

# **Vermont Natural Community Ranking Specifications**



**Vermont Fish and Wildlife Department  
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## Table of Contents

Introduction .....	1
How to Use Natural Community Ranking Specifications.....	3
Natural Community Ranking Specification Matrix .....	8
Detailed Natural Community Ranking Specifications .....	16
Montane Spruce-Fir Forest .....	17
Montane Yellow Birch-Red Spruce Forest .....	23
Lowland Spruce-Fir Forest .....	28
Red Spruce-Northern Hardwood Forest.....	33
Red Spruce-Heath Rocky Ridge Forest.....	38
Northern Hardwood Forest .....	43
Rich Northern Hardwood Forest.....	48
Hemlock Forest and Temperate Hemlock Forest .....	53
Limestone Bluff Cedar-Pine Forest .....	58
Mesic Maple-Ash-Hickory-Oak Forest .....	63
Dry Oak Forest .....	68
Dry Oak-Hickory-Hophornbeam Forest .....	72
Mesic Clayplain Forest and Sand-Over-Clay Forest .....	77
Pine-Oak-Heath Sandplain Forest.....	82
Floodplain Forests.....	88
Red Maple-Black Ash Seepage Swamp .....	94
Red Maple-Sphagnum Acidic Basin Swamp and Hemlock-Sphagnum Acidic Basin Swamp .....	99
Red or Silver Maple-Green Ash Swamp.....	104
Calcareous Red Maple-Tamarack Swamp.....	108
Red Maple-Black Gum Swamp.....	112
Wet Clayplain Forest and Wet Sand-Over-Clay Forest.....	116
Northern White Cedar Swamp types.....	121
Spruce-Fir-Tamarack Swamp .....	127
Red Spruce-Cinnamon Fern Swamp an Black Spruce Swamp .....	131
Hemlock-Balsam Fir-Black Ash Seepage Swamp .....	137
Seep.....	141
Vernal Pool.....	145
Dwarf Shrub Bog and Poor Fen.....	152

Rich Fen and Intermediate Tall Sedge Fen ..... 158

## Introduction

A **natural community** is an interacting assemblage of plants, animals, and other organisms, their physical environment, and the natural processes that affect them.

Natural communities are a powerful ecological concept because there is a pattern to their distribution. The assemblages of plants, animals, and other organisms found in natural communities repeat whenever certain environmental conditions (such as soil, water, and climate) occur. Whereas a natural community refers to an actual occurrence on the ground, a **natural community type** is a composite description summarizing the characteristics of all known examples of that type. In Vermont, there are currently 94 natural community types recognized and classified.

Vermont's natural community classification provides a common language for classifying land for purposes of land use planning, land management, and conservation. They integrate many environmental site conditions into a discrete number of types, allowing us to better understand landscape patterns. Natural communities are one important way of describing, mapping, and predicting habitat for plants, birds, mammals, and other groups. Some species rely on habitat found in only one or two natural community types, while other species depend on habitat provided by multiple community types and landscape patterns. A commonly held conservation hypothesis is that if multiple, high quality examples of all of Vermont's natural communities are conserved at the scale at which they naturally occur, most of the species they contain, from the largest trees and mammals to the smallest insects, will also be conserved.

Each of the 94 natural community types has been assigned to one of three broad categories based on its size, its distribution across the landscape, and the specificity of its association with particular environmental conditions. These scales of community distribution are referred to as matrix, large patch, and small patch.

Each community type is also assigned a **State Rank** that describes the **rarity** of that type in Vermont. State Ranks range from S1 (extremely rare) to S5 (common and widespread) and are assigned based on the number of known occurrences of the type, the total area occupied by the type, and the degree of threat to the type. For example, Calcareous Riverside Seep is an S1 community type that occurs only in areas of calcareous ground water seepage over flood-scoured bedrock river shores, whereas Northern Hardwood Forest is an S5 community type that occurs throughout the state at elevations below 2,500 feet.

Each occurrence of a natural community that is visited and evaluated by the Vermont Fish and Wildlife Department's Natural Heritage Inventory is also assigned an **Element Occurrence Rank**. The Element Occurrence Ranks summarize the **quality** of the occurrence and its probability of persistence over time, and range from A (excellent) to D (poor). This document provides detailed, narrative ranking specifications for 43 of the 94 natural community types as well as a

tabular matrix (spreadsheet) that provides the basic factors needed to rank occurrences of all 94 natural community types. These ranks are based on an assessment of the **size** and **current condition** of the natural community, and the **landscape context** in which the natural community occurs. Large size, condition reflecting minimal human disturbance, and a surrounding landscape with intact natural communities and minimal fragmentation are all factors that contribute to a high Element Occurrence Rank. In general, the higher the rank, the more likely it is that the community will be viable over long time periods, the higher its habitat value for component plant and animal species, and the higher its conservation value.

At the core of the work by the Fish and Wildlife Department's Natural Heritage Inventory is the Natural Heritage database containing information on occurrences of natural communities and populations of rare plant and animal species. For natural communities, occurrences are considered **State-Significant** and are tracked in the database if they meet a combination of State Rank and Element Occurrence Rank ratings as described below:

- S1 or S2 community types with an Element Occurrence Rank of A, B, or C
- S3 or S4 community types with an Element Occurrence Rank of A or B<sup>1</sup>
- S5 community types with an Element Occurrence Rank of A.<sup>2</sup>

The underlying assumption in this sequence of categories is that the rarer the community type, the greater the ecological value that is placed on lower quality occurrences. For the rare Calcareous Riverside Seep, all occurrences of excellent (A) to fair (C) quality are considered State-Significant. In contrast, only the excellent (A) occurrences of the common Northern Hardwood Forest are considered State-Significant. Natural communities that meet these combinations of rarity and quality represent the best occurrences of their community types in Vermont. Natural community occurrences that do not meet these categories may still be considered State-Significant, but this determination will need specific justification.

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<sup>1</sup> C-ranked S3 and S4 natural communities are tracked in the database but are not considered State-Significant. The rationale is that if the C-rank is based on a degraded current condition, recovery or restoration of the community over time will result in assignment of a higher Element Occurrence Rank and a determination of State-Significance.

<sup>2</sup> B-ranked S5 natural communities are tracked in the database but are not considered State-Significant for the same reason as described in footnote 2.

## How to Use Natural Community Ranking Specifications

The natural community ranking specification presented in this document are based on guidelines and templates in "Element Occurrence Data Standards" (February 6, 2002, NatureServe). These guidelines provide a consistent format for ranking natural communities that is used across the network of state Natural Heritage Programs and that has been tested for its effectiveness and ease of interpretation.

The following is a list of all the criteria that are used in each of the following 43 detailed ranking specifications. A brief description of what each criterion means is provided.

**Natural Community Name:** the descriptive name assigned to the natural community type

**General Description:** description of the natural community type, including its characteristic plants and animals, physical setting, distribution, and natural disturbance regimes.

**State Rank:** the rarity rank assigned to the natural community type in Vermont, based on the number of known examples, the overall quality of the known examples, and the total area occupied by the community type.

**Spatial Pattern:** the scale at which the natural community occurs: small patch, large patch, matrix forest.

**Determining Element Occurrences: the following factors are used to decide which mapped examples of natural communities qualify as one or separate element occurrences.**

**Minimum Size for Element Occurrence:** the minimum mapped size that may qualifies as a state-significant example.

**Separation Barriers:** descriptions of natural or human features that function to separate one example of the community type from another.

**Separation Distance – Different Natural/Semi-Natural Communities:** the maximum distance between two mapped polygons of a natural community type with only natural or semi-natural habitat between in which the natural community in question qualifies as one example (element occurrence).

**Separation Distance – Cultural Vegetation:** the maximum distance between two mapped polygons of a natural community type with intervening cultural vegetation (such as agriculture) in which the natural community in question qualifies as one example (element occurrence).

**Alternative Separation Procedure:** any other factors used in determining the separation between nearby natural community examples. For example, for many wetland natural community types, watershed and hydrologic connectivity are considered.

**Separation Justification:** a justification for the separation procedure used.

**Rank Procedure: the following factors are the core of natural community ranking**

**specifications and are the basis for assigning ranks to individual natural community element occurrences.**

**Element Occurrence Rank Factor 1 – Condition:** The factors making up A-D ranks for the current condition of a natural community example.

**Ranking Specifications Justification:** Justification for the current condition factors.

**Element Occurrence Rank Factor 2 – Size:** The size ranges (acres or square feet) making up A-D ranks for the size of a natural community example.

**Ranking Specifications Justification:** Justification for the size ranges.

**Element Occurrence Rank Factor 3 – Landscape Context:** The factors making up A-D ranks for the landscape context in which a natural community occurs.

**Ranking Specifications Justification:** Justification for the landscape context factors.

**Ranking Specifications Date:** latest date that the ranking specifications were revised.

**Ranking Specifications Authorship:** the author of the ranking specifications.

In order to be most efficient and accurate in using the ranking specifications, it is recommended that a complete inventory of the subject natural community be conducted. Time for site-specific inventory always varies, but at a minimum, the natural community should be surveyed in enough detail to be able to describe the dominant vegetation by strata, soils, hydrology, slope, aspect, elevation range, wildlife observed, and evidence of natural and human disturbance. Presence and abundance of non-native invasive species is important for assessing the current condition. The inventory should cover enough of the natural community so as to be able to describe variation within the community – for example, matrix forests should be visited in multiple locations. Additional guidelines for inventory of natural communities are included on the Natural Community Survey Form available on the Vermont Fish and Wildlife Department website.

Collection of ecological data (such as the list above) at multiple observation points, each with a GPS reference is very helpful for improving mapping accuracy of the natural community using ArcMap or other Geographic Information Systems (GIS) software. Mapping discrete polygons of a the natural community is an important step in deciding which polygons can be grouped into the same element occurrence, based on separation barriers and separation distances described in the ranking specifications. The mapping process using GIS is also the most accurate way to determine the size of most natural communities, one of the three primary ranking factors.

The landscape context of a natural community is best determined by a combination of field observation and review of recent aerial photography and other GIS tools and layers.



The combination of site-collected ecological data and information derived from GIS mapping and review of aerial photos and data layers is all relevant for ranking a natural community occurrence, whether using the detailed narrative ranking specifications or the tabular matrix.

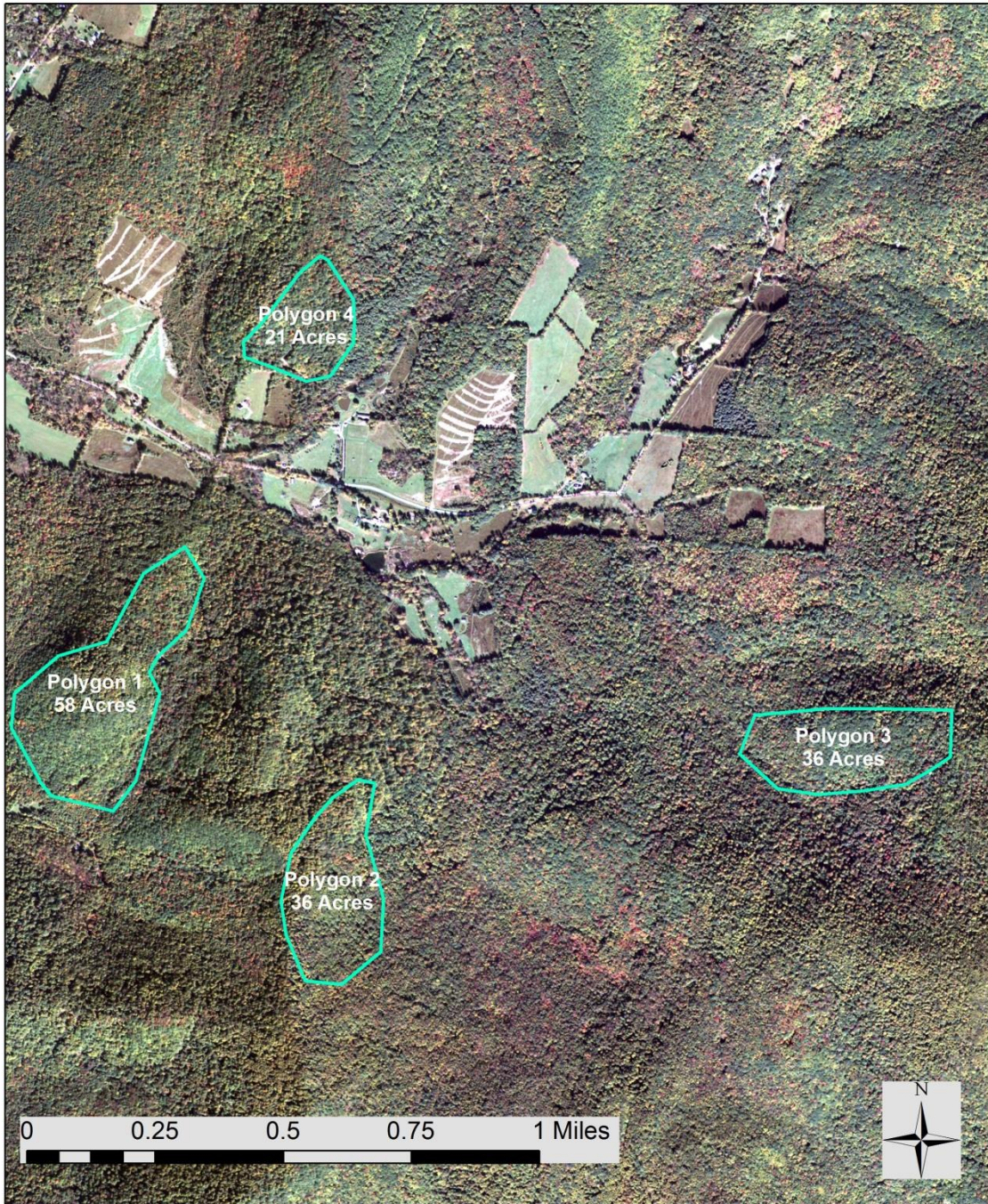
For ranking natural community occurrences for which there are no detailed ranking specifications and the tabular matrix will be used, it is recommended to also review any detailed ranking specification for similar natural community types. In many cases, the same factors apply in ranking similar natural community types. For example, review the detailed ranking specifications for Mesic Maple-Ash-Hickory-Oak Forest and Rich Northern Hardwood Forest when ranking a Mesic Red Oak-Northern Hardwood Forest.

### **A Natural Community Ranking Example**

The map below represents a hypothetical set of natural community polygons. In this scenario, each of these examples is Dry Oak Forest. Dry Oak Forest is an uncommon natural community type that occurs at the small to large patch scale. It is found primarily on dry, warm sites in the Champlain Valley, Taconic Mountains, and the Southern Vermont Piedmont. See the detailed ranking specifications on page 67 to follow along with this ranking example.

For this hypothetical example shown on the map, the condition of Polygons 1, 2, and 3 is considered B-rank, assuming that these forests have been logged in the past, but have been maturing under the influence of natural processes for around 80 years. Tree age varies from 80 to 120 years, and few non-native, invasive species are present. The condition of Polygon 4 is C-rank. This natural community has been logged 30 years ago, and mostly contains young trees. Moderate infestations of invasive honeysuckle were found in one corner of the polygon.

The landscape context for each of these polygons is B. They are buffered by significant areas of forest in a large habitat block, but some of this forest has been logged fairly recently and is in C condition. Also, a developed area of roads, farms, and homes extends into the center of the habitat block.



### Grouping Polygons Into Occurrences

Polygons 1 and 2 are approximately 0.35 miles apart. The forests and habitat between them is natural and made up of several temperate-climate natural community types. The separation

distance for Dry Oak Forest with intervening natural vegetation is 0.5 mile. Therefore, Polygons 1 and 2 would be grouped into the same occurrence.

Polygon 3 is around 0.75 mile from Polygon 2. While the forest between these polygons is intact and supports natural community types similar to the polygons, Polygon 3 is beyond the separation distance of 0.5 miles for natural vegetation. Therefore, Polygon 3 is a second occurrence.

Polygon 4 is only 0.4 miles from Polygon 1. However, there is a significant barrier between these two community polygons created by a road, houses, driveways, agricultural land, and lawns. These features create a significant canopy gap, are likely to alter ecological processes, and are likely to restrict animal movement between the mapped polygons. This development constitutes a separation barrier, so although Polygon 4 is within the separation distance of Polygon 1, it is considered a third and distinct occurrence.

### Ranking Occurrences

The first occurrence consists of Polygons 1 and 2. These natural communities are, respectively, 58 acres and 36 acres, with a total size of 94 acres. This is significantly larger than the A-rank cutoff for Dry Oak Forest of 25 acres, so the size rank is A. As described earlier, the current condition is B and the landscape context is B.

Calculation: A=4, B=3, C=2, D=1

(Condition rank B or 3 x 0.33) + (Landscape Context rank B or 3 x 0.33) + (Size rank A or 4 x 0.33) = EO Rank = 3.33

Element occurrence ranks and their corresponding calculated numeric values:

EO Rank	Numeric Values
A	>3.25 and ≤4.00
B	>2.50 and ≤3.25
C	>1.75 and ≤2.50
D	>1.00 and ≤1.75

This numeric result of 3.33 translates to an overall rank of A. Dry Oak Forest is an S3-ranked natural community so A- and B-ranked examples are considered state significant and therefore this occurrence qualifies as state-significant.

The second occurrence consists only of Polygon 3. This occurrence is 36 acres, so it also qualifies as A-ranked and state significant by the same process as above.

The third occurrence consists only of Polygon 4. At 21 acres the size rank for this natural community is B. The landscape context is also B, but the current condition for this polygon is C. This results in an overall rank of B, but very close to C. This natural community occurrence qualifies as state significant, but just barely.

## Natural Community Ranking Specification Matrix

The following table includes the basic ranking specifications needed to rank all 94 natural community types. For the size classes, anything below the given "Size C" is "Size D". Current condition and landscape context factors should be obtained from a similar natural community type with detailed ranking specifications.

Element occurrence ranks are calculated using the three rank factors scores (size, current condition, and landscape context) and the following matrix:

A=4, B=3, C=2, D=1

$(\text{Condition rank} \times 0.33) + (\text{Landscape Context rank} \times 0.33) + (\text{Size rank} \times 0.33) = \text{EO Rank}$

Element occurrence ranks and their corresponding calculated numeric values:

EO Rank	Numeric Values
A	>3.25 and ≤4.00
B	>2.50 and ≤3.25
C	>1.75 and ≤2.50
D	>1.00 and ≤1.75

Natural Community Type	Patch Size	S-Rank	min (EO/ Polygon)	Separation distance natural vegetation	Separation distance cultural vegetation	Condition	Size	Landscape Context	Size A	Size B	Size C
General Notes: Area in acres unless otherwise specified.											
<b>Spruce-Fir-Northern Hardwood Forest Formation</b>											
Subalpine Krummholz	S	S1	0.5	0.5	0.25	0.33	0.33	0.33	20	10	2
Montane Spruce-Fir Forest	L-M	S3	5/1	0.5	0.25	0.33	0.33	0.33	500	200	20
Lowland Spruce-Fir Forest	L	S3	5/1	0.5	0.25	0.33	0.33	0.33	500	200	20
Montane Yellow Birch-Red Spruce Forest	M	S3	20/5	0.5	0.25	0.33	0.33	0.33	1000	200	50
Red Spruce-Northern Hardwood Forest	M	S5	20/5	0.5	0.25	0.33	0.33	0.33	1000	200	50
Red Spruce-Heath Rocky Ridge Forest	S-L	S3	1	0.5	0.25	0.33	0.33	0.33	100	30	3
Boreal Talus Woodland	S	S3	0.5	0.5	0.25	0.33	0.33	0.33	50	10	2
Cold-Air Talus Woodland	S	S1	0.05	0.5	0.25	0.33	0.33	0.33	3	2	0.5
<b>Northern Hardwood Forest Formation</b>											
Northern Hardwood Forest	M	S5	40/5	0.5	0.25	0.33	0.33	0.33	4000	1500	100
Rich Northern Hardwood Forest	S-L	S4	1	0.5	0.25	0.33	0.33	0.33	100	30	3
Mesic Red Oak-Northern Hardwood Forest	L	S4	1	0.5	0.25	0.33	0.33	0.33	300	50	5
Hemlock Forest	S	S4	5	0.5	0.25	0.33	0.33	0.33	100	30	10
Hemlock-Northern Hardwood Forest	L-M	S5	20/5	0.5	0.25	0.33	0.33	0.33	1000	200	20
Northern Hardwood Talus Woodland	S	S3	0.5	0.5	0.25	0.33	0.33	0.33	15	5	2
<b>Oak-Pine-Northern Hardwood Forest Formation</b>											
Temperate Hemlock Forest	S-L	S4	1	0.5	0.25	0.33	0.33	0.33	100	30	3

Natural Community Type	Patch Size	S-Rank	min (EO/ Polygon)	Separation distance natural vegetation	Separation distance cultural vegetation	Condition	Size	Landscape Context	Size A	Size B	Size C
Temperate Hemlock-Hardwood Forest	L	S3	1	0.5	0.25	0.33	0.33	0.33	300	50	5
Red Pine Forest or Woodland	S	S2	0.5	0.5	0.25	0.33	0.33	0.33	20	5	2
Pitch Pine-Oak-Heath Rocky Summit	S	S1	0.5	0.5	0.25	0.33	0.33	0.33	20	5	2
Limestone Bluff Cedar-Pine Forest	S	S2	0.5	0.5	0.25	0.33	0.33	0.33	25	15	2
Red Cedar Woodland	S	S1	0.1	0.5	0.25	0.33	0.33	0.33	5	1	0.5
Dry Oak Woodland	S	S2	0.5	0.5	0.25	0.33	0.33	0.33	20	5	2
Dry Oak Forest	S-L	S3	1	0.5	0.25	0.33	0.33	0.33	25	15	2
Dry Red Oak-White Pine Forest	S	S3	1	0.5	0.25	0.33	0.33	0.33	25	15	2
Dry Oak-Hickory-Hophornbeam Forest	S-L	S3	1	0.5	0.25	0.33	0.33	0.33	100	30	3
Mesic Maple-Ash-Hickory-Oak Forest	L	S3	1	0.5	0.25	0.33	0.33	0.33	300	50	5
Transition Hardwood Limestone Forest	S	S3	1	0.5	0.25	0.33	0.33	0.33	25	15	2
Mesic Clayplain Forest	L-M	S2	5/1	0.5	0.25	0.33	0.33	0.33	500	100	20
Sand-Over-Clay Forest	L	S2	1	0.5	0.25	0.33	0.33	0.33	300	50	5
White Pine-Red Oak-Black Oak Forest	S	S2	1	0.5	0.25	0.33	0.33	0.33	100	30	3
Pine-Oak-Heath Sandplain Forest	L	S1	1	0.5	0.25	0.33	0.33	0.33	300	50	5
Transition Hardwood Talus Woodland	S	S3	0.5	0.5	0.25	0.33	0.33	0.33	25	5	2
<b>Upland Shores</b>											
Acidic Riverside Outcrop (Square Feet)	S	S3	100	0.5	0.25	0.33	0.33	0.33	4000	800	200
Calcareous Riverside Outcrop (Square Feet)	S	S2	100	0.5	0.25	0.33	0.33	0.33	4000	800	200

Natural Community Type	Patch Size	S-Rank	min (EO/ Polygon)	Separation distance natural vegetation	Separation distance cultural vegetation	Condition	Size	Landscape Context	Size A	Size B	Size C
Erosional River Bluff	S	S2	0.01	0.5	0.25	0.33	0.33	0.33	1	0.25	0.1
Lake Shale or Cobble Beach (Square Feet)	S	S3	100	0.5	0.25	0.33	0.33	0.33	3000	1000	200
Lake Sand Beach	S	S2	<50	0.5	0.25	0.33	0.33	0.33	3	1	0.25
Sand Dune	S	S1	0.01	0.5	0.25	0.33	0.33	0.33	0.5	0.25	0.1
<b>Outcrops and Upland Meadows</b>											
Alpine Meadow	S	S1	0.25	0.5	0.25	0.33	0.33	0.33	25	3	0.5
Boreal Outcrop	S	S4	0.1	0.5	0.25	0.33	0.33	0.33	10	2	0.5
Serpentine Outcrop	S	S1	0.1	0.5	0.25	0.33	0.33	0.33	5	2	0.5
Temperate Acidic Outcrop	S	S4	0.1	0.5	0.25	0.33	0.33	0.33	15	5	0.5
Temperate Calcareous Outcrop	S	S3	0.1	0.5	0.25	0.33	0.33	0.33	10	2	0.5
<b>Cliffs and Talus</b>											
Boreal Acidic Cliff (Vertical square feet)	S	S4	450	0.5	0.25	0.33	0.33	0.33	250000	20000	1000
Boreal Calcareous Cliff (Vertical square feet)	S	S2	250	0.5	0.25	0.33	0.33	0.33	150000	20000	1000
Temperate Acidic Cliff (Vertical square feet)	S	S4	450	0.5	0.25	0.33	0.33	0.33	250000	20000	1000
Temperate Calcareous Cliff (Vertical square feet)	S	S3	250	0.5	0.25	0.33	0.33	0.33	150000	20000	1000
Open Talus	S	S2	0.1	0.5	0.25	0.33	0.33	0.33	10	3	0.5
<b>Floodplain Forests</b>											
Silver Maple-Ostrich Fern Riverine Floodplain Forest	L	S3	1	1.5	N/A	0.33	0.33	0.33	50	10	2
Northern Conifer Floodplain Forest	S	S2	1	1.5	N/A	0.33	0.33	0.33	20	5	2
Silver Maple-Sensitive Fern Riverine Floodplain Forest	L	S3	1	1.5	N/A	0.33	0.33	0.33	50	10	2

Natural Community Type	Patch Size	S-Rank	min (EO/ Polygon)	Separation distance natural vegetation	Separation distance cultural vegetation	Condition	Size	Landscape Context	Size A	Size B	Size C
Sugar Maple-Ostrich Fern Riverine Floodplain Forest	S	S2	1	1.5	N/A	0.33	0.33	0.33	20	5	2
Lakeside Floodplain Forest	S	S3	1	1.5	N/A	0.33	0.33	0.33	20	5	2
<b>Hardwood Swamps</b>											
Red Maple-Black Ash Seepage Swamp	S-L	S4	1	0.5	0.25	0.33	0.33	0.33	20	5	2
Red Maple-Sphagnum Acidic Basin Swamp	S	S3	0.125	0.25	0.25	0.33	0.33	0.33	5	2	0.5
Red or Silver Maple-Green Ash Swamp	L	S3	1	1/0.5	0.25	0.33	0.33	0.33	50	20	5
Calcareous Red Maple- Tamarack Swamp	S	S2	0.5	0.5	0.25	0.33	0.33	0.33	20	5	2
Red Maple-Black Gum Swamp	S	S2	0.125	0.25	0.25	0.33	0.33	0.33	5	2	0.5
Red Maple-Northern White Cedar Swamp	L	S3	1	0.5	0.25	0.33	0.33	0.33	300	50	5
Wet Clayplain Forest	S	S2	0.5	0.5	0.25	0.33	0.33	0.33	100	50	5
Wet Sand-Over-Clay Forest	S	S2	0.5	0.5	0.25	0.33	0.33	0.33	100	50	5
Red Maple-White Pine- Huckleberry Swamp	S	S1	0.5	0.5	0.25	0.33	0.33	0.33	20	5	2
Seepage Forest	S	S3	0.5	0.5	0.25	0.33	0.33	0.33	20	5	2
<b>Softwood Swamps</b>											
Northern White Cedar Swamp	S	S3	0.5	0.5	0.25	0.33	0.33	0.33	60	25	5
Northern White Cedar Sloping Seepage Forest	S	S3	0.5	0.5	0.25	0.33	0.33	0.33	60	25	5
Boreal Acidic Northern White Cedar Swamp	S	S3	0.5	0.5	0.25	0.33	0.33	0.33	60	25	5
Spruce-Fir-Tamarack Swamp	L	S3	1	0.5	0.25	0.33	0.33	0.33	100	25	5
Red Spruce-Cinnamon Fern Swamp	S	S3	0.5	0.5	0.25	0.33	0.33	0.33	20	5	2



Natural Community Type	Patch Size	S-Rank	min (EO/ Polygon)	Separation distance natural vegetation	Separation distance cultural vegetation	Condition	Size	Landscape Context	Size A	Size B	Size C
Black Spruce Swamp	S	S2	0.5	0.5	0.25	0.33	0.33	0.33	25	5	2
Hemlock-Sphagnum Acidic Basin Swamp	S	S2	0.25	0.25	0.25	0.33	0.33	0.33	5	2	0.5
Hemlock-Balsam Fir-Black Ash Seepage Swamp	S	S4	0.5	0.5	0.25	0.33	0.33	0.33	20	5	2
<b>Open Peatlands</b>											
Dwarf Shrub Bog	S	S2	0.25	0.5	0.25	0.33	0.33	0.33	15	5	2
Black Spruce Woodland Bog	S	S2	0.5	0.5	0.25	0.33	0.33	0.33	15	5	2
Pitch Pine Woodland Bog	S	S1	0.5	0.5	0.25	0.33	0.33	0.33	50	10	2
Alpine Peatland	S	S1	0.25	0.5	0.25	0.33	0.33	0.33	3	2	0.5
Poor Fen	S	S2	0.25	0.5	0.25	0.33	0.33	0.33	15	5	2
Intermediate Tall Sedge Fen	S	S2	0.25	0.5	0.25	0.33	0.33	0.33	15	5	2
Rich Fen	S	S2	0.25	0.5	0.25	0.33	0.33	0.33	3	2	0.5
<b>Marshes and Sedge Meadows</b>											
Shallow Emergent Marsh	S	S4	0.5	0.5	0.25	0.33	0.33	0.33	20	5	2
Sedge Meadow	S	S4	0.5	0.5	0.25	0.33	0.33	0.33	50	10	2
Cattail Marsh	S-L	S4	0.5	0.5	0.25	0.33	0.33	0.33	100	20	5
Deep Broadleaf Marsh	S	S4	0.5	0.5	0.25	0.33	0.33	0.33	50	10	2
Wild Rice Marsh	S	S3	0.5	0.5	0.25	0.33	0.33	0.33	20	5	2
Deep Bulrush Marsh	S-L	S4	0.5	0.5	0.25	0.33	0.33	0.33	50	10	2
<b>Wet Shores</b>											
Outwash Plain Pondshore	S	S1	0.25	0.5	0.25	0.33	0.33	0.33	10	5	1
River Mud Shore (Square Feet)	S	S3	100	0.5	0.25	0.33	0.33	0.33	4000	800	200

Natural Community Type	Patch Size	S-Rank	min (EO/ Polygon)	Separation distance natural vegetation	Separation distance cultural vegetation	Condition	Size	Landscape Context	Size A	Size B	Size C
River Sand or Gravel Shore (Square Feet)	S	S3	100	0.5	0.25	0.33	0.33	0.33	4000	800	200
River Cobble Shore	S	S2	0.05	0.5	0.25	0.33	0.33	0.33	2	0.5	0.1
Calcareous Riverside Seep (Square Feet)	S	S1	50	0.5	0.25	0.33	0.33	0.33	4000	800	200
Rivershore Grassland	S	S3	0.05	0.5	0.25	0.33	0.33	0.33	2	0.5	0.1
Lakeshore Grassland	S	S2	0.05	0.5	0.25	0.33	0.33	0.33	2	0.5	0.1
<b>Shrub Swamps</b>											
Alluvial Shrub Swamp	L	S3	0.5	0.5	0.25	0.33	0.33	0.33	100	30	3
Alder Swamp	S-L	S4	0.5	0.5	0.25	0.33	0.33	0.33	100	25	5
Sweet Gale Shoreline Swamp	S	S3	0.5	0.5	0.25	0.33	0.33	0.33	50	10	2
Buttonbush Swamp	S	S2	0.05	0.5	0.25	0.33	0.33	0.33	5	1	0.1
<b>Seeps and Vernal Pools</b>											
Seep	S	S4	0.01	same watershed	N/A	0.33	0.33	0.33	3	1	0.1
Vernal Pool (Square Feet)	S	S3	200	same watershed		0.2	0.2	0.2	5000	2500	400

Calculation: A=4, B=3, C=2, D=1

(Condition rank x 0.33) + (Landscape Context rank x 0.33) + (Size rank x 0.33) = EO Rank

Element occurrence ranks and their corresponding calculated numeric values:

EO Rank	Numeric Values
A	$>3.25$ and $\leq 4.00$
B	$>2.50$ and $\leq 3.25$
C	$>1.75$ and $\leq 2.50$
D	$>1.00$ and $\leq 1.75$

## **Detailed Natural Community Ranking Specifications**

The following sections provide detailed ranking specifications for 43 natural community types. Note that some similar natural community types are combined into one ranking specification, such as for floodplain forests and northern white cedar swamp types.

The order of the detailed natural community specifications is provided in the Table of Contents.

## Montane Spruce-Fir Forest

**General Description:** Along the spine of the Green Mountains, on mountains like Monadnock in Vermont's Northeastern Highlands, and on a few peaks in the Taconic Mountains, Montane Spruce-Fir Forest is dominant. In these places, we consider this forest the matrix-forming community. Montane Spruce-Fir Forests occur mostly above 2,800 feet elevation in the Southern Green Mountains and Taconic Mountains. In the Northern Green Mountains and Northeastern Highlands, the lower limit ranges from 2,500 feet to 2,700 feet. Below this elevation, Montane Yellow Birch-Red Spruce Forest is the dominant community.

The climate on these mountains is cold and severe. Summers are short and foggy; winters are cold and windy. Clouds are frequent and count as one of the main ecological influences on vegetation. Mountaintop clouds form when moist air rises and condenses as it cools. Often, on a still day, the only clouds in sight are those that cap the mountaintops. One of the effects of all this excess moisture is a constant supply of water to the forests. Foliage intercepts water droplets, which then fall to the ground as fog drip. This fog drip can be a significant and important source of moisture for plants. Continually wet, spongy conditions on upper mountain trails testify to the quantity of water captured in this way. Another effect of all the fog, however, is that it limits light infiltration and therefore cuts down on photosynthetic activity, even when the temperatures are quite warm. Considering the influence of clouds on Montane Spruce-Fir Forests, it may well be, as has been proposed by one scientist, that the lower elevational limit of this community on New England mountains corresponds to the prevailing lower limit of clouds.

Soils in Montane Spruce-Fir Forests are spodosols – acidic, leached soils that are low in fertility. A typical soil profile shows dramatic color differences between layers, evidence of the leaching. The soils are vulnerable to disturbance from downslope movement and windthrow, which are common on Montane Spruce-Fir Forests. Downslope movement can be dramatic when soils become super-saturated. In very steep valleys like Smugglers Notch, landslides are commonplace. Other processes that affect these forests are ice and snow damage, which can damage plant tissues and also break tree limbs, and natural fires. Some of the fires that have occurred in these forests in the last 200 years were caused, either directly or indirectly, by humans.

Balsam fir (*Abies balsamea*) and/or red spruce (*Picea rubens*) are the dominant trees of Montane Spruce-Fir Forests. Balsam fir is the more common softwood species at higher elevations. At the very highest elevations of Montane Spruce-Fir Forest, just below Subalpine Krummholz, black spruce (*Picea mariana*) begins to mix in with balsam fir, and red spruce is completely gone. Heart-leaved paper birch (*Betula papyrifera* var. *cordifolia*) and American mountain-ash (*Sorbus americana*) are abundant in some areas. Birch can be abundant where the soil has been disturbed by downslope movement or by fire and can persist for long periods of time where the disturbance recurs with frequency. Yellow birch (*Betula alleghaniensis*) is infrequent in Montane Spruce-Fir Forest but is closely associated with Montane Yellow Birch-Red Spruce Forests at lower elevations.

In this cloudy, cold environment, mosses thrive and are sometimes the dominant vegetation on the forest floor. Dense carpets of sphagnum moss (*Sphagnum* spp.), which are usually associated with bogs, are common throughout the forest on moist sites, for example on cliffs where dripping groundwater and fog provide a constant supply of moisture. Schreber's moss (*Pleurozium schreberi*) is abundant on drier sites, as are other mosses and liverworts: *Hylocomnium splendens*, *Ptilium crista-castrensis*, *Leucobryum*

*glaucum*, *Dicranum* spp., and *Bazzania trilobata*. Lichens do well in these forests, too, hanging from trees and clinging to bark, taking moisture from the air. Herbs are sparse in these dark forests, but those that do thrive are mountain wood fern (*Dryopteris campylopter*), brownish sedge (*Carex brunnescens*), bluebead lily (*Clintonia borealis*), whorled aster (*Aster acuminatus*), common wood sorrel (*Oxalis acetosella*), bunchberry (*Cornus canadensis*), shining clubmoss (*Lycopodium lucidulum*), goldthread (*Coptis trifolia*), Indian pipes (*Monotropa uniflora*), starflower (*Trientalis borealis*), and wild sarsaparilla (*Aralia nudicaulis*). Scattered shrubs include hobblebush (*Viburnum lantanoides*), mountain maple (*Acer spicatum*), Bartram's shadbush (*Amelanchier bartramiana*), and creeping snowberry (*Gaultheria hispidula*).

**Montane Fir Forest Variant:** At upper elevations, where balsam fir dominates and trees are relatively short and stunted. *Abies balsamea* - (*Betula papyrifera* var. *cordifolia*) Forest (CEGL006112)

**Montane Spruce Forest Variant:** At lower elevations, where balsam fir is nearly absent, trees are taller, and hardwoods are more commonly mixed in.

**State Rank:** S3

**Spatial Pattern:** Large Patch to Matrix Forest

**Minimum Size for Element Occurrence:** 5 acres

**Minimum Polygon Size for multipart EOs:** 1 acre

#### **Element Occurrence Separation**

**Separation Barriers:** Barriers that would separate one occurrence from another include rural development, agricultural land in lowlands, roads that create significant canopy breaks, and ski area development. Judgment on what constitutes a separation barrier should be based on whether the barrier interrupts natural processes between two adjacent areas or restricts the movement of animals that are functionally significant to the community.

**Separation Distance – Different Natural/Semi-Natural Communities:** 0.5 mile

**Separation Distance – Cultural Vegetation:** 0.25 mile

**Alternative Separation Procedure:** none

**Separation Justification:** Patches of Montane Spruce-Fir Forest are typically separated from one another by intervening Montane Yellow Birch-Red Spruce Forest or Northern Hardwood Forest and should be considered the same element occurrence if the patches are within the separation distance. A smaller separation distance may be justified in areas where the intervening natural communities are large open wetlands or cliffs with dramatic elevation changes that may limit interaction of species and processes between the patches.

#### **Rank Procedure**

Current condition, landscape context, and size are equally weighted (33%). This large patch to matrix community type occupies large areas on mountain summits with high connectivity to other community types. The current condition of these forests can be extremely variable within one occurrence as a

result of natural disturbance. Natural variability in these forests includes shifting abundance of balsam fir, red spruce, and heart-leaved paper birch; natural disturbance from wind, ice storms, and downslope movement; fir waves, and insect outbreaks. Aspects of current condition that reflect "permanent" degradation of the occurrence (such as roads or invasive exotics) are more important than temporary disturbances (selection harvesting).

Calculation: A=4, B=3, C=2, D=1

(Condition rank x 0.33) + (Landscape Context rank x 0.33) + (Size rank x 0.33) + = EO Rank

Element occurrence ranks and their corresponding calculated numeric values:

EO Rank	Numeric Values
A	>3.25 and ≤4.00
B	>2.50 and ≤3.25
C	>1.75 and ≤2.50
D	>1.00 and ≤1.75

### **Element Occurrence Rank Factor 1 – Size**

#### **A Specifications**

Very Large (>500 acres)

#### **B Specifications**

Large (>200-500 acres)

#### **C Specifications**

Moderate (20-200 acres)

#### **D Specifications**

Small (<20 acres)

#### **Ranking Specifications Justification**

A-Rank Threshold: The largest known occurrence of Montane Spruce-Fir Forest in Vermont is 8,561 acres and there are only 22 element occurrences greater than 500 acres, based on the statewide assessment and mapping of this natural community type.

C/D-Rank Threshold: Examples of Montane Spruce-Fir Forest may be as small as five acres, but at this scale the community is typically poorly developed and intergrades with the adjacent community types. Element occurrences less than 20 acres may provide important habitat functions but provide little matrix forest functions specific to this community type. Based on the statewide assessment and mapping of this community type there are 24 examples less than 20 acres.

### **Element Occurrence Rank Factor 2 – Landscape Context**

#### **A Specifications**

Highly connected: area around the EO is largely intact natural vegetation, with species interactions and natural processes occurring across communities. In general, the condition of the natural communities surrounding the element occurrence should be at least equal to the B Specifications for Condition listed below.

### **B Specifications**

Moderately connected: area around the EO is moderately intact natural vegetation, with species interactions and natural processes occurring across many communities. In general, the condition of the natural communities surrounding the element occurrence should be at least equal to the C Specifications for Condition listed below.

### **C Specifications**

Moderately fragmented: area around the EO is largely a combination of cultural and natural vegetation with barriers between species interactions and processes across communities; EO is surrounded by a mix of fragmented forest, agriculture, and rural development.

### **D Specifications**

Highly fragmented: the EO is entirely, or almost entirely, surrounded by urban development or agriculture. EO is at best buffered on one side by natural communities.

### **Ranking Specifications Justification:**

A-Rank Threshold: Forested landscapes of 4,000 acres or more are likely to accommodate most natural disturbance events from wind, insect, and fire. Only for Vermont's largest EOs will this 4,000 acres be primarily Montane Spruce-Fir Forest. Spruce and fir are especially susceptible to windthrow because of their shallow root systems combined with the exposure to extreme winds on mountain slopes and summits (Lorimer and White, 2003). Graves (1899, from Lorimer and White, 2003) notes that in these extreme habitats in the Adirondacks, windfall was common and that few trees reach biological maturity. Graves also notes that forests on high mountain slopes facing the prevailing winds are often relatively even aged. There is little specific information on the scale of insect epidemics in presettlement spruce-fir forests, although insect-killed trees are susceptible to windthrow and are highly flammable, contributing to the scale of disturbance in these forests (Lorimer and White, 2003). Based on the potential wind disturbance pattern being similar to that of the 1995 Adirondacks storm and the additional disturbance associated with insects and fire, an EO and surrounding landscape of 4,000 acres should be evaluated. This landscape area is the same as for Northern Hardwood Forest, Red Spruce-Northern Hardwood Forest, and Montane Yellow Birch-Red Spruce Forest, the matrix community types that surround most of the Montane Spruce-Fir Forest EOs.

C/D-Rank Threshold: Connectivity to other natural community patches is mostly eliminated, precluding most species interactions and movements; landscape-scale natural disturbance is also precluded by surrounding developed land.

### **Element Occurrence Rank Factor 3 – Condition**

#### **A Specifications**

a) Forest is dominated by red spruce and/or balsam fir, but may also include heart-leaved paper birch, black spruce, and other species characteristics of the community type. Characteristic shrubs and herbs are also present.

b) The forest is mature and displays many characteristics of an old-growth forest, including forest structure with all age classes, some old large-diameter trees, and some standing dead trees. Evidence of natural disturbance processes is present, such as abundant canopy gaps created by windthrow, pit and mound formation, and downed trees in all stages of decomposition. Older spruce trees are generally greater than 150 years old and balsam fir trees



greater than 100 years old. Although these conditions describe a mature forest, examples of Montane Spruce-Fir Forest that are more even aged and have younger trees may be considered A-rank for this factor if there is evidence that this condition is based on natural disturbance.

c) No exotic species present, or if few are present, they are easily controlled.

d) Any past (>20 years ago) selective logging or thinning has had minimal disruption of the understory or ground surface and full recovery is expected.

e) Regeneration of characteristic canopy species is not precluded by heavy moose browsing.

f) If there are openings greater than 0.5 acre within the EO but outside the 500 acre area, they are near an edge of the occurrence where they contribute little to fragmentation and they are small, with total area in the 1-15 year age class less than seven percent of the EO area.

### **B Specifications**

a) Forest dominated by characteristic species and with many structural characteristics of a mature forest as described above, but with selection harvesting resulting in stand age of 60 to 150 years old. Forest is generally uneven aged but may also be even aged.

b) Selection harvesting and thinning have resulted in little disruption of understory vegetation or ground surface over the majority of the EO.

c) Exotic species may be present in low numbers and can be controlled with relatively minor effort.

d) Full recovery to mature forest conditions is expected for the majority of the EO.

e) If there are openings greater than 0.5 acre within the EO, they are near an edge of the occurrence where they contribute little to fragmentation and they are small, with total area in the 1-15 year age class less than seven percent of the EO area.

### **C Specifications**

a) The forest species composition and structure has been significantly altered from the expected mature state by more intensive logging or minor surface alterations (woods roads or grazing). Generally a young, even aged forest (15-60 years).

b) Natural disturbance processes have been largely eliminated by the intensive nature of recent human disturbance.

c) Exotic species may be present in large numbers and their control will take significant effort.

d) Full recovery or restoration of mature forest conditions is expected, but may take many years or significant effort.

### **D Specifications (Note: any EO with a D-rank Condition is not a state-significant natural community)**

a) The forest species composition and structure have been significantly altered by intensive, repeated logging or activities that alter the ground surface and water movement (roads,

culverts, grading, and grazing).

b) Exotic species are present in large numbers and long-term successful control is unlikely.

c) Recovery or restoration of mature forest conditions is unlikely.

**Ranking Specifications Justification:**

A-Rank Threshold: Mature forests contain more biological legacies (fallen logs and rotting wood, well developed moss and herbaceous understory, structural complexity in the canopy and understory layers, accumulated soil organic matter, and seed banks) than young forests. 500 acres is given as a minimum area in which the characteristics of mature forests are likely to be preserved over long time periods. This includes both persistence of biological legacies and adequate size to accommodate many natural disturbance events. The maximum area of seven percent of the EO area in openings is based on Lorimer and White (2003) and the expected percentage of regional presettlement landscape in the 1-15 year age class under natural disturbance regimes. The seven percent figure is based on preliminary estimates for spruce-fir flats, swamps, high elevation sites in Maine (Lorimer and White 2003) and disturbance at this scale has not been documented in Vermont (Cogbill 2001).

C/D-Rank Threshold: highly disturbed forests that are unlikely to recover mature forest conditions.

**Ranking Specifications Date:** March 26, 2014

**Ranking Specifications Authorship:** Eric Sorenson and Robert Zaino

## Montane Yellow Birch-Red Spruce Forest

**General Description:** On mountain slopes and low summits, this forest type characterizes the transition from Northern Hardwood Forest to Montane Spruce-Fir Forest. It ranges from 2,000 feet to 2,900 feet elevation, but the actual elevation at which it occurs varies from north to south in the mountains. In the Northern Green Mountains, 2,500 feet is the upper limit, whereas it may reach 2,900 feet in the Taconic Mountains.

In general, soils are well drained to moderately well drained, and bedrock is often close to the surface or even exposed. Parent material is basal till or ablation till over bedrock. Restricting layers sometimes limit the downward movement of water. There is great variability within this community; locally wet sites are common, and coves and benches can support more nutrient demanding species.

Natural ecological processes influencing these forests include wind, ice loading, landslides, and smaller scale downslope movement of soil and nutrients.

At higher elevations, yellow birch (*Betula alleghaniensis*) and red spruce (*Picea rubens*) are codominant in Montane Yellow Birch-Red Spruce Forests, although balsam fir (*Abies balsamea*) may also be abundant. At lower elevations, sugar maple (*Acer saccharum*), red maple (*Acer rubrum*), and American beech (*Fagus grandifolia*) join the mix. Paper birch (*Betula papyrifera*), pin cherry (*Prunus pensylvanica*), and yellow birch are common in early successional examples. The understory vegetation varies depending upon the composition of the canopy and the local soil conditions. In spruce dominated areas, the understory vegetation is quite sparse due to the dense shade created by the canopy.

Characteristic shrubs are hobblebush (*Viburnum alnifolium*), striped maple (*Acer pensylvanicum*), and mountain maple (*Acer spicatum*). Hobblebush can form nearly impenetrable thickets with its arching stems that root at the nodes. Characteristic herbs are mountain wood fern (*Dryopteris campyloptera*), common wood sorrel (*Oxalis acetosella*), twin-flower (*Linnaea borealis*), bluebead lily (*Clintonia borealis*), Canada mayflower (*Maianthemum canadense*), intermediate wood fern (*Dryopteris intermedia*), whorled aster (*Aster acuminatus*), shining clubmoss (*Lycopodium lucidulum*), and wild sarsaparilla (*Aralia nudicaulis*). In some places, mountain wood fern can be extremely abundant, seeming almost to exclude other species.

**Montane Yellow Birch-Sugar Maple-Red Spruce Variant:** This variant is found at elevations below 2,500 feet, where sugar maple, red maple, and beech are common in the canopy, along with red spruce and yellow birch.

**State Rank:** S3

**Spatial Pattern:** Matrix Forest

**Minimum Size for Element Occurrence:** 20 acres

**Minimum Polygon Size for multipart EOs:** 5 acre

**Element Occurrence Separation**

**Separation Barriers:** Barriers that would separate one occurrence from another include rural development, agricultural land in lowlands, roads that create significant canopy breaks, and ski area development. Judgment on what constitutes a separation barrier should be based on whether the barrier interrupts natural processes between two adjacent areas or restricts the movement of animals that are functionally significant to the community.

**Separation Distance – Different Natural/Semi-Natural Communities:** 0.5 mile

**Separation Distance – Cultural Vegetation:** 0.25 mile

**Alternative Separation Procedure:** none

**Separation Justification:** Patches of Montane Yellow Birch-Red Spruce Forest are typically separated from one another by intervening Montane Spruce-Fir Forest or Northern Hardwood Forest and should be considered the same element occurrence if the patches are within the separation distance. A smaller separation distance may be justified in areas where the intervening natural communities are large open wetlands or cliffs with dramatic elevation changes that may limit interaction of species and processes between the patches.

**Rank Procedure**

Current condition, landscape context, and size are equally weighted (33%). This matrix community type occupies large areas on upper mountain slopes with high connectivity to other community types. The current condition of these forests can be extremely variable within one occurrence as a result of natural disturbance. Natural disturbance and processes in these forests includes wind and ice storms, downslope movement, fir waves, and insect outbreaks. Aspects of current condition that reflect "permanent" degradation of the occurrence (such as roads or invasive exotics) are more important than temporary disturbances (selection harvesting).

Calculation: A=4, B=3, C=2, D=1

(Condition rank x 0.33) + (Landscape Context rank x 0.33) + (Size rank x 0.33) = EO Rank

Element occurrence ranks and their corresponding calculated numeric values:

EO Rank	Numeric Values
A	>3.25 and ≤4.00
B	>2.50 and ≤3.25
C	>1.75 and ≤2.50
D	>1.00 and ≤1.75

**Element Occurrence Rank Factor 1 – Size**

**A Specifications**

Very Large (>1,000 acres)

**B Specifications**

Large (>200-1,000 acres)

**C Specifications**

Moderate (10-200 acres)

**D Specifications**

Small (<10 acres)

**Ranking Specifications Justification**

A-Rank Threshold: Forest occurrences greater than 1,000 acres will be able to accommodate many natural disturbance processes such as individual tree mortality by wind or ice loading and moderate severity disturbances such as blowdowns. Large occurrences of Montane Yellow Birch-Red Spruce Forest in Vermont are known to be over 1,000 acres.

C/D-Rank Threshold: Although Montane Yellow Birch-Red Spruce Forest occur in very small patches, these small patches do not provide the matrix functions attributed to this matrix forest type. At the smallest size there are also edge effects.

Note: For biophysical regions in which Montane Yellow Birch-Red Spruce Forest may be a Large Patch community, the above size ranges should be shifted downward slightly.

**Element Occurrence Rank Factor 2 – Landscape Context**

**A Specifications**

Highly connected: area around the EO is largely intact natural vegetation, with species interactions and natural processes occurring across communities. In general, the condition of the natural communities surrounding the element occurrence should be at least equal to the B Specifications for Condition listed below.

**B Specifications**

Moderately connected: area around the EO is moderately intact natural vegetation, with species interactions and natural processes occurring across many communities. In general, the condition of the natural communities surrounding the element occurrence should be at least equal to the C Specifications for Condition listed below.

**C Specifications**

Moderately fragmented: area around the EO is largely a combination of cultural and natural vegetation with barriers between species interactions and processes across communities; EO is surrounded by a mix of fragmented forest, agriculture, and rural development.

**D Specifications**

Highly fragmented: the EO is entirely, or almost entirely, surrounded by urban development or agriculture. EO is at best buffered on one side by natural communities.

**Ranking Specifications Justification:**

A-Rank Threshold: Forested landscapes of 4,000 acres or more are likely to accommodate most natural disturbance events from wind, insect, and fire. Only for Vermont's largest EOs will this 4,000 acres be primarily Montane Yellow Birch-Red Spruce Forest. Spruce and fir are especially susceptible to windthrow because of their shallow root systems combined with the exposure to extreme winds on mountain slopes and summits (Lorimer and White, 2003). Graves (1899, from Lorimer and White, 2003) notes that in these extreme habitats in the Adirondacks, windfall was common and that few trees reach biological maturity. Graves also notes that forests on high mountain slopes facing the prevailing winds

are often relatively even aged. Based on the potential wind disturbance pattern being similar to that of the 1995 Adirondacks storm and the additional disturbance associated with insects and fire, an EO and surrounding landscape of 4,000 acres should be considered. This landscape area is the same as for Northern Hardwood Forest, Red Spruce-Northern Hardwood Forest, and Montane Spruce-Fir Forest, the matrix community types that surround most of the Montane Yellow Birch-Red Spruce Forest EOs. C/D-Rank Threshold: Connectivity to other natural community patches is mostly eliminated, precluding most species interactions and movements; landscape-scale natural disturbance is also precluded by surrounding developed land.

### **Element Occurrence Rank Factor 3 – Condition**

#### **A Specifications**

At least 500 acres of the EO is in A-rank condition for factors a-e, below:

a) Forest is dominated by red spruce and yellow birch, but may also include balsam fir, sugar maple, beech, and other species characteristics of the community type. Characteristic shrubs and herbs are also present.

b) The forest is mature and displays many characteristics of an old-growth forest, including forest structure with all age classes, some old large-diameter trees, and some standing dead trees. Evidence of natural disturbance processes is present, such as abundant canopy gaps created by windthrow, pit and mound formation, and downed trees in all stages of decomposition. Older spruce and yellow birch trees are generally greater than 150 years old. Although these condition describe a mature forest, examples of Montane Yellow Birch-Red Spruce Forest that are more even aged and have younger trees may be considered A-rank for this factor if there is evidence that this condition is based on natural disturbance.

c) No exotic species present, or if few are present, they are easily controlled.

d) Any past (>20 years ago) selective logging or thinning has had minimal disruption of the understory or ground surface and full recovery is expected.

e) Regeneration of characteristic canopy species is not precluded by heavy moose browsing.

f) If there are openings greater than 0.5 acre within the EO but outside the 500 acre area, they are near an edge of the occurrence where they contribute little to fragmentation and they are small, with total area in the 1-15 year age class less than four percent of the EO area.

#### **B Specifications**

a) Forest dominated by characteristic species and with many structural characteristics of a mature forest as described above, but with selection harvesting resulting in stand age of 60 to 150 years old. Forest is generally uneven aged but may also be even aged.

b) Selection harvesting and thinning have resulted in little disruption of understory vegetation or ground surface over the majority of the EO.

c) Exotic species may be present in low numbers and can be controlled with relatively minor effort.

- d) Full recovery to mature forest conditions is expected for the majority of the EO.
- e) If there are openings greater than 0.5 acre within the EO, they are near an edge of the occurrence where they contribute little to fragmentation and they are small, with total area in the 1-15 year age class less than four percent of the EO area.

### **C Specifications**

- a) The forest species composition and structure has been significantly altered from the expected mature state by more intensive logging or minor surface alterations (woods roads or grazing). Generally a young, even aged forest (15-60 years).
- b) Natural disturbance processes have been largely eliminated by the intensive nature of recent human disturbance.
- c) Exotic species may be present in large numbers and their control will take significant effort.
- d) Full recovery or restoration of mature forest conditions is expected, but may take many years or significant effort.

### **D Specifications (Note: any EO with a D-rank Condition is not a state-significant natural community)**

- a) The forest species composition and structure have been significantly altered by intensive, repeated logging or activities that alter the ground surface and water movement (roads, culverts, grading, and grazing).
- b) Exotic species are present in large numbers and long-term successful control is unlikely.
- c) Recovery or restoration of mature forest conditions is unlikely.

### **Ranking Specifications Justification:**

A-Rank Threshold: Hemlock-Northern Hardwood Forests begin to take on old growth characteristics at ages over 150 years (Tyrrell and Crow, 1994). This mixed forest has many similarities with Red Spruce-Northern Hardwood Forest. These mature forests contain more biological legacies (fallen logs and rotting wood, well developed moss and herbaceous understory, structural complexity in the canopy and understory layers, accumulated soil organic matter, and seed banks) than young forests. 500 acres is given as a minimum area in which the characteristics of mature forests are likely to be preserved over long time periods. This includes both persistence of biological legacies and adequate size to accommodate most wind-disturbance events. The maximum area of four percent of the EO area in openings is based on estimates by Lorimer and White (2003) of the expected percentage of regional presettlement landscape in the 1-15 year age class under natural disturbance regimes (range of 2.4-6.5 percent) for spruce-northern hardwood forests.

C/D-Rank Threshold: highly disturbed forests that are unlikely to recover mature forest conditions.

**Ranking Specifications Date:** March 26, 2014

**Ranking Specifications Authorship:** Eric Sorenson

## Lowland Spruce-Fir Forest

**General Description:** Lowland Spruce-Fir Forest occurs in the colder regions of Vermont. It typically occupies large and small depressions where cold air accumulates. Lowland Spruce-Fir Forest occurs as a matrix forest community type in the Northeast Highlands and Southern Green Mountains, but typically as a large patch type in other biophysical regions. This is due in part to the colder climate found in the two former regions, but is also due to the differences in topography – there are large, cold basins and flats in the Northeast Highlands and Southern Green Mountains, but only relatively small basins in the rolling topography of the Northern Piedmont and Northern Green Mountains. Lowland Spruce-Fir Forest also approaches the southern edge its range in Vermont. The soils are typically somewhat poorly drained, although they may be excessively well drained on some kame and esker settings. Red spruce (*Picea rubens*) and balsam fir (*Abies balsamea*) are dominant and often form a closed canopy. Other canopy species that may be present include paper birch (*Betula papyrifera*), yellow birch (*Betula alleghaniensis*), black spruce (*Picea mariana*), white pine (*Pinus strobus*), red maple (*Acer rubrum*), and white spruce (*Picea glauca*). Shrubs include striped maple (*Acer pensylvanicum*), hobblebush (*Viburnum alnifolium*), mountain holly (*Nemopanthus mucronatus*), and wild raisin (*Viburnum cassinoides*). Boreal herbs are common, including bluebead lily (*Clintonia borealis*), bunchberry (*Cornus canadensis*), twinflower (*Linnaea borealis*), and goldthread (*Coptis trifolia*). The bryophyte layer is well developed and includes *Pleurozium schreberi*, *Hylocomnium splendens*, *Ptilium crista-castrensis*, and *Bazzania trilobata*.

**State Rank:** S3

**Spatial Pattern:** Large Patch

**Minimum Size for Element Occurrence:** 5 acres

**Minimum Polygon Size for multipart EOs:** 1 acre

### Element Occurrence Separation

**Separation Barriers:** Barriers that would separate one occurrence from another include urban development, agricultural land, and highways that create significant canopy breaks. Judgment on what constitutes a separation barrier should be based on whether the barrier interrupts natural processes between two adjacent areas or restricts the movement of animals that are functionally significant to the community.

**Separation Distance – Different Natural/Semi-Natural Communities:** 0.5 mile

**Separation Distance – Cultural Vegetation:** 0.25 mile

**Alternative Separation Procedure:** none

**Separation Justification:** A smaller separation distance may be justified in areas where the intervening natural communities are large open wetlands or aquatic systems that limit interaction of species and processes between the patches. A larger separation distance may be appropriate for areas where the



intervening natural communities are similar in many characteristics and do not limit interaction between the patches, such as Red Spruce-Northern Hardwood Forest or Spruce-Fir-Tamarack Swamp.

**Rank Procedure**

Current condition, landscape context, and size are equally weighted (33%). This community type occurs mostly as a large patch forest, but also as a matrix forest. Even when occurring at sizes considered to meet the definition of large patch communities (<1,000 acres), Lowland Spruce-Fir Forest typically functions as a matrix forest in that it provides the ecological connection between the included softwood swamps and other wetlands. The current condition of these forests can be extremely variable even within one occurrence as a result of natural disturbance, including wind and insect outbreaks. Aspects of current condition that reflect "permanent" degradation of the occurrence (roads and grading) are more important than "temporary" disturbances (selection harvesting).

Calculation: A=4, B=3, C=2, D=1

(Condition rank x 0.33) + (Landscape Context rank x 0.33) + (Size rank x 0.33) = EO Rank

Element occurrence ranks and their corresponding calculated numeric values:

EO Rank	Numeric Values
A	>3.25 and ≤4.00
B	>2.50 and ≤3.25
C	>1.75 and ≤2.50
D	>1.00 and ≤1.75

**Element Occurrence Rank Factor 1 – Size**

**A Specifications**

Very Large (>500 acres)

**B Specifications**

Large (>200-500 acres)

**C Specifications**

Moderate (20-200 acres)

**D Specifications**

Small (<20 acres)

**Ranking Specifications Justification**

A-Rank Threshold: Only seven of the largest known occurrences of Lowland Spruce-Fir Forest in Vermont are greater than 1,500 acres and these are almost entirely in the Northeastern Highlands. Most occurrences are under 1,000 acres.

C/D-Rank Threshold: Examples of Lowland Spruce-Fir Forest may be as small as five acres, but at this scale the community is typically poorly developed and intergrades with the adjacent community types.

**Element Occurrence Rank Factor 2 – Landscape Context**

### **A Specifications**

Highly connected: area around the EO is largely intact natural vegetation, with species interactions and natural processes occurring across communities. In general, the condition of the natural communities surrounding the element occurrence should be at least equal to the B Specifications for Condition listed below.

### **B Specifications**

Moderately connected: area around the EO is moderately intact natural vegetation, with species interactions and natural processes occurring across many communities. In general, the condition of the natural communities surrounding the element occurrence should be at least equal to the C Specifications for Condition listed below.

### **C Specifications**

Moderately fragmented: area around the EO is largely a combination of cultural and natural vegetation with barriers between species interactions and processes across communities; EO is surrounded by a mix of fragmented forest, agriculture, and rural development.

### **D Specifications**

Highly fragmented: the EO is entirely, or almost entirely, surrounded by urban development or agriculture. EO is at best buffered on one side by natural communities.

### **Ranking Specifications Justification:**

A-Rank Threshold: Forested landscapes of 4,000 acres or more are likely to accommodate most natural disturbance events from wind, insect, and fire. Only for Vermont's largest EOs will this 4,000 acres be primarily Lowland Spruce-Fir Forest. Based on land surveyors' records of the 1795 windstorm in northern Maine (Lorimer, 1977; Lorimer and White, 2003), an area of approximately 356,000 acres was affected with numerous windfalls. Severity seems comparable to the 1995 Adirondack storm (Lorimer and White, 2003). Large-scale fires in presettlement forests appear to be uncommon in Vermont based on land surveys (Siccama, 1971; Cogbill, 2000), although large fires (25,000 acres and 79,000 acres in 1825, and 198,000 acres in 1803) were recorded based on land surveys in Maine (Lorimer, 1977). In the Nulhegan Basin where the largest Lowland Spruce-Fir Forests in Vermont occur, there is no evidence of large-scale presettlement fires, although several thousand acres of spruce-fir forest burned in the early 1900s (Cogbill, 2001). There is little specific information on the scale of insect epidemics in presettlement spruce-fir forests, although insect-killed trees are susceptible to windthrow and are highly flammable, contributing to the scale of disturbance in these forests (Lorimer and White, 2003). Based on the potential wind disturbance pattern being similar to that of the 1995 Adirondacks storm and the additional disturbance associated with insects and fire, an EO and surrounding landscape of 4,000 acres should be considered. This landscape area is the same as for Northern Hardwood Forest and Red Spruce-Northern Hardwood Forest, the matrix community types that surround most of the Lowland Spruce-Fir Forest EOs.

C/D-Rank Threshold: Connectivity to other natural community patches is mostly eliminated, precluding most species interactions and movements; landscape-scale natural disturbance is also precluded by surrounding developed land.

### **Element Occurrence Rank Factor 3 – Condition**

#### **A Specifications**

a) Forest is dominated by red spruce and balsam fir, but may also include yellow birch, paper

birch, black spruce, and other species characteristics of the community type. Characteristic shrubs and herbs are also present.

b) The forest is mature and displays many characteristics of an old-growth forest, including forest structure with all age classes, some old large-diameter trees, and some standing dead trees. Evidence of natural disturbance processes is present, such as abundant canopy gaps created by windthrow, pit and mound formation, and downed trees in all stages of decomposition. Older spruce trees are generally greater than 150 years old.

c) No exotic species present, or if few are present, they are easily controlled.

d) Any past (>20 years ago) selective logging or thinning has had minimal disruption of the understory or ground surface and full recovery is expected.

e) Regeneration of characteristic canopy species is not precluded by heavy browsing.

f) If there are openings greater than 0.5 acre within the EO, they are near an edge of the occurrence where they contribute little to fragmentation and they are small, with total area in the 1-15 year age class less than seven percent of the EO area.

#### **B Specifications**

a) Forest dominated by characteristic species and with many structural characteristics of a mature forest as described above, but with selection harvesting resulting in stand age of 60 to 150 years old. Forest is generally uneven aged but may also be even aged.

b) Selection harvesting and thinning have resulted in little disruption of understory vegetation or ground surface over the majority of the EO.

c) Exotic species may be present in low numbers and can be controlled with relatively minor effort.

d) Full recovery to mature forest conditions is expected for the majority of the EO.

e) If there are openings greater than 0.5 acre within the EO, they are near an edge of the occurrence where they contribute little to fragmentation and they are small, with total area in the 1-15 year age class less than seven percent of the EO area.

#### **C Specifications**

a) The forest species composition and structure has been significantly altered from the expected mature state by more intensive logging or minor surface alterations (woods roads or grazing). Generally a young, even aged forest (15-60 years).

b) Natural disturbance processes have been largely eliminated by the intensive nature of recent human disturbance.

c) Exotic species may be present in large numbers and their control will take significant effort.

d) Full recovery or restoration of mature forest conditions is expected, but may take many years

or significant effort.

**D Specifications (Note: any EO with a D-rank Condition is not a state-significant natural community)**

- a) The forest species composition and structure have been significantly altered by intensive, repeated logging or activities that alter the ground surface and water movement (roads, culverts, grading, and grazing).
- b) Exotic species are present in large numbers and long-term successful control is unlikely.
- c) Recovery or restoration of mature forest conditions is unlikely.

**Ranking Specifications Justification:**

A-Rank Threshold: Mature forests contain more biological legacies (fallen logs and rotting wood, well developed moss and herbaceous understory, structural complexity in the canopy and understory layers, accumulated soil organic matter, and seed banks) than young forests. 500 acres is given as a minimum area in which the characteristics of mature forests are likely to be preserved over long time periods. This includes both persistence of biological legacies and adequate size to accommodate many natural disturbance events. The maximum area of seven percent of the EO area in openings is based on Lorimer and White (2003) and the expected percentage of regional presettlement landscape in the 1-15 year age class under natural disturbance regimes. The seven percent figure is based on preliminary estimates for spruce-fir flats and swamps in Maine (Lorimer and White 2003) and disturbance at this scale has not been documented in Vermont (Cogbill 2001).

C/D-Rank Threshold: highly disturbed forests that are unlikely to recover mature forest conditions.

**Ranking Specifications Date:** March 26, 2014

**Ranking Specifications Authorship:** Eric Sorenson

## Red Spruce-Northern Hardwood Forest

**General Description:** This variable community type has many similarities with both Northern Hardwood Forest and Montane Yellow Birch-Red Spruce Forest. It is a widespread community, occurring throughout Vermont, generally in areas with shallow soil due to bedrock or basal tills and in colder settings than Northern Hardwood Forests. In mature forests, red spruce (*Picea rubens*), yellow birch (*Betula alleghaniensis*), and beech (*Fagus granifolia*) are the dominant trees, with sugar maple (*Acer saccharum*) present in varying amounts. White ash (*Fraxinus americana*) may be present in richer sites, hemlock (*Tsuga canadensis*) may be present in low elevation or warmer sites, and balsam fir (*Abies balsamea*) and red maple (*Acer rubrum*) are common in younger stands. The shrub layer is typically well developed with hobblebush (*Viburnum alnifolium*), striped maple (*Acer pensylvanicum*), mountain maple (*Acer spicatum*), and American mountain-ash (*Sorbus americana*). Boreal herbs are common, including common wood sorrel (*Oxalis acetosella*), bluebead lily (*Clintonia borealis*), starflower (*Trientalis borealis*), Canada mayflower (*Maianthemum canadensis*), and twinflower (*Linnaea borealis*). Other herbs include sarsaparilla (*Aralia nudicaulis*), and intermediate woodfern (*Dryopteris intermedia*).

**State Rank:** S5

**Spatial Pattern:** Matrix Forest (mostly Large Patch in the Taconic Mountains, Vermont Valley, Southern Vermont Piedmont, and the Champlain Valley)

**Minimum Size for Element Occurrence:** 20 acres

**Minimum Polygon Size for multipart EOs:** 5 acre

### Element Occurrence Separation

**Separation Barriers:** Barriers that would separate one occurrence from another include urban development, agricultural land, and highways that create significant canopy breaks. Judgment on what constitutes a separation barrier should be based on whether the barrier interrupts natural processes between two areas or restricts the movement of animals that are functionally significant to the community.

**Separation Distance – Different Natural/Semi-Natural Communities:** 0.5 mile

**Separation Distance – Cultural Vegetation:** 0.25 mile

**Alternative Separation Procedure:** none

**Separation Justification:** A smaller separation distance may be justified in areas where the intervening natural communities are large wetlands, aquatic systems, or extensive outcrops or alpine areas that limit interaction of species and processes between the patches. A larger separation distance may be appropriate for areas where the intervening natural communities are similar in many characteristics and do not limit interaction between the patches, such as Northern Hardwood Forest or Montane Yellow Birch-Red Spruce Forest.

### Rank Procedure

Current condition, landscape context, and size are equally weighted (33%). This matrix community type occupies large areas and has high connectivity to other community types. The current condition of these forests can be extremely variable within one occurrence as a result of natural disturbance (wind and ice storms, primarily) and timber harvesting. However, aspects of current condition that reflect "permanent" degradation of the occurrence (such as fragmenting roads or invasive exotics) are more important than temporary disturbances (timber harvesting).

Calculation: A=4, B=3, C=2, D=1

(Size rank x 0.33) + (Landscape Context rank x 0.33) + (Condition rank x 0.33) = EO Rank

Element occurrence ranks and their corresponding calculated numeric values:

EO Rank	Numeric Values
A	>3.25 and ≤4.00
B	>2.50 and ≤3.25
C	>1.75 and ≤2.50
D	>1.00 and ≤1.75

### **Element Occurrence Rank Factor 1 – Size**

#### **A Specifications**

Very Large (>1,000 acres)

#### **B Specifications**

Large (>200-1,000 acres)

#### **C Specifications**

Moderate (50-200 acres)

#### **D Specifications**

Small (<50 acres)

### **Ranking Specifications Justification**

A-Rank Threshold: Forest occurrences greater than 1,000 acres will be able to accommodate many natural disturbance processes such as individual tree mortality by wind or ice loading and moderate severity disturbances such as blowdowns. Large occurrences of Red Spruce-Northern Hardwood Forest in Vermont are known to be over 1,000 acres.

C/D-Rank Threshold: Although Red Spruce-Northern Hardwood Forest do occur in very small patches, these small patches do not provide the matrix functions attributed to this matrix forest type. At the smallest size there are also edge effects.

Note: For biophysical regions in which Red Spruce-Northern Hardwood Forest may be a Large Patch community, the above size ranges should be shifted downward slightly.

### **Element Occurrence Rank Factor 2 – Landscape Context**

#### **A Specifications**

Highly connected: area around the EO is largely intact natural vegetation, with species

interactions and natural processes occurring across communities. In general, the condition of the natural communities surrounding the element occurrence should be at least equal to the B Specifications for Condition listed below.

### **B Specifications**

Moderately connected: area around the EO is moderately intact natural vegetation, with species interactions and natural processes occurring across many communities. In general, the condition of the natural communities surrounding the element occurrence should be at least equal to the C Specifications for Condition listed below.

### **C Specifications**

Moderately fragmented: area around the EO is largely a combination of cultural and natural vegetation with barriers between species interactions and processes across communities; EO is surrounded by a mix of fragmented forest, agriculture, and rural development.

### **D Specifications**

Highly fragmented: the EO is entirely, or almost entirely, surrounded by urban development or agriculture. EO is at best buffered on one side by natural communities.

### **Ranking Specifications Justification:**

A-Rank Threshold: Forested landscapes of 4,000 acres or more could accommodate most natural disturbance events from wind, the primary form of disturbance in Red Spruce-Northern Hardwood Forests. Of 89,000 acres of moderate and severe disturbance (>30% tree mortality) from the 1995 windstorm in the Adirondacks, disturbance patch size ranged from 2.5 acres to 1,730 acres, with most of the patches small, but more than 40% of the blowdown area in patches greater than 250 acres (Jenkins, 1995 in Lorimer and White, 2003). Using two times the maximum disturbance patch size as a minimum dynamic area (Johnson and VanWagner, 1985) to incorporate natural disturbance from wind, the landscape size should be 3,460 acres, or 4,000 with an additional safety factor. So, the EO and surrounding landscape that should be considered is at least 4,000 acres.

C/D-Rank Threshold: Connectivity to other natural community patches is mostly eliminated, precluding most species interactions and movements; landscape-scale natural disturbance is also precluded by surrounding developed land.

### **Element Occurrence Rank Factor 3 – Condition**

#### **A Specifications**

At least 500 acres of the EO is in A-rank condition for factors a-e, below:

- a) Forest is dominated by red spruce, yellow birch, and beech. Other tree species may also be present. Characteristic shrubs and herbs are also present.
  
- b) The forest is mature and displays many characteristics of an old-growth forest, including forest structure with all age classes, a multi-story canopy, some old large-diameter trees, and some standing dead trees. Evidence of natural disturbance processes is present, such as canopy gaps created by windthrow, pit and mound formation, and downed trees in all stages of decomposition. Older trees are generally greater than 150 years old.
  
- c) No exotic species present, or, if few are present, they are easily controlled.

d) Any past (>20 years ago) selection harvesting or thinning has had minimal disruption of the understory or ground surface and full recovery is expected.

e) Regeneration of characteristic canopy species is not precluded by heavy browsing.

f) If there are openings greater than 0.5 acre within the EO but outside the 500 acre area, they are near an edge of the occurrence where they contribute little to fragmentation and they are small, with total area in the 1-15 year age class less than four percent of the EO area.

### **B Specifications**

a) Forest dominated by characteristic species and with many structural characteristics of a mature forest as described above, but with selection harvesting resulting in stand age of 60 to 150 years old. Forest is generally uneven aged, but may also be even aged.

b) Selection harvesting and thinning has resulted in little disruption of understory vegetation or ground surface over the majority of the EO.

c) Exotic species may be present in low numbers and can be controlled with relatively minor effort.

d) Full recovery to mature forest conditions is expected for the majority of the EO.

e) If there are openings greater than 0.5 acre within the EO, they are near an edge of the occurrence where they contribute little to fragmentation, and they are small, with total area in the 1-15 year age class less than six percent of the EO area.

### **C Specifications**

a) The forest species composition and structure has been significantly altered from the expected mature state by more intensive logging or minor surface alterations (woods roads or grazing). Generally a young, even aged forest (15-60 years).

b) Natural disturbance processes have been largely eliminated by the intensive nature of recent human disturbance.

c) Exotic species may be present in large numbers and their control will take significant effort.

d) Full recovery or restoration of mature forest conditions is expected but may take many years or significant effort.

### **D Specifications (Note: any EO with a D-rank Condition is not a state-significant natural community)**

a) The forest species composition and structure has been significantly altered by intensive, repeated logging or activities that alter the ground surface and water movement (roads, culverts, grading, and grazing).

b) Exotic species are present in large numbers and long-term successful control is unlikely.

c) Recovery or restoration of mature forest conditions is unlikely.



**Ranking Specifications Justification:**

A-Rank Threshold: Hemlock-Northern Hardwood Forests begin to take on old growth characteristics at ages over 150 years (Tyrrell and Crow, 1994). This mixed forest has many similarities with Red Spruce-Northern Hardwood Forest. These mature forests contain more biological legacies (fallen logs and rotting wood, well developed moss and herbaceous understory, structural complexity in the canopy and understory layers, accumulated soil organic matter, and seed banks) than young forests. 500 acres is given as a minimum area in which the characteristics of mature forests are likely to be preserved over long time periods. This includes both persistence of biological legacies and adequate size to accommodate most wind-disturbance events. The maximum area of four percent of the EO area in openings is based on lower estimates by Lorimer and White (2003) of the expected percentage of regional presettlement landscape in the 1-15 year age class under natural disturbance regimes (range of 2.4-6.5 percent) for spruce-northern hardwood forests. The maximum area of six percent of the EO for B condition is based on Lorimer and Whites (2003) upper estimate of the regional landscape in the 1-15 year age class for spruce northern hardwood forests (6.5 percent).

C/D-Rank Threshold: highly disturbed forests that are unlikely to recover mature forest conditions.

**Ranking Specifications Date:** March 26, 2014

**Ranking Specifications Authorship:** Eric Sorenson

## Red Spruce-Heath Rocky Ridge Forest

**General Description:** This community occurs on ridgelines, low summits, and exposed ledges where there are thin, well-drained soils over generally acidic bedrock. It is typically found at elevations from 1,500 to 2,500 feet. The community is found throughout Vermont at these elevations. The canopy cover varies from forest (>60%) to woodland (25-60%) depending on the amount of bedrock and ledge exposure. Small open patches of Boreal Acidic Outcrop are typically mixed in with the forest or woodland. The canopy is somewhat stunted due to the dry, nutrient-poor growing conditions. Red spruce (*Picea rubens*) is the dominant tree. Other canopy species that are typically much less abundant include balsam fir (*Abies balsamea*), paper birch (*Betula papyrifera*), mountain paper birch (*Betula papyrifera* var. *cordifolia*), white pine (*Pinus strobus*), and American mountain ash (*Sorbus americana*). Shrub cover is typically dominated by lowbush blueberry (*Vaccinium angustifolium*) and velvet-leaf blueberry (*Vaccinium myrtilloides*), with regeneration of the canopy species. Other heath shrubs may also be present, such as sheep laurel (*Kalmia angustifolia*). Herb cover is typically low and includes Canada mayflower (*Maianthemum canadense*), wild sarsaparilla (*Aralia nudicaulis*), common hairgrass (*Deschampsia flexuosa*), starflower (*Trientalis borealis*), bluebead (*Clintonia borealis*), tree clubmoss (*Lycopodium obscurum*), Virginia polypody (*Polypodium virginianum*), mountain wood fern (*Dryopteris campyloptera*), and pink ladyslipper (*Cypripedium acaule*). Bryophytes and lichens are common and include *Pleurozium schreberi*, *Dicranum fuscens*, *Dicranum scoparia*, *Politrichum juniperinum*, *Hypnum* sp., *Leucobryum glauca*, *Ptilidium ciliare*, and *Cladonia* sp. Droughty summer conditions, low nutrient availability, and wind are likely the dominant natural processes affecting these forests. The role of fire is not known.

**State Rank:** S3

**Spatial Pattern:** Small to Large Patch

**Minimum Size for Element Occurrence:** 1 acre

### Element Occurrence Separation

**Separation Barriers:** Barriers that would separate one occurrence from another include roads and highways that create significant canopy breaks and developed or agricultural lands.

**Separation Distance – Different Natural/Semi-Natural Communities:** 0.5 mile

**Separation Distance – Cultural Vegetation:** 0.25 mile

**Alternative Separation Procedure:** none

**Separation Justification:** Small patches of Red Spruce-Heath Rocky Ridge Forest commonly occur on nearby ridges and summits of the same hill or mountain. They are typically separated from each other by Northern Hardwood Forest, Red Spruce-Northern Hardwood Forest, and/or Montane Yellow Birch-Red Spruce Forest. In these situations with intact natural communities, separation distance may be extended to 0.7 mile.

### Rank Procedure

Current condition, landscape context, and size are equally weighted (33%). Red Spruce-Heath Rocky Ridge Forests are dependent on specific site conditions of shallow soils, droughtiness, and exposure to wind, and therefore, condition is of high importance. Size is variable for this type in Vermont. Landscape context is important for buffering these small to large forest patches and maintaining animal population connections and natural disturbance regimes. Small patch communities are especially susceptible to changes in the surrounding landscape.

Calculation: A=4, B=3, C=2, D=1

(Condition rank x 0.33) + (Landscape Context rank x 0.33) + (Size rank x 0.33) = EO Rank

Element occurrence ranks and their corresponding calculated numeric values:

EO Rank	Numeric Values
A	>3.25 and ≤4.00
B	>2.50 and ≤3.25
C	>1.75 and ≤2.50
D	>1.00 and ≤1.75

### **Element Occurrence Rank Factor 1 – Condition**

#### **A Specifications**

- a) Forest is dominated by red spruce, with balsam fir, white pine, paper birch, and American mountain ash present in varying abundance. Blueberries and other heath shrubs and boreal herbs dominate the groundcover.
  
- b) The forest is mature and displays many characteristics of an old-growth forest, including forest structure with all age classes, a multi-story canopy, some old large-diameter trees, and some standing dead trees. Evidence of natural disturbance processes is present, such as canopy gaps created by windthrow, pit and mound formation, and downed trees in all stages of decomposition. Older trees are generally greater than 150 years old.
  
- c) No exotic species present, or if few are present, they are easily controlled.
  
- d) Any past (>20 years ago) selection harvesting or thinning has had minimal disruption of the understory or ground surface and full recovery is expected. There is no evident disturbance to the processes of downslope movement and nutrient accumulation.
  
- e) Regeneration of characteristic canopy species is not precluded by heavy browsing.
  
- f) For very large examples (>= 100 acres), there may be openings greater than 0.5 acre within the EO, if they are near an edge of the occurrence where they contribute little to fragmentation and they are small, with total area in the 1-15 year age class less than four percent of the EO area. For occurrences less than 100 acres, there are no logging openings greater than 0.5 acre, and these are at the periphery of the occurrence.

#### **B Specifications**

- a) Forest dominated by characteristic species and with many structural characteristics of a mature forest as described above, but with selection harvesting resulting in stand age of 60 to

150 years old. Forest is generally uneven aged, but may also be even aged.

b) Selection harvesting and thinning has resulted in little disruption of understory vegetation or ground surface over the majority of the EO and there is no evident disturbance to the processes of downslope movement and nutrient accumulation. Natural disturbance processes are evident.

c) Exotic species may be present in low numbers and can be controlled with relatively minor effort.

d) Full recovery to mature forest conditions is expected for the majority of the EO.

e) Regeneration of characteristic canopy species is not precluded by heavy browsing.

f) For very large examples ( $\geq 100$  acres), there may be openings greater than 0.5 acre within the EO, if they are near an edge of the occurrence where they contribute little to fragmentation and they are small, with total area in the 1-15 year age class less than four percent of the EO area. For occurrences less than 100 acres, there are no logging openings greater than 0.5 acre, and these are at the periphery of the occurrence.

### **C Specifications**

a) The forest species composition and structure has been significantly altered from the expected mature state by more intensive logging or minor surface alterations (woods roads or grazing). Generally a young, even aged forest (15-60 years).

b) Natural disturbance processes have been largely eliminated by the intensive nature of recent human disturbance. Disturbance of the thin soils may lead to increased erosion which, in turn, may lead to a more open community that may be stable for decades or longer.

c) Exotic species may be present in large numbers and their control will take significant effort.

d) Full recovery or restoration of mature forest conditions is expected, but may take many years or significant effort.

### **D Specifications (Note: any EO with a D-rank Condition is not a state-significant natural community)**

a) The forest species composition and structure has been significantly altered by intensive, repeated logging or activities that alter the ground surface. These activities have also resulted in significant degradation to the process of downslope movement and nutrient accumulation.

b) Exotic species are present in large numbers and long-term successful control is unlikely.

c) Recovery or restoration of mature forest conditions is unlikely.

### **Ranking Specifications Justification:**

A-Rank Threshold: Mature forests display natural disturbance processes that result in formation of microhabitats and abundant coarse woody debris. The maximum area of four percent of the EO area in openings is based on lower estimates by Lorimer and White (2003) of the expected percentage of regional presettlement landscape in the 1-15 year age class under natural disturbance regimes (range of 2.4-6.5 percent) for spruce-northern hardwood forests.

C/D-Rank Threshold: Highly disturbed forests are unlikely to recover mature forest conditions, especially when the thin soils have been eroded.

### **Element Occurrence Rank Factor 2 – Landscape Context**

#### **A Specifications**

Highly connected: area around the EO (>1,000 acres) is largely intact natural vegetation, with species interactions and natural processes occurring across communities. In general, the condition of the natural communities surrounding the element occurrence should be at least equal to the B Specifications for Condition described for Northern Hardwood Forest or Spruce-Northern Hardwood Forest.

#### **B Specifications**

Moderately connected: area around the EO (>1,000 acres) is moderately intact natural vegetation, with species interactions and natural processes occurring across many communities. There are no disturbances altering the processes of downslope movement or nutrient accumulation in the occurrence. In general, the condition of the natural communities surrounding the element occurrence should be at least equal to the C Specifications for Condition described for Northern Hardwood Forest or Spruce-Northern Hardwood Forest.

#### **C Specifications**

Moderately fragmented: area around the EO is largely a combination of cultural and natural vegetation with barriers between species interactions and processes across communities; EO is surrounded by a mix of fragmented forest, agriculture, and rural development.

#### **D Specifications**

Highly fragmented: the EO is entirely, or almost entirely, surrounded by urban development or agriculture. EO is at best buffered on one side by natural communities.

#### **Ranking Specifications Justification:**

A-Rank Threshold: Forested landscapes of 1,000 acres or more with natural communities in good condition will buffer Red Spruce-Heath Rocky Ridge Forests from most other land uses.

C/D-Rank Threshold: Connectivity to other natural community patches is mostly eliminated, precluding most species interactions and movements; landscape-scale natural disturbance is also precluded by surrounding developed land.

### **Element Occurrence Rank Factor 3 – Size**

#### **A Specifications**

Very Large (>100 acres)

#### **B Specifications**

Large (>30-100 acres)

#### **C Specifications**

Moderate (3-30 acres)

#### **D Specifications**

Small (<3 acres)

**Ranking Specifications Justification**

A-Rank Threshold: There are very few known examples over 100 acres. These very large examples are expected to have more diverse microhabitats.

C/D-Rank Threshold: In very small Red Spruce-Heath Rocky Ridge Forests, there is likely less microhabitat diversity and more edge effect.

**Ranking Specifications Date:** March 26, 2014

**Ranking Specifications Authorship:** Eric Sorenson

## Northern Hardwood Forest

**General Description:** This is Vermont's most abundant forest type, occurring in many landscape settings, but generally below 2,700 feet elevation. It is widely distributed across central and northern New England and adjacent areas of Canada. Northern Hardwood Forests are dominated by a canopy of sugar maple (*Acer saccharum*), beech (*Fagus grandifolia*), and yellow birch (*Betula alleghaniensis*). Other canopy species may include red maple (*Acer rubrum*), hemlock (*Tsuga canadensis*), and white ash (*Fraxinus americana*). Hobblebush (*Viburnum alnifolia*), striped maple (*Acer pensylvanicum*), Canada honeysuckle (*Lonicera canadensis*), and beaked hazelnut (*Corylus cornuta*) are common shrubs. Typical herbs include intermediate woodfern (*Dryopteris intermedia*), shining clubmoss (*Lycopodium lucidulum*), Christmas fern (*Polystichum acrostichoides*), wild oats (*Uvularia sessilifolia*), Canada mayflower (*Maianthemum canadense*), and spring beauty (*Claytonia caroliniana*). Four community variants are recognized in Vermont and are all treated together in these ranking specifications.

**State Rank:** S5

**Spatial Pattern:** Matrix Forest (may be Large Patch in the warmest regions of Vermont, such as the Taconic Mountains)

**Minimum Size for Element Occurrence:** 40 acres

**Minimum Polygon Size for multipart EOs:** 5 acre

### Element Occurrence Separation

**Separation Barriers:** Barriers that would separate one occurrence from another include urban development, agricultural land, and highways that create significant canopy breaks. Judgment on what constitutes a separation barrier should be based on whether the barrier interrupts natural processes between two areas or restricts the movement of animals that are functionally significant to the community.

**Separation Distance – Different Natural/Semi-Natural Communities:** 0.5 mile

**Separation Distance – Cultural Vegetation:** 0.25 mile

**Alternative Separation Procedure:** none

**Separation Justification:** A smaller separation distance may be justified in areas where the intervening natural communities are large wetlands, aquatic systems, or extensive outcrops or alpine areas that limit interaction of species and processes between the patches. A larger separation distance may be appropriate for areas where the intervening natural communities are similar in many characteristics and do not limit interaction between the patches, such as Red Spruce-Northern Hardwood Forest or Montane Yellow Birch-Red Spruce Forest.

### Rank Procedure

Current condition, landscape context, and size are equally weighted (33%). This matrix community type

occupies large areas and has high connectivity to other community types. The current condition of these forests can be extremely variable within one occurrence as a result of natural disturbance (wind and ice storms, primarily) and timber harvesting. However, aspects of current condition that reflect "permanent" degradation of the occurrence (such as fragmenting roads or invasive exotics) are more important than temporary disturbances (timber harvesting).

Calculation: A=4, B=3, C=2, D=1

(Condition rank x 0.33) + (Landscape Context rank x 0.33) + (Size rank x 0.33) = EO Rank

Element occurrence ranks and their corresponding calculated numeric values:

EO Rank	Numeric Values
A	>3.25 and ≤4.00
B	>2.50 and ≤3.25
C	>1.75 and ≤2.50
D	>1.00 and ≤1.75

### **Element Occurrence Rank Factor 1 – Size**

#### **A Specifications**

Very Large (>4,000 acres)

#### **B Specifications**

Large (>1,500-4,000 acres)

#### **C Specifications**

Moderate (100-1,500 acres)

#### **D Specifications**

Small (<100 acres)

#### **Ranking Specifications Justification**

A-Rank Threshold: Forest occurrences greater than 1,000 acres will be able to accommodate many natural disturbance processes such as individual tree mortality by wind or ice loading and moderate severity disturbances such as blowdowns. Large occurrences of Northern Hardwood Forest in Vermont are known to be over 20,000 acres.

C/D-Rank Threshold: Although northern hardwood forests do occur in very small patches, these small patches do not provide the matrix functions attributed to this matrix forest type. At the smallest size there are also strong edge effects.

Note: For biophysical regions in which Northern Hardwood Forest may be a Large Patch community, the above size ranges should be shifted downward.

### **Element Occurrence Rank Factor 2 – Landscape Context**

#### **A Specifications**

Highly connected: area around the EO is largely intact natural vegetation, with species interactions and natural processes occurring across communities. In general, the condition of the natural communities surrounding the element occurrence should be at least equal to the B



Specifications for Condition listed below.

### **B Specifications**

Moderately connected: area around the EO is moderately intact natural vegetation, with species interactions and natural processes occurring across many communities. In general, the condition of the natural communities surrounding the element occurrence should be at least equal to the C Specifications for Condition listed below.

### **C Specifications**

Moderately fragmented: area around the EO is largely a combination of cultural and natural vegetation with barriers between species interactions and processes across communities; EO is surrounded by a mix of fragmented forest, agriculture, and rural development.

### **D Specifications**

Highly fragmented: the EO is entirely, or almost entirely, surrounded by urban development or agriculture. EO is at best buffered on one side by natural communities.

### **Ranking Specifications Justification:**

A-Rank Threshold: Forested landscapes of 4,000 acres or more could accommodate most natural disturbance events from wind, the primary form of disturbance in Northern Hardwood Forests. Of 89,000 acres of moderate and severe disturbance (>30% tree mortality) from the 1995 windstorm in the Adirondacks, disturbance patch size ranged from 2.5 acres to 1,730 acres, with most of the patches small, but more than 40% of the blowdown area in patches greater than 250 acres (Jenkins, 1995 in Lorimer and White, 2003). Using two times the maximum disturbance patch size as a minimum dynamic area (Johnson and VanWagner, 1985) to incorporate natural disturbance from wind, the landscape size should be 3,460 acres, or 4,000 with an additional safety factor. So, the EO and surrounding landscape that should be considered is at least 4,000 acres.

C/D-Rank Threshold: Connectivity to other natural community patches is mostly eliminated, precluding most species interactions and movements; landscape-scale natural disturbance is also precluded by surrounding developed land.

### **Element Occurrence Rank Factor 3 – Condition**

#### **A Specifications**

At least 500 acres of the EO is in A-rank condition for factors a-e, below:

- a) Forest is dominated by sugar maple, beech, and yellow birch. Other tree species may also be present. Characteristic shrubs and herbs are also present.
- b) The forest is mature and displays many characteristics of an old-growth forest, including forest structure with all age classes, a multi-story canopy, some old large-diameter trees, and some standing dead trees. Evidence of natural disturbance processes is present, such as canopy gaps created by windthrow, pit and mound formation, and downed trees in all stages of decomposition. Older trees are generally greater than 150 years old.
- c) No exotic species present, or, if few are present, they are easily controlled.
- d) Any past (>20 years ago) selection harvesting or thinning has had minimal disruption of the

understory or ground surface and full recovery is expected.

e) Regeneration of characteristic canopy species is not precluded by heavy browsing.

f) If there are openings greater than 0.5 acre within the EO but outside the 500 acre area, they are near an edge of the occurrence where they contribute little to fragmentation and they are small, with total area in the 1-15 year age class less than two percent of the EO area.

### **B Specifications**

a) Forest dominated by characteristic species and with many structural characteristics of a mature forest as described above, but with selection harvesting resulting in stand age of 60 to 150 years old. Forest is generally uneven aged, but may also be even aged.

b) Selection harvesting and thinning has resulted in little disruption of understory vegetation or ground surface over the majority of the EO.

c) Exotic species may be present in low numbers and can be controlled with relatively minor effort.

d) Full recovery to mature forest conditions is expected for the majority of the EO.

e) If there are openings greater than 0.5 acre within the EO, they are near an edge of the occurrence where they contribute little to fragmentation, and they are small, with total area in the 1-15 year age class less than three percent of the EO area.

### **C Specifications**

a) The forest species composition and structure has been significantly altered from the expected mature state by more intensive logging or minor surface alterations (woods roads or grazing). Generally a young, even aged forest (15-60 years).

b) Natural disturbance processes have been largely eliminated by the intensive nature of recent human disturbance.

c) Exotic species may be present in large numbers and their control will take significant effort.

d) Full recovery or restoration of mature forest conditions is expected but may take many years or significant effort.

### **D Specifications (Note: any EO with a D-rank Condition is not a state-significant natural community)**

a) The forest species composition and structure has been significantly altered by intensive, repeated logging or activities that alter the ground surface and water movement (roads, culverts, grading, and grazing).

b) Exotic species are present in large numbers and long-term successful control is unlikely.

c) Recovery or restoration of mature forest conditions is unlikely.

### **Ranking Specifications Justification:**

A-Rank Threshold: Hemlock-Northern Hardwood Forests begin to take on old growth characteristics only at ages over 150 years, with development of unique old growth characteristics only at ages over 275 years (Tyrrell and Crow, 1994). These mature forests contain more biological legacies (fallen logs and rotting wood, well developed moss and herbaceous understory, structural complexity in the canopy and understory layers, accumulated soil organic matter, and seed banks) than young forests. 500 acres is given as a minimum area in which the characteristics of mature forests are likely to be preserved over long time periods. This includes both persistence of biological legacies and adequate size to accommodate most wind-disturbance events. The maximum area of two percent of the EO area in openings is based on Lorimer and White (2003) and the expected percentage of regional presettlement landscape in the 1-15 year age class under natural disturbance regimes (range of 1.1 to 3 percent).

C/D-Rank Threshold: highly disturbed forests that are unlikely to recover mature forest conditions.

**Ranking Specifications Date:** April 11, 2012

**Ranking Specifications Authorship:** Eric Sorenson

## Rich Northern Hardwood Forest

**General Description:** Rich Northern Hardwood Forests occur in coves and on lower slopes where there is down-slope movement and accumulation nutrients resulting in deep, rich soils. These forests also occur on more shallow soils over calcium-rich bedrock. They may also be associated with seasonal groundwater seepage in some sideslope and toeslope settings. In all these settings, there is an abundant supply of nutrients. Rich Northern Hardwood Forests are found throughout Vermont at elevations generally below 2,500 feet. Individual examples of Rich Northern Hardwood Forest range in size from less than one acre to over 1,000 acres at Mount Equinox. Over most of the state this is a small patch community (most known examples are under 50 acres), although it functions as a large patch community in the Taconics (Mount Equinox). These forests have high productivity and high species richness. Sugar maple (*Acer saccharum*) and white ash (*Fraxinus americana*) are typically the dominant canopy species. Other trees that may also be common include basswood (*Tilia americana*), yellow birch (*Betula alleghaniensis*), black cherry (*Prunus serotina*), beech (*Fagus grandifolia*), and bitternut hickory (*Carya cordiformis*). Sweet birch (*Betula lenta*) is more common in the warmer regions of Vermont and hophornbeam (*Ostrya virginiana*) is more common in the shallow-soils of the Northern Hardwood Limestone Forest variant. Shrubs include striped maple (*Acer pensylvanicum*), alternate-leaved dogwood (*Cornus alternifolia*), maple-leaf viburnum (*Viburnum acerifolia*), red-berried elder (*Sambucus racemosa*), and leatherwood (*Dirca palustris*). The herbaceous flora of Rich Northern Hardwood is very rich in species and is dominated by nutrient demanding herbs (many of which are spring ephemerals) that are closely associated with this community type. These include wild leeks (*Allium tricoccum*), maidenhair fern (*Adiantum pedatum*), blue cohosh (*Caulophyllum thalictroides*), Dutchman's breeches (*Dicentra cucullaria*), hepatica (*Hepatica spp.*), wild ginger (*Asarum canadense*), bulblet fern (*Cystopteris bulbifera*), and plantain-leaved sedge (*Carex plantaginea*). Numerous rare to uncommon herbs are also associated with this community type.

**State Rank:** S4

**Spatial Pattern:** Small Patch to Large Patch (Taconic Mountains)

**Minimum Size for Element Occurrence:** 1 acre

### Element Occurrence Separation

**Separation Barriers:** Barriers that would separate one occurrence from another include urban development, agricultural land, and highways that create significant canopy breaks. Even small roads that cross Rich Northern Hardwood Forests can alter processes of downslope movement of soil and nutrients and should be evaluated as potential separation barriers.

**Separation Distance – Different Natural/Semi-Natural Communities:** 0.5 mile

**Separation Distance – Cultural Vegetation:** 0.25 mile

**Alternative Separation Procedure:** none

**Separation Justification:** Many small patches of Rich Northern Hardwood Forest are separated from adjacent patches by intervening Northern Hardwood Forest or related communities and should be

considered the same EO if they are within the separation distance. Examples associated with seasonal groundwater seepage may be considered separate EOs from nearby examples associated with seepage from another groundwater source.

**Rank Procedure**

Current condition, landscape context, and size are equally weighted (33%). Rich Northern Hardwood Forests are very dependent on natural processes of downslope movement and soil and nutrient accumulation and, therefore, condition is of high importance. They are also susceptible to invasion by exotic species. Size is variable for this type in Vermont with some very large examples on the side-slopes of the Taconic Mountains.

Calculation: A=4, B=3, C=2, D=1

(Condition rank x 0.33) + (Landscape Context rank x 0.33) + (Size rank x 0.33) = EO Rank

Element occurrence ranks and their corresponding calculated numeric values:

EO Rank	Numeric Values
A	>3.25 and ≤4.00
B	>2.50 and ≤3.25
C	>1.75 and ≤2.50
D	>1.00 and ≤1.75

**Element Occurrence Rank Factor 1 – Condition**

**A Specifications**

- a) Forest is dominated by sugar maple, white ash, basswood, yellow birch, and other characteristic species. Characteristic "rich woods" herbs are present.
- b) The forest is mature and displays many characteristics of an old-growth forest, including forest structure with all age classes, a multi-story canopy, some old large-diameter trees, and some standing dead trees. Evidence of natural disturbance processes is present, such as canopy gaps created by windthrow, pit and mound formation, and downed trees in all stages of decomposition. Older trees are generally greater than 150 years old.
- c) No exotic species present, or if few are present, they are easily controlled.
- d) Any past (>20 years ago) selection harvesting or thinning has had minimal disruption of the understory or ground surface and full recovery is expected. There is no evident disturbance to the processes of downslope movement and nutrient accumulation.
- e) Regeneration of characteristic canopy species is not precluded by heavy browsing.
- f) For very large examples (>= 100 acres), there may be openings greater than 0.5 acre within the EO, if they are near an edge of the occurrence where they contribute little to fragmentation and they are small, with total area in the 1-15 year age class less than two percent of the EO area. For occurrences less than 100 acres, there are no openings greater than 0.5 acre.

**B Specifications**

- a) Forest dominated by characteristic species and with many structural characteristics of a

mature forest as described above, but with selection harvesting resulting in stand age of 60 to 150 years old. Forest is generally uneven aged, but may also be even aged.

b) Selection harvesting and thinning has resulted in little disruption of understory vegetation or ground surface over the majority of the EO and there is no evident disturbance to the processes of downslope movement and nutrient accumulation. Natural disturbance processes are evident.

c) Exotic species may be present in low numbers and can be controlled with relatively minor effort.

d) Full recovery to mature forest conditions is expected for the majority of the EO.

e) Regeneration of characteristic canopy species is not precluded by heavy browsing.

f) For very large examples ( $\geq 100$  acres), there may be openings greater than 0.5 acre within the EO, if they are near an edge of the occurrence where they contribute little to fragmentation and they are small, with total area in the 1-15 year age class less than three percent of the EO area. For occurrences less than 100 acres, there are no openings greater than 0.5 acre.

### **C Specifications**

a) The forest species composition and structure has been significantly altered from the expected mature state by more intensive logging or minor surface alterations (woods roads or grazing). Generally a young, even aged forest (15-60 years).

b) Natural disturbance processes have been largely eliminated by the intensive nature of recent human disturbance. Activities that alter the ground surface (roads, culverts, grading, and grazing) have resulted in some degradation to the processes of downslope movement and nutrient accumulation.

c) Exotic species may be present in large numbers and their control will take significant effort.

d) Full recovery or restoration of mature forest conditions is expected, but may take many years or significant effort.

### **D Specifications (Note: any EO with a D-rank Condition is not a state-significant natural community)**

a) The forest species composition and structure has been significantly altered by intensive, repeated logging or activities that alter the ground surface. These activities have also resulted in significant degradation to the process of downslope movement and nutrient accumulation.

b) Exotic species are present in large numbers and long-term successful control is unlikely.

c) Recovery or restoration of mature forest conditions is unlikely.

### **Ranking Specifications Justification:**

A-Rank Threshold: Mature forests display natural disturbance processes that result in formation of microhabitats and abundant coarse woody debris. Abundant organic matter is critical to supporting the rich nutrient character of these forests. The maximum area of two to three percent of the EO area in openings is based on Lorimer and White (2003) and the expected percentage of northern hardwood

regional presettlement landscape in the 1-15 year age class under natural disturbance regimes (range of 1.1 to 3 percent).

C/D-Rank Threshold: Highly disturbed forests are unlikely to recover mature forest conditions, especially when soil and nutrient accumulation processes are altered.

### **Element Occurrence Rank Factor 2 – Landscape Context**

#### **A Specifications**

Highly connected: area around the EO (>1,000 acres) is largely intact natural vegetation, with species interactions and natural processes occurring across communities. There are no disturbances altering the processes of downslope movement or nutrient accumulation in the occurrence. In general, the condition of the natural communities surrounding the element occurrence should be at least equal to the B Specifications for Condition described for Northern Hardwood Forests.

#### **B Specifications**

Moderately connected: area around the EO (>1,000 acres) is moderately intact natural vegetation, with species interactions and natural processes occurring across many communities. There are no disturbances altering the processes of downslope movement or nutrient accumulation in the occurrence. In general, the condition of the natural communities surrounding the element occurrence should be at least equal to the C Specifications for Condition described for Northern Hardwood Forest.

#### **C Specifications**

Moderately fragmented: area around the EO is largely a combination of cultural and natural vegetation with barriers between species interactions and processes across communities; EO is surrounded by a mix of fragmented forest, agriculture, and rural development.

#### **D Specifications**

Highly fragmented: the EO is entirely, or almost entirely, surrounded by urban development or agriculture. EO is at best buffered on one side by natural communities.

#### **Ranking Specifications Justification:**

A-Rank Threshold: Forested landscapes of 1,000 acres or more with natural communities in good condition will buffer Rich Northern Hardwood Forests from most other land uses. For the largest examples (>1,000 acres), a surrounding landscape of 4,000 acres should be used for evaluation (see justification under Northern Hardwood Forest).

C/D-Rank Threshold: Connectivity to other natural community patches is mostly eliminated, precluding most species interactions and movements; landscape-scale natural disturbance is also precluded by surrounding developed land.

### **Element Occurrence Rank Factor 3 – Size**

#### **A Specifications**

Very Large (>100 acres)

#### **B Specifications**

Large (>30-100 acres)

**C Specifications**

Moderate (3-30 acres)

**D Specifications**

Small (<3 acres)

**Ranking Specifications Justification**

A-Rank Threshold: There are very few known examples over 100 acres. These very large examples are expected to have diverse microhabitats.

C/D-Rank Threshold: In very small Rich Northern Hardwood Forests, there is likely less microhabitat diversity and more edge effect.

**Ranking Specifications Date:** March 26, 2014

**Ranking Specifications Authorship:** Eric Sorenson



## Hemlock Forest and Temperate Hemlock Forest

### Hemlock Forest

**General Description:** Hemlock Forests are common throughout the cool and moist Northern Hardwood Forest regions of Vermont, except for the Green Mountains and the Northeastern Highlands. Hemlock Forests generally occur below 1,800 feet elevation. These forests typically occur on rocky slopes, ravines, and summits, and on a variety of soil types, but usually with shallow soils to bedrock or other impeding layer. However, hemlock forests may also occur on deep, well drained soils. The soils are typically acidic, due largely to the decomposition of hemlock needles. It is common to find a white or ashy albic horizon that results from leaching at the top of the mineral soil profile. Hemlock (*Tsuga canadensis*) is the dominant tree, typically making up at least 75 percent of the canopy cover. The dense conifer canopy means that there is less snow cover on the ground and many hemlock forests provide important deer wintering cover. In these northern and cooler regions of Vermont, other common canopy associates include yellow birch (*Betula alleghaniensis*), beech (*Fagus grandifolia*), white pine (*Pinus strobus*), red spruce (*Picea rubens*), sugar maple (*Acer saccharum*), red maple (*Acer rubrum*), and white ash (*Fraxinus americana*). Due to the dense hemlock canopy, little light reaches the forest floor and shrubs and herbs are generally sparse. In mature forests, there can be considerable amount of standing dead trees or snags and large decaying logs on the ground. These decaying logs and stumps provide prime seed germination sites ("nurse" logs) for hemlock and are key to regeneration of the species. Hemlock and other species of shade tolerant trees are sparse in the shady understory. Typical shrubs include striped maple (*Acer pensylvanicum*) and hobblebush (*Viburnum alnifolia*). The scattered herbs include marginal wood fern (*Dryopteris marginalis*), painted trillium (*Trillium undulatum*), common wood-sorrel (*Oxalis acetosella*), Canada mayflower (*Maianthemum canadense*), Indian pipes (*Monotropa uniflora*), partridge berry (*Mitchella repens*) goldthread (*Coptis trifolia*), starflower (*Trientalis borealis*) shining clubmoss (*Lycopodium lucidulum*), and ground cedar (*Lycopodium digitatum*). The pincushion moss (*Leucobryum glauca*) and the liverwort *Bazzania trilobata* are common.

**Temperate Hemlock Forest:** In warmer regions and settings, the hemlock-dominated canopy typically includes red oak (*Quercus rubra*), white oak (*Quercus alba*), black birch (*Betula lenta*), and other more southern species. Beech is also a common associate. On these drier, warm sites maple-leaved viburnum (*Viburnum acerifolium*), witch hazel (*Hamamelis virginiana*), and low sweet blueberry (*Vaccinium angustifolium*) are common shrub species. Characteristic herbs include wintergreen (*Gaultheria procumbens*), Indian pipes, and wild cucumber (*Medeola virginiana*). Other herbs may include bracken fern (*Pteridium aquilinum*), rough-leaved ricegrass (*Oryzopsis asperifolia*), and herbs found in the more northern Hemlock Forests.

**Hemlock-Red Spruce Forest Variant:** This forest type is dominated by hemlock and red spruce. Balsam fir (*Abies balsamea*) and beech may also be present. Shrubs and herbs are more similar to the northern Hemlock Forest than the Temperate Hemlock Forest Variant. It typically occurs on cool, exposed sites, sometimes up to 2000 feet in elevation. More information is needed on this community variant.

**State Rank:** S4

**Spatial Pattern:** Small Patch (Hemlock Forest); Small to Large Patch (Temperate Hemlock Forest)

**Minimum Size for Element Occurrence:** 1 acre

**Element Occurrence Separation**

**Separation Barriers:** Barriers that would separate one occurrence from another include urban development, agricultural land, and highways that create significant canopy breaks.

**Separation Distance – Different Natural/Semi-Natural Communities:** 0.5 mile

**Separation Distance – Cultural Vegetation:** 0.25 mile

**Alternative Separation Procedure:** none

**Separation Justification:** Many small patches of Hemlock Forest are separated from adjacent patches by intervening Northern Hardwood Forest or Mesic Maple-Ash-Hickory-Oak Forest and should be considered the same EO if they are within the separation distance. A smaller separation distance may be justified if there are intervening natural areas that include large wetlands or aquatic systems that limit interaction of species and processes between the forest patches.

**Rank Procedure**

Current condition, landscape context, and size are equally weighted (33%). Current condition is of high importance in this and other small to large patch communities. Landscape context is important for buffering these small to large forest patches and maintaining animal population connections and natural disturbance regimes. Most examples of Hemlock Forest are small patches. Small patch communities are especially susceptible to changes in the surrounding landscape.

Calculation: A=4, B=3, C=2, D=1

(Condition rank x 0.33) + (Landscape Context rank x 0.33) + (Size rank x 0.33) = EO Rank

Element occurrence ranks and their corresponding calculated numeric values:

EO Rank	Numeric Values
A	>3.25 and ≤4.00
B	>2.50 and ≤3.25
C	>1.75 and ≤2.50
D	>1.00 and ≤1.75

**Element Occurrence Rank Factor 1 – Condition**

**A Specifications**

a) For Hemlock Forest: dominated by hemlock, with lesser amounts of yellow birch, beech, red spruce, white pine, and sugar maple. For Temperate Hemlock Forest: dominated by hemlock, with lesser amounts of red oak, white oak, black birch, or other warm climate trees.

b) The forest is mature and displays many characteristics of an old-growth forest, including forest structure with all age classes, a multi-story canopy, some old large-diameter trees, and some standing dead trees. Evidence of natural disturbance processes is present, such as canopy

gaps created by windthrow, pit and mound formation, and downed trees in all stages of decomposition. Hemlock regeneration is evident. Older trees are generally greater than 150 years old.

c) No exotic species present, or if few are present, they are easily controlled.

d) Any past (>20 years ago) selection harvesting or thinning has had minimal disruption of the understory or ground surface and full recovery is expected.

e) Regeneration of characteristic canopy species is not precluded by heavy browsing.

f) For very large examples (>100 acres), there may be openings greater than 0.5 acre within the EO, if they are near an edge of the occurrence where they contribute little to fragmentation and they are small, with total area in the 1-15 year age class less than two percent of the EO area. For occurrences less than 100 acres, there are no openings greater than 0.5 acre.

## **B Specifications**

a) Forest dominated by characteristic species and with many structural characteristics of a mature forest as described above, but with selection harvesting resulting in stand age of 60 to 150 years old. Forest is generally uneven aged, but may also be even aged.

b) Selection harvesting and thinning has resulted in little disruption of understory vegetation or ground surface over the majority of the EO and there is no evident disturbance to the processes of downslope movement and nutrient accumulation. Natural disturbance processes are evident.

c) Exotic species may be present in low numbers and can be controlled with relatively minor effort.

d) Full recovery to mature forest conditions is expected for the majority of the EO.

e) Regeneration of characteristic canopy species is not precluded by heavy browsing.

f) For very large examples (>100 acres), there may be openings greater than 0.5 acre within the EO, if they are near an edge of the occurrence where they contribute little to fragmentation and they are small, with total area in the 1-15 year age class less than three percent of the EO area. For occurrences less than 100 acres, there are no openings greater than 0.5 acre.

## **C Specifications**

a) The forest species composition and structure has been significantly altered from the expected mature state by more intensive logging or minor surface alterations (woods roads or grazing). Generally a young, even aged forest (15-60 years).

b) Natural disturbance processes have been largely eliminated by the intensive nature of recent human disturbance. Activities that alter the ground surface (roads, culverts, grading, and grazing) have resulted in some degradation to the processes of downslope movement and nutrient accumulation.

c) Exotic species may be present in large numbers and their control will take significant effort.

d) Full recovery or restoration of mature forest conditions is expected, but may take many years or significant effort.

**D Specifications (Note: any EO with a D-rank Condition is not a state-significant natural community)**

a) The forest species composition and structure has been significantly altered by intensive, repeated logging or activities that alter the ground surface. These activities have also resulted in significant degradation to the process of downslope movement and nutrient accumulation.

b) Exotic species are present in large numbers and long-term successful control is unlikely.

c) Recovery or restoration of mature forest conditions is unlikely.

**Ranking Specifications Justification:**

A-Rank Threshold: Mature forests display natural disturbance processes that result in formation of microhabitats and abundant coarse woody debris. Abundant coarse woody debris is important for creation of nurse logs that support regeneration of hemlock in these forests. The maximum area of two to three percent of the EO area in openings is based on Lorimer and White (2003) and the expected percentage of northern hardwood regional presettlement landscape in the 1-15 year age class under natural disturbance regimes (range of 1.1 to 3 percent).

C/D-Rank Threshold: Highly disturbed forests are unlikely to recover mature forest conditions, especially when soil and nutrient accumulation processes are altered.

**Element Occurrence Rank Factor 2 – Landscape Context**

**A Specifications**

Highly connected: area around the EO (>1,000 acres) is largely intact natural vegetation, with species interactions and natural processes occurring across communities. In general, the condition of the natural communities surrounding the element occurrence should be at least equal to the B Specifications for Condition described for Northern Hardwood Forests or other matrix forest type surrounding the Hemlock Forest.

**B Specifications**

Moderately connected: area around the EO (>1,000 acres) is moderately intact natural vegetation, with species interactions and natural processes occurring across many communities. In general, the condition of the natural communities surrounding the element occurrence should be at least equal to the C Specifications for Condition described for Northern Hardwood Forest or other matrix forest type surrounding the Hemlock Forest.

**C Specifications**

Moderately fragmented: area around the EO is largely a combination of cultural and natural vegetation with barriers between species interactions and processes across communities; EO is surrounded by a mix of fragmented forest, agriculture, and rural development.

**D Specifications**

Highly fragmented: the EO is entirely, or almost entirely, surrounded by urban development or agriculture. EO is at best buffered on one side by natural communities.

**Ranking Specifications Justification:**

A-Rank Threshold: Forested landscapes of 1,000 acres or more with natural communities in good condition will buffer Hemlock Forests from most other land uses. For the largest examples (>1,000 acres), a surrounding landscape of 4,000 acres should be used for evaluation (see justification under Northern Hardwood Forest).

C/D-Rank Threshold: Connectivity to other natural community patches is mostly eliminated, precluding most species interactions and movements; landscape-scale natural disturbance is also precluded by surrounding developed land.

**Element Occurrence Rank Factor 3 – Size**

**Hemlock Forest and Temperate Hemlock Forest**

**A Specifications**

Very Large (>100 acres)

**B Specifications**

Large (>30-100 acres)

**C Specifications**

Moderate (3-30 acres)

**D Specifications**

Small (<3 acres)

**Ranking Specifications Justification**

A-Rank Threshold: Although most individual patches of Hemlock Forest are very small, linking patches into element occurrences is likely to result in many EOs over 50 acres, the typical cutoff for a small patch community. There are few known examples over 200 acres. These very large examples are expected to have diverse microhabitats.

C/D-Rank Threshold: In very small Hemlock Forests, there is likely less microhabitat diversity and more edge effect.

**Ranking Specifications Date:** March 26, 2014

**Ranking Specifications Authorship:** Eric Sorenson

## Limestone Bluff Cedar-Pine Forest

**General Description:** Limestone Bluff Cedar-Pine Forests occur on limestone and dolomite bluffs and outcrops, typically along the rocky headlands of Lake Champlain. In this situation these dark, coniferous forests typically occupy a narrow band along the top of the bluff or cliff and may extend inland several hundred feet. The thin soils over calcareous bedrock, the droughty conditions, and the exposure to winds off the lake are key environmental factors influencing these forests. Natural disturbance in these forests may be infrequent small fires, individual tree blow-down, and infrequent ice storm or high winds that can flatten several acres of forest. Limestone Bluff Cedar-Pine Forests are rare and restricted to the shorelines of Lake Champlain and occasional sites inland from the lake where these specific environmental conditions are found. Due to their setting on bluffs overlooking Lake Champlain, many examples of this community type have been cleared and converted to residential development. Non-native invasive species like honeysuckle (*Lonicera* spp.) are also a threat, as they thrive in these warm, calcareous sites.

These forests are slow growing and northern white cedar (*Thuja occidentalis*), the dominant tree, is typically stunted, twisted, and wind-swept. Cedars of over 300 years have been documented on the headlands of Mallets Bay. Occasional to locally abundant tree species include white pine (*Pinus strobus*), red pine (*Pinus resinosa*), hemlock (*Tsuga canadensis*), hophornbeam (*Ostrya virginiana*), red oak (*Quercus rubra*), basswood (*Tilia americana*), sugar maple (*Acer saccharum*), white ash (*Fraxinus americana*), shagbark hickory (*Carya ovata*), and eastern red cedar (*Juniperus virginiana*). The shrub layer cover is typically low, but species richness can be high, including snowberry (*Symphoricarpos albus*), bush honeysuckle (*Diervilla lonicera*), Canada yew (*Taxus canadensis*), poison ivy (*Toxicodendron radicans*), purple-flowering raspberry (*Rubus odoratus*), common bittersweet (*Celastrus scandens*), and limber honeysuckle (*Lonicera dioica*). Non-native invasive shrubs include honeysuckles, Japanese barberry (*Berberis thunbergii*), and common buckthorn (*Rhamnus cathartica*). A groundcover of ebony sedge (*Carex eburnia*) is characteristic, but many herbaceous species may be present, including wild columbine (*Aquilegia canadensis*), Virginia polypody (*Polypodium virginianum*), marginal wood fern (*Dryopteris marginalis*), bulblet fern (*Cystopteris bulbifera*), wild sarsaparilla (*Aralia nudicaulis*), herb robert (*Geranium robertianum*), blue-stemmed goldenrod (*Solidago caesia*), peduncled sedge (*Carex pedunculata*), and roseate sedge (*Carex rosea*). Many species of bryophytes thrive on the shady calcareous rock and include *Anomodon rostratus*, *Anomodon attenuatus*, *Thuidium delicatulum*, *Brachythecium digastrum*, *Abietinella abietina*, and *Rhytidium rugosum*.

**State Rank:** S2

**Spatial Pattern:** Small Patch

**Minimum Size:** 0.5 acre

### Element Occurrence Separation

**Separation Barriers:** Barriers that would separate one occurrence from another include residential development, agricultural land, and roads that create significant canopy breaks. Separation barriers should be evaluated on a case by case basis to determine if they alter the natural processes of cedar bluff forests or the movement of resident animals. Although fires may occur infrequently within these forests, fires are restricted to small patches of the community and so firebreaks should not necessarily

be used to determine separate element occurrences. Nearby islands may also be considered the same element occurrence.

**Separation Distance – Different Natural/Semi-Natural Communities:** 0.5 mile

**Separation Distance – Cultural Vegetation:** 0.25 mile

**Alternative Separation Procedure:** none

**Separation Justification:** Limestone Bluff Cedar-Pine Forests are commonly associated with Mesic Maple-Ash Hickory-Oak Forests that extend further back from the bluff or occupy less exposed areas with more soil development between patches of cedar bluff. Treat community patches within specified separation distances as one occurrence when possible for tracking simplicity, as the interaction between adjacent patches is poorly understood.

### **Rank Procedure**

Current condition, landscape context, and size are equally weighted (33%). Limestone Bluff Cedar-Pine Forests are easily disturbed from their natural condition by activities that alter the canopy or the shallow soils, which quickly leads to invasion by exotic species. There are very few Limestone Bluff Cedar-Pine Forests in Vermont that occur in unfragmented landscapes. Size varies considerably between examples, but in general, larger examples are expected to be more resistant to surrounding human disturbances.

Calculation: A=4, B=3, C=2, D=1

(Condition rank x 0.33) + (Landscape Context rank x 0.33) + (Size rank x 0.33) = EO Rank

Element occurrence ranks and their corresponding calculated numeric values:

EO Rank	Numeric Values
A	>3.25 and ≤4.00
B	>2.50 and ≤3.25
C	>1.75 and ≤2.50
D	>1.00 and ≤1.75

### **Element Occurrence Rank Factor 1 – Condition**

#### **A Specifications**

a) Forest is dominated by northern white cedar, with lesser amounts of white pine, hemlock, red pine, sugar maple, red oak, hophornbeam, white ash, basswood, shagbark hickory, or eastern red cedar. Characteristic shrubs and herbs are also present.

b) The forest is mature and displays many characteristics of an old-growth forest, including forest structure with all age classes, a multi-story canopy, some old large-diameter trees, and some standing dead trees. Evidence of natural disturbance processes is present, such as canopy gaps created by windthrow, fire scarred trunks, and downed trees in all stages of

decomposition. Older trees are generally greater than 150 years old.

c) No exotic species present, or if few are present, they are easily controlled.

d) Any past (>20 years ago) selection harvesting or thinning has had minimal disruption of the understory or ground surface and full recovery is expected.

e) Regeneration of characteristic canopy species is not precluded by heavy browsing.

### **B Specifications**

a) Forest dominated by characteristic species and with many structural characteristics of a mature forest as described above, but with selection harvesting resulting in stand age of 60 to 150 years old. Forest is generally uneven aged, but may also be even aged.

b) Selection harvesting and thinning has resulted in little disruption of understory vegetation or ground surface over the majority of the EO.

c) Exotic species may be present in low numbers and can be controlled with relatively minor effort.

d) Full recovery to mature forest conditions is expected for the majority of the EO.

e) Regeneration of characteristic canopy species is not precluded by heavy browsing.

### **C Specifications**

a) The forest species composition and structure has been significantly altered from the expected mature state by more intensive logging or minor surface alterations (woods roads or grazing). Generally a young, even aged forest (15-60 years).

b) Natural disturbance processes have been largely eliminated by the intensive nature of recent human disturbance.

c) Exotic species may be present in large numbers and their control will take significant effort.

d) Full recovery or restoration of mature forest conditions is expected, but may take many years or significant effort.

### **D Specifications (Note: any EO with a D-rank Condition is not a state-significant natural community)**

a) The forest species composition and structure have been significantly altered by intensive, repeated logging or activities that alter the ground surface and water movement (roads, culverts, grading, and grazing).

b) Exotic species are present in large numbers and long-term successful control is unlikely.

c) Recovery or restoration of mature forest conditions is unlikely.

### **Ranking Specifications Justification**



A-Rank Threshold: Mature forests contain more biological legacies (fallen logs and rotting wood, well developed moss and herbaceous understory, structural complexity in the canopy and understory layers, accumulated soil organic matter, and seed banks) than young forests.

C/D-Rank Threshold: Highly disturbed forests are unlikely to recover mature forest conditions, especially when the ground surface has been altered and invasive exotic species are abundant.

### **Element Occurrence Rank Factor 2 – Landscape Context**

#### **A Specifications**

Highly connected: area around the EO (>500 acres) is largely intact natural vegetation, with species interactions and natural processes occurring across communities. A surrounding landscape of >1,000 acres should be evaluated for examples not adjacent to Lake Champlain. In general, the condition of the natural communities surrounding the element occurrence should be at least equal to the B Specifications for Condition described for Mesic Maple-Ash-Hickory Oak Forest.

#### **B Specifications**

Moderately connected: area around the EO (>500 acres) is moderately intact natural vegetation, with species interactions and natural processes occurring across many communities. In general, the condition of the natural communities surrounding the element occurrence should be at least equal to the C Specifications for Condition described for Mesic Maple-Ash-Hickory Oak Forest.

#### **C Specifications**

Moderately fragmented: area around the EO is largely a combination of cultural and natural vegetation with barriers between species interactions and processes across communities; EO is surrounded by a mix of fragmented forest, agriculture, and rural development.

#### **D Specifications**

Highly fragmented: the EO is entirely, or almost entirely, surrounded by urban development or agriculture. EO is at best buffered on one side by natural communities.

#### **Ranking Specifications Justification**

A-Rank Threshold: Forested landscapes of 500 acres or more adjacent to Lake Champlain (1,000 acres or more inland from the lake) with natural communities in good condition will buffer Limestone Bluff Cedar-Pine Forests from most other land uses. The acreage of the surrounding landscape that is evaluated for this community type is lowered to 500 acres for examples adjacent to the Lake Champlain as the lake is at least equally important as the adjacent upland in supporting and maintaining this community.

C/D-Rank Threshold: Connectivity to other natural community patches is mostly eliminated, precluding most species interactions and movements; landscape-scale natural disturbance is also precluded by surrounding developed land.

### **Element Occurrence Rank Factor 3 – Size**

#### **A Specifications**

Very Large (>25 acres)

#### **B Specifications**

Large (>15-25 acres)

**C Specifications**

Moderate (2-15 acres)

**D Specifications**

Small (<2 acres)

**Ranking Specifications Justification**

A-Rank Threshold: Of the 74 occurrences mapped statewide, only 18 are greater than 25 acres and only three are over 75 acres. Other larger examples along the lake have been fragmented into smaller units by development.

C/D-Rank Threshold: In very small Limestone Bluff Cedar-Pine Forests, there is generally less diversity and more edge effect.

**Ranking Specifications Date:** March 26, 2014

**Ranking Specifications Authorship:** Eric Sorenson

## Mesic Maple-Ash-Hickory-Oak Forest

**General Description:** These forests share much in common with Northern Hardwood Forests, but they have some striking affinities with the Central Hardwood Forests of the Appalachians to our south. Sugar maple (*Acer saccharum*), white ash (*Fraxinus americana*), red maple (*Acer rubrum*), basswood (*Tilia americana*), hophornbeam (*Ostrya virginiana*), and hemlock (*Tsuga canadensis*) are common trees, but more southern species, such as red oak (*Quercus rubra*), white oak (*Quercus alba*), and shagbark hickory (*Carya ovata*), are present as well, and are dominant at some sites. Characteristic shrubs include maple-leaved viburnum (*Viburnum acerifolium*), striped maple (*Acer pensylvanicum*), witch hazel (*Hamamelis virginiana*), shadbush (*Amelanchier* sp.), and round-leaved dogwood (*Cornus rugosa*). Common herbs include white snakeroot (*Eupatorium rugosum*), marginal wood fern (*Dryopteris marginalis*), common sweet-cicely (*Osmorhiza claytonii*), large-flowered trillium (*Trillium grandiflorum*), and round-lobed hepatica (*Hepatica americana*). Found in the warmer climate areas of Vermont, these forests see higher-than-average temperatures and lower-than-average rainfall. Mesic Maple-Ash-Hickory Forests have soils that are typically somewhat drier than those in the average Northern Hardwood Forest.

**Transition Hardwoods Limestone Forest Variant:** This variant of the community occurs in warm climate regions of Vermont where calcareous bedrock is close to the soil surface. Moss-covered ledge outcrops are common. Trees may be more stunted than in the more mesic type. Typical trees include sugar maple, white ash, shagbark hickory, basswood, hophornbeam, butternut (*Juglans cinerea*), red oak, white oak, yellow oak (*Quercus muehlenbergii*), and bladdernut (*Staphylea trifolia*). Shrubs and herb richness is high and in addition to those species listed above, the following species indicative of calcium-rich conditions are also frequently present: common bittersweet (*Celastrus scandens*), leatherwood (*Dirca palustris*), blue cohosh (*Caulophyllum thalictroides*), maidenhair fern (*Adiantum pedatum*), wild ginger (*Asarum canadense*), early meadow-rue (*Thalictrum dioicum*), Dutchman's breeches (*Dicentra cucullaria*), broad-leaved sedge (*Carex platyphylla*), herb Robert (*Geranium robertianum*), blue-stemmed goldenrod (*Solidago caesia*), zig-zag goldenrod (*Solidago flexicaulis*), red baneberry (*Actaea rubra*), bulblet fern (*Cystopteris bulbifera*), and maidenhair spleenwort (*Asplenium trichomanes*).

**State Rank:** S3

**Spatial Pattern:** Large Patch

**Minimum Size for Element Occurrence:** 1 acre

### Element Occurrence Separation

**Separation Barriers:** Barriers that would separate one occurrence from another include urban development, agricultural land, and highways that create significant canopy breaks. Judgment on what constitutes a separation barrier should be based on whether the barrier interrupts natural processes between two areas or restricts the movement of animals that are functionally significant to the community.

**Separation Distance – Different Natural/Semi-Natural Communities:** 0.5 mile

**Separation Distance – Cultural Vegetation:** 0.25 mile

**Alternative Separation Procedure:** none

**Separation Justification:** A larger separation distance may be appropriate for areas where the intervening natural communities are similar in many characteristics and do not limit interaction between the patches, such as Northern Hardwood Forest, Dry Oak-Hickory-Hophornbeam Forest, or Valley Clayplain Forest. A smaller separation distance may be justified in areas where the intervening natural communities are large wetlands or aquatic systems that limit interaction of species and processes between the patches.

**Rank Procedure**

Current condition, size, and landscape context are all weighted equally (33%). Although current condition of this large patch community may be of primary importance, the condition is easily affected by the surrounding landscape. This large patch community type is especially susceptible to invasive exotic shrubs. Landscape context is important for maintaining animal population connections and natural disturbance regimes.

Calculation: A=4, B=3, C=2, D=1

(Condition rank x 0.33) + (Size rank x 0.33) + (Landscape Context rank x 0.33) = EO Rank

Element occurrence ranks and their corresponding calculated numeric values:

EO Rank	Numeric Values
A	>3.25 and ≤4.00
B	>2.50 and ≤3.25
C	>1.75 and ≤2.50
D	>1.00 and ≤1.75

**Element Occurrence Rank Factor 1 – Condition**

**A Specifications**

- a) Forest is dominated by sugar maple, white ash, basswood, shagbark hickory, red oak, white oak, and hophornbeam. Other tree species may also be present such as hemlock, black cherry, and red maple. Characteristic shrubs and herbs are also present.
  
- b) The forest is mature and displays many characteristics of an old-growth forest, including forest structure with all age classes, a multi-story canopy, some old large-diameter trees, and some standing dead trees. Evidence of natural disturbance processes is present, such as canopy gaps created by windthrow, pit and mound formation, and downed trees in all stages of decomposition. Older trees are generally greater than 150 years old.
  
- c) No exotic species present, or, if few are present, they are easily controlled.
  
- d) Any past (>20 years ago) selection harvesting or thinning has had minimal disruption of the understory or ground surface and full recovery is expected.
  
- e) Regeneration of characteristic canopy species is not precluded by heavy browsing.

f) For large examples (>100 acres), there may be openings greater than 0.5 acre within the EO, if they are near an edge of the occurrence where they contribute little to fragmentation and they are small, with total area in the 1-15 year age class less than two percent of the EO area. For occurrences less than 100 acres, there are no openings greater than 0.5 acre, and these are at the periphery of the occurrence.

### **B Specifications**

a) Forest dominated by characteristic species and with many structural characteristics of a mature forest as described above, but with selection harvesting resulting in stand age of 60 to 150 years old. Forest is generally uneven aged, but may also be even aged.

b) Selection harvesting and thinning has resulted in little disruption of understory vegetation or ground surface over the majority of the EO.

c) Exotic species may be present in low numbers and can be controlled with relatively minor effort.

d) Full recovery to mature forest conditions is expected for the majority of the EO.

e) For large examples (>100 acres), there may be openings greater than 0.5 acre within the EO, if they are near an edge of the occurrence where they contribute little to fragmentation and they are small, with total area in the 1-15 year age class less than three percent of the EO area. For occurrences less than 100 acres, there are no openings greater than 0.5 acre, and these are at the periphery of the occurrence.

### **C Specifications**

a) The forest species composition and structure has been significantly altered from the expected mature state by more intensive logging or minor surface alterations (woods roads or grazing). Generally a young, even aged forest (15-60 years).

b) Natural disturbance processes have been largely eliminated by the intensive nature of recent human disturbance.

c) Exotic species may be present in large numbers and their control will take significant effort.

d) Full recovery or restoration of mature forest conditions is expected but may take many years or significant effort.

### **D Specifications (Note: any EO with a D-rank Condition is not a state-significant natural community)**

a) The forest species composition and structure has been significantly altered by intensive, repeated logging or activities that alter the ground surface and water movement (roads, culverts, grading, and grazing).

b) Exotic species are present in large numbers and long-term successful control is unlikely.

c) Recovery or restoration of mature forest conditions is unlikely.

**Ranking Specifications Justification:**

A-Rank Threshold: Hemlock-Northern Hardwood Forests begin to take on old growth characteristics only at ages over 150 years, with development of unique old growth characteristics only at ages over 275 years (Tyrrell and Crow, 1994). Hemlock-Northern Hardwood Forests share many characteristics with Mesic Maple-Ash-Hickory-Oak Forests. These mature forests contain more biological legacies (fallen logs and rotting wood, well developed moss and herbaceous understory, structural complexity in the canopy and understory layers, accumulated soil organic matter, and seed banks) than young forests. The maximum area of two percent of the EO area in openings is based on Lorimer and White (2003) and the expected percentage of regional presettlement landscape in the 1-15 year age class under natural disturbance regimes for northern hardwood forests (range of 1.1 to 3 percent).

C/D-Rank Threshold: highly disturbed forests that are unlikely to recover mature forest conditions.

**Element Occurrence Rank Factor 2 – Size**

**A Specifications**

Very Large (>300 acres)

**B Specifications**

Large (>50-300 acres)

**C Specifications**

Moderate (5-50 acres)

**D Specifications**

Small (<5 acres)

**Ranking Specifications Justification**

A-Rank Threshold: The largest known occurrences of Mesic Maple-Ash-Hickory-Oak Forest in Vermont are about 500 acres.

C/D-Rank Threshold: At the smallest size of these forests edge effects may dominate.

**Element Occurrence Rank Factor 3 – Landscape Context**

**A Specifications**

Highly connected: area around the EO is largely intact natural vegetation, with species interactions and natural processes occurring across communities. In general, the condition of the natural communities surrounding the element occurrence should be at least equal to the B Specifications for Condition listed above.

**B Specifications**

Moderately connected: area around the EO is moderately intact natural vegetation, with species interactions and natural processes occurring across many communities. In general, the condition of the natural communities surrounding the element occurrence should be at least equal to the C Specifications for Condition listed above.

**C Specifications**

Moderately fragmented: area around the EO is largely a combination of cultural and natural vegetation with barriers between species interactions and processes across communities; EO is surrounded by a mix of fragmented forest, agriculture, and rural development.

**D Specifications**

Highly fragmented: the EO is entirely, or almost entirely, surrounded by urban development or agriculture. EO is at best buffered on one side by natural communities.

**Ranking Specifications Justification:**

A-Rank Threshold: Forested landscapes of 1,000 acres or more with natural communities in good condition will buffer Mesic Maple-Ash-Hickory-Oak Forests from most other land uses. For the largest examples (>1,000 acres), a surrounding landscape of 4,000 acres should be used for evaluation (see justification under Northern Hardwood Forest).

C/D-Rank Threshold: Connectivity to other natural community patches is mostly eliminated, precluding most species interactions and movements; landscape-scale natural disturbance is also precluded by surrounding developed land.

**Ranking Specifications Date:** March 26, 2014

**Ranking Specifications Authorship:** Eric Sorenson

## Dry Oak Forest

**General Description:** This community is found on rocky ridgetops of acidic or circumneutral bedrock at low elevations. Most of the time, they occur as small patches within larger areas of Dry Oak-Hickory-Hophornbeam Forest, Mesic Maple-Ash-Hickory-Oak Forest, or Northern Hardwood Forest. They are most common in the Champlain Valley, Taconic Mountains, and in the Southern Vermont Piedmont in the lowlands along the Connecticut River. In Dry Oak Forest, bedrock is close to the surface, soils are dry, and nutrients are limited. The low rainfall in the biophysical regions where this community occurs, along with the low moisture-holding capacity of the soils, makes these very dry places. Fire may play a role in this community, but this possibility needs more study. Gypsy moth can affect these forests, as they thrive in oak forests. Overall diversity in these forests is quite low. Red oak (*Quercus rubra*) and white oak (*Quercus alba*) are mixed in the canopy, often with white pine (*Pinus strobus*). Chestnut oak can be abundant in southern regions. Trees are poorly formed, but the canopy is nearly continuous. Heath shrubs, including black huckleberry (*Gaylussacia baccata*) and low sweet blueberry (*Vaccinium angustifolium*) dominate the understory, and witch hazel (*Hamamelis virginiana*) is occasional. Common herbs include poverty grass (*Danthonia spicata*), hairgrass (*Deschampsia flexuosa*), cow-wheat (*Melampyrum lineare*), woodland sedge (*Carex pensylvanica*), rough-leaved ricegrass (*Oryzopsis asperifolia*), and bottlebrush grass (*Elymus hystrix*). When this community occurs on bedrock that is circumneutral and more calcium-rich, additional herbs may include white snakeroot (*Eupatorium rugosum*), wide-leaved Sedge (*Carex platyphylla*), and sharp-lobed hepatica (*Hepatica acutiloba*). Mosses such as *Polytrichum* spp. and *Leucobryum glauca* may be common.

**State Rank:** S3

**Spatial Pattern:** Small to Large Patch

**Minimum Size for Element Occurrence:** 1 acre

### Element Occurrence Separation

**Separation Barriers:** Barriers that would separate one occurrence from another include urban development, agricultural land, and highways that create significant canopy breaks. Judgment on what constitutes a separation barrier should be based on whether the barrier interrupts natural processes between two areas or restricts the movement of animals that are functionally significant to the community.

**Separation Distance – Different Natural/Semi-Natural Communities:** 0.5 mile

**Separation Distance – Cultural Vegetation:** 0.25 mile

**Alternative Separation Procedure:** none

**Separation Justification:** A larger separation distance may be appropriate for areas where the intervening natural communities are similar in many characteristics and do not limit interaction between the patches, such as Northern Hardwood Forest, Mesic Maple-Ash-Hickory-Oak Forest, or Dry Oak-Hickory-Hophornbeam Forest. A smaller separation distance may be justified in there are intervening natural areas that include large wetlands or aquatic systems that limit interaction of species and



processes between the forest patches.

### **Rank Procedure**

Current condition, landscape context, and size are equally weighted (33%). Current condition is of high importance in this and other small to large patch communities. Landscape context is important for buffering these small to large forest patches and maintaining animal population connections and natural disturbance regimes. Most examples of this community are small patches. Small patch communities are especially susceptible to changes in the surrounding landscape.

Calculation: A=4, B=3, C=2, D=1

(Condition rank x 0.33) + (Landscape Context rank x 0.33) + (Size rank x 0.33) = EO Rank

Element occurrence ranks and their corresponding calculated numeric values:

EO Rank	Numeric Values
A	>3.25 and ≤4.00
B	>2.50 and ≤3.25
C	>1.75 and ≤2.50
D	>1.00 and ≤1.75

### **Element Occurrence Rank Factor 1 – Condition**

#### **A Specifications**

- a) Forest is dominated by red oak, white oak, and white pine, with chestnut oak an important component at some sites. Characteristic shrubs and herbs are also present.
  
- b) The forest is mature and displays many characteristics of an old-growth forest, including forest structure with all age classes, a multi-story canopy, some old large-diameter trees, and some standing dead trees. Evidence of natural disturbance processes is present, such as canopy gaps created by windthrow, fire, pit and mound formation, and downed trees in all stages of decomposition. Forests with larger openings or altered species composition created by natural fires should be considered A condition. Older trees are generally greater than 150 years old.
  
- c) No exotic species present, or, if few are present, they are easily controlled.
  
- d) Any past (>20 years ago) selection harvesting or thinning has had minimal disruption of the understory or ground surface and full recovery is expected.
  
- e) Regeneration of characteristic canopy species is not precluded by heavy browsing.

#### **B Specifications**

- a) Forest dominated by characteristic species and with many structural characteristics of a mature forest as described above, but with selection harvesting resulting in stand age of 60 to 150 years old. Forest is generally uneven aged, but may also be even aged.

- b) Selection harvesting and thinning has resulted in little disruption of understory vegetation or ground surface over the majority of the EO.
- c) Exotic species may be present in low numbers and can be controlled with relatively minor effort.
- d) Full recovery to mature forest conditions is expected for the majority of the EO.
- e) Regeneration of characteristic canopy species is not precluded by heavy browsing.

**C Specifications**

- a) The forest species composition and structure has been significantly altered from the expected mature state by more intensive logging or minor surface alterations (woods roads or grazing). Generally a young, even aged forest (15-60 years).
- b) Natural disturbance processes have been largely eliminated by the intensive nature of recent human disturbance.
- c) Exotic species may be present in large numbers and their control will take significant effort.
- d) Full recovery or restoration of mature forest conditions is expected but may take many years or significant effort.

**D Specifications (Note: any EO with a D-rank Condition is not a state-significant natural community)**

- a) The forest species composition and structure has been significantly altered by intensive, repeated logging or activities that alter the ground surface and water movement (roads, culverts, grading, and grazing).
- b) Exotic species are present in large numbers and long-term successful control is unlikely.
- c) Recovery or restoration of mature forest conditions is unlikely.

**Ranking Specifications Justification:**

A-Rank Threshold: Mature forests contain more biological legacies (fallen logs and rotting wood, well developed moss and herbaceous understory, structural complexity in the canopy and understory layers, accumulated soil organic matter, and seed banks) than young forests. Potentially frequent low to moderate intensity fires may occur on these sites and alter canopy closure and species composition, but these should still be considered A-ranked examples. Given the uncertainty regarding the current role of fire in maintaining this community type, the effect of logging openings should be viewed critically.

C/D-Rank Threshold: highly disturbed forests that are unlikely to recover mature forest conditions.

**Element Occurrence Rank Factor 2 – Size**

**A Specifications**

Very Large (>25 acres)

**B Specifications**

Large (>15-25 acres)

### **C Specifications**

Moderate (2-15 acres)

### **D Specifications**

Small (<2 acres)

### **Ranking Specifications Justification**

A-Rank Threshold: The largest known occurrences of Dry Oak Forest in Vermont are just over 100 acres, but most occurrences are less than 25 acres.

C/D-Rank Threshold: At the smallest size of these forests edge effects may dominate.

### **Element Occurrence Rank Factor 3 – Landscape Context**

#### **A Specifications**

Highly connected: area around the EO is largely intact natural vegetation, with species interactions and natural processes occurring across communities. In general, the condition of the natural communities surrounding the element occurrence should be at least equal to the B Specifications for Condition for the surrounding matrix or large patch forest type.

#### **B Specifications**

Moderately connected: area around the EO is moderately intact natural vegetation, with species interactions and natural processes occurring across many communities. In general, the condition of the natural communities surrounding the element occurrence should be at least equal to the C Specifications for Condition for the surrounding matrix or large patch forest type.

#### **C Specifications**

Moderately fragmented: area around the EO is largely a combination of cultural and natural vegetation with barriers between species interactions and processes across communities; EO is surrounded by a mix of fragmented forest, agriculture, and rural development.

#### **D Specifications**

Highly fragmented: the EO is entirely, or almost entirely, surrounded by urban development or agriculture. EO is at best buffered on one side by natural communities.

#### **Ranking Specifications Justification:**

A-Rank Threshold: Forested landscapes of 1,000 acres or more with natural communities in good condition will buffer Dry Oak Forests from most other land uses.

C/D-Rank Threshold: Connectivity to other natural community patches is mostly eliminated, precluding most species interactions and movements; landscape-scale natural disturbance is also precluded by surrounding developed land.

**Ranking Specifications Date:** March 26, 2014

**Ranking Specifications Authorship:** Eric Sorenson

## Dry Oak-Hickory-Hophornbeam Forest

**General Description:** These are open, park-like forests where shrubs are sparse, the ground layer is dominated by a sedge lawn, and one can see for a long distance through the woods. They are found in the warmer parts of the state on hilltops, ridges, and other places where bedrock is close to the surface or is covered by shallow till. Due to the droughty conditions in these settings, tree growth is stunted and understory vegetation is sparse. In addition to droughtiness, occasional fires and past woodland cattle grazing both may have influenced this community. The forest canopy cover is variable, but is typically open (60-85% cover). It is dominated by red oak (*Quercus rubra*) and shagbark hickory (*Carya ovata*). Other canopy species that may be present in low abundance include white pine (*Pinus strobus*), white ash (*Fraxinus americana*), white oak (*Quercus alba*), basswood (*Tilia americana*), and sugar maple (*Acer saccharum*). Hophornbeam (*Ostrya virginiana*) is the characteristic dominant of the sub-canopy, with the largest individuals extending into the canopy. Shrub cover is sparse and usually includes hophornbeam and maple-leaved viburnum (*Viburnum acerifolium*). The ground layer is often dominated by lawns of woodland sedge (*Carex pensylvanica*). Other scattered herbs include bottlebrush grass (*Elymus hystrix*), blue-stemmed Goldenrod (*Solidago caesia*), Peduncled Sedge (*Carex pedunculata*), Broad-leaved Sedge (*Carex platyphylla*), wild oats (*Uvularia sessilifolia*), broad-leaved ricegrass (*Oryzopsis racemosa*), marginal wood fern (*Dryopteris marginalis*), blunt-lobed hepatica (*Hepatica americana*), and four-leaved milkweed (*Asclepias quadrifolia*).

**State Rank:** S3

**Spatial Pattern:** Small to Large Patch

**Minimum Size for Element Occurrence:** 1 acre

### Element Occurrence Separation

**Separation Barriers:** Barriers that would separate one occurrence from another include urban development, agricultural land, and highways that create significant canopy breaks. Judgment on what constitutes a separation barrier should be based on whether the barrier interrupts natural processes between two areas or restricts the movement of animals that are functionally significant to the community.

**Separation Distance – Different Natural/Semi-Natural Communities:** 0.5 mile

**Separation Distance – Cultural Vegetation:** 0.25 mile

**Alternative Separation Procedure:** none

**Separation Justification:** A larger separation distance may be appropriate for areas where the intervening natural communities are similar in many characteristics and do not limit interaction between the patches, such as Northern Hardwood Forest, Mesic Maple-Ash-Hickory-Oak Forest, or Valley Clayplain Forest. A smaller separation distance may be justified in areas where the intervening natural communities are large wetlands or aquatic systems that limit interaction of species and processes between the patches.

### **Rank Procedure**

Current condition, size, and landscape context are all weighted equally (33%). Although current condition of this small to large patch community may be of primary importance, the condition is easily affected by the surrounding landscape. This small to large patch community type is especially susceptible to invasive exotic shrubs. Landscape context is important for maintaining animal population connections and natural disturbance regimes.

Calculation: A=4, B=3, C=2, D=1

(Condition rank x 0.33) + (Size rank x 0.33) + (Landscape Context rank x 0.33) + = EO Rank

Element occurrence ranks and their corresponding calculated numeric values:

EO Rank	Numeric Values
A	>3.25 and ≤4.00
B	>2.50 and ≤3.25
C	>1.75 and ≤2.50
D	>1.00 and ≤1.75

### **Element Occurrence Rank Factor 1 – Condition**

#### **A Specifications**

a) Forest is dominated by red oak, shagbark hickory, and hophornbeam. Other tree species may also be present such as sugar maple, white ash, basswood, white oak, and white pine. Characteristic shrubs and herbs are also present.

b) The forest is mature and displays many characteristics of an old-growth forest, including forest structure with all age classes, a multi-story canopy, some old large-diameter trees, and some standing dead trees. Evidence of natural disturbance processes is present, such as canopy gaps created by windthrow, fire, pit and mound formation, and downed trees in all stages of decomposition. Older trees are generally greater than 150 years old.

c) No exotic species present, or, if few are present, they are easily controlled.

d) Any past (>20 years ago) selection harvesting or thinning has had minimal disruption of the understory or ground surface and full recovery is expected.

e) Regeneration of characteristic canopy species is not precluded by heavy browsing.

f) For large examples (>100 acres), there may be openings greater than 0.5 acre within the EO, if they are near an edge of the occurrence where they contribute little to fragmentation and they are small, with total area in the 1-15 year age class less than two percent of the EO area. For occurrences less than 100 acres, there are no openings greater than 0.5 acre, and these are at the periphery of the occurrence. Given the poorly understood role of fire in this community type, any openings created by logging should be evaluated to determine their effect on fire frequency, including the effect of potential fuel and the increase in spacing between remaining trees.

## **B Specifications**

- a) Forest dominated by characteristic species and with many structural characteristics of a mature forest as described above, but with selection harvesting resulting in stand age of 60 to 150 years old. Forest is generally uneven aged, but may also be even aged.
- b) Selection harvesting and thinning has resulted in little disruption of understory vegetation or ground surface over the majority of the EO.
- c) Exotic species may be present in low numbers and can be controlled with relatively minor effort.
- d) Full recovery to mature forest conditions is expected for the majority of the EO.
- e) For large examples (>100 acres), there may be openings greater than 0.5 acre within the EO, if they are near an edge of the occurrence where they contribute little to fragmentation and they are small, with total area in the 1-15 year age class less than three percent of the EO area. For occurrences less than 100 acres, there are no openings greater than 0.5 acre, and these are at the periphery of the occurrence. Given the poorly understood role of fire in this community type, any openings created by logging should be evaluated to determine their effect on fire frequency, including the effect of potential fuel and the increase in spacing between remaining trees.

## **C Specifications**

- a) The forest species composition and structure has been significantly altered from the expected mature state by more intensive logging or minor surface alterations (woods roads or grazing). Generally a young, even aged forest (15-60 years).
- b) Natural disturbance processes have been largely eliminated by the intensive nature of recent human disturbance.
- c) Exotic species may be present in large numbers and their control will take significant effort.
- d) Full recovery or restoration of mature forest conditions is expected but may take many years or significant effort.

## **D Specifications (Note: any EO with a D-rank Condition is not a state-significant natural community)**

- a) The forest species composition and structure has been significantly altered by intensive, repeated logging or activities that alter the ground surface and water movement (roads, culverts, grading, and grazing).
- b) Exotic species are present in large numbers and long-term successful control is unlikely.
- c) Recovery or restoration of mature forest conditions is unlikely.

## **Ranking Specifications Justification:**

A-Rank Threshold: Mature forests contain more biological legacies (fallen logs and rotting wood, well developed moss and herbaceous understory, structural complexity in the canopy and understory layers,

accumulated soil organic matter, and seed banks) than young forests. The maximum area of two percent of the EO area in openings is based on Lorimer and White (2003) and the expected percentage of regional presettlement landscape in the 1-15 year age class created by windthrow (range of 1-3 percent). This does not take into account the potentially frequent low to moderate intensity fires that may occur on these sites. Given the uncertainty regarding the current role of fire in maintaining this community type, the effect of logging openings should be viewed critically.

C/D-Rank Threshold: highly disturbed forests that are unlikely to recover mature forest conditions.

### **Element Occurrence Rank Factor 2 – Size**

#### **A Specifications**

Very Large (>100 acres)

#### **B Specifications**

Large (>30-100 acres)

#### **C Specifications**

Moderate (3-30 acres)

#### **D Specifications**

Small (<3 acres)

### **Ranking Specifications Justification**

A-Rank Threshold: The largest known occurrence of Dry Oak-Hickory-Hophornbeam Forest in Vermont is over 1,800 acres, but most occurrences are less than 50 acres.

C/D-Rank Threshold: At the smallest size of these forests edge effects may dominate.

### **Element Occurrence Rank Factor 3 – Landscape Context**

#### **A Specifications**

Highly connected: area around the EO is largely intact natural vegetation, with species interactions and natural processes occurring across communities. In general, the condition of the natural communities surrounding the element occurrence should be at least equal to the B Specifications for Condition listed above.

#### **B Specifications**

Moderately connected: area around the EO is moderately intact natural vegetation, with species interactions and natural processes occurring across many communities. In general, the condition of the natural communities surrounding the element occurrence should be at least equal to the C Specifications for Condition listed above.

#### **C Specifications**

Moderately fragmented: area around the EO is largely a combination of cultural and natural vegetation with barriers between species interactions and processes across communities; EO is surrounded by a mix of fragmented forest, agriculture, and rural development.

#### **D Specifications**

Highly fragmented: the EO is entirely, or almost entirely, surrounded by urban development or

agriculture. EO is at best buffered on one side by natural communities.

**Ranking Specifications Justification:**

A-Rank Threshold: Forested landscapes of 1,000 acres or more with natural communities in good condition will buffer Dry Oak-Hickory-Hophornbeam Forests from most other land uses.

C/D-Rank Threshold: Connectivity to other natural community patches is mostly eliminated, precluding most species interactions and movements; landscape-scale natural disturbance is also precluded by surrounding developed land.

**Ranking Specifications Date:** March 26, 2014

**Ranking Specifications Authorship:** Eric Sorenson



## Mesic Clayplain Forest and Sand-Over-Clay Forest

**General Description:** Clayplain forest dominated the post-glacial lake and marine plain of the Champlain Valley prior to European settlement. The clayplain forest is best considered an ecosystem, composed of several forest types occurring together of the glacial lacustrine and marine soils of the Champlain Valley. These fertile, stone-free soils have been prized for agricultural uses, and the majority of the clayplain forest has been cleared. Consequently, the clayplain forest natural community types are all rare in Vermont. Only 12 percent of the clay-soil in the southern Champlain Valley currently supports forest, although it is presumed that this area was nearly 100 percent forested prior to European settlement (Lapin, 2003). Two natural community types of the clayplain forest ecosystem are uplands (Mesic Clayplain Forest and Sand-Over-Clay Forest) and two natural community types are wetlands (Wet Clayplain Forest and Wet Sand-Over-Clay Forest). The two upland types are described here.

### **Mesic Clayplain Forest**

*Quercus alba* - *Acer rubrum* - *Carya ovata* / *Viburnum acerifolium* / *Waldsteinia fragarioides* Forest (CEGL006122)

This type is often considered the dominant or matrix forest of the Champlain Valley. It typically occurs on slightly elevated and on sloping parts of the clay plain, and it is therefore better drained than the wet-mesic type. This forest typically occurs on Vergennes clay soils. The forest canopy is dominated by red maple (*Acer rubrum*), white pine (*Pinus strobus*), hemlock (*Tsuga canadensis*), white oak (*Quercus alba*), red oak (*Quercus rubra*), and sugar maple (*Acer saccharum*). Other prominent tree species include American beech (*Fagus grandifolia*), swamp white oak (*Quercus bicolor*), white ash (*Fraxinus americana*), and basswood (*Tilia americana*). The abundance of red maple and white pine in these forests may reflect past human land use. Hophornbeam (*Ostrya virginiana*) strongly dominates the understory stratum of these forests, along with regeneration of red maple, beech, hemlock, and sugar maple. Maple-leaved viburnum (*Viburnum acerifolium*) is a characteristic shrub. The most abundant herbaceous species are wild sarsaparilla (*Aralia nudicaulis*), woodland sedge (*Carex pensylvanica*), intermediate woodfern (*Dryopteris intermedia*), hog-peanut (*Amphicarpaea bracteata*), wild oats (*Uvularia sessilifolia*), large enchanter's nightshade (*Circaea lutetiana*), wild geranium (*Geranium maculatum*), and lady fern (*Athyrium filix-femina*).

**Sand-Over-Clay Forest:** This type occurs in moderately large patches near the mouths of Otter Creek and Little Otter Creeks and also on ancient glacial-lake shorelines near the foot of the Green Mountains. The presence of an acidic sand layer over calcareous clay has a strong effect on the floristic composition of the forest. The depth of the sand overburden (from several to 30 inches) affects both the soil drainage and the accessibility of the fertile clays to plant roots. These forests typically occur on Swanton, Elmridge, Elmwood, Melrose, Munson, and Whately soils. Sand-over-clay forest is dominated by hemlock and red maple, with lesser amounts of red oak, bigtooth aspen (*Populus grandidentata*), beech, sweet birch (*Betula lenta*), yellow birch (*Betula alleghaniensis*), and white oak. Some examples may have dense hemlock canopy which results in an even denser sapling layer of hemlock and fewer groundcover species. Typical shrubs include witch hazel (*Hamamelis virginiana*) and maple-leaved viburnum. Herbaceous species include intermediate woodfern, New York fern (*Thelypteris noveboracensis*), lady fern, shining clubmoss (*Huperzia lucidula*), interrupted fern (*Osmunda claytoniana*), wild sarsaparilla, Canada mayflower, wild cucumber (*Medeola virginiana*), and cinnamon fern (*Osmunda cinnamomea*). In general, this forest is less species rich than the clay soil forests.

**State Rank:** S2

**Spatial Pattern:** Mesic Clayplain Forest is a former Matrix forest, now reduced to forest fragments (Matrix to Large Patch). Sand-Over-Clay Forest is a Large Patch community.

**Minimum Size for Element Occurrence:** 5 acres for Mesic Clayplain Forest; 1 acre for Sand-Over-Clay Forest

**Minimum Polygon Size for multipart EOs:** 1 acre for Mesic Clayplain Forest

### **Element Occurrence Separation**

**Separation Barriers:** Barriers that would separate one occurrence from another include urban development, agricultural land, and highways that create significant canopy breaks. Judgment on what constitutes a separation barrier should be based on whether the barrier interrupts natural processes between two areas or restricts the movement of animals that are functionally significant to the community. Active agricultural land should typically be considered a separation barrier between clayplain forest fragments. However, intervening agricultural lands between clayplain fragments may not constitute a separation barrier if these agricultural lands are very narrow (less than 300 feet) and specific justification is provided.

**Separation Distance – Different Natural/Semi-Natural Communities:** 0.5 mile

**Separation Distance – Cultural Vegetation:** 0.25 mile

**Alternative Separation Procedure:** none

**Separation Justification:** Most clayplain forest fragments are separated from each other by agricultural land uses and/or country roads. The presence of wooded hedgerows that provide connections between forest patches across agricultural lands for some species should be considered in determining what constitutes an occurrence. Forest patches that are associated with riparian corridors or wetland complexes should typically use the larger (0.5 mile) separation distance. Early-successional shrub or forest patches on clay soils that may not rank as significant Clayplain Forests in their current condition, should be weighed heavily for the value they provide as connections between existing forest patches, as well as their potential for restoration. Early successional communities on abandoned agricultural lands should typically be considered cultural vegetation and should use the 0.25 mile separation distance. Forested hedgerows may be considered cultural vegetation and justify using the 0.25 mile separation distance.

### **Rank Procedure**

Size, landscape context, and current condition are all equally weighted for Mesic Clayplain Forest and Sand-Over-Clay Forest. Mesic Clayplain Forest no longer functions as a matrix forest type and both types occur primarily as forest fragments. The current condition of a particular forest fragment may be very important in assessing the viability of that fragment or the potential for restoration. These community types are especially susceptible to invasive exotic shrubs and so current condition is of high importance. Landscape context is important for maintaining animal population connections and natural disturbance regimes and size is important for minimizing edge effects.

Calculation: A=4, B=3, C=2, D=1

(Condition rank x 0.33) + (Size rank x 0.33) + (Landscape Context rank x 0.33) = EO Rank

Element occurrence ranks and their corresponding calculated numeric values:

EO Rank	Numeric Values
A	>3.25 and ≤4.00
B	>2.50 and ≤3.25
C	>1.75 and ≤2.50
D	>1.00 and ≤1.75

### **Element Occurrence Rank Factor 1 – Condition**

#### **A Specifications**

- a) The forest is dominated by species characteristic of Mesic Clayplain Forest or Sand-Over-Clay Forest.
- b) The forest is mature and displays many characteristics of an old-growth forest, including a forest structure with all age classes, a multi-story canopy, some old large-diameter trees, and some standing dead trees. Evidence of natural disturbance processes is present, such as canopy gaps created by windthrow, pit and mound formation, and downed trees in all stages of decomposition. Older trees are generally greater than 150 years old.
- c) No exotic species present, or, if few are present, they are easily controlled.
- d) Any past (>20 years ago) selection harvesting or thinning has resulted in minimal disruption of the understory or ground surface and full recovery is expected. There are no former patch cut openings over 0.5 acre.
- e) Regeneration of characteristic canopy species is not precluded by heavy browsing.

#### **B Specifications**

- a) The forest is dominated by characteristic species and with many structural characteristics of a mature forest as described above, but with selection harvesting resulting in stand age of 60 to 150 years old. The forest is generally uneven aged, but may also be even aged.
- b) Selection harvesting and thinning has resulted in little disruption of understory vegetation or ground surface over the majority of the EO.
- c) Exotic species may be present in low numbers and can be controlled with relatively minor effort.
- d) Full recovery to mature forest conditions is expected for the majority of the EO.

#### **C Specifications**

- a) The forest species composition and structure has been significantly altered from the expected

mature state by more intensive logging or minor surface alterations (woods roads or grazing). Older post-agricultural sites that were cleared and plowed, but have regenerated many of the characteristic clayplain forest species in the canopy and other strata may best be considered a C condition. Generally a young, even aged forest (15-60 years).

b) Natural disturbance processes have been severely altered by the intensive nature of past human disturbance.

c) Exotic species may be present in large numbers and their control will take significant effort.

d) Full recovery or restoration of mature forest conditions is expected but may take many years or significant effort.

**D Specifications (Note: any EO with a D-rank Condition is not a state-significant natural community)**

a) The forest species composition and structure has been significantly altered from reference condition by past agricultural clearing, intensive logging, or activities that alter the ground surface and water movement (roads, culverts, grading, and grazing). Clayplains dominated by shrubs or pioneer trees on abandoned agricultural land typically lack many of the species found in clayplain forests that were not previously cleared.

b) Exotic species are present in large numbers and long-term successful control is unlikely.

c) Recovery or restoration of mature forest conditions is unlikely.

**Ranking Specifications Justification:**

A-Rank Threshold: Hemlock-Northern Hardwood Forests begin to take on old growth characteristics only at ages over 150 years, with development of unique old growth characteristics only at ages over 275 years (Tyrrell and Crow, 1994). Hemlock-Northern Hardwood Forests share many characteristics with Clayplain Forests. Mature forests contain more biological legacies (fallen logs and rotting wood, well developed moss and herbaceous understory, structural complexity in the canopy and understory layers, accumulated soil organic matter, and seed banks) than young forests.

C/D-Rank Threshold: highly disturbed forests that are unlikely to recover mature forest conditions.

**Element Occurrence Rank Factor 2 – Size**

**Mesic Clayplain Forest**

**A Specifications**

Very Large (>500 acres)

**B Specifications**

Large (>100-500 acres)

**C Specifications**

Moderate (20-100 acres)

**D Specifications**

Small (<20 acres)

**Sand-Over-Clay Forest**

**A Specifications**

Very Large (>300 acres)

**B Specifications**

Large (>50-300 acres)

**C Specifications**

Moderate (5-50 acres)

**D Specifications**

Small (<5 acres)

**Ranking Specifications Justification**

A-Rank Threshold: The clayplain forest ecosystem likely occurred as a contiguous patch of nearly 100,000 acres prior to European settlement (Lapin, 2003). There are currently no known forest fragments over 1,000 acres and most fragments are under 100 acres.

C/D-Rank Threshold: In forest fragments of less than five acres edge effects may dominate.

**Element Occurrence Rank Factor 3 – Landscape Context**

**A Specifications**

Highly connected: area around the EO is largely intact natural vegetation, with species interactions and natural processes occurring across communities. In general, the condition of the forested natural communities surrounding the EO should be at least equal to the B Specifications for Condition listed above.

**B Specifications**

Moderately connected: area around the EO is moderately intact natural vegetation, with species interactions and natural processes occurring across many communities. In general, the condition of the forested natural communities surrounding the EO should be at least equal to the C Specifications for Condition listed above.

**C Specifications**

Moderately fragmented: area around the EO is largely a combination of cultural and natural vegetation with barriers between species interactions and processes across communities; EO is surrounded by a mix of fragmented forest, agriculture, and rural development. Forested hedgerows and/or riparian corridors may provide a primary connection between forest fragments.

**D Specifications**

Highly fragmented: the EO is entirely, or almost entirely, surrounded by urban development or agriculture. EO is at best buffered on one side by natural communities. Forested hedgerows and riparian corridors may provide the only connection between forest fragments.

**Ranking Specifications Justification:**

A-Rank Threshold: Forested landscapes of 1,000 acres or more with natural communities in good condition will buffer Clayplain Forests from most other land uses. For the largest examples (>1,000 acres), a surrounding landscape of 4,000 acres should be used for evaluation (see justification under Northern Hardwood Forest).

C/D-Rank Threshold: Connectivity to other natural community patches is mostly eliminated, precluding most species interactions and movements; landscape-scale natural disturbance is also precluded by surrounding developed land.

**Ranking Specifications Date:** March 26, 2014

**Ranking Specifications Authorship:** Eric Sorenson

## Pine-Oak-Heath Sandplain Forest

**General Description:** Pine-Oak-Heath Sandplain Forests are one of Vermont's rarest – and certainly one of its most threatened – communities. Soils in this community are well drained to excessively well drained sands, varying locally in coarseness and moisture holding capacity. They are acidic and nutrient-poor. The Champlain Valley sands were deposited postglacially, as large, sediment-filled rivers of glacial meltwater emptied into glacial Lake Vermont or, later, into the Champlain Sea. Where the rivers entered the lake or sea, coarse sediments were deposited first, in great fan-shaped deltas. These deltas were formed at various elevations as the lake level gradually subsided creating a series of terraces. Our best examples occupy these flat terraces, but they are typically incised by streams with moderate to steep side slopes. These deltas form our present-day sandplains, primarily near the mouths of the Winooski, Lamoille, and Missisquoi Rivers. Similar events took place in the Connecticut Valley, though on a smaller scale. Based on pre-European settlement descriptions of Chittenden County (Siccama 1971), estimates by Engstrom (1991), and the extent of well-drained sands (Windsor and Adams-Windsor soils) on which this community occurs (NRCS soil surveys), sandplain forests likely occupied tens of thousands of acres in the Champlain Valley. These well drained sites have been prized land for agriculture and development over the past two centuries and there is now only a small percentage of the original sandplain forest remaining. Much of the remaining sandplain forest occurs as small patches of fragmented forest surrounding by urban development.

Like the larger pine barrens of Albany, New York, and Concord, New Hampshire, these forests are fire-adapted communities. Ours are not, however, true pine barrens: they probably never had extensive open areas with stunted trees and parched windblown sand, as true pine barrens have. But Vermont's sandplains almost certainly burned occasionally prior to European settlement, and likely had more of a "barrens" feel then. Pitch pine, one of the important components of this community, is especially well adapted to fire. Its bark protects the trees from light fires that can kill other species. Additionally, pitch pine seeds germinate most successfully in the bare mineral soil that is left after a fire burns away the leaf litter. Pitch pine cones are not serotinous, meaning they do not require fire to open as is the case farther south. Other plants probably benefited from the natural fires, too. A number of the rare and uncommon plants of this community require open, dry areas that would be common where fires were frequent. Ecologists believe that fire was important in Vermont's sandplains and that these communities have, in the last two centuries, lost much of their original character as a consequence of fire suppression and development. Without fire the litter and organic layers build up over time allowing more mesic species to become established while inhibiting the regeneration of sandplain species.

The canopy in these forests is fairly open. Pitch pine (*Pinus rigida*), white pine (*Pinus strobus*), red maple (*Acer rubrum*), black oak (*Quercus velutina*), and red oak (*Quercus rubra*) are the most common canopy species, but white oak (*Quercus alba*), paper birch (*Betula papyrifera*), gray birch (*Betula populifolia*), beech (*Fagus grandifolia*), red pine (*Pinus resinosa*), and black cherry (*Prunus serotina*) may also be present. Tall shrubs are scattered and include witch hazel (*Hamamelis virginiana*), smooth shadbush (*Amelanchier laevis*), and beaked hazelnut (*Corylus cornuta*). Low shrubs, many of the heath family, are typically more abundant than tall shrubs and include low sweet blueberry (*Vaccinium angustifolium*), late low blueberry (*Vaccinium pallidum*), black huckleberry (*Gaylussacia baccata*), sheep laurel (*Kalmia angustifolia*), and sweetfern (*Comptonia peregrina*). The ground herbaceous layer is often very sparse, and typically includes Canada mayflower (*Maianthemum canadense*), wild sarsaparilla (*Aralia nudicaulis*), bracken fern (*Pteridium aquilinum*), rough-leaved ricegrass (*Oryzopsis asperifolia*), woodland

sedge (*Carex pensylvanica*), poverty grass (*Danthonia spicata*), and wintergreen (*Gaultheria procumbens*). Other common herbs include starflower (*Trientalis borealis*), whorled loosestrife (*Lysimachia quadrifolia*), pink ladyslipper (*Cypripedium acaule*), bastard toadflax (*Comandra umbellata*), and cow-wheat (*Melampyrum lineare*). Overall plant diversity is low, although Pine-Oak-Heath Sandplain Forests have a disproportionately high number of rare species, perhaps more than any other natural community. Many of these species are at their range limits in Vermont and are more common elsewhere. The sandy dry soils, fire history, warm climate, and sunny openings of our sandplains provide good habitat for these species.

**State Rank:** S1

**Spatial Pattern:** Pine-Oak-Heath Sandplain Forest is a former Large Patch community, now reduced to mostly small forest fragments.

**Minimum Size for Element Occurrence:** 1 acre

#### **Element Occurrence Separation**

**Separation Barriers:** Barriers that would separate one occurrence from another include urban development, agricultural land, and roads that create significant canopy breaks. Judgment on what constitutes a separation barrier should be based on whether the barrier interrupts natural processes between two areas or restricts the movement of animals that are functionally significant to the community. As periodic fires are a natural component of some examples of this community, barriers that would create a fire break should be carefully evaluated as potential separation barriers.

**Separation Distance – Different Natural/Semi-Natural Communities:** 0.5 mile

**Separation Distance – Cultural Vegetation:** 0.25 mile

**Alternative Separation Procedure:** none

**Separation Justification:** A larger separation distance may be appropriate for areas where the intervening natural communities are similar in many characteristics and do not limit interaction between the patches, such as White Pine-Red Oak-Black Oak Forest. A smaller separation distance may be justified in areas where the intervening natural communities are large wetlands or rocky hillsides that limit interaction of species and processes between the patches. Given the fragmented landscape in which most of Vermont's sandplains occur, separation barriers (roads and development) are more likely encountered than separation distance across natural or cultural vegetation.

#### **Rank Procedure**

Current condition, size, and landscape context are all weighted equally (33%). Although current condition of this large patch community may be of primary importance, the condition is easily affected by the surrounding landscape, including edge effects from adjacent development. Landscape context is important for maintaining animal population connections and natural disturbance regimes, including fire.

Calculation: A=4, B=3, C=2, D=1

(Condition rank x 0.33) + (Size rank x 0.33) + (Landscape Context rank x 0.33) = EO Rank

Element occurrence ranks and their corresponding calculated numeric values:

EO Rank	Numeric Values
A	>3.25 and ≤4.00
B	>2.50 and ≤3.25
C	>1.75 and ≤2.50
D	>1.00 and ≤1.75

### **Element Occurrence Rank Factor 1 – Condition**

#### **A Specifications**

- a) Forest is dominated by pitch pine, white pine, black oak, red maple, and red oak, but may also include white oak, paper birch, gray birch, beech, and red pine. Characteristic shrubs and herbs are also present, usually including some of the rare species associated with this community type. Presence of the heath-dominated low shrub layer is characteristic.
  
- b) The forest is mature and displays many characteristics of an old-growth forest, including forest structure with all age classes, a multi-story canopy, some old large-diameter trees, and some standing dead trees. Evidence of natural disturbance processes is present, such as canopy gaps created by windthrow or fire, pit and mound formation, and downed trees in all stages of decomposition. Older trees are generally greater than 150 years old. Fire scars may be present on trees. Natural fires (or prescribed burns) that reduce the average stand age or open the forest canopy by killing some older trees are part of the natural process supporting this community type and, if present, should not be used as a basis for lowering the condition rank.
  
- c) No exotic species present, or, if few are present, they are easily controlled.
  
- d) Any past (>20 years ago) selection harvesting or thinning has had minimal disruption of the understory or ground surface and full recovery is expected.
  
- e) Regeneration of characteristic canopy species is not precluded by heavy browsing.

#### **B Specifications**

- a) Forest is dominated by characteristic species of trees, shrubs, and herbs. The presence of a robust heath shrub layer is indicative of a relatively long history of natural site conditions. Forests with a significant component of mature pitch pine for which natural or controlled fires are improbable are likely to lose this species over time and should be considered B condition. Pitch pine may be absent in the regeneration layer of these forests. Rare species may be less abundant than in a forest with repeating fires that open the canopy and expose mineral soil.
  
- b) There are many structural characteristics of a mature forest as described above, but with selection harvesting resulting in stand age of 60 to 150 years old. Forest is generally uneven aged, but may also be even aged. The forest canopy may be more closed if fire has been suppressed.



- c) Selection harvesting and thinning or recreational trail development have resulted in little disruption of understory vegetation or ground surface over the majority of the EO.
- d) Exotic species may be present in low numbers and can be controlled with relatively minor effort.
- e) Full recovery to mature forest conditions is expected for the majority of the EO, although this will likely require active management, including prescribed burns.

**C Specifications**

- a) The forest species composition and structure has been significantly altered from the expected mature state by more intensive logging or minor surface alterations (such as recreation trails). Early successional sandplain forests may be dominated by trees such as white pine, birches, red maple, and other species. Generally a young, even aged forest (15-60 years).
- b) Natural disturbance processes have been largely eliminated by the intensive nature of recent human disturbance.
- c) Exotic species may be present in large numbers and their control will take significant effort.
- d) Full recovery or restoration of mature forest conditions is expected but may take many years or significant effort.

**D Specifications (Note: any EO with a D-rank Condition is not a state-significant natural community)**

- a) The forest species composition and structure has been significantly altered by intensive, repeated logging or activities that alter the ground surface (roads, grading, or plowing).
- b) Exotic species are present in large numbers and long-term successful control is unlikely.
- c) Recovery or restoration of mature forest conditions is unlikely.

**Ranking Specifications Justification:**

A-Rank Threshold: Pine-Oak-Heath Sandplain Forests in Vermont have all been altered by past human land use and it is likely that there are no examples with A-rank condition remaining. For sandplain forest examples that have a history of fires, the recurrence of fires is critical to maintaining canopy gaps, reducing fuel loads, reducing accumulated soil duff and exposing mineral soil, and for the maintenance or establishment of pitch pine and many of the rare species associated with this community type. The absence of fire (natural or prescribed) in these fire prone examples will lead to changes in species composition and these examples should be considered B-rank. However, fire may not be a natural process in some of the more mesic sandplains and its absence should not be the basis for lowering the rank of these examples.

C/D-Rank Threshold: highly disturbed forests that are unlikely to recover mature forest conditions.

**Element Occurrence Rank Factor 2 – Size**

**A Specifications**

Very Large (>300 acres)

**B Specifications**

Large (>50-300 acres)

**C Specifications**

Moderate (5-50 acres)

**D Specifications**

Small (<5 acres)

**Ranking Specifications Justification**

A-Rank Threshold: The largest known contiguous patches of Adams-Windsor and Windsor soils in Chittenden and Franklin Counties are 1,000 to 1,400 acres and presettlement examples of Pine-Oak Heath Sandplain forests may have covered areas this large. A-rank specifications for sandplain forests are set to be comparable to other large patch community types, even though no examples over 300 acres are known.

C/D-Rank Threshold: At the smallest size of these forests edge effects may dominate.

**Element Occurrence Rank Factor 3 – Landscape Context****A Specifications**

Highly connected: area around the EO is largely intact natural vegetation, with species interactions and natural processes occurring across communities. In general, the condition of the natural communities surrounding the element occurrence should be at least equal to the B Specifications for Condition listed above or for the appropriate natural community type.

**B Specifications**

Moderately connected: area around the EO is moderately intact natural vegetation, with species interactions and natural processes occurring across many communities. In general, the condition of the natural communities surrounding the element occurrence should be at least equal to the C Specifications for Condition listed above or for the appropriate natural community type.

**C Specifications**

Moderately fragmented: area around the EO is largely a combination of cultural and natural vegetation with barriers between species interactions and processes across communities; EO is surrounded by a mix of fragmented forest, agriculture, and rural/urban development.

**D Specifications**

Highly fragmented: the EO is entirely, or almost entirely, surrounded by urban development or agriculture. EO is at best buffered on one side by natural communities.

**Ranking Specifications Justification:**

A-Rank Threshold: Forested landscapes of 1,000 acres or more with natural communities in good condition will buffer Pine-Oak-Heath Sandplain Forests from most other land uses.

C/D-Rank Threshold: Connectivity to other natural community patches is mostly eliminated, precluding most species interactions and movements; fire and landscape-scale natural disturbance is also precluded by surrounding developed land.

**Ranking Specifications Date:** March 26, 2014  
**Ranking Specifications Authorship:** Eric Sorenson

## Floodplain Forests

### General Descriptions:

#### **Silver Maple-Ostrich Fern Riverine Floodplain Forest**

This is the classic floodplain forest found on the moderate gradient portions of most of Vermont's major rivers. These floodplain forests occur on the active floodplain and generally receive annual overbank flooding, although water tables may be well below the ground surface for most of the growing season. Levees and old channel meander scars are common micro-topographic features. The alluvial soils of these floodplain forests are primarily sandy loams, and generally well to moderately well drained, without mottles in the upper portion. Due to annual soil deposition, there is generally no surface organic layer, although there may be buried A horizons. This floodplain forest type is almost always considered a wetland.

Silver maple (*Acer saccharinum*) dominates the canopy of these forests. Cottonwood (*Populus deltoides*) may be an important part of the canopy at some sites. Other tree species that may be present include American elm (*Ulmus americana*), slippery elm (*U. rubra*), hackberry (*Celtis occidentalis*), and boxelder (*Acer negundo*). Shrubs are very sparse or lacking in this forest type, although river grape (*Vitis riparia*) occurs frequently. Ostrich fern (*Matteuccia struthiopteris*) forms a nearly complete ground cover in many forests, although wood nettle (*Laportea canadensis*) may be abundant in patches.

**State Rank:** S3

**Spatial Pattern:** Large patch

**Minimum Size for Element Occurrence:** 1 acre

#### **Silver Maple-Sensitive Fern Riverine Floodplain Forest**

This is our wetter riverine floodplain forest type. It occurs on floodplains adjacent to the lower gradient portions of our larger rivers. This community also occurs in wetter depressions of floodplains associated with more moderate gradient rivers. These floodplain forests receive annual overbank flooding from the river, in some cases in both the spring and fall. The soils are alluvial with generally a silt loam texture, although clay loam and very fine sandy loam soils were also encountered. Most soils have mottling within the upper 4 inches (10 cm) of the soil surface. There is generally no surface organic layer in these alluvial soils. This floodplain forest type is always considered a wetland.

Silver maple dominates the canopy of these forests, but green ash (*Fraxinus pennsylvanica*) may be abundant at some sites. American elm is also a common canopy associate, although many individuals of this species are now dead or dying. Swamp white oak (*Quercus bicolor*) is a less common canopy associate. Shrubs are generally sparse, although winterberry holly (*Ilex verticillata*) may be abundant in patches. Saplings of silver maple and green ash occur frequently, but are seldom abundant. Sensitive fern (*Onoclea sensibilis*) is the dominant herb, often forming a nearly complete ground cover. Wood nettle is abundant in patches at some sites and absent from others, whereas false nettle (*Boehmeria cylindrica*) is seldom dominant but is characteristic of this floodplain forest type. Other herbaceous plants include marsh fern (*Thelypteris palustris*) and whitegrass (*Leersia virginica*).

This floodplain forest natural community has many similarities of vegetation with lakeside floodplain forests, however, it is generally flooded for a shorter period during the spring and has a more diverse and dense herbaceous layer.

**State Rank:** S3

**Spatial Pattern:** Large patch

**Minimum Size for Element Occurrence:** 1 acre

#### **Sugar Maple-Ostrich Fern Riverine Floodplain Forest**

This natural community is characteristic of the floodplains associated with our higher energy, higher gradient rivers. It is also found on terraces (former floodplains) above some of our lower gradient rivers, although we have very limited information about this forest type due to nearly complete conversion to agricultural use. These floodplains are less frequently flooded than other types, and have well drained to moderately well drained soils. The soil texture is typically a fine sandy loam over a sandy subsoil, and mottling is often absent. There is generally no surface organic horizon or significant profile development in these alluvial soils. These are upland soils, but small hydric soil inclusions may be present in old meander swales.

Sugar maple (*Acer saccharum*) is the dominant tree in the relatively closed canopy of this floodplain forest type, although white ash (*Fraxinus americana*) is abundant at some sites. Basswood (*Tilia americana*) usually occurring in low abundance relative to sugar maple and white ash, but is characteristic of these forests. On well drained sites, red oak (*Quercus rubra*) may be abundant, and on younger sites in the southern part of the state there may be large sycamores (*Platanus occidentalis*) mixed in the canopy. Black cherry (*Prunus serotina*) is another canopy associate. These forests typically have more structural diversity than the silver maple floodplain forest types, with sugar maple and white ash common in the subcanopy. The small tree, musclewood (*Carpinus caroliniana*) is also characteristic of the subcanopy and tall shrub layers of these forests, although its overall cover is low. Other than regeneration of tree species, especially sugar maple, there are few low shrubs, although the vines poison ivy (*Toxicodendron radicans*) and Virginia creeper (*Parthenocissus quinquefolia*) are often present. Ostrich fern dominates the diverse herbaceous layer. Other species that are commonly present include white snakeroot (*Eupatorium rugosum*), zig-zag goldenrod (*Solidago flexicaulis*), bottlebrush grass (*Elymus hystrix*), lady fern (*Athyrium filix-femina*), and graceful sedge (*Carex gracillima*).

**State Rank:** S2

**Spatial Pattern:** Small patch

**Minimum Size for Element Occurrence:** 1 acre

#### **Northern Conifer Floodplain Forest**

This rare and poorly understood floodplain forest occurs along small to moderate-sized streams in northeastern Vermont, although it is also described from New Hampshire, Maine, and Québec. The alluvial soils are typically sandy to silty loams and seasonal flooding may be of short duration.

Balsam fir (*Abies balsamea*) is a characteristic species found in most examples. Other tree species that may be present in the open canopy of these forests include black ash (*Fraxinus nigra*), black cherry (*Prunus serotina*), white spruce (*Picea glauca*), yellow birch (*Betula alleghaniensis*), northern white cedar (*Thuja occidentalis*), and balsam poplar (*Populus balsamifera*). Silver maple (*Acer saccharinum*) and red maple (*Acer rubrum*) may also be present. Shrubs include speckled alder (*Alnus incana*), beaked hazelnut (*Corylus cornuta*), northern wild raisin (*Viburnum cassinoides*), and dwarf blackberry (*Rubus pubescens*). Ostrich fern and/or sensitive fern are typically present and may be dominant. Other herbs include virgin's bower (*Clematis virginiana*), bladder sedge (*Carex intumescens*), common bluejoint grass (*Calamagrostis canadensis*), hairy woods grass (*Brachyeletrum erectum*), rough-stemmed goldenrod (*Solidago rugosa*), and wild sarsaparilla (*Aralia nudicaulis*).

**State Rank:** S2

**Spatial Pattern:** Small patch

**Minimum Size for Element Occurrence:** 1 acre

### **Lakeside Floodplain Forest**

Lakeside floodplain forests have been identified only from the shores of Lake Champlain. They typically occur in former lake coves as a complex of wetland forest types and marsh. There is often a narrow, lakeside beach ridge, with open marsh landward. The more classic floodplain forests often occur as a narrow band between the marsh and the uplands, however, there are many variations on this pattern.

The narrow lakeside beach ridges are formed by wave action deposition of sandy soils. Silver maple, green ash, cottonwood, and American elm are the dominantes of the canopy. There are few shrubs, and the herbaceous layer is sparse, including sensitive fern, white grass, and wild mint (*Mentha arvensis*).

The floodplain behind the beach ridge is typically a silver maple dominated forest, with very few shrubs, and a very sparse ground cover that includes white grass, beggar ticks (*Bidens frondosa*), and water willow (*Decodon verticillatus*) closer to the marsh.

This low diversity forest grades into a slightly higher silver maple dominated forest closest to the uplands. Green ash is an important component of the canopy in this forest, with swamp white oak occurring occasionally. Silver maple and green ash regeneration is abundant, and there are scattered patches of winterberry holly. Sensitive fern is the dominant herb and may have high coverage. Although seldom abundant, false nettle is characteristic of this forest type. Other herbaceous species include white grass, marsh fern, and beggar ticks. This forest is very similar in vegetation to the silver maple-sensitive fern-false nettle riverine floodplain forest type, but differs in landscape setting, soil characteristics, and flooding regime.

Lake Champlain reaches its highest water levels during the months of April, May, and June, when the average maximum level is over 100 feet. The mean monthly lake levels for April and May are over 98 feet. These extended high water periods mean that lakeside floodplain forests must tolerate longer periods of inundation than the riverine floodplain forests. The soils of lakeside floodplain forests are typically silts or clay loams, and usually do not show evidence of recent alluvial deposition. Surface organic layers may be several inches thick and mottling is usually present to the surface.

**State Rank:** S3

**Spatial Pattern:** Small Patch (formerly large patch forest, now reduced to mostly small forest fragments)

**Minimum Size for Element Occurrence:** 1 acre

**Element Occurrence Separation**

**Separation Barriers:** The adjacent rivers (and Lake Champlain for Lakeside Floodplain Forests) should be the focus for determining separations between EOs. River dams that occur between floodplain forest patches should be considered barriers. In general, bridges or culverts that may restrict flows are not barriers, as they are similar to naturally occurring bedrock constrictions in the river channel that may occur between two nearby floodplain forest patches.

**Separation Distance – Natural River Segment:** 1.5 miles

**Separation Distance – Cultural Vegetation:** not applicable

**Alternative Separation Procedure:** none

**Separation Justification:** The location, soils, species composition, and community structure of floodplain forests are largely determined by the flooding regime and energy of the adjacent river. The hydroperiod is also a critical factor in lakeside floodplain forests.

**Rank Procedure**

Current condition, landscape context, and size are equally weighted (33%). Current condition is of high importance in this and other small patch wetland communities in which a specific set of environmental factors (hydrology, organic soil depth and type, nature of underlying bedrock and mineral soils, and climate) affect species composition. Floodplain forest sizes are highly variable and are dependent on regional variations in topography and width of the river valley bottoms.

Calculation: A=4, B=3, C=2, D=1

(Condition rank x 0.33) + (Landscape Context rank x 0.33) + (Size rank x 0.33) = EO Rank

Element occurrence ranks and their corresponding calculated numeric values:

EO Rank	Numeric Values
A	>3.25 and ≤4.00
B	>2.50 and ≤3.25
C	>1.75 and ≤2.50
D	>1.00 and ≤1.75

**Element Occurrence Rank Factor 1 – Condition**

**A Specifications**

- a) The forest is dominated by species characteristic of the specific floodplain forest type as

described above.

b) The forest is mature, with a forest structure with all age classes, a multi-story canopy, some old large-diameter trees (generally trees over 100 years), and some standing dead trees.

c) Evidence of natural disturbance processes is present, such as flooding and/or ice scour, canopy gaps created by windthrow or flooding, alluvial soil deposition or scouring associated with seasonal flooding, and downed trees in all stages of decomposition.

d) No exotic species present, or, if few are present, they are easily controlled.

e) The associated river is free-flowing (not dammed), has access to its floodplain, and has the channel is stable based on hydro-geomorphic assessment.

f) Any past (>20 years ago) harvesting of the forest or other human disturbance has resulted in minimal disruption of the understory or ground surface and full recovery is expected.

### **B Specifications**

a) The forest is dominated by characteristic species of the specific floodplain forest type.

b) The forest is younger, generally with trees 60 to 100 years old, but is beginning to develop a forest structure with all age classes, a multi-story canopy, some old large-diameter trees, and some standing dead trees.

c) Evidence of natural disturbance processes is present, such as flooding and/or ice scour, canopy gaps created by windthrow or flooding, alluvial soil deposition or scouring associated with seasonal flooding, and downed trees in all stages of decomposition.

d) Exotic species may be present in low numbers and can be controlled with relatively minor effort.

e) The associated river may be dammed, but still has access to its floodplain, and has the channel is stable based on hydro-geomorphic assessment.

f) Any past (>20 years ago) harvesting of the forest or other human disturbance has resulted in minimal disruption of the understory or ground surface and full recovery is expected.

### **C Specifications**

a) The forest species composition and structure has been significantly altered from the expected mature state by more timber harvesting, or the floodplain forest is regenerating from past agricultural land use. Generally a young forest (15-60 years).

b) Evidence of natural disturbance processes is present, including flooding and/or ice scour, and alluvial soil deposition or scouring associated with seasonal flooding.

c) Exotic species may be present in large numbers and their control will take significant effort.

d) The associated river may be dammed and/or access to its floodplain is limited due to past



river alterations; the channel is unstable based on hydro-geomorphic assessment.

e) Full recovery or restoration of mature floodplain forest conditions and channel stability are expected but may take many years or significant effort.

**D Specifications (Note: any EO with a D-rank Condition is not a state-significant natural community)**

a) The forest species composition and structure has been significantly altered from reference condition by past agricultural clearing, intensive logging, or other activities that alter the ground surface or hydrology. The forest is young.

b) Exotic species are present in large numbers and long-term successful control is unlikely.

c) The associated river may be dammed and/or access to its floodplain is limited due to past river alterations; the channel is unstable based on hydro-geomorphic assessment.

d) Recovery or restoration of mature floodplain forest conditions and channel stability are unlikely.

**Ranking Specifications Justification:**

**Element Occurrence Rank Factor 2 – Size**

**Silver Maple-Sensitive Fern Riverine Floodplain Forest and Silver Maple-Ostrich Fern Riverine Floodplain Forest (large patch types)**

**A Specifications**

Very Large (>50 acres)

**B Specifications**

Large (>10-50 acres)

**C Specifications**

Moderate (2-10 acres)

**D Specifications**

Small (<2 acres)

**Sugar Maple-Ostrich Fern Riverine Floodplain Forest, Northern Conifer Floodplain Forest, and Lakeside Floodplain Forest (Small Patch Types)**

**A Specifications**

Very Large (>20 acres)

**B Specifications**

Large (>5-20 acres)

**C Specifications**

Moderate (2-5 acres)

## **D Specifications**

Small (<2 acres)

## **Ranking Specifications Justification**

### **Element Occurrence Rank Factor 3 – Landscape Context**

#### **A Specifications**

Highly connected: area around the EO is largely intact natural vegetation, with species interactions and natural processes occurring across communities. In general, the condition of the forested natural communities surrounding the EO should be at least equal to the B Specifications for Condition listed for the surrounding forest type.

#### **B Specifications**

Moderately connected: area around the EO is moderately intact natural vegetation, with species interactions and natural processes occurring across many communities. In general, the condition of the forested natural communities surrounding the EO should be at least equal to the C Specifications for Condition listed for the surrounding forest type.

#### **C Specifications**

Moderately fragmented: area around the EO is largely a combination of cultural and natural vegetation with barriers between species interactions and processes across communities; EO is surrounded by a mix of fragmented forest, agriculture, and rural development.

#### **D Specifications**

Highly fragmented: the EO is entirely, or almost entirely, surrounded by urban development or agriculture. EO is at best buffered on one side by natural communities.

#### **Ranking Specifications Justification:**

**Ranking Specifications Date:** March 26, 2014

**Ranking Specifications Authorship:** Eric Sorenson

## **Red Maple-Black Ash Seepage Swamp**

**General Description:** Red Maple-Black Ash Seepage Swamps are the most common type of hardwood swamp in Vermont. They occur in all biophysical regions, although they are least common in the Northeastern Highlands and in the Green Mountains. Red Maple-Black Ash Seepage Swamps are commonly the dominant community type in small basins in the hilly regions of Vermont, but they also occur as part of large and diverse wetland complexes in the relatively flat Champlain and Vermont Valley. These swamps are very closely associated with groundwater seepage, which is typically visible as seeps and springs at the margins of the swamps. Red Maple-Black Ash Seepage Swamps occur in a variety of topographic settings, from basins to slope bases to streamsides. Red Maple-Black Ash Seepage Swamps are commonly the headwaters for intermittent or small perennial streams, as the groundwater discharge provides a regular flow of water. The shape of the basin in which the swamp occurs and the amount and seasonality of groundwater discharge are primary factors in determining the soil type that has developed in these swamps. The majority of swamps (39 out of 52 studied) had

organic soil depths greater than 20 inches deep, and most of these (32 out of 39) had organic soils greater than 40 inches deep. These organic soils are generally well decomposed. Swamps with mineral soils or thin surface organic horizons generally occur in shallow basins and have intermittent groundwater flow, which allows organic material to dry out periodically and decompose more completely. Surface waters in Red Maple-Black Ash Seepage Swamps vary considerably in chemistry. Surface water pH ranges from 5.1 to 8.1 (40 samples), and conductivity ranges from 20 to 620 $\mu$ S. This variability is probably closely related to the chemistry of underlying bedrock and surficial geologic deposits. Hummocks and hollows are generally well developed in these swamps. These forested wetlands vary in size from a few acres to over 900 acres.

Red maple is typically the most abundant tree in the open canopy of these swamps. Black ash (*Fraxinus nigra*) is commonly a co-dominant tree species and is highly characteristic of the community type. Other trees commonly present include yellow birch (*Betula alleghaniensis*), American elm (*Ulmus americana*), hemlock (*Tsuga canadensis*), and white pine (*Pinus strobus*). Swamp white oak (*Quercus bicolor*) occurs in some swamps in the Champlain Valley. Typical shrubs include winterberry (*Ilex verticillata*), dwarf raspberry (*Rubus pubescens*), northern arrowwood (*Viburnum dentatum*), highbush blueberry (*Vaccinium corymbosum*), speckled alder (*Alnus incana*), and in the south and warmer regions, spicebush (*Lindera bezoin*) and poison sumac (*Toxicodendron vernix*). Musclewood (*Carpinus caroliniana*) is an abundant tall shrub to short tree at some swamps. Cinnamon fern (*Osmunda cinnamomea*) is typically the most abundant herbaceous species. Other common species include sensitive fern (*Onoclea sensibilis*), goldthread (*Coptis trifolia*), Canada mayflower (*Maianthemum canadensis*), royal fern (*Osmunda regalis*), marsh fern (*Thelypteris palustris*), and crested fern (*Dryopteris cristata*). Herbaceous species that are present in varying amounts but reflect the mineral enrichment from groundwater seepage include fowl mannagrass (*Glyceria striata*), water avens (*Geum rivale*), delicate-stemmed sedge (*Carex leptalea*), foam flower (*Tiarella cordifolia*), swamp saxifrage (*Saxifraga pennsylvanica*), golden saxifrage (*Chrysosplenium americanum*), naked miterwort (*Mitella nuda*), and spotted touch-me-not (*Impatiens capensis*). The bryophyte species are also indicative of some mineral enrichment: *Thuidium delicatulum*, *Climacium dendroides*, *Rhytidiadelphus triquetrus*, and *Calliergon cordifolium* (in hollows). On the more acidic, raised hummocks *Sphagnum centrale*, *S. palustre*, and the liverwort *Bazzania trilobata* are more likely to be found.

**State Rank:** S4

**Spatial Pattern:** Small to Large Patch

**Minimum Size:** 1 acre

#### **Element Occurrence Separation**

**Separation Barriers:** These swamps are typically associated with ground water discharge and seepage, and in some cases, with rivers or streams. Swamps associated with distinctly different sources of ground water discharge (distinct bedrock or surficial geology features) or with different river or stream systems should be considered separate EOs. Roads also typically constitute a substantial barrier separating EOs.

**Separation Distance – Different Natural/Semi-Natural Communities:** 0.5 mile

**Separation Distance – Cultural Vegetation:** 0.25 mile

**Alternative Separation Procedure:**

**Separation Justification:** Ground water sources and/or rivers may vary considerably in their contribution of water quantity and quality to seepage swamps. Therefore if the sources of water are distinctly different, nearby swamps should be considered separate EOs. Even small roads near or through these wetlands can alter their surface water hydrology and affect their condition.

**Rank Procedure**

Current condition, landscape context, and size are equally weighted (33%). Current condition is of high importance in this and other small patch wetland communities in which a specific set of environmental factors (hydrology, organic soil depth and type, nature of underlying bedrock and mineral soils, and climate) affect species composition. Size is highly variable and is dependent on regional variations in topography.

Calculation: A=4, B=3, C=2, D=1

(Condition rank x 0.33) + (Landscape Context rank x 0.33) + (Size rank x 0.33) = EO Rank

Element occurrence ranks and their corresponding calculated numeric values:

EO Rank	Numeric Values
A	>3.25 and ≤4.00
B	>2.50 and ≤3.25
C	>1.75 and ≤2.50
D	>1.00 and ≤1.75

**Element Occurrence Rank Factor 1 – Condition**

**A Specifications**

- a) Swamp dominated by a mature forest of red maple and black ash, with lesser amounts of yellow birch and hemlock, with trees generally greater than 150 years old.
- b) Evidence of natural disturbance processes present, such as canopy gaps created by windthrow, standing dead trees, downed trees in all stages of decomposition, and well-developed hummocks and hollows.
- c) Regeneration of characteristic canopy species is not precluded by heavy browsing.
- c) No exotic species present.
- d) No signs of hydrologic alteration by ditching or construction of roads or trails.
- e) Any past selective logging in the swamp has had a minor disturbance on the swamp surface and there appear to be no barriers to full recovery.

**B Specifications**

a) A swamp with many of the above "A" ranked condition characteristics, including characteristic species composition, but selection harvesting resulting in a stand age of 60 to 150 years.

b) Exotic species are present in small numbers and can be controlled with relatively minor effort.

c) Some minor alterations of hydrology at the margins of the swamp from trails or past logging skid trails may be present, but do not affect the majority of the swamp.

#### **C Specifications**

a) Species composition and structure of vegetation has been significantly altered from the expected mature state by logging, hydrologic alterations, or other surface activities in the swamp. Generally a young, even-aged forest with trees 15 to 60 years old.

b) Exotic species are present in large numbers and control will take significant effort.

#### **D Specifications**

a) Swamp hydrology and/or the surface of the swamp has been significantly altered to the point where vegetation composition and structure are very different from reference quality swamps and restoration or recovery is unlikely.

#### **Ranking Specifications Justification**

### **Element Occurrence Rank Factor 2 – Landscape Context**

#### **A Specifications**

Highly connected: area around the EO is largely intact natural vegetation, with species interactions and natural processes occurring across communities. The swamp's surface watershed and ground water recharge area are of primary concern, but in general highly connected conditions occur over >1,000 acre area.

#### **B Specifications**

Moderately connected: area around the EO is moderately intact natural vegetation, with species interactions and natural processes occurring across many communities. The swamp's watershed and surrounding landscape (>1,000 acres) include partially disturbed natural communities, some of it not high quality due to temporary disturbances such as recent logging.

#### **C Specifications**

Moderately fragmented: area around the EO is largely a combination of cultural and natural vegetation with barriers between species interactions and natural processes across communities; EO is surrounded by a mix of fragmented forest, agriculture, and rural development.

#### **D Specifications**

Highly fragmented: area around the EO is entirely, or almost entirely, surrounded by agriculture and urban development. EO is at best buffered on one side by natural communities.

### **Ranking Specifications Justification**

#### **Element Occurrence Rank Factor 3 – Size**

##### **A Specifications**

Very Large (>20 acres)

##### **B Specifications**

Large (>5-20 acres)

##### **C Specifications**

Moderate (2-5 acres)

##### **D Specifications**

Small (<2 acres)

#### **Ranking Specifications Justification**

Red Maple-Black Ash Seepage Swamps occur in all eight Vermont biophysical regions, but vary greatly in size between regions. In the Champlain Valley, there are at least three occurrences greater than 600 acres and one over 900 acres. There are many swamp occurrences greater than 100 acres. In contrast, in the Taconic Mountains and the Northern and Southern Piedmont, all the occurrences are under 100 acres and most are under 10 acres. The geographic distribution of this swamp type is considered much more important than the size.

**Ranking Specifications Date:** March 26, 2014

**Ranking Specifications Authorship:** Eric Sorenson

# Red Maple-Sphagnum Acidic Basin Swamp and Hemlock-Sphagnum Acidic Basin Swamp

## Red Maple-Sphagnum Acidic Basin Swamp

### General Description:

Red Maple-Sphagnum Acidic Basin Swamps occur throughout the state, although no examples are known from the Vermont Valley. These swamps occur in poorly drained basins and generally have deep, peaty organic soils. The mean organic soil depth from 14 swamps sampled was 10.8 feet. These organic soils are permanently saturated. Most swamps are small (mean of 13 acres based on 35 swamps) and occur in small perched basins. Surface watersheds are also small for these swamps, with a mean size of 95 acres for 23 swamps that were evaluated. There are generally no inlet streams and outlet streams are generally seasonal, at best. Some examples of this community type are found in larger wetland basins or associated with streams, but in these cases the Red Maple-Sphagnum Acidic Basin Swamp is above the influence of flooding from the stream. Red Maple-Sphagnum Acidic Basin Swamps are acidic (pH range from 3.7-5.8, 11 samples) and low in dissolved minerals (conductivity mean of 75 $\mu$ S, 9 samples). Although they receive surface water runoff, there is generally no evidence of groundwater seepage at the swamp margins. They have well-developed mossy hummocks and hollows that are also moss covered and generally lack standing water.

The tree canopy is dominated by red maple. Other trees species that are commonly present in lower abundance include yellow birch, hemlock, white pine, and red spruce (*Picea rubens*). The shrub layer of Red Maple-Sphagnum Acidic Basin Swamps is well developed and includes mountain holly, winterberry, highbush blueberry, wild raisin (*Viburnum cassinoides*), black chokeberry (*Photinia melanocarpa*), low sweet blueberry (*Vaccinium angustifolium*), sheep laurel (*Kalmia angustifolia*), swamp dewberry (*Rubus hispidus*), and speckled alder. Herbaceous cover is typically high, with cinnamon fern usually a strong dominant. Other species include three-seeded sedge (*Carex trisperma*), folliculate sedge (*Carex folliculata*), royal fern, marsh fern, northern bugleweed (*Lycopus uniflorus*), and on hummocks, Canada mayflower, wild sarsaparilla, and the boreal herbs goldthread (*Coptis trifolia*), star flower (*Trientalis borealis*), bunchberry (*Cornus canadensis*), and bluebead lily (*Clintonia borealis*). The bryophyte cover is typically near 100 percent across both hummocks and hollows and is strongly dominated by Sphagnum moss. Common hummock species include *Sphagnum centrale*, *Sphagnum magellanicum*, and *Sphagnum palustre*. On low hummocks and moist hollows *Sphagnum angustifolium*, *Sphagnum girgensohnii*, *Sphagnum fimbriatum* are all common. Other bryophytes include *Pleurozium schreberi* and *Bazzania trilobata*.

Basin swamps that are dominated by hemlock are considered Hemlock-Sphagnum Acidic Basin Swamp (see below). Swamps dominated by red spruce and Sphagnum, typically have more mineral enrichment and are considered Red Spruce-Cinnamon Fern Swamp.

**State Rank:** S3

**Spatial Pattern:** Small Patch

**Minimum Size:** 0.125 acres

## Hemlock-Sphagnum Acidic Basin Swamp

### General Description:

Hemlock-Sphagnum Acidic Basin Swamps typically occur in small bedrock basins and are fed by small watersheds. They occur in the Champlain Valley, Taconic Mountains, and Connecticut River valley and are generally at low elevations (mean elevation 752 feet, range 370-1,280 feet, n=5). They generally have deep peat accumulations (mean depth of 12.1 feet, range 0.4-16.0 feet, n=5) of poorly decomposed Sphagnum with common wood pieces. The organic soils are consistently saturated, but there is little standing water in the hollows. Water at or near the peat surface is acidic (pH ranges from 4.1-4.7, mean pH of 4.3, n=4), and receives little mineral enrichment from surface water runoff (mean conductivity of 60  $\mu$ S, range 50-90  $\mu$ S, n=4).

Hemlock (*Tsuga canadensis*) dominates the canopy of these swamps, creating a densely-shaded forest floor. Other canopy trees that vary in their abundance include red spruce (*Picea rubens*), red maple (*Acer rubrum*), yellow birch (*Betula alleghaniensis*), and white pine (*Pinus strobus*). Balsam fir (*Abies balsamea*), a northern species associated with more mineral enrichment, is typically lacking from Hemlock-Sphagnum Acidic Basin Swamps. The shrub layers are sparse and generally dominated by hemlock regeneration. Winterberry holly (*Ilex verticillata*) is present in low abundance as a tall shrub and low sweet blueberry (*Vaccinium angustifolium*) is occasional as a short shrub. Cinnamon fern (*Osmunda cinnamomea*) forms dense stands (25 to 60 percent cover) across the hummocks. Three-seeded sedge (*Carex trisperma*) is common. Boreal herbs are scattered across the mossy hummocks and hollows, including goldthread (*Coptis trifolia*), bluebead lily (*Clintonia borealis*), starflower (*Trientalis borealis*), and Canada mayflower (*Maianthemum canadense*). Other herbs include common waterhorehound (*Lycopus uniflorus*), wild sarsaparilla (*Aralia nudicaulis*), and partridge berry (*Mitchella repens*). The bryophyte cover ranges from 50 to 90 percent and is strongly dominated by *Sphagnum* moss, primarily *Sphagnum centrale* and *Sphagnum girgensohnii*. Other bryophytes include *Hypnum imponens*, pincushion moss (*Leucobryum glaucum*), and the liverwort *Bazzania trilobata*. Hemlock-Sphagnum Acidic Basin Swamps have low species richness. The average number of species in five 400 square meter plots was 30, with a range of 20 to 37 species.

Hemlock-Sphagnum Acidic Basin Swamps are similar to Red Maple-Sphagnum Acidic Basin Swamps, with the dominance of canopy species being the primary distinguishing factor. The relationship between these community types needs additional study. Hemlock-Sphagnum Acidic Basin Swamps are easily distinguished from Hemlock-Balsam Fir-Black Ash Seepage Swamps by the lack of seepage indicators in Hemlock-Sphagnum Acidic Basin Swamps and the relatively low species richness in these swamps.

**State Rank:** S2

**Spatial Pattern:** Small Patch

**Minimum Size:** 0.25 acre

### Element Occurrence Separation

**Separation Barriers:** Each swamp is associated with its own small watershed and the hydrologic conditions of that watershed.

**Separation Distance – Different Natural/Semi-Natural Communities:** 0.25 mile



**Separation Distance – Cultural Vegetation:** 0.25 mile

**Alternative Separation Procedure:**

**Separation Justification:** These small swamps are very dependant on the soil and hydrologic conditions of individual watersheds. Adjacent swamps in separate watersheds may have very different characteristics and should typically be considered separate EOs.

**Rank Procedure**

Current condition, landscape context, and size are equally weighted (33%). Current condition is of high importance in this and other small patch wetland communities in which a specific set of environmental factors (hydrology, organic soil depth and type, nature of underlying bedrock and mineral soils, and climate) affect species composition. Size is variable and is dependent on regional variations in topography, but all examples of these community types are small.

Calculation: A=4, B=3, C=2, D=1

(Condition rank x 0.33) + (Landscape Context rank x 0.33) + (Size rank x 0.33) = EO Rank

Element occurrence ranks and their corresponding calculated numeric values:

EO Rank	Numeric Values
A	>3.25 and ≤4.00
B	>2.50 and ≤3.25
C	>1.75 and ≤2.50
D	>1.00 and ≤1.75

**Element Occurrence Rank Factor 1 – Condition**

**A Specifications**

- a) Swamp dominated by a mature forest of characteristic tree, shrub, and herb species. Trees generally greater than 150 years old.
  
- b) Evidence of natural disturbance processes present, such as canopy gaps created by windthrow, standing dead trees, downed trees in all stages of decomposition, and well-developed hummocks and hollows.
  
- c) Regeneration of characteristic canopy species is not precluded by heavy browsing.
  
- c) No exotic species present.
  
- d) No signs of hydrologic alteration by ditching or construction of roads or trails.
  
- e) Any past selective logging in the swamp has had a minor disturbance on the swamp surface and there appear to be no barriers to full recovery.

### **B Specifications**

- a) A swamp with many of the above "A" ranked condition characteristics, including characteristic species composition, but selection harvesting resulting in a stand age of 60 to 150 years.
- b) Exotic species are present in small numbers and can be controlled with relatively minor effort.
- c) Some minor alterations of hydrology at the margins of the swamp from trails or past logging skid trails may be present, but do not affect the majority of the swamp.

### **C Specifications**

- a) Species composition and structure of vegetation has been significantly altered from the expected mature state by logging, hydrologic alterations, or other surface activities in the swamp. Generally a young, even-aged forest with trees 15 to 60 years old.
- b) Exotic species are present in large numbers and control will take significant effort.

### **D Specifications**

Swamp hydrology and/or the surface of the swamp has been significantly altered to the point where vegetation composition and structure are very different from reference quality swamps and restoration or recovery is unlikely.

### **Ranking Specifications Justification**

## **Element Occurrence Rank Factor 2 – Landscape Context**

### **A Specifications**

Highly connected: area around the EO is largely intact natural vegetation, with species interactions and natural processes occurring across communities. The swamp's watershed is of primary concern, but in general highly connected conditions occur over >1,000 acre area.

### **B Specifications**

Moderately connected: area around the EO is moderately intact natural vegetation, with species interactions and natural processes occurring across many communities. The swamp's watershed and surrounding landscape (>1,000 acres) include partially disturbed natural communities, some of it not high quality due to temporary disturbances such as recent logging.

### **C Specifications**

Moderately fragmented: area around the EO is largely a combination of cultural and natural vegetation with barriers between species interactions and natural processes across communities; EO is surrounded by a mix of fragmented forest, agriculture, and rural development.

### **D Specifications**

Highly fragmented: area around the EO is entirely, or almost entirely, surrounded by agriculture and urban development. EO is at best buffered on one side by natural communities.

**Ranking Specifications Justification**

**Element Occurrence Rank Factor 3 – Size**

**A Specifications**

Very Large (>5 acres)

**B Specifications**

Large (>2-5 acres)

**C Specifications**

Moderate (0.5-2 acres)

**D Specifications**

Small (<0.5 acres)

**Ranking Specifications Justification**

**Ranking Specifications Date:** March 26, 2014

**Ranking Specifications Authorship:** Eric Sorenson

## Red or Silver Maple-Green Ash Swamp

**General Description:** These forested wetlands vary in size from a few acres to over 400 acres. In Vermont, they are restricted to the Champlain Valley, Taconic Mountains, and Vermont Valley. They are associated with the floodplain of Lake Champlain, the floodplains of large rivers like Otter Creek, and more rarely, isolated basins. The common hydrologic conditions of these varied physical settings are a long period of spring flooding and saturated to moist soils for the rest of the growing season. Soils range from deep (>15 feet) organic soils to mineral soils. The most abundant species in the swamp canopy are red maple (*Acer rubrum*), silver maple (*Acer saccharinum*), a hybrid of the two maples, and green ash (*Fraxinus pennsylvanica*). Other tree species that may be present include black ash (*Fraxinus nigra*), swamp white oak (*Quercus rubra*), American and slippery elm (*Ulmus americana* and *U. rubra*), and yellow birch (*Betula alleghaniensis*). Winterberry holly (*Ilex verticillata*) is a common shrub. Typical herbs include royal fern (*Osmunda regalis*), cinnamon fern (*Osmunda cinnamomea*), sensitive fern (*Onoclea sensibilis*), lakeshore sedge (*Carex lacustris*), blue flag (*Iris versicolor*), frondose beggar's ticks (*Bidens frondosa*), hop sedge (*Carex lupulina*), rice cut-grass (*Leersia oryzoides*), water parsnip (*Sium suave*), and false nettle (*Boehmeria cylindrica*). Bryophytes are less abundant than in swamps where there is little spring flooding. Typical species include *Hypnum lindbergii* and *Leptodyctium riparium*.

**State Rank:** S3

**Spatial Pattern:** Large Patch

**Minimum Size:** 1 acre

### Element Occurrence Separation

**Separation Barriers:** Even small roads or driveways that separate the swamp from associated lake or river can alter flooding regime and create a barrier between occurrences.

**Separation Distance – Different Natural/Semi-Natural Communities:** 1 mile

**Separation Distance – Cultural Vegetation:** 0.25 mile

**Alternative Separation Procedure:** For examples occurring in isolated basins in the relatively flat terrain of the Champlain Valley, a more restricted separation distance of 0.5 mile should be used.

**Separation Justification:** Non-contiguous examples of this swamp type that are associated with the same river or lake should usually be considered the same occurrence if there are no road barriers that alter hydrology and if they are within the specified separation distance.

### Rank Procedure

Current condition, landscape context, and size are equally weighted (33%). Current condition is of high importance in this and other small patch wetland communities in which a specific set of environmental factors (hydrology, organic soil depth and type, nature of underlying bedrock and mineral soils, and climate) affect species composition. Size is highly variable and is dependent on regional variations in topography.

Calculation: A=4, B=3, C=2, D=1

(Condition rank x 0.33) + (Landscape Context rank x 0.33) + (Size rank x 0.33) = EO Rank  
 Element occurrence ranks and their corresponding calculated numeric values:

EO Rank	Numeric Values
A	>3.25 and ≤4.00
B	>2.50 and ≤3.25
C	>1.75 and ≤2.50
D	>1.00 and ≤1.75

**Element Occurrence Rank Factor 1 – Condition**

**A Specifications**

- a) Swamp dominated by a mature forest of *Acer rubrum* or *Acer saccharinum* and *Fraxinus pennsylvanicum*, with lesser amounts of *Ulmus americana*, *Fraxinus nigra*, *Quercus bicolor*, and/or *Betula alleghaniensis*, with trees generally greater than 120 years old. There should be no down-weighting of the condition rank in examples where portions of the swamp canopy have been killed by spring flooding and there is little or no evidence of human disturbance.
- b) Evidence of natural disturbance processes present, such as canopy gaps created by windthrow, standing dead trees, downed trees in all stages of decomposition, and well-developed hummocks and hollows. Extensive areas of canopy trees may be killed by especially long duration spring flooding in lakeside examples.
- c) Regeneration of characteristic canopy species is not precluded by heavy browsing.
- c) No exotic species present.
- d) No signs of hydrologic alteration by ditching to drain the wetland or by construction of roads or other barriers that restrict spring flooding or impede natural drainage patterns.
- e) Any past selective logging in the swamp has had a minor disturbance on the swamp surface and there appear to be no barriers to full recovery.

**B Specifications**

- a) A swamp with many of the above "A" ranked condition characteristics, including characteristic species composition, but selection harvesting resulting in a stand age of 60 to 150 years.
- b) Exotic species are present in small numbers and can be controlled with relatively minor effort.
- c) Some minor alterations of hydrology at the margins of the swamp from trails or past logging skid trails may be present, but do not affect the majority of the swamp.

**C Specifications**

a) Species composition and structure of vegetation has been significantly altered from the expected mature state by logging, hydrologic alterations, or other surface activities in the swamp. Generally a young, even-aged forest with trees 15 to 60 years old.

b) Exotic species are present in large numbers and control will take significant effort.

**D Specifications**

a) Swamp hydrology and/or the surface of the swamp has been significantly altered to the point where vegetation composition and structure are very different from reference quality swamps and restoration or recovery is unlikely.

**Ranking Specifications Justification**

**Element Occurrence Rank Factor 2 – Landscape Context**

**A Specifications**

Highly connected: area around the EO is largely intact natural vegetation, with species interactions and natural processes occurring across communities. For river-influenced and isolated basin swamps, the watershed is of primary concern, but in general highly connected conditions occur over >1,000 acre area.

**B Specifications**

Moderately connected: area around the EO is moderately intact natural vegetation, with species interactions and natural processes occurring across many communities. The swamp's watershed and surrounding landscape (>1,000 acres) include partially disturbed natural communities, some of it not high quality due to temporary disturbances such as recent logging.

**C Specifications**

Moderately fragmented: area around the EO is largely a combination of cultural and natural vegetation with barriers between species interactions and natural processes across communities; EO is surrounded by a mix of fragmented forest, agriculture, and rural development.

**D Specifications**

Highly fragmented: area around the EO is entirely, or almost entirely, surrounded by agriculture and urban development. EO is at best buffered on one side by natural communities.

**Ranking Specifications Justification**

**Element Occurrence Rank Factor 3 – Size**

**A Specifications**

Very Large (>50 acres)

**B Specifications**

Large (>20-50 acres)

**C Specifications**

Moderate (10-20 acres)

**D Specifications**

Small (<10 acres)

**Ranking Specifications Justification**

**Ranking Specifications Date:** March 26, 2014

**Ranking Specifications Authorship:** Eric Sorenson

## Calcareous Red Maple-Tamarack Swamp

**General Description:** Forested to woodland swamp associated with calcium-rich ground water seepage. Typically occurring along the margins of streams or in poorly drained depressions where they often form the headwater of streams. Organic soil depths are typically over three feet and surface water pH is greater than 7.2. Associated with calcium-bedrock types, primarily in the Vermont Valley, but also scattered in the Champlain Valley and the Taconic Mountains. Canopy cover is variable, with the most abundant species being red maple (*Acer rubrum*), tamarack (*Larix laricina*), and black ash (*Fraxinus nigra*). Shrubs, herbs, and bryophytes indicative of mineral enrichment and found in fens as well as these swamps include alder-leaved buckthorn (*Rhamnus alnifolia*), shrubby cinquefoil (*Potentilla fruticosa*), yellow sedge (*Carex flava*), inland sedge (*Carex interior*), delicate-stemmed sedge (*Carex leptalea*), water-avens (*Geum rivale*), rough-leaved goldenrod (*Solidago patula*) (in the Vermont Valley), and the mosses *Calliergonella cuspidata*, *Sphagnum warnstorffii*, and *Rhytidiadelphus triquetrus*.

**State Rank:** S2

**Spatial Pattern:** Small Patch

**Minimum Size:** 0.5 acre

### Element Occurrence Separation

**Separation Barriers:** These swamps are typically associated with ground water discharge and seepage, and in some cases, with rivers or streams. Swamps associated with distinctly different sources of ground water discharge (distinct bedrock or surficial geology features) or with different river or stream systems should be considered separate EOs. Two lane roads or larger also typically constitute a substantial barrier separating EOs.

**Separation Distance – Different Natural/Semi-Natural Communities:** 0.5 mile

**Separation Distance – Cultural Vegetation:** 0.25 mile

**Alternative Separation Procedure:**

**Separation Justification:** Ground water sources may vary considerably in their contribution of water quantity and quality to seepage swamps. Therefore if the sources of water are distinctly different, nearby swamps should be considered separate EOs. Even small roads near or through these wetlands can alter their surface water hydrology and affect their condition.

### Rank Procedure

Current condition, landscape context, and size are equally weighted (33%). Current condition is of high importance in this and other small patch wetland communities in which a specific set of environmental factors (hydrology, organic soil depth and type, nature of underlying bedrock and mineral soils, and climate) affect species composition. Size is highly variable and is dependent on regional variations in topography.

Calculation: A=4, B=3, C=2, D=1

(Condition rank x 0.33) + (Landscape Context rank x 0.33) + (Size rank x 0.33) = EO Rank



Element occurrence ranks and their corresponding calculated numeric values:

EO Rank	Numeric Values
A	>3.25 and ≤4.00
B	>2.50 and ≤3.25
C	>1.75 and ≤2.50
D	>1.00 and ≤1.75

### **Element Occurrence Rank Factor 1 – Condition**

#### **A Specifications**

- a) Swamp dominated by a mature forest of *Acer rubrum* and *Fraxinus nigra*, and *Larix laricina*, with trees generally greater than 120 years old. As the successional trends in these swamps are not clearly understood, the age of trees is considered less important than the overall quality of the swamp as judged by lack of human disturbance.
- b) Evidence of natural disturbance processes present, such as canopy gaps created by windthrow, standing dead trees, downed trees in all stages of decomposition, and well-developed hummocks and hollows.
- c) Regeneration of characteristic canopy species is not precluded by heavy browsing.
- c) No exotic species present.
- d) No signs of hydrologic alteration by ditching or construction of roads or trails.
- e) Any past selective logging in the swamp has had a minor disturbance on the swamp surface and there appear to be no barriers to full recovery.

#### **B Specifications**

- a) A swamp with many of the above "A" ranked condition characteristics, including characteristic species composition, but selection harvesting resulting in a stand age of 60 to 150 years.
- b) Exotic species are present in small numbers and can be controlled with relatively minor effort.
- c) Some minor alterations of hydrology at the margins of the swamp from trails or past logging skid trails may be present, but do not affect the majority of the swamp.

#### **C Specifications**

a) Species composition and structure of vegetation has been significantly altered from the expected mature state by logging, hydrologic alterations, or other surface activities in the swamp. Generally a young, even-aged forest with trees 15 to 60 years old.

b) Exotic species are present in large numbers and control will take significant effort.

#### **D Specifications**

a) Swamp hydrology and/or the surface of the swamp has been significantly altered to the point where vegetation composition and structure are very different from reference quality swamps and restoration or recovery is unlikely.

#### **Ranking Specifications Justification**

### **Element Occurrence Rank Factor 2 – Landscape Context**

#### **A Specifications**

Highly connected: area around the EO is largely intact natural vegetation, with species interactions and natural processes occurring across communities. The swamp's surface watershed and ground water recharge area are of primary concern, but in general highly connected conditions occur over >1,000 acre area.

#### **B Specifications**

Moderately connected: area around the EO is moderately intact natural vegetation, with species interactions and natural processes occurring across many communities. The swamp's watershed and surrounding landscape (>1,000 acres) include partially disturbed natural communities, some of it not high quality due to temporary disturbances such as recent logging.

#### **C Specifications**

Moderately fragmented: area around the EO is largely a combination of cultural and natural vegetation with barriers between species interactions and natural processes across communities; EO is surrounded by a mix of fragmented forest, agriculture, and rural development.

#### **D Specifications**

Highly fragmented: area around the EO is entirely, or almost entirely, surrounded by agriculture and urban development. EO is at best buffered on one side by natural communities.

#### **Ranking Specifications Justification**

**Element Occurrence Rank Factor 3 – Size**

**A Specifications**

Very Large (>20 acres)

**B Specifications**

Large (>5-20 acres)

**C Specifications**

Moderate (2-5 acres)

**D Specifications**

Small (<2 acres)

**Ranking Specifications Justification**

**Ranking Specifications Date:** March 26, 2014

**Ranking Specifications Authorship:** Eric Sorenson

## Red Maple-Black Gum Swamp

**General Description:** Red Maple-Black Gum Swamp is a rare community type that is closely related to Red Maple-Sphagnum Acidic Basin Swamps. Red Maple-Black Gum Swamp differs from Red Maple-Sphagnum Acidic Basin Swamp by the abundance of black gum and several other more southern species and its restricted distribution to southern Vermont. Red Maple-Black Gum Swamps occur in small basins that are generally isolated from streams. These swamp basins have very small watersheds. The water table in these wetlands appears to be relatively stable and the deep organic soils (mean depth of 11 feet at six swamps) are saturated throughout the growing season. The surface waters in Red Maple-Black Gum Swamps are acidic (pH range from 3.7-4.9, 5 samples) and low in dissolved minerals (conductivity mean of 55 $\mu$ S, 4 samples), indicating that there is little enrichment of the surface waters through contact with mineral soils. Red Maple-Black Gum Swamps occur primarily in southeastern Vermont, although they are also known much less frequently from the southern Champlain Valley and Vermont Valley. Red Maple-Black Gum Swamps are more common in southern New England, for black gum is at the northern extent of its range in Vermont.

Red maple and black gum co-dominate the canopies of these swamp forests. Black gum may reach very old ages and the deeply fissured bark of these large-diameter trees can be very impressive. Other common trees include yellow birch, red spruce, hemlock, and white pine. Swamps dominated by hemlock mixed with black gum and other hardwoods are considered Hemlock-Hardwood Swamps. Highbush blueberry and winterberry are usually the most abundant shrubs, but mountain holly, wild raisin, sheep laurel, and mountain laurel (*Kalmia latifolia*) are also present in varying amounts. Cinnamon fern is the most abundant herb, with a cover of 15 to 65 percent. Other herbs are generally sparse, including three-seeded sedge, goldthread, Canada mayflower, starflower, partridge berry (*Mitchella repens*), and wild sarsaparilla. The state threatened Virginia chain-fern (*Woodwardia virginica*) and very rare Massachusetts fern (*Thelypteris simulata*) are also associated with these swamps. The well-developed hummocks and hollows are carpeted with sphagnum moss, including *Sphagnum girgensohnii*, *Sphagnum magellanicum*, *Sphagnum centrale*, and *Sphagnum angustifolium*. The liverwort *Bazzania trilobata* occurs on downed, rotting wood and stumps.

**State Rank:** S2

**Spatial Pattern:** Small Patch

**Minimum Size:** 0.125 acres

### Element Occurrence Separation

**Separation Barriers:** Each swamp is associated with its own small watershed and the hydrologic conditions of that watershed.

**Separation Distance – Different Natural/Semi-Natural Communities:** 0.25 mile

**Separation Distance – Cultural Vegetation:** 0.25 mile

**Alternative Separation Procedure:**

**Separation Justification:** These small swamps are very dependant on the soil and hydrologic conditions of individual watersheds. Adjacent swamps in separate watershed may have very different characteristics and should typically be considered separate EOs.

**Rank Procedure**

Current condition, landscape context, and size are equally weighted (33%). Current condition is of high importance in this and other small patch wetland communities in which a specific set of environmental factors (hydrology, organic soil depth and type, nature of underlying bedrock and mineral soils, and climate) affect species composition. Size is variable and is dependent on regional variations in topography, but all examples of this community type are small.

Calculation: A=4, B=3, C=2, D=1

(Condition rank x 0.33) + (Landscape Context rank x 0.33) + (Size rank x 0.33) = EO Rank

Element occurrence ranks and their corresponding calculated numeric values:

EO Rank	Numeric Values
A	>3.25 and ≤4.00
B	>2.50 and ≤3.25
C	>1.75 and ≤2.50
D	>1.00 and ≤1.75

**Element Occurrence Rank Factor 1 – Condition**

**A Specifications**

- a) Swamp dominated by a mature forest of *Acer rubrum*, *Nyssa sylvaticum*, *Tsuga canadensis*, and *Betula alleghaniensis* with trees generally greater than 150 years old.
- b) Evidence of natural disturbance processes present, such as canopy gaps created by windthrow, standing dead trees, downed trees in all stages of decomposition, and well-developed hummocks and hollows.
- c) Regeneration of characteristic canopy species is not precluded by heavy browsing.
- c) No exotic species present.
- d) No signs of hydrologic alteration by ditching or construction of roads or trails.
- e) Any past selective logging in the swamp has had a minor disturbance on the swamp surface and there appear to be no barriers to full recovery.

**B Specifications**

a) A swamp with many of the above "A" ranked condition characteristics, including characteristic species composition, but selection harvesting resulting in a stand age of 60 to 150 years.

b) Exotic species are present in small numbers and can be controlled with relatively minor effort.

c) Some minor alterations of hydrology at the margins of the swamp from trails or past logging skid trails may be present, but do not affect the majority of the swamp.

### **C Specifications**

a) Species composition and structure of vegetation has been significantly altered from the expected mature state by logging, hydrologic alterations, or other surface activities in the swamp. Generally a young, even-aged forest with trees 15 to 60 years old.

b) Exotic species are present in large numbers and control will take significant effort.

### **D Specifications**

a) Swamp hydrology and/or the surface of the swamp has been significantly altered to the point where vegetation composition and structure are very different from reference quality swamps and restoration or recovery is unlikely.

### **Ranking Specifications Justification**

#### **Element Occurrence Rank Factor 2 – Landscape Context**

##### **A Specifications**

Highly connected: area around the EO is largely intact natural vegetation, with species interactions and natural processes occurring across communities. The swamp's watershed is of primary concern, but in general highly connected conditions occur over >1,000 acre area.

##### **B Specifications**

Moderately connected: area around the EO is moderately intact natural vegetation, with species interactions and natural processes occurring across many communities. The swamp's watershed and surrounding landscape (>1,000 acres) include partially disturbed natural communities, some of it not high quality due to temporary disturbances such as recent logging.

##### **C Specifications**

Moderately fragmented: area around the EO is largely a combination of cultural and natural vegetation with barriers between species interactions and natural processes

across communities; EO is surrounded by a mix of fragmented forest, agriculture, and rural development.

**D Specifications**

Highly fragmented: area around the EO is entirely, or almost entirely, surrounded by agriculture and urban development. EO is at best buffered on one side by natural communities.

**Ranking Specifications Justification**

**Element Occurrence Rank Factor 3 – Size**

**A Specifications**

Very Large (>5 acres)

**B Specifications**

Large (>2-5 acres)

**C Specifications**

Moderate (0.5-2 acres)

**D Specifications**

Small (<0.5 acres)

**Ranking Specifications Justification**

**Ranking Specifications Date:** March 26, 2014

**Ranking Specifications Authorship:** Eric Sorenson

## Wet Clayplain Forest and Wet Sand-Over-Clay Forest

**General Description:** Clayplain forest dominated the post-glacial lake and marine plain of the Champlain Valley prior to European settlement. The clayplain forest is best considered an ecosystem, composed of several forest types occurring together of the glacial lacustrine and marine soils of the Champlain Valley. These fertile, stone-free soils have been prized for agricultural uses, and the majority of the clayplain forest has been cleared. Consequently, the clayplain forest natural community types are all rare in Vermont. Only 12 percent of the clay-soil in the southern Champlain Valley currently supports forest, although it is presumed that this area was nearly 100 percent forested prior to European settlement (Lapin, 2003). Two natural community types of the clayplain forest ecosystem are uplands (Mesic Clayplain Forest and Sand-Over-Clay Forest) and two natural community types are wetlands (Wet Clayplain Forest and Wet Sand-Over-Clay Forest). The two wetland types are described here.

### Wet Clayplain Forest

This type typically occurs on broad flats and in low areas of the local landscape where drainage is slow and wetter conditions persist. Wet-mesic clayplain forest is the dominant forest type in the lower lake plain areas, but is also present as smaller patches in other areas of the Champlain Valley. Wet Clayplain Forest typically occurs on Covington, Panton, Kingsbury, and Livingston soils. This wetland forest type occurs as a mosaic with Mesic Clayplain Forest and is typically difficult to map separately due to the fine scale at which these community types are intermingled. The forest canopy is dominated by red maple (*Acer rubrum*), white pine (*Pinus strobus*), shagbark hickory (*Carya ovata*), swamp white oak (*Quercus bicolor*), and bur oak (*Quercus macrocarpa*). Other prominent tree species include hemlock (*Tsuga canadensis*), white oak (*Quercus alba*), basswood (*Tilia americana*), white ash (*Fraxinus americana*), black ash (*Fraxinus nigra*), and green ash (*Fraxinus pennsylvanica*). The understory stratum is co-dominated by hophornbeam, red maple, and musclewood (*Carpinus caroliniana*). Winterberry holly (*Ilex verticillata*) and northern arrowwood (*Viburnum dentatum* var. *lucidulum*) are common shrubs. The most abundant ground cover species are sensitive fern (*Onoclea sensibilis*), barren strawberry (*Waldsteinia fragarioides*), dwarf raspberry (*Rubus pubescens*), graceful sedge (*Carex gracillima*), lady fern, hog-peanut, spotted touch-me-not (*Impatiens capensis*), wild sarsaparilla (*Aralia nudicaulis*), toothed wood fern (*Dryopteris carthusiana*), and woodland sedge. Other high frequency species include swollen sedge (*Carex intumescens*), calico aster (*Aster lateriflorus*), grove sandwort (*Arenaria lateriflora*), wild oats, fowl mannagrass (*Glyceria striata*), Canada mayflower (*Maianthemum canadense*), and northern bugleweed (*Lycopus uniflorus*).

### Wet Sand-Over-Clay Forest

This type also occurs on broad flats in the Champlain Valley, but is usually associated with the sandy deposits along larger rivers. These sandy deposits are of glaciolacustrine or glaciofluvial origin and have a high water table for at least part of the growing season. The soils either have a sandy layer over clay (includes Swanton, Whately, and Enosburg soils) or have deep sand deposits with a high water table (includes Scarboro, Au Gres, Searsport, and Wareham soil). This is a wetland natural community type, although some examples may have no standing water or saturated surface soils at some time during the year. The depth of surface organic layer varies with the hydrology of each site, with sites with permanent saturation having deeper organic layers. On the drier sites, surface organic layers may be only an inch or two thick. The forest canopy is mostly closed and is dominated by either hemlock or red maple. Other trees include green ash, yellow birch (*Betula alleghaniensis*), swamp white oak, and white pine. Black ash may be present, but is typically not abundant. Black gum (*Nyssa sylvatica*) occurs at several of the known examples. Shrubs include winterberry holly, highbush blueberry (*Vaccinium*



*corymbosum*), witch hazel (*Hamamelis virginiana*), musclewood (*Carpinus caroliniana*), and dwarf blackberry. Hummocks are low and poorly developed and hollows may be very large and contain standing water in the spring. Herbaceous cover is less under canopies dominated by hemlock. In the hollows, ferns are common, including cinnamon fern (*Osmunda cinnamomea*), sensitive fern, royal fern (*Osmunda regalis*), and marsh fern (*Thelypteris palustris*). Sedges include long sedge (*Carex folliculata*), common hop sedge (*Carex lupulina*), Tuckerman's sedge (*Carex tuckermanii*), long-hair sedge (*Carex crinita*), and bladder sedge (*Carex intumescens*). Other common herbs include fowl mannagrass, blue flag (*Iris versicolor*), drooping woodreed (*Cinna latifolia*), and spotted water-hemlock (*Cicuta maculata*). The low hummocks support species that cannot withstand the seasonal flooding that occurs in the hollows, including wild sarsaparilla, goldthread (*Coptis trifolia*), Canada mayflower, and bryophytes (*Sphagnum centrale*, *Bazzania trilobata*, and *Leucobryum glaucum*).

**State Rank:** S2

**Spatial Pattern:** These are primarily **small patch** community types based on soil type distribution; however there are several large patches of Wet Clayplain Forest and Wet Sand-Over-Clay Forest soils in Addison and Chittenden Counties. There are no known examples of these community types that remain at the scale of the largest soil patches (1,000 to 4,000 acres).

**Minimum Size for Element Occurrence:** 0.5 acre

#### **Element Occurrence Separation**

**Separation Barriers:** Barriers that would separate one occurrence from another include urban development, agricultural land, and highways that create significant canopy breaks. Judgment on what constitutes a separation barrier should be based on whether the barrier interrupts natural processes between two areas or restricts the movement of animals that are functionally significant to the community. Active agricultural land should typically be considered a separation barrier between clayplain forest fragments. However, intervening agricultural lands between clayplain fragments may not constitute a separation barrier if these agricultural lands are very narrow (less than 300 feet) and specific justification is provided.

**Separation Distance – Different Natural/Semi-Natural Communities:** 0.5 mile

**Separation Distance – Cultural Vegetation:** 0.25 mile

**Alternative Separation Procedure:** none

**Separation Justification:** Most clayplain forest fragments are separated from each other by agricultural land uses and/or country roads. The presence of wooded hedgerows that provide connections between forest patches across agricultural lands for some species should be considered in determining what constitutes an occurrence. Forest patches that are associated with riparian corridors or wetland complexes should typically use the larger (0.5 mile) separation distance. Early-successional shrub or forest patches on clay soils that may not rank as significant Valley Clayplain Forests in their current condition should be weighed heavily for the value they provide as connections between existing forest patches, as well as their potential for restoration. Early successional communities on abandoned agricultural lands should typically be considered cultural vegetation and should use the 0.25 mile separation distance. Forested hedgerows may be considered cultural vegetation and justify using the

0.25 mile separation distance.

**Rank Procedure**

Landscape context, current condition, and size are equally weighted (33%). The current condition of a particular forest fragment may be very important in assessing the viability of that fragment or the potential for restoration. This community type is especially susceptible to invasive exotic shrubs and so current condition is of high importance. Landscape context is important for maintaining animal population connections and natural disturbance regimes. Size is important for minimizing edge effects.

Calculation: A=4, B=3, C=2, D=1

(Condition rank x 0.33) + (Landscape Context rank x 0.33) + (Size rank x 0.33) = EO Rank

Element occurrence ranks and their corresponding calculated numeric values:

EO Rank	Numeric Values
A	>3.25 and ≤4.00
B	>2.50 and ≤3.25
C	>1.75 and ≤2.50
D	>1.00 and ≤1.75

**Element Occurrence Rank Factor 1 – Condition**

**A Specifications**

- a) The forest is dominated by species characteristic of Wet Clayplain Forest or Wet Sand-Over-Clay Forest as described above.
  
- b) The forest is mature and displays many characteristics of an old-growth forest, including a forest structure with all age classes, a multi-story canopy, some old large-diameter trees, and some standing dead trees. Evidence of natural disturbance processes is present, such as canopy gaps created by windthrow, pit and mound formation, and downed trees in all stages of decomposition. Older trees are generally greater than 150 years old.
  
- c) No exotic species present, or, if few are present, they are easily controlled.
  
- d) Any past (>20 years ago) selection harvesting or thinning has resulted in minimal disruption of the understory or ground surface and full recovery is expected.
  
- e) No signs of hydrologic alteration by ditching to drain the wetland or by construction of roads or other barriers.
  
- f) Regeneration of characteristic canopy species is not precluded by heavy browsing.

**B Specifications**

- a) The forest is dominated by characteristic species and with many structural characteristics of a mature forest as described above, but with selection harvesting resulting in stand age of 60 to 150 years old. The forest is generally uneven aged, but may also be even aged.

b) Selection harvesting and thinning has resulted in little disruption of understory vegetation or ground surface over the majority of the EO.

c) Exotic species may be present in low numbers and can be controlled with relatively minor effort.

### **C Specifications**

a) The forest species composition and structure have been significantly altered from the expected mature state by more intensive logging or minor surface alterations (woods roads or grazing). Generally a young, even aged forest (15-60 years).

b) Natural disturbance processes have been largely eliminated by the intensive nature of recent human disturbance.

c) Exotic species may be present in large numbers and their control will take significant effort.

### **D Specifications (Note: any EO with a D-rank Condition is not a state-significant natural community)**

a) The forest species composition and structure has been significantly altered from reference condition by past agricultural clearing, intensive logging, or activities that alter the ground surface and water movement (roads, culverts, grading, and grazing). Clayplains dominated by shrubs or pioneer trees on abandoned agricultural land typically lack many of the species found in clayplain forests that were not previously cleared.

b) Exotic species are present in large numbers and long-term successful control is unlikely.

### **Ranking Specifications Justification:**

#### **Element Occurrence Rank Factor 2 – Landscape Context**

##### **A Specifications**

Highly connected: area around the EO is largely intact natural vegetation, with species interactions and natural processes occurring across communities. In general, the condition of the forested natural communities surrounding the EO should be at least equal to the B Specifications for Condition listed for Mesic Clayplain Forest.

##### **B Specifications**

Moderately connected: area around the EO is moderately intact natural vegetation, with species interactions and natural processes occurring across many communities. In general, the condition of the forested natural communities surrounding the EO should be at least equal to the C Specifications for Condition listed for Mesic Clayplain Forest.

##### **C Specifications**

Moderately fragmented: area around the EO is largely a combination of cultural and natural vegetation with barriers between species interactions and processes across communities; EO is surrounded by a mix of fragmented forest, agriculture, and rural development. Forested hedgerows and/or riparian corridors may provide a primary connection between forest fragments.

#### **D Specifications**

Highly fragmented: the EO is entirely, or almost entirely, surrounded by urban development or agriculture. EO is at best buffered on one side by natural communities. Forested hedgerows and riparian corridors may provide the only connection between forest fragments.

#### **Ranking Specifications Justification:**

A-Rank Threshold: Forested landscapes of 1,000 acres or more with natural communities in good condition will buffer Valley Clayplain Forests from most other land uses. For the largest examples (>1,000 acres), a surrounding landscape of 4,000 acres should be used for evaluation (see justification under Northern Hardwood Forest).

C/D-Rank Threshold: Connectivity to other natural community patches is mostly eliminated, precluding most species interactions and movements; landscape-scale natural disturbance is also precluded by surrounding developed land.

### **Element Occurrence Rank Factor 3 – Size**

#### **A Specifications**

Very Large (>100 acres)

#### **B Specifications**

Large (>50-100 acres)

#### **C Specifications**

Moderate (5-50 acres)

#### **D Specifications**

Small (<5 acres)

#### **Ranking Specifications Justification**

A-Rank Threshold: Most Wet Clayplain Forest and Wet Sand-Over-Clay Forest soils occur as contiguous patches of under 100 acres, with only a very few contiguous patches as large as 4,000 acres. There are currently no known Wet Clayplain Forest or Wet Sand-Over-Clay Forest fragments over 100 acres and most fragments are less than 50 acres.

C/D-Rank Threshold: In forest fragments of less than five acres edge effects may dominate.

**Ranking Specifications Date:** March 26, 2014

**Ranking Specifications Authorship:** Eric Sorenson

## Northern White Cedar Swamp types

### Northern White Cedar Swamp

The typical northern white cedar swamp in Vermont is a closed canopy conifer swamp associated with mineral-enriched ground water seepage. These swamps occur in a variety of physical settings, including wetland basins, lakesides, and valley bottoms adjacent to streams. These settings are predominantly in areas with calcareous bedrock or calcareous glacial deposits, although to the north, northern white cedar swamps occur in non-calcareous conditions as well. The organic soil horizons are shallow to moderately deep (0.2 to 5.5 meters) and are primarily well decomposed (sapric) muck, often with wood fragments throughout. The mineral substrate is variable in texture from silts to sandy gravel and bedrock. Surface waters in these ground water fed swamps are circumneutral to slightly acidic (pH ranges from 5.9 to 7.6). Although northern white cedar swamps occur in stream valleys and adjacent to lakes and ponds, seasonal flooding is not characteristic.

The generally closed canopy of northern white cedar swamps creates a dark, cool forest floor. Leaning trees and blowdowns are common in more mature swamps, resulting in well developed hummocks and hollows. Hollows often contain shallow standing water. The low light levels in most northern white cedar swamps result in low abundance of shrubs and herbaceous plants, but these conditions are ideal for mosses and liverworts, which often carpet the ground.

Northern white cedar (*Thuja occidentalis*) clearly dominates the canopy of these swamps, and in some areas cedar may be the only species present. Balsam fir (*Abies balsamea*) is the most common canopy associate and is present in most swamps, occasionally as a co-dominant with cedar. Black ash (*Fraxinus nigra*) and yellow birch (*Betula alleghaniensis*) are frequently present in the canopy, but seldom in abundance. White pine (*Pinus strobus*) and tamarack (*Larix laricina*) occur in low abundance in many swamps, often as taller trees emerging from the cedar-dominated canopy. Other trees that may be present include red spruce (*Picea rubens*), black spruce (*P. mariana*), white spruce (*P. glauca*), red maple (*Acer rubrum*), paper birch (*Betula papyrifera*), and in more southern areas eastern hemlock (*Tsuga canadensis*).

The tall and short shrub layers are generally very sparse, although several species are very characteristic. In most swamps, seedling and sapling regeneration of cedar and balsam fir are the most abundant species, and may form dense thickets in areas where the canopy has been opened by blowdowns and more light reaches the forest floor. Regeneration of other tree species may also be common. The most characteristic shrubs and those present in most swamps are the low, trailing dwarf raspberry (*Rubus pubescens*), Canada honeysuckle (*Lonicera canadensis*), alder-leaved buckthorn (*Rhamnus alnifolia*), Canada yew (*Taxus canadensis*), and mountain maple (*Acer spicatum*). Other shrubs that occur commonly in these swamps include winterberry (*Ilex verticillata*), mountain holly (*Nemopanthis mucronata*), wild raisin (*Viburnum cassinoides*), red-osier dogwood (*Cornus sericea*), and speckled alder (*Alnus incana*).

The herbaceous layer of northern white cedar swamps is also sparse and is typically made up of fine-leaved sedges and low herbs scattered over mossy hummocks and hollows. The typical fine-leaved sedges include three-seeded sedge (*Carex trisperma*), two-seeded sedge (*C. disperma*), delicate-stemmed sedge (*C. leptalea*), and peduncled sedge (*C. pedunculata*). Characteristic low herbs include naked miterwort (*Mitella nuda*), bunchberry (*Cornus canadensis*), goldthread (*Coptis trifolia*), twin-

flower (*Linnaea borealis*), common wood-sorrel (*Oxalis acetosella*), and starflower (*Trientalis borealis*). Other common herbs include bladder sedge (*Carex intumescens*), fowl mannagrass (*Glyceria striata*), cinnamon fern (*Osmunda cinnamomea*), oak fern (*Gymnocarpium dryopteris*), one-sided pyrola (*Pyrola secunda*), dewdrop (*Dalibarda repens*), narrow beech fern (*Phegopteris connectilis*), crested fern (*Dryopteris cristata*), foamflower (*Tiarella cordifolia*), broad-leaved twayblade (*Listera convallarioides*), one-flowered pyrola (*Moneses uniflora*), and creeping snowberry (*Gaultheria hispidula*). Golden saxifrage (*Chrysosplenium americanum*) is frequently present in seepage areas at the margins of the swamps.

Bryophytes thrive in the cool, moist, shaded conditions of cedar swamp interiors and often form nearly complete carpets over the hummocks and the hollows without standing water. Stair-step moss (*Hylocomnium splendens*) is highly characteristic, and is abundant in nearly all swamps. Almost as abundant is shaggy moss (*Rhytidiadelphus triquetrus*). The liverwort *Bazzania trilobata* is very common on dry hummocks and old tree stumps. Other common species include *Sphagnum warnstorffii*, common fern moss (*Thuidium delicatulum*), the leafy liverwort *Trichocolea tomentella*, *Sphagnum squarrosum*, *Sphagnum subtile*, and *Sphagnum centrale*. Species commonly associated with wet hollows include *Calliergon cordifolium*, *Calliergon giganteum*, *Mnium punctatum*, *Rhytidiadelphus squarrosus*, *Amblystegium riparium*, and *Campylium stellatum*.

### **Northern White Cedar Sloping Seepage Forest**

This variant of the typical northern white cedar swamp has been identified only in northeastern and north central Vermont, and only on the calcium-rich Waits River bedrock formation. This swamp type differs physically from the typical northern white cedar swamp in that examples of the type occur on gentle slopes and have shallow (0.1 to 0.6 meter) accumulations of highly decomposed organic soil. They are strongly associated with ground water discharge and seepage, and moving water is often evident below the swamp surface, at least in the spring. Seasonally drier conditions may be responsible for the highly decomposed and shallow nature of the surface organic soil horizon. Hummock and hollow microtopography is poorly developed. The cedar sloping seepage forest often occurs at the sloping edge of the typical cedar swamp, although it also occurs in isolation from other cedar swamp types.

The canopy of these swamps is very dense and is dominated by northern white cedar, with canopy associates similar to the typical cedar swamp type. Yellow birch is more common in the canopy than in other cedar swamp types. Tall and short shrub cover is very sparse, with seedling and sapling regeneration of canopy species, Canada honeysuckle, mountain maple, and dwarf raspberry the most frequently occurring species. Herbaceous cover is somewhat higher than in the typical cedar swamp, but there is lower species richness. The herbaceous species that characterize the cedar seepage forests are species that commonly occur in upland conditions, including evergreen woodfern (*Dryopteris intermedia*), oak fern, narrow beech fern, lady fern (*Athyrium filix-femina*), foamflower, common wood-sorrel, blue-bead lily (*Clintonia borealis*), wild sarsaparilla (*Aralia nudicaulis*), peduncled sedge, and shining clubmoss (*Lycopodium lucidulum*). The fine-leaved sedges (*Carex trisperma*, *C. disperma*, and *C. leptalea*) are absent from many sites, in contrast to their abundance in the typical cedar swamp. Creeping snowberry is also absent. Another striking difference of these sloping seepage cedar forests is the very low cover of bryophytes, and the relatively large percentage of the ground that is bare of vegetation. Shaggy moss is the most abundant species, likely reflecting this species preference for more calcareous habitats. Stair-step moss and the liverwort *Bazzania trilobata* are present in most swamps, but seldom abundant.

### **Boreal Acidic Northern White Cedar Swamp**

This variant of the typical northern white cedar swamp has been identified only from northeastern and north central Vermont. Soils are permanently saturated with generally acidic water, resulting in accumulations of moderately decomposed organic soils ranging from 0.8 to 3.2 meters deep (8 samples). Hummock and hollow microtopography is well developed, but there are few hollows with standing water. This cedar swamp variant often occurs in the deepest portion of a basin with the typical cedar swamp, or in association with other swamp types, such as spruce-fir-tamarack swamp and black spruce swamp.

The boreal and acidic character of this cedar swamp variant is reflected in the vegetation. Northern white cedar is the dominant canopy species, often occurring with balsam fir or black spruce. Typical shrubs include mountain holly, Canada honeysuckle, dwarf raspberry, wild raisin, velvet-leaved blueberry (*Vaccinium myrtilloides*), Labrador tea (*Ledum groenlandicum*), sheep laurel (*Kalmia angustifolia*), alder-leaved buckthorn, and occasionally speckled alder. Typical herbs and low creeping shrubs include three-seeded sedge, creeping snowberry, goldthread, bunchberry, starflower, twin-flower, and dewdrop. Bryophytes often form a complete carpet, with *Sphagnum girgensohnii*, *Sphagnum centrale*, and *Sphagnum angustifolium* the most dominant and characteristic species. Stair-step moss, the liverwort *Bazzania trilobata*, and *Sphagnum warnstorffii* are also common. Shaggy moss is notably absent or in very low abundance in this swamp variant.

**State Rank:** S3

**Spatial Pattern:** Small Patch

**Minimum Size:** 0.5 acre

#### **Element Occurrence Separation**

**Separation Barriers:** These swamps are typically associated with ground water discharge and seepage, and in some cases, with rivers or streams. Swamps associated with distinctly different sources of ground water discharge (distinct bedrock or surficial geology features) or with different river or stream systems should be considered separate EOs. Two lane roads or larger also typically constitute a substantial barrier separating EOs.

**Separation Distance – Different Natural/Semi-Natural Communities:** 0.5 mile

**Separation Distance – Cultural Vegetation:** 0.25 mile

**Alternative Separation Procedure:**

**Separation Justification:** Ground water sources may vary considerably in their contribution of water quantity and quality to seepage swamps. Therefore if the sources of water are distinctly different, nearby swamps should be considered separate EOs. Even small roads near or through these wetlands can alter their surface water hydrology and affect their condition.

#### **Rank Procedure**

Current condition, landscape context, and size are equally weighted (33%). Current condition is of high importance in this and other small patch wetland communities in which a specific set of environmental

factors (hydrology, organic soil depth and type, nature of underlying bedrock and mineral soils, and climate) affect species composition. Size is highly variable and is dependent on regional variations in topography.

Calculation: A=4, B=3, C=2, D=1

(Condition rank x 0.33) + (Landscape Context rank x 0.33) + (Size rank x 0.33) = EO Rank

Element occurrence ranks and their corresponding calculated numeric values:

EO Rank	Numeric Values
A	>3.25 and ≤4.00
B	>2.50 and ≤3.25
C	>1.75 and ≤2.50
D	>1.00 and ≤1.75

**Element Occurrence Rank Factor 1 – Condition**

**A Specifications**

- a) Swamp dominated by a mature forest of *Thuja occidentalis*, with *Abies balsamea* and/or *Fraxinus nigra* and *Picea mariana* (depending on the types) with trees generally greater than 150 years old.
- b) Evidence of natural disturbance processes present, such as canopy gaps created by windthrow, standing dead trees, downed trees in all stages of decomposition, and well-developed hummocks and hollows.
- c) Regeneration of characteristic canopy species is not precluded by heavy browsing.
- c) No exotic species present.
- d) No signs of hydrologic alteration by ditching or construction of roads or trails.
- e) Any past selective logging in the swamp has had a minor disturbance on the swamp surface and there appear to be no barriers to full recovery.

**B Specifications**

- a) A swamp with many of the above "A" ranked condition characteristics, including characteristic species composition, but selection harvesting resulting in a stand age of 60 to 150 years.
- b) Exotic species are present in small numbers and can be controlled with relatively minor effort.
- c) Some minor alterations of hydrology at the margins of the swamp from trails or past logging skid trails may be present, but do not affect the majority of the swamp.

**C Specifications**



a) Species composition and structure of vegetation has been significantly altered from the expected mature state by logging, hydrologic alterations, or other surface activities in the swamp. Generally a young, even-aged forest with trees 15 to 60 years old.

b) Exotic species are present in large numbers and control will take significant effort.

#### **D Specifications**

Swamp hydrology and/or the surface of the swamp have been significantly altered to the point where vegetation composition and structure are very different from reference quality swamps and restoration or recovery is unlikely.

#### **Ranking Specifications Justification**

A-rank: Mature cedar swamps are most likely to contain biological legacies that are not present in younger swamps. Cedar is a long-lived tree and individuals over 150 years old are a good indication of forest maturity, as are well-developed hummocks and moss-covered logs.

C/D-rank: Swamps that are highly disturbed, especially those with hydrologic alterations, are unlikely to recover to former condition.

### **Element Occurrence Rank Factor 2 – Landscape Context**

#### **A Specifications**

Highly connected: area around the EO is largely intact natural vegetation, with species interactions and natural processes occurring across communities. The swamp's surface watershed and ground water recharge area are of primary concern, but in general highly connected conditions occur over >1,000 acre area.

#### **B Specifications**

Moderately connected: area around the EO is moderately intact natural vegetation, with species interactions and natural processes occurring across many communities. The swamp's watershed and surrounding landscape (>1,000 acres) include partially disturbed natural communities, some of it not high quality due to temporary disturbances such as recent logging.

#### **C Specifications**

Moderately fragmented: area around the EO is largely a combination of cultural and natural vegetation with barriers between species interactions and natural processes across communities; EO is surrounded by a mix of fragmented forest, agriculture, and rural development.

#### **D Specifications**

Highly fragmented: area around the EO is entirely, or almost entirely, surrounded by agriculture and urban development. EO is at best buffered on one side by natural communities.

#### **Ranking Specifications Justification**

### **Element Occurrence Rank Factor 3 – Size**

**A Specifications**

Very Large (>60 acres)

**B Specifications**

Large (>25-60 acres)

**C Specifications**

Moderate (5-25 acres)

**D Specifications**

Small (<5 acres)

**Ranking Specifications Justification**

A-rank: 35 percent of the 129 documented occurrences are greater than 60 acres.

C/D-rank: Only 12 percent of the 129 documented state-significant occurrences are less than 10 acres.

**Ranking Specifications Date:** March 26, 2014

**Ranking Specifications Authorship:** Eric Sorenson

## Spruce-Fir-Tamarack Swamp

**General Description:** Spruce-Fir-Tamarack Swamps are one of Vermont's boreal swamp types, occurring in the colder regions of the state. These swamps are typically found in topographic basins that have little surface water movement. They may occur in isolation from other wetland types or as part of wetland complexes, typically with Black Spruce Swamps, Black Spruce Woodland Bogs, and Dwarf Shrub Bogs or Poor Fens. Spruce-Fir-Tamarack Swamps have organic peat soils that are generally saturated throughout the year. For eight swamps sampled, the peat depth ranged from 1.0 to 14.8 feet, with an average depth of 5.7 feet. These swamps are acidic (pH range of 3.7 to 5.0, mean pH of 4.0, n=8), but may receive some mineral enrichment from surface water runoff or from groundwater seepage near the swamp margin (mean conductivity of 56  $\mu$ S, range 30-80  $\mu$ S, n=8).

The interiors of Spruce-Fir-Tamarack Swamps have a distinct structure. The straight, vertical trunks of red spruce (*Picea rubens*), black spruce (*Picea mariana*), balsam fir (*Abies balsamea*), and tamarack (*Larix laricina*) dominate the relatively closed canopy. There is a well-developed tall shrub layer of mountain holly (*Nemopanthus mucronata*) and northern wild raisin (*Viburnum cassinoides*), and a sparse low shrub layer that consistently includes sheep laurel (*Kalmia angustifolia*), and commonly includes Labrador tea (*Ledum groenlandicum*), bog laurel (*Kalmia polifolia*), low sweet blueberry (*Vaccinium angustifolium*), and velvet-leaf blueberry (*Vaccinium myrtilloides*). Cinnamon fern (*Osmunda cinnamomea*) and three-seeded sedge (*Carex trisperma*) are both abundant herbs, along with the suite of boreal herbs in less abundance, including bluebead lily (*Clintonia borealis*), bunchberry (*Cornus canadensis*), goldthread (*Coptis trifolia*), Canada mayflower (*Maianthemum canadense*), starflower (*Trientalis borealis*), and creeping snowberry (*Gaultheria hispidula*). The low hummocks and shallow hollows are carpeted by mosses, including several species of Sphagnum (*Sphagnum girgensohnii*, *S. angustifolium*, *S. fallax*, and *S. magellanicum*), the windswept moss (*Dicranum polysetum*), and the ubiquitous moss of the north, Schreber's moss (*Pleurozium schreberi*). Other species that may be present in varying abundance include the trees red maple (*Acer rubrum*) and yellow birch (*Betula alleghaniensis*); the shrubs black chokeberry (*Aronia melanocarpa*), American mountain ash (*Sorbus americana*), leatherleaf (*Chamaedaphne calyculata*), rhodora (*Rhododendron canadense*), and wintergreen (*Gaultheria procumbens*); and the herbs tussock sedge (*Carex stricta*) and pitcher plant (*Sarracenia purpurea*).

Species richness is relatively low in the acidic, boreal Spruce-Fir-Tamarack Swamps, with an average of only 31 species recorded in eight plots (range of 26-34 species per plot).

Spruce-Fir-Tamarack Swamps have many similarities with Red Spruce-Cinnamon Fern Swamps. A combination of factors is best used to distinguish between these two types. Tamarack is characteristic of Spruce-Fir-Tamarack Swamps, and black spruce is commonly present. Spruce-Fir-Tamarack Swamps typically have more boggy conditions, with Labrador tea, bog laurel, leatherleaf, rhodora, and occasionally pitcher plant. Total cover by Sphagnum moss tends to be higher, with greater abundance of the boggy species *Sphagnum magellanicum* and *Sphagnum capillifolium*. It is unusual to find herbs indicative of mineral enrichment in Spruce-Fir-Tamarack Swamps, although these are more common in Red Spruce-Cinnamon Fern Swamps.

**State Rank:** S3

**Spatial Pattern:** Large Patch

**Minimum Size:** 1 acre

**Element Occurrence Separation**

**Separation Barriers:** Even small roads or driveways that separate areas a swamp can create a barrier between occurrences, as they may alter hydrology.

**Separation Distance – Different Natural/Semi-Natural Communities:** 0.5 mile

**Separation Distance – Cultural Vegetation:** 0.25 mile

**Alternative Separation Procedure:** For swamps that are within the separation distance but occur in different watersheds, a case-by-case assessment is needed to determine if they should be considered separate EOs. A larger separation distance may be appropriate for spruce-fir-tamarack swamps that are in a matrix of similar communities, such as lowland spruce-fir forests and black spruce swamps of the Nulhegan Basin.

**Separation Justification:** Roads can alter surface water movement and affect nearby swamps. Ecological interaction is more likely to occur across related natural communities than across areas in different watersheds or very different upland natural community types.

**Rank Procedure**

Current condition, landscape context, and size are equally weighted (33%). Current condition is of high importance in this and other small patch wetland communities in which a specific set of environmental factors (hydrology, organic soil depth and type, nature of underlying bedrock and mineral soils, and climate) affect species composition. Size is highly variable and is dependent on regional variations in topography.

Calculation: A=4, B=3, C=2, D=1

(Condition rank x 0.33) + (Landscape Context rank x 0.33) + (Size rank x 0.33) = EO Rank

Element occurrence ranks and their corresponding calculated numeric values:

EO Rank	Numeric Values
A	>3.25 and ≤4.00
B	>2.50 and ≤3.25
C	>1.75 and ≤2.50
D	>1.00 and ≤1.75

**Element Occurrence Rank Factor 1 – Condition**

**A Specifications**

- a) Swamp dominated by a mature forest of *Picea rubens* and *Abies balsamea*, with lesser amounts of *Larix laricina*. Trees generally greater than 150 years old.

b) Evidence of natural disturbance processes present, such as canopy gaps created by windthrow, standing dead trees, downed trees in all stages of decomposition, and well-developed hummocks and hollows.

c) Regeneration of characteristic canopy species is not precluded by heavy browsing.

d) No exotic species present.

e) No signs of hydrologic alteration by ditching to drain the wetland or by construction of roads or other barriers.

f) Any past selective logging in the swamp has had a minor disturbance on the swamp surface and there appear to be no barriers to full recovery.

### **B Specifications**

a) A swamp with many of the above "A" ranked condition characteristics, including characteristic species composition, but selection harvesting resulting in a stand age of 60 to 150 years.

b) Exotic species are present in small numbers and can be controlled with relatively minor effort.

c) Some minor alterations of hydrology at the margins of the swamp from trails or past logging skid trails may be present, but do not affect the majority of the swamp.

### **C Specifications**

a) Species composition and structure of vegetation have been significantly altered from the expected mature state by logging, hydrologic alterations, or other surface activities in the swamp. Generally a young, even-aged forest with trees 15 to 60 years old.

b) Exotic species are present in large numbers and control will take significant effort.

### **D Specifications**

Swamp hydrology and/or the surface of the swamp have been significantly altered to the point where vegetation composition and structure are very different from reference quality swamps and restoration or recovery is unlikely.

### **Ranking Specifications Justification**

## **Element Occurrence Rank Factor 2 – Landscape Context**

### **A Specifications**

Highly connected: area around the EO is largely intact natural vegetation, with species interactions and natural processes occurring across communities. For river-influenced and isolated basin swamps, the watershed is of primary concern, but in general highly connected conditions occur over >1,000 acre area.

**B Specifications**

Moderately connected: area around the EO is moderately intact natural vegetation, with species interactions and natural processes occurring across many communities. The swamp's watershed and surrounding landscape (>1,000 acres) include partially disturbed natural communities, some of it not high quality due to temporary disturbances such as recent logging.

**C Specifications**

Moderately fragmented: area around the EO is largely a combination of cultural and natural vegetation with barriers between species interactions and natural processes across communities; EO is surrounded by a mix of fragmented forest, agriculture, and rural development.

**D Specifications**

Highly fragmented: area around the EO is entirely, or almost entirely, surrounded by agriculture and urban development. EO is at best buffered on one side by natural communities.

**Ranking Specifications Justification****Element Occurrence Rank Factor 3 – Size****A Specifications**

Very Large (>100 acres)

**B Specifications**

Large (>25-100 acres)

**C Specifications**

Moderate (5-25 acres)

**D Specifications**

Small (<5 acres)

**Ranking Specifications Justification**

**Ranking Specifications Date:** March 26, 2014

**Ranking Specifications Authorship:** Eric Sorenson

## Red Spruce-Cinnamon Fern Swamp and Black Spruce Swamp

### Red Spruce-Cinnamon Fern Swamp

#### General Description:

These swamps occur in small bedrock and till basins or may be part of large wetland complexes. They have moderate peat accumulations (mean depth of 6.8 feet, range 0.25-15.7 feet, n=15) and are acidic (pH ranges from 3.5 to 5.9, mean pH of 4.1, n=14) and poor in dissolved minerals (conductivity of 20-60 $\mu$ S). They are typically not associated with flow-through streams, although they are more likely to be headwaters to small, seasonal streams. Red Spruce-Cinnamon Fern Swamps are most common on the plateau of the Southern Green Mountains, where they typically occur as part of larger wetland complexes (mean elevation 2,080 feet, range 807-2,660 feet, n=15). They also occur in other portions of the state, except for the coldest basins.

Red Spruce-Cinnamon Fern Swamps are dominated by red spruce (*Picea rubens*), with lesser amounts of balsam fir (*Abies balsamea*) and red maple (*Acer rubrum*). Other trees that may be present in low abundance include yellow birch (*Betula alleghaniensis*), paper birch (*Betula papyrifera*), and white pine (*Pinus strobus*). Total canopy cover is typically about 70 percent. Tamarack (*Larix laricina*) and black spruce (*Picea mariana*), which are characteristic of Spruce-Fir-Tamarack Swamp, are typically absent from Red Spruce-Cinnamon Fern Swamps. The tall shrub layer is well developed and dominated by mountain holly (*Nemopanthus mucronata*) and northern wild raisin (*Viburnum cassinoides*), although common pinkster flower (*Rhododendron prionophyllum*) and winterberry (*Ilex verticillata*) may also be common. Low shrubs include velvet-leaf blueberry (*Vaccinium myrtilloides*), low sweet blueberry (*Vaccinium angustifolium*), sheep laurel (*Kalmia angustifolia*), and black chokeberry (*Aronia melanocarpa*). Creeping snowberry (*Gaultheria hispidula*) and dwarf blackberry (*Rubus pubescens*) are common on hummocks in the swamps. Three-seeded sedge (*Carex trisperma*) and cinnamon fern (*Osmunda cinnamomea*) are the dominant herbs across hummocks and hollows. Other herbs include wild sarsaparilla (*Aralia nudicaulis*), goldthread (*Coptis trifolia*), bluebead lily (*Clintonia borealis*), dewdrop (*Dalibarda repens*), common wood-sorrel (*Oxalis acetosella*), and evergreen woodfern (*Dryopteris intermedia*). There are usually some species present that are indicative of mineral enrichment, such as slender mannagrass (*Glyceria melicaria*), fowl mannagrass (*Glyceria striata*), drooping woodreed (*Cinna latifolia*), or white turtlehead (*Chelone glabra*). Bryophyte cover is typically greater than 80 percent and is dominated by *Sphagnum fallax* and *Sphagnum girgensohnii*, with *Sphagnum angustifolium*, *Sphagnum magellanicum*, *Bazzania trilobata*, and *Pleurozium schreberi*. Red Spruce-Cinnamon Fern Swamps have relatively low species richness, with an average of 38 species recorded in 15 400 meter square plots (range of 25 to 65 species).

**State Rank:** S3

**Spatial Pattern:** Small Patch

**Minimum Size:** 0.5 acre

## **Black Spruce Swamp**

### **General Description:**

Black Spruce Swamps are dark and shady. They occur in the coldest regions of Vermont, commonly in topographic depressions that receive cold air drainage. They occupy large and small basins with impeded surface water movement. This community is often considered transitional between Black Spruce Woodland Bog and Spruce-Fir-Tamarack Swamp, and it may occur in association with either or both of these communities. Black Spruce Swamps typically have deep organic soils (mean depth of 9.0 feet, range of 4.1 to 15.7 feet, n=8) of partially decomposed Sphagnum and wood fragments. This peat is saturated throughout the year, but there is typically little standing water in the hollows. Black Spruce Swamps are one of the most acidic swamp types (mean pH of 3.8, range 3.5-4.5, n=8) and are generally found in areas of the state with acidic bedrock or in basins that have developed peat of sufficient depth to isolate the surface of the swamp from any significant mineral enrichment from ground or surface waters.

Black spruce (*Picea mariana*) dominates the canopy of these swamps. The canopy varies substantially in the degree of closure from swamp to swamp, with the boggy examples having open canopies and the more enriched examples having closed canopies. Tamarack (*Larix laricina*) is commonly mixed in the canopy and may be substantially taller than the black spruce. Other trees that may be present in low abundance are balsam fir (*Abies balsamea*), red maple (*Acer rubrum*), and paper birch (*Betula papyrifera*). Black spruce may also be common in the tall shrub layer, along with northern wild raisin (*Viburnum cassinoides*) and mountain holly (*Nemopanthus mucronata*). Low shrubs can be abundant and include black spruce, velvet-leaf blueberry (*Vaccinium myrtilloides*), Labrador tea (*Ledum groenlandicum*), bog laurel (*Kalmia polifolia*), sheep laurel (*Kalmia angustifolia*), low sweet blueberry (*Vaccinium angustifolium*), black chokeberry (*Aronia melanocarpa*), and rhodora (*Rhododendron canadense*). Creeping snowberry (*Gaultheria hispidula*) is usually abundant on the mossy hummocks. The presence of black huckleberry (*Gaylussacia baccata*) in some swamps may indicate that these swamps have burned in the past. The herb layer is often sparse, with the fine-leaved, three-seeded sedge (*Carex trisperma*) as the most abundant species. Other species include cinnamon fern (*Osmunda cinnamomea*), bunchberry (*Cornus canadensis*), goldthread (*Coptis trifolia*), bluebead lily (*Clintonia borealis*), dewdrop (*Dalibarda repens*), Virginia cotton-grass (*Eriophorum virginicum*), three-leaved Solomon's seal (*Smilacina trifolia*), pitcher plant (*Sarracenia purpurea*), and pink ladyslipper (*Cypripedium acaule*). Mosses form a nearly complete cover over the low hummocks and moist hollows. *Sphagnum angustifolium* and *Sphagnum magellanicum* are typically the most abundant species, with lesser amounts of *Sphagnum girgensohnii*, *S. fallax*, and *S. capillifolium*. Schreber's moss (*Pleurozium schreberi*) is also common and knight's plume (*Ptilium crista-castrensis*) is often present.

There is low species richness in Black Spruce Swamps, with an average of 28 species recorded in plots (range of 26 to 32 species).

**State Rank:** S2

**Spatial Pattern:** Small Patch

**Minimum Size:** 0.5 acre



### **Element Occurrence Separation**

**Separation Barriers:** Even small roads or driveways that separate areas a swamp can create a barrier between occurrences, as they may alter hydrology.

**Separation Distance – Different Natural/Semi-Natural Communities:** 0.5 mile

**Separation Distance – Cultural Vegetation:** 0.25 mile

**Alternative Separation Procedure:** For swamps that are within the separation distance but occur in different watersheds, a case-by-case assessment is needed to determine if they should be considered separate EOs. A larger separation distance may be appropriate for black spruce swamps that are in a matrix of similar communities, such as lowland spruce-fir forests and spruce-fir-tamarack swamps of the Nulhegan Basin. Adjacent swamps in separate watersheds may have very different characteristics and should typically be considered separate EOs.

**Separation Justification:** Roads can alter surface water movement and affect nearby swamps. Ecological interaction is more likely to occur across related natural communities than across areas in different watersheds or very different upland natural community types.

### **Rank Procedure**

Current condition, landscape context, and size are equally weighted (33%). Current condition is of high importance in this and other small patch wetland communities in which a specific set of environmental factors (hydrology, organic soil depth and type, nature of underlying bedrock and mineral soils, and climate) affect species composition. Size is highly variable and is dependent on regional variations in topography.

Calculation: A=4, B=3, C=2, D=1

(Condition rank x 0.33) + (Landscape Context rank x 0.33) + (Size rank x 0.33) = EO Rank

Element occurrence ranks and their corresponding calculated numeric values:

EO Rank	Numeric Values
A	>3.25 and ≤4.00
B	>2.50 and ≤3.25
C	>1.75 and ≤2.50
D	>1.00 and ≤1.75

### **Element Occurrence Rank Factor 1 – Condition**

#### **A Specifications**

- a) Swamp dominated by a mature forest of characteristic tree, shrub, and herb species. Trees generally greater than 150 years old.

b) Evidence of natural disturbance processes present, such as canopy gaps created by windthrow, standing dead trees, downed trees in all stages of decomposition, and well-developed hummocks and hollows.

c) Regeneration of characteristic canopy species is not precluded by heavy browsing.

c) No exotic species present.

d) No signs of hydrologic alteration by ditching to drain the wetland or by construction of roads or other barriers.

e) Any past selective logging in the swamp has had a minor disturbance on the swamp surface and there appear to be no barriers to full recovery.

### **B Specifications**

a) A swamp with many of the above "A" ranked condition characteristics, including characteristic species composition, but selection harvesting resulting in a stand age of 60 to 150 years.

b) Exotic species are present in small numbers and can be controlled with relatively minor effort.

c) Some minor alterations of hydrology at the margins of the swamp from trails or past logging skid trails may be present, but do not affect the majority of the swamp.

### **C Specifications**

a) Species composition and structure of vegetation has been significantly altered from the expected mature state by logging, hydrologic alterations, or other surface activities in the swamp. Generally a young, even-aged forest with trees 15 to 60 years old.

b) Exotic species are present in large numbers and control will take significant effort.

### **D Specifications**

a) Swamp hydrology and/or the surface of the swamp has been significantly altered to the point where vegetation composition and structure are very different from reference quality swamps and restoration or recovery is unlikely.

### **Ranking Specifications Justification**

## **Element Occurrence Rank Factor 2 – Landscape Context**

### **A Specifications**

Highly connected: area around the EO is largely intact natural vegetation, with species interactions and natural processes occurring across communities. For river-influenced

and isolated basin swamps, the watershed is of primary concern, but in general highly connected conditions occur over >1,000 acre area.

**B Specifications**

Moderately connected: area around the EO is moderately intact natural vegetation, with species interactions and natural processes occurring across many communities. The swamp's watershed and surrounding landscape (>1,000 acres) include partially disturbed natural communities, some of it not high quality due to temporary disturbances such as recent logging.

**C Specifications**

Moderately fragmented: area around the EO is largely a combination of cultural and natural vegetation with barriers between species interactions and natural processes across communities; EO is surrounded by a mix of fragmented forest, agriculture, and rural development.

**D Specifications**

Highly fragmented: area around the EO is entirely, or almost entirely, surrounded by agriculture and urban development. EO is at best buffered on one side by natural communities.

**Ranking Specifications Justification**

**Element Occurrence Rank Factor 3 – Size**

**Red Spruce-Cinnamon Fern Swamp**

**A Specifications**

Very Large (>20 acres)

**B Specifications**

Large (>5-20 acres)

**C Specifications**

Moderate (2-5 acres)

**D Specifications**

Small (<2 acres)

**Black Spruce Swamp**

**A Specifications**

Very Large (>25 acres)

**B Specifications**

Large (>5-25 acres)

**C Specifications**

Moderate (2-5 acres)

**D Specifications**

Small (<2 acres)

**Ranking Specifications Justification**

**Ranking Specifications Date:** March 26, 2014

**Ranking Specifications Authorship:** Eric Sorenson

## Hemlock-Balsam Fir-Black Ash Seepage Swamp

### General Description:

Hemlock-Balsam Fir-Black Ash Seepage Swamps are widely distributed in Vermont, but are most common at lower elevations (mean of 898 feet, range 360-1,600 feet, n=19) in areas with bedrock or till that has moderate to high available calcium. The distinctive feature of these swamps is that they receive ground water discharge from seeps or springs and the surface and near surface waters in these swamps therefore have relatively high concentrations of dissolved minerals. It is common to find springs and cool, slowly moving seepage waters at their margins. Because of this constant source of ground water seepage, Hemlock-Balsam Fir-Black Ash Seepage Swamps typically form the headwaters of perennial streams. The water chemistry of these swamps is variable, with pH ranging from 4.8 to 8.2 (mean pH of 5.4, n=15) and conductivity ranging from 10 to 460  $\mu\text{S}$  (mean of 81  $\mu\text{S}$ , n=15). This surface water variability reflects the variability in underlying bedrock and till composition. There is also considerable variability in soils in these seepage swamps, with organic soil depth ranging from zero to 16.0 feet (mean 6.9 feet, n=19).

Hemlock-Balsam Fir-Black Ash Seepage Swamps are rich in species, with an average of 60 species recorded in 19 400 square meter plots (range of 36 to 85 species per plot). Typically, hemlock (*Tsuga canadensis*) and balsam fir (*Abies balsamea*) are co-dominants in the canopy layer of these conifer swamps, but swamps with only hemlock occur in warmer regions and swamps with only balsam fir occur in cooler regions. Black ash (*Fraxinus nigra*) is a characteristic species of seepage swamps and it may approach co-dominance with hemlock and fir. Other canopy species include Yellow birch (*Betula alleghaniensis*), red maple (*Acer rubrum*), red spruce (*Picea rubens*), and white pine (*Pinus strobus*). The shrub layers are generally sparse. Winterberry holly (*Ilex verticillata*) is typically present in low abundance. In cooler settings, mountain holly (*Nemopanthus mucronata*) and velvet-leaf blueberry (*Vaccinium myrtilloides*) may be present. In warmer settings, spicebush (*Lindera benzoin*), highbush blueberry (*Vaccinium corymbosum*), or poison sumac (*Toxicodendron vernix*) may be present. Typical shrubs indicative of the mineral-enriched surface waters include alder-leaved buckthorn (*Rhamnus alnifolia*), red-osier dogwood (*Cornus sericea*), and poison ivy (*Toxicodendron radicans*). Dwarf blackberry (*Rubus pubescens*) is a common low shrub. The herb layer is diverse. Cinnamon fern (*Osmunda cinnamomea*) is dominant in many swamps, but it is the abundance of seepage indicator species that is characteristic of these swamps. These species include water avens (*Geum rivale*), delicate-stemmed sedge (*Carex leptalea*), inland sedge (*Carex interior*), golden saxifrage (*Chrysosplenium americanum*), swamp saxifrage (*Saxifraga pensylvanica*), foam flower (*Tiarella cordifolia*), orange jewelweed (*Impatiens capensis*), and sensitive fern (*Onoclea sensibilis*). Other herbs include three-seeded sedge (*Carex trisperma*), wild sarsaparilla (*Aralia nudicaulis*), goldthread (*Coptis trifolia*), marsh fern (*Thelypteris palustris*), starflower (*Trientalis borealis*), Canada mayflower (*Maianthemum canadense*), bluebead lily (*Clintonia borealis*), and crested wood fern (*Dryopteris cristata*). Bryophyte cover varies from zero to 90 percent in these seepage swamps, with an average of 50 percent cover. Common fern moss (*Thuidium delicatulum*) is one of the most characteristic mosses and may cover up to 35 percent of the moist ground. Other bryophytes that are also indicative of ground water seepage and that may be present include *Rhytidiadelphus triquetrus*, *Hylocomnium splendens*, *Sphagnum squarrosum*, *Sphagnum teres*, *Sphagnum warnstorffii*, and the liverwort *Trichocolea tomentella*. Other bryophytes include *Sphagnum angustifolium*, *Sphagnum centrale*, *Sphagnum palustre*, and *Sphagnum girgensohnii*.

**State Rank:** S4

**Spatial Pattern:** Small Patch

**Minimum Size:** 0.5 acre

**Element Occurrence Separation**

**Separation Barriers:** These swamps are typically associated with ground water discharge and seepage, and in some cases, with rivers or streams. Swamps associated with distinctly different sources of ground water discharge (distinct bedrock or surficial geology features) or with different river or stream systems should be considered separate EOs. Two lane roads or larger also typically constitute a substantial barrier separating EOs.

**Separation Distance – Different Natural/Semi-Natural Communities:** 0.5 mile

**Separation Distance – Cultural Vegetation:** 0.25 mile

**Alternative Separation Procedure:**

**Separation Justification:** Ground water sources may vary considerably in their contribution of water quantity and quality to seepage swamps. Therefore if the sources of water are distinctly different, nearby swamps should be considered separate EOs. Even small roads near or through these wetlands can alter their surface water hydrology and affect their condition.

**Rank Procedure**

Current condition, landscape context, and size are equally weighted (33%). Current condition is of high importance in this and other small patch wetland communities in which a specific set of environmental factors (hydrology, organic soil depth and type, nature of underlying bedrock and mineral soils, and climate) affect species composition. Size is highly variable and is dependent on regional variations in topography.

Calculation: A=4, B=3, C=2, D=1

(Condition rank x 0.33) + (Landscape Context rank x 0.33) + (Size rank x 0.33) = EO Rank

Element occurrence ranks and their corresponding calculated numeric values:

EO Rank	Numeric Values
A	>3.25 and ≤4.00
B	>2.50 and ≤3.25
C	>1.75 and ≤2.50
D	>1.00 and ≤1.75

**Element Occurrence Rank Factor 1 – Condition**

**A Specifications**

- a) Swamp dominated by a mature forest of *Tsuga canadensis*, *Abies balsamea* and *Fraxinus nigra*, with trees generally greater than 150 years old.

- b) Evidence of natural disturbance processes present, such as canopy gaps created by windthrow, standing dead trees, downed trees in all stages of decomposition, and well-developed hummocks and hollows.
- c) Regeneration of characteristic canopy species is not precluded by heavy browsing.
- c) No exotic species present.
- d) No signs of hydrologic alteration by ditching or construction of roads or trails.
- e) Any past selective logging in the swamp has had a minor disturbance on the swamp surface and there appear to be no barriers to full recovery.

### **B Specifications**

- a) A swamp with many of the above "A" ranked condition characteristics, including characteristic species composition, but selection harvesting resulting in a stand age of 60 to 150 years.
- b) Exotic species are present in small numbers and can be controlled with relatively minor effort.
- c) Some minor alterations of hydrology at the margins of the swamp from trails or past logging skid trails may be present, but do not affect the majority of the swamp.

### **C Specifications**

- a) Species composition and structure of vegetation has been significantly altered from the expected mature state by logging, hydrologic alterations, or other surface activities in the swamp. Generally a young, even-aged forest with trees 15 to 60 years old.
- b) Exotic species are present in large numbers and control will take significant effort.

### **D Specifications**

- a) Swamp hydrology and/or the surface of the swamp has been significantly altered to the point where vegetation composition and structure are very different from reference quality swamps and restoration or recovery is unlikely.

### **Ranking Specifications Justification**

#### **Element Occurrence Rank Factor 2 – Landscape Context**

### **A Specifications**

Highly connected: area around the EO is largely intact natural vegetation, with species interactions and natural processes occurring across communities. The swamp's surface

watershed and ground water recharge area are of primary concern, but in general highly connected conditions occur over >1,000 acre area.

### **B Specifications**

Moderately connected: area around the EO is moderately intact natural vegetation, with species interactions and natural processes occurring across many communities. The swamp's watershed and surrounding landscape (>1,000 acres) include partially disturbed natural communities, some of it not high quality due to temporary disturbances such as recent logging.

### **C Specifications**

Moderately fragmented: area around the EO is largely a combination of cultural and natural vegetation with barriers between species interactions and natural processes across communities; EO is surrounded by a mix of fragmented forest, agriculture, and rural development.

### **D Specifications**

Highly fragmented: area around the EO is entirely, or almost entirely, surrounded by agriculture and urban development. EO is at best buffered on one side by natural communities.

### **Ranking Specifications Justification**

#### **Element Occurrence Rank Factor 3 – Size**

##### **A Specifications**

Very Large (>20 acres)

##### **B Specifications**

Large (>5-20 acres)

##### **C Specifications**

Moderate (2-5 acres)

##### **D Specifications**

Small (<2 acres)

### **Ranking Specifications Justification**

**Ranking Specifications Date:** March 26, 2014

**Ranking Specifications Authorship:** Eric Sorenson



## Seep

### **General Description:**

Seeps occur at or near the base of slopes, in coves, and on benches in areas of upland forest. In these topographic settings, it is common to find a sub-surface layer of bedrock or hardpan that impedes the downward movement of groundwater, resulting in horizontal flow and discharge of water at the surface. The local topography and the linear extent of seepage determine the size of individual seeps. It is common to find several locations with groundwater seepage at the upslope end of each seep. Seeps are typically long and narrow with a total area less than one acre.

Trees and shrubs are usually absent from seeps, although most seeps are so narrow that they are well shaded by the overhanging canopy of the adjacent upland forest. Occasional trees may also be found in the seeps themselves, but these usually tip over at a young age as a result of the saturated, unstable ground.

Herbaceous cover can be lush and dense. Characteristic species include rough-stemmed sedge, slender mannagrass, golden saxifrage, swamp saxifrage, water pennywort, and spotted touch-me-not. Other species that may be abundant include sensitive fern, false hellebore, swamp buttercup, and drooping woodreed. Bryophytes may be abundant on areas of soil without flowing water and covering small stones and rotting logs. Moss species typical of this seepy habitat include *Brachythecium rivulare*, *Atrichum undulatum*, *Mnium punctatum*, and common fern moss.

Characteristic amphibians associated with this community are spring salamander, dusky salamander, and northern two-lined salamander, all species that spend their adult lives in or near water.

**State Rank:** S4

**Spatial Pattern:** Small Patch

**Minimum Size:** 0.01 acres

### **Element Occurrence Separation**

**Separation Barriers:** Each seep is associated with its own small watershed and the hydrologic conditions of that watershed.

**Separation Distance – Different Natural/Semi-Natural Communities:** 0.25 mile

**Separation Distance – Cultural Vegetation:** 0.5 mile

**Alternative Separation Procedure:**

**Separation Justification:** Seeps are very dependant on the soil and hydrologic conditions of individual watersheds. Adjacent swamps in separate watershed may have very different characteristics and should typically be considered separate EOs.

### **Rank Procedure**

Current condition, landscape context, and size are equally weighted (33%). Current condition is of high importance in this and other small patch wetland communities in which a specific set of environmental factors (hydrology, organic soil depth and type, nature of underlying bedrock and mineral soils, and climate) affect species composition. Size is variable and is dependent on regional variations in topography, but all examples of this community type are small.

Calculation: A=4, B=3, C=2, D=1

(Condition rank x 0.33) + (Landscape Context rank x 0.33) + (Size rank x 0.33) = EO Rank

Element occurrence ranks and their corresponding calculated numeric values:

EO Rank	Numeric Values
A	>3.25 and ≤4.00
B	>2.50 and ≤3.25
C	>1.75 and ≤2.50
D	>1.00 and ≤1.75

### **Element Occurrence Rank Factor 1 – Condition**

#### **A Specifications**

- a) Seep dominated by characteristic herb and bryophyte species, with sparse trees and shrubs occasionally present. Canopy from the adjacent upland forest typically shading the seep. Adjacent upland forest at least B condition and providing coarse woody debris for the seep.
- b) No invasive exotic species present.
- e) No signs of hydrologic alteration by ditching to drain the wetland or by construction of roads or other barriers up-gradient of the seep.
- f) Any past selective logging in the upland forests adjacent to the seep has had minor disturbances on the seep surface or vegetation and there appear to be no barriers to full recovery.

#### **B Specifications**

- a) A seep with many of the above "A" ranked condition characteristics, but with some minor alterations that have affected species composition, such as nearby trails or recent adjacent logging activity. Adjacent upland forest in at least C condition.
- b) Exotic species are present in small numbers and can be controlled with relatively minor effort.
- c) Some minor alterations of hydrology from nearby trails or past logging skid trails may be present, but have not altered the ground water discharge at the head of the seep or the vegetated portion of the seep.

### **C Specifications**

a) Species composition and structure of vegetation have been altered from the expected mature state by logging, hydrologic alterations, or other surface activities in or adjacent to the seep. Hydrologic alterations and vegetation changes are likely not permanent and recovery of the seep to B condition is likely.

b) Exotic species are present in large numbers and control will take significant effort.

### **D Specifications**

Seep hydrology and/or ground surface have been significantly altered to the point where vegetation composition and structure are very different from reference quality seeps and restoration or recovery is unlikely.

### **Ranking Specifications Justification**

#### **Element Occurrence Rank Factor 2 – Landscape Context**

### **A Specifications**

Highly connected: area around the EO is largely intact natural vegetation, with species interactions and natural processes occurring across communities. The swamp's watershed is of primary concern, but in general highly connected conditions occur over >1,000 acre area.

### **B Specifications**

Moderately connected: area around the EO is moderately intact natural vegetation, with species interactions and natural processes occurring across many communities. The swamp's watershed and surrounding landscape (>1,000 acres) include partially disturbed natural communities, some of it not high quality due to temporary disturbances such as recent logging.

### **C Specifications**

Moderately fragmented: area around the EO is largely a combination of cultural and natural vegetation with barriers between species interactions and natural processes across communities; EO is surrounded by a mix of fragmented forest, agriculture, and rural development.

### **D Specifications**

Highly fragmented: area around the EO is entirely, or almost entirely, surrounded by agriculture and urban development. EO is at best buffered on one side by natural communities.

### **Ranking Specifications Justification**

#### **Element Occurrence Rank Factor 3 – Size**

### **A Specifications**

Very Large ( $\geq 3$  acres)

### **B Specifications**

Large (1-3 acres)

**C Specifications**

Moderate (0.1-1 acres)

**D Specifications**

Small (<0.1 acres)

**Ranking Specifications Justification**

**Ranking Specifications Date:** March 26, 2014

**Ranking Specifications Authorship:** Eric Sorenson

## Vernal Pool

**General Description:** Vernal Pools are small (generally less than one acre), ephemeral pools that occur in natural basins within upland forests. Vernal pools typically have no permanent inlet or outlet streams and have very small watersheds. These temporary pools generally last only a few months and then disappear by the end of summer, although some pools may persist in wet years. During their dry period, vernal pool depressions may be recognized by the sparse vegetation, by stained leaves marked by seasonal high water, and by the soils that have many more wetland characteristics than the surrounding upland soils. The periodic drying means that there are no fish populations in vernal pools, but there is a unique assemblage of species that typically includes amphibians (such as spotted salamanders and woodfrogs), specialized insects (such as caddis flies), molluscs (fingernail clams), and other invertebrates (fairy shrimp). Vernal pools typically lack trees but are shaded by trees growing in the surrounding upland forest. The vegetation that grows in vernal pools is highly variable in composition and abundance, although most pools have only sparse vegetation. Herbaceous species commonly found in vernal pools include sensitive fern (*Onoclea sensibilis*), marsh fern (*Thelypteris palustris*), common water-horehound (*Lycopus uniflorus*), royal fern (*Osmunda regalis*), cinnamon fern (*Osmunda cinnamomea*), mad-dog skullcap (*Scutellaria lateriflora*), rice cutgrass (*Leersia oryzoides*), and bladder sedge (*Carex intumescens*). Buttonbush (*Cephalanthus occidentalis*) may be present in some vernal pools. Unlike most natural communities that are characterized primarily by their vegetation composition, vernal pools are defined by the physical and hydrologic characteristics of the basin and by the animal species associated with the pool, including mole salamanders, wood frogs, and invertebrates.

**State Rank:** S3

**Spatial Pattern:** Small Patch

**Minimum Size:** 200 square feet (smaller pools with high factor ranking may be included with justification)

### Element Occurrence Separation

**Separation Barriers:** Each vernal pool is associated with its own small watershed and the hydrologic conditions of that watershed and should be treated as a separate EO. Barriers between nearby pools that affect amphibian migration may be natural features (river or cliff) or cultural features (roads, walls, or other development) and are addressed under landscape context.

**Separation Distance – Different Natural/Semi-Natural Communities:** Each pool is considered a separate EO, except for adjacent pools that are connected at high water levels or are contained within the same watershed. Pools within 600 feet may be considered part of a pool cluster and ranked accordingly higher under landscape context.

**Separation Distance – Cultural Vegetation:** same as natural vegetation.

**Alternative Separation Procedure:** none

**Separation Justification:** These small pools are very dependent on the soil and hydrologic conditions of individual watersheds. Nearby pools in separate watersheds may have very different characteristics and should be considered separate EOs. However, a cluster of vernal pools within a small area is a positive

feature for amphibian breeding habitat and this factor affects the ranking of individual pools under landscape context.

**Rank Procedure**

Four ranking factors are used for vernal pools. In addition to the standard factors, amphibian breeding habitat is added as a fourth factor. Documented successful amphibian breeding in a pool is closely related to the condition of the pool, its hydrologic period (depth and duration of standing water), and the surrounding landscape context. The Natural Heritage Inventory of Vermont Fish and Wildlife Department has decided to track only those pools that provide successful amphibian breeding, even though other pools provide other important biological functions. Amphibian breeding habitat is the primary factor and is weighted at 40%. The other three factors are all weighted equally at 20%.

Calculation: A=4, B=3, C=2, D=1

(Amphibian breeding rank x 0.4) + (Condition rank x 0.2) + (Landscape Context rank x 0.2) + (Size rank x 0.2) = EO Rank

Element occurrence ranks and their corresponding calculated numeric values:

EO Rank	Numeric Values
A	>3.25 and ≤4.00
B	>2.50 and ≤3.25
C	>1.75 and ≤2.50
D	>1.00 and ≤1.75

**Element Occurrence Rank Factor 1 – Amphibian Breeding**

**A Specifications**

- a) Produces 20 or more mole salamander (spotted, blue-spotted, or Jefferson salamanders) egg masses in one year, **or** produces terrestrial young (metamorphosed juveniles) of mole salamanders in most years; **or**
- b) Supports many breeding wood frogs that produce 50 or more egg masses in one year; **or**
- c) Is used by the state-endangered western chorus frog.

**B Specifications**

- a) Produces 6 to 19 mole salamander egg masses in one year, **or** produces terrestrial young of mole salamanders in some years; **or**
- b) Supports breeding wood frogs that produce 25 to 49 egg masses in one year.

**C Specifications**

- a) Produces 1 to 5 mole salamander egg masses in one year, **or** produces terrestrial young of mole salamanders in occasional years; **or**
- b) Supports breeding wood frogs that produce 1 to 24 egg masses in one year.

### **A/C Specifications**

Presence of mole salamander or wood frog larvae in the pool, or presence of adult mole salamanders or wood frogs congregated for breeding, or presence of fairy shrimp in the pool.

Note: The presence of amphibian larvae or adults indicates breeding but does not equate with number of egg masses or production of terrestrial young, so the rank could be A, B, or C for this factor. Similarly, the presence of fairy shrimp is associated with high quality pools and may be associated with amphibian breeding. Calculate the overall rank using both the A and C Amphibian Breeding rank and use the resulting numeric range to determine the EO Rank (it may be a split rank, AB or BC).

### **D Specifications**

Pool visited during the appropriate season and there is no evidence that the pool produces terrestrial young of mole salamanders or successful breeding of wood frogs. **Note: pools that are D-ranked for amphibian breeding habitat are not considered state-significant by VT Fish and Wildlife Department.**

### **E Specifications**

Pool not assessed during the appropriate season for amphibian breeding so no rank can be assigned to this factor. The pool needs to be re-evaluated before an overall pool rank can be calculated.

### **Ranking Specifications Justification**

#### **Element Occurrence Rank Factor 2 – Condition**

The condition rank of a vernal pool is based primarily on the physical condition within the actual high water boundary of the pool, but since some critical environmental factors occur outside the pool boundary (such as shading from adjacent trees and changes in surface water runoff in the watershed) the condition rank also takes these factors into account.

### **A Specifications**

**All of the following apply:**

- a) No physical disturbance below the high water line of the vernal pool basin, including alteration of the soil profile (ditching or filling) or vehicle trails (skidders, bicycles, ATVs, etc.).
- b) Forest directly adjacent to the pool is mature and undisturbed by logging, with the canopy providing shade and leaf litter for the pool, and naturally fallen trees and branches providing habitat structure in the pool.
- c) The hydrologic regime of the pool has not been altered by physical disturbance of the pool basin, the pool's outlet, or the pool's watershed (roads, trails, or ditches within the pool's watershed may alter water flow to the pool).
- d) Pool vegetation falls within the natural range of variation of reference quality pools for species composition and abundance. An example of non-reference conditions would be abundant shrubs or trees that are flood intolerant and would indicate that the pool has a very short period of flooding, possibly resulting from a hydrologic alteration.

e) No exotic plant species present in the pool.

### **B Specifications**

**At least one of the following apply:**

a) Some physical disturbance below the high water line of the vernal pool basin has occurred, and either this disturbance is minor in its effect on soils and vegetation or the disturbance happened long ago and recovery is nearly complete.

b) There has been selective logging in the adjacent forest, but the canopy still provides shade and leaf litter for the pool, and naturally fallen trees and branches provide habitat structure in the pool.

c) The hydrologic regime of the pool may have been altered by minor physical disturbance of the pool basin, the pool's outlet, or the pool's watershed, but there does not appear to be a significant adverse effect on pool hydrology.

d) Uncharacteristic species may be present but they are in low abundance and do not indicate an altered pool hydrology. Pool vegetation falls within the natural range of variation of reference quality pools for species composition and abundance.

e) Exotic species may be present in small numbers and can be controlled with relatively minor effort.

### **C Specifications**

**At least one of the following apply:**

a) Significant physical disturbance below the high water line of the vernal pool basin has occurred, altering either the soil profile or vegetation.

b) The forest adjacent to the pool has been heavily cut or part of the land adjacent to the pool is agriculture or other developed land uses. The forest canopy provides limited shade and leaf litter for the pool, and there are few naturally fallen trees and branches providing habitat structure in the pool.

c) The hydrologic regime of the pool has been altered by physical disturbance of the pool basin, the pool's outlet, or the pool's watershed, with a significant adverse effect on pool hydrology.

d) Pool vegetation includes uncharacteristic species indicating an altered pool hydrology or substrate.

e) Exotic species may be present in large numbers and can be difficult to control.

### **D Specifications**

**At least one of the following apply:**

a) Ditching, grading, or filling have occurred in the vernal pool basin and have eliminated many of the basin characteristics.

b) The forest adjacent to the pool has been clear-cut or all of the land adjacent to the pool is agriculture or other developed land uses. The forest canopy provides no shade and leaf litter for



the pool, and there are no adjacent trees and branches to provide habitat structure in the pool.

c) The hydrologic regime of the pool has been significantly altered by physical disturbance of the pool basin, the pool's outlet, or the pool's watershed, resulting in either a basin that does not hold water or that is permanently or semi-permanently flooded.

d) Pool vegetation is dominated by uncharacteristic species indicating an altered pool hydrology or substrate.

e) Exotic species may be dominant and control is unlikely.

### **Ranking Specifications Justification**

A- and B-ranked pools are within the natural range of variation of reference quality pools and are expected to provide most pool functions. D-ranked pools are highly degraded and have lost most pool functions.

### **Element Occurrence Rank Factor 3 – Landscape Context**

#### **A Specifications**

a) **Highly connected:** area around the vernal pool is largely intact natural vegetation, with species interactions and natural processes occurring across communities over an area of at least 500 acres. The vernal pool's watershed is of primary concern for water quality and quantity issues, and the 600 foot zone adjacent to the pool is of primary concern for amphibians (see justification below); **and**

b) 0 to 600 feet from pool edge: a mature forest (A-rank forest condition) with closed canopy and abundant downed coarse woody debris and no artificial barriers to amphibian movement.

#### **B Specifications**

a) **Moderately connected:** area around the vernal pool is moderately intact natural vegetation, with species interactions and natural processes occurring across many communities over an area of at least 500 acres; **and**

b) 0 to 600 feet from pool edge: 100% of the area occupied by forest with selection harvesting and retained canopy closure of at least 60%, common downed coarse woody debris, and no woods roads or skid trails that have created ruts that create amphibian breeding sinks; or more than 50% of the area occupied by mature forest (A-rank forest condition) and the remainder in agriculture or other developed condition. No or few other artificial barriers to amphibian movement within the forested area.

Note: If there are one or more additional vernal pools within 600 feet and these pools provide amphibian breeding at the A or B rank level, the Landscape Context rank should be shifted up from a B to an A.

#### **C Specifications**

a) **Moderately fragmented:** area around the vernal pool is largely a combination of cultural and natural vegetation with barriers between species interactions and natural processes across

communities; vernal pool is surrounded by a mix of fragmented forest, agriculture, and rural development; **and**

b) 0 to 600 feet from pool edge: young or disturbed forest present around the vernal pool, occupying 50% or more of this area; this forest provides moderate upland amphibian habitat and there are barriers to amphibian movement such as roads, or other development, or there are deep ruts in woods roads or skid trails that may create amphibian breeding sinks.

Note: If there are one or more additional vernal pools within 600 feet and these pools provide amphibian breeding at the A or B rank level, the Landscape Context rank should be shifted up from a C to a B.

#### **D Specifications**

a) **Highly fragmented:** area around the vernal pool is mostly surrounded by agriculture and/or urban development. Vernal pool is at best buffered on one side by natural communities.

b) 0 to 600 feet from pool edge: there is less than 50% forest, marginal upland amphibian habitat, and there are significant barriers to amphibian movement.

#### **Ranking Specifications Justification**

Semlitsch (1998) estimated that 95% of mole salamanders stayed within 164.3 m (534 feet) of the breeding pool. He termed this terrestrial habitat supporting 95% of the population around the pool a “life zone”. A recent Vermont study found that adult spotted and Jefferson salamanders moved a combined average of 112.8 m (366 feet) from breeding pools, with spotted salamanders (136.8 m; 445 feet) averaging farther than Jefferson salamanders (92.8 m; 302 feet) (Faccio 2001). Both species could migrate over 200 m (650 feet) from breeding pools. Faccio (2001) estimated that 95% of these salamanders stayed within 157.1 m (516 feet) of breeding pools. Females were found to travel significantly farther from pools than males, indicating that “life zones” would need to be larger for females. Combining his data with those for these two species from the Semlitsch (1998) study, Faccio (2001) estimated a “regional salamander life zone” of 175 m (575 feet).

#### **Element Occurrence Rank Factor 4 – Size**

Vernal pool area should be measured based on high water levels.

#### **A Specifications**

Very Large (>5,000 square feet)

#### **B Specifications**

Large (>2,500-5,000 square feet)

#### **C Specifications**

Moderate (400-2,500 square feet)

#### **D Specifications**

Small (<400 square feet)

#### **Ranking Specifications Justification**

There are few vernal pools over one acre in Vermont. Larger pools tend to provide more habitat for amphibian breeding, however size of pool is not necessarily related to depth and duration of flooding. Very small pools are more likely to dry up in the early summer unless they are associated with a seep or other source of water.

**Ranking Specifications Date:** March 26, 2014

**Ranking Specifications Authorship:** Eric Sorenson and Mark Ferguson

## Dwarf Shrub Bog and Poor Fen

### Dwarf Shrub Bog

#### General Description:

Dwarf Shrub Bogs are open peatlands with acidic water (pH of 3.5 to 5.0) that is very low in dissolved minerals and nutrients. Bogs are referred to as being ombrotrophic if they receive water and nutrients only from precipitation. Ombrotrophic bogs have a slightly raised peat surface and a water table that generally remains just below the peat surface but elevated above the local water table of surrounding wetlands or uplands. Dwarf Shrub Bogs which receive little or no mineral enrichments are distinguished from Poor Fens which do receive some mineral enrichment from surface or groundwater. The permanently saturated, acid conditions severely limit decomposition in bogs, resulting in significant accumulation of poorly decomposed Sphagnum peat. Dwarf Shrub Bogs typically have well-developed microtopography, with tall hummocks and moist hollows resulting from differential rates of peat accumulation.

Bogs in Vermont are relatively small (only Maquam Bog and Peacham Bog are greater than 100 acres) and occur in isolated kettlehole basins and as inclusions in larger wetland complexes. Dwarf Shrub Bogs commonly grade into Black Spruce Woodland Bogs, which in turn may grade into Black Spruce Swamps. Dwarf Shrub Bogs may also grade into Poor Fens in areas where there is some seepage of mineral-enriched groundwater. When occurring in basins surrounded by upland forests, Dwarf Shrub Bogs are typically bordered by a narrow, wet, tall shrub-dominated strip known as a lagg zone or moat. Water accumulates in this lagg zone as a result of drainage from the surrounding uplands and the slightly raised surface of the bog. The water in the lagg zone may be stagnant or slowly moving, but it is enriched with dissolved minerals compared to the open bog.

The dominant vegetation of bogs is peat moss of the genus *Sphagnum*, which forms a continuous carpet over hummocks and hollows, and from which other plants grow. Dwarf Shrub Bogs are open peatlands with less than 25 percent cover of tall shrubs or trees. In many cases trees and tall shrubs are nearly absent. Dwarf shrubs are generally common and may form a dense, low woody layer or a more sparse cover. Sedges are also common and grow in both hummocks and hollows.

Many species of Sphagnum typically occur in any one bog, but there are distinct, easily observed patterns to the distribution of these species. One such pattern can be observed in the species zonation that occurs from dry hummock tops to the moist hollow bottoms two to three feet below. The brown-colored *Sphagnum fuscum* dominates hummock tops, with a progression down the hummock sides of *Sphagnum capillifolium*, *Sphagnum magellanicum*, *Sphagnum rubellum*, *Sphagnum angustifolium*, and *Sphagnum fallax*. Shreber's moss (*Pleurozium schreberi*) occurs on many bog hummocks. *Sphagnum cuspidatum* may occur in the wetter hollows with some standing water. The tops of these raised hummocks are ombrotrophic environments, even if the peatland in which they occur are not truly ombrotrophic.

Low heath shrubs dominate the hummocks of many bogs, with common species including leatherleaf (*Chamaedaphne calyculata*), bog laurel (*Kalmia polifolia*), Labrador tea (*Ledum groenlandicum*), and sheep laurel (*Kalmia angustifolia*). Low plants of the hummocks include small cranberry (*Vaccinium oxycoccus*), three-seeded sedge (*Carex trisperma*), few-flowered sedge (*Carex pauciflora*), and hare's tail cottongrass (*Eriophorum vaginatum*). Pitcher plant (*Sarracenia purpurea*) and round-leaved sundew

(*Drosera rotundifolia*) are also common. Sedges and herbs that require minerally enriched groundwater are absent from Dwarf Shrub Bogs (see species for Poor Fen). On hummocks there may be scattered, stunted black spruce and tamarack trees. Lichens may also be common.

**State Rank:** S2

**Spatial Pattern:** Small Patch

**Minimum Size:** 0.25 acre

### **Poor Fen**

#### **General Description:**

In the continuum of peatland types, Poor Fens are closely related to Dwarf Shrub Bogs. They are open peatlands dominated by Sphagnum mosses, sedges, and heath shrubs.

Poor Fens are typically wetter than Dwarf Shrub Bogs and typically have water levels at or just above the surface layer of peat for much of the growing season. Poor Fen waters are acidic (pH of 3.5 to 5.5), but unlike bogs, they are slightly enriched by groundwater seepage. Because they typically occur in areas of acidic to weakly calcareous bedrock, the groundwater seepage delivers a low concentration of dissolved minerals to the fen surface. The effect of this slight mineral enrichment is clearly evident in the vegetation that grows in the moist hollows of Poor Fens. The tall hummocks stand one to three feet above the water in the hollows and may be completely ombrotrophic, receiving water and nutrients entirely from precipitation. Water squeezed from Sphagnum at a hummock top may have a pH near 3.5, whereas water in an adjacent hollow typically has pH ranging from 5.0 to 5.5. The vegetation on these hummocks shows no signs of mineral enrichment.

Poor Fens occur in a variety of physical settings, from small isolated basins to large wetland complexes that may be associated with streams. They generally have deep peat, made up primarily of poorly decomposed Sphagnum and some sedge and woody material. They also occur as floating peat mats, growing out over the open water of small acidic ponds such as kettle hole depressions. Poor Fens commonly occur with Dwarf Shrub Bogs and/or Intermediate Tall Sedge Fens and may grade into either of these community types.

The well-developed hummocks of most Poor Fens are very similar to those found in Dwarf Shrub Bogs. There is a complete cover of Sphagnum, with the typical zonation from hummock top to bottom being *Sphagnum fuscum*, *Sphagnum capillifolium*, *Sphagnum magellanicum*, *Sphagnum rubellum*, *Sphagnum angustifolium*, and *Sphagnum fallax*. A sparse cover of heath shrubs are present on the hummocks, with leatherleaf (*Chamaedaphne calyculata*) and bog rosemary (*Andromeda glaucophylla*) especially common, and lesser amounts of bog laurel (*Kalmia polifolia*), sheep laurel (*Kalmia angustifolia*), and Labrador tea (*Ledum groenlandicum*). Stunted black spruce (*Picea mariana*) and tamarack (*Larix laricina*) are scattered across the widely spaced hummocks. Small cranberry (*Vaccinium oxycoccus*) is a low, creeping, woody plant, as well as the herbaceous three-seeded sedge (*Carex trisperma*), few-flowered sedge (*Carex pauciflora*), hare's tail cottongrass (*Eriophorum vaginatum*), and round-leaved sundew (*Drosera rotundifolia*) are also common on the hummocks.

The hollows in Poor Fens are larger and wetter than in Dwarf Shrub Bogs and typically contain standing water for much of the growing season. Sedges are common in these wet hollows, especially white

beakrush (*Rhynchospora alba*), and hairy-fruited sedge (*Carex lasiocarpa*), and mud sedge (*Carex limosa*). Other species found in the hollows that are indicators of slight mineral enrichment include bog-bean (*Menyanthes trifoliata*), Virginia cottongrass (*Eriophorum virginicum*), spatulate-leaved sundew (*Drosera intermedia*), and large cranberry (*Vaccinium macrocarpon*). The uncommon rose pogonia (*Pogonia ophioglossoides*) and rare pod-grass (*Scheuchzeria palustris*) are both highly characteristic of Poor Fens.

**Variant:** *Sphagnum papillosum*-Sweet Gale Poor Fen Lawn

This moist lawn commonly occurs as distinct patches within larger Poor Fens. *Sphagnum papillosum* forms a carpet, typically scattered with sweet gale, leatherleaf, white beakrush, and large cranberry.

**Variant:** *Sphagnum rubellum*-Small Cranberry Poor Fen Lawn

*Sphagnum rubellum* - *Vaccinium oxycoccos* Nonvascular Vegetation (CEGL006135)

This moist lawn also commonly occurs as distinct patches within larger Poor Fens. *Sphagnum rubellum* forms a carpet, typically scattered with bog rosemary, leatherleaf, white beakrush, and small cranberry.

**State Rank:** S2

**Spatial Pattern:** Small Patch

**Minimum Size:** 0.25 acre

#### **Element Occurrence Separation**

**Separation Barriers:** Even small roads or driveways that separate areas of peatland can create a barrier between occurrences, as they may alter surface and/or ground water hydrology.

**Separation Distance – Different Natural/Semi-Natural Communities:** 0.5 mile

**Separation Distance – Cultural Vegetation:** 0.25 mile

**Alternative Separation Procedure:** For peatlands that are within the separation distance but occur in different watersheds, a case-by-case assessment is needed to determine if they should be considered separate EOs. A larger separation distance may be appropriate for Dwarf Shrub Bogs and Poor Fens that are in a matrix of similar communities, such as Lowland Spruce-Fir Forests or Spruce-Fir-Tamarack Swamps, especially if these examples occur in the same surface or ground watershed.

**Separation Justification:** Roads can alter surface water movement and affect nearby wetlands and peatlands. Ecological interaction is more likely to occur across related natural communities than across areas in different watersheds or very different upland natural community types. Maintaining peatland hydrology and water quality is critical to ecological integrity.

#### **Rank Procedure**

Current condition, landscape context, and size are equally weighted (33%). Current condition is of high importance in this and other small patch wetland communities in which a specific set of environmental factors (hydrology, organic soil depth and type, nature of underlying bedrock and mineral soils, and

climate) affect species composition. Size is highly variable and is dependent on regional variations in topography.

Calculation: A=4, B=3, C=2, D=1

(Condition rank x 0.33) + (Landscape Context rank x 0.33) + (Size rank x 0.33) = EO Rank

Element occurrence ranks and their corresponding calculated numeric values:

EO Rank	Numeric Values
A	>3.25 and ≤4.00
B	>2.50 and ≤3.25
C	>1.75 and ≤2.50
D	>1.00 and ≤1.75

### **Element Occurrence Rank Factor 1 – Condition**

#### **A Specifications**

- a) Peatland dominated by characteristic tree, shrub, herb, and bryophyte species; the characteristic species on the hummocks are typically very different from those in the hollows. Stunted trees vary in age but seldom reach the maximum age for the species due to the saturated peat substrate and nutrient poor conditions.
- b) Peat profiles indicate no significant alteration in peat accumulation rates from historic conditions in the peatland. Differential rates of peat accumulation have led to well-developed hummocks and hollows. If there are human disturbance related anomalies in peat accumulation, the effects of these should be judged based on the changes in characteristic vegetation, hydrology, and nutrient availability.
- d) No exotic species present.
- e) No signs of hydrologic alteration by ditching to drain the wetland or by construction of roads or other barriers.
- f) Any past selective logging in the peatland, adjacent swamp, or upland forests has had minor disturbances on the peatland surface or vegetation and there appear to be no barriers to full recovery.

#### **B Specifications**

- a) A peatland with many of the above "A" ranked condition characteristics, but with some minor alterations that have affected species composition, such as beaver activity on the periphery of the peatland.
- b) Exotic species are present in small numbers and can be controlled with relatively minor effort.

c) Some minor alterations of hydrology at the margins of the peatland or associated wetland from trails or past logging skid trails may be present, but do not affect the majority of the peatland.

### **C Specifications**

a) Species composition and structure of vegetation has been significantly altered from the expected mature state by logging, hydrologic alterations, or other surface activities in the peatland. Beaver activity may result in significant hydrologic alterations – the extent of alteration of water levels in the peatland, resulting changes in species composition, and the duration of flooding should all be evaluated in determining the importance of beaver-influenced peatland alteration. Unlike ditching, draining, or road construction that typically have permanent effects on a peatland, the effects from beaver may be temporary.

b) Exotic species are present in large numbers and control will take significant effort.

### **D Specifications**

a) Peatland hydrology and/or the surface of the peatland has been significantly altered to the point where vegetation composition and structure are very different from reference quality peatlands and restoration or recovery is unlikely.

### **Ranking Specifications Justification**

## **Element Occurrence Rank Factor 2 – Landscape Context**

### **A Specifications**

Highly connected: area around the EO is largely intact natural vegetation, with species interactions and natural processes occurring across communities. For isolated basin swamps and peatlands, the watershed is of primary concern, but in general highly connected conditions occur over >1,000 acre area.

### **B Specifications**

Moderately connected: area around the EO is moderately intact natural vegetation, with species interactions and natural processes occurring across many communities. The peatland's watershed and surrounding landscape (>1,000 acres) include partially disturbed natural communities, some of it not high quality due to temporary disturbances such as recent logging.

### **C Specifications**

Moderately fragmented: area around the EO is largely a combination of cultural and natural vegetation with barriers between species interactions and natural processes across communities; EO is surrounded by a mix of fragmented forest, agriculture, and rural development.

### **D Specifications**



Highly fragmented: area around the EO is entirely, or almost entirely, surrounded by agriculture and urban development. EO is at best buffered on one side by natural communities.

### **Ranking Specifications Justification**

#### **Element Occurrence Rank Factor 3 – Size**

##### **A Specifications**

Very Large (>15acres)

##### **B Specifications**

Large (>5-15 acres)

##### **C Specifications**

Moderate (2-5 acres)

##### **D Specifications**

Small (<2 acres)

### **Ranking Specifications Justification**

**Ranking Specifications Date:** March 26, 2014

**Ranking Specifications Authorship:** Eric Sorenson

## Rich Fen and Intermediate Tall Sedge Fen

### Rich Fen

#### General Description:

Rich Fens typically occur on a gentle slope and have shallow peat accumulations of less than three feet, although in some cases the peat is considerably deeper. Peat tends to be more decomposed than in Intermediate Tall Sedge Fens, but sedge and moss fragments are still recognizable. The peat is saturated throughout the growing season, and there may be small, shallow pools scattered over the generally concave surface of the fen. Areas of groundwater seepage are usually evident at the upslope margins of Rich Fens where there may be small pools or springs adjacent to the sharp transition to upland forest. This seepage water moves slowly across the fen through the upper layers of peat. It is rich in calcium and has pH ranging from 5.8 to 7.4. Rich Fens occur only in areas of calcium or carbonate-rich bedrock.

Rich Fens may occur in isolation from other wetlands or as part of larger wetland complexes. Rich Fens are commonly found in small topographic depressions, with very small watersheds, and typically form the headwater of perennial streams. When occurring in association with Sedge Meadows, calcareous Alder Shrub Swamps, marshes, Northern White Cedar Swamps, or Intermediate Tall Sedge Fens, Rich Fens generally occur on the upslope edge of the wetland complex where the influence of groundwater seepage is strongest. All examples of Rich Fens in Vermont are small, with all documented examples six acres or less.

Beavers are the primary source of natural disturbance in Rich Fens. Given the proper topographic setting at the outlet stream, a beaver can construct a dam that will impound water over an entire fen or a portion of the fen. The long-term effect of this type of disturbance and subsequent dam breaching on fen vegetation needs further study.

Rich Fens are dominated by "brown" mosses (non-Sphagnum mosses) and low sedges and grasses. Low shrub cover varies from sparse or absent in some fens to occasionally dense in other fens. Although less common than in Poor Fens, Rich Fens may also have scattered low to moderate hummocks with species characteristic of bogs.

The bryophyte component of Rich Fens is well developed, with moss cover generally close to 100 percent. Characteristic mosses are *Campyllum stellatum*, *Calliergonella cuspidata*, *Philonotis fontana*, *Bryum pseudotriquetrum*, *Tomenthypnum nitens*, and *Limprichtia revolvens* var. *intermedius*.

The low, herbaceous cover is primarily sedges, with inland sedge (*Carex interior*), porcupine sedge (*Carex hystericina*), yellow sedge (*Carex flava*), and delicate-stemmed sedge (*Carex leptalea*) present in most fens. Other characteristic herbs include Hudson Bay bulrush (*Scirpus hudsonianus*), water avens (*Geum rivale*), green-keeled cottongrass (*Eriophorum viridi-carinatum*), Kalm's lobelia (*Lobelia kalmii*), golden ragwort (*Senecio aureus*), grass of Parnassus (*Parnassia glauca*), single-spike muhlenbergia (*Muhlenbergia glomerata*), slender beakrush (*Eleocharis tenuis*), bog goldenrod (*Solidago uliginosa*), water horsetail (*Equisetum fluviatile*), and round-leaved sundew (*Drosera rotundifolia*). Many other herbaceous plants may be present. Red-osier dogwood (*Cornus sericea*) is a shrub that occurs in most Rich Fens but is seldom very abundant. Shrubby cinquefoil (*Potentilla fruticosa*) and alder-leaved buckthorn (*Rhamnus alnifolia*) are scattered across many Rich Fens and are abundant in patches in others. There are typically scattered, stunted tamaracks (*Larix laricina*).

**State Rank:** S2

**Spatial Pattern:** Small Patch

**Minimum Size:** 0.25 acre

### **Intermediate Tall Sedge Fen**

#### **General Description:**

Intermediate Tall Sedge Fens are open peatlands dominated by tall sedges, non-sphagnum mosses, and a sparse to moderate cover of shrubs. This community is fed by ground or surface water that is moderately enriched with dissolved minerals and has a pH ranging from 5.4 to 7.4. In this regard, this community type is intermediate between Rich Fens and Poor Fens, with which it often occurs. Intermediate Tall Sedge Fens are wet and commonly have water at or slightly above the surface of the peat for most of the growing season.

Intermediate Tall Sedge Fens are commonly found in former lake or pond basins that have been filled by peat deposits. In some examples, a central pond remains and there is a floating peat mat held together by sedge and shrub roots that extend over the alkaline lake or pond water. Fens with floating mats of this type may also be found extending over the very slowly moving water of rivers and streams flowing through peatland complexes. These pioneering mats may be partially supported by flocculent deposits of peat and colloidal lake sediments, all of which give a false impression of structural integrity to the curious but unwary naturalist who may take an ill-fated step onto the mat.

Intermediate Tall Sedge Fens typically have deep peat deposits that range from three feet to over 13 feet. The poorly decomposed peat is generally sedgy, with some moss and wood fragments present. In deeper basins, it is common to find lake sediments underlying the peat, including gyttja, a greenish, gelatinous, organic sediment made up of planktonic algal remains and the feces of lake bottom fauna.

Although there may be occasional tall hummocks in Intermediate Fens that provide habitat for species typical of bogs, the majority of these fens are open and relatively flat. Some have low hummocks and wet hollows. Hairy-fruited sedge (*Carex lasiocarpa*) is the dominant herbaceous plant, and this tall, gracefully bending sedge may be all that is visible when looking across an expanse of fen. However, there are usually many other shorter herbaceous plants present as well. Other characteristic herbs include water sedge (*Carex aquatilis*), twig rush (*Cladium mariscoides*), and bog-bean (*Menyanthes trifoliata*). Shrubby cinquefoil (*Potentilla fruticosa*) is a characteristic shrub and may be abundant in some fens, as may sweet gale (*Myrica gale*). Other vascular plants that vary in their abundance are Hudson Bay bulrush (*Scirpus hudsonianus*), white beakrush (*Rhynchospora alba*), single-spike muhlenbergia (*Muhlenbergia glomerata*), marsh cinquefoil (*Potentilla palustris*), and the shrubs hoary willow (*Salix candida*), and bog rosemary (*Andromeda glaucophylla*). The low, creeping large cranberry (*Vaccinium macrocarpon*) may be present. There are typically scattered, stunted tamaracks (*Larix laricina*).

The bryophytes of Intermediate Tall Sedge Fens are highly characteristic. Bryophytes may form nearly 100 percent cover under the sedge layer in some areas and be sparse in other areas, especially where

there is standing water. Typically mosses include *Campylium stellatum*, *Calliergonella cuspidata*, *Tomenthyphnum nitens*, and *Sphagnum warnstorffii*. The rare moss *Scorpidium scorpioides* is also characteristic of Intermediate Tall Sedge Fen. In portions of Intermediate Tall Sedge Fen that are pioneering mats over alkaline ponds or slowly moving streams, *Sphagnum teres*, *Sphagnum subsecundum*, and *Calliergon stramineum* may all be common. The thallose liverwort *Moerckia hibernica* is a distinct calciphile (a calcium-loving plant) and is commonly found in mineral-rich fens.

**State Rank:** S2

**Spatial Pattern:** Small Patch

**Minimum Size:** 0.25 acre

### **Element Occurrence Separation**

**Separation Barriers:** Even small roads or driveways that separate areas of peatland can create a barrier between occurrences, as they may alter surface and/or ground water hydrology.

**Separation Distance – Different Natural/Semi-Natural Communities:** 0.5 mile

**Separation Distance – Cultural Vegetation:** 0.25 mile

**Alternative Separation Procedure:** For fens that are within the separation distance but occur in different watersheds, a case-by-case assessment is needed to determine if they should be considered separate EOs, but in most cases these should be separate EOs.

**Separation Justification:** Roads can alter surface water movement and affect nearby wetlands and peatlands. Ecological interaction is more likely to occur across related natural communities than across areas in different watersheds or very different upland natural community types. Maintaining peatland hydrology and water quality is critical to ecological integrity. Groundwater hydrology is the primary driving force in most Rich Fens and many Intermediate Tall Sedge Fens. Although groundwater hydrology is difficult to determine, in general, surface watersheds should be assumed to correlate with ground watersheds and fens in different surface watersheds should be considered separate EOs.

### **Rank Procedure**

Current condition, landscape context, and size are equally weighted (33%). Current condition is of high importance in this and other small patch wetland communities in which a specific set of environmental factors (hydrology, organic soil depth and type, nature of underlying bedrock and mineral soils, and climate) affect species composition. Size is highly variable and is dependent on regional variations in topography.

**Calculation:** A=4, B=3, C=2, D=1

$(\text{Condition rank} \times 0.33) + (\text{Landscape Context rank} \times 0.33) + (\text{Size rank} \times 0.33) = \text{EO Rank}$

Element occurrence ranks and their corresponding calculated numeric values:

EO Rank	Numeric Values
A	>3.25 and ≤4.00
B	>2.50 and ≤3.25
C	>1.75 and ≤2.50
D	>1.00 and ≤1.75

**Element Occurrence Rank Factor 1 – Condition**

**A Specifications**

a) Peatland dominated by characteristic tree, shrub, herb, and bryophyte species; the characteristic species on the hummocks are typically very different from those in the hollows. Stunted trees may be present and likely vary in age but seldom reach the maximum age for the species due to the saturated peat substrate.

b) Peat profiles indicate no significant alteration in peat accumulation rates from historic conditions in the peatland. If there are human disturbance related anomalies in peat accumulation, the effects of these should be judged based on the changes in characteristic vegetation, hydrology, and nutrient availability.

d) No exotic species present.

e) No signs of hydrologic alteration by ditching to drain the wetland or by construction of roads or other barriers.

f) Any past selective logging in the peatland, adjacent swamp, or upland forests has had minor disturbances on the peatland surface or vegetation and there appear to be no barriers to full recovery.

**B Specifications**

a) A peatland with many of the above "A" ranked condition characteristics, but with some minor alterations that have affected species composition, such as beaver activity on the periphery of the peatland.

b) Exotic species are present in small numbers and can be controlled with relatively minor effort.

c) Some minor alterations of hydrology at the margins of the peatland or associated wetland from trails or past logging skid trails may be present, but do not affect the majority of the peatland.

**C Specifications**

a) Species composition and structure of vegetation have been significantly altered from the expected mature state by logging, hydrologic alterations, or other surface activities in the peatland. Beaver activity may result in significant hydrologic alterations – the extent of alteration of water levels in the peatland, resulting changes in species composition, and the duration of flooding should all be evaluated. Unlike ditching, draining, or road construction that typically have permanent effects on a peatland, the effects from beaver may be temporary.

b) Exotic species are present in large numbers and control will take significant effort.

**D Specifications**

a) Peatland hydrology and/or the surface of the peatland have been significantly altered to the point where vegetation composition and structure are very different from reference quality peatlands and restoration or recovery is unlikely.

**Ranking Specifications Justification**

**Element Occurrence Rank Factor 2 – Landscape Context**

**A Specifications**

Highly connected: area around the EO is largely intact natural vegetation, with species interactions and natural processes occurring across communities. For fens, the surface and ground watersheds are of primary concern, but in general, highly connected conditions occur over >1,000 acre area.

**B Specifications**

Moderately connected: area around the EO is moderately intact natural vegetation, with species interactions and natural processes occurring across many communities. The fen's watershed and/or surrounding landscape (>1,000 acres) include partially disturbed natural communities, some of it not high quality due to temporary disturbances such as recent logging.

**C Specifications**

Moderately fragmented: area around the EO is largely a combination of cultural and natural vegetation with barriers between species interactions and natural processes across communities; EO is surrounded by a mix of fragmented forest, agriculture, and rural development.

**D Specifications**

Highly fragmented: area around the EO is entirely, or almost entirely, surrounded by agriculture and urban development. EO is at best buffered on one side by natural communities.

**Ranking Specifications Justification**

**Element Occurrence Rank Factor 3 – Size**

**Intermediate Tall Sedge Fen**

**A Specifications**

Very Large (>15acres)

**B Specifications**

Large (>5-15 acres)

**C Specifications**

Moderate (2-5 acres)

**D Specifications**

Small (<2 acres)

**Rich Fen**

**A Specifications**

Very Large (>3 acres)

**B Specifications**

Large (>2-3 acres)

**C Specifications**

Moderate (0.5-2 acres)

**D Specifications**

Small (<0.5 acres)

**Ranking Specifications Justification**

Only five Intermediate Tall Sedge Fens in Vermont are known that are greater than 15 acres. Almost all Rich Fens are very small, many are just openings in other forested swamp communities.

**Ranking Specifications Date:** March 26, 2014

**Ranking Specifications Authorship:** Eric Sorenson