

Identifying Recoverable, Fire-Dependent Systems on State Forest Land



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Prepared For:

Michigan Department of Natural Resources - Forest Resources Division

December 31, 2024

MNFI Report Number 2024-41



Michigan Natural
Features Inventory

MICHIGAN STATE
UNIVERSITY

Extension



Suggested Citation:

Lincoln, J.M., T.J. Bassett, and J.G. Cohen. Identifying Recoverable, Fire-Dependent Systems on State Forest Land. Report No. 2024-41, Lansing, MI.

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We also acknowledge that Indigenous Peoples and their cultural practices were, and are, integral parts of Michigan’s ecosystems.

Cover Photo: Kinsey Hunt Pine Barrens. Photo by J.M. Lincoln.

ACKNOWLEDGEMENTS

Funding for this project was provided by the Michigan Department of Natural Resources Forest Resources Division. We express our gratitude to Paul Rogers, David Price, and Keith Kintigh for helping to administer this project.

This report relies on help and input from many Michigan Natural Features Inventory scientists. We are especially grateful to our colleagues Helen Enander and Clay Wilton for their work developing the prescribed fire needs assessment model that was foundational to this project. We thank Nicole Smith for her assistance developing graphics for the report. For their support and assistance throughout this project, we thank our MNFI colleagues Ashley Adkins, Kraig Korroch, Sarah Carter, and Mike Monfils. AmeriCorps Servicemembers Emma McCarthy and Isabell Wejrowski and seasonal botanist Henry Wallison assisted during natural community surveys.



Perry Holt Pine Barrens, June 2024. Photo by J.M. Lincoln.

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INTRODUCTION

Numerous globally rare fire-dependent natural communities occur in Michigan. These natural communities and many of the rare species that they support are threatened by fire suppression and habitat fragmentation. In the past, human- and lightning-set fires frequently spread over large areas of the landscape, helping to reduce colonization by trees and shrubs, fostering regeneration of fire-dependent species, and maintaining the open structure of these fire-dependent ecosystems. In the absence of frequent fires, prairies, barrens, and savannas have converted to closed-canopy forests dominated by shade-tolerant native and invasive species. The conversion of prairie, barrens, and savanna ecosystems to closed-canopy forest has resulted in significant reductions in species and habitat diversity (Cohen et al. 2021).

There are over 4 million acres of State Forest across the Upper Peninsula and Northern Lower Peninsula

of Michigan. State Forest is jointly managed by the Forest Resources Division (FRD) and Wildlife Division (WLD) of the Michigan Department of Natural Resources (DNR) for long-term forest health, sustainable forest products, wildlife habitat, recreational opportunities, and ecosystem services. The FRD and WLD are responsible for assuring that management activities do not harm threatened and endangered species, and through dual forest certification, the DNR maintains a network of Ecological Reference Areas composed of high-quality and representative natural communities. Michigan Natural Features Inventory (MNFI) is Michigan's natural heritage program and maintains a geospatial database of benchmark natural communities and populations of rare and declining plants and animals.

The Grayling and Roscommon Forest Management Units (FMU) consists of about 550,000 acres in the Northern Lower Peninsula of Michigan (Figure 1).

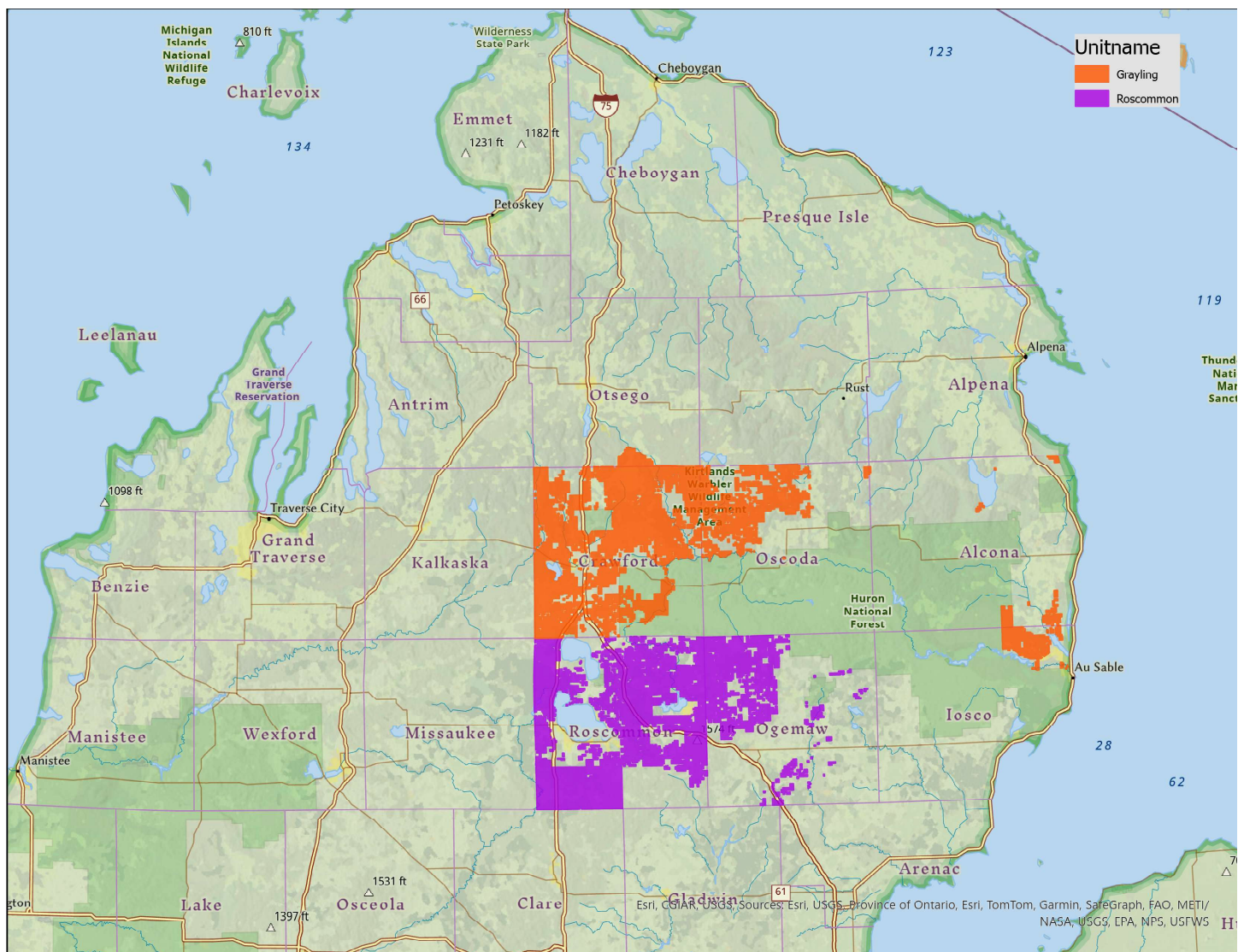


Figure 1. Grayling and Roscommon Forest Management Units in the northern lower peninsula of Michigan.

The DNR commissioned MNFI to identify examples of recoverable, fire-dependent systems (RFDS) within the Grayling and Roscommon FMUs during the 2024 field season. We define RFDS as remnant patches of fire-dependent natural communities with the potential for recovery to a level of substantial conservation value with stewardship intervention. This potential is characterized in part by concentrations of plant species that are associated with high-quality remnants of fire-dependent communities, or indicator species. These natural communities and many of the species associated with them are considered fire-dependent, in that their long-term persistence is contingent on regular and recurring fire.

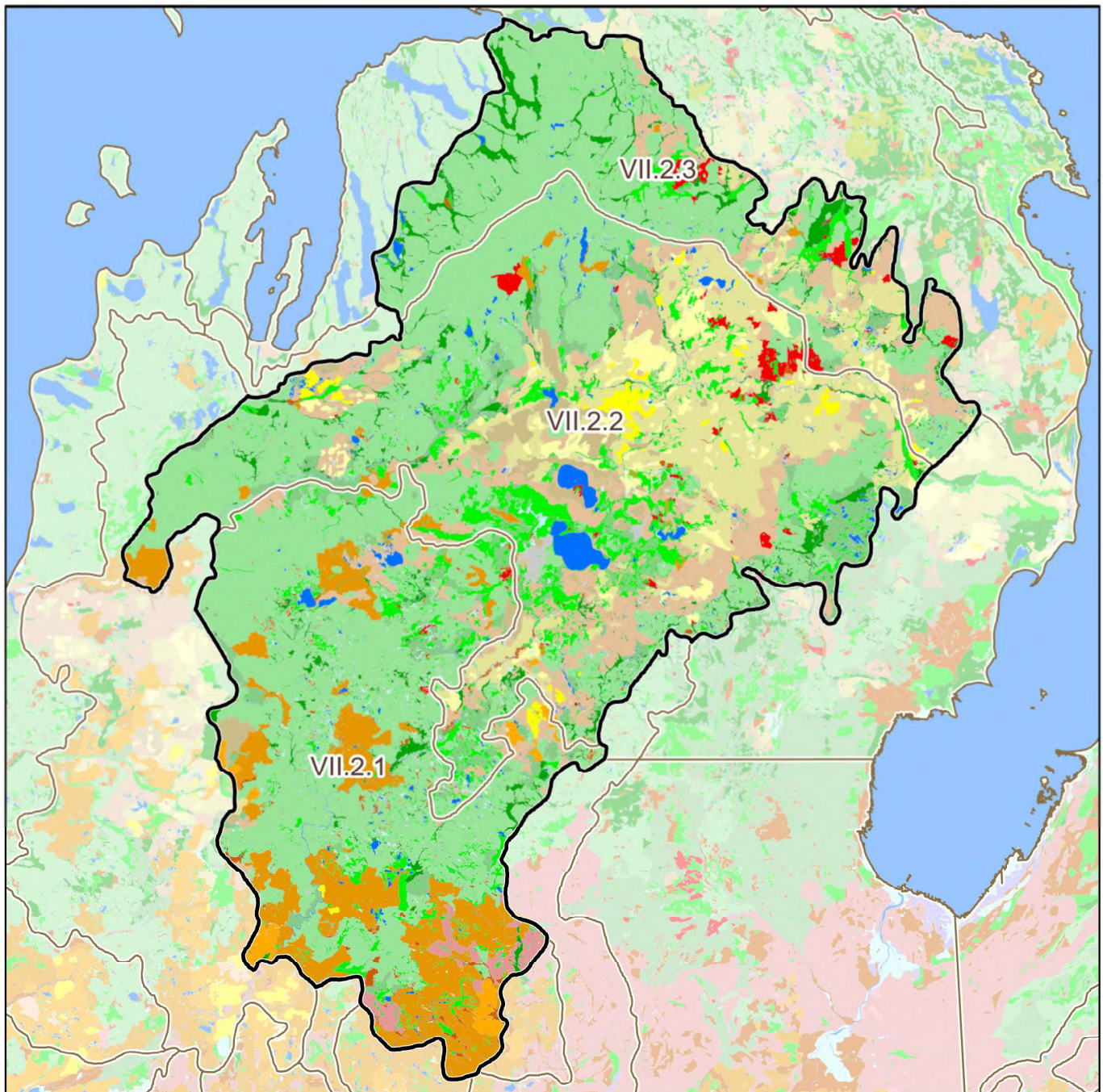
Barrens and prairies were once part of a heterogenous landscape where distribution of natural communities partially shifted over time, depending on landforms and patterns of disturbance (Figure 2) (Albert 1995). This shifting mosaic of fire-dependent

natural communities created a complex and dynamic landscape. Following European colonization, widespread timber harvest and subsequent fire suppression contributed to the drastic decline in fire-dependent natural communities. Michigan prairie, savanna, and barrens remnants have been reduced to less than 1% of their past extent (Comer et al. 1995).

The shifting mosaic model no longer applies to the current landscape and fire-dependent natural communities have been degraded, isolated, and relegated to landscape positions that help slow conversion to closed-canopy forest through drought and late-season frosts. Because of these complex land-use histories, changes in disturbance regimes, and degrading aspects of modern land use, the remaining examples of these natural communities can be difficult to locate and identify.



Pine barrens feature a sparse canopy of jack pine with diverse openings dominated by low shrubs and graminoids. Many of the best examples occur in areas recently impacted by fire, such as Kinsey Hunt Barrens, which was documented over the course of this project in 2024. Photo by J.M. Lincoln.



Vegetation circa 1800

- | | | | | |
|--|--|--|---|---|
| ■ ASPEN-BIRCH FOREST | ■ BLACK OAK BARREN | ■ JACK PINE-RED PINE FOREST | ■ MUSKEG/ BOG | ■ WHITE PINE-MIXED HARDWOOD FOREST |
| ■ BEECH-SUGAR MAPLE FOREST | ■ CEDAR SWAMP | ■ LAKE/ RIVER | ■ OAK/ PINE BARRENS | ■ WHITE PINE-RED PINE FOREST |
| ■ BEECH-SUGAR MAPLE-HEMLOCK FOREST | ■ GRASSLAND | ■ MIXED CONIFER SWAMP | ■ PINE BARRENS | ■ WHITE PINE-WHITE OAK FOREST |
| ■ BLACK ASH SWAMP | ■ HEMLOCK-WHITE PINE FOREST | ■ MIXED HARDWOOD SWAMP | ■ SAND DUNE | |
| | ■ HEMLOCK-YELLOW BIRCH FOREST | ■ MIXED PINE-OAK FOREST | ■ SHRUB SWAMP/ EMERGENT MARSH | |
| | | | ■ SPRUCE-FIR-CEDAR FOREST | |

Sub-subsection

Figure 2. Circa 1800 vegetation of Michigan’s High Plains sub-section (VII.2 on map) within the Northern Lower Peninsula (Albert 1995, Comer et al. 1995).

Several high-quality fire-dependent natural community types were documented from the Grayling and Roscommon FMUs prior to the 2024 surveys. However, there is a continued conversion of much of the region to plantation. Some areas are being converted to red pine plantation but many recoverable barrens sites are being cleared, trenched, planted with jack pine in a weave pattern for Kirtland's warbler. This jack pine weave plantation threatens remaining RFDS. Therefore, there is a need to assess what high-quality fire-dependent systems remain on the landscape to take steps to conserve them. The primary focus of these surveys was on pine barrens but other fire-dependent communities targeted for surveys include dry sand prairie, dry and dry-mesic northern forest, oak-pine barrens, northern wet meadow, fen, and intermittent wetland. Barrens occurred as a matrix community type on historic landscapes and was patterned by frequent fire.

MNFI developed a prescribed fire needs assessment model for Department of Natural Resources (DNR) land in Michigan (Cohen et al. 2021). The model uses a range of factors to identify the ecological need for prescribed fire. The model was used to direct targeted field surveys for the purpose of finding RFDS. The goal of this project is to identify and evaluate the best examples of fire-dependent natural communities in

the Grayling and Roscommon FMUs using MNFI's prescribed fire needs assessment model and expert interpretation.

The natural communities identified in the FMUs were surveyed and specific stewardship recommendations were developed to help managers direct conservation efforts toward the best examples of recoverable, fire-dependent systems in the FMUs. This approach provides a timely opportunity to recognize, prioritize, and manage the remnants to increase diversity and resiliency in this landscape and prevent continuing loss and degradation of rare natural communities and loss of the species that rely on them.

Barrens and prairie remnants continue to support high biodiversity and are especially valuable targets for biodiversity conservation. Protecting and managing representative natural communities is critical to biodiversity conservation because native organisms are best adapted to environmental and biotic forces with which they have survived and evolved over millennia (Cohen et al. 2015). Biodiversity is most easily and effectively protected by preventing high-quality sites from degrading. This project is aimed at directing restoration efforts to the best examples of RFDS on Grayling and Roscommon FMUs.



Jack pine weave plantations feature meandering rows of planted jack pine that create oval-shaped openings between dense rows of pine. This management technique was developed to provide habitat for the Kirtland's warbler and continues to be implemented as part of its recovery. However, the process of converting natural cover to the jack pine weave plantation is eliminating large areas of recoverable pine barrens leading to losses of biodiversity. Photo by J.M. Lincoln.

METHODS

Model Background and Natural Community Crosswalk

See Cohen et al. (2021) for a more in-depth description of the fire needs assessment model. MNFI developed the original model for state lands in Michigan administered by Michigan’s Department of Natural Resources (DNR). The foundational unit of the model is stand-level data that describes canopy and subcanopy species composition, stand age, and other ecological conditions. For each stand, we generated an intersection with numerous spatial data layers including datasets with information on physiographic region, landform, circa-1800 vegetation, slope, aspect, departure from historical fire regime, and occurrences of high-quality natural communities or ecosystems. We used information gleaned from this intersection as well as stand-level data to “crosswalk” or assign a natural community type to as many stands as possible. Anthropogenic systems (e.g., developed, cropland, plantations, roads, ruderal systems, and grassland plantings) were not crosswalked to a natural community type.

Over the course of four decades, MNFI has developed a classification of natural community types in Michigan (Kost et al. 2007, Cohen et al. 2015). This classification includes a detailed discussion of vegetative composition and structure, soil texture and soil moisture, hydrology, and natural disturbance regime for each natural community. In addition, the classification includes information on fire-dependence and fire return interval for relevant communities. Fire return interval is the time in years between two successive fires in a designated area and can be used to estimate fire frequency range. We use fire frequency range throughout to convey the range of time between fire events typical of a given natural community type.

Through literature review, evaluation of available spatial data layers, and discussion with natural resource managers and ecological experts, we identified variables that determine the prescribed fire need for each stand and used this needs assessment to identify potential fire-dependent ecosystems on the landscape. We applied this approach at multiple temporal and spatial scales. In selecting these variables, we tried to incorporate factors that contribute to the past, current, and future relationship of each stand with fire. Because multiple variables interact at different scales in determining the characteristics of a site’s fire regime, we identified critical variables for our model at landscape-, stand-, and species-scales.

GIS-Based Multicriteria Decision Analysis

To synthesize multiple input variables into one prescribed fire needs score, we used GIS-based multicriteria decision analysis, which combines spatially referenced data and multi-attribute criteria in a problem-solving environment. This integrated analysis allows users to apply weights to input variables and combine them into a single output. We assigned weights to variables to infer relative importance to prescribed fire needs, by expert opinion and not empirical statistical analysis. Weights were derived following discussions with natural resource managers and fire ecology experts and literature review on the factors that influence fire disturbance regimes and the response of landscapes, ecosystems, and species to fire. For each stand, the prescribed fire needs score was calculated by summing the weighted scores for each variable, and then rescaling the final score to a 0 to 5 range. Higher scores convey a higher level of ecological need for prescribed fire. To visualize the scoring, the scores were assigned colors on a blue to red color gradient with higher scores corresponding to reds and displayed within GIS.

The Grayling FMU consists of 173 Compartments over 275,136 total acres. The Roscommon FMU consists of 90 compartments over 275,533 total acres. We used the output of the model to identify stands and concentrations of stands with the potential to support RFDS (Figure 3 and Figure 4). Both FMUs had substantial areas identified by our model as “High” or “Very High” fire needs (Table 1). Subsequently, we analyzed topography and texture of aerial imagery helped identify priority areas to survey. A list of target compartments was generated, and priority survey areas were determined.

Table 1: Percentage of the Grayling and Roscommon FMUs by fire needs category.

Fire Need	Percent	
	Grayling	Roscommon
Very High	19.8	10.4
High	29.3	33.3
Moderate	4.9	15.2
Low	0.2	0.6
None	45.8	40.6

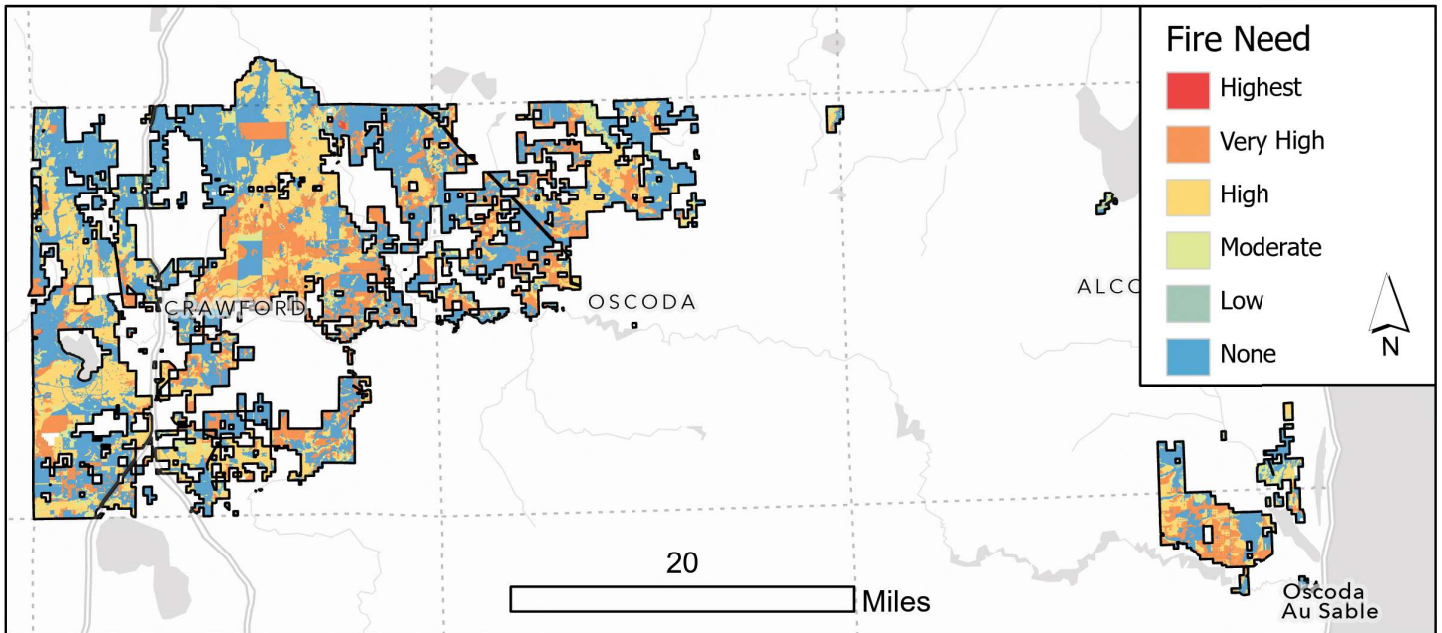


Figure 3: Output of the prescribed fire needs assessment model for the Grayling Forest Management Unit.

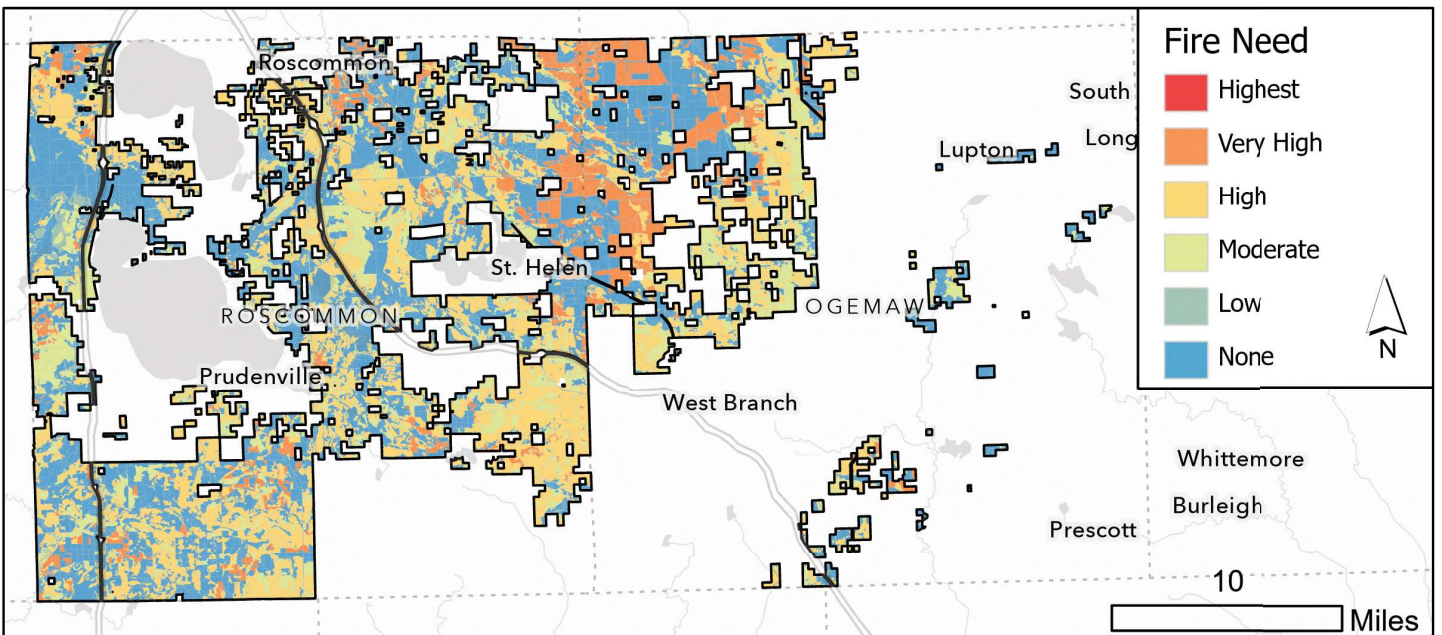


Figure 4: Output of the prescribed fire needs assessment model for the Roscommon Forest Management Unit.

Surveys

We conducted targeted surveys for natural communities in compartments identified as priorities by the MNFI’s prescribed fire needs assessment model and interpretation of aerial imagery and topographic maps. 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. Benchmark natural communities have minimal impact from modern anthropogenic disturbances such as timber harvest, hydrological alteration, and fire suppression. Indigenous peoples have been integral to Michigan’s landscapes, with many

natural community types shaped by native land tending practices such as cultural burning, seeding, planting, and harvesting of plants, wildlife, and fish. This cultural stewardship has been responsibly implemented with sophistication and care at seasonally appropriate times (Kimmerer and Lake 2001, Stewart 2009).

Throughout this report, a documented occurrence of a high-quality natural community at a specific location is referred to as an “element occurrence” (EO). The areas prioritized for natural community surveys were evaluated employing 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, 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 EO, and given a rank of A to D – excellent to poor – based on how well it meets the above criteria. To assess natural community size and landscape context, a combination of field surveys, aerial photographic interpretation, and Geographic Information System (GIS) analysis was employed.

Ecological field surveys were conducted over 30 days during 2024. These surveys occurred in several compartments of the Grayling and Roscommon FMUs during June, July, August, and early September. Qualitative meander surveys were conducted to assess the natural community classification, ecological boundaries, and ranking of the communities. Vegetative structure and composition, soils, landscape and abiotic context, threats, management needs, and restoration opportunities were all assessed. Surveyors carefully documented and framed threats to ecological integrity

of natural communities to develop management recommendations that will serve to protect the high-quality examples of natural communities on the landscape and the rare taxa therein. Ecological evaluations are important for facilitating site-level decisions about prioritizing management objectives to conserve native biodiversity, evaluating the success of restoration actions, and informing landscape-level planning efforts. Methods employed during this survey followed the methodology developed during the initial evaluation of Ecological Reference Areas on state forest land by MNFI ecologists (Cohen et al. 2008; Cohen et al. 2009).

For each high-quality natural community, floristic data were compiled into the Universal Floristic Quality Assessment Calculator (Reznicek et al. 2014, Freyman et al. 2016) to determine the Floristic Quality Index (FQI) for each natural community element occurrence. The floristic quality assessment is derived from a mean coefficient of conservatism and floristic quality index. Michigan sites with an FQI of 35 or greater possess sufficient conservatism and richness that they are considered floristically important from a statewide perspective (Herman et al. 2001).



AmeriCorps Servicemembers Emma McCarthy and Isabell Wejrowski assisting during natural community surveys. Photo by J.M. Lincoln.

RESULTS

The prescribed fire needs assessment model identified 49.1% of the Grayling FMU's 275,136 acres as very high to high fire needs and 43.7% of the Roscommon FMU's 275,533 acres as very high to high fire needs (Table 1). These areas were the focus of the natural community surveys.

We documented 16 new natural communities and updated 1 previously documented natural community in 2024 (Figure 5). New EOs were documented for 5 different natural community types, including dry northern forest (3), dry-mesic northern forest (1), intermittent wetland (1), northern wet meadow (1), and pine barrens (10). We also updated records for 1

previously documented pine barrens (Table 2). In total we documented 1,196 acres of pine barrens within the Grayling and Roscommon FMUs.

We used evaluation of canopy structure, diversity and abundance of native plant species composition, abundance of non-native species, and the history of both anthropogenic and natural disturbances to identify high-quality pine barrens. These remnant ecosystems, when compared to much of the surrounding landscape, have an elevated graminoid diversity, increased species evenness, greater forb diversity and abundance, and more conservative species than other sites. They also had relatively low

Table 2: A list of all natural community element occurrences identified or updated during the 2024 field surveys by location. Ranks are as follows: AB - Excellent to good occurrence; B - Good occurrence; BC- Good to fair occurrence; C - Fair occurrence; CD - Fair to poor occurrence; D - Poor occurrence. State-ranks are as follows: S1 - Critically imperiled; S2 - Imperiled; S3 - Vulnerable; S4 - Uncommon but not rare; S5 - Common and widespread in the state.

EO ID	Site Name	Rank	Size (Ac)	FQI	Compartment	Stands
Grayling						
Dry Northern Forest (S3)						
27692	Ketcham Woods	CD	25.5	24.5	72258	84, 85
27732	Formica Ridge	CD	15.2	26.8	27282	9
Intermittent Wetland (S3)						
27691	A Diamond in the Weave	C	9.6	22.9	72277 (72278)	7, 25 (2)
Pine Barrens (S2)						
27535	Stephan Bridge-North Down River Barrens	BC	40.6	40.6	72257	18, 19
27661	Wildwood Pine Barrens	C	105.5	37.5	72256 (72255)	3 (21)
27534	Red Headed Stranger	C	39.0	34.6	72239	22
27533	The Narrow Way	CD	134.0	34.9	72252	20, 26, 47
27730	Clare's Way Barrens	CD	92.5	35.3	72275	8, 9, 10, 11
27731	612 West Barrens	D	89.4	29.8	72174	11, 14
Roscommon						
Dry Northern Forest (S3)						
27532	Turney Ranch Trail	C	123.4	29.1	71077	140
Dry-mesic Northern Forest (S3)						
27669	East Creek Forest	C	46.5	28.2	71064	57, 64
Northern Wet Meadow (S4)						
27668	East Creek Meadow	B	67.9	30.9	71064	63, 66, 78
Pine Barrens (S2)						
27485	Kinsey Hunt	AB	190.1	40.9	71073	85
26198	South Creek Barrens*	BC	227.2	41.4	71071	55, 56
27651	Perry Holt Barrens	BC	99.0	46.3	71079 (71078)	49, 62 (34)
27531	McGregor Barrens	C	132.5	33.7	71072	22
27486	Sunset Barrens	C	45.8	35.7	71064	37

*denotes site that was previously documented but expanded

invasive species densities. Canopy structure was heterogenous, with clumps of jack and red pine alternating with graminoid-dominated openings. Additionally, these areas had not been converted to plantations.

The following results section presents the natural communities identified through our modeling and survey efforts. We have arranged the natural communities by FMU, then alphabetically by community type, and finally in decreasing order of overall rank. Pine barrens were arranged by conservation priority, starting with the areas we believe most valuable for the conservation of unique natural communities and biodiversity. Overall, stewardship of pine barrens is our highest priority as ranking order for stewardship actions prioritizes the rarity of system (S-rank), condition of the natural communities in the project area, and landscape context. We provide site descriptions of each site with relevant management recommendations.

Several additional RFDS were identified that have conservation value but do not meet the criteria of an element occurrence. We provide a table of these additional RFDS that do not qualify as EO but still have conservation value and would benefit from biodiversity stewardship (Appendix).



Pine barrens are dominated by jack pine and feature an open, savanna structure. Photo by J.M. Lincoln

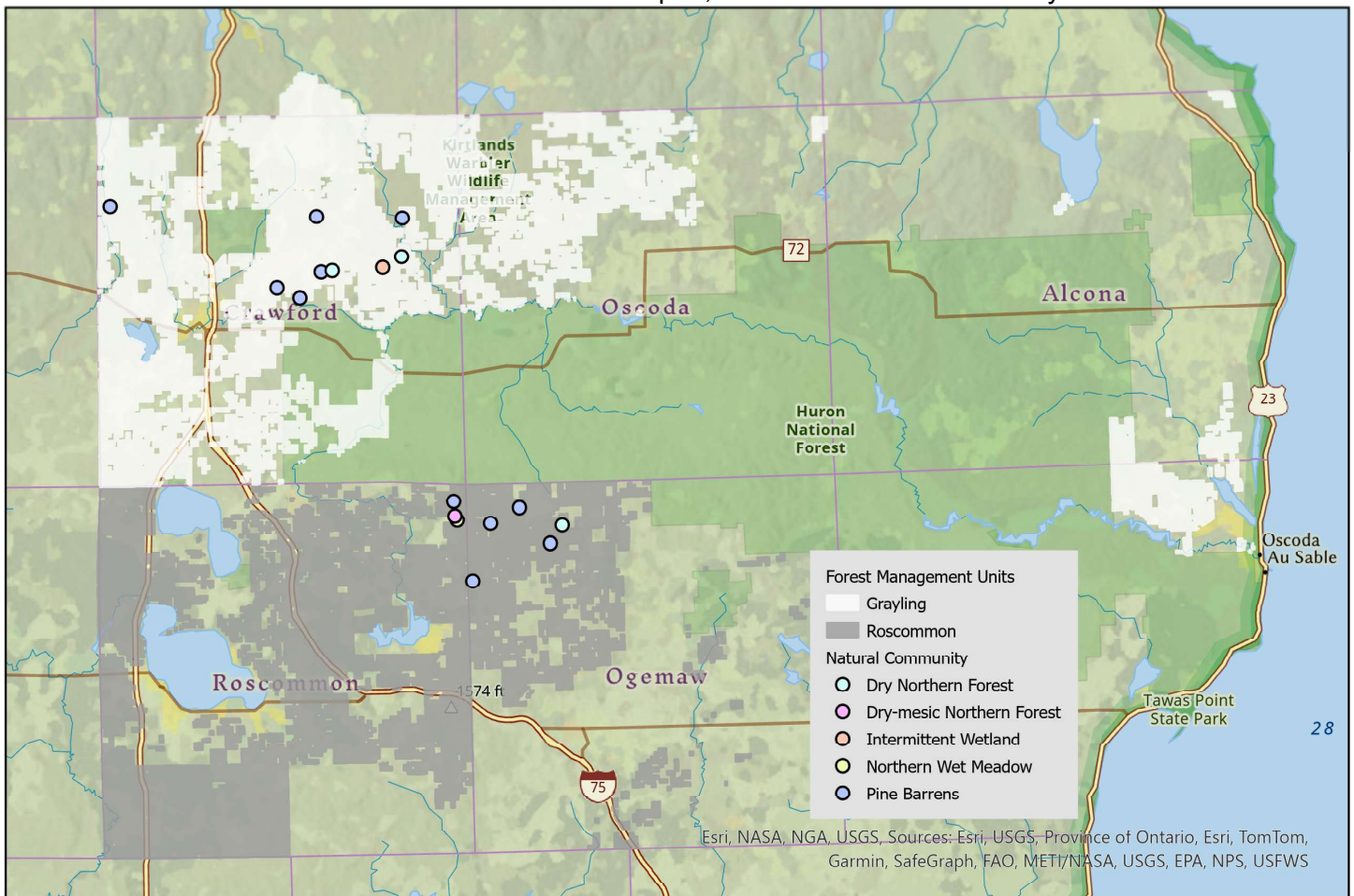


Figure 5: Location of natural community element occurrences identified or updated during 2024 field surveys.

Natural Community Descriptions – Grayling FMU

Dry Northern Forest

Ketcham Woods

Natural Community Type: Dry Northern Forest
Rank: G3 S3, vulnerable globally and vulnerable within in the state
Element Occurrence Rank: CD – Poor to Fair Occurrence.
Size: 25.5 acres

Location: Compartment 72258, Stands 84, 85
Element Occurrence Identification Number: 27692

This is a small, predominantly second-growth forest dominated by red pine on rolling sandy topography. The forest ranges from closed canopy to a canopy with patchy openings. Red pine (*Pinus resinosa*) is dominant with jack pine (*P. banksiana*), northern pin oak (*Quercus ellipsoidalis*), white oak (*Q. alba*) and white pine (*P. strobus*) much less abundant. Trees typically range from 30 to 80 cm. Most trees are part of the 80- to 100-year-old cohort, though about 20% of the canopy is in a 140- to 170-year-old cohort. There are some white pine in the supercanopy, but red pine is the dominant tree and the oldest individuals are developing complex structure and emerging into the supercanopy. The low shrub layer features blueberry (*Vaccinium angustifolium*) and huckleberry (*Gaylussacia baccata*) though they are not flowering or bearing fruit. The herbaceous layer

was sparse and low diversity, typical of the community type but exacerbated by fire suppression and high deer browse pressure.

There are no recent stumps, there is faint char on the oldest red pine and a few have fire scars. Coarse woody debris is trending towards an abundance typical of a mature forest, including canopy deadwood on old trees, cavities, and rotting wood on the forest floor at all stages of decay. The condition could be improved with infrequent low-intensity, low-severity prescribed fires and inclusion of surrounding forests in the prescribed fire burn unit. The forest exists as two polygons and the area between was recently clearcut, eliminating habitat that could have been recovered to improved condition.

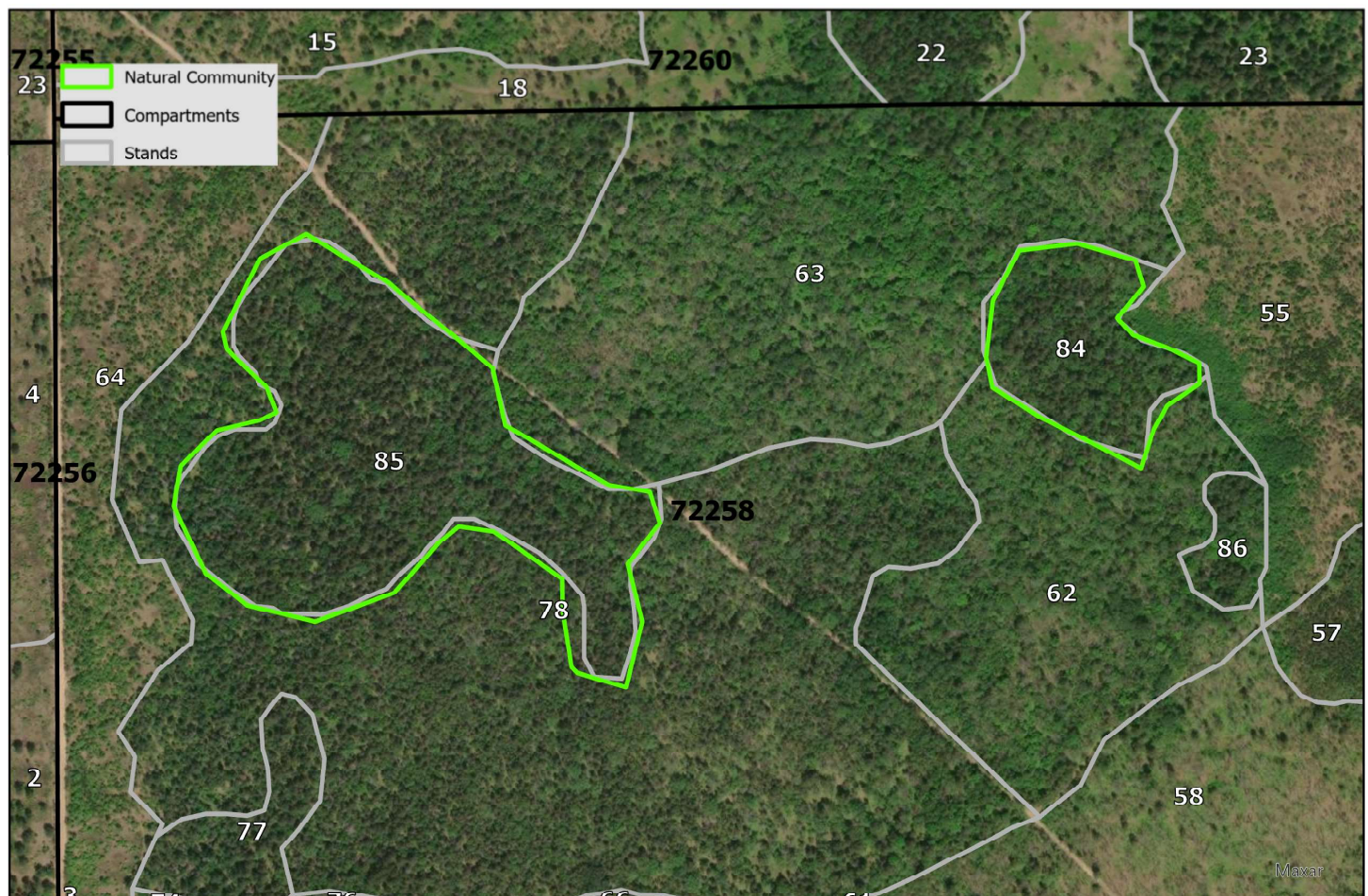


Figure 6: Ketcham Woods dry northern forest (EO ID 27692, Grayling FMU) .

Management Recommendations: Our top recommendation is to apply prescribed fire to this forest and include as much of the surrounding forests as possible. Burn at a frequency of every 10 to 30

years, implementing low intensity prescribed fire to avoid mortality of canopy pine by focusing on late growing to dormant season burns when possible (late September through early March).



Ketcham Woods dry northern forest is dominated by red pine. Most canopy red pine were in the 80- to 100-year-old cohort but several were around 150 years old with some large white oak. The condition of the site could be improved with low-severity, low-intensity prescribed fire and we encourage managers to include surrounding stands in prescribed fires. Photos by J.M. Lincoln.

Formica Ridge

Natural Community Type: Dry Northern Forest

Rank: G3 S3, vulnerable globally and vulnerable within in the state

Element Occurrence Rank: CD – Poor to Fair Occurrence.

Size: 15.2 acres

Location: Compartment 72282, Stand 9

Element Occurrence Identification Number: 27732

This is a small dry northern forest with an atypically heterogenous and open canopy structure (~ 60% cover on average) dominated by 17 to 34 cm DBH jack pine (*Pinus banksiana*) and in northern pin oak (*Quercus ellipsoidalis*), white oak (*Q. alba*), and red pine (*Pinus resinosa*) in decreasing order of importance. Canopy age ranged from 75-year old red pine to 120-year old jack pine. The subcanopy is sparse and composed mostly of northern pin oak regeneration rather than pine, suggesting prolonged fire suppression. An old fireline cuts through the southern and eastern boundaries of the EO, suggesting that this stand was protected from the 1975 Bald Hill Fire and the 1990 Stephan Bridge Road Fire that impacted stands to the south and west. The ground layer is dominated by Pennsylvania sedge (*Carex pensylvanica*) and low sweet blueberry (*Vaccinium angustifolium*), with reindeer lichen (*Cladonia* sp.) and feather mosses abundant.

Species with an affinity for pine barrens such as hairy goldenrod (*Solidago hispida*) and smooth blue aster (*Symphotrichum laeve*) are rare, while those with an affinity for closed-canopied forests are common, such as wintergreen (*Gaultheria procumbens*), bracken fern (*Pteridium aquilinum*), and huckleberry (*Gaylussacia baccata*). Ants in the genus *Formica* are common, with many complexes of large mounds throughout.

Management Recommendations: Our top management recommendations are to prevent logging at this site and introduce low-intensity fire. Include surrounding stands in burns to integrate this dry northern forest in with management of other fire-dependent communities in this and adjacent compartments. Maintain a canopy predominantly of red and jack pine to a coverage of up to 100% with a range between 80 and 100% that could include small barrens-like openings and clusters.

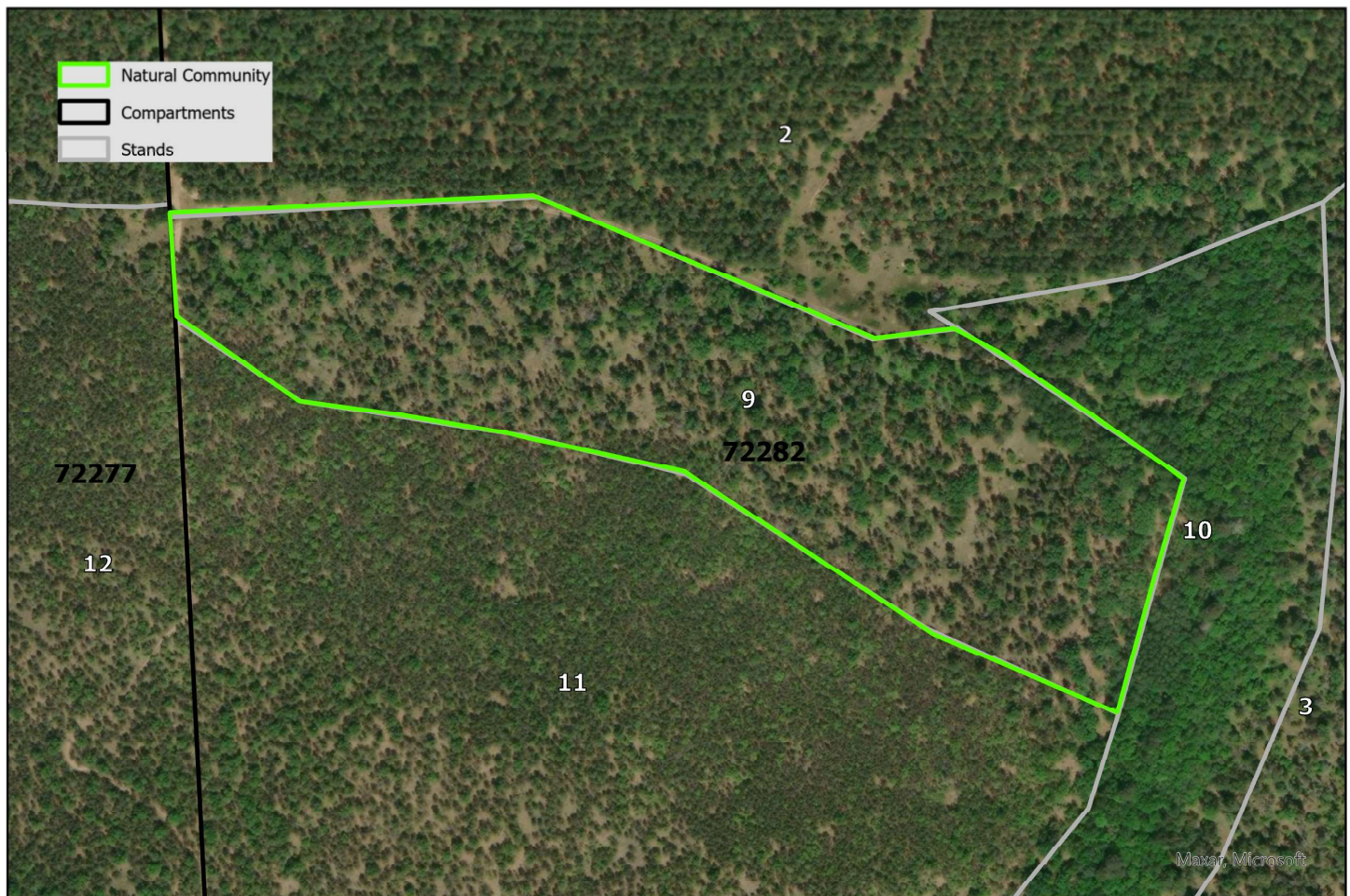


Figure 7: Formica Ridge dry northern forest (EO ID 27732, Grayling FMU) .



Formica Ridge dry northern forest is dominated by widely-spaced jack pine. Despite having an open structure similar to pine barrens, the canopy is between 75 and 120 years old and species composition is dominated by species with forest affinities, such as patches of dense huckleberry under clumps of red pine (*top photo*). Mounds built by ants in the genus *Formica* were frequent throughout the site (*bottom*). Photos by T.J. Bassett.

Intermittent Wetland

A Diamond in the Weave

Natural Community Type: Intermittent Wetland
Rank: G3 S3, vulnerable globally and vulnerable within in the state
Element Occurrence Rank: C – Fair Occurrence.
Size: 15.2 acres
Location: Compartment 72277, Stands 7, 25; 72278, Stand 2
Element Occurrence Identification Number: 27691

This is a graminoid-dominated intermittent wetland composed of four separate polygons, occurring in small, shallow depressions in the landscape. Zonation and species composition are representative of the community type. The intermittent wetland is dominated by sedges (*Carex lasiocarpa*, *C. oligosperma*, *C. buxbaumii*) and ringed by a low shrub zone dominated by leatherleaf (*Chamaedaphne calyculata*) and sheep-laurel (*Kalmia angustifolia*). The wetland transitions into a dry northern forest zone over moist sand and is dominated by jack pine (*Pinus banksiana*). Soils are finely-decomposed, highly acidic (pH 4.5-5.5) peat over moist to wet sands. Peat occurs to a depth of greater than 100 cm in the center

of soils to ~ 60 cm on the margins to ~ 5 cm on dry northern forest edge. The northern polygons occur in the same depression that is bisected by a two-track, and the ORV access from the two-track is leading to rutting and soil disturbance in the northern polygons.

Management Recommendations:

The overarching management goal is to incorporate management of this site in the context of the surrounding fire-dependent landscape. Management would ideally involve including this EO in larger prescribed fires targeted on upland communities. An additional high priority is to limit ORV access.

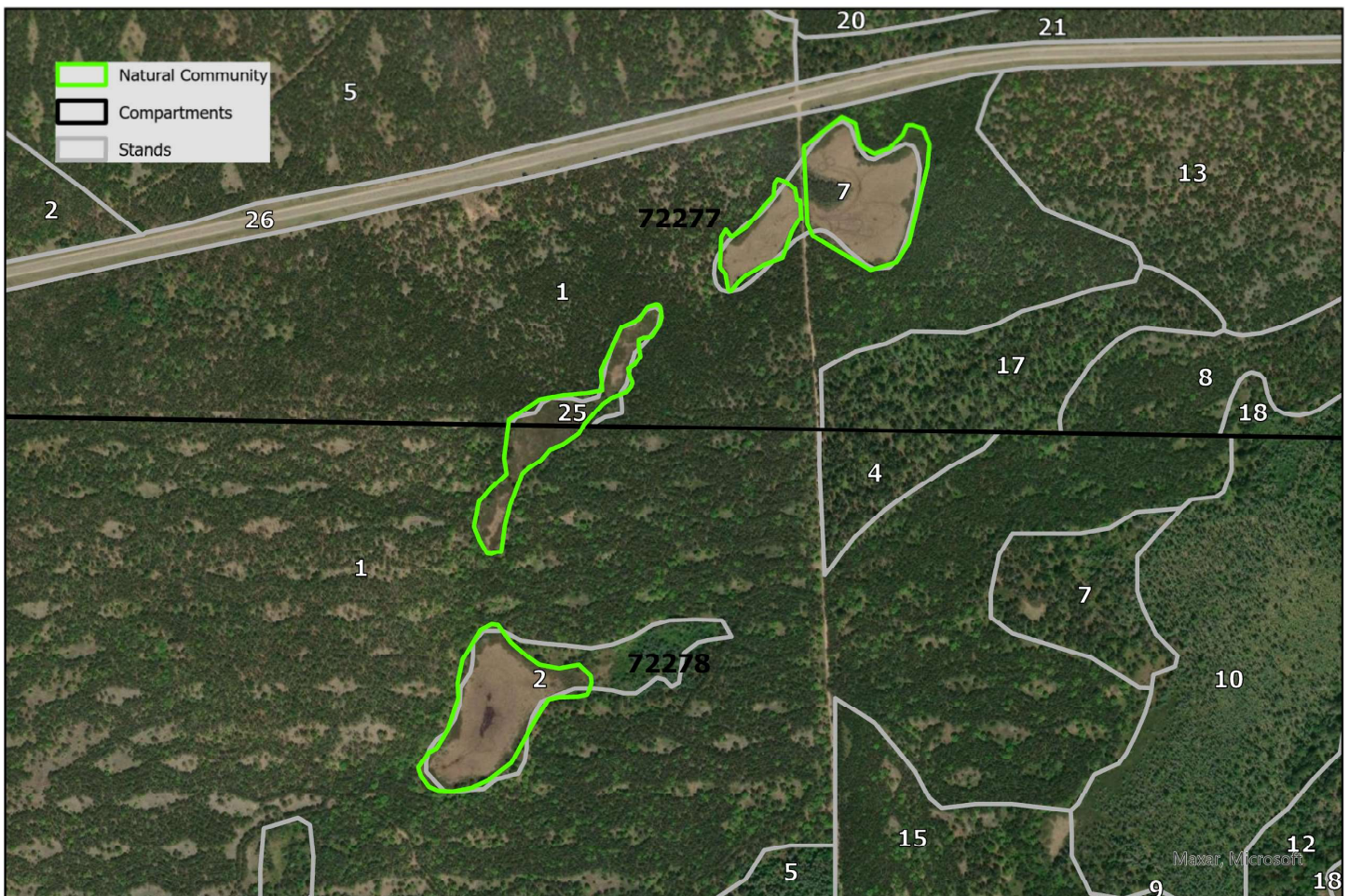


Figure 8: A Diamond in the Weave intermittent wetland (EO ID 27691, Grayling FMU) .



Zonation is well-defined in A Diamond in the Weave intermittent wetland, with a large central sedge-dominated zone, surrounded by low shrub and jack pine zones (*top photo*). Note soil disturbance from ORV access. The outer zones are dominated by leatherleaf (*top*) and sheep-laurel (*bottom*). Photo by T.J. Bassett.

Pine Barrens

Stephan Bridge-North Down River Barrens

Natural Community Type: Pine Barrens

Rank: G3 S2, vulnerable globally and imperiled within the state

Element Occurrence Rank: BC – Good to Fair Occurrence.

Size: 40.6 acres

Location: Compartment 72257, Stands 18, 19

Element Occurrence Identification Number: 27535

This is a moderately diverse but fire-suppressed barrens that occurs on a level outwash plain adjacent to hilly ice-contact features. Canopy closure is high throughout much of the barrens (on average 70%), although there are several small- to medium-sized openings with medium to low diversity. A 35- to 45-year-old cohort of 12 to 30 cm DBH jack pine (*Pinus banksiana*) strongly dominates the canopy. This dominant cohort recruited after the 1975 North Down River Road Fire, although older trees (75 years old) with fire scars are scattered throughout. Red pine is absent from the site. Coarse woody debris (5-10 cm DBH) is locally abundant in areas of denser canopy. Regeneration in the subcanopy is mixed between pines and oaks. Despite canopy closure leading to dominance of feather moss in the ground layer, many heliophytic barrens species persist throughout. Pennsylvania sedge (*Carex pensylvanica*), low

sweet blueberry (*Vaccinium angustifolium*), reindeer lichen (*Cladonia* sp.), and big bluestem (*Andropogon gerardii*) are all abundant, at least locally. Conservative and indicator species are rare to uncommon but found throughout and include western sunflower (*Helianthus occidentalis*), cylindrical blazing star (*Liatris cylindracea*), bird's-foot violet (*Viola pedata*), upland white goldenrod (*Solidago ptarmicoides*), hoary puccoon (*Lithospermum canescens*), prairie brome (*Bromus kalmii*), showy goldenrod (*Solidago speciosa*), June grass (*Koeleria macrantha*), three-toothed cinquefoil (*Sibbaldiopsis trifoliata*), balsam ragwort (*Packera paupercula*), and Gillman's goldenrod (*Solidago simplex*). Non-native species are generally uncommon - orange hawkweed (*Hieracium aurantiacum*) is locally common and spotted St.-John's wort (*Hypericum perforatum*) is occasional throughout - but the proximity to two major

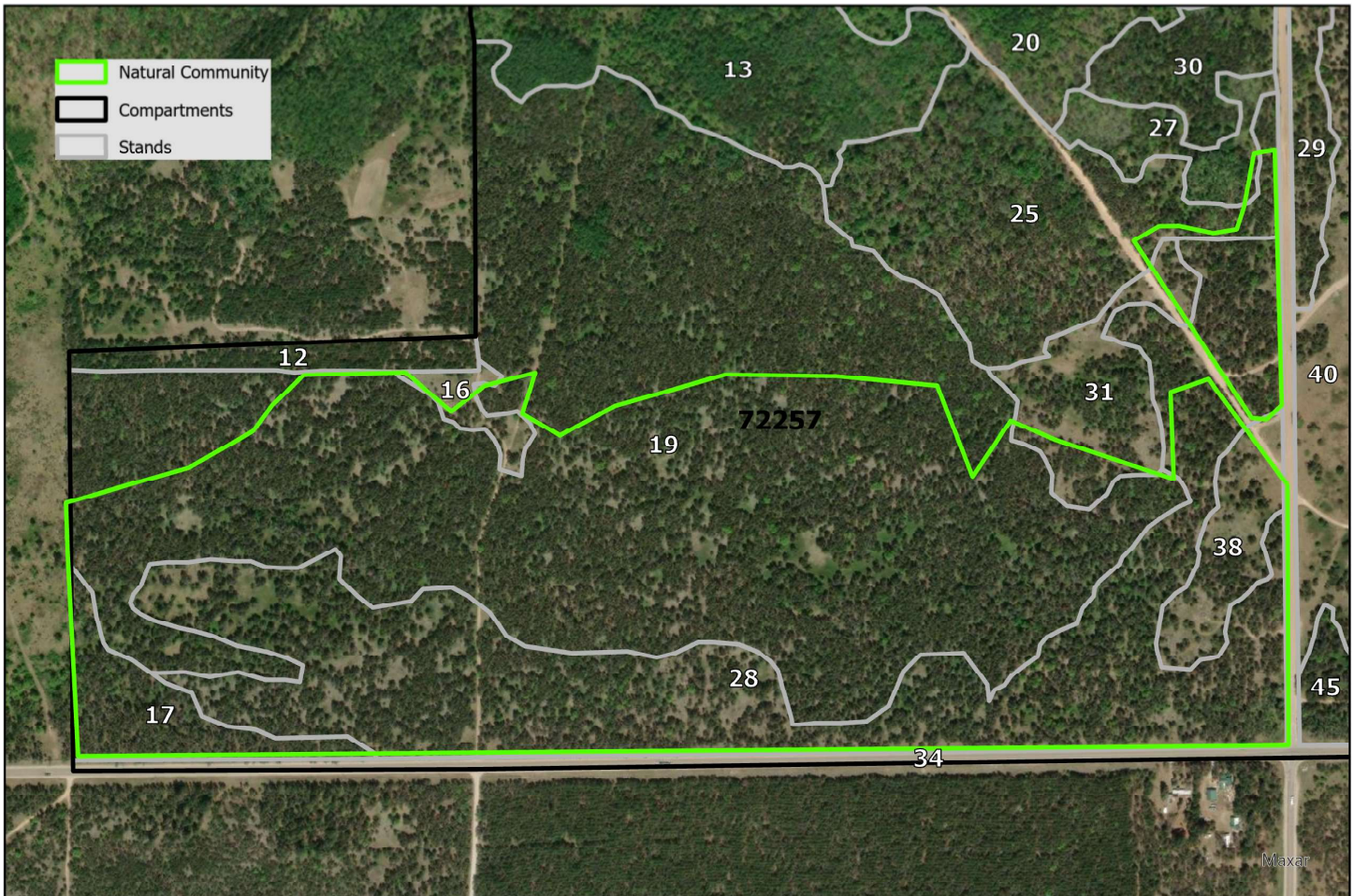
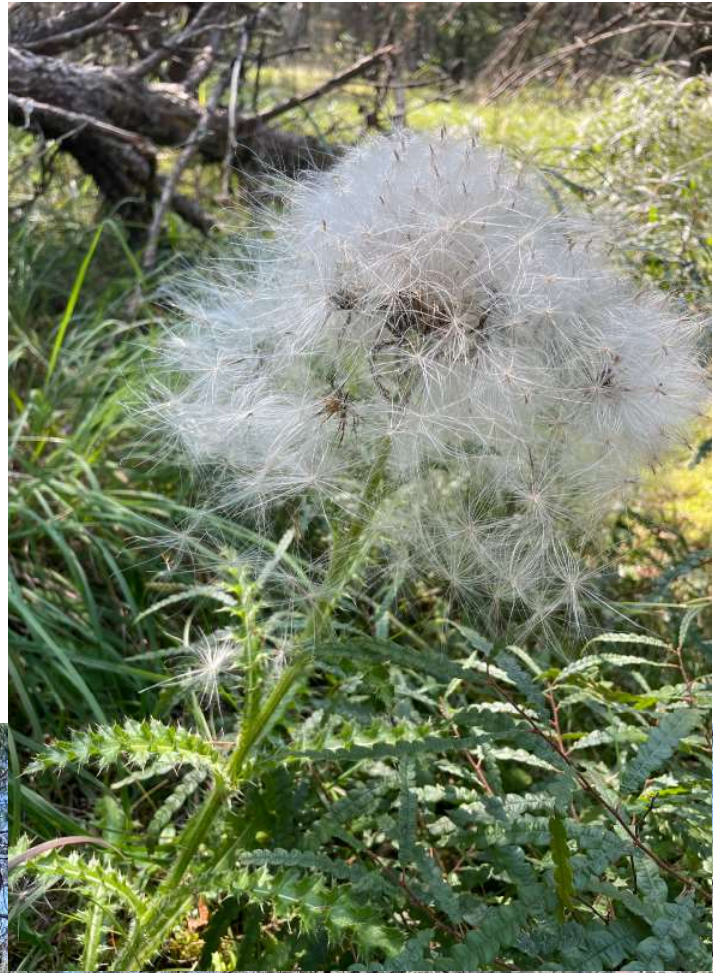


Figure 9: Stephan Bridge-North Down River Barrens pine barrens (EO ID 27535, Grayling FMU) .

roads provides a consistent disturbance and source of propagules. Special Concern species rough fescue (*Festuca altaica*) and Hill's thistle (*Cirsium hillii*) occur in this EO.

Management Recommendations:

The overarching management goal is to develop a large project area that includes surrounding stands to expand and connect the extent of pine barrens and related communities on the landscape. This pine barrens would benefit from frequent (every 5-25 years) low-intensity prescribed fire prescribed fire to slowly thin canopy pine and increase evenness of conservative forbs and graminoids. The target canopy conditions are predominantly of red and jack pine to a coverage of 20 to 70% that includes large openings and clusters of trees consistent with the heterogeneity of barrens.



Stephan Bridge-North Down River Barrens is approaching closed-canopied conditions due to prolonged fire-suppression (*lower photo*), frequent openings persist and support conservative species such as Hill's thistle (*upper right*). Photos by T.J. Bassett.

Wildwood Barrens

Natural Community Type: Pine Barrens

Rank: G3 S2, vulnerable globally and imperiled within the state

Element Occurrence Rank: C – Fair Occurrence.

Size: 105.5 acres

Location: Compartment 72256, Stand 3; Compartment 72255, Stand 21

Element Occurrence Identification Number: 27661

This is a large pine barrens remnant in fair condition. There are two separate polygons that make up this site. The pine barrens is characterized by a canopy of patchy jack pine and some open-grown red pine (*Pinus resinosa*), and northern pin oak (*Quercus ellipsoidalis*). The areas with characteristic pine barrens structure have between 30 and 40% canopy coverage of jack pine (*Pinus banksiana*). Jack pine were typically 18 to 25 cm dbh and estimated to be about 30 years old. The low shrub layer is dense with low sweet blueberry (*Vaccinium angustifolium*), sweet fern (*Comptonia peregrina*), and prairie willow (*Salix humilis*) as the most dominant species. Graminoids are dominant throughout the pine barrens and feature Pennsylvania sedge (*Carex pensylvanica*), hair

grass (*Avenella flexuosa*), big bluestem (*Andropogon gerardii*), poverty grass (*Danthonia spicata*), and prairie brome (*Bromus kalmii*). Several clumps of the Special Concern rough fescue (*Festuca altaica*) were observed in the southeastern portion in an opening along a trail. Non-native Kentucky bluegrass (*Poa pratensis*) is locally dominant along the trail at the eastern and boundary. Forbs are typically 1 to 2 % of the herbaceous layer and typical species include rattlesnake-weed (*Hieracium venosum*), common frostweed (*Crocyanthemum canadense*), smooth aster (*Symphyotrichum leave*), and northern blazing star (*Liatris scariosa*). The Special Concern species Hill's thistle (*Cirsium hillii*) is uncommon throughout. Bracken fern (*Pteridium aquilinum*) is locally dense.

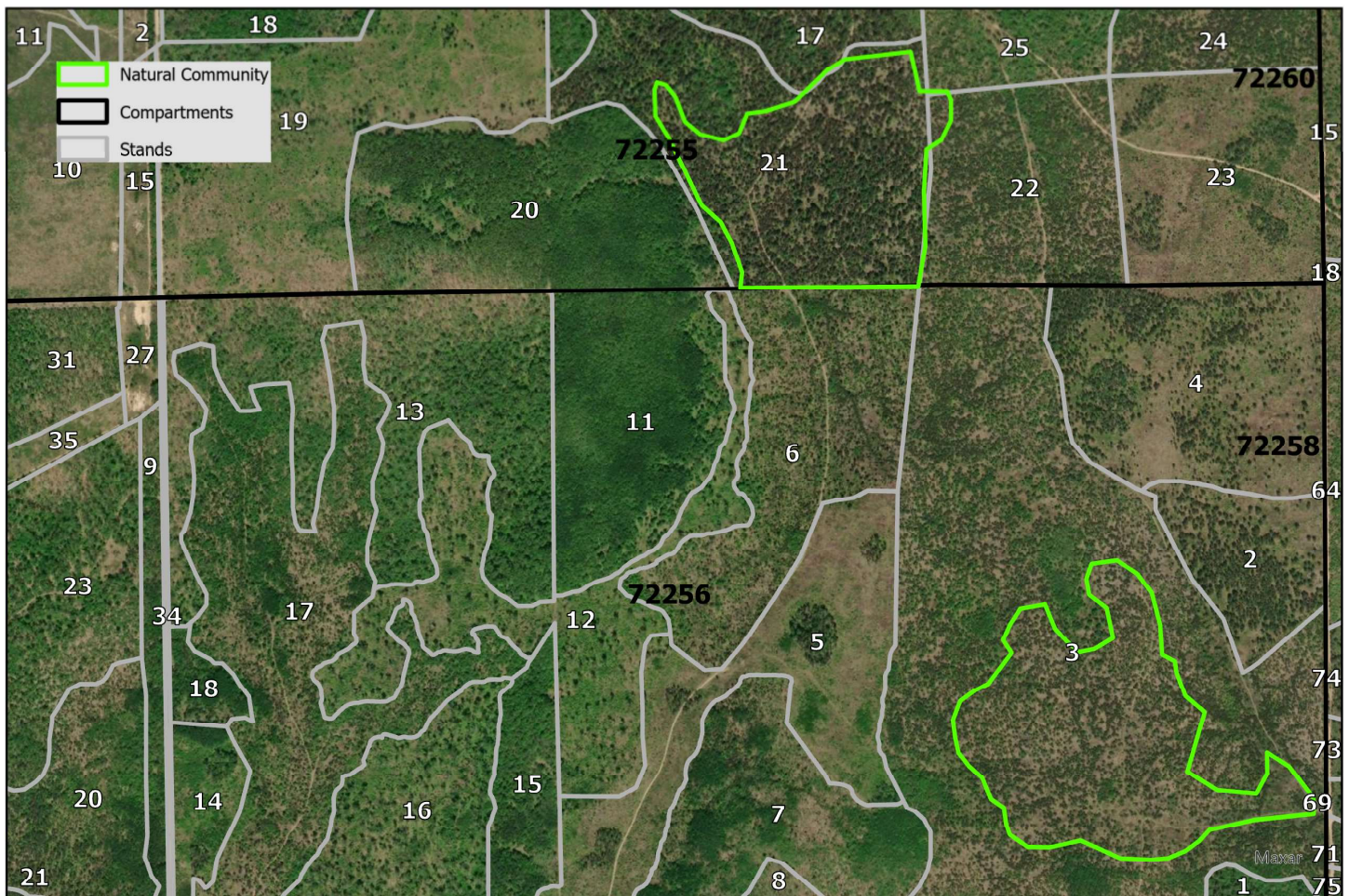


Figure 10: Wildwood Barrens pine barrens (EO ID 27661, Grayling FMU).

Management Recommendations: The overarching management goal is to develop a large project area that includes surrounding stands to expand and connect the extent of pine barrens and related communities on the landscape. Management would ideally involve: implementing low-intensity prescribed fire to maintain existing canopy pine and increase evenness of conservative forbs and graminoids; treating invasive species; maintaining a variable canopy predominantly of red and jack pine to a coverage of 20 to 70% that includes large openings and clusters of trees consistent with the heterogeneity of barrens; closing trails that run through the barrens, and reducing black cherry at all vegetation strata through fire, mechanical thinning, and/or potentially herbicide application. We recommend burning the site at a frequency of every 5 to 25 years.



Wildwood Barrens is characterized by a canopy of patchy jack pine with some open-grown red pine, northern pin oak, and white oak. Some openings are low diversity and dominated by *Carex pensylvanica* (top photo). Overall, the site has excellent structure and composition and is a large example of pine barrens. The condition of the site could be improved with the application of a low-intensity, low-severity prescribed fire and redirecting trails away from the site. Photos by J.M. Lincoln.

Red Headed Stranger

Natural Community Type: Pine Barrens

Rank: G3 S2, vulnerable globally and imperiled within the state

Element Occurrence Rank: C – Fair Occurrence.

Size: 39.0 acres

Location: Compartment 72239, Stand 22

Element Occurrence Identification Number: 27534

This is a small, diverse pine barrens located at the head of a narrow drainage at the margin of a large ice-contact feature. This drainage functions as a frost pocket, slowing tree growth. This site, adjacent to the Camp Grayling firing range 35, burned in the 1975 North Down River Road fire and again in 1997 - fire scars and cat's-faces are frequent on jack pine (*Pinus banksiana*) and red pine (*P. resinosa*) and 30 to 40 cm DBH dead-standing pines are occasional. Canopy and subcanopy structure is heterogenous, with clumps of trees at varying densities, and large, graminoid-dominated openings dominated by Pennsylvania sedge (*Carex pensylvanica*) and reindeer lichen (*Cladonia* sp.). Jack pine (60 years old and 15-41 cm DBH) dominates the canopy and is well-represented in the regeneration class. There is a sparse supercanopy of red pine (80+ years old), but older cohorts are lacking from the site. Due to a history of fire, this site has representative diversity and composition and a heterogenous structure

lacking in many other pine barrens. Special Concern species Hill's thistle (*Cirsium hillii*) and rough fescue (*Festuca altaica*) have been documented in this pine barrens, as well as a several conservative pine barrens indicator forbs and graminoids, including Gillman's goldenrod (*Solidago simplex*), June grass (*Koeleria macrantha*), bird-foot violet (*Viola pedata*), prairie brome (*Bromus kalmii*), slender ladies-tresses (*Spiranthes lacera*), northern hawkweed (*Hieracium umbellatum*), wood lily (*Lilium philadelphicum*), cylindrical blazing-star (*Liatris cylindracea*), northern blazing-star (*Liatris scariosa*), and balsam ragwort (*Packera paupercula*). A bisecting road (Red Headed Lane) provides access to ORVs and military vehicles and is a source of invasive species, although minimal evidence of impacts from either were observed. Spotted knapweed (*Centaurea stoebe*) and other invasive species are mostly concentrated along the road.

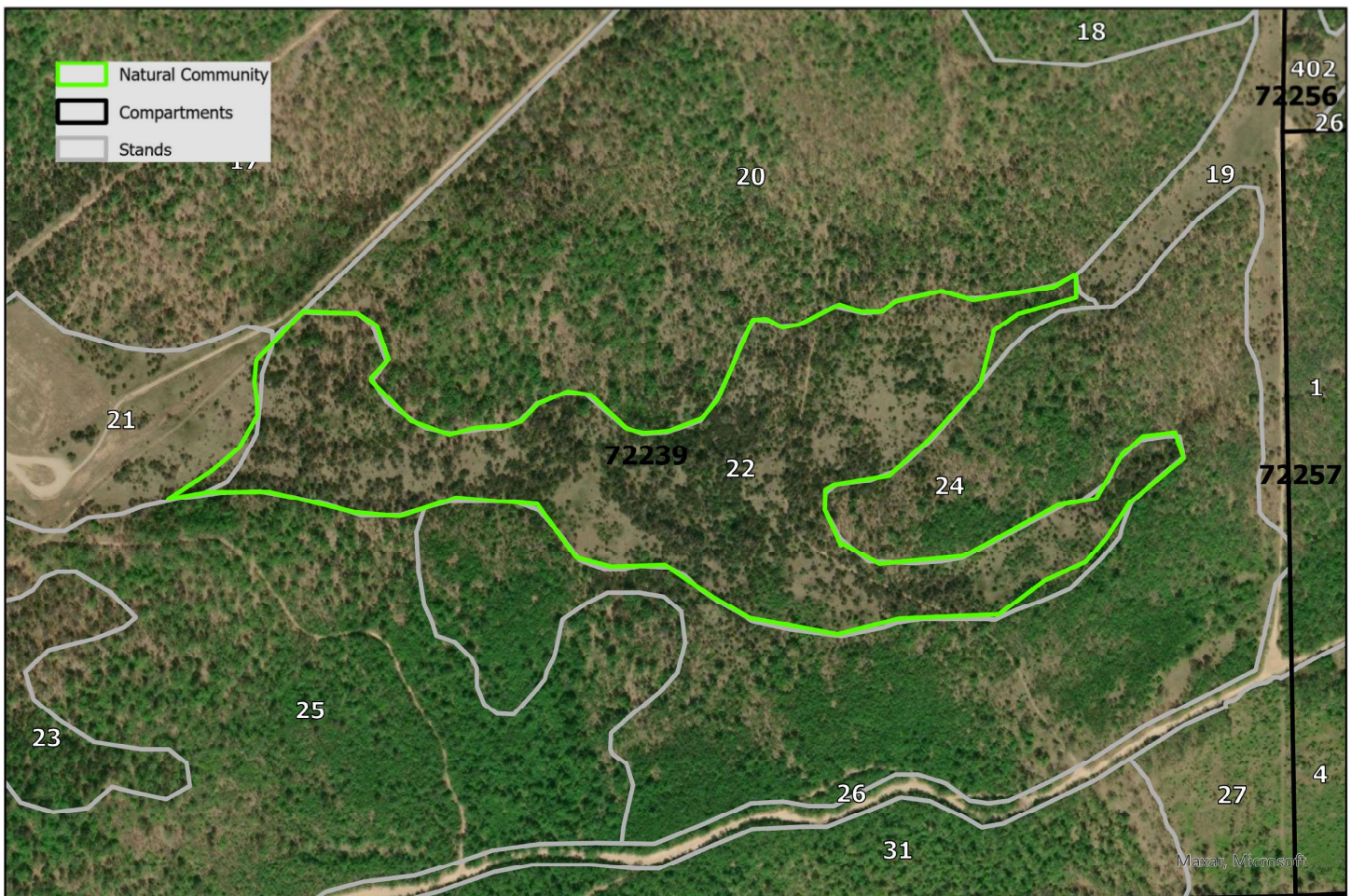


Figure 11: Red Headed Stranger pine barrens (EO ID 27534, Grayling FMU).

Management Recommendations: The overarching management goal is to develop a large project area that includes surrounding stands to expand the extent of pine barrens and related communities on the landscape. Canopy structure in this small pine barrens is within the suggest target of 20 to 70% cover with large openings and clusters of trees consistent with the heterogeneity of barrens. Utilize low-intensity prescribed fire to maintain existing canopy pine and increase evenness of conservative forbs and graminoids. Avoid canopy removal of jack pine and do not cut red pine. Monitor for incursion of oak species from adjacent slopes and invasive species from adjacent two-tracks.



Canopy structure in Red Headed Stranger Barrens is heterogenous, alternating between large openings (*bottom photo*) and sparse patches of jack pine. Both structure and composition are determined in part by 1975 and 1997 wildfires. Many trees showed signs of fire-damage (*top right photo*). Photos by T.J. Bassett.

The Narrow Way

Natural Community Type: Pine Barrens

Rank: G3 S2, vulnerable globally and imperiled within the state

Element Occurrence Rank: CD – Fair to Poor Occurrence.

Size: 134.0 acres

Location: Compartment 72252, Stands 20, 26, 47

Element Occurrence Identification Number: 27533

This pine barrens occurs in two polygons separated by an opening disturbed by military vehicle traffic. Canopy structure is only weakly heterogenous, in part due to a 2000 timber harvest. The western polygon occurs in a narrow drainage that functions as a frost pocket, slowing tree growth. The canopy is dominated by young and even-aged (25 years old) jack pine (*Pinus banksiana*) that regenerated following the 2000 harvest, and most canopy northern pin oak (*Quercus ellipsoidalis*) is multi-stemmed from stump sprouting. Red pine is lacking from much of the site. Regeneration of both jack pine and northern pin oak is sparse. The low shrub layer is patchy overall but locally continuous and locally dominated by bearberry (*Arctostaphylos uva-ursi*), low sweet blueberry (*Vaccinium angustifolium*), sand cherry (*Prunus pumila*), and sweet fern (*Comptonia peregrina*). Prairie willow (*Salix humilis*) is occasional throughout. The ground layer is characterized by moderately

high species richness and evenness, and is rich with conservative and indicator species. Large open areas are dominated by Pennsylvania sedge (*Carex pensylvanica*), poverty grass (*Danthonia spicata*), little bluestem (*Schizachyrium scoparium*), and reindeer lichen (*Cladonia* sp.), although high-diversity patches are found throughout. Gillman's goldenrod (*Solidago simplex*) and northern blazing star (*Liatris scariosa*) are frequent to locally common in openings, while most conservative or indicator species are rare to uncommon, including western sunflower (*Helianthus occidentalis*), showy goldenrod (*Solidago speciosa*), prairie brome (*Bromus kalmii*), June grass (*Koeleria macrantha*), northern hawkweed (*Hieracium umbellatum*), bird's-foot violet (*Viola pedata*), and upland white goldenrod (*Solidago ptarmicoides*). Special Concern Hill's thistle (*Cirsium hillii*) occurs in this barrens. Non-native species are uncommon to rare, including common St.-John's wort (*Hypericum*

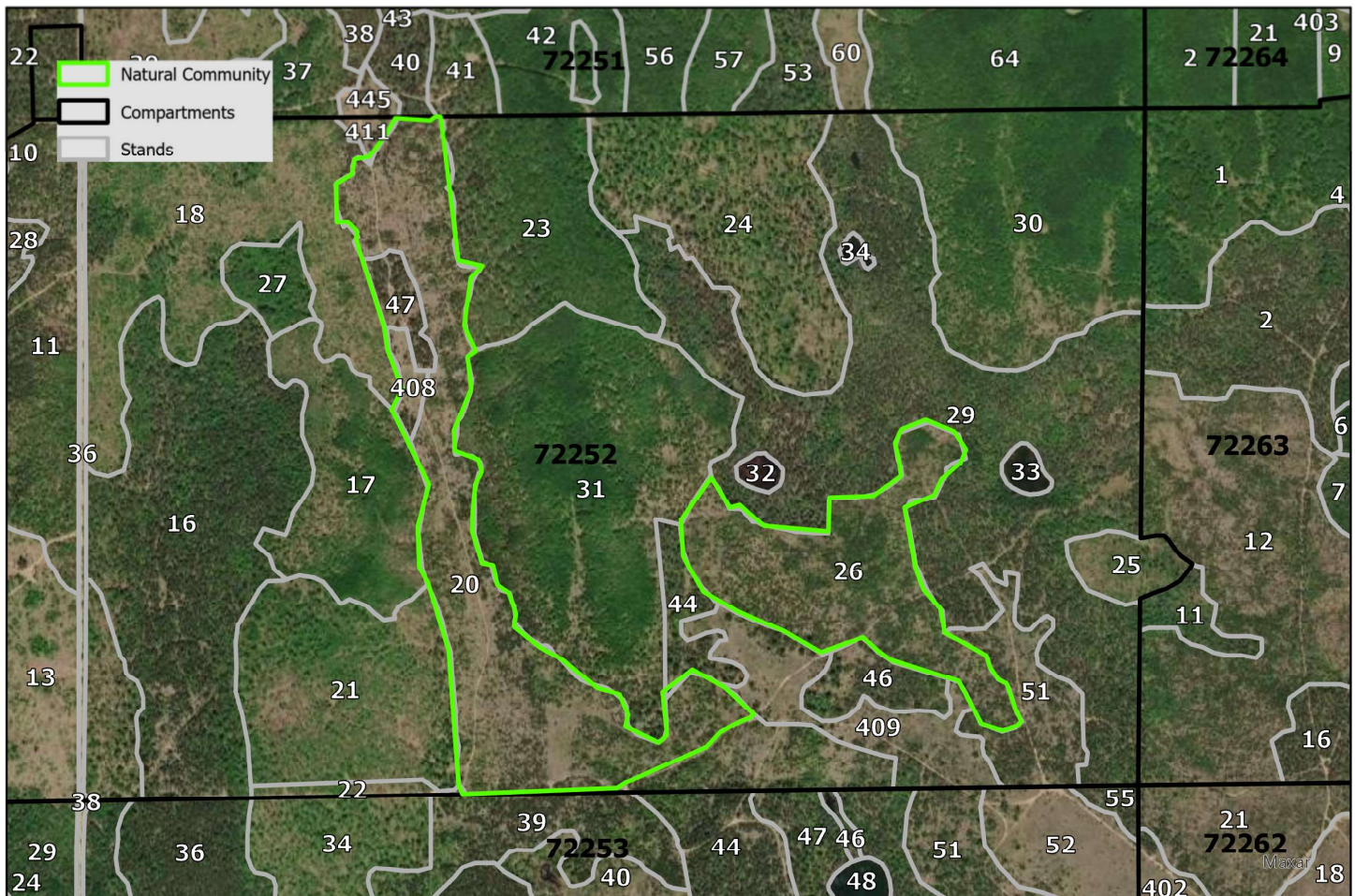


Figure 12: The Narrow Way pine barrens (EO ID 27533, Grayling FMU).

perforatum), spotted knapweed (*Centaurea stoebe*), and king-devil (*Hieracium caespitosum*). There is no evidence of recent fire. *Formica* ant mounds are uncommon. Apparent soil disturbance and mounds from uncertain origin occur in the eastern polygon, possibly due to military vehicles training.

Management Recommendations:

The overarching management goal is to develop a large project area that includes surrounding stands to expand the extent of pine barrens and related communities on the landscape. We suggest canopy openness target of 20 to 70% with large openings. The site is within this range but mostly lacks the spatial heterogeneity characteristic of barrens. Utilize low-intensity prescribed fire to maintain existing canopy pine and increase heterogeneity through stochastic recruitment, and also increase evenness of conservative forbs and graminoids. Avoid canopy removal of jack pine. Monitor for incursion of oak species from adjacent slopes and invasive species from adjacent two-tracks.



The Narrow Way pine barrens is characterized by a narrow open zone in the western polygon flanked by sparse jack pine on the margins (*bottom photo*). Conservative plant species such as northern blazing star (*top right photo*) were observed throughout the site. Photos by T.J. Bassett.

Clare's Way Barrens

Natural Community Type: Pine Barrens

Rank: G3 S2, vulnerable globally and imperiled within the state

Element Occurrence Rank: CD – Fair to Poor Occurrence.

Size: 92.5 acres

Location: Compartment 72275, Stands 8, 9, 10, 11

Element Occurrence Identification Number: 27730

This is a moderately large pine barrens that mostly lacks the heterogenous canopy structure that characterizes barrens due to a strongly bi-modal canopy structure cover. This structure is the result of a 1988 timber harvest resulting in very low canopy cover (0-30%) in the northern and southern portions that are centered around dry sand prairie-like frost pockets; and fire-suppression in the central portion resulting in high cover (70-80% with openings). The retained canopy is dominated by 19 to 37 cm DBH jack pine (*Pinus banksiana*) with a significant component of northern pin oak (*Quercus ellipsoidalis*) and red pine (*Pinus resinosa*), and ranges in age from 80 (jack pine) to 170 (red pine) years. Some natural jack pine mortality was noted in the more forested central section (Stand 9), emphasizing the advanced age of that section. Open patches derived from logging include multi-stemmed northern pin oak.

Regeneration of jack pine and black cherry (*Prunus serotina*) are common but patchily distributed. The low shrub layer is diverse at 16 species, with sand cherry (*Prunus pumila*) and sweet fern (*Comptonia peregrina*) most abundant. Pennsylvania sedge (*Carex pensylvanica*) is dominant in the ground layer, at least locally, and large areas are dominated by disturbance-adapted but characteristic barrens species like hairgrass (*Avenella flexuosa*) in closed-canopied portions and poverty oatgrass (*Danthonia spicata*) in open-canopied portions. Species indicative of persistent closed-canopied conditions also occur locally, including poke milkweed (*Asclepias exaltata*) and wood anemone (*Anemone quinquefolia*). Diversity in the ground layer is high with many conservative species, including Special Concern Hill's thistle (*Cirsium hillii*) and rough fescue (*Festuca altaica*), as well as prairie brome (*Bromus kalmii*),



Figure 13: Clare's Way Barrens pine barrens (EO ID 27730, Grayling FMU).

June grass (*Koeleria macrantha*), Canada hawkweed (*Hieracium kalmii*), northern blazing star (*Liatris scariosa*), cylindrical blazing star (*L. cylindracea*), and long-leaved bluets (*Houstonia longifolia*). Non-native invasive species occasionally dense, especially spotted St.-John's wort (*Hypericum perforatum*), orange hawkweed (*Hieracium aurantiacum*), and King devil (*Hieracium caespitosum*), likely due to disturbance associated with 1988 logging. Fresh bear sign was observed containing blueberries. Dens of either badgers or red fox were observed in the southernmost frost pocket.

Management Recommendations: The overarching management goal is to introduce low-intensity fire to encourage the spatially heterogeneous canopy structure characteristic of barrens. Utilize low-intensity prescribed fire to maintain existing canopy pine and increase heterogeneity through stochastic recruitment, and also increase evenness of conservative forbs and graminoids and reduce invasive species. Limit canopy removal of jack pine to Stand 9 and avoid cutting red pine altogether, maintaining a variable canopy predominantly of red and jack pine to a coverage of 20 to 70% that includes large openings.



The canopy in the central portion of Clare's Way Barrens (Stand 9) is mostly dense, but openings remain that support typical barrens species like Hill's thistle. Photo by T.J. Bassett.

612 West Barrens

Natural Community Type: Pine Barrens

Rank: G3 S2, vulnerable globally and imperiled within the state

Element Occurrence Rank: D –Poor Occurrence.

Size: 89.4 acres

Location: Compartment 72174, Stands 11, 14

Element Occurrence Identification Number: 27731

This is a moderately large pine barrens in a narrow glacial drainage associated with the Manistee River. Canopy structure is somewhat representative of barrens heterogeneity. Jack pine (*Pinus banksiana*) is dominant, with a significant red pine (*P. resinosa*) supercanopy. Canopy trees were between 15 and 50 cm DBH, and were estimated to be 60 years old or less. Pine regeneration is limited due to fire-suppression and northern pin oak (*Quercus ellipsoidalis*) regeneration is locally abundant. Black cherry is regenerating well throughout the site and occurs occasionally in both the subcanopy and low shrub layers. The low shrub layer is consistently patchy throughout (40% cover on average) and dominated by low sweet blueberry (*Vaccinium angustifolium*) and bearberry (*Arctostaphylos uva-ursi*). The ground layer is continuous (90% cover) and dominated by Pennsylvania sedge (*Carex pensylvanica*). Non-vascular species are locally

common, including reindeer lichen (*Cladonia* sp.) and pin cushion moss (*Leucobryum* sp.). Several conservative or indicator species were observed, including showy goldenrod (*Solidago speciosa*), Gillman's goldenrod (*S. simplex*), northern blazing star (*Liatris scariosa*), racemed milkwort (*Polygala polygama*), long-leaved bluets (*Houstonia longifolia*), and Drummond's rock cress (*Boechea stricta*). There are some signs of anthropogenic disturbance. A natural gas well occurs within the barrens. An ORV trail runs through the EO and a two-track and gas pipeline form the northwestern boundary, introducing non-native species and soil disturbance. Non-native species are uncommon and almost entirely limited to the margins of the ORV trail and roads, and include smooth brome (*Bromus inermis*), spotted knapweed (*Centaurea stoebe*), king devil (*Hieracium caespitosum*), common St.-John's wort (*Hypericum perforatum*), and white sweet clover (*Melilotus albus*).

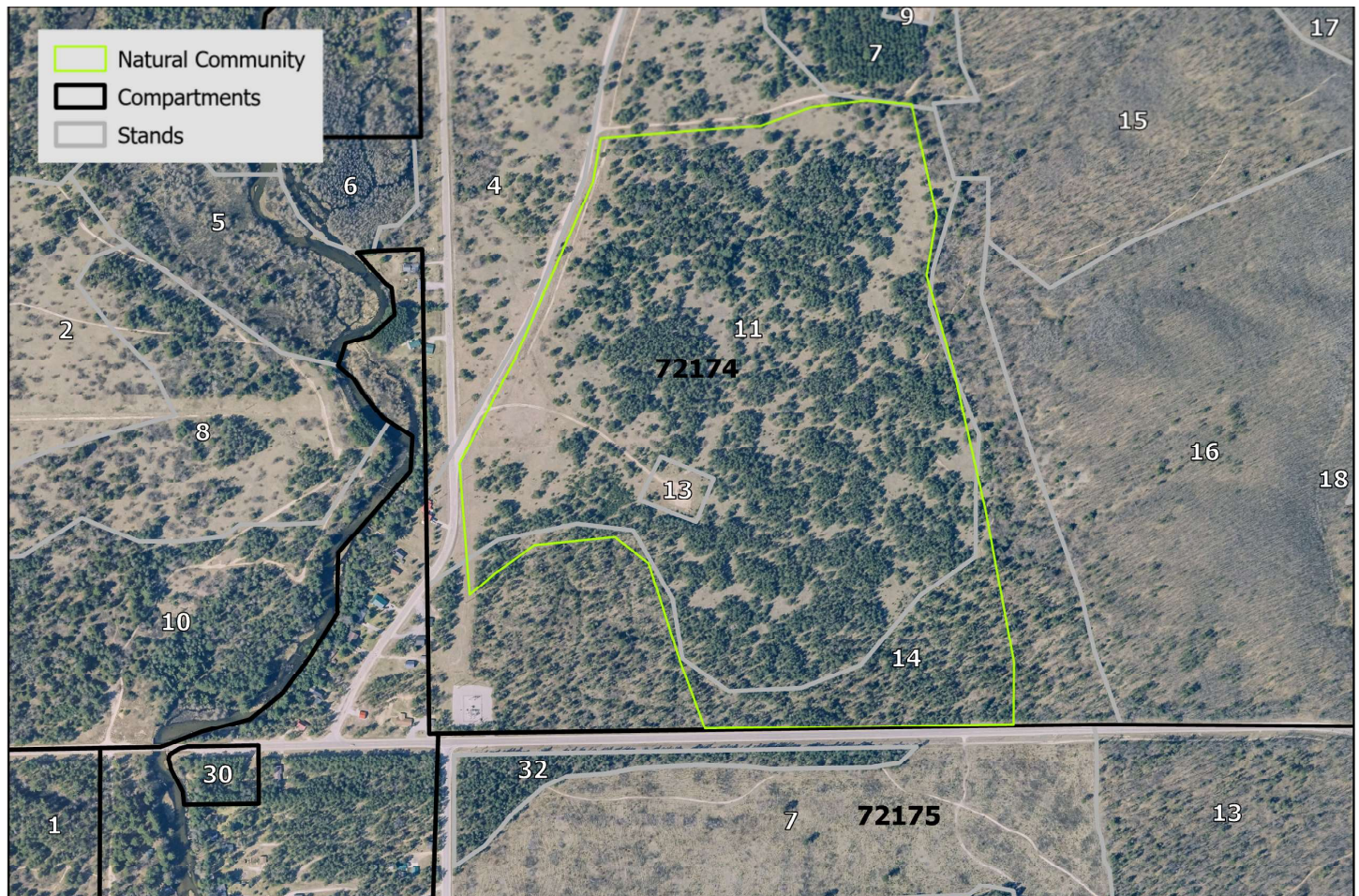


Figure 14: 612 West Barrens pine barrens (EO ID 27731, Grayling FMU).

Management Recommendations:

The overarching management goal is to introduce low-intensity fire to encourage the spatially heterogeneous canopy structure characteristic of barrens. Utilize low-intensity prescribed fire to maintain existing canopy pine and increase heterogeneity through stochastic recruitment, and also increase evenness of conservative forbs and graminoids and reduce invasive species. Limit canopy removal of jack pine and avoid cutting red pine altogether, maintaining a variable canopy predominantly of red and jack pine to a coverage of 20 to 70% that includes large openings. If fire does not reduce black cherry, consider mechanical and herbicide treatments.



Canopy structure in 612 West Barrens is heterogenous, alternating between large openings (*bottom photo*) and sparse patches of jack pine. There are several clumps of supercanopy red pine throughout (*top right photo*). Photos by T.J. Bassett.

Natural Community Descriptions – Roscommon FMU

Dry Northern Forest

Turney Ranch Trail

Natural Community Type: Dry Northern Forest

Rank: G3 S3, vulnerable globally and vulnerable within in the state

Element Occurrence Rank: C – Fair Occurrence.

Size: 123.4 acres

Location: Compartment 71077, Stand 140

Element Occurrence Identification Number: 27532

This is a large dry northern forest along a SW-NE ridgeline with heterogeneity in species composition and canopy age that was structured by the 1988 Perry Holt and possibly other fires. The canopy approaches full closure (90%) and is dominated by 12 to 32 cm DBH jack pine, aged either 65 or 105 years old, with bands of supercanopy 30 to 45 cm (100 yr) red pine supercanopy, and scattered northern pin (*Quercus ellipsoidalis*) and white oak (*Q. alba*). The subcanopy is mostly sparse (30%), possibly due to recent fire, and is dominated by jack pine, and in decreasing order northern pin oak, red pine, and white oak. Low sweet blueberry (*Vaccinium angustifolium*) and huckleberry (*Gaylussacia baccata*) are both occasional to locally dominant and sweet fern

(*Comptonia peregrina*) is common in the low shrub layer, which is patchy overall (40%) as herbaceous vascular and non-vascular plants dominate the ground layer. The non-woody component of the ground layer is continuous (95% cover) is split ~ 60 to 40% between vascular (multiple species) and non-vascular (mostly feather moss) plants. Feather mosses are abundant and reindeer lichen (*Cladonia* sp.) is common. Pennsylvania sedge (*Carex pensylvanica*), bracken fern (*Pteridium aquilinum*), and ground-cedar (*Diphasiastrum tristachyum*) are all common to frequent. Non-native species were not documented. Black cherry (*Prunus serotina*) was not observed in the subcanopy or other vertical strata.

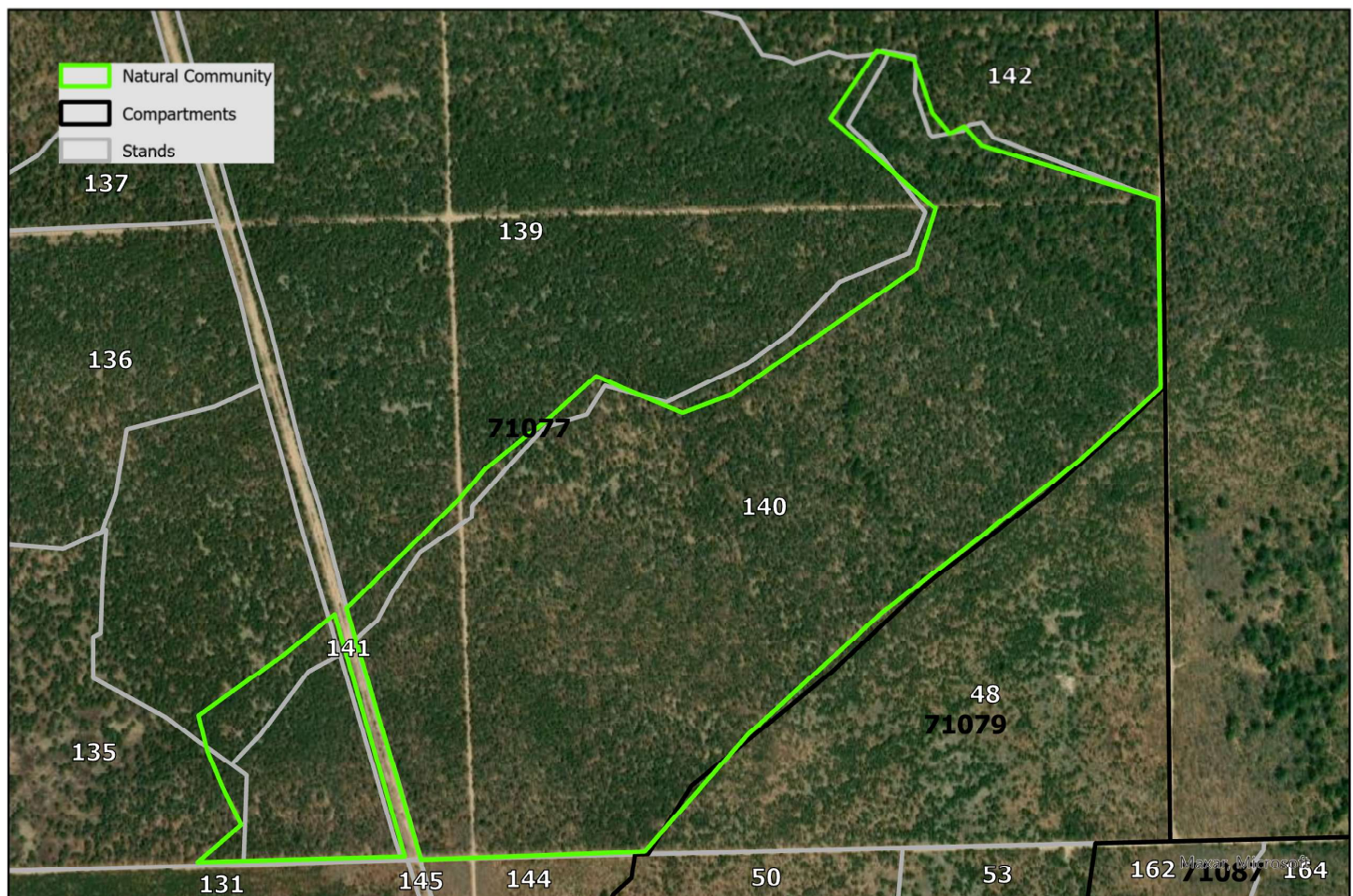


Figure 15: Turney Ranch Trail dry northern forest (EO ID 27532, Roscommon FMU).

Management Recommendations: Our top recommendation is to apply low-intensity fire to this forest, including the EO and adjacent stands supporting pine-dominated systems. Maintain existing canopy pine by applying low intensity, late growing to dormant season (late September through early March) fire every 10 to 30 years.



Turney Ranch Trail dry northern forest is dominated by ~ 100-year-old jack pine. Species composition is dominated by species with forest affinities, such as patches of feather mosses, bracken fern, and huckleberry (*bottom photo*). Many jack and red pine trees showed fire scars (*top*). Photos by T.J. Bassett.

Dry-mesic Northern Forest

East Creek Forest

Natural Community Type: Dry-mesic Northern Forest

Rank: G4 S3, apparently secure globally and vulnerable within in the state

Element Occurrence Rank: C – Fair Occurrence.

Size: 46.5 acres

Location: Compartment 71064, Stands 57, 64

Element Occurrence Identification Number: 27669

This is a small dry-mesic northern forest, in fair condition. This forest is a maturing (~100 to 120 years old), second-growth pine forest with individual trees around 200 years old, particularly on the isolated peninsula that forms the western polygon. Red pine (*Pinus resinosa*) is the dominant tree and some in the 180- to 200-year-old cohort are developing complex structure and emerging into the supercanopy. The site is mesifying with white pine (*P. strobus*) and red maple (*Acer rubrum*) common in the understory and minimal red pine recruitment. The low shrub layer features huckleberry *Gaylussacia baccata* and blueberry (*Vaccinium angustifolium*) though not flowering or bearing fruit. The herbaceous layer is sparse and characterized by low diversity that is typical of this community type. However, the floristic composition has been impacted by both fire suppression and high deer browse pressure. The primary graminoids include Pennsylvania sedge *Carex pensylvanica*, rough-leaved rice-grass

(*Oryzopsis asperifolia*), and hair grass (*Avenella flexuosa*). Forbs are at low abundance and include Canada mayflower (*Maianthemum canadense*), cow-wheat (*Melampyrum lineare*), and star flower (*Trientalis borealis*). Bracken fern (*Pteridium aquilinum*) is common to dominant throughout the forest. Coarse woody debris is developing towards an abundance typical of a mature forest, including canopy deadwood on old trees, cavities, and rotting wood on the forest floor. The adjacent northern wet meadow is high quality and the ecotone along the forest is especially diverse.

Old red pine stumps from late 1800 clearing events persist on the landscape and several had fire scars. The presence of fire scars on tree stumps indicate this area was historically influenced by Indigenous cultural fires. A cross section was taken from a stump in from the easternmost portion of this forest, along the edge of the wet meadow. It was found to have evidence of

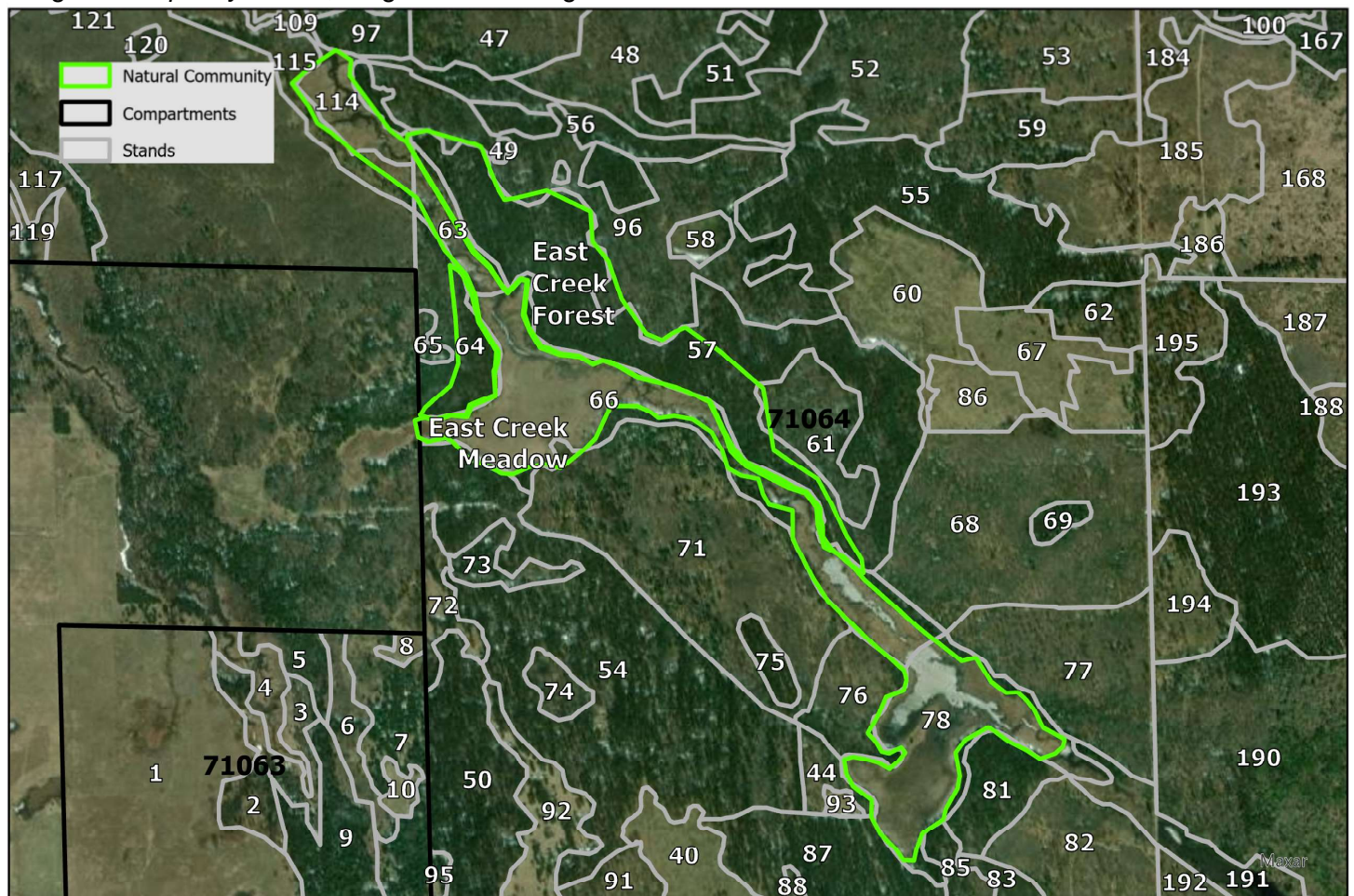


Figure 16: East Creek Forest dry-mesic northern forest (EO ID 27669, Roscommon FMU).

five fires with 10, 17, 18, and 10 years between the fires.

Management Recommendations: Our top recommendation is to return fire to the landscape. We recommend developing large burn units that include the adjacent wet meadow, using the stream as a natural burn break, and avoiding equipment in the ecotone transition between wet meadow and

forest. Maintain existing canopy pine by applying low intensity, late growing to dormant season (late September through early March) fire every 10 to 30 years. Over time, the application of fire will reduce white pine and red maple and facilitate red pine recruitment. We recommend including other surrounding stands in prescribed burns, protecting the site from ORVs, and preventing logging equipment from crossing saturated soils in nearby wetlands.



East Creek Forest occurs at the edges of East Creek Meadow (top photo). The canopy of the forest is dominated by red pine but the understory is mesifying with white pine, red maple, and balsam fir as prevalent components (bottom photo). Red pine is not regenerating as a result of fire suppression. The condition of the site could be improved with low-severity, low-intensity prescribed fire and we encourage managers to include surrounding stands in prescribed fires, especially the adjacent northern wet meadow. Photos by J.M. Lincoln.

Northern Wet Meadow

East Creek Meadow

Natural Community Type: Northern Wet Meadow

Rank: G4G5 S4, apparently secure to secure globally and apparently secure within in the state

Element Occurrence Rank: B – Good Occurrence.

Size: 67.9 acres

Location: Compartment 71064, Stands 63, 66, 78

Element Occurrence Identification Number: 27668

This is a large, sedge- and shrub-dominated meadow in a beaver-mediated opening along East Creek. This wet meadow has intact hydrology, characteristic heterogeneous zonation, moderate diversity for the community type, and minimal invasive species. Tussock sedge (*Carex stricta*) is dominant but other graminoids are occasional to common, including blue-joint (*Calamagrostis canadensis*), wiregrass sedge (*Carex lasiocarpa*), three-way sedge (*Dulichium arundinaceum*), spike-rush (*Eleocharis intermedia*), northern manna grass (*Glyceria borealis*), and native reed (*Phragmites americanus*). Forbs are less abundant and include boneset (*Eupatorium perfoliatum*), wild blue flag (*Iris versicolor*), wild mint

(*Mentha canadensis*), and rough-leaved goldenrod (*Solidago rugosa*). Past beaver floodings along the creek drive vegetation patterning in several areas.

Management Recommendations: Our recommendations are to provide a large, forested buffer between the meadow and logging activities on adjacent uplands to prevent additional fragmentation, runoff, and alterations to the hydrology. We also suggest managers include the meadow in prescribed burns with adjacent forested uplands, using the stream as a fire break and not creating a fire break along the ecotone.

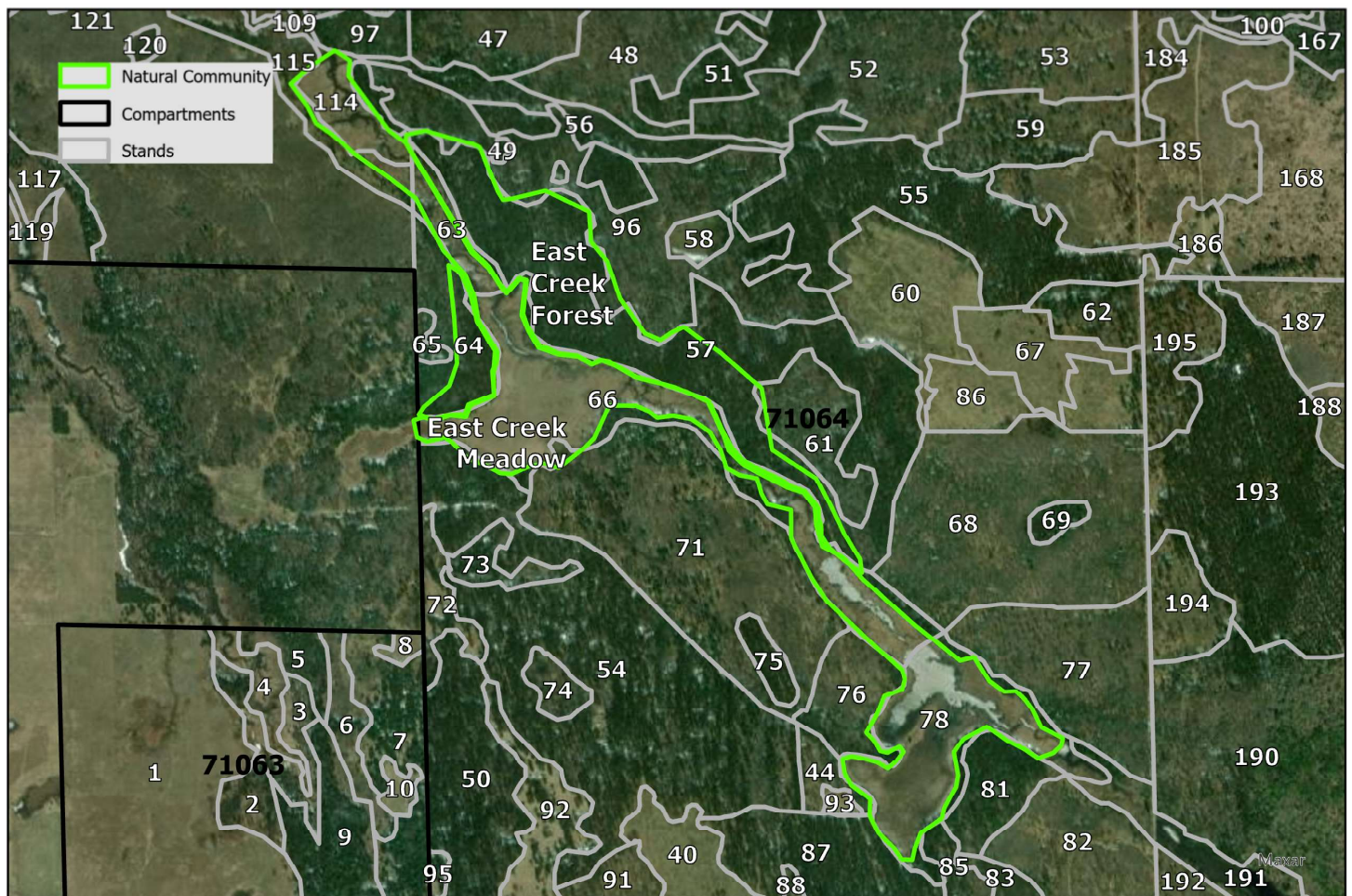


Figure 17: East Creek Meadow northern wet meadow (EO ID 27668, Roscommon FMU).

Pine Barrens

Kinsey Hunt Barrens

Natural Community Type: Pine Barrens

Rank: G3 S2, vulnerable globally and imperiled within the state

Element Occurrence Rank: AB – Fair Occurrence.

Size: 190.1 acres

Location: Compartment 71073, Stand 85

Element Occurrence Identification Number: 27485

This is a large pine barrens in excellent to good condition. This pine barrens occupies the fire scar of the 1999 Mech Fire. About 90% of the site supports a younger cohort of jack pine (*Pinus banksiana*) with around 30% canopy coverage. Trees are consistently about 20 cm dbh, 20- to 30-year-old (germinated after 1999 Mech Fire), and 5 to 7 m tall. Stunted clumps of northern pin oak (*Quercus ellipsoidalis*) are in the 30-year-old cohort and are locally abundant. About 10% of the site supports zones of an older cohort of jack pine (55 to 80 years old). The zones not impacted by fire feature deep feather moss (*Pleurozium schreberi*) and typically have lower diversity but greater structural complexity than the open areas where fire killed the existing canopy cohort in 1999. The open zones are characterized by extensive low shrubs. Sand cherry (*Prunus pumila*)

and low sweet blueberry (*Vaccinium angustifolium*), are the most dominant shrubs covering between 50 to 70% of the openings. Openings impacted by the fire can have extensive patches of lichen. Graminoids are dominant in the herbaceous layer with Pennsylvania sedge (*Carex pensylvanica*) and little bluestem (*Schizachyrium scoparium*) as the most prevalent graminoids in the openings. Several clumps of the Special Concern rough fescue (*Festuca altaica*) were observed in the southeastern portion of the barrens. Forbs are typically at low abundance with long-leaved bluets (*Houstonia longifolia*), balsam ragwort (*Packera paupercula*), tall lettuce (*Lactuca canadensis*), and common frostweed (*Crocianthemum canadense*) among the more common species. The Special Concern Hill's thistle (*Cirsium hillii*) is uncommon throughout.

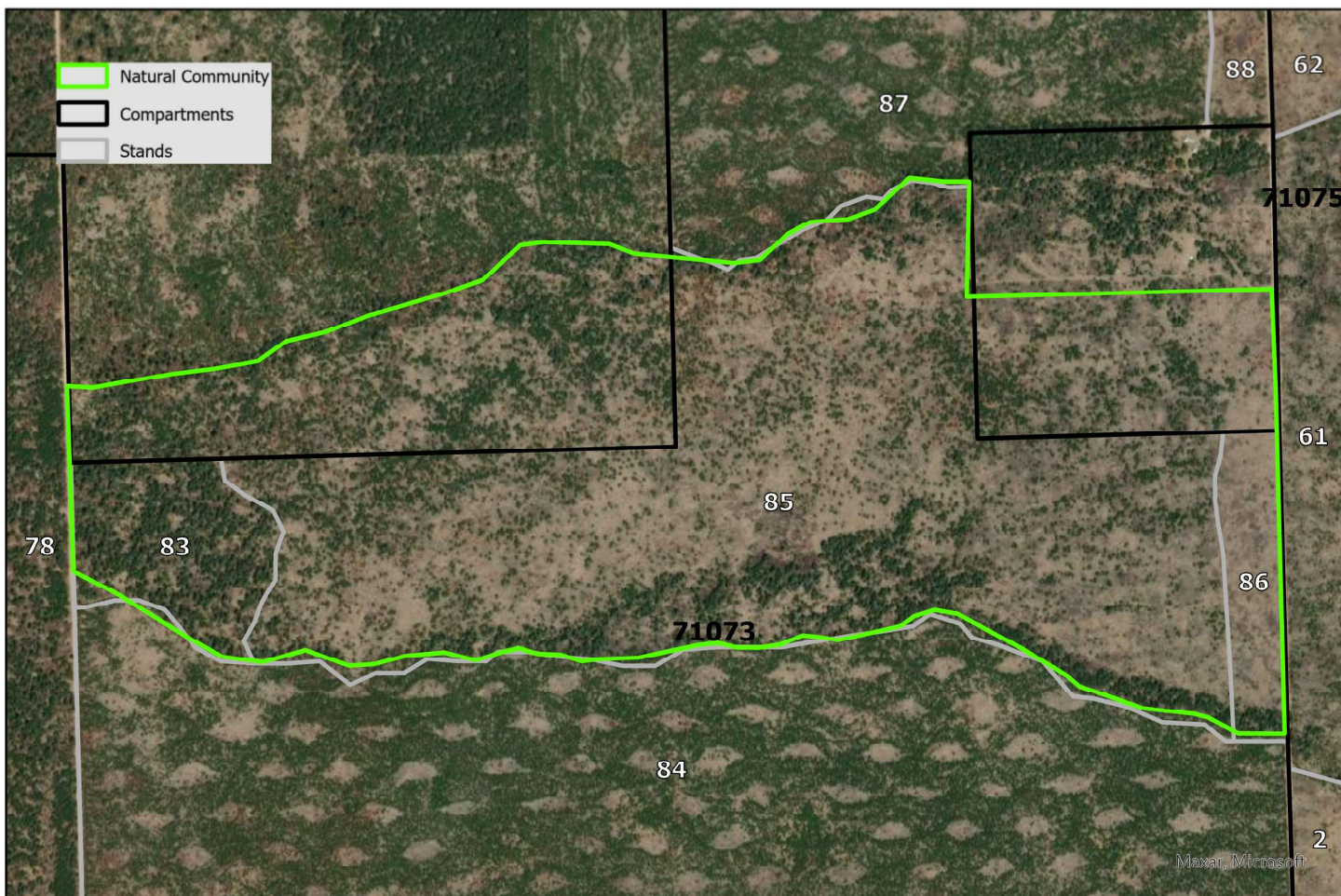


Figure 18: Kinsey Hunt Barrens pine barrens (EO ID 27485, Roscommon FMU).

With the exception of a few, isolated patches of Kentucky bluegrass (*Poa pratensis*) and low levels of king devil (*Hieracium casepitosum*), the interior of this barrens is largely free from invasive species. Common St. John's-wort (*Hypericum perforatum*) is infrequent to locally abundant along the road that forms the eastern boundary and has the potential to spread into quality areas, especially with the prevalence of ORVs.

Management Recommendations: Our primary recommendations are to prevent conversion to the jack pine weave plantation, protect the site from ORVs, and eventually reintroduce fire. The site currently does not need prescribed fire but it could be introduced in the next 5 to 10 years. Ideally, surrounding portions of jack pine weave could be

included in prescribed fires and returned to a natural state to expand the high-quality barrens and improve the condition of the surrounding landscape.

When fire is applied, we urge managers not to mechanically alter the site and to apply a low-intensity, low-severity burn that would minimize canopy mortality. This could best be accomplished when needle moisture and needle density are highest, likely during the late growing season (late September to November) or very early dormant season (March to April). This would produce a patchy fire with short flame lengths. Ideally this would be as large of a burn as the site would allow, using roads as fire breaks to expand the amount of high-quality habitat associated with this site. We recommend burning at a frequency of every 5 to 25 years.



Kinsey Hunt Barrens occupies the fire scar caused by the 1999 Mech Fire. There are two cohorts of jack pine and this contributes to the structural heterogeneity of the site. Photo by J.M. Lincoln.

South Creek Barrens

Natural Community Type: Pine Barrens

Rank: G3 S2, vulnerable globally and imperiled within the state

Element Occurrence Rank: BC – Good to Fair Occurrence.

Size: 227.2 acres

Location: Compartment 71071, Stands 55 and 56

Element Occurrence Identification Number: 26198

This is a pine barrens in two adjacent portions with different fire histories. The northern open-canopied portion (Stand 55) resulted from a 2013 wildfire and the southern portion (Stand 56) has an aging canopy generated by a 1964 wildfire. The canopy of the southern portion (70% cover with many small canopy gaps) is dominated by 16 to 30 cm DBH jack pine (*Pinus banksiana*) with northern pin oak (*Quercus ellipsoidalis*), black cherry (*Prunus serotina*), trembling aspen (*Populus tremuloides*) are occasional to rare canopy components. The canopy regenerated following the 1964 wildfire – a 27.2 cm jack pine had 59 rings and a 39.0 cm red pine (*Pinus resinosa*) had 60 rings. The subcanopy is mostly sparse (20% cover) and is comprised of occasional jack pine and black cherry, with red pine and white pine (*Pinus strobus*) rare (the latter restricted to open areas). The low shrub layer is fairly continuous and dense in many portions (60% cover). Sand cherry (*Prunus pumila*) and low sweet blueberry (*Vaccinium angustifolium*)

are abundant to locally dominant and sweet fern (*Comptonia peregrina*) and bearberry (*Arctostaphylos uva-ursi*) are common to frequent. A few individuals of New Jersey tea (*Ceanothus herbaceus*) and pasture rose (*Rosa carolina*) were observed. The ground layer is continuous or interspersed with dense portions of low shrub layer (80-90% cover) and dominated by either Pennsylvania sedge (*Carex pensylvanica*) or feather mosses, with reindeer lichen also abundant (*Cladonia* sp.). The influence of fire is apparent in the presence and occasionally abundance of indicator pine barrens species, including prairie brome (*Bromus kalmii*), June grass (*Koeleria macrantha*), three-toothed cinquefoil (*Sibbaldiopsis tridentata*), hairy puccoon (*Lithospermum caroliniense*), Gillman's goldenrod (*Solidago simplex*), and balsam ragwort (*Packera paupercula*). Non-native species are well-established, in part due to a two-track bisecting stand 56, but never dense. Common St.-John's wort (*Hypericum perforatum*) was occasional and king

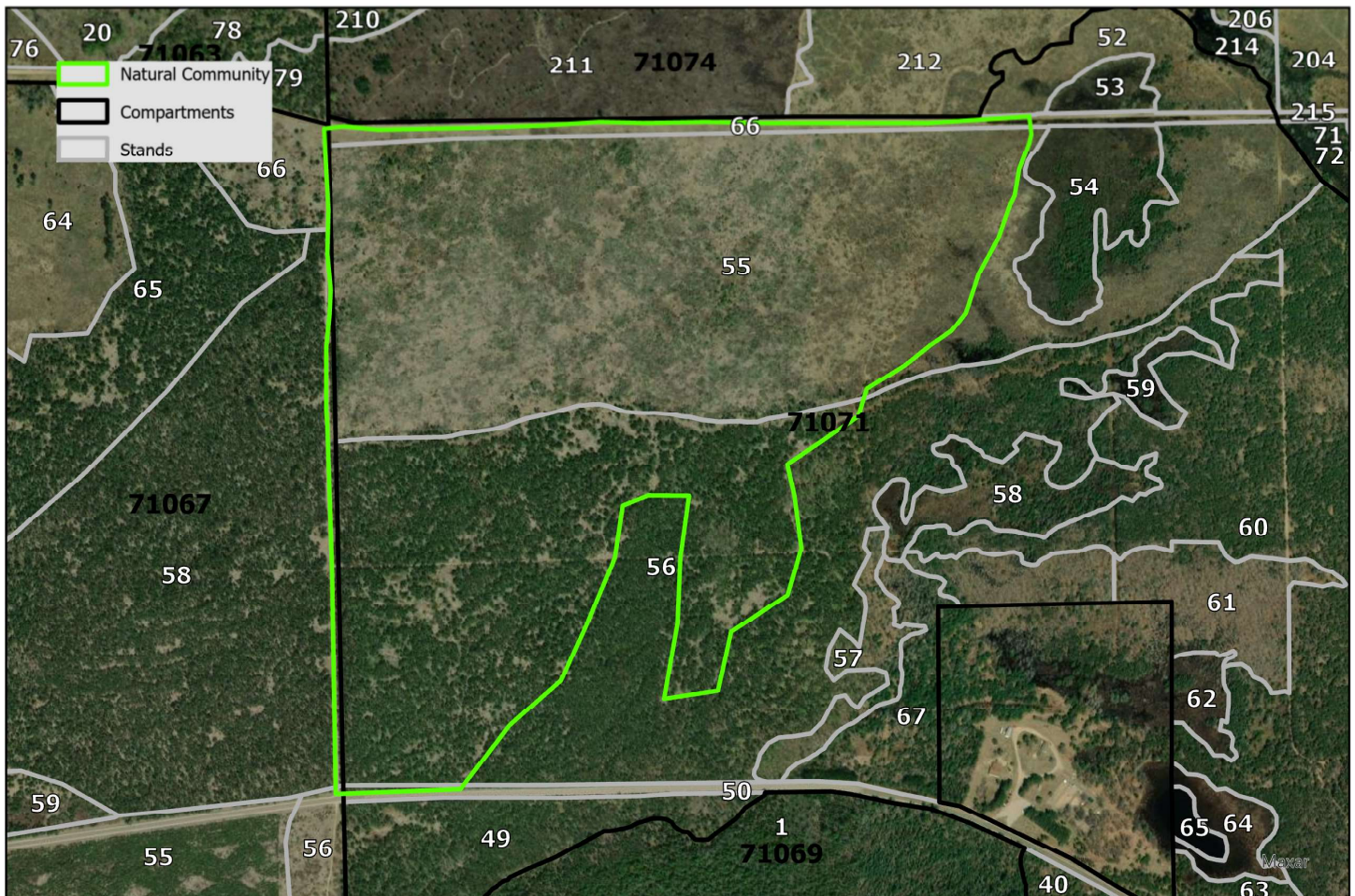


Figure 19: South Creek Barrens pine barrens (EO ID 26198, Roscommon FMU).

devil (*Hieracium caespitosum*) was uncommon. Some areas with the densest canopy (more or less in the center of southern portion) had dense coarse wood debris (5-10 cm DBH jack pine), although much of this was not mapped with the EO. *Formica* ant mounds are locally abundant.

We surveyed a small section of the northern portion in 2024 which has a mostly open canopy structure (5% cover) from a 2013 wildfire. Northern pin oak and black cherry resprouts are becoming dense in the regeneration layer and range from 2 to 5 m tall. Low sweet blueberry and sweet fern are generally dominant in the low shrub layer and Pennsylvania sedge and false melic (*Schizachne purpurascens*) are dominant in the herbaceous layer. The low shrub layer also includes sand cherry, choke cherry (*Prunus virginiana*), snowberry (*Symphoricarpos albus*), shadbush serviceberry (*Amelanchier spicata*), prairie willow (*Salix humilis*), and meadowsweet (*Spiraea alba*). The ground layer also includes big and little bluestem, poverty grass (*Danthonia spicata*), June grass, smooth blue aster, slender wheatgrass (*Elymus trachycaulus*), rough-leaved rice-grass (*Oryzopsis asperifolia*), hairy goldenrod (*Solidago hispida*), Hill's thistle (*Cirsium hillii*, Special Concern), wild bergamot (*Monarda fistulosa*), and low bindweed (*Calystegia spithamea*). Weedy native fireweed

(*Erechtites hieraciifolium*) and non-native bull thistle (*Cirsium vulgare*) were also observed.

Management Recommendations: Our primary recommendations are to avoid conversion to plantation forestry, and to maintain diversity, composition and structure primarily with low-intensity fire. We recommend against clearcuts and other intensive silvicultural practices such as furrowing and scarification. However, black cherry resprouts are dense enough to shade out barrens vegetation and may require mechanical or herbicide treatments. The site has a bi-modal canopy density, with either densely or sparsely canopied portions. The goal of applying fire to the site is to increase the heterogeneity of canopy structure by encouraging pine recruitment in the northern portion and slowly thinning the canopy of the southern portion. Conditions are appropriate for a low-intensity fire when needle moisture is highest, such as during the late growing season (late September to November) or very early dormant season (March to April). Ideally, surrounding managed forests, including jack pine weave plantations, could be included in prescribed fires to improve the condition of the surrounding landscape. We recommend burning at a frequency of every 5 to 25 years.



South Creek Barrens has an open-canopied portion in the north (to the right in photo) and a portion in the south with a patchy canopy approaching closed-canopied conditions (to the left). Photo by T.J. Bassett.

Perry Holt Barrens

Natural Community Type: Pine Barrens

Rank: G3 S2, vulnerable globally and imperiled within the state

Element Occurrence Rank: BC – Good to Fair Occurrence.

Size: 99.0 acres

Location: Compartment 71078, Stand 34; Compartment 71079, Stands 49, 62

Element Occurrence Identification Number: 27651

This is a large pine barrens in good condition. This EO exists as 6 separate polygons that occupy the fire scar of the 1988 Perry Holt Fire. The open zones have around 30% canopy coverage of jack pine (*Pinus banksiana*) and feature the characteristic open pine barrens structure. Trees are consistently about 20 cm dbh and 20- to 30-year-old (germinated after 1988 Perry Holt Fire), and 5 to 7 m tall. Red pine (*P. resinosa*) were relatively rare but one 59.0 cm dbh red pine had a fire scar with at least 2 fires and had 109 growth rings. Some jack pine thickets are dense and though generally small, are forming closed-canopy conditions.

The open zones are characterized by extensive sand cherry (*Prunus pumila*) and low sweet blueberry (*Vaccinium angustifolium*). The Special Concern Alleghany plum (*Prunus umbellata*) was observed at a single location. Graminoids are dominant in the herbaceous layer with Pennsylvania sedge (*Carex pensylvanica*), hair grass (*Avenella flexuosa*), June

grass (*Koeleria macrantha*), rice-grass (*Piptatherum pungens*), false melic (*Schizachne purpurascens*), big bluestem (*Andropogon gerardii*), and little bluestem (*Schizachyrium scoparium*). Several clumps of the Special Concern species rough fescue (*Festuca altaica*) were observed in the multiple polygons of the barrens in openings impacted by the fire. Forbs are at low abundance and include harebell (*Campanula rotundifolia*), balsam ragwort (*Packera paupercula*), tall lettuce (*Lactuca canadensis*), violets (*Viola sagittata* and *V. pedata*), and goldenrods (*Solidago hispida*, *S. speciosa*, and *S. ptarmicoides*). The Special Concern species Hill's thistle (*Cirsium hillii*) is uncommon throughout.

With the exception of a few, isolated patches of Kentucky bluegrass (*Poa pratensis*) and low levels of king devil (*Hieracium caespitosum*), the interior of this barrens is largely free from invasive species. Others are infrequent to locally abundant along the road that forms the eastern boundary and have the

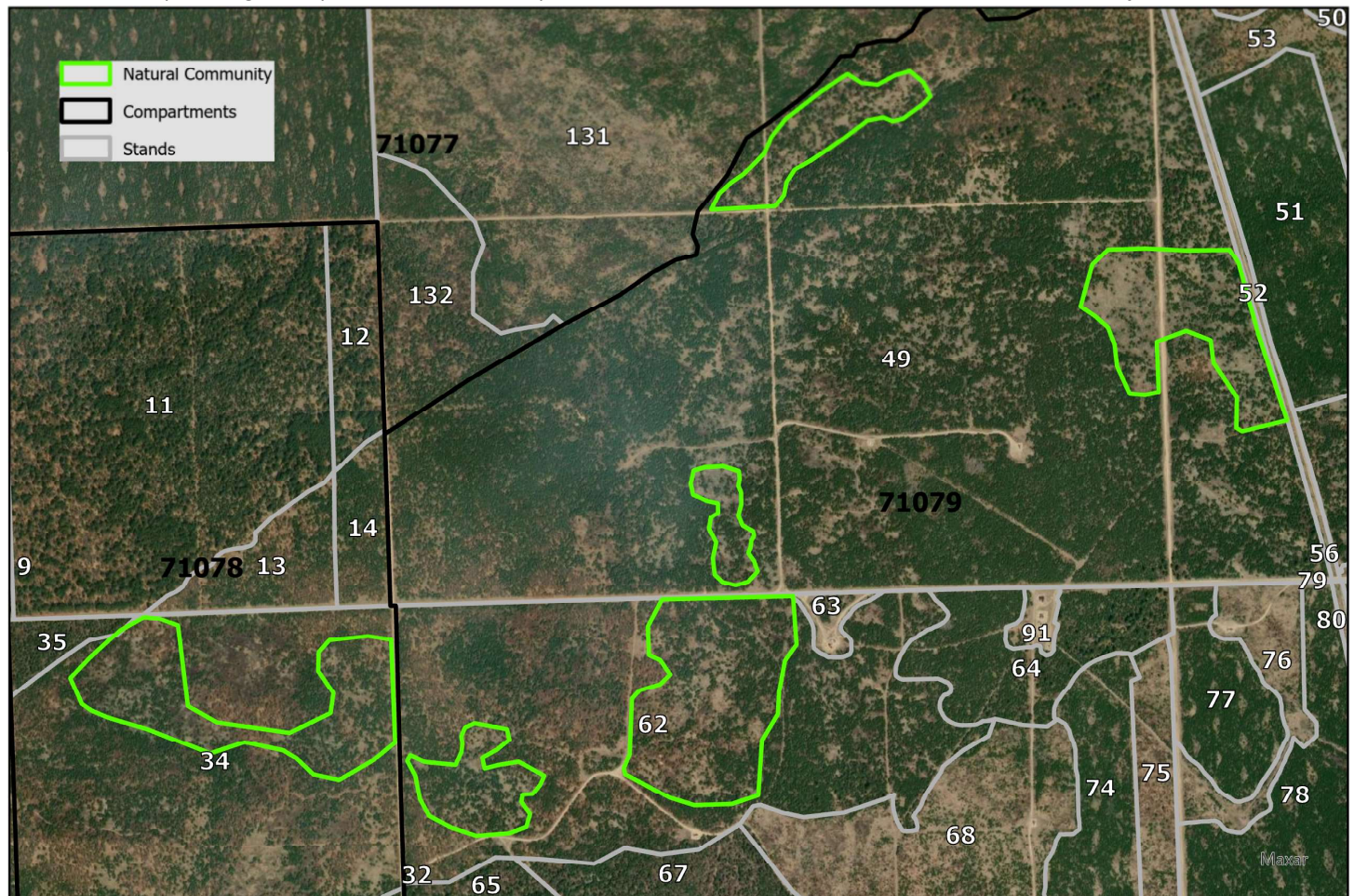


Figure 20: Perry Holt Barrens pine barrens (EO ID 27651, Roscommon FMU).

potential to spread into quality areas, especially with the prevalence of ORVs.

There are areas within the pine barrens that seem to have been furrowed, perhaps prior to the 1988 Perry Holt fire. These past disturbances to the soil are subtle and often difficult to perceive. The composition of the mapped areas is that of characteristic pine barrens and overall the site is very diverse. The polygons of high-quality habitat are separated by thickets of jack pine with lower species diversity. There are numerous roads and trails between the polygons. There are also several oil pads and access drives that will make future fires difficult to execute.

Management Recommendations: Much of the surrounding landscape is being converted to plantations and our primary recommendation is to limit the conversion of natural cover to the jack pine weave plantation. Much of the surrounding area could

be recovered to an improved pine barrens condition and additional surveys for high-quality habitat are warranted. Prescribed fires should include all of the high-quality polygons and any surrounding jack pine forest adjacent to these mapped areas.

Some of the surrounding stands may need to have mechanical treatments prior to a fire, but we urge managers to minimize this treatment to limit soil disturbance. When applying the first fire, we suggest managers apply a low-intensity, low severity burn that would minimize canopy mortality. This could best be accomplished when needle moisture and needle density are highest, possibly during the late growing season (late September to November) or very early dormant season (March to April). This would produce a patchy fire with short flame lengths. Ideally this would be as large of a burn as the site would allow, using roads as fire breaks. We recommend burning at a frequency of every 5 to 25 years.



Perry Holt Barrens occupies the site burned in the 1988 fire by the same name. Photo by J.M. Lincoln.

McGregor Barrens

Natural Community Type: Pine Barrens

Rank: G3 S2, vulnerable globally and imperiled within the state

Element Occurrence Rank: C – Fair Occurrence.

Size: 132.5 acres

Location: Compartment 71072, Stand 22

Element Occurrence Identification Number: 27531

This is a large fire-origin pine barrens located in rolling topography. Canopy structure is very clustered, mostly alternating between dense (80% cover) clusters of jack pine (*Pinus banksiana*) that vary in size from <0.5 to < 5 acres and large openings dominated by Pennsylvania sedge (*Carex pensylvanica*), sand cherry (*Prunus pumila*), and low sweet blueberry (*Vaccinium angustifolium*). The size of the openings is variable, with larger dense patches of jack pine and prairie willow (*Salix humilis*) in the southwestern portion below a low ridge line. Towards the north, there are smaller and more scattered patches of jack pine. The young canopy reflects the impact of the 1995 Perry Holt III Fire on this stand. Jack pine (10-25 cm DBH and 30-40 yrs old) dominates the canopy. Black cherry (*Prunus serotina*) and northern pin oak (*Quercus ellipsoidalis*) are occasional to uncommon in the canopy and red pine (*Pinus resinosa*) is absent from the canopy and subcanopy (but occasional in both layers of the adjacent closed-canopied stand

24 to the southwest). Many standing dead trees are scattered throughout, and canopy northern pin oak trees are often multi-stemmed due to resprouting after the fire. The clumped subcanopy or recruitment class in this EO includes jack pine and black cherry as occasional and northern pin oak as uncommon. There are patches of very dense small-diameter (5-10 cm) jack pine regeneration, especially in the southwest, and increasingly alternating with medium-diameter (10-25 cm) even-aged canopy to subcanopy patches to the northeast. The groundlayer is dominated by herbaceous and low shrub species, while non-vascular species are uncommon to occasional, including reindeer lichen (*Cladonia* sp.) in openings and feather mosses in dense pine. Sweet low blueberry is abundant to locally dominant, especially in the openings, where sand cherry and sweet fern (*Comptonia peregrina*) are common. Prairie willow is also common overall but locally dense in the southwestern ¼ and patchy in the

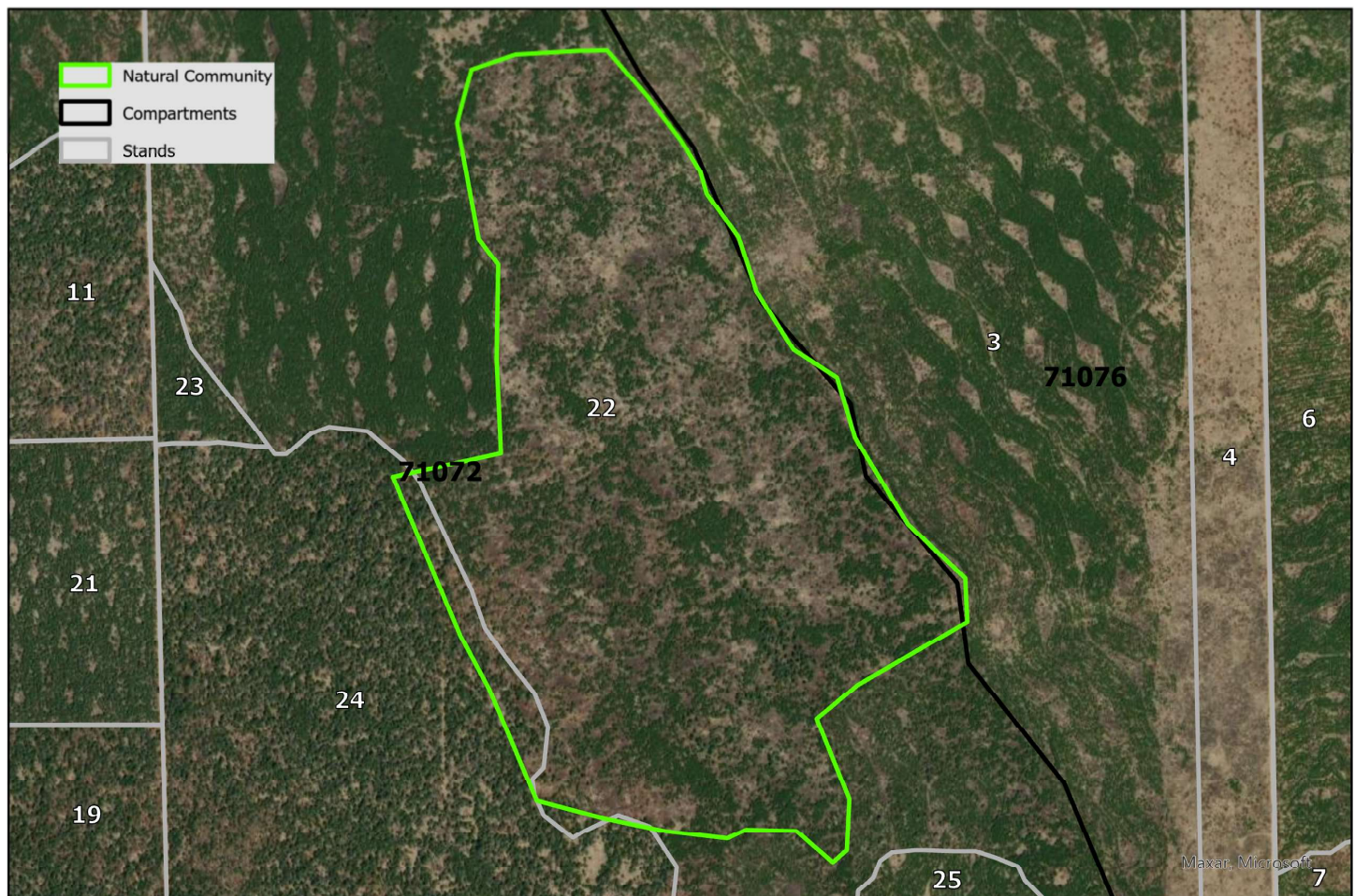


Figure 21: McGregor Barrens pine barrens (EO ID 27531, Roscommon FMU).

northeastern $\frac{3}{4}$. Species with forest affinities are more common in the southwest, particularly bracken fern (*Pteridium aquilinum*) and rough-leaved rice-grass (*Oryzopsis asperifolia*), which are locally dominant in the southwest in dense patches of jack pine and prairie willow. The forb diversity is concentrated in the northern $\frac{1}{2}$. Barrens-associated species increase in abundance with larger openings to the northeast. Conservative or indicator forbs and graminoids are mostly rare to uncommon (or locally common) but observed throughout, including prairie brome (*Bromus kalmii*), balsam ragwort (*Packera paupercula*), upland white goldenrod (*Solidago ptarmicoides*), June grass (*Koeleria macrantha*), rough fescue (*Festuca altiaca*, Special Concern), slender ladies-tresses (*Spiranthes lacera*), long-leaved bluets (*Houstonia longifolia*), and northern and cylindrical blazing star (*Liatris scariosa* and *L. cylindracea*). The abundance and frequency of species such as prairie brome, rough fescue, and June grass is likely a response to recent fire. Deer browse was noted on northern blazing star. Non-native species are uncommon to rare and include common St.-John's wort (*Hypericum perforatum*),

Kentucky bluegrass (*Poa pratensis*), sheep sorrel (*Rumex acetosella*), and goat's beard (*Tragopogon dubius*).

Management Recommendations: Our primary recommendations are to avoid conversion to plantation forestry, and to maintain diversity, composition and structure primarily with low-intensity fire. We recommend against clearcuts and other intensive silvicultural practices such as furrowing and scarification. The goal of applying fire to the site is to enhance the heterogeneity of canopy structure by encouraging pine recruitment in openings and slowly thinning the canopy elsewhere. Conditions are appropriate for a low-intensity fire when needle moisture is highest, such as during the late growing season (late September to November) or very early dormant season (March to April). Ideally, surrounding managed forests, including jack pine weave plantation, could be included in prescribed fires to improve the condition of the surrounding landscape. We suggest burning at a frequency of every 5 to 25 years.



Several large openings characterize McGregor Barrens. The majority of the floristic diversity is found in these openings. Photo by T.J. Bassett.

Sunset Barrens

Natural Community Type: Pine Barrens

Rank: G3 S2, vulnerable globally and imperiled within the state

Element Occurrence Rank: C – Good to Fair Occurrence.

Size: 45.8 acres

Location: Compartment 71064, Stand 37

Element Occurrence Identification Number: 27486

This is a small pine barrens remnant in fair condition. The areas with characteristic pine barrens structure have between 20 and 70% canopy coverage of jack pine (*Pinus banksiana*) with sparse red pine (*Pinus resinosa*) and black cherry (*Prunus serotina*) along with infrequent northern pin oak (*Quercus ellipsoidalis*). Most Jack pine were between 25 and 40 cm dbh and around 40 to 50 years old. Locally this pine barrens trends towards a forested system, particularly in the southern portion. The low shrub layer is locally dense sweet fern (*Comptonia peregrina*), sand cherry (*Prunus pumila*), low sweet blueberry (*Vaccinium angustifolium*), and prairie willow (*Salix humilis*). Graminoids are dominant throughout with Pennsylvania sedge (*Carex pensylvanica*), hair grass (*Avenella flexuosa*), false melic (*Schizachne purpurascens*), big bluestem

(*Andropogon gerardii*), and prairie brome (*Bromus kalmii*). Characteristic forbs include wild strawberry (*Fragaria virginiana*), northern blazing star (*Liatris scariosa*), hairy goldenrod (*Solidago hispida*), old-field cinquefoil (*Potentilla simplex*), low bindweed (*Calystegia spithamea*), and the Special Concern species Hill's thistle (*Cirsium hillii*) is uncommon throughout. Kentucky bluegrass (*Poa pratensis*), sheep sorrel (*Rumex acetosella*), and common St. John's-wort (*Hypericum perforatum*) are locally abundant along the trail in the northern portion of the barrens and have the potential to spread into quality areas, especially with the prevalence of ORVs.

Management Recommendations: Our top management recommendations are to prevent logging at this site and develop a large project area that

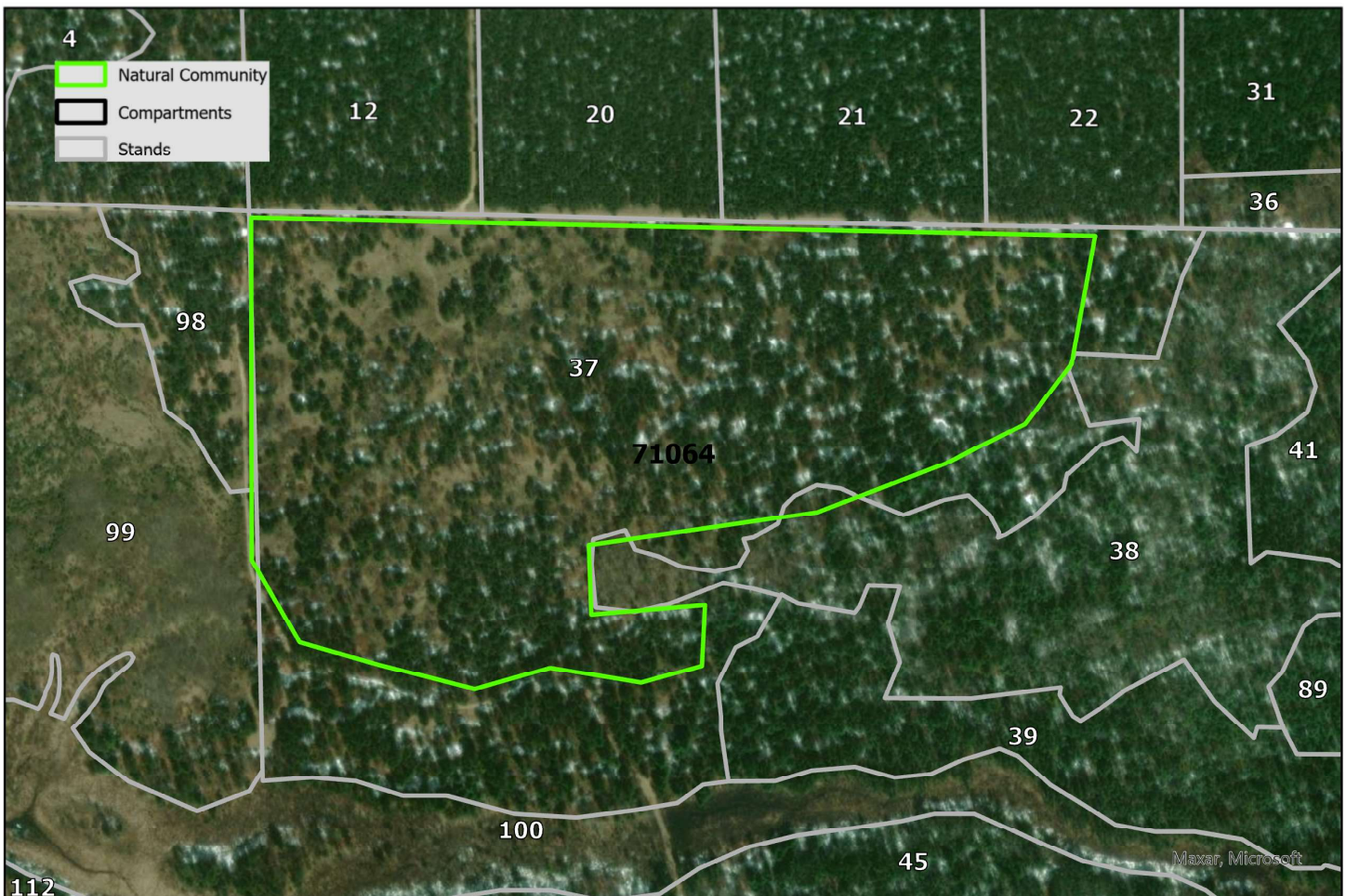


Figure 22: Sunset Barrens pine barrens (EO ID 27486, Roscommon FMU).

includes surrounding stands to expand the patch of pine barrens. Management would ideally involve implementing low-intensity prescribed fire to maintain existing canopy pine; treating invasive species; maintaining a variable canopy predominantly of red and jack pine to a coverage of around 50% with a range between 20 and 70% that includes large openings and clusters of trees consistent with the heterogeneity of barrens; and reducing black cherry in all vegetation strata through fire, mechanical thinning, and/or potentially herbicide application. We recommend burning at a frequency of every 5 to 25 years.



Sunset Barrens has excellent structure with open-grown red pine. Photos by J.M. Lincoln.

DISCUSSION

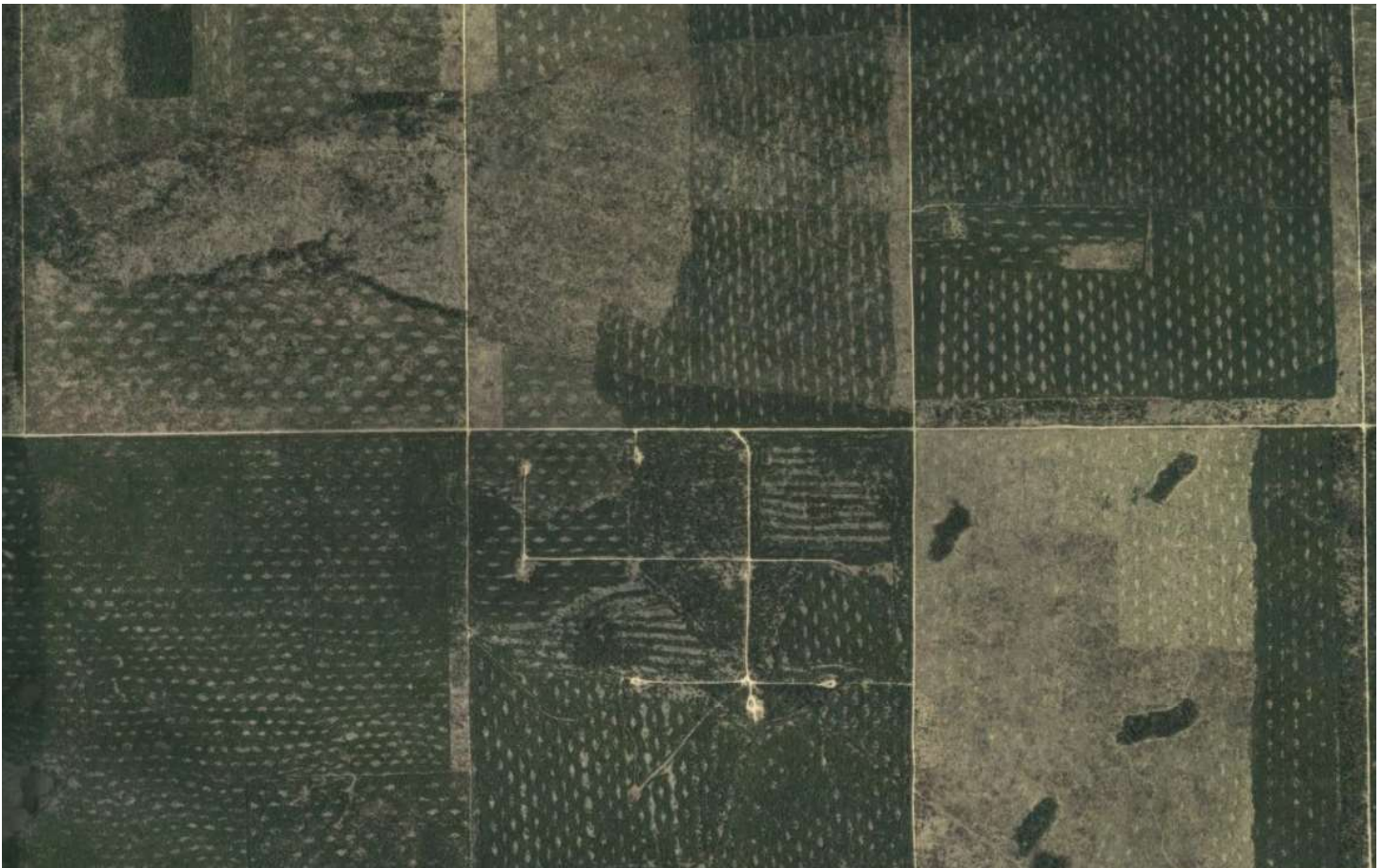
Applying the prescribed fire needs assessment model to the Grayling and Roscommon Forest Management Units (FMU) was an effective method for developing site leads for identifying previously undocumented high-quality natural communities. Field evaluation of these site leads resulted in the documentation of 16 natural communities and the identification of numerous recoverable, fire-dependent systems (RFDS) that are suitable for inclusion in long-term restoration projects. These RFDS do not currently meet the standards of high-quality natural community but can serve as valuable focal points for stewardship actions to recover and enhance existing natural communities.

The conservation of pine barrens is a regional priority because of the severe decline in the community type and Kirtland's warbler (*Setophaga kirtlandii*, State Threatened) and other rare species that depend upon pine barrens. Pine barrens once covered over 270,000 acres in Michigan (Comer et al. 1995). Approximately 50.5% (136,518 acres) of those pine barrens occurred in the Highplains Sub-section of Northern Lower Michigan (Albert 1995) (Figure 2). There were 133 distinct patches of barrens in northern Michigan documented during the GLO surveys in the

mid-1800s. These historic barrens were an average of 1,027 acres in size with the largest being 17,772 acres. Today, there are 41 documented pine barrens in Michigan, including 10 newly documented during this study. These remaining sites range in size from 9 to 920 acres and cover ~ 2 % (5,785 acres) of the *a priori* extent, meaning a decline of nearly 98% of the natural community type in the past 200 years.

This decline in pine barrens is due to fire suppression, agricultural uses, and conversion to pine plantations. Pine barrens occur in a fire-dependent landscape that supports several other natural communities that require fire to stimulate regeneration of canopy tree species and the forbs and graminoids that comprise the majority of plant diversity. Examples include dry northern forest, dry-mesic northern forest, dry sand prairie, and oak pine barrens. Because barrens were the rarest and most imperiled community type documented during this project, they are the focus of this discussion.

Much of the remaining pine-dominated forests and barrens in the Highplains Subsection have been and continue to be converted to pine plantations.



Large portions of the landscape that were once pine barrens have been converted to the jack pine weave plantation as part of the Kirtland's warbler recovery.

In particular jack pine weave plantations are established to support the Kirtland's warbler (Huber et al. 1996, MDNR, USFWS, and USFS 2014). These plantations are often in areas that were historically pine barrens. During the conversion process, overall plant biodiversity appears to decline at the site level. While expansion of the jack pine plantations has supported recovery of the Kirtland's warbler, broad suites of other species associated with pine barrens are now in decline (e.g., Tucker et al. 2016, Tucker and Kashain 2018). Systems that persisted for thousands of years have become unrecoverable over much of their former extent and the patches that remain are often degraded and much smaller than their historic extent.

The historic landscape was governed by numerous interacting factors that led to a "shifting mosaic" where the boundary between closed-canopied forests and open-canopied savannas shifted over time (Comer et al. 1995). These factors include climate, human occupancy, soil edaphic condition, and populations of large herbivores, such as elk (Cleland 1966). However, fire was and is the disturbance factor that determines canopy structure and plant species composition in pine barrens remnants. Historic Indigenous populations were important igniters of fire and used it for myriad reasons including berry production, reducing ticks, and influencing grazing patterns of wildlife (Cleland 1966, Stewart 2009).



Sites converted to the jack pine weave plantation have diminished diversity and structural complexity. Photo by J.M. Lincoln.



Large areas of recoverable pine barrens are being converted to the jack pine weave plantation. This is substantially reducing biodiversity and eliminating areas of recoverable pine barrens. Photo by J.M. Lincoln.

Management Considerations

Broadly, the goals of the management recommendations are to promote native biodiversity by promoting ecosystem integrity and resiliency. This can be accomplished on a landscape scale by identifying and protecting high-quality natural communities through: the return of landscape-level prescribed fire; control of invasive species; creating large buffers surrounding these sites; restricting the establishment of new plantations from sensitive areas; monitoring the response of systems to management; and iteratively improving stewardship as we learn from monitoring. We also recommend managing sites as larger patch sizes to reflect the historic scale and heterogeneity of pine barrens.

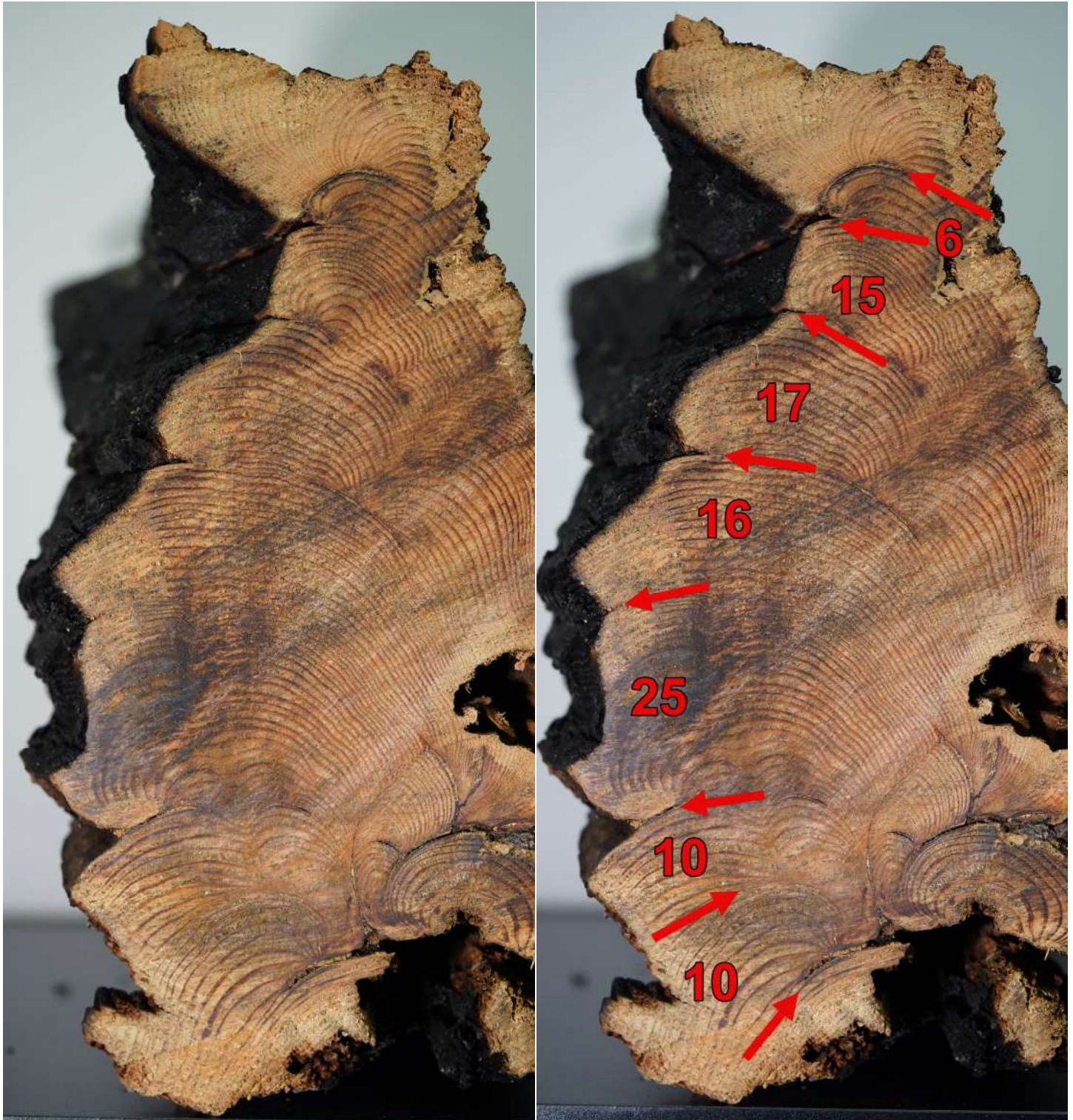
High-quality pine barrens and the numerous species dependent on these systems – including the Kirtland's warbler – assembled, persisted, and thrived under historic Indigenous influence, especially cultural burns. Therefore, the application of prescribed fire that reflects the timing and frequency of Indigenous burning should be the most effective approach for supporting the biodiversity of the region. This will require careful evaluation of fire timing, frequency, and intensity. Ideally, partnerships with Tribes would be established to replicate the cultural practices around fire that promoted the persistence of fire-dependent natural communities.



The area on the left has been converted to jack pine weave plantation for the Kirtland's warbler. Kinsey Hunt Barrens occurs to the right of the weave. We urge managers to attempt to expand high-quality barrens habitat by applying prescribed fire in large blocks, particularly areas adjacent to recoverable pine barrens such as the sites we documented during the 2024 project. Photo by J.M. Lincoln.

Ongoing studies of red pine stumps in the Grayling and Roscommon FMUs suggest a historic fire return interval between 5 and 25 years (MNFI 2024), which closely matches the habitat requirements of Kirtland's warbler which nests in jack pine between the ages of 5 and 23 (Probst 1987). We encourage approximating

that frequency of prescribed fire and conducting burns in the late fall (late September and later) for several reasons. Conducting the initial burn in the dormant season may cause less canopy tree mortality and have less of a destabilizing influence on the understory than a late spring or growing-season burn



A cross-section of red pine stump recovered from a pine barrens in the Mio District of the Huron-Manistee National Forest. Such samples are useful for developing an area's fire history. The stump shows evidence of at least eight fires. These scars are annotated in the image on the right with the number of years between fires indicated. This historic fire frequency in a nearby pine barrens provides managers with a target for fire return intervals of pine barrens. Based on this and other stumps from the area, we urge managers to apply low-intensity prescribed burns at a rate of every 5 to 25 years. Photo by J.M. Lincoln.

(Jolly et al. 2016). Regardless of the seasonality of prescribed fire, these are fire-starved systems and fire at any season is likely more beneficial than continued fire suppression.

We recommend applying prescribed burns across large project areas around RFDS using existing features like roads and rivers as burn breaks. Ideally ecotones or the transition area between upland and lowland would be included within prescribed burn boundaries to avoid damaging these especially diverse areas which have historically been the location of burn breaks and frequently excluded from burns. In addition, we recommend that burn breaks and trails be kept away from high-quality openings to minimize risk of invasive species and limit access for ORVs. Burning more than the identified remnants across the landscape at a landscape scale will potentially express new RFDS.

Additionally, many areas that once supported pine barrens have been converted to jack pine plantation to support the Kirtland's warbler. It appears that once barrens are converted to plantation, when the forbs are exhausted by herbivory, and when the graminoid composition is oversimplified, the capacity to recover the site is greatly diminished. Once lost, returning composition becomes a challenging process that will require substantial time to deliver. We urge managers to avoid converting the most recoverable portions of the landscape to plantation.

In general, we recommend that managers do not supplement the floristic composition of mapped EOs by planting additional species. This can reduce the site's status as a valuable reference area and makes it difficult to elucidate the community response to restoration. Restoration targets not immediately adjacent to high-quality remnants could be supplemented with additional species to improve diversity. We urge managers to use locally sourced seeds or plants as much as possible. Ideally, the seeds would come from nearby remnants. These actions should be carefully recorded so managers can understand the process that leads to future conditions.

Future Work

Monitoring is critical for evaluating the effectiveness of stewardship. We have developed a barrens vegetation monitoring protocol and recommend implementing longitudinal monitoring of these restoration projects to ensure that management approaches are successful in restoring and maintaining barrens structure and composition (Tucker et al. 2018, Bassett and Lincoln 2024).

There were several areas that we were unable to get to during the 2024 surveys and we recommend additional surveys for recoverable, fire-dependent systems in the Grayling and Roscommon FMUs. Applying this methodology to additional state forest FMUs would likely help identify additional conservation priorities.



The highest quality pine barrens we documented during this project were structured by fires and characterized by a spatially heterogeneous, uneven-aged canopy and a diverse plant community. Canopy structure included clumps of jack and often red pine at varying densities, and medium to large, graminoid-dominated openings. The plant community was rich with conservative species indicative of the pine barrens natural community and evenly distributed. Coarse woody debris and dead standing trees were often a component of these sites, as were badger dens and mounds constructed by ants in the genus *Formica*. Photo by J.M. Lincoln.

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APPENDIX

Appendix: Recoverable, fire-dependent systems (RFDS) that did not meet the MNFI standards for a high-quality natural community but still provide conservation value and could be improved with stewardship such as prescribed fire. We urge managers to avoid converting these into pine plantations and instead attempt to recover to improved condition.

Priority Tier	FMU	Compartment	Primary Stands	Other Stands to Include	Community Type	Site Description	Management Recommendations
1	Grayling	72275	28	C72285 - St 25, Pine barrens or Oak- 26 pine barrens		Excellent composition, older jack pine, openings closing in	<ul style="list-style-type: none"> • Low intensity fire • Masticate ~30% of jack pine
1	Grayling	72252	8, 9, 28, 42, 43, 50	NA dry northern forest (42, 43, 50)	Pine barrens (8, 9, 28), dry northern forest (42, 43, 50)	Large ecosystem complex w indicators present but rare. Complex of recoverable pine barrens and dry northern forest adjacent to Frog Lake barrens and intermittent wetland (EOID 16049). Canopy in St 42/43 with ca. 180 yr red pine over ca. 60 yr jack pine.	<ul style="list-style-type: none"> • Treat/mow black cherry in St 28 • Masticate ~30% of jack pine in St 8, 9 • Retain canopy red pine and white oak • Low intensity fire throughout
1	Grayling	72288	19, 58, 27	16, 15, 24, 31 (58), dry northern forest (27)	Pine barrens (19), dry sand prairie forest (27)	This is an excellent site for a large restoration project. There are three community types here and all are borderline EO but small and degraded in some way. Collectively, they are a worthy project area and might be elevated to natural community status with stewardship intervention.	<ul style="list-style-type: none"> • Develop large project area to include multiple habitat types • Masticate young jack pine/aspens/cherry in stands 16, 18 • Apply frequent low intensity fire
1	Grayling	72272	41	C72290- St 30 Pine barrens		Excellent composition, older jack pine, openings closing in. Western half is low diversity.	<ul style="list-style-type: none"> • Low intensity fire • Masticate ~30% of jack pine
1	Grayling	72174	11, 14	4 Pine barrens		EO-quality pine barrens but small and isolated in poor to fair landscape context. High diversity with barrens indicators frequent to uncommon.	<ul style="list-style-type: none"> • Retain at least 30% canopy in cut • Retain all or most canopy red pine • Low intensity fire
1	Grayling	72275	8, 9, 10, 11	NA Pine barrens		High diversity, with barrens indicators including Hill's thistle and rough fescue. Sts 8, 11 cut in 1980s but retain ground flora and structure developing. Sts 9, 11 with older jack pine (ca. 80) and red pine (ca. 180) and in need of thinning.	<ul style="list-style-type: none"> • Thin jack pine in St 9, 11 to about 50% • Retain all or most canopy red pine • Low intensity fire

Appendix (Continued): Recoverable, fire-dependent systems (RFDS) that did not meet the MNFI standards for a high-quality natural community but still provide conservation value and could be improved with stewardship such as prescribed fire. We urge managers to avoid converting these into pine plantations and instead attempt to recover to improved condition.

Priority Tier	FMU	Compartment	Primary Stands	Other Stands to Include	Community Type	Site Description	Management Recommendations
1	Roscommon	71072	11, 17, 18, 19, 20, 24	22	Pine barrens	Some remnant barrens ground layer, mostly dense jack pine (ca 40-60 yrs), with occasional old red pine (ca. 120 yrs) supercanopy. Adjacent with existing pine barrens EOs (EOID 27531 in St 22; EOID 27485 in Comp 71073, St 85) - good project area.	<ul style="list-style-type: none"> • Close roads, protect from ORVs • Manage with St 22 (McGregor Barrens EOID 27531) • Low intensity fire
1	Roscommon	71077	133, 134, 136, 137, 139, 142	140	Dry northern forest (some pine barrens)	Sub-EO dry northern forest w/ barrens openings, including Hill's thistle.	<ul style="list-style-type: none"> • Manage as dry northern forest but monitor for barrens species/structure • Manage with St 140 (Turnery Ranch Trail EOID 27532) • Low intensity fire
2	Grayling	72026	37	49	Pine barrens or Oak-pine barrens	~180 to 200 year old red pine. Openings with several barrens indicators	<ul style="list-style-type: none"> • Low intensity fire • Treat/mow black cherry
2	Grayling	72251	1, 5, 8, 11	NA	Pine barrens (1, 5), dry to dry-mesic northern forest (8, 11)	Ok quality dry to dry-mesic northern forest and pine barrens adj to high quality wetlands in 7, 13, 63, 66, 163 and above E Branch Au Sable R; some portions have seen fire.	<ul style="list-style-type: none"> • Close roads, protect from ORVs • Thin only lightly, retaining red pine • Low intensity fire
2	Grayling	72277	6, 12, 13, 20, 21?)	C72282 - St 9, 11	Pine barrens	Mostly overgrown barrens with isolated openings and patches of barrens species. St 6 is high diversity but small. Bald Hill Fire 1975. Comp 72282 St 9 is EO-worthy dry northern forest, but small.	<ul style="list-style-type: none"> • Masticate ~30% of jack pine • Low intensity fire
2	Roscommon	71051	106	NA	Pine barrens	Many indicators. Good barrens structure.	<ul style="list-style-type: none"> • Close roads, protect from ORVs • Low intensity fire
2	Roscommon	71076	50, 64	14?	Pine barrens	Okay barrens structure/ground flora. Occurs in frost pocket drainage, typical landform of barrens.	<ul style="list-style-type: none"> • Treat/mow black cherry in St 14 • Low intensity fire