Johnson, Vt.

Natural Resource Inventory

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Tables and Figures

1. Introduction

In 2016, Arrowwood Environmental (AE) was retained by the Johnson Conservation Commission to conduct a natural resources inventory of the town. The purpose of the inventory was to map and assess the natural features of the town in order to inform townspeople, land managers and town officials about the ecological value of these features. This baseline data can be used to guide land management and help to plan for future development in a way that protects significant resources.

Figure 1. Land Cover Patterns in Johnson, Vt.

The scope of the study included the identification, inventory, assessment and ranking of three resource elements: wetlands, upland natural communities, and wildlife habitat and connecting lands. The inventory process involved three phases: 1) remote landscape analysis; 2) field

work and public input; and 3) final ranking and map creation. The methodology used in mapping and assessing these resources is presented in Appendix 1. The results of the inventory are divided into the three resource areas and presented below, starting in Section 3.

2. Natural Resources Elements Overview

2.1. Upland Natural Communities

The town of Johnson contains a wide range of natural communities and habitats, from high elevation forests to lowland marshes. The composition and distribution of these natural features in the town are largely a result of underlying forces of climate, geology, topography and soils. Putting the town into this larger perspective can help us understand these how these natural features developed.

The State of Vermont has been divided up into different biophysical regions based on climate, geologic history, topography, soils and human history. Johnson is located within the Northern Green Mountains biophysical region, which runs from central Vermont to the Canadian border. The dominant natural feature within this region is the spine of the Green Mountains. This region includes some of the highest peaks in the state and is characterized by cool summer temperatures, steep mountain slopes, and granitic bedrock (Thompson and Sorenson, 2000).

In Johnson, this underlying bedrock consist of 4 main bedrock formations: the Ottauquechee, Hazens Notch, Fayston and Jay Peak Formations. All of these consist of metamorphic phyllites, quartzites and schists. These bedrock types typically give rise to soils that are not calcium-rich (sweet) soils. Large enriched communities like the Rich Northern Hardwood Forest are not, therefore found in Johnson, though locally enriched pockets can occur. The surficial geology of Johnson consists of sediments that have been laid down by glacial, riverine and lacustrine forces since the retreat of the last glaciers. These sediments have a significant impact on the development of natural communities. Most of the hilly and mountainous terrain of the town is covered by glacial till. This is the material that was deposited by the glaciers and consists of unsorted sediments. Large forests such as Northern Hardwood Forests, Hemlock-Northern Hardwood Forests and Montane forests are all commonly found on this glacial till. This jumble of rocks and gravel of varying sizes contrasts sharply with the sorted materials present in the low-lying valleys in town. Before the Lamoille and Gihon Rivers were present, much of these valleys were a part of glacial Lake Vermont. This lake left behind areas of well-sorted sandy deposits, which can still be found on the edges of these valleys and are mostly colonized by the Hemlock Forest types. When the lake drained about 12,000 years ago and the rivers developed, some of this sand was washed away to be replaced by alluvial deposits of sands and gravels. These flatter, rock-free areas along the rivers were once home to Floodplain Forests but have mostly been converted to agricultural production.

The soils that have developed from these various geologic processes include loamy sands from the Lake Vermont deposits to silt loams and sandy loams on glacial till. The wide variety of soils that we see today in Johnson have taken thousands of years to develop and are an interplay of

vegetation, substrate and topography. These soils are part of the landscape diversity that give rise to the upland natural communities in the town.

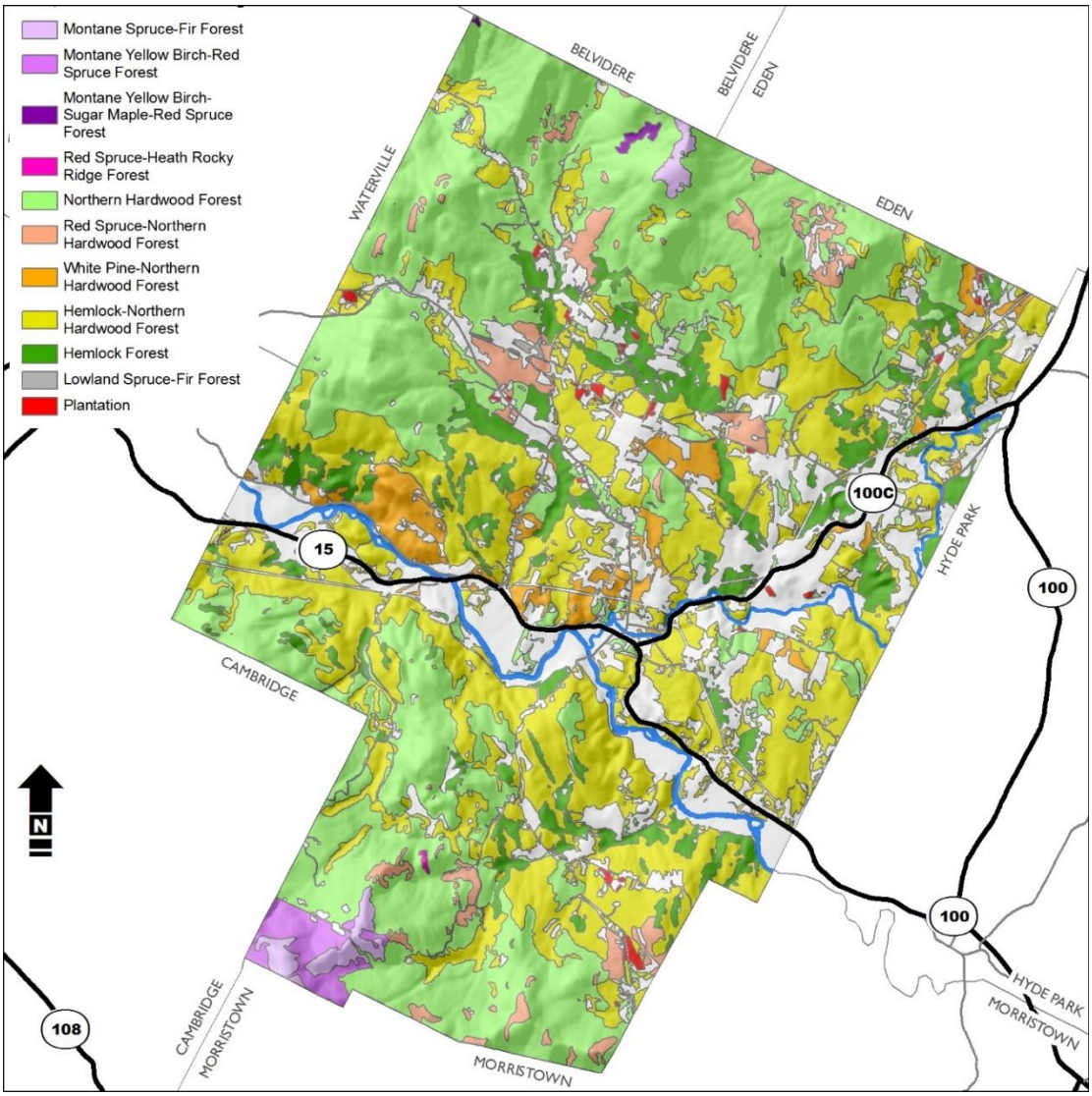

Figure 2. Upland Natural Communities

2.2. Wetland Natural Communities

The town of Johnson sits entirely within the Lamoille River watershed. This means that everything from rain on the highest peak to runoff in the village eventually flows into the Lamoille River and Lake Champlain. The Lamoille and Gihon River valleys are also centerpieces of the town's ecological landscape and home to the town's largest wetlands. The wetland natural communities in Johnson include 18 different natural community types in a wide variety of landscape settings. The type of wetland that develops at a particular location is generally determined by topography, geology, soils and hydrology. Topographically, the Lamoille and Gihon River valleys are surrounded by the more hilly and mountainous terrain of the northern

Green Mountains. The lower river valleys are mostly overlain with well-drained alluvial and glaciolacustrine sands. However, many wetlands have developed associated with these rivers and the pockets of poorly drained soils adjacent to them. These include wetlands such as Floodplain Forests, Shallow Emergent Marshes, Cattail Marshes and Shrub Swamps.

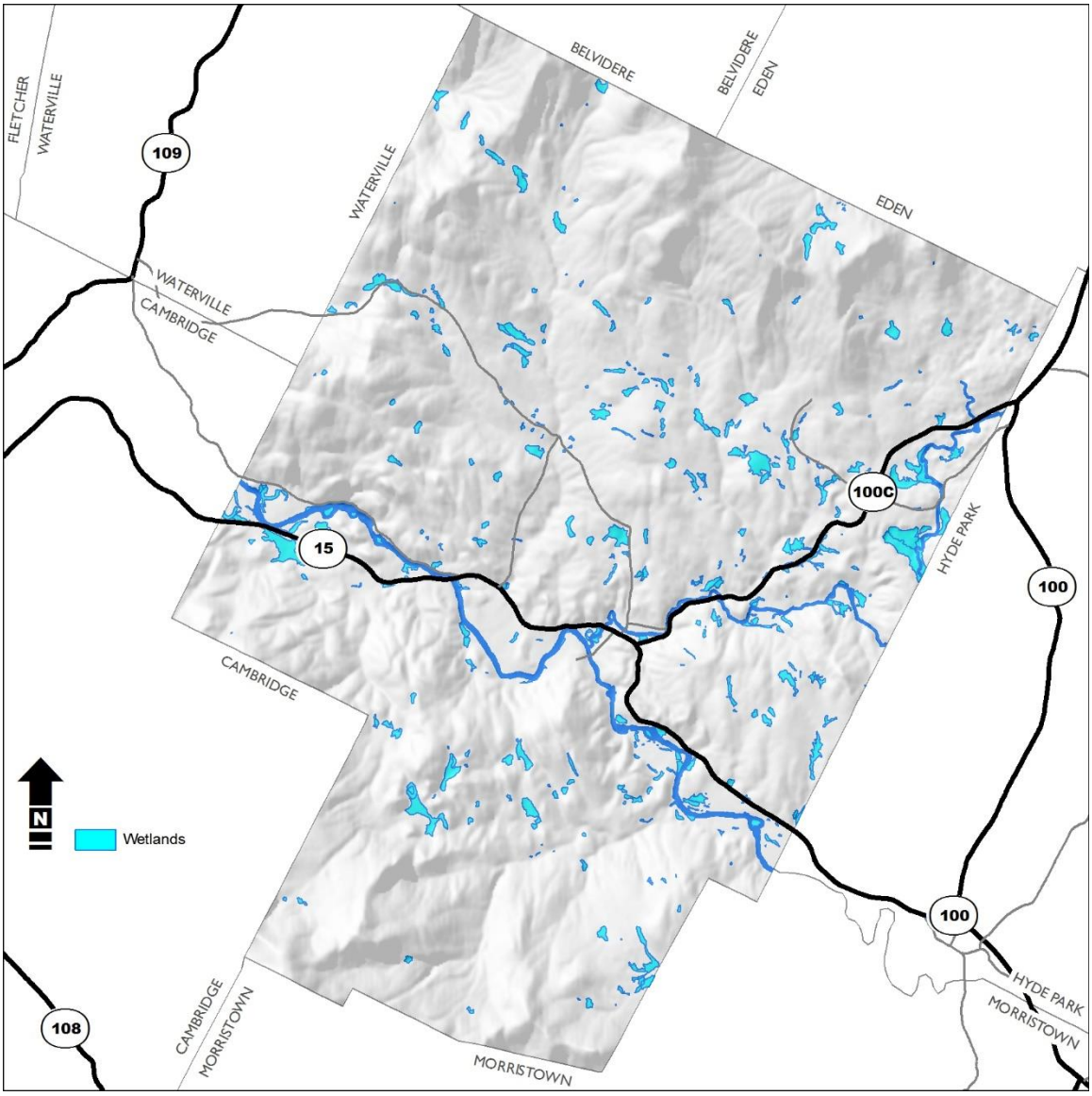

Figure 3. Wetland Natural Communities

The more varied topography above the river valleys, which occupies most of the town, is also conducive to the development of a large number of wetlands. These are mostly associated with headwaters or smaller stream courses and typically form in small areas with flatter topography. Because of the limiting topography, most of these wetlands are smaller in size than the wetlands found in the valley. These wetland types include Seeps, Northern Hardwood Seepage Forests, forested swamps and beaver wetlands. Beaver in particular have played a significant role in the development of wetlands in the town. Many stream courses which cut through the

more hilly and mountainous regions have been colonized by beaver. These industrious animals have created a large number of wetland complexes throughout the town and have added to the wildlife habitat in these areas.

2.3. Wildlife Habitat

The town of Johnson sits at the juncture of two very large forested habitats: the Butternut Mountain area to the north and the Sterling Mountain area to the south. From the high elevation Montane Spruce-Fir Forests to the many beaver wetlands along drainages, the diversity of wildlife habitats and the remote nature of these sites are extremely valuable to the wildlife community in the town. These forested regions comprise some of the largest unfragmented forest blocks in the area and provide habitat to large, wide-ranging mammals such as black bear, fisher, moose, coyote and bobcat. While the wetland areas provide habitat for these species as well as mink, otter, beaver and a wide variety of songbirds and raptors.

Because of the size of these habitat units and their undisturbed nature, wildlife have room to grow, expand, and to export individuals to new locations within the town. This may include movement to areas that contain smaller more fragmented wildlife habitat units, some of which may not support viable populations on their own. Therefore, these large habitat units serve as a "source" for wildlife, a place where the reproduction of wildlife exceeds their mortality. Because of this, wildlife populations grow and young animals can venture out of these areas into the smaller units in Johnson and surrounding areas.

Most of the other wildlife habitats of the town occur at lower elevations along the Lamoille and Gihon Rivers. Though not as large as the two units to the north and south, many are still large enough to provide some core wildlife habitat. In most circumstances, these habitats are located closer to population centers and roads. The western areas likely harbor larger populations of wide-ranging wildlife species such as bear, fisher, and bobcat. Eastern Johnson is more finely divided, although generally only by dirt roads. The well-travelled Route 15 and Route 100C may act as a barrier for many species of wildlife, discouraging individuals from crossing these roads.

The smaller habitats, primarily in eastern and central Johnson, are also important wildlife habitats and range from just over 100 acres to over 800 acres in size. These woodlots and forests form the backyards of many homes and farms and the backdrop for much of the recreational activities that occur in Johnson. These woods line the roads that most people in Johnson travel as they move about the landscape on foot, bike, or in cars and trucks. These smaller habitat units are home to deer, fox, coyote, weasels, hare and rabbit, groundhogs, gray squirrel and many raptors and songbirds. In addition, residents of Johnson also benefit from the larger forest habitats to the north and south when they encounter black bear, moose, fisher or bobcat moving through these areas.

3. Upland Natural Communities

The upland natural communities in Johnson comprise the backbone of the natural environment in the town. The varying geology, soil types, slope, aspect and elevation result in a variety of

different community types. In general, the lower slopes, ridges and ravines are dominated by Hemlock Forests and Hemlock-Northern Hardwood Forests. The ubiquitous Northern Hardwood Forests cover the lower slopes of the Sterling Range in the south, Butternut Mountain in the north and other peaks in the western end of town. As you go up in elevation, the Montane forest types take over from the hardwood forests. These occupy the ridges, steep slopes and summits above 2000 feet in elevation.

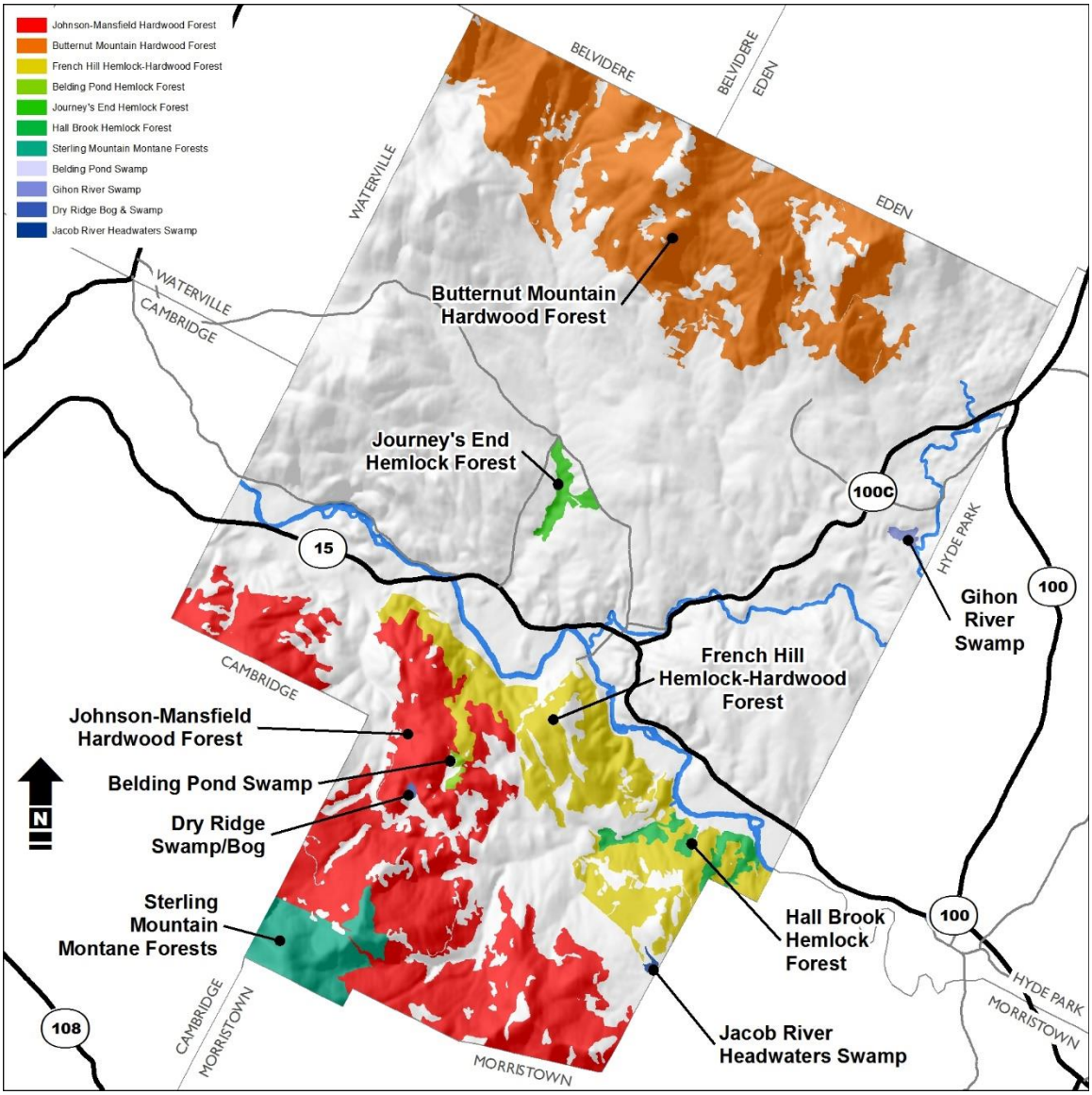

Figure 4 State Significant Natural Communities

A summary of the natural communities found in Johnson is shown in Table 1. As can be seen from this table, Northern Hardwood Forests occupy the most acreage in the town. This is not uncommon; this community is considered a "matrix" natural community type because it occurs in large tracts, often as a background forest. Other forest types occur in small or large patches, depending on the nature of the natural community, typically surrounded by matrix communities.

In Johnson, the Hemlock-Northern Hardwood forest is a close second in terms of total acreage and is by far the most common natural community in the town in terms of number of occurrences. This community type can occur as large patches on the landscape and, as in Johnson, it can occur as a matrix community. The lowers hills and slopes in the town provide excellent habitat for these natural community types.

Table 1. Summary of Upland Natural Communities in Johnson

Natural Community	# of Occurrences	Average Acreage	Total Acreage
Hemlock Forest	98	23.1	2266.3
Hemlock-Northern Hardwood Forest	393	21.3	8363.3
Lowland Spruce-Fir Forest	1	13.0	13.0
Montane Spruce-Fir Forest	6	43.7	262.3
Montane Yellow Birch-Red Spruce Forest	3	94.6	283.7
Montane Yellow Birch-Sugar Maple-Red Spruce Forest	2	15.0	30.1
Northern Hardwood Forest	172	59.1	10168
Plantation	43	2.6	111.3
River Sand or Gravel Shore	10	0.4	4.2
Red Spruce Northern Hardwood Forest	61	13.5	823.7
Red Spruce-Heath Rocky Ridge Forest	1	7.0	7.0
White Pine-Northern Hardwood Forest	53	15.8	836.4
TOTAL	843		23169

3.1. Significant Upland Natural Communities

The Vermont Natural Heritage Inventory (NHI) has developed a methodology for assessing the significance of a particular community on a statewide basis. This methodology assesses three factors of a particular site: the community condition, the size of the community and the landscape context. These factors along with the rarity rank of each type are used to determine the overall rank of the site (called the Element Occurrence or EO Rank). State significant natural communities are tracked by the Vermont NHI and can often be designated as Ecologically Sensitive Treatment Areas (ESTAs) for landowners in the Land Use Value Appraisal (Current Use) program. In some cases, a particular forest may fall just short of the criteria for state significance but may still be locally important. In these cases, the more informal

"Locally Significant" designation is used to bring attention to a natural community on the local level.

Table 2. Significant Upland Natural Communities in Johnson

Site Name	S-Rank (Rarity Rank)	EO-Rank	Acres in Johnson	Significance
French Hill Hemlock-Northern Hardwood Forest	S5	A	1457	State Significant
Butternut Mountain Northern Hardwood Forest	S5	A	3375	State Significant
Johnson-Mansfield Northern Hardwood Forest	S5	A	3362	State Significant
Hall Brook Hemlock Forest	S4	B	160	State Significant
Sterling Mountain Montane Forests*	S3	A	466	State Significant
Belding Pond Hemlock Forest	S4	C	18	Locally Significant
Journey's End Hemlock Forest	S4	C	95	Locally Significant
* The Sterling Mountain Montane Forests were assessed and ranked by the Vermont Natural Heritage Inventory and not visited as part of this project.				

Seven upland communities have been found to be state or locally significant, as summarized in Table 2. The process of determining significance of a natural community requires field data, so only communities that received a site visit in Johnson were assessed in this manner. Since field work for this inventory was limited, this should not be considered a list of all the state significant communities in the town. Further inventory work will likely result in the discovery of other important sites.

Each of the sites visited is described below.

3.1.1. STATE SIGNIFICANT

3.1.1.1. French Hill Hemlock-Northern Hardwood Forest

In a town dominated by mixed hemlock forests, the French Hill site stands out as one of the largest forests of this type in Johnson. This occurrence dominates the north facing slopes of the Lamoille River valley and stretches from the Morrisville-Johnson town line to West Settlement Road, comprising over 1400 acres. This forest type is characterized by a mixture of hemlock and at least 25% cover of hardwoods. The French Hill stand occurs as areas of this "mixed" forest but also as a mosaic of small patches of hardwood forest interspersed with small patches of hemlock forest. Dominant canopy species include hemlock, sugar maple, red spruce, yellow birch, red maple and occasional white ash and American beech. The tall shrub/sub canopy layer consists of various canopy species as well as hophornbeam. Understory is fairly sparse and dominated by the ubiquitous intermediate woodfern as well as occasional Christmas fern and Canada mayflower. Some of the hardwood dominated areas show slight signs of enrichment, harboring species such as spring beauty, blue cohosh and Dutchman's breeches. Small seepy areas are common on the slopes within these forests, especially in the areas with dense hemlock. Most of these sites are actively managed for timber, with some areas marked for cutting at the time of the site visit. However, most forest management has been minimal and has not significantly affected the condition of the community. This size of this stand is impressive and is among the largest in the region. This, coupled with the condition and landscape context make this a state significant natural community.

Figure 5. French Hill Hemlock-Northern Hardwood Forest

3.1.1.1. Butternut Mountain Northern Hardwood Forest

The Butternut Mountain Northern Hardwood Forest consists of a 3000-acre block of forest which occupies the entire north end of the town of Johnson. As large as it is, this section of the forest is really only the southern tip of a hardwood forest which includes an additional 12,000 acres and extends north to Route 109 in Belvidere and Route 118 in Eden. Like most hardwood forests in the northern Green Mountains, this forest is dominated by a mixture of sugar maple,

yellow birch, American beech and red maple. Much of the areas visited for this inventory are managed for maple syrup production. This impacts not only the composition of the canopy (favoring sugar maple over other species), but also typically results in a less diverse and sparser understory as well. In areas not heavily managed for maple syrup, canopy species regeneration in the understory is common, along with species such as moosewood, white birch and occasional red spruce saplings. As the elevation increases, hobblebush can also be a common understory component. Typical herbaceous species in these forests include intermediate woodfern, sarsaparilla, Canada mayflower and clubmoss. No obvious areas of enriched forest were documented during the site visit, but it is likely that these occur. As elevation increases, this community type grades into the Montane forest types. There are also areas where Red Spruce-Northern Hardwood Forests and Hemlock-Northern Hardwood Forests are interspersed with the background hardwood forest and can share characteristic vegetation. With the maple syrup production and occasional logging operations that occur, much of this forest in Johnson is part of the working landscape. While this does impact the community condition rank, the magnitude of this forest and its landscape context together make this a state significant natural community. More work assessing the condition and diversity of this forest should be conducted.

Figure 6. Butternut Mountain Northern Hardwood Forest

3.1.1.2. Johnson-Mansfield Northern Hardwood Forest

Figure 7. A small patch of trout lilies in the Johnson-Mansfield Northern Hardwood Forest

The Johnson-Mansfield Northern Hardwood Forest is an expansive deciduous forest which stretches from near the banks of the Lamoille River to the lower slopes of the Sterling Range south to Route 108. Encompassing approximately 3,300 acres in Johnson and 10,000 acres in total, this matrix forest consists of a wide variety of soils, topography and management histories. This physical variation results in a biological diversity on the species level and also on the community level. Within this forest, there are areas of early successional growth characterized by more open canopies and young woody regeneration. There are also pockets of enriched forest which exhibit signs of mineral enrichment, especially in the spring where spring wildflowers are abundant. Other areas grade into mixed forest types where red spruce or hemlock share dominance with hardwoods. In general, this forest is dominated by sugar maple and yellow birch. In areas with poorer soils, red maple and American beech become more dominant; whereas in more enriched areas, white ash and black cherry are abundant with the maple and birch. Moosewood and hobblebush are common woody plants in the understory. The herbaceous layer is quite variable depending on local topography and soils. The most common species include intermediate wood fern, wood aster and wild sarsaparilla. Other species such as jack-in-the-pulpit, marginal woodfern, wild oats, and spring beauty may be locally abundant depending on site conditions. This extensive forest forms the background for the largest contiguous wildlife habitat unit in the town ("State Forest" CHU). As such, it is not only a significant natural community in Vermont, but vital to a wide variety of wildlife species that depend on large tracts of undisturbed, core forest.

3.1.1.3. Hall Brook Hemlock Forest

While the mixed Hemlock-Northern Hardwood forest type can occur in large patches, or even form matrix communities, the conifer-dominated Hemlock Forest is typically found in much

smaller patches. This pattern arises because the site conditions that result in the development of a Hemlock Forest (to the exclusion of hardwoods), are less common on the landscape. These conditions include steep slopes and ravines and shallow soils with frequent bedrock outcrops and surficial rocks. The Hall Brook Hemlock forest consists of three nearby stands of hemlock on the north facing slopes above the Lamoille River Valley. They are characterized by dense conifers in the canopy which creates a dark, shaded feel in contrast to the hardwood forests that surround them. While hemlock is the clear dominant species, these stands also contain a fair amount of red spruce. As such, these stands would be considered the Hemlock-Red Spruce variant of this community. Hardwoods such as yellow birch, trembling aspen and red maple can be found, but always less than 20% cover. Occasional hemlock, red maple and moosewood occupy the sub-canopy / tall shrub layer. Because of the dense shade, the herbaceous layer is quite sparse. Total cover is under 10% and consists of intermediate woodfern, tree clubmoss and oak woodfern. A moss layer of around 5% typically covers old logs and rocks; common species include *Dicranum spp*. and *Hypnum spp*. Most of these sites show very little signs of human disturbance, aside from some evidence of historic logging. While the Hemlock Forest community is not uncommon in the state, the Hall Brook stands are quite large and relatively undisturbed. As such, they warrant the designation of being state significant natural communities.

Figure 8. The Hall Brook Hemlock Forest has a dense conifer canopy and sparse understory

3.1.2. LOCALLY SIGNIFICANT

3.1.2.1. Belding Pond Hemlock Forest

The Belding Pond Hemlock Forest occupies the steep slopes above the eastern and northern edges of Belding Pond. Like the Hall Brook Hemlock Forest, the canopy in this stand includes both hemlock and red spruce and the type is considered the Hemlock-Red Spruce variant. Sugar maple and American beech can also be found in the canopy, but at low percentage cover. A sparse cover of hemlock and hobblebush are found in the understory. Like many of these conifer-dominated forests, the herbaceous layer is very sparse and consists of a few intermediate woodfern plants. Some of the areas in the forest have larger trees (DBH around 22") while in other areas trees were much younger. The size, condition and landscape position of this forest fall just short of the state significance designation; however, this community should be considered locally significant.

Figure 9. Belding Pond Hemlock Forest

3.1.2.2. Journey's End Hemlock Forest

The Journey's End Hemlock Forest is the main forest on the Journey's End town property and includes the woods around the popular swimming hole. Like the other Hemlock Forests described in Johnson, this is the Hemlock-Red Spruce variant of the community. The canopy

consists of hemlock, red spruce and small amounts of yellow birch, white ash and red maple. In some areas, white pine is found as a “super canopy” tree (trees that rise above the main canopy). There are occasional canopy openings, likely from historic land use, dominated by white pine, hardwoods and hemlock. American beech, yellow birch and hophornbeam are common components of the understory, but together rarely reach 20% cover. Intermediate wood fern, wood sorrel and Canada mayflower are found in the understory at very low cover, typically less than 8%. In areas of canopy openings, the understory species reach much higher cover. Along the banks of the brook below the swimming hole, there are multiple infestations of Japanese knotweed within this forest. The invasive species and frequent canopy openings prevent this site from being a state significant community. However, given its size, condition and landscape position (not to mention the use it gets from the public), this should be considered a locally significant community.

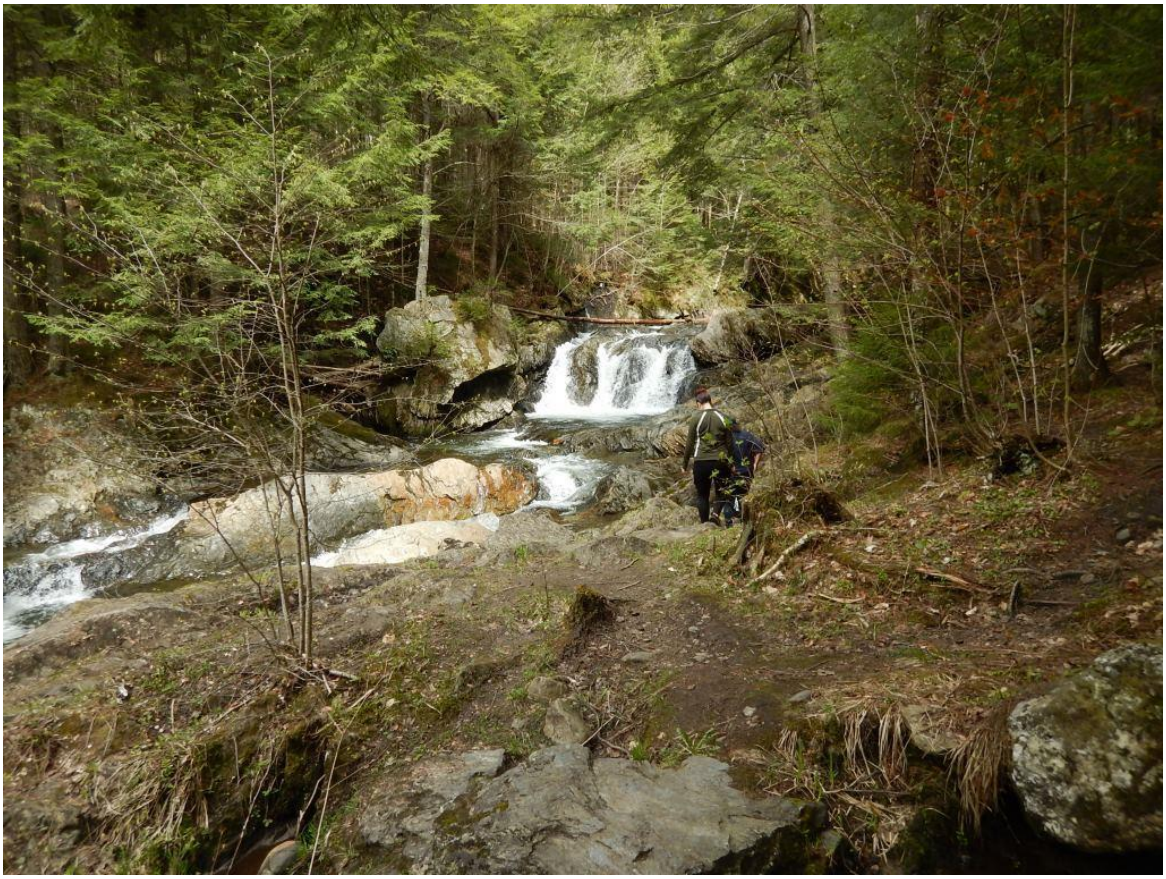

Figure 10. The Journey’s End Hemlock Forest surrounds the popular swimming hole

3.2. Management Recommendations

Management recommendations for upland communities that are considered significant depend largely on the type of forest, how rare the community is, and how large of an area it typically occupies on the landscape. Communities are broken up into rarity ranks (S-ranks, see Appendix 1) as well as typical patch size. Large types like the Northern Hardwood Forest occur

as matrix-forming forests whereas communities like the Hemlock Forest typically occur in small patches.

3.2.1. Matrix Communities

Large, common, matrix-forming communities such as Northern Hardwood Forests are much more resilient to small perturbations than rarer communities that occur in small patches. Activities such as well-planned logging operations would not likely have a detrimental effect on the overall community. Indeed, a forest management plan that incorporates wildlife habitat and mimics natural disturbance regimes can increase diversity on the landscape and ensure long-term regeneration of the stand. Because they are larger and more resilient, these forests can readily "recover" from most logging operations if the managers adhere sound forestry management and best management practices. Maintaining the integrity of these communities is more an issue of limiting fragmenting development that would break up the forests and degrade their condition. For this reason, infringement by residential development on the edges of these communities is not a cause for concern as much as the development of large fragmenting features into the heart of the community.

3.2.2. Patch Communities

The recommended management for large patch communities (such as Hemlock-Northern Hardwood Forests) is similar to that presented above for the matrix communities. It differs primarily in the matter of scale. Large fragmenting developments that cut across or reach into the center of these sites should be discouraged. Some degree of encroachment around the margins of these sites is tolerable as long as it does not impact or degrade a significant section (>20%) of the community. If some impact to these communities is inevitable, development that is clustered near the edges is preferable to those that are scattered over a wider area. Logging operations in large-patch communities can also occur and not degrade the condition of the stand. However, large clear cuts that may be appropriate in matrix communities are not typically appropriate in these sites. Smaller patch cuts and thinning operations are generally recommended.

Communities that occur in smaller patches such as Hemlock Forests are generally more sensitive to disturbance than larger patch communities. The site conditions that give rise to these communities (geology, soils, slope, aspect etc.) are typically localized. This, coupled with the fact that they are small, means that any development in part of the community could have a detrimental effect on the entire stand. Responsible forest management operations in these sites can also be a challenge because steep slopes and small seeps are common within Hemlock Forests.

4. Wetland Natural Communities

The wetland natural communities in Johnson consist of a wide variety of different wetland types, as summarized in Table 3. This diversity includes everything from islands in the Lamoille River occupied by Floodplain Forests, to isolated seepage wetlands at the highest elevations. A total of 411 different wetlands comprising 923 acres have been mapped in the town. Of these, the

*Table 3. Wetland Natural Communities in Johnson**

Natural Community	# of Occurrences	Average Acreage	Total Acreage
Agricultural Field Wetland	76	1.0	74.9
Alder Swamp	55	1.4	75.0
Alluvial Shrub Swamp	5	2.7	13.3
Beaver Wetland Complex	66	4.5	297.3
Cattail Marsh	12	0.2	2.1
Deep Broadleaf Marsh	1	3.5	3.5
Dwarf Shrub Bog	1	1.7	1.7
Floodplain Forest	36	2.4	87.2
Hemlock-Balsam Fir-Black Ash Seepage Swamp	29	3.2	93.9
Hemlock-Sphagnum Acidic Basin Swamp	1	1.7	1.7
Northern Hardwood Seepage Forest	4	1.6	6.6
Old Field Wetland	48	2.3	108.1
Poor Fen	1	0.6	0.6
Pond	13	0.6	7.6
Red Maple-Black Ash Seepage Swamp	11	4.3	46.9
Red Spruce Cinnamon Fern Swamp	2	3.3	6.5
Seep	21	0.5	9.9
Shallow Emergent Marsh	19	4.2	79.9
Spruce-Fir-Tamarack Swamp	1	4.9	4.9
Vernal Pool	9	0.2	1.6
TOTAL	411	-	923

*This includes wetlands that are considered “Potential Wetlands”. Due to the difficulty in remotely mapping wetlands, there is some degree of uncertainty in designating some sites as wetland. For this reason, the wetland database includes data on the confidence of the wetland mapping. See Appendix 1 for more information.

large number of beaver wetland complexes in the town, and the large amount of acreage that they occupy, is particularly impressive. The large number of Hemlock-Balsam Fir-Black Ash Seepage Swamps that occur at stream headwaters is also significant.

This diversity of wetland systems in the town together perform a wide variety of functions and values. These include flood control, improving water quality, erosion control, wildlife habitat, aesthetics, fisheries habitat, and providing educational and recreational opportunities. Not all wetlands, however, have all of these functions or perform them at the same level . Some wetlands may be particularly good at improving water quality or erosion control. Others, like agricultural field wetlands, may perform no significant functions at all. An assessment of wetland significance is therefore important to understand which wetlands in the study area are especially important on the ecological landscape.

4.1. Significant Wetland Natural Communities

Determining the significance of wetlands within the town is done in two different ways. First, wetlands are assessed as natural communities using the methods summarized in Section 3 for uplands (and detailed in Appendix 1). The wetlands identified as state significant natural communities are summarized in Table 4 and described in Section 4.1.1. Unlike upland communities, however, wetlands can be considered significant for the functions and values that they perform on the landscape. A field visit is the best way to assess the functions and values of a wetland. However, a lot of information can be obtained about a wetland from remote sources. AE has developed and employed a remote functions and values analysis that takes into account how a wetland meets certain functions and values criteria. Wetlands that have scored high using this protocol are described in Section 4.1.2.

Table 4. State Significant Wetland Natural Communities in Johnson

Site Name	Natural Community Type	S-Rank (Rarity Rank)	EO-Rank	Acres
Gihon River Swamp	Hemlock-Balsam Fir-Black Ash Seepage Swamp	S3	B	21
Dry Ridge Bog	Dwarf Shrub Bog	S2	B	1.7
Dry Ridge Swamp	Spruce-Fir-Tamarack Swamp	S3	B	4.8
Jacob Brook Headwaters Swamp	Hemlock-Balsam Fir-Black Ash Seepage Swamp	S3	B	8
Belding Pond Swamp	Hemlock-Sphagnum Acidic Basin Swamp	S2	C	1.7

4.1.1. State Significant Wetland Natural Communities

4.1.1.1. Gihon River Swamp

The Gihon River swamp sits in the eastern end of town near the Gihon River. It is adjacent to a moderate sized beaver wetland complex which contains open water, shrub swamp and shallow emergent marsh. Many swamps associated with beaver activity ultimately become flooded, drastically changing the composition and ecology of the community. Most of the Hemlock Seepage swamps in the town are small 1-2 acre headwaters swamps. At just over 20 acres, this swamp is by far the largest Hemlock Seepage swamp in town and likely in the region. The canopy is around 50' tall and is dominated by red spruce and balsam fir with lesser amounts of red maple and black ash. The sub-canopy consists of about 45% cover and includes mostly balsam fir, yellow birch and red spruce. These canopy species are also found in the shrub layer along with speckled alder and Juneberry. The herbaceous layer is quite diverse and includes foamflower, pyrola, bluejoint grass, dewberry, goldthread, cinnamon fern, marsh marigold, sensitive fern and golden saxifrage. The reason for the diverse herbaceous flora is that the hummocks and hollows in the swamp are well developed. This results in a high degree of microtopography and variation in available habitat, with standing water in the low hollows and dry conditions on the high hummocks. On these hummocks and hollows is a near complete cover of mosses. Species such as *Thuidium spp.*, *Bazzania trilobata, Sphagnum recurvum, Drepanocladus spp.*, and *Hylocomnium splendens* are common.

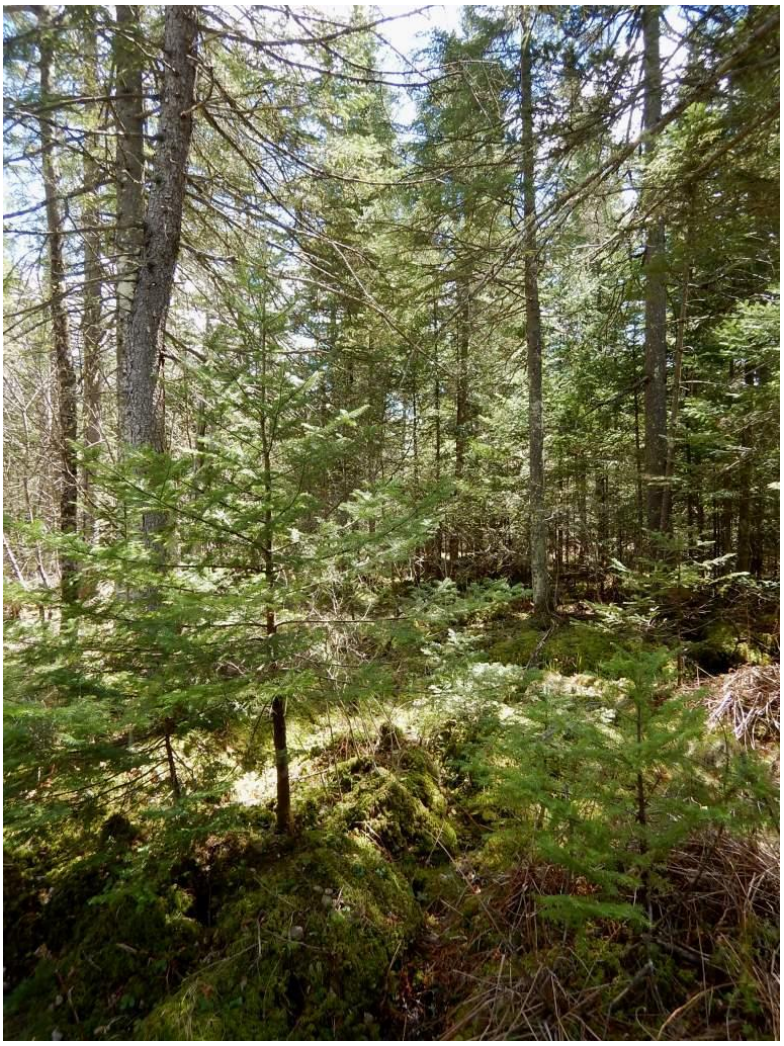

Figure 11. The Gihon River Swamp is a structurally and floristically diverse wetland

The diversity of this swamp is impressive, and it is not an easy site to navigate. There is a lot of vertical diversity (well-developed sub-canopy and tall and short shrub layers) in addition to

frequent fallen trees and wet hollows. This, however, attests to the fact that natural ecological conditions predominate. The hydrology of the swamp appears to be intact and there was no sign of logging, invasive species or other human disturbance. This large, intact, diverse swamp is a real gem in the town, and deserves the state significance designation.

4.1.1.2. Dry Ridge Bog

Dwarf Shrub Bogs are special places. Not only are they a rare community in Vermont, but they are also unique in their origin, development and flora. Over the thousands of years it takes for these wetland to develop, Sphagnum peat can build up above the underlying water. When this happens, the plants that grow out of the peat are isolated from the underlying water and the minerals it contains. The result is a condition where plants can only get nutrient input from rainwater. Very few species can tolerate such conditions, and they are typically species that are restricted to these peatland environments. In the case of Dry Ridge Bog, the dominant vascular plant is leatherleaf. This is a dwarf shrub that, in this bog, grows no more than 2 feet tall and occupies about 85% cover. Above this dwarf shrub layer, scattered larch, black spruce and white pine trees are found, collectively less than 10% cover. The difficult growing conditions also stunt the growth of these trees such that they are all less than 10 feet tall. The field visit to this site was conducted in mid-May and the only obvious herbaceous plant present in the bog was hare's tail cotton grass, though other species may be present as well. There were, however, no obvious signs of mineral enrichment in the main part of the bog. The Sphagnum moss which comprises the substrate of the bog consists mostly of a high "lawn" of *Sphagnum capillifolium*. This is a beautiful species which turns red when growing in sunlight. Other species include *Sphagnum magelanicum* (which also

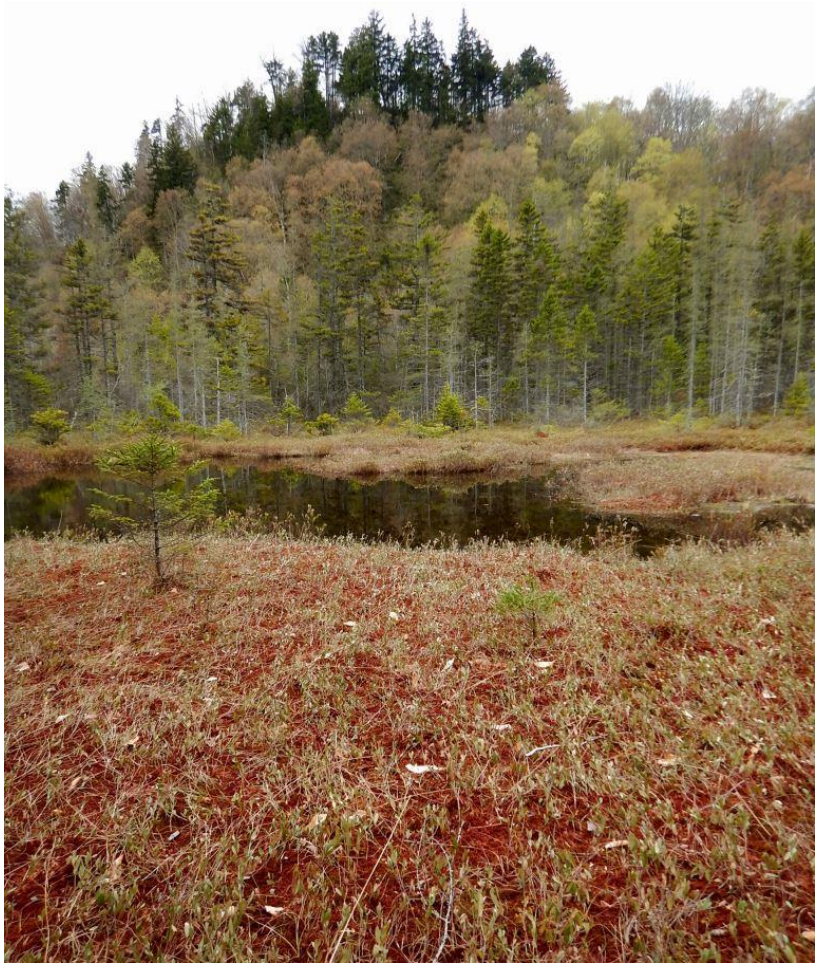

Figure 12. The red Sphagnum lawn and open water pond of the Dry Ridge Bog

turns red) on the few hummocks and *Sphagnum recurvum* (a nice contrasting green) in the few hollows.

Another interesting feature of the Dry Ridge Bog is the open water near the center. These areas are somewhat common within peatlands and occur as the peat slowly grows over the underlying open water. In this circumstance, the peat mat was quite firm right up to the edge of the open water. As is common in many bogs, this community grades into a more mineral rich swamp along the outer edges of the wetland (the Dry Ridge Swamp). As this gradation occurs, more mineral rich species become established and the woody plants grow taller and become more abundant. Overall, this is a beautiful, undisturbed natural community in excellent condition. It lacks any sign of human disturbance and sits within a larger forested matrix. All of these factors combine to make this a special place in Johnson and a state significant natural community.

4.1.1.3. Dry Ridge Swamp

As mentioned above, the Dry Ridge Swamp is a relatively mineral rich swamp which encircles the Dry Ridge Bog. Like the Bog, Sphagnum moss dominates the ground in the swamp. All three species present in the bog are also present in the swamp. In addition, feather mosses such as *Pleurozium schreberii* occupy the high hummocks. Unlike the bog, a more sapric (well-decomposed) peat layer is present below the undecomposed peat. The plants growing here, by contrast, have access to the more mineral rich water table evidenced by the more diverse flora.

Figure 13. Moss covers the floor of the Dry Ridge Swamp

Herbaceous species such as cinnamon fern, three-seeded sedge, creeping snowberry, goldthread, and Canada mayflower are common. Dwarf shrubs such as bog laurel, sheep laurel and leatherleaf are occasional, especially in the zone in between the swamp and the bog. Tall shrubs are common, collectively comprising 60% cover and consist mainly of mountain holly with a few Juneberry shrubs as well. Above the tall shrub layer, there is a sub-canopy of trees (mostly red maple) approximately 30' tall comprising 20% cover. The canopy of the swamp consists of mostly red spruce and tamarack and comprises 70% cover. There are a few hemlock trees within the swamp and a few black spruce trees in the zone between the swamp and the bog. There is a small area of open water within the swamp which contained spotted salamander eggs. The hummocks are relatively low and some of the deeper hollows contained standing water, especially near the upland edge. There were no signs of logging, invasive species or other human disturbance. This is an uncommon natural community in Vermont and although this site is relatively small, it is undisturbed and sits in a large forested matrix. These factors combine to make this a state significant natural community.

4.1.1.4. Jacob Brook Headwaters Swamp

Figure 14. The Jacob Brook Headwaters Swamp

The Jacob Brook Headwaters Swamp sits in the southeastern part of town and is located near the headwaters of Jacob Brook. As is typical for this community type, groundwater upwelling creates wet and nutrient-rich conditions for plant growth. The perennially saturated soils, however, make difficult growing conditions for trees. Most of the trees are located on drier hummocks, but this microtopography does not prevent frequent windthrow, which in turn creates more hummocks. The most abundant trees in this swamp include balsam fir and red maple, with lesser amounts of red spruce and yellow birch. Canopy cover is around 70%. There is a sparse sub-canopy of yellow birch and balsam fir. Because of the enriched mineral content, the herbaceous layer is quite diverse. Dominant species

include slender mannagrass, common horsetail, goldthread, dewberry, sensitive fern, water avens and golden saxifrage. Mosses cover about 40% of the hummocks and hollows in this swamp. Common species include *Thuidium spp*., *Sphagnum capillifolium* and *Bazzania trilobata*. Standing water is common in the low hollows of this swamp, and provides habitat for the plants that prefer wetter conditions. This is a nice, diverse swamp which lacks any signs of logging, invasive species or other human disturbance. Its moderate size, good community condition and landscape context make this a state significant natural community.

4.1.1.5. Belding Pond Swamp

The Belding Pond Swamp is a Hemlock-dominated swamp unlike any others inventoried in Johnson. Most of the hemlock swamps are mineral rich seepage swamps that harbor a diverse herbaceous flora. The Belding Pond Swamp is an example of a Hemlock-Sphagnum Acidic Basin Swamp. This community type is much more rare than the mineral-rich version and, as the name implies, it is more acidic and mineral poor. Most of the swamps of this type occur in isolated basins, but a few (like this one) occur as part of larger wetlands. In this case, the Belding Pond Swamp sits on the upper margin of a beaver wetland which is connected to Belding Pond. The beaver activity has had a negative impact on this plant community and has flooded portions of the swamp. In these areas, standing dead trees are common and the vegetation is in transition. However, parts of the swamp are intact and retain the characteristics of this community type. The canopy consists of a mixture of hemlock, red spruce and red maple. A shrub layer of canopy species as well as balsam fir is also present. Unlike the other hemlock swamp type, the herbaceous layer lacks diversity. Meadowsweet plants are occasional but the dominant herb is cinnamon fern which, during the summer months, comprises around 40% cover. Sphagnum moss dominate the forest floor (mainly *Sphagnum recurvum*) while the drier hummocks are occupied by the

Figure 15. Cinnamon fern hummocks in the Belding Pond Swamp

Polytrichum spp. mosses. While this swamp is fairly small and somewhat disturbed, because of the rarity of this swamp type, the site should be considered a state significant natural community.

4.1.2. Wetlands Significant for Functions and Values

4.1.2.1. Riverine Wetlands: Floodplain Forests, Shrub Swamps and Marshes

The assemblage of wetlands along the Gihon and Lamoille Rivers in Johnson are worth noting because they score very high in the functions and values analysis. They consist of Floodplain Forests, Alluvial Shrub Swamps and Shallow Emergent Marshes. Johnson is home to 36 different occurrences of Floodplain Forest comprising 87 acres along the Lamoille and Gihon Rivers. Most of the Floodplain Forests in the state have been converted to agriculture. Because of the disturbance created by annual flooding and ice scour in these communities, the fragments that remain are often plagued by non-native invasive species. Due to lack of landowner permission and time constraints, most of these sites were not visited as part of the inventory. Many exist only as narrow bands of vegetation along the river bank; the largest and seemingly most intact examples occur as islands in the Lamoille. Others are undoubtedly early successional forests, lacking the signature tall, majestic silver maple canopy. However, their association with major rivers and their landscape position makes them significant for many functions and values.

Figure 16. Even early successional Floodplain Forests can be functionally significant

The Alluvial Shrub Swamps include 6 sites in Johnson along the Lamoille and Gihon Rivers. These sites are dominated by speckled alder and are wetter than Floodplain Forests but are functionally similar. The wet conditions and dense alder tends to limit the historical disturbance and the amount of invasives that become established in these sites. The marshes associated with the rivers in town include both the Shallow Emergent Marsh and the Deep Broadleaf Marsh communities. These wetlands consist of beaver influenced areas along the river or old oxbow wetlands with open water. These herbaceous and open water wetlands also perform similar functions and can be especially important wildlife habitat.

All of these wetland systems are known to provide an expandable basin for flood waters thereby mitigating the downstream effects of floods. Persistent vegetation helps to prevent erosion along the banks of rivers by holding soil in place. In the case of the Floodplain Forests, the trees shade the waters and, when they fall into the river, provide important habitat for aquatic species. Their unique position in between agricultural activities and surface waters makes them valuable as a buffer, thereby improving water quality. These riverine wetlands provide valuable habitat for a wide variety of song birds which breed in them. They also are used by otter, mink, muskrat and other wetland dependent animals that travel along these river corridors. The back-swamps and old oxbows provide significant breeding habitat for many species of amphibians including mole salamanders, spring peepers and green frogs. Many of these sites along the Lamoille are highly visible, making them significant for aesthetics. Finally, since many people recreate along the river, often using these wetlands, these sites are considered significant for recreation. Overall, this series of Floodplain Forests, shrub swamps and marsh wetlands are an essential part of a healthy, functioning river system. Further work to enhance or restore these wetlands should be encouraged.

4.1.2.2. Beaver Wetlands

Johnson is home to an impressive 65 different beaver wetlands comprising 257 acres. Because of the dynamic nature of these wetlands, both the number and acreage occupied by these wetlands changes from year to year, but this is also what makes these areas unique. The open water ponds can include areas of floating leaved aquatic wetlands and Deep Broadleaf Marshes. These can give way to Shallow Emergent Marshes, which are often ringed by Alder Swamps. Along the margins of these sites, forested swamps are common.

As beaver populations fluctuate, the distribution, abundance and diversity of these wetland types at a particular location changes. This dynamic and diverse wetland landscape creates a wetland system that is significant for many different functions and values. The open water in the ponds can be significant for fisheries, providing valuable habitat for a wide variety of species. These wetlands can also be significant for water quality, allowing sediments to settle out into the pond before reaching other surface waters. They can attenuate flood waters by decreasing peak flow into during flood events. Perhaps the most significant function that these wetlands serve is that of wildlife habitat. The combination of open water, herbaceous wetland and shrub swamp offer an extensive variety of habitats to a wide range of species. These include moose, deer, bear, mink, otter, woodcock, grouse, frogs, salamanders, reptiles and a wide variety of

songbirds and raptors. In Johnson, many of these beaver wetland complexes occur within large core forests. These more isolated sites are particularly important as wildlife habitat.

Figure 17. Beaver Wetlands are dynamic wetland systems that provide valuable wildlife habitat

4.2. Management Recommendations

Wetlands are complex systems. The community types that develop on a particular site are the result of the interaction of geology, climate, soils, slope, hydrology, site history, wildlife, and human disturbance (or lack thereof). Of these factors, hydrology is perhaps one of the most significant, complex and most easily disturbed. At the most basic level, therefore, wetland protection starts with protection of wetland hydrology. In terms of managing wetlands, any activity that disrupts the hydrology of a wetland should be avoided. This can include obvious activities such as filling or ditching a wetland, building roads through wetlands, or development in a wetland. This can also occur in more subtle ways such as skidder ruts through a headwater seep.

For significant wetlands, it is sometimes not enough to just protect the wetland itself. The aim must be to protect the wetland and its functions and values. Depending on the site and the functions, this may require a 50' or greater buffer from development or other activity. As a general recommendation, any activity that negatively affects the listed functions or values of a wetland should be avoided or minimized. In addition, it must be recognized that wetlands have very fragile soils. Any ground disturbance has the potential to disrupt local hydrology and open up the site to colonization by non-native, invasive species. While these general wetland

management recommendations apply to all wetlands, more specific recommendations based on wetland types are discussed below.

4.2.1. Forested Swamps

Wetlands that are dominated by woody vegetation (shrubs or trees) are generally termed "swamps". The general management recommendations presented above also apply to these wetlands. However, because many of these sites contain marketable timber, additional recommendations are warranted. The actual loss of a tree from a forested swamp is not something that would typically be detrimental to the community. The challenge comes in how that tree is removed. Wetland soils are fragile soils. Ruts created by a skidder often disrupt local hydrology of the site, expose soils and open the site up to colonization by invasive species. These are factors that can significantly degrade the condition of a swamp community. If logging operations are to occur, they should be conducted only when soils are sufficiently frozen and soils are not disturbed. In addition, since these sites are typically "small patch" communities, selective thinning is preferable to clear cutting. Because of the difficulties in logging these fragile sites, it is recommended that state significant examples be excluded from any logging operations.

4.2.2. Floodplain Forests

Floodplain forests are some of the most beleaguered natural communities in the state. Having been mostly converted to agriculture, only small remnants of these forests still remain. In addition, most of them are colonized by large populations of invasive species. At the same time, they are one of the most highly functioning wetlands in the area, in a large part due to their close association with the Lamoille and Gihon Rivers. Any further activity that would compromise these systems such as development, logging or further conversion to agriculture should be avoided. Furthermore, many of these sites would benefit from enhancement or restoration activities such as efforts to control invasive species. Also, if there are willing landowners, the re-establishment of floodplain forests on former agricultural lands is a worthy endeavor.

4.2.3. Vernal Pools

Vernal Pools are temporarily flooded wetlands typically found in a forested landscape that retain water for the spring and early summer months and then usually dry up. A total of XX Vernal Pools were mapped in Johnson, but, due to the difficulty in remotely identifying them, the actual number of these wetlands in the town is likely much higher. Despite their small size, these wetlands provide critical wildlife habitat to a wide range of species including wood frogs, spotted and Jefferson salamanders, fairy shrimp and many invertebrates. All of the amphibians that rely on these pools spend most of their lives in the forested habitats which surround the pools. For this reason, the health and functioning of the vernal pool wetland is intimately linked with the condition of the upland forest surrounding the pool.

Buffer zone and management recommendations for these wetlands are therefore different than for most other wetland types. Much of these management recommendations are based on the

work of Calhoun and Klemens (2002) and Calhoun and deMayandier (2004). The vernal pool system is broken up into zones. The first is the actual border of the vernal pool. Any disturbance or impact to the actual vernal pool should be avoided. The second zone is the Vernal Pool envelope, which consists of a 100' diameter buffer around the pool. This first buffer is important because the density of amphibians within this area is very high both during the spring breeding period and the fall juvenile dispersal period. As mentioned above, the nature of the forest immediately around the vernal pool has a tangible effect on the nature of the pool itself. Shading from surrounding trees can drastically prolong the hydroperiod of a pool. In addition, leaf litter that enters the pool from the surrounding trees forms the basis of the food chain in the vernal pool ecosystem.

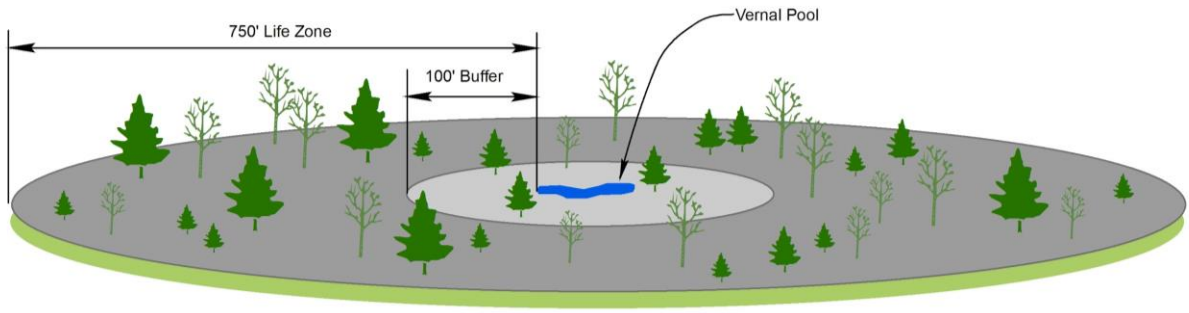

Figure 18. Vernal Pool Buffer Zones

The condition of the forest in this 100' buffer zone is therefore strongly linked to the condition of the vernal pool itself. For this reason, it is recommended that the vernal pool envelope be managed in a way that will not interfere with the functioning of the vernal pool. This includes maintaining a complete forested cover within this envelope. Light thinning of forest trees is, in most cases, acceptable but should come no closer than 25' to the pool's edge. Since many amphibians require a dense leaf litter on the forest floor with un-compacted soils, logging should occur when the soils are frozen and there is adequate snow cover. The creation of ruts in this area can often disrupt the hydrology of the nearby vernal pool. Development and other barriers to amphibian movement should be avoided within this 100' buffer zone.

The third zone is termed the "amphibian life zone" and is calculated 750' from the vernal pool boundaries. Amphibians that breed in vernal pools spend most of their adult lives in the forests surrounding their natal pools. These amphibians require a forest with dense leaf litter, decomposing woody debris, un-compacted soils, and adequate canopy cover. Calhoun and Klemens (2002) recommend maintaining 75% forested cover within this life zone to retain adequate habitat for forest dwelling amphibians. If logging is to occur in this area, it should occur in the winter when the ground in frozen and there is adequate snow cover. Ruts that occur in the life zone can fill with water and create population sinks when amphibians lay eggs in the ruts and never reach the more reliable vernal pool. In addition, soil compaction can cause loss of habitat for many salamanders and should be avoided.

4.2.4. Beaver Wetlands

Beaver wetlands are some of the most diverse wetland systems found in the town. They perform a wide variety of functions and often provide valuable wildlife habitat. When they occur near development, however, they can also be the most challenging to manage. As with any wetland, the general management recommendations apply: do not disrupt the hydrology and protect the functions and values. For some sites where water quality and wildlife habitat functions are a concern, this can mean leaving a significant buffer between the wetland and development. When beaver dams threaten roads and houses, management of the wetland becomes necessary. It is best to find a solution to the problem that both prevents damage to infrastructure and preserves the functions and values of the wetland system. Many innovative techniques for accomplishing these goals are outlined in the Best Management Practices for Human-Beaver Conflicts (VT Fish and Wildlife and Department of Environmental Conservation, 2004).

5. Wildlife Habitat

The wildlife habitat in this study is defined by Contiguous Habitat Units (CHU). Each CHU is an assemblage of wildlife habitat features such as forested riparian buffers, ledges, deer wintering areas, wetlands, mast stands and early successional habitats which function together as a unit of diverse and relatively continuous wildlife habitat. The largest forested area, often the most valuable wildlife habitat, is the core area (largely free from most human activities). CHUs are largely a human-derived construct (as they are bound by our roads), but they represent the largest contiguous wild areas in the study area. The CHUs can be the basis of wildlife management and planning for wildlife in the town of Johnson.

5.1. CHU Wildlife Habitat Components

In constructing CHUs, core forest areas are combined with early successional habitats, forested riparian habitats, wetlands, deer wintering habitat, mast stands, and ledge or cliff habitats. In some cases, these specific wildlife habitat features (like riparian areas) may not add new area to the already mapped central core as they are often already subsumed within the core area boundary. In other cases (when they are tangential but not within the mapped core area) they add new area and additional acreage to the CHU. Each of the following habitat components can serve as a source of food or water, seasonal or year-round habitat, escape cover, breeding and rearing habitat, movement habitat or all of the above for one or more species of wildlife. Each of the CHU component features is discussed in detail below.

5.1.1. Core Areas

Core habitat is forested wildlife habitat that is far removed from human activities and their artifacts such as roads, houses, and active farmlands. For the purposes of this analysis, it is defined as forested land 100 meters or more from regular human disturbance such as development, open fields and roads. This remote wildlife habitat is qualitatively distinct from small, fragmented habitats, in that it provides important mating, nesting, feeding, and denning

habitats for species that cannot survive in these human-dominated landscapes. These animals typically require travel corridors between various landscape patches that provide other distinct habitat elements.

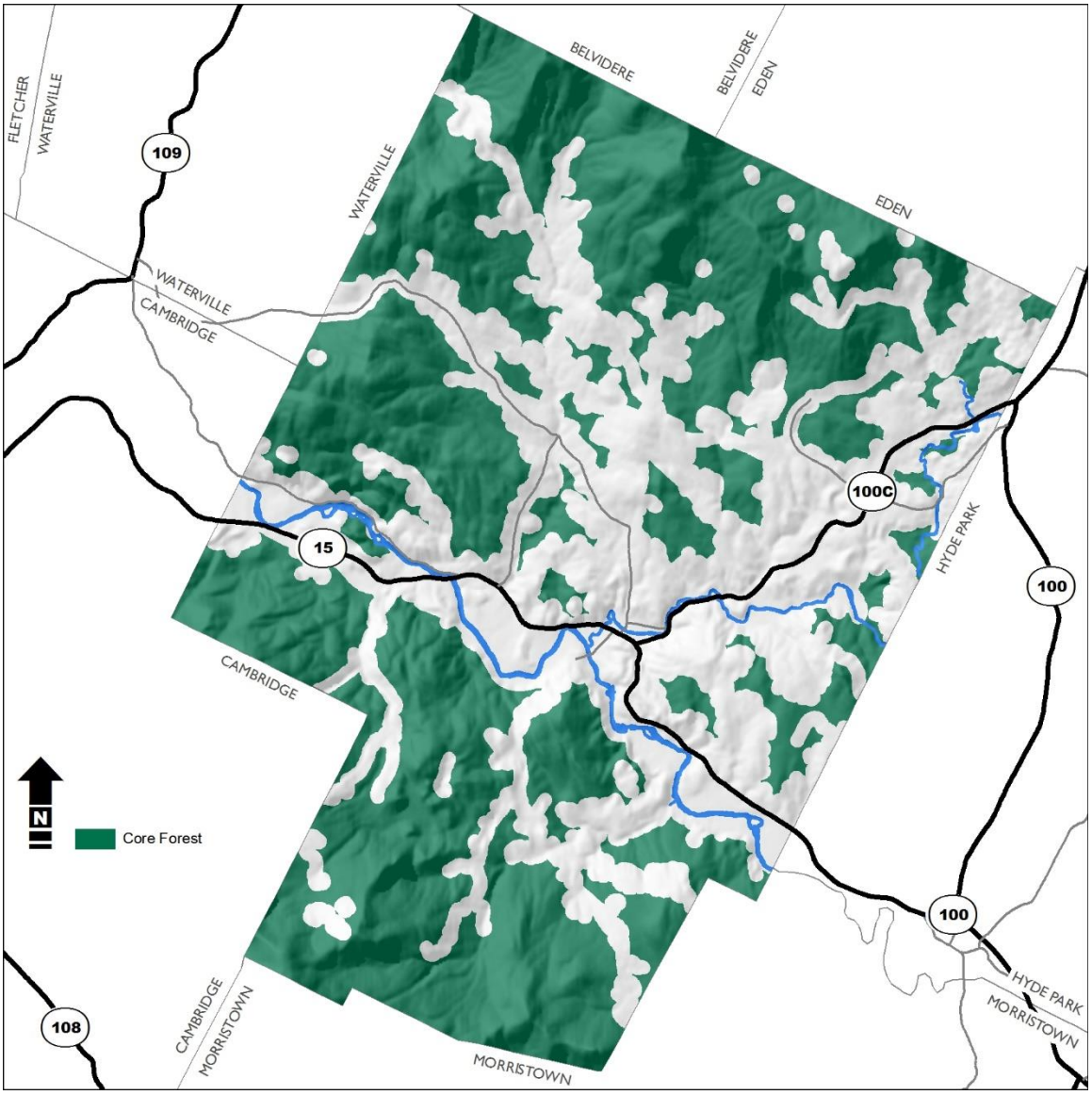

Figure 19. Core Forest

Core habitat is generally characterized as having a lower amount of forest edge habitat. Also in core areas, edge habitat is often "soft" and the result of differences in ecological conditions such as a variable site aspect. In contrast, our human-caused "abrupt or hard" edges, occur where different land-uses have created different cover types or ages of communities. Edge habitat, and especially abrupt edge habitat, is characterized by extremes in climatic variables such as temperature and wind speed. Bird species composition and behavior is often different in edge habitat.

A wide-variety of birdlife in the northeast utilizes the larger contiguous forests available only in core areas. These birds include species such as the broad-winged and red-shouldered hawks, owls, and forest songbirds like the ovenbird, wood thrush, scarlet tanager, pileated woodpecker, and the Canada and black and white warblers. Several of these species suffer from greater nest predation (by animals such as squirrels, raccoons, snakes and other birds) and nest parasitism (by other birds such as the brown-headed cowbird) where nesting grounds are near human disturbance and the habitat edges it creates. Bird populations throughout Johnson and the region, therefore, benefit from the deep forest "interior" habitat provided by core areas See Figure 19 for core forested habitat locations in Johnson.

Remote wildlife habitat found in core areas can provide the various habitat elements for wide-ranging species such as fisher, bobcat, and black bear. Core areas are often hilly or mountainous, without easy access, and only rarely or seasonally visited by landowners, hunters, and loggers. Wide ranging species thrive in the remote habitat of the core areas. Core areas are often the most important "source areas" where reproductively active female bear, bobcat, fisher, and coyote can defend territories, have their young and contribute to the overall population of these species. In general, the larger the core area size, the greater the population (and territories) of individual species it can support. Larger populations are generally more stable over longer periods. Core areas often provide the breeding grounds and nurseries that support relatively high populations of these deep forest species. Although most human wildlife observations may be near town, within our small woodlots and crossing roads, it is these core areas that produce a surplus of young and without them many populations would likely decline.

The smaller more fragmented wildlife habitats throughout Johnson, are dependent upon these large core habitats, for maintaining stable, self-sustaining populations of species that have relatively large home ranges (such as bear, bobcat and fisher). Animals living near humans, roads, pets, hunters, and trappers suffer higher rates of mortality than do animals deep in core wildlife habitats. The long-term maintenance of wildlife populations in Johnson may be dependent on keeping these core habitats biologically meaningful and free from deleterious fragmentation.

5.1.2. Ledge, Talus and Cliff Habitats

Ledge habitat is generally associated with steep land and vertical rock structure. Vertical rock structure itself is only valued by a limited number of species such as nesting peregrine falcon, common ravens, and the small-footed bat. If the ledge is broken, that is, with crevices, hollows and caves, it becomes important habitat for a wider variety of animals.

In many areas throughout the northeast, bobcats use ledges for courting and breeding grounds and the broken ledge (often at the foot of a ledge) for birthing and rearing of their young. Broken ledge is considered defendable from predators like the coyote that may try to kill and eat bobcat young. Bobcats (and other animals) are reported to also utilize broken ledge when it's cold and snowy as well as when it's hot (for relief from the heat). There is some evidence that ledges facing south and west (areas that generally are more exposed to the sun) may receive higher use by certain species and are more valuable to wildlife.

Porcupines and raccoons also live in ledge hollows, under larger rocks, and in deeper cave-like structures in ledge and talus environments. Fisher and coyote often use these sites for protection from the weather while moving throughout their home ranges. Ruffed grouse and small rodents often utilize these areas for varying periods of time. Figure 20 shows the likely ledge and talus areas that were identified in Johnson, and more are assumed to exist.

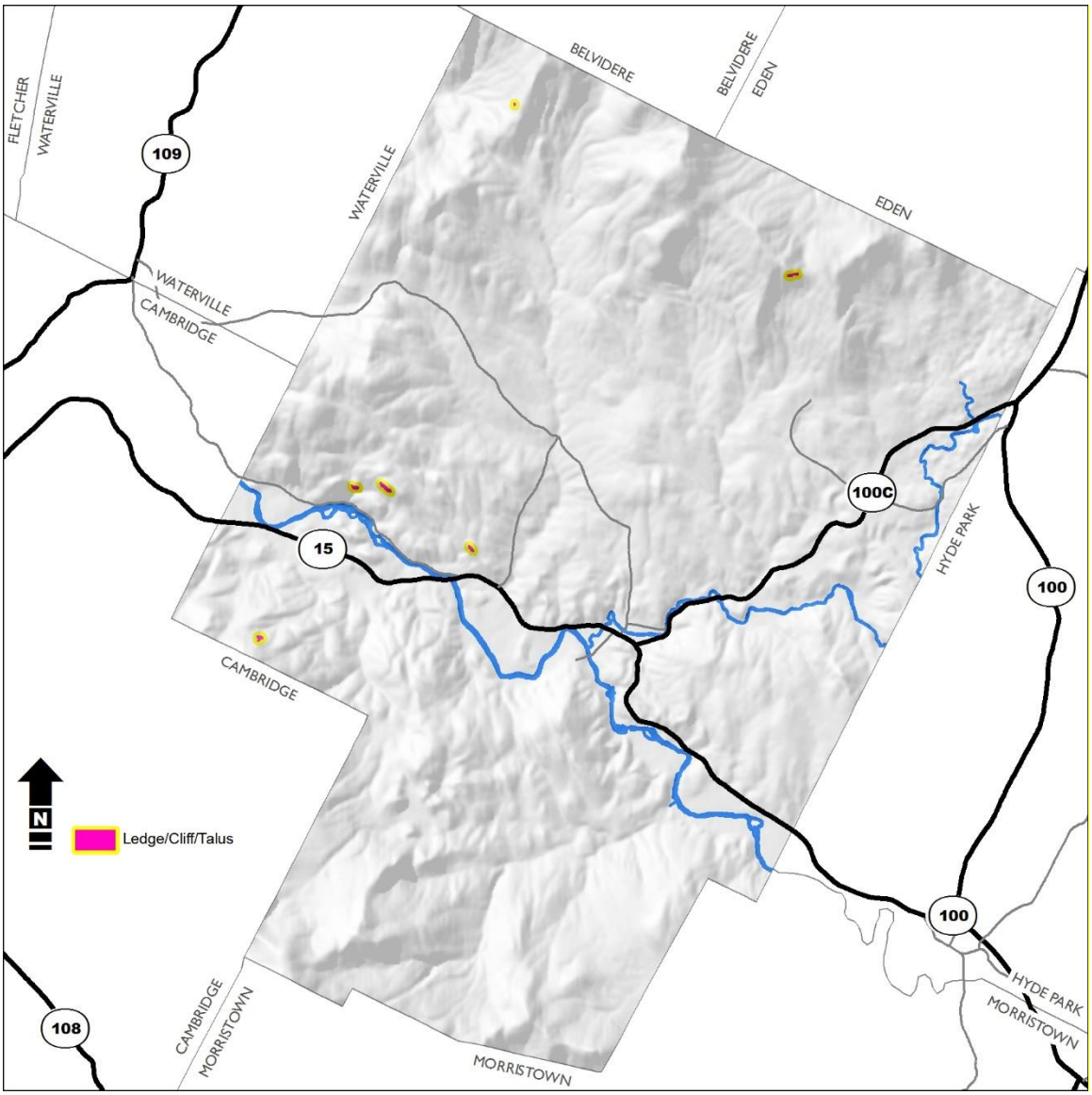

Figure 20. Ledge, Cliff & Talus Habitats

5.1.3. Bear Wetlands

Black bear utilize a wide variety of wetlands during the spring and summer months. Forested, shrubby, beaver-flow wetlands, and forested seeps are sought out for the flush of early vegetation that often grows in these environments. In the early spring, wetlands with ground-water discharge promote an early growth of leafy green vegetation at a time when the trees are

still barren of nutritious buds and new leaves. Black bears (as well as deer and turkeys among other animals) will utilize this food source and also search out plant roots, grasses, sedges and ants in these environments. Free flowing water is also available at many of these wetlands. Bear wetlands typically have shrubs or tree vegetation nearby which provide concealment.

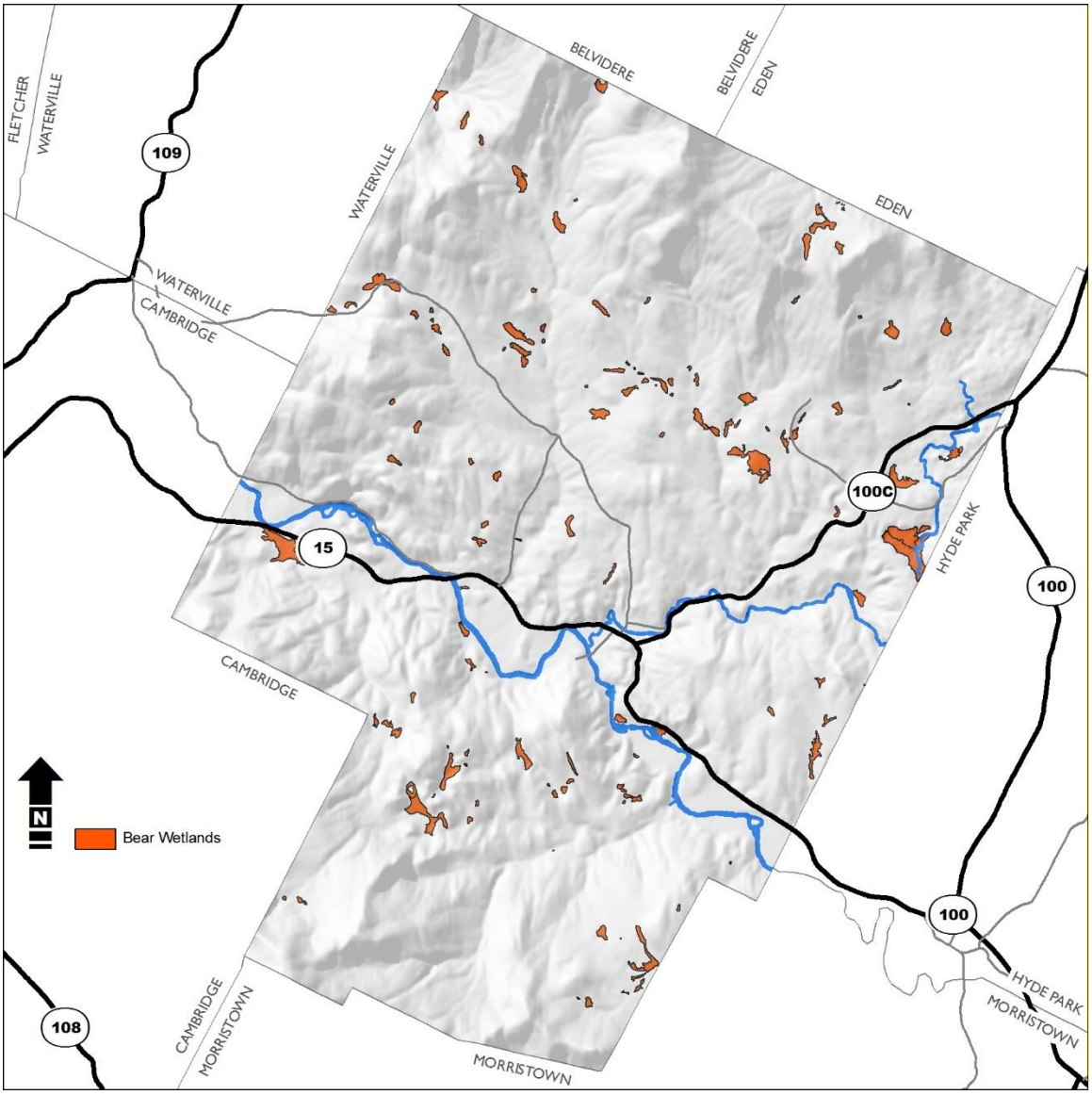

Figure 21. Bear Wetlands

Throughout the Johnson area forested seeps are probably the most heavily utilized wetlands by bear. In many locations, these seep wetlands are located in remote areas relatively close to bear denning areas far away from humans. As such, they warrant special protection for their wildlife value.

The wetlands identified as preferential bear habitat in this study represent a mix of wetlands that were either observed in the field to have sign of bear use or were determined to be potential

candidates to fulfill bear wetland habitat requirement (i.e. sufficient cover for bear use and potential food resources) based on their community type and cover characteristics.

5.1.4. Early Successional Habitats (ESH)

ESH are forested habitat that is characterized by regenerating young, often dense shrubs, saplings or trees. Active forest management or natural disturbances such as disease infestation, ice storms, or wind blow can sufficiently open the forest canopy to sunlight and encourage a new growth of woody vegetation. Old fields and power line ROWs with a substantial shrub component were also identified as ESH in this study.

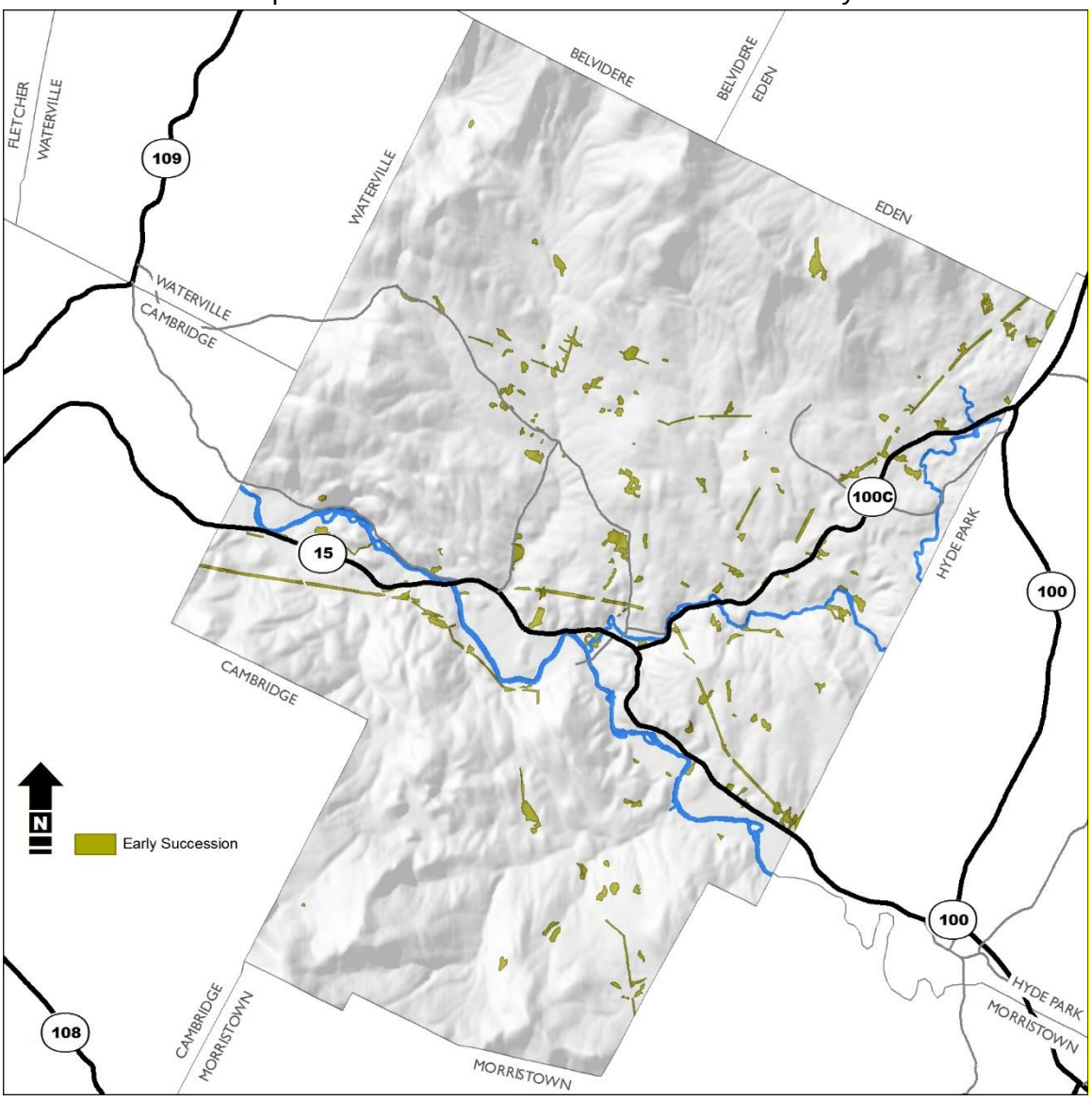

Figure 22. Early Succession Habitat

ESHs are important for many species of birds and mammals. Bird species that thrive in areas with tree saplings and shrubs include: the song sparrow and field sparrow, chestnut-sided and

golden-winged warbler (rare), common yellowthroat, gray catbird, indigo bunting, brown thrasher, American woodcock, and ruffed grouse.

ESH that is interspersed with older forestland, old fields, and wetlands harbors many small mammals that are prey for predators. Snowshoe hare, woodchucks, white-footed and woodland jumping mice, and shrews are often found in high densities in areas of successional patches on the landscape. Red and gray fox, coyote, ermine, skunk, raccoon, and bobcat will search these patches for food. Black bears and other animals will utilize these areas extensively in years when berry-producing shrubs are thick with fruit.

Recently, early successional patches within an otherwise forested matrix have been shown to provide feeding habitat to bird species that were otherwise thought to be forest "interior" specialist. These birds visit the fruit and insect rich openings between the end of the breeding season and beginning of migration to bulk up on the copious foods in preparation for the long migratory flights.

5.1.5. Forested Riparian Habitats

Forested streamside riparian habitats are important for species that utilize the aquatic habitats, terrestrial vegetation and cover that are provided. Riparian forested vegetation anchors the stream shoreline and limits streambank erosion. It also provides coarse woody debris to streams which adds to the stream structural and substrate diversity as well as provides food that fuels stream food chains. In addition, the tree canopy provides critical shade important for maintaining cooler water temperatures necessary for fish survival. The contribution of coarse woody debris (especially during leaf-fall on low order streams) to energy budgets of shady headwaters streams is pronounced.

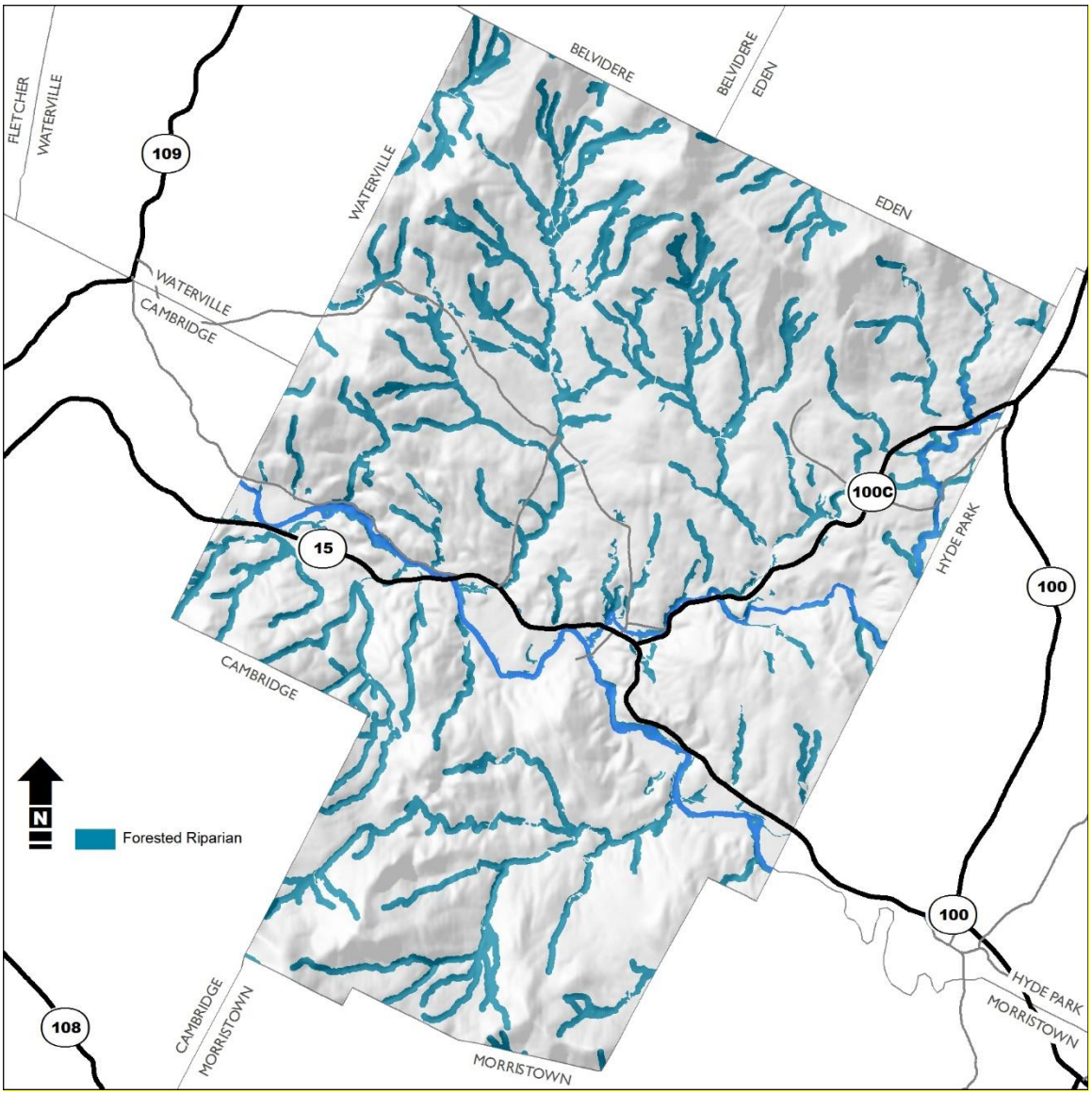

Figure 23. Forested Riparian Habitats

Amphibians such as the spring, Northern dusky and two-lined salamanders live along streams in forested habitat and utilize the adjacent riparian environment. The raccoon and long-tailed weasel use streamside forested habitats to hunt for food and for denning habitat. The moose and white-tailed deer use streams and streamside forested habitats for cover and water. Aquatic animals such as the river otter, mink, muskrat, and beaver use streamside vegetation for cover, denning and food. Several species of bats such as the little brown myotis and the big brown bat use these environments to hunt for insects. Birds such as the belted kingfisher, wood duck, red-shouldered hawk, snipe, Eastern screech and barred owl, the wood pee-wee and alder flycatcher, American gold finch, tufted titmouse, and the yellow, Canada, and cerulean warblers make extensive use of forested riparian habitats.

Forested riparian areas also function as important travel corridors for a variety of wildlife species. Often these zones are the only treed route affording cover and facilitating movement.

5.1.6. Mast Stands

Masting trees are those which synchronize fruit production in an area. Within Johnson "hard mast" trees are Northern red oak and American beech trees. These trees, when found clumped into stands, are regularly frequented by many species of wildlife.

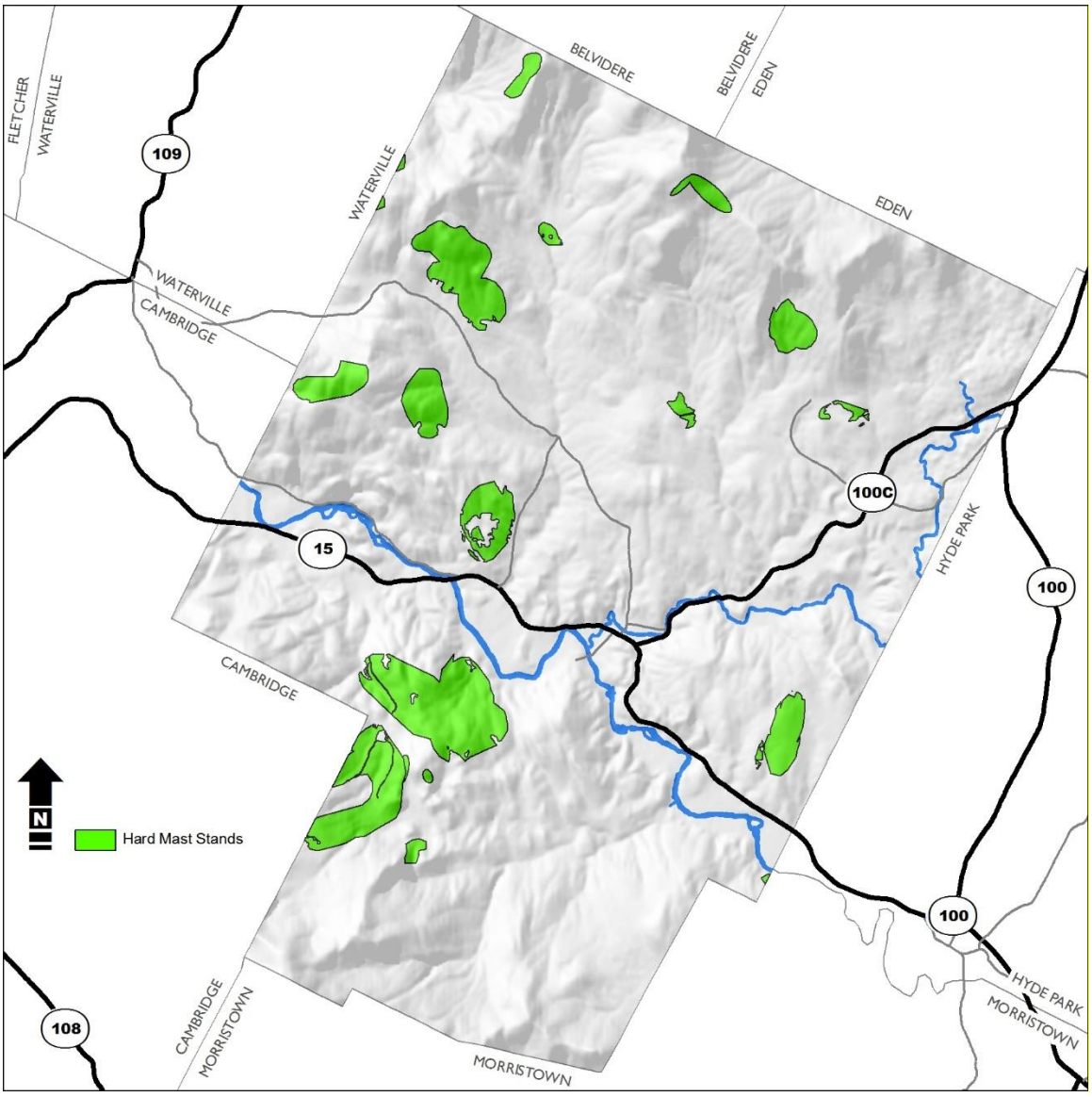

Figure 24. Potential Hard-Mast Stands

Various sized beech stands have been identified within Johnson. When beech and oak stands are remote, use by black bear is generally higher than stands near human activities. Wildlife attracted to the fruits of American beech (beechnuts) and oak trees (acorns) include squirrels,

wild turkey, deer, and bear. Northern red oak is considerably less common in Johnson than the American beech trees which are part of the Northern Hardwood forest natural community.

Bear will climb the beech trees in fall to gather beechnuts, leaving scars from their climbing activities. They often return in spring and scavenge beechnuts from the ground under the beech trees. Bears act in a similar fashion in search of acorns, however, their climbing activities do not usually leave persistent scars and their use is therefore difficult to detect on the tree itself.

This study compiled known mast resources, field identified stands and utilized natural community designations to identify probable stands of mast trees. Additional mast stands, especially American beech stands are likely present on the landscape.

5.1.7. Deer Winter Habitat

In years where significant amounts of snow accumulate in the woods, white-tailed deer utilize evergreen forests for winter habitat. Evergreen trees intercept snow as it falls to the ground generally resulting in shallower snow depths. These habitats offer an overhead canopy of needles that shield deer from the cold. Deer congregate in these areas when snow depths exceed about 15 inches and often remain until the snow melts in spring. These winter habitats can be critical in limiting the energy expenditures of deer and supporting the overall survival of this species in the north.

Deep snow can occur anywhere within Johnson, but probably lasts longer into spring in the higher elevation areas within town such as in the northern and southern sections of town. Years with significant snow cover mixed with cold temperatures tax the deer population. In these years, or over multiple years with several harsh snow winters, the cumulative drain on deer energy resources can take its toll. For this reason deer wintering habitats are seen as crucially important to the long-term maintenance of deer populations in the Johnson region.

Deer winter habitat that faces into the sun (either west or south) is often more valuable than east or north facing areas. Eastern hemlock, balsam fir, and Northern white-cedar stands provide the best cover and food value to deer, but pine and spruce will sometimes be utilized. These deer winter habitats are also home to bobcat, fisher, coyote, and scavenging bears that come looking for live deer to eat during the winter or carrion to scavenge in spring. Other animals such as conifer-nesting birds, porcupines and fox utilize these habitats during other seasons.

For this study, potential deer winter habitat was divided into either “likely” or “potential” categories (see Figure 25). Likely deer winter habitats are comprised of evergreen dominated forests such as Hemlock Forests and Hemlock-Northern Hardwood forests that have a west, south, or southwest aspect. These natural communities often receive the heaviest deer use and use tends to be the most consistent from year to year. These “likely” deer winter habitats are those generally sought out in the longest, coldest, and snowiest winters. The strong spring sun in these communities melts snow early and warms cold bodies.

Potential deer winter habitats may be less likely to be used by deer each year-particularly in the coldest and snowiest of years. Some of these communities may not offer the most protection from the cold resulting from a less complete evergreen canopy, the dominance of tree species that do not form a closed protective treed canopy, or even from having a cold northern aspect. Some of these deer winter habitats may be abandoned in early or mid-winter for other more protective overwinter habitats and some may function in varying capacity throughout the winter.

Figure 25. Deer Winter Habitat

All winter deer habitats provide some thermal benefits and aid deer in fending off starvation, cold and a continually declining energy budget during the harsh winter and spring months. Energy loss during the winter and spring is cumulative, that is, whatever fat and energy are lost by deer during the early winter months are not available for deer metabolism during late winter

and spring. For the most part, it is not until plants produce green leafy material or ripen buds in spring that deer climb out of their energetic downhill spiral.

5.1.8. Grassland Bird Habitats

There are numerous bird species that do not utilize forested (or early successional forest) environments to fulfil their breeding requirements. In the Johnson area, grassland birds are probably the largest non-forest dwelling group, and throughout the region, are likely most at risk. Grassland bird species utilize open field grasslands, typically of at least 10 acres or larger for their breeding, nesting and feeding. Many of these species are historically more associated with mid-western prairie habitats, but have established a foothold in the open agricultural fields throughout the northeast.

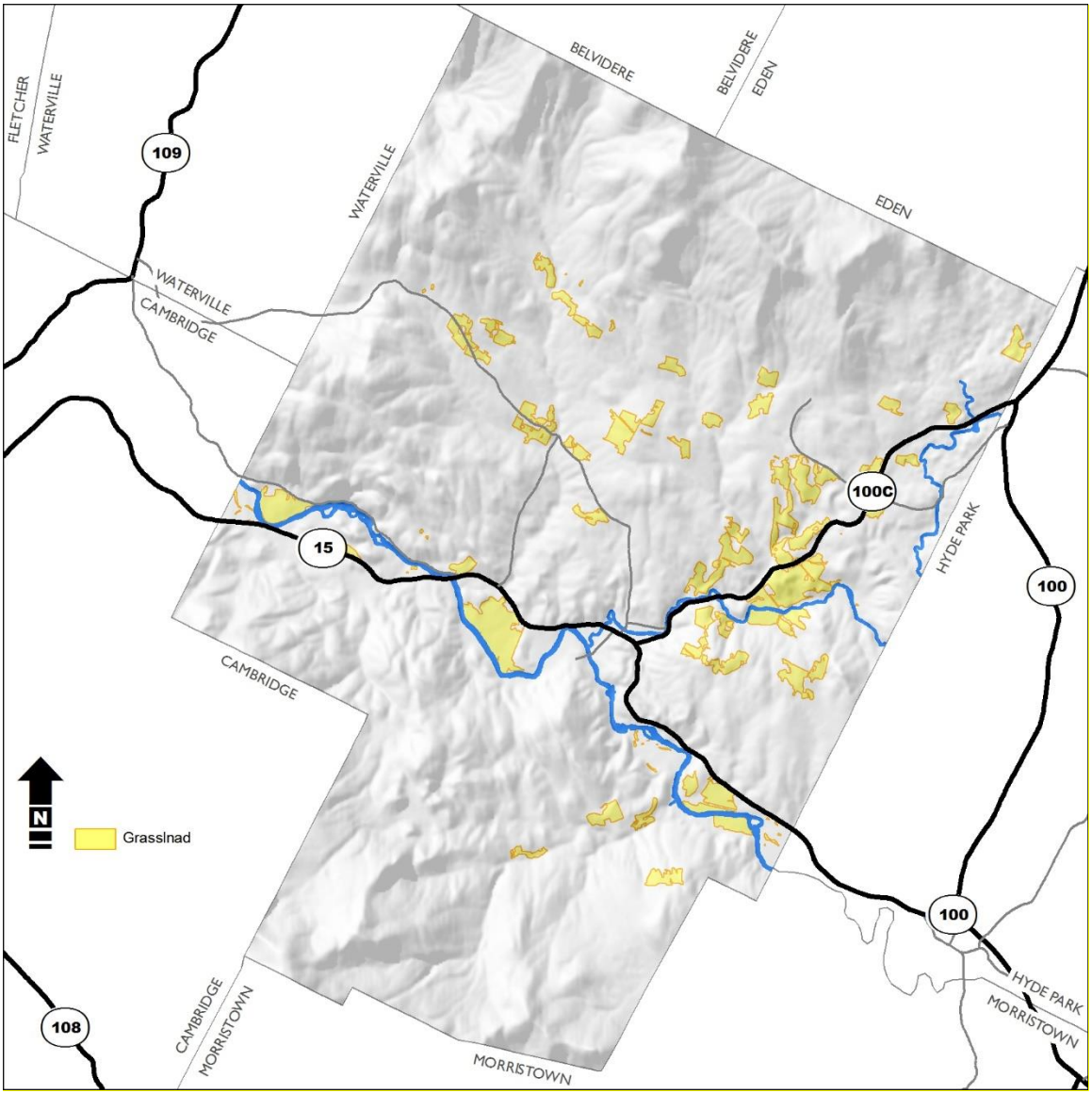

Figure 26. Grassland Habitats

These species, such as bobolink, savannah sparrow and grasshopper sparrow are seeing drastic population declines attributed to a variety of factors. As agricultural practices become more and more mechanized and new genetic modification and nutrient application technologies allow far more frequent grass harvesting, many young fledglings are destroyed while still in the nest from contact with harvesting equipment. Add to that the conversion of hayfields to row crops such as corn and soybeans and extensive deforestation of winter habitats in South and Central America, and these species are losing ground quickly.

Grassland habitats were mapped in this study based on remote review of cover conditions as apparent in aerial photographs. Since grass conditions are highly temporal and very dependent on current management practices, this is only a snapshot of potential grassland that may be providing habitat for this group of species.

Many bird species do not utilize grassland environments to fulfil their breeding requirements. According to the current tally from the 2003-2007 breeding bird atlas there are over 200 bird species that breed in the State of Vermont. In fact, the northern New-England region is referred to as a "veritable breeding factory" by the Partners in Flight Land Bird Conservation Plan (Rich et al, 2004) for its abundance of breeding neo-tropical migrating bird species.

Table 5. Audubon Vt. Forest Responsibility Species

Birds of wetlands and riparian areas	Birds of early-succession and old fields	Birds of high elevation and boreal forest	Birds of mature forests
Swamp Sparrow	Chestnut-sided Warbler	Spruce Grouse	Ovenbird
Lincoln's Sparrow	Mourning Warbler	Black-backed Woodpecker	Wood Thrush
Rusty Blackbird	White-throated Sparrow	Olive-sided Flycatcher	Veery
Alder Flycatcher	Ruffed Grouse	Yellow-bellied Flycatcher	Eastern Wood-Pewee
Louisiana Waterthrush	American Woodcock	Gray Jay	Yellow-bellied Sapsucker
	Nashville Warbler	Cape May Warbler	Black-throated Blue Warbler
	Canada Warbler	Tennessee Warbler	Blackburnian Warbler
	Magnolia Warbler	Blackpoll Warbler	Black-throated Green Warbler
	Northern Flicker	Bay-breasted Warbler	Scarlet Tanager
		Palm Warbler	American Redstart
		Boreal Chickadee	Chimney Swift
		Bicknell's Thrush	Northern Parula
			Purple Finch
			Blue-headed Vireo

Due to this extensive list of breeding bird species, discussion of breeding birds found in the forestlands of Johnson is focused primarily on a set of 40 "Responsibility Species" as developed by Audubon Vermont. This list covers a range of species that have a high proportion of their breeding population within our Atlantic Northern Forest region.

Many of these species are experiencing global declines in population, sometimes severe. However, many of these are fairly familiar to anyone who spends a bit of time in the forests and fields of central Vermont. The species on this list range throughout the forested habitat types found in the region, from big interior forests, to wetlands and forested stream corridors, and on to early successional and regenerating old-field forest types. Focus on these species, and their range of habitat requirements will help insure that these birds, ubiquitous to our region, remain common and that those experiencing sharp declines may be stabilized or restored before being lost for good.

5.2. Contiguous Habitat Units (CHUs)

A total of 23 contiguous wildlife habitat units (CHUs) were identified in Johnson. The following table provides summary data for specific habitat components within the CHUs for the town. A summary data table is provided in Appendix 2 detailing the individual habitat elements within all the CHUs.

Table 6. CHU Wildlife Habitat Summary

Habitat Feature	Core Habitat	Deer Winter Habitat	Streams	Wetland	Early Succession	Forested Riparian	Vernal Pools	Cons. Land
Total Amount in All CHUs	15848 acre	11133 acres	136.9 miles	694 acres	372 acres	4497 acres	8 pools	6424 acres

A description of each CHU is presented below. For each CHU, a list of habitat features is provided. Features in black are present within the unit, and those in grey are absent. Each CHU is also assigned a "Habitat Block" ranking. In 2012, the Vermont Department of Fish and Wildlife completed a project to map and quantify large blocks of wildlife habitat throughout the State. The inputs used in the project were of a coarser scale than applied in the development of Johnson's CHUs, but the habitat blocks identified by Vermont Department of Fish and Wildlife cover the entire state and are ranked relative to habitat areas statewide. Each CHU in Johnson has been assigned the priority ranking value of the underlying Habitat Block. The Vermont Habitat Block scale runs from 0 to 10, with 0 being the lowest conservation priority[A1] ranking and 10 the highest. The ranks of the Johnson CHUs range from 3-7 on the statewide scale. For more information on the Vermont Department of Fish and Wildlife Habitat Block project see: http://tinyurl.com/VtFWHabitatBlocks.

5.2.1. State Forest

5269.3 Acres **Core Forest** **Deer Winter Habitat** **Streams** **Wetlands** **Early Succession** **Forested Riparian** **Mast Stands** Ledge/Cliff/Talus **Bear Wetlands** **Vernal Pools** **Sig. Nat Comm** **48% Conserved** **ANR Block Priority: 6**	 Wetland Complex in State Forest CHU

The State Forest area is the largest contiguous wildlife habitat in Johnson consisting of 5246 acres of forest, stream, and wetland located south and west of French Hill Road. There are 4545 acres of core forest habitat in this CHU. State Forest ranges in elevation from 497' - 3086' elevation and contains Caper Hill and the foothills of the Sterling Range and continues to the west and south in neighboring towns. The forest is dominated by northern hardwoods on the hillsides and montane forests at higher elevations. This CHU contains over 24 miles of streams, nearly 900 acres of forested riparian habitat and over 100 acres of wetland habitat, including a large beaver wetland that likely functions as a bear wetland. The area has extensive early successional forest habitat, large areas of masting trees, and a vernal pool. The lower and mid-elevations contain over 2000 acres of deeryard habitat, most of which is in the "likely used" category. Higher elevations likely harbor montane birdlife including Bicknell's Thrush. Over 2490 acres of this CHU are conserved, much of it as state forest land but also as the Johnson Town Forest.

Local sightings of bear, bobcat, moose, and interior forest songbirds have been reported in this CHU along with numerous amphibian crossings on French Hill Road associated with vernal pools and wetlands.

5.2.2. Butternut Mtn

5171.6 Acres **Core Forest** **Deer Winter Habitat** **Streams** **Wetlands** **Early Succession** **Forested Riparian** **Mast Stands** **Ledge/Cliff/Talus** **Bear Wetlands** **Vernal Pools** **Sig. Nat Comm** **53% Conserved** **ANR Block Priority: 9**	 Recent Bear Nests in Northern Hardwood Forest on Butternut Mountain

This CHU is the second largest in Johnson with contiguous wildlife habitat over 5195 acres, providing 4380 acres of remote core wildlife habitat. This CHU includes much of the north part of Johnson, including Butternut Mountain and ranges in elevation from 799' - 2643'. Wild land extends north into the Towns of Eden and Belvidere. The Butternut CHU provides over 37 miles of streams and 1278 acres of forested riparian wildlife habitat. The well-drained slopes of this area have Northern Hardwood Forests, while the higher elevations have Montane Red Spruce - Balsam Fir forests. Mixed Hemlock Forests are more common at lower elevations. Over 1820 acres of deeryard habitat occur here, some of which is high quality ("likely used" category). Grassland habitats are found near this unit at lower elevations as are early successional forests. This wildlife habitat unit includes several areas of mast, especially American beech trees which have been climbed by black bear. Over 100 acres of wetlands are present including remote beaver wetlands which are potential bear wetlands. There are at least 2 vernal pools in this CHU and ledge habitat as well. There are 2744 acres of conserved land in this CHU.

Local citizens have reported numerous wildlife sightings in this area. An abandoned talc mine has been used by bats as a hibernacula. There have been several reports of bear sightings, the presence of bear scarred beech trees, apple trees used by bear and potential bear dens. Moose have also been reported within this CHU. Several ledges that are likely used by wildlife have also been identified.

5.2.3. Prospect

2432.8 Acres
Core Forest
Deer Winter Habitat
Streams
Wetlands
Early Succession
Forested Riparian
Mast Stands
Ledge/Cliff/Talus
Bear Wetlands
Vernal Pools
Sig. Nat Comm
24% Conserved
ANR Block Priority: 7

This 2433 acre CHU is located in western Johnson north of Hogback Road and includes Prospect Rock. This is the largest wildlife unit close to Route 15. The CHU also rises to over 1700 feet elevation. Most of the forests are composed of Northern Hardwood Forests and Hemlock-Northern Hardwood Forests with lesser amounts of Hemlock Forest. There are over 11 miles of streams and 423 acres of streamside riparian forests. The Prospect CHU has early successional habitat and nearby grasslands. There are substantial mast stands as well as numerous ledge habitats and potential bear wetlands. This CHU contains 2 vernal pools and provides 2077 acres of core wildlife habitat and over 1355 acres of deeryard habitat, much of which is categorized as "likely used". Five-hundred and ninety-four acres in this area are conserved.

Deeryard use of the lower conifer forests was reported during the winter of 2017. Sign of moose, bobcat, fisher and mink have also been reported in this CHU.

5.2.4. Barrows

1531.4 Acres
Core Forest
Deer Winter Habitat
Streams
Wetlands
Early Succession
Forested Riparian
Mast Stands
Ledge/Cliff/Talus
Bear Wetlands
Vernal Pools
Sig. Nat Comm
20% Conserved
ANR Block Priority: None

Beaver-influenced Wetland in Barrows CHU

This 1531 acre CHU is located in northwestern Johnson and spans over 1000 feet of elevational change. This CHU as mapped in only a portion of the actual habitat, which continues in the neighboring town of Waterville. This area is dominated by expansive Northern Hardwood

Forests, with lesser amount of mixed hardwood-conifer forests. This CHU contains over 14 miles of streams and over 450 acres of streamside riparian habitat. There are over 50 acres of wetlands here, including a vernal pool and potential bear wetlands. There are large beaver-influenced wetlands just north of Foote Brook Road. This area has extensive grasslands nearby and contains 16 acres of early successional wildlife habitat with additional acreage likely due to recent forest management activities. Barrows CHU provides 1198 acres of core wildlife habitat and 444 acres of deeryard habitat, some of which is high quality, south-facing habitat "likely used" by deer. Three hundred and eight acres of this CHU are conserved.

5.2.5. Sterling Slopes

1162.7 Acres
Core Forest
Deer Winter Habitat
Streams
Wetlands
Early Succession
Forested Riparian
Mast Stands
Ledge/Cliff/Talus
Bear Wetlands
Vernal Pools
Sig. Nat Comm
0% Conserved
ANR Block Priority: None

The Sterling Slopes CHU borders the town of Cambridge, just south of Route 15 and consists of 1163 acres. This CHU is dominated by Northern Hardwood Forests and Hemlock-Northern Hardwood Forests providing 970 acres of core wildlife habitat. The area contains some early successional habitat as well as remote ledge habitat. This CHU contains over 8 miles of streams and over 290 acres of forested riparian wildlife habitat. It harbors over 38 acres of wetland habitat, including a large Shallow Emergent Marsh and a potential bear wetland Alder Swamp near Route 15. There are 659 acres of deeryard habitat, much of which is categorized as "likely used".

5.2.6. French Hill

805.9 Acres **Core Forest** **Deer Winter Habitat** **Streams** **Wetlands** **Early Succession** **Forested Riparian** Mast Stands Ledge/Cliff/Talus **Bear Wetlands** Vernal Pools **Sig. Nat Comm** **3% Conserved** **ANR Block Priority: 6**	 Deer and coyote trail or narrow ridge, French Hill CHU

French Hill CHU is an 806 acre wildlife habitat located south of Route 15 between French Hill and Waterman Road in central Johnson. The forest is dominated by Hemlock-Northern Hardwood communities. There are early successional and grassland wildlife habitats both along French Hill and Waterman Roads. The CHU contains Shallow Emergent Marsh and open water wetlands, including potential bear wetlands. French Hill has over 2 miles of streams and more than 75 acres of forested riparian habitat. Over 500 acres of the CHU are core wildlife habitats. The unit has 720 acres of mapped deeryard habitat, much of which consists of Hemlock Forest categorized as “likely used” by deer. The CHU contains 25 acres of conserved wildlife habitat.

5.2.7. Porcupine Hill

649.3 Acres
Core Forest
Deer Winter Habitat
Streams
Wetlands
Early Succession
Forested Riparian
Mast Stands
Ledge/Cliff/Talus
Bear Wetlands
Vernal Pools
Sig. Nat Comm
11% Conserved
ANR Block Priority: 5

This 650 acre wildlife CHU extends north from Route 15 up to Sinclair Road along Johnson's eastern border with Morristown. This mid-elevation area is dominated by Hemlock-Northern Hardwood Forest which comprises the majority of this CHU's 294 acres of core wildlife habitat. This CHU contains an extensive beaver-influenced wetland that may serve as a bear wetland. The area also contains over a mile of streams and 67 acres of forested riparian habitat. Porcupine Hill has substantial grassland and early successional wildlife habitats and over 70 acres of conserved land. Over 500 acres are mapped as deeryard habitat, some of which is south-facing or flat and is categorized as “likely used” by deer.

Local citizens confirmed use of the deeryard in 2017, and reported recent use of this CHU by both fisher and coyote.

5.2.8. Hall Brook

528.6 Acres
Core Forest
Deer Winter Habitat
Streams
Wetlands
Early Succession
Forested Riparian
Mast Stands
Ledge/Cliff/Talus
Bear Wetlands
Vernal Pools
Sig. Nat Comm
2% Conserved
ANR Block Priority: None

Evidence of extensive deeryard use in the Hall Brook CHU

Hall Brook CHU is a 529-acre wildlife habitat located along the Lamoille River in the eastern part of Johnson where it continues into Morristown. The forest is dominated by Hemlock Forest and

Hemlock-Northern Hardwood Forest natural communities. This CHU contains small areas of early successional forest and grassland habitats along Waterman and Grow Roads. It contains about 5 acres of mapped wetlands and over 500 acres of mapped deeryard habitat. Field investigation confirmed deer use in winter of 2016-17. Both mast resources and potential bear wetlands are present. This CHU contains over 3.9 miles of streams and over 100 acres of forested riparian habitat.

5.2.9. Foote Brook

451.7 Acres **Core Forest** **Deer Winter Habitat** **Streams** **Wetlands** **Early Succession** **Forested Riparian** Mast Stands Ledge/Cliff/Talus **Bear Wetlands** Vernal Pools **Sig. Nat Comm** **0% Conserved** **ANR Block Priority: 4**	 Hemlock Forest at Journey's End- Foote Brook CHU

The Foote Brook CHU is a 452-acre habitat located in the center of town, just west of Johnson Village. The CHU is dominated by Hemlock Hemlock-Northern Hardwood Forests. Because the CHU has several narrow arms -- it contains only 171 acres of core forest. The area has a nice conifer swamp (a potential bear wetland) deep in its woods, contains over 4 miles of streams, and has 119 acres of forested riparian wildlife habitat. Large grasslands habitats border the CHU and early successional forest lies within its borders. Over 350 acres of the CHU are deeryard habitat, much of this is south or south-west facing and categorized as "likely used" by deer. Field investigation confirmed the use of this deeryard by deer in the winter of 2016-2017. This area includes the Journey's End Town Forest and swimming hole on Foote Brook.

5.2.10. Clay Hill

378.3 Acres **Core Forest** **Deer Winter Habitat** **Streams** **Wetlands** **Early Succession** **Forested Riparian** Mast Stands Ledge/Cliff/Talus Bear Wetlands Vernal Pools Sig. Nat Comm **0% Conserved** **ANR Block Priority: 4**	 Deer use in a Hemlock Forest northeast of Johnson State College

This CHU consists of the 386-acre habitat unit north of Johnson State College and south of Cemetery Street. This mixed forest habitat provides 198 acres of core wildlife habitat. Hemlock and Hemlock-Northern Hardwood Forests (mixed with white pine) make up this CHU. It contains early successional forest, small wetlands, over 1 mile of stream habitat and 55 acres of forested riparian habitat. Over 292 acres of this CHU consist of deeryard habitat, some of which is classified as “likely used”, and parts of which were utilized by deer during the winter of 2016-17.

Over the years local citizens have identified an amphibian crossing in the north. In addition, moose and fisher have been observed in this CHU. A deer crossing area has also been identified near the intersection of Clay Hill and Cemetery Roads.

5.2.11. East Lamoille

386.2 Acres
Core Forest
Deer Winter Habitat
Streams
Wetlands
Early Succession
Forested Riparian
Mast Stands
Ledge/Cliff/Talus
Bear Wetlands
Vernal Pools
Sig. Nat Comm
29% Conserved
ANR Block Priority: None

The East Lamoille CHU is located in eastern Johnson, south of Whitcomb Island Road and bordering Hyde Park. This 386 acre CHU is dominated by Hemlock and Hemlock-Northern Hardwood Forests. This area provides 159 acres of core wildlife habitat, as well as deeryards and early successional habitat. Portions of the deeryard habitat rank as "likely used" by deer. There are shrub and marsh wetlands within this mid-elevation wildlife habitat as well as a vernal pool. The CHU contains a little over a mile of streams, much of it consisting of the Gihon River, and 49 acres of forested riparian habitat. There are 111 acres of conserved land in this CHU.

Beaver have been reported on the banks of the Gihon River here.

5.2.12. Dukes

384.3 Acres
Core Forest
Deer Winter Habitat
Streams
Wetlands
Early Succession
Forested Riparian
Mast Stands
Ledge/Cliff/Talus
Bear Wetlands
Vernal Pools
Sig. Nat Comm
0% Conserved
ANR Block Priority: None

The Dukes CHU is a 385-acre wildlife habitat is located west of Ober Hill Road in northeastern Johnson. This mid-elevation forest is dominated by Hemlock and Hemlock-Northern Hardwood Forests. The unit contains early successional wildlife habitats, nearby grassland habitats, and mast trees. This CHU contains over 2.8 miles of streams and 66 acres of forested riparian habitat. A roadside beaver wetland is present and some Seepage wetlands are potential bear wetlands. This CHU also contains 220 acres of core wildlife habitat. There are 342 acres of deeryard mapped in this CHU and a portion of the area is categorized as "likely used" by deer.

5.2.13. Wild Brook

327.9 Acres
Core Forest
Deer Winter Habitat
Streams
Wetlands
Early Succession
Forested Riparian
Mast Stands
Ledge/Cliff/Talus
Bear Wetlands
Vernal Pools
Sig. Nat Comm
0% Conserved
ANR Block Priority: 5

This 328-acre mid-elevation wildlife unit is located in the far northeastern corner of Johnson near Route 110 C. This CHU has 24 acres of early successional habitat and has some grasslands contiguous to it. The forest is dominated by Hemlock and Hemlock-Northern Hardwood Forests. The area contains almost 2.7 miles of streams and has 76 acres of forested riparian habitat. There are minor amounts of wetlands, 113 acres of core habitat, and over 300 acres of deeryard habitat within Wild Brook CHU. Small sections of these deeryards are categorized as “likely used”.

5.2.14. Bell Brook

307.1 Acres
Core Forest
Deer Winter Habitat
Streams
Wetlands
Early Succession
Forested Riparian
Mast Stands
Ledge/Cliff/Talus
Bear Wetlands
Vernal Pools
Sig. Nat Comm
0% Conserved
ANR Block Priority: None

The Bell Brook CHU is a 307-acre habitat located south of Ben Ober Road and west of Patch Road. It is dominated by Hemlock and Hemlock-Northern Hardwood Forests. These communities provide for 169 acres of core forest wildlife habitat. This CHU has early successional forest, nearby grassland habitat, over 2.8 miles of streams and 67 acres of forested riparian habitat. Fourteen acres of wetland are found in the Bell Brook CHU, some of which is mapped as potential bear wetland. About 225 acres of this forest has been mapped as deeryard, much of which is south to southwest-facing, and categorized as “likely used”.

Grasslands near Clay Hill Road have been reported as harboring grassland birds and beaver ponds in the CHU are reported to contain wood frogs.

5.2.15. Johnson Village

255.3 Acres
Core Forest
Deer Winter Habitat
Streams
Wetlands
Early Succession
Forested Riparian
Mast Stands
Ledge/Cliff/Talus
Bear Wetlands
Vernal Pools
Sig. Nat Comm
0% Conserved
ANR Block Priority: 3

The 255 acre Johnson Village CHU is located along Lower Main St. just north of the Lamoille River. This relatively low-lying area is dominated by Hemlock and Hemlock-Northern Hardwood Forests. This unit contains small areas of core forest, early successional habitat, wetlands, streams, and forested riparian habitat. The CHU does contain 83 acres of core habitat and a relatively small south and south-west facing deeryard that is categorized as "likely used" deeryard habitat.

Local citizens have reported a historic deer crossing in the north of this CHU across Collins Hill Road.

5.2.16. Gihon North

237.5 Acres
Core Forest
Deer Winter Habitat
Streams
Wetlands
Early Succession
Forested Riparian
Mast Stands
Ledge/Cliff/Talus
Bear Wetlands
Vernal Pools
Sig. Nat Comm
1% Conserved
ANR Block Priority: 4

The Gihon North CHU is a 238-acre mid-elevation habitat unit located in northeastern Johnson north east of Wilson Road. The forest consists of Hemlock and Hemlock-Northern Hardwood Forest communities. This CHU also contains early successional and nearby grassland wildlife habitats. It is dominated by the Gihon River and large beaver-influenced emergent wetlands which also serve as potential bear wetlands. Over 3.3 miles of rivers and streams as well as almost 100 acres of forested riparian habitat are located within this CHU. Gihon North has only 54 acres of core habitat but provides over 185 acres of deeryard habitat, some of which is flat and "likely used" as deeryard. Three acres of conserved land are found here.

5.2.17. Swamp Rd

219.2 Acres
Core Forest
Deer Winter Habitat
Streams
Wetlands
Early Succession
Forested Riparian
Mast Stands
Ledge/Cliff/Talus
Bear Wetlands
Vernal Pools
Sig. Nat Comm
0% Conserved
ANR Block Priority: 4

The Swamp Rd CHU is a mid-elevation 219-acre habitat southeast of the intersection of Codding Hollow and Swamp Roads. The forest here is dominated by Hemlock and Hemlock-Northern Hardwood Forest communities. The CHU contains early successional habitats and grasslands nearby. This area has small wetlands which are potential bear wetlands. There are 1.6 miles of streams and 45 acres of forested riparian habitat. Sixty-six acres of core are contained within this CHU, and the area has 186 acres of deeryard habitat - large sections of which are south-facing and categorized as “likely used” habitat.

Grassland birds have been recently reported near Clay Hill Road.

5.2.18. West Settlement

195.4 Acres
Core Forest
Deer Winter Habitat
Streams
Wetlands
Early Succession
Forested Riparian
Mast Stands
Ledge/Cliff/Talus
Bear Wetlands
Vernal Pools
Sig. Nat Comm
0% Conserved
ANR Block Priority: None

This relatively small (195 acres) CHU is south of Route 15 located in the foothills of the Sterling Range of the Green Mountains and reaches over 1100 feet in elevation. The forest in this CHU is dominated by Northern Hardwoods and 119 acres is considered core wildlife habitat. The area contains both deer and bear habitat with substantial mast trees and potential bear wetlands. Small sections of the deeryard habitat are categorized as “likely used” habitat. The West Settlement CHU contains over 3 miles and 100 acres of stream and forested riparian habitat. The expansive forests of Cambridge and the Green Mountains are west of and contiguous with this CHU.

5.2.19. Cemetery

188.3 Acres
Core Forest
Deer Winter Habitat
Streams
Wetlands
Early Succession
Forested Riparian
Mast Stands
Ledge/Cliff/Talus
Bear Wetlands
Vernal Pools
Sig. Nat Comm
0% Conserved
ANR Block Priority: 4

Cemetery CHU is a 188-acre habitat located north of Johnson Village, west of Clay Hill and northeast of Plot Road. This small unit is surrounded by roads. This area is mid-elevation and the forest is dominated by a mix of hemlock and northern hardwood communities. The CHU has small areas of early successional habitat and is adjacent to large grassland habitats. There are over 2.5 miles of streams and 58 acres of forested riparian wildlife habitat. There is a mixed conifer-hardwood swamp along a stream within the interior of this CHU. The Cemetery CHU provides 54 acres of core habitat and 179 acres of deeryard wildlife habitat.

5.2.20. Plot

150.3 Acres
Core Forest
Deer Winter Habitat
Streams
Wetlands
Early Succession
Forested Riparian
Mast Stands
Ledge/Cliff/Talus
Bear Wetlands
Vernal Pools
Sig. Nat Comm
0% Conserved
ANR Block Priority: 4

Mixed emergent marsh and forested swamp in Plot CHU

Plot is a 150-acre mid-elevation CHU and is located in central Johnson between Plot and Foot Brook Roads. The CHU is dominated by Hemlock and Hemlock-Northern Hardwood Forests. This CHU also contains early successional forests and has grasslands bordering it. It contains

about 0.6 miles of streams and contains a small amount of forested riparian habitat, and larger amounts of wetland habitat including Hemlock-Balsam Fir-Black Ash Seepage Swamps, which are potential bear wetlands. Much of this CHU is undergoing active forest management. This CHU provides 53 acres of core habitat and 133 acres of deeryard, a small section of which is categorized as "likely used" deeryard habitat.

5.2.21. Gihon South

135.5 Acres **Core Forest** **Deer Winter Habitat** **Streams** **Wetlands** Early Succession **Forested Riparian** Mast Stands Ledge/Cliff/Talus **Bear Wetlands** Vernal Pools **Sig. Nat Comm** **0% Conserved** **ANR Block Priority: 5**	 Gihon River Swamp in the South Gihon CHU

The Gihon South CHU is a relatively small (135 acres) habitat located along the border with Hyde Park, south of Wilson Road. The habitat consists of Hemlock and Hemlock-Northern Hardwood Forest communities. A large wetland complex with beaver-influenced emergent marsh, shrub wetlands, and a large Hemlock-Balsam Fir-Black Ash Seepage Swamp form the interior of this habitat. The large swamp is a state significant natural community and is a potential bear wetland. Areas within this wetland complex have dense early successional conifers and are utilized by numerous snowshoe hares, fox, and coyotes. The surrounding upland conifers serve as deeryard habitat, some of which is high quality and categorized as "likely used" habitat. Small streams and the Gihon River provide over 1 mile of stream and over 50 acres of forested riparian habitat.

5.2.22. Fairground

119 Acres
Core Forest
Deer Winter Habitat
Streams
Wetlands
Early Succession
Forested Riparian
Mast Stands
Ledge/Cliff/Talus
Bear Wetlands
Vernal Pools
Sig. Nat Comm
0% Conserved
ANR Block Priority: None

The Fairground CHU is a 125-acre mid-elevation wildlife habitat south of the Mines Road in Johnson. This CHU is dominated by Hemlock and Hemlock-Northern Hardwood Forests. Because of this CHU's long narrow shape with narrow arms there is no core forest habitat. This CHU is surrounded by extensive grassland habitats, and contains small amounts of wetlands and early successional wildlife habitat. The site has over 2 miles of streams and 58 acres of forested riparian habitat. The conifer forests provide over 100 acres of deeryard habitat, much of which is of high quality as categorized as “likely used” habitat.

5.2.23. West Lamoille

119.9 Acres
Core Forest
Deer Winter Habitat
Streams
Wetlands
Early Succession
Forested Riparian
Mast Stands
Ledge/Cliff/Talus
Bear Wetlands
Vernal Pools
Sig. Nat Comm
44% Conserved
ANR Block Priority: 5

The West Lamoille CHU is a small, 120-acre habitat area located north of Route 15 and south of Hogback Road. The low-lying forest is dominated by Hemlock-Northern Hardwood Forests. This forest contains small amounts of early successional forests, is close to substantial grasslands, and provides 50 acres of core wildlife habitat. This CHU contains numerous small stream, forested riparian habitat as well as a section of the Lamoille River away from Vermont Route 15. Over 100 acres of largely south or south-western conifer forests serve as winter deeryards as well. Fifty- three acres of this habitat unit are conserved.

5.3. Travel Corridors

5.3.1. General Wide-Ranging Mammal Corridors

Travel corridors are places where landscape and land use characteristics combine to form an area where wildlife can move across roads to and from different habitat areas. Many species of wildlife utilize a diversity of different habitat and plant community types within their home ranges (or territories). Wildlife move across the landscape for a variety of reasons, most often in search of new territories, food resources, or potential mates.

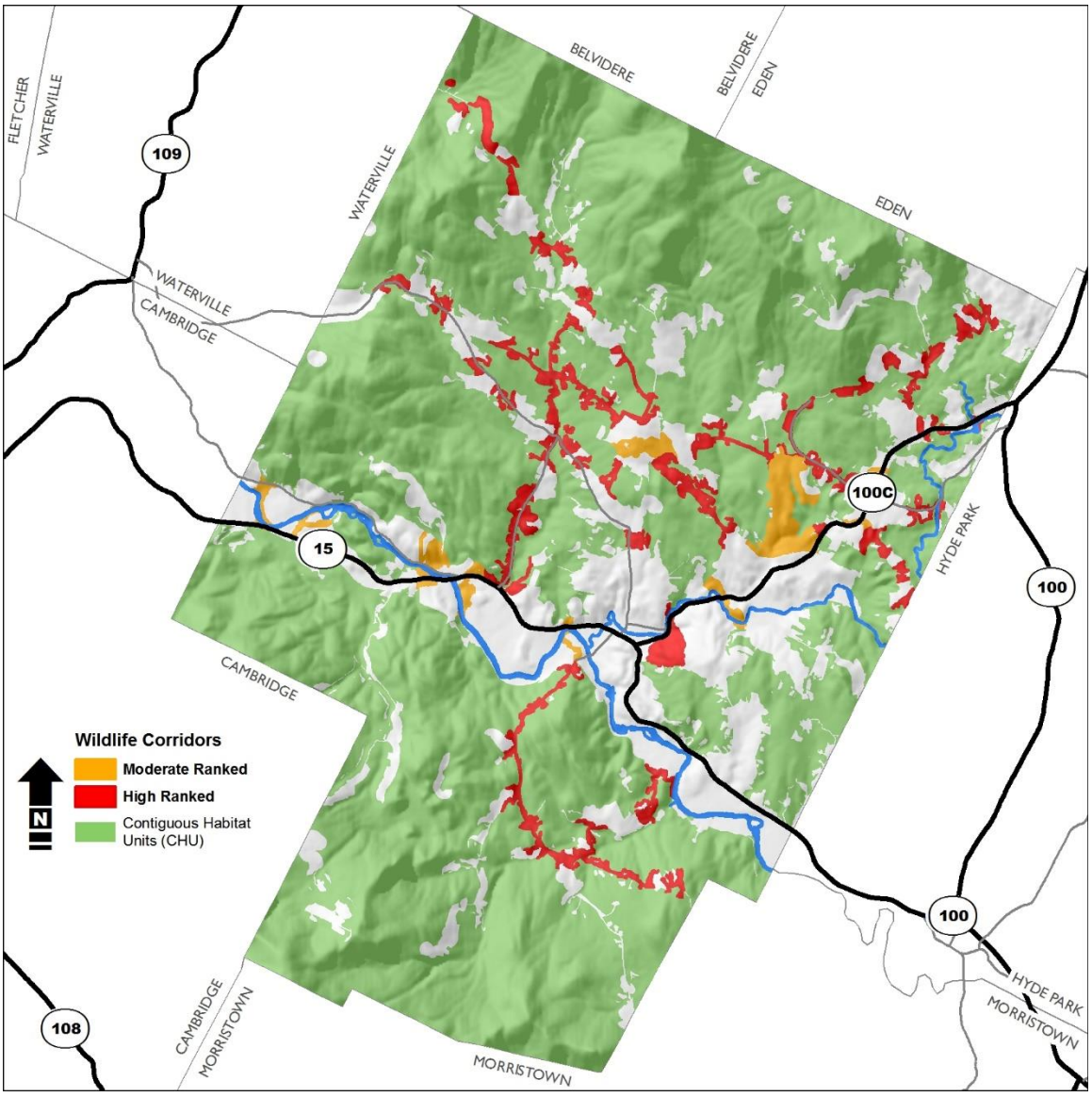

Figure 27. Corridors

A good example to illustrate seasonal wildlife movements is that of the black bear in Vermont. The black bear typically moves in spring from its high, remote denning areas to wetlands (often

forested seeps) lower on the landscape. In summer, bear will seek berry patches (soft mast) in openings and along old logging roads within the forest. In fall, bears will move to beech stands, orchards, or corn fields depending on the availability of natural foods in the forest.

Many of the wide-ranging wildlife corridors identified in Johnson are located within areas of limited development and contain large, significant habitat features in close proximity to the corridors. As would be expected, wide ranging mammals are likely to find these areas most preferential as movement zones due to the relative lack of human disturbance and the necessities of moving between critical food, cover and/or other habitats. General wildlife corridors for wide ranging species are shown in Figure 27.

The potential corridors identified in Johnson are based on permeability of the landscape- that is, the assumption that wildlife will be more comfortable moving through certain landscape conditions than others. Not considered in this initial evaluation are specific resources that may be drawing certain types of wildlife- for example nearby beech stands might result in heavier bear use, while a stream between two wetland complexes may see more activity by beaver and otter.

While a few potential travel corridors were identified along the Lamoille River valley, in general this area appears difficult to cross from a wildlife perspective. The farmland and heavily traveled roads help to isolate the northern half of town from the southern half. Improvement and expansion of the vegetated buffer conditions of the Lamoille River and the tributaries feeding it could assist in improved north-south wildlife permeability. In addition, maintenance of forested conditions within some of the smaller valley CHUs such as West Lamoille and Johnson Village is beneficial as they provide cover and rest “islands” in a matrix of developed land, effectively shortening the travel distances between larger forest blocks. Near the junction of Hogback Road and Route 15 numerous wildlife tracks crossing these roads were observed. Efforts at improving the attractiveness of this crossing, such as increasing roadside vegetation, might yield ever greater crossing rates in the future.

As part of the field assessment, winter road tracking was conducted with the goal of documenting road crossings and travel corridors currently being used by wildlife in Johnson. The Road Tracking Map, Figure 28 below, presents the summary of this data.

Areas along Foote Brook Road south of Joe Brook Branch experienced many wildlife crossings in the winter of 2017. Nearby, at the junction of Clay Hill and Plot Roads one of the heaviest concentration of wildlife crossing was observed during our road tracking exercises. This area just north of Johnson Village also includes the intersection of Clay Hill and Swamp Roads. On Route 100C the greatest concentration of winter road crossings was near Sandy Birch Road and just north of the Ober Hill intersection with 100C.

The dirt roads extending deep into Johnson’s hills such as French Hill, Coddling Hollow, and upper Plot Roads generally do not have areas of high concentration of wildlife crossings, instead these more remote and less frequently travelled roads are crossed nearly equally all along their lengths.

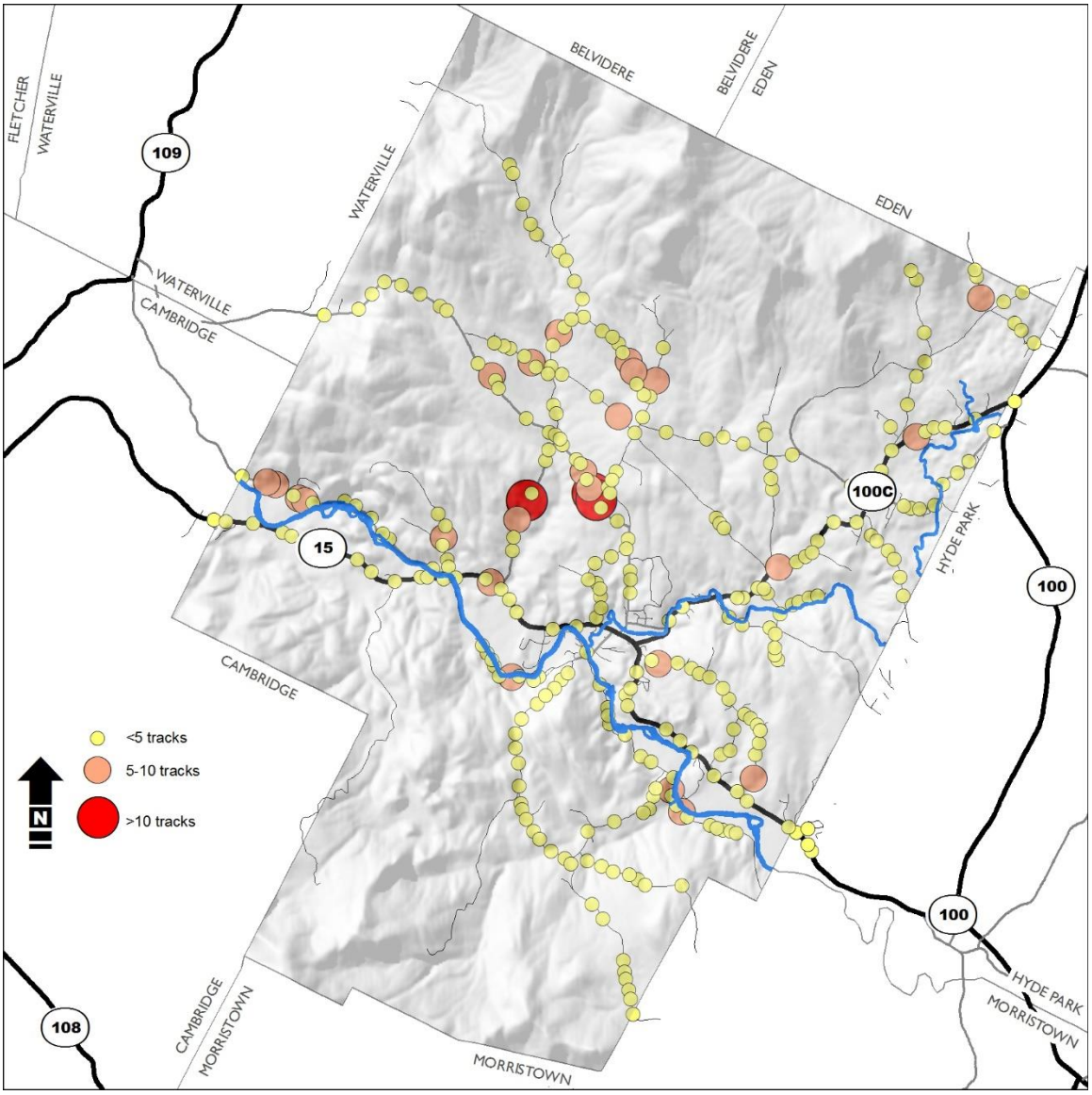

Figure 28. Road-tracking results

Wildlife in Johnson and elsewhere cross roads seasonally to access, food, space, and during breeding seasons, to find a mate. Deer movements during the winter were generally associated with coniferous forest cover, and then most often hemlock forest. Deer may seek denser canopy cover as the snow deepens and winter progresses. Young animals may cross roads as they leave their mother's homes ranges and disperse into their own territories. The wariest of species such as the black bear cross heavily travelled paved roads very infrequently -- and generally those crossing are subadult bears or males in search of mates.

Signs of aquatic mammals such as mink and otter were most often observed near wetlands or watercourses such as along the Gihon and Lamoille Rivers or the large wetlands associated

with these waters. Often these species and others such as the red fox will use culverts to cross under roads.

These probable corridors should be field verified and, if used by wildlife, should be considered as high conservation and protection priorities. Additional corridor areas may also be discovered during additional field and more detailed, site-specific evaluation.

5.4. Management Recommendations for Wildlife Habitat

5.4.1. Large Contiguous Habitat Units

The following recommendations apply in principle to all of Johnson's CHUs but are more important in the eight larger CHUs where the wariest of Johnson's wildlife such as black bear likely reproduce.

- Forest fragmentation in these larger CHUs should be discouraged. Roads, housing and most other human activities should be restricted to the periphery of these units.
- Forest management activities that support a diversity of forest and early successional natural communities are an appropriate use of these areas.
- Roads built to facilitate forest management activities should be closed and allowed to revegetate when management activities are completed in an area.
- Old forest roads should have barriers placed at their entrance to discourage use of motorized vehicles.
- Natural connections between the various wildlife habitats/elements within the units should be maintained.
- To maintain deep forest habitat for many declining songbirds, heavy forest cutting which promotes the development of edge conditions should be limited in these areas.

5.4.2. High Elevation Bird Habitat

High elevation songbird habitat is found in the Butternut and State Forest CHUs. Bicknell's thrush and other high-elevation birdlife may nest in the higher elevations (generally above 2700 ft) within these units.

- Any forest removing activities proposed for areas above 2700 ft should be assessed by a professional biologist to ensure the minimization of impact to Bicknell's' thrush breeding habitat.

5.4.3. Grassland Bird Habitat

As mentioned above, the presence of suitable habitat to support grassland bird species is in decline. The availability of this habitat is dependent upon proper land management. There are a number of resources available to assist landowners in developing management practices that not only provide for successful breeding by grassland species, but also allow continued agricultural use of the land.

Additional information about land management activities that can directly benefit grassland birds is available from Audubon Vermont at: http://vt.audubon.org. Communities should consider encouraging landowners to work with Audubon and other partners such as the USDA NRCS (Natural Resource Conservation Service) to provide and maintain grassland bird habitat. The Vermont Department of Fish & Wildlife provides a number of management guidelines for grassland birds on the following webpage: http://www.vtfishandwildlife.com/cwp_elem_spec_gbh.cfm. Audubon Vermont has recently taken over the Bobolink Project, a win-win initiative where farmers are paid to leave their fields uncut until after bobolink and other grassland bird species have fledged. Participation takes two forms- farmers willing to delay mowing in exchange for monetary reimbursement, and financial donations by those interested in directly supporting grassland bird conservation efforts.

5.4.4. Bear Habitat

Black bears require extensive remote areas to meet their yearly habitat requirements. Large, non-road areas must be preserved to maintain sustainable populations within Johnson. Bears must continue to have access to mast stands and forested wetlands. Bear habitat management can also focus on beech stands that have documented bear use (see Wildlife Habitat Elements Map included in the Appendix).

- Mapped beech stands and forested wetlands utilized by bear should be protected from development activities with buffers ¼ mile in extent.
- A professional biologist should address potential impacts to bear and their populations for activities within ¼ mile of bear habitat.
- Harvesting of beech that shows current or historic use by bear should be discouraged, even if Beech Bark Disease is present.

5.4.5. Ledge, Talus, and Cliff Habitats

Ledge, talus and cliff habitats are utilized by nesting birds, resting wildlife, and in some cases denning bobcats and porcupine.

- Concentrated human development activities should be discouraged on and near remote ledges, talus, and cliffs, or ledges, talus, or cliffs actively occupied by wildlife.
- A minimal 100’ buffer should be maintained between these habitats and human development activities.
- Artificial lighting should be discouraged within 200’ - 300’ from these resources.

5.4.6. Deer Winter Habitat

These habitats are critical to the survival and maintenance of deer populations in Johnson. Without deer winter habitat preservation, deer populations could decline.

- Deer winter habitats identified in this report should be protected from human activities by 300’ buffers.

- A professional biologist should assess potential impacts from human development activities (except forest management activities) proposed within 300' of deer winter habitats.

5.4.7. Forested Riparian Communities

Forested riparian habitats offer important wildlife habitat and provide cover for wildlife movement.

- Wherever possible, forested riparian communities should not be fragmented by human activities.
- Forest management activities in forested riparian communities should utilize selective harvesting techniques only and maintain a continual forest cover.

5.4.8. Travel Corridors

Functioning travel corridors allow for the movement of wildlife across the landscape. Conservation of wildlife travel corridors is often a difficult undertaking in that much of the negative impact to these features happens slowly over time. The effect on a particular corridor from one residential development, for example, may be small. Over the years, however, as more small development occurs, the once functioning travel corridor may receive less use and eventually be abandoned. Concrete management recommendations for the travel corridors presented here are, therefore, difficult to develop. The following steps, however, will increase the knowledge about the specific corridors in Johnson and enable planners to draw more specific conservation guidelines.

- Conduct field verification studies to identify and characterize the important travel corridors within the Johnson region and especially those identified in this study.
- Prioritize these travel corridors for conservation action.
- Take steps to conserve the most important travel corridors by creating isolation buffers around them to maintain wildlife movement patterns.
- Limit development to the outside edge of corridors and encourage screening, natural color schemes and other actions to limit negative effects of development in or near corridors.
- Limit artificial lighting within and adjacent to wildlife corridors.
- Improve vegetated buffer conditions along rivers and streams to provide protected movement opportunities for wildlife.
- Promote the growth of natural dense vegetation as close to the road edge as possible at important crossing areas.
- Inventory culverts and other stream-crossing structures for their ability to provide aquatic organism passage as well as road crossing opportunities for land-based wildlife.
- Provide natural banks and stream bottoms in the design and installation of any new or replacement culverts and bridges.

6. Conclusions

In the heart of the Green Mountains, the town of Johnson contains a diverse array of wetlands, upland natural communities and wildlife habitats. From the high elevation Montane forests down to the river-bottom Floodplain Forests, the topographic variation provides a backdrop for the natural features of the town.

This Natural Resource Inventory mapped a total of 18 different wetland natural communities in the town, comprising 923 total acres. Floodplain Forests, Alluvial Shrub Swamps and Marshes are common in the Lamoille and Gihon River valleys and provide important functions and values in these low-lying areas. In the hill and mountainous regions of the town, Seeps, Seepage Forests, and various forested swamps are common. This includes a surprising number of Hemlock-Balsam Fir-Black Ash seepage swamps. Two of these swamps that were visited during this inventory were determined to be state significant, while many more wait to be explored and assessed. Beaver influenced wetlands are also a significant part of the wetland landscape in the town. Many of the smaller streams have been dammed by beavers, creating a dynamic system of wetlands which provide valuable wildlife habitat. Finally, two peatland wetland types were documented during this inventory, the Dry Ridge Bog and Swamp. These are the only known peatland types in the town and are rare and uncommon natural community types in the state.

The upland natural communities mapped in Johnson form the backdrop for much of the natural environment. Large Northern Hardwood forests are found on both the northern and southern ends of the town. These expansive forests continue outside the town and form large, state significant matrix communities. The higher elevation forests in these areas include some Montane forests, including one in the south mapped as state significant by the Vermont Natural Heritage Inventory. The lower elevations in Johnson are dominated by hemlock forest types. Both the mixed Hemlock-Northern Hardwood Forest and the conifer dominated Hemlock Forest are common on the slopes and ravines in the town. Some of these forests are quite large and in very good condition, warranting the state significance designation.

Wildlife habitat in Johnson is as diverse as its natural communities. A total of 23 Contiguous Wildlife Habitats Units were mapped and characterized as part of this project. Varying in size from just over 100 acres to over 5200 acres, many of these units contain a wide variety of habitat features such as ledges, mast stands, early successional habitat, grasslands, forested riparian areas and a wide variety of wetland habitats. The larger Habitat Units to the north and south harbor significant core forests. These expansive forests provide important habitat for wide ranging mammals such as black bear, moose, fisher and bobcat as well as a wide variety of songbirds which rely on core forests.

Contiguous Wildlife Habitat Units adjacent to the Lamoille and Gihon River valleys also contain a variety of wildlife habitat features, including many large wetlands. These areas provide valuable habitat for fish and aquatic mammals such as mink, muskrat, and otter. Ducks, geese, herons, shorebirds and American bittern live in the marshes, lakes, and ponds, and streams of these areas. Johnson is home to extensive hemlock forests on the mid-elevation slopes and stream valleys of the town. These forests, especially those that have a south or west aspect are critical habitats for the survival of deer in Johnson and all northern Vermont.

The diversity of Johnson's natural features are the result of both thousands of years of geologic forces as well as hundreds of years of human resource management. Continued wise management is only possible with information about the location and abundance of natural resources as well as an understanding of how those resources function on the ecological landscape. It is our hope that this inventory is the first step in that process and can provide the basis for wise management for both landowners and town managers.

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Johnson Natural Resources Inventory

Appendix 1:

METHODOLOGY

May 31, 2017

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A. Methodology

The Johnson Natural Resources Inventory project included the identification, inventory and assessment of natural communities and wildlife habitat in the town of Johnson, Vermont. Existing digital and paper databases were used remotely mapping resources and determining areas of potential significance to identify sites for field assessments. These natural areas were evaluated by specific ecological and landscape criteria to determine the significance and value that these areas have to the natural heritage of the town. The methodology and findings of the inventory are documented in this appendix.

The methodology section is organized into four sections, A. Public Sightings Map, B. Landcover Delineation, C. Wetlands, D. Upland Natural Communities, and E. Wildlife Habitat.

B. Public Sightings Map

Arrowwood Environmental, through the Johnson Conservation Commission sought public comments from members of the professional natural resource management community with experience in the Town. An on-line mapping application (http://arrowwoodvt.com/johnson) was created whereby professionals and amateur naturalists could document and map known locations of specific natural communities, wildlife habitat, wildlife crossing areas, or actual sightings of wildlife, or their sign. Access to the application was distributed by the Johnson Conservation Commission. This online application can stay active if the Johnson Conservation Commission wishes to continue to solicit sightings from the community.

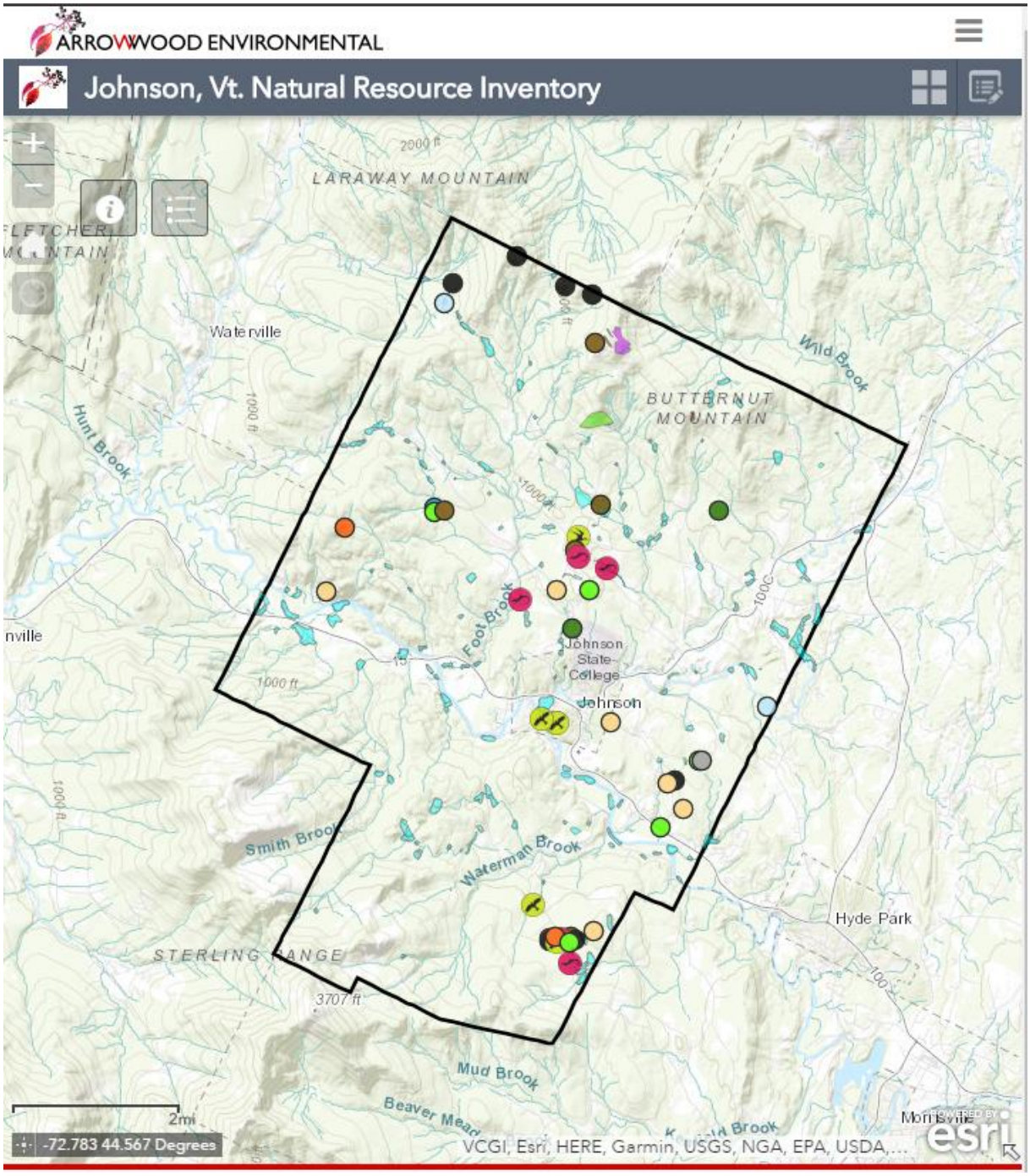

Figure 1 Local Habitat and Species Sightings Mapping Application

C. Landcover Delineation

Arrowwood Environmental (AE) built several of the GIS layers utilized in this project from a foundation of basic landcover analysis. This analysis was conducted by AE personnel, and is intended to replace the use of the statewide LCLU (landcover/landuse) dataset available from the Vermont Center for Geographic Information (VCGI). Although the VCGI LCLU data is available covering the entire state of Vermont, AE has found the level of detail too coarse (30 meter resolution) to effectively assist on a town-scale analysis of natural heritage elements. For this inventory, AE conducted a combined automated and manual digitization of broad classifications of land cover types.

Development- Developed areas were delineated using a collection of publicly available statewide data sources obtained from VCGI. Features in these source datasets were buffered to approximate an average development disturbance as detailed in the table below.

Selected Data	Data Source	Source Data Type	VCGI Layer Name	Source Data Date	Buffer Generated
Driveways	E-911 Driveway Centerlines	Polyline shapefile	EmergencyE911_DW	2014	12 feet both sides of line
Houses & Other Buildings	E-911 Site Location	Point shapefile	EmergencyE911_ESITE	2013	100 feet around point
Major Roads-Class 1,2, State	Vtrans Road Centerlines	Polyline shapefile	Trans_RDS	2014	30 feet both sides of line
Major Roads-US Routes	Vtrans Road Centerlines	Polyline shapefile	Trans_RDS	2014	50 feet both sides of line
Minor Roads- AOT Class 3,4, trail & Forest Roads	Vtrans Road Centerlines	Polyline shapefile	Trans_RDS	2014	20 feet both sides of line
Railroads	Vtrans_RR	Polyline shapefile	Trans_RR_Line	2007	50 feet both sides of line

Further modifications were made to the developed areas during the hand delineation process described below.

Open Land- open, non-forested land was delineated by hand from 2013 series Vermont Mapping Program 0.5 meter resolution color and color-infrared orthophotography. The orthophotography was visually analyzed at a scale of approximately 1:5000 or better on a computer monitor within a geographic information system (GIS) software platform. Non-forested agricultural, recreational, residential, commercial and industrial areas were digitized by hand in the GIS software.

Transitional areas were best fit by the assessor into "open land" or "developed land" categories.

Using GIS based geoprocessing tools, the buffered developed areas were erased from the hand digitized open areas. From these, wetland natural communities, as described in Section C of this report were also erased. At this point, anything not depicted as developed, open, or wetland was considered an upland natural community and mapped according to methodology explained in Section D. Boundaries were adjusted and classifications adjusted as appropriate through the remainder of the inventory and assessment project. A sample result of this process is shown in Figure 2.

While an effort was made to be relatively accurate at the working scale, the scope of this project did not include either the budget or time necessary to complete a highly accurate manual digitization of landcover classes. The intention of this exercise was to provide a more accurate depiction of landcover types within the towns than is currently available from remotely sensed sources in a rapid fashion. Other than visual review, no quality assurance was conducted, no tests of consistency were completed and no measure of expected accuracy was assessed.

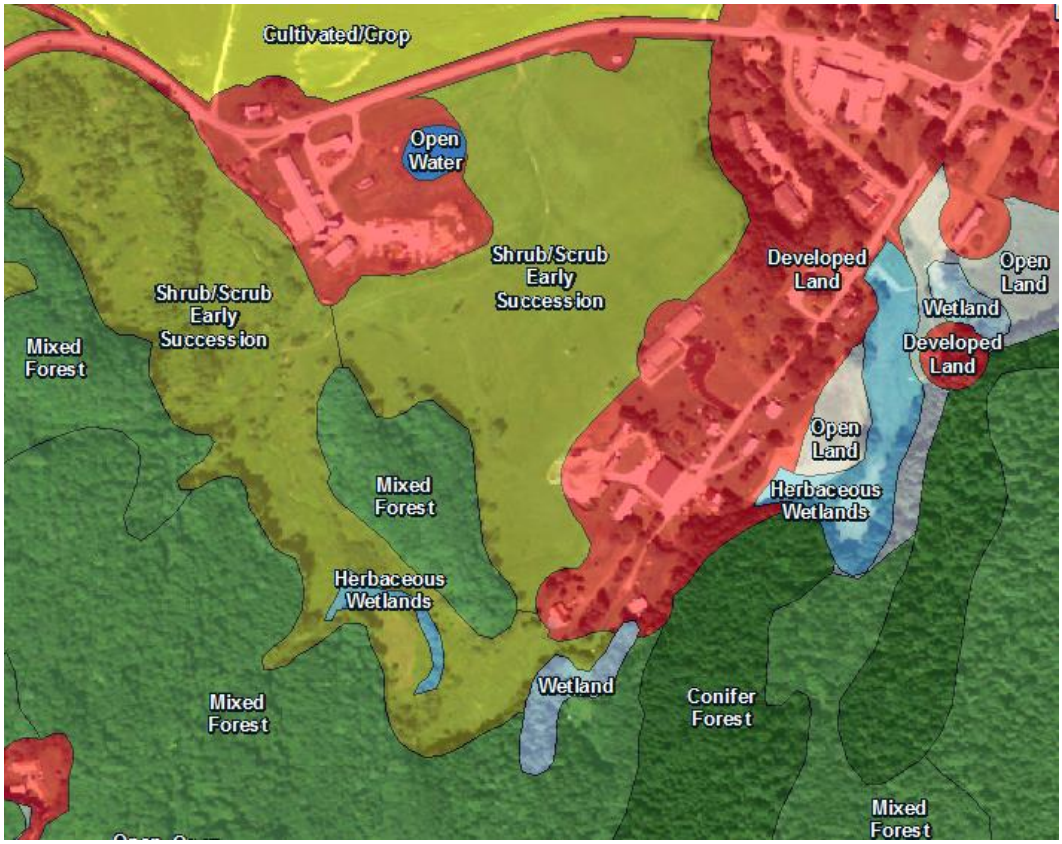

Figure 2. Sample Result of Land Cover Mapping

D. Wetland Mapping and Assessment

For the purposes of this inventory, a wetland is defined as an area that is inundated by surface or ground water with a frequency sufficient to support organisms that depend on saturated or seasonally saturated soil conditions for growth and reproduction. For any particular site to be considered a wetland there needs to be the following three criteria present: 1) hydrophytic (wetland) vegetation, 2) hydric soils, and 3) wetland hydrology. The boundaries of wetlands cannot be determined and/or delineated remotely. The boundaries present on the attached inventory map are for planning purposes only; detailed fieldwork is required to determine the actual presence and extent of wetlands. The field work conducted during this study did not attempt to formally delineate the boundaries of any wetlands. The wetlands inventory consists of three related tasks, 1) Remote Wetland Mapping, 2) Field Assessments, 3) Public Access Inventory, 4) Remote Functions and Values Analysis and, 5) Wetland Map Creation. The methodology for each of these tasks is outlined below.

D.1. Remote Wetlands Mapping

The landscape analysis represents the first step in conducting an inventory of a Town's wetlands. As part of this Phase, AE identified and mapped the wetlands in Johnson through a comprehensive review and interpretation of available paper and digital resource inventories, maps and photographs.

Information sources that were reviewed during the landscape analysis process include: Natural Resources Conservation Service soil survey maps, Black and White Orthophotography, NAIP Color orthophotography, 2010 Color Infrared orthophographs, Vermont Significant Wetlands Inventory maps and U.S. Geological Survey (USGS) topographic maps.

In general, the process for identifying and mapping wetlands starts with the Color Infra-Red orthophotographs. Polygon lines (approximate wetland boundaries) were drawn in this digital wetlands map using common landscape features present in both the CIR photos other digital sources. The digital Natural Resource Conservation Service (NRCS) hydric soils maps, Vermont Significant Wetlands Inventory (VSWI) maps, and U.S. Geological Survey (USGS) topographic maps were also consulted during this inventory. As each wetland was mapped, it was given a preliminary natural community name based on Wetland, Woodland, Wildland. A Guide to the Natural Communities of Vermont (Thompson and Sorenson 2000) and the Natural Heritage Inventory (NHI) updated community classification (October 26, 2015). The main data sources that were used during this inventory are described below.

D.1.1. Vermont Significant Wetlands Inventory Map (VSWI)

The VSWI map is based on the National Wetlands Inventory Map (NWI) and is used as the standard regulatory wetlands map for Vermont by the State Wetlands Office. For the purposes of this inventory, VSWI and NWI are used interchangeably. All wetlands that occur on the VSWI map appear on the attached wetlands inventory map. In many cases, the location of the wetland from the VSWI map is inaccurate and does not reflect the actual location of the wetland. Using the orthophotos and other map sources, these locations were corrected on the wetlands inventory map. In most instances, the wetlands on the VSWI map are indeed wetlands. There are a few instances where information from other map sources suggests that the site is not actually a wetland. In these situations, the wetland remained on the wetlands inventory map because it is a state regulated wetland and should be checked in the field. In the Comments field

of the database, however, it is noted that the site does not appear to be wet from other map sources.

D.1.2. USGS Topographic Maps

The USGS topographic maps were used as a secondary map source to better understand a wetlands position on the landscape. The topographic position can give insight to the nature of a wetland and the potential for wetlands to occupy certain areas.

D.1.3. Digital Orthophotographs

Orthophotographs are aerial photographs that are geo-rectified and, in the case of this inventory, used in a digital format. Orthophotographs are important because they are digitized and geo-rectified. This allows the photo interpreter to accurately (and digitally) map a wetland.. These orthophotographs were therefore used as a base map and all mapping of wetlands was done based on common landscape features present in these photographs.

D.1.4. Natural Resource Conservation Service (NRCS) Soil Survey

A digital copy of the Lamoille County Soil Survey was used during this inventory. A map of all hydric soils in the towns was used to identify areas that may contain wetlands. Each soil type forms under different environmental conditions and can give clues to the nature of the wetland or potential wetland site.

As mentioned above, the presence of a wetland is dependent on hydric soils, wetland hydrology and wetland vegetation. Some areas of hydric soil, therefore, are not wetlands. Wherever hydric soils were present, other remote data sources were used to determine if the site likely contained a wetland. In many circumstances, other data sources led to the conclusion that wetlands occurred only in part of the hydric soil area. In these cases, polygon lines were redrawn to reflect probable wetland boundaries. The NRCS hydric soils boundary and the approximate wetland boundary are therefore not identical. In most cases, the wetland areas are smaller than the hydric soil areas.

D.1.5. Wetland Confidence

The above remote data provides a lot of information about the presence and nature of wetlands on the landscape. In most cases, using this data, wetland locations and extent can be confidently mapped. In some cases, however, the remote data is unclear if a site contains a wetland or not.

This is complicated by the fact that, even in the field, determination of a jurisdictional wetland can sometimes be difficult. In order to track this varying level of mapping accuracy, a wetland "Confidence" ranking is built into the database. Wetlands are ranked Low/Medium/High; wetlands that are ranked Low Confidence could be considered "potential" wetlands. In these cases, a field visit is recommended to determine if the site actually contains a wetland.

D.1.6. Field Assessments

Field assessments of selected wetlands were conducted during the spring of 2017. The purpose of the field inventory was to assess the accuracy of the remote wetlands identification procedure and to obtain more in depth data about a wetland's natural community type and functions and values. Wetlands selected for a site visit were chosen with the intent of visiting a cross-section of wetlands in terms of natural communities, functions and values, and remote mapping confidence. Landowner permission for conducting field visits was secured before field visits were made. No parcels were visited without landowner permission.

D.1.7. Natural Community Assessments

Each wetland that was visited received a natural community assessment. This assessment involves collecting data on wetland soils, vegetation structure and composition, topographic position and other relevant ecological information. Special attention was paid to noting factors that may degrade the quality of the wetland community such as invasion of exotic plants, disruption of local hydrology, surrounding landuse or direct development in the wetland. Together, this information was used to assign each community visited a final natural community name and to give information about the current condition of the community.

For wetlands that received a field visit, the natural community ranking protocol outlined in Section D.1.8 was employed.

D.1.8. Field-Based Functions and Values Assessment

Each wetland that obtained a field visit also received an in-depth functions and values assessment. The assessment involves evaluating a wetland based on its vegetation, hydrology, habitat diversity, topographic position, shape, size and position in the watershed for select functions and values. The Vermont Wetland Evaluation Form, US Army Corps of Engineers Highway Methodology Handbook and Golet Model Wetland Evaluation Form were used as

guides for establishing the functions and values criteria. As a result of the assessment, each wetland is given a functional score based on a scale of no/low/medium/high. Each visited wetland was assessed for the following functions and values:

- Water Storage for Flood Water and Storm Runoff
- Surface and Ground Water Protection (Water Quality)
- Wildlife Habitat
- Fisheries Habitat
- Exemplary Wetland Natural Community
- Rare, Threatened and Endangered Species Habitat
- Erosion Control through Binding and Stabilizing the Soil
- Open Space and Aesthetics
- Recreation Value and Economic Benefit
- Education and Research in Natural Sciences

The following is a description of how wetlands perform the specified function and/or value listed above. The functional assessment is based upon whether the wetland has the capacity for the function or value and whether there is an opportunity for the wetland to perform the specific function or value

D.1.8.1. Water Storage for Flood Water and Storm Runoff

Wetlands that retain and slowly release floodwaters are usually associated with streams or rivers. In order for a wetland to perform this function, there must be an expandable basin present in the wetland that allows room for the floodwater to disperse. This expandable basin and the presence of persistent vegetation have the effect of slowing the water down and diffusing the energy of the floodwater.

The most significant wetlands for this function are located upstream of significant natural resources or human resources such as developed areas, culverts, and roads. In these circumstances, the upstream wetlands may be protecting these resources from floodwaters, such that any activity that impairs the wetland's ability to perform this function will often have serious impacts to downstream resources.

D.1.8.2. Surface and Ground Water Protection (Water Quality)

Many wetlands filter sediments and nutrients, such as phosphorus and nitrogen, from surface waters resulting in improved water quality. Wetlands that retain nutrients generally have diffuse or sinuous drainage pathways which slow down the flow of water. Slower water velocity provides more opportunity for sediments and nutrients to settle out and to be absorbed by vegetation. The velocity of the water moving through a wetland is determined by slope, landscape position and the outlet conditions in the wetland. Wetlands with constricted outlets generally have much slower water velocities and greater potential for sediment and nutrient removal. The presence of persistent vegetation is also important for slowing down water velocities.

The water quality function takes on particular importance in impaired watersheds where water and its uses are diminished. The opportunity for a particular wetland to perform this function is determined by the presence of agricultural lands, urban impervious surfaces, steep slopes, and areas of impaired water quality. Wetlands that recharge a wellhead protection area or contribute to the flows of Class A surface water may also be of particular importance.

D.1.8.3. Wildlife Habitat

Wildlife use of wetlands is widely variable and dependent upon the size, diversity and structure of the wetland. In general, the wetlands that are the most valuable for wildlife are those that have multiple community types, greater vegetative diversity, some open water and multiple layers of vegetation. The interspersion of the open water and different vegetation cover can also be important for determining wildlife use. In general, a greater diversity of wildlife is often found in wetlands that have open water that is extensively interspersed with vegetation. The interspersion of different vegetation or cover types is also important.

Large wetlands, with ample space and a variety of food and cover resources often harbor a greater diversity of wildlife. Smaller wetlands are also important for wildlife when viewed not as individual wetlands but as groups or clusters of wetlands on the landscape. These smaller wetlands often work in concert to provide habitat for species that utilize several different wetlands throughout their weekly or yearly movements on the landscape.

D.1.8.4. Fisheries Habitat

The fisheries function is determined primarily upon a wetland's connection to a permanent surface water that could provide fish habitat. Wetlands that are associated with these permanent surface waters can increase the fisheries habitat by: 1) providing pools and refugia during periods of low water; 2) providing shade to the surface waters thereby lowering the temperature of the water (which is crucial to some species of fish); 3) providing stream bank stability thereby decreasing the amount of river clogging sediments in the water system; 4) providing undercut banks which offer spawning, nursery, feeding and cover habitat for fish and; 5) providing an

D.1.8.5. Exemplary Wetland Natural Community

This function is meant to evaluate whether or not wetlands may harbor significant natural communities or vegetation. In general, wetlands of rare or unusual types are considered significant for this function. Any wetland community that is tracked by NNHP is considered significant. Also, any wetland of the following community types is considered significant for this function: Dwarf Shrub Bog, Poor Fen, Rich Fen, Alpine Peatlands, Red Maple-Black Gum Swamp, Red Maple-Black Ash Seepage Swamp, Deep Bulrush Marsh, Cattail Marsh, Northern White Cedar Swamp, Spruce-Fir-Tamarack Swamp.

Also, wetlands with deep peat accumulation, old growth swamps, and wetland mosaics are often significant for this function.

D.1.8.6. Rare, Threatened and Endangered (RTE) Species Habitat

The presence of the RTE function is determined based upon the presence of a Federal or State listed Threatened and Endangered species of plant or animal within the wetland. Also, a wetland can rank for this function if there is a population of a very rare (S1), rare (S2), historic (SH) species present in the wetland. Finally the presence of multiple uncommon (S3) species can also be sufficient reason to rank a wetland for this function.

D.1.8.7. Erosion Control through Binding and Stabilizing the Soil

Many wetlands located in areas where erosive forces are present are important for this function. This includes wetlands along rivers and streams and wetlands along lakes and ponds where there is enough fetch to produce erosion along the shore. In Johnson, wetlands found along the Lamoille and Gihon Rivers are most important for this function. The most important element in

a wetland significant for this function is the presence of persistent vegetation, especially woody vegetation such as trees and shrubs. The roots of this vegetation act to bind the soil and prevent it from eroding. Wetlands that perform this function upstream of biologically significant areas such as spawning habitat, significant natural communities, or RTE element sites are very valuable.

D.1.8.8. Open Space and Aesthetics

The Aesthetics function is determined primarily by a wetland's position in the landscape in relation to ease of public viewing. Wetlands that can be readily viewed by the public, such as those on public lands or along the road network are often significant for this function. These wetlands are important because they enhance the likelihood of observing wildlife and colorful wildflowers. A higher rank is given for wetlands that possess special or unique aesthetic qualities or are prominent on the landscape. Open space becomes a particularly important function in more developed areas.

D.1.8.9. Recreation Value and Economic Benefits

The recreation function is determined based on the presence or likelihood of recreational activities occurring within the wetland or wetlands that provide economic benefits. This includes wetlands that provide habitat for species that can be fished, hunted or trapped and/or the presence of wild foods that are harvested.

D.1.8.10. Education and Research in Natural Sciences

Wetlands that are significant for Education and Research are generally those that have a history of use for these purposes or have the real potential to be used for these purposes. Wetlands that are owned by an education or research institution are typically significant for this function.

D.1.9. Public Access Inventory

As part of the inventory process, information on wetland boundaries and community types was gathered from points of public access such as public roads. Observations from this "windshield survey" were used to help refine the wetland map. Roads in Johnson were travelled and information about wetland boundaries, community types and functions and values was recorded.

D.1.10. Remote Wetland Functions and Values Assessments

In order to gain a better understanding of wetlands that did not receive a field visit, a remote functions and values analysis was performed for each wetland in Johnson. This assessment involves understanding information about a wetland's soils, vegetation, shape and size, connection to surface waters, habitat diversity and position in the landscape to produce a composite picture about a wetland's role in the larger ecosystem. This information is integrated with the criteria for functions and values (detailed above) to make predictions about the likelihood of a wetland performing any of these listed functions and values.

Because this is a remote inventory process, field work should be used to confirm the results of this analysis.

D.2. Wetlands Map Creation

Once fieldwork was concluded, field data was compiled and integrated into the Wetlands Inventory Map. This involved adding wetlands that were discovered during the field inventory, changing wetland boundaries on the map and removing sites that were determined not to be wetlands. Data from the field visits were also incorporated into the attribute table which is linked to the map. The information included in the attribute table is listed in Appendix 3.

E. Upland Natural Community Mapping and Assessment

Upland natural communities were identified and mapped in Johnson during this inventory. The natural community assessment was conducted in two phases. The first phase was a remote landscape analysis of the study area and the second was field evaluations of selected sites. Results of each of the phases were brought together to create the final Natural Communities Inventory Map. The phases of the assessment are described in more detail below.

E.1. Remote Uplands Landscape Analysis

The remote landscape analysis consist of using existing remote data sources of natural resources in the town to develop a preliminary map of upland natural communities. Information sources that were reviewed during the landscape analysis process include: Natural Resources Conservation Service soil survey maps, Black and White Orthophotography, NAIP Color orthophotography, 2010 True Color and Color Infrared orthophotography, U.S. Geological Survey (USGS) topographic maps, and the Natural Heritage Inventory (NHI) database. The

NHI database includes information on previously mapped and assessed significant natural communities in the town and area. These sites were incorporated into the natural community mapping and noted in the attribute data for each occurrence.

Preliminary boundaries of natural communities were drawn using various orthophotographs as a base map. Each site was given a preliminary natural community name based on Wetland, Woodland, Wildland: A Guide to the Natural Communities of Vermont (Thompson and Sorenson, 2000) and the NHI updated community classification (October 29, 2015).

E.2. Field Assessments

Field assessments of selected sites were conducted in 2016-2017. Using the information from the remote analysis, the field inventory seeks to refine the base map and gain more in depth information not obtainable from remote sources. The field inventory focused on 1) classifying the natural communities mapped during the remote analysis and 2) assessing the current condition of those natural communities. Landowner permission for conducting field visits was secured by the Johnson Conservation Commission before field visits were made. No parcels were visited without landowner permission.

For natural communities that received a site visit, an overall ecological inventory was conducted. This inventory included the identification of the dominant plant species by strata, information on soils, and an explanation of the development of the community, where appropriate. Notes on the current condition of the community were also taken. This brief assessment includes information on the degree of and time since major human disturbance and information on the presence or absence of non-native, invasive plant species.

E.3. Upland Natural Community Map Creation

Once fieldwork was concluded, field data was compiled and integrated into the Upland Natural Communities Inventory Map. This involved adding natural communities that were discovered during the field inventory, changing community boundaries on the map and removing sites that were determined not to be uplands. Due to the difficulty of mapping natural communities on a town-wide scale, some larger polygons contain small fields and areas of residential development. Some smaller forest patches (especially those surrounded by open land) did not get mapped.

Data from the field visits were also incorporated into the attribute table which is linked to the map. Attribute information for the upland natural community map is presented in Appendix 3.

E.4. Natural Community Ranking and Significance Determination

Determining the local or state significance of natural features occurs after all of the field work is completed and the final maps are compiled. The local or state significance methodology is based on the system used by the Vermont Natural Heritage Inventory (NHI). For natural communities this methodology takes into account the rarity, size and condition of the community as well as the quality of the landscape that the community exists in.

The state has a system of rarity rankings that are based on a numeric system of 1-5 (from rarest to most common). This rank is usually preceded by an "S" to indicate that the rank is on the state-wide scale. This ranking is assigned to each community type as a whole and does not refer to specific examples of the community. This rarity ranking is included in the database in the "State_Rank" field and is based on the following system:

- S1 Very Rare (1-5 occurrences)
- S2 Rare (6-20 occurrences)
- S3 Uncommon (> 20 occurrences)
- S4 Apparently Secure
- S5 Demonstrably Secure

Particular occurrences of communities are ranked based on the conditions present on the site. As mentioned above, the factors that determine the rank of a particular community include its condition, size and condition of the landscape. This alphabetic ranking (A-D) is included in the database in the "EO_Rank" (Element Occurrence) field. Sites that did not receive a field visit were not ranked.

For many natural communities, the ranking methodology allows for multiple communities to be grouped together and ranked as a single unit. Multiple communities of the same type which are separated by short distances on the landscape may be considered as one "element" when ranking. The grouping of some of these communities is shown in the "ElementGrp" field.

Once particular communities are ranked, the Element Occurrence ("EO_Rank" field) is compared to the State rarity rank ("State_Rank" field). A community would be considered state significant if the following criteria are met: S1 or S2 communities with an EO rank of A, B or C; S3 or S4 communities with an EO rank of A or B; S5 communities with an EO rank of A. These guidelines are considered in conjunction with professional judgment and knowledge about the site.

Local significance is determined following the methodology of determining state significance but puts the community in a local perspective. Local geology, biophysical region, size and condition of the community all play a role in determining local significance. All communities that were considered to be state significant are also considered locally significant. In addition, any community that doesn't meet the criteria for state significance but is considered to be significant on the town scale is also labeled as locally significant.

The reason for assigning significance to a community is listed in the "Justificat" (Justification) field of the attribute table.

F. Wildlife Habitat Mapping and Assessment

Wildlife habitat elements were identified within the Johnson study area utilizing Geographic Information Systems (GIS). All GIS data presented in this project should be considered approximate. The locations depicted are for planning and community level analysis purposes, and further field biological assessments should be considered a requirement for additional understanding of the function of the wildlife unit area on the landscape and its importance to any or all species that may utilize it. This section describes the derivation process for the individual habitat unit polygons, the attributes and assessment are discussed in the study report.

The following habitat elements were identified and mapped:

- Core forest units
- Deer winter habitat
- Mast stands
- Early succession areas
- Forested riparian corridors

- Wetlands
- Ledges, cliffs & talus

F.1. Core Forest

Core forest areas for the State of Vermont were originally developed by the UVM Spatial Analysis Lab (SAL) for inclusion in a region wide GAP analysis. AE utilized similar parameters as the original SAL project, but updated the inputs using landcover classifications from the land cover/natural community (NCLC) mapping efforts described above.

Developed and open land features from the NCLC were buffered by 100 meters and the remaining areas within the study area were considered Core Forest. For the purposes of this project, any Core Forest Units with an area of 20 acres or less were eliminated.

F.2. Deer Winter Habitat

Delineation of deer winter habitat, or deer wintering areas (DWA) began with review of the existing State of Vermont Deeryard data layer. Deer winter habitat was assessed remotely based on upland natural community descriptions discussed earlier in this report. Natural community polygons with an appropriate conifer component were assessed using GIS processing tools for their average aspect. Communities were then ranked using the following matrix where 1 is the highest value and 3 is the lowest and 0 denotes no value as a deer wintering area:

Natural Community	Deer Winter Rank
Dry Red Oak-Pine Forest	0
Hemlock Forest	1
Hemlock-Northern Hardwood Forest	2
Hemlock-Red Oak-White Pine Forest	2
Hemlock-Red Spruce Forest	1
Lowland Spruce-Fir Forest	1
Montane Spruce-Fir Forest	0
Montane Yellow Birch-Red Spruce Forest	3
Montane Yellow Birch-Sugar Maple-Red Spruce Forest	3
Plantation	3
Rich Northern Hardwood Forest	0
Mesic Red Oak-Northern Hardwood Forest	0
Red Pine Forest or Woodland	3
Red Spruce-Northern Hardwood Forest	3
Red Spruce-Heath Rocky Ridge Forest	2
Subalpine Krummholz	0
Temperate Hemlock Forest	1
White Pine-Northern Hardwood Forest	0
White Pine-Red Oak-Black Oak Forest	0
Spruce-Fir Tamarack Swamp	1

Average aspect was used to further refine the rankings as displayed in the

table below:

Rank	Aspect	Deer Winter Value
0	Any	None
1	Any	Likely
2	South or West	Likely
2	Other	Potential
3	Any	Potential

Following field evaluations, the polygons were modified to reflect conditions noted in the field, including current signs of use and habitat potential based on professional experience.

F.3. Mast Stands

Hard mast of importance to black bear within the study area is assumed to be American Beech and Red Oak tree species. Mast stands as identified for the purposes of this study originated from the following sources:

- Natural Communities mapped as a component of this project with a significant Oak component.
- Vermont Dept. of Fish and Wildlife bear points database (vector- point)
- Mast locations identified by the public on a project specific online mapping platform set up to collect local knowledge (none reported).
- Field visits by AE personnel
- Vermont Dept. of Forest Parks & Recreation, aerial forest health monitoring data- The VT Dept. FPR conducts annual aerial surveys throughout the State of Vermont in order to map forest health threats, insect attacks and tree disease. One disease identified and mapped by the aerial forestry team is Beech Bark Disease, a disease specific to American beech trees, and unfortunately quite prevalent in our region. AE utilized the FPR Beech Bark Disease data as provided in draft form by the VT Dept. FPR to identify areas where concentrations of American beech trees are likely to occur. As this data identifies areas of diseased beech trees, not necessarily those used by black bears, it was not utilized as a primary source for this project, but was referenced during secondary review.

Mast stands from all the above sources were confirmed or refined when visited in the field; however, no attempt was made to provide an accurate depiction of the extent or boundary of any American beech stand or concentration. Mast stands appearing in the data and maps accompanying this report are very general locations. Numerous possible mast areas were not evaluated in the field. This should NOT be construed as a complete accounting of all mast stand areas present within the project area. It is highly likely that unmapped mast stands exist in the town, and their identification should continue to be a conservation priority. Boundaries presented for this project are to be considered approximate, habitat quality and bear use were not methodically evaluated within the scope of this project.

F.4. Early Succession Habitat

Areas of early succession forest were delineated as a land cover component during the landcover analysis discussed above. Due to the limitation and resolution of the imagery, the areas defined as early succession were typically logging patch cuts, clear cuts or old fields. Small early succession patches in forested settings were not typically able to be seen, and therefore do not appear in the dataset. Wetlands identified as "old field" as well as beaver complexes and shrub community wetlands were added to the early succession habitat data, as many of these wetlands provide the vegetative structure and composition required by early succession obligate and facultative species. Any additional early succession areas discovered in the field were subsequently added to the dataset.

F.5. Forested Riparian Corridors

Identification of forested riparian corridors was completed through a remote GIS model with the following inputs:

- Vermont Hydrography Dataset stream layer (line)
- Vermont Hydrography Dataset waterbodies layer (polygon)
- AE Johnson Landcover analysis, described above

Streams were buffered at 50 meters, giving a 100 meter wide corridor. Areas within the corridor that were described in the AE landcover analysis as open, developed or misc, or were classified as agriculturally impacted wetlands in the natural community assessment were eliminated. Remaining forested areas within 50 meters of a stream, but separated from the stream by a road

or not in contact with the stream centerline or waterbody edge were also eliminated using an automatic selection process.

All resulting corridor areas were merged to provide an approximation of intact riparian corridor areas.

F.6. Bear Wetlands

Wetlands more likely to be utilized by black bear for spring feeding activity were derived from the complete wetland inventory data described in the Wetland Inventory study report (AE, 2005). The following wetland communities were included in this dataset:

Beaver wetlands, Seeps, Shallow Emergent Marsh, Cattail Marsh, Hemlock-Balsam Fir-Black Ash Seepage Swamp, Red Maple-Black Ash Seepage Swamp, Red/Silver Maple-Green Ash Swamp, Red Spruce Hardwood Swamp, Spruce-Fir-Tamarack Swamp, Alluvial Shrub Swamp, Northern White Cedar Swamp and Alder Swamp.

These wetland types were buffered by 500 feet and the composition of forested to non-forested area within each wetland buffer was derived based on the project land cover types. In addition, the perimeter of each wetland was evaluated for surrounding land cover types and the composition of the immediately surrounding landscape was determined. Because bears are more likely to visit and feed from wetlands in a landscape matrix that affords both thermal and visual cover, the following selection criteria were utilized to identify potential bear wetlands from the natural community group listed above:

Wetlands where: >50% of the surrounding landscape (500' buffer) is forested;

AND for forested wetland community types (ie. Hemlock-Balsam Fir-Black Ash Seepage Swamp, etc.) at least 50% of the wetland perimeter is adjacent to a forested area, OR, for non-forested wetland community types (ie. Shallow Emergent Marsh, etc.) where more than 60% of the wetland

F.7. Ledges, Cliffs & Talus

Ledges, cliffs and talus areas were derived from the following sources:

- Slopes over 100% (45 degrees)- from an automated slope analysis conducted by AE using the VCGI 10 meter resolution "VT HYDRODEM" elevation data as input.
- Natural community units indicating ledge outcrops, cliffs or talus.
- Field identified ledges, cliffs or talus by AE ecologists.

F.8. Contiguous Habitat Units

Contiguous habitat units (CHUs) were derived from the above mentioned habitat elements. The contiguous units are patches of habitat that should be expected to provide a range of critical habitat function for a range of wildlife species including mammals, birds, reptiles and amphibians. CHUs were derived through combining the following previously described polygon layers:

- Core forest units
- Deer winter habitat
- Early succession areas
- Forested riparian corridors
- Wetlands
- Ledges, cliffs & talus

In many cases, there are forest zones adjacent to CHUs that likely function as secondary or possibly even primary habitat for some species but fall out of the definition used for development of the CHU layer.

Horizontal diversity was delineated within each CHU from 2006/2007 and 2011 orthophotography. Two separate axis were drawn (1) a north-south axis at the widest point of a core area, and (2) an east-west axis at the widest point of each CHU.

Along each transect a point was given for each natural community type, another point was given when a minor change in the community, such as a change in hardwood species dominance, or the additional of minor amounts of evergreen trees in an otherwise deciduous forest-- that was at least 100 meters, was encountered. A point was also recorded whenever a major physiognomic change was encountered along the transect and was at least 10 meters in extent. Major changes include a change in dominance from a deciduous to a conifer dominated forest, a change from forest to shrubland, or when a wetland was encountered.

All the changes along both transects were then totaled and divided by the length of the two lines (combined) to arrive at a measure of change per unit linear distance – as a measure of overall horizontal diversity for the CHU. The number of changes divided by the total linear length of the axis yields a measure of the amount of vegetative change per unit length.

The more the vegetation changes along each axis-the greater the gross vegetative structural change within that CHU. By itself, and on a statewide basis, the amount of change per CHU is essentially meaningless (because we do not have this data over the range of the state). However, the high, medium, and low rankings provided in this study are a comparison of the relative diversity of the vegetative structure of CHU areas within the Johnson study area.

Each CHU was then described by a variety of statistics as presented in summary table format in Appendix 2 and listed below.

- Size of Contiguous Habitat (core habitat and overall)
- Horizontal Diversity of CHU
- Length of Streams
- Size of Deer Winter Habitat
- Area of Wetlands
- Presence (Count) of Vernal Pools
- Area of Early Succession Habitat
- Area of Riparian Corridor
- Presence of Mast Stands
- Presence of Ledge/Cliff/Talus
- Presence of Significant Natural Communities
- Elevation metrics
- Area of Conserved Land

F.9. Wildlife Travel Corridors

Travel corridors, also called connecting lands or connecting habitats are land areas that serve to link other patches of important wildlife habitats together. Some species of wildlife rely on a variety of habitat features that are often separated from each other by roads, houses or other

impediments to easy movement. Species in this category include many amphibians, bobcat, fisher, and river otter. Others species such as moose, deer and black bear require large tracts of similar landscape that are quite rare in the developed northeastern United States. In order to survive in this region, these wide ranging species must move between several habitat patches of similar makeup.

F.10. CHU Corridors

The process of identifying general wildlife travel corridors seeks to predict areas within a town or area that are most likely to provide safe and preferable passage to a wide range of non-specific wildlife from one large habitat patch (in this case: CHUs) to another. AE utilized three components in attempting to identify these locations. The components and their parameters all consider the landscape in somewhat general terms, at varying levels of resolution, with the intent of rapidly capturing a sense of potential habitat blocks and movement potential between them. The following steps were taken to identify potential wildlife travel corridors.

1. Road Track Value- road tracking points were counted based on a 150 meter square cell. Cells were assigned a ranking value based on the number of track points present:

# Track Pts	Rank
<5	Low
5-10	Moderate
>5	High
0	NoData

2. CHU Corridor Rank- Corridor values were calculated and modeled in GIS as follows: Cost-Distance values were developed for each CHU within the study area. The result represented a combined distance and cost score for every 10 meter x 10 meter cell within the study area relative for each CHU. These maps used the combined Natural Community and landcover data to determine travel cost as animals move across the landscape where lower cost represents a "safer" cover type for wildlife movement while numbers in the middle of the scale are considered "neutral" in the Land Cover/Cost table below:

Land Cover	Cost Score
Forested	1
Mixed Forest	1
Forested/Shrub Wetlands	1
Conifer Forest	2
Herbaceous Wetlands	2
Deciduous Forest	3
Open- Grassland	3
Agricultural	3
Pasture/Hay	3
Shrub/Scrub Early Succession	4
Unknown	5
Open Water	5
Barren- Rock/Sand/Clay	5
Wetland	5
Upland	5
Open Land	6
Developed- Open Space	7
Cultivated/Crop	7
Developed Land	10

The costs for each CHU and each of its adjacent CHUs in turn (1-3, 2-3, 2-3, 2-8 etc.) were then summed to provide a relative accumulated cost value for travel between each CHU and each of its neighbors.

The Cost Value between CHUs was reclassified and ranked based corridor potential using the following scale: (note corridor values are relative for the study area and are simply accumulative cost and distance measures, the breakout below was subjective based on professional judgment and local knowledge)

Corridor Value	Rank
1-500	High
500-1200	Low
>1200	None

If a CHU to CHU corridor had areas with values scoring 500 or below, those areas were ranked High. If however, a given CHU to CHU corridor score was higher than 500, the areas scoring less than 1200 were ranked Moderate. This procedure insures that in areas of high permeability between CHUs, only the best areas are flagged as potential corridors, while in areas of lower permeability, the threshold is lowered allowing for more compromised movement in these zones.

F.11. Road Tracking

Two road tracking assessments were conducted as part of the Johnson NRI. On February 22-23, 2017, and March 20, 2017 all of the public roads (with the exception of roads within the Village of Johnson) were driven and wildlife tracks that were observed within the road ROW were recorded.

Wildlife tracking assessments were timed to occur under the best available conditions, with no new snowfall within the previous 48 hours at a minimum. Snow and crust conditions varied between tracking dates. Snow depths in both years were above average and deep snow banks along roadsides made for challenging conditions. Because of this, it was often difficult to observe tracks from the road that were located within the ROW but behind the high snow banks.

All wildlife tracks which came into the ROW were recorded and the location mapped with a mapping grade GPS (assumed accuracy+/-30 feet). In general, tracks made by small animals such as rodents, squirrels and birds were not recorded, however larger birds that serve as significant prey species such as wild turkey were recorded when observed. An attempt was made to isolate tracks of animals that may have walked parallel to the road entering the ROW at more than one location. Tracking along the corridors was limited to the road ROW and because of this a positive identification of all wildlife tracks was not always possible. When a positive identification of a track to species was not possible, an educated guess was attempted wherever adequate features were available. If no educated guess could be made, an "unknown track" was recorded for that location.

Every attempt was made to distinguish between tracks that were comprised of singular or multiple individual animals leaving sign of their passing. Where a well-worn path was left as a result of multiple animal passings -- the location was recorded as a "multiple trail". This was

common in areas where white-tailed deer utilized common trails to move on the landscape in the latter part of the winter of 2016-2017 when more snow cover was present.

Appendix 2: Johnson, Vt Natural Resource Inventory. Contigous Habitat Unit, Summary of Attributes

Id	Acres	NAME	CORE_ACRES	DRYD_ACRES	STRM_MILE	WET_ACRES	ES_ACRES	FRC_ACRES	MAST_PRES	LEDGE_PRES	BW_PRES	VP_COUNT	SIG_NATCOM	ELEV_MAX	ELEV_MIN	ELEV_MEAN	ELEV_RANGE	CONS_ACRES	ANR_HBlk_R
Unique ID	*CHU Acres*	*CHU Name*	*Acres of Core Habitat*	*Acres of Deer Winter Habitat*	*Miles of Streams*	*Acres of Wetland*	*Acres of Early Succession Habitat*	*Acres of Forested Riparian Habitat*	*Mast Stand Present*	*Ledge/Cliff/Talus Present*	*Bear Wetland Present*	*Number Vernal Pools*	*Significant Natural Community Present*	*Maximum Elevation*	*Minimum Elevation*	*Mean Elevation*	*Elevation Range (ft)*	*Conserved Acres*	*ANR Habitat Block Ranking*
1	528.57	Hall Brook	305	519	3.92	5.43	2	104	Y	N	Y	0	Y	1147	526	748	621	11	-none-
2	805.93	French Hill	505	721	2.86	35.99	18	79	N	N	Y	0	Y	1165	531	841	634	25	6
3	255.32	Johnson Village	83	239	0.24	0.24	16	9	N	N	N	0	N	815	529	696	286	0	3
4	195.42	West Settlement	119	77	3.41	4.23	0	107	Y	N	Y	0	N	1689	804	1128	885	0	-none-
5	649.34	Porcupine Hill	294	543	1.79	37.11	25	67	Y	N	Y	0	N	1009	548	771	461	71	5
6	5,269.29	State Forest	4545	2151	24.62	100.16	61	897	Y	N	Y	1	Y	3086	497	1479	2589	2504	6
7	386.20	East Lamoille	159	359	1.04	22.30	18	49	N	N	Y	1	N	831	602	715	229	111	-none-
8	1,162.73	Sterling Slopes	970	659	8.64	38.88	22	293	N	Y	Y	1	Y	1674	466	882	1208	0	-none-
9	119.87	West Lamoille	50	107	0.69	8.37	2	29	N	N	N	0	N	679	464	538	215	53	5
10	135.51	Gihon South	65	63	1.28	72.03	0	57	N	N	Y	0	Y	844	747	773	97	0	5
11	378.28	Clay Hill	198	255	1.32	2.15	14	55	N	N	N	0	N	1089	541	855	548	0	4
12	118.98	Fairground	<Null>	93	2.01	10.94	5	57	N	N	Y	0	N	894	698	794	196	0	-none-
13	451.73	Foote Brook	171	353	4.93	22.96	39	119	N	N	Y	0	Y	822	490	672	332	0	4
14	307.10	Bell Brook	169	225	2.65	42.97	9	67	N	N	Y	0	N	949	629	822	320	0	-none-
15	237.53	Gihon North	54	186	3.34	45.68	9	97	N	N	Y	0	N	886	771	822	115	3	4
16	188.29	Cemetery	54	179	2.51	9.24	1	58	N	N	Y	0	N	988	769	889	219	0	4
17	384.28	Dukes	220	342	2.86	17.81	17	66	Y	N	Y	0	N	1087	824	961	263	0	-none-
18	150.32	Plot	53	133	0.57	4.15	9	17	N	N	Y	0	N	1165	849	982	316	0	4
19	219.22	Swamp Rd	66	185	1.63	7.67	21	45	N	N	Y	0	N	1147	905	1005	242	0	4
20	327.93	Wild Brook	113	303	2.69	5.53	24	76	N	N	N	0	N	1046	831	954	215	0	5
21	2,432.77	Prospect	2077	1329	11.86	39.36	13	423	Y	Y	Y	2	N	1722	469	1073	1253	594	7
22	1,531.42	Barrows	1198	443	14.44	51.80	16	451	Y	N	Y	1	N	1991	881	1447	1110	308	-none-
23	5,171.55	Butternut Mtn	4380	1669	37.63	108.68	31	1275	Y	Y	Y	2	Y	2643	799	1592	1844	2744	9

Appendix 3

Table 1: Natural Community Attributes (Wetland and Upland Communities)

Field Name	Meaning	Responses	Description
FID	Feature Identification	Integer	Feature identification number, assigned by ArcGIS software
UniqueID	Unique Identification	Integer	Unique identification number
Type	Landcover Type	General Text	Indicates general landcover type
LCLU	Landcover / Landuse	General Text	Indicates specific landcover / landuse classification
NatCom	Natural Community	General Text	Lists the primary natural community present on the site
NatCom2	Natural Community 2	General Text	Lists an alternate or co-dominant natural community on site
Comments	Comments	General Text	Comments on the ecology, vegetation or mapping of the community
Source	Source	See Source table Above	Indicates who conducted the mapping of the site.
Conserved	Conservation Status	Percentage	Percentage of the site that is conserved.
Acres	Acres	Integer	The size of the community in acres
Field_Visit	Field Visit	Y/N/D: Yes/ No/ Windshield Survey (Drive-by via public access)	Indicates whether the site received a field visit. "D"denotes sites that were viewed from a public access site such as trails or roads.
State_Rank	State Rank	S1/S2/S3/S4/S5/NR S1 is rare, S5 is common. NR indicates sites that are not ranked	The state rarity rank of the natural community.
ElementGrp	Element Group	General Text	A grouping method used in determining local and state significance.
EO_Rank	Element Occurrence Rank	A/B/C/D/E A=Excellent, E=Poor	Rank of the particular natural community.
Local_Sig	Local significance	Y/N Yes/No	Indicates if the site is a locally significant site
State_Sig	State Significance	Y/N Yes/No	Indicates if the site is a state significant site
Justificat	Justification	General Text	Indicates the reason for assigning local or state significance
Landscape	Landscape Condition	A=surrounded by 1,000 acres of intact matrix of natural communities B=surrounded by forest or undisturbed communities but there may be developed land or clear cutting nearby C=surrounded by fragmented forest, agricultural land or rural development D=surrounding area intensely developed	Landscape quality of the natural community-
Condition	Site Condition	A=great-Pristine forest, areas of mature forest, no or minimal human disturbance B=Good-Some minor signs of human disturbance or exotic species C=Moderate-Significant logging, disturbance, or exotic species but site will recover D=Poor-Significant logging, disturbance, or exotic species; recovery unlikely	Current condition of the natural community
Size_Rank	Rank based on overall size of the natural community	A=larger…D=smaller	Ranking depends on community type, contact Vt. Fish and Wildlife Natural Heritage Inventory or Arrowwood Environmental for more information.
SiteName	Site Name	General Text	Name of site given for significant communities. Some based on previously assigned NHI site names. Other assigned based on location of site.
PriorityVs	Priority Site Visit	L/M/H/N: Low/Moderate/High/No	Used by AE after the remote inventory to rank sites for a field visit.

Table 1 (cont.): Natural Community Attributes (Wetland and Upland Communities)

Field Name	Meaning	Responses	Description
Attributes present for wetland sites only			
Confidence	Confidence	L/M/H/C: Low/Moderate/High/Confirmed	Indicates the confidence that a wetland exists at the site based on the remote inventory. Sites that were field verified receive a "C"
VSWI	Vermont Significant Wetlands Inventory	Y/N Yes/No	Indicates if the site is on the VSWI map and is a Class II wetland.
FLOODWATER	Floodwater	L/M/H/N: Low/Moderate/High/No	Indicates if the site functions for floodwater retention
WTRQUALITY	Water Quality	L/M/H/N: Low/Moderate/High/No	Indicates if the site functions for water quality
FISHERIES	Fisheries	L/M/H/N: Low/Moderate/High/No	Indicates if the site functions for fisheries
WILDLIFE	Wildlife	L/M/H/N: Low/Moderate/High/No	Indicates if the site functions for wildlife habitat
EXEMPLARYNC	Vegetation	L/M/H/N: Low/Moderate/High/No	Indicates if the site functions for significant vegetation
RTE	Rare, Threatened or Endangered Species	L/M/H/N: Low/Moderate/High/No	Indicates if the site functions for RTE species. Either known occurrences or possible occurrences based on habitat.
AESTHETICS	Aesthetics	L/M/H/N: Low/Moderate/High/No	Indicates if the site functions for aesthetics
EROSIONCTL	Erosion	L/M/H/N: Low/Moderate/High/No	Indicates if the site functions for erosion control
REC-ECON	Recreation- Economics	L/M/H/N: Low/Moderate/High/No	Indicates if the site functions for recreation or economics
OPEN_SPACE	Open Space	L/M/H/N: Low/Moderate/High/No	Indicates if the site functions for open space
EDUC-RES	Education - Research	L/M/H/N: Low/Moderate/High/No	Indicates if the site functions for education or research
ComplexAcre	Complex Acre	Integer	Size of the wetland complex (defined as wetland natural communities within 100' of each other)
FVSize	Complex Size	L/M/H/N: Low/Moderate/High/No	Size score for wetland and associated complex (defined as wetland natural communities within 100' of each other)
FXNVALSUM	Function and value summary	Integer	Summary weighted score of functions and values. Calculated as a sum of all Function/Value scores above using the following matrix: N=0, L=1, M=2, H=3. Provides comparative score for all wetland communities within the study area.

Table 2: Wildlife Contiguous Habitat Unit (CHU) Attributes

Field Name	Meaning	Responses	Description
Id	Unique ID number	Integer	Unit identification number assigned by Arrowwood Environmental
Name	Name of unit	Text	Unit name designation, typ. based on nearby features or location
ACRES	Acres	Integer	The size of the CHU
Core_acres	Core acres	Integer	The acres of core habitat within the CHU
Dryd_acres	Deeryard acres	Integer	The acres of deeryard within the CHU
Strm_mile	Stream miles	Integer	The length in miles of stream within the CHU
Wet_acres	Wetland acres	Integer	The area of wetlands within the CHU
ES_acres	Early Successional acres	Integer	The acres of early successional habitat within the CHU
FRC_acres	Forested riparian corridor acres	Integer	The acres of forested riparian corridor within the CHU
Mast_pres	Mast present	Yes/blank	Indicates if mast is present within the CHU
Ledge_pres	Ledge present	Yes/blank	Indicates if ledge is present within the CHU
BW_pres	Bear wetland present	Yes/blank	Indicates if bear wetland is present within the CHU
VP_count	Vernal Pool count	Integer	Indicates the number of vernal pools identified within the CHU
Sig_natcom	Significant natural community	State/local	Indicates the presence of locally or state significant natural communities within the CHU
Elev_min	Elevation minimum	Integer/Feet	Indicates the minimum elevation (in feet) within the CHU
Elev_max	Elevation maximum	Integer/Feet	Indicates the maximum elevation (in feet) within the CHU
Elev_range	Elevation range	Integer/Feet	Indicates the range of elevation (in feet) within the CHU
Elev_mean	Elevation mean	Integer/Feet	Indicates the mean elevation (in feet) within the CHU
Cons_acres	Conservation acres	Integer	Area of conserved land within the CHU

Table 3: ***NCLC Dataset Land Cover Classification Codes***

Code	Land Cover Type
0	Unknown
11	Open Water
2	Developed Land
21	Developed- Open Space
22	Developed- Low Intensity
23	Developed- Medium Intensity
24	Developed- High Intensity
3	Upland-general
31	Barren- Rock/Sand/Clay
4	Forested
41	Deciduous Forest
42	Conifer Forest
43	Mixed Forest
52	Shrub/Scrub Early Succession
7	Open Land
71	Open- Grassland
8	Agricultural
81	Pasture/Hay
82	Cultivated/Crop
9	Wetland-general
90	Forested/Shrub Wetlands
95	Herbaceous Wetlands