2017

Master's Project: An Ecological Assessment of the Atlas Timberlands, Vermont

Hannah B. Phillips
University of Vermont

ATLAS TIMBERLANDS ECOLOGICAL ASSESSMENT

SIGNIFICANT NATURAL COMMUNITIES AND
WILDLIFE HABITAT OF THE ATLAS TIMBERLANDS

PREPARED BY HANNAH PHILLIPS
UNIVERSITY OF VERMONT ECOLOGICAL PLANNING PROGRAM
RUBENSTEIN SCHOOL OF THE ENVIRONMENT AND NATURAL RESOURCES

FOR THE

ATLAS TIMBERLANDS PARTNERSHIP
VERMONT LAND TRUST
THE NATURE CONSERVANCY-VERMONT CHAPTER

ACKNOWLEDGEMENTS

This project was completed with the guidance and support of the following individuals:

Liz Thompson, Vermont Land Trust
Jon Binhammer, The Nature Conservancy-Vermont Chapter
David McMath, M.D. Forestland Consulting
Beth Daut, M.D. Forestland Consulting
Brett Engstrom, Consulting Ecologist
Marc Lapin, Middlebury College
Charlie Hohn, Vermont Department of Environment Control, Wetlands Division
Robert Zaino, Vermont Department of Fish and Wildlife, Natural Heritage Program
Eric Sorenson, Vermont Department of Fish and Wildlife, Natural Heritage Program
Nancy Patch, Franklin County Forester
Jared Nunery, Orleans County Forester
Gus Goodwin, The Nature Conservancy-Vermont Chapter
Dr. Jeffrey Hughes, UVM Field Naturalist Program

University of Vermont Academic Committee:

Deane Wang, PhD, Co-Advisor
Anthony D'Amato, PhD, Co-Advisor
Liz Thompson, M.S., Committee Member
Cathy Paris, PhD, Committee Chair

CONTENTS

LIST OF TABLES

LIST OF FIGURES

EXECUTIVE SUMMARY

The Atlas Timberlands cover 26,789 acres in the northern Green Mountains of Vermont, comprised of fourteen parcels in Franklin, Orleans, and Lamoille counties. The Vermont Land Trust and The Nature Conservancy-Vermont chapter purchased the land together in 1997, forming the Atlas Timberlands Partnership (ATP). Their primary ownership objectives were to restore the ecological integrity of the forest – which had been harvested heavily by the prior owner(s) – and to identify the economic and social implications of large-scale ecological forest management.

In March 2015, ATP announced their intent to sell nearly 23,000 acres of the Atlas Timberlands and to reinvest the profits in additional forest conservation projects in Vermont. A strict conservation easement held by the Vermont Land Trust will accompany the parcels at sale and will ensure the forest is managed in an ecologically-responsible manner (development will not be allowed).

To further strengthen the ecological protections assigned to the Atlas Timberlands in preparation for their sale, ATP hired Hannah Phillips, a graduate student in the University of Vermont Ecological Planning Program to map state-significant natural communities and significant wildlife habitat on eight of the Atlas parcels during summer 2016: Bogs, Burnt Mountain, Deep Gibou, Eden-Craftsbury, Eden Square, Haystack East, Richford-Jay, and Tillotson (*Figure 1*).

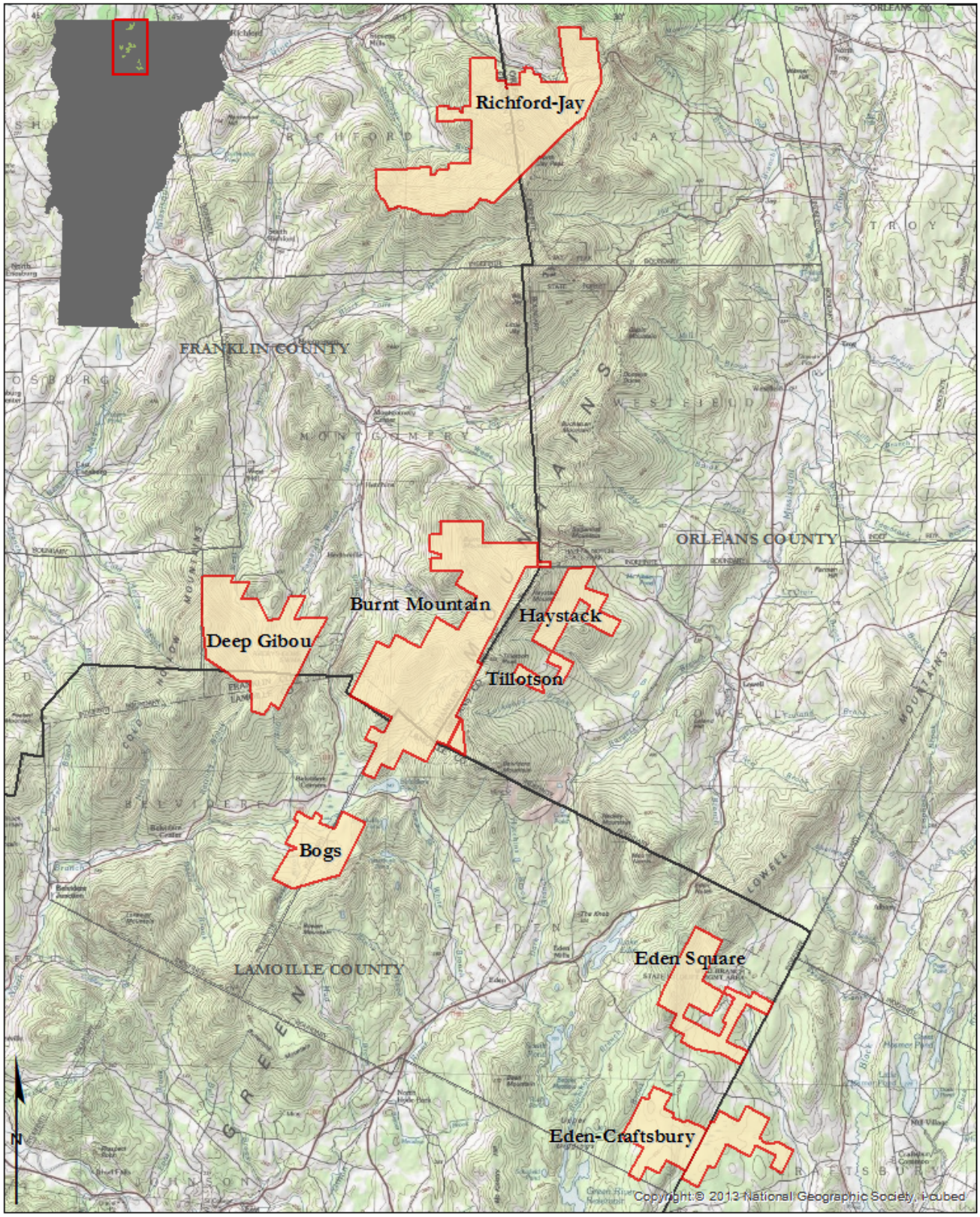
This ecological assessment was conducted between May and August 2016 using a mixture of remote GIS assessment and field work. Parcels were remotely assessed to determine areas that had the highest probability of diverging from the matrix forest condition, and these areas were then visited in the field. Following these field visits, natural communities and wildlife habitat were mapped for each parcel, and ranked according to the Vermont Natural Heritage Program ranking specifications (Sorenson et al. 2014). Protections were then recommended for significant ecological features based on established VLT easement policies. If those protections seemed insufficient to protect the ecological integrity, a higher-level of protection was recommended. Reports and GIS data were provided to ATP in March 2017.

Seventy-two natural community occurrences were mapped as state-significant, spanning 4152 acres, or 23% of the total land area within the focal parcels. The majority of this acreage is montane forest (71%) and wetlands (21%). Three S2 natural communities were mapped on the Bogs parcel (Dwarf Shrub Bog, Black Spruce Woodland Bog, Black Spruce Swamp), and 35 occurrences of S3 communities were mapped elsewhere on the Atlas lands. The majority of S3 communities are Northern Hardwood Seepage Forests, a newly recognized natural community type in Vermont that is believed to be more abundant in the northern Green Mountains than elsewhere in the state (Lapin and Engstrom 2015). Some of the best examples of this natural community type occur on the Eden Square, Eden-Craftsbury, and Bogs parcels.

An additional 326 acres of significant wildlife habitat were mapped, which includes beech mast stands, rock outcrops, beaver ponds, and old forest. Twenty-nine vernal pools were mapped across the Atlas lands, ten of which are naturally-occurring and exceed the two hundred square foot Vermont Natural Heritage Inventory criteria for minimum size and the Vermont Land Trust threshold for protection.

The products created from the summer 2016 ecological assessment of the Atlas Timberlands add to the ecological knowledge of these parcels generated by other field ecologists and foresters. David McMath (MD Forestland Consulting) has managed the Atlas Timberlands since ATP purchase in 1997, and in conjunction with Beth Daut and Robert Turner has compiled extensive forest management plans for each of the properties. Field ecologists Brett Engstrom and Marc Lapin conducted ecological assessments of the property in 1999 and 2015; their reports offer excellent commentary on the significance of the Atlas Timberlands on a landscape scale and also highlight specific features of ecological interest, including rare, threatened, and endangered species. This report should be considered in conjunction with these other resources to obtain the full body of knowledge about these extensive and special parcels.

FIGURE 1 ATLAS TIMBERLANDS 2017 ECOLOGICAL ASSESSMENT FOCAL PARCELS



Map created by Hannah Phillips
UVM Field Naturalist Program

Atlas Timberlands Project Key

0 1.25 2.5 5 Miles

INTRODUCTION

ATLAS TIMBERLANDS ECOLOGICAL ASSESSMENT

PREPARED BY HANNAH PHILLIPS
UVM ECOLOGICAL PLANNING PROGRAM
SITE VISITS ON JUNE 30 AND JULY 1, 14 2016

Vermont Land Trust

The Nature Conservancy

PROJECT DESCRIPTION

In 1997, the Vermont Land Trust (VLT) and The Nature Conservancy (TNC) created the Atlas Timberlands Partnership (ATP) to collaboratively purchase and manage the Atlas Timberlands. Since acquiring the Atlas lands, the second largest timber holding in the state of Vermont (26,789 acres), VLT and TNC have managed the forest sustainably, taking into consideration the ecological, economic, and social implications of timber harvest (Vermont Land Trust, 2016). The Atlas Timberlands are Forest Stewardship Council (FSC) certified.

In March 2016, ATP announced their plan to sell up to 23,000 acres of the Atlas Timberlands to finance additional forestland conservation in Vermont. ATP seeks buyers whose stewardship values are consistent with the conservation missions of both organizations, and VLT will maintain easements on the properties to ensure the Atlas Timberlands remain sustainably-managed working forests, and to protect ecologically-sensitive areas and public access.

During the summer of 2016, I conducted an ecological assessment of 17,400 acres of the Atlas Timberlands in eight towns on eight parcels (Bogs, Burnt Mountain, Deep Gibou, Eden-Craftsbury, Eden Square, Haystack, Richford-Jay, Tillotson). My objective was to identify ecologically-significant areas, including state-significant natural communities, vernal pools, wetlands, streams, and significant wildlife habitat. Based on this fieldwork, I made easement protection recommendations to VLT/TNC to be applied to the parcels prior to sale.

BACKGROUND

The Atlas Timberlands Partnership, established in 1997, establishes VLT and TNC as partners in the acquisition, management, and use of the Atlas Timberlands parcels in a manner consistent with both organizations' conservation missions. The management philosophy of this joint venture is as follows:

> *The mission of the Atlas Timberlands Partnership is to explore ways to balance ecological, economic, and community values on a medium-size land base; to develop and implement management actions that sustain and enhance these three components; and to protect this work over the long term through the use of easements. As part of that mission, ATP will encourage research and public access on its land base; own all or parts of its land base for the length of time needed to meet its primary goal of learning about and defining the ecological, social and economic balance; and eventually transfer all or portions of its land base in a manner that will provide for similar continued management on its land base while promoting similar management on other lands. A core holding may be retained for the long term* (Turner and McMath 2007).

PREVIOUS WORK

Since purchasing the Atlas Timberlands in 1997, multiple parties have conducted ecological inventories across the entirety of the parcels. In 1999, Brett Engstrom and Marc Lapin conducted an ecological assessment of the property with the goal to "1) identify significant ecological and botanical features, and 2) to analyze the conservation importance of the lands in a regional context" (Lapin and Engstrom 1999). They were hired again by ATP in 2015 to complete an in-depth but non-comprehensive assessment of the parcels.

In 2015, Michael Lew-Smith and Aaron Worthley of Arrowwood Environmental conducted a remote inventory of vernal pools on the Atlas Lands, and ground-truthed the mapped vernal pools to determine viability as breeding amphibian habitat. Through this process, they located six vernal pools across the Atlas lands, and three additional pools that had formed in man-made sites (logging roads). Of these, only four pools were located on the parcels that were the focus of my inventory (the remaining five were located on the Little Elmore Pond parcel). Through their remote assessment, they also generated a GIS layer of potential wetlands which were not ground-truthed.

Forest management plans and detailed forest inventories exist for all parcels, prepared by David McMath and Robert Turner, of MD Forestland Consulting and R.J. Turner Forest Consulting, respectively. These plans were revised in 2007 to reflect the improved forest conditions and progression towards the initial management objectives.

Despite the extent of the existing fieldwork on the Atlas Parcels, much detail remained to be ascribed to the parcels in preparation for their sale. While some of the reports mention natural communities of statewide significance, the GIS mapping was not uniform across the parcels, nor had all of the natural communities been assigned a ranking of significance. 2016 provided an opportunity to refine the data resolution and gather supplemental information.

NATURAL COMMUNITY APPROACH

Natural community mapping is a coarse-filter conservation framework commonly employed in landscape-scale conservation efforts. In contrast to a "fine-scale conservation strategy," in which ecologists actively seek out individual species occurrences to assess abundance and distribution, the "coarse filter" conservation strategy prioritizes conservation of broader habitat conditions that meet the needs of those species commonly contained within (Hunter, 1991; Noss, 1996). A natural community, defined by Thompson and Sorenson (2000) as "an interacting assemblage of organisms, their physical environment, and the natural processes that affect them," serves as one such coarse filter used to guide conservation decision-making. Of course, this approach is not appropriate for all species. Species with limited distribution (*i.e.,* rare, threatened, or endangered species) may not be represented within a natural community, and species with complex life history strategies that depend on landscape position may also be excluded. For this reason, the coarse-filter conservation approach is often applied in conjunction with a fine-filter conservation strategy.

Natural communities are deemed "state-significant" if they meet a series of criteria set forth by the Vermont Department of Fish and Wildlife's Natural Heritage Inventory. First, each natural community type receives a Rarity ranking (S1-S5[1], extremely rare to common and widespread) based on the frequency of that natural community type in the state. Then, each natural community encountered in the field (an "element occurrence") receives an Element Occurrence Rank, based on size, current condition, and landscape context (Sorensen et al. 2014). Size is scaled based on the standard patch size for a given natural community type; patch sizes are assigned by the Vermont Natural Heritage Inventory and are either small patch (50 acres or less), large patch (50 to 1,000 acres), or matrix forming (1,000 to 100,000 acres; Thompson and Sorenson 2005). Generally speaking, large patches, minimally impacted by human activity, located in proximity to other high-quality examples of natural communities, rank higher. Higher ranked sites are perceived to have higher conservation value, as they are believed to better meet the needs of the plants and animals that occupy the community. Therefore, various combinations of rarity and community quality dictate which natural communities are deemed state-significant. It should be noted that, in many cases, protection of adjacent communities may be necessary for the target natural community to retain significance.

Field identification of vernal pools and significant wildlife habitat resembles a fine-filter conservation approach. Because vernal pools are critical habitat for a number of breeding amphibians that rely on their protected waters for survival and reproduction, searching for vernal pools represents an effort to isolate a specific class of vertebrates. Furthermore, significant wildlife habitat identifiable by landscape features (ie., cliffs, mast stands, deer wintering yards, bear wetlands, vernal pools, etc.) may apply to a small number of vertebrate species (bear, moose, deer, bobcat, fisher, porcupine, etc.) that rely on a variety of specific habitat features for their survival.

[1] S=state rank. This rarity ranking is assigned by the Vermont Natural Heritage Inventory.

PROJECT OBJECTIVES

The following objectives were established in collaboration with the Vermont Land Trust, The Nature Conservancy, and my UVM Graduate Studies Committee:

- Locate and map state-significant natural communities on the focal parcels of the Atlas Timberlands through remote geospatial assessment and field work.
- Locate and map significant water resources on the property including wetlands and vernal pools through remote geospatial assessment and boots-on-the-ground field work.
- Locate and map significant habitat features using geospatial data, including beech mast stands, cliffs, wetlands, and vernal pools.
- Recommend protections in accordance with the Vermont Land Trust policies.
- Recommend easement attributes and easement language to ensure adequate protection of ecological features.
- Map Northern Hardwood Seepage Forests and describe their patterns on the landscape.

METHODS

I mapped natural communities on the Atlas Timberlands between May 24 and August 17, 2016, over thirty-one field days.

Field work was preceded by a remote geospatial assessment of the property using ArcMap version 10.4.1. I used the following layers to identify areas that seemed likely to deviate from the matrix forest condition (Northern Hardwood Forest).

- USGS topographic map (2013; 1:250,000-scale)
    - Concavities, steep slopes (cliffs), basin topography
- Bedrock geology map of Vermont (Ratcliff et al. 2011; 1:100,000-scale)
    - Mafic, ultramafic, or calcareous bedrock
- Soils data (Soil survey staff, NRCS, Web Soil Survey)
    - Hydric soils, perched water tables
- Color-infrared imagery (Vermont Center for Geographic Information 2013)
- National Agriculture Imagery Program (NAIP) imagery (Vermont Center for Geographic Information 2014)
- Atlas harvest history (McMath 2016)
- Arrowwood Wetlands layer (Arrowwood Environmental 2015)
- Arrowwood Vernal Pools layer (Arrowwood Environmental 2015)
- Vermont Significant Wetlands Inventory layer (VT Department of Environmental Conservation, Wetlands Program 2015)
- Vermont Natural Heritage Program rare, threatened, or endangered species data layer (VT Department of Fish and Wildlife 2016)
- Vermont Natural Heritage Program state-significant element occurrence data layer (VT Department of Fish and Wildlife 2016).

I also met with David McMath prior to beginning my field work to identify ecological areas of interest, and to discuss access and adjacent landowner issues on each of the parcels.

After meeting with David McMath and assessing the geospatial layers, I mapped points of interest to visit in the field. I made an effort to avoid duplicating inventory efforts by Brett Engstrom and Marc Lapin. In some cases, their reports called attention to sites of ecological significance but did not map the boundaries of the community or rank the state significance of the occurrence. When that was the case, I visited the areas mentioned in their report to refine the mapping.

I viewed maps in the field using an iPhone with the Avenza PDF Maps iPhone application in conjunction with a BadElf GPS Pro+ unit, accurate to within nine feet. I logged points of interest in the field on the Bad Elf GPS unit, and took geolocated field photos through the Gaia GPS iPhone application. My field route was dictated by these previously established points of interest. I deviated from my route if I encountered unexpected features of interest, but would return to my pre-planned trajectory afterwards.

Over the course of the field day, I took ongoing notes about dominant plant and tree species, forest structure, evidence of land use history, wildlife sign, and landform. When I entered a natural community that was *not* a Northern Hardwood Forest, I took notes on dominant plant species and species characteristic of the natural community type, forest structure and composition, landform, soils, and hydrology. For S3, S2, and S1 natural communities, I dug a soil pit to notate soil color, texture, pH and layer depth. When mapping vernal pools, I noted vernal pool shape, water depth, presence of leaf litter, coarse woody debris, approximate canopy coverage, and presence/absence of amphibian egg masses.

To establish boundaries on natural communities, I compared the observed boundary to leaf-on aerial imagery on GaiaGPS in the field (GaiaGPS MapBox Aerial layer). This allowed me to establish visual signatures for most natural communities, which then guided my mapping indoors. When I was not able to establish a visual signature for a community, I took detailed field notes about the approximate location of the boundary in relation to my track, and then mapped my closest approximation of the boundary in ArcMap. Although I did not walk the boundary of the natural communities in the field, I took notes each time I exited or entered a natural community. When mapping natural communities in ArcMap, I relied on leaf-on NAIP imagery, leaf-off ArcMap World Imagery basemap (ESRI 2016), and my field points to draw the boundaries around natural communities.

After individual polygons were created for each natural community type, I grouped polygons together that were within the separation distance outlined in the Vermont Natural Community Ranking Specifications (Sorenson et al. 2014). I then assigned a ranking for the size (acres), element occurrence condition, and landscape context, and calculated the element occurrence ranking. For newly recognized natural community types (Northern Hardwood Seepage Forest, Montane Seepage Forest), I used the Northern White Cedar Sloping Seepage Forest ranking specifications. This seemed appropriate for the Northern Hardwood Seepage Forest, but perhaps a bit large for the Montane Seepage Forest, which tends to occur in small pockets in Montane Yellow Birch-Red Spruce Forests.

Wildlife features that are not natural communities (outcrops, beech mast stands) were mapped within the natural community layer but were not assigned quality rankings. Small wetlands (seeps, vernal pools) were mapped as polygons if they were state-significant (Sorenson et al. 2014). Non state-significant element occurrences appear in the point features layer, as do all vernal pools. Intermittent streams were mapped using field points and a combination of leaf-on and leaf-off aerial imagery as reference.

All of my field notes appear in the point features layer for each parcel, and those classified as streams, intermittent streams, seeps, evidence of land use history, boundary markers, or rare, threatened, or endangered plant species occurrences appear on the Points of Interest maps in the subsequent reports.

I assigned Vermont Land Trust special easement protection categories to element occurrences, where appropriate. If these existing protection categories did not feel sufficient, I made a note of this in the report and suggested alterations. Easement language was selected to describe the ecological function and preserve the integrity of the natural community even as management objectives and the political climate guiding easement protections develop and change.

Element occurrences were designated as eligible for a Current Use Ecologically Significant Treatment Area (ESTA) if they met the criteria outlined in the Use Value Appraisal Manual (Vermont Department of Forests, Parks, and Recreation 2010). The following features qualify for ESTA protection: natural communities of statewide significance, rare, threatened, or endangered species, riparian areas, vernal pools with amphibian breeding habitat, forested wetlands, or old forests.

RESULTS

STATE-SIGNIFICANT NATURAL COMMUNITIES

Over the course of the summer, twenty-two different natural community types were identified and mapped on the Atlas Timberlands. Of these, 72 natural community occurrences were mapped as state-significant, spanning 4092 acres, and 23% of the total land area (*Table 1*, *Table 2*, *Appendix D)*. Northern Hardwood Seepage Forests were mapped most frequently (13 occurrences), followed by Rich Northern Hardwood Forest (10 occurrences), Seeps (10 occurrences), and Hemlock-Balsam Fir-Black Ash Seepage Swamp (Red Spruce variant; seven occurrences; *Table 1*). By acreage however, the Montane Yellow Birch-Red Spruce Forest natural community covers the most ground (2290 acres), followed by Montane Spruce-Fir (586 acres), and Northern Hardwood Seepage Forests (576 acres; *Table 2*).

The Richford-Jay parcel has the greatest land area of state-significant natural communities (1545 acres), largely due to the high elevation Montane Yellow Birch-Red Spruce Forest and Montane Spruce-Fir communities on the ridgeline. Burnt Mountain is second (934 acres), followed by Deep Gibou (731 acres), both of which are driven by the high-elevation montane forests on ridgelines within the parcels.

When considering which parcels have the greatest percent of their land area classified as state-significant, Richford-Jay, Gibou, and Burnt Mountain are highest, again due to their high-elevation ridgelines (37%, 26%, 20% respectively). Notably, the Bogs parcel comes in fourth (19%), due to the large wetland complex on site (approximately 125 acres), and the Northern Hardwood Seepage Forests (88 acres). These measures do not take into consideration the beaver ponds on site.

Of the 72 state-significant natural community occurrences mapped, 38 were classified as either S2 or S3 rarity ranking, spanning 3714 acres (*Appendix D*). The large majority of these natural community occurrences are S3 natural communities (3709 acres). Vermont Land Trust assigns special easement protections to natural communities ranked S3 or higher, and state-significant S1-S3 natural communities are also eligible for the ESTA designation within the Use Value Appraisal tax structure.

SIGNIFICANT WILDLIFE FEATURES

Twenty-eight different occurrences of five types of significant wildlife features were mapped on the Atlas Timberlands over approximately 326 acres, not including the wildlife value of the mapped natural communities. The features mapped included beech mast stands, deer wintering areas, old forests, beaver ponds, and outcrops (Appendix F. Wildlife). Beaver ponds were the most common type of wildlife feature (10 occurrences, 184 acres), followed by old forest (eight occurrences, 87 acres), and beech mast stands (seven occurrences, 37 acres).

The Eden-Craftsbury parcel has the greatest land area of significant wildlife features (131 acres) due to the large beaver ponds and wetland complexes on site. This is closely followed by Deep Gibou, which has 35 acres of beaver meadows and 37 acres of old forest in the Montane Yellow Birch-Red Spruce Forest and the Northern Hardwood Forest. Although the Bogs parcel only has 34 acres of mapped wildlife features, the 125 acres of wetland on site also have high wildlife value.

Twenty-nine vernal pools were mapped across the Atlas lands (*Appendix G*). Ten of these vernal pools meet preliminary Vermont Land Trust criteria for a Vernal Pool Special Treatment Area, but have not yet been assessed for the presence of breeding amphibians. These ten vernal pools are naturally-occurring and exceed 200 square feet in size. Ten additional vernal pools are naturally occurring but fall below the 200 square-foot size threshold. The remaining nine vernal pools are not naturally occurring, and exist on or adjacent to logging roads. The ten vernal pools that meet the preliminary protection criteria will need to be revisited in the spring to determine the presence or absence of breeding amphibians.

NARRATIVE SUMMARY OF THE ATLAS LANDS

For over a century, the Atlas lands have been thought of as a single entity. From a distance, we know them as a productive timberland, classified broadly by unbroken stands of Northern Hardwood Forest and high-elevation ridgelines. And yet, a summer's worth of study reveals notable variation amongst the parcels. These parcels can be coarsely grouped into those that are governed by montane processes, and those that are not. The steep slopes and high elevations of the northern Green Mountains have a noticeable influence on forest character and ecological features, both of which have, are, or will influence past, present, or future land use in these forests.

Three parcels in particular exhibit landforms and vegetative communities classic of the Northern Green Mountains biophysical region. Richford-Jay, Burnt Mountain, and Deep Gibou all encompass montane ridgelines with spruce-fir forests that thrive with cool temperatures and high elevations. Lower down on their flanks, broad expanses of Northern Hardwood Forest run mostly uninterrupted to valley bottoms. Their moderately steep slopes drain water well, although the north-facing slopes tend to hold small pockets of water on benches or in small coves, likely derived from lingering snow melt. These montane wet coves are especially apparent on the north-facing ridgelines of Richford-Jay South.

Burnt Mountain stands apart from Richford-Jay with its prolonged toeslopes extending to valley bottoms below the steep, montane forests, a feature present in Deep Gibou as well. The north-facing toeslopes hold water especially well, a condition that is clearly on display in the Wade Brook watershed on Burnt Mountain and, to a lesser extent, in the Pacific Brook drainage. Burnt Mountain has large, healthy stands of sugar maple which thrive in the nutrient-enriched soils, a feature that is also present, albeit less so, in Deep Gibou.

Wet forests at toeslopes are common throughout the Atlas Lands, and they are abundant on the parcels that feature this landform and landscape position. Eden Square, Bogs, and Haystack East/Tillotson are all located at the base of steeper montane slopes, and water accumulation in soils is a common feature. In both Eden Square and Haystack East/Tillotson, the milder slopes never coalesce into a topographic basin, but the slopes become gradual enough to hold water. These forested wetlands (Seepage Forests) seem to be a common feature on the Atlas lands, and are most expansive on the mid-elevation properties. Eventually, these headwaters drain into a stream or basin swamp, as is visible on the Bogs parcel.

Eden-Craftsbury stands alone as a parcel lacking affiliation with a montane ecosystem. Although part of the Northern Green Mountains biophysical region, its mild topography is akin to the Northern Vermont Piedmont region, albeit without the calcareous bedrock unpinnings. Its mild slopes hold water well, and basin swamps provide important habitat for wildlife. Large expanses of Northern Hardwood Forest are punctuated by wet Northern Hardwood Seepage Forest, yet these arise from conditions not replicated elsewhere on the Atlas lands, as this water is not derived from upslope montane regions.

In their entirety, the Atlas lands contain impressive expanses of matrix and large-patch size forest communities, including Northern Hardwood Forest, Montane Spruce-Fir, and Montane Yellow Birch-Red Spruce Forest. Notable variations to this community include Rich Northern Hardwood Forests and Northern Hardwood Seepage Forests. The Northern Hardwood Seepage Forests seem to span greater land areas than observed elsewhere in Vermont (although I have only seen a few other examples of this forest type). The precise combination of landscape position, topography, and aspect seem all to contribute to this phenomena, although the exact causes are all still the subject of much deliberation.

Taken together, the extensive forests of the Atlas lands provide significant ecological value to Vermont and the Northern Forest Region. Their unbroken forests provide space for species to move and adapt to climate change, offer connectivity to other large forest patches, protect water quality, and sequester and store carbon from the atmosphere. Their connection and proximity to a number of different wetland complexes offer high wildlife value, providing early spring forage before the surrounding uplands produce desirable mast. Future forest management within the Atlas lands should strive to maintain and improve the many ecological services that these lands provide; these lands hold within them lessons of our land use past, and the promise of an economically and ecologically productive future.

TABLE 1 STATE-SIGNIFICANT NATURAL COMMUNITY OCCURRENCES ON THE ATLAS TIMBERLANDS (COUNT)

COUNT - STATE SIGNIFICANT	Bogs	Burnt Mountain	Eden-Craftsbury	Eden Square	Gibou	Haystack-Tillotson	Richford-Jay North	Richford-Jay South	TOTAL
Alder Swamp	1				1				2
Black Spruce Swamp	1								1
Black Spruce Woodland Bog	1								1
Boreal Talus Woodland						1			1
Dwarf Shrub Bog	1								1
Hemlock-Balsam Fir-Black Ash Seepage Swamp	4		1	2					7
Lowland Spruce-Fir			1						1
Montane Seepage Forest		1			1			3	5
Montane Spruce-Fir		1			1			1	3
Montane Yellow Birch-Red Spruce Forest		1			1	1	1	1	5
Northern Hardwood Seepage Forest	1	3	2	3	2	2			13
Red Maple-Black Ash Seepage Swamp		1							1
Red Spruce-Cinnamon Fern Swamp			2						2
Rich Northern Hardwood Forest	1	4		3	1		1		10
Rich Northern Hardwood Seepage Forest		1		1					2
Sedge Meadow/Alluvial Shrub Swamp	1								1
Seep				2	3	2	1	2	10
Shallow Emergent Marsh					2				2
Spruce-Fir-Tamarack Swamp	1		1						2
Temperate Acidic Outcrop					2				2
TOTAL	**12**	**12**	**7**	**11**	**14**	**6**	**3**	**7**	**72**

TABLE 2 STATE-SIGNIFICANT NATURAL COMMUNITIES ON THE ATLAS TIMBERLANDS (ACRES)

ACRES - STATE SIGNIFICANT	Bogs	Burnt Mountain	Eden-Craftsbury	Eden Square	Gibou	Haystack-Tillotson	Richford-Jay North	Richford-Jay South	TOTAL
Alder Swamp	43.4				12.6				56.0
Black Spruce Swamp	2.6								2.6
Black Spruce Woodland Bog	1.6								1.6
Boreal Talus Woodland						2.6			2.6
Dwarf Shrub Bog	1.4								1.4
Hemlock-Balsam Fir-Black Ash Seepage Swamp	29.4		39.6	33.6					102.6
Lowland Spruce-Fir			45.3						45.3
Montane Seepage Forest		11.6			9.9			63.0	84.4
Montane Spruce-Fir		175.9			77.9			333.0	586.9
Montane Yellow Birch-Red Spruce Forest		574.6			474.9	63.3	104.4	1073.2	2290.4
Northern Hardwood Seepage Forest	88.2	31.7	197.8	156.9	70.5	31.6			576.8
Red Maple-Black Ash Seepage Swamp		9.6							9.6
Red Spruce-Cinnamon Fern Swamp			13.5						13.5
Rich Northern Hardwood Forest	6.5	69.5		34.8	45.4		18.4		174.5
Rich Northern Hardwood Seepage Forest		61.5		6.7					68.2
Sedge Meadow/Alluvial Shrub Swamp	36.3								36.3
Seep				3.8	16.4	1.2	0.1	15.9	37.4
Shallow Emergent Marsh					22.8				22.8
Spruce-Fir-Tamarack Swamp	18.4		19.5						38.0
Temperate Acidic Outcrop					1.2				1.2
Total Acres State Significant	**227.9**	**934.5**	**315.7**	**235.7**	**731.5**	**98.7**	**122.9**	**1485.2**	**4152.1**
Total Acreage of Parcel	1200	4782	2000	1632	2820	1125	745	4084	18388
Percent Acreage State Significant	19%	20%	16%	14%	26%	9%	16%	36%	23%

Bogs Field Report

ATLAS TIMBERLANDS ECOLOGICAL ASSESSMENT

PREPARED BY HANNAH PHILLIPS
UVM ECOLOGICAL PLANNING PROGRAM
SITE VISITS ON JUNE 30 AND JULY 1, 14 2016

Vermont Land Trust

The Nature Conservancy

Bogs Field Report

Prepared by Hannah Phillips, UVM Ecological Planning Program
Fieldwork conducted on 30 June and 1, 14 July 2016

The Bogs parcel contains the following significant ecological features, all of which are recommended for mention in the conservation easement:

1. Two vernal pools, one of which is larger than 200 square feet, which provide important amphibian habitat.
2. Twelve state-significant natural community occurrences representing 11 natural community types, seven of which are ranked as S3 or high: Dwarf Shrub Bog, Black Spruce Woodland Bog, Black Spruce Swamp, Northern Hardwood Seepage Forest, Lowland Spruce-Fir, Alluvial Shrub Swamp, and Spruce-Fir Tamarack Swamp.
3. A rare natural community, Dwarf Shrub Bog (S2), which contains the southern twayblade orchid (*Neottia bifolia)*, an endangered species.
4. Headwater wetlands (Seeps, Northern Hardwood Seepage Forests, and Hemlock-Balsam Fir-Black Ash Seepage Swamps), which provide flood resilience, water quality protection, and amphibian habitat.
5. A portion of the Belvidere wetland, a Class II wetland which may be upgraded to a Class I wetland, which provides water storage, water quality protection, exemplary wildlife habitat, and contains rare, threatened, or endangered plant species.
6. Habitat for black bear, including wetlands that provide spring forage.
7. Habitat for deer and moose, especially in the Lowland Spruce-Fir Forest and mixed hardwood-conifer swamps.
8. Habitat for bobcat and porcupine, especially in the rock outcrops.

LANDSCAPE CONTEXT

The Bogs parcel is positioned on the gradual north-facing slopes of Bowen Mountain in the towns of Eden and Belvidere. The North Branch of the Lamoille River runs through the northernmost edge of the property and is surrounded by a variety of wetland communities. A series of smaller headwater streams drain north from forested wetlands in the southwest corner of the property, including Perkins Brook. Another stream channel, now converted to beaver ponds, drains west into the Lamoille from a gap in the north-south Green Mountain chain (Devil's Gulch), through which the Long Trail runs. Elevations on the property range from 1050 feet in the wetland complex at the north end, up to about 1500 feet in the southwest corner.

GEOLOGY

The bedrock underlying the Bogs parcel is characteristic of its location in the center of the Green Mountain Anticline. The majority of the Bogs parcel (95%) is atop phyllite of the Ottauquechee Formation, while schist of the Hazen's Notch Formation underlies a small area of the property in the northeast corner.

The surficial geology of the site is unique–glacially-derived features not found elsewhere on Atlas lands provide atypical surficial substrates. Wright (2009) postulates that following the last ice age, the Belvidere Valley filled with a glacial lake created by an ice dam formed by the retreating Laurentide Ice Sheet (*Figure 4*). Prior to dam release, water would have drained east through Devil's Gulch toward Ritterbush Pond. Water would have covered all of the land west of Devil's Gulch up to approximately 1280 feet in elevation, and fine sediments would have accumulated on the lake bottom. The sand pit on the Bogs parcel shows further geologic evidence of this post-glacial period. Dropstones occasionally interrupt the fine

lacustrine sediments; they may have rafted from the shore into the center of the glacial lake on chunks of ice. Downslope of this gravel pit, the valley-bottom likely still contains lacustrine sediments, over which the Belvidere wetland complex flows.

SOILS

Soils on the Bogs parcel can be broadly grouped into three categories. Soils in the southwest corner of the property are poorly-drained, basal till-derived silty sediments or fine sandy loams of the Marlow, Cabot, or Peru soil series (*Table 3*, *Figure 5*). Peru fine sandy loam has a perched water table, meaning water sits atop a lower, dry layer, in this case composed of basal till. Cabot silt loam soils have an apparent water table, meaning water is present through all horizons up to two meters depth, or to the base depth of the study pit.

TABLE 3 SOILS OF THE BOGS PARCEL

Soil Series	*Acres*	*Percent*
Cabot	14.7	1.2%
Walpole	90.6	7.6%
Berkshire	156.0	13.0%
Borohemists,	16.9	1.4%
Lyman-Tunbridge-Rock	139.5	11.7%
Tunbridge-Lyman	239.9	20.0%
Colton-Duxbury	191.8	16.0%
Londonderry-Stratton	35.9	3.0%
Peru	160.7	13.4%
Marlow	71.6	6.0%
Rumney	44.3	3.7%
Adams	34.9	2.9%
Histic	0.3	0.0%
	1197.2	100.0%

Soils on the northwest portion of the parcel are primarily hydric soils underlying the wetland complex, through which the North Branch of the Lamoille River flows. The soils include Rumney fine sandy loam, Walpole fine sandy loam, and Borohemist soils. All of these soils are hydric and have an apparent water table. Parent material of these soils is primarily organic material and alluvium deposited during flooding events.

Soils along the eastern edge of the property are more typical of till-derived upland soils in the Green Mountains. They include soils of the Lyman-Tunbridge-Rock outcrop complex, the Tunbridge-Lyman complex, and the Londonderry-Stratton complex. Parent material of these soils is primarily supraglacial till, and the water table is at a depth greater than six feet below the surface.

Taken together, these soil patterns align with the natural communities observed on site. Hemlock-Balsam Fir-Black Ash Seepage Swamps and Northern Hardwood Seepage Forests exist in the southwest corner of the property on the Cabot, Peru, and Marlow soils, while other swamp types exist atop the hydric soils in the northwestern portion of the property. The remainder of the parcel – especially the eastern half – is Northern Hardwood Forest or other upland forest variants.

FEATURES OF ECOLOGICAL SIGNIFICANCE

WETLANDS:

Approximately 133 acres of the 392-acre Belvidere Bog wetland complex are located within the ATP property boundary, The North Branch of the Lamoille River, which is fed by Calavale Brook, flows through the center of the wetland. It is notable that this wetland is near the top of the watershed, thereby influencing the flood resilience of towns and rivers downstream. The Belvidere wetland complex is under review for Class 1 wetland status by the Vermont Wetlands Division at the time of this report.

Within ATP property boundaries, the wetland complex contains state-significant examples of an Alluvial Shrub Swamp (*Figure 3*, *Table 4*, B-9[2]), a Sedge Meadow (B-9), an Alder Swamp (B-7), a Dwarf Shrub Bog (B-1), a Black Spruce Woodland Bog (B-2), a Black Spruce Swamp (B-14), a Spruce-Fir-Tamarack Swamp (B-12), and multiple Hemlock-Balsam Fir-Black Ash Seepage Swamps around the edges (B-4; *Figure 3*). Beaver activity is obvious throughout the wetland complex, especially in the eastern arm that extends toward Devil's Gulch. The wetland complex is partially fed by a state-significant Northern Hardwood Seepage Forest (B-3), which is perched on the north-facing slopes of the mountains on the south edge of the property.

[2] Site identification code for individual natural community occurrence. See Table 4 for more information.

The primary channel of the wetland complex, which contains the Sedge Meadow and Alluvial Shrub Swamp, appears largely unaltered and in excellent condition. Tussock sedge dominates the herbaceous layer, with blue-joint grass, steeplebush, and purple-stemmed American aster as regular components of the Sedge Meadow community. The Alluvial Shrub Swamp primarily contains speckled alder and meadowsweet, with virgin's bower a common understory component.

Mixed hardwood-softwood swamps flank the edge of the wetland complex to the west and the east, and all appear to be in relatively good condition. On the southern side of the wetland complex, the Spruce-Fir-Tamarack Swamp (B-12) contains balsam fir and red spruce as primary canopy components, with red maple occasionally interspersed. Soils are hydric, deep, and acidic (4.5-5.0 in some spots); the ground is blanketed with *Sphagnum.* No tamarack is present, though areas that appeared to be groundwater-fed contain black ash and red maple. In some areas, the softwood swamp grades into Lowland Spruce Fir forest (B-6), although the access road traverses the property at the transition between wetland and upland, severing this gradation. The eastern edge of the wetland seems to have greater interchange with the groundwater, as indicated by the large Hemlock-Balsam Fir-Black Ash Seepage Swamp (B-4). Although this large swamp is proximate to an old logging road, it is not clear if this swamp was logged in the past.

The large Northern Hardwood Seepage Forest in the southern half of property (B-3) feeds into the Belvidere Bog wetland complex. Emerging from the hillside at the inflection point from steeper slopes to more gentle slopes, the ground immediately becomes very wet, and the soil saturated. Almost immediately, the seepage forest takes on an open, woodland feel with red maple and black ash scattered infrequently about. In some areas, the tree canopy disappears almost entirely giving way to a dense, herbaceous understory of wetland facultative species like joe-pye weed, boneset, and purple-stemmed American aster, among others. The community continues down the hill slope, terminating eventually in a Hemlock-Balsam Fir-Black Ash Seepage Swamp (B-17), which then grades into a beaver pond (B-13) that shows signs of having once been a Red Spruce-Cinnamon Fern Swamp. A portion of this seepage forest (~20 acres) was cut in the 2012 harvest on the site[3], offering an excellent opportunity to study seepage forest succession following harvest.

FIGURE 2 NARROW-LEAF GLADE FERN (DIPLAZIUM PYCNOCARPON) IN B-4.

The Dwarf Shrub Bog (B-1), Black Spruce Woodland Bog (B-2), and Black Spruce Swamp (B-14) are all state-significant natural communities, and are partially located on the Atlas lands. The bogs appear largely in good condition. However, there seems to be some boundary confusion to the south of the bog where there is a large mowed field, a trailer home, and a gated road on Atlas land. Additionally, a small, flagged footpath links the mowed field to the property north of Belvidere Bog, cutting through the Black Spruce Swamp. Although the southern twayblade orchid (*Neottia bifolia)* was previously documented in Belvidere Bog, I did not find this plant during my survey.

Finally, there is an abundance of seeps in the southeast corner of the property. They may serve as important amphibian breeding habitat.

UPLANDS:

A state-significant Rich Northern Hardwood Forest (B-5, B-rank) in the northeast corner of the property contains an extensive population of narrow-leaved glade fern (*Figure 2*, S3) and Goldie's fern (S4) beneath an overstory of black ash, sugar maple, white ash, and yellow birch. Other herbaceous plants include crested wood fern, cinnamon fern, wood nettle, false hellebore, and purple-stemmed American aster. The hillsides surrounding this rich cove also shows signs of enrichment, and are blanketed with plantain-leaved sedge and blue cohosh. The rich area is fed by drainage from the upslope seepage swamps (B-4), and is downslope of some exposed rocky outcrops. Eventually the rich forest grades into the downslope swamps and beaver meadows, taking on seepage swamp character.

[3] The cut area was delineated as seepage forest by reviewing NAIP leaf-on aerial imagery from before and after the harvest.

Two examples of Lowland Spruce-Fir Forests (B-6, B-11) flank the edges of the wetland complex, but are too small to be state-significant. These eventually grade into the Spruce-Fir-Tamarack Swamp or Hemlock-Balsam Fir Black Ash Seepage Swamp communities. The portion of the Bogs parcel to the west of Bogs Road and south of the wetland complex appears to have been primarily softwood. However, harvest during summer 2016 made it difficult to assess the species assemblage. Trees left along the banks of Perkins Brook were primarily hemlock.

OUTCROPS:

A few small ledge systems are scattered throughout the property. All occur on the eastern half of the property. The most prominent of these ledge systems lie on the steep slopes between B-5 and B-4 in the northeast corner of the property, and form a nearly continuous band of rocky outcrops. These ledges undoubtedly serve as a barrier to large mammal movement, driving wildlife traffic north-south towards the beaver ponds at either end of the rise.

Two other prominent outcrops occur on either side of the ridge located upslope of B-4 and B-6 on the south side of the beaver meadow complex. I found a white tarp atop one of these outcrops and it is unclear if the tarp was placed there or transported there by wind.

WILDLIFE FEATURES:

Undoubtedly, the wetland complex provides excellent wildlife habitat for waterfowl, amphibians, and beaver, as well as for large animals that rely on wetland vegetation as a part of their early spring diet (bear and moose). In particular, the hardwood and softwood swamps provide excellent cover and easy access to food. I startled one large animal while moving along the edge of the beaver pond (B-13). Furthermore, tree tip-ups in or adjacent to seepage forests provide suitable bear dens when the substrate beneath is dry. I found one site that seemed to be used as a bear den, identified by the path worn in and out of the den and numerous piles of bear scat.

Multiple outcrops throughout the site provide potential denning habitat for porcupine and bobcat, although I found no animal sign. Finally, three vernal pools were located on the eastern edge of the property, identified by the lack of herbaceous vegetation and depressed leaves that were previously covered with water (*Appendix G;* see POIs_Bogs_Phillips2017 data layer for coordinates). One of these vernal pools is naturally occurring and larger than 200 square feet, the minimum size threshold for Vermont Land Trust protection (B-VP-1). The other two vernal pools are either smaller than 200 square feet (B-VP-2), or exist in unnatural features like old logging roads (B-VP-3).

Because these sites were visited after the amphibian breeding season, the presence of breeding amphibians will need to be verified in the early spring months. Finally, although the seeps scattered throughout the property host dense vegetation, they also have areas of standing water, which may provide suitable breeding habitat for amphibians. Additionally, numerous unidentified dragonflies were observed in the forest seeps; a few species of rare or uncommon dragonflies are closely associated with seeps in Vermont but were not observed on the Bogs parcel.

STEWARDSHIP CONSIDERATIONS

Boundaries

There seems to be confusion about property ownership in the spur in the northwest corner of the property (*Figure 7*). There, a road restricted by a locked chain (*Figure 7*, A) gives access to a large mowed field (*Figure 7*, B), adjacent to which is a trailer (*Figure 7*, C) that overlooks the wetland complex. I did not encounter the owner of the trailer during my visit to this portion of the property. The house across the road also appears within the GIS boundary of the Atlas lands (*Figure 7*, D); I did not try to locate boundary marking in these areas.

Illicit Property Use

Locals enjoy shooting guns in the sandpit off Bogs Road (*Figure 7*, E), and at the landing at the end of the logging access road (*Figure 7*, F). ATVs no longer seem to be an issue throughout the property. Log barricades on the old logging roads have effectively deterred ATV traffic in unwanted areas.

RECOMMENDED EASEMENT PROTECTIONS

The protection recommendations made in this report are based on ecological considerations. The final easement configuration may differ from the recommended protections because of practical considerations not explored in this report. Final protections are the decision of the Vermont Land Trust and The Nature Conservancy.

Surface Water Protection Zone + 50-foot Buffers

- *Dwarf Shrub Bog (B-1)* – As a state-significant example of a rare natural community (S2), active forest management should be restricted within 50 feet of this area to protect the site's natural heritage, including the endangered orchid, *Neottia bifolia,* which was previously reported within this bog. Active forest management in or around the bog may affect the hydrologic processes that sustain this rare natural community.

- *Black Spruce Woodland Bog (B-2)* – This state-significant rare natural community (S2) may be sensitive to hydrologic alteration by forest management in or immediately adjacent to the site. Designating this area a "no-touch" zone with 50-foot buffers will protect the hydrologic processes that sustain this natural community.

- *Northern Hardwood Seepage Forest (B-3)* – The Seepage Forest on the Bogs parcel is one of the best examples of this natural community type on the Atlas lands. This state-significant uncommon natural community (S3) may be sensitive to hydrologic alteration by forest management due to the shallow, wet soils and its position on a gradual slope. As a headwater wetland, this community likely provides water quality protection and downstream flood resilience. The impacts of hydrologic alteration on these communities is not yet well understood, although changes in water table depth by inadvertent draining or ponding may have a lasting impact on the resulting plant communities (please see *Appendix J* for forest management recommendations in Seepage Forests). Furthermore, this community is hydrologically connected to the Belvidere Bog parcel; impacts to the upslope Seepage Forest have the potential to negatively affect the downslope wetland. Protections on this forest should include a 50-foot buffer to ensure that inputs to these Seepage Forests are not disrupted by management activities.

- *Hemlock-Balsam Fir-Black Ash Seepage Swamp (B-4, B-15, B-16, B-17); Spruce-Fir-Tamarack Swamp (B-12)* – These mixed wood swamps are part of the Belvidere Bog wetland complex, a Class II state wetland that is under consideration for a Class I upgrade. Protection of these swamps ensures the Belvidere wetland complex retains its ecological integrity and the wide variety of natural communities, species, and ecological processes that it contains. These wetlands provide important spring habitat for large mammals (early spring forage), amphibians (breeding territory), and important winter habitat for deer (wintering areas).

- *Alder Swamp (B-7); Beaver Ponds (B-8, B-10, B-13)*; *Sedge Meadow / Alluvial Shrub Swamp (B-9)* – These shrub and sedge wetlands are part of the Belvidere Bog wetland complex, a Class II state wetland that is under consideration for a Class I upgrade. Protection of these wetlands ensures the Belvidere wetland complex retains its ecological integrity and the wide variety of natural communities, species, and ecological processes that it contains. These communities are all part of important floodplain ecosystem, which mitigates the effects of heavy precipitation events for downstream communities. They also provide important wildlife habitat for migratory waterfowl, beavers, mink, river otter, muskrat, wood turtles, and amphibians.

- *Black Spruce Swamp (B-14)* – This state-significant rare natural community (S2) may be sensitive to hydrologic alteration by forest management in or immediately adjacent to the site. Designating this area as a no-touch zone with 50-foot buffers may preserve the hydrologic processes that sustain this natural community. This community also serves as an important wintering habitat for white-tailed deer, and provides habitat for some rare bird species.

Ecological Protection Zone

- *Rich Northern Hardwood Forest (B-5)* – This natural community contains a large population of uncommon plants (narrow-leaved glade fern, S3). The extent of this fern population would make it difficult to operate in this area without directly impacting the fern population.

Forest Management Plan and Easement Attribute Language

- *Lowland Spruce-Fir Forest (B-6, B-11)* – This uncommon natural community (S3) used to be more widespread throughout Vermont but has been reduced throughout the state by logging. While this is not a state-significant example of a Lowland Spruce-Fir Forest, it does have ecological merit as a deer wintering area and as a relic of a previously abundant community. Harvest in this area should mimic the natural disturbance regime of the site to encourage regeneration of characteristic tree species.

Vernal Pool Special Treatment Area

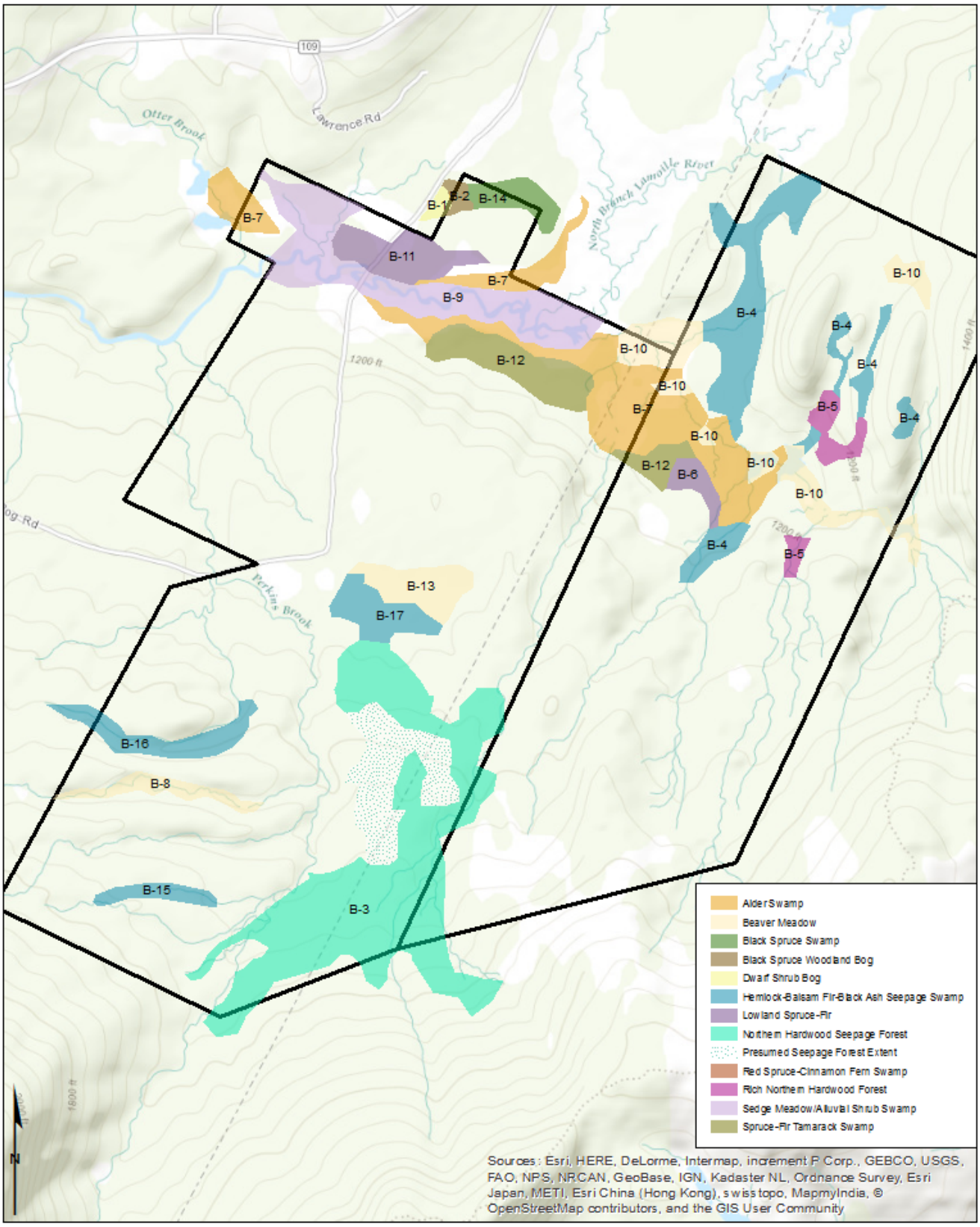
- *B-VP-1:* If a spring survey reveals that this vernal pool is used as amphibian breeding grounds, it should be protected under the Vernal Pool Special Treatment Area clause, with 100-foot primary and 500-foot secondary buffer zones. These restrictions will ensure the maintenance of natural features necessary to preserve desirable habitat (ex. canopy cover, shade, downed woody debris, etc.).

ACCOMPANYING FILES

Bogs Geodatabase

- *NatComms_Bogs_Phillips2017*: Polygon feature of state-significant natural communities, significant wildlife habitat, and other ecologically significant areas (including old forest). This file contains Natural Heritage Rankings and easement protection recommendations in accordance with VLTs easement provisions. Overlay POIs for more detail about field observations.
- *POIS_Bogs_Phillips2017*: Point features containing field notes, which include species observations, rare/uncommon plant element occurrence data, land use alteration notes, and other general field observations.
- *Tracks_Bogs_Phillips2017:* Line features showing path taken on field days.

FIGURE 3 ECOLOGICALLY SIGNIFICANT FEATURES OF THE BOGS PARCEL



Map created by Hannah Phillips
UVM Field Naturalist Program
Field work conducted in June/July 2016

Atlas Timberlands Partnership
Bogs Resource Map

0 0.1 0.2 0.4 Miles

FIGURE 4 GLACIAL RETREAT OVER THE COLD HOLLOW MOUNTAINS NEAR BELVIDERE, VERMONT (WRIGHT, 2009)

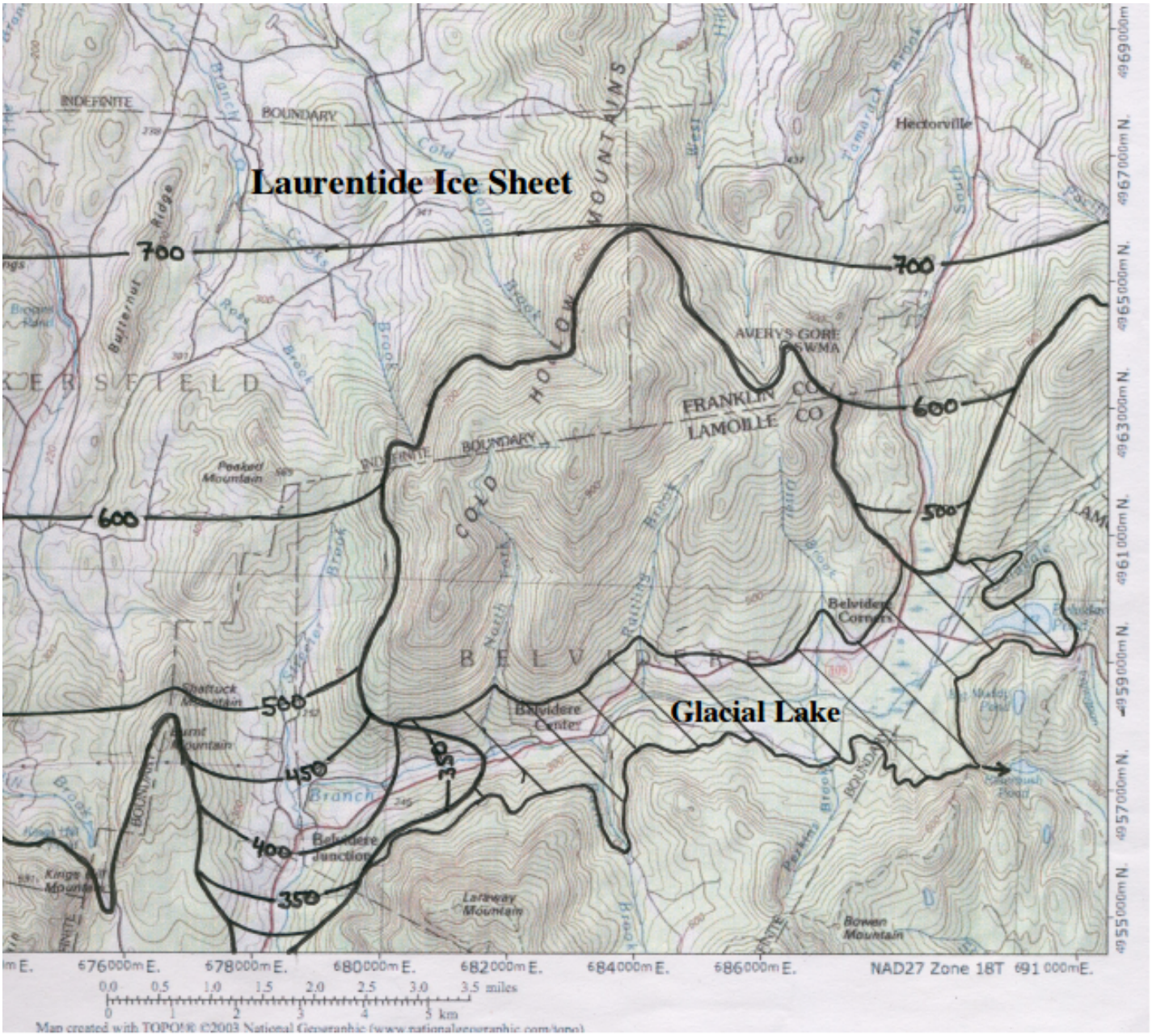
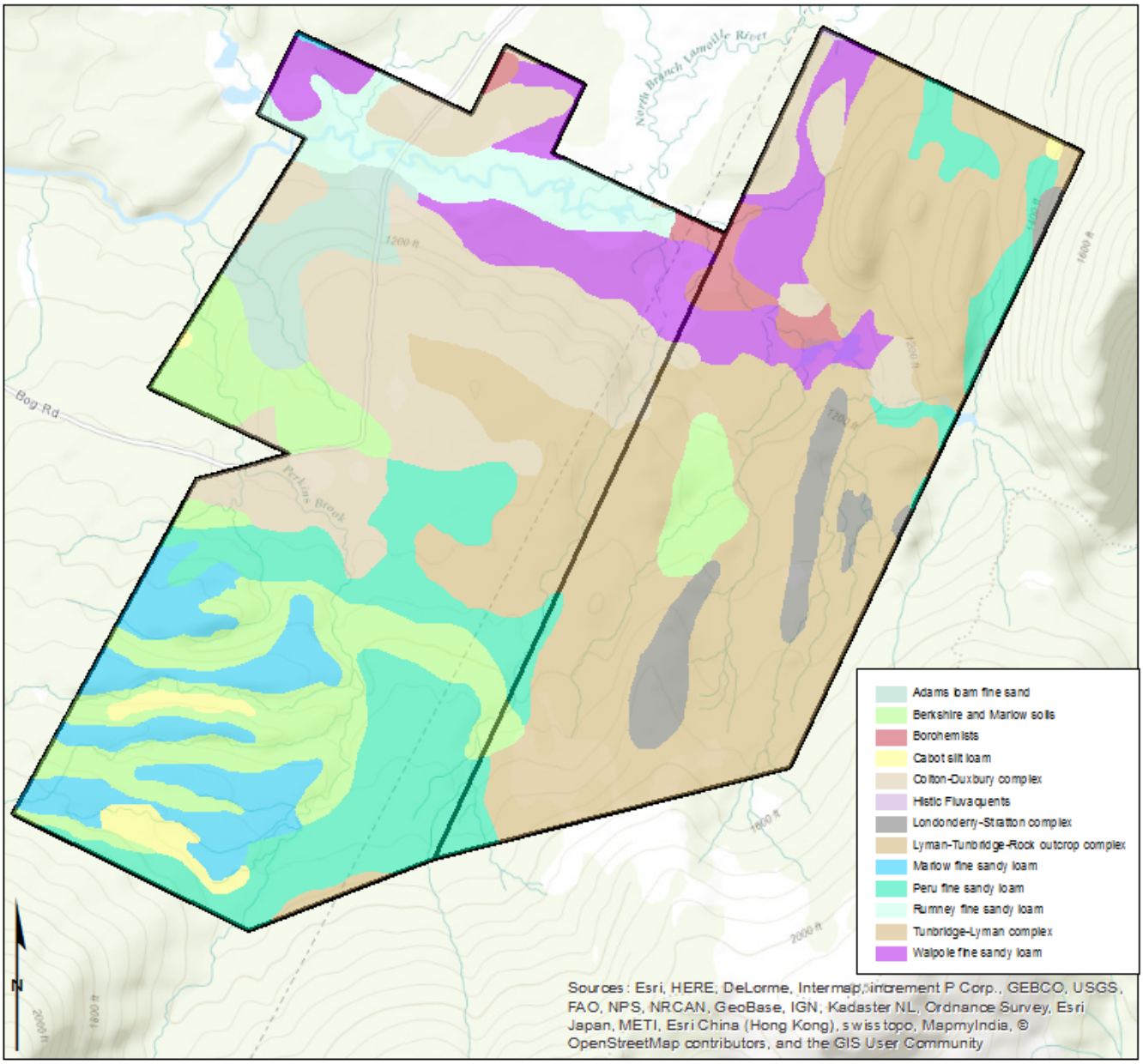


FIGURE 5 SOILS OF THE BOGS PARCEL

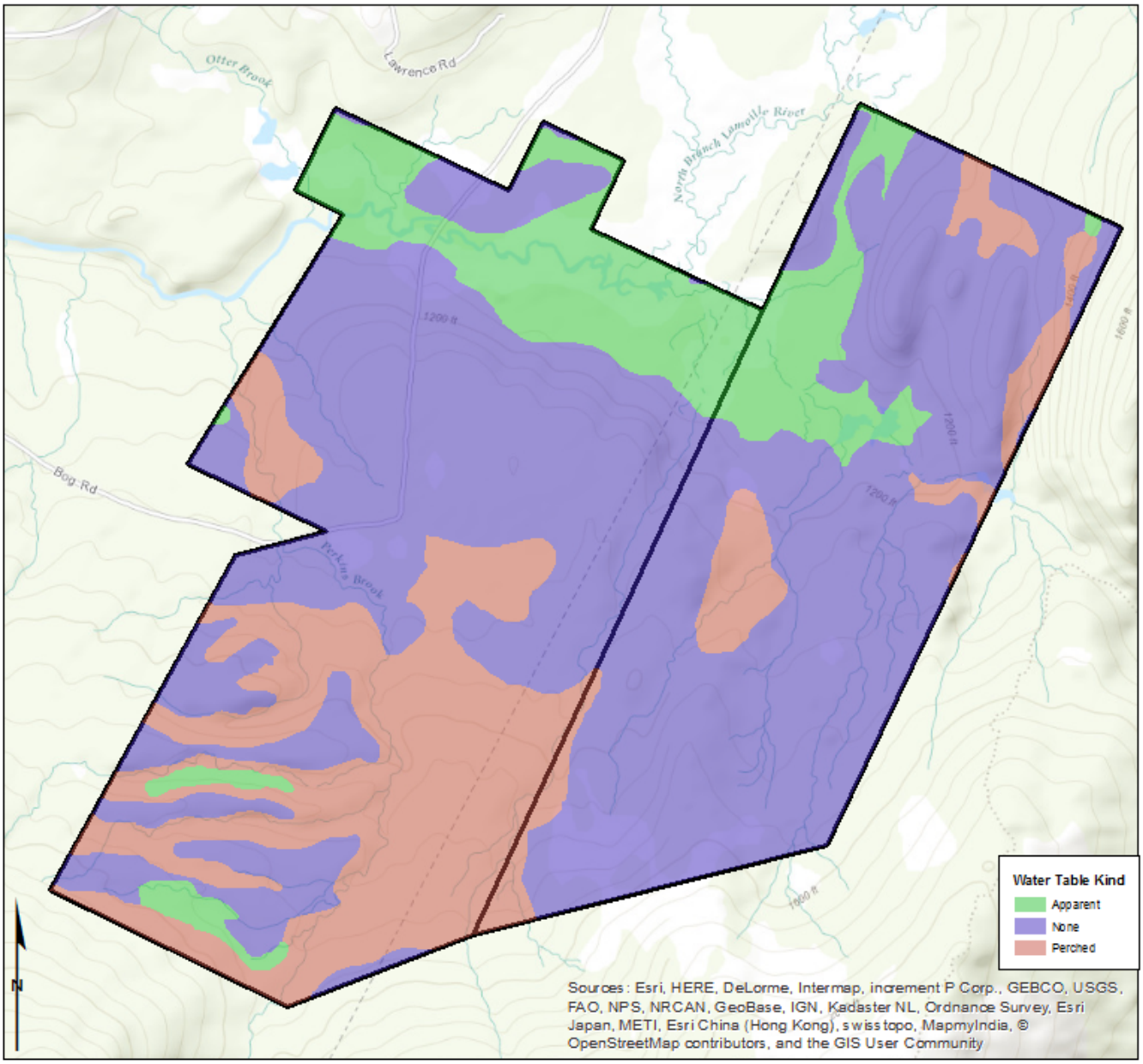


Map created by Hannah Phillips
UVM Field Naturalist Program
Field work conducted in June/July 2016

Atlas Timberlands Partnership
Bogs Soils Map

0 0.125 0.25 0.5 Miles

FIGURE 6 SOIL WATER TABLE ON THE BOGS PARCEL

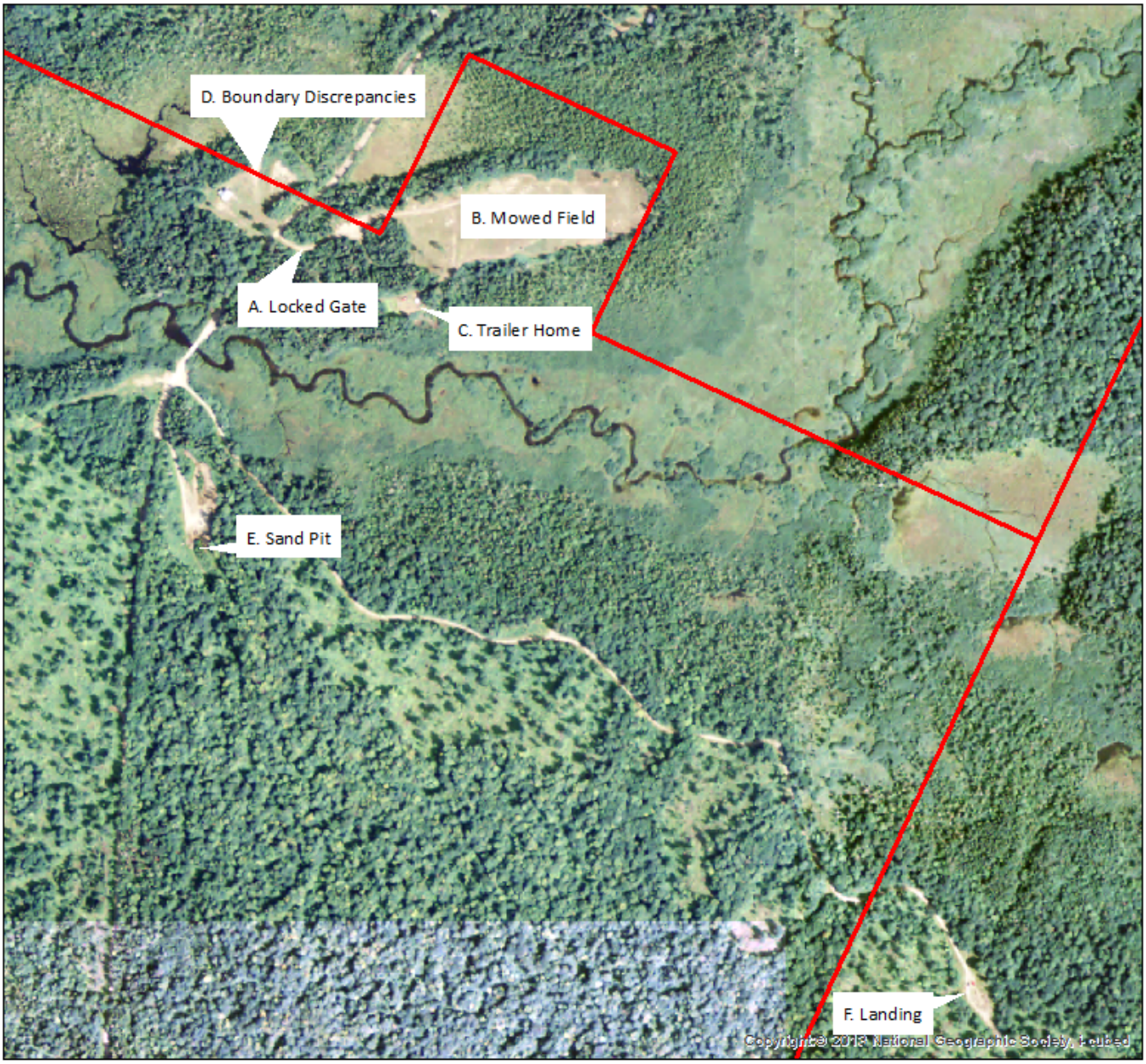


Map created by Hannah Phillips
UVM Field Naturalist Program
Field work conducted in June/July 2016

Atlas Timberlands Partnership
Bogs Soils Map

0 0.125 0.25 0.5 Miles

FIGURE 7 STEWARDSHIP CONCERNS ON THE BOGS PARCEL



Map created by Hannah Phillips
UVM Field Naturalist Program
Field work conducted in June/July 2016

Atlas Timberlands Partnership
Bogs Lot - Management Concerns

0 0.05 0.1 0.2 Miles

TABLE 4 NATURAL COMMUNITY RANKINGS AND SIGNIFICANT WILDLIFE HABITAT OF THE BOGS PARCEL

Site ID	Type	Acres	Rarity Rank	State-Significant?	Rank Sum	Description	Rank Size	Rank Condition	Rank Context	Comments	Recommended Protection	ESTA Eligible?
B-1	Dwarf Shrub Bog	1.4	S2	Y	C	Plants: Sarracenia purpurea, Kalmia polifolia, Kalmia angustifolia, Rhododendron groenlandicum, Chamaedaphne calyculata, Carex magellanica	D	B - road construction has altered hydrology, but has not negatively impacted species composition	B - moderately connected landscape; roads interrupt wetland complex in two spots	This bog may exist BECAUSE road construction created a hydrologic barrier. Continuous with wetland complex that is interrupted by Bog Rd and Route 118.	SWPZ+50' buffer	Y
B-2	Black Spruce Woodland Bog	1.6	S2	Y	C	Plants: Sarracenia purpurea, Kalmia polifolia, Kalmia angustifolia, Rhododendron groenlandicum, Chamaedaphne calyculata, Carex magellanica.	C/D	B - road construction has altered hydrology, but has not negatively impacted species composition	B - moderately connected landscape; roads interrupt wetland complex in two spots	This bog may exist BECAUSE road construction created a hydrologic barrier. Continuous with wetland complex that is interrupted by Bog Rd and Route 118.	SWPZ+ 50'buffer	Y
B-3	Northern Hardwood Seepage Forest	88.2	S3	Y	A	Plants: Glyceria melicaria, Impatiens, Carex gynandra, Chrysosplenium, Carex scabrata, foamflower, ostrich fern, virgin's bower, sensitive fern, wood nettle. Physical: tip-ups, flowing water/standing water even in such a dry summer. EC 43 mS.	A	B - logging road passes through the upper section of swamp, creating artificial pools	B - proximity of logging activity surrounding these communities	Red Spruce Variant; Section below beaver pond is turning back into seepage swamp. Now, more closely resembles Red Spruce-Cinnamon Fern Swamp	SWPZ+ 50'buffer	Y
B-4	Hemlock-Balsam Fir-Black Ash Seepage Swamp	6.1	S4	Y	B	Plants: Cinnamon fern, Rubus pubescens, false hellebore, Chrysosplenium, Northern white bog orchid, lesser purple-fringed bog orchid, royal fern, NY fern, hobblebush, Tiarella, northeastern mannagrass.	C	B - logging road passes between and through on westernmost example	B - lands around have been logged.	Red Spruce Variant; Black ash, yellow birch, red maple, red spruce, balsam fir, sensitive fern, water avens, Impatiens, Carex intumescens,	SWPZ+ 50'buffer	Y
B-5	Rich Northern Hardwood Forest	6.5	S4	Y	B	Seepage characteristics through here, with sugar maple mixed in. Large narrow-leaf glade fern population. Goldie's wood fern, blue cohosh, silvery glade fern, wood nettle, Allium tricoccum, Canada	C	A	B - logging on surrounding land	Northern polygon is extremely rich; Narrow-leaved glade fern population	EPZ	—

						white violet, northeastern mannagrass, black ash						
B-6	Lowland Spruce-Fir Forest	3.8	S3	N	-	Cinnamon fern, balsam fir.	-	-	-	Does not meet minimum size requirements	Forest Management Plan, easement attributes	—
B-7	Alder Swamp	43.4	S4	Y	B		B	B - Bog road bisects swamp; beaver activity in wetland may alter extent	B - surrounding lands managed for logging; road networks may alter wetland hydrology		SWPZ+ 50'buffer	—
B-8	Beaver Pond / Shallow Emergent Marsh	6.5	-	-	-		-	-	-		SWPZ+ 50'buffer	—
B-9	Sedge Meadow/Alluvial Shrub Swamp	36.3	S4/S3	Y	A	Carex stricta, Calamagrostis canadensis, Spiraea alba, Clematis virginiana, Symphyotrichum puniceum, Alnus incana. See Charlie Hohn's accompanying layer for higher resolution data mapping.	A	A - appears not to have been drained, or the hydrology altered.	B - Bog Rd and Rt 109 may increase runoff into wetland complex.		SWPZ+ 50'buffer	Y
B-10	Beaver Pond / Shallow Emergent Marsh	17.7	S4	-	-		-	-	-		SWPZ+ 50'buffer	—
B-11	Lowland Spruce-Fir Forest	11.5	S3	N	C	Arceuthobium pusillum	D	B - some cutting has occurred within the forest.	C - a road bisects this EO, and is adjacent to a large forest clearcut and two residences.	Boundaries need to be field truthed	Forest Management Plan, easement attributes	—
B-12	Spruce-Fir Tamarack Swamp	18.4	S3	Y	B	Balsam fir, red spruce, red maple, Sphagnum. Cinnamon fern beneath. PH 4.5 to 5 in some places. Organic muck/peat, no bottom detected. Strong smell of anaerobic decomp and undecomposed wood in substrate.	C	B - road above affects flow from upslope into wetland	B - logging upslope may cause altered hydrology		SWPZ+ 50'buffer	Y

B-13	Beaver Pond (Red Spruce-Cinnamon Fern Swamp)	9.6	S3	-	-		-	-	-	Recovering from Beaver activity	SWPZ+ 50'buffer	—
B-14	Black Spruce Swamp	2.6	S2	Y	B	Creeping snowberry, cinnamon fern, mountain holly, black spruce, balsam fir, lowbush blueberry, Sphagnum, Cornus canadensis, red maple, red spruce, speckled alder	B	B - some alteration of natural community due to trail passing through	C - moderately fragmented, roads disrupting the wetland complex in multiple areas		SWPZ+ 50'buffer	Y
B-15	Hemlock-Balsam Fir-Black Ash Seepage Swamp	4.3	S4	Y	B	Part stream, part seep, part RS-CF swamp, Carex scabrata, impatiens, sensitive fern, cinnamon fern, red spruce, yellow birch	C	B - logging passes adjacent and upslope. Unclear if this section was cut.	B - proximity of logging activity surrounding these communities	Red Spruce Variant; Section below beaver pond is turning back into seepage swamp. Now, more closely resembles Red Spruce-Cinnamon Fern Swamp	SWPZ+ 50'buffer	Y
B-16	Hemlock-Balsam Fir-Black Ash Seepage Swamp	10.0	S4	Y	B	Part stream, part seep, part RS-CF swamp, Carex scabrata, Impatiens, sensitive fern, cinnamon fern, red spruce, yellow birch.	B	B - logging passes adjacent and upslope. Unclear if this section was cut.	B - proximity of logging activity surrounding these communities	Red Spruce Variant; Section below beaver pond is turning back into seepage swamp. Now, more closely resembles Red Spruce-Cinnamon Fern Swamp	SWPZ+ 50'buffer	Y
B-17	Hemlock-Balsam Fir-Black Ash Seepage Swamp	9.0	S4	Y	B	Black ash, northeastern mannagrass, red maple, red spruce, cinnamon fern, Carex gynandra, beaked hazelnut, interrupted fern, Chelone glabra, cattail, wool grass, wild raisin. EC 90 mS.	B	B - Logging beaver activity adjacent impact site hydrology. Unclear harvest history.	B - proximity of logging activity surrounding these communities	Red Spruce Variant; Section below beaver pond is turning back into seepage swamp. Now, more closely resembles Red Spruce-Cinnamon Fern Swamp	SWPZ+ 50'buffer	Y

Burnt Mountain Field Report

ATLAS TIMBERLANDS ECOLOGICAL ASSESSMENT

PREPARED BY HANNAH PHILLIPS
UVM ECOLOGICAL PLANNING PROGRAM
SITE VISITS ON AUGUST 2, 3, 8, 9, 10 2016

Vermont Land Trust

The Nature Conservancy

Burnt Mountain Field Report

Prepared by Hannah Phillips, UVM Ecological Planning Program
December 2016 based on fieldwork from August 2,3, 8, 9, 10 2016

Burnt Mountain contains the following significant ecological features, all of which are recommended for mention in the conservation easement:

1. At least one naturally occurring vernal pool, which may provide important amphibian habitat.
2. Twelve state-significant natural community occurrences representing six natural community types, three of which are ranked as S3 or higher: Seepage Forest, Montane Spruce-Fir, and Montane Yellow Birch-Red Spruce Forest.
3. Headwater wetlands (Seeps, Northern Hardwood Seepage Forests, Montane Seepage Forests, and Red Maple-Black Ash Seepage Swamps), which provide flood resilience, water quality protection, and amphibian habitat.
4. Habitat for black bear, and at least one beech mast stand.
5. Habitat for deer and moose, especially in the Montane Yellow Birch-Red Spruce Forest.

LANDSCAPE CONTEXT

The Burnt Mountain parcel is located in the Northern Green Mountains biophysical region of Vermont along the Green Mountain chain. The parcel occupies the western flanks of the main ridgeline, which runs from Belvidere Corners to Hazen's Notch and contains four named peaks: Belvidere Mountain, Tillotson Peak, Haystack Mountain, and Burnt Mountain. There are three primary drainages within the parcel, which drain to two major watersheds: the Lamoille to the south and the Missisquoi to the north. The Wade Brook headwaters bowl faces north toward Hazen's Notch and drains into Wade Brook, a tributary of the Missisquoi. Pacific Brook drains west from the saddle between Haystack and Tillotson Peaks into the South Branch of the Trout River, a tributary of the Missisquoi River. Calavale Brook drains south from the flanks of Tillotson Peak and Belvidere Mountain into the Belvidere wetland complex, which eventually drains into the Lamoille River.

Some of the land adjacent to the Burnt Mountain parcel is conserved. The Green Mountain Club owns land to the east of the Atlas Lands spanning Belvidere Mountain and Tillotson Peak, through which The Long Trail runs. To the northeast of the parcel, the state owns the Hazen's Notch State Forest. The rest of the adjacent land is privately owned, and much of it is enrolled in UVA/Current Use.

GEOLOGY

The bedrock geology of the Burnt Mountain tract features depositional and metamorphic processes present elsewhere in the Green Mountain Anticlinorium. Phyllites and schists of the Jay Peak Formation and the Hazen's Notch Formation underlie the western flanks of the Green Mountain chain, bearing the metamorphic folds of both the Taconic and the Acadian orogenies. The spine of the Green Mountain chain contains some accreted bedrock that was deposited in its current location by collision of the Taconic Island Arc with proto-North America during the Taconic Orogeny. A highly metamorphosed gneiss intrusion is intermingled with intrusions of ultramafic serpentenite, which occurs just off the property on the summit of Haystack Peak. While the majority of these rocks are relatively inert from a plant-nutrient uptake perspective, serpentine occasionally hosts rare plants that are able to grow despite the inhospitable environment created by the high abundance of heavy metals and low calcium-magnesium ratio.

SOILS

Soils within the Burnt Mountain parcel can be classified broadly into two categories (*Table 5*, *Figure 9*). The rocky upland soils (Woodstock complex, Lyman-Tunbridge complex, Londonderry-Stratton complex, Hogback-Rawsonville complex, etc.) are mapped primarily along the ridgelines and along the steep flanks of the Green Mountain spine. The silty loams derived from basal till (Cabot, Berkshire, Marlow, Peru, Rumney, and Stowe series), are primarily located in the valley bottoms in the Pacific Brook and Calavale Brook drainages. Additional pockets of silty loam can be found in the low elevations of the west-facing slopes on the side of Burnt Mountain, and at the headwaters of an unnamed tributary of the South Branch of the Trout River, south of Pacific Brook.

FEATURES OF ECOLOGICAL SIGNIFICANCE

UPLANDS:

Burnt Mountain hosts an abundance of Rich Northern Hardwood Forests across its west-facing slopes, especially within the Pacific Brook drainage (*Figure 8*). The same drainage that seems to give rise to local enrichment also produces seepage conditions in some areas of the Burnt Mountain complex. These seepage forests are described in greater detail in the wetlands portion of this report. The Green Mountain ridgeline also hosts a state-significant Montane Yellow Birch-Red Spruce Forest, and a state-significant Montane Spruce-Fir Forest, although the extent of these natural communities was not verified during summer 2016. Natural communities within the Pacific Brook and Wade Brook drainages are also described in Engstrom and Lapin's reports of the Atlas Timberlands (1999, 2015).

TABLE 5 SOILS OF BURNT MOUNTAIN

Soil Series	*Acres*	*Percent*
Woodstock-Rock	2876.2	53.3%
Stowe	690.5	12.8%
Rock	453.8	8.4%
Tunbridge-Lyman	361.8	6.7%
Lyman-Tunbridge-Rock	262.2	4.9%
Peru	229.4	4.3%
Berkshire	164.1	3.0%
Tunbridge-Peru	161.0	3.0%
Hogback-Rawsonville	100.0	1.9%
Marlow	63.0	1.2%
Londonderry-Stratton	23.5	0.4%
Tunbridge-Woodstock	5.2	0.1%
Rumney	3.1	0.1%
Cabot	0.9	0.0%

RICH NORTHERN HARDWOOD FOREST (S4)

BM-4 (5.9 acres, state-significant, B rank)

This small Rich Northern Hardwood Forest is perched on a steep northwest-facing slope which drains into a tributary of the South Branch of the Trout River, and on into the Missisquoi River. The upper flanks of the bowl have large sugar maples and yellow birch, and the understory is blanketed with wood nettle, pale touch-me-not, maidenhair fern, blue cohosh, Braun's holly fern, and other herbaceous indicators of enrichment (*Table 6*). The soils are moist, loamy, and with a deep organic layer derived from colluviation within the cove. At the base of the slope, the slope decreases a bit, and water begins to concentrate in the soils, giving rising to small areas to facultative wetland species, including sensitive fern, purple-fringed bog orchid, and bladder sedge. These wet areas are organized on a terrace in the slope. Downslope of this terrace, water coalesces into stream channels and flows through Northern Hardwood Forest.

BM-5 (61.5 acres, state-significant, A rank)

A large swath of Rich Northern Hardwood Seepage Forest occupies the broad, even slopes of the Wade Brook headwater zone between 2000-2400 feet. Throughout BM-5, seepage conditions are present in small pockets, but the majority of the community feels like a slightly wet Rich Northern Hardwood Forest. Throughout the forest, small intermittent streams meander down the gradual slope, occasionally gathering in wet pockets and percolating back into the soil matrix. At the top of the bowl, rocky outcrops, shallow soils, and steeper slopes trigger a community conversion back to Northern Hardwood Forest, before then shifting to the higher elevation Montane Yellow Birch-Red Spruce Forest. Seeps appear abundantly at the topographic inflection point, providing hydrologic input to the downslope communities.

The slope on this hillside is uncharacteristically mild for the terrain; in some places it feels to be no more than a 10-degree slope, while the average across the hillside is approximately 15 degrees. Soils are twelve inches of dark brown loam mixed

with organic matter, subtended by another foot of A2, tan/brown loamy layer. Beneath this, a dense, gleyed/mottled B-layer acts as a hydrologic barrier, keeping water perched and contained within the upper levels of the soil matrix. Within the gleyed layer, occasional large, rounded rocks (approximately six inches in diameter) are perched atop one another. The depth of this B layer is unknown.

Herbaceous plants within BM-6 are indicative of both enrichment and seepage. Enrichment indicator plants include pale touch-me-not, wood nettle, blue cohosh, silvery glade fern, wild leeks, plantain-leaved sedge, sweet cicely, and lance-leaved twisted stalk, among others. Seepage indicator plants include northern white bog orchid, dwarf raspberry, foamflower, and boreal bedstraw (S3). Sugar maple is a dominant element of the overstory canopy.

BM-6 (44.1 acres, state-significant, B rank)

A state-significant Rich Northern Hardwood Forest exists within the Pacific Brook headwater bowl on the north and north-west facing hillslopes. Although these occur as three separate inclusions within standard Northern Hardwood Forest, they are close enough to one another to be considered a single element occurrence. The largest of the three inclusions spans a terrace on the southern rim of the bowl. There, wild leeks, plantain-leaved sedge, blue cohosh, and wood nettle appear in the understory, while sugar maple forms a dominant canopy. Elderberry is present in the shrub layer. This enrichment continues up the steep slopes over the terrace, eventually giving way to Montane Yellow-Birch Red Spruce Forest on the ridgeline above. Seeps and intermittent streams are present throughout this natural community occurrence. Downslope of the zone of enrichment, water gathers within the soil matrix to form a Northern Hardwood Seepage Forest (BM-8). This natural community was first identified by Engstrom and Lapin (2015) by assessing the timber cruise data for the site.

The other two enriched sections of forests that comprise BM-7 are located on the north-facing slopes of the Pacific Brook headwater bowl, and exist within small colluvial coves downslope of minor outcrops and Montane Yellow Birch-Red Spruce Forest. The slope between these two pockets of enrichment did not show the same signs of enrichment, perhaps because the water was channelized into streams that were running off site, disrupting the potential for colluviation. These two northern occurrences did not appear to be disrupted by harvest activity, perhaps in part due to their inaccessibility on steep slopes.

BM-8 (2.1 acres, state-significant, B rank)

An exceptionally rich Northern Hardwood Forest cove is perched on the west-facing flanks of Burnt Mountain between 1900-2100 feet. The slope is steep – approximately 20 degrees – making it difficult for water to gather on site. At the base of the cove, however, water coalesces and forms a stream that ultimately drains into an unnamed tributary of the South Branch of the Trout River. Sugar maples are abundant throughout, and the herbaceous layer includes a number of enrichment indicators including plantain-leaved sedge, blue cohosh, doll's eyes, wild leeks, silvery glade fern, zig-zag goldenrod, white snakeroot, northern white bog orchid, maidenhair fern, rattlesnake fern, basswood, beaked hazelnut, and baneberry. The cove appears largely undisturbed, and there are no signs of adverse effects of logging around the cove. A logging road passes just over the top of the community in the Montane Yellow Birch-Red Spruce Forest, but does not disrupt the processes within the cove.

BM-11 (17.4 acres, state-significant, A rank)

This A-ranked Rich Northern Hardwood Forest is located in a series of coves on the south-facing slopes of the Pacific Brook drainage, between 2100-2500 feet in elevation. Although not visible on topographic maps of these areas, this bowl is bisected by a series of north-south ridges that force water to drain into adjacent, rich coves. Eventually the drainage emanating from these coves consolidates at a terrace that runs beneath the southern termini of these small ridges, across which enrichment is abundant. Within the coves, small intermittent streams host boreal bedstraw (S3), while the terrace below shows mild seepage conditions, with seepage indicator plants like northeastern mannagrass, sensitive fern, dwarf raspberry, foamflower, and boreal bedstraw present in low levels. The ridges bisecting the coves are formed by steep bedrock exposures, some nearly 60-degrees steep in places.

WETLANDS:

Multiple headwater wetlands exist in the upper reaches of the Wade Brook, Pacific Brook, and Calavale West bowls, occurring just below the contact between the Northern Hardwood Forest and the Montane Yellow Birch-Red Spruce Forest matrix. However, the character of the headwater wetlands in each of these three bowls is markedly different. The Wade Brook bowl features a classic example of a Northern Hardwood Seepage Forest, while the Pacific Brook drainage features an extensive, enriched Seepage Forest. Shallower slopes in the Calavale West bowl allow seepage to collect in shallow depressions, forming a Red Maple-Black Ash Seepage Swamp at an unusually high elevation.

RED MAPLE-BLACK ASH SEEPAGE SWAMP (S4)

BM-3 (9.6 acres, state-significant, B rank)

A series of small seepage swamps dot the southwest corner of the property, west of the Calavale Brook bowl. There a low elevation east-west divide separates the streams that drain south to the Belvidere Swamp and the Lamoille River, and the streams that drain north to the Missisquoi River. Despite its location as a prominent watershed divide, the ridgeline is at a low elevation and relatively insignificant. The 16-acre swamp is actually comprised of six small swamps, all of which present as seepage swales that follow topographic low points that have not yet coalesced to form stream channels. The northeastern-most inclusion is now a beaver pond. Although I observed a beaver dam within the pond, I did not see a beaver during my visit. The dam, however, appeared to be in good condition.

Within each swale, wetland facultative or obligate herbaceous plants like joe-pye weed, golden saxifrage, water penny, foamflower, purple-fringed bog orchid, turtlehead, and cinnamon fern thrive. Elsewhere, seepage forest indicator species like dwarf raspberry, touch-me-not, and northeastern mannagrass were present. Trees are predominantly Northern Hardwood Forest trees with black ash mixed in.

While this community in many ways fits the species composition of a Northern Hardwood Seepage Forest, I opted to map it as a Red Maple-Black Ash Seepage Swamp because it lacks the lateral flow through the soil, fills a topographic depression, appears regularly saturated, and has primarily hardwoods in the canopy.

NORTHERN HARDWOOD SEEPAGE FOREST (S3)

BM-1 (21.9 acres, state-significant, B rank)

A beautiful example of a Northern Hardwood Seepage Forest extends north from the Wade Brook headwater bowl towards Hazen's Notch on the north side of Burnt Mountain, ranging in elevation between 1950-2400 feet. The seepage forest originates from a seep located in the transition zone to Montane Yellow Birch-Red Spruce Seepage Forest. Soils within the seepage forest are saturated, near neutral pH (6.5-7.0), and have a thick layer of colluvium perched atop a hardpan layer, which drives the lateral flow of water through the forest. The hill slope within the seepage forest is approximately 15 degrees. There is a stream bisecting the two mapped seepage forests, which was dry at the time of my visit. The dry stream adjacent to the wet seepage forest suggests the water that feeds the two drainages may be hydrologically isolated, or from different sources.

Trees within the seepage forest are of small diameter and have buttressed roots; there are tip-ups throughout. Herbaceous plants are indicative of both enrichment and seepage, and include zig-zag goldenrod, white baneberry, white snakeroot, sweet cicely, Braun's holly fern, foamflower, boreal bedstraw (S3), dwarf raspberry, blue cohosh, scabrous sedge, northeastern mannagrass, and lance-leaved twisted stalk.

BM-2 (11.6 acres, state-significant, B rank)

A Montane Seepage Forest is located in the Wade Brook headwater bowl on the north slopes of Haystack Mountain. There, a series of glades form a continuous seepage matrix within the Montane Yellow Birch-Red Spruce Forest. The lower edge of

this seepage forest contains human artifacts including a cast iron stove door and a gas can. These were found adjacent to a large clearing, which suggests that this may have been a homestead. However, other structures indicating previous habitation were absent from the area.

From the clearing extending up the hill, large, ornate yellow birch sprawl wide. Beneath them, the ground is wet, with seeps scattered abundantly across the hillside. Unlike a Northern Hardwood Seepage Forest, water within Montane Seepage Forests seems not to flow in a lateral sheet within the soil matrix, but rather to be kept wet by a higher-than-average concentration of small seeps. Ground saturation is more variable within the mapped seepage forest than within a Northern Hardwood Seepage Forest.

Within the wettest inclusion, herbaceous plants include northeastern mannagrass, purple-stemmed American aster, northern white bog orchid, tall meadow rue, false hellebore, turtlehead, dwarf raspberry, mountain wood fern, and boreal bedstraw (S3). An electroconductivity test taken in a wet pool near the top of the seepage forest measured at 17 mS, which is lower than seen in other seepage forests on Atlas lands. A vernal pool (BM-VP-1, detailed below) sits within one of the higher-elevation seepage glades (105 square feet).

BM-7 (3 acres, state-significant, B rank)

A small Northern Hardwood Seepage Forest sits below a Rich Northern Hardwood Forest site (BM-7) on the northwest-facing slopes of the Pacific Brook drainage. Here, the water from upslope gathers on a seepage terrace, which then continues down a gradual slope before the water gathers into a stream. A logging road travels parallel to the fall line here, in which water from the seepage forest drains rapidly. Presumably, this seepage forest would be more extensive if this road was not diverting water from the site. The common seepage indicator plants are within this forest, including foamflower, northeastern mannagrass, and scabrous sedge, as well as Virginia waterleaf.

BM-13 (2.7 acres, state-significant, B rank)

A seepage forest extends off the property onto a private ownership above Regan Road. Here, large tips-ups, saturated soils, and a predictable suite of seepage indicator plants (northeastern mannagrass, sensitive fern, foamflower, northern white bog orchid) blanket the ground. Off the Atlas property, logging roads regularly bisect the forest and many are saturated from runoff from the adjacent seepage forest.

BM-15 (3 acres, state-significant, B rank)

In the southern end of the Burnt Mountain tract, on the slopes west of Calavale Brook, a Northern Hardwood Seepage Forest is perched on a flat terrace above the Belvidere wetland complex. Much of the water contained within drains from the upslope Red Maple-Black Ash Seepage Swamp (BM-4). Within, touch-me-not, silvery glade fern, sensitive fern, and dwarf raspberry blanket the ground.

SEEP (S4)

BM-12 (0.7 acres, state-significant, B rank)

A small seep is tucked in a notch on the ridgeline separating the Pacific Brook headwater bowl from the west-facing slopes above Regan Road. This area is difficult to access and has likely not been disrupted by logging activity due to its inaccessibility.

WILDLIFE FEATURES:

Much of Burnt Mountain's wildlife value comes from the size of the unfragmented forest blocks and connectivity with other large forested landscapes. For more detail about the landscape-scale value of this tract, please see Engstrom and Lapin (2015). However, within the forest matrix, there are a variety of features that provide wildlife value, including beech mast

stands, forested wetlands (which provide early spring forage for large animals), vernal pools (which provide amphibian breeding habitat), and two swaths of old forest.

BEECH MAST STAND

BM-9 (0.8 acres)

A 0.8-acre patch of healthy, bear-marked beech is perched on a west-trending ridgeline descending off the west flanks of Burnt Mountain. Within this area, the nearly pure beech stand seems to be without beech bark disease, and bear claw marks appear to be from a variety of years. Some of the beech are up to 12 inches in diameter.

VERNAL POOLS

Five vernal pools were located throughout the Burnt Mountain parcel (*see Appendix G* and POIs_BurntMountain_Phillips2017 data layer for coordinates). None of these vernal pools meet the criteria for a Vernal Pool Special Treatment Area, which requires the vernal pools to be greater than 200 square feet in size and naturally-occurring. These vernal pools were not assessed for the presence of breeding amphibians due to the timing of the field work. Four additional vernal pools of anthropogenic origin were located on the property.

OLD FOREST

BM-10 (11.5 acres)

Nearly 12 acres of old forest on the western slopes of Burnt Mountain contain large, ornate yellow birch with tertiary bark. The forest contains a higher level of structural complexity than is visible elsewhere on the Atlas lands, with a number of standing dead snags, abundance of coarse woody debris, and evidence of self-pruning on the older trees. Though there are logging roads visible passing through this area, these trees appear to have escaped harvest. There is a noticeable lack of red spruce, suggesting perhaps red spruce was the target species of a previous harvest.

BM-16 (7.3 acres)

A difficult-to-access notch on the slopes west of Calavale Brook contain a few exceptionally large, decadent yellow birch, one with a diameter of 37 inches. Although it appears an old logging road passes through this notch, I see no evidence of harvest. The ground is wet, and herbaceous plants include wood nettle, white snakeroot, touch-me-not, northeastern mannagrass, mountain wood fern, and blue cohosh. Mountain maple, mountain ash, sugar maple, yellow birch, and red spruce are the primary tree species.

OTHER FEATURES OF NOTE:

The Montane Yellow Birch-Red Spruce Forest and Montane Spruce-Fir Forest along the ridgeline were both mapped remotely by Vermont Natural Heritage and appear in the Vermont ANR Atlas online. Although I did not walk along this boundary to confirm the accuracy of the mapping, I did take GPS points each time I crossed into the Montane Yellow Birch-Red Spruce Forest, and the Montane Spruce-Fir Forest. I used these to modify the GIS polygon created by Eric Sorenson.

Boreal bedstraw (*Galium kamtschaticum)* was mapped in sixteen locations around the site, at elevations ranging from 1750 feet up to 2500 feet, always in wet seeps. It seemed to grow comfortably in both undisturbed sites and disturbed sites; it was found growing in old logging roads on a number of occasions.

STEWARDSHIP CONSIDERATIONS

Illegal Ski Lines (BM-14, 8.7 acres)

At least two illegally-cut ski trails ascend the north-facing slopes of Haystack Mountain from the Hazen's Notch Road, extending from the Northern Hardwood Forest, through a patch of Rich Northern Hardwood Forest, up into the Montane Yellow Birch-Red Spruce Forest on the ridgeline. At the lower elevations, small-diameter trees have been recently cut to make an open ski run, forming a trail that is nearly 20 feet wide in some places. At the higher elevations the trail travels through natural couloirs descending from the ridgeline, and obtrusive vegetation has been removed to make a descent possible. At the base of the couloir and within, there was evidence of yellow birch removal up to about six to eight inches in diameter. This cutting appeared to have occurred within summer 2016, or during winter 2015-2016, as the downed trees were still on site and poorly decomposed. From the ridge top, there are at least two couloirs that have been cleared, and the clearing continues into the Montane Yellow Birch-Red Spruce zone. It is my impression that this area is well-known and regularly maintained, and the ridgeline may be a focus of expanded activities if left unaddressed. My map *does not* include the illegal ski trail identified by TNC staff on a hike on the east side of Burnt Mountain within the Wade Brook drainage.

Access to Pacific Brook

Access to the north-facing slopes on the south side of the Pacific Brook bowl is via the legal right-of-way on a private road. However, the landowners who maintain this private road did not acknowledge the legal rights of ATP owners to pass through this road, and requested that I instead access the property via the road that traveled due east into Pacific Brook bowl proper. Dave McMath, Jon Binhammer, and Gus Goodwin are all aware of the nuances of access to this portion of the property.

Boundary Discrepancies

The southern boundary in the Pacific Brook drainage, through which the legal right-of-way passes, has some boundary discrepancies in the corner. Although it only appeared to be off by about 50 feet, this was a greater discrepancy than I observed elsewhere on the Atlas lands.

RECOMMENDED EASEMENT PROTECTIONS

The protection recommendations made in this report are based on ecological considerations. The final easement configuration may differ from the recommended protections because of practical considerations not explored in this report. Final protections are the decision of the Vermont Land Trust and The Nature Conservancy.

Surface Water Protection Zone + 50-foot Buffer

- *Northern Hardwood Seepage Forests (BM-1, BM-7, BM-13, BM-15); Montane Seepage Forest (BM-2); Rich Northern Hardwood Seepage Forest (BM-5)* — These state-significant uncommon natural communities (S3) may be sensitive to hydrologic alteration by forest management due to the shallow, wet soils and their position on a gradual slope. As headwater wetlands these communities likely provide water quality protection and downstream flood resilience, and offer early spring forage for large mammals. Changes in water table depth by inadvertent draining or ponding may have a lasting impact on the resulting plant communities (please see *Appendix J* for forest management recommendations in Seepage Forests). Protections on these forests should include a 50-foot buffer to ensure that inputs to these Seepage Forests are not disrupted by management activities.

- *Red Maple-Black Ash Seepage Swamp (BM-3)* – This state significant natural community is a headwater wetland, which likely provides water quality protection and downstream flood resilience, and offers early spring forage for large mammals. Protections on this swamp should include a buffer to ensure the ecological integrity of the swamp is not compromised by forest management activities.

- *Seep (BM-12)* – The seeps on Burnt Mountain may serve as important amphibian breeding habitat, and produce early spring forage for large mammals like moose and black bear. Because they tend to occur amidst the state-significant Montane Yellow Birch-Red Spruce Forest, they are unlikely to be impacted by harvest.

Ecological Protection Zone

- *Montane Spruce-Fir Forest (BM-17)*— This uncommon natural community (S3) is a state-significant, A-ranked occurrence. Montane Spruce-Fir Forest affords excellent high-elevation wildlife habitat with mature trees. A no-touch protection on this forest will ensure it retains the structural heterogeneity that it has developed over time.

- *Montane Yellow Birch-Red Spruce Forest (BM-18)*— This state-significant uncommon natural community (S3) is an A-ranked occurrence. This forest appears mature in some places, and features well-developed glades and a dense understory of hobblebush, both of which provide excellent habitat for moose.

- *Old Forest (BM-10, BM-16)* – The structurally complex Old Forests on Burnt Mountain provide habitat for a variety of animals in the form of standing and downed woody debris. Additionally, they serve as a carbon sink, an important landscape feature as global carbon emissions continue to rise.

Forest Management Plan and Easement Attribute Language

- *Rich Northern Hardwood Forest (BM-4, BM-6, BM-8, BM-11)* – The state-significant Rich Northern Hardwood Forest communities host plant species which depend on nutrient enrichment, a site condition created by the downslope migration of organic matter in a process called colluviation. So long as forest management preserves the processes that give rise to these communities, this community will tolerate active management.

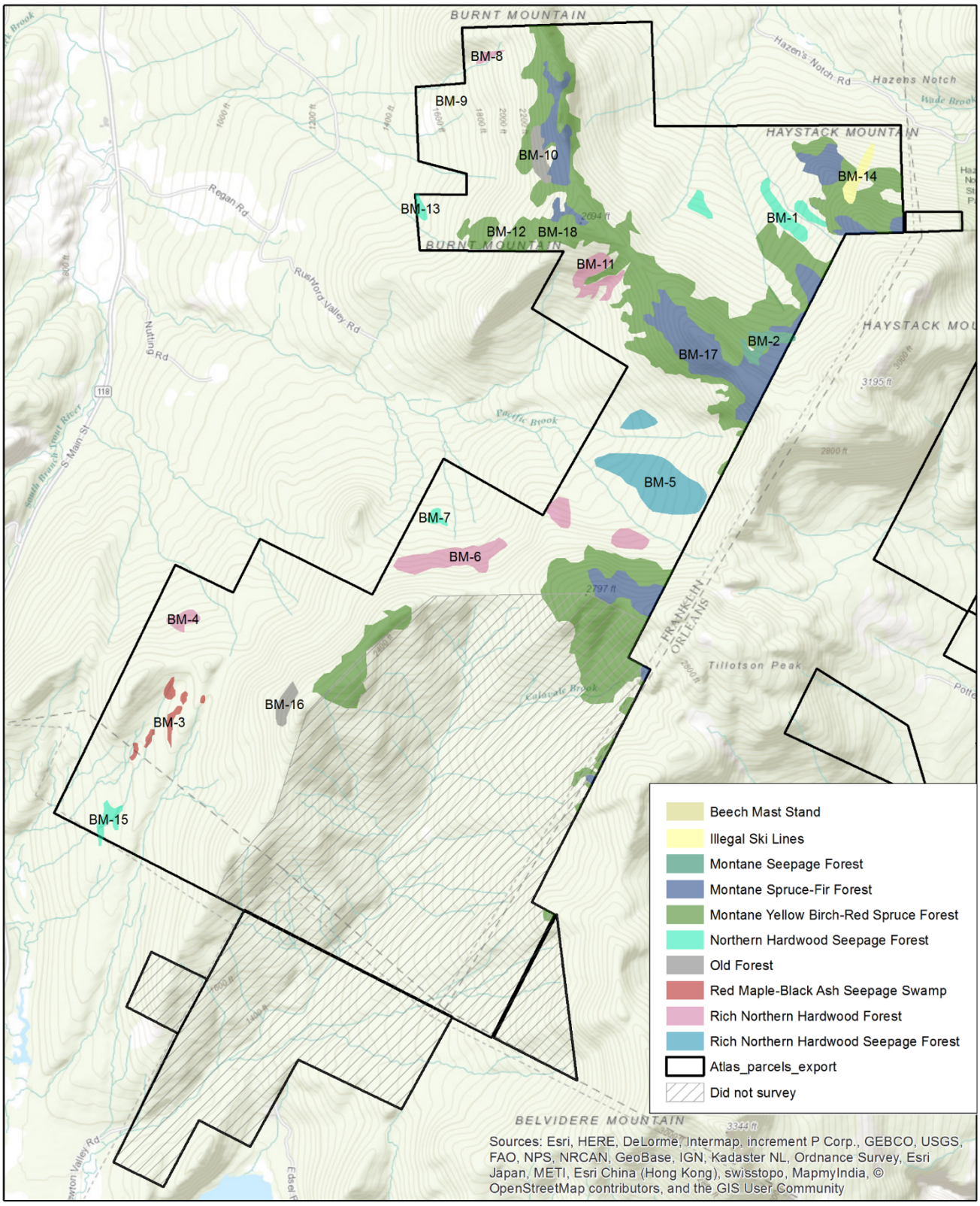
- *Beech Mast Stand (BM-9)* – The beech mast stand on Burnt Mountain offers critical black bear habitat and features mature individuals free of beech bark disease. Forest management in these areas should emphasize retention of disease-free and mast-producing individuals.

ACCOMPANYING FILES

Burnt Mountain Geodatabase

- *IntermittentStreams_BurntMtn_Phillips2017:* Line file containing previously unmapped intermittent streams. This layer should be viewed with the National Hydrography Dataset stream layer.
- *NatComms_BurntMountain_Phillips2017*: Polygon feature of state-significant natural communities, significant wildlife habitat, and other ecologically significant areas (including old forest). This file contains Natural Heritage Rankings and easement protection recommendations in accordance with VLT's easement provisions. Overlay POIs for more detail about field observations.
- *POIS_BurntMountain_Phillips2017*: Point features containing field notes, which include species observations, rare/uncommon plant element occurrence data, land use alteration notes, and other general field observations.
- *Tracks_BurntMountain_Phillips2017:* Line features showing path taken on field days.

FIGURE 8 ECOLOGICALLY SIGNIFICANT FEATURES OF BURNT MOUNTAIN

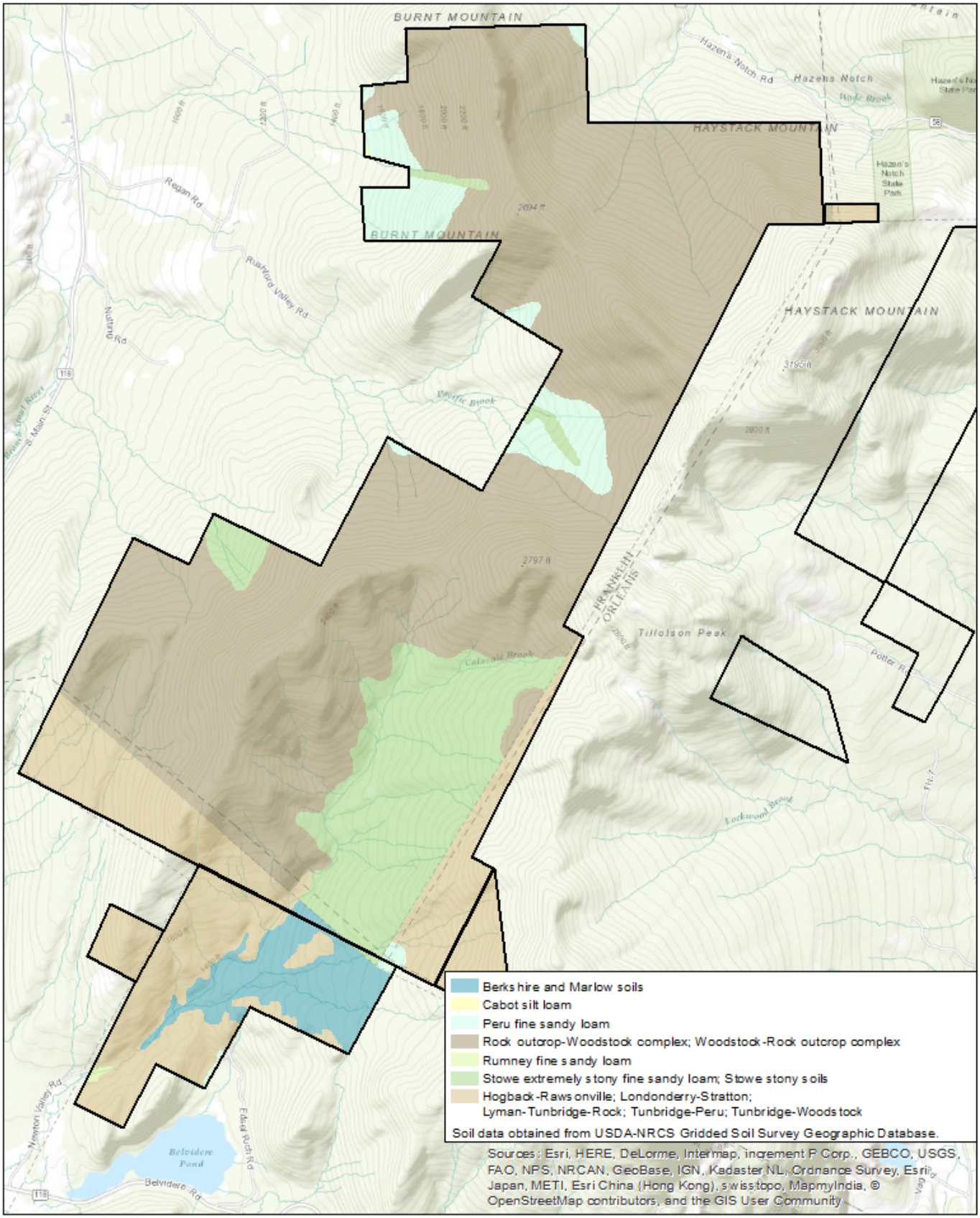


Map created by Hannah Phillips
UVM Ecological Planning Program
Field work conducted in August 2016

Atlas Timberlands Partnership
Burnt Mountain Resource Map

0 0.275 0.55 1.1 Miles

FIGURE 9 SOILS OF BURNT MOUNTAIN

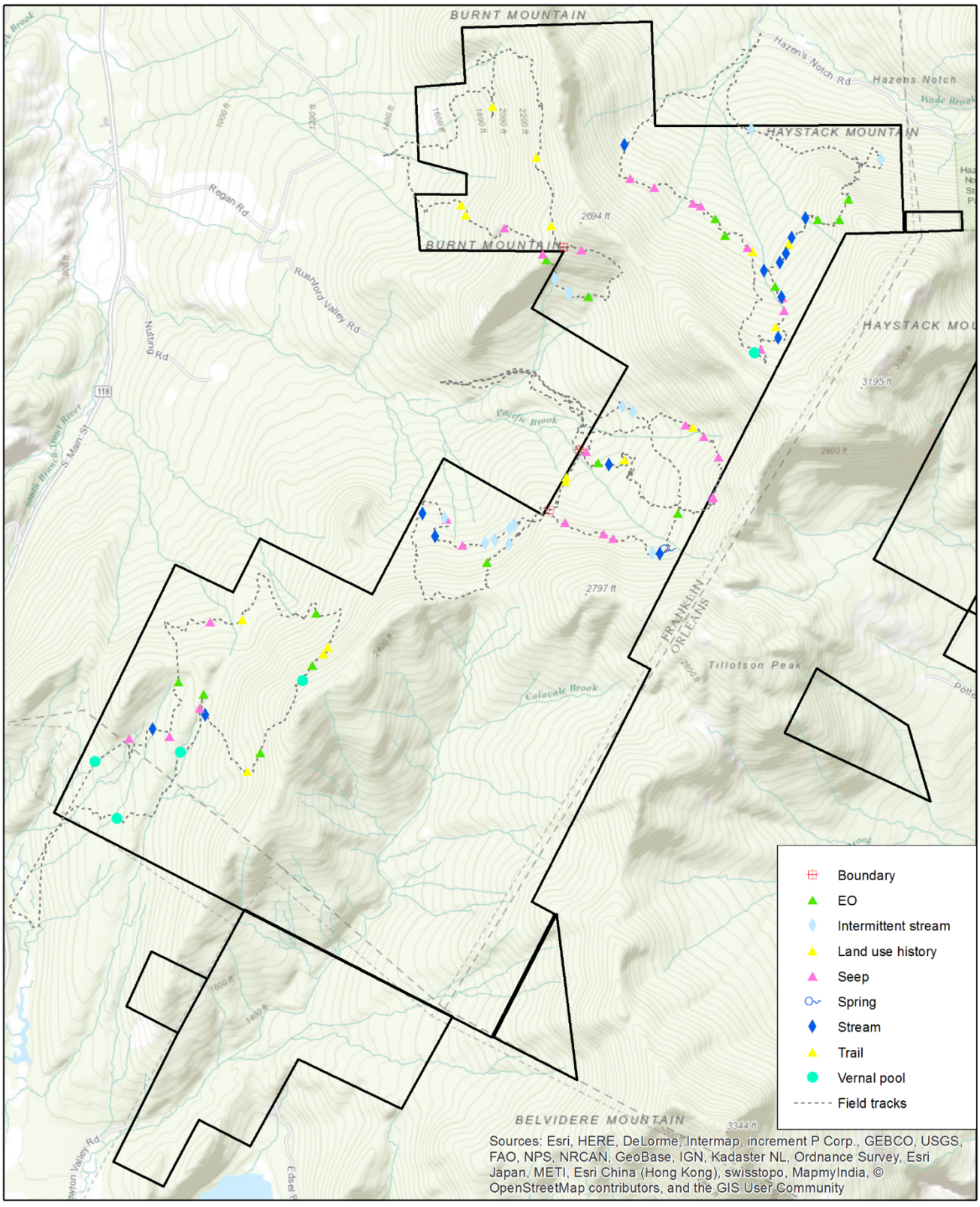


Map created by Hannah Phillips
UVM Ecological Planning Program
Field work conducted in August 2016

Atlas Timberlands Partnership
Burnt Mountain Soils Map

0 0.3 0.6 1.2 Miles

FIGURE 10 POINTS OF INTEREST ON BURNT MOUNTAIN



Map created by Hannah Phillips
UVM Ecological Planning Program
Field work conducted in August 2016

Atlas Timberlands Partnership
Burnt Mountain Points of Interest

0 0.275 0.55 1.1 Miles

TABLE 6 NATURAL COMMUNITY RANKINGS AND SIGNIFICANT WILDLIFE HABITAT OF BURNT MOUNTAIN

Site ID	Type	Acres	Rarity Rank	State-significant?	Rank Sum	Description	Rank Size	Rank Condition	Rank Landscape Context	Comments	Recommended Additional Protections	ESTA Eligible?
BM-1	Northern Hardwood Seepage Forest	21.9	S3	Y	B	Zig-zag goldenrod, white baneberry, white snakeroot, sweet cicely, Braun's holly fern, foamflower, sugar maple, boreal bedstraw, dwarf raspberry, blue cohosh, scabrous sedge, northeastern mannagrass, lance-leaved twisted stalk. Tip-ups, trees shorter, smaller DBH.	C	A	B-logging in the surrounding forest	Ranked according to Northern White Cedar Sloping Seepage Forest criteria	SWPZ + 50' buffer zone	Y
BM-2	Montane Seepage Forest	11.6	S3	Y	B	Northeastern mannagrass, white turtlehead, purple-stemmed aster, northern white bog candles, false hellebore, tall meadow rue, mountain wood fern, boreal bedstraw, dwarf raspberry, broadly creepy roots, EC 17 mS.	C	B-appears some clearing on the lower edge	B-logging in the surrounding area	Ranked according to Northern White Cedar Sloping Seepage Forest criteria	SWPZ + 50' buffer zone	Y
BM-3	Red Maple-Black Ash Seepage Swamp	9.6	S4	Y	B	Joe-pye weed, golden saxifrage, water penny, zig-zag goldenrod, blue cohosh, northeastern mannagrass, wood nettle, black ash, dwarf raspberry, touch-me-not, virgin's bower, foamflower, sugar maple, purple-fringed bog orchid, white turtlehead, cinnamon fern.	B	A	B-logging in the surrounding forest; beaver	One of these polygons is a beaver pond. Boreal bedstraw throughout. Seem to roughly follow streams	SWPZ + 50' buffer zone	Y
BM-4	Rich Northern Hardwood Forest	5.9	S4	Y	B	Maidenhair fern, blue cohosh, doll's eyes, Braun's holly fern, wood nettle, Virginia waterleaf, lance-leaved twisted stalk, sensitive fern, foamflower, touch-me-not.	C	B-some logging ruts through here	B-logging in the surrounding forest		Forest Management Plan, easement attributes	—
BM-5	Rich Northern Hardwood Seepage Forest	61.5	S3	Y	A	Wild leeks, bog candles, creeping snowberry, silvery glade fern, bladder sedge, blue cohosh, sweet cicely.	A	B-some logging roads throughout	B-logging in the surrounding forest	Low level richness. 12" OM/A: Dark brown, A2 12" tan/brown, B: gleyed/mottled with large rounded rocks. Informed by seeps above (58 mS/, 60deg). Roads pass through.	SWPZ + 50' buffer zone	Y
BM-6	Rich Northern Hardwood Forest	44.1	S4	Y	B	Doll's eyes, alternate leaf dogwood, wild millet, boreal bedstraw, white snakeroot, purple-fringed bog orchid, rose-twisted stalk, elderberry, silvery glade fern, foamflower, wood nettle, lady fern, blue cohosh, Braun's holly fern, sugar maple dominant.	B	B-some logging ruts through here	B-logging in the surrounding forest		Forest Management Plan, easement attributes	—

BM-7	Northern Hardwood Seepage Forest	3.0	S3	Y	B	Foamflower, scabrous sedge, Virginia waterleaf.	C	B-some logging ruts through here	B-logging in the surrounding forest		SWPZ + 50' buffer zone	Y
BM-8	Rich Northern Hardwood Forest	2.1	S4	Y	B	Plantain-leaved sedge, blue cohosh, doll's eyes, wild leeks, silvery glade fern, zig-zag goldenrod, white snakeroot, purple-fringed bog orchid, maidenhair, rattlesnake fern, basswood, beaked hazelnut, baneberry.	D	A	B-logging in the surrounding forest		Forest Management Plan, easement attributes	—
BM-9	Beech Mast Stand	0.8	—	—	—	~1 acre of bear-marked beech	—	—	—	—	Forest Management Plan Language	—
BM-10	Old Forest	10.1	—	—	—	Old forest	—	—	—		EPZ	Y
BM-11	Rich Northern Hardwood Forest	17.4	S4	Y	A	Wood nettle, blue cohosh, Braun's holly fern, purple-fringed bog orchid, zig-zag goldenrod, wild leeks, doll's eyes, white snakeroot, plantain-leaved sedge, silvery glade fern, EC 37 mS.	C	A	A-undisturbed; steep cliffs	Largely inaccessible due to steep cliffs	Forest Management Plan, easement attributes	—
BM-12	Seep	0.7	S4	—	—	In small notch in the mountains.	—	—	—	Too small to count as separate EO	SWPZ + 50' buffer zone	Y
BM-13	Northern Hardwood Seepage Forest	2.7	S3	—	C	Large tip-ups, northeastern mannagrass, sensitive fern.	C	C	B		SWPZ + 50' buffer zone	Y
BM-14	Illegal Ski Lines	8.7	—	—	—	Some enrichment within, Braun's holly fern, lady fern, doll's eyes, wood nettle, dwarf raspberry, foamflower, pale touch-me-not, boreal bedstraw.	—	—	—	—	—	—
BM-15	Northern Hardwood Seepage Forest	6.7	S3	Y	B	Touch-me-not, silvery glade fern, sensitive fern, dwarf raspberry.	C	B-some logging roads through center	B-logging in the surrounding forest	One of these polygons in a beaver pond. Boreal bedstraw throughout. Seem to roughly follow streams	SWPZ + 50' buffer zone	Y
BM-16	Old Forest	7.3	—	—	—	Huge yellow birch, DBH 37".	—	—	—		EPZ	Y
BM-17	Montane Spruce-Fir	175.9	S3	Y	A		A	B	A	Sorenson mapping from Natural Heritage database	EPZ	Y
BM-18	Montane Yellow Birch-Red Spruce Forest	574.6	S3	Y	A		A	B	A	All info per Sorenson mapping from Natural Heritage database	EPZ	Y

Deep Gibou Field Report

ATLAS TIMBERLANDS ECOLOGICAL ASSESSMENT

PREPARED BY HANNAH PHILLIPS
UVM ECOLOGICAL PLANNING PROGRAM
SITE VISITS ON JUNE 15, 16, 17, 24, 27 2016

Vermont Land Trust

The Nature Conservancy

Deep Gibou Field Report

Prepared by Hannah Phillips, UVM Ecological Planning Program
Fieldwork conducted on 15, 16, 17, 24, 27 June 2016

The Deep Gibou parcel contains the following significant ecological features, all of which are recommended for mention in the conservation easement:

1. At least five vernal pools, two of which are larger than 200 square feet, which may provide important amphibian breeding habitat.
2. Fourteen state-significant natural community occurrences representing nine natural community types, four of which are ranked as S3 or higher: Montane Spruce-Fir Forest, Montane Yellow Birch-Red Spruce Forest, Northern Hardwood Seepage Forest, Montane Seepage Forest.
3. Headwater wetlands, including Seeps, Northern Hardwood Seepage Forests, Montane Seepage Forests, which provide flood resilience, water quality protection, and amphibian habitat.
4. More than 70 acres of basin wetlands, comprised of beaver ponds, Shallow Emergent Marsh, and Alder Swamps, which provide flood resilience, water quality protection, and habitat for large mammals, waterfowl, and amphibians.
5. Two patches of structurally complex Old Forest, spanning over 35 acres, which offers habitat for a variety of animals.
6. Habitat for deer and moose, especially in the Montane Yellow Birch-Red Spruce Forest and basin wetlands.

LANDSCAPE CONTEXT

Deep Gibou is located in the Northern Green Mountains biophysical region of Vermont. The Gibou parcel, located in the northeastern quadrant of the Cold Hollow Mountains, ranges from 1260-2508 feet in elevation. Small peaks to the west, east, and south create a headwater bowl for Tamarack Brook (flowing northeast) and West Hill Brook (flowing northwest), which both drain to the Trout River and then into the Missisquoi. The property is bisected by a small north-south ridge (elevation 1584 feet). Beavers have heavily modified the lowlands in the center of the property and the resulting wetlands, in varying stages of succession, cover the valley bottom. Both wetland complexes in the east and west of the property show signs of beaver activity.

TABLE 7 SOILS OF DEEP GIBOU

Soil Series	*Acres*	Percent
Londonderry-Stratton	24.5	0.9%
Tunbridge-Lyman	22.1	0.8%
Lyman-Tunbridge-Rock	142.5	5.2%
Water	4.6	0.2%
Peru	503.7	18.5%
Tunbridge-Woodstock	12.2	0.4%
Woodstock-Rock	1236.7	45.3%
Terric	27.3	1.0%
Podunk	38.6	1.4%
Stowe	540.9	19.8%
Colton	41.4	1.5%
Rock	20.7	0.8%
Wareham	3.7	0.1%
Rumney	4.3	0.2%
Cabot	51.2	1.9%
Carlisle	18.1	0.7%
Peacham	31.9	1.2%
Missisquoi	5.6	0.2%
	2730.1	

BEDROCK

The mountains on the west side of the drainage sit predominantly atop quartzite schist of the Hazens Notch Formation. Portions of the southern rim of the Gibou Bowl and the eastern “valley” are underlain by phyllite of the Jay Peak Formation, while a strip of schist from the Fayston Formation bisects the property down the middle. The easternmost spine of peaks in the Gibou drainage is comprised of a carbonaceous phyllite of the Ottauquechee Formation, which continues down the eastern flanks of the property into Avery’s Gore. A small serpentenite outcrop is located in the northwestern corner of the property. The surficial geology of the site is mapped entirely as till.

SOILS

The majority of Gibou is mapped as Woodstock Rock-Outcrop complex, with portions of the central basin mapped as Stowe stony soils (*Table 7*, *Figure 13*). Drainages in the northwest, central, and northeast part of the property are perched atop Peru fine sandy loam or Stowe extremely stony fine sandy loam, with one small patch of Cabot soils in the northwest corner of the property (see map at end).

HUMAN INFLUENCE

Human activity on the property is readily apparent. Logging roads provide easy access for ATVs, and evidence of visitation is apparent in the lower elevations in the center of the parcel on both the east and west. Two paths of travel are of particular note: on the west, ATVs regularly travel up the streambed to access a campsite and fire pit at the base of a waterfall. On the east, an old logging road provides access to a cleared landing with a fire pit and access to Lost Pond. In both examples, regular traffic has caused deterioration of the roadbed and motorists are now seeking alternative paths of travel, disrupting the adjacent vegetation. A road connects Deep Gibou Road with Lost Pond on the southern boundary, which serves as a VAST trail in the winter. The most recent logging activity of the property was in 2006 and 2007 on the eastern half of the parcel.

FEATURES OF ECOLOGICAL SIGNIFICANCE

UPLANDS:

The uplands of Deep Gibou bear a predictable suite of mid-to-high elevation forest types (*Table 8*, *Figure 11*). High elevation forests cover the ridgeline in the southwest portion of the property, while Northern Hardwood Forest is abundant elsewhere. Pockets of wet forest (Seepage Forest) emerge in the northwest corner of the property and to the southeast in areas where mild slopes occur just downslope of steeper slopes or outcrops. The north-facing slopes in the northeast corner of the property are moderately enriched. While some of these natural communities are state-significant, none of them stand out as truly exceptional within the Atlas lands; larger and better examples exist of each of these community types elsewhere. Despite this, one of Deep Gibou's great merits, like the other Atlas lands, is the large, unfragmented forest block. Its connectedness with the Bakersfield parcel to the west (a prior Atlas parcel) increases the size of this forest block.

RICH NORTHERN HARDWOOD FOREST (S4)

G-9 (45.4 acres, state-significant, B rank)

A state-significant Rich Northern Hardwood Forest is located on the north-facing slopes of the eastern ridge of the property, just downslope of rock outcrops of the Ottauquechee Formation. The exposed bedrock and downslope groundwater seepage gives rise to an exceptionally rich slope, featuring maidenhair fern, wild leeks, blue cohosh, and wood nettle. This parcel received a B-rank for size, A-rank for landscape context, and a C-rank for condition, because 2006/2007 logging activity disrupted the forest in the southwest corner. This community was delineated from summer 2016 field work and Marc Lapin's field work of summer 2015.

G-1 (8.8 acres, not state-significant)

There is another Rich Northern Hardwood Forest cove on the northwest property boundary (G-1). Although it is currently in excellent condition, it falls mostly outside of the Atlas boundary on the neighbor's land. That neighbor has harvested extensively downslope of the cove, but has not disrupted the vegetation within. The top of this cove is Northern Hardwood Talus Woodland; large circumneutral talus blocks are anchored by a well-developed tree layer, and the herbaceous understory is indicative of enrichment (blue cohosh, Goldie's fern, Braun's holly fern, jewelweed, Canada violet, maidenhair fern). The talus blocks create desirable denning habitat for wildlife.

MONTANE YELLOW BIRCH-RED SPRUCE FOREST (S3, G-10, 474.9 ACRES, STATE-SIGNIFICANT, B RANK)

This state-significant 475-acre Montane Yellow Birch-Red Spruce Forest formation extends along the flanks of the west and south ridges that form the Gibou bowl, giving way to Montane Spruce-Fir Forest at the highest elevations. At the lower elevations and in the northernmost portion of this forest yellow birch is dominant, with red spruce confined mostly to the understory. In upper elevations, though, yellow birch gives way to red spruce. It seems likely that red spruce was harvested from much of this area, excluding the 34-acre area of old growth on east-facing slopes of the western bowl. Hobblebush is dominant in the understory of this community, and moose browse is extensive. In some areas, large, open-grown yellow birch dominate the overstory and mountain wood fern blankets the understory, creating high-elevation glades. Mountain ash is occasionally present in the shrub layer. Common herbaceous plants include bluebead lily, starflower, and shining club moss.

MONTANE SPRUCE-FIR FOREST (S3, G-4, 77.9 ACRES, STATE-SIGNIFICANT, B RANK)

A state-significant Montane Spruce-Fir Forest covers the highest elevations of the Deep Gibou ridgeline in the southwest corner of the property, extending into the Atlas lands from adjacent parcels. Neighboring lands to the south have been aggressively harvested; this community was assigned B-rank for landscape context. Presumably, the Montane Spruce-Fir forest on the neighboring Bakersfield parcel was managed in a similar manner to Gibou.

OUTCROPS:

TEMPERATE ACIDIC OUTCROP (S4)

G-2 (0.9 acres, state-significant, A rank)

A state-significant temperate acidic outcrop located in the northwest corner of the property is represented on the bedrock geology map of Vermont as serpentenite. I found none of the rare species restricted to Serpentine Outcrops, however, and the species composition more closely resembled a Temperate Acidic Outcrop. This particular outcrop was topped with a dense red spruce stand, within which moose sign was abundant.

G-3 (0.3 acres, state-significant, A rank)

A small east-facing cliff band was located in the northwest corner of the property, proximal to the beaver wetland. At its highest, the cliff is twenty feet tall, although it is broken into a series of shorter bands. Wood nettle grows densely at the base of the cliff, and an obvious lack of trees may be due to occasional rock fall or an inability to establish on the small talus slope beneath. Maidenhair spleenwort is growing from the rock in one location, although the lack of other calcium-loving plants suggests this may be the acidic-tolerant variety of *A. trichomanes (*ssp. *trichomanes).*

WETLANDS

The Deep Gibou tract features over 70 acres of basin wetlands in the drainages at the bottom of the Cold Hollow Mountains. These wetlands have been heavily altered by beavers and by All-Terrain Vehicles, but they maintain certain ecological functions (water retention and flood resilience), if not their floristic integrity. Despite their impacted state, they have the potential to rebound from human impacts if ATV use is curbed, especially in G-5 and G-7. Forested wetlands upslope, including Northern Hardwood Seepage Forests and Seeps, feed into the downslope wetlands.

SEEPS (S4, G-14, G-15, STATE-SIGNIFICANT, A RANKED)

There are many seeps on the Deep Gibou tract, but they seem to be concentrated on the central and in the northwest corner of the tract. All of these seeps contained some combination of characteristic seep plants, including boreal bedstraw (S3), greater purple-fringed bog orchid, golden saxifrage, northeastern mannagrass, touch-me-not, and false hellebore. PH

in the seeps is close to neutral (6.5-7.0), with six to twelve inches of wet organic matter perched on top of an impenetrable layer of stony silty loam.

NORTHERN HARDWOOD SEEPAGE FOREST (S3)

G-13 (39.3 acres, state-significant, B rank)

A Northern Hardwood Seepage Forest is located in the northwest corner of the property (G-13, 39.3 acres). Herbaceous plants observed in G-13 include sensitive fern, false hellebore, wood nettle, jewelweed, northeastern mannagrass, foamflower, dwarf raspberry, two-leaved toothwort, and turtlehead. Black ash was present, although typical northern hardwood forest trees were dominant. An old logging road passes through this community, traveling up slope adjacent to a stream, and eventually crossing over the ridge towards the Bakersfield parcel. While some of this natural community is impacted by the road, there are a number of untouched small seeps that drain into the stream that eventually runs into the wetland complex in the valley bottom.

G-12 (31.1 acres, state-significant, A rank)

A seepage forest is perched on a gradual hillside with a northwest aspect and is heterogeneous in character. Small seeps (many less than 0.5 acres in size) – featuring characteristic seep species including boreal bedstraw, purple-fringed bog orchid, golden saxifrage, northeastern mannagrass, touch-me-not, and false hellebore—occur patchily throughout the forest; small intermittent streams link the patches together. At the lower end of the forest, the seepage begins to converge into an established stream channel. Soils in each of these seeps are six to eight inches of poorly decomposed muck perched atop an impermeable stony silty loam with a pH of 6.5-7.0. The forest surrounding these small wetland patches has many intermittent streams scattered throughout and small patches of wetland-opportunists like false hellebore and wood nettle.

MONTANE SEEPAGE FOREST (S3, G-21, 9.9 ACRES, STATE-SIGNIFICANT, B RANK)

Several small seeps are located in close proximity to one another on a terrace amidst Montane Yellow-Birch Seepage Forest in the southern portion of the Deep Gibou property. Boreal bedstraw and northern white bog orchid are both present in the seepage openings, along with other seepage indicator plants. An overgrown ATV track passes along the east edge of the community and has started to take on seepage characteristics.

SHALLOW EMERGENT MARSH (S4, G-6, G-8, STATE-SIGNIFICANT, A RANK, B RANK)

Two state-significant examples of Shallow Emergent Marsh sit adjacent to the beaver meadows on the west and east portions of the property. The western example of this community type (G-6; B-rank; 4.2 acres) has been altered by ATV tracks that pass adjacent to the marsh and through it in places. Additionally, upstream logging (off of ATP property) may alter beaver activity, which will impact the downstream marsh. The eastern shallow emergent marsh (G-8; A-rank) is larger (18.6 acres), although is interspersed with sections of alder swamp and small upland islands. This area, too, is prone to alteration as a result of beaver activity.

ALDER SWAMP (S4, G-5, STATE-SIGNIFICANT, B RANK)

A 12.6-acre Alder Swamp (G-5; B-rank) connects two beaver ponds in the western part of the property. The access road passes through the middle, and ATV trails used to access the waterfall campsite have cut through the Alder Swamp in some areas. The rank of this swamp has been reduced due to disturbance by the road and ATV trails, and also because beaver activity downstream may alter the boundaries of this natural community.

WILDLIFE FEATURES:

Vernal Pools (G-VP-1, G-VP-2, G-VP-3, G-VP-4, G-VP-5)

Five small vernal pools, all D-rank in size, but A-rank in condition and landscape context, are perched throughout the property (see *Appendix G* and POIs_DeepGibou_Phillips2017 data layer for coordinates). Of note, the vernal pools seem to be located proximal to zones with higher-than-average seepage; the hydrologic conditions of the site are conducive to water accumulation and may remain satisfactorily cool for amphibian reproduction, perhaps due to the influx of water from groundwater seeps. Although amphibian breeding rank was not classified due to the time of year during which the area was surveyed, wood frogs and green frogs were regularly observed in the adjacent seeps and seepage swamps.

Only two of these vernal pools—G-VP-2 and G-VP-3—meet the criteria to receive a higher level of protection under Vermont Land Trust's protection schema (greater than 200 square feet in size and naturally occurring). These will both need to be assessed for the presence of breeding amphibians before they qualify for a Vernal Pool Special Treatment Area.

Old Forest (G-18, G-19)

Two patches of old growth forest, one on an east-facing flank of the west ridge (G-24; 34.3 acres) and one on the east-facing flank of the east ridge (G-23; 2.9 acres) are dominated by inoperably steep slopes, large yellow birch, and a vertically-complex forest structure with standing dead snags and downed woody debris. G-24 may be smaller than mapped along an east-west dimension, although the north-south dimension is valid.

Beech Mast Stands (G-16, G-17)

Two beech mast stands (G-21, 3.2 acres; G-22, 0.8 acres) were identified by a high percentage of healthy beech trees, including some with bear claw marks. Although beech is abundant across the property and dominates regeneration in the recently harvested areas, care should be taken to preserve large, high-quality mast producing beech trees amidst future management on the property.

Beaver Wetland (G-7, G-11)

Two active beaver wetlands are present on the property (G-8, 8.6 acres; G-13, 14.7 acres), along with numerous recently abandoned beaver ponds that still contain open water and beaver lodges (G-7, 7.8 acres; G-12, 3.9 acres). In both instances, the beaver wetlands continue off-site. These wetlands give rise to a variety of wetland swamp types (Alder Swamp; Shallow Emergent Marsh) which have high wildlife value for the forage they provide. Beaver activity should neither be encouraged nor discouraged, but as long as the beaver ponds are in existence management should avoid disturbing vegetation within 50ft of the edge of the pond to protect valuable wildlife habitat.

STEWARDSHIP CONSIDERATIONS

ATVs

ATV use is rampant throughout Deep Gibou. On the west side of the drainage divide, ATVs drive up the wash through G-5 and G-7 to access a well-established campsite by the waterfalls (see POI 39 and POI 40 in POIs_DeepGibou_Phillips2017 data layer for coordinates). I encountered a group of four teenagers on ATVs who were *en route* to the waterfalls. Another campsite between G-14 and G-15 is accessible by ATV, from a trail that branches off of the main VAST trail. ATV trails connect from G-5 up and over the ridge to the eastern drainage. There, an established track travels beside G-8 and G-11.

RECOMMENDED EASEMENT PROTECTIONS

The protection recommendations made in this report are based on ecological considerations. The final easement configuration may differ from the recommended protections because of practical considerations not explored in this report. Final protections are the decision of the Vermont Land Trust and The Nature Conservancy.

Surface Water Protection Zone + 50-foot Buffers

- *Northern Hardwood Seepage Forest (G-12, G-13); Montane Seepage Forest (G-21)* — These state-significant uncommon natural communities (S3) may be sensitive to hydrologic alteration by forest management due to the shallow, wet soils and their position on a gradual slope. As headwater wetlands these communities likely provide water quality protection and downstream flood resilience, and offer early spring forage for large mammals. Changes in water table depth by inadvertent draining or ponding may have a lasting impact on the resulting plant communities (please see *Appendix J* for forest management recommendations in Seepage Forests). Protections on these forests should include a 50-foot buffer to ensure that inputs to these Seepage Forests are not disrupted by management activities.

- *Alder Swamp (G-5); Shallow Emergent Marsh (G-6, G-8); Beaver Pond (G-7, G-11)* — protection of these natural communities ensures the Deep Gibou wetland complex will continue to mitigate the effects of heavy precipitation events for downstream communities. They may also provide important wildlife habitat for migratory waterfowl, beavers, mink, river otter, muskrat, wood turtles, and amphibians. With time, these natural communities may shift as the land use changes, at which time the appropriateness of this protection should be revisited.

- *Seeps (G-14, G-15, G-20)* — The seeps on Deep Gibou may serve as important amphibian breeding habitat, and also produce early spring vegetation desirable to large mammals like moose and black bear.

Ecological Protection Zone

- *Montane Spruce-Fir Forest (G-4)* – This Montane Spruce-Fir Forest affords excellent high-elevation wildlife habitat with mature trees. A no-touch protection on this forest will ensure it retains the structural heterogeneity that it has developed over time. These forests may also become reduced in size as the climate warms.

- *Montane Yellow Birch-Red Spruce Forest (G-10)* – This state-significant uncommon natural community (S3) is a B-ranked occurrence. This forest has well-developed glades and a dense understory of hobblebush, both of which provide excellent wildlife habitat for moose.

- *Old Forest (G-18, G-19)* – This old forest provides habitat for a variety of animals in the form of standing and downed woody debris. Additionally, it serves as a carbon sink, an important landscape feature as global carbon emissions continue to rise.

Forest Management Plan and Easement Attribute Language

- *Temperate Acidic Outcrops (G-2, G-3)* – Outcrops on Deep Gibou provide potential denning sites for animals like porcupine and bobcat. Owners should survey this outcrop prior to undertaking management actions in close proximity to avoid disrupting wildlife of conservation concern.

- *Rich Northern Hardwood Forest (G-9)* - The state-significant Rich Northern Hardwood Forest community hosts plant species that depend on nutrient enrichment, a site condition created by the downslope migration of organic matter in a process called colluviation. So long as forest management preserves the processes that give rise to these communities, this community will tolerate active management.

- *Beech Mast Stands (G-16, G-17)* – Beech mast stands on Deep Gibou offer critical black bear habitat and feature mature individuals free of beech bark disease. Forest management in these areas should emphasize retention of disease-free and mast-producing individuals.

Vernal Pool Special Treatment Areas

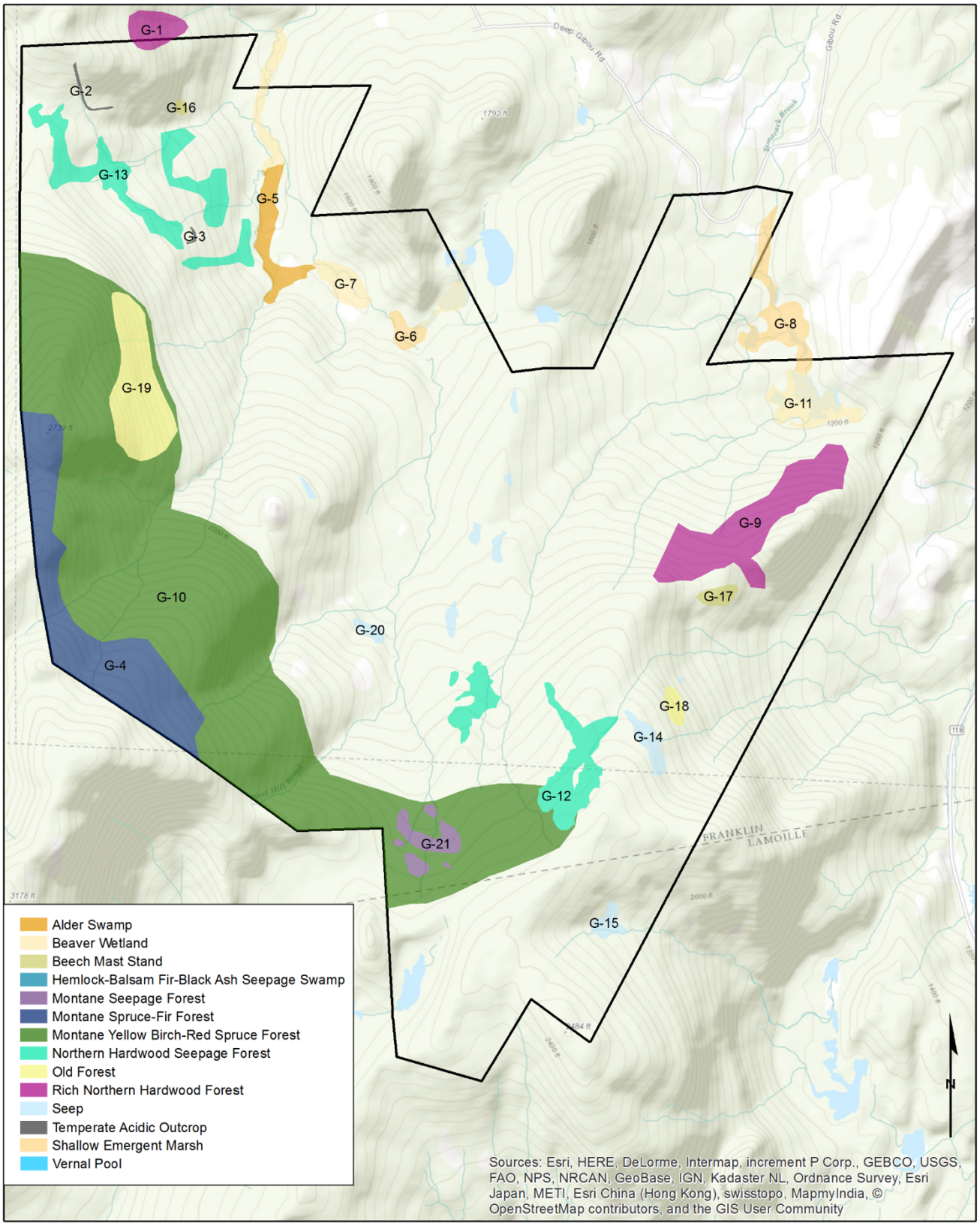
- *Vernal Pools (G-VP-2, G-VP-3)* – If a spring survey reveals that these vernal pools are used as amphibian breeding grounds, they should be protected under the Vernal Pool Special Treatment Area clause, with 100-foot primary and 500-foot secondary buffer zones. These restrictions will ensure the maintenance of natural features necessary to preserve desirable habitat.

ACCOMPANYING FILES

Deep Gibou Geodatabase

- *IntermittentStreams_DeepGibou_Phillips2017:* Line file containing previously unmapped intermittent streams. This layer should be viewed with the National Hydrography Dataset stream layer.
- *NatComms_DeepGibou_Phillips2017*: Polygon feature of state-significant natural communities, significant wildlife habitat, and other ecologically significant areas (including old forest). This file contains Natural Heritage Rankings and easement protection recommendations in accordance with VLTs easement provisions. Overlay POIs for more detail about field observations.
- *POIS_DeepGibou_Phillips2017*: Point features containing field notes, which include species observations, rare/uncommon plant element occurrence data, land use alteration notes, and other general field observations.
- *Tracks_DeepGibou_Phillips2017:* Line features showing path taken on field days.

FIGURE 11 ECOLOGICALLY SIGNIFICANT FEATURES OF DEEP GIBOU

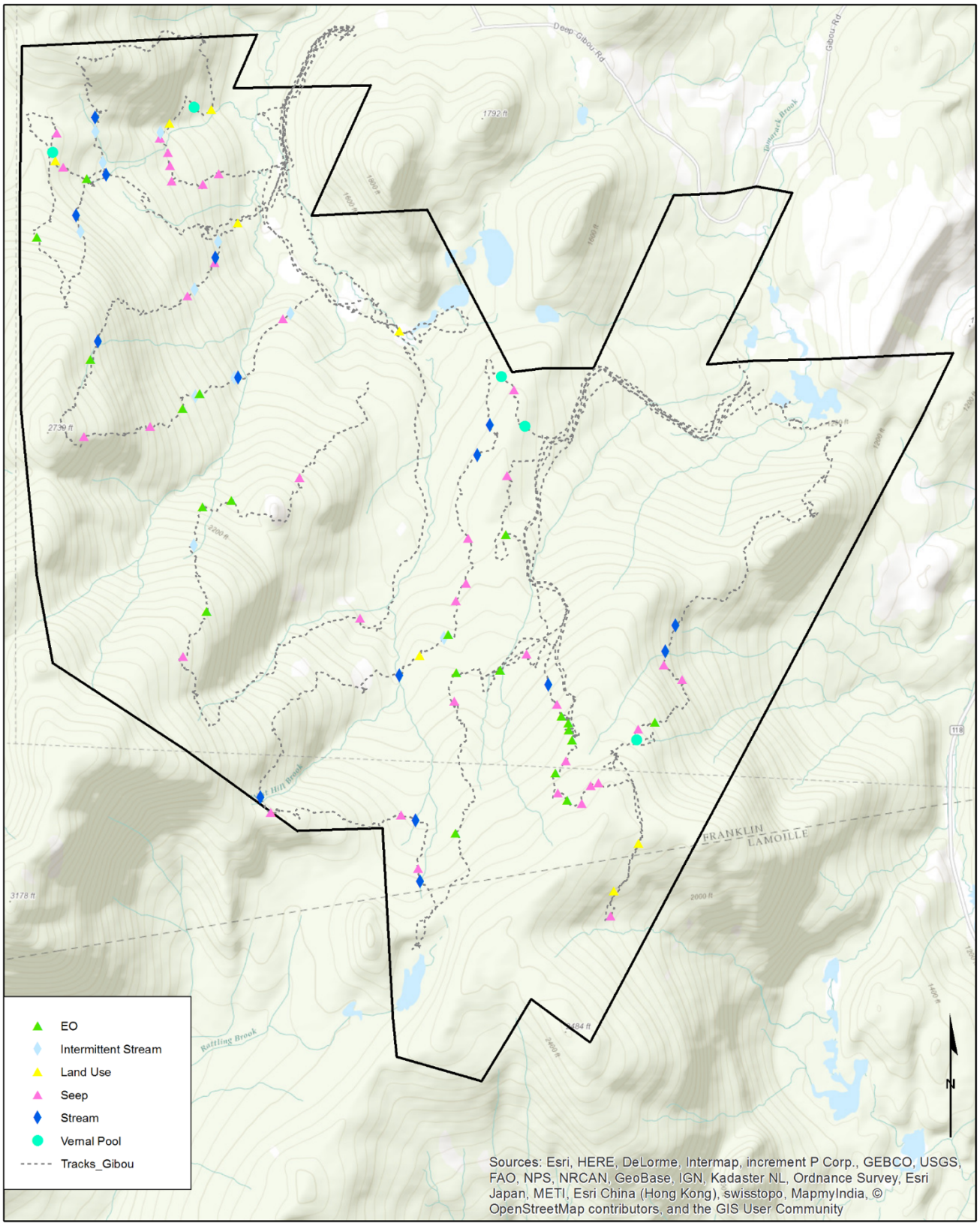


Map created by Hannah Phillips
UVM Ecological Planning Program
Field work conducted in June 2016

Atlas Timberlands Partnership
Deep Gibou Resource Map

0 0.15 0.3 0.6 Miles

FIGURE 12 POINTS OF INTEREST OF DEEP GIBOU



Map created by Hannah Phillips
UVM Ecological Planning Program
Field work conducted in June 2016

Atlas Timberlands Partnership
Deep Gibou Points of Interest Map

0 0.15 0.3 0.6 Miles

FIGURE 13 SOILS OF DEEP GIBOU

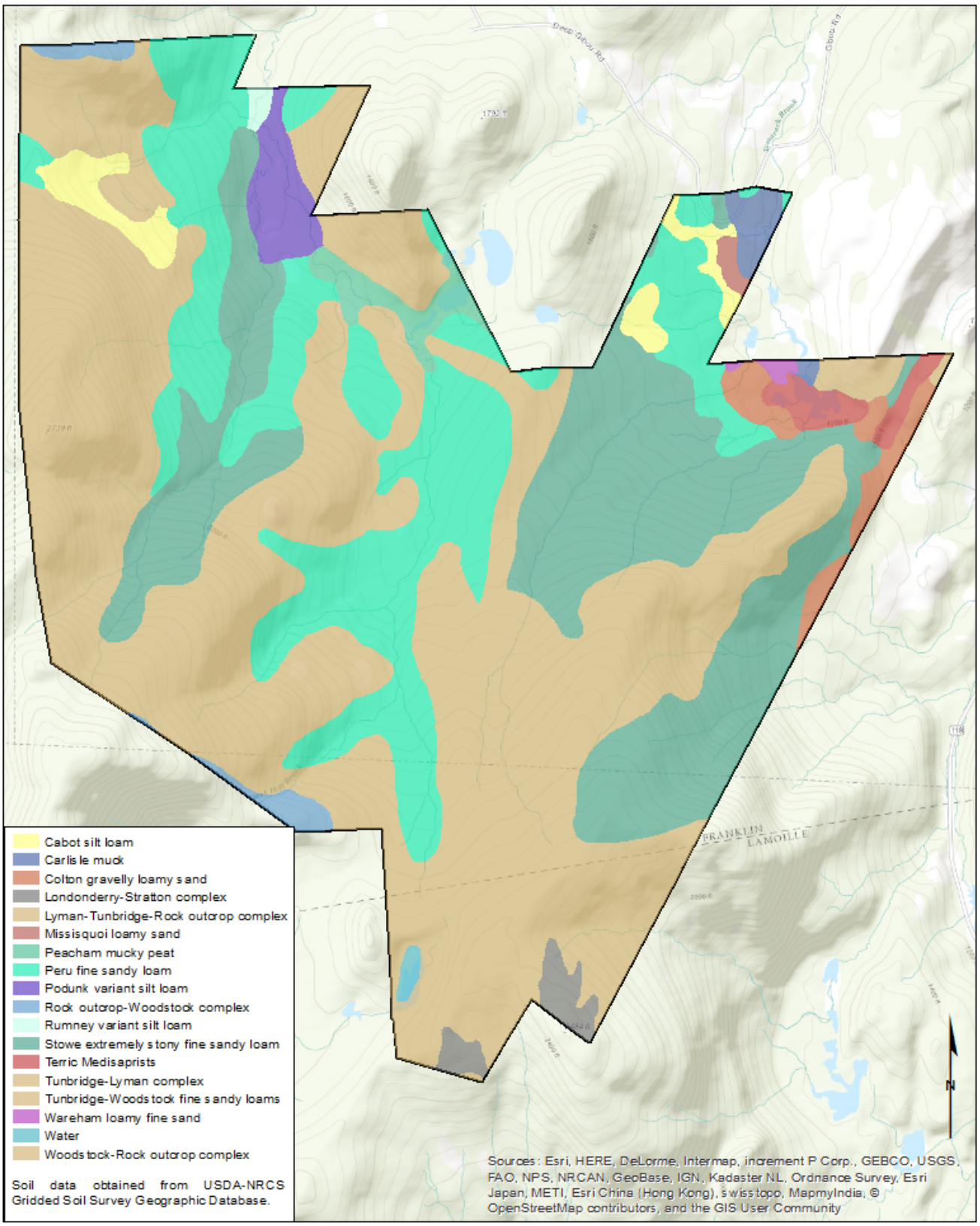


TABLE 8 NATURAL COMMUNITY RANKINGS AND SIGNIFICANT WILDLIFE HABITAT OF BURNT MOUNTAIN

Site ID	Natural Community	Acres	Rarity Rank	State Significant?	EO Rank	Description	Rank Size	Rank Condition	Rank Landscape Context	Comments	Recommended Additional Protection	ESTA Eligible?
G-1	Rich Northern Hardwood Forest	8.8	S4	N	C	Rich NHF with large maples, blue cohosh, Goldie's fern, Braun's holly fern, touch-me-not, Canada violet, maidenhair fern, talus blocks at toe of slope	C	B - Nearly mature forest; recover to full maturity is expected.	C - Adjacent landowner is actively harvesting; fate of this site in unclear	Continues onto adjacent property; majority is off-site. Adjacent landowner has been harvesting site.	Forest Management Plan, easement attributes	—
G-2	Temperate Acidic Outcrop	0.9	S4	Y	A	No plants abnormal to Temperate Acidic Outcrop. Topped with dense red spruce stand; lots of moose activity atop.	B	A	A	Mapped as serpentenite on bedrock geology map; outcrop confirmed, though no plants abnormal for Temperate Acidic Outcrop were observed.	Forest Management Plan, easement attributes	—
G-3	Temperate Acidic Outcrop	0.3	S4	Y	A	—	C	A	A	—	Forest Management Plan, easement attributes	—
G-4	Montane Spruce-Fir	77.9	S3	Y	B	Boundary mapped from aerial photo.	C	B - Heavy moose browse throughout; selected areas appear to have been harvested	B - Adjacent lands offer excellent connectivity; active management both to west and south.	—	EPZ	Y
G-5	Alder Swamp	12.6	S4	Y	B	Boundary mapped from aerial photo	C	B - Logging road passes through the middle; condition in flux due to beaver	B - Downstream logging activity may impact beaver activity in alder swamp	—	SWPZ + 50'buffer	—
G-6	Shallow Emergent Marsh	4.2	S4	Y	B	—	B	B - Some ATV ruts throughout	B - Upstream logging activity may impact beaver activity in alder swamp	—	SWPZ + 50' buffer	—
G-7	Beaver Wetland	20.2	—	—	—	—	—	—	—	—	SWPZ + 50'buffer	—

G-8	Shallow Emergent Marsh	18.6	S4	Y	A	—	A	A	A	Not entirely shallow emergent marsh; pocketed with sections of Alder Swamp and open water.	SWPZ + 50' buffer	—
G-9	Rich Northern Hardwood Forest	45.4	S4	Y	B	—	B	C - Significant disturbance by logging in some areas	A - Atlas lands adjacent and Avery's Gore WMA	This polygon drawn from HP field work summer 2016 combined with BE/ML field work fall 2015.	Forest Management Plan, easement attributes	—
G-10	Montane Yellow Birch-Red Spruce Forest	474.9	S3	Y	B	Balsam fir, hobblebush, red spruce, mountain wood fern, boreal bedstraw, yellow birch, mountain ash, mosses, striped maple, false hellebore	B	B - Disturbance by logging in some areas (selection harvest)	B - Extensive harvest on property to the south	Pockets of old growth interspersed; see EPZ layer.	EPZ	Y
G-11	Beaver Wetland	14.7	—	—	—	—	—	—	—	—	SWPZ + 50'buffer	—
G-12	Northern Hardwood Seepage Forest	31.1	S3	Y	A	Seepage, boreal bedstraw, false hellebore, cinnamon fern, bladder sedge	B	A	B- 2007 logging adjacent	—	SWPZ + 50'buffer	Y
G-13	Northern Hardwood Seepage Forest	39.3	S3	Y	B	Seepage glade: False hellebore, wood nettle, touch-me-not, northeastern mannagrass	B	C - Old logging road passes through the center; natural vegetation altered	B - Proximity of logging road may alter hydrology	—	SWPZ + 50'buffer	Y
G-14	Seep	5.1	S4	Y	A	Seepage meadow (akin to ones at Haystack-E). False hellebore, scabrous sedge, touch-me-not, yellow birch dominated. Vernal pool at top of seepage meadow. 150 square feet. 15ftx10ft.	A	A - This areas appears untouched by logging	A - This area appears untouched by logging	—	SWPZ + 50'buffer	Y
G-15	Seep	3.5	S4	Y	A	Montane seepage glade. False hellebore, yellow birch dominated, altered hydrology in seepage glade above - ATV trail; old logging road. Well established.	A	B- ATV road passes along the upper edge; pooling water has altered hydrology	B - ATV traffic is likely to continue	—	SWPZ + 50'buffer	Y
G-16	Beech Mast Stand	0.8	—	—	—	—	—	—	—	—	Forest Management Plan, easement attributes	—
G-17	Beech Mast Stand	3.2	—	—	—	—	—	—	—	—	Forest Management Plan, easement attributes	—

G-18	Old Forest	2.8	—	—	—	—	—	—	—	—	EPZ	Y
G-19	Old Forest	34.3	—	—	—	—	—	—	—	—	EPZ	Y
G-20	Seep	7.8	S4	Y	A	—	A	A	B - Reduced due to proximity of 2007 logging	Boreal bedstraw, northern white bog orchid.	SWPZ + 50'buffer	Y
G-21	Montane Seepage Forest	9.9	S3	Y	B	—	C	A	B - Reduced due to proximity of 2007 logging	MYBRSF Seepage Glade	SWPZ + 50'buffer	Y

Eden Square Field Report

ATLAS TIMBERLANDS ECOLOGICAL ASSESSMENT

PREPARED BY HANNAH PHILLIPS
UVM ECOLOGICAL PLANNING PROGRAM
SITE VISITS ON JULY 25, 26, 27, 28 2016

Vermont Land Trust

The Nature Conservancy

Eden Square Field Report

Prepared by Hannah Phillips, UVM Ecological Planning Program
Fieldwork conducted on 25, 26, 27, 28 July 2016

The Eden Square parcel contains the following significant ecological features, which are recommended for mention in the conservation easement:

1. At least four vernal pools, two of which are larger than 200 square feet, which may provide important amphibian breeding habitat.
2. Eleven state-significant natural community occurrences representing four natural community types, two of which are ranked as S3 or higher: Northern Hardwood Seepage Forest, and Seep.
3. Headwater wetlands, including Northern Hardwood Seepage Forests and Seeps, which provide flood resilience, water quality protection, and amphibian habitat.

LANDSCAPE CONTEXT

Eden Square is located in the northern Green Mountains biophysical region of Vermont, which is characterized by cooler summer temperatures and acidic metamorphic rocks (Thompson and Sorenson 2005). It lies on the eastern flanks of the Lowell Mountain ridgeline, which runs north-south from Lake Memphremagog down to the town of Eden. The parcel extends eastward down to the Wild Branch Tributary of the Lamoille River. Elevations on the parcel range from just below 1170 feet on the southeastern corner of the parcel, to nearly 2100 feet in the southwestern corner of the parcel, at the southern terminus of the Lowell Mountain ridge line. Multiple tributaries run through the property, all draining to the east into the Wild Branch. Square Road bisects the property and an inholding (Eden Dog Sledding Adventures) sits in the center of the property.

GEOLOGY

The Eden-Square lot is primarily located atop granofels of the Moretown Formation. The mountains on the western side of the property are comprised of phyllites, conglomerates, and granofels of the Cram Hill Formation, deposited as accretionary terrain when the Taconic Island Arc collided with proto-North America during the Taconic Orogeny (Ratcliffe et al. 2011).

SOILS

Soils differ significantly from the eastern half of the property to the west (*Figure 16*). In the western half of the property, soils of the Lyman-Tunbridge rock outcrop complex and the Tunbridge-Lyman complex span the ridgeline, with the highest points classified as Londonderry-Stratton complex. These soil series make up the majority of the property (71%, *Table 9*, *Figure 16*). Silty loams of the Marlow, Peru, and Cabot soil series form noticeable inclusions within the property, alongside the stream flowing south from Bigelow Basin and east of Square Road in the southern half of the property (23%). Small inclusions of wetland (Peacham) or fluvial soils (Udifluvents) are scattered elsewhere throughout the property, comprising less than 1% of the soil on site. Of these soils, the only soils classified as hydric are Cabot silt loam and Peacham mucky peat, which together cover 2% of the soil on the property.

TABLE 9 SOILS OF EDEN SQUARE

Soil Series	*Acres*	*Percent*
Berkshire	4.2	0.3%
Cabot	30.2	1.9%
Colton-Duxbury	0.0	0.0%
Londonderry-Stratton	85.7	5.4%
Lyman-Tunbridge-Rock	525.1	32.9%
Marlow	195.6	12.3%
Peacham	2.3	0.1%
Peru	141.5	8.9%
Stratton-Londonderry	3.6	0.2%
Tunbridge-Lyman	607.7	38.1%
Tunbridge-Peru	0.0	0.0%
Udifluvents	0.3	0.0%
	1596.1	

HUMAN INFLUENCE

Historical aerial imagery from the 1940s reveals agricultural land use in some areas of the property that are no longer cleared. In particular, the forests on both sides of Square Road in the southern half of the property were cleared for agriculture, and an old agricultural field was positioned in the southern half of the central square of the property.

At present, evidence of land use is abundant throughout Eden Square lot. Most obvious are the impacts of harvest in 2001 (central), 2004 (northeast), and 2013 (Bigelow Basin). Additionally, a road passes through the northeastern corner of the property to access the mountain peak above Bigelow Basin. This road appears well-traveled, and numerous ATVs were passing by on the road as I was doing field work in the adjacent forest. In the rectangular portion of the plot in the southeast, a hunting stand in a tree reveals visitation. Additionally, further east in this rectangle, a ~15-acre timber trespass crosses into the Atlas lands (David McMath was already aware). Closer to Square Road, periwinkle blankets the ground adjacent to an old homestead, crowding out all native vegetation.

FEATURES OF ECOLOGICAL SIGNIFICANCE

UPLANDS:

Upland communities on the Eden Square lot are heavily influenced by topography. Forest communities west of Square Road on the east-facing slopes of the Lowell Range are primarily Northern Hardwood Forest, while the concave toe slope at the base of the mountains are wetter in character (*Table 10*, *Figure 14*). East of Square Road, Northern Hardwood Seepage Forest spans the mild slopes descending to Collinsville Road. The seepage swamps west of Square Road may be hydrologically connected to this Seepage Forest, but the road has likely disrupted hydrologic processes upslope, forcing water accumulation. The Bigelow Basin bowl in the northwest corner of the property includes an extensive Rich Northern Hardwood Forest, which grades into a Rich Northern Hardwood Seepage Forest at the base of the slope.

RICH NORTHERN HARDWOOD FOREST (S4)

Multiple pockets of Rich Northern Hardwood Forest sit on the east-facing slopes of the Lowell Mountain ridgeline, and on the west-facing slopes in the Bigelow Basin bowl in the northern portion of the property. Two exceptional examples are located in the northern portion of the property (ES-5, ES-6). Engstrom and Lapin (2015) explored Bigelow Basin north of the Atlas lands in search of enrichment and found little; the majority of the rich Northern Hardwood Forest in Bigelow Basin is within Atlas bounds.

ES-5 (24 acres, state-significant, A rank)

Steep east-facing slopes on the western side of the Bigelow Basin bowl show impressive enrichment. Nutrient-enriched wet soils host enrichment indicator plants including wood nettle, pale touch-me-not, silvery glade fern, Northeastern mannagrass, lady fern, foamflower, Goldie's fern, blue cohosh, wild millet, maidenhair fern, wild leeks, plantain-leaved sedge, and zig-zag goldenrod. The canopy is dominated by sugar maple and yellow birch. Enrichment continues up to the ridgeline at approximately 1350 feet in elevation. Small terraces on the steep slope seem to accumulate more water from downslope drainage, and tip-ups are common, forming canopy gaps in which herbaceous vegetation is dense, and sugar maple and yellow birch are regenerating. At the base of the slope, water saturates the soil as the slope lessens, giving rise to seepage forest conditions. This saturation eventually coalesces into a stream channel that joins the Bigelow Basin stream. For more detail on ES-5, see Lapin and Engstrom's report (2016).

ES-6 (5.3 acres, state-significant, B rank)

On the eastern face of the Lowell Mountain ridgeline, a cove of Rich Northern Hardwood Forest stands out from the matrix forest. Sugar maple and yellow birch are dominant. Enrichment indicator plants include maidenhair fern, blue cohosh, wood nettle, doll's eyes, and Braun's holly fern. Intermittent seeps throughout contribute to the enrichment, and contain wood nettle, golden saxifrage, foamflower, and touch-me-not. A stream nearby registered an electroconductivity reading of

63 mS. An old logging road passes through the center of the community and appears, eventually, to cross the ridge toward Eden town. The enrichment continues in isolated pockets downslope of the mapped boundary of this natural community. Further downslope, I noted the aforementioned plants, along with silvery glade fern, wild ginger, and plantain-leaved sedge. Also downslope I noted a small seep/vernal pool (50 square feet), which was still wet at the time of my visit.

ES-8 (1.3 acres, not state-significant, C rank)

A small, enriched patch of Northern Hardwood Forest extends down the east-facing slopes of the Lowell Mountain ridgeline in the southwestern portion of the property. Enrichment on the site is likely derived from the seep just upslope. Enrichment indicators within the forest included wild leeks, blue cohosh, doll's eyes, wood nettle, zig-zag goldenrod, and Braun's holly fern. Pockets of enrichment much like this one are likely scattered throughout the east-facing slopes, deriving some enrichment from the bedrock beneath and the scattered, small seeps.

ES-16 (5.5 acres, state-significant, A rank)

A beautiful Rich Northern Hardwood Forest sits in a cove on the west-facing slopes of Bigelow Basin, just east of the road. A series of small outcrops form a colluvial basin, within which tall, straight sugar maples claim canopy dominance. The maples appear to be of a similar age and diameter. The ground is moist and densely blanketed with enrichment indicators including wood nettle, blue cohosh, zig-zag goldenrod, silvery glade fern, plantain-leaved sedge, maidenhair fern, sweet cicely, and Braun's holly fern. This area has not been harvested since coming under ATP ownership, and is an excellent example of this natural community type. A stream flows through the center of this natural community.

WETLANDS:

Wetlands on the Eden Square parcel are also heavily influenced by topography. The mild slopes that begin at the base of the Lowell Mountains support Hemlock-Balsam Fir-Black Ash Seepage Swamps and Northern Hardwood Seepage Forests. Forest management has altered the character of some of the wetlands on the Eden Square lot. The lasting impact of these harvests is not yet clear, although portions of the Seepage Forest east of Square Road bear an abundance of wetland herbaceous plants. This may be early indicators of natural community conversion (see seepage forest management considerations in *Appendix J: Northern Hardwood Seepage Forest Natural Community Description*).

NORTHERN HARDWOOD FOREST SEEPAGE FORESTS (S3)

Numerous large seepage forests are scattered throughout the eastern portion of the Eden Square lot. Past harvest makes it difficult to determine how past land use has influenced the present day species composition as well as the successional phase. Furthermore, deterrents to present day regeneration, like heavy browse and the crowding of dense wetland vegetation, make it difficult to deduce what species would naturally regenerate without the aforementioned suppressing factors.

ES-1 (16 acres, state-significant, B rank)

Scattered seepage forests throughout the northeastern corner of the parcel punctuate the landscape in areas of excessive wetness and areas of more mild seepage. The seepage inclusions present as long swales of standing water or saturated soils, and seepage indicator plants like cinnamon fern, touch-me-not, dwarf raspberry, foamflower, and sensitive fern. Trees in these runs include black ash, sugar maple, yellow birch, and white ash. The eastern half of this corner of the property was last harvested around 2003 (McMath 2007), and the current species composition is primarily hardwoods, including sugar maple, white ash, American beech, and yellow birch. By contrast, the western half of the property was last harvested around 1992, and contains a more dominant hemlock component surrounding the seepage swales.

Due to the diffuse arrangement of this EO and the uncertain role of harvest in contributing to the presentation of this community, mention of this community in the forest management plan may allow protection of the wet zones, while allowing passage through the surrounding dry forest. Any harvests in this area should be laid out in the summer months to

accurately identify the distribution of wet soils, and harvest should occur in winter months under frozen ground conditions to minimize impact to the soils and hydrology of the site.

ES-3 (16 acres, state-significant, B rank)

ES-3 presents itself as a seepage forest throughout, though a complicated harvest history makes it difficult to deduce the successional age of this forest. Muck soils perched on top of an impenetrable till layer kept water aloft, and small stream channels migrating over the surface of the till reveal the regular soil saturation of this site. Common seepage indicator plants, including northeastern mannagrass, cinnamon fern, touch-me-not, and dwarf raspberry blanket the ground, while white ash, yellow birch, black ash, and sugar maple dominate the canopy. Notes in the forest management plan reveal that a portion of this parcel was salvage harvested in 2001 to recover tip-ups from Hurricane Floyd, which turned up a number of trees in 1999 (McMath 2007). Some areas remain more open than others, and stocking appears variable throughout the stand. Recent harvest on the northern edge of ES-3 offers yet another opportunity to study the impacts of timber harvest on seepage forest communities. Of particular note are the abundant seeps (five) located just upslope of this natural community at the inflection point in the slope. These are represented as points on the map.

ES-4 (6.7 acres, state-significant, B rank)

The water that creates seepage conditions in ES-4 originates in ES-5, the Rich Northern Hardwood Forest located just upslope. As the slope reaches an inflection point and forms a plateau, water saturates the soil, eventually coalescing into a stream channel that joins the Bigelow Basin stream. Plants within this community include silvery glade fern, touch-me-not, northeastern mannagrass, lady fern, foam flower, wood nettle, Goldie's fern (S3), blue cohosh, wild millet (S3), maidenhair fern, wild leeks, plantain-leaved sedge, and zig-zag goldenrod. The overstory is dominated by sugar maple and yellow birch. For more detail on ES-4 and ES-5, see Lapin and Engstrom's report (2016).

ES-10 (125 acres, state-significant, A rank)

The natural community east of Square Road in Eden has been heavily impacted by past land use and logging activity. While some areas are still in forest, other areas appear to have been harvested with limited regeneration success due to heavy browse and a conversion to dense facultative and obligate wetland species, including dwarf raspberry, joe-pye weed, purple-stemmed American aster, nodding sedge, wool grass, and scabrous sedge. Despite these dramatic differences in successional phase and presentation, the soils throughout this area are similar, and seepage indicator plants appear throughout.

Soils within the seepage forests are approximately eight inches of muck with a pH of 6.5, below which three inches of A-layer classified as fine sandy loam appears mottled and reddish with a pH of 6.5-7.0. The A-layer appears to hold water occasionally, as indicated by the mottling and oxidation within the matrix. The B-layer continues to an indeterminate depth, and is best described as a dense, silt grey till with a pH of 7.0. It is less mottled than the above A-layer, indicating it does not experience the same fluctuations in water saturation.

At the upslope edge of the seepage forest, trees are of smaller diameters and are establishing primarily on top of hummocks. A dense bryophyte layer covers the ground, and the hollows contain seepage indicator plants including golden saxifrage, touch-me-not, and northeastern mannagrass. Tree species include balsam fir, yellow birch, and black ash. Canada mayflower, oak fern, wild oats, silvery glade fern, and starflower all grow on the hummocks.

In the central portion of ES-10, the natural community more closely resembles a Hemlock-Balsam Fir-Black Ash Seepage Swamp. Herbaceous plants like sensitive fern, scabrous sedge, northeastern mannagrass, water avens, and touch-me-not, along with red maple, yellow birch, and balsam fir regeneration, suggest wetter soils and an accumulation of water from upslope. In some areas, cinnamon fern and red spruce are more abundant.

The easternmost portion of ES-10 is in excellent condition. This area appears less disturbed by logging, and has an open-canopy woodland feel dominated by black ash, sugar maple, yellow birch, and basswood. Northeastern mannagrass is a

primary component of the understory, along with sensitive fern and touch-me-not. In one area, enough water has coalesced to form a small vernal pool (50 square feet), which did not contain water during my visit, but showed depressed, wet leaves. At the time of my visit, the herbaceous vegetation was just starting to establish in the vernal pool. This pool would need to be revisited in the spring to determine if it hosts breeding amphibians.

Large portions of the seepage forest continue onto private property to the south. Inappropriate land use to the south of the Atlas parcel could have an undesirable effect on the natural community in its entirety. Heavy clearing or rutting could force the seepage to channelize, diverting the lateral flow from within the soil matrix into stream channels.

While walking through this part of the property I heard what I believe were two bear cubs calling to their mother, who responded from off the property to the south. After their call and response, I then heard the cubs crashing through the brush toward their mother's call. Although I did not see the bears, I am fairly confident in my identification. This was my second bear encounter in a seepage forest, attesting to the wildlife value of the wet forests.

HEMLOCK-BALSAM FIR-BLACK ASH SEEPAGE SWAMP (S4)

ES-7 (1 acre, not state-significant, C rank)

A 1-acre high-elevation Hemlock-Balsam Fir-Black Ash Seepage Swamp stands in a saddle near the southern end of the Lowell Mountain Range along the western edge of the Eden Square tract. Here, wild millet (S3), northeastern mannagrass, touch-me-not, scabrous sedge, and golden saxifrage all grow in the wetland matrix. At the time of the visit, there was standing water in the site, making this site potentially desirable as amphibian breeding habitat. This seems like a likely spot in which to find boreal bedstraw, although none was observed during the field visit.

ES-14 (3 acres, state-significant, A-rank if including off-property portion of swamp)

A small Hemlock-Balsam Fir-Black Ash Seepage Swamp extends west from a well-established logging road in the center of the property. Standing water is present throughout the swamp, along with vegetation like nodding sedge, turtlehead, joe-pye weed, and boneset. Large balsam fir and red spruce are present throughout the swamp; hemlock is absent. Black ash and red maple are scattered throughout the swamp as well. Tip-ups are present, and game trails are visible passing through the swamp on the bryophyte-covered hummocks.

ES-15 (18 acres, state-significant, A rank)

ES-15 is a Hemlock-Balsam Fir-Black Ash Seepage Swamp (Red Spruce variant) that appears to have formed in the depression created by the construction of Square Road. The topography of the site is gently sloping, suggesting that this swamp was likely previously connected to ES-10, and may have presented itself as a seepage forest. Altered hydrology has likely led to pooling and community conversion. Plants within the swamp include sensitive fern, northeastern mannagrass, white turtlehead, joe-pye weed, nodding sedge, purple-fringed bog orchid, cinnamon fern, touch-me-not, royal fern, *Persicaria* sp., and water avens. The canopy is relatively open, with small islands of balsam fir, red spruce, and yellow birch. The openness may be a function of past harvest. A small stand of *Phragmites* has established in the center of the swamp adjacent to an old logging road.

There is standing water at the fringes of the swamp, and a small stream runs through the center. Electroconductivity in the middle of the swamp (in a puddle adjacent to the stream) was 67 mS, and was also 67 mS at the outlet stream. The swamp continues to the north off of Atlas land, and eventually reenters Atlas land. The northern portion of the swamp is bisected by a well-established logging road. This area appears to have been harvested recently.

ES-17 (1.53 acres, not state-significant, C rank)

Another small seepage swale descends down to Albany Road in the northeastern corner of the parcel, and features wet, organic soils to four inches, with black ash, balsam fir, American beech, and speckled alder in the overstory and shrub

layers. The herbaceous layer contains scabrous sedge, New York fern, touch-me-not, foamflower, purple-stemmed American aster, sensitive fern, and water avens. Trees are of small diameter, and there are many tip-ups. This swamp was abnormal in that I generally did not see wetland obligate vegetation on a slope as I did in this community.

RED-SPRUCE CINNAMON FERN SWAMP (S3)

ES-12 (0.4 acres, does not meet minimum size requirements)

A small Red Spruce-Cinnamon Fern Swamp sits in a minor plateau in the central portion of Eden Square, which has characteristics of both a Red Spruce-Cinnamon Fern Swamp and a Hemlock-Balsam Fir-Black Ash Seepage Swamp. A dense bryophyte mat occasionally gives way to pockets of herbaceous vegetation which include sensitive fern, wool grass, cinnamon fern, with red spruce and yellow birch in the canopy. Deep skidder tracks traversed the side of the swamp and now hold standing water. The area surrounding the swamp has been harvested recently.

SEEPS (S4)

ES-13 (3.3 acres, state-significant, A rank)

A small seep is perched on a north-facing slope south of Albany Road in Eden. Electroconductivity in the seep was measured at 45 mS. Nodding sedge, touch-me-not, foamflower, and sensitive fern were all present in the understory. Although water emerges from the hillside here as a seep (diffuse emergence, rather than a point source), it gathers into a stream in relatively short order as the slope steepens.

ES-18 (0.5 acres, state-significant, B rank)

A small seepage run descends from the saddle between the two southernmost mountains in the Lowell Mountain Range, to the east. At the time of my visit, it contained standing water. Black ash, yellow birch, and sugar maple all grow intermittently throughout. Eventually, a right-hand turn in the topography forced the seep to a close. What seepage escapes further downslope seems to contribute to the Rich Northern Hardwood Forest (ES-8). This area appears to have avoided nearby harvest since ATP acquired the Atlas lands.

VERNAL POOLS (S3)

ES-VP-1 (1392 square feet)

A massive vernal pool sits at the base of a rock ledge, and runs in a north-south direction (*Appendix G;* see POIs_EdenSquare_Phillips2017 data layer for coordinates). The shape and location suggests it originated as a road, though evidence of the road to the north and south of the pool was difficult to find. It is surrounded by a beech-dominated Northern Hardwood Forest, and canopy coverage over the vernal pool is excellent. Though it was dry at the time of my visit, matted leaves and a dense bryophyte layer on the woody debris suggested regular saturation. Coarse woody debris was present throughout the vernal pool. No amphibians were observed in the vicinity, and this pool would need to be revisited in the spring to determine whether it is used as breeding habitat. This information will help determine the state significance of the vernal pool.

ES-VP-4 (300 square feet)

A vernal pool is located in the saddle of the southern two peaks in the Lowell Range, located in the southwest of the Eden Square property, adjacent to a smaller 100 square feet vernal pool (ES-VP-3; *Appendix G*). The two vernal pools were separated by a patch of wetland vegetation, though it seems probable that the water is shared between the two pools. Considered together, these pools may qualify as a C-ranked size occurrence. They will, however, need to be visited in the early spring to determine whether they act as a single vernal pool, and to assess for the presence of breeding amphibians.

WILDLIFE FEATURES:

Seeps/Vernal Pools

Multiple seeps on the property appear to hold enough water to function as vernal pools in the early spring months. Although they had grown sporadic wetland vegetation throughout the extent of the pool at the time of my visit, the bedded, wet leaves gave the appearance of a late season vernal pool.

Seepage Forests and Seepage Swamps

The Northern Hardwood Seepage Forests and seepage swamps on site provide early spring forage for large animals, including bear and moose. Additionally, the landscape heterogeneity (offering both horizontal and vertical complexity) within seepage forests provide a variety of habitats in which to forage, hide, and sleep. The same characteristics that make these communities desirable habitats may also fuel their use as connectivity corridors across an elevational gradient, connecting streams and wetlands with higher elevation uplands that offer alternative habitat throughout the changing seasons. Furthermore, the small pockets of water within the seepage forests likely provide suitable amphibian habitat, although little research has been done to document the ways that amphibians use these wet forests.

Outcrop (ES-9)

A series of small ledges cascade down the east-facing slopes of the Lowell Mountain ridgeline in the western portion of the property. One in particular, ES-9, is larger than the rest. Diffuse richness is present throughout the forest above and below the cliff, and a small seep gathers in the shadows of the cliff on the downslope side. This seep converges into a small intermittent stream, which was not flowing at the time of my visit.

The outcrop may provide a secluded denning site for porcupines or bobcat. Though sign of these animals was not observed during my field work, there were structural elements of the outcrop that appeared suitable for den site creation, including overhanging rocks and small shelfs on which to den. Although the area immediately surrounding the outcrop was not disturbed in the most recent harvest, the 2013 harvest came within 1/10th of a mile of the outcrop, which may have disturbed wildlife activity in the area. Ultimately, the early successional vegetation now proximate to the outcrop may provide a desirable site for bobcat to forage for small rodents.

STEWARDSHIP CONSIDERATIONS

Bigelow Basin Road

ATVs were regularly traveling along Bigelow Basin Road during my visit to the site to access the cleared lot at the summit north of the Atlas property. Although there are few signs of impact on the land beyond the road within Atlas boundaries, the frequency of visitation could potentially give rise to management issues in the future. Additionally, because the Bigelow Basin parcel north of Atlas is available for sale, this road (right-of-way) may become a more prominent topic of conversation. I also observed a flag hanging from a tree beside the road that read “Wetland Delineator, 5-204 Open.”

Invasive Plants

A large patch of *Vinca* (periwinkle; POI 73) has colonized the ground at an old homestead site adjacent to Square Road. It continues to spread, and limits the establishments of other herbaceous plants or trees in the understory. *Phragmites* is established alongside old logging roads in the seepage forest and seepage swamp to the west and east of Square Road (ES-10, ES-15). Without intervention, it may continue to spread.

Timber Trespass

A timber trespass in the southeast corner of the property has come onto the Atlas lands as far as the stream that flows into the beaver meadow. Dave McMath was already aware of this encroachment.

Hunting

A hunting stand is located in the seepage forest (ES-10) east of Square Road.

RECOMMENDED EASEMENT PROTECTIONS

The protection recommendations made in this report are based on ecological considerations. The final easement configuration may differ from the recommended protections because of practical considerations not explored in this report. Final protections are the decision of the Vermont Land Trust and The Nature Conservancy.

Surface Water Protection Zone + 50-foot Buffer

- *Beaver Ponds (ES-11)* – Protection of this wetland ensures that the pond will continue to provide valuable wildlife habitat. Given that beavers may eventually abandon this pond, the protection boundary may eventually need to be altered to reflect the extent of the community. Additionally, in the absence of beavers, the natural community concealed by beaver activity may become apparent with time.

- *Hemlock-Balsam Fir-Black Ash Seepage Swamp (ES-2, ES-7, ES-12, ES-14, ES-15, ES-17)* – The Hemlock-Balsam Fir-Black Ash Seepage Swamps provide valuable wildlife habitat and downstream water quality. Restricting activity within these wetlands will protect the hydrologic processes that give rise to these natural communities.

- *Northern Hardwood Seepage Forest (ES-1, ES-3, ES-10)* – The Seepage Forest on the Eden Square parcel is one of the largest examples of this natural community type on the Atlas lands. This state-significant uncommon natural community (S3) may be sensitive to hydrologic alteration by forest management due to the shallow, wet soils and its position on a gradual slope. As a headwater wetland, this community likely provides water quality protection and downstream flood resilience. The impacts of hydrologic alteration on these communities is not yet well understood, although changes in water table depth by inadvertent draining or ponding may have a lasting impact on the resulting plant communities (please see *Appendix J* for forest management recommendations in Seepage Forests). Protections on this forest should include a 50-foot buffer to ensure that inputs to these Seepage Forests are not disturbed by management activities.

- *Rich Northern Hardwood Seepage Forest (ES-4)* – The Rich Northern Hardwood Seepage Forest in the Bigelow Basin drainage is a unique natural community seen only in two other locations on the Atlas Timberlands (*Appendix D*). This occurrence, in particular, serves as a headwater wetland to a tributary of the Wild Branch. Soils in this forest are unconsolidated, wet, and may be prone to disruption by logging equipment. The long-term impacts of disruption are not immediately clear; possible outcomes include the channelization of water from diffuse sources into a single channel.

- *Seep (ES-13, ES-18)* – The seeps on Eden Square may serve as important amphibian breeding habitat, and also produce early spring vegetation desirable to large mammals like moose and black bear. Given their small size, disruption by logging could mean a complete loss of these ecological services.

Forest Management Plan and Easement Attributes Language

- *Rich Northern Hardwood Forest (ES-5, ES-6, ES-16)* – The Rich Northern Hardwood Forests on Eden Square, especially ES-5 and ES-16, are exceptional examples of this forest type. A dense herbaceous understory and well-developed canopy class show a forest well on its way to maturity. Additionally, the physical processes that sustain these forests are largely unaltered. Management activities should strive to maintain the processes that give rise to this natural community.

- *Temperate Circumneutral Outcrop (ES-9)* - Outcrops on Deep Gibou provide potential denning sites for animals like porcupine and bobcat. Owners should survey this outcrop prior to undertaking management actions in close proximity to avoid disrupting wildlife.

Vernal Pool Special Treatment Area

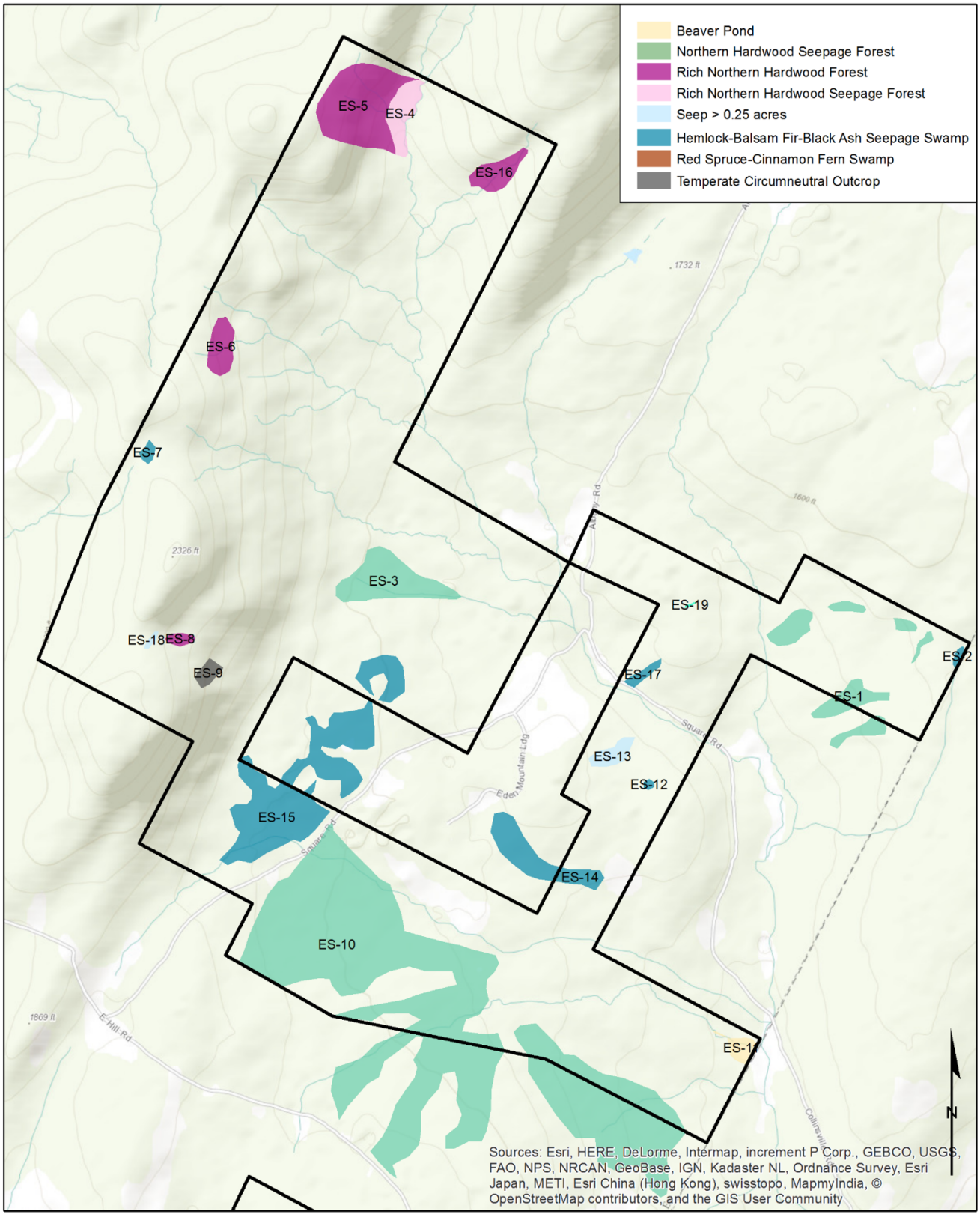
- *Vernal Pools (ES-VP-1, ES-VP-4)* – If a spring survey reveals that these vernal pools are used as amphibian breeding grounds, they should be protected under the Vernal Pool Special Treatment Area clause, with 100-foot primary and 500-foot secondary buffer zones. These restrictions will ensure the maintenance of natural features necessary to preserve desirable habitat (ex. canopy cover, shade, downed woody debris, etc.).

ACCOMPANYING FILES

Eden Square Geodatabase

- *IntermittentStreams_EdenSquare_Phillips2017:* Line file containing previously unmapped intermittent streams. This layer should be viewed with the National Hydrography Dataset stream layer.
- *NatComms_EdenSquare_Phillips2017*: Polygon feature of state-significant natural communities, significant wildlife habitat, and other ecologically significant areas (including old forest). This file contains Natural Heritage Rankings and easement protection recommendations in accordance with VLTs easement provisions. Overlay POIs for more detail about field observations.
- *POIS_EdenSquare_Phillips2017*: Point features containing field notes, which include species observations, rare/uncommon plant element occurrence data, land use alteration notes, and other general field observations.
- *Tracks_EdenSquare_Phillips2017:* Line features showing path taken on field day

FIGURE 14 ECOLOGICALLY SIGNIFICANT FEATURES OF EDEN SQUARE

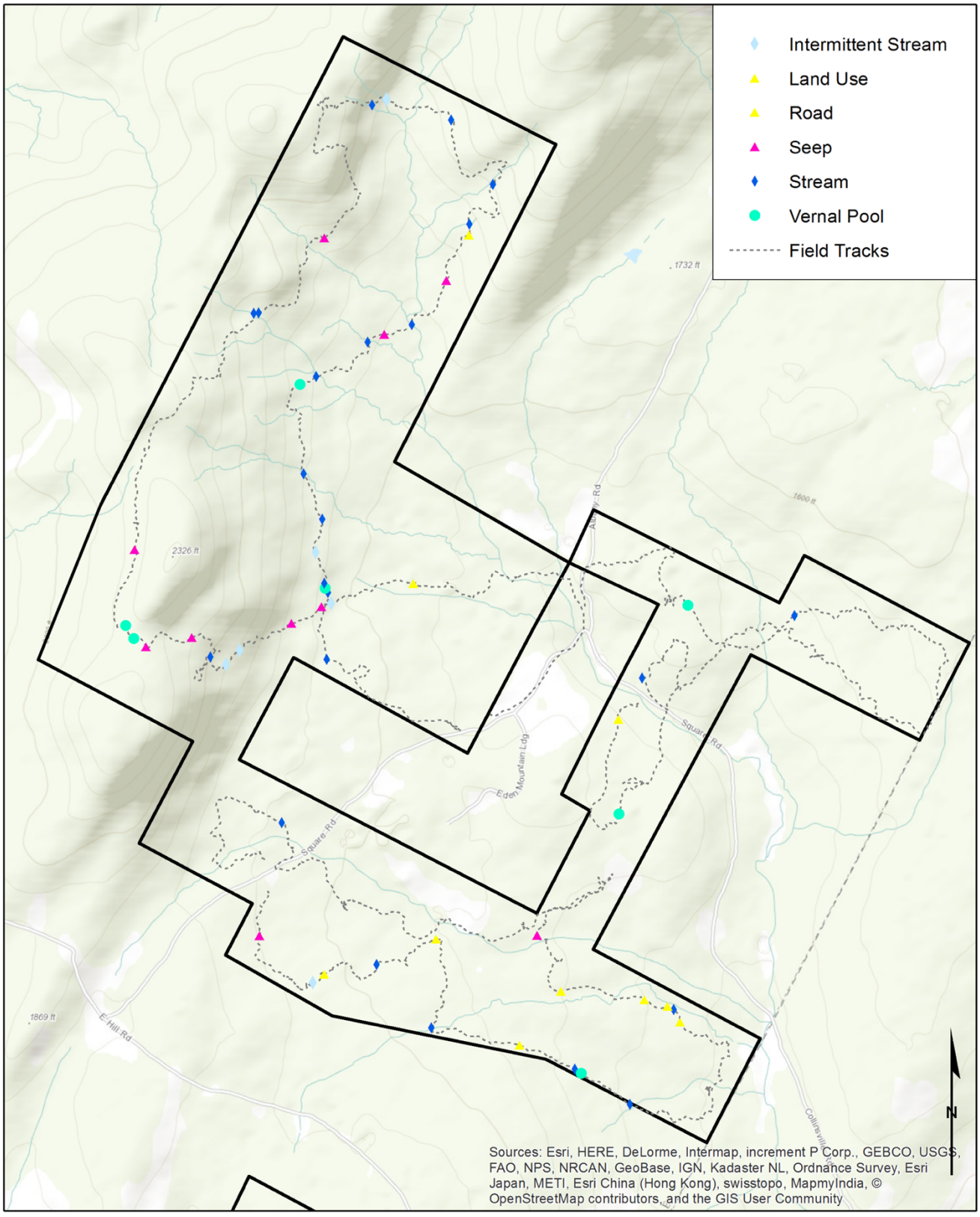


Map created by Hannah Phillips
UVM Ecological Planning Program
Field work conducted in July 2016

Atlas Timberlands Partnership
Eden Square Resource Map

0 0.15 0.3 0.6 Miles

FIGURE 15 POINTS OF INTEREST ON EDEN SQUARE

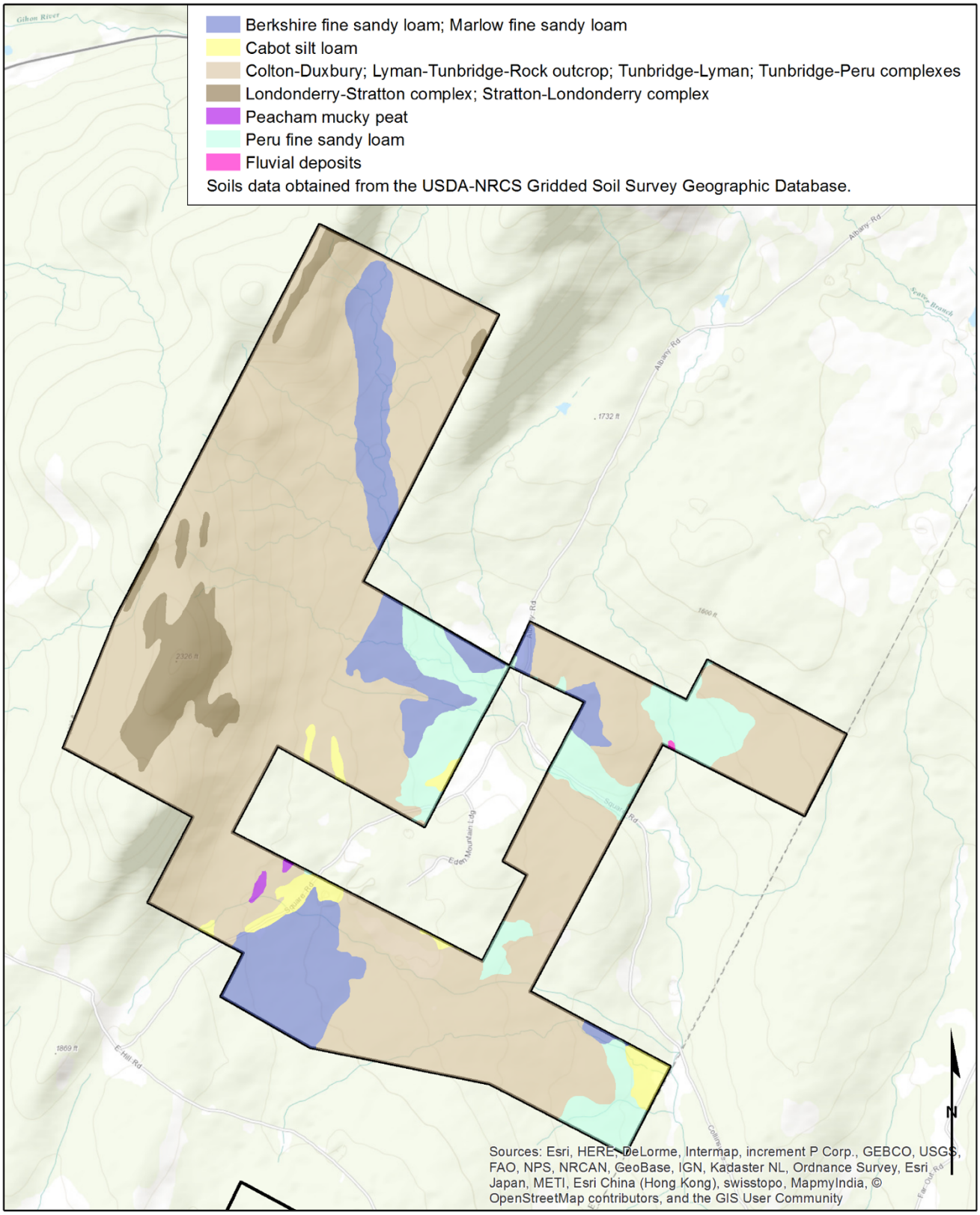


Map created by Hannah Phillips
UVM Ecological Planning Program
Field work conducted in July 2016

Atlas Timberlands Partnership
Eden Square Points of Interest

0 0.15 0.3 0.6 Miles

FIGURE 16 SOIL MAP OF EDEN SQUARE



Map created by Hannah Phillips
UVM Ecological Planning Program
Field work conducted in July 2016

Atlas Timberlands Partnership
Eden-Square Soils Map

0 0.175 0.35 0.7 Miles

TABLE 10 NATURAL COMMUNITY RANKINGS AND SIGNIFICANT WILDLIFE HABITAT OF EDEN SQUARE

Site ID	Type	Acres	Rarity Rank	State-significant?	EO Rank	Description	Rank Size	Rank Condition	Rank Landscape Context	Comments	Recommended Protection	ESTA Eligible?
ES-1	Northern Hardwood Seepage Forest	16.3	S3	Y	B	—	C	B - Portions were cut in 2004.	B - Wild Branch WMA to the N; private harvest to S	—	SWPZ+50' buffer	Y
ES-2	Hemlock-Balsam Fir-Black Ash Seepage Swamp	0.5	S4	N	C	—	D	A/B - Boundary location means likely was not cut	B - Conserved land to north; private land to S	—	SWPZ+50' buffer	Y
ES-3	Northern Hardwood Seepage Forest	16.1	S3	Y	B	Black ash	C	B - Young forest; may have been cut in 2001.	B - Within ecologically-managed timberlands.	—	SWPZ+50' buffer	Y
ES-4	Rich Northern Hardwood Seepage Forest	6.7	S3	Y	B	—	C	A/B - This area not harvested since acquisition.	A/B - Within conserved basin (Atlas) and to north.	—	SWPZ+50' buffer	Y
ES-5	Rich Northern Hardwood Forest	24.0	S4	Y	B	Silvery glade fern, touch-me-not, northeastern mannagrass, lady fern, yellow birch, sugar maple, foamflower, wood nettle, Goldie's fern, blue cohosh, wild millet, maidenhair, wild leeks, plantain-leaved sedge, zig-zag goldenrod	C	A/B - This area not cut since ATP acquired.	A	—	Forest Management Plan, easement attributes	—
ES-6	Rich Northern Hardwood Forest	5.3	S4	Y	B	Maidenhair fern, blue cohosh, wood nettle, doll's eyes, Braun's holly fern, intermittent seeps throughout, richness is diffuse.	C	B - Logging road passes through here.	B - Within ecologically-managed timberland.	—	Forest Management Plan, easement attributes	—
ES-7	Hemlock-Balsam Fir-Black Ash Seepage Swamp	1.0	S4	N	C	Northeastern mannagrass, wild millet, touch-me-not, scabrous sedge, golden saxifrage. Physical: standing water, high-elevation seepage swamp.	D	A/B - This area not harvested since ATP acquired.	B - Within ecologically-managed timberland.	—	SWPZ+50' buffer	Y
ES-8	Rich Northern Hardwood Forest	1.3	S4	N	C	Wild leeks, blue cohosh, doll's eyes, wood nettle, zigzag goldenrod, Braun's holly fern.	D	B	B	—	—	—

ES-9	Temperate Circumneutral Outcrop	2.0	S4	Y	B	—	C	B - This area not cut since ATP acquired.	B - Within ecologically-managed timberland	—	Forest Management Plan, easement attributes	—
ES-10	Northern Hardwood Seepage Forest	124.6	S3	Y	A	Black ash, yellow birch, wool grass, golden saxifrage, touch-me-not, bryophytes, balsam fir, northeastern mannagrass, dwarf raspberry, foamflower, scabrous sedge, sensitive fern, red maple. *Phragmites*, cattails. Rich downslope: basswood, sugar maple.	A	B - logging in the surrounding forests; Phragmites	B - Surrounded by managed forest land.	Electroconductivity: 50 mS; Land Use History in here?	SWPZ+50' buffer	Y
ES-11	Beaver Pond	2.5	-	N	-	—	-	-	-	—	SWPZ+50' buffer	—
ES-12	Hemlock-Balsam Fir-Black Ash Seepage Swamp	0.4	S3	N	-	Location within small topographic basin makes this present more as a swamp than a seep. But, location in headwater zone protects the ecological functions of this community type.	-	-	-	Does not meet minimum size requirements of EO	SWPZ+50' buffer	Y
ES-13	Seep	3.3	S3	Y	A	—	A	B	B	—	SWPZ+50' buffer	Y
ES-14	Hemlock-Balsam Fir-Black Ash Seepage Swamp	3.1	S4	Y	B	—	C	B	B	—	SWPZ+50' buffer	Y
ES-15	Hemlock-Balsam Fir-Black Ash Seepage Swamp	30.5	S4	Y	A	Sensitive fern, northeastern mannagrass, purple-fringed bog orchid, cinnamon fern, touch-me-not, royal fern, *Persicaria* sp., water avens, white turtlehead, sensitive fern, joe-pye weed, nodding sedge, *Phragmites*, standing water throughout.	A	B - Road cuts through Northern polygon.	B - Proximal to road. Downslope of harvest.	Land use history of this site is not clear; cannot tell how recently (if at all) this was harvested. Electroconductivity: EC 67 mS in middle; 67 mS at outlet stream.	SWPZ+50' buffer	Y
ES-16	Rich Northern Hardwood Forest	5.5	S4	Y	B	Cove: zig-zag goldenrod, doll's eyes, wood nettle, blue cohosh, silvery glade fern, plantain-leaved sedge, maidenhair fern, sweet cicely, and Braun's holly fern.	C	B - Has not been cut for 25+ years.	B - Within ecologically-managed timberlands	—	Forest Management Plan, easement attributes	—
ES-17	Hemlock-Balsam Fir-Black Ash Seepage Swamp	1.5	S4	N	C	Red Spruce variant	D	B - Old growth conditions; tip-ups; varied ages	B - Road cuts it off at the base.	—	SWPZ+50' buffer)	Y

ES-18	Seep	0.5	S4	Y	B	Black ash, yellow birch, sugar maple, squishy with standing water.	C	B - Has not been cut for 25+ years	B - Within ecologically-managed timberlands	—	SWPZ+50' buffer	Y

EDEN-CRAFTSBURY FIELD REPORT

ATLAS TIMBERLANDS ECOLOGICAL ASSESSMENT

PREPARED BY HANNAH PHILLIPS
UVM ECOLOGICAL PLANNING PROGRAM
SITE VISITS ON JULY 8, 11, 12, 13, 28 2016

Vermont Land Trust

The Nature Conservancy

EDEN-CRAFTSBURY FIELD REPORT

Prepared by Hannah Phillips, UVM Ecological Planning Program
Fieldwork conducted on 8, 11, 12, 13, 28 July 2016

The Eden-Craftsbury parcel contains the following significant ecological features, which are recommended for mention in the conservation easement:

1. Seven state-significant natural community occurrences representing five natural community types, four of which are ranked as S3 or higher: Spruce-Fir-Tamarack Swamp, Northern Hardwood Seepage Forest, Red Spruce-Cinnamon Fern Swamp, and Lowland Spruce-Fir Forest.
2. More than 150 acres of wetlands, which provide flood resilience, water quality protection, and habitat for large mammals, waterfowl, and amphibians.
3. Habitat for black bear, provided especially by the early spring herbaceous vegetation in Northern Hardwood Seepage Forests.
4. Over eighteen acres of structurally complex Old Forest, which offers habitat for a variety of animals.

LANDSCAPE CONTEXT

The Eden-Craftsbury lot is located in the Northern Green Mountains biophysical region of Vermont. The parcel ranges in elevation from 1100 feet in the easternmost corner to 1560 feet in the northwest corner of the property. A drainage divide runs north-south through the property at approximately 1500 feet just west of the Eden-Craftsbury town line. Water west of the divide flows into Wiley Brook and the Green River Reservoir before joining the Lamoille River, while water east of the divide flows into the Wild Branch tributary of the Lamoille River. Gradual slopes and poorly-drained soils on both sides of the drainage divide lend themselves to water accumulation. As a result, a variety of forested wetlands prevail throughout the property.

GEOLOGY

The entire property sits atop granofels and quartzite of the Moretown Formation, deposited during the Ordovician Period. This area is perched along the Taconic accretionary belt, a zone of bedrock that was deformed and pushed up when the Taconic Island Arc collided with proto-North American during the Taconic Orogeny. Ecologically, the rocks beneath the Eden-Craftsbury plot are relatively inert, and may only offer nutrient enrichment in areas of recent bedrock exposure. Alternatively, nutrient enrichment may be derived from the till matrix.

TABLE 11 SOILS OF EDEN-CRAFTSBURY

Soil Series	*Acres*	*Percent*
Borohemists	5.2	0.2%
Cabot	341.1	15.1%
Colton-Duxbury	10.5	0.5%
Lyman-Tunbridge-Rock	344.4	15.3%
Marlow	78.8	3.5%
Nicholville	28	1.2%
Peacham	47.1	2.1%
Peru	694	30.7%
Roundabout	4	0.2%
Salmon	0.2	0.0%
Searsport	5.6	0.2%
Tunbridge-Lyman	468.1	20.7%
Tunbridge-Peru	138.9	6.2%
Wonsqueak	91.1	4.0%
	2257	100.0%

SOILS

The Eden-Craftsbury lot has high percentages of both Peru and Cabot soils series (31% and 15% of total acreage, respectively; *Table 11*, *Figure 18*). These soils tend to occur in proximity to one another, with the more well-drained Peru soil often located upslope of the poorly drained Cabot soil. Cabot soils tend to form on loamy lodgment till in previously glaciated uplands and lowlands, on slopes up to a 25% grade (Soil Survey Staff 2015). The majority of the remainder of the site is on rocky upland soils of the Lyman-Tunbridge-Rock, Tunbridge-Lyman, and Tunbridge-Peru series (42% combined), with some

inclusions of Marlow fine sandy loam (3%), Nicholville fine sandy loam (1%), and a variety of mucky peat soil types (~6%; see map at end).

The Cabot and Peru soils on site are generally situated flanking the streams on the property in their upper reaches. This, along with their perched water table and their topographic position in the landscape, allow them to function as headwater zones for the rest of the watershed. Viewed in this way, the Eden-Craftsbury parcel has high ecological value as a headwater recharge zone, for both of the watersheds that it feeds.

HUMAN INFLUENCE

While research into the human history on the Atlas Timberlands was not extensive, review of historical imagery on the Eden-Craftsbury site in the 1960s and 1940s reveals little human influence beyond timber management. On the westernmost side of the property, a small clearing extending north from a clearing on Bornemann Road reveals past human use, which is visible in the 1940s aerial imagery (*Figure 19*). Today, the clearing is smaller than it was originally, although the central portion remains cleared with wetland herbaceous and shrub vegetation growing in the understory. No structural remnants were found within or adjacent to the clearing, nor are structures visible in the historic imagery.

More recently, harvest has recommenced on the site in 2009 on the west side of the property, and a second harvest followed in 2012 on the east side of the property. Prior to this timber harvest, it is not clear when the last took place.

FEATURES OF ECOLOGICAL SIGNIFICANCE

UPLANDS:

The matrix forest on the Eden-Craftsbury lot is Northern Hardwood Forest (*Table 12*, *Figure 17*). With a maximum elevation of 1560 feet, the parcel does not feature the same high-elevation forest types found elsewhere on the Atlas lands. It does, however, feature small sections of Lowland Spruce-Fir Forest around the periphery of the mixed swamps. Many of these have been altered by beaver activity in the swamps and timber harvest in the uplands; their historical extent may have been greater than was observed in summer 2016.

LOWLAND SPRUCE-FIR (S3)

EC-5 (S3, state-significant, B rank)

This Lowland Spruce-Fir Forest flanks the rim of the beaver pond in the center of the Eden-Craftsbury lot. Dense red spruce stands, with balsam fir and yellow birch intermingled, make foot travel adjacent to the wetland challenging. The understory of the spruce-fir forest contains many characteristic plants of this natural community, including *Sphagnum* moss, New York fern, cinnamon fern, lowbush blueberry, and black huckleberry. On the edge closest to the wetland, cinnamon fern, striped maple, and nodding sedge become increasingly common. Upslope of the band of Lowland Spruce-Fir, the forest shifts in composition to Red Spruce-Northern Hardwood Forest. Much of this upland was harvested in 2012, creating a stark divide between the Lowland Spruce-Fir adjacent the wetland complex and the upland that was recently cut. This community seems important wintering habitat for deer and moose, and also shady cover for ungulates in the summer months. I saw deer and moose beds and droppings throughout, and traveled on wildlife paths through the dense vegetation.

Forest management adjacent to the Lowland Spruce-Fir Forest could focus on allowing regeneration of conifers; this community may be more extensive than is represented in this map due to the 2012 harvest. The previously extent of this natural community type is visible in the historic aerial imagery from 1941 (*Figure 19*).

WETLANDS:

The gradual slopes, lower elevations, and basal-till derived soils of the Eden-Craftsbury lot support a variety of wetland types, including Northern Hardwood Seepage Forests, Red Spruce-Cinnamon Fern Swamps, Spruce-Fir-Tamarack Swamps, and Hemlock-Balsam Fir-Black Ash Seepage Swamps. Although some of these natural communities are undisturbed, beavers are active in many of the wetlands across the property. Remnant examples of the preceding communities flank the edges of beaver ponds, hinting at the character of the obscured natural communities. Timber harvest in some of the Northern Hardwood Seepage Forests and Hemlock-Balsam Fir-Black Ash Seepage Swamps has made natural community classification challenging, but presents an interesting opportunity to study the effects of timber harvest on wet forest successional processes.

NORTHERN HARDWOOD FOREST SEEPAGE FORESTS (S3)

Eden-Craftsbury has some of the best examples of the Northern Hardwood Seepage Forest natural community on the Atlas Lands. Two of these communities, EC-1 and EC-12, are state-significant examples. The gradual hillslope of the Eden-Craftsbury tract, and the abundance of Cabot soils (which possess the water-retaining qualities to support a seepage forest) combine to produce characteristics ideal for groundwater seepage. Furthermore, the recent harvest on the site in 2009 and 2012 offers opportunities to study the influence of harvest activities on seepage forests. In a few areas, harvest along the edge of a seepage forests gives a chance to study regeneration, understory vegetation dynamics, successional trends, and impacts on soil.

EC-1 (155 acres, state-significant, A rank)

The seepage forest on the western half of the property is the largest and best example of a Northern Hardwood Seepage Forest on the Atlas lands. It forms the headwaters of Wiley Brook, draining eventually into the Green River Reservoir. This area nicely represents the heterogeneity that exists within the Northern Hardwood Seepage Forest community type. In some areas, swales of black ash concentrate along flow paths, forming nearly pure stands. Elsewhere, black ash forms a minor component of the canopy, while other species like sugar maple, yellow birch, red spruce, and white ash compete for canopy dominance.

Understory species vary throughout the area, too, depending on soil saturation. In the black ash dominated swales, a greater abundance of wetland-obligate herbaceous species comprise the understory, including northeastern mannagrass, purple-stemmed American aster, nodding sedge, water avens, and occasionally turtlehead. Elsewhere, in the hummock/hollow topography of the Northern Hardwood Seepage Forest matrix, facultative wetland species thrive. In the wet hollows, touch-me-not, false hellebore, marsh fern, sensitive fern, and dwarf raspberry regularly establish; occasional colonizers include boreal bedstraw (S3) and golden saxifrage.

There are also numerous opportunities to study successional trends of seepage forests within EC-1. Patch cuts adjacent the central polygon of EC-1 provide a chance to assess regeneration and understory vegetative trends following harvest. Additionally, ash dieback in the northwestern parcel may foreshadow ash decline due to Emerald Ash Borer, which presents an opportunity to monitor species transition in wet forests.

EC-12 (42.9 acres, state-significant, B rank)

On the eastern end the Eden-Craftsbury property, another Northern Hardwood Seepage Forest represents an older, more mature example of this natural community, though scattered stumps speak to past harvest. This community has a stronger softwood component, featuring a greater abundance of red spruce, hemlock, and balsam fir. Additionally, this site also shows signs of enrichment, with basswood, maidenhair fern, blue cohosh, plantain-leaved sedge, and wild millet appearing along the toe-slope. This site features a well-developed hummock/hollow topography, perhaps because it appears not to have been harvested for some time. Upslope of the main land areas containing EC-12, a terrace positioned partway up the steep slope above the stream contains an abundance of seepage plants and characteristics.

EC-2 (15.4 acres, not state-significant, C rank)

This natural community does not qualify as state-significant because the northern portion is heavily modified and in poor condition. Although wetland obligate vegetation has colonized this mapped clearing and the ground was noticeably wet, the VAST trail travels right through the center of it and appears well-travelled, as indicated by the well-maintained road upslope and downslope of the swampy clearing.

However, the southern portion of EC-2 is a beautiful seepage forest that should be a priority for protection, and considered separately of the northern occurrence. This is the steepest example of a Northern Hardwood Seepage Forest that I observed on the Atlas lands; transporting machinery through this site under thawed-ground conditions would undoubtedly channelize the water within the seepage forest and divert it downslope. In fact, a logging road from long ago exemplifies this risk – an older road became an established flow path and has eroded into a channelized, steep stream.

EC-19 (5.45 acres, not state-significant, C rank)

A black ash seepage forest is perched on the east-facing slopes in the center of the Eden-Craftsbury lot. Although this community was not extensively surveyed, I noted black ash as a primary canopy component as I passed through the edge of the community. The boundaries were delineated remotely using leaf-on aerial imagery.

RED SPRUCE-CINNAMON FERN SWAMPS (S3)

EC-11 (9.7 acres, state-significant, B rank)

This swamp is connected to the beaver pond downstream, but is bisected by the VAST trail that travels through the center. An old road on the upper edge of the swamp interrupts the hydrologic connectivity with the upstream swamp. The downslope (southern) end of the swamp more closely resembles a Hemlock-Balsam Fir-Black Ash Seepage Swamp based on the presence of black ash, balsam fir, and yellow birch. However, the floor of the swamp is coated with *Sphagnum* moss, and the pH is fairly low (5.5). The northern end of the swamp is a Red Spruce-Cinnamon Fern Swamp. It seems plausible that the roads interrupting the hydrology on site have slowed the flow of water through the swamp, prompting acidification. Based on these upslope trends, it also seems likely that the beaver pond to the south would have previously expressed itself as a Hemlock-Balsam Fir-Black Ash Seepage Swamp.

EC-4 (3.8 acres, state-significant, B rank)

The land surrounding these two Red Spruce-Cinnamon Fern Swamps was harvested in 2010. A buffer was left around the swamps to protect their interior, and the adjacent harvest appeared to have occurred during the winter months, reducing the risk of erosion into the swamps. The swamps appear to be in good condition.

SPRUCE-FIR-TAMARACK SWAMP (S3)

EC-17 (19.5 acres, state-significant, B rank)

I did not get to make extensive observations of this wetland community during my visit to the Eden-Craftsbury parcel, but did observe the exterior edge. The edge of the swamp is surrounded by a dense layer of spruce, while the interior of the swamp contains a black spruce and balsam fir overstory, with *Sphagnum* blanketing the ground. Creeping snowberry, bunchberry, wild raisin, and mountain holly were all growing atop the sphagnum. Beaver activity is apparent along the southern and western edge. Although the flooding due to damming has only overtaken a small portion of the swamp, the alteration to the flow regime may influence the residence time and acidity of the water upstream.

HEMLOCK-BALSAM FIR-BLACK ASH SEEPAGE SWAMP (S4)

EC-6 (18.9 acres, not state-significant, C rank)

A series of small Hemlock-Balsam Fir-Black Ash Seepage Swamps are scattered throughout the south central portion of the property, adjacent to the group selection cuts. Within each of these swamps, canopy coverage is sparse but contains black ash, red spruce, and yellow birch as primary overstory components. Hemlock is absent. Regenerating trees have been browsed by deer. The understory is dominated by wetland facultative plants, including sensitive fern, nodding sedge, and cinnamon fern. It is not clear why the canopy is open in these swales; tree fall is not apparent. The site's proximity to a recovering beaver meadow downstream may hint at the cause; perhaps flooding up to this point caused tree dieback, and the beaver pond neglect has allowed water to flow away from this spot. Alternatively, perhaps logging traffic through this site allowed for a slight water table rise, which led to a vegetative community conversion. I did not see beaver stumps nor logging stumps to support these hypotheses.

EC-7 (39.6 acres, state-significant, B rank).

In the northeastern portion of the property, the relatively flat topography allows for the establishment of a number of softwood-dominated basin swamps, some of which have been disturbed by recent logging. Red spruce, black ash, and balsam fir dominate the canopy, which is sparse and infrequent. The understory contains abundant northeastern mannagrass, touch-me-not, sensitive fern, cinnamon fern, foamflower, and golden saxifrage. In the most open areas, purple-stemmed aster, joe-pye weed, virgin's bower, and poison ivy become more dominant in the understory. Much like the nearby seepage forests, the soils here have an impeding layer at a depth of 7-12 inches, on top of which the soils are primarily organic and wet. pH in the soils was near neutral: 6.5 at the surface, 7.0 at the base of the muck layer, and 7.0 within the impeding layer. This swamp has been disturbed by beavers on the western edge, and by recent logging in the southwestern polygon. The eastern swamps appear to have been altered prior to ATP ownership.

WILDLIFE FEATURES:

Beaver Wetlands

The beaver wetlands on site hold high wildlife value for large mammals in the region. They offer early spring forage, cool water to wade in during the summer, protection and isolation from upland human disturbances (logging, ATVs), and habitat connectivity to other areas of the parcel. When travelling alongside beaver wetland EC-14 I scared a large animal (moose or deer), and saw ample scat, bedding sites, and footpaths throughout the adjacent upland.

Vernal Pools

The only vernal pools I observed on the Eden-Craftsbury lot were the product of land use (EC-VP-1, EC-VP-2; see POIs_EdenCraftsbury_Phillips2017 data layer for coordinates). Logging roads in the south-central portion of the lot had created vernal pools that appeared to meet the habitat requirements of breeding amphibians. The canopy above was shaded, there was leaf litter in the artificial pond, and the water was nearly 12 inches deep in the center. While no evidence of ATV use in this area was apparent during my visit, the location of the vernal pools makes them vulnerable to disruption. Additionally, while the pools seem stable now, further logging in the area may alter the habitat suitability.

Old Forest

One forest stand on the Eden-Craftsbury lot (EC-18) appears to have escaped harvest for some time. Large diameter yellow birch are scattered across a very steep slope. Sporadic rock outcrops would make this terrain difficult to access and harvest. Large limbs are scattered across the ground and the canopy of the remaining trees shows evidence of self-pruning. Large standing dead snags offer desirable habitat for small woodland creatures and birds. Bear scat (both mom and cubs) was abundant throughout.

Seepage Forests

The seepage forests on site undoubtedly provide excellent habitat for large mammals that rely on wetland vegetation as part of their early spring diet (bear and moose). Throughout the seepage forests, I noticed that nearly all of the purple-stemmed American aster tops had been nibbled off; this was universal across all sites on the Atlas lands. Furthermore, tree tip-ups in or adjacent to seepage forests may provide suitable denning sites when the substrate beneath is dry or frozen. I observed two bear cubs climbing a tree in one of the patch cuts adjacent the seepage forests on the western side of the property, though I did not see the mother.

RECOMMENDED EASEMENT PROTECTIONS

The protection recommendations made in this report are based on ecological considerations. The final easement configuration may differ from the recommended protections because of practical considerations not explored in this report. Final protections are the decision of the Vermont Land Trust and The Nature Conservancy.

Surface Water Protection Zone + 50-foot Buffer

- *Northern Hardwood Seepage Forest (EC-1, EC-12, EC-19)* – Eden-Craftsbury contains one of the best examples of a Northern Hardwood Seepage Forest on the Atlas lands (EC-1). This state-significant uncommon natural community (S3) may be sensitive to hydrologic alteration by forest management due to the shallow, wet soils and its position on a gradual slope. As a headwater wetland, this community likely provides water quality protection and downstream flood resilience. The impacts of hydrologic alteration on these communities is not yet well understood, although changes in water table depth by inadvertent draining or ponding may have a lasting impact on the resulting plant communities (please see *Appendix J* for forest management recommendations in Seepage Forests). Protections on this forest should include a 50-foot buffer to ensure that inputs to these Seepage Forests are not disturbed by management activities.

- *Hemlock-Balsam Fir-Black Ash Seepage Swamp (EC-3, EC-6, EC-7)* – Hemlock-Balsam Fir-Black Ash Seepage Swamps may serve as critical habitat for white-tailed deer as wintering yards, and also provide downstream flood resilience and water quality protection. Restricting activity within these wetlands will protect the hydrologic processes that give rise to these natural communities.

- *Red Spruce-Cinnamon Fern Swamp (EC-4, EC-11)* – This natural community is uncommon in the state (S3) and contains peat at a mean depth of 6.8 feet (Sorenson et al. 2014). Disruption of this substrate may alter the hydrology of the site, a driving physical process on which the plant community depends. Given the "uncommon" status of this plant community, as well as its ability to host rare plant species, this natural community should be protected with a surface water protection zone with a 50-foot buffer.

- *Spruce-Fir-Tamarack Swamp (EC-17)* – This natural community is uncommon in the state (S3) and contains peat at a mean depth of 5.7 feet (Sorenson et al. 2014). Disruption of this substrate may alter the hydrology of the site, a driving physical process on which the plant community depends. Given the "uncommon" status of this plant community, as well as its ability to host rare plant species, this natural community should be protected with a surface water protection zone with a 50-foot buffer.

- *Beaver Pond/Shallow Emergent Marsh (EC-13, EC-14, EC-15, EC-16)* – Protection of these wetlands ensures that they will continue to provide valuable wildlife habitat. Given that beavers may eventually abandon these ponds, the protection boundary may eventually need to be altered to reflect the extent of the community. Additionally, in the absence of beavers, the natural communities concealed by beaver activity may eventually become apparent.

Ecological Protection Zone

- *Lowland Spruce-Fir Forest (EC-5)* – This uncommon natural community (S3) used to be more widespread throughout Vermont but has been reduced throughout the state by logging. This B-ranked state-significant occurrence may have additional ecological merit as a deer wintering area (although evidence of this use was not observed during fieldwork). Harvest in this area should be restricted to protect the integrity of this occurrence.

- *Old Forest (EC-18)* – This old forest provides habitat for a variety of animals in the form of standing and downed woody debris. Additionally, it serves as a carbon sink, an important landscape feature as global carbon emissions continue to rise.

Forest Management Plan and Easement Attribute Language

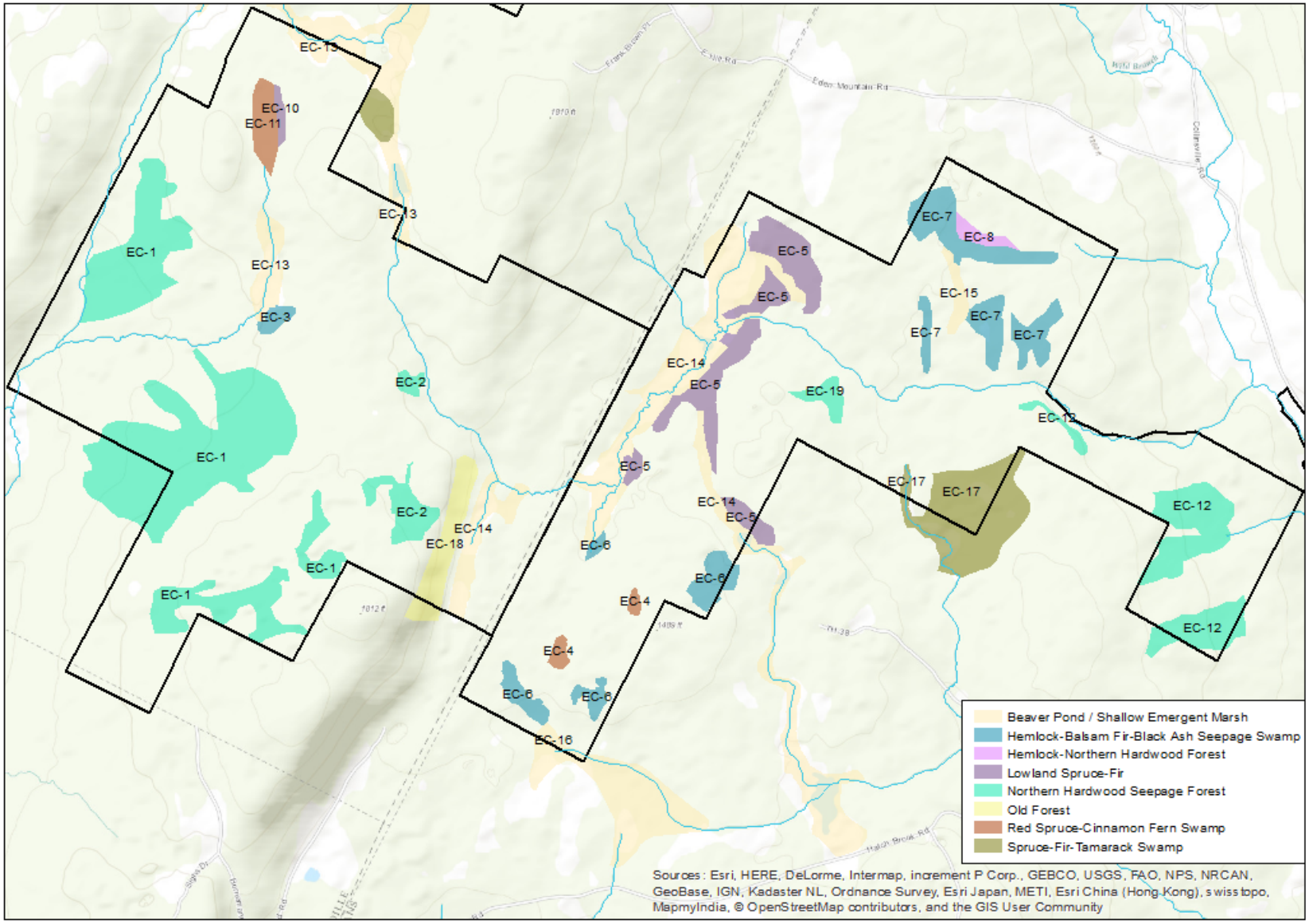
- *Lowland Spruce-Fir Forest (EC-8, EC-10)* - This uncommon natural community (S3) used to be more widespread throughout Vermont but has been reduced throughout the state by logging. While this is not a state-significant example of a Lowland Spruce-Fir Forest, it does have ecological merit as a deer wintering area and as a relic of a previously abundant community. Harvest in this area should mimic the natural disturbance regime of the site to encourage regeneration of characteristic tree species.

ACCOMPANYING FILES

Eden-Craftsbury Geodatabase

- *IntermittentStreams_EdenCraftsbury_Phillips2017:* Line file containing previously unmapped intermittent streams. This layer should be viewed with the National Hydrography Dataset stream layer.
- *NatComms_EdenCraftsbury_Phillips2017*: Polygon feature of state-significant natural communities, significant wildlife habitat, and other ecologically significant areas (including old forest). This file contains Natural Heritage Rankings and easement protection recommendations in accordance with VLTs easement provisions. Overlay POIs for more detail about field observations.
- *POIS_EdenCraftsbury_Phillips2017*: Point features containing field notes, which include species observations, rare/uncommon plant element occurrence data, land use alteration notes, and other general field observations.
- *Tracks_EdenCraftsbury_Phillips2017:* Line features showing path taken on field days.

FIGURE 17 ECOLOGICALLY SIGNIFICANT FEATURES OF EDEN-CRAFTSBURY

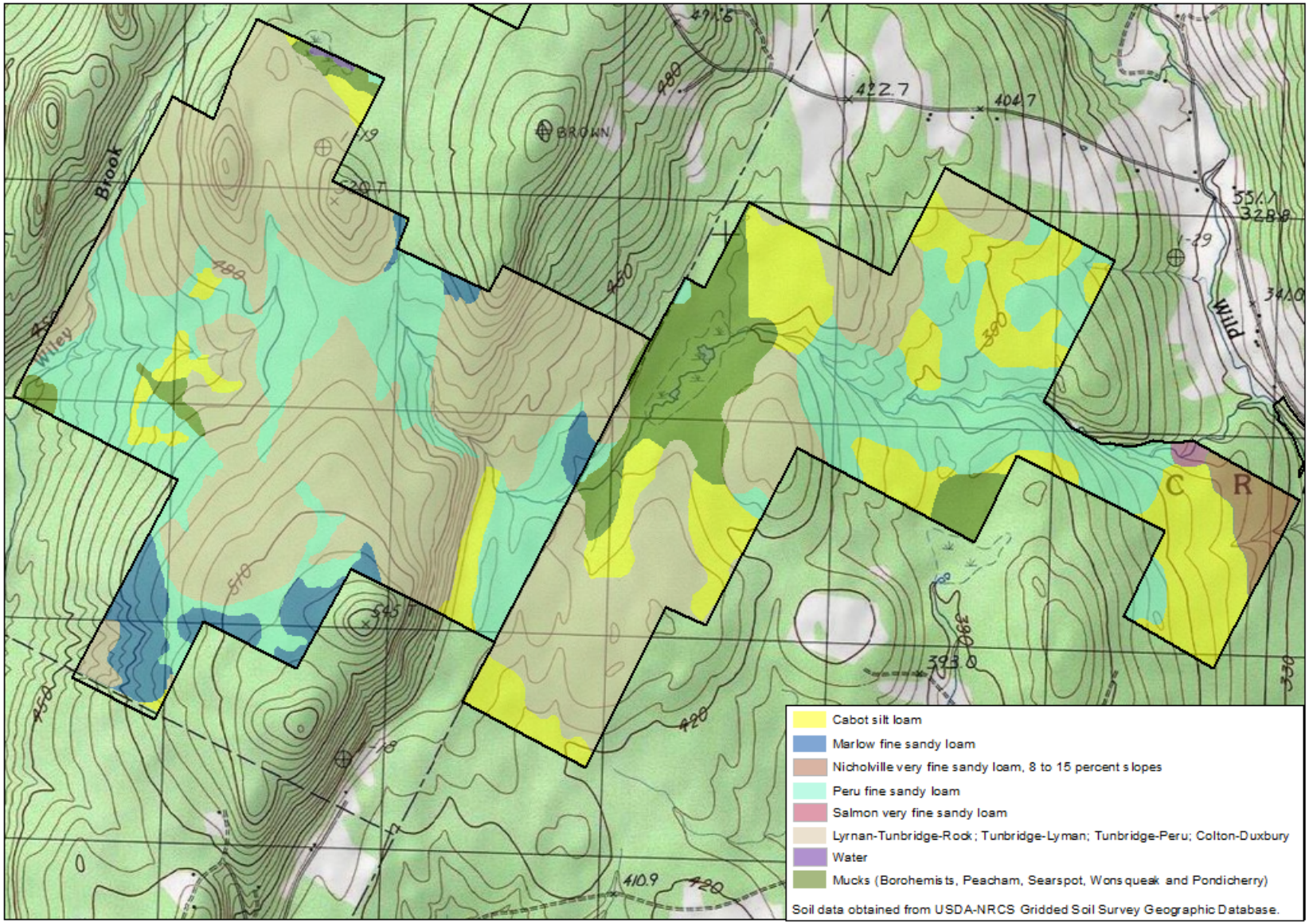


Map created by Hannah Phillips
UVM Ecological Planning Program
Field work conducted in July 2016

Atlas Timberlands Partnership
Eden-Craftsbury Resource Map

0 0.225 0.45 0.9 Miles

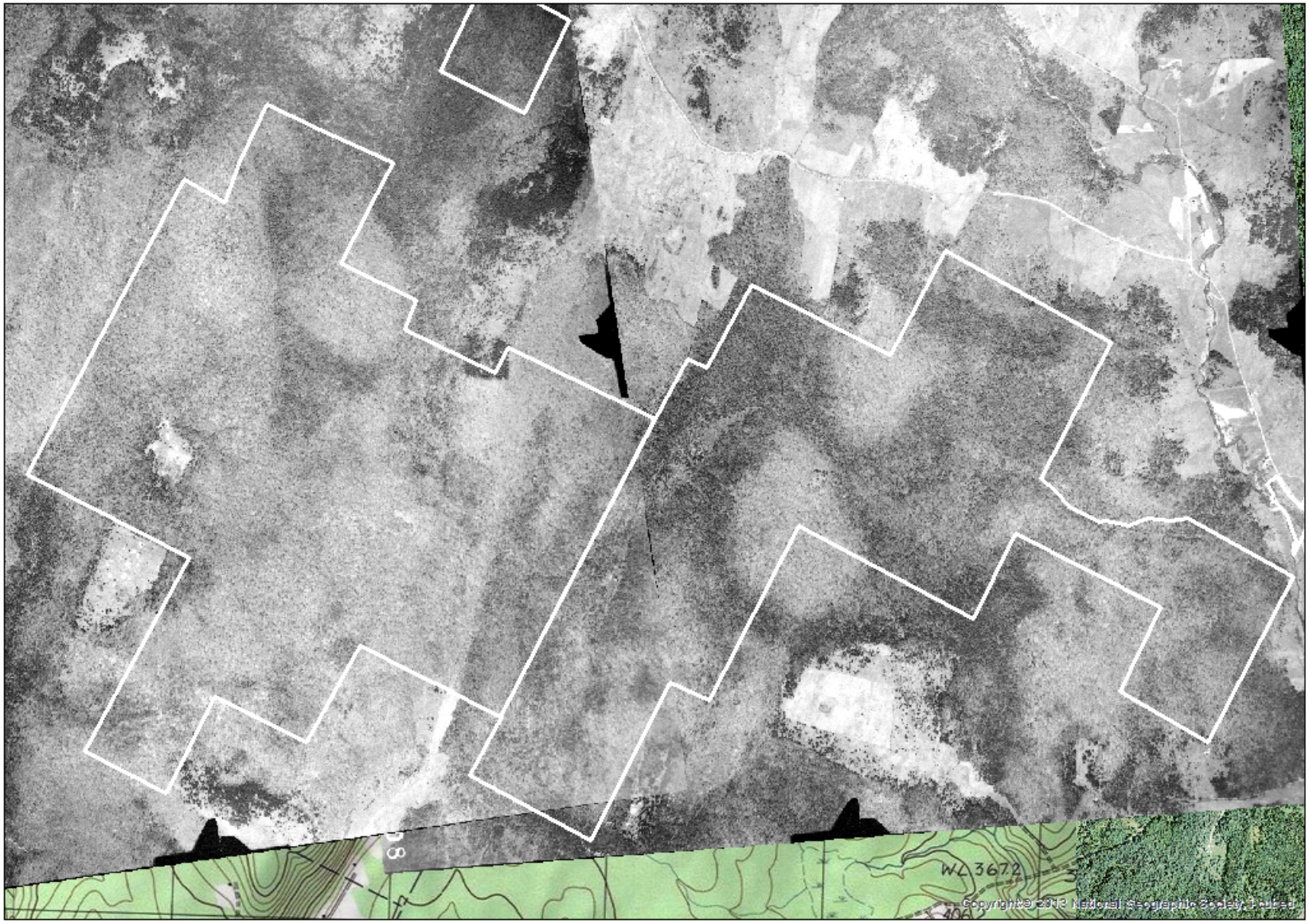
FIGURE 18 SOILS OF EDEN-CRAFTSBURY



Map created by Hannah Phillips
UVM Ecological Planning Program
Field work conducted in June/July 2016

Atlas Timberlands Partnership
Eden-Craftsbury Soil Map

FIGURE 19 1941 AERIAL IMAGERY OF EDEN-CRAFTSBURY



Map created by Hannah Phillips
UVM Field Naturalist Program
Field work conducted in June/July 2016

Atlas Timberlands Partnership
Eden-Craftsbury 1941 Aerial Imagery

0 0.225 0.45 0.9 Miles

TABLE 12 NATURAL COMMUNITY RANKINGS AND SIGNIFICANT WILDLIFE HABITAT OF EDEN-CRAFTSBURY

Site ID	Natural Community	Acres	Rarity Rank	State-significant?	EO Rank	Description	Rank Size	Rank Condition	Rank Landscape Context	Comments	Recommended Additional Protections	ESTA Eligible?
EC-1	Northern Hardwood Seepage Forest	155.0	S3	Y	A	Northeastern mannagrass, touch-me-not, false hellebore, black ash, white ash, striped maple, yellow birch, marsh fern, sensitive fern, nodding sedge, yellow birch. red spruce, balsam fir, boreal bedstraw, dwarf raspberry.	A	B - Roads pass through middle; small patch cuts on northern edge are in seepage	B - Land around has been managed for timber in an ecologically-responsible manner.	This forms the headwaters of the Green River Reservoir. Used the Northern White Cedar Sloping Seepage Forest Criteria for Ranking	SWPZ+50'buffer	Y
EC-2	Northern Hardwood Seepage Forest	15.4	S3	N	C	Touch-me-not, northeastern mannagrass, wood nettle.	C	C - The northern polygon has been aggressively modified; intersection of the road and the VAST trail	B - The land around has been managed for timber extraction in an ecologically-responsible manner.	Used the Northern White Cedar Sloping Seeping Forest Criteria for ranking.	—	—
EC-3	Hemlock-Balsam Fir-Black Ash Seepage Swamp	3.4	S3	N	C	Tamarack present.	D	B - Beaver activity affecting community condition; road passes adjacent to east.	B - Land around has been harvested recently (2009).	Prediction of what this community was prior to beaver activity. Used the Northern White Cedar Sloping Seeping Forest Criteria for ranking.	SWPZ+50'buffer	Y
EC-4	Red Spruce-Cinnamon Fern Swamp	3.8	S3	Y	B	Sphagnum, yellow birch, feels like old beaver wetland.	C	B - Area around has been harvested recently (2010). Roads pass along edges	B - Land around has been harvested (2010). In some places, logging roads have impacted hydrology.		SWPZ+50'buffer	Y
EC-5	Lowland Spruce-Fir	45.3	S3	Y	B	New York fern, cinnamon fern, lowbush blueberry, black huckleberry, nodding sedge, sphagnum, striped maple, balsam fir, red spruce, yellow birch.	C	B - Area around has been harvested recently (2012). Beaver activity has encroached on NC boundaries.	B - Surrounding land has been managed for timber in an ecologically-responsible manner.		EPZ	Y
EC-6	Hemlock-Balsam Fir-Black Ash Seepage Swamp	18.9	S4	B	Y	Very wet and open. All classic seepage forest indicator plants.	C	B/C: Harvest operations affected southern	B - Land around managed for timber in an ecologically-	Red Spruce variant	SWPZ+50'buffer	Y

						Encountered a moose in this swamp.		polygons. Beaver activity affected northern polygon.	responsible manner.			
EC-7	Hemlock-Balsam Fir-Black Ash Seepage Swamp	39.6	S4	Y	B	Ash dieback. northeastern mannagrass, touch-me-not, sensitive fern, foamflower, golden saxifrage, cinnamon fern, sensitive fern. Impeding layer at 12 inches; basin topography. Very open. pH 6.5 (surface), 7.0 (base of OM), 7.0 in impeding layer.	A	B/C - Harvest intrusion in western polygon. Eastern polygons appear altered prior to ATP ownership.	B - Land around managed for timber in an ecologically-responsible manner.	Red Spruce variant	SWPZ+50'buffer	Y
EC-8	Hemlock-Northern Hardwood Forest	4.1	S3	N	C	Ground not wet now, but seems like it would hold lots of vernal pools in the spring.	D	B - Land around has been harvested.	B - Land around managed for timber in an ecologically-responsible manner.		—	—
EC-10	Lowland Spruce-Fir	2.4	S3	N	-		-	-	-	Does not meet minimum size for Element Occurrence	Forest Management Plan Language; protect as SWPZ buffer	—
EC-11	Red Spruce-Cinnamon Fern Swamp	9.7	S3	Y	B	More acidic on the northern hend than the southern end. Red spruce, black ash, balsam fir, yellow birch, no hemlock yet, sphagnum coating ground, pH 5.5.	B	B - Old logging road to north and VAST trail to south influence hydrology	B - Swamp is downstream of dirt road, and the area surrounding it is regularly logged.		SWPZ+50'buffer	Y
EC-12	Northern Hardwood Seepage Forest	42.9	S3	Y	B	Northeastern mannagrass, water avens, pale touch-me-not, wood millet, sensitive fern, yellow birch, hemlock, black ash, basswood, balsam fir, northeastern mannagrass, hobblebush (on hummocks), cinnamon fern, maidenhair fern, blue cohosh, plantain-leaved sedge.	B	A/B - Logging here in the past, but now looks healthy and aging.	B - Surrounding land has been managed for timber in an ecologically-responsible manner.	Used the Northern White Cedar Sloping Seeping Forest Criteria for ranking.	SWPZ+50'buffer	Y
EC-13	Beaver Pond / Shallow Emergent Marsh	20.0	—	N	—	—	—	—	—	—	SWPZ+50'buffer	—

EC-14	Beaver Pond / Shallow Emergent Marsh	85.0	—	N	—	—	—	—	—	—	SWPZ+50'buffer	—
EC-15	Beaver Pond / Shallow Emergent Marsh	5.2	—	N	—	—	—	—	—	—	SWPZ+50'buffer	—
EC-16	Beaver Pond / Shallow Emergent Marsh	2.7	—	N	—	—	—	—	—	—	SWPZ+50'buffer	
EC-17	Spruce-Fir-Tamarack Swamp	19.5	S3	Y	B	Bryophytes, sensitive fern, black spruce, balsam fir, flowering dogwood, creeping snowberry, Sphagnum, pH 6.5 (bottom), 7.0, 7.0, 6.5 (top).	B	B - Beaver alteration on edge, recent logging upstream, and an ATV trail passes along the north edge	A/B - Surrounding land is in excellent condition with only minor logging disturbance upstream.	Higher B-ranking if including the area of the swamp located off property.	SWPZ+50'buffer	Y
EC-18	Old Forest	18.8	—	—	—	Maidenhair fern, plantain-leaved sedge, blue cohosh.	—	—	—	—	EPZ	Y
EC-19	Northern Hardwood Seepage Forest	5.4	S3	N	C	—	C	B/C - Patch cut in northern portion disrupted large portion of polygon	B - Land around has been managed for timber in an ecologically-responsible manner.	—	SWPZ+50'buffer	Y

HAYSTACK EAST AND TILLOTSON FIELD REPORTS

ATLAS TIMBERLANDS ECOLOGICAL ASSESSMENT

PREPARED BY HANNAH PHILLIPS
UVM ECOLOGICAL PLANNING PROGRAM
SITE VISITS ON MAY 24, 25, 27 2016

Vermont Land Trust

The Nature Conservancy

HAYSTACK EAST AND TILLOTSON FIELD REPORTS

Prepared by Hannah Phillips, UVM Ecological Planning Program
Fieldwork conducted on 24, 25, 27 May 2016

The Haystack East and Tillotson parcels contains the following significant ecological features, which are recommended for mention in the conservation easement:

1. Six state-significant natural community occurrences representing four natural community types, three of which are ranked as S3 or higher: Boreal Talus Woodland, Northern Hardwood Seepage Forest, and Montane Yellow Birch-Red Spruce Forest.
2. Two vernal pools greater than 200 square feet in size, which may provide important amphibian breeding habitat.
3. Habitat for black bear, and at least two high-quality beech mast stands.
4. Habitat for deer and moose, especially in the Montane Yellow Birch-Red Spruce Forest.
5. Two occurrences of structurally complex Old Forest, which offers habitat for a variety of animals.

LANDSCAPE CONTEXT

The Haystack and Tillotson tracts are located east of the Green Mountain spine in the Northern Green Mountains biophysical region of Vermont, and range in elevation from about 1000 feet on the southeast corner of the Tillotson tract to nearly 2400 feet in the northwest corner of Tillotson. Haystack and Tillotson Peaks are just west of the parcel boundaries, and the Long Trail spans the ridge connecting them.

The parcels themselves are primarily east-facing slopes, although Haystack has an east-west ridge that bisects the property in the center, forming two separate drainage bowls. Streams from both parcels form the headwaters of the Missisquoi River, which forms in the valley to the east, travels north into Canada, and eventually curves west and south on its path toward Lake Champlain.

The ridgeline west of the Tillotson tract is owned by the Green Mountain Club in a parcel that contains the summits of both Tillotson Peak and Mt. Belvidere. To the north, Hazen's Notch State Park protects a small parcel of land that encompasses the cliffs in the notch. West of the ridgeline, the Atlas Timberlands Partnership owns the Burnt Mountain tract.

GEOLOGY

The geology of the Haystack and Tillotson tracts is characteristic of the eastern side of the Green Mountain Anticlinorium, the prominent bedrock fold that gives rise to our mountain chain. While the western side of the Green Mountains bear folds resulting from the Taconic Orogeny, the eastern side of the mountains is known as the accretionary zone, a zone in which rocks accumulated as they were plowed up by the collision between the Taconic Island Arc and proto-North America 480-450 million years ago. These rocks were subsequently metamorphosed a second time by the Acadian Orogeny (370-345 million years ago), producing a conglomerate today of highly-metamorphosed gneiss, schist, and small inclusions of ultramafic meta-igneous rocks, which began their "life" as igneous intrusions on the sea bottom floor. These ultramafic rocks often contain the mineral serpentenite, an inhospitable substrate for many plants, but one that occasionally hosts rare plants, including the Green Mountain maidenhair fern.

The Haystack and Tillotson parcels sit squarely over an assemblage of bedrock that is representative of this accretionary zone. Tillotson and the southern half of the Haystack parcel are primarily atop schists. The northern portion of the Haystack east tract sits atop a large intrusion of gneiss, which is primarily composed of plagioclase feldspar and quartz, both of which

are inert from a plant nutrient uptake perspective. Although not mapped within the Atlas parcel boundaries, there are known outcrops of serpentenite on Haystack Peak and further to the east in the valley. Two UVM Geology graduate students were mapping this USGS quadrangle over summer 2016; their work may reveal more serpentine outcrops throughout this area.

SOILS

The soils of the Haystack and Tillotson parcels contain a mix of montane and valley-bottom soils, which differ noticeably in the plant communities they are able to support (*Table 13*, *Figure 22*). The Haystack-Tillotson ridgeline primarily contains soils of the Hogback-Rawsonville complex, which intersects with soils of the Tunbridge-Lyman complex and the Tunbridge-Peru complex on the steeper slopes at lower elevations. In the valley bottoms and on the milder slopes though, soils of the Cabot, Colonel-Cabot, and Peru series prevail.

TABLE 13 SOILS OF HAYSTACK EAST AND TILLOTSON

Soil Series	*Acres*	*Percent*
Cabot	10.9	1%
Colonel-Cabot	156.4	14%
Hogback-Rawsonville	296.6	27%
Peru	201.0	18%
Tunbridge-Lyman	274.2	25%
Tunbridge-Peru	151.2	14%
	1090.3	

Two additional NRCS metrics provide insight into the water-holding properties of these soils, which has a noticeable impact on the natural communities on site. 15% of the soils have an "apparent" water table within the soil matrix (Cabot silt loam, and Colonel-Cabot complex soils; this value coincides with the Hydric Soils designation), while an additional 32% of the soils have a "perched" water table (Peru fine sandy loam, and Tunbridge-Peru complex). A perched water table means that there is a water table perched over a dry soil layer.

FEATURES OF ECOLOGICAL SIGNIFICANCE

UPLANDS:

The uplands of the Haystack East-Tillotson lots are Northern Hardwood Forest matrix up to about 1800 feet, at which point they begin to transition to Montane Yellow Birch-Red Spruce Forest (*Figure 20*, *Table 14*). These higher elevation forests are restricted to the western limits of the Tillotson lot, and central western portions of the Haystack East lot. The small east-west ridge extending from the summit of Haystack Peak in the Haystack lot also possesses high-elevation montane forest.

The character of these forests differs noticeably between the northern and southern halves of the Haystack East lot, which appears to be largely a function of topography and slope. Steeper slopes and well-drained soils in the northern half of the property give rise to more classic Northern Hardwood Forests, while milder slopes and poorly drained soils in the southern half of the property support wetter forests. In drainage paths and on terraced formations, water accumulates in the soil and gives rise to Northern Hardwood Seepage Forests. The north-facing slopes on the eastern spur of Haystack East showed signs of enrichment not observed elsewhere on these two tracts.

MONTANE YELLOW BIRCH-RED SPRUCE FOREST (S3)

HT-9 (77.7 acres, state-significant, A rank)

The Green Mountain ridgeline connecting Haystack Peak and Tillotson Peak contains examples of both Montane Yellow Birch-Red Spruce Forest and Montane Spruce-Fir Forest. The edges of the Montane Yellow Birch-Red Spruce Forest community extends eastward from the ridgeline onto the Atlas lands, covering 77.7 acres of the two parcels combined. Alone, this qualifies as an A ranked natural community. Given the connectedness with the land to the east (which is owned by the Green Mountain Club), this becomes an excellent, large forest worthy of protection. A small patch (one acre) of old growth was found at the base of the Haystack East cliffs. It seems probable that there are more instances of old growth forest along the rest of this ridgeline.

BOREAL TALUS WOODLAND (S3)

HT-3 (2.6 acres, state-significant, A rank)

Large talus blocks at the base of the Haystack peak cliffs provide an exciting scramble to the base of the cliffs. Some vegetation grows on the talus blocks, including yellow birch, red spruce, and heart-leaved paper birch. Rock fall does not seem especially common in the area; many of the boulders are well covered with rock-cap polypody and bryophytes. Fragile fern was also growing out of crevices in the rock in multiple locations.

WETLANDS:

Wetlands on the Haystack East and Tillotson tracts form the headwaters of the Missisquoi River. An extensive Northern Hardwood Seepage Forest wetland complex extends across the mild slopes and poorly drained soils on the southern half of the Haystack East property, connecting to the Tillotson parcel through private land. These extensive examples of headwater wetlands provide an opportunity to study the ecological functions and services of this previously undescribed natural community type. Furthermore, forest management on these wet soils has led to ponding and channelization of water in some locations, highlighting the potential impacts of management on the ecological integrity of headwater wetlands. Wetlands are not as abundant in the northern half of the property, although a small Hemlock-Balsam Fir-Black Ash Seepage Swamp (HT-4) sits in the northeast corner of the property where milder slopes prevail.

NORTHERN HARDWOOD SEEPAGE FOREST (S3)

HT-6 (28.9 acres, state-significant, B rank)

A large, patchy Northern Hardwood Seepage Forest sprawls across the basin between Tillotson and Haystack Peaks in the Northern Green Mountains, spanning portions of the southern half of the Haystack East tract. If these occurrences are connected, they together represent a single element occurrence that exceeds 100 acres in size, which would make it A-ranked occurrence by size (and the third largest occurrence on the Atlas lands, including the portion that exists off property). Considering just the properties on the Atlas lands, the occurrence is C-rank for size.

Trees within this natural community form a woodland canopy, and in some areas the canopy coverage is so sparse that the community looks more like a marsh than a seepage forest. In the marshy areas, tree dieback is apparent, and a number of dead snags still stand throughout the seepage marsh. While it is difficult to determine the tree species due to lack of bark and branches, it seems likely that these are stands of black ash dieback. No evidence of historic beaver activity exists around these swamps, nor are beaver ponds visible in historic aerial photos (from 1962). While the cause of black ash dieback is not well understood, it is hypothesized to be a function of natural senescence, hydrologic alteration (perhaps due to the presence of logging roads), or proximity to heavily salted roads (irrelevant in this location; Palik 2011). Cohort senescence could explain the marshy appearance of the understory, as the gaps created by canopy dieback create an early successional environment.

In the forests surrounding the marshy areas, seepage forest hummock and hollow topography is common, and tree tip-ups are present throughout. Trees within this natural community include red maple, black ash, yellow birch and red spruce. The shrub layer includes some species of willow, as well as hobblebush on the upland hummocks. The herbaceous layer includes a number of seepage indicator plants, including golden saxifrage, false hellebore, lady fern, cinnamon fern, dwarf raspberry, northeastern mannagrass, sensitive fern, nodding sedge, tall meadow-rue, wood nettle, and purple-stemmed American aster. Enrichment indicators are also present, including jack-in-the-pulpit, blue cohosh, and toothwort.

Water flows laterally through the soils within this seepage forest. A soil pit at the edge of the largest seepage forest, where the forest meets the wetland clearing, revealed approximately 12 inches of moist, silty loam perched on top of a restricting layer of dense, coarse, mottled till. The pH of the soil in the 12 inches above the till was near neutral (6.5). At a soil pit in the smaller seepage forest northeast of the primary seepage arm, water was visibly draining from the perched soil matrix above

the restrictive layer. The water within these seepage forests eventually drains to tributaries of Burgess Brook, which drains north to the East Branch of the Missisquoi River.

Skid trails occasionally pass through the seepage forest matrix. In some areas, the passage of logging equipment has led to pooling water. In numerous instances, I observed amphibian egg masses, tadpoles, or frogs using these disruptions as breeding habitat. Although the ponding was an unintended consequence of land use, these roads did not appear to divert water from the site given the gentle slope and small topographic depressions located throughout. The larger access road does bisect this natural community, which likely makes the northern seepage forests hydrologically separate from the southern occurrences.

HT-7 (2.8 acres, state-significant, B rank)

A small section of seepage forest is located in the topographic flats at the southeastern corner of the Tillotson parcel. At the time of my visit in late May, I found wild leeks blanketing the ground, and false hellebore and cinnamon fern just beginning to unfurl. Striped maple was abundant throughout the wet forest, and moose had chewed a majority of the striped maples. The seepage on this site extends off the property to the south. Although not investigated in the field, assessment of aerial imagery suggests that this portion of seepage forest may connect to the seepage forest on the Haystack East tract. This hypothesized point of connection is represented on the Haystack-Tillotson Resource Map as "Seepage Forest Extent."

HEMLOCK-BALSAM FIR-BLACK ASH SEEPAGE SWAMP (S4)

HT-4 (3.9 acres, not state-significant, C rank)

A large, wet, open meadow adjacent to the property boundary contains many species commonly found in seepage forests, although the community presents as an early successional, open marsh. The harvest history of this area is not clear. Paper birch, red maple, and red spruce are all growing in the overstory, while false hellebore, cinnamon fern, and horsetail are abundant in the understory. Aerial imagery suggests that this wet forest extends further north, ultimately draining into the Hazen's Notch tributary of the East Branch of the Missisquoi River, although this was not verified on the ground. Water from the swamp now appears to be feeding a privately owned pond that exists just off site to the north of the property boundary. A logging road passes through the eastern portion of this occurrence, and another road passes along the southern edge of the mapped forest.

SEEP (S4)

HT-5 (0.3 acres, state-significant, A rank)

A small seep is perched in a high-elevation cove at the point of contact between Northern Hardwood Forest and the Montane Yellow Birch-Red Spruce Forest in the center of the Haystack East tract. Large rocky outcrops to the west form a topographic barrier. Much like HT-8, a small topographic depression provides space for seepage to gather, forming a small wet depression. The herbaceous vegetation in this seep was denser than the vegetation observed in HT-8 despite a similar elevation. Moose tracks were observed in this seep and along a game trail exiting the uphill side of the seep into the dense red spruce above.

HT-8 (1 acre, state-significant, A rank)

A small 1-acre seep is perched in a topographic depression at the base of a large rock outcrop in the higher elevations of the Tillotson parcel. At the time of my visit, prior to full leaf-out, false hellebore was abundant and Dutchmen's breeches blanketed the ground. Water was standing in pools in some spots, but was not deep enough to serve as a vernal pool. Large mature yellow birch was the dominant canopy component, with some red spruce intermingled, albeit sparingly. This seepiness and enrichment is diffuse across the steep hillside to the north, but this is the only site in which the water gathers.

HT-12 (0.9 acres, state-significant, B rank)

Two small seeps adjacent to a major stream of the Haystack East tract feed into the stream. Canopy openings caused by tree tip-ups give rise to abundant herbaceous vegetation growing in the evacuated tree well. Herbaceous species characteristic of seepage forests include sensitive fern, foamflower, wood nettle, and dwarf raspberry.

WILDLIFE FEATURES:

BEECH MAST STANDS

HT-1 (12.2 acres)

A large beech mast stand sits atop a knoll in the center of the Haystack parcel. There, a high abundance of healthy, bear-marked beech span the flat-topped knoll, before giving way to more classic Northern Hardwood Forest on the downhill slope. Some of the trees exceed 12 inches in diameter, and many have bear claws marks on the side, or bear nests in the treetops. Along the lower (northern) reaches of this forest, there is an abundance of striped maple with moose sign on the trunks.

A higher-elevation ridgeline is located just to the west of this knoll, topped with red spruce and balsam fir. When descending off of this ridgeline, I paralleled what I believe was a bear's track from descending the steep slopes on its belly. Bear scat was abundant along the ridgeline.

HT-2 (6.5 acres)

A second beech mast stand is located on the east-facing flanks of Haystack Peak on a topographic bench below a steep slope. Here, numerous healthy, large, bear-marked beech occur in close proximity to one another. Some of the stands have bear "nests" in the canopy, as well.

TEMPERATE CIRCUMNEUTRAL OUTCROP

HT-13 (2.1 acres)

A large outcrop on the east-facing slopes of Haystack Peak bisects the slope, on top of which there is a small stand of large-diameter yellow birch (HT-11). Large, continuous slabs of rock are kept wet by seepage from upslope. A stream bisects two primary outcrops.

VERNAL POOLS

Natural Vernal Pools

Two natural vernal pools are located in the saddle dividing the northern half of the Haystack East parcel from the southern half of the Haystack east parcel (*Appendix G*; see POIs_HaystackTillotson_Phillips2017 data layer for coordinates. Although these are described in Lapin and Engstrom (2015), the GPS point was incorrect for one of the locations. Vernal pools were not assessed for the presence/absence of breeding amphibians (due to the timing of my visit), and should be revisited in the spring to determine viability as an amphibian breeding ground.

- HT-VP-1 is 375 square feet and has partial canopy coverage (although at the time of my visit, the trees had not reached full leaf-out). The shape was irregular; it was comprised of a series of connected smaller pond, punctuated by large yellow birch growing on hummocks. The middle of the vernal pool was approximately three inches deep. I did see tadpoles, but did not see egg masses. There was an abundance of leaf litter in the base of the pond, and some coarse woody debris scattered about.

- HT-VP-2 is 600 square feet, but was dry at the time of my visit in late May. It appears to be connected to the upslope vernal pool by an intermittent stream, although travel between the two vernal pools would not have been possible. Perhaps in winters with a more substantial snow pack this vernal pool would stay wet for longer. It should be revisited in a future spring to determine its viability as an amphibian breeding ground.

Unnatural Vernal Pools

Multiple ruts created by logging activity on the southern half of the Haystack East property have led to the creation of large pools that were being used as amphibian breeding sites. I observed egg masses in at least two of these artificially created pools, and they were popular gathering sites for adult wood frogs. In their present location, continued travel on the established logging road will not disrupt their breeding habitat, although further alteration of the roadbed surface may have adverse effects on the vernal pools. More information about these vernal pools can be found in the POIs_HaystackTillotson_Phillips2017 data layer.

OTHER NOTABLE FEATURES:

OLD FOREST

HT-10 (1 acre)

A one-acre swath of old forest sits at the base of the Boreal Talus Woodland below the summit of Haystack Peak. Here, the steep slopes and rocky outcrops make access to a flat, wooded terrace difficult and impractical. Large, old growth yellow birch grow atop talus blocks, and the ground cover is dominated by seepage and enrichment loving plants, including wood nettle, touch-me-not, Dutchmen's breeches, trillium, lady fern, foamflower, golden saxifrage, jack-in-the-pulpit, and swamp currant.

HT-11 (1 acre)

Another one-acre patch of old growth is located atop the outcrops on the east-facing slopes of Haystack Peak. Although this area was likely accessed for logging (it is not impossible to get up here, and there are still northern hardwood species available for harvest), this patch of yellow birch on top of the outcrops was not removed. Those that remain are of impressive girth and show signs of natural senescence (self-pruning); their fallen limbs lay scattered on the forest floor. The high degree of structural complexity may offer a wanted haven for wildlife; I observed a young female moose reclining beneath one of these large trees, before we scared each other and parted ways.

CLIFFS

Although I did not explore the cliffs above the Boreal Talus Woodland on the side of Haystack Peak, Engstrom and Lapin include an excellent description of the flora of the cliffs. The size of these cliffs may make them suitable peregrine nesting habitat.

STEWARDSHIP CONSIDERATIONS

ATVs

There was some evidence of ATV travel up the logging road that extending from the end of Brookside Drive, although it did not travel too far within the property boundaries, nor was it causing undesirable erosion or trail destruction.

Boundaries

The parcel boundary in the northeast corner of the Haystack property was not consistent with the parcel boundary observed on the ground. My field tracks follow the property blazes. The adjacent landowners are sugaring on their land, and the tap lines extend up to the property boundary. It is possible that this discrepancy was arrived at due to some

complications with the GPS unit, as the track takes a large turn to the west parallel to the stream, which is not a path that I followed in the field.

RECOMMENDED EASEMENT PROTECTIONS

The protection recommendations made in this report are based on ecological considerations. The final easement configuration may differ from the recommended protections because of practical considerations not explored in this report. Final protections are the decision of the Vermont Land Trust and The Nature Conservancy.

Surface Water Protection Zone + 50' Buffer

- *Northern Hardwood Seepage Forest (HT-6, HT-7)* —This state-significant uncommon natural community (S3) may be sensitive to hydrologic alteration by forest management due to the shallow, wet soils and its position on a gradual slope. As a headwater wetland, this community likely provides water quality protection and downstream flood resilience. The impacts of hydrologic alteration on these communities is not yet well understood, although changes in water table depth by inadvertent draining or ponding may have a lasting impact on the resulting plant communities (please see *Appendix J* for forest management recommendations in Seepage Forests). Protections on this forest should include a 50-foot buffer to ensure that inputs to these Seepage Forests are not disturbed by management activities.

- *Hemlock-Balsam Fir-Black Ash Seepage Swamp (HT-4)* — Hemlock-Balsam Fir-Black Ash Seepage Swamps may serve as critical habitat for white-tailed deer as wintering yards, and also provide downstream flood resilience and water quality protection. Restricting activity within these wetlands will protect the hydrologic processes that give rise to these natural communities. This designation may conflict with current land use (see HT-4 description above). Before allowing active management in this area, the extent of the element occurrence should be assessed off property to the north.

- *Seep (HT-5, HT-8, HT-12)* — Seeps may serve as important amphibian breeding habitat, and also produce early spring vegetation desirable to large mammals like moose and black bear. Given their small size, disruption by logging could mean a complete loss of these ecological services.

Ecological Protection Zone

- *Old Forest (HT-10, HT-11)* — Old forest provides habitat for a variety of animals in the form of standing and downed woody debris. Additionally, it serves as a carbon sink, an important landscape feature as global carbon emissions continue to rise.

- *Montane Yellow Birch-Red Spruce Forest (HT-9)* – This state-significant uncommon natural community (S3) is an A-ranked occurrence. This forest has well-developed glades and a dense understory of hobblebush, both of which provide excellent wildlife habitat for moose.

- *Boreal Talus Woodland (HT-3)* — This uncommon natural community (S3) is a state-significant, A-ranked occurrence. The talus slope provides important wildlife habitat and may host uncommon plant species.

Forest Management Plan mention and Easement Attribute Language

- *Beech Mast Stand (HT-1, HT-2)* — The beech mast stand on Haystack East offers critical black bear habitat and features mature individuals free of beech bark disease. Forest management in these areas should emphasize retention of disease-free and mast-producing individuals.

- *Temperate Circumneutral Outcrop (HT-13)*— Outcrops provide potential denning sites for animals like porcupine and bobcat. Owners should survey this outcrop prior to undertaking management actions in close proximity to avoid disrupting wildlife.

Vernal Pool Special Treatment Area

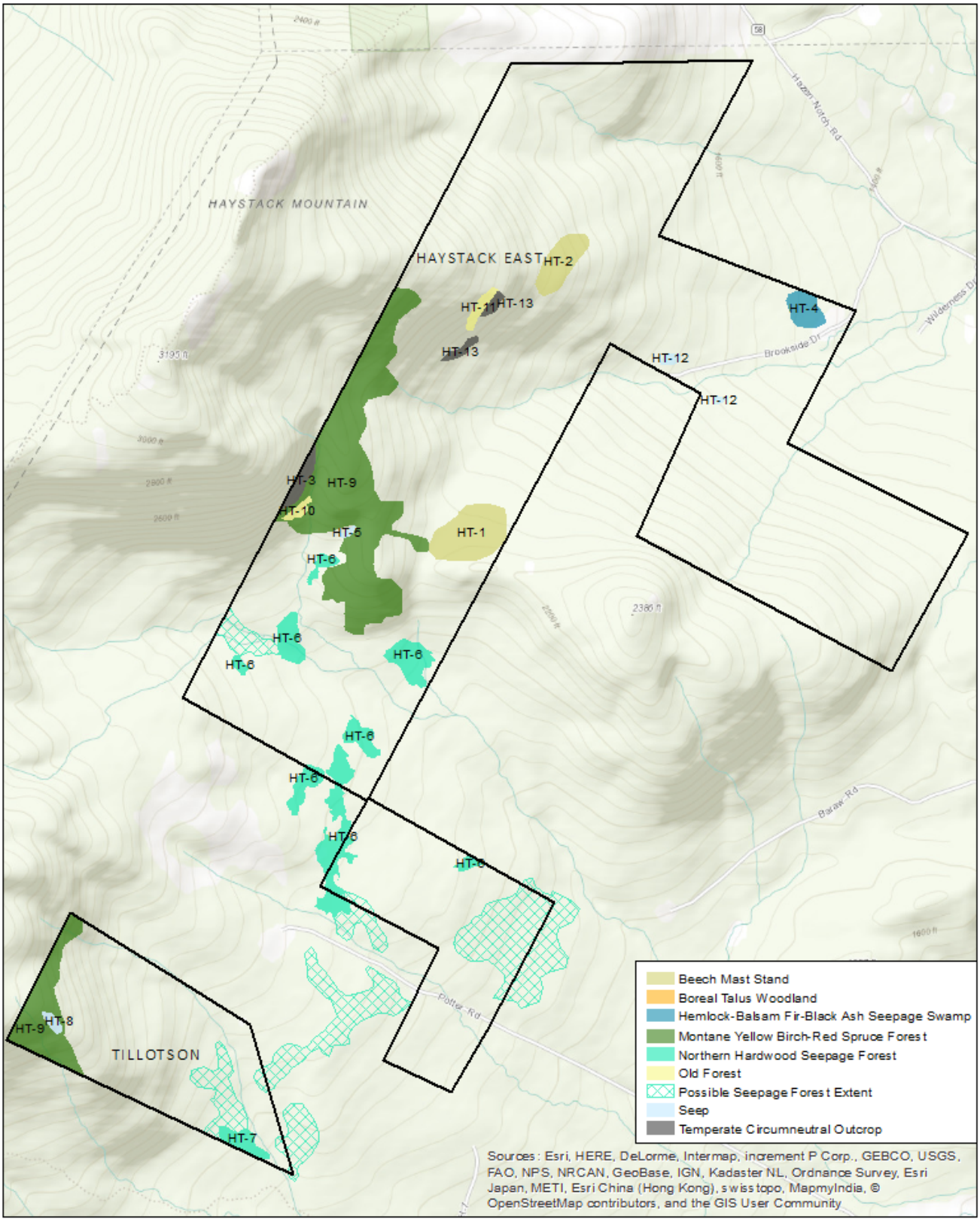
- *Vernal Pools (HT-VP-1, HT-VP-2)* — If a spring survey reveals that these vernal pools are used as amphibian breeding grounds, they should be protected under the Vernal Pool Special Treatment Area clause, with 100-foot primary and 500-foot secondary buffer zones. These restrictions will ensure the maintenance of natural features necessary to preserve these vernal pools as amphibian breeding habitat (ex. canopy cover, shade, downed woody debris, etc.).

ACCOMPANYING FILES

Haystack-Tillotson Geodatabase

- *IntermittentStreams_HaystackTillotson_Phillips2017:* Line file containing previously unmapped intermittent streams. This layer should be viewed with the National Hydrography Dataset stream layer.
- *NatComms_HaystackTillotson_Phillips2017*: Polygon feature of state-significant natural communities, significant wildlife habitat, and other ecologically significant areas (including old forest). This file contains Natural Heritage Rankings and easement protection recommendations in accordance with VLTs easement provisions. Overlay POIs for more detail about field observations.
- *POIS_HaystackTillotson_Phillips2017*: Point features containing field notes, which include species observations, rare/uncommon plant element occurrence data, land use alteration notes, and other general field observations.
- *Tracks_HaystackTillotson_Phillips2017:* Line features showing path taken on field days.

FIGURE 20 ECOLOGICALLY SIGNIFICANT FEATURES OF HAYSTACK EAST AND TILLOTSON

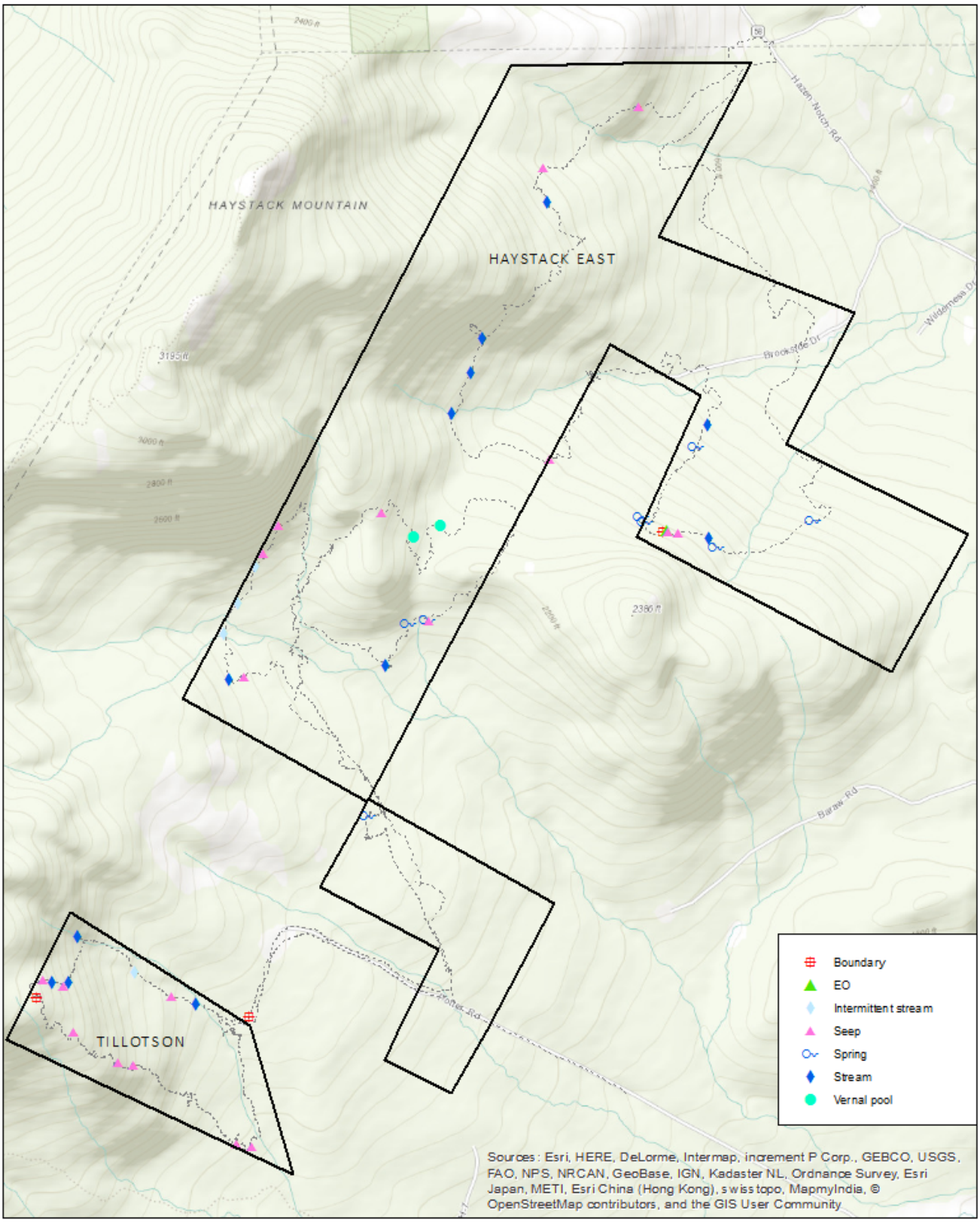


Map created by Hannah Phillips
UVM Ecological Planning Program
Field work conducted in May 2016

Atlas Timberlands Partnership
Haystack-Tillotson Resource Map

0 0.125 0.25 0.5 Miles

FIGURE 21 POINTS OF INTEREST ON HAYSTACK EAST AND TILLOTSON

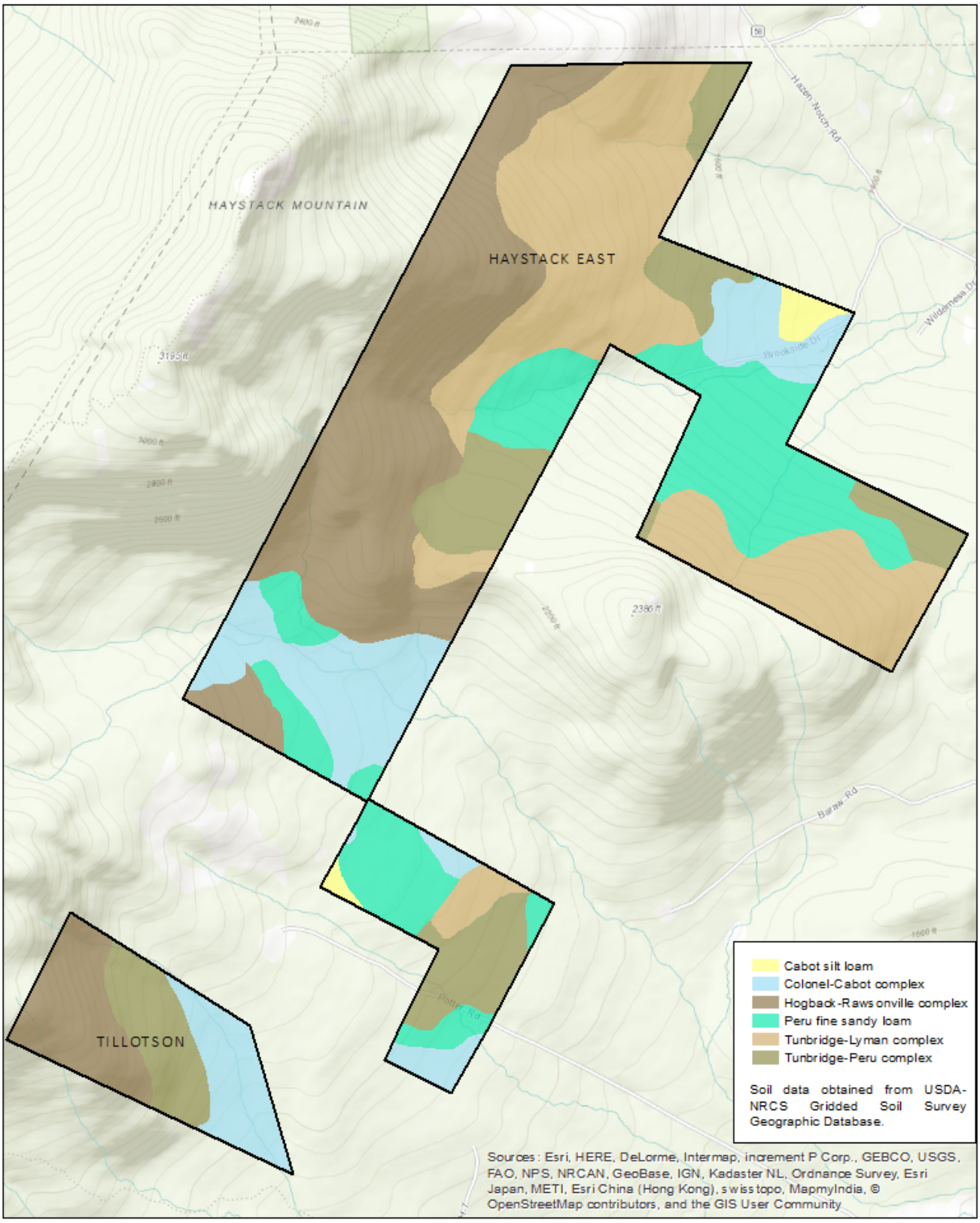


Map created by Hannah Phillips
UVM Ecological Planning Program
Field work conducted in May 2016

Atlas Timberlands Partnership
Haystack-Tillotson Points of Interest

0 0.125 0.25 0.5 Miles

FIGURE 22 SOILS OF HAYSTACK EAST AND TILLOTSON



Map created by Hannah Phillips
UVM Ecological Planning Program
Field work conducted in May 2016

Atlas Timberlands Partnership
Haystack-Tillotson Soil Map

0 0.125 0.25 0.5 Miles

SID	Type	Acres	Rarity Rank	State-significant?	EO Rank	Description	Rank Size	Rank Condiiton	Rank Landscape Context	Comments	Recommended Additional Protection	ESTA Eligible?
HT-1	Beech Mast Stand	12.2	—	—	—	Lots of large, healthy beech. Logging roads throughout. Also lots of striped maple and signs of moose feeding. Many contain bear claw marks.	—	—	—	Wildlife feature	Forest Management Plan, easement attributes	—
HT-2	Beech Mast Stand	6.5	—	—	—	Numerous bear marked beech and bear nests up in trees. Moose sign abundant on striped maples as well.	—	—	—	Wildlife feature	Forest Management Plan, easement attributes	—
HT-3	Boreal Talus Woodland	2.6	S3	Y	A	The talus below the cliff on the east side of Haystack Peak primarily contains trees from the Montane Yellow Birch-Red Spruce Forest.	C	A	A	—	EPZ	Y
HT-4	Hemlock-Balsam Fir-Black Ash Seepage Swamp	3.9	S4	N	C	Seepage forest: sensitive fern, paper birch, red spruce, false hellebore, horsetail, sugar maple, cinnamon fern. Harvest history unclear. Water feeds the pond just downslope on private property.	C	C-appears canopy cover removed in here.	B-on edge of property; residence adjacent	Road passes along the edge. Swamp takes on marshy feel - unclear whether this is due to past harvest history and community conversion, or the natural state of this wetland.	SWPZ+50' buffer	Y
HT-5	Seep	0.3	S4	Y	A	Red spruce, yellow birch, false hellebore. Small higher-elevation seep has established in topographic basin. It is slow to percolate out of the depression, so takes on a seepage swamp feel.	C	A	A	—	SWPZ+50' buffer	Y
HT-6	Northern Hardwood Seepage Forest	28.9	S3	Y	B	Enriched seepage forest. Pockets of northeastern mannagrass, lady fern, blue cohosh, dwarf raspberry, wood nettle, Dutchmen's breeches, swamp saxifrage, false hellebore, jack-in-the-pulpit. Lots of tip-ups. Water pooling on mini-terraces as it cascades down the hill. Logging roads occasionally pass through northern occurrences.	C	B	B	Combined HP / Marc Lapin mapping. Boundaries of some polygons mapped remotely from aerial imagery. See GIS attribute table for polygon authorship, and see Engstrom and Lapin (2015) report for additional description of "seepage woodland."	SWPZ+50' buffer	Y
HT-7	Northern Hardwood Seepage Forest	2.8	S3	Y	B	Patchy seepage woodlands. Large open swaths of grassy patches. Foamflower.	D	A	B	This is likely a conservative estimate of the extent of this forest. I would like to revisit this during the height of the summer (July/August) to determine the true extent of	SWPZ+50' buffer	Y

										this seepage forest. I anticipate it is part of a single EO with HT-6.		
HT-8	Seep	0.9	S4	Y	A	Scattered patches of seepiness along steep hillside, emerging from rocky outcrops. Northern parcel draining into site from plateau above. Blue cohosh, squirrel corn, wood nettle, dutchmen's breeches.	B	A - no logging up this high	A-minimal evidence of logging up here		SWPZ+50'buffer	Y
HT-9	Montane Yellow Birch-Red Spruce Forest	79.6	S3	Y	A	Mapped remotely via aerial imagery. Field notes were taken when crossing into this community, but the boundary was not field-truthed.	C	A	A	Adjacent property is owned by the Green Mountain Club and is protected Montane Yellow Birch-Red Spruce Forest	EPZ	Y
HT-10	Old Forest	1.0	—	—	—	Old growth forest. Inaccessible to logging equipment because of rocky terrain. Enrichment within: dutchmen's breeches, wood nettle, trillum, lady fern, foamflower, golden saxifrage, jack-in-the-pulpit	—	—	—	Wildlife feature	EPZ	Y
HT-11	Old Forest	1.6	—	—	—	Scared a young female moose up here. Did not have an opportunity to measure trees (was trying to give her space).	—	—	—	Wildlife feature; may be more extensive than is mapped here.	EPZ	Y
HT-12	Seep	0.9	S4	Y	B	Red maple, yellow birch, red spruce, false hellebore, toothwort, silvery glade fern, striped maple, pin cherry, dwarf raspberry, sensitive fern, foamflower, wood fern, marginal wood fern	C	B-logging road passes through center of one	B-logging in surrounding forest	Some logging roads through here and early successional species (pin cherry)	SWPZ+50’ buffer	Y
HT-13	Temperate Circumneutral Outcrop	2.1	—	—	—	Sloping bedrock is wet; water is seeping from above forest to plateau at base of these outcrops. Logging road travels along the base.	—	—	—	—	Forest Management Plan and Easement Attribute Language	—

RICHFORD-JAY NORTH FIELD REPORT

ATLAS TIMBERLANDS ECOLOGICAL ASSESSMENT

PREPARED BY HANNAH PHILLIPS
UVM ECOLOGICAL PLANNING PROGRAM
SITE VISITS ON MAY 31 AND JUNE 1 2016

Vermont Land Trust

The Nature Conservancy

RICHFORD-JAY NORTH FIELD REPORT

Prepared by Hannah Phillips, UVM Ecological Planning Program
Fieldwork conducted on 31 May and 1 June 2016

The Richford-Jay North parcels contains the following significant ecological features, which are recommended for mention in the conservation easement:

1. Three state-significant natural community occurrences representing three natural community types, one of which is an S3 natural community: Montane Yellow Birch-Red Spruce Forest.
2. One vernal pool greater than 200 square feet in size, which provides important amphibian habitat.
3. Habitat for black bear, and at least four beech mast stands.
4. Habitat for deer and moose, especially in an area of Hemlock Forest along a stream in the southwestern portion of the property, and in the Montane Yellow Birch-Red Spruce Forest.
5. One occurrence of structurally complex Old Forest, which offers habitat for a variety of animals.

LANDSCAPE CONTEXT

The section of the Richford-Jay Tract located north of Route 105 in the Town of Jay includes portions of the headwater bowl for Lucas Brook, which eventually drains into the Missisquoi River. The parcel ranges in elevation from 1400 feet at the western edge to 2400 feet at the northeastern corner of the parcel. A minor ridge, dominated by Montane Yellow Birch-Red Spruce Forest, runs northwest to southeast and defines the northern boundary of the property.

Rocky spruce-fir outcrops are scattered throughout the eastern portion of the parcel in the stream's upper reaches (over approximately 2200 feet), while Northern Hardwood Forest with patchy Rich Northern Hardwood Forest fills the remainder of the bowl below approximately 2200 feet in elevation. The northwestern portion of the property is noticeably wetter and richer; small seeps emerge on terraced knolls, and the forests downslope of these seeps show signs of enrichment and higher-than-average soil moisture content. The majority of these seeps converge to form intermittent streams across the hillside. Others drain into an enriched, gradually sloping cove in the center of the parcel, which contains large, healthy sugar maples, low herbaceous cover, and a sparse shrub layer. Additional seepage exists in the southern half of the property in the acreage contained by the bend in Route 105. Here, a terrace just above the river and below a series of rocky outcrops is sporadically wet, but does not show the same level of richness as that contained within the Lucas Brook bowl.

Wildlife sign is abundant throughout. Of particular note is a large beech mast stand (approximately five acres) in the northwest corner of the property, with numerous healthy beech trees, many of which contain black bear sign. Three smaller beech mast stands are located in the northern portion of the property as well. Moose sign is abundant throughout the property, especially in the hobblebush glades along the ridgeline, and in the moist Northern Hardwood Seepage Forest in the southwest portion of the property. Two vernal pools, and numerous other small wetlands (seeps) are located in the northwestern corner of the property. In the southwestern corner, deer sign is plentiful in the streamside Hemlock Forest.

Finally, there is a patch of forest with old-growth characteristics on the western portion of the ridge, which seems to drop off the back (north) side of the property into steep and inoperable terrain. The proximity of this mapped area to the well-established beech mast stand establishes the northwest corner of the property as an ecologically significant area with high wildlife value.

GEOLOGY

The Richford-Jay North tract sits entirely on quartzite schist of the Hazen's Notch Formation, a fine-grained schist common throughout the Green Mountains. The weathering of pyrite may release calcium for plant uptake in point-specific locations, although the bedrock massif is generally provides few desirable nutrients for plant uptake.

SOILS

Soils of the Richford-Jay North tract are classic upland soils of the Green Mountains. The large majority of the soils in Richford-Jay North are of the Tunbridge-Peru and Hogback-Rawsonville complex (*Table 15*). These same soils are mapped Woodstock-Rock soils in the portion of the property that is located in Franklin County. Soils adjacent to the major streams on the property are mapped as Peru fine sandy loam. The noticeable shift in soil mapping between Franklin and Orleans Counties is indicative of mapping by two different soil scientists.

TABLE 15 SOILS OF RICHFORD-JAY

Soil Series	*Acres*	*Percent*
Woodstock-Rock	1028.6	25.3%
Peru	949.6	23.4%
Tunbridge-Peru	864.1	21.3%
Hogback-Rawsonville	651.2	16.0%
Stowe	392.6	9.7%
Ricker-Londonderry-Stratton	119.2	2.9%
Tunbridge-Lyman	30.7	0.8%
Tunbridge-Woodstock	9.9	0.2%
Cabot	9.4	0.2%
Sheepscot	6.8	0.2%
	4062.1	

FEATURES OF ECOLOGICAL SIGNIFICANCE

UPLANDS

The Richford-Jay North parcel is primarily matrix forest communities, with few other natural communities embedded within (*Table 16*, *Figure 23*). The parcel is primarily Northern Hardwood Forest up to about 2100 feet in elevation, at which point Montane Yellow Birch-Red Spruce Forest gains dominance. Two small pockets of Rich Northern Hardwood Forest are present on the mid-elevation south-facing slopes, and Hemlock Forest dominates the riparian zone in the southwestern corner of the property. The western portion of the ridgeline appears very old, and a portion of this old forest contains a stand of mature, bear-marked beech.

MONTANE YELLOW BIRCH-RED SPRUCE FOREST (S3)

RJ-3, 104.4 acres, state-significant, B-rank

A Montane Yellow Birch-Red Spruce community spans the ridgeline that runs along the northern boundary of the parcel. Along the ridgeline, open yellow birch glades with dense thickets of hobblebush are interspersed with red spruce and balsam fir. On steeper slopes dipping into the drainages to the south, stands of red spruce and balsam fir prevail. Occasionally, hobblebush gives way to a carpeted floor of Canada mayflower and blue-bead lily. Moose browse, scat, and bedding sites are abundant along the ridgeline.

This community received a B-rank primarily due to its size. When considered in a landscape context, however, this community is arguably deserving of an A-rank, as the additional acreage extending off the property to the north and along the ridgeline to the south across Route 105 increases the size enough to bump it to A-rank status. I gave it a B-rank for condition because some of the lower-elevation reaches were likely logged prior to ATP ownership. I gave it an A-rank for landscape context because the area around the EO is intact vegetation of at least B-rank conditions.

RICH NORTHERN HARDWOOD FOREST (S4)

RJ-6, 18.4 acres, State-significant, B-rank

Much of the upslope seepage converges in a small area of Rich Northern Hardwood Forest in the center of the parcel. Here, the ground is covered with a dense herbaceous layer of blue cohosh, wild leeks, trout lilies, and occasional wood nettle;

shrubs are noticeably absent in the understory, and sugar maples dominate the canopy. A rocky, eroded stream cuts through the center of the forest; I believe it was once a poorly managed logging road. The soil downslope of this stream is comprised of nearly five inches of sandy, gravelly loam, (pH 6.5) on top of 12 inches of organic soil (pH 5.5). I did not reach a B- or C-layer. I believe that the sandy/gravelly substrate at the surface is derived from washout events in the dugout road, which may explain the lack of understory/shrubbery. These presumed land use factors discouraged me from assigning an A-rank condition, although this community is state-significant due to its size and landscape context.

NORTHERN HARDWOOD SEEPAGE FOREST (S3)

RJ-4, 16.6 acres, not state-significant

A 17-acre seepage forest in the southwestern corner of the property exhibits diffuse seepage with little to no richness. However, this provides a good example of how logging machinery may alter the hydrology of the site enough to dramatically change the species composition. In areas where skidder traffic or logging roads have not passed through, the forest is a matrix of upland and wetland patches, with seeps occasionally appearing from the rocky slope/outcrops above. In areas where skidder traffic has passed through, however, pooling water has given rise to sedge meadows with dominated by obligate wetland species, including nodding sedge.

RICH NORTHERN HARDWOOD SEEPAGE FOREST (S3)

RJ-7, 2 acres, not state-significant

A small 2-acre Rich Northern Hardwood Seepage Forest hugs the flanks of a Lucas Brook tributary in the northwestern portion of the property. Though small, this natural community seems to epitomize the supposed characteristics of this community type: exceptional richness, high soil moisture content, and scattered presence of facultative wetland species (*ie.,* wood nettle, false hellebore*)*.

WILDLIFE FEATURES:

BEECH MAST STAND

RJ-1, 12.4 acres

Four beech mast stands throughout the property each host more than five healthy, bear-marked beech in close proximity to one another. The stand in the northwestern corner of the property hosts a number of large, healthy beech trees, many of which are marked with bear claw marks, showing signs of use over many years. Three smaller stands also contain an abundance of large, healthy beech trees. Many of the younger, unmarked trees in these stands appear healthy and free of beech bark disease.

VERNAL POOLS

RJN-VP-1, RJN-VP-2

Two vernal pools, also in the northwestern corner of the property, may serve as amphibian breeding grounds in the early spring (*Appendix G*; see POIs_RichfordJayNorth_Phillips2017 data layer for coordinates). Although these had dried up by the time of my visit, the depressed leaves and lack of herbaceous vegetation suggests they contained standing water until recently. The eastern-most vernal pool was larger (400 square feet); the western pool was 40 square feet. The smaller pool does not meet the minimum size requirements necessary to receive special protections. VLT staff should revisit the larger pool in the spring to confirm the presence (or absence) of breeding amphibians.

HEMLOCK FOREST

RJ-2, 7.4 acres

The hemlock forest in the southwestern portion of the property contained signs of deer and moose. Despite its proximity to the road, I found the area to be surprisingly isolated and the road inaccessible because of the river ravine and steep banks to the road. Droppings, prints, and browse suggests ungulates use this area frequently.

RECOMMENDED EASEMENT PROTECTIONS

The protection recommendations made in this report are based on ecological considerations. The final easement configuration may differ from the recommended protections because of practical considerations not explored in this report. Final protections are the decision of the Vermont Land Trust and The Nature Conservancy.

Surface Water Protection Zone + 50-foot Buffer

- *Northern Hardwood Seepage Forest (RJ-4); Rich Northern Hardwood Seepage Forest (RJ-7)* — This uncommon naturally community (S3) only occurs in two other locations on the Atlas Timberlands. Although this is not a state-significant occurrence, it may be sensitive to hydrologic alteration by forest management due to the shallow, wet soils and their position on a gradual slope. As a headwater wetland, this community is likely to provide water quality protection and downstream flood resilience, and offer early spring forage for large mammals. Changes in water table depth by inadvertent draining or ponding may have a lasting impact on the resulting plant communities (please see *Appendix J* for forest management recommendations in Seepage Forests). Protections on these forests should include a 50-foot buffer to ensure that hydrologic inputs to these Seepage Forests are not disrupted by management activities.

- *Seep (RJ-8)* — the seep on Richford-Jay North may serve as important amphibian breeding habitat and produce early spring vegetation desirable to large mammals like moose and black bear.

Ecological Protection Zone

- *Montane Yellow Birch-Red Spruce Forest (RJ-3)* — this state-significant uncommon natural community (S3) is a B-ranked occurrence. This forest has well-developed glades and a dense understory of hobblebush, both of which provide excellent habitat for moose.

- *Old Forest (RJ-5)*— This old forest provides habitat for a variety of animals in the form of standing and downed woody debris. Additionally, it serves as a carbon sink, an important landscape feature as global carbon emissions continue to rise.

Forest Management Plan and Easement Attribute Language

- *Beech Mast Stand (RJ-1)* — The beech mast stand on Richford-Jay North offers critical black bear habitat and contains mature individuals free of beech bark disease. Forest management in these areas should emphasize retention of disease-free and mast-producing individuals.

- *Rich Northern Hardwood Forest (RJ-6)*— The state-significant Rich Northern Hardwood Forest community hosts plant species which depend on nutrient enrichment, a site condition created by the downslope migration of organic matter in a process called colluviation. So long as forest management preserves the processes that give rise to these communities, this community will tolerate active management.

Vernal Pool Special Treatment Area

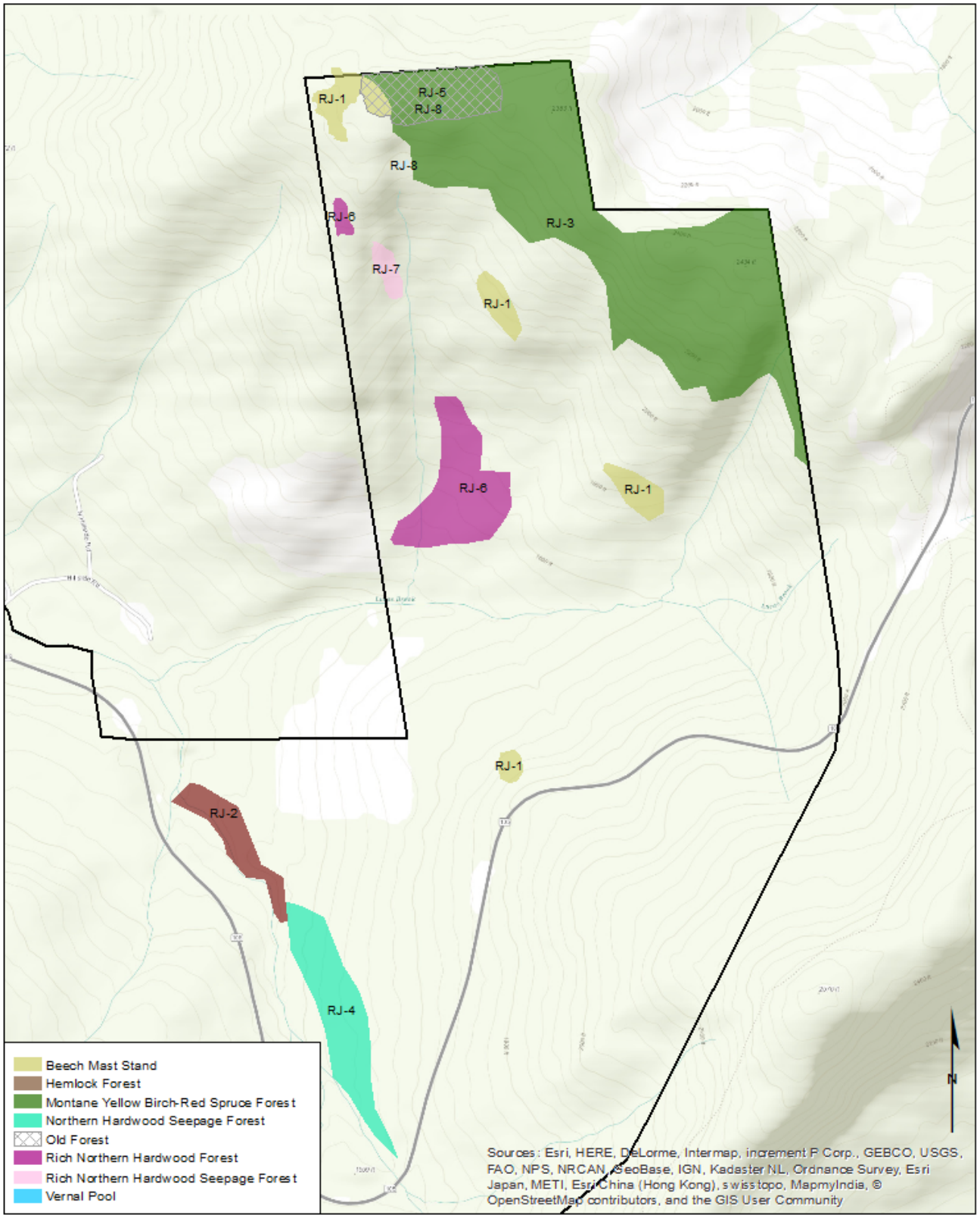
- *Vernal Pool (RJN-VP-2)* — If a spring survey reveals that this vernal pools is used as an amphibian breeding ground, it should be protected under the Vernal Pool Special Treatment Area clause, with 100-foot primary and 500-foot secondary buffer zones. These restrictions will ensure the maintenance of natural features necessary to preserve desirable habitat (ex. canopy cover, shade, downed woody debris, etc.).

ACCOMPANYING FILES

Richford-Jay North Geodatabase

- *NatComms_RichfordJayNorth_Phillips2017*: Polygon feature of state-significant natural communities, significant wildlife habitat, and other ecologically significant areas (including old forest). This file contains Natural Heritage Rankings and easement protection recommendations in accordance with VLTs easement provisions. Overlay POIs for more detail about field observations.
- *POIs_RichfordJayNorth_Phillips2017*: Point features containing field notes, which include species observations, rare/uncommon plant element occurrence data, land use alteration notes, and other general field observations.
- *Tracks_RichfordJayNorth_Phillips2017:* Line features showing path taken on field days.

FIGURE 23 ECOLOGICALLY SIGNIFICANT FEATURES OF RICHFORD-JAY NORTH

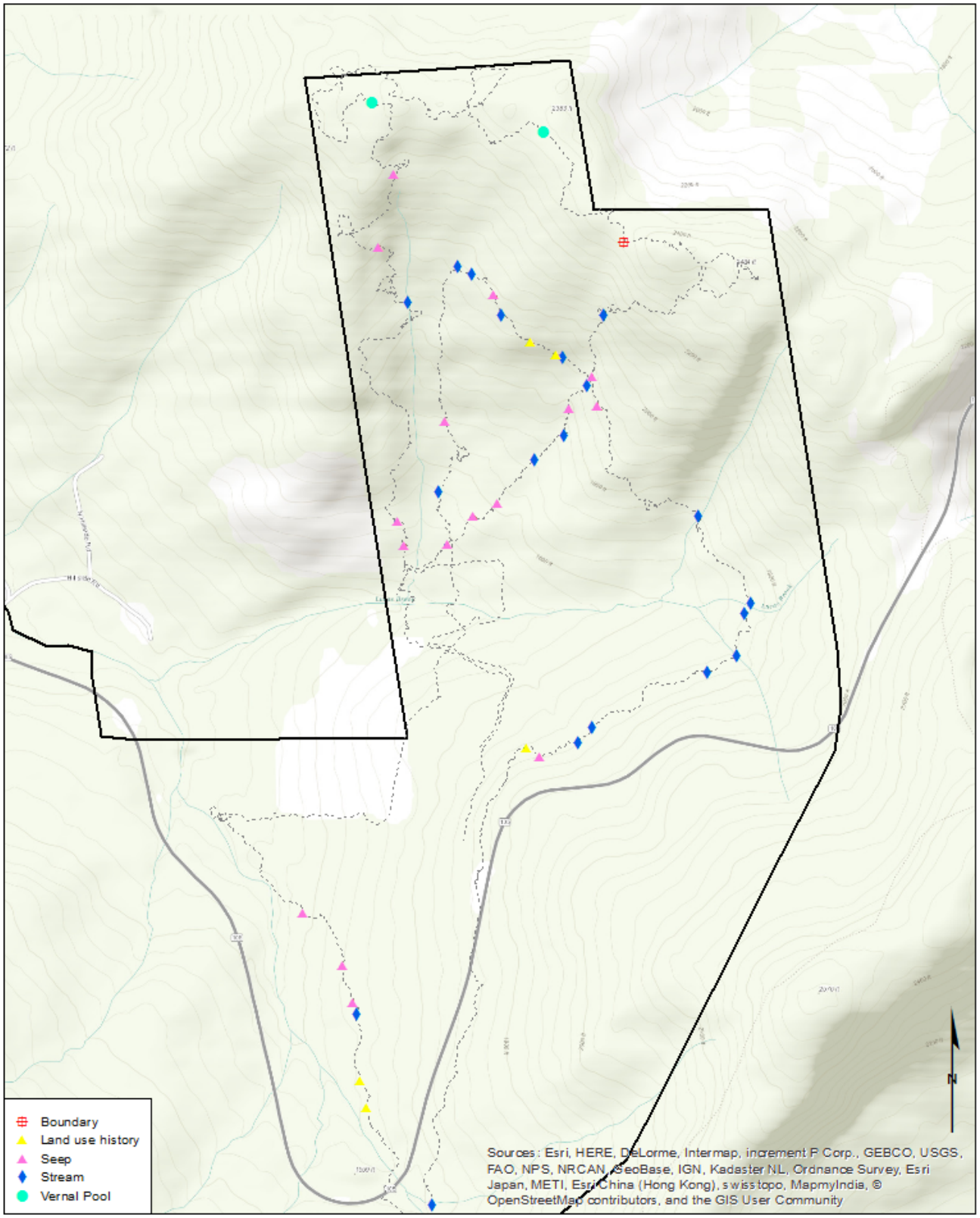


Map created by Hannah Phillips
UVM Ecological Planning Program
Field work 5/31 and 6/1/2016

Atlas Timberlands Partnership
Richford-Jay North Resource Map

0 0.1 0.2 0.4 Miles

FIGURE 24 POINTS OF INTEREST OF RICHFORD-JAY NORTH

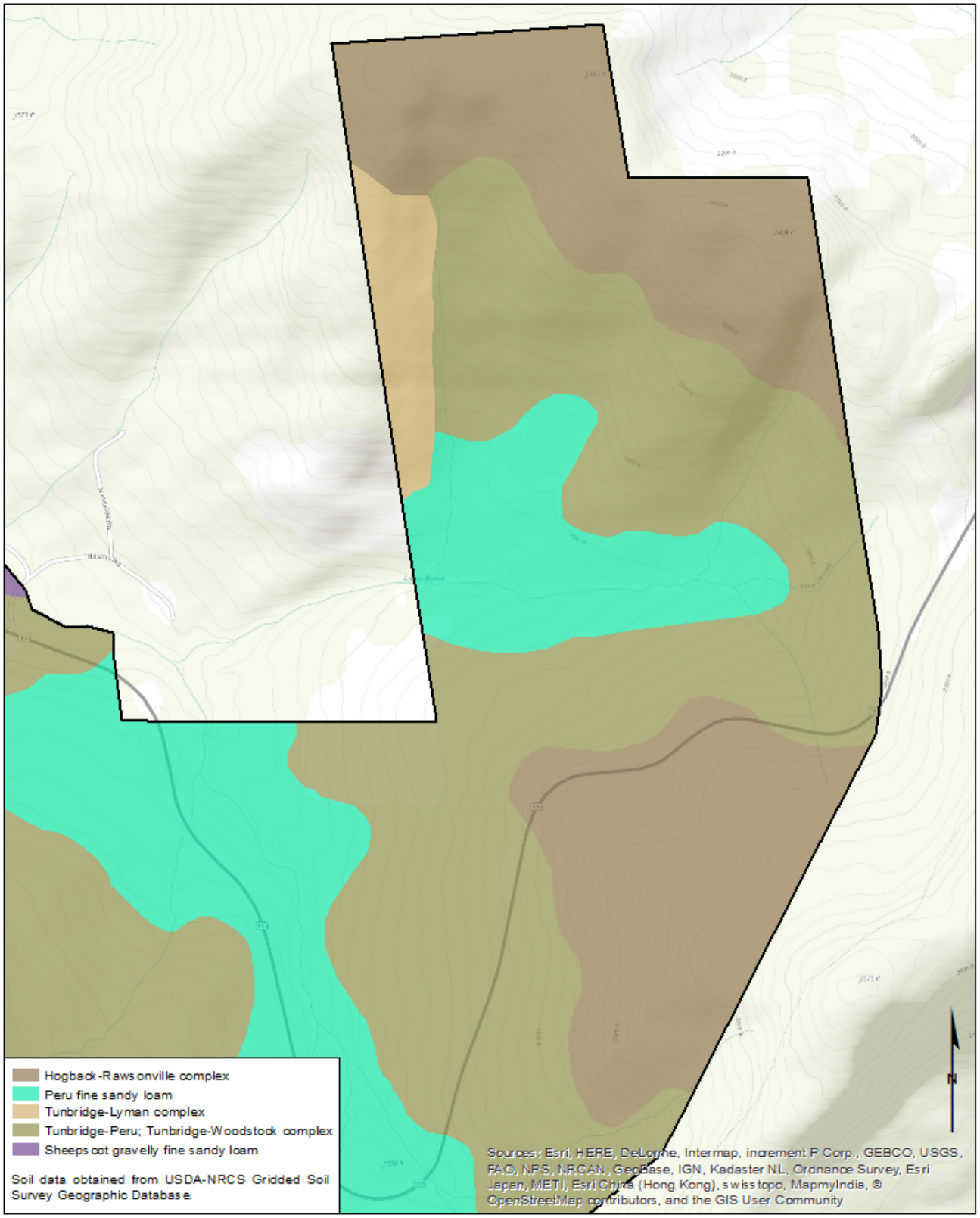


Map created by Hannah Phillips
UVM Ecological Planning Program
Field work 5/31 and 6/1/2016

Atlas Timberlands Partnership
Richford-Jay North Points of Interest

0 0.1 0.2 0.4 Miles

FIGURE 25 SOILS OF RICHFORD-JAY NORTH



Map created by Hannah Phillips
UVM Ecological Planning Program
Field work 5/31 and 6/1/2016

Atlas Timberlands Partnership
Richford-Jay North Soils Map

0 0.1 0.2 0.4 Miles

TABLE 16 NATURAL COMMUNITY RANKINGS AND SIGNIFICANT WILDLIFE HABITAT OF RICHFORD-JAY NORTH

SID	Natural Community	Acres	State Rareness Rank	State-significant?	EO Rank	Description	Rank Size	Rank Condition	Rank Landscape Context	Recommended Additional Protections	ESTA Eligible?
RJ-1	Beech Mast Stand	12.4	—	—	—		—	—	—	Forest Management Plan, easement attributes	—
RJ-2	Hemlock Forest	7.4	S5	—	—		—	—	—	—	—
RJ-3	Montane Yellow Birch-Red Spruce Forest	104.4	S3	Y	B	Moose sign all over, gladed throughout, hobblebush, sugar maple, paper birch, yellow birch, marginal wood fern, pink lady's slipper	C	A	B	EPZ	Y
RJ-4	Northern Hardwood Seepage Forest	16.6	S3	N	C	Sugar maple, beech, black cherry, nodding sedge, cinnamon fern, northeastern mannagrass	C	C	B	SWPZ+50'buffers	Y
RJ-5	Old Forest	11.5	—	—	—		—	—	—	EPZ	Y
RJ-6	Rich Northern Hardwood Forest	18.4	S4	Y	B	Sensitive fern, Canada violet, blue cohosh, foamflower, wood nettle, zig-zag goldenrod, golden saxifrage, dwarf raspberry, lamb's quarters, lady fern	C	B	B	Forest Management Plan, easement attributes	—
RJ-7	Rich Northern Hardwood Seepage Forest	2.0	S3	N	C	False hellebore, Dutchmen's breeches, wild leeks, foamflower, wood nettle	D	B	B	SWPZ+50'buffers	Y
RJ-8	Seep	0.1	S4	Y	B	Foamflower, wood nettle, sedges, red maple, yellow birch, Canada violet, blue cohosh, wild leeks, balsam fir, *Sphagnum*, prop roots	C	A	B	SWPZ+50'buffer	Y

RICHFORD-JAY SOUTH FIELD REPORT

ATLAS TIMBERLANDS ECOLOGICAL ASSESSMENT

PREPARED BY HANNAH PHILLIPS
UVM ECOLOGICAL PLANNING PROGRAM
SITE VISITS ON JUNE 6, 8, 14 2016

RICHFORD-JAY SOUTH FIELD REPORT

Prepared by Hannah Phillips, UVM Ecological Planning Program
Fieldwork conducted on 6, 8, 14 June 2016

The Richford-Jay South parcel contains the following significant ecological features, which are recommended for mention in the conservation easement:

1. Seven state-significant natural community occurrences representing four natural community types, three of which are ranked as S3 or higher: Montane Spruce-Fir Forest, Montane Yellow Birch-Red Spruce Forest., and Montane Seepage Forest.
2. Headwater wetlands (Montane Seepage Forest), which offer water quality protection, flood resilience, herbaceous forage for large mammals, and habitat for amphibians and uncommon plants.
3. Two vernal pools greater than 200 square feet in size, which provide important amphibian breeding habitat.
4. Habitat for deer and moose, including a possible 14-acre deer wintering yard.

LANDSCAPE CONTEXT

Route 105 South

South of Route 105, an east-west ridge with north-facing slopes, drains into the Lucas Brook watershed (described in detail the Richford-Jay 105 North report). A series of smaller peaks comprise the ridgeline, originating with an unnamed peak (2348 feet) in the west, and terminating in the east on North Jay Peak (3438 feet). A band of rocky outcrops traverses the ridgeline at approximately 2600 feet, above which shallow-to-bedrock soils give rise to Montane Spruce-Fir Forest. Below this band of outcrops, organic soils underlain by post-glacial deposits (till) support Montane Yellow Birch-Red Spruce Forest and Northern Hardwood Forest communities. Soils are noticeably wetter below this system of outcrops; seeps appear in regular intervals on terraced plateaus, and the forest communities downslope of these terraces host plant species indicative of higher-than-average soil moisture content. Although this area has likely seen regular logging in the past due to its accessibility and proximity to Route 105, the band of Montane Yellow Birch-Red Spruce Forest immediately below the outcrop system appears to be in remarkably good condition, and perhaps quite old. This area was recently harvested (2014) up to about 2000 feet elevation. Areas that were recently harvested were not closely assessed for forest richness/seepage, as many clues indicating natural communities have been obscured by early successional vegetation.

Stanhope Brook Basin

Stanhope Brook emerges from the steep western flanks of North Jay Peak, bounded on the north and south by ridgelines comprising minor summits. The upper reaches of the central bowl are dominated by steep slopes, which encourage stream channelization and discourage seepage in the adjacent forests. Perhaps due to these drier soils, the Montane Spruce-Fir Forest community creeps lower in elevation than elsewhere on the parcel, descending to approximately 2500 feet. Bedrock outcrops appear regularly along the southern rim of the bowl, disappearing as slopes become shallower to the west. There, in the southwest corner of the property, a series of seeps within the Montane Yellow-Birch Red Spruce Forest trickle downslope into Northern Hardwood Forest, giving rise to elevated richness. Along the northern rim of the bowl, a similar outcrop-terrace landform constrains a narrow band of unclassified wetlands, which are surrounded by yellow birch, red spruce, and balsam fir, and have a boreal feel. Of particular note here, and elsewhere in the Stanhope Brook Basin, is the abundance of moose sign. Throughout the bowl, moose browse was obvious on the hobblebush in the yellow birch glades, moose beds and scat were abundant, and paths of travel were well worn. The northern rim of the Stanhope Brook basin

was particularly well-traveled; the open glades, flat topography, and remote location provide exceptional moose habitat. Records indicate this portion of the property has not been harvested since ATP acquired the property.

Stanhope Basin South

This north-facing ridge runs approximately 2.5 miles from the Stanhope Brook basin west, ranging in elevation from 1500 feet to nearly 3000 feet at the peak of the highest unnamed summit along the ridgeline. This portion of the parcel gives rise to a number of unnamed tributaries of Stanhope Brook. Of particular significance on this portion of the Richford-Jay parcel are the recurring seepage glades, which emerge predictably below a line of bedrock outcrops at approximately 2500-2600 feet in the Montane Yellow Birch-Red Spruce forest community on a system of terraces. The forest downslope of these seepage glades exhibits seepage characteristics, and aerial photos of this area reveal the gradual formation of dendritic headwater streams, preceding the convergence of an established tributary. This north-facing slope offers a top-notch example of headwater systems, the landforms that give rise to these systems, and their ecological function and conservation value. Also of note in this portion of the property is the forest structure and age in the yellow birch glades. Large canopied yellow birch appear open grown and old; further field work is needed to determine the age and land use history of this parcel. This portion of the parcel has not been harvested since ATP acquired the property.

GEOLOGY

The majority of the Richford-Jay tract sits on quartzite schist of the Hazen's Notch Formation. Schists of the Jay Peak Formation and the Fayston Formation intrude into the property from the west, both of which are common throughout the Green Mountains. Three small outcrop of talc-carbonate ultramafic bedrock are documented in the upper reaches of the Stanhope Brook basin.

SOILS

Soils of the Richford-Jay South tract are classic upland soils of the Green Mountains (*Figure 28*). The large majority of the soils are of the Rock outcrop-Woodstock complex, which is mapped as Tunbridge-Lyman, Tunbridge-Peru, and Hogback-Rawsonville complex on the half of the property that is located in Orleans County (*Table 15*). Streambeds are mapped as Stowe stony soils, while the lower reaches of the mountain slopes (adjacent to the streams) are mapped as Peru fine sandy loam. The noticeable shift in soil mapping between Franklin and Orleans Counties is indicative of mapping by two different soil scientists.

FEATURES OF ECOLOGICAL SIGNIFICANCE

The uplands of Richford-Jay South are significant for the high elevation forest types they support: Montane Spruce-Fir and Montane Yellow Birch-Red Spruce Forest. Both are part of larger element occurrences that are A-ranked in size and offer some of the most extensive examples of these natural community types in the state. Equally significant on this parcel is the 48.9-acre Montane Seepage Forest (RJ-13), which spans the north-facing slopes of the Stanhope Brook watershed just below the point of contact between the two high-elevation forest types. These headwater wetlands occur in gladed openings in the Montane Yellow Birch-Red Spruce Forest and have both ecological value—as habitat for uncommon plants and as amphibian breeding habitat— and value to humans by offering water quality protection and downstream flood resilience. The emerging significance of this wetland type warrants careful consideration; they may be deserving of a "headwater wetland zone" protection.

UPLANDS

MONTANE SPRUCE-FIR FOREST (S3)

RJ-20 (333 acres, state-significant, A rank)

A Montane Spruce-Fir Forest community covers the ridgelines of the Richford-Jay parcel, radiating from the summit of North Jay Peak (3384 feet), beginning at around 2800 feet (*Figure 26*). The forest community consistently covers the ridge dividing the Stanhope Brook and Lucas Brook watersheds, and sporadically enters the property along the ridgeline in the Stanhope Brook South section of the property as the minor summits rise and fall in elevation. This community reliably dominates above the major bedrock outcrops outlined above, where shallow-to-bedrock dry soils and steep slopes prevail.

This community received a B-rank for size. However, when ranked for size according to the true extent of the natural community, it receives an A-rank. I gave it a B-rank for condition, because it is still recovering from logging activities prior to ATP ownership, during which red spruce was likely selectively logged from the upper reaches of this parcel. Finally, I gave an A-rank for landscape context, as adjacent communities are intact and A-rank condition. These three ratings combined qualify this parcel as an A-ranked, S3, state-significant natural community.

MONTANE YELLOW BIRCH-RED SPRUCE FOREST (S3)

RJ-18 (1073 acres, state-significant, A rank)

The Montane Yellow Birch-Red Spruce Forest flanks the higher elevations of the ridgelines contained within the Richford-Jay parcel, ranging from approximately 2200 feet to 2800 feet. This natural community hosts many of the significant ecological features on this property, as it hosts functional headwater zones characterized by seeps/seepage glades, highest-order headwater streams, patches of old forest, and open hobblebush-yellow birch glades that are hotspots for moose activity. As an extensive and well-developed example of this community type in northern Vermont, management activities within this community should be prohibited to preserve the wide range of ecological functions it provides.

This community received an A-rank for size, a B-rank for condition (although there are excellent examples of old forest interspersed in the community, there are also numerous instances where past logging practices altered the forest structure, perhaps by selectively removing red spruce), and an A-rank for landscape context, as adjacent communities are of at least B-rank condition.

RICH NORTHERN HARDWOOD FOREST (S4)

RJ-17 (50 acres, state-significant, B rank)

A large patch of Rich Northern Hardwood Forest radiates down a north-facing slope in the Stanhope Brook basin, gaining richness and moisture from upslope seepage glades. Wild leeks blanket the ground, while regular patches of blue cohosh and wood nettle cover sites of exceptional richness. Evidence of past logging remains in this area, as rich site species reclaim ground in old logging roads that have become sedge and grass dominated. Although these logging roads call to question the impact of land use history on hydrology and therefore on displayed richness, the higher elevation reaches of this forest lack evidence of this past disturbance and still display rich-site indicators. Care should be taken to avoid this area with logging equipment when the ground is soft. This area received a B-rank for size, C-rank for condition, and A-rank for landscape context (conditions are conducive to a larger patch size), which combine to offer a B-rank EO ranking.

RJ-19 (10 acres, not state-significant)

A 10-acre patch of Rich Northern Hardwood Forest was delineated amidst recent logging slash (2014). Because this delineation was made based on sporadic herbaceous cover (occasionally overtaken by early successional vegetation), similar topography/land form, and aerial photos, it is recommended that the boundary of this natural community be

reassessed as the forest matures (reassess again in 10 years). This forest received a C-rank for size, a C-rank for condition (despite the logging above, the soil profile remains intact and hydrologic conditions on site are preserved), and an A-rank for landscape context, because the surrounding conditions appear conducive to a natural community of greater extent.

WETLANDS

MONTANE SEEPAGE FOREST (RJ-11, RJ-13, RJ-16)

The extensive seepage glades that occur primarily on the north-facing slopes within the Richford-Jay tract may provide amphibian breeding habitat for native herpetofauna, and may also provide early-spring and summer forage for black bears. These seepage glades tend to occur below rocky outcrops at the transition point between Montane Yellow Birch-Red Spruce Forest and Montane Spruce-Fir Forest. Common plants within include crested wood fern, false hellebore, long beech fern, trout lily, dwarf raspberry, boreal bedstraw, and broad-leaved twayblade. Vegetation from the surrounding upland community, including hobblebush and mountain wood fern, generally subsides within the seepage glade. See *Appendix K* for a thorough description of the Montane Seepage Forests on Richford-Jay South.

WILDLIFE FEATURES:

MONTANE YELLOW BIRCH-RED SPRUCE FOREST

Large open-grown yellow birch glades distributed between 2300 feet and 2500 feet in elevation offer excellent moose habitat, and show extensive signs of browse (on hobblebush), bedding, and travel. These areas should be protected with Ecological Protection Zone that extends over the entirety of the Montane Yellow Birch-Red Spruce Forest.

VERNAL POOLS (S3)

Five vernal pools are located throughout Richford-Jay South (*Appendix G*; see POIs_RichfordJaySouth_Phillips2017 data layer for coordinates). Two of these vernal pools meet the Vermont Land Trust criteria for a Vernal Pool Special Treatment Area pending the results of a spring survey to identify presence or absence of breeding amphibians. Vernal pools must be greater than 200 square feet in size and naturally occurring.

- RJS-VP-2 (300 square feet) – In talus/yellow birch glades at the base of a cliff. The vernal pool is small, and I observed no egg masses, amphibians or tadpoles. Canopy coverage was excellent.
- RJS-VP-3 (600 square feet) – Located in the Montane Yellow Birch-Red Spruce Forest on the north-facing slopes in the Stanhope Brook basin south drainage. No amphibians or egg masses were observed. Some spots in the vernal pool were still wet at the time of my visit, but there was no longer standing water.

SEEP (S4)

RJ-12 (4.6 acres, state-significant, A rank)

Two long wetlands (1-acre; 3.5acres) run east-west in a trough on a south-facing slope of the Stanhope Brook basin. Although these wetlands exhibit many of the same plants characteristic of seeps and seepage glades, the landform is unique in that it appears to funnel water through a long, narrow channel, rather than allowing it to seep out. As a result, bryophyte mats have developed sporadically throughout the wetlands. A near-neutral pH and a plant assemblage characteristic of seeps suggest that water does not remain stagnant in the wetlands for long. Moose tracks were present throughout the wetlands; browse and early-spring/summer vegetation may make this an important site for moose, bears, as well as amphibians that use this as a breeding or overwintering site.

RJ-14 (11.4 acres, state-significant, A rank)

A number of small seeps within the Northern Hardwood Forest dot the north-facing hillside of the Stanhope Brook basin. Located downslope of the Montane Seepage Forest (RJ-13), these are hydrologically connected, but the steepness of the slope makes it so that the water occasionally coalesces into a stream, and then pools up in small seeps and pools on benches and in the flats. Additionally, small outcrops occasionally produce new small seeps.

DEER WINTERING YARD (RJ-15)

A 14-acre deer wintering area, composed primarily of red-spruce and balsam fir, occurs on a rocky outcrop at the transition point between Montane Yellow Birch-Red Spruce Forest and Northern Hardwood Forest. Deer scat was observed throughout the stand, and moose browse was abundant in the hobblebush surrounding the stand. It is not apparent whether this area is truly used during the winter time; its small size and location on a north-facing slope may detract from its value as a low-snow zone.

RECOMMENDED EASEMENT PROTECTIONS

Surface Water Protection Zone + 50-Foot Buffers

- *Montane Seepage Forest (RJ-11, RJ-13, RJ-16)*— These state-significant uncommon natural communities (S3) may be sensitive to hydrologic alteration by forest management due to the shallow, wet soils. As headwater wetlands, these communities likely provide water quality protection and downstream flood resilience, and offer early spring forage for large mammals. Changes in water table depth by inadvertent draining or ponding may have a lasting impact on the resulting plant communities (please see *Appendix J* for forest management recommendations in Seepage Forests). Protections on these forests should include a 50-foot buffer to ensure that inputs to these Seepage Forests are not disrupted by management activities.

- *Seeps (RJ-12, RJ-14)*— The seeps on Richford-Jay South may serve as important amphibian breeding habitat, and also produce early spring vegetation desirable to large mammals like moose and black bear.

Ecological Protection Zone

- *Montane Yellow Birch-Red Spruce Forest (RJ-18)*— This state-significant uncommon natural community (S3) is an A-ranked occurrence. This forest has well-developed glades and a dense understory of hobblebush, both of which provide excellent wildlife habitat for moose.

- *Montane Spruce-Fir Forest (RJ-20)*— This state-significant uncommon natural community (S3) is an A-ranked element occurrence. It affords excellent high-elevation wildlife habitat with mature trees. These forests may also become reduced in size as the climate warms.

Forest Management Plan and Easement Attribute Language

- Deer Wintering Yard (RJ-15)— A 14-acre softwood stand, composed primarily of red-spruce and balsam fir, may serve as a deer wintering yard for white-tailed deer. Forest management in this area should take care not to disrupt this important wildlife resource.

- *Rich Northern Hardwood Forest (RJ-17)*— This state-significant Rich Northern Hardwood Forest community hosts plant species which depend on nutrient enrichment, a site condition created by the downslope migration of organic matter in a process called colluviation. So long as forest management preserves the processes that give rise to these communities, this community will tolerate active management.

Vernal Pool Special Treatment Area

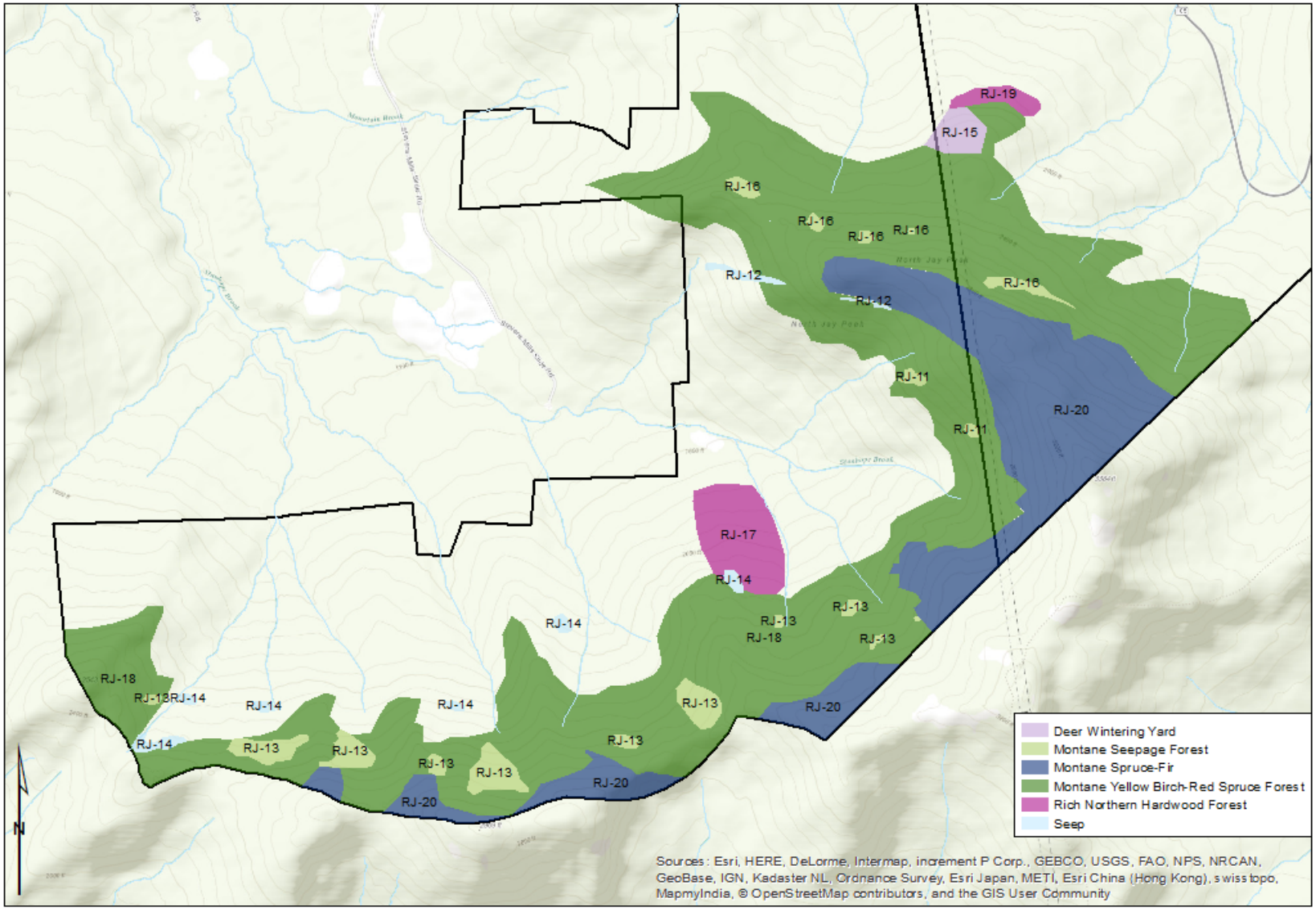
- *Vernal Pools (RJS-VP-2, RJS-VP-3)*— If a spring survey reveals that these vernal pools are used as amphibian breeding habitat, they should be protected under the Vernal Pool Special Treatment Area clause, with 100-foot primary and 500-foot secondary buffer zones. These restrictions will ensure the maintenance of natural features that create desirable habitat (ex. canopy cover, shade, downed woody debris, etc.).

ACCOMPANYING FILES

RichfordJaySouth_AtlasTimberlands_Phillips2017.gdb

- POIs_RichfordJaySouth_Phillips2017: Point file featuring points of interest from field work
- NatComms_RichfordJaySouth_Phillips2017: Polygon file featuring natural communities, element occurrence rankings, significant wildlife habitat, and recommended additional protections
- Tracks_RichfordJaySouth_Phillips2017: Tracks of field path taken on field days

FIGURE 26 ECOLOGICALLY SIGNIFICANT FEATURES OF RICHFORD-JAY SOUTH

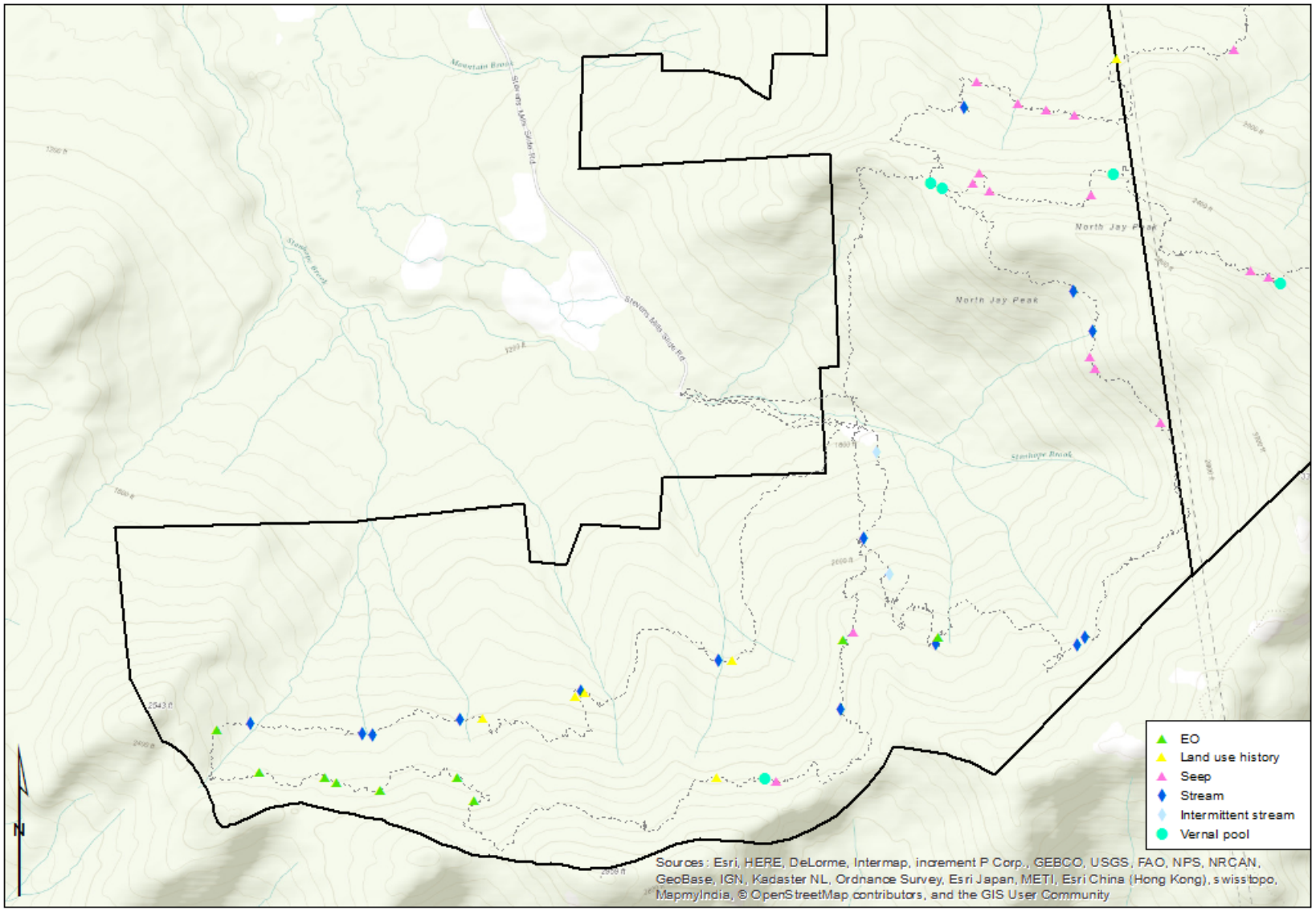


Map created by Hannah Phillips
UVM Ecological Planning Program
Fieldwork conducted in June 2016

Atlas Timberlands Partnership
Richford-Jay South Resource Map

0 0.175 0.35 0.7 Miles

FIGURE 27 POINTS OF INTEREST ON RICHFORD-JAY SOUTH

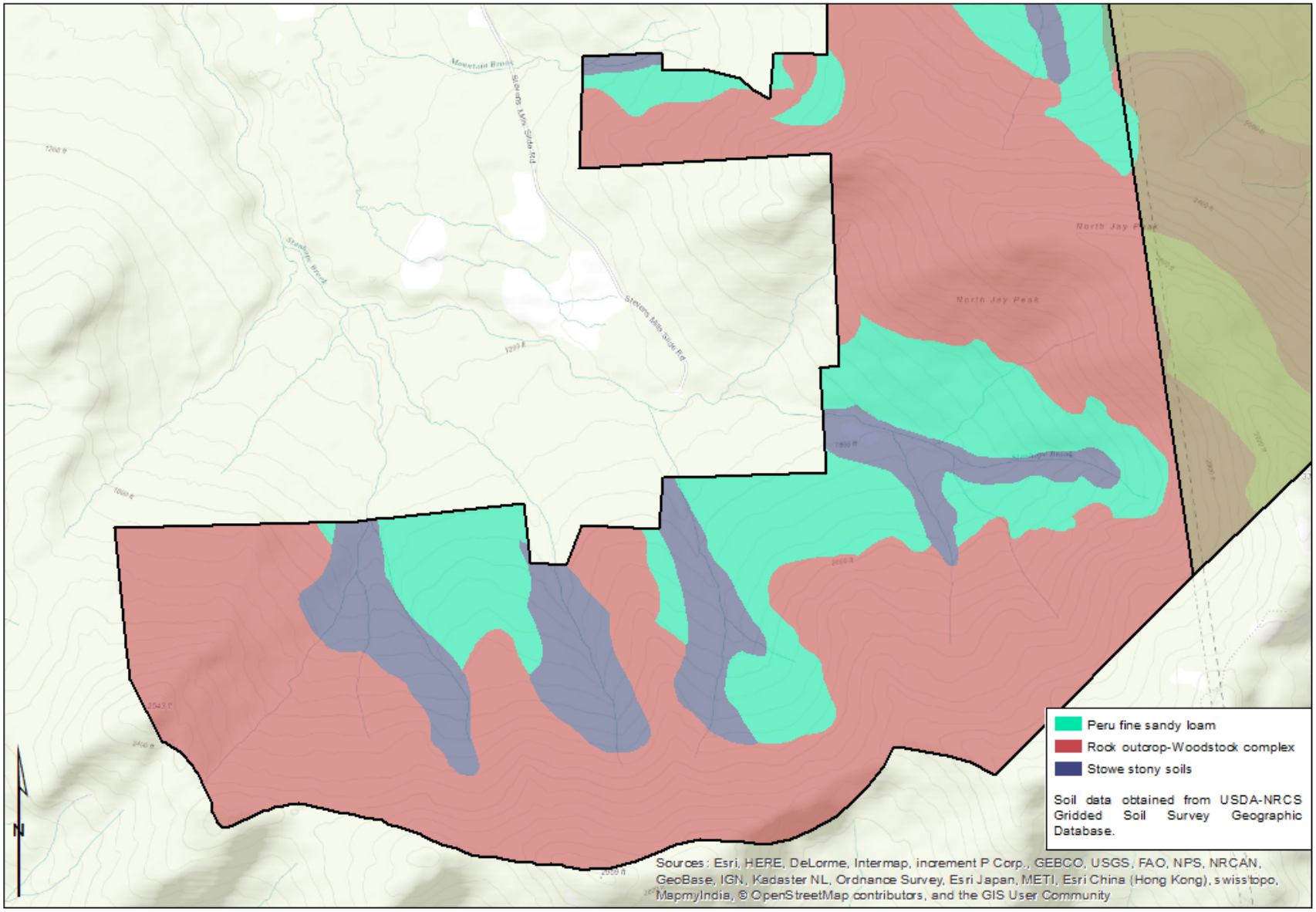


Map created by Hannah Phillips
UVM Ecological Planning Program
Fieldwork conducted in June 2016

Atlas Timberlands Partnership
Richford-Jay South Points of Interest

0 0.15 0.3 0.6 Miles

FIGURE 28 SOILS OF RICHFORD-JAY SOUTH



Map created by Hannah Phillips
UVM Ecological Planning Program
Fieldwork conducted in June 2016

Atlas Timberlands Partnership
Richford-Jay South Soil Map

0 0.15 0.3 0.6 Miles

TABLE 17 NATURAL COMMUNITY RANKINGS AND SIGNIFICANT WILDLIFE HABITAT OF RICHFORD-JAY SOUTH

Site ID	Natural Community	Size (Acres)	Rarity Rank	State-significant?	Rank Sum	Description	Rank Size	Rank Condition	Rank Landscape Context	Recommended Protection	ESTA Eligible?
RJ-11	Montane Seepage Forest	3.1	S3	N	C	Seepy cove. Back in sugar maples. Looks like logging happened here but no stumps.	D	B	B	SWPZ + 50' buffer	Y
RJ-12	Seep	4.6	S4	Y	A	Paper birch, red spruce, balsam fir, sphagnum, false hellebore, raised roots	A	A	A	SWPZ + 50' buffer	Y
RJ-13	Montane Seepage Forest	48.9	S3	Y	A	Boreal bedstraw, mountain wood fern, nodding sedge, bladder sedge, false hellebore, bluebead lily, purple-stemmed American aster, trout lily, long beech fern, wild leeks, sphagnum, common strawberry, broad-leaved twayblade, This community is unranked because the Natural Heritage ranking specifications were not complete at the time of this report. This is likely a state-significant element occurrence.	B	A	B	SWPZ + 50' buffer	Y
RJ-14	Seep	11.4	S4	Y	A	Wood nettle, lady fern, wild millet, blue cohosh, foamflower, northeastern mannagrass, purple-stemmed American aster.	A	B-some impact of logging on drainage	B-logging in surrounding forest	SWPZ + 50' buffer	Y
RJ-15	Deer Wintering Yard	14.0	—	—	—	Red spruce, yellow birch, dense balsam fir	—	—	—	Forest Management Plan, easement attributes	—
RJ-16	Montane Seepage Forest	11.0	S3	Y	B	Boreal bedstraw, Braun's holly fern, Canada violet, zig-zag goldenrod, pale touch-me-not, tall meadow rue, bladder sedge, wood nettle, false hellebore.	C	A	B	SWPZ + 50' buffer	Y
RJ-17	Rich Northern Hardwood Forest	50.1	S4	—	B	Recovering from logging. Wood nettle, blue cohosh, wild leeks, touch-me-not, sugar maple, Canada violet, *Nabulus* sp., Braun's holly fern, squirrel corn,	B	C-recovering from logging; roads pass through	A-conditions conducive to more extensive patch	Forest Management Plan, easement attributes	—
RJ-18	Montane Yellow Birch-Red Spruce Forest	1073.2	S3	Y	A	Elevational limits of natural community noted during field work. Boundary mapped remotely via aerial imagery.	A	B- recovering from logging	A	EPZ	Y
RJ-19	Rich Northern Hardwood Forest	10.0	S4	N	C	Logged. Wild leeks, Canada violet, wood nettle.	C	C-recently logging; nearly indistinguishable	A-conditions conducive to larger extent	—	—
RJ-20	Montane Spruce-Fir Forest	333.0	S3	Y	A	Lower elevational limit of natural community noted during field work. Boundary mapped remotely via aerial imagery.	B	A	A	EPZ	Y

APPENDICES

ATLAS TIMBERLANDS ECOLOGICAL ASSESSMENT

PREPARED BY HANNAH PHILLIPS
UVM ECOLOGICAL PLANNING PROGRAM

Vermont Land Trust

The Nature Conservancy

APPENDIX A. PLANT SPECIES MENTIONED IN THE TEXT SORTED BY LATIN NAME

Reference text: New England Wildflower Society GoBotany [2.5] (2017).

Rare, threatened, or endangered species are shown in bold, with state rarity and global rarity following in parentheses.

By Latin Name	
Latin Name	Common Name
Abies balsamea (L.) P. Mill.	Balsam fir
Acer rubrum L.	Red maple
Acer saccharum Marsh.	Sugar maple
Acer spicatum Lam.	Mountain maple
Actaea pachypoda Ell.	Doll's eyes
Adiantum pedatum L.	Maidenhair fern
Agrimonia striata Michx.	Roadside agrimony
Allium tricoccum Ait.	Wild leeks
Alnus incana L. Moench	Speckled alder
Anaphalis margaritacea (L.) Benth. & Hook. f.	Pearly everlasting
Angelica atropurpurea L.	Purple-stemmed angelica
Arceuthobium pusillum Peck	Dwarf mistletoe
Arisaema triphyllum (L.) Scott	Jack-in-the-pulpit
Asclepius syriaca L.	Common milkweed
Asplenium trichomanes L.	Maidenhair spleenwort
Athyrium angustum (Willd.) C. Presl.	Northern lady fern
Betula alleghaniensis Britt.	Yellow birch
Botrychium virginianum (L.) Sw.	Rattlesnake fern
Calamagrostis canadensis (Michx.) Beauv.	Bluejoint grass
Calla palustris L.	Water arum
Caltha palustris L.	Marsh-marigold
Carex annectens (Bickn.) Bickn.	Yellow-fruited sedge
Carex flava L.	Yellow-green sedge
Carex gynandra Schwein.	Nodding sedge
Carex intumescens Rudge	Bladder sedge
Carex magellanica Lam.	Boreal bog sedge
Carex plantaginea Lam.	Plantain-leaved sedge
Carex scabrata Schwein.	Scabrous sedge
Carex stricta Lam.	Tussock sedge
Carex trisperma Dewey	Three-seeded sedge
Caulophyllum thalictroides (L.) Michx.	Blue cohosh
Chamaedaphne calyculata (L.) Moench	Leatherleaf
Chelone glabra L.	Turtlehead
Chenopodium album L.	Lambsquarters
Chrysosplenium americanum Schwein. ex Hook.	Golden saxifrage
Claytonia caroliniana Michx.	Carolina spring-beauty
Clematis virginiana L.	Virgin's bower
Comarum palustre L.	Marsh-cinquefoil
Corallorhiza trifida Chatelain	Early coral root
Cornus canadensis (L.) Aschers. & Graebn.	Flowering dogwood
Corylus cornuta Marsh.	Beaked hazelnut
Cypripedium acaule Ait.	Pink lady's slipper
Cystopteris fragilis (L.) Bernh.	Fragile fern
Deparia acrostichoides (Sw.) M. Kato	Silvery glade fern
Dicentra canadensis (Goldie) Walp.	Squirrel corn

Dicentra cucullaria (L.) Bernh.	Dutchman's-breeches
Diplazium pycnocarpon **(Spreng.) M. Broun**	**Narrow-leaf glade fern (S3)**
Dryopteris campyloptera (Kunze) Clarkson	Mountain wood fern
Dryopteris goldiana (Hook. ex Goldie) Gray	Goldie's wood fern
Dryopteris marginalis (L.) Gray	Marginal wood fern
Epipactis helleborine (L.) Crantz	Helleborine
Equisetum spp.	Horsetail
Erythronium americanum Ker-Gawl.	American trout-lily
Eupatorium perfoliatum L.	Boneset thoroughwort
Eutrochium fistulosum(Barratt) E.E. Lamont	Joe-pye weed
Fragaria virginiana Duchesne	Common strawberry
Fraxinus nigra Marsh.	Black ash
Galium aparine L.	Scratch bedstraw
Galium circaezans Michx.	Forest licorice bedstraw
Galium kamtschaticum **Stellar ex. J.A. & J.H. Schultes**	**Boreal bedstraw (S3)**
Gaultheria hispidula (L.) Muhl. ex. Bigelow	Creeping snowberry
Geranium robertianum L.	Herb robert
*Geum rivale*L.	Water avens
Glyceria melicaria (Michx.) F.T. Hubbard	Northeastern mannagrass
Gymnocarpium dryopteris (L.) Newman	Oak fern
Hydrocotyle americana L.	Marsh-pennywort (american)
Hydrophyllum virginianum L.	Eastern waterleaf
*Hypericum ellipticum*Hook.	Pale St. John's-wort
Ilex mucronata (L.) M. Powell, Savol., & S. Andrews	Mountain holly
Impatiens spp.	Touch-me-not
Iris versicolor L.	Blue iris
Kalmia angustifolia L.	Sheep laurel
Kalmia polifolia Wangenh.	Bog laurel
Laportea canadensis (L.) Weddell	Wood nettle
*Lychnis flos-cuculi** L.	Ragged robin lychnis
Lysimachia borealis (Raf.) U. Manns & A. Anderb.	Starflower
Maianthemum canadense Desf.	Canada mayflower
Matteuccia struthiopteris (L.) Todaro	Ostrich fern
Milium effusum L.	Wild millet
Mimulus moschatus **Dougl. ex Lindl.**	**Musky monkey-flower (S3)**
Neottia convallarioides **(Sw.) Rich.**	**Broad-leaved twayblade (S3)**
Oenothera parviflora L.	Small-flowered evening-primrose
Onoclea sensibilis L.	Sensitive fern
Osmunda cinnamomea (L.) C. Presl	Cinnamon fern
Osmunda claytoniana L.	Interrupted fern
Osmunda regalis L.	Royal fern
Oxalis montana Raf.	Wood sorrel
Panax trifolius L.	Dwarf ginseng
Parathelypteris novaboracensis (L.) Ching	New York fern
Phegopteris connectilis (Michx.) Watt	Long beech fern
Phragmites	Phragmites
Picea mariana (P. Mill.) B.S.P.	Black spruce
Picea rubens Sarg.	Red spruce
Platanthera clavellata (Michx.) Luer	Little club spur bog orchid
Platanthera grandiflora (Bigelow) Lindl.	Greater purple-fringed bog orchid
Platanthera psycodes (L.) Lindl.	Lesser purple-fringed bog orchid

Polystichum acrostichoides (Michx.) Schott	Christmas fern
Polystichum braunii (Spenner) Fee	Braun's holly fern
Prunus serotina Ehrh.	Black cherry
Pteridium aquilinum (L.)	Bracken fern
Pyrola americana Sweet	American shinleaf
Ranunculus recurvatus Poir.	Hooked buttercup
Rhamnus alnifolia L'Her.	Alder-leaved buckthorn
Rhododendron groenlanidum (Oeder) Kron & Judd)	Labrador tea
Ribes triste Pallas	Swamp red currant
Rubus odoratus L.	Flowering raspberry
Rubus pubescens Raf.	Dwarf raspberry
Salix bebbiana Sarg.	Long-beaked willow
Sambucus racemosa L.	Red elderberry
Sarracenia purpurea L.	Northern pitcher plant
Scirpus cyperinus (L.) Kunth	Wool grass
Scutellaria galericulata (L.)	Marsh skullcap
Solidago flexicaulis L.	Zig-zag goldenrod
Sorbus americana Marsh	Mountain ash
Sphagnum spp.	Sphagnum
Spiraea alba Du Roi	Meadowsweet
Streptopus lanceolatus (Ait.) Reveal	Lance-leaved twisted stalk
Swida alternifolia (L.f.) Small	Alternate leaf dogwood
Symphyotrichum puniceum(L.) A. & D. Love	Purple-stemmed American aster
Thalictrum dioicum L.	Early meadow-rue
Thalictrum pubescens Pursh	Tall meadow-rue
Tiarella cordifolia (L.)	Foamflower
Tilia americana L.	Basswood
Toxicodendron radicans L. Kuntze	Poison ivy
Trillium erectum L.	Wake robin
Trillium grandiflorum (Michx.) Salisb.	White trillium
Tsuga canadensis L. Carr.	Eastern hemlock
Tussilago farfara L.	Coltsfoot
Typha spp.	Cattail
Uvularia perfoliata L.	Perfoliate bellwort
Uvularia sessilifolia L.	Wild oats
Vaccinium angustifolium Ait.	Lowbush blueberry
Vaccinium myrtilloides Michx.	Velvet-leaved blueberry
Veratrum viride Ait.	False hellebore
Viburnum lantanoides Michx.	Hobblebush
Viburnum nudum L.	Wild raisin
Viola canadensis L.	Canada white violet

APPENDIX B. PLANT SPECIES MENTIONED IN THE TEXT SORTED BY COMMON NAME

Reference text: New England Wildflower Society GoBotany [2.5] (2017).

Rare, threatened, or endangered species are shown in bold, with state rarity and global rarity following in parentheses.

Common Name	Latin Name
Alder-leaved buckthorn	*Rhamnus alnifolia* L'Her.
Alternate leaf dogwood	*Swida alternifolia* (L.f.) Small
American shinleaf	*Pyrola americana* Sweet
American trout-lily	*Erythronium americanum* Ker-Gawl.
Balsam fir	*Abies balsamea* (L.) P. Mill.
Basswood	*Tilia americana* L.
Beaked hazelnut	*Corylus cornuta* Marsh.
Black ash	*Fraxinus nigra* Marsh.
Black cherry	*Prunus serotina* Ehrh.
Black spruce	*Picea mariana* (P. Mill.) B.S.P.
Bladder sedge	*Carex intumescens* Rudge
Blue cohosh	*Caulophyllum thalictroides* (L.) Michx.
Blue iris	*Iris versicolor* L.
Bluejoint grass	*Calamagrostis canadensis* (Michx.) Beauv.
Bog laurel	*Kalmia polifolia* Wangenh.
Boneset thoroughwort	*Eupatorium perfoliatum* L.
Boreal bedstraw (S3)	***Galium kamtschaticum* Stellar ex. J.A. & J.H. Schultes**
Boreal bog sedge	*Carex magellanica* Lam.
Bracken fern	*Pteridium aquilinum* (L.)
Braun's holly fern	*Polystichum braunii* (Spenner) Fee
Broad-leaved twayblade (S3)	***Neottia convallarioides* (Sw.) Rich.**
Canada mayflower	*Maianthemum canadense* Desf.
Canada white violet	*Viola canadensis* L.
Carolina spring-beauty	*Claytonia caroliniana* Michx.
Cattail	*Typha spp.*
Christmas fern	*Polystichum acrostichoides* (Michx.) Schott
Cinnamon fern	*Osmunda cinnamomea* (L.) C. Presl
Coltsfoot	*Tussilago farfara* L.
Common milkweed	*Asclepius syriaca* L.
Common strawberry	*Fragaria virginiana* Duchesne
Creeping snowberry	*Gaultheria hispidula* (L.) Muhl. ex. Bigelow
Doll's eyes	*Actaea pachypoda* Ell.
Dutchman's-breeches	*Dicentra cucullaria* (L.) Bernh.
Dwarf ginseng	*Panax trifolius* L.
Dwarf mistletoe	*Arceuthobium pusillum* Peck
Dwarf raspberry	*Rubus pubescens* Raf.
Early coral root	*Corallorhiza trifida* Chatelain
Early meadow-rue	*Thalictrum dioicum* L.
Eastern hemlock	*Tsuga canadensis* L. Carr.
Eastern waterleaf	*Hydrophyllum virginianum* L.
False hellebore	*Veratrum viride* Ait.
Flowering dogwood	*Cornus canadensis* (L.) Aschers. & Graebn.
Flowering raspberry	*Rubus odoratus* L.
Foamflower	*Tiarella cordifolia* (L.)
Forest licorice bedstraw	*Galium circaezans* Michx.
Fragile fern	*Cystopteris fragilis* (L.) Bernh.

Golden saxifrage	*Chrysosplenium americanum* Schwein. ex Hook.
Goldie's wood fern	*Dryopteris goldiana* (Hook. ex Goldie) Gray
Greater purple-fringed bog orchid	*Platanthera grandiflora* (Bigelow) Lindl.
Helleborine	*Epipactis helleborine* (L.) Crantz
Herb robert	*Geranium robertianum* L.
Hobblebush	*Viburnum lantanoides* Michx.
Hooked buttercup	*Ranunculus recurvatus* Poir.
Horsetail	*Equisetum spp.*
Interrupted fern	*Osmunda claytoniana* L.
Jack-in-the-pulpit	*Arisaema triphyllum* (L.) Scott
Joe-pye weed	*Eutrochium fistulosum*(Barratt) E.E. Lamont
Labrador tea	*Rhododendron groenlanidum* (Oeder) Kron & Judd)
Lambsquarters	*Chenopodium album* L.
Lance-leaved twisted stalk	*Streptopus lanceolatus* (Ait.) Reveal
Leatherleaf	*Chamaedaphne calyculata* (L.) Moench
Lesser purple-fringed bog orchid	*Platanthera psycodes* (L.) Lindl.
Little club spur bog orchid	*Platanthera clavellata* (Michx.) Luer
Long beech fern	*Phegopteris connectilis* (Michx.) Watt
Long-beaked willow	*Salix bebbiana* Sarg.
Lowbush blueberry	*Vaccinium angustifolium* Ait.
Maidenhair fern	*Adiantum pedatum* L.
Maidenhair spleenwort	*Asplenium trichomanes* L.
Marginal wood fern	*Dryopteris marginalis* (L.) Gray
Marsh skullcap	*Scutellaria galericulata* (L.)
Marsh-cinquefoil	*Comarum palustre* L.
Marsh-marigold	*Caltha palustris* L.
Marsh-pennywort (American)	*Hydrocotyle americana* L.
Meadowsweet	*Spiraea alba* Du Roi
Mountain ash	*Sorbus americana* Marsh
Mountain holly	*Ilex mucronata* (L.) M. Powell, Savol., & S. Andrews
Mountain maple	*Acer spicatum* Lam.
Mountain wood fern	*Dryopteris campyloptera* (Kunze) Clarkson
Musky monkey-flower (S3)	***Mimulus moschatus* Dougl. ex Lindl.**
Narrow-leaf glade fern (S3)	***Diplazium pycnocarpon* (Spreng.) M. Broun**
New york fern	*Parathelypteris novaboracensis* (L.) Ching
Nodding sedge	*Carex gynandra* Schwein.
Northeastern mannagrass	*Glyceria melicaria* (Michx.) F.T. Hubbard
Northern lady fern	*Athyrium angustum* (Willd.) C. Presl.
Northern pitcher plant	*Sarracenia purpurea* L.
Oak fern	*Gymnocarpium dryopteris* (L.) Newman
Ostrich fern	*Matteuccia struthiopteris* (L.) Todaro
Pale St. John's-wort	*Hypericum ellipticum*Hook.
Pearly everlasting	*Anaphalis margaritacea* (L.) Benth. & Hook. f.
Perfoliate bellwort	*Uvularia perfoliata* L.
Phragmites	*Phragmites*
Pink lady's slipper	*Cypripedium acaule* Ait.
Plantain-leaved sedge	*Carex plantaginea* Lam.
Poison ivy	*Toxicodendron radicans* L. Kuntze
Purple-stemmed American aster	*Symphyotrichum puniceum*(L.) A. & D. Love
Purple-stemmed angelica	*Angelica atropurpurea* L.
Ragged robin lychnis	*Lychnis flos-cuculi** L.
Ramps	*Allium tricoccum* Ait.

Rattlesnake fern	*Botrychium virginianum* (L.) Sw.
Red elderberry	*Sambucus racemosa* L.
Red maple	*Acer rubrum*L.
Red spruce	*Picea rubens* Sarg.
Roadside agrimony	*Agrimonia striata* Michx.
Royal fern	*Osmunda regalis* L.
Scabrous sedge	*Carex scabrata* Schwein.
Scratch bedstraw	*Galium aparine* L.
Sensitive fern	*Onoclea sensibilis* L.
Sheep laurel	*Kalmia angustifolia* L.
Silvery glade fern	*Deparia acrostichoides* (Sw.) M. Kato
Small-flowered evening-primrose	*Oenothera parviflora* L.
Speckled alder	*Alnus incana* L. Moench
Sphagnum	*Sphagnum spp.*
Squirrel corn	*Dicentra canadensis* (Goldie) Walp.
Starflower	*Lysimachia borealis* (Raf.) U. Manns & A. Anderb.
Sugar maple	*Acer saccharum* Marsh.
Swamp red currant	*Ribes triste* Pallas
Tall meadow-rue	*Thalictrum pubescens* Pursh
Three-seeded sedge	*Carex trisperma* Dewey
Touch-me-not	*Impatiens spp.*
Turtlehead	*Chelone glabra* L.
Tussock sedge	*Carex stricta* Lam.
Velvet-leaved blueberry	*Vaccinium myrtilloides* Michx.
Virgin's bower	*Clematis virginiana* L.
Wake robin	*Trillium erectum* L.
Water arum	*Calla palustris* L.
Water avens	*Geum rivale*L.
White trillium	*Trillium grandiflorum* (Michx.) Salisb.
Wild millet	*Milium effusum* L.
Wild oats	*Uvularia sessilifolia* L.
Wild raisin	*Viburnum nudum* L.
Wood nettle	*Laportea canadensis* (L.) Weddell
Wood sorrel	*Oxalis montana* Raf.
Wool grass	*Scirpus cyperinus* (L.) Kunth
Yellow birch	*Betula alleghaniensis* Britt.
Yellow-fruited sedge	*Carex annectens* (Bickn.) Bickn.
Yellow-green sedge	*Carex flava* L.
Zig-zag goldenrod	*Solidago flexicaulis* L.

APPENDIX C. INDEX OF WETLAND INDICATOR PLANTS

The following list of wetland indicator plants found on the Atlas lands reflects the U.S. Army Corps of Engineers wetland indicator rankings (2016). The following codes are used to describe their wetland status:

- FACW: Facultative wetland; usually occur in wetlands, but may occur in non-wetlands
- FAC: Facultative; occur in wetlands and non-wetlands
- OBL: Obligate wetland; almost always occur in wetlands

Latin Name	Common Name	Wetland Indicator Status
Abies balsamea	Balsam fir	FAC
Acer rubrum	Red maple	FAC
Alnus incana	Speckled alder	FACW
Angelica atropurpurea	Purple-stemmed angelica	OBL
Arceuthobium pusillum	Dwarf mistletoe	FAC
Arisaema triphyllum	Jack-in-the-pulpit	FAC
Athyrium angustum	Northern lady fern	FAC
Betula alleghaniensis	Yellow birch	FAC
Botrychium virginianum	Rattlesnake fern	FAC
Calamagrostis canadensis	Bluejoint grass	OBL
Calla palustris	Water arum	OBL
Caltha palustris	Marsh-marigold	OBL
Carex annectens	Yellow-fruited sedge	FACW
Carex flava	Yellow-green sedge	OBL
Carex gynandra	Nodding sedge	OBL
Carex intumescens	Bladder sedge	FACW
Carex magellanica	Boreal bog sedge	OBL
Carex plantaginea	Plantain-leaved sedge	OBL
Carex scabrata	Scabrous sedge	OBL
Carex stricta	Tussock sedge	OBL
Carex trisperma	Three-seeded sedge	OBL
Chamaedaphne calyculata	Leatherleaf	OBL
Chelone glabra	Turtlehead	OBL
Chrysosplenium americanum	Golden saxifrage	OBL
Clematis virginiana	Virgin's bower	FAC
Comarum palustre	Marsh-cinquefoil	OBL
Corallorhiza trifida	Early coral root	FACW
Cornus canadensis	Flowering dogwood	FAC
Cypripedium acaule	Pink lady's slipper	FACW
Deparia acrostichoides	Silvery glade fern	FAC
Diplazium pycnocarpon	Narrow-leaf glade fern	FAC
Dryopteris goldiana	Goldie's wood fern	FAC
Equisetum spp.	Horsetail	FAC
Eupatorium perfoliatum	Boneset thoroughwort	FACW
Eutrochium fistulosum	Joe-pye weed	FACW
Fraxinus nigra	Black ash	FACW
Gaultheria hispidula	Creeping snowberry	FACW
Geum rivale	Water avens	OBL
Glyceria melicaria	Northeastern mannagrass	OBL
Hydrocotyle americana	Marsh-pennywort (american)	OBL
Hydrophyllum virginianum	Eastern waterleaf	FAC
Hypericum ellipticum	Pale st. john's-wort	OBL
Impatiens spp.	Touch-me-not	FACW
Iris versicolor	Blue iris	OBL

Kalmia angustifolia	Sheep laurel	FAC
Kalmia polifolia	Bog laurel	OBL
Laportea canadensis	Wood nettle	FACW
Ledum groenlanidum	Labrador tea	FAC
Lysimachia borealis	Starflower	FAC
Matteuccia struthiopteris	Ostrich fern	FAC
Mimulus moschatus	Musky monkey-flower	OBL
Neottia convallarioides	Broad-leaved twayblade	FACW
Onoclea sensibilis	Sensitive fern	FACW
Osmunda claytoniana	Interrupted fern	FAC
Osmunda regalis	Royal fern	FAC
Osmundastrum cinnamomeum	Cinnamon fern	FACW
Panax trifolius	Dwarf ginseng	FACW
Picea mariana	Black spruce	FACW
Pyrola americana	American shinleaf	FAC
Ranunculus recurvatus	Hooked buttercup	FACW
Rhamnus alnifolia	Alder-leaved buckthorn	OBL
Ribes triste	Swamp red currant	OBL
Rubus odoratus	Flowering raspberry	FAC
Rubus pubescens	Dwarf raspberry	FACW
Salix bebbiana	Long-beaked willow	OBL
Sarracenia purpurea	Northern pitcher plant	OBL
Scirpus cyperinus	Wool grass	OBL
Sorbus americana	Mountain ash	FAC
Spiraea alba	Meadowsweet	FACW
Swida alternifolia	Alternate leaf dogwood	FACW
Symphiotrichum puniceum	Purple-stemmed American aster	FACW
Thalictrum pubescens	Tall meadow-rue	FACW
Toxicodendron radicans	Poison ivy	FAC
Trillium grandiflorum	White trillium	FAC
Typha spp.	Cattail	OBL
Vaccinium myrtilloides	Velvet-leaved blueberry	FACW
Veratrum viride	False hellebore	FACW
Viburnum nudum	Wild raisin	FACW
Viola canadensis	Canada white violet	FACW

APPENDIX D. S1, S2, S3 STATE-SIGNIFICANT NATURAL COMMUNITIES OF THE ATLAS TIMBERLANDS

SID	Natural Community	State Rareness Rank	Acres	State-significant?	EO Rank	Rank Size	Rank Condition	Rank Context	Recommended Protection
B-14	Black Spruce Swamp	S2	2.6	Y	B	B	B	C	SWPZ + 50' buffer
B-2	Black Spruce Woodland Bog	S2	1.6	Y	C	C/D	B	B	SWPZ + 50' buffer
B-1	Dwarf Shrub Bog	S2	1.4	Y	C	D	B	B	SWPZ + 50' buffer
HT-3	Boreal Talus Woodland	S3	2.6	Y	A	C	A	A	EPZ
EC-5	Lowland Spruce-Fir	S3	45.3	Y	B	C	B	B	EPZ
BM-2	Montane Seepage Forest	S3	11.6	Y	B	C	B	B	SWPZ + 50' buffer
G-24	Montane Seepage Forest	S3	9.9	Y	B	C	A	B	SWPZ + 50' buffer
HT-7	Montane Seepage Forest	S3	3.0	Y	B	D	A	B	SWPZ + 50' buffer
RJ-11	Montane Seepage Forest	S3	3.1	Y	C	D	B	B	SWPZ + 50' buffer
RJ-13	Montane Seepage Forest	S3	48.9	Y	A	B	A	B	SWPZ + 50' buffer
RJ-16	Montane Seepage Forest	S3	11.0	Y	B	C	A	B	SWPZ + 50' buffer
BM-17	Montane Spruce-Fir	S3	175.9	Y	A	A	B	A	EPZ
RJ-20	Montane Spruce-Fir	S3	333.0	Y	A	B	A	A	EPZ
G-4	Montane Spruce-Fir	S3	77.9	Y	B	C	B	B	EPZ
BM-18	Montane Yellow Birch-Red Spruce Forest	S3	574.6	Y	A	A	B	A	EPZ
HT-8	Montane Yellow Birch-Red Spruce Forest	S3	63.3	Y	A	C	A	A	EPZ
RJ-18	Montane Yellow Birch-Red Spruce Forest	S3	1073.2	Y	A	A	B	B	EPZ
G-10	Montane Yellow Birch-Red Spruce Forest	S3	474.9	Y	B	B	B	B	EPZ
RJ-3	Montane Yellow Birch-Red Spruce Forest	S3	104.4	Y	B	C	A	B	EPZ
B-3	Northern Hardwood Seepage Forest	S3	88.2	Y	A	A	B	B	SWPZ + 50' buffer
ES-10	Northern Hardwood Seepage Forest	S3	124.6	Y	A	A	B	B	SWPZ + 50' buffer
EC-1	Northern Hardwood Seepage Forest	S3	155.0	Y	A	A	B	B	SWPZ + 50' buffer
G-12	Northern Hardwood Seepage Forest	S3	31.1	Y	A	B	A	B	SWPZ + 50' buffer
BM-1	Northern Hardwood Seepage Forest	S3	21.9	Y	B	C	A	B	SWPZ + 50' buffer
BM-7	Northern Hardwood Seepage Forest	S3	3.0	Y	B	C	B	B	SWPZ + 50' buffer
BM-15	Northern Hardwood Seepage Forest	S3	6.7	Y	B	C	B	B	SWPZ + 50' buffer
ES-1	Northern Hardwood Seepage Forest	S3	16.3	Y	B	C	B	B	SWPZ + 50' buffer
ES-3	Northern Hardwood Seepage Forest	S3	16.1	Y	B	C	B	B	SWPZ + 50' buffer
EC-12	Northern Hardwood Seepage Forest	S3	42.9	Y	B	B	A/B	B	SWPZ + 50' buffer
G-13	Northern Hardwood Seepage Forest	S3	39.3	Y	B	B	C	B	SWPZ + 50' buffer

HT-6	Northern Hardwood Seepage Forest	S3	28.9	Y	B	B	B	B	SWPZ + 50' buffer
HT-7	Northern Hardwood Seepage Forest	S3	2.8	Y	B	D	A	B	SWPZ + 50' buffer
EC-11	Red Spruce-Cinnamon Fern Swamp	S3	9.7	Y	B	B	B	B	SWPZ + 50' buffer
EC-4	Red Spruce-Cinnamon Fern Swamp	S3	3.8	Y	B	C	B	B	SWPZ + 50' buffer
BM-5	Rich Northern Hardwood Seepage Forest	S3	61.5	Y	A	A	B	B	SWPZ + 50' buffer
ES-4	Rich Northern Hardwood Seepage Forest	S3	6.7	Y	B	C	A/B	A/B	SWPZ + 50' buffer
ES-13	Seep	S3	3.3	Y	A	A	B	B	SWPZ + 50' buffer
B-12	Spruce-Fir-Tamarack Swamp	S3	18.4	Y	B	C	B	B	SWPZ + 50' buffer
EC-17	Spruce-Fir-Tamarack Swamp	S3	19.5	Y	B	B	B	A/B	SWPZ + 50' buffer

APPENDIX E. SUMMARY OF NATURAL COMMUNITIES ON THE ATLAS TIMBERLANDS

COUNT - TOTAL	Bogs	Burnt Mountain	Eden-Craftsbury	Eden Square	Deep Gibou	Haystack-Tillotson	Richford-Jay North	Richford-Jay South	TOTAL
Alder Swamp	1				1				2
Black Spruce Swamp	1								1
Black Spruce Woodland Bog	1								1
Boreal Talus Woodland						1			1
Dwarf Shrub Bog	1								1
Hemlock Forest							1		1
Hemlock-Balsam Fir-Black Ash Seepage Swamp	4		3	6		1			14
Hemlock-Northern Hardwood Forest			1						1
Lowland Spruce-Fir	2		2						4
Montane Seepage Forest		1			2			3	6
Montane Spruce-Fir		1			1			1	3
Montane Yellow Birch-Red Spruce Forest		1			1	1	1	1	5
Northern Hardwood Seepage Forest	1	4	4	3	2	2	1		17
Red Maple-Black Ash Seepage Swamp		1							1
Red Spruce-Cinnamon Fern Swamp			2						2
Rich Northern Hardwood Forest	1	4		4	2		1	2	14
Rich Northern Hardwood Seepage Forest		1		1			1		3
Sedge Meadow/Alluvial Shrub Swamp	1								1
Seep		1		2	3	2	1	2	11
Shallow Emergent Marsh					2				2
Spruce-Fir-Tamarack Swamp	1		1						2
Temperate Acidic Outcrop					2				2
TOTAL	**14**	**14**	**13**	**16**	**16**	**7**	**6**	**9**	**95**

COUNT - STATE-SIGNIFICANT	Bogs	Burnt Mountain	Eden-Craftsbury	Eden Square	Deep Gibou	Haystack-Tillotson	Richford-Jay North	Richford-Jay South	TOTAL
Alder Swamp	1				1				2
Black Spruce Swamp	1								1
Black Spruce Woodland Bog	1								1
Boreal Talus Woodland						1			1
Dwarf Shrub Bog	1								1
Hemlock-Balsam Fir-Black Ash Seepage Swamp	4		1	2					7
Lowland Spruce-Fir			1						1
Montane Seepage Forest		1			1			3	5
Montane Spruce-Fir		1			1			1	3
Montane Yellow Birch-Red Spruce Forest		1			1	1	1	1	5
Northern Hardwood Seepage Forest	1	3	2	3	2	2			13
Red Maple-Black Ash Seepage Swamp		1							1
Red Spruce-Cinnamon Fern Swamp			2						2
Rich Northern Hardwood Forest	1	4		3	1		1		10
Rich Northern Hardwood Seepage Forest		1		1					2
Sedge Meadow/Alluvial Shrub Swamp	1								1
Seep				2	3	2	1	2	10
Shallow Emergent Marsh					2				2
Spruce-Fir-Tamarack Swamp	1		1						2
Temperate Acidic Outcrop					2				2
TOTAL	**12**	**12**	**7**	**11**	**14**	**6**	**3**	**7**	**72**

ACRES - TOTAL	Bogs	Burnt Mountain	Eden-Craftsbury	Eden Square	Deep Gibou	Haystack-Tillotson	Richford-Jay North	Richford-Jay South	TOTAL
Alder Swamp	43.4				12.6				56.0
Black Spruce Swamp	2.6								2.6
Black Spruce Woodland Bog	1.6								1.6
Boreal Talus Woodland						2.6			2.6
Dwarf Shrub Bog	1.4								1.4
Hemlock Forest							7.4		7.4
Hemlock-Balsam Fir-Black Ash Seepage Swamp	29.4		61.9	37.0		3.9			132.2
Hemlock-Northern Hardwood Forest			4.1						4.1
Lowland Spruce-Fir	15.3		47.7						63.1
Montane Seepage Forest		11.6			644.1			63.0	718.7
Montane Spruce-Fir		175.9			77.9			333.0	586.9
Montane Yellow Birch-Red Spruce Forest		574.6			474.9	63.3	104.4	1073.2	2290.4
Northern Hardwood Seepage Forest	88.2	34.4	218.7	156.9	70.5	31.6	16.6		617.0
Red Maple-Black Ash Seepage Swamp		9.6							9.6
Red Spruce-Cinnamon Fern Swamp			13.5						13.5
Rich Northern Hardwood Forest	6.5	69.5		36.1	54.1		18.4	60.1	244.7
Rich Northern Hardwood Seepage Forest		61.5		6.7			2.0		70.2
Sedge Meadow/Alluvial Shrub Swamp	36.3								36.3
Seep		0.7		3.8	16.4	1.2	0.1	15.9	38.2
Shallow Emergent Marsh					22.8				22.8
Spruce-Fir-Tamarack Swamp	18.4		19.5						38.0
Temperate Acidic Outcrop					1.2				1.2
TOTAL	**243.2**	**937.9**	**365.4**	**240.4**	**1374.6**	**102.6**	**148.9**	**1545.3**	**4958.3**

ACRES - STATE-SIGNIFICANT	Bogs	Burnt Mountain	Eden-Craftsbury	Eden Square	Deep Gibou	Haystack-Tillotson	Richford-Jay North	Richford-Jay South	TOTAL
Alder Swamp	43.4				12.6				56.0
Black Spruce Swamp	2.6								2.6
Black Spruce Woodland Bog	1.6								1.6
Boreal Talus Woodland						2.6			2.6
Dwarf Shrub Bog	1.4								1.4
Hemlock-Balsam Fir-Black Ash Seepage Swamp	29.4		39.6	33.6					102.6
Lowland Spruce-Fir			45.3						45.3
Montane Seepage Forest		11.6			9.9			63.0	84.4
Montane Spruce-Fir		175.9			77.9			333.0	586.9
Montane Yellow Birch-Red Spruce Forest		574.6			474.9	63.3	104.4	1073.2	2290.4
Northern Hardwood Seepage Forest	88.2	31.7	197.8	156.9	70.5	31.6			576.8
Red Maple-Black Ash Seepage Swamp		9.6							9.6
Red Spruce-Cinnamon Fern Swamp			13.5						13.5
Rich Northern Hardwood Forest	6.5	69.5		34.8	45.4		18.4		174.5
Rich Northern Hardwood Seepage Forest		61.5		6.7					68.2
Sedge Meadow/Alluvial Shrub Swamp	36.3								36.3
Seep				3.8	16.4	1.2	0.1	15.9	37.4
Shallow Emergent Marsh					22.8				22.8
Spruce-Fir-Tamarack Swamp	18.4		19.5						38.0
Temperate Acidic Outcrop					1.2				1.2
Total Acres State-significant	**227.9**	**934.5**	**315.7**	**235.7**	**731.5**	**98.7**	**122.9**	**1485.2**	**4152.1**
Total Acreage	1200	4782	2000	1632	2820	1125	745	4084	18388
Percent Acreage State-significant	**19%**	**20%**	**16%**	**14%**	**26%**	**9%**	**16%**	**36%**	**23%**

APPENDIX F. WILDLIFE FEATURES BY PARCEL ON THE ATLAS TIMBERLANDS (COUNT AND ACREAGE)

Count of Wildlife Features by Parcel on the Atlas Timberlands, Vermont, 2016.

COUNT	Burnt Mountain	Deep Gibou	Haystack-Tillotson	Richford-Jay North	Richford-Jay South	Eden-Craftsbury	Bogs	Eden Square	TOTAL
Beech Mast Stand	2	2	2	1	0	0	0	0	7
Deer Wintering Yard	0	0	0	0	1	0	0	0	1
Old Forest	2	2	2	1	0	1	0	0	8
Beaver Pond	0	2	0	0	0	4	3	1	10
Outcrop	0	0	1	0	0	0	0	1	2
TOTAL	**4**	**6**	**5**	**2**	**1**	**5**	**3**	**2**	**28**

Acreage of Wildlife Features by Parcel on the Atlas Timberlands, Vermont, 2016

ACRES	Burnt Mountain	Deep Gibou	Haystack-Tillotson	Richford-Jay North	Richford-Jay South	Eden-Craftsbury	Bogs	Eden Square	TOTAL
Beech Mast Stand	1.6	4.0	18.7	12.4	0.0	0.0	0.0	0.0	36.6
Deer Wintering Yard	0.0	0.0	0.0	0.0	14.0	0.0	0.0	0.0	14.0
Old Forest	17.4	37.2	2.7	11.5	0.0	18.8	0.0	0.0	87.4
Beaver Pond	0.0	34.9	0.0	0.0	0.0	112.9	33.9	2.5	184.1
Outcrop	0.0	0.0	2.1	0.0	0.0	0.0	0.0	2.0	4.1
TOTAL	**18.9**	**76.1**	**23.5**	**23.9**	**14.0**	**131.6**	**33.9**	**4.4**	**326.3**

APPENDIX G. VERNAL POOL INVENTORY

Parcel	Vernal Pool ID	Class	Size (Feet^2)	Description	Rank Size	Rank Landscape Context	Rank Condition	Needs Spring Survey?
Eden Square	ES-VP-1	Natural	1392	Massive vernal pool- dry now. 58 paces x 8 paces. Continues in both direction (N/S)	C	B	B	Y
Haystack East/ Tillotson	HT-VP-2	Natural	600	Large VP (600 square feet.): 30'x20' dry.	C	-	-	Y
Richford-Jay South	RJS-VP-3	Natural	600	Big vernal pool. Some spots still wet. No herps; no herp eggs. 30x20 feet	C	-	-	Y
Richford-Jay North	RJN-VP-2	Natural	400	Vernal pool (20 feet x 20 feet)	C	B	C	Y
Haystack East/ Tillotson	HT-VP-1	Natural	375	Vernal pool (375 square feet.) - full sun; no eggs, yes tadpoles, 25 feet x 15 feet, three inches deep	D	-	-	Y
Eden Square	ES-VP-4	Natural	300	Vernal pool. 20x15 (triangle), EAD pt 20 cruise pt. Could be considered a single element occurrence with ES-20 (need to assess in spring).	D	B	A	Y
Richford-Jay South	RJS-VP-2	Natural	300	Talus/yellow birch glade at base of cliffs. Small VP, but no egg masses/tadpoles. 10 feet x 30 feet.	D	-	-	Y
Deep Gibou	G-VP-2	Natural	250	Vernal pool. No eggs, no amphibians. 250 square feet. 20 feet x 15 feet.	D	A	A	Y
Deep Gibou	G-VP-3	Natural	225	Vernal pool - dried up now. 225 square feet. 15 feet x 15 feet.	D	A	A	Y
Bogs	B-VP-1	Natural	200	Vernal pool, 20 feet x 10 feet, still has standing water, no eggs. At downslope end of seepage glade.	D	-	-	Y
Deep Gibou	G-VP-1	Natural	150	Vernal pool at top of seepage meadow. 150 square feet. 15 feet x 10 feet.	-	-	-	-
Deep Gibou	G-VP-4	Natural	150	VP – 150 square feet. 15 feet x 10 feet - photo 0298	-	-	-	-
Bogs	B-VP-2	Natural	100	Small vernal pool (10x10 feet).	-	-	-	-
Deep Gibou	G-VP-5	Natural	100	Vernal pool 10x10; 100 square feet. dry now; p0300	-	-	-	-
Eden Square	ES-VP-3	Natural	100	Vernal pool here. Still wet. 20 x5. Could be considered a single element occurrence with ES-21 (need to assess in spring).	-	-	-	-
Burnt Mountain	BM-VP-1	Natural	60	Vernal pool in large seepage glade, 15x4 feet, pine needles, birch leaves. Likely fed by seed.	-	-	-	-
Eden Square	ES-VP-2	Natural	50	Small vernal pool - 10x5.	-	-	-	-
Richford-Jay North	RJN-VP-1	Natural	40	Vernal pool - dried up and relatively small. 5 feet x 8 feet.	-	-	-	-
Richford-Jay South	RJS-VP-1	Natural		Vernal pool	-	-	-	-
Richford-Jay South	RJS-VP-4	Natural		Vernal pool	-	-	-	-
Burnt Mountain	BM-VP-3	Road	250	250 square feet. VP formed by road. Dry now (still squishy). 25x10. No coarse woody debris.	-	-	-	-

Burnt Mountain	BM-VP-2	Road	150	150 square feet. Vernal pool formed by road, but excellent quality. 12 inches deep in center, shaded, leaves in bottom. ~15x10. No amphibians/egg masses observed.	-	-	-	-
Richford-Jay South	RJS-VP-5	Road	125	Many small vernal pools (5 - 5 feet x 5 feet); they seem to be gathering in old logging road bed.	-	-	-	-
Burnt Mountain	BM-VP-5	Road	120	120 square feet. Vernal pool in the road. 15x8 feet, shaded. Well-shaded, leaf litter, coarse woody debris.	-	-	-	-
Bogs	B-VP-3	Road	50	Likely a vernal pool. Originated from logging road, but now tree stumps are created hummocks that will keep it here. ~10x5 feet	-	-	-	-
Burnt Mountain	BM-VP-4	Road	-	Vernal pools here on edge of seepage swamp (BM-3). Swamp ends at vernal pools. No amphibians/eggs observed. Pool still had water at time of visit.	-	-	-	-
Eden Square	ES-VP-5	Road	-	Old logging road? Now a pond / vernal pool. EC 23 mS.	-	-	-	-
Eden-Craftsbury	EC-VP-1	Road	-	Vernal pool in logging roads this area was H-BF-BA Seepage Forest	-	-	-	-
Eden-Craftsbury	EC-VP-2	Road	-	Logging road made vernal pool. Seepage forest below here.	-	-	-	-

APPENDIX H. ACRONYMS REFERENCED IN REPORT

Acronym	Acronym Expanded	Description
ATP	Atlas Timberlands Partnership	Owners of the Atlas Timberlands; comprised of the Vermont Land Trust and The Nature Conservancy
EPZ	Ecological Protection Zone	Vermont Land Trust easement protection classification
ESTA	Ecologically Significant Treatment Area	Current use (UVA) protection for ecologically significant areas
SWPZ	Surface Water Protection Zone	Vermont Land Trust easement protection classification
TNC	The Nature Conservancy	Atlas Timberland co-owner
UVA	Use-Value Appraisal	Vermont current use tax structure
VLT	Vermont Land Trust	Atlas Timberlands co-owner
POI	Points of Interest	Hannah Phillips' field data organization schema

APPENDIX I. LIST OF ACCOMPANYING ARCGIS FILES

ALL PARCELS

- *VernalPools_AtlasTimberlands_Phillips2017*: Point file containing locations of vernal pools throughout the Atlas Timberlands.
- *NatComms_AtlasTimberlands_Phillips2017:* Polygon file depicting all mapped natural communities on the Atlas Timberlands.

BOGS GEODATABASE

- *NatComms_Bogs_Phillips2017*: Polygon feature of state-significant natural communities, significant wildlife habitat, and other ecologically significant areas (including old forest). This file contains Natural Heritage Rankings and easement protection recommendations in accordance with VLTs easement provisions. Overlay POIs for more detail about field observations.
- *POIS_Bogs_Phillips2017*: Point features containing field notes, which include species observations, rare/uncommon plant element occurrence data, land use alteration notes, and other general field observations.
- *Tracks_Bogs_Phillips2017:* Line features showing path taken on field days.

BURNT MOUNTAIN GEODATABASE

- *IntermittentStreams_BurntMtn_Phillips2017:* Line file containing previously unmapped intermittent streams. This layer should be viewed with the National Hydrography Dataset stream layer.
- *NatComms_BurntMountain_Phillips2017*: See description above.
- *POIS_BurntMountain_Phillips2017*: See description above.
- *Tracks_BurntMountain_Phillips2017:* See description above.

DEEP GIBOU GEODATABASE

- *IntermittentStreams_DeepGibou_Phillips2017:* See description above.
- *NatComms_DeepGibou_Phillips2017*: See description above.
- *POIS_DeepGibou_Phillips2017*: See description above.
- *Tracks_DeepGibou_Phillips2017:* See description above.

EDEN-CRAFTSBURY GEODATABASE

- *IntermittentStreams_EdenCraftsbury_Phillips2017:* See description above.
- *NatComms_EdenCraftsbury_Phillips2017*: See description above.
- *POIS_EdenCraftsbury_Phillips2017*: See description above.
- *Tracks_EdenCraftsbury_Phillips2017:* See description above.

EDEN SQUARE GEODATABASE

- *IntermittentStreams_EdenSquare_Phillips2017:* See description above.
- *NatComms_EdenSquare_Phillips2017*: See description above.
- *POIS_EdenSquare_Phillips2017*: See description above.
- *Tracks_EdenSquare_Phillips2017:* See description above.

HAYSTACK-TILLOTSON GEODATABASE

- *IntermittentStreams_HaystackTillotson_Phillips2017:* See description above.
- *NatComms_HaystackTillotson_Phillips2017*: See description above.
- *POIS_HaystackTillotson_Phillips2017*: See description above.
- *Tracks_HaystackTillotson_Phillips2017:* See description above.

RICHFORD-JAY NORTH GEODATABASE

- *NatComms_RichfordJayNorth_Phillips2017*: See description above.
- *POIS_RichfordJayNorth_Phillips2017*: See description above.
- *Tracks_RichfordJayNorth_Phillips2017:* See description above.

RICHFORD-JAY SOUTH GEODATABASE

- *NatComms_RichfordJaySouth_Phillips2017*: See description above.
- *POIS_RichfordJaySouth_Phillips2017*: See description above.
- *Tracks_RichfordJaySouth_Phillips2017:* See description above.

APPENDIX J: NORTHERN HARDWOOD SEEPAGE FOREST NATURAL COMMUNITY DESCRIPTION AND MANAGEMENT CONSIDERATIONS

TO: Liz Thompson, Vermont Land Trust
FROM: Hannah Phillips, UVM Ecological Planning Program
DATE: February 17, 2017
SUBJECT: Northern Hardwood Seepage Forest Community Description and Management Considerations

---

This report summarizes the ecological characteristics and processes of a newly recognized natural community type, the Northern Hardwood Seepage Forest, based on field observations on the Atlas Timberlands from May-August 2016. Management considerations are provided to contribute to conversations about seepage forest management and protection.

Ecology and Physical Setting

Northern Hardwood Seepage Forests occur as inclusions within Northern Hardwood Forests in areas where groundwater inundates the soil. They are most common in mid- to low-elevation forests (300-1500ft) in montane or foothill formations and often originate at a topographic inflection point where steep slopes transition to more gradual slopes. There is great ecological variation within this community type, which seems largely driven by degree of soil saturation and the processes that govern groundwater flow. Seepage forests tend to be more common in northern latitudes, which scientists believe may be due to reduced evapotranspiration due to colder temperatures (Sperduto and Kimball 2011).

Seepage forests tend to occur on Cabot, Peru, or Marlow fine sandy loam soils. Soils are generally 2-10 inches of mostly decomposed muck perched on top of a glacial till hardpan layer. Groundwater travels laterally atop the till layer, which usually appears mottled, indicating periods of both saturation and aeration. In wetter conditions on shallower slopes, water occasionally organizes itself into shallow stream channels which migrate across the impenetrable till layer and seem to have no loyalty to a particular flow path. Depending on the topographic position of the seepage forest, water can either exit into a stream channel or gather in a basin seepage swamp. Rarely does a seepage forest exist in isolation from another, more prominent, hydrologic feature.

Within Northern Hardwood Seepage Forests, trees are relatively shallow-rooting, of small stature and diameter, and are often toppled by wind if they grow too large. The hummock and hollow topography that results from fallen trees leads to a differentiation between upland herbaceous species on the hummocks, and wetland facultative or obligate species in the hollows. Sugar maple, yellow birch, and red maple are all common upland trees that establish on the hummocks, while black ash and red maple occasionally establish in the wetter hollows. Across the landscape, nearly pure stands of black ash populate the seepage forests in the wettest depressions, sometimes occupying two to three acres.

The primary natural disturbance dynamics governing seepage forest structure are wind throw and hydrologic alteration by beavers, when located adjacent to a basin swamp. Over time, small-scale gap disturbances resulting from wind throw give rise to a spatially and vertically heterogeneous forest structure. This structural complexity, paired with the hummock/hollow microtopography, may allow high floristic diversity to develop. Larger patch-scale disturbances are caused by beaver impoundments in adjacent basin swamps, which may alter the hydrologic functioning of the upslope seepage forests, leading to community conversions favoring wetland tolerant species.

The hydrologic source of groundwater seepage is unknown. Scientists hypothesize that seepage may be emerging from the interstitial space in glacial till upslope of the seepage site (S. Wright, *personal communication*) and that contacts between

ablation till (upslope) and basal till (downslope) may force an upwelling of water stored in the till matrix (G. Goodwin and S. Bailey, *personal communications*). Studies of black ash wetlands in Minnesota reveal that snowmelt provides a major early season hydrologic contribution, but that both precipitation and groundwater inputs keep the basin swamps saturated throughout the summer months (Slesak et al. 2014). Continued saturation of Northern Hardwood Seepage Forests in northern Vermont in summer 2016, despite drought conditions, supports the hypothesis that aquifer-derived groundwater supplements hydrologic inputs from precipitation.

Vegetation

HERBS - HOLLOWS
Abundant Species
Northeastern mannagrass – *Glyceria melicaria*
Dwarf raspberry - *Rubus pubescens*
Golden saxifrage - *Chrysosplenium americanum*
Foamflower - *Tiarella cordifolia*
Jewelweed - *Impatiens* spp.
Occasional to Locally Abundant Species
False hellebore – *Veratrum viride*
Cinnamon fern – *Osmundastrum cinnamomeum*
Purple-stemmed swamp aster - *Symphyotrichum puniceum*
Sensitive fern - *Onoclea sensibilis*
Water avens - *Geum rivale*
Tall white bog orchid - *Platanthera dilatata*
Greater purple-fringed bog orchid - *Platanthera grandiflora*
Wood nettle – *Laportea canadensis*
Virgin's bower – *Clematis virginiana*
Scabrous sedge – *Carex scabrata*
Nodding sedge – *Carex gynandra*

HERBS - HUMMOCKS
Abundant Species
Intermediate wood fern – *Dryopteris intermedia*
Wild sarsaparilla – *Aralia nudicaulis*
Bunchberry - *Cornus canadensis*
Occasional to Locally Abundant Species
Whorled aster – *Oclemena acuminatus*
Canada mayflower – *Maianthemum canadense*
False solomon's seal – *Maianthemum racemosum*
Starflower – *Lysimachia borealis*
Zig-zag goldenrod – *Solidago flexicaulis*
Common wood sorrel – *Oxalis montana*

TREES
Abundant Species
Yellow birch – *Betula alleghaniensis*
Sugar maple – *Acer saccharum*
Occasional to Locally Abundant Species
Black ash – *Fraxinus nigra*
American elm – *Ulmus americana*
Red maple – *Acer rubrum*
Red spruce – *Picea rubens*
Balsam fir – *Abies balsamea*

SHRUBS
Occasional to Locally Abundant Species
Hobblebush – *Viburnum lantanoides*
Striped maple – *Acer pensylvanicum*
Alder-leaved buckthorn – *Rhamnus alnifolia*
Beaked hazelnut – *Corylus cornuta*
Black elderberry – *Sambucus nigra*
Wild raisin – *Viburnum cassinoides*

INVASIVE EXOTIC PLANTS
Phragmites australis ssp. *australis*
Narrow-leaved cattail – *Typha angustifolia*

RARE AND UNCOMMON PLANTS
Boreal bedstraw – *Galium kamtschaticum*
Wood millet – *Milium effusum*

Animals

Northern Hardwood Seepage Forests may provide an important early spring food source for large mammals. Black bears may feed on the wetland herbaceous vegetation soon after emerging from hibernation in the spring, while moose may rely on the wetland vegetation throughout the summer months. During summer 2016, I observed two bear cubs in a seepage forest and moose prints were common in the wetter inclusions. Northern Hardwood Seepage Forests may also be important habitat for amphibians, although little is known about their use of and distribution within these forested wetlands.

Successional Trends

Because this natural community is heavily influenced by the hydrologic characteristics of the site, fluctuations in water table depth and water chemistry can have significant impacts on the successional trajectory of the forest.

Early successional variants of this community contain a tree species assemblage reflective of the mid-successional community, though intolerant and intermediate shade tolerant species like black ash and American elm may have an early advantage. The ground layer tends to be dominated by wetland obligate sedge species, along with jewelweed, joe-pye weed, white turtlehead, boneset, and purple-stemmed swamp aster. As the community matures, and increased evapotranspiration draws the water table to its mid to late successional levels, shade-tolerant trees like red maple, sugar maple, yellow birch, and red spruce all establish on drier hummocks, eventually becoming primary components of the natural community. No late successional examples were observed on the Atlas Timberlands.

Major fluctuations in water table depth may alter the successional pathway of the Northern Hardwood Seepage Forest community by altering the structure of the hummock/hollow microtopography. If the water table rises, water-tolerant tree species like black ash and red maple may gain a competitive advantage over upland species on the hummocks, while wetland obligate sedges and forbs gain dominance in the hollows. If the water table drops from its original position, the Northern Hardwood Forest species may take over the low points of the forest, converting it back to an upland community. Drought years may effectively increase the "hummock" dominance, while reducing the "hollow" component of the seepage forest.

Variants

Within the Northern Hardwood Forest Seepage community, inclusions of nearly pure stands of black ash take on a woodland canopy (<60% cover). Within these *Black Ash Seepage Woodlands,* hummocks and hollows are less pronounced, and the ground is blanketed with a dense layer of northeastern mannagrass, jewelweed, sensitive fern, and purple-stemmed swamp aster, with dwarf raspberry, water avens, and golden saxifrage colonizing the wettest hollows. While these communities may become largely uneven-aged due to windthrow vulnerability, gaps tend to be filled by regenerating black ash or American elm.

Related Communities

Hemlock-Balsam Fir-Black Ash Seepage Swamp: Northern Hardwood Seepage Forests often grade into Hemlock-Balsam Fir-Black Ash seepage swamps as the slope flattens out and water accumulates in a basin. However, in northern latitudes, they occur in conjunction with the *Red Spruce variant* of this natural community. These swamps, in turn, can grade into ***Red Spruce-Cinnamon Fern Swamps*** if the water slows down enough and begins to lose its mineral enrichment. When this occurs, peat accumulation begins to acidify the swamp, thereby limiting the number of species that can thrive.

Red Maple-Black Ash Seepage Swamp: Northern Hardwood Seepage Forests are also often located proximate to Red Maple-Black Ash Seepage Swamps. These seem to occur adjacent to the *Black Ash Seepage Woodland* variant of the Northern Hardwood Seepage Forest community.

Conservation Status

Actions that influence the hydrologic functions of a Northern Hardwood Seepage Forest risk shifting the plant community to an "alternative steady state" (Schefer et al. 2001). Emerald ash borer infestations and heavy timber harvest both threaten to decrease water table depth by reducing evapotranspiration, while management actions such as ditching and draining threaten to increase the depth to water table. Road building may also increase water table depth if built parallel to groundwater flow, whereas perpendicular roads may decrease the depth by obstructing flow.

Slesak et al. (2014) found that simulated black ash die-off and clearcuts lead to heightened water tables, which prevail for at least two years following the disturbance. This altered condition threatens a community conversion to favor wetland obligate species. While data about the resulting early successional vegetation is forthcoming, anecdotal evidence suggests

that graminoid obligate wetland species dominate the herb layer following water table rise (Looney et al. in press). It is not yet clear what impact this dense early successional vegetation has on tree regeneration.

Management Considerations

- Mechanical travel through seepage forests should be restricted to frozen ground. Travel through seepage forests when the ground is thawed disrupts the muck layer and creates rutting and ponding.

- Care should be taken to preserve the hummock and hollow microtopography of these sites. Disruption of organic matter accumulation or microtopography may impact vegetative species richness.

- Laying out timber harvests in the summer months will allow more reliable identification of seepage areas; these are difficult to recognize when understory plants indicative of seepage forest conditions are not detectable.

- The Current Use Ecologically-Sensitive Treatment Area (ESTA) designation does not allow for buffers around forested wetlands. However, seepage forest functioning is dependent upon hydrologic inputs and outputs, which may extend beyond mapped seepage forest boundaries. Forest managers should consider the impacts of upslope and downslope management actions on seepage forests.

- Nearly pure black ash stands may be at greatest risk for natural community conversion following Emerald Ash Borer invasion due to reduced evapotranspiration following tree death (heightened water table favors wetland obligate species). Land managers should consider the conservation priority of these areas to determine recommended action steps.

- Large patch cuts in seepage forests may “water up”; the initial vegetative conversion is heavy to graminoids. It is not yet clear how this dense herbaceous layer impacts the success of tree regeneration.

- Small seedlings in patch cuts are vulnerable to deer and moose browse. If cutting in these areas, consider caging/protecting the seedlings to allow successful establishment or growth. Otherwise, their inability to establish may exacerbate community conversion.

- If harvesting, silvicultural treatments should mimic the natural disturbance processes of seepage forests, primarily wind throw and small-gap creation.

- Seed trees are susceptible to windthrow; retaining in groups or strips may reduce likelihood of tip-ups.

- Strip shelterwoods, under mesic conditions, should be oriented perpendicular to the prevailing wind to reduce likelihood of windthrow. In seepage forests, however, the resulting road orientation may cause undesirable drainage of lateral groundwater flow.

- Within patch-cuts, preserving uneven-age structure (instead of two-age or even-age) may help protect hydrologic integrity of the sites by promoting a steady water table and new seedling regeneration.

- It is not known how temporary road beds influence the hydrology of the site and/or the microtopography.

Places to Visit

Atlas Timberlands, Eden-Craftsbury Lot, Site EC-1, Eden, Vermont
Atlas Timberlands, Eden Square Lot, Site ES-10, Eden, Vermont
Atlas Timberlands, Bogs Lot, Site B-3, Belvidere, Vermont

APPENDIX K: MONTANE SEEPAGE FOREST NATURAL COMMUNITY NOTES

MONTANE SEEPAGE FOREST REFLECTIONS FROM JUNE 20, 2016

Patterns

The following conditions seem likely to give rise to seepage conditions, and have been used to successfully predict natural community occurrences remotely.

Landform: areas where steep slopes transition abruptly to shallow slopes, forming "terraces" or "plateaus" on which water can pool. This can be deduced with some accuracy remotely through topographic lines, and sharp conifer-to-deciduous transitions in aerial imagery indicating a cliff band.

Canopy "patchiness": fine-scale aerial imagery taken during the fall, winter, or spring when deciduous trees have lost their leaves, makes it possible to see the open-canopy "glades" that often give rise to seepage conditions. These, considered in combination with the topographic lines, is perhaps the most accurate remote assessment of seepage extent.

Headwater regions: fine-scale aerial imagery reveals dendritic headwater drainage pattern that eventually converges into a single established stream channel. A relatively high density of many small drainages converging into a single larger drainage, located just downstream of an "open canopy glade" is likely a seepage zone.

Elevation: Although these seepage forests range in elevation depending on their type (see below), the seepage glades seem to be the highest-elevation variant, often appearing along the transition line between Montane Yellow Birch-Red Spruce Forest and Montane Spruce-Fir forest.

Aspect: I am finding these to be more common on north-facing slopes.

Montane Seepage Forest

Natural Community Notes: These seem to occur in Montane Yellow Birch-Red Spruce forests, just below the Montane Spruce-Fir line. In these areas, the shrub and herbaceous layer of the "upland" version of this community type occasionally subsides (dominated by hobblebush and mountain wood fern) and wetland obligate or facultative species take over. These seems to have a distinct boundary/extent, made obvious by the wetland vegetation contained within. Size seems to range from ~0.5-3 acres. By all definitions, these are large seeps (and rarely exceed the 3-acre A-rank size cutoff indicated in the ranking specifications). However, the proximity of multiple seeps to one another creates a band of seepage which is more accurately represented as one element occurrence.

Landform: often located just below rocky-outcrops on a topographic plateau/terrace. Usually found at higher elevations (~1800-2500 feet), occasionally repeat down the slope if terraces are recurring.

Termination: These seem to terminate in one of three ways: (a) pooling action with no outlet leads to infiltration back into the ground, (b) run down an adjacent slope giving rise to seepage forest characteristics, sometimes pooling in lower terraces or diffusely draining, or (c) converge into stream, forming "headwaters."

Characteristic plants: Veratrum viride, Carex intumescens, Gallium kamtschaticum, Neottia convallarioides, Platanthera dilantata, wild millet, *Laportea canadensis,* bryophytes…

Exemplary sites: Richford-Jay, on north-facing slopes south of Route 105, and north-facing slopes in the Stanhope Brook drainage.

REFERENCES

Almendinger, J. 2010. Silvicultural Interpretation of WFn64: Very Wet Ash Swamp. Minnesota Department of Natural Resources. <http://files.dnr.state.mn.us/forestry/ecssilviculture/plantcommunities/WFn64.pdf>

Arrowwood Environmental. 2015. Arrowwood_Vernal_Pools [ArcGIS shapefile]. Huntington, VT: Arrowwood Environmental.

Arrowwood Environmental. 2015. Arrowwood_Wetlands [ArcGIS shapefile]. Huntington, VT: Arrowwood Environmental.

Asbjornsen, H. G.R. Goldsmith, M.S. Albarado-Barrientos, K. Rebel, F.P. Van Osch, M. Rietkerk, J. Chen, S. Gotsch, C. Tobon, D.R. Geissert, A. Gomez-Tagle, K. Vache, T.E. Dawson. 2011. Ecohydrological advances and applications in plant-water relations research: a review. Journal of Plant Ecology 4(1-2): 3-22.

Belvidere Planning Commission. 2015. Town of Belvidere, Vermont, Town Plan 2015-2020. Accessed 11/25/2016:

Hunter, M.L. Jr. 1991. Coping with ignorance: The coarse filter strategy for maintaining biodiversity. Pages 266-281. in Kohn, KA, ed. Balancing on the Brink of Extinction: The Endangered Species Act and Lessons for the Future. Washington (DC): Island Press.

Keddy, P.A. and P. MacLellan. 1990. Centrifugal organization in forests. Oikos 59(1): 75-84.

Kotar, J., and T. Burger. 2009. Habitat Type Classification for Wetland Forests, Region 3 (Preliminary Version). Wisconsin Agency of Natural Resources.

Lapin, M. and B. Engstrom. 1999. Ecological Significance of the Atlas Timberlands: a report to The Nature Conservancy-Vermont Chapter and Vermont Land Trust.

Lapin, M. and B. Engstrom. 2016. Atlas Lands Ecological Assessment 2015.

Looney, C.R., A.W. D'Amato, B.J. Palik, R.A. Slesak, and M. Slater. In press. The response of Fraxinus nigra forest ground-layer vegetation to emulated emerald ash borer mortality and management strategies in northern Minnesota, USA. Forest Ecology and Management.

McMath, D. 2016. Atlas Timberlands Harvest History [ArcMap shapefile]. Calais, VT: MD Forestland Consulting.

New England Wildflower Society. 2017. GoBotany. http://gobotany.newenglandwild.org.

Noss, R.F. 1996. Ecosystems as conservation targets. Trends in Ecology and Evolution. 11(8): 351.

Ratcliffe, N.M., Stanley, R.S., Gale., M.H., Thompson, P.J., and Walsh, G.J., 2011, Bedrock geologic map of Vermont: U.S. Geological Survey Scientific Investigations Map 3184, 3 sheets, scale 1:100,000, http://pubs.usgs.gov/sim/3184/

Ridolfi, L., P. D'Ordorico, and F. Laio. 2006. Effect of vegetation-water table feedbacks on the stability and resilience of plant ecosystems. Water Resources Research 42(1): 1-5.

Soil Survey Staff, Natural Resource Conservation Services. 2015. Official Soil Series Descriptions – Cabot Series. https://soilseries.sc.egov.usda.gov/OSD_Docs/C/CABOT.html.

Schefer, M., S. Carpenter, J.A. Foley, C. Folke, and B. Walker. 2001. Catastrophic shifts in ecosystems. Nature 413 (6856): 591-595.

Slesak, R.A., C.F. Lenhart, K.N. Brooks, A.W. D'Amato, and B.J. Palik. 2014. Water table response to harvesting and simulated emerald ash borer mortality in black ash wetlands in Minnesota, USA. Canadian Journal of Forest Research. 44(8): 961-968.

Sorenson, E., R. Zaino, and C. Hohn. 2014. Vermont Natural Community Ranking Specifications. Vermont Fish and Wildlife Department.

Sorenson, E., R. Zaino, J. Hilke, and E. Thompson. 2015. Vermont Conservation Design: Maintaining and Enhancing an Ecologically Functional Landscape. Vermont Fish and Wildlife Department and Vermont Land Trust.

Thompson, E.H., and E.R. Sorenson. 2005. Wetland, Woodland, Wildland - A guide to the natural communities of Vermont. University Press of New England. Hanover, NH.

Turner, R. and D. McMath. 2007. Atlas Timberlands Partnership Master Management Document. R.J. Turner Company and David C. McMath Consulting Forestry.

Palik, B. M.E. Ostry, R.C. Venette, E. Abdela. 2011. Fraxinus nigra (black ash) dieback in Minnesota: Regional variation and potential contributing factors. Forest Ecology and Management 261:128-135.

U.S. Army Corps of Engineers. 2016. 2016 Update National Wetland Plant List. <http://rsgisias.crrel.usace.army.mil/NWPL/>

Vermont Center for Geographic Information. 2013. VTORTHO_0_5_M_CLRIR_2013 [2013-Color & Infrared-Northwestern Vermont (0.5m); Raster Image]. 1:4000. Montpelier, VT: Vermont Center for Geographic Information.

Vermont Center for Geographic Information. 2014. NAIP_1M_CLRIR_2014 [2014 – Color & Infrared (4 band) – Statewide NAIP (1m); Raster Image]. 1:12000. Montpelier, VT: Vermont Center for Geographic Information.

Vermont Department of Environmental Conservation, Watershed Management Division. 2016. DRAFT – 2016 Tactical Basin Plan – Lamoille River Basin.

Vermont Department of Environmental Conservation, Wetlands Program. 2015. Vermont Significant Wetlands Inventory (VSWI) [ArcGIS shapefile]. 1:80,000. Montpelier, VT: Vermont Agency of Natural Resources.

Vermont Department of Fish and Wildlife, Vermont Natural Heritage Inventory. 2016. Atlas_Eos [ArcGIS shapefile]. Montpelier, VT: Vermont Department of Fish and Wildlife.

Vermont Department of Fish and Wildlife, Vermont Natural Heritage Inventory. 2015. Rare and Uncommon Native Vascular Plants of Vermont. Montpelier, VT: Vermont Department of Fish and Wildlife.

Vermont Department Forest, Parks, and Recreation. Forestry Division, County Forester Program. 2010. Use Value Appraisal Program Manual.

Vermont Land Trust. 2016. Atlas Timberlands. Retrieved from http://www.vlt.org/atlas-timberlands.

Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. Web Soil Survey. Available online at https://websoilsurvey.sc.egov.usda.gov/.

Worthley, A. and M. Lew-Smith. 2015. Vernal Pool Assessment of the Atlas Tracts. Arrowwood Environmental.

Wright, S.W. 2009. Ice flow, subglacial hydrology, and glacial lake history, Northern Vermont. New England Intercollegiate Geological Conference, Field Trip Guide A4.