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A report on the identification and mapping of the Native Plant Communities at the Hubachek Wilderness Research Center

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INTRODUCTION:

The University of Minnesota's (UMN) Hubachek Wilderness Research Center (HWRC) is located on 365 acres of land in Lake County Minnesota northeast of the city of Ely, Minnesota (Gill et al. 2019). The property includes shoreline on Fall Lake and Browns Lake and shares borders with private and federal (Superior National Forest and the Boundary Waters Canoe Area Wilderness) land. Established in its current form with the gift of private land and an endowment to the UMN from the family of Frank B. Hubachek, Sr., it is currently part of the Research and Outreach Center network for the College of Food, Agricultural, and Natural Resource Sciences.

The HWRC forest is primarily passively managed as a reserve (Seymour & Hunter, 1999) with the intention that the property remain in a "wilderness" state; exceptions include areas artificially planted to red pine and a few areas with ongoing manipulative experiments. In order to best utilize and monitor this resource, an ecological survey of the site was conducted to achieve cover-type mapping representative of present and potential ecological diversity.

The Ecological Classification System (ECS) initiated and currently used by the Minnesota Department of Natural Resources (DNR) was chosen as the survey method, as it is the most comprehensive ecological classification scheme currently in publication for Minnesota. Developed by the DNR and the U. S. Forest Service within the framework of the National Hierarchical Classification of Ecological Units (Cleland *et al.*, 1997), this system attempts to define plant communities via bundles of ecological processes, and places these communities in a continuum of available moisture and nutrients. The system is designed as a hierarchy of six classification levels, beginning with System Group, and concluding with Native Plant Community (NPC) subtype. The details of the system will not be enumerated here; they are covered in the introduction to the DNR's Field Guides to the Native Plant Communities of Minnesota (2003).

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The ECS was originally designed to identify functional communities composed of native plants in order to better identify and prioritize areas in need of preservation. Fitting this purpose, the approximately 4,500 plots used to analyze data and construct the system were located in "relatively undisturbed samples of native vegetation," with an emphasis on forested communities. For this reason, the currently published version of the ECS is more applicable to areas similar to those used in its development. The HWRC is an ideal locale for ECS typing in this regard because many communities have not been undergone any anthropogenic management actions since the turn of the 20th century. However, the original ECS dataset did not contain many plots in the vicinity of the HWRC or in non-forested upland communities – such as those that form a large part of the vegetation mosaic at the HWRC – so these limitations must be considered.

Ecological History of the HWRC:

The HWRC consists of 365 acres of primarily wooded land in the Northern Superior Uplands Ecological Section. The topography is defined by a number of rocky ridges running from NE to SW along the length of the property. The upland areas primarily contain a thin (< 18 cm) layer of loamy sediment over bedrock. The bedrock is primarily mafic to ultramafic metamorphosed igneous rock such as Ely Greenstone exposed during the Wisconsin Glacial Episode. Lower slopes and depressions are currently filled with deep layers of peat or muck, primarily of the Rifle soil series, with variation in surface water flow, including stagnation, in depressions across the landscape.

The ecological history of the area has not been extensively recorded, but some information can nevertheless be inferred or implied. Fire and wind disturbance were likely the primary drivers of succession in this system prior to European colonization of the area. Evidence remaining on the landscape, such as fire scars, charcoal under wind-thrown trees, and visible resprouts confirm the presence of these disturbances, but not their frequency, intensity, or origin. The area currently containing the HWRC was most likely logged by the Swallow-Hopkins timber company between 1898 and 1912 (Heinselman 1972) with most available and merchantable red and white pine removed at that time. Black spruce and tamarack may also have been harvested, but other species such as black ash and jack pine were likely retained due to low timber values.

Geospatially explicit management history at the HWRC is not available but the Mukluk Manual (unpublished; available at the Cloquet Forestry Center [CFC]) outlines some of the general land management history. The Hubachek family moved their private family resort from Basswood Lake to its current location around 1973. At this time, ongoing annual planting of 1,200 to 2,000 *Pinus resinosa*, and some *Picea glauca,* around the property occurred, primarily near facilities, along roadways, areas of recreational usage, or along property boundaries. Individuals of *Quercus macrocarpa* and *Tilia americana* appear near roadways or paths, but not in more undisturbed areas of the forest matrix, suggesting that these are other species that may have been planted even though documentation of their planting is not current known. Mowing and planting of grasses and clovers also occurred around the HWRC, and significant numbers of non-native, disturbed-site species occur near areas of frequent human use. Likewise, some hydrological changes around the facilities area were made. Outside of road construction, the most major hydrological change was damming an underground flowage to create a 1.5 acre trout pond. Stocking of this pond ceased in 1983 but occasional dredging and trapping of

beavers and muskrats continued until around 2010. Other hydrological alterations may have also included ditching, changing of drainages, or other alterations that are less well documented.

It is assumed that extensive logging and fire have been excluded from the site since the early 20th century, yet wind and stand development have continued to be major drivers of change at the HWRC. Large windthrow events, such as known events in July 2016 and July 1999, open canopy gaps and drive succession in many areas. Due to the extremely shallow bedrock, most trees on the site have poor resistance to wind-throw, thus wind will continue to be a major disturbance at this site, especially considering that many climatic predictions call for an increase in the frequency of severe weather events in this area.

METHODS:

The mapping protocol for the HWRC NPC survey consisted of three main phases during the summer of 2017. First, preliminary borders of suspected NPC types were established. Next, field surveys were used to test these preliminary classifications and establish ecological baselines for the area. Finally, the results of the field surveys were used to produce a final GIS database and map of NPC Classes, Types and Subtypes at the site.

Initial NPC type identifications were carried out exclusively with remote-sensed data, primarily a hillshade derived from a statewide 1m LiDAR data collection published in 2012 by the Minnesota State Geospatial Information Office. DNR near-IR and visible spectrum photography from 2009 published by the same office was also used. Generally, the procedure was to identify landforms (uplands or wetlands) with the hillshade, and then identify cover, canopy type, and the presence of sphagnum using imagery. This allowed lowland communities to be placed within broad categories such as peatland, ash forest, or black spruce bog. UMN-led Continuous Forest Inventory (CFI) plot data was also used to verify some of these NPC type identifications, especially for identifying relative frequency of species in some lowland areas.

The sampling phase was conducted during the week of Aug. 14-20 at the HWRC. Two representative plots of each hypothesized cover type were selected from accessible areas, and square plots of 100-400m^2 were sampled for species composition, as outlined in The Relevé Method (MNDNR 2013). Species were either identified in the field, bagged and returned to the lab for identification using keys, or deemed unimportant to the typing process (typical for observed species of moss). Once sufficient plots had been taken to establish community variation across the landscape, the majority of the center was either directly traversed, visited by canoe, or overflown with a small drone to establish vegetation types. In total, 13 plots were established at the HWRC during this period. Some communities were classified with less-rigorous criteria, as complete surveys of lakeshore/emergent communities were deemed to be outside the scope of this study.

NPC classification was conducted with the 2003 Field Guide to the Native Plant Communities of Minnesota: The Laurentian Mixed Forest Province, proceeding from the probability keys for the Northern Superior Uplands to the Subtype descriptions for each relevant NPC. In some cases, special probability tables provided by the DNR (Almendinger 2006, 2007a, 2007b) were used to differentiate between similar communities. In all cases, precedence was given to descriptions of disturbance history, community structure, and landscape setting over results obtained through plant species identifications, keys, and tables. This was especially important in this case because the area around the

HWRC was not extensively sampled for the production of the 2003 NPC publication, and does not exactly correspond to the probabilistic species distribution model used for the NPC publication. Some of the HWRC communities, especially Rock Outcrop (RO) communities, were found to be entirely novel in the context of the 2003 classification system (see the RO community-specific description for more detail).

Products and data locations

Data generated with these methods were collected on current, as of 2017, DNR Relevé method data sheets. In total, 13 plots were sampled, each on their own data sheets. Plot sampling data sheets were scanned and a shapefile dataset generated through interpretation of the relevé data and are archived on UMN data servers. Data and the associated shapefile can be made available upon request to CFC or HWRC research staff.

HWRC NATIVE PLANT COMMUNITY DESCRIPTIONS:

Native Plant Communities at the HWRC

Nine different NPCs were identified across the HWRC property (see Fig. 1). Two distinct communities were found in upland land positions and six in lowland land positions (see Table 1). The two upland NPCs identified were FDn43b and ROn23a. These covered a total of 275 acres (75% of HWRC acreage). Lowland communities were more diverse, comprising a mix of acid peatland (AP80a1), forested peatland, both alder and tamarack dominated (FPn73a and FPn82a), wet forest dominated by black ash (WFn55a and WFn64a/c), and lakeshore emergent marsh communities (MRn83a and MRn93a). In total, lowland communities covered 90 acres (25% of HWRC acreage). Short descriptions of each community are provided here, while complete records of relevé plots can be found in the CFC records.

Upland Communities:

FDn43b: Northern Mesic Mixed Forest, Aspen-Birch Forest

This was the dominant upland forest type at the HWRC, appearing on the slopes and crests of the rocky ridges interspersed with Rock Outcrop inclusions, and on more loamy sites on the southern and eastern sides of the property. Both the balsam fir and hardwood subtypes (b1 and b2) were present, primarily on the scoured bedrock and loamy till, respectively. *Populus tremuloides* was the most common canopy species, with *Acer rubrum, Abies balsamea,* and *Fraxinus nigra* also present, depending on the site. A diverse mix of minerotrophic and rich site indicator species made up the understory, with *Eurybia macrophylla, Lonicera canadensis*, and blackberries, either of *Rubus ablatus* or similar species, being most useful for separating this community from adjacent wet sites. Canopy species were a mix of those found at both drier and wetter sites, due to the proximity of these communities, so were not considered to be diagnostic on their own. The fire-dependent nature of these upland communities is evident in the large number of fire-scarred *Pinus spp.* stumps present throughout the upland landscape.

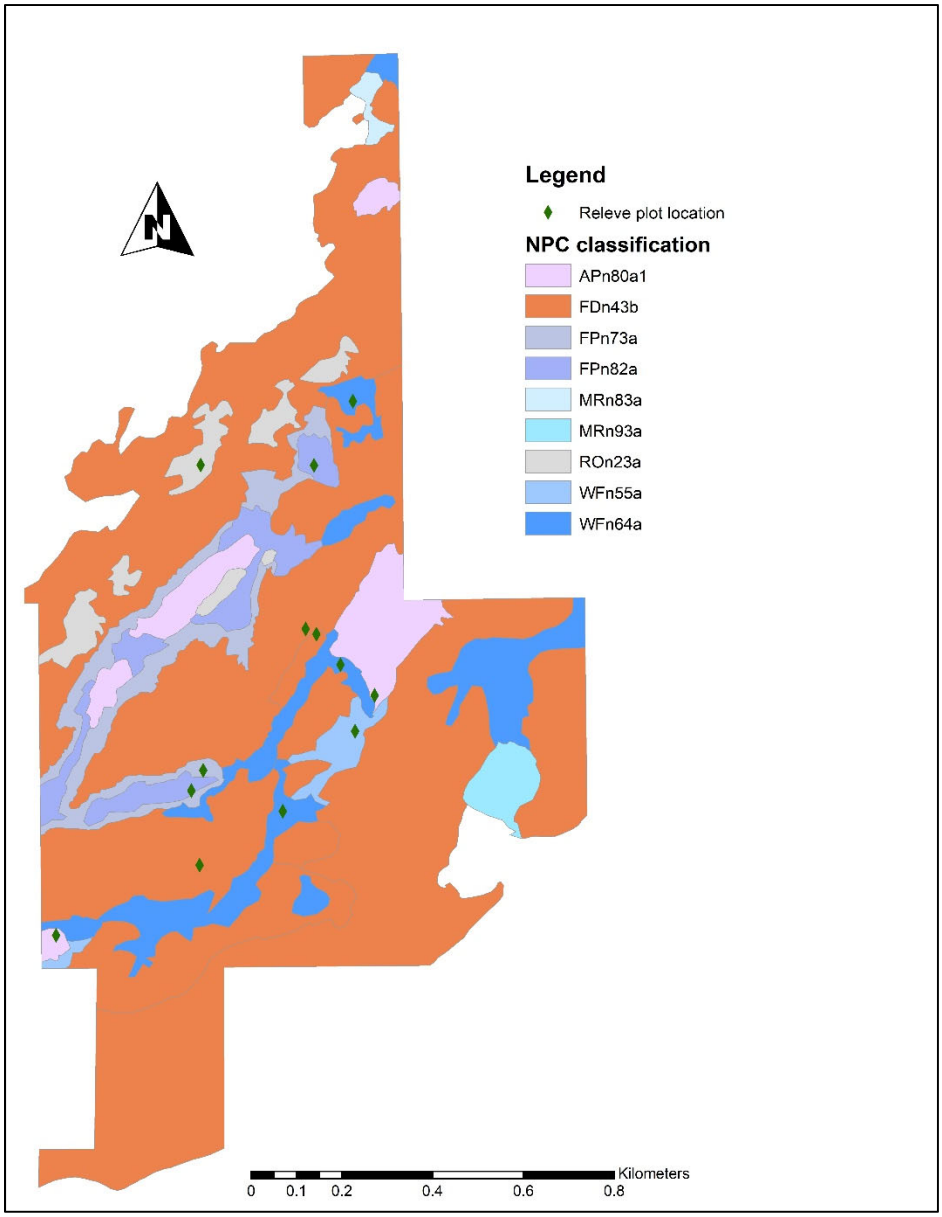

Figure 1. Map of HWRC showing NPC types and locations of relevé plots. Data available upon request.

ROn23a: Northern Bedrock Shrubland (inland)

At the HWRC, the ROn23a community type (see below for further RO community discussion) was found to be both common and consistent across the uplands, generally appearing on east- or south-facing slopes, or crests of the rocky ridges that transect the property. It occurred on exposed greenstone bedrock with little to no soil cover, in both distinct large (>1 ac/.4 ha) patches and interspersed with the greater FDn43b community in small exposed areas, in which it was treated as an inclusion. It consisted of a patchwork of shrubby plants surrounded by exposed rock with lichens in the *Cladina*, *Cladonia*, *Stereocaulon, Xanthoparmelia,* and *Peltigera* genera. *Rhus glabra* was usually

the most common and prevalent shrub, followed by *Juniperus virginiana*. *Vaccinium* and *Amelanchier* were both also usually present, as were dry specialist species like *Polypodium virginianum*, *Woodsia ilvensis*, *Antennaria neglecta,* and *Dichanthelium boreale*. Tree cover was minimal, and generally only on edges, although saplings were also present. Larger individuals, especially of *Pinus banksiana*, that survived to maturity on these sites were commonly found to be blown-down.

The ROn23a community at the HWRC is thought to be somewhat different than, though closely related to, the community described in the 2003 NPC Field Guide. For the Field Guide, the community type description was derived from nine survey and relevé locations near the north shore of Lake Superior, primarily describing the ROn23b community. The ROn23a community is not quantitatively described in the field guide, but is noted to occur inland of Lake Superior throughout the NSU. In comparison to the ROn23 communities described in the Field Guide, this community at HWRC contains more *Rhus* and *Juniperus* in the shrub layer (25-75% cover), which appear to be local indicators of this community type. Other present genera such as *Amerlanchier* and *Vaccinium* are previously described in the field guide as important indicators of this community type. In general, ROn23a at the HWRC is consistent with the description from the 2003 Field Guide in terms of landscape location, moisture levels, genera present, and nutrient availability, but contains a slightly different species mix, especially in the shrub layer, than the communities described nearer to lake Superior.

Table 2. Summary of native plant communities and their total acreage and percentage of the total Hubachek Wilderness Research Center acreage.

Land position	NPC Code	NPC Name	Total acreage	Percentage of HWRC total
Upland	FDn43b	Northern mesic mixed forest, aspen-birch forest	262.5	71.2%
Upland	ROn23a	Northern bedrock shrubland (inland)	12.7	3.4%
Lowland	APn80a1	Northern spruce bog, black spruce bog (treed subtype)	19.4	5.3%
Lowland	FPn73a	Northern alder swamp	17.7	4.8%
Lowland	FPn82a	Northern rich tamarack swamp (western basin), rich tamarack - (alder) swamp	14.4	3.9%
Lowland	WFn55a	Northern wet ash swamp	4.8	1.3%
Lowland	WFn64a	Northern very wet ash swamp	37.0	8.8%
Lowland	MRn83a	Northern mixed cattail marsh, cattail - sedge marsh (northern)	1.5	0.4%
Lowland	MRn93a	Northern bulrush - spikerush marsh, bulrush marsh (northern)	5.1	1.4%

Lowland Communities:

APn80a1: Northern Spruce Bog, Black Spruce Bog (Treed Subtype)

This subtype appeared on deep peat soils (typically Rifle series) in isolated depressions or at the center of larger peatlands. It was typified by a lack of diversity (<20 species/100m^2), a continuous cover of *Sphagnum* spp., and a mature, closed or nearly closed *Picea mariana* canopy (although due to a July 2016 blowdown event, this was not always the case). *Rhododendron groenlandicum, Carex trisperma, Gaultheria hispidula* and *Vaccinium angustifolium* typically comprised nearly all non-*Sphagnum* species, with others appearing as scattered individuals. Microtopography was dominated by moss hummocks, with heights of 20-70 cm common. Standing water was not present at the time of sampling in August, except in depressions created by wind-thrown trees.

FPn73a: Northern Alder Swamp

This community type occupied transition areas between upland fire-dependent and forested lowland communities where mucky peat or peat soil was present. It was typified by a nearly continuous canopy of *Alnus incana* and a lack of significant cover of other woody species. *Sphagnum* cover ranged from nearly continuous to around 50%. Common understory species included *Cornus sericea, Kalmia polifolia,* and *Chamaedaphne calyculata*. This community occupied a similar landscape setting to WFn64a and FPn82a, appearing on the boundaries and as inclusions in these communities.

FPn82a: Northern Rich Tamarack Swamp (Western Basin), Rich Tamarack - (Alder) Swamp

The FPn82a community at the HWRC tended to occur in transition between shrub-dominated lowlands and Acid Peatland (AP) systems with black spruce canopies on peat or mucky peat soils. Typically, canopy cover was sparse to incomplete, with *Larix laricina* and *Picea mariana* both present. *Sphagnum* cover was nearly continuous and species composition was similar to APn80a, albeit with more minerotrophic species present, such as *Dryopteris cristata, Maianthemum canadensis* and *Salix spp. Thuja occidentalis* often was present as seedlings in the understory but will likely not become a canopy species in this community due to whitetail deer browse pressure. This system was distinguished from FPn73a primarily by a more extensive canopy and from APn80a by a more diverse collection of understory species, although it occurred bordering and within inclusions in these two communities.

WFn64a: Northern Very Wet Ash Swamp, Black Ash – Conifer Swamp, and WFn64c: Northern Very Wet Ash Swamp, Black Ash – Alder Swamp

Two community types within the Northern Very Wet Ash Swamp class were documented at the HWRC: Black Ash - Conifer Swamp (WFn64a) and Black Ash - Alder Swamp (WFn64c). These communities were found in wet areas where some surface water flow existed during all or part of the growing season and standing water remained in the late summer: at the edges of larger wetlands (including acidic peatland), in depressions that were not hydrologically isolated year-round, and along flowages. Canopies were dominated by *Fraxinus nigra* and included isolated individuals of other species, especially in WFn64a. The understories of both types were somewhat variable but typically included ferns of either *Dryopteris* or *Athyrium* genera, other wet site indicators such as *Glyceria striata, Carex disperma*, and *Rubus pubescens*, and had distinctly less Sphagnum cover than FP systems. WFn64a species composition was more similar to FP communities, with species like *Rhododendron groenlandicum* and *Vaccinium angustifolium* being common, while WFn64c included species like *Impatiens capensis*, *Caltha palustris*, and *Onoclea sensibilis*. Typically, a strong, continuous midstory of *Alnus incana* appeared in WFn64a, while WFn64c had a more open midstory, with occasional individuals of *Alnus* or *Acer* appearing in patches.

WFn55a: Northern Wet Ash Swamp, Black Ash – Aspen - Balsam Poplar Swamp (Northeastern)

The WFn55a community classification at the HWRC represented the driest ash swamp sites, where standing water had disappeared by late summer. The soil on these sites tended towards a thin loam or muck layer over a substrate of coarse glacial till. *Fraxinus nigra* was present in the canopy but often alongside *Acer rubrum, Abies balsamea, Betula papyrifera,* and *Populus tremuloides*. *Sphagnum* was rare, if present, typically with <10% cover, and exposed rock was common. Species composition was highly dependent on microtopography with upland minerotrophic species and wet site species both observed.

MRn83a: Northern Mixed Cattail Marsh, Cattail - Sedge Marsh (Northern), and MRn93a: Northern Bulrush - Spikerush Marsh, Bulrush Marsh (Northern)

These two community types at the HWRC represented areas of emergent vegetation on the shores of Browns and Fall Lakes. These sites were identified primarily by the species of graminoids that were dominant- *Carex lacustris* and *Calamagrostis canadensis* in MRn83a and *Scirpus/Juncus* rushes in MRn93a.

CONCLUSION:

The landscape of the HWRC included a mosaic of upland and lowland ecological community macro-systems. The upland systems consisted of a matrix of forested areas and rock outcrops, defined by a historical regime of fire and wind disturbances, and more recently by wind disturbance alone. The lowland systems followed a gradient of hydrologic activity from relatively isolated depression black spruce peatlands to wet forests and lakeshores with flowing surface water. Many of these communities contain somewhat novel species assemblages in comparison to those described in the field guide, perhaps warranting further study. The enumeration and mapping of these areas will facilitate more direct study of specific plant communities and their attributes in the future and help account for present and changing ecological diversity.

In accordance with the mission of the HWRC, managing these communities as wilderness would allow them to be accessible for future ecological research. This study collected a baseline of the ecological communities present at the time sampling. It is intended to inform land management decisions, provide a baseline for monitoring and future research, and be informative for all HWRC users.

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