An Ecological Inventory and Assessment of the Pond Brook Region in Monkton, Vermont

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for the Agricultural and Natural Areas Committee of Monkton
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"Monkton Boro and Monkton Ridge...would be ideal places for the romantic dreamer to while away his summer days. It is but a few miles to the Green Mountains and all around the foothills, where fertile meadows broaden away from the fringe of cedars found everywhere. If the sojourner wishes to hide himself from the sun, let him penetrate these cedar lands—and in the heaviest of them he finds the darkness of twilight at the hour of midday. "

William Wallace Higbee, 1842-1911

Acknowledgements

This project would not have been possible without the generosity of the residents of Monkton and Starksboro. I'm deeply grateful to all of the people who allowed me to explore the landscapes they call home. I'd also like to thank the Agricultural and Natural Areas Committee of Monkton for their support, especially chair Laura Farrell and town lister Sam Burr. Laura's steady guidance and support over the course of this project was indispensable, and Sam provided substantial assistance during the landowner contact process. Sharon Gomez, the Town Clerk of Monkton, also provided many resources throughout this project and I appreciate her answering all of my emails and phone calls. I'd also like to thank Gil Coates of the Monkton Historical society for sharing his photographs and stories with me. I remain inspired by the willingness of the people of Monkton to allow me into their town and their lives.

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Many outside organizations provided me with key insights for this project, including the Vermont Monitoring Cooperative, The United States Geological Service, the Vermont Natural Heritage Program, the Vermont Land Trust, and the Vermont Agency of Natural Resources. I appreciate being exposed to the important work each of these organizations does every day, and I am grateful to every scientist before me who contributed data to the Vermont Center for Geographic Information.

I want to thank my mother Sally, who taught me everything I ever needed to know about loving the world, and my brothers Logan and Conor for believing in me for 30 years straight. I am also endlessly grateful for the never ending support of my aunt and trusty editor Jan Gardner. Finally, to my partner Drew, thank you for making my life an adventure and tolerating the chaos of the last two years. I look forward to many more days with you in the wild world.

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All photographs within this report were taken by Lyra Brennan

Project Abstract

The Pond Brook Watershed in Monkton, Vermont, is a 19,000-acre patchwork of northern white cedar swamps, oak-covered ridgetops, and prime agricultural soils. Over 95% of the watershed is privately owned, limiting ecologists' abilities to conduct a landscape-scale field assessment or determine significant natural resources within the area. I was hired by the Agricultural and Natural Areas Committee of Monkton [ANAC] to conduct an ecological assessment of land within and surrounding Pond Brook Watershed by visiting a diverse sampling of privately-owned parcels and inventorying the 300-acre town owned wetland.

I worked with over 30 individual landowners to understand current and historical land use in Monkton and inventoried nearly 4,000 acres of land. By aggregating this data with existing spatial data, I mapped state-significant natural communities, rare species, wildlife habitat, and areas of special conservation concern throughout the watershed. The maps and individual property reports I have created will guide ANAC and town conservation planning in the future. In order to reinforce residents' appreciation and connection to the Monkton landscape, I have also created a separate photographic guide to the common habitats and species of the watershed.

Bristol Pond

Introduction

The Pond Brook Watershed is located in Monkton, Vermont, and spans approximately 19,000 acres in the Champlain Valley. (Fig 1.) While broad-scale information has been collected over time on the natural resources within this watershed, the Agricultural and Natural Areas Committee of Monkton [ANAC] provided a proposal for a full ecological assessment and inventory of the area in the spring of 2016, and delineated the boundaries of a 35,000 acre study area. In the summer of 2016, I spent approximately 40 days gathering comprehensive field data from different properties across the watershed. ANAC and other town agencies hope to use this data to inform future conservation action and planning in the town of Monkton. This project also aims to enhance the communities' connection to the landscape of Monkton by sharing field data with the public.

What does it mean to eceologically assess and inventory a watershed? Individual stream health is commonly defined by macroinvertebrate life, sediment load, and stream bank erosion metrics, but assessing broader ecological factors at play across a landscape requires a more comprehensive approach. A holistic watershed assessment evaluates riparian areas, but also examines the surrounding environment and other factors including wildlife usage, natural communities, forest condition, soil characteristics, and geological features. By connecting and comparing these features across a watershed, it becomes easier to designate areas of ecological significance.

The Pond Brook Watershed study area is an intensively parcelized patchwork of primarily private land, and communicating with landowners was necessary to gain access to properties and gather information about natural resources. Over the course of this project, I was able to comprehensively inventory 32 parcels under the ownership of 27 different owners within the Pond Brook Watershed. These properties are mapped in Figure 2. More limited soil and habitat data was collected at 4 additional land parcels. The results of these inventories reveal diverse natural resources on both public and private land in Monkton. Some of these resources include:

- 7 rare plant species state-ranked as S3 or rarer
- 16 natural communities ranked as S3 or rarer
- 2 reptile species ranked as S3 or rarer
- 6 bird species ranked as S3 or rarer

A list of these rare and uncommon species found in the study area can be referenced in Appendix 2., while the State Ranking system of Vermont is detailed in Figure 14. (page 31). While rare and uncommon species are thrilling to discover, they are not the sole benchmark for determining ecological integrity. Land parcels that may not initially appear critical in terms of natural resources often provide imporant functions for a variety of species and ecosystem services. Continuous swaths of intact Northern Hardwood Forest, varying edge habitat, beaver ponds, uninterrupted streams, and even dead snags all play varying roles in a multitude of ecological functions.

No less important than the ridge tops and rivers of Monkton are the people who populate this township The members of the community I spoke to were deeply invested in both their land and the surrounding landscape. Many of them can trace their lineage back to early settlers of Monkton, and some families harvest timber and grow crops just like their ancestors did on this very land. They were curious about the assessments I was making on the landscape but protective of their way of life and the things that they love about Monkton. It is my hope that this report and its supporting materials underscore their appreciation for this landscape. A full list of accessed land and and contacted landowners can be found in Appendix 3. and Appendix 4.

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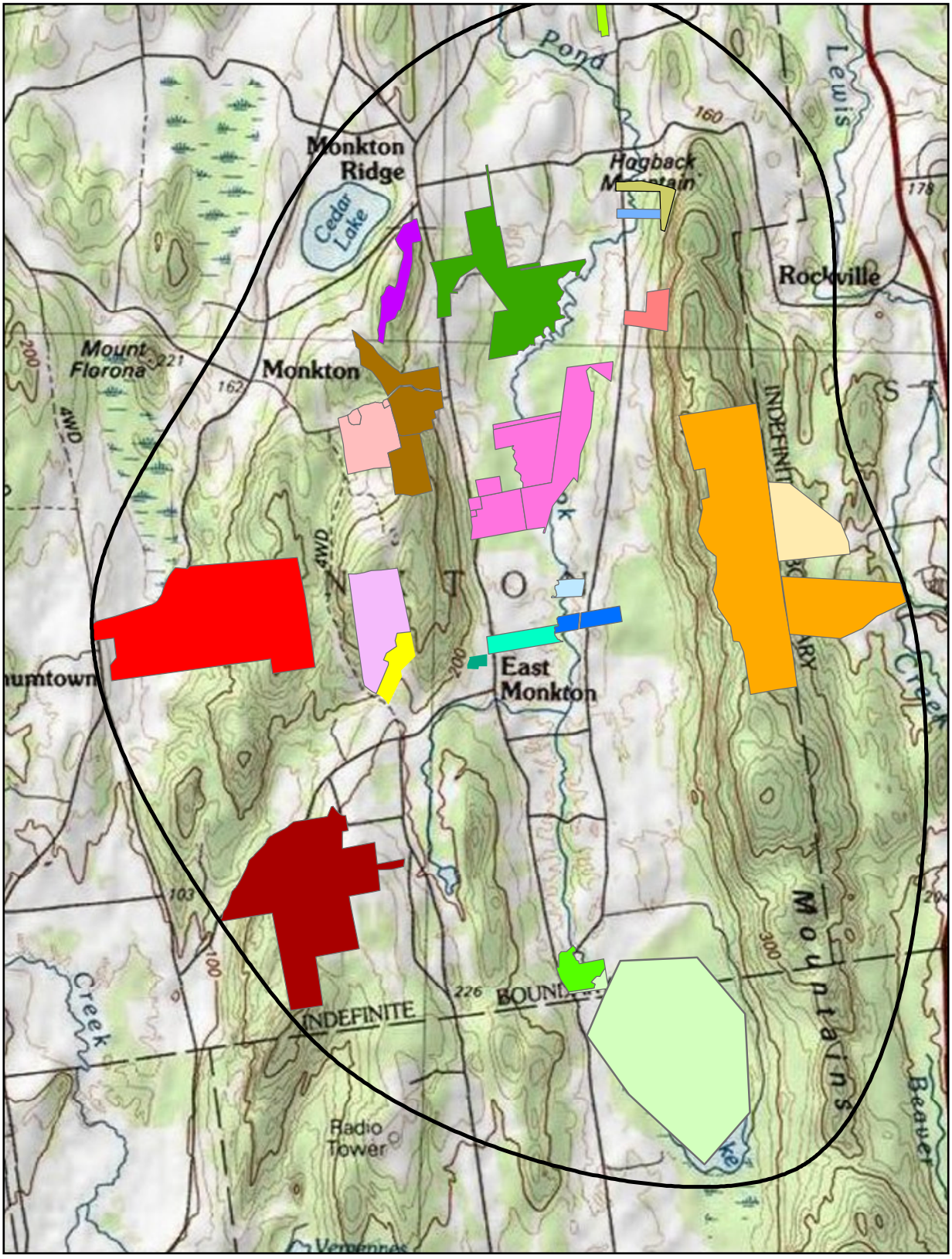
Pond Brook Watershed Study Area
(as delineated by project sponsor)

Figure 1. Pond Brook Study Area

0 0.5 1 2 Miles



8 Figure 2. Properties accessed within the Pond Brook Watershed.

Project Objectives

- Carry out an inventory and assessment of significant natural resources within the Pond Brook Watershed study area.
- Synthesize these findings with existing data in order to produce a comprehensive landscape report for ANAC, including spatial data. Ideally, this will aid future planning by providing ANAC and other conservation-minded agencies with the information they can use to support conservation easements, zoning decisions, and town planning.
- Prepare and give a presentation on the natural resources and species found within the Pond Brook Watershed for the community of Monkton in order to enhance residents' connection to, and knowledge of, the surrounding landscape.
- Prepare a key species guide as a reference for the Town of Monkton and ANAC.
- Provide feedback and recommendations in regards to the Pond Brook Management Plan for the town-owned parcels within the Pond Brook Wetlands Conservation Area.

Physical Geography of the Pond Brook Watershed Study Area

Pond Brook is a tributary of Lewis Creek, which eventually reaches its terminus at Lake Champlain. Lewis Creek and its tributaries are recognized as significant aquatic resources in the state and enhance the function of surrounding agricultural communities in the Champlain Valley. While the Lewis Creek system contains a variety of aquatic habitats, Pond Brook is primarily a warm, large, low gradient brook with headwaters at Bristol Pond. Pond Brook is fed by smaller, higher gradient, and colder streams flowing down from higher elevations within the Big and Little Hogback ranges. The Vermont Agency of Natural Resources ranks almost all of the surface water in Monkton as *Highest Priority Surface Water and Riparian Areas* as seen in Figure 16.

Pond Brook and its numerous smaller tributaries bisect a valley just west of the Big Hogback Range, a range which marks the border between Starksboro and Monkton. This valley is bordered by the Little Hogback range to the west and Bristol Pond to the south. Lake Champlain is approximately 7 miles west, and the Pond Brook-Lewis Creek confluence is located in the town of Hinesburg 1.5 miles to the north. Figure 3. demonstrates the greater regional location of the Pond Brook watershed, which strays east into Starksboro, and south into Bristol, but is primarily located within Monkton. There is a substantial wetland complex in the center of the valley bisected by Pond Brook, which is one of the principal areas investigated by this report.

The landscape within the Pond Brook Watershed study area ranges from 400 to 1500 feet in elevation, and these elevations directly correlate with habitat type. Figure 4. reveals three general elevation classes present within the study area:

Upland elevations: *Elevations above of 600 feet*

Transition elevations: *Elevations between 500 and 600 feet*

Lowlands: *Elevations below 500 feet*

Each elevation class tends to share certain characteristics, including depth to bedrock, surficial geology, hydrological conditions, and exposure to solar radiation and wind. Because of these shared characteristics, the species assemblages in these areas tend to be similar and occassionally predictable.

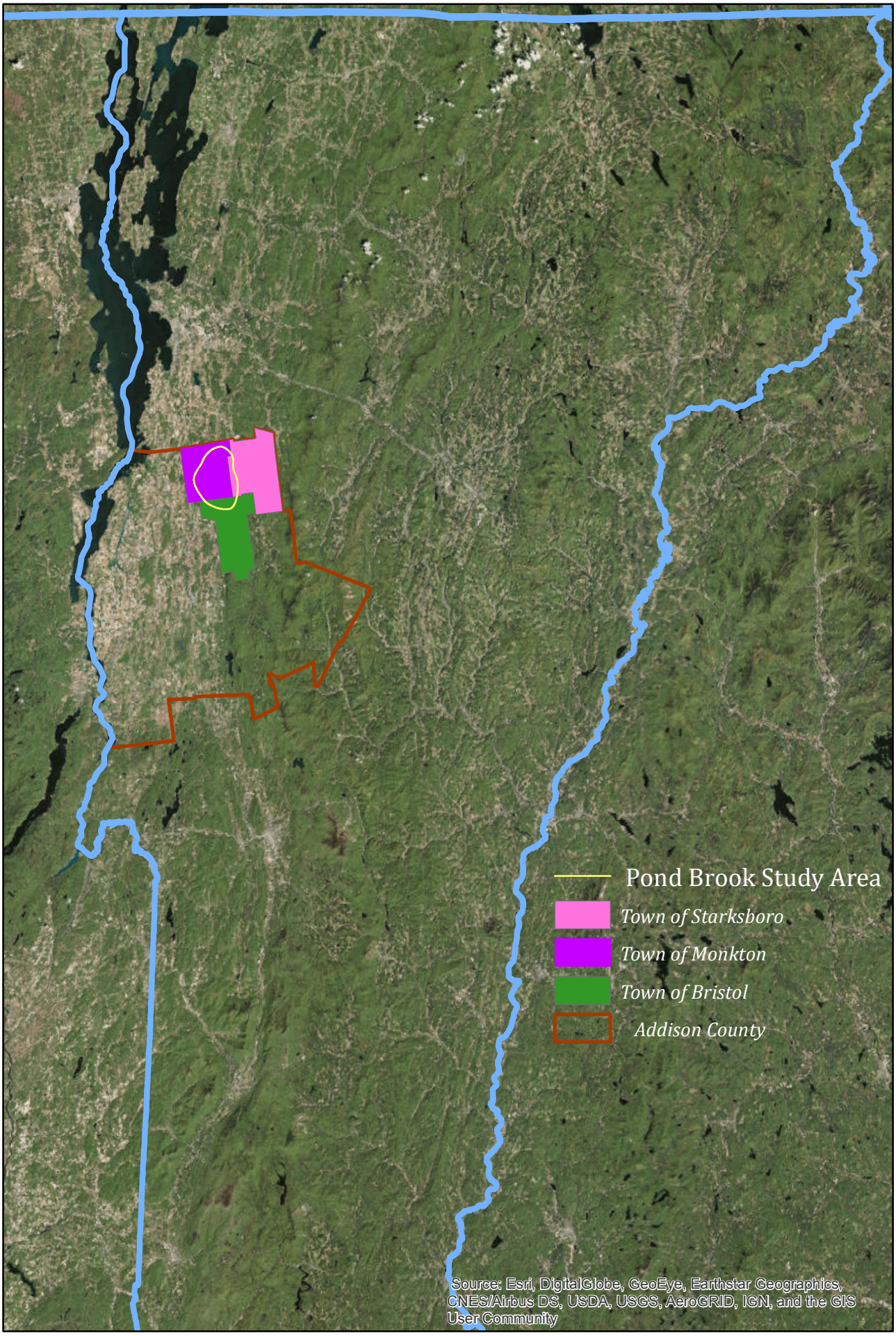


Figure 3. Regional Map

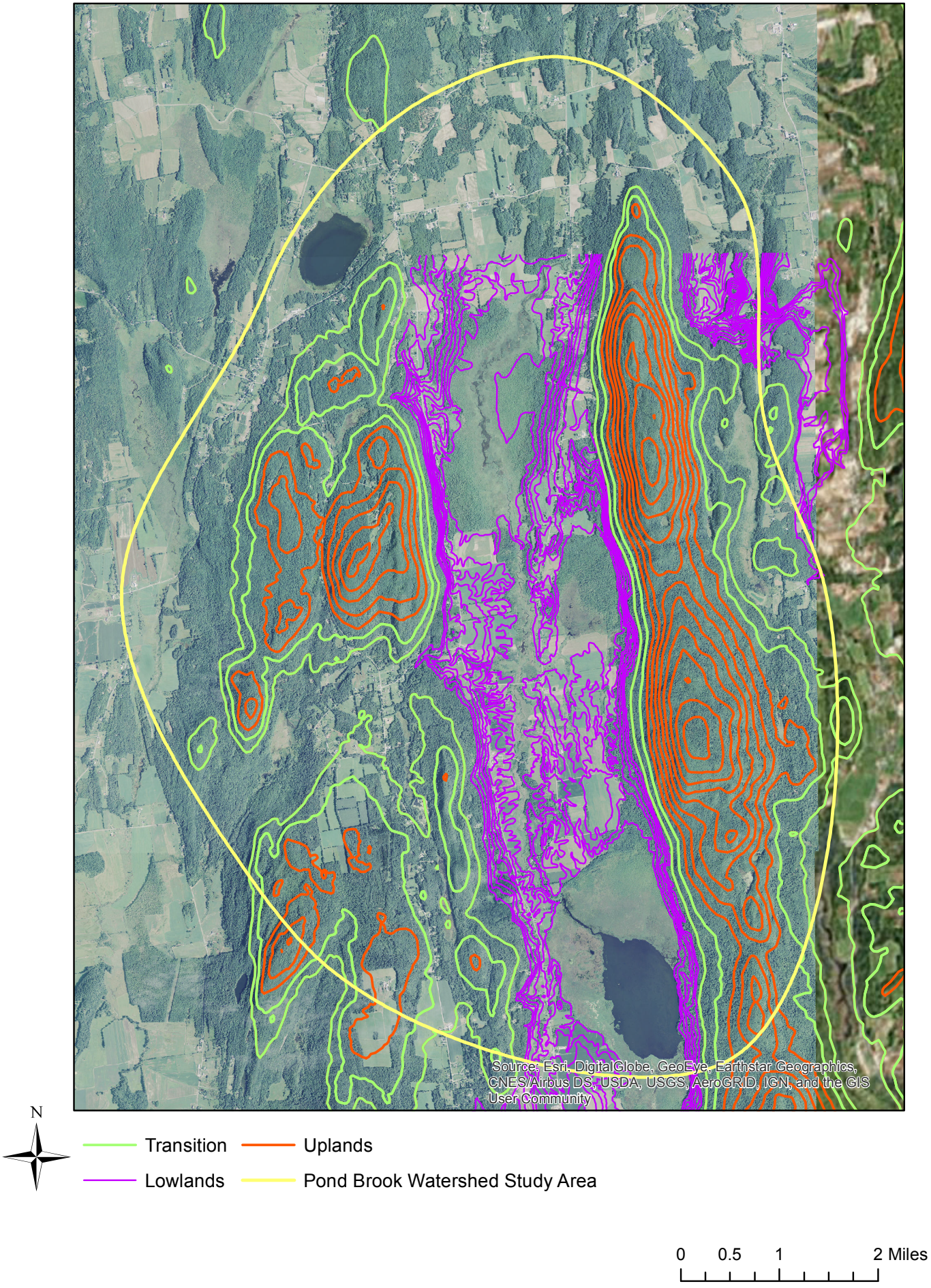


Figure 4. Elevation Zones

Methods and Approach

Study Area Delineation
The study area for this project was defined by the Agricultural and Natural Areas Committee [ANAC]. It includes a large portion of the Pond Brook Watershed and additional land parcels situated outside of this watershed to the east, west, and southwest. ANAC hopes that field data from adjacent watersheds can serve as a point of comparison for the data found in within the Pond Brook Watershed.

Research
Available spatial and historical data, along with data gathered by other conservation organizations, provided a context for approaching the landscape.

Selecting and Accessing Land Parcels
Selecting land parcels to access was a multi-step process that required prioritizing land parcels, determining the contact information for landowners, and initiating contact in order to request access to private land. 38% percent of landowners contacted granted access, resulting in a more intensive inventory of land parcels than was initially expected.

The land selection process prioritized land that met one or more of the following criteria:
- Strong representation of one of 4 land types: agricultural land, wetlands/riparian areas, slope areas on the Big or Little Hogback and high elevation areas.
- Remote or extensive contiguous habitat

By accessing a sampling of different land types, this project aimed to obtain a broad understanding of the range of habitat types within the watershed. These criteria were also meant to prioritize areas where the likelihood of finding the following features increased: state significant natural communities, wildlife activity, and rare species. The town-owned Pond Brook wetlands meet many of these criteria, and an inventory and assessment of the wetland complex was defined as a focal point of this project by ANAC.

Evaluating properties
Assessing properties in the field was guided by the following process:
1. Upon arrival at any land parcel, if the landowner had requested contact, a short meeting would take place upon which the landowner related their experience with the land parcel. If landowners had not elected for such a meeting, landscape inventory began immediately.
2. Efforts were directed first towards locating special features on the site that had been determined prior to the visit using spatial data. Examples of such special features include talus slopes, exposed outcrops, wetlands, high elevation points with southern exposure, and areas with clay soils.
3. While approaching these special features, a rapid ecological assessment was carried out in transit on natural communities, wildlife activity, and herbaceous and tree species as they occurred.
4. After arriving at areas with special features, in-depth assessment, inventory, and mapping was carried out at the location.
5. Once the area of special interest had been thoroughly assessed, natural communities and areas noted earlier were returned to and mapped. As time allowed, more comprehensive surveying was carried out on these areas.

Data
Programs used to facilitate this process include GaiaPro and a GPS device.

Bedrock Geology

There are three types of bedrock that form the geological foundation of the Pond Brook Watershed Study Area, and they all date from the Lower Cambrian Period, which began approximately 550 million years ago. These bedrock formations cover large swaths of the landscape, but they are also interlayered in certain areas. It would not be unusual to find an exposure of one bedrock type within an area that is dominated by another. While it is not always the case across the Champlain Valley, the bedrock types here strongly influence the plant assemblages and natural communities found within the Pond Brook Watershed. This is a function of varying nutrient availability and weathering rates within separate bedrock types.

Cheshire Quartzite

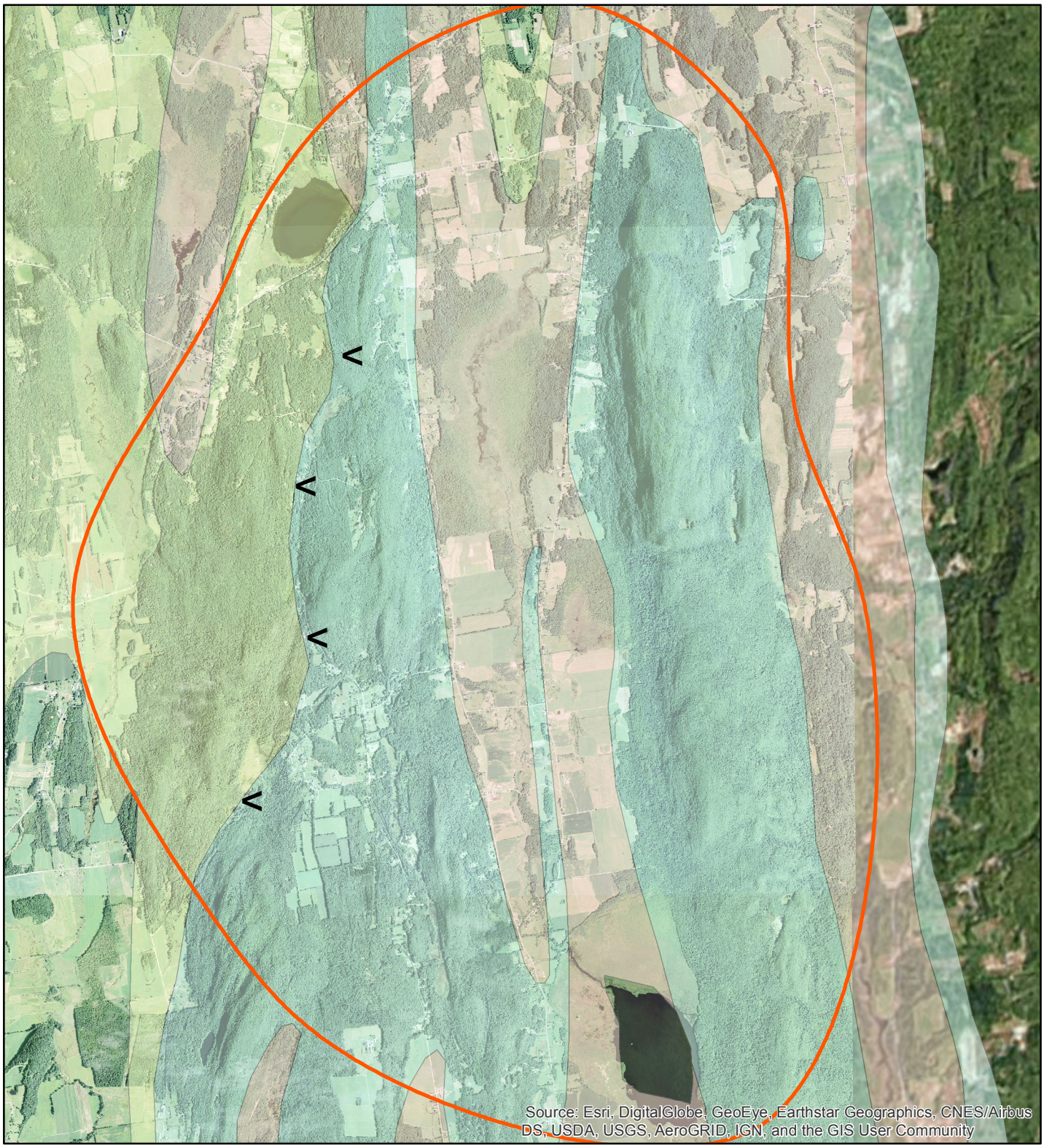
The most commonly exposed bedrock in Monkton is Cheshire Quartzite. A massive (without visible bedded layers) light grey to brown bedrock, Cheshire Quartzite is a metamorphic formation, having undergone intense heat and pressure created by tectonic plate action in Vermont's past. This bedrock has plentiful quartz, and has undergone a high degree of recrystallization. In other words, metamorphosis has occurred several times over, forming additional mineral crystals within the bedrock. Cheshire Quartzite has a hard texture and contains inter-bedded metamorphosed clay and schist. This quartzite forms the towering, resistant ridges in the Big Hogback range and grades into the overlying Dunham Dolomite down in the Pond Brook Valley. It is more resistant to erosion than both of the other bedrock types in Monkton, and does not contribute a significant amount of nutrients to the soil.

Dunham Dolomite

This tan to white calcareous bedrock is formed from the shells and bodies of ancient sea creatures that lived 500 million years ago, when all of Vermont was covered by a tropical sea. This rock was initially a limestone, formed by calcite-secreting and shedding organisms, but it was eventually enriched by magnesium-rich groundwater in order to form Dolomite. Dunham Dolomite, as one would expect, has a high calcium carbonate (CaCO3)content and lines the lower elevations of the watershed. It weathers more easily than the other two dominant bedrock types of Monkton, and contributes a significant amount of calcium to the water and soil of the valley.

Monkton Quartzite

This bedrock derives its name from this locale, and is found in abundance in western Monkton. It is distinguished by its often deep red or purple coloring. Monkton Quartzite is typically well-bedded, or has layers that are easier to discern than the previous two bedrock types. This formation is more calcareous than the Cheshire bedrock, but less so than the Dolomite. It contains alternating beds of red or purple shale, composed primarily of metamorphosed mud. Ripple marks and mud cracks on layers within this formation are sometimes visible—a rock solid reminder of Vermont's past as an ancient ocean. Fig 5. illustrates the bedrock geology of the Pond Brook Watershed.



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Pond Brook Study Area

< Monkton Fault

Cc *Cheshire Quartzite*

Cd *Dunham Dolomite*

Cm *Monkton Quartzite*

Figure 5. Bedrock Geology

Arrangement of bedrock

In a typical bedrock sequence, where faulting and erosion has not occured, layers of bedrock will be arranged with the oldest layer on the bottom and the youngest on top. For the bedrock of Monkton, this means that the two Quartzite formations would be separated by Dunham Dolomite, with the Monkton Quartzite exposed on top, as seen in in Figure 6.

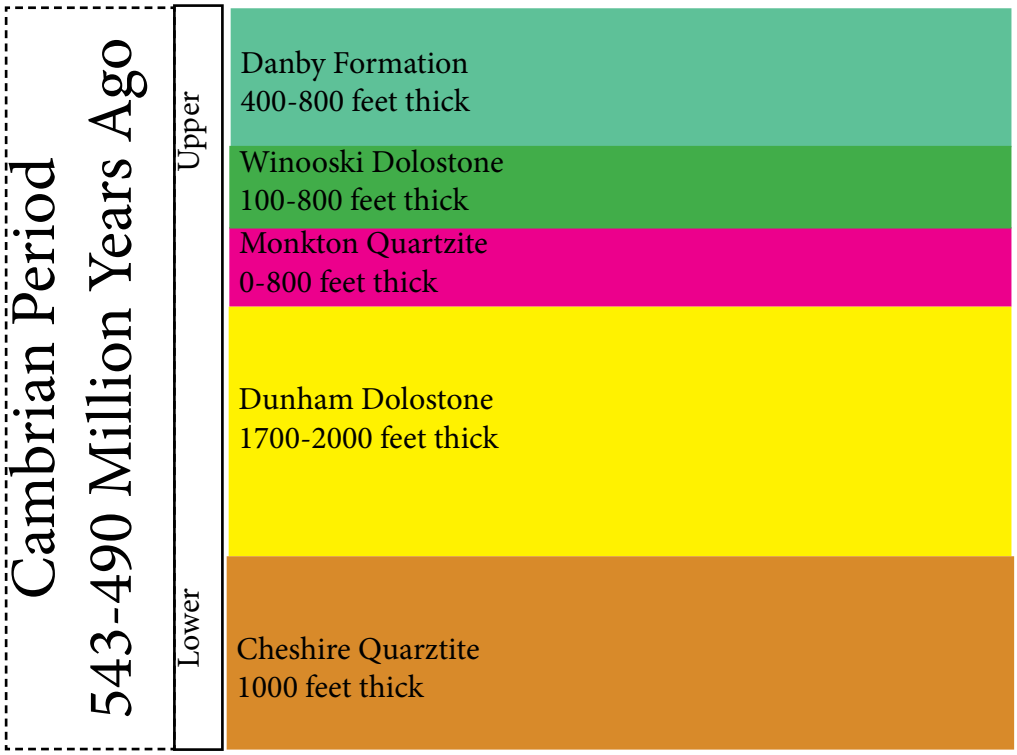


Figure 6. Normal bedrock sequence, inspired by *Sequence of Strata Near Middlebury, VT, Welby, 1961 and Cady, 1945*

This is not the case within much of the Pond Brook Watershed. Here, the oldest bedrock type, Cheshire Quartzite, has been folded and thrust from the east onto the younger Monkton Quartzite, forming the Monkton fault in western Monkton. The fault location is noted by arrows in Figure 5. One definition of a geological fault is a place where the normal bedrock sequence has been disrupted by tectonic activity. Further altering the bedrock sequence, Dunham Dolomite has been eroded off the top of the Big Hogbacks, but still lines the valley below. Monkton Quartzite can generally be found along the western edge of the watershed. Fig 7. illustrates the distinctive layering of bedrock within the Pond Brook Watershed.

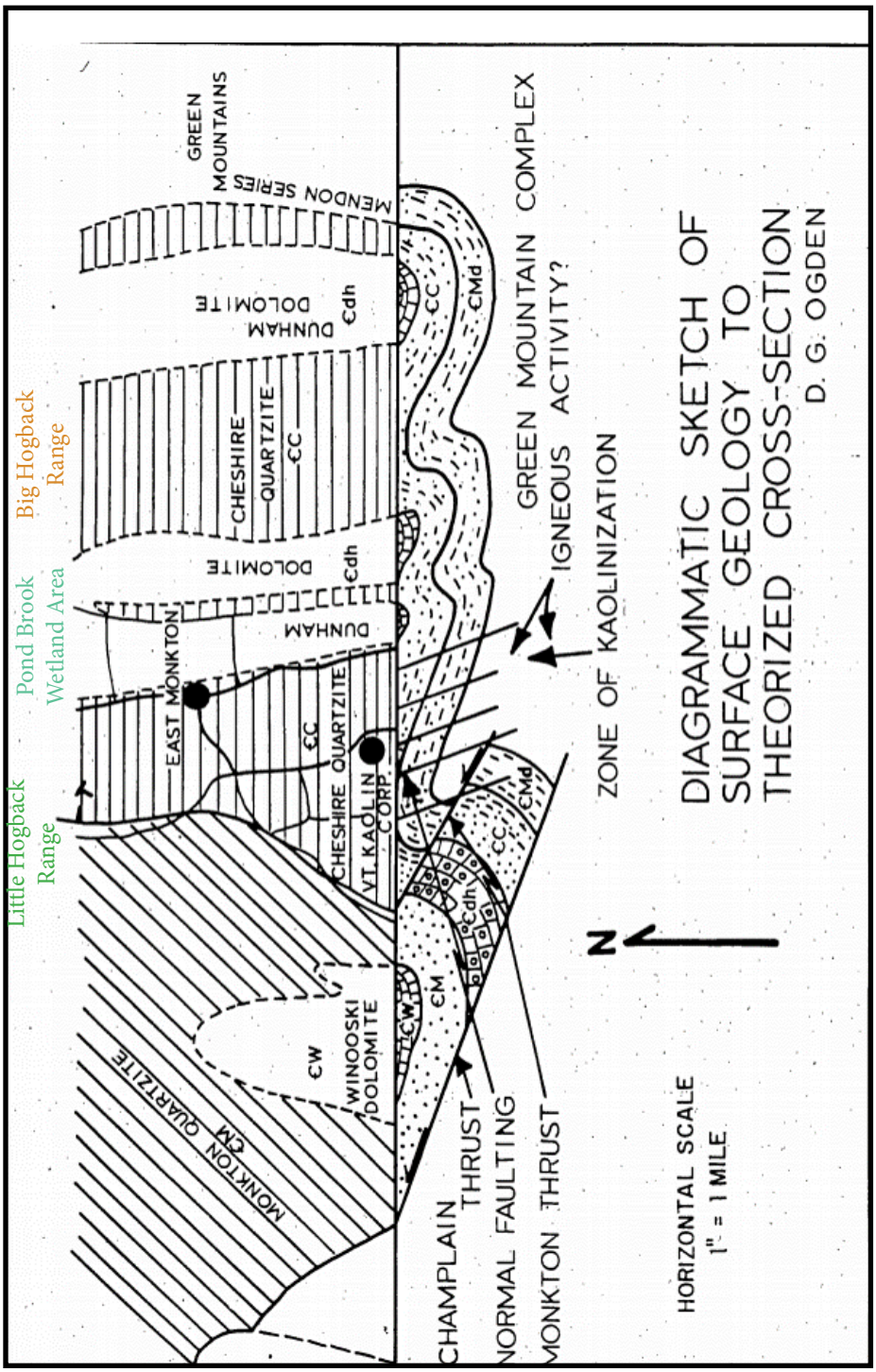


Figure 7. Bedrock Cross Section,
Ogden, D.G. (1969). Geology and origin of the kaolin at east Monkton, Vermont.

The structure of the Pond Brook Watershed is a result of the tectonic plate action that created the Monkton fault. The steep slopes surrounding the Pond Brook valley are part of a geological structure called an anticline. Anticlines are areas where bedrock has been squeezed together and crumpled upward, much like what would happen if you pushed together a piece of paper inwards from both sides. A syncline is a downward fold in the center of such a structure, and in this case, the syncline is synonymous with the lowest elevations in the valley. The anticline in Monkton was likely formed in the Taconic orogeny, a mountain building event that took place 440 million years ago. The Big Hogback ridges of Monkton are unique in that west slope dips almost vertically into the valley, and the east slope dips about 70 degrees. The differing slopes result in varying levels of soil retention, water runoff, and plant species.

Surficial Geology

Jumping forward in time to approximately 14,000 years ago, Vermont was reaching the end of the Wisconsinian Glaciation, also known as the most recent "ice age" of North America. At this time, the Laurentide ice sheet was receding northwards, or melting, and many valleys throughout Vermont were damned by glacial ice. These ice blockages, combined with abundant melt water, created glacial lakes in many present-day valleys. Such was the case in the Pond Brook and surrounding valleys.

Two stages of Glacial Lake Vermont have left evidence here: the Coveville stage and the Fort Anne Stage. The Coveville Stage of Lake Vermont began around 13,500 years ago, at which point the shore of Glacial Lake Vermont was situated at approximately 600 feet. The Fort Anne Stage of Glacial Lake Vermont, lasting from 12,800 to 12,000 years ago, left shoreline deposits around 500 feet in elevation. These shoreline deposits resemble bathtub rings on the slopes of the Hogback Mountain ranges, and as a result, the surficial geology of this landscape varies depending on topographical position. Figure 8. shows the Surficial Geology of the Pond Brook study area.

The surficial geology in Monkton provides the parent material for soil formation, strongly influencing soil genesis and nutrient content. As explored in Figure 4., the wide range of elevations in Monkton can be categorized into three classes that demonstrate similar soil features. Exceptions to these elevation classes are listed below.

Upland elevations: *Elevations above of 600 feet*
Including the highest areas on the Hogback ranges, these areas were likely never underwater for long periods of time, and have surficial geology layers composed of glacial till or bare exposed bedrock. The till varies in thickness and substrate, often containing cobbles, boulders, or gravel in a dense matrix of clay or sandy clay. The soils that form as a result of these parent materials are either shallow organic soils on exposed bedrock or acidic, nutrient-poor, till-based soils.

Transition elevations: *Elevations between 500 and 600 feet*
These elevations are found in the mid-elevations of slopes on both Hogback ranges, and represent the shoreline areas from the aforementioned glacial lakes. They tend to be well-sorted sands or gravels, and are often rocky and varying in thickness. Areas lined by these deposits tend to have sandy and stony soils low in nutrients that are acidic or circumneutral. More acidic soils in transition areas tend to be a function of the conifer species that dominate these soils. These soils also have flatter or colluvial pockets that can be slightly richer than the surrounding environment.

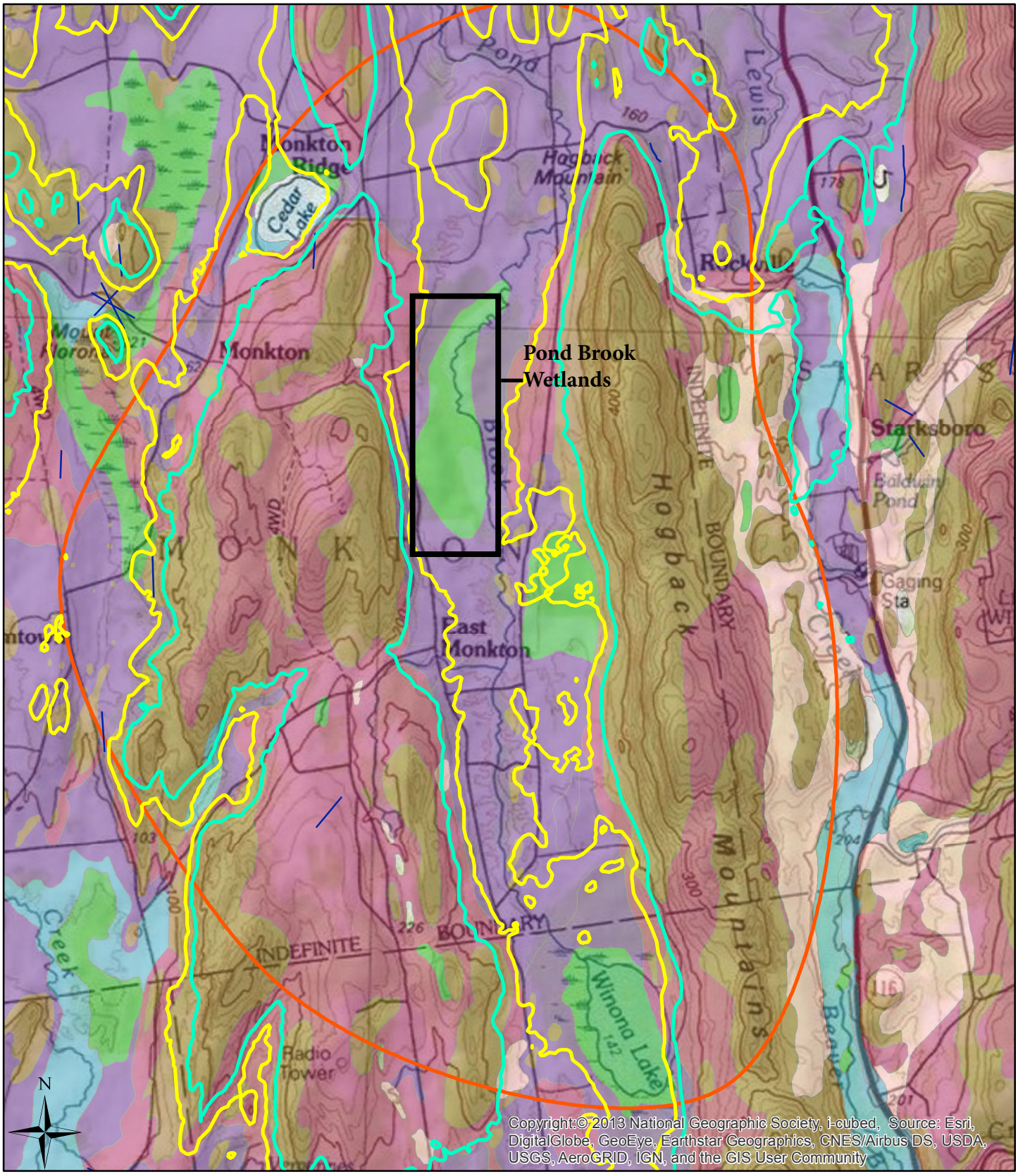
Lowlands: *Elevations below 500 feet*
The depositional environment for sediments at these elevations were the still, deep waters of Glacial Lakes, and as a result, they are home to the thickest and most well-developed soils in the watershed. Fine lacustrine deposits line these elevations, which include silt, clay, and silt or clay loams. These fine deposits are nutrient-rich, often neutral or slightly alkaline, and contribute to the impressive fertility of the Pond Brook Valley. While these sediments were historically host to diverse and plentiful forests, much of the forest resting on these lowlands was cleared for farmland.

Streambeds
Surficial deposits diverge from these three elevation classes when streams and alluvial action come into play. In areas where streams and rivers have shaped the landscape, alluvial deposits like sand, silt, and cobbles cover stretches of soil. Oftentimes these stream channels were far larger in the past.

Depressions
Another exception to the soils being derived from elevation results from deep, concave depressions on the landscape. These depressions often lack drainage and as a result, thousands of years of organic matter have accumulated within them. This organic matter has varying levels of decomposition depending on the oxygen content of these soils. Fibric, or slightly decomposed matter, still has visible roots and organic materials present. Hemic soils are more decomposed, while Sapric soils are the most thoroughly decomposed. Collectively, these organic materials are referred to as peat (when less decomposed) and muck (when almost completely decomposed). Muck and peat deposits are prime environments for forested swamps, bogs, and fens to form. In Monkton, the most prominent example is the central depression in the geologic syncline, at the lowest point in the valley. This area happens to be influenced by calcareous bedrock and is referred to as the Pond Brook wetlands.

Summary of Bedrock and Surficial Geology
While many of geological characteristics in the study area are enough to encourage species diversity alone, the varying combinations of these characteristics gives way to a diverse species assemblage over a relatively small land parcel. For example, calcareous bedrock is understood to influence plant diversity indepdently, but calcareous bedrock overlain with rich silt or neutral sand deposits will encourage two different species assemblages. Numerous pairings of bedrock varying in nutrient content, surficial geology parent material and depth, and hydrological conditions provide Monkton with the means to support a vast array of tree and herbaceous diversity.


Sandy soils in western Monkton



Coveville Stage of Lake Vermont

Fort Anne Stage of Lake Vermont

Pond Brook Watershed Study Area

Glacial Till and Exposed Bedrock

Glacial Till

Glaciofluvial Deposits

Silt and Clay

Peat and Muck

Postglacial Fluvial Deposits

0 0.5 1 2 Miles

Figure 8. Surficial Geology

Wildlife

Monkton is a place of abundant wildlife. The Pond Brook Watershed Study Area represents many diverse habitats at a range of elevations, large swaths of undeveloped land, and edge forest. The GPS location of each sign of wildlife located over the course of this project was recorded and mapped in Figure 10., providing hints as to the the way animals are moving across the landscape. Common animals of Monkton are detailed in Figure 9. Animal sign was only recorded on accessed properties, and as a result, blank areas on the map should not be assumed to have less wildlife value. It should also be noted that these were rapid ecological assessments, and even properties that I assessed were not comprehensively surveyed for all wildlife sign**. Bird hotspots,** one attribute in Figure 10., are defined as areas where 10 bird species or more were directly sighted on one parcel. A complete list of all bird species seen over the course of this project can be found in Appendix 1.

A young porcupine in western Monkton

Common Wildlife in Monkton

Species	Common Species	Sign	Habitat
Black Bear	*Ursus americanus*	claw scratches, scat, tracks	mature American beech stands, wetlands, hickory stands, oak stands
Bobcat	*Lynx rufus*	scat, tracks	rocky ridges, caves, sens in large trees or brush
Porcupine	*Erethizon dorsatum*	quills, scat,	sheltered caves or dens, mixed forest
White-tailed deer	*Odocoileus virginianus*	browse, scat, tracks, bedding marks	softwood stands
Reptiles	Garter snake, *Thamnophis sirtalis*	direct sightings	variable
Amphibians	Wood frog, *Lithobates sylvaticus;* spring peeper, *Pseudacris crucifer;* American bullfrog, *Lithobates catesbeianus;* green frog, *Lithobates clamitans;* leopard frog, *Lithobates pipiens;* Eastern newt *Notophtalmus viridescens.*	direct sightings	wetland and riparian areas.
Beaver	*Castor canadensis*	tooth marks, beaver dams, scat	close to water sources
Fisher	*Martes pennanti*	scat, tracks	continuous mixed forest, riparian habitat, dense woody debris
Mink	*Neovison vison*	scat, tracks	forested areas near streams, rivers, or wetlands
Red Fox	*Vulpes vulpes*	scat, tracks	Mixed forests, edge habitat, and dens
Moose	*Alces alces*	browse, antler marks, scat, tracks	High elevations, wetlands, dense forest, riparian areas
Birds	*See separate Appendix 1.Bird Species of Monkton*	direct sighting/audible	variable
River Otter	*Lontra canadensis*	scat, shell middens, scent piles, visual	wide range of riparian habitat
Coyote	*Canis latrans*	audible calls, scat, tracks	variable

A bobcat print in northern Monkton

An eastern newt in southeastern Monkton

This table excludes rare or uncommon species, which can be found in Appendix 3.

Figure 9. Wildlife

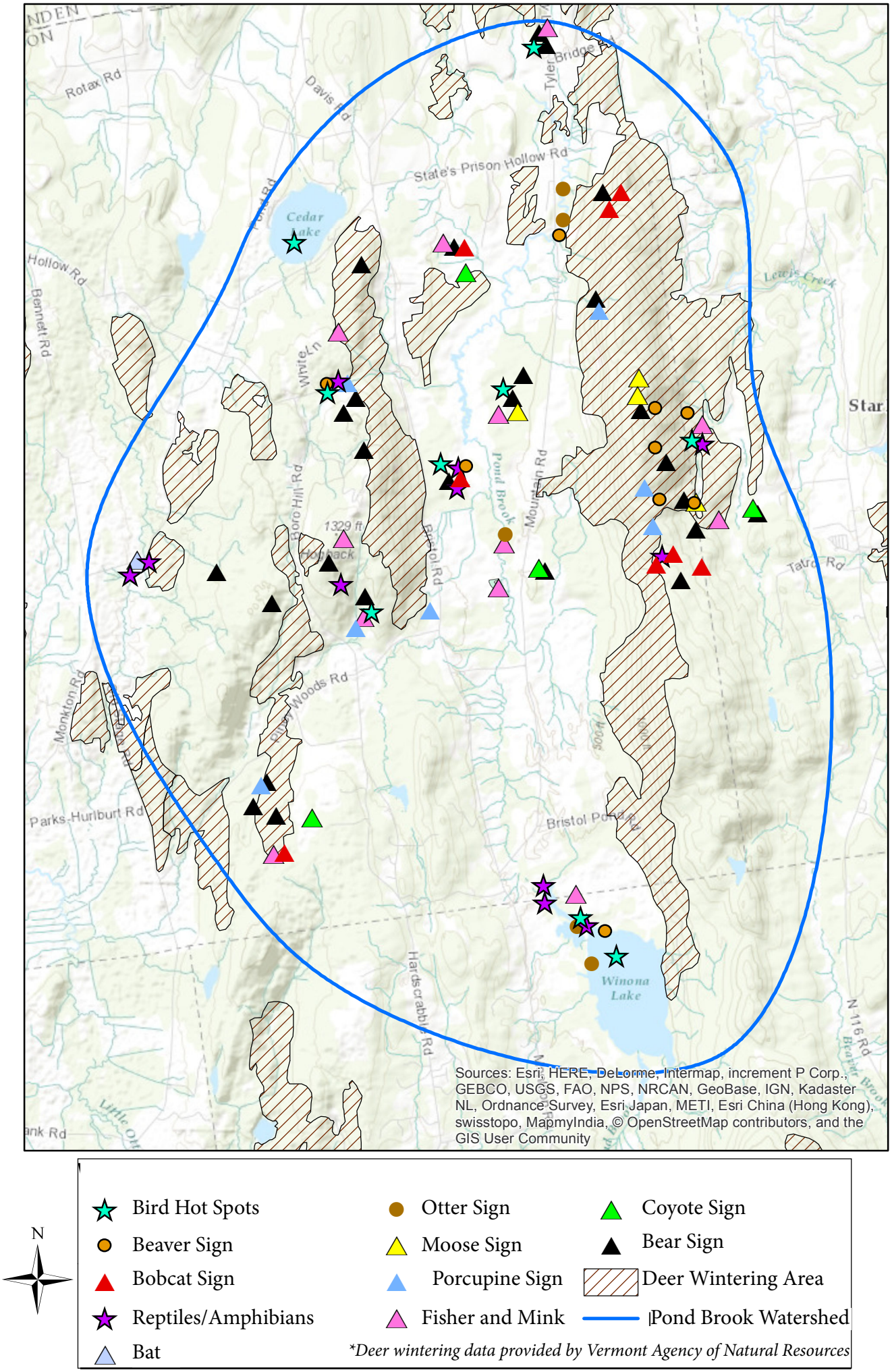


Figure 10. Wildlife Sign

Connectivity

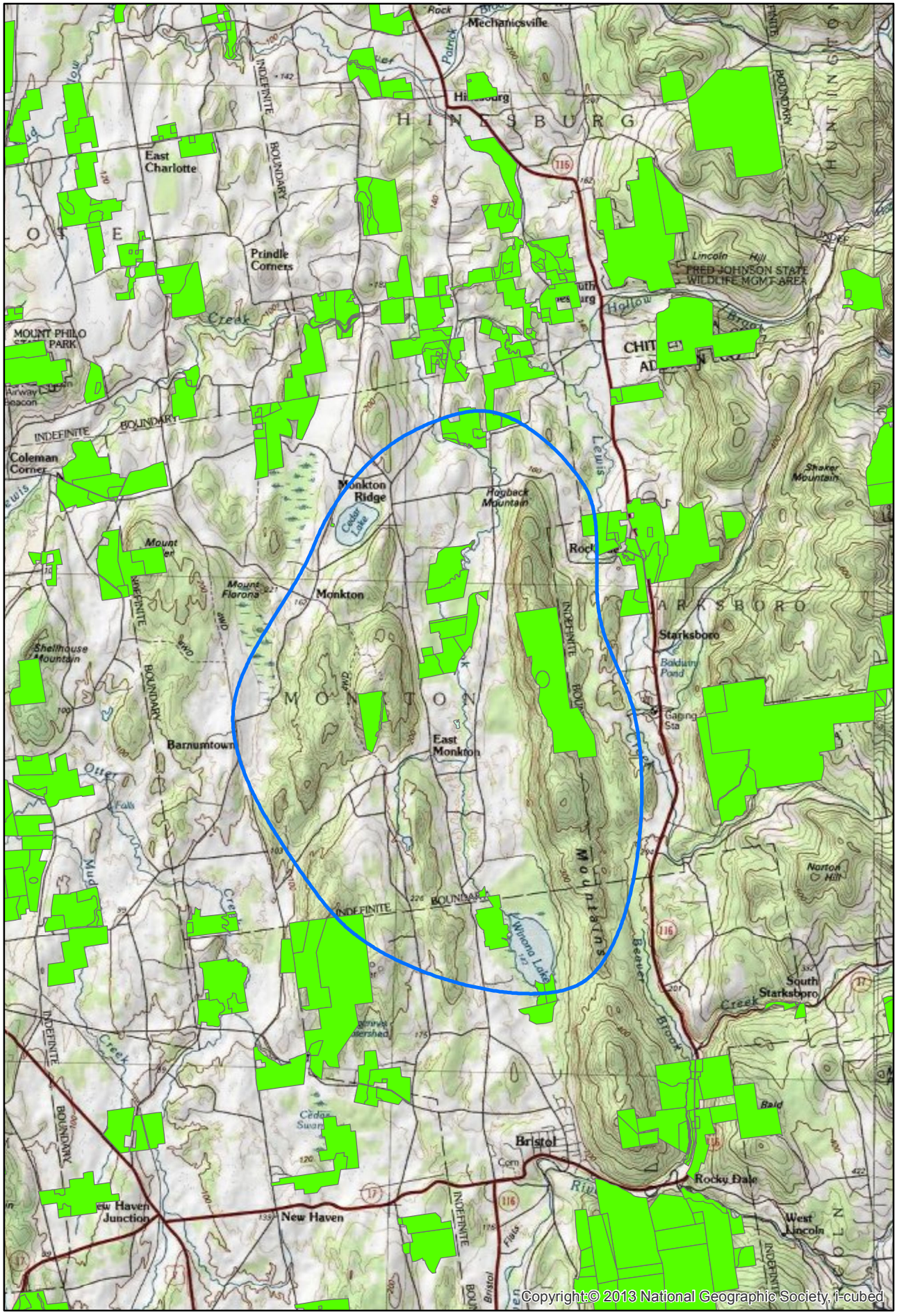
The Pond Brook Watershed serves as a connecting block between major sections of the Green Mountains and their foothills, including the Fred Johnson Wildlife Management Area, the mountains of Starksboro, and Bristol Cliffs Wilderness. Figure 11. shows Vermont Land Trust-conserved landscapes across the Champlain Valley and into the Green Mountains. While supporting wildlife travel to and from other areas is vital, it is also crucial that smaller wildlife corridors within Monkton and surrounding towns are maintained. There are currently only 7 properties in Monkton that are conserved under a Vermont Land Trust conservation easement. The wildlife sign in Figure 10. and the natural community data collected in the field can help reveal where willdife corridors are active within Monkton.

State Significant Habitat

Biofinder, a program created by the Vermont Agency of Natural Resources, identifies areas in Vermont that support high priority ecosystems and species. This program designates extensive **Highest Priority** habitat within the Pond Brook Watershed study area. While a selection of these maps are included in this written report, the entire spatial data package is included with the spatial data portion of this project. Figure 12. shows areas ranked as **Highest Priority Road Crossings** and confirmed American beech mast stands, while Figure 13. shows **Highest Priority Interior Forest Blocks**. Other **Highest Priority** designations within the Pond Brook Watershed study area also include:

- **Highest Priority Surface Water and Riparian Areas** (Figure 16.)
- **Highest Priority Connectivity Blocks**

While any of these rankings occuring within the study area would be meaningful for the natural resources of Monkton, four separate **Highest Priority** rankings occuring in conjunction provides evidence for high levels of biodiversity and habitat found within the Pond Brook Watershed Study Area



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Vermont Land Trust Conserved Land

Pond Brook Watershed

Figure 11. Conserved lands

Figure 12 . Wildlife Crossing and Beech Mast Stands

Figure 13.Highest Priority Interior Forest Blocks

History of Monkton

History of Monkton

The Pond Brook Watershed was used intensively by the Abenaki people before European settlers arrived in the area around the early 18th century. Artifacts and tools have been uncovered north of Bristol Pond, where some tribes overwintered, and along Pond Brook on what is now private property. Monkton was chartered by 64 settlers in 1762, and by the early 19th century, Pond Brook and other water sources in the area were being utilized for various commercial ventures. Old cellar holes and foundations can occasionally be found in the forests of Monkton, showing the footprint of earlier settlers.

Grist mills and saw mills were common in the town of Monkton, and there are even rumors of a fish hatchery that was once located off Bristol Road. Mining for iron ore and manganese was also practiced in Monkton and Bristol, the iron ore used to manufacture cannonballs for use during the 1812 war. However, the most prosperous mining venture was the pursuit of Kaolin. Kaolin, discovered in Monkton in 1792, is a white compound composed of four separate clay minerals, and it was used to create everything from the coating on paper to fine China and ceramics. Marble quarries were another way that earlier generations used the landscape of the Pond Brook Watershed, and in some areas large blocks of marble abandoned in the forest are still visible today. Photographs depicting the Kaolin works are visible in Appendix 5.

Like much of Vermont, Monkton was almost completely deforested twice over, once in the early 19th century and once again in the early 20th century. Approximately 75 % of the state was cleared by 1850. Timber served many purposes, but it was primarily used for building, burned for heat, and exported. Northern white cedar was also a prominent natural resource for the people of Monkton. Although a robust Northern White Cedar Swamp still exists within the Pond Brook Wetland Complex, it was historically divided into ownership plots and harvested in the winter. Cedar is decidedly rot-resistant and was often—and still is—used for fence posts.

Cleared forest was quickly converted into farmland. Grazing sheep and wool production were cornerstones of the first agricultural movement in Vermont, and "nearly every hillside" was covered by grazing sheep by 1850. (*Johnson, The Nature of Vermont.)* Monkton was no exception to this practice, and beginning in the early 20th century, the advent of dairy farming arrived. Old barbed wire and stone walls can be found in the woods throughout Monkton, signifying old grazing properties and property divisions.

Eventually, farming became rarer and rarer in Monkton. Mr. Gill Coates of the Monkton Historical Society, whose great-great-grandfather worked in the Monkton kaolin mines, has a theory about why this change came about. "Beginning in the 1950s, family farming wasn't really what America was about anymore. It was all about industrialization and modern progress. Family farming didn't fit with a modern view of America."

Mr. Coates mentioned the coming of the bulk tank to Vermont dairy farms in the early 1960s. The bulk tank created a situation where larger quantities of milk could be produced by fewer farms, saturating the market and dropping the price of milk. "Selling off farm parcels became the only resource some farmers had in order to keep their farms operating." In 1959, he remembers the first commuter building a house on old farmland along Mountain road where his family's farm was located. It was a road that prior to the commuter's arrival had only seen the mailman travel each weekday. It wasn't long before many more commuters moved into the neighborhood.

In the late 1950's, the Federal Soil Bank Program began paying farmers to retire their land from production in order to preserve land for the future. New regulations were developed mandating that floors under livestock had to

be concrete, rather than wood, which raised the price of farming substantially. **These** are just a sampling of factors that eventually discouraged small farms across the Champlain Valley.

Landscape Change

These large-scale landscape alterations have shaped the landscape of the Pond Brook Watershed that exists today. It's fair to suggest that the flow of Pond Brook was much more robust prior to mining, timber, and sawmill use, as these activities frequently cause extensive erosion. The deposition of those eroded sediments likely altered hydrological function across the watershed. Aggressive timber harvests over many years have resulted in relatively young forests over much of the watershed today, making old growth trees a rarity.

Forest species composition in Monkton has not gone unaltered either, with species like eastern hemlock (favored for tanning processes) nearly extirpated from their historical range. For some time, they were banished to deep ravines and steep slopes, and are only recently beginning to recolonize their preferred, richer territory. White pine, a species expert at growing in old pastures, has rocketed in abundance. These changes can be referred to as altered pathways of succession, a phrase meant to explain all of the different directions the regrowth of a forest may take in response to disturbance.

Soil development was reset as a result of heavy agricultural use in much of the valley and low slopes, and highly disturbed soils lacking developed horizons still dominate much of lowland Monkton. Because wetlands were often drained for farmland, it is likely that before human activity more extensive portions of the valley could have been classified as wetlands. While wild places exist in Monkton, it is helpful to remember that the fingerprint of human activity has helped develop and change the ways this watershed has developed and changed over time. It is difficult to demonstrate landscape change on a small scale over the last 75 years, but broad changes can begin to be explored using aerial photos. Appendix 6. shows a series of aerial photos taken in 1942 of the Pond Brook Watershed and places them next to orthophotos from 2014 detailing the same areas. By examining these photos, large-scale forest trends begin to take shape. In the earlier photographs, large swaths of cleared land and thinned forest dominate the picture, while in later photographs these forests have significantly regenerated.

The Agricultural and Natural Areas Committee of Monkton

The Agricultural and Natural Areas Commission of Monkton [ANAC], which came to fruition in 2007, is a five-member team lead by chair Laura Farrell. ANACs' chief objectives include:

- *Protecting the farmland, woodland, natural, and recreational areas, and other open spaces that help give Monkton its distinctive rural character and quality of life*
- *Assisting landowners interested in conserving property, and evaluating applications for financial assistance with land conservation associated expenses.*

(http://monktonvt.com/boards-and-committees/anac/)

The data collected for this project aim to serve ANAC's goals by helping them direct their resources and add to existing knowledge about the natural landscape of Monkton. 22 individual property reports have been created for this report, along with a landowner contact database, Appendix 4., and a property details summary, Appendix 3.

Recent Research

In 2013, the Lewis Creek Association [LCA] a nonprofit organization, carried out a water quality assessment of Pond Brook, finding that Pond Brook was the source of the highest phosphorus load in the Lewis Creek Watershed, and was "impaired for contact recreation use due to E.coli impacts likely resulting from farm runoff." Pond Brook's headwaters, Bristol Pond, is considered to be eutrophic, or so overwhelmed by nutrients that it supports an excessively dense plant population.

Monkton developed a recommendation plan for newly acquired town land within the Pond Brook Wetland Conservation Area in 2003. The town acquired two additional parcels in 2016 in this same wetland complex. The primary goals of this plan and additional recommendations can be found in the P**ond Brook Wetland Conservation Area Recommendations** section on page 37.

State Ranking System

The State of Vermont has previously documented both rare and state significant natural communities within this watershed including Mesic Red Oak Forests, Northern White Cedar Swamps, and a Black Spruce Woodland Bog. Furthermore, a multitude of rare species have also been documented in the area. Vermont utilizes a state ranked system described in Figure 14. A list detailing all S1-S3 significant communities and species confirmed during the summer of 2016 can be found in Appendix 2.

Vermont State Ranking System for Uncommon and Rare Species		
Ranking	**Status**	**Description**
S1	Very Rare (Critically imperiled)	At very high risk of extinction or extirpation due to extreme rarity (often 5 or fewer populations or occurrences), very steep declines, or other factors
S2	Rare (Imperiled)	At high risk of extinction or extirpation due to very restricted range, very few populations (often 20 or fewer), steep declines, or other factors
S3	Uncommon (Vulnerable)	Moderate risk of extinction/extirpation due to restricted range, relatively few populations or occurrences (often 80 or fewer), recent and widespread declines, or other factors
S4	Common to uncommon (Apparently Secure)	Locally common or widely scattered to uncommon, but not rare; some cause for long-term concern due to declines or other factors, or stable over many decades and not threatened but of restricted distribution or other factors
S5	Common (Secure)	Widespread and abundant

Figure 14. Vermont State Ranking System

Monkton today

In 2014, Monkton had a population of about 2,047 people. It is home to eight working farms, plentiful timber land, and apiaries, all found within the Pond Brook Watershed. Monkton grew by 12.5 % between 2000 and 2010, and 3.5% between 2010 and 2014. (*Vermont Gas Systems)* While the community is growing, it is growing at a slower pace relative to the surrounding communities of Shelburne and Hinesburg. Many residents expressed the desire to avoid that kind of growth in order to maintain the culture and way of life that they appreciate in Monkton.

One recent development in Monkton that has affected both natural resources and residents alike is a natural gas pipeline that was installed as part of the Addison Gas Project. This pipeline will extend natural gas service 41 miles south of its old terminus to Middlebury, VT. The pipeline project is only one example of potential anthropogenic alterations to a changing watershed landscape. While Monkton may not be explosively developing, it is subject to other kinds of alterations and developments now and in the future. Having specific ecological information about the landscape of Monkton may be important if other potential developments arise in the future.

The town plan from 2014 sets a high standard for Natural Resources, including the goals below:

- *To promote land use development, practices and techniques which protect Monkton's natural and scenic resources.*
- *To support public education, knowledge and involvement regarding the town's natural resources, and their maintenance and enjoyment.*
- *To encourage measures that protect, maintain or regain the health of the water, air, land, plants and wildlife and their habitats; these resource systems underpin our economy and quality of life through the ecological services they provide, use as the working lands, and scenic and recreational value.*
- *To foster the growth of Monkton's agricultural and forest economies to support the working landscape.*
- *To support, develop and maintain techniques to encourage natural and scenic resource conservation, including the work of Monkton's Agricultural and Natural Areas Committee, and the use of conservation easements, proper zoning, tax incentives and voluntary measures such as enrollment in the State's Use Value Appraisal Program.*

(*Monkton's Town Plan, 2014)*

In addition to providing information and context to reinforce these goals, the data collected for this project aims to illuminate the natural resources of the Pond Brook Watershed for the people of Monkton. By reinforcing the connection residents have to the landscape, this project hopes to foster a sense of pride, an appreciation for natural environments, and how they are linked to quality of life and working landscapes.

Natural Communities

Wetland Woodland Wildland by Eric Sorenson and Elizabeth Thompson was instrumental in the process of this project. The authors refer to a natural community as "an interacting assemblage of organisms, their physical environment, and the natural processes that affect them." This was used as the working definition to guide this project, and each natural community designation listed in the reports to follow was dependent on soil type, bedrock, the role of water in the landscape, and topography. Natural communities are patterns across the landscape that are often predictable, but they can also deviate significantly. It helps to envision two ways to classify a community:

1. Potential or (expected) species assemblages
2. Current (expected or unexpected) species assemblages

While this project aims to represent current natural communities, atypical communities are noted and briefly analyzed. It's important to note that all of these communities exist in a continuum, with different rates of gradation into surrounding natural communities.

Pond Brook Wetlands

While this project aimed to assess a broad sample of habitats found in and around the Pond Brook Watershed, the town-owned wetland complex in the center of this watershed served as a focal point of this assessment. In addition to this centrally located wetland, there are other substantial wetlands located throughout the watershed, including areas west of the Little Hogback, the western base of the Big Hogback, and state-managed areas surrounding Bristol Pond. Figure 15 shows the Vermont Agency of Natural Resource's recorded Class 2 Wetlands within the study area. While the public generally understands wetlands to be of importance, it is worthwhile to briefly describe some of the key functions of these wetlands as they relate to both natural and anthropogenic processes taking place on the landscape.

Upon initial settlement by Europeans, wetlands in the United States were widely perceived as an undeveloped resource. In Monkton, early settlers heavily harvested forested wetlands and often drained them in order to create prime agricultural land. Drained wetland soils tend to be extremely fertile and high in nutrients. The Swamp Act of 1850 even encouraged people to drain wetlands because of the potential for agricultural use of these areas. Once a wetland ecosystem is drained or its hydrology significantly altered, it can require an intensive restoration process to return it to a wetland state, and in some cases it is impossible to do so. Luckily, many federal acts were put into place in the 20th century that helped protect wetland habitat, including the Federal Agriculture Improvement and Reform Act of 1996, the Rivers and Harbors Appropriation Act of 1899, the National Environmental Policy Act of 1970, and the Clean Water Act of 1972.

Different states have varying criteria for what classifies a wetland. Vermont defines wetlands as, "Areas of the state that are inundated by surface or ground water with a frequency sufficient to support plants and animals that depend on saturated or seasonally saturated soil conditions for growth and reproduction." This definition includes everything from open peat bogs to forested swamps. Wetland environments are defined as having hydric soils, soils with characteristics resulting from saturation periods such as redoximorphic features, or slow rates of decomposition. Wetlands usually—but not always—act as a transition zone from dry land into surface waters. The Pond Brook Wetland complex in Monkton is an example of wetlands that do occupy this transitional zone, providing a riparian buffer to Pond Brook.

Functions of Wetland Habitats

Water Storage
During precipitation events, water penetrates the soil and flows below ground or moves across the surface of the earth towards *surface water*, or water that collects on the surface of the ground in the form of ponds or lakes. In times of high precipitation and snowmelt, more water is more likely to remain on the surface of the ground, which increases the risk of flood events. When high volume runoff flows through wetland areas prior to entering surface water, wetlands will temporarily store that excess water. This water spreads throughout the wetland, and is slowly released over time back into surface water. This helps reduce flood risk, but also maintains a water source in times of scarce water. In this way, wetlands moderate and regulate ground and surface water interface.

Water quality protection
During these very same precipitation events, water washes pollutants into surface waters from across the landscape. These pollutants range from fertilizers and pesticides to grease and oil from roads. When this pollutant-laden runoff reaches a wetland, the flow of water is immediately slowed and spread out, causing fine organic matter and sediments to settle out of the water. Because contaminants often bond directly to pieces of sediment, this settling filters pollutants like heavy metals out of surface waters. Further filtering action occurs when roots of

wetland plants bind sediment flowing through the wetland. Excess nutrients like phosphorus, which encourage excessive plant and algal growth, are also readily taken up by some wetland plant species.

Pond Brook eventually flows into Lewis Creek, which then flows into Lake Champlain. Lake Champlain has an overwhelming excess of phosphorus, which leads to a variety of cyanobacteria and algal growth. While the Lewis Creek Water Quality Project has detected that the Pond Brook Wetlands are modifying phosphorus and nitrogen, they are not removing them completely. Pond Brook ultimately delivers an irregularly high phosphorus load into Lewis Creek, even after being filtered by the Pond Brook Wetlands. This high nutrient load likely results from farmland both adjacent to the wetland and downstream. However, without this wetland complex, the nutrient load in Pond Brook would likely be significantly higher. Bristol Pond, the headwaters of Pond Brook is *eutrophic,* or so overwhelmed by nutrients that excessive plant growth has caused low oxygen levels in the water. While considering the health of Pond Brook, it is important to understand the condition of the brook's source.

Erosion Control
As water flows through a wetland, wetland plants absorb the energy of that water, slowing it down. Sediments and soil passing through bind to dense root systems, strengthening them. These strong root systems help hold soils in place within wetland ecosystems.

Food Production
Wetland environments are places of plentiful primary production, and they provide an abundance of decomposing organic matter. This organic matter forms the foundation of an extensive food web, one of the reasons that so many aquatic and terrestrial species thrive in and on the edges of wetlands.

Wildlife
In Monkton, wetlands support a significant amount of plant and animal biodiversity, hosting an array of obligate wetland species and providing abundant food and shelter for a multitude of wildlife.

The Future of Wetlands
"While the values of wetlands are debatable to humans, the functions are not." (William Lewis Jr.)Humans have many perspectives on wetlands, but there is no debating the extraordinary ecosystem services that wetlands provide. Wetlands are threatened across the United States and in Vermont, with 70% of wetlands in Vermont currently at less than 10 acres in size. The Vermont Wetlands program estimates that 35% of the original wetlands in Vermont have been lost over time. The State of Vermont protects wetlands in order to maintain the functions and ecological value of these habitats, and state laws enforces an activity buffer zone and restricts activities on or within wetlands. But even today, despite of all we know about them, wetlands are still being drained, especially on private properties. This makes the Pond Brook Wetland complex even more important to protect.

Figure 15. Wetland Classes

Pond Brook Wetland Conservation Area Recommendations

The Town of Monkton owns approximately 279 acres on Pond Brook that was designated as the Pond Brook Wetland Conservation Area in a 2003 preliminary management plan. This management plan anticipated further inventory and assessment of these wetlands at a later date. To fulfill this objective, the Pond Brook Conservation Area was a focal point of my inventory work this past summer. After assessing the current condition and species of the area, a review was undertaken of the the original management plan to determine if there are new or pressing management concerns that should be taken into account. The Pond Brook Wetland Conservation Area has had significant time to continue regenerating since the 2003 report was written, which should be taken into account while reviewing both the inventory and these recommendations. Ideally, both the Agricultural and Natural Areas Committee and the Monkton Conservation Committee would work together to address the recommendations in this document, or commission and work closely with an outside source to plan or facilitate these recommendations.

The 2003 Management Plan, created by the Monkton Conservation Commission and the Vermont Land Trust, specified the following goals concerning any conservation action in the Pond Brook Conservation Area:

- *Respect the traditional users of the land and wishes of neighbors while ensuring the long-term health of the land.*
- *Protect wildlife habitats and natural communities.*
- *Protect the integrity of Pond Brook and its associated wetlands.*
- *Provide for non-motorized and non-mechanized nature-based activities.*
- *Demonstrate the value of partnering with conservation organizations to conserve Monkton's natural heritage*
- *Determine what the highest values of the conservation area are to the most people.*

The 2003 Management Plan also suggested the following actions. Many of them may increase in efficacy when amended slightly.

2003: *Collect and legally dispose of trash found on the property.*

2016 recommendation: Trash dumping was most prominent on the northern side of the conservation area off of Bristol Road. One way to dissuade this kind of activity would be to implement signs citing fines or fees should anyone be seen dumping trash into the conservation area. It may be worthwhile to include such a regulation in the town newsletter or newspaper. An organized trash clean-up day was organized in 2004, but all cleaning events should be carefully planned to avoid more fragile places on the landscape, and participants should be briefed on picking or destroying rare vegetation.

2003: *Horse and other domestic animal use of the area is discouraged...with the exception of trained hunting dogs during hunting season.*

2016 recommendation: Due to significant wildlife usage, it may be worthwhile to prohibit domestic animals all together within the conservation area. Horses could create extensive erosion, and many areas within the conservation area are extremely dense with trees and contain prominent exposed roots that could also easily injure a horse, a rider, or other domestic animals. If permitted in the wetland area, domestic dogs are likely to disturb a wide variety of wildlife, including bobcat, mink, and fisher. Ground nesting animals and bird species that utilize root systems or woody debris for nesting are particularly susceptible to domestic dog disturbance. Part of what makes this wetland complex ideal for wildlife passage and foraging is the structural complexity of both living and dead tree species, and if domestic dogs, especially hunting dogs, become a regular occurrence, a decline in wildlife

Pond Brook Wetland Conservation Area Recommendations

usage in regularly trafficked areas can be expected. Similarly, if domestic dogs were permitted to access the Pond Brook Wetland Conservation Area, dog waste may begin to contaminate the water within the wetland.

2003: *Limited signage for guidance and interpretation at this time is not anticipated. The one exception may be the placement of a sign near Mountain Rd indicating the location of a legal right of way.*

2016 recommendation: Signs indicating legal rights-of-way on both sides of the conservation area would make it clear that access is allowed within the Pond Brook Conservation Area. At this point in time, the conservation area is very difficult for residents to access unless they are within walking distance, and even then, they may resort to " bushwacking" if they are unaware of the legal rights of way. Some residents are unaware that they are permitted to access this area. Furthermore, signs explaining the ecological sensitivities of the conservation area would help inform and connect people to this significant natural resource. As it stands now, there is no place to park in order to access the area on either side, even by the rights of way. One pull-off on Bristol Road is labeled as a "No Parking Zone" by the fire department. Even designating part of this small lot as "Conservation Area Parking" may encourage residents and visitors alike to walk a short ways into the area.

2003: *Provide Nesting Boxes and other enhancements for wildlife*

2016 recommendation: Nest boxes are a positive gesture in encouraging wildlife, but there is extensive nesting habitat and abundant dead snags throughout the Pond brook Conservation Area, and the resources needed for such a project may be more useful if directed towards other actions.

2003: *Control Invasive Species*

2016 recommendation: Because invasive species tend to be increasingly abundant on the edges of the wetland near the major roads—Mountain and Bristol Roads—this may be feasible under the observation of an ecologist or botanist. Invasive species located within the wetlands include:

- Common buckthorn
- Japanese barberry
- Japanese Knotweed
- Creeping saxifrage
- Climbing nightshade.

In one case, an uncommon species was found 5 meters away from the road, and supervision would be prudent when removing invasives in order to avoid unnecessary ecological damage.

Additional Recommendations (based on findings from the of Summer 2016)

A lack of accessibility to the Pond Brook Conservation Area is a prominent issue and should become part of the ongoing management conversation. Allowing parking and some kind of access, whether it be on an old logging road (some of which exist within the eastern portion of the complex) or a new walking path created with a goal of minimal ecological damage, might increase appreciation and understanding of this conservation area. Mountain road, which borders the east side of the wetland complex, is a dirt road, and more research should be carried out to determine the influence of sediment runoff from this road on the adjacent habitat.

With the exception of some trash dumping and primitive trails, significant current anthropogenic damage was not

Pond Brook Wetland Conservation Area Recommendations

noted within the wetland during this assessment, such as illegal tree harvesting or ATV trails.

While it is true that the ecological benefits of wetlands will remain if people do not access the area, this conservation area encompasses a large part of the town of Monkton, and should ideally be appreciated by more of the community. At this point enjoying the wetland area is an experience limited to those who live adjacent to it. Myriad bird species, reptile and amphibian species, rare and uncommon plants, and a particularly aesthetically pleasing natural community make this conservation area an unseen gem for recreation and education. It is also true that drier swaths of land exist on both sides of Pond Brook, and these areas may end up being ideal for a walking path or blazed trail access. Along with this recommendation comes the assumption that continual monitoring or adaptive monitoring would take place to track the effects of such traffic on the environment.

It may also be an option to encourage guided tours by naturalists or botanists who can explain what people are seeing and also enforce best recreational practices while within the conservation area. There are risks accessing such an area alone; it is easy to get turned around and lose your sense of direction, daylight disappears much faster under a dense coniferous canopy, exposed roots and deep hollows provide extensive tripping and ankle hazards, and sinking into deep muck is a common occurrence.

Access aside, these wetlands are classified as **Highest Priority Surface Water and Riparian Areas** by the Vermont Agency of Natural Resources. (Figure 16.) This defines the wetland area to be, "of critical importance for water quality, flood attenuation, erosion prevention and wildlife movement. This is based on the very high value of this component in its contribution to biological diversity." (Biofinder, ANR) In response to this designation, continued care should be given to avoid damage to the species within the wetlands.

Ice-melting chemicals and salt regulations should be developed on the roads adjacent to the swamp. Northern white cedar is particularly susceptible to these chemicals, which can kill trees and contaminate the waters of the Conservation Area. Areas of northern white cedar dieback do occur throughout the wetland, but in some areas this is a function of hydrology rather than contamination.

Act 64, or the Total Maximum Daily Load Act enacted by the State of Vermont, seeks to mitigate the amount of phosphorus reaching Lake Champlain by way of impaired tributaries like Pond Brook. More research will need to be done on how Act 64 and a TMDL will directly or indirectly affect the Pond Brook Conservation Area. A Lewis Creek Association water quality study in 2013 determined that the Pond Brook Wetlands are actively mitigating phosphorus levels in Pond Brook. However, Pond Brook remains a significant contributor of phosphorus as it flows into Lewis Creek. Should drastic action be taken to reduce the phosphorus load in Pond Brook, it will likely affect landowners with property adjacent to Pond Brook before it impacts the ecological function of the conservation area itself.

Figure 16. Highest Priority Surface Water and Riparian Areas

Synthesis

The Monkton landscape tells a story of resilience. Nearly all of the land assessed for this project was intensively farmed or harvested for timber regularly over the last 200 years. Large tracts of wetland were drained repeatedly, forests underlain by clay soils were cut down, and streams were overwhelmed by eroded sediment. And yet, a look around Monkton today does not reveal a legacy of environmental degradation. Despite the long legacy of human use, there is a diverse patchwork of flora and fauna in Monkton.

32 natural communities were uncovered within the 50 square miles of the study area. Dry, high elevation communities growing on bedrock exposures provide a stark contrast to the wetlands that line the valley floor. Small alluvial floodplains grade into ravines thick with eastern hemlock and northern white cedar. Beaver ponds support a myriad of wildlife and birds nest in rocky outcrops above talus slopes. Over 60 bird species were confirmed within the study area, likely a small fraction of the full range of birds that use this area. Wildlife sign from 18 species-- everything from otters to bobcat-- is abundant. Areas that once saw heavy human traffic, including old marble quarries and crumbling foundations of mills, now host northern white cedar stands and northern watersnake populations.

However, these natural communities do not exist in isolation. The runoff from steep slopes on the Big Hogback influence the forested wetlands that line the base of the mountains, and oak forests bordering Northern Hardwood Forests are slowly being infiltrated by a robust American beech understory. Just as each habitat is subject to the influence of bordering habitats, Monkton is not unaffected by the surrounding landscape. The study area for this project is just one small piece of the Lake Champlain basin, and the health of Lake Champlain continues to be a priority of many agencies in Vermont. The detailed assessment methods used in Monkton may prove useful in the future when examining other tributaries and creeks within the Lake Champlain watershed.

While still ecologically valuable, the majority of these natural communities are not in optimal ecological condition. However, given time, and thoughtful management, I believe this could change. Young American beech forests, for example, will need years before they are mature enough to provide an abundant food source for large black bear populations. Rather than large-scale management action, small steps could guide many of these habitats in the right direction. Invasive species should be identified and controlled, areas of erosion should be stabilized, wildlife corridor should be maintained, and wetlands should be taken into account when determining the range of grazing livestock. Water quality projects, like those carried out by the Lewis Creek Association, can continue to provide valuable information about Monkton's surface waters.

Private ownership presents a unique array of challenges for conservation, but working with landowners in Monkton revealed a common objective of many residents: to use the land and enjoy the land, often in equal measure. Landowners may want to clear forest to sell timber, or hunt wildlife on their property, but they are rarely aiming to severely alter the landscape. Supporting these common objectives to maintain a working landscape and enjoy the natural resources of Monkton may be the easiest way to continue protecting land within this watershed. Land development is a threat that many Monkton residents expressed the desire to avoid, and may serve as an additional unifying principle when addressing conservation concerns in the future.

Both agricultural and conservation agencies within Monkton can continue to support landowners by offering more information about sustainable land practices. Whether this means encouraging more people to enroll in current-value tax programs or sharing the financial possibilities of easements, I believe it is possible to acknowledge the decades of experience Monkton landowners have on this landscape while providing new ideas and support. Likewise, sharing information about the species found in Monkton will strengthen the connection people

Synthesis

have to the Monkton landscape and to enhance the way residents enjoy and perceive the landscape. Landowners responded with overwhelming positivity when I shared the field findings of their property.

If natural and agricultural land in Monkton is thoughtfully managed, and town conservation organizations strive to develop relationships with and among residents, Monkton could eventually become a successful model of a small-town conservation that exhibits the traditional cultural values of rural Vermont with a backdrop of biodiversity. If town organizations start small, continue discovering the landscape, and plan for the future, both the social and environmental resources of Monkton will grow.

Appendix 1: Bird Species of The Pond Brook Watershed

Bird species listed below were either visually or auitorily confirmed within the study area.

Common Name	Latin Name
Peregrine falcon	*Falco peregrinus*
American kestrel	*Falco tinnunculus*
Yellow warbler	*Setophaga petechia*
Common yellowthroat	*Geothlypis trichas*
Virginia rail	*Rallus limicola*
Northern water thrush	*Parkesia noveboracensis*
Hermit thrush	*Catharus guttatus*
Wood thrush	*Hylocichla mustelina*
Red-eyed vireo	*Vireo olivaceus*
Sandhill crane	*Grus canadensis*
Green heron	*Butorides virescens*
Great blue heron	*Ardea herodias*
Magnolia warbler	*Setophaga magnolia*
Broad-winged hawk	*Buteo platypterus*
Sharp-shinned hawk	*Accipiter striatus*
Loggerhead shrike	*Lanius ludovicianus*
Baltimore oriole	*Icterus galbula*
American goldfinch	*Spinus tristis*
Winter wren	*Troglodytes hiemalis*
Carolina wren	*Thryothorus ludovicianus*
Gray catbird	*Dumetella carolinensis*
Northern mockingbird	*Mimus polyglottos*
American bittern	*Botaurus lentiginosus*
Field sparrow	*Spizella pusilla*
Swamp sparrow	*Melospiza georgiana*
Vesper sparrow	*Pooecetes gramineus*
Song sparrow	*Melospiza melodia*
Downy woodpecker	*Picoides pubescens*
Pileated woodpecker	*Hylatomus pileatus*
Black-capped chickadee	*Poecile atricapillus*
Chipping sparrow	*Spizella passerina*
Ruffed grouse	*Bonasa umbellus*
Barred owl	*Strix varia*
Yellow-rumped warbler	*Setophaga coronata*
Common raven	*Corvus corax*

Common Name	Latin Name
American crow	*Corvus brachyrhynchos*
Wood duck	*Aix sponsa*
Brown creeper	*Certhia americana*
Red-breasted nuthatch	*Sitta canadensis*
Blue jay	*Cyanocitta cristata*
Turkey vulture	*Cathartes aura*
Wild turkey	*Meleagris gallopavo*
Red-tailed hawk	*Buteo jamaicensis*
Indigo bunting	*Passerina cyanea*
Eastern bluebird	*Sialia sialis*
Ruby-throated hummingbird	*Archilochus colubris*
Eastern kingbird	*Tyrannus tyrannus*
Eastern wood-peewee	*Contopus virens*
Eastern phoebe	*Sayornis phoebe*
Veery	*Catharus fuscescens*
Northern flicker	*Colaptes auratus*
European starling	*Sturnus vulgaris*
Common grackle	*Quiscalus quiscula*
Killdeer	*Charadrius vociferus*
Belted kingfisher	*Megaceryle alcyon*
Cedar waxwing	*Bombycilla cedrorum*
Bohemian waxwing	*Bombycilla garrulus*
Barn swallow	*Hirundo rustica*
Tree swallow	*Tachycineta bicolor*
White-breasted nuthatch	*Sitta carolinensis*
Red-winged blackbird	*Agelaius phoeniceus*
Bobolink	*Dolichonyx oryzivorus*

Appendix 2: Rare and Uncommon Species of the Pond Brook Watershed

Rare and Uncommon species listed below were not recorded unless directly observed. Rankings are taken from Vermont's State Ranking system, Figure 14 on page 31.

Rare and Uncommon Species and Communities		
Species Common Name	**Scientific Name**	**Rank**
Herbaceous Species		
Showy lady's slipper	*Cyprepedium reginale*	S3
White adder's mouth	*Malaxis monophyllos var. brachypoda*	S2/S3
Mountain fly honeysuckle	*Lonicera villosa*	S3
Dwarf mistletoe	*Arceuthobium pusillum*	S2
American ginseng	*Panax quinquefoilus*	S3
Harsh sunflower	*Helianthus strumosus*	S2/S3
Arrowleaf	*Peltandra virginica*	S2/S3
Animals		
Northern watersnake	*Nerodia sipedon*	S3
Eastern ribbon snake	*Thamnophis sauritus*	S2
Sandhill crane	*Grus canadensis*	S1
Great blue heron	*Ardea herodias*	S3/S4
Red-bellied woodpecker	*Melanerpes carolinus*	S3
Peregrine falcon	*Falco peregrinus*	S3
Common raven	*Corvus corax*	S3
Bohemian waxwing	*Bombycilla garrulus*	S3

Appendix 2: Rare and Uncommon Species of the Pond Brook Watershed

Natural Communities		
Northern White Cedar Swamp		S3
Red Maple Northern White Cedar Swamp		S3
Dry Oak Forest		S3
Dry Oak Woodland		S2
Northern Hardwood Talus Woodland		S3
Dry-Hophornbeam-Hickory-Oak Forest		S3
Mesic Maple-Ash-Hickory Oak Forest		S3
Vernal Pool		S3
Hemlock Swamp		S2
Wet Clayplain Forest		S2
Black Spruce Woodland Bog		S2
River Mud Shore		S3
Rivershore Grassland		S3
Sweet Gale Shoreline Swamp		S3

Appendix 3: Historical Photos

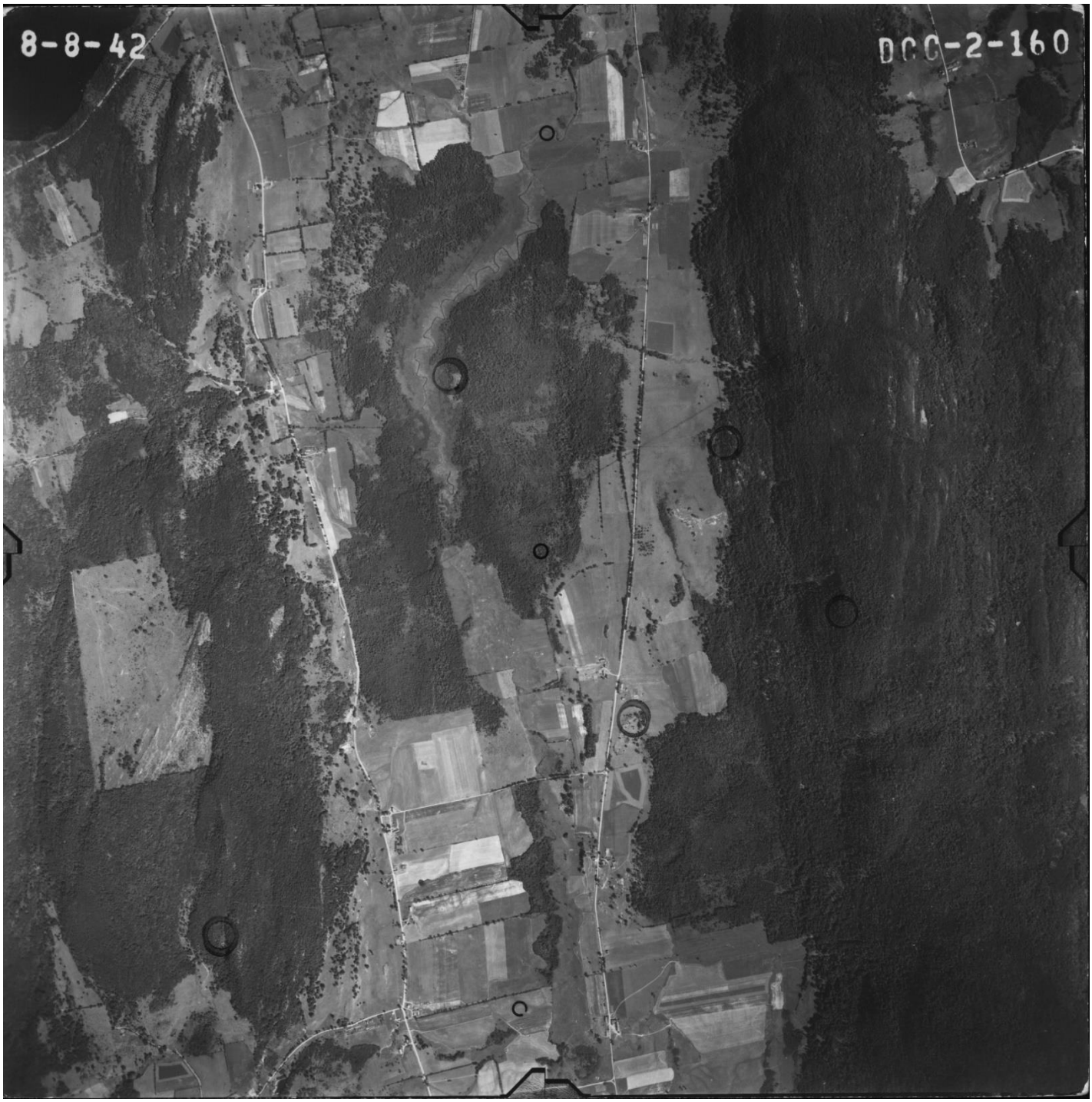
These historical photos, courtesy of the Monkton Historical Society, show Monkton residents working at the Kaolin works around the turn of the 19th century.

Drying Kaolin at the Kaolin Works in Monkton, Vermont. (Monkton Historical Society)

Horse carts carrying Kaolin through Monkton, Vermont (Monkton Historical Society)

Appendix 4: Photo Comparisons

The following pages show aerial photographs of the Pond Brook Watershed Study Area taken in the summer of 2014 compared to aerial photos taken August of 1942. The latter photos reveal a notable increase of forest and a decrease of open agricultural lands.

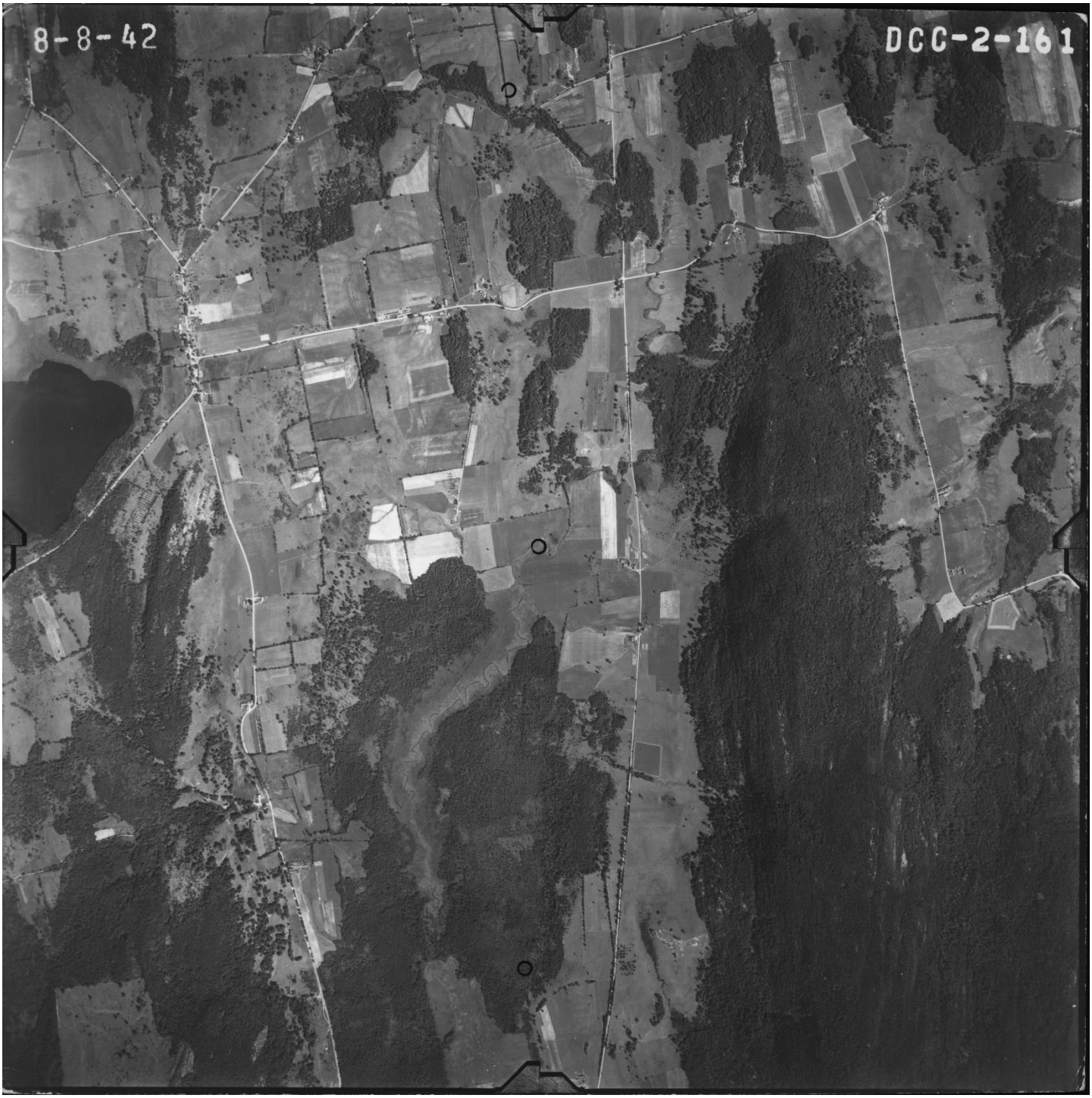


Pond Brook Wetlands and Hogback Ranges, 1942
Approximately 60% covered by forest

Appendix 4: Photo Comparisons

Pond Brook Wetlands and Hogback Ranges, 2014
Approximately 80% covered by forest

Appendix 4: Photo Comparisons

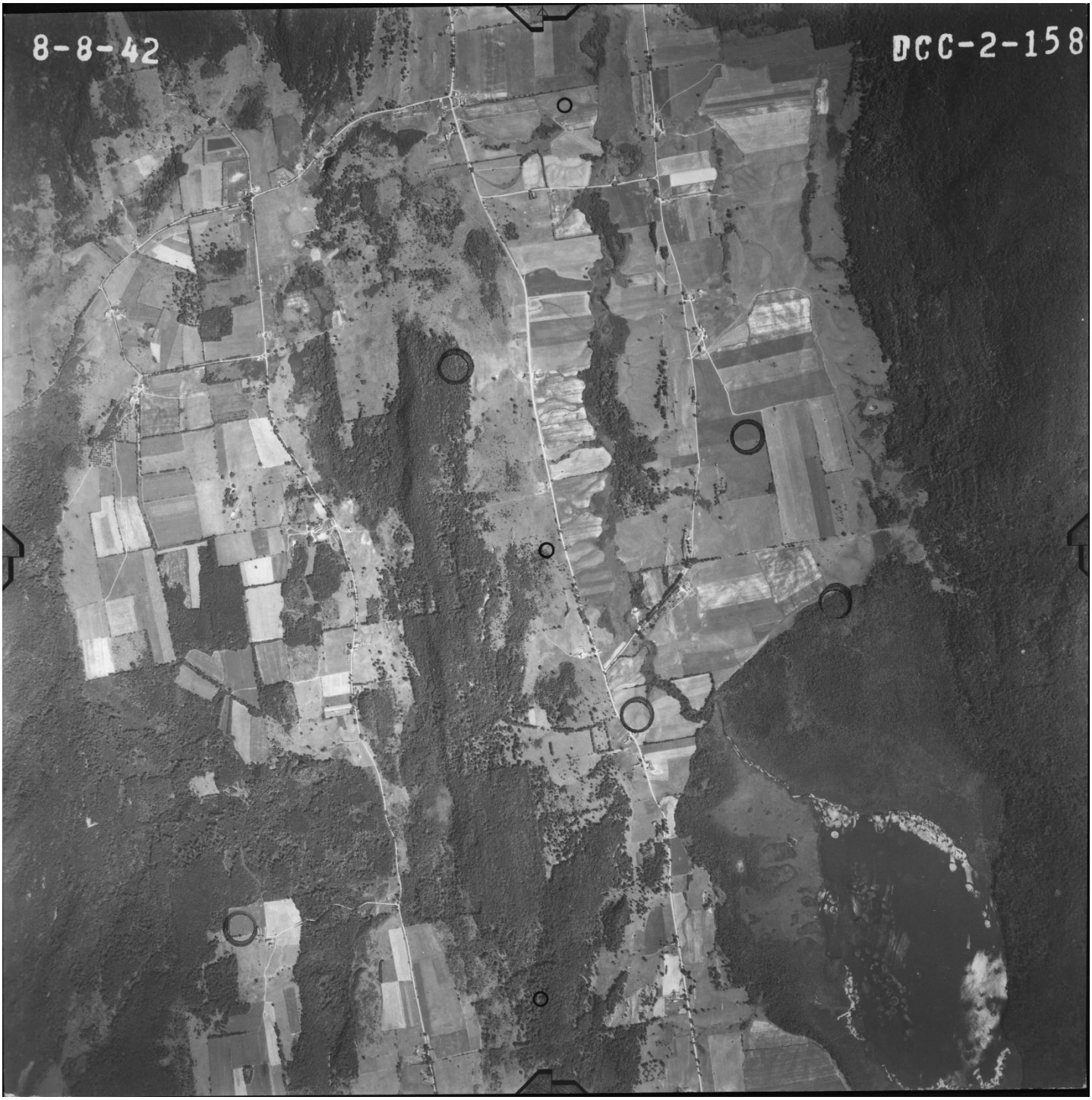


North of Pond Brook Wetlands, 1942
Approximately 30% covered by forest

Appendix 4: Photo Comparisons

North of Pond Brook Wetlands, 2014 50%
Approximately 50% covered by forest

Appendix 4: Photo Comparisons



Bristol Pond and west of Bristol Pond, 1942
Approximately 40% covered by forest

Appendix 4: Photo Comparisons

Bristol Pond and west of Bristol Pond, 2014
Approximately 70% covered by forest

Appendix 4: Photo Comparisons

South of the Pond Brook Wetlands,. 1942
Approximately 30% covered by forest

Appendix 4: Photo Comparisons

South of the Pond Brook Wetlands, 2014
Approximately 60% covered by forest

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