Greensboro Phase I
Natural Resource Inventory

2019

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This report contains an inventory, analysis, and maps of natural resources in the town of Greensboro, Vermont. These were prepared by Jesse Mohr of Native Geographic, LLC (NG) in 2018 and 2019 for the Greensboro Land Trust (GLT). This inventory was prepared to support GLT's conservation mission and focuses on the following natural resources identified in the trust's mission and objectives:

Table 1: Resources included in this Phase-I Natural Resource Inventory

Resource Areas	Resources
Farmland Resources GLT Objectives: 1 and 3	Important Agricultural Soils Farmlands (Fields, Pastures, and Cropland) Active Farms
Working Forest Resources GLT Objectives: 1 and 3	Productive Forest Soils Large Forestlands
Water, Wetland, and Riparian Resources GLT Objectives: 1, 2 and 5	Streams/Rivers Ponds/Lakes Wetlands River Corridors Floodplains and Flood Hazard Areas Exemplary Surface Waters Representative Lakes/Ponds Priority Surface Waters and Riparian Areas Potential Floodplain Forest Public Water Sources Surface Water and Ground Water Source Protection Areas
Wildlife, Plant, and Natural Community Resources GLT Objectives: 1, 2 and 5	Rare, Threatened and Endangered Species Occurrences Uncommon Species Significant Natural Communities Uncommon Natural Communities Priority Wildlife Road Crossings Bear Mast Areas Deer Wintering Areas Shrubland and Grassland Habitats Vernal Pools Active Road Crossings Moose Salt Pools/Walls
Forest Block, Connectivity, and Resiliency Resources GLT Objectives: 1, 2 and 5	Priority Interior Forest Blocks Priority Connector Forest Blocks Physical Landscape Diversity Blocks Priority Resilient Lands
Recreation Resources GLT Objectives: 1 and 6	Trails Boating/Fishing Access Points Trout Streams Fishing Lakes/Ponds
GLT Mission and Objectives	
GLT's by-laws specify six objectives: 1. Protect and enhance the natural and human resources of Greensboro in order to promote the well-being of present and future generations. 2. Preserve and aid in the preservation of all types of natural areas including wetlands, wildlife habitat, and other significant areas; 3. Conserve and aid in the conservation of productive agricultural and forest lands and encourage their use within the framework of a limited renewable resource necessitating careful stewardship; 4. Preserve and aid in the preservation of significant historic buildings, structures, and sites in order to maintain the cultural heritage of Vermont; 5. Protect and preserve the natural beauty of the area; 6. Acquire and aid in the acquisition of lands suitable for public recreation for the benefit of the general public.	

This is a Phase-I and primarily computer-based natural resource inventory. The inventory is limited in detail, reflects conditions in and prior to 2018, and mostly draws from data layers that are available through state and federal agencies and regional conservation organizations. This inventory also includes new data layers created by NG specifically for the project. As part of this Phase-I inventory, natural resources and areas needing further study were identified and recommended for Phase-II inventory As originally proposed, these inventories will serve as the basis for future strategic conservation planning efforts and analysis.

The report is divided into seven sections, each with its own map or suite of maps. The first section includes an overview of the property and town. Sections 2, 3, and 4 address the town's farmland, working forest, and recreational r resources, respectively. Section 5 covers water, wetland, and riparian resources, while Section 6 addresses the town's coarse forest biodiversity and climate resilience features, including forest block, connectivity, and resiliency resources The last section, Section 7, address the town's finer-scale biodiversity features, including wildlife, plant, and natural community resources.

1. TOWN OVERVIEW

The nearly 40-square mile[1] town of Greensboro, Vermont is a rural mix of dispersed residents and businesses, forests, farms, wetlands, natural areas, and other open spaces. The town also has two village centers—Greensboro Village and Greensboro Bend—with a mix of small commercial properties and higher residential density. Dotting this rural landscape are variety of recreational opportunities, streams, wetlands, lakes/ponds, and rivers.

Greensboro is predominately forested, with nearly 70 percent (see figure 1) of the town supporting a mix of northern hardwood, spruce-northern hardwood, and lowland-spruce fir forests, as well as smaller areas of white pine, pine-hardwood, floodplain forest, and various forested swamps. These large areas of forest are an important natural resource within the town (see Sections 3, 6, and 7) and are part of a larger regional network of connected lands (see Subsection 1.1 and Section 3). In addition to the forested swamps, five percent of the town is in a more open wetland condition, including shrub swamps, emergent marshes, cattail marshes, sedge meadows and even some smaller peat-accumulating fens and bogs. Many of these more open wetlands and forested swamps are located along or near open surface waters. Approximately four percent of the town is covered by a pond, lake, river, or large stream. The town's wetlands, surface waters, and associated riparian areas are also an important natural resource (see Sections 2, 4, and 7) for people and wildlife.

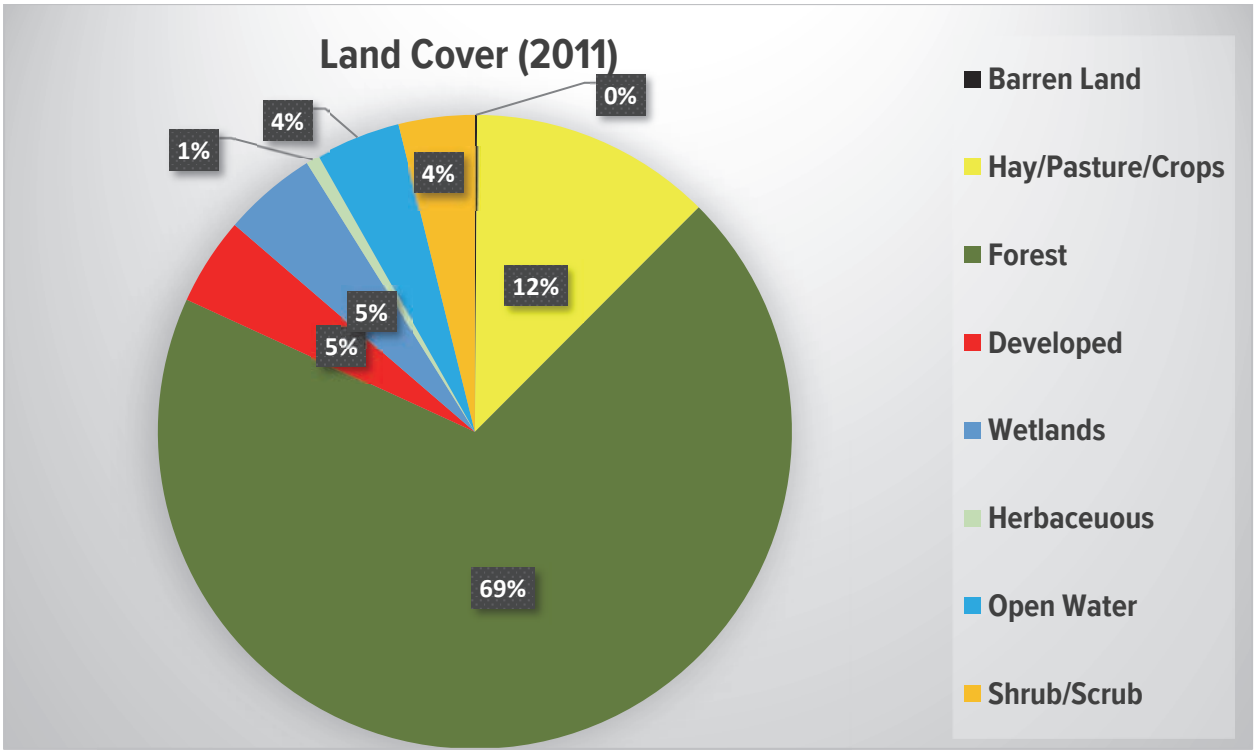

Figure 1: Greensboro Land Cover-Percent land cover type in town as calculated by NG using the 2011 *National Land Dover Dataset*.

[1] 39.4 square miles (Greensboro Planning Commission, 2015) or 25,216 acres

As discussed in more detail in Section 5 and Subsection 1.1, the town's soils can be productive for agriculture. As of 2011, about 12 percent of the town was either in hay, pasture, corn, or crop production. These agriculturally productive soils and the town's farming infrastructure is also an important natural resource for people and in some instances wildlife (see Section 7). Areas classified as herbaceous in figure 1, about one percent of the town, are mostly lawns and other open grassy areas, but may also include the occasional agricultural area.

1.1 The Northern Vermont Piedmont and the Surrounding Region

Greensboro is located within the Northern Vermont Piedmont biophysical region[2], a hilly portion of northeast Vermont (see figure 2) characterized, in part, by its underlying calcium-rich bedrock, which has produced rich and productive soils. These rich soils have spurred a history of agricultural development and land clearing. The region's generally subtle topography, which is dominated by low rolling hills, has also enabled the historic expansion of farmland. Today, the region continues to support a relatively high density of farms, roads, and residential development and more limited forest cover compared to the surrounding biophysical regions.

Greensboro is primarily underlain by limestone bedrock of the Waits River Formation. This type of calcium-rich bedrock weathers and erodes relatively easily and as a result tends to support more gentle topography and rich soils. While calcium-rich bedrock is relatively common in Greensboro, it is limited in the surrounding northeast and as a result, tends to support rare to uncommon natural communities and aquatic habitat types (see Section 7). There are a few granitic bedrock intrusions in town. These intrusions are more resistant to weathering and includes some of the highest and steepest terrain in town, including Paddock Hill and Cate Hill. Unlike the more calcium-rich Waits River Formation, these granitic bedrock intrusions are more likely to develop acidic soil environs.

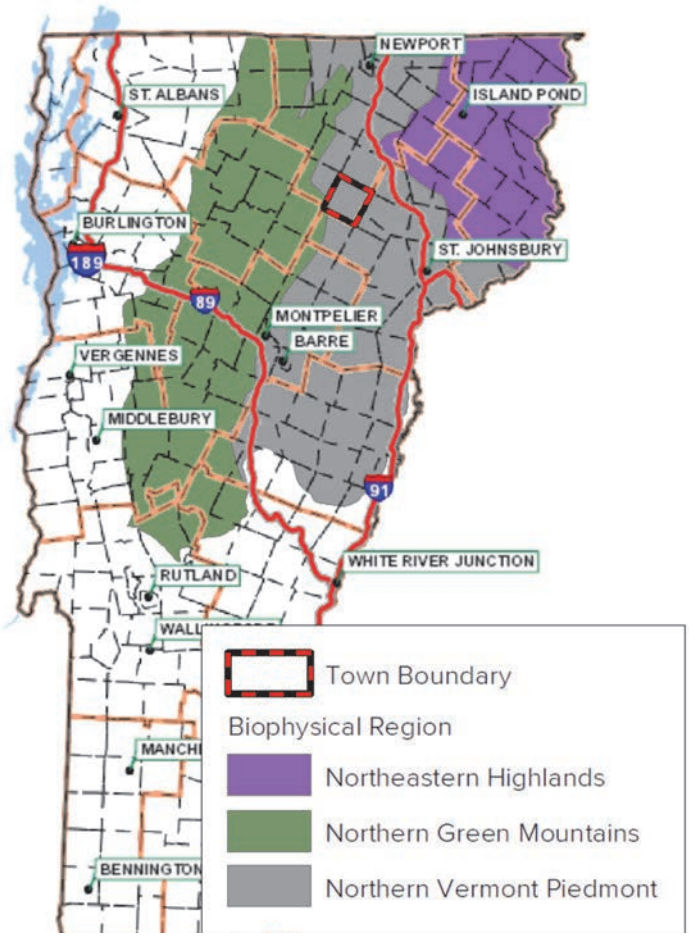

Figure 2: Biophysical Regions -Greensboro is in the Northern Vermont Piedmont, a biophysical region of rich bedrock and mixed agricultural-forested landscapes.

[2] A biophysical regional is an area of similar climate, geology, geomorphology and broad-scale vegetation patterns.

1.2 Worcester to Northeast Kingdom Linkage

Greensboro is centrally located in a priority location for maintaining connectivity across the broader Northern Appalachian region. The international Staying Connected Initiative has worked across state and national boundaries to identify a network of connected lands that facilitate long-term and long-distance wildlife movement, genetic exchange, and climate change adaptation. The network of connected lands is primarily anchored by large areas of public ownership and, in some instances, large areas of private forest ownership with more limited development pressure. Between the large areas of public ownership/private forest lands, the collaborative identified priority linkage areas to focus conservation and planning efforts; these linkages include areas where the broader connected network is most vulnerable to fragmentation. The linkages include areas of private and often non-conserved lands with some degree of development threat.

The Worcester to Northeast Kingdom Linkage provides important connectivity between the large areas of public and/or conserved lands associated with the Green Mountains and Nulhegan Basin. This Linkage comes to a partial pinch point or narrowing in Greensboro, marked in red on the map below. The Worcester to Northeast Kingdom Linkage pinch point is also visible in the *Forest Block*, *Connectivity*, and *Resiliency Resource* Map[3]. Connectivity is important for sustaining many natural resources and is further detailed in Section 3.

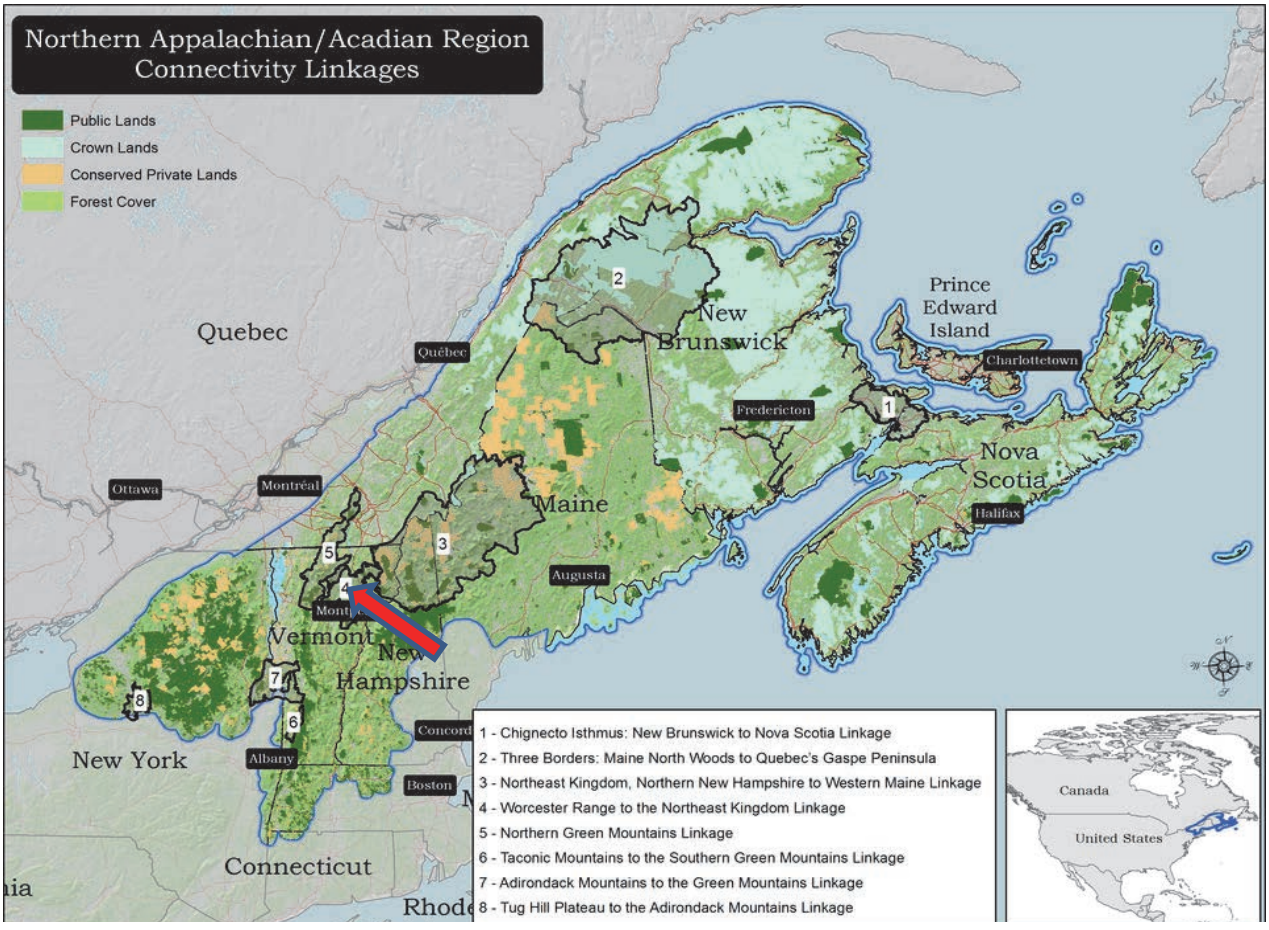

Figure 3:Northern Appalachian Priority Linkages-The Staying Connected Initiative has identified 8 priority Linkages across the broader Northern Appalachian Region for maintaining broad-scale connectivity. Greenboro (marked by red arrow) is located within the Worcester to Northeast Kingdom Linkage. Map from the Staying Connected Initiative.

2. WATER, WETLAND, AND RIPARIAN RESOURCES

Surface waters, wetlands, and their associated riparian areas are essential for people and wildlife. In addition to providing habitat for multiple *Species of Greatest Conservation Need*[4] (SGCN), they provide and recharge drinking water sources. Wetlands, river corridors, floodplain forests, and riparian forests are also an important water resource as they help to filter out and attenuate sediments, excess nutrients, and other containments damaging to water quality, habitat, and drinking water. Taken in concert with Vermont's priority forest blocks—see the *Forest Block, Connectivity*, and *Resiliency Resources Map* in Section 3—the interconnected network of large forest blocks, streams, rivers, ponds, lakes, and riparian corridors allow for movement of wildlife and plants across the landscape, as well as continuity of other ecological processes critical to Vermont's waterways and biodiversity.

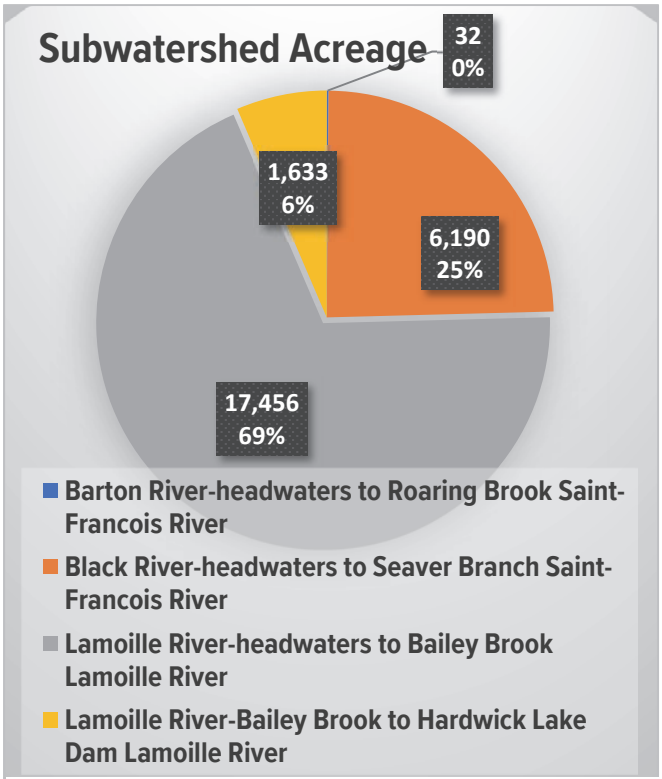

Figure 4: Area of Greensboro's Subwatersheds-Greensboro contains four smaller, subwatersheds. Acreage and percent area of each subwatershed as calculated by NG using USGS HUC 12 watersheds.

Greensboro sits on a major watershed divide, with the northwest corner of town draining north towards the Saint Lawrence via the Saint-Francois River. Rest of the town drains to the south and east towards the Lamoille River, which eventually flows west into Lake Champlain. Nested within these two major watersheds are the town's four subwatersheds[5], which are detailed in figure 4. More than 75 percent of the town drains towards the Lamoille, with the smaller Barton and Black River subwatersheds draining towards the Saint-Francois.

Besides the better-known Caspian Lake, Elligo Lake, Long Pond, Horse Pond, and Mud Pond, there are 159 other small ponds and pools with standing water in Greensboro, totaling 1,142 acres[6]. Ninety percent of these waterbodies are less than one acre in size, unnamed, and often barely visible on maps. While these smaller waterbodies may be of benefit for wildlife and water quality, they have more limited recreational capacity and generally lack access. The largest ponds and lakes are listed below in table 2 and further described in the recreation resources in Section.

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[4] *Species of Greatest Conservation* need are identified in the Vermont Wildlife Action Plan (Vermont Wildlife Action Plan Team, 2015) and include declining, rare, and at-risk species that are a priority for conservation and management.

[5] In this Section, subwatershed are defined as USGS HUC 12 watersheds

[6] 4.5 percent of the town's total land area. Some of the smaller ponds and pools are also classified as wetlands and counted in the wetland acreage.

Table 2: Lakes and Major Ponds in Greensboro

Lake or Pond Name	USGS Subwatershed	Lake/Pond Acres
Caspian Lake	Lamoille River-headwaters to Bailey Brook	790
Elligo Lake	Black River-headwaters to Seaver Branch	147
Long Pond	Lamoille River-headwaters to Bailey Brook	99
Horse Pond	Lamoille River-headwaters to Bailey Brook	34
Mud Pond (Southwest)	Lamoille River-Bailey Brook to Hardwick Lake Dam	7
Mud Pond (Northeast)	Lamoille River-headwaters to Bailey Brook	3

The town has over 80 miles of mapped rivers and streams, ranging in size from the Lamoille River, which builds to a moderately-sized fourth order stream as it flows through town, to the many small and often intermittent headwater streams. There are likely many more small headwater streams because these smaller waterways can be difficult to map. In terms of stream order, the next largest streams after the Lamoille River are Greensboro Brook, which drains Caspian Lake, then Sawmill Brook, which drains Long Pond. The length and stream order of the town's rivers and major streams are listed below in table 3.

Table 3: Rivers and Major Streams in Greensboro

Stream (Order)	USGS Subwatershed	Miles
Lamoille River (1-4)	Lamoille River-headwaters to Bailey Brook	6.2
Greensboro Brook (4)	Lamoille River-headwaters to Bailey Brook	2.9
Sawmill Brook (1-4)	Lamoille River-headwaters to Bailey Brook	3.8
Alder Brook (1-3)	Lamoille River-Bailey Brook to Hardwick Lake Dam	1.3
Flagg Brook (3)	Lamoille River-headwaters to Bailey Brook	0.4
Mud Pond Brook (3)	Lamoille River-headwaters to Bailey Brook	3.4
Porter Brook (1-3)	Lamoille River-headwaters to Bailey Brook	3.0
Paine Brook (1-2)	Lamoille River-headwaters to Bailey Brook	2.7
Stanley Brook (1-3)	Lamoille River-headwaters to Bailey Brook	2.6
Whetstone Brook (1-3)	Black River-headwaters to Seaver Branch	3.0
Whitney Brook (1-3)	Black River-headwaters to Seaver Branch	3.1

Lining these surface waters are floodplain forests, riparian areas, river corridors, and other valley bottom lands that interact with the waterway through flooding, ice scour, erosion, and other stream processes. The town's network of streams, rivers, ponds, lakes and their inter-connected riparian areas provide habitat for aquatic, upland, and amphibious species and can function as travel ways for many species of wildlife. This inter-connected network is also essential for broader ecosystem health and resilience by, for example, providing space for stream channel evolution and plant migration. Computer modelling done by state ecologists and biologists[7] suggests just under 23 percent[8] of the town is occupied by this network of surface waters and its adjacent riparian land area. The state ecologists consider the entire surface water and riparian network to be a priority for long-term ecological function.

[7] see Priority Riparian Areas in the Subsection 2.1.7
[8] 5,771 acres

Within these riparian areas are floodplains, or areas flooded every 1-2 years on average. In addition to flooding, these areas can also be subject to semi-annual ice scour and sediment deposition. The exact extent of the town's floodplains is unknown, but not widespread. Forested floodplains are even more limited as floodplains typically develop prime agricultural soils and are frequently converted to farming uses. Floodplain forests are critical to the long-term function of streams and rivers and are also important for biodiversity conservation as they tend to support uncommon species and natural communities. During this inventory, 209 acres [9] of potential floodplain forest were identified, but these need additional investigation.

River corridors are also a subset of the broader riparian area and, where they have been mapped, include the land area most likely to be impacted by river-related erosion and channel migration. There are 643 acres of river corridors in town. River corridors have been delineated and/or approved by state river scientists but have not been mapped systematically throughout town. Mapping efforts in town have focused on the Lamoille and its major tributaries. Buildings, roads, and other infrastructure within these river corridor areas could be exposed and vulnerable to erosive river forces, such as rapid stream channel migrations, bank erosion, and flooding.

There are 890 acres[10] of mapped wetlands in town as identified in the *Vermont State Wetlands Inventory*. There are likely more small and forested wetlands than currently mapped; these types of wetland are more difficult to map from remote sources. The town's wetlands vary widely in vegetation, size, and condition. As a result, the functions these wetlands provide for people and wildlife, such as providing clean drinking water and suitable habitat, also vary widely. The Vermont Department of Environmental Conservation recognizes that wetlands can provide the following functions:

1. water storage for flood water and storm runoff
2. surface and ground water protection
3. fisheries habitat
4. wildlife and migratory bird habitat
5. hydrophytic vegetation habitat
6. threatened and endangered species habitat
7. education and research in natural sciences
8. recreational value and economic benefits
9. open space and aesthetics
10. erosion control through binding and stabilizing the soil

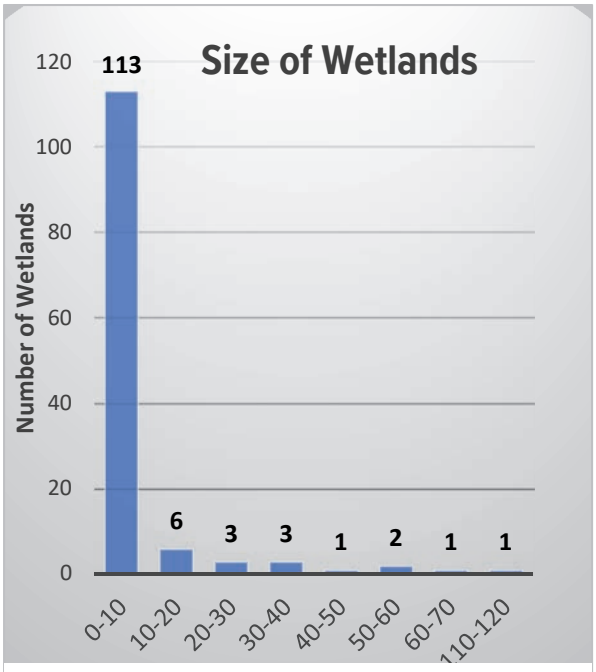


Figure 5: Frequency of Wetland Sizes in Greensboro- Large wetlands are limited in Greensboro. Wetland size and frequency calculated by NG using the Vermont Signficant Wetlands Inventory.

[9] Less than 1 percent of the town's total land area

[10] 3.5 percent of the town's total land area. This does not include Caspian Lake or any of the town's other major ponds, which are not included in the Vermont State Wetland Inventory but are included in the National Wetlands Inventory

Not always, but often, larger wetlands, more diverse wetlands, and wetlands with less human encroachment provide more wetland functions, particularly for wildlife. Vegetation type, presence/duration of standing water, and landscape position also affect wetland function. An assessment of wetland function and condition is beyond the scope of this report, but current national and state wetland data provide information on wetland type and size. Across the town, wetlands range in size from less than a 1/10th of an acre to well over 100 acres. However, large wetlands (> 25 acres) are limited with more than 75 percent of the wetlands less than eight acres in size (see figure 5).

There is a diversity of wetland vegetation types in Greensboro, with duration of standing water, soil/water chemistry, and substrate being important variables affecting wetland vegetation. The town supports forested swamps, scrub-shrub swamps, emergent marshes, and open water wetland classes (see figure 6). This a coarse generalization of the town's wetland vegetation types. There is far greater variety and diversity.

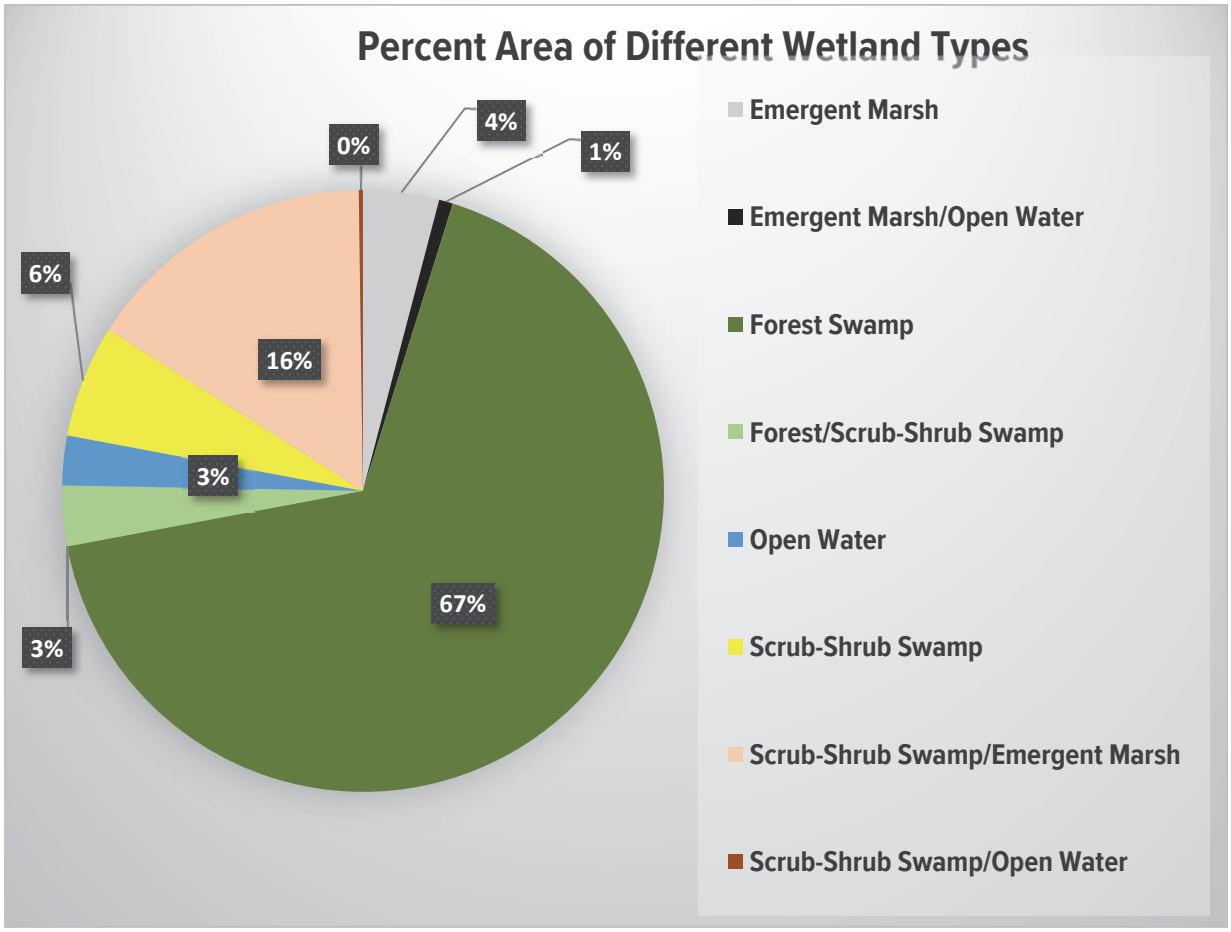


Figure 6: Area of Different Wetland Type-Based on acreage, the percentage of each major wetland type mapped in town. This chart uses data from the National Wetlands Inventory. For this analysis, wetlands were condensed at the class level of the Classification of Wetlands and Deepwater Habitats of the United States (Cowardin et al., 1979). Caspian Lake and the other major ponds in the town are included in the National Inventory, but not the Vermont State Wetland Inventory. Caspian Lake and the other major ponds were not included in the above analysis.

Water resources provide many benefits to the town, including drinking water. Surface waters and wetlands help to recharge groundwater supplies and wells. Wetlands and riparian areas also help to filter and maintain water quality. There are 384, mostly private, groundwater wells in town. In addition to these wells, surface waters and shallow wells are occasionally used for drinking water; historically, this was a more common practice. Surface water drinking sources are more susceptible to contamination, so groundwater wells are now the more common practice.

To help protect public drinking water supplies, particularly pre-1970 water supplies that may be more vulnerable to contamination, the Department of Environmental Conservation requires a source water protection plan. The plans can require minimizing the risk of the potential contaminants in a designated source protection area[11]. Not all the public water sources depicted are currently being used and not all necessitate a source protection area to maintain water quality. There are two clusters of source water areas in town, totaling 384 acres[12]. One cluster is located near Greensboro Bend and the second, northwest of Caspian Lake, surrounds fire department water supplies.

For aquatic wildlife and plants, not all surface waters are created equal, with some systems supporting exceptional levels biodiversity. There are also some lakes and ponds that are important for aquatic wildlife and plants because of their physical and chemical make-up. Several of the town's ponds, lakes, rivers, and streams support exceptional concentrations of aquatic biodiversity; these exemplary surface waters are listed in table 4 and typically support some combination of healthy fish and macro-inveterate populations and/or rare species. In addition to the exemplary surface waters listed in table 4, there are also several un-named streams and brooks. All combined, there are 1,381 acres of exemplary surface waters in town.

Table 4: Exemplary Surface Waters

Caspian Lake
Elligo Lake
Long Pond
Mud Pond (Northeast)
Bailey Brook
Cemetery Brook
Edson Brook
Mud Pond Brook
Paine Brook
Porter Brook
Sawmill Brook

As mentioned in the town overview, a substantial portion of the town is underlain by calcium-rich or moderately calcium-rich bedrock and as a result of this relatively uncommon underlying geology, Greensboro's lakes and ponds tend to a have an alkaline, or calcium-rich, water chemistry; this is a relatively uncommon type of aquatic habitat. State ecologists (Sorenson and Zaino, 2018) recognize that Caspian Lake, Long Pond, and Horse Pond represent some most important alkaline or moderately alkaline aquatic habitat in the state.

Surface waters and wetlands also tend to be hotspots for recreation, which is detailed in the Section 4. The *Water, Wetland, and Riparian Resources Map* shows the town's surface waters, wetlands, exemplary surface waters, priority surface waters/riparian areas, representative lakes/ponds, potential floodplain forest, river corridors, public water supplies, and ground water source protection areas.

[11] Area of land that likely recharges or passes groundwater through to the public water source
[12] 1.5 percent of the town's total land area

2.1 Water, Wetland, and Riparian Data Layers

The following data layers were used and/or developed during the inventory and analysis of surface water, wetland, and riparian resources in town:

2.1.1 Wells

Location of known wells completed by licensed drillers since 1966, including drinking water wells for single family homes, public buildings, subdivisions and public water supplies. In addition to operational drinking water wells this may also include monitoring wells, geothermal wells, or closed wells.

2.1.2 (Pre 1970s) Public Water Supplies

Location of active and inactive public water sources--wells, springs and surface water intakes--that predate current regulation established in the 1970s. Public water sources may include community, non-transient non-community, and transient non-community water sources listed in the *State Drinking Water Database* (SDWIS). Location data also from SDWIS. This data layer is maintained by the Vermont Agency of Natural Resources Department of Environmental Conservation (DEC)

2.1.3 Ground Water Source Protection Areas

Location of source protection areas (SPA) surrounding wellheads that predate current (1970s era) regulation. This layer includes SPAs around active and inactive community and non-transient non-community ground water sources in the SDWIS. SPA boundaries located by DEC and Vermont Department of Health Staff.

2.1.4 River Corridors

River corridors are the lands immediately around and adjacent to a river/stream that may be at higher risk to fluvial (i.e. river/stream) related erosion. River corridors are mapped to encapsulate the rivers'/streams' potential meander pattern and floodplain. River corridors are delineated by DEC river scientists and their consulting partners utilizing a mix of field data collection and measurements, topographic data, and aerial imagery.

2.1.5 Exemplary Surface Water

These are surface waters—rivers, streams, lakes, and ponds—that support known concentrations of rare species, exceptional species diversity, and/or exemplary aquatic habitat. These exemplary surfaces waters were identified by state ecologists and biologists during the *Vermont Conservation Design* (Sorenson and Zaino, 2018) and a are a subset of the 2010 *Vermont Hydrography Dataset*.

2.1.6 Representative Lakes/Ponds

Vermont's ponds and lakes support a range of different aquatic habitat types and biological communities. Water depth and chemistry are just a few of the variables that influence aquatic habitat. This layer includes a subset of the best examples of each different aquatic habitat type found across Vermont. These lakes and ponds were identified by state ecologists and biologists during the *Vermont Conservation Design* (Sorenson and Zaino, 2018). This layer integrates a variety of hydrologic and biological data.

2.1.7 Priority Surface Waters/Riparian Areas

Includes the town's network of streams and rivers and immediately adjacent valley bottoms, floodplains, and riparian areas. These priority areas were identified by state ecologists and biologists during the *Vermont Conservation Design* (Sorenson and Zaino, 2018) as they provide vital habitat and are critical to broader ecological connectivity. This layer integrates a variety of hydrologic and topographic data.

2.1.8 Potential Floodplain Forest

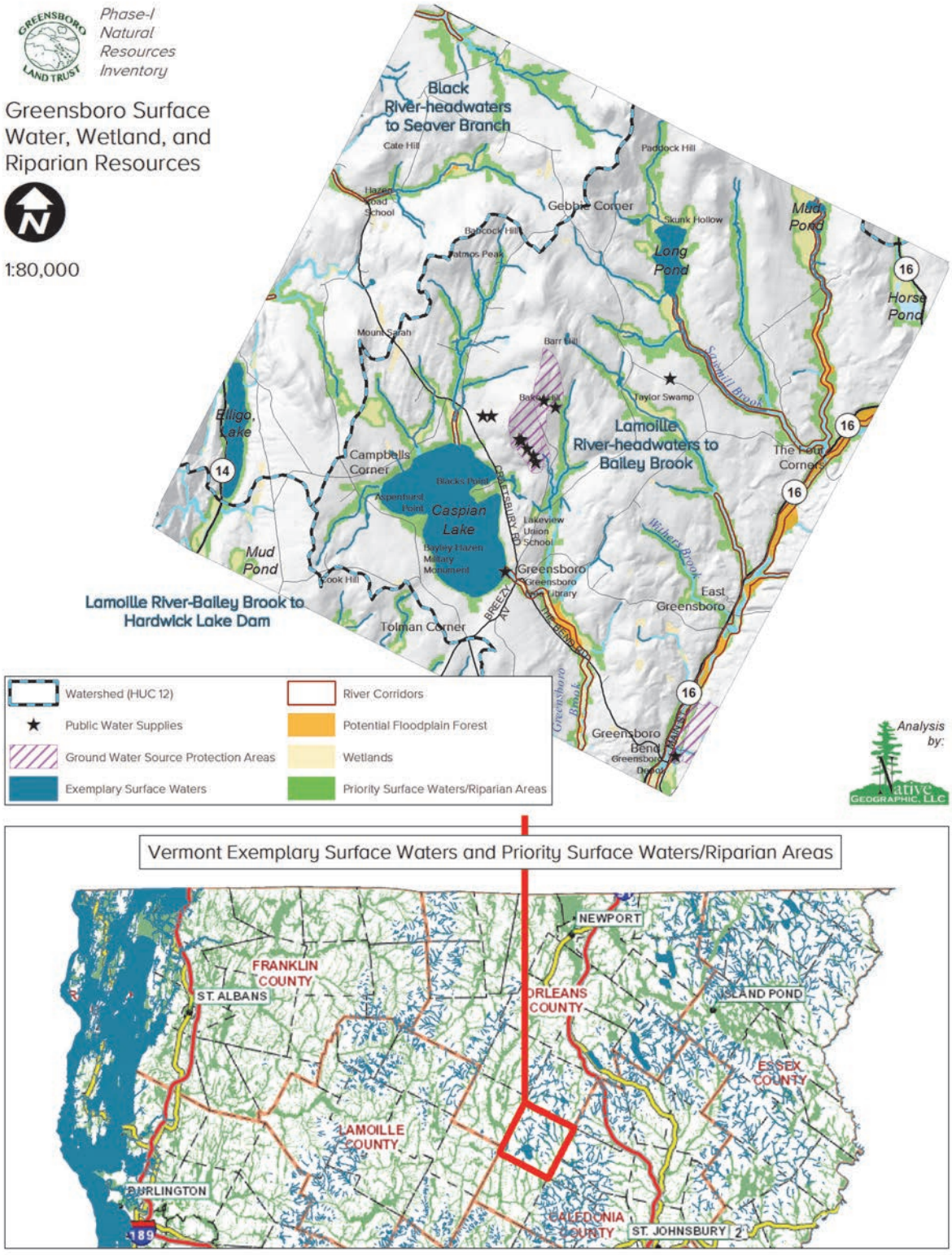
Location of potential floodplain forests along rivers and major streams. Based on topographic position, these forested areas are likely subject to flooding and other floodplain processes. These sites have not been verified in the field and were remotely mapped by NG from multiple vintages aerial imagery and high-resolution elevation data. Generally delineated at a scale of 1:5,000 or finer.

2.1.9 Wetlands

Depicts the location of Vermont' regulatory wetlands mapped in the 2010 *Vermont Significant Wetlands Inventory* (VSWI). State wetland ecologists created this data layer utilizing the *National Wetlands Inventory* (NWI), prior versions of the VSWI, and a mix of aerial imagery, soil, and topographic data.

2.1.10 Surface Waters

Streams, rivers, ponds, lakes, and other surface waters mapped by the USGS and extracted from the 2010 *Vermont Hydrography Data*set (VHD). The VHD is derived from the National Hydrography Dataset, nationwide effort to map the country's surface waters.



Map 1: Surface Water, Wetland, and Riparian Resources

3. Forest Block, Connectivity, and Resiliency Resources

Forest blocks are areas of contiguous forest and other natural systems (i.e. wetlands, ponds, ledges, etc.) that are unfragmented by roads, development, or agriculture (Sorenson and Osborne 2014). Large forest blocks provide essential habitat for interior and wide-ranging wildlife species and species sensitive to human encroachment. Taken in concert with Vermont's priority surface waters and riparian areas—see the water, wetland, and riparian resources in Section 2—the interconnected network of large forest blocks, riparian corridors, and other natural systems allow for movement of wildlife and plants across the landscape, as well as continuity of other ecological processes critical to Vermont's forests, biodiversity, and climate resiliency. This inter-connected network of forest blocks is also vitally important for sustaining ecological processes that provide important services to people, such as sequestering and storing carbon, growing forest products, and helping to maintain air quality, water quality, and flood resilience (Vermont Forests, Parks & Recreation Department, 2015).

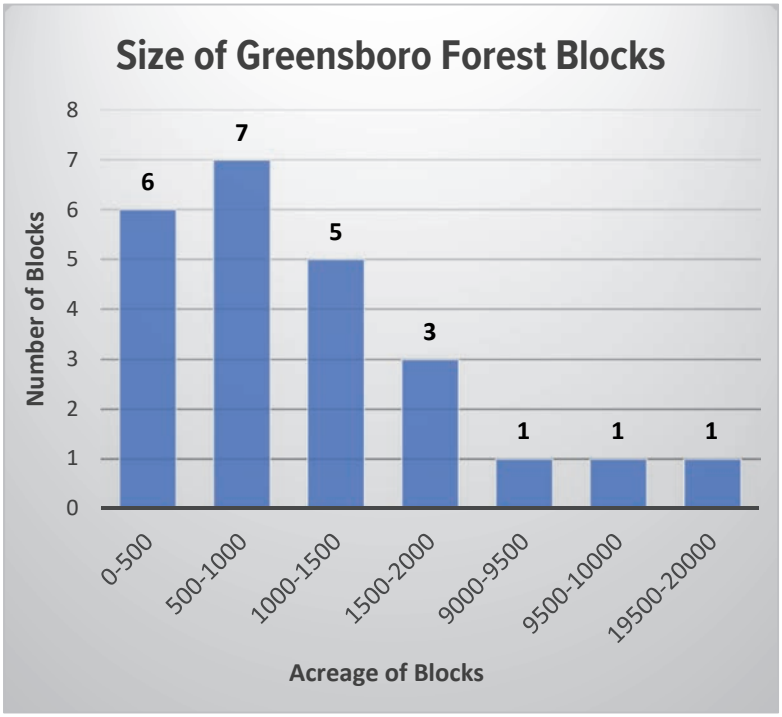


Figure 7: Frequency of Forest Block Sizes in Greensboro- Forest block size and frequency calculated by NG using the Vermont Conservation Design

There are 24 forest blocks in town, varying widely in size, including one exceptionally large block. The smallest block is just over 36 acres, while the largest block is almost 20,000 acres. Even compared to rest of the state, the 20,000-acre block along the eastern edge of town is very large, with less than one percent of the other blocks in the state being larger. This large block is centered around Stream Mills Wildlife Management Area. In addition to Greensboro, the block also extends into Wheelock, Glover, Stannard, and Sheffield.

Typically, larger blocks and well-connected blocks have more capacity for sustaining biodiversity and ecological functions and are more resilient to natural disturbances, climate change, and other stressors (Sorenson and Zaino, 2018; Vermont Forests, Parks & Recreation Department, 2015). Large forest blocks connected to other forest blocks are better able to accommodate the seasonal and daily movements of resident wildlife and are more likely to accommodate long-term shifts in the distribution of wildlife and plants as they adjust to climate change. Large and well-connected forest blocks are also more likely to support bigger, robust breeding populations.

As part of the *Vermont Conservation Design* (Sorenson and Zaino, 2018), a statewide strategic conservation plan, state ecologists and biologists evaluated and prioritized forest blocks based on three different attributes and associated functions: interior forest, connectivity, and geophysical diversity. Interior forest includes the central portions of a forest block removed from the block perimeter and associated detrimental edge effects. Edge effects can include changes in micro-climate --typically drier, sunnier, and windier—and impacts associated with adjacent land uses spilling over, such as pets and the establishment/spread of invasives. While some species are dependent on interior forest conditions, many species do best when they have access to interior forest for some aspect of their life cycle; a sample of species likely to benefit from interior forest is included in table 5. Under the interior forest evaluation, blocks were prioritized based on the availability and quality of interior forest habitat and their capacity to support interior species and ecological functions associated with large areas of unfragmented forest, such as intact predator-prey relationships, dispersal, and carbon sequestration.

Table 5: Species that Benefit from Interior and Connected Forest-Compiled by NG using information from the Vermont Conservation Design (Sorenson and Zaino, 2018), Vermont Forest Fragmentation Report (Vermont Forests, Parks & Recreation Department. 2015), Vermont Wildlife Action Plan (Vermont Wildlife Action Plan Team, 2015), and Audubon.

Species/Species Groups That Benefit from Interior Forest	Species/Species Groups That Benefit from Connected Interior Forest
salamanders	moose
northern long-eared bat	black bear
northern flying squirrel	goshawk
scarlet tanager	fisher
black-throated green warbler	bobcat
wood thrush	american marten
hermit thrush	
veery	
canada warbler	
northern parula	
blue-headed vireo	
blackburnian warbler	

The town supports parts of four highest priority[13] interior forest blocks totaling 6,645 acres. The highest priority interior blocks are concentrated in the northeast and northwest corners of town and not surprisingly, includes the nearly 20,000-acre block along the eastern edge of town. The other highest priority interior block in the northeast corner of town is just under 10,000 acres and includes Long Pond, Mud Pond, and Horse Pond, as well as Paddock Hill; this is the largest block completely within town. In the northwest corner of town, two priority interior blocks surround Elligo Lake, including a smaller 1,139-acre block east of the Lake and a 9,294-acre block on the west side of the Lake and extending into Craftsbury and Wolcott.

In addition to these highest priority interior forest blocks, are seven priority interior forest blocks. These priority interior blocks are not as highly ranked but do also support interior

[13] Includes the highest ranked blocks in the surrounding Northern Green Mountain and Northern Vermont Piedmont biophysical regions. 26 percent of the town's total land area.

forest habitat and help to buffer the nearby highest priority interior blocks. There are an additional 7,598 acres[14] of priority interior forest blocks in town.

The location or the landscape context can also dramatically influence the importance of a forest block as it relates to connectivity. Connectivity is the degree to which blocks of suitable habitat are connected to each other and facilitate or impede the movement of organisms and processes across the landscape. Generally, large blocks and landscapes with a high degree of connectivity have more capacity for wide-ranging species, sustaining long-term ecological function, and climate change resiliency. A sample of wide-ranging species likely to benefit from connectivity is included in table 5. Under the connectivity evaluation, state ecologists prioritized blocks based their contribution to connectivity across the surrounding biophysical region, state, or broader northeast region. Generally, forest blocks that are part of the Staying Connected Initiative linkages[15], along the spine of the Green Mountains, located between larger forest blocks, and/or or located in pinch points between adjacent blocks are a higher priority for connectivity.

The town contains seven highest priority connector blocks, totaling 11,433 acres[16]. All the highest priority connector blocks in town are part of the much larger *Staying Connected Initiative* linkage across Vermont, New Hampshire, and Western Maine. The town is located along a major east-west axis connecting the large unfragmented habitats of the Worcester Range to the northeast kingdom. This major connection crosses town and narrows to a pinch point along Craftsbury Road. These connector blocks and associated road crossings are vital to maintaining connectivity in Greensboro, across the state, and broader northeast region. In addition to these highest priority connector blocks, there are ten other priority connector blocks totaling 5,452 acres[17]. These priority connector blocks provide secondary pathways and redundancy to the highest priority connector blocks.

Lastly, as part of the *Vermont Conservation Design* (Sorenson and Zaino, 2018), state biologists and ecologists evaluated and prioritized forest blocks based on their underlying geophysical diversity, including differing combinations of soil, bedrock, and terrain. Priority physical landscape diversity blocks were identified to ensure that the full range of potential habitats and growing conditions available in Vermont remain accessible to wildlife and plants into the future. The physical landscape diversity blocks include areas with combinations of bedrock, soil, and/or terrain that are either rare in Vermont, rare in the surrounding region, or not adequately represented in the highest priority interior and connectivity blocks. This entire network of blocks —highest priority interior forest blocks, highest priority connector blocks, and physical landscape diversity blocks—should capture and represent the full array of physical landscape diversity in the region.

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[14] 30 percent of the town's total land area

[15] The Staying Connected Initiative is an international collaborative to conserve, restore, and enhance landscape connectivity across the Northern Appalachian/Acadian region of the U.S. and Canada. The Initiative and partners have identified a network of linkage and protected area areas designed to sustain connectivity across the broader region.

[16] 45 percent of the town's total land area

[17] 22 percent of the town's total land area

Not surprisingly, almost every forest block in town is a priority physical landscape diversity block; this is mostly due to the uncommon bedrock types that underlie town. Most of the town is underlain by a calcium-rich bedrock. Calcium rich bedrock is somewhat common in parts of Vermont but is generally rare in the greater northeast region. Similarly, the northeast corner of town is underlain by a granitic bedrock type. Granite bedrock is relatively rare in Vermont, but common in parts of the surrounding northeast. Of the 24 forest blocks in town, only six are not identified as a priority physical landscape diversity block. All the highest priority connector and interior forest blocks are also priority physical landscape diversity blocks.

Addressing climate change resilience and adaptation is an international challenge and requires planning and analysis across state, federal, and international boundaries. Working across these boundaries, The Nature Conservancy has identified areas important for climate resilience across eastern North America. Like the *Vermont Conversation Design*, The Nature Conservancy evaluated and identified resilient sites based on connectivity, geophysical diversity, and forest block size. Generally, larger, more physically diverse, and more connected landscapes had greater climate resilience.

Per The Nature Conservancy analysis, approximately 5,000 acres of Greensboro have above average climate change resilience; these priority resilient lands are mostly located in the northeast and northwest corners of town. These have a high degree of overlap with the highest priority blocks identified by the *Vermont Conservation Design*. While these two separate analyses have similar goals, they did employ different methods and utilize different data. The high degree of resulting overlap between the two separate studies speaks to the importance of the large forest blocks in the northeast and northwest corners of town.

The Forest Block and Connectivity Resources map shows the town's interior forest blocks, connector blocks, and priority resilient lands.

3.1 Forest Block, Connectivity, and Resiliency Data Layers

3.1.1 Interior Forest Blocks

This is a subset of forest blocks that provide the highest quality and often largest area of interior forest habitat. These priority forest blocks were identified by state ecologists and biologists during the *Vermont Conservation Design* (Sorenson and Zaino, 2018). Interior forest blocks were evaluated and ranked based on the amount and quality of interior forest habitat; topographic diversity; and capacity for other associated ecological functions. Forest block boundaries are derived from 2011 *National Land Cover Data* (Sorenson and Osborne 2014). A variety of other data layers were used to evaluate and rank the forest blocks.

3.1.1.1 Highest Priority: The largest and/or highest ranked interior forest blocks in the surrounding biophysical region. They are critical for maintaining interior forest habitat and associated ecological functions

3.1.1.2 Priority: Also, highly ranked interior forest blocks relative to the surrounding biophysical region. They provide important interior forest habitat and help to buffer and maintain the integrity of the highest priority interior forest blocks.

3.1.2 Connector Blocks

This is a subset of forest blocks that are part of a larger inter-connected network of forests, riparian areas, and other habitats that provide connectivity across the state and broader northeast region. These forest blocks were identified by state ecologists and biologists during the *Vermont Conservation Design* (Sorenson et al., 2015). Forest block boundaries are derived from 2011 *National Land Cover Data* (Sorenson and Osborne 2014). A variety of other data layers, connectivity computer models, and studies were used to evaluate and identify the connector blocks.

3.1.2.1 Highest Priority: Block is central to the larger inter-connected network of forests blocks across the state and broader northeast. Statewide, the highest priority connector block network includes the spines of the major mountain ranges, connections to outside Vermont, and connection across the State's biophysical regions.

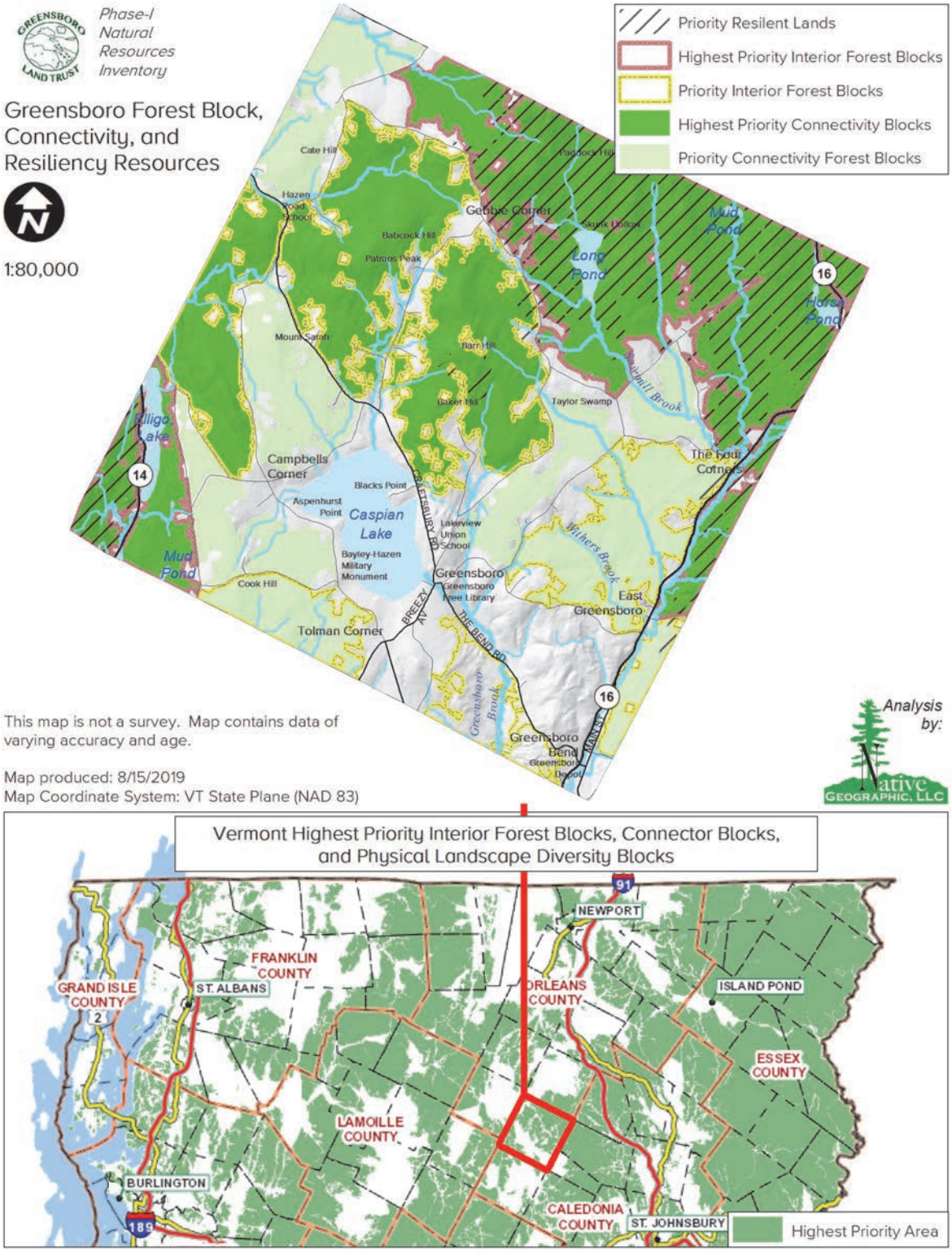
3.1.2.2 Priority: Block provides alternate pathways and redundancy to the Highest Priority Connector Blocks network. These block help to support and maintain the integrity of the Highest Priority Blocks.

3.1.3 Physical Landscape Diversity Blocks

Subset of the forest blocks that include combinations of bedrock, soils, landforms, and/or other physical landscape features that are either rare in Vermont or the surrounding region. These forest blocks were identified by state ecologists and biologists during the *Vermont Conservation Design* (Sorenson et al., 2015) to supplement the physical diversity included in the highest priority interior forest blocks and connector blocks and to ensure that the state's full diversity of physical habitats is captured in and represented by the overall V*ermont Conservation Design* network.

3.1.4 Priority Resilient Lands

Location of sites with above average climate resilience and most likely to sustain native plants, animals, and ecological processes in a changing climate. While conceptually like the *Vermont Conservation De*sign, these sites were prioritized by a team of 60 scientists led by The Nature Conservancy using slightly different methods and over a far greater geographic (Anderson et al., 2016). In terms of climate resilience and adaptation, these are the best sites in the greater Northeast. These sites are generally a priority because they support a wide range of micro-climates within a highly connected landscape, which not only allows wildlife and plants to move across the landscape, but also increases the likelihood each that species will find suitable habitat.



Map 2: Forest Block, Connectivity, and Resiliency Resources

4. RECREATION RESOURCES

Recreation is important to the quality of life for Vermont's citizens and is important to the state's rural economy. Fishing, swimming, camping, skiing, hiking, snowmobiling, hunting, and numerous other outdoor pursuits attract residents and tourists to the region. Vermont's outdoor recreation industry supports over 10,000 jobs and outdoor-based tourism accounts for about 11.5 percent of the state's employment (Vermont Forests, Parks & Recreation Department. 2015). Outdoor recreation generally benefits from undeveloped open spaces, clean waterways, and access. Throughout the state, publicly owned lands provide critical access to trails, waterways, and other open spaces. Equally important, many of the state's private landowners also allow public access or passage for recreation.

While the town lacks large public lands like Green Mountain National Forest, smaller lands owned by Highland Lodge, Vermont Agency of Natural Resources, The Nature Conservancy and some privately-owned lands do provide opportunities for trail-based recreation (see table 6). In town, there are 1,589 acres[18] of protected land[19] with some degree of public access; only four ownerships (a total of eight separate parcels) have public trail systems. Additionally, in the winter, a publicly accessible snowmobile trail traverses the southwest corner of town. This snowmobile trail crosses many private properties, most without any form of long-term protection, like a conservation easement.

Table 6: Protected Properties with Public Trail Systems

Name	Owner	Acres
Long Pond	The Nature Conservancy	473
Barr Hill	The Nature Conservancy	254
Green Mountain Monastery (in-progress)	Green Mountain Monastery	157
Porter Brook Nature Trail	Highland Lodge	75

Caspian Lake and three of the town's ponds are accessible to boats, anglers, and other recreationists through a series of Vermont Fish and Wildlife and other public accesses. Caspian Lake and the ponds support a mix of trout and other sportfish. Caspian Lake, particularly, is a destination for anglers. Similarly, there are stretches of the Lamoille River that are accessible to anglers and recreators. The Lamoille and many of the streams in town support wild trout populations.

The *Recreation Resources Map* shows the town's outdoor recreation sites, properties with public trails, protected lands with public access, snowmobile trail, and trout streams/rivers.

[18] 6 percent of the town's total land area

[19] Includes properties owned in fee by Greensboro, The Nature Conservancy and Vermont Agency of Natural Resources and private properties with conservation easements. Also includes properties that are in the process of being conserved.

4.1 Recreation Data Layers

The following data layers were used and/or developed during the inventory and analysis of recreation resources in town:

4.1.1 Trout Streams/Rivers

Sub-watersheds with known trout populations. Trout populations and distributions mapped by state fisheries biologists using long-term monitoring data (Vermont Fish and Wildlife Department, 2018). The trout data uses HUC-14 watersheds to summarize and display distribution. Sub-watershed boundaries are from the USGS.

4.1.2 Trout Lakes/Ponds

Lakes and ponds supporting known trout populations. Trout and other resident fish populations identified by the Greesnboro Land Trust and consultation of Vermont Fish and Wildlife Department resources, including the Vermont Management Plan for Brook, Brown, and Rainbow Trout (Vermont Fish and Wildlife Department, 2018). Lake and pond locations extracted from the 2010 Vermont Hydrography Dataset.

4.1.3 Outdoor Recreation Sites

Location of recreational sites in town. Depicts a wide range of recreation activities, including but not limited to, boat access/boat ramps, public parks, ski areas, and ballfields. Site locations originally from the *Outdoor Recreation Site* GIS database compiled by Vermont Department of Forests, Parks, and Recreation in 1999. IN 2018, site names were then modified by NG at the direction of the Greensboro Land Trust. Also, at the direction of the Trust, closed and erroneous sites were removed from the layer depicted.

4.1.4 Snowmobile Trail

Approximate location of the public snowmobile trail maintained by the Sno-Flake Ridge Runners. The trail location is extracted from the Vermont Agency of Natural Resources Trails GIS database, which was created in 1993. Based on review of the Sno-Flake's 2018 trail map, it appears there has been some minor shifts in trail location since 1993.

4.1.5 Surface Waters

Streams, rivers, ponds, lakes, and other surface waters mapped by the USGS and extracted from the 2010 *Vermont Hydrography Dataset* (VHD).

4.1.6 Properties with Public Trails

Parcels with public recreation trails. Parcels identified by the Greenboro Land Trust and mapped by NG. Parcel boundaries extracted from the 2017 Greensboro parcels GIS layer.

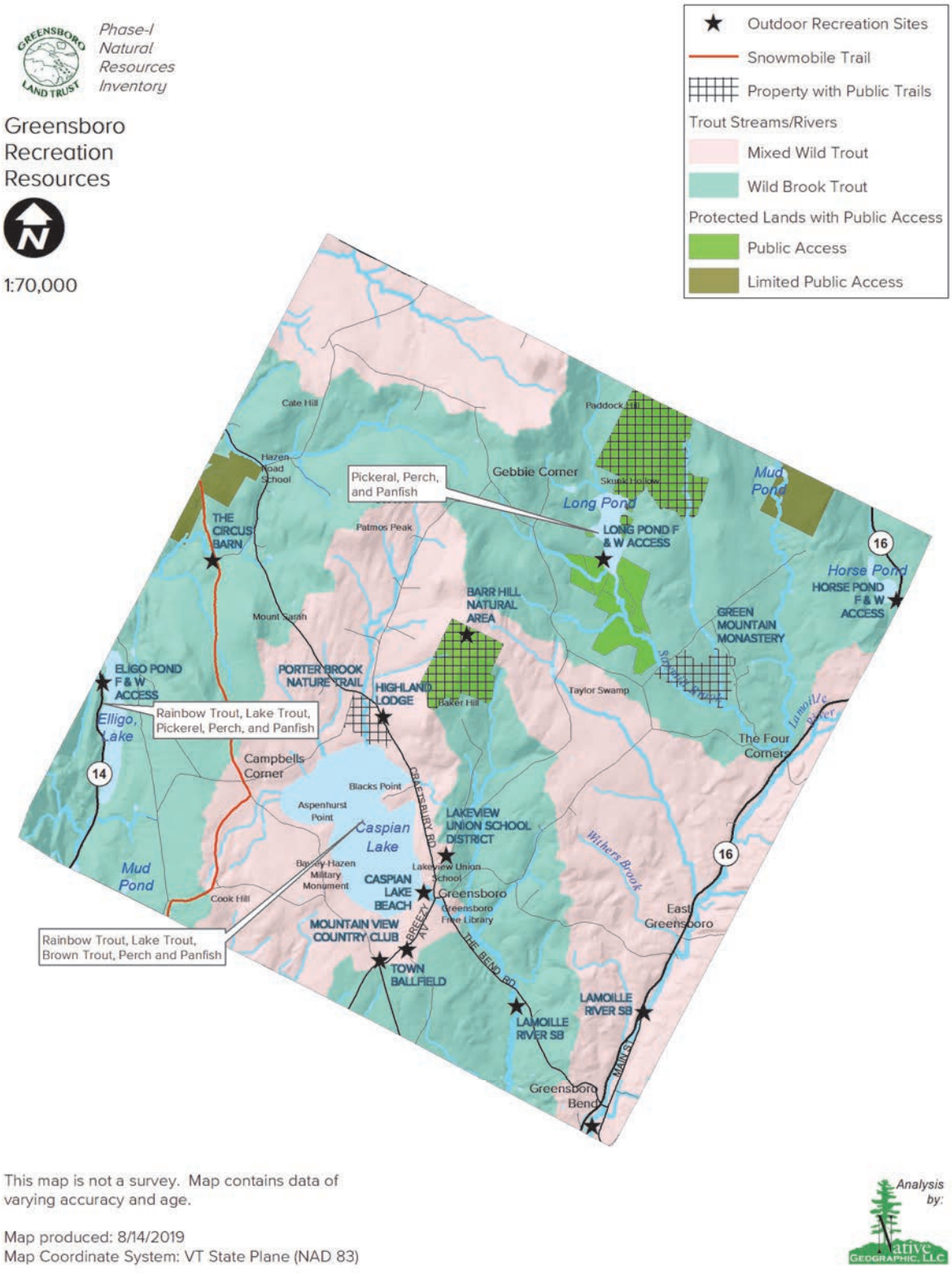
4.1.7 Protected Lands with Public Access

Protected lands with public access from the 2017 *Vermont Protected Lands Database* (VPLD). VPLD is a statewide database of parcels that are currently protected from development through public ownership, private ownership, or protection mechanisms such as easements. VPLD is maintained by the VT Center for Geographic Information (VCGI). Parcel boundaries depicted in the database are from a variety of sources, including, but not limited to, surveys, digital tax maps, and photo interpretation.

4.1.7.1 Public Access: Subset of publicly-owned land and land owned by conservation organizations with open public access.

4.1.7.2 Limited Public Access: Subset of privately-owned lands with conservation easements that guarantee limited access for recreation. Parcel may provide restricted access for trails, waterways, and dispersed recreation, such as hunting.

4.1.7.3 No or Unknown Public Access: Protected lands with no guaranteed public access or where the public access is unknown.



Map 3: Recreation Resources

5. FARMLAND RESOURCES

Vermont's farms grow regional sources of food, contribute to the local economy, and help to perpetuate the scenic landscape of pastures and forested mountains often appreciated by residents and tourists. Vermont's farms can also provide essential habitat for wildlife, including multiple grassland bird *Species of Greatest Conservation Need* (Vermont Wildlife Action Plan Team, 2015). Barns and other ancillary farm infrastructure, like manure pits, paddocks, and silage bunkers, are essential parts of the working farm, as are the fields and pastures. All fields and pastures are not created equal. Some soils and topographies are much more productive and important for agriculture. The Farmland Resources map shows the town's farming backbone, including the Active Farms, Idle Farms, Potential Fields/Croplands, and Important Agricultural Soils (see following Subsection for a description of these data layers).

Except for the far northeast corner of the town, farmland resources are well distributed across Greensboro, with hill farms and farms of rolling terrain being the most widespread. However, the most productive farming resources are concentrated in the low-lying and flatter terrain around Caspian Lake, Porter Brook, Greensboro Brook, Stanley Brook, and the Lamoille River. The distribution and productivity of these farmlands are very much influenced by the underlying soils and terrain, as well as the road network. Most of the major farms have direct road frontage on a state or town road.

The town contains 14 active farms currently producing and selling commercial products, including beef, dairy, grain, and fruit. There are 3,300 acres[20] of fields and other open spaces associated with these farms. As part of this inventory, fields were delineated across the town. See figure 8 for the different types and uses that were interpreted across town. Most of the fields are in hay production or some

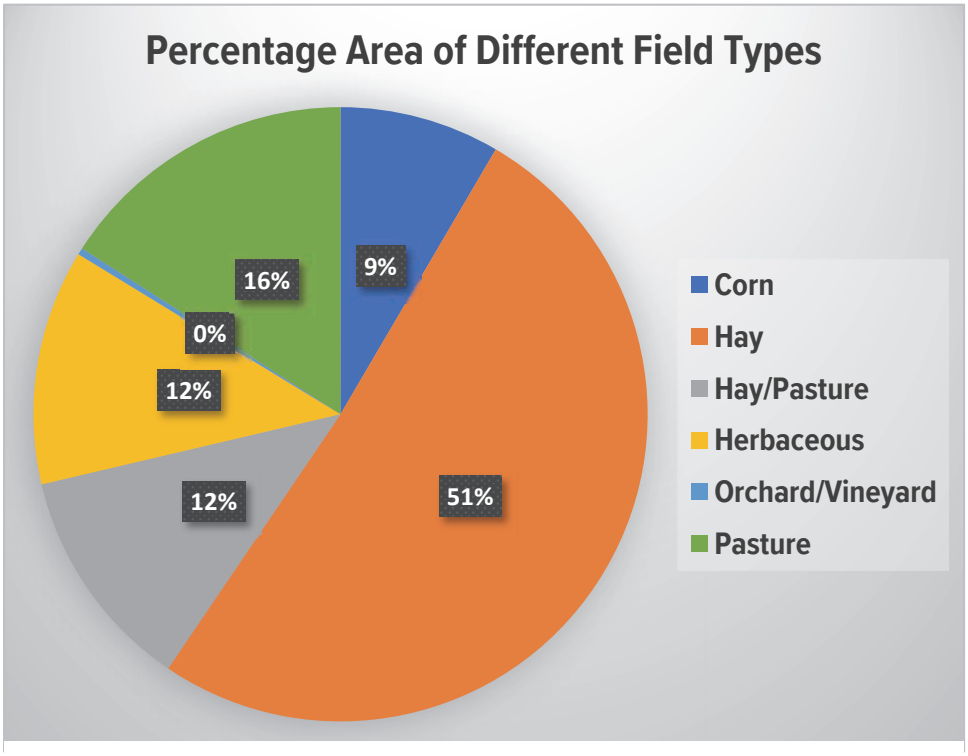


Figure 8: Area of Different Field Type-Based on acreage, the percentage of each different field type mapped across town. This chart uses data collected by NG as part of this inventory. Herbaceous areas are grassy openings where field type could not be determined; this may include idle or active agricultural fields and/or large lawns

[20] 13 percent of the town's total land area

combination of hay and pasture. A little less than 10 percent of the town's potential fields are in corn production, although throughout town, fields may be rotationally cycled through corn and hay.

The town also contains fields where type could not be determine, residences with large lawns, and/or other open areas maintained in an herbaceous or grassy condition, but not necessarily for agricultural uses; approximately 12 percent of the fields mapped during this inventory need some further evaluation and may not be in agricultural production, instead being maintained for aesthetics and other residential functions.

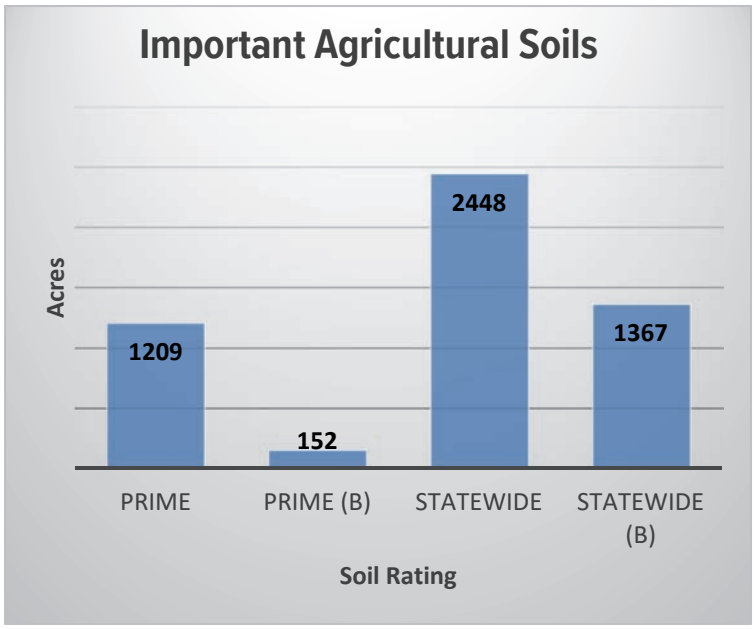


Figure 9: Area of Important Agricultural Soils-Acreage of prime and statewide soils of agricultural importance. (B) indicates soils requiring artificial drainage for farming. Based on data from the NRCS Soil Survey

When it comes to growing crops and many other agricultural uses, some soils and terrains have much greater capacity for production. There are 5,176 acres[21] of important agricultural soils in town, including prime soils and soils of statewide importance (see figure 9). These soils generally have a favorable combination of texture, nutrients, topography, drainage, and soil moisture, although there are some soils or locations requiring artificial drainage.

5.1 Farmland Data Layers

The following data layers were used and/or developed during the inventory and analysis of farming resources in town:

5.1.1 Active Farms

Location of active farms selling commercial products. One point per farm centrally located near the farm infrastructure, including barn, paddocks, manure pit, etc. Active farms interpreted by Native Geographic, LLC from multiple vintages of aerial imagery, including 2016 NAIP, 2015 VT Orthros, 2011 VT Orthos, and 2009 NAIP. Farm locations then reviewed and updated by Clive Gray (GLT) and Jon Ramsay (VLT/Center for an Agricultural Economy).

5.1.2 Fields

Location of hay, pasture, hay/pasture, corn, other crops and grassy openings at least 1-acre in size or nearly contiguous with other farm fields. Digitized and interpreted by Native Geographic, LLC from multiple vintages of leaf-on and leaf-off aerial imagery. Final

[21] 20.5 percent of the town's total land area

determination and extent based on 2016 NAIP, but 2015 Orthros, 2011, and 2009 NAIP also consulted. Fields generally delineated at a scale of 1:5000. Throughout the town, hay and corn fields may be used rotationally. Hay/pasture includes areas that may be rotationally hayed and pastured or where the land use could not be readily interpreted. Also, likely to include some large lawns.

5.1.3 Important Agricultural Soils

Subset of NRCS Soil Survey (SSURGO soil data) depicting prime and other important agricultural soils. The soil map and data used in were prepared by soil scientists as part of the National Cooperative Soil Survey. The subset includes soils of Prime and Statewide Importance:

5.1.3.1 Prime: Suite of the most productive agricultural soils in the state. Soil capable of high and sustained productivity. Soil has a favorable combination of texture, nutrients, topography, drainage, and soil moisture.

5.1.3.2 Statewide: Also, highly productive agricultural soils across the State. As compared to Prime soils, may have lower productivity due to limited moisture availability, slow drainage, flooding, and or steepness.

5.1.3.3 Prime with Limitations: Prime soils requiring artificial drainage for farming. Without drainage, these are not Prime soils.

5.1.3.4 Statewide with Limitations: Statewide soils requiring artificial drainage for farming. Without drainage, these are not Statewide soils.

Map 4: Farmland Resources

6. WORKING FOREST RESOURCES

Working forests are vital to Vermont's scenic backdrop, rural economy, and long-term capacity to temper and adapt to climate change. Across Vermont, forest product harvesting and manufacturing contributes $1.4 billion to the state's economy (NEFA, 2013). Working forests also provide important habitat for a variety of wildlife, including non-game and game species and multiple Species of Greatest Conservation Need. Not all forest ownerships are of equal capacity. Large ownerships are typically more efficient for forest management and are often more financially viable over the long-term. Some soils and topographies are also much more productive and important for growing forest products. In addition to finances, larger working forest properties also generally have greater capacity to contribute to less tangible working forest values, such as scenery and mitigating the effects of climate change. The Working Forest Resources map shows the town's Forestlands and Productive Forest Soils.

As of 2018, in Greensboro there were 15,952 acres[22] across 130 separate parcels of land enrolled in the Forest Use Value Appraisal Program (UVA)[23]. There are not necessarily 130 separate Forest UVA owners, as some ownerships span multiple parcels. While not all acreage enrolled in the Forest UVA program is working forest, most of the acreage is productive and actively managed.

Across town, UVA forestland parcels range in size from a few acres to almost 750 acres (see figure 10), likely representing a great disparity in their contribution to working forest values, with the larger parcels generally being more efficient for long-term forest management and having great capacity to support other working forest values. In Greensboro, the median forestland UVA parcel size is 94 acres with nearly 75 percent of the UVA parcels being less than 150 acres in size. To qualify for the UVA program, landowners must enroll a minimum of 25 acres; this acreage is sometimes spread across multiple parcels, so there may be individual parcels smaller than 25 acres.

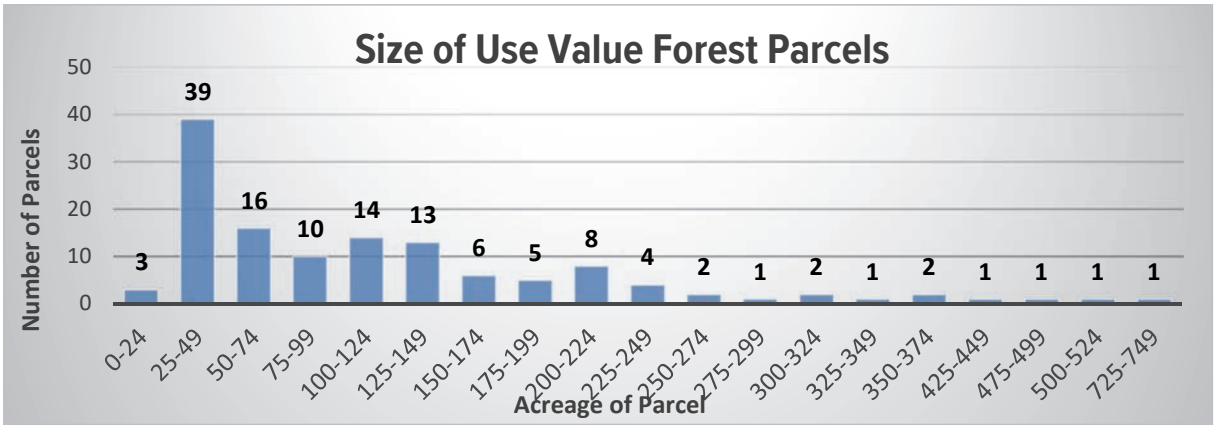


Figure 10: Frequency of Forest UVA Parcel Size Greensboro- Size and frequency of parcels enrolled in the Forest UVA program calculated by NG using the Agency of Natural Resources UVA Forestland data.

[22] 63 percent of the town's total land area

[23] A tax abatement program for landowners practicing long-term forest management guided by an approved forest management plan

While smaller UVA parcels are widely distributed throughout town, most of the larger UVA forestland parcels are found in three or four clusters. The largest UVA parcels are in the northeast corner of town, around Paddock Hill, Long Pond, Mudd Pond, and Horse Pond; this cluster of large UVA forestland parcels is part of a highest priority interior forest block (See Section 3). Similarly, in the southwest corner of town and extending into adjacent Wolcott and Craftsbury is another cluster of larger UVA parcels embedded within a high priority interior forest block. There are also smaller clusters of UVA forest parcels around the Babbcock Hill-Patmos Peak area and the Edson-Withers Brooks area.

Soils vary widely in their productivity and capacity to grow forest products and their susceptibility to erosion, which can be a concern and limitation during forestry operations. There are 6,852 acres[24] of productive soils for forestry in town, including soils with very high productivity, high productivity, and moderate productivity. Productive forest soils generally have a loamy texture, good soil moisture, favorable drainage and few or no operability limitations, such as steep slopes or extreme rockiness.

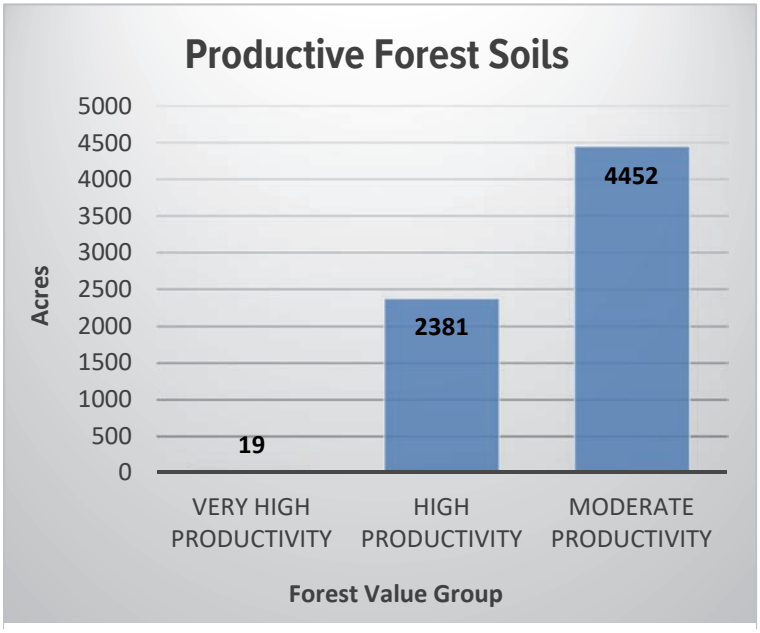


Figure 11: Area of Productive Forest Soils-Acreage of very high, high, and moderately productive forestry soils in Greensboro. Based on data from the NRCS Soil Survey

6.1 Working forest data layers

The following data layers were used and/or developed during the inventory and analysis of working forest resources in town:

6.1.1 Use Value Forestland

Parcels of land enrolled in the Vermont use value appraisal (UVA) program as forestland, requiring an active forest management plan. While all forestland UVA parcels are shown, only parcels greater than 200 acres are shaded in green to emphasize long-term working forest viability. This database is maintained by the Vermont Agency of Natural Resources, but the parcel boundaries are derived from local digital tax maps.

6.1.2 Productive forest soils

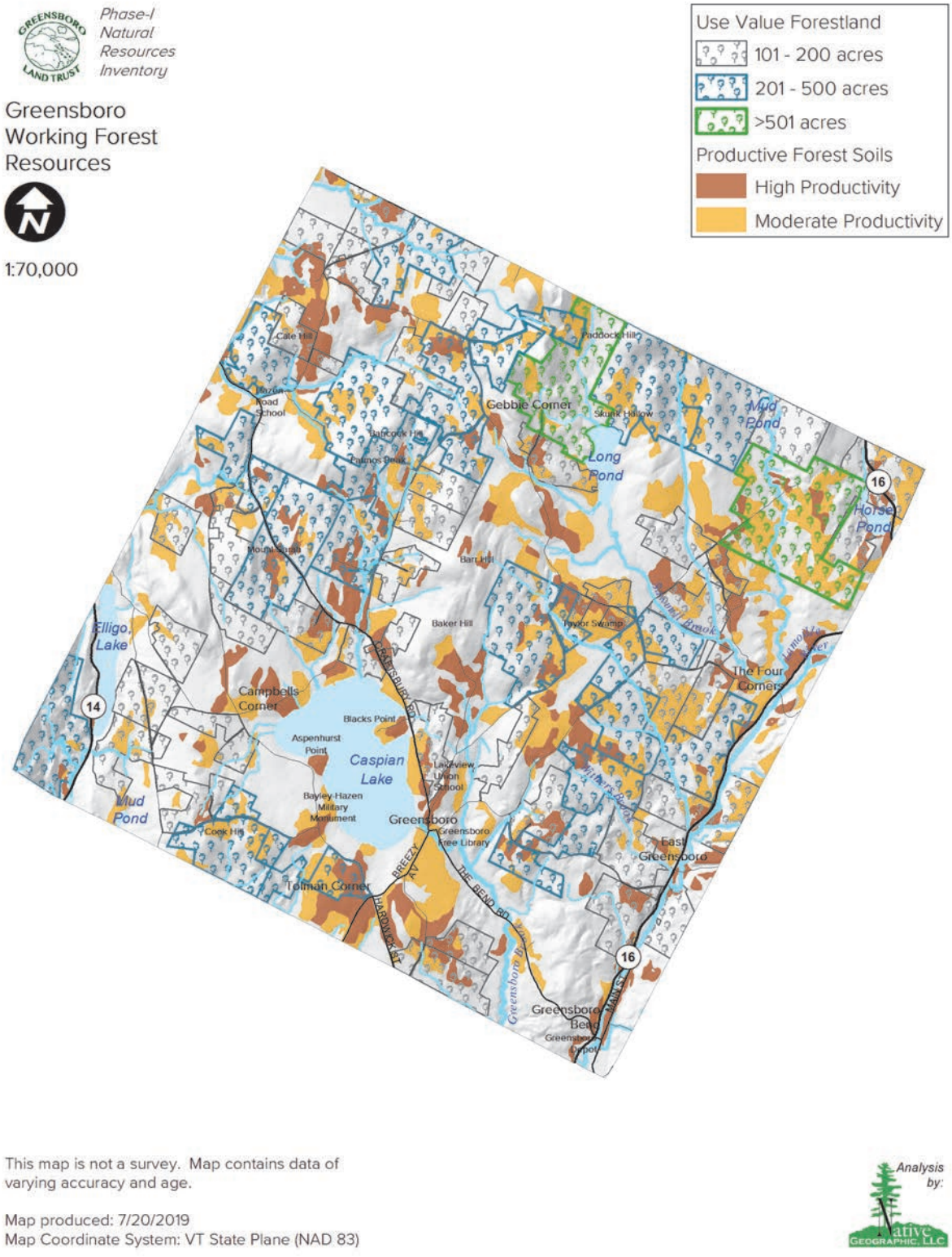
Subset of NRCS soil survey (SSURGO soil data) depicting productive soils for the growth of forest products, including soils of very high productivity, high productivity, and moderate productivity. The soil map and data were prepared by soil scientists as part of the national cooperative soil survey. Forest soil groups, a classification of productivity, were developed and determined in partnership with the Vermont Department of Forest, Parks and Recreation (USDA-NRCS and Vermont Department of Forest, Parks and Recreation, 2003).

[24] 27 percent of the town's total land area

6.1.2.1 Very high productivity: Subset of the most productive forest soils in the state. Includes forest soil group 1 (USDA-NRCS and Vermont Department of Forest, Parks and Recreation, 2003). Soil is highly productive, has good drainage and of favorable terrain and texture for cost-efficient management. Steep slopes, outcrops/ledges, extremely rocky areas, heavy clay soils, and other limitations that can reduce access or operability and increase management costs are limited. The slopes and soils included in this subset also typically have less potential for severe erosion.

6.1.2.2 High productivity: Subset of highly productive forest soils across the state. Includes forest soil group 2 (USDA-NRCS and Vermont Department of Forest, Parks and Recreation, 2003). As compared to very high productivity soils, has slightly more limitations and/or or higher cost associations.

6.1.2.3 Moderate productivity: Subset of moderately productive forest soils across the state. Includes forest soil group 3 (USDA-NRCS and Vermont Department of Forest, Parks and Recreation, 2003). More limitations and/or or higher cost associations than preceding productivity groups.



This map is not a survey. Map contains data of varying accuracy and age.

Map produced: 7/20/2019
Map Coordinate System: VT State Plane (NAD 83)

Analysis by: Native Geographic, LLC

Map 5: Working Forest Resources

7. WILDLIFE, PLANT, AND NATURAL COMMUNITY RESOURCES

Wildlife and nature are important to many of Vermont's residents, as well as the many tourists who visit the state each year. According to a 2011 survey by the U.S. Fish and Wildlife Service, 62 percent of Vermonters engage in fishing, hunting, or wildlife watching (Vermont Wildlife Action Plan Team, 2015). Wildlife is also central to Vermont's outdoor-based tourism industry, which accounts for approximately 11.5% of the state's overall employment (Vermont Forests, Parks & Recreation Department. 2015). Conserving the town's multi-faceted natural heritage, including animals and plants, is likely to benefit from complimentary fine and coarse filter strategies, an approach also taken in this report and inventory.

In a coarse filter approach to maintaining the town's natural heritage, animal and plant species of conservation need are not singly protected. Instead, the habitats and natural communities these species are associated with are the priorities for conservation. Such a strategy often has three distinct advantages: the species-specific data needed to track and protect single plant/animal occurrences are usually not available; whole suites of plant and animal species, often including multiple Species of Greatest Conservation Need (SGCN) are protected; and many times the unforeseen ecological processes or the currently unknown wealth of fungi and macroinvertebrates are afforded some level of protection as well. This report and inventory contains many coarse filter elements, including the natural communities and wildlife road crossings presented in this Section as well as the water, wetland, and riparian resources in Section 2 and the forest block, connectivity, and resiliency resources in Section 3.

The second complementary approach is a fine-filter strategy. Ideally, all the endangered, threatened, or significant animal or plant occurrences in the town are protected by well-buffered and largely intact forest blocks. This may not, however, always be the case. Very rare species, species suffering rapid population decline unrelated to habitat loss, and/or other species of high public value may not always be adequately protected by a coarse filter approach. In these instances, using a fine filter approach, the very rare or otherwise priority species occurrences and their specific habitat needs are singly considered and if needed, protected. This report and inventory also contains fine filter elements, including the rare, threatened, and endangered species occurrences; uncommon species occurrences; vernal pools; deer wintering areas; moose wallows/salt pools; potential mast areas; shrublands; and potential grasslands.

Across Greensboro, the interplay of geology, climate, topography and moisture combine to create a diverse array of growing conditions. This interplay of environmental conditions can foster an equally diverse, and often somewhat predictable, array of natural community types[25]. While over 90 natural community types have been identified and described in Vermont, there is a tremendous disparity in the relative rarity or commonness of the community types. This

[25] A natural community is a recurring assemblage of plants and animals found in a particular physical environment. Three characteristics distinguish natural communities: 1) plant species composition, 2) vegetation structure (e.g., forest, shrubland, or marsh), and 3) a specific combination of physical conditions (e.g., water, light, nutrient levels, and climate). Each natural community type occurs in specific settings in the landscape, such as wind-exposed rocky summits at high elevations, or muddy coastal river shores flooded daily by tides. Natural community types vary with changes in physical settings, resulting in predictable patterns across the landscape.

inventory primarily addresses known state significant natural community occurrences using data, classification, and methodology of the Vermont Natural Heritage Inventory. Generally, all viable occurrences of rare natural community types are considered state significant, as are high quality occurrences of uncommon natural community types. Occurrences of common natural community types may also be considered significant if they exhibit some exceptional characteristics, such as old growth structures or extremely large size. While a full assessment of Greensboro's natural communities is beyond the scope of this inventory, some information about natural communities can be gleaned from the town's geology and prior studies.

Not surprising, the town's signficant natural community occurrences are mostly rare or uncommon community types associated with calcium-rich bedrock and somewhat northern growing conditions, including northern wide cedar swamps and rich fens (see table 7). As part of this inventory, areas with the potential to support signficant or uncommon natural community occurrences were identified by NG for future study (see next section). Based on this review, there may be additional state signficant natural community occurrences in town.

The town is likely to support a mix of forest natural community types, with northern hardwood, lowland spruce-fir, and spruce-northern hardwood forest community types likely being the most widespread. Because of the calcium rich bedrock, the town is also likely to support occurrences of rich northern hardwood forest. For wetlands, a mix of marsh and shrub natural community types appear to be abundant; these wetland types are relatively common throughout Vermont. Besides the common wetland types, the town also supports calcium-rich or somewhat calcium-rich wetland types including fens, northern white cedar swamp, and spruce-fir-tamarack swamps. See table 7 for known natural community occurrences, as well as some community types likely to occur in town.

Table 7: Potential and Known Natural Communities in Greensboro. State significant natural community occurrences and known uncommon occurrences are from the *Vermont Natural Heritage Inventory* (Vermont Fish & Wildlife, 2018). State significant occurrences are marked with an "*". Other occurrences interpreted by NG.

Community Type	Rarity	Town Distribution
northern hardwood forest	Very Common (S5)	Known widespread
red spruce-northern hardwood forest	Very Common (S5)	Known widespread
lowland spruce-fir forest	Uncommon (S3)	Potentially limited
rich northern hardwood forests	Common (S4)	Potentially somewhat limited
floodplain forest	NA	Potentially limited
red maple-black ash seepage swamp	Common (S4)	Potentially widespread in wetland areas
red maple-northern white cedar swamp	Uncommon (S3)	Potentially limited
spruce-fir-tamarack swamp	Uncommon (S3)	Potentially limited
northern white cedar swamp*	Uncommon (S3)	Known with limited distribution
shallow emergent marsh	Common (S4)	Potentially widespread in wetland areas
cattail marsh	Common (S4)	Potentially widespread in wetland areas
sedge meadow	Common (S4)	Potentially widespread in wetland areas
alluvial shrub swamp	Uncommon (S3)	Potentially somewhat limited
alder swamp	Very Common (S5)	Potentially widespread in wetland areas
rich fen*	Rare (S2)	Known with limited distribution

Another of the report's coarse filter elements are wildlife road crossings, including locations where wildlife species approach and cross active roadways. Wildlife road crossings are typically identified using a mix of computer modelling to detect areas with suitable roadside conditions for crossing and site assessment to document actual wildlife movement. While computer modelling of potential high priority wildlife crossings has been completed for the whole town as part of the *Vermont Conservation Design* (Sorenson and Zaino, 2018), only a small percentage of the road segments have been studied for sign of actual wildlife movement. Along Route 16, two active wildlife road crossing were identified by NG during the *Critical Paths 2* project in 2010. At both locations, moose were observed to be active at or near the roadside. The more northern active road crossing also supported evidence of bear, bobcat, and fisher. For a 2014 project (Austin and Osborne), Vermont Fish and Wildlife also compiled information about known road crossings by interviewing state and county foresters, houndsman, hunters, and biologists. During these interviews, the same stretch of Route 16 in the northeast corner of town was also identified as being a regular bear crossing; two other bobcat crossings were identified near Saw Mill Brook. In the northeast corner of town, there is a high degree of overlap between the two separate studies and computer modelling, which suggests that is likely a very important road crossing.

Growing and breeding in Greensboro are multiple rare plants, a rare moss, and one rare bird, including two species listed as threatened and one as endangered under Vermont's Endangered Species Law. These rare species generally have a very limited distribution in Vermont and are at risk of being extirpated from the state. Many of these rare species are associated with significant natural community occurrences. In addition to these eight rare species are five more species considered uncommon in the state. These species also have a somewhat limited distribution in the state and are at some risk of extirpation. A breakdown of the known rare and uncommon species is included in table 8.

Table 8: Known Rare and Uncommon Species in Greensboro-From the Vermont Natural Heritage Inventory (Vermont Fish and Wildlife Department, 2018)

species (common)	Type	Status	Legal and Other Listing
a moss	Moss	Rare	SGCN
a moss (2)	Moss	Uncommon	
blunt-leaf pondweed	Plant	Uncommon	
case's ladies'-tresses	Plant	Rare	SGCN
common loon	Bird	Uncommon	SGCN
eastern blue-eyed-grass	Plant	Rare	SGCN
fairy slipper	Plant	Rare	State-Threatened, SGCN
false cyperus sedge	Plant	Uncommon	
ground-fir	Plant	Rare	SGCN
lesser bur-reed	Plant	Rare	State-Threatened, SGCN
northern ground-cedar	Plant	Rare	SGCN
rusty blackbird	Bird	Rare	State-Endangered, SGCN
water bur-reed	Plant	Uncommon	
white water-crowfoot	Plant	Uncommon	

Beyond the rare and uncommon species, the town is likely to support other SGCN and associated priority habitats. In 2015, Vermont revised its *Wildlife Action Plan* (Vermont Wildlife Action Plan Team, 2015). The revision is underlain by a statewide assessment to identify declining species and habitats that should be a priority for conservation and management before they necessitate some form of regulatory protection, such as being listed under the state Endangered Species Law. The *Wildlife Action Plan* identifies priority species— SGCN—and habitats that are critical to the long-term viability of these species. Many of these priority habitats correspond to features described in prior sections, including the water, wetland, and riparian resources in Section 2 and the forest block, connectivity, and resiliency resources in Section 3. The town also supports or has the potential to support other priority habitats associated with SGCN, including vernal pools, moose wallows/salt pools, mast areas, shrublands, and grasslands.

Vernal pools and moose wallows are both small wetland types that provide very time sensitive functions for SGCN. Vernal pools are fish-free and typically ephemeral water bodies that are critical to the long-term breeding success of some frogs and salamander SGCN (see table 9). They are used in the spring by breeding adults and then support hatched larvae through much of the summer. While many vernal pool-dependent species may breed in other wetland types, they typically have their highest levels of breeding success in these fish-free waterbodies. While vernal pools and other fish-free waters tend to be small and seasonally dry bodies of water, they support extremely high levels of biodiversity on a per acre basis. There are at least four potential and unconfirmed vernal pools in town; these potential pools have been remotely mapped but have not field verified or assessed for the presence of vernal pool dependent species. Verifying these potential and unconfirmed vernal pools is a recommended area for further study.

Moose wallows/salt pools are small wetlands or muddy spots seasonally frequented by moose. Road runoff, including road salts, typically concentrate in these areas, attracting moose and other species. There may also be naturally occurring salt licks, salt pools, and wallows in town, which similarly attract moose. Seasonal moose usage occurs in these areas: 1.) during spring/early summer when moose actively seek out large quantities of sodium to compensate for mineral deficiencies incurred during winter foraging and 2.) during late summer/early fall when moose are seeking mates and engaging in other breeding activities. These roadside features were identified in 2010, but it is unknown if moose continue to use these features. Re-evaluating these moose wallows/salts pools are recommended for further study.

Table 9: Vernal Pool and Grassland Species of Greatest Conservation Need- SGCN that rely on vernal pools or grassland habitat that have the potential to occur in the Northern Vermont Piedmont and potentially Greensboro. "C" indicates a known or confident Northern Vermont Piedmont distribution while "P" indicates a probable distribution and "U" indicates an unknown distribution. From the *Vermont Wildlife Action Plan* (Vermont Wildlife Action Plan Team,2015).

Highest Priority Vernal Pool Species	Medium Priority Vernal Pool Species
jefferson salamander (c) wood turtle (c) odonates-bog/fen/swamp/marshy pond group (c) freshwater snails group (u)	great blue heron (u) spotted salamander (c)
Highest Priority Grassland species	Medium Priority Grassland Species
grasshopper sparrow (u) upland sandpiper (u) northern harrier (c) sedge wren (u) vesper sparrow (c) wood turtle (c) butterflies-grassland group moths group (c) eastern red bat (c) hoary bat (p) woodland vole (c)	peregrine falcon (c) short-eared owl (p) bobolink (c) american kestrel (c) purple martin (p) field sparrow (c) eastern meadowlark (c) hairy-tailed mole (c)

Shrublands and grasslands are both priority habitats with the potential to support multiple, often bird, SGCN. Grasslands, as the name implies, are grass-dominated habitats, such as fields and pastures, while shrublands are shrub and brush dominated habitats. Both habitats are transitional in nature, meaning they are likely to transition to a forest without some degree of management or disturbance. Mowing or grazing is required to maintain grassland areas, while logging, flooding, and other disturbances typically create and sometimes perpetuate shrublands. Many of the priority grassland SGCN listed in table 9 are dependent on the town's open hay fields, pastures, and other large grassy areas for nesting. Grasslands are also important foraging areas for even more SGCN, including multiple bats, raptors and insects. Without farming, these grassland areas are likely to succeed to shrub and eventually forest dominated systems. The town does not have any naturally occurring grasslands. Consequently, the very mowing and grazing that maintains the grassland condition can also cause high mortality in nesting grassland birds. Grassland bird breeding success is dependent on the timing and frequency of mowing and/or grazing, with grassland birds often requiring 60-70 days to lay, hatch, and fledge young; this time can come before 1st cut or between 1st and 2nd cut. Data from the breeding bird survey indicates that grassland birds are present in Greensboro, but the abundance and breeding success of these birds is unknown. Understanding the quality of Greensboro's grassland habitat is recommended for further study.

Similarly, naturally occurring shrublands or shrub-dominated systems are limited in town and most of the shrublands are the result of forest management and to a lesser degree, clearing along utility line corridors and other ROWs. The naturally occurring shrublands are mostly swampy areas along streams, backwaters, and ponds where flooding, ice scour, beaver, and poor drainage can perpetuate a shrubby condition for longer timer periods. Shrub swamp SGCN are listed in table 10. Shrub swamps are similar in structure—being shrub dominated—to upland shrub systems, but they can support different species mixes and wildlife functions.

Table 10:Shrub Swamp Species of Greatest Conservation Need- SGCN that rely on shrub swamps or upland shrubland habitat that have the potential to occur in the Northern Vermont Piedmont and potentially Greensboro. "C" indicates a known or confident Northern Vermont Piedmont distribution while "P" indicates a probable distribution and "U" indicates an unknown distribution. From the *Vermont Wildlife Action Plan* (Vermont Wildlife Action Plan Team,2015).

Highest Priority Shrub Swamp Species	Medium Priority Shrub Swamp Species
american woodcock (c)	red-shouldered hawk (c)
american black duck (c)	chimney swift (c)
black tern (p)	black-billed cuckoo (c)
vesper sparrow (c)	rusty blackbird (c)
wood turtle (c)	pied-billed grebe (c)
odonates-bog/fen/swamp/marshy pond group	spotted salamander (c)
(c) freshwater snails group (u)	smooth greensnake (c)
butterflies-wetland group (c)	eastern musk turtle (u)
hoary bat (p)	dekay's brownsnake (p)
water shrew (c)	

During severe winter temperatures and deep snows, deer, moose, and other wildlife species, will seek areas that provide thermal protection and have shallower snow depths. Slightly warmer temps and/or slightly shallower snow depths can help deer and other wildlife conserve energy and more efficiently forage. Wintering habitat is fundamental to the survival of deer and the same areas tend to be used year after year. Typically, these wintering areas are dense with conifer cover and have favorable sun exposure. Deer wintering habitat is widespread in town. There are 4,321 acres[26] of deer wintering habitat in town.

Mast areas are forest patches with a high concentration of nut (i.e. hard mast) producing beech and/or, in some locales, oak. While many species of wildlife will take advantage of available mast, black bears, deer, turkey, mice, squirrels, grouse, and even fisher depend on seasonal mast. Beech nuts are especially high in fat and protein and mature at a critical time in late summer/early fall, when most animals are trying to build up their winter fat reserves. Bears tend to repeatedly return to the same mast area and the presence of bear feeding sign is typically used to assess the quality and function of the mast area. In the northeast corner of town, there is 180-acre mast area, about half of which is in town. Previous visits to this area have documented bear feeding sign, but the current function or feeding activity is unknown. There are likely other patches of mast producing beech and possibly oak scattered across town. Understanding the condition and extent of this mast area and potentially others in town is recommended for further study.

7.1 Wildlife, Plant, and Natural Community Data Layers

The following data layers were used and/or developed during the inventory and analysis of wildlife, plant, and natural community resources in town:

[26] 17 percent of the town's total land area

7.1.1 Signficant Natural Communities

Location of known state signficant natural community occurrences from the *Vermont Natural Heritage Inventory* (Vermont Fish and Wildlife Department, 2018). The *Heritage Inventory* maintains a database of natural community occurrences that meet criteria for state significance, including the highest quality examples of each natural community type. Natural community data may come from one or more sources, including state and federal studies, consultants, researchers, and collections. Natural communities are classified using *Wetland, Woodland, and Wildlife* (Sorenson and Thompson, 2000) and updated communities in the *Vermont Natural Community Ranking Specifications* (Sorenson et al, 2014). All community occurrences are evaluated for state significance based on the V*ermont Natural Community Ranking Specifications*.

7.1.2 Potential High Priority Wildlife Road Crossings

Road segments with suitable and well-connected habitat at the roadside and in the surrounding landscape, including road segments with moderate to high crossing potential based on computer modelling done by Vermont Department of Fish and Wildlife (Sorenson and Osborn, 2014; Sorenson et al., 2015). At these locations, the road is likely to be the primary impediment to wildlife movement and often includes segments along forest blocks or between two blocks. Actual wildlife activity has never been verified along these road segments.

7.1.3 Active Road Crossings

Road segments previously studied by NG with known wildlife crossing activity, including documented usage by bobcat, bear, moose, fisher, otter, mink, weasels, fox, deer, and/or coyote. Using a mix of roadside wildlife tracking and computer modelling these areas were identified and studied by NG as part of Critical Paths 2 in 2010. This 2010 studied did not systematically cover all of the town's road and was restricted to Route 16.

7.1.4 Bear and Bobcat Crossings

Location of previously observed bear and bobcat crossing activity. As part of a 2006 study on wildlife linkage habitat —a precursor to the *Vermont Conservation Design*—the Vermont Fish and Wildlife Department compiled a statewide database of known wildlife crossings, using many sources of varying accuracy and quality, including interviews with houndsman, biologists, hunters, game wardens, and foresters. This dataset does not reflect a systematic study of crossings.

7.1.5 Rare, Threatened and Endangered Species

Location of known rare species occurrences from the *Vermont Natural Heritage Inventory* (Vermont Fish and Wildlife Department, 2018), including state and/or federally identified threatened or endangered species. These rare species typically have a high risk of extirpation and may have less than 20 populations statewide. The Heritage Inventory is responsible for maintaining a database of rare species occurrences, but data may come from one or more sources, including state and federal studies, consultants, researchers, and collections.

7.1.6 Uncommon Species

Location of known uncommon species occurrences from th*e Vermont Natural Heritage Inventory* (Vermont Fish and Wildlife Department, 2018). These species typically have a moderate risk of extirpation and may have less than 80 populations statewide.

7.1.7 Shrublands

Location of shrub-dominated or young forest habitats, a priority and declining habitat in Vermont because it has the potential to support multiple *Species of Greatest Conservation Need* (Vermont Wildlife Action Plan Team, 2015). These sites have not been verified in the field and were remotely mapped by NG using multiple vintages aerial imagery and wetland data. Generally delineated at a scale of 1:5,000 or finer.

7.1.8 Moose Wallow/Salt Pools

Location of roadside pool, wetland, or muddy spot seasonally frequented by moose. Road runoff, including road salts, are likely to concentrate in these areas. Seasonal moose usage occurs in these areas: 1.) during spring/early summer when moose actively seek out large quantities of sodium to compensate for mineral deficiencies incurred during winter foraging and 2.) during late summer/early fall when moose are seeking mates and engaging in other breeding activities. These roadside features were identified by NG in 2010 as part of *Critical Paths 2*. In Greensboro, *Critical Paths 2* only evaluated Route 16.

7.1.9 Unconfirmed Vernal Pools

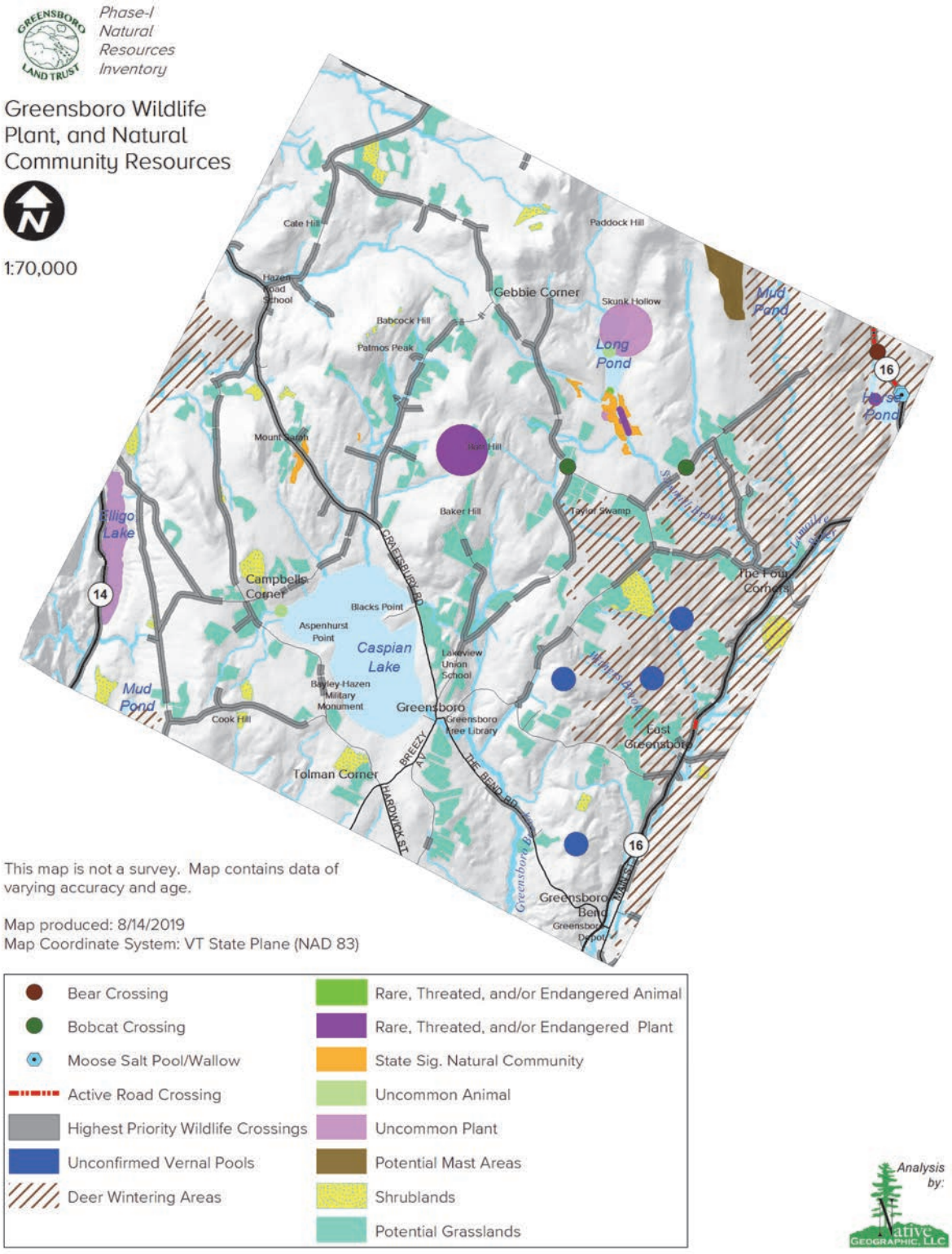
Location of potential vernal pools from the *Vermont Vernal Pool Mapping Projec*t, a statewide project to map, verify and advance conservation of vernal pools. Includes pools that lack necessary data to verify function for amphibians and other vernal pool-dependent species. This may include pools that were remotely mapped and never visited or pools that were visited but the visit took place out of season or the assessor, often a citizen scientist, did not provide the necessary species identification and confirmation of pool-dependent species.

7.1.10 Potential Mast Area

Location of hardwood or mixed-wood forest with a signficant amount of mature, nut-producing beech trees and some evidence of current or historic bear feeding. Mast areas are an important resource for bear and other wildlife species. In 2001, across the state, Vermont Department of Fish and Wildlife mapped known mast areas using anecdotal information from wardens, foresters, and wildlife biologists; the effort was not a systematic study of bear habitat but does represent some of the best available data. The one mast area in Greensboro was generally identified in this state dataset. In 2018, the extent of the possible mast area was remotely mapped by NG using aerial imagery and high-resolution elevation data. This revision or the area's current condition was not verified in the field.

7.1.11 Potential Grasslands

Location of hay, pasture, hay/pasture, and other grassy openings at least 10-acres in size. Depending on the timing and intensity of mowing and/or pasturing; these areas have the potential to support nesting grassland birds. Digitized and interpreted by NG using multiple vintages of leaf-on and leaf-off aerial imagery. Final determination and extent based on 2016 NAIP imagery. Fields were generally delineated at a scale of 1:5,000. Throughout town, hay and corn fields may be used rotationally. Hay/pasture includes areas that may be rotationally hayed and pastured or where the land use could not be readily interpreted. Also, likely to include some large lawns.



Map 6: Wildlife, Plant, and Natural Community Resources

8. NEXT STEPS

This natural resource inventory is a substantial first step in developing a more comprehensive understanding of Greensboro's natural resources and conservation priorities. However, the Phase-I inventory is mostly computer-based and primarily relied upon the compilation and interpretation of previous regional, state, and local studies, aerial imagery and already developed data layers. This inventory also includes some new data layers created by NG specifically for the project. While the Phase-I inventory covers a wide breadth of natural resources, the depth of detail underlying some of these natural resources is limited and often incomplete. Rare species and signficant natural communities, for example, have not been systematically mapped across town and, instead, have only been mapped where trained biologists have made site visits. Ultimately, identifying strategic areas for conservation can be improved by addressing these data limitations.

Broadly, as next steps NG recommends filling in the data gaps and limitations identified during this Phase-I inventory with a suite of targeted and systematic Phase-II Natural Resource Inventories[27]. Then, utilizing the Phase- I and Phase-II Natural Resource Inventories, NG recommends GLT conduct a co-occurrence or similar analysis to identify focus areas for the strategic conservation of priority natural and cultural resources.

[27] See Memo regarding *Recommendations for Further Study*

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