# Baseline sampling of jack pine ecosystems in the Kirtland's Warbler Wildlife Management Area


Prepared By:

Tyler J. Bassett and Jesse M. Lincoln, Michigan Natural Features Inventory, Michigan State University Extension, PO Box 13036, Lansing, MI 48901-3036


Prepared For:

Huron Pines, 4241 Old US 27 South, Suite 2, Gaylord, MI 49735

January 5, 2024


MNFI Report Number 2024-01



Michigan Natural Features Inventory
Discover. Define. Deliver.

MICHIGAN STATE UNIVERSITY | Extension

Suggested Citation:

Bassett, T.J. and J.M. Lincoln 2024. Baseline sampling of jack pine ecosystems in the Kirtland's Warbler Wildlife Management Area. Michigan Natural Features Inventory, Report No. 2024-01, Lansing, MI.



We collectively acknowledge that Michigan State University occupies the ancestral, traditional, and contemporary Lands of the Anishinaabeg – Three Fires Confederacy of Ojibwe, Odawa, and Potawatomi peoples. In particular, the University resides on Land ceded in the 1819 Treaty of Saginaw. We recognize, support, and advocate for the sovereignty of Michigan's twelve federally recognized Indian nations, for historic Indigenous communities in Michigan, for Indigenous individuals and communities who live here now, and for those who were forcibly removed from their Homelands. By offering this Land Acknowledgement, we affirm Indigenous sovereignty and will work to hold Michigan State University more accountable to the needs of American Indian and Indigenous peoples.

Cover: Diverse opening in wave plantation, in southwest portion of Tract OS11. All photos by T.J. Bassett.

**ACKNOWLEDGEMENTS**

Funding for this project was provided by Huron Pines. We would like to thank Steve Woods of Huron Pines, and Lindsey Grayson and Sara Siekierski of the United States Fish and Wildlife Service for their communications and support throughout our work on this project. Administrative support was provided by Ashley Adkins, Mike Monfils, Sarah Carter, and Deb Richardson. Thank you to Paul Schilke for providing helpful edits.

**TABLE OF CONTENTS**

**LIST OF TABLES**

**LIST OF FIGURES**

## INTRODUCTION

The Northern Lower Peninsula and Eastern Upper Peninsula of Michigan support millions of acres of ecosystems dominated or co-dominated by jack pine (*Pinus banksiana*): pine barrens and dry northern forest natural communities, early successional grasslands with young jack pine, and jack pine plantations. Jack pine ecosystems provide the majority of the global breeding habitat for the Kirtland's warbler (*Setophaga kirtlandii*), a species recently delisted from federal endangered species status (Olson 2002). Natural jack pine ecosystems were historically influenced by regular fire, either ignited by lightning or Indigenous Peoples (Kashian et al. 2012, Booth et al. 2023). Today, jack pine ecosystems are managed for Kirtland's warbler and other wildlife and plant species, using prescribed fire and canopy thinning (Spaulding and Rothstein 2009, Comer 2010, Kashian et al. 2012).

The United States Fish and Wildlife Service (USFWS) owns and manages 2,710 hectares (6,700 acres) in the Kirtland's Warbler Wildlife Management Area (KWWMA) containing jack pine ecosystems in eight counties in the Northern Lower Peninsula. The KWWMA is comprised of 127 separate tracts ranging in size from 2 to 315 hectares (5-780 acres) (Figure 1). Effective management of the KWWMA tracts requires surveys and monitoring to determine baseline conditions and to track management through time. Surveys to describe natural communities are needed to better understand the range of ecological integrity across the region and to calibrate targets for management. Monitoring is needed prior to management to establish quantitative baseline conditions, so that the impacts of management on vegetative composition and ecosystem structure can be assessed. To this end, Michigan Natural Features Inventory (MNFI) contracted with Huron Pines in 2023 to conduct baseline surveys and monitoring in several KWWMA tracts.

Furthermore, these efforts can serve as a model for tracking the successes of restoring and managing jack pine ecosystems across the Northern Lower Peninsula and Eastern Upper Peninsula. There is growing interest in the region to collaborate and share resources across land managed by USFWS, Huron Pines, the United States Forest Service, the Michigan Department of Natural Resources, and other partners under the coordination of the Northern Pine Plains Partnership. Calibrating methods for surveys and monitoring, and sharing metrics of success, will improve outcomes for the conservation of jack pine ecosystems across the landscape.

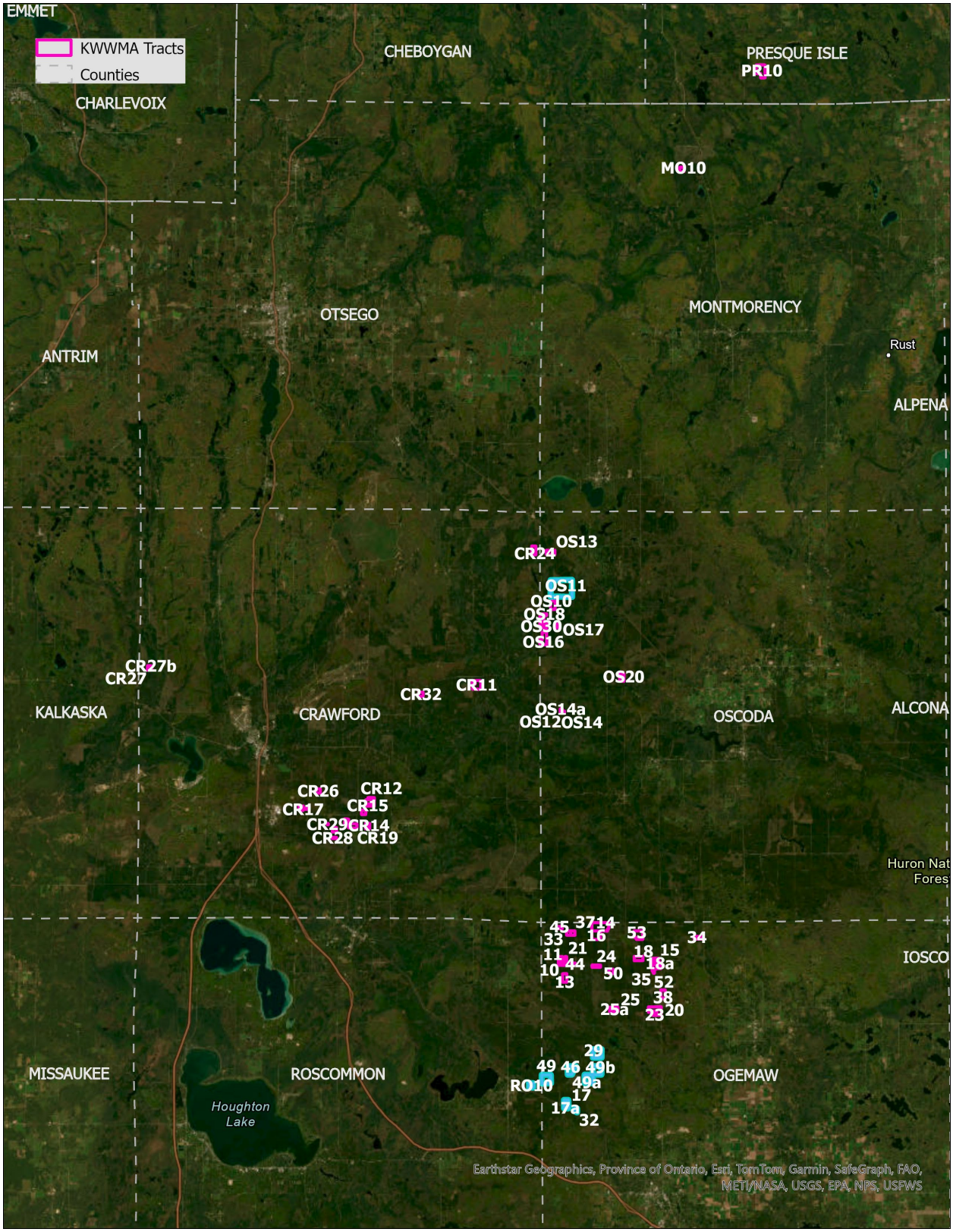


**Figure 1.** Spatial extent of KWWMA tracts in the Northern Lower Peninsula of Michigan, with 2023 sampling targets in Ogemaw, Oscoda, and Roscommon Counties highlighted in cyan.

## METHODS

We conducted quantitative sampling and meander surveys in the KWWMA from July 17 to 21 to generate pre-management baseline data. Quantitative sampling occurred in nine tracts in Ogemaw (17, 17a, 29, 32, 46, 49, 49a, 49b) and Roscommon Counties (RO10) (Figures 1, 2). We sampled 1,000 $m^2$ circular plots (18 $m^2$ radius) and 1x1 m frequency quadrats along parallel, equidistant transects. For each tract, we generated one transect for every 20 acres (tracts < 20 acres received one transect). On each transect, we generated two equidistant circular plot sampling points and seven equidistant frequency quadrat sampling points (Figure 2). Transects and sampling points were generated in ArcGIS Pro 2.9.5. See Figures 3 through 10 for location of transects and sampling points in each tract.

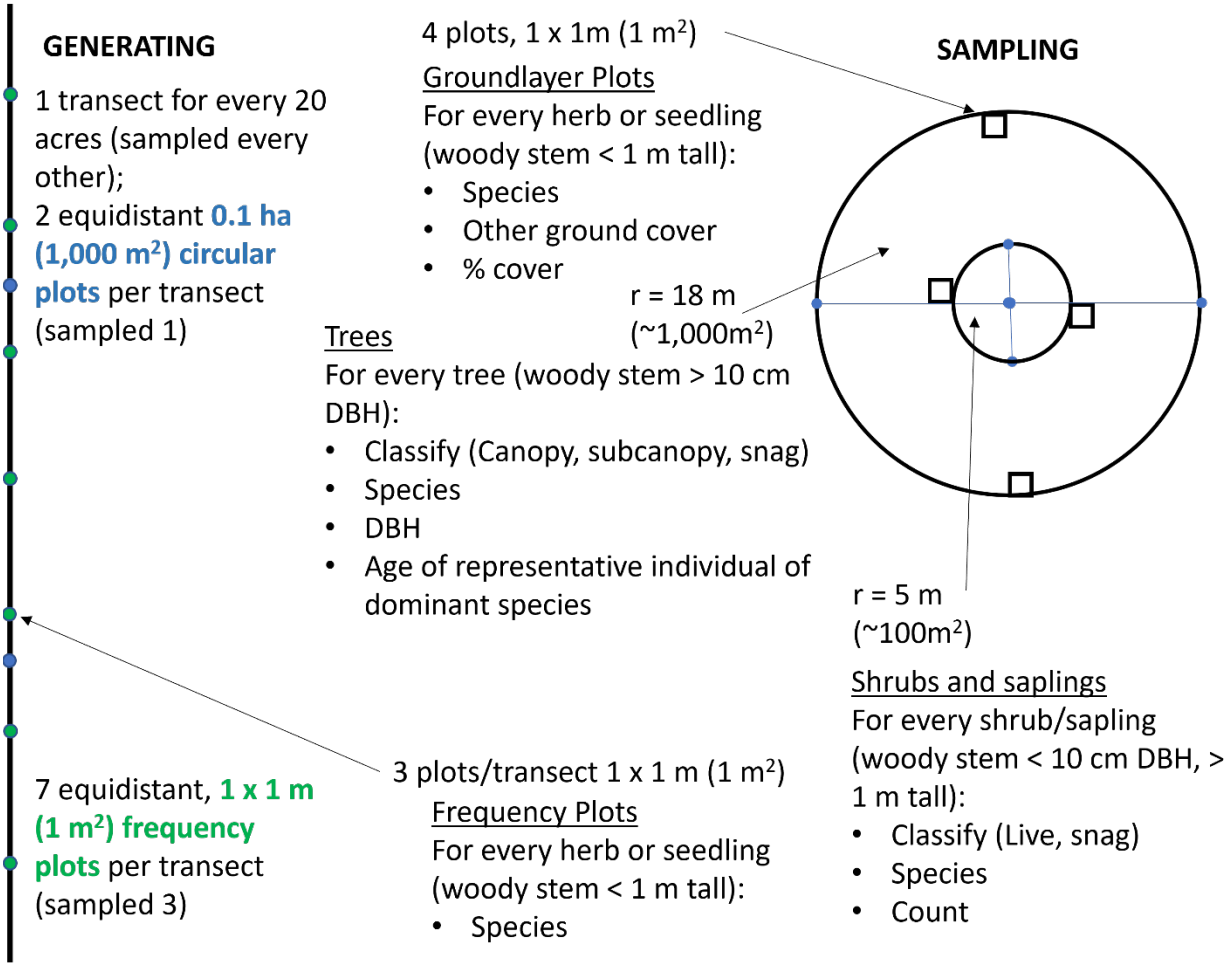


**Figure 2.** Sampling protocol.

In most cases, we sampled every other transect at each site (N = 25 transects) (Table 1). On each sampled transect, we randomly selected one circular plot and recorded vegetation data in three vertical strata (canopy, shrub and sapling, ground layer). In the 1,000 $m^2$ circular plot, we recorded the diameter at breast height (DBH; cm) of all trees (woody stems > 10 cm DBH), noting tree class (canopy, subcanopy, snag), and estimated the age of a representative canopy

tree with an increment borer (Figure 2). In a 100 $m^2$ nested plot (5 $m^2$ radius) in the center of the circular plot, we counted the number of shrub or sapling stems (woody stem < 10 cm DBH, > 1 m tall) for each species, noting shrub class (live, snag) (Figure 2). We sampled the ground layer plant community (herbaceous plants and woody stems < 1 m tall) in four, 1 $m^2$ quadrats, two along the transect inside the margin of the circular plot, and two at opposite ends of a line parallel to the transect outside the nested plot (Figure 2). Here, we recorded the percent cover of each species, as well as the abundance of leaf litter, woody debris, bare ground, and tree bases, according to the following classes: 0-1%, 1-5%, 5-25%, 25-50%, 50-75%, 75-95%, and 95-100%. We measured the depth of leaf litter (to the nearest 0.5 cm) inside each of the four quadrat corners. Finally, we conducted a meander survey for ground layer plant species within the circular plot not previously recorded within the ground layer quadrats.

We recorded the presence of ground layer plant species in three equidistant frequency quadrats along each transect (the two closest to each end and the central quadrat) (Figure 2). When equidistant frequency quadrats were in unsuitable habitat (e.g., wetland), we selected the next available quadrat. We also conducted meander surveys while sampling transects to generate more comprehensive vascular plant species lists for each tract, beyond those previously recorded within frequency quadrats or circular plots. With these meanders, we also generally characterized natural communities, and documented rare species encountered opportunistically. We conducted meander surveys only in an additional 780-acre tract in Oscoda County (OS11), focusing on generally describing upland communities and noting the presence of wetland communities (Figure 1).

Finally, we conducted Floristic Quality Assessments (FQAs) for each tract (Reznicek et al. 2014). The FQA utilizes plant species composition to derive the Floristic Quality Index (FQI), a quantitative metric of habitat quality that can be used as a relatively objective comparison among natural community occurrences of the same type. We conducted multiple FQAs for Tract OS11, which contains multiple occurrences of multiple community types. Drawing upon expert consensus among botanists familiar with the flora of Michigan, each vascular plant species native to Michigan has been assigned an a priori coefficient of conservatism (C-value) that ranges from 0 to 10 on a scale of increasing conservatism or fidelity to pre-European colonization habitats (Reznicek et al. 2014). Plant species with a C-value of 7 to 10 are considered highly conservative (Herman et al. 2001). A C-value of 4 to 6 indicates moderate conservatism and a C-value of 1 to 3 indicates low or no conservatism (e.g., ruderal species). Non-native species were given a C-value of 0 for these calculations. We calculated FQI for each natural community occurrence as

$$FQI = \overline{C} \times \sqrt{n}$$

where $\overline{C}$ = mean C-value and n = species richness. Sites with an FQI of 35 or greater are generally considered to be floristically important from a statewide perspective (Herman et al. 2001).

## RESULTS AND DISCUSSION

We do not provide the results of detailed data analyses in this report, because most data were collected to serve as a baseline against which to gauge management efficacy. We have provided raw data, shapefiles, and select data summaries to Huron Pines and USFWS, and provide a few summary figures in Appendix A. Rare plant observations have been entered into the Michigan Natural Heritage Database (MNFI 2023).

Here, we provide general characterizations of each tract (Table 1). First, we note the primary natural community represented by each tract (with additional natural communities listed in parentheses where appropriate), and any rare species observed during surveys. We emphasize characteristic vegetation patterns for each tract, especially ecological features that differentiate each tract from other tracts, and that suggest opportunities or barriers for restoration.

**Table 1**. Summary of surveyed sites.

| Tract | County | Hectares (acres) | Transects | Primary Natural Community | Canopy Age | Species Richness (% native) | FQI | Mean C |
|---|---|---|---|---|---|---|---|---|
| 17 | Ogemaw | 27.68 (68.41) | 2 | Pine barrens | 72.5 | 38 (92%) | 27.1 | 4.4 |
| 17a | Ogemaw | 1.81 (4.47) | 1 | Wave plantation | 23 | 14 (100%) | 18 | 4.8 |
| 29 | Ogemaw | 65.52 (161.9) | 4 | Pine barrens | 79 | 82 (94%) | 41.7 | 4.6 |
| 32 | Ogemaw | 6.49 (16.03) | 1 | Row plantation | 25 | 33 (100%) | 28.1 | 4.9 |
| 46 | Ogemaw | 44.96 (111.1) | 3 | Pine barrens | 73 | 71 (96%) | 38.8 | 4.6 |
| 49 | Ogemaw | 69.0 (170.49) | 4 | Wave plantation | 23 | 60 (97%) | 39.5 | 5.1 |
| 49a | Ogemaw | 63.01 (155.69) | 4 | Dry northern forest | 80.5 | 24 (100%) | 26.5 | 5.4 |
| 49b | Ogemaw | 65.09 (160.83) | 4 | Wave plantation | 24.5 | 47 (81%) | 30.9 | 4.5 |
| OS11 | Oscoda | 316.04 (780.95) | 0 | Rich conifer swamp | NA* | NA* | NA* | NA* |
| RO10 | Roscommon | 16.36 (40.44) | 2 | Pine barrens | 97 | 41 (95%) | 28.8 | 4.5 |
| | | Total: | 25 | | | | | |

*Summaries not provided for OS11, represented by multiple natural community types

### Tract 17

*Natural communities:* Pine barrens (Dry northern forest)

This tract is comprised of two distinct portions bisected by an east-west road (Figure 2). The southern portion is characterized by a patchy canopy with at least 60% cover, and dense moss cover in the understory. This dense moss cover appears to be limiting ground layer vascular

plant diversity, as many characteristic pine barrens species occurred at very low evenness and abundance. Prescribed fire may reduce moss density and increase vascular plant diversity. The northern portion has a more open canopy structure typical of barrens, with under 60% canopy cover. There are some characteristic grass- and sedge-dominated openings, although conservative plant species are lacking. There is a high density of wild black cherry (*Prunus serotina*) in the overstory.

**Tract 17a**

*Natural communities:* None – Wave plantation

This small wave plantation had very few characteristics of a pine barrens natural community (Figure 3). While some wave plantations retain high floristic diversity in openings (e.g., tract 49), openings in Tract 17A were dominated by Pennsylvania sedge (*Carex pensylvanica*) and reindeer lichen (*Cladonia* spp.), potentially indicating past soil scarification or scraping.

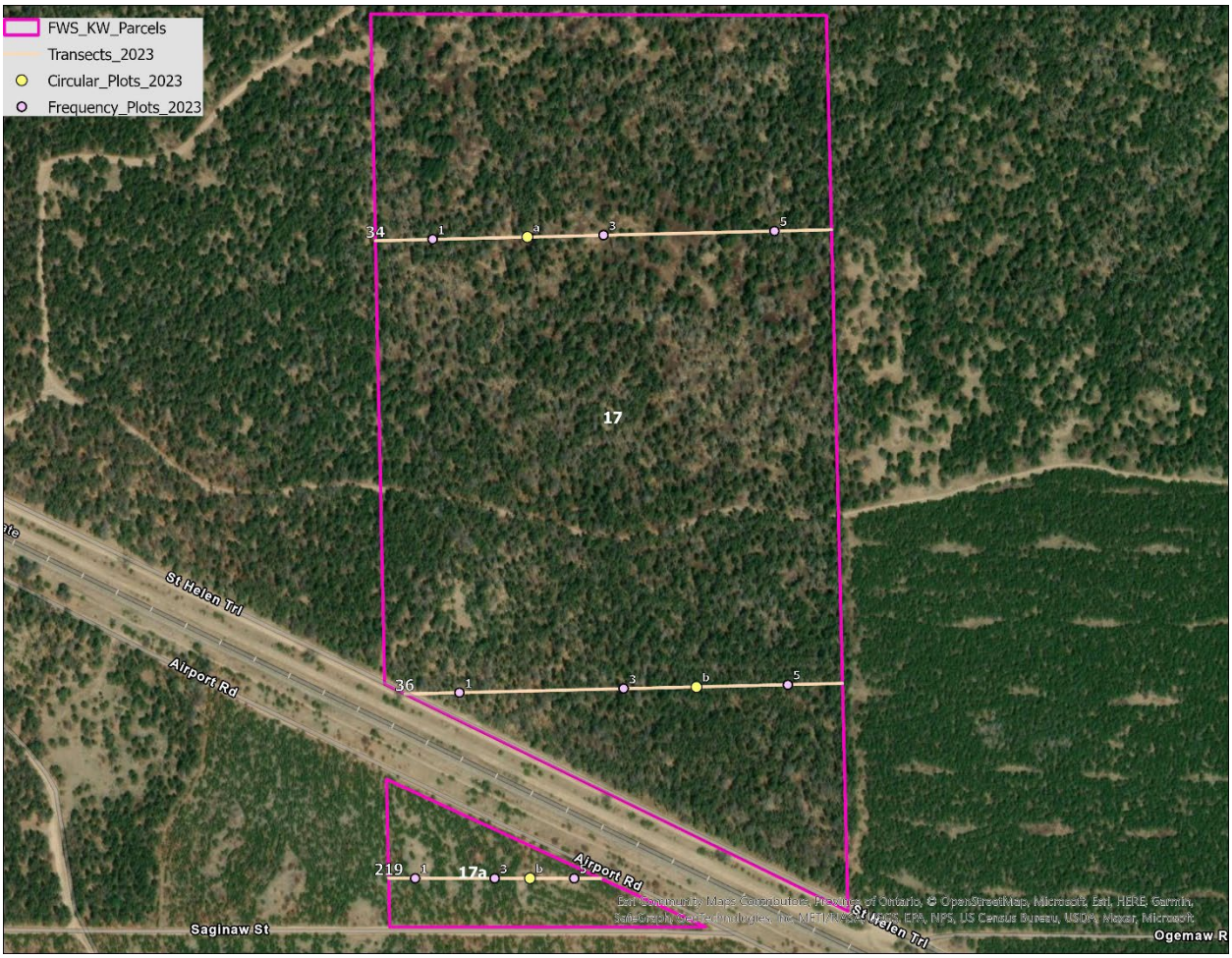


**Figure 3.** Tracts 17 and 17a. Canopy cover in Tract 17 is noticeably lower north of east-west road between transects 34 and 36.

**Tract 29**

*Natural community*: Pine barrens (Dry northern forest, northern wet meadow)
*Rare species*: Hill's thistle (*Cirsium hillii*, Special Concern)

This heterogeneous tract includes a large, recently burned area dominated by young jack pine and quaking aspen (*Populus tremuloides*) (Figure 4). This burned over area contains many small depressions supporting northern wet meadow (potentially some bog or poor fen) and the transitions between uplands and these wetlands often harbors very rich plant communities. High-quality pine barrens occurs in the northwest, and possibly in the southeast, of Tract 29. A small band of relatively high-quality dry northern forest occurs in the western ¼ of this tract, including several canopy red pine (*Pinus resinosa*) and white oak (*Quercus alba*). These canopy species are a historically important component of jack pine ecosystems, including dry northern forest and pine barrens, and should generally be retained.

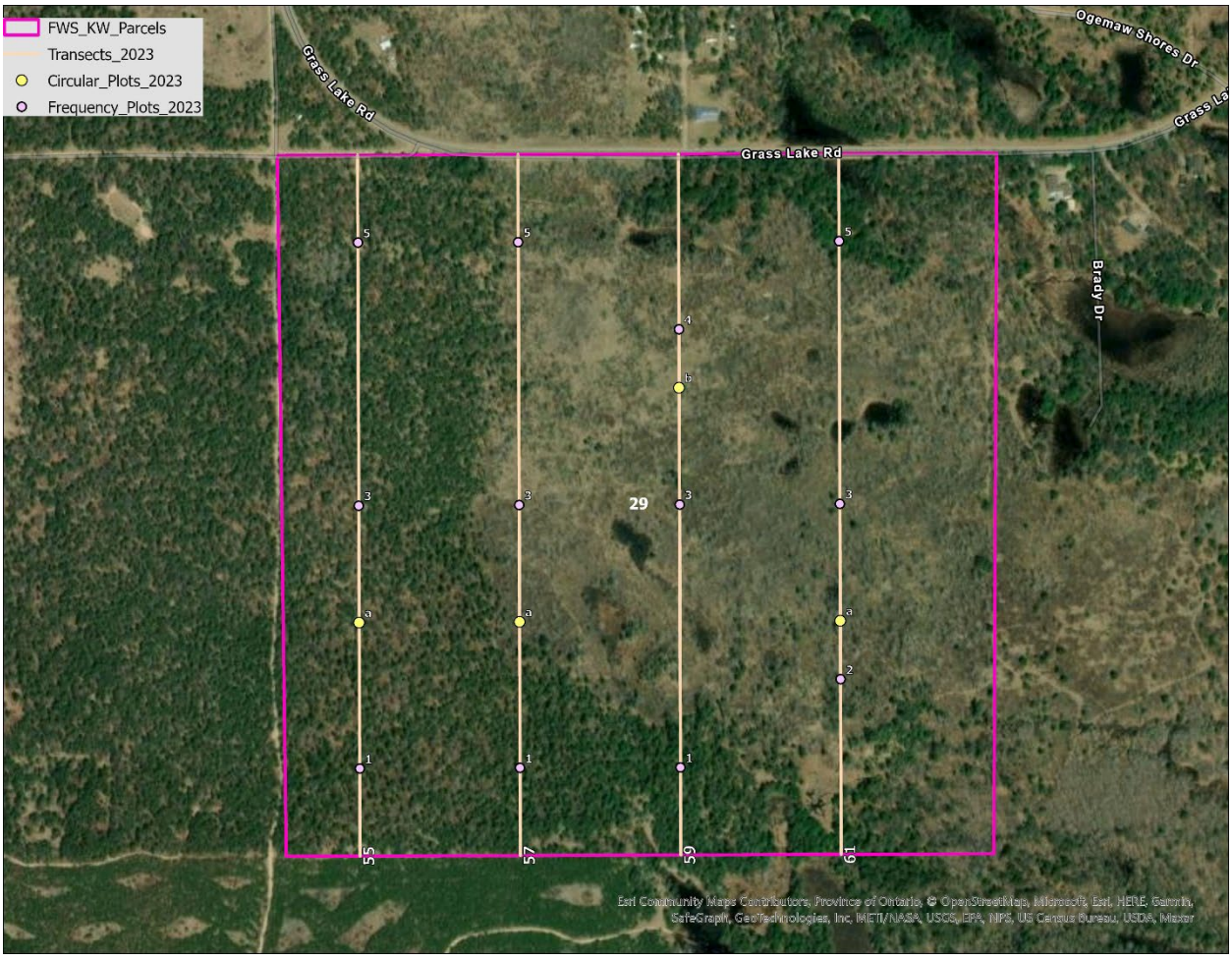


**Figure 4.** Tract 29. Large gray portion represents recently burned jack pine and aspen. Dark patches are northern wet meadow.

**Tract 32**

*Natural community*: None – Row plantation

Tract 32 is a young, low-diversity jack pine plantation (Figure 5). Moss density is high, and only the most common vascular plant species associated with pine barrens such as hair grass (*Avenella flexuosa*) and rice-grass (*Piptatherum pungens*) are present. Moderately and highly conservative species are lacking.

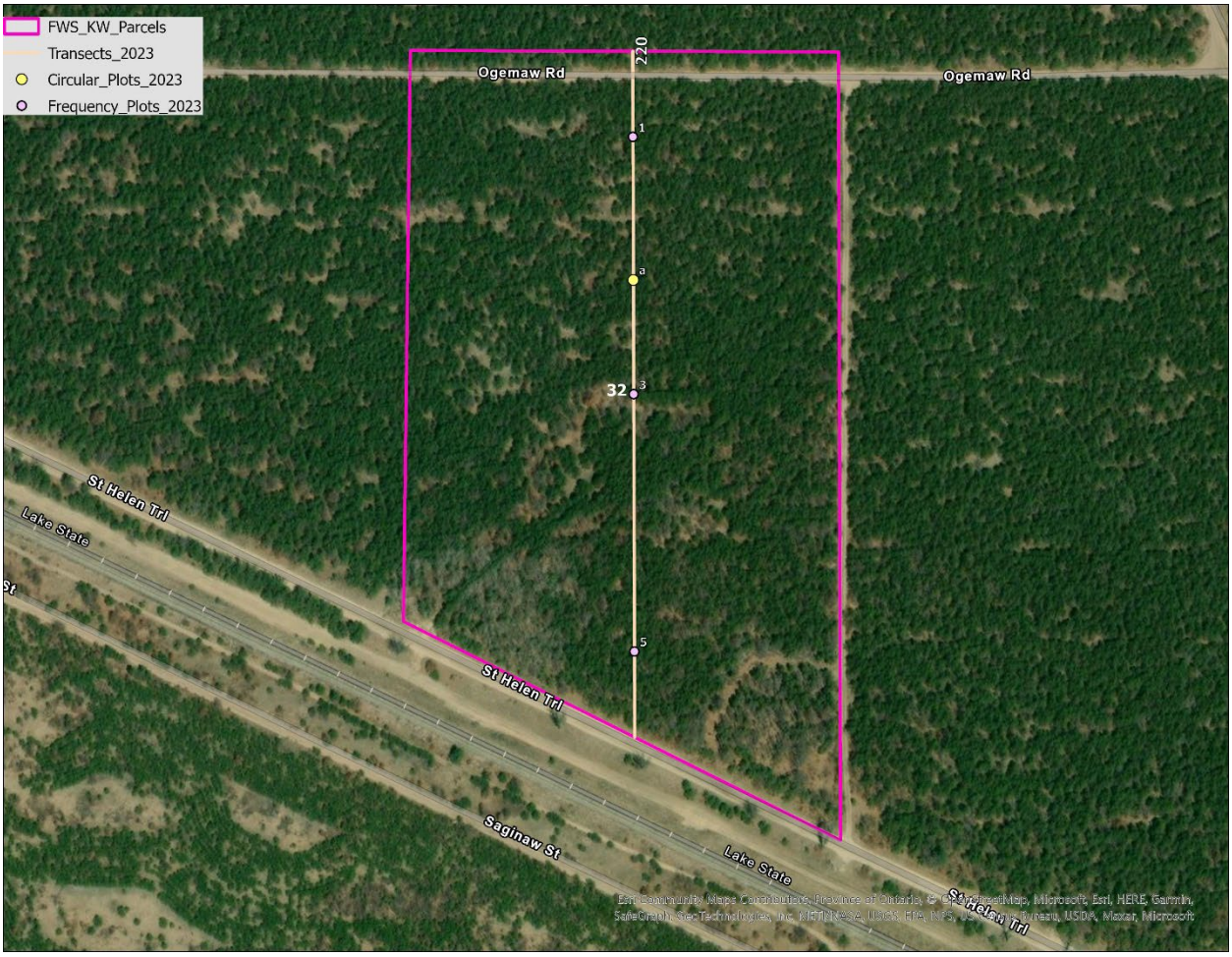


**Figure 5.** Tract 32.

**Tract 46**

*Natural community*: Pine barrens (Oak-pine barrens)
*Rare species*: Hill's thistle (*Cirsium hillii*, Special Concern)

This tract (Figure 6) is a fire-suppressed pine barrens, with a heterogeneous canopy structure of old (aged at 73 years) but limited subcanopy pine regeneration. The ground layer plant community is very diverse and includes many moderately conservative barrens species such as wood lily (*Lilium philadelphicum*) and hairy puccoon (*Lithospermum carolinense*), while frequently dominant species such as Pennsylvania sedge are never monotypic or occur too densely. There are indications of higher productivity or soil moisture retention than is typical of pine barrens, including species such as fringed brome (*Bromus ciliatus*) that are typically associated with lowland habitats. Given the barrens canopy structure and ground layer diversity, this tract should respond well to fire alone, which should thin some of the older jack pine from the canopy and stimulate regeneration of jack pine in the subcanopy and ground layer plant species.

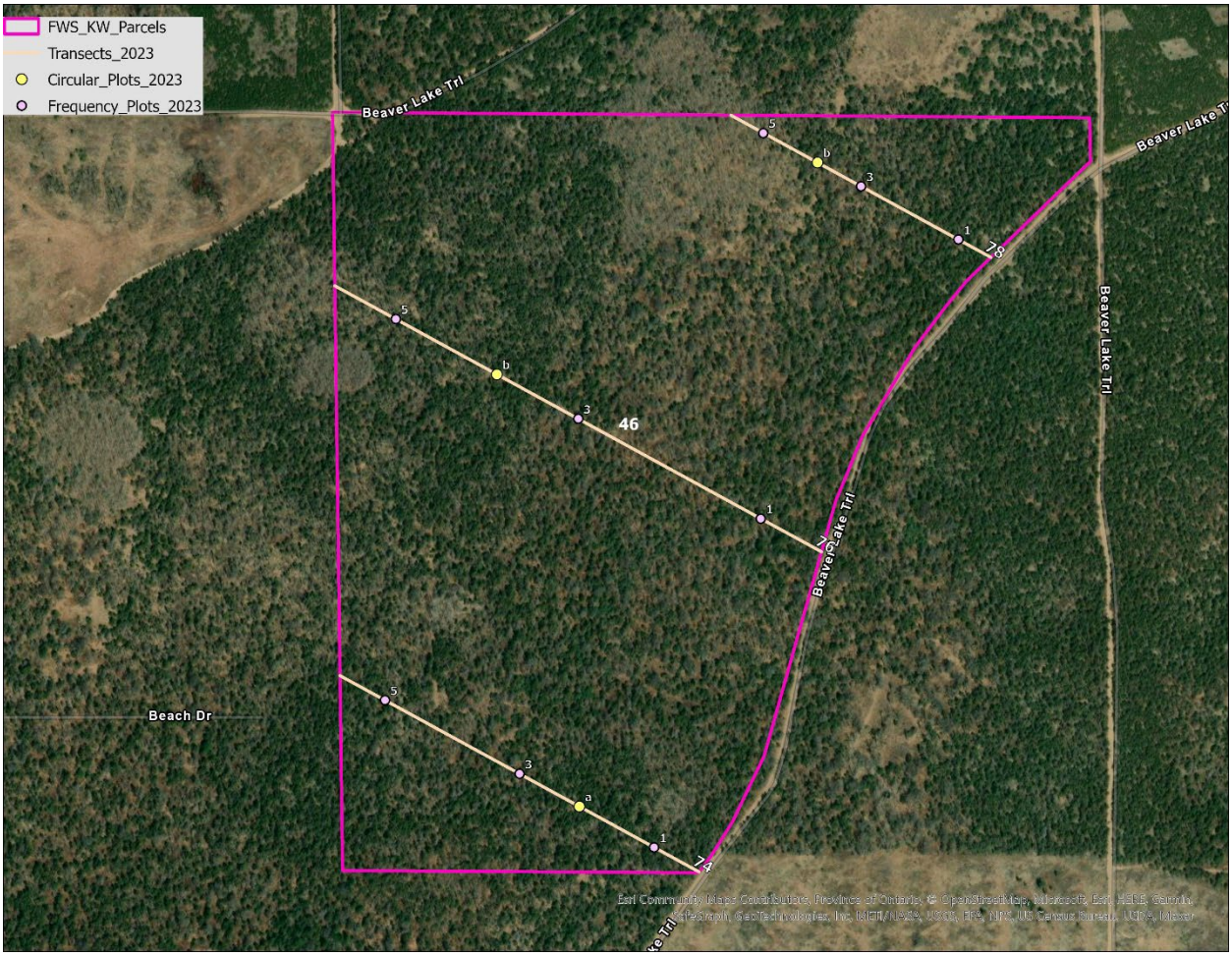

**Figure 6.** Tract 46.

**Tract 49**

*Natural community*: None – Wave plantation
*Rare species*: Hill's thistle (*Cirsium hillii*, Special Concern)

This wave plantation (Figure 7) exhibited surprisingly high ground layer diversity in some of the openings. We observed several moderately to highly conservative species in openings, including wood lily, hairy puccoon, prairie brome (*Bromus kalmii*), June grass (*Koeleria cristata*), prairie ragwort (*Packera paupercula*), fringed polygala (*Polygala polygama*), and long-leaved bluets (*Houstonia longifolia*). Diverse pockets appeared to be concentrated in the west and the southeast, with most of the eastern portion lacking conservative species.

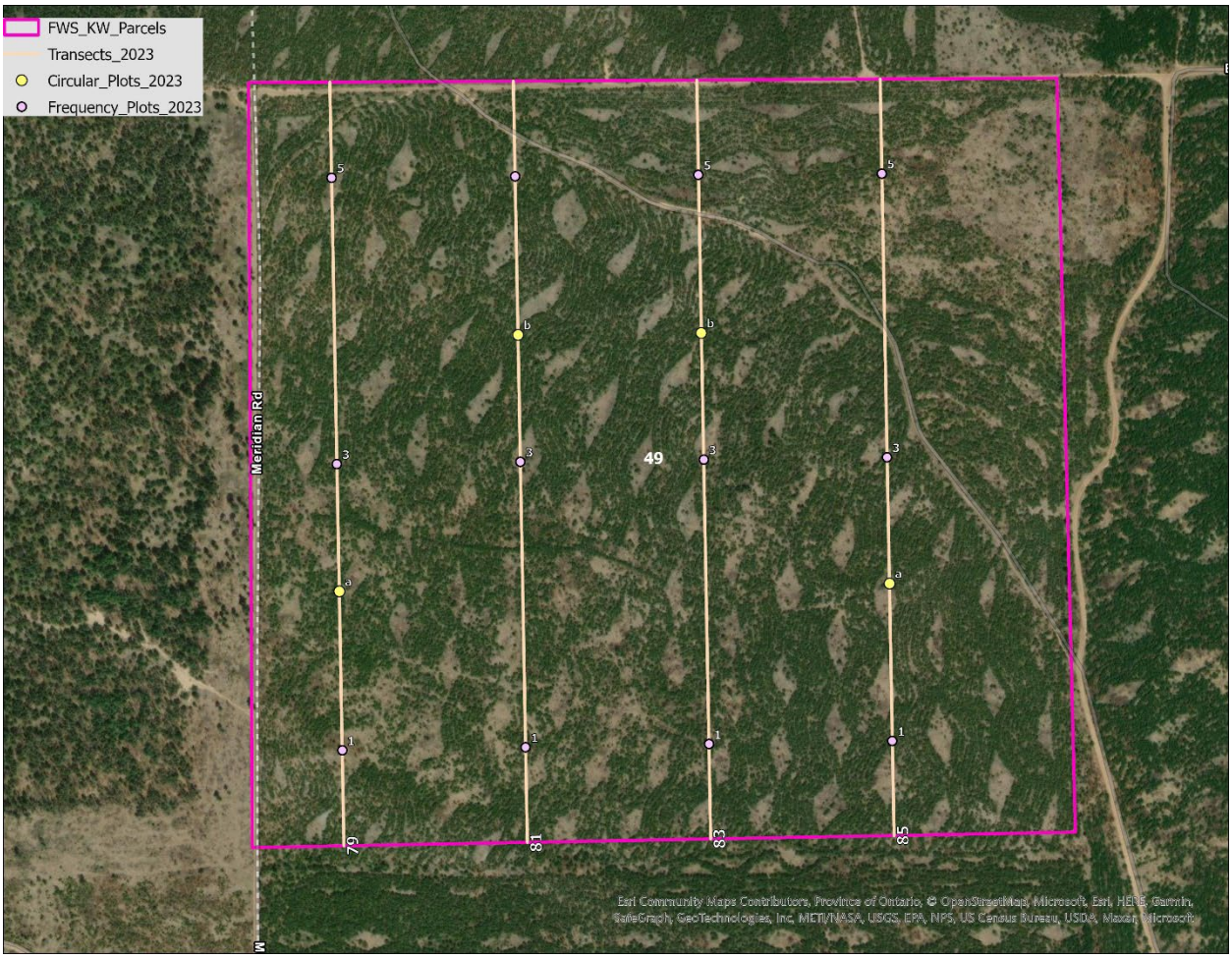


**Figure 7.** Tract 49.

**Tract 49a**

*Natural community*: Dry northern forest

This tract is a high-quality dry northern forest, with several 150 year-old red pine trees in the canopy, several large canopy white oak, and a diverse canopy overall with an uneven age distribution. Huckleberry (*Gaylussacia baccata*) is sometimes associated with older natural red pine stands, and this low shrub is extensive in much of the western portion of this tract. The ground layer is dominated by species associated with forests or span forests and barrens, such as wintergreen (*Gaultheria procumbens*), low sweet blueberry (*Vaccinium angustifolium*), and false melic (*Schizachne purpurascens*). There is also an extensive network of large ant mounds here. In contrast to most other tracts, the ground layer species composition and the overall canopy and subcanopy structure suggest that dry northern forest rather than pine barrens is the appropriate restoration target in this tract and we recommend limiting canopy thinning here. We noted that many of the "legacy trees" (i.e. > 120 years old) are marked for retention, and we recommend retaining as many of these and other legacy individuals as is feasible. Red pine and white oak in particular are the most fire-resilient and long-lived trees in this system, so retaining older individuals will facilitate a more rapid transition to a fire-managed forest.

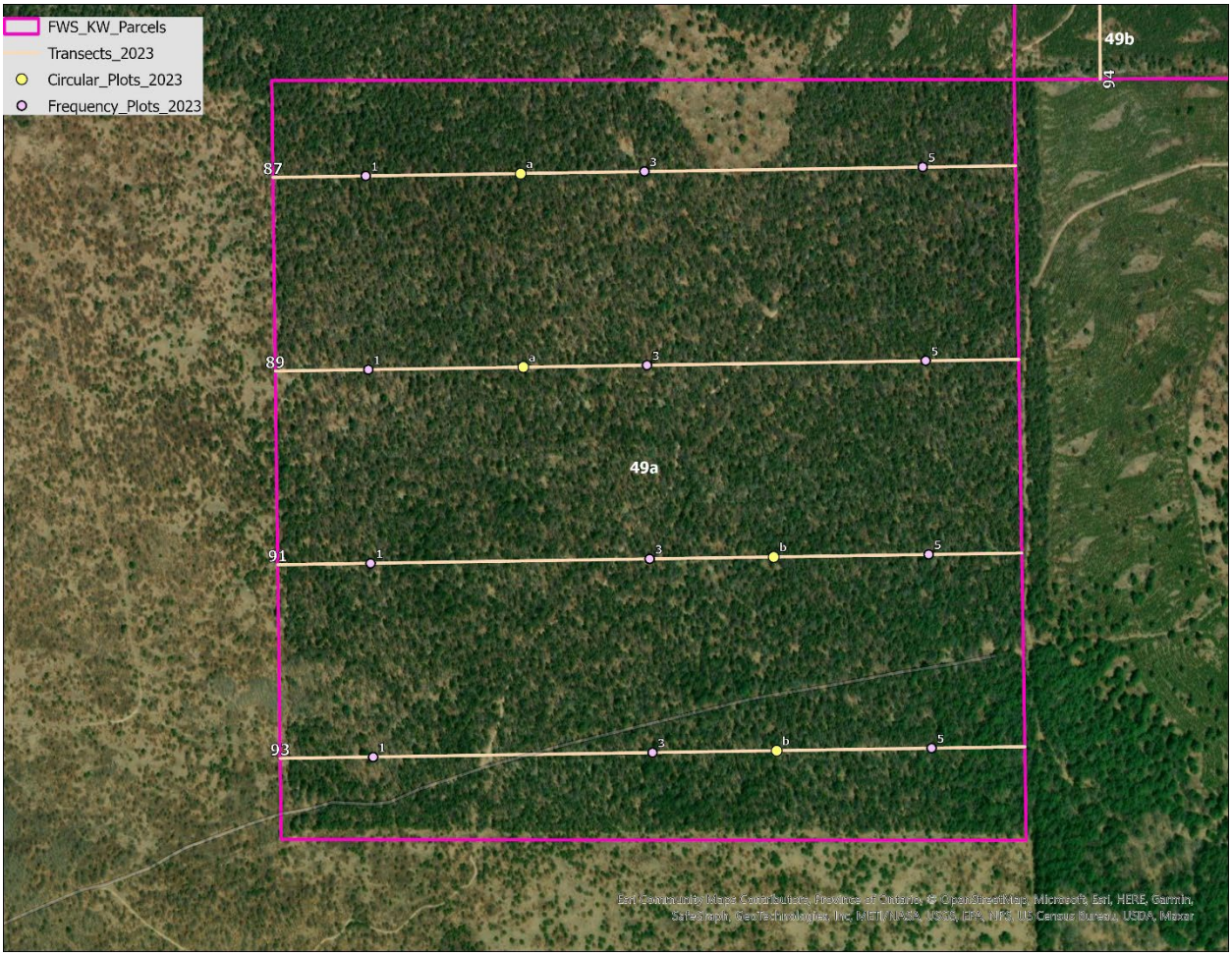


**Figure 8.** Tract 49a.

**Tract 49b**

*Natural community*: None – Wave plantation

This tract is a typical low-diversity wave plantation (Figure 11). The openings lacked conservative species. There is little apparent plant community restoration potential.


**Figure 9.** Tract 49b.

**Tract RO10**

*Natural community*: Pine barrens

There were small pockets of conservative ground layer plant species in this degraded pine barrens (Figure 12), particularly along trails and in the south where light availability was higher. The canopy contained some deciduous patches, including wild black cherry and trembling aspen, under which we observed very few barrens species. On the other hand, there were some mature red pine and white oak that we recommend retaining to maintain canopy diversity and fire-resiliency in the canopy. Selective thinning and prescribed fire may reveal additional areas of diversity, in addition to restoring typical barrens canopy structure.

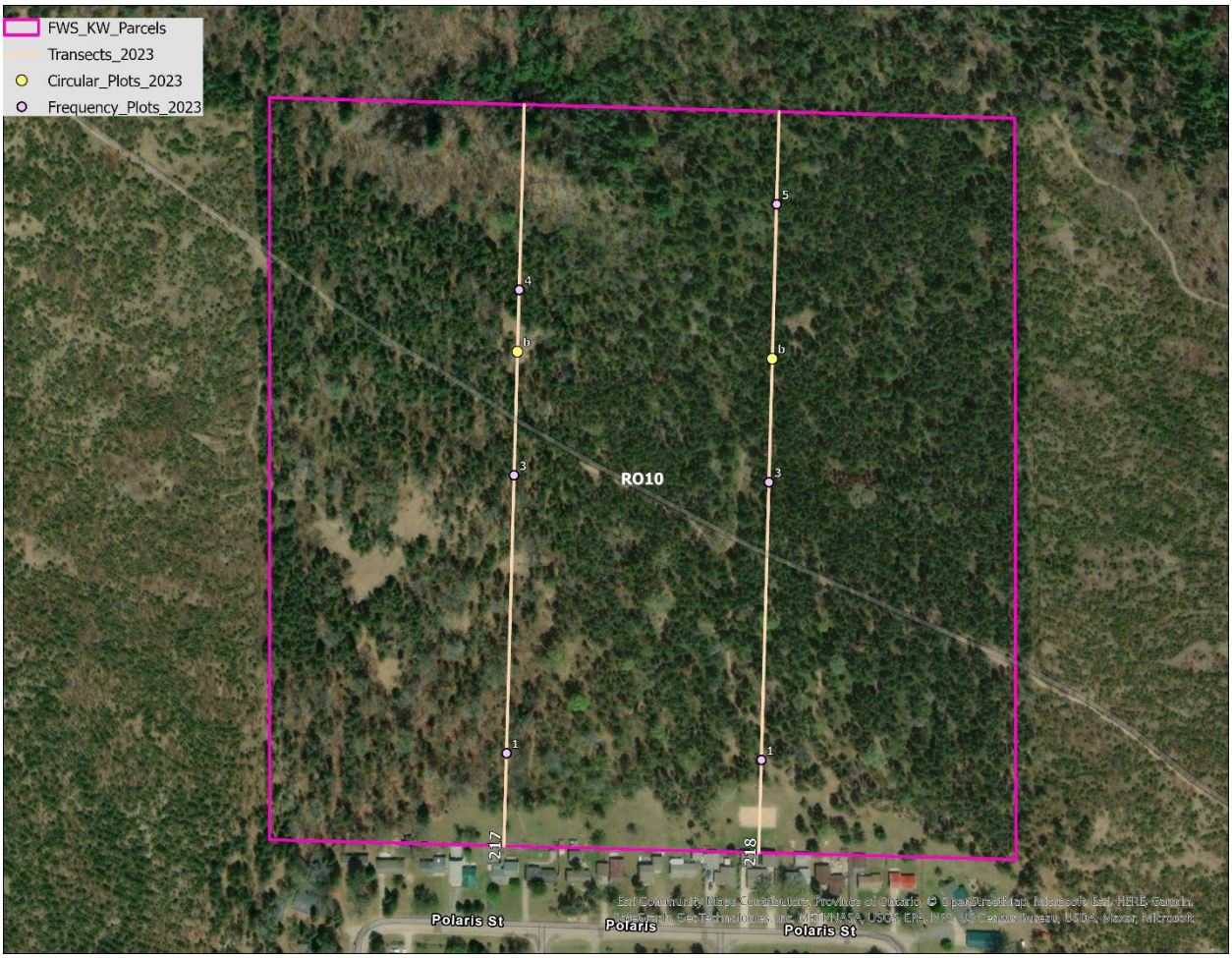


**Figure 10.** Tract RO10.

**Tract OS11**
*Natural community*: Rich or poor conifer swamp (Pine barrens, oak-pine barrens, dry to dry-mesic northern forest, northern wet meadow, bog)
*Rare species*: Hill's thistle (*Cirsium hillii*, Special Concern)

This large tract supported multiple cover types (Figure 11), including some high-quality natural communities. We limited our surveys in 2023 to mainly the upland portions of this tract due to time constraints. Uplands include wave plantation in the southwest and fire-suppressed barrens openings in a forested matrix in the remainder of the tract. The wave plantation south of Farrington Road (see cover photo) retained small patches of moderately conservative ground layer plant species, although these were generally limited to areas north of a bulldozed berm. The alleys to the south of the berms were possibly scraped to form that berm. The uplands in the northwest contained large expanses of dry-mesic to mesic hardwood forest with mature trembling aspen (aged at 60 years old) and red oak (*Quercus rubra*; aged at 95 years old) in the canopy, as well as a few patches of red pine (aged at 47 years old). There were occasional isolated barrens openings. Non-native species such as king devil (*Hieracium caespitosum*), common St.-John's wort (*Hypericum perforatum*), and white clover (*Trifolium repens*) were occasional to locally common in these openings and the abundance of conservative species was generally low (Figure 12). Finally, the uplands in the southeast of the tract were characterized by fire-suppressed pine barrens along Farrington Road, albeit with a canopy dominated by jack pine in a patchy barrens structure. The ground layer was dominated by Pennsylvania sedge and low sweet blueberry, and locally by bracken fern (*Pteridium aquilinum*) and big bluestem (*Andropogon gerardii*). We aged a 32.1 cm DBH jack pine at 69 years old. This barrens grades into closed canopy, dry to dry-mesic northern forest to the north, co-dominated by red and white (*Pinus strobus*) pine in the canopy and dominated by huckleberry, wintergreen, and bracken fern in the ground layer. We aged a 53.7 cm DBH red pine at 63 years old.

The predominant cover type in Tract OS11 is a large swamp complex. The swamp, as assessed from the margin, is dominated by a combination of white cedar (*Thuja occidentalis*) and black spruce, so is likely a rich conifer swamp with potential poor conifer swamp inclusions. Future surveys are needed to map and characterize this occurrence, requiring at least one full day of survey. We surveyed a small patch of northern wet meadow along the powerline in the west of the tract (Figure 13). This meadow was dominated by tussock sedge (*Carex stricta*) and was punctuated with small islands of sphagnum moss (*Sphagnum* sp.), black spruce (*Picea mariana*), and tamarack (*Larix laricina*). Soils were saturated to inundated sapric peat (pH 7.0), although sphagnum islands were strongly acidic (pH 4.0-4.5). We aged a 19.6 cm DBH black spruce at 57 years old. The sandy margins of this meadow supported a small community of species typical of wet-mesic sand prairie (e.g., beak-rush [*Rhynchospora capitellata*]). Additionally, a small bog occurs in the southeast portion of the tract, north of the closed canopy white and red pine forest described above. This bog has a sparse (20%) canopy of black spruce and tamarack, and is dominated by a dense low shrub layer of leatherleaf (*Chamaedaphne calyculata*). Labrador-tea (*Rhododendron groenlandicum*) and velvet blueberry (*Vaccinium myrtilloides*) are common in the low shrub layer, and three-seeded sedge (*Carex trisperma*) and cotton grass (*Eriophorum*

sp. ) are common in the herbaceous ground layer. Finally, northern shrub thicket occurs along the stream in the south-central portion of the tract as at Farrington Road, and likely elsewhere.

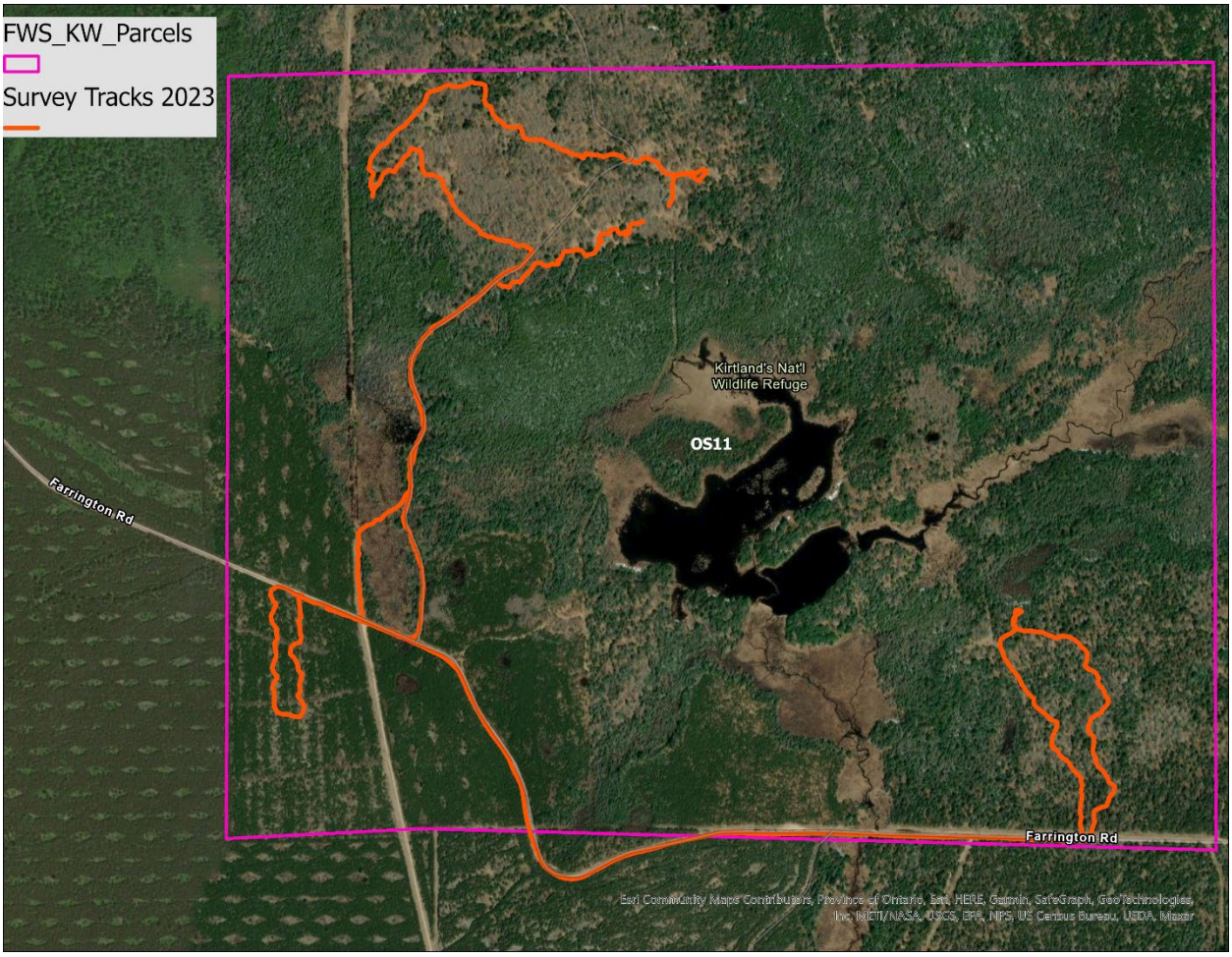


**Figure 11.** Tract OS11. Note large wetland complex in center, primarily conifer swamp, surrounded by uplands supporting pine barrens and other communities.

**Figure 12.** Low-diversity barrens opening in northwest portion of Tract OS11.

**Figure 13.** Northern wet meadow in west portion of Tract OS11, with conifer swamp in background.

**Figure 14.** Hill's thistle (Special Concern) with unidentified pollinators in Tract OS11.

**LITERATURE CITED**


Booth, R.K., G.W. Schuurman, E.A. Lynch, M.G. Huff, J.A. Bebout, N. Melonee Montano. 2023. Paleoecology provides context for conserving culturally and ecologically important pine forest and barrens communities. Ecological Applications 33:e2901.

Comer P.J. 2010. Natural community abstract for pine barrens. Michigan Natural Features Inventory, Lansing, MI. 4 pp. Original 1996, updated 2010.

Herman, K.D., L.A. Masters, M.R. Penskar, A.A. Reznicek, G.S. Wilhelm, W.W. Brodovich, and K.P. Gardiner. 2001. Floristic quality assessment with wetland categories and examples of computer applications for the State of Michigan - Revised, 2nd Edition. Michigan Department of Natural Resources, Wildlife, Natural Heritage Program, Lansing, MI. 19 pp. + appendices.

Kashian, D.M., R.G. Corace, L.M. Shartell, D.M. Donner, P.W. Huber. 2012. Variability and persistence of post-fire biological legacies in jack pine-dominated ecosystems of northern Lower Michigan. Forest Ecology and Management 263: 148–158.

Michigan Natural Features Inventory (MNFI). 2023. Michigan Natural Heritage Database, Lansing, MI.

Olson, J. A. 2002. Special animal abstract for Dendroica kirtlandii (Kirtlandís warbler). Michigan Natural Features Inventory, Lansing, MI. 5 pp.

Reznicek, A.A., M.R. Penskar, B.S. Walters, and B.S. Slaughter. 2014. Michigan Floristic Quality Assessment Database. Herbarium, University of Michigan, Ann Arbor, MI and Michigan Natural Features Inventory, Michigan State University, Lansing, MI.

Spaulding, S.E., and D.E. Rothstein. 2009. How well does Kirtland's warbler management emulate the effects of natural disturbance on stand structure in Michigan jack pine forests? Forest Ecology and Management 258: 2609–2618.

## APPENDIX A: SELECT DATA SUMMARY FIGURES

Here, we include example figures, summarizing canopy density (Figures A1, A2), shrub and sapling density (Figure A3), groundcover metrics (Figure A4), and plant species richness (Figures A5, A6) for each tract. There were statistically significant differences between tracts for canopy metrics (Figures A1, A2), but not for the other comparisons included below. See figure captions for more info.

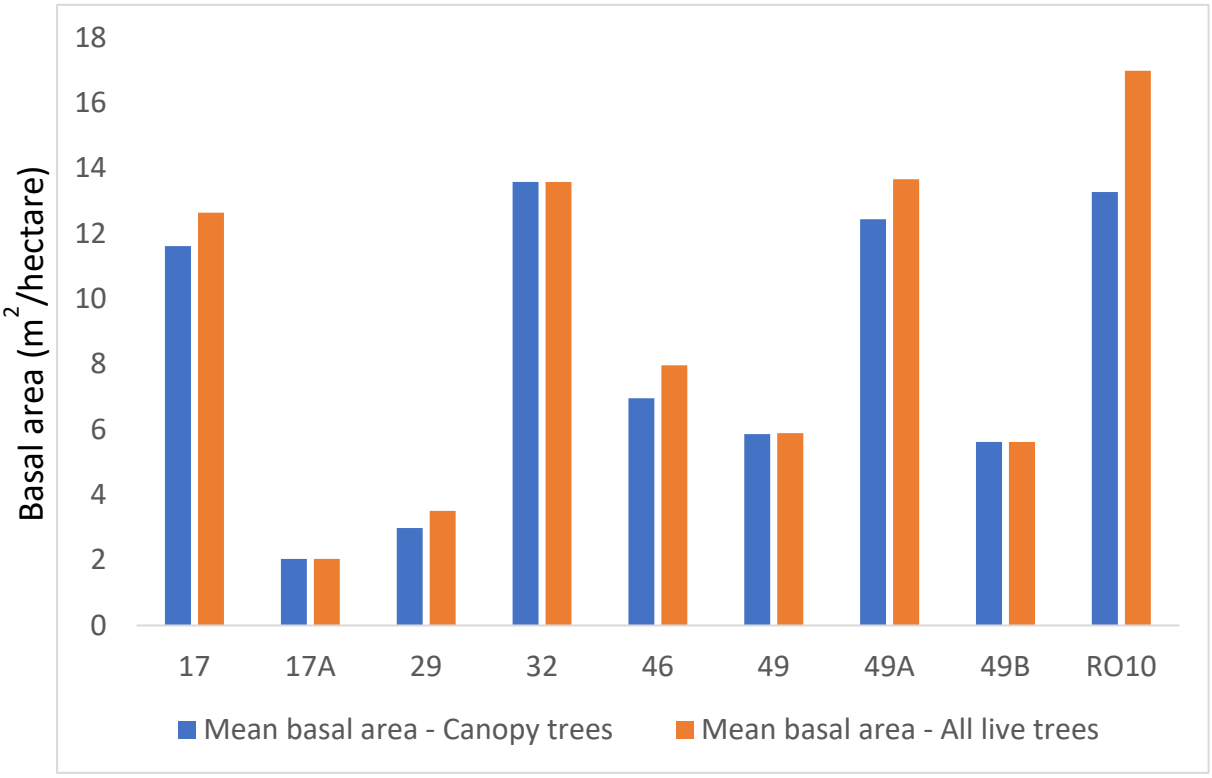


**Figure A1.** Mean stocking rates for all living trees, and for only canopy trees. Stocking rate was significantly lower in tract 29 than in 49A and RO10.

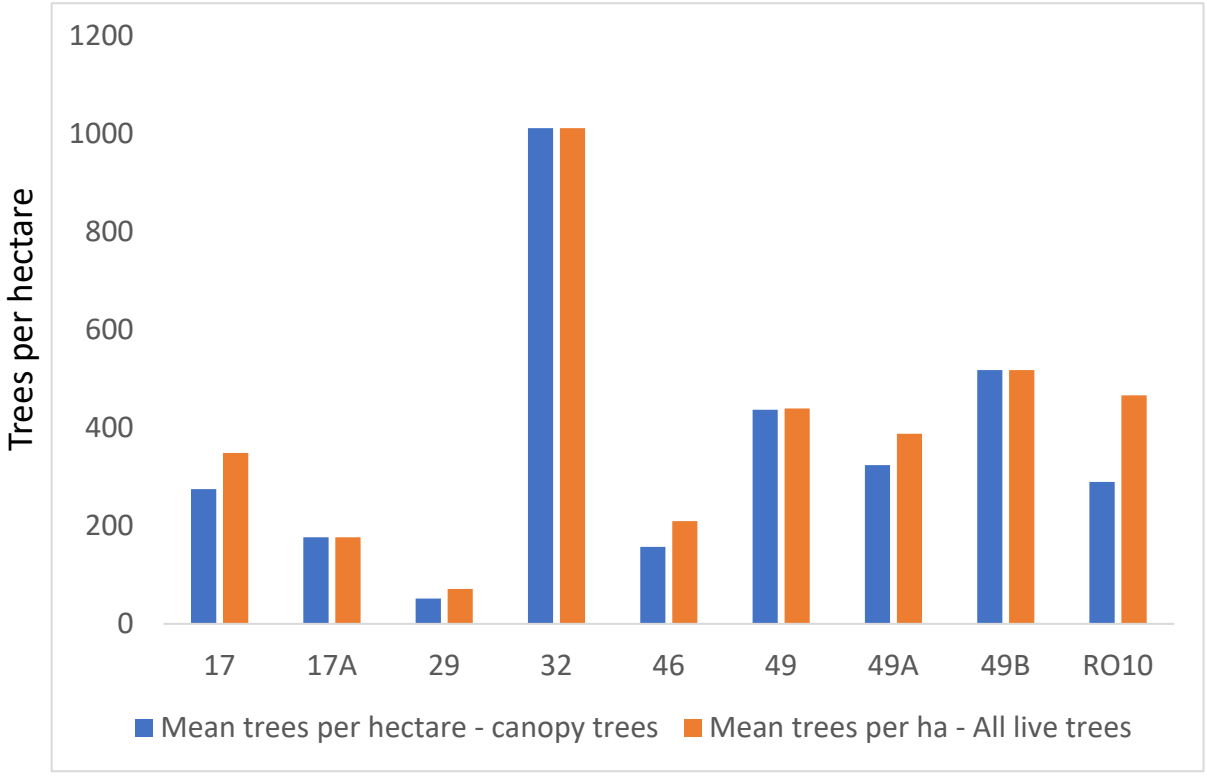


**Figure A2.** Mean tree density, for all living trees, and for only canopy trees. Tree density was signicantly higher in tract 32 than in 17, 17A, 29, 46, and 49A; and tract 49B than in 29.

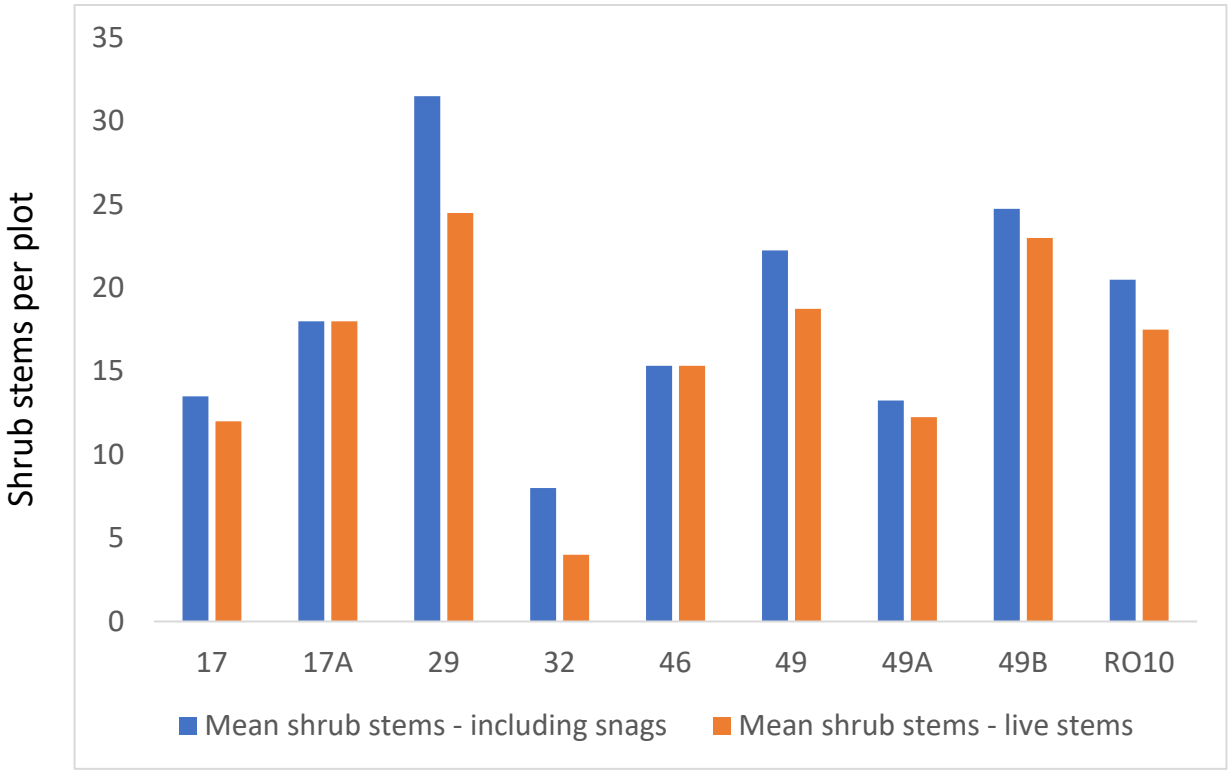


**Figure A3.** Mean shrub/sapling density, for all living stems, and living stems + snags.

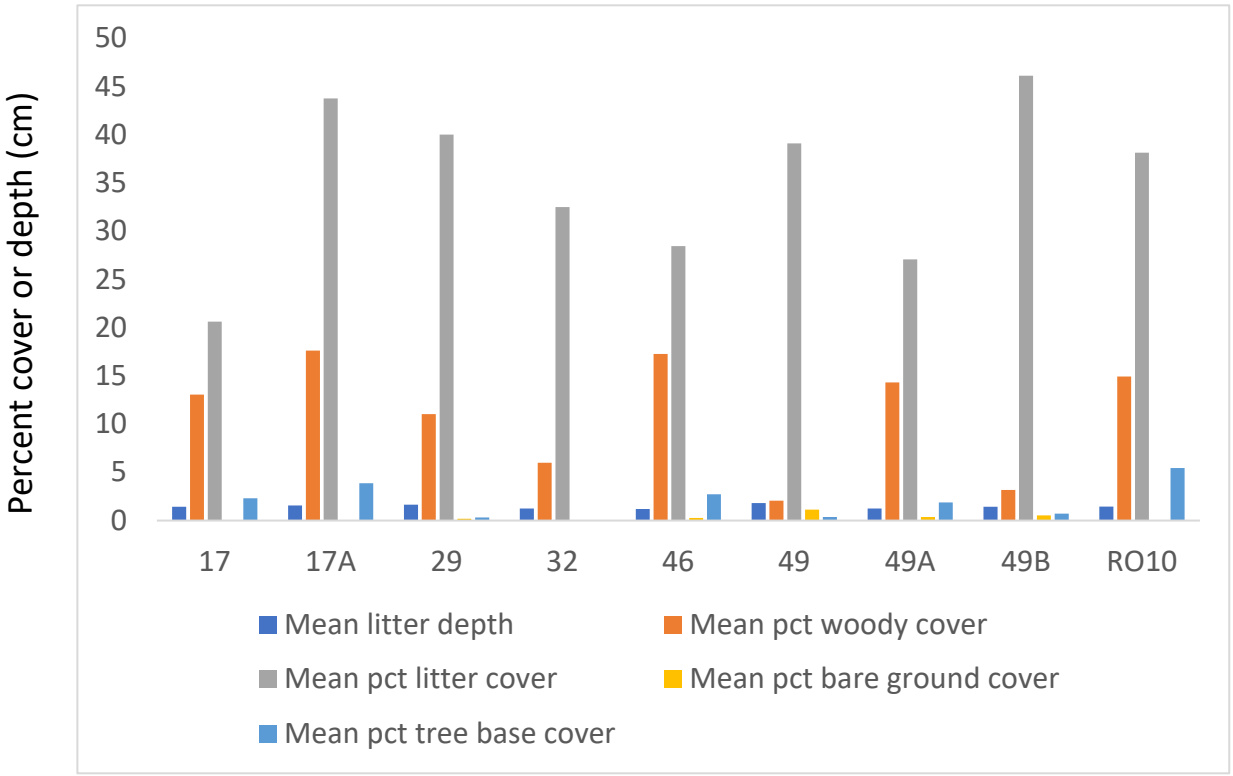


**Figure A4.** Mean abundance for types of ground cover, and mean depth of leaf litter.

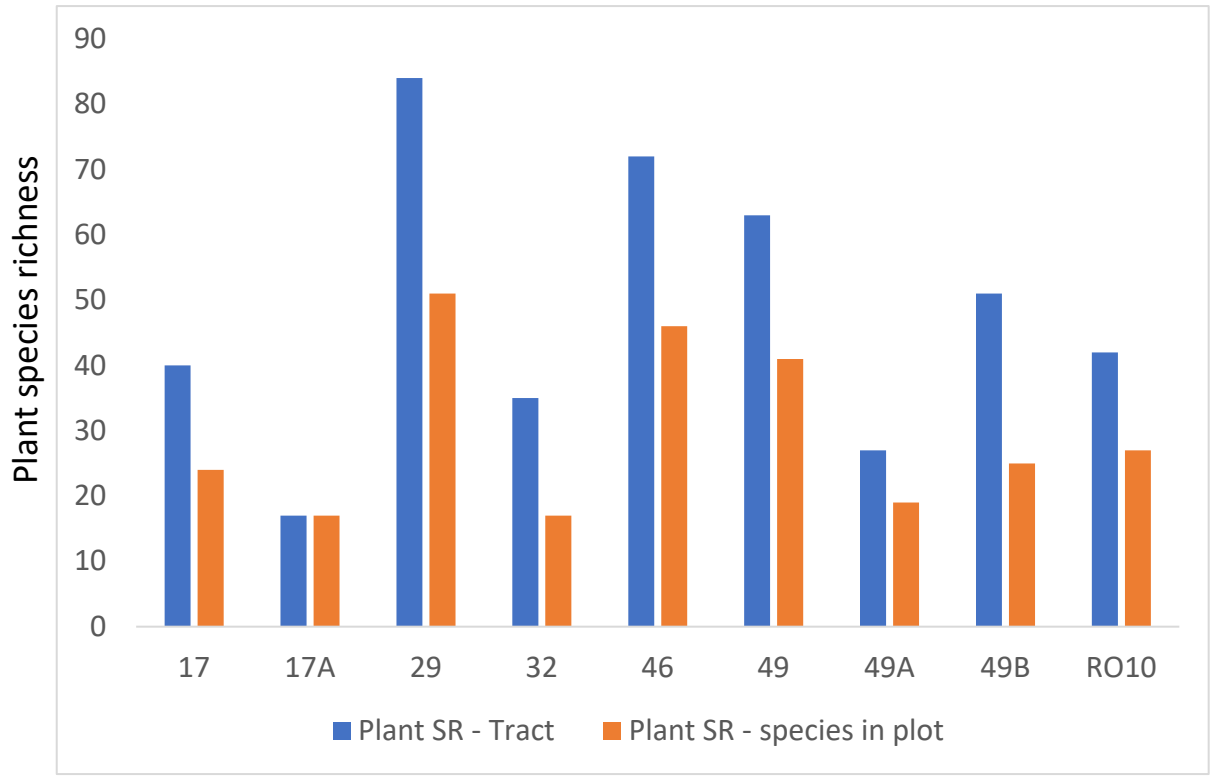


**Figure A5.** Plant species richness, for all species, and only those observed in circular plots.

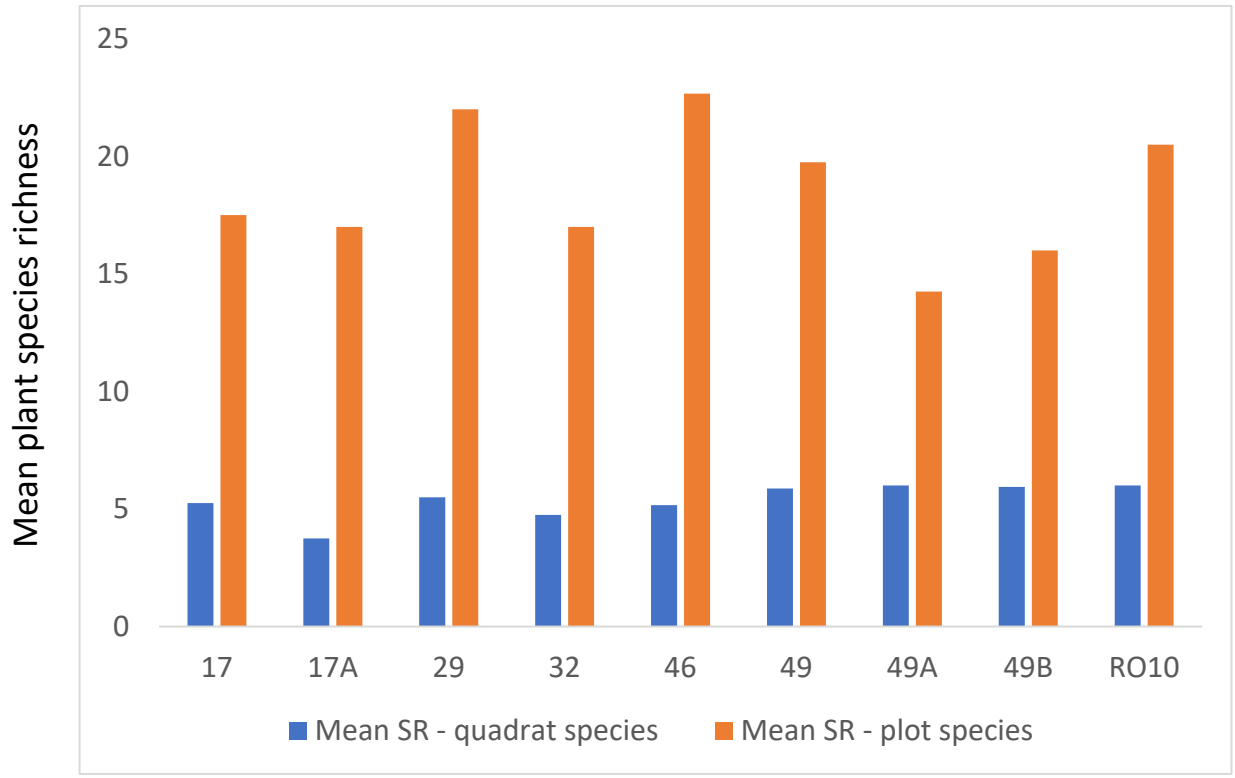


**Figure A6.** Mean plant species richness, for all species observed in circular plots, and for only those observed in ground layer quadrats (excluding frequency quadrats).