey Methods

A natural community is defined as an assemblage of interacting plants, animals, and other organisms that repeatedly occurs under similar environmental conditions across the landscape and is predominantly structured by natural processes rather than modern anthropogenic disturbances (Cohen et al. 2015a). Protecting and managing representative natural communities is critical to biodiversity conservation, since native organisms are best adapted to environmental and biotic forces with which they have survived and evolved over the millennia (Kost et al. 2007). According to MNFI's natural community classification, there are 77 natural community types in Michigan (Kost et al. 2007, Cohen et al. 2015a). Surveys assessed the current ranking, classification, and delineation of these occurrences and detailed the vegetative structure and composition, ecological boundaries, landscape and abiotic context, threats, management needs, and restoration opportunities. The primary goal of this survey effort is to provide resource managers and planners with standardized, baseline information on each natural community EO. This baseline information is critical for facilitating site-level decisions about biodiversity stewardship, prioritizing protection, management and restoration, monitoring the success of management and restoration, and informing landscape-level biodiversity planning efforts.

Each natural community was evaluated employing Natural Heritage and MNFI methodology, which considers three factors to assess a natural community's ecological integrity or quality: size, landscape context, and condition (Faber-Langendoen et al. 2008, Faber-Langendoen et al. 2015). If a site meets defined requirements for these three criteria (MNFI 1988) it is categorized as a high-quality example of that specific natural community type, entered into MNFI's database as an element occurrence, and given a rank based on the consideration of its size, landscape context, and condition. Ecological field surveys were conducted during the growing season (primarily from June to August of 2015) to evaluate the condition and classification of the sites. To assess natural community size and landscape context, a combination of field surveys, aerial photographic interpretation, and Geographic Information System (GIS) analysis was employed. Typically, a minimum of a half day to a day was dedicated to each site, depending on the size and complexity of the site.

The ecological field surveys typically involved:

a) compiling comprehensive plant species lists and noting dominant and representative species
b) describing site-specific structural attributes and ecological processes
c) measuring tree diameter at breast height (DBH) of representative canopy trees and aging canopy dominants (where appropriate)
d) analyzing soils and hydrology
e) noting current and historical anthropogenic disturbances
f) evaluating potential threats
g) ground-truthing aerial photographic interpretation using GPS (Garmin units were utilized)
h) taking digital photos and GPS points at significant locations
i) surveying adjacent lands when possible to assess landscape context
j) evaluating the natural community classification and mapped ecological boundaries
k) assigning or updating element occurrence ranks
l) noting management needs and restoration opportunities or evaluating past and current restoration activities and noting additional management needs and restoration opportunities

Following completion of the field surveys, the collected data were analyzed and transcribed to update or create new EO records in MNFI's statewide biodiversity conservation database (MNFI 2017a). Natural community boundaries were mapped or re-mapped. Information from these surveys was used to produce site descriptions, threat assessments, and management recommendations for each natural community occurrence, which appear within the following **Natural Community Surveys Results** section.

Vernal pools occur throughout the game area and provide critical habitat to a variety of species, particularly reptiles and amphibians. Heiss Forest (Compartment 2; Stand 23). Photo by Jesse M. Lincoln.

Vernal Pools Survey Methods

Potential vernal pools (PVPs) were identified and mapped across the game area using aerial photograph interpretation (Figure 7). Aerial photo interpretation is currently still the most effective method available for identifying and mapping vernal pools remotely (Calhoun and deMaynadier 2008). Aerial photograph interpretation consisted of using ESRI ArcGIS software to visually examine available aerial imagery and data layers of the game area on a computer screen.

Aerial imagery that were examined to identify and map PVPs included color infrared, leaf-off aerial imagery from the spring of 1998, and natural color aerial imagery from the summer of 2005, 2010, and/or 2012 (NAIP 2005, NAIP 2010, and NAIP 2012 True Color). Topographic maps of the game area also were examined. Aerial imagery and other data layers were available through Michigan State University's Remote Sensing and GIS (RSGIS) Center and the State of Michigan. We used a map scale of 1:5000 for spatial extent of the aerial imagery displayed on the computer screen to detect PVPs. PVPs were digitized and mapped as polygons using ESRI ArcGIS software. PVPs were added to a statewide vernal pool geodatabase developed by MNFI to record and track data on the locations and characteristics of potential and verified vernal pools in the state (MNFI 2017b). Each PVP polygon was assigned a unique identification number for reference, and preliminary information about these polygons were included in the geodatabase.

A subset of the PVPs mapped in the game area was surveyed between June 21st and September 30th, 2016 to verify, map, and collect data on vernal pools in the field (Figure 7). These surveys were primarily conducted during surveys for rare amphibians and reptiles. Most PVPs were surveyed only once or twice during the sampling period. Surveyors verified if PVPs represented actual vernal pools in the field, or if the PVPs were other types of wetlands or other habitats. The status of PVPs visited in the field was

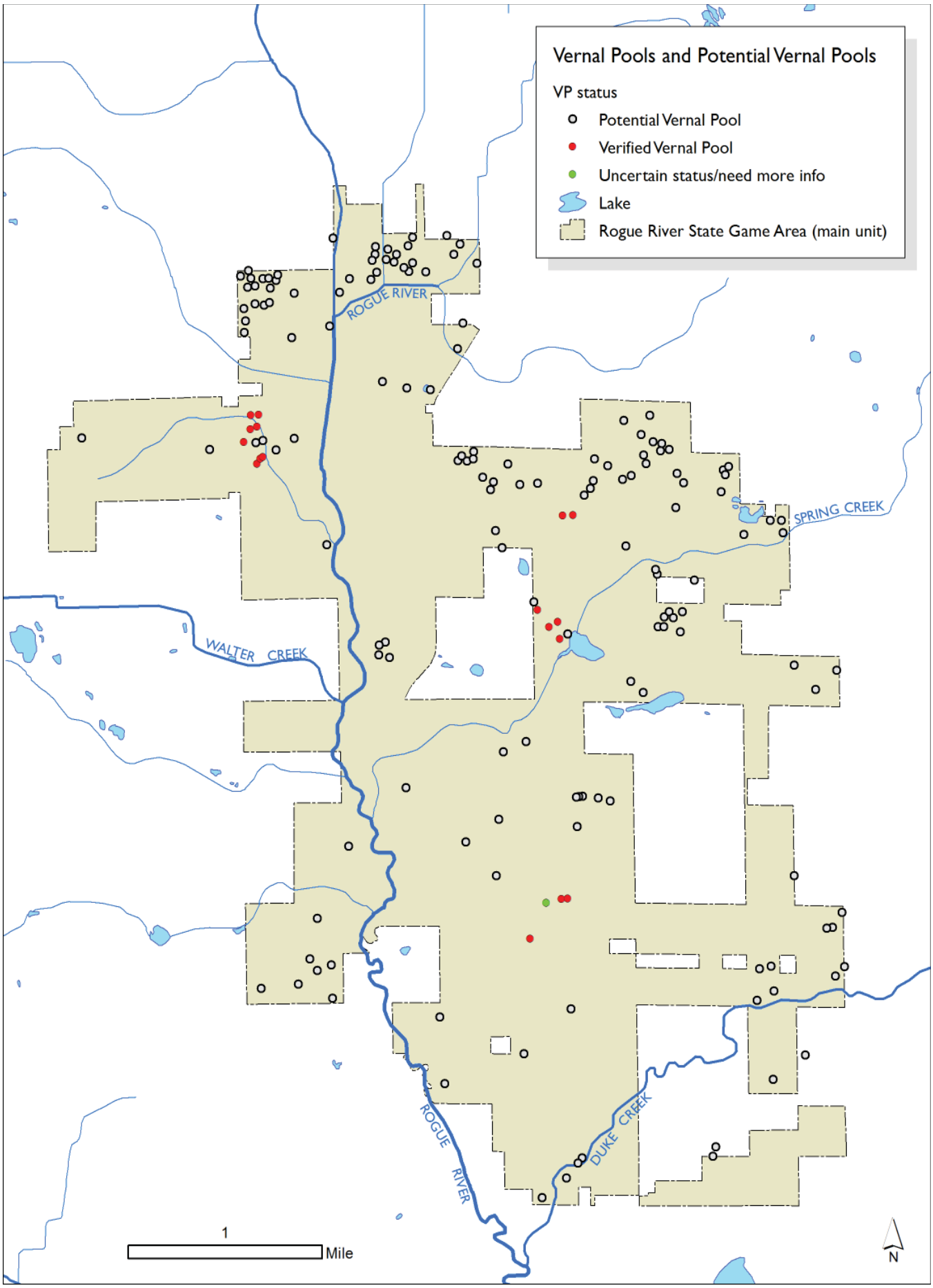


Figure 7. Location of vernal pools and potential vernal pools in Rogue River State Game Area.

documented using one of the following five designations: 1) verified as a vernal pool and is active/present; 2) verified as a vernal pool and is no longer active/has been destroyed; 3) visited in the field but status still uncertain/ insufficient information; 4) visited in the field and is not a vernal pool/some other wetland type; and 5) visited in the field and is not a vernal pool/no water present. Vernal pools verified in the field were mapped using a GPS unit or tablet. Additional vernal pools that were encountered opportunistically during field sampling and had not been mapped as PVPs were recorded and mapped.

Basic information about the physical characteristics, general condition, surrounding habitat, vegetative structure, and presence of vernal pool indicator species (i.e., fairy shrimp, wood frog egg masses and tadpoles, and/or blue-spotted and spotted salamander egg masses and larvae) and other animals in the pools were recorded in the field using a standardized vernal pool monitoring data form (Appendix 1). Vernal pools verified in the field were classified into the following six general vernal pool types based on vegetation within the pools: open pools, sparsely vegetated pools, shrubby pools, forested pools, marsh pools, and other (e.g., half open and half shrubby). Definitions of vernal pool types are provided in Appendix H2. Vernal pools and other wetlands and habitats identified in the field were photographed for documentation and verification. Field sampling results and data were incorporated into the Michigan Vernal Pool Database (MNFI 2017b), a statewide vernal pool geodatabase with locational information as well as ecological data about potential and field-verified vernal pools.

Rare Animal Survey Methods

We identified rare animal target species for surveys using historical distribution within Michigan, past occurrences in or near Rogue River SGA, and the presence of potential habitat within the game area. A variety of data sources were used to determine if potential habitat occurs within the game area, including natural community occurrences, MiFI descriptions, aerial photography, and on-the-ground observations. We conducted surveys for target animal species in appropriate potential habitats during time periods when targeted elements were expected to be most active and detectable (e.g., breeding season). Surveys were done to identify new occurrences, update and/or expand existing occurrences, and revisit historical occurrences of select rare species. In addition to documenting rare species, we also recorded observations of species of greatest conservation need (SGCN) identified in Michigan's Wildlife Action Plan (Derosier et al. 2015).

Bird Surveys

Given the presence of tracts of mature forest and results of previous surveys, we focused bird surveys in the game area on rare songbirds and raptors (red-shouldered hawk [*Buteo lineatus*, state threatened] and northern goshawk [*Accipiter gentilis*, state special concern], both DNR featured species). Contiguous forest stands at least 4 ha (10 acres) in area were considered potential habitat for target species. We generated a 250 m X 250 m grid of possible survey points that was overlaid over the potential survey stands. Those points falling within the potential survey stands were used for conducting raptor and songbird surveys. Because of the high number of potential survey points identified for game areas to be surveyed in 2016, we prioritized the potential survey points based on stand type, age, and density. We did not survey points falling in pine plantations. Remaining points were classified as priority 1, 2, 3, and 4 in order of highest to lowest priority. Priority 1 points fell within stands having an age of at least 80 years (i.e., ≥ 80 years since harvest, year of entry 1936 or earlier) and stand a density of 9 (saw timber, well stocked). Points occurring in stands less than 80 years of age but having a stand density of 9 were assigned priority 2. Priority 3 points fell within stands of at least 80 years in age but having stand densities of 7 or 8 (saw timber, poor to medium stocking). Points not meeting the criteria for priority 1, 2, or 3 were assigned priority 4; these points were not targeted for survey but were occasionally visited opportunistically. One hundred ninety possible points were identified for Rogue River SGA stands, of which 86 were priority 1, 14 were priority 2, 18 were priority 3, and 72 were priority 4. Points were assigned unique identification numbers and uploaded to a GPS unit or tablet computer for field location. In addition to surveying for rare raptors and songbirds, point-count sampling was used to gather baseline information about the forest bird community, including relative abundance and species richness.

We conducted three-minute raptor surveys at systematically located point count stations (Figure 8; Mosher et al. 1990, Anderson 2007, Bruggeman et al. 2011). Each three-minute point count consisted of two minutes of broadcasts (one minute for red-shouldered hawk and one minute for northern goshawk) and one minute of silent listening. Surveys were conducted during April 18th to May 16th, 2016. At each station the following data were recorded: whether or not a red-shouldered hawk or northern goshawk was detected, all other raptor sightings or vocalizations, other bird observations, and other rare animal species detections or potential habitats. If a rare raptor 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.

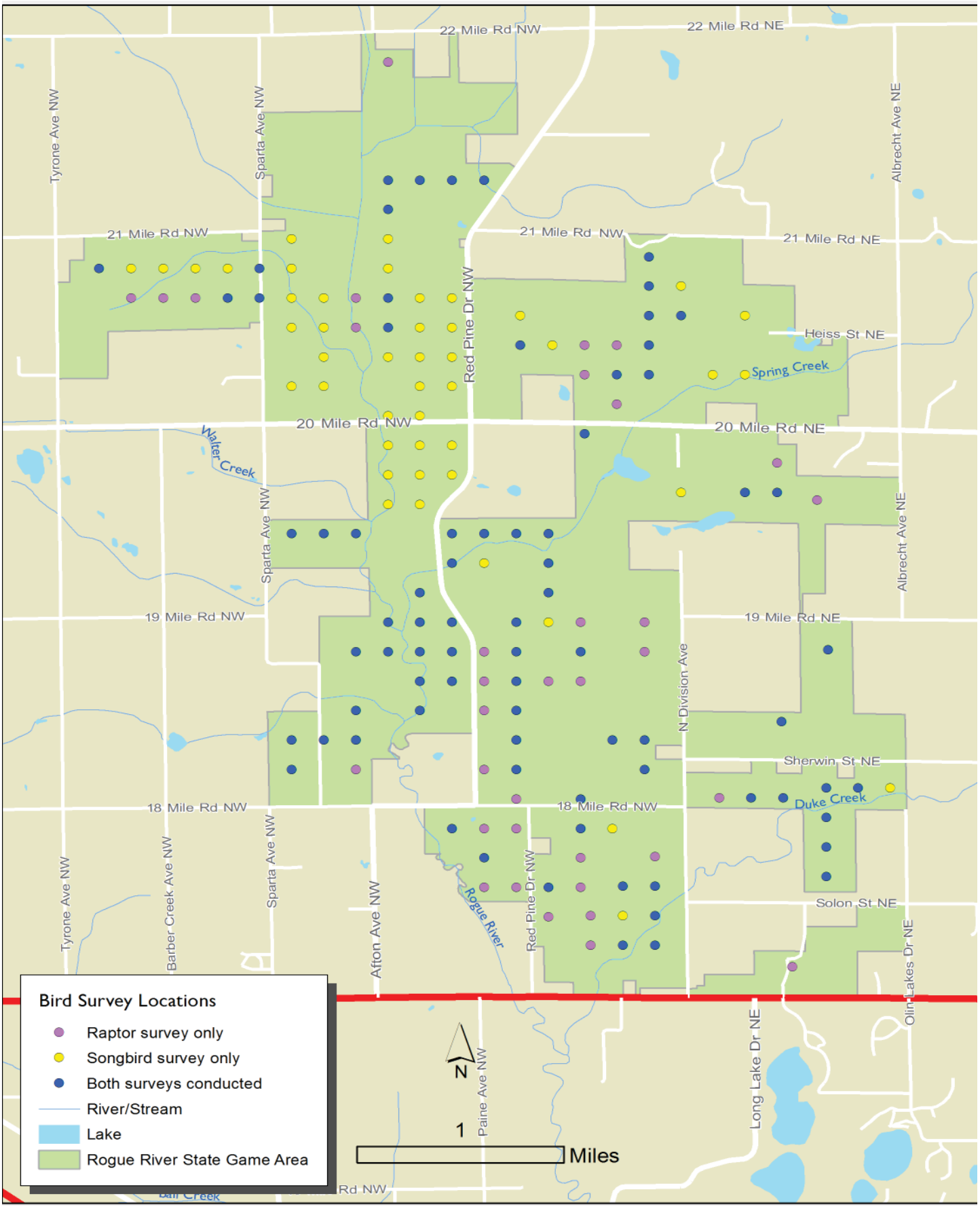


Figure 8. Location of forest songbird and raptor point counts conducted in Rogue River State Game Area in 2016.

We targeted forest bird surveys toward detecting cerulean warbler (*Dendroica cerulea*, state threatened), hooded warbler (*Setophaga citrina*, state special concern), and Louisiana waterthrush (*Parkesia motacilla*, state threatened). Louisiana waterthrush was detected in the area previously and there was potential for the other two species to occur in the game area (Table 4). Forest bird point counts were conducted at the same systematically located points used for raptor surveys (Figure 8). Ralph et al. (1995) noted that 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, so we visited each point only once. Surveys were conducted during May 26th to July 17th, 2016 between sunrise and four hours after sunrise. In addition to documenting observations of the three rare species, we gathered data on all birds seen or heard during each 10-minute point count. We recorded the species and number of individuals observed during three independent periods (2 minutes, 3 minutes, and 5 minutes) for a total of 10 minutes at each station (Ralph et al. 1995). Use of the three survey periods provides flexibility in making comparisons with other surveys (e.g., North American Breeding Bird Surveys) 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 of the bird from the observer to facilitate future distance analyses and refinement of density and population estimates. At each point-count station, we noted if the site appeared suitable for cerulean warbler, hooded warbler, and Louisiana waterthrush and recorded any invasive plant species seen.

Reptile and Amphibian Surveys

The following rare species of amphibians and reptiles (i.e., herptiles) were targeted for surveys in Rogue River SGA in 2016: Blanding's turtle (*Emydoidea blandingii*, state special concern), eastern box turtle (*Terrapene carolina carolina*, state special concern), spotted turtle (*Clemmys guttata*, state threatened), wood turtle (*Glyptemys insculpta*, state special concern), and eastern massasauga (*Sistrurus catenatus*, state special concern and proposed as federally threatened) (Appendix 3). These species have been identified as Species of Greatest Conservation Need (SGCN) in Michigan's updated Wildlife Action Plan, with eastern massasauga and eastern box turtle identified as focal or priority SGCN for conservation actions (Derosier et al. 2015). These species were targeted for surveys because they had been previously documented in or near the game area, or they had potential to occur within the game area due to the species' range within the state and presence of suitable habitat for the

Louisiana waterthrush utilize stream-side habitat in mature deciduous forests and were documnted along Duke Creek (Compartment 5; Stand 23). Photo by Jesse M. Lincoln.

species. Surveys in 2016 also had potential for detecting several additional amphibian and reptile rare species and/or SGCN in Michigan's Wildlife Action Plan (Derosier et al. 2015, Appendix 3). These included the Blanchard's cricket frog (*Acris blanchardii*, state threatened), pickerel frog (*Lithobates palustris*, state special concern), eastern musk turtle (*Sternotherus odoratus*), blue racer (*Coluber constrictor foxii*), northern ribbonsnake (*Thamnophis sauritus septentrionalis*), northern ring-necked snake (*Diadophis punctatus edwardsii*), smooth green snake (*Opheodrys vernalis*), and gray ratsnake (*Pantherophis spiloides*, state special concern) (Derosier et al. 2015). Visual encounter surveys, basking surveys, and dipnetting surveys were conducted for the target species. Surveys focused on identifying new occurrences or additional locations for existing occurrences.

Visual encounter surveys were conducted from June 21st through September 30th, 2016 using a standard method for surveying amphibians and reptiles (Campbell and Christman 1982, Corn and Bury 1990, Crump and Scott 1994). Visual encounter surveys were conducted in or along the edge of open wetlands, waterbodies (e.g., vernal pools, permanent ponds, lakes, streams, and rivers), upland and lowland deciduous or mixed forest stands, and/or open uplands adjacent to wetlands or waterbodies. Visual encounter surveys were conducted in three main areas with suitable habitats for target species within the Rogue River SGA (Figure 9). Survey areas included 6 non-forested wetland stands, 17 vernal pools/potential vernal pools, and 8 upland or lowland forest stands (identified and mapped through Stage 1 MiFI). Wetlands that were surveyed included a bog, inundated shrub swamp, southern wet meadow (EO ID 20550), and southern hardwood swamp. Survey sites were visited one to two times during the field season. Visual encounter surveys were conducted during daylight hours and under appropriate weather conditions when target species were expected to be active and/or visible [i.e., between 60-80°F (16-27°C), wind less than 15 mph, no or light precipitation]. These surveys consisted of one surveyor walking slowly through areas with suitable habitat for survey targets, overturning cover (e.g., logs, rocks, etc.), inspecting retreats, and looking for basking, resting, and/or active individuals on the surface or under cover.

Basking surveys were conducted in late June 2016 to search for Blanding's turtles and other turtles and snakes. We conducted basking surveys at three survey sites (Compartment 4; Stands 12, 67, and 79) containing open and/or shrubby wetlands or waterbodies and eight vernal pools that appeared to provide suitable habitat for Blanding's turtles (Figure 9). Basking surveys were conducted during daylight hours and under appropriate weather conditions when target species were expected to be active and/or visible [i.e., between 60-80°F (16-27°C), wind less than 15 mph, no or light precipitation]. Basking 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 and snakes partially submerged in the water or basking on logs, woody debris, islands, or other structures.

Dipnetting surveys were conducted in eight vernal pools (Figure 9) to document amphibian species occurring in the pools. Surveys were focused on vernal pool indicator species including the wood frog (*Lithobates sylvaticus*), blue-spotted salamander (*Ambystoma laterale*), and spotted salamander (*Ambystoma maculatum*). These species primarily breed in vernal pools (Harding 1997, Colburn 2004, Calhoun and deMaynadier 2008). Dipnetting surveys were conducted on June 21st and 22nd in 2016. Dipnetting consisted of using a small aquarium net to take multiple sweeps through the water column and along the substrate and cover objects (e.g., woody debris, emergent or submergent vegetation) in the pools to try to capture adults and larvae of target species and other amphibians. Amphibian larvae were identified to the lowest taxonomic level possible. Invertebrates captured during dipnetting surveys also were identified if possible and recorded to the lowest taxonomic level possible. Specimens were recorded, photographed, and released at the capture site. Photographs of the amphibian larvae were used for species verification and documentation.

Survey data forms (Appendix 4) were completed for all herptile surveys, and survey locations were recorded with a Garmin GPS unit or using the Backcountry Navigator application on a Samsung tablet. We documented all rare and common reptiles and amphibians and other animals encountered during surveys. 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. We completed MNFI special animal survey forms when rare herptiles were encountered, and recorded spatial locations with a Garmin GPS unit or a Samsung tablet. Whenever possible, photos of rare species were taken for supporting documentation.

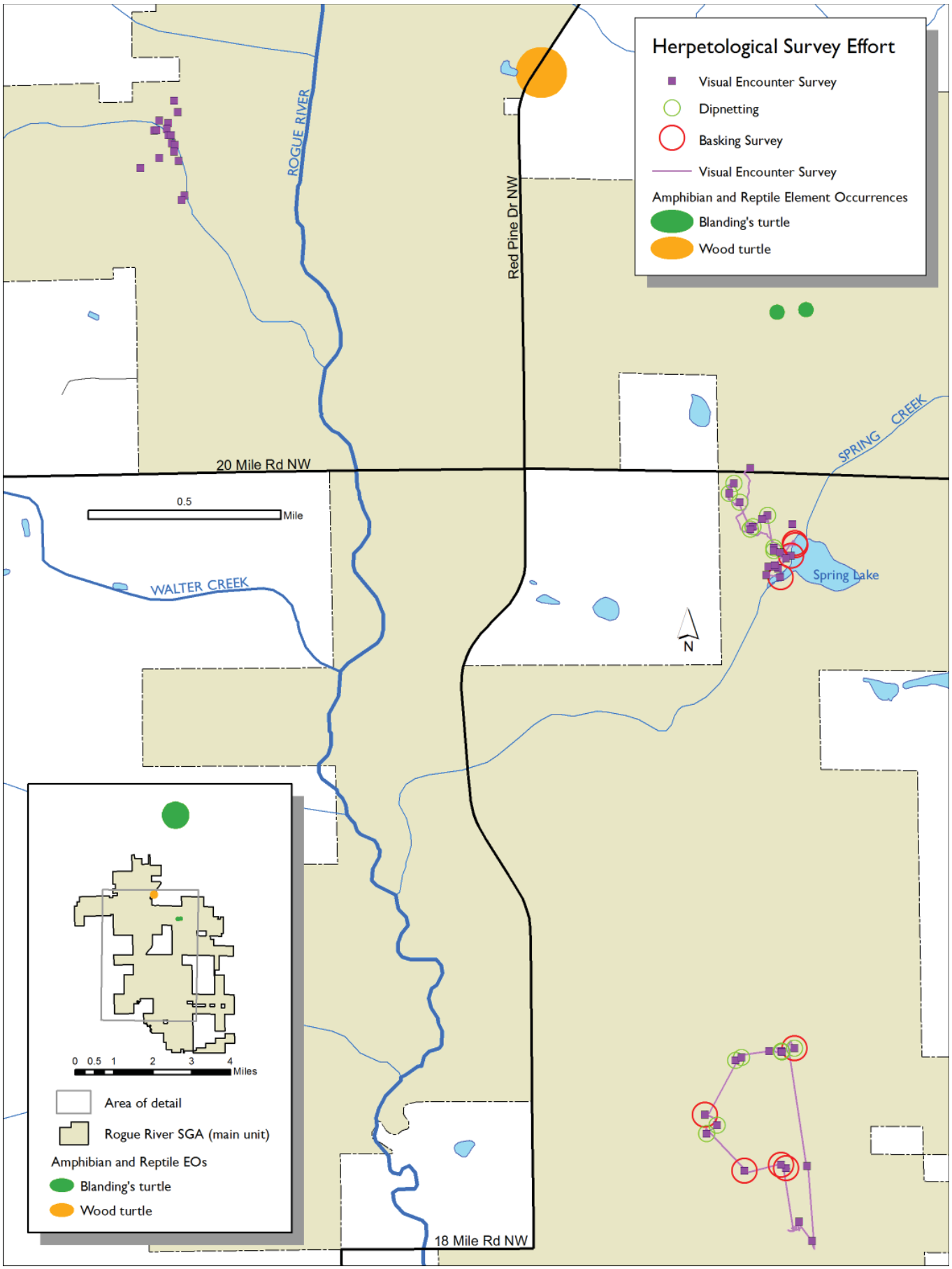


Figure 9. Location of reptile and amphibian surveys conducted in Rogue River State Game Area in 2016.

Mussel Surveys

Aquatic surveys were performed at eleven sites within the Rogue River, Duke Creek, and Spring Creek to determine the presence/absence and abundance of unionid mussels at each site, as well as document stream water chemistry and physical habitat characteristics (Figure 10). Additional taxa including aquatic snails, fish, crayfish, and fingernail clams were recorded as incidental finds. Presence/absence was documented for non-native gastropods and bivalves as well [i.e., banded mysterysnail (*Viviparus georgianus*), zebra mussel (*Dreissena polymorpha*) and Asian clam (*Corbicula fluminea*)]. Three waterways within the state game area provide potential habitat for native unionid mussels: the main stem of the Rogue River, Duke Creek, and Spring Creek.

Surveys took place in wadeable habitats (less than approximately 70 cm deep). The search area at each site was measured to standardize sampling effort among sites and allow unionid mussel density estimates to be made. The search area typically extended from bank to bank in order to include the widest range of microhabitats. Live unionids and shells were located with a combination of visual and tactile means. Glass bottom buckets were used to facilitate visual detection. Tactile searches through the substrate were made to help ensure that buried individuals were being detected, including smaller sized unionid mussels. Live individuals were identified to species and placed 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. The number of individuals was determined for each unionid mussel species at each site. Gastropod shells were collected by hand and brought back to the lab for identification. Latitude and longitude of survey sites were recorded with handheld Garmin GPS units (Table 1). Habitat data were recorded to document stream conditions at the time of the surveys. The substrate within each search area was characterized by visually estimating percent composition of each of the following six particle size classes (diameter): boulder (>256 mm); cobble (256-64 mm); pebble (64-16 mm); gravel (16-2 mm); sand (2-0.0625 mm); and silt/clay (<0.0625 mm) (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 was estimated visually, and a characterization of current speed was made by timing floating debris over a measured distance. Conductivity and pH were recorded with an Oakton handheld meter. Alkalinity and hardness were measured with LaMotte kits (models 4491-DR-01 and 4824-DR-LT-01).

Stream habitat was carefully characterized at each site. Photo by Peter J. Badra.

Table 1. Locations of mussel survey sites within Rogue River State Game Area, Summer 2016.

Site #	Waterbody	Access	Latitude (N)	Longitude (W)
1	Rogue River	22 Mile Rd./North Country Trail	43.29237	-85.70210
2	Rogue River	South of 22 Mile Rd.	43.28760	-85.70249
3	Rogue River	Red Pine Dr./North Country Trail	43.24279	-85.69666
4	Rogue River	20 Mile Rd./N. Country Trail/ORV Trail	43.25744	-85.69942
5	Rogue River	Friske Dr./trail	43.14766	-85.59907
6	Rogue River	Friske Dr.	43.14718	-85.60144
7	Rogue River	Algoma Ave./trail	43.14006	-85.60717
8	Rogue River	Wolven Ave. NE	43.15489	-85.58388
9	Duke Creek	N. Division Ave.	43.22763	-85.67249
10	Duke Creek	Power line right of way off Sherwin St. NE	43.23434	-85.66043
11	Spring Creek	Red Pine Dr.	43.25228	-85.69519

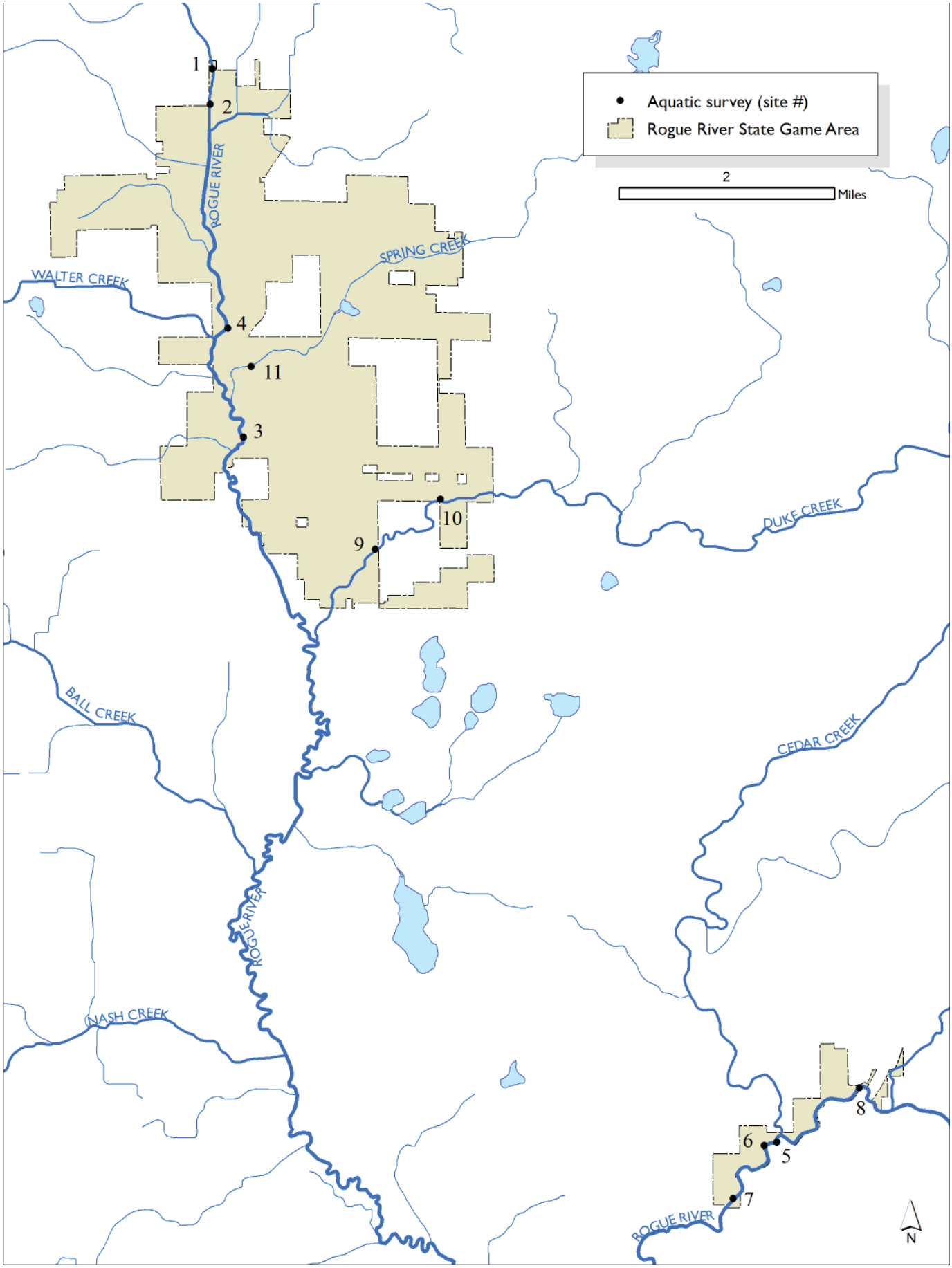


Figure 10. Location of aquatic surveys conducted in Rogue River State Game Area in 2016.

RESULTS

During the Integrated Inventory Project at Rogue River SGA, MNFI documented 13 new EOs and provided information for updating an additional 4 EOs (Tables 2-6). Data compiled on these EOs was entered into MNFI's Biotics database (MNFI 2017a). In total, 10 SGCN were documented during the project including 7 different rare animal species (Table 12). The locations in Rogue River SGA of all natural community and rare species occurrences (both new and prior occurrences) are illustrated in Figures 11 through 14. In addition, MNFI scientists mapped the location of 17 vernal pools within the game area (Figure 7). The Results section is divided into three sections, a Natural Community Survey Results section, a Vernal Pools Results section, and a Rare Animal Survey Results section. The Natural Community Survey Results section provides in depth description of each natural community EO as well as site-specific threat assessments and management recommendations. The Vernal Pools Results section describes survey results for the vernal pools surveys. The Rare Animal Survey Results section describes survey results for each grouping of rare animals: birds, reptiles and amphibians, and mussels.

Natural Community Survey Results

MNFI ecologists documented seven new high-quality natural communities in the Rogue River SGA and also evaluated one known high-quality community EO, a dry-mesic southern forest that has since been removed from the database. This former EO no longer meets the criteria required to qualify as an element occurrence. The site, which corresponds to (Compartment 4; Stand 52) has been selectively logged, is bisected by a road that is causing severe erosion, has been impacted by off-road vehicles, has low floristic diversity, and is locally impacted by invasive species. Although the site has been degraded, it is characterized by mature trees and relatively few invasive species compared to the surrounding forest. Therefore, considerations for maintaining ecological integrity should be afforded this forested system when developing management plans. Table 2 lists Rogue River SGA's seven natural community EOs, their element occurrence ranks, their unique element occurrence identification number (EO ID), and the year first and last observed. Five different natural community types are represented in the seven element occurrences surveyed including: bog (1 EO), dry-mesic northern forest (1 EO), floodplain forest (1 EO), hardwood-conifer swamp (3 EOs), and southern wet meadow (1 EO).

Over the course of the project, one rare plant EO, three-ribbed spike-rush (*Eleocharis trichostata*, state threatened), was opportunistically documented (Table 3, Figure 11). Three-ribbed spike-rush is a coastal plain disjunct and within Rogue River SGA it was collected from a small wetland depression (Compartment 2; Stand 10) and occurred with other species characteristic of coastal plain marsh. A historic record for orange fringed orchid (*Platanthera ciliaris*, state threatened) was documented in the wetlands around Chrishaven Lake but has not been observed since 1941. Potential habitat for this species remains throughout the game area, particularly along the margins of bogs and open wetland complexes. The general location of the plant EOs within and in the vicinity of the game area is illustrated along with the natural community EOs in Figure 11.

The following site summaries contain a detailed discussion for each of the seven natural communities organized alphabetically by community type and then by element occurrence. A summary of priority management recommendations is provided for each natural community EO in Table 13. The beginning of each grouping of communities contains an overview of the natural community type, which was adapted from MNFI's natural community classification (Kost et al. 2007, Cohen et al. 2015a). In addition, an ecoregional distribution map is provided for each natural community type (Albert et al. 2008). For each site summary, the following information is provided:

a) site name
b) natural community type
c) state and global rank (see Appendix 5 for ranking criteria)
d) current element occurrence rank
e) size
f) locational information
g) digital photograph(s)
h) aerial photograph with mapped natural community boundary
i) detailed description
j) threat assessment
k) management recommendations

Table 2. Newly documented and previously known natural community element occurrences for the Rogue River State Game Area. EO rank abbreviations are as follows: B, good estimated viability; C, fair estimated viability; and CD, fair or poor estimated viability. * indicates that the EO was newly documented in 2015 and ** indicates that the former EO was eliminated from the database following evaluation in 2015.

Site Name	Community Type	EO ID	EO Rank	Year First Observed	Year Last Observed	Global Rank	State Rank
Solon Bog*	Bog	20814	B	2015	2015	G3G5	S4
Heiss Forest*	Dry-mesic Northern Forest	20782	CD	2015	2015	G4	S3
Clear Lake Woods**	Dry-mesic Southern Forest	11674	NA	1991	2015	G4	S3
Rogue River Floodplain*	Floodplain Forest	20545	CD	2015	2015	G3?	S3
North Kent Swamp*	Hardwood-Conifer Swamp	20547	C	2015	2015	G4	S3
Sherwin Swamp*	Hardwood-Conifer Swamp	20549	CD	2015	2015	G4	S3
Spring Creek Swamp*	Hardwood-Conifer Swamp	20546	C	2015	2015	G4	S3
Sherwin Meadow*	Southern Wet Meadow	20550	B	2015	2015	G4?	S3

Table 3. Newly documented and previously known rare plant element occurrences at Rogue River State Game Area and in the vicinity. State status abbreviation of T signifies state threatened and E signfies state endangered. EO rank abbreviations are as follows: B, good estimated viability; and H, historical.

Common Name	Scientific Name	State Status	EO ID	EO Rank	Year First Observed	Year Last Observed
Three-ribbed spike rush	*Eleocharis tricostata*	T	20820	B	2015	2015
Orange-fringed orchid	*Platanthera ciliaris*	E	5440	H	1942	1942

The previously documented dry-mesic southern forest in Compartment 4; Stand 52 was removed from MNFI's Biotics Database as an EO because of selective logging, locally-abundant invasive species, and severe erosion from ATVs. Photo by Jesse M. Lincoln.

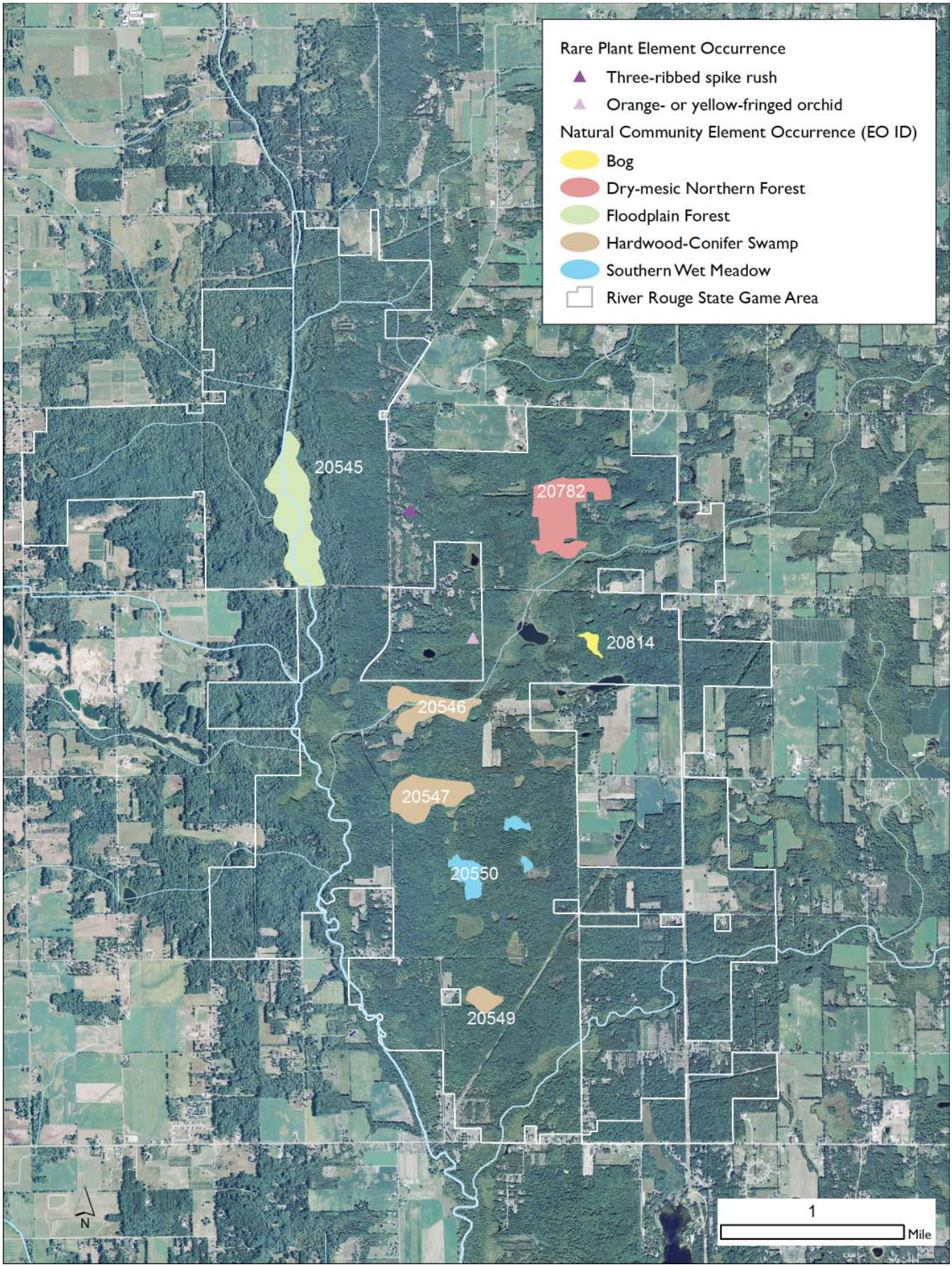
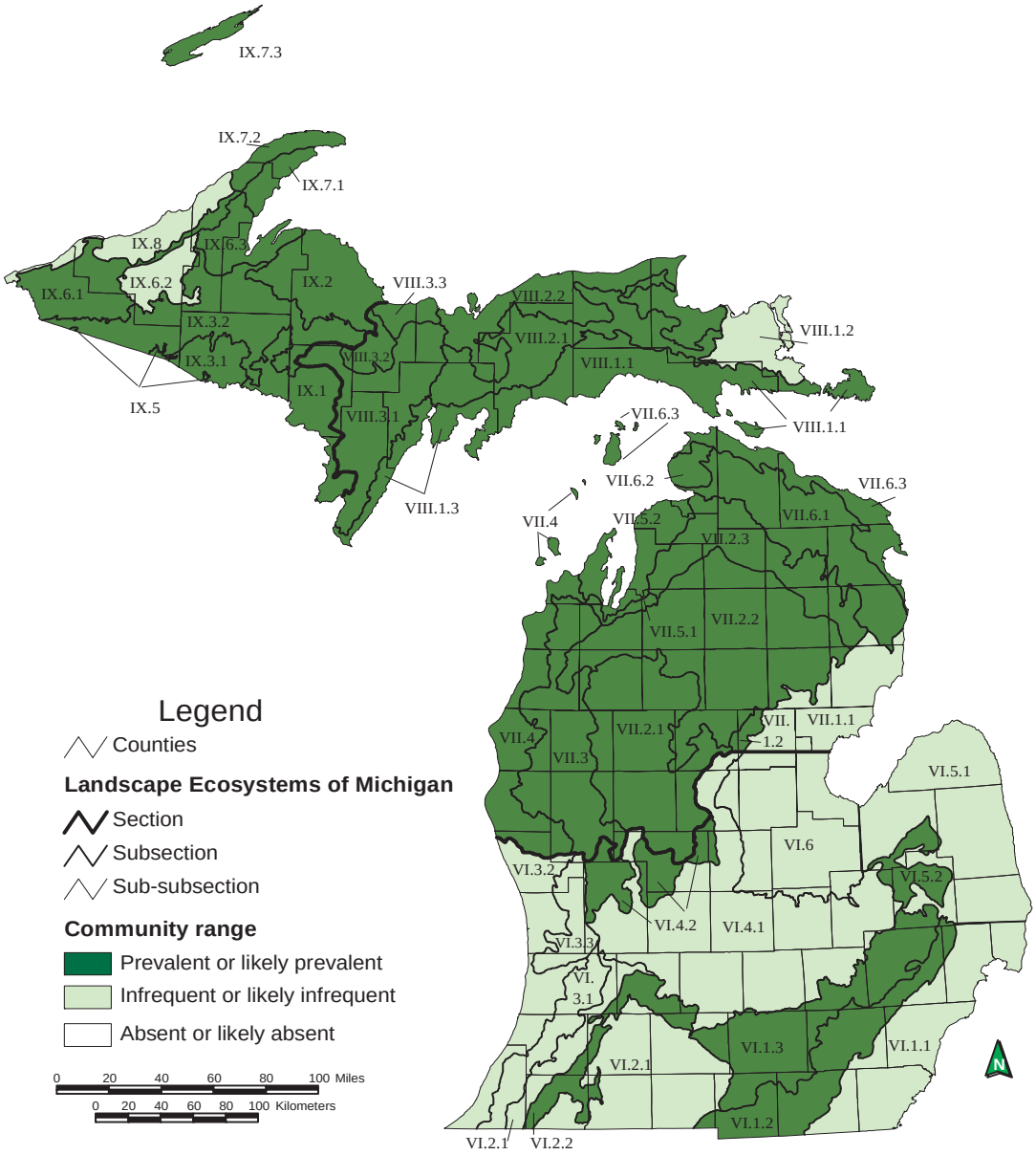


Figure 11. Natural community and rare plant element occurences in Rogue River State Game Area.

SITE SUMMARIES

BOG

Overview: Bogs are nutrient-poor peatlands characterized by a continuous carpet of sphagnum moss, a species-poor herbaceous layer, low ericaceous, evergreen shrubs, and widely scattered and stunted conifers. Though much more prevalent in the north, bogs occur throughout Michigan in kettle depressions within pitted outwash plains and moraines and in shallow depressions on glacial outwash plains and glacial lakeplains. Bogs often develop on the margins of lakes and slowly colonize the lake basin. Soils are extremely acidic to very strongly acidic, saturated peat. Natural processes that influence species composition and community structure include peat accumulation, insect outbreaks, flooding by beaver, windthrow, and occasional fires. Bogs are dominated by sphagnum mosses (*Sphagnum* spp.), few-seed sedge (*Carex oligosperma*), ericaceous shrubs such as leatherleaf (*Chamaedaphne calyculata*), bog rosemary (*Andromeda glaucophylla*), bog laurel (*Kalmia polifolia*), low sweet blueberry (*Vaccinium angustifolium*), highbush blueberry (*V. corymbosum*), large cranberry (*V. macrocarpon*), and small cranberry (*V. oxycoccos*), and scattered trees, especially conifers such as black spruce (*Picea mariana*), tamarack (*Larix laricina*), and pines (*Pinus* spp.). Insectivorous plants are characteristic of bogs and include round-leaved sundew (*Drosera rotundifolia*), pitcher-plant (*Sarracenia purpurea*), and bog bladderwort (*Utricularia geminiscapa*) (Kost et al. 2007, Cohen et al. 2015a).



Map 1. Distribution of bogs in Michigan (Albert et al. 2008).

1998 aerial photograph of Solon Bog (EO ID 20184. Compartment 4; Stand 41).

1. Solon Bog
Natural Community Type: Bog
Rank: G3G5 S4, vulnerable to secure globally and secure within the state
Element Occurrence Rank: B
Size: 5 acres
Location: Compartment 4; Stand 41
Element Occurrence Identification Number: 20814 (New EO)

Site Description: Solon Bog is a small bog that occupies a kettle depression within a narrow band of glacial till between moraine and outwash features. It is separated from groundwater hydrology by peat accumulation. The low-oxygen environment and the increasing acidification associated with decay of sphagnum leads to the accumulation of organic matter. The extremely acidic conditions (pH 4.0-4.5) and saturated substrates limit the species that can occupy this system. The hydrology of the wetland is primarily influenced by precipitation with surface water runoff from adjacent uplands impacting the margins of the wetland depression and contributing to the formation of a moat. The system is completely surrounded by forested uplands. The forest to the east is a maturing dry-mesic southern forest. The bog is a shrub-dominated wetland characterized by an extensive floating sphagnum peat mat that features a continuous layer of leatherleaf (*Chamaedaphne calyculata*). Surrounding the floating peat mat is a distinct moat where surface water pools.

This is an open bog with the floating sphagnum mat dominated by leatherleaf. There are a few scattered white pine (*Pinus strobus*) and red maple (*Acer rubrum*) taller than 6 m (20 ft). Understory and shrub-layer white pine, red maple, and tamarack (*Larix laricina*) occur throughout. Tall shrubs within the floating bog mat are scattered and Michigan holly (*Ilex verticillata*) is the primary species throughout. Buttonbush (*Cephalanthus occidentalis*) and swamp loosestrife (*Decodon verticillatus*) occur at the bog margins in the moat and occasionally in wetter areas of the floating mat. The moat has areas of high species diversity with zones being dominated by three-way sedge (*Dulichium arundinaceum*), lake sedge (*Carex lacustris*), broad-leaved cat-tail (*Typha latifolia*), wool-grass (*Scirpus cyperinus*), and softstem bulrush (*Schoenoplectus tabernaemontani*). Other herbaceous species found in the moat and occasionally within the floating mat include: *Carex crinata*, pale false mannagrass (*Torreyochloa pallida*), tufted loosestrife (*Lysimachia thyrsiflora*), common water horehound (*Lycopus americanus*), cut grass (*Leersia oryzoides*), tickseed-sunflower (*Bidens trichosperma*), common bladderwort (*Utricularia vulgaris*), and *Carex oligosperma*.

This site was visited once during the 2015 field season. The floristic data was compiled into the Michigan Floristic Quality Assessment (Reznicek et al. 2014). A total of 24 plant species were documented with 24 native species and no non-native species observed. The mean coefficient of conservatism (*C*) for this bog is 5.3 and the total floristic quality index (*FQI*) is 26.

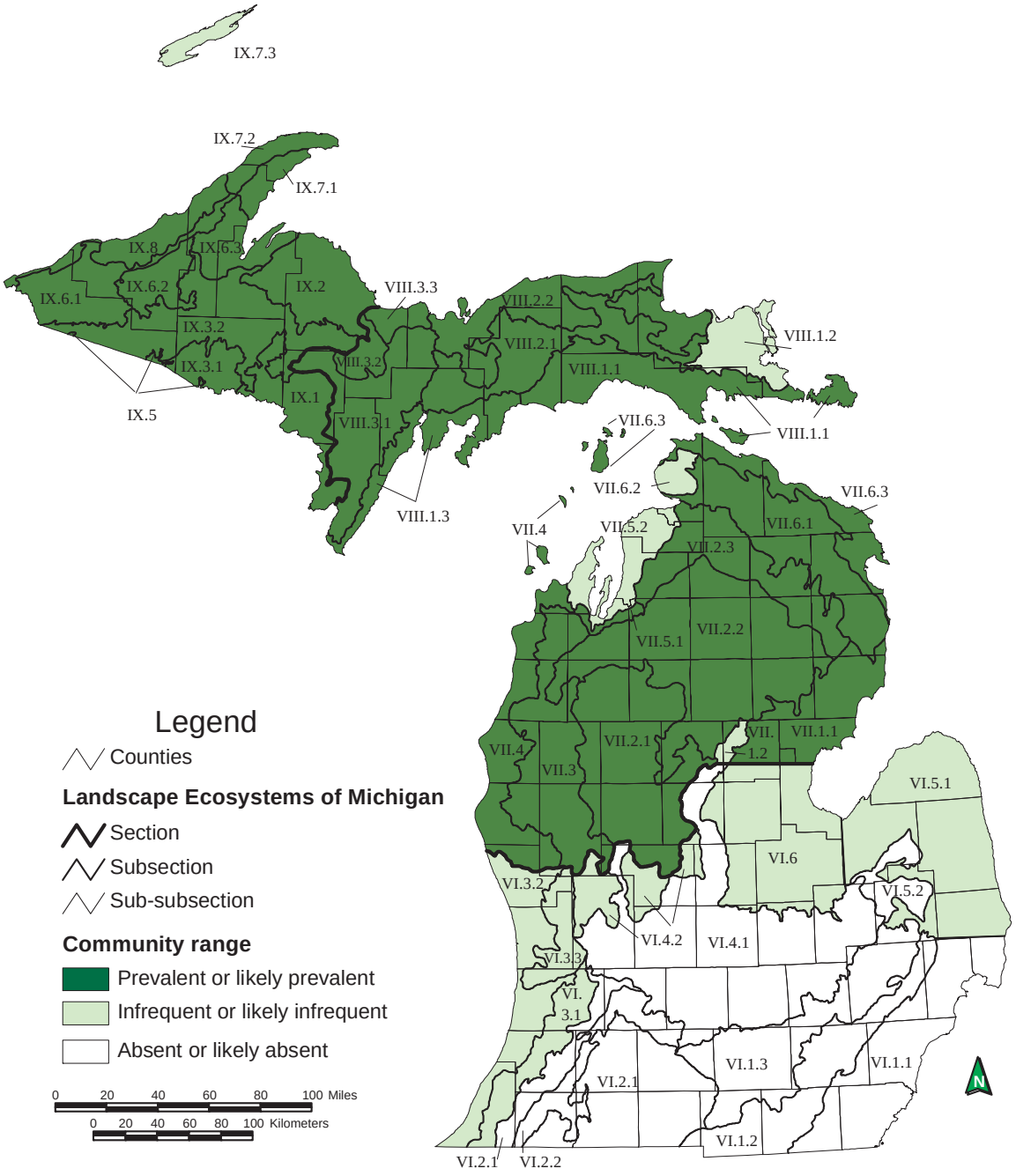
Threats: Species composition and vegetative structure of the bog are driven by natural processes and the primary threat is the alteration of the cover of the adjacent uplands, most likely as a result of logging.

Management Recommendations: The main management recommendation is to retain an intact buffer of natural communities surrounding the wetland to minimize the threat of hydrological alteration. Logging should be avoided on slopes surrounding the bog and the canopy of the adjacent forest should remain intact. The bog should be allowed to burn if prescribed fire or wildfires enter the wetland basin. Monitoring should be implemented following fire events.

Solon Bog is characterized by a floating sphagnum peat mat that is dominated by leatherleaf. Photo by Jesse M. Lincoln.

DRY-MESIC NORTHERN FOREST

Overview: Dry-mesic northern forests are pine or pine-hardwood forests found throughout the Upper Peninsula and northern Lower Peninsula and less frequently in the southern Lower Peninsula. The community occurs principally on sandy glacial outwash plains, sandy glacial lakeplains, and less often on inland dune ridges, coarse-textured moraines, and thin glacial drift over bedrock. Dry-mesic northern forests develop on extremely to very strongly acidic sands or loamy sands. Dry-mesic northern forests historically originated in the wake of catastrophic fire and was maintained by frequent low-intensity ground fires. Natural processes that influence species composition and community structure include fire, windthrow, and insect outbreaks. The canopy is dominated by white pine (*Pinus strobus*) with associates including red pine (*P. resinosa*), hemlock (*Tsuga canadensis*), white oak (*Quercus alba*), and red oak (*Q. rubra*) (Kost et al. 2007, Cohen et al. 2014).



Map 2. Distribution of dry-mesic northern forest in Michigan (Albert et al. 2008).

1998 aerial photograph of Heiss Forest (EO ID 20782. Compartment 2; Stand 23).

2. Heiss Forest
Natural Community Type: Dry-Mesic Northern Forest
Rank: G4 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: CD
Size: 72 acres
Location: Compartment 2; Stand 23
Element Occurrence Identification Number: 20782 (New EO)

Site Description: Heiss Forest is a mature dry-mesic northern forest with large trees occurring on a narrow band of glacial till with varying topography. The soils are sandy loam to loamy sand (pH 5.5) to depths of 50 cm over coarse sands (pH 6.0 to 6.5). Vernal pools and areas of saturated soils occur throughout and there is a small inclusion of inundated shrub swamp in the southeast portion of the forest. These wetland inclusions occupy small kettle depressions. Variability in soil topography and moisture contribute to the floristic diversity and structural complexity of the system. The forest was selectively cut around 1900 and thinned around 1980. Stumps occur throughout from both operations with white pine (*Pinus strobus*) stumps being prevalent. Logging likely removed canopy and supercanopy white pine from this forest and potentially hemlock (*Tsuga canadensis*) from wetter areas. Logging also has transformed this forest from an uneven-aged system to a predominantly even-aged forest. In addition, fire suppression has altered the floristic composition of the understory and ground cover, imparting a competitive advantage to mesophytic species. Heiss Forest is surrounded by young forests that were likely historically very similar. These younger forested stands tend to have lower diversity and a greater component of invasive species. Many of the surrounding forests were historically tilled, though this EO was not.

The canopy of Heiss Forest is diverse and variable. White oak (*Quercus alba*) and red oak (*Q. rubra*) are the dominant trees throughout, though fire suppression and deer herbivory have largely eliminated both from the understory. Beech (*Fagus grandifolia*) is locally dominant in the canopy and some large beech occur scattered throughout and may be old growth. Red maple (*Acer rubrum*) and big-tooth aspen (*Populus grandidentata*) occur as codominants. Big-tooth aspen is locally abundant as a result of logging history but is succumbing to succession. Notably, living white ash (*Fraxinus americana*) were observed in the canopy in the northern portion of this EO and may be resistant to emerald ash borer. Tree diameters typically range from 38 to 89 cm (15 to 35 in) with a few beech over 102 cm (40 in). Beech and maple are particularly dominant in the subcanopy and understory and have likely increased in these strata due to prolonged fire suppression. The subcanopy is quite dense with shade-tolerant, fire-intolerant species and these seem to be locally suppressing oak regeneration and herbaceous cover. Shrubs are sparse to locally abundant and include witch-hazel (*Hamamelis virginiana*), bush honeysuckle (*Diervilla lonicera*), prickly gooseberry (*Ribes cynosbati*), low sweet blueberry (*Vaccinium angustifolium*), red-berried elderberry (*Sambucus racemosa*), and huckleberry (*Gaylussacia baccata*). The herbaceous layer is locally diverse with characteristic species including Pennsylvania sedge (*Carex pensylvanica*), Canada mayflower (*Maianthemum canadense*), long-awned wood grass (*Brachyelytrum erectum*), star flower (*Trientalis borealis*), rough-leaved rice-grass (*Oryzopsis asperifolia*), naked tick-trefoil (*Hylodesmum nudiflorum*), and sarsaparilla (*Aralia nudicaulis*). Ferns such as cinnamon fern (*Osmunda cinnamomeum*), interrupted fern (*O. claytoniana*), and New York fern (*Thelypteris noveborancensis*) tend to dominate the wetter areas. There is little oak regeneration as a result of deer herbivory and competition with dense maple and beech regeneration. Wet areas, which likely have lenses of clay in the soil, are characterized by tip-ups and a greater diversity of herbaceous vegetation and more musclewood (*Carpinus caroliniana*) in the subcanopy and understory. South-facing slopes in the southern portion of the stand seem drier, may have been more prone to fire historically, and support species characteristic of fire-adapted systems, such as huckleberry, poverty grass (*Danthonia spicata*), and panic grass (*Dichanthelium dicotomum*).

Hiess Forest is a dry-mesic northern forest characterized by large-diameter oaks. Photo by Jesse M. Lincoln.

This site was visited once during the 2015 field season. The floristic data was compiled into the Michigan Floristic Quality Assessment (Reznicek et al. 2014). A total of 118 plant species were documented with 113 native species and 5 non-native species. The mean coefficient of conservatism (*C*) for this dry-mesic northern forest is 4.4 and the total *FQI* is 46.7.

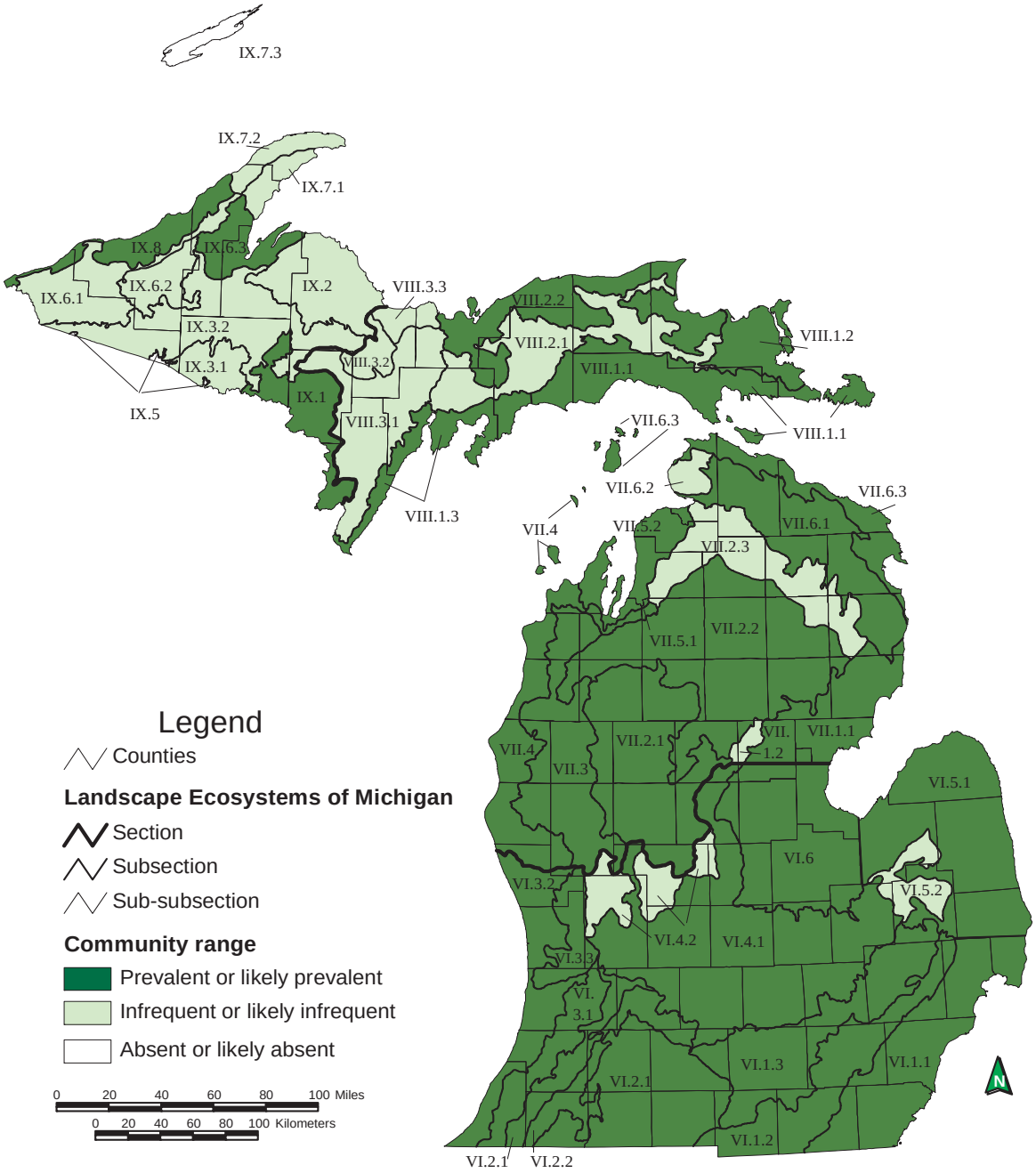
Threats: Species composition, vegetative structure, and successional trajectory are strongly influenced by gap dynamics, past logging, fire suppression, invasive species, and deer herbivory. Invasive species are sparse in the understory and include autumn olive (*Elaeagnus umbellata*) and Morrow honeysuckle (*Lonicera morrowii*). Fire suppression has led to mesophytic invasion, a lack of oak regeneration, and the dominance of red maple and beech in the understory and subcanopy.

Management Recommendations: The primary management needs are to allow the system to continue maturing, reintroduce fire as a prevalent disturbance factor, control invasive shrubs through cutting and herbicide, prevent additional fragmentation around this stand, provide a large forested buffer surrounding this system where logging activities are to be prevented, and provide a forested buffer around nearby wetlands to protect subterranean seeps that appear to be influencing many systems. Monitoring should be implemented to assess efforts to control non-native plant populations, to gauge the impact of deer herbivory, and evaluate oak and white pine regeneration and response of the forest to fire management.

Beech is locally abundant in the canopy of Heiss Forest but tends to dominate the subcanopy as a result of protracted fire suppression. Photo by Jesse M. Lincoln.

FLOODPLAIN FOREST

Overview: Floodplain forests are a bottomland, deciduous or deciduous-conifer forest community occupying low-lying areas adjacent to streams and rivers of third order or greater, and subject to periodic over-the-bank flooding and cycles of erosion and deposition. Species composition and community structure vary regionally and are influenced by flooding frequency and duration. Silver maple (*Acer saccharinum*) and green ash (*Fraxinus pennsylvanica*) are typically major overstory dominants, although green ash is declining in importance with the spread of emerald ash borer (*Agrilus planipennis*). Floodplain forests occur along major rivers throughout the state, but are most extensive in the Lower Peninsula. Species richness is greatest in the southern Lower Peninsula, where many floodplain species reach the northern extent of their range (Kost et al. 2007, Cohen et al. 2015a).



Map 3. Distribution of floodplain forests in Michigan (Albert et al. 2008).

1998 aerial photograph of Rogue River Floodplain Forest (EO ID 20545. Compartment 1; Stand 56).

A panoramic view of the Rogue River Floodplain Forest. Photo by Jesse M. Lincoln.

3. Rogue River Floodplain
Natural Community Type: Floodplain Forest
Rank: G3? S3, vulnerable throughout range
Element Occurrence Rank: CD
Size: 89 acres
Location: Compartment 1; Stand 56
Element Occurrence Identification Number: 20545 (New EO)

Site Description: Rogue River Floodplain is part of a large, nearly-contiguous forested wetland complex beginning near the headwaters of the Rogue River and extending south to the Grand River. This system occurs in a narrow, flat outwash channel where deep sands were deposited and the water table is relatively high. The small, sandy-bottom stream has a low flow rate and the forest is relatively uniform compared to other floodplain forests in the region. The floodplain generally lacks obvious levee and second-bottom features and locally resembles southern hardwood swamp. The floodplain is characterized by periodic over-the-bank flooding and broad expanses of first-bottom swamp with meander scars and small oxbow channels. Meander scars tend to have less canopy coverage than the first-bottom. Back swamps occur along the margins of the floodplain and the adjacent upland and transition into hardwood-conifer swamps where hydrology is influenced by cold, groundwater seeps. The heterogeneous soils of the floodplain are characterized by high nutrient availability and an abundance of soil water throughout much of the growing season. The substrate tends to be fine organics (pH 8.0) over coarse sand (pH 7.0). Localized windthrow events have caused canopy gaps throughout and a moderate volume of coarse woody debris. Coarse woody debris, tree hummocks, and tip-up mounds provide important substrate for plant establishment, especially in inundated portions of the floodplain. Downed logs within the floodplain also serve as basking sites for herptiles and thorough fares for small animals. In addition, numerous snags occur throughout the floodplain and provided important habitat for cavity nesting species.

The Rogue River Floodplain is a mostly closed-canopy floodplain forest characterized by an extensive first-bottom forest dominated by silver maple (*Acer saccharinum*) with cottonwood (*Populus deltoides*), American elm (*Ulmus americana*), green ash (*Fraxinus pennsylvanica*), black ash (*F. nigra*), basswood (*Tilia americana*), and bur oak (*Quercus macrocarpa*) as important canopy associates. Most trees range from 30 to 61 cm (12 to 24 in) with the largest measured silver maple reaching 112 cm (44 in). Canopy ash and elm have mostly been killed due to emerald ash borer and Dutch elm disease. Snags of both species remain and there are several downed ash creating abundant coarse woody debris. The subcanopy of the floodplain is sparse with silver maple and box-elder (*Acer negundo*) as the primary constituents and green ash, American elm, and basswood as important codominants. Spicebush (*Lindera benzoin*) and nannyberry (*Viburnum lentago*) are the primary understory shrubs with buttonbush (*Cephalanthus occidentalis*) locally common to dominant, especially in the meander scars. Wood nettle (*Laportea canadensis*), stinging nettle (*Urtica dioica*), sensitive fern (*Onoclea sensibilis*), wood reed (*Cinna arundinacea*), and Virginia wild-rye (*Elymus virginicus*) are characteristic herbaceous species found throughout the system. Meander scars tend to be characterized by cut grass, American bur-red (*Sparganium americanum*), broad-leaved cat-tail (*Typha latifolia*), and buttonbush. At the margins of the floodplain and the adjacent upland, the forest trend towards hardwood-conifer swamp with a sparse canopy that includes yellow birch (*Betula allegheniensis*), quaking aspen (*Populus tremuloides*), bur oak, white pine (*Pinus strobus*), northern white-cedar (*Thuja occidentalis*), and tamarack (*Larix larcinia*). The hardwood-conifer swamp is characterized by a dense coverage of cinnamon fern (*Osmunda cinamomea*) and a very diverse herbaceous layer.

This site was visited once during the 2015 field season. The floristic data was compiled into the Michigan Floristic Quality Assessment (Reznicek et al. 2014). A total of 96 plant species were documented with 93 native species and 3 non-native species. The mean coefficient of conservatism (*C*) for this floodplain northern forest is 4.1 and the total *FQI* is 40.2.

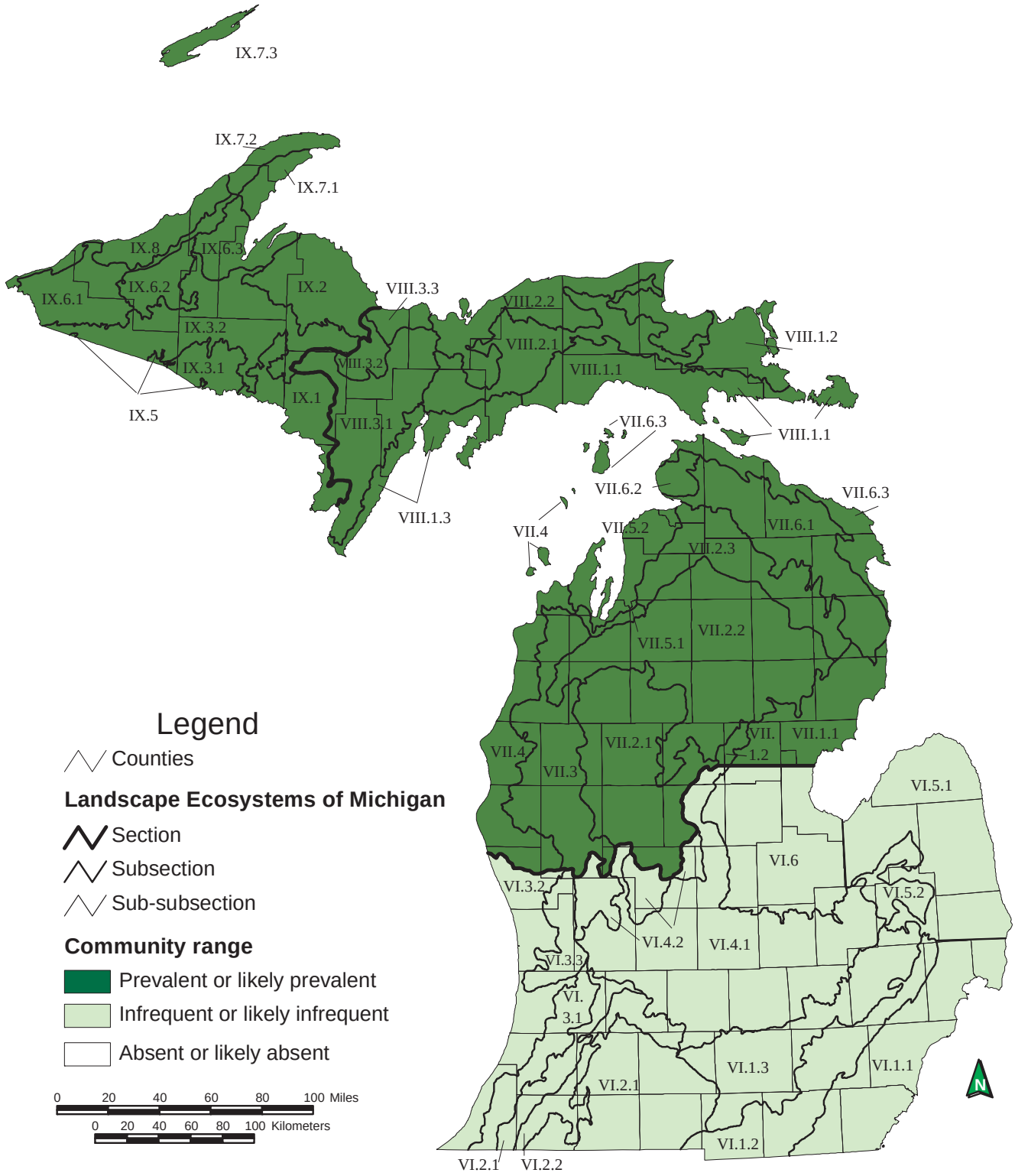
Threats: Species composition, vegetative structure, and successional trajectory are strongly influenced by gap dynamics and over-the-bank-flooding but they are also impacted by invasive species and past logging. Emerald ash borer has killed the canopy ash within this floodplain forest generating numerous snags, light gaps, and coarse woody debris. Reed canary grass (*Phalaris arundinacea*) is the most serious invasive species and occurs primarily at the southern end of the EO, near 20 Mile Road. The biggest threat to the system is further alteration of the river's hydrology upstream or where the 20 Mile Road crosses the Rogue River to the south. Additional threats include forestry practices that tend to leave no buffer of intact forest adjacent to wetlands. These practices potentially jeopardize spawning habitat for important game fish. Additionally, the massive agricultural operations upstream in Newaygo County may potentially impact this floodplain system due to inputs of pesticides that may potentially negatively influence insects and herptiles that complete their lifecycle in the river system.

Management Recommendations: The primary management recommendations are to maintain the mature floodplain forest and the hydrology of the river, reduce local deer populations, control invasive species, monitor for invasives and deer browse, prevent alterations to the hydrology of adjacent wetlands (i.e., ditching, damming, diking), and retain an intact buffer of natural communities surrounding the floodplain forest.

Silver maple is the dominant canopy species of the Rogue River Floodplain Forest. Historically, American elm and green ash were important canopy codominants. Photo by Jesse M. Lincoln.

HARDWOOD-CONIFER SWAMP

Overview: Hardwood-conifer swamps are minerotrophic forested wetlands dominated by a mixture of lowland hardwoods and conifers, occurring on organic (i.e., peat) and poorly drained mineral soils throughout Michigan. The community type occurs on a variety of landforms, often associated with headwater streams and areas of groundwater discharge. Species composition and dominance patterns can vary regionally. Windthrow and fluctuating water levels are the primary natural disturbances that structure hardwood-conifer swamp (Kost et al. 2007, Cohen et al. 2014).



Map 4. Distribution of hardwood-conifer swamps in Michigan (Albert et al. 2008).

1998 aerial photograph of North Kent Swamp (EO ID 20547. Compartment 4; Stand 33).

4. North Kent Swamp
Natural Community Type: Hardwood-Conifer Swamp
Rank: G4 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: C
Size: 48 acres
Location: Compartment 4; Stand 33
Element Occurrence Identification Number: 20547 (New EO)

Site Description: North Kent Swamp is a hardwood-conifer swamp with inclusions of mesic northern forest that occurs along a stream in a narrow outwash plain within the Rogue River basin. The stream is fed by numerous seeps that occur throughout the complex. The site is flat to gently sloped with distinctive pit-and-mound topography generated by frequent windthrow. The floristic composition and vegetative structure of the complex are patterned by gap-phase dynamics, groundwater seepage and a fluctuating water table, and fine-scale gradients in soil moisture and soil chemistry. The soils are characterized by saturated, fine-textured sandy loam with organics (pH ~7.0) with wettest zones occurring where clay lenses underlie the sands (pH 7.0). Hardwood-conifer swamp intergrades with mesic northern forest throughout, especially along the upland margins of the complex. These soils of these upland zones are characterized by fine deep sands (pH 5.5 - 6.0). In addition, hardwood-conifer swamp locally grades to southern hardwood swamp in the eastern portion of the complex. The loss of canopy ash (*Fraxinus* spp.) within this portion of the complex is resulting in the gradual transition from swamp to shrub thicket and wet meadow. Inclusions of mesic northern forest are characterized by deep sands, pronounced pit-and-mound topography, groundwater seeps, and small pockets of intermittent wetlands. Within these inclusions, the pits of the tip-up mounds are often filled with saturated mucks and characterized by wetland vegetation while the mounds support upland vegetation. The canopy tree age and composition of the hardwood-conifer swamp and mesic forest inclusions was determined to be similar. A 71 cm (28 in) white oak (*Quercus alba*) was cored and estimated to be 130 years old. In addition, a 61 cm (24 in) hemlock (*Tsuga canadensis*) was aged to 122 years with a clear release suggesting a logging event around 1895. Coarse woody debris is abundant throughout the complex and has recently increased as a result of emerald ash borer and Dutch elm disease. Active porcupine (*Erethizon dorasatum*) dens were observed in a few beech (*Fagus grandifolia*) trees and this may be the furthest south that these animals occur regionally.

North Kent Swamp is a forested swamp interlaced with upland inclusions, creating a structurally and biologically diverse system. Photo by Jesse M. Lincoln.

The upland inclusions within North Kent Swamp support unusually large trees for the area and have a notably depauperate herbaceous layer. Photo by Jesse M. Lincoln.

Ash mortality has generated an abundance of coarse woody debris throughout much of the swamp. Photo by Jesse M. Lincoln.

Areas of hardwood-conifer swamp are concentrated along the stream margins and tend to have a sparse canopy (40-70%) of red maple (*Acer rubrum*), hemlock (*Tsuga canadensis*), yellow birch (*Betula allegheniensis*), and historically green ash (*Fraxinus pennsylvanica*) and American elm (*Ulmus americana*). Supercanopy white pine (*Pinus strobus*) occur scattered throughout the complex, and based on the numerous large decaying pine stumps, were likely more prevalent historically. Canopy trees range in size from 30 to 82 cm (12 to 32 in). The subcanopy and understory are also relatively sparse with the noted canopy species as primary constituents along with musclewood (*Carpinus caroliniana*) and tag alder (*Alnus incana*). The invasive glossy buckthorn (*Frangula alnus*) occurs sporadically throughout but is not currently a significant feature of the shrub layer. The low shrub layer is also sparse and includes spicebush (*Lindera benzoin*), Michigan holly (*Ilex verticillata*), tag alder, and silky dogwood (*Cornus amomum*). The herbaceous layer is diverse and ranges from sparse to very dense, especially in areas where windthrow is prevalent. Ferns are prevalent throughout the swamp and include marsh fern (*Thelypteris palustris*), maiden hair fern (*Adiantum pedatum*), sensitive fern (*Onoclea sensibilis*), cinnamon fern (*Osmunda cinnamomeum*), and wood fern (*Dryopteris carthusiana*). Characteristic graminoids within the swamp include numerous sedges (*C. scabrata, C. bromoides, C. leptalea, C. intumescense*), and various grasses with fowl manna grass (*Glyceria striata*) and wood reed (*Cinna arundinacea*) most prevalent. Numerous forbs are present throughout, including hog peanut (*Amphicarpaea bracteata*), spotted touch-me-not (*Impatiens capensis*), skunk cabbage (*Symplocarpus foetidus*), jack-in-the-pulpit (*Arisaema triphyllum*), bishop's cap (*Mitella diphylla*), southern blue flag (*Iris virginica*), and goldthread (*Coptis trifolia*). Emergent vegetation is prevalent along the stream and includes bulrushes (*Schoenoplectiella* spp.), arrowhead (*Sagittaria latifolia*), *Carex crinata*, swamp milkweed (*Asclepias incarnata*), and joe-pye weed (*Eutrochium maculatum*).

The mesic northern forest inclusions are characterized by 70 to 80% canopy closure with a diverse mix of trees including white oak, red oak (*Quercus rubra*), red maple, hemlock, beech, and supercanopy white pine. These canopy trees tend to be large and widely-spaced and tower above a very dense subcanopy and sparse understory/shrub layer. The subcanopy is characterized by hemlock, beech, red maple, American elm, musclewood, ironwood (*Ostrya virginiana*), and sassafras (*Sassafras albidum*). In addition to the aforementioned canopy species, witch-hazel (*Hamamelis virginiana*), low sweet blueberry (*Vaccinium angustifolium*), and maple-leaved viburnum (*Viburnum acerifolium*) comprise the sparse low shrub layer. The herb layer is locally absent to sparse with the primary species being Canada mayflower (*Maianthemum canadense*), running ground pine (*Dendrolycopodium obscurum*), rough rice grass (*Oryzopsis asperifolia*), Pennsylvania sedge (*Carex pensylvanica*), beech drops (*Epifagus virginiana*), wintergreen (*Gaultheria procumbens*), Indian cucumber root (*Medeola virginiana*), sarsaparilla (*Aralia nudicaulis*), bracken fern (*Pteridium aquilinum*), and tall white lettuce (*Prenanthes alba*).

This site was visited once during the 2015 field season. The floristic data was compiled into the Michigan Floristic Quality Assessment (Reznicek et al. 2014). A total of 105 plant species were documented with 104 native species and 1 non-native species. The mean coefficient of conservatism (*C*) for this hardwood-conifer swamp is 4.6 and the total *FQI* is 47.1.

Threats: Species composition and floristic structure are influenced primarily by the seasonally fluctuating water table and windthrow. Threats to the swamp include changes in hydrology, fragmentation from logging in adjacent systems, invasive species encroachment (especially glossy buckthorn), and high levels of deer herbivory.

Management Recommendations: The main management recommendations are to allow natural processes to operate unhindered, avoid altering the hydrology of the seeps and streams that feed this wetland, monitor for nightshade and glossy buckthorn, and deer browse, and retain an intact buffer of natural communities surrounding the hardwood-conifer swamp.

Within the upland inclusions of North Kent Swamp, the water table is close to the soil surface and pit-and-mound topography contributes to the variability of soil moisture and influences species distribution. Photo by Jesse M. Lincoln.

5. Sherwin Swamp
Natural Community Type: Hardwood-Conifer Swamp
Rank: G4 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: CD
Size: 12 acres
Location: Compartment 5; Stand 10
Element Occurrence Identification Number: 20549 (New EO)

Site Description: Sherwin Swamp occupies a small kettle depression in a narrow outwash channel that occurs within the basin of the Rogue River. The swamp occurs in a moderately fragmented landscape that is dominated by young dry-mesic northern forest. Floristic composition and vegetative structure of the swamp are patterned by gap-phase dynamics, groundwater seepage, and fine-scale gradients in soil moisture and soil chemistry. The organic soils of the swamp are characterized by saturated, circumneutral peats (pH 7.0). Groundwater seepage forms numerous seeps, and locally, groundwater-fed intermittent streams drain into the Rogue River. Surface runoff also collects and pools at the upland margin of the swamp where deep, moat-like pools form. Windthrow has caused abundant tip-ups throughout, leading to pit and mound topography, which drives structural diversity and distribution of herbaceous vegetation. The hummocks are comprised of decaying wood and provide the substrate for growth of canopy trees, shrubs, and ferns. The hollows are filled with deep, saturated muck, which tend to be less vegetated than the hummocks but are locally occupied by sedges and grasses. Dying ash (*Fraxinus* spp.) and American elm (*Ulmus americana*) along with windthrow has created an abundance of coarse woody debris at all stages of decay, creating a structurally complex system that provides many niches for wildlife. Historic logging has reduced the prevalence of white pine in the canopy and the harvested pines seem to have been larger based on the size of the residual stumps. A 51 cm (20 in) white pine (*Pinus strobus*) was cored and estimated to be 98 years old.

Sherwin Swamp is characterized by a very dense herbaceous layer that is dominated by cinnamon fern. Photo by Jesse M. Lincoln.

1998 aerial photograph of Sherwin Swamp (EO ID 20549. Compartment 5; Stand 10).

The canopy of the hardwood-conifer swamp ranges from sparse to dense (40 to 80% canopy closure) with canopy dominants including red maple (*Acer rubrum*), white pine, yellow birch (*Betula allegheniensis*), and American elm (*Ulmus americana*). White pine is beginning to form a distinct super canopy. Locally, northern white-cedar (*Thuja occidentalis*), hemlock (*Tsuga canadensis*), tamarack (*Larix larcinia*), and swamp white oak (*Quercus bicolor*) are codominant and red oak (*Q. rubra*) and black cherry (*Prunus serotina*) are rare. Canopy trees tend to range from 25 cm to 92 cm (10 to 36 in). The canopy is sparser where the loss of green ash (*Fraxinus pennsylvanica*) and American elm are creating gaps. The subcanopy is locally dense, often with black ash (*F. nigra*) and American elm being quite abundant along with red maple, white pine, and locally northern-white cedar. The shrub layer is sparse to locally dense and includes Michigan holly (*Ilex verticillata*), spicebush (*Lindera benzoin*), poison sumac (*Toxicodendron vernix*), tag alder (*Alnus incana*), swamp rose (*Rosa palustris*), and dogwoods (*Cornus* spp.). Prevalent low shrubs within the hardwood-conifer swamp include swamp dewberry (*Rubus hispidus*), low sweet blueberry (*Vaccinium angustifolium*), Canadian fly honeysuckle (*Lonicera canadensis*), and wild red raspberry (*Rubus strigosis*). The herbaceous layer is very diverse and ranges from sparse to dense. Ferns are typically dominant throughout, except where broad muck flats along the eastern edge of the swamp are totally saturated and largely un-vegetated. The dominant fern species are cinnamon fern (*Osmunda cinnamomeum*), royal fern (*O. regalis*), and sensitive fern (*Onoclea sensibilis*). Herbaceous species that are prevalent on the hummocks include star flower (*Trientalis borealis*), Canada mayflower (*Maianthemum canadense*), gold thread (*Coptis trifolia*), partridge berry (*Mitchella repens*), jack-in-the-pulpit (*Arisaema triphyllum*), sarsaparilla (*Aralia nudicaulis*), enchanters nightshade (*Circaea canadensis*), northern bugleweed (*Lycopus uniflora*), Indian cucumber root (*Medeola virginiana*), rough-leaved goldenrod (*Solidago patula*), marsh marigold (*Caltha palustris*), and purple fringed orchid (*Platanthera psycodes*). A diverse array of fungi occur throughout the swamp. In the hollows, or saturated depressions, graminoids tend to be more dominant with characteristic sedges including *Carex bromoides, C. leptalea, C. stipata, C., lupuliformis, C. radiata,* and *C. crinata*. Common grasses include fowl manna grass (*Glyceria striata*), wood reed (*Cinna arundinacea*), long-awned wood grass (*Brachyelytrum erectum*), and cut grass (*Leersia oryzoides*). Forbs that are common in the hollows include skunk cabbage (*Symplocarpus foetidus*), southern blue flag (*Iris virginica*), clearweed (*Pilea pumila*), and water parsnip (*Sium suave*).

Northern white cedar occurs ocassionally throughout Sherwin Swamp. Photo by Jesse M. Lincoln.

Vegetation patterns within Sherwin Swamp are strongly influenced by the presence of rotting wood and pools of deep, saturated muck. Photo by Jesse M. Lincoln.

In the western portion of the swamp complex, there is very little forest canopy and broad-leaved cat-tail (*Typha latifolia*) and lake sedge (*Carex lacustris*) are more dominant in the ground cover and there is a dense understory with tag alder, Michigan holly, poison sumac, pussy willow (*Salix discolor*), and wild raisin (*Viburnum cassinoides*). The canopy here is characterized by sparse, small diameter red maples that occupy scattered hummocks.

This site was visited once during the 2015 field season. The floristic data was compiled into the Michigan Floristic Quality Assessment (Reznicek et al. 2014). A total of 91 plant species were documented with 90 native species and 1 non-native species. The mean coefficient of conservatism (*C*) for this hardwood-conifer swamp is 4.2 and the total *FQI* is 40.1.

Threats: Threats to the swamp include invasive species encroachment and high levels of deer herbivory. Deer browse was noted throughout and autumn olive (*Elaeagnus umbellata*) occurs locally on the peat hummocks. Canopy ashes have died due to emerald ash borer. Ditching near the private property in the western portion of the stand seems to have locally altered hydrology with minimal impact on the entirety of the swamp.

Management Recommendations: The main management recommendations are to allow natural processes to operate unhindered, reduce local deer populations, control the autumn olive, monitor for invasives and deer browse, prevent alterations to hydrology in adjacent wetlands (i.e., ditching, damming, and diking), and retain an intact buffer of natural communities surrounding the hardwood-conifer swamp.

Forestry operations adjacent to Sherwin Swamp were particularly detrimental in wet seeps that feed this swamp. Such actions should be avoided and larger buffers established around wetlands and important natural communities. Photo by Jesse M. Lincoln.

6. Spring Creek Swamp
Natural Community Type: Hardwood-Conifer Swamp
Rank: G4 S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: C
Size: 39 acres
Location: Compartment 4; Stand 4
Element Occurrence Identification Number: 20546 (New EO)

Site Description: Spring Creek Swamp occurs along a sandy outwash channel that contains Spring Creek. Spring Creek feeds into the Rogue River approximately half a mile west of the hardwood-conifer swamp. The forested wetland is bound by steep banks that are 3 to 5 m (10 to 15 ft) higher than the stream. The swamp occupies the area from the banks to the stream. The system occurs on a gentle to moderate slope between the uplands and the stream and the swamp ranges from narrow to quite broad. Numerous seeps occur along the slopes and frequently form small rivulets that feed Spring Creek. The soils are hemic to sapric peats that are circumneutral to alkaline (pH 7.5-8.0). Floristic composition and vegetative structure of the swamp are patterned by gap-phase dynamics, groundwater seepage, and fine-scale gradients in soil moisture and soil chemistry. The swamp is characterized by leaning trees, snags, tip-ups, and canopy gaps, features that are associated with tree mortality, windthrow, and permanently saturated soils. A 36 cm (14 in) northern white-cedar (*Thuja occidentalis*) was aged to 130 years old, indicating that the area was likely logged during the late 1800s. Larger trees within the swamp may be approaching 200 years old. Within the closed-canopy forest, variability in moisture and topography contributes to microheterogeneity and high plant diversity. There is abundant coarse woody debris throughout; often in the form of standing dead ash (*Fraxinus pennsylvanica* and *F. nigra*) and American elm (*Ulmus americana*) but also along the stream where localized erosion has caused cedar to fall across the stream. Within the system, large dead trees appear to be feeding a high diversity of mushroom species. These logs also are acting as nurse logs for plant seedlings. Insects and amphibians rely on downed woody debris for habitat and this feature is greatly contributing to the swamp's overall biodiversity.

Spring Creek is a prominent feature throughout Spring Creek Swamp. Photo by Jesse M. Lincoln.

1998 aerial photograph of Spring Creek Swamp (EO ID 20546. Compartment 4; Stand 4).

The wetland complex along the stream channel is characterized by several zones that are not always distinct and intergrade locally. The zones include swamp forest, shrub transition, stream edge, emergent marsh within Spring Creek, and shrub thicket, which occurs to the west and upstream. As the western portion of the complex transitions into open shrub thicket, the canopy species become sparse and tamarack (*Larix larcinia*) becomes dominant, tip-ups become more frequent, and glossy buckthorn (*Frangula alnus*) becomes more abundant. Based on aerial imagery from 1938, this western portion may be influenced by increased water levels as a result of a crossing at Red Pine Drive. The system has also likely been impacted from previous logging (from the late 1800s) though it still has characteristic vegetation, large trees, and is influenced by natural processes.

This hardwood-conifer swamp is characterized by a canopy dominated by hemlock (*Tsuga canadensis*) with a supercanopy of white pine (*Pinus strobus*). Northern white-cedar is frequent along seeps and the stream edge. Red maple (*Acer rubrum*) and yellow birch (*Betula allegheniensis*) occur throughout with green ash and American elm historically occurring as dominant or codominant canopy associates. Red oak (*Quercus rubra*), white oak (*Q. alba*), and beech (*Fagus grandifolia*) occur occasionally along drier portions of the banks sloping down from the adjacent uplands or along drier ridges occasionally found throughout the swamp. Diameters of canopy constituents typically range from 30 to 66 cm (12 to 26 in) with supercanopy white pine reaching larger diameters (the largest measured white pine was 117 cm or 46 in). The species that comprise the canopy are also the primary constituents of the subcanopy and understory, especially hemlock, maple, and ash. Musclewood (*Carpinus caroliniana*) is also common to locally dominant in the understory as is tag alder (*Alnus incana*), which occurs primarily along the stream and in the flooded portion to the west. The low shrub layer is dominated primarily by spicebush (*Lindera benzoin*) and seedlings of the canopy species. Additional shrub species include swamp dewberry (*Rubus hispidus*), prickly gooseberry (*Ribes cynosbati*), dogwoods (*Cornus* spp.), partridge berry (*Mitchella repens*), running strawberry bush (*Euonymus obovatus*), and witch-hazel (*Hamamelis virginiana*). The herbaceous layer is complex with variability driven by gradients in soil moisture from abundant groundwater seeps, tip-ups from windthrow, and proximity to the stream. Ferns and graminoids tend to dominate with a diversity of forbs throughout. Dominant ferns include cinnamon fern (*Osmunda cinnamomeum*), New York fern (*Thelypteris noveboracensis*), marsh fern (*T. palustris*), sensitive fern (*Onoclea sensibilis*), royal fern (*Osmunda regalis*), maiden-hair fern (*Adiantum pedatum*), and spinulose woodfern (*Dryopteris carthusiana*).

Seeps form along slopes as the upland forest transitions to confier swamp. Photo by Jesse M. Lincoln.

Graminoids include *Carex scabrata*, fowl manna grass (*Glyceria striata*), cut grass (*Leersia oryzoides*), wood reed grass (*Cinna arundinacea*), and long-awned wood grass (*Brachyelytrum erectum*). Prevalent forbs include enchanter's nightshade (*Circaea canadensis*), gold thread (*Coptis trifolia*), sarsaparilla (*Aralia nudicaulis*), jack-in-the-pulpit (*Arisaema triphyllum*), wood-betony (*Pedicularis canadensis*), goldenrods (*Solidago* spp.), swamp buttercup (*Ranunculus hispidus*), wild geranium (*Geranium maculatum*), Canada mayflower (*Maianthemum canadense*), and star flower (*Trientalis borealis*). Vines include Virginia creeper (*Parthenocissus quinquefolia*), river grape (*Vitis riparia*), poison ivy (*Toxicodendron radicans*), ground nut (*Apios americana*), hog peanut (*Amphicarpaea bracteata*), and bristly greenbrier (*Smilax hispida*). Areas of exposed muck with little vegetation occur locally in the wettest portions of the swamp that are inundated in the spring and early summer. Liverworts occur locally in saturated areas. Drier soils tend to have more mosses than liverworts, as do rotting logs. Spring Creek contains significant pockets of emergent marsh that are characterized by expansive monocultures of bur-reed (*Sparganium* spp.), bulrush (*Schoenoplectus acutus*), forget-me-not (*Myosotis scorpioides*), spike rush (*Eleocharis* spp.), and watercress (*Nasturtium officinale*).

This site was visited once during the 2015 field season. The floristic data was compiled into the Michigan Floristic Quality Assessment (Reznicek et al. 2014). A total of 125 plant species were documented with 118 native species and 7 non-native species. The mean coefficient of conservatism (*C*) for this hardwood-conifer swamp is 4.2 and the total *FQI* is 47.

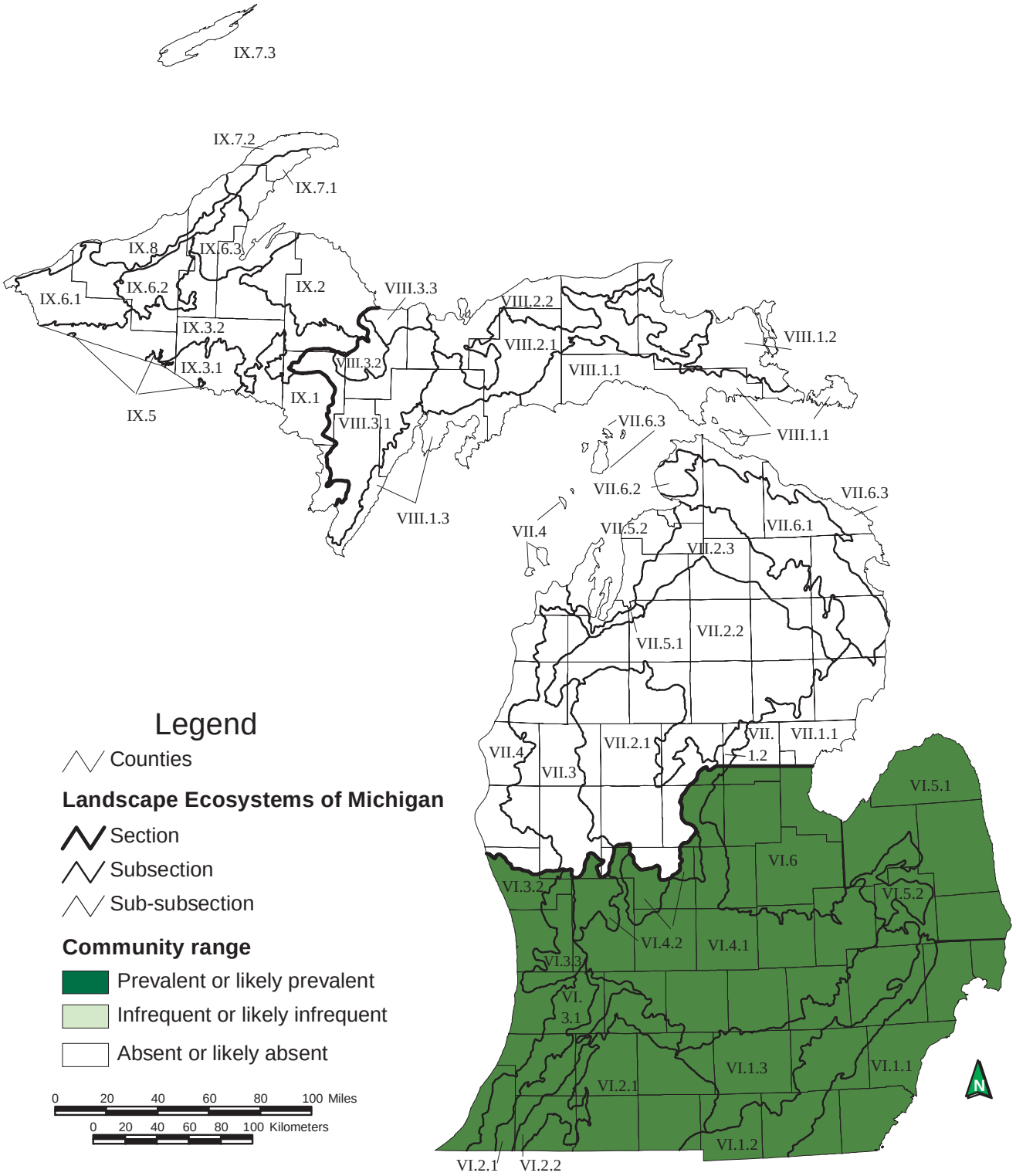
Threats: Threats to the swamp include invasive species encroachment and high levels of deer herbivory. Deer browse was noted throughout and deer browse is likely impacting floristic composition and vegetative structure. Multiflora rose (*Rosa multiflora*) is locally common within the swamp. This swamp has been historically logged as manifest by scattered cut stumps. Emerald ash borer has impacted the ash with much of the canopy ash dying from this invasive pest. Adjacent land use (primarily logging) is a threat to the system and would likely lead to sedimentation of the stream, additional tree mortality from lack of wind protection, and an influx of invasive species as a result of increased edge habitat.

Management Recommendations: The main management recommendations are to allow natural processes to operate unhindered, reduce deer densities within the larger landscape, control invasive species, monitor for invasives and deer browse, prevent alterations to hydrology in adjacent wetlands (ditching, damming, diking), and to retain an intact buffer of natural communities surrounding the hardwood-conifer swamp.

An abundance of coarse woody debrise is a characterisic of mature forests such as Spring Creek Swamp. Rotting wood sustains a diversity of fungus. Here hemlock reishi (*Ganoderma tsugae*) is decomposing a dead hemlock. Coarse woody debris is a critical component of the forested ecosystem. Photo by Jesse M. Lincoln.

SOUTHERN WET MEADOW

Overview: Southern wet meadows are groundwater-influenced, sedge-dominated wetlands that occur in the central and southern Lower Peninsula. Southern wet meadows occur along lakes and streams and occupy abandoned glacial lakebeds. Natural processes that influence species composition and community structure include seasonal flooding, flooding by beaver, and fire. The community typically develops on circumneutral sapric peat. Sedges in the genus *Carex*, in particular tussock sedge (*C. stricta*) and lake sedge (*C. lacustris*), dominate the community. Common associates include blue-joint (*Calamagrostis canadensis*), marsh bellflower (*Campanula aparinoides*), common boneset (*Eupatorium perfoliatum*), joe-pye-weed (*Eutrochium maculatum*), northern bugle weed (*Lycopus uniflorus*), goldenrods (*Solidago* spp.), and asters (*Symphyotrichum* spp.) (Kost et al. 2007, Cohen et al. 2015a).



Map 5. Distribution of southern wet meadows in Michigan (Albert et al. 2008).

1998 aerial photograph of Sherwin Meadows (EO ID 20550. Compartment 4; Stands 56, 67, 75).

1. Sherwin Meadows
Natural Community Type: Southern Wet Meadow
Rank: G4? S3, apparently secure globally and vulnerable within the state
Element Occurrence Rank: B
Size: 24 acres
Location: Compartment 4, Stands 67, 56, and 75
Element Occurrence Identification Number: 20550 (New EO)

Site Description: Sherwin Meadows consists of three polygons of southern wet meadow occurring in poorly drained kettle depressions within an outwash feature that is part of the basin of the Rogue River. The three polygons are separated by several hundred yards of closed-canopy forest. The surrounding outwash landscape is characterized by fine, deep sands and the outwash plain is dotted with small depressions that tend to have clay lenses. These kettle depressions correspond to ice blocks left from the retreating glacier thousands of years ago. Ditching appears to have locally lowered the water table of these wetlands and allowed trees to encroach along the margins of these meadows. These graminoid-dominated wetlands have areas of standing water for most of the year and permanently saturated soils. Water depth is variable across these wetlands and changes in depth correspond to changes in species dominance. Zonation within the system is driven primarily by water depths. Areas of deeper water depth are characterized by 50% open water with sparse vegetation. Loose, floating sphagnum occurs locally in areas with the deepest water. The soils of the meadow are characterized by 15 cm (6 in) of sapric, acidic peat (pH 5.5) over sandy clay (pH 5.5-6.0). The system and the adjacent uplands may have historically burned during dry years and probably in late summer or fall. The system was clearly ditched by the 1930s, based on aerial imagery. However, this seems to have had little impact within the EO.

Sherwin Meadows has open zones with deeper water that are beneficial for migratory waterfowl. Photo by Jesse M. Lincoln.

The meadows are dominated by a diversity of graminoids with zones of sparse shrubs and scattered trees at the margins. The wetland is dominated by sedges, grasses, and rushes, including lake sedge (*Carex lacustris*), tussock sedge (*C. stricta*), few-seed sedge (*C. oligosperma*), Canada bluejoint (*Calamagrostis canadensis*), broad-leaved cat-tail (*Typha latifolia*), pale false mannagrass (*Torreyochloa pallida*), wool-grass (*Scirpus cyperinus*), spike-rush (*Eleocharis palustris*), and prairie cordgrass (*Spartina pectinata*).There are scattered trees at the margins, primarily stunted red maple (*Acer rubrum*), black gum (*Nyssa sylvatica*), and quaking aspen (*Populus tremuloides*). Shrubby zones occur throughout, particularly at the margins and prevalent shrubs include sandbar willow (*Salix exigua*), leatherleaf (*Chamaedaphne calyculata*), and meadowsweet (*Spiraea alba*).

This site was visited once during the 2015 field season. The floristic data was compiled into the Michigan Floristic Quality Assessment (Reznicek et al. 2014). A total of 38 plant species were documented with 37 native species and 7 non-native species. The mean coefficient of conservatism (*C*) for this hardwood-conifer swamp is 4.3 and the total *FQI* is 26.5.

Threats: Species composition, vegetative structure, and successional trajectory are influenced by season water level fluctuation and fire suppression. Reed canary grass (*Phalaris arundinaceae*) is the primary invasive species of concern at this time. It was found dominating the southern portion of Stand 75 and also occurs locally along the margins of the wetland.

Management Recommendations: The main management recommendations are to allow natural processes to operate unhindered, retain an intact buffer of natural communities surrounding the wetland to preserve its hydrology, control reed canary grass with herbicide, burn the wet meadow with the surrounding forested uplands, and monitor for invasive species following prescribed fire.

The wet meadow complex is dominated by sedges and grasses and would have historically burned late in the season and also during periods of drought. Photo by Jesse M. Lincoln.

Vernal Pools Survey Results

A total of 168 potential vernal pools (PVPs) were identified and mapped in the Rogue River SGA through aerial photograph interpretation (Figure 7, page 14). These PVPs were distributed throughout the game area. Several PVPs were identified and mapped within or adjacent to four natural community EOs in the game area including the Rogue River Floodplain (EO ID 20545), Heiss Forest dry-mesic northern forest (EO ID 20782), North Kent Swamp hardwood-conifer swamp EO (EO ID 20547), and Sherwin Swamp hardwood-conifer swamp EO (EO ID 20549) (MNFI 2017a).

A total of 17 PVPs were surveyed in the field in the Rogue River SGA in 2016. Nine of these had been identified and mapped as PVPs from aerial imagery, and the remaining eight were encountered and identified in the field during vernal pool and/or amphibian and reptile surveys. Of the 17 PVPs that were surveyed in 2016, 15 were verified as vernal pools. The remaining two PVPs need additional information to confirm their status (i.e., whether they are vernal pools or not) (Figure 7). When these two PVPs were first identified in the field, they were dry, and additional surveys are needed to confirm whether or not they hold water for at least two months in the spring. In addition to the 15 vernal pools verified during targeted surveys, 2 additional vernal pools were confirmed in the field incidentally during raptor surveys in 2016, resulting in a total of 17 field-verified vernal pools in 2016.

We collected some basic information about the physical and ecological characteristics of vernal pools verified in the field. Most (14 of 17, or 82%) of the vernal pools verified in the field were surrounded by upland deciduous forest within 30 meters (100 ft) of the pools. The remaining pools were surrounded by emergent wetlands (n = 6), upland mixed forest (n = 2), lowland deciduous forest (n = 5), and/or other vernal pools (n = 5) within 30 meters (100 ft). Most of the 17 verified vernal pools were classified either as open or sparsely vegetated vernal pools with little to no vegetation growing in the pools [n = 8 (47%)] or forested vernal pools [n = 7 (41%)] with trees covering over 30% of the pool basin. Two (12%) of the pools were classified as half forested and half sparsely vegetated. Ten (59%) of the verified vernal pools were isolated basins or depressions and not connected to other wetlands or water bodies. Thirteen (76%) of the 17 verified vernal pools had no inlet or outlet, and four vernal pools had a temporary inlet or outlet. The verified vernal pools ranged in size or area from 106 to 2,802 m^2 (0.03 to 0.69 acre), and averaged 1,154 m^2 (0.3 acre) in area. The total acreage of all verified and potential vernal pools mapped from aerial imagery and field surveys in 2016 was 324,094 m^2 (80 acres). Maximum vernal pool depths during the surveys ranged from 15 cm (6 in) to 61 cm (2 ft). Most of the 17 verified vernal pools [n=14 (82%] had no disturbances within 30 m (100 ft) of the pool. Three vernal pools had paved or dirt roads and light development within 30 m (100 ft) of them. Nearly all 17 of the verified vernal pools did not appear to have any disturbances within or immediately adjacent to the pool basin. Invasive species was documented adjacent to only one vernal pool.

Visual encounter surveys and dipnetting surveys of vernal pools in 2016 documented blue-spotted salamander larvae, a vernal pool indicator species, in only one pool

An example of an open vernal pool. Photo by Yu Man Lee.

(Pool ID MNFI9-371). Wood frogs, which also are a vernal pool indicator species, were documented in the game area but only as adults/juveniles and were not in or adjacent to vernal pools. Fingernail clams (Veneroida: Sphaeriidae), which are often found in vernal pools and are a good indicator of vernal pools when they are dry, were found in nine (53%) of the verified vernal pools, of which six were dry. Additionally, one adult Blanding's turtle was found in a dry-mesic southern forest stand (Compartment 2; Stand 17) next to a vernal pool (Pool ID MNFI9-331), and two adult Blanding's turtles were observed basking in a nearby vernal pool (Pool ID MNFI9-332). Other amphibian and reptile species documented in or adjacent to the vernal pools include green frogs (*Lithobates clamitans*), spring peepers (*Pseudacris crucifer*), and western chorus frog (*Pseudacris triseriata*) tadpoles. In addition to herptiles and fingernail clams, a number of invertebrates also were found in the pools. These included clam shrimp (Lynceidae), phantom midges (Chaoboridae), chironomid midge larvae (Chironomidae), water boatmen (Corixidae), backswimmers (Notonecta), dragonfly larvae (Odonata), whirligig beetles (Gyrinidae), predacious diving water beetles (Dytiscidae), bladder snails (Physidae), and ram's-horn snails (Planorbidae/Gyraulus).

Several central mudminnow (*Umbra limi*) were found in two of the vernal pools (Pool IDs MNFI9-369 and MNFI9-431) west of Spring Lake in Sec. 13. The central mudminnow is a small fish, typically about 51-102 mm (~2-4 inches) long, that lives in slow-moving water around ponds, lakes, and streams (NatureServe 2017). This fish can tolerate low oxygen levels and high temperatures, and can survive low water levels and dry spells by burrowing

Fish were ocassionally observed in some of the sampled vernal pools. Photo by Yu Man Lee.

into soft substrates until wet conditions return (Simons et al. 2012, NatureServe 2017, Ohio Department of Natural Resources 2017). This fish also can breathe air using a modified air bladder that acts as a lung (Simons et al. 2012, Ohio DNR 2017). Because vernal pools dry up, the absence of fish or permanent fish populations is a key characteristic of vernal pools. Occasionally, though, some vernal pools can have small fish in them when the pools are wet, but the fish generally do not persist when the pools dry. Because of the central mudminnow's unique adaptations for surviving drought conditions, central mudminnows can be found in areas where no other fish can survive; even potentially surviving year round (Ohio DNR 2017). However, the fish found in the two pools were fairly small (i.e., less than 3 inches long), and will feed on insect larvae, other small aquatic invertebrates, and potentially other small fish (Simons et al. 2012, Ohio DNR 2017) but likely do not pose significant predation pressure on the invertebrates and other animals in the pools.

A sparsely vegetated vernal pool within a forested wetland complex. Photo by Yu Man Lee.

Table 4. Rare bird element occurrences at Rogue River State Game Area. State status abbreviation of "T" signifies state threatened. Element occurrence (EO) rank abbreviations are as follows: BC, good to fair viability; and C, fair viability. An * indicates the EO was updated with information collected during 2016 surveys.

Common Name	Scientific Name	State Status	EO ID	EO Rank	Year First Observed	Year Last Observed
Red-shouldered hawk	*Buteo lineatus*	T	20818	C	2016	2016
Louisiana waterthrush*	*Parkesia motacilla*	T	13400	BC	2003	2016

Rare Animal Survey Results

Birds

We completed rare raptor surveys at 112 points within the game area (Figure 12). Red-shouldered hawks were detected at 25 (22%) of the points visited. We found an active red-shouldered hawk nest near the Rogue River to the west of Red Pine Road and north of 20 Mile Road (Figures 12), adjacent to the Rogue River Floodplain EO. The nest represents a new EO (EO ID 20818) and the first documented within the game area. The new nest was being incubated at the time when it was found in April. During subsequent visit in late May, no young were seen but an adult was flushed from the nest and returned after a short time. We did not detect any northern goshawks during surveys but the game area does appear to have potential habitat. A red-tailed hawk (*Buteo jamaicensis*) responded to broadcasts at one point.

Forest songbird surveys were conducted at 123 points within forest stands (Figure 8). Louisiana waterthrush was the only rare, forest-nesting songbird detected during surveys. The species had been previously documented in the game area in 2003 (Table 4). We recorded seven singing male Louisiana waterthrushes at six locations of the game area (Figure 12). Three males were detected at three locations near the Rogue River, three males were observed at two locations along Duke Creek, and one male was heard in hardwood swamp to the north of Sherwin Street and west of the powerline corridor (Figure 12). These new observations are considered part of the existing EO (EO ID 13400).

We recorded a total of 70 bird species during point counts within Rogue River SGA (Appendix 6). The seven most commonly detected species were red-eyed vireo (*Vireo olivaceus*; 87% of points), ovenbird (*Seiurus aurocapilla*; 85% of points), eastern wood-pewee (*Contopus virens*; 70% of points), American crow (*Corvus brachyrhynchos*; 59% of points), black-capped chickadee (*Poecile atricapillus*; 59% of points), tufted titmouse (*Baeolophus bicolor*; 53% of points), and great crested flycatcher (*Myiarchus crinitus*; 51% of points). The following twelve species were regularly observed (25-50% of points surveyed): Acadian flycatcher (*Empidonax virescens*), blue jay (*Cyanocitta cristata*), blue-gray gnatcatcher (*Polioptila caerulea*), brown-headed cowbird (*Molothrus ater*), common yellowthroat (*Geothlypis trichas*), northern cardinal (*Cardinalis cardinalis*), red-bellied woodpecker (*Melanerpes carolinus*), rose-breasted grosbeak (*Pheucticus ludovicianus*), scarlet tanager (*Piranga olivacea*), veery (*Catharus fuscescens*), white-breasted nuthatch (*Sitta carolinensis*), and wood thrush (*Hylocichla mustelina*). Fourteen (20%) of the species were detected at 10 to 25% of the survey points and 37 species (53%) were detected at less than 10% of the survey points. On average, we recorded 12.4 bird species per point count station.

Several of the bird species detected have special conservation status (Table 12 and Appendix 6). Eight species are considered featured species for habitat management by the Wildlife Division of the MDNR. These featured species are wood duck (*Aix sponsa*), mallard (*Anas platyrhynchos*), ruffed grouse (*Bonasa umbellus*), wild turkey (*Meleagris gallopavo*), red-shouldered hawk, pileated woodpecker (*Dryocopus pileatus*), eastern bluebird (*Sialia sialis*), and wood thrush. Red-shouldered hawk and Louisiana waterthrush are also considered SGCN (Derosier et al. 2015). In addition, we observed three species (veery, wood thrush, and Louisiana waterthrush) that are considered focal species for conservation efforts under the Landbird Habitat Conservation Strategy (Potter et al. 2007) of the Upper Mississippi River and Great Lakes Region Joint Venture.

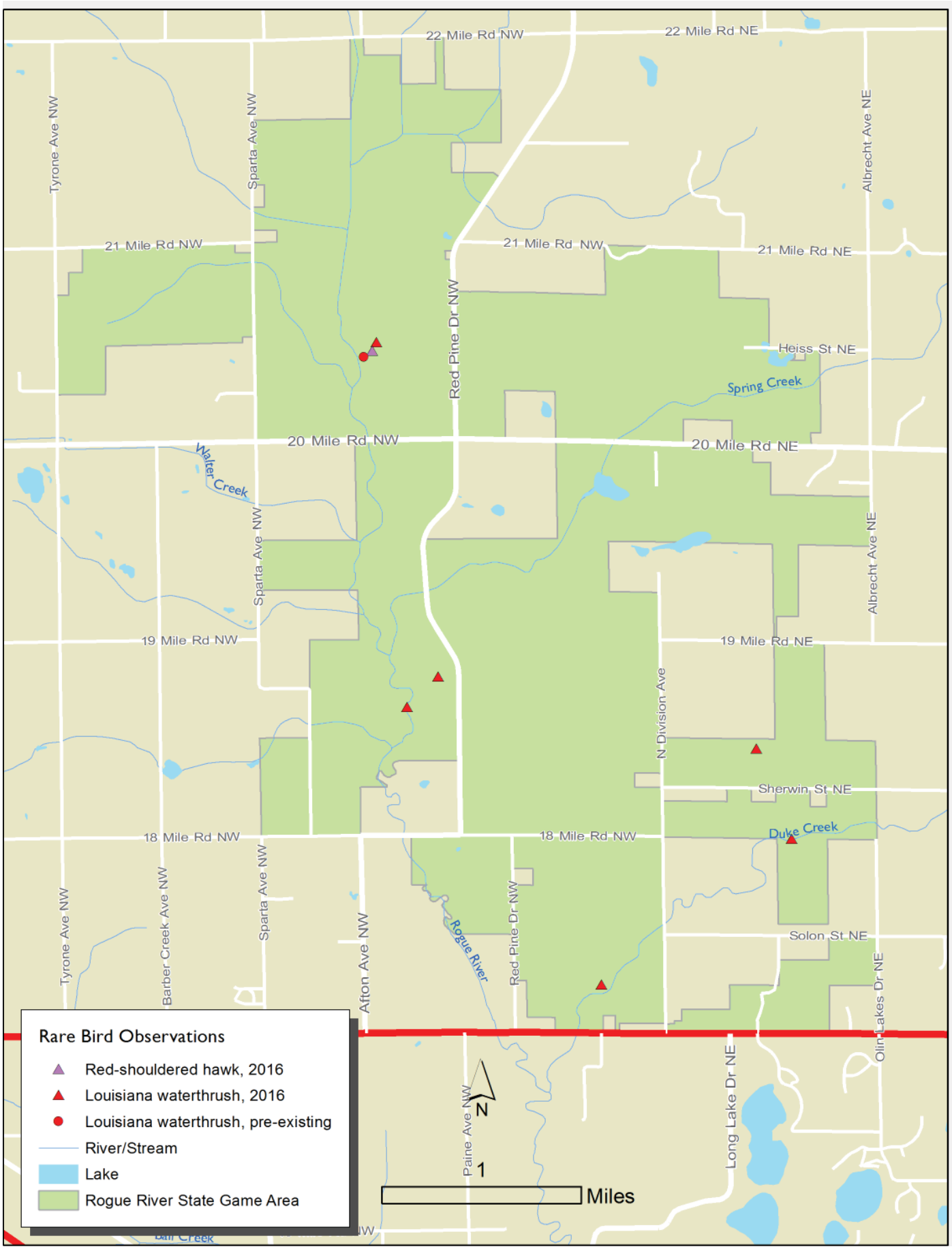


Figure 12. Rare bird element occurences in Rogue River State Game Area.

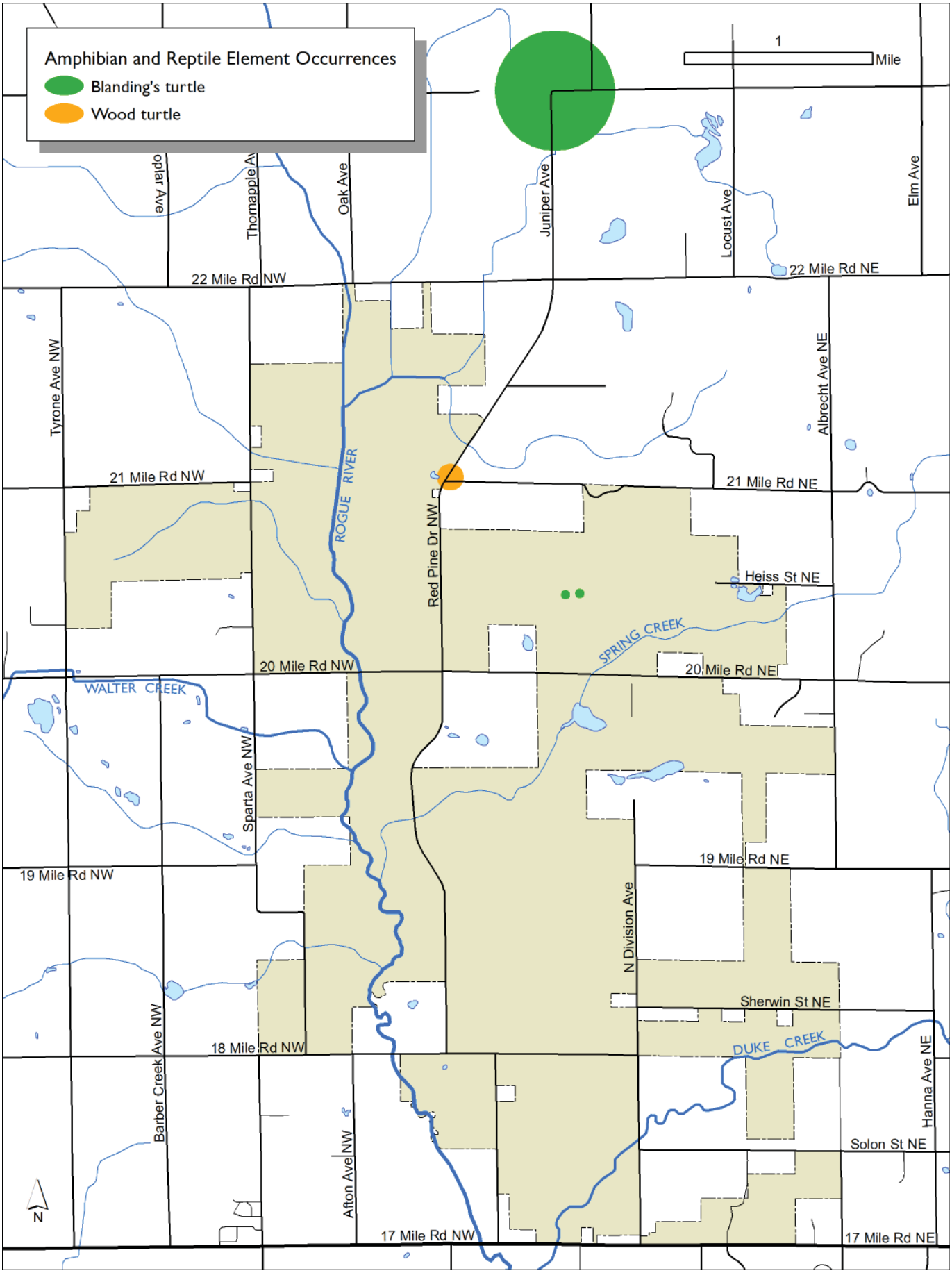


Figure 13. Rare reptile element occurences in Rogue River State Game Area.

Table 5. Rare reptile element occurrences at Rogue River State Game Area. State status abbreviation of "SC" signifies state special concern. Element occurrence (EO) rank abbreviations are as follows: BC, good to fair viability; and E, verified extant but with insufficient information to rank viability at this time. An * indicates the EO was updated with information obtained during the 2016 surveys. "P" refers to parent EO, and "S" refers to sub-EO.

Common Name	Scientific Name	State Status	EO ID	EO Rank	Year First Observed	Year Last Observed
Blanding's turtle*	*Emydoidea blandingii*	SC	20822 (P)	BC[1]	2016	2016
Blanding's turtle	*Emydoidea blandingii*	SC	8153 (S)	E	1996	1996
Wood turtle	*Glyptemys insculpta*	SC	6533	E	1996	1996

Reptiles and Amphibians

Amphibian and reptile and other animal surveys in Rogue River SGA in 2016 documented eight species, including two rare species and SGCN: Blanding's turtle and blue racer. These observations resulted in an update of a known element occurrence (EO) of Blanding's turtle within and in the vicinity of the game area (Table 5). Surveys were not able to reconfirm a previously documented EO of wood turtle in the game area.

Three adult Blanding's turtles were observed incidentally on April 18th, 2016 during rare bird/raptor surveys in Rogue River SGA. One adult Blanding's turtle was observed in a dry-mesic southern forest stand near a vernal pool (Pool ID MNFI9-331), and two adult Blanding's turtles were seen basking in a nearby vernal pool (Pool ID MNFI9-332) (Figure 13). The turtles and the vernal pools in or near which they were observed were located in a dry-mesic southern forest stand (Compartment 2; Stand 17) to the west of the Heiss Forest dry-mesic northern forest EO (EO ID 20782) in the northern portion of the game area. The Blanding's turtle observations in 2016 represent an update of a known EO of this species (EO ID 20822) that was originally just from the vicinity of the Rogue River SGA. Although EOs of this species had not been reported within Rogue River SGA prior to 2016, Blanding's turtle EOs had been documented in 1996 about 4 km (~2.5 miles) to the north (136th Street, EO ID 8153) and in 2009 about 8 km (~5 miles) to the southeast (Duke Creek, EO ID 17503) of where they were observed in the game area in 2016 (Table 5, Figure 13, MNFI 2017b). Since the Blanding's turtle EO within the Rogue River SGA (EO ID 20822) and the 136th Street EO to the north (EO ID 8153) are within 10 km (6 mi) along a continuous riverine-riparian and within a fairly contiguous mosaic of aquatic-wetland and undeveloped upland habitat, we combined and made these two EOs part of the same EO or population by making the 136th Street EO a sub-EO of the Rogue River EO. The Duke Creek Blanding's Turtle EO remains as a separate EO at this time because it is not continuously connected to the

Blanding's turtle was the only rare herptile documented during the 2016 surveys of Rogue River. Photo by Aaron P. Kortenhoven.

Northern leopard frogs occur throughout the Rogue River State Game Area. Photo by Yu Man Lee.

Rogue River EO and is separated by more fragmented and unsuitable habitat. However, if additional Blanding's turtles are documented in areas between these two EOs, these EOs could warrant further examination and potentially be combined in the future. Suitable habitat for Blanding's turtles appeared to be available throughout the Rogue River SGA in the vernal pools/potential vernal pools that have been mapped as well as other open and forested wetlands and waterbodies in the game area (e.g., Compartment 4; Stands 12 and 18, 67, 75, 79 and 87).

Two blue racers were found during the ecological surveys, one in Heiss Forest (EO ID 20782, Compartment 2; Stand 23) and the other in a small hardwood-conifer swamp in Compartment 3; Stand 22. Additional suitable habitat for SGCN occurs throughout the game area. A wood turtle EO was documented in the Rogue River SGA in 1996 (Red Pine Drive EO, EO ID 6533, Figure 13, MNFI 2017a). Surveys in 2016 did not reconfirm this species in the game area although suitable wetland habitat for this species was found and surveyed, particularly the vernal pools and surrounding forest in Stand 27 in Compartment 1.

In addition to the Blanding's turtle and blue racers, herptile surveys in the Rogue River SGA in 2015 and 2016 documented observations of six other amphibian and reptile species. These included observations of green frogs (*Lithobates clamitans*), wood frogs (*Lithobates sylvatica*), spring peepers (*Pseudacris crucifer*), northern leopard frogs (*Lithobates pipiens*), western chorus frogs (*Pseudacris triseriata*), and blue-spotted salamanders (*Ambystoma laterale*) (Appendix 3). Green frog adults, spring peeper adults, western chorus frog tadpoles, and blue-spotted salamander larvae were observed during dipnetting surveys in several vernal pools (Pool IDs MNFI9-369, MNFI9-370, and MNFI9-371 by Spring Lake in Compartment 4 Stand 5, and MNFI9-307 in Compartment 1; Stand 27). Green frog adults and wood frog adults/juveniles were observed in Stands 57 and 74 in Compartment 4, and in Stand 12 on the west and south sides of Spring Lake in Compartment 4. Spring peepers and northern leopard frogs also were observed in Stand 12 on the southwest side of Spring Lake. Additional amphibian and reptile species likely occur within the Rogue River SGA given the amount of available suitable aquatic and wetland habitats.

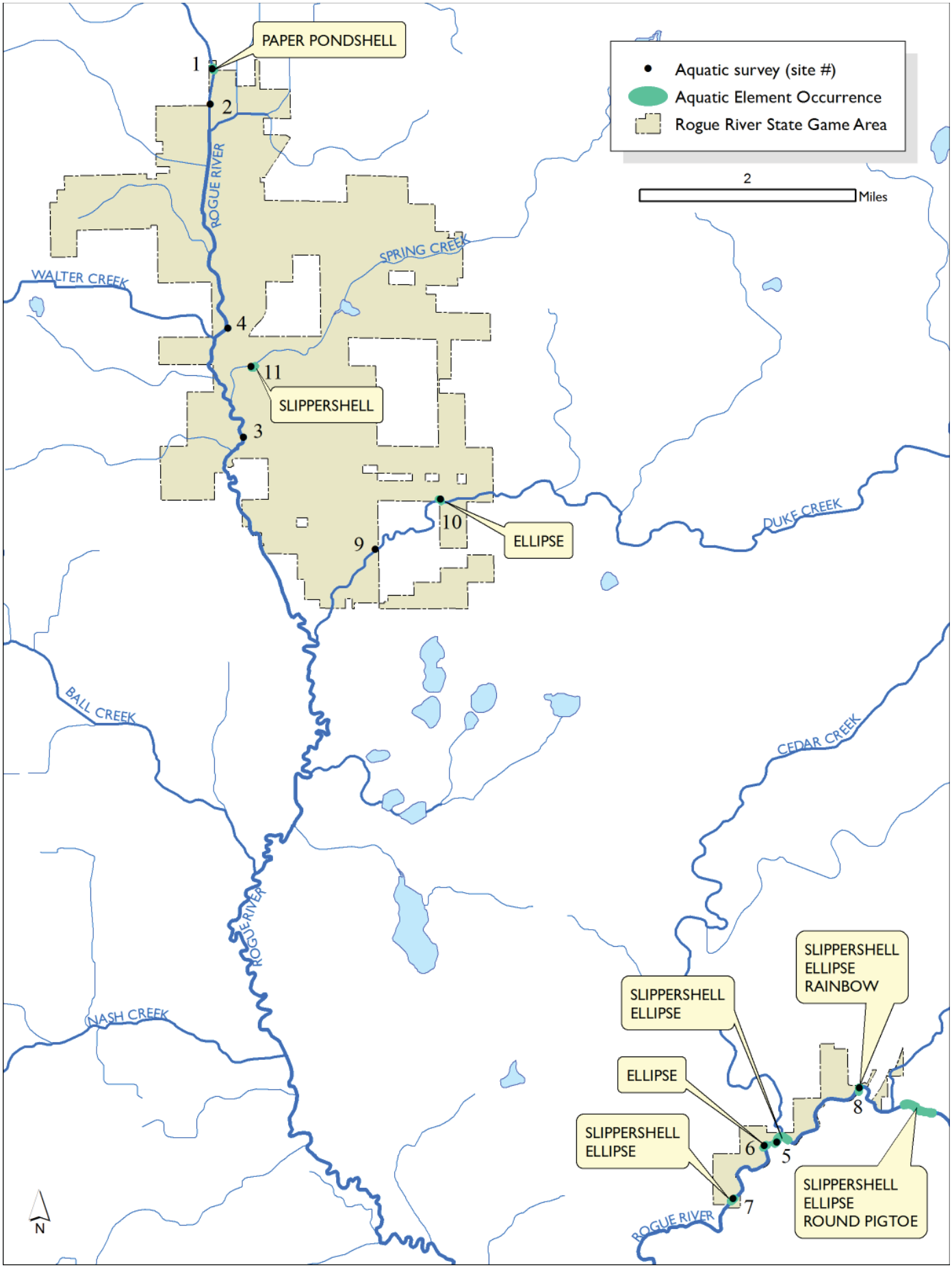


Figure 14. Rare unionid mussel element occurences in Rogue River State Game Area.

Table 6. New and previously known rare mussel element occurrences at Rogue River State Game Area. State status abbreviations are as follows: T, state threatened; and SC, state special concern. Element occurrence (EO) rank abbreviations are as follows: E, verified extant but with insufficient information to rank viability at this time; H, historical. An * indicates the EO was updated with information collected during 2016 surveys and ** indicates that the EO was newly documented in 2016.

Common Name	Scientific Name	State Status	EO ID	EO Rank	Year First Observed	Year Last Observed	Site
Slippershell*	*Alasmidonta viridis*	T	17975	E	1939	2016	7, 8
Slippershell**	*Alasmidonta viridis*	T	20829	E	2016	2016	11
Round pigtoe	*Pleurobema sintoxia*	SC	18331	H	1939	1939	
Paper pondshell**	*Utterbackia imbecillis*	SC	20851	E	2016	2016	1
Ellipse*	*Venustaconcha ellipsiformis*	SC	18064	E	1939	2016	5, 6, 7, 8
Ellipse**	*Venustaconcha ellipsiformis*	SC	20847	E	2016	2016	10
Rainbow**	*Villosa iris*	SC	20826	E	2016	2016	8

Mussels and Aquatic Species

Aquatic surveys were performed at eleven sites within Rogue River SGA. Eight sites were located in the Rogue River main stem, four within the southeast Extension Unit, two sites were located in Duke Creek, and one site in Spring Creek (Table 10 and Figure 14). Locations of sites are given in Table 1 and numbers of each species found at each site are given in Table 7. Substrate characterization and water chemistry measures are provided for each site (Tables 9 and 10). A total of nine unionid mussel species were found including one state threatened species, and three species of special concern. These four species are also species of greatest conservation need (SGCN).

The state threatened slippershell (*Alasmidonta viridis*) was found at Sites 7 and 8 in the main stem of the Rogue River within the southeast Extension Unit and Site 11 in Spring Creek. The only live individual of this species was found at site 8. The shells found at Sites 7 and 11 were in relatively good condition, indicating the presence of live individuals nearby in the recent past. The occurrences at Sites 7 and 8 update and expand a 1939 historical element occurrence record for the species (EO ID 17975). The shell at Site 11 represents a new element occurrence (EO ID 20829) as it is greater than 10 km river distance from the other occurrence.

The special concern ellipse (*Venustaconcha ellipsiformis*) was found at Sites 5, 6, 7, and 8 in the main stem of the Rogue River in the southeast Extension Unit (Figure 14). These observations update and expand a 1939 record for the species (EO ID 18064). Live individuals were found at three of the four sites. In addition, ellipse was found at Duke Creek at site 10. The ellipse shells found in Duke Creek at Site 10 constitute a new EO (EO ID 20847), as they are greater than 10 km river distance from Sites 5, 6, 7, and 8. Five live individuals of rainbow (*Villosa iris*, state special concern) were found at Site 8. This is a new EO (EO ID 20826) and the first record of the species within Rogue River SGA. Paper pondshell (*Utterbackia imbecillis*, state special concern and SGCN) was found at the northern most part of the SGA at Site 1 in the Rogue River main stem. This occurrence is a new EO (EO ID 20851) and the first record of the species in the Rogue River watershed.

Fluted-shell (*Lamigona costata*), a species recommended to be a species of special concern in 2014 and a SGCN, was documented for the first time in the Rogue River watershed at Site 8. Wabash pigtoe (*Fusconaia flava*), a non-listed species, was documented in the Rogue River watershed for the first time at Sites 5, 6, 7, and 8 in this 2016 survey. Creek heelsplitter (*Lasmigona compressa*), another species recommended to be listed as special concern in 2014, is known historically from a site just outside Rogue River SGA in Cedar Creek. However, no creek heelsplitters were found in this 2016 survey. Round pigtoe (*Pleurobema sintoxia*), a species of special concern recorded in the Rogue River SGA in 1939, was not observed during 2016 surveys. One of the historical records for this species was in close proximity to Site 8. Historically it was also found near the city of Rockford in 1977.

Survey Site 8, in the lower main stem of the Rogue River, supports the most significant mussel community of the eleven sites surveyed. The greatest number of species (6), greatest density (1.22/m^2), and most species of rare mussels (3) were recorded at this site (Table 7). All three of the listed or special concern mussels present at Site 8 were represented by live individuals, including the only live slippershell documented in the survey. State threatened or special concern mussel species were found at seven of the eleven sites surveyed (Table 7).

Table 7. Numbers of unionid mussels (#), relative abundance (RA), and density (D = individuals/m2) by site number during surveys conducted in Rogue River State Game Area in 2016. The number of unionid shells (S) found is given in parentheses. Status in Michigan is listed in parentheses after the scientific name (E = state endangered; T = state threatened; SC = state special concern).

		Rogue River															
		1			2			3			4			5			6		
Species		#	RA	D	#	RA	D	#	RA	D	#	RA	D	#	RA	D	#	RA	D
Slippershell	*Alasmidonta viridis* (T)																		
Spike	*Elliptio dilatata*													9	0.64	0.07	3	0.50	0.1
Wabash pigtoe	*Fusconaia flava*													1	0.07	0.01	S		
Fatmucket	*Lampsilis siliquoidea*	9	1.00	0.07	4	0.57	0.03				S								
Fluted-shell	*Lasmigona costata*													1	0.07	0.01			
Strange floater	*Strophitus undulatus*				3	0.43	0.02												
Paper pondshell	*Utterbackia imbecillis* (SC)	S(1)																	
Ellipse	*Venustaconcha ellipsiformis* (SC)													3	0.21	0.02	3	0.50	0.1
Rainbow	*Villosa iris* (SC)																		
	Total # individuals and density	9		0.07	7		0.05	0		0.00	0		0.00	14		0.11	6		0.17
	# species live	1			2			0			0			4			2		
	# species live or shell	2			2			0			1			4			3		
	Area searched (m^2)	128			128			128			128			128			36		
Asian clam	*Corbicula fluminea*																		
Zebra mussel	*Dreissena polymorpha*																		

		Rogue River						Duke Creek						Spring Creek			
		7			8			9			10			11			
Species		#	RA	D	#	RA	D	#	RA	D	#	RA	D	#	RA	D	
Slippershell	*Alasmidonta viridis* (T)	S(4)			1	0.01	0.02							S(1)			
Spike	*Elliptio dilatata*	3			66	0.85	1.03										
Wabash pigtoe	*Fusconaia flava*	S			S												
Fatmucket	*Lampsilis siliquoidea*																
Fluted-shell	*Lasmigona costata*				2	0.03	0.03										
Strange floater	*Strophitus undulatus*													1	1.00	0.02	
Paper pondshell	*Utterbackia imbecillis* (SC)																
Ellipse	*Venustaconcha ellipsiformis* (SC)	S(6)			4	0.05	0.06				S(2)						
Rainbow	*Villosa iris* (SC)				5	0.06	0.08										
	Total # individuals and density	3		0.04	78		1.22	0		0.00	0		0.00	1		0.02	
	# species live	1			5			0			0			1			
	# species live or shell	4			6			0			1			2			
	Area searched (m^2)	84			64			128			128			60			
Asian clam	*Corbicula fluminea*																
Zebra mussel	*Dreissena polymorpha*																

Table 8. Physical habitat characteristics and measures taken at mussel survey sites in Rogue River State Game Area during 2016

Site #	Waterbody	Current speed (m/second)	Aquatic vegetation?	Woody debris?	Eroded banks?	%Pool	%Riffle	%Run
1	Rogue River	0.3	Y	Y	Y			100
2	Rogue River	0.3	N	Y	Y			100
3	Rogue River	0.3	N	Y	N	10		90
4	Rogue River	0.3	N	Y	Y[1]			100
5	Rogue River	0.3	N	Y	Y			100
6	Rogue River	1.0	N	Y	Y[2]		10	90
7	Rogue River	0.5	N	Y	N		10	90
8	Rogue River	0.5	Y	Y	N			100
9	Duke Creek	0.5	N	Y	Y	20		80
10	Duke Creek	0.4	N	Y	Y		20	80
11	Spring Creek	0.2	Y	Y	Y[3]			100

[1]ATV tracks were seen along the bank of the Rogue River at this site.

[2]Boulders placed on bank by road and small diameter culvert.

[3]Erosion at the side of Red Pine Dr. around culvert.

Table 9. Substrate characterization by mussel survey site in Rogue River State Game Area during 2016

Site #	Waterbody	Boulder	Cobble	Pebble	Gravel	Sand	Silt
1	Rogue River					70	30
2	Rogue River					80	20
3	Rogue River					90	10
4	Rogue River					95	5
5	Rogue River			10	20	40	30
6	Rogue River	5	20	25	20	20	10
7	Rogue River				40	40	20
8	Rogue River	3	20	25	20	20	12
9	Duke Creek				2	90	8
10	Duke Creek	2	25	25	20	20	8
11	Spring Creek					40	60

Table 10. Water temperature and chemistry measures collected at mussel survey sites in Rogue River State Game Area 2016.

Site #	Waterbody	pH	Conductivity (µS)	Alkalinity (mg/l CaCO3)	Hardness (mg/l)	Water temp. (C)
1	Rogue River	8.02	646	160	240	19.2
2	Rogue River	7.95	640	156	236	19.4
3	Rogue River	8.08	577	172	228	18.3
4	Rogue River	8.25	620	168	292	17.9
5	Rogue River	8.14	596	152	224	16.8
6	Rogue River	8.11	593	192	212	17.5
7	Rogue River	8.25	581	196	228	18.6
8*	Rogue River	8.41	617	228	244	12.8
9	Duke Creek	8.22	532	200	200	17.0
10*	Duke Creek	8.19	514	236	232	15.0
11*	Spring Creek	8.17	503	228	228	16.5

* Water samples collected October 4-11, 2016, all others were collected September 7-15, 2016.

Live aquatic snails (Gastropoda) were observed at all survey sites except Sites 4 and 10 where only shells were found, and Site 2 where no live snails or shells were found (Table 11). An especially high density (approximately 20 indvs./m^2) of liver elimia (*Elimia livescens*), a native aquatic snail, was noted at Site 8 in the lower Rogue River main stem. This species' state conservation rank is considered "vulnerable" (S3) in Ontario and Indiana, but it is not ranked in Michigan. In addition, boreal fossaria (*Fossaria galbana*) an aquatic snail and SGCN was documented at Site 1. The non-native banded mysterysnail (*Viviparus georgianus*) was noted at Sites 5 and 8 in the lower Rogue River. It was particularly abundant at Site 8 with a density of approximately 30 indvs./m^2. Banded mysterysnail is native to the Mississippi drainage and southern United States.

Live fingernail clams (Sphaeriidae) were observed at all survey sites except Site 4 where only shells were found, and Site 2 where no live clams or shells were found. Site 8 supported a high density (>50 indivs./m^2) of fingernail clams. Freshwater sponge (Spongillidae) was found at Site 6 in the lower main stem of the Rogue River (Table 11). The green color comes from green algae, an endosymbiont that provides nutrients to the sponge via photosynthesis. Northern clearwater crayfish (*Orconectes propinquus*), were noted at all aquatic survey sites except Site 9 in Duke Creek (Photo on page 68). This species is common throughout Michigan in small creeks to medium sized rivers. Three species of fish were observed during surveys: mottled sculpin (*Cottus bairdii*), Johnny darter (*Etheostoma nigrum*), and blackside darter (*Percina maculata*). None of these are state listed, special concern, or SGCN. No zebra mussels or Asian clams were seen at any of the survey sites.

Stream substrate in the lower main stem of the Rogue River (Sites 5, 6, 7, and 8 in the southeast Extension Unit) and in Duke Creek (Sites 9 and 10) was favorable for unionid mussels (i.e., a mix of pebble, gravel, and sand with a small component of silt). Sites 1, 2, 3, and 4 in the upper Rogue River had larger components of sand and silt, making them more suitable to species like fatmucket (*Lampsilis siliquoidea*), strange floater (*Strophitus undulatus*), and paper pondshell that are more tolerant to fine particle substrates (Table 7).

Cover for fish was found at nearly all sites, in the form of large woody debris (Table 8). Aquatic vegetation was largely absent. Bank erosion was noted at one or more sites within all three streams. There was erosion of the steep bank at the Red Pine Dr. crossing of Spring Creek around the culvert (Site 11). Empty turtle eggs were scattered in the sandy gravel exposed at the culvert, giving evidence of turtle nesting. Stream morphology at the survey sites was primarily run, with a small component of pool and/or riffle at five of the sites.

The Rogue River at Site 1 appears to have been straightened and channelized historically. Off-road vehicle tracks were seen in the muddy bank of the Rogue River at Site 4. Water clarity was high and visibility was very good at all sites at the time of surveys.

Table 11. Species observed incidentally by site number during mussel surveys conducted at Rogue River State Game Area in 2016. An "X" indicates at least one individual of the taxa was detected at a site.

Common Name	Species/Taxa	1	2	3	4	5	6	7	8	9	10	11
Snails	Gastropoda	X	X	X	X(shell only)	X	X	X	X	X	X(shell only)	X
Mud amnicola	*Amnicola limosa*		x									
Pointed campeloma	*Campeloma decisum*	x		x		x	x		x	x		x
Liver elimia	*Elimia livescens*				x		x	x	x(20/m^2)			
Dusky fossaria	*Fossaria dalli*			x								
Boreal fossaria	*Fossaria galbana*	x							x			
Golden fossaria	*Fossaria obrussa*	x										
Disk gyro	*Gyraulus circumstriatus*			x								
Flexed gyro	*Gyralus deflectus*		x									x
Two-ridge rams-horn	*Helisoma anceps*	x	x	x								
Tadpole physa	*Physella gyrina*	x								x		x
Bellmouth rams-horn	*Planorbella campanulata*	x										
Marsh rams-horn	*Planorbella trivolvis*		x	x	x			x				x
Sharp hornsnail	*Pleurocera acuta*											
Marsh pondsnail	*Stagnicola elodes*	x										x
Banded mysterysnail*	*Viviparus georgianus**					x		x	x(30/m^2)			x
Fingernail clams	Sphaeriidae	X		X	X(shell only)	X	X	X	X(>50/m^2)	X	X	X
Crayfish	Decapoda											
Northern clearwater crayfish	*Orconectes propinquus*	X	X	X	X	X	X	X	X		X	X
Sponge	Spongillidae						X				X	
Mottled sculpin	*Cottus bairdii*						X					
Johnny darter	*Etheostoma nigrum*	X							X			
Blackside darter	*Percina maculata*					X		X				

* Native to the Mississippi River drainage and southern U.S.

Fatmucket was documented in the main stem of the Rogue River. Photo by Peter J. Badra.

Northern clearwater crayfish was documented at several survey sites. Photo by Peter J. Badra.

Table 12. Rare species, Species of Greatest Conservation Need (SGCN), DNR featured species, and DNR focal species documented at Rogue River State Game Area. State status abbreviations are as follows: T, state threatened; and SC, state special concern.

Common Name	Scientific Name	State Status	SGCN	DNR Featured Species	Year Last Observed
AQUATIC SPECIES					
Slippershell (mussel)	*Alasmidonta viridis*	T	X		2016
Boreal fossaria (snail)	*Fossaria galbana*		X		2016
Fluted-shell (mussel)	*Lasmigona costata*		X		2016
Round pigtoe (mussel)	*Pleurobema sintoxia*	SC	X		1939
Paper pondshell (mussel)	*Utterbackia imbecillis*	SC	X		2016
Ellipse (mussel)	*Venustaconcha ellipsiformis*	SC	X		2016
Rainbow (mussel)	*Villosa iris*	SC	X		2016
BIRDS					
Wood duck	*Aix sponsa*			X	2016
Mallard	*Anas platyrhynchos*			X	2016
Ruffed grouse	*Bonasa umbellus*			X	2016
Red-shouldered hawk	*Buteo lineatus*	T	X	X	2016
Pileated woodpecker	*Dryocopus pileatus*			X	2016
Wood thrush	*Hylocichla mustelina*		X	X	2016
Wild turkey	*Meleagris galloparvo*			X	2016
Louisiana waterthrush	*Parkesia motacilla*	T	X		2016
Eastern bluebird	*Sialia sialis*			X	2016
HERPTILES					
Blanding's turtle	*Emydoidea blandingii*	SC	X		2016
Wood Turtle	*Glyptemys insculpta*	SC	X		1996

The state special concern ellipse is a designated species of greatest conservation need that was documented at five locations within the Rogue River State Game Area. Photo by Peter J. Badra.

DISCUSSION

Natural Community Discussion and Recommendations
In addition to the specific management recommendations provided in the above Natural Community Survey Results section, we provide the following general management recommendations for your consideration. We encourage invasive species control focused in high-quality natural communities, the maintenance of the canopy closure of high-quality forest, the reduction of fragmentation and promotion of connectivity across the game area but focused in the vicinity of wetlands and high-quality natural communities, the use of landscape-scale prescribed fire, and the careful prioritization of stewardship efforts in the most critical habitats. Finally, monitoring of these management activities is recommended to facilitate adaptive management.

Forest Biodiversity and Fragmentation
The Rogue River SGA supports over 5,022 acres of upland and lowland forest and over 261 acres of high-quality forest, primarily lowland forest (i.e., hardwood-conifer swamp and floodplain forest). Each of the documented forest EOs that were detailed in this report had *FQI* scores over 35. Michigan sites with an *FQI* of 35 or greater possess sufficient conservatism and richness that they are floristically important from a statewide perspective (Herman et al. 2001). Because the landscape surrounding Rogue River SGA is dominated by agriculture and rural development (Figure 1, page 2), the large area of forest within the game area serves as an important island of biodiversity for the local region. Additionally, the greater Grand Rapids metropolitan area is one of the three fastest growing economic regions in the country, making remaining natural areas in the region valuable resources for the conservation of local biodiversity. Maintaining the forest canopy of mature forest systems 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 conservation significance of these forests is heightened by the documentation of numerous vernal pools within these forests and the recording during point-count surveys of seventy species of birds of which two are SGCN and eight are DNR featured species (Table 12 and Appendix 6).

Although Rogue River SGA is relatively unfragmented compared to the surrounding landscape, its past history of agricultural development, subsequent abandonment, and logging activity has resulted in significant fragmentation of native habitat within the game area. The effects of forest fragmentation on native plants and animals and ecosystem processes are drastic (Heilman et al. 2002). Fire regimes in fragmented landscapes are reduced because roads, agriculture, and development enhance modern forest fire suppression (Leahy and Pregitzer 2003). Forestry and wildlife management practices that focus on species- and stand-based management have directly and indirectly promoted landscape fragmentation and exacerbated edge effects through prescriptions that generate and maintain small discrete patches of habitats or stand types (Bresse et al. 2004). The small and insularized nature of forest fragments may make them too small to support the full array of species formerly found in the landscape (Rooney and Dress 1997). Local population extinctions within fragments are accelerated by reduced habitat and population size. Within fragmented forests, avian diversity is reduced by nest predation and nest parasitism, and herptile diversity is reduced by the prevalence of mesopredators (e.g., raccoons, skunks, and opossums). Numerous neotropical migrant songbirds are dependent on interior forest habitat and are highly susceptible to nest parasitism and predation (Robinson et al. 1995, Heske et al. 2001, Heilman et al. 2002). Native plant diversity within forested fragments is threatened by low seedling survivorship, infrequent seed dispersal, high levels of

Stand 92 in Compartment 4 is a mature oak forest that would benefit from protection against fragmentation and the application of prescribed fire. Photo by Jesse M. Lincoln.

herbivory, and growing prevalence of invasive species and native weeds, which thrive along the increasing edges and disperse throughout fragmented landscapes along roads and trails (Brosofske et al. 2001, Heilman et al. 2002, Hewitt and Kellman 2004).

In general, dampening the effects of forest fragmentation can be realized by targeting large blocks of mature, contiguous forest and limiting timber harvest in those and adjacent stands (Figures 15 and 16). Further, closing redundant forest roads, limiting the creation of new roads, halting the creation of new wildlife openings within forested landscapes, and decreasing forest harvest levels is also beneficial for limiting forest fragmentation. We recommend that efforts to reduce fragmentation and promote connectivity be concentrated in the vicinity of existing wetlands, riparian corridors, and especially around the high-quality natural communities described in this report.

In addition to the forested natural community EOs, there are several forested areas of interest within Rogue River SGA that are regionally important for biodiversity considerations. Although these forested stands did not meet the criteria for inclusion as high-quality natural communities in MNFI's database, we suggest that these stands be considered for management as mature, closed-canopy systems. The areas mentioned in the subsequent discussion are located adjacent to high-quality natural community EOs, are part of the Rogue River corridor, and/or provide significant areas of mature forest in a county increasingly depleted of this resource.

In Compartment 1 important forested areas for the protection of biodiversity include Stands 49 and 62. These stands would benefit from prescribed fire and existing fire breaks are already in place as the stands are bounded by roads and the Rogue River.

North Kent Swamp is an unusual community type for Kent County. The swamp is buffered from fragmentation and is characterized by high floristic diversity and complex vegetative structure. Photo by Jesse M. Lincoln.

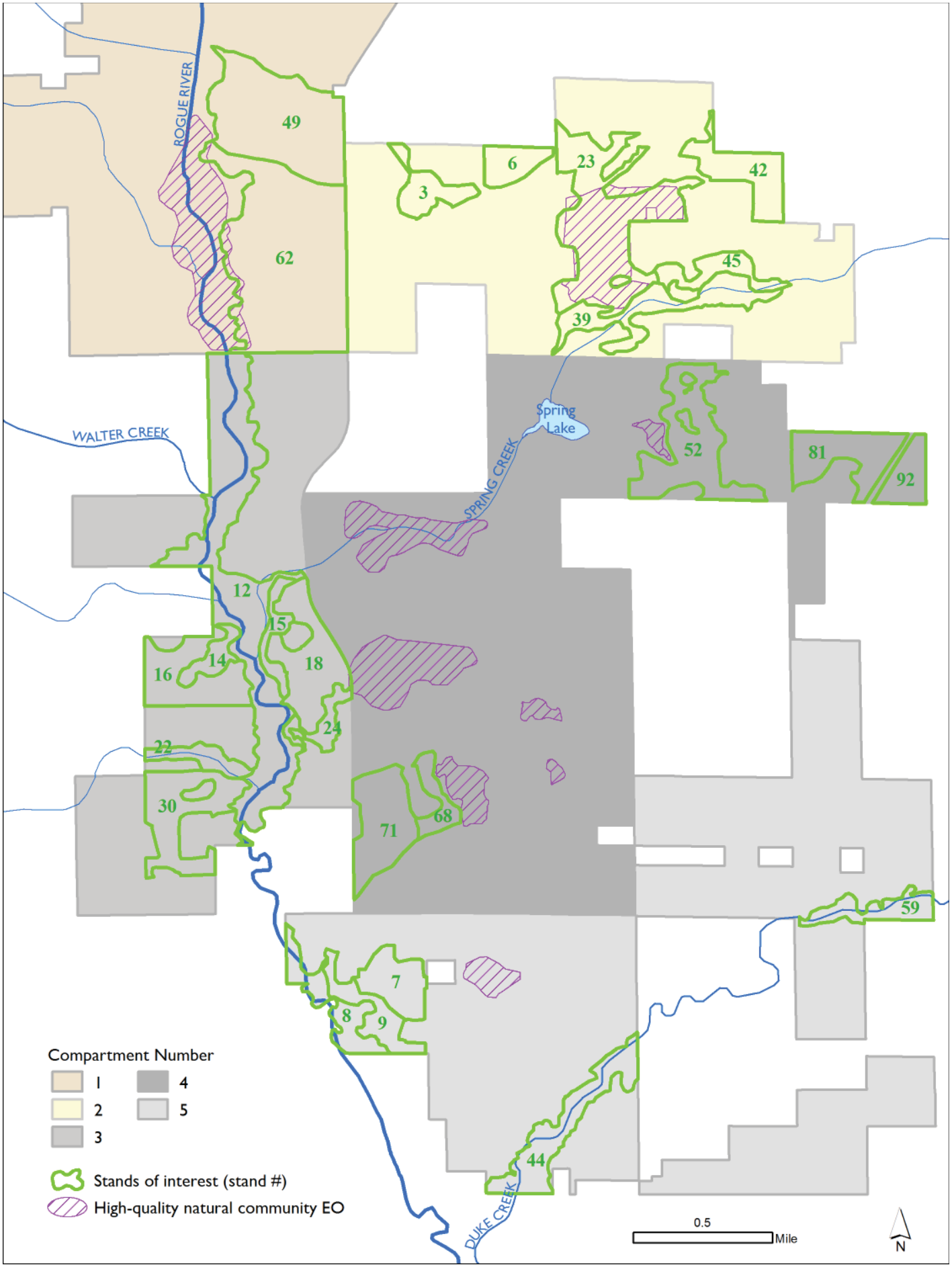


Figure 15. Notable stands in Rogue River State Game Area.

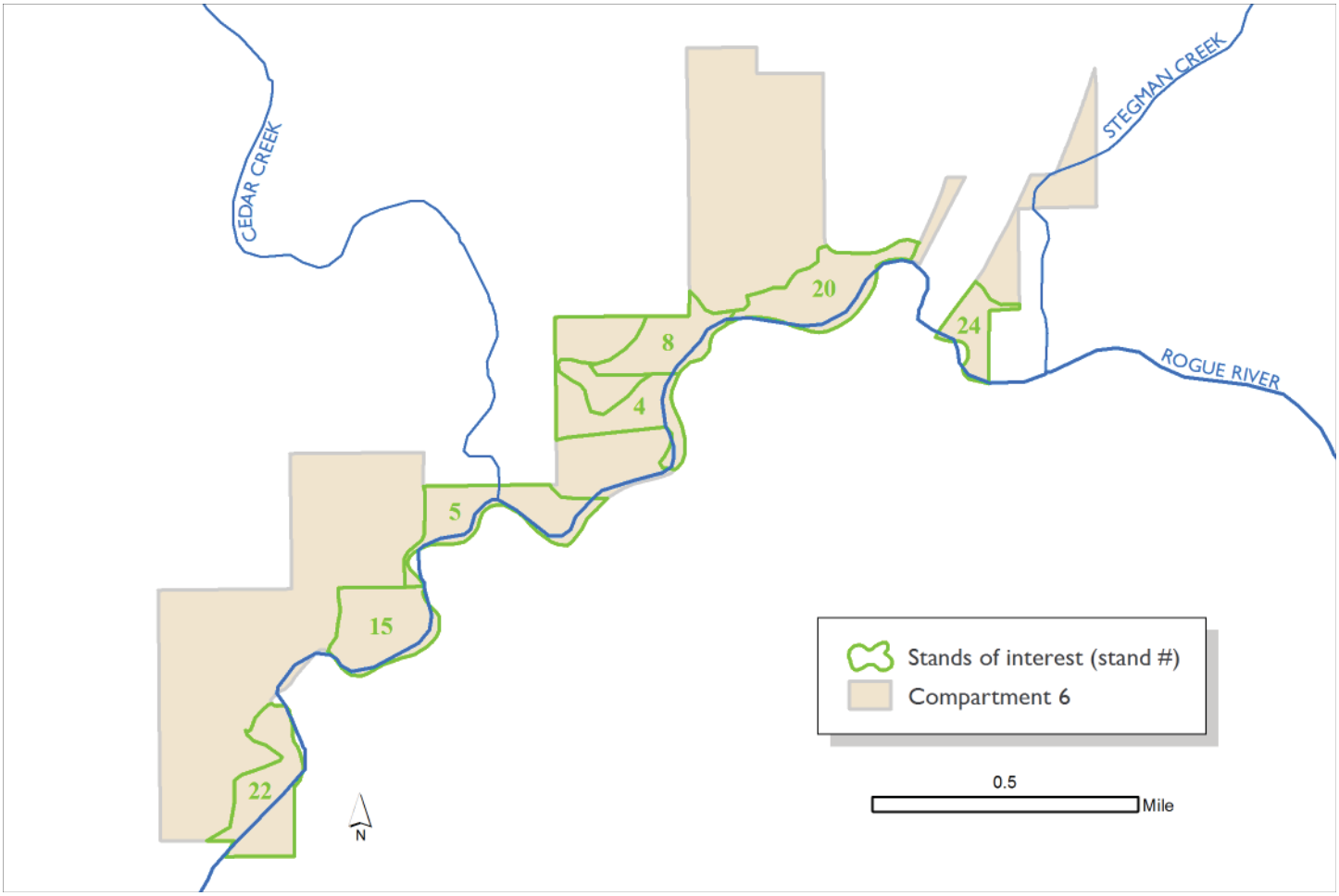


Figure 16. Notable stands in the Southeast Extension of the Rogue River State Game Area.

In Compartment 2, stands surrounding the existing EO in Stand 23 (Heiss Forest dry-mesic northern forest) are important to protect and include Stands 6, 42, and 45. Stand 39 is also important to protect as it surrounds Spring Creek. There is also a small forested wetland in Stand 3 that is a noteworthy hardwood-conifer swamp.

Within Compartment 3, there are several forested wetlands where intensive forestry should be avoided. This includes the lowland forest flanking the Rogue River in Stand 12. Additional significant wetlands that feed the Rogue River include Stands 14, 15, 22, and 24. Some important, maturing upland forests flanking the river corridor include Stands 16, 18, and 30.

In Compartment 4, there are two significant streams that feed the Rogue River: Spring Creek and Duke Creek. The areas along these streams should be protected from intensive forestry activity by providing a buffer of 150 ft away from saturated soils. Compartment 4, Stand 52 is a former dry-mesic southern forest EO. This is a closed-canopy forest with maturing trees and several small wetland inclusions. While it is important for biodiversity – particularly canopy nesting neotropical migrants – this stand was removed from Biotics as an EO because it has been degraded by selective logging, fire suppression, invasive species encroachment, and a major road that passes through the forest. The road is a conduit for invasive species and illegal off-road vehicle activity that is causing severe erosion within the forest. Additional stands of mature forest within Compartment 4 include Stands 68, 71, 91, and 92.

Within Compartment 5, Stand 8 encompasses the lowlands surrounding Rogue River and should be protected from intensive forestry actions. Uplands flanking this river corridor include Stands 7 and 9 and these stands should be managed as a buffer for the riparian corridor. Stand 44 is encompasses the forested wetland complex surrounding Duke Creek and should also be protected from intensive management actions. We also recommend managing Stand 59 as a mature forest to help protect the hydrologic integrity of Duke Creek and habitat for Louisiana waterthrush.

In Compartment 6, Stands 4, 5, 8, 15, 20, 22, and 24 should be managed as mature, closed-canopy systems since they provide a buffer to the river.

Because of its capacity to invade wetlands, uplands, forested, and non-forested systems, glossy buckthorn is one of the most significant invasive species in Rogue River State Game Area. Photo by Jesse M. Lincoln.

Invasive Species Control

Invasive species pose a major threat to species diversity and habitat heterogeneity within Rogue River SGA. By out-competing and replacing native species, invasive species can change floristic composition of natural communities, alter vegetative 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). Advanced regeneration in the understory of the forested stands in Rogue River SGA is influenced by the interaction of competition from invasive shrubs, fire suppression, and deer herbivory. Lastly, non-native invasive species often have no natural predators and spread aggressively through rapid sexual and asexual reproduction.

Although 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 glossy buckthorn (*Frangula alnus*), Japanese barberry (*Berberis thunbergii*), autumn olive (*Elaeagnus umbellata*), Morrow honeysuckle (*Lonicera morrowii*), multiflora rose (*Rosa multiflora*), narrow-leaved cat-tail (*Typha angustifolia*), reed canary grass (*Phalaris arundinacea*), purple loosestrife (*Lythrum salicarea*), and reed (*Phragmites australis*). Additional invasive species that were not seen in Rogue River SGA, such as Oriental bittersweet (*Celastrus orbiculata*) and Japanese knotweed (*Fallopia japonica*), 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://mnfi.anr.msu.edu/invasive-species/best-control-practice-guides.cfm

Invasive species management at Rogue River SGA should focus on controlling populations of pernicious invasive species within high-quality forests and wetlands and also in the surrounding landscape. Additionally, treatment of invasive species in the understory of forested stands slated for harvest should occur before logging operations proceed. Glossy buckthorn appears to be of particular concern as it exists in the subcanopy of many stands and will likely respond positively to forest prescriptions that include significant reductions of canopy coverage. Management actions should include treatment of this shrub prior to reduction of canopy coverage in order to prevent a complete shift of species composition. While this species is generally an invader of wetlands, the water table within many parts of the game area is close enough to the surface to allow it to persist in upland habitats characterized by high water tables.

Prescribed fire can be employed as the primary mechanism for reducing invasive species at the landscape scale in dry-mesic forests and targeted prescribed fire and spot treatment through cutting and/or herbicide application can be employed locally within priority high-quality natural community EOs. However, compared to other game areas in southwestern Michigan, Rogue River SGA has fewer fire dependent ecosystems and was less influenced historically by wildfire. Management activities within this game area will likely have much less of a focus on prescribed fire than other game areas.

We encourage a multi-faceted approach to invasive species control and emphasize that improving the landscape context surrounding the high-quality natural areas is critical and that reducing background levels of invasive species will reduce the seed source for these invaders. Logging in southern Michigan has been found to locally increase invasive species populations with areas of recent logging being associated with local dominance of garlic mustard (*Alliaria petiolata*) (Michele Richards, personal communication, July 2010). Restricting future logging operations to winter months when the soils are frozen may limit the establishment and expansion of invasives, such as

garlic mustard, that benefit from soil disturbance and can also reduce detrimental impacts to plant and animal species. We strongly encourage the implementation of monitoring within the high-quality natural communities and throughout actively managed areas to gauge the success of restoration activities at reducing invasive species populations. In addition, periodic early-detection surveys should be implemented to allow for the identification of invasive species that have yet to establish a stronghold within Rogue River SGA.

Fire as an Ecological Process

Only a few areas within Rogue River SGA historically supported fire-dependent ecosystems, including dry-mesic southern forest and dry-mesic northern forest. Historically, pockets of oak-pine barrens may have occurred within these dry-mesic systems. In the past, lightning- and human-set fires frequently spread over large areas of southern Michigan and other Midwestern states. Closed-canopy dry-mesic forests within Rogue River SGA are negatively impacted by fire suppression due to strong regeneration of thin-barked, shade-tolerant or mesophytic trees, such as red maple and beech, and invasive shrubs such as honeysuckle, multiflora rose, and autumn olive. These native and invasive mesophytic species compete with oaks and white pine and contribute to the regeneration failure of oaks. Within oak-dominated forested ecosystems, a sustained, landscape-scale, 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, oaks, and white pine.

Plant communities benefit from prescribed fire in several ways. Depending on the season and intensity of a burn, prescribed fire may be used to decrease the cover of 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). Burning 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). Many host plants for rare insect species are fire-dependent plant species.

Heiss Forest is fire-suppressed and maple and beech are dominating the subcanopy, thereby limiting regeneration of oaks that characterize the canopy. Photo by Jesse M. Lincoln.

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 subterranean 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. Where rare invertebrates and herptiles are a management concern, burning strategies should allow for ample refugia to facilitate effective post-burn recolonization (Siemann et al. 1997). Insects and herptiles, characterized by fluctuating population densities, poor dispersal ability, and patchy distribution, rely heavily on unburned sanctuaries from which they can reinvade burned areas (Panzer 1988). Dividing large contiguous areas into two or more separate burn units or non-fire refugia 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 herptile species, such as eastern box turtle. 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 (<13 °C or 55 °F) can help protect reptiles, because 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.

We recommend the implementation of prescribed fire at a landscape-scale and the creation of large burn units (e.g., several hundred acres in size). If resources for burning are limited, we recommend that prescribed fire be prioritized for high-quality and/or underrepresented, fire-dependent natural communities (e.g., high-quality forests and areas of barrens restoration) and habitat immediately adjacent to these systems. Fire-suppressed sites should be burned using an initially aggressive fire-return interval. Because Rogue River SGA is characterized primarily by forested communities, we recommend focusing fire efforts on existing blocks of relatively high-quality forest. In particular, we recommend focusing on areas surrounding

Forested wetlands around Sherwin Meadows have many species typical of wet meadows in the herbaceous layer. We recommend implementing prescribed fire within Sherwin Meadows and adjacent forests to maintain and expand open wetland habitat and set back woody encroachment. Photo by Jesse M. Lincoln.

Characteristic barrens flora and structure occur throughout (Compartment 2; Stand 10). This would be the best place to focus the application of prescribed fire if barrens restoration was a management objective. Photo by Jesse M. Lincoln.

existing high-quality natural communities. We recommend considering burning Heiss Forest dry-mesic northern forest and the surrounding forested stands to reduce dominance of beech and maple in the subcanopy, increase oak and pine regeneration, and stimulate the expression of fire-adapted species existing in the seedbank. We also recommend burning the areas surrounding the wet meadows in Compartment 4 including Stands 56, 67, 68, 71, 72, and 75. Because this is a wetland complex this should be a late season prescribed burn. Special attention should be given to Stand 72 as it has abundant wet meadow species but is quickly transitioning to forest. Additionally, glossy buckthorn will be a significant issue throughout this area and should be treated before and after prescribed burns. We also recommend implementing prescribed fire in Compartment 5, Stands 63, 64, and 67 within oak-dominated forests that would have burned historically. When implementing prescribed fire, we recommend that the seasonality of burns be varied across the game area. Prescribed fire is often seasonally restricted to spring. Fires have the greatest impact on those plants that are actively growing at the time of the burn. Repeated fires at the same time of year impact the same species year after year, and over time, can lower floristic diversity (Howe 1994, Copeland et al. 2002). For example, forbs that flower in early spring often overwinter as a green rosette or may have buds very close to the soil surface and in the litter layer. Repeated burns in early spring can be detrimental to these species. Historically, fires burned in a variety of seasons, including spring, during the growing season, and fall (Howe 1994, Copeland et al. 2002, Petersen and Drewa 2006). Dry-mesic northern forest, the fire-dependent natural community that was historically found at Rogue River SGA likely burned primarily in late summer and early fall. Varying the seasonality of prescribed burns to match the full range of historical variability better mimics the natural disturbance regime and leads to higher biodiversity (Howe 1994, Copeland et al. 2002). In other words, pyrodiversity (that is, a diversity of burn seasons and fire intensity) leads to biodiversity.

Repeated early spring burns are of particular concern in dry-mesic forest, and degraded barrens where a goal for prescribed burning is control of woody species. Prior to bud break and leaf flushing, the vast majority of energy in a woody plant is stored in roots as carbohydrate reserves (Richburg 2005). As plants expend energy to make leaves, flowers and fruits, these carbohydrate reserves diminish, reaching a seasonal low during flowering and fruiting. As fall approaches, energy root reserves are replenished. Thus, when woody species are top-killed by early spring fires, they are able to resprout vigorously using large energy stores, a phenomenon seen frequently with sassafras, black locust, and sumac (Cohen et al. 2009). However, if burns are conducted later in the spring after leafout, or during the growing season, energy reserves are already partially depleted, and resprouting vigor is lower, particularly for clonal species like sassafras, sumac, and black locust (Axelrod and Irving 1978, Reich et al. 1990, Sparks et al. 1998).

Resource managers restrict prescribed fire to the early spring for numerous reasons including ease of controlling burns, greater windows of opportunity for conducting burns because suitable burning conditions are often most prevalent this time of year, and to reduce the probability of detrimentally impacting fire-sensitive animal species, such as herptiles (e.g., eastern box turtle). Although these are all legitimate reasons, we feel that the long-term benefits of diversifying burn seasonality across the game area outweigh the costs and that ultimately, successful restoration of fire-dependent ecosystems at Rogue River SGA will depend on expansion of the burn season beyond early spring. Several techniques for reducing the risk to fire-sensitive species can be employed during burns in the summer and fall. For example, burn specialists can establish rotating refugia within large burn units and avoid burning within and around rotted logs, vernal pools, and seepage areas.

Barrens Restoration

Notes from GLO surveys describe no barrens areas and no high-quality oak-pine barrens were documented during the course of the surveys. However, based on MiFI surveys and observations by MNFI ecologists, barrens ecosystems appear to have historically occurred locally within small areas of the Rogue River SGA. MNFI ecologists observed plant species and vegetative structure typical of barrens remnants in several areas: Compartment 2; Stand 10; Compartment 3; Stand 21; and Compartment 5; Stands 63 and 67.

The first management step for savanna and barrens restoration is the restoration of the savanna/barrens physiognomy through prescribed fire and/or selective cutting or girdling. Savanna/barrens restoration efforts that combine repeated prescribed fire application in conjunction with mechanical thinning are most likely to succeed where populations of relict savanna/barrens plants persist (Lettow et al. 2014).Where canopy closure has degraded the savanna/barrens character, resource managers can selectively cut or girdle the majority of trees (White 1986), leaving between 10 and 60% canopy closure. Fire is the single most significant factor in preserving savanna, barrens, and prairie ecosystems. Once open-canopy conditions have been re-established, the reintroduction of annual fire is essential for the maintenance of floristic composition and structure. In some instances, prairie grasses may need to be seeded or planted to provide an adequate fuel matrix to support frequent burns (Botts et al. 1994, Packard 1997a, 1997b). Seed and plant donors should come from local sources and similar vegetative communities (Apfelbaum et al. 1997). In addition to maintaining open canopy conditions, prescribed fire promotes internal vegetative patchiness and high levels of grass and forb diversity, deters the encroachment of woody vegetation and invasive species, and limits the success of dominants (Bowles and McBride 1998, Leach and Givnish 1999, Abella et al. 2001). Numerous studies have indicated that fire intervals of one to three years bolster graminoid dominance, increase overall grass and forb diversity, and remove woody cover of saplings and shrubs (White 1983, Tester 1989, Abella et al. 2001). Once the structure has been securely established, burning at longer time intervals can be employed to allow for seedling establishment and the persistence of desirable woody plants. Apfelbaum and Haney (1991) recommend gaps of five to ten years to allow for canopy cohort recruitment. Varying the burn interval from year to year and by season can increase the diversity of savanna, barrens, and prairie remnants.

Despite the presence of barrens species at a few locations, these sites are relatively degraded and would require significant effort and resources to restore. Additionally, the high-quality natural communities found in Rogue River SGA should take precedence. Therefore, the mentioned barrens areas may not be a high stewardship priority for resource managers.

Table 13. Summary of management recommendations for natural community element occurrences in Rogue River State Game Area.

Site Name	Community Type	Management Recommendations
Solon Bog	Bog	• Maintain intact buffer of natural communities surrounding bog • Protect hydrology and avoid logging in adjacent uplands • Allow bog to burn if prescribed fire or wildfire enter the wetland basin • Monitor for invasives
Heiss Forest	Dry-mesic Northern Forest	• Maintain closed canopy • Apply prescribed fire to reduce invasive species and native mesophytic species • Cut and herbicide invasive shrubs • Monitor following fire and for invasives, advanced regeneration, and deer herbivory
Rogue River Floodplain	Floodplain Forest	• Maintain closed canopy and protect hydrology • Retain intact buffer of natural communities surrounding floodplain • Monitor to evaluate invasives and deer herbivory
North Kent Swamp	Hardwood-Conifer Swamp	• Maintain closed canopy • Retain an intact buffer of natural communities surrounding the swamp • Protect hydrology • Monitor to evaluate invasives and deer herbivory
Sherwin Swamp	Hardwood-Conifer Swamp	• Maintain closed canopy • Retain an intact buffer of natural communities surrounding the swamp • Protect hydrology • Control autumn olive through cutting and herbicide • Monitor to evaluate invasives and deer herbivory
Spring Creek Swamp	Hardwood-Conifer Swamp	• Maintain closed canopy • Retain an intact buffer of natural communities surrounding the swamp • Protect hydrology • Control invasive species through cutting and herbicide • Monitor to evaluate invasives and deer herbivory
Sherwin Meadows	Southern Wet Meadow	• Maintain intact buffer of natural communities surrounding meadow to protect hydrology • Burn meadow with surrounding uplands • Monitor for invasive species and following prescribed fire

Providing a large forested buffer around Spring Creek Swamp will ensure the protection of the creek's water quality, which feeds directly into the Rogue River. Photo by Jesse M. Lincoln.

Setting Stewardship Priorities

This report provides site-based assessments of seven natural community EOs that occur in Rogue River SGA. Detailed site descriptions, threats, management needs, and restoration opportunities specific to each individual site have been discussed. The baseline information presented in the current report provides resource managers with an ecological foundation for prescribing site-level biodiversity stewardship, monitoring these management activities, and implementing landscape-level biodiversity planning to prioritize management efforts. Threats such as invasive species and fire suppression are common across Rogue River SGA. Because the list of stewardship needs for the game area (Table 13) may outweigh available resources, prioritizing activities is a pragmatic necessity.

We provide the following framework for prioritizing stewardship efforts across all high-quality natural community EOs within Rogue River SGA in order to facilitate difficult decisions regarding the distribution of finite stewardship resources. In general, prioritization of stewardship within these natural community EOs should focus on the highest quality examples of the rarest natural community types and the largest sites. 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. Within Rogue River SGA, we recommend that stewardship efforts be focused in natural communities that harbor high levels of biodiversity and provide potential habitat for numerous rare plant and animal species.

We also recommend the prioritization of stewardship in sites located along riparian corridors and in forests that include vernal pools and other wetland inclusions, so that management efforts impact the upland and wetland interface. Sites that meet these criteria include Rogue River Floodplain Forest (Floodplain Forest, EO ID 20545), North Kent Swamp (Hardwood-Conifer Swamp, EO ID 20547), Spring Creek Swamp (Hardwood-Conifer Swamp, EO ID 20546), Heiss Forest (Dry-Mesic Southern Forest, EO ID 20782), and Sherwin Meadows (Southern Wet Meadows, EO 20550) (Table 14).

Monitoring

We recommend that monitoring be implemented at Rogue River SGA and that it be concentrated within the high-quality natural communities but also throughout actively managed areas. Monitoring can help inform adaptive management by gauging the success of restoration at meeting the goals of reducing invasive species populations, limiting woody encroachment in understories of fire-prone systems, and fostering regeneration in fire-dependent ecosystems. Assessing the impacts of prescribed fire on herptile populations should also be a component of the burning program, especially following potential burns in the summer and fall, and can help direct adaptive management. In addition, monitoring deer densities and deer herbivory will allow for the assessment of whether deer browsing threatens floristic structure and composition and whether active measures to reduce local deer populations are needed.

Table 14. Stewardship priorities for Rogue River State Game Area natural community element occurrences with the highest priorities highlighted with asterisks.

Site Name	Community Type	EO ID	EO Rank	Year First Observed	Year Last Observed	Global Rank	State Rank
Heiss Forest	Dry-Mesic Northern Forest	20782	CD	2015	2015	G4	S3
Rogue River Floodplain*	Floodplain Forest	20545	CD	2015	2015	G3?	S3
North Kent Swamp*	Hardwood-Conifer Swamp	20547	C	2015	2015	G4	S3
Sherwin Meadows	Southern Wet Meadow	19971	B	2015	2015	G4?	S3

Vernal Pools Discussion and Management Recommendations

Despite their small size and temporary nature, vernal pools can be incredibly diverse and productive wetlands, and are important for maintaining healthy forest ecosystems. Vernal pools could be considered "keystone ecosystems" in some cases because of the important ecological role they play in forest ecosystems, especially given their small size (Calhoun and deMaynadier 2008). The mapping and survey of potential and actual vernal pools in the Rogue River SGA provide valuable baseline information on the status, distribution, and ecology of vernal pools in the game area. This information will enhance our knowledge of vernal pools and help inform management and protection of these critical wetlands in the Rogue River SGA and statewide.

A total of 168 PVPs were identified and mapped from aerial photo interpretation in the Rogue River SGA in 2016. Surveys in 2016 were able to confirm 17 vernal pools in the field, and 2 potential vernal pools that may be verified as vernal pools in the future. Of the 17 vernal pools verified in the field, 11 were initially mapped from aerial photos, and 6 were first identified during field surveys in 2016. These results indicate a vernal pool mapping accuracy rate of 65% (i.e., 11 of 17 verified vernal pools originally mapped from aerial imagery), and an omission error rate of 35% (i.e., 6 of 17 verified vernal pools that were missed and not initially mapped from aerial imagery). It is important to note that all 11 (100%) of the PVPs that had been identified and mapped from aerial imagery and surveyed in 2016 were verified as actual vernal pools in the field. Although the number of PVPs that were surveyed and verified in the Rogue River SGA in 2016 was fairly small, the mapping accuracy rates obtained from these surveys and from previous vernal pool mapping efforts (i.e., Lee et al. 2014, Cohen et al. 2015b, Cohen et al, 2015c, Cohen et al. 2016) suggest it is likely that a significant number of the PVPs mapped in the game area represent actual vernal pools in the field. However, it also is likely that there are additional vernal pools in the field that were not mapped as PVPs. Thus, additional surveys are warranted to verify and map vernal pools in the field to obtain more accurate information on the status and distribution of vernal pools in the game area.

Vernal pools provide critical habitat for wood frogs, blue-spotted salamanders, spotted salamanders, and fairy shrimp, which are considered vernal pool obligate or indicator species in Michigan. Surveys in 2016 in Rogue River SGA only documented one vernal pool indicator species, blue-spotted salamander larvae, in only one vernal pool. This may have been due to the limited nature and timing of the surveys, small sample size, variability in species'

The diversity of vernal pools in Rogue River State Game Area provide critical habitat for a range of species. Photo by Yu Man Lee.

Blue-spotted salamader larvae were documented from several vernal pools. Photo by Yu Man Lee.

occupancy and breeding among pools and years (i.e., this species may breed in some pools/years and not others), and/or missed detection. A number of the pools were surveyed in September 2016 when the pools were dry, and after the larvae of these species would have metamorphosed and left the pool basins. Fairy shrimp (*Eubranchipus* spp.) are mainly found in flooded vernal pools in early spring until about mid to late May, or when water temperatures reach 68°F to 72°F (20°C to 22°C), which can vary in terms of the timing depending on local weather conditions in the spring (Colburn 2004). Surveys were conducted in late June in 2016, and may have been too late for finding fairy shrimp (although water temperatures were in the low 60s). Fairy shrimp, wood frogs, blue-spotted salamanders, and spotted salamanders also may not breed every year in a given pool (Colburn 2004, Calhoun and deMaynadier 2008). Usage of vernal pools for breeding may vary from year to year due to low water levels, local amphibian population swings, etc. (Lathrop et al. 2005). Additional surveys (ideally, multi-year surveys at multiple intervals over the breeding season) are needed to determine the occurrence and distribution of vernal pool indicator species in the game area to obtain more complete and accurate information on the ecology of vernal pools, and to increase our knowledge of the statewide status and distribution of these species. This is particularly crucial for fairy shrimp since we have so little information on these species, including how many and which species occur in Michigan and their status and distribution.

Wood frogs, blue-spotted salamanders, and spotted salamanders can use a variety of vernal pools, but several factors can strongly influence occupancy and successful reproduction in vernal pools by these species. These include pool hydroperiod (i.e., length of time a pool holds water), canopy closure, and landscape composition and structure surrounding vernal pools. These species generally require vernal pools that hold water from March or early April to at least early July so that their larvae can complete metamorphosis before the pool dries (Harding 1997, Colburn 2004). Several studies have found that wood frog and spotted salamander breeding populations in vernal pools are positively correlated with longer hydroperiods (e.g., ≥16 or 18 weeks) (Calhoun et al. 2003, Babbitt 2005, Baldwin et al. 2006, Green et al. 2013). These species also are more prevalent in densely shaded, closed-canopy pools (Skelly et al. 1999, Colburn 2004, Calhoun and deMaynadier 2008). Because these species spend most of their life cycle outside of the breeding season in forested terrestrial habitats, these species are associated with vernal pools that are primarily surrounded by forests, and are unlikely to utilize vernal pools surrounded by large areas of open habitat (Calhoun and deMaynadier 2008). Wood frog, spotted salamander, and blue-spotted salamander occupancy in vernal pools have been positively associated with forest cover or amount of forest within a 1-km radius around the pools (Guerry and Hunter 2002). Additionally, critical thresholds in forest cover or amount of forest around vernal pools have been documented for these species. Studies have reported spotted salamanders only occurring in vernal pools that had forest cover/forested habitat in at least 20 to 35% of the surrounding area within 100 to 300 m of the pool (Porej et al. 2004, Homan et al. 2004). For wood frogs, thresholds of about 10 to 30% forest cover within 100 to 300 m, and 15% forest cover within 200 m to 1 km of vernal pools have been reported (Porej et al. 2004, Homan et al. 2004). Gibbs (1998) also reported critical thresholds of about 30% forest cover around vernal pools for both these species.

The number or density of vernal pools and/or other wetlands as well as the diversity of these wetlands (e.g., different hydroperiods) also can impact the presence and abundance of these species (Gibbs 1993, Calhoun and deMaynadier 2008, Brodman 2010). Brodman (2010) found that sites with greater number of wetlands and hydroperiod classes had higher species richness, abundance, and occupancy of pond-breeding salamanders including spotted and blue-spotted salamanders. Wetland clusters with 14 or more wetlands had significantly greater species richness and percentage occupancy than wetland clusters with 2 to 13 wetlands (Brodman 2010). Isolated wetlands had significantly lower species richness, occupancy, and abundance than sites with two or more wetlands (Brodman 2010). Additionally, wetland clusters with three hydroperiod classes had significantly greater species richness, abundance, and occupancy of salamanders

Management of vernal pools should focus on protecting the vernal pool's physical basin and water quality, and the integrity of the surrounding forest. Photo by Yu Man Lee.

than sites with two hydroperiod classes, and sites with one hydroperiod class had significantly lower abundance and occupancy than sites with two hydroperiod classes) (Brodman 2010). In general, species composition and richness can vary dramatically among pools, even between individual pools located close to one another, and clusters of pools typically support more taxa overall than any one pool within the cluster (Colburn 2004). However, isolated or partially isolated pools also can be very important in some areas as some studies have found that species may disproportionally use partially isolated pools in some areas because of fewer available options and these isolated pools may also be used as stepping stones for dispersal between wetland clusters (Gibbs 2000, Calhoun et al. 2003, Baldwin et al. 2006).

Identifying and mapping vernal pools and understanding their ecological values are critical for effective planning, management, and conservation of these important wetlands. The best time to survey for vernal pools and associated indicator species is in the spring, particularly early spring, when the pools are flooded. However, vernal pools also can be detected during other times of the year as well, including when the pools are dry. Signs that indicate presence of a vernal pool in the field include the presence of a small, isolated basin or depression with no permanent inlets/outlets or persistent surface water connections to permanent water and abrupt change in vegetation from surrounding forest; presence of obligate and/or facultative wetland plant species in upland forests; presence of hydric soils (e.g., saturated or mucky soils); water lines/marks at the base of tree trunks; exposed, lateral tree roots; matted, dark-stained leaves; and/or presence of fingernail clams and freshwater snails under leaf litter when the pool is dry. Ideally, surveys should consist of multiple visits to each pool within a year and across several years to verify pool drying and because vernal pool hydrology and ecology can vary significantly within a year and between years. Additional information about the ecology of individual vernal pools in the game area would help inform the development and implementation of appropriate and more site-specific management of vernal pools within the game area.

Management of vernal pools should focus on protecting the vernal pool's physical basin and water quality, and the integrity of the surrounding forest to maintain habitat for associated species, particularly pond-breeding amphibians (Calhoun and deMaynadier 2008). Activities that disturb soils, tree canopies, or coarse woody debris within and immediately adjacent to vernal pools should be avoided or minimized, particularly during critical time periods for most amphibians (i.e., March/April through July/August) (Thomas et al. 2010). Equipment use and canopy alteration can impact water quality and quantity and shift

vegetation composition and structure, resulting in changes to microhabitat that can pose serious problems for many amphibians (Semlitsch et al. 1988; deMaynadier and Hunter 1995, 1998, 1999; Waldick et al. 1999). The State of Michigan's sustainable soil and water quality practices for forest lands recommend no disturbance within the vernal pool depression, limiting use of heavy equipment within 30 meters (100 ft) or at least one tree length of the pool to avoid creating deep ruts, and maintaining at least 70% canopy closure within the 30-meter (100 ft or 1.4 ac) buffer (Michigan DNR and Michigan DEQ 2009). Because many of the pool-breeding salamanders and frogs travel 125 meters (400 ft) or more from the breeding pools into the surrounding forest (Semlitsch 1998), maintaining an additional buffer from 31 to 125 m (100-400 ft or 13 ac) or greater [e.g., 140 to 180 meters (450-600 ft)] around the pools with at least 50% canopy cover around vernal pools and abundant cover on the forest floor (i.e., leaf litter and coarse woody debris) would protect terrestrial non-breeding habitat for vernal pool–dependent amphibians and invertebrates (Semlitsch 1998, Calhoun and deMaynadier 2004 and 2008, Massachusetts Natural Heritage and Endangered Species Program 2007). This would be especially beneficial around vernal pools that are utilized by vernal pool–obligate species for breeding. Dramatic shifts in forest cover type also may adversely impact forest-dwelling amphibians as they are sensitive to changes in leaf litter composition and chemistry (deMaynadier and Hunter 1995, Waldick et al. 1999). Construction of roads and landings and applications of chemicals (e.g., herbicides and/or pesticides) should be avoided within the 30-meter buffer around a vernal pool, and minimized within the larger buffer (Calhoun and deMaynadier 2008). Maintaining or restoring forest cover, wetland density and diversity, and drainage connections between individual vernal pools and clusters of vernal pools across the landscape would facilitate species dispersal among vernal pools and other wetlands, and likely lead to greater species richness in areas with vernal pool complexes (Calhoun and deMaynadier 2008). Rutting and scarification of the forest floor may create barriers and prevent salamanders from travelling to breeding pools (Means et al. 1996), and should be avoided around vernal pools. For information comparing vernal pools found in Rogue River to those found elsewhere in Michigan, please refer to Appendix 9.

Rare Animal Discussion and Management Recommendations

Birds

Management of Rogue River SGA has maintained large blocks of forest within a landscape consisting of agricultural land, residential development, and small forest fragments. These large blocks of forest are providing valuable nesting habitat for red-shouldered hawk, Louisiana waterthrush, and other Neotropical migrant songbirds. One active red-shouldered hawk nest was documented in the game area. We also observed Louisiana waterthrush, a species known to occur in landscapes dominated by mature deciduous forest, at several locations during point count surveys. Although Michigan represents the northern edge of the breeding range for this rare songbird, Louisiana waterthrush is a regularly occurring breeding species in parts of the southern Lower Peninsula. We documented 70 bird species using forests of the game area (Appendix 6). Recorded bird species included eight MDNR featured species, two SGCN, and three species (veery, wood thrush, and Louisiana waterthrush) identified as focal species in the Landbird Habitat Conservation Strategy (Potter et al. 2007) of the Upper Mississippi River and Great Lakes Region Joint Venture.

We documented an active red-shouldered hawk nest within the game area, so we suggest the *Management Guidance for Woodland Raptors (Specifically Red-Shouldered Hawks and Northern Goshawk) on State Forest Lands* (MDNR 2015; Appendix 10) be followed at the site. According to the guidance, active nests should be buffered by a five-chain radius (8 acres) protection area centered on the

The stick nest of a red-shouldered hawk was documented from Compartment 1; Stand 62. Photo by Michael J. Monfils.

Red-shouldered hawks were observed within the Rogue River Floodplain Forest. Photo by Jesse M. Lincoln.

nest, in which there should be no cutting or new roads constructed. Human disturbance, including loading and skidding, should also be avoided within the protected area (MDNR 2015). A second zone of five chains, or an area with a 10-chain radius centered on the nest, should also be established in which no management activity should occur between February 15th and July 1st. Within this 10-chain zone, at least one-third of residual woody debris should be retained per the Woody Biomass Harvesting Guidance (MDNR 2010). These guidelines should be implemented at active nests until the nest is determined to be inactive by evaluation of local WLD staff. Inactive nests should be protected by a one-chain no harvest buffer; however, if the nest is found to be in disrepair or unoccupied for multiple years, the nest can be classified as unsuitable and no buffer is required (MDNR 2015). If DNR personnel find active or inactive nests, they should relay the information to MNFI so the data can be integrated into the MNFI Biotics database and used in monitoring nests, tracking trends, identifying research opportunities, evaluating management guidelines, and developing habitat suitability indices for red-shouldered hawk and northern goshawk.
The management guidance for woodland raptors (MDNR 2015) also provides general forest management recommendations to maintain habitat for red-shouldered hawk and northern goshawk. For cover types where uneven-aged management techniques are appropriate, encourage large (>300 acre) contiguous blocks of relatively mature hardwood and mixed hardwood-conifer forest with moderate (about 70%) canopy closure and nearby or interspersed wetlands (MDNR 2015). Managers should also apply Within-stand Retention Guidance (MDNR 2012) to identify and retain mature trees for future nests, existing stick nests, snags, and coarse woody debris, and where appropriate, retain a minimum of one large-diameter deciduous tree (other than beech) per five acres (multi-crotched, high-canopy trees preferred). For cover types requiring even-aged stand management techniques, apply Within-stand Retention Guidance (MDNR 2012) to retain patches of several large-diameter deciduous trees (multi-crotched, high canopy trees preferred). To maintain adequate prey base for raptors, the management guidelines suggest following Within-stand Retention Guidance for stand diversity (MDNR 2012). We also recommend conducting periodic surveys for red-shouldered hawk to track its breeding status in the game area and identify active nests and nesting territories, so that appropriate management actions can be implemented.

Forest management at Rogue River SGA should consider the habitat needs of the rare songbird species we observed. We reconfirmed the presence of Louisiana waterthrush within the game area, which was first documented in 2003. Louisiana waterthrush typically uses mature forest adjacent to small (e.g., first-order) fast-flowing streams within large blocks of deciduous forest (Eaton 1958, Dunn and Garrett 1997). Where Louisiana waterthrushes were observed, we recommend managing for mature stands of riparian forest and adjacent upland forest.

The maintenance and expansion of mature forest blocks within the game area would likely benefit Louisiana waterthrush, and other forest-interior species, such as Acadian flycatcher and wood thrush. Activities that reduce the cover of mature forest or increase fragmentation could reduce the value of Rogue River SGA to forest-interior nesting songbirds. Furthermore, we observed brown-headed cowbirds at 28% of the point-count stations surveyed in the game area. Cowbirds thrive in fragmented landscapes and reduce the reproductive success of forest-breeding songbirds through nest parasitism (Robinson et al. 1995). Efforts to reduce forest fragmentation could decrease nest parasitism by brown-headed cowbirds on rare and declining forest songbirds.We recommend conducting songbird point counts periodically to monitor use of the game area by rare species and track overall forest bird assemblages over time. Periodic surveys would allow us to determine if the stands where Louisiana waterthrushes were observed continue to be occupied over time and would provide an opportunity to monitor the effects of management actions on these and other species of management interest. Although we did not detect cerulean warbler or hooded warbler in 2016, suitable nesting habitat was observed and there is potential for these species to occur within the game area. Because rare species often are not detected even when present, additional surveys would help determine if rare songbirds occur at sites where the habitat appeared suitable, but they were not observed.

Reptiles and Amphibians

Amphibian and reptile surveys in the Rogue River SGA in 2016 documented a total of eight different species (Appendix 3). These included one rare and declining species, the Blanding's turtle, and seven common species. Surveys did not document four other listed or rare amphibian and reptile species targeted for surveys in 2016, the eastern massasauga, spotted turtle, wood turtle, and eastern box turtle. Suitable habitats for these species appear to be available in Rogue River SGA. Additional surveys for these species should be conducted in the future to determine if and where they occur within the Rogue River SGA, and to reconfirm the wood turtle EO in the game area.

Surveys in 2016 documented an EO of Blanding's turtles at one location within the Rogue River SGA, which updated an existing EO previously known from the north

of the game area. Potential exists for this species to occur throughout the game area given the extent of available suitable habitat (i.e., vernal pools, other wetlands/ waterbodies, and forests). The Blanding's turtle population in the Rogue River SGA has been ranked as having good to fair estimated viability or probability of persisting into the foreseeable future (i.e., at least 20-30 years, Table 5), if current conditions prevail (Hammerson et al. 2008). This EO viability rank was based on the small number of turtle observations and unknown population size at this time, extensive suitable habitat available within the game area, long-lived nature of this species, presence of roads and other potential threats (e.g., road mortality, nest predation, etc.), and habitat fragmentation in the surrounding landscape due to agricultural development and roads. Additionally, as a state game area, this site has been and will continue to be managed to protect natural and cultural resources. Continued surveys, research, and monitoring are needed to verify the status and viability of the Blanding's turtle population.

Management and protection of the Blanding's turtle and wood turtle populations in the Rogue River SGA are critical given the rare and declining status and vulnerable life histories of these species and the game area's goal of protecting natural and cultural resources. In addition to their state status, the Blanding's turtle and wood turtle have been petitioned for federal listing, and the U.S. Fish and Wildlife Service (USFWS) has determined federal listing may be warranted and is currently assessing the range-wide status of both species (USFWS 2015). The most critical conservation need for the Blanding's turtle is protection and management of landscape complexes of suitable wetland and adjacent upland habitats (Lee 1999a, NatureServe 2017). 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 (i.e., <0.4 ha or 1 ac) within habitat complexes for this species since it frequently uses multiple small wetlands (Joyal et al. 2001). Blanding's turtles also require open and forested upland habitats for locating mates, nesting, basking, aestivating, and dispersing (Rowe and Moll 1991, Harding 1997, Joyal et al. 2001, NatureServe 2017). They prefer to nest in open, sunny areas with moist but well-drained sandy or loamy soil, but also will use lawns, gardens, plowed fields, or road edges for nesting if suitable natural nesting habitat is not available (Harding 1997). Blanding's turtles move frequently and may travel considerable distances over land to locate mates, nest sites, and aestivation sites (Harding 1997, Joyal et al. 2001, NatureServe 2017). Maintaining large and small wetland systems connected to suitable upland habitats is crucial for Blanding's turtles (Harding 1997, Joyal et al. 2001). Maintaining good water quality in wetland habitats also would be beneficial to this species. This can be accomplished by maintaining natural buffers around wetlands, minimizing roads near wetlands, restricting use of pesticides in or near wetlands, and using only herbicides approved for use in open water when working in and adjacent to wetlands.

A wood turtle EO was documented in the Rogue River SGA in 1996 (Red Pine Drive EO, EO ID 6533, Figure 13, MNFI 2017a). Surveys in 2016 did not reconfirm this species in the game area although suitable wetland habitat for this species was found and surveyed, particularly the vernal pools and surrounding forest in Stand 27 in Compartment 1. Wood turtles are associated with clear, medium-sized rivers and streams (ranging in width from 7 to 100 feet) with sand or sand and gravel substrates and moderate flow (Buech and Nelson 1991, Harding 1991). They tend to avoid drainages with clay or muck bottoms and very slow or fast flow. They utilize forested floodplains and non-forested habitats such as willow and alder thickets, sphagnum bogs, swamps, wet meadows, and fields within or near the floodplain (Buech and Nelson 1991, Harding 1997). Though wood turtles in Michigan appear to be fairly aquatic, they are also active on land, moving up to a third of a mile inland (Ewert et al. 1998). A study of wood turtle movement in Michigan by Harding (1991) found all individuals within 500 feet of the river during a 20-year study.

Minimizing mortality or loss of adult and juvenile Blanding's turtles and wood turtles is important for maintaining viable populations of these species. Long-lived vertebrates, such as Blanding's turtles and wood turtles, have life histories that are characterized by delayed sexual maturity, low annual recruitment rates, and high adult survival rates (Congdon et al. 1993 and 1994). Populations of these species require high annual adult and juvenile survivorship (e.g., over 93% adult and over 72% juvenile survivorship for Blanding's turtles) to maintain stable populations due to these life history characteristics (Congdon et al. 1993). Long-term demographic studies of Blanding's turtle and other 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 loss and fragmentation, nest predation, road mortality, and illegal

The Rogue River Floodplain provides potential nesting habitat for wood turtles. Photo by Jesse M. Lincoln.

collection can impact adult and/or juvenile survival and threaten the viability of Blanding's turtle and wood turtle populations. Habitat fragmentation can lead to increased populations of mesopredators, 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 protecting nest sites are potential management strategies that could help increase recruitment. Road mortality can pose a substantial threat to Blanding's turtles and wood turtles. Blanding's turtles are particularly threatened by road mortality because of their 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. These turtle species also are vulnerable to collection for commercial pet trade, personal collection, and/or consumption (e.g., Asian turtle markets) (Harding 1997). These populations may be particularly vulnerable to collection because they are on readily accessible public land. Research and monitoring are needed to determine whether these threats are facing the Blanding's turtle, wood turtle, and other turtle populations in the Rogue River SGA. Additional management and monitoring may be needed to address these threats and monitor the impact and effectiveness of management efforts.

The wood turtle and Blanding's turtle may be vulnerable to certain habitat management activities, such as prescribed burning and mechanical vegetation control or removal. These management practices are important for maintaining and restoring suitable wetland and upland habitats for these and other herptile species. Adjusting the timing and/or manner in which these management practices are conducted can reduce the potential for adversely impacting herptiles. Conducting these management practices in early spring before amphibian and reptile species emerge (e.g., March – early/mid-April), in the fall after species have entered their hibernacula (e.g., mid to late October), or after the species have left a particular area or habitat would minimize the potential for adversely impacting these species. For example, conducting management activities in open upland habitats in early spring (April – early May) or mid to late summer (July – early August) prior to or after the turtle nesting season (primarily late May –June) and before turtle hatchlings emerge (late August – early October) would minimize the potential for harming Blanding's turtles, wood turtles, and other turtles. If prescribed burning needs to occur during the active season, burning later in the spring when turtles are more active may reduce the potential for adversely impacting them. Extending the management interval (e.g., burning every 5 years instead of every 1-2 years), and/or conducting management on only a portion of the available habitat at a site and leaving some refugia also can help reduce adverse impacts to turtle populations. Kingsbury and Gibson (2012) and Mifsud (2014) provide general habitat management guidelines and recommendations for amphibians and reptiles.

Suitable habitat for spotted turtles also appears to be available within Rogue River SGA. Spotted turtles require clean, shallow, slow-moving bodies of water with muddy or mucky bottoms and some aquatic and emergent vegetation. They utilize a variety of shallow wetlands including shallow ponds, wet meadows, swamps, bogs, fens, sedge meadows, wet prairies, shallow cattail marshes, sphagnum seepages, small woodland streams, and roadside ditches (Ernst et al. 1994, Harding 1997). They also utilize terrestrial habitats, particularly during the mating and nesting seasons, including open fields and woodlands (Ward et al. 1976, Lee 2000). Areas with suitable habitat for spotted turtles include the same areas that provide suitable habitat for Blanding's turtles (e.g., Compartment 4; Stands 12, 18, 67, 75, 79 and 87). Although spotted turtles have not been documented in the Rogue River SGA, they have been documented to the south and north of the game area, and potential exists for the species to occur within the game area.

Although eastern massasaugas and eastern box turtles were not observed during surveys in the Rogue River SGA in 2016 and have not been documented near the game area, suitable habitat for both species appears to be available within the game area. As a result, potential exists for both species to occur in the Rogue River SGA. Eastern massasaugas in Michigan utilize a variety of wetland habitats, including bogs, fens, peatlands, shrub carr/thickets, wet meadows, emergent marshes, moist grasslands, wet prairies, floodplain forests, and forested swamps (Reinert and Kodrich 1982, Hallock 1991, Weatherhead and Prior 1992, Johnson 1995, Harding 1997, Johnson et al. 2000, Ernst and Ernst 2003, Harvey and Weatherhead 2006, Marshall et al. 2006, Moore and Gillingham 2006). The eastern box turtle is Michigan's only truly terrestrial turtle. It typically occurs in forested habitats with sandy soils near a source of water such as a stream, pond, lake, marsh or swamp (Tinkle et al. 1979). Box turtles also may be found in adjacent thickets, old fields, pastures, vegetated dunes, marshes, and along the edges of bogs. Access to unshaded nesting sites in sandy, open areas is critical for successful reproduction. Stand 12 around Spring Lake and surrounding upland forests (e.g., Stands 5 and 11) in Compartment 4 appeared to provide suitable habitat for eastern massasaugas and eastern box turtles. The Heiss Forest dry-mesic northern forest EO and surrounding upland forests and wetlands to the north of Spring Lake in Sec. 12 and the upland forest stands that were surveyed in Sec. 24 (i.e., Compartment 4; Stands 57, 63, 74, and 83) also appear to provide suitable habitat for eastern box turtles.

Although breeding frog call surveys were not conducted within Rogue River SGA in 2016, frogs that were seen or heard while conducting visual encounter surveys, basking turtle surveys, and dipnetting surveys were noted. Rogue River SGA is within the range of the Blanchard's cricket frog, but this species was not seen or heard during herptile surveys. Blanchard's cricket frogs inhabit the open edges of permanent ponds, lakes, floodings, bogs, seeps and slow-moving streams and rivers. They prefer open or partially vegetated mud flats, muddy or sandy shorelines, and mats of emergent aquatic vegetation in shallow water (Harding 1997, Lee et al. 2000). Extensive suitable habitat for this species did not appear to be available within the game area, but Spring Lake in Sec. 13 and the wetland/waterbody on private land to the northwest of Spring Lake north of 20 Mile Rd and west of Stands 15 and 25 in Compartment 4 may provide suitable habitat for Blanchard's cricket frog.

Wood turtles can persist with moderate levels of habitat alterations and human disturbance as long as sufficient habitat and natural mortality levels are maintained (Lee 1999b). In some cases, wood turtles can even benefit from human activities (e.g., timber harvesting or other activities that create forest openings or open, sandy areas along rivers). Maintaining good water quality, controlling sedimentation, restricting pesticide use near waterways, implementing minimum development set-back distances, and leaving buffer zones along streams during timber harvest, grazing, and agricultural operations can preserve good wood turtle habitat (Harding 1991). Maintaining stream dynamics that create sand bars, islands, and open sandy banks is crucial for providing suitable nesting habitat (Soule 1992). Maintaining mature floodplains with natural disturbance openings can provide foraging, basking, and/or nesting habitat. Harvesting during the winter would minimize impact on this species (Harding pers. comm.). Predator control may be beneficial at some nesting sites (Soule 1992). Road construction near streams and rivers should be avoided or minimized. Management practices such as sand traps in trout streams and streambank stabilization can eliminate or reduce good wood turtle habitat, and should be avoided (Harding 1991, Soule 1992). Stream channelization and dams also should be avoided. Finally, limiting intense human activity along rivers (e.g., canoe put-ins, campgrounds), particularly at nest sites, is critical for habitat protection.

In addition to rare herptile species, a number of more common species were found in the Rogue River SGA in 2016 (Appendix 3). Two blue racers were found during ecological surveys. One in the Heiss Forest dry-mesic northern forest EO (Compartment 2; Stand 23) and a second in a small hardwood-conifer swamp (Compartment 3, Stand 22). These SCGN likely occur elsewhere within the game area. Additionally, several frog and salamander species were observed during the herptile surveys. Frogs and salamanders are important components of forest and

A particularly alert blue racer was documented in an area of hardwood-conifer swamp (Compartment 3; Stand 22). Photo by Jesse M. Lincoln.

wetland ecosystems. These species can represent significant biomass and important components of food chains (Burton and Likens 1975). Frogs and salamanders also can serve as important bioindicators of ecosystem health because of their amphibious life cycles and permeable skin and eggs. Spotted salamanders, blue-spotted salamanders, and other amphibian species require or prefer vernal pools for breeding, but they only inhabit these pools for a few days to a couple of weeks per year. These species spend the majority of their time in the upland forest or open uplands surrounding the breeding pools, and readily travel about 125 meters (400 ft) or more from the breeding pools (Semlitsch 1998). Spotted and blue-spotted salamanders are considered to be forest management–sensitive species, and require relatively undisturbed upland forests with temporary woodland ponds (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 more likely to occur in breeding ponds that are in more forested landscapes and are within or adjacent to forests. As described earlier, these species also appear to have critical habitat thresholds in which species occupancy or probability of occurrence declines significantly below a certain level of forest cover/forested habitat (Gibbs 1998, Porej et al. 2004, Homan et al. 2004). *Ambystomatid* salamanders, such as the spotted and blue-spotted salamanders, 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, incompatible land use, and acidification of breeding ponds. Management recommendations for these and other amphibians that breed in vernal pools are provided in the vernal pools discussion section. Mifsud (2014) provides additional best forest management practices for protecting pool-breeding amphibians.

Finally, because many herptile species are cryptic and difficult to detect in the field, particularly if they are rare, additional surveys and monitoring are needed to determine the status and distribution of rare herptile species and other SGCN that have been documented or have potential to occur in the Rogue River SGA. In addition to the eastern massasauga, eastern box turtle, spotted turtle, and Blanchard's cricket frog, the gray ratsnake, pickerel frog, queen snake (*Regina septemvittata*, state special concern), smooth greensnake (*Opheodrys vernalis*, state special concern), and mudpuppy (*Necturus maculosus maculosus*, state special concern) have potential for occurring in the Rogue River SGA based on known ranges of these species in the state and available habitat in the game area. The general habitats with which these species are associated are provided in Appendix 3. These species were not specifically targeted during surveys in 2016 because of the cryptic nature of these species and difficulty detecting these species in the field with limited time and resources. Additional surveys of the Rogue River SGA in the future should consider surveying for and compiling reports of these species from external sources and the general public.

Aquatic Species and Habitat

Mussel Element Occurrences and Fish Species

Rare mussels documented within Rogue River SGA included slippershell, rainbow, and ellipse. The occurrences of state threatened slippershell at Sites 7 and 8 in the Rogue River, and Site 11 in Spring Creek are the first documented occurrences in the Rogue River watershed since 1939. Based on historical (pre-1960) occurrence data from the University of Michigan, Museum of Zoology (UMMZ) Mollusk Collection, slippershell was present in 36 of Michigan's 58 major watersheds (8-digit HUC). Slippershell was documented in the Grand River as well as other tributaries in addition to the Rogue River. The state conservation rank of slippershell in Michigan is S2S3, "imperiled/vulnerable" (Badra et al. 2014). Although records for slippershell are fairly widespread in Michigan, most records for this species are of empty shells and/or are historical occurrences. The state conservation rank for rainbow in Michigan is S3, "vulnerable". Based on historical (pre-1960) occurrence data from the UMMZ Mollusk Collection, rainbow was present in 29 of Michigan's 58 major watersheds (8-digit HUC). The ellipse is also considered "vulnerable" (S3) in Michigan. Historically it was documented in just nine of Michigan's 58 major watersheds. The conservation rank of paper pondshell is S2S3, "imperiled/vulnerable". Historically it was known from 11 of Michigan's 58 major watersheds.

Three mussel species not previously documented in the Rogue River watershed were found during this 2016 survey. These are paper pondshell, Wabash pigtoe, and fluted-shell. Two species known from Rogue River SGA historically but not found in this survey are round pigtoe and cylindrical papershell (*Anodontoides ferussacianus*). Round pigtoe was found in 1939 at the most downstream section of the Rogue River SGA near Site 8 (Appendix 8). The source population for individuals that migrated into the lower reaches of the Rogue River likely came from the Grand River. One possible explanation for why it appears to not be present is that a sub-population could have been cut off from its source population in the Grand River by a barrier to fish host movement and was unable to sustain itself.

The fish species observed during aquatic surveys all have a rank of S5 and are considered secure in Michigan. Johnny darter is one of the most common fish in Michigan and is tolerant of a wide range of habitat conditions throughout the state. Mottled sculpin is often associated with coldwater streams, and is relatively common in Michigan except for within the Saginaw River watershed. Blackside darter, a species of small to medium rivers, has a range that extends throughout the Lower Peninsula and central Upper Peninsula (Bailey et al. 2004).

Unionid Mussel/Host Fish Relationship and Implications for Management

Unionid mussels rely on fish hosts to reproduce. Eggs are fertilized within the female in the summer months and develop into larvae, called glochidia. These glochidia are brooded within marsupial gills of female mussels until they are ready to be released. In some species, the glochidia overwinter within the parent mussel (bradytictic), while in other species they are released in the fall (tachytictic). When they are released, glochidia must attach to the gills

Mottled sculpin were documented during the aquatic surveys. This species is a host for the state threatened slippershell. Photo by Peter J. Badra.

or fins of a fish host in order to survive and develop into the adult mussel form. The fish host provides a stable environment for the glochidia to grow. Glochidia do not harm fish hosts. Without the proper species of fish co-occurring with the unionid mussel population, glochidia do not survive and 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.

Some species of unionid mussels have lures that attract fish hosts when glochidia are ready to be released. The lures of species in the *Lampsilis* genus (e.g., fatmucket, *Lampsilis siliquoidea*) resemble minnows, complete with an eye spot and fringes that look like fins. The female mussel extends and moves the lure in an undulating motion. When the potential host fish bites the lure, glochidia are released and have a much better chance of attaching to their fish host. Dr. Chris Barnhart's website at http://unionid.missouristate.edu/ provides video footage of mussel lures in action.

Known hosts for slippershell are mottled sculpin, banded sculpin (*Cottus carolinae*), and Johnny darter, though banded sculpin does not occur in Michigan. Maximum lifespan of slippershell is around 10 years. The slippershell is found almost exclusively in small streams and creeks, and has one of the strongest associations to headwater habitats of any freshwater mussel species. No fish host lure has been documented for slippershell. They are suspected to be bradytictic (Watters et al. 2009).

Rainbow have been found to utilize fifteen different host fish species including the common and widespread mottled sculpin, green sunfish (*Lepomis cyanellus*), bluegill (*Lepomis macrochirus*), and smallmouth bass (*Micropterus dolomieu*). They are most common in creeks and small rivers, occasionally in larger rivers. Female rainbow display one of the most remarkable lures of the unionid mussels. The lure resembles a crayfish with legs, tail, and eyespots, and the mussel can move the lure with very convincing motion (http://unionid.missouristate.edu/gallery/Villosa_iris/villosa_iris_movie.htm). Maximum lifespan is around 15 years, and they are bradyticitc.

Ellipse are known to use 14 fish species as hosts, including Johnny darter, blackside darter, and mottled sculpin. They are most often found in headwater streams and small rivers. Maximum lifespan is around 10 years and they are bradytictic.

Paper pondshell are typically found in soft substrates in lakes, ponds, and impoundments. They are known to utilize a wide range of over 45 host species, including Centrarchids (sunfish and bass), Percidae (darters and perch), Cyprinidae (minnows), and even leopard frog tadpoles. They grow quickly and reach a maximum life span of approximately 5 years (Watters et al. 2009).

The Grand River is the primary pathway for fish and mussel species to colonize habitats and exchange genes among populations in the Rogue River watershed and the rest of the Grand River watershed. The Grand River is the second largest river in Michigan and supports diverse fish and unionid mussel communities. Historically the lower Grand River supported 31 native mussel species, making it the second most species rich river in Michigan behind only the Detroit River (pre-1960 occurrence data from the University of Michigan, Museum of Zoology Mollusk Collection). Twenty-three species have been recorded in recent surveys (1989-2009 occurrence data from the Natural Heritage Database and MNFI surveys) including the federally endangered snuffbox mussel (*Epioblasma triquetra*). Snuffbox is now a Focal SGCN (Derosier et al. 2015). A population of snuffbox is located in the Grand River near the city of Grand Rapids. Two known host fish species for snuffbox, mottled sculpin and blackside darter, were observed in Rogue River SGA during these surveys.

The unionid diversity of the Rogue River is particularly impacted by the dam on the lower section of the Rogue River. Dams restrict fish passage, and since unionid mussels rely on fish hosts for transportation to new locations, dams also in turn restrict the passage of mussels (Watters 1996). The Rockford Dam is located approximately five river miles upstream of the confluence with the Grand River. This dam is a barrier to fish passage in and out of the Rogue watershed, as well as to unionid mussels that utilize fish as hosts. Historically another dam, the Childsdale Dam, was located about two river miles downstream of the Rockford Dam. The Childsdale Dam was built in 1848 by Henry Childsdale and was used to power a sawmill. It was converted into a papermaking facility in 1866 in what was once the town of Childsdale. The dam was eventually destroyed by high-water in 1986 which again allowed the passage of fish and mussels (including non-game and game species) upstream to Rockford (Garret Ellison, MLive, January 2, 2012). The Rogue River has received national attention for its steelhead and trout fishery. As part of the Kent County Brook Trout Project, concrete rubble remaining from the Childsdale Dam was removed in September of 2014 (Schrems West Michigan Trout Unlimited, River Currents, August 4, 2014).

Water Chemistry

Conductivity measures taken at the time of surveys were within normal expected ranges (503-646µS) (Table 10). Conductivity of rivers in the United States ranges between 50 and 1500µS. Streams supporting good fisheries typically measure between 150 and 500µS. 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 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 granite have lower conductivity because granite has an abundance of materials 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.

Alkalinity and hardness measures at all aquatic survey sites were within normal ranges, indicating enough buffering capacity to help protect aquatic life from normal fluctuations in pH (152-236mg/l CaCO3) (Table 10). Site 8, which appears particularly well suited to supporting abundant mussel, snail, and fingernail clam populations had the highest pH (8.41), and second highest water hardness (244) and alkalinity (228). The toxicity of some pollutants can depend in part on alkalinity. For example, the toxicity of copper to fish increases when alkalinity is <50mg/l. Alkalinity is a measure of how much 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 it buffers against rapid changes in pH. Hardness is a similar measure that 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.

Rogue River Watershed Planning

The Rogue River is a relatively high-quality waterway that contributes to maintaining the quality of downstream habitats like the lower Grand River. Due to cumulative downstream effects of non-point source impacts including erosion/siltation, impervious surface, and pollutants, the quality of large river habitats is dependent upon the quality of headwater habitats. Excessive siltation does not appear to be a large problem within the Rogue River SGA. The benefit that Rogue River SGA provides through relatively wide intact riparian buffers, low levels of impervious surface (large amount of natural land cover), and low levels of other non-point and point source impacts extends into the lower Grand River watershed. Rogue River SGA contributes to the habitat quality of the Grand River and the species that system supports, including the state and federally endangered snuffbox mussel.

A nation-wide assessment of threats to imperiled freshwater fauna identified altered sediment loads and nutrient inputs from agricultural nonpoint pollution, non-native species, and altered hydrologic regimes associated with impoundments as the three leading threats (Richter et al. 1997). The river and streams within Rogue River SGA are buffered from agricultural impacts by relatively wide riparian zones of natural vegetation cover. There is opportunity to restore connectivity, fish movement, and hydrologic characteristics of the Rogue River watershed to a more natural state by removing unneeded dams.

The hydrology of the Rogue River watershed is affected by surrounding land use. Less permeable area results in quicker surface runoff after rains, resulting in relatively high increases in volume of stream flow over short periods of time (increased flashiness). Overall, the relatively high proportion of natural land cover in the Rogue River SGA contributes to maintaining natural stream flow regimes. However,

Damage from ATVs was observed along the Rogue River near Site 1. This type of disturbance is detrimental to water quality and degrades important habitat for both unionid mussels and sport fish such as trout. Photo by Peter J. Badra.

erosion of stream banks was noted at several sites, which could be an indicator of flashy hydrology. Channelization of the headwater reaches of the Rogue River north of the State Game Area, in combination with less natural land cover in that area is likely contributing to flashy hydrology within the State Game Area. Maintaining the largest natural vegetated riparian buffers possible and replacing failing culverts may help lessen impacts from erosion and altered hydrology, and reduce sediment and nutrient loads.

A potential management action that could improve the viability of populations of slippershell, ellipse, rainbow, and other mussels, as well as fish species within Rogue River SGA is to improve river connectivity. Removing barriers and improving fish passage with the Rogue River watershed will improve connectivity of mussel populations, allowing for migration to new habitats and transportation of mussels between populations. Gene flow among populations prevents problems from inbreeding and genetic isolation of populations.

Although zebra mussels were not observed at any of the survey sites in this study, this invasive species remains a potential threat to the Rogue River ecosystem. Public outreach and monitoring should be implemented to reduce the chance for introduction and to promote early detection if it does become established. Zebra mussels have had dramatic negative effects on native unionid mussels and aquatic ecosystems 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 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. The risk of introduction can be reduced by promoting the washing and drying of gear before it is used in the watershed. Gear include boats, canoes, kayaks, waders and anything that could transport zebra mussel larvae or adults.

The most likely potential introduction sites for zebra mussels in the Rogue River watershed are boat ramps and launch areas. There are five gravel surfaced ramps in the Rogue River watershed that handle small- to medium-sized trailered boats. Two are located in the headwaters (Ransom Lake and Bills Lake, Newaygo State Park), two are connected to an unnamed tributary (Camp Lake and Lime Lake, Newaygo State Park), and one is located at the mouth of the Rogue River in Plainfield Township.

There are three carry-down launch areas in the watershed suitable for canoes and small car-top boats (City of Rockford, Clear Lake, and Spring Lake). These sites are good targets for education and outreach signage to inform the public how to minimize the risk of introducing zebra mussels to the Rogue River watershed. These boat launch sites should be checked periodically for zebra mussels to ensure early detection of this invasive species.

Site 8 in the Rogue River main stem had a high abundance (30 indvs./m^2) of the banded mysterysnail (*Viviparus georgianus*), a non-native species in Michigan. Banded mysterysnail is native to the Mississippi River drainage and southern U.S., and is thought to have invaded Michigan, Wisconsin, Quebec, and other northern areas sometime since 1867 (Clench and Fuller 1965). Densities have been measured up to 864 indvs./m^2 in Michigan (Pace and Szuch 1985). Impacts of this species have not been well documented, but they have been shown to reduce survival of largemouth bass eggs in experimental settings (Eckblad and Shealy 1972).

The Rogue River is a conservation target for multiple organizations. Trout Unlimited has made the Rogue River watershed one of its Home River Initiatives. This is a multi-year watershed restoration project involving local partners to address issues such as stormwater runoff, expand vegetated stream buffers, and remove barriers to fish movement. Trout Unlimited has identified nine barriers in the watershed as top priorities and is seeking funding to remove them. A Clean Michigan Initiative Plan for the Rogue River was approved by MDEQ in 2000 opening up grant funding opportunities under Section 319 of the EPA Clean Water Act. Partners involved in Rogue River watershed restoration have included Kent County and Newaygo County Road Commissions, Courtland Township, West Michigan Trout Unlimited, Grand Valley State Univ. Annis Water Resources Institute, MDEQ, MDNR, and others. The Rogue River Watershed Management Plan is available at http://www.michigan.gov/documents/deq/wb-nps-rogue-wmp_293406_7.pdf

CONCLUSION

During the Integrated Inventory Project at Rogue River SGA, MNFI scientists documented 13 new element occurrences (EOs) and updated an additional 4 EOs (Tables 2-6). In total, 12 SGCN were documented during the project including 8 rare animal species (Table 12). Surveys for exemplary natural communities resulted in seven new high-quality natural communities and also updated one known high-quality community EO that was subsequently removed from the database. Five different natural community types are represented in the seven element occurrences surveyed including: bog (1 EO), dry-mesic northern forest (1 EO), floodplain forest (1 EO), hardwood-conifer swamp (3 EOs), and southern wet meadow (1 EO) (Table 1). We assessed the current ranking, classification, and delineation of these occurrences and detailed the vegetative structure and composition, ecological boundaries, landscape and abiotic context, threats, management needs, and restoration opportunities. For each natural community EO, a detailed site description, threats assessment, and management discussion is provided. Additionally, the forest EOs of Rogue River SGA that were outlined in this report had particularly high *FQI* scores and possess sufficient conservatism and richness that they are floristically important from a statewide perspective.

Over the course of the project, one rare plant EO, three-ribbed spike-rush (*Eleocharis trichostata*, state threatened), was opportunistically documented. Three-ribbed spike-rush is a coastal plain disjunct and within Rogue River SGA it was collected from a small wetland depression and occurred with other species characteristic of coastal plain marsh. A historic record for orange fringed orchid (*Platanthera ciliaris*, state threatened) was documented locally in the wetlands around Chrishaven Lake but has not been observed since 1941. Potential habitat for this species remains throughout the game area, particularly along the margins of bogs and open wetland complexes.

In 2016, A total of 168 potential vernal pools (PVPs) were identified and mapped in the Rogue River SGA through aerial photograph interpretation, and 17 vernal pools were surveyed and verified in the field. These survey and mapping results provide baseline information on vernal pool status, distribution, and ecology in the game area, which will help natural resource planners and managers develop and implement appropriate management of these wetlands.

Three-ribbed spike-rush was documented for the first time in Kent County from a small coastal plain marsh remnant in Compartment 2; Stand 10. Glossy buckthorn and reed canary grass are invasive species of concern for this system. Photo by Jesse M. Lincoln.

Two rare bird species have been documented in the game area with both being recorded during the 2016 breeding season (Table 4). We updated and existing EO for Louisiana waterthrush and documented a new EO for red-shouldered hawk. Surveys resulted in the documentation of eight species that are considered featured species for habitat management by the Wildlife Division of the MDNR. Additionally, both red-shouldered hawk and Louisiana waterthrush are also considered SGCN (Table 12).

During the course of the project several Blanding's turtles (*Emydoidea blandingii*, state special concern and SGCN) were observed, updating the existing EO for the species (Tables 5 and 12). Additionally, two blue racers were observed during surveys for a total of two SGCN herptiles.

A total of nine unionid mussel species were found including four rare species that are also SGCN (Table 12). The state threatened slippershell (*Alasmidonta viridis*) was documented at two locations, updating an existing EO and establishing a new EO for the species. The special concern ellipse (*Venustaconcha ellipsiformis*) was found at four sites in the main stem of the Rogue River and these observations update and expand an existing EO. New records for rainbow (*Villosa iris*, state special concern) were documented. This represents the first record of the species within Rogue River SGA. The first record for paper pondshell (*Utterbackia imbecillis*, state special concern) in the Rogue River watershed was documented during the surveys (Tables 11 and 12).

Primary management recommendations for the Rogue River SGA include: 1) the promotion of ecosystem integrity of the floodplain complexes along the Rogue River and the tributaries that feed it; 2) the maintenance of the canopy closure of mature upland and lowland forest ecosystems; 3) the reduction of fragmentation and promotion of connectivity across the game area but focused in the vicinity of riparian corridors, wetlands, and high-quality natural communities; 4) the use of landscape-scale prescribed fire focused in high-quality natural communities and with rotating non-fire refugia where fire-sensitive rare species occur; 5) the control of invasive species in high-quality ecosystems; and 6) the careful prioritization of management efforts in the most critical habitats. Monitoring of these management activities is recommended to facilitate adaptive management.

The Rogue River SGA supports over 5,022 acres of forest and over 261 acres of high-quality forest, primarily lowland forest (i.e., hardwood-conifer swamp and floodplain forest). The large area of upland forest and lowland forest within the game area serves as an important island of biodiversity for the local region, which is dominated by agricultural lands and rural development. Maintaining the canopy of mature forest and avoiding additional forest fragmentation 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. Dampening the effects of forest fragmentation within this landscape can be realized by closing redundant forest roads,

Reed canary grass is a particularly pernicious invasive grass that is ubiquitious on the landscape. In response to disturbance, it can form dense mats that prevent other species from establishing. Intensive forestry activities should be avoided in forested wetlands to prevent its spread. Photo by Jesse M. Lincoln.

limiting the creation of new roads, halting the creation of new wildlife openings within forested landscapes, and decreasing forest harvest levels. In addition, conversion of wildlife openings and old agricultural fields to forest and other native habitats can also contribute to the increase of forest and native habitat connectivity and decrease in forest fragmentation. We recommend that efforts to reduce fragmentation be concentrated in the vicinity of riparian corridors, wetlands, and existing high-quality natural communities.

Invasive species pose a major threat to species diversity and habitat heterogeneity within Rogue River SGA. Although 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 include Japanese barberry (*Berberis thunbergii*), autumn olive (*Elaeagnus umbellata*), Morrow honeysuckle (*Lonicera morrowii*), multiflora rose (*Rosa multiflora*), narrow-leaved cat-tail (*Typha angustifolia*), glossy buckthorn (*Frangula alnus*), reed canary grass (*Phalaris arundinacea*), purple loosestrife (*Lythrum salicarea*), and reed (*Phragmites australis*). Invasive species management at Rogue River SGA should focus on controlling populations of pernicious invasive species within high-quality natural communities and also in the surrounding landscape. Managers should bear in mind that invasive plants are much easier to eradicate when they are not yet well established, and their local population size is small. The primary mechanisms for reducing invasive species are targeted spot treatment through cutting and/or herbicide application within priority high-quality natural community EOs and landscape-scale prescribed fire.

Much of the land within Rogue River SGA historically supported fire-dependent forested ecosystems. Fire historically helped to reduce colonization by mesophytic trees and shrubs, fostered regeneration of fire-dependent species, and maintained the open structure of many ecosystems. Due to fire suppression, closed-canopy forests within Rogue River SGA are experiencing strong regeneration of thin-barked, shade-tolerant mesophytic trees and invasive shrubs. Within forested upland ecosystems, a sustained, landscape-scale, fire-management program would reduce the density of shade-tolerant understory and help facilitate increased recruitment of fire-adapted native species.

We recommend the implementation of prescribed fire at a landscape-scale and the creation of large burn units (e.g., several hundred acres or more in size). We recommend that prescribed fire be prioritized for high-quality and/or underrepresented fire-dependent natural communities (e.g., dry-mesic northern forest) and adjacent systems. Where sensitive species are a management concern, burning strategies should include the use of multiple subunits managed on a rotational basis and allow for ample refugia to facilitate effective post-burn recolonization

In general, prioritization of stewardship within Rogue River SGA should focus on the highest quality examples of the rarest natural community types and the largest sites. Biodiversity is most easily and effectively protected by preventing high-quality sites from degrading. Within Rogue River SGA, we recommend the following: 1) that stewardship efforts be focused in natural communities that harbor high levels of biodiversity and provide habitat for numerous rare plant and animal species; 2) that management efforts focus on riparian corridors and forested sites that include vernal pools and other wetland inclusions; and 3) that canopy closure be maintained in the highest-quality and largest forest ecosystems. Critical to any effective management strategy is the adaptive capacity to modify stewardship activities and priorities following monitoring.

Rogue River State Game Area is a relatively small game area but its impact on local biodiversity is quite high due to the extent of development in the region. Photo by Jesse M. Lincoln.

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Appendix 1. Vernal Pool Monitoring Form.

Michigan Natural Features Inventory

MICHIGAN STATE UNIVERSITY EXTENSION

Michigan Vernal Pools Project

Volunteer Vernal Pool Monitoring Form

http://mnfi.anr.msu.edu/vernalpools/ - Contact MNFI at (517) 284-6200

QC Date: _____

QC Initials: _____

Date Entered: _____

1a) Observer Information ☐ Visit 1 ☐ Visit 2 ☐ Visit 3 Time: from _____ ☐AM ☐PM to _____ ☐AM ☐PM

Name(s): _____ Date: _____

1b) Property Information Ownership? ☐ Public ☐ Private Landowner/Manager Name: _____

Site name: _____ Address: _____

Plot # _____ City: _____ State: _____ Zip: _____

2a) Vernal Pool Location Was pool mapped as a Potential Vernal Pool (PVP)? ☐ Yes ☐ No

Pool ID #: _____ New Pool ID #: _____

Township/Range/Section/1/4 info : _____

County: _____

Method for locating pool? ☐ In the Field

☐ GPS ☐ Topo Map ☐ Google Earth ☐ Air Photo

Enter coordinates in Decimal Degrees (e.g. Latitude: 44.764322 Longitude: -72.654222)

Latitude: _____ Longitude: _____

For verification of PVP's location please enter names and coordinates for the nearest crossroads. Record as Decimal Degrees as shown above.

Latitude: _____ Longitude: _____

Crossroad names: _____

2b) Brief Site Directions to Pool **

**** Written site directions to pool** (This should include: (1) description of a logical starting point; (2) the distance from the starting point to pool; (3) the direction of travel; and (4) distinctive landmarks and water bodies.): For example 'Enter Robinhood Park on the trailhead at Jordan Road. Follow the trail west approximately 1/2 mi. This is the first pool on your left, just behind a low stone wall.'

3a) Pool Type Is this a Vernal Pool? ☐ Yes ☐ No ☐ Not Sure Pool Photo Numbers: _____

☐ Open Pool ☐ Sparsely Vegetated Pool ☐ Shrubby Pool

☐ Forested Pool ☐ Marsh Pool ☐ Other (describe): _____

3b) Presence of Inlet or Outlet

Is this pool isolated or connected to a part of another water feature? ☐ culvert ☐ lake ☐ open/emergent/shrubby wetland

☐ Yes, pool is isolated ☐ No, pool is connected to: (check **ALL** that apply) ☐ stream ☐ ditch ☐ forested wetland ☐ vernal pool

If inlet/outlet is present, indicate type: ☐ permanent ☐ temporary ☐ do not know ☐ none

3c) Surrounding Habitat (within 100 feet of pool) (check **ALL** that apply)

☐ Upland Deciduous Forest ☐ Lowland Deciduous Forest

☐ Upland Coniferous Forest ☐ Lowland Coniferous Forest

☐ Upland Mixed Forest ☐ Lowland Mixed Forest

☐ Floodplain ☐ Grassland or open

☐ Emergent Wetland (marsh, bog)

Disturbances:

☐ Agriculture

☐ Road/driveway

☐ paved

☐ dirt/gravel

☐ Powerline right-of-way ☐ Other: _____

☐ Light development (<25%) ☐ No disturbances

☐ Intensive development (>25%)

☐ Minor logging (> or = 70% canopy remaining)

☐ Major logging (< or = 70% canopy remaining)

4a) Approximate Maximum Pool Depth

☐ Ankle-deep (<6") ☐ Hip-deep (2-3 ft)

☐ Shin-deep (6-12") ☐ Chest-deep (3-4 ft)

☐ Knee-deep (12-24") ☐ Deeper than 4 ft

4b) Water Level at Time of Survey (check one)

☐ Full/Nearly full 75-100% ☐ Less than half 25-49%

☐ Partially full 50-74% ☐ Dry/mostly dry 0-24%

4c) Water temperature (*F): _____

4d) Approximate Size of Pool (at maximum capacity - at widest and longest points)

Width: _____ feet

Length: _____ feet

Size determined by: ☐ Pacing ☐ Measuring ☐ Using GPS

4e) Substrate (when dry - check **ALL** that apply)

☐ Leaf litter ☐ Sand - Gravel ☐ Unknown

☐ Bedrock ☐ Muck - Peat ☐ Other: _____

☐ Loam ☐ Silt - Clay

Funding for this project was provided by the US Environmental Protection Agency along with the Michigan Department of Environmental Quality

Appendix 1 (continued). Vernal Pool Monitoring Form.

4f) Vegetation in Pool

Are trees (trees = or > 4" in diameter) present in the basin? (check one)

☐ No ☐ Yes, within pool basin ☐ Yes, but only at the edge

# of trees only within the pool basin? _____ ☐ live and/or ☐ dead/snags

% Cover within the pool (check one):

Floating vegetation: ☐ 0% ☐ 1 to 9% ☐ 10 to 25% ☐ 26 to 50% ☐ >50%

Emergent vegetation: ☐ 0% ☐ 1 to 9% ☐ 10 to 25% ☐ 26 to 50% ☐ >50%

Shrubs: ☐ 0% ☐ 1 to 9% ☐ 10 to 25% ☐ 26 to 50% ☐ >50%

Tree canopy over pool basin (when leaves are fully out): ☐ 0% ☐ 1 to 9% ☐ 10 to 25% ☐ 26 to 50% ☐ >50%

4h) Cover (Any material in the pool that can provide egg attachment sites and offer concealment to adults and/or larvae; check all that apply):

☐ Shrubs ☐ Submergent vegetation

☐ Branches, twigs ☐ Logs or large woody debris

☐ Sphagnum moss ☐ Emergent vegetation (grasses, cattails)

☐ Algae ☐ Other: _____

☐ Leaf litter

4g) Pool Disturbance (in pool, immediately adjacent or along shore of pool - check all that apply)

☐ Dumping - Refuse ☐ Filling ☐ Invasive Species Present

☐ Ditching - Draining ☐ Sediment ☐ Purple loosestrife ☐ Garlic mustard

☐ Agricultural runoff ☐ Vehicle ruts ☐ Reed canary grass ☐ Other: _____

☐ Cultivation - Livestock ☐ Presence of rock pile or other anthropogenic disturbance ☐ No disturbances

5) Indicator Species and Additional Species (if other species are observed please list below in blank fields under Fingernail Clams)

Provide a photograph of each indicator species (adults, juveniles/larvae, or egg masses) observed. **Photos of species observed are required.**

Species Observed	Adults	Tadpoles/Larvae	Egg Masses			Photo? Yes	Notes/Photo ID#
			Number	Estimated	Counted		
Wood Frog				☐	☐	☐	
Spotted Salamander				☐	☐	☐	
Blue-spotted Salamander				☐	☐	☐	
Fairy Shrimp							
Fingernail Clams							
				☐	☐	☐	
				☐	☐	☐	
				☐	☐	☐	
				☐	☐	☐	
				☐	☐	☐	
				☐	☐	☐	
				☐	☐	☐	

Were any of the following observed? (check **ALL** that apply)

☐ Fish: (indicate all lengths observed) ☐ ≤ 3" ☐ > 3" ☐ Green frogs: ☐ tadpoles ☐ adults

☐ Bullfrogs: ☐ tadpoles ☐ adults ☐ Other: _____

Comments:

Draw diagram of pool (include landmarks, location of indicated species, north arrow and area surveyed if entire pool was not surveyed)**:**

Funding for this project was provided by the US Environmental Protection Agency along with the Michigan Department of Environmental Quality

Appendix 2. Vernal Pool Types.

1) **Open Pool** – "Classic" vernal pool with trees, shrubs, and herbaceous (non-woody) plants covering less than 10% of the ground within the pool when the pool is flooded or wet. Herbaceous plants are plants whose stems and leaves die at the end of the growing season and have no woody stems above ground.


2) **Sparsely Vegetated Pool** – Trees, shrubs, and non-woody herbaceous plants covering 10% to less than 30% of the ground within the pool when the pool is flooded or wet.


3) **Shrubby Pool** – Pool is dominated by shrubs, with shrubs covering 30% or more of the ground within the pool when it is flooded or wet, and representing the tallest vegetation layer within the pool.


Appendix 2 (continued). Vernal Pool Types.

4) **Forested Pool** – Pool is dominated by trees with rooted, live trees covering 30% or more of the ground within the pool when it is flooded or wet, and representing the tallest vegetation layer within the pool. For example, a forested swamp pool, pool within a larger forested swamp, and a floodplain pool.

Floodplain

5) **Marsh Pool** – Pool dominated by non-woody herbaceous plants, including emergent plants which are plants that grow in water and stick up out of the water. Non-woody herbaceous and emergent plants cover 30% or more of the ground within the pool when it is flooded or wet, and represent the uppermost vegetation layer within the pool. Trees and shrubs may be present but cover less than 30% of the pool.

Appendix 3. List of amphibian and reptile species known to occur or with potential to occur in Rogue River State Game Area. Each species' status at federal and state levels and within the game area is provided along with general habitat associations. State status abbreviation of "T" signifies state threatened and "SC" signifies state special concern. Federal status abbreviation of "LT" signifies federally threatened. An asterisk (*) indicates rare species not targeted for surveys in 2016 due to low likelihood or probability of detecting the species given available methods and resources for surveys. Two asterisks (**) indicates that the species was a SGCN prior to 2015 but was removed as a SGCN by the Michigan DNR in 2015.

Amphibian/ Reptile	Common Name[1,3]	Scientific Name[1]	US Status	State Status	WAP SGCN[2]	Rare Species Targeted for 2016 Surveys	Species Found During 2016 Surveys	Species Found Prior to 2016	General Habitats[3,4]
Amphibian	Eastern Newt	*Notophthalmus viridescens*							Small, permanent ponds, temporary ponds, and shallows of large lakes, river sloughs and backwaters with abundant aquatic vegetation
Amphibian	Blue-spotted Salamander**	*Ambystoma laterale*					X		Deciduous and coniferous forests from moist bottomlands to dry uplands; ponds that retain water into midsummer
Amphibian	Spotted Salamander**	*Ambystoma maculatum*							Moist closed-canopy deciduous or mixed forests, temporary/semi-permanent ponds within or adjacent to woods. Avoid cutover forests and those subject to flooding.
Amphibian	Eastern Tiger Salamander**	*Ambystoma tigrinum*							Forests, marshes, and grasslands; breeding - permanent and semi-permanent ponds
Amphibian	Eastern Red-backed Salamander	*Plethodon cinereus*							Deciduous, coniferous, and mixed forests
Amphibian	Four-toed Salamander**	*Hemidactylium scutatum*							Moist deciduous, coniferous, or mixed forests, usually in vicinity of spring-fed creeks, sphagnum seepages, bogs, or boggy ponds
Amphibian	Mudpuppy*	*Necturus maculosus maculosus*		SC	X				Permanent waters, including rivers, reservoirs, inland lakes, and Great Lakes bays and shallows
Amphibian	Eastern American Toad	*Anaxyrus [Bufo] americanus americanus*							Open forests, forest edges, prairies, marshes, and meadows
Amphibian	Fowler's Toad*	*Anaxyrus [Bufo] fowleri*		SC	X				Open woods and fields, particularly those with sandy soils, prairies, savannas, and forests in sand dunes.
Amphibian	Blanchard's Cricket Frog	*Acris blanchardi*		T	X	X			Open, muddy edges of permanent ponds, lakes, bogs, and slow-moving streams or rivers with abundant aquatic vegetation, including fens and wet or sedge meadows
Amphibian	Spring Peeper	*Pseudacris crucifer*					X		Temporary and permanent ponds, marshes, floodings, and ditches, as well as forests, old fields, shrubby areas
Amphibian	Western Chorus Frog**	*Pseudacris triseriata*					X		Marshes, wet meadows, swales, and other open habitats, also mesic forests and swamp forests
Amphibian	Gray Treefrog	*Hyla versicolor / Hyla chrysoscelis*							Temporary ponds, swamps, floodings, shallow edges of permanent lakes, and sloughs, surrounded by forested or open habitats
Amphibian	American Bullfrog	*Lithobates [Rana] catesbeianus*							Permanent waterbodies - river backwaters, sloughs, lakes, farm ponds, impoundments, marshes, shallow Great Lakes bays; abundant emergent and submergent vegetation
Amphibian	Green Frog	*Lithobates [Rana] clamitans*					X		Ponds, lakes, swamps, sloughs, impoundments, and slow streams
Amphibian	Pickerel Frog	*Lithobates [Rana] palustris*		SC	X	X			Bogs, fens, ponds, streams, springs, sloughs, and lake coves; cool clear waters, grassy stream banks
Amphibian	Northern Leopard Frog**	*Lithobates [Rana] pipiens*					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
Amphibian	Wood Frog	*Lithobates [Rana] sylvaticus*					X		Moist, forested habitats (deciduous, coniferous, and mixed); breeding - vernal ponds, floodings, forested swamps, and quiet stream backwaters
Reptile	Snapping Turtle	*Chelydra serpentina*							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	*Sternotherus odoratus*			X	X			Permanent waterbodies - ponds, lakes, marshes, sloughs, rivers; highly aquatic
Reptile	Spotted Turtle	*Clemmys guttata*		T	X	X			Shallow ponds, wet meadows, tamarack swamps, bogs, fens, marshes, sphagnum seepages, slow streams; require clear shallow water with mud/muck bottom and ample aquatic and emergent vegetation
Reptile	Wood Turtle	*Glyptemys insculpta*		SC	X	X		X	Sandy-bottomed streams or rivers and adjacent upland and lowland forests, alder shrub thickets, wet meadows, vernal pools, and old fields within or near the floodplain.
Reptile	Eastern Box Turtle	*Terrapene carolina carolina*		SC	X	X			Deciduous or mixed forests, especially with sandy soils, also adjacent old fields, pastures, dunes, marshes, and bog edges

Listed/rare amphibian and reptile species and/or SGCN targeted for surveys and documented in Rogue River SGA in 2016.

Additional listed/rare amphibian and reptile species and/or SGCN that were not documented in Rogue River SGA during MNFI surveys in 2016 but have been documented prior to 2016.

Additional amphibian and reptile species that have been documented in Rogue River SGA during MNFI or other surveys in 2016 and/or prior to 2016.

Sources:

[1]Crother, B.I. (ed.). 2012. Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico, With Comments Regarding Confidence In Our Understa

[2]Derosier, A.L., S.K. Hanshue, K.E. Wehrly, J.K. Farkas, and M.J. Nichols. 2015. Michigan's Wildlife Action Plan. Michigan Department of Natural Resources, Lansing, MI. http://www.

[3]Harding, J.H. 1997. Amphibians and Reptiles of the Great Lakes Region. The University of Michigan Press, Ann Arbor, MI. 378 pp

[4]Harding, J.H., and J.A. Holman. 1992. Michigan Frogs, Toads, and Salamanders. Michigan State University, Cooperative Extension Service, East Lansing, MI. 144 pp

Appendix 3 (continued). List of amphibian and reptile species known to occur or with potential to occur in Rogue River State Game Area. Each species' status at federal and state levels and within the game area is provided along with general habitat associations. State status abbreviation of "T" signifies state threatened and "SC" signifies state special concern. Federal status abbreviation of "LT" signifies federally threatened. An asterisk (*) indicates rare species not targeted for surveys in 2016 due to low likelihood or probability of detecting the species given available methods and resources for surveys. Two asterisks (**) indicates that the species was a SGCN prior to 2015 but was removed as a SGCN by the Michigan DNR in 2015.

Amphibian/ Reptile	Common Name[1,3]	Scientific Name[1]	US Status	State Status	WAP SGCN[2]	Rare Species Targeted for 2016 Surveys	Species Found During 2016 Surveys	Species Found Prior to 2016	General Habitats[3,4]
Reptile	Blanding's Turtle	*Emydoidea blandingii*		SC	X	X	X		Shallow, weedy waters - ponds, marshes, forested and shrub swamps, wet meadows, lake inlets and coves, rivers backwaters, embayments, sloughs, vernal pools
Reptile	Northern Map Turtle	*Graptemys geographica*							Larger lakes, rivers, reservoirs, oxbow sloughs, open marshes, Great Lakes bays and inlets; also smaller lakes and streams and ponds
Reptile	Painted Turtle	*Chrysemys picta*							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	*Apalone spinifera spinifera*							Rivers and larger streams, inland lakes, reservoirs, protected bays and river mouths; can tolerate fairly swift currents; prefer sandy or muddy substrates and open habitats with little aquatic vegetation; rarely leave vicinity of water
Reptile	Common Five-lined Skink	*Plestiodon [Eumeces] fasciatus*							Moist but not wet, forested or partially forested habitats with ample cover and basking sites - stumps, logs, rock outcrops, wood or brush piles, sawdust piles, fallen bark; moist not wet habitats
Reptile	Northern Watersnake	*Nerodia sipedon sipedon*							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*	*Regina septemvittata*		SC	X				Warm, shallow, rocky-bottomed streams with abundance of crayfish; also edges of ponds, lakes, marshes, ditches and canals, open to mostly forested but totally shaded sites are avoided; often bask at water's edge or in overhanging shrubbery or tree branches.
Reptile	Dekay's Brownsnake	*Storeria dekayi*							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
Reptile	Northern Red-bellied Snake	*Storeria occipitomaculata occipitomaculata*							Deciduous or mixed forests, and adjacent fields, pastures, road embankments, marshes and sphagnum bogs
Reptile	Eastern Gartersnake	*Thamnophis sirtalis sirtalis*							Almost any natural habitats - open and forested habitats and moist grassy places - edges of ponds, lakes, streams ditches,
Reptile	Northern Ribbonsnake	*Thamnophis sauritus septentrionalis*			X	X			Edges of lakes, ponds, streams, marshes, especially with grasses, sedges and low shrubs, open sunny areas/habitats
Reptile	Northern Ring-necked Snake	*Diadophis punctatus edwardsii*			X	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**	*Heterodon platirhinos*							All types of terrestrial habitats - from open pine or deciduous forests to old fields, meadows, and pastures. Prefer sandy, well-drained soils.
Reptile	Blue Racer	*Coluber constrictor foxii*			X	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 Ratsnake	*Pantherophis spiloides*		SC	X	X			In or near forests, and adjacent open habitats - shrubby fields, pastures, marsh and bog edges
Reptile	Eastern Milksnake	*Lampropeltis triangulum triangulum*							Open forests, bogs, swamps, forest edges, marshes, lakeshores, old fields, and pastures
Reptile	Smooth Greensnake	*Opheodrys vernalis*		SC	X	X			Moist grassy places including prairie remnants and savannas, meadows, old fields, pastures, roadsides, marsh and lake edges, also open deciduous and pine forests
Reptile	Eastern Massasauga	*Sistrurus catenatus*	LT	SC	X	X			Open and forested wetlands including shrub swamps, bogs, fens, marshes, wet or sedge meadows, moist prairie, and forested swamps, and adjacent open and forested upland habitats including prairies, old fields, meadows, shrub thickets, and deciduous, coniferous, and mixed forests.

Listed/rare amphibian and reptile species and/or SGCN targeted for surveys and documented in Rogue River SGA in 2016.
Additional listed/rare amphibian and reptile species and/or SGCN that were not documented in Rogue River SGA during MNFI surveys in 2016 but have been documented prior to 2016.
Additional amphibian and reptile species that have been documented in Rogue River SGA during MNFI or other surveys in 2016 and/or prior to 2016.

Sources:

[1]Crother, B.I. (ed.). 2012. Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico, With Comments Regarding Confidence In Our Understa
[2]Derosier, A.L., S.K. Hanshue, K.E. Wehrly, J.K. Farkas, and M.J. Nichols. 2015. Michigan's Wildlife Action Plan. Michigan Department of Natural Resources, Lansing, MI. http://www.1
[3]Harding, J.H. 1997. Amphibians and Reptiles of the Great Lakes Region. The University of Michigan Press, Ann Arbor, MI. 378 pp
[4]Harding, J.H., and J.A. Holman. 1992. Michigan Frogs, Toads, and Salamanders. Michigan State University, Cooperative Extension Service, East Lansing, MI. 144 pp

Appendix 4. Rare Herptile Survey Form.

STATE LANDS INVENTORY SPECIAL ANIMAL SURVEY FORM - HERPS

I. LOCATION INFORMATION

Site Name _____ Stand Number(s)_____ Date_____

Observer(s)_____ Stand classifications_____

Quad_____County_____ Town, Range, Sec_____

Directions/access _____

_____

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

II. SURVEY INFORMATION

Time Start _____ Time End _____ Weather: Air Temp – Start_____End _____ RH – Start_____ End_____

Sky Code – Start _____ End _____ Wind Code - Start _____ End _____ Precip Code - Start_____ End _____

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 _____

_____

01/05/2016

Appendix 4 (continued). Rare Herptile Survey Form.

V. LISTED ANIMAL OR PLANT SPECIES or COMMUNITY EOS _____

_____

_____

VI. ADDITIONAL ASSOCIATED SPECIES FOUND

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

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

Wind Codes (Beaufort wind scale):

0 = Calm (< 1 mph) smoke rises vertically

1 = Light air (1-3 mph) smoke drifts, weather vane inactive

2 = Light breeze (4-7 mph) leaves rustle, can feel wind on face

3 = Gentle breeze (8-12 mph) leaves and twigs move, small flag extends

4 = Moderate breeze (13-18 mph) moves small tree branches, twigs & leaves, raises loose paper

5 = Strong breeze (19-24 mph) small trees sway, branches move, dust blows

6 = Windy (> 24 mph) larger tree branches move, whistling

Precipitation Codes:

0 = None

1 = Mist

2 = Light rain or drizzle

3 = Heavy rain

4 = Snow/hail

Sky Codes:

0 = Sunny/clear to few clouds (0-5%)

1 = Mostly sunny (5-25% cloud cover)

2 = Partly cloudy, mixed variable sky (25-50%)

3 = Mostly cloudy (50-75%)

4 = Overcast (75-100%)

5 = Fog or haze

Global and State Element Ranking Criteria

GLOBAL RANKS

G1 = critically imperiled: at very high risk of extinction due to extreme rarity (often 5 or fewer occurrences), very steep declines, or other factors.

G2 = imperiled: at high risk of extinction due to very restricted range, very few occurrences (often 20 or fewer), steep declines, or other factors.

G3 = vulnerable: at moderate risk of extinction due to a restricted range, relatively few occurrences (often 80 or fewer), recent and widespread declines, or other factors.

G4 = apparently secure: uncommon but not rare; some cause for long-term concern due to declines or other factors.

G5 = secure: common; widespread.

GU = currently unrankable due to lack of information or due to substantially conflicting information about status or trends.

GX = eliminated: eliminated throughout its range, with no restoration potential due to extinction of dominant or characteristic species.

G? = incomplete data.

STATE RANKS

S1 = critically imperiled in the state because of extreme rarity (often 5 or fewer occurrences) or because of some factor(s) such as very steep declines making it especially vulnerable to extirpation from the state.

S2 = imperiled in the state because of rarity due to very restricted range, very few occurrences (often 20 or fewer), steep declines, or other factors making it very vulnerable to extirpation from the state.

S3 = vulnerable in the state due to a restricted range, relatively few occurrences (often 80 or fewer), recent and widespread declines, or other factors making it vulnerable to extirpation.

S4 = uncommon but not rare; some cause for long-term concern due to declines or other factors.

S5 = common and widespread in the state.

SX = community is presumed to be extirpated from the state. Not located despite intensive searches of historical sites and other appropriate habitat, and virtually no likelihood that it will be rediscovered.

S? = incomplete data.

Appendix 6. List of bird species detected during 123 point counts conducted in forested areas of Rogue River State Game Area during 2016. State status (T = threatened, SC = special concern) and the proportion of points having detections are provided for each species. Bird species considered as Michigan Department of Natural Resources featured species, species of greatest conservation need (SGCN), and focal species of the Upper Mississippi River and Great Lakes Region Joint Venture (JV) are indicated with an "X."

Common Name	Scientific Name	State Status[1]	Featured Species[2]	SGCN[3]	JV Focal Species[4]	Prop. of Points
Acadian flycatcher	*Empidonax virescens*					0.43
Alder flycatcher	*Empidonax alnorum*					0.02
American crow	*Corvus brachyrhynchos*					0.59
American goldfinch	*Spinus tristis*					0.11
American redstart	*Setophaga ruticilla*					0.13
American robin	*Turdus migratorius*					0.23
Baltimore oriole	*Icterus galbula*					0.03
Barred owl	*Strix varia*					0.02
Black-and-white warbler	*Mniotilta varia*					0.02
Black-billed cuckoo	*Coccyzus erythropthalmus*					0.07
Black-capped chickadee	*Poecile atricapillus*					0.59
Black-throated green warbler	*Setophaga virens*					0.08
Blue jay	*Cyanocitta cristata*					0.36
Blue-gray gnatcatcher	*Polioptila caerulea*					0.29
Blue-headed vireo	*Vireo solitarius*					0.01
Brown creeper	*Certhia americana*					0.10
Brown thrasher	*Toxostoma rufum*					0.01
Brown-headed cowbird	*Molothrus ater*					0.28
Canada goose	*Branta canadensis*					0.02
Cedar waxwing	*Bombycilla cedrorum*					0.15
Chestnut-sided warbler	*Setophaga pensylvanica*					0.01
Chipping sparrow	*Spizella passerina*					0.09
Common grackle	*Quiscalus quiscula*					0.08
Common yellowthroat	*Geothlypis trichas*					0.35
Downy woodpecker	*Picoides pubescens*					0.19
Eastern bluebird	*Sialia sialis*		X			0.03
Eastern kingbird	*Tyrannus tyrannus*					0.02
Eastern phoebe	*Sayornis phoebe*					0.01
Eastern towhee	*Pipilo erythrophthalmus*					0.03
Eastern wood-pewee	*Contopus virens*					0.70
Field sparrow	*Spizella pusilla*					0.03
Gray catbird	*Dumetella carolinensis*					0.03
Great crested flycatcher	*Myiarchus crinitus*					0.51
Hairy woodpecker	*Picoides villosus*					0.11
House wren	*Troglodytes aedon*					0.02
Indigo bunting	*Passerina cyanea*					0.11
Least flycatcher	*Empidonax minimus*					0.03
Louisiana waterthrush	*Parkesia motacilla*	T		X	X	0.07
Mallard	*Anas platyrhynchos*		X			0.02
Mourning dove	*Zenaida macroura*					0.11
Northern cardinal	*Cardinalis cardinalis*					0.42
Northern flicker	*Colaptes auratus*					0.07
Northern waterthrush	*Parkesia noveboracensis*					0.01
Ovenbird	*Seiurus aurocapilla*					0.85

Appendix 6 (continued). List of bird species detected during 123 point counts conducted in forested areas of Rogue River State Game Area during 2016. State status (T = threatened, SC = special concern) and the proportion of points having detections are provided for each species. Bird species considered as Michigan Department of Natural Resources featured species, species of greatest conservation need (SGCN), and focal species of the Upper Mississippi River and Great Lakes Region Joint Venture (JV) are indicated with an "X."

Common Name	Scientific Name	State Status[1]	Featured Species[2]	SGCN[3]	JV Focal Species[4]	Prop. of Points
Philadelphia vireo	*Vireo philadelphicus*					0.02
Pileated woodpecker	*Dryocopus pileatus*		X			0.21
Pine warbler	*Setophaga pinus*					0.03
Rose-breasted grosbeak	*Pheucticus ludovicianus*					0.29
Red-bellied woodpecker	*Melanerpes carolinus*					0.42
Red-eyed vireo	*Vireo olivaceus*					0.87
Red-shouldered hawk	*Buteo lineatus*	T	X	X		0.07
Red-tailed hawk	*Buteo jamaicensis*					0.02
Red-winged blackbird	*Agelaius phoeniceus*					0.12
Ruby-throated hummingbird	*Archilochus colubris*					0.04
Ruffed grouse	*Bonasa umbellus*		X			0.01
Savannah sparrow	*Passerculus sandwichensis*					0.01
Scarlet tanager	*Piranga olivacea*					0.46
Sharp-shinned hawk	*Accipiter striatus*					0.01
Song sparrow	*Melospiza melodia*					0.16
Swamp sparrow	*Melospiza georgiana*					0.02
Tree swallow	*Tachycineta bicolor*					0.02
Tufted titmouse	*Baeolophus bicolor*					0.53
Veery	*Catharus fuscescens*				X	0.47
White-breasted nuthatch	*Sitta carolinensis*					0.29
Wild turkey	*Meleagris gallopavo*		X			0.03
Wood duck	*Aix sponsa*		X			0.04
Wood thrush	*Hylocichla mustelina*		X	X	X	0.33
Yellow warbler	*Setophaga petechia*					0.07
Yellow-billed cuckoo	*Coccyzus americanus*					0.17
Yellow-throated vireo	*Vireo flavifrons*					0.22

[1]Michigan listing status (T = state threatened).
[2]Identified as featured species for habitat management by MDNR Wildlife Division.
[3]Species of greatest conservation need in the Michigan Wildlife Action Plan (Derosier et al. 2015).
[4]Focal species in the Upper Mississippi River and Great Lakes Region Joint Venture Landbird Habitat Conservation Strategy (Potter et al. 2007).

Appendix 7. List of bird species having special status that were detected at Rogue River State Game Area during 2016 surveys and general habitat requirements.

Species	General Habitat Requirements	State Status[1]	Featured Species[2]	WAP SGCN[3]	JV Focal Species[4]
Eastern bluebird	Open oak and pine woodlands, residential and roadside hedges, old fields, pastures, and hayfields.		X		
Louisiana waterthrush	Large blocks of mature deciduous forest with moderate to sparse understory occurring adjacent to fast-flowing streams.	T		X	X
Mallard	Shallow marshes and ponds, lakes, rivers, and streams. Nests in grasslands, wetlands, hayfields, and shrublands.		X		
Pileated woodpecker	Mature mesic deciduous, lowland, and mixed hardwood-conifer forests with dead or dying trees.		X		
Red-shouldered hawk	Mature swamp and upland forest, interspersed with marshy openings, oxbows, bayous, and grasslands.	T	X	X	
Ruffed grouse	Mixed-aged stands of deciduous and mixed forest, especially early successional aspen.		X		
Veery	Large tracts of moist forest, with dense understory of deciduous trees/shrubs				X
Wild turkey	Variety of forest types that provide mast-producing trees, herbaceous openings, and protection from disturbance.		X		
Wood thrush	Large tracts of wet and mesic deciduous forest and sometimes dry forest.		X	X	X
Wood duck	Variety of swamps, marshes, streams, beaver ponds, and lakes. Nests in tree cavities of mature forests near wetlands or water bodies.		X		

[1]Michigan listing status (T = state threatened).
[2]Identified as featured species for habitat management by MDNR Wildlife Division.
[3]Species of greatest conservation need in the Michigan Wildlife Action Plan (Derosier et al. 2015).
[4]Focal species in the Upper Mississippi River and Great Lakes Region Joint Venture Landbird Habitat Conservation Strategy (Potter et al. 2007).

Appendix 8. A checklist of Michigan's unionid mussel species found at sites surveyed in Rogue River State Game Area in 2016. "S" denotes that surveys found shells of dead mussels and "L" denotes that surveys found living mussels. In addition, species with historical (pre-1960) records from the Rogue River Watershed are indicated with an "X". Historical records are from the University of Michigan Museum of Zoology Mollusk Collection. State and federal status abbreviations are as follows: E, state or federally endangered; T, state threatened; and SC, state special concern.

		Historical records in Rogue River Watershed	Rogue River SGA 2016	State status	Federal status
Actinonaias ligamentina	Mucket				
Alasmidonta marginata	Elktoe			SC	
Alasmidonta viridis	Slippershell	X*	L	T	
Amblema plicata	Threeridge				
Anodontoides ferussacianus	Cylindrical papershell	X*			
Cyclonaias tuberculata	Purple wartyback			T	
Elliptio complanata	Eastern elliptio				
Elliptio crassidens	Elephant-ear				
Elliptio dilatata	Spike	X*	L		
Epioblasma obliquata perobliqua	White catspaw			E	E
Epioblasma torulosa rangiana	Northern riffleshell			E	E
Epioblasma triquetra	Snuffbox			E	E
Fusconaia flava	Wabash pigtoe		L		
Lampsilis fasciola	Wavy-rayed lampmussel			T	
Lampsilis siliquoidea	Fatmucket	X (Bills Lake)	L		
Lampsilis ventricosa	Pocketbook				
Lasmigona complanata	White heelsplitter				
Lasmigona compressa	Creek heelsplitter	X			
Lasmigona costata	Fluted-shell		L		
Leptodea fragilis	Fragile papershell				
Leptodea leptodon	Scaleshell			SC	E
Ligumia nasuta	Eastern pondmussel			E	
Ligumia recta	Black sandshell			E	
Obliquaria reflexa	Three-horned wartyback			E	
Obovaria olivaria	Hickorynut			E	
Obovaria subrotunda	Round hickorynut			E	
Pleurobema clava	Clubshell			E	E
Pleurobema sintoxia	Round pigtoe	X*		SC	
Potamilus alatus	Pink heelsplitter				
Potamilus ohiensis	Pink papershell			T	
Ptychobranchus fasciolaris	Kidney-shell			SC	
Pyganodon grandis	Giant floater	X (Sand Lake)			
Pyganodon lacustris	Lake floater			SC	
Pyganodon subgibbosa	Lake floater			T	
Quadrula pustulosa	Pimpleback				
Quadrula quadrula	Mapleleaf				
Simpsonaias ambigua	Salamander mussel			E	
Strophitus undulatus	Strange floater	X (Bills Lake)	L		
Toxolasma lividus	Purple lilliput			E	
Toxolasma parvum	Lilliput			E	
Truncilla donaciformis	Fawnsfoot			T	
Truncilla truncata	Deertoe			SC	
Utterbackia imbecillis	Paper pondshell		S	SC	
Venustaconcha ellipsiformis	Ellipse	X*	L	SC	
Villosa fabalis	Rayed bean			E	E
Villosa iris	Rainbow	X	L	SC	

* Historical records within Rogue River SGA

Appendix 9. Comparison of vernal pool survey results from Rogue River to survey results from elsewhere in Michigan.

The physical and landscape characteristics of the vernal pools verified in the Rogue River SGA in 2016 were similar to those of vernal pools found in other parts of Michigan and other states in the glaciated Northeast. For example, 47% of the vernal pools verified in the Rogue River SGA were classified as open or sparsely vegetated vernal pools with little to no vegetation growing in the pools, and 41% were classified as forested vernal pools. MNFI's previous vernal pool mapping efforts and other studies in the northeastern U.S. also reported open/sparsely vegetated and forested vernal pools being more common than marshy or shrubby vernal pools (Colburn 2004, Lee 2014). Lee (2014) reported about half of the vernal pools verified in the project's study area in the western Upper Peninsula (U.P.) of Michigan in 2014 were open or sparsely vegetated pools, and about one-third of the pools were forested pools. Cohen et al. (2015a, 2015b, 2016) reported that 79%, 70%, and 69% of the verified vernal pools in the Middleville SGA, Lost Nation SGA, and Flat River SGA, respectively, were classified as open or sparsely vegetated pools. The percentage of open/sparsely vegetated vernal pools found in the Rogue River SGA in 2016 was similar to those reported by Lee (2014) for the western U.P. but lower than the percentages found in Middleville, Lost Nation, and Flat River SGAs during MNFI's surveys in 2014 and 2015. The percentage of forested vernal pools found in the Rogue River SGA in 2016 was slightly higher than the percentages of forested vernal pools found in the western U.P. (~33%) in 2014 (Lee 2014) and in the Flat River SGA (23%) in 2015 (Cohen et al. 2016). However, the sample size of vernal pools that were surveyed in Rogue River SGA in 2016 was fairly small. Additional pools should be surveyed and classified to confirm these results.

Additionally, one of the key characteristics for identifying vernal pools is that they are generally isolated basins or depressions, and have no continuous surface-water connections to permanently flooded water bodies (Colburn 2004). Vernal pool surveys in Rogue River SGA in 2016 found that 59% of the verified vernal pools were isolated and not connected to other wetlands or waterbodies, and 76% of the pools had no inlet or outlet. These percentages are lower than those reported for vernal pools surveyed in the western U.P. (Lee 2014) and in the Flat River SGA in 2015 (75% isolated and 96% with no inlet/outlet) (Cohen et al. 2016). Similar results were reported for vernal pools that were verified in Middleville and Lost Nation SGAs in 2014 (Cohen et al. 2015a and 2015b). Although many of the verified vernal pools in the Rogue River SGA occurred in isolated basins or depressions, many of them occurred in clusters or in the general vicinity of other vernal pools or other wetlands and water bodies.

Another key characteristic of vernal pools is that they are generally small and shallow (Colburn 2004). Verified vernal pools in the Rogue River SGA were small and shallow, and were similar in size or area to those found by Lee (2014) in the western U.P. The verified vernal pools in the Rogue River SGA ranged in size from 106 to 2,802 m^2 (0.03 to 0.7 acre), and averaged 1,154 m^2 (0.3 acre) in area, based on mapped polygons. The verified vernal pools in the study area in the western U.P. ranged from about 4 to 16,187 m^2 (0.001 ac to about 4 ac), with mean vernal pool area about 931 m^2 (0.23 ac) (Lee 2014).

It also is important to note that vernal pool indicator species do not occur in all vernal pools. For example, wood frogs and/or blue-spotted salamanders were found breeding and reproducing in about half (i.e., 46%) of the vernal pools verified in the Flat River SGA in 2015 (Cohen et al. 2016). Other studies have reported similar vernal pool occupancy rates for vernal pool indicator species. Wood frog, blue-spotted salamander, and/or spotted salamander adults, larvae, and/or metamorphs were documented in 20% to 55% of vernal pools surveyed in several study areas in southern Michigan (Lee et al. 2014, Cohen et al. 2015a and 2015b). Lathrop et al. (2005) found either a single vernal pool obligate species or multiple vernal pool facultative species in about 22% of the documented vernal pools in their study. However, some studies in the northeastern and midwestern U.S. have documented higher occupancy rates for wood frogs (70-90%) and blue-spotted salamanders (62%) (Calhoun et al. 2003, Egan and Paton 2004, Skidds and Golet 2005, Baldwin et al. 2006, Brodman 2010). Some studies have reported lower vernal pool occupancy rates for spotted salamanders compared to those of wood frogs (e.g., 27% compared to 43%, respectively) (Porej et al. 2004) and blue-spotted salamanders (e.g., 22% compared to 62%, respectively) (Brodman 2010), while other studies have reported vernal pool occupancy rates similar to those of wood frogs and blue-spotted salamanders (e.g., 80-90%) (Baldwin et al. 2006). Wood frogs, blue-spotted salamander, and spotted salamander also have high site fidelity, with all or most adults returning to their natal pools and the same pools to breed in year after year (Colburn 2004). Thus, the low number of vernal pools within which vernal pool indicator species were documented in the Rogue River SGA may have been due to small sample size and lower occupancy rates or abundance in the game area.

Appendix 10. Management Guidance for Woodland Raptors (Specifically Red-Shouldered Hawks and Northern Goshawk) on State Forest Lands.

MICHIGAN DEPARTMENT OF NATURAL RESOURCES

INTEROFFICE COMMUNICATION

Management Guidance for Woodland Raptors (specifically Red-Shouldered Hawks and Northern Goshawk) on State Forest Lands

June 11, 2015

Background

Draft management guidelines for Red-shouldered hawk (RSH) were developed for the northern Lower Peninsula ecoregion by a Woodland Raptor Working Group in 1999. Those draft guidelines were never formally adopted by the Department. Survey information on RSH populations helped inform a decision to re-assess and update the draft guidelines and additional information also helped inform the decision to include the Northern goshawk (NG) in these guidelines and identified them as interim guidance in 2012. These interim management guidelines served to inform actions on state land as part of the State Forest Management Plan. The Field Coordinators from Wildlife Division (WLD) and Forest Resources Division (FRD) were tasked with finalizing guidance materials for woodland raptors (including RSH and NG) in 2014.

Objectives

These guidelines will focus on the following main objectives for woodland raptors:

1. Protect woodland raptors.
2. Establish raptor guidelines that recognize and compliment timber cover type management objectives to the extent possible.
3. Continue to evaluate methods and determine if management changes are necessary (adaptive management strategies).
4. Develop a special data layer within the MiFi system for tracking woodland raptor nests (specifically Red-shouldered hawks and Northern goshawks).

Management Guidelines

These new guidelines, approved by the joint management team of Wildlife and Forest Resources Divisions shall be used by the two divisions' field staff for woodland raptors, including Red-shouldered hawks and Northern goshawks on all state forest lands. These guidelines supersede guidelines contained in the draft 1999 "*Management Guidelines for Red-shouldered Hawks on State-owned Lands in Michigan"* and the 2012 "*Interim Guidance for Red-shouldered Hawks and Northern goshawk on State Forest Lands."* The current guidelines were developed from multiple sources but primarily from recommendations in Szuba and Bell (1991), Naylor (2009), and Naylor et al. (2004).

Nest Site Guidelines

1. If an active red-shouldered hawk or goshawk nest is found, the following guidelines will be put into place until such time as the nest is determined to be inactive.

    a. Active RSH and NG nests will be buffered with a 5-chain radius (8 acre) protection area, centered on the nest tree, in which there will be no cutting or new roads constructed. Avoid human disturbance, including loading and skidding, in this protection area.

   b. An additional zone of 5 chains (total of 10 chains centered on the active nest trees) will be established in which there is no management activity during the following activity times: Southern Lower Peninsula from February 15 to July 1; Northern Lower Peninsula from March 15 to July 15; Upper Peninsula from April 1 to July 30.
   c. Within this 10 chain zone, retain at least one-third of residues per the Woody Biomass Harvesting Guidance (Michigan DNR 2010).
   d. Deviation from these guidelines is contingent on compartment review agreement and/or approval from WLD Field Operations Managers and FRD District Managers (or their supervisors if agreement cannot be reached).

2. Red-shouldered and goshawk nests determined to be inactive by joint decision involving local WLD and FRD staff will be protected with a 1-chain no-harvest buffer. If the nest is found to be in disrepair or un-occupied for multiple years, it can be classified as an unsuitable nest in which case no buffer is required.

3. Record observations of active and inactive nests as an opportunistic field survey in the enterprise GIS. This will involve developing and jointly (FRD and WLD staff) populating a separate layer in MiFi specific to raptor nests. This layer will be used for determining baseline information for use in long-term nest monitoring. It will also be used to identify trends, research opportunities, and eventual feedback/ evaluation for management guidelines and development of a Habitat Suitability Index for RSH and NG.

Management Area Guidelines

1. In cover types where uneven-aged management techniques are used:

   a. When possible, and considering forest health conditions, encourage large contiguous blocks (usually >300 acres) of relatively mature, northern hardwood and mixed hardwood-conifer forest cover types, with moderate (about 70%) canopy closure and nearby or interspersed wetland habitats (blocks can be comprised of multiple stands in different Years of Entry).
   b. Apply Within-Stand Retention Guidance (Michigan DNR 2012), to identify and retain mature trees for future nests, existing stick nests, snags, and coarse woody debris. Where possible, retain a minimum of one large diameter deciduous (other than beech) tree per 5 acres, and with a preference for multi-crotched trees high in the canopy.

2. In cover types where even-aged management techniques are used:
   a. Apply Within-Stand Retention Guidance (Michigan 2012), retaining patches of several large diameter deciduous trees (especially multi-crotched trees high in the canopy).

3. Maintain adequate prey base by managing for appropriate levels of coarse woody debris:

   a. Follow Within-Stand Retention Guidance (Michigan 2012) for stand diversity.

Appendix 10 (continued). Management Guidance for Woodland Raptors (Specifically Red-Shouldered Hawks and Northern Goshawk) on State Forest Lands.

Citations

Michigan Department of Natural Resources. 2012. Within-Stand Retention Guidance. IC4119. Michigan Department of Natural Resources, Lansing, MI. 39 pp.

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Szuba, K. J., and P. Bell. 1991. Hawk guide for Ministry of Natural Resources field personnel. OMNR, Wildlife Policy Branch, Toronto.